(10)

# CRREL TECHNICAL PUBLICATIONS

## December 1975




US Army Corps of Engineers
Cold Regions Research & Engineering Laboratory

# CRREL
# TECHNICAL PUBLICATIONS

**December 1975**

# THE COLD REGIONS RESEARCH AND ENGINEERING LABORATORY

## CRREL

In nearly half the land of the Northern Hemisphere, the cold of winter freezes the earth and covers it with ice and snow. Low temperatures continue throughout the year in much of the Arctic and Antarctic, perpetually challenging the men and women who live and work there.

To adapt to the environmental conditions of these cold regions, we must fully understand their special characteristics. We must determine how the cold affects our activities and how our civilization in turn affects the cold regions. We must also learn how to adjust to the extreme changes that take place between summer and winter seasons.

Gaining this knowledge through scientific and engineering research, and making the results available to governmental, military and other public organizations, is the job of CRREL—the Cold Regions Research and Engineering Laboratory of the U.S. Army Corps of Engineers.

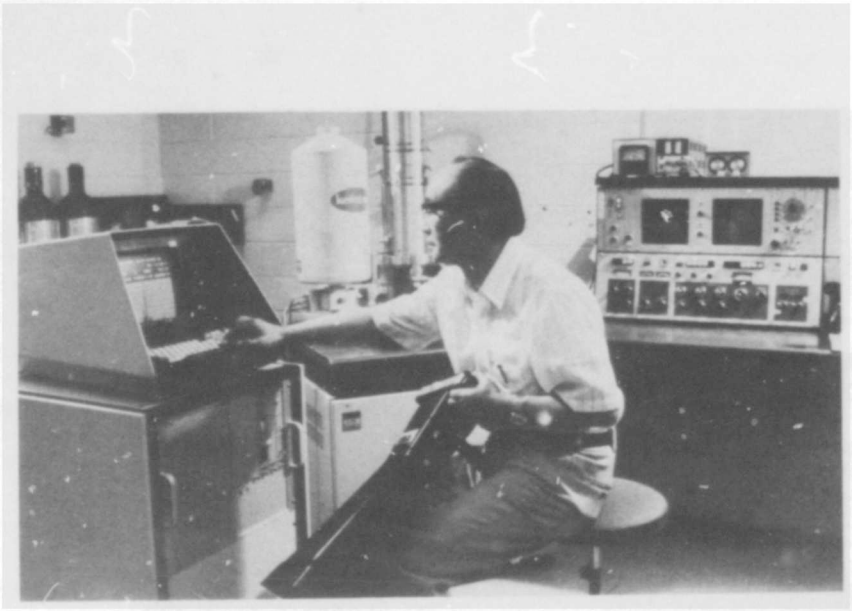
## THE MISSION

CRREL is a federal laboratory with a special mission—to understand the characteristics of the cold regions of the world and to apply this knowledge to make it easier for people to live and work there.

CRREL was created in 1961 by combining two existing Corps of Engineers organizations: the Arctic Construction and Frost Effects Laboratory and the Snow, Ice and Permafrost Research Establishment. Between them the two labs brought together at CRREL a group of research personnel with expertise in virtually all aspects of cold regions science and technology.

As a Corps of Engineers lab, CRREL has the advantage of the Corps' long-held tradition of service to the nation. CRREL research facilities and expertise are available to any federal, state or local agency that has need for them, and work has occasionally been done for private organizations as well. This approach helps to account for the diversity of research activities at CRREL and the overall character of the laboratory. Each research or study project, whether funded by the Corps of Engineers or other agencies, has a well-defined scope and objective chosen by its sponsor.

*Sonar profiling of pressure ridge keel in Beaufort Sea*



*Scanning electron microscope*

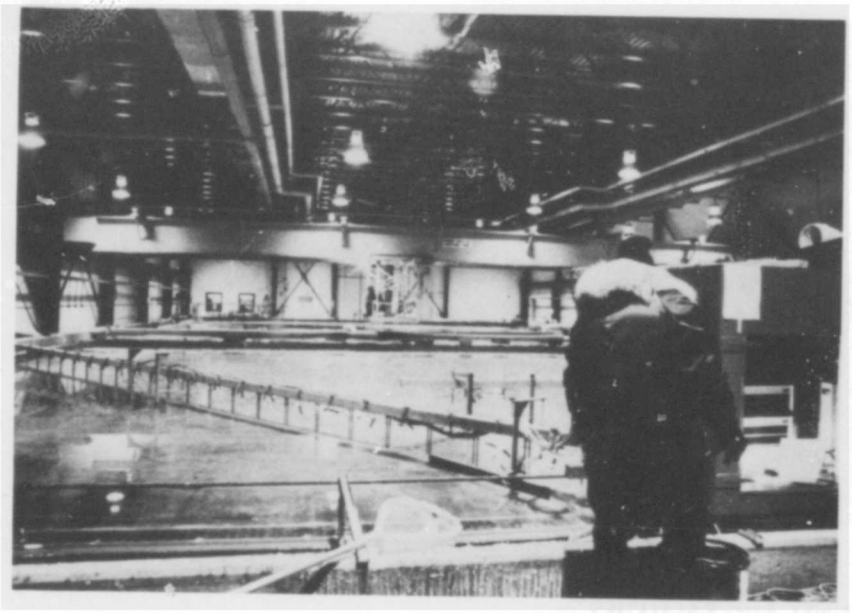
## CRREL PERSONNEL AND FACILITIES

Cold regions science and technology is a specialty that cuts across traditional disciplinary lines. As a result, the CRREL staff is quite diverse, with specialists from many different backgrounds. The total staff numbers about 300, including more than 100 research scientists and engineers. These researchers include civil, hydraulic, electrical, chemical and mechanical engineers, and agronomists, biologists, chemists, geographers, geologists, geophysicists, glaciologists, meteorologists, physicists and soil scientists. In addition, scientists and engineers from other institutions often pursue long-term research projects at the laboratory.

The support staff at CRREL also comprises a variety of professionals. Administrators, support engineers, technicians, computer specialists, photographers, illustrators, editors, typesetters, secretaries and dozens of others help to keep the laboratory running smoothly. These personnel often bring their expertise outside CRREL when needed for the research projects of other organizations.

The physical facilities that support the CRREL research effort really merit the description "unique." The main laboratory building contains 24 coldroom laboratories, many capable of achieving temperatures of -30°C or below. Along with

*Instrumentation in vehicle for measuring mobility through snow*



*Model of ice control structure in Ice Engineering Facility*

the cold laboratories are chemistry, physics, soils and electronics labs with highly specialized equipment for research at below-freezing temperatures.

In 1978 an Ice Engineering Facility was completed that is devoted to the study of problems caused by ice in waterways. This lab, acclaimed as the finest in the world, permits research that will lessen the effects of winter on the nation's waterways. In the Ice Engineering Facility is a refrigerated modeling area in which scaled-down rivers, harbors and lakes can be studied, a tilting refrigerated flume for river ice research, and a large test basin in which ice force problems can be studied at nearly full-scale dimensions.

A Frost Effects Research Facility, to be completed in 1983, will be devoted to the study of frost action in soils. This laboratory will contain refrigerated research areas for below-freezing testing of pavements, foundations and underground utilities, and will permit the study of destructive freeze-thaw cycles in a controlled setting.

CRREL also has an Alaskan Projects Office at Fairbanks with a research and supporting staff to aid in conducting CRREL's many projects in Alaska. In Fox, Alaska, CRREL excavated and helps to maintain a research tunnel in permafrost, the only facility of its type in the Western World.

## CRREL RESEARCH

### Snow and ice

Basic to the understanding of the cold regions is the study of snow and ice. Because they change with the characteristics of their environment, snow and ice are far more complex than most people realize.

CRREL scientists and engineers have extensively studied both freshwater ice and sea ice. They have extracted drill cores from ice caps, icebergs and sea ice

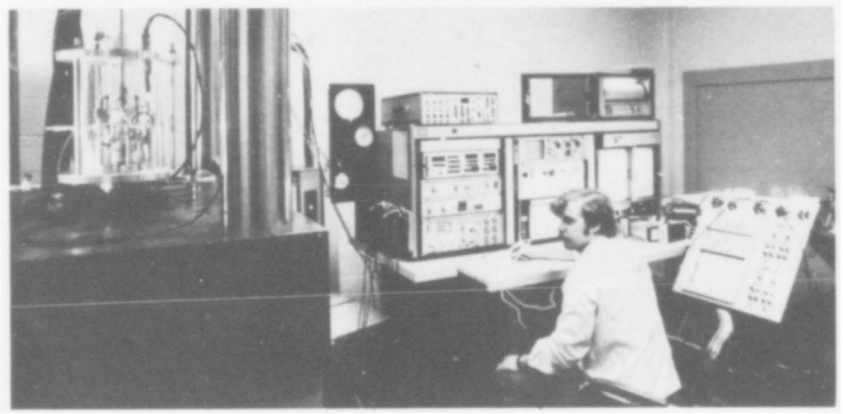
*Drilling through ice in Antarctica*

*Examining an ice core*

floes to scrutinize them with a number of analytical methods. Crystalline structure, which can greatly affect strength characteristics, has been investigated microscopically and with specialized radar devices. The minute quantities of certain elements in ice cores have been determined to the precision of 1 part per billion, and electron micrographs have revealed trace particles in snow crystals under thousands of powers of magnification.

The accumulation of ice on helicopter blades, ship superstructures, and communications antennas is a problem that has received considerable attention. CRREL researchers have explored the basic mechanisms that cause the ice accumulation and have developed methods for its prevention.

Ice can be a source of support for buildings, vehicles and machinery placed over water bodies or on glacial ice. But ice can also be a source of destruction when sheets of sea ice crush against navigation structures or river ice smashes against bridges. To make use of its positive aspects and to guard against its destructive effects, the engineering properties of ice must be thoroughly known. Strength testing of ice samples and the measurement of ice forces on instrumented structures has revealed much information about the basic properties of different types of ice.



*Strength testing machine*

Snow also takes many different forms, depending on temperature, age, and snowpack pressure. In glaciers, snow is transformed by the pressure of the accumulating snowpack first into a consolidated substance called firn and then eventually into ice. The massive ice sheets—such as those in Greenland and Antarctica—were formed in this way, and examination of the drill cores has revealed thousands of years of climatic history.

Research on mountain glaciers has helped to explain the forces that were working thousands of years ago when much of the Northern Hemisphere was covered with ice. The accumulation and breakup of the massive Antarctic glaciers have been carefully studied, as any fluctuation could drastically affect the global climate and the level of the world's oceans. Even the effects of the eruptions of Mt. St. Helens on its glaciers have been observed by CRREL scientists.

Melting of snow and the subsequent runoff are important to flood control and hydroelectric power production. Predictive models developed for estimating snowmelt and runoff have compared favorably with results from test sites. Eventually this work may result in accurate methods of predicting the amount and rate of spring runoff into watersheds throughout the country.

**Frozen ground**

Along with snow and ice, the other major natural material in cold regions is frozen ground. This material is even more complex, as it can take a multitude of forms. In the Far North, permanently frozen ground or *permafrost* is of particular concern because ice-rich permafrost will melt and settle if seriously disturbed. In virtually all areas with subfreezing temperatures, frost heaving can be a very destructive force to roads, airfields, pipelines, and all types of foundations.

An extensive effort has been made to understand the basic mechanisms of frost heaving so that this phenomenon can be reliably predicted. Although heaving can be prevented by placement of soils that permit sufficient drainage, these soils are becoming increasingly scarce and expensive in many areas. Special techniques, such as surrounding problem soils with water-resistant membranes and precisely classifying soils with marginal frost susceptibility, promise to reduce both construction costs and potential for frost damage.

*Installing a temperature-monitoring system in ground along trans-Alaska pipeline haul road*

As with snow and ice, the mechanical properties of permafrost and seasonally frozen ground must be well understood before construction on these materials can take place. A number of laboratory and field tests have been devised to determine the moisture content and the frost-susceptibility of soils. In permafrost regions, an extensive program has sought to determine the ground ice content at substantial depths by electromagnetic methods and core drilling. CRREL researchers have helped to discover the characteristics of the permafrost beneath the Beaufort Sea near the oil fields at Prudhoe Bay, Alaska.

**Cold regions construction**

Among CRREL's first accomplishments was the design of airfields and living facilities in Greenland and Antarctica. This emphasis on cold regions construction has actively continued since that time. Major accomplishments have been the moving of a 3300-ton DEW Line station in Greenland onto a new and more stable foundation, and assistance in preparing design and installation procedures for the thousands of piles that support the aboveground portions of the trans-Alaska pipeline.

The design of roads and airfields has received particular emphasis. Experimental roads in New Hampshire and Alaska have tested new building techniques for cold regions. A study of the "haul road," built to bring materials to construction sites along the trans-Alaska pipeline, has shown the 360-mile-long road's response to the harsh northern climate and its effects upon the surrounding environment. In remote areas of Alaska, construction of airfields that are insulated from the permafrost has prevented disturbance of the ground ice and deterioration of the tundra.

*Measuring movement of trans-Alaska pipeline*

*Air-transportable shelter*

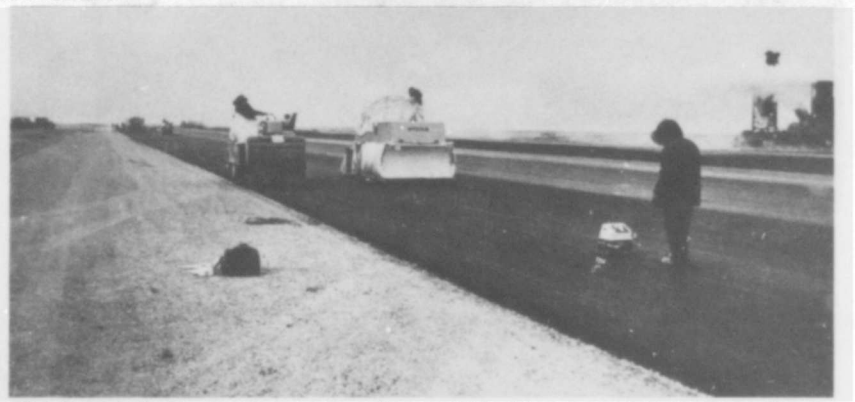
CRREL engineers have designed an air-transportable shelter for use in severe cold regions, and have conducted a long-term program on the correct design of roofs in heavy snowfall areas. From an extensive statistical analysis, a method of estimating roof snow loads for any area in the United States has been developed. In one application of their expertise, CRREL engineers determined the roof load at the time of the collapse of the huge roof of the Hartford, Connecticut, Civic Center.

Other CRREL construction-related research has investigated the use of special asphaltic paving mixtures and concretes that can be placed at low temperatures. Blasting techniques for use in permafrost and on ice have been developed. And CRREL engineers have worked with several agencies in remedying the detrimental effects of cold weather on existing facilities. In particular, a new program is helping to find ways of reducing the "potholes" in northern roads.

**Land transportation**

In areas where no roads exist or where they are clogged with snow, land transportation with conventional vehicles can be extremely difficult or virtually impossible. This problem has been addressed in two ways. First, methods are being developed for predicting the performance of wheeled and tracked vehicles in snow so that their design can be improved.

A second approach was a study of the use of surface-effect vehicles ("hovercraft") in arctic regions. These vehicles, modified for arctic use, were found to work well over snow-covered tundra, and they had little effect on the underlying permafrost.



*Laying asphalt concrete at Deadhorse Airfield, near Prudhoe Bay, Alaska*

*Sampling wastewater applied to a land treatment system*

**Environmental protection**

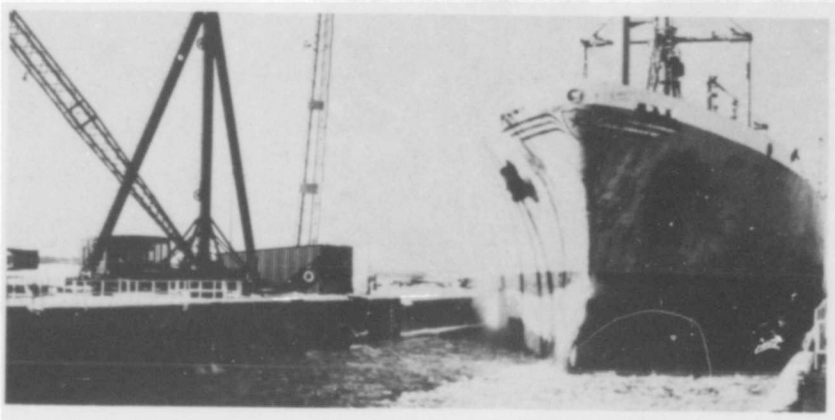
Due to the instability of ice-rich permafrost and the short growing season in northern regions, environmental protection is crucial. Several CRREL researchers have taken part in studies of the climate and biology of northern Alaska that are providing the first detailed documentation of this environment.

The impact of civilization has also been closely monitored. A long-term study has shown the effects of artificial oil spills on vegetation in a controlled environment, and the clean-up methods for spills along the trans-Alaska pipeline have been carefully observed to determine their effectiveness.

Restoration of areas damaged by construction activities has been documented and strategies developed to speed recovery. CRREL scientists have monitored erosion control and restoration activities along the entire trans-Alaska pipeline and on test slopes in New Hampshire and Alaska. Procedures for mapping wetlands through aerial photography and satellite imagery are being developed as part of a nationwide Corps of Engineers land use inventory. Similar remote sensing methods have assessed shore erosion in the Great Lakes and at Cape Cod and determined the potential environmental impact of construction projects in Alaska and northern Maine.

A multimillion dollar research program on improving methods for the land treatment of wastewater is now drawing toward completion. Land treatment renovates municipal wastewater in a scientifically controlled manner to maximize the removal of waste substances and to minimize environmental effects and energy costs. The land treatment research program has placed this new technology on a firmer engineering basis so that millions of dollars will be saved in the construction and operation of new systems.

*Blasting an ice jam*



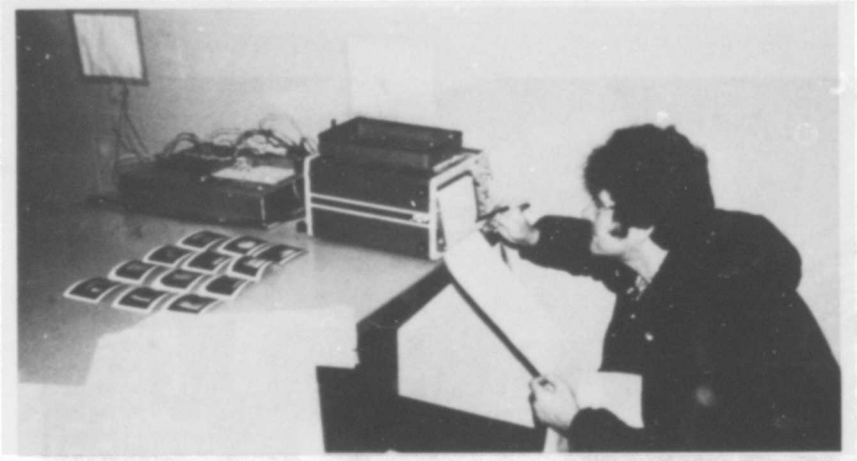
*High flow bubbler system (foreground) to keep ice from entering lock*

**Ice engineering**

CRREL's Ice Engineering Facility has already been used in a variety of ways to improve winter navigation in cold regions. Studies of model icebreakers, conducted in the large refrigerated test basin, have resulted in devices that keep ice from damaging the ships' propellers. Studies of the interaction of moving ice sheets with test structures have helped to explain the destruction of offshore navigation facilities and to formulate new designs.

Refrigerated flume studies have resulted in methods for minimizing ice accumulation at dams and water intakes. Large-scale modeling of ice control structures in the Ice Engineering Facility's research area has demonstrated how existing structures can be modified and new ones designed to help protect shipping in ice-clogged northern rivers. As ice jams cause serious flooding each year in northern communities, the mechanics of ice jamming have received considerable attention so that this phenomenon can be prevented or controlled.

Various methods of keeping navigation locks free of ice have been devised to help extend the navigation season of the upper Ohio River system and St. Lawrence Seaway. The development of underwater air bubblers to keep navigation channels open has been applied extensively in northern harbors and navigation facilities.



*Checking heat flow data*

**Energy conservation**

Due to the large heating requirements of buildings in cold regions, several projects have focused on conserving energy while maintaining comfortable living conditions. Infrared sensing devices have been used extensively to detect heat losses and wet insulation. From these infrared surveys, recommendations can be made as to how to most cost-effectively improve the thermal performance of a building's walls and roof.

Heat pumps for reclaiming waste heat from industrial cooling water have been studied and used to heat two buildings at CRREL. A method of analyzing the thermal losses from heat distribution systems has helped to maximize the efficiency of centralized heating systems, and a project in Alaska has assessed the use of waste heat for improving agricultural production in the Far North.

**Military operations**

To aid the Army in preparing for military action in cold regions is one of CRREL's continuing concerns. Field tests have shown that snow fortifications can be used for stopping small arms fire, and an extensive program has contributed to the design of a new baseplate for a lightweight mortar.

Currently, CRREL is coordinating extensive tests on the effects of winter weather on the electro-optical guidance systems used in modern weapons. The test program will lead to an understanding of the performance of these systems during heavy snowfall and other adverse weather conditions. Another program is examining the effects of the cold regions environment on land mines.

*Mine sensitivity test*

*CRREL library*

## TECHNICAL INFORMATION

Since scientific and technological research depends on the effective transfer of information, CRREL has a very active publication program. CRREL publishes approximately 100 technical reports, engineering technical letters and draft translations each year, along with a general-interest newsletter. In addition, CRREL maintains a current international bibliography of available cold regions publications entitled the *Bibliography on Cold Regions Science and Technology*. Approximately 100,000 publications have been accessioned to date. New CRREL publications are listed in the laboratory's information bulletin and in a cumulative annual supplement. The results of many CRREL investigations are also published in professional journals.

The CRREL library maintains an extensive collection of material on cold regions science and technology. The library is open to the public and welcomes requests from other organizations for information about cold regions technical literature.

All CRREL publications can be obtained from the National Technical Information Service, Springfield, Virginia, 22151. Many are available directly from the CRREL Publications Office. For general information about the laboratory, contact CRREL's Public Affairs Office at the following address:

USACRREL
72 Lyme Road
Hanover, New Hampshire 03755
Telephone: 603-643-3200
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CRREL welcomes requests from other organizations for assistance with cold regions problems. These requests will be forwarded to the engineer or scientist who specializes in the specific problem area.

## DESCRIPTION OF CRREL TECHNICAL PUBLICATIONS

*Bibliography on Cold Regions Science and Technology*

The *Bibliography on Cold Regions Science and Technology*, CRREL Report 12, was first published in 1951 and is a continuing publication of the Cold Regions Bibliography Section of the Library of Congress. It is sponsored by and prepared for CRREL. Volumes 1-15 were issued as the *Bibliography on Snow, Ice and Permafrost*, SIPRE Report 12. Beginning with volume 16 the title was changed to *Bibliography on Snow, Ice and Frozen Ground, with Abstracts*, and with volume 23 the current title was adopted.

Nearly all of the literature cited in the *Bibliography on Cold Regions Science and Technology* has been placed on microfiche and is available for the cost of reproduction. Those interested in purchasing a photocopy of documents cited should address their request to: The Library of Congress, Photo Duplication Service, Dept. C-177, 10 First Street S.E., Washington, D.C. 20540. A complete bibliographic citation should be given. Online search of the *Bibliography on Cold Regions Science and Technology* (File Cold) is offered by the Systems Development Corporation, Santa Monica, Calif. 90406.

*Current Literature—Cold Regions Science and Technology*

*Current Literature* is also prepared for CRREL by the Cold Regions Bibliography Section of the Library of Congress. All CRREL reports and outside publications are announced as published. Cumulative author and subject indexes are prepared quarterly; however, these are available only in the CRREL library. The 12 monthly listings are proofed, cumulated and published along with indexes in December of each year as CRREL Report 12, *Bibliography on Cold Regions Science and Technology*. Photocopies of documents cited can be purchased for the cost of reproduction from the same source as for the *Bibliography* (above).

*CRREL Reports*

The results of all major research efforts at CRREL are published in the *CRREL Report* series. This series replaced the *Technical Report* and *Research Report* series (described below) in 1976.

*Technical Reports*

The *Technical Report* series contains the results of technical investigations in applied research and experimental engineering published by CRREL and the Snow, Ice and Permafrost Research Establishment (SIPRE) between 1950 and 1975.

*Research Reports*

The *Research Report* series contains the results of theoretical or basic research in science and engineering published by CRREL and SIPRE between 1950 and 1975.

*Special Reports*

The *Special Report* series contains a wide variety of types of reports that do not fall within the *CRREL Report* category, e.g. literature reviews, data compilations, interim reports.

*Monographs*

The *Cold Regions Science and Engineering Monograph* series comprises comprehensive reviews of a field of scientific or technical knowledge with analysis and evaluation.

*ACFEL Technical Reports*

Technical reports published by the Arctic Construction and Frost Effects Laboratory, which was combined with SIPRE in 1960 to form CRREL.

*ACFEL Miscellaneous Papers*

Miscellaneous papers published by the Arctic Construction and Frost Effects Laboratory. These are reports of average or minor investigations of limited scope and/or interest; interoffice and intraoffice memoranda of sufficient importance to warrant recording; or memoranda concerning technical investigations written for record purposes only.

*ACFEL Translations*

Published translations of foreign language technical articles by the Arctic Construction and Frost Effects Laboratory.

*SIPRE Translations*

Published translations of foreign language technical articles by the Snow, Ice and Permafrost Research Establishment.

*Draft Translations*

*Draft Translations* are published as received from the translator with no editorial review or graphics work. (The reproduction quality of these reports is often poor and in some instances the original foreign language publication may have to be referred to.)

*Miscellaneous Publications*

This series is made up mainly of papers by CRREL authors that are published outside the laboratory (e.g. journal articles, conference papers, reports published by other agencies.)

*Internal Reports and Technical Notes*

The *Internal Report* series contains documents that have not been published for reasons such as excessive expense, limited interest, etc. Copies are available for review in the CRREL library. *Technical Notes* are informal, preliminary, unreviewed papers that are not intended for external distribution.

## AVAILABILITY OF PUBLICATIONS

Most CRREL reports are announced as published in *Government Reports Announcements,* a semi-monthly abstract journal. They are available from the National Technical Information Service (NTIS), Springfield, VA 22151.

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The three-volume set, published by the Technical Information Analysis Center of the U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, is available from the National Technical Information Service, Springfield, Virginia, 22161, U.S.A. Payment may be made by check or money order, or by charging to an American Express credit card. If you have an NTIS deposit account the usual deposit account order form may be used. Foreign buyers may send payment in the form of a check in U.S. currency, an international money order, a traveler's check or by charging to an American Express credit card.

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| June 1964 | | Cum. Subj. & Auth. Index Vol. 1-17 | AD 602778 | | | | 30.50 | |
| June 1964 | SIP 21,001-22,000 | 18 | AD 447121 | | | | 30.50 | |
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| Dec 1978 | 32-1 to 32-4772 | 32 | AD A083017 | | | | 30.50 | |
| Dec 1978 | | Cum. Subj. & Auth. Index Vol. 28-32 | AD A083015 | | | | 30.50 | |
| Dec 1979 | 33-1 to 33-4770 | 33 & Index | AD A097639 | | | | 30.50 | |
| Dec 1980 | 34-1 to 34-4255 | 34 & Index | AD A102357 | | | | 30.50 | |
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# TECHNICAL REPORTS

**TR 1**
**INTERIM REPORT TO SNOW, ICE AND PERMAFROST RESEARCH ESTABLISHMENT.**
Minnesota. University. Institute of Technology. Engineering Experiment Station, Jan. 1950, , 60p., AD-661 307.
24-3001
ICE THERMAL PROPERTIES, ICE ADHESION, MILITARY RESEARCH, RESEARCH PROJECTS.
This report was written to analyze the requirements for and recommend an orderly program for research in snow, ice and permafrost, including the use of existing facilities and the recommendation of any new facilities to accomplish the research. Military end points and corresponding problems are enumerated and the problems in turn reduced to fundamental operations, environmental factors, and properties. Twenty-seven research projects are listed with priority, and briefly described as to nature and scope. Among the appended information is a summary of the present status of knowledge of snow, ice, and frozen ground. The report is particularly complete in an appraisal of snow and ice. Frozen ground is treated much less thoroughly.

**TR 2**
**FIRST SIPRE COMPACTION CONFERENCE 13-14 DECEMBER 1950.** Jan. 1951, , 30p., AD-098 525.
24-3002
SNOW COMPACTION, SNOW COVER, SNOW ROADS, MEETINGS, CLASSIFICATIONS, HARDNESS, EQUIPMENT, CONSTRUCTION.
The conference was attended by representatives from the U.S. Army, Navy and Air Force, Stevens Inst. Tech., Univ. Minn., SIPRE, Can. Air Force and the Natl. Research Council, Can. The purpose of the meeting was to find out what various groups were doing and what cooperation could be rendered. The speakers discussed the work on snow compaction in U.S., Canada and Switzerland, snow classification, new or modified apparatus for snow surveying designed by the Univ. Minn., and the relationship between soils and snow mechanics. The recommendations during the final discussion included developing a scheme of snow classification and a standard hardness test related to bearing pressure of snow.

**TR 3**
**PROCEEDINGS OF THE SECOND SIPRE SNOW COMPACTION CONFERENCE, MAY 24-25, 1951.**
SIPRE Snow Compaction Conference, June 1951, Var. pagination, AD-711 900.
25-2252
SNOW COMPACTION, PENETRATION, HEAT TRANSFER, TESTS, RESEARCH PROJECTS, MEETINGS.
Contents: DED Kapsukasing snow compaction trials, 1951; DED Fort Churchill snow compaction trials, 1951; ERDL progress in development of a pilot model snow packer; BuDocks' snow compaction program, Camp Hale, Colorado, 1950; BuDocks' snow compaction testing at Point Barrow, Alaska, 1950-51; Use of the drop cone penetrometer; Thermodynamic problems associated with compaction of snow; Preliminary snow cover maps of the Northern Hemisphere; 1951-52 DED snow compaction trials; Canadian NRC future plans.

**TR 3A**
**MINUTES OF SIPRE SNOW COMPACTION CONFERENCE, SEPT. 4-5, 1952.**
SIPRE Snow Compaction Conference, Sept. 1952, Var. pagination, AD-711 901.
25-2253
SNOW COMPACTION, MEETINGS, RESEARCH PROJECTS.
Contents: List of conferees; Minutes of the conference; Agenda of conference; Minimum program of measurements to be made on snow in relation to snow compaction work; Snow compaction measurements to be made if adequate personnel and equipment are available; Instructions for use of Rammsonde; Meteorological observations to be made at test sites; Simplified field classification of natural snow type for engineering purposes: DED snow compaction school; and Graph forms for recording data.

**TR 4**
**REVIEW OF THE PROPERTIES OF SNOW AND ICE.**
Mantis, H.T., ed., July 1951, , 156p., AD-696 397, 167 refs.
Minnesota. University. Institute of Technology. Engineering Experiment Station.
24-3003
ICE CRYSTAL STRUCTURE, ICE ELECTRICAL PROPERTIES, SNOW CRYSTALS, SHEAR STRENGTH, GLACIER ICE, SNOW PHYSICS, ICE MECHANICS, ICE PHYSICS.
Includes chapters on mechanical properties, strength of snow and ice, electrical properties, geometric properties, thermal properties, radiation properties, heat economy of the snow pack, phase relations, supercooling and ice formation in open water. An extensive bibliography with abstracts appears p.108-156.

**TR 5/1**
**A STUDY OF ICE ON AN INLAND LAKE.**
Wilson, J.T., et al, April 1954, , 78p., AD-043 143, 19 refs.
Zumberge, J.H., Marshall, E.W., Michigan. University. Research Institute.
24-3004
LAKE ICE, ICE CRYSTAL STRUCTURE, ICE PRESSURE, CLASSIFICATIONS.
The final report is given on laboratory and field studies on ice of both small and large lakes in the Great Lakes ares during 1950-1953. The 3 main topics discussed are: development of a genetic classification of lake ice; studies of the crystallinity of lake ice from the descriptive and genetic viewpoints; and the thermal push of an ice cover. The 2 main types of ice cover occurring in the area are classified as sheet and agglomeritic ice. Four ice textures were identified: granular, columnar, porphyritic, and tabular. Ice push on Wamplers Lake (SE Mich.) amounted to about 2 ft. each winter, averaging 2 in. each cycle.

**TR 6**
**CRYOLOGICAL RESEARCH FACILITIES IN NORTH AMERICA.** June 1951, 72p., AD-716 673, 330 refs.
25-4046
LABORATORIES, RESEARCH PROJECTS, ICE, SNOW, PERMAFROST.
The report contains a detailed survey of the programs and existing facilities throughout the National Military Establishment to determine (a) a comprehensive research program and (b) the extent and capabilities of existing facilities and any proposed new facilities necessary to conduct the research by the Snow, Ice and Permafrost Research Establishment.

**TR 7**
**PRELIMINARY INVESTIGATIONS OF SOME PHYSICAL PROPERTIES OF SNOW.**
Bader, H., et al, June 1951, , 49p., U-25920.
Hansen, B.L., Joseph, J.A., Sandgren, M.A., Minnesota. University. Institute of Technology. Engineering Experiment Station.
24-3005
SNOW PHYSICS, INSTRUMENTS, SNOW COMPACTION, SNOW MECHANICS.
The triaxial behavior of snow is discussed on the basis of an analysis of the velocities of deformation and stresses. Special cases are presented and the shear strength-normal stress diagram is calculated from triaxial data. High speed compactor data are interpreted as a function of height and time. An equation for the determination of tensile strength of snow by a centripetal force apparatus is given. Calorimeter theory and X-ray density scanning of snow are discussed. Preliminary experimental results of the determination of the cross-section number, specific velocities of uniaxial compression, tensile and shear strength, and use of cone and disk penetrometers are presented. A description of instruments used, with specifications and part numbers, is given. Included are hydraulic press, triaxial apparatus, disaggregator, penetrometer, and high speed compactor. Assembly drawings and wiring diagrams are appended.

**TR 9**
**REVIEW OF CERTAIN PROPERTIES AND PROBLEMS OF FROZEN GROUND, INCLUDING PERMAFROST.**
Lovell, C.W., Jr., et al, March 1953, , 124p., AD-014 616, Numerous refs.
Herrin, M., Purdue University, Lafayette, Ind. Engineering Experiment Station.
24-3007
PERMAFROST, FROZEN GROUND, ARTIFICIAL FREEZING, FROST HEAVE, THERMAL CONDUCTIVITY.
The intrinsic factors and a limited coverage of the environmental factors influencing freezing and thawing actions are presented. The topics reviewed include: the theory of frost action in saturated and non-saturated soils and the disturbances produced by the freezing and thawing cycle; the effects of frost action as manifested by frost heave on freezing in seasonally and perenially frozen ground; reduction in load-carrying capacity on thawing, and soil movements along slopes. Material on ground properties and conditions affecting or affected by frost action include reports on the composition and thermal properties of soils, structure of unfrozen and frozen ground, density and degree of compaction, degree of saturation and the theory of f.p. depression. Surface icing and its control conclude the review. A summary of research recommendations is included.

**TR 10**
**SOME ASPECTS OF SNOW, ICE AND FROZEN GROUND.** Aug. 1953, , 32p., AD-031 052, Bibliog. p.29-32.
24-3008
SNOW PHYSICS, TRAFFICABILITY, ENGINEERING, SNOW MECHANICS, ICE PHYSICS.
The exploration and rapid development of the Arctic and Subarctic have focused attention on living and working in this region. Civilian and military operations have been hampered by a lack of knowledge of the characteristics of the earth's layer or sublayer of snow, ice, and permafrost. This report discusses the problems and presents a brief review of the present state of knowledge of snow, ice, and frozen ground, and a statement of research needs.

**TR 11**
**CREEP OF SINGLE CRYSTALS OF ICE.**
Griggs, D.T., et al, Dec. 1954, , 24p., AD-053 214.
Coles, N.E.
24-3009
ICE CRYSTALS, CREEP PROPERTIES.
A commercial deep-freeze unit was modified to serve as a laboratory for growing single crystals, cutting specimens of a given orientation, testing these specimens in compressive creep, and studying thin-sections of the results on a universal stage. A method of growing single crystals of adequate size was developed by adapting the Bridgman method. Forty-one creep tests were made at temperatures ranging from -1 to -18 C. These gave an unexpected form of creep-curve in which the rate of strain continuously increases with time. The mechanism of deformation is dominantly basal translation-consistent with earlier work. The dependence on temperature and stress is expressed empirically.

**TR 12**
**BIBLIOGRAPHY ON COLD REGIONS SCIENCE AND TECHNOLOGY.** 1951- , , Several vols., Title varies. Later vols. designated CRREL Report 12. Continuing bibliography issued approx. annually.
24-3010
BIBLIOGRAPHIES, SNOW, ICE, FROZEN GROUND, ENGINEERING.

**TR 13**
**SNOW COMPACTION.**
Taylor, A., Jan. 1953, , 64p., AD-007 710.
24-3011
SNOW COMPACTION, SNOW ROADS, TRAFFICABILITY, SNOW CRYSTALS.
The current concept of snow formation is presented by Ukichiro Nakaya to provide better understanding of snow dynamics involved in snow compaction. Conditions necessary for the formation and precipitation of snow are presented. The metamorphism of snow including firnification and hardening are discussed. Snow is considered as an engineering material with changeable mechanical properties easily modified by natural and artificial processes. Snow compaction techniques used in maintenance of roads and airport runways consist of cementing the first 3 or 4 in. of snow to the ground by rolling, thus forming a firm foundation for future surfaces. The equipment used in compressive snow-compaction is described and the processes involved are studied. Compaction of deep snow beds by depth processing through scarification is discussed. Methods of snow road construction developed by the logging industry are appended.

**TR 14**
**MIGRATION OF MOISTURE IN THE THERMAL REGIME.**
Brasted, R.C., June 1954, 137p., AD-716 676, 330 refs.
25-4047
MOISTURE TRANSFER, SOIL MOISTURE MIGRATION, FROST PENETRATION, SNOW WATER CONTENT, PERMEABILITY, THERMAL REGIME, BIBLIOGRAPHIES.
Contents: Thermodynamic considerations related to moisture movement at low temperatures; Capillarity of soil related to moisture migration; Moisture migration through snow; Thermal gradients and thermal translocation of moisture; Frost penetration as influenced by soil type, soil moisture, and soil cover; Migration of saline solutions; Barometric pressure as a function of moisture migration; Deterioration of building materials by moisture penetration and frost action.

**TR 15**
**SNOW, ICE AND PERMAFROST IN MILITARY OPERATIONS.**
Flint, R.F., Sept. 1953, , 6p., AD-023 582.
24-3012
MILITARY OPERATION.
The background history, mission and operational features of SIPRE are outlined. Basic research, long-range plans, field

studies, cooperation with other agencies, and expected results are discussed. Operational needs and research to meet the needs are indicated. SIPRE performs fundamental scientific research as well as applied engineering research since the fundamental properties of snow and ice have not been established by civilian research. Military problems created by cold climate are summarized.

**TR 16**
**SPECTRAL CHARACTERISTICS OF WET AND DRY SNOW BETWEEN 0 AND -60C.**
California. University. Institute of Engineering Research, Aug. 31, 1955, Snow Characteristics Project. Final progress report, 122p., Contract DA-11-190-ENG-3, AD-088 575, 21 refs.
Dunkle, R.V., Gier, J.T.
24-3013
ALBEDO, SPECTRA, SNOW OPTICS.

**TR 16/1**
**PROGRESS REPORT FOR THE YEAR ENDING JUNE 27, 1953.**
Dunkle, R.V., et al, June 1953, 73p., AD-016 830, 12 refs.
Gier, J.T.
25-4048
SNOW OPTICS, ALBEDO, SPECTRA.
The report summarizes the progress which has been made in the basic activities which are: 1. study of the spectral characteristics of wet and dry snow and the total emissivities and absorptivities of wet and dry snow for temperatures between 0 C and -60 C; 2. related investigations; the study of the radiant characteristics of various types of paints and materials which might be used in arctic conditions; 3. determination of criteria for the selection of materials, coatings and clothing for arctic camouflage and for identification under arctic whiteout conditions.

**TR 16/2**
**RADIATION IN A DIFFUSING MEDIUM WITH APPLICATION TO SNOW.**
Dunkle, R.V., et al, Nov. 1953, 14p., AD-023 217, 3 refs.
Gier, J.T.
25-4049
SNOW OPTICS, ALBEDO, LIGHT TRANSMISSION, ANALYSIS (MATHEMATICS).
The transmission through an idealized snow cover has been shown to be directly related to the albedo and to be an exponentially decreasing function. Two parameters have been proposed as possible correlating factors for transmission and albedo measurements. The first factor is a characteristic of the surface condition of the cover and the second is a characteristic of the snow beneath the surface.

**TR 16/3**
**SNOW EMISSIVITY METER AND ITS USE IN EVALUATING THE EMISSIVITY OF ICE, FROZEN GROUND AND OTHER MATERIALS.**
Dunkle, R.V., et al, Dec. 1953, 14p., AD-024 635, 2 refs.
Gier, J.T.
25-4050
RADIATION MEASURING INSTRUMENTS, SNOW OPTICS, ICE OPTICS, FROZEN GROUND PHYSICS.
An objective of this research program is the measurement of the total emissivity and absorptivity of wet and dry snow, ice, frozen ground and materials used in the arctic regions. To accomplish this, an instrument, the Snow Emissivity Meter, was designed utilizing a mirror to focus the incident energy upon a thermopile detector and an ideal radiator for controlling radiation from the surroundings. The preliminary results obtained from laboratory testing are reported herein.

**TR 16/4**
**SPECTRAL REFLECTING OF CERTAIN MINERALS AND SIMILAR INORGANIC MATERIALS.**
Dunkle, R.V., et al, Jan. 1954, 15p., AD-026 394, 5 refs.
Gier, R.V.
25-4051
SPECTRA, REFLECTIVITY, MINERALS.
Of particular interest to investigators in the problems of radiative exchange and over-all heat balances of the natural environment, is the emission characteristics of the different constituents of what is loosely termed the earth. Thus, the spectral reflectivity characteristics of minerals and associated materials is of prime importance. The following report is the result of a preliminary investigation of the spectral reflectivity of certain minerals and other similar materials.

**TR 17**
**FRICTION ON SNOW AND ICE.**
Minnesota. University. Institute of Technology. Mechanical Engineering Department, June 1955, 286p., AD-084 888, Includes appenc 372 refs.
25-2254
FRICTION, MEASUREMENT, SNOW, ICE.
Various theories of friction, particularly those related to snow and ice, are reviewed, and results of theoretical and experimental work begun in 1951 are discussed. Experimental data were obtained on the static and kinetic friction of sliders on ice and snow under various conditions of load, apparent area, material, temperature, humidity, time of stationary contact, and carriage velocity. It is concluded that the resistance to motion over compacted snow and ice is mainly a dry friction phenomenon relieved slightly by the presence of a film on the surface. The basic mechanism forming this film is probably either the frictional heating mechanism suggested by Bowden or the electrical dipole theory suggested by Weyl, although neither fully explains all frictional phenomena on ice and snow. The application of Weyl's dipole theory and preparation of a smooth, clear ice surface are included in the appendix. Suggested problems for future research are outlined.

**TR 18**
**REVIEW OF SNOW COMPACTION METHODS WITH RECOMMENDATIONS FOR ROAD AND AIRFIELD CONSTRUCTION ON SNOW.**
Gerdel, R.W., et al, Nov. 1954, 12p., AD-050 313, 8 refs.
Diamond, M.
25-2255
SNOW COMPACTION, SNOW ROADS, ROAD MAINTENANCE, CONSTRUCTION.
This report presents a review of results of past snow compaction studies, assesses present snow compaction techniques and recommends methods of constructing and maintaining snow roads in area of deep snow such as the Greenland Ice Cap.

**TR 19**
**PROJECT MINT JULEP. PART III. SNOW STUDIES.**
Schuster, R.L., Oct. 1954, , 7p. plus 16 unnumbered leaves., AD-050 563, 2 refs.
24-3014
SNOW DENSITY, TEMPERATURE EFFECTS, SNOW WATER EQUIVALENT, SNOW COVER, SNOW STRENGTH, GREENLAND.
Nine snow-profile study sites were established during the 1953 summer field season along a 24-mi. E-W base line through the Mint Julep area (SW Greenland). Snow studies were made at each of these sites at 2-week entervals beginning in early June and ending Aug. 10. Data obtained on stratigraphy, temperature, density and ram resistance are graphed for each study site.

**TR 20**
**EXCAVATIONS AND INSTALLATIONS AT SIPRE TEST SITE, SITE 2, GREENLAND.**
Bader, H., et al, April 1955, , 32p., AD-123 155(d), 1 ref.
Waterhouse, R.W., Landauer, J.K., Hansen, B.L., Bender, J.A., Butkovich, T.R.
24-3015
SNOW TRENCHES, SNOW STRENGTH, SNOW DENSITY, EXCAVATION, GREENLAND.
Work carried out at the SIPRE Test Site, Site 2, on the Greenland Ice Cap, during the summer 1954, included: (1) Excavation of trenches, a circular tunnel and a deep pit; (2) Instrumentation of excavations for pressure and deformation measurements; (3) Tests on the properties of snow from the deep pit; (4) Construction of a snow house as an experimental structure and to provide a heated shelter for an observer stationed at the site for the winter. Observations and measurements over a period of five years are expected to provide sufficient information for the establishment of satisfactory design criteria for all kinds of surface and subsurface military installations on high polar ice caps.

**TR 21**
**SEWAGE DISPOSAL AT ICE CAP INSTALLATIONS.**
Bader, H., et al, April 1955, , 4p., AD-123 155(g).
Small, F.A.
24-3016
SEWAGE DISPOSAL, SUBSURFACE INVESTIGATIONS, GREENLAND.
The sewage disposal pits at Sites 1 and 2 on the Greenland Ice Cap were studied, and the size of the cavity produced by sewage was calculated from the data obtained. It was concluded that no serious collapsing of cavities will occur. Increased settlement of the overlying snow surface may cause the edge of the station nearest the sewage pit to be tipped very slowly, which can be corrected by lengthening the sewage pipe. The present sewage disposal means at Sites 1 and 2 are considered entirely adequate for many years to come.

**TR 22** Record deleted.

**TR 23**
**INSTRUMENTATION OF ICE-CAP STATIONS (PRELIMINARY REPORT).**
Hansen, B.L., April 1955, , 7p., AD-123 155(e).
24-3017
TEMPERATURE MEASURING INSTRUMENTS, PRESSURE FACTORS, BENCH MARKS, INSTRUMENTS, DEFORMATIONS, COLD WEATHER CONSTRUCTION.
Two stations on the Greenland Ice Cap were instrumented as follows: (1) copper resistance thermometers were installed to determine the effect of the buildings on the subsurface temperatures; (2) a recording bench mark was installed and the elevations of selected points in the buildings were determined by leveling from the bench mark; (3) reference points were established at which diameters of the tubes are measured and from which the orientation of the tubes can be determined by observations with a transit; and (4) various types of pressure cells were installed in order to determine some of the forces causing deformation of the buildings.

**TR 24**
**SCIENTIFIC WORK OF PARTY CRYSTAL, 1954 (PRELIMINARY REPORT).**
Benson, C.S., April 1955, , 10p., AD-123 154(a).
24-3018
SNOW COVER DISTRIBUTION, SNOW MELTING, RESEARCH PROJECTS, SNOW PHYSICS, GREENLAND.
Party Crystal, a small mobile scientific party, conducted snow studies during the summer of 1954 on the Greenland Ice Cap eastward from Thule, Greenland. Work included measurements of elevation, snow accumulation, summer melting, and snow properties. Final results of the season's work will be combined with the work of 1952 and 1953 and published at a later date. The average annual accumulation is approximately 60 cm of water equivalent for the first segment of the trail (58.5 mi); drops to 20 cm in the next 30 mi and remains low for approximately 45 mi; rises to nearly 40 cm for the next 85 mi; then decreases again to the east. Along the first 40 mi of the trail, the year's accumulation of snow becomes completely soaked during the melt season, making a very poor surface for vehicles. Beyond that point, the depth of soaking decreases rapidly. Ice masses due to percolation of melt water are very common and frequently large along the first 58.5 mi, decrease in size along the next 60 mi, and occur very infrequently farther east.

**TR 25**
**OPERATIONS AND LOGISTICS OF ICE-CAP PARTY CRYSTAL, 1954.**
Benson, C.S., April 1955, , 21p., AD-123 154(b).
24-3019
COLD WEATHER OPERATION, LOGISTICS, SNOW VEHICLES, MEASURING INSTRUMENTS, SHELTERS, GREENLAND.
Party Crystal was a small mobile scientific party whose purpose was to make snow studies on the ice cap, as a part of the Corps of Engineers activities in northern Greenland in the summer of 1954. The over-all rate of travel was slow, with a great deal of time spent at test stations en route. Wannigans were used for living quarters and weasels for hauling the wannigans and a variety of scientific equipment. Fuel consumption averaged 1.8 mi/gal. The 5-in-1 and C-rations which formed the bulk of the food supply were not satisfactory because of the weight involved -7.4 lb/man/day including packaging were required. It is expected that the operational details will be useful for planning future projects of this nature and, to a certain degree, for planning any small ice-cap party.

**TR 26**
**STUDY OF ICE FABRICS, THULE AREA, GREENLAND.**
Rigsby, G.P., April 1955, , 6p., AD-123 154(c).
24-3020
ICE CRYSTALS, GLACIER ICE, SHEAR STRESS, GREENLAND.
Crystal fabric studies were made on glacier ice taken from 11 locations on the Nuna Ramp and three locations on the Moltke Glacier, Greenland. From samples taken near the surface of the glacier, 1/16-in. sections of ice were prepared, and the orientation of the optic axis of each ice crystal in the section was determined with a large universal stage with four axes of rotation, mounted between crossed polaroid sheets. The optic axes, when plotted on a Schmidt equal-area projection, often show very strong patterns with concentrations as high as 30 per cent in 1 per cent of the area. Ice appears to be very sensitive to shearing forces and the crystals in polar glaciers tend to become oriented so that the basal glide plane is parallel to the shear plane. The strength of the pattern appears to be more or less proportional to the strength of the shearing forces imposed on the ice. Strong shearing forces seem to produce small crystals with strong preferred orientations, while high temperatures tend to produce larger crystals.

**TR 27**
**STRUCTURES FOR SNOW INVESTIGATIONS ON THE GREENLAND ICE CAP.**
Waterhouse, R.W., April 1955, , 38p., AD-123 155(f).
24-3021
PORTABLE SHELTERS, TRENCHING, SNOW LOADS, STRESS ANALYSIS, GREENLAND.
Lightweight portable structures have been installed in excavations in snow for the purpose of procuring, over a long period of time, stress-and-strain behavior data of massive snow such as exists over an extensive area of Greenland. The trench-shoring-type structures will develop lateral pressures, and column-type structures supporting trench covers will develop increasing loads from snow accumulation, both of which are to be measured periodically with electrical strain-gage-type pressure cells. Supplementary structures exhibiting visible responses to snow accumulation and consolidation with time, including lightweight metal arches and a shelter composed of snow-block walls with a prefabricated metal roof structure, were also installed and observed. Initial observations include description of the excavation procedure and, briefly, load characteristics.

**TR 28**
**GLACIOLOGICAL INVESTIGATIONS IN THE THULE RAMP AREA.**
Schytt, V., April 1955, , 88p., AD-123 155(a).
24-3022
GLACIER ABLATION, GLACIER ICE, ICE FORMATION, GLACIER MASS BALANCE, METEOROLOGICAL DATA, TRAFFICABILITY, GREENLAND—THULE.

During the 1954 field season, from 19 June to 29 August, accumulation and ablation measurements were made on the Ramp and farther inland to Mile 20 (from Thule Take-off). Meteorological measurements were obtained for correlation with the glaciological work. Accumulation on the Ramp averaged 55 cm of snow and varied considerably, showing high values on concave slopes and low values on convex slopes. Farther inland, the order of magnitude of winter snow depths was 100 cm from Mile 4 to Mile 7; 150 cm from Mile 8 to Mile 14; and 100 cm from Mile 15 to Mile 20. Except for a narrow belt of winter accumulation just inside the edge of the glacier, the Ramp below 700 m belonged to the area with net ablation. Studies were made on formation of superimposed ice; debris features in the moraine area; and ice movement and structure in the vicinity of Thule Take-off. Some observations on trafficability of the route are included.

**TR 29**

**AVALANCHE CONDITIONS AND AVALANCHE RESEARCH IN THE UNITED STATES, WITH RECOMMENDATIONS FOR FUTURE WORK.**

Fuchs, A., July 1955, 33p., AD-716 675, 3 refs.

25-4052

AVALANCHE FORECASTING, AVALANCHE ENGINEERING.

Most of the important avalanche areas and research stations of the western United States were visited during the period of February 15 through March 21, 1955. The avalanche defense measures and research work are discussed. Suggestions are made for improving methods of predicting avalanche danger and for control by explosives. For some avalanches, other defense measures (snow fences, barriers, reforestation) are proposed. The work and equipment of the research and observation stations are appraised, and in some cases improvements suggested. A research program suited to the existing facilities is outlined.

**TR 30**

**EXCAVATIONS IN FROZEN GROUND. PART II. EXPLOSION TESTS IN FROZEN GLACIAL TILL, FT. CHURCHILL.**

Livingston, C.W., et al, July 1959, , 19p. plus 13p. of tables., AD-233 474, 8 refs.

Murphy, G.

24-3023

FROZEN GROUND MECHANICS, EXPLOSION EFFECTS, PERCUSSION DRILLING, CANADA—MANITOBA—FORT CHURCHILL.

Explosion tests were conducted in frozen ground near Fort Churchill, Manitoba, Canada, as an extension of previous tests in Keweenaw silt. Atlas 60 Percent straight Gelatin Dynamite, Demolition Block M5 Composition C-3, and Atlas Coalite 7S Ammonia-Base Permissible Dynamite were used as the explosives in amounts ranging from 0.5 to 20 lb. Approximately 150 craters were produced. The charges were cylindrical with height-diameter ratios ranging from 0.12 to 9.12, but the majority were in the interval between 2.5 and 4.0. The depths of charges varied, some being quite shallow and others sufficiently deep that no surface effect was observed. In general the results verify scaling laws and show that the critical depth varies as the cube root of the weight of charge. Consistent differences in performance of the explosives were observed. The shape of the charge also influenced the results, but scatter of the data preclude establishing conclusive trends of the influence. Detailed data on the shapes and sizes of the individual craters are reported.

**TR 31** Record deleted.

**TR 32** Record deleted.

**TR 33**

**STRUCTURE OF ICE.**

Brill, R., July 1957, , 67p., AD-149 029.

24-3024

ICE CRYSTAL GROWTH, STRUCTURAL ANALYSIS, VISCOELASTICITY, ICE DIELECTRICS, X RAY DIFFRACTION.

The procedures for growing samples of ice used in the experiments are described. Experiments using the method of bending bars of ice to determine their viscoelastic behavior were made. Tests were conducted on single crystals with various orientations, polycrystalline samples, and mixed crystals of ice-NH4F. These tests showed that the hexagonal base plane is the gliding plane at plastic deformation and that Becker's equation can be used for description of the viscoelastic creep of ice. Studies show that amounts up to 10 per cent of NH4F may be absorbed in the ice lattice. Dielectric studies indicate that the relaxation time decreases markedly with increasing concentration of NH4F, down to a minimum value corresponding to some concentration between 0.1 and 1 per cent NH4F, and then increases again with further increasing concentration. The dc resistivity of ice-NH4F increased with the x-ray diffraction techniques to determine the thermal amplitudes of H2O molecules as well as of hydrogen atoms in ice. The molecular vibration can be described as having a characteristic temperature of 220K.

**TR 34**

**COUPLING BETWEEN MOVING LOADS AND FLEXURAL WAVES IN FLOATING ICE SHEETS.**

Wilson, J.T., Sept. 1955, , 28p., AD-099 494, Contract No. DA-11-190-ENG-8, 7 refs.

24-3025

FLOATING ICE, WATER WAVES, WAVE PROPAGATION, RIGIDITY, RESONANCE.

The elementary theory of coupling or resonance between a moving load and the flexural waves generated by it in a floating ice sheet is developed and verified by experiments. The theory indicates that for shallow water the critical velocity is approximately 20 percent greater than the velocity of long water waves. Experiments were carried out, using one and two vehicles as moving loads on ice sheets one to two feet thick. At the critical speed (for a single vehicle) the maximum observed motion was approximately 2.5 times the static deflection. For two vehicles running in tandem a half wave length apart, a considerable cancellation was observed. Attempts to solve the problem of a simi-infinite plate on an elastic foundation with a free edge under concentrated load (the ice-breaker problem) are reported. No satisfactory solution was obtained.

**TR 35**

**STUDIES ON VEHICULAR TRAFFICABILITY OF SNOW (PARTS 1 AND 2).**

Diamond, M., et al, April 1956, July 1959, , 24 plus 16p., AD-099 687, AD-237 653, 14 refs.

Bader, H., Lanyon, J.L.

24-3026

SNOW VEHICLES, TRAFFICABILITY, SNOW COVER.

Part 1. Four light snow vehicles of the personnel carrier type were used to test the trafficability of the snow cover at the Keweenaw Field Station near Houghton, Michigan, in February and March 1955. It was found that the maximum drawbar coefficient, (drawbar pull/vehicle weight) was obtained at a track slip of 20-40 per cent, indicating that drawbar pull is a function of the frictional resistance of the snow. The Kamm-type 30 deg.-angle grouser attached to the M-7 tractor produced a significant increase in the drawbar coefficient obtainable. On the basis of an efficiency coefficient, the M-7, with or without angle grousers, out-performed the ladder-type tractor. The maximum efficiency coefficient occurred at lowest track slippage. Part 2. The results are reported of investigations during the winters of 1955, 1956, and 1957 at the Keweenaw Field Station (Mich.) and in summer 1956 in N. Greenland to determine the relationship between certain meteorological parameters and the traffic-supporting capacity of snow cover. The vehicles used in the studies included an M-7 Ordnance snow tractor, a 4-pontoon Tucker Sno-Cat, and an M-29C weasel. A Bombardier Muskeg Tractor was modified and instrumented for use as a testing dynamometer vehicle. Vehicle performances in various configurations were compared.

**TR 36**

**AIRFIELDS ON FLOATING ICE SHEETS FOR REGULAR AND EMERGENCY OPERATIONS.**

Assur, A., April 1956, , 24p., AD-099 688, Supp. 1, not for distribution. Supp. 2: "Criteria for landing selected Canadian aircraft on ice," Oct. 1956, 3p. Supp. 3: "Criteria for using selected heavy equipment on sea ice," Oct. 1956, 5p.

24-3027

AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), FLOATING ICE, ICE BEARING CAPACITY, ICE COVER THICKNESS.

The practical aspects of establishing and maintaining airfields on sea and fresh-water ice for normal and emergency operations are discussed. The principles of the bearing capacity of ice, and the effects of static and moving loads are reviewed. Practical recommendations are given for the choice of location, exploratory field survey, and the preparation of the airstrip. Formulas are developed for estimating ice thicknesses in a given region at a given time, taking into account accumulated degree-days below freezing, snow-cover depth, stream flow, and other local conditions. Estimates of the required ice thicknesses for safe and emergency landings of selected aircraft, with and without skis, are tabulated, as well as the radius of influence of loads, critical load velocities, and the thermal insulating effects of different types of snow and ice covers.

**TR 37** Record deleted.

**TR 38**

**PRELIMINARY STUDY OF CREVASSE FORMATION, BLUE ICE VALLEY, GREENLAND, 1955.**

Meier, M.F , et al, July 1957, , 80p., AD-696 398, Contract No. DA 11-190-ENG-21, 56 refs.

Conel, J.E., Hoerni, J.A., Melbourne, W.G. Pings, C.J., Walker, P.T.

24-3028

GLACIER ICE, CREVASSES, SHEAR STRESS, STRAIN RATE, ICE MECHANICS, DEFORMATIONS, METEOROLOGICAL FACTORS, GREENLAND—BLUE ICE VALLEY.

**TR 39**

**STUDY OF ICE CLIFF IN NUNATARSSUAQ, GREENLAND.**

Goldthwait, R.P., Oct. 1960, , 108p., AD-091 484, Contract No. DA-11-190-ENG-19, 34 refs. Incl. 7 maps. Also incl. "Supplementary glacial studies, 1957" by Robert E. Hilty.

24-3029

GLACIAL GEOLOGY, GLACIER OSCILLATION, GLACIAL TILL, VEGETATION, GLACIER MELTING, GREENLAND—NUNATARSSUAQ.

The present activity and history of an ice cliff on the E. margin of North Ice Cap (near its junction with the main Greenland Ice Cap) and of adjacent glaciers are deduced on the basis of detailed glaciological, meteorological, geomorphological, and botanical studies in the summers of 1955 and 1956. Detailed descriptions are given of the climatic, ablation, and runoff regimes of the glacier, the motion of the ice-cliff surface and glacier surface and base, the structure of the ice, including physical properties, foliation and fracture, crystal distortion, and englacial strain.

**TR 40**

**USE OF A SHEAR VANE IN SNOW.**

Diamond, M., et al, July 1956, , 10p., AD-115 157, 3 refs.

Hansen, D.L.

24-3030

MEASURING INSTRUMENTS, SNOW STRENGTH, SHEAR STRENGTH, VANE SHEAR TESTS, TRAFFICABILITY.

Two shear vanes of different size were used to measure the shear and frictional resistance of snow at various normal pressures. Tests were conducted in Northern Michigan and in Greenland. The relationship between shear and frictional resistance and normal pressure was found to be linear in 60 per cent of the tests and exponential in about 20 per cent of the tests. There was no apparent relationship in the other 20 per cent. Values for the angle of shearing resistance, and angle of internal friction, were about the same for artificially disaggregated snow and for snow which was undisturbed prior to the test. These values compared favorably with values computed from data obtained in vehicular tests. The results of trials with the large-and small-diameter shear vanes on the same type of snow indicate that the size of the instrument may influence the values obtained. The trials indicate some dependence of angle of shearing resistance and angle of internal friction on snow density. This type of instrument appears to yield larger values for angle of internal friction than obtained by experiments with snow blocks sliding on an inclined snow plane.

**TR 41**

**PREPARATION OF PLASTIC REPLICAS AND THIN SECTIONS OF SNOW.**

Fuchs, A., Nov. 1956, 6p., AD-125 679, 3 refs

25-4053

SNOW CRYSTALS, REPLICAS, PLASTICS, THIN SECTIONS.

A solution of polyvinylformaldehyde in 1, 2-dichloroethane mixed with white, fine-grained titanium oxide (Titanox-RA) is used to make plastic replicas of snow samples for petrofabric studies. A second clear film of Plexiglas may be applied. Formulas and details of preparation are given. A method is described for preparing snow samples for thin sections by filling the pores with ice without changing the structure of the snow.

**TR 42**

**TESTING OF A COMPACTED SNOW RUNWAY.**

Bender, J.A., July 1956, 38p., AD-717 206, 16 refs.

25-4054

RUNWAYS, SNOW (CONSTRUCTION MATERIAL), BEARING CAPACITY, COMPRESSIVE PROPERTIES, TRAFFICABILITY, TESTS, AIRCRAFT LANDING AREAS.

The processing of the snow for the runway, by modified pulvimixers using heat, was started on 6 July and completely finished by 1 September. Successful landings on the 200 x 10,000 ft strip were made by C-47, C-54, and C-124 type aircraft. The conclusion that the strip could support these aircraft and the decision to land the planes were based on the laboratory testing. This report decribes the methods and techniques used in testing a snow runway built on deep snow, and gives suggested requirements of a snow runway to support various type aircraft. It is not intended as a report on the operational aspects of making such a runway, nor as a critique on the techniques used. Also, it should be realized that this represents the beginning of a long-range program and that additional theoretical work and field work are still necessary.

**TR 43** Record deleted.

**TR 44**

**ICE TUNNEL, TUTO AREA, GREENLAND, 1956.**

Rausch, D.O., Feb. 1958, , 34p., AD-206 423, 10 refs.

24-3031

ICE (CONSTRUCTION MATERIAL), TUNNELING (EXCAVATION), GLACIER ICE, GREENLAND—CAMP TUTO.

The excavations made by the ice tunnel project during 1956 demonstrated the feasibility of construction of large openings within the Greenland Ice Cap. The room excavated contained 2500 cu. yd., had 3600 sq. ft. of floor space, and a 25-ft height. No limiting size for an opening in ice was determined. The extension of the tunnel indicated that an overburden depth has been reached where hand methods of tunnel driving are not practical. This overburden depth is approximately 160 ft. In view of the difficulty encountered, either explosives or automatic coal mining machinery will be needed for deeper excavations. The mechanics of the glacier, with respect to openings, indicated that an excessive deformation does not occur at the overburden depth of 180 ft reached in the tunnel extension.

**TR 45**

**PENETRATION OF SHAPED CHARGES INTO FROZEN GROUND.**

Benert, R., April 1957, , 19p., AD-141 808, 8 refs.

24-3032

FROZEN GROUND MECHANICS, PENETRATION TESTS, EXPLOSION EFFECTS, BLASTING.

During March and April, 1955, and February and March, 1956, shaped charges were fired into permanently frozen ground, rock, and ice at Fort Churchill, Manitoba, in order to determine the feasibility of using shaped charges to produce a hole in frozen ground that can be loaded with other explosives to form a crater adequate for use as a foxhole. Charges tested were: standard U.S. Army shaped charges M3 (40 lb), M2A3 (15 lb), and M2 (10 lb); two experimental shaped charges furnished by the Terminal Ballistics Laboratory of Aberdeen Proving Ground, Maryland (20 lb and 5 lb); and a 2 3/4-oz jet trapper manufactured by Du Pont. The M2, M2A3, and M3 gave holes which met the requirements - 5 ft minimum depth and 2-in minimum diameter, but the M3 is undesirable for the purpose because of weight, extremely loud noise, blast effect, and shrapnel-throwing characteristics. Both experimental charges gave holes that were too small for the purpose. The jet tapper produced too small a hole, but the excellent results for its size suggest that the same method of manufacture should be tried for experimental charges, in order to reduce the weight required.

**TR 46**

**A RECONNAISSANCE FOR A SOUTHERN GREENLAND ICE-CAP ACCESS FOR MILITARY PURPOSES.**

Frost, R.E., April 1957, , 18p., AD-138 264, 7 refs.
24-3033

ROADS, GREENLAND.

The area under conions Research and Engineering Laboratory (SIPRE)

**TR 47**

**GLACIOLOGICAL INVESTIGATIONS IN THE TUTO AREA OF GREENLAND.**

Griffiths, T.M., April 1960, , 63p., AD-237 655, 7 refs.
24-3034

GLACIER MOVEMENT, GLACIER ABLATION, GREENLAND—THULE.

Investigations conducted in 1956 on accumulation and ablation, ice velocity on the Thule Ramp, firn and ice temperatures, and net surface velocity in the Blue Ice region, and the establishment of a control network for ice-edge photogrammetry are described in detail; the results are discussed and correlated with similar studies in 1954 and 1955; and recommendations for future studies are made. The firn line on the Thule Ramp closely approximates the 635-m contour line and is lower than the climatic regime of the region could justify, as evidenced by P-Mountain Glacier. The Thule lobe appears to be in near-balance, and since local alimentation is insufficient, losses are compensated for by the movement of inland ice toward the margin. Net accumulation, therefore, is recorded to the very edge of the lobe. The Thule lobe is occupied by a dry polar glacier, and the surface melting does not permit larg amounts of water to accumulate at the surface. Surface water above the firn line percolates to the lower snow layers, where it refreezes and becomes a net loss only when the firn reaches the ablating margin of the lobe below the firn line. The narrowness of the ablation zone contributes to the state of balance of the lobe.

**TR 48**

**ICE-CAP ACCESS ROUTE, NARSSARSSUAQ, GREENLAND - LOCATION AND ENGINEERING EVALUATION.**

Leighty, R.D., et al, May 1960, , 36p., AD-239 456.
Poulin, A.O.
24-3035

ROADS, GREENLAND.

The location and surroundings of an overland route from the Narsarssuak Air Base to the ice cap are described and evaluated on the basis of a survey in the summer of 1957, with emphasis on engineering problems. The physical characteristics of the terrain, as determined from aerial photography and field reconnaissance, and possible alternate routes are discussed; an engineering analysis of the entire route is given section by section; and recommendations for continued study are made. The route is about 45 miles long and extends from the air base, which is near sea level, to an elevation of 3942 ft on the ice cap at the end of the route. The location established utilizes the natural terrain and materials. About 95 per cent of the grades will be 6 per cent or less and none will exceed 10 per cent. Two locations will require switchbacks because of steep slopes. The route is mostly over rocky terrain and will necessitate considerable blasting. Good sources of granular materials are available at many locations along the route.

**TR 49**

**A PORTABLE ADIABATIC CALORIMETER.**

Hansen, B.L., et al, July 1957, , 6p., AD-146 699.
Jellinek, H.H.G.
24-3036

CALORIMETERS.

An adiabatic calorimeter was constructed and tested on glacier ice. The heat of fusion thus determined was found to be within a small fraction of a percent of published values for ice. The calorimeter is considered to be suitable for the determination of water in snow.

**TR 50**

**A THERMALLY CONTROLLED SOIL FREEZING CABINET.**

Schmertmann, J.H., May 1958, , 13p. plus appends., AD-208 955.
24-3037

ARTIFICIAL FREEZING, COLD CHAMBERS, SOIL FREEZING.

Freezing cabinet performance requirements are set up as: one-dimensional heat flow within the sample, control of water access to the sample, proper instrumentation, and adequate cabinet utility. A preliminary freezing cabinet was tested. Its poor thermal performance lead to a theoretical investigation of the performance of several cabinets of different designs. The investigation developed the need for additional control of the thermal boundary conditions of the contained sample. A cabinet was designed with the sample surrounded by six controllable heating elements. The cabinet is used in a cold room. The temperature of each element is individually adjusted by a Variac transformer. By matching insulation and sample temperatures, it is possible to greatly reduce heat transfer between the insulation and the sample. Tests have shown that the heat transfer between insulation and sample can be reduced to 1 per cent of the heat leaving the sample. This cabinet provides good thermal control for one-dimensional heat transfer experiments, such as soil freezing. The cabinet also successfully meets the other performance requirements.

**TR 51**

**REVIEW OF FROZEN GROUND EXCAVATION METHODS.**

McCullough, C.R., Feb. 1958, , 9p., AD-160 080, Bibliog. p.7-9.
24-3038

EXCAVATION.

Present methods of frozen ground excavation include thawing prior to excavation by means of solar heat, steam jets, water and electric needles, valveless pulsejet engines, and hydraulic methods as well as fracturing by hand, with saws, drop and pneumatic hammers, and cutter and scraper blades. The use of explosives for excavating frozen ground is not included in the scope of this report. Evaluation on the basis of a literature survey indicates that modification of bulldozers to permit installation of pneumatic hammers horizontally along the base of the blade shows considerable promise. The use of alternate cutter and scraper blades for trench excavation has proved satisfactory, and drop hammers are suitable for enlarging existing excavations. Sawing frozen ground has not yielded satisfactory results. The potentiality of resonant sound waves for loosening frozen ground should be studied.

**TR 52**

**PROPOSED RELOCATION OF CAMP TUTO AND ACCESS ROAD - AN AIRPHOTO SURVEY.**

Leighty, R.D., April 1958, , 16p., AD-202 623.
24-3039

ROADS, AERIAL SURVEYS, STATIONS.

A new location for Camp TUTO and an access road to the ice cap was selected by use of aerial photography and field checking. For this study a simplified soil classification system was designed, considering: broad grain size classification, the recognition of natural deposits in the field, the use of soil as borrow material and natural subgrade, and the general engineering problems concerned with frost action, permafrost, and moisture.

**TR 53**

**PRELIMINARY SNOW COMPACTION FIELD TESTS USING DRY PROCESSING METHODS.**

Wuori, A.F., March 1959, , 8p., AD-217 600.
24-3040

SNOW COMPACTION, COMPACTING, SNOW ROADS, AIRCRAFT LANDING AREAS, SNOW (CONSTRUCTION MATERIAL).

During the winter of 1956-57 at Houghton, Michigan, several test lanes were constructed of dry processed snow in order to determine the feasibility of constructing runways of snow processed without the addition of heat or water. The test lanes were composed of snow disaggregated by and discharged from rotary snowplows. The surfaces of the leveled snow deposits were additionally processed by rolling or vibratory compacting. It was found that the vibratory compactor was effective in densifying and strengthening the surface layer when used on freshly processed snow and less effective when age hardening of the snow had taken place. Rolling was most effective when the snow temperature was near the melting point. There may be a significant difference in the properties of disaggregated snow dependent on the mechanical and operating characteristics of the different snowplows used.

**TR 54** Record deleted.

**TR 55**

**SNOW BEAMS AND ABUTMENTS USING PETER SNOW.**

Stearns, S.R., Feb. 1959, , 6p., AD-217 546.
24-3041

SNOW (CONSTRUCTION MATERIAL).

The results are reported of a pilot study in August 1957 at Site 2, Greenland, to determine the feasibility of roofing a plowed trench 8 ft wide with beams cut from Peter snow, to study the deflection of the roof beams, and to test Peter snow abutments under direct vertical load. Tapered beams 8 ft long were cantilevered over the trench to a distance of 4 ft singly and in opposed (haunched) pairs, with and without slush cementation at the median joint. The single cantilever beam showed a linear time-deflection relation, with a deflection rate of 3.15 cm/hr under severe loading and flexural stress of 1.5 kg/cm sq without immediate failure. The haunched beam without slushed center joint behaved similarly, the 2 halves apparently acting as individual beams. The deflection rate was 1 mm/hr for the first 3 days, decreasing to 0.7 mm/hr for the last 8 days. The deflection curve for the double slushed beam was similar to that of a plastic material. A rapid but decreasing deflection rate was recorded the first day, becoming constant at 1.58 mm/hr after 20 hr. The computed allowable abutment loading was 1150 lb/ft using a safety factor of 2 and the smallest failure load measured in 4 tests.

**TR 56**

**THE NARROW INFINITE WEDGE ON AN ELASTIC FOUNDATION.**

Nevel, D.E., July 1958, , 20p., AD-208 019, 3 refs.
24-3042

FLOATING ICE, CRACKING (FRACTURING), ELASTIC PROPERTIES, ICE ELASTICITY.

A method is presented for the solution of a narrow free infinite wedge on an elastic foundation loaded with a uniformly distributed load for a distance r from the corner of the wedge. This problem is important in the analysis of cracked ice sheets. The differential equation which describes this and the solution for the equation are presented. Work is continuing for obtaining numerical results for practical application.

**TR 57**

**RECOMMENDED STANDARDS FOR SMALL-SCALE ICE STRENGTH TESTS.**

Butkovich, T.R., Nov. 1958, , 6p., AD-211 569, 4 refs.
24-3043

COMPRESSIVE STRENGTH, ICE STRENGTH.

Several criteria for use in ice strength tests are reported, and a new tensile strength test for ice is described. It is recommended that in unconfined compressive strength tests the sample be cylindrical (diam 3 in.; length-to-diam ratio 3:1), and that the loading rate exceed 0.5 kg/sq cm/sec to minimize plastic effects accompanying slow loading of ice. In the new tensile strength test, a ring of ice is caused to fail under a compressive load normal to its axis; a centrally perforated ice core 2.5-3 in. long and 3 in. in diam is proposed as a standard together with a loading rate greater than 0.5 kg/sq cm/sec. The recommended sample length for beam tests of flexural strength is 75 cm; beam span, 60 cm; height, 5-6 cm; width, 10-12 cm; and loading rate, greater than 0.5 kg/sq cm/sec. As far as is known, no good simple test exists in which ice can be made to fail in pure shear.

**TR 58**

**CRITERIA FOR LANDING BOMBER AND FIGHTER AIRCRAFT ON FLOATING ICE SHEETS.**

Assur, A., April 1959, 14p., AD-317 509, 5 refs.
25-2437

ICE (CONSTRUCTION MATERIAL), AIRCRAFT LANDING AREAS, ICE COVER THICKNESS, FLOATING ICE, ICE BEARING CAPACITY, ANALYSIS (MATHEMATICS).

The purpose of this paper was to formulate the principles leading to the calculation of the required ice thickness under varying conditions and, to place the necessary operational criteria for some military aircraft.

**TR 59**

**STRENGTH DATA ON LAKE ICE.**

Frankenstein, G.E., Dec. 1959, , 6p. plus appends., AD-236 204.
24-3044

ICE COVER STRENGTH, LAKE ICE, ICE STRENGTH, TEMPERATURE FACTORS.

The results of in-place cantilever beam tests and small-beam tests with center loading, conducted in 1956-57 on lake ice in Minnesota, Wisconsin, and Michigan, are reported; the testing procedures and equipment used are described; and the data are tabulated and graphed. The tests were made on clear ice, snow-ice (dense, medium, and rough), and a combination of clear ice and snow-ice. The flexural strength of clear ice was high when the bottom was in tension and low when the surface was in tension. The flexural strength of snow-ice was unusually high, especially when the surface ice was put in tension. The flexural strength of the combination of clear ice and snow-ice was approximately the same whether the surface was in tension or compression, and higher than that of cold clear ice. No significant relation was found between temperature and strength. The strength values in small-beam tests were much higher than in in-place beam tests, but had a wider scatter. The flexural strength of clear ice in late winter or early spring with the surface layer in tension decreases at a faster rate than with the surface layer in compression.

**TR 60**

**DEEP CORE DRILLING IN ICE, BYRD STATION, ANTARCTICA.**

Patenaude, R.W., et al, July 1959, , 7p., AD-227 121.
Marshall, E.W., Gow, A.J.
24-3045

CORE SAMPLERS, DRILLING, ICE CORING DRILLS, ANTARCTICA—BYRD STATION.

The preliminary results of core examinations and drill-hole temperature studies from November 1957 - January 1958 are reported, and the drilling equipment and techniques are described. Drilling was accomplished with a Failing model 314 rotary skid-mounted well-drilling rig with a 38-ft mast, powered by a 43-bhp Buda gasoline engine. Two types of bits, both cutting a 3 7/8-in. core and a 5 3/4-in. hole, were used. The speed of rotation was varied from 40-75 rpm, and the rate of penetration ranged from 2.5-10 in/min. Compressed air was used as the drilling fluid. Good quality cores were obtained down to 1013 ft with a 98 per cent recovery. Examination of the cores revealed the presence of a detailed stratigraphic sequence down to a depth of 400 ft, consisting of alternating layers of coarse and fine-grained snow associated with ice bands 4 mm thick, which appeared singly or in closely spaced groups at regular intervals. Below this depth the ice was very homogeneous, except for thin ice bands which persisted to the bottom. The mean densities for meter increments to a depth of 150 ft, densities determined

from spot samples at 5 points from 400-721.5 ft, and drill-hole temperatures down to 1000 ft are tabulated.

**TR 61** Record deleted.

**TR 62**
**ICE FABRICS AND THE UNIVERSAL STAGE.**
Langway, C.C., Jr., Aug. 1958, , 16p., AD-206 681, 35 refs.
24-3046
ICE CRYSTAL OPTICS, OPTICAL PROPERTIES, OPTICAL MEASURING INSTRUMENTS.
Techniques for using a specially constructed universal stage for study of ice fabrics are outlined, methods of preparing ice-thin sections are discussed, and the construction of fabric diagrams is described. A table of angular corrections is given for the differences in refraction indexes between air and ice relative to the orientation of the optic axis. Applications of the data are indicated and discussed.

**TR 63** Record deleted.

**TR 64**
**SEISMIC SURVEY 1957, THULE AREA, GREENLAND.**
Roethlisberger, H., Sept. 1959, , 13p., AD-235 203, 10 refs.
24-3047
SEISMIC SURVEYS, ICE COVER THICKNESS, GLACIER ICE, GREENLAND—THULE.
Seismic reflection soundings have been carried out in the vicinity of Camp TUTO, Thule, Greenland, on the edge of the ice cap. Ice thicknesses ranging from 200 to 800 ft have been determined. With a short shot point to geophone distance only sporadic results could be obtained, while with a long distance, up to 3.5 times the ice thickness, very strong reflection signals were recorded. Evidence was found that some of the reflections did not occur at a single clear interface, indicating the presence of alternate layers of moraine and ice at the bottom of the ice cap. At one location, where the result of the seismic sounding could be compared with drilling results, the error was found to be less than 10 ft, the depth at the place being about 200 ft. Later reflection signals on the seismic records are analyzed by means of a master chart (Fig. 7). The usefulness of the reflection method has been established along the ice tunnel.

**TR 65**
**FLEXURAL STRENGTH OF CLEAR LAKE ICE.**
Hitch, R.D., July 1959, , 8p., AD-231 914, 5 refs.
24-3048
LAKE ICE, FLEXURAL STRENGTH, ICE COVER STRENGTH, ELASTICITY, TEMPERATURE EFFECTS, ICE CRYSTAL SIZE.
Values for the modulus of elasticity and strength of fresh-water lake ice in flexure were determined by laboratory experiments on 63 beams tested under various rates of loading at -5C and -20C. The results were obtained by measuring the center deflection of the test beam and the load simultaneously. Third point loading was used in order to develop a more favorable distribution of bending stresses in the middle third of the beam than with a simple beam. The experiments indicate that properties of ice vary according to loading rate, temperature, and crystal size. Specifically the results show: (1) lower temperatures give higher values of the modulus of elasticity and strength, (2) ice with larger crystals will have a higher modulus of elasticity but little difference in strength, (3) the rate of loading increases the modulus of elasticity but has little effect on the strength except at low temperatures where higher strength values are obtained with a faster rate of loading.

**TR 66**
**GLACIOLOGICAL INVESTIGATIONS, NUNATARSSUAQ ICE RAMP, NORTHWESTERN GREENLAND.**
Nobles, L.H., May 1960, , 57p., AD-652 709, 33 refs.
24-3049
GLACIER ICE, GLACIER MASS BALANCE, ABLATION, GLACIER MOVEMENT, ICE STRUCTURE, ICE COVER THICKNESS.
These investigations were conducted from 1953-55 on a gently sloping ice mass of 8 square miles extent that forms part of the margin of the Greenland Ice Cap. The ice has a subpolar thermal regime with a constant temperature of -14C at 25 ft. All runoff is on the surface forming slush avalanches, algal pits, and an integrated drainage pattern. The firn limit is at 3000 ft elevation. The ramp has a strongly negative budget balance, with local ablation as high as 25 in. of water equivalent. Velocities of ice movement range up to 2 in. per day with the vertical angle of the movement vector never deviating from the horizontal by more than 5 deg. Budget and movement studies suggest complete decay of the ramp in 300 to 600 years under present climatic conditions. Metamorphic structures of both tensional and shear origin are common and include foliation, blue bands, amber bands, joints, small crevasses and ice dikes. The military trafficability of the ramp is discussed in the appendix.

**TR 67**
**TABLES OF KELVIN FUNCTIONS AND THEIR DERIVATIVES.**
Nevel, D.E., June 1959, , 6p. plus 67p. of tables., AD-227 374.
24-3050
ANALYSIS (MATHEMATICS), MATHEMATICAL TABLES, KELVIN FUNCTIONS.
Tables of the basic functions and their first derivatives necessary for the solution of problems related to the trafficability of ice sheets are tabulated. A differential equation is given which describes the bearing capacity of a floating ice sheet (considered as a plate on an elastic foundation) together with a solution in terms of Kelvin functions. The formulas for these functions and their first derivatives are also presented. The functions were computed with a Bendix G-15D electric computer and are accurate to the last digit (12th), except for 4, which are occasionally in error in the last digit.

**TR 68**
**SNOW STABILIZATION USING DRY PROCESSING METHODS.**
Wuori, A.F., July 1960, , 16p., AD-652 710, 3 refs.
24-3051
SNOW COMPACTION, SNOW VEHICLES, COMPACTING, SNOW (CONSTRUCTION MATERIAL), SNOW REMOVAL EQUIPMENT.
Experiments were made with several methods of dry processing and compacting snow on the Greenland Ice Cap. The Peter snow miller was used to process the snow initially, followed by compaction with vibratory compactors, rollers, and a D-8 tractor. The vibration frequency was found to have some effect on the degree of compaction with the vibratory compactors. Better results were obtained by precompacting with a roller before vibration. The best compaction was obtained using a D-8 tractor with low ground pressure tracks to compact the freshly processed Peter snow. Tests show that this method of processing may be adequate to produce a snow surface and base structure capable of supporting certain types of aircraft.

**TR 69**
**PHOTO-INTERPRETATION OF VEGETATION - LITERATURE SURVEY AND ANALYSIS.**
Finley, V.P., July 1960, , 36p. plus 13p. of appends., AD-216 411, Bibliog. p.23-36.
24-3052
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, VEGETATION PATTERNS, REVIEWS.
The results of a literature survey on the applicability, capabilities, and limitations of existing airphoto interpretation techniques in determining certain physical properties of vegetation are reported. The interpretation of tree and scrub stands is emphasized, with special attention given to measurements of trunk diam and spacing, canopy height and coverage, density and height of undergrowth, and type of foilage. The accuracy of measurements are examined with respect to scale, photo characteristics, seasonal effects, and light conditions. Photographic factors affecting vegetation images, vegetation characteristics obtainable from aerial photographs, and vegetation identification and its significance as an indication of terrain conditions are discussed. The appendices contain information relative to type of photography, instrumentation, species identification, physical characteristics of vegetation, and vegetative keys used in the various literature sources studied.

**TR 70**
**DEEP CORE DRILLING IN THE ROSS ICE SHELF, LITTLE AMERICA V, ANTARCTICA. PARTS I AND II.**
Ragle, R.H., et al, June 1960, , 10p., AD-648 511.
Hansen, B.L., Gow, A.J., Patenaude, R.W.
24-3053
DRILLING, DRILL CORE ANALYSIS, ICE CORES, ANTARCTICA—LITTLE AMERICA V.
Drilling operations and core and drill hole investigations at Little America V in Oct. - Dec. 1958, as well as measurements at Byrd Station in Dec. 1958 are discussed. The hole at Little America V reached 836 ft, and core recovery was 98 per cent of the footage drilled. No saline ice was found in the bottom core, indicating that the bottom ice is melting. Periods of 2-3 consecutive years at more or less regular intervals of 10-20 yr showed intense ice formation. Layers of foreign material, tentatively identified as volcanic ash, were observed at 172.1 m, 219.4 m, and 222.8 m. The depth-density curve steepened between 20.7 and 36.5 m. If annual precipitation is estimated as 21 cm of water, Little America V rests on about 1225 yr of accumulated snow. Data (some of a preliminary nature) are tabulated and graphed: the depth-density profile to a depth of 53 m, the nature of ice at various depths, spot densities below 53 m, and the annual increments at depth and corresponding water equivalents at Little America V; ice temperature at various depths at both stations; and depth-inclination measurements as well as the diam-vs-depth curve at Byrd Station. The future research program at Little America V is outlined.

**TR 71**
**BOMB PENETRATION TESTS, FORT CHURCHILL, CANADA.**
Livingston, C.W., Sept. 1960, , 61p. plus 41 pages of appends., AD-612 875, 8 refs.
24-3054
FROZEN GROUND, MUSKEG, PROJECTILE PENETRATION, BOMBING, SUBSURFACE TRAJECTORIES, CANADA—MANITOBA—FORT CHURCHILL.
Inert mortar shells and inert general-purpose, semi-armor-piercing, and armor-piercing bombs were dropped on frozen ground (glacial till) near Fort Churchill (Can.) during the 1956-57 winter to observe projectile penetration and determine the feasibility of forming trenches and foxholes in frozen ground with aerial bombs. An analogy is drawn between plastic deformation and fluid flow, and an equation is derived which expresses the path length of a bomb penetrating a solid in terms of the weight and diam of the bomb, the density and unit weight of the material penetrated, and two coefficients which are related to the material and its resistance to bomb penetration. Using the plastic deformation equation and the postulated model law for impact, equations are derived for predicting the type of fracturing, the degree of fragmentation, and the shape of the underground trajectory. None of the bombs presently available meets the requirements for making trenches and foxholes in frozen ground. Design characteristics are given for a series of new bombs, the FH series (for foxholes), which are expected to have a greater ballistic coefficient, less bombing error, and greater penetration.

**TR 72**
**UNDER-ICE MINING TECHNIQUES.**
Abel, J.F., Jr., Jan. 1961, , 43p. plus 27p. of appends., AD-652 711, 6 refs.
24-3055
SUBSURFACE STRUCTURES, EXPLOSION EFFECTS, MINING, ICE COVER STRENGTH, ICE TUNNELS, GREENLAND—CAMP TUTO.
Methods of excavating in the Greenland Ice Cap, and the planning required, equipment employed, and the problems encountered are described individually for each of 5 operating seasons (1955-1959), and relative cost evaluations of the different methods are given. Three basic methods were used: hand-picking and manual haulage; explosives and manual haulage (drill-blast-muck cycle); and mechanized mining and haulage. Manual methods, which are of low capacity and limited to widths under 12 ft, are justified only when small openings are required, and in remote, inaccessible regions. The drill-blast-muck cycle of mining has a slightly higher capacity than manual methods, but requires power to operate the drills and to ventilate after blasting. Explosives can be used for room spans not exceeding 12 ft; when greater spans are excavated by blasting, the resulting roof is unstable. The machine method using mechanized coal mining equipment has the highest capacity and the lowest unit cost. Openings with roof spans in excess of 36 ft have been made with coal mining machines without dangerous roof conditions developing.

**TR 73**
**PERMAFROST TUNNEL, CAMP TUTO, GREENLAND.**
Abel, J.F., Jr., Oct. 1960, , 19p., AD-652 712, 6 refs.
24-3056
ICE TUNNELS, FROZEN GROUND, GLACIAL TILL, EXCAVATION, EXPLOSION EFFECTS, TUNNELING (EXCAVATION), GREENLAND—CAMP TUTO.
An experimental tunnel, 300 x 9 ft. was driven into a glacial till hillside near Camp TUTO during the summer of 1959 for the purposes of determining the feasibility of excavating subsurface openings in frozen glacial till, developing efficient methods for excavating this material, and determining the characteristics of the glacial till at depth. Excavation of frozen glacial till by conventional hard-rock mining methods, modified slightly to allow for low temperatures, was found to be feasible. The employment, effectiveness, and possible improvement of the mining methods and equipment are discussed and problems for future study are suggested.

**TR 75**
**EXPLOSIONS IN ICE.**
Livingston, C.W., Dec. 1960, 50p. plus 39p. of appends., AD-276 605, 12 refs.
24-3058
SUBSURFACE INVESTIGATIONS, UNDER-ICE EXPLOSIONS, PRESSURE WAVES, GREENLAND—CAMP TUTO.
Tests included 24 instrumented and 106 uninstrumented blasts using 4 types of explosives in spherical charges weighing 2.5-40 lb and detonated above, in contact with, and at various depths below the ice surface. Measurements were made of underice pressure, crater dimensions, flyrock travel, and airblast pressures. The results for all explosives and weights tested indicate that explosives in glacier ice deviate from cube-root scaling. Comparisons of the relations between crater volume and depth ratio, and between flyrock travel height and depth ratio indicate that: the energy used in deforming the ice without loss of cohesion is not available to the fracture process; the energy used to deform without loss of cohesion and to fracture the ice is not available to accelerate the isolated fragments; and events subsequent to the breakage process depend on the manner in which energy is partitioned to the breakage process and on all parameters affecting cratering in ice. The depth of the crater is the sum of the depth to the center of gravity of the charge and the vertical radius of the explosion cavity, which is larger for a contact burst than a charge at optimum depth, larger at critical than at optimum depth, larger at critical depth than at optimum weight, and is affected both by charge shape and type of explosive.

**TR 76**
**CUT-AND-COVER TRENCHING IN SNOW.**
Waterhouse, R.W., July 1960, , 9p., AD-652 713, Incl. 28 illus. of trenching process.
24-3059
SNOW TRENCHES, SNOW (CONSTRUCTION MATERIAL), GREENLAND.
During 1955 and 1956 a technique was developed and tested in Greenland for making snow-arch covered trenches designed for use as subsurface military shelters and communication ways on the Ice Cap. The initial installation consisted of a trench 8 ft wide and 10 ft deep over which an arched snow cover was formed on a removable steel form system. A track-mounted Swiss snow-milling machine driven by a gasoline engine was used in both the trench-cutting and roof forming operations.

Five hundred feet of covered trench were formed and instrumented to gage the time deformation and closure rate of the cavity. A sequence of photographs is included to show details of the construction technique. The appendix contains details of the snow forms.

**TR 77**

**EXCAVATIONS IN FROZEN GROUND - IGLOO FOXHOLES.**

Benert, R., Sept. 1960, , 12p., AD-652 714.

24-3060

FROZEN GROUND, EXPLOSION EFFECTS.

Tests were conducted near Houghton, Mich., in December 1954 to determine the feasibility of producing man-sized cavities beneath the frozen ground layer. Charges from 0.1-10 lb of low-velocity explosives (Coalite 7S and Gelodyn 1) were fired at depths from 10.5-48 in. in ground frozen to a depth of 6-24 in. The development of these igloo-shaped foxholes by explosive is not recommended since it is not possible to predict accurately the amount of explosive required and the igloo shape is not suitable for combat areas. However, 1 to 2 lb of Coalite 7S is sufficient to produce a 24-in. diam crater in ground frozen to a depth of 1 to 2 ft. The crater can be enlarged easily by excavating the underlying thawed ground.

**TR 78**

**DRILL-HOLE MEASUREMENTS AND SNOW STUDIES AT BYRD STATION, ANTARCTICA.**

Gow, A.J., Jan. 1961, , 12p., AD-276 606, 11 refs.

24-3061

BOREHOLE INSTRUMENTS, STRAIN RATE, BOREHOLES, DRILL CORE ANALYSIS, SNOW PHYSICS, ANTARCTICA—BYRD STATION.

Closure, temperature and inclination have been measured in a deep drill hole at Byrd Station, Antarctica. The deep hole was drilled to 1013 ft during the 1957-58 summer season, and was first fully instrumented in December 1958. The results of remeasurement in January 1960 and January 1961 indicate that temperatures in the uncased portion of the deep hole (below 150 ft) have stabilized; that the closure rate is increasing; and that insignificant inclination has occurred since the hole was drilled 3 yr ago. Results of snow studies in January 1960 show that the present rate of accumulation at Byrd Station is between 14 and 15 cm of water equivalent per year.

**TR 79**

**EXCAVATIONS IN FROZEN GROUND - CRITICAL DEPTH SHOTS (100 AND 500 LB) IN FORT CHURCHILL TILL.**

Benert, R., Jan. 1961, , 6p., AD-652 715.

24-3062

EXCAVATION, EXPLOSION EFFECTS, FROZEN GROUND, EXPLOSIVES.

Tests were conducted from February to March 1956 at Fort Churchill (Canada) to determine if the critical depth curve obtained earlier for small charges (0.5-20 lb) could be extrapolated for larger charges. The results, based on firings of three 100-lb and four 500-lb charges of Atlas 60 per cent gelatin dynamite, indicate that the definition for critical depth must be revised for the larger charges if the extrapolation is to be valid.

**TR 80**

**STRENGTH DATA ON LAKE ICE, II.**

Frankenstein, G.E., Jan. 1961, 18p., AD-701 054, 2 refs. For Pt. 1 see 24-3044.

25-2438

LAKE ICE, ICE COVER STRENGTH, BEARING TESTS.

Results are reported of 245 in-place supported beam tests and 56 in-place cantilever beam tests conducted during the 1957-58 winter on clear ice and a combination of clear and snow-ice from Chassel and Keweenaw Bays (Mich.). The supported beams had a higher computed flexural strength than similar cantilever beams. The flexural strength of the supported beams with the surface layer in tension was always higher than the supported beams with the bottom layer in tension. As reported earlier, the flexural strength of cantilever beam tests was highest when the bottom layer was in tension. On a clear day with air and ice temperatures near 0C, ice strength will decrease by as much as 6 times from morning to mid-aft. The testing equipment is illustrated, summary data are tabulated and graphed, and results of individual tests are appended.

**TR 81**

**THE APPLICABILITY OF SEISMIC REFRACTION SOUNDINGS IN PERMAFROST NEAR THULE, GREENLAND.**

Roethlisberger, H., Feb. 1961, , 19p., AD-276 607, 12 refs.

24-3063

SEISMIC REFRACTION, SEISMIC VELOCITY, PERMAFROST THICKNESS, GLACIAL DEPOSITS, ATTENUATION, TEMPERATURE EFFECTS, GREENLAND—THULE.

The applicability of the seismic refraction method for engineering purposes was investigated in the Thule area of Greenland. Special attention was given to the cases in which shallow ice overlies frozen ground and in which frozen glacial drift up to a few hundred feet thick overlies bedrock. Seismic velocities were measured in different types of sediments of the "Thule formation" and in the crystalline basement rock. The velocities in rock and frozen ground were generally high, cementation by ice being the most likely reason at the relatively low ground temperatures of about -10C. It was found that, with comparable velocity discrimination, the refraction method gives more complete information in permafrost than in unfrozen material, since later seismic events can be identified on the records shortly after the first arrival. Later events also made wide angle reflection soundings possible at a depth as shallow as 200 ft. A negative velocity gradient in the frozen ground is believed to be responsible for the rapid attenuation of the direct wave.

**TR 82**

**SUPPORTING CAPACITY OF PROCESSED SNOW RUNWAYS.**

Wuori, A.F., Aug. 1962, , 16p., AD-287 049, 3 refs.

24-3064

AIRCRAFT LANDING AREAS, SNOW (CONSTRUCTION MATERIAL), SNOW BEARING STRENGTH, STATIC LOADS, COMPRESSIVE STRENGTH.

A study of the wheel-load supporting capacity of processed snow runways was conducted at Houghton, Michigan, during 1959 and 1960. Static load tests were made on processed snow in test bins to determine the extent of disturbance by a surface load and type of failure produced. Test sections of processed snow runways were trafficked with an aircraft tire using wheel loads of up to 35,000 lb. Ram hardness, unconfined compression, and California Bearing Ratio field tests were also performed, and results of the tests were compared. It was found that it will be possible to predict the supporting capacity of snow pavements from the results of simple tests, especially the ram hardness tests.

**TR 83**

**SNOW STABILIZATION FOR ROADS AND RUNWAYS.**

Wuori, A.F., Jan. 1963, , 20p., AD-414 995, 3 refs.

24-3065

SNOW ROADS, AIRCRAFT LANDING AREAS, SNOW (CONSTRUCTION MATERIAL), SNOW COMPACTION, SNOW BEARING STRENGTH, GREENLAND.

A study of methods of stabilizing snow for roads and runways was conducted on the Greenland Ice Cap during the summer of 1959. Dry-processing methods included use of two types of rotary snow plows followed by leveling and compaction with a D-8 low ground pressure tractor. A thin surface layer of a previously dry-processed lane was also heat-processed to produce a stronger wearing surface. Tests showed that dry processing produced a pavement structure which was capable of supporting certain types of wheeled cargo aircraft after 3 weeks of age hardening. For support of aircraft with tire pressures exceeding 100 psi, heat processing of a thin surface layer may be necessary.

**TR 84**

**EXPERIMENTS ON GREENLAND WHITEOUT MODIFICATION - 1960.**

Jiusto, J.E., et al, Aug. 1961, , 21p., AD-276 608, 9 refs.

Rogers, R.R.

24-3066

WHITEOUT, WEATHER MODIFICATION, CLOUD SEEDING, DRY ICE (TRADEMARK), NUCLEATING AGENTS.

A 2-month experimental program was conducted in Greenland to determine the extent to which arctic whiteouts and low clouds could be modified using cloud dissipation techniques. Seven seeding agents, applicable to supercooled or warmer-than-freezing clouds, were tried employing aircraft, tethered blimp-balloon, and rocket delivery. Successful dissipation of supercooled clouds was achieved with dry ice. As little as 5 lb of dry ice per mile, dispersed from aircraft, produced efficient clearing action and line openings up to 2.5 miles wide. An inexpensive seeding scheme, involving a tethered blimp-balloon and open baskets of dry ice attached at intervals along the tether line, was shown to be capable of opening holes in low cloud overcasts. Such a technique appears feasible for maintaining safe landing corridors at ice-cap airstrips during fog and low stratus conditions. Seeding materials that were ineffective in dissipating the supercooled clouds or warmer-than-freezing clouds encountered were liquid carbon dioxide, Greenland soil particles, silver iodide, carbon black, calcium chloride, and sodium chloride. Cloud hydrometeor and atmospheric nuclei measurements were made in relation to the modification tests. Specialized seeding equipment for specific arctic operations are recommended.

**TR 85**

**A CORRELATION OF UNCONFINED COMPRESSIVE STRENGTH AND RAM HARDNESS OF PROCESSED SNOW.**

Abele, G., Jan. 1963, , 14p., AD-299 263, 17 refs.

24-3067

SNOW COMPRESSION, SNOW STRENGTH, HARDNESS TESTS, COMPRESSIVE STRENGTH.

Extensive snow road and runway tests were made at Houghton, Michigan and Site 2, Greenland in 1958-1960, and the tests were conducted in such a way that the results could be used for correlating compressive strength and ram hardness of processed snow. The testing and coordination methods are described and the results are summarized graphically. The unconfined compressive strength of dry, processed snow was found to be a function of the logarithm of the ram hardness number; an equation of this relationship is presented. The correlation is intended as an aid to determining unconfined strength from ram hardness and the scatter of points indicates that it should be used with caution. Possible modifications of present Rammsondes for use in compacted snow are discussed.

**TR 86**

**EXPLOSIONS IN SNOW.**

Livingston, C.W., May 1968, , 124p., AD-672 056, 9 refs.

24-3068

SEISMIC SURVEYS, EXPLOSION EFFECTS, EXPLOSIVES, SNOW MECHANICS, SUBSURFACE INVESTIGATIONS, SNOW LOADS.

Studies were made to establish means of predicting and optimizing the results of blasts in snow of the Greenland Ice Cap. A total of 141 test blasts were fired above and at various depths below the snow surface using three types of explosives. Seismic measurements were taken of all shots, and 32 were instrumented for measurement of airblast and/or undersnow shock pressure. The failure process in snow differs from that in glacier ice, frozen ground, rock, and certain types of soil. Characteristic features of this failure (referred to here as "viscous-damping failure") are: 1) damping of the disturbance during the rise to peak pressure, and 2) substantial recovery of stored potential energy during unloading. Both features result because air in substantial quantity is trapped within the voids in snow. Tables, curves, equations, and example problems presented in the report make it possible, within the range of the experiments, to accurately predict any desired dimensions of the limit of complete rupture. Limits of complete rupture and limits of extreme rupture in snow are correlated empirically using cube-root scaling as a first approximation. The effect of the type of material upon the relation of energy utilization number and depth ratio is summarized for snow, ice, and frozen ground.

**TR 87**

**ELECTRICAL D-C RESISTIVITY MEASUREMENTS ON GLACIER ICE NEAR THULE, GREENLAND.**

Meyer, A.U., et al, Oct. 1962, , 34p., AD-292 935, 11 refs.

Roethlisberger, H.

24-3069

GLACIER ICE, ICE ELECTRICAL PROPERTIES, ELECTRICAL RESISTIVITY, ICE COVER THICKNESS, GREENLAND—THULE.

The results of electrical d-c resistivity measurements carried out at the surface of cold glaciers near Thule and on the firn of the Greenland ice sheet as well as inside excavations in glacier ice are reported. A resistivity of the order of 100 kilo-ohm-m was found in the firn at temperatures of about -24C and in glacier ice at about -12C, as opposed to values of many megohm-m in temperate glaciers as reported in the literature. An indication was obtained of considerably higher resistivities than 100 kilo-ohm-m in the ice of a long valley glacier and close to the bottom of thin glaciers with little movement. The interpretation in terms of ice thickness proved to be highly ambiguous, and the resistivity method was accordingly of little use for sounding purposes under the conditions encountered. Non-linear phenomena were observed with small electrode separations inside the excavations. Recommendations are made on the construction of a field instrument for measurements on glaciers or other high resistivity material.

**TR 88**

**TRAFFICABILITY IN SNOW TRENCHES.**

Abele, G., Feb. 1963, , 13p., AD-430 193, 3 refs.

24-3070

SNOW TRENCHES, TRAFFICABILITY, SNOW (CONSTRUCTION MATERIAL), VEHICLES, RAILROADS, SUBSURFACE STRUCTURES, SNOW BEARING STRENGTH, HARDNESS, COMPRESSIVE STRENGTH, GREENLAND.

During the 1960 Greenland test season, a study was made on the trafficability of snow-trench floors, including rail traffic on a natural snow floor and heavy wheel-load traffic on both natural snow and snow processed by a Peter snow miller. The effect of aluminum landing mats and a neoprene-coated nylon membrane was investigated. It was found that a natural-snow trench floor is not capable of supporting heavy, standard wheel-load traffic. The processed-snow floor is capable of supporting 7000-lb wheel loads for at least 500 coverages without any indications of failure or surface wearing. The use of landing mats appears to be unnecessary, and the membrane as a wearing surface is unsuitable because of its slippery surface. The natural snow floor is capable of supporting mine rail traffic and may be able to support a full-size railroad system, but further study is necessary. Investigation is also needed on heavy wheel-load traffic in a curved trench and at a higher speed.

**TR 89**

**LOAD TEST DATA FOR LAKE ICE SHEETS.**

Frankenstein, G.E., Jan. 1963, 14p. plus 15p. appendix, AD-414 955, 3 refs.

24-3071

LAKE ICE, ICE COVER THICKNESS, ICE COVER STRENGTH, LOADS (FORCES).

This report gives the results of 13 load tests conducted at Dollar Bay, Michigan; Riverdale, North Dakota, and Keweenaw Bay, Michigan, to determine the bearing capacity of lake ice. A large tank filled with water was used as the load. In 7 tests (large load tests) a 12 ft diam tank was used as the bearing surface; a 17.3 in. diam block was used in the other six (concentrated load tests). The platform on which the tank was set in the large load tests was balanced on the block in the concentrated load tests. The large load tests produced circumferential cracks which indicated that the ice was about to fail. In the concentrated load tests, no circumferential cracks were present and consequently there was no indication as to when the ice would fail.

**TR 90**
**SHEAR STRESS MEASUREMENTS IN SITU OF SOILS SUBJECTED TO VIBRATORY LOADS.**
Bernhard, R.K., Nov. 1963, 11p., AD-433 800, 10 refs.
24-3072
SOIL STRENGTH, SOIL MECHANICS, SOIL TESTS, TEST EQUIPMENT.
A miniaturized shear cell is described. Results of measurements in situ with this shear cell are compared with those of pressure cells. Vibratory (sinusoidal) loads were generated by a mechanical oscillator on the surface of the soil and transmitted to both types of cells buried underneath. A predominantly homogeneous and non-cohesive soil was selected so that as a first approximation the theory for biaxial stress distribution could be applied in the analysis. The standard deviations of the corresponding shear and normal stresses did not exceed 5.3 per cent.

**TR 91**
**TUNNELING IN PERMAFROST, II.**
Swinzow, G.K., Jan. 1964, 18p. plus 6p. appends., AD-435 608, 16 refs.
24-3073
TUNNELING (EXCAVATION), PERMAFROST, MINING, EXPLOSION EFFECTS, FROZEN GROUND.
During the 1960 field season, the permafrost tunnel begun in 1959 in the Tuto area in Greenland was extended to 605 ft and three rooms were excavated off the main drift. Mining methods and equipment are described and evaluated. The action of explosives on permafrost was investigated and various types of powder are evaluated. The use of advantages provided by the cold environment was demonstrated. A new building material, "permacrete", was successfully used and its application demonstrated. The glaciology of the region is re-examined in the light of evidence revealed by excavation. It is concluded that permafrost provides a safe underground shelter and that "permacrete" presents a most suitable material for fortification.

**TR 92**
**EFFECT OF EXPLOSIONS ON SNOW STRUCTURES.**
Szostak, H., et al, April 1966, 25p. plus 31p. appendix, AD-640 974.
Benert, R.
24-3074
EXPLOSION EFFECTS, SNOW MECHANICS.
Tests were made to study the effects on snow structures of surface and above-surface high explosive blasts from 4- and 32-lb spherical cast TNT charges. A number of small- and full-scale vertical and full-size horizontal arches were constructed in processed snow pads. Arch spans and arch crown thickness were varied to establish a relation between surface overpressure and the ratio of arch span (S) to arch crown thickness (T). Some correlation was found for vertical arches but none between vertical and horizontal arches. The results show that, for the same charge weight and S/T ratio, the horizontal arches can withstand over 100 psi over-pressure while small-scale vertical arches fail at 20 psi.

**TR 93**
**PENETRATION OF PROJECTILES INTO FROZEN GROUND.**
Livingston, C.W., et al, March 1965, 44p., AD-616 348, Contract DA-11-190-ENG-94.
Waldron, H.L.
24-3075
EXPLOSIVES, FROZEN GROUND MECHANICS, BOMBING.
During 1960 and the first half of 1961, Barodynamics, Inc., designed, manufactured, and field tested 105 bombs specially designed to penetrate deeply frozen ground. The bombs were divided in three series: 2.50 in. diam (approx 30 lb each), 2.75 in. diam (approx 40 lb each), and 3.25 in. diam (approx 66 lb each). These bombs (29 of each series) were made geometrically similar to eliminate shape as a variable. In addition, 3 bombs of each diameter were made shorter and 3 longer in order to check the effect of different geometry. During three field tests, bombs were dropped from helicopters into unfrozen, shallowly frozen, and deeply frozen ground at striking velocities ranging from 252 to 800 ft/sec; penetrations up to 25 ft were achieved. Data concerning design, manufacture, and field tests, and their results were presented. For a given bomb penetrating a given material, penetration of the nose in feet is shown to be a straight-line function of striking velocity in feet per second. This is in accordance with the Livingston penetration equation, the basis of design.

**TR 94**
**DEEP ROTARY CORE DRILLING IN ICE.**
Lange, G.R., Feb. 1973, 47p., AD-758 156, 28 refs.
27-2947
ICE CORING DRILLS, GLACIER ICE, CRACKING (FRACTURING), GREENLAND, ANTARCTICA—BYRD STATION, ANTARCTICA—LITTLE AMERICA V.
Rotary drilling equipment was modified and used to obtain cores from glaciers in Northwest Greenland, Byrd Station and Little America V, Antarctica. Using cold compressed air, specially designed bits and other modifications, cores were obtained to 1545 feet in Greenland, 1000 feet at Byrd Station and the Ross Ice Shelf was penetrated to a depth of 840 feet at Little America V. In all locations cracks in the core appeared with increasing frequency at depth due to the sudden release of the overburden load when the core was cut in the air-filled hole. Special equipment and techniques developed dealt with the problem with some success. It is suggested that better cores and greater depths may be obtained by using diesel fuel as the circulating medium. A wireline system instead of drill pipe is suggested for coring to 10,000 foot depths in polar glaciers.

**TR 95**
**ROTARY DRILLING AND CORING IN PERMAFROST - PART 1, PRELIMINARY INVESTIGATION, FORT CHURCHILL, MANITOBA.**
Lange, G.R., Nov. 1968, 19p., AD-681 218, 9 refs.
24-3076
ROTARY DRILLING, PERMAFROST STRUCTURE, CORING, EQUIPMENT.
A small rotary drill rig was instrumented and used at Fort Churchill, Monitoba, to investigate the problems of drilling and coring in permafrost. Small diameter augers were also tested. Adequate rates of penetration were easily achieved. However, difficulties were encountered when hole walls and core were thawed by warm drilling fluid. Some success was achieved when coring with water cooled by ice. It was concluded that the feasibility of using a low freezing point liquid and/or compressed air and a portable refrigerator should be investigated.

**TR 95/3**
**ROTARY DRILLING AND CORING IN PERMAFROST. PART III, DEEP CORE DRILLING, CORE ANALYSIS AND BORE HOLE THERMOMETRY AT CAPE THOMPSON, ALASKA.**
Lange, G.R., et al, Sept. 1972, 28p., AD-762 355, 10 refs.
Smith, T.K.
28-590
ROTARY DRILLING, CORING, DRILL CORE ANALYSIS, PERMAFROST SAMPLERS, SOIL TEMPERATURE, PERMAFROST THERMAL PROPERTIES, UNITED STATES—ALASKA.
Two holes were successfully drilled and cored to depths of 1000 ft and 1200 ft in the frozen mudstone of the Tiglukpuk formation at Cape Thompson, Alaska. Permafrost extends to a depth of approximately 1000 ft. The hole walls were successfully stabilized, even in zones of very weak rock, by the use of refrigerated diesel fuel as a drilling fluid, and frozen cores of good quality were taken with little difficulty. A thermistor cable was inserted in one of the holes and ground temperatures were measured to 1000 ft with a high order of accuracy and stability. Data required to predict accurate equilibrium temperatures were available one month following installation. The frozen cores were shipped to refrigerated laboratories where special methods of testing were developed for determination of some of their physical properties in the naturally frozen state. The total liquid content, as determined by oven drying, was found to be substantially greater than the water content as determined by Soxhlet extraction. It is inferred that water content determinations as normally carried out in the laboratory often do not indicate the original water content of the rock or soil samples obtained by core drilling with a liquid.

**TR 96**
**LABORATORY EVALUATION OF FROST HEAVE CHARACTERISTICS OF A SLAG - FLY ASH - LIME BASE-COURSE MIXTURE.**
Kaplar, C.W., Jan. 1963, 28p., AD-404 622, 5 refs.
24-3077
SUBGRADE SOILS, FROST ACTION, FROST HEAVE, COUNTERMEASURES, TESTS.
Sixteen specimens of a slag-fly ash-lime base-course mixture were tested for frost susceptibility in the laboratory. The mixture consisted of 66 per cent slag, 30 per cent fly ash and 4 per cent lime, by weight. Base courses of this type are being used in certain parts of the country in competition with conventional base-course materials. Test results showed that oven-cured specimens heaved insignificantly even after 10 cycles of slow freezing in an open-system test, and were classified to be of low frost susceptibility. In accordance with adopted criteria, based on average rate of heave in mm/day, most moist-cured and soaked specimens were classified as very low frost-susceptible. Specimens cured only in moist sand performed significantly better on the whole than those first submerged in water and then moist-cured. On "moist-cured only" specimens, heaving decreased with increase in curing time. The maximum measured heave of any of the cured specimens, soaked or otherwise, during any one freezing cycle was approximately 0.2 in. and about 3.3 per cent.

**TR 97**
**A REVIEW OF MUSKEG AND ITS ASSOCIATED ENGINEERING PROBLEMS.**
Pihlainen, J.A., Dec. 1963, 56p. plus 4p. appendix, AD-434 077, 197 refs.
24-3078
MUSKEG, CONSTRUCTION EQUIPMENT.
Towards a reassessment of muskeg, an appraisal of the problems of muskeg showing the complexity of the subject and the implications for engineering is presented based on field experience and a study of the literature. A theory of the origin of muskeg is given from the engineer's point of view by considering climatic, biotic, and geologic factors. Muskeg research in other countries is reviewed with emphasis on Canadian research. The Radforth Muskeg Classification System, its application to problems and modifications are discussed. Empirical data on the engineering properties of peat are broadly described in four main categories: (1) index properties, for identification; (2) strength and deformation properties; (3) thermal properties; and (4) geophysical properties. Engineering problems, construction equipment, and costs to be considered in vehicle trafficability, road construction, corrosion and drainage operations, and frozen muskeg and permafrost construction when muskeg is involved are fully discussed. Comprehensive conclusions and recommendations on the present state of knowledge of muskeg and needs for further research are outlined.

**TR 98** Record deleted.

**TR 99**
**TRAFFIC TESTS ON PORTAGE LAKE ICE.**
Stevens, H.W., et al, Dec. 1969, 49p. plus plates, AD-700 130, 4 refs.
Tizzard, W.J.
25-984
TRAFFICABILITY, LAKE ICE, FLOATING ICE, ICE BEARING CAPACITY, LOADS (FORCES), COMPRESSIVE STRENGTH, FLEXURAL STRENGTH, ICE CRYSTAL SIZE, ICE CRYSTAL STRUCTURE.
A limited series of traffic tests was conducted on floating lake ice using a dual-wheel loaded to gross weights of 20,250; 28,250 and 36,250 lbs. Deflections were measured under static and moving loads on a continuous ice sheet and adjacent to a free edge. Representative samples of the ice were tested in unconfined compression, direct shear, flexure, and under a dynamic load (steady-state vibration). Crystal size and orientation were measured. An analysis of test results is presented using linear elastic theory and a method is proposed for estimating time variations of deflection.

**TR 100**
**GROUND TEMPERATURE OBSERVATIONS, FORT YUKON, ALASKA.** July 1962, 14p., AD-295 862.
24-3079
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—FORT YUKON.
This report summarizes climatological, ground-temperature, and soil data obtained at Fort Yukon, Alaska. The climatological data were obtained from U.S. Weather Bureau records for the years 1928 to 1958; the ground-temperature data were obtained from daily observations during the years 1947 to 1958; and the soil data were obtained from samples taken while drilling two holes: one in July 1946 and the other in July 1958.

**TR 101**
**GROUND TEMPERATURE OBSERVATIONS, ANIAK, ALASKA.**
Aitken, G.W., et al, Aug. 1962, 14p., AD-404 752.
Fulwider, C.W.
24-3080
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—ANIAK.
This report summarizes climatological, ground-temperature, and soil data obtained at Aniak, Alaska. The climatological data were obtained from U.S. Weather Bureau Records for the years 1944 to 1958; the ground-temperature data were obtained from daily observations during the years 1947 to 1958; and the soil data were obtained from samples taken while drilling two holes: one in August 1946 and the other in July 1958.

**TR 102**
**GROUND TEMPERATURE OBSERVATIONS, GALENA, ALASKA.**
Aitken, G.W., May 1963, 15p., AD-430 015.
24-3081
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—GALENA.
This report summarizes climatological ground-temperature and soil data obtained at Galena, Alaska. The climatological data were obtained from U.S. Weather Bureau Records for the years 1944 to 1957; the ground-temperature data were obtained from daily observations during the years 1947-1958; and the soil data were obtained from samples taken while drilling two holes: one in July 1946, and the other in April 1958.

**TR 103**
**GROUND TEMPERATURE OBSERVATIONS, MCGRATH, ALASKA.**
Aitken, G.W., Jan. 1964, 13p., AD-446 904.
24-3082
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—MCGRATH.
This report summarizes climatological, ground-temperature, and soil data obtained at McGrath, Alaska. The climatological data were obtained from U.S. Weather Bureau records for the years 1944 to 1958; the ground-temperature data were obtained from daily observations during the years 1947 to 1958; and the soil data were obtained from samples taken while drilling two holes: one in August 1946 and the other in July 1958.

**TR 104**
**GROUND TEMPERATURE OBSERVATIONS, BIG DELTA, ALASKA.**
Aitken, G.W., May 1964, 15p., AD-446 905.
24-3083
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—BIG DELTA.

This report summarizes climatological, ground-temperature and soil data obtained at Big Delta, Alaska. The climatological data were taken from U.S. Weather Bureau records. Various periods-of-record were used with a minimum period of 10 years unless otherwise stated in the report. The ground-temperature data were obtained from daily observations during the years 1947-1960; and the soil data were obtained from samples taken when drilling the ground-temperature well in June 1946, and during the excavation of a test pit in May 1962.

**TR 105**
**GROUND TEMPERATURE OBSERVATIONS, BARROW, ALASKA.**
Aitken, G.W., May 1965, 15p., AD-471 018.
24-3084
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—BARROW.

This report summarizes climatological, ground-temperature, and soil data obtained at Barrow, Alaska. The climatological data were obtained from U.S. Weather Bureau records. Various periods-of-record were used, the minimum being 10 years unless otherwise noted in the report. The ground-temperature data presented were obtained from daily observations during the years 1947 through 1956 with the soil data obtained from samples taken while drilling two holes: one in July 1946 and the other in October 1957.

**TR 106**
**GROUND TEMPERATURE OBSERVATIONS, GULKANA, ALASKA.** Nov. 1964, 13p., AD-471 019.
24-3085
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—GULKANA.

This report summarizes climatological, ground-temperature, and soil data obtained at Gulkana, Alaska. The climatological data were obtained from U.S. Weather Bureau records. Various periods-of-record were used, the minimum being 10 years unless otherwise noted in the report. The ground-temperature data presented were obtained from daily observations during the years 1952 to 1958, and the soil data were obtained from samples taken while drilling two holes; one in June 1946 and the other in February 1955.

**TR 107**
**GROUND TEMPERATURE OBSERVATIONS, NORTHWAY, ALASKA.**
Aitken, G.W., Oct. 1964, 14p., AD-451 313.
24-3086
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—NORTHWAY.

This report summarizes climatological, ground-temperature and soil data obtained at Northway, Alaska, in the period 1952-1961. The climatological data were obtained from U.S. Weather Bureau records. Various periods-of-record were used, the shortest being 10 years unless otherwise noted in the report; the ground-temperature data were obtained from observations during the years 1952-1960; and the soil data were obtained from two holes: one drilled in September, 1952 and the other in October, 1961.

**TR 108**
**GROUND TEMPERATURE OBSERVATIONS, KOTZEBUE, ALASKA.**
Aitken, G.W., June 1965, 14p., AD-471 020.
24-3087
SOIL TEMPERATURE, SOIL ANALYSIS, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA—KOTZEBUE.

This report summarizes climatological ground-temperature and soil data obtained at Kotzebue, Alaska. The climatological data were taken from U.S. Weather Bureau records. Various periods of record were used with a minimum period of 10 years unless otherwise stated in the report. The ground-temperature data were obtained from daily observations during the period 1947-1958; and the soil data were obtained from samples taken during drilling operations in August 1946, July 1958, July 1962 and June 1963.

**TR 109** Record deleted.

**TR 110** Record deleted.

**TR 111** Record deleted.

**TR 112** Record deleted.

**TR 113** Record deleted.

**TR 114** Record deleted.

**TR 115** Record deleted.

**TR 116** Record deleted.

**TR 117** Record deleted.

**TR 118** Record deleted.

**TR 119** Record deleted.

**TR 120**
**EXCAVATIONS IN FROZEN GROUND ALASKA, 1960-61.**
McCoy, J.E., Feb. 1965, 10p. plus 18p. appends., AD-616 314.
24-3088
FROZEN GROUND MECHANICS, EXCAVATION.

Spherical and cylindrical charges of 1, 4, 8, 32, 256 and 2560 lb were exploded in frozen silt near Fairbanks, Alaska, to investigate the applicability of lambda scaling for placing charges in frozen ground. One hundred and thirty holes, ranging from 3 to 6 in. in diameter, and 2 to 6 ft in depth, were drilled with a truck-mounted core drill. Compressed air, passed through an air-to-air heat exchanger to cool it below 25 deg F, was used as a drilling fluid. Charge emplacement, stemming, and detonation are also described. Six basic series were fired which, except for the 2560-lb shots, consisted of two spheres and two cylinders buried at each of six scale depths. The crater volume was calculated by the centroid-volume method. A planimeter was used to measure the area of two mutually perpendicular cross sections through the center of the blast hole. Upon detonation of charges of a given weight at increasing depths, the resultant crater will increase to a maximum and rapidly drop off and disappear. At depths slightly beyond optimum, lambda scaling does not apply and the results are indeterminate.

**TR 121**
**CAMP CENTURY MOVEMENT RECORD.**
Waterhouse, R.W., et al, May 1963, 75p., AD-430 148, 5 refs.
Tobiasson, W., Scott, B.G.
24-3089
METEOROLOGICAL DATA, DEFORMATION, CONSTRUCTION MATERIALS, UNDERSNOW FACILITIES, SNOW PHYSICS, SNOW DENSITY.

Snow deformation studies are being made in the undersnow facilities at Camp Century on the N. Greenland Ice Cap to define the "useful life" of such facilities. The initial measurements were made in Aug. 1959 and since then cross section measurement stations, settlement recording Helipots (helical potentiometers), and a camp bench mark system have been installed. Results through May 1962 are presented. Twenty-nine Helipots, installed on structures within the tunnels, record movement between the structure and the tunnel arch or floor. The horizontal and vertical distances between wooden pegs set in the tunnel walls at 19 stations to determine profile variations in the tunnel cross sections are measured periodically with a steel tape. Grid lines were painted on several side tunnel portals of various sizes and shapes and will be photographed periodically to determine patterns of deformation. The various Helipot installations are diagrammed and the relative movements recorded by each are graphed. The 19 tunnel cross sections being studied are also diagrammed and rates of closure at each station graphed, and the elevation variations of the bench marks with time are tabulated.

**TR 122**
**MECHANICS OF PENETRATION OF PILES INTO PERMAFROST.**
Charest, J., et al, Sept. 1965, 98p., AD-632 198, Contract DA-11-190-ENG-92, 9 refs.
Duler, P., Rinehart, J.S.
24-3090
PILE DRIVING, PERMAFROST PHYSICS.

A comprehensive study was made of rapid pile driving into permafrost. The experimental work was limited to the study of piles alone. Laboratory tests were conducted by driving various model piles with guns into artificial permafrost. A single series of field tests was made near Fairbanks, Alaska, in which hollow, circular, full-size piles were launched into permafrost, using an Army practice solid-fuel rocket as the driving agent. Penetration was studied as a function of impact velocity, mass, and pile-shape factor. In both laboratory and field tests the ratio of pile penetration to maximum transverse pile dimension was limited to less than 20. The artificial permafrost used for most of the laboratory tests was prepared from graded Ottawa sand, type Wausau 3/0, saturated with water and frozen at -6C. This mixture has an average density of 1.77 g/cu cm and an average water content of 23 per cent. Other more limited testing was done with a few other types of permafrost made with bauxite, fine Ottawa sand, pure ice, Golden sand, and ground silica. The similarity of results obtained with different types of artificial permafrost indicates that the relationships developed in the laboratory could be applicable to field-test results.

**TR 123/1**
**ADDITIVES FOR MODIFYING THE FROST SUSCEPTIBILITY OF SOILS.**
Lambe, T.W., et al, March 1971, 41p., AD-721 752, 20 refs.
Kaplar, C.W.
26-2298
FROST ACTION, SOIL AGGREGATES, SOIL CHEMISTRY, FROST PROTECTION, WATERPROOFING, SOIL TESTS, SOIL FREEZING.

Fifty-two additives to reduce the frost susceptibility of soil were tested on twenty-five soils. The theoretical considerations underlying the choice of additives are discussed. The additives are divided into five groups according to their action in soil: (1) void fillers and cements, (2) aggregants, (3) metallic salts, (4) waterproofers, and (5) dispersants. A number of additives, especially dispersants and polyvalent cation salts, merit further laboratory evaluation. Resins and waterproofers also look promising. Four freeze-thaw cycles on four different dispersant-treated soils tested in the laboratory showed no diminution of effectiveness of treatment. A small-scale field test showed a laboratory-proved dispersant to be effective under field conditions: measurements made over two seasonal freezing cycles showed retention of original effectiveness of the dispersant treatment.

**TR 123/2**
**ADDITIVES FOR MODIFYING THE FROST SUSCEPTIBILITY OF SOILS. PART 2.**
Lambe, T.W., et al, Oct. 1971, 41p., AD-733 321, 10 refs.
Kaplar, C.W., Lambie, T.J.
26-2768
FROST ACTION, SOIL CHEMISTRY, FROST PROTECTION, SOIL AGGREGATES, WATERPROOFING, SOIL TESTS, FROST HEAVE.

Tests showed that a dispersant, tetrasodium pyrophosphate (TSPP), and an aggregant, ferric chloride, possess good frost-heave-modifying capabilities. Limited field tests indicated that TSPP can reduce heave significantly under natural conditions. Laboratory tests were conducted to determine the effect of prolonged water attack on the frost-heave-modifying capabilities of 0.3 percent treatments of TSPP and ferric chloride when used with two silty sandy gravels. The tests showed that in terms of percentage reduction of heave, the effectiveness of TSPP was not mitigated by water attack while the effectiveness of ferric chloride was slightly lessened. Both additives reduced the frost susceptibility of the soils from classification of "medium to high" to "very low to low." Theory and experimental data are presented which help to explain the response of the soils to treatment and freezing.

**TR 124**
**ELEVATIONS ON THE ICE SHEET OF SOUTHERN GREENLAND.**
Mock, S.J., et al, March 1963, 9p., AD-430 062, 6 refs.
Ragle, R.H.
24-3091
GLACIER OSCILLATION, GLACIAL FEATURES, ELEVATION, HEIGHT FINDING.

A Corps of Engineers research expedition operating on the Greenland ice sheet during the summer months of 1959 and 1960 studied the stratigraphy, density and temperature variations through the upper 10 m of snow and firn. Elevations of over 200 points on the ice sheet were determined from barometric readings taken by leap frog altimeter techniques. These elevations are within p/m 50 ft of the true elevation and are consistently several hundred feet lower than those indicated on the latest World Aeronautical Charts. The theory and equations of the relationship between elevation and pressure, corrections for temperature, relative humidity, effect of variation of gravity, and cyclonic-induced pressure changes are shown. Equipment and methods used are described and compared with the Expeditions Polaires Francaises techniques.

**TR 125**
**APPROACH ROADS, GREENLAND 1958-59.**
Davis, R.M., June 1971, 91p., AD-726 914, 10 refs.
26-2345
ROADS, GLACIER ICE, CULVERTS, CLIMATOLOGY, ABLATION, TEMPERATURE MEASUREMENTS, THAW DEPTH, GREENLAND—CAMP TUTO.

Project 1, Approach Roads, Greenland R & D Program, was organized in 1954 to develop methods, techniques and criteria for constructing roads on both glacial ice surfaces and adjacent ice-free terrain. This report covers activities for the years 1958 and 1959, which consisted of construction of additional roads and culverts and an annual assessment of the performance of the various roads and other structures on the ice cap. Special measurements were made of ice surface movement, subsurface temperature and melt-water runoff.

**TR 126**
**PRODUCTION ANALYSIS OF CUT-AND-COVER TRENCH CONSTRUCTION.**
Abele, G., Aug. 1964, 16p., AD-613 266, 6 refs.
24-3092
SNOW TRENCHES, SNOW TUNNELS, CONSTRUCTION MATERIALS, TRENCHING.

During the 1961 and 1962 summer test seasons at Camp Century, Greenland, a 1600-ft-long trench containing horizontal curves was constructed. A total of 105 hr 45 min of Peter-plow machine time was required for the cutting operation. Of this, 64 hr 45 min were spent in actual cutting, which gives a rate of 24.7 ft of trench per hr, or 300 ft (24 ft deep, 18 ft wide at bottom) per 20-hr work day. The overall cutting production, including spoil cuts, was 446 cu yd/hr or 166 tons/hr of snow excavated. The trench-cut average was 359 cu yd/hr or 134 tons/hr. The trench-covering operation required an additional 16 Peter-plow-hr and a total of 290 man-hr for the arch installation, a rate of 5.5 ft of roof per man-hr. The arch removing required approxmately 27 per cent of the installation time. The trench-floor processing was done at a rate of 160 ft of floor per hr, and the leveling at a rate of 400 ft/hr. A total of 176 man-hr was required to install the electrical system and exhaust fans. The production factor for cutting a straight trench was between 1.3 and 1.4 times that of a curved trench.

**TR 127**
**PRELIMINARY INVESTIGATIONS OF PERMACRETE.**
Swinzow, G.K., Feb. 1965, 19p. plus 1p. appendix, AD-624 798, 13 refs.
24-3093
COLD WEATHER CONSTRUCTION, CONSTRUCTION MATERIALS, CONCRETES, PERMACRETE, TESTS.

Ultimate flexural strength and certain creep properties of single-size soil-material aggregates cemented by ice are investigated.

The relation of ultimate strength to particle size and temperature is given in the form of graphs. Rules for mixing various sizes are established, and their validity tested under field conditions. Experimental construction in permacrete (artificial concrete-aggregate mixtures cemented by ice) disclosed that it should be applied and handled like concrete, providing the temperature is below the freezing point. Permacrete, although dissimilar to concrete in many important properties, may be used successfully as a building material in place of concrete. Its low cost and the availability of ingredients can make permacrete an important building material in permafrost regions.

**TR 128**
**SURVEY OF SNOW AND ICE REMOVAL TECHNIQUES.**
Minsk, L.D., Dec. 1964, 48p., AD-614 431, 27 refs.
24-3094
ICE REMOVAL EQUIPMENT, SNOW REMOVAL EQUIPMENT, CHEMICAL ICE PREVENTION, MECHANICAL ICE PREVENTION.
This report summarizes snow removal techniques, status of knowledge in this field as of 1960, and future considerations. During the winter of 1958-59, a comprehensive survey of snow and ice removal practices at eight Air Force bases, thirteen state highway departments, and one R.C.A.F. base in Canada was made. During Jan-March 1960, a similar survey was made in six European countries. Mechanical, chemical, and thermal methods of snow removal are discussed and extensive data are given on various types of snow and ice removal equipment.

**TR 129** Record deleted.

**TR 130**
**PENETRATION OF SHAPED CHARGES INTO FROZEN GROUND PART II.**
Benert, R., Nov. 1963, 10p. plus 6p. appendix, AD-433 194, For Part 1 see 24-3032. 5 refs.
24-3095
FROZEN GROUND MECHANICS, EXPLOSION EFFECTS, PENETRATION TESTS, BLASTING.
The effect of various parameters was studied to design a charge that would do the work of the U.S. Army M2A3 (15 lb) shaped charges with as large a saving in weight as possible. During February and March 1957, shaped charges of special design with a 4 in. diameter and weighing from 2 1/2 to 3 1/2 lb were fired into frozen ground at Fort Churchill, Manitoba. Data were obtained on the effect of standoff, charge weight and cone material, thickness, and angle. Results of the testing showed that a hole 5 ft deep and 1.7 in. in diameter in frozen ground can be obtained with a shaped charge weighing 2.8 lb. Aluminum cones are superior to copper or steel cones. Machined aluminum cones give greater penetration than rotary extruded aluminum cones. A 75 deg. cone angle gave the best results. A thickness of 0.2 in. for the cone meets the minimum weight requirements. Additional studies to get greater penetration were recommended on weight and shape of charge, fabrication of copper and steel cones, and the validity of the cube root scaling for shaped charges.

**TR 131** Record deleted.

**TR 132**
**UNDERSNOW STRUCTURES: N-34 RADAR STATION, GREENLAND.**
Mellor, M., Aug. 1964, 29p., AD-445 872, 7 refs.
24-3096
SUBSURFACE STRUCTURES, PREFABRICATION, UNDERSNOW FACILITIES, DEFORMATION, HEAT LOSS, STRUCTURAL CHANGES.
Data previously obtained in a program of instrumentation and observation to appraise the performance of radar station N-34 built at an altitude of about 7000 ft in the dry-snow zone of the Greenland Ice Cap are condensed and presented. N-34 consisted of prefabricated buildings erected inside tubular corrugated-steel shells and the whole complex was interconnected with a closed network of steel tubes. The snow cover accumulation on the abandoned station, from 1957 to 1963, of more than 20 ft is still being restrained by the structural shells. Observations of long-term effects on this unique structure are utilized to analyze new and existing data in evaluating design concepts. Structural deformation, differential settlement, and heat loss are discussed, and some remarks relevant to future design are made.

**TR 133**
**APPROACH ROADS, GREENLAND 1960-1964.**
Davis, R.M., June 1967, 40p., AD-657 261, 5 refs.
24-3097
COLD WEATHER CONSTRUCTION, ROADS, ICE (CONSTRUCTION MATERIAL), SUBSURFACE INVESTIGATIONS, TEMPERATURE MEASUREMENT, THAW DEPTH, SEASONAL FREEZE THAW, DESIGN CRITERIA, ABLATION, SNOW FENCES.
Project 1, Approach Roads, Greenland R and D Program, was organized in 1954 to develop methods, techniques and criteria for constructing roads on both glacial ice surfaces and adjacent ice-free terrain. This report covers activities for the years 1960 through 1964, which consisted primarily of an annual assessment of the performance of the various roads and other structures on the ice cap. Emphasis is placed on climate; design, construction and performance of the new ramp road; performance of past construction; ice surface movement; subsurface temperature measurements; and the use of snow fences to reduce ablation.

**TR 134**
**CONSTRUCTION IN MUSKEG - A SUMMARY AND COMPILATION OF CURRENT PRACTICE.**
Pihlainen, J.A., May 1965, 25p. plus 111p. of appends., AD-627 043, Bibliography p.18-25.
24-3098
MUSKEG, CONSTRUCTION, BEARING CAPACITY, FROZEN GROUND.
The basic approaches to constrction in muskeg areas are to (1) avoid muskeg, (2) remove the peat, or (3) design for and utilize the muskeg. The complete removal of peat and its replacement by good fill to provide a solid foundation is usually employed for roads crossing shallow deposits or main highways carrying heavy traffic. Current practice in Canada and in the northern U.S. appears to favor mechanical excavation, although deep peat deposits are troublesome. Hydraulic stabilization or jetting is almost confined to Minnesota, although the method has considerable potential where large amounts of granular fill and water are available. With flotation methods the bearing capacity is utilized and continued settlements are accepted. The sand-grain technique has been applied to stabilize "soft" deposits but it is now questionable. Drainage of a muskeg area is extremely difficult. Extracts of selected references on muskeg and peat have been grouped in 9 appendixes dealing with general aspects, mechanical excavation, displacement, jetting, explosives, flotation, consolidation, accelerated settlements, and subsidiary methods in current practice.

**TR 135**
**HYDRAULIC ANALOG STUDY OF PERIODIC HEAT FLOW IN TYPICAL BUILDING WALLS.**
Hawk, R., et al, Nov. 1963, 37p. plus 25p. of appends., AD-697 135, 7 refs.
Lamb, W.
24-3099
HEAT TRANSFER, BUILDINGS, WALLS, COMPUTER APPLICATIONS.
A hydraulic analog computer was programmed to record transient temperatures within building walls of various construction, and cumulative heat flow and instantaneous heat flux into the room. Three different daily cyclic input temperatures at the outside wall surface were used. The ability of each wall to dampen load fluctuations was determined as was the time lag of heat flow into the room. A comparison of the cumulative heat flow into the room during office hours was made for each type of exterior wall construction. Walls having high thermal capacitance results in a large thermal time lag, thus permitting the wall to store heat during the day and thereby delay full capacity operation of air conditioners until after working hours. It is tentatively concluded that a wall's damping characteristics are improved when the thermal resistance and capacitance are evenly distributed throughout the wall. The results of the study also showed that the greater the thermal capacitance, the greater the damping ability of the wall; this would be expected from theoretical considerations. It is concluded that the hydraulic analog computer can be successfully applied to solving heat flow problems subject to a few modifications necessary to reduce the average error of results.

**TR 136**
**A NEW TABLE AND APPROXIMATION FORMULA FOR THE RELATIVE OPTICAL AIR MASS.**
Kasten, F., Nov. 1964, 10p., AD-610 554, 14 refs.
24-3100
SOLAR RADIATION, ANALYSIS (MATHEMATICS), TABLES (MATHEMATICAL), ATMOSPHERIC OPTICS.
A new table of the relative optical air mass as a function of solar altitude is computed from the air density profile of the ARDC Model Atmosphere, 1959, up to 84 km; refractive index of air at ground level equal to 1.000276 corresponds to air of 15 deg C and 1013.25 mb and to the wavelength 0.7 micron. This wavelength is more representative for the whole solar spectrum than 0.54 micron (peak of the visibility spectrum) because it divides the solar spectrum into 2 parts of equal energy. The new approximation formula contains constants which were calculated from the new tabulated values of the relative optical air mass as a function of solar altitude (deg) by successive approximation, applying the method of least squares to obtain each approximation. The values from this formula are in very good agreement with the tabulated values. The deviation is less than 0.1 per cent for solar altitude greater than 4 deg. The highest deviation, 1.25 per cent, occurs at solar altitude equal to 0.5 deg. The formula can also be applied to the old Bemporad table and to the table of relative optical water vapor mass computed by Schnaidt (1938).

**TR 137**
**CRUSHING STRENGTH AND LONGITUDINAL WAVE VELOCITY IN PROCESSED SNOW.**
Smith, J.L., Jan. 1965, 11p. plus 2p. appendix, AD-611 749, 8 refs.
24-3101
SNOW STRENGTH, SNOW COMPACTION, SNOW PHYSICS.
This study establishes a relation between the longitudinal wave velocity and the crushing strength of processed snow at a common density and temperature, provides information on the aging effect of processed snow under controlled temperatures, and shows how sonic measurements can be taken continuously through one sample during the aging process. The study was conducted at Houghton, Michigan, on snow processed by the Peter snow miller and deposited in plywood boxes 1.5 x 1.5 x 1.5 ft. Two sets of samples were obtained, each consisting of 6 boxes of processed snow. A constant-velocity motorized press was used to determine the crushing strengths. The specimens were prepared with a length to diameter ratio of 2.5 to 1, and the measurements were independent of the loading rates. The longitudinal wave velocity was measured with piezo-electric transducers in conjunction with a soniscope, which provided the exciting source and the time-measuring device. A relation between the longitudinal wave velocity and crushing strength at -10C was established.

**TR 138**
**UNDERSNOW STRUCTURES BYRD STATION, ANTARCTICA.**
Mellor, M., et al, Feb. 1965, 38p. plus 8p. appends., AD-613 051, 14 refs.
Hendrickson, G.
24-3102
UNDERSNOW FACILITIES, DEFORMATION, METEOROLOGICAL DATA, SNOW PHYSICS.
Byrd Station consists of a network of shallow tunnels containing light, T-5-type, prefabricated buildings and other items of equipment. Some small buildings (e.g., aurora tower, balloon pavilion, rawin dome) are elevated above the snow surface on extensible columns. The tunnels were constructed by the "cut-and-cover" method. Data are given concerning tunnel deformation, floor levels and foundation settlement, temperature measurements, ventilation, and other tests. Deformation data are analysed to provide design information for future construction, and it is shown that heat loss from buildings increases the rate of tunnel deformation substantially. The appendixes discuss snow reinforcement tests, air permeability of snow and the ventilation of undersnow camps, and the thermal effects of water wells and sewage sinks.

**TR 139**
**INSTALLATION OF DRIVEN TEST PILES IN PERMAFROST AT BETHEL AIR FORCE STATION, ALASKA.**
Crory, F.E., Dec. 1973, 17p., AD-774 291, 7 refs.
28-3696
PILE DRIVING, PILE FOUNDATIONS, FROZEN GROUND STRENGTH, BEARING CAPACITY.
The installation, testing, and analysis of driven test piles installed at Bethel, Alaska, in conjunction with the construction of a radar tower foundation are discussed in detail. Investigations were conducted to obtain further information on driving piles in permafrost, studying effects of auxiliary refrigeration pipes on driving resistance, and verification of design assumptions. Test and production piles, 8- and 10-in. H-beams, were installed to maximum depth (34 ft) using a high-energy diesel hammer. While the size of the pile had little effect, the refrigeration pipes on both sides of the web increased driving resistance significantly. The load test results of a pile driven to a depth of 20 ft were extended to evaluate the capacity of the longer or larger radar tower piling. Recommendations on extending the use of the driving method of installing piles in frozen ground to different soil types and colder temperatures are presented.

**TR 140** Record deleted.

**TR 141** Record deleted.

**TR 142** Record deleted.

**TR 143** Record deleted.

**TR 144** Record deleted.

**TR 145**
**MEASUREMENT OF FROST HEAVING FORCES ON PILES.**
Crory, F.E., et al, Oct. 1965, 27p., AD-484 955, 10 refs.
Reed, R.E.
24-3103
FROST HEAVE, PILE STRUCTURES, COLD WEATHER CONSTRUCTION.
A program of studies has been conducted at Fairbanks, Alaska, incorporating reaction measuring devices and SR-4 strain gages, to measure the magnitude of heave force on piles and distribution of stresses in piles during seasonal freezing of the silt active layer. This report summarizes the results of frost heave force measurements with the reaction type devices on creosoted timber and steel pipe piles during the period 1956-1959 and during the 1962-1963 freezing season. The heave force measurements, along with air and ground temperatures, are presented and analyzed. The results of the studies using SR-4 strain gages will be presented in a separate report.

**TR 146** Record deleted.

**TR 147**
**POSSIBLE PRECIPITATION CHANGES RESULTING FROM THE PROPOSED RAMPART DAM RESERVOIR.**
Henry, D.M., March 1965, 18p., AD-615 275, 12 refs.
24-3104
PRECIPITATION (METEOROLOGY), WEATHER FORECASTING, RESERVOIRS.
Results of computations are presented which show the changes in monthly precipitation that may occur in the Yukon basin, Alaska, after a large body of water is formed in the valley. Two methods were used. In the first method the changes in precipitation were computed by estimating the changes in precipitable water in the air caused by the new water source. The changes in precipitation are limited to the basin and are uniformly distributed downwind from the reservoir. The second method as-

sumes that the percent change of specific humidity as a result of the reservoir is proportional to the precipitation change. Results of both methods indicate that an important increase in precipitation will occur in the southwestern quadrant of the basin during the fall months. The study also shows a small negative change in precipitation throughout the basin in late spring and early summer. This decrease as predicted by the first method is greater than that obtained by the second method.

**TR 148**
**INVESTIGATION OF WHITEOUT DISSIPATION TECHNIQUES.**
Jiusto, J.E., et al, May 1964, 14p. plus 6p. appends., AD-613 288, 24 refs.
Mee, T.R., Jr.
24-3105
WHITEOUT, DRY ICE (TRADEMARK), ARTIFICIAL PRECIPITATION.
This final report on Project Whiteout summarizes the whiteout program findings and recommendations, and investigates means for modifying whiteouts in Arctic regions in support of Army functions. Dry ice is the most useful material yet found for dissipating whiteouts. Dry-ice pellets falling freely through a cloud (as when released from an airplane, rocket, tethered blimp, or drone) are effective in nucleating supercooled clouds whose temperatures are colder than -5C. If a "stationary" seeding technique is used, dry ice seeding can be made effective at all subfreezing temperatures. A bench-model pellet maker, constructed for efficient conversion of liquid carbon dioxide to dry-ice pellets of a prescribed size, is described. The relationships among dry-ice pellet size, pellet fall velocity and distance, cloud temperature, and number of ice crystals produced were established. With this information, favorable seeding patterns and equipment were postulated to maintain safe landing corridors at fixed ice-cap installations, provide aircraft with an emergency landing capability over isolated terrain, and facilitate group operations.

**TR 149** Record deleted.

**TR 150**
**DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS.**
Linell, K.A., et al, Aug. 1966, 10p., AD-800 034, For a draft of this report see 25-2552.
Kaplar, C.W.
24-3106
FROZEN GROUND CHEMISTRY, SOIL CLASSIFICATION.
The description and classification of frozen soils is presented as an extension of the Unified Soil Classification System adopted by the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation in 1952. Descriptions, based on physical appearance, are nongenetic and are applicable to both naturally and artificially frozen soils. Field identification data pertaining to frozen soils and those pertinent properties of frozen materials which can be measured by physical tests are indicated. Also, guides are presented for construction on soils subject to freezing and thawing. The report includes photographic illustrations of frozen soil types; a chart showing relationships between unit dry weight of soil, water content, and ice volume; and an example of graphical presentation of frozen soil data.

**TR 151**
**STRAIGHT-WALL CUT-AND-COVER SNOW TRENCH.**
Tobiasson, W., et al, Oct. 1966, 39p., AD-646 306, 18 refs.
Rissling, D.L.
24-3107
SNOW TRENCHES, SNOW PHYSICS, UNDERSNOW FACILITIES, TEST EQUIPMENT.
During the summer of 1962, a straight-wall cut-and-cover snow trench was constructed at Camp Century, Greenland, to house tests performed by USA CRREL Project 33, Feasibility Study of Pile Foundations in Snow. In this report, the parameters used to design the trench and the equipment and methods used in the construction are presented and evaluated. Time-motion studies covering all phases of construction are included as a guide for planning and evaluation of similar construction. Performance is discussed and documented by instrumentation installed in the trench.

**TR 152**
**STRAIN GAGE INSTRUMENTATION OF STEEL PILES IN SNOW.**
Sohlberg, E.T., April 1965, 30p., AD-615 996, 7 refs.
24-3108
PILE DRIVING, SNOW (CONSTRUCTION MATERIAL), STRESS ANALYSIS, INSTRUMENTS.
This report describes instrumentation for a preliminary test of friction piles in snow. Dynamic measurements of strain were made during driving by means of a dual oscilloscope fitted with a Land camera. The larger of the two H piles tested was an 8 x 8 WF 35 section and the smaller was a 6 x 6 M 20. Both were 30 ft long, driven in Sept. 1962, and left unloaded until the 1963 summer. A switch box was constructed and used during static tests, which allowed a forward, reverse, and calibration reading to be taken at each gage position in a minimum of time. Immediately after the load was applied, the upper section of the pile took most of the load. After the load was held in place for several weeks, each unit length of the pile had accepted an equal share of the total load. The 8 x 8 WF 35 pile was loaded to 40,000 lb and the 6 x 6 M 20 to 28,000 lb. Immediately after removal of the load, the upper section of the pile was relieved but most of the loaded strain remained in the bottom section. A few days later the entire pile was relieved of strain. Analysis of the static and dynamic data shows the capabilities of the instrumentation techniques used. Complete strain vs. depth profiles were obtained. Welded resistance strain gages and oil wax moisture protection were the most satisfactory.

**TR 153**
**STUDY OF THE RAMMSONDE FOR USE IN HARD SNOW.**
Niedringhaus, L., April 1965, 23p., AD-615 997, 7 refs.
24-3109
SNOW STRENGTH, PENETROMETERS, SNOW DENSITY, HARDNESS, TEST EQUIPMENT.
Studies were performed at Houghton, Mich. and Camp Century, Greenland, during 1963 to investigate various modifications of the Rammsonde and to improve its suitability for use in hard snow. The report includes theoretical considerations, a description of the study, and the design and use of the instrument. The Rammsonde presently used by USA CRREL was found to be unsatisfactory for use in processed, age-hardened snow of extreme hardness. It was discovered that the hammer-drop height had little effect on the hardness values obtained, but the hammer weight and the time interval between blows had a noticeable effect on the results and must be taken into consideration when performing ram-hardness tests.

**TR 154**
**ILLUSTRATED SUMMARY OF THE GEOLOGY OF THE YUKON FLATS REGION, ALASKA.**
Heinsohn, F.P., et al, Sept. 1964, 27p., AD-451 722, 65 refs.
Johnson, P.L., Poulin, A.O.
24-3110
GEOGRAPHY, GEOMORPHOLOGY, GEOLOGY, PERMAFROST DISTRIBUTION, UNITED STATES—ALASKA—YUKON FLATS.
The primary purpose of this report is to introduce the reader to the area and to provide him with a guide to the available geologic literature. It is based on a review of the literature and a field reconnaissance of the region. The major landforms of Yukon Flats are flood plains with many meander scars and oxbow lakes, terraces, alluvial fans, and sand dunes. Permafrost is discontinuous but in the poorly drained areas, other than lakes, it occurs to a considerable depth. Glacial drift and moraines, formed during the Pleistocene glaciation of the southern Brooks Range, occur as extensive deposits in the Chandalar River drainage system. Pleistocene valley glaciation is evidenced in the higher mountains of the Hodzana Highland and the Ray Mountains by cirques, hanging valleys, U-shaped valleys, and moraine and outwash deposits. The geologic history of the area is summarized.

**TR 155**
**INFRARED DETECTION OF MILITARY VEHICLES ON SNOW-COVERED BACKGROUND.**
Leighty, R.D., et al, July 1965, 101p., AD-369 624.
Vogel, T.C.
26-2339
AERIAL RECONNAISSANCE, REMOTE SENSING, SNOW COVER, VEHICLE DETECTION, MILITARY EQUIPMENT, INFRARED DETECTION.
This report presents a detailed analysis of the infrared imagery with particular attention to dectability with respect to the natural and physical parameters which permitted or limited detection. From the imagery, indications of vehicle activity or presence on a snow-covered background were found to fit one of five detection classes. This classification of detection indicators was then used to classify each signal from each vehicle site on each of the aircraft overflights of the targets. Two approaches were used in the analysis of the data: grouping detection classes with regard to site, and investigating each vehicle site with respect to its detection situation.

**TR 156**
**REFRIGERATION OF A PIPE PILE BY AIR CIRCULATION.**
Reed, R.E., June 1966, 19p., AD-486 400.
24-3111
PILE FOUNDATIONS, PILE STRUCTURES, FROZEN GROUND THERMODYNAMICS, REFRIGERATING, TEST EQUIPMENT.
The data obtained from this investigation, carried out in an area of relatively warm permafrost, indicate that the circulation of cold ambient air through foundation pipe piles can be effective in lowering the temperature of frozen and unfrozen soil. The system created a concentrated cooling effect immediately adjacent to the pile during exhaust fan operation. This concentration could effectively produce the desired heat removal for freezeback of hollow piles in preaugered holes back filled with slurry. Site conditions, the test installation, and the test procedure are described, and the temperature data are given. In areas of borderline permafrost conditions, this system would provide an efficient and economical method of assisting the freezeback of piles during the winter months and insuring stability; there is less need for such techniques in areas of low temperature permafrost. The advantages over commonly used brine or oil circulants include the following: air circulation is relatively inexpensive, no recirculation is required, and no heat exchanger is needed to remove heat from the circulant. More study is needed on such aspects as rate of lateral heat transfer into the soil and ranges of operating conditions which might produce accumulation of moisture in the system in the form of ice crystals.

**TR 157**
**STRENGTH STUDIES ON ANTARCTIC SEA ICE.**
Hendrickson, G., et al, July 1965, 20p., AD-622 773, 5 refs.
Rowland, R.
24-3112
SEA ICE, ICE SALINITY, ICE COVER STRENGTH, MODELS, ANTARCTICA—MCMURDO.
The strength of sea ice was studied at McMurdo, Antarctica, during two successive field seasons. Three hundred tensile tests were made on continuous core samples taken at various locations on ice aged 1 year, 2 years, and more than 5 years. Salinity profiles were obtained for each core. A relationship between strength (kg/sq cm) and volume of brine cavities (per cent), as suggested by Assur, adequately represents the data for brine volumes less than 0.400: strength equals 29.1 - 48.0 times the square root of the volume. The constants agree satisfactorily with values obtained previously for Arctic sea, the value for the strength of very low brine volume approaching the value for fresh-water ice. The model on which the above expression is based apparently breaks down at high brine volumes.

**TR 158**
**SUMMARY OF WHITEOUT STUDIES.**
Hicks, J.R., March 1965, 20p. plus 9p. appends., AD-615 276, 9 refs.
24-3113
WHITEOUT, ARTIFICIAL PRECIPITATION, INSTRUMENTS, COUNTERMEASURES.
Previous whiteout work done by CRREL from 1954 to 1962 is outlined and field studies by CRREL in 1963, including instrumentation, seeding materials, and test procedures are discussed. The 1963 experiments were designed to test the feasibility of using recently developed rockets (cold-propellant and solid-fuel types), continued the investigation of tethered balloon techniques, and field test the organic compound phloroglucinol, which was recently found to be an effective ice-nucleating reagent in the laboratory. A ground-based system for fog dispersal is promising. It can be moved easily to any suitable area, penetrate fog or clouds to heights of about 4000 ft, and is less expensive to buy and operate. It was concluded that better tracking and observing techniques are needed to determine if the seeding is effective. Monitoring a test from the ground in a dense low fog is difficult because (1) observers easily get lost, and (2) variable air movements make uncertain the drift of the seeded area.

**TR 159**
**PEDO-ECOLOGICAL INVESTIGATIONS - BARROW, ALASKA.**
Brown, J., et al, April 1965, 32p. plus 5p. appends., AD-615 998, 20 refs.
Johnson, P.L.
24-3114
SOILS, ECOLOGY, FROST ACTION, PERMAFROST PHYSICS.
This report is an introduction to the cooperative research investigations underway at Barrow, Alaska, and includes field activities from the spring of 1962 to the summer of 1964. The primary objectives of the study are to quantify the environmental parameters and ecosystem processes which are responsible for generating the complex Arctic landscape and to evaluate the effect of micro- and macrorelief upon soils and vegetation. The experimental design and methodologies employed for acquisition and analysis of data are described. Data are presented from 20 plots which include depth of summer thaw for 1962 and 1963, soil moisture content at 80 sample sites, soil chemical concentrations at the 3/4-meter depth, selected soil temperature for an entire year, and lichen, moss, and vascular plant cover. Microclimatic data at 6 stations along a 2-km transect are presented for summer 1963. The interdisciplinary approach to these investigations has been directed towards an understanding of the edaphic, geomorphic, botanical, and ecological characteristics of the landscape, and to a lesser extent to their interactions with the microenvironment.

**TR 160**
**SUBSURFACE TRANSPORTATION METHODS IN DEEP SNOW.**
Abele, G., Dec. 1965, 48p., AD-631 949, 16 refs.
24-3115
SNOW TRENCHES, TRAFFICABILITY, TRANSPORTATION, SNOW (CONSTRUCTION MATERIAL).
Wheel trafficability tests on a snow trench floor were conducted at Camp Century, Greenland, in 1962, with 2 types of low-pressure tires and with standard truck tires on an M-54 5-ton truck with a 5-ton load. Skid tests were performed and the friction coefficient between the tires and the processed snow surface was determined. A 1300 ft long, standard gage railroad truck was installed in the trench after the wheel traffic tests. A standard size flatcar with a 30-ton load, towed by a 5-ton truck equipped with rail wheels, was used for rail traffic tests. It was found that the natural, unprocessed snow surface in a trench 26 ft below the snow surface is not suitable for extensive traffic with vehicles such as 5-ton trucks even when equipped with low-pressure flotation tires. However, a Peter plow-processed, age-hardened snow surface is capable of supporting a virtually unlimited amount of vehicle traffic using standard tires. Even heavier wheeled vehicles could be supported by a processed-snow trench floor. The friction coefficient was found to be in the range of 0.2 to 0.3. For transporting ex-

tremely heavy items, the use of a railroad system installed on an unprocessed snow trench floor is feasible but expensive. The installation of a railroad system in a covered snow trench presents no serious problems.

**TR 161**
**SURVEY OF ARCTIC AND SUBARCTIC TEMPERATURE INVERSIONS.**
Bilello, M.A., Oct. 1966, 35p., AD-645 597, 8 refs.
24-3116
AIR TEMPERATURE, ATMOSPHERIC CIRCULATION, THERMODYNAMIC PROPERTIES, TEMPERATURE INVERSIONS.
This study provides a statistical analysis of available data on Arctic and subarctic inversions, and includes data from locations in Canada, Greenland, and Alaska. The analysis considers inversions with respect to frequency, base height, thickness, base temperature, and temperature gradient.

**TR 162**
**SURVEY OF FROZEN PRECIPITATION IN URBAN AREAS AS RELATED TO CLIMATIC CONDITIONS.**
Bilello, M.A., May 1967, 29p., AD-657 212.
24-3117
SNOWFALL, CLIMATE, METEOROLOGICAL FACTORS, PRECIPITATION (METEOROLOGY).
This study investigates relationships between observed frozen precipitation and associated meteorological conditions in large cities, and develops procedures for presenting tabulated data on frozen precipitation in a readable and usable form. An explanation of several interpretations is included with methods of analysis, sample diagrams, advantages and disadvantages, and comparisons of the different interpretations. To avoid excessive bulk, only the diagrams for LaGuardia Airport and Buffalo, New York, are discussed in this paper. Similar figures for 22 other stations are on file at USA CRREL.

**TR 163**
**ACCURACY OF FIELD SNOW SURVEYS - WESTERN UNITED STATES, INCLUDING ALASKA.**
Work, R.A., et al, Aug. 1965, 43p., AD-627 130.
Stockwell, H.J., Freeman, T.G., Beaumont, R.T.
24-3118
SNOW DENSITY, SNOW SURVEYS, SNOW WATER EQUIVALENT, SNOW COVER DISTRIBUTION, SNOW SURVEY TOOLS.
The results, observations, and conclusions are presented of one season's study by the Water Forecasting Unit of the Soil Conservation Service which was undertaken to help in the selection of the best system and equipment for measuring the depth and density of Arctic and sub-Arctic snow. Further objectives of the study were to define specific snow survey problems in the Yukon River basin.

**TR 164**
**ICE SURFACE MOVEMENT ON THE TUTO RAMP IN NORTH GREENLAND.**
Davis, R.M., March 1967, 24p., AD-652 870, 6 refs.
24-3119
GLACIER FLOW, ICE ROADS, GLACIER MOVEMENT, SURVEYING, SURVEYING INSTRUMENTS.
As part of a study of road construction on glacier ice, a program of measurements of the horizontal and vertical movement of the surface of the ice has been conducted. This report covers measurements from 1956 through the 1963 thaw season. The measurement procedure is described, and the movement data are tabulated. Appendixes A and B present short-term horizontal movement measurements and station elevations, respectively. The rate and direction of both the vertical and horizontal movement on the Tuto ramp are fairly consistent on an annual basis. The upward vertical movement from Station 20 to 58 on the original Ramp Road is probably caused by the ice upthrust over a stagnant wedge of ice at the edge of the glacier. The existence of this wedge is evidenced by the small amount of horizontal movement at the edge of the glacier and the upward vertical movement of the ice in the area in front of the wedge.

**TR 165**
**OBSERVATIONS ON TAXIWAY ELMENDORF AFB, ALASKA 1962-1964.**
Fulwider, C.W., Oct. 1965, 10p., AD-485 138L.
24-3120
AIRCRAFT LANDING AREAS, CONSTRUCTION, FROST HEAVE, SOIL FREEZING.
The results are presented of observations made during 1962-64 on a taxiway extension constructed in 1956 at Elmendorf AFB, Alaska, over a subgrade with vertically oriented, alternating silty clay and sand strata. Failure of the pavement occurred in the winter of 1956-57 due to extensive cracking caused by frost heave. The probable causes of the frost heave are stated and comments on the pavement failure are presented. Observations on a ground temperature assembly installed under the pavement and vertical movement points established on the surface are analyzed. It is concluded that the use of subsurface drainage lines had only a limited effect on frost heave and that design for similar unusual soil conditions should provide for full frost protection or employ other expedients such as insulation.

**TR 166**
**DEGRADATION OF BASE COURSE AGGREGATES DURING COMPACTION.**
Aughenbaugh, N.B., et al, July 1966, 77p., Contract DA-19-016-ENG-6553, AD-800 072, 15 refs.
Johnson, R.B., Yoder, E.J., Purdue University. Purdue Research Foundation.
24-3121
CONCRETE AGGREGATES, COMPACTING, DEGRADATION.
An investigation has been made of the mechanics of construction compaction degradation, the properties of mineral aggregates that influence degradation, and existing laboratory tests for evaluating degradation susceptibility. Field investigations consisted of concrete-base tests and soil-base tests. Laboratory tests investigated were the Los Angeles abrasion, the mechanical kneading compactor, repetitive loading, the modified AASHO, freeze-thaw, and absorption and specific gravity. Petrographic studies included megascopic and microscopic examination, X-ray analysis, differential thermal analysis, insoluble residue analysis, and chemical analysis. The greatest degradation to the aggregate mass occurs during the first compactor pass, with progressively less breakage resulting from each successive pass. Degradation and density are interrelated and are affected by each other. One-size materials are the most susceptible to degradation and dense-graded materials are the least susceptible. Freeze-thaw action lowers the degradation quality of aggregates. Petrographic analysis is a reliable means of evaluating degradation quality and is recommended as a routine laboratory test.

**TR 167**
**ELASTIC CONSTANTS, STRENGTH AND DENSITY OF GREENLAND SNOW AS DETERMINED FROM MEASUREMENTS OF SONIC WAVE VELOCITY.**
Smith, J.L., Nov. 1965, 18p., AD-632 357, 8 refs.
24-3122
SNOW DENSITY, SNOW STRENGTH, SNOW PLASTICITY, ELASTIC PROPERTIES, ACOUSTIC MEASUREMENT.
The measurement of sonic wave velocities on undisturbed samples of Greenland snow was accomplished using piezo-electric transducers in conjunction with a soniscope which provided the exciting source and the time measuring device. These velocity measurements were correlated with density determinations, crushing strength tests, and the elastic constants of the samples for a density range of 0.4 to 0.9 g/cm cu. Empirical formulas were derived that present the density, crushing strength, and the elastic constants as functions of sonic wave velocity.

**TR 168**
**WATER PRODUCTION IN A POLAR ICE CAP BY UTILIZATION OF WASTE ENGINE HEAT.**
Russell, F.L., Dec. 1965, 15p., AD-632 050.
24-3123
WATER SUPPLY, ELECTRIC POWER PLANTS, UTILITIES.
The results are discussed of the useful reclamation of heat from engine exhaust gas and coolant, which is normally rejected into the atmosphere and wasted, for the production of domestic water and for space and water heating. During the period of occupancy of the Tuto ice tunnel and under-ice camp (Greenland), domestic water was produced and stored in a subterranean reservoir beneath the floor of a cross-drift in the ice 40 ft from the northeast wall of the power-plant building. Energy to produce water by melting the reservoir perimeter was supplied by rejected heat from one of two D 13,000 Caterpillar diesel engines driving a 75-kw 120/240-v generator which supplied camp electrical requirements. The power supply and heat exchange system are described.

**TR 169**
**PREVENTION OF ACCUMULATION OF SNOW AND ICE ON OPEN MESH METAL PANELS.**
Minsk, L.D., Nov. 1966, 62p., AD-650 089, 3 refs.
24-3124
ICE FORMATION, PANELS, ACCUMULATION, SNOWFALL, ANTIICING ADDITIVES, COUNTERMEASURES.
Investigations have been conducted to (1) determine the extent to which open mesh metal panels will accumulate snow, and (2) to devise methods for controlling or eliminating accumulation and adhesion. Methods investigated include electrical resistance heating, forced air movement, icephobic surface coatings, infrared heating, mechanical vibration, fluid flow, and power broom sweeping. The influence of meteorological parameters on unheated panel tests was also investigated. It is concluded that passive methods alone are incapable of keeping a perforated steel panel free of snow and ice accumulation under all conditions. Forced air moving at a minimum speed of 300 to 500 ft/min through the panels can prevent accumulation of snow. Near the freezing point, however, and with slight precipitation of snow or ice, forced air can result in ice accretion. Mechanical vibration will remove dry snow but not wet snow or ice. Fluid flow over the panel cannot prevent snow accumulation at moderate rates of fall. Resistance heating using the perforated panel as the resistance element is an effective and practical method.

**TR 170**
**ELECTRICALLY OPERATED IMPACTORS FOR HYDROMETEOR SAMPLING.**
O'Brien, H.W., et al, Dec. 1965, 15p., AD-631 950, 4 refs.
Kumai, M.
24-3125
METEOROLOGICAL INSTRUMENTS, PRECIPITATION GAGES.
Two models of impactors have been designed for remote sampling of hydrometeors. One, a flashbulb-activated model, is quite suitable for multiple simultaneous sampling, but is prone to occasional mechanical failure. The other, a solenoid-operated model, is almost failure proof but requires considerably more electrical current for multiple simultaneous sampling than does the flash type unit. Results of some laboratory tests on the impactors are shown and field use of the impactors is discussed. The appendix contains electrical specifications for each type of unit.

**TR 171** Record deleted.

**TR 172**
**RING TENSILE STRENGTH STUDIES OF ICE.**
Frankenstein, G.E., Feb. 1969, 36p., AD-686 284, 8 refs.
24-3126
SEA ICE, LAKE ICE, ICE COVER STRENGTH.
This paper gives the results of ring tensile strength tests of lake and sea ice. The sea ice tested was normal, low-salinity, and high-salinity sea ice. The strength results plotted against the square root of the brine volume gave a least squares equation. A series of tests was conducted to test the theory that the concentration factor, K, for a solid cylinder is equal to 6. The average of the new K values computed from the test results is 5.2.

**TR 173**
**MEASUREMENT OF THE COMPLEX MODULI AND DAMPING OF SOILS UNDER DYNAMIC LOADS; LABORATORY TEST APPARATUS, PROCEDURE AND ANALYSIS.**
Stevens, H.W., April 1966, 36p., AD-484 956, 17 refs.
24-3127
SOIL MECHANICS, SOIL COMPACTING, TEST EQUIPMENT.
A laboratory method is described which is currently being used to investigate the required soil properties necessary in solving foundation design problems for facilities that incorporate dynamic or vibration loading within the structure and have extremely high stability requirements. Emphasis is placed on the test apparatus, nomenclature, and the analysis and computation of the test results. It has been determined that the moduli and damping vary with soil physical conditions (density, water content, degree of saturation, etc.), static load conditions (vertical and lateral pressures), and dynamic loading conditions (frequency, drive force, and drive amplitude). The test provides a measure of these relationships.

**TR 174**
**CAMP CENTURY; EVOLUTION OF CONCEPT, AND HISTORY OF DESIGN, CONSTRUCTION AND PERFORMANCE.**
Clark, E.F., Oct. 1965, 60p., AD-477 706, 32 refs.
24-3128
MILITARY OPERATION, SNOW (CONSTRUCTION MATERIAL), SUBSURFACE STRUCTURES.
This report tells the story of Camp Century, an effort to learn how to construct military facilities on the Greenland Ice Cap. It describes briefly the research done by a number of laboratories, scientists, and engineers in achieving this objective. It discusses the development of concepts, methods, and engineering techniques which made the construction of Camp Century possible. Engineering performance of the camp and its facilities is summarized, and some of the more important reports resulting from the effort are referenced. It is concluded in the report that subsurface ice-cap camps are feasible and practicable, that nuclear power offers significant advantages in reducing the logistical burden of supporting isolated, remote military facilities, and that the wealth of data and experience obtained from the Camp Century project will be of inestimable value in the development of designs for future ice-cap camps.

**TR 175**
**SPREAD FOOTING FOUNDATIONS ON SNOW.**
Reed, S.C., April 1966, 40p., AD-637 112, 12 refs.
24-3129
FOOTINGS, SNOW PHYSICS, SNOW (CONSTRUCTION MATERIAL), FOUNDATIONS.
A series of nine spread footing tests was installed on snow at Camp Century, Greenland, in 1961 and continuously observed through the 1963 summer. The influence of footing load, size and shape on settlement was investigated and the effects of the uncontrolled parameters (temperature and snow density) were recorded. The results indicate that settlement is dependent on 6 basic parameters: time, snow density, temperature, load intensity, footing size, and footing shape. Snow deformation beneath a footing occurs in a bulb-shaped zone whose lateral and vertical dimensions approach 1.5 times the footing width. In general, spread footings placed on snow in the density range 0.4 to 0.5 g/cm cu can be expected to show a high initial settlement rate, occurring during the construction period in an actual installation. Rectangular spread footings will produce the least

settlement if all other factors are equal, but care should be exercised in the design of large or very long shapes as differential settlement could induce severe stresses in any rigid structure. To minimize differential settlements all footings should be placed on snow having similar characteristics with a density approaching 0.5 g/cm cu and all footings should be designed to have about the same size and load intensity.

**TR 176**
**SNOW AND ICE PROPERTIES AS RELATED TO ROADS AND RUNWAYS IN ANTARCTICA.**
Abele, G., et al, Oct. 1967, 37p., AD-665 386, 14 refs.
Frankenstein, G.E.
24-3130
SEA ICE, ICE COVER STRENGTH, SNOW STRENGTH, SNOW ROADS, ICE ROADS.

Dynamic tests were performed to determine the Young's modulus of sea ice, derived from longitudinal wave velocities measured with a soniscope. Static tests consisted of standard ring tensile strength and simple beam or flexural strength tests. The strength data were plotted on a base of the brine volume for each test. The test results indicate that the annual sea ice at McMurdo Sound is capable of supporting cargo type aircraft. Snow runways capable of supporting a C-130 aircraft on wheels and providing marginal support to a C-121 can be constructed either with the Peter plow or with the pulvimixer. However, the runway would be reliable only during comparatively low temperatures (less than -15C). Peter snow miller processing and bulldozer compaction methods appear to be feasible for effective depth processing and compaction of high strength snow pavements. The criteria for support of various types of aircraft on a snow runway are presented.

**TR 177**
**HIGH SNOWFIELDS OF THE ST. ELIAS MOUNTAINS, YUKON TERRITORY, CANADA.**
Grew, E., et al, March 1966, 18p., AD-633 032, 18 refs.
Mellor, M.
24-3131
SNOW PHYSICS, SOLAR RADIATION, METAMORPHISM (SNOW).

Observations made during the 1964 summer provide a description of snow and radiation characteristics for the region and give insight into effects of altitude, regarded as a gross variable, when anomalous wind and slope effects are excluded. Divide Camp, Seward Camp, and Lucania Camp were occupied successively within a minimum period of time to compare conditions at different altitudes. Data are presented on snow profiles, snow accumulation measurements, the development of the annual snow layer, snow conditions at depth, the mechanical properties of the snow, snow densification, solar radiation, and the variation of snow properties and surface processes seem to be simple. However, in mountain regions it is probably a combination of local conditions which produces the most remarkable effects.

**TR 178**
**DEFINING THE COLD REGIONS OF THE NORTHERN HEMISPHERE.**
Bates, R.E., et al, June 1966, 11p., AD-639 406, 26 refs.
Bilello, M.A.
24-3132
MAPS, CLIMATE, AIR TEMPERATURE, SNOW COVER DISTRIBUTION, PERMAFROST DISTRIBUTION.

The boundaries of the cold regions of the Northern Hemisphere are located by using parameters of air temperature, snow depth, ice cover, and frozen ground. Each parameter is discussed in detail and references used to develop four Northern Hemisphere cold regions maps are given. In all mountainous areas where few reporting stations exist, specific elevations or ridge lines were used to locate the limits of certain zones. In some areas, for example Greenland and expansive bodies of water, no isopleths were drawn because the parameter was not applicable or because of insufficient information. It is concluded that nearly all of the land mass north of 40 deg lies within the cold regions, and that nearly half of the land mass in the Northern Hemisphere can be classified as cold regions.

**TR 179**
**FLUCTUATIONS OF THE TERMINUS OF THE MOLTKE GLACIER.**
Mock, S.J., May 1966, 5p., AD-636 272, 11 refs.
24-3133
GLACIER FLOW, GLACIER OSCILLATION.

The terminus position of the Moltke Glacier has been mapped from existing maps and from aerial and terrestrial photographs for the years 1946-47, 1954, 1956, 1962 and 1965. With earlier work by J.W. Wright (1939), a fairly detailed record of terminus position exists for the period 1916 to 1965. The glacier has been in nearly continuous retreat during this period interrupted by a slight advance from 1926 to 1932. Loss of area has been accelerating since 1946-47. Ice flow velocity near the terminus has fluctuated through a known range from 30 meters/year to over 1000 meters/year.

**TR 180**
**BRIDGE FOUNDATIONS IN PERMAFROST AREAS GOLDSTREAM CREEK, FAIRBANKS, ALASKA.**
Crory, F.E., Feb. 1968, 28p., AD-667 945, 6 refs.
U.S. Bureau of Public Roads.
24-3134
BRIDGES, PERMAFROST STRUCTURE, PILE FOUNDATIONS, PILE DRIVING, SOIL TEMPERATURE.

Under a joint research project between the Alaska Department of Highways and the U.S. Army Cold Regions Research and Engineering Laboratory, cooperative field observations and tests were conducted during and following construction of the Goldstream Creek bridge, Fairbanks, Alaska. This report presents site investigations and bridge foundation design of the Alaska Department of Highways, bridge pile installation data, and ground temperature conditions for the six-month period following construction. Two test piles and three anchor piles were installed in proximity to the site and load settlement tests were performed. Observations of bridge performance will be continued for a three-year period after construction.

**TR 181**
**IMPROVING VISIBILITY DURING PERIODS OF SUPERCOOLED FOG.**
Hicks, J.R., Dec. 1966, 35p., AD-648 484, 7 refs.
24-3135
WHITEOUT, ARTIFICIAL PRECIPITATION, NUCLEATING AGENTS.

Six tests of dispersal systems using propane were conducted in Hanover, New Hampshire during winter 1964-65 and a like number in Greenland during summer 1965 mainly on supercooled fogs and in a few instances when air temperatures were within the lower 2 meters at or slightly above freezing. Propane was introduced into the fog as a liquid aerosol to induce spontaneous nucleation either by cooling or by clathrate reaction which may be important in fog modification. The tests show that liquid propane will improve visibility in fogs, is safe to use, and no standby time is needed. The system may be permanently installed with either radio or manually controlled valve units, and is inexpensive, a cost of twenty dollars/hr estimated to keep an airport approach zone clear of fog. Details of the individual tests conducted are given. The dispensing apparatus, propane flammability tests, and the theory of formation, growth, and precipitation of ice crystals, thermal reaction, and the clathrate concept are discussed.

**TR 182**
**DEVELOPMENT OF THERMAL CONDUCTIVITY PROBES FOR SOILS AND INSULATIONS.**
Wechsler, A.E., Oct. 1966, 83p., AD-645 337, Contract DA-27-021-AMC-25(X), 26 refs.
Little (Arthur D.) inc.
24-3136
THERMAL CONDUCTIVITY, SOIL TEMPERATURE, INSULATION.

Eighteen laboratory-type and 3 field-type probes were designed, constructed and tested. Stainless steel, copper and plastic probe sheaths with epoxy resin, ceramic, or Wood's metal fillings were used with bifilar and single or multiple wire constantan heaters. Copper-constantan thermocouples and thermistors located both within the probe and on the probe sheath were used as temperature sensors. Probes from 0.020 in. to 1/4 in. in diam. and from 3 to 24 in. in length were used. The probes were laboratory tested in dry and moist silts, gravelly sand, beaded polystyrene, and Foam-glass insulations over the temperature range from -40 to plus 90F. Measurements were also made in snow, ice, insulation boards, dry and moist silt, and gravel. The results of the tests indicate that the design and construction of probes for measurements of thermal conductivity of soils and insulating materials can be based on theoretical considerations with reasonable assurance of good probe performance and that the probes are useful and valuable for laboratory and field measurements.

**TR 183**
**PURDUE RESEARCH FOUNDATION LAFAYETTE IND BASE COURSE REQUIREMENTS FOR RIGID PAVEMENTS.**
Yoder, E.J., et al, Oct. 1966, 67p., AD-809 471L, Contract DA-19-016-ENG-2625, 52 refs.
Chamberlin, W.P., Walker, R.D., Havers, J.A., Purdue University.
24-3137
PAVEMENT BASES, FROST ACTION.

The factors affecting pumping of rigid pavements were investigated to establish base course requirements which preclude the development of detrimental pumping. Investigations included a literature review, review of experience data obtained from visits to various State highway departments and Corps of Engineers Division and District Offices, inspections at selected airfields and highway locations during both the normal and frost-melting periods, and laboratory studies to evaluate the relative influence of various subgrade factors on pumping. The principal purpose of the investigations was to validate or recommend revision to the base course composition requirements set forth in Engineering Manual, Part XII, Chapter 4, "Airfield Pavement Design, Frost Conditions." The present designation is Department of the Army TM5-818-2 (EM1110-1-306), "Airfield Pavement Design for Frost Conditions," May 1962.

**TR 184**
**REDUCTION OF FROST HEAVE BY SURCHARGE STRESS.**
Aitken, G.W., Aug. 1974, 24p., AD-785 505, 10 refs.
29-1636
SOIL MECHANICS, FROST HEAVE, MEASURING INSTRUMENTS, STATIC LOADS.

The results of a six-year field test program conducted near Fairbanks, Alaska, to investigate the reduction in frost heave obtained by applying a surcharge stress on the soil are presented. Seasonal heaves of 25-ft-square test sections with nominal surcharge loads of 2, 4, 6, and 8 psi were compared with heaves at adjacent unloaded sections. The test sections were on a silt soil in an area where permafrost existed at about a 7-ft depth. Results showed that only a small surcharge load was needed to cause significant reductions in heave. Data are included that indicate that heave reduction was achieved by minimizing groundwater migration. A method for correlating field and laboratory rate-of-heave data is suggested.

**TR 185**
**A CLOUD DROPLET CAMERA.**
Itagaki, K., Nov. 1966, 10p., AD-645 959, 10 refs.
24-3138
CLOUD DROPLETS, PARTICLE SIZE DISTRIBUTION, PHOTOGRAPHIC EQUIPMENT, FOG.

The problems encountered in measuring the size distribution of water droplets by impactor may be solved by making in situ photographs of air-suspended droplets. Exposure must be sufficiently short to stop the moving droplets and is accomplished by using electronic strobes having a nominal duration of about 1.2 mic sec at medium range. The almost linear relationship, up to 200 microns, between actual droplet size and ring diameter was determined from photographs of droplets suspended by fibers and droplets produced by an atomizer. Camera and impactor results of size distribution in atomizer generated fog, steam fog and natural fog are summarized. Comparing the advantages and disadvantages of previously developed photographic, electronic, and laser apparatus the present procedure may result in a standard method of cloud or fog observation.

**TR 186**
**APPLICATION OF METHOD FOR PREDICTING THERMAL ERROR IN MEASUREMENT OF GROUND TEMPERATURE.**
Rohsenow, W.M., May 1967, 4p., AD-818 015, 1 ref.
24-3139
SOIL TEMPERATURE, THERMAL MEASURING INSTRUMENTS, HEAT TRANSFER, AIR TEMPERATURE, SNOW, ICE.

This report illustrates the use of generalized charts in estimating the thermal error in measurement of ground temperature in the case of a probe inserted in a pit wall. The word "ground" includes snow and ice as well as soil materials. Two major sources of error, other than instrument error, are inherent in this type of measurement. If the air temperature differs from the ground temperature, heat will be exchanged between the air and side walls of the excavation as soon as the pit is opened. The ground temperature must be read before appreciable heat transfer occurs. A second error is introduced upon insertion of the temperature sensing element if the element temperature differs from the ground temperature.

**TR 187**
**TRANSIENT TEMPERATURE DISTRIBUTION WITHIN THERMAL SENSING ELEMENTS.**
Clark, J.A., May 1967, 10p., AD-818 016, 11 refs.
24-3140
THERMAL MEASURING INSTRUMENTS, ACCURACY.

Errors inherent in temperature measuring elements immersed in fluid streams are discussed for both steady-state and transient temperature conditions. Errors in steady-state conditions are due to calibration error, irregularities in signal transmission, mechanical malfunction of instrumentation, and thermal effects owing to the exchange of heat between the measuring element and its environment. These may generally be reduced to an acceptable minimum by proper design and installation. An additional source of error which must be considered in transient temperature conditions is the "thermal lag" which results from the fact that any physical system immersed in a fluid of changing temperature does not respond with time nor amplitude as does the fluid itself. This report presents a criterion by which to judge the acceptability of the premise of instantaneous spatially uniform temperature within a temperature sensing element during thermal transients, and the subsequent use of a simplified analysis to determine the dynamic error in measurement.

**TR 188**
**PROPERTIES OF THERMISTORS.**
Clark, J.A., et al, May 1967, 23p., AD-818 017, 149 refs.
Kobayashi, Y.
24-3141
THERMISTORS, SEMICONDUCTORS (MATERIALS), ACCURACY, ELECTRICAL RESISTANCE, BIBLIOGRAPHIES.

The characteristics of thermistors, semi-conductors with large negative temperature coefficients of electrical resistance, are reviewed and compared with standard resistance thermometers. Descriptions are given of the various sizes and shapes commercially available, thermal limitations in their use, and the various materials used in manufacture. Other uses for thermistors, such as temperature control, electrical regulation, and measurement of other variables are considered. Classification of semi-

conductors and the theory of operation is discussed and an expression for electronic conductivity is developed from which a method is proposed for the comparison of various thermistors. Steady state and transient thermal errors are evaluated, and factors affecting calibration stability are described. Recommendations for selection of thermistors and proper circuitry are given. A selected bibliography on thermistors is given.

**TR 189**
**SURFACE CHARACTERISTICS EFFECT ON THERMAL REGIME PHASE II.**
Kritz, M.A., et al, June 1967, 40p., AD-819 321, 43 refs.
Wechsler, A.E.
24-3142
THERMAL INSULATION, ROADS, CELLULAR MATERIALS, PAVEMENTS.
Various methods were investigated for improvement of the structural stability of raodways, airstrips, and other similar structures through the use of passive thermal control techniques. The principal methods considered were: (1) control of the thermal absorption and radiation properties of construction materials and surface coatings, (2) control of the bulk thermal properties of construction materials, and (3) integration of insulating materials into the designs of structures to minimize the effects of adverse heat flow conditions. A survey and evaluation of commercially available thermal control materials was made, and the most promising materials were selected for further laboratory and field investigation. Sixteen white paint samples were also obtained for laboratory and field study. Most of the paints tested were alkyd resins. A 2.5 lb/cu ft extruded polystyrene foam appeared to be the most practical of the present commercially available insulations; others show promise of future usefulness. High-quality alkyd resin white traffic paints were most satisfactory for use as passive thermal control coatings.

**TR 190**
**CREEP OF FROZEN SANDS.**
Sayles, F.H., Sept. 1968, 54p., AD-680 902, 13 refs.
24-3143
FROZEN GROUND COMPRESSION, COMPRESSIVE STRENGTH, CREEP PROPERTIES, STRESS ANALYSIS, STRAIN MEASUREMENT.
Unconfined compressive creep strengths and strains were measured for frozen saturated Ottawa sand (20-30) and Manchester fine sand. The creep tests were conducted at approximate stress levels of 60, 35, 20 and 5 per cent of the conventional unconfined compressive strength. Testing temperatures were 15, 25, 29 and 31F. It was found that the unconfined compressive creep strength of the frozen sand can be predicted using Vialov's strength formula; that creep strain can be predicted using two short-term, high-stress-level creep tests; that total strain can be predicted; and that for stresses below the long-term strength, the strain rate is directly proportional to the reciprocal of time during stress action until complete stabilization occurs.

**TR 191**
**SOIL SAMPLING AND DRILLING NEAR FAIRBANKS, ALASKA EQUIPMENT AND PROCEDURES.**
Davis, R.M., et al, Jan. 1967, 50p., AD-816 654, 24 refs.
Kitze, F.F.
24-3144
FROZEN GROUND PHYSICS, CORE SAMPLERS, DRILLING, ACTIVE LAYER.
Soil explorations were conducted by core drilling methods and by drive sampling methods in thawed and frozen silty soils. The Cyclone churn drill is an effective means for drive sampling in frozen silt soils to a depth in excess of 100 ft. Core drilling and sample recovery has been accomplished by using the Longyear, Acker, and

**TR 192** Record deleted.

**TR 193** Record deleted.

**TR 194**
**HEAT TRANSFER AND PERFORMANCE ANALYSIS OF A THERMAL PROBE FOR GLACIERS.**
Aamot, H.W.C., Sept. 1967, 12p., AD-661 050, 5 refs.
24-3145
THERMAL MEASURING INSTRUMENTS, HEAT TRANSFER, GLACIER ICE, ICE RESISTIVITY, PROBES, DRILLING, ANALYSIS (MATHEMATICS).
A thermal probe penetrating a glacier requires heat at the hot point for melting as well as along its entire length to balance the radial heat dissipation in the ice and thus prevent freezing in. The heat transfer problem is solved with a LaPlace transform and the results are developed graphically to simplify the numerical calculations. A performance diagram, developed as a design and operating aid, serves for analysis of the anticipated penetration performance of the probe and the required power levels.

**TR 195**
**PREDICTED DEPTH OF FREEZE OR THAW IN SOILS BY CLIMATOLOGICAL ANALYSIS OF CUMULATIVE HEAT FLOW.**
Scott, R.F., Sept. 1969, 46p., AD-696 414, 7 refs.
25-985
FROST PENETRATION, FROZEN GROUND THERMODYNAMICS, FORECASTING, SEASONAL FREEZE THAW, ACTIVE LAYER, HEAT TRANSFER.
A procedure is described for applying the cumulative heat flow concept previously developed by the author to the prediction of the depth of freeze and thaw in soils. Step-by-step instructions for performing the calculations are given. The procedure is illustrated by detailed application to selected turfed and paved areas for specific periods at four specific sites: Fairbanks and Kotzebue, Alaska; Thule AB, Greenland; and Dow AFB, Bangor, Maine. Results of the study indicated negligible variation from measured values. Mathematical derivations are presented in Appendix A, and the development of the relationship between cumulative heat flow through the ground surface and thaw (frost) penetration is given in Appendix B.

**TR 196**
**EARTH FILL DAM ON PERMAFROST HESS CREEK DAM, LIVENGOOD, ALASKA.**
Kitze, F.F., et al, March 1972, 50p., AD-742 216, 10 refs.
Simoni, O.W.
27-177
EARTH DAMS, PERMAFROST BENEATH DAMS, PERMAFROST PRESERVATION, HYDRAULIC FILL, EARTH FILLS, UNITED STATES—ALASKA—LIVENGOOD.
The Hess Creek Dam is a combination hydraulic fill and rolled earth fill structure containing about 479,000 cu yd of earth fill. A steel sheet pile cutoff wall runs along the base centerline. A 48-in.-diam metal pipe outlet with control gate was installed through the embankment at one end and a spillway 1300 ft long and 100 ft wide was built to accomodate flood flow. The performance and present condition of the dam suggest that construction of earth fill embankments on permafrost is feasible and practical. The embankment appears to have had little or no detrimental effect on the underlying permafrost. The refrigeration system installed at the base of the embankment seems to have accomplished its purpose of refreezing foundation soil thawed during the summer construction period.

**TR 197**
**SOME OBSERVATIONS ON THE DENSIFICATION OF ALPINE SNOW COVERS.**
Keeler, C.M., July 1967, 13p., AD-658 656, 15 refs.
24-3146
SNOW DENSITY, SUBSIDENCE, METAMORPHISM (SNOW).
Through pit measurements on selected deep seasonal snow covers, observations have been made on the densification rates of dry snows. The variation between rates has been compared with such physical characteristics of the snow as temperature, grain size, and loading rate. The rate of densification does not appear to be affected by temperature in the -1 to -10C range but it is inversely proportional to grain size and sensitive to rates of loading during the formative stage of any particular snow layer. Values of compressive viscosity vary from 1,000,000 to 1,000,000,000 gm/sq cm per second which is an order of magnitude less than the lowest values for polar snow. Plots of specific volume against overburden reveal a sharp discontinuity at a specific volume of about 3.0 cu cm/gm. The peristence of this discontinuity from location to location indicates that it may reflect a real phenomenon. It is suggested that it may be accounted for by extremely high strain rates at low densities.

**TR 198**
**FOG DISPERSAL EXPERIMENTS USING PROPANE AT WALLA WALLA, WASHINGTON.**
Hicks, J.R., April 1967, 11p., AD-653 636.
24-3147
FOG DISPERSAL, ARTIFICIAL PRECIPITATION, PROPANE.
Propane is an effective agent causing glaciation of supercooled fog droplets and subsequent improvement of visibility. When wind is less than 5 or 6 knots and steady with respect to direction, two or three dispensers, each emitting 2.5 to 3 lb/min. of liquid propane, could probalby keep an airfield open to air traffic at a cost of about 20 dollars per hour. The propane system is easy to use, inexpensive, requires neither preparation nor personnel standby time after the initial installation, and is effective at temperatures higher than the effective temperature of the more commonly used agents. No combustible mixture has been found beyond 8 ft from the discharge nozzle of the propane-air mixture. On airports with short runways, the reduced aircraft braking index caused by snow accumulation might be sufficient to render the system unsuitable unless the dispensers could be positioned far enough from the airport to allow the snow to fall upwind of the runway.

**TR 199**
**GEOLOGY OF THE USA CRREL PERMAFROST TUNNEL FAIRBANKS, ALASKA.**
Sellmann, P.V., July 1967, 22p., AD-660 310, Bibliog. p.20-22.
24-3148
GLACIAL GEOLOGY, GROUND ICE, AGE DETERMINATION, TUNNELS, PERMAFROST TUNNELS.
This study provides the pertinent regional and historical geology of the tunnel site and immediate surroundings as well as data on the index properties and seismic velocities of the material through which the tunnel passes. The tunnel, located in the discontinuous permafrost zone, is discussed with emphasis on bedrock, gravel, silt, ground ice, and chemical gradient. A study of the stratigraphy of the section reveals a record of the past climatic history of the area, based on the structure and distribution of the ice wedges, chemical gradients, sedimentary structures, radiocarbon dates, and the lithology of the material exposed along the tunnel section and vertical ventilation shaft. Two recognizable unconformities appear in the section. The large size of the wedges suggests that depositional rates were fairly slow during the period of wedge development. It can also be concluded that within the last 30,000 yr a minimum of 30 ft of silt was deposited, most of which is Wisconsin age.

**TR 200** Record deleted.

**TR 201** Record deleted.

**TR 202**
**ICE CAP STRAINS AND SOME EFFECTS ON ENGINEERING STRUCTURES.**
Mellor, M., et al, Dec. 1967, 10p., AD-665 373, 14 refs.
Reed, S.C.
24-3149
FOUNDATIONS, STRUCTURES, STRAINS, GLACIER MOVEMENT.
The components of strain for the upper layers of ice sheets are given in terms of ice flow velocity and snow accumulation rate. Methods of estimating the components of strain rate which are necessary for design of engineering structures are outlined, and representative measured values are given. The relation between observed structural deformation and ice cap straining is discussed.

**TR 203**
**SETTLING CHARACTERISTICS OF ACTIVATED SLUDGE AT LOW TEMPERATURE.**
Reed, S.C., Nov. 1970, 29p., AD-717 239, 25 refs.
25-4042
SEWAGE TREATMENT, TEMPERATURE FACTORS, SLUDGES.
A series of activated sludge settling tests were observed with particle concentration and temperature as the controlled variables. Based on the experimental data, an equation defining settling velocity in terms of concentration, fluid temperature, and organic loading was developed. Although empirical in nature the equation provides a rational basis for the determination of temperature influence and should have special value for cold regions designs. It was possible to describe the results of other investigations with this equation.

**TR 204**
**CROWDS ON ICE.**
Nevel, D.E., et al, Oct. 1968, 4p., AD-681 214, 2 refs.
Assur, A.
24-3150
LAKE ICE, ICE COVER STRENGTH, ICE BEARING CAPACITY.
This report considers a floating ice sheet supporting a crowd of people who are free to assume any distribution. The problem is analyzed when the people gather into a long strip, two strips, or a circular area, all of which may vary in size. The worst possible size is determined for the safe bearing capacity in each case. Upon comparison of the results, a single equation is suggested for practical use.

**TR 205** Record deleted.

**TR 206**
**PREPARATION OF LOW DENSITY SULFUR FOAM.**
Dale, J.M., et al, Sept. 1967, 14p., AD-661 315, Contract DA-27-021-AMC-34(X).
Ludwig, A.C., Southwest Research Institute.
24-3151
INSULATION, CELLULAR MATERIALS, SULFUR FOAM.
It has been demonstrated that it is possible to lower the density of rigid sulfur foam to as low as 10 lb/cu ft in continuous pressurized process equipment and as low as 6 lb/cu ft in laboratory glassware at atmospheric pressure. Based on past experience, each reduction of foam density becomes progressively more difficult to achieve. With further research the densities might be further reduced, lowering the unit volume cost of the material and improving the thermal conductivity of the foam. The attractive features of the foam include stress-strain characteristics which should allow use in a variety of structural applications; low thermal conductivity, making it a good thermal insulation material; low moisture absorption; low water vapor permeation; low cost; insensitivity to ambient temperature conditions but favored by low temperatures; and the capability of being produced at a remote field site.

**TR 207**
**EFFECT OF MINERALOGICAL COMPOSITION OF FINES ON FROST SUSCEPTIBILITY OF SOILS.**
Lambe, T.W., et al, Sept. 1969, 31p., AD-697 134, 14 refs.
Kaplar, C.W., Lambie, T.J.
24-3152
CLAYS, FROZEN FINES, FROST HEAVE, SOIL FREEZING.

Freezing tests performed on about 400 artificially blended specmens with various amounts and different kinds of mineral fines

**TR 208** Record deleted.

**TR 209** Record deleted.

**TR 210**
**INSTRUMENTED PROBES FOR DEEP GLACIAL INVESTIGATIONS.**
Aamot, H.W.C., May 1968, 6p., AD-672 057, 9 refs.
24-3153
THERMAL MEASURING INSTRUMENTS, PROBES, DRILLING, GLACIER ICE, HEAT TRANSFER.
Thermal probes have been developed that can carry instrumentation packages into polar ice sheets for geophysical investigations and long-term observations by remote measurement. They are self-contained, surface-controlled devices. During development work at USA CRREL problems with materials, fabrication, and heat transfer analysis were solved. The Philberth probe, named after its inventor, demonstrated its performance capability in Greenland. The pendulum probe was a further development with increased performance and versatility.

**TR 211**
**AN EXPERIMENTAL SNOW RUNWAY PAVEMENT IN ANTARCTICA.**
Abele, G., Nov. 1968, 25p., AD-681 219, 28 refs.
24-3154
RUNWAYS, SNOW ROADS, SNOW COMPACTION, ANTARCTICA—MCMURDO.
The strength properties of a Peter miller-processed and -compacted snow runway test strip at McMurdo, Antarctica, and the snow pavement performance during simulated C-130 and C-121 aircraft wheel-load tests are discussed and evaluated. The correlation of shear strength, obtained by a test method developed by NCEL, with ram hardness and unconfined compressive strength of high-density snow is discussed and an approximate relationship is developed. Data from actual aircraft and simulated aircraft wheel-load tests on snow pavements are compared with previously developed criteria for snow pavement supporting capacity. The agreement between predicted values and actual test data is generally good; the predicted required strength values are somewhat higher than actual required strength values. The production data from the test strip construction are included.

**TR 212**
**DESIGN CRITERIA FOR SNOW RUNWAYS.**
Abele, G., et al, Nov. 1968, 36p., AD-681 220, Bibliog. p.16-18.
Ramseier, R.O., Wuori, A.F.
24-3155
RUNWAYS, SNOW ROADS, SINTERING, SNOW COMPACTION.
The mechanical properties of processed snow have been correlated with its wheel-load supporting capacity. The correlation shows the effect of such parameters as wheel load, tire contract pressure, and repetitive wheel coverages on the required hardness or strength of a compacted snow layer. Strength profiles which can be expected from certain snow processing and compaction procedures are shown and compared with required strength profiles for various types of wheeled vehicles and aircraft. The purpose of this study was to combine the knowledge gained from fundamental research in the processes of sintering with methods and procedures developed by engineers for using snow as a construction material. The results are readily applicable to the construction of snow runways for a large variety of wheeled aircraft and the construction of snow roads for wheeled vehicle traffic, not only in polar and subpolar areas, but in temperate regions with a heavy seasonal snow cover. The methods described apply not only to areas like Greenland or Antarctica but to areas with an annual snow cover. These methods, together with a fundamental understanding of the sintering process, have recently been applied in the construction of runway test strips at McMurdo, Antarctica.

**TR 213**
**EFFECT OF SOLAR RADIATION ON PROCESSED SNOW IN ENGINEERING CONSTRUCTION.**
Kovacs, A., et al, Oct. 1968, 23p., AD-680 184, 7 refs.
Ramseier, R.O.
24-3156
SNOW (CONSTRUCTION MATERIAL), SINTERING, ICE HOUSES, SOLAR RADIATION.
This report discusses the effect of solar radiation on the strength of in situ processed Peter snow. The effect of short term (less than 2 weeks) solar radiation on the strength of in situ processed snow sintering in the environment of Camp Century, Greenland, can be considered insignificant. Under the environmental conditions at Camp Century, an in situ processed snow deposit can achieve in 45 days 90 to 95 percent of the unconfined compressive strength of natural snow of comparable density at -9C.

**TR 214**
**THE 50-MAN WINTER CAMP AT TUTO, GREENLAND.**
Lufkin, L.E., et al, Aug. 1969, 57p., AD-694 375, 36 refs.
Tobiasson, W.
24-3157
EXCAVATION, FOUNDATIONS, COLD WEATHER CONSTRUCTION, PREFABRICATION, WASTE DISPOSAL, WATER SUPPLY.
In 1965 a U.S. Army research camp was constructed near Thule, Greenland. Research needs, site conditions and available equipment strongly influenced design and construction. Data collected from other facilities in Greenland were used to establish space, utility and power requirements. Orienting structures to minimize snow drifting, elevating floors to prevent degradation of permafrost, and protection of utility lines from freezing were given particular attention. Timber spread footings resting on non-frost-susceptible fill were used to support two rows of wooden T-5 Arctic buildings, interconnected by a corrugated steel passageway. Water was piped 4470 ft from a glacial lake and waste water discharged into a lagoon downwind of the facility. Excavation of permafrost with a routing tooth was the major construction problem. The extra effort expended to consider the special problems of the Arctic site was fully justified: snow drifting and utility problems were minimal and the overall performance of the facility exceeded that of several previously constructed camps.

**TR 215**
**A BUOYANCY STABILIZED HOT POINT DRILL FOR GLACIER STUDIES.**
Aamot, H.W.C., Oct. 1968, 5p., AD-678 580.
24-3158
ICE DRILLS, DRILLING, HOT POINT DRILLS.
Hot point drills are practical tools for penetrating glaciers for ice thickness and temperature measurements and other glaciological studies. Buoyancy stabilization ensures a vertical attitude of the drill and a plumb hole using a heavy hot point and a light upper section which floats in the surrounding melt water. The buoyant force is less than the weight of the drill in air but its rectifying moment about the fulcrum (the tip) is greater than the tilting moment of the drill weight. Two methods to prevent refreezing of the melt water are proposed to permit drilling in cold ice and to assure continued access to the hole.

**TR 216**
**DETERMINING THE DYNAMIC PROPERTIES OF SNOW AND ICE BY FORCED VIBRATION.**
Smith, N., June 1969, 17p., AD-694 376, 6 refs.
24-3159
ELASTIC PROPERTIES, SHEAR MODULUS, SNOW MECHANICS, ICE MECHANICS, POISSON'S RATIO.
The complex dynamic Young's and shear moduli, loss factor and Poisson's ratio are presented for naturally compacted glacial snow through a density range of 0.4 to 0.9 g/cu cm. A frequency dependence of the moduli and its effect on the computation of Poisson's ratio is demonstrated. Considerable scatter is exhibited in the loss factor measurements; however, indications are that the loss factors have negligible effect on the modulus computations.

**TR 217**
**SNOW ALBEDO MODIFICATION - A REVIEW OF LITERATURE.**
Slaughter, C.W., Oct. 1969, 25p., AD-698 023, Bibliog. p.19-24. 114 refs.
24-3160
ALBEDO, RADIATION ABSORPTION, SNOW MELTING, DUSTING, CARBON BLACK.
A summary of published information on snow albedo modification is presented. Consideration of energy balance parameters is followed by discussion of qualitative and quantitative results of albedo modification, both increasing (lightening) and decreasing (darkening). Practical applications of albedo modification are discussed.

**TR 218**
**SHOCK TUBE EXPERIMENTS ON SNOW.**
Smith, J.L., June 1969, 16p., AD-692 291, 8 refs.
24-3161
ELASTIC WAVES, SNOW MECHANICS, SHOCK TUBES.
Hugoniot curves were generated by measuring the pressures and velocities of a series of elastic shock waves that represent final shock states. A shock tube was employed to create a controlled shock pressure that was applied to the snow specimen. The shock wave velocity was determined from the measured values of arrival time and the length of the sample obtained for each magnitude of incident pressure. An impedance mismatch relation was used to determine the stress induced on the snow sample. The data obtained were transformed into pressure-volume equations of state by applying the Rankine-Hugoniot conservation equations. Empirical relationships represented by the Bridgman equation and that derived from a linear relationship of shock and particle velocities produced essentially the same values.

**TR 219**
**DESIGN OF FOOTING FOUNDATIONS ON POLAR SNOW.**
Reed, S.C., Sept. 1974, 27p., AD-787 287, 11 refs.
29-2435
FOOTINGS, SETTLEMENT (STRUCTURAL), SNOW COVER STABILITY, SNOW MECHANICS.
Settlement of spread footings on snow is dependent on time, snow density, snow temperature, load intensity, footing size and footing shape. Empirical equations, based on field test results at Camp Century, Greenland, relating these parameters are developed in this report. The equations are written to permit simple hand calculations so they do not require a complex mathematical technique or computer application.

**TR 220**
**COLD CONCRETE.**
Stormer, C.D., April 1970, 27p., AD-705 561, 27 refs.
25-986
CONCRETE ADMIXTURES, COMPRESSIVE STRENGTH, CONCRETE STRENGTH, WINTER CONCRETING, FREEZE THAW TESTS.
The primary techniques commonly practiced for placing concrete in the winter include heating the mix materials and providing a suitable protective insulating material to the form work. An additive of 2% calcium chloride is permitted by most building codes to accelerate the growth of strength and allow faster removal of protection and forms. Another method developed in the USSR, is the use of cold concrete. This involves the greater use of calcium chloride and sodium chloride as accelerators, and freezing point depressants. The purpose of this study was to verify some of the translated data to determine whether this method is practicable and worthy of further investigation. A comparison of USSR compression test results and those of this study showed similarities in the water/cement ratios, strengths, and curing temperatures. Salt contents were 1 1/2 to 2 times those reported in the Russian literature.

**TR 221**
**PERMAFROST TUNNELING BY A CONTINUOUS MECHANICAL METHOD.**
Swinzow, G.K., Nov. 1970, 37p., AD-717 240, 16 refs.
25-4043
TUNNELING (EXCAVATION), FROZEN GROUND MECHANICS, EXCAVATING EQUIPMENT, SHELTERS, PERMAFROST.
A mechanical method tunneling in permafrost was investigated by excavating the Alaska Experimental Permafrost Tunnel in a perennially frozen stratum of Fairbanks silt at the edge of a gold dredge field 11 miles north of Fairbanks. The tunnel is 360 ft long and about 7 x 13 ft in cross section. It was cut by the Alkirk continuous cyclic mining method. Certain properties of the frozen silt were investigated and the tunnel was evaluated as a shelter for military purposes. Temperatures, mechanical compositions and moisture contents are discussed and observations on plastic deformation are given. The machine uses a pilot-pull principle to provide face pressure. Its potential performance was evaluated. Special observations of cutting strain and power consumption were performed and the cutting process was analyzed. It was found that the mechanical process is expedient and that with modifications the Alkirk principle promises to become a feasible method of excavating deep shelters in permafrost. Subsurface shelters in permafrost provide advantageous protection against high velocity shocks. The operation's efficiency is analyzed in the appendix.

**TR 222**
**DYNAMIC YOUNG'S MODULUS AND FLEXURAL STRENGTH OF SEA ICE.**
Frankenstein, G.E., et al, May 1970, 13p., AD-710 975, 10 refs.
Garner, R.
25-1471
ELASTIC PROPERTIES, SEA ICE, WAVE PROPAGATION, ICE ACOUSTICS, FLEXURAL STRENGTH.
This report describes the results of tests made to determine the dynamic Young's modulus E of young sea ice. The ice samples were mainly parallelepipeds but a few were 7.62-cm-diam cores. The longitudinal wave velocity was determined by measuring the time required for a sound wave to travel the length of the sample. The measured wave velocities were corrected, by Love's frequency equation, to apply to infinite wavelengths. The flexural strength of the ice was determined by conducting a number of simple beam tests. The average value for the flexural strength was 11.3 kg/sq cm.

**TR 223**
**EXPERIMENTS TO SIMPLIFY FROST SUSCEPTIBILITY TESTING OF SOILS.**
Kaplar, C.W., Jan. 1971, 21p., AD-719 237, 18 refs.
26-369
FROST RESISTANCE, SOIL FREEZING, FROST HEAVE, SOIL TESTS, HEAT TRANSFER, LABORATORY TECHNIQUES.
Experiments conducted at USA CRREL in recent years indicate that the two weeks or so required for the frost susceptibility testing of soils with previous procedures can be shortened considerably. Results of these experiments show that useful frost heaving data can be obtained in a matter of 2 or 3 days by a more rapid freezing technique. Results of experiments in which soil specimens were exposed to a constantly maintained temperature are presented. Data show that heave rate in laboratory ex-

periments is a variable, not a constant, of a soil and is strongly dependent upon the heat extraction rate. The important role of frost susceptibility testing and soil evaluation for highway design is discussed. The suitability of equipment for use in conducting frost-heaving tests is also discussed.

**TR 224**
**RESTUDY OF RED ROCK CLIFF NUNATARSSUAQ, GREENLAND.**
Goldthwait, R.P., et al, Aug. 1971, 29p., AD-732 411, Also designated Contribution No.130, Inst. of Polar Studies, Ohio State Univ. 9 refs.
Brecher, H.H., Wrestler, S.P., Weissman, S., Einersson, E.
26-2769
GLACIER OSCILLATION, GLACIER ABLATION, PLANTS (BOTANY), GLACIER MELTING, MAPPING, GLACIOLOGY, PHOTOGRAMMETRY, GREENLAND—NUNATARSSUAQ.
A follow-up study of Red Rock Ice Cliff was undertaken in summer 1965 to time-test findings of more comprehensive studies in 1955 and 1956. Work was limited to mapping the ice cliff face and a portion of the ice drainage basin above it and to studying the effects upon vegetation. A total ice loss of 500,000 cubic meters/year was calculated for the small 2.2-sq km ice drainage basin whose surface dropped 5 m in a decade. Five regions, totaling 6 percent of the 1 sq km mapped, dropped by 8 m or more. Ice loss from the ice cliff decreased from about 2 percent to less than 1 percent due largely to a 30 percent reduction in the area of exposed cliff. The overall position of the cliff remained unchanged. There was less difference in cliff face detail in the two July maps ten years apart than in the several maps over one season.

**TR 225**
**ISOTHERMAL COMPRESSIBILITY OF FROZEN SOIL AND ICE TO 30 KILOBARS AT -10 C.**
Chamberlain, E., et al, June 1970, 33p., AD-708 867, 19 refs.
Hoekstra, P.
25-1649
COMPRESSIVE PROPERTIES, FROZEN GROUND MECHANICS, PHASE TRANSFORMATIONS, SOIL MOISTURE, PRESSURE FACTORS, ICE COMPRESSION.
The isothermal compressibilities of ice and partially and fully saturated sand and silt at -10 C are presented. The tests employ a piston-die device with which a uniaxial load is imposed on a lead encapsulated specimen, resulting in the hydrostatic compression of the test specimen. Pressures to 30 kbars are obtained. The compressibility of ice is as reported by P.W. Bridgman. The various phase transformations of ice I to water to ice V to ice VI to ice VIII appear as expected. It is shown that the compressibility of frozen soil can be readily predicted from the knowledge of material properties such as degree of saturation with ice, porosity, and the compressibilities of the ice and mineral components.

**TR 226**
**ENERGY BALANCE ON A PAVED SURFACE.**
Berg, R.L., June 1974, 51p., AD-781 508, 43 refs.
29-913
CONCRETE PAVEMENTS, FROST PENETRATION, THAW DEPTH, HEAT BALANCE.
Energy balance data from portland cement concrete test slabs at the Lebanon Regional Airport, Lebanon, New Hampshire, are compared with calculated quantities. Energy balance components are calculated from techniques used by Scott in developing the cumulative heat flow technique for determining frost and thaw depths. Techniques for computing frost and thaw depths are briefly reviewed to illustrate applications of the surface energy balance in frost and thaw depth calculations. Comparison of calculated and measured components of the energy balance indicates that computational techniques and/or data measurement techniques must be improved to provide estimated frost and thaw depths that are within 15% of measured depths.

**TR 227**
**INVESTIGATION OF LIGHTWEIGHT SULFUR FOAM FOR USE IN FIELD APPLICATIONS.**
Dale, J.M., et al, Oct. 1969, 19p., AD-698 461.
Ludwig, A.C.
25-2256
BUILDINGS, INSULATION, CELLULAR MATERIALS, PANELS, SUBGRADES, FOUNDATIONS.
Previous studies indicated that lightweight sulfur foams had thermal insulating characteristics and mechanical properties which were sufficiently attractive that they could be considered for a number of structural applications. The subject study was undertaken in order to determine if the process for preparing sulfur foam could be scaled up from small laboratory-size equipment, producing 4 lb of foam per batch, to large conventional pressure-heated equipment capable of producing 500 lb of foam per batch. This was accomplished, and large quantities of sulfur foam were prepared and tested for such applications as subbases for roadways, as foam core panels, and for foamed-in-place structures. The sulfur foams appear particularly attractive for the subbase applications and foam core panels. Further investigations are required for the foamed-in-place structures because of the initial creep characteristics associated with the sulfur foams, first identified during the course of this study.

**TR 228** Record deleted.

**TR 229** Record deleted.

**TR 230**
**PHYSICAL CHARACTERISTICS OF THE SNOW COVER FORT GREELY, ALASKA, 1966-67.**
Bilello, M.A., et al, Sept. 1970, 33p., AD-714 646, 34 refs.
Bates, R.E., Riley, J.
25-2439
SNOW COVER, SNOW DENSITY, METEOROLOGICAL FACTORS, MEASUREMENT, SNOW TEMPERATURE, SNOW HARDNESS, UNITED STATES—ALASKA—FORT GREELY.
Observations were made at 19 sites in and around the Fort Greely Military Reservation in Alaska during the winter of 1966-67 to obtain data on the depth and physical properties of the snow cover. Measurements at nine sites showed that the snow density at Fort Greely was generally light; e.g., the average density in the forest did not exceed 0.24 g/cu cm. On the average, less snow falls at Fort Greely than at other interior Alaskan locations; but the average density of the snow cover at all interior Alaska sites is quire light. Relationships between snow-cover properties and climate were tested using data collected at Fort Greely. The results substantiated the relationships between (1) snow hardness and snow density measurements and (2) average snow densities with average windspeed and air temperatures.

**TR 231**
**CORE DRILLING THROUGH THE ANTARCTIC ICE SHEET.**
Ueda, H.T., et al, Dec. 1969, 17p., AD-700 998, 8 refs.
Garfield, D.E.
25-987
ICE DRILLS, CORING, DRILL CORE ANALYSIS, ICE SHEETS, ICE TEMPERATURE, HEAT FLOW, BOTTOM ICE, MELTING.
The Antarctic ice sheet was penetrated by core drilling at Byrd Station during the 1967-68 austral summer. The drill was a cable-suspended electromechanical rotary type 87 ft long, weighing 2650 lb. An electrohydraulic hoist raised and lowered the drill at a maximum rate of 150 ft/min. Other equipment included 12,000 ft of armored electrical cable and a 70-ft-high aluminum tower. During the 1966-67 austral summer, the equipment was installed and a depth of 745 ft was drilled. Drilling resumed in November 1967 and the hole was completed in January 1968. Cores 10 to 20 ft long averaging 4 1/4 in. diam were recovered over 99% of the depth. Liquid water, indicative of pressure melting at the bottom of the ice sheet, was encountered at 7101 ft. Attempts to recover a core of sub-ice material were not successful. The hole began deviating from the vertical at 750-ft depth and, despite corrective measures, was inclined 15 deg at the bottom. Ice temperatures increased steadily from a minimum of -28.8C at 2400 ft to -13.0C at 5942 ft, where temperature measurement ceased.

**TR 232**
**MEASUREMENT OF HEAT FLOW IN THE GROUND AND THE THEORY OF HEAT FLUX METERS.**
Schwerdtfeger, P., Nov. 1970, 33p., AD-717 027, 12 refs.
25-4044
MICROMETEOROLOGY, SOIL TEMPERATURE, HEAT FLOW METERS, HEAT FLUX.
The behavior of heat flux meters has been examined by experimental, electrical analogue and numerical means. The results indicate the $more general applicability of the flux meter equation first proposed by Phillip (1961) for the special case of spheroidal meters, provided certain precautions are taken. The purely geometric parameter appearing in this equation has been related to meter shape and a functional connection has been suggested. It is proposed that pairs of thermal sensors be used to monitor thermal conductivity continuously and the use of nonuniform "focusing" heat flux meters is recommended in cases where the physical cross section of a thermopile should remain small compared to the resultant thermal cross section. Finally a number of calibration techniques are reported, including the use of a novel radiation enclosure in which meters are temporarily tested as net radiometers.

**TR 233**
**FUNDAMENTAL CONCEPTS FOR THE RAPID DISENGAGEMENT OF FROZEN SOIL. PHASE I.**
Foster-Miller Associates, Inc., May 1973, 145p., AD-763 198, 97 refs.
28-694
FROZEN GROUND MECHANICS, COLD WEATHER CONSTRUCTION, PERMAFROST EXCAVATION.
Phase I includes a literature survey to identify important permafrost properties, to determine previous methods used, and to uncover useful information in allied fields. System concepts for disengaging permafrost were devised and physical processes which can be used to implement these concepts were tabulated. These fundamental processes were then analyzed to determine their potential. In general, structural relaxation processes were not found promising for rapid excavating systems. Promising structural fracture processes include: mechanical cutting and breaking processes; material removal by high-speed liquid drop impingement; fracture by internal electrical discharge; internal gas generation by rapid electrical heating at grain boundaries; and controlled explosive loading. Recommendations have been made for a series of tasks for Phase II designed to obtain the necessary data to more fully evaluate these processes.

**TR 234**
**FUNDAMENTAL CONCEPTS FOR THE RAPID DISENGAGEMENT OF FROZEN SOIL. PHASE II.**
Foster-Miller Associates, Inc., May 1973, 109p., AD-763 199, 51 refs.
28-693
FROZEN GROUND MECHANICS, COLD WEATHER CONSTRUCTION, PERMAFROST EXCAVATION.
Mechanical processes are considered to offer the most satisfactory short-term answer to permafrost disengagement problem. The most satisfactory primary processes include shear cutting and indentation cutting. Also satisfactory from an effectiveness standpoint is highly-velocity liquid droplet impingement, but extensive development is required to advance the technology sufficiently to make it practical as a large-scale material disengagement device. Promising secondary processes include cantilever bending fracture, brittle ridge fracture and controlled explosive loading. Analysis of the various combinations of the promising primary and secondary processes resulted in three complete permafrost disengagement concepts: a. Penetration and brittle ridge fracture, b. Kerfing and cantilever fracture, c. Penetration and airblasting. No exceptional increase in energy effectiveness or rate of material disengagement are possible at the present time by using novel energy interactions, such as lasers and high-energy electron beams, because they present severe implementation problems within the existing state of the art.

**TR 235**
**RADAR CROSS-SECTION MEASUREMENTS OF SNOW AND ICE.**
Hoekstra, P., et al, Nov, 1972, 37p., AD-752 900, 9 refs.
Spanogle, D.
27-2796
RADAR ECHOES, SNOW DIELECTRICS, ICE DIELECTRICS, REFLECTIVITY.
The radar backscatter from undisturbed snow surfaces was measured at 10 GHz, 35 GHz and 95 GHz and at grazing angles of 1 to 0.4 deg. For horizontally polarized radiation the ground clutter per unit area sq m at 10 GHz from a flat snow terrain decreased from -50 db at 1 deg to -70 db at 0.4 deg. The return was approximately 10 db lower for vertically polarized radiation. The ground clutter depended on the free water content of the snow. The return at 35 GHz was approximately 10 db higher than that at 10 GHz at horizontal and vertical polarizations and at a grazing angle of 0.4 deg. The difference between the return at 10 GHz and that at 35 GHz decreased at higher grazing angles. Because of its narrow beamwidth the 95-GHz radar saw individual patches in the terrain and no meaningful number for the terrain radar cross section could be obtained. The radar cross section of ice blocks placed on the snow surface was roughly proportional to the square of the area of the ice blocks facing the radar at 10 and 35 GHz and was about 20 dbsm below the return expected for a perfectly reflecting plane surface. At 95 GHz the ice blocks became diffuse reflectors. The power reflection coefficient at normal incidence for ice blocks with carefully prepared surfaces measured in free space was from 0.005 to 0.08 at 10 GHz and from 0.009 to 0.031 at 35 GHz.

**TR 236**
**SOILS OF THE CARIBOU-POKER CREEKS RESEARCH WATERSHED INTERIOR ALASKA.**
Rieger, S.R., et al, April 1972, 10p., AD-744 451.
Furbush, C.E., Schoephorster, D.B., Summerfield, H., Jr., Geiger, L.C.
27-711
SOIL CLASSIFICATION, SOIL MAPPING, PERMAFROST HYDROLOGY, WATERSHEDS.
Soils of the 41.5 sq mi Caribou-Poker Creeks Research Watershed, central Alaska, have been mapped by standard Soil Conservation Service (USDA) methods. Seven soil series are recognized: Bradway silt loams, Ester silt loams, Karshner silt loams and Saulich silt loams, all underlain by permafrost at shallow depth, make up 27 per cent of the basin area. Olnes silt loams, Gilmore silt loams and Fairplay silt loams, covering 73 per cent of the watershed area, are free from permafrost. Areal distribution of soils is depicted on a photo-mosaic base at 1:31,680 scale.

**TR 237**
**EFFECT OF LOW VISIBILITY ON THE PERFORMANCE OF VEHICLE OPERATORS.**
Liston, R.A., Aug. 1972, 12p., AD-749 248.
27-1179
COLD WEATHER OPERATION, ALL TERRAIN VEHICLES, VISIBILITY, HUMAN FACTORS ENGINEERING, WHITEOUT.
An experimental program to identify the relationship between visibility conditions and operator performance is discussed. Average speed in negotiating a controlled course is taken as the measure of operator performance. The method to measure visibility is discussed. It is shown that despite use of a contrived test course and artificially reduced visibility conditions and average speed can be represented with a simple, second order equation.

**TR 238**
**TERMINAL BALLISTICS IN ORDINARY SNOW.**
Swinzow, G.K., Nov. 1972, 20p., AD-752 114, 18 refs.
27-1682
PENETRATION TESTS, SNOW COVER EFFECT, PROJECTILE PENETRATION, SMALL ARMS.
The terminal ballistics of various types of snow were investigated experimentally and the resulting data have been researched and tabulated. The experimental procedures, especially designed for this purpose, are described and illustrated. It was concluded that snow is an effective protective material, with measurable and significant capability to attenuate small arms fire and neutralize fragment action. A brief discourse was made into the role of snow-covered terrain in combat, its geography and general properties.

**TR 239**
**EFFECT OF SNOW COVER ON OBSTACLE-CROSSING PERFORMANCE OF VEHICLES.**
Hanamoto, B., Nov. 1972, 29p., AD-752 901, 10 refs.
27-2795
TRACKED VEHICLES, SNOW COVER EFFECT, COLD WEATHER PERFORMANCE, SNOW VEHICLES, TOPOGRAPHIC FEATURES.
This study concerns the effect of snow cover on the obstacle-crossing performance of over-snow tracked vehicles. Analyses of the performance of vehicles crossing vertical-walled steps and trenches were made based on obstacle geometry and vehicle characteristics and dimensions and were programmed for computer analysis. Obstacle-crossing field tests were conducted using the snow-trac and the M-29-C Weasel to obtain verification data. In areas of snow 2 to 3 ft deep, the snow cover, along with snow transport and drifting, changed vertical-walled steps of over 5 ft into gently sloped, easily negotiable terrain features. Data were collected for vehicles crossing vertical-walled steps covered with up to 16 in. of shallow, soft snow. The agreement between predicted and measured negotiable step heights was good when vehicle and obstacle geometry, as well as vehicle sinkage and track deflection, were taken into account.

**TR 240**
**OBSERVATIONS OF SURFACE EFFECT VEHICLE PERFORMANCE.**
Liston, R.A., April 1973, 59p., AD-762 169, 8 refs.
28-656
AIR CUSHION VEHICLES, ARCTIC TERRAIN, DESIGN CRITERIA.

**TR 241**
**ERTS VIEW OF ALASKA, A REGIONAL ANALYSIS OF EARTH AND WATER RESOURCES BASED ON SATELLITE IMAGERY.**
Anderson, D.M., et al, June 1973, 101p., AD-765 442/9.
Crowder, W.K., Gatto, L.W., Haugen, R.K., Marlar, T.L.
28-2145
REMOTE SENSING, TERRAIN ANALYSIS, PHOTOINTERPRETATION, PERMAFROST INDICATORS, MAPPING, SEA ICE DISTRIBUTION, VEGETATION PATTERNS, ERTS IMAGERY.
A preliminary study has been made of the value of satellite imagery in synoptic surveys of the distribution and environmental interrelationships of permafrost terrain and of coastal sedimentation and related processes in Cook Inlet, Alaska. Earth Resources Technology Satellite multispectral scanner (MSS) imagery was the primary data source for this investigation. Aerial underflight imagery and ground observations of selected sites were secondary data sources. Emphasis has been placed on evaluating the feasibility of mapping permafrost terrain from textural and tonal patterns related to surficial geology and vegetation. A mosaic of a 153,400-sq. km. area in north-central Alaska has been prepared at a scale of 1:1 million. Seven surficial geology, eight vegetative cover and four permafrost terrain units were defined and delineated. Many geomorphic features were also recognized: thaw lakes, stream drainage patterns, glacial moraines, cirques, abondoned glacial valleys and volcanic cones. Preliminary analysis of the regional hydrological and oceanographic processes in Cook Inlet has been accomplished. It is evident that the distribution of sediments and regional circulation patterns can be monitored using satellite imagery. (Auth.)

**TR 242**
**CIRCULAR FOOTINGS ON VISCOELASTIC FOUNDATIONS.**
Lee, T.-M., Sept. 1973, 21p., AD-767 247 .
29-295
FOOTINGS, FOUNDATIONS, VISCOELASTICITY.
The interaction of a vibrating circular footing with its foundation was investigated. To account for the energy dissipation when propagating through the supporting ground, the foundation was assumed to behave as a viscoelastic medium. The response of the footing was found to depend upon its own mass and vibration frequencies and the foundation material properties. But, for the convenience of engineering applications, the response was expressed in terms of a scaled amplitude ratio and the static deflection of the footing.

**TR 243**
**OPERATIONAL EVALUATION OF THE SK-5 AIR CUSHION VEHICLE IN ALASKA.**
Liston, R.A., Sept. 1973, 39p., AD-767 247, 8 refs.
28-2874
AIR CUSHION VEHICLES, COLD WEATHER TESTS.
This report discusses the evaluation of the SK-5 air cushion vehicle, manufactured by the Bell Aerospace Company, during operations on terrain typical of central Alaska. The intent of the evaluation was to consider the SK-5 as representative of the state of the art rather than as a candidate for a specific military role in Alaska. The study included tests to: determine slope-climbing ability; measure skirt drag; identify maneuverability as a function of surface conditions; determine air flow characteristics through the gap between the skirt and ground; and to identify the change in cushion pressure as a function of obstacle geometry. The test procedures and results are discussed. Conclusions for each test are drawn as is an overall conclusion concerning the potential value of air cushion vehicles in helping to solve Alaskan transportation problems.

**TR 244**
**MEASURING THE THERMAL PROPERTIES OF CYLINDRICAL SPECIMENS BY THE USE OF SINUSOIDAL TEMPERATURE WAVES.**
Hoekstra, P., et al, Oct. 1973, 16p., AD-770 425, 9 refs.
Delaney, A.J., Atkins, R.T.
28-3034
SOIL PROFILES, THERMAL DIFFUSIVITY, TEMPERATURE MEASURING INSTRUMENTS, WAVE PROPAGATION, PERIODIC FUNCTIONS.
An apparatus for measuring the thermal diffusivity of cylindrical specimens of soil and rock was constructed and tested. A cylindrical specimen 25 cm long with a diameter of 7.72 cm was used in the tests, but the basic design allows much versatility in adapting the specimen dimensions to the size of cores. The amplitude of the temperature wave used was about 1C and the frequency of the wave was 2 cycles per hour. The results of tests on standard samples agreed well with values obtained by other investigators using different methods. Because the direction of the temperature gradient is constantly reversed, the method has advantages for specimens where water migration is a problem. Also, because of the small temperature differentials that can be used the method is suited for materials for which the thermal properties are temperature dependent, such as, for example, frozen ground in the temperature range from 0C to -10C.

**TR 245**
**INVESTIGATION OF CORE DRILLING IN PERENNIALLY FROZEN GRAVELS AND ROCK.**
Lange, G.R., Dec. 1973, 26p., AD-772 705, 8 refs.
28-3035
ROTARY DRILLING, FROZEN ROCKS, FROZEN GRAVEL, CORE SAMPLERS.
The problems of obtaining frozen samples by core drilling of perennially frozen gravel and rock were investigated. Most of the core drilling was carried out in ice-bonded, well-graded alluvial gravel with the ground temperature near its freezing point using compressed air and oil-based liquids as drilling fluids. The details of both successful and unsuccessful coring attempts are reported and related to descriptions and photographs of samples of a wide range of quality. Drilling variables such as weight on the bit, rotational velocity, rate of penetration, fluid temperatures, viscosities, flow rates and pressures and mechanical details of the diamond bits are reported. To make the information more widely applicable, calculated values for the pressure on the bit, the lineal velocity range of the diamond points, the force per diamond point and the uphole velocity of the fluid stream are given. It is concluded that with careful control of the drilling variables, good samples of these difficult materials can be obtained at satisfactory drilling rates so long as the material is well-bonded by ice. Suggestions are given for improvement of equipment and methods.

**TR 246** Record deleted.

**TR 247**
**ARCTIC TERRAIN CHARACTERISTICS DATA BANK.**
Mock, S.J., et al, March 1974, 47p., AD-777 551, 4 refs.
LaGarde, V., Tucker, W.B.
28-4120
ARCTIC TERRAIN, DATA PROCESSING, SEA ICE, ICE NAVIGATION, AERIAL PHOTOGRAPHY, AIR CUSHION VEHICLES.
An Arctic terrain characteristics data bank was established as part of a program to evaluate advanced surface effect vehicle (SEV) designs for Arctic use. The data bank contains approximately 4300 kilometers of terrain profiles in digital form acquired with an airborne laser profilometer system, and approximately 50 digital terrain maps for areas ranging from 0.01 sq km to 1 sq km, photogrammetrically derived from aerial photography. The development and data processing techniques are described along with descriptions of the data bank contents.

**TR 248**
**APPLICATION OF ELECTRICAL ENERGY TO CULVERT ICING PROBLEMS. A LABORATORY STUDY.**
Gaskin, D.A., et al, March 1974, 44p., AD-777 516, 6 refs.
Stanley, L.E.
28-4121
ROAD MAINTENANCE, DRAINAGE, ICING, HEATING, ICE AIR INTERFACE, ICE FORMATION, ICE PREVENTION, ICE CONTROL.
A laboratory study was made to investigate the use of electric heat cables to counteract culvert icing. An automatic system for producing a thaw tunnel of a preselected diameter was developed and tested. An 80 in. long, 1 ft in diameter culvert with a 10 ft copper sheath heating cable modelled a typical Alaskan installation. Tests were made to evaluate several continuous power levels, a short-term percentage timer, and the automatic system. Maximum efficienty (cross section produced/unit energy input) occurred when the cable was operated continuously at its maximum permissible power level. The short-term timer system was less efficient than applying the same amount of energy continuously. The automatic system performed well in the laboratory, but may need additional design work to ensure high reliability in field applications. Observations indicate that the major heat transfer mechanism is convection. Marked constrictions in tunnel size were observed at the ice/air interfaces. These observations imply that the cable should be installed near the bottom of the culvert and the end risers doubled or tripled. The relative cost comparison among the three modes of heat cable operation indicated that the continuous operation mode is the most reliable, but the most expensive. The pulsed system was less expensive. The automatic system was the least expensive, within the constraints of the comparison. Six recommendations are made for further studies based upon the experience gained from field studies and the results of the laboratory study.

**TR 249**
**MOISTURE AND FREEZE-THAW EFFECTS ON RIGID THERMAL INSULATIONS.**
Kaplar, C.W., April 1974, 30p., ADA-008 869, 12 refs.
29-4016
THERMAL INSULATION, FREEZE THAW CYCLES, MOISTURE TRANSFER, CELLULAR MATERIALS.
This report presents data from a limited investigation of some physical properties of predominantly rigid foamed plastic thermal insulations of various types. Included in the study were boards of mineral wool, cork, perlite, calcium silicate, urethane, extruded polystyrene and polystyrene beadboard. Long term moisture absorption tests were conducted both in water and after burial in moist soil. Simulated deep submersion tests (1 atmospheric pressure) were made and wetted insulations were subjected to 30 freeze-thaw cycles to observe the effect of these parameters. Strength and flammability characteristics were also evaluated. The results of these studies indicated the following: 1) None of the insulating boards were completely moisture resistant. 2) Many foamed plastics were relatively resistant to excessive water absorption. 3) Fused polystyrene beadboards were more absorbent than extruded polystyrene. 4) The two extruded polyurethanes in these tests were generally more absorbent than the polystyrenes. 5) Special surface densification treatment on some of the extruded polystyrene boards appeared effective in reducing moisture absorption.

**TR 250**
**FREEZING TEST FOR EVALUATING RELATIVE FROST SUSCEPTIBILITY OF VARIOUS SOILS.**
Kaplar, C.W., June 1974, 36p., AD-781 511, 14 refs.
29-914
TEST EQUIPMENT, LOW TEMPERATURE TESTS, FROZEN GROUND MECHANICS, FROST HEAVE, FROST RESISTANCE.
This report presents a description of the equipment and procedures used in the laboratory test of the relative frost susceptibility of different soils on Corps of Engineers construction projects and includes typical results of freezing tests of natural soils. The test utilizes a slow unidirectional freezing of a 6-in. high, remolded or undisturbed soil specimen with water available at the base (open system). The heaving rate measured during the test is used as the basis for classification of the frost susceptibility potential of the soil. This type of test, which measures heaving rate, is considered most versatile and adaptable for evaluating the effects of numerous soil parameters on frost heave.

**TR 251**
**RESEARCH HYDRAULIC FLUME FOR MODELING DRIFTING SNOW: DESIGN, CONSTRUCTION AND CALIBRATION.**
Calkins, D.J., June 1974, 14p., AD-782 952, 10 refs.
29-915
HYDRAULIC STRUCTURES, LABORATORY TECHNIQUES, SNOWDRIFTS, MODELS.
A fluvial bed hydraulic flume was designed and constructed for the purpose of modeling drifting snow. Each section has bolted connections which allow flexibility if a section needs to be modified. The facility took approximately one year to build from the time the working drawings were completed. Three butterfly valves control the operation of the storage tank system, and a variable-speed control on the pump-motor unit permits a wide range of flow velocities for any given depth. The

discharge can be monitored continuously from a differential-pressure transducer which is connected to the venturi. Ease of operation cannot be overemphasized as it allows for a greater flexibility in the design of experiments in the hydraulic flume facility.

**TR 252**
**CREEP OF FROZEN SILT AND CLAY.**
Sayles, F.H., et al, July 1974, 50p., AD-784 088, 18 refs.
Haines, D.
29-1637
FROZEN GROUND MECHANICS, CREEP TESTS, COMPRESSIVE STRENGTH.
Unconfined compressive creep strengths and strains were measured for remolded saturated frozen Hanover silt and Suffield clay. The creep tests were conducted at the approximate stress levels of 60, 35, 20 and 5% of the conventional unconfined compressive strength. Testing temperatures were -9.45 deg, -3.89 deg, -1.67 deg and -0.56 deg C. Unconfined compression creep strength can be estimated by Vialov's strength equation. Long-term creep strength is less than 45% of unconfined compression strength and can be as low as 10% of this strength. Expressions were developed to show the relationships of the unconfined compression peak strength variation with temperature and of the increase in long-term creep strength with the decrease in soil temperature, and to obtain a close estimate of the long-term creep strain.

**TR 253**
**TRIAXIAL CONSTANT STRAIN RATE TESTS AND TRIAXIAL CREEP TESTS ON FROZEN OTTAWA SAND.**
Sayles, F.H., Aug. 1974, 28p., AD-785 506, 12 refs.
29-1638
FROZEN SAND, ICE CORES, COMPRESSIVE STRENGTH, CREEP RATE, STRAIN TESTS.
Saturated frozen Ottawa sand cylinders and polycrystalline columnar ice were tested in the laboratory under triaxial compressive stress conditions using: 1) constant rate of axial strain, and 2) constant load, i.e. creep tests. The constant rate of axial strain tests were performed by applying axial strain rates in the range from 0.1 to 50% per minute and confining pressures from 0 to 1200 psi (84.4 kg/sq cm). The triaxial compression creep tests were conducted for time periods up to 3000 hr using a range of confining pressures from 0 to 800 psi (56 kg/sq cm) and deviator stresses from 37.5 to 1000 psi (2.6 to 70.3 kg/sq cm). The resulting stress-strain curves and Mohr envelopes for the constant rate of axial strain tests indicate that at rates of strain greater than about 0.02 per minute, the ice matrix fractures prior to the development of friction between the sand grains. At slower rates of applied strain, the friction between sand grains develops, presumably because ice has sufficient time to creep from between the sand grains. The relationship between the observed maximum deviator stress and the applied strain rate can be represented by an empirical expression for all the confining pressures tested. Results from the triaxial creep tests show that creep strength increases with confining pressure and axial creep strain is reduced by increasing the confining pressure. It is suggested that the long-term ultimate creep strength of saturated frozen sand is a function of the internal friction of the sand which could be determined through triaxial tests on freely drained unfrozen sand.

**TR 254**
**EXPERIMENTAL PROTECTED MILITARY POL INSTALLATION.**
Swinzow, G.K., Sept. 1974, 12p., AD-787 286, 10 refs.
29-2436
PERMAFROST STRUCTURE, EXCAVATION, FUELS, UNDERGROUND STORAGE.
Permafrost either is or can be very easily made impermeable for nonfreezing liquids such as hydrocarbon fuels. Fine-grained, ice-rich permafrost can easily be excavated by application of steam or relatively warm water. An experimental cavity was prepared by melting permafrost and was filled with hydrocarbon fuel. The thermal conditions around the cavity were observed for approximately a year. An artificial heat exchange experiment was conducted. It was concluded that this fuel storage method is suitable for military and civilian needs.

**TR 255**
**COMPLEX REFRACTIVE INDEX OF ICE FOG AT A RADIO WAVELENGTH OF 3 MM.**
Perry, J.W., et al, Oct. 1974, 97p., ADA-008 870, Numerous refs.
Straiton, A.W., Fannin, B.M.
29-4017
ICE FOG, REFRACTION, INDEXES (RATIOS), ICE DIELECTRICS, RADIO WAVES, LABORATORY TECHNIQUES.
An investigation of the complex index of refraction at 97 GHz for low temperature ice fogs was carried out over the temperature interval -30 deg to -48 deg C in a specially constructed environmental chamber of approximately 70 cubic foot volume. The various apparatus used in the experiments are described; techniques of operating the equipment are explained; and the measurements and results of the study are reported.

**TR 256**
**MODEL STUDIES OF DRIFTING SNOW PATTERNS AT SAFEGUARD FACILITIES IN NORTH DAKOTA.**
Calkins, D.J., Nov. 1974, 15p., ADA-006 018, 8 refs.
29-4018
SNOWDRIFTS, MODELS, SIMULATION, WIND FACTORS.
A model study of simulated drifting snow was conducted in a hydraulic flume. Various structures at the Safeguard facilities in North Dakota were modeled at scales of 1:100 and 1:200. Preliminary results indicate that drifting snow problems are minimal at this site, except for the utility tunnel entrance to the Missile Site Radar structure. Excessive drifting occurred when the flow approached the buildings at a 45 deg angle to any of the sides. The drifts were reduced significantly when the flow was normal to any of the sides. Simulated flow directions were based on meteorological wind rose data. Field verification of the amount and extent of the drifts has not been completed.

**TR 257**
**MANAGEMENT OF POWER PLANT WASTE HEAT IN COLD REGIONS.**
Aamot, H.W.C., Dec. 1974, 178p., ADA-993 217, 36 refs.
29-2708
ELECTRIC POWER PLANTS, HEAT SOURCES, HEAT RECOVERY, WATER SUPPLY.
Surface water resources cannot meet the increasing cooling needs of power plants in the future and in cold regions the need for dry methods of waste heat disposal is pressing now. The dry or hybrid cooling tower is the best alternative to avoid adverse environmental effects. During cold weather it also permits low condensing temperatures that can be utilized by an organic fluid Rankine bottoming cycle. This is shown to increase the overall conversion efficiency for generating electricity by 5 to 10% and to reduce the amount of waste heat to be dissipated. Space heating is one of the largest potential opportunities for waste heat utilization and, consequently, for reducing waste heat disposal. Steam is used in some urban areas to that effect. Cooling water has not been exploited for that purpose because it is too cool for direct use, but heat pumps are shown to make it practical and economically very attractive as a heat source. Cooling water can be transported efficiently over greater distances than steam or hot water and supplied to less densely populated areas. It also offers an opportunity to reduce energy needs for air conditioning because it is a more efficient heat sink than ambient air. The same heat pump provides heating as well as cooling. The design of a heat pump system using power plant cooling water to heat homes in Fairbanks, Alaska, shows that, compared with oil burning and electric resistance heating, waste heat disposal from the plant is reduced, air pollution is reduced and its control improved, overall energy needs are reduced, opportunities for fuel substitution are increased, available technology and equipment can be used, and the cost of conversion from existing heating methods pays for itself with a small profit.

**TR 258**
**ON THE THEORY OF GROUND ANCHORS.**
Kovacs, A., et al, Jan. 1975, 68p., ADA-006 582, 229 refs.
Blouin, S.E., McKelvy, B., Colligan, H.
29-4019
ANCHORS, SOIL MECHANICS, FROZEN GROUND MECHANICS.
The findings of a literature review of anchor design are presented to give a synopsis of the numerous theoretical and empirical techniques available for predicting anchor capacity. The review revealed that anchor capacity is related to anchor configuration, soil characteristics and depth of anchor embedment and that the mode of soil failure as a result of anchor loading is dependent upon soil type and state as well as on the ratio of the depth of anchor embedment to anchor diameter. As a result it was found that no single equation can be used to predict anchor capacity under all soil conditions or anchor embedment depths.

**TR 259**
**ROADWAY DESIGN IN SEASONAL FROST AREAS.**
Johnson, T.C., et al, Mar. 1975, 104p., ADA-010 633, Also designated as National Cooperative Highway Research Program Synthesis of Highway Practice No. 26. 207 refs.
Berg, R.L., Carey, K.L., Kaplar, C.W.
32-2596
ROADS, FROST HEAVE, SOIL MOISTURE, SEASONAL FREEZE THAW, SOIL STRUCTURE, FINES.
This report describes and assesses the merit of current practice in roadway design in seasonal frost areas. Information is presented on the mechanisms of frost heaving and thaw weakening, the factors that contribute to frost problems, criteria for estimating frost susceptibility, surveying practices for locating areas of detrimental frost action, subgrade treatment and drainage to minimize the effects of frost action, and the structural design of pavements to accommodate the influences of frost action. Research needs in the area are identified.

**TR 260**
**FIELD TEST OF A MESL (MEMBRANE-ENVELOPED SOIL LAYER) ROAD SECTION IN CENTRAL ALASKA.**
Smith, N., et al, July 1975, 43p., ADA-047 366.
Paszint, D.A.
32-1516
EMBANKMENTS, PROTECTIVE COATINGS, WATERPROOFING, PERMAFROST PRESERVATION, SOIL MOISTURE, ROADS.
The MESL (Membrane-Enveloped Soil Layer) concept for using fine-grained soil as a structural embankment for expedient military uses was tested in a subarctic environment over two freeze-thaw seasons. The encapsulated silt was placed at a moisture content of approximately 4.5% below the optimum of 17.5% for the CE-12 compaction effort. Non-woven polypropylene membranes with CRS-2 emulsified asphalt was used as a waterproofing agent for both the bottom and top membranes. The emulsion was hand-applied with roofing cement brushes to simulate a remote tactical situation. The test section had dimensions of approximately 20 by 2-1/2 in. thick. The north end of the section, which was undamaged by snow removal equipment, withstood over 500 traffic passes of a loaded military dump truck having a gross weight of nearly 9 tons during the second and third spring thaw seasons without major rutting.

**TR 261**
**CUTTING FROZEN GROUND WITH DISC SAWS.**
Mellor, M., June 1975, 65p., ADA-012 114, Includes CRREL Technical note Mechanics of transverse-rotation cutting devices by Mellor. 9 refs.
30-900
SAWS, FROZEN GROUND, FROZEN GRAVEL.
The largest commercially available disc saws (7 ft diameter) were tested in frozen ground. Cutting performance was reasonably attractive, specific energy consumption was acceptable, but cutter durability in frozen gravel was judged to be totally inadequate. A new cutter system was developed for the saw that provided best general capabilities, and a dramatic improvement in cutter durability was achieved (wear rate and cutter cost dropped by a factor greater than 10 and possibly by a factor of 100). The modified saw cut slots 3.7 in. wide and 30 to 34 in. deep at rates up to 6.6 ft/min in coarse frozen gravel and up to 16.3 ft/min in frozen silt. Overall values of specific energy for sawing (based on gross machine power) were 4700 lbf/sq in for gravel and 1800 lbf/sq in for silt. Effective specific energy for bulk excavation using the kerf-and-rib technique was projected to be lower than these values by a factor of 5, taking a depth/width ratio for the uncut ribs of 2. Axle forces on the cutter wheel depend on the design of the cutting teeth and on the state of wear. For the test machine, horizontal cutting resistance with well-worn teeth could exceed the tractive capability of the carrier vehicle on some types of running surfaces. All essential data needed to design disc-saw attachments for crawler tractors are now available.

**TR 262**
**FOAMED-IN-PLACE POLYURETHANE INSULATED TRAFFIC TEST SECTIONS FOR EXPEDIENT ROADS.**
Smith, N., et al, June 1975, 17p., ADA-012 115, 2 refs.
Berg, R.L., Muller, L.
30-901
ROADS, THERMAL INSULATION, SEASONAL FREEZE THAW, THAW DEPTH, VEHICLES.
Foamed-in-place polyurethane was tested as an expedient road surface insulation and load distributing structural layer with T15 aluminum airfield landing mat as a trafficking surface. The insulation was sprayed on leveling courses of either woodchips or gravel with thicknesses of about 15 cm. Various thicknesses of insulation with two densities were used singly and in combination of layers. Total insulation thicknesses ranged from 2.5 to 28 cm. The test sections were constructed in April 1970 and trafficked during the thaw seasons of 1970 and 1971 with a military dump truck loaded with gravel. The total test vehicle weight was 12,270 kg with a maximum single wheel load of 2,415 kg. The test sections withstood over 1,000 passes of the test vehicle without suffering complete failure. Observations by surface level measurements showed settlements of 0.0 to 14.0 cm. Subgrade temperature observations by thermocouples showed thaw depths in the subgrade from 24.0 to 99 cm. This method of expedient road construction would provide satisfactory service throughout two thaw seasons and possibly longer without deleterious effects to the subgrade and adjacent environment.

**TR 263**
**FIELD TEST OF A FOAMED POLYSTYRENE BOARD EXPEDIENT ROAD TEST SECTION IN CENTRAL ALASKA.**
Smith, N., June 1975, 18p., ADA-012 111, 10 refs.
30-902
ROADS, THERMAL INSULATION, SEASONAL FREEZE THAW, THAW DEPTH, SETTLEMENT (STRUCTURAL).
Foamed polystyrene in board stock form was tested as an expedient surface insulation with XM-18 airfield landing mats as a trafficking surface. The insulation was placed on a frozen subgrade in 2 layers, making a total thickness of 4 in. The test section was constructed in May 1971 near Fairbanks, Alaska, at the USA CRREL Farmers Loop Road Facility. The section was trafficked with a load cart which applied a total wheel load of 26.2 kips on a C-130 main landing gear wheel having a tire

inflation pressure of 80 psi. Four hundred passes of the load cart were made on the test section; the final level surveys showed a minimum of settlement and structural distress to the insulation boards. The maximum depth of thaw beneath the insulation did not exceed 20 in. during each of the summers of 1971 and 1972. This method of expedient road construction would provide satisfactory service throughout a summer thaw season and probably longer without deleterious effects on the subgrade and the adjacent environment.

**TR 264**
**GENERAL CONSIDERATIONS FOR DRILL SYSTEM DESIGN.**
Mellor, M., et al, June 1975, 34p., ADA-012 646, Numerous refs.
Sellmann, P.V.
30-1111
ICE DRILLS, ROTARY DRILLING, PERCUSSION DRILLING, THERMAL DRILLS, FROZEN GROUND STRENGTH.

Drilling systems are discussed in general terms, component functions common to all systems are identified, and a simple classification is drawn up in order to outline relations between penetration, material removal, hole wall support, and ground conditions. Energy and power requirements for penetration of ice and frozen ground are analyzed for both mechanical and thermal processes. Power requirements for removal of material and for hoisting of drill strings are considered, and total power requirements for complete systems are assessed. Performance data for drilling systems working in ice and frozen ground are reviewed, and results are analyzed to obtain specific energy values. Specific energy data are assembled for drag-bit cutting, normal impact, and indentation, liquid jet attack, and thermal penetration. Torque and axial force capabilities of typical rotary drilling systems are reviewed and analyzed. The overall intent is to provide data and quantitative guidance that can lead to systematic design procedures for drilling systems for cold regions.

**TR 265**
**RESPONSE OF FROZEN SOILS TO VIBRATORY LOADS.**
Stevens, H.W., June 1975, 98p., ADA-013 831, 26 refs.
30-1287
FROZEN GROUND MECHANICS, VIBRATION, FLEXURAL STRENGTH.

This study was conducted to provide reliable values of the stiffness and damping properties of frozen soils subjected to vibratory loads and to define the significant factors affecting these parameters. A laboratory test was conducted on prepared specimens of frozen soils wherein a right circular cylinder was subjected to steady-state sinusoidal vibration. The material was considered to be linearly viscoelastic. Analysis of test data based on one-dimensional wave propagation yielded the complex Young's modulus, the complex shear modulus, the phase velocity of wave propagation, the shear velocity, the damping property expressed as the angle representing time lag between stress and strain, an attenuation coefficient, and a complex Poisson's ratio. The frequency of vibration was varied from 500 to 10,000 Hz, and the peak dynamics stress was varied from 0.1 to 5.0 psi. Specimens were remolded or cored in-situ, frozen, and tested at temperatures of 0, +15 and +25 degrees F. A few tests were conducted on identical soils nonfrozen. Test results from a limited number of tests on selected soils indicate that the stiffness of these soils varies with the volume of ice/volume of soil ratio, and that ice is less stiff than saturated frozen soils. Frozen soils have stiffnesses up to 100 times those of identical soils nonfrozen.

**TR 266**
**BRIDGE FOUNDATIONS IN PERMAFROST AREAS.**
Crory, F.E., July 1975, 30p., ADA-013 520, 11 refs.
30-1288
PILE FOUNDATIONS, BRIDGES, SOIL STRUCTURE, PERMAFROST DEPTH, FROZEN GROUND TEMPERATURE, FROST HEAVE, SETTLEMENT (STRUCTURAL).

Under a joint project between the Alaska Department of Highways and the U.S. Army Cold Regions Research and Engineering Laboratory, cooperative field observations and tests were conducted during and following construction of the Moose and Spinach Creek bridges, Fairbanks, Alaska. Site investigations and bridge foundation designs of the Alaska Department of Highways, bridge pile installation data, and ground temperature conditions for a one-year period are present. Two test piles and three anchor piles were installed in close proximity to the Moose Creek bridge and load settlement tests were performed. The capacity of a sand-water slurried test pile was less than 10 tons, while that of an adjacent driven pile was about 45 tons. Greater capacities could have been easily achieved by driving the piles to bedrock rather than a specified elevation. To prevent frost heaving of the shallow piles at Spinach Creek an antiheaving soil-oil-wax mixture was employed to a depth of 10 feet.

**TR 267**
**CONTROLLED PERIMETER BLASTING IN COLD REGIONS.**
Mellor, M., Oct. 1975, 24p., ADA-047 367, 15 refs.
32-1631
EXPLOSION EFFECTS, ICE BLASTING, FROZEN ROCKS, FROZEN GROUND ANALYSIS, ICE WHARVES.

The general principles of pre-split blasting and smooth blasting are described, and practical procedures that have been developed for work in common rocks are reviewed systematically. The topics covered include shothole spacing, charge weight per unit length of shothole, decoupling ratio, adjustments for explosive type and rock type, and weight of explosive per unit face area. Relevant properties of frozen rocks, frozen soils, and ice are compared with those of common unfrozen rocks, and appropriate adjustment of blast design is discussed. Interim relationships for the design of controlled perimeter blasting in frozen soils and massive ice are put forward, recognizing that additional experimentation is required. Special problems in controlled blasting of ice are discussed. These include effects of wet holes, delayed removal of burden, and submerged burden. Special attention is given to the cutting of ice islands and icebergs. An Appendix describes an operation in which the face of the ice wharf at McMurdo Sound was trimmed by pre-split blasting.

**TR 268**
**VEHICLE PERFORMANCE OVER SNOW; MATH-MODEL VALIDATION STUDY.**
Harrison, W.L., et al, Dec. 1975, 84p., ADA-021 228, 11 refs., Includes as App. C, USAEWES methodology for predicting vehicle performance in subarctic snows by S.J. Knight, and, as App. D, Land Locomotion Laboratory method of prediction of shallow and deep snow vehicle performance by R.A. Liston. 19 refs.
Knight, S.J., Liston, R.A.
30-1813
VEHICLES, SNOW MECHANICS, SNOW DEPTH, MATHEMATICAL MODELS, TRACKED VEHICLES, VEHICLE WHEELS.

A field validation study was conducted to assess the accuracy of predicting vehicle performance over snow by two popular methods. The methods were those in use by the U.S. Army Waterways Experiment Station and the U.S. Army Tank Automotive Command. Tests were conducted in shallow and deep snows with two military wheeled vehicles, the M151 1/4-ton truck and the M34 2 1/2-ton truck, and three tracked vehicles, the M113 APC, the ST-4B Snow-Trac, and the BV-202. The results of the study indicate that both methods were acceptable in predicting tracked vehicle performance in deep snow but very poor in shallow snow. The capability of the two methods relative to predicting wheeled vehicle performance in shallow or deep snow was unacceptable in their current form. No attempts were made to modify the methods during the study.

**TR 269**
**ICE FORCE MEASUREMENTS ON THE PEMBINA RIVER, ALBERTA, CANADA.**
Haynes, F.D., et al, Oct. 1975, 12p., ADA-018 223, 12 refs.
Nevel, D.E., Farrell, D.R.
30-2521
RIVER ICE, ICE PRESSURE, PIERS, BRIDGES, SIMULATION.

Just before spring breakup in 1972, 23 in situ tests were conducted on the Pembina River, in Alberta, Canada, to measure ice forces. These tests simulated an ice sheet pushing against a bridge pier. The apparatus utilized a hydraulic ram to push a 5 1/2-in. (14.0-cm)-wide vertical pile section horizontally against the ice sheet, which varied from 11.5 to 19.5 in. (29.2 to 49.5 cm) in thickness. The velocity of the pile was varied from 0.07 to 21 in./sec (0.18 to 53.3 cm/sec) by hyraulic flow control valves. Both flat and round piles were used to represent the pier. Some tests began with the piles a few inches away from the ice sheet, whose edge was cut flat. Other tests began with the pile in contact with the ice sheet. For some of the round pile tests, augered holes were used to provide better initial contact. These in situ test results were compared with the ice force measurements made by other workers on a nearby bridge during ice breakup. The in situ test forces were about 50% higher than the bridge pier test results. This disagreement was caused by a difference between the sizes of the piles and the size of the pier and a three-day warming of the ice before the ice impacted against the pier.

**TR 270**
**COMPARISON OF THE PERFORMANCE OF ALL-BITUMINOUS CONCRETE AND REDUCED SUBGRADE STRENGTH HIGHWAY PAVEMENT TEST SECTIONS UNDER FREEZING CONDITIONS.**
Eaton, R.A., Dec. 1975, 34p., ADA-019 104, 17 refs.
30-3063
BITUMINOUS CONCRETES, CONCRETE PAVEMENTS, CONCRETE STRENGTH, SUBGRADES, FROST PENETRATION, FREEZE THAW CYCLES.

Four highway pavement test sections were built at CRREL in July 1971. Two sections were designed using the Asphalt Institute full-depth criteria in which the pavement is placed directly upon the subgrade with no granular base course, and the other two were based on similar traffic volumes using the Corps of Engineers reduced subgrade strength criteria which incorporate a granular base course. The sections were constructed to compare and evaluate the performance of the two different concepts under freeze-thaw conditions. The first three years' observations show that: 1) the maximum frost penetration of 35 to 40 in. was essentially the same beneath all four sections, 2) the thawing condition in the subgrade existed a fraction of the time beneath the crushed stone base course sections vs the full-depth sections (2 or 3 days vs 11 to 20 days), 3) the subgrades beneath the full-depth sections were subjected to twice as many freeze-thaw cycles as the subgrades under the crushed stone bases due to the thinner pavement structure (8 cycles vs 4 cycles), 4) moisture increases of 8 to 12 percent occurred each year in the top foot of subgrade directly beneath the full-depth sections and caused high Benkelman bean deflections of up to 0.12 in. in the thinnest (5-in) section and visible transitory rutting, and 5) uniform frost heaves of at least 2 1/2 in. were measured on both full-depth sections each year vs 1 1/2 and 1/2 in. heaves on the crushed stone base sections. From September 1971 to May 1974, 49,000 vehicles traversed the sections. There were over 12,000 equivalent 18,000-lb axle loads, with the bulk of the truck traffic traversing the sections during the frost melting period.

# RESEARCH REPORTS

**RR 1**
**CORRELATION OF DENSITY OF NEW SNOW WITH 700 MB TEMPERATURE.**
Diamond, M., et al, Aug. 1953, 3p., AD-023 581, 3 refs.
Lowry, W.P.
24-3162
SNOW DENSITY, TEMPERATURE FACTORS.
New-snow density was measured at the Central Sierra Snow Lab., and the air temperature at both 700- and 500-mb. levels was used to study the relationship between upper air conditions and the density. The upper air temperatures were determined from radiosonde flights at Oakland (Calif.) immediately prior to or at the same time when the density was measured. A graph of the air temperatures at the 700-mb. level against the new-snow density indicates a definite relationship between the 2 variables. The correlation coefficient of 0.639 is significant at the 1 percent level. No relationship was found for the 500-mb. level. Surface-air temperatures were plotted against the new-snow density. The correlation coefficient between the variables is 0.503 which is significant at the 1 percent level.

**RR 2**
**SORGE'S LAW OF DENSIFICATION OF SNOW ON HIGH POLAR GLACIERS.**
Bader, H., June 1953, 3p., AD-014 366, 2 refs.
24-3163
SNOW DENSITY.
The density of snow at any given depth does not change with time at Eismitte (Greenland) because summer melting does not occur. The load of the overlying snow at any depth is equal to the density integrated over the depth. The time required for a snow particle to reach any depth is equal to the load divided by the accumulation in unit time. The vertical velocity is equal to the accumulation in unit time divided by the density. A formula for the specific velocity of densification is also derived. The measurements of density, weight of overlying snow, time elapsed since deposition, the vertical velocity and the rate of densification of the snow observed at Eismitte by Sorge for a depth of 15 m. accumulated over a period of 22 years show good correlation with the calculated values.

**RR 3**
**FORMATION OF SNOW CRYSTALS.**
Nakaya, U., Jan. 1954, 12p., AD-027 515, 17 refs.
24-3164
SNOW CRYSTALS.
The relation between snow-crystal form and external conditions is discussed. A classification of atmospheric ice-crystal formation into snow crystals proper and ice crystals is suggested. Snow crystals are usually formed in the range above water saturation. The importance of minute water droplets about 1 micron in diam. in the formation of snow crystals is discussed. Most snow crystals proper form not only by sublimation of water vapor, but also by condensation of the minute droplets on ice crystals.

**RR 4**
**EVIDENCE OF THE EXISTENCE OF A LIQUID-LIKE FILM ON ICE SURFACES.**
Nakaya, U., et al, Nov. 1953, 6p., AD-027 517, 1 ref.
Matsumoto, A.
24-3165
ICE SURFACE FEATURES, ICE ADHESION, WATER FILMS, ICE BONDS.
Experiments were made on the adhesive force between 2 ice spheres, 1.5-4.0 mm. in diam., suspended on thin cotton filaments. The normal adhesive force, which tends to decrease with decreasing temperature, was measured by the inclination of a filament as the spheres separated. The ice spheres occasionally rotated before separation, and 2 or 3 successive rotations were noted with a 0.1 percent solution of NaCl. The phenomena may be explained by assuming the existence of a liquid film on the ice surface.

**RR 5**
**A METHOD OF ANALYZING GEOTHERMAL DATA IN PERMAFROST.**
Nakaya, U., Aug. 1953, 7p., AD-024 821, 1 ref.
24-3166
GEOTHERMY, PERMAFROST PHYSICS, PERMAFROST THERMAL CYCLES, SOIL TEMPERATURE, ANALYSIS (MATHEMATICS).
The empirical formula of hyperbolic form developed by MacCarthy to obtain undisturbed or equilibrium temperatures from geothermal measurements in permafrost is criticized. The rate of cooling, after an initial period, is expressed as a function of the difference between the observed and undisturbed temperatures. Extrapolation of this formula to infinity is permissible and can be accomplished with suitable computing equipment. A method of successive approximation for calculating the equilibrium temperature without special devices is presented. The calculations are made on the assumption of constant permafrost temperature at a given location. Effects of any secular variation in the permafrost temperature are discussed.

**RR 6**
**EVAPORATION OR MELT OF SNOW COVER.**
Diamond, M., Nov. 1953, 6p., AD-024 748, 10 refs.
24-3167
SNOW EVAPORATION, SNOW MELTING.
The relative rates of melting and evaporation of a snow cover under meteorological conditions favoring evaporation are discussed. Snow-surface evaporation occurs only with a snow-to-air vapor pressure gradient and is proportional to the gradient, other things being equal. Appreciable evaporation occurs only when there is turbulent transfer of heat from the air to the snow. Little evaporation occurs without simultaneous melting at a higher rate. A graph is presented for predicting evaporation or condensation over a snow cover when temperature and relative humidity of the air, and snow-surface temperature are known.

**RR 7**
**DENSITY OF SINGLE CRYSTALS OF ICE FROM A TEMPERATE GLACIER.**
Butkovich, T.R., Dec. 1953, 7p., AD-029 230, 4 refs.
24-3168
GLACIER ICE, ICE CRYSTALS, DENSITY (MASS/VOLUME).
Density measurements of single crystals from the Mendenhall Glacier (Alaska) were made by weighing the crystal, first in air and then in a liquid of known density, in this case, 2, 2, 4-trimethylpentane. The density of the liquid was determined by specially designed pycnometers. Values determined for different crystals are tabulated. The calculated estimated error of the density determinations of the ice specimens is 2.1/10,000g/cu. cm. Measurable density variations were found for different crystals. Clear crystal aggregates can have a lower density than pure single ice crystals.

**RR 8**
**NOMOGRAPHS FOR COMPUTATION OF RADIATION HEAT SUPPLY.**
Gerdel, R.W., et al, Feb. 1954, 6p., AD-031 051, 7 refs.
Diamond, M., Walsh, K.J.
24-3169
SOLAR RADIATION, HEAT BALANCE, RADIATION ABSORPTION, SNOW OPTICS.
A nomogram is given for computing the total daily amount of solar and sky radiation for 40-90 N lat. Correction values for elevation and cloud cover are tabulated. A second nomogram is presented which permits conversion of the values of radiation received to the net radiational heat balance of a snow cover, including the volume of meltwater produced when the snow temperature is at 0 C. A third nomogram is given which may be used to determine the radiation through a snow cover for snow densities from 0.2-0.6. An example of the use of the nomograms is illustrated.

**RR 9**
**HARDNESS OF SINGLE ICE CRYSTALS.**
Butkovich, T.R., May 1954, 12p., AD-041 580, 5 refs.
24-3170
ICE CRYSTALS, HARDNESS TESTS.
Brinell and scratch hardness tests were made on single ice crystals. The Brinell hardness tests were conducted with a modified Olsen Baby Brinell Hardness Tester and the hardness numbers obtained were computed from the standard Brinell formula. The scratch hardness tests were made with a Spencer Microcharacter and the hardness numbers were computed from a special formula developed for the instrument. The hardness of single ice crystals increases with decreasing temperature; the Brinell hardness numbers range from about 4 at -5 C to 17 at -50 C. The greatest increase in the hardness values occurs at the higher temperatures. The temperature dependence of the scratch hardness was similar to that of Brinell hardness. An anisotropism of hardness is evident; the single ice crystal is harder parallel to the c-axis than in the direction normal to the c-axis. An apparent difference in surface structure with respect to orientation was noticed during the scratch hardness tests. A consistent wavy scratch was produced normal to the c-axis, while the scratch parallel to the c-axis was always straight.

**RR 10**
**SOME FACTORS AFFECTING THE VEHICULAR TRAFFICABILITY OF SNOW.**
Gerdel, R.W., et al, Dec. 1954, 13p., AD-055 056, 3 refs.
Parrott, W.H., Diamond, M., Walsh, K.J.
24-3171
TRAFFICABILITY, SNOW VEHICLES.
The drawbar pull and hill-climbing potentials of an M-7 Ordnance half-track, a 2- and a 4-pontoon Tucker Sno-Cat were measured in the High Sierra during the winter-spring of 1951-52. The physical and mechanical properties of the top 15-20 in. of snow determined the trafficability of the snow cover for light-weight, tracked vehicles. The drawbar pull of the snow vehicles was directly related to the density of the snow cover for density values below 0.40, but at greater density values no relationship was noted. A direct relationship between air temperature and trafficability was found during the winter, while an inverse relationship prevailed during spring tests. The 4-pontoon Sno-Cat climbed slopes steeper than 55 percent, while the average slopes climbed by the 2-pontoon model and M-7 were 42 percent and 34 percent respectively. The ratio of drawbar pull for the 3 vehicles was: M-7, 1; 2-pontoon Sno-Cat, 1.16; and 4-pontoon Sno-Cat, 2.15.

**RR 11**
**ULTIMATE STRENGTH OF ICE.**
Butkovich, T.R., Dec. 1954, 12p., AD-050 514, 10 refs.
24-3172
ICE COVER STRENGTH, ULTIMATE STRENGTH.
The crushing and torsional shear strengths of clear lake ice, natural snow ice and commercial artificial ice as well as the tensile strength of commercial ice were measured in the laboratory. Data are tabulated and graphed, and earlier results obtained by different investigators are reviewed. Specimen shape influenced crushing-strength values with machined cylindrical specimens yielding the highest values. Crushing strength parallel to the ice sheet was about 75 percent of that normal to the ice sheet for clear lake ice, but differences between the 2 orientations were insignificant for natural snow ice. Values obtained for commercial ice were slightly lower than those for clear lake ice. Torsional shear strength for clear lake ice showed a strong temperature dependence as well as anisotropism between shear and orientation, while for snow ice temperature dependence was weak and anisotropism absent. Tensile strength for commercial ice increased linearly with decreasing temperatures to -40 C; a sudden increase in strength occurred with further temperature lowering.

**RR 12**
**STRESS-STRAIN RELATIONS IN SNOW UNDER UNIAXIAL COMPRESSION.**
Landauer, J.K., Feb. 1955, 9 refs., AD-059 687.
24-3173
SNOW COMPRESSION, STRAIN TESTS, STRESS ANALYSIS, SNOW MECHANICS.
Laboratory tests on the uniaxial compression of snow were conducted at constant specific velocity, and creep tests at constant load. The dependence of uniaxial deformation on stress increases from a linear relationship at low stress to an approximately cubic relationship at stresses above approximately 1 kg./sq. cm. The temperature dependence indicated in the creep tests leads to a value for the activation energy of about 14,000 cal./mole. Significant deviations in the relations were observed, however, and greater reproducibility is necessary if more fundamental relationships are to be found.

**RR 13**
**PROPERTIES OF SINGLE CRYSTALS OF ICE, REVEALED BY INTERNAL MELTING.**
Nakaya, U., April 1956, 80p. plus 105 plates, AD-116 013, 29 refs.
24-3174
ICE CRYSTAL STRUCTURE, ICE CRYSTAL FORMATION, MELTING, FREEZING.
Melting within a single crystal of ice produces a 6-petaled cavity called a "Tyndall figure." This cavity is filled with water except for a vapor bubble. When refrozen, this bubble remains in the ice as a hexagonal disk which is called a "vapor figure." The composition, changes in shape, and properties of Tyndall figures and vapor figures were investigated. The plane of the Tyndall figure is always perpendicular to the c-axis and the direction of the branches coincides with the a-axis. The side of the hexagonal vapor figure coincides with the direction of the branches of the Tyndall figure. Once internal melting has taken place, the crystalline structure of the crystal is revealed. Vapor figures were found to migrate and change in shape when a thermal gradient was applied across the sample. The experimental values for the migration velocity agree with the theoretical values. The deformation of the vapor figure under isothermal conditions was investigated and considered to be chiefly due to vapor transfer rather than migration of water molecules on the ice surface.

**RR 14**
**ENERGY OF SNOW COMPACTION AND ITS RELATION TO TRAFFICABILITY.**
Landauer, J.K., et al, Oct. 1956, 11p., AD-122 666, 6 refs.
Royse, F.
24-3175
SNOW COMPACTION, TRAFFICABILITY.
Penetrometer tests were performed in the field on natural snow to determine the work of compaction. It was found that the work per unit area was independent of the penetrometer area and was not a strong function of velocity. The power used to compact snow is much less than that available from over-snow vehicles. Other effects must be responsible for the high observed energy losses.

**RR 15**
**CRUSHING STRENGTH OF LAKE ICE.**
Butkovich, T.R., Aug. 1955, 5p., AD-075 249.
24-3176
LAKE ICE, ICE ADHESION, ICE COVER STRENGTH.

Tests were made to determine the effects of size of prismatic specimens, cross section, ratio of overall length to length of side of square section, types of ice, both natural clear ice and snow ice, orientation of c-axis, and size of candle. Rough-cut specimens were crushed in a 120,000 lb capacity press. The results of the tests show that: (1) Large-grained clear ice is stronger in compression. (2) Ice is stronger parallel to the ice sheet than normal to it. (3) Specimens of smaller cross-section have higher crushing strength. (4) Prisms with lower ratios of length to width are stronger. No effect of c-axis orientation was detected.

**RR 16**
**MEASUREMENTS ON ANISOTROPY OF THERMAL CONDUCTIVITY OF ICE.**
Landauer, J.K., et al, April 1956, 4p., AD-094 686, 5 refs.
Plumb, H.
24-3177
ICE THERMAL PROPERTIES, ANISOTROPY, THERMAL CONDUCTIVITY, MEASUREMENT.

A comparison technique is used to measure the anisotropy in the thermal conductivity of ice. Samples of laboratory grown monocrystals, glacial monocrystals and polycrystalline commercial ice were studied. No effects due to the grain boundaries are observed. The experiments indicate that the conductivity in the direction of the c-axis may be about 5 percent greater than normal to it. The probable error in the results is about 2 percent. Analysis of the data leads to the conclusion that, if a difference in conductivity exists, it is less than 8 percent. More accurate experimentation is necessary to specify the anisotropy with greater precision.

**RR 17**
**SHEAR MORAINES IN THE THULE AREA, NORTHWEST GREENLAND.**
Bishop, B.C., Jan. 1957, 46p., AD-137 858, 5 refs.
24-3178
MORAINES, ICE CREEP, ICE SURFACE FEATURES, GLACIER ABLATION.

Glacial-geomorphologic investigations during the summers of 1954 and 1955 lead to the conclusion that the ice-cored moraine on the margin of the Greenland Ice Cap occurs as follows: (1) the mobile ice of the interior overrides the stagnant ice of the ice margin in a series of high-angle imbricate shears, which carry old ground moraine from the subglacial floor toward the surface; (2) differential ablation results in the formation of ice-cored moraine ridges, parallel to the strike of the shear. Recent stagnation and recession of the ice margin in the Thule area has resulted in the formation of a belt of successive shear moraines. Other geomorphic processes, particularly wind action, also control the surface. Subglacial topography is the primary control on the trend of both ice edge and moraine ridges. Structural and geomorphic features indicate glacial cycles of both long and short duration in the area. These shear moraines offer a possible explanation for the mode of ground moraine deposition in some area of continental glaciation during the late Pleistocene.

**RR 18**
**STRENGTH STUDIES OF HIGH-DENSITY SNOW.**
Butkovich, T.R., Oct. 1956, 19p , AD-122 665, 16 refs.
24-3179
SNOW STRENGTH, INSTRUMENTS.

Various strength properties of naturally compacted high-density snows, in the density range from 0.40 to 0.75 g/cu. cm. are reported. Test results are given for: unconfined compression; unconfined and confined double shear; ring, flexural, and centrifugal tensile strength; torsional shear; and work of disaggregation. The work of disaggregation per unit volume was related to crushing, tensile, and shear strength at various lateral pressures, using the same empirical relationship. The results of the various tests measuring the tensile strength of the snow compare favorably with each other. An attempt was made to use the direct shear strength results in Coulomb's equation for the determination of Mohr's envelope of rupture for snow. These tests yield higher values than those obtained in unconfined compression tests. However, angles of internal friction obtained considering Mohr's envelope to be a straight line seem to agree with measurements taken on an unconfined compression specimen.

**RR 19**
**RADIATION MEASUREMENTS ON THE GREENLAND ICE CAP.**
Diamond, M., et al, Oct. 1956, 20p., AD-121 350, 9 refs.
Gerdel, R.W.
24-3180
SOLAR RADIATION, RADIATION MEASURING INSTRUMENTS, GLACIAL METEOROLOGY.

During the period July 6-Aug. 7, 1955, global and net radiation measurements were made at a permanent station located approximately 200 mi. E. of Thule and near 6800 ft. elevation. Total incident global radiation amounted to 20,628 ly., of which about 15 percent was absorbed by the snow cover. Most of the absorbed radiation was re-emitted as long-wave radiation. Diffuse sky radiation amounted to about 19 percent of the total incoming radiation. The long-wave radiation balance remained negative. Slightly higher radiation values were measured in blowing snow at a level 1.25 m. above the snow as compared to levels higher up; this increase may be due to multiple reflection. The heat balance of the snow cover at this site was computed at 7.6 ly./day. All data are tabulated and graphed, including hourly values of the incident and reflected solar radiation.

**RR 20**
**STRENGTH STUDIES OF SEA ICE.**
Butkovich, T.R., Oct. 1956, 15p., AD-125 593, 6 refs.
24-3181
SEA ICE, ICE COVER STRENGTH, TEST EQUIPMENT, SHEAR STRENGTH.

Investigations on sea ice at Hopedale, Labrador, March 1956, included: small beam tests and in-place cantilever beam tests for flexural strength; ring tensile-strength tests; unconfined compression tests, with stress-strain studies to determine "Young's modulus"; and double shear tests. The results exhibit a great deal of scatter, primarily due to the inhomogeneity of sea ice. Ring tensile strength values range between 3.3 kg/sq. cm and 22.3 kg/sq. cm between -2.5C and -19.1C. The small beam tests give flexural strength values from 0.5 to 17.3 kg/sq. cm in a similar temperature range. The in-place pull-up cantilever beam tests give flexural strength values of 2.2 to 4.0 kg/sq. cm, with much less scatter. Crushing strength values range from 26.3 to more than 107 kg/sq. cm in the range -4.9C to -18.3C. Values for Young's modulus obtained from the slope of the straight line portion of the stress-strain curves in compression ranged between 4520 and 10,225 kg/sq. cm. There is a temperature dependence, explained by the effect of change in brine content, on sea-ice structure. The double shear tests give values of 7.8 to 34.2 kg/sq. cm in the range -5.5C to -12.8C. These are higher than the tensile-strength values. These failures occurred normal to the direction of growth, while the tensile strength was obtained with failure parallel to it

**RR 21**
**WHITE-OUT IN GREENLAND.**
Gerdel, R.W., et al, Dec. 1956, 12p., AD-125 806, 9 refs.
Diamond, M.
24-3182
WHITEOUT, ICE FOG, VISIBILITY, WEATHER OBSERVATIONS.

Investigations on white-out undertaken on the ice cap in North Greenland indicate that the fog-type white-out and possibly the stratus-type of white-out are associated with identifiable microclimatic phenomena and synoptic situations. It appears that these types of white-out are the product of the uplift of maritime air, which, when transported by winds of 5 to 12 knots across the cold ice cap surface, produces a supercooled water droplet or ice crystal fog. Radiational cooling of the snow surface may contribute to the formation of the white-out. A shift in the prevailing wind direction occurs frequently prior to the onset of white-outs, indicating that a study of upper air circulation patterns in this area may provide a means of developing forecast procedures for fog and stratus-induced white-outs.

**RR 22**
**PRECIPITATION TRENDS IN GREENLAND DURING THE PAST 30 YEARS.**
Diamond, M., Dec. 1956, 9p., AD-716 662, 6 refs.
25-4065
SNOWFALL, PRECIPITATION (METEOROLOGY), ACCUMULATION, GREENLAND.

The record of annual precipitation as obtained from stratigraphic studies on snow profiles in the interior of Northern Greenland shows a decreasing precipitation trend since 1920 with the largest decrease occuring since 1932. A residual mass curve analysis of the data indicates that, in spite of large fluctuations in the accumulated precipitation, the decreasing trend may be considered valid over a period of several years.

**RR 23**
**TENSILE STRENGTH PROPERTIES OF ICE ADHERING TO STAINLESS STEEL.**
Jellinek, H.H.G., Jan. 1957, 27p., AD-716 663, 14 refs.
25-4066
ICE ADHESION, ADFREEZING STRENGTH, STEELS, TENSILE PROPERTIES, STATISTICAL ANALYSIS.

Tensile strength measurements on ice cylinders adhering to stainless steel have been made as a function of rate of loading, thickness and cross-sectional area of specimens, and temperature. The experimental results are interpreted by means of a statistical treatment involving imperfections in the specimens. The statistics for a model consisting of a large number of parallel elements is elaborated. The conclusion reached is that the tensile strength is a statistical function of the volume and cross-sectional area of the specimens due to imperfections. Superimposed on to the statistical effect is a stress distribution effect, which becomes predominant for large volumes.

**RR 24** Record deleted.

**RR 25**
**OCCURRENCE OF BLOWING SNOW ON THE GREENLAND ICE CAP.**
Diamond, M., et al, April 1957, 5p., AD-137 859, 2 refs.
Gerdel, R.W.
24-3183
BLOWING SNOW, VISIBILITY, WEATHER.

Blowing snow, a major weather phenomenon on the northwest Greenland Ice Cap, occurs most often in winter and is at a minimum during June, July, and August. Blowing snow is most commonly associated with winds of over 20 knots, but occurs about 30 percent of the time when wind velocities are 15-19 knots. Very little blowing snow occurs at wind velocities below 15 knots. During periods of blowing snow, visibility is usually greater than 1 mile when wind speeds are less than 20 knots and less than 1 mile when wind velocities exceed 20 knots. Blowing snow is most frequent during periods when air temperatures are 10 to 14F and -11 to -25F at Site 1 and -1 to -20F and -41 to -45F at Site 2. Periods of continuous blowing snow are usually less than 24 hr in duration and almost half of them are less than 6 hr in duration.

**RR 26**
**PHYSICAL INVESTIGATIONS ON THE SNOW AND FIRN OF NORTHWEST GREENLAND 1952, 1953, AND 1954.**
Benson, C.S., Sept. 1959, 62p. plus 8p. appends., AD-239 701, 46 refs.
24-3184
SNOW PHYSICS.

The results of temperature, density, ram-hardness and grain-size measurements at 118 test sites along a 300-mi. traverse, ranging in elevation from 2000 to 8000 ft, are reported in detail, and their meteorological and climatic implications are discussed. Four types of diagenetically produced facies were recognized: ablation facies, soaked facies, percolation facies, and dry-snow facies. The recognition of facies allows greater resolution of glacier characteristics than Ahlmann's classification, permitting quantitative subdivision of all types of large glaciers. Regional precipitation (entirely from cyclonic storms) is about 5 times greater than at Thule; and the prevailing katabatic winds control the vertical component of the temperature gradient in the snow and firn. The depth-density curve of the firn at elevations where melt is negligible is invariant with time, as in Sorge's law, so that the densification can be treated as a steady-state situation with load as the only significant variable.

**RR 27**
**PROBLEMS IN MAPPING SNOW COVER.**
Espenshade, E.B., Jr., et al, Dec. 1956, 92p., AD-202 625, 2 refs.
Schytt, S.V.
24-3185
SNOW COVER DISTRIBUTION, MAPPING.

The results of a study on the feasibility of mapping selected snow-cover characteristics for military purposes, taking into account both current synoptic and average conditions, are reported in detail. Problems associated with the construction of isolines for depicting individual or combinations of snow-cover conditions are discussed; the need for other statistical parameters in addition to the means is stressed; and the adaptation of frequency and variability indices is suggested. The use of a regional technique, which identified areas somewhat homogeneous or substantially different from adjacent areas, is investigated. Problems in mapping snow density are also considered as well as the possibility of estimating snow density from meteorological data. Three sets of codes for the systematic recording and transmission of data are proposed, including a code for ground observers, a simplified code for use where no instruments or trained personnel are available, and a code for aerial observations.

**RR 28**
**MECHANICAL PROPERTIES OF SINGLE CRYSTALS OF ICE. PART I. GEOMETRY OF DEFORMATION.**
Nakaya, U., Oct. 1958, 46p. plus 42 plates, AD-216 992, 19 refs.
24-3186
ICE CRYSTALS, PLASTICITY TESTS, MECHANICAL PROPERTIES, DEFORMATION.

Bending tests were performed on nearly 300 rectangular bars of glacier ice cut from large single crystals (up to 16 in.) at varying orientations. Vertical displacement of a median loaded wedge was measured by a screw micrometer. The deformation was complex, sometimes varying with slight changes in crystallographic orientation. The phenomena observed can be explained by assuming that: single crystals of ice have a layer structure stacked in the direction of the optic axis; plasticity is due to gliding between these elementary layers; a small-angle boundary is likely to occur at the point of intense stress concentration (upon which the sample deforms like an assembly of blocks); and the elementary layer is flexible but not stretchable.

**RR 29**
**PARTICLE-SIZE DISTRIBUTION OF PULVERIZED SNOW.**
Jellinek, H.H.G., et al, May 1957, 8p., AD-143 289.
Schlueter, W.
24-3187
CRYSTAL STRUCTURE, PARTICLE SIZE DISTRIBUTION.

Development of a micrometric-statistical method for determining size distributions is described. Screened samples were measured in a cold room with a filar micrometer using filtered and cooled light and finely ruled glass slides immersed in silicone oil. Products of max. and min. diameters ("areas") were then plotted in a cumulative percentage curve, and a derivative distribution curve was obtained by graphical differentiation with respect to area. Experimental trials showed that min. representative sample size is 200 particles, and that faster but slightly less accurate determinations can be made by estimating particle size.

**RR 30**
**ON THE DEFORMATION OF EXCAVATIONS IN THE GREENLAND NEVE.**
Landauer, J.K., April 1957, 14p., AD-137 860, 7 refs.
24-3188
EXCAVATION, SNOW PLASTICITY, VISCOSITY, DEFORMATION, SNOW TUNNELS.
Deformations in a tunnel, two trenches, and a 30 m deep pit in the Greenland neve have been measured over a period of 2 years since excavation. Experimental results indicate that closure rates increase with lateral distance from a restraining boundary up to distances of about 1 m. At large distances, the effect of the boundary is not appreciable. Closure rates for deep excavations are not found to be strongly depth-dependent, due to a roughly parallel increase of viscosity and pressure with depth. Vertical compaction results from the pit agree well with those calculated from the depth-density relation using Sorge's Law. A theoretical calculation for the tunnel and pit closure, which is a modification of existing theories for the deformation of an elastic, compressible, thick-walled cylinder, is in fair agreement with observed deformations. From this agreement it appears that the flow behavior of the neve can be described on the basis of a Newtonian viscosity. The trench closure is described as the squeezing out of horizontal layers, fixed at some distance from the trench, and modified only slightly by the drag of neighboring layers.

**RR 31**
**DETERMINATION OF THE MODULUS OF ELASTICITY OF ARTIFICIAL SNOW-ICE IN FLEXURE.**
Halvorsen, L.K., Feb. 1959, 9p. plus 14p. appends., AD-216 681, 5 refs.
24-3189
SNOW ICE, SNOW STRENGTH, ELASTIC PROPERTIES.
Studies were conducted on 58 snow-ice beams (7.5 cm wide, 10.0 cm high, and 56.0 cm long) ranging in density from 0.621-0.719 g/cu. cm under varying loads, at uniform loading rates (except for 23 beams which were tested with repeated loading), and at a constant temperature of -5.5 to -4.5C. All beams were tested to failure. The modulus of elasticity of the beams increased with density and loading rate. The modulus of elasticity ranged from 13,500 to 22,200 kg/sq. cm for densities of 0.621-719 g/cu. cm respectively. A variation in the relative time of deflection from 42-23 sec/0.0200 cm gave a variation in the modulus of elasticity from 12,200 to 14,200 kg/sq. cm. The modulus of rupture was roughly a linear function of density, increasing from 7.79-11.54 kg/sq. cm with density. Failure of the beams was sudden, with a conchoidal fracture occurring in the middle third of the span, and appeared to be a combination of shear and flexure.

**RR 32**
**EFFECT OF HYDROSTATIC PRESSURE ON VELOCITY OF SHEAR DEFORMATION OF SINGLE CRYSTALS OF ICE.**
Rigsby, G.P., May 1957, 7p., AD-143 290, 2 refs.
24-3190
ICE CRYSTALS, DEFORMATION, PRESSURE FACTORS, SHEAR STRAIN, STRAIN RATE.
Apparatus was built for deforming ice crystals under hydrostatic pressures up to 350 atmospheres. Single crystals were placed in the mounts in such a way that the deformation occurred by gliding on the basal glide plane. It was found that the shear strain rate increased as the pressure was increased at constant temperature, but that the rate is practically independent of hydrostatic pressure when the difference between the ice temperature and the melting point is kept constant.

**RR 33**
**SOME PRELIMINARY OBSERVATIONS ON THE PLASTICITY OF GREENLAND GLACIERS.**
Landauer, J.K., July 1957, 6p., AD-146 697, 5 refs.
24-3191
GLACIER FLOW, SHEAR PROPERTIES, GLACIER ICE, DEFORMATION, CORING, GREENLAND.
Preliminary evaluation of flow and shear in glacier ice is given based on deformation measurements made at two tunnel sites in the Thule area of NW Greenland. Measurements included the horizontal deformation of a vertical series of pegs placed in one tunnel wall, deformation of core holes at the other site, and tunnel closure at both sites. The analysis assumes Nye-type laminar flow. The agreement obtained in calculated results has limited reliability due to uncertainty in the experimental data.

**RR 34**
**COMPRESSIVE STRENGTH PROPERTIES OF SNOW.**
Jellinek, H.H.G., Aug. 1957, 16p., AD-158 194, 6 refs.
24-3192
SNOW PHYSICS, COMPRESSIVE STRENGTH, SNOW IMPURITIES.
The compressive strength of snow cylinders was investigated as a function of age of snow, snow-particle size, and age of the cylinders. The effect of gases such as carbon dioxide, methane, and ammonia on the strength of snow cylinders has also been studied. The experimental results show that the older the snow from which snow cylinders are made, the smaller the compressive strength. The compressive strength of the cylinders decreases with the snow particle size. An equation describing the aging curves for snow cylinders is presented. Whereas carbon dioxide and methane in small quantities have no effect on the compressive strength, ammonia appreciably lowers the compressive strength of snow cylinders. All strength measurements were carried out at -10C.

**RR 35**
**THIN SECTION ANALYSIS.**
Jellinek, H.H.G., July 1957, 14p., AD-146 698, 9 refs.
24-3193
SNOW, PARTICLE SIZE DISTRIBUTION, THIN SECTIONS, ANALYSIS (MATHEMATICS).
Derivations are developed to permit application of thin section analysis, similar to that employed in geology and mineralogy, to the special problem of determining particle size distribution of snow from sections cut through the snow. Equations are derived to permit transformation of data from either 1-dimensional random cuts (chords) through the particle cross sections or from 2-dimensional cuts (cross-sectional areas) of the particles. The case for the rectangular distribution and the case for the normal distribution are discussed in the appendix.

**RR 36**
**CONTACT ANGLES BETWEEN WATER AND SOME POLYMERIC MATERIALS.**
Jellinek, H.H.G., Aug. 1957, 10p., AD-149 030, 3 refs.
24-3194
WATER, ADHESIVE STRENGTH, ICE ADHESION, CONTACT ANGLES, POLYMERIC FILMS.
Measurements were made with 32 more or less hydrophobic polymers and lacquers at intervals of 5 or 10 min for periods up to 1 hr. All surfaces were carefully cleaned, and some surfaces were baked. Highest initial (time 0) average contact angles (106 deg to 106.6 deg) were measured for Foster Snell rain repellant wax, Barrett 25-218 water repellant varnish (air-dried), and Cardolite NRL-7241. After 40 min, contact angles for these substances were 95.6 deg, 90.9 deg, and 91.0 deg. The measurement apparatus is illustrated, and data are tabulated.

**RR 37**
**AIR PERMEABILITY OF SNOW.**
Bender, J.A., Nov. 1957, 19p. plus appends., AD-158 193, 95 refs.
24-3195
SNOW SAMPLERS, PERMEABILITY, POROSITY, SNOW DENSITY, ANALYSIS (MATHEMATICS).
The air permeability of various screened and natural snows was measured to determine whether the parameters obtained from the measurements could be used to define a snow type. The permeability of a snow sample of known porosity (calculated from density) was determined over a wide range of air velocities, the sample was then compacted artificially a few mm, its density was determined, and its permeability measured again. The procedure was used to obtain curves for several densities of the same sample. Air flow appeared laminar for velocities less than 5 cm/sec in fine-grained snow (less than 0.8 mm in diam), 2 cm/sec in medium-grained snow (0.8-1.2 mm diam), and 1 cm/sec in larger-grained snow. A single relationship is presented which describes the results of measurements of these parameters under laminar flow conditions.

**RR 38**
**ADHESIVE PROPERTIES OF ICE.**
Jellinek, H.H.G., Sept. 1957, 20p., AD-149 061, 24 refs.
24-3196
ICE ADHESION, ADHESIVE STRENGTH, STAINLESS STEELS, TEMPERATURE EFFECTS.
Shear tests of the system snow-ice/stainless steel gave pure adhesive breaks down to a temperature of about -13C, where a sharp transition to cohesive breaks was observed. Adhesive strength of the system was a linear function of temperature and independent of cross-sectional area and height of samples in the range tested. Shear tests of the system ice/polystyrene gave pure adhesive breaks, with adhesive strength decreasing linearly with temperature to -15C and independent of cross-sectional area. Tensile tests of the system ice/polystyrene revealed a linear relation between adhesive strength and temperature in the range -2C to -25.5C regardless of cross-sectional area and rate of stress application. The test results are interpreted on the basis of an assumed liquidlike layer at the interface.

**RR 39**
**A SURVEY OF ARCTIC SNOW-COVER PROPERTIES AS RELATED TO CLIMATIC CONDITIONS.**
Bilello, M.A., Nov. 1957, 9p., AD-158 191, 3 refs.
24-3197
SNOW DENSITY, TEMPERATURE DISTRIBUTION, CLIMATE, SNOW HARDNESS.
An analysis of snow-cover density, temperature, and hardness data, measured over a period of several years at five stations in Alaska and six stations in the Canadian Arctic, shows the snow cover in the Canadian Archipelago to be colder, denser, and harder than in the interior of Alaska. A series of nomographs was developed to estimate average monthly snow-cover density from mean monthly air temperature and wind velocity. The nomographs are applicable for the months November through March, for the Alaskan and Canadian areas north of 62 N latitude, and for elevations below 1500 ft. A comparison of observed snow-cover densities with those derived from the nomographs indicates that the method will provide a reliable regional estimate of snow-cover density. Studies of the relation between snow-cover temperature and air temperature from November through March disclosed the snow to be on the average from 4C to 9C warmer than the air at the Alaskan stations and 4.5C warmer at the Canadian Archipelago stations. An investigation of snow-cover hardness revealed regional variations similar to that for density. Measured snow hardness during the period of no melting was found to be related to densities between 0.15 and 0.36 g/cu cm.

**RR 40**
**LINEAR THERMAL EXPANSION OF ICE.**
Butkovich, T.R., Dec. 1957, 10p., AD-158 192, 8 refs.
24-3198
ICE CRYSTALS, ICE THERMAL PROPERTIES, SNOW ICE, THERMAL EXPANSION, COEFFICIENTS.
Experiments were conducted on natural and artificial single ice crystals, commercial ice, snow-ice, and a glacial single crystal at temperatures from 0C to -30C to determine the effect of orientation on the linear thermal expansion coefficients. The orientation of the c-axis, the type of ice (whether single or polycrystalline), and the grain size did not appreciably affect the values of the coefficient; ice was practically isotropic with respect to thermal expansion at the temperatures tested. There was a steady decrease of the expansion coefficient with each succeeding measurement on the same specimen, a phenomenon attributable to slow annealing. The ratio of the specific heat at constant pressure to that at constant volume averaged 1.030 from 0C to -30C. Gruneisen's constant was found to be about 0.78 and independent of temperature. An equation expressing the average coefficient of linear thermal expansion of ice of any type or orientation is presented.

**RR 41**
**CREEP OF SNOW UNDER COMBINED STRESS.**
Landauer, J.K., Dec. 1957, 12p., AD-202 624, 13 refs.
24-3199
COMPRESSIVE PROPERTIES, STRESS ANALYSIS, SNOW CREEP, DEFORMATION.
Laboratory experiments on the creep of sifted snow under uniaxial, hydrostatic, and confined-side compressive stresses are described, and the results are discussed on the basis of an additive theory for combined stresses. Stress (4-40 psi) and temperature (-3.6C to -13.6C) dependence was investigated for 35 samples (initial density approximately 0.4 g/cu. cm.) subjected to uniaxial and hydrostatic stress for 200-sec time increments. Another series of 104 samples (initial densities 0.36-0.63) was subjected to uniaxial, hydrostatic, and confined-side compressive stresses until an arbitrary change in density was reached. In all cases the applied stress ultimately became a shear stress acting between grains, the open structure reacting differently to combined stresses and separate uniaxial stresses. An activation energy of 13,400 cal/mol was obtained from the first group of tests.

**RR 42**
**SOME STRUCTURAL PROPERTIES OF GREENLAND SNOW.**
Fuchs, A., Dec. 1959, 24p., AD-236 864, 7 refs.
24-3200
SNOW SAMPLERS, SNOW PHYSICS, SNOW DENSITY, THIN SECTIONS.
The results of petrofabric studies in the laboratory on five samples of high-density snow collected in 1954 and 1955 at depths of 8.0, 15.5, 23.0, 34.2, and 46.3 m in a pit at Site 2 are reported. The porosity of the samples, the number of grains/sq cm, the mean number of adjacent grains per grain, the mean grain cross section, the size distribution of grain cross sections, and the orientation of c-axes were determined from enlarged photomicrographs of thin sections, using reflected light and transmitted polarized light. The number of adjacent grains per grain, the ratio of free to occupied grain surface, and the sphericity clearly depended on porosity and on each other. There was no strong relation between these data and the number of grains/sq cm. Hence, the structure of high density snow can be satisfactorily described by the porosity and the number of grains/sq cm. Conclusions from a two-dimensional thin section can be applied to a spatial sample only if the sample is isotropic by strata.

**RR 43**
**AIR TEMPERATURE AND PRECIPITATION ON THE GREENLAND ICE CAP.**
Diamond, M., Oct. 1958, 9p., AD-214 671, 16 refs.
24-3201
GLACIER ICE, PRECIPITATION (METEOROLOGY), AIR TEMPERATURE, CLIMATOLOGY, STATISTICAL ANALYSIS.
Mean annual air temperatures and precipitation on the Greenland Ice Cap, as estimated from snow profile studies and long-term meteorological records at coastal stations, have been used to prepare mean annual air temperature and mean annual precipitation charts for the Greenland Ice Cap. It is shown that melting of surface snow may occur at elevations of about 1300 m in North Greenland and up to 2700 m in South Greenland. The warming trend in the Arctic, as indicated by increases in mean annual air temperature, may have occurred to a lesser extent on the ice cap than at sea-level coastal stations. Annual accumulation of precipitation is two or three times as great at 2500 m on the west side of the ice cap than at the crest. South of 66N, precipitation may be about twice as great on the east side of the crest as on the west side.

**RR 44**
**COMPOSITION OF SEA ICE AND ITS TENSILE STRENGTH.**
Assur, A., Dec. 1960, 49p., AD-276 604, 30 refs.
24-3202
SEA ICE, TENSILE STRENGTH, CHEMICAL COMPOSITION, SALINITY, BRINES, SALT ICE, ANALYSIS (MATHEMATICS).
Part of the salts contained in sea water are trapped in sea ice upon freezing. They form liquid and solid inclusions in a systematic pattern. The amount depends upon temperature and salinity. A detailed table of phase relations is given and a general theory is derived to show how the internal cavities may affect the strength of sea ice. The general theory leads to specific models. The principle of ring tensile strength tests is explained and a series for evaluation is given. Test data lead to a substantiation of theoretical principles and to an illustration of several hypotheses concerning the effect of solid salt inclusions upon strength. Observed sea ice phenomena are explained on the basis of internal structure.

**RR 45**
**EXPERIMENTAL STUDY OF FROST HEAVING.**
Higashi, A., Aug. 1958, 20p., AD-214 672, 8 refs.
24-3203
FROST HEAVE, FROST PENETRATION, SOIL TEMPERATURE, TEMPERATURE DISTRIBUTION, FROZEN GROUND, THERMAL CONDUCTIVITY.
Laboratory studies on the effects of the soil-temperature regime on the type of ice segregation and the rate of frost heaving are described in detail, and the results are analyzed quantitatively on the basis of thermodynamic and hydraulic theory, assuming that suction is created by ice formation. The heaving rate varied with the type of ice segregation, which in turn depended on the rate of frost penetration. Ice-filament layers or sirloin-type freezing were observed at low penetration rates and concrete-type freezing at high penetration rates. The heaving rate decreased with increasing frost-penetration rate, and varied, in the case of filament-type freezing, according to the amount of sensible heat lost at the freezing interface. The sensible heat loss was 0.62 cal/cm-sec in the case of maximum heaving (7 mm/day); higher values resulted in thermal conditions favoring sirloin-type freezing. The moisture content of frozen soil was found to be related to the heaving ratio, inasmuch as the amount of heaving is attributed to the amount of segregated ice.

**RR 46**
**VISCO-ELASTIC PROPERTIES OF SNOW AND ICE IN THE GREENLAND ICE CAP.**
Nakaya, U., May 1959, 29p., AD-226 274, 16 refs.
24-3204
GLACIER ICE, VISCOELASTICITY, ICE TUNNELS, CORE SAMPLERS, SNOW DENSITY.
The results of studies in the summer of 1957 on ice samples taken from the ice tunnel at TUTO, core samples obtained by drilling in the ice cap at Site 2, and snow samples, using the transverse vibration method and a new portable meter, are reported. The modulus of elasticity of samples of density from 0.917-0.90 g/cu cm (tunnel ice) decreased sharply with slight deviations of the density from that of pure ice. At densities from 0.90-0.50 g/cu cm (deep-pit and drill-core samples) the relation between the modulus of elasticity and density was linear, while in the density range from 0.50-0.25 g/cu cm (surface snow) the modulus of elasticity decreased exponentially. The viscosity-density relation of the samples was similar to that of elasticity vs density. Young's modulus increased slightly with decreasing temperature, while viscosity increased exponentially. The activation energy was calculated as 18.7 kcal/mol for old ice-cap ice, 13.9 kcal/mol for tunnel ice with elongated bubbles, and 13.5 kcal/mol for superimposed ice.

**RR 47**
**SOME PHYSICAL PROPERTIES OF ICE FROM THE TUTO TUNNEL AND RAMP, THULE, GREENLAND.**
Butkovich, T.R., May 1959, 17p., AD-225 569, 7 refs.
24-3205
GLACIER ICE, COMPRESSIVE STRENGTH, TENSILE STRENGTH, FLEXURAL STRENGTH, ELASTIC PROPERTIES, DENSITY (MASS/-VOLUME), ICE TUNNELS.
Results of unconfined compressive strength, ring tensile strength, and flexural strength tests are given. Crushing strength values for tunnel ice fit the empirical equation relating crushing strength to density which was found for high-density snows. However the values for ramp ice do not fit the equation when the average density values are used, probably due to the layering. The empirical equation relating ring tensile strength to density of high-density snows gives results 20 per cent greater than those obtained for tunnel ice. Ice with large grains consistently gives lower values. Flexural strength of the ramp ice is about half that of the tunnel ice. Comparing these results with the ring tensile values leads to the conclusion that the beams tend to fail in the lowest-density (mostly bubbly) bands. Temperature curves as a function of depth into the wall and along the tunnel length are presented. A 30-day study of deformation in a 100 x 30 ft room at 650 ft into the tunnel indicated that the room is closing primarily by a block action, with rates of closure being less only very near the walls.

**RR 48**
**GROWING OF LARGE SINGLE CRYSTALS OF ICE.**
Landauer, J.K., July 1958, 7p., AD-209 356, 10 refs.
24-3206
ICE CRYSTAL GROWTH.
A new method has been developed for growing large single crystals of ice. Crystals 15 cm in diameter by 25 cm high have been grown. No large differences exist for rate of growth in different crystallographic directions. The use of specially prepared water does not appreciably affect the results. The crystals grown by this method have a somewhat distorted appearance under polarized light. The nature of the imperfect structure is discussed.

**RR 49**
**ROLE OF THE ELECTRIC DOUBLE LAYER IN THE MECHANISM OF FROST HEAVING.**
Cass, L.A., et al, Aug. 1959, 15p. plus appends., AD-237 654, 21 refs.
Miller, R.D.
24-3207
FROST HEAVE, CLAY SOILS, ICE WATER INTERFACE, ICE LENSES, FREEZING POTENTIAL (ELECTRICAL), OSMOSIS.
It is suggested that the osmotic activity of the electrical double layer on mineral particles can account for the heaving phenomenon in soils, and equations are given relating the osmotic pressure (and freezing temperature) of water at the base of a growing ice lens to overburden pressure, depth of water table, depth to the conducting stratum, hydraulic conductivity of soil, and rate of heave. Water flows to the ice face ordinarily by hydraulic conduction, but by diffusion in the unfrozen film between the upper-most particles and the underside of the ice lens. Coarse materials show little heave because of diffusion limitations on recharge of the unfrozen film. The theory of Jackson and Chalmers that supercooling is required for heaving is denied, and a "solution model" is proposed in which heaving can occur in the absence of soil. Various methods of modifying or controlling frost heaving are reviewed in the light of the theory, and experiments are proposed for evaluating the theory.

**RR 50**
**CRYOCONITE OF THE THULE AREA.**
Gerdel, R.W., et al, Nov. 1958, 12p. plus 2p. appendix, AD-217 599, 6 refs.
Drouet, F.
24-3208
SNOW SURFACE, CRYOGENIC FORMATIONS, SNOW IMPURITIES.
The cryoconite holes on the Nuna and Thule ramps are described, and the results of analyses of their mineral and organic content are discussed in relation to their formation. The closely spaced cylindrical holes of Nuna ramp range from a few cm to more than 1 m in diam with a uniform depth of 50-60 cm. The larger holes are found at low elevations in the wet-ice zone, and small holes (1-2 cm in diam) occur near the firn line. The holes on the Thule ramp are less uniform, 50 cm or less wide, and 30 cm or less deep. Water fills the holes to within a few cm of the ice surface, and a gelatinous, gritty material (cryoconite) covers the bottom. Oven drying of the drip-free cryoconite yielded 93-96 percent water and a dry residue containing 13.-2-20.1 percent organic matter (algae, fungi, desmids, and rotifers), with the mineral fraction consisting of fine sharp grains, apparently wind-transported over short distances. The holes may be at least partly the product of energy released from photosynthesis and metabolism of the algae (the largest fraction of the organic matter), since algae primarily utilize radiation in the blue region from 0.40-0.65 micron where ice has the greatest transmissivity. The organisms are identified, and the algae are described in detail.

**RR 51**
**PLASTIC DEFORMATION OF HOLLOW ICE CYLINDERS UNDER HYDROSTATIC PRESSURE.**
Higashi, A., July 1959, 10p., AD-233 534, 10 refs.
24-3209
PLASTIC DEFORMATION, PLASTICITY TESTS, ICE COMPRESSION.
The study was made in order to simulate the deformation of a tunnel in glacier ice and compare the results with the theoretical value derived from compression or tension tests. The plastic deformation of commercial polycrystalline ice and manufactured snow-ice was determined by measuring the discharge of oil from the cavity of closed hollow ice cylinders subjected to high external pressure in an oil-filled pressure chamber. The deformation vs time curves were similar to those obtained in compression or tension tests. The relationships between minimum strain rate and applied pressure, or between minimum strain rate and the circumferential stress at the surface of the inner cavity, were found. Analysis of time-deformation curves indicates that viscoelastic models proposed by former investigators do not apply to the mechanism of the plastic deformation of ice.

**RR 52**
**INVESTIGATIONS OF FOG WHITEOUT.**
Reiquam, H., et al, July 1959, 18p. plus 1p. appendix, AD-226 992, 35 refs.
Diamond, M.
24-3210
WHITEOUT, ICE FOG.
The results of studies on the physical properties of fog whiteout, as it occurred at Site 2 on the Greenland Ice Cap in the summers of 1956 and 1957, are reported and compared with the results of other studies; the instruments, methods of measurement, and data-reduction techniques used are described; and attempts at dissipating whiteout by AgI seeding are discussed briefly. Emphasis was given to measurements of fog-particle size distribution, liquid-water content, relative humidity, visibility, and atmospheric nuclei. The data are tabulated. The synoptic situations for 2 selected cases of fog whiteout at relative humidities of less than 100 percent (possibly because of the presence of salt solutions) are described; and the balance between the rate at which water is made available in the air as it is lifted over the Ice Cap and the rate of water flux to the snow surface is computed using various equations. Efforts at fog dispersal by AgI seeding from the ground were inconclusive.

**RR 53**
**STRUCTURE OF AGE-HARDENING DISAGGREGATED PETER SNOW.**
Fuchs, A., May 1960, 15p. plus 5p. appendix, AD-239 455.
24-3211
SNOW COMPACTION, STRUCTURAL CHANGES, METAMORPHISM (SNOW).
The results of investigations on the structural changes of Greenland snow during age-hardening in the first 49 hr after ejection by a Peter snow miller from a trench 4.7 ft deep are reported, and the method of study is described. The samples of snow were taken at various distances from the trench 1, 3, 14, 25, and 49 hr after deposition, and their changes were studied as a function of time and distance from the trench. The porosity remained constant at an average of 47 to 53 percent. The number of grains/sq cm. decreased with time and increased with distance from the trench because of the different speeds of sedimentation and wind sifting. The mean grain cross-section showed a similar dependence. The relative length of grain boundaries increased with time and slightly with distance from the trench, while the mean length of new grain-to-grain boundaries increased with age and decreased with distance from the trench. The mean number of adjacent grains per grain vs relative length of grain boundaries showed a linear relation. A slight increase of new boundaries with increasing number of neighbors was also observed. Suggestions for a precise study of the age-hardening process of snow are made.

**RR 54**
**ON THE MECHANICAL PROPERTIES OF SEA ICE, THULE, GREENLAND, 1957.**
Butkovich, T.R., Aug. 1959, 11p. plus 9p. appends., AD-235 872, 6 refs.
24-3212
SEA ICE, MECHANICAL PROPERTIES, ELASTIC PROPERTIES, ICE COVER STRENGTH, FLEXURAL STRENGTH.
The investigations on sea ice, conducted at Thule, Greenland, during February and March 1957 included: unconfined compressive strength, ring tensile strength, and flexural strength tests on simple beams for both horizontal and vertical test specimens. Additional tests were made to determine the modulus of elasticity with the simple beams in flexure. Tests were also made for creep in uniaxial compression. Although there is a high scatter of results, a dependence of strength and creep on temperature and brine volume is evident. Higher compressive, tensile, and flexural strengths, along with higher values of the elastic modulus were obtained at lower temperatures or brine volumes. The minimum creep rate decreases with decreasing temperature and brine volume.

**RR 55**
**EXPERIMENTAL FORMATION OF SORTED PATTERNS IN GRAVEL OVERLYING A MELTING ICE SURFACE.**
Corte, A.E., July 1959, 15p., AD-225 269, 3 refs.
24-3213
GLACIER MELTING, POLYGONS, ICE SURFACE FEATURES, GRAVEL.
The results of field studies at the edge of the ice cap SE of Thule (Greenland) in the summer of 1957 are reported. Four differently modeled surfaces were covered with sandy gravel in varying thicknesses, and the effect of differential melting was observed and photographed at 7-day intervals. A 2-in. gravel cover promoted more rapid melting than a cover of 6 in., and resulted in the formation of depressions and mounds. Coarse particles were segregated in the depressions by natural sorting when set in motion by differential melting. The sorting produced well-developed stone rings. A uniform gravel cover over a smooth ice surface failed to produce sorted nets, although stripes formed in meltwater naturally at the edge of the ice cap, suggesting that natural patterns are started by differential melting under a gravel cover of nonuniform thickness. Mechanical sorting resulting from the differential collapse of newly-thawed permafrost is considered as a primary factor in sorted-pattern formation in outwash material.

**RR 56**
**THE FLOW LAW FOR ICE.**
Butkovich, T.R., et al, Aug. 1959, 7p., AD-235 263, 18 refs.
Landauer, J.K.
24-3214
GLACIER FLOW, ICE CREEP, CREEP PROPERTIES, DEFORMATION, SHEAR MODULUS.
The results of laboratory creep tests in a shear apparatus at -5C on 2 x 2 x 3/8 in. samples of commercial ice, artificial single crystals, and 6 types of ice from the Greenland Ice Cap, at shear stresses of about 0.5 - 3 kg/sq. cm are reported. Some uniaxial tests were made at stresses from 6 - 28 kg/sq. cm to supplement the shear tests. Creep data could usually be represented ap-

proximately by one or more linear sections on a log-deformation vs log-time plot. The linear sections of the double logarithmic curve imply a creep curve of the form "e equals ct exp.m," where e is the strain. For all samples tested, except single crystals sheared in easy glide, m averaged 0.5 for shear deformations up to about 1 percent, and approached unity for more deformation. For single ice crystals oriented for easy glide, m averaged 1.7, implying a strain softening. Single crystals oriented for hard glide behaved similarly to polycrystals, indicating a rate-controlling process such as dislocation climb. For all but single easy-glide crystals, the min. creep rate was tangent to the deformation curve at the end of the experiment. Creep rates for single easy-glide crystals were several hundred times larger than for the other crystals, the flow laws being similar.

**RR 57**

**PLASTIC DEFORMATION OF FLOATING ICE PLATES SUBJECTED TO STATIC LOADS.**

Kerr, A.D., Sept. 1959, 10p. plus 1p. appendix, AD-237 533, 12 refs.

24-3215

FLOATING ICE, PLASTIC DEFORMATION, FLEXURAL STRENGTH, ICE COVER STRENGTH.

The problem is analyzed mathematically for decreasing and increasing rates of deflection. The analysis is based on the assumptions that for decreasing rates of deflection the floating ice plate will deform under lateral load without failure until the weight of the displaced water is equal to that of the load, and that for increasing rates, deflection increases until the ice plate collapses under and near the load. It is also suggested that the total deflection at a certain time is the result of the elastic deflection surface and the plastic deflection due to shear only, the shear forces obeying Newton's law of viscosity. Deflection equations for plastic deflection due to shear and derived for an infinite plate subjected to a line load, an infinite plate subjected to a concentrated force (axially symmetrical flexure), and an infinite plate subjected to uniform circular load. Equations for elastic deflection to be added to the plastic deflection due to shear are suggested. According to the statements and assumptions made and the results obtained, the total system of an ice plate resting on a liquid base can be considered as a Kelvin body for the case of decreasing rates of deflection.

**RR 58**

**VISCO-ELASTIC PROPERTIES OF PROCESSED SNOW.**

Nakaya, U., Sept. 1959, 22p., AD-235 329, 6 refs.

24-3216

ELASTIC PROPERTIES, VISCOSITY, SNOW ELASTICITY.

The results of investigations at Site 2 (Greenland) on rectangular samples of Peter snow (2 x 20 x 1.0 - 1.6 cm) of varying ages are reported, and the methods of study are described. Young's modulus was obtained from the frequency of resonance vibration and viscosity from the rate of damping, using a new visco-elastic meter. A simple relation was obtained between Young's modulus and density when the specimens were grouped according to structure, and the results of the experiments were analyzed for each of the groups, taking age as the parameter. Peter snow 2-3 yr old had almost the same modulus of elasticity as snow naturally compacted for 10 yr. The modulus of elasticity vs density curve for new Peter snow was similar to that of naturally compacted snow, except that the absolute value of the modulus of elasticity was smaller for the same density. Young's modulus, however, increased with time, and the curve approached that of naturally compacted snow. When the grain-size distribution was heterogeneous, Young's modulus was larger than for naturally compacted snow of the same density. Mechanical vibration immediately after processing effected an increase in snow density, but did not accelerate age hardening.

**RR 59**

**ELASTIC PLATES WITH SIMPLY SUPPORTED STRAIGHT BOUNDARIES, RESTING ON A LIQUID FOUNDATION.**

Kerr, A.D., Sept. 1959, 12p. plus 1p. appendix, AD-237 338, 14 refs.

24-3217

ICE COVER STRENGTH, FLEXURAL STRENGTH, MECHANICAL PROPERTIES, SHEAR PROPERTIES, PLATES, DEFORMATION.

The deflection expression of an infinite plate subjected to a concentrated force is used with the "method of images" to obtain solutions for 6 plates with simply supported edges. The semi-infinite plate, the wedge-shaped plate, and its special case, the rectangular corner plate, are solved in closed form; and the infinite strip, the semi-infinite strip, and the rectangular plate are solved as rapidly covergent series. Behavior under a concentrated force is studied in more detail for the semi-infinite plate and the rectangular corner plate. Relationships for obtaining bending moments, shear forces and reaction distributions as well as derivatives of the kei-function with respect to r and theta are given in the appendices.

**RR 60**

**ANALYSIS OF A SUB-ICE HEAT SINK FOR COOLING POWER PLANTS.**

Tien, C., July 1960, 17p. plus 6p. appendix, AD-696 399, 8 refs.

24-3218

ELECTRIC POWER PLANTS, HEAT TRANSFER, COOLING SYSTEMS.

A feasibility study is presented of the use of subsurface ice as a heat sink into which the surplus heat from an under-ice power plant can be rejected. Two types of systems are analyzed: an open-loop system in which water is used as the heat transfer medium (the heated water pumped into subsurface ice and the cold melt water returned to the power plant); and a closed-loop system using a glycol solution which is cooled by passing through coils in the ice. The amount of heat rejected is estimated as 27 million Btu/yr with an inlet temperature up to 130F. Numerical calculations given can serve as the basis for future engineering work.

**RR 61**

**BONDING OF FLAT ICE SURFACES - SOME PRELIMINARY RESULTS.**

Jellinek, H.H.G., July 1960, 6p. plus 4p. appendix, AD-696 400, 9 refs.

24-3219

ICE ADHESION, ICE BONDS, ICE SURFACE FEATURES.

Experiments have been performed on the bonding of polished and microtomed ice surfaces at -5C. These surfaces showed an appreciable curvature and unevenness. The force of separation after bonding for 60 min under different weights increased with weight. The surfaces placed together immediately after preparation showed an appreciably higher force of separation than those placed together after a time interval. The force of separation for surfaces placed together at zero humidity showed a higher force of separation than those placed together in an atmosphere of 100 percent relative humidity. A preliminary simplified theory of bonding of irregular surfaces has been developed.

**RR 62**

**ADHESIVE PROPERTIES OF ICE, PART II.**

Jellinek, H.H.G., July 1960, 10p., AD-638 344, 11 refs.

24-3220

ICE ADHESION.

The results of shear tests on the system ice/stainless steel and ice/optically flat fused quartz as a function of the rate of shear and roughness of the steel surface are reported. The adhesive strength decreased with decreasing roughness of steel surface, and the force-vs-time curves for smooth steel plates resembled those of 2 solids sliding over each other with a liquid layer between. This behavior was especially evident in the case of quartz. The adhesive strength as a function of rate of shear was linear for both ice/stainless steel and ice/quartz, but there were indications of yield values. The results agree with the assumption of a liquid-like layer on ice. Ratios of viscosity coefficient to layer thickness were evaluated for both systems, and viscosity coefficients are estimated. The importance of interfacial free-energy considerations is pointed out.

**RR 63**

**PLASTIC DEFORMATION OF THICK-WALLED SNOW-ICE CYLINDERS UNDER HYDROSTATIC PRESSURE.**

Jellinek, H.H.G., July 1960, 7p., AD-696 401, 7 refs.

24-3221

SNOW PLASTICITY, STATIC LOADS, ICE PLASTICITY.

The results of experiments on the plastic deformation of hollow snow-ice cylinders, closed at one end, as a function of circumferential stress and temperature are discussed. Data are graphed on deformation as a function of time for a snow-ice cylinder under 7.03 and 14.06 kg/sq. cm hydrostatic pressure at -4.5C, deformation as a function of hydrostatic pressure from 2.11 -7.03 kg/sq. cm, and deformation as a function of temperature at a constant pressure of 10.55 kg/sq. cm. The natural strain rate of closure at constant circumferential stress and temperature was a constant, which varied with circumferential stress as a sine function and was exponentially dependent on temperature, with an activation energy of 14.1 kcal/mole at an average circumferential stress of 3.1 kg/sq. cm. The experiments agree well with an earlier interpretation of the plastic flow process representing flow between grain boundaries.

**RR 64**

**TEMPERATURE DISTRIBUTION OF AN IDEALIZED ICE CAP.**

Tien, C., July 1960, 8p., AD-696 402, 8 refs.

24-3222

GLACIER ICE, ICE TEMPERATURE, ICE GROWTH.

The problem is analyzed mathematically, assuming that the icecap has constant physical properties, that it grows at a constant rate from an initial zero thickness, is internally static, and subject to a linear climatic change and a constant geothermal heat flux. The results are compared with direct measurements in Greenland and in the Ross Ice Shelf. The problem is treated as a Stefan-type problem, and the solution is obtained by the principle of superposition. The results indicate that the temperature at the base of the icecap increases with time, and eventually would reach the melting point of ice. Under such conditions the icecap is not resting on permafrost as suggested earlier. The predicted results agree fairly well with direct measurements for greater depths.

**RR 65**

**FORMATION, GROWTH, AND DECAY OF SEA ICE IN THE CANADIAN ARCTIC ARCHIPELAGO.**

Bilello, M.A., July 1960, 18p. plus 16p. appends., AD-653 137, 16 refs.

24-3223

SEA ICE, ICE FORMATION, ICE GROWTH, DEFORMATION, ICE DISINTEGRATION.

Equations relating the accretion and decay of sea ice to standard meteorological data are derived empirically from observations at 5 stations (Alert, Eureka, Isachsen, Mould Bay, and Resolute) with varying periods of record from 1947-1957. The equations differ from existing formulas in that they are differential in nature, to permit calculation of ice growth by increments, and contain a separate term allowing for variations in snow-cover depths. The use of the formulas requires only a knowledge of air temperatures and snow depths. A good correlation is found between the decrease in ice thickness and accumulated degree days above -1.8C. The location of each station, the names of the surrounding water bodies, and the approximate water depths where ice thickness measurements were made are listed in Appendix A; the techniques used in the measurements are described in Appendix B; data on observed ice thickness are tabulated in Appendix C; and accumulated degree days of frost and average snow depths for 20-cm increments of ice growth are tabulated in Appendix D.

**RR 66**

**EXPERIMENTAL RESEARCH ON DESICCATION CRACKS IN SOIL.**

Corte, A.E., et al, Dec. 1964, 72p. plus 4p. appendix, AD-615 277, 22 refs.

Higashi, A.

24-3224

SOILS, DESICCATION, POLYGONS, CRACKS, SOIL PATTERNS.

The final report on model studies of patterned ground deals with a theory proposed for crack formation by soil desiccation. Experimental procedures and results are described in reproducing desiccation cracks under controlled conditions for soil with and without stones. The crack pattern and number of cell sides are more dependent on thickness of the soil sample and the bottom container material than temperature or humidity and show a cell area of log normal size distribution. Cracking was found to begin from the center and extend to the surface or bottom with non-uniform speed. The shape, size, porosity, and depth of scattered stones affect the initiation of cracks but do not relate to geometry and mean area of cells. Soil "habituation" to crack in the same manner is promoted by complete soil soaking and stone admixing. Surface stones affect "habituation" differently. Sorting of particles into desiccation cracks requires "habituation." This is accomplished if the soil is soaked and dried repeatedly under wind and rain without vegetation. Areas above the timber line in cold environments have the proper conditions for sorting into desiccation cracks.

**RR 67**

**TEMPERATURE DISTRIBUTION OF SNOW WITH GAMMA RAY RADIATION.**

Tien, C., Jan. 1960, 4p., AD-237 172.

24-3225

SNOW SURFACE TEMPERATURE, SNOW (CONSTRUCTION MATERIAL), THERMAL PROPERTIES, RADIATION ABSORPTION, SNOW TEMPERATURE.

The temperature distribution in snow subjected to gamma radiation from an operating nuclear reactor is analyzed mathematically, assuming that the effect of radiation is equivalent to a continuous heat source, the intensity of which is a function of the radial distance from the reactor. Steady-state solutions are derived for two cases: when the radial distance is 13 ft and when it is 19.1 ft. The results indicate that the temperature of the snow in certain regions in the several feet immediately below the foundation will exceed the design limit of 20F. Increasing the shielding of the reactor will reduce the intensity of the radiation and snow temperature. Other possible ways to reduce the snow temperature include the use of refrigeration coils and the forcing of atmospheric air through the snow.

**RR 68**

**PROPERTIES OF ICE.**

Brill, R., et al, May 1961, 75p. plus 2p. appendix, AD-277 536, Contract DA-21-018-ENG-16, 34 refs.

Camp, P.R.

24-3226

ICE CRYSTALS, ICE ELECTRICAL PROPERTIES, ICE PHYSICS.

This report summarizes the results of a number of studies on ice performed by researchers at the Polytechnic Institute of Brooklyn during the period 1955-1959. Sections of the report are entitled as follows: growth of large single crystals of ice and ammoniumfluoride ice; lattice constants of mixed crystals of ice and ammoniumfluoride; degree of perfection of glacial ice crystals; thermal motion in ice and heavy ice; viscoelastic properties of ice; diffusion of ammoniumfluoride through ice; dielectric relaxation; effect of pressure on dielectric properties; and investigation of the polarity of ice crystals.

**RR 69**
**THEORY OF DENSIFICATION OF DRY SNOW ON HIGH POLAR GLACIERS.**
Bader, H., Jan. 1960, 8p., AD-239 888, 3 refs.
24-3227
SNOW COMPACTION, SNOW DENSITY, SUBSIDENCE.

Relations between rate of snow accumulation, snow density, time, and depth below the surface are formulated in terms of a compactive viscosity factor, assumed to be a function of density and temperature alone. The parameters vary with the snow-type sequences of different climatic areas of high-polar glaciers. The theory could be useful in an analysis of the data obtained from the large number of snow pits in Greenland, Ellesmere Island, and Antarctica. It is applicable to all observed depth-density profiles except those from very deep pits and corings. The rate of densification is no longer proportional to stress under higher stresses, but is some stronger function, and the theory then becomes more complicated.

**RR 70**
**STRATIGRAPHIC STUDIES IN THE SNOW AND FIRN OF THE GREENLAND ICE SHEET.**
Benson, C.S., July 1962, 93p. plus 14p. appends. plus 10 data sheets, AD-288 219, 76 refs.
24-3228
SNOW COVER STRUCTURE, STRATIFICATION, FIRNIFICATION, SNOW PHYSICS, SNOW SURVEYS, GREENLAND.

During a 4-yr period (1952-55) 146 pit studies and 288 supplementary Rammsonde profiles were made along 1100 miles of oversnow traverse in western greenland. Temperature, density, ram hardness, and grain size were measured in the strata exposed in each pit. Stratification of snow, resulting from variations in conditions of deposition and emphasized by diagenesis, gives a sequence of recognizable annual layers in the upper 10 to 20 m which can be correlated between pits to provide a picture of annual accumulation. The concept of facies is applied to the ice sheet. Four diagenetic facies are recognized: (1) ablation; (2) soaked; (3) percolation; and (4) dry-snow. A revised estimate for the balance of the ice sheet gives a slightly positive balance which is interpreted to mean that the Greenland ice sheet is essentially in equilibrium with present-day climate.

**RR 71**
**SNOW DENSIFICATION THEORY AND ITS ENGINEERING APPLICATION.**
Waterhouse, R.W., et al, Nov. 1960, 10p., AD-653 134, 9 refs.
Steeves, H.F.
24-3229
SNOW COMPACTION, SNOW DENSITY, SUBSIDENCE, METAMORPHISM (SNOW).

Simplified mathematical expressions are developed for approximating the densification process at depths between 10 and 40 ft in continuously accumulating polar snow. The expressions are based on accumulation and densification rates deduced from pit studies in 1959 at three locations on the Greenland Ice Cap. The depth-density relationship of surface snow to a depth of 30 ft is graphed for the three sites studied, as well as loads, densities, and rates of densification in relation to depth and time. Examples are given of the application of the derived relationships to specific problems of under-snow military construction.

**RR 72**
**CREEP OF ICE AT LOW STRESSES.**
Butkovich, T.R., et al, Aug. 1960, 6p., AD-653 135, 16 refs.
Landauer, J.K.
24-3230
ICE CREEP, COMPRESSIVE PROPERTIES, ICE PLASTICITY.

Uniaxial compression tests were made on 2 x 2 x 6 cm samples of large-grained commercial ice and small-grained glacier ice at temperatures from -1.3 to -18.9C and stresses down to about 10,000 dynes/sq. cm, using a special apparatus to permit simultaneous measurement of 3 samples at different stresses. The uniaxial stresses and strain rates were reduced to shear stresses and strain rates by dividing and multiplying, respectively, the former by sq. root of 3. The log shear strain rate vs log shear stress curves was essentially linear for the low-stress creep measurements. Assuming a linear flow law for low-stress creep, activation energies for creep of about 14,300 cal/mole were determined. The smaller-grained ice had a higher viscosity coefficient than the larger-grained ice. The observed activation energy for creep of ice is probably that for self-diffusion. Although lacking a concrete deformation mechanism, the rate process theory, which leads to a hyperbolic sine stress dependence, seems to best describe the experimental results.

**RR 73**
**SCALE MODEL STUDIES ON SNOW DRIFTING.**
Strom, G.H., et al, Sept. 1962, 50p., AD-297 460, Contract DA-11-190-ENG-31, 15 refs.
Kelly, G.R., Keitz, E.L., Weiss, R.F.
24-3231
SNOWDRIFTS, MODELS.

Scale model tests were conducted to study experimental and theoretical aspects of snow drifting phenomena. Modeling criteria for drifting snow were developed and a number of materials were tested for use as geometrically and physically scaled synthetic snow. Crystalline borax 0.01 cm in diam was found satisfactory for a 1/10 model scale. The feasibility of using scaled materials to simulate drifting snow was demonstrated by the similarity of drift patterns obtained in the wind tunnel tests and those observed around full-scale structures on the Greenland Ice Cap. Further, several years of Arctic snow drift can be simulated in the wind tunnel in a matter of hours. Qualitative analyses are offered of drift accumulation characteristics around various scale model structures. The following experimental results were obtained. (1) Close spacing of buildings will result in coalescence of drifts. (2) If rectangular buildings must be grouped together, they should be erected with their long axis parallel to the dominant wind direction. (3) Erosion of the snow surface may occur beneath buildings erected on columns. (4) V-shaped snow fences produce a clear area downwind for a distance of approximately 25 times the height of the fence.

**RR 74**
**THERMODYNAMIC STUDIES OF A SNOW COVER IN NORTHERN MICHIGAN.**
Portman, D.J., et al, Jan. 1961, 73p., AD-653 138, Contract DA-11-190-ENG-30, 33 refs.
Ryznar, E.
24-3232
SNOW PHYSICS, HEAT TRANSFER, THERMODYNAMICS, AIR TEMPERATURE, METEOROLOGICAL FACTORS.

The heat transfer processes between a snow cover and its environment were studied and evaluated in order to predict changes in the physical characteristics of the snow cover from standard meteorological information. The study was based on micrometeorological and related snow and soil data collected at the Keeweenaw Field Station (Mich.) from 1954-1956. Computations of conductive heat transfer in snow, using the Liljequist method, showed significant correlation with average air temperatures. Average values of the cold content of snow can be estimated from average air temperatures. Average temperature differences through the snow can be estimated from a knowledge of the previous 20-hr average air temperature; snow hardness can be estimated graphically from snow density and depth.

**RR 75**
**SURFACE TEMPERATURES AND GROWTH OF SEA ICE.**
Bilello, M.A., Jan. 1961, 10p., AD-653 136, 8 refs.
24-3233
SEA ICE, ICE GROWTH, ICE TEMPERATURE.

Concurrent measurements of ice growth and ice-surface temperatures made at Eureka (N.W.T.) during the 2 seasons 1949-51 were utilized to compute a composite numerical value for 3 physical properties of sea ice - thermal conductivity k, latent heat of fusion L, and density rho combined as k/L x rho. Values for this expression were found to: (1) increase from approximately 4.7-7.0/100,000 during ice growth from 0.6-1.0 m thickness (Nov. 6-Dec. 22); (2) range from 7.0-8.0/100,000 during ice growth from 1.1-1.3 m thickness (Jan. 20-Feb. 10); (3) decrease slightly during the remaining growth period. These variations may be considered as due to changes in the effective conductivity related to physical changes and brine distribution in sea ice. A near linear relationship was found between mean daily ice accretion and sea-ice temp gradient.

**RR 76** Record deleted.

**RR 77**
**STRATIGRAPHIC ANALYSIS OF A DEEP ICE CORE FROM GREENLAND.**
Langway, C.C., Jr., May 1967, 130p., AD-655 164, Refs. on p. 104-121.
24-3234
ICE CORING DRILLS, STRATIFICATION, GLACIER ICE, AGE DETERMINATION, ACCUMULATION, CORES, GREENLAND.

A deep rotary core drilling project in 1957 at Site 2 on the Greenland ice sheet (76 deg. 59'N, 56 deg. 04'W) provided ice core to a depth of 411 m. Continuous stratigraphic measurements and observations were made over the upper 110 m of the profile and detailed physical and chemical analyses were made on continuous 1.5 to 3.9-m core increments at 100, 200, 300 and 411-m depths. The average total ionic concentration in the ice sheet ranges between 0.65 and 1.35 mg/liter. The annual global mass deposit of black spherules as calculated from these studies varies from 2.10 x 100,000 metric tons in 700 year old ice to 6.57 x 100,000 metric tons in 12 year old firn. The oxygen isotope ratio variation provides the best means of estimating accumulation at depth. Results of the investigations indicate rates of net snow accumulation of 42.3, 34.2, 37.4, 41.1 and 41.6 g/sq. cm -yr at the surface, A.D. c.1957, c. 1773, c. 1513, c. 1233 and c. 934, respectively. Accumulation data and other physical and chemical evidence allow climatological inferences to be made over the 10-century profile.

**RR 78**
**CLIMATOLOGICAL MEANS AND EXTREMES ON THE GREENLAND ICE SHEET.**
Haywood, L.J., et al, April 1961, 13p. plus 9p. appends., AD-265 060, 22 refs.
Holleyman, J.B.
24-3235
CLIMATOLOGY, GLACIAL METEOROLOGY, WEATHER OBSERVATIONS, GLACIER ICE.

The study is based on available temperature, wind, and precipitation records for 12 stations on the Greenland Ice Sheet for varying periods dating back to 1930. The means of the climatological parameters studied are tabulated, including mean and extreme temperatures for the period of record at each station, the frequency distribution of wind speed and direction, and the precipitation, accumulation, and number of days with snowfall. A climatological map is included which presents a cartographic picture of the overall climatology of the Ice Sheet.

**RR 79**
**NARROW FREE INFINITE WEDGE ON AN ELASTIC FOUNDATION.**
Nevel, D.E., July 1961, 11p. plus 3p. appendix plus 12p. graphs plus 24p. table., AD-277 538, 3 refs.
24-3236
FLOATING ICE, WEDGES, ICE COVER STRENGTH.

The theory of a plate on an elastic foundation will closely predict the radial cracks observed in loading tests on floating ice sheets. However, the plate theory does not predict accurately the circumferential crack which forms ultimately with increased loading. The wedge theory is developed in an attempt to better predict the location and magnitude of the stresses causing the circumferential crack. The results obtained can be applied to help predict the ultimate bearing capacity of an ice sheet, provided the modulus of elasticity and flexural strength of the ice are known.

**RR 80**
**STUDIES OF SALT ICE, I: THE TENSILE STRENGTH OF NACL ICE.**
Weeks, W.F., Aug. 1961, 30p. plus 23p. appends., AD-277 540, Contract DA-11-190-ENG-64, 26 refs.
24-3237
ICE SALINITY, SALT ICE, SEA ICE, TENSILE STRENGTH, ICE COVER STRENGTH.

Ice samples from fresh water and at salinities ranging from 1 - 22 per mill were prepared in a tank designed to simulate the one-dimensional cooling of natural water bodies. Phase and density relations were computed for these salinities in the temperature range 0 to -35C and a determination made of the dependence of ring-tensile strength of the ice samples on temperature, brine volume, NaCl.2(H2O) volume, and thermal history. The results indicate that the strength of fresh water ice is essentially temperature independent in the temperature range -10 to -30C; the strength of ice containing crystals of NaCl.2(H2O) is essentially independent of the temperature of the sample and the volume of NaCl.2(H2O) in the ice. The strength of salt ice at temperatures between -5C and the eutectic point (1-21.2C) decreases with an increase in the volume of brine in the ice and can be considered a unique function of the brine volume, independent of the individual temperature and salinity values. It is suggested that the strength of fresh water ice should be considered as a limit which is approached but not exceeded by salt ice.

**RR 81**
**SETTLEMENT AND TILTING OF FOOTINGS ON A VISCOUS FOUNDATION.**
Kerr, A.D., March 1962, 12p., AD-278 533, 6 refs.
24-3238
SNOW CREEP, VISCOELASTICITY, SNOW PLASTICITY, FOOTINGS, LOADS (FORCES).

The concept of the Pasternak foundation, consisting of the Winkler foundation with shear interactions, is extended to the case of viscoelastic deformation, and the behavior of the foundation subjected to different types of load is studied as a function of time. The differential equation for the vertical surface displacements due to creep is formulated, and solutions for several loading cases are worked out. Two material parameters are also considered - a viscosity parameter related to the shear deformations and a visco-compressibility parameter of the vertical foundation elements. A procedure to determine these parameters is suggested, and the application of the analysis to the creep behavior of snow foundations is discussed.

**RR 82**
**ELASTIC PROPERTIES OF PROCESSED SNOW WITH REFERENCE TO ITS INTERNAL STRUCTURE.**
Nakaya, U., Oct. 1961, 25p., AD-277 541, 8 refs.
24-3239
ELASTIC PROPERTIES, SNOW DENSITY, SNOW ELASTICITY.

Young's modulus was measured as a function of density and age hardening for snow processed by Peter and Snowblast millers during the summer of 1959 at Site 2 located 220 miles E. of Thule near 78 N lat. and altitude 7000 ft. For processed snow, as for naturally compacted snow, a linear relationship exists for Young's modulus density at densities above 0.5 g/cu. cm and an exponential relationship for densities below this value. Thin section studies indicated that the number and size of bonds determine Young's modulus. Bonding begins a few hours after deposition by the snow miller; the bonds develop to approximately 0.2 mm in diam some 20 days after deposition.

**RR 83** Record deleted.

**RR 84**
**EQUILIBRIUM PROFILE OF ICE CAPS.**
Weertman, J., Sept. 1961, 12p., AD-277 542, 13 refs.
24-3240
GLACIER MOVEMENT, VELOCITY.

Nye's theory of the equilibrium surface profile of a two dimensional ice sheet lying on a horizontal bed is modified to include the effect of the presence of a longitudinal stress. It is shown from 2 sample calculations that for a large ice cap, Nye's theory is satisfactory; for a small ice cap (of the order of 30 km in width) it is important to include the longitudinal stress.

**RR 85**
**FROST BEHAVIOR OF SOILS: LABORATORY AND FIELD DATA FOR A NEW CONCEPT. PART 1: VERTICAL SORTING. PART 2: HORIZONTAL SORTING.**
Corte, A.E., July 1961, Sept. 1962, 22p. and 20p., AD-277 543, AD-288 295, Numerous refs.
24-3241
SORTING, FROST ACTION, SOIL FORMATION, FREEZE THAW CYCLES.

Samples of well-graded, sandy gravels were subjected to alternate freezing and thawing cycles under complete saturation and without surcharges. The results indicate that there is a tendency for a heterogeneous mixture of grains to become vertically sorted (fine particles move downward, coarse ones move upward) under repeated freeze-thaw action, when adequate moisture is present, thereby increasing the volume of the mixture. Changes in volume produced by the freeze-thaw cycles are functions of the heterogeneity of the grains in the soil. In the horizontal sorting experiment, fine particles migrated away from the freezing front in a parabolic path. Coarse particles (7.9-10 mm) also migrated away from the freezing front, but to a lesser extent than the fine particles. Soil particles thus tend to become sorted because of a tendency for particles to be excluded from the growing ice. The size most likely to be excluded is the one which can migrate in the pore openings.

**RR 86**
**STUDY OF ICE SINTERING.**
Kuroiwa, D., Feb. 1962, 8p., AD-277 539, 5 refs.
24-3242
ICE SINTERING, THIN SECTIONS, PHOTOMICROGRAPHY, MICROSCOPE SLIDES, ICE BONDS.

The process of sintering of small ice spheres was examined at various temperatures and in different environments by microscopic observation of thin sections. Inference as to the sintering mechanism of small ice spheres was drawn by employing the conventional method used in powder metallurgy. The results obtained indicate that in air saturated with respect to ice the sintering of an ice sphere having a radius of less than 100 microns is mainly due to volume diffusion (a few specimens showed surface diffusion). Sintering was also observed in a kerosine environment, where the vapor phase was completely excluded; there the growth rate of an ice bond was much lower than in air. Further evidence of material flow due to solid diffusion was obtained from the photomicrographs of thin sections of ice bonds. The phenomena known as regelation, adhesion of ice, and ice bonding of snow may then all be explained reasonably in terms of sintering.

**RR 87**
**PLANE PLASTIC DEFORMATION OF SOILS.**
Takagi, S., July 1966, 42p., AD-638 515, 25 refs.
24-3243
PLASTIC DEFORMATION, SOIL MECHANICS, COMPRESSIVE PROPERTIES, ANALYSIS (MATHEMATICS).

A consistent theory of plane plastic deformation of soil is formulated by assuming soil as an ideal material that has constant cohesion and friction angle. Such an ideal soil is an extension of the ideal metal that has, in the terminology of soil mechanics, cohesion only. After a review of the existing theories from which the present theory has emerged, the mathematical expression referred to as the "compression characteristic" is developed. Then the system of differential equations is shown by the theory of characteristic lines. Many mathematical and physical problems remain to be solved before the perfect explanation of the plasticity of ideal soil will be attained.

**RR 88**
**RELATIONSHIP BETWEEN FOUR GROUND PATTERNS, STRUCTURE OF THE ACTIVE LAYER, AND TYPE AND DISTRIBUTION OF ICE IN THE PERMAFROST.**
Corte, A.E., Feb. 1962, 79p. plus maps, AD-281 807, 45 refs.
24-3244
PATTERNED GROUND, ACTIVE LAYER, GROUND ICE, ICE LENSES, ICE WEDGES, GREENLAND—THULE.

Four ground patterns were investigated by means of trenches cut in the outwash near Thule, Greenland: circular and linear depressions in unsorted material, polygonal troughs in unsorted material, sorted circles, and irregular mounds and depressions of low relief formed in unsorted finer grained material. Correlation is made between surface pattern, grain size and structure of the active layer, and type and distribution of ground ice for the patterns investigated. Classification of the active layer as disturbed, slightly disturbed, and undisturbed is based on the condition of primary depositional bedding and the presence or absence of vertical sorting. Fabric analysis of four kinds of ground ice is presented: ice wedge, relict ice, ice mass, and ice lens, as well as analysis of the contact of ice wedges with relict and mass ice. Practical applications, based on the conclusions, are given for the selection of foundation sites and the location of non-frost-susceptible building materials.

**RR 89**
**PHYSICAL PROPERTIES AND INTERNAL STRUCTURE OF GREENLAND SNOW.**
Nakaya, U., et al, Jan. 1970, 32p., AD-702 904, For related article see 23-1997. 21 refs.
Kuroiwa, D.
25-1070
SNOW DENSITY, COMPRESSIVE STRENGTH, SNOW CREEP, PLASTIC DEFORMATION, MICROSCOPE SLIDES, PERMEABILITY.

About 150 snow samples obtained to 26 m depth were measured for elastic modulus, air permeability, unconfined compressive strength, static compression and creep. The observed density profile curve deviated from the theoretical curve at a depth of 10 m. and density of 0.52 g/cu cm. A positive correlation was found between Young's modulus and density, and an inverse correlation between average grain diameter and Young's modulus or density. There were reciprocal correlations between average air permeability and density or unconfined compressive strength, and between the number of grains and their average diameters. Kozeny's constant of Greenland snow was obtained from air permeability values and the length of peripheries of cross sections of grains. To demonstrate the change of internal structure of snow due to densification, static compression tests of snow cylinders were conducted, and thin sections with change of internal structure. Basal slip, buckling, cell or subgrain formation, recrystallization and grain boundary migration occurring during plastic deformation of snow texture were observed by static compression of thin section snow under the microscope.

**RR 90**
**ANALYSIS OF DATA FROM A SNOW PROFILE.**
Waterhouse, R.W., Feb. 1962, 14p. plus appends., AD-278 735, 7 refs.
24-3245
SNOW DENSITY, SNOW PHYSICS, PERMEABILITY, METHODOLOGY, DATA ANALYSIS.

A new method is presented for extracting more meaningful information from snow profile data which will simplify the study of the permeability of snow. Earlier analyses normally employed statistical methods to determine property variations with depth, with the line of mean values established by the method of least squares. The new graphical methods described distinguish the separate effects of densification and thermal metamorphism on permeability, permitting future advances in the analysis. Profile data obtained in 1954 and 1960 are reanalyzed using the new techniques. For a natural polar pack under conditions when no melting occurs and the accumulation is assumed continuous, the following conclusions may be made: permeability for a given density of snow increases with depth and time except possibly near the surface or at depths below 30 m; the rate of permeability change with depth for given densities decreases in a calculable way relative to the density; and, mean permeability changes with depth in a complex manner.

**RR 91** Record deleted.

**RR 92** Record deleted.

**RR 93**
**INVESTIGATION OF SHEAR ZONES IN THE ICE CAP MARGIN THULE, GREENLAND.**
Swinzow, G.K., Feb. 1964, 16p., AD-600 074, 9 refs.
24-3246
GLACIER ICE, MORAINES, SHEAR PROPERTIES, ICE TUNNELS.

The shear moraine phenomenon of glaciers is examined in the light of new evidence collected in the general Tuto area during 1958-1959. The formation and composition of silt bands, some heavy accumulations of boulders and gravel, and streaks of clayey ice exposed during the excavation of two ice tunnels in the margin of the ice cap are described in detail. Surface investigations have furnished information on the location and concentration of the glacial ice-snow-drift ice interface, variations of silt, sand, and rock bands, and other materials produced by the shear surfaces. A general view of the outcropping shear moraines shows a tendency toward a broad arch-shaped pattern, perpendicular to the direction of flow and, in most cases, parallel to the ice edge. Motion measurement between two ice levels is presented in the form of limiting angles on a velocity distribution curve. The indication of great variability in conditions at the edge of the moving ice is discussed in terms of contact zone between the glacier bottom and ground surface, nature of interaction occurring in zones containing glacier-ground surface interface, and mechanics of the migration of inclusion bands which occur during the formation of glacial shear moraines.

**RR 94**
**MECHANISM FOR THE FORMATION OF INNER MORAINES FOUND NEAR THE EDGE OF COLD ICE CAPS.**
Weertman, J., Feb. 1962, 12p., AD-281 708, 23. refs.
24-3247
GLACIER ICE, MORAINES, ICE TEMPERATURE, GLACIAL DEPOSITS, GLACIER ABLATION, MELTWATER.

A new mechanism is described which explains the formation of moraines in the ablation areas of cold ice caps. The mechanism involves the freezing of water onto the bottom surface of an ice cap. This water comes from regions of the bottom surface where the combination of the geothermal heat and the heat produced by sliding of ice over the bed is sufficient to melt ice. A number of criticisms are made of the shear hypothesis, which has been advanced to explain moraines occurring on Baffin Island and near Thule, Greenland. It is concluded that this older hypothesis may be inadequate to account for these moraines. Although in theory the mechanism proposed here undoubtedly would lead to the formation of moraines, the existing field data are insufficient to prove conclusively that actual moraines have originated in this way.

**RR 95**
**COOLING OF AN UNDERSNOW CAMP.**
Yen, Y.-C., et al, Feb. 1962, 17p., AD-281 709.
Bender, J.A.
24-3248
UNDERSNOW FACILITIES, COOLING SYSTEMS, HEAT EXCHANGE, TRENCHING, AIR TEMPERATURE.

An investigation was conducted at Camp Century, Greenland, to study the feasibility of using air wells to cool undersnow structures in the arctic during the summer months. From results obtained during the summers of 1959 and 1960 and late November, 1960, it was found that the air well is a practical and effective means of providing a -20C air supply at volumetric flow rates of 1200 to 1700 cu ft/min. The extent and rate of warming of the snow beneath the trench floor by heat exchange between the air and the snow foundation was found to depend upon trench air temperature, fan capacity, fan arrangement, and casing length. For example, in a well cased to a depth of 17.5 ft and equipped with a 5 hp fan drawing in air at a rate of 1700 cu ft/min, the maximum warming was found to be 12.5C during a 42-day period. Snow temperature differences of about 7C were found between similar trenches with and without a fan installation. The minimum permissible distance between two adjacent fans to eliminate overlap in warming up the snow foundation is approximately 80 ft.

**RR 96**
**QUANTITATIVE DATA FROM A PATTERNED GROUND SITE OVER PERMAFROST.**
Schmertmann, J.H., et al, Feb. 1965, 76p., AD-614 780, 22 refs.
Taylor, R.S.
24-3249
PATTERNED GROUND, ACTIVE LAYER, FROST HEAVE, SOIL MOISTURE, FROST PENETRATION, PERMAFROST PHYSICS, GREENLAND—CAMP TUTO.

Techniques were established by which quantitative data can be obtained from patterned ground features. The field work was carried out during the summers of 1954 and 1955 near Camp Tuto, Greenland. The chemical nature of the soils does not contribute to feature formation; it is the mechanical processes acting on these materials that are important. A sharp rise in the soil water content in the form of ice was consistently noted when passing through the base of the active layer into the present permafrost. A net heave occurred at both feature center and border locations. The magnitude of the heave is about 0.05 ft for the centers and 0.03 ft for the borders. Feature age was estimated to be about 150 yr. Vertical sorting occurs over the entire depth of the active layer but radial sorting is confined to the upper 2 ft. Ground-water flow occurs mostly through the feature borders, and incoming radiation has an important effect on the progression of the frost line. The progression of thaw is very rapid and, by the end of summer, the thaw penetration is greatest under the feature centers.

**RR 97**
**STABILITY OF ICE-AGE ICE CAPS.**
Weertman, J., June 1962, 12p., AD-284 937, 10 refs.
24-3250
GLACIER MASS BALANCE, GLACIER FLOW, SNOWFALL, ABLATION, ICE GROWTH.

The stability of large ice caps is investigated using the present-day theory of the flow of ice in glaciers and ice sheets. The type of instability considered is that first mentioned by Bodvarsson. It is concluded that a small arctic ice cap can become unstable and expand into a large ice-age ice sheet as a result of moderate changes in the regime of the ice cap. A large continental ice cap also can become unstable and shrink to nothing if the snow accumulation is reduced or the ablation rate increased. The results obtained fit well into the Ewing-Donn theory of ice ages. There is the possibility that the inherent instability of ice-age ice caps is in itself sufficient to explain both the formation and disappearance of these ice caps.

**RR 98**
**SALINITY DISTRIBUTION IN YOUNG SEA ICE.**
Weeks, W.F., et al, Feb. 1962, 13p., AD-284 938, 21 refs.
Lee, O.S.
24-3251
SEA ICE, ICE SALINITY, YOUNG ICE.

Studies were conducted at North Star Bay (NW Greenland) during Oct-Nov 1956 to examine the lateral and vertical salinity variation in known types of natural sea ice. Sampling procedures and data analysis are described in detail. The data show that the standard deviation of the salinity values from closely spaced cored samples in sheet ice are always equal or greater than p/m 0.3 per cent. In pancake ice, the standard deviation is usually p/m 1.0 per cent. This uncertainty will produce a standard deviation of approximately p/m 4 to 6 per cent of the total brine volume in the sheet ice and p/m 11 to 19 per cent in pancake ice. This accounts for a considerable portion of the scatter observed in studying the strength properties of sea ice.

**RR 99**
**STUDIES OF THE AGE HARDENING OF PROCESSED SNOW.**
Butkovich, T.R., June 1962, 12p., AD-284 939, 13 refs.
24-3252
SNOW (CONSTRUCTION MATERIAL), HARDNESS, SNOW PHYSICS, SNOW DENSITY, SNOW CREEP, COMPRESSIVE STRENGTH, STRESS STRAIN DIAGRAMS, TEMPERATURE EFFECTS.
A study of how age hardening affects the various mechanical properties of processed snow was made. A description of how the age hardening process is affected by the variables of density, temperature, grain size, and shape is given. An empirical equation relating creep rate to stress, age, and density was obtained. The study also shows that the various mechanical properties are related to age by an exponential function.

**RR 100**
**SIZE DISTRIBUTION AND LIQUID WATER CONTENT OF FOG, NORTHWESTERN GREENLAND.**
Kumai, M., et al, Sept. 1962, 13p., AD-294 195, 10 refs.
Francis, K.E.
24-3253
WATER CONTENT, PARTICLE SIZE DISTRIBUTION, DROPLETS, ADVECTION FOG, RADIATION FOG, GREENLAND.
A microscope-stage fog impactor was designed for the purpose and its collection efficiency was determined both empirically and theoretically. The fog collected on the ice cap has a droplet size range of 1-33 micr radius, a mean radius of 8.6 micr, a mean volume radius of 10.4 micr, a mode radius of 7.3 micr, a predominant radius of 14.7 micr, and a liquid water content of 0.015 g/cu cm. The sea fog at Thule had a droplet size range of 1-31 micr radius, a mean radius of 9 micr, a mean volume radius of 11.0 micr, a mode radius of 7 micr, and a predominant radius of 17 micr. Collections were made at approx. 2-min. intervals during a fog, and a total of 5499 droplets was observed. The volume distribution, concentration, and liquid water content of each collection differed considerably, indicating a variation in the physical properties of the fog with air mass, space, and time. No appreciable variation in the efficiency of the collection method was found.

**RR 101**
**PETROGRAPHIC CHARACTERISTICS OF YOUNG SEA ICE, POINT BARROW, ALASKA.**
Weeks, W.F., et al, Oct. 1962, 11p., AD-294 162, Contract DA-11-190-ENG-64, 17 refs.
Hamilton, W.L.
24-3254
SEA ICE, ICE CRYSTAL STRUCTURE, ICE COVER THICKNESS, SLUSH.
Horizontal thin sections under low magnification of a 31.4 cm-long sea ice core were examined. Important intercrystalline structural features are a systematic increase in crystal size with depth and a fairly constant 2:1 ratio between the length and width of the ice crystals. Similar features are well known from studies of the solidification of metals. The frequency distributions of plate widths, i.e., the distance between the centers of adjacent sub-grains measured parallel to the c-axis, commonly show significant positive skews. The average plate width, increases with increasing depth in the ice sheet. Within the limited range of observations, a strong linear correlation exists between average plate width and the growth velocity of the ice. Plots of sub-plate widths vs sub-plate lengths show an extreme scatter and a slight increase in the modal values of the plate length with increasing plate width. The packings of the subplates in sea ice are compared with packings observed in zinc and are found to be quite similar.

**RR 102**
**CATASTROPHIC GLACIER ADVANCES.**
Weertman, J., Sept. 1962, 8p., AD-292 934, 15 refs.
24-3255
SHEAR STRESS, TEMPERATURE FACTORS, GLACIER SURGES, SUBGLACIAL FACTORS.
A theory is developed to explain catastrophic glacier advances, based on a previously developed glacier sliding theory (Weertman, 1957). It is found that catastrophic sliding is possible when the thickness of the water layer at the bottom of a glacier exceeds the size of the obstacles which normally control the velocity of sliding. The conditions which appear to be necessary for catastrophic advances to occur are: (1) The glacier should be long (10 - 30 km) and its bottom surface should be at the melting point. (2) The water at the glacier bed should flow as a sheet of water with only negligible flow in stream channels. (3) An above-average shear stress (of the order of 2 bar) should act at the bed. Such an abnormal stress could be produced by the arrival of large kinematic glacier waves. (4) The glacier bed should be smoother with respect to large protuberances and obstacles than to small hindrances. The theory can be applied to explain the rapidly fluctuating velocity changes observed in ordinary glaciers. Kinematic water waves in the water layer at the bottom of a glacier can produce rapidly changing fluctuations in the surface velocity of the glacier.

**RR 103**
**EFFECTIVE THERMAL CONDUCTIVITY OF VENTILATED SNOW.**
Yen, Y.-C., Feb. 1963, 14p., AD-414 952, 9 refs.
24-3256
SNOW COVER, THERMAL CONDUCTIVITY, HEAT TRANSFER.
The effect of air flow on the thermal conductivity of snow was investigated. Steady-state temperature measurements were made along the edge and axis of a cylindrical bed of snow to determine the effective axial thermal conductivity of snow. Unconsolidated snow samples were used, with densities ranging from 0.376 to 0.472 g/cu cm and corresponding snow particle sizes of 0.065 to 0.219 cm nominal diameter; the mass flow rates employed ranged from approximately .001-.004 g/sq cm/sec. Snow density and sample size apparently have opposite effects on the effective thermal conductivity because of the flow of fluid in snow. The test apparatus is described in detail and is illustrated. The results of the experiments are tabulated, and a least square equation is given which represents the results well.

**RR 104**
**OPERATION COLD DECK: A COLD REGIONS AERIAL INFRARED SENSING PROGRAM.**
Michigan. University. Institute of Science and Technology, July 1962, 93p., AD-330 231, Project Michigan Rept. No. 2900-319-T. 16 refs.
U.S. Army Signal Corps.
26-3618
AERIAL RECONNAISSANCE, INFRARED EQUIPMENT.
A coordinate program of simultaneous airborne and ground measurements in the thermal region of the spectrum was conducted in the subarctic environment of the Keweenaw Peninsula in northern Michigan. The research program was primarily intended to determine the usefulness of airborne infrared sensors in analyzing cold terrain, detecting undersnow structures, calculating the effects of environmental parameters, and detecting vehicles in various states of activity. Results show that under certain conditions the sensors are extremely useful for all these purposes. This report provides extensive data on the effects of various weather parameters on the imagery of man-made and natural structures, and the appearance of these structures against a low temperature background.

**RR 105**
**VERTICAL MIGRATION OF PARTICLES IN FRONT OF A MOVING FREEZING PLANE.**
Corte, A.E., Jan. 1963, 8p., AD-295 985, 2 refs.
24-3257
INTERFACES, PARTICLE MIGRATION, FREEZING RATE.
A principle of particle segregation by freezing is demonstrated experimentally by means of a transparent freezing cabinet in which a sample of distilled water freezes from the bottom upward so that the freezing front travels vertically and the particles are carried against gravity. It was demonstrated that an important factor in particle migration is the shape of the particle or its contact area with the interface. Other important factors are particle size and rate of freezing. Fine particles migrate under a wide range of rates of freezing; coarser particles migrate at slower and narrower ranges of rates of freezing. Freezing from the bottom more closely approximates freezing of the active layer above permafrost than freezing from the top down, and also eliminates friction with the cylinder testing wall.

**RR 106**
**HEAT TRANSFER CHARACTERISTICS OF VENTILATED SNOW.**
Yen, Y.-C., Jan. 1965, 8p. plus appends., AD-611 019, 4 refs.
24-3258
HEAT TRANSFER, SNOW HEAT FLUX, VAPOR DIFFUSION, THERMAL CONDUCTIVITY.
A method of evaluating the effect of air flow on the rate of heat transfer due to vapor transfer is developed. Cold room snow samples screened for densities of 0.376 to 0.472 gm/cu cm were used in snow beds where measurements of the steady-state temperature distribution were taken and the weight loss of the snow sample obtained at the completion of each experimental run. The essential part of the experimental apparatus is shown. The experimental technique consists of determining the effective diffusivity of water vapor through snow, which is subsequently used to calculate the contribution of heat transfer through the mechanism of vapor diffusion. When there is no air flow through snow, vapor transfer portion contributes about 7.5 per cent of the total value of the effective thermal conductivity of snow. When the pore velocity reaches about 1.3 cm/sec, vapor transfer is about 19 per cent of the effective thermal conductivity of snow. Vapor transfer hence, significantly affects the processes of heat transfer in a natural snow cover.

**RR 107**
**FORMATION OF LAKE ICE IN A TEMPERATE CLIMATE.**
Ragle, R.H., Aug. 1963, 22p., AD-433 794, 13 refs.
24-3259
LAKE ICE, ICE FORMATION, ICE CRYSTAL STRUCTURE, ICE CRYSTAL SIZE.
The formation of lake ice in a temperate continental climate was studied during the winter of 1956-1957 at Post Pond, Lyme, New Hampshire. In the thirty-six blocks of ice studied, four textures and three structures were observed. The textures, tabular, columnar, granular, and crenulate, are discussed in terms of relative growth velocity. The structures were Forel striations, Tyndall figures, and bubbles. Strain shadows, a structural feature, were also observed. The average crystal area increased with increasing ice thickness. Generally the rate of increase was greater toward the center of the lake. However, within a pronounced bubble layer, which was continuous through a horizontal plane in the lake-ice sheet, the average crystal area ceased to enlarge. The lake-ice sheet grew both from the top and bottom with individual crystals growing most rapidly in the direction of their a-axes. Downward growth was by crystals which had the plane of their a-axes approximately vertically oriented. These crystals grew rapidly, eliminating those crystals whose a-axes were less favorably oriented. The upward ice growth was caused by water flowing on the original upper ice surface and freezing.

**RR 108**
**THEORY OF DENSIFICATION OF DRY SNOW ON HIGH POLAR GLACIERS, II.**
Bader, H., Sept. 1962, 18p. plus appends., AD-294 158, For Part I see 24-3227. 5 refs.
24-3260
SNOW DENSITY, VISCOSITY, SNOW LOADS, STRESS ANALYSIS, METAMORPHISM (SNOW), ANALYSIS (MATHEMATICS).
The theory of snow densification is further developed on the basis of an exponential relation between viscosity and density. A linear relation between load-stress and strain rate is not valid for high stresses, and is replaced by a hyperbolic sine function. An empirical function is given for the temperature cycle correction. Two equations are derived for calculating depth-density curves with computers, and a simplified one for use with desk calculators. Instructions are given for determination of function parameters from field data. Four depth-density curves for Greenland and Antarctic locations are computed and graphed to show that the theory is useful.

**RR 109**
**CONTINUITY IN FOUNDATION MODELS AND RELATED PROBLEMS.**
Kerr, A.D., June 1965, 15p., AD-619 343, 19 refs.
24-3261
FOUNDATIONS, SURFACE MIGRATION, VISCOELASTICITY, ANALYSIS (MATHEMATICS).
The present paper contains a critical study of a number of foundation models suggested by various investigators, as well as a further development of some of the ideas involved. It is found that the model by Pasternak is the most natural extension of the Winkler foundation. It is also shown that the "nonsolvability" of the problem of a finite beam or plate resting on a continuous foundation as posed by Wieghardt and further elaborated by Pflanz is not correct, and that problems of this type are solvable for any load distribution permissible in classical plate theory. The paper concludes with derivations of differential equations for plates resting on viscous and viscoelastic foundations, which may be used for solving problems involving compacted snow and permafrost bases.

**RR 110**
**REFLECTION AND TRANSMISSION COEFFICIENTS AT THE INTERFACE ICE-SOLID.**
Roethlisberger, H., May 1964, 17p., AD-602 414.
24-3262
COEFFICIENTS, REFLECTION, TRANSMISSION, ICE SOLID INTERFACE, COMPUTER APPLICATIONS.
Nafe's (1957) presentation of reflection and transmission coefficients at a solid-solid interface was used to compute tables for the case of ice in contact with another solid at a plane interface. Energy ratios of all the combinations of reflected and refracted plane P and S waves were computed for 30 different cases of the second solid. A compressional velocity of 3.6 km/sec, a density of 0.9 g/cu cm, and a value of one-third for Poisson's ratio were assumed for the ice. For the other solid, the velocity ranged from 1.2 to 6.0 km/sec, the density from 1.5 to 3.0 g/cu cm, and Poisson's ratio from 0 to one-third. The computations were carried out with an electronic computer, and the results are presented graphically.

**RR 111**
**VISUAL RESOLUTION AND OPTICAL SCINTILLATION OVER SNOW, ICE, AND FROZEN GROUND. PARTS I AND II.**
Portman, D.J., et al, April 1964, Oct. 1965, 32p. plus 61p. appends.; 44p., AD-600 926, AD-630 603, 39 refs.
Ryznar, E., Elder, F.C., Noble, V.E.
24-3263
OPTICAL PROPERTIES, ICE OPTICS, FROZEN GROUND, SCINTILLATION, VISUAL RESOLUTION, SNOW OPTICS.
Optical scintillation, visual resolution, and wind and temperature profiles were measured over snow, ice, and frozen ground. The data were analyzed to determine relationships between scintillation and meteorological and surface conditions independent of time of day. Principal results of the analysis of the resolution data obtained over snow and frozen ground showed that, for turbulent flow in stable stratification, visual resolution (1) deteriorated systematically as the vertical temperature gradient increased, (2) deteriorated with clear skies as the wind speed increased up to about 5 mph and then improved at higher wind speeds, and (3) was optimum and nearly independent of wind speed during low overcast cloudiness. Over a snow-free ice surface and with air temperatures below freezing, only minor scintillation was observed.

**RR 112**
**AGE HARDENING OF SNOW AT THE SOUTH POLE.**
Gow, A.J., et al, Nov. 1964, 19p., AD-614 430, 15 refs.
Ramseier, R.O.
24-3264
SNOW COMPACTION, HARDNESS, COMPRESSIVE STRENGTH, SNOW (CONSTRUCTION MATERIAL), ANTARCTICA—SOUTH POLE.
The age hardening of artificially and naturally compacted snow has been investigated at the South Pole. Results show that the age-hardening process is greatly retarded at low temperatures. Artificially compacted samples of density 0.55 g/cu cm attained a compressive strength of less than 3.0 kg/sq cm after one year's aging at -49C. Exposure to solar radiation accelerated the age hardening. Irradiated samples attained a strength of 6.0 kg/sq cm after 100 hr, increasing to a virtual maximum of 8.0 kg/sq cm at 600 hr. Compressive strengths increased with a decrease in snow-particle size and with an increasing angularity of the particles. Below 3 m the strength of naturally compacted snow was found to increase rapidly with an increase in density. Thin-section studies show that age hardening can be correlated with the formation and growth of intergranular bonds, and that bond growth falls off rapidly with decreasing temperature. In view of the low strength found in both naturally and artificially compacted snow at the South Pole, "cut-and-cover" undersnow camp construction may not prove practical at the South Pole.

**RR 113**
**STRUCTURAL CONTROL OF THE VERTICAL VARIATION OF THE STRENGTH OF SEA AND SALT ICE.**
Weeks, W.F., et al, April 1964, 16p., AD-602 458, 18 refs.
Assur, A.
24-3265
SEA ICE, ICE COVER STRENGTH, SALT ICE, BRINE DISTRIBUTION.
The vertical variation in the strength of sea ice was studied by using data from NaCl ice which shows a structural similarity to sea ice and has straightforward phase relations. Nested horizontal thin sections were prepared at sever. different levels below the surface of the test NaCl ice sheet and the plate spacing and the distance between centers of adjacent brine layers measured parallel to the c-crystallographic axis were determined. The measurements show that the plate spacing is a linear function of the sixth root of the distance below the upper ice surface (z). Available values of the same parameter for natural sea ice are in good agreement with this relation. Equations giving the dependence of the ring-tensile strength of the ice on z are developed. It is demonstrated that in NaCl ice sheets the systematic increase in the plate width with depth produces significant changes in the ring-tensile strength of the ice. Field tests previously performed indicate that similar relations hold for sea ice.

**RR 114**
**PROPERTIES OF ICE. PART II.**
Camp, P.R., Nov. 1963, 38p., AD-600 883, For Part I, see 24-3226. 19 refs.
24-3266
ICE CRYSTAL GROWTH, ICE DIELECTRICS, ICE THERMAL PROPERTIES.
Modifications are reported of a previously described apparatus for the preparation of single crystals of pure and doped ice. Some results of using this apparatus to grow crystals of several crystallographic orientations are discussed. An effect of an electric field on the nucleation of ice at a metal-water interface is described. Various X-ray techniques for investigating the quality of ice crystals are discussed and experimental results of applying them to Alaskan Glacier crystals are given. Dielectric relaxation and electrical conductivity of ice are discussed. Experiments have been performed to determine the effect of length of the sample and to study the effect of small amounts of NH4F as a substitutional impurity. Special attention is given to long period dielectric processes. At least two such processes seem to be present, one which dominates the first 3 to 30 seconds of discharge and the other which determines the long time behavior. The possibility of altering the conductivity and dielectric relaxation of ice by optical generations of Bjerrum defects is explored and experiments to test this possibility are reported.

**RR 115**
**STRUCTURES IN THE UPPER SNOW LAYERS OF THE SOUTHERN DOME GREENLAND ICE SHEET.**
Davis, T.C., Jr., Oct. 1964, 22p., AD-452 460, 26 refs.
24-3267
SNOW SURVEYS, TRAVERSES, STRATIGRAPHY, METEOROLOGICAL FACTORS.
Between 1 July and 7 Aug 1960, measurements of snow accumulation, temperature, density, ram hardness, and grain size were made at 7 pit studies along 191 mi of over-snow traverse. Additionally, 38 Rammsonde profiles were measured and 166 shallow pits were dug to measure temperature in the first meter of snow. The annual accumulation of snow was found to decrease westward, from 97 cm water equivalent 50 mi from the east coast to 40 cm 80 mi from the western margin. A possible precipitation shadow and the decrease in accumulation westward indicated that the source area for the precipitation lies to the east of the southern dome in the Greenland Sea. The study was considered to be in the percolation facies located along an east to west traverse crossing at maximum dome elevation. The daily heat exchange in the first meter of snow, near the time of maximum melt conditions, was 20-35 cal/sq cm. Effective values of thermal conductivity and diffusivity, were determined from the temperature curves with no attempt to isolate radiation and convection.

**RR 116**
**SOME PHYSICAL AND MECHANICAL PROPERTIES OF POLAR SNOW.**
Ramseier, R.O., Feb. 1966, 22p., AD-631 685, 21 refs.
24-3268
SNOW PHYSICS, PHYSICAL PROPERTIES, MECHANICAL PROPERTIES, COMPRESSIVE STRENGTH, SNOW DENSITY, PERMEABILITY.
Specimens of snow from the South Pole were tested to investigate air permeability, ultimate compressive strength and dynamic Young's modulus as a function of density. Anisotropy in a single layer of snow (snow between two summer crusts) was found in all three properties. Comparison with data for snow from Site II, Greenland, showed an empirical relation for both areas. Air permeabilities are different at the two sites because of time and meteorological effects.

**RR 117**
**OPERATOR VARIANCE IN THE DETERMINATION OF THE PLASTIC LIMIT.**
Ballard, G.E.H., et al, Sept. 1963, 8p., AD-433 188, 4 refs.
Weeks, W.F.
24-3269
PLASTICITY TESTS, EXPERIMENTAL DATA, OPERATOR VARIANCE.
An experiment designed to investigate operator variance in determining the plastic limit of cohesive soils, independent of sample preparation and hydration time, is reported. A standard sample of "Grundite" and pure silt was prepared, the sample was hydrated for 3 weeks, 5 random samples were taken, and 5 replicates performed on each sample. Analysis of variance showed that the sample was homogeneous at the 0.05 level of significance. Random samples were distributed to 5 zones (groups) of operators, each with different backgrounds and engineering interests. Two operators from each group performed 5 replicates. No correlation was found between an operator's internal variance and has deviation from the grand mean. There was no reason to doubt that an "untrained operator" can produce satisfactory data. The major factor contributing to the total sample variance was the inconsistency between the individual operators, who could duplicate their own determinations but did not call the same end point.

**RR 118**
**CIRCULAR PLATES ON ELASTIC, SEALED FOUNDATIONS.**
Nevel, D.E., Dec. 1963, 14p., AD-434 084, 2 refs.
24-3270
ICE COVER STRENGTH, LOADS (FORCES), ANALYSIS (MATHEMATICS).
The observation that newly frozen ice sheets, resulting from pools of water freezing over, support more than would be predicted by ordinary theory is assessed. A solution is presented for a circular plate on an elastic, sealed foundation. Graphical results are shown for supports at the circumference of the plate. Graphs to obtain moments in a circular plate on an elastic bearing surface, using a sealed or unsealed foundation, are compiled for fixed and simple supports. In reality the foundation may not be completely sealed, calling for discretion in selecting the actual moment. The ability of the refrozen ice sheet to support the extra load is explained by the fact that the water has been sealed between the surface and main sheet of ice and the volume occupied by the water cannot change.

**RR 119**
**DYNAMIC RESPONSE OF SNOW TO HIGH RATES OF LOADING.**
Napadensky, H., March 1964, 24p. plus append., AD-600 075, 12 refs.
24-3271
WAVE PROPAGATION, STRESS ANALYSIS, SNOW LOADS, ICE LOADS, EXPLOSION EFFECTS, SNOW PLASTICITY, HYDRODYNAMICS.
An experimental investigation of stress-wave propagation in snow and ice is described. Seven types of Greenland snow were investigated to determine the extent to which the variation in dynamic response of the snow is a function of snow types, and were compared with results of similar Michigan snow experiments. A low-density explosive charge was detonated, sending a steep-fronted shock wave through a metal transfer plate and into the snow sample, compressing the snow and setting it in motion. Measurements were made on shock waves with amplitudes of less than 200 atm. Density and pressure behind the wave fronts were determined by simultaneous measurement of wave-propagation and particle velocity as limited by the fast elastic wave and the slow plastic wave of the two-front structure. Values calculated by the Rankine-Hugoniot jump conditions determined the point at which the material behaves plastically or hydrodynamically. The maximum stable pressure-volume states that snow can reach under shock loading are also shown. Sources of scatter in the results from variations in snow type and errors in data reduction and geometry changes are pointed out.

**RR 120**
**STRESS AND WAVE PATTERNS IN SOILS SUBJECTED TO DYNAMIC LOADS.**
Bernhard, R.K., March 1967, 52p., AD-652 871, 44 refs.
24-3272
SOIL MECHANICS, SHEAR STRESS, STRESS ANALYSIS, VIBRATORY LOADS.
The report is divided into four parts: Parts I and II cover investigations of the reliability of shear stress measurements in soils subjected to vibratory loads for biaxial and triaxial systems, respectively. Part I is a summary only (see USA CRREL Technical Report 90, 24-3072, for detailed treatment). Part III is a study of three-dimensional "principal" stress patterns produced in soil subjected to vibratory loads. Part IV is a theoretical analysis of some aspects of soil wave propagation in stratified soil. From the measurements of five shear stresses and one normal stress, the stress distribution of a triaxial system can be determined. In noncohesive soils triaxial stress fields due to vibratory loads can be determined by recording six independent stress components. Sinusoidal force excitation and impact excitation yield time-distance graphs which can be used to determine reflection and refraction techniques in stratified soils.

**RR 121**
**ICE FOG: LOW TEMPERATURE AIR POLLUTION.**
Benson, C.S., June 1970, 116p., AD-708 544, Bibliography p.111-116.
25-1861
ICE FOG, AIR POLLUTION, ICE CRYSTALS, TEMPERATURE INVERSIONS.
Stable pressure systems over interior Alaska sometimes produce prolonged, extreme (below -40C) cold spells at the surface. Radiation fogs formed during the onset of cold spells are generally of short duration because the air soon becomes desiccated. These fogs consist of supercooled water droplets until the air temperature goes below the "spontaneous freezing point" for water droplets (about -40C); the fog then becomes an ice crystal fog, or simply "ice fog." The polluted air over Fairbanks allows droplets to begin freezing at the relatively high temperature of 35C. Between -35 and 40C the amount of water vapor condensed by freezing a supercooled water droplet is 3 to 5 times greater than the amount condensed by 1C of cooling at these temperatures. This results in rapid and widespread formation of ice fog which persists in the Fairbanks area as long as the cold spell lasts.

**RR 122**
**METHOD OF DETERMINING DYNAMIC PROPERTIES OF VISCO-ELASTIC SOLIDS EMPLOYING FORCED VIBRATION.**
Lee, T.-M., Nov. 1963, 10p., AD-434 085, 7 refs.
24-3273
DYNAMIC PROPERTIES, VISCOELASTICITY, VIBRATORY LOADS, ANALYSIS (MATHEMATICS).
The dynamic properties of visco-elastic solids are evaluated by using the forced longitudinal and torsional vibration techniques. A method of eliminating experimental difficulties due mainly to the coupling of sample with supporting system is introduced in using the maximum amplitude ratio of the free end of a sample to the end attached to a driver and the corresponding vibration frequency as a criterion. Experimental measurements of these values are sufficient to determine the dynamic properties of samples. The complex modulus is used to describe the stress-strain relationship for a visco-elastic solid. In the method presented, matching of natural frequencies of the sample and the driver is not necessary and the same driving unit may be used throughout the experiment. The expressions derived for longitudinal and torsional vibrations bear direct relationship between the measured items and the dynamic properties and are simple to use.

**RR 123**
**ICING AND SNOW ACCRETION ON ELECTRIC WIRES.**
Kuroiwa, D., Jan. 1965, 10p., AD-611 750, 5 refs.
24-3274
ICE ACCRETION, ICE LOADS, METEOROLOGICAL FACTORS, POWER LINE ICING, SNOW ACCRETION, GLAZE, RIME, ELECTRICAL HEATING.
Experimental data on icing and snow accretion on electric wires and antennas is presented. The accumulation of supercooled droplets on a single wire stretched in an air flow has been calculated as icing in the form of soft rime, hard rime, and glaze, per unit time and unit length of wire. The difference between calculated values and observed values in Japan is discussed in terms of ice deposit, wire tension, and wind velocity and pressure. Iced wire will be cut more often by dynamic wind pressure than by the deposited ice load. The differences between icing and accretion of snow are discussed, the wire failures being attributed to the heavy weight of snow accretion. This phenomenon will be less frequent in polar regions than in temperate regions because the main cause of snow accretion—existence of liquid-water film on the surface of snow flakes—is less prevalent. A simple experiment for anti-icing an electric wire by means of electrical heating is briefly described.

**RR 124**
**AN INVESTIGATION OF SPECIALIZED WHITEOUT SEEDING PROCEDURES.**
Mee, T.R., Jr., et al, March 1963, 11p. plus appends., AD-414 539, 19 refs.
Eadie, W.J.
24-3275
WHITEOUT, CLOUD SEEDING, NUCLEATING AGENTS, DRY ICE (TRADEMARK), FALL DISTANCE, WEATHER MODIFICATION.
Phase I of Project Whiteout was conducted in North Greenland to determine the extent to which whiteouts could be modified. Phase II is a laboratory experiment to develop specialized whiteout-dissipation procedures. Findings indicate that a "stationary" seeding technique may modify supercooled clouds and fogs in the -5C to 0C range and the use of low-density, high drag flakes or pellets of dry-ice may permit an extension of conventional aircraft seeding techniques to warmer temperatures. Several types of seeding vehicles were examined, including drone aircraft, mortar shells, rockets, and standard aircraft. A mechanism for the conversion of liquid CO2 into dry-ice pellets was conceived for use in emergency-seeding aircraft devices.

**RR 125**
**LAMINAR HEAT TRANSFER OVER A MELTING PLATE - THE MODIFIED LEVEQUE PROBLEM.**
Yen, Y.-C., et al, Jan. 1964, 10p. plus appends., AD-435 609, 3 refs.
Tien, C.
24-3276
HEAT TRANSFER, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS), ICEBERGS, FREEZING, MELTING.
Heat transfer in a system consisting of a fluid flowing over a melting plate composed of the same material as the fluid was investigated. The test model is similar to the heat transfer phenomenon occurring when an iceberg drifts in warm sea water. The flow of a liquid, initially at a uniform temperature, over a flat plate composed of the solid phase of the flowing liquid at constant temperature was assumed. For simplification of subsequent analysis the flow was stipulated as the Leveque type. The temperature distribution in the flowing fluid is determined; melting at the interface is shown to result in a decrease in the Nusselt number; consideration is given to the practical application of the results; and a simple numerical calculation of the melting rate of ice is given.

**RR 126**
**ULTRASONIC PULSE MEASUREMENTS IN ANISOTROPIC LAKE ICE.**
Roethlisberger, H., July 1966, 21p., AD-642 110, 16 refs.
24-3277
LAKE ICE, ULTRASONIC TESTS, ANISOTROPY, ICE COVER THICKNESS.
Travel-time measurements of ultrasonic pulses were carried out in March 1960 on Lake Superior (Keweenaw Bay) near Baraga, Mich. The ice was about 45 cm thick and consisted of grains with vertical c-axis orientation with the exception of a surface layer of variable thickness. Ultrasonic pulses were transmitted and received by barium titanate cells of cylindrical and spherical shape. The transducers were mounted at the surface and the distance was varied. A number of direct and reflected signals could be identified. Of the reflected events, the PS type were by far the clearest and strongest of distances many times the ice thickness, and thus best suited for ice thickness determination. In order to obtain satisfactory agreement between theoretical and measured travel times the anisotropy of the ice had to be taken into account. The elastic constants determined by Bass et al. (1957) gave reasonably good agreement between computed and measured travel times, but some discrepancies remain to be explained. Part of the observed reflections occurred on cracks in the ice. Using equipment with approx 100-kc signals the ice thickness was determined by the ultrasonic pulse method, destruction free, with an accuracy of 2-4 cm or 5-10 per cent. For day-to-day comparisons the relative accuracy would be in the order of 0.5 cm.

**RR 127**
**CRITERIA FOR MEASUREMENT OF STRAIN RATES IN DEEP BORE HOLES IN POLAR GLACIERS.**
Bader, H., Dec. 1964, 9p., AD-614 781, 2 refs.
24-3278
BOREHOLES, STRAIN RATE, GLACIER ICE, GREENLAND—CAMP CENTURY, ANTARCTICA—BYRD STATION.
The different components of vertical strain rate are discussed, as well as their relation to horizontal strain rate. Based on a simplified model, strain rates as a function of depth below the surface are calculated for Camp Century, Greenland and Byrd Station, Antarctica. The results indicate that only very high measurement accuracy is likely to yield useful results. Measurement of horizontal shear rate is also discussed.

**RR 128**
**FORCES ON A SPHERE ACCELERATING IN A VISCOUS FLUID.**
Odar, F., March 1964, 18p. plus 11p. appends., AD-602 777, 25 refs.
24-3279
FLUID DYNAMICS, PARTICLE PATHS, SPHERE MOTION, REYNOLDS NUMBERS.
A study of the determination of the forces exerted by a fluid due to the relative velocity and acceleration of a sphere is presented, and previous work on rectilinear motion of bodies in a still fluid and the rectilinear motion of a fluid past fixed objects is reviewed. Experimental procedure, equipment, and tests are described. A formula is given for determining the resisting forces acting on a sphere moving rectilinearly in a viscous fluid, in terms of sphere radius, fluid density and viscosity, object velocity in the fluid, object acceleration, and force coefficients. The latter were determined experimentally by measuring the forces on a sphere moving sinusoidally within the range of Reynolds numbers from zero to less than 62.

**RR 129**
**ICE PREDICTION CURVES FOR LAKE AND RIVER LOCATIONS IN CANADA.**
Bilello, M.A., July 1964, 12p. plus 41p. appends. and graphs, AD-445 874, 8 refs.
24-3280
LAKE ICE, RIVER ICE, ICE FORECASTING, AIR TEMPERATURE, ICE FORMATION.
From the relationship between mean daily air temperatures and the date of ice formation, a series of curves was developed to provide an operational method for predicting ice formation at 1 bay, 10 lake, and 17 river locations. Fort Good Hope is used as an example in this report. The first appearance of ice in the fall and the date of complete ice coverage are considered. To apply the curves, an adjusted temperature record, based on a numerical constant (N) and mean daily air temperatures, is maintained starting in early summer. Subsequently, this daily-adjusted temperature is applied to the family of curves to provide a day-to-day forecast of the date of ice formation. The N-values indicate some geographic similarities. For stations where computations were made for both first-ice and freeze-over, the N-values are correlated.

**RR 130** Record deleted.

**RR 131**
**INTERNAL FRICTION OF H2O, D2O AND NATURAL GLACIER ICE.**
Kuroiwa, D., Jan. 1965, 45p., AD-615 732, 19 refs.
24-3281
GLACIER ICE, INTERNAL FRICTION, ICE CRYSTALS, IMPURITIES.
The three parts of this report are entitled (1) internal friction of pure H2O, D2O and doped ice crystals, (2) internal friction at crystal boundaries, and (3) the internal friction of natural glacier ice. Part 1 uses the flexural vibration method and expresses internal friction as a logarithmic decrement of free oscillation. Equations are given for the logarithmic decrement, internal friction, and the resonant frequency of a rectangular bar. In Part 2 the grain boundary internal friction of ice grown from a melt was measured by cutting blocks containing individual crystal boundaries from polycrystalline ice and inlaying these in single crystal bars. This friction depends upon concentrated chemical impurities. In Part 3 the internal friction of glacier ice was measured in specimens from Antarctica, Greenland, and Le Conte Glacier, Canada. Distinctively different curves were obtained for the specimens. These differences can be attributed to (1) environmental conditions at the time of formation, and (2) the environmental conditions that acted on the sample from the time of formation until the time of sampling.

**RR 132**
**VIBRATION OF SPHERE FOR DETERMINING THE DILATATIONAL CONSTANTS OF VISCOELASTIC MATERIALS.**
Lee, T.-M., Feb. 1964, 7p., AD-435 610, 6 refs.
24-3282
VISCOELASTIC MATERIALS, DILATATIONAL CONSTANTS, FORCED VIBRATION, ANALYSIS (MATHEMATICS).
The forced vibration problem of a finite sphere with an exciting source embedded inside it has been treated. The source is assumed to oscillate sinusoidally and the complex dilatational modulus is used to describe the motion inside the sphere. It is found that if the outer surface of the sphere is restrained from radial displacement, the ratio of the amplitude of a mid-point (between the outer surface of the sphere and the inner exciting source) to the amplitude of a point on the exciting source could be used as an indication of the dilatational properties of the sphere. Therefore, from the criterion of maximum amplitude ratio in connection with the frequency, the dilatational properties of a testing material can be determined. This method can be applied to visco-elastic fluids as well as solids.

**RR 133** Record deleted.

**RR 134**
**PROFILE AND HEAT BALANCE AT THE BOTTOM SURFACE OF AN ICE SHEET FRINGED BY MOUNTAIN RANGES.**
Weertman, J., May 1964, 7p., AD-446 743, 10 refs.
24-3283
GLACIER FLOW, GLACIAL FEATURES, ICE TEMPERATURE, HEAT BALANCE, ICE COVER THICKNESS.
The profile of an ice sheet surrounded by mountains is calculated and, by means of heat balance considerations, the pressure melting point conditions of the bottom ice are examined. A circular ice sheet and an ice sheet which is infinitely long in one direction are considered. The approximate profile of the whole ice sheet is obtained by adding the profiles calculated for 3 regions: an outer glacier, drainage basin on the ice sheet at the head of each outlet glacier, and from the center of the ice cap to the drainage region of each outlet glacier. The fact that the heat lost down the temperature gradient is of the same order as the geothermal heat and the heat of sliding, makes it difficult to determine whether or not the bottom of the ice sheet is at the melting point at a particular location, causing uncertainty in profile calculation. It is concluded that the profile of an ice sheet is little influenced by the presence of encircling mountains, and that the bottom temperature of immature outlet glaciers ordinarily should be at the pressure melting point, thus enabling such glaciers to erode their beds.

**RR 135**
**GROWTH, STRUCTURE, AND STRENGTH OF SEA ICE.**
Assur, A., et al, Oct. 1964, 19p., AD-450 186, 26 refs.
Weeks, W.F.
24-3284
SEA ICE, ICE GROWTH, PHYSICAL PROPERTIES, ICE COVER STRENGTH.
The freezing interface determines the basic characteristics of salt ice. As the platelets composing the individual crystals of salt-ice grow, impurities such as salt are rejected by the ice crystals and diffuse away from the platelets. The freezing point is lowered within the diffusion cloud preventing other platelets from growing in the vicinity. As a result, the plate spacing decreases with increasing growth rate. The physical constants involved are the diffusion coefficient of salt in water, and the roughness of the freezing interface. Several solutions to the problem of developing a general relation using only physical parameters are considered. The strength of sea ice is shown to depend upon past weather history. The relations allow the determination of sea-ice strength and explain observed discrepancies between properties of sea ice in various geographical areas.

**RR 136**
**A SEMI-INFINITE PLATE ON AN ELASTIC FOUNDATION.**
Nevel, D.E., March 1965, 12p. plus 2p. appendix, AD-616 313, 7 refs.
24-3285
FLOATING ICE, ICE COVER STRENGTH, STRESS ANALYSIS.
The solution of the problem of a semi-infinite plate on an elastic foundation is presented. This problem occurs when a load is applied near the edge of a floating ice sheet. The equations are evaluated for an edge load, and the results are given in graphical form for the following: (a) the maximum deflection which occurs at the edge under the load, (b) the movement which causes the initial cracking of the plate, (c) the distance from the edge that the circumferential crack will occur, and (d) the moment that causes the circumferential crack. The same method of solution can be applied to an infinite strip on an elastic foundation with any combination of simple, rigid, or free support at the edges.

**RR 137**
**A THEORY OF SNOW FAILURE.**
Ballard, G.E.H., et al, Aug. 1965, 9p., AD-XL 624 198, 6 refs.
McGaw, R.
24-3286
SNOW STRENGTH, POROSITY, SNOW MECHANICS.
A failure theory for dry snow is based on the supposition that the nature of ice at the temperatures found in natural snow will cause stress concentration at a pore boundary to be minimized. External stresses will therefore tend to be uniformly distributed across constricted areas of solid substance. Failure is considered to occur when the available solid substance is stressed to its ultimate strength which is taken to be a function of temperature and type of failure, i.e., tension, compression, or shear. Failure strength and the effective porosity on a potential failure surface is shown to be generally higher in value than the bulk porosity n, leading to the conclusion that there will be some upper limiting bulk porosity for which which the potential failure surface approaches unity and the failure strength approaches zero. This limiting porosity appears to be related to dense packing. Published experimental data for -10C appear to verify the validity of the equation for natural snow, showing the proposed linearity to be reasonable and predicting reasonable values for the ultimate strength. For these data the limiting bulk porosity is nearly constant at 0.56.

**RR 138**
**CONFINED CREEP TESTS ON POLAR SNOW.**
Mellor, M., et al, Feb. 1965, 8p., AD-613 043, 8 refs.
Hendrickson, G.
24-3287
SNOW CREEP, SNOW DENSITY, SNOW PLASTICITY.
Snow was sampled from various depths below the surface of the ice sheet at Byrd and Amundsen-Scott Stations, Antarctica. The samples were obtained either by sawing blocks from trench and tunnel walls or by coring with the CRREL hand auger. The creep specimens were introduced into their stainless-steel cylinders by "screwing" the saw-edged cylinders into larger sample blocks. The cylinders were standard CRREL snow-sampling tubes, lined with silicone grease to reduce friction and adhesion. The tubes were set vertically on a bench, and pressure was applied axially with a loose piston loaded by a guided yoke, deformations being read periodically from dial micrometers. The mechanics of creep is discussed and the data are tabulated and graphed with respect to temperature and density effects. At the lower densities, the compressive viscosities are in reasonable agreement with those deduced from depth-density profiles. At the higher densities, the viscosities are signifi-

cantly lower than those calculated from depth-density profiles. It is suggested that at least part of the discrepancy may be attributed to the strain history of the snow. The creep tests suggest a functional relationship between viscosity and density different from that suggested by analyses of natural snow densification.

**RR 139**
**MEASUREMENT OF NATURAL PARTICULATE FALLOUT ONTO HIGH POLAR ICE SHEETS. PARTS 1 AND 2.**
Bader, H., et al, Nov. 1965, March 1967, 86 and 39p., AD-630 902, AD-669 612, 4 refs.
Hamilton, W.L., Brown, P.L.
24-3288
GLACIER ICE, IMPURITIES, PARTICLE SIZE DISTRIBUTION, LABORATORIES, LABORATORY EQUIPMENT.
The paper describes specifications for the laboratory, the purification of tap water for use as wash water and in making moderately clean NaCl solutions, the cleaning of glassware, the preparation and cleaning of NaCl solutions, the processing of ice samples, the measurement of electrical conductance, the Coulter particle counter and its use, and some of the underlying principles. The equipment used is identified and some first results obtained on cores from Byrd Station, Antarctica, are presented. Greenland and Antarctica ice samples were analyzed for size distribution of the particulate content. Annual accumulation determined by peak to peak measurement on the dust concentration profiles compares favorably with that determined by surface stratigraphy. The results indicate that winter snow is dirtier, mean particle size changes as a result of relatively discrete addition of well sorted fallout to the log-normal distribution, and that annual accumulation of dust was about 8 times higher in Greenland than in Antarctica at the times represented by the samples studied.

**RR 140**
**PRINCIPLES OF FROST HEAVING.**
Takagi, S., Sept. 1965, 24p., AD-626 174, Refs. on p.7-10.
24-3289
SOIL FREEZING, FROST HEAVE.
Two formulations of soil freezing are presented, using a simple frost heaving model. Equations are given for freezing by segregation. A model is suggested to understand the properties of the segregating water layer in freezing by segregation, the adsorbed water around soil particles, the liquid-like layer on the ice surface, and various boundary liquids. The appendices present a literature review, an analysis of energy balance at the freezing front in freezing by segregation, additional equations for freezing by segregation, and technical notations.

**RR 141**
**THEORY OF DENSIFICATION OF DRY, BUBBLY GLACIER ICE.**
Bader, H., July 1965, 16p., AD-622 192, Contract DA-11-190-ENG-91, 5 refs.
24-3290
GLACIER ICE, DENSITY (MASS/VOLUME), BUBBLES.
Density and air-bubble pressure data obtained from ice cores from Site 2, Greenland, are analyzed to determine porosity at the pore close-off level, which is found to have a very small standard deviation. A theory of densification of bubbly ice is developed on the assumption that the rate of decrease in porosity is proportional to pore volume and to the difference between absolute load pressure and air bubble pressure. The determination of pore close-off porosity in principle requires only the measurement of the weight of a sample, and the volume of air liberated upon melting, reduced to in situ temperature and average atmospheric pressure at a given pore close-off level.

**RR 142**
**STUDIES OF ICE ETCHING. I APPLICATION OF THERMAL ETCHING TO THE STUDY OF SURFACE ABRASION IN ICE CRYSTALS.**
Kuroiwa, D., May 1965, 26p., AD-XL 624 199, 8 refs.
24-3291
ICE CRYSTAL STRUCTURE, ICE FRICTION, ICE CRYSTALS, ABRASION, PRESERVING.
Thermal etching ice and its application to the investigation of surface abrasion in ice crystals is explained. Investigations of surface abrasion in ice crystals provide fundamental information in the study of snow and ice friction. The technique of producing evaporation etch pits by the application of Formvar film to the ice crystal surface is described and the development of microcrystals by recrystallization is compared with the surrounding mother crystals. Experimental data are presented and discussed with emphasis on the development of thermal etch pits, scratches on different crystal faces, damage to the prismatic face, thermal etch channels on the basal plane, predominant orientation of etch channels on the basal plane, and etch-pit-free zones and stress concentrations around solid inclusions.

**RR 143**
**ISOTHERMAL FLOW OF AIR THROUGH SNOW OF VARIABLE PERMEABILITY.**
Yen, Y.-C., , Aug. 1964, 11p. plus 5p. appends., AD-449 422, 5 refs.
Tien, C., Bender, J.A.
24-3292
FLUID FLOW, PERMEABILITY, SNOW COVER.
A fan was used to create a lower than atmospheric pressure at the surface of a trench wall, causing a circulation of air through the snow pack. The top of the wall was covered to make the warm air pass as deeply into the snow as possible before being drawn into the trench. Assumptions made in the formulation of the mixed boundary problem are: (1) the trench is sufficient length so that the end effect becomes insignificant; (2) the flow is steady and isothermal; (3) D'Arcy's law is valid; (4) at a given depth, the air permeability of the snow is zero; (5) flow is symmetrical with respect to the y-axis; (6) the permeability of snow is only a function of depth. Equations are given which (1) describe the problem, (2) consider boundary conditions, air density, and snow permeability, and (3) can be solved by a numerical method, asymptotic solutions, and Rayleigh's estimate method. The problem is solved numerically to account for the effect of variable permeability. The expression for pressure distribution is given as a function of position, and the total air flow rate is obtained in terms of operating variables. An illustrative example based on actual permeability data is given to explain the procedures.

**RR 144**
**FLOW OF AIR INTO A PARTIALLY-CASED SNOW TRENCH.**
Yen, Y.-C., , Aug. 1964, 9p. plus 3p. appends., AD-449 420, 6 refs.
Fisher, D.
24-3293
PERMEABILITY, SNOW COVER, FLUID FLOW.
For isothermal, steady, two-dimensional flow with constant permeability, an expression has been derived for the quantity of air flowing into a partially cased rectangular snow trench. The formula for the mass flow rate calculation, which is readily evaluated for any flow geometry, is presented. Simplicity and flexibility of equations presented make it possible to determine flow rates for a variety of conditions.

**RR 145**
**RATE OF GROWTH OR SHRINKAGE OF NONEQUILIBRIUM ICE SHEETS.**
Weertman, J., Aug. 1964, 16p., AD-449 421, 20 refs
24-3294
GLACIER MASS BALANCE, GLACIER ABLATION, ICE GROWTH.
An analysis is made of the time required to build up an ice-age ice sheet and of the time required to destroy such an ice sheet. The calculations are based on the approximation that the theory of perfect plasticity is valid. It is concluded that the time required to build up an ice-age ice sheet is longer than the time required to eliminate it. If it is assumed that the accumulation rate of an ice-age ice sheet lies in the range of 0.2 to 0.6 meter/year, it is found that growth time of a large ice sheet is of the order of 15,000 to 30,000 years. Ablation rates of 1 to 2 meters/year lead to shrinkage times of the order of 2000 to 4000 years, provided ablation occurs over an appreciable area of the ice sheet.

**RR 146**
**PRELIMINARY CALCULATION OF THE ENERGY REQUIREMENT FOR PLACING AN INSTRUMENT PACKAGE UNDER ICE.**
Tien, C., Nov. 1965, 20p., AD-630 982, 3 refs.
24-3295
HEAT TRANSFER, THERMAL HEATING, ICE, MELTING, ANALYSIS (MATHEMATICS).
The energy requirement for dispatching an instrument package through ice by thermal heating was estimated, and the feasibility of such an undertaking was determined. Heat fluxes were supplied through the bottom surface of the package as well as through the circumferential surfaces. The ice in contact with the package melts after sufficient heating, and as a consequence the package moves downward. With given assumptions, the energy requirement was estimated first by expressing the rate of melting (downward velocity of the package) in terms of the heat supplied through the bottom surface. With this information, the heat loss through the cylindrical surface was calculated. The sum of these two energy terms gives the total heat required.

**RR 147**
**DILATATION CONSTANTS AND COMPLEX RATIO FROM FORCED VIBRATION OF A FREE VISCOELASTIC SPHERE.**
Lee, T.-M., Jan. 1965, 8p., AD-611 751, For related material see USA CRREL RR 132.
24-3296
FORCED VIBRATION, DILATATIONAL CONSTANTS, VISCOELASTIC MATERIALS, ANALYSIS (MATHEMATICS).
The technique of forced vibration has been applied to the study of the properties of viscoelastic materials. It is found, through the analysis of a free sphere with a harmonic oscillating internal source, that the vibration amplitude ratio of two measuring points is associated with the complex dilatational constants and the complex ratio of the material, a quantity directly related to the complex Poisson's ratio. Therefore, from the criterion of maximum amplitude ratio (i.e. by adjusting the frequency of the source until the amplitude ratio reaches maximum), these properties can be expressed in terms of the amplitude ratios and their frequencies. For the convenience of laboratory testing, two particular amplitude ratios, in conjunction with their frequencies, have been employed for this purpose. Simple expressions are given, relating the properties of the test material to quantities measurable in the laboratory, namely the maximum amplitude ratios and their corresponding frequencies.

**RR 148**
**ICE BRIDGE ANALYSIS.**
Nevel, D.E., April 1965, 10p., AD-615 736, 4 refs.
24-3297
RIVER ICE, ICE COVER THICKNESS, ICE COVER STRENGTH, ELASTIC PROPERTIES, DEFORMATION, LOADS (FORCES), ANALYSIS (MATHEMATICS).
A technique for strengthening of the ice on naturally frozen rivers is to successively flood and freeze within a confined width, creating a much thicker "ice bridge." An exact analysis is made of the elastic deformation and the moments in the bridge for arbitrarily placed, concentrated and distributed loads. The results are given in terms of infinite convergent series, which may easily be evaluated numerically. For the case of the infinitely wide river, the solutions become integrals.

**RR 149**
**INFRARED DETECTION OF HEAT SOURCES OBSCURED BY TROPICAL RAIN FOREST VEGETATION.**
Rinker, J.N., et al, Oct. 1963, 43p., AD-352 277.
Johnson, P.L., Vogel, T.C.
32-603
AERIAL RECONNAISSANCE, AIRBORNE EQUIPMENT, INFRARED EQUIPMENT, HEAT SOURCES, VEGETATION FACTORS, DETECTION.
This study was conducted in Puerto Rico during November 1962 in order to determine the aerial detection of ground-level heat sources, e.g., cooking fires, of the type associated with guerilla operations in tropical areas. Two infrared scanners, one radiometer, and a K17 camera, all housed in a Navy aircraft, were used to obtain the aerial imagery data. The detectors utilized with the scanners were an indium antimonide detector, filtered and unfiltered, and a copper-doped germanium detector filtered for acceptance of wavelengths between 8 micron and 14 micron. The spectral-band choice was based on an analysis of blackbody radiation curves. Charcoal fires in 14-in.-diameter, 8.5-in.-high galvananized pails served as the heat-source targets. It was found that: (1) The use of an airborne infrared thermal scanner was feasible to detect small ground fires obscured by a vegetative canopy. (2) The filtered indium antimonide cell performed best. (3) In open, grassy areas, the indium antimonide cell detected personnel from a flight altitude of 500 ft. (4) Under conditions of a high, dense canopy, target detection depended as much on the distribution of openings in the vegetation as it did on the total amount of openings. (5) Though most of the flights were flown at an altitude of around 1000 ft (2500 ft maximum), the signal intensity of many of the fires was so great that detection would have been possible at much higher altitudes.

**RR 150**
**A STUDY OF ICE FOG AND ICE-FOG NUCLEI AT FAIRBANKS, ALASKA, PARTS 1 AND 2.**
Kumai, M., Aug. 1964 and April 1965, 27p. and 14p., AD-451 667, AD-676 811, 29 refs.
O'Brien, H.W.
24-3298
ICE FOG, SUPERCOOLED FOG, ICE CRYSTALS, NUCLEATING AGENTS, METEOROLOGICAL FACTORS, TEMPERATURE FACTORS, UNITED STATES—ALASKA—FAIRBANKS.
These studies in Jan. and Feb. 1962 and 1963 of arctic whiteout present the results of condensation nuclei counts; identification of nuclei in fog, supercooled fog, and ice crystals; and the measurement of concentrations and liquid-water contents of ice-fog crystals. Ice fog occurred at temperatures of -37C or lower only over the populated area of Fairbanks. The crystals formed at -40C were predominantly spherical (2 to 15 micr in diam.), the remainder being hexagonal and columnar (5 to 30 micr diam.). The investigation also encompassed (1) a meteorological study of conditions favoring the occurrence and persistence of ice fog; (2) observations of ice-forming nuclei provided by combustion products from a power plant chimney and an automobile exhaust; (3) design of a cascade impactor for use with a tethered blimp; (4) studies of the size relationship between ice-fog crystals and their nuclei; and (5) a comparison of size distributions between some seeding agents and natural ice-fog crystals, and their nuclei. The climatic trends in the area are discussed.

**RR 151**
**PENETRATION OF PLATES IN DENSE SNOW.**
Mellor, M., et al, May 1965, 11p., AD-617 617, 6 refs.
Ramseier, R.O.
24-3299
SNOW COVER, PLATES, PLATE PENETRATION, LOADS (FORCES), UNDERSNOW FACILITIES.
As part of a program of snow studies in Greenland, instrumented struts were placed in rooms excavated below the surface of the ice cap. Closure rates were measured in the undersnow cavities, and strut loads developed by snow pressure on the circular end plates were recorded. The strut installations are described and the data are interpreted in terms of Kerr's viscous foundation theory. Emphasis is placed on the penetration of a circular rigid plate, the evaluation of the viscosity coefficients, comments on the values of the parameters for a given material, shear viscosity, and thickness in the Kerr model, and the effect of plate size on penetration rate. It is tentatively concluded that (1) until a suitable treatment for the viscoelastic continuum

becomes available, the Kerr model offers a rational approach to problems of foundations in snow and to certain problems involving pressures on undersnow structures, (2) the viscosity coefficients of the model are not in themselves characteristic constants for a given snow, (3) as a comparing data for plates of widely differing sizes, and (4) if the thickness coefficient were found to be independent of plate size, as seems possible, it would become a valuable index for determining size effect.

**RR 152**
**PLASTIC LIMIT AS A BINARY PACKING PHENOMENON.**
Ballard, G.E.H., Nov. 1964, 16p., AD-452 459, 8 refs.
24-3300
CLAY SOILS, PLASTIC PROPERTIES, WATER CONTENT, PARTICLE PACKING.

The plastic limit data used in this report are the result of determinations on artificial soils which had been hydrated above the plastic limit for at least 24 hr. Four theoretical zones of behavior are defined from a two-component particle packing theory to account for variations in Atterberg's plastic limit of the artificial clay-silt-water systems as the weight fraction dry clay content (X) varies from 0 to 1. From X equals 0 to X equals 1 the experimental plastic limit successively approaches binary packing behaviors defined by "zones" A, B, C, and D in which the clay content is the operating factor. Three constants, K the packing constant, K sub a the angularity constant, and K sub g the grading constant, of zone behavior are defined to account for the experimental deviation from the theoretical behavior. For the illite- and kaolin-silt-water systems, K equals K sub a plus K sub g.

**RR 153**
**MOVEMENT OF WATER IN A FILM BETWEEN GLASS AND ICE.**
Hoekstra, P., et al, May 1965, 8p., AD-616 315, 8 refs.
Miller, R.D.
24-3301
PARTICLE SIZE DISTRIBUTION, ICE WATER INTERFACE, ICE GROWTH, ICE FORMATION, PARTICLE MIGRATION.

The properties of the film between glass and ice were studied by (1) investigating the influence of particle size on the repulsion and trapping of glass particles by a growing ice surface, and (2) measuring the migration of glass particles embedded in ice. The transport of material in the thin film between the glass and ice is common to both types of experiments. The experimental arrangement and apparatus are described. The process by which glass particles are carried upward by an advancing ice front is shown to be controlled by the transport of water in the film between the glass and the ice. A relationship, derived on the assumption that the transport is by diffusion, predicts the influence of the rate of advance of the ice on the size of the largest particle carried by the ice. The movement rate of particles embedded in ice resulting from a temperature gradient is mainly determined by the thickness of the unfrozen film between the glass and the ice.

**RR 154**
**COMPARISON BETWEEN SNOW-IMBEDDED AND INDUSTRIAL BLACK SPHERULES.**
Langway, C.C., Jr., et al, Oct. 1964, 17p., AD-451 668, 28 refs.
Marvin, U.B.
24-3302
SNOW IMPURITIES, CHEMICAL COMPOSITION, MINERALOGY, PHYSICAL PROPERTIES, DENSITY (MASS/VOLUME), WELD SPATTER.

The chemical and physical properties of black spherules collected from shallow firn and deep ice layers on the Greenland ice sheet are compared with industrial spherules (weld spatter). Morphologically, both groups of spherules closely resemble each other. Electron probe microanalyses are compared with X-ray diffraction analyses on both groups of spherules. Chemically most of the Greenland spherules are Fe-rich with some Si and traces of Mn. Of the five varieties of industrial spherules examined, four contain Ni, some up to 50 per cent; one variety contains no Ni and is chemically similar to the Greenland spherules. Density measurements show the Greenland spherules range between 4.2 and 5.9 g/cu cm and that the industrial spherules studied range between 5.1 and 8.7 g/cu cm.

**RR 155**
**ICE COVER OF AN ARCTIC PROGLACIAL LAKE.**
Swinzow, G.K., March 1966, 43p., AD-632 987, 15 refs.
24-3303
BUBBLES, GAS INCLUSIONS, LAKE ICE, ICE COVER, ICE WATER GAS INTERFACE.

This report contains the results of two field seasons of research on Lake Tuto, N. W. Greenland. Special forms of ice and coarse air inclusions called "worm bubbles" are reported. An observation of ice waste from the upper surface at low temperatures is attributed to a combination of sublimation and abrasion by blowing snow. Temperatures in the 2 m thick ice cover, as well as in water, were observed during ice growth. These and other observations suggest that sunlight is the main heat source and that sun penetration of the ice may raise the water temperatures an appreciable degree. It was found that the lake water contains 3 per cent to 4 per cent gas while the ice contains 0.5 per cent of dissolved gases of a composition probably differing from that of the air. Free gas was found in the form of exsolutions in the ice of the lake, giving it a specific character. Existing theories of solute rejection by the moving solid-liquid interface are found inadequate for the case of the ice-water-gas system. It was concluded that worm bubbles may form by a mechanism other than nucleation at the interface.

**RR 156** Record deleted.

**RR 157**
**GLACIOLOGICAL STUDIES IN THE VICINITY OF CAMP CENTURY, GREENLAND.**
Mock, S.J., March 1965, 20p., AD-615 282, 23 refs.
24-3304
SNOW COVER, GLACIER ICE, GLACIER FLOW, GLACIOLOGY.

The results are presented of a program, begun during the 1961 summer, to determine ice-movement rates and particle paths from Camp Century to the point of discharge from the ice sheet. The investigation area and previous work are discussed. Pit studies (made at 13 to 18-km intervals along the main trail), the survey program, and seismic ice-thickness determinations are described. Mean annual accumulation ranges from 16.2 to 60.3 g/sq cm, decreasing linearly with distance from the moisture-source area. The Thule Peninsula creates a pronounced precipitation shadow. Mean annual temperatures, as measured at 10-m snow depth, decreased 1.2 C/100-m rise in elevation, and are primarily a function of elevation and secondarily a function of latitude. Camp Century is at an elevation 1885 m and is underlain by 1380 m of ice.

**RR 158**
**SPHERICAL WAVES IN VISCOELASTIC MEDIA.**
Lee, T.-M., April 1965, 14p., AD-615 999, 11 refs.
24-3305
VISCOELASTICITY, WAVE PROPAGATION, MECHANICAL PROPERTIES, SOLIDS, MATERIALS.

Closed form solutions to the propagation of spherical waves from an internal steady oscillating pressure source and the transient response of the viscoelastic medium to a pressure impulse are presented. The displacement functions and the stress functions are expressed in terms of the input source and the basic mechanical constants of the medium. In the investigation of impulse-caused propagation phenomenon it is assumed that the loss factors are independent of frequency. Numerical examples for the displacement and stress functions illustrate the damping effect of a viscoelastic medium by comparison with its special case—the elastic medium. The amplitude of the viscoelastic waves from a spherical source decays exponentially; this factor causes the amplitude to depart from that of an elastic wave when the vibration frequency is high and when the distance from the source is large. The "resonant frequency" for a viscoelastic medium can be observed from the motion at the cavity surface when under the forced harmonic vibration of a spherical pressure source. The motion in a viscoelastic medium caused by an impulse lags behind that in an elastic one.

**RR 159**
**ORIGIN AND ENVIRONMENTAL SIGNIFICANCE OF LARGE-SCALE PATTERNED GROUND, DONNELLY DOME AREA, ALASKA.**
Church, R.E., et al, June 1965, 71p., AD-XL 474 477, Refs. on p.59-63.
Péwé, T.L., Andresen, M.J.
24-3306
POLYGONAL TOPOGRAPHY, SOIL STRUCTURE, PATTERNED GROUND, CLIMATOLOGY, ICE WEDGES.

The patterned ground consists of polygons 25 to 46 m in diameter bounded by shallow troughs 1 to 2 m wide that form the sides of the polygons. The troughs are underlain by wedge-shaped masses of sediments that extend downward 2 to 3 m. Sediments of the wedge vary texturally along the strike and vertically within a given wedge. The coarsest material in the wedge is about 75 mm in diameter, which is the same size as the coarsest material in the outwash. The fine material in the wedges is silt, the same as that which blankets the area. The patterned ground originated during Wisconsin time when the mean annual air temperature was at least 3 C colder than now. A polygonal network of large-scale thermal contraction cracks formed in the gravel during the winters and ice wedges grew in the permafrost. With the warming of the climate in post-Wisconsin time most of the perennially frozen gravel thawed and the ice wedges melted. The voids created by the melting of the ice wedges were filled with sediment that was washed from the surface or collapsed from the thawed sides of the voids. The troughs bounding the polygons are no longer underlain with ice wedges but with ice-wedge pseudomorphs ("fossil" ice wedges).

**RR 160**
**DAILY SUMS OF GLOBAL RADIATION FOR CLOUDLESS SKIES.**
Folsenga, S.J., Nov. 1964, 124p., Ad-610 552, Consists mainly of radiation tables. 15 refs.
24-3307
SOLAR RADIATION, HUMIDITY, CLIMATOLOGY, METEOROLOGY.

Quantitative information on global radiation for studies pertaining to the distribution, accretion, and ablation of ice and snow, thawing of soils, evaporation, and climatology is given in tables containing radiation received on a horizontal surface under cloudless skies. Sums of global radiation were computed as a function of geographic latitude, declination of the sum, precipitable water content of the atmosphere, and atmospheric dust attenuation to the solar beam. A method of computation published by W.H. Klein (1948) for determining global radiation inside the atmosphere was followed. Expressions are given for determining (1) daily sums of extraterrestrial solar radiation, (2) daily solar radiation at the surface of the earth, (3) atmospheric transmission as a function of the optical airmass, (4) the effect of dust attenuation on solar energy, (5) daily sums of direct solar radiation at the surface of the earth, and (6) total precipitable water vapor content of the atmosphere.

**RR 161**
**MOVEMENT STUDIES BY SEISMIC SOUNDINGS ON THE GREENLAND ICE SHEET.**
Roethlisberger, H., , April 1965, 25p., AD-617 618, 2 refs.
Bentley, C.R., Bennett, H.F.
24-3308
GLACIER MOVEMENT, SEISMIC SURVEYS, SURFACE MIGRATION, SUBSURFACE INVESTIGATIONS, SEISMIC REFLECTION, GREENLAND.

A detailed seismic reflection survey was carried out at Site 2, Greenland in 1956 in a rectangle 3160 x 2400 ft. marked by bamboo poles, and was repeated in 1959. The results were essentially the same, indicating that the surface had not moved much in the 3-yr period. However, the reflection records were not of sufficiently high quality to give an accurate estimate of the possible shift, leaving an uncertainty of the order of 50 to 100 m in the direction of the subsurface dip (SW) and more in the direction of the strike. Under more favorable conditions the method should give an estimated accuracy of 30 to 50 m.

**RR 162**
**GLACIER SLIDING.**
Weertman, J., Nov. 1964, 14p., AD-610 553, 13 refs.
24-3309
GLACIER MOVEMENT, PRESSURE FACTORS, MELTING, SUBGLACIAL INVESTIGATIONS, SLIDING VELOCITY.

The theory of the sliding of glaciers presented in earlier papers has been generalized (1) by taking into account the resistance to sliding offered by obstacles both smaller and larger than the controlling obstacles and (2) by relaxing the assumption that ice is always in intimate contact with the bed at the downstream side of an obstacle. The sliding velocities and controlling obstacle sizes which are found from the earlier theory. A new result obtained from the present theory is the fact that a water layer an order of magnitude smaller in thickness than the height of the controlling obstacles can cause an appreciable increase in the sliding velocity. The generalized theory contains Liboutry's sliding theory as an extreme limiting case. For certain thicknesses of a glacier the sliding velocity is a double-valued function of the shear stress exerted at the bed.

**RR 163**
**LABORATORY DETERMINATION OF DYNAMIC MODULI OF FROZEN SOILS AND OF ICE.**
Kaplar, C.W., Jan. 1969, 45p., AD-686 282, Bibliog. p.24-27.
24-3310
ELASTIC PROPERTIES, FROZEN GROUND MECHANICS, DYNAMIC PROPERTIES, COEFFICIENTS, ICE MECHANICS.

This report presents a summary of results of laboratory investigations of frozen soils and ice to determine the elastic moduli by the dynamic (sonic) method. The elastic moduli were indirectly obtained by measuring the fundamental resonsant frequencies of flexural, longitudinal, and torsional vibrations induced in prismatic beams by electromagnetic means. Vibration tests were performed on a total of 56 specimens presenting 12 different materials. The dynamic moduli of elasticity of the frozen soils were found to increase with a decrease in temperature, the greatest rate of increase occuring between plus 32F and plus 20F. Coarse granular soils gave the highest values and clays the lowest in the ratio of more than 4 to 1. Dynamic Young's modulus, E, computed from flexural vibrations was usually lower than dynamic E computed from longitudinal vibrations. Average values of dynamic Poisson's ratio for all soil types computed from average values of E and G (longitudinal vibrations) ranged from 0.26 to 0.38. least temperature dependent and gave the most consistent results. Dynamic moduli of ice E (longitudinal vibration) and G compared closely with values reported by other investigators.

**RR 164**
**GEOMETRIC INTERPRETATION OF THE THREE-DIMENSIONAL YIELD CRITERION OF SOILS.**
Takagi, S., July 1965, 8p., AD-622 429, 7 refs.
24-3311
SOIL MECHANICS, PLASTIC DEFORMATION, STRESS ANALYSIS, SOIL GEOMETRY.

A geometric interpretation of the invariants of a three-dimensional tensor is developed. With this interpretation, the yield criterion for three-dimensional plastic deformation is given geometric expression similar to the Coulomb criterion of yielding for plane plastic deformation. It is discovered that the procedure conventionally used in triaxial tests to determine the yield criterion is not theoretically valid. An alternative method based on the geometric interpretation developed herein is suggested.

**RR 165**
**COMPLEX POISSON'S RATIO DILATATION CONSTANTS FROM FORCED VIBRATION OF A SPHERE.**
Lee, T.-M., Feb. 1965, 12p., AD-614 461, 3 refs.
Smith, J.L.
24-3312
FORCED VIBRATION, DILATATIONAL CONSTANTS, VISCOELASTIC MATERIALS.
Following previous investigations on methods of determining dynamic mechanical properties of viscoelastic materials employing forced vibration, this report proposes a similar technique for determining the complex Poisson's ratio and the complex dilatation constants. Through the study of forced vibration of a free viscoelastic sphere with an internal harmonic oscillating source, it is found that these properties of the test material are related to the ratio of the vibration amplitude of two measurable points. Thus, when using the criterion of this ratio approaching its maximum, the maximum amplitude ratio, these properties can be expressed in simple relationship with laboratory-measurable quantities, namely the maximum amplitude ratios and their corresponding vibration frequencies. Investigations have been carried out for three sphere sets.

**RR 166**
**HEAT TRANSFER CHARACTERISTICS OF NATURALLY COMPACTED SNOW.**
Yen, Y.-C., June 1965, 9p., AD-619 344, 3 refs.
24-3313
SNOW COMPACTION, HEAT TRANSFER, THERMAL CONDUCTIVITY, WATER VAPOR, DIFFUSIVITY.
The heat transfer characteristics of naturally compacted snow have been determined experimentally. The results are interpreted as effective thermal conductivity k sub e and water vapor diffusivity D sub e and equations are derived for these characteristics. In contrast with the results obtained from previous investigations on unconsolidated snow, in the case of naturally compacted snow, values of k sub e and D sub e are found to be not only a function of air flow rate but also of snow density. From present as well as previous studies, it can be concluded that air flow has considerable effect on the thermal conductivity and water vapor diffusivity of unconsolidated and naturally compacted snow. It is reasonable to state that the essential factor influencing the formation of depth hoar and avalanches is a prolonged process of simultaneous heat and mass transfer due to steep temperature gradients.

**RR 167**
**ON ISOTHERMAL FLOW OF AIR INTO A PARTIALLY CASED RECTANGULAR SNOW TRENCH.**
Yen, Y.-C., June 1965, 19p., AD-622 193, 6 refs.
24-3314
SNOW TRENCHES, FLOW RATE, AIR FLOW.
In a previous paper (CRREL Res. Rpt. 144, 24-3293) Yen and Fisher developed an expression for evaluating the quantity of air flowing into a partly cased rectangular porous trench of constant permeability. The flow was assumed to be isothermal, steady and two-dimensional. The mass flow rate per unit length of trench was expressed in terms of a configuration factor, permeability and viscosity of air, average density, and air pressure at the top and on the walls of the trench. The configuration factor in this earlier work was arrived at by considering the effects of depth to the impermeable layer, depth of the trench, and depth of the trench casing. In the present study, however, values of the configuration factor were determined which included the effect of half trench width as well as the various depth considerations. It is found that in any practical analysis the effect of trench width is not negligible and should be considered.

**RR 168**
**STRENGTH STUDIES OF SNOW.**
Mellor, M., et al, Jan. 1966, 21p., AD-631 717, 14 refs.
Smith, J.H.
24-3315
SNOW STRENGTH, SNOW DENSITY, COMPRESSIVE STRENGTH, TEMPERATURE EFFECTS.
Strength measurements were made on some 650 samples of homogeneous snow prepared under controlled conditions, primarily to investigate the effect of temperature variation. Comparative measurements were made on ice and frozen sand, and the variation of ram hardness with temperature was examined. An equation is derived to express the relationship between rupture strength and temperature of the snow samples studied. An equation representing the effects of density variation for temperature in snow and ice samples is also given. However because of inadequate density measurements for describing grain structure, the derivative for ice is questionable.

**RR 169**
**OPTICAL MEASUREMENTS ON SNOW.**
Mellor, M., June 1965, 19p., AD-622 775, 8 refs.
24-3316
LIGHT SCATTERING, ATTENUATION, GRAIN SIZE, SNOW DENSITY, SNOW OPTICS.
Spectral extinction measurements for the visual range were made on homogeneous snow samples prepared under controlled conditions, with snow density and grain size as variables. Comparative measurements were made on coarse-grained natural snow. In the fine-grained snow, where scattering is thought to be the dominant attenuating process, there is a general decline in extinction coefficient, as wavelength increases from 0.4 to 0.7 microns. In the coarse-grained snow, where absorption becomes significant, spectral selection was slight, with a weak minimum in the region 0.5 to 0.6 microns. When extinction coefficient is related to density it must have a maximum value; limited data for fine-grained snow show this maximum in the density range 0.45 to 0.60 g/cu cm, and the density for maximum extinction is inversely related to wavelength. For a given density extinction coefficient decreases as grain size increases, the rate of change varying with wavelength. Spectral reflectance measurements on natural snow are reported, and attenuation data are interpreted to give surface reflectivity for fine-grained snow.

**RR 170**
**DISTRIBUTION OF TEN-METER SNOW TEMPERATURES ON THE GREENLAND ICE SHEET.**
Mock, S.J., et al, Sept. 1965, 44p., AD-629 977, Bibliog. p.16-18 and 43-44.
Weeks, W.F.
24-3317
TEMPERATURE DISTRIBUTION, AIR TEMPERATURE, SNOW TEMPERATURE, TEMPERATURE GRADIENTS, CHARTS, ISOTHERMS, GREENLAND.
All available 10-meter snow temperatures from the Greenland ice sheet have been collected and analyzed using multiple regression techniques to develop equations capable of accurately predicting these temperatures. The analysis was carried out for north Greenland; for two sub-areas of north Greenland, the Thule Peninsula and the dry snow facies; for south Greenland; and for all Greenland. The resulting equations show that 10-meter snow temperatures in north Greenland and its subareas can be accurately predicted from the independent parameters latitude and elevation. Longitude was found to be another significant parameter in south Greenland. In all cases the values of the multiple correlation coefficients were .928 or greater.

**RR 171**
**AN X-RAY STUDY OF THE ETHYLENE GLYCOL-MONTMORILLONITE COMPLEX.**
Reynolds, R.C., Jr., July 1965, 9p., AD-622 328, 18 refs.
24-3318
SPECTROMETERS, SPECTROSCOPY, X RAY DIFFRACTION, CLAY MINERALS, ETHYLENE GLYCOL.
Oriented aggregates of ethylene glycol-montmorillonite were studied by X-ray spectrometric methods. Basal reflections, through the 00 14, provided the basis for structural analysis by Fourier and trial and error methods. On the basis of the intensity data, it is concluded that glycol molecules form a staggered, two-layered complex; water molecules and exchangeable cations lie close to but not coincident with a plane that separates the two glycol layers. The glycol molecules in each layer are disposed in c-axis face-centered array. They are oriented so that the plane of symmetry of the aliphatic chain parallels the c-axis. This proposed structure is a two-layer modification of a previously described glycol-vermiculite structure.

**RR 172**
**THEORETICAL INVESTIGATION ON THE EFFECT OF MELTING ON FORCED CONVECTION HEAT TRANSFER.**
Tien, C., et al, Oct. 1965, 10p., AD-629 066, 10 refs.
Yen, Y.-C.
24-3319
HEAT TRANSFER, CONVECTION, MELTING, ANALYSIS (MATHEMATICS).
The effect of melting on convective heat transfer between a melting body and surrounding fluid was studied quantitatively from the point of view of boundary layer theory, film theory and penetration theory. These studies indicate that melting retards the rate of heat transfer and the decrease in heat transfer coefficient is found to be a unique function of the parameter C sub p delta T over dalta H sub m, where delta T is the temperature difference between the fluid and melting body, C sub p is the heat capacity of the fluid, and delta H sub m is the enthalpy change due to melting.

**RR 173**
**ON THE MODE OF UPLIFT OF THE FISH AND FOSSILIFEROUS MORAINES OF THE MCMURDO ICE SHELF, ANTARCTICA.**
Gow, A.J., et al, Oct. 1965, 16p., AD-628 513, 25 refs.
Weeks, W.F., Hendrickson, G., Rowland, R.
24-3320
ICE SHELVES, CORE SAMPLERS, FOSSILS, MORAINES, FRESH WATER ICE, ANTARCTICA—MCMURDO ICE SHELF.
The McMurdo Ice Shelf and associated faunal remains were examined in the vicinity of the easternmost Dailey Island. Stratigraphic, petrographic, and chemical composition studies of cores from two holes drilled through the ice shelf show that at these locations the shelf is composed only of fresh water ice. Although cores from the deeper hole possessed typically glacial textures throughout, much of the ice from this part of the McMurdo Ice Shelf may have been formed from the freezing of a layer of fresh water found sandwiched between shelf bottom and the underlying sea water. The existence of fresh water under the ice shelf can most probably be attributed to drainage of surface melt water during the ablation season. There was no evidence to indicate that this part of the McMurdo Ice Shelf is being nourished by the growth of sea ice onto its lower surface. The fish remains found on the ice surface were confined to a narrow zone along the tide crack and are believed to have been left in this vicinity by deep diving seals.

**RR 174**
**SIMULATION OF DRIFTING SNOW.**
Odar, F., Oct. 1965, 16p., AD-630 116, 18 refs.
24-3321
SNOWDRIFTS, SIMULATION, BLOWING SNOW, WIND TUNNELS, SCALE FACTORS, TURBULENT FLOW, ANALYSIS (MATHEMATICS).
Scale factors which are based on geometric, kinematic and dynamic similarity requirements are derived in order to simulate drifting snow in a wind tunnel. The scale factors related to threshold characteristics involved unknown functions that should be determined if a proper simulation of drifting snow is desired. The scale factors derived from the equation of motion of the particles apply to the conditions where low frequency turbulence with large eddies occurs. Further research is necessary to extend knowledge of the motion of particles in a medium where high frequency turbulence with small eddies exists.

**RR 175**
**CONDUCTIVITY CHANGES PRODUCED IN ICE BY OPTICAL IRRADIATION 0.8 TO 2.7 MICRONS.**
Camp, P.R., , Aug. 1966, 27p., AD-638 923, 12 refs.
Spears, D.L.
24-3322
ICE OPTICS, DEFECTS, ORIENTATION, ICE ELECTRICAL PROPERTIES, CONDUCTIVITY.
This report describes a series of experiments in which it was attempted to produce orientational defects and ions by optical injection. The basic experiment was one on transient photoconduction produced by an intense light pulse. The effects of intensity and wavelength of the incident light, temperature of the sample and area of illumination of the sample were studied. It was concluded that neither orientational defects nor ion pairs were produced in appreciable quantity by the light but that the apparent photo-conduction observed was the result of flash-heating of a thin surface region which had significantly different properties than had the bulk of the sample. Simple and somewhat speculative assumptions regarding the photo-generation process lead to the conclusion that the photo-efficiency, at least for ion pair production, must be very low indeed.

**RR 176**
**FROST-HEAVING PRESSURES.**
Hoekstra, P., , Oct. 1965, 12p., AD-626 175, 28 refs.
Chamberlain, E., Frate, A.
24-3323
FROST HEAVE, PRESSURE FACTORS, SOIL MOISTURE, PORE PRESSURE, FROZEN GROUND.
Upon freezing a saturated soil in an open system from the top down a considerable pressure develops. The pressure is the result of the surface energy of a curved ice-water interface. The curvature of the interface is necessary for ice to proliferate through the soil pores. The curvature is related to the pore size distribution of the soil. The test chamber is designed to minimize the friction of the soil with the wall. An accurate control of heat removal is obtained by thermoelectric cooling. A load cell placed on top of the sample is used to measure the pressure developed and at the same time prevents heaving of the sample. By measuring the pressure on a layered sample it can be shown that the pressure develops at the freezing front. The results on several soils indicate that the maximum pressure that develops has a characteristic value for each soil. For each soil used the water content versus tension curve is given and the maximum pressure is related to this curve.

**RR 177**
**SNOW STUDIES IN ANTARCTICA.**
Gow, A.J., Nov. 1965, 20p., AD-631 718, 21 refs.
24-3324
SNOW COVER DISTRIBUTION, SURFACE ROUGHNESS, STRATIGRAPHY, ICE CRYSTALS, LAYERS, SEASONAL VARIATION, ICE FOG, SUBLIMATION.
The seasonal distribution of snow at the South Pole and its relationship to stratigraphy was investigated in pits dug beside a number of 4 year old accumulation stakes. Results show that conventional stratigraphic methods yield thoroughly reliable values of accumulation rates. The bulk of the year's accumulation is deposited as dunes during winter. Most dunes are subsequently transformed into linear sastrugi so that by winter's end the amplitude of the surface relief frequently exceeds the thickness of snow accumulated annually. During the summer, however, these dunes and sastrugi are gradually worn down by a process of sublimation - deflation. This leveling of the surface relief is believed to be the significant factor in the formation of the remarkably uniform stratigraphy observed in pits at the South Pole. Three years' measurements of snow accumulation on undulating surfaces around Byrd Station, Antarctica, indicate that the undulations are tending to be filled in. These results are discussed in the light of current knowledge of the origin and migration of such features.

**RR 178**
**SELF-DIFFUSION IN ICE SINGLE CRYSTALS.**
Itagaki, K., March 1966, 14p., AD-613 719, Bibliog. p.12-14.
24-3325
ICE CRYSTALS, DIFFUSIVITY.
Measurements of the diffusion constants in single crystals of ice in directions parallel and perpendicular to the c-axis are described. The anisotropy of activation energy was obtained. The higher activation energy perpendicular to the c-axis indicates the free interstitial molecular jump mechanism for diffusion in ice.

**RR 179**
**THREE-DIMENSIONAL YIELD CRITERION OF C-PHI MATERIAL.**
Takagi, S., Oct. 1965, 17p., AD-629 875, 11 refs.
24-3326
SOIL MECHANICS, PLASTIC PROPERTIES, DEFORMATION, YIELD CRITERION, ANALYSIS (MATHEMATICS).
A general three-dimensional yield criterion of an ideal soil, called c-phi material, is determined that can coincide with the Shield yield criterion and the Drucker-Prager yield criterion by giving appropriate values to the parameters contained. When expressed on an octahedral plane in the principal-stress space, the yield criterion is represented by a hexagon of curved sides formed of conic sections. The geometric relationships satisfied by a family of curved hexagons are investigated.

**RR 180**
**ALBEDO AND SKY RADIANCE MEASUREMENTS IN GREENLAND.**
Kasten, F., April 1966, 10p., AD-635 376, 7 refs.
24-3327
SNOW SURFACE, ALBEDO, SOLAR RADIATION, CLOUD COVER, SNOW OPTICS, GREENLAND.
This paper presents the results of measurements made in June 1961 on the ice sheet of Northern Greenland. The following quantities were measured: total and visual albedo of the snow surface under overcast and blue skies as well as the corresponding albedos in several spectral ranges; vertical distributions of the luminance and of the radiance of densely overcast sky and snow surface in several spectral ranges; and azimuthal distributions of luminance and near-infrared radiance of overcast skies of different densities. The interdependence of these quantities and their relationship to whiteout are discussed on the basis of the measurements. It is concluded that in order to fully or partly overcome whiteout, the luminance distribution must be made more or less nonuniform. This may be accomplished by cloud seeding, dark objects on the ground, or the use of light of other than visible wavelength.

**RR 181**
**AN APPROACH TO THE CONSOLIDATION OF SNOW.**
Feldt, E.D., et al, Dec. 1965, 13p., AD-630 648, 22 refs.
Ballard, G.E.H.
24-3328
SNOW COMPRESSION, SNOW DENSITY, COMPRESSIVE PROPERTIES, POROSITY, VISCOSITY, SNOW STRENGTH, STRESS ANALYSIS.
A consolidation theory is developed for an age-hardened snow under uniaxial stress in the porosity range of 35 to 55 per cent by considering one mechanism, viz., viscous flow of interparticle bonds. For a uniaxial stress a differential equation for porosity is developed in terms of time using two structural parameters and the coefficient for the viscosity of ice. Comparison of the equation and the integrated form with existing date predicts consistent and reasonable values for a, a structural parameter. The predicted values of the ice viscosity coefficient over v, a second structural parameter range from .01 to 100 times the published values for ice viscosity coefficient, which may indicate that the consolidation rate is greatly affected by the diagenetic history of the snow and the conditions of experimentation.

**RR 182**
**SATURATION, PHASE COMPOSITION AND FREEZING POINT DEPRESSION IN A RIGID SOIL MODEL.**
Lange, G.R., et al, Nov. 1967, 21p., AD-664 141, 10 refs.
McKim, H.L.
24-3329
FROZEN GROUND, TEMPERATURE FACTORS, SOIL MOISTURE, MODELS.
Calorimetry was used to explore the effects of saturation and temperature upon the phase composition of the water at below freezing temperatures in a porcelain block with fine pore spaces. The effect of pore size upon phase composition was held constant by the rigid model. The percent of original water frozen was determined for a wide range of saturations and several temperature levels. Nucleation was avoided. After 20 hr of freezing, 64 of 74 determinations showed less than 10 per cent or more than 70 per cent of the water frozen. Thus, a metastable condition of saturation and temperature for guaranteed freezing was defined for the pore space model with time of freezing held constant. Freezing points were also measured at various levels of saturation in the same porcelain blocks. A range of effective pore sizes was calculated from these data, thus characterizing the pore size distribution. It is concluded that the phase composition of the water in frozen soils is dependent upon the degree of saturation as well as the temperature. It is suggested that rigid models are useful tools for investigating the freezing process in soils.

**RR 183**
**MIGRATION OF LIQUID INCLUSIONS IN SINGLE ICE CRYSTALS.**
Hoekstra, P., et al, Dec. 1965, 8p., AD-630 978, 18 refs.
Osterkamp, T.E., Weeks, W.F.
24-3330
ICE CRYSTALS, BRINES, IMPURITIES, DESALTING, TEMPERATURE GRADIENTS, SALT ICE.
The migration of brine pockets of KCl and NaCl under the influence of a temperature gradient was investigated in single ice crystals. The observed migration velocities are compared with velocities calculated from a simple diffusion model using the data on electrolytic solutions available in the literature. Although the relative movements of KCl and NaCl pockets were consistent with the diffusion theory, the observed velocities were always less than the calculated. Neither the direction of the gravitational field nor the crystallographic orientation of the host crystal significantly influenced the rate of migration. It was also shown that the migration of solid KCl particles occurs at temperatures below the eutectic point. Two mechanisms are proposed that would impede the mechanical differentiation of salts that crystallize at high temperatures relative to salts that remain in the brine of sea ice. These mechanisms explain recent field observations that the SO sub 4/Cl ratio of sea ice does not increase with the age of the ice.

**RR 184**
**CONSIDERATIONS OF THE STRENGTH OF SNOW.**
Ballard, G.E.H., et al, Dec. 1965, 11p., AD-631 000, 12 refs.
Feldt, E.D.
24-3331
SNOW STRENGTH, COMPRESSIVE STRENGTH, POROSITY, ANALYSIS (MATHEMATICS).
An expression is derived for the strength of snow in terms of age hardening at a constant porosity. The expression uses the parameters of the strength of ice, time at failure, a bonding mechanism and a temperature dependent element.

**RR 185**
**AN ANALYTICAL INVESTIGATION OF A MODIFIED STEFAN PROBLEM.**
Yen, Y.-C., et al, March 1966, 15p., AD-633 489, 6 refs.
Tien, C.
24-3332
ICE THERMAL PROPERTIES, MELTING POINTS, HEAT TRANSFER, ANALYSIS (MATHEMATICS).
Approximate solutions of temperature distribution and melting rate of ice have been obtained for the case where the mode of heat transfer is natural convection due to the thermal instability caused by the heated lower surface. Extensive numerical solutions were obtained for the ice-water system corresponding to various thermal conditions in terms of the temperature of the heat source, the melting point of ice, initial ice temperature, latent heat of fusion, and heat capacity of ice.

**RR 186**
**STUDY OF A NEW FOUNDATION MODEL.**
Kerr, A.D., March 1966, 10p., AD-635 738, 11 refs.
24-3333
FOUNDATIONS, PRESSURE FACTORS, LOADS (FORCES), MODELS.
The characteristics of a new foundation model, consisting of two spring layers interconnected by a shear layer, are studied. The study is conducted on the classical problem of a foundation subjected to a rigid stamp. In order to reduce the number of foundation constants to an absolutely necessary minimum, special attention is given to a possible dependence of the constants of the upper and lower spring layers, particularly to the spring constant ratio three which is suggested by Reissner's foundation model. A comparison of the obtained pressure distributions with relevant experimental data seems to support the adoption of this value, thus reducing the number of foundation constants to two. Advantages of the presented model over other foundation models are pointed out.

**RR 187**
**BENDING OF CIRCULAR PLATES CONFINING AN INCOMPRESSIBLE LIQUID.**
Kerr, A.D., Aug. 1966, 8p., AD-640 887, 4 refs.
24-3334
ICE COVER STRENGTH, FLEXURAL STRENGTH, LOADS (FORCES), ELASTIC PROPERTIES.
Frozen potholes subjected to lateral loads suggest the study of the effect of the confined incompressible liquid upon the behavior of the covering ice plate. Since, for loads of short duration, no creep is expected, the plate may be assumed to behave elastically. The method of solution is described and two examples are treated in detail. A comparison of numerical results shows the strong effect of the confined incompressible liquid upon the deflections and stresses of the plate.

**RR 188**
**SOILS OF THE OKPILAK RIVER REGION, ALASKA.**
Brown, J., May 1966, 49p., AD-639 691, Bibliog. p.46-49.
24-3335
ARCTIC SOILS, FROST ACTION, PATTERNED GROUND, FROZEN GROUND, GEOCRYOLOGY, ICE WEDGES, SEASONAL FREEZE THAW, UNITED STATES—ALASKA—OKPILAK RIVER.
Concepts of arctic pedology are applied to the glaciated and unglaciated terrains in the vicinity of the Okpilak River, northeastern Alaska (69 deg 25'N, 144 deg 00'W). The manifestations of frost action in arctic soils are considered under two general forms: 1) the surficial configurations or patterned ground and 2) the morphological characteristics of the seasonally thawed soil and the upper zone of perennially frozen ground. Approximately 55 types of soil conditions and surface features are described and mapped in an area encompassing both the northern Brooks Range and the southern Foothill Provinces. The arctic brown soils are distributed on the well-drained sites along valley (longitudinal) traverses and across mountain (altitudinal) gradients. Weakening of the soil-forming processes with increasing altitude is suggested in the mountains. In the valleys, a podzol-like soil is observed in close proximity to the arctic brown soils and in association with acid parent materials, dwarf birch-heath vegetation and protected microrelief positions. A combination of peaty soils associated with ice-wedge polygons constitutes an organic terrain. The developments of these soils under the arctic environment are discussed.

**RR 189**
**TEMPERATURE DEPENDENCE AND MECHANISM OF SINTERING.**
Ramseier, R.O., , July 1966, 16p., AD-640 150, 18 refs.
Sander, G.W.
24-3336
SNOW STRENGTH, SNOW COMPRESSION, SINTERING, TEMPERATURE EFFECTS, METAMORPHISM (SNOW), SNOW DENSITY.
Both the degree of sintering of snow and the rate constant as a function of temperature can be represented satisfactorily by an exponential equation. The results strongly suggest that the sintering process is one of evaporation, diffusion through the ambient temperature, and condensation.

**RR 190**
**VERIFICATION OF THE PROPOSED EQUATION FOR CALCULATION OF THE FORCES ON A SPHERE ACCELERATING IN A VISCOUS FLUID.**
Odar, F., July 1966, 20p., AD-639 207, 5 refs.
24-3337
VISCOUS FLOW, SPHERES, PARTICLES, ANALYSIS (MATHEMATICS).
An equation proposed for the calculation of forces on a sphere accelerating in a viscous fluid (Odar and Hamilton, 1964) is verified by comparing the velocities of spheres falling under gravity in a viscous fluid with those calculated from the equation. The excellent agreement between the experimental and calculated values suggests wide application for the equation.

**RR 191**
**SEISMIC SURVEY NORTHWEST GREENLAND, 1964.**
Clarke, G.K.C., July 1966, 19p., AD-640 454, 9 refs.
24-3338
SEISMIC SURVEYS, ICE COVER THICKNESS, TEMPERATURE GRADIENTS, DENSITY (MASS/VOLUME), TRAVERSES, GREENLAND.
The thickness of the Greenland Ice Cap has been determined by seismic sounding along the trail from Camp TUTO to Camp Century in Greenland and on traverses northwest and southwest from Camp Century. The average velocity of vertically traveling seismic waves at each shot location was estimated using the first-arrival data from reflection records and the 10-m temperature at each location. The results of three long refraction profiles and measurements of temperature, density and seismic velocities at the Camp Century drill hole were used to check velocity estimates. An empirical formula from Robin (1958) satisfactorily related seismic wave velocities to the temperature and density of the firn and ice. A two-layer glacier model having a homogeneous ice layer overlain by a firn layer in which the P-wave velocity increased linearly with depth was used.

**RR 192**
**MIGRATION AND CRYSTALLIZATION OF INTERLAMELLAR WATER DURING FREEZING AND THAWING OF WYOMING BENTONITE.**
Anderson, D.M., , Dec 1965, 17p., AD-631 150, 28 refs
Hoekstra, P.
24-3339
GROUND ICE, SOIL FREEZING, SOIL MOISTURE, ICE CRYSTALS, CLAYS, BENTONITE, FREEZE THAW CYCLES, MOISTURE CONTENT.
Homo-ionic, clay-water pastes of Wyoming bentonite were studied at near freezing temperatures by X-ray diffraction. On

freezing, the initial high d(001) spacings of the lithium- and sodium-bentonite pastes decreased, first to about 19A and, at about -10C, to 16A. When the temperature was raised the d(001) spacings of the frozen clays increased substantially; on melting, the d(001) spacings quickly expanded to their initial high values. The behavior of the hydrogen-aluminum-, potassium-, and calcium-bentonite was similar except that spacings greater than about 20A did not occur. Evidently, when bentonite-water pastes are frozen, all but two or three monomolecular layers of the interlamellar water migrate into the pore space to form ordinary ice. The remaining interlamellar water therefore must correspond to the "unfrozen" water of previous investigations. Only the diffraction peaks corresponding to the normal hexagonal ice structure were detected. The relative intensities of the diffraction peaks revealed evidence of epitaxy in that the ice crystals appeared to be preferentially oriented with their c-axes perpendicular to the c-axes of the clay crystals.

**RR 193**
**LIGHT SCATTERING AND PARTICLE AGGREGATION IN SNOWSTORMS.**
Mellor, M., Feb. 1966, 16p., AD-633 539, 5 refs.
24-3340
SNOWFALL, LIGHT SCATTERING, VISIBILITY, SNOW OPTICS, SNOW CRYSTALS.
Attenuation of visible radiation by falling snow was studied by a method based on brightness contrast between topographic features and the adjacent sky. Extinction coefficient and visual range are related to snow density, and are compared with data for Antarctic blizzards. Since attenuation depends more on the size and concentration of discrete particles than on the mass density of suspended snow, the process of particle aggregation and snowflake formation during fall is considered by collision theory, and an expression describing aggregation effects is developed. This offers an explanation for the relative constancy of particle concentration observed at ground level during snowfalls of varying intensity. Since there is no strong justification for relating extinction coefficient to snow density, an empirical correlation between extinction coefficient and precipitation rate is given for particle use. It is shown that visual range estimated by eye in hilly terrain may be less than the true value, since sky brightness is locally reduced over broad hilltops with low albedo.

**RR 194**
**INFRARED AERIAL RECONNAISSANCE IN THE ARCTIC (SPRING CONDITION).**
Poulin, A.O., Oct. 1965, 89p., AD-374 853, 11 refs.
26-2340
INFRARED PHOTOGRAPHY, AERIAL RECONNAISSANCE, PHOTOINTERPRETATION, REMOTE SENSING, SNOW COVER, SEA ICE, TERRAIN IDENTIFICATION.
Infrared thermal imagery and concurrent conventional photography is analyzed. Imagery was obtained with a mercury-doped germanium detector in a modified AN/AAD-2 scanner, and conventional aerial photography with Plus-X Panchromatic and infrared films was obtained with a 6-in. focal length camera. Included is sea ice of all ages; icebergs; ice islands; snow-covered terrain of various types; ice-bound and snow-covered land masses whose boundaries were visually indistinguishable; ice caps, glaciers and associated features, including crevasses and marginal lakes; and installations varying from 2-man, temporary stations to a major airbase. It was found that the thermal and visual images supplement each other to provide an effective system for aerial reconnaissance during the early Arctic spring. Infrared thermal imagery often permitted identifications of land and ice features where snow hindered visual recognition.

**RR 195**
**EFFECT OF GROWTH PARAMETERS ON SUBSTRUCTURE SPACING IN NACL ICE CRYSTALS.**
Lofgren, G., et al, Jan. 1969, 17p., AD-687 280, 32 refs.
Weeks, W.F.
24-3341
ICE CRYSTAL GROWTH, SALT ICE, SALINITY, THIN SECTIONS, MICROSCOPE SLIDES, ICE CRYSTAL STRUCTURE.
The effect of growth velocity v and solute concentration C on the cellular substructure that develops in NaCl ice is studied in the range .003 to .00003 cm/sec and 1 to 100 per cent respectively. The substructure is the result of the formation of a constitutionally supercooled zone in the liquid ahead of the advancing interface. Unidirectional freezing runs were made by placing a cold plate in contact with the top of the solution and using cold-plate temperatures of -20 and -70C. The growth velocities were determined from a least-squares fit of the growth data to a power series. The average spacings between neighboring substructures were measured from photomicrographs of precisely located thin sections.

**RR 196**
**TIME DEPENDENT DEFLECTION OF A FLOATING ICE SHEET.**
Nevel, D.E., July 1966, 9p., AD-638 717, 12 refs.
24-3342
FLOATING ICE, ICE COVER STRENGTH, STRESSES, ELASTIC PROPERTIES, VISCO-ELASTICITY.
A solution for a viscoelastic plate on an elastic foundation is presented for an infinite bulk modulus and a shear modulus which obeys Maxwell's model. Observed deflections of a floating ice sheet agree with this solution. A solution for a viscous shear modulus is also presented.

**RR 197**
**DEEP CORE STUDIES OF THE ACCUMULATION AND DENSIFICATION OF SNOW AT BYRD STATION AND LITTLE AMERICA V, ANTARCTICA.**
Gow, A.J., March 1968, 45p., AD-669 240, Refs. p.37-39.
24-3343
CORES, ICE CORING DRILLS, ACCUMULATION, SNOW DENSITY, AGE DETERMINATION, ANTARCTICA—BYRD STATION.
Snow and ice cores from two deep drill holes at Byrd Station and Little America V in Antarctica were studied to determine past records of snow accumulation and density variations with depth in the Antarctic ice sheet. Data on the variation of porosity and ice load with depth were also obtained. No saline ice was encountered in any of the cores and all indications are that the bottom of the Ross Ice Shelf at Little America V is melting rather than accreting sea ice. Occasional periods of intensive melt and thin layers of debris, tentatively identified as volcanic ash, were observed. These ashes may have been deposited from volcanoes in Marie Byrd Land more than 2000 years ago. The densification process in polar snow is discussed and a method of predicting depth-density profiles from mean annual accumulation and temperature data is presented together with examples and other useful applications of the data.

**RR 198**
**ELECTRICAL CONDUCTION IN ICE.**
Camp, P.R., et al, Sept. 1967, 52p., AD-665 354, 21 refs.
Kiszenick, W., Arnold, D.A.
24-3344
ICE ELECTRICAL PROPERTIES, ELECTRICAL RESISTIVITY.
In an attempt to resolve the conflict existing in the literature as to dc electrical conductivity of ice, an extensive series of measurements has been made. Since surface conduction is a possible cause of some of the confusion, both bulk and surface conductivity have been measured at dc and audio-frequencies. Evidence was found for significant surface conductivity when slight contamination was present. In order to explain these results quantitatively, it is necessary to postulate a surface conduction region whose thickness varies with temperature. Extrinsic bulk conductivity due to trace impurities has been found to play an important part also and probably accounts for some of the disagreement in the literature. Using ice of the highest purity, bulk measurements show that, for a fresh sample, the dc conductivity is nearly independent of temperature down to temperatures at which the high frequency ac and dc conductivities are about equal. The results suggest that the high frequency conductivity is limited by 2 processes in parallel and that the dc conductivity is limited by the same 2 processes in series.

**RR 199**
**EXPERIMENTAL AND THEORETICAL STUDIES OF THE MECHANISM OF FROST HEAVING.**
Chalmers, B., et al, Oct. 1970, 23p., AD-714 641, 4 refs.
Jackson, K.A.
25-2432
FROST HEAVE, ICE LENSES, SOIL WATER, THEORIES, ANALYSIS (MATHEMATICS).
The paper discusses the Jackson and Chalmers theory of frost heave and describes attempts to verify it experimentally. The theory takes into account the local thermal conditions in the soil and the permeability of the soil. The theory predicts (or explains) stationary ice lens formation, where there is no advance of the frost line, and also predicts a rate of heave that is independent of the rate of advance of the freezing front. The theory assumes that a soil can be represented by a single characteristic void size although in real cases soils are not as uniform and homogeneous as assumed. Several experiments to verify the theory are described. They were generally unsuccessful, neither disproving nor substantiating the theory.

**RR 200**
**ICEBERGS AS A FRESH WATER SOURCE: AN APPRAISAL.**
Weeks, W.F., et al, January 1973, 29p., AD-755 815, 37 refs.
Campbell, W.J.
27-2530
ICEBERGS, WATER SUPPLY, LOGISTICS.
A history of the idea of transporting large icebergs to arid regions to provide a fresh water source is presented and the problem is considered in four main parts: 1) Location of a supply of icebergs. 2) Towing. 3) Melting in transit. 4) Economic feasibility. The problems related to both iceberg transport and processing are reviewed and although substantial problems do exist, they appear to be within the capabilities of current technology. It is suggested that the overall idea is indeed feasibile and should be explored further by specific groups of experts. (Author mod.)

**RR 201**
**SYSTEMATIC PACKING FROM THE STANDPOINT OF THE PRIMITIVE CELL.**
McGaw, R., Dec. 1967, 23p., AD-665 372, 23 refs.
24-3345
SPHERES, POROSITY, CRYSTAL STRUCTURE, SNOW COMPACTION, SYSTEMATIC PACKING.
The systematic packing of uniform spheres is generalized by describing the primitive rhombohedral cell which characterizes the arrangement between layers. Volume and porosity are found in the equations to depend on only two angular parameters, the angle between rows in a layer beta, and alpha the altitude angle between members of adjacent layers. An azimuth angle determines the position of the plane in which alpha is measured but does not enter into the porosity calculation. Four critical stacking arrangements are described, the porosities of which may be written as functions of the single parameter beta. The stable packings studied by Graton and Fraser (1935) are special cases of the critical positions. Typically unstable packings lie between these positions. Tables and graphs are presented which give the porosity of the primitive cell, as a function of alpha and beta, over the entire range from open to close packing for every possible 15vyer configuration.

**RR 202**
**HEAT OF FREEZING AND MELTING OF SEA ICE.**
Anderson, D., July 1966, 15p., AD-640 151, 16 refs.
24-3346
SEA ICE, ICE THERMAL PROPERTIES, SEA WATER FREEZING, MELTING, LATENT HEAT.
Computations are presented which show that the latent heat of freezing ice in equilibirum with sea water is less than that associated with freezing pure water of 0 C. The difference is due primarily to a temperature effect that is opposed to some extent by the effect of dissolved substances in the brine. The difference probably amounts to about 7 cal/gm of ice for a brine of about 150 per mill salinity, freezing at -8 C. When the effect of this difference in the total heat required to raise the temperature and melt sea ice is computed by Schwerdtfeger's method, it is found to be of the order of 0.5 cal/gm of sea ice for an overall ice salinity of 8 per mill and an initial temperature of -8 C. The differences are small but significant and until true values are established, published values of heats of freezing and melting and specific heats of sea ice should be used with discretion.

**RR 203**
**EFFECT OF A LOW VISCOSITY LAYER ON CONVECTION IN THE MANTLE.**
Weertman, J., May 1966, 20p., AD-635 158, 11 refs.
24-3347
GEOTHERMY, CONVECTION, EARTH MANTLE.
If thermal convection occurs in the Earth's mantle, it may also occur within the Moon and Mars. The dimensions of these planets are comparable to the thickness of the Earth's mantle. Presumably the amount of radioactive heat generated per unit mass is similar in all three bodies. However, the surface morphology of the Earth differs markedly from that of the Moon or Mars. The explanation for the difference is based on the effect produced on convection in the mantle by the presence of a low "viscosity" or low creep strength layer. A low viscosity layer changes the amount of "coupling" between the outer crust and mantle convection. The theory assumes that the viscosity or creep strength is essentially zero in the low viscosity layer. The analysis is similar to that developed earlier for the calculation of stresses within the mantle. The deeper the low viscosity layer lies within the mantle, the greater is the coupling of the outer crust of the mantle convection currents. If the low creep strength layer lies close to the surface the outer crust is decoupled from the interior. According to the literature, the depth of the low velocity layer is determined by the temperature and pressure profiles within the mantle.

**RR 204**
**EFFECT OF A BASAL WATER LAYER ON THE DIMENSIONS OF ICE SHEETS.**
Weertman, J., Aug. 1966, 22p., AD-644 596, 20 refs.
24-3348
GLACIER MOVEMENT, GLACIER FRICTION, GLACIAL FEATURES, PLASTIC FLOW, GROWTH, MODELS.
The effect of a basal water layer on the equilibrium dimensions of an ice sheet is examined. A thick water layer can decrease the equilibrium thickness of an ice sheet such as covers Antarctica (which contains no significant ablational areas) by a factor of the order of 2. Similar large changes in the equilibrium dimensions occur for ice-age ice sheets (which have extensive ablational areas). The extent of the ablation area of an ice-age ice sheet which may be covered with morainal debris also is calculated.

**RR 205**
**PROCESSING MAGNETICALLY TAPED INFRARED DATA ACQUIRED IN THE ARCTIC, AND ASSOCIATED STUDIES.**
Dembsey, D.A., et al, March 1966, 49p., AD-370 918.
England, G.
26-3617
INFRARED MAPPING, PHOTOINTERPRETATION, AERIAL RECONNAISSANCE, DATA PROCESSING.

Under the sponsorship of the United States Army Cold Regions Research and Engineering Laboratory, personnel of the Infrared Physics Laboratory at Willow Run Laboratories engaged in studies aimed at improving the utility and interpretability of infrared data acquired in arctic regions. The first area of inquiry was the processing of infrared scanner signals recorded on magnetic tape so as to produce enhanced imagery, and found this technique yields imagery of greater utility. Two other studies were concerned with the thermodynamics of ice and snow; in one, the infrared emissivity of snow was measured, while the other derived a steady-state model for surface temperatures in a sheet of snow and ice.

**RR 206**
**EFFECTS OF THERMAL POLLUTION ON RIVER ICE CONDITIONS. PART 1. A GENERAL METHOD OF CALCULATION. PART II. SIMPLIFIED METHOD OF CALCULATION.**
Dingman, S.L., et al, Dec. 1967 and Aug. 1969, 33p. and 11p., AD-666 205, AD-694 372, 21 refs.
Weeks, W.F., Yen, Y.-C., Assur, A.
24-3349
POLYNYAS, RIVER ICE, WATER POLLUTION, NAVIGATION, WATER TEMPERATURE, THERMAL POLLUTION.
An attempt is made to calculate the length of the ice-free reach which develops during the winter below a thermal pollution site on a river. A differential equation for the steady state heat balance of a volume element of a river is developed. The two principal limitations in accurately calculating downstream temperature changes are related to difficulties in evaluating the degree of lateral mixing in natural rivers and the convective and evaporative heat losses under unstable atmospheric conditions. Observations of lengths of ice-free reaches on the Mississippi River are in good agreement with the calculated values. Significant portions of the St. Lawrence Seaway can be kept ice-free by the installation of nuclear reactors at appropriate locations.

**RR 207**
**UNIFIED TREATMENT OF VECTORS AND TENSORS IN N-DIMENSIONAL EUCLIDEAN SPACE.**
Takagi, S., June 1968, 44p., AD-674 186, 13 refs.
24-3350
TENSORS, VECTORS, RIEMANNIAN MANIFOLDS, DEFORMATION, SNOW, SOILS.
A unified treatment of vectors, tensors and multivectors in n-dimensional Euclidean space is presented. The unified treatment is so systematized that n-dimensional tensors of abritrary order are treated similarly to three-dimensional vectors. Work on this subject was done in connection with difficulties which arise in the continuum mechanics pertaining to large deformations of such media as soil and snow.

**RR 208**
**ARTIFICIAL RADIOACTIVITY REFERENCE HORIZONS IN GREENLAND FIRN.**
Crozaz, G., et al, Aug. 1966, 8p., AD-644 597, 13 refs.
Langway, C.C., Jr., Picciotto, E.
24-3351
FALLOUT, RADIOACTIVITY.
Total beta measurements have been made on melt water samples from a stratigraphically dated firn core profile from the inland Greenland ice sheet. A marked increase in radioactivity is found in the 1953 firn layer which corresponds to the first important fallout from nuclear test bombs. The pre-1953 natural beta activity is 5 dpm/kg. The influx of artificial debris from the Ivy tests in 1953 is noted by a sharp rise in beta activity to 10 dpm/kg. Total Sr-90 deposit to June 1964 is 9.3 millicuries/sq km. Average Pb-210 activity at time of deposit is 3.9 dpm/kg.

**RR 209**
**VEGETATION OF THE YUKON FLATS REGION, ALASKA.**
Johnson, P.L., et al, Nov. 1966, 53p., AD-647 237, 34 refs.
Vogel, T.C.
24-3352
VEGETATION, CLIMATE, ECOLOGY, UNITED STATES—ALASKA—YUKON FLATS.
This paper describes the characteristic vegetation types and their ecology in the Yukon Flats Region, Alaska, and associates aerial photographic patterns with these types. The discussion includes the physiographic setting, vegetation patterns, forest fires, bog succession, the selection of sample sites, vegetation sampling, photographic interpretation, composition and structure of vegetation, and radar and thermal imagery. Appendix A lists the scientific and common names of plants, while Appendix B tabulates selected soil samples from vegetation stands. Ground and air reconnaissance were used to select 43 stands representative of the common plant communities. Ten individual trees were harvested by meter increments, and stem, branch, and leaf components were weighed. Three kinds of vegetation type maps were constructed from an examination of aerial photography by application of the ground data to photo interpretation.

**RR 210**
**PRESSURE WAVE PROPAGATION IN SNOW WITH NONUNIFORM PERMEABILITY.**
Yen, Y.-C., et al, Aug. 1966, 9p., AD-640 451, 9 refs.
Fan, S.S.T.
24-3353
WAVE PROPAGATION, PERMEABILITY, DETONATION WAVES, SNOW PERMEABILITY.
A mathematical analysis of pressure wave propagation through a deep layer of snow with nonuniform permeability is presented. The study extends previous investigations on porous media in which the physical properties and imposed boundary conditions have been assumed or kept constant. Two cases of boundary conditions were considered. Case I: imposed pressure at the boundary remains constant. Case II: imposed pressure at the boundary falls exponentially with time. Darcy's law was assumed to be valid. The nonlinear differential equation was solved by the finite difference technique and the results are presented in terms of dimensionless variables.

**RR 211**
**NATURAL CONVECTION IN ICE MELTING FROM BELOW.**
Yen, Y.-C., Dec. 1966, 13p., AD-648 515, 12 refs.
24-3354
ICE HEAT FLUX, MELTING, ICE THERMAL PROPERTIES, HEAT TRANSFER, ANALYSIS (MATHEMATICS).
An experimental technique has been successfully developed to study the effect of natural convection (thermal instability) on the melting rate of ice. Reproducible results were obtained by using homogeneous, bubble-free ice samples for the melting process. The problem of volume change due to phase transition or separation of the ice-water interface encountered when melting from below was solved by continuosuly adding water at the same temperature as the constant temperature bath which supplied the heat for melting. Under certain temperature conditions irregularities in the interface, a result of convective motion, became very apparent and could be observed visually. By periodically measuring the amount of water added and varying the initial temperature of the ice sample and that of the heat source, extensive results were obtained demonstrating the effects of these temperatures on the melting rate which could be expressed in terms of dimensionless parameters. The results from this experimental investigation are compared with those obtained from an analytical solution of the same problem.

**RR 212**
**HEAT CONDUCTION IN MOIST POROUS MEDIA.**
Yen, Y.-C., Dec. 1966, 10p., AD-652 872, 3 refs.
24-3355
HEAT FLUX, THERMAL CONDUCTIVITY, POROSITY, PERMEABILITY, SNOW THERMAL PROPERTIES, SNOW PERMEABILITY.
An equation has been developed to describe heat conduction in moist porous media. Specific examples are given to demonstrate the effect of dry medium density and water vapor diffusivity through the medium on the rate of temperature propagation in snow.

**RR 213**
**WATER TEMPERATURES IN A SHALLOW LAKE DURING ICE FORMATION, GROWTH AND DECAY.**
Bilello, M.A., Dec. 1967, 20p., AD-696 408, 35 refs.
24-3356
WATER TEMPERATURE, LAKE ICE, FREEZING, MELTING, PHASE TRANSFORMATIONS.
Continuous water temperature measurements were made in a shallow lake in upper Michigan prior to and during ice formation, and during ice growth and decay. Szeveral full circulations or "overturns" at 4zC w5tre observed during autumn and the temperature throughout the lake just prior to complete freeze-over reduced to a minimum of 0.2C. After a permanent ice cover had formed, the water beneath the ice began to warm up. Within a 25-day period during December the water temperature near the bottom of the lake increased from 0.3C to 3.0C. Quantitative analysis of this heat gain showed that it came principally from the energy stored during the summer in the underlying soils. During the ice thaw period in April a unique reduction in temperature was recorded throughout the main mass of water. Since the lake is thermally stratified, it was assumed that this cooling could only result from mechanical action in the water. This phenomenon probably takes place as the surface water from melting snow around the area flows into the lake and causes overturning.

**RR 214**
**ROLE OF SINTERING IN SNOW CONSTRUCTION.**
Ramseier, R.O., July 1967, 10p., AD-659 350, 21 refs.
24-3357
SNOW (CONSTRUCTION MATERIAL), SNOW COMPACTION, SINTERING, RUNWAYS, AIRCRAFT LANDING AREAS, METAMORPHISM (SNOW).
The mechanism of sintering and the effect of compaction on snow is discussed. Examples of possible snow runway construction using processed snow for Site II, Greenland, and McMurdo Sound and Amundsen-Scott South Pole Station, Antarctica, are given. From theory and the examples discussed, it is concluded that snow runways capable of handling large aircraft can be constructed in any polar or temperate region with enough snow and temperatures below the melting point for a sustained period.

**RR 215** Record deleted.

**RR 216**
**SLIDING OF NON-TEMPERATE GLACIERS.**
Weertman, J., Dec. 1966, 4p., AD-647 272, 5 refs.
24-3358
PLASTIC FLOW, GLACIER MOVEMENT, TEMPERATURE DISTRIBUTION, MELTING POINTS, FRICTION, SHEAR STRESS.
It is shown that the temperature gradient normal to the bed is an important parameter in determining whether sliding can or cannot occur in a glacier whose bottom surface is at the melting point. Only if a large temperature gradient exists will sliding be prevented. Since the temperature gradient of a glacier whose bottom surface is at the melting point is expected to be small, it is concluded that sliding usually will occur in such a glacier even if obstacles in the bed may protrude into cold ice.

**RR 217**
**A NEW SOLUTION OF THE BOUNDARY LAYER EQUATION AND ITS APPLICATION.**
Odar, F., Aug. 1967, 25p., AD-660 339, 7 refs.
24-3359
PLASTIC FLOW, BOUNDARY LAYER, UNSTEADY FLOW, FRICTION, ANALYSIS (MATHEMATICS).
Solutions of the boundary layer equation for an unsteady flow have previously been obtained for only a few boundary conditions such as those which exist in suddenly accelerated or uniformly accelerating flows. In this paper a general solution using the method of successive approximations for an arbitrarily accelerating flow is presented. The solution, which is expressed in an integral form including the acceleration as a chosen function of time, is valid for both two-dimensional and axially symmetrical flows. An example is presented in which the variation of velocity outside of the boundary layer is a fourth degreee polynomial in time multiplied by a function depending on shape of object.

**RR 218**
**PHASE COMPOSITION OF FROZEN MONTMORILLONITE-WATER MIXTURES FROM HEAT CAPACITY MEASUREMENTS.**
Anderson, D.M., May 1967, 10p., AD-656 601, 15 refs.
24-3360
HEAT MEASUREMENT, FROZEN GROUND, CLAY SOILS, UNFROZEN WATER CONTENT, TEMPERATURE FACTORS.
Equations are written that form the basis of a method for determining the unfrozen water content of frozen clay-water mixtures from heat capacity measurements. The heat capacity of frozen sodium-montmorillonite water mixtures was determined at -4.7 and -9.6C with a Calvet Microcalorimeter. The data were then used in conjuction with the method described to obtain the unfrozen water content of these clay water mixtures. The data obtained indicate that the method is applicable at temperatures below about -5C. The amount of unfrozen water found in the frozen clay-water mixtures at -5 to -10C is equivalent to an interfacial surface layer of water of from one to two molecular diameters in thickness. Most of this water can be accommodated and is thought to be located in interlamellar regions.

**RR 219**
**INTERFACE BETWEEN ICE AND SILICATE SURFACES.**
Anderson, D.M., March 1967, 31p., AD-653 612, Bibliog. p.27-31.
24-3361
ICE SOLID INTERFACE, CLAY SOILS, UNFROZEN WATER CONTENT, SILICATES, FREEZING POINTS, SUPERCOOLING, ADSORPTION, PHASE TRANSFORMATIONS.
Experiments have been conducted with a particular layer lattice silicate, montmorillonite, in order to study the interaction of water and ice with silicate surfaces. The structural features of this class of silicate minerals are described, and other aspects which have a particular bearing on interfacial phenomena are discussed. Emphasis is placed on the nature of water and aqueous solutions, mechanisms of clay-water interaction, physical and thermodynamic properties of clay-adsorbed water, freezing point depression and supercooling, the existence of unfrozen interfacial water, spatial distribution of unfrozen water, the nature of the ice phase, and phase relationships.

**RR 220**
**CREEP OF SNOW AND ICE.**
Mellor, M., , Dec. 1966, 13p., AD-649 367, 23 refs.
Smith, J.H.
24-3362
ICE CREEP, SNOW CREEP, STRAIN RATE, STRESS ANALYSIS, SNOW DENSITY, LOADS (FORCES), VISCOSITY.
Constant load creep tests in uniaxial unconfined compression were performed on samples of sintered snow and bubbly polycrystalline ice. Nominal axial stresses were in the range 0.1 to 1.0 kgf/sq cm for snow, and 0.5 to 20 kgf/sq cm for ice. The range of temperatures investigated was from -0.5 to -34.5C. Assuming creep to follow the Arrhenius relation, values of apparent activation energy for secondary creep under a nominal axial stress of 0.5 kgf/sq cm varied from 10.7 kcal/mole for

ice of density 0.83 g/cu cm to 17.8 kcal/mole for snow of density 0.44 g/cu cm. An equation is presented relating the dependence of strain rate on stress for polycrystalline ice through a range of stresses and temperatures. It is suggested that the creep of polycrystalline ice depends on at least two distinct mechanisms in the stress range studied. If each mechanism has its own characteristic activation energy, the apparent activation energy measured in creep experiments may well vary with stress level. In snow subjected to a given nominal stress, such an effect should be reflected in variation of apparent activation energy with bulk density.

**RR 221**
**GIBBS-EINSTEIN TENSOR ANALYSIS WITH APPLICATION TO CONTINUUM MECHANICS AND CANONICAL FORMS OF GENERAL SECOND-ORDER TENSORS.**
Takagi, S., Nov. 1968, 31p., AD-680 900, 11 refs.
24-3363
THERMODYNAMICS, DEFORMATION, STRAIN MEASUREMENT, DYADS, ANALYSIS (MATHEMATICS).
A new tensor analysis, called the Gibbs-Einstein tensor analysis, is developed based on the concept that directions are algebraic quantities subject to the rule of forming scalar products, tensor products, and linear combinations. The new tensor analysis is explained in this paper by way of reformulating continuum mechanics and the Hamilton-Cayley theorem in matrix theory. The latter reformulation yields an explanation of the deformation dyads introduced in the former reformulation. A scalar product of two deformation dyads yields the strain tensor, which is a thermodynamic state variable for thermodynamically reversible deformations. Mathematics dealing with directions in a flat space becomes much simpler and more understandable when the Gibbs-Einstein tensor expression is used.

**RR 222**
**SOME THERMODYNAMIC RELATIONSHIPS FOR SOILS AT OR BELOW THE FREEZING POINT. PART 1. FREEZING POINT DEPRESSION AND HEAT CAPACITY. PART 2. EFFECTS OF TEMPERATURE AND PRESSURE ON UNFROZEN SOIL WATER.**
Low, P.F., et al, Dec. 1966 and July 1967, 18p. and 5p., AD-649 729, AD-662 048, 24 refs.
Anderson, D.M., Hoekstra, P.
24-3364
FROZEN GROUND, THERMODYNAMICS, WATER CONTENT, TEMPERATURE EFFECTS, PRESSURE FACTORS, FREEZING POINT DEPRESSION, HEAT CAPACITY.
An extended equation was derived relating the relative partial molar free energy of water in a soil to its freezing point depression and relative partial molar heat content. The equation was used to prepare a table from which each of these 3 quantities can be ascertained if the other 2 are known. The table was used with experimental data to obtain a curve of freezing point depression vs. water content for Na-Wyoming bentonite. An equation for the heat capacity of a partially frozen soil was also derived. This equation was employed to calculate the heat capacities of the clay at different water contents and sub-zero temperatures. A comparison of the calculated unfrozen water contents and heat capacities of the partially frozen Na-Wyoming bontonite with the available experimental data indicated satisfactory agreement, especially as regards the unfrozen water contents.

**RR 223**
**UMIAT BENTONITE: AN UNUSUAL MONTMORILLONITE FROM UMIAT, ALASKA.**
Anderson, D.M., , Mar. 1967, 11p., AD-654 988, 13 refs.
Reynolds, R.C., Jr.
24-3365
CLAY SOILS, X RAY DIFFRACTION, MONTMORILLONITE, UNITED STATES—ALASKA—COLVILLE RIVER.
Numerous bentonite clays interbedded with shale and coal are exposed in the interfingering, Cretaceous sediments along the Colville River and its tributaries in northern Alaska. Two bentonite beds of high purity, ten to twelve inches thick, are conveniently accessible at Umiat Mountain, four miles northeast of Umiat, Alaska. X-ray diffraction, X-ray fluorescence and other diagnostic techniques revealed the bentonite to be nearly pure montmorillonite with certain beidellitic characteristics. It is proposed that this clay be known as Umiat bentonite.

**RR 224** Record deleted.

**RR 225**
**LASER SCINTILLATION CAUSED BY TURBULENCE NEAR THE GROUND.**
Portman, D.J., , Jan. 1968, 77p., AD-666 798, 42 refs.
Ryznar, E., Waqif, A.A.
24-3366
TURBULENT FLOW, LASERS, ELECTROMAGNETIC PROPERTIES, WAVE PROPAGATION, LOW-LEVEL TURBULENCE, SCINTILLATION, TEMPERATURE FACTORS.
Laser scintillation was measured for a horizontal optical path 500 m long and 1 m high for various conditions of horizontally homogeneous turbulence. Wind direction, average vertical distributions of wind speed and temperature, and, in some cases, turbulent fluctuations of wind velocity were measured simultaneously. The results of the measurements were analyzed in relation to a set of theoretical relationships derived by Tatarski (1961) for electromagnetic wave propagation in turbulent flow. Tatarski's derivation of the scintillation frequency spectrum is summarized and interpreted for various conditions of turbulence. Analysis of the spectral data showed that their characteristics were similar to Tatarski's theoretical spectrum if the divergence of the laser beam, the size of the receiver aperture, the intensity of scintillation and turbulence spectra were considered. The Appendix consists of a description and discussion of the method of spectral analysis and its application to processing the scintillation and turbulence data.

**RR 226**
**SINTERING PROCESS IN SNOW.**
Ramseier, R.O., , Feb. 1967, 4p., AD-651 452, 12 refs.
Keeler, C.M.
24-3367
SNOW SAMPLERS, ICE CRYSTALS, COMPRESSIVE STRENGTH, SINTERING, EVAPORATION, CONDENSING, MASS TRANSFER.
The growth of bonds between snow grains or ice spheres has been variously attributed to surface diffusion, volume diffusion, and evaporation-condensation. To distinguish among these possible mechanisms, the unconfined compressive strength of two groups of snow samples was determined as a function of time.One group was allowed to sinter under atmospheric conditions while the other group was kept immersed in silicone oil. The much lower rate of strengthening of the later group suggests that evaporation-condensation must be the major mechanism of mass transport in snow under atmospheric conditions. The possible magnitudes of the various mass transfer coefficients are discussed.

**RR 227**
**SOME MECHANICAL PROPERTIES OF ALPINE SNOW, MONTANA 1964-66.**
Keeler, C.M., et al, March 1967, 43p., AD-655 528, 36 refs.
Weeks, W.F.
24-3368
SNOW SURVEYS, SNOW DENSITY, SNOW MECHANICS, MECHANICAL PROPERTIES.
Data on the physical properties of seasonal alpine snow have been collected from the Beartooth Mountains near Cooke City, Montana, and the Bridge Range near Bozeman, Montana. Systematic measurements of snow density, temperature, structure, ram and Canadian hardness, centrifugal tensile strength and shear strength measured with a shear box and several types of shear vanes are included. Test results were grouped according to gross snow types and whether the snow was wet or dry. Interrelations between the different test parameters were studied. Experiments were also conducted to study the sources of error in making in-situ mechanical tests on snow without utilizing a pit wall. The main factor contributing to the experimental scatter is lateral inhomogeneity in the snow cover. However, the standard deviation of a group of strength tests is shown to be directly proportional to the mean value of the group. The systematic relations between snow properties invariably become obscured when different snow "types" are indiscriminantly grouped together.

**RR 228** Record deleted.

**RR 229**
**FORCES ON A SPHERE MOVING STEADILY ALONG A CIRCULAR PATH IN A VISCOUS FLUID.**
Fuat, O., April 1967, 6p., AD-652 267, 2 refs.
24-3369
LOADS (FORCES), SPHERES, VISCOUS FLOW.
Forces on a sphere moving steadily along a circular path in a viscous fluid are measured and it is found that within the experimental range both the longitudinal and normal forces are dependent on the Reynolds number and not on the radius of the path. Thus, the conventional drag coefficient can also be obtained from a rotational motion.

**RR 230**
**DEPOSITION AND EROSION OF SNOW BY THE WIND.**
Radok, U., Sept. 1968, 23p., AD-680 179, 49 refs.
24-3370
BLOWING SNOW, SNOWDRIFTS, WIND FACTORS, MASS FLOW.
The theories of uniform and non-uniform drifting snow are summarized with special emphasis on drift transport as a function of wind velocity. It is confirmed that the snow drift process involves a mobile surface layer of salting particles, with a self-regulating thickness depending only on the surface stress and not on the snow concentration in the free air stream. It is shown to be a characteristic of snow (in contrast to sand or silt) that saltation and suspension drift occur side by side and that the latter reaches predominance as the wind velocity rises through the most common range of surface values. Theoretical reasons and observational evidence are produced for the view that deposition or erosion occurs on the snow surface during snow drift primarily as the result of mass flux convergence or divergence in the free air stream. This implies that the associated vertical mass flux penetrates the saltation layer which moves up or down with the snow surface. The survey concludes with suggestions for the experimental study of snow deposition and erosion in terms of the free air flow field and for a study of pneumatic particle transport in terms of saltation and of its electrical effects.

**RR 231**
**STUDY OF HEXAGONAL AND CUBIC ICE AT LOW TEMPERATURES.**
Kumai, M., July 1967, 17p., AD-660 323, 19 refs.
24-3371
ICE CRYSTAL STRUCTURE, TEMPERATURE EFFECTS. ICE THERMAL PROPERTIES, CUBIC ICE, LATTICE MODELS.
The formation of hexagonal and cubic forms of ice was studied by the use of a cold stage in an electron microscope within the temperature range of -190 to 170 C. Ice crystal specimens were made on cold substrates, i.e., a collodion film, gold foil, or copper grid on the specimen holder of the cold stage. The structural forms of the ice were detected with the electron microscope using the selected area electron diffraction method. The hexagonal form of ice formed on the cold substrates at temperatures from -90 to -100 C. At -100 to -130 C, both hexagonal and cubic forms of ice were detected. From -130 to -160 C, only cubic ice was found. At temperatures below -170 C, minute crystals of cubic ice were detected. No transformation of the structural form of ice from hexagonal to cubic or from cubic to hexagonal occurred when the temperature of the specimens was varied in the range of -90 to -160 C. The minute crystals of cubic ice formed below -160 C were transformed into larger cubic ice crystals by heating them to a temperature between -130 and -150 C. The lattice constants of hexagonal and cubic ice, and the coefficient of thermal expansion of ice were calculated from the experimental results.

**RR 232**
**SELF-DIFFUSION IN ICE MONOCRYSTALS.**
Ramseier, R.O., Oct. 1967, 40p., AD-662 196, 53 refs.
24-3372
ICE CRYSTAL GROWTH, ARTIFICIAL ICE CRYSTALS, SELF DIFFUSION, DIFFUSIVITY.
The self-diffusion of tritium, parallel and perpendicular to the optical axis of naturally occurring and artificially grown ice monocrystals, was studied between -2.5 and -35.9C. The artificial ice monocrystals were grown using a zone-melting technique. Activated samples were stored for several weeks, then sectioned by microtome and analyzed in a liquid scintillation counter to obtain the self-diffusion coefficients. The plane source solution of Fick's second law was used in treating the data. The diffusion coefficients were found to be identical for both types of ice. A slight anisotropy was found due to the geometry of the crystal. Based on the experimental data, it is concluded that the diffusion takes place by a vacancy mechanism and that entire water molecules are diffusing, i.e., molecular diffusion occurs.

**RR 233**
**ACCUMULATION PATTERNS ON THE GREENLAND ICE SHEET.**
Mock, S.J., July 1967, 11p., AD-661 638, 16 refs.
24-3373
ACCUMULATION, GLACIER MASS BALANCE, GLACIER ICE, FORECASTING, LATITUDE, LONGITUDE, ELEVATION, GREENLAND.
All available mean annual accumulation data on the Greenland ice sheet (excluding the Thule Peninsula) have been collected and analyzed using multiple regression techniques to develop equations capable of predicting mean annual accumulation. The analysis was carried out for north Greenland, south Greenland, and for the transition zone between the two major regions. The resulting equations show that mean annual accumulation can be predicted from the independent parameters, latitude, longitude, and elevation. The patterns of accumulation are shown in a series of isohyetal maps (contours of accumulation in terms of water). The major feature shown is a well defined asymmetry in accumulation; a pronounced east slope maximum in south Greenland and an equally pronounced west slope maximum in north Greenland. Poleward of 69 N, isohyets decrease in elevation to the north. Mean annual accumulation ranges from greater than 90 g/sq cm in southeast Greenland to less than 15/sq cm in northeast Greenland. A brief discussion of mass balance estimates of the Greenland ice sheet and of the relevance of this study to them is included.

**RR 234**
**AN ANALYTICAL AND EXPERIMENTAL STUDY OF A MELTING PROBLEM WITH NATURAL CONVECTION.**
Yen, Y.-C., July 1967, 8p., AD-659 780, 4 refs.
24-3374
HEAT TRANSFER, CONVECTION, PHASE TRANSFORMATIONS, ICE HEAT FLUX, MELTING.
The correlation by O'Toole and Silverston (1959) of natural convection heat transfer for fluids confined between two parallel horizontal plates has been extended to the case involving phase change. The new correlation, which is applicable for melting from below in a water-ice system, is described with special focus on theoretical considerations, estimation of heat flux, and the experimental and analytical results. In all experiments, bubble-free, homogeneous ice samples were prepared beforehand to assure reliable and reproducible results. In general, the results from theory and experiment are in close agreement.

**RR 235**
**FORMATION AND REDUCTION OF ICE FOG.**
Kumai, M., March 1969, 21p., AD-691 325, 8 refs.
24-3375
ICE FOG, ICE CRYSTALS, NUCLEATING AGENTS, WATER VAPOR, AEROSOLS, AIR POLLUTION.
During January and February of 1962, 1963 and 1964, Fairbanks, Alaska, and vicinity was the site of a series of studies dealing with ice fog and ice crystals. This report presents the results of an investigation of the amount and extent of air pollution and ice fog in the area with special emphasis on reducing ice fog by decreasing the water vapor being emitted into the atmosphere. The major sources of water vapor at the two military installations in the region, Fort Wainwright and Eielson AFB, are the heating and power plants and their associated cooling ponds. In the populated areas around Fairbanks, a high aerosol concentration of about 100,000 particles/cu cm exists, whereas in the uninhabited areas the concentration is extremely low (about 300 particles/cu cm). Much of the high concentration is due to the burning of coal for heat and power. Because the coal is of low grade it also emits about 350,000 kg of water vapor into the atmosphere on a day when the temperature is 40C. This water vapor condenses on the aerosols and produces ice fog. Anthracite or semi-bituminous coal would reduce the water vapor output to only 1/5 of the amount produced by the low grade coal. Water vapor from cooling ponds can be reduced by freezing the surfaces of the ponds.

**RR 236**
**AN IN SITU GAS EXTRACTION SYSTEM FOR RADIOCARBON DATING.**
Oeschger, H., et al, Oct. 1967, 4p., AD-662 214, 5 refs.
Langway, C.C., Jr., Alder, B.
24-3376
GLACIER ICE, RADIOCARBON DATING, BOREHOLES, GAS EXTRACTION.
In March 1966 at the Tuto ice tunnel, Greenland, a team from USA CRREL and the University of Bern tested a new down-borehole device which would allow gas to be extracted from within shallow or deep boreholes. The tunnel ice was unfractured and its temperature was constant at -10 C. A location where, in 1964, C-14 age dates had been obtained was used as a check point for the down-borehole tests. Comparative samples show good agreement and indicate a mean value of 5120 years B.P. for the age of ice at this location. The simplicity of the down-borehole gas extraction system enables application of the carbon dating method to any natural, undisturbed glacier ice mass which can be sampled by boring. The gas extraction apparatus and field experiments are described.

**RR 237**
**MEASUREMENTS OF ULTRASONIC WAVE VELOCITIES IN ICE CORES FROM GREENLAND AND ANTARCTICA.**
Bennett, H.F., June 1972, 55p., AD-745 904, Bibliography p.53-55.
27-671
ICE ACOUSTICS, SOUND WAVES, WAVE PROPAGATION, SEISMIC VELOCITY, ICE CORES, ANTARCTICA, GREENLAND.
Detailed ultrasonic velocity measurements were made on snow and ice cores from Greenland and Antarctica in order to study velocity anisotropy and its relationship to the petrofabric analysis of these cores. In addition, ultrasonic velocities were measured in the near-surface snow layers at Byrd Station and South Pole Station, Antarctica, to provide a detailed velocity profile in the region of the ice sheet where the velocity is greatly influenced by the snow structure. The experimental arrangement, including the design of equipment, measurement errors, techniques, and problems encountered in the study, is discussed. The theory of wave propagation in a general anisotropic medium is reviewed and a detailed presentation of this theory, concerning transversely isotropic media, is given. A method is developed for calculating a theoretical velocity model from the petrofabric analysis of the ice cores, thus providing a means of testing the theory with field and laboratory observations. Based on a comparison of the field and laboratory observations with the theoretical predictions, these conclusions were made: 1) the surface snow layers act as a high-frequency-cut filter on sonic wave propagation; 2) there is good agreement between the theoretical velocity models based on the petrofabric ice core analysis and the observed seismic and ultrasonic shear-wave velocity observations, but poorer agreement with the compressional wave velocities; 3) there is good agreement between the theoretical ray path calculations and the observed data in the near-surface anisotropic snow layers; 4) acoustic birefringence is demonstrated in the single ice crystal and observed in the ice sheets of Greenland and Antarctica; and 5) the ice sheets of Greenland and Antarctica display varying degrees of anisotropy.

**RR 238**
**SNOW ACCUMULATION STUDIES ON THE THULE PENINSULA, GREENLAND.**
Mock, S.J., Feb. 1968, 22p., AD-667 947, 31 refs.
24-3377
SNOW COVER DISTRIBUTION, ICE SURFACE FEATURES, ACCUMULATION, GLACIER FLOW, GREENLAND—THULE.
Data from stake measurements, marker boards and pits along a 136-km trail crossing the Thule Peninsula sector of the Greenland ice sheet have been used to determine both the regional and local distribution of snow accumulation. On a regional scale, trend surfaces of mean annual accumulation can be adequately predicted from a model using distance from moisture source and elevation as independent parameters. A series of steplike or wavelike features breaks the smooth profile of the ice sheet and causes profound changes in accumulation rates on a local scale. The accumulation pattern over these features can be predicted from surface slope and departure from regional elevation. Profiles of surface and subsurface topography indicate a direct relationship between subsurface hills and steplike features but cannot be quantitatively accounted for by existing ice flow theory. Detailed accumulation studies in conjunction with a program of spirit leveling in the vicinity of Camp Century have revealed the development of a shallow valleylike feature. Within this feature accumulation rates have increased, indicating that it is the result of flow phenomena.

**RR 239**
**LIMNOLOGICAL RECONNAISSANCE IN INTERIOR ALASKA.**
Likens, G.E., et al, June 1968, 41p., AD-675 405, Bibliog. p.29-31.
Johnson, P.L.
24-3378
LIMNOLOGY, LAKES, UNITED STATES—ALASKA.
Chemical, physical and biological measurements were made in about 40 lakes and 9 other aquatic habitats in interior Alaska, primarily in the Tanana and Yukon River drainages. The lake waters were generally very alkaline in both the Yukon and Tanana drainages. Calcium, magnesium, sodium and bicarbonate ions dominated the water chemistry. In several lakes concentrations of sulfate and magnesium exceeded the limits suggested for potable water. The chemistry of surface water from various springs and the Arctic Coastal Plain was contrasted with that of lakes in interior Alaska. Sediment temperatures demonstrated a significant feature of unfrozen lakes in cold regions: a considerable net amount of heat flows from the water to the underlying sediments annually. Light penetration into the lakes varied widely (extinction coefficients of 0.46/m to 3.57/m). A relatively high rate of carbon fixation (764 mg C/cu m day) was measured in C-14 experiments. It was inferred that nutrients were the more probable limiting factor for primary production in these lakes.

**RR 240**
**HYDROLOGY OF A DRAINAGE BASIN ON THE ALASKAN COASTAL PLAIN.**
Brown, J., et al, April 1968, 18p., AD-671 005, 26 refs.
Dingman, S.L., Lewellen, R.I.
24-3379
PERMAFROST HYDROLOGY, HYDROLOGIC CYCLE, STREAM FLOW, RUNOFF, PRECIPITATION (METEOROLOGY), PERMAFROST BENEATH LAKES, PATTERNED GROUND, ICE WEDGES, SEASONAL FREEZE THAW, UNITED STATES—ALASKA—BARROW.
A 4-summer hydrologic record from a 1.6-sq km drainage basin at Barrow, Alaska is analyzed. The watershed, a drained lake basin, is underlain by continuous permafrost within 0.3 m of the tundra surface and is covered by ice-wedge polygons and numerous small shallow ponds. Considerable variations from the 20-yr means of summer climate (thaw period 88 days, precipitation 67 mm) are represented in the data: 1963 - cold, extremely wet; 1964 - cold, extremely dry; 1966 - cool, wet. Runoff varied greatly from storm to storm, occurring primarily through and over the tundra mat and through an intricate system of polygonal troughs and ponds. As a result of the subdued coastal topography, varying areas (0.3 sq km to 1.6 sq km) contribute to runoff from different storms. Analyses of hydrographs revealed: 1) lag times generally from 3 to 10 hr; 2) recession constants of about 50 hr, but occasionally as much as 160 hr; and 3) runoff from individual storms between 1 and 70 per cent. About 5 per cent of the thaw season precipitation normally runs off.

**RR 241** Record deleted.

**RR 242**
**ATTENUATION OF VISIBLE LIGHT BY FALLING SNOW.**
O'Brien, H.W., June 1969, 27 p., AD-702 905, 21 refs.
25-1071
ATMOSPHERIC ATTENUATION, LIGHT SCATTERING, SNOW CRYSTALS, LIGHT (VISIBLE RADIATION), OPTICAL PROPERTIES, PHOTOMETRY, SNOWFALL, CLASSIFICATIONS.
The attenuation of visible light by falling snow was studied by making simultaneous attenuation measurements and snow concentration measurements. The attenuation coefficient was calculated from photometric measurements and from visual observations. Snow concentration in the air was evaluated by two methods: from Formvar replicas collected during the snowfall, and by mass accumulation of snow in collecting pans. The snowflakes were arbitrarily classified by crystal types according to their estimated fall velocity. It was found that the correlation between extinction coefficient (attenuation) and snow concentration was generally much higher by types than when all snowflakes were considered together regardless of crystal components and degree of riming. Two types, apparently improperly classified, displayed lower correlations than the overall group. When no fog is present during the snowfall, the experimental results coincide well with attenuation theory if a reasonable correction is applied to the values obtained in the measurement of snowflake diameters. Measurements of mass flux indicate that for a given intensity the attenuation caused by snow is an order of magnitude greater than that caused by the same mass flux of rain.

**RR 243**
**INTERNAL FRICTION OF SINGLE-CRYSTAL ICE.**
Van Devender, J.P., et al, March 1973, 39p., AD-759 930, 32 refs.
Itagaki, K
28-687
ICE ACOUSTICS, WAVE PROPAGATION, DISLOCATIONS (MATERIALS), INTERNAL FRICTION, ICE FRICTION.
The internal friction of single-crystal ice has been attributed to reorientation of the water molecule under periodic stress. However, the theory for damped dislocations, which offers another mechanism for the internal friction of ice, has not been investigated. The effects of scratching the surface of ice samples and X-irradiating and plastically deforming them were evaluated. The effects observed on the internal friction of pure, single-crystal ice, in the flexure mode of oscillation between 400 and 1400 Hz, supported the existence of a dislocation-controlled mechanism, with the drag produced by the interaction of the dislocation with the protons in the crystal. In addition, analysis of the detailed shape of the data curve showed two peaks of tan delta as a function of temperature. The second peak, which had not been previously reported, had an activation energy of 0.16 eV and a relaxation time of 1.7 x 1/100,000,000 sec at infinite temperature. These experiments indicated that both peaks were controlled by the dislocation mechanism described above.

**RR 244**
**SUMMER TEMPERATURES IN INTERIOR ALASKA.**
Haugen, R.K., et al, Oct. 1971, 37p., AD-733 317, 20 refs.
Lynch, M.J., Roberts, T.C.
26-2770
ARCTIC CLIMATE, AIR TEMPERATURE, CLIMATOLOGY, TEMPERATURE VARIATIONS, CORRELATION, STATISTICAL ANALYSIS, UNITED STATES—ALASKA.
Annual degree-day summations over bases of 43 F and 50 F in 15-day periods from May through August are given for the period of record for five interior Alaska climatic stations. Average temperature and precipitation data are included. Patterns of summer temperature in interior Alaska are analyzed in terms of historical, elevational and areal differences. Correlation analysis of daily and monthly average July temperatures indicates areas of uniformity with respect to temperature variation. This provides information on lowland climatic stations that are representative of highland locations, especially the Yukon-Tanana Uplands.

**RR 245**
**MICROSPHERULES IN SNOW AND ICE-FOG CRYSTALS.**
Kumai, M., March 1969, 10p., AD-691 326, 29 refs.
24-3380
IMPURITIES, ICE FOG, SNOW CRYSTALS, MICROSPHERULES, CONDENSATION NUCLEI, ELECTRON MICROSCOPY.
Spherules found in snow crystals, ice-fog crystals, fallout particles, and fly ash were studied with an electron microscope using the electron diffraction method. The central part of the residues of 1004 specimens of natural snow crystals from Greenland, the United States, and Japan were examined; 14 spherules 0.1 to 1.5 microns in radius were found among them. The residues of 658 artificial ice-fog crystals formed from water vapor in flue gases of coal-burning electric power plants at Fairbanks, Alaska, were also examined; nine spherules were found. Spherules similar to those found in ice-fog residues were found in furnace-produced fly ash fallout at Fairbanks, Alaska. The properties of spherules and the mean mass of snow crystals from Greenland are described. The electron microscope study indicated that less than 0.7 per cent of the 1004 snow crystals contained spherules of possible extraterrestrial origin, and that snow crystals are formed mainly on clay mineral particles by heterogeneous nucleation.

**RR 246**
**COMPARISON BETWEEN MEASURED AND THEORETICAL TEMPERATURE PROFILES OF THE CAMP CENTURY, GREENLAND, BOREHOLE.**
Weertman, J., May 1968, 13p., AD-671 626, 14 refs.
24-3381
GLACIER ICE, BOREHOLES, TEMPERATURE DISTRIBUTION, HEAT TRANSFER, GREENLAND—CAMP CENTURY.
Steady-state temperature profiles are calculated for the borehole drilled through the Greenland ice sheet at Camp Century. The profiles are found by modifying Robin's theory through the addition of several correction terms. One of these terms is the internal heating arising from creep deformation. The importance of this term was emphasized by Lliboutry. The new theoretical profiles do not differ appreciably from the profile derived from Robin's theory. The theoretical profiles do differ substantially from the Camp Century profile measured by Hansen. It is concluded that Hansen's observations are evidence that factors such as accumulation rate and the upper surface temperature are not in a long-term steady-state condition. Better agreement between theoretical and measured curves is obtained if it is assumed that the accumulation rate was

about 40 percent smaller in the past and that the mean annual surface temperature varied by about 0.5C over the past 1000 years.

**RR 247**
**THE GENERAL SOLUTION OF A WEDGE ON AN ELASTIC FOUNDATION.**
Nevel, D.E., Nov. 1968, 15p., AD-680 901, 6 refs.
24-3382
WEDGES, FOUNDATIONS, ELASTIC PROPERTIES, ANALYSIS (MATHEMATICS).
The problem of a wedge on an elastic foundation, expressed as a differential equation, is solved by means of contour integration

**RR 248**
**ELECTROLYTIC CONDUCTIVITY OF SNOW AND GLACIER ICE FROM ANTARCTICA AND GREENLAND.**
Gow, A.J., Oct. 1968, 8p., AD-680 180, 14 refs.
24-3383
ICE ELECTRICAL PROPERTIES, ELECTRICAL RESISTIVITY, SNOW ELECTRICAL PROPERTIES, SNOW SAMPLERS, CORE SAMPLERS.
Conductivity measurements have been made on snow and ice samples from pits and deep drill holes at a number of localities in Antarctica and Greenland. Data from deep cores representing more than 1900 years of continuous snow accumulation at Byrd Station, Antarctica, and more than 400 years deposition at Inge Lehmann, Greenland, showed no significant variations of conductivity with time. The substantial increase observed in the conductivity of core samples from near the surface of the Ross Ice Shelf at Little America V can be attributed most probably to windborne salts of marine origin that had accumulated on the surface after the snow was deposited. A peak conductivity was recorded in snow estimated to have been deposited within 20 km of the seaward edge of the Ross Ice Shelf and the maritime effect could still be detected in samples deposited more than 40 km from the ice front. The very low conductivities observed in ice cores from near the bottom of the Ross Ice Shelf confirm earlier conclusions based on detailed petrographic studies of the cores that the 258-m-thick ice shelf at Little America V is composed entirely of glacial ice.

**RR 249**
**BUBBLES AND BUBBLE PRESSURES IN ANTARCTIC GLACIER ICE.**
Gow, A.J., Oct. 1968, 16p., AD-680 181, 19 refs.
24-3384
BUBBLES, CORE SAMPLERS, ICE SAMPLING, ICE DENSITY, AIR BUBBLE PRESSURE, ICE CRACKS, ANTARCTICA—BYRD STATION, ANTARCTICA—LITTLE AMERICA V.
Application of the gas law to fourth-place density measurements of ice samples from two deep drill holes at Byrd Station and Little America V, Antarctica, shows that virtually all density increase beyond the pore close-off density can be attributed to compression of the entrapped bubbles of air. By substituting the overburden pressure for the bubble pressure in the pressure-density relationship based on the gas law, ice densities below 200 m can be calculated more accurately than they can be measured per se on cores because of the relaxation that occurs in samples recovered from high confining pressures. This relaxation, resulting in a progressive increase in the bulk volume of the ice with time, is generally attributed to decompression of the entrapped air bubbles following removal of the ice from high confining pressures. However, calculations of the stress in ice due to bubble pressure, together with measurements of bubble sizes in cores from various depths at Byrd Station, both tend to indicate that there has been negligible decompression of the inclosed bubbles. It is suggested that most of this relaxation may be due to the formation of microcracks in the ice.

**RR 250**
**AERIAL SENSING AND PHOTOGRAPHIC STUDY OF THE EL VERDE RAIN FOREST, PUERTO RICO.**
Johnson, P.L., et al, Dec. 1969, 19 p., AD-703 123, 13 refs.
Atwood, D.M.
25-1072
AERIAL PHOTOGRAPHY, INFRARED PHOTOGRAPHY, PHOTOINTERPRETATION, GAMMA IRRADIATION, RAIN FORESTS, DENSITOMETERS, RADIATION EFFECTS, PUERTO RICO.
Aerial and ground photographs were taken over a 2-year period of sites in the El Verde rain forest to record the consistency of the vegetational patterns in untreated sites and the changes that occurred following gamma irradiation. Four emulsions were used: panchromatic, infrared, false color transparency and color transparency. Densitometry was used to evaluate color film and the vegetation response to 3 months of radiation. The color emulsions provided the sharpest indication of damage to vegetation and the succession following treatment. Hemispherical photography of the canopy was evaluated in terms of a canopy cover index defined as per cent of light passing through the negative in a 90-degree cone area. Control stations were remarkably constant in all photography, establishing the stability and slow natural changes in rain forest structure. Spectral light measurements within the forest confirmed the predominance of far red shade light. Compared to similar studies on the chronic irradiated forest at Brookhaven National Laboratory the El Verde results were less distinct.

**RR 251**
**BUBBLE COALESCENCE IN ICE AS A TOOL FOR THE STUDY OF ITS DEFORMATION HISTORY.**
Weertman, J., Sept. 1968, 5p., AD-682 723, 9 refs.
24-3385
COALESCING, GLACIER ICE, DEFORMATION, BUBBLES, SHEAR STRAIN, STRAIN RATE.
An analysis is made of the rate of bubble coalescence in a deforming ice mass. A total strain of at least 8 is required before appreciable coalescence occurs. The analysis has been applied to deforming ice shelves and ice sheets. No appreciable coalescence is expected in ice shelves but coalescence should occur in ice sheets (or glaciers) if the shear strain rate at the bottom surface is of the order of 0.075/yr or larger. Measurements of bubble concentration are capable of setting limits on paleo-strain rates of the present ice sheets. Buble migration down temperature gradients presents complications to the study of bubble coalescence.

**RR 252**
**DIFFUSION LAW FOR THE DISPERSION OF HARD PARTICLES IN AN ICE MATRIX THAT UNDERGOES SIMPLE SHEAR DEFORMATION.**
Weertman, J., Sept. 1968, 6p., AD-680 958, 12 refs.
24-3386
PARTICLE DISPERSION, DEFORMATION, DIFFUSIVITY, ICE MATRICES, GLACIER MOVEMENT.
A diffusion equation is obtained that describes the mechanical dispersion of a dilute mixture of solid particles within an ice matrix that is undergoing deformation. It is shown that within the limits of time intervals and strain rates appropriate to the movement of glaciers and ice sheets the dispersal distance usually is no larger than a distance about one order of magnitude greater than the size of the particles themselves.

**RR 253**
**EVALUATION OF FOREST CANOPIES BY PHOTOGRAPHY.**
Johnson, P.L., , Oct. 1968, 20p., AD-680 182, 22 refs.
Vogel, T.C.
24-3387
FOREST CANOPY, PHOTOGRAPHIC TECHNIQUES, MEASUREMENT.
A technique for evaluating forest canopies was developed based on the use of a divergent lens system to obtain hemispherical photographs of tree crowns. The photography was processed from 35 mm film and enlarged as a silhouette, and the light transmission was measured with a specially fabricated macrodensitometer. It is concluded that the amount of forest canopy can be expressed as canopy closure index (CCI) at a precision of approximately 5 percent. It is shown by application to a variety of problems in diverse geographical areas that this technique can be used for measuring both temporal and spatial changes in the canopy, for estimating the shade light climate, and specifying the probability of target detection through a canopy. Data are presented to analyze changes caused by explosions, radioactivity, growing season, and vegetation types. The geometry of gaps in tree crowns is discussed and the nature of shade light quality under forests is illustrated.

**RR 254**
**HIGH-RESPONSE TRIAXIAL STRAIN-GAGE ANEMOMETER.**
Odar, F., Jan. 1969, 15p., AD-685 847.
24-3388
ANEMOMETERS, METEOROLOGICAL INSTRUMENTS, WIND VELOCITY, TURBULENCE.
A triaxial semiconductor strain-gage anemometer measuring wind velocities in three directions and thereby also determining the direction of the wind was designed and subjected to many crucial tests under various conditions. It was found that the measurements were affected by temperature and vibrations. Temperature compensation in two directions was made and wind tunnel tests on an almost vibration-free platform were performed. The results show that this type of instrument can be successfully used to measure large-scale turbulences. Throughout this report, emphasis is placed on the compensation necessary for temperature and vibration effects and the determination of input-output relationships. It is concluded that it is possible to design a practical triaxial strain-gage anemometer with high-frequency response and high sensitivity and to measure wind velocities accurately with this type of instrument when temperature and vibration compensations are properly made.

**RR 255**
**UNSTEADY MOTION OF A SPHERE ALONG A CIRCULAR PATH IN A VISCOUS FLUID.**
Odar, F., Mar. 1969, 10p., AD-687 279, 6 refs.
24-3389
VISCOUS FLOW, FLUID MECHANICS, SPHERES, HYDRODYNAMICS.
Forces on a sphere moving unsteadily along a circular path in a viscous fluid are measured, and it is found that within the experimental range the formula valid for rectilinear motion has to be modified to account for the curvature of the path.

**RR 256**
**NONSTEADY ONE DIMENSIONAL COMPRESSIBLE FLUID FLOW THROUGH ANISOTROPIC POROUS MEDIA.**
Fan, S.S.T., , Nov. 1968, 13p., AD-681 211, 12 refs.
Yen, Y.-C.
24-3390
SNOW DENSITY, PERMEABILITY, SNOW COMPACTION, POROSITY, COMPUTER APPLICATIONS.
The flow of a compressible fluid through a deep layer of a porous medium with nonuniform permeability was analyzed. The volumetric behavior of the fluid was described first by the perfect gas law, then by the van der Waal's equation of state. Darcy's law was assumed to be valid. For illustration, the model of air flowing through a deep bed of naturally compacted snow was used to carry out numerical computation. The permeability of snow was considered as a function of depth. The nonlinear partial differential equation obtained by combining the continuity equation with Darcy's law was solved by finite difference technique. A time dependent exponential decay boundary condition was used which included the step-rise constant boundary condition as a limiting case. Pressure distributions in the porous medium calculated from the assumption of ideal gas and van der Waal's gas were compared. The data were presented in dimensionless variables.

**RR 257**
**EQUATION OF STATE OF ICE AND COMPOSITE FROZEN SOIL MATERIAL.**
Anderson, G.D., June 1968, 50p., AD-674 248, 6 refs.
24-3391
WAVE PROPAGATION, FROZEN GROUND PHYSICS, ICE CRYSTALS, WATER CONTENT, PRESSURE FACTORS, SOIL MECHANICS.
To compute shock wave propagation in frozen soil-water mixtures it is necessary to know a constitutive relation or an equation of state of the medium under consideration. Shock wave techniques provides a powerful tool for the investigation of equations of state at very high stress levels. The stress-volume behavior of frozen soil-water mixtures in the range from 60 to 500 kbar was investigated. Hugoniot data were obtained for Ottawa banding sand (pure quartz sand) and West Lebanon (New Hampshire) glacial till of varying degrees of saturation and for polycrystalline and monocrystalline ice (c-axis oriented in the direction of shock propagation). Release cross curve data were obtained for dry and saturated Ottawa banding sand and for polycrystalline ice. All materials were at an initial temperature of -10 C. In all experiments plane one-dimensional shock waves were used. The Hugoniots and release curves for the soil materials show evidence of a quartz-stishovite phase transition at about 300 kbar. The Hugoniots of single and polycrystalline ice do not differ significantly over the stress range studied - 30 kbar to 300 kbar.

**RR 258**
**FOG MODIFICATION STUDIES ON THE GREENLAND ICE CAP.**
Kumai, M., March 1969, 9p., AD-689 448, 8 refs.
24-3392
FOG DISPERSAL, CLOUD SEEDING, SUPERCOOLED FOG.
During the summer of 1965, the CRREL cloud physics group carried out a study of fog modification by propane and dry ice seeding on the Greenland Ice Cap, an area with one of the lowest concentrations of atmospheric pollution on earth. The nuclei of supercooled fog droplets before seeding were observed using electron microscopy and electron diffraction methods. The nuclei of ice crystals formed by dry ice and propane seeding were also observed using the same technique. The nuclei of the supercooled fog droplets and the ice crystals formed by seeding were found to be hygroscopic sea salt particles that were easily distinguished from the clay mineral nuclei of natural snow crystals. The sublimation temperature of carbon dioxide is -78.5C. The boiling point of liquid propane is -44.5C at 1 atm pressure. It is concluded that the ice nucleation of supercooled fog by dry ice and liquid propane seeding is due to thermal effects.

**RR 259**
**FORMATION OF A MODERN ICE-PUSH RIDGE BY THERMAL EXPANSION OF LAKE ICE IN SOUTHEASTERN CONNECTICUT.**
Pessl, F., Jr., Aug. 1969, 13p., AD-694 373, 22 refs.
24-3393
AIR TEMPERATURE, ICE PUSH, ICE THERMAL PROPERTIES, THERMAL EXPANSION, SOLAR RADIATION, BEACH RIDGES.
A modern ice-push ridge on the northwest shore of Gardner Lake in southeastern Connecticut is 0.6-1.2 m high and 1.2-3.1 m wide. In February and March 1967, the positions of survey stakes placed on the lake ice were measured periodically. During the same period, air and ice temperature and solar radiation intensity were also recorded. Analysis of the data supports the hypothesis that thermal expansion of the lake ice rather than wind action, was the principal cause of ice push. An ice-temperature change of approximately 1C/hr increase for 6 hr was sufficient to induce ice thrust. In a 30-day period, the average net shoreward movement of the surveyed area of the ice surface was 1.0 m. During the 1966-67 winter, approximately 14 cu m of beach material was reworked and deposited, forming a discontinuous ice-push ridge along 260 m of shoreline.

**RR 260**
**ON PLATES SEALING AN INCOMPRESSIBLE LIQUID.**
Kerr, A.D., Nov. 1968, 11p., AD-681 212, 9 refs.
24-3394
ICE COVER STRENGTH, PLATES, LIQUIDS, ANALYSIS (MATHEMATICS), LOADS (FORCES), STRESSES.
After a brief description of the circumstances which led to the investigation of the title problem and discussion of some related previous investigations, exact solutions are derived for a circular plate which seals an incompressible liquid, is clamped along the boundary and is subjected at an arbitrary point to a lateral concentrated force P. For the case when the plate is covered by a thin liquid layer the solution is obtained in closed form. When this liquid layer is absent, the solution is obtained as an infinite series. The paper concludes with a study of the range of the parameter (lambda a) for which the effort of buoyancy is negligible upon the deflections and stresses in the plate.

**RR 261**
**MOVING LOADS ON A FLOATING ICE SHEET.**
Nevel, D.E., May 1970, 13p., AD-707 923, 10 refs.
25-988
SEA ICE, FLOATING ICE, LOADS (FORCES), DYNAMIC PROPERTIES, ICE BEARING CAPACITY, ANALYSIS (MATHEMATICS).
This paper considers a load moving with a constant velocity across an ice sheet that is floating on water. The ice sheet is assumed to be an isotropic, elastic, thin plate extending to infinity. The water is assumed to be inviscous, incompressible, and of a constant depth. The dynamic equations describing this ice-water system are solved for the steady state solution. Both a concentrated load and a uniform load distributed over a circular area are considered. The velocity which causes resonance is determined. The deflection and stress directly under the load are numerically evaluated.

**RR 262**
**HYDROLOGIC RECONNAISSANCE OF THE DELTA RIVER AND ITS DRAINAGE BASIN, ALASKA.**
Dingman, S.L., et al, Feb. 1971, 83p., AD-722 217, 74 refs.
Samide, H.R., Saboe, D.L., Lynch, M.J., Slaughter, C.W.
26-2303
HYDROLOGY, RIVER BASINS, DRAINAGE, STREAM FLOW, CHANNELS (WATERWAYS), RUNOFF, AERIAL PHOTOGRAPHY, WATERSHEDS, UNITED STATES—ALASKA—DELTA RIVER.
A one-year reconnaissance study was made of a large braided glacial river and its drainage basin for which a minimum of hydrometric and meteorologic data existed. The report includes estimates of the water balance, flow-duration curves, and sediment characteristics, and descriptions of stream response to glacial melt and rain, channel geometry and channel processes. Surveys and ground and aerial photography are used to describe channel changes.

**RR 263**
**THERMAL INSTABILITY IN A LAYER OF WATER FORMED BY MELTING ICE FROM BELOW.**
Yen, Y.-C., March 1969, 12p., AD-686 283, 10 refs.
24-3395
HEAT TRANSFER, THERMAL CONDUCTIVITY, CONVECTION, MELTWATER, MELTING.
The transition in the mode of heat transfer from conduction to convection in a layer of water formed continuously by melting ice from below has been determined experimentally. This was accomplished by locating the inflection point on the curve relating the water-ice interface (or melting front) and time. Thus, the critical Rayleigh number at which convective heat transfer started can be correlated empirically as a function of warm plate temperature between 7.72 and 25.50C. The initial ice temperature was varied from -4.8 to -22.00C, and its effect was found to be insignificant. Homogeneous, bubble-free ice was prepared and used in all the experiments.

**RR 264**
**ATTENUATION AND BACKSCATTERING OF INFRARED RADIATION BY ICE FOG AND WATER FOG.**
Kumai, M., et al, April 1969, 7p., AD-689 447, 10 refs.
Russell, J.D.
24-3396
VISIBILITY, LIGHT TRANSMISSION, BACKSCATTERING, FOG, INFRARED RADIATION.
Ice-fog crystals consisting of many spherical particles, and some hexagonal plates and columns, were observed at ambient temperatures of about -40C in the Fairbanks, Alaska, area during mid-winter. The concentrations and the size distributions of the ice-fog crystals were measured. The attenuation and backscattering of infrared radiation by ice-fog crystals were computed for optical wavelengths of 2.2 mu, 2.7 mu, 4.5 mu, 5.75 mu, 9.7 mu and 10.9 mu using the Mie theory. The minimum attenuation coefficients and backscattering functions of ice fog were found to be at 9.7 mu wavelength in the observed wavelengths. Optical attenuation coefficients and volume backscattering functions of water fogs were also computed using the Mie theory. The minimum attenuation coefficients and backscattering functions of water fog were found to be at 10.9 mu wavelength in the region of 2.2 mu, 2.7 mu, 4.5 mu, 5.75 mu, 9.7 mu and 10.9 mu. Both the attenuation coefficients and backscattering functions of ice fog are within the same order of magnitude as water fog for equivalent fog concentrations and wavelengths.

**RR 265**
**CONCENTRATED LOADS ON PLATES.**
Nevel, D.E., March 1970, 8p., AD-703 876, 11 refs.
25-989
SEA ICE, ICE BEARING CAPACITY, ELASTIC PROPERTIES, LOADS (FORCES), ANALYSIS (MATHEMATICS).
An infinite plate on an elastic foundation is considered for a uniform load distributed over a circular area. The analysis of the problem is based on three-dimensional theory of elasticity. A numerical evaluation for the critical stress is made assuming a bending type of failure and the results closely agree with Westergaard's equations.

**RR 266**
**DIELECTRIC PROPERTIES OF CLAY SUSPENSIONS IN THE FREQUENCY RANGE FROM 50 HZ TO 20 KHZ.**
Hoekstra, P., et al, Aug. 1969, 15p., AD-695 662, 12 refs.
O'Brien, H.W.
24-3397
CLAY SOILS, DIELECTRIC PROPERTIES, SOIL PHYSICS, CLAY MINERALS.
The dielectric properties of Na- and K-montmorillonite suspensions were measured at 25C in the frequency range of 50 Hz to 20 kHz. Effects of electrode polarization were minimized by using the same stainless steel electrodes at different interelectrode distances and a correction was applied to compensate for stray fields. This investigation establishes the fact that the high dielectric constants of clay suspensions at audio-frequencies are real and not the results of electrode polarization. The polarization that determines the dispersion is an interfacial phenomenon between the ionic atmosphere and the negatively charged clay particle. The results of this study show that clay suspensions have the same dispersion as soil samples, indicating the probability that the dispersion of wet soils in the frequency range from 50 Hz to 20 kHz is similar for most soils. The actual value of the dielectric constant, however, cannot yet be predicted.

**RR 267**
**RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA.**
Bilello, M.A., Dec. 1969, 20p., AD-700 990, For another version and abstract of this paper see 23-2002. 26 refs.
25-1073
CLIMATE, SNOW COVER DISTRIBUTION, SNOW DENSITY, WIND FACTORS, TEMPERATURE FACTORS.

**RR 268** Record deleted.

**RR 269**
**FRACTURE OF LAKE AND SEA ICE.**
Weeks, W.F., et al, Sept. 1969, 77 p., AD-697 750, 175 refs.
Assur, A.
25-990
LAKE ICE, SEA ICE, FRACTURING, ICE BREAKUP, ICE COVER STRENGTH, ICE CRYSTAL STRUCTURE, ICE FORMATION, COMPRESSIVE STRENGTH, TENSILE STRENGTH, FLEXURAL STRENGTH.
The increased activity in cold regions has made a thorough understanding of fracture in lake and sea ice quite desirable, inasmuch as this information has application to a number of problems of geophysical as well as engineering importance. This survey starts with a discussion of the structure of ice I and the macro- and microstructures of sea and lake ice as well as their chemistry and phase relations. Recent work on the direct observation of dislocations as well as the formation of cracks in ice is summarized. Formal ice-brine-air models for analyzing variations in ice strength are also reviewed. The results of the different types of tests are discussed and compared (compressive, indentation, direct and simple beams, shear, and impact). Scale effects are considered as well as the rapid strength deterioration experienced by ice sheets in the spring. Finally, a number of recommendations are made concerning future research in this field.

**RR 270** Record deleted.

**RR 271**
**SOME PHYSICAL PROPERTIES OF ALPINE SNOW.**
Keeler, C.M., Dec. 1969, 67p., AD-700 129, 116 refs.
25-991
SNOW COVER, SNOW DENSITY, SNOW STRENGTH, GRAIN SIZE, SNOW FABRIC, POROSITY.
Snow research to date has largely consisted of measuring index properties of snow, such as bulk density and snow strength, and correlating them. This is useful, particularly for engineering purposes, but it does not grapple with the basic problem of what fundamental properties of snow determine the magnitude of the index properties and how these properties respond to environmental conditions. This study was an attempt to measure, quantitatively, the fundamental properties of grain size, shape, and fabric (relationship between grains) and relate these to the index or derived properties of bulk density, shear and tensile strength, permeability for air, and the dielectric static permittivity and loss tangent. Despite numerous difficulties in defining fabric and quantifying it, it was possible to show that: 1) snow strength is a function of bond area; and 2) the rate of densification of low density snow can be explained in part by high stress concentrations at intergranular contracts and by such factors as riming on crystals. The effect of the environmental factors of time, temperature, and gravitational stress is difficult to study in situ because they are not independent variables.

**RR 272**
**IONIC CONCENTRATION GRADIENTS IN PERMAFROST, BARROW, ALASKA.**
Brown, J., Oct. 1969, 25p., AD-699 329, 16 refs.
25-992
SOIL CHEMISTRY, SEASONAL FREEZE THAW, PERMAFROST TRANSFORMATION, GEOMORPHOLOGY, ION DENSITY (CONCENTRATION), UNITED STATES—ALASKA—BARROW.
The ionic concentration gradients of soils and permafrost sediments were investigated to provide a means of interpreting present and past chemical activity and geomorphological processes in this coastal plain environment. Within short distances at comparably shallow depths and in sediments of similar texture, ionic concentrations commonly vary between less than 1 meq/100 g and 10 meq/100 g oven-dried soil. These differences represent modification of the marine sediment by such processes as lake migration and freshening, local and regional thawing, and leaching followed by refreezing of the ground. Higher concentrations (more than 5 meq/100 g) are found close to the surface in areas unaffected by such processes. Lower values (less than 5 meq/100 g) are encountered in present and ancient lake basins and under several apparent primary land surfaces. The seasonally thawed soil contains, on an average, 24 times fewer extractable ions than the underlying permafrost. Data for all samples are presented in the appendix and consist of moisture content, conductivity of solution, and concentrations in solution and soils.

**RR 273**
**DEFORMATION OF SNOW UNDER RIGID PLATES AT A CONSTANT RATE OF PENETRATION.**
Abele, G., March 1970, 65p., AD-704 708, 88 refs.
25-442
SNOW BEARING STRENGTH, SNOW DENSITY, DEFORMATION, LOADS (FORCES), SNOW ROADS, AIRCRAFT LANDING AREAS, FOUNDATIONS.
This report presents the results of a study performed on the behavior, particularly the deformation, of snow under a load applied to a rigid plate at a constant rate of penetration. The results will eventually be used in the development of design criteria for snow roads, runways, and foundations in the polar regions. It was determined that density, in the range 0.3 to 0.6 g/cu cm, can be used as a reasonably reliable index for predicting deformation and behavior of snow under load. In general, the critical pressure (bearing strength) increased as a power function of density, and critical sinkage decreased as a power function of density. It was also observed that the deformation bulb resembled the typical Boussinesq stress bulb. The experimental pressure-sinkage relationships agreed closely with recently developed theoretical values. For the range of plate sizes used, the test data did not provide conclusive evidence of the effect of plate size on deformation and bearing capacity of snow. The possibility of using the Moiré fringe method for determining deformation patterns in snow and soils under various loading conditions should be investigated.

**RR 274**
**PHASE BOUNDARY WATER IN FROZEN SOILS.**
Anderson, D.M., May 1970, 17p., AD-706 840, 41 refs.
25-994
ICE WATER INTERFACE, SOIL WATER, FROZEN GROUND HYDROLOGY, SILICATE WATER ICE INTERFACE.
Interfacial regions in frozen soils are of the following types: ice/ice (grain boundary) ice/water/air, silicate/water/silicate (interlamellar) and silicate/water/ice (extralamellar). For the last, the mid portion of the interfacial region should be regarded as a liquid-like solution of the ionic and undissociated substances sorbed by the interface and expelled from the ice during freezing. From the evidence and arguments considered, it is concluded that distinctly different zones of orientational order can be distinguished within the interfacial regions. For an advancing silicate/water/ice interface it is proposed that there is a zone of strong perturbation and disorder immediately proximate to silicate surfaces in which the protons of water molecules are partially delocalized; this makes them more easily dissociated. Two or three molecular diameters removed from the silicate surface the interfacial forces operative there combine to create a zone of enhanced order in the molecular configurations. At some farther distance, depending upon the temperature below freezing, it is suggested that there exists a disordered transition zone proximate to the ice surface as portrayed in Drost-Hansen's model.

**RR 275** Record deleted.

**RR 276**
**VARIATION OF SOME MECHANICAL PROPERTIES OF POLAR SNOW, CAMP CENTURY, GREENLAND.**
Kovacs, A., et al, Dec. 1969, 33p., AD-700 995, 20 refs.
Weeks, W.F., Michitti, F.
25-1074
SNOW PHYSICS, SNOW DENSITY, COMPRESSIVE STRENGTH, TENSILE STRENGTH, POROSITY, LOADS (FORCES).
The unconfined compressive strengths and the ring-tensile strength of snow and ice specimens from the Inclined Drift at Camp Century, Greenland, were determined. The specimen densities varied over essentially the complete natural density range of polar snow and ice (0.340 to 0.890 g/cu cm). The specimens were loaded rapidly to failure with times varying between 0.2 and 1.4 sec. During loading, head speeds varied between 5.1 and 23.6 cm/min, although during individual tests they were constant. Even the low density specimens failed in the brittle mode. Although a plot of tensile strength vs density is linear, compressive strength is clearly nonlinear. There is no pronounced change in compressive strength with changes in strain rate. A significant increase in tensile strength, compressive strength and modulus values was noted at bulk densities greater than 0.830 g/cu cm. This increase is presumable caused by the close-off of the air passages.

**RR 277**
**STABILITY OF DIFFERENCE APPROXIMATION TO SHOCK WAVE PROPAGATION IN INHOMOGENEOUS ELASTIC-PLASTIC MEDIA.**
Nakano, Y., Dec. 1969, 13 p., AD-700 996, 4 refs.
25-1075
WAVE PROPAGATION, SHOCK WAVES, STABILITY CRITERIA.
An analysis is made of the stability of difference approximation to one-dimensional shock wave propagation in elasticplastic media. The necessary condition for stability is obtained.

**RR 278** Record deleted.

**RR 279**
**NUMERICAL COMPUTATION OF THE SHOCK WAVE DIFFRACTED BY A CIRCULAR CYLINDRICAL CAVITY IN ELASTIC-PLASTIC MEDIA.**
Nakano, Y., Jan. 1970, 21 p., AD-702 906, 20 refs.
25-1076
WAVE PROPAGATION, EXPLOSION EFFECTS, UNDERGROUND FACILITIES, SHOCK WAVES.
A finite difference method for predicting the effect of shock waves on a circular cylindrical cavity in elasticplastic media was studied. A two-dimensional Langrangean code was found quite satisfactory. Attenuation of the shock waves through the cavity and the deformation of the cavity wall were discussed.

**RR 280** Record deleted.

**RR 281**
**VIBRATION OF A FLOATING ICE SHEET.**
Nevel, D.E., Aug. 1970, 8p., AD-712 995, 2 refs.
25-2732
SEA ICE, FLOATING ICE, ELASTIC PROPERTIES, ANALYSIS (MATHEMATICS).
The solution for the vibration of an elastic plate floating on water is developed. The water is assumed to be incompressible and to have irrotational flow. In free vibration upon release of the plate, the maximum negative rebound of the deflection is 25 per cent. For forced vibration, the steady state part of the solution shows that there is a frequency at which the deflection is a maximum. The stresses become a maximum at a frequency higher than the one for deflection. These critical frequencies depend upon the plate's characteristic length and the depth of the water. For most situations the critical frequency for a stress is less than 0.2 cycle per second. At this critical frequency the stresses are amplified over the static case by a factor less than 10 per cent.

**RR 282**
**DEEP CORE STUDIES OF THE CRYSTAL STRUCTURE AND FABRICS OF ANTARCTIC GLACIER ICE.**
Gow, A.J., Feb. 1970, 20p., AD-704 348, 36 refs.
25-443
GLACIER ICE, ICE CRYSTAL GROWTH, ICE CRYSTAL STRUCTURE, DEFORMATION, CORES, ANTARCTICA.
Radical differences in the crystal structure and fabrics of glacier ice cores at Byrd Station and Little America V, Antarctica, are attributed to gross differences in the thermal and deformational histories of the ice at these two locations. At Byrd Station the mean size of crystals increased more than sixfold between 65 m and the bottom of the drill hole at 309 m. Crystal size was also found to increase linearly with the age of the ice. However, this growth was not accompanied by any orientation of crystals or entrapped bubbles. These observations imply that negligible shearing is occurring in the top 300 m of the thick grounded ice sheet at Byrd Station. By contrast very considerable deformation is indicated for the floating 258-m-thick Ross Ice Shelf at Little America. Exaggerated growth of crystals below 150 m is attributed to increasing temperatures in the ice shelf. The crystal structure of these cores clearly demonstrates that glacial ice only is present in the Ross Ice Shelf at Little America V.

**RR 283**
**DETERMINATION OF CATION EXCHANGE CAPACITY OF EARTH MATERIALS USING A RADIOTRACER TECHNIQUE.**
Murrmann, R.P., et al, Feb. 1970, 12 p., AD-702 907, 3 refs.
Reynolds, R.C., Jr., Leggett, D.C.
25-1077
SOIL ANALYSIS, SOIL CHEMISTRY, RADIOACTIVE ISOTOPES, ION EXCHANGING.
Two radiochemical methods were investigated for determining the cation exchange capacity of earth materials having a wide range in physicochemical properties. The first method attempted was unsuccessful but involved determination of the radio-activity of a 22Na-NaOAc solution in isotopic equilibrium with a Na-ion-saturated mineral phase. The logic of this method is presented in order to illustrate principles of isotopic exchange in mineral systems. The method finally adopted is based upon determination of the radioactivity of a salt-free, Na-ion-saturated mineral sample prepared using a radioactive NaOAc solution with a known 22Na-NaOAc composition. This method is less time-consuming and more accurate than the conventional ammonium acetate method for cation exchange capacity determinations.

**RR 284**
**EFFECT OF THERMAL GRADIENT ON IONIC DIFFUSION IN FROZEN EARTH MATERIALS. 1: EXPERIMENTAL.**
Murrmann, R.P., et al, Sept. 1970, 8p., AD-714 644, 13 refs.
Hoekstra, P.
25-2433
SOIL WATER, ION DIFFUSION, BENTONITE, FROZEN GROUND.
Ionic concentration and water profiles in frozen bentonite samples subject to a thermal gradient of 0.3C/cm but different temperature intervals were obtained in the temperature range from 0C to -12C in order to determine the extent to which thermal gradients influence the movement of ions in thin films of interfacial water. The moisture content distribution was found to remain virtually unchanged after times ranging from 20 to 54 days, indicating that ionic movement was not affected by mass flow of mobile water in thin films. The ionic distribution profiles were essentially as expected in the absence of a temperature gradient. These observations support the conclusion that thermal gradients have little influence on redistribution of ions in frozen earth materials.

**RR 285**
**EFFECT OF THERMAL GRADIENT ON IONIC DIFFUSION IN FROZEN EARTH MATERIALS 2: THEORETICAL.**
Nakano, Y., et al, Oct. 1970, 35p., AD-714 642, 13 refs.
Murrmann, R.P.
25-2434
SOIL WATER, ION DIFFUSION, FROZEN GROUND, ANALYSIS (MATHEMATICS).
The influence of a temperature gradient on the redistribution of chemicals by diffusion through thin films of interfacial water in frozen soil was predicted by two different methods. In one case, an exact solution of the diffusion equation with a distance-dependent diffusion coefficient was obtained. Secondly, a new approach based on the Monte Carlo method was developed. The advantage of the Monte Carlo method is that the dependence of the diffusion coefficient on distance may assume any functionality where one exponential form was used in obtaining the exact solution. The ionic concentration distributions computed using both approaches were in excellent agreement with experimental results. In all cases, the concentration distribution was virtually the same as that obtained in the absence of a thermal gradient, indicating that thermal gradients have little influence on the diffusion of ions in frozen soil.

**RR 286**
**VIBRATORY SURFACE LOADINGS ON A VISCOELASTIC HALF-SPACE.**
Lee, T.-M., Sept. 1969, 33p., AD-714 643, 10 refs.
25-2435
VISCOELASTICITY, WAVE PROPAGATION, SOIL MECHANICS, LOADS (FORCES), VIBRATION, ANALYSIS (MATHEMATICS).
Wave propagation generated by vibratory load on a homogeneous, isotropic, linear viscoelastic half-space is studied. The effect of a single concentrated force and a group of forces applied over a circular area has been examined and solutions of the displacement functions are presented. In the case of the group forces, the three types of force distribution used by Reissner and Sung were employed. At a great distance (far field) from the applied load, surface displacements are reduced to closed form expressions. A field method based on these results is recommended for determining the complex modulus and the damping property of a viscoelastic material. For areas near the source (near field), numerical procedures were employed to evaluate the integral solution. To facilitate the application, two simplified versions are provided for calculating the center displacement under the load. They both provide good approximation to the integral solution and, most important of all, they speed up the computation enormously.

**RR 287**
**SHOCK EFFECTS ON FROZEN MATERIALS: EXPLODING WIRE EXPERIMENTS.**
Smith, J.L., June 1970, 11p., AD-707 924, 6 refs.
25-996
FROZEN GROUND MECHANICS, WAVE PROPAGATION, EXPLOSION EFFECTS, SHOCK WAVES, EXPLODING WIRES.
Hugoniot curves were generated from simultaneous measurements of shock and free-surface velocities, obtained from samples of frozen Fairbanks (Fox) silt, using the exploding wire technique. The abrupt change in slope of the U sub s - U sub p Hugoniot is indicative of a phase change. The shape of the P-V Hugoniot suggests that the transformation begins immediately but does not go to completion. This means that, although the pressure lies slightly above the Rayleigh line through the mixed phase region, the slope does not increase as rapidly as it would if the material had stayed in the initial phase.

**RR 288**
**INFLUENCE OF SOIL ON DETECTION OF BURIED EXPLOSIVES AND TUNNELS BY TRACE GAS ANALYSIS.**
Murrmann, R.P., et al, June 1971, 37p., AD-727 667, 25 refs.
Nakano, Y., Simpson, T.J., Leggett, D.C., Anderson, D.M.
26-2354
SOIL STRUCTURE, TUNNELS, DETECTION, VAPOR DIFFUSION, TRACE GAS ANALYSIS, STATISTICAL ANALYSIS.
Detection of mines, explosives, and tunnels may be accomplished by sensing associated volatile effluvia. This investigation was undertaken to provide a basis for predicting the diffusion of volatile compounds from underground sources into the atmosphere. Diffusion of a volatile compound was studied for a range of soil conditions utilizing soils from the mine detection sites in Puerto Rico. A new mathematical analysis based on the Monte Carlo method was developed for predicting vapor diffusion through soil into the atmosphere. It was determined that diffusion in soil can be reliably predicted if soil porosity, moisture content, and affinity for the compound are known. Detection in the atmosphere of TNT vapor from mines and explosives buried in moist, porous soil should be possible under ideal sample collection conditions.

**RR 289**
**GAMMA-RAY SPECTRA OF RESONANCE NEUTRON IRRADIATED EARTH MATERIALS.**
Murrmann, R.P., et al, Aug. 1970, 27p., AD-714 220, 15 refs.
Winters, R.W., Martin, T.G.
25-2436
SOIL CHEMISTRY, NEUTRON ACTIVATION ANALYSIS, ISOTOPIC LABELING, CLAY MINERALS, GAMMA RAY SPECTRA.
Clay mineral and soil samples were subjected to neutron activation analysis in order to identify and measure the abundances of trace elements having radionuclides with long half-lives. After exposure of cadmium-shielded samples to neutrons for a period of five days, the gamma radiation associated with the decay of the resulting radionuclides was observed using a high resolution Ga (Li) detector. Trace elements identified without prior chemical separation using the gross gamma-ray spectra included Fe, Zn, Ti, Ni, Co, Cr, Sr, Ba, Ca, La, Eu, Tb, Hf, Ta, Th, and U. It should be possible to determine quantitatively the amount of each of these elements. This is a considerable improvement over the number of elements determined in soils previously by activation analysis without destructive chemical treatments.

**RR 290**
**LOW-TEMPERATURE PHASES ON INTERFACIAL WATER IN CLAY-WATER SYSTEMS.**
Anderson, D.M., et al, Oct. 1970, 15p., AD-715 714, 19 refs.
Tice, A.R.
25-3463
THERMAL ANALYSIS, CLAY SOILS, SOIL MOISTURE, HEAT MEASUREMENT, FROZEN GROUND THERMODYNAMICS, UNFROZEN WATER CONTENT, PHASE TRANSFORMATIONS, MINERAL CONTENT, FREEZE THAW CYCLES.
Low temperature differential thermal analyses of selected clay-water systems were made to locate important phase change temperatures and to define fruitful temperature-pressure fields for precise calorimetric investigation. In addition to an exotherm corresponding to initial freezing, one, two or three exotherms were observed between -35C and -60C. The low temperature exotherms do not depend critically upon water content, but clearly they are related to clay mineral and exchangeable cation type. The evolution of heat in this temperature range probably corresponds to a phase change in the interfacial water.

**RR 291**
**TEMPERATURE STRUCTURE OF A MID-LATITUDE, DIMICTIC LAKE DURING FREEZING, ICE COVER AND THAWING.**
Parrott, W.H., et al, Nov. 1970, 21p., AD-715 716, 32 refs.
Fleming, W.M.
25-3464
LAKE ICE, HEAT MEASUREMENT, LAKE WATER, THERMAL ANALYSIS, ICE FORMATION, ICE BREAKUP.
The temperature structure of Post Pond, in west-central New Hampshire, was studied during autumn, winter and spring of 1968-1969. The lake was instrumented over its max depth (11.7 m) with a string of 24 thermocouples. Temperatures in 9 m of sediments were measured with a thermistor probe. Secondary and tertiary thermocline development in the epilimnion occurred during short warming periods in the early autumn. The autumn lasted 25 days, whereas the spring overturn lasted only 4 days. The entire lake mixed isothermally in the autumn to 3.2C. During the period of ice cover, the lower 5 m of water gained approximately 51.5 cal/sq cm from the bottom sediments. A thermal gradient of 0.07C/m was found for the deeper sediments during ice cover. Late winter cooling of bottom water under the ice cover may be the result of snowmelt. Melting of the clear ice portion was primarily the result of heat from snowmelt water, and occurred on the underside of the ice sheet.

**RR 292**
**PHASE COMPOSITION OF PORE WATER IN COLD ROCKS.**
Mellor, M., Dec. 1970, 59p., AD-719 236, 37 refs.
26-371
FROZEN ROCKS, PHASE TRANSFORMATIONS, THERMAL EXPANSION, ELECTRICAL RESISTIVITY, UNFROZEN WATER CONTENT, COMPRESSIVE PROPERTIES.
The phase composition of pore water in three types of rock subjected to temperature below 0 C was explored by a variety of techniques. Freezing point depression was measured as a function of water content by differential thermal analysis, the results yielding relationships between unfrozen water content and temperature. In an effort to avoid the practical difficulties involved in differential thermal analysis, attempts were made to determine freezing characteristics indirectly by air penetration and mercury penetration techniques applied at ordinary room temperatures. Electrical conductivity measurements were made as a function of temperature down to -195 C in an attempt to obtain information on characteristics of interfacial water films at low temperatures. Thermal strain was measured as a function of temperature in order to detect direct mechanical effects associated with phase changes, chiefly strain discontinuities brought about by volume changes in the pore water during rapid freezing and thawing. Finally, isothermal compressibility measurements, with pressures up to 27 kb, were made at -10 C so as to determine whether the rock underwent step changes in volumetric strain at pressures corresponding to those of the phase boundaries for ice polymorphs.

**RR 293**
**NUMERICAL DIFFERENTIATION BY SPLINE FUNCTIONS AND ITS APPLICATION TO ANALYZING A LAKE TEMPERATURE OBSERVATION.**
Takagi, S., Feb. 1971, 18p., AD-719 697, 11 refs.
26-370
ANALYSIS (MATHEMATICS), LAKE WATER, TEMPERATURE MEASUREMENT, LAKE ICE, HEAT TRANSFER.
Numerical differentiation by use of classical interpolation formulas yields a diversity of results. Consistent numerical differentiation can be performed by using a spline function as an interpolating function. As an application, temperature observed in a lake is numerically differentiated as a function of time and of depth by use of cubic splines. The deviation of the actual heat transfer mechanism from vertical heat conduction can thus be detected. The reliability of numerical differentiation by spline functions is manifest in this example.

**RR 294**
**STRENGTH AND DEFORMABILITY OF ROCKS AT LOW TEMPERATURES.**
Mellor, M., May 1971, 75p., AD-726 372, 54 refs.
26-2347
FROZEN ROCKS, ROCK MECHANICS, COMPRESSIVE STRENGTH, LOW TEMPERATURE RESEARCH, ELASTIC PROPERTIES, DEFORMATION, TENSILE STRENGTH, TESTS, WATER CONTENT.
Strength tests were made on three types of rock, both "air-dry" and water-saturated, at temperatures from +25 to -195 C, and stress/strain tests were made down to -60 C. Strength of air-dry specimens increased with decreasing temperature at an average rate, and quasi-elastic moduli increased at comparable rates. Static fatigue mechanisms in air-dry rock were apparently influenced by temperature-modification of adsorbed water. Strength of water-saturated specimens increased dramatically as pore water froze, and continued to increase down to -120 C, where compressive and tensile strengths were greater than room temperature values by factors of 5, 4 and 2 for sandstone, limestone and granite respectively. Compressive stress/strain curves for saturated rocks became steeper after freezing, and initial tangent moduli for saturated high porosity rocks increased by well over an order of magnitude.

**RR 295**
**AN ANALYSIS OF NONDESTRUCTIVE SENSING OF WATER CONTENT BY MICROWAVES.**
Hoekstra, P., et al, July 1971, 20p., AD-728 831.
Cappillino, P.
26-2356
MOISTURE CONTENT, CONSTRUCTION MATERIALS, MICROWAVES, THERMAL INSULATION, TESTING EQUIPMENT, COMPUTER PROGRAMS, ROOFS.
Microwave instrumentation is used for nondestructive measurement of the water content of materials. The basis of all microwave moisture sensors is that the dielectric constants of material that contains water are a strong function of water content. The microwave moisture sensors based on a reflection or transmission principle are shown to have the disadvantage of requiring that a calibration be made for each sample thickness. Several alternative routes for developing reliable microwave moisture sensors are discussed.

**RR 296**
**ONE DIMENSIONAL WATER FLOW THROUGH SNOW.**
Colbeck, S.C., Aug. 1971, 23p., AD-730 304.
26-2358
SNOW PERMEABILITY, WATER FLOW, FLUID FLOW, POROSITY, ANALYSIS (MATHEMATICS), FIRN, GLACIERS, THEORIES.
A theory is developed to describe the percolation of water through isothermal snow with a vertical porosity gradient. While the necessary laboratory experiments have not been done for snow, concepts from the general theory of two phase flow through porous media are used in the development. The general solution for the one-dimensional problem is given, which, when combined with any periodic boundary condition, can be used to make quantitative predictions. The theory is applied to water percolation through firn on the upper Seward Glacier.

**RR 297**
**HYDROLOGY OF THE GLENN CREEK WATERSHED TANANA RIVER BASIN, CENTRAL ALASKA.**
Dingman, S.L., Sept. 1971, 111p., AD-732 410, 115 refs.
26-2771
WATERSHEDS, RUNOFF, STREAM FLOW, WATER SUPPLY, HYDROLOGY, HYDROGRAPHY, RIVER BASINS, PRECIPITATION (METEOROLOGY), DISCONTINUOUS PERMAFROST, VEGETATION, EVAPOTRANSPIRATION, SEASONAL VARIATIONS, UNITED STATES—ALASKA—FAIRBANKS.
The results of a four-summer (1964-1967) hydrologic study of the watershed of Glenn Creek, about 8 miles north of Fairbanks, Alaska, in the Yukon-Tanana uplands physiographic province, are presented. In regard to topography, geology, soils, permafrost, vegetation, and climate, the watershed seems to be representative of low-order, low-elevation drainage basins in the province. Analysis of rainfall-runoff data indicates that about half the 12.3-in. normal annual precipitation is runoff. The remainder is the actual evapotranspiration, which equals only about 30 percent of estimated potential evapotranspiration. For individual storms, runoff/rainfall proportions were from 0.03 to 0.42, and were positively correlated with antecedent discharge of the stream, which is a measure of watershed wetness.

**RR 298**
**MODEL ANALYSIS OF VEHICLE TRAFFICABILITY WITH APPLICATION TO SURFACE EFFECT VEHICLES ON SEA ICE FIELDS.**
Smith, M., et al, Jan. 1972, 17p., AD-737 601, 3 refs.
Nakano, Y.
26-3382
AIR CUSHION VEHICLES, SEA ICE, STATISTICAL ANALYSIS, MODELS, TRAFFICABILITY.
Efforts were made to derive the design criteria of surface effect vehicles operated on arctic sea ice. Statistical theories were developed to describe trafficability of the vehicles and topography of the sea ice. By the use of actual sea ice surface profiles obtained by an aerial laser profiler, the usefulness of the present statistical method was demonstrated.

**RR 299**
**ON THE DETERMINATION OF ELASTIC AND ANELASTIC PROPERTIES OF ISOTROPIC SPHERES.**
Smith, M.L., March 1972, 45p., AD-741 355.
27-1261
SOIL MECHANICS, COMPRESSIVE PROPERTIES, ELASTIC PROPERTIES, FROZEN GROUND MECHANICS.
The author has presented a self-contained account of the theoretical framework necessary to infer the elastic properties of layered spheres from their forced or free resonance spectra. In support of these results, the author has provided numerical and experimental results, limited for external reasons to singly layered bodies. The author has also provided graphical aids which enable a rapid and fairly accurate determination of compressional and shear velocities for a homogeneous sphere from a single, particular pair of modes. This technique is useful down to Q's at least as low as 100, although unambiguous interpretation of observed spectra requires recourse to the theoretical spectral amplitudes and application of the interference rules. (Auth.)

**RR 300**
**DEPTH TIME TEMPERATURE RELATIONSHIPS OF ICE CRYSTAL GROWTH IN POLAR GLACIERS.**
Gow, A.J., Oct. 1971, 19p., AD-733 318, 22 refs.
26-2772
GLACIER ICE, ICE CRYSTAL GROWTH, FIRN, THERMAL FACTORS, SINTERING, CRYSTAL SIZE, ANALYSIS (MATHEMATICS), ANTARCTICA, GREENLAND.
The growth of ice crystals as a function of depth and time in polar firn and glacier ice has been investigated at a number of locations in Antarctica and Greenland. Thin sections of snow and ice were used to measure crystal size variations which showed, in all cases, that crystal size increases essentially linearly with the age of samples. Crystal growth rates are strongly temperature dependent. At Camp Century, Greenland, where the firn temperature is -24 C, crystals grow approximately 23 times faster than at Plateau Station, Antarctica, where the in situ temperature is -57 C. Extrapolation of the existing data indicates that crystal growth rates in polar firn and ice could be expected to vary by about two orders of magnitude over the temperature range -60 C to -15 C. Examination of the changes in the pore - crystal structure relationships to a depth of 100 m at Camp Century shows that these changes closely resemble those occurring in the full-scale isothermal sintering of powder compacts.

**RR 301**
**CHEMICAL INDICATORS OF ARCTIC BIOLOGICAL AND ENVIRONMENTAL ACTIVITIES.**
McCown, B.H., et al, April 1972, 30p., AD-741 797.
Brown, J., Murrmann, R.P.
27-993
ARCTIC VEGETATION, TUNDRA SOILS, CARBON DIOXIDE, FROZEN GROUND CHEMISTRY, ECOSYSTEMS.
Two approaches were used to study the carbon cycling in a cold-dominated ecosystem at Barrow, Alaska. One involved a detailed analysis of the flow of CO2 between the atmosphere, soil and biota and the other concentrated on the internal carbon cycling in plants. A pilot study was also conducted which investigated the possibility of estimating underground plant biomass by biochemical means. Both laboratory and field studies were conducted to analyze the input of CO2 to the arctic atmosphere by frozen tundra soils. Data are presented which indicate that frozen soil is a major source of CO2. A procedure for the extraction and estimation of organic nutrients (lipids and carbohydrates) was developed and used. Plant survival and organic nutrient levels were followed during the winter.

**RR 302**
**MEASUREMENTS OF LASER EXTINCTION IN ICE FOG FOR DESIGN OF SEV PILOTAGE SYSTEM.**
Munis, R.H., et al, Aug. 1972, 21 p., AD-750 114, 7 refs.
Delaney, A.J.
27-1184
ICE FOG, LASERS, ABSORPTIVITY, AIR CUSHION VEHICLES.
Laser extinction measurements in ice fog were made at wavelengths of 0.6328, 1.15 and 3.39 microns. The ice fog was generated in an environmental chamber whose temperature could be lowered to -43C. Particle sampling was carried out simultaneously with the laser measurements using an impactor. Size distributions were derived from the impactor measurements. These data were used to compute Mie extinction coefficients at the three laser wavelengths. These coefficients were compared with the coefficients derived experimentally. Although some discrepancy exists between theory and experiment, both agree fairly well on the behavior of the extinction coefficient as a function of particle concentration.

**RR 303**
**SOIL FAILURE UNDER INCLINED LOADS.**
Harrison, W.L., Aug. 1972, 91p., AD-750 115, 28 refs.
27-1185
SOIL MECHANICS, SOIL STRENGTH, LOADS (FORCES), COMPUTER APPLICATIONS.
The most common example of the application of inclined loads to the soil is the plate-grouser. This consists of a strip footing with a vertical arm at one end. The most usual loading arrangement is one in which a fixed vertical load is applied and then the horizontal load is increased until failure occurs. A theory has been developed which will predict the maximum horizontal force, assuming that the soil is dense enough to be reasonably described by the Coulomb equation. The theory is based on slip line fields including wedges of soil that are not failing. These slip line fields vary systematically with the interface angle and the angle of internal shearing resistance of the soil, and they are a function of the direction of motion of the interface. A computer program is provided which will solve the problem directly if the direction of motion is given. It will also solve the more practical situation described above by an iterative procedure. The postulated slip line fields have been shown to be correct by means of glass box photographs giving excellent agreement with the theory. The predictions of pas-

sive pressure have been verified by a series of force measurements on quite large grousers driven into saturated clay, dry sand and an intermediate loam.

**RR 304**
**DESIGN AND MAXIMUM ERROR ESTIMATION FOR SMALL ERROR LOW PASS FILTERS.**
Hibler, W.D., III, Sept. 1972, 12p., AD-750 116, 9 refs.
27-1186
LASERS, SPECTRA, FILTERS, PACK ICE, PROFILES.
By using standard spectral windows small error low pass nonrecursive filters may be designed with transition bandwidths inversely proportional to the number of filter weights. The maximum ripple error outside the transition band for any low pass filter using discrete smoothing by the three most standard spectral windows is estimated. Consequently, the straightforward design equations may be used to calculate low pass digital filter weights with a guaranteed maximum error of less than 0.9 per cent or 0.05 per cent depending on how wide the transition band is made. Filters designed in this way have errors comparable to or smaller than those of filters designed by existing techniques and have the advantage that the maximum error is known before hand.

**RR 305**
**MINERALOGY OF SUSPENDED SEDIMENT IN SOME ALASKAN GLACIAL STREAMS AND LAKES.**
Tice, A.R., et al, Dec. 1972, 14p., AD-754 578, 11 refs.
Gatto, L.W., Anderson, D.M.
27-2531
MINERALOGY, SUSPENDED SEDIMENTS, CHEMICAL ANALYSIS, WEATHERING, GLACIAL RIVERS, X RAY DIFFRACTION.
Suspended sediments were collected from glacial streams and lakes close to the sources to determine if any physical or chemical weathering had occurred within them. The mineralogical composition and the major constituents were determined using X-ray diffraction. In almost all cases the composition of the samples parallel that of the native parent materials, indicating that no chemical changes had occurred in the fine suspended material.

**RR 306**
**PREVAILING WIND DIRECTIONS IN THE ARCTIC OCEAN.**
Bilello, M.A., March 1973, 53p., AD-761 074, 41 refs. (passim).
28-688
WIND (METEOROLOGY), WIND DIRECTION, CLIMATOLOGY, METEOROLOGICAL DATA.
Prevailing monthly and seasonal surface wind directions were obtained from 1) weather records for 21 coastal stations around the Arctic Ocean and 2) a series of U.S. Navy wind charts for 15 to 20 locations in the arctic marginal seas and the ocean's interior. This information was combined and analyzed to develop 2 charts which depict the surface flow of air in these areas during the mid-summer and mid-winter months. Since the ice floe stations used in the offshore wind analysis are not permanently located, the Arctic Ocean was selectively divided into 6 zones. Three of these zones separate Polar regions north of 84 N latitude, and 3 other zones separate the seas bordering the north coasts of Europe, Siberian Russian and North America. Except for a few stations where wind directions are apparently controlled by local influences the results showed the following mid-winter patterns: 1) a near anticlockwise flow within the circle north of 75 N; 2) winds from the north over and near the Chukchi and Bering Seas; 3) northeast winds along the Alaskan coast and northwest along the Canadian Archipelago Islands; and 4) southwest and southeast winds along the northern coasts of Europe and Asia respectively. Although the wind direction during mid-summer becomes more variable the study showed that the prevailing surface winds for most areas in this season are nearly opposite those observed in winter.

**RR 307**
**THEORY OF SOIL PLASTICITY WITH INDEFINITE ANGLE OF NON-COAXIALITY.**
Takagi, S., May 1973, 29p., AD-762 560, 22 refs.
28-692
SOIL MECHANICS, PLASTIC PROPERTIES, STRAIN RATE, THEORIES, ANALYSIS (MATHEMATICS).
One of the difficulties that has hampered the development of the mathematical theory of soil plasticity was recently overcome by Mandl and Luque. They showed that the non-coaxiality of the principal axes of a stress tensor and a strain-rate tensor can occur only in plane deformation. Their assumption that the angle of non-coaxiality should be a material constant cannot be supported, however. The angle of non-coaxiality should be determined so that the solution to the given problem can exist. It is demonstrated in one of the examples in this paper that a well-known solution in which the angle of non-coaxiality is assumed to be zero does violate the assumed boundary condition. The theory was reorganized by using new insights given by Mandl and Luque. It is concluded that still missing is one condition that enables us to determine the angle of non-coaxiality as a function of space.

**RR 308**
**EFFECT OF SALINITY ON THE OPTICAL EXTINCTION OF SEA ICE AT 6328Å.**
Davis, H., et al, July 1973, 14p., AD-763 882, 8 refs.
Munis, R.H.
28-623
SEA ICE, ICE OPTICS, LIGHT TRANSMISSION, LASERS, ICE SALINITY.
An investigation is made into the determination of the relationship between the extinction coefficient and the salinity of sea ice. A HeNe laser is used to propagate a beam of red light, of wavelength 6328Å, through a series of ice samples at -20 C. The optical extinction coefficients were calculated and plotted against the measured salinities. The results of the experiment indicated an exponential relationship between extinction coefficient and salinity. The relationship may be described by the equation $y = 2.41 + 0.001 \exp(1.19x)$ where y is the extinction coefficient and x is the salinity.

**RR 309**
**ISUA, GREENLAND: CALCULATIONS OF GLACIER FLOW FOR AN OPEN PIT MINE.**
Colbeck, S.C., July 1973, 24p., AD-766 300, 11 refs.
28-2875
GLACIER FLOW, MINING, ICE REMOVAL, SLOPE PROCESSES.
The Marcona Corporation and Kryolitselskabet Öresund, A/S (a Danish corporation) are cooperatively investigating the possibility of developing an open-pit mine along the edge of the Greenland Ice Cap. The response of the glacier to a sudden change in surface slope and thickness is calculated. The existing flow is diverted away from the mineral deposit but will increase when the excavation begins. It is calculated that 66 million cubic meters of ice must be removed in order to establish a stable profile beyond the pit. An additional 7.9 million cubic meters of ice must be removed yearly in order to maintain the profile.

**RR 310**
**SALINITY VARIATIONS IN SEA ICE.**
Cox, G.F.N., et al, Aug. 1973, 22p., AD-768 170, 13 refs.
Weeks, W.F.
28-2872
SEA ICE, SALINITY, ICE COVER THICKNESS, VARIATIONS.
The salinity distribution in multiyear sea ice is dependent on the ice topography and cannot be adequately represented by a single average profile. The cores collected from areas beneath surface hummocks generally showed a systematic increase in salinity with depth from 0 per thousand at the surface to about 4 per thousand at the base. The cores collected from areas beneath surface depressions were much more saline and displayed large salinity fluctuations. Salinity observations from sea ice of varying thicknesses and ages collected at various arctic and subarctic locations revealed a strong correlation between the average salinity of the ice, and the ice thickness, h. For salinity samples collected from cold sea ice at the end of the growth season, this relationship can be represented by two linear equations: Salinity = 14.24 - 19.39h ($< 0.4$ m); Salinity = 7.88 - 1.59h ($h > 0.4$ m). It is suggested that the pronounced break in slope at 0.4 m is due to a change in the dominant brine drainage mechanism from brine expulsion to gravity drainage. A linear regression for the data collected during the melt season gives Salinity = 1.58 + 0.18h. An annual cyclic variation of the mean salinity probably exists for multiyear sea ice. The mean salinity should reach a maximum at the end of the growth season and a minimum at the end of the melt season.

**RR 311**
**EFFECTS OF STRATIGRAPHIC LAYERS ON WATER FLOW THROUGH SNOW.**
Colbeck, S.C., Sept. 1973, 13p., AD-767 248, 21 refs.
28-2873
WATER FLOW, SNOW STRATIGRAPHY, ICE COVER THICKNESS, PERMEABILITY, FIRN STRATIFICATION, MELTWATER.
The flow of water through layered snowpacks is discussed. A method for predicting flow through unsaturated layers is given. The flow along ice layers and through ice layers is analyzed in terms of the slope, permeability, thickness and length of the layers. It is shown that the permeability of ice layers required to cause large flow diversions is quite small. The effect of slope is large even at small angles.

**RR 312**
**TENSILE STRENGTH OF ICE UNDER TRIAXIAL STRESSES.**
Haynes, F.D., Dec. 1973, 24p., AD-774 194.
29-187
ICE STRENGTH, TENSILE STRENGTH, STRESSES.
An investigation was conducted to determine the effect of a compressive stress on the tensile strength of bubbly polycrystalline ice. One hundred forty-five tests were made in an apparatus of novel design. A cylindrical dumbbell specimen was stressed in axial tension and radial and tangential compression by a hydraulic system which minimized bending stresses. Compression-tension ratios ranging from 0.21 to 10.14 were used for the tests. Tensile strength was found to decrease with an increase in the ratio. At the ratio of 3.155 the tensile strength is about one third the uniaxial value. The test results support the evidence that the Brazil test underestimates the tensile strength for ice. They also indicate that the Brazil test value for ice can be no greater than one third the uniaxial tensile strength.

**RR 313**
**THEORY OF METAMORPHISM OF WET SNOW.**
Colbeck, S.C., Dec. 1973, 11p., AD-772 692, 13 refs.
28-3040
SNOW CRYSTAL GROWTH, SNOW WATER CONTENT, METAMORPHISM (SNOW), WET SNOW, AVALANCHES, SNOWMELT.
Grain growth, bond growth and densification of wet snow are described in terms of the distribution of equilibrium temperature in the snow matrix. At high water saturations the equilibrium temperature increases with grain size; hence, small particles melt away as large particles grow. Melting also occurs at the intergrain bonds, causing a low strength and rapid densification. At low saturations the equilibrium temperature is determined by the capillary pressure and the particle sizes have only a second order effect. Therefore, grain growth proceeds slowly and, even at large overburden pressures, no intergrain melting occurs. At low saturations the water "tension" acts through a finite area, thus large attractive forces exist between the grains, and the strength of the snow matrix is large.

**RR 314**
**SEA ICE TERRAIN MODEL AND ITS APPLICATION TO SURFACE VEHICLE TRAFFICABILITY.**
Hibler, W.D., III, et al, Dec. 1973, 26p., AD-774 195, For this paper from another source see 30-3386.
Ackley, S.F.
29-186
SEA ICE, TOPOGRAPHIC FEATURES, AIR CUSHION VEHICLES, TRAFFICABILITY, MODELS, PRESSURE RIDGES.
A sea ice terrain model, based upon previously tested height and spacing distributions for sea ice pressure ridging, is developed. Using this model, and additional information on pressure ridge extents, a trafficability model for vehicles traversing the pack ice is developed. Both analytic and Monte Carlo calculations of vehicle trafficability, measured in terms of the average ratio of the total distance traveled over a straight-line distance, are performed. The calculations include cul-de-sacs due to ridge intersections. The trafficability ratio is given as a function of ridge-height-clearance ability of the vehicle and of ridging parameters which may be obtained from laser profiles of the arctic pack ice.

**RR 315**
**INVESTIGATIONS PERFORMED ON THE ARCTIC ICE DYNAMICS JOINT EXPERIMENT MARCH 1971.**
Ackley, S.F., et al, Dec. 1973, 66p., AD-775 381, Numerous refs.
Hibler, W.D., III, Kovacs, A., Weeks, W.F., Hartwell, A.D., Campbell, W.J.
28-4122
SEA ICE, STRAIN ANALYSIS, ICE SURFACE, ICE DEFORMATION, AERIAL PHOTOGRAPHY, PACK ICE, PRESSURE RIDGES.
This report is in 5 parts. Part I, Mesoscale Strain Measurements on the Beaufort Sea Pack Ice (see also 28-1321) discusses fracture orientations in correlation with strain rate ellipse. Part II, Structure of a Multiyear Pressure Ridge (28-62), discusses transverse profile measurement of a ridge. Part III, Top and Bottom Roughness of a Multiyear Ice Floe (28-3869), is a spectral study of snow and ice topography. Part IV, Airphoto Analysis of Ice Deformation in the Beaufort Sea (27-514) gives time, direction, and magnitude of deformational motion along with mesoscale measurements of strains. Part V, Data on Morphological and Physical Characteristics of Sea Ice in the Beaufort Sea discusses measurements of ice blocks in ridges and of salinity and temperature.

**RR 316**
**CHEMICAL PROFILE OF THE ROSS ICE SHELF AT LITTLE AMERICA V, ANTARCTICA.**
Langway, C.C., Jr., et al, Jan. 1974, 5p., AD-774 196, 17 refs.
Herron, M.M., Cragin, J.H.
28-3698
ICE CORES, CHEMICAL ANALYSIS, ION DENSITY (CONCENTRATION), GEOCHEMISTRY, ANTARCTICA—ROSS ICE SHELF.
Measurements of the cationic concentrations of Na, K, Mg, and Ca were made on 28 samples from the 255-m-deep ice core from Little America V. All concentrations decreased sharply with depth from the firn-ice transition at 52 m to somewhere between 125 m and 150 m. From 150 m to 250 m the cationic concentrations are relatively constant. This is interpreted to indicate that the ice above 125 m fell as snow on the Ross Ice Shelf and that ice below 150 m originated inland on Marie Byrd Land. (Auth. mod.)

**RR 317**
**ADHESION OF ICE FROZEN FROM DILUTE ELECTROLYTE SOLUTIONS.**
Jellinek, H.H.G., March 1974, 9p., AD-776 370, 10 refs.
28-4123
ICE ADHESION, ICE FORMATION, ICE ELECTRICAL PROPERTIES, DEICING.
Experiments by Smith-Johannsen on the adhesion of ice frozen from a number of electrolyte solutions to a wax-treated alumi-

num surface at -10C are discussed. It is concluded that the adhesive strength measured by the force per sq cm needed to shear the ice off the substrate surface is mainly due to a liquid interfacial solution layer between the ice and the substrate surface. The thickness of such a layer is largely determined by the same considerations as the thickness of grain boundary layers in ice obtained from dilute electrolyte solutions.

**RR 318**
**ISUA, GREENLAND: GLACIOLOGICAL INVESTIGATIONS DURING 1973.**
Colbeck, S.C., et al, March 1974, 15p., AD-776 946, 9 refs.
Gow, A.J.
28-4124
GLACIOLOGY, ICE TEMPERATURE, GLACIAL HYDROLOGY, ICE CORES, ICE CRYSTAL STRUCTURE.
Two holes were drilled through the Greenland ice sheet during 1973 and temperature measurements were made in one hole drilled during 1972. These measurements show that the area of liquid water beneath the ice cap extends to ice depths as shallow as 100 m. The consequences of removing the frozen margin of glacial ice could be serious and more temperature measurements are needed to exactly locate the subglacial water. Petrographic studies of a few ice cores revealed a strongly oriented crystal fabric and an appreciable surface accumulation of superimposed ice.

**RR 319**
**AIR MASSES, FRONTS AND WINTER PRECIPITATION IN CENTRAL ALASKA.**
Bilello, M.A., June 1974, 58p., AD-780 696.
29-1591
AIR MASSES, FRONTS (METEOROLOGY), PRECIPITATION (METEOROLOGY), METEOROLOGICAL DATA.
The physical, meteorological and climatological aspects of freezing precipitation in the Tanana River Basin of central Alaska are examined. Periods of inclement weather are evaluated with respect to frequency and duration, and concurrent temperature, wind, atmospheric pressure and visibility conditions. Although relatively dry polar continental air masses dominate the area in winter, massive intrusions of maritime air occasionally produce a major snowstorm and, in rare instances, rain or freezing rain. Because of the surrounding mountain ranges, snow occurs most often when the atmospheric pressure is rising and the winds are from the west. Ice fogs are observed at temperatures below -21F, and very few water-droplet fogs are reported at temperatures below -31F. The relationships between air masses, fronts and local climatic influences may be used in forecasting winter precipitation in central Alaska. The statistical survey presented also contributes new information on winter weather conditions in this region.

**RR 320**
**SORPTION OF CADMIUM BY SOILS.**
Blom, B.E., June 1974, 29p., AD-782 949, 42 refs.
29-906
SOIL CHEMISTRY, SEWAGE TREATMENT.
Experimentally, the interaction of cadmium with two soils and one naturally occurring zeolite was examined using calcium-saturated and potassium-saturated samples. The soils preferentially bound cadmium in the presence of either calcium or potassium with decreasing cadmium selectivity as the fractional cadmium surface coverage increased. Cadmium sorption was relatively higher with the potassium soils as compared with the calcium soils. For the loamy fine sand this increase was accounted for by electroselectivity principles, while such reasoning was inadequate to explain the increases observed with the Charleton loam sample. The preference for cadmium over calcium, as measured by the selectivity coefficient, was higher for the sandy soil. The zeolite was found to be calcium-selective. A method for monitoring the flow of cadmium through soil columns was examined. The use of spatial filtering, involving Fourier transforms, was found to be a suitable technique for monitoring the changes in cadmium concentration as it flows through soils. The experimental technique involves the use of gamma-emitting metal isotopes in conjunction with an external scintillation counter.

**RR 321**
**DEGRADATION OF POLYMERS AT LOW TEMPERATURES BY NO2, O3 AND NEAR-UV RADIATION.**
Jellinek, H.H.G., June 1974, 23p., AD-782 950, 7 refs.
29-907
POLYMERS, LOW TEMPERATURE TESTS, TENSILE STRENGTH, BRITTLENESS, AIR CUSHION VEHICLES.
A tensile strength, a static and a dynamic stiffness tester have been constructed for measuring appropriate mechanical properties of polymers as a function of temperature, environmental conditions (i.e. air plus NO2, O3 etc. or of the pollutants alone), exposure time and pollutant concentration. The apparatus were found to perform satisfactorily. The dynamic stiffness tester is particularly sensitive to the onset of cracking in polymeric materials due to ozone. The tensile strength of linear polyurethane was affected appreciably by NO2 alone and also by NO2 in presence of air. Chain scission cross-linking, evolution of CO2 and other small molecular weight compounds, and formation of nitro and nitroso groups along the polymer backbone are reactions underlying the observed changes in mechanical properties of the polymer. The static "stiffness" tester allows one to measure "stiffness" (Young's modulus) of polymers (especially elastomers) as a function of the above-mentioned parameters. A preliminary selection of polymeric skirting materials for SEV's can be made on the basis of results obtained as functions of temperature. Two industrial samples appeared to be suitable for this purpose on the basis of results obtained. "Stiffness" of these samples started to increase rapidly only at -40 deg C and -30 deg C whereas others became brittle at higher temperatures. The dynamic stiffness tester was tested with a natural rubber compound because of its susceptibility to ozone. Onset of cracking was accurately and clearly indicated by this instrument. An EPM compound proved quite resistant to ozone over prolonged periods of time. Time did not allow tests to be completed on all the compounds supplied by industry.

**RR 322**
**WATER-ICE PHASE COMPOSITION OF CLAY/WATER SYSTEMS. 1. THE KAOLINITE/WATER SYSTEM.**
Anderson, D.M., et al, June 1974, 8p., AD-782 951, 19 refs.
Tice, A.R., Banin, A.
29-908
PHASE TRANSFORMATIONS, UNFROZEN WATER CONTENT, CLAY SOILS, SOIL TEMPERATURE.
Previous studies indicated that when water-ice phase composition curves are normalized to unit surface area, the unfrozen water content values at given temperatures for the kaolinite/water system are higher than those of other soils and soil constituents. The water-ice phase composition curve for this system has been redetermined using an improved isothermal calorimeter and the earlier curve confirmed. For most soils, water-ice phase composition curves are well represented by a simple power curve. In contrast, the layer-lattice silicate/water systems so far investigated behave differently; segments of two power curves are required to fit the data. Values of unfrozen water content per unit surface area (determined by ethylene glycol adsorption) for the kaolinite/water systems are more than twice as large as those for the two representative montmorillonite/water systems investigated.

**RR 323**
**ANALYSIS OF THE FREEZEBACK OF WATER IN A CYLINDRICAL BOREHOLE DRILLED IN AN ICE SHEET.**
Takagi, S., Sept. 1974, 18p., ADA-000 693.
29-2778
FLOATING ICE, BOREHOLES, ICE COVER THICKNESS, TEMPERATURE DISTRIBUTION, ANALYSIS (MATHEMATICS).
Presented is a solution of the freezeback of water in a cylindrical bore-hole drilled in an ice sheet floating on water, based on the assumption that the temperature distribution does not depend on the vertical direction and the temperature of the water in the borehole is the freezing temperature. The solution is found by using the thickness of the newborn ice in place of time. Because of the complexity of the analysis, the solution can be found only for the first few terms of the series solution. Numerical computation of the solution thus found by use of the first few terms of the series solution yields the growth curve of the newborn ice that reaches maximum at a certain time. The solution ceases to be valid before the time of maximum is reached. (Auth.)

**RR 324**
**AIRBORNE RESISTIVITY MAPPING OF PERMAFROST NEAR FAIRBANKS, ALASKA.**
Hoekstra, P., et al, Sept. 1974, 51p., ADA-000 694.
Sellmann, P.V., Delaney, A.J.
29-2779
ELECTRICAL RESISTIVITY, PERMAFROST DISTRIBUTION, MAPPING.
Airborne resistivity methods using radio waves in three frequency bands were tested in the vicinity of Fairbanks, Alaska. The test sites were selected because much ground control is available for this area. The objectives of this study were to determine the ability of these methods to map permafrost and other soils and to investigate the advantages of multifrequency mapping. The airborne resistivity data obtained in this study were contoured and the contour maps were compared with surficial geological maps and other ground truth data available. The following conclusions were reached: (1) in areas where the near-surface sediments are relatively uniform, VLF resistivity best delineates permafrost; and (2) in areas where surface sediments vary widely (e.g., recent flood plains), resistivity at all frequencies gives little information on permafrost conditions, but provides other important information, such as bedrock type, depth to bedrock, soil type and layering. (Modified author abstract)

**RR 325**
**MEASUREMENTS OF THE DIELECTRIC PROPERTIES OF WET SNOW USING A MICROWAVE TECHNIQUE.**
Sweeny, B.D., et al, Oct. 1974, 31p., ADA-001 550, 42 refs.
Colbeck, S.C.
29-2350
SNOW WATER CONTENT, SNOW DIELECTRICS, MICROWAVES, POROSITY, WET SNOW.
An accurate method of measuring liquid water in snow covers is required to determine the properties of wet snow. The dielectric properties of wet snow must be utilized to adequately measure its liquid water content. In this study of the effect of liquid water on the complex dielectric constant of natural snow is determined in the microwave frequency range. Deloor's method for calculating the dielectric constant for mixtures and the results of waveguide experiments on samples of wet snow and glass beads are used to construct a calibration curve relating the measured dielectric loss factor directly to the water content of wet snow. The results are independent of porosity, past history and chemical impurities. A relation between the effective dielectric constant and the porosity and water content is proposed and tested experimentally. The general nature of this relation is described and suggestions are made for the development of a more precise relation. It is concluded that the dielectric constant is a function of porosity and water content only.

**RR 326**
**DETECTING STRUCTURAL HEAT LOSSES WITH MOBILE INFRARED THERMOGRAPHY. PART 1—DESCRIPTION OF TECHNIQUE.**
Munis, R.H., et al, Oct. 1974, 12p., ADA-001 549, 3 refs.
Berger, R.H., Marshall, S.J., Bush, M.A.
29-2349
BUILDINGS, INSULATION, HEAT LOSS, INFRARED PHOTOGRAPHY.
A method to assess quickly the insulation effectiveness of buildings using mobile infrared thermography has been developed at USA CRREL. In contrast to the infrared thermography done in Sweden, this method concentrates on obtaining useful data by measuring the outside surface temperature of structures. This report outlines the basic principles involved in these measurements, and discusses field measurements and the inherent advantages of infrared thermography. Typical thermograms are presented in the appendixes.

**RR 327**
**LABORATORY STUDIES OF COLD FOG DISPERSAL BY COMPRESSED AIR.**
Lukow, T.E., et al, Dec. 1974, 10p., ADA-008 866, 6 refs.
Hicks, J.R.
29-3997
FOG DISPERSAL, LABORATORY TECHNIQUES, ICE CRYSTAL FORMATION, NUCLEATING AGENTS.
Two compressed air systems for glaciating supercooled clouds were studied in the laboratory. The first system used the sudden expansion of compressed air and was found to be most efficient at 27 psig producing an average of 520 million ice crystals per cu cm of air. The second system used a continuous flow of air through nozzles of various designs, of which the supersonic nozzle was found to be the most efficient, producing a maximum of 250 million crystals per cu cm of air at 27 psig. The above data were obtained at an ambient temperature of -4 deg C, but data for other temperatures and pressures were obtained and are presented in the text.

**RR 328**
**SPLINE APPROXIMATION TO THE FREEZING OF WATER IN A CYLINDRICAL HOLE DRILLED IN AN ICE SHEET.**
Takagi, S., Feb. 1975, 13p., ADA-006 581, 2 refs.
29-3998
ICE PHYSICS, ANALYSIS (MATHEMATICS), HEAT BALANCE, ICE WATER INTERFACE.
An interpolation continuous up to the first-order derivatives is needed to solve this problem, because the first-order derivatives are used in the formulation of the movement of the freezing front. The requirement is met in this paper by use of a parabolic spline. The Crank-Nicholson formula is used to set up the predictor-corrector scheme of time integration. Several iterations are needed to advance one step in time because of the implicit nature of the Crank-Nicholson formula and the nonlinearity involved in the freezing problem.

**RR 329**
**DIFFERENTIAL SEA ICE DRIFT.**
Hibler, W.D., III, et al, March 1975, 37p., ADA-007 733, 35 refs.
Weeks, W.F., Kovacs, A., Ackley, S.F.
29-3999
SEA ICE, DRIFT, ICE DEFORMATION, SHEAR STRAIN, ATMOSPHERIC PRESSURE, WIND VELOCITY.
Measurements of mesoscale sea ice deformation over a region approximately 20 km in diameter were made over a five-week period in the spring of 1972 at the main AIDJEX camp in the Beaufort Sea. They have been analyzed to determine nonlinearities in the ice velocity field (due to the discrete small-scale nature of the ice pack), as well as a continuum mode of deformation represented by a least squares strain rate tensor and vorticity. The deformation rate time series between Julian day 88 and 113 exhibited net areal changes as large as 3% and deformation rates up to 0.16% per hour. A comparison of mesoscale strain measurements with the atmospheric pressure field and the wind velocity field indicated that the ice divergence rate and vorticity followed the local pressure and wind divergence with significant correlation. For low atmospheric pressures and converging winds, the divergence rate was negative with the vorticity being counterclockwise. The inverse behavior was observed for high pressures and diverging winds. This behavior agreed with predictions based upon the infinite boundary solution of a linearized drift theory in the absence of gradient current effects and using the constitutive law proposed by Glen for pack ice.

**RR 330**
**SUBARCTIC PLANT COMMUNITIES AND ASSOCIATED LITTER AND SOIL PROFILES IN THE CARIBOU CREEK RESEARCH WATERSHED, INTERIOR ALASKA.**
Troth, J.L., et al, March 1975, 25p., ADA-009 063, 25 refs.
Deneke, F.J., Brown, L.M.
29-4000
PLANT ECOLOGY, VEGETATION PATTERNS, SOIL CHEMISTRY, WATERSHEDS.
Studies were completed in several black spruce and aspen/birch communities of the Caribou Creek Watershed. Frequency and basal area or percent cover are detailed for tree, sapling, shrub, herbaceous, moss, and lichen species. Organic layer mass was greatest beneath a north slope black spruce community. Carbon and nitrogen levels were higher in litter layers beneath the hardwood stands, whereas carbon/nitrogen ratios were higher in the living and decaying organic mat beneath black spruce. Concentrations of P, Ca, Mg, Mn and Zn were higher in hardwood than in conifer organic layers. K and Fe concentrations in organic layers were similar beneath hardwoods and conifers. Soils beneath conifer and hardwood stands could not be separated on the basis of pH, %C, %N or C/N ratios. Cation exchange capacity closely reflected %C in all soils. More exchangeable bases were present in soils beneath hardwood communities than beneath black spruce communities. Increases in extractable P were found near the soil surface in aspen-dominated communities. Extractable soil P increased below 15 cm in conifer stands.

**RR 331**
**DIGITAL COMPUTER SIMULATION OF THE ANNUAL SNOW AND SOIL THERMAL REGIMES AT BARROW, ALASKA.**
Outcalt, S.I., et al, March 1975, 18p., ADA-007 734, 21 refs.
Goodwin, C., Weller, G., Brown, J.
29-4001
SNOW TEMPERATURE, SOIL TEMPERATURE, COMPUTERIZED SIMULATION, WATER SUPPLY.
An annual snow-soil simulator for Arctic tundra was developed using coupled models of surface equilibrium temperature and substrate thermal diffusion. Snow ripening, melt and accumulation are modeled in the simulator which is forced with daily weather data. The simulator predicts that a snow fence array capable of producing drift deeper than 4.2 meters will initiate a permanent snowfield at Barrow, Alaska. Such a man-induced snowfield could serve as a reliable source of fresh water for Barrow and similar villages in the North Slope region of Alaska. Further analysis indicated that albedo reduction due to dust fall, snow removal, etc., is dominant over aerodynamic effects in producing the early spring meltout observed at Barrow Village.

**RR 332**
**RED AND NEAR-INFRARED SPECTRAL REFLECTANCE OF SNOW.**
O'Brien, H.W., et al, March 1975, 18p., ADA-007 732, 6 refs.
Munis, R.H.
29-4002
SNOW COVER, REFLECTANCE, SNOW OPTICS, INFRARED SPECTROSCOPY.
The spectral reflectance of snow in the range of 0.60 to 2.50 microns wavelengths was studied in a cold laboratory using natural snow and simulated preparations of snow. A white barium sulfate powder was used as the standard for comparison. The high reflectance (usually nearly 100%) of fresh natural snow in the visible wavelength declines rapidly at wavelengths near and beyond 0.80 microns, as the spectral absorption coefficients of ice increase. Aging snow becomes only somewhat less reflective than fresh snow in the visible region and usually retains a reflectance greater than 80%. In the near infrared, aging snow tends to become considerably less reflective than fresh snow. The rate of decline of near-infrared reflectance due to aging is strongly affected by the history of the snow during aging. Snow aged under certain conditions may retain 90% or so of its reflectance in the visible red, yet may be only about 10% as reflective as the original fresh snow beyond 2.2 microns. Several environmental factors such as ambient temperature and wind effects which contribute to the variability in snow reflectance are discussed.

**RR 333**
**BEARING CAPACITY OF FLOATING ICE PLATES SUBJECTED TO STATIC OR QUASI-STATIC LOADS, A CRITICAL SURVEY.**
Kerr, A.D., April 1975, 43p., ADA-009 363, 157 refs.
29-4003
FLOATING ICE, BEARING CAPACITY, STATIC LOADS.
This report contains a critical survey of the literature on the bearing capacity of floating ice plates. It consists of a discussion of general questions, a critical survey of analytical attempts to determine the bearing capacity of floating ice plates, and a survey of field and laboratory tests on floating ice plates and their relation to the analytical results. The paper concludes with a systematic summary of the results, a discussion of observed shortcomings, and suggestions for needed investigations.

**RR 334**
**ISUA, GREENLAND: GLACIER FREEZING STUDY.**
Ashton, G.D., April 1975, 19p., ADA-009 705, 10 refs.
29-4004
GLACIER MOVEMENT, ICE REFRIGERATION, MINING, ARTIFICIAL FREEZING.
A scheme for cooling the lower portion of the edge of the Greenland ice sheet, which abuts a potential mining operation, is examined. The magnitude of cooling which may be accomplished by drilling a series of holes about the periphery of the mine site is determined as a function of hole size, spacing and time. Refrigeration is accomplished by pumping a coolant downhole in a central pipe, then uphole in an annulus between the pipe and hole wall, and then through a thin-walled pipe exposed to the surface climate above the ice sheet. It was found possible to achieve a temperature change in the ice of the order of -1 deg C with hole spacings and pumping requirements which are considered reasonable. Other effects are briefly examined and include an estimate of the basal water thickness and flow rates.

**RR 335**
**HEAT TRANSFER CHARACTERISTICS OF A BUBBLE-INDUCED WATER JET IMPINGING ON AN ICE SURFACE.**
Yen, Y.-C., Apr. 1975, 16p., ADA-010 635, 13 refs.
For another version of this report see 31-1948 (MP 827).
32-2597
HEAT TRANSFER, WATER FLOW, BUBBLES, ICE REMOVAL.

**RR 336**
**COMPRESSIBILITY CHARACTERISTICS OF UNDISTURBED SNOW.**
Abele, G., et al, May 1975, 57p., ADA-012 113, 9 refs.
Gow, A.J.
30-894
SNOW MECHANICS, SNOW COMPRESSION, SNOW DEFORMATION.
The effects of snow temperature, rate of deformation, and initial density on the stress vs density and stress vs deformation relationships were investigated in the pressure range of 0.1 to 75 bars. The rate of deformation in the range of 0.027 to 27 cm/sec does not have a significant effect. A decrease in temperature in the range of 0 degrees to -40 degrees C increases the resistance to stress and deformation, the temperature effect increasing with applied pressure and initial density. The effect of initial density is significant. For any stress, an increase in the initial density results in an increase in the resulting density, particularly at low stress levels and at temperatures near 0 degrees C. The texture of artifically compacted snow is significantly different from that of naturally compacted snow of the same density because of the very short recrystallization time period.

**RR 337**
**INTERPRETATION OF YOUNG ICE FORMS IN THE GULF OF ST. LAWRENCE USING SIDE-LOOKING AIRBORNE RADAR AND INFRARED IMAGERY.**
Dunbar, M., et al, July 1975, Canada. Department of National Defence. Defence Research Establishment, Ottawa. DREO report no. 711, July 1975, 41p., ADA-015 457, 9 refs.
Weeks, W.F.
30-2064
SEA ICE, ICE CONDITIONS, AIRBORNE RADAR, INFRARED PHOTOGRAPHY, PHOTOINTERPRETATION, CANADA—SAINT LAWRENCE GULF.
Ice conditions during mid-January 1974 in the Gulf of St. Lawrence and in the estuary as far upstream as Rimouski are described utilizing side-looking airborne radar, infrared and photographic imagery. The interpretations were verified by simultaneous surface observations on the ice by investigators operating from the CSS Dawson. The ice examined was undergoing rapid drift and deformation and showed a wide variety of thin ice (0-40 cm) features formed under the influence of strong winds and currents. These observations should serve as a guide in interpreting ice conditions in similar areas where ground truth data are not available.

**RR 338**
**DETECTING STRUCTURAL HEAT LOSSES WITH MOBILE INFRARED THERMOGRAPHY. PART II-SURVEY OF PEASE AIR FORCE BASE PORTSMOUTH, NEW HAMPSHIRE.**
Munis, R.H., et al, June 1975, 29p., ADA-012 117, 4 refs.
Berger, R.H., Marshall, S.J., Bush, M.A.
30-895
BUILDINGS, HEAT LOSS, INFRARED EQUIPMENT, UNITED STATES—NEW HAMPSHIRE—PEASE AIR FORCE BASE.
During winter of 1973-74 a mobile infrared thermography system was used to survey housing units and base facilities at Pease Air Force Base, Portsmouth, New Hampshire. This report provides both qualitative and quantitative evidence regarding heat flow out of the eave vents of these housing units. Calculations indicate that a significant amount of heat is being lost in this manner due to inadequate attic (cap) insulation. Possible evidence of incomplete ventilation could explain the presence of condensation in the housing units. Analyses of thermograms are presented to show the possible existence of low and high pressure areas around a structure and how they relate to heat loss.

**RR 339**
**GAS INCLUSIONS IN THE ANTARCTIC ICE SHEET AND THEIR SIGNIFICANCE.**
Gow, A.J., et al, Oct. 1975, 18p., ADA-018 016, 17 refs.
Williamson, T.C.
30-2507
ICE SHEETS, DRILL CORE ANALYSIS, GAS INCLUSIONS, AIR ENTRAINMENT, BUBBLES, ANTARCTICA—BYRD STATION.
Cores obtained to the bottom of the Antarctic Ice Sheet at Byrd Station were used to analyze the physical properties of air bubbles trapped in the ice. These bubbles originate as pockets of air in the upper layers of snow and approximately 10% by volume is retained permanently when the snow transforms into ice. Parameters measured were the sizes, shapes, abundances, spatial distributions, gas volumes and pressures of bubbles, and their variations with depth in the ice sheet. Bubbles occur abundantly in the top 800 m of ice but then gradually disappear until they can no longer be detected optically below 1100 m. All available evidence indicates that the air actually diffuses into the ice in response to increasing overburden pressure. The possibility exists that the dissolved gases are retained in the form of a gas hydrate or clathrate which, because of release of confining pressures, begins to decompose soon after ice cores are pulled to the surface. This decomposition is accompanied by the growth of gas-filled bubble-like cavities, and as much as 40% of the dissolved air has exsolved already from some cores in less than three years. Only small variations were observed in the entrapped air content of the ice cores; they probably reflect variations in the temperature and/or pressure of the air at the time of its entrapment, but the data are not sufficient to draw any firm conclusions regarding past variations in ice sheet thickness. Only ice from the bottom 4.83 m was found to lack any detectable trace of air. Since this absence of air coincided precisely with the first appearance of stratified moraine in the cores, it is concluded that this ice originated from the refreezing of air-depleted water produced under pressure melting conditions at the bottom of the ice sheet. (Auth. mod.)

**RR 340**
**ANALYSIS OF HYDROLOGIC RESPONSE TO RAIN-ON-SNOW.**
Colbeck, S.C., July 1975, 16p., ADA-013 383.
32-3593
SNOW HYDROLOGY, RUNOFF, RAIN, ANALYSIS MATHEMATICS.
The equations describing water movement in a dry snow cover are derived and examples of flow through ripe, refrozen and fresh snows are given. The grain size of snow has a large effect on the timing of water discharge. Water is retained by dry snow to raise its temperature and satisfy the irreducible water saturation. These requirements delay and reduce runoff following rain on dry snow.

**RR 341**
**CHEMISTRY OF 700 YEARS OF PRECIPITATION AT DYE 3, GREENLAND.**
Cragin, J.H., et al, July 1975, 18p., ADA-014 970, 30 refs.
Herron, M.M., Langway, C.C., Jr.
30-2046
SNOW COMPOSITION, ICE CORES, CHEMICAL ANALYSIS, GREENLAND.
Concentrations of sodium, potassium, magnesium, calcium, silicon, aluminum, lead and sulfate were measured in surface snow and in individual annual accumulation layers from a 373-m-deep ice core from Dye 3, Greenland, covering the time period from 1232 to 1971 A.D. Average background (pre-1840) concentrations in micrograms/liter are: Na, 12.9; K, 2.2; Mg, 1.5; Ca, 4.8; Si, 12; Al, 3.3; Pb, 0.07; and SO4, 56. Deviations are due mainly to the variability of the concentrations in the samples deposited over the stated time interval rather than analytical precision. Observed concentrations of sodium, potassium, magnesium, calcium, silicon and aluminum can be adequately explained by relative abundances of these elements in seawater and terrestrial dust. Late 19th century annual ice layers contain twice as much sulfate as pre-1840 deposits, reflecting the increased use of fossil fuels in the Northern Hemisphere. Lead concentrations in post-1955 snow deposits are more than an order of magnitude greater than pre-1840 baseline concentrations and are attributed to smelting and the increased use of lead alkyls in gasoline.

**RR 342**
**WORK-HARDENING AND STRAIN RATE SENSITIVITY OF FLOW STRESS IN HIGH PURITY ICE SINGLE CRYSTALS.**
Parameswaran, V.R., Oct. 1975, 11p., ADA-018 015, 16 refs.
30-2504
ICE DEFORMATION, COMPRESSIVE STRENGTH, STRAIN TESTS, STRESS STRAIN DIAGRAMS.
Single crystals of high purity ice deformed by uniaxial compression on an Instron machine showed remarkable work-hardening

after about 8% strain. By changing the strain rate during compression tests in the plastic region of the stress-strain curve, an apparent activation volume V* and a dislocation mobility exponent m were calculated from the strain rate sensitivity of flow stress. The large work-hardening and the rapid increase in the value of m beyond about 10% strain indicate that the plastic flow in this region is controlled by dislocation intersections and nonconservative motion of jogs.

**RR 343**
**SIMULTANEOUS MEASUREMENT OF LASER EXTINCTION IN WARM FOG AT WAVELENGTHS OF 0.6328, 1.15, AND 10.6 MICRONS.**
Munis, R.H., et al, Oct. 1975, 7p., ADA-017 943, 3 refs.
Delaney, A.J.
30-2505
LASERS, MEASURING INSTRUMENTS, ABSORPTIVITY, FOG.
Simultaneous laser extinction measurements were made in warm fog at wavelengths of 0.6238, 1.15 and 10.6 microns. The warm fog was generated in a 4-cu m environmental chamber. Particle sampling was carried out simultaneously with the laser measurements using an impactor. Using the same size distribution in each case the theoretical extinction coefficients were calculated and compared with the experimental coefficients. Results obtained during this experiment and a previous one indicate that propagation at 1.15 micron is adversely affected by the presence of atmospheric water vapor. Experimental data obtained simultaneously at 0.6328 and 10.6 micron indicate that virtually no difference exists between the extinction coefficients at these two wavelengths for moderate particle concentrations while at much larger concentrations the former increases indefinitely while the latter levels off at 0.2.

**RR 344**
**CLASSIFICATION AND GEOMORPHIC IMPLICATIONS OF THAW LAKES ON THE ARCTIC COASTAL PLAIN, ALASKA.**
Sellmann, P.V., et al, Dec. 1975, 21p., ADA-021 266, 30 refs.
Brown, J., Lewellen, R.I., McKim, H.L., Merry, C.J.
30-3096
LAKE ICE, CLASSIFICATIONS, REMOTE SENSING, ERTS IMAGERY.
The lakes of the Arctic Coastal Plain of northern Alaska were classified, based on size, shape, orientation and distribution, into six lake units and three nonlake units. Regional slope and relief were demonstrated to control lake size, the largest lakes occuring on the flattest, northernmost segment of the Coastal Plain. Using ERTS-1 sequential imagery and existing photography and data, lakes were grouped according to three depth ranges, < m, 1-2 , and > 2m. Deepest lakes have the longest period of summer ice cover. Ice on shallow lakes melts the earliest. Maximum depths of lakes were computed based on ice volume content of the perennially frozen ground (permafrost) and these agreed with observed values and ranges. The lake classification and regional ERTS-1 coverage also appear to provide additional information on the limits of late-Pleistocene transgressions on the Coastal Plain.

**RR 345**
**BRINE DRAINAGE AND INITIAL SALT ENTRAPMENT IN SODIUM CHLORIDE ICE.**
Cox, G.F.N., et al, Dec. 1975, 85p., ADA-021 765, 41 refs.
Weeks, W.F.
30-1805
SEA ICE, ICE GROWTH, SALT ICE, ICE SALINITY, BRINES, MATHEMATICAL MODELS.
Using radioactive 22Na as a tracer, it was possible to determine both the concentration and movement of the brine within the ice without destroying the sample. A detailed temperature and growth history of the ice was also maintained so that the variation of the salinity profiles could be properly interpreted. In all respects, the salinity profiles are similar to those of natural sea ice. They have characteristic C-shape, and clearly exhibit the effects of brine drainage. To determine the relative importance of the desalination mechanisms, a theoretical brine expulsion model was derived and compared to the experimental data. As input for the model, equations describing the variation of some properties of NaCl brine with temperature were derived. These included the brine salinity, viscosity, specific heat, thermal conductivity, and latent heat of freezing. The theoretical brine expulsion model was derived by performing mass and energy balances over a control volume of NaCl ice. A simplified form of the model, when compared to the experimental results, indicated that brine expulsion was only important during the first several hours of ice growth, and later became a minor desalination process relative to gravity drainage which continued to be the dominant mechanism for the remainder of the study period (up to 6 weeks). The rate of gravity drainage was found to be dependent on the brine volume and the temperature gradient of the ice. As either the brine volume or temperature gradient was increased, the rate of change of salinity due to gravity drainage increased. The equation commonly used to calculate the effective distribution coefficient (Weeks and Lofgren 1967) was modified and improved by taking brine drainage into account. An expression was also derived to give the distribution coefficient at very low growth velocities.

**RR 346**
**BIOLOGICAL ASPECTS OF TERRESTRIAL OIL SPILLS—USA CRREL OIL RESEARCH IN ALASKA, 1970-1974.**
Deneke, F.J., et al, Dec. 1975, 74p., ADA-047 365, Refs. p.62-66.
McCown, B.H., Coyne, P.I., Rickard, W., Brown, J.
31-4108
OIL SPILLS, SOIL POLLUTION, SOIL MICROBIOLOGY, ARCTIC VEGETATION, REVEGETATION, ENVIRONMENTAL IMPACT, PIPELINES, ECOSYSTEMS, UNITED STATES—ALASKA.
Knowledge concerning the biological effects of oil pollution on arctic and subarctic terrestrial ecosystems is limited. USA CRREL research personnel conducted investigations from 1970 through 1974 to expand information in this field. Objectives were to: 1) define the ecosystems most sensitive to the presence of crude oil or its refined products, 2) quantify and understand the injury response, and 3) establish time frames for manifestation of damage and natural restorative processes in arctic and subarctic regions. This was accomplished through: 1) surveys of natural oil seepages and past accidental spills in the Arctic and Subarctic, 2) initiation of controlled oil spills and 3) detailed laboratory investigations. Results demonstrated that terrestrial oil spills will to some degree be detrimental to both arctic and subartic plant communities. Degree and longevity of damage will be influenced primarily by the magnitude of the spill, season of occurrence and existing soil moisture content. Rapid recovery of plant communities subjected to spills will occur only if root systems remain relatively unaffected. Damage will be more extensive and long-term when root systems are saturated with oil. Effects of damage will be manifested gradually over several seasons being influenced by winter stresses. Variation does exist in plant species susceptibility. *Carex aquatilis*, a predominant sedge of the arctic, is markedly resistant to crude oil damage. In the taiga *Picea mariana* is very susceptible. Plant recovery can be enhanced through the application of fertilizer. Fertilization, in addition to its direct effect on plant nutrition, will stimulate microbial decomposition of crude oil.

**RR 347**
**SEASONAL VARIATIONS OF CHEMICAL CONSTITUENTS IN ANNUAL LAYERS OF GREENLAND DEEP ICE DEPOSITS.**
Langway, C.C., Jr., et al, Dec. 1975, 5p., ADA-021 319, 14 refs.
Cragin, J.H., Klouda, G.A., Herron, M.M.
30-1806
ICE SHEETS, CHEMICAL COMPOSITION, SEASONAL VARIATIONS, ICE DATING.
Chemical analysis of century-old ice from continuous 5 to 7 year intervals of three ice cores from south and central Greenland (Dye 3, Milcent and Crete) show maximum concentrations of Na, Mg, Ca, K, and Al during early spring and minimum concentrations during late summer and early fall. Peak spring values are as much as 10 times greater than fall values. Because of the large seasonal chemical variations, samples used for depth-age or annual deposition rate studies must represent accumulation from exactly one year or whole multiples of a year. The seasonal chemical variations seem promising as a new method of defining annual layers and thus dating old ice cores.

**RR 348**
**DETECTING STRUCTURAL HEAT LOSSES WITH MOBILE INFRARED THERMOGRAPHY PART III—SURVEY OF USA CRREL.**
Munis, R.H., et al, Dec. 1975, 9p., ADA-020 375, 2 refs.
Berger, R.H., Marshall, S.J., Bush, M.A.
30-1807
BUILDINGS, HEAT LOSS, INFRARED EQUIPMENT, SOLAR RADIATION.
During the winter of 1973-74 a mobile infrared thermography system was used to survey the USACRREL building at Hanover, New Hampshire. This report provides a description of excessive heat losses at several locations around the building. This report also discusses the need to carefully monitor meteorological conditions before starting a survey of a building exterior to determine if solar radiation decay from the building surface might interfere with thermographic analysis by masking the heat emanating from within the building.

**RR 349**
**FLEXURAL STRENGTH OF LAKE ICE IN RELATION TO ITS GROWTH STRUCTURE AND THERMAL HISTORY.**
Gow, A.J., et al, Dec. 1975, 28p., ADA-020 964, 13 refs.
Langston, D.
30-1808
LAKE ICE, FLEXURAL STRENGTH, ICE GROWTH, THERMAL REGIME, ICE CRYSTAL STRUCTURE, TEMPERATURE EFFECTS.
In-place cantilever beam tests on Post Pond and Mascoma Lake ice yielded a maximum flexural strength of 7.1 kg/sq cm. The minimum strength, unrelated to failure along pre-existing cracks in the ice, was 2.9 kg/sq cm. The majority of tests were performed in the push-down mode after it was discovered that beams tested in the pull-up mode, which places the bottom surface in tension, frequently broke prematurely along cracks in the bottom of the ice. Premature failures of this kind usually occurred at stresses of 2-3 kg/sq cm. Data further demonstrate that the intrinsic strength of lake ice decreases significantly as the surface air temperature goes to 0 degree C. Ice that has just become isothermal, but has not yet begun to candle, has a strength of about 4 kg/sq cm; ice that has been subjected to prolonged periods of above-freezing air temperatures generally fails at about 3 kg/sq cm. Tests also show that cold unrecrystallized snow-ice is as strong as the underlying lake ice. Tests of the effect of crystalline structure indicate that ice composed of crystals with their c-axes horizontal is measurably stronger than ice in which the crystals are oriented with their c-axes vertical.

**RR 350**
**STRAIN RATE EFFECT ON THE STRENGTH OF FROZEN SILT.**
Haynes, F.D., et al, Dec. 1975, 27p., ADA-021 981, 16. refs.
Karalius, J.A., Kalafut, J.
31-402
FROZEN GROUND MECHANICS, COMPRESSIVE STRENGTH, TENSILE STRENGTH, STRAIN MEASURING INSTRUMENTS.
Uniaxial compression and tension tests were conducted on frozen Fairbanks silt at a temperature of -10C. A relatively stiff testing machine was operated at a constant displacement rate for each test. The tests showed that compressive strength is very sensitive to strain rate and that tensile strength is relatively insensitive to it. As was found in other investigations, tangent moduli increased slightly with greater strain rates. The specific energy increased at higher strain rates for compression tests and decreased slightly for tension tests. For increased strain rates, uniaxial compression strength showed no tendency to plateau; nor did the specific energy reach a minimum during uniaxial tensile testing.

# SPECIAL REPORTS, PRE-1976

**SR 1** Record deleted.

**SR 2** Record deleted.

**SR 3** Record deleted.

**SR 4** Record deleted.

**SR 5** Record deleted.

**SR 6**
**CLIMATOLOGICAL STUDY OF KEWEENAW PENINSULA.**
Gerdel, R.W., et al, June 1953, 11p., AD-716 671.
Diamond, M.
25-4055
MICROCLIMATOLOGY, WEATHER STATIONS, SITE SURVEYS, UNITED STATES—MICHIGAN—KEWEENAW PENINSULA.
The microclimatological survey conducted in the Keweenaw Peninsula during the 1952-53 winter season indicates that the Calumet-Hancock Airport, Ahmeek Flats, and Brockway Mountain Drive sites are all suitable for a SIPRE field station. The lower winter temperatures at the Calumet-Hancock Airport site combined with the physiographic features and availability of facilities and utilities at this site favor its selection for the Keweenaw Field Station of SIPRE. Since it is well centered with respect to the other sites, with good open, all-season highways available, advantage may be taken of the special features exhibited by the other sites if necessary to the accomplishment of special studies.

**SR 7**
**SUMMARY ON SNOW COMPACTION TESTS 1952-53, KAPUSKASING, CANADA.** May 1954, 24p., AD-716 670, 3 refs.
25-4056
SNOW STRENGTH, SNOW COMPACTION, SNOW HARDNESS, TRAFFICABILITY, TESTS.
The report is based on an analysis of data obtained during the 1952-53 Snow Compaction Trials conducted at Kapuskasing, Canada. It is generally known that, if snow is intensively mixed before it is compacted, the hardness or bearing capacity usually continues to increase for some time after compaction. This process is commonly referred to as age hardening. At the present time the hardness of a snow cover as measured with a rammsonde is used as an index of its strength or trafficability. The ultimate hardness attained by the snow is determined by the type of compaction process used, the thermodynamic and mechanical properties of the snow, and the air temperatures. It is necessary to measure as many of these factors as possible in order to evaluate compaction processes.

**SR 8**
**TESTS ON SNOW BEAMS.** Oct. 1953, 38p., AD-716 669.
25-4057
SNOW COMPACTION, FLEXURAL STRENGTH, SNOW (CONSTRUCTION MATERIAL), BEAMS, TESTS.
The report is concerned with flexural tests on beams of compacted snow. These tests were made in conjunction with a program to evaluate, on a rational basis, the load-carrying capacity of compacted snow sections.

**SR 9** Record deleted.

**SR 10**
**OBSERVATIONS OF SNOW COVER - KAPUSKASING, CANADA 18-26 JANUARY 1954.**
Benson, C.S., March 1954, 4p., AD-034 199.
24-3422
SNOW TEMPERATURE, TEMPERATURE DISTRIBUTION, TEMPERATURE GRADIENTS, SNOW BEARING STRENGTH, TRAFFICABILITY, RECRYSTALLIZATION, SNOW DENSITY.
Snow observations taken in conjunction with a vehicle test program are reported. The shallow snow cover (11-22 in.) and loose bonding within the snow cover resulted in a poor bearing surface and unsatisfactory test conditions. A high temperature at the bottom of the pack combined with a steep temperature gradient within the pack caused considerable recrystallization by sublimation. The insulating effect of snow and other conditions as factors in snow trafficability are discussed. Temperature, density and hardness profiles are illustrated.

**SR 11**
**PRELIMINARY REPORT ON CREVASSES.**
Schuster, R.L., et al, April 1954, 6p., AD-711 897.
Rigsby, G.P., Small, F.A.
25-2244
CREVASSES, ACCIDENTS, CREVASSE DETECTION.
The general characteristics of transverse, longitudinal, marginal, and radial crevasses and bergschrunds, the mechanics of crevasse formation, and features indicating the presence of crevasses are reviewed. An account of 8 crevasse accidents is given in the appendix.

**SR 12** Record deleted.

**SR 13**
**OCCURRENCE OF BLOWING SNOW ON THE GREENLAND ICE CAP DURING 1953-1954.**
Walsh, K.J., June 1954, 9p., AD-716 664.
25-4058
BLOWING SNOW, SNOW ROADS, ROAD MAINTENANCE, GREENLAND.
Construction and maintenance of compacted snow roads on the Greenland Ice Cap may be considerably hindered by blowing snow. This study was undertaken to determine the number of days and the number of hours each month when blowing snow occurred at Sites 1 and 2 on the Greenland Ice Cap. The information obtained from this study may be used in determining the amount of time available for operational programs and research work on the Ice Cap.

**SR 14** Record deleted.

**SR 15**
**GEOGRAPHY OF NORTHEAST GREENLAND.**
Victor, P.-E., Nov. 1965, 51p., AD-102 287, Numerous refs. passim.
24-3423
GEOGRAPHY, TOPOGRAPHIC FEATURES, MAPS, LAND ICE, SEA ICE, LAKE ICE, GREENLAND.
A detailed geographical outline of Peary Land and Kronprins Christian Land regions are given. The strategic importance and possibilities of the region are indicated, and the particular lack of natural defenses is noted. Routes and brief descriptions of overland expeditions in NE Greenland are included.

**SR 16**
**AIRFIELDS ON SEA ICE.**
Assur, A., Oct. 1955, 7p., AD-078 151.
24-3424
SEA ICE, AIRCRAFT LANDING AREAS, ICE COVER THICKNESS, ICE COVER STRENGTH, AIRPLANES, RUNWAYS.
The basic procedures for establishing and maintaining airfields on sea ice are presented. Practical recommendations are given for the preliminary choice of location, exploratory field survey, and construction of the airstrip. Estimates of the required sea-ice thickness for landing various types of naval aircraft, with and without skis, are tabulated.

**SR 17**
**RESUPPLY OF ICE-CAP EXPEDITIONS BY AIR DROP.**
Benson, C.S., Nov. 1955, 3p., AD-078 090.
24-3425
EXPEDITIONS, LOGISTICS, AERIAL RESUPPLY, DROP ZONES.
The layout of a drop zone for air supply is described and diagrammend, and packaging of supplies for air drops is discussed briefly. The procedure requires prudent use of colored flags to aid the pilot's depth perception and to facilitate height estimates from the surface, smoke bombs to outline the drop zone and indicated wind conditions, and constant radio communication between pilot and expedition leader at the surface.

**SR 18**
**PROJECT JELLO: SIPRE GREENLAND EXPEDITION 1955. REPORT ON SPECIAL FOODS PROVIDED BY THE QUATERMASTER FOOD AND CONTAINER INSTITUTE.**
Benson, C.S., et al, Jan. 1957, 53p., AD-716 668, Revision of report dated Feb. 1956. 4 refs.
Ragle, R.H.
25-4059
EXPEDITIONS, LOGISTICS, DIETS.
Expedition Jello conducted a program of glaciological research for 100 days on the Greenland Ice Cap during the Spring and Summer of 1955. The expedition was resupplied entirely by air drops which were spaced approximately 30 days apart. This report discusses the specific logistic problem of food and its solution. The problem was two-fold: (1) To provide a proper and adequate diet for six men engaged in strenuous physical work at high elevations and low temperatures. These conditions result in increased food consumption. (2) To restrict the necessary food-cargo weight per man-day so that it did not equal nor exceed the figure required for a diet of C-6 or 5-in-1 rations. Special dehydrated and frozen foods were utilized with excellent results. The expedition personnel were provided with a greater quantity and variety of foods than could have been obtained with 5-in-1 or C-6 rations; however, the total required weight was significantly less than that required by either 5-in-1 or C-6 rations or combinations thereof.

**SR 19**
**MEASUREMENTS BY SIPRE IN 1955 ON THE ACCUMULATION MARKERS OF EXPEDITIONS POLAIRES FRANCAISES IN CENTRAL GREENLAND.**
Benson, C.S., , July 1956, 5p. plus illus, tables, graphs and chart, AD-117 338.
Ragle, R.H.
24-3426
SNOWFALL, MARKERS, ACCUMULATION.
The results of investigations made in the summer of 1955 by SIPRE Expedition JELLO as a continuation of the work begun by the French 5 yr. earlier are summarized. Measurements were made of snow accumulation at 14 French markers from 1951-1955. The average accumulation of snow was 1.14m./yr., comparing well with the 1.18m./yr. obtained by the French in 1950-51, and showing a decrease toward the higher elevations of the interior. Data on snow accumulation in 1950-51, 1951-1955, and 1950-1955, and the deviation from the mean value of the 4- and 1-yr. accumulation values are tabulated and graphed.

**SR 20**
**OBSERVATIONS ON PROJECT LAKE HAZEN.**
Bender, J.A., May 1956, 6p., AD-105 206.
25-2245
AIRCRAFT LANDING AREAS, ICE BEARING CAPACITY, PROJECT LAKE HAZEN, SNOW COVER.
Discusses the ability of Lake Hazen to support heavy type aircraft, its strategic location, huge size, and good approach conditions. The estimated snow removal effort and a projected operation period for various type of aircraft are given. Information on the meteorological conditions, snow conditions and bearing capacity of the lake the year around is necessary if the potentialities of the lake are to be fully exploited. Recommendations to supply the required information are included.

**SR 21**
**PROJECT BLUE ICE: GREENLAND CREVASSE RECONNAISSANCE, SUMMER 1954.**
Small, F.A., April 1955, 43p., AD-716 665.
25-4060
CREVASSES, AERIAL RECONNAISSANCE, PHOTOINTERPRETATION, GREENLAND.
The Corps of Engineers program in northwestern Greenland during the summer of 1954 included a reconnaissance group whose purpose was to investigate a crevassed area on the Ice Cap, to provide information for initiating a research program in 1955. This report on the project, called 'Blue Ice' in the field, is intended, first, as an information source for outlining a research program and, second, as a record of observations in a crevassed area.

**SR 22**
**THE EFFECT OF SNOW PROPERTIES ON VEHICLE TRAFFICABILITY IN THE ARCTIC.**
Skinrood, A.C., Feb. 1957, 13p., AD-136 810, 5 refs.
24-3427
SNOW VEHICLES, TRAFFICABILITY, SNOW STRENGTH, DRAWBAR PULL.
Instrumentation, techniques, and results of tests carried out with modified weasels in central Greenland during the summer of 1955 are given. Max. drawbar pull was measured together with meteorological conditions and conditions of the snow cover, including snow temperature, density, and depth of distortion due to the vehicle tracks. With this vehicle, the depth to which snow properties determine max. drawbar pull may vary from 15-30 cm. No correlation was found between drawbar pull and average density to any given depth. A similar lack of correlation was found in the case of ram hardness numbers. Max. drawbar pull of the weasel cargo carrier varied from 2800-3700 lb., and 75 percent of the tests from 3000-3400 lb. Recommendations for future test programs are given.

**SR 23**
**EFFECTS OF EXPLOSIVES ON SNOW.**
Fuchs, A., July 1957, 9p., AD-203 809, 2 refs.
24-3428
SNOW MECHANICS, EXPLOSION EFFECTS, CRACK PROPAGATION, AVALANCHE COUNTERMEASURES.
Blast effects of 1-6 sticks (205 gm. each) of 40 per cent gelatin and charges of 0.5-2 lb. of TNT placed at depths of 0-102 in. were studied near Alta (Utah) during Feb.-March 1956 in snow ranging from 110-120 in. deep. Disturbance of the snow by the blasts was determined by the diam. of the outermost concentric cracks, the diam. of the crater, and the depth of the crater. With constant charge, the diam. of the cracks or crater increased with increasing charge depth until a max. was reached, beyond which the value decreased rapidly to zero. With constant charge depth, the crack diam. increased with increasing charge. Ram profiles showed an inhomogeneous age hardening in the crater. Temperature measurements indicated snow warming in a vertical profile line in the crater's center. Problems and proposals for a future test program are summarized.

**SR 24**
**MOVEMENT OBSERVATIONS ON THE GREENLAND ICE SHEET.**
Wallerstein, G., Aug. 1957, 4p., AD-203 810, Also published in journal of glaciology, 3:207-210, March 1958 5 refs.
24-3429
GLACIER MOVEMENT, GREENLAND.
Certain positions on the Icecap, established by the French in 1951, were redetermined in 1955 by observations of the sun to measure the movement of the ice surface. A movement of 774 m. in 4 yr. in a S. direction (not with the surface slope) was noted for the Central Station, confirming French findings. The direction of the movement may be due to the deflection of the ice to the S. by a 20-mi. ridge (discovered by seismic measurements) rising 760 m. in 10 mi. W. of the station. A motion of 611 m. in a W. direction was measured at Mile 100, indicating the importance of surface slope for ice movement at this point halfway between Central Station and the firn line. Assuming a constant velocity with depth, the total flow of ice per yr. in a 1-m. cross section is calculated as 360,000 cu. m., while accumulation over the 100 mi. between Mile 100 and Central Station is 82 m./yr. The uncertainty of the measures is large since the time scale is so short.

**SR 25**
**GUIDE FOR GREENLAND DUTY.**
Hinchcliffe, R.R., et al, April 1958, 33p., AD-716 667, Revision of report dated April 1957.
Morrison, B.J.
25-4061
MANUALS, PERSONNEL, GREENLAND.
The manual was prepared as a guide for USA SIPRE and USA SIPRE contract personnel assigned to duty in Greenland. Primary emphasis has been placed on the Thule area.

**SR 26**
**POLAR GLACIOLOGY STUDY COURSE.**
Ragle, R.H., July 1958, 14p., AD-711 896, 17 refs.
25-2246
GLACIOLOGY, EDUCATION, GREENLAND.
During August 1956 a SIPRE polar glaciology study course was held on the Greenland Ice Cap. Seventeen scientists from Europe and the Americas, who were to participate in the glaciological program during the International Geophysical Year, observed and practiced techniques concerned with snow-pit studies. Ram hardness, density, temperature, and stratigraphic measurements were taken in a dry snow zone, a soaked zone, and an intermediate zone between dry and soaked. Snow features were seen and discussed. Crevasse rescue techniques were practiced, and high-polar logistics, travel, and working conditions observed.

**SR 27** Record deleted.

**SR 28**
**MEASUREMENTS OF ICE TUNNEL DEFORMATION CAMP RED ROCK, GREENLAND.**
Hilty, R.E., July 1959, 12p., AD-711 898.
25-2247
ICE TUNNELS, DEFORMATION, MEASUREMENT.
Detailed scientific studies on the regimen of the cliff terminus of the North Ice Cap in Greenland were initiated as a full scale project (CE Project 24) in the summer of 1955, at Camp Red Rock, Nunatarssuaq, 40 miles northeast of Thule Air Base. One of the several means of gathering information was through deformation studies in a 30-m deep horizontal tunnel excavated normal to the trend of the cliff face and aligned essentially parallel to the direction of glacier flow. During the spring and summer of 1956, a tunnel addition (referred to here as the 1956 tunnel) was extended from the side of the 1955 tunnel. The excavation in 1956 was dug to a lower level and exposed approximately 15 sq/m of bouldery subglacial floor. This provided an excellent opportunity to obtain precise and detailed information on basal glacier movement as well as to study the effects on a patch of frozen ground suddenly relieved of high stresses. The tunnel walls and ceiling were instrumented with several rings of motion pegs which were surveyed with a theodolite from a system of stations by stakes. Mapping of the ice stratigraphy and other deformation studies augmented the motion survey. The primary objective of Project 24 in 1957 was to resurvey the position of the pegs in the 1956 tunnel. Compilation of data and conclusions derived constitute the basis of this report.

**SR 29** Record deleted.

**SR 30** Record deleted.

**SR 31**
**SNOW STUDIES AND OTHER OBSERVATIONS-OPERATION KING DOG, SONDRESTROM, GREENLAND.**
Langway, C.C., Jr., July 1959, 12p., AD-634 469.
24-3430
ICE MOUNDS, ICE SURFACE FEATURES, SNOWFALL, ACCUMULATION, METEOROLOGICAL DATA, TOPOGRAPHIC FEATURES, SNOW VEHICLES, TRAVERSES.
Described are the land features and weather conditions encountered during the traverse made in Greenland during Operation King Dog, 1958. The objective was to select an access route from Sonderstrom to the edge of the ice cap and thence to the dry snow area on the ice cap. Temperature data was obtained at the snow surface and at depth and the snow stratigraphy was observed.

**SR 32**
**LITERATURE SURVEY OF MOISTURE MIGRATION IN SOILS DUE TO THERMAL GRADIENTS.**
Osterberg, J.O., et al, Feb. 1959, 10p., AD-711 899, 11 refs.
Fead, W.N.
25-4062
SOIL MOISTURE MIGRATION, TEMPERATURE GRADIENTS, FROST ACTION, BIBLIOGRAPHIES.
The purpose of this study was to discover what work had been done on vapor diffusion in soils, in order to uncover any theory which might explain the occurrence of ice lenses in permafrost.

**SR 33** Record deleted.

**SR 34**
**GRID TECHNIQUE FOR MEASURING ICE TUNNEL DEFORMATION.**
Butkovich, T.R., et al, July 1959, 8p., AD-716 666, 3 refs.
Landauer, J.K.
25-4063
ICE TUNNELS, DEFORMATION, MEASUREMENT.
A new method for measuring deformation and closure of an ice tunnel was devised. This technique requires the installation of grid lines on a smooth section of tunnel wall. Although this necessitates the work of smoothing the wall, it has the significant advantage over other methods of making the movement readily visible.

**SR 35**
**CORRECTION FOR BROMIDE DURING CHLORIDE TITRATION OF SEA-ICE BRINE.**
Assur, A., Jan. 1960, 4p., AD-653 133, 4 refs.
24-3431
SEA ICE, BRINES, CHEMICAL ANALYSIS.
An explanation is given to account for the effect of bromide on the chlorinity of sea water brine; the resultant is termed chloride equivalent. In many cases the correction for bromide will not be significant but should be included in striving for greatest accuracy in the chemical analysis of sea water.

**SR 36** Record deleted.

**SR 37**
**SOME FRICTIONAL PROPERTIES OF THIN WATER FILMS.**
Jellinek, H.H.G., June 1960, 12p., AD-653 132, 6 refs.
24-3432
WATER FILMS, FRICTION, SHEAR RATE, TEMPERATURE FACTORS, STRESS CONCENTRATION.
An optical method has been established to measure film thickness down to about 0.2 micr and a shear apparatus has been constructed for the investigation of frictional properties of water films sandwiched between optically flat glass plates. Friction has been studied as a function of film thickness, rate of shearing and temperature. It rises very rapidly from very low values to high values when the film becomes 1 micr or thinner. The stress is inversely proportional to the film thickness and only slightly dependent on rate of shear, decreasing with increasing shear. The phenomenon is clearly that of dry friction due to particulate matter and some remaining asperities in the glass surface.

**SR 38**
**PERFORMANCE OF A WILLIAM AUGER PERMAFROST.**
McCoy, J.E., Jan. 1960, 12p., AD-716 672, 1 ref.
25-4064
DRILLING, AUGERS, PERFORMANCE.
It was found necessary to auger holes in frozen ground up to 30 inches in diameter and up to 50 feet deep. A Williams Auger, Model LDH 50, was purchased to do this work. It was winterized, then shipped by rail to Fort Churchill, Manitoba. Its use as an operational piece of equipment and the daily record kept of its capabilities and deficiencies is the basis of the report.

**SR 39**
**EFFECTS OF SHOCK WAVE ON A PETER SNOW ARCH.**
McCoy, J.E., et al, July 1960, 5p., AD-653 147.
Waterhouse, R.W.
24-3433
WAVE PROPAGATION, SNOW TRENCHES, EXPLOSION EFFECTS, PRESSURE FACTORS, SNOW (CONSTRUCTION MATERIAL), SNOW COMPRESSION, COMPRESSIVE STRENGTH, SHOCK WAVES.
Two shots were fired above trench arches constructed of Peter snow in Greenland to determine the effect of the shock waves on the arches. The tests indicated that a 9-ft span of Peter snow 24 in. thick could withstand a 15 psi blast overpressure.

**SR 40** Record deleted.

**SR 41**
**PERFORMANCE TESTING OF A SNOWBLAST PLOW.**
Jackovich, E.R., et al, April 1963, 25p., AD-447 722.
Wuori, A.F.
24-3434
SNOW REMOVAL EQUIPMENT, SNOWBLAST PLOWS.
The Snowblast, a tractor-mounted rotary snow plow, was first tested on the Greenland Ice Cap during the 1958 and 1959 test seasons. The unit operated for a total of 50 hours, 17 of which were spent constructing six snow runway test sections. Two major breakdowns occurred in the power train consisting of bearing failures in the transfer gear box. The plow was then returned to Houghton, Michigan where repairs and modifications were performed. The machine was operated for an additional 20 hours after modification. It was found that the modifications had corrected many of the original deficiencies in the machine. However, although the rotary unit itself is effective in milling and moving snow, additional modifications would have to be made to make the Snowblast operationally satisfactory on the Greenland Ice Cap.

**SR 42**
**CONSERVATION OF M29C WEASEL TRACKS.**
Lanyon, J.J., Sept. 1962, 7p., AD-696 409.
24-3435
SNOW VEHICLES, METALS, TESTS, TRACKED VEHICLES.
In the winter of 1958-59, tests were conducted to improve the usefulness of the M29C weasel track system for extensive travel in arctic regions and conserve the remaining supply of weasel tracks. A standard weasel track was cut into five equal lengths and rejoined with specially designed links to form a sectionalized track. Five

**SR 43**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC; PT. I, 1958-59, 1959-60; PT. II, 1960-61, 1961-62; PT. III, 1962-63, 1963-64; PT. IV, 1964-65, 1965-66.**
Bilello, M.A., et al, July 1961, Feb. 1964, July 1966, Nov. 1969, 43, 101, 103 and 130p., AD-653 143, AD-600 483, AD-649 768, AD-699 328.
Bates, R.E.
24-3436
ICE COVER THICKNESS, ICE REPORTING, CLIMATE, METEOROLOGICAL DATA, UNITED STATES—ALASKA, CANADA.
Data on ice thickness, freeze-over, breakup, ice surface conditions, etc., are given for ice stations in Canada and Alaska.

**SR 43/1**
**ICE THICKNESS OBSERVATIONS IN THE NORTH AMERICAN ARCTIC AND SUBARCTIC FOR 1958-59, 1959-60.**
Bilello, M.A., July 1961, 43p., AD-653 143, See also 24-3436.
79-112
ICE COVER THICKNESS, ICE REPORTING, METEOROLOGICAL DATA, CLIMATE, SNOW DEPTH, UNITED STATES—ALASKA, CANADA.

**SR 43/2**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC FOR 1960-61, 1961-62.**
Bilello, M.A., Feb. 1964, 112p., AD-600 483, See also 24-3436.
79-113
ICE COVER THICKNESS, ICE REPORTING, METEOROLOGICAL DATA, SNOW DEPTH, CLIMATE, UNITED STATES—ALASKA, CANADA.

**SR 43/3**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC, 1962-63, 1963-64.**
Bilello, M.A., et al, July 1966, 103p., AD-649 768, See also 24-3436.
Bates, R.E.
79-114
ICE COVER THICKNESS, ICE REPORTING, METEOROLOGICAL DATA, SNOW DEPTH, CLIMATE, UNITED STATES—ALASKA, CANADA.

**SR 43/4**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC, 1964-65, 1965-66.**
Bilello, M.A., et al, Nov. 1969, 130p., AD-699 328, See also 24-3436.
Bates, R.E.
79-115
ICE COVER THICKNESS, ICE REPORTING, METEOROLOGICAL DATA, SNOW DEPTH, CLIMATE, UNITED STATES—ALASKA, CANADA.

**SR 43/5**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC 1966-67, 1967-68.**
Bilello, M.A., et al, March 1971, 111p., AD-722 783, 18 refs.
Bates, R.E.
26-2299
ICE REPORTING, ICE COVER THICKNESS, ICE FORMATION, ICE BREAKUP, UNITED STATES—ALASKA, CANADA.
The paper is a fifth in a series of reports on lake and river ice and land-fast sea ice, records ice thicknesses observed throughout the North American arctic and subarctic during the 1966-67 and 1967-68 seasons. Information on ice surface conditions, dates of first ice, freeze-over and breakup, and detailed measurements of ice thickness across Alaskan rivers are also included. Continued reports from the Alaska National Guard Network on ice thickness measurements on lakes and rivers in the remote regions of interior Alaska are presented. Analyses on maximum observed ice thicknesses reported during the two winters in North America and deviations from the mean ice thickness amounts measured across Alaska rivers between 1965 and 1968 were conducted.

**SR 43/6**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC, 1968-69, 1969-70.**
Bilello, M.A., et al, June 1972, 95p., AD-746 256, 19 refs.
Bates, R.E.
27-674
ICE COVER THICKNESS, SEA ICE, RIVER ICE, LAKE ICE, STATISTICAL DATA.
This sixth in a series of reports on lake and river ice and land-fast sea ice records ice thicknesses observed throughout the North American arctic and subarctic during the 1968-69 and 1969-70 seasons. Information on ice surface conditions, dates of first ice, freeze-over and breakup, and measurements of ice thickness made on the second voyage of the S.S. Manhattan are also included. Continued reports from Alaska National Guard Network on ice thickness measurements on lakes and rivers in the remote regions of interior Alaska are presented. Analyses are made of maximum observed ice thicknesses reported during the two winters in North America, including data from additional stations in western Alaska.

**SR 43/7**
**ICE THICKNESS OBSERVATIONS, NORTH AMERICAN ARCTIC AND SUBARCTIC 1970-71, 1971-72.**
Bilello, M.A., et al, April 1975, 103p., AD/A-010 329, 24 refs.
Bates, R.E.
30-126
ICE COVER THICKNESS, STATISTICAL ANALYSIS, CLIMATOLOGY.
This seventh in a series of reports on lake and river ice and land-fast sea ice presents ice thickness measurements observed throughout the North American Arctic and subarctic during the 1970-71 and 1971-72 winter seasons. Information on surface ice conditions, dates of first ice, freeze-over and breakup, and detailed measurements of ice thickness across Alaskan rivers are also included. Some reports from the Alaska National Guard network on ice thickness measurements in remote areas of western Alaska are also presented. Analyses were made of maximum observed ice thicknesses reported during the two winters, and deviations from the mean ice thickness measured across rivers and creeks in southeast Alaska between 1965 and 1972. A tabulation of the dates when maximum ice was observed at 25 locations in Alaska, 44 in Canada and 1 in Greenland during each year from 1961 to 1972 is also given. Computations of the average annual date of maximum ice at all the stations and an isoline map showing the results for northern North America is presented.

**SR 44**
**UNDER-ICE CAMP IN THE ARCTIC.**
Russell, F.L., July 1961, 14p., AD-653 150.
24-3437
UNDERSNOW FACILITIES, TUNNELS, DESIGN CRITERIA, ICE HOUSES, GREENLAND.
Design criteria for under-ice camps are described which will allow the structure to be self-contained at a constant temperature of 17F the year round. As part of the basic research, a tunnel complex was excavated on the Greenland ice cap. The general layout of the complex is given, the structural design is described along with its portal, heating facilities and ventilating and power supply systems.

**SR 45** Record deleted.

**SR 46** Record deleted.

**SR 47** Record deleted.

**SR 48**
**OPERATION HOT DECK (PRELIMINARY REPORT).**
Leighty, R.D., July 1962, 25p., AD-331 711, 10 refs.
26-3616
AERIAL PHOTOGRAPHY, INFRARED RECONNAISSANCE, THERMAL RADIATION, DESERTS, TERRAIN IDENTIFICATION.
Operation Hot Deck was initiated in April 1961 and continued into June 1961 with a series of aerial missions over selected "hot" surfaces which included desert surfaces heated by solar radiation, mining areas supposedly heated by oxidation of ore bodies, areas of intense hydrothermal activity, and areas of burning lignite beds. This report covers the preliminary study of the imagery from these natural high temperature terrain features. Illustrations show the variations in thermal contrasts and tones throughout the day and the appearance of the thermal features with respect to the infrared pattern of the background.

**SR 49** Record deleted.

**SR 50** Record deleted.

**SR 51** Record deleted.

**SR 52**
**PRELIMINARY STUDIES OF INFRARED IMAGERY OF SEA-ICE PATTERNS.**
Anderson, V.H., Oct. 1962, 13p., AD-334 048, 5 refs.
24-3438
INFRARED MAPPING, SEA ICE.
This report demonstrates the value of airborne infrared scanner imagery as an aid in determining some of the physical characteristics of sea ice. It contains an interpretation of some infrared scanner imagery of sea-ice patterns which existed in Baffin Bay near Thule, Greenland, in December, 1960. It also outlines a program to further the study of sea ice by using various airborne sensing devices sensitive to different portions of the electromagnetic spectrum.

**SR 53**
**PERFORMANCE TESTING OF A MODIFIED FIELD PLANER ON PROCESSED SNOW.**
Wuori, A.F., April 1963, 7p., AD-447 721.
24-3439
SNOW COMPACTION, SNOW (CONSTRUCTION MATERIAL), RUNWAYS, PLANERS.
A Gurries field planer was tested at Houghton, Michigan as a means of leveling processed snow to produce a trafficable surface. The unit was a tow-type, hydraulically controlled, automatic leveler, used normally as a finish planer for airfield and highway construction work. It was modified to include skis for work in snow. The initial tests indicated the need for several modifications. They included a manual cross-slope and blade-height control, ski adjustment, and an adjustable hydraulic valve. After these modifications were made, the planer was again tested and found to be a satisfactory implement for leveling processed snow.

**SR 54**
**HORIZONTAL VISUAL RANGE IN POLAR WHITEOUT.**
Kasten, F., May 1962, 5p., AD-653 149, 14 refs.
24-3440
WHITEOUT, VISIBILITY.
A theory on the horizontal visual range of objects of any color under overcast sky and over homogeneous ground is briefly outlined. The theory takes into account the influence of the visual ground albedo on the illumination of the object and the dependence of the contrast threshold of the human eye on the visual angle subtended by the object viewed. The results explain the optical conditions encountered in polar whiteout. Measurements made in whiteouts in North Greenland proved the validity of the theory.

**SR 55**
**TESTING OF A VIBRATORY SNOW COMPACTOR.**
Wuori, A.F., Jan. 1965, 11p., AD-461 141, 3 refs.
24-3441
SNOW COMPACTION.
A vibratory snow compactor was tested for its effectiveness in compacting snow for support of wheeled vehicles and aircraft traffic. The compactor was tested on both undisturbed snow and on snow which had been processed with a Peter snow miller. It was found that the use of the vibratory compactor alone is adequate for construction of roads for light, wheeled traffic only. A combination of the milling process and vibratory compaction is essential for support of heavy wheeled vehicles and aircraft. The vibratory compactor was not as effective in compacting snow as the tracks of the crawler tractor required for towing.

**SR 56**
**PICTORIAL PERFORMANCE STUDY OF CAMP CENTURY (1960-1962).**
Leighty, R.D., Jan. 1963, 17p., AD-634 470.
24-3442
PHOTOGRAPHY, UNDERSNOW FACILITIES, SNOW (CONSTRUCTION MATERIAL), ICE HOUSES, ICE TUNNELS, GREENLAND—CAMP CENTURY.
In this series of photographs the performance of the Camp Century snow and ice structures is observed. The magnitude of the deformation problem is evident in the dramatic changes which occurred between Nov. 1960 and April 1962. Panaramic views identify the surface changes which took place over the camp.

**SR 57**
**TABLE OF SOLAR ALTITUDES FOR GEOGRAPHICAL LATITUDES 77 DEG 10 MIN N AND 77 DEG 10 MIN S.**
Kasten, F., July 1962, 169p., AD-653 145, 2 refs.
24-3443
METEOROLOGICAL DATA, SOLAR RADIATION, INSOLATION.
The tables were prepared as an aid in the measurement of solar radiation in the higher latitudes and to take this radiation into account in the analysis of meteorological data for these areas. The indicated latitude was selected because there are a number of arctic meteorological stations at or near that latitude. The astronomical calculations used to develop the tables are presented.

**SR 58**
**SCOPE, PROBLEMS, AND POTENTIAL VALUE OF DEEP CORE DRILLING IN ICE SHEETS.**
Bader, H., Dec. 1962, 6p. plus appends., AD-653 141, Includes Estimate of age of ice to be reached by deep coring, suggested by John F. Nye and Station glaciology and the deep drilling program by Carl S. Benson. 4 refs.
Miami, University of, Coral Gables, Fla. School of Engineering.
24-3444
ICE DRILLS, CORE SAMPLERS, DRILL CORE ANALYSIS, AGE DETERMINATION, GLACIOLOGY.
Included in this discussion of deep core drilling are some of the technical problems involved such as the design and operation of the coring drill; measurements to be made on the hole and the core; the determination of the age of the ice and the total strain on the ice core; and the choice of the drilling site, drilling schedule and the value of the project.

**SR 59**
**FLEXURAL PROPERTIES OF SNOW AND SNOW-ICE.**
Stearns, S.R., Oct. 1964, 8p. plus appends., AD-610 143, 12 refs.
24-3445
SNOW DENSITY, FLEXURAL STRENGTH, ELASTIC PROPERTIES, SNOW ICE, LAKE ICE, RIVER ICE.
One testing objective was to determine if small, select samples of natural snow-ice, tested in bending, would provide consistent and higher values for the flexural strength and modulus of elasticity. Another objective was to investigate the surface bearing properties of snow-ice layers, formed during winter on lakes or rivers, which are often separated from clear ice by an interlayer of slush or water. Dense snow-ice at 5C had high flexural strength (avg. 347.5 psi) and a high modulus of elasticity (avg. 6.08 x 100,000 psi), probably the result of a large, interlocking crystal structure. The apparent relationship between modulus of elasticity and density of snow-ice is affected by the rate of loading and temperature. There appears to be a relationship between density and flexural strength for snow, snow-ice, and high-density snow in the natural undisturbed state; but processing, including snow compaction, lowers the tensile strength at early ages. The formulas used in computations are given and test results are tabulated and summarized.

**SR 60**
**SOME PROPERTIES OF SAWDUST-SNOW-ICE MIXTURES.**
Abele, G., July 1964, 8p., AD-606 127, 6 refs.
24-3446
SNOW (CONSTRUCTION MATERIAL), SNOW BEARING STRENGTH, ADMIXTURES, SAWDUST, SNOW TRENCHES.
The addition of some sawdust to processed snow increases the ultimate bearing capacity of snow. There are indications that if the amount of sawdust exceeds a certain percentage, the age-hardening process will be retarded. Foreign particles in processed snow will decrease the snow grain-to-grain contact which is necessary for age hardening to occur. It is expected that the optimum additive content would be considerably higher for ice than for snow. It would be desirable to perform a complete series of sawdust-snow mixture tests, with sawdust content as the only variable. Then similar series of tests could be performed with temperature as the variable. The most favorable sawdust particle size would also have to be determined. Standard sawdust appears to be superior to wood chips as an additive in processed snow. Hanson (1958) indicates that softwood sawdust is superior to hardwood sawdust. The type of sawdust warrants further study.

**SR 61** Record deleted.

**SR 62**
**CONSTRUCTION OF A SNOW RUNWAY AT CAMP CENTURY FOR WHEEL LANDINGS WITH LIGHTWEIGHT AIRCRAFT.**
Abele, G., Aug. 1964, 6p., AD-609 981, 4 refs.
24-3447
SNOW ROADS, RUNWAYS, AIRCRAFT LANDING AREAS, SNOW (CONSTRUCTION MATERIAL).
This report discusses the type of runway required, the method of construction, the effort involved, approximate construction time, and suggested maintenance of such a runway at Camp Century. Data are presented concerning the specifications and

average contact pressure (35 to 38 psi) of a typical lightweight aircraft (the "Caribou"), and required ram-hardness profiles. A 200 to 300 ram-hardness range is required. Periodic ram-hardness tests should be made during the initial age-hardening period as well as during the use of the runway. The first landing should be made on skis. Drift-snow accumulation during summer months should be compacted with an LGP tractor. New snow accumulation should never be removed. Oil or fuel spots on the runway surface should be removed or covered with snow to avoid the formation of pot holes when exposed to sun. The appendix discusses the use of the rammsonde hardness instrument for determining the supporting capacity of a snow runway and an expression is given for computing ram hardness.

**SR 63**

**FREEZING INDEX IN NEW ENGLAND.**

Gilman, G.D., June 1964, 16p. plus tables, AD-603 464, 7 refs.

24-3448

AIR TEMPERATURE, METEOROLOGICAL DATA, FREEZING WEATHER, COLD WEATHER CONSTRUCTION.

Utilizing U.S. Weather Bureau records for the period 1931-1960 graphs and tables of freezing indexes were developed specifically to provide guidance for the protection of various types of construction in New England. Air temperature data, average and mean daily, for a number of locations used in computing the indexes are given and the specialized terms are defined.

**SR 64**

**DENSITY OF ICE AS A FUNCTION OF TEMPERATURE AND STRESS.**

Bader, H., Aug. 1964, 6p., AD-448 069, 5 refs.

24-3449

ICE CRYSTALS, DENSITY (MASS/VOLUME), ICE TEMPERATURE, STRESSES, ICE DENSITY.

The equations for calculating the density of ice of moderate porosity (density more than 0.8) as a function of temperature and stress condition are developed, and the values of parameters are calculated from the best available experimental data.

**SR 65**

**AERIAL RECONNAISSANCE OF SEA ICE AND SNOW COVERED TERRAIN.**

Poulin, A.O., et al, July 1963, 15p., AD-352 349.

Anderson, V.H., McAnerney, J.M.

26-2341

INFRARED PHOTOGRAPHY, AERIAL RECONNAISSANCE, SEA ICE, SNOW COVER, REMOTE SENSING, PHOTOINTERPRETATION.

**SR 66**

**STUDY OF CURBING TYPES SUITABLE FOR PERMANENT INSTALLATIONS IN NORTHERN NEW ENGLAND.**

U.S. Army Cold Regions Research and Engineering Laboratory, Sept. 1963, 56p., AD-696 410.

24-3450

CONCRETES, CHEMICAL ICE PREVENTION, WEATHERING, COLD STRESS, BITUMINOUS CONCRETES, DAMAGE.

The defective cast-in-place curbing was found to be composed of inferior quality concrete, without air entrainment. Use of de-icing salts on the roads and physical damage by snow plows were major contributing factors to the rapid deterioration of the curbs. Similar damage and deterioration to precast as well as cast-in-place concrete curbs has been generally experienced by state and municipal agencies in New England, particularly in the northern portions. Granite curbs are generally used by these agencies because of demonstrated resistance to salts, weathering, and impact, providing essentially unlimited life. Bituminous concrete curbs, while resistant to salts and weathering, are not resistant to damage by snow plows and other vehicles and their use should be limited to non-critical areas.

**SR 67**

**INSTALLATION OF ICE MOVEMENT POLES IN GREENLAND.**

Mock, S.J., , Jan. 1964, 6p. plus 8p. appends, AD-609 347, 3 refs.

Alford, D.L.

24-3451

GLACIER MOVEMENT, SNOWFALL, ACCUMULATION, MARKERS.

During May 1963, snow-movement poles were installed at the former HIRAN sites on the Greenland ice sheet to prevent the loss of these positions through snow accumulation. It is anticipated that the poles will project above the snow surface for approximately 10 years, during which time they will be resurveyed to determine movement of the ice sheet. HIRAN stations and erection techniques are described.

**SR 68**

**PERFORMANCE TESTING OF AN AUTOMATIC SNOW LEVELER.**

Abele, G., Nov. 1964, 11p., AD-609 346, 3 refs.

24-3452

SNOW ROADS, RUNWAYS, SNOW (CONSTRUCTION MATERIAL), EQUIPMENT.

A modified Gurries Automatic Road Builder was tested at the Keweenaw Field Station, Houghton, Michigan and in Greenland to determine its feasibility for leveling snow and producing trafficable snow surfaces, such as roads and runways in deep snow areas. The unit, a tow-type, hydraulically controlled, automatic leveler, normally used for accurate, finish leveling in highway and airfield construction work, had been modified for use in snow. The initial performance test results were very satisfactory. A few minor modifications were required, which were performed before the completion of the initial tests. The final performance tests were conducted in Greenland and consisted of trail and runway improvement and maintenance work. It was determined that the Gurries Automatic Road Builder can be used quite effectively for snow road and trail improvement and maintenance, and is especially well suited for snow runway leveling

**SR 69**

**PERFORMANCE OF SUBSURFACE DRAINS AT SELECTED AIRFIELDS DURING THE 1960 FROST MELTING PERIOD.**

Sayman, W.C., , Oct. 1964, 19p., AD-608 683.

Gilman, G.D.

24-3453

SUBSURFACE DRAINAGE, THAWING, AIRPORTS.

During the 1960 frost melting period, the performance of subsurface drainage systems was investigated at selected airfields in the northern continental United States by periodic observations at manholes and/or risers. Records of air temperature, subsurface temperature, and precipitation were also maintained. The observations were one-time "spot" notations, intended to determine the feasibility of performing more comprehensive studies and no quantitative measurements were undertaken; nor do the data obtained permit evaluation as to the overall effectiveness of the inspected systems or the validity of the criteria used in their design. However, the study showed that the observed subdrain systems were generally performing their function of removing subsurface water. The study also confirms the need for periodic inspection and maintenance of all subsurface systems.

**SR 70**

**LIQUID-LIKE (TRANSITION) LAYER ON ICE.**

Jellinek, H.H.G., Oct. 1964, 19p., AD-609 328, 32 refs.

24-3454

ICE ADHESION, ICE MICROSTRUCTURE, ICE SURFACE FEATURES, SUPERCOOLING.

A survey of the literature covering about the last hundred years is presented concerning the existence of a liquid-like transition layer on ice below its melting point. The conclusion is reached that the available evidence is very strongly in favor of the existence of such a layer. However, more direct measurements of the properties of such a layer are needed and possible methods for obtaining such information are indicated.

**SR 71**

**BACKGROUND STUDY OF PUERTO RICO.**

Prentice, V.L., Feb. 1965, 58p. plus 14p. appends., AD-458 509, refs. p.44-58.

24-3455

AERIAL SURVEYS, CLIMATE, GEOLOGY, GEOGRAPHY, SOILS, AGRICULTURE, TRANSPORTATION.

Information contained in this report provided the basis for briefing field personnel about natural and cultural aspects of Puerto Rico prior to field work. The material was obtained through an extensive literature search and review. Primary emphasis was placed on soils, rocks, vegetation, physical makeup, and land use. Secondary emphasis was given to historical and sociological aspects.

**SR 72**

**PERFORMANCE STUDY OF THE DEWLINE ICE CAP STATIONS GREENLAND, 1963.**

Read, S.C., May 1966, 25p., AD-638 136, 11 refs.

24-3456

ICE BEARING CAPACITY, ACCUMULATION, FOUNDATIONS, UTILITIES, WEATHER STATIONS, SNOW ACCUMULATION.

To study the performance of the DEWline ice cap stations, the following semiannual observations are made: footing elevation and settlement, horizontal angle measurements to indicate lateral movement of the structure, measurement of vertical movement in the sewage disposal and fuel storage systems, and measurement of snow temperature, accumulation, and density. The 1963 observations indicate that in general the structures and utilities are performing as predicted.

**SR 73**

**USA CRREL ICE CHIPPER.**

Frankenstein, G.E., Oct. 1965, 11p., AD-479 632.

24-3457

ICE REMOVAL EQUIPMENT, RUNWAYS, ICE PRESSURE, HUMMOCKS.

One of the problems in constructing roads and runways in cold regions is that of humnocks which develop on the ice pressure ridges. They are harder and more difficult to remove than the ridges so that special equipment is needed to remove them. This paper describes the design, construction, performance, and modification of such equipment.

**SR 74**

**NUCLEAR MEASUREMENT OF SNOW DENSITY.**

Leighty, R.D., Apr. 1965, 14p. plus 6p. appends., AD-464 422, 11 refs. Also publ. in J. Glaciol. 6(43):171-176, 1966.

24-3458

SNOW DENSITY, RADIOACTIVE SNOW GAGES.

During the period 8-19 May 1963 a preliminary field investigation was conducted in Greenland to determine the feasibility of using a nuclear technique to determine snow and ice density profiles. A standard nuclear soil-moisture depth probe was used with two modes of processing and recording the nuclear pulses. Example data are compared with snow densities obtained by the standard weighing technique. The nuclear method was found to be feasible; however, deficiences related to poor resolution render the probe unusable for detailed profiling of snow stratigraphy in its present form, but expected progress in nucleonics should enable improved resolution and accuracy to be achieved by improvement of nuclear detectors.

**SR 75**

**DYNAMIC PILE FOUNDATION MEASUREMENTS BARTER ISLAND, ALASKA.**

Aamot, H.W.C., Jun. 1966, 32p., AD-448 574.

24-3459

PILE FOUNDATIONS, OSCILLATIONS, STATIC LOADS, STRAIN MEASUREMENT, DYNAMIC PROPERTIES.

This investigation was initiated to study the possibility that generator vibrations were causing the foundation settlement of the power plant at Barter Island, Alaska. The principal findings were: 1. The settlement is a result of the loss of adfreeze support of the pipe piles due to painting prior to embedment. The end bearing strength is insufficient to carry the load. 2. There is a possible contributing or aggravating condition in the similarity of the natural frequency of vibration of the piles and the forcing frequency of the generator vibration. 3. The piles directly under the generators carry loads that are greater than is desirable. The recommended corrective action is to increase the pile support by attaching bearing plates. General recommendations are made to overcome disturbing pile vibrations: 1. The natural frequency can be raised by filling more sand-/water slurry into the piles. 2. Good vibration isolation can be achieved by installing lead/asbestos pads between the piles and the superstructure. Finally, a recommendation is made to relocate the generators and distribute their weight to more piles, thus reducing some excessively high loads.

**SR 76**

**SURVEY OF WINTER CONSTRUCTION PRACTICES EARTHWORK, CONCRETE AND ASPHALT.**

Yoakem, D., July 1966, 144p., AD-801 626.

24-3460

CONSTRUCTION REQUIREMENTS, ACTIVE LAYER, CONCRETE CONSTRUCTION, ASPHALTS, PAVEMENTS, FOUNDATIONS, EARTHWORK.

A survey was made by submitting questionaires to various federal, state, local, and private agencies engaged in cold weather construction, soliciting their specification requirements and practices in relation to soil, concrete, and asphalt used in foundations, structures and pavements. The report presents a summary of the results of the survey, evaluation of and comments on the results.

**SR 77**

**GOOSE LAKE MONTANA, 1964 ACCESSIBILITY FIELD METHODS AND LOGISTICS.**

Alford, D.L., et al, June 1965, 30p., AD-474 576, 6 refs.

Weeks, W.F.

24-3461

TOPOGRAPHIC FEATURES, SNOW VEHICLES, LOGISTICS, RESEARCH PROJECTS, SNOW MECHANICS, METEOROLOGICAL INSTRUMENTS.

Presented is a general outline and discussion of experience gained during the planning and execution of a research project to study the physical properties snow in a high mountain cirque at Goose Lake, Montana. The paper includes sections on the geographical setting, the problem of gaining access to the area, equipment and supplies, the nature of the research project, and some comments on mountain safety.

**SR 78**

**NOTES ON HIGH ELEVATION RESEARCH WITH SELECTED BIBLIOGRAPHY.**

Alford, D.L., Aug. 1965, 34p., AD-474 577, Bibliog. p.14-21.

24-3462

RESEARCH PROJECTS, ELEVATION, LOGISTICS, MOUNTAINS, SOLAR RADIATION, ICE, SNOW, MECHANICAL PROPERTIES, TOPOGRAPHIC FEATURES.

Recognizing that only superficial knowledge exists in high elevation research and anticipating a future need for more detailed knowledge in this area, an extensive literature search was made to discover what was known of the high elevation environment. The results of that search are presented. Because of the harsh environment very little scientific research has been made. Pre

sented are a general plan for future research, disciplines which need investigation and support requirements for high elevation research. Included are suggested areas in the Andes and Himalayas.

**SR 79**
**PILE FOUNDATIONS IN DISCONTINUOUS PERMAFROST AREAS.**
Crory, F.E., March 1967, 12p., AD-814 700, 18 refs.
24-3463
PILE FOUNDATIONS, PERMAFROST HEAT BALANCE, PERMAFROST THERMAL CYCLES.
The design and installation of piles in areas of warm permafrost present many unusual problems. Design considerations and construction methods and controls to minimize disturbance of the delicate thermal balance of warm permafrost are included in an evaluation of pile installation techniques. The importance of adequate site investigations and proper construction inspection and control is emphasized. Preconstruction temperature information is used with climatological records and theoretical methods to predict the freezing and/or thawing that will be experienced under the structure. Natural and artificial freezeback of piles are discussed in terms of construction schedules, installation methods, and the volumetric heat capacity of the permafrost.

**SR 80**
**COLD REGIONS RESEARCH AND DEVELOPMENT SYMPOSIUM.** March 1964, 185p., AD-634 471, Numerous refs. passim.
24-3464
RESEARCH PROJECTS, MILITARY OPERATION, VISIBILITY, FOG DISPERSAL, GLACIER ABLATION, SEWAGE DISPOSAL, PILE FOUNDATIONS, REMOTE SENSING, FROZEN GROUND MECHANICS, MUSKEG, TRAFFICABILITY, SCINTILLATION, WHITEOUT, ICE FOG.
Included are the papers presented at the symposium and the discussions which accompanied them. Among the topics were cold regions research programs, military problems in Alaska and Greenland, visibility, sea and lake ice structure, glacier water supply and sewage disposal, pile foundations in permafrost and trafficability of snow and muskeg.

**SR 81**
**CORING OF FROZEN GROUND BARROW, ALASKA, SPRING 1964.**
Sellmann, P.V., et al, July 1965, 8p., AD-472 341.
Brown, J.
24-3465
PERMAFROST SAMPLERS, CORING, DRILL CORE ANALYSIS, STRATIGRAPHY, FROZEN GROUND.
The coring program is to provide additional detailed sampling and analyses for late Pleistocene stratigraphy, to ascertain the boundary between the reworked sediment and the underlying undisturbed sediments, and to ascertain moisture-depth relationships on representative geomorphic units. The field methods, equipment, and sample processing are described, and the cost of the operation and the preliminary observations are discussed. The sampling was confined mainly to a strip across the Barrow peninsula which had been sampled in 1962 and 1963. Sites were selected to avoid ice wedges and were generally in the centers of polygons. The solution of the stratigraphic problems will utilize statistical sedimentation techniques.

**SR 82**
**METHODS OF LABORATORY AND FIELD MEASUREMENTS OF THERMAL CONDUCTIVITY OF SOILS.**
Wechsler, A.E., et al, Sept. 1965, 31p., AD-475 793, Contract DA-27-021-AMC-5(X), 38 refs.
Glaser, P.E., McConnell, R.K., Jr., Little (Arthur D.) inc.
24-3466
SOIL TEMPERATURE, DIFFUSIVITY, THERMAL CONDUCTIVITY, INSULATION, TEMPERATURE MEASUREMENT, TEST EQUIPMENT.
This study evaluates experimental methods of measurement of thermal conductivity and diffusivity of soils and building construction and insulation materials under laboratory and field conditions. The applicability, cost, accuracy, and limitations of these techniques are assessed. Following a brief review of the steady-state and transient methods of measuring thermal conductivity and diffusivity, the probe method is discussed in greater detail. Factors such as moisture migration, instrumentation requirements, methods of probe emplacement, and experimental technique used in probe measurements are considered. The probe method is the most applicable technique for rapid measurement in the laboratory and in the field, and it is suitable for measurements of dry and moist materials. This method can be used for basic studies of heat and mass transfer in soils as well as specific measurements of a practical nature. The emplacement of probes in situ indicates changes in moisture content of materials.

**SR 83**
**BIBLIOGRAPHY ON WINTER CONSTRUCTION 1940-1967.**
Fulwider, C.W., et al, April 1968, 84p., AD-675 415, Revised edition 1940-1967. 751 items.
Stearman, J.H.
24-3467
BIBLIOGRAPHIES, COLD WEATHER CONSTRUCTION.
This bibliography was derived primarily from a search of the U.S. Army Cold Regions Research and Engineering Laboratory library, the Arctic Bibliography, the Bibliography on Snow, Ice and Permafrost (USA CRREL Report No. 12, Volumes 1-20), the Polar Bibliography, the Industrial Arts Index and the Applied Science and Technology Index. The period covered by the bibliography purposely was limited to the years after 1940 because of the rapid technological advances since World War II. The 751 references are subdivided into twenty-two categories.

**SR 84**
**EVALUATION OF AN ECONOMICAL INSTRUMENT SHELTER FOR MICROCLIMATOLOGICAL STUDIES.**
Vogel, T.C., et al, May 1966, 4p., AD-640 384, 1 ref.
Johnson, P.L.
24-3468
SHELTERS, METEOROLOGICAL INSTRUMENTS, MICROCLIMATOLOGY, PROTECTION.
A lightweight, aluminum instrument shelter is described which is inexpensive, collapsible for shipment, easily assembled in the field, capable of housing recording instruments as large as a Friez hygrothermograph, and comparable to a standard U.S. Weather Bureau shelter or Stevenson screen in its ambient thermal characteristics. The shelter was successfully employed at six sites at Barrow, Alaska, during July and August 1964. It was fabricated from four 15 x 15-in. aluminum, household double louvers, which form the front, rear, and side panels. Access to the shelter is provided through the hinged roof, which extends 1 in. beyond the sides. If the primary objective of the instrumentation is the recording of relative differences rather than absolute temperatures, and all shelters are exposed to similar solar radiation load, then the shelter has distinct advantages. If the ambient thermal measurements can be made with thermocouples or thermistors rather than large mass thermal sensors, then the large volume shelter is inappropriate.

**SR 85**
**WHITEOUT MODIFICATION EXPERIMENTS USING GROUND BASED SYSTEMS.**
Bortell, P., et al, Oct. 1965, 18p., AD-478 907, 8 refs.
Hicks, J.R.
24-3469
WHITEOUT, DRY ICE (TRADEMARK), ARTIFICIAL PRECIPITATION, NUCLEATING AGENTS.
The purpose of tests conducted during the summer of 1964 was to further evaluate the relative effectiveness of ground-based whiteout dissipation systems. The tests included the evaluation of rocket systems, ground fog dissipation by static systems, and further study of the field effectiveness of various agents in initiating precipitation of undercooled water droplets. The CRICKET rocket system performed well and met all operational criteria. The adverse weather conditions common to Camp Century had no detrimental effect on the system other than to lower available launch pressures. The solid-fuel rockets appear to be excellent vehicles for lifting powdered reagents to altitudes in the vicinity of 2000 ft. In order to further evaluate whiteout dispersal equipment, some system of tracking or following the seeded area must be developed. In all instances, dry ice produced a definite local "plume" of ice particles under whiteout conditions, but no large-scale results were observed. The appearance of large conglomerated ice crystals in the air following the application of propane should justify its continued testing in future whiteout dispersal programs.

**SR 86**
**HYDROLOGICAL STUDIES OF THE GLENN CREEK DRAINAGE BASIN NEAR FAIRBANKS, ALASKA.**
Dingman, S.L., Feb. 1966, 30p., AD-631 948, 19 refs.
24-3470
HYDROLOGY, METEOROLOGICAL DATA, RUNOFF, RAIN, SEDIMENTS, SNOW MELTING.
During the period June-October, rainfall, runoff, dissolved and suspended sediment concentrations, and air and water temperatures were measured. The following observations and tentative conclusions are based on the first summer's study of Glenn Creek and its drainage basin: (1) relationships comprising at-a-station hydraulic geometry are similar to those for larger streams in other areas; (2) the lag time between rainfall and peak storm discharge is much longer for Glenn Creek than for similar-sized streams in mid latitude regions; (3) hydrograph recessions are drawn out in time relative to those for similar-sized streams in mid-latitude regions; (4) base flow was low in early and mid-summer, rose to a peak in late summer, and very gradually diminished thereafter, accounting for most of the flow in Sept. and Oct.; (5) direct runoff must occur largely as interflow; (6) about 24 per cent of the rain which fell appeared as runoff; (7) the fraction of rainfall appearing as direct runoff varied from 3 per cent to 30 per cent, and showed no seasonal trends; (8) the suspended and dissolved sediment concentrations are within the ranges reported for larger streams in the area; and (9) suspended sediment yield was 5 times as large as dissolved sediment yield.

**SR 87**
**EXPERIMENTS ON THE DISSIPATION OF WARM FOG BY HELICOPTER-INDUCED AIR EXCHANGE OVER THULE AB GREENLAND.**
Hicks, J.R., Aug. 1965, 7p., AD-474 070.
24-3471
FOG DISPERSAL, VISIBILITY, HELICOPTERS, METEOROLOGICAL FACTORS.
Theoretical considerations and experimental technique are discussed, and the results are given of an attempt to dissipate a shallow advection fog which frequently forms over the open water of North Star Bay just north of Thule Air Base, Greenland. The tests demonstrated that certain types of shallow fogs can be dispersed by the downwash created by helicopters flying at near-hovering airspeeds a few feet above the top of the fog. One helicopter can clear an area about 75 yd wide by a mile long every 10 to 15 min. This technique is recommended for emergency use only because it requires unsafe flying conditions.

**SR 88**
**SURFACE CHARACTERISTICS EFFECT ON THERMAL REGIME PHASE I.**
Wechsler, A.E., et al, April 1966, 26p., AD-485 168, 36 refs.
Glaser, P.E., Little (Arthur D.) inc.
24-3472
CONSTRUCTION MATERIALS, THERMAL FACTORS, HEAT ABSORPTION, HEAT TRANSMISSION.
The work reported herein was conducted under Phase I of Contract No. DA 27-021-AMC-23(X). The purpose of the contract is to investigate various methods for control of the heat reflectance and absorption characteristics of construction materials. Phase I consisted of a literature review and survey of characteristics of materials and techniques; a review of present heat flow calculation techniques with recommendations as to those most applicable for further study by USA CRREL; and presentation of recommendations as to the most promising solutions to the control of the heat reflecting and absorbing characteristics of construction materials with an outline of applicable field and laboratory procedures for refrigeration of the recommended solutions.

**SR 89**
**BIBLIOGRAPHY ON SOIL DYNAMICS.**
Bernhard, R.K., Sept. 1965, 111p., AD-477 379.
24-3473
BIBLIOGRAPHIES, SOIL DYNAMICS, GEOPHYSICAL SURVEYS, SOIL MECHANICS, EXPLOSION EFFECTS, WAVE PROPAGATION, ELASTIC WAVES, SEISMIC PROSPECTING.
Cumulative index of contemporary literature, 1885-1963, classified by years and subjects and indexed by authors.

**SR 90**
**INVESTIGATION OF MASS TRANSFER BY SUBLIMATION FROM A SNOW-SURFACE.**
Edgar, C.B., Jr., Sept. 1966, 51p., AD-645 275, 16 refs.
24-3474
SNOW EVAPORATION, SUBLIMATION, UNDERSNOW FACILITIES.
The problem of mass transfer by sublimation from a snow surface subjected to radiation and forced convection is investigated. The effect of irradiation from a nonisothermal source on the mass transfer rate is studied. Forced convection of the "flat plate" and "entrace region" type is investigated. Entrance effects are seen to have a negligible influence on the mass transfer rate. A thermal network analysis is developed to predict the mass transfer rate due to the combined effects of radiation and forced convection. Experimental results for mass transfer from a snow surface in the entrance region of a rectangular duct show good agreement with the predicted mass transfer rate.

**SR 91**
**PERFORMANCE TESTING OF AN AIR CUSHION VEHICLE ON THE GREENLAND ICE CAP.**
Abele, G., Feb. 1966, 19p., AD-632 570, 4 refs.
24-3475
AIR CUSHION VEHICLES.
During the summer of 1964, performance tests were conducted on the Greenland Ice Cap to determine and evaluate the feasibility of the air cushion vehicle concept as a transportation method in polar regions. Results from tests with the Bell Tri-Cell Plenum Air Cushion Vehicle indicated that the test vehicle can cruise over an undisturbed snow surface at speeds up to 35 mph and produce a maximum speed of 42 mph. The test vehicle was capable of ascending a 6 to 10 per cent slope against a 15-knot wind, traveling over soft snow drifts up to 30 inches high, and crossing ditches of at least a 5-ft width. The payload capacity of the vehicle was approximately 1000 lb, not including the operator and fuel. The skirt lifting sideforce concept and the harrow disk attachment proved to be very effective for control and maneuverability of the vehicle.

**SR 92**
**DIRECT SHEAR STUDY ON SNOW PROCEDURE AND DATA.**
Ballard, G.E.H., et al, Dec. 1965, 14p., AD-631 140, 1 ref.
Feldt, E.D., Toth, S.R.
24-3476
SNOW STRENGTH, SHEAR STRENGTH, POROSITY, TEMPERATURE EFFECTS.
A direct shear experiment was performed on a standardized disaggregated snow, investigating the effect of porosity, age-hardening time, normal stress, and temperature on the shear strength. Incidental to the direct shear test, consolidation, frictional resistance, and strain data were recorded.

**SR 93**
**INVESTIGATION OF SUGAR CANE VIGOR WITH AERIAL PHOTOGRAPHY IN PUERTO RICO.**
Johnson, P.L., June 1965, 38p., AD-624 625.
24-3477
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, VEGETATION PATTERNS, PUERTO RICO.
Aerial photointerpretation was attempted to identify reasons for the reduction of sugar cane yield in Puerto Rico. Although lack of vigor in the crop was evident on the film, the cause was difficult to identify. Areas of low vigor can be located on aerial photography, the causal agent confirmed, and control measures applied with considerable economic advantages over ground surveys alone.

**SR 94**
**RADAR IMAGERY OR ARCTIC PACK ICE, KANE BASIN TO NORTH POLE.**
Anderson, V.H., April 1968, 31p., AD-721 901.
26-2305
RADAR PHOTOGRAPHY, SEA ICE, PHOTOINTERPRETATION, AERIAL PHOTOGRAPHY, AERIAL RECONNAISSANCE.
The pictorial brochure has been compiled to show an existing radar system's capability of imaging large areas of sea ice in relatively short periods of time. The radar imagery was obtained during the latter part of April 1962 by a USAF high-altitude reconnaissance aircraft equipped with a side-looking, scanner-type radar unit. USA CRREL personnel made visual aerial observations of the ice imaged by radar, utilizing USN ice reconnaissance aircraft active in the area during this period. Conventional hand-held aerial photography of the ice characteristics was obtained on these flights and some of these photographs are included to supplement the radar imagery.

**SR 95**
**DESIGN, CONSTRUCTION AND PERFORMANCE DATA OF UTILITY SYSTEMS THULE AIR BASE.**
Davis, R.M., Feb. 1966, 62p., AD-483 678L, 29 refs.
24-3478
COLD WEATHER CONSTRUCTION, PIPELINE HEATING, INSULATION, FOUNDATIONS, WATER SUPPLY, SEWAGE DISPOSAL, WATER TREATMENT, UTILITIES, ELECTRIC POWER PLANTS, WHARVES.
The report covers the design, construction, performance, and maintainance of the utilities system of Thule Air Base as modified for the arctic climate and permafrost conditions. The basic designs are covered in various U.S. Army engineering manuals for military construction. The modifications were primarily concerned with foundations of structures and heating and insulation of pipe lines.

**SR 96**
**EVALUATION OF THE AASHO PROFILOMETER FOR MEASURING AIRFIELD PAVEMENT PROFILES.**
Yoder, E.J., et al, April 1966, 22p., AD-486 830.
Walker, R.D.
24-3479
AIRCRAFT LANDING AREAS, MEASURING INSTRUMENTS, PAVEMENTS, TEST EQUIPMENT, ELEVATION, SURFACE ROUGHNESS.
The report presents an evaluation of an instrument, the profilometer, which measures roughness of pavement surfaces and the profile of the surface through measurement of slope angles. The profilometer results were compared with those obtained using standard precise level procedures. The general shape of the profiles obtained by both methods were in good agreement, but the numerical values of elevation were not. The profilometer is basically sound but requires further development of the horizontal reference system to improve its accuracy.

**SR 97**
**RESONANCE CURVE ANALYSIS.**
Bernhard, R.K., March 1967, 34p., AD-653 144, 12 refs.
24-3480
WAVE PROPAGATION, RESONATORS, SOIL MECHANICS, SNOW MECHANICS.
Resonance curves, defining the relation between displacement, velocity, or power and exciter frequency are analyzed. A distinction is made between excitation by sinusoidal force vectors of constant amplitude and by vectors whose amplitudes increase with the square of the frequency. Both types are applied to one-degree-of-freedom systems with linear characteristics. Evaluation of these resonance curves to determine dynamic responses is discussed and followed up by some practical applications.

**SR 98**
**X-RAY DIFFRACTION ANALYSIS OF THE TUTO (GREENLAND) CLAY.**
Anderson, D.M., et al, May 1966, 3p., AD-636 541.
Tice, A.R.
24-3481
X RAY DIFFRACTION, CLAY SOILS, SOIL CHEMISTRY, GREENLAND—CAMP TUTO.
A 50 lb. sample of clay of unknown composition was found near Tuto and sent to the CRREL laboratory for analysis. X-ray analysis showed that the clay was a mixture of (1) a magnesium-rich chlorite, (2) a vermiculate with mica or an iron-rich illite, (3) plagioclase feldspar, and (4) trace amounts of quartz.

**SR 99**
**AN OPTIMIZATION STUDY OF AN EXPLOSIVE-DRIVEN PILE.**
Savitt, J., April 1966, 40p., AD-634 738, Contract DA-27-021-ENG-5, 9 refs.
Explosiform, Inc.
24-3482
PILE DRIVING, EXPLOSIVES.
The propulsion of metals by the detonation of explosives in direct contact with them and propulsion effectiveness of various explosives for such purposes was studied. The results of these studies were applied to the design and evaluation of explosives systems for pile driving. It was determined that piles with external grooves along their entire lengths which are driven by the detonation of high explosives upon the lips of these grooves are not as effectively propelled as those which are driven by explosive "hammerheads" on top of the piles. The results indicate that long, heavy-walled steel piles may successfully be driven into ordinary and frozen ground by the appropriate design and use of such explosive hammerhead systems.

**SR 100**
**REEVALUATION OF THE RAMMSONDE HARDNESS EQUATION.**
Waterhouse, R.W., Aug. 1966, 9p., AD-641 482, 5 refs.
24-3483
SNOW STRENGTH, HARDNESS TESTS, RAMMSONDES.
A rational derivation is provided for a hardness term which relates the Rammsonde number to a simple but more accurate and universal energy equation. Major losses are accounted for and the use of different weights for the test can be accommodated without complicating the evaluation. The Hiley equation provides better correlation of Rammsonde coefficient of restitution which will further improve the correlations. Utilization of the Hiley expression for the Rammsonde number will permit future correlation over a broad range of materials and conditions since the Hiley formula is fundamentally sound and is accepted in pile driving technology as one of the best approximations available. Future work should be directed towards determining the true maximum velocity after impact and obtaining information from which mean values of the resisting force can be determined.

**SR 101**
**U.S. ARMY CRREL TOPOGRAPHIC MAP BARROW, ALASKA (1:25,000).**
Brown, J., et al, May 1966, 1p. and map, AD-644 602.
Johnson, P.L.
24-3484
INFRARED MAPPING, TOPOGRAPHIC MAPS, UNITED STATES—ALASKA—BARROW.
The map covers the land area north of 71 deg. 15 min. N in the vicinity of Barrow, Alaska. Infrared aerial photography was flown at scale of 1:9500 with an infragon, 3-in. focal length lens and a Wratten 89B filter in July 1964. Twenty-six map sheets at a scale of 1:5000 were prepared photogrammetrically with a contour interval of .5 m. These sheets were then compiled on a photographic base for the present map.

**SR 102**
**ON MEASURING DISPERSED POPULATIONS.**
Waterhouse, R.W., Nov. 1968, 6p., AD-681 215, 5 refs.
24-3485
DISPERSIONS, SNOW MORPHOLOGY, MICROSCOPE SLIDES, ICE CRYSTALS, STATISTICAL ANALYSIS.
Accuracy and speed of property estimating of randomly dispersed populations can be improved by identifying and accounting for the influence of shape of both the element and the viewing stage. Perimeter intercept count of high density non-over-lapping dispersions provides a rapid method of density evaluation provided the influence of shape on location and orientation of elements and on the random definition of the intercepts is recognized. The efficiency of the circular stage is seen to be due to its randomizing of intercepts. Models demonstrate these influences and comparative accuracy of three systems of estimating.

**SR 103**
**RADAR ICE THICKNESS PROFILES NORTHWEST GREENLAND.**
Rinker, J.N., et al, May 1967, 16p., AD-654 985, 11 refs.
Mock, S.J.
24-3486
ICE COVER THICKNESS, RADAR ECHOES, SOUNDING, SEISMIC SURVEYS, GLACIER ICE, ICE SHEETS, GREENLAND.
In June and July of 1964, extensive field trials of radar ice sounding equipment were held on the ice sheet in northwest Greenland. The results, in the form of profiles over 350 km of trail, made from seismic depth measurements along the Tuto-Century trail and Project 42 trails provide a good representation of surface and subsurface topography. A continuous trace of the ice/bedrock interface was obtained for over 97 per cent of the route traveled, through ice up to 1400 meters thick. The film record obtained by the Scott Polar Research Institute, as a result of providing the Scott Polar Research radar set with continuously moving photographic film to record echo traces, shows a richness of detail (internal structure of the ice sheet) not portrayed by the manual plot. A sample of this film is given. References are made to project work on previous seasons.

**SR 104**
**DEPTH OF FROST PENETRATION IN NONUNIFORM SOIL.**
Aldrich, H.P., et al, Oct. 1966, 11p., AD-805 365, 4 refs.
Paynter, H.M.
24-3487
FROST PENETRATION, NONUNIFORM SOILS, FORECASTING, LATENT HEAT, SPECIFIC HEAT, ANALYSIS (MATHEMATICS).
This report presents the results of an investigation relative to the collection and improvement of techniques developed for the prediction of frost penetration depth and rate into non-uniform (multilayered) soil. The approximate techniques encompassing latent heat only, latent heat plus volumetric specific heat, and an adaptation of the modified Berggren equation are reviewed and compared. A sample problem is treated mathematically using each technique. Results indicate that an adaptation of the modified Berggren equation is the best technique for determining the depth of frost penetration in a non-uniform soil.

**SR 105**
**MASS SPECTRA OF VOLATILE CONSTITUENTS IN MILITARY EXPLOSIVES.**
Anderson, D.M., et al, Oct. 1969, 14p., AD-699 325, 3 refs.
Kistner, F.B., Schwarz, M.J.
25-997
SPECTROSCOPIC ANALYSIS, EXPLOSIVES, MASS SPECTRA, VAPOR PRESSURE.
The mass spectra of the volatile constituents of the military explosives: composition A-3, composition B, composition C-4, pressed TNT, and cast TNT were surveyed with a residual gas analyzer mass spectrometer. The vapor pressure of these explosives was too low for accurate measurement with the apparatus at hand but was in the range 10 to the -6th to 10 to the -5th Torr. The mass spectra of the residual gases above these propellants after pumping down to about 10 to the -6th Torr are given as relative ion currents up to mass 100. Unresolved peaks up to 250 mass units were observed. The spectral signatures are sufficiently distinct to warrent further investigation and cataloguing for purposes of developing an explosive vapor detection device based on mass spectroscopy.

**SR 106**
**FLUIDIZATION PHENOMENA IN SOILS DURING VIBRO-COMPACTION AND VIBRO-PILE-DRIVING AND-PULLING.**
Bernhard, R.K., Oct. 1967, 58p., AD-662 054, 5 refs.
24-3488
SOIL COMPACTING, PILE DRIVING, PILE EXTRACTION, STATIC LOADS, THIXOTROPY, VIBRATORY LOADS, DYNAMIC LOADS.
Investigations dealing with response of soils to sinusoidal force excitation were conducted to determine: under what conditions fluidization can be obtained, particularly the correlation between the required magnitude, direction and frequency of the vibratory surface loads; and the character of the liquified soil volume with respect to dimensions and sustainability. Fluidization, representing the change of soils from a solid into a quasi-fluid state by means of vibratory forces, is discussed. The hydrodynamic state is of particular importance for vibratory compaction and vibratory-pile driving and pulling. Experiments "in situ" and in the laboratory are described. The response of soils to static and dynamic loads was analyzed to determine the prerequisites for liquefaction. Results indicate that under certain conditions a thin discrete zone in the immediate vicinity of the exciting source exists which shows characteristics similar to those of a viscoelastic fluid.

**SR 107**
**FEASIBILITY STUDY OF BURIED ANCHORS IN POLAR SNOW.**
Kovacs, A., March 1967, 41p., AD-652 869, 8 refs.
24-3489
ANCHORS, PILE FOUNDATIONS, SNOW STRENGTH, SNOW (CONSTRUCTION MATERIAL).

The load resistance behavior of buried anchors in polar snow was investigated to determine the feasibility of using them as part of a reaction system for containing the forces generated by pile test loading devices. The test program was conducted at Camp Century, Greenland. Ten anchors were load-tested: eight in quick extraction and two under sustained long-term extraction. Ultimate load capacities of the anchors to resist quick extraction forces and their ability to hold sustained loads have not been definitely established, and no mathematical solution has been brought forward to predict the unit load creep rate or the ultimate load vs. embedment depth of an anchor in snow. The results of this exploratory study established the feasibility of using buried anchors in polar snow for the pile test program.

**SR 108**
**TEMPERATURE-MILLIVOLT CONVERSION TABLES COPPER-CONSTANTAN THERMOCOUPLES 32F REFERENCE TEMPERATURE.**
Aitken, G.W., Aug. 1966, 49p., AD-805 751, 4 refs.
24-3490
TEMPERATURE MEASURING INSTRUMENTS, TABLES (DATA), THERMOCOUPLES.
This report presents a temperature-millivolt conversion table for copper-constantan thermocouples having microvolt resolution. The computational method is described.

**SR 109**
**PRESSURE DROP ACROSS CURVED INTERFACES.**
Low, P.F., July 1967, 9p., AD-657 580, 3 refs.
24-3491
PRESSURE FACTORS, INTERFACES, CAPILLARITY.
The analysis of a general mathematical equation derived for the pressure drop across a curved interface indicates a valid result as long as the thickness of the interfacial region is small compared to its radius of curvature. However, if the interfacial region is within the range of surface forces, the value of the interfacial tension to be used in the equation may not be that identified with the interface between corresponding bulk phases. Further, if surface forces influence the phases in question, then it cannot be assumed that capillary rise and other associated phenomena are due only to pressure differences across curved interfaces. Also, it cannot be assumed that the curvature of the air-solution interface is controlled entirely by the shape of the capillary.

**SR 110**
**BIBLIOGRAPHY ON SOIL DYNAMICS.**
Bernhard, R.K., June 1969, 96p., AD-692 290, 532 items.
24-3492
BIBLIOGRAPHIES, SOIL DYNAMICS, SOIL CLASSIFICATION, STRESSES, TEMPERATURE FACTORS, SEISMOLOGY, VISCOELASTICITY.
Five hundred and thirty-two books, papers, bibliographies and symposium proceedings concerning soil dynamics are listed, each with an accompanying annotation describing its contents. The items listed were published from 1961 to 1965.

**SR 111**
**INVESTIGATION OF SUBSURFACE DRAINAGE AT BMEWS FACILITY, THULE, GREENLAND.**
McAnerney, J.M., June 1968, 32p., AD-675 411, 7 refs.
24-3493
SUBSURFACE DRAINAGE, COLD WEATHER CONSTRUCTION, FOUNDATIONS, SEEPAGE, THAW CAVITIES, THERMAL MEASURING INSTRUMENTS.
Thaw cavities (sinkholes) formed in the drainage ditch at Scanner 6 or the BMEWS facility, Greenland, in 1962. A contract was let for rebuilding the damaged ditch. In 1963 the program was expanded to include inspection of the entire surface drainage system. Field work accomplished from August through 6 October 1963 comprised 38 diamond drill (NXM) borings refrigerated for extracting frozen cores; 4 dye tests for seepage studies; 23 thermocouple strings installed under 12 structures; initial elevation readings on all foundations in the technical site; aerial photographs in stereo at low altitudes; and inspection of ditches and all heated buildings for settlement or distress. From this, the conclusions drawn are that the thaw cavities do not extend under adjacent foundations, but are confined to the ditch bottom; the drainage diversion and ditch repair as accomplished provides an adequate solution to the problem; seepages northeast of the site were not connected with the ditch; sinkholes found elsewhere are of similar origin but are not dangerous to existing structures and can be repaired easily.

**SR 112**
**UNDERSTANDING THE VARIATIONS OF THE PHYSICAL PROPERTIES OF SEA ICE.**
Weeks, W.F., May 1967, 15p., AD-657 213, 39 refs.
24-3494
SEA ICE, ICE GROWTH, ICE COVER STRENGTH, ICE CRYSTAL STRUCTURE, ICE DIELECTRICS, BRINES, ICE PHYSICS.
Information and test results are presented concerning the mechanism of growth, brine content, strength, structure, and dielectric properties of sea ice. Suggestions are given for improving methods of calculating growth conditions and a schematic drawing is given of the solid-liquid interface for sea ice together with photomicrographs of sea ice at low temperatures.

**SR 113**
**CONSTRUCTION OF AN UNATTENDED SEISMOLOGICAL OBSERVATORY (USO) IN PERMAFROST.**
Lange, G.R., Feb. 1973, 43p., AD-760 463.
28-1921
PERMAFROST STRUCTURE, SOIL TEMPERATURE, THERMAL REGIME, SEISMOLOGY, RECORDING INSTRUMENTS, MEASURING INSTRUMENTS, BOREHOLES.

**SR 114**
**CALCULATING THE AMOUNT OF UNFROZEN WATER IN FROZEN GROUND FROM MOISTURE CHARACTERISTIC CURVES.**
Keune, R., et al, July 1967, 7p., AD-659 781, 10 refs.
Hoekstra, P.
24-3495
FROZEN GROUND HYDROLOGY, UNFROZEN WATER CONTENT, SOIL MOISTURE, TEMPERATURE FACTORS, ANALYSIS (MATHEMATICS).
The unfrozen water content of a soil can be determined by calculating the partial molar free energy of water delta F bar sub l at any temperature and referring this value to the plot of delta F bar sub l vs. the water content of the soil under consideration. A plot of delta F bar sub l vs. water content can be obtained from a moisture characteristic curve at room temperature. Methods of calculating the numerical values for the graphs are outlined. Data are given for granular, clay, loam, and peat soils and for Na-montmorillonite, so that the results should be useful in estimating unfrozen water by comparing an unknown soil with a similar soil in the report.

**SR 115**
**DENSITY, TEMPERATURE AND THE UNCONFINED COMPRESSIVE STRENGTH OF POLAR SNOW.**
Kovacs, A., July 1967, 25p., AD-660 309, 19 refs.
24-3496
SNOW DENSITY, TEMPERATURE DISTRIBUTION, SNOW STRENGTH, COMPRESSIVE STRENGTH, ANALYSIS (MATHEMATICS).
The relationships between several empirical and theoretical methods of determining the unconfined compressive strength of polar snow from depth-density and temperature profiles are discussed and graphically compared. Two unconfined compressive strength equations are proposed for snow at -10C. The formulas take into consideration the decided changes in slope of the Young's and shear modulus curves at a density of 0.5 g/cu cm for Greenland snow. The slope changes signify that at this density a structural and, therefore, a strength change occur. Analysis of existing test data confirms this reasoning.

**SR 116**
**PENDULUM STEERING FOR THERMAL PROBES IN GLACIERS.**
Aamot, H.W.C., July 1967, 4p., AD-657 581.
24-3497
PROBES, ICE CORING DRILLS, DRILLING, THERMAL DRILLING, PENDULUMS.
A new concept of attitude stabilization for thermal probes or coring drills in ice eliminates instability. The center of support is placed above the center of gravity. A lower and an upper hot point produce melt penetration. The ratio of their power levels is the basis for stabilization. This is provided by the automatic control of the heater in the upper hot point.

**SR 117**
**VEHICULAR ACCESS TO UNDERSNOW FACILITIES.**
Tobiasson, W., et al, June 1969, 54p., AD-694 374.
Grant, J.
24-3498
UNDERSNOW FACILITIES, SNOW COMPACTION, SNOW (CONSTRUCTION MATERIAL), VEHICLES, COLD WEATHER CONSTRUCTION, ACCESS RAMPS.
Substantial effort is required to produce vehicular access ramps leading to subsurface ice cap facilities and to keep them from filling with drift snow. This report describes a technique for producing, maintaining and closing such ramps and outlines the procedure for covering the ramps, first to the surface and then, using a formed processed snow structure, above the surface. The results of a series of tests designed to evaluate various snows as construction materials indicate that snow disaggregated by the backcast Peter miller and subjected to immediate vibratory compaction is an excellent construction material. Application of the test results to a number of previously defined relationships for snow produced a method for designing formed processed snow structures. The method is illustrated by the design and construction of an above-surface access to an existing facility at Camp Century, Greenland. Performance of the access is discussed and documented by installed instrumentation. Construction of entire ice cap stations of formed processed snow is suggested.

**SR 118**
**BREAKUP OF ICE, MEADE RIVER, ALASKA.**
Johnson, P.L., et al, Oct. 1967, 12p., AD-667 946, 12 refs.
Kistner, F.B.
24-3499
RIVER ICE, ICE BREAKUP, CLIMATOLOGY, AERIAL PHOTOGRAPHY, ICE DAMS, FLOODING, CHANNELS (WATERWAYS), EROSION.
The climatic conditions and chronology of ice breakup on the Meade River, Alaska, in 1966 are reported and documented photographically. These observations and the interpretation of aerial photography suggest that ice damming, flooding, and dam release are the typical patterns of breakup that progress repetitiously downstream. The implications of ice breakup on plant succession on river bars and on channel erosion are discussed.

**SR 119**
**PHILBERTH PROBE FOR INVESTIGATING POLAR ICE CAPS.**
Aamot, H.W.C., Sept. 1967, 11p., AD-661 049, 5 refs.
24-3500
PROBES, DRILLING, THERMAL DRILLING.
The Philberth probe is a surface-controlled, nonrecoverable instrumented vehicle that can penetrate polar ice sheets down to 3600 m by melting. It can be used to measure temperature, stress, ice movement, and seismic, acoustic and dielectric properties. It can also be used for other investigations with remote instrumentation. The probe consists of a hot point for melt penetration, instrumentation for control and measurement functions, two supply conductor coils to link the probe with the surface for transmission of power and measurement signals, and a reservoir section. The probe is filled with a dielectric fluid.

**SR 120**
**EFFECTS OF A 20-TON TNT EXPLOSION ON A SNOW COVER.**
Bates, R.E., et al, April 1968, 16p., AD-696 411.
Hicks, J.R.
24-3501
EXPLOSION EFFECTS, SNOW DENSITY, HARDNESS TESTS, SNOWDRIFTS, SNOW MECHANICS.
The effects of a 20-ton surface burst explosion on the physical properties of drifted snow were measured. Density of the snow cover increased an average of 17 per cent. Snow hardness decreased an average of 3 per cent. Topographic surveys showed that snowdrift heights decreased through compaction resulting from ground shock and airblast. The results are for drifted snow accumulated around a drift fence. Different results might occur in a naturally accumulated snow cover.

**SR 121**
**ICE CONDITIONS AND PREDICTION OF FREEZE-OVER ON STREAMS IN THE VICINITY OF FT. GREELY, ALASKA.**
Bates, R.E., et al, Oct. 1968, 58p., AD-681 216, 15 refs.
Saboe, D.L., Bilello, M.A.
24-3502
RIVER ICE, ICE JAMS, ICE FORMATION INDICATORS, FREEZEUP, ICE FORECASTING, TEMPERATURE FACTORS.
The Delta River, within the boundary of Ft. Greely, Alaska, is mainly a series of braided channels that freeze over and can be crossed early in winter. However, ice jams and areas that remain ice free due to the influx of ground water could cause traversing problems. Descriptions of the events leading to freeze-over, including ground and aerial photos and diagrams showing the changes in river ice conditions, are given. The formation of a large ice jam on the Delta River and its probable causes are also discussed. Curves that can be used to forecast ice formation at three river locations near Ft. Greely, Alaska, were developed. Daily adjusted air temperatures, based on numerical constants, are applied to the curves to provide day-to-day forecasts of the dates of freeze-over. A survey of 13 bodies of water throughout interior Alaska during 1966 showed that freeze-over occurred between 19 and 29 October.

**SR 122**
**DIGITAL SOLUTION OF MODIFIED BERGGREN EQUATION TO CALCULATE DEPTHS OF FREEZE OR THAW IN MULTILAYERED SYSTEMS.**
Aitken, G.W., et al, Oct. 1968, 18p., AD-680 959, 4 refs.
Berg, R.L.
24-3503
FROST PENETRATION, COMPUTER APPLICATIONS, NONUNIFORM SOILS, FORTRAN, FROZEN GROUND.
This report presents a method for a digital computer solution, using the FORTRAN language, of the modified Berggren equation for computing depths of frost and thaw penetration in non-homogeneous (multilayered) soil systems. A program source listing, sample solutions, and tables of thermal properties of soils and construction materials are presented.

**SR 123** Record deleted.

**SR 124**
**PERMEABILITY AND STRENGTH OF AGING SNOW (TEST RESULTS).**
Waterhouse, R.W., et al, March 1969, 17p., AD-687 278, 8 refs.
Bunten, L.
24-3504
SNOW STRENGTH, PERMEABILITY, COMPRESSIVE STRENGTH, METAMORPHISM (SNOW).
Old snow or ice disaggregated at -10C or below produces a noncohesive aggregation of granular particles resembling sand. In contrast to rock particles, the surface properties of ice granules are not passive. Such aggregations are metamorphic, exhibiting a broad range of property changes in a relatively short time. Two mechanical properties, compressive strength and air permeability, characterize this behavior. Results of tests with disaggregated snow reported here show this time dependency of these properties - their density and temperature dependency is also indicated. The initial noncohesive aggregations are characterized by density, mean particle size and the standard geometric deviation of the size distribution.

**SR 125**
**ICE THICKNESS OBSERVATIONS ALONG THE COASTS OF EASTERN CANADA AND SOUTHERN GREENLAND.**
Bilello, M.A., et al, Oct. 1970, 56p., AD-715 424, 3 refs.
Bates, R.E., Riley, J.
25-3465
ICE COVER THICKNESS, FAST ICE, ICE SURFACE FEATURES, AIRCRAFT LANDING AREAS, ICE OBSERVATION.
Between 1943 and 1951 the U.S. Air Force, in cooperation with Canada and Denmark, made ice thickness measurements at 22 stations along the coasts of eastern Canada and southern Greenland and on nearby lakes and rivers. This report includes the thickness data (not previously published) as well as descriptions of surface conditions, snow depths and other information bearing on aircraft and ice surface transport operations. Greatest ice thickness ranged from 31 inches (Presque Isle, Maine) to 94 inches (Sondre Stromfjord, Greenland). Least thickness at the time of maximum ice ranged from 15 inches (Presque Isle) to 47 inches (Cape Dan, Greenland). The average number of days of ice cover is given for all stations. It ranged from around 100 days in southern Newfoundland to around 250 days in northern Baffin Island.

**SR 126**
**DRILLING THROUGH THE GREENLAND ICE SHEET.**
Ueda, H.T., et al, Nov. 1968, 7p., AD-696 412, 9 refs.
Garfield, D.E.
24-3505
ICE CORING DRILLS, GLACIER ICE, DRILLING, THERMAL DRILLING, ELECTRODRILLS, GREENLAND—CAMP CENTURY.
In July 1966 a USA CRREL drilling team succeeded in penetrating the Greenland ice sheet at Camp Century, drilling through 4550 feet of ice and 12 feet of sub-ice material. The objectives of the project were to gain an understanding of the basic flow mechanism of large ice masses and to collect continuous, undisturbed cores for scientific analyses. The two techniques of core drilling used to complete the hole were thermal drilling and electrodrilling. This preliminary report describes the drilling equipment and techniques used at Camp Century from 1963 to the completion of the deep drill hole in 1966.

**SR 127**
**SURFACE MEASUREMENTS OF SNOW AND ICE FOR CORRELATION WITH AIRCRAFT AND SATELLITE OBSERVATIONS.**
Bilello, M.A., May 1969, 9p., AD-689 449, 14 refs.
24-3506
SNOW COVER DISTRIBUTION, SNOW SURVEYS, ICE COVER THICKNESS, ICE REPORTING, AERIAL SURVEYS, SPACEBORNE PHOTOGRAPHY, METEOROLOGICAL DATA.
The seasonal extent of the earth's snow and ice cover can easily be determined by aircraft and satellite reconnaissance. However, determination of the depth and physical properties of the snow cover and the thickness of ice on lakes, rivers and along coastlines by these remote sensors is in an early stage of development. Correlation of the remote sensing data with actual surface conditions could be accomplished through use of an existing network of snow and ice stations located throughout North America. This network, comprising over 100 stations, is maintained by U.S. Army Terrestrial Sciences Center (USA TSC) in cooperation with other government agencies and accumulates the most extensive and reliable data for such correlation studies.

**SR 128**
**WINDING LONG, SLENDER COILS BY THE ORTHOCYCLIC METHOD.**
Aamot, H.W.C., Feb. 1969, 9p., AD-685 848, 5 refs.
24-3507
PROBES, THERMAL DRILLING, COILS, WINDING.
Thermal probes, like certain rockets and torpedoes, contain power and guidance wire for trailing payout. This wire must be wound into long, slender coils to obtain a slim profile, with a winding pattern of high density and perfect regularity to assure reliable payout from inside the mandrel-less coils. The development of a winding capability using the orthocyclic method solved problems of maintaining complete control of the winding pattern throughout the whole coil. A collapsible, grooved mandrel was developed which can be readily removed from the finished coil for reuse. Coils were wound with diameters of up to 8.5 cm and lengths up to 79 cm with wire lengths to 2100 m.

**SR 129**
**THERMAL CONDUCTIVITY OF ORGANIC SEDIMENTS FROM TWO WISCONSIN LAKES.**
McGaw, R., Nov. 1974, 16p., ADA-025 086, 9 refs.
32-2598
LAKE WATER, BOTTOM SEDIMENT, THERMAL CONDUCTIVITY.
The thermal conductivity of four organic sediments was measured using transient heating. It was found that a gelatinous constituent reduces conductivity to below that of water. The magnitude of the reduction diminishes with increasing heat flow. A fibrous constituent apparently increases conductivity, and shows no variation with heat input.

**SR 130**
**EVAPORATION FROM SNOW AND EVAPORATION RETARDATION BY MONOMOLECULAR FILMS.**
Slaughter, C.W., June 1970, 30p., AD-708 860, 174 refs.
25-1603
SNOW EVAPORATION, EVAPORATION CONTROL, REVIEWS.
Evaporation from snow is discussed. Methods of determining snow evaporation are explained; a summary of available data on snow evaporation is presented. The general field of evaporation retardation is also discussed, along with the limited information currently available on retardation of evaporation from snow.

**SR 131**
**DEVELOPMENT AND EVALUATION OF AN APPARATUS FOR THE DIRECT TENSILE TESTING OF ICE.**
Hawkes, I., Oct. 1969, 27p., AD-698 022, 21 refs.
25-998
STRAIN MEASURING INSTRUMENTS, ICE CRYSTALS, TENSILE STRENGTH, COMPRESSIVE STRENGTH, STRAIN RATE, STRESS ANALYSIS.
This report discusses the theory of the uniaxial tensile test of a brittle material and describes in detail the development and calibration of an apparatus designed to subject fine-grained polycrystalline ice specimens to uniaxial tensile and compressive loads up to failure, and to give a continuous stress-strain curve during the loading cycle. A technique for preparing fine-grained ice specimens is also given together with a preliminary tensile strength value (19.3 kg/sq cm) and stress-strain relationships (initial tangent modulus 5.6 x 100,000 kg/sq cm) at a temperature of 15F and a strain rate of 3.6 x 10 to the -6th strain/sec.

**SR 132** Record deleted.

**SR 133**
**BIAXIAL STRESS AND STRAIN MEASUREMENTS USING PHOTOELASTIC HOLLOW CYLINDER INCLUSION METERS.**
Hawkes, I., June 1969, 28p., AD-692 289, 15 refs.
24-3508
ROCK MECHANICS, STRESS CONCENTRATION, STRAIN MEASUREMENT.
It is shown that for a wide range of rock and concrete-like materials a glass stressmeter will enable the stresses to be determined directly without knowledge of the host material modulus. The results of tests using frozen sand slabs have shown that under uniaxial stress there is little effect of creep on the meter readings until excessive fracturing occurs. There is also close agreement between the theoretical and experimental values for the meter sensitivity when it is assumed that the Poisson's ratio of the host materials falls to 0.5 during creep (no volume change in stressed material during creep). Experiments are also described which show that the stress can be determined in a material which is creeping by inserting a stressmeter and measuring the final steady reading. It is shown that for a low modulus (plastic) inclusion the sensitivity is a function of the ratio of the moduli of the host and gauge materials except when the host material is undergoing continuous creep. The long term sensitivity is then again independent of these factors.

**SR 134**
**PHOTOELASTIC UNIDIRECTIONAL STRESSMETER: A BOREHOLE ROCK STRESS GAUGE.**
Hawkes, I., Oct. 1969, 19p., AD-697 752, 14 refs.
25-999
MEASURING INSTRUMENTS, ROCK MECHANICS, STRESS ANALYSIS.
The development, calibration and use of a simple and robust, unidirectional borehole rock stressmeter is described. Readout is in terms of the photoelastic isochromatic fringe order in a glass cylinder built into the meter. The meter, which is preloaded in the borehole, is intended for both stress change and absolute rock stress measurements.

**SR 135**
**LONGITUDINAL FORCED VIBRATION OF VISCOELASTIC BARS WITH END MASS.**
Norris, D.M., Jr., et al, April 1970, 25p., AD-707 925, 6 refs.
Young, W.-C.
25-2248
VISCOELASTICITY, FORCED VIBRATION, SHEAR MODULUS, AUDIO FREQUENCIES.
A simple method is presented to measure the complex modulus of suitably rigid linear viscoelastic materials over the audiofrequency spectrum. The case is considered where one end of a rod of the material is driven harmonically and the complex displacement ratio is measured. The effect of a rigid end mass on the free end is accounted for. It is shown that, at specific frequencies near resonance, it is easy to obtain modulus data with standard equipment usually found in the vibratory. An experimental program is described.

**SR 136**
**RATIONAL APPROACH TO THE DESIGN OF AERATED SEWAGE LAGOONS.**
Pohl, E.F., Oct. 1970, 23p., AD-717 241, 27 refs.
25-4041
SEWAGE TREATMENT, PONDS, AERATION, ANALYSIS (MATHEMATICS).
The use of aerated lagoons as an economical sewage treatment system is a recently developed concept. Its adaptability to arctic and subarctic environments has been established through test programs in Alaska. This report summarizes current developments and discusses the physical and biochemical parameters which must be considered during design.

**SR 137**
**EVALUATION OF A 20-INCH GUARDED HOT-PLATE THERMAL CONDUCTIVITY APPARATUS RANGE -50F TO 250F.**
Kaplar, C.W., June 1971, 39p., AD-727 668, 13 refs.
26-2353
SOIL TESTS, TEST EQUIPMENT, THERMAL INSULATION, THERMAL CONDUCTIVITY, FROZEN GROUND THERMODYNAMICS.
A new custom-made guarded hot-plate thermal conductivity test apparatus capable of accommodating two 20 x 20-in. specimens up to 3 in. thick is described. The apparatus was designed for testing materials ranging from thin, rigid, foamed thermal insulations to 3-in.-thick pavement sections of asphaltic or portland cement concrete, with a 1-ft-sq metered area. The effective temperature range of the apparatus is from +250F to -50F. Some performance test data on a calibrated gum rubber specimen and results of evaluation tests on a frozen wet sand are presented. The k-values obtained for the frozen sand compare well with those obtained by other techniques.

**SR 138**
**EFFECT OF DISTURBANCE ON PERMAFROST TERRAIN.**
Brown, J., et al, Nov. 1969, 15p., AD-699 327, 10 refs.
Rickard, W., Vietor, D.
25-1000
ARCTIC SOILS, ARCTIC VEGETATION, PERMAFROST TRANSFORMATION, THAWING, SOIL EROSION.
The influence of surface cover on thaw penetration in alpine and arctic soils of Alaska was determined. Several manipulated treatments were employed: removal of all vegetation, mulching, shearing and fire. Thaw and subsidence more than doubled on the bare and sheared plots and increased up to 50% on the burned areas. Bulldozing of and traffic over ice-rich permafrost terrain resulted in considerable erosion and thaw.

**SR 139**
**FUZE ACTION IN SNOW.**
Swinzow, G.K., March 1970, 23p., AD-868 215, 9 refs.
25-2249
SNOW COVER EFFECT, FRAGMENTATION AMMUNITION, FUZES (ORDNANCE).
Fragmentation ammunition as used with point detonating (PD) fuzes does not receive sufficient resistance from a snow cover to detonate at the surface. The result is burial before detonation with a significant fragmentation effect loss. The Harry Diamond Laboratories have developed a new fuze with a non-mechanical action which senses the approach of a surface ensuring a detonation above a snow-covered surface with a full fragmentation effect. The new fuze is designated the near surface burst fuze (XN588NSB). A comparative study of the two fuzes was conducted to determine the action difference over snow. The study consisted of two basically different parts: 1) Free-fall experiments with a non-detonating round and an electronic flash signal were conducted using snow targets with different properties. 2) Realistic full-scale firings into a structural snow-covered terrain were conducted using an 81 mm mortar round covered and equipped with a pyrotechnic powder charge producing a bright light signal at the instant of detonation. Data were gathered using conventional high speed motion picture photography together with new specially developed methods of information gathering. It was concluded that the XM588 fuze is superior, and is not subjected to fragmentation effect degradation over snow-covered terrain.

**SR 140**
**NONLINEAR STRESS-WAVE PROPAGATION IN A SOIL COLUMN.**
Lachenmaier, R., June 1970, 71p., AD-710 234, 42 refs.
25-2250
WAVE PROPAGATION, SOIL DYNAMICS, MODELS, NONLINEAR VIBRATIONS.
A mathematical model was developed to describe one-dimensional wave propagation in a resonating column of a material with a nonlinear constitutive relation. The nonlinear partial differential equation which resulted was solved using a finite differencing method, and a computer program was written to simulate a resonating column. The computer simulation program was used to find a dynamic nonlinear constitutive relation for a sand and a clay by a trial-and-error method. It was discovered that the constitutive relation for these soils found by using a pseudo-nonlinear method (which is based on linear theory) agreed surprisingly well with the constitutive relation found using a genuine nonlinear theory. Convergence studies for the finite-differencing method were also made.

**SR 141**
**PILE DRIVING BY MEANS OF LONGITUDINAL AND TORSIONAL VIBRATIONS.**
Kovacs, A., et al, July 1970, 17p., AD-711 533, 25 refs.
Michitti, F.
25-1843
PILE DRIVING, RESONANT FREQUENCIES, TORSIONAL VIBRATION, LONGITUDINAL VIBRATION.
This report discusses vibratory pile driving with particular emphasis on pile driving at resonance where maximum driving efficiency can be expected. The theories and concepts associated with longitudinal and torsional pile driving are presented to show that torsional resonance does not appear to be as effective a method as longitudinal resonance and that considerable variations can exist between calculated and observed resonant frequencies. While it is pointed out that equations by Bernhard and Kovacs predict pile resonance in close agreement with that observed during actual pile driving, it is also suggested that these equations be subjected to a more rigorous evaluation to determine whether they can predict the resonant frequency of all force generator - column systems.

**SR 142**
**LOW TEMPERATURE BEHAVIOR OF N-5 PROPELLANT.**
Anderson, D.M., et al, Jan. 1970, 22 p., AD-700 997, 11 refs.
Tice, A.R., Bartizek, B.A.
25-1078
LOW TEMPERATURE TESTS, TENSILE STRENGTH, THERMAL ANALYSIS, ROCKET PROPELLANTS.
The low temperature behavior of several samples of N-5 rocket propellant was studied using DTA. The only significant occurrence during cooling to -100C was the glass transition. The temperature of this transformation was found to be -58F plus or minus 3 deg. by dilatometry. In addition, the variability of tensile strength, elongation, and strength modulus among three producers was examined. Significant variations were found among lots from any one plant; but variations in the average values for each plant were not significant.

**SR 143**
**PHYSICAL PROPERTIES OF THE SNOW COVER AND CLIMATIC CONDITIONS AT LEBANON, N.H. AND VICINITY.**
Bates, R.E., Sept. 1970, 23p., AD-714 645, 16 refs.
25-2440
SNOW PHYSICS, METEOROLOGICAL DATA, SOIL TEMPERATURE, SNOW TEMPERATURE.
The characteristics of the snow cover at Lebanon Regional Airport, New Hampshire and vicinity for the three winters between 1964 and 1967 were investigated. Report includes information on snowfall amounts, snow depth, snow hardness, snow density, and water equivalent. Meteorological data and snow and ground temperatures were also investigated. A mean annual snowfall map for northern New England was developed. Relationships between snow density and climate were investigated. Wind and air temperature data were used to estimate values of snow density; these values were on the average 14 percent less than the observed values. The mean snow density for the three winters studied was 0.272 g/cu cm; the mean snow-cover hardness was 885 g/sq cm; the average water equivalent of the the snow at Lebanon Regional Airport at the time of maximum snow depth was 8 cm; and the average temperature gradient through the snow cover was 0.4C/cm.

**SR 144**
**DESCRIPTION OF SOILS AT MINE-TUNNEL DETECTION RESEARCH SITES, PUERTO RICO.**
Simpson, T.J., et al, Nov. 1969, 18 p., AD-707 926, 2 refs.
Murrmann, R.P.
25-1079
SOIL SURVEYS, SOIL CLASSIFICATION, MINE DETECTION, TUNNEL DETECTION.
Soils at mine-tunnel detection research sites, Puerto Rico, were described and classified. A priority for development of the sites for USA CRREL needs was arrived at using both this information and that on landform, climate and vegetation. The suitability of the various great soil groups for both mine and tunnel detection was discussed.

**SR 145**
**SNOW TESTS CAMP DRUM, NEW YORK 1967-69.**
Boyd, W.K., ed, May 1970, 45p., AD-738 565.
26-3555
SNOW MECHANICS, SNOW MANUFACTURING.
Support given the Degradation Effects Program (DEP) by the U.S. Army Cold Regions Research and Engineering Laboratory during two winter test seasons include logistical preparation, meteorological data acquisition, snow cover characterization and limited crater studies of missiles impacting in snow. Methods for producing artificial snow were also developed, since natural snow amounts were insufficient for the tests. The use of artificial snow proved marginally satisfactory since it required favorable meteorological conditions, was logistically complex and produced snow with undesirable properties. "Processed" snow blown into boxes by a rotary snowplow was also unsatisfactory. Testing must be done in naturally deposited snow to give realistic results. Logistical and data acquisition techniques used in other environments must be modified for the unique snow environment. A single test site combining a military range with an adequate snow supply is difficult to find.

**SR 146**
**USA CRREL SNOW AND ICE TESTING EQUIPMENT.**
Ueda, H.T., et al, Sept. 1975, 14p., ADA-015 512, 19 refs.
Sellmann, P.V., Abele, G.
30-2503
ICE CORING DRILLS, PENETROMETERS, TEST EQUIPMENT.
This paper summarizes available information on the history, development, and application of three items of special equipment designed or modified by USA CRREL for testing and sampling snow and ice. These items have become universally known and accepted, providing measurement techniques that are used, in some cases, on an international basis. The equipment described includes the 3-in. ice coring auger, the ice thickness kit, and the Rammsonde.

**SR 147**
**CHEMICAL PROPERTIES OF SOILS AT MINE-TUNNEL DETECTION RESEARCH SITES, PUERTO RICO.**
Simpson, T.J., et al, June 1970, 7p., AD-708 545, 8 refs.
Murrmann, R.P.
25-1810
SOIL CHEMISTRY, EXPLOSIVES DETECTION, TUNNEL DETECTION, PUERTO RICO.
Soil at each of the proposed mine-tunnel detection research sites in Puerto Rico was analyzed. Samples were obtained at 1-ft intervals to a depth of 8 ft at three locations at the Laguna Joyuda tunnel site to determine chemical variability at the site. At the remaining 20 sites to be used primarily for explosives detection research, samples were obtained at only one location to a 3-ft depth. Analyses performed included cation exchange capacity, exchangeable ions, exchange acidity, pH, salt conductivity, carbonates, organic matter, organic carbon, nitrogen, and free iron oxides. The variation in results observed from one site to another could be explained in terms of primary laterization and silication, two soil formation processes which occur in subtropical and tropical environments.

**SR 148**
**FEASIBILITY OF TUNNEL DETECTION BY TRACE GAS ANALYSIS.**
Murrmann, R.P., et al, June 1970, 8p., AD-708 861, 13 refs.
Leggett, D.C., Jenkins, T.F.
25-1605
GAS ANALYSIS, GAS CHROMATOGRAPHY, TUNNEL DETECTION.
The feasibility of tunnel detection by trace gas analysis was investigated at the USA CRREL permafrost tunnel near Fox, Alaska. Under favorable conditions, the presence of an odor unique to the tunnel could be sensed at least 200 yards downwind from the air vent. Under extremely unfavorable conditions, trace gases identified in the tunnel were present 40 yards downwind from the air vent in concentrations 10 to 100 times greater than were observed upwind. These results support the principle of detection by trace gas analysis.

**SR 149**
**LOW-TERMPERATURE DIFFERENTIAL THERMAL ANALYSIS OF HYDROXY-TERMINATED AND CARBOXY-TERMINATED POLYBUTADIENE.**
Tice, A.R., et al, June 1970, 7p., AD-708 862, 8 refs.
Bartizek, B., Anderson, D.M.
25-1604
THERMAL ANALYSIS, ROCKET PROPELLANTS.
A low-temperature differential thermal analysis of hydroxy-and carboxy-terminated polybutadiene was performed with varying amounts of n-butylferrocene. No distinct phase changes were observed to indicate that the sample components became separated during cooling. However, the slow transformation into the glassy state was observed, yielded glass transition temperatures of -80 to -95C. This is far below the low temperature specification for these propellants. This analysis yielded no evidence of a physical or chemical transition that might cause a low-temperature firing failure in the finished propellants.

**SR 150**
**CAMP CENTURY REVISITED - A PICTORIAL VIEW - JUNE 1969.**
Kovacs, A., July 1970, 53p., AD-711 862, 18 refs.
25-1837
COLD WEATHER CONSTRUCTION, DEFORMATION, PHOTOGRAPHIC RECONNAISSANCE, GREENLAND—CAMP CENTURY.
Camp Century, Greenland, constructed in 1959 and abandoned in 1966, was revisited 22 May and 2 June 1969. Ninety-six photographs show local surface features and conditions existing within the buried camp complex. The effects of trench closure are dramatically shown.

**SR 151**
**ICING OCCURRENCE, CONTROL AND PREVENTION, AN ANNOTATED BIBLIOGRAPHY.**
Carey, K.L., July 1970, 59p., AD-711 534.
25-2251
ICE CONTROL, ICING, ICE PREVENTION, TRAFFICABILITY, BIBLIOGRAPHIES.
Icings present severe problems for highways, railroads, airfields, and structures. Details of icing processes, and past and present practices of icing prevention and control, are given in annotations for 93 of 94 bibliographic entries. The entries were selected from over 200 references examined through March 1968. Of the 94 entries, 51 are from the Soviet Union, 37 from the United States, and 6 from Canada. Fourteen recent Russian papers were translated specifically for this study.

**SR 152**
**TEMPERATURE AND ICE DISTRIBUTION IN THE NORTH SASKATCHEWAN RIVER BELOW THE EDMONTON GENERATING PLANT.**
Dingman, S.L., et al, Oct. 1970, 31p., AD-738 797, 4 refs.
Weeks, W.F.
26-3539
RIVER ICE, WATER TEMPERATURE, THERMAL POLLUTION, CANADA—ALBERTA—EDMONTON.
A field study in a thermally polluted reach of the North Saskatchewan River at Edmonton, Alberta, was organized in December 1968, to test a previously developed method of predicting river temperatures due to thermal pollution sources. Lateral mixing was found to be relatively fast, the entire cross section was heated only 1.45 km below the heat source, which is on the left bank. The ice front was located upstream of the zero isotherm when ice jams, caused by fluctuating river levels, formed in channel constrictions. At other times, the zero isotherm was several km upstream of the ice front, but this relation may have been affected by additional thermal pollution below the main source. Frazil ice formed continuously in an open reach above the main (and farthest upstream) thermal pollution source. The heat loss due to the melting of this ice in the heated reach could not be estimated, but it may have been sufficient to account for the fact that the actual heat loss was six times greater than the calculated. Meteorological measurements in the valley of the North Saskatchewan River showed air temperatures about 2 C colder than at the official station on the plain 50 m above the river. Windspeeds were also considerably lower in the valley than on the plain, and there were significant differences in windspeeds depending on valley orientations. Several operational problems encountered in the course of the field work are discussed.

**SR 153**
**EXPERIMENTAL BLASTING IN FROZEN GROUND.**
Mellor, M., et al, Nov. 1970, 32p., AD-738 798, 17 refs.
Sellmann, P.V.
26-3540
FROZEN GROUND MECHANICS, EXPLOSION EFFECTS, BLASTING, EXPLOSIVES, PENETRATION TESTS.
A program of experimental blasting carried out in Alaska during winter, 1970, is described, and results are given. Results of earlier studies on shaped charge penetration and crater formation by single concentrated charges are reviewed and summarized. Blasting procedures for excavation of trenches in deeply frozen soils are considered.

**SR 154**
**REMOTE ANALYSIS OF PLANETARY WATER.**
Anderson, D.M., April 1971, 13p., AD-722 782, 13 refs.
26-2300
MARS (PLANET), EXTRATERRESTRIAL ICE, REMOTE SENSING, PLANETARY ENVIRONMENTS, WATER ANALYSIS, RESEARCH PROJECTS.
The analysis of the various forms of water occurring in the surficial material of planetary bodies is a requirement of high priority in extraterrestrial explorations. It was an initial requirement of the 1973-75 Viking project to explore the planet Mars. A scheme for identification and analysis of ice, free or adsorbed water, and water of construction based on scanning

calorimetry and found suitable for the Viking missions is described and critically examined from the point of view of sensitivity and freedom from ambiguity and interferences. It is concluded that a thermal method, for example, differential thermal analysis or differential scanning calorimetry combined with effluent gas analysis is well suited for surveying the amounts and states of water at the surface of Mars.

**SR 155**
**SPRING BREAKUP OF THE DELTA RIVER, ALAKSA.**
Slaughter, C.W., et al, April 1971, 33p., AD-724 683, 12 refs.
Samide, H.R.
26-2301
RIVER ICE, ICE BREAKUP, AIR TEMPERATURE, CHANNELS (WATERWAYS), STREAM FLOW, UNITED STATES—ALASKA—DELTA RIVER.
Spring "breakup" of snow and ice on the Delta River, Alaska, was monitored in 1967. Breakup on this braided river was a relatively calm event, with gradual development of open-water channels from headwaters to mouth. Air temperature data at Big Delta, near the mouth of the river, indicated an accumulation of 30 positive degree-days (F) above 32 F, using mean daily values, prior to first observation of continuous open water from headwaters to mouth; a corresponding value, but using maximum daily air temperatures, was 224 degree-days (F). A photographic sequence of breakup at several points along the river is included.

**SR 156**
**ANOMALOUS WATER: NUCLEATION, GROWTH AND PROPERTIES.**
Swinzow, G.K., May 1971, 42p., AD-724 684.
26-2333
ANOMALOUS WATER, NUCLEATION.
An anomalous liquid phase forming in an atmosphere of reduced water vapor pressure was investigated. The liquid was grown in capillary tubes. Technical experimental refinements resulted in high nucleation rates not previously observed. An examination of vapor pressures disclosed the relationship of nucleation growth and equilibria of anomalous water. The possibility of nucleation and growth of anomalous water on flat surfaces was confirmed by observation. Growth rates on free flat surfaces were higher, and the total amount of fluid obtained was several orders of magnitude higher, than those obtained from capillary tubes. Refractive indexes and other properties were measured directly. The new method of growing anomalous water outside capillary tubes is an advantage that may lead to large-scale production.

**SR 157**
**CARIBOU-POKER CREEKS RESEARCH WATERSHED, INTERIOR ALASKA. BACKGROUND AND CURRENT STATUS.**
Slaughter, C.W., May 1971, 13p, AD-726 373, 20 refs.
26-2348
RESEARCH PROJECTS, WATERSHEDS, HYDROLOGY, DRAINAGE, STREAM FLOW, ECOLOGY, NATURAL RESOURCES, PERMAFROST, UNITED STATES—ALASKA.
The Caribou-Poker Creeks Research Watershed was established in 1969 as a site for cooperative, inter-agency investigation of hydrologic and related aspects of a subarctic environment. The relatively undisturbed 40-square-mile drainage basin includes both permafrost-dominated and non-permafrost watersheds, and has a variety of vegetation communities. Initial research is directed to furthering understanding of hydrologic behavior of north-facing (permafrost) and south-facing (non-permafrost) basins in this upland setting.

**SR 158**
**COMPOSITION AND MASS SPECTRA OF IMPURITIES IN MILITARY GRADE TNT VAPOR.**
Murrmann, R.P., et al, May 1971, 17p., AD-725 474, 18 refs.
Jenkins, T.F., Leggett, D.C.
26-2302
EXPLOSIVES, CHEMICAL ANALYSIS, DETECTION, TRINITROTOLUENE, GAS ANALYSIS, SPECTRA.
Using a gas chromatographic method, the DNT and TNT isomeric impurities in vapor in equilibrium with typical military grade TNT were established. The 2, 4 DNT content of the vapor was almost as high as that of 2, 4, 6 TNT, the major component of the solid TNT. Mass spectra of all possible DNT and TNT isomers with the exception of 3, 4, 5 TNT were obtained as a function of ionization voltage. Mass spectra were also taken of several military grade TNT samples. Mass peaks common to both 2, 4 DNT and 2, 4, 6 TNT at m/e equals 63 and 89 may be diagnostic for TNT using fragment ion type detection systems in that these peaks are not found in the mass spectra of compounds present in the atmosphere.

**SR 159**
**SOME STRENGTH PROPERTIES OF FROZEN SOIL AND EFFECT OF LOADING RATE.**
Kaplar, C.W., June 1971, 25p., AD-726 913, 19 refs.
26-2349
FROZEN GROUND MECHANICS, FROZEN GROUND STRENGTH, COMPRESSIVE PROPERTIES, ADFREEZING STRENGTH, LOADS (FORCES), SOIL MOISTURE.
This report presents frozen soil strength data for several soil types. The data include the effects of unit dry weight and the degree of saturation on the strength of frozen soils. The frozen soil strength increases with moisture content (frozen) up to full saturation and then drops off at greater ice contents. Data are presented showing that the compressive strength of many materials, frozen (including sea ice) and non-frozen, is greater under rapid loading rates. Fresh water ice shows the opposite effect. Values of the adfreeze bond of frozen soils to various materials are also presented.

**SR 160**
**AIR AND WATER TEMPERATURES AND ICE CONDITIONS ON THE CONNECTICUT RIVER.**
Bilello, M.A., et al, July 1971, 14p., AD-729 363.
Smith, D.
26-2357
RIVERS, FREEZING, RIVER ICE, WATER TEMPERATURE, MEASURING INSTRUMENTS, WATER FLOW, UNITED STATES—NEW HAMPSHIRE—CONNECTICUT RIVER.
Observations made in and along the shores of the Connecticut River, near Hanover, New Hampshire, showed that the water temperature decreased from 14C on 23 October to 3.5 degrees on 21 November 1968. The river froze over on 10 December 1968 and the ice water cover midriver was 9 to 11 in. thick on 16 January 1969. The water temperature beneath the ice sheet decreased from 2.3C to 0C just below the surface between 4 and 18 December 1968 and remained so down to a 15-ft depth until observations ended on 22 January 1969. These persistent near-freezing temperatures in the river were attributed to mixing caused by the constant flow of water beneath the ice sheet.

**SR 161**
**SURFACE EFFECT VEHICLE ENGINEERING TEST PROCEDURES.**
Liston, R.A., Aug. 1971, 28p., AD-731 214.
26-2359
AIR CUSHION VEHICLES, PERFORMANCE, TESTS, SLOPES.
The objective of the test program was to identify the performance parameters that would establish the effectiveness of a surface effect vehicle and to design test procedures which would measure these parameters.

**SR 162**
**ICE FOG MODIFICATION BY USE OF HELICOPTERS.**
Hicks, J.R., et al, Sept. 1971, 14p., AD-731 215.
Kumai, M.
26-2360
ICE FOG, FOG DISPERSAL, HELICOPTERS, WEATHER MODIFICATION, TESTS, THERMAL RADIATION, TEMPERATURE INVERSIONS, UNITED STATES—ALASKA—FORT WAINWRIGHT.
The objects of the report are to increase the knowledge of the physical and optical properties of ice fog and to develop techniques for its dispersal. Two series of flight tests to determine the effects of CH-47 helicopter downwash on ice fog were conducted near Ft. Wainwright, Alaska, in January 1971. During the first series, clearings were produced which were large enough for helicopter operations. This series of tests was conducted when the ice fog was in a dissipating state. The second series of tests was conducted in a denser ice fog during its developing stage. The same flight procedures were used, but clearings were not produced.

**SR 163**
**SNOW SURFACE EROSION FROM A PERIPHERAL JET CUSHION ACV.**
Abele, G., et al, Oct. 1971, 19p., AD-733 319.
Parrott, W.H.
26-2773
AIR CUSHION VEHICLES, SNOW EROSION, SNOW SURFACE, DEFORMATION, TESTS.
Travel with an SK-5 ACV over soft snow results in surface deformation/erosion of a few inches, caused primarily by rear skirt drag; on windswept snow only scratches can be seen. During hovering on soft snow, deformation below the cushion chamber usually does not exceed a few inches. The action of the air flow, which has an escape velocity of 70 to 120 ft/sec, produces a 1-ft ditch below the peripheral skirt in less than a minute; thereafter the extent of erosion does not increase appreciably during continued hovering. A partial seal between the inner face of the skirt, above the fingers, and the snow surface may exist, arresting further settling of the vehicle. Relatively cohesive layers of snow such as wind slabs and crusts are not eroded. A level snow cover, regardless of how deep or soft, does not appear to be capable of immobilizing an ACV of this or larger size.

**SR 164**
**LANDSCAPE OF NORTHERN GREENLAND.**
Davies, W.E., March 1972, 67p. plus maps, AD-739 934, Bibliography p.50-55.
26-3613
ARCTIC TOPOGRAPHY, TOPOGRAPHIC FEATURES, GEOLOGIC STRUCTURES, PERMAFROST DISTRIBUTION, CLIMATE, CLASSIFICATIONS, GREENLAND.
The terrain, geomorphology, physiography and general environmental setting of Northern Greenland are the subject of this report. There are no clear cut regional designations for Greenland; therefore for the purposes of this report Northern Greenland has been arbitrarily set as the area north of 79N on both the east and west coasts. The general topography, geology, vegetation, climate and permafrost conditions are discussed to provide an indication of the environmental setting. A new physiographic classification for Northern Greenland is proposed. Three basic concepts have been followed in establishing the psysiographic divisions: (1) the divisions have been established to be applicable to all of Greenland; (2) they have been correlated as far as practicable with those already established in Canada; and (3) to be systematic, they follow the general criteria and scheme established by Fenneman and others for the United States. A terrain classification of this is also presented with an emphasis toward cross-country operation of air cushion vehicles. This type of approach is very useful for operational analysis of vehicles of this type in this area. The land area has been broken down into seven categories with varying degrees of suitability for air cushion vehicle operations. Under each category a number of specific conditions are discussed such as: landform; terrain, including relief and slope relief features, their height, spacing and orientation; stream frequency; vegetation; soil types; and winter conditions. Additional information is provided on relief and conditions associated with summer and winter shore ice. The detailed geomorphology of five selected areas at scales of 1:100,000 or larger was mapped. These areas were selected to provide additional detail on Northern Greenland since they include most of the landforms and physiographic types found in this region.

**SR 165/1**
**TERRAIN AND COASTAL CONDITIONS ON THE ARCTIC COASTAL PLAIN. ARCTIC ENVIRONMENTAL DATA PACKAGE. SUPPLEMENT 1.**
Sellmann, P.V., et al, March 1972, 83p., AD-741 354.
Carey, K.L., Keeler, C.M., Hartwell, A.D.
27-1270
COASTAL TOPOGRAPHIC FEATURES, SEA ICE, SHORE EROSION, PATTERNED GROUND, OCEAN WAVES.
The group of four reports describes the characteristics and seasonal variation of prominent relief features on and along the margin of the arctic coastal plain. These relief features include polygonal ground patterns, lake scarps and coastal features. The range of polygonal ground patterns commonly found is illustrated by a number of transects. The influence of the seasonal snow cover on relief is indicated by profiles taken during the summer and the winter. The winter profiles were taken during the period of maximum snow accumulation. The subduing influence of the seasonal snowpack is much more apparent in areas of high relief. Irregularities in the snow surface may approach those found in the more featureless areas of summer relief. A discussion of properties of the snow cover is also included from observations in the Barrow study area. (Auth.)

**SR 166**
**FOG DROP MEASUREMENTS AT BARROW, ALASKA.**
Kumai, M., et al, March 1972, 15p., AD-752 129, 9 refs.
Glienna, R.F.
27-1683
FOG FORMATION, CLOUD DROPLETS, PARTICLE SIZE DISTRIBUTION.
Arctic fog droplets were sampled on chloride-sensitive gelatin-coated glass slides at Point Barrow, Alaska, in the summer of 1971. The collection efficiency of the fog droplets was determined. About 20,000 fog drop radii were measured. The results of analysis of the concentration and the size distribution of fog drops are presented in the form of tables and photomicrographs. It is shown that the concentration and the size distribution changed rapidly with time and space; the drop radii ranged widely between 3.3 and 65 microns; the mean radius was 10 microns; the maximum concentration was 24 drops/cu cm and the liquid water content was 0.09 g/cu m at a visibility of 250 m. Calculations were made of the attenuation by fog at wavelengths of 0.571 and 1.06 microns for the observed size distributions and concentrations of fog drops.

**SR 167**
**PROCEDURES FOR REMOVING SURFACE CONTAMINANTS FROM DEEP ICE CORES.**
Ragone, S.E., et al, March 1972, 7p., AD-739 993, 7 refs.
Finelli, R.V.
26-3614
ICE CORES, IMPURITIES, ICE WASHING.
The surfaces of the deep ice cores from Greenland and Antarctica were contaminated during drilling at concentration levels several orders of magnitude greater than those found in the uncontaminated ice. Several procedures for removing these contaminants were studied. Ultrasonic vibration followed by self-cleaning in meltwater was found to be the most effective procedure for removal of surface contamination.

**SR 168**
**MICROBIOLOGY OF TERRESTRIAL CRUDE OIL DEGRADATION.**
Hunt, P.G., April 1972, 17p., AD-742 674.
27-1001
CRUDE OIL, OIL RECOVERY, SOIL MICROBIOLOGY, DECOMPOSITION, OIL SPILLS.
As most oil mishaps have been on water most of the progress or prevention and cleanup has been in the area of aquatic spills and relatively little has been done or considered in the area of terrestrial spills. Yet numerous petroleum transport systems

are terrestrial. For example, the proposed Alyeska pipeline will cross 800 miles of ecologically sensitive terrain in Alaska. Terrestrial oil spill clean-up is difficult in any area, but in Alaska, where permafrost soils and slow growing vegetation are prevalent, the potential problems are magnified immensely. Therefore, after the potential water pollution and health hazards have been addressed, one of the most logical approaches for treating a terrestrial oil spill in Alaska is by microbiological means. The report concerns the topic of microbial decomposition of crude oil in soils.

**SR 169**
**ANALYSIS OF THE MAJOR CATIONIC CONSTITUENTS OF THE 1964 TO 1969 SNOW ACCUMULATIONS AT DYE SITES 2 AND 3, GREENLAND.**
Ragone, S.E., et al, April 1972, 7p., AD-743 473, 7 refs.
Wolf, C.A.
27-329
SNOW ACCUMULATION, CHEMICAL ANALYSIS, ION DENSITY (CONCENTRATION), GREENLAND.
The Na, K, Ca, Mg and Fe cation concentrations in the 1964 to 1969 annual snow accumulations at Dye Sites 2 and 3 on the Greenland Ice Cap were measured. Although the concentrations of most of these cations showed significant variations on an annual and seasonal basis, no clear-cut trend or relationship between these parameters and the concentrations was observed.

**SR 170**
**PRELIMINARY INVESTIGATIONS OF PETROLEUM SPILLAGE, HAINES-FAIRBANKS MILITARY PIPELINE, ALASKA.**
Rickard, W., et al, April 1972, 27p., AD-744 450.
Deneke, F.J.
27-1563
HOT OIL LINES, PLANTS (BOTANY), OIL SPILLS, ENVIRONMENTAL IMPACT.
The effect of various petroleum products on arctic and subarctic environments is of considerable importance. As part of the research effort into this problem, past fuel spills along the Haines to Fairbanks, Alaska military pipeline were investigated. Since the incorporation of the pipeline in 1956 there have been 40 reported ruptures in the 8-in.-diameter pipe that traverses 626 surface miles. Little new vegetation has grown in the areas of the spills. An inventory of new vegetation or lack of it is reported.

**SR 171**
**WASTEWATER MANAGEMENT BY DISPOSAL ON THE LAND.**
Reed, S.C., et al, May 1972, 183p., AD-752 132, Numerous refs.
Murrmann, R.P., Koutz, F., Rickard, W., Hunt, P.G., Buzzell, T.D., Carey, K.L., Bilello, M.A., Buda, S., Guter, K., Sorber, C.
27-1684
WASTE DISPOSAL, WATER TREATMENT, SOIL CHEMISTRY, SOIL MICROBIOLOGY, CLIMATIC FACTORS.
This report presents a comprehensive technical assessment of the effects and effectiveness of the methods used for disposal of wastewaters on the land. Three basic application techniques are considered: Spray irrigation, overland runoff, and rapid infiltration, and the related ecosystem responses to each. The report concludes that the product water from such operations can and should approach drinking water-irrigation water standards in quality. Of the three modes, spray irrigation offers the highest degree of reliability and potential longevity. Further definition is required for system capacity for the other two modes, but overland runoff is given preference over rapid infiltration based on currently available information. The report not only provides an assessment of the current state of the art but documents the need for work leading to optimum criteria for design, construction and operation of cost-effective and environmentally compatible systems.

**SR 172**
**LITERATURE SURVEY OF COLD WEATHER CONSTRUCTION PRACTICES.**
Havers, J.A., et al, May 1972, 172p., AD-745 395, Numerous refs.
Morgan, R.M.
27-330
COLD WEATHER CONSTRUCTION, COLD WEATHER OPERATION, BUILDINGS, EXCAVATION, WINTER CONCRETING, WINTER MAINTENANCE.
The objective of this study was to survey existing literature on cold-weather construction practices. The seasonality problem was defined and its economic and operational implications were identified. The effects of cold weather on men, material, and equipment were reviewed. Cold weather construction tasks were examined for technological constraints and comparisons were made with existing military and civilian codes. Research and observations pertaining to the construction tasks being examined were listed to provide a base for current and future development of cold-weather construction techniques. An attempt was made to analyze the natural and technological constraints imposed by the weather on men, material, and equipment, The economic feasibility of cold-weather construction was examined by reviewing the recorded experience of many segments of the international construction industry, and the economic advantages of cold-weather construction were listed. It was concluded that 1) construction seasonality in the United States is a major economic problem; 2) reducing it and overcoming its effects are major tasks to be accomplished; and 3) cold-weather construction is not a panacea for seasonal unemployment, but would help to alleviate it.

**SR 173**
**MILITARY FACILITIES AND ENVIRONMENTAL STRESSES IN COLD REGIONS.**
Murrmann, R.P., et al, June 1972, 20p., AD-745 394, 29 refs.
Reed, S.C.
27-331
WATER POLLUTION, AIR POLLUTION, LOW TEMPERATURE RESEARCH, PERMAFROST PRESERVATION, MILITARY FACILITIES, ENVIRONMENTAL IMPACT.
This report was prepared as a preliminary step to identifying research problems which arise as a special consequence of military facilities in cold regions. Atmospheric impacts of military facilities are due primarily to emissions of combustion by-products. This problem differs in cold regions due to a combination of factors including local environmental conditions which cause accumulation of pollutants, higher inputs due to disposal and energy requirements, and the influence of temperature on physical and chemical interactions of combustion products. Under extreme conditions, the unique condition of ice fog occurs for which there is apparently no practical solution. Terrain impacts result from disposal on land of all types of solid and liquid wastes. Due to low temperature conditions, these wastes do not undergo biological or chemical degradation at desirable rates. Other unique pollution problems result from the operation of special facilities such as military pipelines, and from accidental or intentional release of hazardous chemicals like pesticides during maintenance operations. Permafrost in arctic and subarctic areas exists in a delicate state of thermal balance which may be perturbed by almost any activity. Degradation and erosion of permafrost causes both engineering and environmental problems. For large stresses such as earth moving during construction, serious permafrost degradation can occur within one season. In the case of small stresses such as compaction of surface vegetation, the impact is small at first but cumulates irreversibly over many years. Addition of effluents and sediments to natural water systems also causes special problems in cold environments. The effect of lower temperatures on physical, biological and chemical processes reduces the net capacity of water bodies to assimilate foreign materials. The biological effects of thermal contamination are undoubtedly greater than for temperate regions. Formation of ice is also a special consideration in water contamination problems. Research is required in all of these areas in order to develop a capability for environmental management in conjunction with military facilities in cold regions.

**SR 174**
**USE OF ATOMIC ABSORPTION SPECTROSCOPY IN THE DETERMINATION OF THE MICROGRAM/LITER CONCENTRATIONS OF NA, K, CA2, AND MG2 CATIONS.**
Ragone, S.E., et al, June 1972, 4p., AD-745 905.
Finelli, R.V.
27-672
CHEMICAL ANALYSIS, SALT WATER, ATOMIC SPECTROSCOPY.
Routine analyses of microgram/liter concentrations of various cations are possible in aqueous solutions with good sensitivity down to 2 microgram/liter. A two-month study showed that: 1) standard solutions can be kept for relatively long periods of time with no change in concentration or interference between cations (at these concentration levels) and 2) relative deviation of absorption increases with decreasing concentration, but never exceeds 100 percent even at 2 microgram/liter concentrations, so detection limits can be assured to this level.

**SR 175** USA CRREL Technical Publications.
79-57

**SR 176**
**METHOD FOR CONCENTRATING AND DETERMINING TRACE ORGANIC COMPOUNDS IN THE ATMOSPHERE.**
Leggett, D.C., et al, June 1972, 14p., AD-745 125.
Murrmann, R.P., Jenkins, T.F., Barriera, R.
27-1554
ATMOSPHERIC COMPOSITION, LABORATORY TECHNIQUES, GAS CHROMATOGRAPHY, ORGANIC COMPOUNDS.
Determination of subpart-per-billion (sub-ppb) levels of volatile organic compounds in the atmosphere by flame ionization gas chromatography requires sample sizes of at least several hundred milliters of air. Cryogenic methods of concentrating trace compounds before analysis have the disadvantage of also concentrating large amounts of water, a serious problem in gas-liquid chromatography. A simple method was developed for sample collection and concentration using porous polymer adsorbants with the unique properties of high capacity for retention of organic compounds and minimal capacity for retention of water. This technique was used to determine sub-ppb levels of volatile organic compounds in a typical rural atmosphere. Probable sources of these organic compounds were vehicle exhaust, biological processes, natural gas leaks, and industrial chemicals. (Auth.)

**SR 177**
**GEOLOGY AND PROPERTIES OF MATERIALS EXPOSED IN THE USACRREL PERMAFROST TUNNEL.**
Sellmann, P.V., July 1972, 14p., AD-749 246, 10 refs.
27-1180
PERMAFROST STRUCTURE, RADIOACTIVE AGE DETERMINATION, TUNNELING (EXCAVATION), GEOLOGIC STRUCTURES, COMPRESSIVE STRENGTH.
The U. S. Army Cold Regions Research and Engineering Laboratory (USA CRREL) permafrost tunnel near Fairbanks, Alaska, was recently enlarged. A new winze and lower room were constructed in the tunnel, permitting examination of new silt exposures and previously unexposed, stratigraphically lower gravels and bedrock. From these exposures additional stratigraphic information was obtained by radiocarbon dating; new data on the material properties of the perennially frozen gravels were also acquired. An age of 33,750 plus or minus 2,000 years was obtained from the upper part of the gravel section. Lower in the gravel a small log was dated at more than 39,000 years. A silt date from immediately above the gravels does not indicate any major break in time between the silt and gravel. Based on the existing dates it is difficult to determine if the gravels were deposited during the last 30-40,000 years or if just the upper portion of the gravels was reworked around 33,000 years ago. Values for the compressive and tensile strengths of the frozen gravels were obtained at various temperatures. The samples had a mean moisture content of 13.5 per cent and mean density of 133 lb/cu ft. Mean compressive strength values at 28F and 0F are 846 lbf/sq in and 2560 lbf/sq in, respectively. The mean value for tensile strength obtained at 18F was 308 lbf/sq in. A summary of tunnel-closure rate data and pressure-volume relationships for the frozen silts is presented, drawing on investigations conducted by other USA CRREL personnel. References to Bureau of Mines' compressive strength and acoustic property data are also provided. Limited investigation of the decomposed bedrock exposed at the base of the section by X-ray diffraction techniques indicates a high montmorillonite content.

**SR 178**
**PHYSICAL PROPERTIES OF THE SNOW COVER IN THE FT. GREELY AREA, ALASKA.**
Benson, C.S., Aug. 1972, 24p., AD-749 245, See also 23-4062. 12 refs.
27-1181
SNOW COVER STRUCTURE, SNOW PHYSICS, METEOROLOGICAL FACTORS, UNITED STATES—ALASKA—FORT GREELY.
The Fort Greely area in the interior of Alaska is especially interesting because it has such a wide variety of snow types. It contains the low density snow, consisting mostly of depth hoar, which is typical of wind sheltered valleys. It also has hard windpacked snow in unforested places because of the prevalence of strong winds from Isabell Pass in the Alaska Range. The snow structure evolves through the winter in different ways, depending on exposure to wind and to temperature gradients in the snow. The effect of snow structure on vehicle traffic is extremely variable from place to place. This is documented by measurements of density, temperature, and ram hardness together with 21 photographs and 9 line drawings.

**SR 179**
**CATIONIC ANALYSIS OF THE CAMP CENTURY, GREENLAND, ICE CORE.**
Ragone, S.E., et al, Aug. 1972, 13p., AD-749 240, 19 refs.
Finelli, R.V., Leung, S., Wolf, C.A.
27-1182
ICE CORES, CHEMICAL ANALYSIS, ION DENSITY (CONCENTRATION), GREENLAND—CAMP CENTURY.
Over 100 samples taken at about 15-m intervals in the portion of the Camp Century ice core between 70 and 1360 m depth were analyzed for their Na, K, Ca2 and Mg2 ion contents by atomic absorption spectroscopy. The Na and K ion concentrations varied from 4 to 106 micrograms/l respectively; average values were 32 micrograms/l and 13 micrograms/l respectively. The Mg2 and Ca2 ion concentrations remained fairly constant over most of the profile except between 1160 and 1280 m where several maxima were observed: the Mg2 ion maxima, from 11 to 49 micrograms/l in this region, compared with a mean concentration of 5 micrograms/l; the Ca2 ion maxima, from 83 to 342 micrograms/l, compared with a mean concentration of 15 micrograms/l. Based on independent stable isotope analyses these maxima occurred over the last third of the Wisconsin glaciation.

**SR 180**
**CATIONIC ANALYSIS OF THE BYRD STATION, ANTARCTICA, ICE CORE.**
Ragone, S.E., et al, Aug. 1972, 8p., AD-749 247, 18 refs.
Finelli, R.V.
27-1183
ICE CORES, ION DENSITY (CONCENTRATION), CHEMICAL ANALYSIS, ANTARCTICA—BYRD STATION.
Eighty-five ice samples taken from the Byrd Station, Antarctica, ice core were analyzed for Na, K, Ca2 ion concentrations by atomic absorption spectroscopy. From 168 to 1243 m of the portion of the ice core analyzed the mean Na, K, Ca2 and Mg2 ion concentrations were 21, 3, 2 and 3 micrograms/l respectively, increasing to 37, 5, 5, and 7 micrograms/l respec-

tively from 1264 to 2090 m, then decreasing to 19, 4, 2, and 2 micrograms/l respectively from 2100 to 2153 m. The 1264 to 2090-m region represents snow accumulations deposited over the last 13,000 to 60,000 years, based on independent stable isotope analysis; this correlates roughly with the Wisconsin stage cold interval, 11,000 - 74,000 years before the present.

**SR 181**
**VEHICLE DETECTION/CLASSIFICATION USING CHEMICAL SENSORS.**
Murrmann, R.P., et al, Aug. 1972, 57p., AD-751 740, 8 refs.
Jenkins, T.F., Appel, L.G., Harden, C.S., Chalcraft, J.C., Renius, O.
27-1685
REMOTE SENSING, VEHICLES, EXHAUST GASES, CHEMICAL DETECTION.
The concept of using chemical sensors for remote surveillance of vehicle activity was evaluated through field and laboratory studies, and consideration of the state of the art of current chemical sensor concepts. Reliable detection of vehicles was found to be feasible at downwind ranges up to several hundred meters depending on the type of chemical sensor employed. By use of a two-sensor array, detection independent of wind direction was highly successful at reduced detection range. False-alarm rates in remote areas were virtually zero due to low levels of exhaust chemicals in ambient air. Potential was shown for classification of diesel and gasoline vehicles by using a classifier unit consisting of two detectors. By trade-off analysis, it was determined that the condensation nuclei, surface adsorption, and Honeywell ionization sensors showed most immediate promise for development as vehicle detectors. Recommendations were made on additional work required in development of chemical sensors for Remotely Monitored Battlefield Sensor System (REMBASS) applications.

**SR 182**
**PRELIMINARY ECOLOGICAL EVALUATION OF THE EFFECTS OF AIR CUSHION VEHICLE TESTS ON THE ARCTIC TUNDRA OF NORTHERN ALASKA.**
Rickard, W., Sept. 1972, 22p., AD-751 741, 25 refs.
27-1686
AIR CUSHION VEHICLES, TUNDRA SOILS, TUNDRA VEGETATION, ALBEDO, ENVIRONMENTAL TESTS, SOLAR RADIATION, PATTERNED GROUND.
Of prime concern in the Arctic is the need for a nondestructive and efficient means of transportation over both frozen and unfrozen arctic terrain. As part of the effort to develop such a means, the Advanced Research Projects Agency established a program to determine the potential to using an air cushion vehicle (ACV). Studies on the effects of ACV tests were conducted in two areas at Barrow, Alaska. One area was a drained lake bottom with a fairly homogeneous vegetation cover and soil type. The second area, much drier than the first, consisted of low-centered polygons composed of a wet tundra soil and a varying vegetation complex. The initial effects of the ACV tests in both areas were quite similar. The amount of litter decreased from 40-44 percent to 0-2 percent as the number of vehicle passes increased. The amount of standing dead vegetation decreased much less. Quantities of living vegetation remained fairly constant regardless of the number of vehicle passes, with clumps of mosses being torn loose in the low-centered polygon areas. The albedo also changed; this may become important over a long period with respect to the amount of solar radiation absorbed by the lighter and darker terrain surfaces.

**SR 183**
**USE OF ERTS-1 IMAGERY IN THE NATIONAL PROGRAM FOR THE INSPECTION OF DAMS.**
McKim, H.L., et al, Dec. 1972, 15p., AD-754 579, 3 refs.
Marlar, T.L., Anderson, D.M.
27-2528
REMOTE SENSING, DAMS, PHOTOINTERPRETATION, ERTS IMAGERY.
ERTS-1 imagery can be useful in locating circular water bodies over 152 m (500 ft) in diameter. Dams on streams can be identified by an abrupt change in stream width. A linear termination on a water body is a reliable indication of a dam, particularly when it is inconsistent with the normal drainage pattern. Care must be exercised to avoid confusing cloud shadows with water bodies. However, the association of a cloud with its shadow usually can be accomplished since the sun angle is noted in the data given on each ERTS image. The following information generally can be derived from ERTS imagery: 1) The location of water bodies; 2) The size and shape of water bodies; 3) The identifications of dam sites on major rivers; 4) The direction of stream flow of major hydrologic networks; 5) Relative water depths and/or gross sedimentation patterns. ERTS-1 imagery, in general, does not supply information suitable for determining: 1) Dam height; 2) Type of dam construction (concrete or earth fill) 3) Depth of water bodies; 4) Location of water bodies less than 6 acres.

**SR 184**
**BREAKAGE OF FLOATING ICE BY COMPRESSED GAS BLASTING.**
Mellor, M., et al, Dec. 1972, 41p., AD-755 504, 15 refs.
Kovacs, A.
27-2529
ICE BLASTING, EXPLOSION EFFECTS, FLOATING ICE, COMPRESSED GAS.
Tests were made to determine the effectiveness of compressed-gas blasting devices for breaking floating ice sheets. Experiments were made on frozen lakes in New Hampshire and Alaska using the Cardox and Aircox blasting systems, and comparative tests were made with conventional chemical explosives. Gas blasting devices were found to be closely comparable to chemical explosives in terms of specific energy consumption, but absence of any significant shock wave in the gas blast results in a different mode of action. The gas devices fractured the ice largely by flexure, giving large fragments. Practical applications of gas blasting for ice breaking are discussed.

**SR 185**
**MODEL ICE HEAT SINK.**
Perham, R.E., March 1973, 18p., AD-761 075, 6 refs. (passim).
28-691
COOLING SYSTEMS, HEAT TRANSFER, MODELS, HEAT SINKS, ANNULAR FLOW.
The concept of using a model ice heat sink as a device for indicating the feasibility of large ice container heat sinks was investigated from a conceptual and parametric viewpoint. The main problem addressed was the assurance that heat could be transferred to the sink quickly enough to prevent overheating of the coolant water. To avoid the need for scaling the properties of water, normally used heat transfer relationships were applied to both the model and to the large heat sink. The resultant equations were then converted to ratio and reduced to combinations of terms. These included a geometrical ratio, heat flow ratio, temperature difference ratio and a time ratio. The report also includes preliminary model design and test parameter information for time ratios up to 20:1.

**SR 186**
**GROWTH AND SURVIVAL OF NORTHERN PLANTS AT LOW SOIL TEMPERATURES. GROWTH RESPONSE, ORGANIC NUTRIENTS AND AMMONIUM UTILIZATION.**
McCown, B.H., May 1973, 13p., AD-763 195, 22 refs.
28-689
ARCTIC VEGETATION, SOIL TEMPERATURE, TEMPERATURE EFFECTS, LOW TEMPERATURE TESTS, PLANT NUTRITION.
Low soil temperatures have been implicated as one of the limiting factors for plant growth in northern regions and may be responsible for the failure of some revegetation attempts in such areas. Because of the importance of maintaining an adequate plant cover over ice-rich artic and subarctic soils, laboratory experiments were performed to further clarify the influence of soil temperature on plant growth. At two soil temperatures (5 and 15 C) and with three levels of soil ammonium, data were obtained that showed that low soil temperatures can be extremely inhibitory for the growth of introduced graminoid revegetation species. In contrast to the adapted native arctic grasses, introduced species were not able to utilize increased soil nutrient levels at 5 C. No significant influence of soil temperature on the organic nutrient content of the plants was observed. High levels of organic nutrients were found in both adapted and unadapted species, indicating that this factor may not be a specific adaptation to northern regions. It is suggested that species intended for revegetation purposes in northern regions be screened for tolerance to low soil temperature utilizing such relatively rapid laboratory techniques.

**SR 187**
**WATER BALANCE IN THE ARCTIC AND SUBARCTIC REGIONS. ANNOTATED BIBLIOGRAPHY AND PRELIMINARY ASSESSMENT.**
Dingman, S.L., June 1973, 131p., AD-763 883.
28-625
BIBLIOGRAPHIES, WATER BALANCE, ARCTIC REGIONS, SUBARCTIC REGIONS.
The introductory section of this report discusses the global hydrologic cycle and summarizes current estimates of the quantities of water involved in various portions of it. Following this, the definitions and boundaries of the arctic and subarctic are reviewed; a map showing these boundaries and annotations of a number of publications dealing with this problem are also presented. The main part of the report gives several hundred annotations of reports that directly discuss elements of the water balance in arctic and subarctic regions. These annotations are grouped by geographic area: the Northern Hemisphere, Europe, the U.S.S.R., Alaska, Canada, and Greenland and Iceland. For each area, annotations are presented according to water-balance elements: precipitation, evapotranspiration, runoff, streamflow, groundwater contributions to runoff, and changes in glacial storage. A subsequent section gives annotations of articles on the water balance of the Arctic Ocean. This is followed by a brief assessment of the state of knowledge on the water-balance elements in each geographic region. Finally, there is a bibliography of the 295 publications referred to in previous sections. This bibliography is intended to be complete for the period 1950-1971 (some earlier articles are included), especially for articles published in English. A large number of items from the Russian and European literature is included, but the bibliography is probably less complete for these. A total of 688 annotations is included; many articles are annotated in more than one section, as they include information on more than one water-balance element or more than one geographic area.

**SR 188**
**SOLUBLE PARTICULATES IN ICE FROM SITE 2, GREENLAND.**
Linkletter, G.O., July 1973, 17p., AD-764 247, 31 refs.
28-624
GLACIER ICE, ICE COMPOSITION, ICE CORES, PARTICLE SIZE DISTRIBUTION, GREENLAND.
Collections of soluble and insoluble particles made by sublimation techniques from small pieces of polar ice are well suited for microscopic and microchemical analysis. Examination of an 89 cm vertical profile of a polar ice core from a depth of 100 m at Site 2, Greenland, indicated no seasonal cycle in the abundance of particles >2 micron in diameter. Microchemical spot tests made on individual particles indicated the presence of $NH_4^+$, $K^+$, $Ca^{2+}$, $Na^+$ and $Cl^-$. Whole filter spot tests for $K^+$ indicated no systematic variation in the concentration of potassium-bearing particles. Approximately 4 percent of the particles >2 micron in the ice studied were soluble salts of $Na^+$, $K^+$, $Mg^{2+}$ and $Ca^{2+}$. The concentrations of $Na^+$, $K^+$, $Ca^{2+}$ and $Mg^{2+}$ were measured in melted fractions of the same core profile by atomic absorption spectrophotometry. Variation of the $K^+$ concentration and variation of the number of potassium-bearing particles per gram of ice have a correlation coefficient of 0.93 over the 2 1/2 years of accumulation studied.

**SR 189**
**TRANSMISSION OF 2.0 TO 3.4 MICRON INFRARED RADIATION IN ICE FOG.**
O'Brien, H.W., et al, July 1973, 7p., AD-766 301, 10 refs.
Kumai, M.
28-2876
ICE FOG, INFRARED RADIATION, INFRARED SPECTROSCOPY, ATTENUATION, SCATTERING.
Limited measurements were made of the transmission of infrared radiation (2.00- to 3.40-micron wavelengths) through ice fog. The experimental results are compared with the spectral transmission predicted by Mie theory for ice spheres and for water fog. The experimental measurements of attenuation by ice fog tend to agree, within the experimental error expected, with values predicted by Mie theory for ice spheres. The present studies are adversely affected by the limited state of the art in making accurate measurements of ice fog concentration, and by inadequate control of environmental $CO_2$.

**SR 190**
**ANTICIPATED CLOSURE RATES FOR A PROPOSED DRILL HOLE, ROSS ICE SHELF, ANTARCTICA.**
Weertman, J., July 1973, 8p., AD-766 302, 17 refs.
28-2869
ICE SHELVES, DRILLING, BOREHOLES, ICE CREEP.
Closure rates are calculated for the proposed drill hole through the Ross Ice Shelf, using the best experimental data on power law creep of polycrystalline ice. Without pressurization of the drill hole closure rates greater than 0.1 per day are estimated to occur at the bottom of the drill hole.

**SR 191**
**GROUND RESISTIVITY SURVEY IN THE AREA OF THE TENNESSEE-TOMBIGBEE WATERWAY.**
Hoekstra, P., et al, Aug. 1973, 17p., AD-767 246, 2 refs.
Delanet, A.J.
28-2870
ELECTRICAL RESISTIVITY, SOIL STRUCTURE, GEOLOGICAL SURVEYS, AERIAL SURVEYS.
Electrical resistivity measurements were made on the ground in the area of the proposed Tennessee Tombigbee Waterway in the vicinity of Fulton, Mississippi. The objective of the project was to determine if electrical resistivity surveys could be used to advantage in exploration required for the canal section. In general in this area a layer of fine-grained material overlies sands and gravels. In most of the area a bentonitic layer is situated at a depth from 10 to 90 ft below the surface. The conclusion was reached that an airborne resistivity survey would probably map the fine-grained top layer within classes of 0-1 m, 1-5 m, and more than 5 m thick. Clean, extensive gravel layers would also be detected.

**SR 192**
**ICEBREAKING BY TOW ON THE MISSISSIPPI RIVER.**
Ashton, G.D., et al, Aug. 1973, 70p., AD-768 169.
DenHartog, S.L., Hanamoto, B.
28-2883
RIVER ICE, ICE BREAKING, ICE NAVIGATION, BARGES, UNITED STATES—MISSISSIPPI RIVER.
A field investigation of icebreaking by the motor vessel Rence G, operating on the Mississippi River between Alton, IL, and Fort Madison, IA, is reported. The operation encountered a wide variety of ice conditions and was performed with a variety of barge configurations and arrangements. Important qualitative observations of the nature and difficulties encountered while icebreaking were made; and, by instrumenting the propeller shafts and using load cells between the towboat and the barges, quantitative information was obtained on the resistance encountered while icebreaking. Also described are the effects

of repeated passage through an ice cover, navigation procedures peculiar to icebreaking, and minor damage sustained by the towboat. (Auth.)

**SR 193**
**ANALYSIS OF VAPORS EMITTED FROM MILITARY MINES.**
Jenkins, T.F., et al, Sept. 1973, 13p.. AD-768 709, 12 refs.
O'Reilly, W.F., Murrmann, R.P., Leggett, D.C., Collins, C.I.
28-2871
EXPLOSIVES, CHEMICAL ANALYSIS, SPECTROSCOPY, MILITARY EQUIPMENT, MINES (ORDNANCE), GAS CHROMATOGRAPHY.
The vapor evolving from several types of intact military mines was analyzed using gas chromatography and gas chromatography/mass spectroscopy. Cyclohexanone was positively identified in the vapor from M15 (metallic) and M19 (nonmetallic) antitank mines. This compound originates from composition B, the explosive used in these mines. Acetone, toluene and an unknown organo-silicon compound were identified and are attributable to the nonmetallic mine casings. Although positive mass spectral identification is lacking, chromatographic data obtained using an electron capture detector indicated that 2, 4, 6 trinitrotoluene was detected in the vapor from the M16 (metallic) antipersonnel mines which are loaded with TNT.

**SR 194**
**EXPLORATORY ANALYSIS OF VAPOR IMPURITIES FROM TNT, RDX AND COMPOSITION B.**
O'Reilly, W.F., et al, Oct. 1973, 18p., AD-769 731, 12 refs.
Jenkins, T.F., Murrmann, R.P., Leggett, D.C., Barriera, R.
28-3036
MILITARY RESEARCH, EXPLOSIVES, VAPOR DIFFUSION, CHEMICAL ANALYSIS, GAS CHROMATOGRAPHY.
Vapors collected from TNT, RDX and composition B explosives maintained at 25 C and 70 C were analyzed using a gas chromatographic/mass spectrometric technique to identify the most prominent vapor components. A gas chromatograph equipped with electron capture and flame ionization detectors also was used to screen vapors for components present at concentrations below the sensitivity of the GC/MS. Cyclohexanone which could have significance in development of an explosive or mine detector was identified in vapors from RDX and composition B. Water vapor, carbon dioxide, probably nitrous oxide and a number of unidentified compounds were evolved from all samples. It may be possible to identify these unknown compounds present at trace levels, but extreme analytical care and precaution to avoid contamination would be required. In this rebard, differentiation between compounds which are incorporated into the explosive matrix during manufacturing and those which are adsorbed from air by the explosive at a later time is also required.

**SR 195**
**ANALYTICAL STUDY OF A COILED-PIPE HEAT SINK.**
Zehnder, A., et al, Nov. 1973, 33p., AD-771 125, 4 refs.
Yen, Y.-C., Perham, R.E., Quinn, W.F.
28-3037
PIPES (TUBES), HEAT TRANSMISSION, WASTE DISPOSAL, HEAT SINKS.
An analytical study was conducted to determine the practicality of using a buried closed-loop, small-diameter coiled-pipe heat sink instead of a reservoir-type sink for emergency disposal of waste heat. The analysis was broadly based to permit application to a variety of soil types, mean ground temperatures, heat rejection rates, coolant water flow rates, pipe sizes, coil surface areas and coil spacings. The intent of the study was to present a problem-solving technique that would be useful to a design engineer faced with considering the use of a buried coiled pipe to dissipate a rather large amount of heat to the ground during a very limited period. The feasibility of such a system was found to be highly dependent upon the length of pipe required and the installation layout requirements for such a pipe network.

**SR 196**
**MICROBIAL DEGRADATION OF PETROLEUM IN CONTINENTAL SHELF SEDIMENTS.**
Hunt, P.G., et al, Dec. 1973, 16p., AD-772 698, 38 refs.
Koutz, F.R., Murrmann, R.P., Martin, T.G.
28-3038
WASTE DISPOSAL, PETROLEUM PRODUCTS, OXYGEN, SEDIMENTS, BIODETERIORATION.
A study was conducted to determine whether petroleum waste products deposited in surficial sediments of the United States Continental Shelf would be subject to microbial degradation. Published information indicates that degradation of these waste products should occur under the aerobic conditions commonly present in the sediments, but that, under anaerobic conditions, degradation of hydrocarbons would, at best, be extremely slow. It was verified using carbon-14 labeled hydrocarbons that degradation of petroleum in sediments occurs when oxygen is very limited; however, it was estimated that several hundred years would be required for complete degradation to occur. Thus, it was concluded that, while degradation of petroleum waste products would occur in continental shelf sediments, the rate of degradation would be extremely slow under the low-oxygen conditions likely to be created by the high-oxygen demand of the petroleum wastes.

**SR 197**
**HEIGHT VARIATION ALONG SEA ICE PRESSURE RIDGES AND THE PROBABILITY OF FINDING "HOLES" FOR VEHICLE CROSSINGS.**
Hibler, W.D., III, et al, Dec. 1973, 9p., AD-772 696, For this paper from another source see 30-3387. 6 refs.
Ackley, S.F.
28-3039
SEA ICE, HEIGHT FINDING, ICE CROSSINGS, VEHICLES, AIR CUSHION VEHICLES, AERIAL PHOTOGRAPHY, PRESSURE RIDGES.
Height variations along sea ice pressure ridges were studied to determine whether low spots in the ridges persisted over long enough distances for a wide vehicle such as the surface effect vehicle to pass through them. Heights along eight pressure ridges varying in length from 0.9 km to 2.2 km were measured at 5 m intervals using aerial photographic data obtained over the Beaufort Sea. The probabilities of finding holes at the mean heights of the ridges and 0.67 m above and below the mean heights were calculated as a function of the hole widths using an autocorrelation function obtained from the height data. The curves obtained were in good agreement with passage probabilities calculated directly from the data. The results indicate that the probability of finding passage through a hole at least 0.67 m below the mean ridge height is less than 0.1 for holes greater than 10 m wide. It is concluded that a large vehicle such as a surface effect vehicle that cannot cross ridges at their mean heights will have to go around such ridges because low, wide holes do not appear with sufficiently high probability to make hole-searching a useful method.

**SR 198**
**EXPEDIENT SNOW AIRSTRIP CONSTRUCTION TECHNIQUE.**
Clark, E.F., et al, Dec. 1973, 17p., AD-774 290, 8 refs.
Abele, G., Wuori, A.F.
28-3697
AIRCRAFT LANDING AREAS, SNOW (CONSTRUCTION MATERIAL), CONSTRUCTION EQUIPMENT.
Specialized snow runway processing and construction equipment ordinarily is not available to Army engineer troop units. Therefore, utilization of existing equipment and devices improvised in the field is necessary. Disaggregation of the natural snow cover, followed immediately by compaction and grading, is the fundamental procedure required for preparing a snow pavement capable of supporting, after age hardening, wheeled aircraft of the Caribou and C-47 class. A peg-toothed A-frame harrow, a corrugated roller and drags, constructed in the field, can be used with available D-7 or D-8 bulldozers for the disaggregation, compaction, and grading processes.

**SR 199**
**FIELD TEST OF A STEAM CONDENSER HEAT SINK CONCEPT.**
Quinn, W.F., et al, Jan. 1974, 44p., ADA-005 578, 17 refs.
Aamot, H.W.C., Greenberg, M.M.
29-4005
HEAT TRANSFER, ELECTRIC POWER PLANTS, ROCKS, STEAM.
A concept to reject heat generated by an underground power plant by disposal of exhaust steam to rock tunnels was evaluated by means of a field test. The tunnel walls would, thus, be used to condense the steam and store the heat under a transient heating load. Heat transfer to the rock was initially predicted using the well-known Carslaw and Jaeger analytical model which considers the test tunnel to be represented by a hollow cylinder in an infinite medium initially at a constant temperature. Information was developed regarding the heat transfer coefficient associated with the condensation of steam on rock Establishing a comparison between the measured and predicted temperatures was complicated by the problem of rock fall which retarded the rate of temperature rise. The writers feel that meaningful comparisons are valid for the first few days of the test, prior to any substantial rock fall.

**SR 200**
**FORCES GENERATED IN ICE BOOM STRUCTURES.**
Perham, R.E., Jan. 1974, 36p., AD-775 822, 10 refs.
28-4126
ICE BOOMS, HYDRAULIC STRUCTURES, STRAIN ANALYSIS, RIVER ICE, ICE PRESSURE, STRAIN MEASURING INSTRUMENTS.
Two ice booms in the St. Lawrence were instrumented to measure ice forces during the 1972-73 winter. Measurements were made by two systems and related data including ice thickness, wind, air temperature, and water velocity were measured. The winter was mild; forces measured in the shore anchor were 6 tons during a Jan. thaw, 8 tons at spring breakup; a 24 ton load was measured at mid-stream in Jan. It occurred in the boom rope and not in the river bottom anchor rope, indicating that the anchor had moved downstream. Ice booms underwent harsh treatment from ice action even at relatively light loads.

**SR 201**
**SNOWBLOWERS: PERFORMANCE AND EVALUATION.**
Hanamoto, B., Feb. 1974, 29p., AD-917 916.
29-542
SNOW REMOVAL EQUIPMENT, COLD WEATHER TESTS, PERFORMANCE.
Twelve small snowblowers were evaluated for use in removing snow from around Safeguard missile cell covers. The snowblowers that performed better under a variety of snow conditions and for a number of specific tasks had some of the following features: large diameter cutter, double lead open-bladed cutter, slow turning cutter, fast turning impeller, large diameter tires and a cg located near the drive wheel axle for ease of tipping and maneuvering. Difficult snow removal tasks included removing snow up to 24 in. deep, removing wet spring snow, removing layered snow resulting from aging and freeze/thaw cycles, removing snow from around obstacles, and removing snowdrifts.

**SR 202**
**AIRBORNE RESISTIVITY SURVEY NEAR FAIRBANKS, ALASKA.**
Sellmann, P.V., et al, March 1974, 16p., AD-777 792, 6 refs.
Hoekstra, P., Delaney, A.J.
28-4127
AERIAL SURVEYS, ELECTRICAL RESISTIVITY, PERMAFROST THICKNESS, GEOLOGICAL SURVEYS.
An airborne electrical resistivity survey in Alaska found high values of resistivity in association with valley bottoms, reflecting thick, permafrost sediments. To separate the resistivity variation caused by the depth and the frozen or thawed state of the overburden silt, ridge top overlay was made. Because the silt cover is thin on ridge tops, the resistivity variations there most likely reflect rock types. Differences between schists and intrusives are discussed.

**SR 203**
**DETECTION OF CYCLOHEXANONE IN THE ATMOSPHERE ABOVE EMPLACED ANTITANK MINES.**
Jenkins, T.F., et al, April 1974, 15p., AD-778 741, 17 refs.
O'Reilly, W.F., Murrmann, R.P., Collins, C.I.
29-909
MILITARY RESEARCH, DETECTION, GAS DETECTORS, ANTITANK MINES.
Atmospheric samples were taken at the soil surface above field-emplaced M-15 and M-19 antitank mines and military explosive Composition-B. These samples were analyzed to determine if trace chemicals generated by the explosive material are detectable. Cyclohexanone was positively identified and is attributable to the explosive. Calculations were made, based on the amount of cyclohexanone found, to approximate its flux rate through the surface.

**SR 204**
**BIBLIOGRAPHY ON WINTER CONSTRUCTION 1967-1971.**
Kaplar, C.W., et al, April 1974, 77p., AD-778 742.
Metrish, R.M.
29-4006
BIBLIOGRAPHIES, COLD WEATHER CONSTRUCTION.
The bibliography covers world literature published during 1967-1971 on the subject of construction during cold weather. The contents are drawn mainly from the continuing current literature search performed by the Science and Technology Division of the Library of Congress for the U.S. Army Cold Regions Research and Engineering Laboratory. The contents include 746 items grouped into 17 categories, plus an author index. This bibliography is an addendum to the revised edition of USA CRREL Special Report 83, *A Bibliography on Winter Construction, 1940-1967,* published in 1968.

**SR 205**
**MEASUREMENT OF FORCES WITHIN THE STRUCTURAL FRAME OF DEW LINE ICE CAP STATIONS DYE-2 AND DYE-3.**
Tobiasson, W., et al, April 1974, 36p., AD-780 051, 4 refs.
Ueda, H.T., Hine, G.
29-910
STRAIN TESTS, STRUCTURAL ANALYSIS, SETTLEMENT (STRUCTURAL), LOADS (FORCES), SNOW COVER STABILITY, SNOW ACCUMULATION, SUSPENDED STRUCTURES.
Regional straining of the ice cap and differential settlement and tilt of footings has induced secondary loads into the structural frame of these facilities. These loads have been measured using hydraulic cylinders at sway bolt interaction points. The measurements indicate that large secondary loads exist within these facilities. It is recommended that structural components be analysed in detail to assess the influence of the measured loads on the integrity of each structure.

**SR 206**
**LABORATORY PREPARATION OF ARTIFICIAL SEA AND SALT ICE.**
Weeks, W.F., et al, June 1974, 15p., AD-780 694.
Cox, G.F.N.
29-1592
LABORATORY TECHNIQUES, ARTIFICIAL ICE, SALT ICE.
The characteristics of several successful schemes that have been used to produce artificial sea and salt ice for laboratory studies are discussed. Difficulties that have been encountered in developing suitable experimental designs for investigating a variety of specific sea ice problems (salinity, grain size, substructure and orientation variations; preparation of single crystals and underwater ice) are discussed and suggestions are given for improved methods.

**SR 207**
**COBRA: POSITIVE PITCH CONTROLLED ARTICULATED TESTBED.**
Hanamoto, B., May 1974, 10p., AD-780 695, 3 refs.
29-4007
TRACKED VEHICLES, TOWING VEHICLES, DRAWBAR PULL.
Previous tests with the multiunit articulated testbed Cobra resulted in better performance in terms of drawbar pull when the unique pitch control feature between units of the testbed was locked. The tests were run with standard differentials in the drive trains of the units. Recent tests were conducted with locked differentials on each unit so that all tracks were driving equally. The results of drawbar pull with the modified testbed show no difference in the pull values, regardless of whether the pitch control was locked or unlocked. Analysis of the force system for the drawbar pull test showed slight differences in the shift of the center of pressure between the two modes of pitch operation but not enough to affect the performance noticeably. Slope climbing tests were also conducted and no difference in slope climbing ability resulted from locking or unlocking the pitch control. The most notable advantage of the controllable pitch joint was in obstacle negotiation; natural earth walls 6 to 7 feet in height were crossed with ease.

**SR 208**
**EXPERIMENTAL STUDY OF SEVERAL ICE HEAT SINK CONCEPTS.**
Stubstad, J., et al, June 1974, 37p., AD-782 942, 13 refs.
Quinn, W.F.
29-911
ICE PHYSICS, MODELS, HEAT SINKS.
An analytical and laboratory model study was conducted on the potential use of ice as a medium for storage of waste heat developed by a hardened underground defense installation during the time it was operating on a closed cycle system. The use of ice is an attractive concept because of its high heat storage capacity per unit volume and its associated low coolant water temperatures. Three ice configurations were studies; a solid ice cylinder with annular flow, an ice block-water mixture, and an ice cube-water mixture. All of these configurations are shown to be feasible with the solid ice cylinder yielding the best overall performance.

**SR 209**
**IDENTIFICATION OF SOIL ORGANICS USING A GAS CHROMATOGRAPHIC/MASS SPECTROMETRIC METHOD.**
O'Reilly, W.F., et al, June 1974, 11p., AD-782 991, 34 refs.
Murrmann, R.P.
29-912
SOIL CHEMISTRY, ORGANIC SOILS, SPECTROSCOPY, GAS CHROMATOGRAPHY.
As part of a study on the role of natural organics in determining the physical properties of soils, the use of combined gas chromatographic/mass spectrometric methods for identification of the more volatile organic chemicals in soils were explored. Soil was first treated at 100 deg, 150 deg, and 200 deg C to select the optimum temperature where minimum pyrolysis of soil organic matter occurred. The vapors from three soils heated in a closed system at 150 deg C were then analyzed. Subsequent refinement in technique involved collection of vapor from the three soils maintained at 150 deg C using a constant flow sample holder/inlet system. About 50 organic compounds were identified. While application of this approach is restricted to the volatile compounds in the lower molecular weight range, conditions of analysis are thought to be suitable for identification of compounds originally present as opposed to pyrolysis products of soil organic matter.

**SR 210**
**AIR BUBBLER SYSTEMS TO SUPPRESS ICE.**
Ashton, G.D., Sept. 1974, 35p., ADA-008 867, 27 refs.
29-4008
ICE PREVENTION, BUBBLING.
Two-dimensional line source air bubbler systems used to induce convective melting of the undersurface of an ice cover over a water body are analyzed and a procedure is developed for predicting the effectiveness of the systems. Various field conditions are considered and limitations to the effectiveness of the systems are pointed out. Example applications of the concepts and the procedures are illustrated in the Appendix.

**SR 211**
**COLD REGIONS HABITABILITY: A SELECTED BIBLIOGRAPHY.**
Ledbetter, C.B., Sep. 1974, 25p., ADA-000 692.
32-2599
BIBLIOGRAPHIES, HUMAN FACTORS, ENVIRONMENTS.
The effects on people of isolation and confinement in man-made structures in cold regions, commonly termed "cabin fever," also occur in other environments, such as spacecraft, underwater vessels, and elements of the urban environment such as hospitals and prisons. Habitation characteristics of cold regions are discussed and literature dealing with a variety of types of isolation and confinement environments is segregated into topical areas.

**SR 212**
**SOIL ORGANICS. I. COMPLEXATION OF HEAVY METALS. II. BOUND WATER.**
Jellinek, H.H.G., Sept. 1974, 57p., ADA-008 868, 81 refs.
29-4009
ORGANIC SOILS, SOIL CHEMISTRY, HYGROSCOPIC WATER, ION EXCHANGING, WATER TREATMENT.
Organic matter such as humic substances (e.g. fulvic and humic acids) is discussed. Complexation of these acids with heavy metal ions is especially emphasized and the fundamental background of multiple equilibria is presented in this connection. Ion exchange and titration methods are considered with respect to their use for the determination of complex stability constants. The relative importance of organic and inorganic matter in soils is emphasized. The composition of wastewaters with a view to their purification by irrigation of soils is indicated. A general overview is given of humic substances with respect to their role in soil irrigation by wastewaters. Possible research areas are also indicated. The role of organic matter with respect to water retention is discussed on the basis of water structure near polyelectrolytes.

**SR 213**
**UNDERMANNING AND ARCHITECTURAL ACCESSIBILITY.**
Ledbetter, C.B., Oct. 1974, 8p., AD-001 548, 10 refs.
29-2351
MILITARY FACILITIES, BUILDINGS, HUMAN FACTORS ENGINEERING.
Preliminary results from behavior setting surveys conducted at remote military stations in Alaska for deriving habitability criteria for cold regions military installations reveal the architectural factor of accessibility to significantly influence undermanning. Undermanning is the organizational situation in which there are fewer people available to perform any job and hence each person is under pressure to participate. Centralized informal gathering areas, called focal points, were found to be determined by architectural design and appear to influence the degree of undermanning, permitting a reduction in the formal work load.

**SR 214**
**EVALUATION OF ICE MANAGEMENT PROBLEMS ASSOCIATED WITH THE OPERATION OF A MECHANICAL ICE CUTTER ON THE MISSISSIPPI RIVER.**
Ashton, G.D., Oct. 1974, 37p., ADA-002 058, 29 refs.
32-2600
ICE BREAKING, ICE CUTTING, RIVER ICE, ICE CONDITIONS.
The study concentrates on effects occurring after the cutting operation. Included in the evaluation are assessments of refreezing rates, movement and disposition of the slabs produced by the cutting, and an examination of effects related to ice jams. The evaluation is specific to the upper Mississippi River, in particular Pool 19 above Lock and Dam 19 at Keokuk, Iowa. It was found that most ice production during a winter occurs during a small fraction of the period of ice cover; hence removal after these short periods may allow navigation to proceed for significant wintertime periods. A relation was found between cut slab dimensions and critical velocity to move them that will enable estimates to be made of accumulation. Breakage of adjacent ice by vessel waves was found to impose a possible restraint on vessel speed but not a serious one.

**SR 215**
**PROTECTED MEMBRANE ROOFING SYSTEM INSTALLATION AT HANOVER, NEW HAMPSHIRE.**
Schaefer, D., Dec. 1974, 27p., ADA-005 030, 7 refs.
29-4010
ROOFS, COST ANALYSIS, CONSTRUCTION COSTS.
Protected membrane roofing is a relatively new concept that is currently under development by USA CRREL. A major problem with continued development is the reluctance of designers and contractors to specify and bid on this roofing procedure. This paper reports on the construction of a protected membrane roof on the CRREL laboratory at Hanover, N.H. It includes discussions of the bidding procedure, cost breakdown as supplied by the contractor and photographic coverage of the various construction procedures. The concept proved to be material-sensitive rather than labor-sensitive (labor costs 12% of total, materials 58%). A pre-bid conference with potential bidders was found to be valuable. The completed roof has performed satisfactorily.

**SR 216**
**SUMMER CLIMATE AT SELECTED SITES ON THE ROSS ICE SHELF AND THE GREENLAND ICE SHEET.**
Bilello, M.A., et al, Jan. 1975, 16p., ADA-005 034, 23 refs.
Bates, R.E.
29-4011
CLIMATE, METEOROLOGICAL DATA, GREENLAND, ANTARCTICA—ROSS ICE SHELF.
Climatic summaries for several sites on the Ross Ice Shelf, Antarctica, and selected locations on the Greenland ice sheet were analyzed to determine the type of weather that can be expected in these areas during the summer months. Daily minimum and maximum air temperatures of from 0 deg to 25 deg F are estimated to occur near 82.5 deg S and 166 deg W during December, January and February on the Ross Ice Shelf. Snowfall in summer is relatively infrequent and total amounts generally light, so that extended periods of good flying weather can be expected in summer. However, intervals of poor weather, including heavy snow, fog, whiteout and strong winds with drifting and blowing snow can occur each summer. Average minimum and maximum air temperatures during June, July and August range from 8 deg F to above freezing in the southern portion of the Greenland ice sheet and from -9 deg to 17 deg F near the summit. Stations east of the crest record light winds from the north and northeast, and those west of the crest stronger winds from the east. Winds near South Site at 63 deg N in mid-summer are predicted to be generally westerly and to average 9 to 10 mph. Snowfall and fog also apparently occur more frequently in the southern region of the ice sheet. Although good flying weather can be expected during much of the summer near the summit, intervals of snow, fog, whiteout or strong winds with drifting or blowing snow can occur.

**SR 217**
**ACCUMULATING SNOW TO AUGMENT FRESH WATER SUPPLY AT BARROW, ALASKA.**
Slaughter, C.W., et al, Jan. 1975, 20p., ADA-005 031, Condensed version issued in Arctic bulletin 1(5):218-224, 1975. 16 refs.
Mellor, M., Sellmann, P.V., Brown, J., Brown, L.
29-3345
WATER SUPPLY, RUNOFF, MELTWATER, SNOW FENCES, SNOW ACCUMULATION.
With appropriate snow management techniques, it appears that local freshwater runoff can be significantly increased in northern Alaska, providing additional water for community needs. At Barrow, Alaska, snow fences 1.5 and 2.7 m high were installed in September of 1972, at two orientations (north-south and east-west). By February 1973 the fences were very near saturation. Influence of the fences was evident at 10 to 15 times fence height on both sides of the fences. Surface reworking and slight accumulation increases were shown in subsequent April and June measurements. Snow accumulation on adjacent, relatively flat terrain at all three measurement times was about 40 cm depth. The average increase in water equivalent over the drift cross section for the 1.5 m fence was 15 cm, with a maximum of 50 cm within 1.0 m of the fences. For the 2.7 m fence, the average increase in water equivalent was 45 cm, with a maximum of 1.5 m within 1 meter of the fence. Snow density at each measurement time was in the range of 0.40 to 0.55 g/cu cm.

**SR 218**
**HYDROLOGIC EFFECTS OF FROZEN GROUND: LITERATURE REVIEW AND SYNTHESIS.**
Dingman, S.L., Mar. 1975, 60p., ADA-010 645.
32-1499
FROZEN GROUND HYDROLOGY, FROZEN GROUND PHYSICS, SEASONAL VARIATIONS.
The report, intended as a section of a future comprehensive monograph on cold regions hydrology, summarizes existing knowledge of the profound hydrologic effects of frozen ground. The general characteristics of seasonally and perennially frozen ground also are described, and the geographical distribution of frozen ground is discussed.

**SR 219**
**SIMULATED SNOWDRIFT PATTERNS; EVALUATION OF GEOMETRIC MODELING CRITERIA FOR A THREE DIMENSIONAL STRUCTURE.**
Calkins, D.J., March 1975, 15p., ADA-007 735, 12 refs.
29-4012
SNOWDRIFTS, SIMULATION, STRUCTURES, WIND VELOCITY.
Simulated drifting snow patterns were examined for a single structure using fine sand and water in a hydraulic flume. Three models of the structure were constructed at different scales and the experimental data revealed that model scale had very little effect on the areal distribution patterns. Flow velocity also had very limited influence on the drift patterns, provided the channel velocity was greater than the threshold velocity of the sand particle. Lengthening the duration of the test runs made it easier to distinguish the patterns but did not change their shape. The above experimental data suggest that modeling under the concept of Reynolds number independence is satisfactory.

**SR 220**
**INUNDATION DAMAGE TO VEGETATION AT SELECTED NEW ENGLAND FLOOD CONTROL RESERVOIRS.**
McKim, H.L., et al, March 1975, 49p., ADA-009 075, 20 refs.
Gatto, L.W., Merry, C.J.
29-4013
VEGETATION, DAMAGE, FLOODING, INFRARED PHOTOGRAPHY, UNITED STATES—NEW ENGLAND.
The effect on vegetation of inundation caused by the regulation and impoundment of water at six New England flood control reservoirs during the June-July 1973 flood was assessed from color infrared photography and corroborative ground surveys. A large amount of reservoir storage was utilized during the two-week inundation period, resulting in extensive damage to vegetation. Four degrees of apparent vegetative damage were differentiated from color infrared photography based on color differences ranging from bright red or magenta for healthy foliage to cyan for unhealthy, damaged or dying vegetation. Correlative ground truth data showed that the deciduous trees, particularly silver maple and red oak, were least affected and that coniferous trees, especially white pine, were most affected by siltation and inundation. Much of the understory vegetation, i.e. polar, basswood and hornbeam, lost all leaves after inundation but new buds and shoots reappeared by late September 1973. Generally, trees inundated for less than 90 hours were not extensively damaged.

**SR 221**
**ANALYSIS AND CONCEPTUAL DESIGN OF PRACTICAL ICE-WATER HEAT SINKS.**
Grande, E., March 1975, 149p., ADA-009 498, 26 refs.
29-4014
RADIOACTIVE WASTES, UNDERGROUND STORAGE, HEAT SINKS.
This study considers the analysis and conceptual design of an ice-water heat sink for use with a 1500 kw nuclear power plant applicable to hardened underground installations. The purpose of the heat sink is to contain the waste heat from the power system during a period in which the installation is completely sealed off from dependence on any surface facilities. An ice-water heat sink system is a very attractive concept due to the large amount of heat associated with the melting of ice. This study is based, to a considerable extent, directly on the results of prior work, and is intended to provide additional information on configuration parameters and system performance to permit development of a practical system design. Two alternative heat sink configurations are recommended for the prototype design: an annual flow heat sink and a top surface melting heat sink. A high level of confidence is placed in the predicted performance of the annular flow configuration. The top surface melting configuration is considered superior in terms of meeting the design objectives, but its predicted performance is based on assumptions that, although reasonable, must be verified by experiments.

**SR 222**
**ARCHING OF FRAGMENTED ICE COVERS.**
Calkins, D.J., et al, April 1975, 16p., ADA-009 499.
Ashton, G.D.
29-4015
FLOATING ICE, ICE FLOES, EXPERIMENTAL DATA, ICE CROSSINGS.
A study of arching by fragmented ice floes across a gap in a surface obstacle is reported. The study included several series of experiments in a hydraulic flume in which simulated ice was released upstream of the surface obstacle at controlled rates and the occurrence or non-occurrence of the formation of a stable arch was observed. The threshold of arching was found to correlate well as a function of the supply rate of surface area of ice, the exit ice surface discharge at the gap, and the ratio of individual floe size to gap dimension. In a series of corollary experiments an arch, once formed, was subjected to a disturbance in the form of a vertical rod traversed longitudinally through the accumulation in the upstream direction. The quantity of ice released and the rate of release prior to another arch re-forming was determined.

**SR 223**
**TEMPORARY ENCLOSURES AND HEATING DURING CONSTRUCTION: A CASE STUDY OF THE LABORATORY BUILDING ADDITION, UNIVERSITY OF ALASKA.**
Bennett, F.L., Sep. 1975, 36p., ADA-015 566.
32-2601
BUILDINGS, CONSTRUCTION, HEATING, TEMPERATURE VARIATIONS, PORTABLE SHELTERS.
Temporary enclosures and heating activites during the construction of the Laboratory Building Addition, University of Alaska, were observed during the winter of 1973-74. Methods for providing enclosures and temporary heat are described; a total cost of $14,110, or 0.79% of the construction contract price, is estimated for these activities, which focused mainly on the first floor of the three-story building. Records of temperatures inside and outside the building were maintained, and a least squares linear regression relationship with correlation coefficient 0.523 was developed between these temperature differences and the heating requirement. Extensive photo documentation was developed, part of which is contained herein.

**SR 224**
**PREVENTION AND CONTROL OF CULVERT ICING. SUMMARY REPORT ON STUDIES FY 1966-70.**
Carey, K.L., et al, April 1975, 79p., AD/A-010 328, 10 refs.
Huck, R.W., Gaskin, D.A.
30-127
ICE CONTROL, ICE PREVENTION, ELECTRIC HEATING, CULVERTS.
U.S. Army Cold Regions Research and Engineering Laboratory field inspections and data collection on icing conditions and methods of control prior to 1966 provided background to the overall study. A literature survey, covering primarily American and Russian experience, and a survey by questionnaire of highway maintenance forces in Alaska provided background to a field study of icing prevention and control covering four winter seasons in Alaska. Climatological, culvert temperature, ground temperature and hydrologic data were collected at Grenac, Steele and Flume Creeks near Fairbanks, Alaska, to extend understanding of icing phenomena. Field trials were conducted at Bear Creek, Grenac Creek, Steele Creek, Moose Creek and Gakona Spring to test three expedient techniques for controlling icing: electric heating cables, channel improvement and channel covers. Electric heating cables and channel deepening proved to be very promising for icing control, and improved installation and operating procedures for electric heating cables were developed during the study. The usefulness of channel covers proved to be rather restricted. Ground temperature data were collected from an array of thermocouples beneath and adjacent to a 24-in. corrugated metal culvert at Mile 15 on the Elliott Highway to study the thermal regime surrounding an ice-flooded culvert. These data demonstrated that culvert ends were the critical regions of heat loss.

**SR 225**
**ACCUMULATION OF ATMOSPHERIC POLLUTANTS NEAR FAIRBANKS, ALASKA, DURING WINTER.**
Jenkins, T.F., et al, Apr. 1975, 27p., ADA-010 646, 14 refs.
Murrmann, R.P., Brockett, B.E.
32-2602
AIR POLLUTION, CONDENSATION NUCLEI, VEHICLES, WIND VELOCITY, TEMPERATURE INVERSIONS.
Concentrations of hydrocarbons, carbon monoxide, carbon dioxide, condensation nuclei and nitric oxide were monitored near Fairbanks, Alaska, at a selected location not under the direct influence of a local pollution source. The measurements were made continuously over a period of weeks during January and February 1973, the period when atmospheric pollution would be expected to be most severe. Accumulation and dissipation of the pollutants was found to be related to atmospheric inversion conditions, wind speed and daily traffic patterns. Maximum hourly average concentrations of hydrocarbons, carbon monoxide, carbon dioxide and condensation nuclei were 9.7 ppm, 22.1 pp, 482 ppm and more than 10,000 nuclei/cu cm respectively. Comparative background levels are reported to be 1.4 ppm, 0.1 ppm, 320 ppm and 100-400 nuclei/cu cm. Vehicle emissions appeared to be the primary source of the various pollutants.

**SR 226**
**MECHANICS OF CUTTING AND BORING. PART I: KINEMATICS OF TRANSVERSE ROTATION MACHINES.**
Mellor, M., May 1975, 34p., ADA-010 634.
31-4176
ROCK DRILLING, EXCAVATING EQUIPMENT, CUTTING TOOLS.
This report, which is one of a series on the mechanics of cutting and boring in rock, deals with the kinematics of machines such as disc saws, drum millers, rotary planers and bucketwheel excavators, in which the rotary cutting element revolves about an axis that is normal to the direction of working travel. The analysis covers the geometry and motion of various components of the cutting system, touching on topics such as chipping depth, cutting transfer, excavation rate, tool trajectories, tool speeds, rake and relief angles on tools and tool layout. Worked examples are given to illustrate various points.

**SR 227**
**HOLOGRAPHIC TECHNIQUE FOR MEASUREMENT OF STRAIN.**
Berger, R.H., et al, May 1975, 9p., ADA-011 247, 19 refs.
Marshall, S.J., Munis, R.H., Fourney, M.E.
32-2603
ICE STRENGTH, STRAIN TESTS, MEASURING INSTRUMENTS, PHOTOGRAPHY.
An experimental program was carried out to see if holographic interferometry could be used to determine Young's modulus and Poisson's ratio of ice using the ring test. Spurious rigid body deflections of up to 0.5 microinch were found when the sample was compressed. These motions are of such magnitude that they will affect the accuracy of the bore gauge measurements of ice strength. The technique most suited to measurements of the deformation of the ice ring is speckle interferometry. This technique is most sensitive to motions of the magnitude found when using the ring test on ice and it allows measurement of motion in each of the three orthogonal directions separately so that Young's modulus and Poisson's ratio may be obtained easily.

**SR 228**
**1973 PERFORMANCE SURVEY OF DEW LINE ICE CAP STATIONS DYE-2 AND DYE-3.**
Tobiasson, W., et al, May 1974, 35p., ADA-012 112, 6 refs.
Hine, G., Redfield, R., Blanchard, W.
30-893
COLD WEATHER PERFORMANCE, BUILDINGS, SETTLEMENT (STRUCTURAL), STRUCTURAL ANALYSIS, WASTE DISPOSAL, SNOW LOADS, ICE LOADS.
Precise elevation surveys indicate that established trends are continuing for settlement and tilt of the eight footings which support each elevated structure. Individual footings are settling and tilting at significantly different rates with the result that secondary stresses are accumulating in the structural frame. Cracked roof joists, buckled wall studs and failed wall plates provide evidence that the timber truss enclosure at each station is heavily overstressed and failing locally. Snow and ice must have entered the DYE-2 truss enclosure through gaps in the distorted roof. Meltwater cavities created along the exterior wall of the DYE-2 truss enclosure have caused the wall-water systems to separate. The truss enclosure at each station needs attention. The existing DYE-2 wastewater disposal sump will fill during the summer of 1974 and a new sump will be required at that time. The DYE-3 sump should last until the summer of 1977. At both DYE-2 and DYE-3 the 1972-73 snow accumulation rate exceeded the average rate measured since 1959 by more than 1 ft/yr.

**SR 229**
**HOOK ANCHOR TESTS IN FROZEN AND UNFROZEN GROUND.**
Kovacs, A., May 1975, 31p., ADA-011 250.
32-2604
ANCHORS, STRAIN TESTS, FROZEN GROUND MECHANICS.
The findings of an exploratory study of the holding capacity of hook anchors in frozen and unfrozen ground are presented. Testing revealed that hook anchors are capable of being driven and retrieved from frozen silt and that their holding capacity was reasonably high in comparison to their size. Hook anchor capacity in the frozen silt at -2C was found to be three times higher than in the unfrozen silt.

**SR 230**
**USE OF SIDE-LOOKING AIRBORNE RADAR TO DETERMINE LAKE DEPTH ON THE ALASKAN NORTH SLOPE.**
Sellmann, P.V., et al, May 1975, 6p., ADA-011 249, 7 refs.
Weeks, W.F., Campbell, W.J.
32-2605
AIRBORNE RADAR, RADAR ECHOES, LAKE WATER, ICE COVER EFFECT, SIDE LOOKING RADAR.
Side-looking airborne radar (SLAR) imagery obtained in April-May 1974 from the North Slope of Alaska between Barrow and Harrison Bay indicates that tundra lakes can be separated into two classes based on the strength of the radar returns. Correlations between the areal patterns of the returns, limited ground observations on lake depths, and information obtained from ERTS imagery strongly suggest that freshwater lakes giving weak returns are frozen completely to the bottom while lakes giving strong returns are not. Brackish lakes also give weak returns even when they are not completely frozen. This is presumably the result of the brine present in the lower portion of the ice cover limiting the penetration of the X-band radiation into the ice. Although the physical cause of the differences in radar backscatter has not been identified, several possibilities are discussed. The ability to rapidly and easily separate the tundra lakes into these two classes via SLAR should be useful in a wide variety of different problems.

**SR 231**
**CONTINUOUS MONITORING OF TOTAL DISSOLVED GASES IN NATURAL WATERS: A FEASIBILITY STUDY.**
Jenkins, T.F., May 1975, 8p., ADA-011 248, 7 refs.
32-2606
WATER, GAS INCLUSIONS, MONITORS, REMOTE SENSING.
A preliminary investigation was undertaken to determine if a monitoring device capable of unattended operation could be configured to continuously measure total dissolved gases in natural waters. A three-component system was designed consisting of a pumping system, a continuous gas stripper, and a detector. Prototypes of the first two components were assembled and evaluated under field conditions. Based upon these results, it is possible to configure a monitor capable of unattended operation for continuous measurement of total dissolved gas concentrations in natural waters.

**SR 232**
**TRACTION AID FOR WHEELED VEHICLES.**
Hanamoto, B., July 1975, 9p., ADA-013 828, 1 ref.
30-1289
VEHICLE WHEELS, TRACKED VEHICLES, TRAFFICABILITY.
Performance tests with the Tyr-Trac traction aid for wheeled vehicles had been conducted in Alaskan snow, and the results were so encouraging that further testing of the device was requested. In comparison to tire chains, the Tyr-Trac out-performed chains in all areas of operation: slope climbing, snow drifts and deep snow conditions. Additional tests were con-

ducted in northern Michigan, comparing the drawbar pull-slip performance of an M35-A2 2 1/2-ton, 6 X 6 truck equipped with the Tyr-Trac, tire chains and with standard military tires at an inflation pressure of 15 psi. The results of these tests in no way duplicate the Alaskan results. Traction aids were of no use in snow deeper than 20 inches. Tests could be conducted only by reducing the snow cover to a depth of 12 to 17 inches. Under these conditions both Tyr-Trac and chains performed equally, with a drawbar pull to weight ratio, DBP/W, equal to about 0.10. If traction aids were to be used in shallower snow, tire chains would be preferred over the Tyr-Trac for these reasons: less weight and bulk for more convenient on-board stowage, more economical, and easier installation and removal in the field.

**SR 233**
**LAND USE/VEGETATION MAPPING IN RESERVOIR MANAGEMENT, MERRIMACK RIVER BASIN.**
McKim, H.L., et al, July 1975, 17p., AD-013 490, 2 refs.
Gatto, L.W., Merry, C.J., Anderson, D.M., Marlar, T.L.
30-1290
AERIAL PHOTOGRAPHY, SPACEBORNE PHOTOGRAPHY, VEGETATION PATTERNS, MAPPING, PHOTOINTERPRETATION.
The purpose of this investigation was to demonstrate the extent to which ERTS-1 imagery, Skylab S190A and S190B photography, and RB-57 photography can be utilized in the preparation of land use/vegetation maps. The analysis was accomplished with black and white enlargements (1:63, 360 scale) of the original NASA photography acquired on cloud-free days within a 47-day period. Ancillary data were not used during the mapping exercise to eliminate bias in the comparisons and to ensure that the results were derived strictly from interpretations of tones and textures on the photography. The classification scheme was a modified version of the U.S. Geological Survey Land Use Classification System for use with remote sensor data. The mapping units delineated from each of the data products are as follows: ERTS-1 MSS band 5—5 individual level I, 2 combined level I, and 8 level II; S190A—6 level I and 13 level II; S190B—6 level I, 17 level II and 1 level III; and RB-57—6 level I, 21 level II and 5 level III. This investigation demonstrates that for land use/vegetation mapping the Skylab S190B photography compares favorably with the RB-57 photography and is much superior to ERTS-1 imagery and Skylab S190A photography. The 12.5-m resolution of the S190B photography is sufficient to accomplish rapid land use and vegetation surveys required in many of the management problems of reservoirs or watersheds. The ERTS-1 and S190A data products are not considered adequate for this purpose, although they are useful for rapid regional level I surveys of land use and vegetation.

**SR 234**
**EFFECT OF POROSITY ON THE HYDROSTATIC COMPRESSION OF ICE.**
Gow, A.J., et al, Oct. 1975, 9p., ADA-017 302, 4 refs.
Sheehy, W.
30-2506
ICE SHEETS, ICE COMPRESSION, POROSITY, BUBBLES, DRILL CORE ANALYSIS, ANTARCTICA—BYRD STATION.
A cathetometer was used in conjunction with a window-equipped pressure chamber to measure linear deformation in porous polycrystalline ice samples compressed hydrostatically at pressures of up to 0.31 kb. Tests show that a porosity as little as 1% can increase the compressibility of ice four- or fivefold. However, the compression is of a substantially nonelastic nature, since very little recovery (expansion) occurs during and following pressure release. Pore closure, which is virtually complete at the higher pressures, can be attributed to a combination of plastic and cataclastic deformation of ice in the walls of the pores.

**SR 235**
**FROST PENETRATION MEASUREMENTS AT THE USAF INTRUSION SENSOR SITE, ROME, NEW YORK, 1973-74.**
Tobiasson, W., et al, Sept. 1974, 47p., ADA-015 471, 5 refs.
Atkins, R.T.
30-2072
FROST PENETRATION, MEASURING INSTRUMENTS, SNOW COVER EFFECT, VEGETATION FACTORS.
During the winter of 1973-74, 55 color-change frost gages and 17 thermocouple assemblies were installed in a field in Rome, New York, to monitor frost penetration. The maximum frost penetration during the winter ranged from 13 in. to 24 in. depending on location. Shallower depths occurred below disturbed snow and greater depths occurred below paths where the snow was compacted and less effective as an insulator. Variations in soils, vegetative cover and undisturbed snow depth also influenced frost penetration. Some difficulties were experienced with both frost gages and thermocouples because of meltwater seepage down around the assemblies. Methods of eliminating this seepage were developed. Direct probings showed that the color-change frost gages registered somewhat more rapid thaw than was occurring. However, the net performance of the frost gages during the winter exceeded that of the thermocouples. Both techniques need to be complemented by direct probings when the ground is nearly isothermal at the freezing point. The thermocouple and frost gage measurements provided a valuable record of frost penetration.

**SR 236**
**ANNULAR FLOW ICE-WATER MODEL HEAT SINK.**
Brown, J.L., et al, Sept. 1975, 67p., ADA-015 468, 26 refs.
Quinn, W.F.
30-2073
HEAT RECOVERY, MATHEMATICAL MODELS, HEAT SINKS.
An analytical and laboratory experimental study was conducted on a scale model annular flow ice-water sink which represent a medium for storing waste heat developed by a hardened defense installation during a transient period in which it operates on a closed cycle system. The study developed 1) an understanding of the flow processes and melting patterns in such a sink, 2) a mathematical procedure for predicting relationships between coolant water and heat rejection rates, 3) a validation of the math procedure using a scaled experiment model, and 4) an assessment of the effect of some water inlet manifold configurations. Advantageous performance characteristics include provision for 1) maximum thermal efficiency during the early (probably most crucial) stages of use and 2) a relatively constant outlet sink temperature to the power plant heat exchanger during the ice melting period.

**SR 237**
**EFFECTS OF VARIATION IN DRAWBAR HITCH LOCATION ON VEHICLE PERFORMANCE.**
Hanamoto, B., Sep. 1975, 16p., ADA-016 911, 11 refs.
30-4513
ALL TERRAIN VEHICLES, SNOW COVER EFFECT, NONCOHESIVE SOILS, DRAWBAR PULL.
The drawbar hitch point location has a direct effect on the trim attitude of a vehicle and also influences the net pull developed by a vehicle during a drawbar pull test. These results have indicated an area of study needing expansion: the relationship of sinkage and slip. Slip-sinkage is a factor which cannot be neglected in the analytical evaluation of vehicle performance. The equations relating sinkage, resistance, trim angle and the traction require further development. One procedural modification that could be made when a drawbar pull test was being conducted to obtain validation data would be to locate the tow hitch point at ground level, eliminating the trim attitude caused by the rearward shift of the center of pressure beneath the contact area.

**SR 238**
**RADIOWAVE RESISTIVITY MEASUREMENTS IN NORTHERN MAINE FOR IDENTIFYING BEDROCK TYPE.**
Sellmann, P.V., et al, Oct. 1975, 11p., ADA-017 944, 6 refs.
Delaney, A.J., Hoekstra, P.
30-3269
RADIO WAVES, ELECTRICAL RESISTIVITY, ROCKS.
A preliminary ground resistivity survey using the VLF radiowave method was conducted in northern Maine to establish if adequate resistivity contrasts exist between bedrock types in the area to warrant further bedrock distribution studies by airborne resistivity techniques. Field observations were made all rock types commonly found in the area, including the dominant gray slates and the less common orthoquartzites and granodiorites. Results suggest that an airborne survey could differentiate between the granodiorites and the surrounding gray slates in areas of shallow overburden, although resistivity contrasts between the slates and the orthoquartzite were probably not great enough to differentiate between these rock types. More than 70 percent of the resistivity values from the granodiorite sites exceeded 10,000 ohm-m; in contrast, approximately 8 percent of the slate values and none of the orthoquartzite values exceeded 10,000 ohm-m. Resistivity values correlated well with subsurface information obtained during earlier Corps of Engineers drilling investigations. Major breaks in the resistivity data agreed with variations in ground conditions such as increases in till thickness over bedrock and the occurrence of silt and clay in the valley of the Saint John River. Resistivities ranged from 100 to 9000 ohm-m along the line. The lowest values were associated with the silts and clays and the highest with areas where bedrock is near the surface.

**SR 239**
**LOCK WALL DEICING WITH WATER JETS: FIELD TESTS AT SHIP LOCKS IN MONTREAL, CANADA AND SAULTE STE. MARIE, MICHIGAN.**
Brierley, W.H., et al, Dec. 1975, 13 p., ADA-021 768, 4 refs.
Calkins, D.J., DenHartog, S.L., Mellor, M., Ueda, H.T.
30-3293
ICE REMOVAL EQUIPMENT, HYDRAULIC JETS, LOCKS (WATERWAYS).
Tests were made to evaluate a proposed technique for removing ice from lock walls during winter navigation. The technique involves use of a high-pressure water jet to slice through ice collars that adhere to vertical walls. The test equipment consisted of (1) a jet lance tipped with a nozzle designed to produce a long coherent jet, (2) a small tractor (hydraulically driven) to carry the lance, and (3) a high-pressure pump unit to supply water to the lance. Tests were made with operating pressures from 3,000 to 14,000 lbf/sq in and nozzle diameters from 0.063 to 0.152 in. Most of the work involved pressures around 9,000 lbf/sq in and nozzle diameters of approximately 0.09 in. Traverse speeds were in the range 3 to 17 ft/min. Jet penetrations of up to 4 ft were achieved in a single pass, and the equipment proved capable of cleaning the lock wall under the prevailing conditions. However, performance was somewhat less favorable than had been predicted, and a revised scheme involving changes in lock operating procedures was proposed.

**SR 240**
**CONTROL OF SNOW AND ICE ON MISSILE FIELDS.**
Minsk, L.D., Oct. 1975, 65p., ADA-018 558, 9 refs.
30-3397
SNOWDRIFTS, ICE CONTROL, SNOW FENCES, METEOROLOGICAL DATA, MILITARY FACILITIES, MILITARY ENGINEERING.
The effect of snow and ice on the operation and maintenance of a subsurface missile system was investigated during the construction stage of the Grand Forks Safeguard system site. Meteorological observations were made daily from 1 November to the following 30 April for the two winters 1971-72 and 1972-73, and compared with observations made at the 1st order stations of Minot and Grand Forks, North Dakota, west and east respectively of the Safeguard site. Though differences occured, the climatic patterns at the 1st order stations were similar, and indicate that 25-40 snowstorms can be expected each winter, snowfall in a single storm may reach 11 in. each year, and 20 in. 1 year in 30. A full-scale model of a portion of the Spartan missile mound was constructed, as well as part of the double chain link security fence and plywood models of six cell covers, and snow accumulation was observed during one winter. It was concluded that accumulation would never exceed the height of a cell cover, nor would snow completely bridge the pavement between cells. However, snow could accumulate to depths approaching 5-6 ft around the security fence under extreme conditions. When a hydraulic flume for conducting model tests for snowdrift potential became available late in the investigation, major structures at two of the radar installations were investigated, and a problem identified at one location. Performance tests were conducted on 12 models of 7-8 hp walk-behind snowblowers to evaluate the three tasks of lane, obstacle, and drift clearing which could be expected on the missile field. An analysis was made of the equipment requirements for snow clearance based on an estimate of accumulation on the site. Various plastic mesh materials were tested in a coldroom and in field trials for their performance as non-debris-forming snow fences, and satisfactory materials were found.

**SR 241**
**1974 ICE BREAKUP ON THE CHENA RIVER.**
McFadden, T., et al, Oct. 1975, 46p., ADA-018 352, Numerous refs.
Stallion, M.
30-2217
RIVER ICE, ICE JAMS, ICE BREAKUP, ICE COVER THICKNESS, UNITED STATES—ALASKA—CHENA RIVER.
The Alaskan Projects Office of USA CRREL made a detailed study of the ice breakup, ice jams, and ice thicknesses on the Chena River prior to and during the actual breakup. Ice thicknesses were measured at specific locations on the Chena River, from its confluence with the Tanana River upstream to the first bridge on the Chena Hot Springs Road. Average ice thicknesses were computed, as well as average ice volumes per mile of river length. Water temperatures and velocities were measured at different locations on the river. Aerial and ground reconnaissance was maintained on the river during the breakup period, and ground parties were dispatched to almost all ice jams observed on the river. Comparisons to other years' breakups were made, and it was concluded that the 1974 breakup was extremely mild.

**SR 242**
**USE OF REMOTE SENSING TO QUANTIFY CONSTRUCTION MATERIAL AND TO DEFINE GEOLOGIC LINEATIONS, DICKEY-LINCOLN SCHOOL LAKES PROJECT, MAINE, PARTS I AND II.**
McKim, H.L., et al, Dec. 1975, 21p., ADA-023 276, Part II is an oversized folder containing 8 map mosaics showing surficial geology and drainage of the Dickey-Lincoln area. 11 refs.
Merry, C.J.
30-3395
REMOTE SENSING, CONSTRUCTION MATERIALS, GEOLOGICAL MAPS, UNITED STATES—MAINE—FT. KENT.
During November 1974 a study was initiated to apply state-of-the-art remote sensing techniques to the delineation and quantification of surficial geology units to locate construction material at a potential hydroelectric power generation/flood control site within the headwaters of the St. John River Basin. A photomosaic was prepared from 1966 black and white photography (scale 1:33,600). Fourteen surficial geology units were delineated in an 1100-square-mile area: alluvial fan, alluvial terrace, esker, floodplain, glacial moraine, kame, kame terrace, outwash, outwash terrace, bedrock, till, till over bedrock, wet outwash and wet till. These units were field checked and the depths estimated utilizing initial boring data, field measurements and seismometer values. The aereal extent of each surfical geology unit within a four-mile radius of the three dike sites and a six-mile radius of the main dam site was quantified using a planimetric color densitometer. The volume

of construction material was computed based upon these aereal determinations and estimated depths and found to be sufficient for the project. In addition, the lineations observed on the LANDSAT imagery provided a sound base for analysis of possible tectonism in the Dickey-Lincoln area. It is believed that future movement along the east, northeast, north and N60degW lineations will be negligible.

**SR 243**

**RESURVEY OF BYRD STATION, ANTARCTICA, DRILL HOLE.**

Garfield, D.E., et al, Dec. 1975, 11p., ADA-021 657, 9 refs.

Ueda, H.T.

30-3270

BOREHOLES, ICE SURVEYS, MEASURING INSTRUMENTS, ANTARCTICA—BYRD STATION.

The drill hole at Byrd Station, which was surveyed in January 1968 to a vertical depth of 7063 ft (2153 m) below the top of the casing, was resurveyed in January 1975 to a vertical depth of 4835 ft (1474 m). Inclination and azimuth measurements were made with a Parsons multiple-shot inclinometer and compared with the earlier measurements made during drilling. The results indicate a progressively increasing displacement with depth to a value of 51.2 ft (15.6 m) at the 4835-ft (1474 m) level, or about 7.3 ft/yr (2.23 m/yr). The direction of movement relative to the surface varies from southwest at 300 ft (91.5 m) to northeast at 1100 ft (335 m), to east at 3368 ft (1027 m), and to northeast at 4835 ft (1474 m), indicative of a complex twisting motion. An increase in accessible depth along the hole axis of 18 ft (5.49 m) beyond the 1969 depth was noted. No attempt was made to measure hole diameter or vertical strain. It is recommended that the hole be resurveyed in 3-5 years if it is still logistically feasible, using a better inclinometer.

**SR 244**

**SUMMARY OF WEATHER OBSERVED AT CRETE AND SUMMIT STATIONS, GREENLAND JUNE 1974.**

Bilello, M.A., et al, Dec. 1975, 15p., ADA-021 227, 13 refs.

Langway, C.C., Jr., Mock, S.

30-3271

METEOROLOGICAL DATA, WEATHER OBSERVATIONS, METEOROLOGICAL INSTRUMENTS, GREENLAND.

Daily observations of air temperature, atmospheric pressure, wind speed and direction were made at Crete Station on the Greenland ice sheet from 5 to 24 June 1974. The average air temperature during this period was -16.6C and ranged from a minimum of -30C to a maximum of -6C. The wind speed averaged 7.6 knots and was predominantly from the north. Extended periods of clear or partly cloudy weather were observed, although ground fog and reduced surface visibility occurred simultaneously. During passages of low pressure troughs, light snow, blowing snow and a whiteout were observed; at these times visibility became quite limited. At Summit Station the minimum air temperature observed between 7 and 14 June was -27C and the maximum was -13C. These observations, however, were not made during the coldest or warmest part of the day, so the true extremes were probably greater than these. During passage of a low pressure trough at both stations, the pressure at Crete Station dropped 9 mb over a 45-hour period, and that at Summit Station dropped 6 mb over a 37-hour period.

**SR 245**

**COLD WEATHER CONSTRUCTION MATERIALS PART 1 REGULATED-SET CEMENT FOR COLD WEATHER CONCRETING.**

Houston, B.J., et al, Dec. 1975, 23p., ADA-021 658, 21 refs.

Hoff, G.C.

30-3272

CONSTRUCTION MATERIALS, WINTER CONCRETING, CONCRETE ADMIXTURES, COMPRESSIVE STRENGTH.

This report covers part of an investigation to locate and evaluate existing and new cementing materials that allow concrete to be placed at ambient temperatures as low as 15F. A newly developed cement termed "regulated-set" cement, which is an accelerated set cement, was tested in mortars and concretes with the following results: 1. The longer freshly mixed regulated-set cement concrete remains above freezing before exposure to below freezing temperatures the greater the subsequent early strength gain; however, considerable strength gain was exhibited by specimens exposed at 15 deg immediately after casting. Specimens protected one hour before exposure exhibited almost as much strength at 28 days as specimens cured at 70 deg for the full time. 2. The heat development in 3-, 6- and 12-in.-thick slabs exposed at 15F immediately after casting, peaked in one to two hours at 46.5 deg, 58 deg and 69 deg F, respectively, and remained above freezing long enough to gain considerable strength. 3. The introduction of a retarder into the mixture caused an increase in slump and a 13 to 19 percent decrease in 28-day strength in specimens exposed at both 70 deg and 15 deg F. There was still considerable strength developed, however in the specimens exposed at low temperatures.

# MONOGRAPHS

**M I-A**
**CHARACTERISTICS OF THE COLD REGIONS.**
Gerdel, R.W., Aug. 1969, 51p., AD-695 661, 64 refs.
24-3398
TEMPERATURE DISTRIBUTION, SNOW COVER DISTRIBUTION, GLACIER ICE, FROZEN GROUND, PERMAFROST STRUCTURE, LAKE ICE, RIVER ICE, SEA ICE.
The paper gives a brief introduction to total cold environments relating the characteristics of the cold regions to the problems produced which hinder man's activities in these regions. Discussed are the zonal temperature regimes, the various forms and aspects of snow and ice, frozen ground and permafrost and the atmospheric phenomena of the greenhouse effect, refraction, reflection, and luminance.

**M I-A1**
**SELECTED ASPECTS OF GEOLOGY AND PHYSIOGRAPHY OF THE COLD REGIONS.**
Stearns, S.R., July 1965, 40p., AD-630 983, 50 refs.
24-3399
GEOLOGIC STRUCTURES, MOUNTAINS, PLAINS, TEMPERATURE DISTRIBUTION, TOPOGRAPHIC FEATURES, SEA ICE, PERMAFROST.
The cold regions of the earth are defined and described in terms of their physiographic features, geologic histories, temperature characteristics, vegetation limitations, permafrost line, and sea ice limits.

**M I-A2**
**PERMAFROST (PERENNIALLY FROZEN GROUND).**
Stearns, S.R., , Aug. 1966, 77p., AD-642 730, Includes, p.71-77, Description and classification of frozen soils by K.A. Linell and C.W. Kaplar. Bibliog. p.65-69.
Linell, K.A., Kaplar, C.W.
24-3400
PERMAFROST DISTRIBUTION, PERMAFROST STRUCTURE, PERMAFROST HEAT BALANCE, SURFACE FEATURES, VEGETATION PATTERNS, COLD WEATHER CONSTRUCTION.
This monograph summarizes information on permafrost for engineering construction in cold regions. The distribution and origin of permafrost is discussed and information on structure, thickness, and thermal regime is summarized. Patterned ground and vegetation in the cold regions are discussed and the engineering significance of permafrost is reviewed.

**M I-A3a**
**CLIMATOLOGY OF THE COLD REGIONS. INTRODUCTION. NORTHERN HEMISPHERE, PART I.**
Wilson, C., June 1967, 141p., AD-656 447, For Part II See 24-3402. 323 refs.
24-3401
CLIMATOLOGY, TOPOGRAPHIC FEATURES, ATMOSPHERIC CIRCULATION, HEAT BALANCE, RADIATION BALANCE.
A review summary of the climatological environment of the Northern Hemisphere contains a general introduction to the cold regions and a discussion of geographic controls and meteorological aspects including: 1) the hemisphere surface in terms of configuration and relief, vegetation zones and permanent and seasonal ice and snow; 2) the general circulation and weather system dealing with the circumpolar vortex, sea-level pressure and cyclonic frequency, circulation system persistence, and surface weather associated with high latitude pressures; 3) the net radiation and heat balance.

**M I-A3b**
**CLIMATOLOGY OF THE COLD REGIONS NORTHERN HEMISPHERE. PART II.**
Wilson, C., Aug. 1969, 158p., AD-674 185, For Part I, see 24-3401. Extensive bibliogs. with each major section.
24-3402
CLIMATOLOGY, TEMPERATURE FACTORS, HUMIDITY, PRECIPITATION (METEOROLOGY), WIND FACTORS, ICE FOG.
Three major topics are treated in this paper: temperature, humidity and precipitation, and surface winds. Temperature data for structural design, vegetation and soil temperetures, and inversions are presented. Visibility and icing data are included with the section on atmospheric humidity and precipitation. Average and maximum wind speeds with their prevailing directions and blowing snow data are given.

**M I-A3c**
**CLIMATOLOGY OF THE COLD REGIONS SOUTHERN HEMISPHERE.**
Wilson, C., May 1968, 77p., AD-674 185, 281 refs.
24-3403
CLIMATOLOGY, ATMOSPHERIC CIRCULATION, HEAT BALANCE, METEOROLOGICAL DATA, ANTARCTICA.
This monograph summarizes the climatology of the cold regions of the Southern Hemisphere which consist almost entirely of the Antarctic Continent. Comparsions with the northern cold regions are followed by a systematic treatment of general circulation, the energy budget, and meteorological elements forming the climate of the region. Thirty-two illustrations (many of several parts) and ten tables give climatological data, and a selected bibliography of 281 items provides complete coverage for further details.

**M I-A3d**
**RADIOACTIVE FALLOUT IN NORTHERN REGIONS.**
Wilson, C., Feb. 1967, 35p., AD-656 448, 119 refs.
24-3404
FALLOUT, RADIOACTIVE ISOTOPES, ATMOSPHERIC CIRCULATION.
Information and data are given on the distribution of radioactive fallout and atmospheric processes, announced nuclear detonations, and monthly fallout deposition collection. It is pointed out that the 3 dangerous isotopes are Sr-90, Cs-137, and I-131. The data suggest that the arctic and subarctic stratosphere plays an important role in the retention and release of radioactive fallout so that, regardless of the latitude at which the debris is injected into the stratosphere, the fallout pattern may be unchanged. There is a close relationship between the tropospheric jet streams and associated cyclonic disturbances and the distribution of fallout at the earth's surface. This hypothesis calls for the transfer of the debris in well-defined layers from the arctic stratosphere deep down into the troposphere in the vicinity of the jet stream, where subsidence in the rear of cyclonic disturbances and the precipitation processes aid the rapid fall to earth. In the northern regions, fallout behavior depends on the initial pattern of the westerly vortex at the time of the detonation and its subsequent development.

**M I-B1**
**ANTARCTIC ICE SHEET.**
Mellor, M., Feb. 1961, 50p., AD-276 609, 65 refs.
24-3405
LAND ICE, ICE COVER THICKNESS, ICE TEMPERATURE, SNOW COVER, MASS BUDGET, ANTARCTICA.
The paper summarizes existing (as of 1960) knowledge of the Antarctic continent for the use of professional engineers engaged in design or construction in that region. Treated are the topographic features, accumulation, ablation, and drifting of snow, and a variety of ice characteristics including flow, thickness, variation of properties, temperature, mass budget, and annual gains and losses.

**M I-B2**
**GREENLAND ICE SHEET.**
Bader, H., Sept. 1961, 18p., AD-276 610, 11 refs.
24-3406
LAND ICE, ICE COVER THICKNESS, ICE TEMPERATURE, SNOW DENSITY, FIRNIFICATION.
The paper summarizes the existing (as of 1961) knowledge of Greenland for use of professional engineers engaged in design or construction in that region. Discussed are the extent and thickness of the ice sheet, the regimen under which it exists, surface and subsurface temperatures, and snow densification.

**M II-A1**
**HEAT EXCHANGE AT THE GROUND SURFACE.**
Scott, R.F., July 1964, 49p. plus append., AD-449 434, 56 refs.
24-3407
MEASURING INSTRUMENTS, METEOROLOGICAL DATA, WIND FACTORS, TEMPERATURE FACTORS, SOIL TEMPERATURE, HEAT BALANCE, FREEZE THAW INDEXES.
The paper summarizes existing (as of 1964) knowledge of heat exchange at the ground surface from an engineering viewpoint, aiming at the solution of the problem of predicting the ground penetration of the freezing point isotherm from weather, soil, and surface conditions. As perameters used in the solution, radiation, wind and air temperature, soil and subsurface temperatures, surface heat balance, and freezing and thawing indexes are considered.

**M II-A2a**
**SEISMIC EXPLORATION IN COLD REGIONS.**
Roethlisberger, H., Oct. 1972, 138p., AD-752 111, 199 refs.
27-1681
SUBSURFACE INVESTIGATIONS, SEISMIC VELOCITY, ICE PLASTICITY, SNOW PLASTICITY, FROZEN GROUND MECHANICS, GLACIERS.
This monograph contains a comprehensive review of the use of seismic methods and related techniques based on elastic waves, to gain information on the geometry and physical properties of the substrata in cold regions, particularly snow, ice and frozen ground. Pertinent elastic properties of these materials are described and methods for determining seismic velocities are summarized. Theories and application of reflection and refraction soundings on glaciers, continental ice sheets, ice shelves, and frozen ground are reviewed. Surveys employing surface waves, and special application of elastic waves, are described. Included with the text are 73 figures and about 200 selected references.

**M II-B**
**PHYSICS AND MECHANICS OF SNOW AS A MATERIAL.**
Bader, H., et al, July 1962, 79p., AD-287 052, 60 refs.
Kuroiwa, D.
24-3408
SNOW PHYSICS, ELECTRICAL PROPERTIES, THERMAL PROPERTIES, METAMORPHISM (SNOW), CLASSIFICATIONS, SNOW DENSITY, SNOW COMPRESSION, COMPRESSIVE STRENGTH, SNOW CREEP, TENSILE STRENGTH, SHEAR STRENGTH.
The paper summarizes existing (as of 1962) knowledge of the properties of snow as a material. Its structure, changes, permeability, classification, mechanics, thermal and electrical properties are described and illustrated.

**M II-C1**
**SNOW AND ICE ON THE EARTH'S SURFACE.**
Mellor, M., July 1964, 163p., AD-449 925, Chapter bibliographies.
24-3409
SEA ICE, SNOW PHYSICS, GLACIER ICE, GLACIOLOGY, ICE FORMS.
An extensive treatment is given to the various aspects of glaciers including classification, area and thickness, and distribution; flow, wastage, mass economy, temperatures, past glaciations, and study techniques. The natural forms of ice, i.e., snow, frost, lake ice, river ice, sea ice, icebergs, and ground ice are described. Snow is treated from the viewpoint of its effects and changes after it has fallen to the surface.

**M II-C2a**
**PHYSICS OF ICE.**
Glen, J.W., April 1974, 81p., AD-778 009.
28-4125
ICE PHYSICS, ICE CRYSTAL STRUCTURE, ICE MELTING, ICE SURFACE.
Existing knowledge of ice physics is summarized. Ice crystalline structure including defects in structure, polycrystalline ice and grain boundaries, electrical properties, thermal properties, propagation of electromagnetic waves in ice and optical properties, nucleation and growth of ice crystals, melting and evaporation, and surface properties are covered. A comprehensive bibliography is given.

**M II-C2b**
**MECHANICS OF ICE.**
Glen, J.W., Dec. 1975, 43p., ADA-022 797, 134 refs.
30-3396
ICE MECHANICS, ICE ELASTICITY, ICE CREEP, PLASTIC DEFORMATION, BIBLIOGRAPHIES.
This monograph summarizes knowledge of the mechanics of ice to 1970. It is concerned principally with the effect of stress on the mechanical properties of ice, including elasticity, anelasticity, sound propagation, plastic deformation and creep in single crystals and in polycrystalline ice, fracture, and recrystallization and grain growth that accompanies plastic deformation. The monograph also includes a comprehensive bibliography.

**M II-C3**
**MECHANICAL PROPERTIES OF SEA ICE.**
Weeks, W.F., et al, Sept. 1967, 80p., AD-662 716, 199 refs.
Assur, A.
24-3410
SEA ICE, ICE COVER STRENGTH, TENSILE STRENGTH, FLEXURAL STRENGTH, SHEAR STRENGTH, COMPRESSIVE STRENGTH, ICE CREEP, MECHANICAL PROPERTIES.

This review discusses the state of thinking of each of the main national groups investigating sea ice and gives an overall appraisal of the field as a whole. Emphasis is placed on (1) the physical basis for interpreting sea ice strength (phase relations, air volume, and structural considerations), (2) theoretical considerations (strength models, air bubbles and salt reinforcement, and interrelations between growth conditions and strength), (3) experimental results (tensile, flexural, shear, and compressive strength, elastic modulus, shear modulus and Poisson's ratio, time dependent effects, and creep), and (4) plate characteristics. The paper includes a review of problems in sea ice investigations, relates the chemical, crystallographic, mechanical, and physical aspects involved, and concludes by showing how to utilize this knowledge to solve practical problems.

**M II-D1**
**FREEZING PROCESS AND MECHANICS OF FROZEN GROUND.**
Scott, R.F., Oct. 1969, 65p., AD-697 136, 64 refs.
24-3411
FROZEN GROUND MECHANICS, FREEZING, FROST ACTION, VISCOELASTICITY, SOIL STRENGTH.

Outlined are two current theories on the freezing of water in soils. The classification and description, standardized in the United States and Canada, of frozen soils, leads to some laboratory data on the mechanical behavior of frozen soils. The Monograph concludes with the application of linear viscoelastic theory to typical field problems. Twenty-one illustrations, 7 tables and 64 references are included.

**M III-A1**
**PROPERTIES OF SNOW.**
Mellor, M., Dec. 1964, 105p., AD-611 023, Chapter refs.
24-3412
SNOW PHYSICS, SNOW STRENGTH, LOADS (FORCES), SHEAR STRENGTH, SNOW CREEP, THERMAL PROPERTIES, ELECTRICAL PROPERTIES.

The paper summarizes existing (as of 1964) knowledge of the properties of snow. Snow structure and structural changes are discussed as products of variations in grain size, porosity, density and as the result of loading variations which affect the ultimate strength and creep of snow. Emphasized also are ways in which heat is transferred through snow and the changes which result.

**M III-A2a**
**METHODS OF BUILDING ON PERMANENT SNOWFIELDS.**
Mellor, M., Oct. 1968, 43p., AD-681 889, 14 refs.
24-3413
COLD WEATHER CONSTRUCTION, SNOW (CONSTRUCTION MATERIAL), UNDERSNOW FACILITIES, ANTARCTICA, GREENLAND.

Construction on the polar ice sheets of Greenland and Antarctica is a challenge, mainly because of the mechanical and thermal sensitivity of snow, the major constructional material. Adverse weather, logistical difficulties, and lack of experience add to the problem to make every project a costly experiment. This monograph describes the development of building in, on, and of, snow, beginning with the Eskimo snowhouse for temporary shelter, and leading to permanent installations like 6500-ton steel structures above the snow surface, and a large subsurface encampment maintained with the help of a nuclear reactor. The work is introductory to other monographs dealing with specific aspects of design, construction and operation.

**M III-A2b**
**INVESTIGATION AND EXPLOITATION OF SNOWFIELD SITES.**
Mellor, M., Jan. 1969, 57p., AD-686 314, 32 refs.
24-3414
COLD WEATHER CONSTRUCTION, SNOW (CONSTRUCTION MATERIAL), UNDERSNOW FACILITIES, MEASURING INSTRUMENTS, SNOW STRENGTH, EXCAVATING EQUIPMENT.

This monograph is the 2nd of a series of 5. It covers the site investigations and laboratory tests in connection with construction on a permanent snowfield, and then deals with the technology of excavation and building where snow is almost the only constructional material. The author draws heavily on the work of the Cold Regions Research and Engineering Laboratory (CRREL) in the development of Camp Century and other projects on the Greenland ice sheet and shows the application of the techniques to Antarctic Research Stations.

**M III-A2c**
**FOUNDATIONS AND SUBSURFACE STRUCTURES IN SNOW.**
Mellor, M., Oct. 1969, 54p., AD-699 336, 31 refs.
25-2184
FOUNDATIONS, SNOW PHYSICS, SNOW (CONSTRUCTION MATERIAL), SUBSURFACE STRUCTURES.

Various types of foundations suitable for use in very deep snow are described, and design principles are given. Dependence of settlement rate on heaving pressure, size and shape of foundation, snow temperature, and snow density is treated analytically, and field data from test procedures for foundation design are outlined. In treating the design of tunnels, shafts and subsurface structures in very deep snow, the distributions of stress, strain and displacement in polar ice sheets are first obtained analytically. Observed patterns of deformation are given for a variety of excavations and deformable structures, and methods of analysis are put forward. The loading of restraining structures is discussed, and finally some notes on the monitoring and maintenance of subsurface structures are given.

**M III-A2d**
**UTILITIES ON PERMANENT SNOWFIELDS.**
Mellor, M., Oct. 1969, 42p., AD-699 337, 46 refs.
25-2243
COLD WEATHER CONSTRUCTION, WATER SUPPLY, WASTE DISPOSAL, UTILITIES, FIRE PROTECTION, HEATING, VENTILATION.

The topics covered in the monograph include water supply, waste disposal, heating, ventilating and fire protection at installations built on polar ice sheets. The section on water supply discusses energy requirements, consumption rates, water quality and treatment, techniques and equipment for melting snow and ice, and water distribution systems. A number of actual water supply systems are described in detail. The section on waste disposal deals with sewage and sewage sinks, latrines, garbage, trash and scrap and radioactive waste. Examples of sanitation systems at polar base are described in some detail. The section on heating discusses heating load, heat losses and insulation, energy sources, and heating systems. The ventilation section covers air demands, intakes and exhausts, ventilation of undersnow tunnels, and carbon monoxide problems. The report concludes with some notes on fire protection.

**M III-A3a**
**EXPLOSIONS AND SNOW.**
Mellor, M., June 1965, 34p., AD-623 418, 23 refs.
24-3415
EXPLOSION EFFECTS, ATTENUATION, SHOCK WAVES, SNOW MECHANICS.

Described are experiments with blasting in snow. Weight of the charge and the depth placed are related to the size and configuration of the resulting crater and the permanent deformation of the snow. Shockwaves in the snow and in the air are discussed and engineering applications of snow blasting are indicated.

**M III-A3b**
**SNOW REMOVAL AND ICE CONTROL.**
Mellor, M., April 1965, 37p., AD-615 795, 32 refs.
24-3416
SNOW REMOVAL, ICE CONTROL.

Climatology of snow cover in the northern hemisphere is briefly presented along with a description of significant snow properties. More extensively treated are the various equipments and methods used to control ice and snow. Snow plows, heating systems, and chemical means of snow removal are compared and details of costs and organization of removal techniques are presented.

**M III-A3c**
**BLOWING SNOW.**
Mellor, M., Nov. 1965, 79p., AD-630 328, 97 refs.
24-3417
SNOWDRIFTS, BLOWING SNOW, WIND FACTORS, SNOW FENCES, TURBULENT DIFFUSION.

The monograph reviews available information on blowing snow and the formation of snowdrifts. The mechanics of wind transport is discussed, with special emphasis on turbulent diffusion of snow particles in the surface boundary layer. The metering of blowing snow is explained, and field data are given for concentration and flux of snow particles as functions of wind speed and height above the surface. Deposition and erosion of snow is discussed and wind tunnel modeling is considered. The construction and deployment of snow fences is described, and snow fence performance is analysed. Snow drifting on highways and around structures is considered. Some electrical and optical phenomena are reviewed.

**M III-A3d**
**AVALANCHES.**
Mellor, M., May 1968, 215p., AD-671 614, 134 refs.
24-3418
AVALANCHES, AVALANCHE COUNTERMEASURES, AVALANCHE MECHANICS, AVALANCHE TRIGGERING, SLOPE STABILITY.

This monograph contains a comprehensive review of the formation and occurrence of avalanches together with a technical treatment of the principles and practice of avalanche defense. Major sections deal with avalanche hazard, snowfall and snow cover, avalanche terrain, avalanche classification, stress and deformation in snow slopes, engineering mechanics, avalanche dynamics, avalanche defenses, design of supporting structures and galleries, avalanche triggering and slope stabilization, probability forecasting, warning and rescue, and ice avalanches. A glossary of avalanche terminology in English, German and French is given in an appendix.

**M III-A4**
**OVERSNOW TRANSPORT.**
Mellor, M., Jan. 1963, 58p. plus appends., AD-404 778, 32 refs.
24-3419
SNOW VEHICLES, CREVASSE DETECTION, DESIGN CRITERIA.

Snow vehicles of various types are described and illustrated. Use, capabilities, limitations, and design features are presented and the procedures used to test the vehicles are given. Characteristics of good oversnow vehicles in terms of speed, power, load capacity, flotation, and traction are described.

**M III-B1b**
**ICE PRESSURE ON ENGINEERING STRUCTURES.**
Michel, B., June 1970, 71p., AD-709 625, 79 refs.
25-1650
ICE PRESSURE, STRUCTURES, ICEBREAKERS, ICE BREAKING, STATIC LOADS, DYNAMIC LOADS.

This monograph summarizes existing knowledge on forces exerted by an expanding ice sheet, impact forces of ice on structures, and vertical forces exerted by ice on hydraulic structures. Sections are also devoted to icebreakers and ice models.

**M III-B1a**
**WINTER REGIME OF RIVERS AND LAKES.**
Michel, B., April 1971, 131p., AD-724 121, 164 refs.
26-2304
LAKE ICE, RIVER ICE, ICE SURVEYS, ICE FORMATION, HEAT BALANCE, FRAZIL ICE, ICE BREAKUP, ICE CONTROL, ICE FORECASTING.

The monographs summarizes existing knowledge of river and lake ice surveys, heat balance on open water in winter, frazil, ice cover formation, ice breakup and ice control.

**M III-C4**
**FOUNDATIONS OF STRUCTURES IN COLD REGIONS.**
Sanger, F.J., June 1969, 91p., AD-694 371, 62 refs.
24-3420
COLD WEATHER CONSTRUCTION, FOUNDATIONS, PILE FOUNDATIONS, FROST HEAVE, PERMAFROST PRESERVATION, SEASONAL FREEZE THAW.

This monograph describes the various kinds of foundations used for structures on permafrost with a brief discussion of foundations in areas of seasonal frost. Special attention is given to piled foundations in permafrost and the design of ventilation systems for controlling thaw under heated buildings. Appendixes outline techniques for computing the depth of freezing or of thawing, the design of refrigeration systems for artificial freezing, and the recommended procedure in the USSR for static pile tests. Included in the main text are 51 figures and 62 selected references.

**M III-C5a**
**WATER SUPPLY IN COLD REGIONS.**
Alter, A.J., Jan. 1969, 85p., AD-685 850, 228 refs.
24-3421
COLD WEATHER OPERATION, WATER SUPPLY, WATER TREATMENT.

The monograph outlines the influence of a cold environment on sanitary engineering works and services. It then deals with water supply in cold regions: sources, distribution systems, treatment processes and possible future supply from other than geological sources.

**M III-C5b**
**SEWERAGE AND SEWAGE DISPOSAL IN COLD REGIONS.**
Alter, A.J., Oct. 1969, 106p., AD-698 452, 225 refs.
25-2237
SEWAGE DISPOSAL, SEWAGE TREATMENT, UTILITIES, WASTE DISPOSAL, COLD WEATHER OPERATION.

The main items dealt with in this monograph are: practice and problems encountered by the builder and operator of sewerage works facilities in cold regions; collection and transport systems; treatment and processing of sewage; thermology; reuse and regenerative processes for treating waste water; and construction and operation of sewage facilities. Six appendixes treat stabilization ponds, venetilation of buildings having sewage treatment plant, management of solid waste and classification of wastes and incinerators.

**M III-D3**
**ICINGS DEVELOPED FROM SURFACE WATER AND GROUND WATER.**
Carey, K.L., May 1973, 71p., AD-765 452, 80 refs.
28-2877
ICE FORMATION, GROUND WATER, ICE CONTROL, ENGINEERING.

This monograph summarizes existing knowledge of the occurrence, control, and prevention of icings. It covers brief history of icing studies, general descriptions of icings, engineering significance of icings, origins of icings and factors affecting icing formation, techniques for studying icings, techniques for counteracting icings, avoiding icing problems in new construction, and selected bibliography.

# ACFEL TECHNICAL REPORTS

**ACFEL TR 1**
**FROST INVESTIGATION 1944-1945. REPORTS ON SIOUX FALLS, S.DAK., AIRFIELD, FAIRMONT, NEBR., AIRFIELD, GREAT BEND, KANS., AIRFIELD, GARDEN CITY, KANS., AIRFIELD, AND PRATT, KANS., AIRFIELD.** July 1945, 156p., AD-713 280.
25-2441
FROST ACTION, AIRCRAFT LANDING AREAS, PAVEMENT BASES, SOIL MECHANICS, SEASONAL VARIATION.
The purpose of this investigation was the determination of the development of frost action in subsurface pavement elements as affected by varying conditions of weather, soils, and ground water. The investigation was made to determine the development of frost action in areas having varying winter weather conditions, varying annual precipitation and water tables, together with subsurface soils having an indicated varying susceptibility of frost action under the proper moisture conditions. The scope of this report covers investigations under both flexible and rigid type pavements.

**ACFEL TR 2**
**FROST INVESTIGATION 1944. REPORT ON FROST INVESTIGATIONS AND PAVEMENT BEHAVIOR TESTS DOW FIELD, BANGOR, MAINE.** Jan. 1946, 243p., AD-712 391.
25-2442
FROST ACTION, AIRCRAFT LANDING AREAS, PAVEMENT BASES, TRAFFICABILITY, FROST PENETRATION, TESTS.
This is a report of the frost investigations performed at Dow Field, Bangor, Maine, during the winter, spring and summer of 1944 by the Boston District Office. The purpose of these investigations was to determine the influence of frost action in the subgrade soils beneath both rigid and flexible pavements at Dow Field upon the gross plane weight evaluation of these pavements.

**ACFEL TR 3**
**FROST INVESTIGATION 1945-1946. REPORT ON FROST INVESTIGATIONS AND TRAFFIC TESTS, SELFRIDGE FIELD, MICHIGAN.** June 1946, 109p., AD-712 358.
25-2443
PAVEMENT BASES, FROST HEAVE, AIRCRAFT LANDING AREAS, TRAFFICABILITY, FROST PENETRATION, WEATHER.
The report presents the results of the frost investigation conducted at Selfridge Field, Michigan, during the period from 31 October 1945 through 25 June 1946. The investigation includes observations of surface temperatures, subsurface temperatures, ground water table, frost penetration, ice segregation, pavement heave, water content, density and climatic conditions. Plate bearing tests were made on the pavement and base materials. Laboratory tests were performed on representative subgrade base materials and on Portland cement concrete beams and cores. The traffic tests consisted of the daily application of the specified repeated load on 2 traffic test areas during and subsequent to the frost melting period.

**ACFEL TR 4**
**FROST INVESTIGATION 1945-1946. REPORT ON STUDIES OF BASE COURSE TREATMENT TO PREVENT FROST ACTION.** June 1946, 55p., AD-712 359.
25-2444
FROST PROTECTION, ADMIXTURES, PAVEMENT BASES, FROST ACTION.
The report presents a summary of previous investigations performed by others, to study the effect of admixtures on frost action, in the form of excerpts from the conclusions sustained by the reports of these investigations, the results of laboratory tests performed to determine the suitability of various admixtures and combinations of admixtures to prevent frost action in materials susceptible to frost action, and the results of laboratory tests to determine whether leaching of salts could be retarded or prevented by the addition of bituminous materials. Representative data are presented herein.

**ACFEL TR 5**
**SUBSURFACE DRAINAGE INVESTIGATION 1945-1946. COMPREHENSIVE REPORT.** Sept. 1946, 166p., AD-712 386, 16 refs.
25-2445
SUBSURFACE DRAINAGE, SURFACE WATER RUNOFF, AIRCRAFT LANDING AREAS, PAVEMENT BASES, DESIGN CRITERIA, ANALYSIS (MATHEMATICS).
The purpose of the subsurface drainage investigation is to develop design criteria for the drainage of airfield base courses and subgrades with the object of establishing satisfactory design standards for inclusion in the Engineering Manual. The purpose of this report is to summarize and correlate the theoretical studies, laboratory model tests, test results from four full scale field sections and the data obtained from existing airfield drainage installations during the fiscal year 1945-1946 and to present design criteria determined therefrom.

**ACFEL TR 5 APP 1**
**SUBSURFACE DRAINAGE INVESTIGATION 1945-1946. APPENDIX 1. THEORETICAL ANALYSIS OF DRAINAGE OF BASE COURSES.**
Pipes, L.A., March 1946, 60p., AD-610 201.
25-2446
PAVEMENT BASES, SUBSURFACE DRAINAGE, SOIL MECHANICS, ANALYSIS (MATHEMATICS).
The purpose of the first part of this report is to review the present status of the theory of two and three dimensional motion of ground water with a free surface and to investigate the possibilities of applying modern instruments of calculation to the determination of the shape of the free surface, the extent of the surface of seepage and other pertinent data of importance in gravity flow systems. A comprehensive review of the existing literature is included in order that subsequent investigations may be facilitated by this report. The second part of this report is devoted to the calculation of rates of drainage of base courses by assuming approximate geometrical shapes for the free surface during the process of drainage. The various rates of drainage obtained by these approximations are compared with each other and with experimental tests conducted at the soil laboratory.

**ACFEL TR 5 APP 2**
**SUBSURFACE DRAINAGE INVESTIGATION 1945-1946. APPENDIX 2. REPORT ON VISCOUS FLUID MODEL TESTS.** March 1946, 49p., AD-712 385.
25-2447
FLUID FLOW, MODELS, DRAINAGE, AIRCRAFT LANDING AREAS, SOIL MECHANICS.
The purpose of the laboratory model tests is to determine the time-drainage characteristics of facsimile models of previous base courses of various depth-length ratios with impervious pavement and subgrade and a free outlet at lower edge. The results of these tests will be studied and correlated with the results of theoretical investigations and full scale model tests.

**ACFEL TR 5 APP 3**
**SUBSURFACE DRAINAGE INVESTIGATION 1945-1946. APPENDIX 3. REPORT OF FIELD INVESTIGATIONS.** July 1946, 212p., AD-712 428.
25-2448
AIRCRAFT LANDING AREAS, SUBSURFACE DRAINAGE.
The report summarizes the field investigations conducted at 12 selected airfields located in the United States. For the purpose of obtaining the most information possible during the year, the fields chosen were divided into two groups: survey sites and comprehensive sites. In each of these groups, investigations were conducted at sites where combination drains were installed, and where subsurface drains were installed. At the survey sites, an inspection of the fields was made to determine the condition, operation, maintenance and effectiveness of the drainage system. At comprehensive sites the operation of the subsurface drains was investigated in a systematic manner, measuring the discharge of the drains at selected locations, gaging the precipitation and observing the ground water conditions by means of observation wells; and the operation of combination drains was investigated by measuring the discharge of selected drains and obtaining precise records of precipitation for every storm.

**ACFEL TR 5 APP 4**
**SUBSURFACE DRAINAGE 1945-1946. APPENDIX 4. REPORT ON FULL SCALE FIELD DRAINAGE TESTS.** Aug. 1946, 93p., AD-712 429.
25-2449
AIRCRAFT LANDING AREAS, SUBSURFACE DRAINAGE, PAVEMENT BASES, SOIL MECHANICS, PERMEABILITY.
The purpose of the full scale tests is to determine the time drainage characteristics of two types of saturated base course materials each in two thicknesses, laid upon an impervious subgrade and with impervious sides and pavement. The tests were conducted upon sections of the same transverse slope, length and width with two thicknesses, using pea gravel, and sand and gravel for the base course materials. Field in-place and laboratory permeability tests on remolded samples were conducted. In addition, laboratory tests were performed for grain size, effective porosity, and critical velocity; and field tests were performed to determine unit dry weight and water content.

**ACFEL TR 6**
**FROST INVESTIGATION 1944-1945. COMPREHENSIVE REPORT.** Feb. 1947, 120p., AD-712 533.
25-2450
FROST ACTION, AIRCRAFT LANDING AREAS, PAVEMENT BASES, DESIGN CRITERIA.
The purpose of the report is to unify and summarize the results of observations and tests made at various airfields in the U.S. and reported in detail as appendices to this report, and to present the recommended design and evaluation criteria resulting from a study of the accumulated data.

**ACFEL TR 6 APP 1**
**FROST INVESTIGATION 1944-1945. APPENDIX 1. REPORT ON DOW FIELD, BANGOR, MAINE.** June 1945, 248p., AD-712 362.
25-2451
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENT BASES, SOIL MECHANICS, TRAFFICABILITY.
The report presents the results of the frost investigation conducted at Dow Field, Bangor, Maine during the period from September 1944 through June 1945. The investigation at Dow Field includes 3 test areas in which observations were made of ground water table, frost penetration, ice segregation, water content and density. Pavement bearing tests, traffic tests and foundation modulus tests were conducted.

**ACFEL TR 6 APP 11/12**
**FROST INVESTIGATION 1944-1945. APPENDIX 11. REPORT ON SUBSURFACE TEMPERATURE INVESTIGATIONS AT PIERRE AIRFIELD, PIERRE, SOUTH DAKOTA, WATERTOWN AIRFIELD, WATERTOWN, SOUTH DAKOTA, FARGO MUNICIPAL AIRFIELD, FARGO, NORTH DAKOTA. APPENDIX 12. REPORT ON SUBSURFACE TEMPERATURE INVESTIGATIONS AT DOW FIELD, BANGOR, MAINE, PRESQUE ISLE AIRFIELD, PRESQUE ISLE, MAINE.** June 1945, 123p., AD-712 478.
25-2458
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENT BASES, TEMPERATURE MEASUREMENT, SOIL TEMPERATURE.
The purpose of the subsurface temperature investigations was the determination of the temperature changes occurring in and beneath airfield pavements during winter weather conditions, and a correlation of this data with air temperature and cumulative degree-days below freezing data obtained during the same period of time. Depth of freezing temperature penetration and data relative to heat movements through the surface and from deep earth were also obtained.

**ACFEL TR 6 APP 13**
**FROST INVESTIGATION 1944-1945. APPENDIX 13. REPORT ON LABORATORY TESTS ON FROST PENETRATION AND THERMAL CONDUCTIVITY OF COHESIONLESS SOILS.** June 1945, 44p., AD-712 471.
25-2459
AIRCRAFT LANDING AREAS, PAVEMENTS, SOIL TEMPERATURE, THERMAL CONDUCTIVITY, FROST PENETRATION, TESTS.
The purpose of this investigation was to study temperature changes within laboratory specimens of sand due to suddenly impressed surface temperatures and the thermal conductivity of several representative materials commonly used for base course construction beneath pavements and one sample of bituminous concrete. The materials selected for testing were limited to those which are non-frost susceptible, that is materials in which frost action is not possible. In connection with the analysis of test results it was necessary to utilize and develop theoretical solutions for temperature changes under ideal conditions. These studies are included in this report. Also included is a brief summary of the work accomplished by H. E. Patten on thermal conductivity and the results of his investigations are compared with those reported herein. All tests for thermal conductivity were limited to the material in the unfrozen state.

**ACFEL TR 6 APP 14**
**FROST INVESTIGATION 1944-1945. APPENDIX 14. REPORT ON LABORATORY AND FIELD TEST PROCEDURES. PART 1. MISSOURI RIVER DIVISION. PART 2. GREAT LAKES DIVISION. PART 3. BOSTON DISTRICT.** June 1945, 42p., AD-712 472.
25-2460
AIRCRAFT LANDING AREAS, PAVEMENT BASES, FROST PENETRATION, SOIL MECHANICS, TESTS.

The report describes test methods and procedures used for investigation of frost action beneath airfield pavements in selected areas of the United States.

**ACFEL TR 6 APP 15**
**FROST INVESTIGATION 1944-1945. APPENDIX 15. BIBLIOGRAPHY.** June 1945, 11p., AD-712 470.
25-2461
BIBLIOGRAPHIES, FROST ACTION, PAVEMENT BASES.
The bibliography is a reference to published articles on subject matter related to frost phenomena. Most of the publications listed have influenced the general development of laboratory and field procedures for frost investigations.

**ACFEL TR 6 APP 2**
**FROST INVESTIGATION 1944-1945. APPENDIX 2. REPORT ON PRESQUE ISLE AIRFIELD, PRESQUE ISLE, MAINE.** June 1945, 106p., AD-712 382.
25-2452
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENT BASES, SOIL MECHANICS, FROST HEAVE, TRAFFICABILITY.
The purpose of the investigation was the determination of development of frost action in the soils underlying airfield pavements as affected by various conditions of weather, soils, and ground water. The report presents the results of the frost investigation conducted at Presque Isle Airfield, Presque Isle, Maine during the period from 22 October 1944 through 16 June 1945.

**ACFEL TR 6 APP 3/4**
**FROST INVESTIGATION 1944-1945. APPENDICES 3/4. REPORT ON OTIS FIELD, SANDWICH MASSACHUSETTS, AND HOULTON AIRFIELD, HOULTON, MAINE.** June 1945, 112p., AD-712 426.
25-2453
AIRCRAFT LANDING AREAS, FROST PENETRATION, SUBGRADES, SOIL MECHANICS, WATER CONTENT.
The report presents the results of the frost investigation conducted at Otis Field, Sandwich, Massachusetts and Houlton Airfield, Houlton, Maine during the period from November 1944 through May 1945. The investigation includes test areas in which observations were made of frost penetration, ice segregation, water content, and density. In place C. B. R. tests were made on the subgrade soil. Atterberg limits and mechanical analysis tests were performed on representative samples. The climatic and other general conditions related to the frost investigation also are included in this report.

**ACFEL TR 6 APP 5**
**FROST INVESTIGATION 1944-1945. APPENDIX 5. REPORT ON TRUAX FIELD, MADISON, WISCONSIN.** June 1945, 145p., AD-712 383.
25-2454
AIRCRAFT LANDING AREAS, FROST PENETRATION, FROST HEAVE, PAVEMENT BASES, SOIL MECHANICS.
The purpose of this report is to present the complete results of the investigation performed by the Milwaukee District at Truax Field. The general scope of the investigation included field tests to determine the development of frost in the soil and changes in soil and pavement conditions as a result of the frost; laboratory tests on pavement, base and subgrade materials; and traffic tests during the frost melting period.

**ACFEL TR 6 APP 6**
**FROST INVESTIGATION 1944-1945. APPENDIX 6. REPORT ON PIERRE AIRFIELD, PIERRE, SOUTH DAKOTA.** June 1945, 151p., AD-712 388.
25-2455
AIRCRAFT LANDING AREAS, PAVEMENT BASES, FROST HEAVE, SOIL MECHANICS, FROST ACTION, BEARING CAPACITY.
The report covers a comprehensive investigation of moisture and density changes occurring in the various pavement subsurface elements during the period from early fall, 1944, through the spring thaw period in 1945, the measurement of heaving of the pavement caused by frost action; and the determination, by means of accelerated traffic tests, of the carrying capacity of the airfield pavements during and immediately after thaw. The investigation includes both flexible and rigid type pavements, with further investigations of conditions under turf surfaces and of soils in specially constructed test boxes.

**ACFEL TR 6 APP 7**
**FROST INVESTIGATION 1944-1945. APPENDIX 7. REPORT ON WATERTOWN AIRFIELD, WATERTOWN, SOUTH DAKOTA.** June 1945, 70p., AD-712 389.
25-2456
AIRCRAFT LANDING AREAS, FROST ACTION, PAVEMENT BASES, BEARING CAPACITY, SOIL MECHANICS.
The purpose of the investigation was the determination of the development of frost action in pavement elements as affected by varying conditions of weather, soils, and ground water; and further, the obtaining of data relative to the reduct on of load carrying capacities of the pavements caused by the action of frost in the various pavement elements. The invest gation at Watertown Airfield was made to determine the effects of frost in an area having generally severe winter temperature conditions, a fairly high rate of annual precipitation, a high water table, and subsurface conditions favoring the development of frost action during the winter period.

**ACFEL TR 6 APP 8/10**
**FROST INVESTIGATION 1944-1945. APPENDICES 8, 9, AND 10. REPORT ON CASPER AIRBASE, CASPER, WYOMING; FARGO MUNICIPAL AIRFIELD, FARGO, NORTH DAKOTA; AND BISMARCK MUNICIPAL AIRFIELD, BISMARCK, NORTH DAKOTA.** 1945, 70p., AD-712 390.
25-2457
AIRCRAFT LANDING AREAS, FROST ACTION, PAVEMENT BASES, HYDROLOGY, METEOROLOGICAL FACTORS.
This report contains analyses of three airfields under varying hydrological and meteorological parameters and describes the effect of frost action on existing landing strips.

**ACFEL TR 7**
**REPORT ON FROST INVESTIGATION 1944-1945.** April 1947, 167p., AD-712 489, 112 refs.
25-2462
AIRCRAFT LANDING AREAS, PAVEMENT BASES, SOIL MECHANICS, FROST ACTION, DESIGN CRITERIA.
The purpose of the frost investigation was to provide test data and analyses to establish criteria and methods for the design of airfield pavements where conditions are conducive to frost action, both in theaters of operation and in the United States; and to establish criteria and methods for the evaluation of airfield pavements where subgrade soils or base courses experience frost action. The purpose of this report is to unify and summarize the results of observations and tests made at various airfields in the U. S. and to present design and evaluation criteria resulting from a study of the accumulated data.

**ACFEL TR 8**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE 1946-1947. REPORT OF INVESTIGATIONS.** May 1947, 320p., AD-741 269.
27-1273
AIRCRAFT LANDING AREAS, ICE RUNWAYS, SNOW (CONSTRUCTION MATERIAL), SEA ICE, ICE STRENGTH.
A preliminary investigation of the feasibility of and methods for the design, construction and maintenance of airdromes on ice was conducted by the Soils Laboratory of the New England Division during the 1946-1947 fiscal year. The phenomena of formation and melting of ice were reviewed. A few of the pertinent characteristics of snow were examined. Data on locations and characteristics of possible airdrome sites in the Arctic and Sub-Arctic were compiled, and maps were prepared. (Auth.)

**ACFEL TR 8 APP A**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE 1946-1947. APPENDIX A. AVIATION USES OF ICE.**
Stefansson, W., May 1947, 129p., AD-712 473.
25-2463
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), SNOW (CONSTRUCTION MATERIAL), SURFACE PROPERTIES, TEMPERATURE, PERIODIC VARIATIONS.
The report describes the feasibility of landing strip construction on snow and ice environments in the Arctic regions.

**ACFEL TR 8 APP B**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES IN ICE 1946-1947. APPENDIX B. TRANSLATIONS.** May 1947, 243p., AD-712 536, Also designated ACFEL TL 1-4.
25-2464
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), EXPEDITIONS, ICE ISLANDS, ICE MECHANICS, SEA ICE.
Includes Trans-1, Sea Ice, by A. Burke, Moscow, 1940; Trans-2, In the Center of the Arctic, by N. N. Zubov, Leningrad, 1940, with notes by Vilhajalmur Stefansson; Trans-3, Air expedition to High Latitudes of the Arctic in 1941, by D. B. Karelin, pub. in Vsesoiuznoe geograficheskoe obshchestvo. Izvestiia (USSR) Vol.77 No.3 p.164ff 1945; and Trans-4, Airfields on Ice by G. Volkov, pub. in Morskoĭ sbornik (USSR) Vol.3 p.77-78, 1940.

**ACFEL TR 9**
**FROST INVESTIGATION 1945-1946. COMPREHENSIVE REPORT.** June 1947, 159p., AD-712 357, Also designated ACFEL TL 6-8.
25-2465
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENTS, FROST HEAVE, SOIL MECHANICS, BEARING CAPACITY, ANALYSIS (MATHEMATICS).
The frost investigation program for the fiscal year 1945-1946 was conducted by the Frost Effects Laboratory in the New England Division with the cooperation of the Great Lakes Division and the Missouri River Division. Field investigations were made at nine airfields, with varying subsurface conditions, located in the northern part of the United States and laboratory studies at the Frost Effects Laboratory. This report contains a method of predicting the depth of frost penetration, based upon the properties of the soils encountered. A study of the pavement failures which were caused by frost action or to which frost action was a contributing cause is presented.

**ACFEL TR 9 APP 1**
**FROST INVESTIGATION 1945-1946. REPORT ON DOW FIELD, BANGOR, MAINE.** June 1946, 101p., AD-712 356.
25-2466
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENT BASES, FROST HEAVE, SOIL MECHANICS, WATER CONTENT.
The report presents the results of the frost investigation conducted at Dow Field, Bangor, Maine during the period from 11 October 1945 through June 1946. The investigation at Dow Field includes four test areas in which observations were made of ground water table, subsurface temperatures, frost penetration, ice segregation, water content, and density. Plate bearing tests were conducted. The climatic and other general conditions related to the frost investigation at Dow Field also are included in this report.

**ACFEL TR 9 APP 2/3**
**FROST INVESTIGATION 1945-1946. REPORTS ON PRESQUE ISLE AIRFIELD, PRESQUE ISLE, MAINE AND BEDFORD AIRFIELD, BEDFORD, MASS.** June 1946, 138p., AD-712 353.
25-2467
AIRCRAFT LANDING AREAS, SUBGRADES, FROST PENETRATION, PAVEMENT BASES, FROST HEAVE, WATER CONTENT, SOIL MECHANICS.
The reports present the results of the frost investigation conducted at Presque Isle, Maine, and Bedford, Mass., Airfields during the period Oct. 1945-June 1946. The investigation included four test areas in which observations were made of ground water table, subsurface temperatures, frost penetration, ice segregation, pavement heave, water content, and density. Plate bearing tests were conducted. The climatic and other general conditions related to the frost investigation at Presque Isle Airfield and Bedford Airfield are included in these reports.

**ACFEL TR 9 APP 4**
**FROST INVESTIGATION 1945-1946. REPORT ON TRUAX FIELD, MADISON, WISCONSIN.** June 1946, 107p., AD-712 354.
25-2468
AIRCRAFT LANDING AREAS, FROST PENETRATION, SUBGRADES, FROST HEAVE, SOIL MECHANICS.
The scope of the investigation at Truax Field included periodic test pits to determine the changes in soil conditions, observation of air and subsurface temperatures, ground water observations, measurement of frost heave and subsidence, and field plate bearing tests.

**ACFEL TR 9 APP 5/6**
**FROST INVESTIGATION 1945-1946. REPORTS ON PIERRE AIRFIELD, PIERRE, SOUTH DAKOTA AND SIOUX FALLS AIRFIELD, SIOUX FALLS, SOUTH DAKOTA.** June 1946, 148p., AD-712 553.
25-2469
AIRCRAFT LANDING AREAS, FROST PENETRATION, SOIL MECHANICS, PAVEMENT BASES, FROST HEAVE.
The report presents the results of the frost investigation conducted at Pierre Airfield, Pierre, South Dakota, Sioux Falls Airfield, Sioux Falls, S. D., during the period 14 November 1945 through June 1946, and supplements the results of the investigations conducted during the period 13 November 1944 through 1 May 1945, and reported on in June 1945. The investigation included the observation of subsurface temperatures, frost penetration, pavement heaving and ground water table.

**ACFEL TR 9 APP 7/9**
**FROST INVESTIGATION 1945-1946. REPORT ON WATERTOWN AIRFIELD, WATERTOWN, SOUTH DAKOTA, FARGO MUNICIPAL AIRFIELD, FARGO, NORTH DAKOTA AND GREAT BEND AIRFIELD, GREAT BEND, KANSAS.** June 1946, 102p., AD-712 355.
25-2470
AIRCRAFT LANDING AREAS, PAVEMENT BASES, FROST HEAVE, FROST PENETRATION, GROUND WATER.
This report presents the results of the frost investigations conducted at Watertown Airfield, Fargo Municipal Airfield, and Great Bend Airfield during the period November 1945 through May 1946. The investigations included the measurement of pavement heaving caused by frost action, the observation of subsurface temperatures, frost penetration and ground water table. The investigations include both flexible and rigid type pavements.

**ACFEL TR 10**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE 1946-1947. REPORT OF LANDINGS ON ICE AT CAMBRIDGE BAY, CANADA.** June 1947, 63p., AD-712 554.
25-2471
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), ICE BEARING CAPACITY, SNOW COVER EFFECT, MAINTENANCE, CONSTRUCTION.
Field observations were made of the operation of wheeled aircraft from water supported ice at Cambridge Bay, Victoria Island, Canada for 'Project Beetle'. Observations and studies were made as follows: Effect of airplane wheel loads on ice; effect of snow cover on operation of wheeled aircraft on ice; effect of weather on ice formation; effect of operation of construction and maintenance equipment on ice surfaces; effect of oil, gasoline and debris on ice surfaces; and construction and maintenance of snow covered ice airfield.

**ACFEL TR 11**
**FROST INVESTIGATION 1946-1947. REPORT ON STUDIES OF BASE COURSE TREATMENT TO PREVENT FROST ACTION.** Aug. 1947, 58p., AD-712 493, 7 refs.
25-2472
PAVEMENTS, AIRCRAFT LANDING AREAS, FROST ACTION, ADMIXTURES, SOIL FREEZING, ICE PREVENTION, TESTS.
The report presents the results of the investigations made since those reported in 'Report on Studies of Base Course Treatment to Prevent Frost Action', June 1946. It presents a study of previous investigations to determine the relationship between void ratio and the amount of salt required to prevent frost action, the results of laboratory tests to determine the effect of rock content of soils on the amount of admixture required to make them non-frost susceptible, and the results of laboratory tests to determine the effectiveness of 'Darex AEA' as an admixture for preventing frost action. Representative data are presented.

**ACFEL TR 12**
**MOLE DRAINAGE INVESTIGATION 1946-1947. DRAFT REPORT.** June 1947, 101p., AD-712 555, 19 refs.
25-2473
AIRCRAFT LANDING AREAS, SUBSURFACE DRAINAGE, EARTH HANDLING EQUIPMENT, PIPES (TUBES).
Mole drainage as used in agriculture consists of towing a specially constructed plow through the earth to make a hole three or four inches in diameter, parallel and approximately two to three feet below the ground surface with a narrow slot to the ground surface cut by the vertical blade of the plow. The purpose of this investigation is to develop a method of placing a strengthening liner on the walls of a mole hole and to determine the feasibility of adapting this type of drainage to airfield subgrades and shoulders, both as an aid during construction and as a method of installing permanent subsurface drainage systems.

**ACFEL TR 13**
**SUBSURFACE DRAINAGE INVESTIGATION, 1946-1947. (DRAFT) COMPREHENSIVE REPORT.** July 1947, 165p., AD-712 431.
25-2474
AIRCRAFT LANDING AREAS, SUBSURFACE DRAINAGE, MODELS, RAINFALL, RUNOFF, FLUID FLOW, ANALYSIS (MATHEMATICS).
The basic purpose of the subsurface drainage investigation is to establish design criteria for inclusion in the Engineering Manual, with the secondary purpose of investigating the effectiveness of drainage systems at several existing airfields. The study includes the investigation of both combination and subsurface drains. The investigation of combination drains consists of obtaining rainfall and runoff records at test areas on three selected airfields. The investigation of subsurface drains to date has consisted of observing the operation of subsurface drainage installations of six airfields, by means of observation wells and drain discharge measurements. The data obtained at these field sites are presented in this report. A theoretical analysis of base course drainage was made during the fiscal year 1945 - 1946. This analysis was supplemented by viscous fluid model tests and full scale field drainage tests were conducted to verify theoretical formulas.

**ACFEL TR 14**
**COMPREHENSIVE REPORT, TURF RUNWAY INVESTIGATION 1946-1947. (DRAFT).** July 1947, 170p., AD-712 436.
25-2475
AIRCRAFT LANDING AREAS, TRAFFICABILITY, DRAINAGE, SUBGRADE SOILS, TURF RUNWAYS, TESTS.
A field section simulating a portion of a turf runway and shoulder was constructed at Fort Ruckman, Nahant, Massachusetts. Recording equipment was installed at the test section, observations made and field and laboratory tests performed as required to accomplish the stated purposes. This report presents the essential details of the construction of the test section, describes the observation equipment and presents the observed data obtained during the Fiscal Year 1946-1947.

**ACFEL TR 15**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE 1947-1948. REPORT OF ENGINEER OBSERVERS ON PROJECT SNOWMAN OF ATLANTIC DIVISION, ATC.** Dec. 1947, 201p., AD-712 653.
25-2476
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), AIRCRAFT OPERATIONS, RESEARCH PROJECTS, CONSTRUCTION, MAINTENANCE, GREENLAND.
Project Snowman was organized and carried out by the Atlantic Division, Air Transport Command during the summer of 1947 in order to investigate a portion of the Greenland Ice Cap with the objects of determining search and rescue procedures and equipment appropriate for that area and of determining feasibility of using the Ice Cap surface for air operations. The report presents principally the observations and tests made by the Engineer Observers during Project Snowman. However, some data developed by other members of the Project are also included which are pertinent to the overall problem of construction and maintenance of airfields on the Ice Cap.

**ACFEL TR 16**
**FROST INVESTIGATION 1946-1947. COMPREHENSIVE REPORT.** April 1948, 59p., AD-712 469.
25-2477
AIRCRAFT LANDING AREAS, CONCRETE PAVEMENTS, FROST ACTION, SOIL MECHANICS, FROST PENETRATION, PAVEMENT BASES.
Field investigations were made at five airfields, with varying subsurface conditions, located in the northern part of the United States and laboratory studies were conducted at the Frost Effects Laboratory. The purpose of the investigations was to augment the tests made and data obtained from the frost investigations conducted during the years 1944 to 1946 inclusive. The report with the appendices presents the data obtained during the fiscal year 1946-1947 with the conclusions based on these studies. On the basis of these studies, a change in the design curves for rigid pavements is recommended which would decrease the required thickness of concrete for the 60,000 and 150,000 pound wheel load designs by one inch in most cases.

**ACFEL TR 16 APP 1**
**FROST INVESTIGATION 1946-1947. APPENDIX 1. REPORT ON NEW ENGLAND DIVISION INVESTIGATIONS.** Aug. 1947, 234p., AD-712 430.
25-2478
AIRCRAFT LANDING AREAS, FROST PENETRATION, SOIL MECHANICS, WATER CONTENT, PAVEMENT BASES, TRAFFICABILITY.
This report contains, in detail, a description of tests and methods, the data collected, and the results of the frost investigation conducted during the period from 1 July 1946 through 2 July 1947. The investigation included four test areas in which observations were made of ground water table, subsurface temperatures, frost penetration, ice segregation, water content, and density. Plate bearing tests were conducted.

**ACFEL TR 16 APP 2**
**FROST INVESTIGATION 1946-1947. REPORT ON GREAT LAKE DIVISION INVESTIGATIONS. APPENDIX 2. REPORT ON SELFRIDGE FIELD, MICHIGAN.** Aug. 1947, 53p., AD-712 432.
25-2479
AIRCRAFT LANDING AREAS, CONCRETE PAVEMENTS, FROST HEAVE, GROUND WATER, FROST PENETRATION, PAVEMENT BASES.
The purpose of the frost investigation was the determination of development of frost action in the soils underlying airfield Portland cement concrete pavements as affected by the various conditions of weather, soils, and ground water at Selfridge Field.

**ACFEL TR 16 APP 3**
**FROST INVESTIGATION 1946-1947. REPORT ON MISSOURI RIVER DIVISION INVESTIGATIONS. APPENDIX 3. REPORT ON SIOUX FALLS AIRFIELD, SIOUX FALLS, SOUTH DAKOTA.** Aug. 1947, 92p., AD-712 435.
25-2480
AIRCRAFT LANDING AREAS, PAVEMENT BASES, FROST HEAVE, FROST PENETRATION, GROUND WATER, WEATHER.
The report presents the results of the frost investigation conducted at Sioux Falls Airfield, Sioux Falls, South Dakota, during the period 5 September 1946 through 3 June 1947, and supplements the results of the investigations conducted during the period from early fall, 1944 through June 1946, and reported on in June 1945 and June 1946. The investigation at Sioux Falls included the measurement of pavement heaving caused by frost action, test pits for water content, the observation of subsurface temperatures, frost penetration, and ground water table. The investigation was made on both flexible and rigid type pavements.

**ACFEL TR 17**
**DATA REPORT 1946-1948 OF TURF RUNWAY INVESTIGATION AT FORT RUCKMAN.** Aug. 1948, 170p., AD-712 387.
25-2481
AIRCRAFT LANDING AREAS, DRAINAGE, CONSTRUCTION, RUNOFF, TRAFFICABILITY, SUBGRADE SOILS, TURF RUNWAYS.
A field test section was constructed at Fort Ruckman, Nahant, Massachusetts and observation equipment installed for recording rainfall, surface and subsurface runoff. This report presents the essential details of the construction of the test section, describes the observation equipment and presents the observed data obtained up until 30 June 1948.

**ACFEL TR 18**
**STRENGTH AND USES OF FRESH AND SALT WATER ICE.**
Hansen, R., et al, Jan. 1949, 36p., AD-661 627, 15 refs. Also designated ACFEL TR 18.
Linell, K.A.
25-2482
ICE BEARING CAPACITY, ICE COVER STRENGTH, SEA ICE.
The report is an analysis of the structural usefulness of fresh and salt water ice in the Arctic. The uses of both sea ice and fresh water ice as an aid to transportation are given. Ranges of ice strength test results are given in tables.

**ACFEL TR 19/1**
**INVESTIGATION OF AIRFIELD DRAINAGE ARCTIC AND SUBARCTIC REGIONS. PART I. FIELD RECONNAISSANCE AND ANALYSIS.**
Straub, L.G., et al, April 1949, 186p., AD-703 392, 30 refs.
Johnson, L.A.
25-2483
AIRCRAFT LANDING AREAS, DRAINAGE, CONSTRUCTION, MAINTENANCE, ICING, RUNOFF, CLIMATOLOGY, DESIGN CRITERIA, UNITED STATES—ALASKA.
The ultimate aim of the investigations and studies is the determination of design, construction, and maintenance procedures suitable for the drainage of airfields located in arctic and subarctic regions. The report is intended to summarize the outcome of a field investigation of selected sites in Alaska.

**ACFEL TR 19/1 SUPP**
**INVESTIGATION OF AIRFIELD DRAINAGE ARCTIC AND SUBARCTIC REGIONS, FIELD RECONNAISSANCE AND ANALYSIS.**
Straub, L.G., et al, Jan. 1950, 87p., AD-712 427, 69 refs.
Johnson, L.A.
25-2484
AIRCRAFT LANDING AREAS, DRAINAGE, HYDROLOGY, ROADS, ICING, RUNOFF, WATERSHEDS, EROSION, UNITED STATES—ALASKA.
The report summarizes observations that were made during a field trip to Alaska in the spring of 1949. Principal objectives of this phase of the Arctic and Subarctic Airfield Drainage Investigation were (1) to make supplemental on-the-ground observations over a wide range of hydrological phenomena, (2) to note the various forms and effects of icing, (3) to observe springtime runoff from natural watersheds, and (4) to crystallize the findings of activity completed at this time into definite recommendations and point out various aspects where continuation and even expansion of research and study are essential.

**ACFEL TR 19/2**
**INVESTIGATION OF AIRFIELD DRAINAGE ARCTIC AND SUBARCTIC REGIONS. PART II. TRANSLATION OF SELECTED TOPICS.**
April 1949, 148p., AD-462 973, 44 refs.
25-2485
COLD WEATHER CONSTRUCTION, DRAINAGE, BIBLIOGRAPHIES, SOIL FREEZING, SEASONAL FREEZE THAW, ICING, WATERPROOFING, PERMAFROST, COUNTERMEASURES.
The report is a collection of translations of selected topics from three Russian sources and is composed of three parts. Water proofing and drainage of defense and nondefense structures, is an exact translation, including six chapters corresponding respectively to Chapters I, II, III, IV, VIII, and XIV of the original text. The next part, Abstracts of scientific research work for 1945, Obruchev Institute of Frost Science, is also an exact translation; it includes only that section of the original manuscript which contains the reports of the Institute of Frost Science. The last part, Icings and countermeasures is a detailed abstract of the original test.

**ACFEL TR 20/1**
**DATA REPORT OF FROST INVESTIGATIONS FISCAL YEARS 1943-1949.** June 1949, 433p., AD-712 437, 334 refs.
25-2486
AIRCRAFT LANDING AREAS, PAVEMENTS, SUBGRADES, PAVEMENT BASES, FROST PENETRATION, FROST HEAVE, THERMAL PROPERTIES, EXPERIMENTAL DATA, TESTS.

The overall purpose of the frost investigational program is to develop and establish design and evaluation criteria for concrete and flexible pavements placed on subgrade or base soils subject to seasonal frost action. The specific purpose of this report is to present in unified form all data and results of tests obtained during the four years of frost investigations conducted at 17 different sites in northern United States together with results of the supplemental laboratory and theoretical studies. The report presents all data obtained from frost investigations for both field and laboratory tests conducted under the supervision of the Frost Effects Laboratory. No analyses of data or conclusions are presented.

**ACFEL TR 20/2**
**DATA REPORT OF FROST INVESTIGATIONS 1943-1949. INVESTIGATIONS IN THE NEW ENGLAND DIVISION.** June 1949, 480p., AD-712 538.
25-2487
AIRCRAFT LANDING AREAS, PAVEMENTS, FROST PENETRATION, SOIL MECHANICS, STATISTICAL DATA, SOIL FREEZING, TRAFFICABILITY.
The report contains statistical data obtained from frost investigations performed on numerous New England airfields.

**ACFEL TR 20/3**
**DATA REPORT OF FROST INVESTIGATIONS 1943-1949. INVESTIGATIONS IN THE GREAT LAKES AND MISSOURI RIVER DIVISIONS.** June 1949, 465p., AD-712 539.
25-2488
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENTS, SOIL MECHANICS, SOIL FREEZING, STATISTICAL DATA, TRAFFICABILITY.
The report is a compilation of statistical data obtained as a result of frost investigation performed on various airfields in the midwestern and northwestern United States.

**ACFEL TR 21**
**IDENTIFICATION AND EVALUATION OF ALASKAN VEGETATION FROM AIRPHOTOS WITH REFERENCE TO SOIL MOISTURE AND PERMAFROST CONDITIONS. PRELIMINARY PAPER.**
Stoeckeler, E.G., June 1949, 103p., AD-139 314, Part of Investigation of airfield construction in the Arctic and Subarctic regions. 32 refs.
25-2489
AERIAL PHOTOGRAPHY, PERMAFROST INDICATORS, PHOTOINTERPRETATION, TERRAIN ANALYSIS, SOIL MOISTURE, UNITED STATES—ALASKA.
The purpose of this paper was to familiarize the airphoto interpreter with basic natural influences which govern plant growth and distribution; the value of vegetation as an indicator of soil texture, drainage, and permafrost conditions; and the description of airphoto patterns of the different cover types occurring in the permafrost zone of Alaska.

**ACFEL TR 22**
**INVESTIGATION OF SNOW COMPACTION METHODS 1949.** June 1949, 216p., AD-495 992, Conducted for Engineer Research and Development Laboratories, FY 1949.
25-2490
AIRCRAFT LANDING AREAS, SNOW COMPACTION, EQUIPMENT, MODELS, TRAFFICABILITY, SNOW BEARING STRENGTH, ELASTIC PROPERTIES, TESTS.
Field tests were performed with both full scale and scale model equipment. Full scale tests were performed to measure effectiveness of various types of compaction and steam injection apparatus and to examine the effect of repeated breaking up and recompaction of the snow. Scale model pontons were used to investigate effects of individual variables on compaction results. Additional studies were performed covering static laboratory compaction, California Bearing Ratio, modulus of elasticity and photomicrography. This paper describes tests conducted and presents in detail the results obtained, together with conclusions based on the results, and recommendations concerning future investigations.

**ACFEL TR 22 APP**
**INVESTIGATION OF SNOW COMPACTION METHODS 1949. APPENDIX.** June 1949, 248p., AD-495 993, Conducted for Engineer Research and Development Laboratories, FY 1949.
25-2491
AIRCRAFT LANDING AREAS, SNOW COMPACTION, EQUIPMENT, SNOW BEARING STRENGTH, MOISTURE FACTORS, ELASTIC PROPERTIES, SNOW CRYSTALS.
Contains tables, and plates of test results, photographs, and descriptions of specialized test procedures: modulus of elasticity and frequency measurements, and equipment and techniques used in taking photomicrographs.

**ACFEL TR 23**
**LABORATORY RESEARCH FOR THE DETERMINATION OF THE THERMAL PROPERTIES OF SOILS.**
Kersten, M.S., June 1949, 235p., AD-712 516, Final report.
25-2492
SOILS, THERMAL CONDUCTIVITY, PERMAFROST THERMAL CONDUCTIVITY, THERMAL INSULATION, DIFFUSIVITY, UNITED STATES—ALASKA.
The report presents the results of an investigation to determine the thermal properties of a variety of soils and insulating materials. This study represents only one phase of a comprehensive program of research. In addition to the thermal tests on soils, the program was extended to include tests on pre-cast insulating slabs and an asphalt paving mixture. Since this is the final report on the investigation, the data are given in detail; the thermal conductivity test data on soils are tabulated in appendix 1. In the discussion of the effects of various factors, graphs for just one or two soils are given in the body of the report, and similar curves for the other soils are included in an appendix.

**ACFEL TR 24**
**REPORT ON FROST INVESTIGATION 1944-1945. ADDENDUM 1, 1945-1947.** Oct. 1949, 213p., AD-712 479, 28 refs.
25-2493
AIRCRAFT LANDING AREAS, PAVEMENTS, TRAFFICABILITY, FROST PENETRATION, THERMAL PROPERTIES, SOIL MECHANICS, TESTS, ANALYSIS (MATHEMATICS).
The purpose of the report is to present the results of studies made and data obtained during the frost investigation program for the fiscal years 1945-1946 and 1946-1947 and to recommend warranted revisions to Chapter 4, Part XII of the Engineering Manual entitled Frost Conditions. This report was prepared as an addendum to the Report on Frost Investigation, 1944-1945 dated April 1947 (see 25-2462).

**ACFEL TR 25**
**DEVELOPMENT OF ICE MECHANICS TEST KIT. FINAL REPORT.** March 1950, 166p., AD-712 490, Investigation made for U.S. Navy. Hydrographic Office.
25-2494
SEA ICE, TEST EQUIPMENT, ICE CORING DRILLS, CORING, ICE MECHANICS.
A portable test kit has been developed in which is included hand-operated equipment for penetrating ice to a depth of 15 feet or more and for obtaining ice specimens, together with equipment for measuring ice thickness, density, salinity, temperature and compressive strength. With construction of necessary adapters, additional tests may be performed, such as tension, shear, and flexure strength tests. A specially-designed auger included in the kit is of particular interest providing hitherto unavailable equipment for drilling and coring ice.

**ACFEL TR 26**
**TURF EVALUATION, SECTION 6, FORT RUCKMAN, NAHANT, MASSACHUSETTS.** March 1950, 22p., AD-495 991.
25-2495
AIRCRAFT LANDING AREAS, GROWTH, TURF RUNWAYS, GRASSES.
The report presents results of a turf evaluation study of Section 6 (Turf Runway Test Section) constructed during late summer 1946, Fort Ruckman, Mass. The specific purpose was to determine the relationship between existing plant population and seed mixture used, and the effect of various fertility treatments on plant population and on root development.

**ACFEL TR 27**
**PREPARATIONS OF FROST EFFECTS LABORATORY FOR PROJECT OVERHEAT. FINAL REPORT.** June 1950, 170p., AD-712 477.
25-2496
AIRCRAFT LANDING AREAS, COLD WEATHER CONSTRUCTION, TEST EQUIPMENT, ICE MECHANICS, SNOW MECHANICS, GREENLAND.
Project Overheat was organized by the Military Air Transport Service, U.S. Air Force to extend the studies on the Greenland Ice Cap which were initiated in Project Snowman in 1947. The Corps of Engineers was invited to participate in Project Overheat by the Military Air Transport Service, and the Frost Effects Laboratory was designated by the Chief of Engineers to assign technical personnel, and to plan and execute investigations of surface and subsurface conditions, on the Ice Cap, in developing its use as a landing area for aircraft. After preparations had been carried to a relatively advanced stage, the U. S. Air Force found it necessary to terminate the project because of other commitments. This report summarizes the equipment preparations made by the Frost Effects Laboratory up to the time of the termination, in order that the information may be available in planning future projects.

**ACFEL TR 28**
**INVESTIGATION OF MILITARY CONSTRUCTION IN ARCTIC AND SUBARCTIC REGIONS, 1945-1948. COMPREHENSIVE REPORT.** June 1950, 149p., AD-703 360, 18 refs.
25-2497
AIRCRAFT LANDING AREAS, COLD WEATHER CONSTRUCTION, SOILS, THERMAL PROPERTIES, PERMAFROST INDICATORS, METEOROLOGICAL DATA, AERIAL PHOTOGRAPHY, UNITED STATES—ALASKA.
The report presents a summary of the data and results obtained from the beginning of the investigation. It includes results of tests at Northway Airfield, Eielson Air Force Base, Ladd Air Force Base, Alaska, and at the Fairbanks Research Area near Fairbanks, Alaska; data on construction equipment and methods; data collected at Alaskan weather stations; laboratory research on tests of thermal properties of soils and insulating materials; interpretation of frozen and unfrozen ground conditions from aerial photographs; library research; geophysical exploration methods; theoretical studies; and field tests of model structures.

**ACFEL TR 28 APP 1**
**INVESTIGATION OF MILITARY CONSTRUCTION IN ARCTIC AND SUBARCTIC REGIONS, 1945-1948. AIRFIELD SITE STUDIES AT NORTHWAY AIRFIELD, ALASKA.** June 1950, 76p., AD-703 363.
25-2498
COLD WEATHER CONSTRUCTION, AIRCRAFT LANDING AREAS, GROUND WATER, SOIL MECHANICS, DRAINAGE, PERMAFROST, UNITED STATES—ALASKA—NORTHWAY.
The object of this investigation is to collect basic physical data on soil characteristics, ground temperatures, groundwater, foundation designs, and other factors as they affect designs and construction at this site, with particular reference to permanently frozen ground and its associated problems. The purpose of this investigation is to observe the effect of permafrost on the facilities of the Northway Airfield throughout a series of seasonal cycles.

**ACFEL TR 28 APP 2**
**INVESTIGATION OF MILITARY CONSTRUCTION IN ARCTIC AND SUBARCTIC REGIONS 1945-1948. LIBRARY RESEARCH.** June 1950, 182p., AD-703 361.
25-2499
COLD WEATHER CONSTRUCTION, AIRCRAFT LANDING AREAS, BIBLIOGRAPHIES, PERMAFROST.
The objectives of the program are to prepare a bibliography on permafrost and allied subjects and to collect published information on permanently frozen ground and construction thereon.

**ACFEL TR 28 APP 3**
**INVESTIGATION OF MILITARY CONSTRUCTION IN ARCTIC AND SUBARCTIC REGIONS 1945-1948. DESIGN AND CONSTRUCTION STUDIES AT FAIRBANKS RESEARCH AREA.** June 1950, 122p., AD-703 362.
25-2500
COLD WEATHER CONSTRUCTION, AIRCRAFT LANDING AREAS, PAVEMENTS, FOUNDATIONS, SOIL MECHANICS, PERMAFROST, BUILDINGS, UNITED STATES—ALASKA—FAIRBANKS.
The Fairbanks Research Area was constructed for the purpose of providing an opportunity to observe various types of structures erected on permafrost under conditions that would be known and recorded from the beginning to the conclusions of operations.

**ACFEL TR 29**
**INVESTIGATIONS OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE, 1950. REPORT OF INVESTIGATIONS.** June 1950, 115p., AD-495 989, 117 refs.
25-2501
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), ICE BEARING CAPACITY, SNOW COVER, MAPS, BIBLIOGRAPHIES.
Investigations of the feasibility of, and methods for, construction and maintenance of airdromes on ice which had been made by the Frost Effects Laboratory of the New England Division in Fiscal Years 1947 and 1948, were continued and extended during Fiscal Year 1950. The report summarizes the investigations made during 1950, presents summary maps of ice and snow data, and a bibliography.

**ACFEL TR 29 APP A**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE, 1950. REPORT OF INVESTIGATIONS. APPENDIX A. TRANSLATIONS.** June 1950, 169p., AD-495 990, 100 refs. Also designated ACFEL TL 5.
25-2502
ICE BEARING CAPACITY, ICE CROSSINGS, ICE COVER STRENGTH, DEFORMATION, FLOATING ICE.
Contents: The Problem of Calculating the Load Carrying Capacity of the Ice Cover; Contribution to the Problem of Deformation of the Floating Ice Layer; The Calculation of the Load Carrying Capacity of Ice Crossings Based on the Theory of Central Bending of an Elastic Plate on an Elastic Foundation; Methods of Calculating the Load Carrying Capacity of Ice Crossings; The Problem of the Value of Temporary Resistance of Thawing Spring Ice to Bending; The Theoretical and Experimental Basis for the Tables of Load Carrying Capacity of the Ice Cover.

**ACFEL TR 30**
**LANDING ON ICE FOR PROJECT RESUPPLY 1950, RESOLUTE BAY PHASE.** June 1950, 103p., AD-125 198.
25-2503
AIRCRAFT LANDING AREAS, ICE (CONSTRUCTION MATERIAL), TEST EQUIPMENT, ICE OBSERVATION, MAINTENANCE, CANADA—NORTHWEST TERRITORIES—RESOLUTE BAY.
The investigation covered the period from 29 March to 17 April 1950 of the Resolute Resupply Project during Project Resupply 1950 and was accomplished by visual observation, by interviews with various personnel, and by use of ice mechanics test equipment.

**ACFEL TR 31**
**FROST INVESTIGATION 1949-1950. PAVEMENT SURFACE TEMPERATURE TRANSFER STUDY.** June 1950, 35p., AD-712 570.
25-2504
AIRCRAFT LANDING AREAS, PAVEMENTS, FROST PENETRATION, HEAT TRANSFER, SURFACE TEMPERATURE, STATISTICAL ANALYSIS.
The report presents the results of a study to determine the relationship between the Freezing Indexes computed using mean air temperature and those computed using pavement surface temperature. The study is based on subsurface temperature data available at the Frost Effects Laboratory consisting of periodic subsurface temperature readings throughout a complete normal freezing period from three airfields and limited readings from a fourth airfield, all located in the northern part of the United States. From these readings a factor for modifying the Air Freezing Index is obtained and applied to the theoretical equations, and a correlation made between the observed depth and predicted depth of frost penetration.

**ACFEL TR 32**
**FROST INVESTIGATIONS 1949-1950. SUMMARY TABULATION OF AIRFIELD PAVEMENTS 1943-1949, AT AIR FORCE INSTALLATIONS CONSTRUCTED ON FROST SUSCEPTIBLE SUBGRADES.** June 1950, 59p., AD-712 581.
25-2505
AIRCRAFT LANDING AREAS, PAVEMENT BASES, SUBGRADES, FROST ACTION, TRAFFICABILITY, STATISTICAL DATA.
The report presents a summary tabulation of the pertinent data on pavements, base courses, and subgrades and on traffic histories from twenty-five Air Force bases where the pavement design is affected by frost conditions. The gross plane load evaluations of the pavements during both the normal period, where there is no weakening due to frost melting, and during the frost melting period were determined. Results of pavement condition surveys made at fifteen of the airfields are tabulated and correlated with the pavement evaluations and traffic histories.

**ACFEL TR 33**
**FROST INVESTIGATIONS 1949-1950. INTERIM REPORT OF COLD ROOM STUDIES.** July 1950, 149p., AD-712 624.
25-2506
FROST ACTION, COLD CHAMBERS, TEST EQUIPMENT, FROST PENETRATION, FROST HEAVE.
Cold room studies of frost action in soils are being performed by the Frost Effects Laboratory, Corps of Engineers, New England Division for the Airfields Branch, Office, Chief of Engineers, as part of a continuing program of frost investigations aimed toward establishing and improving design and evaluation criteria for roads, highways and airfield runways constructed on soils which are subject to seasonal freezing and thawing. The present laboratory studies are being made chiefly to determine the quantitative effects of individual factors which influence ice segregation in soils, such as gradation, percent finer than 0.02 mm, percent rock content, permeability, capillarity, proximity of water supply, density, and the initial degree of saturation in a closed system. Data from studies completed up to Jun. 15, 1950, are presented in this interim report.

**ACFEL TR 34/1**
**EVALUATION OF SOILS AND PERMAFROST CONDITIONS IN THE TERRITORY OF ALASKA BY MEANS OF AERIAL PHOTOGRAPHS.**
Frost, R.E., Sept. 1950, , 163p., AD-703 359.
25-2507
PERMAFROST DISTRIBUTION, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, TERRAIN IDENTIFICATION, LANDFORMS, COLD WEATHER CONSTRUCTION, UNITED STATES—ALASKA.
The report, entitled 'Evaluation of Soils and Permafrost Conditions in The Territory of Alaska by Means of Aerial Photographs,' presents the results of one phase of the investigation of airfield construction in arctic and subarctic regions being conducted by the St. Paul District, Corps of Engineers, Department of the Army. The overall investigation has as its objective the determination of design criteria and construction methods for areas of permanently frozen ground. The objective of this phase of the investigation has been the development of a technique whereby engineering soils and permafrost conditions could be evaluated from aerial photographs.

**ACFEL TR 34/2**
**EVALUATION OF SOILS AND PERMAFROST CONDITIONS IN THE TERRITORY OF ALASKA BY MEANS OF AERIAL PHOTOGRAPHS. VOLUME 2.**
Frost, R.E., Sept. 1950, 166p., AD-703 343, 207 refs.
25-2508
AERIAL PHOTOGRAPHY, TERRAIN IDENTIFICATION, ENGINEERING GEOLOGY, PHOTOINTERPRETATION, SOILS, PERMAFROST DISTRIBUTION, UNITED STATES—ALASKA.
Water-deposited materials in Alaska are important for engineering uses because of their general flat topographic situation and abundance. For the purposes of this study, the airphoto patterns of water deposited materials are divided on the basis of origin as follows: coastal plain; stream-deposited materials in the form of flood plains and terraces; and deltas. There are several other water-deposited types such as lacustrine, valley fill, and the several outwash groups. Outwash materials are discussed in the chapter on glacial patterns since complete knowledge of the pattern and its suggested features frequently depend on an analysis of glacial events. Successful interpretation of conditions of various water-deposited materials is contingent on the treatment of each topographic situation as an entire and separate unit.

**ACFEL TR 35**
**HYDROLOGICAL ANALYSIS AND DESIGN OF SURFACE DRAINAGE FACILITIES FOR AIRFIELDS IN ARCTIC AND SUBARCTIC REGIONS.**
Johnson, L.A., Feb. 1951, 43p., AD-712 598.
25-2509
HYDROLOGY, SURFACE WATER RUNOFF, AIRCRAFT LANDING AREAS, DRAINAGE, RAINFALL, ICING, UNITED STATES—ALASKA.
The report is a suggested modification of Part 13, Chapter 1, Surface Drainage Facilities for Airfields, of the Engineering Manual for War Department Construction. The modifications are intended to make possible the application of methods contained in the initial report to arctic and subarctic conditions. The original outline has been followed quite closely. Essential differences are (1) a new design storm index to fit Alaskan conditions, (2) new supply curves to match rainfall intensities, frequencies, and durations in Alaska, (3) elimination of pondering, (4) addition of a list showing recommended practices, and (5) addition of a few paragraphs on the subject of icings. Also included are maps, diagrams, and drawings.

**ACFEL TR 36/1**
**FROST INVESTIGATIONS, 1951. COLD ROOM STUDIES. SECOND INTERIM REPORT OF INVESTIGATIONS.** June 1951, Vol.1, 109p., AD-721 103, 14 refs.
26-2281
FROZEN GROUND MECHANICS, FROST ACTION, FROST HEAVE, FROST PENETRATION, COLD CHAMBERS, TESTS, AIRCRAFT LANDING AREAS.
The report presents the results of cold room studies of frost action in soils. The studies are being conducted chiefly to determine the effects of each of the individual factors which influence ice segregation in soils, including gradation per cent finer than 0.02 mm., per cent and size of aggregate greater than 2.0 mm., degree of compaction, surcharge pressures, initial degree of saturation in a closed system, alternate cycles of freeze-thaw, admixtures, capillarity, condensation, proximity of water supply, rate of penetration of 32 F. temperature, mineral composition of fine soil fraction, and permeability.

**ACFEL TR 36/2**
**FROST INVESTIGATIONS, 1951. COLD ROOM STUDIES. SECOND INTERIM REPORT OF INVESTIGATIONS.** June 1951, Vol.2, 225p., AD-712 623.
26-2282
COLD CHAMBERS, TEST EQUIPMENT, SOIL FREEZING, SOIL MECHANICS, FROST HEAVE, FROST ACTION.
The report includes Appendix A: 'Equipment and Test Procedures', which contains a description of the cold room and equipment and test procedures, and Appendix B: 'Investigational Data', which contains tables of test results, plots of temperature and heave versus time, and water content distribution in each sample before and after testing, for each test series.

**ACFEL TR 37**
**FROST INVESTIGATIONS, 1951. FIELD INVESTIGATIONS AT FROST TEST SECTION LIMESTONE, MAINE.** June 1951, 81p., AD-712 571.
25-2511
AIRCRAFT LANDING AREAS, FROST PENETRATION, PAVEMENT BASES, BEARING TESTS, FROST HEAVE, GROUND WATER.
The purpose of the field studies was to obtain information relative to the magnitude and the duration of the reduction in pavement supporting capacity due to frost action as measured by plate bearing tests, and to verify established criteria for the design and evaluation of pavements for airfields and highways. A test section was constructed at the Limestone Air Force Base, Limestone, Maine, with provisions made for performing plate bearing tests at selected locations to obtain comparative strength values at various periods during the year, and under varying ground water conditions. Additional areas were provided for excavation of test pits to measure density and water content variations, to study ice lens formation, and to perform California Bearing Ratio tests on the subgrade for the purpose of correlation with the other studies. Facilities were also provided for water table control and observation.

**ACFEL TR 38**
**MOLE DRAINAGE.**
Williams, H.M., et al, Sept. 1951, 36p., AD-712 582.
Haley, J.F.
25-2512
AIRCRAFT LANDING AREAS, SUBSURFACE DRAINAGE, PIPES (TUBES), EARTH HANDLING EQUIPMENT, CONCRETES, MODELS, CEMENTS, TESTS.
A mole drainage system has proved very effective in reclaiming many acres of low-lying, poorly drained agricultural lands and should prove a valuable tool in the construction of airfields under similar conditions. The mole drain's usefulness is severely limited unless some simple but effective method of making the drain a relatively stable structure in a wide variety of soil conditions could be achieved. It was to study this problem that a series of laboratory investigations and model tests were initiated in the Soils Laboratory of the New England Division, Corps of Engineers, in 1946. The investigations to date have followed two general paths of study: First, to attempt to strengthen the existing soil walls of the mole drain by a coating of liner cast in place during the passage of the mole plow and, second, to insert a suitable prefabricated liner into the mole drain behind the plow.

**ACFEL TR 39**
**INVESTIGATION OF MILITARY CONSTRUCTION IN ARCTIC AND SUBARCTIC REGIONS. TREES OF INTERIOR ALASKA, THEIR SIGNIFICANCE AS SOIL AND PERMAFROST INDICATORS.**
Stoeckeler, E.G., 1952, 28p., AD-712 597, 11 refs.
25-2513
TREES (PLANTS), VEGETATION PATTERNS, PERMAFROST INDICATORS, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, SOIL TEXTURE, GROUND WATER.
The purpose of the paper is to aid soil survey crews in the field. It is intended that information contained in this handbook be useful both from the standpoint of agricultural and engineering surveys. Identification of the eight major species which attain tree size in the Permafrost Zone in Alaska is made easy by actual photographs illustrating tree form, branching habits, bark, leaves, and fruit. A brief discussion of the relative value of each of the eight species as an indicator of soil texture, ground water, and permafrost conditions is included.

**ACFEL TR 40/1**
**INVESTIGATION OF DESCRIPTION, CLASSIFICATION, AND STRENGTH PROPERTIES OF FROZEN SOILS; FISCAL YEAR 1951, VOL.1.** June 1952, 338p., AD-721 745, 53 refs. For abstract see SIP 5197.
79-109
ELASTIC PROPERTIES, FROZEN GROUND MECHANICS, FROZEN GROUND, COMPRESSION, SHEAR STRENGTH, TENSILE STRENGTH, SOIL CLASSIFICATION.
The report presents the results of an exploratory test program whose purpose is to determine methods of describing and classifying frozen soils and to determine the strength characteristics of frozen soils. The investigation was performed by the Frost

Effects Laboratory, New England division, Corps of Engineers, U.S. Army, for the Snow, Ice and Permafrost Research Establishment, Corps of Engineers, U.S. Army, located at Wilmette, Illinois. (Auth.)

**ACFEL TR 40/2**
**INVESTIGATION OF DESCRIPTION, CLASSIFICATION, AND STRENGTH PROPERTIES OF FROZEN SOILS; FISCAL YEAR 1951, VOL.2.** June 1952, c300p., AD-721 746, Composed entirely of tables and graphs. For abstract see SIP 5197.
79-110
FROZEN GROUND MECHANICS, FROZEN GROUND STRENGTH, STATISTICAL DATA.

**ACFEL TR 41/1**
**AIRPHOTO PATTERN RECONNAISSANCE OF NORTHWESTERN CANADA.** June 1962, 130p., AD-701 180, 382 refs.
25-2514
AERIAL PHOTOGRAPHS, PHOTOINTERPRETATION, TERRAIN IDENTIFICATION, PERMAFROST INDICATORS, SOIL PATTERNS, VEGETATION, BIBLIOGRAPHIES.
The report presents the results of a reconnaissance survey of selected sites in northern Canada during the summer of 1951 conducted by the Purdue Canadian Arctic Permafrost Expedition and sponsored by the U.S. Army Corps of Engineers. Field data were obtained on soils and permafrost, and airphoto patterns of those sites where aerial photographs were taken for study are described.

**ACFEL TR 41/2**
**AIRPHOTO PATTERN RECONNAISSANCE OF NORTHWESTERN CANADA.** June 1962, 128p., AD-701 204.
25-2515
AERIAL PHOTOGRAPHS, PHOTOINTERPRETATION, TERRAIN ANALYSIS, PERMAFROST INDICATORS, SOIL PATTERNS, VEGETATION.
The report contains aerial photographs and airphoto patterns made at selected sites in northwestern Canada by the Purdue Canadian Arctic Permafrost Expedition and sponsored by the US Army Corps of Engineers.

**ACFEL TR 42**
**FROST INVESTIGATIONS 1953. ANALYTICAL STUDIES OF FREEZING AND THAWING OF SOILS. FIRST INTERIM REPORT.**
Aldrich, H.P., et al, June 1953, 66p., AD-113 175, 28 refs.
Paynter, H.M.
25-2516
FROST PENETRATION, HEAT TRANSFER, MODELS, FREEZE THAW CYCLES, FROZEN GROUND, ANALYSIS (MATHEMATICS).
Results of studies related to the prediction of the frost penetration depth below ground surfaces are presented. The problem is mathematically formulated and derived from first principles of heat transfer. Practical methods of computations such as numerical and machine solutions are discussed including descriptions of a hydraulic model and an electronic anolog computer applicable to freezing and thawing problems. A rational formula for the depth of frost penetration is derived, and the results of statistical studies involving actual frost penetration data are described. The effects of cyclic variations in surface temperature and of multilayered systems on the depth of freezing are presented. A depth of frost penetration nomograph is developed and instructions for its use, limitations and assumptions are included. The physical nature of the thaw-consolidation problem, a mathematical formulation of the problem and a discussion of solution techniques are included.

**ACFEL TR 43/1**
**FROST INVESTIGATIONS, 1952-1953. COLD ROOM STUDIES. THIRD INTERIM REPORT OF INVESTIGATIONS.** Oct. 1958, 46p., AD-217 742, 12 refs.
25-2517
SOIL FREEZING, FROST PENETRATION, FROST HEAVE, FROST ACTION, TESTS.
The effects of several factors which influence the formation and growth of ice in soils were tested, and the results and recommendations are presented. The specimens of 38 soils of various gradations and geography were frozen under laboratory-controlled criteria. Susceptibility to frost heave is best determined by gradation characteristics. The soil type and moisture content does not influence the temperature of initial crystallization but does influence the temperature to which the soil rises immediately after crystallization and the duration of this temperature. The proportion of soil moisture frozen increases as the temperature decreases in clay but is completely frozen at 32 F in silt and sand. The size and orientation of ice crystals in silt is more random than in clay.

**ACFEL TR 43/2**
**FROST INVESTIGATIONS, 1952-1953. COLD ROOM STUDIES, THIRD INTERIM REPORT OF INVESTIGATIONS. MINERAL AND CHEMICAL STUDIES.**
Lambe, T.W., June 1953, 25p., AD-217 743, 8 refs.
25-2518
SOIL FREEZING, SOIL CHEMISTRY, FROST HEAVE, ADMIXTURES, FROST ACTION.
The effect of soil fines composition on the frost susceptibility of the soil and finding admixtures which can in trace amounts reduce the frost susceptibility of soil are described. Freezing tests were made on a clean sand to which various monomineral fines were added. Results show that the composition of soil fines has a tremendous influence on the frost behavior of the soil. The nature of the exchangeable ion has a pronounced effect on the frost susceptibility of montmorillonoid fines. Trace minerals reduce frost susceptibility by altering soil structure, waterproofing, and altering permeability. Dispersants, which alter soil structure, have considerable promise as frost inhibitors, as well as several waterproofers.

**ACFEL TR 44/1**
**INVESTIGATION OF THE STRENGTH PROPERTIES OF FROZEN SOILS, FY 1952. REPORT OF INVESTIGATIONS.** June 1953, Vol.1, 135p., AD-725 156.
26-2337
FROZEN GROUND MECHANICS, FROZEN GROUND STRENGTH, TESTS, SHEAR STRESS, COMPRESSIVE PROPERTIES, FLEXURAL STRENGTH.
The report contains the data obtained during the second consecutive year of investigational laboratory work on the strength properties of frozen soils. It is a continuation and extension of the investigational program initiated in Fiscal Year 1951 and reported fully in SIPRE Report 8, 'Investigation of Description, Classification, and Strength Properties of Frozen Soils, Fiscal Year 1951', dated June 1952.

**ACFEL TR 44/2**
**INVESTIGATION OF THE STRENGTH PROPERTIES OF FROZEN SOILS, 1952. INVESTIGATIONAL DATA.** June 1953, Vol.2, 220p., AD-712 651.
26-2338
FROZEN GROUND MECHANICS, FROZEN GROUND STRENGTH, STATISTICAL DATA, COMPRESSIVE PROPERTIES.
The report contains tabular data describing the mechanical properties of various types of frozen soils.

**ACFEL TR 45**
**MANUAL FOR FROST CONDITION EVALUATION OF AIRFIELD PAVEMENTS IN THE ZONE OF INTERIOR (DRAFT).** Nov. 1953, 19p., AD-022 436.
25-2520
AIRCRAFT LANDING AREAS, PAVEMENT BASES, FROST ACTION, FROST PENETRATION.
The determination of wheel loads for flexible and rigid airfield pavements is outlined together with procedures for obtaining data relating specifically to frost effects. Frost-evaluation criteria are applied on the basis of direct inspection during the thaw period, gradation of the base course and subgrade soils, groundwater conditions and air-temperature records of 10-30 yr. duration. The distribution of mean freezing indices in the U. S. (expressed in degree-days below 30 F) is mapped. The thickness of pavement and base course required to prevent substantial subgrade freezing is graphed.

**ACFEL TR 46**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE, 1954. DEVELOPMENT OF POWER ICE CORING RIG.** March 1954, 106p., AD-712 537.
25-2521
ICE CORING DRILLS, COLD WEATHER OPERATION. SPECIFICATIONS, CONSTRUCTION, DRILLING RIGS.
An experimental, special-purpose, power-driven ice coring rig has been constructed which cuts and extracts 3-inch diameter cores. It is primarily designed for rapid exploration of extensive expanses of ice and snow to depths of 6 to 25 feet, the emphasis being on areal coverage with numerous, relatively shallow holes. However, it is also intended for occasional deeper drilling. It is intended for use in remote arctic regions and is ski-mounted for easy mobility on snow and ice surfaces. It can be towed by weasel, tractor or dog sled. It may be transported by aircraft of the C-47 type and, when assembled at the site of operations, is a complete operating unit except that it is not self-propelled. Two men are required for operation of the rig. Complete working drawings are presented, together with a summary of the basis of design, descriptions of the separate parts, an outline of the method of operation, and a summary of modifications indicated by tests and operating experience with the rig to date.

**ACFEL TR 47**
**COMPILATION AND STUDY OF ICE THICKNESS IN THE NORTHERN HEMISPHERE, 1952-1953.**
Ryder, T., June 1954, 193p., PB-162 794, 566 refs.
25-2522
AIRCRAFT LANDING AREAS, ICE COVER THICKNESS, MEASUREMENT, STATISTICAL DATA, BIBLIOGRAPHIES.
Ice thickness data on rivers and lakes in the U.S., Canada and environs were compiled from the literature. A number of annual ice thickness curves for one or two yr as well as snow depth data are given for 53 stations in the U.S., Canada and Alaska. Six average ice thickness curves are also given for smaller geographical regions. Appended is a bibliography containing 566 refs. some with brief annotations.

**ACFEL TR 47 SUPP A**
**COMPILATION AND STUDY OF ICE THICKNESSES IN THE NORTHERN HEMISPHERE, 1952-1953. TABULATIONS OF ICE THICKNESS DATA.**
Ryder, T., 1953, 90p., AD-701 615.
25-2523
ICE COVER THICKNESS, SNOW COVER DISTRIBUTION, ICE REPORTING, STATISTICAL DATA.
The report contains tables on ice thickness and snow depth for the Northern Hemisphere for 1952 to 1953.

**ACFEL TR 48/1**
**INVESTIGATION OF THE STRENGTH PROPERTIES OF FROZEN SOILS, 1953. REPORT OF INVESTIGATIONS.**
Kaplar, C.W., June 1954, 197p., AD-712 360, 15 refs.
25-2524
FROZEN GROUND MECHANICS, COMPRESSIVE PROPERTIES, SHEAR STRENGTH, TENSILE STRENGTH.
The report contains the test results and data obtained during the third consecutive year of investigational laboratory work on the strength properties of frozen soils. The studies reported herein are a continuation of the investigational program initiated in Fiscal Year 1951 and extended in Fiscal Year 1952.

**ACFEL TR 48/2**
**INVESTIGATION ON THE STRENGTH PROPERTIES OF FROZEN SOILS, 1953. INVESTIGATIONAL DATA.** June 1954, 286p., AD-712 361.
25-2525
FROZEN GROUND MECHANICS, COMPRESSIVE PROPERTIES, SHEAR STRENGTH, TENSILE STRENGTH, STATISTICAL DATA.
The report contains tabulation of mechanical properties of various types of frozen soils.

**ACFEL TR 49**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE, 1954. DEPTH OF SNOW COVER IN THE NORTHERN HEMISPHERE.** June 1954, 56p., AD-052 767, 80 refs.
25-2526
SNOW COVER DISTRIBUTION, SNOW DEPTH.
Snow depths are depicted on a broad scale with no attempt to present local detail. Data from 511 stations are tabulated. Station location and evaluation are included along with the period and number of years of record. Snow-depth values given for each month include the arithmetical mean, maximum, minimum, second-highest observation and median. Monthly snow-cover maps from Oct. 31-May 31 are given for the mean, maximum and minimum snow depths. Frequency curves of various depths of snow are plotted for 312 individual stations.

**ACFEL TR 50**
**INVESTIGATION OF CONSTRUCTION AND MAINTENANCE OF AIRDROMES ON ICE, 1953-1954. PROJECT MINT JULEP, INVESTIGATION OF A SMOOTH ICE AREA OF THE GREENLAND ICE CAP. PART IV.** June 1954, 77p., AD-073 243, 12 refs.
25-2527
AIRCRAFT LANDING AREAS, CONSTRUCTION, MAINTENANCE.
Tests were conducted during the summer of 1953 in a small area located at 65 N lat. on the W slope of the Ice Cap about 90 mi. ESE of Sondrestrom AFB to evaluate the feasibility of wheeled-aircraft operation. Several possible airstrip sites were selected and observed, a ski-wheel C-47 airplane being used for the observations. It is concluded that runways for wheeled aircraft can be constructed and maintained on ice surfaces near the firn line for 10-11 months each year. Snow compaction procedures are necessary for runway construction in areas of substantial snow cover above the firn line.

**ACFEL TR 51**
**FROST INVESTIGATIONS, 1953. RIGID PAVEMENT PUMPING EXPERIENCE.** Sept. 1954, 119p., AD-051 192, 16 refs.
25-2528
CONCRETE PAVEMENTS, ROADS, RUNWAYS, DRAINAGE, FROST ACTION, SUBGRADES.
The purpose of the investigation is to provide information which will either substantiate or serve as a basis for revising existing Corps of Engineers criteria for base courses between rigid pavements and frost-susceptible subgrade soils. The information in general indicated an advantage in the use of a properly graded filter course between a rigid pavement and fine-grained frost-susceptible subgrade soils. It was not possible, from the information obtained, to define clearly pumping or non-pumping conditions because of a general lack of pertinent soils data and traffic and behavior records.

**ACFEL TR 52**
**FROST INVESTIGATIONS, 1954. ANALYSIS OF ERRORS IN GROUND AND AIR TEMPERATURE MEASUREMENTS.**
Rohsenow, W.M., et al, Oct. 1954, 43p., AD-085 468, 11 refs.
Clark, J.A., Van Alstyne, P.C.
25-2529
AIR TEMPERATURE, SOIL TEMPERATURE, TEMPERATURE MEASUREMENT, ACCURACY.
Results are given of theoretical studies to determine the minimum requirements for temperature-measuring installations to obtain results within specified limits of error. The effects on the measured temperature of the design and the thermal properties of the sensitive element are considered together with the method of placement in the media, but no consideration is given to errors that may result from inaccuracies or lack of sensitivity in the equipment. Installations were studied in soil, loose and dense snow, fresh-water ice and air; the instruments considered include glass thermometers, thermocouples, resistance thermometers, thermistors and temperature probes. Recommendations for further research are included.

**ACFEL TR 53**
**FROST INVESTIGATIONS. COLD ROOM STUDIES. MINERAL AND CHEMICAL STUDIES.**
Lambe, T.W., April 1959, 73p., AD-715 722, 10 refs.
25-2530
SOIL FREEZING, FROST ACTION, SOIL CHEMISTRY, ADMIXTURES, FROST HEAVE.
The report presents the results of continuing studies to determine the effect of the mineral composition of soil fines on frost action and of laboratory investigations with various chemical additives to modify frost action in frost-susceptible soils. Frost tests were performed with 32 additives; 12 of these are listed which will reduce the rate of heave by 50 percent or more when one percent or less (by soil weight) of additive is used. Ten specific conclusions are given. App. A presents laboratory data for the mineral and chemical studies presented in main part of report.

**ACFEL TR 54**
**REPORT OF THAW PENETRATION AND SUBSIDENCE RUNWAY AND TAXIWAY SECTIONS THULE AIR FORCE BASE. 1953 AND 1954 THAWING SEASONS.** Jan. 1955, 120p., AD-712 491.
25-2531
RUNWAYS, PAVEMENTS, SUBSIDENCE, FROST HEAVE, THAWING, SUBGRADE SOILS, GREENLAND—THULE.
Construction of the runway at Thule Air Force Base, Greenland, began in the Summer of 1951. The subsidence of certain runway pavement sections during the summer of 1952 resulted in the initiation of a program of field investigations at those locations. The report presents an analysis of the data obtained during the 1953 and 1954 thawing seasons at the runway and taxiway test installations. An analysis of the pavement subsidence, which occurred in two areas, is given and a correlation is made between subsidence, depth of thaw and the characteristics of the subgrade soils. The effect of pavement surface color is discussed and tentative conclusions are drawn. The existence of a seasonal ground water table is noted and explained.

**ACFEL TR 55**
**PERMAFROST INVESTIGATIONS, 1955. FIELD INVESTIGATIONS IN ARCTIC AND SUBARCTIC REGIONS. BUILDING FOUNDATION STUDY FAIRBANKS RESEARCH AREA.** May 1955, 135p., AD-712 492.
25-2532
PILE FOUNDATIONS, SEASONAL FREEZE THAW, HEAT TRANSFER, SOIL MECHANICS, PERMAFROST BENEATH BUILDINGS, DAMAGE, UNITED STATES—ALASKA—FAIRBANKS.
A study of the changes brought about in the thermal regime beneath buildings constructed over permafrost and the effect of these changes on the buildings has been made by observing eleven test buildings with various types of foundations for a period of about five years. The principal measurements included temperature readings in the foundation and soils beneath the structures and vertical movements of points on the buildings. These observations have resulted in findings concerning the permanence or degradation of permafrost, the seasonal freezing and thawing patterns, the relation of these thermal changes to seasonal and yearly vertical displacements of the buildings, and structural damage in the buildings resulting from the movements. The effect of such foundation features as air spaces beneath floors, fills of non-frost-susceptible materials, post and pad construction, concrete slab floor construction on fills, insulated and non-insulated built-up wooden floors on fills, and insulation layers in fills have been studied.

**ACFEL TR 56**
**ADMIXTURE TEST AREA, LORING AIR FORCE BASE, LIMESTONE, MAINE.** June 1955, 11p., AD-496 265.
25-2533
SOIL FREEZING, ADMIXTURES, SUBGRADES, FROST PENETRATION, FROST HEAVE, FROST RESISTANCE, FREEZE THAW CYCLES.
The purpose of this small-scale field admixture test area is to add perspective to the laboratory program of treating frost-susceptible soils, reduce their frost susceptibility and render them satisfactory for use in construction.

**ACFEL TR 57**
**FIELD STUDIES, FROST TEST AREA, LIMESTONE MAINE AND SUPPLEMENTARY INVESTIGATIONS.** 1955, 44p., AD-712 569.
25-2534
AIRCRAFT LANDING AREAS, FROST ACTION, PAVEMENT BASES, FROST HEAVE, BEARING TESTS, ROADS.
The Frost Test Area located at Loring Air Force Base, Limestone, Maine, was constructed for the purpose of conducting field studies to obtain information relative to the magnitude and duration of reduction in pavement supporting capacity, due to frost action, as measured by plate bearing tests. In addition, it was desired to determine the effect of natural field and climatic conditions on frost action and to verify criteria for design and evaluation of pavements for airfields and highways.

**ACFEL TR 58**
**INTERIM REPORT ON LOAD TESTS OF PILES IN PERMAFROST.**
Linell, K.A., 1954, 10p., AD-712 568.
25-2535
PILE FOUNDATIONS, BEARING CAPACITY, PERMAFROST, COLD WEATHER CONSTRUCTION, LOADING, FRICTION.
In order to develop and improve engineering design criteria for construction of pile foundations in areas of frozen ground, the Arctic Construction and Frost Effects Laboratory is carrying out a program of pile tests at its Fairbanks Research Area on Farm Loop Road near Fairbanks, Alaska. The research program includes study of the manner in which load supporting capacity is developed in piles supported in permafrost and measurement of skin friction and end bearing values under various combinations of conditions.

**ACFEL TR 59**
**PILE EXTRACTION TESTS, FAIRBANKS RESEARCH AREA.** June 1955, 41p., AD-712 567.
25-2536
FROZEN GROUND MECHANICS, FROST HEAVE, SHEAR STRESS, PILE EXTRACTION, PILE FOUNDATIONS, PERMAFROST.
The report describes the installation of structural columns (piles) in permafrost soils and the interactions displayed between the soil and the columns in their subsequent removal.

**ACFEL TR 60**
**APPROACH ROADS, 1955, GREENLAND PROGRAM.** Oct. 1955, 94p., AD-712 512, Preliminary report on Project 1.
25-2537
ROADS, CONSTRUCTION MATERIALS, GLACIER ICE, EQUIPMENT, MAINTENANCE, GREENLAND—CAMP TUTO.
The overall objective of the report was to investigate and develop methods, techniques and design criteria for construction and maintenance of gravel fill roads on ice surfaces, with particular reference to surfaces of the glacier type as exemplified by the TUTO ramp on the Greenland Ice Cap.

**ACFEL TR 61**
**MODIFICATION OF FROST-HEAVING OF SOILS WITH ADDITIVES. 1953 THRU 1955 INVESTIGATIONS.**
Lambe, T.W., Jan. 1956, 62p., AD-712 513, 13 refs.
25-2538
SOIL FREEZING, ADMIXTURES, FROST HEAVE, FROST PROTECTION.
A 3-year search for additives to reduce the frost susceptibility of soil is described. Fifteen soils and about forty additives have been tested. A discussion of the theoretical considerations for the choice of additives is presented. The additives are divided into four groups: (1) void pluggers and cements, (2) aggregants, (3) dispersants, and (4) 'waterproofers' - according to their action in soil.

**ACFEL TR 62**
**DESIGN AND OPERATION OF AN HYDRAULIC ANALOG COMPUTER FOR STUDIES OF FREEZING AND THAWING OF SOILS.** May 1956, 36p., AD-132 901, 21 refs.
25-2539
FROST PENETRATION, SOIL TEMPERATURE, COMPUTER APPLICATIONS, GROUND THAWING, SOIL FREEZING.
The design, construction, and operation of the hydraulic analog computer developed by the Corps of Engineers in order to improve techniques for predicting subsurface temperatures, especially frost and thaw penetration below airfield pavements, are described. The computer and the analogous relationships among parameters in the thermal and fluid-flow systems are discussed, and the developments in hydraulic analogs in various countries are outlined. The design requirements, including the simulation of freezing and thawing, the selection of the working fluid, and the assembly of the various components of the computer are described. The programming procedures for the computer are outlined, and the solution for a sample problem is given. The computer has been found very useful for solving complex one-dimensional freezing and thawing problems in soil, and its applicability for solving other diffusion problems in engineering is broad.

**ACFEL TR 63**
**HEAT TRANSFER AT THE AIR-GROUND INTERFACE WITH SPECIAL REFERENCE TO AIRFIELD PAVEMENTS.** Jan. 1961, 131p., AD-257 961, 121 refs.
25-2540
AIRCRAFT LANDING AREAS, PAVEMENTS, FROST PENETRATION, SOIL TEMPERATURE, HEAT TRANSFER, COMPUTER PROGRAMS, THAW DEPTH.
The variables which affect the transfer of heat at the air-earth interface were studied as a part of an investigation to improve techniques for predicting subsurface temperatures. Methods used to develop charts and diagrams for the convenient programming of a hydraulic analog computer fabricated under contract with the U.S. Army Engineer Div., are presented. Particular emphasis is placed on freeze and thaw penetration beneath airfield pavements, although analyses of the factors heat transfer to the air by convection and conduction, and heat generated or lost by radiation, are valid for any ground surface.

**ACFEL TR 64**
**APPROACH ROADS, GREENLAND 1954 PROGRAM, PROJECTS 1 AND 10A.**
Linell, K.A., et al, May 1956, 36p., AD-123 155(b).
Fulwider, C.W., Stevens, H.W., Carozza, A.T.
25-2541
ROADS, GLACIER ICE, THAW DEPTH, CONSTRUCTION, PERMAFROST, GREENLAND.
The purpose of Project 1, Approach Roads in Boulder Fields, was to develop effective methods and techniques for the construction and maintenance of roads on a bouldery, permafrost terrain, typified by the TUTO area near Thule Air Force Base, Greenland. The purpose of Project 10A, Ramp Roads, was to investigate and develop methods, techniques, and design criteria for construction and maintenance of gravel-fill roads on ice surfaces of the glacial type such as occurs at TUTO. The report summarizes the results of field work from June to September 1954 on the phases assigned to the Arctic Construction and Frost Effects Laboratory. The report has been kept as concise as possible, dealing only with the most pertinent aspects of the entire problem.

**ACFEL TR 65**
**STUDY OF ICE FORMATION IN SOILS.**
Jackson, K.A., et al, May 1956, 29p., AD-134 951, 11 refs.
Chalmers, B., McKay, G.
25-2542
SOIL FREEZING, FROST HEAVE, ICE LENSES.
Ice formation in soil is examined in the light of the nucleation theory, which assumes that the water immediately in contact with the soil particles remains supercooled as a result of interaction with the particles and has free energy to help it freeze, produce heaving, and pull the water up from the water table. Nucleation temperatures in water are examined in terms of surface energy, of water molecules, angle of contact, and cluster size, and the process of soil freezing is described. The freezing temperature of a soil, cooling curves, and the theory of frost heave are discussed in the appendices.

**ACFEL TR 66**
**PERMAFROST INVESTIGATIONS 1956. FREEZEBACK CONTROL AND PILE TESTING KOTZEBUE AIR FORCE STATION, KOTZEBUE, ALASKA (DRAFT).** May 1957, 145p., AD-712 514, 8 refs.
25-2543
PERMAFROST PRESERVATION, FROST HEAVE, PILE FOUNDATIONS, SOIL STRENGTH, BEARING CAPACITY, ARTIFICIAL FREEZING, UNITED STATES—ALASKA—KOTZEBUE.
A timber pile foundation was installed in permafrost at Kotzebue, Alaska, as part of the construction of an Air Force Installation in 1955 and 1956. The piles were placed in augered holes, slurried and frozen back by artificial means. Data were obtained on the effectiveness of the artificial refrigeration in achieving freezeback and on the bearing capacity of the piles. Soils Temperatures were measured with copper-constantan thermocouples. Fiberglas moisture cells were also tried. Level observations were made on the piling to detect heave and settlement. Two types of pile load tests were conducted; point bearing tests on piles confined by small amounts of unfrozen soil, and load settlement tests on piles completely slurried and frozen back.

**ACFEL TR 67**
**FROST PENETRATION IN MULTILAYER SOIL PROFILES.** June 1957, 15p., AD-202 667, 9 refs.
25-2544
FROST PENETRATION, SOIL PROFILES, AIRCRAFT LANDING AREAS, CONCRETE PAVEMENTS, SURFACE TEMPERATURE, ANALYSIS (MATHEMATICS).
The results are reported of investigations on the effectiveness of an adaptation of the modified Berggren formula for predicting the depth of frost penetration in multilayer soil profiles, assuming that the thermal properties of the soil and the boundary temperature conditions are known. Nine cases representing 6 different soil profiles were examined, all having a 3-in. bitumi-

nous concrete surface. The computed values, for both a step change in pavement-surface temperature and for a surface temperature varying sinusoidally, are compared with "exact" solutions determined by the hydraulic analog computer developed under the contract. The results indicate that the proposed adaptation of the formula underpredicts the frost depth by about 3 percent. The error is believed insignificant compared to errors in any practical case due to uncertainties in the thermal properties of soil and unknown pavement-surface temperature.

**ACFEL TR 68** Record deleted.

**ACFEL TR 69** Record deleted.

**ACFEL TR 70**
**ELECTRICAL ANALOG STUDY OF ERRORS IN GROUND TEMPERATURE MEASUREMENT.**
Cunningham, J.P., et al, April 1960, 35p., AD-238 361, 3 refs.
Rohsenow, W.M.
25-2547
SOIL TEMPERATURE, TEMPERATURE MEASURING INSTRUMENTS, COMPUTERS.

This report covers an investigation or errors inherent in the measuring of temperatures in the ground using temperature-sensing devices attached to a conducting probe inserted vertically in the ground (snow, ice, or soil). Of particular interest is the use of a standard copper-rubber cable. Analogue computer results are presented with ground materials of light snow, heavy snow, and ice, with cables 4.5 ft and 7.5 ft long. Errors are measured 16 hours after immersion of the probe, when a quasi-steady state is reached. The errors occurring with uniform temperature gradients in the ground, at least 1 ft to 1.5 ft from either end of the cable, are shown to be equivalent to an error in depth of less than 1 in. in light snow, and less than 1/8 in. in heavy snow and more conductive grounds. An approximate analytical solution is given and compared with the computer solutions.

**ACFEL TR 71**
**EFFECT OF ELECTRIC CURRENT ON THERMISTOR TEMPERATURE ERROR.**
Rohsenow, W.M., et al, April 1960, 8p., AD-238 362, 2 refs.
Stekly, J.
25-2548
THERMISTORS, HEAT TRANSFER, TEMPERATURE MEASUREMENT, SOIL, SNOW, ICE .

An analysis of the effect of internal heat generation in thermistors due to electric current during temperature measurements is presented. Calculations of steady-state temperature rise above ambient for one type of thermistor located in soil, ice, light snow, medium snow, and heavy snow, ranged from 6.5 x 1/10000 to 246 x 1/10000 F. while for a thermistor located in air, the magnitude of error ranged from 712 x 1/10000 to 1425 x 1/10000 F, depending on the heat transfer coefficient. The calculations indicate that errors due to internal heating may be disregarded for ground and air temperature.

**ACFEL TR 72**
**EFFECT OF FREEZE-THAWING CYCLES ON THERMISTOR CALIBRATION.**
Clark, J.N., et al, June 1960, 14p., AD-238 363.
Spahr, J.A., Hindle, R.A.
25-2549
THERMISTORS, SOIL MOISTURE, FREEZE THAW CYCLES.

Laboratory tests are described wherein three soil-moisture units containing thermistors and five exposed disc-type thermistors were imbedded in moist soil and subjected to 20 freeze-thaw cycles. Thermistor resistance at the ice point was determined at the end of 1, 5, 10, 15, and 20 cycles for each unit and compared with initial readings. From the temperature-resistance relations, less than 0.1 F. change in calibration was observed at the end of 20 cycles for the thermistors contained in the soil-moisture units while changes for the exposed disc-type thermistors ranged from 0.19 to 3.56 F. All thermistors showed accelerated deterioration in their original ice-point calibration at 20 cycles.

**ACFEL TR 73**
**PAVEMENT PROFILE AND ROUGHNESS MEASUREMENT (A REVIEW OF METHODS).**
Yoder, E.J., et al, June 1960, 51p., AD-238 364, 58 refs.
Hampton, D.
25-2550
PAVEMENTS, SURFACE ROUGHNESS, MEASUREMENT, INSTRUMENTS, PROFILES.

The various techniques which may be adopted for measuring pavement profiles and pavement roughness are discussed and evaluated. A summary bibliography of available pertinent literature is included. Detailed descriptions of some of these techniques, and abstracts of several articles appearing in the literature, are given. The basic requirements for profile and roughness measurements include mobility, rugged construction, accuracy of measurement, and usability of data. Since none of the instruments reviewed are completely satisfactory, a recommended device is outlined and discussed.

**ACFEL TR 74**
**ICE TUNNEL CLOSURE PHENOMENA.**
Abel, J.F., Jr., Jan. 1961, , 37p., AD-278 532, 21 refs.
24-3057
ICE (CONSTRUCTION MATERIAL), ICE TUNNELS, ICE CREEP, VISCOUS FLOW, PLASTIC FLOW, GREENLAND—CAMP TUTO.

Closure data obtained in Greenland during the 4 summers of 1955-1958 are presented and analyzed in relation to this phenomena in under-ice tunnels and rooms. Maximum closure rates can be predicted with reasonable accuracy with the empirical equations given for glacial ice in the temperature range of 15-25F and with depths and spans of the openings ranging from 30-200 ft and 5-38 ft respectively. The construction of large openings in glacial ice at depths in excess of 150 ft is not feasible because of the rapid closure rates at those depths.

**ACFEL TR 75**
**DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS. (DRAFT).** Jan. 1961, 20p., AD-712 515, For another version see 24-3106. 2 refs.
25-2552
SOIL CLASSIFICATION, PERMAFROST, SOIL STRUCTURE, CONSTRUCTION, WATER CONTENT.

The description and classification of frozen soils presented herein is an extension of the Unified Soil Classification System adopted by the U. S. Army Corps of Engineers and the U. S. Bureau of Reclamation in 1952. Descriptions, based on physical appearance, are non-genetic and are applicable to both naturally and artificially frozen soils. Field identification data pertaining to frozen soils and those pertinent properties of frozen materials which can be measured by physical tests are indicated. Also, guides are presented for construction on soils subject to freezing and thawing. The report includes photographic illustrations of frozen soil types; a chart showing relationships between unit dry weight of soil, water content, and ice volume; and an illustrative example of graphical presentation of frozen soil data.

**ACFEL TR 76** Record deleted.

# ACFEL MISCELLANEOUS PAPERS

**ACFEL MP BL 1**
**REPORT ON COLD ROOM AND EQUIPMENT FOR FROST INVESTIGATION.** May 1950, 25p., AD-712 535.
25-4045
COLD CHAMBERS, TEST EQUIPMENT, SOIL FREEZING, FROST HEAVE.
A cold room has been constructed at the Frost Effects Laboratory, New England Division, Corps of Engineers, U.S. Army, for the purpose of conducting laboratory studies to determine the effect of various factors influencing ice segregation in soils and to study, in general, the frost phenomena in soils, with the objective of establishing design and evaluation criteria for roads highways, and airfield runways constructed on frost susceptible soils which are subject to seasonal freezing and thawing.

**ACFEL MP 1**
**COLD ROOM STUDIES OF FROST ACTION IN SOILS.**
Haley, J.F., et al, 1950, 40p., AD-712 556, 13 refs.
Kaplar, C.W.
25-2565
FROST ACTION, FROST HEAVE, COLD CHAMBERS, TEST EQUIPMENT, ROADS, RUNWAYS.
Cold room studies of frost action in soils were performed as part of a continuing program of frost investigations aimed toward establishing and improving design and evaluation criteria for roads, highways and airfield runways constructed on soils which are subject to seasonal freezing and thawing. The present laboratory studies are being made chiefly to determine the quantitative effects of individual factors which influence ice segregation in soils, such as gradation, per cent finer than 0.02 mm., per cent stone, permeability, capillarity, proximity of water supply, compaction, and the initial degree of saturation in a closed system. The chief purpose of this paper is to present the testing program and methods and equipment that are being used.

**ACFEL MP 2**
**INVESTIGATION OF THE EFFECT OF FROST ACTION ON PAVEMENT SUPPORTING CAPACITY.**
Linell, K.A., et al, 1950, 61p., AD-712 557, 10 refs.
Healy, J.F.
25-2566
FROST ACTION, PAVEMENTS, BEARING CAPACITY, AIRCRAFT LANDING AREAS, SUBGRADE SOILS.
The paper presents a summary of studies which have been made of the effect of frost action on pavement supporting capacities as part of a comprehensive frost investigational program initiated by the Corps of Engineers in 1944. The purpose of the program was to develop design and evaluation criteria for pavements constructed on subgrade soils subject to frost action. The studies represent the first large scale investigation directed toward the development of pavement design and evaluation criteria based on the weakened condition of thawed subgrade soils.

**ACFEL MP 3**
**INSULATION OF CONCRETE FLOOR SLABS ON GRADE (PRELIMINARY REPORT).** Feb. 1952, 16p., AD-712 534.
25-2567
THERMAL INSULATION, CONCRETE SLABS, FLOORS.
The report presents the results of a study made to determine the need for and effectiveness of edge insulation for concrete floor slabs on grade, for military construction in the New England area. Such insulation may serve the following three possible functions: (1) prevent excessive heat losses at edge of slab and exterior walls, (2) maintain a comfortable floor temperature for personnel occupancy and (3) prevent condensation on floor surface adjacent to exterior walls.

**ACFEL MP 4**
**ELECTRICAL GROUND TEMPERATURE MEASURING EQUIPMENT.** March 1952, 60p., AD-712 422.
25-2568
SOIL TEMPERATURE, ELECTRIC MEASURING INSTRUMENTS, TEMPERATURE MEASURING INSTRUMENTS.
The report briefly describes the various types of electrical ground temperature measuring equipment, which have been employed in the Permafrost Investigation from inception of the program in 1945 to the present time, and discusses the characteristics and uses of each type. Special emphasis and greater detail included for those types which are considered best adapted for use by Highway Departments in the northern tier of states for research purposes in connection with road restrictions during the spring breakup. Photographs, diagrams, and specifications are presented to illustrate and describe various details of the equipment discussed.

**ACFEL MP 5**
**MEASUREMENT OF TEMPERATURES AND FROST PENETRATION IN PAVED OR UNPAVED AREAS WITH THERMOCOUPLES.** May 1952, 18p., AD-712 423.
25-4001
FROST PENETRATION, TEMPERATURE MEASUREMENT, PAVEMENTS, SOIL TEMPERATURE.
Records of air, pavement and ground surface, and subsurface temperatures are needed from widely distributed geographical areas, in order to improve knowledge of and methods of estimating frost penetration and thaw conditions beneath various types of pavements and for various soil conditions. The results will be used in the design of pavements, utilities, building footings, and other construction. This report describes equipment, installation and a general observational program for obtaining pavement and ground temperature records and for measuring depth of frost penetration under either paved or unpaved areas. Two types of installations are described.

**ACFEL MP 6** Record deleted.

**ACFEL MP 7**
**COLD ROOM STUDIES OF FROST ACTION IN SOILS. PROGRESS REPORT.**
Haley, J.F., 1953, HRB-Bull-71, p.1-18, AD-712 627, 8 refs. Also NAS-NRC-Pub-262.
25-4002
FROST ACTION, SOIL FREEZING, COLD CHAMBERS, FROST HEAVE.
This paper is a progress report of cold-room studies of frost action in soils performed between February 1950 and October 1952 by the Frost Effects Laboratory, New England Division, Corps of Engineers. They are part of a comprehensive field and laboratory investigational program for the improvement of engineering design, construction, and evaluation criteria for pavements and other structures constructed on soils subject to seasonal freezing and thawing. Cold-room tests were performed to determine the effects of individual factors considered to influence ice segregation in soils. Tests were conducted on a large number of natural soils obtained from several locations and on specimens prepared by blending soil fractions in proportions to give desired investigational gradations.

**ACFEL MP 8**
**PERMAFROST REFERENCE BIBLIOGRAPHY.** Dec. 1953, 195p., AD-035 940.
25-4003
PERMAFROST, BIBLIOGRAPHIES.
Contains approximately 1500 references, some with abstracts or annotations. The entries are arranged alphabetically by author, and indexed under approx. 50 subject headings.

**ACFEL MP 9**
**SUMMARY OF KNOWLEDGE ON MOISTURE MOVEMENT OF HELD WATER IN SOILS.**
Sanger, F.J., Oct. 1954, 46p., AD-712 628, 65 refs.
25-4004
SOIL MOISTURE MIGRATION.
The report contains an analysis of research and theory of movement of water through the soil.

**ACFEL MP 10**
**LOSS OF PAVEMENT SUPPORTING CAPACITY DUE TO FROST ACTION AS MEASURED BY PLATE BEARING TESTS.**
Sayman, W.C., Jan. 1955, 13p., AD-712 629, 1 ref.
25-4005
BEARING TESTS, FROST ACTION, PAVEMENTS.
This paper presents a summary of field studies which have been made to determine the effect of frost action on the magnitude and duration of loss in pavement supporting capacity, measured by plate bearing tests, as part of a comprehensive frost investigational program initiated by the Corps of Engineers in 1944. The purpose of this program is to develop design and evaluation criteria for pavements constructed on subgrade soils subjected to frost action.

**ACFEL MP 11**
**FROST INVESTIGATIONS. PREDICTION OF FREEZING TEMPERATURE PENETRATION IN NEW ENGLAND.** June 1955, 13p., AD-712 631.
25-4006
FROST PENETRATION, FREEZING INDEXES, SOILS, UNITED STATES—NEW ENGLAND.
The report presents a summary of mean freezing indexes for all U.S. Weather Bureau Stations in New England at which temperatures have been recorded for a sufficient length of time to establish mean values. It also gives the elevation of each station and the number of years upon which the mean is based.

**ACFEL MP 12**
**THAWING BENEATH BUILDINGS CONSTRUCTED ON PERMAFROST NEAR FAIRBANKS, ALASKA.**
Haley, J.F., Aug. 1955, 12p., AD-712 630.
25-4007
THAWING, PERMAFROST PRESERVATION, PERMAFROST BENEATH BUILDINGS, COUNTERMEASURES, UNITED STATES—ALASKA—FAIRBANKS.
The paper deals with some observations made by personnel of the Arctic Construction and Frost Effects Laboratory to determine the effectiveness of various methods of preventing thawing beneath heated buildings constructed over permafrost. At the Fairbanks Research Area on Farm Loop Road near Fairbanks, Alaska, temperature changes beneath 11 buildings were recorded for a period of 5 to 8 years; the effects on 4 of these buildings are reported. Vertical movements of the buildings were also noted.

**ACFEL MP 13**
**FREEZING OF SLURRY AROUND WOOD AND CONCRETE PILES.**
Scott, R.F., May 1956, 6p., AD-105 275.
25-4008
PILE FOUNDATIONS, CONSTRUCTION MATERIALS, FREEZING, SOIL TEMPERATURE.
A series of solutions to the problem of the approximate time required to freeze a given slurry placed around piles sunk in permafrost was carried out on an electronic analog computer. Vertical heat flow was considered negligible, reducing the problem to one involving two-dimensional radial flow in a sector of a circle containing a pile at the center, the adjacent slurry, and the natural ground beyond the slurry. A generalized solution of the problem is graphed as well as curves showing freezing times for slurry, at 3 different water contents, around a common size of pile, in soil with the given thermal properties (silty clay). The curves can be used in cases of mechanical drilling but their use is not recommended when steam jets are used for the excavations. Insufficient actual test data are available to provide a good practical check on the curves.

**ACFEL MP 14**
**LIST OF REPORTS OF THE ARCTIC CONSTRUCTION AND FROST EFFECT LABORATORY.** Jan. 1961, 20p., AD-258 889.
25-4009
BIBLIOGRAPHIES, SNOW, ICE, FROST ACTION, PERMAFROST.
This publication lists important technical reports and other ACFEL publications, along with reports prepared by the former Permafrost Division of the St. Paul District, Corps of Engineers. Included in the tabulation are 76 technical reports (July 1945-Jan. 1961), 1 bulletin (May 1950), 22 misc. papers (Jan. 1951-Oct. 1958), 32 translations (May 1947-June 1960), and 1 instruction report (Nov. 1956). The principle subjects represented are construction techniques in cold regions, frost action effects, permafrost, frozen ground, and the mechanics of ice and snow.

**ACFEL MP 15**
**FROST INVESTIGATIONS, 1957. DETERMINATION OF ERRORS IN TEMPERATURE MEASURING EQUIPMENT. FIRST INTERIM REPORT.** Dec. 1956, 43p., AD-712 647.
25-4010
TEMPERATURE MEASURING INSTRUMENTS, ACCURACY, TESTS.
A number of relatively elementary tests were run with thermocouples, connectors and potentiometers to determine response characteristics under transient and differential temperature conditions. Results are intended to serve as a guide to observers in obtaining accurate temperature determinations. Under the conditions of the tests, as much as 10 minutes was required before accurate readings could be obtained, while connectors or potentiometers were adjusting to temperature changes. Other effects of temperature differences were also observed.

**ACFEL MP 16**
**SOME EXPERIMENTS IN DRIVE SAMPLING OF FROZEN GROUND.**
Kitze, F.F., Sept. 1956, 22p., AD-712 648.
25-4011
FROZEN GROUND PHYSICS, SAMPLING, SOIL ANALYSIS.
The study deals with experiments in drive sampling in frozen ground for the recovery of undisturbed soil samples. The drive-sampling experiments discussed in this paper were performed in frozen, fine-grained soils consisting of silts, clays, and fine sand. In addition, the drive sampling was performed in permafrost having temperatures ranging from approximately 29 to 31.5 degrees Fahrenheit. The drive method of sampling consists essentially of driving a tube or sampler into the soil and

recovering the soil that enters the sampler as a result of the driving action. Driving of the sampler and subsequent withdrawal may be accomplished by power equipment or by manual procedures depending on the depth of the exploration.

**ACFEL MP 17**

**PERMANENT BENCHMARKS IN PERMAFROZEN FINE GRAINED SOILS.** May 1957, 17p., AD-701 617.

25-4012

PERMAFROST STRUCTURE, BENCH MARKS, SOIL ANALYSIS, FROZEN FINES.

The problem of satisfactory benchmarks is common to all agencies doing engineering or investigational work in Alaska and other permafrost areas. This report presents a brief review of past experience and behavior of known benchmark installations in permafrost, together with the best recommendations for benchmark installations presently known.

**ACFEL MP 18**

**INSTALLATION OF PILES IN PERMAFROST.**

Kitze, F.F., Sept. 1957, 34p., AD-712 650.

25-4013

PILE FOUNDATIONS, PERMAFROST, COLD WEATHER CONSTRUCTION.

In the summer of 1952, a study of foundation piles installed in permafrost was initiated at the Fairbanks Permafrost Research Area, Fairbanks, Alaska, as part of a continuing program of research directed toward the development of design criteria for construction on frozen ground. The purpose of the pile study was to determine the feasibility of various pile installation methods, ascertain factors affecting pile stability, and to develop criteria related to load carrying capacity of piles embedded in permafrost. The paper is a summary of experiences at the Fairbanks Permafrost Research Area in connection with methods for installing piles in permafrost.

**ACFEL MP 19**

**USE OF ICE AS A LOAD SUPPORTING SURFACE.**

Linell, K.A., Aug. 1958, 28p., AD-659 332.

25-4014

LOADING, TEST EQUIPMENT, ICE STRENGTH, ICE MECHANICS.

Ice in the mass is perhaps best described as a highly viscous material having the characteristics of a solid. It may fracture like a brittle material, or it may flow and deform gradually depending upon the intensity of the stress and rate of loading, the temperature, the degree of confinement and the structure of the ice itself. The proportional limit of the stress-strain curve for ice has been reported to be on the order of 20 to 25 psi or even less. At higher static load intensities ice will deform at a steady rate; the higher the stress, the higher the rate. Since floating ice is normally stressed to far beyond the proportional limit in order to carry useful loads, theoretical stress analysis methods using the theory of elasticity become no longer strictly applicable and must be applied with caution. Fortunately most load applications of appreciable magnitude on floating ice involve periods of stress duration much shorter than the structural designer deals with in the case of permanent structures, such as buildings and bridges, and the plastic deformation is usually not as serious a matter as it might seem.

**ACFEL MP 20**

**AIRFIELDS ON PERMAFROST.**

Linell, K.A., July 1957, 83(AT1), p.1326(1-15), 13 refs. Microfilm No. SIP 15650.

25-2195

AIRCRAFT LANDING AREAS, RUNWAYS, FROZEN GROUND MECHANICS, CONSTRUCTION, DEGRADATION, FROST ACTION.

In this paper the author outlines the special problems of constructing air-field pavements on permafrost foundations. Particular attention is devoted to problems of construction in areas of discontinuous permafrost, the importance of non-frost-susceptibility soils is shown, and means of combating degradation of pavements are carefully explained. The effects of frost loosening on subgrade soil compaction outlined.

**ACFEL MP 21**

**FACTOR OF SOIL AND MATERIAL TYPE IN FROST ACTION.**

Linell, K.A., et al, Dec. 1958, 91p., AD-712 649, 60 refs.

Kaplar, C.W.

25-4015

FROST ACTION, PAVEMENT BASES, FROST HEAVE, FREEZE THAW CYCLES.

The present paper is one of four prepared for presentation at the January 1959 Annual Meeting of the Highway Research Board and intended to bring out, the present and latest basic knowledge concerning frost heave and frost action in soils in relation to pavements. The present paper reviews the elements which are significant in annual freeze and thaw action in soils and pavement supporting materials. In general, it does not attempt to cover special physical factors encountered only under permafrost conditions. However, the principles brought out herein are, in general, basically applicable not only to frost action which occurs in areas of purely seasonal freezing, but also to that which occurs in the zone of annual freeze and thaw in permafrost regions.

# ACFEL TRANSLATIONS

**ACFEL TL 1**
**SEA ICE.**
Boorke, A., May 1947, p.1-115, AD-712 536, Translated from Russian.
79-102
ICE COVER THICKNESS, ICE SALINITY, CLASSIFICATIONS, SEA ICE, ICE FORMATION, PHYSICAL PROPERTIES, ICE PRESSURE.

**ACFEL TL 2**
**IN THE CENTER OF THE ARCTIC.**
Zubov, N.N., May 1947, p.116-202, AD-712 536, Selected excerpts from the book translated from Russian.
79-103
ICE TEMPERATURE, ICE COVER STRENGTH, SEA ICE, DRIFT STATIONS, ICEBREAKERS, OCEAN CURRENTS, EXPEDITIONS, ICE NAVIGATION, ICE CRYSTAL STRUCTURE.

**ACFEL TL 3**
**AIR EXPEDITION TO HIGH LATITUDES OF THE ARCTIC IN 1941.**
Karelin, D.B., May 1947, p.203-214, AD-712 536, Translation of Izvestiia Vsesoiuznogo geograficheskogo obshchestva, 77(3):164ff, 1945.
79-104
ICE CONDITIONS, AERIAL RECONNAISSANCE, SEA ICE, ICE FLOES, AIRCRAFT LANDING AREAS, ICE NAVIGATION.

**ACFEL TL 4**
**AIRFIELDS ON ICE.**
Volkov, G., May 1947, p.215-236, AD-712 536, Translation of Morskoĭ sbornik, No.3, 1940, p.77-88.
79-105
METEOROLOGICAL FACTORS, HUMMOCKS, DYNAMIC LOADS, STATIC LOADS, AIRCRAFT LANDING AREAS, ICE RUNWAYS, ICE PHYSICS, ICE FORMATION.

**ACFEL TL 6**
**WATERPROOFING AND DRAINAGE OF DEFENSE AND NONDEFENSE STRUCTURES.**
Bukreev, P.A., 1949, 64p., AD-462 973, For original Russian text see SIP 739. 6 refs.
79-106
BUILDINGS, WATERPROOFING, PERMAFROST HYDROLOGY, SOIL MECHANICS, GROUND WATER, DRAINAGE, PUMPS, SEEPAGE.
Adequate drainage must be maintained during construction of buildings by means of open ditches, collecting wells, pumps, and other devices. Waterproof plastering of tunnels, water and oil tanks is frequently accomplished with the aid of a spray-gun. Military barracks, shelters, trenches, wartime storage houses or tanks, made of earth and lumber, may be made waterproof by using locally available materials, including salt solution. Subterranean waters, which might deteriorate concrete, should be removed or made impervious by improved insulation. Capillary action can be prevented by the addition of layers of insulating material. Injection of cement, clay, silicates, and tar in the ground as well as intentional freezing is employed wherever much ground water is present.

**ACFEL TL 7**
**ICINGS AND COUNTERMEASURES.**
Chekotillo, A.M., 1940, 47p., AD-462 973, For Russian original see SIP U658. 20 refs.
79-107
ICING, PIPELINE FREEZING, ROAD ICING, PERMAFROST HYDROLOGY, GROUND ICE, SPRINGS (WATER), PINGOS, NALEDS.
This basic textbook is intended for use in planning and building railroads and highways in permafrost regions. Nearly half of the text is devoted to description and classification of icing processes and phenomena, theory of icing formation, magnitude of subsurface water pressure, and influence of snow cover on icing. One chapter deals with description of icing effects on railroad dams and excavations, tunnels, railroad stations, living quarters, and shipping. The following anti-icing measures are discussed: (1) transfer of structures, (2) clearing away of icing, (3) widening excavations, (4) removal of water causing icing, (5) protective dams and fences, (6) drainage, (7) permafrost barriers, and (8) deepening, straightening and warming of river and creek beds.

**ACFEL TL 8**
**ABSTRACTS OF SCIENTIFIC RESEARCH WORK FOR 1945 OF THE OBRUCHEV INSTITUTE OF FROST SCIENCE.** Minnesota. University. Saint Anthony Falls Hydraulic Laboratory. Report No.17, Minneapolis, Minn., Apr. 1949, p.67-98, AD-462 973, Translation from Russian. Pt.2 of Investigation of airfield drainage, Arctic and Subarctic regions.
79-108
PERMAFROST THERMAL PROPERTIES, PERMAFROST HYDROLOGY, SOIL MOISTURE MIGRATION, FROZEN GROUND TEMPERATURE, ENGINEERING GEOLOGY, DIELECTRIC PROPERTIES, THERMOCARST, FOUNDATIONS, ACTIVE LAYER, AIRPORTS.

**ACFEL TL 9**
**BUILDING FOUNDATIONS IN THE BOL'SHEZEMEL'SKAYA TUNDRA.**
Saltykov, N.I., 1950, 66p., AD-462 974, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Trudy, Vol.4:125-204, 1944. 12 refs.
25-4016
PERMAFROST BENEATH BUILDINGS, FOUNDATIONS, PERMAFROST PRESERVATION, USSR.
The paper is divided into four parts: (1) a description of the ground ice and climatic conditions of the district in question; (2) a consideration of the thermal state of the ground beneath heated and unheated buildings; (3) a presentation of averaged data on vertical dislocations of buildings, and a description of their state; and finally (4) practical advice as to selection of types of foundations and recommended depths. The closing portion advances certain views relative to the planning of foundations under the conditions imposed by the war.

**ACFEL TL 10**
**BUILDING FOUNDATIONS IN YAKUTSK.**
Saltykov, N.I., 1950, 49p., AD-463 235, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Trudy, Vol.1:102-136, 1946. 9 refs.
25-4017
FOUNDATIONS, PERMAFROST PRESERVATION, COLD WEATHER CONSTRUCTION, PILE FOUNDATIONS.
Data on the construction practices in Yakutsk for the past 200 yrs. are reviewed. It is shown that wooden structures erected on pile foundations were well preserved, and stone and brick structures showed evidence of cracking and settling. It is believed that ignoring the permafrost conditions was the main cause of failures. Well-drained, sandy building sites are recommended and pile-type foundations are considered more reliable and economical than continuous foundations. The use of a dry gravel fill, wooden shields, and proper drainage will protect the structure from ground swelling. Ventilated sub-floors assist in maintaining the existing upper level of permafrost under large buildings. Wooden structures constructed on wooden piles driven 1 to 2 m. into the ground will not disturb the permafrost table.

**ACFEL TL 11**
**CONSTRUCTION AND CARE OF FOUNDATIONS UNDER SMALL INDUSTRIAL BUILDINGS IN THE DUDINKA REGION.**
Lukin, G.O., 1950, 63p., AD-462 986, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Trudy, Vol.1:27-101, 1946.
25-4018
FOUNDATIONS, PERMAFROST BENEATH BUILDINGS, INDUSTRIAL BUILDINGS.
Permafrost studies were conducted to determine the temperatures and the thawing processes in the soil under various types of foundations, and to observe the settling and deformation of the foundations and other parts of buildings. The data were collected during the construction and operation of 2 small power-plant buildings and a brick kiln for 2 yrs. One power plant and the kiln were constructed to preserve the permafrost, and the other power plant was built without considering the thermal effect of the boiler furnace on the permafrost. Results indicate that proper design, suitable construction methods, and adequate thermal insulation of underground structures are essential in permafrost areas. Proper drainage of snow and rain water increased the stability of buildings.

**ACFEL TL 12**
**DETERMINATION OF ADFREEZING STRENGTH OF WOOD AND CONCRETE TO GROUND AND SHEAR STRENGTH OF FROZEN GROUND UNDER FIELD CONDITIONS.**
Meĭster, L.A., et al, 1950, 19p., AD-462 987, Translation from Akademiia nauk SSSR. Komitet po vechnoĭ merzlote. Trudy. Vol.10:85-105, 1940. 2 refs.
Mel'nikov, P.I.
25-4019
SHEAR STRENGTH, ADFREEZING STRENGTH, FROZEN GROUND STRENGTH, CONSTRUCTION MATERIALS.
Wooden and concrete poles were set into the ground at the Igarka test station in August and extracted in March using a lever ratio of 1:7 or 1:8. A force of over 30 tons was needed to extract some of the poles. The adfreezing force for wood and sand with moisture content of 35 to 42 per cent at -0.9 C to -8.9 C, varied between 5 and 10 kg/sq.cm.; for sands and sandy loams with moisture content of 53.4 to 83.5 per cent at 0 C to -10.8 C, the force varied between 1.5 and 4 kg./sq.cm. The adfreezing force for concrete and sand with moisture content of 30.8 to 38.9 per cent at -0.7 C to -6.8 C varied between 4 and 8 kg./sq.cm. The resistance to shearing force increased with decreasing temperature, reaching a maximum of 15 kg./sq.cm. at -10 C for silty soils containing 46.5 per cent moisture.

**ACFEL TL 13**
**GROUND SWELLING UNDER RAILWAY BEDS UNDER PERMAFROST CONDITIONS.**
Datskiĭ, N.G., 1950, 12p., AD-462 992, Translation from Akademiia nauk SSSR. Komissiia po izucheniiu vechnoĭ merzloty. Trudy, Vol.4:171-187, 1935. 2 refs.
25-4020
RAILROADS, FROST HEAVE, FROST ACTION, SUBGRADE SOILS, CRACKING (FRACTURING), PERMAFROST.
An investigation was carried out in Skorovodino to determine the methods through use of which the deep cracking and heaving of railroad beds could be minimized. Soil tests indicated the presence of 0.40 to 0.43 g. of water per cu.cm. of soil. Observations over a period of 12 months showed that water above 0.20 g./cu.cm. of soil invariably caused nonuniform and uncontrollable dislocation and heaving of the road bed. It was recommended that a water retaining wall be constructed along the upland side of the road bed for drainage.

**ACFEL TL 14**
**INVESTIGATION OF ELASTIC AND PLASTIC DEFORMATION OF FROZEN GROUND.**
Tsytovich, N.A., 1950, 26p., AD-462 993, Translation from Akademiia nauk SSSR. Komitet po vechnoĭ merzlote. Trudy, Vol.10:5-35, 1940.
25-4021
FROZEN GROUND MECHANICS, ELASTIC PROPERTIES, PLASTIC DEFORMATION.
Tests were carried out in the laboratory at temperatures varying from -0.5 C to -10 C. Pure sand, silt and clay samples were tested with the aid of specially built apparatus. It was found that Young's modulus for permafrost decreased with the increase of pressure, the variation being linear for temperatures between -0.3 C and -5 C and nonlinear for lower temperatures. The succession of elastic deformation, plastic deformation and progressive flow of permafrost under stress was established. The plastic deformation of a sand sample at a temperature of -1.5 C began at a pressure rate of 2 kg./sq.cm. when free expansion was possible. The flow began when the rate of pressure attained 5 kg./sq.cm. The viscosity of permafrost was found to be very slight and similar to that of pure ice. Thus a mass of permafrost can start flowing under the pressure of its own weight, especially on slopes.

**ACFEL TL 15**
**POSSIBILITY OF APPLICATION OF SEISMIC INVESTIGATION TO THE STUDY OF PERMAFROST.**
Koridalin, E.A., 1950, 5p., AD-462 988, Translation from Akademiia nauk SSSR. Komitet po vechnoĭ merzlote. Trudy, Vol.3:15-19, 1934.
25-4022
SEISMIC SURVEYS, PERMAFROST STRUCTURE, WAVE PROPAGATION.
Seismic methods, analogous to those used in geologic research were attempted in the study of the subterranean relief and the geologic structure of permafrost, because these procedures were cheaper and quicker than drilling. It was assumed that permafrost would offer no particular difficulties in seismic investigation. Indications are, however, that more knowledge is needed concerning the speed of propagation in permafrost and its surrounding media. Further improvement is needed for studying

permafrost soils consisting of many layers. It is possible that the theory of auto vibrations of the layers and that of stationary waves could be applied. A brief theoretical background and description of the apparatus are given.

**ACFEL TL 16**
**PRINCIPLES OF CONSTRUCTING AND ESTIMATING THE FOUNDATIONS OF BUILDINGS ERECTED ON PERMAFROST.**
Tsytovich, N.A., 1950, 17p., AD-462 989, Translation from Geologiia i poleznye iskopaemye severa SSSR, Vol.3:78-101, 1936. 5 refs.
25-4023
PERMAFROST BENEATH BUILDINGS, FOUNDATIONS.
Durability and stability of building foundations erected in permafrost regions are discussed with reference to the influence of temperature, heaving of frozen ground, and action of external forces. Passive and active methods of construction are analyzed. The passive method leaves the permafrost undisturbed and provides for sufficient insulation so that the heat generated by the erected structure will not cause any thawing of the ground and thus weaken its stability. In areas with a relatively thin layer of permafrost and ground of sufficient stability and strength when thawed, measures are taken to completely thaw the ground prior to laying the foundation. This procedure is called the active method.

**ACFEL TL 17**
**SEWAGE DISPOSAL IN PERMAFROST IN THE FAR NORTH OF THE EUROPEAN USSR.**
Saltykov, N.I., 1950, 46p., AD-462 990, Translation of Kanalizatsiia v usloviiakh vechnoĭ merzloty kraĭnego severa Evropeĭskoĭ chasti SSSR. Moscow, Izd-vo AN SSSR, 1944. 51p.
25-4024
SEWAGE, PIPELINES, PERMAFROST THERMAL CONDUCTIVITY, FROST HEAVE.
An investigation of a sewage plant layout after 2 cold seasons indicated that from 65 to 75 per cent of all the wells exhibited cracks, the bulk of which appeared in the transconical parts and at the top of the well chambers. The swelling which apparently caused this excessive cracking reached a force of approximately 120 to 150 kg./cm. on the outer perimeter of the well. This force decreased with depth. At levels 2.75 to 3 m. below the surface the standard brick foundation was not affected. Reinforcement of the upper parts of the wells, thermal insulation and proper drainage of the wells are recommended. The temperature of the permafrost around the trunk lines of the sewage system at a depth of 2.5 m. was about -1.5 C, and around the collector at 4.0 m. about -2.1 C. Heat losses in the system were 5.0 kg. cal./sq. m. hr. C for cast-iron pipes and 4.5 kg.cal./sq.m. hr. C for concrete pipes, necessitating a constant flow of warm water.

**ACFEL TL 18**
**SHALLOW LAYING OF FOUNDATIONS OF LOW BUILDINGS.**
Bogoslovskiĭ, N.N., 1950, 13p., AD-462 991, Translation from Glubina zalozheniia fundamentov maloetazhnykh zdaniĭ v sviazi s sezonnym promerzaniem gruntov. Moscow, Izd-vo AN SSSR, 1946. p.16-42.
25-4025
FOUNDATIONS, FROST PENETRATION.
One or two story homes without cellars or utility pipes may be built on any type of ground because such buildings can withstand small, uneven settlement of the ground. Prior to 1930, the law required all foundations to be laid below the depth of frost penetration. More recently, deviations from this code have been permitted under certain conditions. The determining factor is the amount of ground swelling, which depends on the volume of ground water, the type of ground, and the filtering ability of intermediate layers. Where there is no danger of swelling, the depth of foundations must reach 0.5-1.0 m., depending on the type of ground and the nature of the drainage. If frost action is expected, the depths of foundations are defined by the estimated depth of freezing as determined by local meteorological data in conjunction with the type of ground.

**ACFEL TL 19**
**SOME PECULIARITIES OF OCCUPIED BUILDINGS IN THE NORTHERN PORTIONS OF THE PERMAFROST ZONE.**
Tumel', V.F., 1950, 42p., AD-712 854, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Trudy, Vol.1:5-26, 1946. 27 refs.
25-4026
FOUNDATIONS, PERMAFROST BENEATH BUILDINGS, FROST HEAVE, DEFORMATION.
The report contains statistical data obtained from soil analyses. Damage assessment of building foundations constructed on permafrost bearing soils is delineated.

**ACFEL TL 20**
**COMPRESSIVE STRENGTH OF PERMAFROST AND ICE IN THEIR NATURAL STATES.**
Khomichevskaia, L.S., Oct. 1951, 45p., AD-462 971, Translation from Akademiia nauk SSSR. Komitet po vechnoĭ merzlote. Trudy, Vol.10:37-83, 1940. 8 refs.
25-4027
PERMAFROST PHYSICS, COMPRESSIVE STRENGTH, FROZEN GROUND COMPRESSION.
Specimens of permafrost soils and ice consisted of cubes of natural structure measuring from 2 to 10 cm along the edges. A 10-ton press was used and the sample was maintained at its original temperature. The greatest compression strength was exhibited by permafrost dust (up to 200 kg/sq cm). Sandy soils were the second (147 kg/sq cm on the average). Clayey soils, coarse-grained soils, peat and ice possessed the lowest compression strength (40 to 45 kg/sq cm). It was found that compression strength increases with the lowering of temperature and decreases with the addition of coarse-grained soils. It also depends on the rate of increasing the load.

**ACFEL TL 21**
**CONSTRUCTION ON PERMAFROST.**
Liveroskiĭ, A.V., et al, May 1952, 306p., AD-462 972, Translation of Stroitel'stvo v usloviiakh vechnoĭ merzloty. Leningrad, Strolizdat Narkomstroia, 1941. 244p. 36 refs.
Morozov, K.D.
25-4028
PERMAFROST PHYSICS, CONSTRUCTION, BUILDINGS.
The pertinent information available in 1941 concerning the nature and destructive effects of permafrost upon the planning, building and maintenance of engineering structures is summarized. The deformation causes, such as ground swelling, thawing of the upper surface of permafrost, and the development of ice fields are described, and precautionary measures are presented. Proper selection of building plots or roadbeds in considered of primary importance. Detailed instructions on various phases of surveying and building are included.

**ACFEL TL 22**
**DURABILITY AND BEARING CAPACITY OF AN ICE LAYER.**
Persson, B.O.E., 1954, 13p., AD-042 748, Translation from Svenska vägförening, Vol.35:406-417, Dec. 1948. 8 refs.
25-4029
ICE BEARING CAPACITY, ICE COVER STRENGTH.
Various conditions under which cracks in sea and lake ice occur are discussed. Turbulent eddies are a frequent cause of ice-cover destruction. The partial breakup of the winter road over the Jansjärv Sea is cited as an example. The bearing capacity of ice was measured and the values obtained were in good agreement with those derived from Westergaard's formula. The values ranged from 386 kg. for a 4.7-cm. ice cover to 2920 kg. for a 13.0-cm. cover. Calculated values given for the bearing capacity of an ice cover must be used cautiously in practical applications.

**ACFEL TL 23**
**WINTER ROADS ON ICE.**
Wolff, A., 1954, 15p., AD-040 516, Translation from Svenska vägförening, Vol.27:268-282, Dec. 1940.
25-4030
ICE ROADS, ROAD MAINTENANCE.
The maintenance of ice roads for motor traffic over sea, lakes and rivers in Sweden is discussed. Motor traffic starts on the dual highway when the ice is 15 cm. thick. One side of the road is used for 2-way traffic until the other side develops a thicker ice cover. The snow removed by plowing becomes a closed snow fence along the highway. Snowbanks are utilized for molding the ice quays on the weakest spots, where ice meets land. The banks are stabilized by repeated sprinkling and freezing. Board and timber quays replace the ice quays when they become too weak to maintain traffic through May or until the ferries can operate. The bearing capacity of ice for all kinds of motor vehicles is given. The occurrence of pockets in the ice that melt from below results from warmer ground water from below the sea bottom.

**ACFEL TL 24**
**ICE CROSSINGS, SELECTED EXCERPTS.**
Bregman, G.R., et al, Oct. 1954, 62p., AD-102 282, Translation of selected portions of Ledianye perepravy, by Bregman, G.R. and B.V. Proskuriakov. Trudy nauchno-issledovatel'skikh uchrezhdeniĭ ser. 4, Vol.5, Gidrometeoizdat, Moscow, 1943. 151p.
Proskuriakov, B.V.
25-4031
ICE CROSSINGS, ICE BEARING CAPACITY, ICE COVER STRENGTH, ROAD MAINTENANCE.
The importance of ice crossings in peace and war time is reviewed. The characteristics of an ice cover, and the physical and mechanical properties of ice and snow are described. The procedure for a preliminary site survey, the route selection, and the hydrometeorological conditions during construction and operation of an ice crossing are outlined. Formulas for the computation of the carrying capacity of an ice cover are presented. Specific examples describing approaches, reinforcements, and closures of longitudinal cracks in ice crossings are included. The problems connected with railroads operating upon ice cover are briefly reviewed. Equipment for the maintenance of ice crossings is described.

**ACFEL TL 25**
**DATA ON THE PROBLEM OF ICE CROSSINGS.**
Lagutin, G.L., ed., Dec. 1954, 126p., AD-076 127, Revised edition of ACFEL TL 5 originally translated by the Stefansson Library and issued as ACFEL TR 29 App.A.
25-4032
ICE CROSSINGS, ICE BEARING CAPACITY, ICE COVER STRENGTH, DEFORMATION, FLOATING ICE, ICE MECHANICS.

**ACFEL TL 26**
**HYDRAULIC APPARATUS FOR ENGINEERING COMPUTATIONS.**
Luk'ianov, V.S., June 1955, 32p., AD-701 174, Translation from Akademiia nauk SSSR. Otdelenie tekhnicheskikh nauk. Izvestiia, No.2:53-67, 1939.
25-4033
COMPUTER APPLICATIONS, HYDRAULICS, THERMODYNAMICS, CIVIL ENGINEERING.
The method of computation using the hydraulic apparatus developed by the author is based on the application of principles of hydraulic analogies in correlation with partial use of the principles of computation based on finite differences. The application of these hydraulic computers allows one to find the approximate numerical solutions for a whole class of differential equations. Therefore, these machines might be called hydraulic integrators. Insofar as the application concerns itself with the solution of differential equations, it is possible to use this method to solve problems in many different fields of technology. To approach the problem more concretely, and for clarity of presentation we look at the applications of thermodynamics to civil engineering and the problems that can now be solved by this method.

**ACFEL TL 27**
**ACCUMULATION OF NATURAL COLD FOR GROUND FREEZING.**
Trupak, N.G., 1960, 4p., AD-238 974, Translation from Stroitel'naia promyshlennost', 17(6):47-50, 1939. 5 refs.
25-4034
ARTIFICIAL FREEZING, COOLING TOWERS, SOIL STABILIZATION.
A method is described for utilizing natural, cold air for freezing ground without refrigeration machinery. A $CaCl_2$ solution freezing at -55 C is pumped in a cooling tower and cooled by external air. The cooled solution can be transferred in pipes and used to freeze soil in mines over 90 m. deep, in water-saturated pits, in the construction of dams, docks, and building foundations. A combined method utilizes cold air in summer and permafrost in winter. The control of landslides by freezing the soil is indicated.

**ACFEL TL 28**
**FUNDAMENTAL CONCEPTS AND TERMS IN GEOCRYOLOGY (PERMAFROST STUDIES).**
Akademiia nauk SSSR. Institut merzlotovedeniia, June 1960, 11p., AD-238 977, Translation of Osnovnye poniatiia i terminy geokriologii (merzlotovedeniia). Moscow, Izd-vo AN SSSR, 1956. 16p. 3 refs.
25-4035
GEOCRYOLOGY, TERMINOLOGY, CLASSIFICATIONS.
The present project on basic terms of geocryology has been compiled by the Commission on Terminology of the V. A. Obruchev Institute of Geocryology, Academy of Sciences, USSR. The work of the Commission on Terminology consisted of two phases: the first devoted to the compilation of existing definitions and terms of geocryology and their listing; the second in which the existing terms and definitions were considered and criticized, new concepts and terms brought forth; the latter, after being discussed by the editorial and the terminological committees, are published in the present edition.

**ACFEL TL 29**
**DAMS IN PERMAFROST REGIONS.**
Savarenskiĭ, F.P., 1960, 2p., AD-238 978, Translation from Izbrannye sochineniia. Moscow, AN SSSR, 1950. p.370-371.
25-4036
DAMS, SEEPAGE, GROUND THAWING.
Water reservoirs built over permafrost will disrupt the natural thermal regime in the riverbed, especially in the vicinity of the dam. Heat is accumulated by the water and is transmitted to the ground. The ground thaws and water seepage occurs. Frequently an ice-crust is formed below the dam. The dam freezes and cracks. One reservoir examined lost up to 90 per cent of the water content due to seepage and ice formation. This dam underwent considerable deformation and was heavily damaged by high spring waters. At another dam the upper level of permafrost decreased 4-5 m.

**ACFEL TL 30**
**NONFREEZING WATER IN SOIL.**
Vershinin, P.V., et al, 1960, 10p., AD-238 979, Translation from Akademiia nauk SSSR. Izvestiia, seriia geograficheskaia i geofizicheskaia, 13(2):108-114, 1949. 20 refs.
Deriagin, B.V., Kirilenko, N.V.
25-4037
FREEZING POINTS, UNFROZEN WATER CONTENT, FROST ACTION.
The presence of free water in soil under freezing conditions may be attributed to 2 factors: (1) the lowered freezing point of the water film on soil particles, and (2) the expansion of water upon freezing. It was found that the excessive expansion of freezing soils is due to a directional growth of ice crystals and not to a change in volume alone. The expansion is greater in dense soils even though only part of the water freezes. The segregation of ice crystals and the resulting pressure during the freezing of soils causes excessive expansion of the soil. The subsequent rearrangement of adjoining particles of soil changes the density of the soil. The effect of freezing on soil density is such that a direct relationship exists between the nonfrozen volume and the density.

**ACFEL TL 31**
**STRENGTH OF PERMAFROST UNDER BUILDING FOUNDATIONS.**
Berezantsev, V.G., 1960, 7p., AD-239 781, Translation from Merzlotovedenie 2(1):48-54, 1947.
25-4038
FROZEN GROUND STRENGTH, PERMAFROST BENEATH BUILDINGS.
The strength of permafrost is basically determined by the force of cohesion which usually varies between 2.5 and 18 kg/sq cm. The angle of internal friction does not exceed 20 degree either in frozen clay or in frozen sandy soils, and may be disregarded whenever the cohesion force is expressed by the magnitude of 2.0 kg/sq cm or more. A modified version of Prandtl's formula is given to determine the critical load of the ground under foundations.

**ACFEL TL 32**
**MATHEMATICAL ANALYSIS OF ARTIFICIAL GROUND FREEZING.**
Mariupol'skiĭ, G.M., 1960, 5p., AD-238 980, Translation from Gornyĭ zhurnal, 116(5):65-68, 1940. 3 refs.
25-4039
SOIL FREEZING, ARTIFICIAL FREEZING, ANALYSIS (MATHEMATICS).
The process of freezing ground by artificial cooling, particularly as used in excavating, is mathematically analyzed; formulas for calculating time and degree of cooling are given; and selected freezing rates are graphed. Freezing occurs in 2 stages: small cylindrical sections of ground freeze first around each of the cooling pipes surrounding the space to be excavated; and then the cylinders fuse into a solid ring of frozen ground enclosing the pipes. Differences in the thermal properties of frozen and unfrozen ground result in changes in the rate of cooling.

**ACFEL TL 33**
**PROTECTION OF BENCH MARKS AT POLAR GAGE STATIONS.**
Koblents, IA.P., 1961, 7p., AD-701 175, Translation from Problemy Arktiki, No.1:111-113, 1957. 3 refs.
25-4040
BENCH MARKS, DAMAGE, FOUNDATIONS.
Bench-mark damage in polar regions associated with permafrost and ground ice is analyzed, and proper construction methods are discussed. A metal pipe about 60 mm in diameter, with a disk about 150 mm in diameter welded on the lower end, is not liable to destruction or change in elevation when the disk is placed at a depth equal to three times the thickness of the active layer.

# SIPRE TRANSLATIONS

**SIPRE TL 1**
**CONTACT POTENTIAL DIFFERENCE BETWEEN WATER AND ICE.**
Arabadzhi, V.I., 1950, 2p., AD-659 640, For original Russian text see SIP U1165. 2 refs.
25-2257
ICE ELECTRICAL PROPERTIES, ICE WATER INTERFACE, CONDUCTIVITY.
A container with distilled water on which a film of ice was formed was placed on an insulated stand. A metal-hooded radio-thorium receiver connected to a sensitive single-filament Wolf electrometer was placed 5 mm. above the ice surface. The water beneath the ice was grounded. Readings of the potential were taken at a 17C ambient temperature before and after the ice was melted. The measurements indicated that a 0.17 v contact potential difference existed between water and ice.

**SIPRE TL 2**
**DIELECTRIC PROPERTIES OF BARIUM TITANATE.**
Averbukh, R.E., et al, 1950, 5p., AD-718 899, Translation from Zhurnal eksperimental'noĭ fiziki, 19(11): 965-970, 1949. 2 refs.
Kosman, M.S.
25-4067
DIELECTRIC PROPERTIES, BARIUM TITANATE.
The subject of the experiment was the dependence of the dielectric permeability of barium titanate upon temperature and upon field intensity. The experiment was conducted by a new type of ballistic method. It was determined that the dielectric permeability consisted of two parts, sharply distinguished by magnitude and by their dependence upon the time of discharge, the temperature and the field intensity.

**SIPRE TL 3**
**POLARIZATION OF ICE.**
Averbukh, R.E., et al, 1950, 3p., AD-718 888, Translation from Zhurnal eksperimental'noĭ fiziki, 19(11): 971-972, 1949.
Kosman, M.S.
25-4068
ICE ELECTRICAL PROPERTIES, POLARIZATION (CHARGE SEPARATION).
The polarization of ice was subjected to study by means of a new arrangement of the ballistic method. It was established that the dielectric permeability of ice consists of two parts, sharply differentiated the magnitude, in accordance with the charging interval and the direction of the field.

**SIPRE TL 4**
**ON THE ELASTIC CONSTANTS OF ICE.**
Hess, H., 1950, 12p., AD-881 102, Translation from Zeitschrift für Gletscherkunde, Vol.27:1-19, 1940-41. 15 refs.
25-4069
ICE ELASTICITY, WAVE PROPAGATION, ANALYSIS (MATHEMATICS).
Data from earlier experiments were used to establish the dependency of Young's modulus on temperature and pressure within the range of 0-9 C. Functional relationships involving Poisson's ration, the factor of incompressibility, the modulus of torsion, and Young's modulus were obtained. In measuring glacial depths with seismic waves, it was shown that in order to use appropriate velocity formulas, which are dependent on the above mentioned factors, a correction factor (between 1.5 and 3) must be applied to Young's modulus. Application of these formulas in connection with the seismic method yielded smaller depths for Greenland ice than had previously been found.

**SIPRE TL 5**
**TEMPERATURE DEPENDENCE OF ICE VISCOSITY.**
Lavrov, V.V., 1950, 7p., AD-718 887, Translation from Zhurnal tekhnicheskoĭ fiziki, 17(9): 1027-1034, 1947. 6 refs.
25-4070
ICE DEFORMATION, VISCOSITY, TEMPERATURE FACTORS.
The role and significance of crystalline structure in the study of the plastic properties of ice has been demonstrated. An anomalous change in the rate of plastic deformation of specimens of sufficiently regular crystalline structure occurs when they are subjected to sharp change in temperature, constituting a phenomenon of interest to the theory of plasticity. It has been demonstrated that the phenomenon of rest, well known in the literature on crystallography, holds for ice as well. A sufficiently well-grounded evaluation of the relation between the viscosity of ice, and temperature is offered for the first time, within a temperature range of -3 degrees and -23 degrees C.

**SIPRE TL 6**
**SNOW COVER, ITS FORMATION AND PROPERTIES.**
Rikhter, G.D., Aug. 1954, 66p., AD-045 950, For original Russian text see SIP U743. 102 refs.
25-2258
SNOW COVER DISTRIBUTION, SNOW COVER EFFECT, SNOW PHYSICS, SNOW DENSITY.
The characteristic properties of a snow cover are determined by the structure and shape of snow flakes, the degree of snow flake modification during the fall, condensation and evaporation from the snow surface, compression as a result of force gravitation, melting and regelation, recrystallization and firnization, and mechanical effect of storms, liquid precipitation, inclusion of mechanical admixtures, and the characteristics and thermal state of the ground and the thermal conditions within the snow cover. The basic physical properties of a snow cover, such as heat conductivity, radiation properties, color, penetrability of light, gases and water, sliding resistivity, acoustic effects, and electrical properties are discussed. The influence of snow on visibility on a clear day and in fog, the grinding effects of snow in motion, and the effects of snow thawing are described. The territory of the USSR is classified according to the duration of snow cover, the depth and density of snow.

**SIPRE TL 7**
**ENERGY OF GLACIATION AND THE LIFE OF GLACIERS.**
Shumskiĭ, P.A., 1950, 27p., AD-659 641, For original Russian text see SIP U1038. 19 refs.
25-2259
GLACIATION, METEOROLOGICAL FACTORS, GLACIER ABLATION, CLASSIFICATIONS, GLACIER MOVEMENT.
The following topics are included: (1) Khionosphere, the zone between the lower and upper snow line; (2) dynamics of glaciation; (3) intensity of accumulation and ablation processes along the snow line; (4) geological activity of glaciers; (5) snow line; (6) relationship between the glaciation dynamics and the altitude of the snow line; (7) energy of glaciation and oscillation of glaciers; (8) meteorological factors of accumulation and ablation; (9) climatic character of glaciation; (10) consequences of general cooling and the glacier preservation problem; (11) Simpson's hypothesis; (12) genetic classification of glaciers.

**SIPRE TL 8**
**MEASUREMENTS RELATIVE TO PERFORMANCE AND EFFICIENCY OF SNOW REMOVAL MACHINES FOR HIGHWAYS. BASIS OF DESIGN AND CONSTRUCTION.**
Croce, K., Sept. 1951, AEWES-Trans 51-5, 80p., AD-712 855, Translation of Messversuche an Schneeraummaschinen für Landstrassen. Entwurfsgrundlagen. Strassen- und Tiefbau, Vol.4, 1950. 78p. 112 refs.
25-4071
PERFORMANCE, SNOW REMOVAL EQUIPMENT, ROADS.
Results obtained during test runs of various types of snow removal machines during 1940 to 1945 are presented. Equipment tested includes Peter drum-type rotary plows, Snogo rotors, Crosti rotary plows, rotary plows with concave blower wheels, and snowbank removers. The performance of individual machines was determined in the snow and a relationship was established between performance and driving output. Measurements were made of the volume of snow removed per unit of time, rate of travel, distance snow is thrown, degree of snow compaction, and engine output. Units with concave blower wheels and the Snogo machine have the highest collecting performances. Internal and over-all efficiencies were found to be considerably low for all units.

**SIPRE TL 9**
**STRENGTH PROPERTIES OF A SNOW COVER AND ITS MEASUREMENT.**
De Quervain, M., Nov. 1951, 9p., AD-881 019, Translation from Geofisica pura e applicata, Vol.18:178-191, 1950. 5 refs.
25-4072
SNOW STRENGTH, TEST EQUIPMENT, SNOW HARDNESS.
A survey is given on various methods of measuring strength and hardness of snow. Besides older well known instruments newer ones are described. A suggestion is made for a rough hardness scale whose application does not require any particular instruments. Measurements taken in a snow profile with different instruments show a good agreement in the general course of hardness and strength.

**SIPRE TL 10**
**PECULIARITY OF THE MECHANISM OF THE PLASTIC DEFORMATION OF ICE.**
Ivanov, K.E., et al, 1951, 3p., AD-718 766, Translation from Zhurnal tekhnicheskoĭ fiziki, 20(2):230-231, 1950.
Lavrov, V.V.
25-4073
ICE DEFORMATION, ICE PLASTICITY, TESTS.
It is well known that crystalline bodies differ from amorphous bodies, not only because they are anisotropic, but also because of their special behavior in plastic deformation. The latter in crystals occurs in leaps and bounds and, as a result, the deformation curves clearly show this step-like characteristic. Up till now, this phenomena had been discovered in the crystals of NaCl, brass, zinc and cadmium, and also in metals in the polycrystalline state (as brass and aluminum). It is shown that this peculiarity is also present in ice.

**SIPRE TL 12**
**INFLUENCE OF THE RADIATION FACTOR ON THE GROWING AND SHRINKING OF GLACIERS.**
Sauberer, F., et al, 1951, AEWES-TR-No. 51-1, 22p., AD-711 859, For original German text see SIP U1390. 14 refs.
Dirmhirn, I.
25-2260
GLACIER OSCILLATION, ALBEDO, RADIATION BALANCE, SOLAR RADIATION, THAWING, MEASUREMENTS.
Incoming radiation consists of direct solar, sky, and long wave counterradiation of the atmosphere. Outgoing radiation is determined by the albedo of the surface and by long wave irradiation. Measurements of these components were conducted at altitudes of 3000 m. on a horizontal plane under various conditions of cloudiness, duration of sunshine, and albedo. Mean daily radiation totals of the surfaces are computed. The actual daily radiation balance is determined for the various outgoing radiation types. It is shown that the effect of sunshine duration and variation in the intensity of solar radiation do not contribute to glacier fluctuation. The variability of the albedo due to impurities on the glacier, freezing and thawing processes, and precipitation, was found to be the most important factor. It is suggested that attention be given to the distribution of precipitation and that an analysis be made of the daily radiation balance curves.

**SIPRE TL 13**
**SOME OBSERVATIONS ON PROCESSES CONNECTED WITH THE FORMATION OF ICE.**
Seliakov, N.IA., 1951, 4p., TT-60 13694, Translation from Akademiia nauk SSSR. Doklady, Vol.70:821-824, 1950.
25-4075
WATER, FREEZING, ICE CRYSTAL STRUCTURE, ICE FORMATION.
Ice crystals are made visible for study purposes by 3 methods: (1) dessication, (2) etching or outlining, and (3) light projection. It was determined by these methods that ice crystals were a few cm. in size. The orientation of ice crystals in relation to the freezing water surface and the physical properties of melting ice, were determined by developing the melting pattern method, a technique first divised by Tyndal. Two methods of freezing water are described: (1) side cooling and (2) surface cooling with constant pressure underneath the ice. Two types of "freezing out" (vymorazhivanie) are distinguished: (1) when evaporation takes place during the crystallization process, and (2) when evaporation originates from the solid phase surface, after the liquid has been totally crystallized. The latter process is called sublimation.

**SIPRE TL 14**
**SNOW AND ITS METAMORPHISM.**
Bader, H., et al, Jan. 1954, 313p., AD-030 965, Translation of Der Schnee und seine Metamorphose. Beiträge zur Geologie der Schweiz. Geotechnische Serie, Hydrologie, Vol.3:340 p. 232 refs.
Haefeli, R., Bucher, E., Neher, J., Eckel, O., Thams, C.
25-4076
METAMORPHISM (SNOW), SNOW THERMAL PROPERTIES, SNOW MECHANICS, SNOW HARDNESS, SNOW PERMEABILITY.
Contents: Mineralogical and structural characterization of snow and its metamorphism. Snow mechanics with reference to soil mechanics. Time profile, a graphic representation of the development of the snow cover. Snow investigations in the field. Investigations of the density, temperature and radiation conditions of the Davos snow cover. Summary of the investigations by the Institute of Snow and Avalanche Research, Davos, since 1940.

**SIPRE TL 15**
**PHYSICAL PROCESSES IN A SNOW COVER.**
Shakhov, A.A., Jan. 1952, 17p., AD-495 997, Translation from Akademiia nauk SSSR. Izvestiia, ser. geograficheskaia i geofizicheskaia, Vol.12:239-248, 1948. 34 refs.
25-4077
SNOW PHYSICS, MECHANICAL PROPERTIES, SUBLIMATION, SNOW HARDNESS.
Water vapor contained in a snow cover migrates upwards where snow temperatures and water vapor density are higher. In this process, all voids between the snow-flakes are saturated with water vapor which sublimates on the surface of the snow crystals and cements them together. As a result, the hardness of snow increases. A brief, intense mixing of snow increases the hardness still more, but prolonged mixing decreases the hardness by allowing the escape of water vapor.

**SIPRE TL 16**
**REPORT ON PERMAFROST SURVEYING (MANCHURIA, 1943).**
Nakaya, U., et al, Jan. 1953, TT-382, 11p., AD-007 676.
Sugaya, J.
25-4078
FROZEN GROUND TEMPERATURE, ACTIVE LAYER, FROST PENETRATION.
The distribution of ground temperatures in permafrost in early autumn when the active layer has melted to a maximum depth was studied to evaluate the hardness of the upper layer of the permafrost and to estimate the solidity of foundations. Thermocouples were inserted into holes bored through the permafrost to 3 m. below the frozen surface. The temperature is close to 0 C in the upper part of the frozen layer, -0.3 C at 1 m. below the frost line, and remains above -0.4 C to a depth of several m. Temperature measurements at the ground surface and at depths of 10 and 20 cm. gave a value of 0.005 c.g.s. units for the coefficient of thermal diffusion in the active layer in the thawed state. The character of the soil in the thaw layer and in the frost layer was examined. The fine particles wash out of the active layer when it thaws. Permafrost forms by cooling from above. A frost-heaving ratio of 8 percent was calculated for a sample obtained at 2.68 m. below the surface, or 0.58 m. in the frost layer.

**SIPRE TL 17**
**THERMAL FIELD LAWS OF THE PERMAFROST IN THE VORKUTA REGION.**
Redozubov, D.V., Feb. 1954, 22p., AD-718 889, Translation from Akademiia nauk SSSR. Institut merzlotovedeniia. Trudy, Vol.1:137-166, 1946. 9 refs.
25-4079
MINE SHAFTS, GEOTHERMOMETRY, PERMAFROST THERMAL PROPERTIES, ANALYSIS (MATHEMATICS).
The work presented here consists of two basic chapters. The first chapter expounds those thermal field laws in permafrost bodies which are general for the permafrost region as a whole. The second chapter discusses the thermal field laws which are characteristic of the permafrost in the Vorkuta region.

**SIPRE TL 18**
**CONTRIBUTION TO THE THEORETICAL FOUNDATIONS OF AVALANCHE DEFENSE CONSTRUCTION.**
Bucher, E., Feb. 1956, 109p., AD-102 286, For original German text see SIP U1948, U1951-U1958. 236 refs.
25-2261
AVALANCHE COUNTERMEASURES, SNOW PLASTICITY, SNOW STRENGTH, SNOW DYNAMICS, METAMORPHISM (SNOW), AVALANCHE ENGINEERING, THEORIES.
Discusses the distinction between different types of snow, relations of snow to elastic and plastic materials, plastic and strength properties of snow, statics and dynamics of snow cover, formation of avalanches, and avalanche defense constructions.

**SIPRE TL 19**
**PRINCIPLES OF MECHANICS OF FROZEN GROUND.**
Tsytovich, N.A., et al, Apr. 1959, 288p., AD-230 484, For Russian original see SIP 885.
Sumgin, M.I.
32-4378
FROZEN GROUND ANALYSIS, PERMAFROST PHYSICS, PERMAFROST BENEATH STRUCTURES, FROST HEAVE, SOIL MOISTURE MIGRATION, LOADS (FORCES).

**SIPRE TL 21**
**SNOW AS A CRYSTALLINE AGGREGATE.**
De Quervain, M., May, 1954, 7p., AD-035 122, Translation from Experientia, Vol.1:207-212, 1945. 11 refs.
25-4082
METAMORPHISM (SNOW), SNOW CRYSTALS, PLASTIC DEFORMATION.
Changes in the atmospheric conditions determine the growth and structure of fresh snow crystals. The density is increased after the snow is deposited due to the weight of the snow and the action of inter-crystalline forces. Metamorphism of the snow crystal depends on the stability of the crystalline form. The early transformation phase is attributed to surface expansion of a superficial layer having fluid-like properties with which the crystals are believed to be covered. Subsequent change into coarsely grained old snow takes place due to temperature variations and the exchange of diffusion and convection vapor currents in the snow cover. The relationship between the plasticity of the snow aggregate to the crystal plasticity is studied by means of deformation tests. It is shown that snow is a viscous liquid. Thin ground plates of snow are used for microscopic studies of the snow grain orientation.

**SIPRE TL 22**
**THERMAL CONDUCTIVITY OF THE SNOW COVER AND PHYSICAL PROCESSES CAUSED BY THE TEMPERATURE GRADIENT.**
Kondrat'eva, A.S., no date, 13p., AD-035 124, For original Russian text see SIP U888. 21 refs.
25-2262
THERMAL CONDUCTIVITY, SNOW DENSITY, SUBLIMATION.
Laboratory tests were conducted to determine the relationship between the density and thermal conductivity of snow. Snow of known densities was placed in 30 x 50 cm. open-top wooden boxes with metal bases immersed in a NaCl solution at -1C. The air temperature surrounding the box was kept constant at -12C. Thermocouples were placed at various depths, approximately 10 cm. apart. The initial temperature of the snow was recorded and new recordings were plotted every 30 min. The results indicated that the ratio of the coefficient of thermal conductivity to the square of the density was 0.00068 for smaller densities and 0.0085 for larger densities.

**SIPRE TL 23**
**BLASTING OPERATIONS.**
Lobotskiĭ, N.B., Oct. 1953, 3p., TT-60 17740, Translation from Stroitel'naia promyshlennost', 21(9):11-13, 1943.
25-4083
BLASTING, EXCAVATION, FROZEN GROUND.
Two excavation methods in frozen ground using explosives are described. Long trenches varying in width from 0.5-3 m. were made by placing charges in inclined 1.3-1.5-m. holes facing a sharp scarp. Preparations for excavators were made by arranging explosives in a checkerboard pattern over the area at depths ranging from 1-1.3 m. Precaution was taken to maintain a 20-cm. layer of frozen ground under the charge. Methods of calculating the weight of explosives are outlined.

**SIPRE TL 24**
**CALCULATION OF SNOW COVER DENSITY USING METEOROLOGICAL DATA.**
Dmitrieva, N.G., Jan. 1954, 4p., AD-718 883, Translation from Meteorologiia i gidrologiia, No.2:39-44, 1950. 6 refs.
25-4084
SNOW DENSITY, METEOROLOGICAL DATA.
Systematic observations of snow density were begun in Russia in 1903-04. However, sufficient data on snow density were not collected even for such regions of European USSR as the Ukraine and the Northeast at the time the quantitative survey of water resources was made. Data on density are scarcest for Siberia, especially the mountain regions. The necessity for calculating the water equivalent in the snow cover stimulated the investigation of the quantitative effects of the principal meteorological factors on snow settling during winter and spring snow melting.

**SIPRE TL 25**
**MECHANICS OF FROZEN GROUND.**
Pokrovskiĭ, G.I., Feb. 1954, 20p., AD-070 495, Translation from Zhurnal tekhnicheskoĭ fiziki, 5(6):1047-1056, 1935. 6 refs.
25-4085
FROZEN GROUND MECHANICS, ANALYSIS (MATHEMATICS).
The basic properties of frozen ground are quantitatively described and treated from a mathematical standpoint. Formulas are introduced for the determination of adhesive forces between solid particles unified by ice, the moisture content and the hydrodynamic forces of the active layer (permafrost areas), and the rate of settling of structures erected upon frozen ground. Continuation and expansion of these studies are suggested.

**SIPRE TL 26**
**USE OF SNOW, ICE AND FROZEN GROUND IN FORTIFICATIONS.**
Chekotillo, A.M., 1954, 26p., AD-070 496, Translation of Primenenie snega, l'da i merzlogo grunta v fortifikatsii. Moscow, 1943. 34p. 18 refs.
25-4086
FORTIFICATIONS, ICE (CONSTRUCTION MATERIAL), SNOW (CONSTRUCTION MATERIAL), FROZEN GROUND, CONSTRUCTION.
The physico-mechanical and construction properties of snow, ice and frozen ground are described, as well as the technical methods and rules for building fortifications from these materials. Construction techniques for such buildings and their upkeep are discussed.

**SIPRE TL 28**
**WATER SUPPLY OF RAILROADS IN PERMAFROST REGIONS.**
Sumgin, M.I., et al, Oct. 1955, 64p., TT-50 17739, Translation of excerpts from Vodosnabzhenie zheleznykh dorog v raionakh vechnoĭ merzloty. Moscow, Transzheldorizdat, 1939.
Geniev, N.N., Chekotillo, A.M.
25-4087
WATER SUPPLY, WATER PIPELINES, GROUND WATER, PERMAFROST, THERMODYNAMICS.
The types of water sources and methods of locating water are described. Studies of water above and below permafrost layers are presented. The procedures used in transporting water in conduits from the source to the railroad are discussed. The construction methods employed in laying water pipes and in erecting supplementary structures are included.

**SIPRE TL 29**
**METHODS OF TEMPERATURE OBSERVATIONS ON A SNOW SURFACE.**
Nechaev, I.N., July 1953, 7p., AD-035 123, Translation from Leningrad. Glavnaia geofizicheskaia observatoriia. Trudy, No.25(87):84-87, 1951.
25-4088
SNOW SURFACE TEMPERATURE, MEASUREMENT.
An experimental verification of the accuracy of the method recommended in the Manual of the Hydrometeorological Service was made at the Central Observatory during the spring of 1950. Five thermometers were placed horizontally on and under the snow surface at air temperatures below and above 0 C. Good agreement was maintained between air and snow temperatures during the period with negative air temperatures. The rapid snow melting at positive air temperatures reduced the heat exchange between the thermometers and snow which resulted in high readings not associated with the snow surface temperature.

**SIPRE TL 30**
**MEASUREMENT OF THE THERMAL CONDUCTIVITY OF SNOW COVER.**
Yosida, Z., et al, Nov. 1954, 7p., AD-070 465, Translation from Seppyo, Vol.8:48-53, 1946.
Iwai, H.
25-4089
SNOW THERMAL PROPERTIES, THERMAL CONDUCTIVITY.
A new method of measuring the thermal conductivity of a small sample of snow is described. A snow sample of cylindrical form, 10 cm in diameter and 5 cm in height, was packed in an airtight vessel. The sides were insulated to permit heat flow only in the vertical direction. The temperature of the terminal surfaces of the cylinder was -1 C at the beginning of the test run. Both surfaces were rapidly cooled to -6 C until the temperature of the entire sample was -6 C. The rate of decrease of pressure in the vessel was measured. A mathematical analysis resulted in an equation from which the value of thermal conductivity can be determined from the rate of decrease in pressure. Data obtained by this method are given. A total of 13 measurements of thermal conductivity of snow determined by the older, established method are included in the appendix by Shigeji uOgiya.

**SIPRE TL 31**
**ELECTRICAL RESISTANCE OF SNOW.**
Shimada, H., Nov. 1954, 4p., AD-070 467, Translation from Seppyo, Vol.3:503-506, 1941.
25-4090
ELECTRICAL RESISTIVITY, SNOW ELECTRICAL PROPERTIES.
The resistance of snow was measured for various layers by the potentiometric method. Galvanized iron plates, 4.5 x 20 cm., were used as electrodes. D. C. current was used because no polarization phenomenon was observed. The snow contained about 13 per cent of free water. The specific resistance was 31 x 1/100,000 ohms for the upper layer of granular snow of large grains, 16 x 1/100,000 ohms for the second layer of settled snow, and 9 x 1/100,000 ohms for the third layer of granular snow of medium-sized grains.

**SIPRE TL 32**
**PROPERTIES OF SNOW AND ITS DENSTY.**
Oda, T., et al, Nov. 1954, 21p., AD-070 497, Translation from Seppyo, Vol 3:109-121, 1941. 4 refs.
Kudo, K.
25-4091
SNOW DENSITY, SNOW WATER CONTENT, SNOW MECHANICS.
The results of the snow studies conducted at the Institute of Agricultural Economics in heavy snow districts during the winters 1938-1940 are summarized. Snow is classified into: new, settled, powder, dry, wet, dry settled, wet settled, granular, and frozen snow. The density, depth, subsidence, meltwater content and weather conditions were recorded for both winters, and are discussed. Compaction of successive layers of snow is presented in a diagram, showing the compression of each layer and the process of snow melting. The capillary action of the sow cover is discussed as the result of the capillary action of narrow air spaces in the snow.

**SIPRE TL 33**
**ON THE HARDNESS OF SNOW.**
Inaho, Y., March 1955, 6p., AD-070 466, Translation from Seppyo, Vol.3:343-349, 1941.
25-4092
SNOW HARDNESS, HARDNESS TESTS.
The hardness of snow was measured by the cone dropping method and the total resistance of the snow to the cone is expressed in an equation in which the load unit area is equal to the amount of compression multiplied by constants varying with different kinds of snow. It is concluded that the compression characteristics of snow are related to texture, grain size, porosity, humidity, and the depth of snow. Mixtures of different kinds of snow influence the compression results.

**SIPRE TL 34**
**FREEZING OF THE SUNGHALI RIVER MANCHURIA.**
Murakami, M., June 1955, 12p., AD-070 468, Translation from Seppyo, Vol.3:333-342, 1941.
25-4093
RIVER ICE, ICE FORMATION.
The temperature of the Sunghali river basin drops as low as -30 C in midwinter. A survey of the processes of freezing and melting of the river ice was carried out in the winter of 1940-41 and the data obtained are tabulated. Data of daily observations of the ice thickness and growth are presented. The rate of increase in thickness was found to be linearly proportional to the minimum temperature of the date. The relation between the thickness of ice and the rate of increase in thickness is studied. The effect of stream velocity on the thickness of ice is examined and results are tabulated.

**SIPRE TL 35**
**COMPACTION OF SNOW BY STATIC AND KINETIC LOADS.**
Nagasawa, M., Aug. 1955, 8p., AD-076 727, Translation from Seppyo, Vol.5:249-256, 1943.
25-4094
SNOW COMPACTION, SNOW ROADS, SNOW REMOVAL EQUIPMENT.
The compaction of snow to insure open roads for heavy traffic was studied. Several instruments used in civil engineering for earth packing were tested. The breaking of the stratigraphic structure and the addition of water to dry snow are considered effective methods. The bearing capacity and the hardness of the packed snow surface were measured.

**SIPRE TL 36**
**RESISTANCE OF SNOW TO A SLEDGE (SECOND REPORT).**
Kuroda, M., Feb. 1955, 5p., AD-070 469, For Japanese original see SIP 3469.
32-4379
SNOW VEHICLES, SNOW PHYSICS, SNOW STRENGTH, WOOD SNOW FRICTION, RUBBER SNOW FRICTION.

**SIPRE TL 37**
**SETTLING OF SNOW AND BENDING OF IRON BARS IN SNOW COVER.**
Hirata, T., Dec. 1954, 11p., AD-070 470, Translation from Seppyo, Vol.3:225-236, 1941.
25-4096
SNOW STRENGTH, SHEAR STRESS, SUBSIDENCE.
Subsidence of a snow cover was measured by imbedding celluloid discs at various depths in the snow. Subsidence results from snow melting at the ground surface and compression of the snow layer. An iron tube, 3.4 cm in outer diameter, 2.8 cm in inner diameter, and 178 cm long, was held horizontally at each end and exposed to snowfall. The mechanics of resulting barbending was studied. A snow depth of 46 m would be required to bend the iron tube by weight alone of the snow directly above the tube. The snow layer was found to curve around the tube making the tube support the entire weight of a large snow area. A snow layer, 20 cm thick, can bend the tube if the breaking shear stress of the snow cover is more than 50 gm/sq.cm.

**SIPRE TL 38**
**STUDIES OF SNOW COVER.**
Takahashi, T., 1955, 8p., AD-070 498, Translation from Seppyo, Vol.3:414-418, 1941.
25-4097
SNOWFALL, ACCUMULATION, SNOW COVER DISTRIBUTION, JAPAN.
The snow cover is the snow covering the ground through the winter season with intermittent melting. The relationship between the duration of the snow cover and the date of the first snowfall, the date of the beginning of snow cover, and the maximum and mean heights of snow accumulation are studied. An attempt is made from these data to forecast the duration of the snow cover. Observed and estimated values for the duration of the snow cover from 1937-1941 show that a satisfactory estimate can be given.

**SIPRE TL 39**
**ON THE MELTING OF SNOW.**
Tajima, S., et al, March 1955, 3p., AD-070 491, Translation from Seppyo, Vol.3:260-263, 1941. 2 refs.
Mimuro, Y.
25-4098
SNOW MELTING, MEASUREMENT, SNOWMELT.
The melting of the snow cover due to the earth's temperature is almost constant at a given area and can readily be measured. The amount of melting in the melting season is difficult to measure, because the meltwater does not permeate evenly through the snow cover but gathers in irregular paths. An attempt was made to determine the course of meltwater from changes in the distribution of snow density in the cover.

**SIPRE TL 40**
**HARDNESS TEST OF SNOW.**
Takahashi, T., et al, June 1955, 7p., AD-070 492, Translation from Seppyo, Vol.3:264-270, 1941.
Kudo, K.
25-4099
SNOW HARDNESS, HARDNESS TESTS, TEST EQUIPMENT.
The hardness of snow was determined by using a hollow right-angle cone of aluminum with a steel tip. The diameter of the base was 20 cm, the height 10 cm and the weight 300 gm. The cone, tip downward, was dropped from a specified height. The compression of the snow in relation to the weight and height of the cone constitutes a measure of the hardness of the snow cover. Deviations in results from various heights were small for settled snow with evenly distributed small grains; deviations were large for granular snow and frozen snow. Different instruments are recommended for measuring hard and soft snow.

**SIPRE TL 42**
**ANGLE OF KINETIC FRICTION OF SNOW.**
Inaho, Y., Jan. 1955, 5p., AD-070 493, Translation from Seppyo, Vol.3:303-307, 1941.
25-4101
FRICTION, SLIDING, SNOW SLIDES.
An attempt was made to measure the dynamic friction between snow and a slope from the acceleration of a block of snow sliding down an inclined plane. The construction of the apparatus used is described and formulas are developed for calculating acceleration and friction and the necessary corrections. The results are somewhat inconclusive because the number of measurements was insufficient, and because quality of snow cannot be expressed quantitatively. The data indicate that the angle of dynamic friction ranged from 23 - 29 degrees when a block of granular snow slides down a 3-m slope of granular snow.

**SIPRE TL 43**
**STRUCTURAL SOILS, SOLIFLUCTION, AND FROST CLIMATES OF THE EARTH.**
Troll, C., Oct. 1958, 121p., AD-211 333, For original German text see SIP U2291. 410 refs.
25-2263
GROUND ICE, SOILS, SOLIFLUCTION, CLIMATIC FACTORS.
The extent of ground ice formations, structural soils, and textural soils are considered. Various climatic assumptions of structural soil formation are indicated, and existing theories analyzed. Included are the convection hypothesis and frost strain theory, solifluction, structural analysis of ground ice, and grain size classification. An individual analysis is made of various structural soils and related soil frost phenomena on the basis of the area in which they appear. The structural soils of the tropical high mountains, the polar zones, eastern Europe, Greenland, and Scandinavia are reviewed.

**SIPRE TL 44**
**FRICTION OF RUNNERS ON SNOW AND ICE.**
Ericksson, R., April 1955, 23p., AD-070 494, Translation from Föreningen skogsarbetens och Kungl. Domänstyrelsens arbetsstudieavdening. Meddelande No.34/35:1-63, 1949. 12 refs.
25-4102
SLEDS, ICE FRICTION, SLIDING, SNOW FRICTION.
Laboratory and field measurements of friction with metal and wooden runners on snow and ice are discussed. Sliding friction was determined by measuring the retardation of freely moving sleds, and initial friction with a dynamometer. Coefficients of sliding friction varied from 0.006-0.3 and initial friction from nearly 0 to over 1. The coefficient of friction depends on the finnish and dimension of the runner, air temperature, snow-particle size, water content of the snow, sliding speed and stress. Friction usually increases with falling temperatures. Friction for steel runners doubled in the temperature range 0 to -30 C and increased for wooden runners up to 40 per cent. Sliding depends largely on the lubrication effect of the water layer between the snow or ice surface and the runner.

**SIPRE TL 45**
**ICE PRESSURE WITH INCREASING TEMPERATURES.**
Royen, N., Aug. 1955, 11p., TT-60 13693, Translation from Hyllningsskrift tillägnad F. Vihl. Hansen. Stockholm, Gunnar Tisells Tekniska Forlag, 1922. p.357-371. 7 refs.
25-4103
ICE PRESSURE, ICE MECHANICS, TEMPERATURE FACTORS.
The ice pressure resulting from temperature increases in a confined ice cover is discussed. Results of earlier investigations on the mechanical properties of ice are reviewed. The relationships between time, stress, temperature and compression for ice and paraffin were studied; equations expressing the various relationships are given. The maximum ice pressure for conditions occurring in Sweden cannot exceed 30 tons/m. for an ice cover 1 m. thick or 22 tons/m. for an ice cover 0.75 in. thick. Factors serving to reduce the ice pressure are presented.

**SIPRE TL 46**
**CALCULATING THE VALUE OF FROST HEAVING FORCES ON FOUNDATIONS.**
Saltykov, N.I., 1955, 11p., AD-070 500, Translation from Akademiia nauk SSSR. Izvestiia, otdelenie tekhnicheskikh nauk, No.6:405-412, 1944. 13 refs.
25-4104
FOUNDATIONS, FROST HEAVE.
Laboratory and field experiments were made at the Vorkuta Permafrost Station in the einter of 1941-42 to evaluate the heaving forces in the active layer. Heaving forces under field conditions were determined by placing markers at various distances from a wooden pile driven through the active layer to the permafrost table and held by a load of 1 ton during the freezing period. Heaving forces in both laboratory and field experiments are formulated and graphed. The thickness of the heaving layer at Vorkuta does not normally exceed a value of 40-60 cm. for fine loam of average moisture content in the absence of ground water alimentation, although the thickness of the active layer is 80-220 cm. The frozen ground around the immovable supports is in a plastic rather than in an elastic or rigid state.

**SIPRE TL 47**
**AN ATTEMPT TO FORMULATE A THEORY OF CRACK FORMATION IN GLACIERS.**
Legally, M., March 1954, 18p., AD-070 156, Translation from Zeitschrift für Gletscherkunde, 17(4/5):285-301, 1929. 3 refs.
25-4105
ICE PLASTICITY, ICE CRACKS, CRACKING (FRACTURING), CREVASSES, GLACIER MOVEMENT.
The plasticity of glacier ice and the relation between the internal deformation of glaciers and fissure formation are investigated on the basis of Somigliana's theory of the mechanics of glacier motion. The forces and strains involved in the deformation of granular ice masses and the resulting fissuring are discussed and analyzed mathematically for glaciers with a linear increase of velocity toward the edges, with a parabolic increase toward the edges and with a constant surface velocity.

**SIPRE TL 48**
**DEFLECTION OF A SEMI INFINITE PLATE ON AN ELASTIC FOUNDATION.**
Shapiro, G.S., Jan. 1955, 9p., AD-070 155, Translation from Prikldanaia matematika i mekhanika, Vol.7, 1943. 7 refs.
25-4106
FLOATING ICE, LOADS (FORCES), STRESS ANALYSIS, ANALYSIS (MATHEMATICS).
The mechanics of a floating ice sheet subject to the action of a load near or on an edge or a crack is one of the basic problems in the bearing capacity of ice. The paper studies the problem of an infinite strip plate under the action of a point load using the Westergaard-Gersanov method, but applying Fourier integral instead of series. Results of computations for a plate loaded by a concentrated force on the edge, for a uniformly distributed load on a part of the edge, and uniformly distributed load on a line perpendicular to the edge, are given.

**SIPRE TL 49**
**INFLUENCE OF RADIATION AND TEMPERATURE ON THE MELTING PROCESS OF THE SNOW COVER.**
Hoeck, E., Jan. 1958, 60p. plus append., TT 59-18580, For original German text see SIP U5433. 36 refs.
25-2264
RADIATION, HEATING, SNOWMELT.
Daily meltwater quantities for a random station during the melting period of the snow cover are calculated. The calculations are based on measurements of air temperature and humidity, and on assumed solar, sky, and atmospheric radiation values. A climatological analysis is made of the relationship between the observed elements of temperature, humidity, and cloudiness, and the radiation energy available during a certain day at a station of random elevation and exposure. A general consideration is given to the melt process of a snow cover, and the influence of radiation and temperature on the melt process is analyzed, including the influence of negative snow temperatures and special conditions. A comparison of calculated with measured values of meltwater quantities indicates good agreement.

**SIPRE TL 51**
**BUOYANCY OF SEA ICE.**
Nazarov, V.S., 1955, 2p., AD-070 154, Translated from Severnyĭ Morskoĭ Put', Vol.11:62-63, 1939.
25-4108
SEA ICE, FLOATING ICE, BUOYANCY, ICE DENSITY.
The inverse relationship between the buoyancy of sea ice and its density is applicable only to winter ice that has not been subjected to melting. The density of winter ice averages from 0.900 to 0.940 g./cu. cm. Spring ice has an average density of 0.839 to 0.900 g./cu. cm. due to melting and the formation of inner cavities. It is believed that these cavities eventually fill with water and that the corrected density of spring ice is about 0.977 to 0.993 g./cu. cm., which indicates reduced buoyancy. A table is presented for loads that can be moved over winter and spring ice of varied thicknesses.

**SIPRE TL 52**
**MECHANISM OF AVALANCHE RELEASE.**
Roch, A., April 1956, 11p., AD-102 284, Translation from Les Alpes, 31(4):94-104, 1955.
25-4109
AVALANCHE MECHANICS, AVALANCHE TRIGGERING.
Mechanical forces active in avalanches are outlined, and the causes for snow rupture and descent are discussed. Two types of rupture are examined: rupture in a snow cover with little cohesion caused by a loss of equilibrium, excess pressure, destructive snow metamorphism, and a temperature increase; and that taking place in a cohering snow cover through excessive tensile stress at the lower surface and at the limits of individual snow layers. The propagation of movement in a snow cover under varying conditions is also considered as well as the release of avalanches through exterior forces. Characteristics for determining avalanche danger are: snow-cover stratification and the cohesion between layers; the relation between the tensile strength of the weakest layer and the tensile stress exerted by overlying layers; snow depth and type; wind and temperature conditions; and terrain configuration.

**SIPRE TL 53**
**EXCAVATION OF FROZEN GROUND.**
Gal'perin, M.I., et al, 1955, 5p., RT-3401, Translation from Stroitel'naia promyshlennost', 32(10):14-17, 1954.
Torgonenko, E.A., Degtiarev, A.P.
25-4110
EXCAVATION, FROZEN GROUND.
The effectiveness of various methods of excavating frozen ground is discussed. Current procedures employ thawing, crushing or explosive techniques to break up the ground to be excavated. Recent experiments have shown that excavation is readily accomplished by cutting a frozen area into squares to at least 80 per cent of the thickness of the frozen layer. High-speed disk saws (revolving at 40 m./sec.) were found to cut easily, partly because of heat effects, but because of rapid wear at high speeds compromise saws revolving at 5-6 m./sec. were adopted for general use. A draw knife mounted on a mobile crane has also been found to give good results.

**SIPRE TL 54**
**SNOW AND ICE AS MATERIALS FOR ROAD CONSTRUCTION.**
Buvert, V.V., et al, May 1957, 9p., AD-141 961, Translation from Sukhoputnyĭ transport lesa. Moscow, Golesbumizdat, 1951. p.202-212. 1 ref.
Ionov, B.D., Kishinskiĭ, M.I., Syromiatnikov, S.A.
25-4111
SNOW (CONSTRUCTION MATERIAL), ICE (CONSTRUCTION MATERIAL), SNOW ROADS, ICE ROADS.
The mechanical properties of snow and ice are discussed and formulas for calculating snow density, and hardness are given. A theory on snow compaction is presented.

**SIPRE TL 57**
**QUANTITATIVE STUDY OF THE METAMORPHISM OF SNOW CRYSTALS BY SUBLIMATION.**
Yoshida, Z., May 1958, 10p., TT-59 15585, Translation from Teion kagaku, Ser.A, Vol. 13:11-28, 1954. 5 refs.
25-4112
SNOW CRYSTALS, METAMORPHISM (SNOW), SUBLIMATION, ANALYSIS (MATHEMATICS).
The smoothing of snow-crystal surfaces and the evaporative thinning of dendritic snow-crystal branches in the attachment regions during metamorphism are analyzed mathematically. The analysis indicates that vapor-tension differences responsible for thinning and smoothing are not due to curvatures nor to elastic stresses in single crystals but to elastic stresses in masses of crystals. A value of less than 1 hr. was calculated for the time required for elastic stresses to act on a rod-like ice crystal 0.1 mm. in diameter and 0.35 mm. long standing on edge in a layer of similar crystals 0.3 gm./cc. in density and 40 cm. thick projecting 50 cm. horizontally over an edge. Elastic stress is effective only on ice grains of small diameter, since its effect reduces rapidly with increasing grain diameter.

**SIPRE TL 58**
**EXPLORATION OF "INLAND ICE"; GREENLAND AND ANTARCTICA.**
Loewe, F., May 1959, 5p., AD-228 934, Translated from Umschau, No.4, p.110-113, 1956. 8 refs.
25-2265
EXPLORATION, GLACIER ICE, ICE SHEETS, ANTARCTICA, GREENLAND.

**SIPRE TL 59**
**WETTING AND STRENGTH OF ADHESION.**
Kobeko, P.P., et al, July 1958, 6p., Translation from Zhurnal tekhnicheskoĭ fiziki, Vol.16:277-282, 1946. 5 refs.
Mareĭ, F.I.
25-4113
ICE ADHESION, PROTECTIVE COATINGS.
Unsuccessful attempts to develop a water repellant coating for deicing airplanes prompted an investigation of existing relationships between wetting and strength of adhesion. An instrument, based on the leverage principle, was constructed to determine the force required for a hemispherically shaped test item to break away from the ice to which it was frozen. Several wetting and nonwetting systems were tested. The average strength of adhesion for polystyrene-water system was 2.2 kg./sq. cm. The behavior of the polystyrene-wat[illegible]ystem was similar to that other polymers, and to lacquers. Further experiments indicated that the large coefficient of expansion of the plastics and not their wetting-nonwetting properties caused this low adhesion strength.

**SIPRE TL 60**
**RESISTANCE TO AIR FLOW THROUGH SNOW LAYERS (PART 1).**
Ishida, T., et al, Oct. 1958, 8p., TT-59 15150, Translation from Teion kagaku, Ser.A., Vol.14:33-42, 1955. 7 refs.
Shimizu, H.
25-4114
SNOW PERMEABILITY, AIR FLOW.
The results of experiments on various types of snow are discussed, and the method of measurement is described. The flow of air through snow is similar to that through granular, porous materials. The resistance to air flow is low in new snow of small density, medium in granular snow of high density, and high in settled snow of medium density. Data are tabulated and graphed.

**SIPRE TL 61**
**PERMAFROST STUDIES OUTSIDE THE USSR UNTIL 1955. A LITERATURE REVIEW.**
Chekotillo, A.M., Oct. 1958, 21p., AD-718 885, Translation from Materialy k osnovam ucheniia o merzlykh zonakh zemnoĭ kory, Vol.3:186-198, 1956. 260 refs.
25-4115
PERMAFROST, BIBLIOGRAPHIES.
The review is based on studies of reports published outside the USSR which were started in the Institute of Permafrostology before the last war and continued systematically since 1945. The U. S. and USSR are noted as countries where permafrostology and the solution of engineering problems associated with frozen ground have reached wide development. A leading role in permafrost research is noted for the Corps of Engineers and for its well-equipped research establishment-SIPRE. A large network of institutions and numerous scientists in the U. S. have promoted the systematic development of engineering permafrostology. The SIPRE and Arctic bibliographies are cited as particularly valuable because abstracts are included.

**SIPRE TL 62**
**ON THE SUPERCOOLING AND EVAPORATION OF THIN WATER FILMS.**
Hori, T., Feb. 1960, 8p., TT 60-17344, For original Japanese text see SIP 15679.
25-2266
WATER FILMS, SUPERCOOLING, EVAPORATION, FREEZING.
The results of laboratory studies with thin films of water sandwiched between glass or quartz plates and cooled to -100C are reported, and the experimental procedure and apparatus used are described. The degree of supercooling showed a tendency to increase with decreasing film thickness and was independent of volume or interface area. Water films thinner than 0.01 mm. frequently remained unfrozen at temperatures below -90C. While the vapor pressure in equilibrium with a water film of a certain thickness was approximately equal to the saturation vapor pressure of bulk water (as a function of temperature), it fell more or less rapidly with decreasing film thickness to reach zero pressure at a limiting thickness of 90 millimicron for quartz and 140 millimicron for glass, independently of temperature. Sufficiently thin films of water (of less than the limiting thickness), held between solid surfaces, acquire a high rigidity without crystallizing and exhibit a high resistance both to freezing and evaporation.

**SIPRE TL 63**
**SUGGESTIONS FOR METEOROLOGICAL MEASUREMENTS FOR FUTURE EXPEDITIONS TO GREENLAND.**
Georgi, J., April 1959, 21p., AD-881 020, Translation from Polarforschung, Vol.3:146-161, 1952. 32 refs.
25-4116
METEOROLOGICAL FACTORS, RESEARCH PROJECTS, GLACIAL METEOROLOGY.
To determine the state of the inland ice it is necessary among other things to measure simultaneously the incoming radiation, the absorption, reflection and diffusion of the incident radiation, and the heat consumption during melting and evaporation at numerous points. Instruments used for these measurements are evaluated and those giving the best results are included in lists for use by stations and field parties. Techniques and instruments for the measurement of the air layer near the ground, the temperatures at the firn surface and within the firn, upper air winds and daily variations of surface winds are also described.

**SIPRE TL 64**
**PRESENT METHODS OF PREPARING FROZEN GROUND FOR EXCAVATION.**
Chelnokov, S.S., May 1960, 7p., AD-701 176, For original Russian text see SIP 11441.
25-2267
FROZEN GROUND MECHANICS, EXCAVATION.
Methods used in Moscow for digging frozen ground are described, and their effectiveness as conditioned by soil composition and the thickness of the frozen layer is discussed. Personal safety in the city and safe methods of underground construction limit the application of the simple and inexpensive method of blasting. Wedge-shaped strikers have been used successfully to break up ground frozen to depths less than 0.7-0.8 m. Preliminary thawing of frozen ground has proved effective near the end of winter, when frost penetration reaches 1.5 m. or more in Moscow. Square cuts to depths of 60-80 cm. in ground frozen to 1.5 m. were effectively used in the construction of the Volga-Don Canal.

**SIPRE TL 65**
**DIGGING FROZEN GROUND.**
Sergeev, A.I., Jan. 1961, 5p., AD-648 510, For original Russian text see SIP 13546. 2 refs.
25-2268
FROZEN GROUND MECHANICS, EXCAVATING EQUIPMENT, EXCAVATION.
Tests of methods for cutting frozen ground during 1953-1955 are reported, and an excavator for digging frozen ground is described. Abrasive properties of ice, frozen clay, and sand change considerably the cutting conditions as compared to thawed ground. The usefulness of circular saws, impact cutters, and drop hammers is limited due to poor performance or rapid deterioration. The excavator described cuts the upper layers and shears off deeper strata.

**SIPRE TL 66**
**WATER PERMEABILITY OF FROZEN SAND.**
Komarov, V.D., Jan. 1961, 5p., AD-701 177, For original Russian text see SIP 16576. 5 refs.
25-2269
FROZEN GROUND HYDROLOGY, PERMEABILITY, SANDS.
Experiments carried out by the Institutes of Permafrostology and Weather Forecasts are described, and data obtained are compared with those compiled by L. N. Stepanov in 1951-52. Sand samples consisted of particles 0.05-1 mm. in diam. (98 percent) with some less than 0.05 mm. in diam. (2 percent) and moisture contents of 2-17 percent. Water at 0 C filtering from the surface into sandy soil previously cooled to -3 or -5 C caused a temperature jump to -0.2 or -0.3 C because of the latent heat associated with crystal formation. Permeability diminished with increased ice content: a permeability of 6 mm./min. for a 3 percent ice content dropped to 0.07 mm./min. when the ice content reached 27 percent.

**SIPRE TL 67**
**ON SNOW STORMS.**
Arai, H., et al, 1970, 9p., AD-715 729, Translation from Seppyo, 15(1):1-5, 1953. 2 refs.
Shiotani, M., Ogasawara, T.
25-4117
SNOWDRIFTS, METEOROLOGICAL INSTRUMENTS, STATISTICAL DATA.
The developing conditions of snow-storms, shifing quantities of flying snow, vertical distribution of flying snow and so on have been studied by people concerned with counter-measures against snowdrift damages. Whereas numerous data are available on the developing conditions, sufficient data are hard to find on the shifting quantities and vertical distribution that have larger bearing in the problem of snowdrift. The authors, also engaged in the investigations on the performance of snow fences and shelterbelts, undertook some measurements of vertical distribution which was closely related with their theme of research. The data obtained are reported here.

**SIPRE TL 74**
**RHEOLOGICAL PROPERTIES AND BEARING CAPACITY OF FROZEN SOILS.**
Vialov, S.S., Sept. 1965, 188p., AD-481 856, Translation of Reologicheskie svoĭstva i nesushchaia sposobnost' merzlykh gruntov. Moscow, Izd-vo AN SSSR, 1959. 166 refs.
25-4118
FROZEN GROUND STRENGTH, RHEOLOGY, BEARING CAPACITY, FOUNDATIONS.
Rheological processes in frozen ground and their influence on the strength and stability of frozen ground under foundations are treated in detail on the basis of laboratory and field studies from 1950-1953 at the Igarka Permafrost Station, and data are tabulated and graphed. Part 1 is devoted to the strength and creep of frozen ground, including theory and the results of investigations on the adhesive strength of frozen ground, the adfreezing strength between frozen ground and both ice and wood rods, the compressive and tensile strength of frozen ground, its limiting deformation, and the principles of the deformation and resistance of frozen ground under load. Frozen ground behavior under foundations, its bearing capacity, and the distribution of

**SIPRE TL 76**
**STRENGTH AND CREEP OF FROZEN SOILS AND CALCULATIONS FOR ICE SOIL RETAINING STRUCTURES.**
Vialov, S.S., et al, Sept. 1965, 301p., AD-484 093, Translation of Prochnost' i polzuchest' gruntov i raschety ledogruntovykh ograzhdeniĭ. Moscow, Izd-vo AN SSSR, 1962. 254p. 82 refs.
Gmoshinskiĭ, V.G., Gorodetskiĭ, S.E., Grigor'eva, V.G.
25-4119
FROZEN GROUND STRENGTH, SOIL CREEP, SOIL STRENGTH, CONSTRUCTION MATERIALS, ANALYSIS (MATHEMATICS).

The main postulations of the theory of frozen-ground rheology, and the current methods of calculating the strength and creep of ice-earth enclosures (cylinders) are discussed in application to the use of soil-freezing methods in construction. The text is divided into 9 chapters as follows: I. Laws of rheology, II. Principles of calculating strength and creep of frozen ground, III. Formation of cryogenic texture and its effect on strength, IV. Method of testing strength and creep, V. Experimental study of creep, VI. Experimental study of strength, VII. Calculation of strength and creep of walls of mine shafts formed by soil freezing, VIII. Modeling of ice-earth cylinders, IX. Comparison of analytical solutions with results of modeling, and recommended calculation formulas. The book is intended for engineers and designers of foundation and underground-installation construction, and for specialists in the field of frozen-soil mechanics.

# CRREL DRAFT TRANSLATIONS

**TL 1**
**EARTHWORK UNDER WINTER CONDITIONS.**
Hanover, N.H., CRREL, 1970, 172p., AD-711 890, Translation of Proizvodstvo zemlianykh rabot v zymnykh usloviiakh. Moscow, Gosstroĭizdat, 1961. 151p. 18 refs.
25-2427
FROZEN GROUND MECHANICS, FROZEN GROUND PHYSICS, EARTHWORK, EARTH HANDLING EQUIPMENT, MELTING, EXPLOSION EFFECTS, WINTER.
The manual gives information on the physical and mechanical properties of frozen ground, methods for their loosening and thawing and methods for safeguarding the ground from freezing. Also given are the characteristics of earthwork in winter (inapplicable to areas of permafrost) and the technical and economic indices for the working of frozen ground by different methods.

**TL 2** Record deleted.

**TL 3**
**INVESTIGATION OF SNOW THAWING USING RADIOACTIVE ISOTOPES.**
Agashkin, IU.N., Hanover, N.H., CRREL, 1970, 8p., AD-711 907, Translation of Issledovaniia snegotaianiia metodom radioaktivnykh izotopov, Akad. Nauk SSSR. Izvest. ser. geogr. July-Aug. 1960, No.4, p.117-121. 4 refs.
25-2270
MELTWATER, RUNOFF, RADIOACTIVE SNOW GAGES.
Study of the influence of agrotechnical measures on runoff is one of the themes on which experimental work is being done for study of slope runoff in special runoff areas and drainage gullies. In the investigations of the course of springtime snow thawing, as one of the factors involved in runoff, a method was used which made it possible to study this process without disrupting its natural course, which is inevitable when using an instrument based on the snow-weighing principle. This requirement now is satisfied best by use of the radioactive isotopes method. Using this method it is possible with sufficient accuracy to study the change of the water reserves in the snow at the time of thawing, tracing its diurnal variation on different underlying surfaces and under different conditions (forest, glade, open plowed land).

**TL 4**
**SUBTERRANEAN STRUCTURE OF CERTAIN PHYTOCOENOSES OF ARCTIC TUNDRA ON BOL'SHOY LYAKHOVSKIY ISLAND.**
Aleksandrova, V.D., Hanover, N.H., CRREL, 1970, 19p., AD-711 871, Translation of Problemy botaniki (USSR), Vol.6, 1962, p.148-150. 15 refs.
25-2271
TUNDRA VEGETATION, PLANTS (BOTANY), ROOT SYSTEMS, USSR.
The author in 1956, during a study of flora and vegetation on Bol'shoy Lyakhovskiy Island, collected material giving some idea on the subterranean structure of the phytocoenoses in the arctic tundra. These data were obtained for the polygonal moss-herb tundra and for the hillocky-spotted grass-woodrush-willow (salic polaris)-moss tundra in digging up the root systems, drawing their horizontal and vertical placement and in determining the bulk of subterrean organs according to the various horizons of the soil profile.

**TL 5**
**MEASUREMENT OF STRESS WAVES IN SOFT SOIL.**
Alekseenko, V.D., et al, Hanover, N.H., CRREL, 1970, 15p., AD-711 864, Translation from Zhurnal prikladnoĭ mekhaniki i tekhnicheskoĭ fiziki (USSR), 1963, No.2, p.135-141. 3 refs.
Grigorian, S.S., Koshelev, L.I., Novgorodov, A.F., Rykov, G.V.
25-2272
STRESS WAVES, WAVE PROPAGATION, SOIL MECHANICS, EXPLOSION EFFECTS, MODELS, ELASTIC PROPERTIES.
The problems associated with the propagation of explosive waves in soil are of known urgency. It is interesting to calculate the wave pattern developing in soil close to the focus of the explosion (underground or above ground) or during the passage of the shock wave from the air or water into the soil. At considerable distances from the focus, this pattern can be described by the equations taken from the theory of elasticity; however, at closer distances, these equations are unsuitable and must be replaced by another system of formulas, taking into account the complex nature of the deformation and flow of the medium at high stresses, and only at the boundary in case of reduction of stresses do we transfer to the equations taken from the linear theory of elasticity. Such a type of mathematical model of the medium has been suggested for describing the movements of soft soil (sand, clay etc).

**TL 6**
**USE OF AERIAL METHODS FOR THE STUDY OF TUNDRA LANDSCAPES AND FOR THEIR AGRICULTURAL UTILIZATION.**
Andreev, V.N., 1969, FSTC-HT-23, 8p., AD-691 972, For original Russian article see 23-1392.
25-2273
AERIAL PHOTOGRAPHY, TUNDRA SOILS, TUNDRA TERRAIN.
Aerial methods make possible the study of individual types of the microrelief of the tundra landscapes and the establishment of correlations of the soil-vegetation groupings. The results are of practical importance for agriculture.

**TL 7**
**INTERPRETATION OF DIFFERENT TYPES OF TUNDRA FROM AERIAL PHOTOGRAPHS AND THEIR AEROVISUAL DESCRIPTION ON THE BASIS OF FROST JOINTING.**
Andreev, V.N., 1969, FSTC-HT-23-316-68, 25p., AD-692 646, For original Russian text see 23-1477. 13 refs.
25-1186
FROST SHATTERING, PATTERNED GROUND, VEGETATION PATTERNS, TUNDRA SOILS, AERIAL PHOTOGRAPHY, POLYGONAL TOPOGRAPHY, SWAMPS.

**TL 8**
**CALCULATION OF THE DEPTH OF THAWING TAKING INTO ACCOUNT THE EXTERNAL HEAT EXCHANGE.**
Balobaev, V.T., Hanover, N.H., CRREL, 1970, 12p., AD-715 069, Translation from Sezonnoe protaivanie i promerzanie gruntov na territorii Severo-Vostoka SSSR. Moscow, Nauka, 1966. p.47-57. 9 refs.
25-2301
FROST PENETRATION, SEASONAL FREEZE THAW, HEAT TRANSFER, THAWING, BOUNDARY LAYER, FROZEN GROUND, ANALYSIS (MATHEMATICS).
An approximate solution of the problem concerning the calculation of thawing-depth variation in time in the course of melting is presented, in which that part of the heat energy spent on evaporation and turbulent heat-exchange in air, and that penetrating the ground are accounted for. The temperature field of air and of frozen and thawed rocks is described by a system of three differential equations of thermal conductivity for certain boundary conditions, assuming that the thermal field of air is quasi-stationary. This system is solved by the method of successive approximations developed by M. E. Shvetsov for the problems of boundary layer dynamics. Its advantage lies in the possibility of reducing the solution of a system of differential equations with moving boundary to the solution of a system of ordinary differential equations with respect to thawing-depth.

**TL 9**
**ACTIVE GLACIERS ON SECTION 23 OF THE RIGHT OF WAY.**
Arutiunian, S.Z., June 1969, FSTC-HT-23-558-68, 10p., AD-691 545, For original Russian article see 23-0608.
25-2275
NALEDS, RAILROAD TRACKS.
Problems encountered by railroad men in their struggle against naleds along the 23rd section of the Eastern Siberian Railway tracks are discussed. Methods for reducing the hazardous effects of naleds on railroad beds and eliminating them through proper drainage techniques are suggested. Experience over the last ten years has shown that the construction of small bridges and culverts in dry climatic areas often results in the appearance of new naleds.

**TL 10**
**FILTRATION DIKES IN ICY AREAS.**
Bakharev, I.I., Aug. 13, 1969, FSTC-HT-23-629-68, 12p., AD-859 516L, For original Russian text see SIP 25824. 5 refs.
26-2734
DAMS, NALEDS, SEEPAGE, ICING, CONSTRUCTION, STRUCTURES, DRAINAGE, PIPES, PERMAFROST UNDER DAMS.
The rationality of building water filtration dikes in cold regions is discussed, and their structure analyzed from two standpoints: their effect on the natural regime of the surface and ground waters and on the formation of naled, and the through-put capacity of a filtration dike in the case of its icing. It is concluded that filtration dikes do not disturb the natural regime of ground waters, they do not contribute to the formation of naled, and therefore may be built in permafrost regions. Through-put of a dike may be increased if needed by installing drainage pipe systems.

**TL 11**
**ACCELERATED TESTING OF CONCRETE FOR FROST RESISTANCE UNDER NATURAL CONDITIONS.**
Baklanov, A.S., Hanover, N.H., CRREL, 1970, 6p., AD-711 865, For original Russian article see 23-2580.
25-2276
CONCRETE FREEZING, FROST RESISTANCE, TESTS.
The report describes test methods and results obtained from accelerated freezing tests performed on concrete samples representing building materials.

**TL 12**
**UTILIZATION OF DEEP WATER HEAT IN RESERVOIRS FOR THE MAINTENANCE OF UNFROZEN WATER AREAS.**
Balanin, V.V., et al, 1970, 275p., AD-716 306, Translation of Ispol'zovanie tepla glubinnykh vod vodoemov dlia podderzhaniia nezamerzaiushchikh akvatoriĭ. Moscow, Izd-vo Transport, 1964. 121 refs.
Borodkin, B.S., Melkonian, G.I.
25-2430
RESERVOIRS, ICE CONTROL, HEAT TRANSFER, BUBBLING, DAMS.
Laboratory and field data are presented on measures for maintaining water areas in reservoirs in an unfrozen state by using the heat of deep waters. The thermal regime of reservoirs and the physical principles of the methods of utilizing water heat are reviewed. Descriptions and diagrams are provided of various installations in use at dam gates, navigable locks and canals, port and ship-building facilities, etc. Laboratory investigations include kinematics of lifting bottom waters by air bubbles, the phenomenon of air outlet freezing, and air movement in a perforated pipe used to keep a water area ice-free by compressed air. Theories and computations are provided for the operation of pneumatic installations and flow generators and maintaining a pool of unfrozen water during transfer of warm deep water from one reservoir to another. Recommendations are made regarding planning of installations and the nature and extent of future research.

**TL 13**
**SEMINAR ON THE USE OF WATER-REPELLENT FLY ASH IN ROOFS AND OTHER COMPONENTS.** Jan. 1972, 68p., AD-738 126, Translation from Czech of Použitie hydro-fobizovanych popolčekov na stresne a ine konstrukcie, Priemstav, Technicko-Ekonomiche Informacie 5-6, 1966, by U.S. Joint Publications Research Service.
26-3556
CONSTRUCTION MATERIALS, THERMAL INSULATION, WATERPROOFING, ROOFS, DESIGN.

**TL 14**
**HEAT AND MASS TRANSFER DURING VAPOR CONDENSATION IN THE PRESENCE OF NONCONDENSING GASES.**
Berman, L.D., Hanover, N.H., CRREL, 1970, 21p., AD-712 246, Translation of Moscow. Vses. teplotekhnicheskiĭ institut. Izvest. Aug. 1947, 16(8), p.11-18. 36 refs.
25-2277
CONDENSING, HEAT TRANSFER, MASS TRANSFER.
The article gives a brief review of the investigations carried out, it shows the permissible areas of application of the relationships suggested by different authors for the heat- and mass-transfer coefficients and notes the errors contained in some of the works.

**TL 15**
**PROCESS OF FAILURE IN STATICALLY REINFORCED CONCRETE PAVEMENTS.**
Bernell, L., 1970, 29p., AD-878 739, Translation from Betong, 37(2):119-142. 13 refs.
26-2735
CONCRETE PAVEMENTS, REINFORCED CONCRETE, LOADS (FORCES), BEARING CAPACITY, ANALYSIS (MATHEMATICS), TESTS, AIRCRAFT LANDING AREAS, CRACKING (FRACTURING), SUBGRADES.
A report on the investigations carried out in conjunction with loading tests is presented. The purpose of these investigations has been that of securing better knowledge regarding the failure process in statically reinforced concrete pavements, and also that of finding suitable methods of computation for designing these pavements.

**TL 16**
**SALT COMPOSITION OF SEA WATER AND ICE.**
Blinov, L.K., Hanover, N.H., CRREL, 1970, 76p., AD-711 925, Translation of Moscow. Gos. okeanograficheskiĭ inst. Trudy, 1965, Vol. 83, p.5-55. 62 refs.
25-2278
SALINITY, SEA ICE, SEA WATER, PHASE TRANSFORMATIONS, CHLORINITY.
The report consists of two chapters of an unfinished book, 'Khimiia Moria' ('Marine Chemistry'). It discusses the salt composition of ocean waters, salinity and the composition of salts in sea ice in relation to processes of phase transitions and formation of ice from sea water as a complex solution.

**TL 17**
**TRANSPARENT ICE.**
Bobkov, V.A., Hanover, N.H., CRREL, 1970, 16p., AD-711 908, Translation of Prozrachnyĭ led. Kholodil'naia promyshlennost' 1937, 15(3), p.15-20.
25-2279
ICE MAKERS, ICE OPTICS.
Transparent ice is now produced exclusively from regular water which during freezing is brought into motion, thereby ensuring the free release of salts and dissolved gases from forming ice.

**TL 18**
**SNOW PATCHES AND SNOW EROSION IN THE NORTHERN PART OF THE URALS.**
Boch, S.G., Hanover, N.H., CRREL, 1970, 25p., AD-715 078, Translation of Snezhniki i snezhnaia eroziia v severnykh chastiakh Urala. Vses. geogr. o-vo. Izvestiia 1946, 78(2): 207-222. 26 refs.
25-2302
SNOW EROSION, SNOWMELT, SOLIFLUCTION, NIVATION.
Observations indicate that erosion by permanent ice fields is increased by an accumulation of moisture. Meltwater carries heat downward from the edges toward the centers of the snow fields. The underlying frozen ground is thawed and becomes saturated with the meltwater. The continuation of this throughout the summer months greatly facilitates solifluction. Nivation occurs on the slopes and is assisted by the lack of vegetation. Chemical composition of the rocks influences only the rate and not the result of nivation. Arctic climate does not favor nivation processes.

**TL 19**
**SOME REMARKS ON THE NATURE OF SNOW EROSION.**
Boch, S.G., Hanover, N.H., CRREL, 1970, 6p., AD-715 082, Translation of Eshche neskol'ko zamechaniĭ o prirode snegovoĭ erozii. Vses. geogr. o-vo. Izvestiia 1948, 80(6):609-611. 9 refs.
25-2303
MELTWATER, SOLIFLUCTION, SNOW EROSION.
Meltwater from snowfields alternately freezes and thaws with daily temperature fluctuations. The consequent expansion between layers of rock disintegrates the larger rock formations. Some of the rocks and soil are carried away in streams by the meltwater; some seeps into soil. The saturated, pasty mass of soil moves downslope forming solifluction slopes and altiplantation terraces. The erosion of soil underneath the snowfield is insignificant and uniformly distributed. The maximum erosion takes place down slope from snowfields with subsequent change in topography.

**TL 20**
**MATHEMATICAL FUNDAMENTALS OF AERIAL PHOTO-INTERPRETATION OF FORESTS.**
Bocharov, M.K., et al, June 1969, FSTC-HT-23-733-68, 274p., AD-691 916, For original Russian article see 23-1156. 83 refs.
Samoilovich, G.G.
25-2280
FORESTRY, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, COMPUTER APPLICATIONS.
Present status of photointerpretation of forests is discussed along with results of theoretical and experimental studies on use of mathematical modeling in investigating tree stands. The use of computers in forest management is feasible and requires starting information and the preparation of special maps bearing information essential for electronic computer operation. Mathematical modeling expands the theory of timber stand study and leads to new methods of measurement and determination of appraisal indexes concerning timber stands.

**TL 21**
**ACOUSTICAL CHARACTERISTICS OF ICE UNDER STATIC PRESSURE.**
Bogorodskiĭ, V.V., et al, Hanover, N.H., CRREL, 1970, 11p., AD-711 867, Translation of Akusticheskie kharakteristiki l'da... Akusticheskiĭ zhurnal 1967, 13(1), p.18-22. 5 refs.
Khokhlov, G.P.
25-2281
ICE ACOUSTICS, ICE COVER THICKNESS, ACOUSTIC MEASUREMENT.
Measurements were made of the speed of longitudinal ultrasonic waves in fresh polycrystalline ice at variable static pressure.

**TL 22**
**INVESTIGATIONS ON THE TEMPERATURE REGIME OF EARTH DAMS UNDER PERMAFROST CONDITIONS.**
Bogoslovskiĭ, P.A., 1966, 15p., AD-715 083, Translation of Issledovaniia temperaturnogo rezhima zemlianykh plotin v usloviiakh rasprostraneniia mnogoletnemerzlykh gruntov. Nauchnye doklady vysshei shkoly, Stroitel'stvo, 1958, No.1:228-238. 17 refs.
25-2304
EARTH DAMS, PERMAFROST THERMAL CYCLES, SOIL TEMPERATURE, CONSTRUCTION, ANALYSIS (MATHEMATICS).
The static and non-static temperature regime of earth dams constructed over permafrost both in the abscence and presence of seepage is analyzed theoretically, and a method of thermal calculation for dam design is described. An analytical solution to the 2-dimensional problem of thermal conductivity, taking into account the heat of phase transitions, is derived using the method of finite differences for individual points in the dam and differential Fourier equations, and the results of calculations are compared with data from model laboratory experiments, showing good agreement. Temperature changes take place at an exceedingly slow rate, indicating that the ultimate temperature conditions should be created during construction to avoid deformation. Seasonal freezing and thawing in the body of the dam should also be taken into account.

**TL 23**
**SURFACE ICING (NALED') AS A NEGATIVE PHYSICAL AND GEOLOGICAL PHENOMENON.**
Bol'shakov, S.M., June 19, 1969, FSTC-HT-23-413-68, 16p., AD-690 399, For original Russian text see 23-0616. 19 refs.
25-1187
ICE FORMATION, RAILROAD TRACKS, PERMAFROST STRUCTURE.

**TL 24** Record deleted.

**TL 25** Record deleted.

**TL 26**
**EXPERIENCE IN THE PLANNING, CONSTRUCTION AND USE OF EARTH DAMS AT NORIL'SK.**
Borisov, G.A., et al, Hanover, N.H., CRREL, 1970, 10p., AD-715 044, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Materialy po inzhenernomu merzlotovedeniiu. Moscow, 1959, p.110-119.
Shamshura, G.IA.
25-2305
EARTH DAMS, PERMAFROST PRESERVATION.
The methods used in the construction of earth dams in small rivers are described and evaluated; data on soil characteristics within the dams are tabulated; and cross-sections through various dams are included. All dams were constructed so as to preserve permafrost in their foundations. Experience with 2 dams indicates that, to preserve a dam in the frozen state, it is necessary to make it absolutely waterproof by artificial freezing. Freezing is best achieved by installing refrigeration pipes in the central part of the dam and using cold air as a coolant. Brine is less effective because of the possibility that it may penetrate into the soil. For best results, a dam should be founded in a talik at the river bottom surrounded by permafrost.

**TL 27**
**PRELIMINARY REPORTS ON THE USE OF ELECTROMETRY IN STUDYING THE MOVEMENT OF GLACIERS.**
Borovinskiĭ, B.A., et al, Hanover, N.H., CRREL, 1970, 9p., AD-711 911, Translation of Akad. nauk Kazakhskoĭ SSR. Vestnik 1959, Vol.15, No.7(172), p.45-50. 11 refs.
Makarevi ., K.G.
25-2284
GLACIER MOVEMENT, ELECTRICAL MEASUREMENT.
The first measurements of the surface rate of movement of glaciers were made 200 years ago. Extensive data on the movement of glaciers have now been collected on a planetary scale, but in the overwhelming majority of cases it characterizes with sufficient accuracy only the surface rates for different parts of glaciers. In determining the rate of ice movement within a glacier when studying the electric field created by an electrode in a borehole it is recommended that the potential gradient be measured, since this is most sensitive to field change. Since the conductivity of an electrode lowered into the ice exceeds by many times the conductivity of the surrounding rock-ice medium, the field will be created for the most part by the electrode itself and the potential gradient can be computed using a formula proposed.

**TL 28**
**COMPRESSIBILITY OF FROZEN GROUND.**
Brodskaia, A.G., Hanover, N.H., CRREL, 1965, 80p., AD-715 087, Translation of Szhimaemost' merzlykh gruntov. Moscow, AN SSSR, 1962. 33 refs.
25-2306
FROZEN GROUND PHYSICS, FROZEN GROUND MECHANICS, COMPRESSIVE PROPERTIES.
The techniques and the results of experimental investigations of the compressibility of frozen ground are described in detail and the relationship of physical properties to soil modification analyzed. The compressibility of frozen ground is influenced mainly by the mechanical properties, the temperature, the ice content and the cryogenic texture of the ground. It was highest in clayey soils and lowest in sand and increased with an increase of temperature and ice content in the soil. Frozen ground with thin interstratification of ice and minerals has a greater compressibility than those with uniform structure. Compression coefficients compiled for various types of ground are related to the volumetric changes in frozen ground, and indicate soil porosity variations with applied pressure. Decrease in volume of compressed ground depends on the elastic compression of all soil components (mineral structure, unfrozen water, ice and air), thawing ice, and on the squeezing out of air, water, and melting ice from the ground.

**TL 29**
**SOLVING ONE-DIMENSIONAL PROBLEMS OF THAWING GROUND CONSOLIDATION, ACCOUNTING FOR VARIABLE PERMEABILITY AND COMPRESSIBILITY.**
Fel'dman, G.M., Jan. 1972, 9p., AD-737 809, For Russian text see 23-1438. 3 refs.
26-3361
FROZEN GROUND MECHANICS, GROUND THAWING, SOIL COMPACTING, ANALYSIS (MATHEMATICS).

**TL 30**
**STUDY OF THE PHYSICO-MECHANICAL PROPERTIES OF FROZEN BEDROCK.**
Burshteĭn, L.S., et al, Hanover, N.H., CRREL, 1970, 11p., AD-715 042, For original Russian article see 23-2140.
Kurochkin, A.N.
25-2307
FROZEN ROCKS, ROCK MECHANICS.
Negative temperature in rock gives it increased strength due to which safety is improved and sometimes it becomes possible to manage without reinforcement of subterranean diggings. The intensity and character of manifestations of rock pressure in semi-permanently frozen rocks depend on the temperature conditions of the diggings. Temperature fluctuations lead to changes in the physical and mechanical properties of rocks, and consequently also the conditions for maintaining the diggings, the carrying capacity of pillars and the strength of the exposed overhead. Depending on the actual conditions, problems of rock technology may be solved by methods of mechanically solid media or structural mechanics, for which the knowledge of physical and mechanical properties of rocks is a necessary condition.

**TL 31**
**ICINGS IN THE USSR AND THEIR CONTROL.**
Chekotillo, A.M., et al, Hanover, N.H., CRREL, 1970, 258p., AD-711 933, Translation of Naledi na territorii SSSR i bor'ba s nimi. Blagoveshchensk, Amurskoe knizhnoe izdatel'stvo, 1960. 365 refs.
Tsvid, A.A., Makarov, V.N.
25-2285
NALEDS, ICE CONTROL, ICE FORMATION, ENGINEERING GEOLOGY.
After a brief review of early reports and identification of naleds and their causes, a systematic description is given of river, spring, ground, snowmelt, and mixed types of naleds. The importance of various geological, hydrological, and topographic factors in their formation is examined and several theoretical principles are advanced. As naleds must be considered in construction work in permafrost areas and areas of seasonal freezing of the ground, their effects on roads, railroads, and other structures are set out and measures for coping with them are described. These measures are exemplified in a detailed account of naled control work during the construction of the Urgal-Izvestkovaya stretch of the Amur Railroad.

**TL 32**
**POSSIBLE SETTLING OF PERENNIALLY FROZEN LOOSE DEPOSITS IN WEST SIBERIA DURING THAWING.**
Dubikov, G.I., Jan. 1972, 5p., AD-738 127, For Russian original see 25-3810.
32-4356
SETTLEMENT (STRUCTURAL), PERMAFROST THICKNESS, GROUND THAWING, FOUNDATIONS, BUILDINGS, GROUND ICE, SEDIMENTS.
In the development of land with perennially frozen friable deposits of great depth, a serious danger is presented by the thermal settlings of buildings erected on high-ice soils. Therefore a knowledge of the amounts of possible settlings permits the builder to form a rough judgment concerning the suitability or unsuitability of soils as a foundation for construction and to

recommend a building technique even during the initial stage of studies. Since during thawing, the settlings are determined by the extent of ice saturation of the frozen friable deposits, while iciness is linked largely with the lithological composition and method of freezing the soils, the values of possible settlings also depend on these factors. The report gives values of possible settlings during the thawing of the upper levels of frozen quaternary deposits in western Siberia.

**TL 34**
**CONSIDERATION OF HEAVING FORCES IN THE DESIGN OF DEEP PILE FOUNDATIONS.**
Chezin, V.A., Hanover, N.H., CRREL, 1960, 9p., AD-711 912, Translation of Uchet sil pucheniia pri proektirovanii vysokikh svaĭnykh rostverkov. Transportnoe stroitel'stvo, Jan. 1958, 8(1), p.19-22. 2 refs.
25-2286
PILE FOUNDATIONS, FROST HEAVE, SOIL MECHANICS, CONSTRUCTION.
Factors affecting frost heaving in the clay soils of the N. are examined, and formulas for calculating the proper structure and depth of pile foundations are given. Frost heaving is a function of depth of frost penetration, and the composition, structure and moisture content of the ground, as well as of the level of ground water. Max. deformations associated with frost heaving can be calculated with sufficient accuracy from data on the max. depth of frost penetration and on the pore water, taking into account the moisture increase associated with its migration to frozen strata. The piles should be placed at slightly varying angles to increase heaving resistance.

**TL 35**
**INFLUENCE OF MOISTURE MIGRATION ON GROUND FREEZING.**
Chistotinov, L.V., Hanover, N.H., CRREL, 1970, 8p., AD-715 055, For original Russian article see 23-0239. 6 refs.
25-2308
FROZEN GROUND HYDROLOGY, SOIL MOISTURE MIGRATION.
Moisture migration which takes place during ground freezing leads to essential redistribution of the moisture in the strata. This process is responsible for the characteristic structure of frozen ground, the formation of interstitial ice layers and lenses in it and the development of heaving. In the course of studies on moisture migration in finely dispersed rock with incomplete water saturation the dependency of moisture migration on the freezing rate was experimentally established. The migration flow in loamy soil at a certain freezing rate reached its maximum value then decreased with further increase in the freezing rate. A certain part of the total migration flow is spent on accumulation of moisture on the phase interface, and the rest of it goes to increase the ground moisture directly in the freezing zone. From the curve for the migration flow which increases the moisture only on the phase boundary, it is possible to obtain an important corollary which deals with this moisture increment as a function of the freezing rate.

**TL 36**
**COMPLEX MECHANIZATION EXCAVATION IN PERMAFROST.**
Dakhno, G.D., 1969, FSTC-HT-23-223-69, 116p., AD-692 487, 33 refs.
25-1193
PERMAFROST PRESERVATION, EXCAVATION, GROUND THAWING, RADIATION, TRENCHING.

**TL 37**
**SEASONAL FREEZING AND THAWING OF ROCKS.**
Dostovalov, B.N., et al, 1968, FSTC-HT-23-62-68, 11p., AD-842 408, Translation from Russian of General geocryology 1967, chapter 7, n.p.
Kudriavtsev, V.A.
25-2287
SEASONAL FREEZE THAW, PERMAFROST, ROCKS, HEAT TRANSFER.
Seasonal freezing and thawing of rocks in the permafrost zone are examined from the standpoint of geographical, geological, and geocryological factors in connection with construction. In order to facilitate proper planning of construction programs in areas affected by the above-mentioned processes in consideration of year-to-year variations in their conditions, it is suggested that a permafrost chart be formulated which would make it possible to predict the limits of variation of the freezing and thawing processes on a long-term basis.

**TL 38**
**EXPLOITATION OF ROADBEDS IN ICING AREAS.**
Demanov, D.A., June 27, 1969, FSTC-HT-23-509-68, 9p., AD-691 544, For original Russian article and abstract see SIP 25820.
25-1175
RAILROADS, ICE ACCRETION, ROADBEDS, SURFACE DRAINAGE, GROUND ICE.

**TL 39**
**POSITION OF PERMAFROST BENEATH SMALL WATERCOURSES.**
Dmitriev, IU.V., 1970, 13p., AD-711 929, Translation from Vses. Mezhduvedomstvennoe soveshchanie po geokriologii (merzlotovedeniiu), 8th, 1966. Materialy, No.2:185-195.
25-2545
WATER FLOW, PERMAFROST BENEATH RIVERS, PERMAFROST DEPTH, ANALYSIS (MATHEMATICS).
Taking into account the contradictory nature of existing points of view and the conclusions drawn concerning the position of permafrost beneath small watercourses, in the southern zone of dissemination of permafrost in the Far East a study was made of 50 small watercourses, both permanent and ephemeral, as well as runoff zones and water-intake canals. Data for more than 150 stations were considered. Computation formulas are proposed for determining the maximum depth of the upper permafrost boundary in places where watercourses flow.

**TL 40**
**LOWERING STRENGTH OF ROCKS BY DEEP FREEZING.**
Dobretsov, V.B., Hanover, N.H., CRREL, 1970, 4p., AD-715 043, For original Russian article see 24-0298. 4 refs.
25-2309
FROZEN ROCKS, ARTIFICIAL FREEZING, COMPRESSIVE STRENGTH, FREEZE THAW CYCLES.
The effect of low temperature (-16C) on physical and mechanical rock properties was studied by determining temporary resistance to compression of granite, diabase, granite-gneiss, and sandstone samples subjected to 25 freezing-thawing cycles, heating to 400C and cooling in moist sand. The results indicated that the temporary compressive strength of the rocks was in some cases lowered to 43 percent. To study the compressive strength variation during heating and cooling (to -180C) of sandstones, gabbro, graphite, and marble samples were cooled in liquid nitrogen for 20 to 25 minutes and tested in a hydraulic press with the following results: compressive strength of the samples temporarily increased 1.75 times, which amounted to 11.4 percent granites and 5.6 percent for marble. It was concluded, that the temporary compressive strength of rocks, as well as all solid bodies, is increased by deep freezing.

**TL 41**
**ROCKFALLS IN PRESSURE GALLERIES.**
Detzlhofer, H., Hanover, N.H., CRREL, 1970, 23p., AD-874 929, Translation from Felsmechanik und Ingenieurgeologie, 1968, suppl.4, p.158-180. 3 refs.
25-2288
ROCK MECHANICS, ENGINEERING GEOLOGY, TUNNELS, WATER PRESSURE, PRESSURE TESTS.
This paper deals with rockfalls which occur during the operation of pressure galleries at various power plants, and which result from the decomposition of fissure filling and from local disintegration of rock structure under the influence of varying pressure, when the gallery water gains access to the rock. The symptoms which indicate the possibility of such rockfall are often very inconspicuous during the heading period. A good example was a section of the Kauner Valley pressure gallery in schist gneiss on the occasion of a pressure test over a greater length, as yet unlined. The reasons for such a large-scale pressure test and its execution are described. The similarity between the stresses during the periods of tunnel filling, of building up and maintaining pressure as well as of tunnel draining on one hand and the varying pressure owing to the load control operation of the power plant on the other hand are shown. Thus the conditions of the test were similar to those during the subsequent operation.

**TL 42**
**FOUNDATIONS AND BASES ON PERPETUALLY FROZEN GROUND.**
Dokuchaev, V.V., Hanover, N.H., CRREL, 1970, 157p., AD-711 909, Translation of Osnovaniia i fundamenty na vechnomerzlykh gruntakh, Leningrad, Gosstroĭizdat, 1963, 196p. 53 refs.
25-2289
PERMAFROST, FOUNDATIONS, SOIL MECHANICS, DESIGN, CONSTRUCTION.
The physical and mechanical properties, bearing capacity, and ground temperature are given as characteristics to be considered in the methods outlined for using frozen ground as a building foundation base. Standards and design for the effectiveness of foundations on frozen bases are related to active ground levels and frost heaving. Similar planning is given for foundations on thawing bases. Various types of foundations and footings are illustrated showing the effect of distributed and concentrated loads, and related to ground temperature gradients. Mathematical analysis and instrumentation for soil investigation and subsequent structural design are presented.

**TL 43**
**USE OF ULTRASONIC METHOD FOR STUDY OF STRUCTURE OF SNOW COVER.**
Durynin, IU.F., Hanover, N.H., CRREL, 1970, 5p., AD-711 918, For original Russian article see 23-4399. 3 refs.
25-2290
SNOW COVER STRUCTURE, ULTRASONIC TESTS, SNOW ACOUSTICS.
The study of the stratigraphic characteristics of the snow cover and its development now is done by visual-instrumental observations in holes in the snow cover. The imperfection and the limitations of the method of making observations in holes has made it necessary to seek other means for making observations and checking on the state of the snow cover. Work was undertaken on the study of the acoustic properties of snow by ultrasonic methods and clarification of the basic and practical possibility of use of this method for study of the structure of the snow layer.

**TL 44**
**ON LONGITUDINAL SHOCK WAVES IN NONLINEAR ELASTIC MEDIA.**
Duvaut, G., Hanover, N.H., CRREL, 1970, 47p., AD-874 905, Translation from Journal de mécanique, 1967, 6(3), p.371-404.
25-2291
WAVE PROPAGATION, THERMODYNAMIC PROPERTIES, SHOCK WAVES, ELASTIC MEDIA.
Longitudinal shock waves of finite amplitude in non-linear hyperelastic materials were studied. Using physically admissible thermodynamic hypotheses, an attempt was made to determine the nature of waves capable of stable propagation in the material or reflection from fixed or free confines which furnished indications on the thermodynamic properties which make possible the existence of these phenomena.

**TL 45**
**STATIONARY FIELD METHOD FOR INVESTIGATING DISASSOCIATION PROCESSES IN LIQUID AND SOLID BODIES.**
Eigen, M., et al, Hanover, N.H., CRREL, 1970, 31p., AD-874 928, Translation from Zeitschrift für Elektrochemie, 1956, 60(9/10), p.1037-1048. 9 refs.
De Mayer, L.
25-2292
ICE MICROSTRUCTURE, MOLECULAR STRUCTURE, WATER, DISSOCIATION, ELECTRIC FIELDS.
Using powerful electric fields, it is possible to reduce ion concentration in very thin layers of slightly disassociated media to a point where the saturation current thus created gives a direct measure of the disasssociation velocity. Following a detailed discussion of the theoretical conditions, several measurement methods and a particular experimental arrangement are described. An application to measure disassociation on velocity of water molecules and proton mobility and concentration in very pure ice is discussed. The preliminary results lead to the assumption of a very high proton mobility in H-bridges. The disassociation velocity of the H2O molecules in the ice lattice was found to be smaller by several orders of magnitude than in water.

**TL 46**
**USSR REPORTS TO THE ELEVENTH INTERNATIONAL CONGRESS ON ROAD BUILDING, RIO DE JANEIRO, 1959.**
Federov, V.T., Hanover, N.H., CRREL, 1970, 156p., AD-711 913, Translation of Dokladv ot SSSR XI Mezhdunarodnomu dorozhnomu kongressu, Rio de Zhaneiro, 1959. Moscow. N.-tekhn. izd-vo Ministerstva avtomobil'nogo transporta i shosseinykh dorog RSFSR, 1959. 127p.
25-2293
ROADS, SOIL MECHANICS, PAVEMENTS, CONSTRUCTION, CONSTRUCTION MATERIALS, RUNWAYS.
This book presents the reports which were presented by the USSR delegation at the 11th International Congress on Road Building in 1959. The reports are devoted to different modern road building problems (road foundations, nonrigid and rigid pavements, city streets, low cost roads) and shed light on the experience which the USSR has had in solving these problems.

**TL 47**
**MAPS OF FREEZING INDEX FOR SWEDEN.**
Fellenius, B., et al, Hanover, N.H., CRREL, 1960, 13p., AD-874 930, Translation of Köldmängdskartor över Sverige. Kungl. Järnvagsstyrelesens. Geotekniska avdelning. Meddelande April 20, 1959, No.6. 9 refs.
Rengmark, F.
25-2294
FREEZING, INDEXES (RATIOS), METEOROLOGICAL CHARTS, MAPPING, SWEDEN.
Freezing index maps were prepared for Sweden showing the distribution of mean freezing index and maximum freezing index during the 1901-1959 period. The maps are based on data from 273 weather stations. Methods of approximating mean values for the 50-year period for stations with incomplete observation records are discussed. The distribution of the magni-

tude of freezing index is given in percent of occurrence for all stations with complete observation record and a method is presented for using the mean map to predict the distribution of freezing index at any specific location.

**TL 48**
**DETERMINATION OF THE WATER VALUE OF A SNOW COVER WITH RADIOACTIVE SUBSTANCES.**
Fischmeister, V., Hanover, N.H., CRREL, 1970, 16p., AD-874 911, Translation of Die Bestimmung des Wasserwertes einer Schneedecke mit radioaktiven Stoffen. Wasserwirtschaft, April 1956, 8(4), p. 86-93.
25-2295
SNOW WATER EQUIVALENT, RADIOACTIVE SNOW GAGES.

The design, operation, and calibration of an Austrian radioactive snow gage are described, and the instrument is evaluated on the basis of comparative tests in the Spring of 1955. The gage consists essentially of a Co-isotope irradiator shielded by a lead bell and suspended on a pole above the snow cover and a Geiger-Müller counter installed flush with the soil surface. The radiation received is transformed into electric pulses, amplified, and transmitted by an ultrashort-wave sender to a remote receiver. The sender is equipped with a time switch set to transmit once a day. Satisfactory agreement was found between daily readings of the radioactive snow gage and weekly measurements with a snow sampler with values for the gage falling slightly short of the others. The causes for the discrepancy are discussed, and data on the water equivalent of snow measured with both instruments, snow density, and weather conditions at the time of the tests are graphed.

**TL 49**
**GEOLOGICAL MAP OF VIETNAM-CAMBODIA-LAOS. NOTICE ON THE HUÉ SHEET.**
Hoffet, J.H., et al, 1970, 29p., AD-878 895, Translation from National Geographic Service of Vietnam, Dalat, 1962. 42 refs.
Fontaine, H., Saurin, E.
25-2546
GEOLOGICAL MAPS, VIETNAM—HUÉ PROVINCE.

**TL 50**
**GROUNDWATER AND FROZEN GROUND IN THE SOUTHERN YAKUT COAL BASIN.**
Fotiev, S.M., Hanover, N.H., CRREL, 1970, 224p., AD-711 866, Translation of Podzemnye vody i merzlye porody IUzhno-IAkutskogo uglenosnogo basseĭna. Moscow, Nauka, 1965. 229p. 82 refs.
25-2296
PERMAFROST DISTRIBUTION, HYDROLOGY, GROUND WATER, USSR—YAKUTIA.

Contents: Natural conditions of formation of groundwater and frozen ground relief: (Geological structure, tectonics, climate, hydrology, vegetation and soil); Frozen ground (Temperature conditions of the rock and thickness of the frozen formations of the Chul'man plateau, sides of troughs and river valleys, variation in rock temperature after removal of the peat moss and snow cover, frozen rock of the Stanovoy ridge and the Zapadnyye Yangi ridge, lateral extent of the permafrost, cryogenic and postcryogenic formations); Early glaciation and the conditions of formation of permafrost; Groundwater.

**TL 51**
**THEORY OF VAPOR CONDENSATION IN THE PRESENCE OF NON-CONDENSING GASES.**
Frank-Kamenetskiĭ, D.A., et al, Hanover, N.H., CRREL, 1970, 62p., AD-712 247, Translation from Zh. tekhnicheskoĭ fiziki, 1942, 12(7), p.327-356. 7 refs. Also includes transl. of Corrections and additions to Frank-Kamenetskiĭ's article by A.G. Amelin, Zh. tekhnicheskoĭ fiz, 1945, 15(4-5), p.287-296. 13 refs.
Amelin, A.G.
25-2297
CONDENSING, HEAT TRANSFER, GASES, MASS TRANSFER, DIFFUSIVITY, STEFAN PROBLEM, ANALYSIS (MATHEMATICS).

The aim of the paper is a consideration of the condensation of a vapor diluted with non-condensing gases, with strict account of the basic diffusion process, but without account of the secondary factors of external heat transfer. For this we will assume the heat transfer of the surrounding medium from the wall to be so intensive that the temperature of the surface on which the condensation occurs, i.e., the internal surface of the film of condensate, can be assumed constant and equal to the given temperature of the surrounding medium. With these assumptions, the Stefan equation can be integrated analytically over the whole length of the apparatus; a simple and convenient equation is obtained, which shows graphically the basic qualitative regularities of the process and permits making rough calculations with exceeding ease and simplicity without unwieldy and laborious graphical methods.

**TL 52**
**DIELECTRIC PROPERTIES OF SEA ICE.**
Fujino, K., Hanover, N.H., CRREL, 1970, 54p., AD-877 403, For original Japanese article see 23-2752. 30 refs.
25-2298
ICE DIELECTRICS, SEA ICE, CONDUCTIVITY.

Temperature characteristics and frequency characteristics of dielectric properties of natural sea ice gained by measurement may be summarized as follows. Corresponding to changes in volume and composition of brine due to temperature at the precipitation point and the eutectic point at which liquid brine solidifies, discontinuous changes are manifested. Frequency characteristic curves with temperature as a parameter are divided into three groups corresponding to those temperatures. The frequency characteristic in the temperature range above the eutectic point where liquid brine exists manifests a notably different characteristic than the temperature range below it. It can be inferred that in the temperature range above the eutectic point, structural dispersion on the surface of ice and liquid brine (which is an electrolytic solution) is dominant, and that in the temperature range below that where liquid brine does not exist, the contribution of electrolytic brine disappears and molecular dispersion of ice molecules themselves becomes dominant.

**TL 53**
**INVESTIGATION ON THE FORMATION OF NEEDLE FROST, II.**
Fujita, M., Hanover, N.H., CRREL, 1970, 13p., AD-874 906, Translation from Natural Science Study Group of the Free Academy (Jiyu Gakuen) May 1940, p.1-15.
25-2299
FREEZING POINTS, CRYSTAL GROWTH, ICE NEEDLES.

**TL 54**
**SUBNIVAL ZONE AND ITS LOWER DELIMITATION IN THE ALPS OF THE GRISONS AND THE VALAIS.**
Furrer, G., 1969, FSTC-HT-23-139-69, 13p., AD-858 691 L, Translation from Geographica Helvetica, 1965, no.4, p.185-192. 16 refs.
25-2300
SOLIFLUCTION, FROST SHATTERING, PATTERNED GROUND, SUBNIVAL ZONE, SWITZERLAND—ALPS.

This essay takes the lower boundary of the occurrence of solifluction phenomena as the lower limit of the subnival zone. This lies within the Alpine pasture belt and though not necessarily parallel, is analagous to the timberline. Observations from the northern perimeter of the Alps (Lake of Thun) to the Matterhorn and from Raetikon to the Bernina (a distance of some 50 miles), show this lower boundary to ascend from 2000 m to over 2400 m. However, the exact delimitation of subnival forms needs further field observation and mapping.

**TL 55**
**SWAMPY FOREST ZONE TERRAIN.**
Galkina, E.A., Aug. 1969, FSTC-HT-23-736-69, 13p., AD-692 654, For original Russian article see 23-1476. 18 refs.
25-2310
SWAMPS, AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS.

The author shows the necessity for the use of aerial photography in the study of swamp terrain. He then discusses some of the general features of swamp terrain as it appears in aerial photographs of different scale. The article is taxonomic and classificatory in nature. Ten basic types of swamp terrain are discerned, the chief criteria are size and course of development. The author concludes with a favorable appraisal of the advantages and potentialities of the use of aerial photography for the study of swamp terrain.

**TL 56**
**QUANTITATIVE MEASUREMENTS ON ELECTRICITY PRODUCTION BY THE WATERFALL EFFECT ON ICE.**
Gnam, G., et al, Hanover, N.H., CRREL, 1962, 17p., AD-877 318, Translation of Quantitatives zur Elektrizitätserzeugung durch den Wasserfalleffekt auf Eis. Arch. Meteorologie, Geophys. Bioklimatologie, Ser.A., 9(2):232-241, 1956. 19 refs.
Wolf, F.
25-2311
ICE ELECTRICAL PROPERTIES, CLOUD DROPLETS, ELECTRIC CHARGE.

Laboratory studies are described that simulate the effect of the impact of cloud droplets upon ice for the production of electricity in thunderstorms. Measurements were made for various ice and drop temperatures, falling heights, drop masses, and impurities. The charge decreased considerably as ice temperature decreased, due to the immediate freezing of the droplets. Variation of falling height and mass of droplet led to the result that, in a certain range, the separated charge was approximately proportional to the kinetic energy of the droplet. The charges also decreased as the purity of the droplets decreased.

**TL 57**
**POROUS ALABASTER AND SNOW CONCRETE.**
Grinblat, Sh.B., Hanover, N.H., CRREL, 1970, 3p., AD-711 872, Translation of IAcheistyĭ alebastr i snego-tsementnyĭ kamen'. Promyshlennoe stroitel'stvo, 1941, 19(7-8):39.
25-2312
SNOW (CONSTRUCTION MATERIAL), ADMIXTURES, CELLULAR CONCRETES, ALABASTER.

Ice and snow alabaster is obtained by mixing alabaster with snow and water, and after 10-15 minutes the member is strong enough to be carried into the drying room. In this way, a material with much better properties than foam alabaster can be obtained from alabaster without wasting valuable products in preparing a foaming emulsion. Similarly, it is possible to obtain a foam concrete which can be used as load-bearing members, ceilings, etc.

**TL 58**
**ICE LAYERS IN TUNNELS.**
Gritsyk, V.I., June 30, 1969, FSTC-HT-23-679-68, 3p., AD-691 975, For original Russian article and abstract see SIP 25825. 2 refs.
25-1179
RAILROAD TUNNELS, ICE PREVENTION, SURFACE DRAINAGE, SEALING COMPOUNDS.

**TL 59**
**AIR CURRENTS ARISING DURING MOVEMENT OF AVALANCHE SNOW.**
Gvinchidze, N.M., Hanover, N.H., CRREL, 1966, 6p., AD-715 030, Translation of Vozdushnye techeniia, voznikaiushchie pri dvizhenii snezhnykh lavin. Priroda, 1950, 39(6):67-69. 8 refs.
25-2313
AVALANCHE COUNTERMEASURES, AVALANCHE WIND.

A destructive shock wave was observed to precede most snow avalanches formed within a 48-hr. period following a dry snowfall. The density of the snow cover was found to be less than 0.1 prior to the avalanche formation. The theory is advanced that the shock wave of an avalanche is caused by a rapid compression of the fresh and dust-like snow. The air squeezed out of the rolling snow masses rides the front of the avalanche and its force is proportional to the avalanche speed and the snow masses participating in the slide. Methods of avalanche control and protection are given.

**TL 60**
**SURVEY OF MENDENHALL GLACIER.**
Higashi, A., et al, Hanover, N.H., CRREL, 1966, 45p., AD-877 347, Translation of Mendengoru hyoka no chosa. Shizen, 1961, 16(2):24-32, 16(3):42-52.
Hashimoto, S.
25-2314
GLACIER ICE, GLACIER MOVEMENT, SURVEYS, UNITED STATES—ALASKA—MENDENHALL GLACIER.

Results of studies made by a Hokkaido University research group during a field trip to the Mendenhall Glacier (Alaska) from May-July 1960, are reported. Geographical lay-out of the glacier is described. Stratification, foliation, ogives and crevasses are described and illustrated. Surface velocity of glacier was measured by observing bamboo poles erected over the glacier surface. The changes of axial distribution of ice crystals along the side and center, and in the upstream and downstream of the glacier are described and plotted. The growth process of ice crystals within the glacier is briefly considered. Studies of oxygen concentration and the electrical conductivity of ice samples are also reported.

**TL 61**
**MARCHING AND ENCOUNTERS.**
Loza, D.F., Jan. 1972, 16p., AD-737 808, For Russian text see 24-0494.
26-3362
ARCTIC TERRAIN, MOUNTAINS, MILITARY OPERATION, MILITARY TRANSPORTATION, ICE CROSSINGS.

**TL 62**
**USE OF THE RESULTS OF GEOBOTANIC INTERPRETATION OF AERIAL PHOTOGRAPHS AND THE IDENTIFICATION OF LANDSCAPE FEATURES OF TERRITORIES. LENS FORMATION OF LEAKAGE WATERS ON BLACK EARTH AND IN THE SARPINSK LOWLAND.**
Iordanskaia, N.N., et al, Oct. 10, 1969, FSTC-HT-23-464-68, 6p., AD-695 956, For original Russian article see 23-1405. 5 refs.
Shavyrina, A.V.
25-1838
AERIAL PHOTOGRAPHY, TERRAIN IDENTIFICATION, GEOBOTANICAL INTERPRETATION.

**TL 63**
**SIZE DISTRIBUTION, CRYSTAL FORM AND FALLING VELOCITY OF SNOW-FLAKES.**
Itoo, K., et al, Hanover, N.H., CRREL, 1970, 15p., AD-877 402, Translation from J. Meteorological Soc. Japan, June 1953, 31(6):219-231. 2 refs.
Yano, T., Hama, K.
25-2316
SNOWFLAKES, PARTICLE SIZE DISTRIBUTION, SNOW CRYSTALS, VELOCITY.

Mainly graupel-type snowflakes were studied. Photographic determinations were made of the fall velocities. The size distribution and fall velocities of the snowflakes are graphed. The relation between the crystal size and equivalent waterdrop diam. is shown. No relationship was found for particles smaller than 0.8 mm. in diam.

**TL 64**
**STABILITY OF LAYERS OF SNOW.**
Jaccard, C., Hanover, N.H., CRREL, 1970, 18p., AD-877 350, Translation from Int. Assoc. Sci. Hydrology. Publ. No.69: 170-181, 1966. 2 refs. For another translation of this paper see 23-4814.
25-2317
SNOW STRENGTH, SLOPE PROCESSES, STABILITY, ANALYSIS (MATHEMATICS).
The comparison of the stresses in the weakest layer with the corresponding critical curve in the Mohr plane allows the defining of a primary stability. It is investigated as a function of the slope angle and of the distributed load, and it is shown that it is absolute in certain cases (independent of the load). The secondary stability characterizes the absence of sensitivity to perturbations, especially at a localized rupture of the critical layer. Different shapes of the broken zone are considered, and also the influence of a vertical concentrated force, applied to the surface.

**TL 65**
**THEORETICAL AND EXPERIMENTAL STUDY OF THE ELECTRICAL PROPERTIES OF ICE.**
Jaccard, C., Hanover, N.H., CRREL, 1970, 53p., AD-877 345, Translation of Etude théorique et expérimentale des propriétés électriques de la glace. Helv. phys. acta, 32(2):89-128,1959. 24 refs.
25-2318
ICE ELECTRICAL PROPERTIES, ICE CRYSTAL STRUCTURE.
The mechanical and chemical properties of ice are related to its electrical characteristics which cannot be derived from its regular hexagonal crystalline configuration since a perfect crystal structure would have a conductivity of zero, but require the assumption of the existence of ionized states and orientational lattice defects. All 4 types of lattice defects were studied compositely, and the complex electrical conductivity was computed for the cases of classical and quantum-mechanical proton transfer. The dielectric constant which closely follows a Debye dispersion, the relaxation time, and the high frequency conductivity were determined by the defects of highest specific conductivity. The methods for the production of pure and doped ice crystals and the high frequency equipment are described.

**TL 66**
**GROUND FROST: A LISTING AND EVALUATION OF MORE RECENT LITERATURE DEALING WITH THE EFFECT OF FROST ON THE SOIL.**
Jessberger, H.L., Jan. 13, 1970 , FSTC-HT-23-311-70, 494 p., AD-865-128L, Translation of Bodenfrost. Zusammenstellung und Auswertung des neueren Schrifttums über die Wirkung des Frostes auf den Boden, Research Report W. 44, Munich. February 1969, p. 1-429.
25-1069
FROST HEAVE, FROST PENETRATION, POROSITY, HEAT TRANSFER, HYGROSCOPIC WATER, FROST ACTION, BIBLIOGRAPHIES, SOIL FREEZING, GROUND THAWING.

**TL 67**
**ON THE DETERMINATION OF THE CARRYING CAPACITY OF AN ICE COVER FOR LOADS OF LONG DURATION.**
Panfilov, D.F., Jan. 1972, 14p., AD-737 812, Translation of Russia. Ministerstvo vysshego i srednego spetsial'nogo obrazovaniia. Izvestiia vysshikh uchebnykh zavedeniĭ No.6, 1961, p.47-57. 12 refs.
26-3363
ICE BEARING CAPACITY, PLASTIC DEFORMATION, ICE PLASTICITY, STATIC LOADS, DYNAMIC LOADS, ICE CREEP.

**TL 68**
**ON THE THEORY OF LINEAR CRYSTALLIZATION VELOCITY.**
Kaishev, R., et al, Hanover, N.H., CRREL, 1970, 6p., AD-877 408, Translation from Z. phys. Chemie, Vol-.A170:295-299, 1934. 8 refs.
Stranskiĭ, I.N.
25-2319
ICE CRYSTAL NUCLEI, CRYSTALLIZATION, ANALYSIS (MATHEMATICS).
The kinetic derivation of the velocity of formation of crystal nuclei is applied to the case of linear crystallization velocity. The results obtained are compared with experimental data.

**TL 69**
**PHYSICAL AND MECHANICAL PROPERTIES AND THE FORMING OF THE SNOW FIRN COVER OF EASTERN ANTARCTICA.**
Kartashov, S.N., 1965, 146p., AD-715 206, Translation of Fiziko-mekhanicheskie svoĭstva i protsessy formirovaniia snezhno-firnovogo pokrova Vostochnoĭ Antarktidy. Moscow, Izd-vo AN USSR, 1962. 105 refs.
25-2320
SNOW PHYSICS, METAMORPHISM (SNOW), TRAFFICABILITY, ANTARCTICA.
Contents: A brief review on research on the snow-firn cover in areas of continental glaciation; Conditions for the forming of the snow-firn cover of Eastern Antarctica; Research on the physico-mechanical properties of snow and firn; The formation and physico-mechanical properties of the snow-firn cover in the Eastern Antarctic; The passability conditions of the snow-firn cover and certain other practical conclusions.

**TL 71**
**DIFFERENTIAL THERMAL ANALYSIS OF CLAY MINERALS BETWEEN THE TEMPERATURE OF 0 AND -195 C.**
Kato, C., Hanover, N.H., CRREL, 1970, 7p., AD-874 931, Translation from Yogyo kyokai shi (J. of the Ceramics Assoc. of Japan) 67(7):97-100, 1959. 10 refs.
25-2321
CLAYS, THERMAL ANALYSIS, TEMPERATURE FACTORS.
A differential thermal analysis of montmorillonite and other clay minerals was conducted from room temperature to -195C. Montmorillonite gave three peaks of different type. The first peak at around -4C probably due to the freezing of mechanically mixed water, while the second one at about -7C to the freezing of the adsorbed layer composed of liquid water. The third peak coming out between -20 and -30C may be attributed to a part of liquid water being in existence in the interfacial layer between the layer lattice of montmorillonite. From the equilibrium diagram of water the author was able to estimate that the pressure, under which the water film between the lattices may exist as liquid should be as high as 2000 atm. The differential thermal analysis of attapulgite, nontronite, vermiculite, and hydrated halloysite gave three peaks somewhat similar to montmorillonite.

**TL 72**
**PROBLEMS IN THE THEORY AND PRACTICE OF ARTIFICIAL FREEZING OF SOIL.**
Khakimov, Kh.R., Hanover, N.H., CRREL, 1970, 178p., AD-711 891, Translation of Voprosy teorii i praktiki iskusstvennogo zamorazhivaniia gruntov. Moscow, AN SSSR, 1957. 97 refs. For another translation see 25-3083.
25-2322
ARTIFICIAL FREEZING, SOIL FREEZING, SOIL STABILIZATION, HYGROSCOPICITY, UNDERGROUND STRUCTURES.
Engineering problems and methods of artificial ground freezing are discussed on the basis of an analysis of new and previously published data on the physical processes occurring in ground during freezing and thawing. A theory explaining several phenomena in frozen clay and permitting approximation of the quantitative increase of moisture is suggested. Soil moisture and composition are the basic factors affecting the course and intensity of the freezing processes and the concomitant changes in properties. The moisture increase in clay and decrease in sand after freezing are associated with effects of soil structure on moisture migration. Experiments have also shown decreased frost heaving with rapid freezing as well as peculiarities in frost penetration associated with the size and distribution of coolers and the cooling regime.

**TL 73**
**DYNAMICS OF THE ICE COVER.**
Kheĭsin, D.E., Sept.18, 1969, FSTC-HT-23-485-69, 258p., AD-695 178, For original Russian text and abstract see SIP 25624. 109 refs.
25-1172
SEA ICE, FLOATING ICE, ICE COVER STRENGTH, OCEAN WAVES, DYNAMIC PROPERTIES, WAVE PROPAGATION, ANALYSIS (MATHEMATICS).

**TL 74**
**STUDY OF THE HARDNESS OF ICE.**
Krushchov, M.M., et al, 1970, 48p., AD-716 457, Translation of Izuchenie tverdosti l'da. Moscow, Izdvo AN SSSR, 1960. 25 refs.
Berkovich, E.S.
25-2551
HARDNESS TESTS, ICE HARDNESS, FROZEN GROUND.
The present monograph is intended as a systematic representation of data collected on the hardness of ice by the present authors and other investigators using various methods. It is believed that the monograph will be of general interest to scientists and engineering-technical workers concerned in any way with ice, frozen soil, or snow at low temperatures.

**TL 75**
**SNOW PLOW INVESTIGATIONS.**
Kihlgren, B., Hanover, N.H., CRREL, 1970, 44p., AD-877 406, Translation of Undersökningar rörande snoplogar. National Swedish Road Research Institute. Stockholm. Report No.38, 1961, 44p.
25-2323
SNOW REMOVAL EQUIPMENT.
The National Swedish Road Research Institute has been investigating snow plows since 1947. These investigations including theoretical studies, scale model, full-scale tests and practical tests of new-type snow plows are presented.

**TL 76**
**TEMPERATURE VARIATIONS IN A WATER RESERVOIR DURING WINTER.**
Kolesnikov, A.G., Hanover, N.H., CRREL, 1970, 7p., AD-715 028, Translation of Khod temperatury vody v vodokhranilishche v zimniĭ period. Akademiia nauk SSSR. Doklady 1953, 92(1): 37-40. 1 ref.
25-2324
RESERVOIRS, WATER TEMPERATURE, FREEZING, ANALYSIS (MATHEMATICS).
The processes of thermal exchange between water and ground during the period of ice-cover formation and during winter are analyzed. Equations for calculating temperature in water-storage reservoirs and near the ice-water boundary are suggested. The temperature distribution in the ground near the time of freeze-up may be calculated from data on water temperatures in the summer and the time interval between maximum water temperature and reservoir freezing.

**TL 77** Record deleted.

**TL 78**
**EFFECT OF EXCHANGE CATIONS ON THE CRYOGENIC TEXTURE OF SOILS AND THE STRUCTURE OF SEGREGATED ICE.**
Konnova, O.S., 1970, 35p., AD-716 595, Translation from Issledovaniia po fizike i mekhanike merzlykh gruntov, No.4:53-80, 1961. 6 refs.
25-2553
FROZEN GROUND PHYSICS, GROUND ICE, ICE CRYSTAL GROWTH, SOIL COMPOSITION.
The results of this study show that the structure of segregated ice and its crystallographic orientation, as well as the intensity of ice segregation and the nature of the growth of ice inclusions, are directly dependent on the physicochemical properties of the soil. Three types of cryogenic texture and segregated ice structures were established according to their dependence on physicochemical properties. These are described with reference to the presence of univalent and polyvalent exchange cations. Changes in ice structure caused by the effect of exchange cations on the nutrition regime and crystal growth are described. Clays and clayey loams were used in the investigation.

**TL 79**
**PROBLEM OF FORMATION OF THE ION COMPOSITION AND MINERALIZATION OF FRESH WATER ICE UNDER VARIOUS CONDITIONS.**
Korenovskaia, I.M., et al, Hanover, N.H., CRREL, 1970, 21p., AD-711 873, For original Russian article see 23-5311. 27 refs.
Tarasov, M.N.
25-2326
IONS, ICE COMPOSITION, CHEMICAL COMPOSITION.
The research discussed pursued three main goals: Establishment of the nature of the dependence of the concentration of various ions (Cl(-), SO4 (-2), HCO3 (-)) in the ice on their concentration in initial solution; Establishment of the nature of the dependence of the concentration of various ions in the ice on the freezing temperature (or, the equivalent, the ice formation rate); and Discovery of whether the standard natural water solutions of the corresponding chemical composition are subject to these relations.

**TL 80**
**EXPERIENCE IN THE CONTROI OF GLACIERS ON THE TAYSHET-LENA RAILWAY.**
Korzh, V.I., June 1969, FSTC-HT-23-571-68, 8p., AD-691 318, For original Russian article see 23-0610.
25-2327
NALEDS, RAILROAD TRACKS, ICING, ICE CONTROL.
The problem of combating key and ground naleds along the railroad had been solved, however, it is still a serious problem as regard to river naleds since the retaining of ice by earthen embankments surrounding man-made structure prove to be inadequate. In many cases the hydrogeological and topographic conditions prevented the construction of embankments. The prevention of the formation of naleds near man-made structure should be regarded as the most effective means of controlling ice. Constant or periodic electrical heating of a stream near installations can be used on electrified railroads. On non-electrified railroads attempts should be made to construct an embankment on the upper side of installations with a basin depth of 4-5 meters, and in this case the installations themselves should lead off to the slopes of the valleys or into the streams.

**TL 81**
**EVALUATION OF THE COMPRESSIVE STRENGTH OF ICE UNDER THE SHORT-TERM RAPIDLY INCREASING LOAD.**
Korzhavin, K.N., et al, Aug. 21, 1969, FSTC-HT-23-188-68, 14p., AD-69[illegible]. For original Russian article and abstract see SIP 25871. 9 refs.
Ptukhin, F.I.
25-1178
ICE COVER STRENGTH, COMPRESSIVE STRENGTH, LOADS (FORCES).

**TL 82**
**QUESTION OF SLOPE EVOLUTION.**
Krivolutskiĭ, A.E., Hanover, N.H., CRREL, 1970, 15p., AD-715 065, For original Russian article see 23-4386. 7 refs.
25-2328
SLOPE PROCESSES, SOLIFLUCTION.
To study the structural and developmental characteristics of slopes, three typical cases, determined not only by morphological types of relief, but also by the status of a region in the system of a young erosion incision are presented: 1) mountainous regions well worked by a young erosion; 2) mountainous regions situated in the depth of the continent and still not affected by a young erosion; and 3) denudation plains and plateaus in regions of weak manifestation of a young erosion.

**TL 83**
**PROTON RELAXATION IN ICE CRYSTALS AND IN FROZEN PARAMAGNETIC IONIC SOLUTIONS.**
Krüger, G.J., Hanover, N.H., CRREL, 1961, 74p., AD-874 907, Translation of Doctoral thesis, Stuttgart Inst. of Technology, 1961.
25-2329
ICE CRYSTALS, IONIC SOLUTION, PROTONS, RELAXATION (MECHANICS).
In the first part of the paper a pulse apparatus for the measurement of nuclear magnetic relaxation time is described. With this apparatus the proton relaxation in single ice crystals was investigated. From the nuclear signal after a 90 degree pulse the proton-proton separation was determined. The proton resonance line in a single ice crystal is a doublet which is maintained for pure ice up to the vicinity of the melting point. For HF doped ice the inner mobility is increased, so that the doublet separation vanishes in the vicinity of the melting point. The spin-grating relaxation time of pure and HF doped ice crystals was measured in relation to the temperature. The nuclear magnetic relaxation time of the protons in frozen solutions of paramagnetic ions was measured as a function of the temperature and the ion concentration.

**TL 84**
**BASIC PROBLEMS OF GENERAL AND REGIONAL GEOCRYOLOGY IN THE NEXT FEW YEARS.**
Kudriavtsev, V.A., Hanover, N.N., CRREL, 1970, 8p., AD-711 870, For original Russian article see 23-2328.
25-2330
GEOCRYOLOGY, MODELS, THEORIES, RESEARCH PROJECTS.
The principal problem of the general theoretical and historical geocryology was and remains the problem of studies of the general laws governing the formation and development of frozen layers. In them we must uncover both the thermophysical and geologic-geographical sides of development of the freezing process in their interaction and interrelationship. The logical completion of theoretical studies should be the creation of classification of seasonally frozen layers and those frozen over many years, in which the thermophysical features and thermodynamic conditions of formation and development of the frozen layers should be taken into account.

**TL 85**
**NOMOGRAMS FOR CALCULATING THE DEPTHS OF PERENNIAL FREEZING OF ROCKS AND THERMAL CYCLES WITHIN THEM.**
Kudriavtsev, V.A., et al, Hanover, N.H., CRREL, 1970, 7p., AD-711 881, For original Russian article see 23-2333.
Melamed, V.G.
25-2331
PERMAFROST THICKNESS, HEAT TRANSFER, NOMOGRAPHS, FROST PENETRATION, THERMAL CYCLES.
In a collection of permafrost reports equations were proposed for calculating the depths of the perennial freezing and thawing of layers of rocks, and of the heat exchanges taking place in them. For a calculation of the heat exchanges Q (kcal) in the layer of rocks, pressing through the surface of the Earth during perennial freezing, formulas are given.

**TL 86**
**PRELIMINARY REPORT OF A MODEL EXPERIMENT ON HEAT AVALANCHES.**
Kuroda, M., Hanover, N.H., CRREL, 1966, 15p., AD-877 410, Translation of Netsu nadare mokei jikken hokoku. Seppyo, 1941, Vol.3:295-302.
25-2333
AVALANCHE MODELING.
A mix containing 98 percent paraffin and 2 percent silica sand by weight was used as test material representing a snow layer. The shear strength of this test material is roughly 800 gm/sq.cm; the tensile strength is 100 gm/sq.cm. The mixture was melted at 60 C and poured on a rough wooden surface. A paraffin layer of uniform thickness was made on the wooden plate. The temperature was measured with thermocouples at the upper surface, the middle of the layer and the bottom. The wooden plate was tilted to a given angle, and the temperature of the test material was raised gradually with an incandescent lamp. The temperature was measured when the sheet of test material ruptured. The relation between the rupture temperature and the inclination was studied. The equipment was found suitable for model experiments of heat avalanches.

**TL 87**
**DYNAMIC STUDIES ON THE OCCURRENCE OF AVALANCHES.**
Kuroda, M., Hanover, N.H., CRREL, 1966, 7p., AD-877 411, Translation of Yukinadare hassei no rikigakuteki kosatsu. Seppyo no kenkyo, Nov. 1953, No.1:203-206. 2 refs.
25-2332
AVALANCHE MECHANICS, AVALANCHE FORMATION, ANALYSIS (MATHEMATICS).
The causes of various types of avalanches are outlined, and equations are derived describing the shear stresses on a snow-covered slope (using a linear relation of shear and compressive strength) and the supporting force of the surrounding snow cover. Heat avalanches are caused by solar radiation effecting differences in the strength of the upper snow layer. Ground avalanches result from the weakening of the entire snow cover under the action of heat. Slab avalanches occur when the hard surface snow layer is suspended on 2 sides and loses its support. Crust avalanches take place when the upper snow layer, resting on hard snow, is put into motion by an outside force (e.g., a running ski).

**TL 88**
**PLANNING OF BUILDINGS FOR FAR NORTHERN REGIONS.**
Kushnev, A.P., Hanover, N.H., CRREL, 1965, 170p., AD-715 052, Translation of Proektirovanie zdaniĭ dlia raĭonov Kraĭnego Severa. Leningrad, Gosstroĭizdat, 1961. 196p.
25-2334
COLD WEATHER CONSTRUCTION, URBAN PLANNING, PERMAFROST.
The results of 20 yr. of design and construction experience in the Noril'sk mining region are reviewed to provide construction engineers, designers and contractors with a handbook of industrial construction in the Far North. General information is provided on the considerations imposed by frozen ground, climatic, and local-geographic factors on the planning of buildings and settlements. Specific recommendations are made for the erection of buildings on rock foundations, taliks, and permafrost. The factors involved in the choice of building material are discussed, technical specifications are stated, and information is given on cost of materials. It is noted that considerable savings can be effected by using aluminum alloy sheets for roofing in place of reinforced concrete panels. Stone, concrete, reinforced concrete, and metal structures are treated separately.

**TL 89**
**EXPERIMENTAL INVESTIGATION ON THE WATER YIELD FROM SNOW BY MEANS OF RADIOACTIVE COBALT.**
Kuz'min, P.P., Hanover, N.H., CRREL, 1965, 29p., AD-715 062, Translation of Opyt issledovaniia vodootdachi iz snega s pomoshch'iu radioaktivnogo kobal'ta. Gos. gidrol. inst. Trudy 1958, No.65:30-49. 7 refs.
25-2335
RADIOACTIVE SNOW GAGES, SNOW WATER EQUIVALENT, MEASUREMENT.
Formulas expressing the water balance of a melting snow cover, the use of radioactive isotopes for determining the total water content of snow, and the results of tests in 1957 in the Valday region are discussed. Data are tabulated and graphed on the characteristics of the test sites and methods of measurement, the total water content of snow at the beginning of melting and water yields in March and April as determined with radioactive gage and other methods, the calculated variations in the water content of snow for various numbers of impulses received by the radiation counter, and the most probable errors in the determination of the water content of snow with the radioactive gage. The radioactive method was found valid for snow with a water content exceeding 50 mm. For snow with a lesser water content the relative error exceeded the allowable limit.

**TL 90**
**USE OF THE PROPERTIES OF THE SOIL COVER IN THE INTERPRETATION OF GROUND WATER ON AERIAL PHOTOGRAPHS.**
Kuznetsov, V.V., 1969, FSTC-HT-23-393-68, 19p., AD-692 627, For original Russian article see 23-1298. 10 refs.
25-2336
AERIAL PHOTOGRAPHY, GROUND WATER, TERRAIN ANALYSIS, PHOTOINTERPRETATION.
A study was made of the relationships between the soil cover and ground water using aerial photographs taken in different landscape areas in the Northern Caspian Lowland and Turkemenia. The work was done in key areas together with geobotanical, geomorphological and hydrological studies. It was found that a study of the soil cover (thickness of genetic horizons, color, moisture content, humus content, content of salts, etc., as well as the characteristics of the structure and mechanical composition of the soils) gives information on the character and depth of ground water. Soils beneath which fresh ground water is situated close to the surface appear on aerial photographs in dark tones.

**TL 91**
**ELECTRICAL AND TELLURIC MEASUREMENTS ON THE GREAT GLACIER OF ALETSCH.**
Lefèvre, C., et al, Hanover, N.H., CRREL, 1970, 19p., AD-877 349, Translation of Mesures électriques et telluriques sur le Grand Glacier d'Aletsch. Ann. Géophys. 1957, 12(1):54-68. 2 refs.
Alberinoli, P., Bauer, A., Blum, A., Cagniard, L., Fournier, H.
25-2337
GLACIER ICE, ICE ELECTRICAL PROPERTIES, ELECTRIC MEASURING INSTRUMENTS.
The electrical properties of ice are outlined; experiments conducted near Paris and on the Swiss glacier in June 1956 as well as the apparatus and method used are described in detail; and the possibility of exploring glaciers by electrical methods is evaluated. Data are tabulated and graphed on the voltage drop across the ice and original records are reproduced. In spite of the high resistance of ice, electric methods can be applied to the geophysical exploration of glaciers and permafrost using electrometers and taking the special precautions electrostatic measurements require.

**TL 92**
**DISTRIBUTION OF SNOW COVER DENSITY THROUGHOUT THE USSR.**
Lipovskaia, V.I., June 1968, FTD-HT-23-268-68, 10p., AD-681 269, For original Russian article see 23-1152. 6 refs.
25-2338
SNOW COVER DISTRIBUTION, SNOW DENSITY, USSR.
The principal factors governing the distribution of the snow cover densities throughout the USSR are reviewed. In general, the snow cover density was found to increase with the weight of the snow, the wind velocity and the temperature changes. Within the range of 0.27 to 0.36 g/cu cm, the density rises by 0.04 g/cu cm for every degree of positive temperature. It also depends on the length of time the snow cover exists. Thus, the density of snow cover triples from 0.05 to 0.15 g/cu cm while its thickness decreases by 8 to 10 times.

**TL 93**
**METHODS FOR COMPILING LARGE-SCALE SOILS MAPS USING AERIAL PHOTOGRAPHS.**
Liverovskiĭ, IU.A., 1969, FSTC-HT-23-734-68, 179p., Ad-694 579, Bibliog. p.177-179.
25-1192
SOIL SURVEYS, SOIL MAPPING, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION.

**TL 94**
**TEMPERATURE AND ACCUMULATION MEASUREMENTS ON THE GREENLAND ICECAP.**
Loewe, F., Hanover, N.H., CRREL, 1970, 5p., AD-877 409, Translation from Annales de Géophysique, April-June 1957, Vol.13:158-159. 7 refs.
25-2340
GLACIER OSCILLATION, ACCUMULATION, TEMPERATURE MEASUREMENT, GREENLAND.
Georgi's contention that a snow layer of higher temperature than that below or above, found in 1950 at Eismitte II at a depth of 19 m, is identical with that discovered at a depth of 8-9 m by Sorge in 1930 at Eismitte I, is examined theoretically. Georgi's conclusion is found untenable, since, according to calculations, the particular layer would be only 0.001 C warmer than the rest of the snow after 2 yr. The excess in temperature of 1.25 C observed in 1950 at a depth of 17-27 m over that of snow of the same age in 1930 is attributed to the difference in elevation and position of the 2 stations and to a warming of 0.9 C at the surface between 1930-1950.

**TL 95**
**AVALANCHES IN THE USSR (DISTRIBUTION, DIVISION, FORECASTING POSSIBILITIES).**
Losev, K.S., Hanover, N.H., CRREL, 1970, 166p., AD-715 090, Translation of Laviny SSSR (rasprostranenie, raĭonirovanie, vozmozhnosti prognoza). Leningrad, Gidrometizdat, 1966. 150 refs.
25-2341
AVALANCHES, AVALANCHE FORECASTING.
The distribution of avalanches over the USSR territory is discussed with the conclusion that they develop with various degrees of intensity in all the mountain regions of the country. New indications are described according to which the degree of avalanche danger during summer can be determined; such indications are the relief forms, vegetation types, particular kinds of soil, neve basins, and others, with emphasis on the hydrological symptoms of avalanche danger. The existing methods of snow slide forecasting are analyzed and several new ways of prognosis are offered. An attempt is made to subdivide mountain regions of the USSR on the basis of a genetic classification of avalanches, according to the degree of snow slide danger and the avalanche-forming factors.

**TL 96**
**ON THE MECHANISM OF NIVAL PROCESSES.**
Liubimov, B.P., Hanover, N.H., CRREL, 1970, 14p., AD-711 879, Translation from Podzemnyĭ led, Popov, A.I. ed., Moscow, Izd-vo Moskovskogo Universiteta, 1967. Pt.3, No.3:158-175. 9 refs.
25-2339
NIVATION, SNOW EROSION, GEOMORPHOLOGY, SLOPES.
The 'nivation' concept is understood as the geomorphological process of the formation of corrie-like recesses on the slopes in the places of occurrence of firns as a result of the disruption of rocks along the edges of the firns under the effect of physical erosion and the subsequent removal of the material with the aid of fine streams of meltwater. The first combines the processes of disruption in continuity or the rocks and the active preparation of the material for displacement. The first group includes the following processes: (1) microclimatic: the development of a low-temperature zone under the firn, with the retention of a layer of seasonally frozen ground and the upheaval of the cover of ever-frozen rocks. The second group of the processes combines the processes of transporting and depositing the material; as a result, we have the formation of nival deposits and nival relief forms.

**TL 97**
**ARTIFICIAL AIR COOLING FOR LAYING PILE FOUNDATIONS IN PERMAFROST.**
Maksimov, G.N., 1969, FSTC-HT-23-780-68, 20p., AD-693 069 Translation of Iskusstvennoe vozdushnoe okhlazhdenie pri ustroĭstve svaĭnykh fundamentov na vechnomerzlykh gruntakh. Moscow. Nauchno-issledovatel'skiĭ institut osnovaniĭ podzemnykh sooruzheniĭ. Sbornik trudov 1964, No.55:103-115. 14 refs.
25-2342
PILE FOUNDATIONS, PERMAFROST PRESERVATION, REFRIGERATING, CONSTRUCTION.
Two ways of laying pile foundations in permafrost soils are common: sinking piles in steam-thawed ground and sinking piles in boreholes. Both methods have their advantages and disadvantages, relating to specific soil conditions. The article examines one of the possible methods of improving these techniques - using artificial air cooling in the course of construction work.

**TL 98**
**INFLUENCE OF THE SOIL-FORMATION PROCESS ON THE COMPOSITION AND PROPERTIES OF THE DEPOSITS OF THE SEASONALLY FREEZING AND SEASONALLY THAWING LAYERS.**
Maksimova, L.N., Hanover, N.H., CRREL, 1970, 13p., AD-711 888, For original Russian article see 23-2342. 9 refs.
25-2343
ACTIVE LAYER, SOIL FORMATION, SEASONAL FREEZE THAW, SOIL CHEMISTRY.
Data are cited which indicate the complex and multiform influence of the soil-forming process on the composition, properties and structure of the seasonally freezing and thawing layers.

**TL 99**
**EXPERIMENTAL INVESTIGATION OF THE CARRYING CAPACITY OF AN ICE COVER.**
Panfilov, D.F., Jan. 1972, 20p., AD-737 811, Translation of Vsesoiuznyĭ nauchno-issledovastel'skiĭ institut gidrotechniki. Izvestiia Vol.64, 1960, p.101-115. 9 refs.
26-3364
ICE BEARING CAPACITY, RIVER ICE, LOADS (FORCES).

**TL 100**
**INTERPRETATION OF GROUND WATER OF TYPICAL LANDSCAPES IN TURKMENIA ON AERIAL PHOTOGRAPHS.**
Meier, G.IA., et al, June 1969, FSTC-HT-23-498-68, 35p., AD-691 566, For original Russian article see 23-1295.
Nefedov, K.E.
25-2349
GROUND WATER, AERIAL PHOTOGRAPHS, PHOTOINTERPRETATION, AERIAL SURVEYS.
The report gives a geographical description of the natural landscapes existing in Turkmenia and the individual landscape elements in that Soviet Republic: topography, climate, hydrography, soils and culture features. The article gives the results of aerial surveys made in the principal landscape types of Turkmenia; particular attention in this article is given to the relationship between ground water and relief, vegetation and soils, and a description of what features serve as indicators of ground water and how these indicators appear on aerial photographs.

**TL 101**
**EFFECT OF THE ICE-SEPARATION CURVE ON THE THAWING OF GROUND.**
Melamed, V.G., Hanover, N.H., CRREL, 1970, 6p., AD-711 887, For the original Russian article see 23-2335. 3 refs.
25-2345
GROUND THAWING, STEFAN PROBLEM, ANALYSIS (MATHEMATICS).
Phase transitions of bound water play an important role in the process of thawing in fine-grained media. Solution of the Stefan problem for this factor is complicated by the fact that the differential equations become nonlinear for the different zones. Moreover, the internal sources of heat, distributed continuously throughout the frozen ground layers, must be considered. The intensity of these sources depends on an unknown function.

**TL 102**
**COMPUTING THE FORMATION OF ICE INTERLAYERS IN FREEZING MOIST SOIL.**
Melamed, V.G., Hanover, N.H., CRREL, 1970, 11p., AD-711 874, Translation from Moscow. Universitet. Merzlotnye issledovaniia, No.6:28-37, 1966. 9 refs.
25-2346
FROZEN FINES, THERMODYNAMICS, GROUND ICE, PHASE TRANSFORMATIONS, SOIL MOISTURE, ANALYSIS (MATHEMATICS).
An equation is derived which represents an essentially new condition of ice formation in the soils penetrated by frost, establishing the nature of the feeezing, linking the dynamics of the temperature fields in both zones and the rate of the freezing front's advance with the dynamics of a moisture field.

**TL 103**
**MANUAL FOR USING AERIAL PHOTOGRAPHS IN SOIL MAPPING.**
Mershin, A.P., May 1970, FSTC-HT-23-732-68, 52p., AD-708 787, For original Russian article see 23-1157. 16 refs.
25-2554
SOIL MAPPING, AERIAL PHOTOGRAPHS.
Discusses the use of aerial photography in the mapping of soils. Much attention is given to the methods of interpreting soils by aerial photographs and to the study of interpreting soils by their distinctive characteristics in various zones and provinces. The authors also point out that the application of aeromethods in the practice of large-scale soil mapping in the Soviet Union and abroad indicates that the use of materials from aerial survey increases considerably the accuracy of soil mapping, reduces the volume of the field work, cuts down its cost and increases the practical value of soil maps.

**TL 104**
**DECODING AERIAL PHOTOGRAPHS OF GLACIAL LANDSCAPES—INDICATORS OF GROUND WATERS.**
Meier, G.IA., et al, Oct. 1969, FSTC-HT-23-398-68, 28p., AD-696 181, For original Russian article see 23-1297. 10 refs.
Markovskiĭ, V.K.
25-2348
GROUND WATER, AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, PHOTOINTERPRETATION.
Characteristics of landscape indicators of ground water are described for the following: four glacial types of landscape, including hilly-moraine, drumlin, morainic plain and terminal-moraine; three water-glacial types of landscape, including kame (and os), lake-glacial plain and outwash plain; the karst erosion type of landscape; and seashores. The decoding of these types of terrain on aerial photographs is discussed.

**TL 105**
**EFFECT OF LOW MINUS TEMPERATURES ON THE STRENGTH OF CONCRETE.**
Mironov, S.A., et al, Hanover, N.H., CRREL, 1970, 9p., AD-711 878, For original Russian article see 23-2561. 7 refs.
Arben'ev, A.S., Legashova, V.P.
25-2351
CONCRETE DURABILITY, CONCRETE FREEZING, LOW TEMPERATURE TESTS.
The report describes structural/physical response of concrete exposed to sub zero temperature and subsequent aging/thawing.

**TL 106**
**USE OF AERIAL METHODS FOR STUDYING ZONAL AND REGIONAL LANDSCAPE PATTERNS.**
Miroshnichenko, V.P., Sept. 1969, FSTC-HT-23-531-68, 52p., AD-695 724, For original Russian article see 23-1390. 14 refs.
25-2555
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS.
Presents a number of specific examples showing the effectiveness of the use of aerial photography in landscape studies. Followed by a review of the author's proposals for coverage of the country by a system of geographic reference profiles running east to the west and north to south across the entire Soviet Union, which could serve as a basis for making more detailed landscape studies.

**TL 107**
**AVALANCHE MECHANICS.**
Moskalev, IU.D., Hanover, N.H., CRREL, 1970, 183p., AD-715 049, Translation of Vozniknovenie i dvizhenie lavin. Leningrad, Gidrometeoizdat, 1966. 152p. 145 refs.
25-2352
AVALANCHE MECHANICS, SNOW STRENGTH, ANALYSIS (MATHEMATICS).
Methods for computing the mechanical stability of the snow on slopes and some problems of the motion of avalanches are presented. The principal purpose of this study is a generalization of the methods for evaluating the stability of the snow cover on the slopes of mountains and computing the motion of avalanches; problems of statics and dynamics of anti-avalanche structures are not considered.

**TL 108**
**EFFECT OF NEGATIVE TEMPERATURES ON THE STRENGTH AND ELASTOPLASTIC PROPERTIES OF CONCRETE.**
Moskvin, V.M., et al, Hanover, N.H., CRREL, 1970, 11p., AD-711 889, For original Russian article see 23-1645.
Kapkin, M.M., Antonov, L.N.
25-2353
CONCRETE STRENGTH, FROST RESISTANCE, COLD WEATHER TESTS.
The report describes investigations carried out to determine the strength and deformation of concrete exposed to the effect of negative temperatures.

**TL 109**
**AERIAL PHOTOGRAPHY AND MAPPING OF THE SIBERIAN FOREST.**
Motovilov, G.P., July 1969, FSTC-HT-23-46-68, 185p., AD-693 226, Translation of Aerofotos"emka i kartografirovanie lesov Sibiri. Moscow, 1966. 171p. 10 refs.
25-2354
AERIAL SURVEYS, AERIAL PHOTOGRAPHY, FORESTRY, MAPPING, USSR—SIBERIA.
A number of theoretical and methodical problems of aerial survey and cartography are discussed in this book and a new method of determining the seasonal conditions of aerial surveys by phenological maps is described.

**TL 110**
**MORPHOLOGY AND GENESIS OF GLACIERS /NALEDS/ IN CENTRAL TRANSBAYKALIYA.**
Mudrov, IU.V., Aug. 9, 1969, FSTC-HT-23-489-68, 16p., AD-692 373, For original Russian text see 23-0559. 5 refs.
25-1182
ICE FORMATION, RIVER ICE, GROUND ICE, GROUND WATER, ICE FORECASTING.

**TL 111**
**AERIAL PHOTOGRAPHY AS A METHOD FOR THE COMPLEX STUDY OF THE LANDSCAPE OF SEMI-DESERTS AND DRY STEPPES.**
Nikolaev, V.A., et al, Sept. 1969, FSTC-HT-23-507-68, 26p., AD-695 723, For original Russian article see 23-1395. 42 refs.
Riabtseva, Z.G.
25-2556
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, STEPPES, DESERTS.
Identification of different components of the natural medium (soils, topography, ground waters, etc.) by means of aerial photographs is possible only if there is knowledge of the intra-landscape relationships of the components. The data used successfully in the Caspian area were not suitable in the Turgay area because the former has accumulative plains while the latter has denudation plains. The whole problem of the study of the structure of landscapes is related with advances in typology and cartography of landscapes.

**TL 112**
**CONTROLLING ROAD ICING IN KRASNOYARSK REGION.**
Obraztsov, N.P., June 27, 1969, FSTC-HT-23-560-68, 9p., AD-691 546, For original Russian article and abstract see SIP 25821.
25-1177
RAILROADS, ROADS, ICE FORMATION, ICE CONTROL, PERMAFROST DEPTH, PERMAFROST PRESERVATION, GROUND WATER.

**TL 113**
**CLIMATE IN WLOCLAWEK AND PLOCK.**
Paszynski, J., et al, Hanover, N.H., CRREL, 1964, 26p., AD-874 926, Translation from Wiadomosci sluzby hydrologicznej i meteorologicznej, Vol.7, No.5, 1960. 9 refs.
Zych, S., Boniecka-Zolcik, H.
25-2355
RESERVOIRS, MICROCLIMATOLOGY, POLAND—WLOCLAWEK.
The microclimatic and local climatic changes caused by the projected construction of a system of cascades on the Vistula

River are studied. One of the cascades about 11 m high, is to be located in Wloclawek and its back-up is to reach above Plock.

TL 114
METHODS OF ENGINEERING FORECASTING OF DEPTH TO WHICH THE GROUND FREEZES AND THAWS.
Pavlov, A.V., Hanover, N.H., CRREL, 1970, 20p., AD-715 027, Translation from Sezonnoe protaivanie i promerzanie gruntov na territorii Severo-Vostoka SSSR. Moscow, Izd-vo Nauka, 1966. p.58-76. 8 refs.
25-2356
FROST PENETRATION, THAWING, MEASUREMENT.
An attempt is made to increase the accuracy of certain approximate methods developed for the calculation of freezing- and thawing-depths of ground. Such methods are based on the solution of a system of thermal conductivity equations for the frozen and thawed zones without accounting for mass-exchange in the ground. It is believed, that more accurate results may be obtained in two ways: by calculating more precisely the boundary conditions determining heat exchange in the ground, and by developing convenient ways of accounting for water convection and migration in the ground during its freezing and thawing. Only the first way is analyzed in this article for the case of a horizontal terrain, and new equations for depth determination are obtained on the basis of this analysis. The use of these formulas is illustrated by practical examples.

TL 115
SHEAR STRENGTH OF FROZEN GROUNDS AND ITS DEPENDENCE ON TEXTURE.
Pekarskaia, N.K., Hanover, N.H., CRREL, 1965, 98p., AD-715 091, Translation of Prochnost' merzlykh gruntov pri sdvige i ee zavisimost' ot tekstury. Moscow, Izd-vo AN SSSR, 1963. 107p. 80 refs.
25-2357
FROZEN GROUND MECHANICS, SHEAR STRENGTH, MEASUREMENT.
Frozen ground is a complicated anisotropic body whose strength depends on the arrangement of its components and the direction of the shearing force. The role of the coefficients of friction and cohesion in the shear-strength of frozen ground and dependence on composition, structure, texture, temperature, and duration of the displacing action are explained. The method and the instruments used for shear-strength measurements are described. The influence of the variation of the temperature below the freezing point on the strength properties of the ground depends not only on the change of phase of the water contained in the frozen ground but also on the strength of the ice crystal lattice. The influence of texture on ground strength under rapid increase of force or prolonged action is studied. The plastic flow of frozen ground is determined by texture and ice content. Laboratory tests are described, and rheological curves of the behavior of frozen grounds and ice are presented and compared.

TL 116
CHARACTERISTICS OF ROAD BED DESIGN IN AREAS OF GLACIERS.
Peretrukhin, N.A., Oct. 1969, FSTC-HT-23-619-68, 16p., AD-696 182, Translation from Transport, No.7:29-40, 1966. 3 refs.
25-2358
RAILROAD TRACKS, ROADBEDS, ICE PREVENTION, CONSTRUCTION, DESIGN.
Features in the design of railroad and highway earth-filled road beds in areas characterized by the development of ice fields and glaciers are examined from the standpoint of the natural hydrogeological conditions of the area and the effect of road building on these conditions. The construction of highways, railroads, and associated facilities has been responsible for the development of artificial glaciers, which pose hazards to highway and rail traffic due to the damage of the road beds by the effect of the ice. Measures for controlling the ice and for eliminating the glaciers when possible are proposed. The author strongly urges that the present methods of highway and railway design and construction be reexamined and that certain new techniques be adopted.

TL 117
ICE SCIENCE AND ICE TECHNOLOGY.
Peschanskii, I.S., Hanover, N.H., CRREL, 1968, 66p., AD-715 026, Translation from Ledovedenie i ledotekhnika. 2d ed. Leningrad, Gidrometeoizdat, 1967. p.134-149, 160-171, 194-201, 328-335, 351-355, 367-379.
25-2359
ICE FORMATION, ICE (CONSTRUCTION MATERIAL), ICE BREAKING, ICE PHYSICS.
The properties of the ice cover are dependent both on the properties of the ice and on the characteristics of the ice cover itself. Among the characteristics determining the ice over, other than the form of ice of which it consists, are its horizontal extent, thickness, temperature, strength, type of surface and intactness. These characteristics of the ice cover are determined by its origin. Existing classifications of sea ice inadequately emphasize the role of the principal factors determining the origin of the ice cover and make difficult their quantitative evaluation. In contrast to the existing classification, the author has proposed a classification of the ice cover on the basis of its origin.

TL 118
UTILIZATION OF AERIAL PHOTOGRAPHY FOR THE GEOGRAPHIC STUDY OF THE DESERTS OF CENTRAL ASIA.
Petrov, M.P., Sept. 1969, FSTC-HT-23-500-68, 15p., AD-693 147, For original Russian article see 23-1396. 17 refs.
25-2360
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, PHOTOINTERPRETATION, DESERTS.
Aerial photographic work in the deserts of East Central Asia, in comparison with the deserts in West Central Asia, does not differ basically. The methods of Soviet scientists using aerial photography in geographic studies on deserts of the Soviet Union could be used also in East Central Asia and elsewhere.

TL 119
ON THE PROBLEM OF THE TRANSMISSION OF HEAT IN A CONDUCTIVE, ISOTROPIC, AND HOMOGENEOUS MEDIUM THAT HAS NO BOUNDARIES.
Picone, M., Hanover, N.H., CRREL, 1970, 14p., AD-874 915, Translation from Italian; Mathematische Annalen, Vol.101, 1929. 3 refs.
25-2362
HEAT TRANSFER, CONDUCTION, ANALYSIS (MATHEMATICS).

TL 120
SWAMPY FORESTS AND BOGS OF SIBERIA.
P'iavchenko, N.I., Dec. 1969, FSTC-HT-23-310-70, 219p., AD-700 300, For original Russian text see 23-1506.
25-2361
SWAMPS, TUNDRA SOILS, PEAT, ARCTIC VEGETATION, USSR—SIBERIA.
The lands of the forest reserves of Siberia and the Far East include over 110 million hectares of swamps and very swampy forest covered lands, the dendritic vegetation of which is not considered timber. This amounts to about 79 percent of the entire areas of swamp and swampy lands of the Soviet Union, accounted for by forestry statistics. The present thematic collection includes data almost entirely pertaining to the territory of Siberia. In it examination is made of the specific features of swamp formation, types of swamp and swampy forests in various geographical regions. The results of studies of the structure and growth of the root systems of dendritic plants in swamps of various types are presented; the characteristics of the composition and seasonal dynamics of the soil fauna and microflora are given and the interaction between earth worms and the microflora of swampy forest soils are described.

TL 121
GRANULOMETRIC AND MICROAGGREGATE COMPOSITION OF GROUND IN THE SEASONAL THAW LAYER AND ITS FLUID PROPERTIES.
Poltev, N.F., Hanover, N.H., CRREL, 1970, 18p., AD-711 917, Translation from Merzlotnye issledovaniia, Vol.3:289-306, 1963. 25 refs.
25-2364
ACTIVE LAYER, SOIL EROSION, SOIL CHEMISTRY, HYGROSCOPICITY, SOIL PROPERTIES, FROZEN GROUND.
In the area of occurrence of perennially frozen rocks, in the summer thawing layer physical erosion processes leading to the formation of primary silty particles are taking place, as well as extensive physico-chemical, chemical and microbiological processes, as evidenced by: The presence of a large quantity of secondary silty particles; a sufficiently large absorbing complex of the soils in the North; the presence in their mineralogical composition, of secondary minerals; intensive processes of gleying. The gleying processes are accompanied by the formation of a considerable amount of hydrophilic organic and mineral colloids, which under conditions of oversaturation promote the development of the thixotropic structure of the soils. The thixotropic soils during a mechanical effect (mixing, shaking) convert to a quicksand state; it is necessary to take this into account in an engineering-geological evaluation of these soils.

TL 122
PERIGLACIAL FORMATIONS UNDER CONDITIONS OF PREDOMINANT DENUDATION.
Hanover, N.H., CREEL, 1970, 12p., AD-711 924, Translation of Periglacial of Territory of the USSR, edited by K.K. Markov and A.I. Popov, U. of Moscow, 1960, Chapter 3, p.10-36.
25-2429
GEOMORPHOLOGY, FROST ACTION, EROSION, ALTIPLANATION, PERIGLACIAL PROCESSES.
According to our observations, frost-induced fracturing also occurs in the mountains and predetermines the existence and development of quite distinctive forms of relief. The problem of the origin of so-called mountain terraces, forms of relief peculiar to mountainous regions with severe climate, in the polar zone or in the bald-mountain zone of highlands, has been discussed in the literature for a long time. These are typical group forms of mountain slopes, forming lobe-type little terraces of several tens and hundreds of meters in diameter, situated approximately at even distances one above the other and having the same structure in cross-section. Their dimensions and form are more or less stable for each mountain slope. The structure of these terraces indicates that the process of their development is connected with the weathering of bedrocks — crystalline or metamorphic — of which the mountain slopes are composed. The friable cover, formed in this process, is deposited in a regular pattern; this fact, besides the other features of the structure of mountain terraces, helps to explain their origin.

TL 123
STRENGTH OF SHIPS SAILING IN ICE.
Popov, IU.N., et al, Feb.5, 1969, FSTC-HT-23-96-68, 228p., AD-684 596, For original Russian text and abstract see SIP 25859. 58 refs.
Faddeev, O.V., Khelsin, D.E., IAkovlev, A.A.
25-1173
ICEBREAKERS, ICE NAVIGATION, SEA ICE, ICE COVER STRENGTH, DESIGN CRITERIA, SHIPBUILDING.

TL 124
FOUNDATION ANCHORING IN THAWED GROUND.
Porkhaev, G.V., Hanover, N.H., CRREL, 1967, 8p., AD-715 029, Translation of Zaankerivanie fundamentov v talom grunte. Akademiia nauk SSSR. Inst. merzlotovedeniia. Trudy 1958. Vol.14:56-59. 3 refs.
25-2365
FOUNDATIONS, THAWING, FROST HEAVE, ANCHORS.
A method of computing the anchoring forces necessary to counteract heaving of foundations laid below the freezing layer in areas of deep frost penetration is described. The anchoring forces are calculated under the assumptions that the pressure at the contact surface between frozen and unfrozen ground is equal to that of the entire layer of seasonal freezing, that the unfrozen layer is underlain by an infinite mass of frozen ground, and that frozen ground is incompressible, using the Gorbunov-Posadov equation for normal stresses at the boundary between a compressible and an incompressible layer below the center of a foundation. A sample calculation for a reinforced concrete foundation with a square anchor is presented.

TL 125
TEMPERATURE CONDITIONS OF A SMALL WATER FLOW IN A SEGMENT OF A CULVERT.
Potatueva, T.V., June 1969, FSTC-HT-23-686-68, 10p., AD-691 321, For original Russian article see 23-0618. 5 refs.
25-2366
DRAINAGE, ICE PREVENTION, FLUID FLOW, CULVERTS.
The article pertains to the design and construction of culverts and other water passages along railroad lines and highways for water streams likely to freeze up under winter conditions. Several design recommendations are made for the purpose of keeping the water flowing freely. Culverts and other water passageways should be designed with consideration of the various heat losses which occur in the channel. Flow rates and velocities of streams are other important factors to be considered in the design of culverts, bridges, and other water passages.

TL 126
USE OF FOAM PLASTICS FOR PREVENTING SEASONAL GROUND FREEZING.
Prilmak, A.I., Hanover, N.H., CRREL, 1970, 8p., AD-711 905, For original Russian article see 23-0241. 1 ref.
25-2367
FROST PROTECTION, SEASONAL FREEZE THAW, THERMAL INSULATION, CELLULAR MATERIALS, FROZEN ROCKS.
The report describes experimental efforts to install foam plastics in excavations to act as thermal protection against freezing.

TL 127 Record deleted.

TL128
NATURE OF IMPACT OF AVALANCHE SNOW ON AN OBSTACLE.
Puzanov, V.P., Hanover, N.H., CRREL, 1966, 4p., AD-715 045, Translation of O kharaktere udara lavinnogo snega v prepiatstvie. Akademiia nauk SSSR. Izvestiia. Ser. geogr. i geofiz. 1943, No. 2:86-88. 1 ref.
25-2368
AVALANCHE PRESSURE, IMPACT STRENGTH.
Two dynamometers with automatic recording devices were subjected to impacts of a fresh, dry snow avalanche and an old well-packed avalanche. The fresh snow avalanche reached a maximum impact of 11.8 tons/sq.m. in 5.5 sec. and maintained that level for abbut 8 sec. The total mass of snow was about 25,000 cu.m. The old, well-packed avalanche had a total mass of about 3500 cu.m. A maximum impact of 5.5 tons/sq.m. was reached in 0.5 sec. at which it remained for less than 4 sec.

**TL 129**
**ROAD AND FOUNDATION IV.** Hanover, N.H., CRREL, 1970, 185p., AD-874 910, Translation of Strasse und Untergrund IV. Forschungsarbeiten aus dem Strassenwesen, n.s. No.74, 1969. 76 refs.
Rengmark, F., Weils, G., Behr, H., Eisenmann, J., Schneider, W., Gandahl, R., Skogseid, A., Mantel, L., Taivainen, O.A., Meffert, R.
25-2369
ROADS, FROST PROTECTION, THERMAL INSULATION, CELLULAR MATERIALS, DESIGN.
Includes the following articles: 1) Designing roads to protect against ground frost in Sweden, by F. Rengmark. 2) Tests on the use of thermal-insulating layers in road construction, by G. Weils. 3) Electric analog tests for studying thermal insulating layers in roads, by H. Behr. 4) Temperature studies on concrete pavements with and without thermal insulating layers, by J. Eisenmann. 5) Experience gained from experimental sections laid with insulating courses of foamed plastics, by W. Schneider. 6) Testing frost inhibiting layers in Edsvalla, Sweden, by R. Gandahl. 7) Heat and moisture conditions in connection with insulating layers used as frost protection in road construction, by A. Skogseid. 8) Thermal insulation of roadways against frost heaves, by L. Mantel. 9) Experiences with frost protection using various thermal insulating materials in Finland, 1965-1968, by O.A. Taivainen. 10) Frost protection through use of thermal insulating courses, by R. Meffer and P. Bayer.

**TL 130**
**GOLETS TERRACES.**
Richter, H., et al, 1969, FSTC-HT-23-214-69, 33p., AD-859 043L, Translation from Petermanns geographische Mitteilungen, 107(3): 183-192, 1963. 23 refs.
Haase, G., Barthel, H.
25-2370
ALTIPLANATION, PATTERNED GROUND, FROST SHATTERING, CLIMATIC FACTORS.
This article is a study of the geological formation known as golets terrace or altiplanation terrace (a flat terrace found on a slope). The authors' findings on an expedition to the Hangayn Nuruu Mountains and the northern part of the Gobi Desert are reported.

**TL 131**
**TYPES OF ANTI-ICE LAYER STRUCTURES ON/WELL SPRING/ICE LAYERS.**
Rumiantsev, E.A., Oct. 13,1969, FSTC-HT-23-414-68, 8p., AD-695 988, For original Russian article and abstract see SIP 25823. 9 refs.
25-1176
ICE FORMATION, ICE PREVENTION, SPRINGS (WATER), EARTH DAMS.

**TL 132**
**DYNAMICS OF ICE FORMATION.**
Rumiantsev, E.A., Aug. 9, 1969, FSTC-HT-23-683-68, 21p., AD-692 653, For original Russian text see 23-0617. 21 refs.
25-1185
ICE FORMATION, RAILROAD TRACKS, METEOROLOGICAL FACTORS, GROUND ICE, SEASONAL FREEZE THAW.

**TL 133**
**HORIZONTAL TRANSPORT OF SNOW IN ANTARCTICA.**
Rusin, N.P., Hanover, N.H., CRREL, 1970, 11p., AD-711 914, Translation of Gorizontal'nyi perenos snega v Antarktide. Leningrad. Glavnaia geofizicheskaia observatoriia. Trudy 1959, No.96:31-37. 2 refs.
25-2371
SNOWDRIFTS, SNOWSTORMS, WIND FACTORS, ANTARCTICA.

**TL 135**
**FUNDAMENTALS OF GEOCRYOLOGY (PERMAFROSTOLOGY). PART II, ENGINEERING GEOCRYOLOGY.**
Saltykov, N.I., ed., 1966 TT-1232, 1967 TT-1276, 1967 TT-1287, 3 pieces, Translation of chapter 11, 12, and 13 from Osnovy geokriologii (merzlotovedeniia). Moscow, Izd-vo AN SSSR, 1959. Part 2, p.285-357. For abstract and original article see SIP 17844-17846.
25-2372
COLD WEATHER CONSTRUCTION, CRYOGENIC PROCESSES, ENGINEERING GEOLOGY, FROZEN GROUND PHYSICS.

**TL 136**
**THERMAL EXCHANGE BETWEEN WATER CURRENTS AND ATMOSPHERE IN WINTER TIME.**
Samochkin, V.M., Hanover, N.H., CRREL, 1970, 5p., AD-715 048, For original Russian article see 23-0619. 9 refs.
25-2373
WATER TEMPERATURE, AIR TEMPERATURE, AIR WATER INTERACTIONS, HEAT TRANSFER, FREEZEUP.
The thermal exchange processes on the boundary between water and air play an important part in the formation of ice layers. If the incoming or consumed heat resulting from radiation processes were determined by a uniform method, even if not very accurately, or it those components of the heat exchange could be measured, there are a number of formulas that could be used for calculating the loss of heat by evaporation and convection. Formulas developed by several authors to calculate heat losses are discussed.

**TL 137**
**USE OF AERIAL PHOTOGRAPHY IN STUDYING FOREST TYPES.**
Samoilovich, G.G., 1969, FSTC-HT-23-285-68, 21p., AD-692 360, For original Russian text see 23-1393. 7 refs.
25-1184
AERIAL PHOTOGRAPHY, FORESTRY, MAPPING.

**TL 138**
**PROCESSES DURING THE FREEZING OF WATER.**
Schipper, W., Hanover, N.H., CRREL, 1970, 9p., AD-874 933, Translation from Kältetechnik 1952, Vol.4:62-65. 4 refs.
25-2374
ARTIFICIAL FREEZING, ICE MAKERS, ICE FORMATION.
The cause for opaqueness in ice blocks made by the can ice process were investigated. Freezing experiments with distilled and deaerated water produced a clear block of ice that contained a narrow, tubular, opaque core which widened considerably at the base and top of the block. A chemical analysis indicates a strong concentration of dissolved salts at the base and top of the block. The direction of formation of the ice during freezing is shown to be from the can wall to the core. A movement of the water along the vertical axis of the block is decisive for the distribution of the different solutions in the water. Ice blocks produced by agitation of drinking water contained heavy cores more equally distributed through the blocks. It is concluded that the prerequisite for the production of a clear, transparent ice block is the separation of the salts from the water.

**TL 139**
**ROAD CONSTRUCTION.**
Schnitter, G., Hanover, N.H., CRREL, 1960, 25p., AD-877 319, Translation of Aufbau der Strasse. Versuchsanstalt für Wasserbau und Erdbau an der Eidgenössischen technischen Hochschule, Vol.45, 1959.
25-2375
ROADS, CLIMATIC FACTORS, ROADBEDS, DESIGN.
Subgrade characteristics, climatic conditions and load factors which must be considered in highway design and construction are described and the interrelationship of these features in the development of the most economical adequate design is discussed. The use of the soil classification system as a design tool is discussed and illustrated and design examples are presented.

**TL 140**
**EXPERIENCE IN PLANNING HYDRAULIC STRUCTURES WITH PROLONGED SOIL FREEZING.**
Sereda, V.A., Hanover, N.H., CRREL, 1966, 9p., AD-715 058, For original Russian article see 24-0765.
25-2377
EARTH DAMS, ARTIFICIAL FREEZING, PERMAFROST HEAT TRANSFER, PERMAFROST PRESERVATION.
The advantages of refrigeration systems for freezing earth dams and keeping them frozen and waterproofed are discussed, and the refrigeration methods used by Giproarktika are described and compared with methods used elsewhere. The refrigeration system uses brine as a coolant, which is considered superior to cold-air system. A cold air system has the disadvantages of poorer heat exchange between metal and air, the possibility that rust or ice plugs will form in the pipes, and limited use, since it is only effective when air temperatures are low. The cost of installation and maintenance of permanently refrigerated dams is only 10 percent higher than that of dams frozen during construction only. Various designs of dams and harbor facilities with permanent refrigeration systems are described and diagrammed.

**TL 141**
**SNOW REMOVAL EQUIPMENT.**
Shalman, D.A., 1968, FSTC-HT-23-52-68, 21p., AD-843 120, Translation of Snegoochistiteli. Leningrad, Mashinostroenie, 1967. p.3-20.
25-2379
SNOW REMOVAL EQUIPMENT, SNOW PHYSICS, SNOW MECHANICS.
The physical-mechanical properties of snow are treated. As for deformation, snow shows properties of elastic solids, plastic material and viscous liquids as well, depending on the temperature and applied load. A mathematical expression for deformation of material of this kind is given by Maxwell. Shear and tensile strength, as well as cohesion, increase with density of snow. For the purpose of designing snow removal equipment, a special coefficient of resistance to cutting is used, instead of the conventional coefficients of tensile, shear and cohesive strength. Hardness of snow is given consideration, since it influences the design of snow removal equipment to a great extent. The coefficients of friction, resistance to rollover and sliding are also discussed, which play an important role in the design and choice of snow removal equipment.

**TL 142**
**NOMOGRAMS FOR CALCULATING TURBULENT HEAT EXCHANGE AND HEAT LOSS BY EVAPORATION.**
Shamont'ev, V.A., Hanover, N.H., CRREL, 1970, 9p., AD-711 916, Translation of Nomogrammy dlia vychisleniia turbulentnogo teploobmena i zatrat tepla na isparenie. Problemy Arktiki i Antarktiki, 1967, No.26:39-44. 7 refs.
25-2380
NOMOGRAPHS, AIR WATER INTERACTIONS, SEA WATER, THERMODYNAMICS, EVAPORATION, TURBULENT EXCHANGE.
Calculation of turbulent heat exchange and heat loss by evaporation with empirical formulas is a rather long and work-consuming operation, requiring cumbersome computations, consisting of series of successive calculations. To facilitate such calculations it is expedient to use uncomplicated nomograms, which enable us to obtain directly from them the values of heat currents resulting from turbulent heat exchange and evaporation. Such nomograms were used in calculating the heat balance components of one of the Arctic seas for the navigation period. Plotting of such nomograms, connected with the graphic solution of an equation with three unknowns, is based on the method of application of the system of Cartesian coordinates.

**TL 143**
**ROLE OF PERIGLACIAL PROCESSES IN FORMING THE RELIEF OF THE NORTHERN SLOPES OF CAUCASUS MAJOR IN THE EXAMPLE OF THE ELBRUS REGION.**
Shcherbakova, E.M., Hanover, N.H., CRREL, 1970, 16p., AD-711 877, For original Russian article see 23-5935. 2 refs.
25-2381
PERIGLACIAL PROCESSES, SLOPE PROCESSES, USSR—CAUCASUS.
The El'brus region is the center of significant contemporary and important ancient mountainous glaciation. It places at our disposal rich material for studying the geological and geomorphological activity of snow and ice under mountainous conditions. It is convincing from the example of the El'brus region that the manifestation of the processes of the nival-glacial complex changes appreciably from place to place both quantitatively and qualitatively in dependence upon the change of the following indices: the intensity of neotectonic movements, the nature of the geological structure, and the peculiarity of the climatic conditions.

**TL 144**
**FORCE OF IMPACT OF SNOW AVALANCHES.**
Shinoda, N., Hanover, N.H., CRREL, 1966, 6p., AD-715 057, Translation of Nadare no shogekuryoku. Seppyo kenkya, Nov. 1957, No.1:215-217.
25-2382
AVALANCHE PRESSURE, IMPACT STRENGTH, AVALANCHE MODELING.
The impact force of artificial avalanches was studied and the results are tabulated. The impact ranged from 1430-3310 kg/sq. m.

**TL 145** Record deleted.

**TL 146**
**STUDY OF PROLONGED BEARING STRENGTH OF FROZEN SOILS UNDER UNIAXIAL COMPRESSION.**
Shusherina, E.P., et al, Hanover, N.H., CRREL, 1965, 33p., AD-715 056, Translation of Izuchenie dlitel'noi prochnosti zamorozhennykh gruntov pri odnoosnom szhatii. Merzlotnye issledovaniia, 1963, No. 3:314-347. 11 refs.
Vialov, S.S.
25-2384
FROZEN GROUND COMPRESSION, COMPRESSIVE STRENGTH, CREEP PROPERTIES, TESTS.
Presents results of a study of creep and prolonged strength of frozen ground under uniaxial compression. The principal problems considered were the character of the creep in the case of constant stress, determination of the relationship between time and stress before destruction, and between deformation and stress taking into account the time factor.

**TL 147**
**COEFFICIENT OF LATERAL DEFORMATION AND VOLUME DEFORMATION OF FROZEN SOIL IN THE CREEP PROCESS.**
Shusherina, E.P., April 1970, FSTC-HT-23-751-70, 17p., AD-714 918, Translation of O koeffitsiente poperechnoĭ deformatsii i ob ob"emnykh deformatsiiakh merzlykh gruntov v protsesse polzuchesti. Merzlotnye issledovaniia, No.4:229-240, 1966. 9 refs.
25-2557
FROZEN GROUND MECHANICS, SOIL CREEP, DEFORMATION.
The article is a review of experimental data characterizing the lateral deformation coefficient for frozen soils in the creep process; these data are analyzed in relation to volume deformations. The article was written using data obtained by the author in the

Permafrost Department of Moscow State University during 1958-59.

**TL 148**
**UTILIZATION OF THE RESULTS OF GEOBOTANICAL INTERPRETATIONS OF AERIAL PHOTOGRAPHS IN LANDSCAPE INVESTIGATIONS OF THE NORTHERN CASPIAN SEA REGION.**
Shvyriaeva, A.M., June 30, 1969, FSTC-HT-23-415-68, 36p., AD-691 973, For original Russian text see 23-1403. 14 refs.
25-1183
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, VEGETATION PATTERNS, TERRAIN IDENTIFICATION, SOIL PATTERNS.

**TL 149**
**EFFECT OF HEIGHT OF THE SNOW COVER ON THE NATURAL REGULATION OF RIVER RUNOFF IN EASTERN GEORGIA.**
Sidorova, L.V., 1968, FSTC-HT-23-158-68, 12p., AD-843 096, For Russian original see SIP 25840. 5 refs.
25-2385
RUNOFF, MELTWATER, USSR—GEORGIA.
The effect of the depth or thickness (height) of the snow cover in the mountains of Eastern Georgia on the regulation or training of river runoff, or coefficient of natural runoff regulation phi, is studied. The relationship between phi and the average altitude of the watershed has been determined for the purpose of investigating the above-stated. It has been found that an increase in the thickness of the snow cover through the basin as a whole over a period of several years results in increased regulation of river runoff, but causes a reduction in runoff regulation during individual years at a given altitude.

**TL 150**
**FROST PROTECTION VIA INSULATING MATERIALS.**
Skogseid, A., Hanover, N.H., CRREL, 1970, 17p., AD-874 913, For original Norwegian article see 24-1942. 8 refs.
25-2386
ROADBEDS, INSULATION, FROST HEAVE, FROST PROTECTION.
Some proposals for frost-safe highway constructions with insulation, and a comparison of laying costs for a couple of these and for conventionally constructued highways with 100 cm. and 120 cm. thick pavements are presented. With transport distances above 10 km. for the reinforcing material the insulated highways are the cheaper. A highway pavement consisting of an insulating layer and a concrete surface alone has not yet been tested in the field. The technical and economic prospects for the proposal are, however, interesting.

**TL 151**
**LANDSCAPE INVESTIGATIONS OF RESERVOIRS USING AERIAL METHODS.**
Sokolov, N.N., Aug. 1969, FSTC-HT-23-744-68, 13p., AD-692 375, For original Russian article see 23-1404.
25-2388
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, RESERVOIRS, AERIAL SURVEYS.
Reservoirs are man-made features which are in a state of constant change, both seasonally and over a relatively short number of years. Being important economic units, of great concern to a number of branches in the national economy, they must be kept under constant surveillance in order to determine any significant changes. The most effective means for conducting such observations is the use of aerial photographs. The article is devoted to the importance of aerial photographs for this purpose giving some examples of the type of information which can be read from aerial photographs, and some proposals for the more effective use of aerial photographs in studying the dynamic picture of changes in reservoirs.

**TL 152**
**MEASUREMENT OF THE WATER CONTENT OF SNOW WITH RADIOACTIVE ISOTOPES.**
Sternzat, M.S., et al, Hanover, N.H., CRREL, 1965, 4p., AD-715 059, Translation of Izmerenie zapasov vody v snezhnom prokrove s pomoshch'iu radioaktivnykh izotopov. In: Meteorologicheskie pribory, nabliudeniia i ikh obrabotka. Leningrad, Gidrometeoizdat, 1959, p.114-117.
Sapozhnikov, A.A.
25-2391
RADIOACTIVE SNOW GAGES, SNOW WATER CONTENT, MEASUREMENT.
The principles of the method are discussed, and the portable radioactive snow gage Type M-31 is described. The gage is designed for surveys in areas of deep snow, where measurement with other instruments is cumbersome. The gage consists essentially of a graduated snow stake with a lead container for the isotope at the lower end and a horizontal arm at the upper end to which a gamma-ray counter and a scaler are attached. The background radiation is measured first; then the counter is attached to the arm; and the stake is driven into the snow. The gage permits measurement with an accuracy of 3-5 percent at a snow depth of 3 m. Formulas for calculating water content and density from the counter readings are presented.

**TL 153**
**CHARACTERISTICS OF LARGE SCALE HYDRAULIC CONSTRUCTION IN THE ZONE OF PERMAFROST AND DEEP SEASONAL FREEZING IN THE EASTERN SECTOR OF USSR.**
Stotsenko, A.V., 1966, 9p., AD-715 205, For original Russian article see 24-0772.
25-2392
HYDROELECTRIC POWER GENERATION, COLD WEATHER CONSTRUCTION, CONTINUOUS PERMAFROST.
The report describes problems encountered, and their solutions, in construction of hydroelectric power systems in areas of extreme cold.

**TL 154**
**ICING ON THE ZAVATAI-BUREI SECTION.**
Tarbeev, A.P., Oct. 1969, FSTC-HT-23-355-68, 7p., AD-696 809, For original Russian article see 23-0607.
25-2558
RAILROAD TRACKS, ICING, ICE CONTROL, NALEDS.
The article describes icing and efforts for controlling this icing on the Zavitay-Burey section of the Transbaikal Railroad.

**TL 155**
**MAN-MADE STRUCTURES ON WATER-COURSES WITH ICING AND ICE BUILDUP.**
Targulian, IU.O., Hanover, N.H., CRREL, 1970, 82p., AD-715 089, Translation of Isskustvennye sooruzheniia na vodotakakh s nalediami. Moscow, Avtotransizdat, 1961. 80p. 57 refs.
25-2393
ROADS, BRIDGES, ICE PREVENTION, ICE CONTROL.
The results of studies of ground-water and river icing and their effect on bridges, viaducts and roads are summarized in 3 chapters dealing, respectively, with (1) a description of icings, their origin, and the damage they do man-made installations; (2) methods of coping with icings, and (3) the design principles of anti-icing devices and bridge construction. Methods of combatting icings on existing roads, e.g., the construction of frozen-ground strips, the use of water-impermeable sand-clay and rubberoid barriers, wooden shields, and earthen embankments, are discussed and evaluated.

**TL 156**
**STRENGTH OF THAWING GROUND.**
Titov, V.P., 1970, 10p., AD-716 458, For original Russian article see 23-0657.
25-2559
FROZEN GROUND MECHANICS, GROUND THAWING, SOIL STRENGTH.
Many roadbed deformations occur during the spring ground thaw. In that period the strength of the ground is reduced by the winter accumulation of moisture and the structural changes occurring in the process of freezing. The extent of the changing ground strength depends on its initial compactness and moisture, the relative loss of strength being highest near the limit of the flattening process. The investigations carried out have revealed that the strength of thawing ground varies with time. The ground is weakest during the thawing process, but its strength increases in the course of time.

**TL 157**
**ROLE OF SOILS IN THE INTERPRETATION OF ARID-ZONE LANDSCAPES FROM AERIAL PHOTOGRAPHS.**
Tolchel'nikov, IU.S., 1969, FSTC-HT-23-492-69, 7p., AD-692 656, For original Russian article see 23-1399. 18 refs.
25-2394
AERIAL PHOTOGRAPHY, TERRAIN IDENTIFICATION, PHOTOINTERPRETATION, SOIL SURVEYS.
The characteristics of soil cover are closely related with all components of the landscape, reflecting the specifics of the geologic and geomorphologic structure of the territory, hydrological conditions, migration of chemical compounds, composition of vegetative cover, etc. Examples of interpretation of aerial photographs are given.

**TL 158**
**DETERMINATION OF RELATIVE NORMAL FORCES OF GROUND FROST HEAVING.**
Tolkachev, N.A., 1971, 10p., AD-720 079, Translation from Moscow. Nauchno-issledovatel'skiĭ institut osnovaniĭ i podzemnykh sooruzheniĭ. Sbornik trudov, No.54:165-170, 1964. 2 refs.
26-28
FROST ACTION, FROST HEAVE, FROZEN GROUND MECHANICS, FOUNDATIONS.
The report discusses the tangential and normal forces on foundation structures as the result of freezing and thawing of soils.

**TL 159**
**RULES FOR THE CALCULATION OF BEARING CAPACITY AND FOUNDATION SETTLEMENT BASED ON PRESSURE-METER TESTS.**
Ménard, L., Jan. 1972, 14p., AD-738 128, Translation of Règles pour le calcul de la force portante et du tassement des foundations en fonction des résultats pressiométriques, Proceedings, 6th International Conference on Soil Mechanics and Foundation Engineering, Vol.2, p.295, Univ. of Toronto Press, 1965, by U.S. Joint Publications Research Service. 4 refs.
26-3557
FOUNDATIONS, SETTLEMENT (STRUCTURAL), SANDS, GRAVEL, BEARING CAPACITY.

**TL 160**
**AREAL VARIABILITY OF SNOW COVER CHARACTERISTICS.**
Trifonova, T.S., Hanover, N.H., CRREL, 1970, 14p., AD-711 868, Translation of O prostranstvennoĭ izmenchivosti kharakteristik snezhnogo pokrova. Leningrad. Glavnaia geofizicheskaia observatoriia. Trudy 1962, No.130:29-37. 3 refs.
25-2395
SNOW SURVEYS, MEASUREMENT, SNOW COVER DISTRIBUTION, SNOW DENSITY, THICKNESS.
The article gives information on the variability in the height and density of snow cover, as well as on the accuracy of determining them in various physiographic regions.

**TL 161**
**EXPERIENCE IN DAM CONSTRUCTION IN PERMAFROST REGIONS.**
Tsvetkova, S.G., Hanover, N.H., CRREL, 1966, 22p., AD-715 060, Translation of Opyt stroitel'stva plotin v raĭonakh rasprostraneniia mnogoletnemerzlykh gruntov. Materialy k osnovam ucheniia o merzlykh zonakh zemnoĭ kory, No.6:87-112, 1960. 32 refs.
25-2396
DAMS, COLD WEATHER CONSTRUCTION, PERMAFROST.
The construction of earth dams in permafrost regions is reviewed on the basis of the description of a number of dams built between the end of the 18th century and the 1950's. It is shown that many of these dams failed because of excessive seepage due to improper principles of construction and ignorance of past experience. Special attention is given to the use of materials either in their natural frozen state or frozen by means of circulating brine or low-temperature air ducts. The principle of using frozen materials is said to be justified in spite of defects that have appeared in some dams based on the principle. In this connection, a dam built on the Myaundzha River in 1952 is discussed in detail. Findings on seepage and the effects of dams on underlying permafrost are summarized.

**TL 162**
**INSTRUCTIONS FOR DETERMINING THE COHESIVE STRENGTH OF FROZEN SOIL.**
Tsytovich, N.A., Hanover, N.H., CRREL, 1970, 17p., AD-715 072, Translation of Instruktivnye ukazaniia po opredeleniiu sil stsepleniia merzlykh gruntov. Materialy po laboratornym issledovaniiam merzlykh gruntov, 1954, No.2:162-175. 8 refs.
25-2397
FROZEN GROUND COMPRESSION, COHESION, SOIL STRENGTH, MEASUREMENT.
Determination of the cohesive forces in frozen ground is discussed with emphasis on the method and theory of pressing steel spheres into the ground. This method was evaluated at the Institute of permafrostology and shown to be accurate and readily applicable for laboratory and field investigations. An apparatus for pressing the spheres into the frozen ground to a 10-mm. depth and measuring the penetration within 0.01 mm. is described in detail, and observational procedures are outlined. The cohesive strength under loading varies considerably with time and thus the value must be determined both for the initial loading and after reaching a stable value. Equations characterizing these variations with time are suggested.

**TL 163**
**CHARACTERISTICS OF THE PHYSICAL PROPERTIES OF STRUCTURALLY UNSTABLE GROUND: PHYSICAL PROPERTIES OF FROZEN GROUND.**
Tsytovich, N.A., Hanover, N.H., CRREL, 1966, 16p., AD-715 066, Translation from Mekhanika gruntov. 4th ed. Moscow, Gostroĭizdat, 1963. p.90-104. 22 refs.
25-2398
FROZEN GROUND PHYSICS, SOIL MOISTURE, UNFROZEN WATER CONTENT.
Frozen ground consists of substances existing in three phases: solid (ice), liquid (unfrozen water) and gaseous (water vapor). Ice is the most important element, being the main cementing force governing the properties which differentiate frozen from ordinary ground. Some water always remains liquid in frozen ground even at temperatures below freezing. According to studies made by the Institute of Permafrostology, different ground at temperatures varying from -0.3 to -30 C contained

from 0.5 percent (in sands) to 35 percent (in clays) unfrozen water. Below the freezing point the amount of ice increases as does the strength of the ground. Frozen clays therefore have far less strength than frozen sands. Moisture translocation is mainly governed by osmotic pressure occuring during the cooling process and causes the formation of ice lenses and bands. Ice contents in frozen grounds can be determined by proposed formulas and with sufficient accuracy by the calorimeter.

**TL 164**
**BIOCHEMICAL FEATURES OF UPPER AND LOWER GROWTHS OF THE CROWN OF NATURAL ROOT AND GRAFTED APPLE TREES.**
Solov'eva, L.V., Sept. 1969, FSTC-HT-23-737-68, p.10-17, AD-693 149, Translation of O biokhimecheskikh osobennostiakh verkhnego i nizhnego iarusov krony kornesobstvennykh i privitykh iablon'. Moscow. Universitet. Vestnik, ser. 6, 1967. No.6:91-95. 7 refs.
25-2402
TREES (PLANTS), GROWTH, PLANT TISSUES.
Research was conducted at the agricultural biological station of the Moscow State University on groups of fruit bearing apple trees, including natural root and grafted trees. Tabular data is presented to show that the content of some leaf substances is not identified depending on crown level. Vitamin C and chlorophyll content depended on plant development conditions.

**TL 165**
**EFFECTS OF MICRORELIEF FORMS ON SEASONAL THAWING.**
Tumel', N.V., Hanover, N.H., CRREL, 1970, 8p., AD-715 047, For original Russian article see 23-0545. 5 refs.
25-2399
SEASONAL FREEZE THAW, MICRORELIEF.
Observations made during summer on the nature of the seasonal thawing in the Bol'shezemel'skaya Tundra indicated that the thawing dynamics depend greatly on the microrelief forms. As is known, the large polygonal forms (blocks) of this region often are sectors of variegated tundra. The latter is typified by the presence of soil patches, surrounded by a border of hummocks. In the origination and development of these forms, a significant role is played by the freezing processes, particularly the seasonal freezing and thawing, recorded by many researchers. The dimensions and form of the patches and of the hummocks surrounding them, and also their extent of sodding are quite diversified, depending on the location in the relief, the drainage conditions, and the nature of the snow cover.

**TL 166**
**SWAMP VEGETATION — AN INDICATOR FOR NON-FROZEN AREAS IN THE NORTHERN TAIGA OF WESTERN SIBERIA.**
Tyrtikov, A.P., Aug. 1969, FSTC-HT-23-741-68, 10p., AD-692 523, For original Russian article see 23-1330. 8 refs.
25-2400
SWAMPS, VEGETATION, TALIKS, TAIGA VEGETATION, USSR—SIBERIA.
In the northern taiga of Western Siberia, swamp vegetation can be used to determine the location of frozen and non-frozen areas. The type of vegetation is determined by: 1) the presence or absence of water on the surface of swamps: 2) the presence or absence of a permanently-frozen layer of soil. Surface water in the swamps is a critical factor in thaw, freeze, and temperature of the soil. A number of factors cause variations in the depth and time of thawing and freezing, keeping the swamps in a state of change. The surface levels of the swamps change, causing variation in the amount of surface water, the depth of thaw and freeze, and finally, the vegetation.

**TL 167**
**DYNAMICS OF VEGETATION AND DEVELOPMENT OF PERENNIALLY FROZEN GROUND IN FLUVIAL FLOOD PLAINS IN THE NORTHERN TAIGA OF WESTERN SIBERIA.**
Tyrtikov, A.P., Sept. 1969, FSTC-HT-23-737-68, p.1-9, AD-693 149, For original Russian article see 23-1551. 5 refs.
25-2401
VEGETATION, PERMAFROST ORIGIN, TAIGA SOILS, USSR—SIBERIA.
Significant changes in the flood-plain conditions lead to changes in the vegetative communities. The changes in the vegetation depend on the flood plain conditions such as period of flooding, amount and quality of silt deposition, effect of ice drift, Within the limits of the northern taiga, during the development of vegetation in the fluvial and central sections of the flood plains of the rivers, the following three stages are observed: meadow, brush, and forest, each of which includes a number of changing communities.

**TL 168**
**DESIGN OF BUILDING FOUNDATIONS ON FROZEN GROUND ACCORDING TO DEFORMATIONAL LIMITS.**
Ushkalov, V.P., Hanover, N.H., CRREL, 1960, 4p., AD-715 053, Translation of O raschete osnovanii sooruzhenii na merzlykh gruntakh po predel'nym deformatsiiam. Stroitel'naia promyshlennost' 1958, 36(7):39-41.
25-2403
DEFORMATION, FOUNDATIONS, FROZEN GROUND SETTLING, FROST PENETRATION, PERMAFROST BENEATH BUILDINGS.
A new method, based on theoretical and field studies, for making design calculations for foundations on permanently frozen ground which is highly compressible on thawing is discussed. The method takes into account the interrelationship between the building and its base, and provides for the stability of buildings by selecting structural rigidity according to the compressibility of the ground, by computing the possible depth and rate of thawing as well as allowable settling and deformation and by utilizing the corresponding methods of regulating thawing and differential settling. Data are tabulated on the allowable limits for thaw rate and depth, settling rate and depth and deformation for various types of structures, as well as values for a coefficient expressing the decrease with depth of the pressure exerted by rectangular foundations of varying side-to-side ratios.

**TL 169**
**ULTIMATE DEFORMATIONS OF BUILDING FOUNDATIONS ON THAWING GROUND.**
Ushkalov, V.P., Hanover, N.H., CRREL, 1960, 15p., AD-715 079, Translation of O predel'nykh deformatsiiakh osnovanii sooruzhenii na ottaivaiushchikh gruntakh. Voprosy issledovaniia gruntov osnovanii sooruzhenii, 1956. No.29:80-88, 7 refs.
25-2404
FOUNDATIONS, GROUND THAWING, FROZEN GROUND SETTLING, DEFORMATION.
The results of systematic observations from 1941-1950 on the settling of 75 structures on thawing ground are examined in relation to design criteria; the various deformation characteristics are defined; and a formula for calculating the speed of settling is given. The soils on which the structures were built consisted of ice-saturated clays, sandy loam, sand of various grain sizes, and mixtures of sand and gravel of varying degrees of compressibility. Design data are tabulated.

**TL 170**
**EXPERIMENTAL DETERMINATION OF FROST HEAVE FORCES IN THE GROUND.**
Vialov, S.S., et al, Hanover, N.H., CRREL, 1970, 23p., AD-711 904, Translation of Eksperimental'noe opredelenie sil pucheniia gruntov. Akademiia nauk SSSR. Institut merzlotovedeniia. Trudy 1958, No.14:40-55. 6 refs.
Egorov, N.I.
25-2410
FROST HEAVE, FOUNDATIONS, TESTS, PERMAFROST.
Any rational system for constructing building foundations in regions where permafrost and deep seasonal freezing are prevalent is impossible without due regard for the heaving forces which are built up during freezing of the ground. However, the data on the actual magnitude of these forces are incomplete. One factor which hinders experiments for determining heaving forces under field conditions appears to be undeveloped methods and the lack of enough simple procedural methods for such determinations. The purpose of the work was to test a new system for determining heaving forces under field conditions and development of some recommendations for using such a system.

**TL 171**
**INTERPLAY OF FROZEN GROUND WITH PILES AND PIPES DURING VIBRATORY DRIVING.**
Vialov, S.S., et al, Sept. 1969, FSTC-HT-23-944-68, 12p., AD-694 120, For original Russian article see 23-1441. 5 refs.
Targulian, IU.O., Vysotskii, D.P.
25-2411
PILE DRIVING, FROZEN GROUND.
The article deals with excavation experiments in the frozen climates of Siberia. Tests were conducted to determine the most productive method of sinking boreholes and driving piles. Three types of excavation machinery were tested: impact, vibratory-impact, and pure vibratory action. Of the three, the vibration method of pile driving was considered to be the most productive under certain permafrost conditions. The thermal energy, which is produced in the area surrounding pile point, helps to reduce resistivity of the soil and facilitates pile insertion. The meltwater also reduces friction of the sides of the pile against the soil.

**TL 172**
**LAWS OF ICE DEFORMATION.**
Vialov, S.S., 1970, 15p., AD-715 032, Translation of Zakonomernosti deformirovaniia l'da. Sov. antarktich. eksp. 2nd, Gliats. issled., 1960, No.10:239-248.
25-2406
PLASTIC DEFORMATION, PLASTICITY TESTS, ICE MECHANICS.
During the Second Continental Expedition, a special laboratory was created to carry out ice deformation tests. These included compressive tests with and without lateral extension, shear tests and hardness tests. Ice having different structural characteristics was investigated. An analysis including plots of ice compaction and flow as functions of crystal orientation, time, and loading conditions, is presented. Elastic deformations in ice have a twofold nature - pure elastic deformation occurring instantly and an elastic aftereffect developing with time.

**TL 173**
**RESISTANCE OF FROZEN SOILS TO TRIAXIAL COMPRESSION.**
Vialov, S.S., et al, June 1970, FSTC-HT-23-750-70, 37p., AD-713 981, For original Russian article see 23-0338. 10 refs.
Shusherina, E.P.
25-2561
FROZEN GROUND COMPRESSION, FROZEN GROUND MECHANICS, RHEOLOGY.
The regularities in the strain and resistance of frozen soil to loads with allowance for time in the simple forms of tests (compression, expansion, sheer) at the present time have been relatively well studied. However, it should be taken into account that the frozen soils, just as most of the unfrozen soils, possess 'friction,' more exactly the ability to increase their resistance to shear under the effect of normal stress, which also should be taken into account in the determination of the rheological parameters. Therefore, in order to best study the mechanical properties of frozen soils, it is necessary to conduct tests during a complex stressed state, when the soil is influenced by a combination of stress components.

**TL 174** Record deleted.

**TL 175**
**VISCO-PLASTIC FLOW OF GLACIAL COVERS AND THE LAWS OF ICE DEFORMATION.**
Vialov, S.S., Hanover, N.H., CRREL, 1970, 28p., AD-715 031, Translation from Issledovaniia po fizike i mekhanike merzlykh gruntov, 1961. No.4:137-155. 8 refs.
25-2407
GLACIER FLOW, PLASTIC FLOW, PLASTIC DEFORMATION, ICE MECHANICS, ANALYSIS (MATHEMATICS).
Results of investigations carried out during the Second Antarctic Expedition (1956-1958) are reported. The first part deals with various experiments at the Mirnyy base camp on the creep, compression, shear, and hardness of ice under different test conditions. Data are analyzed mathematically. The second part covers the flow of ice sheets. Earlier studies are mentioned. Calculated data are compared with actual measurements between the Mirnyy camp and Vostok in E. Antarctica and are found to be in good agreement as regards surface configuration and in satisfactory agreement with respect to the rate of flow.

**TL 177**
**USE OF AERIAL METHODS IN LANDSCAPE STUDIES.**
Viktorov, S.V., et al, Oct. 1969, FSTC-HT-23-1101-68, 403p., AD-698 170, For original Russian book see 23-1389. For individual papers see 25-1183, -1184, -1838, -2273, -2360, -2394, -2388, -2413, -2418.
25-2412
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, MAPPING, TUNDRA.
The collection of articles covers a wide range of problems: The use of aerial methods in the tundra, taiga, steppes, and sandy deserts; the possibilities of aerial methods for the study of regional characteristics of landscapes; and the applications of aerial photography to large-scale mapping.

**TL 178**
**EXPERIENCE IN LARGE-SCALE LANDSCAPE INTERPRETATION AND MAPPING OF KEY SECTORS IN THE ARID AND SUBARID ZONES OF CENTRAL ASIA AND KAZAKHSTAN.**
Vinogradov, B.V., Aug. 1968, FSTC-HT-23-505-68, 32p., AD-692 374, For original Russian article see 23-1391. For another translation see 25-2412. 27 refs.
25-2413
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, MAPPING, PHOTOINTERPRETATION.
The paper is a presentation of some results in an experiment with large-scale landscape mapping based on the interpretation of aerial photographs taken during geological, soil and hydrogeological studies in western Turkmenia and in Northern and Western Kazakhstan in 1952-1958. The author deals with all the basic problems involved in landscape mapping, such as scales and accuracy. In the text a number of aerial photographs are accompanied by landscape maps compiled on the

basis of these photographs. These landscape maps in turn are fully analyzed as examples of the application and problems of landscape mapping. The author demonstrates the complexity in interpreting aerial photographs because of the spatial and functional correlations among the individual elements, such as geology, soils, vegetation and hydrology. The methods used in compiling such maps are described and the possible applications of such maps in the national economy are discussed.

**TL 179**
**GEOGRAPHIC CORRELATIONS IN DISTANT EXTRAPOLATION OF INTERPRETATION CHARACTERISTICS OF LANDSCAPE ANALOGS.**
Vinogradov, B.V., Nov. 1969, FSTC-HT-23-740-68, 54p., AD-696 915, For original Russian article see 23-1300. 33 refs.
25-2414
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, PHOTOINTERPRETATION.
Distant extrapolation of interpretation characteristics is determined primarily by geographic correlations and is conducted along basic geographic zones and within the limits of zone it is conducted by landscape analogs. Interpretation characteristics developed on key sections can be extrapolated for landscape analogs. Interpretation characteristics developed on key sections can be extrapolated for landscape analogs in the USSR and foreign countries.

**TL 180**
**INTERPRETATION OF GROUND WATER OF TYPICAL LANDSCAPES IN THE CASPIAN LOWLAND ON AERIAL PHOTOGRAPHS.**
Vinogradov, B.V., et al, Sept. 8, 1969, FSTC-HT-23-530-68, 81p., AD-693 148, For original Russian text see 23-1296. 20 refs.
Kuznetsov, V.V., Markovskiĭ, V.K., Popova, T.A.
25-1181
GROUND WATER, AERIAL PHOTOGRAPHS, PHOTOINTERPRETATION, VEGETATION PATTERNS, TOPOGRAPHIC FEATURES, SOIL PATTERNS.

**TL 181**
**AERIAL ANALYSIS OF VEGETATION IN ARID ZONES.**
Vinogradov, B.V., Nov. 1969, FSTC-HT-23-735-68, 510p., AD-698 850, For original Russian text see 23-1550. 427 refs.
25-2562
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, VEGETATION, DESERTS.
The report is a complete survey of the application of aerial photography to the analysis of vegetation in arid zones. Techniques for photographing, identifying, analyzing and interpreting vegetation at all photographic scales from 1:3,00 and larger to 1:50,000 and smaller are discussed. The technique which receives primary emphasis for the photographic interpretation of vegetation over wide areas is the selection of key sites, the preparation of aerial photographic interpretation standards and the extrapolation of these standards from the key sites over the entire area. Almost 400 different plants are mentioned by name, and there is an extensive bibliography. Areas discussed are primarily within the bounds of the Soviet Union, with some references to Africa and the Near East.

**TL 182**
**USING AERIAL PHOTOGRAPHY IN DIFFERENT SPECTRUM INTERVALS TO STUDY VEGETATION AND SOILS.**
Vinogradova, A.I., 1969, FSTC-HT-23-309-70, 24p., AD-693 225, For original Russian article see 23-1475. 16 refs.
25-2415
AERIAL PHOTOGRAPHY, SOIL SURVEYS, VEGETATION.
In recent years, in our nation there has been a significant increase in the number of specialists in different areas who make extensive use of aerial photography in their work. Along with broadening the sphere for using aerial methods, we can also clearly note a general move toward greater specificness in the technical and natural conditions of aerial photography. Various departments have ceased to be satisfied with the available finished materials from an aerial photographic survey which have been obtained for different purposes. They are working out their own requirements upon the conditions of aerial photography in terms of the survey scale, the type of film and the light filter, the focal length of the camera and the type of camera, as well as in terms of the season of the photographing, and are conducting the corresponding aerial photographic surveys.

**TL 183**
**UNLOADING AND HEATING OF NONMETALLIC CONSTRUCTION MATERIALS UNDER WINTER CONDITIONS.**
Vladimirov, A.P., et al, Feb. 5, 1969, FSTC-HT-23-25-68, 178p., AD-691 971, For original Russian text and abstract see SIP 25914. 53 refs.
Braĭnina, E.IU.
25-1174
ICE PREVENTION, CONSTRUCTION MATERIALS, SANDS, GRAVEL, CEMENTS, STORAGE, HEATING, VIBRATION.

**TL 184**
**GEOMORPHOLOGIC INTERPRETATION FOR LANDSCAPE STUDIES.**
Volkov, I.A., Hanover, N.H., CRREL, 1970, 2p., AD-715 050, For original Russian article see 23-1408. For another translation see 25-2412.
25-2418
AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, GEOMORPHOLOGY.
Soviet physical geography shows a trend from general, comparatively cursory descriptions of extensive areas to a more fundamental thorough study of small sections of territory with a detailed analysis of the correlations in their development and mapping. The geologic structure and relief determine greatly the area distribution of large geographic units. Of still greater importance is the study of the specific features of the geologic structure and relief and detailed geographic studies which are accompained by more detailed demarcation, that is, in landscape studies proper. These components of the landscape exert a deep influence on local relationships of heat and moisture and predetermine to a considerable degree the area of disposition of the boundaries, the morphologic composition and structure of the landscape itself as well as its components.

**TL 185**
**ON THE LINEAR CRYSTALLIZATION VELOCITY OF UNDERCOOLED MELTS AND UNDERCOOLED SOLID MODIFICATION.**
Volmer, M., et al, Hanover, N.H., CRREL, 1970, 16p., AD-874 914, Translation from Zeitschrift der Physik und Chemie, 1931, A, No.154:97-112. 11 refs.
Marder, M.
25-2419
CRYSTALLIZATION, SUPERCOOLING, GLYCEROL, ANALYSIS (MATHEMATICS).
The crystallization velocity of glycerin as a function of bath and limiting temperature was determined, and the thermal characteristics of glycerin were measured. Two different methods were tried to determine crystallization velocity from a theoretical quantitative viewpoint. The first most obvious equation showed fundamental deviations from the experimental findings which resulted in its rejection. The second equation equally failed to agree with the experiment, however, the deviations may be attributed to the items neglected by us.

**TL 186**
**DESIGN OF ROADS TO RESIST FROST ACTION.**
Moos, A. von, 1960, 24p., AD-878 740, Translation of Die Dimensionierung der Strassen bezüglich Sicherheit gegen Frost. Strasse und Verkehr, Vol. 42:395-401, Aug. 24, 1956. 13 refs.
25-2421
ROADS, FROST PENETRATION, PAVEMENT BASES, FROST PROTECTION, DESIGN.
Design specifications for frost resistant roads in Switzerland are suggested on the basis of experiences, observations, and experiments. Specifications for similar roads in other countries are outlined. Factors associated with frost damage, such as soil structure, water conditions, and frost index, are examined. A table is presented, suggesting road design norms and protective layer thicknesses for elastic and rigid pavements with various subgrade conditions. Monthly winter temperature sums and frost indexes for Zurich are given for selected winters between 1928 and 1955.

**TL 197**
**SOLID GAS HYDRATES.**
Stackelberg, M. von, Hanover, N.H., CRREL, 1970, 24p., AD-874 927, Translation from Naturwissenschaften, 1949, 36(11/12):328-333, 359-362. 26 refs.
25-2390
GASES, MOLECULAR STRUCTURE, HYDRATES.
It is shown that although the ideal composition of gas hydrates is M.6H2O, for structural reasons larger molecules have higher water contents. The author turned to gas hydrates following his determination of the structure of borides (MeB6). Although the structure of the gas hydrate has not been completely determined, some fundamental characteristics are presented briefly.

**TL 198**
**EFFECT OF MINUS TEMPERATURES ON THE CARRYING CAPACITY OF A PRESTRESSED BEAM.**
IAkushin, V.A., Hanover, N.H., CRREL, 1970, 9p., AD-712 245, For original Russian article see 23-2562. 4 refs.
25-2315
TEMPERATURE FACTORS, COLD WEATHER TESTS, PRESTRESSED BEAMS.
The accumulation of experience in the studies of prestressed beams of considerable age has appreciable importance for estimating the behavior of such designs over a period of time. This is particularly important for the actual prestressed beams in the roofs of industrial buildings, which are used in our country in a large volume and exist under varying operational conditions. Discussed are the results obtained from testing the prestressed-pitched beam in the roofing of industrial buildings with a span of 18 m (the beam is placed in the roofing with a spacing of 6m), having been located in an open area for more than three years (1,251 days).

**TL 199**
**STUDY ON THE REFLECTION OF ELECTROMAGNETIC WAVES FROM NONHOMOGENEOUS MEDIA, ESPECIALLY THE EFFECT OF SNOW COVER ON ULTRAHIGH FREQUENCIES.**
Yokoto, K., Hanover, N.H., CRREL, 1966, 55p., AD-877 346, Translation from Yamagata diagaku kiyo. Kogaku (Bulletin of Yamagata Univ. Dept. of Engineering) 7(2):163-210, 1963. 22 refs.
25-2422
SNOW COVER EFFECT, REFLECTIVITY, WAVE PROPAGATION.
The reflection of electromagnetic waves from snow cover is investigated in order to determine the effect on radio-wave communications using ultrahigh frequencies. A theoretical analysis was made of the reflection of a plane wave from a parallel stratified medium consisting of an inhomogeneous and a homogeneous layer. Electromagnetic properties of snow and ground such as permittivity, loss tangent, and attenuation were studied based on experimental data. The changing behavior of snow permittivity as a funciton of depth was examined using Cumming's relation, and 5 snow-cover models were constructed. The theoretical reflection coefficients are found to be in good agreement with experimental results.

**TL 200**
**THERMODYNAMIC THEORY ON THE VAPOR PRESSURE AND MELTING POINT OF ICE UNDER ELASTIC STRAIN.**
Yoshida, Z., Hanover, N.H., CRREL, 1970, 56p., AD-877 342, Translation from Teion kagaku (Low temperature sci.), 1962, Ser.A, Vol.20:1-27. 10 refs.
25-2423
VAPOR PRESSURE, MELTING POINTS, ICE THERMAL PROPERTIES, THERMODYNAMIC PROPERTIES, PLASTIC DEFORMATION.
Various theories which attempt to quantify the changes in the melting point of ice strained elastically by external forces are examined. Riecke's treatment of the reduction of the melting point of the side surface of an ice pillar subjected to vertical stress is discussed, as well as Williamson's treatment of the stressed top surface of such a pillar. Verhoogen's thermodynamic theory concerning the chemical potential of a strained solid body is also examined in application to an ice pillar. The relationship between the melting point and vapor pressure of ice crystals subjected to elastic strain is examined in detail and an experiment illustrating this relationship is discussed.

**TL 202**
**METHODS OF THE THEORY OF PLASTICITY IN THE MECHANICS OF SNOW.**
Ziegler, H., Hanover, N.H., CRREL, 1970, 30p., AD-877 348, Translation of Methoden der Plastizitätstheorie in der Schneemechanik. Zeitschrift für angewandte Mathematik und Physik, 1963, 14(6):713-737. 12 refs.
25-2425
AVALANCHE FORMATION, SNOW PLASTICITY, SNOW MECHANICS.
It seems reasonable to assume that, in certain problems, some types of snow may be considered perfect plastic bodies. With this assumption, various problems concerned with the formation of avalanches and with its prevention are discussed.

**TL 203**
**THERMAL MOISTURE REGIME AROUND PILES IN PREDRILLED HOLES.**
Zhigul'skiĭ, A.A., Hanover, N.H., CRREL, 1970, 11p., AD-715 054, For original Russian article see 23-0245. 5 refs.
25-2424
SOIL TEMPERATURE, SOIL FREEZING, MOISTURE FACTORS, PILE FOUNDATIONS.
Discusses freezing of the solution and restoration of the temperature regime of the ground and formation of the moisture regime of the ground solution in the course of its freezing.

**TL 204**
**DESIGN OF PAVEMENTS OVER FROST SUSCEPTIBLE SUBGRADES.** Hanover, N.H., CRREL, 1960, 10p., AD-874 925, Translation of Schweizerische Normenvereiningung (SNV) 40325, 1957.
25-2426
ROADS, FROST ACTION, FROST PROTECTION, DESIGN CRITERIA.
A standard presenting a design procedure for road pavements to prevent damage due to frost action in the subgrade.

**TL 205**
**EXPERIMENTAL METHOD OF SOIL CLASSIFICATION ACCORDING TO DEGREE OF FREEZING.**
Aguirre-Puente, J., et al, Jan. 1972, 48p., AD-738 129, Translation of Méthode experimentale de classement des sols selon leur degré de gélivité, Rapport 70-5, Meudon, Centre National de la Recherche Scientifique, Laboratoire d'Aérothermique, 1970, by U.S. Joint Publications Research Service. 15 refs.
Dupas, A.
26-3558
SOIL FREEZING, SOIL CLASSIFICATION, FROST PENETRATION, COOLING RATE, LOW TEMPERATURE TESTS, LABORATORY TECHNIQUES.

**TL 206**
**RESISTANCE COEFFICIENT AT THE LOWER SURFACE OF AN ICE COVER.**
Sokolov, I.N., Hanover, N.H., CRREL, 1970, 3p., AD-715 080, Translation from Meteorologiia i gidrologiia, 1960, No.4:34-36. 1 ref.
25-2387
ICE WATER INTERFACE, FLOATING ICE, SHEAR STRENGTH, COEFFICIENTS.
The present article gives data on the value of the resistance coefficient for a flat lower surface of ice, obtained by experiments with small blocks of ice in the shape of rectangular plates. The test consisted of measuring the net force on ice blocks of given dimensions floating on the surface of the water with the current at different rates of flow. The resistance coefficient at the water-ice boundary was calculated from the test results.

**TL 207**
**STUDYING THE SLIDE PATTERN OF AVALANCHES BY MEANS OF PHOTOGRAMMETRIC METHODS.**
Kahn, M., Jan. 1972, 10p., AD-737 810, Translation of McGill University, Axel Heiberg Expedition, 1964.
26-3365
AVALANCHE MECHANICS, PHOTOGRAMMETRY.

**TL 208**
**THERMORESISTORS.** June 1969, FSTC-HT-23-775-68, 18p., AD-691-976, Translation of Soviet patent No.10688-63. Incl. to IR 1 771 0358 68 p.1-17.
25-2431
THERMISTORS, SPECIFICATIONS.
The document establishes standards for the manufacture, testing, storage, packing and transportation of thermistors. Detailed specifications in tabular and schematic form show the authorized physical configurations and basic electrical parameters for thermistors of standard design. Technical test criteria are outlined, including authorized deviations from established standards.

**TL 209**
**STUDY OF THE SPECTRAL BRIGHTNESS OF SOME LANDSCAPE ELEMENTS FOR INTERPRETATION OF GROUND WATER ON AERIAL PHOTOGRAPHS.**
Artsybashev, E.S., June 1969, FSTC-HT-23-353-68, 38p., AD-692 647, For original Russian text see 23-1299. 9 refs.
25-2274
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, TERRAIN ANALYSIS, GROUND WATER.
This article presents experience in the study of the spectral reflectivity of some landscape elements (primarily vegetation and soils) which are ground water indicators and describes the use of these data for the hydrogeological interpretation of aerial photographs. The studies were made during 1958-1960 in the desert (Turkmenia) and semi-desert (Caspian Lowland). The method for interpreting ground water described in this paper was checked by making similar studies in the forest zone of the northwestern regions of the USSR. Particular emphasis was on study of the role of vegetation and soils as indicators of ground water, their relationship to the depth at which such water is found, mineralization of ground water and the regions in which it occurs. One section is devoted to an analysis of the different types of aerial film and light filters which can be used in such work and conclusions are drawn as to their applicability under different climatic, meteorological and other meteorological and other conditions.

**TL 210**
**HEATING WITH GAS.**
Titov, V., et al, Jan. 1972, 2p., AD-738 143, Translated by U.S. Joint Publications Research Service. For original Russian text see 24-1233.
Badtiev, IU.
26-3559
MOTOR VEHICLES, TANK CARS, WATER SUPPLY, COLD WEATHER OPERATION, PIPES (TUBES), DEFROSTING, HEATING.

**TL 211**
**OPERATION OF CONSTRUCTION MACHINERY UNDER WINTER CONDITIONS.**
Smolin, A.P., July 1970, FSTC-HT-23-319-70, 183p., AD-714 828, For original Russian text see 24-1397. 91 refs.
25-2560
COLD WEATHER OPERATION, CONSTRUCTION EQUIPMENT.
This book sets forth special features of operation of construction machinery (chiefly excavators, bulldozers and tractors) under winter conditions. It examines difficulties arising during the operation and caused by the effect of freezing temperatures on the lubricants, fuels, brake and operating fluids of the hydraulic-control systems and also on the steels and other materials. It analyzes in detail the causes which make the starting of the carburetor-type and diesel engines difficult at low temperatures. It also examines the methods of making the starting easier. In addition to this, the book gives information on the preparation of construction machinery and on the organization of work under winter conditions, the data on the economic effect obtained with proper organization of the maintenance and use of the means for making the operation of construction machinery easier.

**TL 212**
**INVESTIGATIONS AIMED AT THE DEVELOPMENT OF AN EFFICIENT ROCK EXCAVATION FOR DRIVING-MACHINERY IN HARD ROCK.**
Hendriks, H., Jan. 1972, 32p., AD-738 130, Translation of Untersuchungen Gesteinsangriff von Vortriebsmaschinen für hartes Gestein. Technical University of Clausthal. Glückauf-Forschungsheft, 6(31), p.291, 1970, by U.S. Joint Publications Research Service. 4 refs.
26-3560
EXCAVATING EQUIPMENT, DRILLS.

**TL 213**
**RAVINE DEVELOPMENT IN TUNDRA.**
Kosov, B.S., et al, Jan. 1972, 11p., AD-738 144, Translated by U.S. Joint Publications Research Service. For original Russian text see 26-273. 16 refs.
Konstantinova, G.S.
26-3561
TUNDRA SOILS, SOIL EROSION, GULLIES, SLOPE PROCESSES, SOIL STABILIZATION, TUNDRA VEGETATION, FROZEN FINES.

**TL 214**
**RELATIONSHIP BETWEEN STRESS AND DEFORMATION OF FROZEN SOILS TAKING INTO ACCOUNT THE TIME FACTOR.**
Vialov, S.S., 1970, 9p., AD-717 304, Translation from Akademiia nauk SSSR. Doklady, June 21, 1956, 108(6):1049-1052. 6 refs.
25-2405
FROZEN GROUND MECHANICS, DEFORMATION, STRESSES, VISCOSITY.
The deformation of frozen ground was studied under shearing and compressive stresses applied to samples of various compositions for periods from several minutes to 1 yr. or more. Data obtained on the effects of shearing stress are graphed and discussed. The viscous properties of frozen ground (creep factors) are responsible for the persistent deformation, the duration of which varied in the tests with the composition of the samples Formulas are given to express the interrelations determined between applied stress, time, and type of deformation, as well as variations in the moduli of shearing and residual deformation as a function of stress and duration. A final series of experiments included studies on deformation under intermittent stress and continuous stress increasing with time.

**TL 215**
**STRENGTH AND CREEP OF FROZEN GROUND.**
Voĭtkovskiĭ, K.F., 1970, 187p., AD-717 317, Translation of Prochnost' i polzuchest' merzlykh gruntov. Moscow, 1963.
25-2563
FROZEN GROUND MECHANICS, SOIL CREEP, SOIL STRENGTH, RHEOLOGY, EXCAVATION, COMPRESSIVE PROPERTIES.
The book presents results of experimental and theoretical investigations on the strength and creep of frozen ground, summing up modern views of the rheology of frozen ground. Problems of the compressibility and creep of frozen ground in the complex stressed state are examined. Characteristics of creep of frozen skeletal and rocky fissured ground are highlighted, along with methods of evaluating their bulk strength. The results of experimental studies of the resistance of frozen ground under the ends of pile foundations are set forth. Methods of computing creep of frozen ground are proposed in the evaluation of the stability of underground excavations. The book intended for designers, construction engineers, and mining engineers working in foundation-laying and sinking of underground excavations in long-frozen ground, and also for scientific workers concerned with the mechanics of frozen ground.

**TL 216**
**CUTTING OF SOILS.**
Zelenin, A.N., 1964, 92p., AD-716 981, Translation of Rezanie gruntov. Moscow, Izd-vo AN SSSR, 1959.
25-2564
EXCAVATION, COLD WEATHER CONSTRUCTION, EARTH HANDLING EQUIPMENT, FROZEN GROUND.
The large-scale earthwork performed annually in the Soviet Union not only calls for a complete mechanization of the operations involved but for continuing them under winter conditions at a high efficiency and with the least power expenditure. The excavation of frozen soils has been a laborious operation, its cost many times higher than the cost of analogous operations performed in summer. Almost all the types of excavating machinery are little used during the winter because of the high strength of frozen soils. The existing methods of excavating frozen soils are given and discussed.

**TL 217**
**FROST INSULATION OF PIPE TRENCHES.**
Gundersen, P., Jan. 1972, 13p., AD-738 145, Translation from Norwegian of Frostisolering av rörgrøfter, Symposium - Frost i Jord, 23-24 Nov. 1970. Pt.1, Nr.2, Feb. 1971, p.65, by U.S. Joint Publications Research Service.
26-3562
WATER PIPELINES, PIPELINE INSULATION, TRENCHING, PIPE LAYING, HEAT TRANSFER.

**TL 218**
**DISCUSSION ON CONCRETE WATERPROOFING IN ROOF TERRACES.**
Varlan, G.E., Jan. 1972, 47p., AD-738 146, Translation of Discussion de cas concrets d'étancheité en toitures-terrasses, Annales de l'Institut Technique du Batiment et des Travaux Publics, 5(51)p.310, 1952, by U.S. Joint Publications Research Service. 37 refs.
26-3563
ROOFS, INSULATION, WATERPROOFING.

**TL 219**
**INTERFERENCES IN ATOMIC ABSORPTION WITH A KING GRAPHITE FURNACE.**
Baudin, G., et al, Jan. 1972, 14p., AD-737 816, Translation of Spectrochimica Acta, V.24B, p.425-436, 1971. 7 refs.
Chaput, M., Feve, L.
26-3366
ATOMIC ABSORPTION, RADIOACTIVE SUBSTANCES.

**TL 220**
**EFFECT OF THE COLLOIDAL AND CHEMICAL NATURE OF HUMUS ON THE INTENSITY OF ICE SEPARATION IN SOIL.**
Poltev, N.F., 1970, 5p., AD-716 461, For original Russian article see 23-2341. 4 refs.
25-2363
FROZEN GROUND PHYSICS, ICE FORMATION, SOIL CHEMISTRY, HUMUS.
The quicksand state of the Northern soils in thawed form, and the high ice content of certain levels of them in frozen condition is associated to a significant extent with the hydrophilic nature of the humus of these soils. In a survey of the seasonal freezing of the soils by zones, one can in no event overlook also the zonality of their ice state, depending to a known extent on the colloidal chemical nature of the humus of the given soils.

**TL 221**
**ICE. SEA ICE AND PACK ICE.**
Arctowski, H., 1971, 55p., AD-881 363, 35 refs.
26-2283
SEA ICE, PACK ICE, EXPEDITIONS, SEA WATER FREEZING, ICE GROWTH, ANTARCTICA.
A summarized and coordinated account is given of personal observations made during the expeditions of the Belgica. Ice conditions at the edge of the pack, the freezing of sea water, ice growth, transformations of young sea ice, the characteristics of old ice and snow on the ice, the formation of blue ice and névé on ice floes, the effect of wind on the ice, the characteristics of ice fields and icebergs, and the formation of areas of open water, crevasses, and pressure ice are discussed, and representative data are tabulated.

**TL 222**
**PROCEDURE FOR PROCESSING METEOROLOGICAL DATA ON SNOW USING THE SETUN' DIGITAL COMPUTER.**
Al'tshuler, Z.E., et al, 1971, 16p., AD-720 055, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.76:65-74, 1968. 7 refs.
Kamenskaia, K.G.
26-6
SNOWDRIFTS, METEOROLOGICAL DATA, COMPUTER PROGRAMS.
When planning, designing, building and operating railroads and highways, traction and high-voltage substations and other projects in the territory of Western Siberia, it is necessary to consider the problem of snowdrifts. For preliminary estimation of

the snowdrifts in the given area when no special drift gage observations are available, it is possible to use the data of the closest weather stations by subjecting them to special processing. The results obtained after processing are used as the basis for compiling snow transport rose diagrams permitting correct orientation of the designed object and insurance of the required snow protection.

**TL 223**
**PROBLEM OF EXPERIMENTAL STUDY OF THE PHYSICAL-MECHANICAL CHARACTERISTICS OF AVALANCHE FLOW.**
Matvienko, V.S., 1971, 12p., AD-720 056, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.76:75-80, 1968. 4 refs.
26-7
AVALANCHE MECHANICS, AVALANCHE PRESSURE, ANALYSIS (MATHEMATICS), IMPACT TESTS.
Many domestic and foreign research papers are devoted to the resolution of the problems of dynamics of snow avalanches. In these papers efforts have been made many times to present methods of quantitative evaluation of the impact of a snow avalanche against an obstacle. At different times different authors have proposed formulas for calculating the force of impact of an avalanche. It is noted that an experimental setup permitting all around study of an avalanche flow has been developed for the first time.

**TL 224**
**DENSITY OF GLACIER ICE.**
Shumskiĭ, P.A., 1971, 12p., AD-720 057, Translation from Akademiia nauk SSSR. Doklady 126(4): 767-770, 1959.
25-2383
GLACIER ICE, ICE DENSITY, ICE MECHANICS.
A method of calculating variations in ice density with depth is described, and contributing factors are discussed. The calculation is based on the known coefficient of the volume compressibility of ice, its mean coefficient of linear thermal expansion, its density under a normal pressure of 1 atm. at 0 C, and the coefficient of volume expansion of air inclusions, assuming that the processes of densification and expansion are often elastic and occur suddenly, so that at any moment of time the density of ice is determined by outside pressure and temperature only. Formulas are presented for calculating ice density, the parameters involved, and the age of the ice, its rate of subsidence, its rate of densification, its rate of relative compression, and the gradient of its speed of subsidence with depth.

**TL 225**
**HEAT TRANSFER DURING CONDENSATION OF VAPOR IN A TUBE.**
Boĭko, L.D., et al, 1971, 25p., AD-720 058, For original Russian article see 23-3863. 15 refs.
Kruzhilin, G.N.
26-8
PIPES (TUBES), HEAT TRANSFER, ANALYSIS (MATHEMATICS).
The work sets forth an approximated theoretical calculation of heat transfer during the condensation of vapor in a tube based on the analogy between the hydraulic friction resistance and heat exchange according to Reynolds. A review of the works by other authors on the subject mentioned is given. The work also sets forth the experimental data obtained during vapor condensation within tubes with a diameter of up to 18 mm, a length of up to 12 meters at pressures of up to 90 bars. In the case mentioned the calculated results and experimental data on heat transfer agree.

**TL 226**
**ROLE OF CERTAIN NATURAL FACTORS IN THE FORMATION OF SNOW AVALANCHES.**
Marin, IU.A., 1971, 17p., AD-720 059, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.76:81-88, 1968. 3 refs.
26-9
AVALANCHE FORMATION, METEOROLOGICAL FACTORS.
Problems connected with the effect of atmospheric conditions have defining significance for railroad building in mountainous and taiga terrain and also for successful protection of the operated railroads from snow avalanches. From this comes the necessity of investigating the effect of meteorological conditions considering the relief and afforestation of the area on the occurrence of avalanches. In this article an effort is made to establish at least approximately the effect of air temperature, amount of precipitation, the wind rose diagram and the snow transport connected with it on the formation of snow avalanches in one section of the Kuybyshev Railroad.

**TL 227**
**SNOW AVALANCHES AND THEIR CONTROL ON RAILWAYS ON SAKHALIN ISLAND.**
Isaenko, E.P., et al, 1971, 21p., AD-720 060, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:92-105, 1969.
Lokhin, V.K., Anfilof'ev, B.A., Matvienko, V.S., Managadze, A.V., Ivanov, A.V.
26-10
AVALANCHE COUNTERMEASURES, RAILROADS, DAMAGE, AVALANCHE ENGINEERING.
It is indicated that the inception of snow avalanches is intimately bound up with topographic and climatic characteristics of Sakhalin Island. Data are given that characterize levels of damage inflicted by avalanches on railways. Methods and techniques of controlling slides and snow avalanches used in the Yuzhno-Sakhalinsk Railway Division are analyzed. The need for scientific research on avalanche activity in these regions is posed.

**TL 228**
**AVALANCHE HAZARD ON THE UST'-KAMENOGORSK—ZYRYANOVSK RAILWAY.**
Isakov, L.M., et al, 1971, 14p., AD-720 061, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:106-111, 1969.
Anfilof'ev, B.A.
26-11
RAILROADS, AVALANCHE COUNTERMEASURES.
The article presents data on formation and descent of avalanches and on their volumes in the vicinity of the Ust'-Kamenogorsk—Zyryanovsk railway. Avalanche protective measures used on the line are analyzed. Included are several recommendations on protection of the railway from avalanches.

**TL 229**
**SNOW AVALANCHES ON THE NOVOKUZNETSK—TASHTAGOL RAILWAY.**
Anfilof'ev, B.A., 1971, 14p., AD-720 062, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:112-120. 8 refs.
26-12
RAILROADS, AVALANCHE FORMATION, METEOROLOGICAL DATA, STATISTICAL ANALYSIS.
Based on analysis of project-surveying materials, data of the line section, and on-site observations, geomorphological and climatic factors affecting formation of avalanche conditions of this region are characterized. The article presents data on the number and volumes of avalanches affording estimation of the avalanche hazard in developing avalanche protective measures along the line.

**TL 230**
**SNOW CONTROL METHODS ON MOUNTAIN ROADS.**
Komarov, A.A., et al, 1971, 24p., AD-720 063, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:121-134, 1969. 5 refs.
Kamenskaia, K.G., Al'tshuler, Z.E.
26-13
ROAD MAINTENANCE, SNOW REMOVAL, SNOWDRIFTS, COUNTERMEASURES.
Snow control methods applied to conditions of mountain localities are examined in the article. Here field and experimental studies conducted in the Khibiny Range are used. Recommendations on determination of the amount of snow onto the line and on a rational technology for snow removal operations are given.

**TL 231**
**POSSIBLE USE OF COMPRESSED AIR IN SNOW PROTECTION APPLICATIONS.**
Markevich, G.S., 1971, 9p., AD-720 064, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:138-141, 1969. 2 refs.
26-14
MODELS, SNOWDRIFTS, COUNTERMEASURES, COMPRESSED AIR.
Wind tunnel experiments with a model of air snow protection showed that beyond the air barrier — consisting of successively arranged circular jets — snow accumulates corresponding to typical snow deposits beyond the lattice protective structures. The action of pneumo-snow protection (air snow protection) and its functionability depend on direction and jet-wind angle of attack. This study is the first stage in developing a new type of snow protection.

**TL 232**
**ECONOMICAL SNOW RETENTION METHODS IN PROTECTING ROADS FROM DRIFTS.**
Kamenskaia, K.G., et al, 1971, 7p., AD-720 065, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:135-137, 1969. 2 refs.
Al'tshuler, Z.E.
26-15
SNOWDRIFTS, ROADS, SNOW FENCES, ECONOMICS.
The article examines a method of combined protection of roads from snow drifts by using shields and trenches. Use of snow trenches reduces the number of shield repositionings and thus substantially cuts snow protection costs. Economic benefits from using combined protection is shown on the example of one of the roads in Novosibirskaya Oblast. Snow trenches are used in conjunction with other kinds of protection: tree strips, fences, and so on.

**TL 233**
**TECHNICAL-ECONOMIC COMPARISON OF VARIANTS OF AVALANCHE-PROTECTIVE MEASURES.**
Isaenko, E.P., 1971, 11p., AD-720 066, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No. 89:142-146, 1969. 3 refs.
26-16
AVALANCHE COUNTERMEASURES, RAILROADS, COST ANALYSIS.
The report contains a method for comparing variants of avalanche-protective measures that allow for the effect of initial capital investments, outlays for current upkeep of structures, and their service life. For measures not involving construction of structures, it is recommended to bring under the proposed formula annual costs for artificial collapsing of snow masses, for clearing the line from snow slides, and railway losses due to train delays during the periods when lines are cleared free of snowbanks.

**TL 234**
**ECONOMIC JUSTIFICATION OF TIME OF INITIAL OPERATIONS TO CONSOLIDATE SANDY AREAS WITH VEGETATION WHEN BUILDING RAILWAYS IN DESERTS AND SEMIDESERTS.**
Zakirov, R.S., 1971, 15p., AD-720 067, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:147-152, 1969. 7 refs.
26-17
RAILROADS, CONSTRUCTION COSTS, SANDS, SOIL STABILIZATION.
As a result of technical-economic calculations, the soundness of executing operations to secure sand areas in the preparatory period and not in the basic period simultaneously with building the roadbed has been established. Sand-consolidating operations and sand-protective tree plantings must be included in the preparatory period and this period is singled out for a separate integrated flow. Operations in the preparatory period must be begun 6-12 months after basic operations begin.

**TL 235**
**SOME THEORETICAL PROBLEMS IN THE FORMATION AND MOVEMENT OF SNOW AVALANCHES.**
Gongadze, D.N., 1971, 26p., AD-720 068, Translation from Akademiia nauk Gruzinskoĭ SSR. Institut geofiziki. Trudy, Vol.13:161-174, 1954. 10 refs.
26-18
AVALANCHE MECHANICS, SNOW COVER STABILITY, AVALANCHE PRESSURE, ANALYSIS (MATHEMATICS).
In the present paper an attempt is made to resolve certain questions of the statics and dynamics of snow avalanches on the basis of the data of the existing literature in the field and the analysis of the material accumulated by the author during high altitude expeditions of the Institute of Geophysics of the Academy of Sciences Georgian SSR during the 1948-54 period.

**TL 236**
**CALCULATING SNOW AVALANCHE IMPACT ON A FIXED OBSTACLE.**
Gongadze, D.N., et al, 1971, 13p., AD-720 069, Translation from Akademiia nauk Gruzinskoĭ SSR. Soobshcheniia, 16(6):437-442, 1955. 6 refs.
Papinashvili, L.K.
26-19
AVALANCHE ENGINEERING, AVALANCHE PRESSURE, ANALYSIS (MATHEMATICS).
The forces developing from snow avalanches are mathematically analyzed on the basis of experiments at the Georgian Institute of Geophysics and observations in the Caucasian Mts. The impact force is determined as a function of depth and density of the moving snow mass, length of avalanche route, slope, and factors characterizing the increase in the snow mass during avalanching. Data on the impact force for slopes from 20 - 40, snow depths from 1-6.5 m., and avalanche paths from 0.5-1.5 km. are tabulated and graphed.

**TL 237**
**SNOWSTORM DRIFTS AT DIFFERENT ELEVATIONS.**
Komarov, A.A., et al, 1971, 21p., AD-720 070, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No. 89:56-57, 1969. 5 refs.
Al'tshuler, Z.E.
26-20
SNOWDRIFTS, SNOWSTORMS, EXPERIMENTAL DATA, STATISTICAL ANALYSIS.
The article is based on experimental data for Novosibirskaya Oblast' and for Kola Peninsula for the winters of 1965-1966 and 1966-1967. A brief description of installations and instruments for observations is given. Observation methods are set forth. Experimental findings treated by a statistical method afford tracing changes in solid consumption of snow-wind flow as a function of elevation. An attempt is made at estimating existing theoretical developments and empirical functions from the viewpoint of the experimental data presented.

**TL 238**
**AERODYNAMIC AND SNOW-RESTRAINING CAPABILITY OF SNOW RIDGES, SNOW WALLS, AND TRENCHES.**
Kamenskaia, K.G., 1971, 18p., AD-720 071, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:45-55, 1969. 6 refs.
26-21
SNOWDRIFTS, COUNTERMEASURES, ANALYSIS (MATHEMATICS).
The document states that up to the present time there have been no theoretical developments on problems involved in erecting snow-protective structures made of snow along highways and railways and finding their optimal parameters. It presents a theoretical study of aerodynamic properties of snow-protective structures made of snow. Derived formulas afford calculations for practical purposes.

**TL 239**
**GLACIOLOGY SECTION AT GENERAL ASSEMBLY OF INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS (14TH).**
Diunin, A.K., 1971, 36p., AD-720 072, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:73-91, 1969.
26-22
AVALANCHE COUNTERMEASURES, GLACIOLOGY, MEETINGS.
The article recounts the work of the glaciology section of the 14th General Assembly of the International Union of Geodesy and Geophysics held in Switzerland in the autumn of 1967. The author, an Assembly participant, sets forth the basic content of papers on avalanches, describes his impressions of a four-day expedition in the Swiss Alps for familiarizing himself and others in the field with methods of avalanche protection.

**TL 240**
**METHODS OF DISRUPTING AN ICE COVER.**
Peschanskiĭ, I.S., 1971, 63p., AD-720 073, Translation from Ledovedenie i ledotekhnika. 2d ed. Leningrad, Gidrometeoizdat, 1967. p.308-367.
26-23
SEA ICE, ICE PHYSICS, ICE BREAKING, ICE FORMATION.
For solving the problems in ice technology, it is necessary to resort to the engineering methods of breaking down an ice cover, predetermined by the features of the water basin and the purposes of the tasks which are being conducted. In this report, the following problems are discussed: disruption of ice cover during cruising of ships in ice; disruption of ice barriers; protection of structures and ships; creation of conditions favoring a delay in the ice formation process; removing the ice and snow from water basins; and cutting holes around ships.

**TL 241**
**MEASUREMENT OF SNOW TRANSPORT BY PHOTOELECTRIC METHOD.**
Komarov, A.A., et al, 1971, 10p., AD-720 074, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:68-72, 1969. 3 refs.
Kolmakov, V.V., Titovets, V.T.
26-24
SNOWDRIFTS, MEASURING INSTRUMENTS.
Different methods of measuring snow transport in laboratory and field conditions are examined. It is noted that existing procedures of measuring snow transport using the VO-2 snowstorm gages are imprecise and so cannot be recommended for practical use. The method of measuring snow transport based on the photoelectric effect is highlighted.

**TL 242**
**ROUTING AND DESIGNING OF RAILROAD PLAN VIEW IN DESERTS AND SEMIDESERTS.**
Zakirov, R.S., 1971, 25p., AD-720 075, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:31-44, 1969. 10 refs.
26-25
RAILROADS, DESIGN, DESERTS.
The article examines basic factors affecting choice of line routing and presents materials of experimental laboratory studies of the velocity field of the air flow streaming past forms of sand relief in a wind tunnel. Based on study findings, requirements placed on routing and designing of railroad plan view are set forth.

**TL 243**
**EXPERIMENTAL WIND TUNNEL STUDY OF AIR FLOW PAST A MODEL OF MOUNTAIN TERRAIN.**
Lokhin, V.K., et al, 1971, 20p., AD-720 076, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:19-30, 1969. 5 refs.
Matvienko, V.S.
26-26
MOUNTAINS, AIR FLOW, MODELS, AVALANCHE COUNTERMEASURES.
The problem of wind tunnel study of the pattern of air stream flow past a model of mountain terrain for one area in which an industrial complex is being designed. Theoretical justification for using the modeling method and the method of model scale selection is set forth. These results were compared with full-scale photographs and satisfactory agreement between these data was found. Results of experimental studies made it possible to establish snow accumulation zones where placement of snow-protective structures is required.

**TL 244**
**AIR WAVE ACCOMPANYING A SNOW AVALANCHE.**
Matveev, S.N., 1971, 21p., AD-720 077, Translation from Problemy fizicheskoĭ geografii, Vol.9:83-90, 1940. 10 refs.
25-2344
AVALANCHE WIND.
The problem of the air wave that forms in front of a snow avalanche is discussed and hypotheses are suggested to explain the phenomenon. The forward direction of the wave leading the avalanche is probably a result of an intense compression of the air in front of the avalanche. Banks, terraces and similar relief features causing a sharp increase in avalanche velocity are factors conducive to the appearance of the air wave.

**TL 245**
**THEORY OF CONTROLLING AVALANCHES ON RAILROADS.**
Diunin, A.K., 1971, 25p., AD-720 078, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.89:5-18, 1969. 9 refs.
26-27
RAILROADS, AVALANCHE COUNTERMEASURES, ANALYSIS (MATHEMATICS).
The article examines the present status of the theory and movement of avalanches, snow stability on avalanche-prone slopes, and its accumulation thereon. The possibility of using the principles of the mechanics of continuous discrete media is explored in construction of this theory. Functions are derived for estimating stability of snow layer on slopes and for balancing momenta of the avalanche body.

**TL 246** Record deleted.

**TL 247**
**PROBLEM OF CHARACTERIZING AVALANCHE AREAS ON RAILROADS IN KUZNETSKII ALATAU.**
Anfilof'ev, B.A., 1971, 21p., AD-720 080, Translation from Novosibirsk. Institut inzhenerov zheleznodorozhnogo transporta. Trudy, No.76:89-101, 1968. 9 refs.
26-29
RAILROADS, AVALANCHES, STATISTICAL ANALYSIS, MOUNTAINS.
At the present time, on a section of the railroad extending about 83 kilometers there are 20 locations with a total length of 5,000 meters where avalanching is observed every winter. The general nature of the probability distribution of the avalanche volumes and their distribution by months in the investigated 83 km for 1964-1966 are presented.

**TL 248**
**STRENGTHENING COHESIVE SOILS BY MINERAL STABILIZERS FOR BUILDING ROADS IN THE SECOND CLIMATIC ZONE.**
Pechorskiĭ, I.A., et al, 1971, 7p., AD-722 104, For original Russian article see 25-1596.
Ekhlakova, N.G.
26-2284
SOIL STABILIZATION, ROADS, AGGREGATES, FROST HEAVE, FREEZE THAW CYCLES, COLD WEATHER CONSTRUCTION.
The basic problem which is pursued in reinforcing the soils for roadbuilding purposes is to develop ways to impart to them an irreversible cohesiveness, increased strength, and resistance to the effect of water and frost. In the tests on studying the variation in the aggregate composition and properties of soils, the authors used a silty carbonaceous clay, a heavy silty loam of podzolic type and a heavy loam with a neutral reaction. As stabilizers, use was made of cement, lime, electric steel smelting slags and ferrochrome slags. Results are discussed.

**TL 249**
**BUILDING FROST RESISTANT ROADS.**
Kamenev, A.M., 1971, 7p., AD-722 105, For original Russian article see 25-1575.
26-2285
ROADS, ROADBEDS, FROST HEAVE, CLIMATIC FACTORS, FROZEN GROUND, CONSTRUCTION.
Operating highways in the foothill regions of southeastern Kazakhstan demonstrates that here one has all the conditions for the origination and development of the most dangerous frost deformations. The foothills are characterized by natural climatic conditions differing from the flat plains and are included in the region of high (vertical) zonation or belong to a separate series of near-mountain or foothill zoning. Therefore the foothill regions of southeastern Kazakhstan, situated in northern sector V of the road-climatic zone, must be considered in relation to the plains regions, as extra-zonal areas, as is assumed in the existing pattern of the road-climatic regioning of the USSR.

**TL 250**
**FORCE OF ICE COHESION WITH SOME METALS.**
Dolov, M.A., et al, 1971, 8p., AD-722 106, For original Russian article see 25-1741. 7 refs.
Makushev, M.K.
26-2286
ICE ADHESION, METALS, TEST EQUIPMENT.
Based on analysis of test data, it is established that: (1) force of ice cohesion with various materials depends on the type of material, condition of its surface and the temperature; (2) force of ice cohesion increases at a decrease in temperature and an increase in roughness of surface; and, (3) force of ice cohesion depends on ice structure and rate of increase of external load. The faster the rate of load increase, the greater the value of cohesion force. At gradual loading, the viscous-plastic properties of ice are manifested.

**TL 251**
**LARGE SCALE TESTS TO DETERMINE THE DEGREE OF FROST SUSCEPTIBILITY OF GRAVEL.**
Brandl, H., 28p., AD-882 850L, For original German article see 25-531. 15 refs.
26-2736
GRAVEL, FROST RESISTANCE, FREEZE THAW TESTS, ROADS, FROST HEAVE, PAVEMENTS, THERMAL CONDUCTIVITY.
The data from the freezing tests are valid for a compaction of the gravel to 100 percent of the simple proctor density at optimal water content. The water content and the degree of compaction influence the behavior of the loose rocks under frost effect as follows: the better the gravel layers are compacted, the stronger becomes the suction force in the pores, the greater their thermal conductance at constant water content and the frost penetration rate and depth. In addition, the permeability index decreases with increasing compaction of the soils, so that the water quantity drawn upward in the time unit from the still unfrozen, deeper lying layers, remains slight.

**TL 252**
**INFLUENCE OF FROST AND THAW ON THE PERFORMANCE OF ROADS IN SWITZERLAND.**
Bonnard, D., et al, 1971, 9p., AD-882 851L, For original French article see 24-1840. 8 refs.
Recordon, E.
26-2737
FROST PENETRATION, FROST HEAVE, FROST ACTION, SEASONAL FREEZE THAW, ROADS, PAVEMENTS, COLD WEATHER PERFORMANCE, FROST PROTECTION, TRAFFICABILITY.
Two kinds of studies on the depth of frost action have been carried out in Switzerland for more than ten years; measurement of the maximum depth of frost penetration in existing roads in the course of winter at locations distributed in the lowlands and mountains up to an altitude of more than 2000 m, and study of the effect of the kind and thickness of the paving in a test station specially constructed for this purpose. The principal results acquired and measures to counteract the effect of freezing are discussed.

**TL 253**
**GROUNDING ELECTROTECHNICAL ASSEMBLIES UNDER PERMAFROST CONDITIONS.**
Nozhevnikov, V.E., 1971, 7p., AD-722 221, For original Russian article see 24-771.
26-2287
CONTINUOUS PERMAFROST, ELECTRICAL GROUNDING, TRANSMISSION LINES, ELECTRIC EQUIPMENT.
The report discussed the problem of choosing the type of grounds and the kind of ground network in the presence of a layer of permafrost soil.

**TL 254**
**BUILDING EMBANKMENTS ON SWAMP.**
Prokhorenkov, V., 1971, 5p., AD-722 222, For original Russian article see 25-1625.
26-2288
ROADS, SWAMPS, EMBANKMENTS, TRAFFICABILITY, PAVEMENTS, CONSTRUCTION.

For improving the soil conditions, the soft soils are either reinforced or they are replaced by harder ones. In the construction of a road surfacing, as a rule the topping is not placed directly on the soil but on a sandy base with a thickness up to 1 m for transferring pressure from the traffic load to a fairly large surface of soil in order that the permissible pressure on the soil would not be exceeded. For the proper fulfillment of its function, the underlying layer of sand should be dry; this is possible only with good water drainage. With the new design, the underlying sand layer and drainage are not needed. In the sectors with unfavorable soil conditions, it is proposed to lay a ferroconcrete covering strip with a thickness of 10-15 cm.

**TL 255**
**VARIATION OF PHYSICO-MECHANICAL PROPERTIES OF SOILS UNDER THE ACTION OF CYCLIC FREEZE-THAW.**
Shusherina, E.P., 1971, 11p., AD-722 223, For original Russian article see 24-660.
26-2289
FREEZE THAW CYCLES, SOIL PHYSICS, SOIL MECHANICS.
For solving many questions in engineering practice, i.e. the building and operation of various structures and also for investigating such natural phenomena as frost erosion, shore dynamics, etc., a study of the variations in the physico-mechanical properties of the soils subjected to freeze-thaw cycles has very great significance. The experimental study had the purpose of clarifying the essential tendencies in the variations of certain physico-mechanical properties of soils (resistance to shear and compressibility) under the effect of a freeze-thaw cycle with allowance for the influence of the most significant factors, primarily, of their structure.

**TL 256**
**SHORT NOTE ON THE SNOW STORM.**
Shiotani, M., et al, New York University. Bronx School of Engineering and Science, 1971, 3p., AD-882 666, Translation from Proceedings of the Japan National Congress for Applied Mechanics, 2 d, 1952, p.217-218.
Arai, H.
26-2738
SNOWSTORMS, SNOWDRIFTS, SNOW DEPTH, WIND VELOCITY, TURBULENT DIFFUSION, SNOW DENSITY.
When the snow falls in a strong wind at low temperature, or the wind blows heavily just after a fresh snowfall, the snow moves horizontally along the snow cover. During a snow-storm the quantity of drifting snow is very large in the air layer adjacent to the snowy surface and rapidly decreases upwards. The vertical distribution of drifting snow was measured above the level snowy surface during the snow storm. Most of the drifting snow lies in the air layer below 1 meter high.

**TL 257**
**STRUCTURE AND REGULARITY OF WIND CURRENT IN SNOW BLIZZARD.**
Diunin, A.K., 1971, 21p., AD-721 739, Translation of Moscow, Izdatel'stvo Akademii nauk SSSR, 1956.
26-2290
SNOWDRIFTS, SNOWSTORMS, WIND FACTORS, METAMORPHISM (SNOW), ANALYSIS (MATHEMATICS).
The snow cover and its variations are very important to agriculture and transportation. The most important is the drifting snow. But its behavior has not been well studied. The author tries to find similarities between the drifting snow and the transfer of heavy particles by liquid currents and in this way the author correlates the process of snow blizzard with the transfer process of sand particles in water and in air. The following 2 essential problems are taken into consideration: the structure of the transferred material as defined by its granulometric composition, and the weight of the transferred materials moving in a unit time period.

**TL 258**
**TRANSFER AND DEPOSITION OF SNOW.**
Kungurtsev, A.A., 1971, 27p., AD-721 741, Translation from Moscow, Izdatel'stvo Akademii nauk SSSR, 1956, 10 refs.
26-2291
SNOWDRIFTS, WIND VELOCITY, TOPOGRAPHIC FACTORS, SNOW ACCUMULATION.
The principal factor in the movement and deposit of snow is the wind force, particularly when associated with great constancy in wind direction. Wind observations taken by instruments of the type registering momentary or instantaneous values of wind speed and velocity show that these qualities of the wind are rarely constant very long. Sharp changes in wind velocity have been observed near the surface also. The decrease of wind velocity for snow is the principal factor causing snow deposits and 2.4 m/s is the value of wind velocity (for European USSR) below which the wind is unable to transfer snow flakes under normal conditions.

**TL 260**
**ACTION OF ICE ON ENGINEERING STRUCTURES.**
Korzhavin, K.N., 1971, 321p., AD-723 169, 209 refs.
26-2292
RIVER ICE, ICE BREAKUP, ICE BREAKING, ICE PRESSURE, STRUCTURES, ANALYSIS (MATHEMATICS), ICE MECHANICS, ICE CONTROL.
Conditions of ice-breakup in the rivers of the European part of the Soviet Union are described and compared with those of the Siberian rivers. Methods of computing the strength of ice under compression, cutting, bending and fracturing during the ice flow are offered and conversely methods are recommended for determining the strength of structural supports, taking into account the shape of the ice guards, load, size of ice packs, contact pressures, velocity of the flow, and the air temperature. The effect of the edge slope of ice breakers is discussed. A proposed method for the determination of the minimum permissible span of bridges or apertures in hydraulic structures insures a free flow of ice.

**TL 261**
**STUDIES ON FROST HEAVE, FROST PENETRATION AND RATIO OF REPLACEMENT TO PREVENT FROST DAMAGE OF ROADS IN HOKKAIDO.**
Ifukube, M., 1971, 261p., AD-883 628, For original article see SIP 20379. 76 refs.
26-2739
FROST HEAVE, FROST PENETRATION, ROADS, PAVEMENTS, THERMAL CONDUCTIVITY, FROST RESISTANCE, CONSTRUCTION MATERIAL, ANALYSIS (MATHEMATICS).
Numerous data have been obtained from investigations of frost penetration and frost heaving of roads in all parts of Hokkaido over a period of several years. The following are discussed; (1) calculation of the frost penetration by application of the heat conduction theory, (2) verification of frost penetration, (3) comparison of the frost depth before and after replacement, (4) investigation of the ratio of replacement based on frost heave and frost penetration studies, (5) investigations of the depth of replacement, and (6) a suggested method of determining the frost susceptibility of volcanic ash as a replacement material.

**TL 262**
**SCALE MODEL EXPERIMENTS ON SNOWDRIFTS AROUND BUILDINGS. REPORT 1.**
Kimura, K., et al, 1971, 7p., AD-883 629, For original article see SIP 16068.
Yoshisaka, T.
26-2740
SNOWDRIFTS, BUILDINGS, SIMULATION, SNOW ACCUMULATION, WIND TUNNELS.
The paper describes a scale model experiment which was carried out to determine the pattern of distribution of snowdrifts around buildings, and is intended as a reference material for constructors planning buildings in snowy districts. Field surveys have limitations because of difficulties in varying the experimental conditions arbitrarily and locating an adequate profile of the building. The advantage of scale model experimentation is that it can reproduce the distribution of snowdrifts under different conditions and profiles of building.

**TL 263**
**STRENGTH AND THIXOTROPIC PROPERTIES OF THAWED SOIL.**
Zhestkova, T.N., 1971, 7p., AD-722 599, For original Russian article see 24-1035.
26-2293
FROZEN GROUND MECHANICS, THIXOTROPY, THAWING, ROADBEDS, SOIL STRENGTH.
This paper contains an investigation of problems connected with variation and stability and supporting capacity of thixotropic and quick ground in the base of the earthen road bed and the soils put in the fill. When solving the problems of stability of structures it was necessary to establish under what conditions and in what types of soils with respect to composition and moisture the given properties occur and how this is reflected in the strength characteristics of the soil.

**TL 264**
**VARIATION OF SHEAR STRENGTH OF CLAYEY GROUND DURING FREEZING AND THAWING.**
Mikhaĭlov, G.D., 1971, 5p., AD-722 600, For original Russian article see 23-2590.
26-2294
SEASONAL FREEZE THAW, SHEAR STRENGTH, GROUND THAWING.
Railroad fills made with clayey ground in the winter frequently deform during spring thawing. The fills settle grossly, the banks cave in, and formation of ballast troughs is observed. One of the causes of such deformations can be lowering of the basic strength index of the soil — the shear strength — during freezing and thawing. The Novosibirsk branch of the Research Institute of Transportation Construction has studied the variation in shear strength and cohesion of the soil as a result of freezing and thawing for various soil moistures and densities. Samples of the required density and moisture were prepared from the soils in the laboratory.

**TL 265**
**SHEAR STRENGTH OF CLAYEY GROUND DURING THAWING (ACCORDING TO LABORATORY AND FIELD STUDIES).**
Mikhaĭlov, G.D., et al, 1971, 12p., AD-722 601, For original Russian article see 23-1425. 4 refs.
Brediuk, G.P.
26-2295
GROUND THAWING, CLAY SOILS, SHEAR STRENGTH, FROZEN GROUND MECHANICS, FOUNDATIONS, ROADBEDS, SOIL FREEZING.
The weakening of clayey ground during thawing and failure to consider this fact when planning and designing the foundations of structures and earth road beds are frequently the cause of their deformation, especially in deep freezing regions. In order to estimate the weakening of thawing clayey ground, the Novosibirsk branch of the All-Union Scientific Research Institute of Transportation Construction performed laboratory and field studies of the shear strength of these soils before freezing and after freezing and thawing. The characteristics of the investigated soils are presented.

**TL 266**
**PROCEDURE FOR DETERMINING THE SHEAR STRENGTH OF THAWED SOILS.**
Shusherina, E.P., 1971, 7p., AD-722 602, For original Russian article see 23-2364. 3 refs.
26-2296
SHEAR STRENGTH, GROUND THAWING, LABORATORY TECHNIQUES.
The report describes laboratory techniques used in USSR to determine the shear strength of thawed soils.

**TL 267**
**STRENGTH CHARACTERISTICS OF THAWED CLAYEY GROUND AT VARIOUS STAGES OF CONSOLIDATION.**
Vodolazkin, V.M., 1971, 12p., AD-724 634, Translation from Akademiia nauk SSSR. Inst. merzlotovedeniia. Severnoe otdelenie. Trudy, 2:66-72, 1962. 11 refs.
26-2328
SOIL STRENGTH, GROUND THAWING, CLAY SOILS, BEARING CAPACITY, SOIL TESTS, COLD WEATHER CONSTRUCTION, SOIL MECHANICS.
As a result of direct and indirect thermal effects of buildings and structures on the permafrost in the Vorkuta industrial region, significant sections of unfrozen, thawed clayey ground up to 15 meters and more thick have appeared. In a number of cases these sections are already being used for building two-story wood and stone buildings. However, planned use of the sections for construction of buildings and other structures is still difficult as a result of poor study of the bearing capacity of thawed soil and lack of defined recommendations for allowable pressures. It is known that any ice, saturated soil, including the Vorkuta soil, loses its bearing capacity to a significant extent on going from the frozen state to the thawed state as a result of increased moisture in the soil which was created during freezing.

**TL 268**
**FROST HEAVE DAMAGE TO ELECTRICAL CABLES.**
Smirnov, N.P., 1971, 5p., AD-724 635, Translation from Elektricheskie stantsii, 12(7):31-32, April 1941.
26-2329
TRANSMISSION LINES, FROST HEAVE, FROST PROTECTION, DAMAGE, FREEZING.
The effects of the composition, moisture and temperature of the ground on the severity of frost heaving are analyzed, and measures to prevent cable damage by frost heaving are listed, including drainage, covering the cables with sand, the use of chemicals to depress the f.p. of the ground and the allowance of slack when laying cable in ground subject to heaving.

**TL 269**
**EFFECT OF FROST HEAVE ON COMMUNICATION CABLES.**
Peretrukhin, N.A., et al, 1971, 31p., AD-724 636, For original Russian article see 23-4429. 10 refs.
Kulikov, IU.G., Novoderezhkin, V.A.
26-2330
TRANSMISSION LINES, FROST HEAVE.
Frost heave and its effect on cables were studied in experimental sections under natural conditions. The effect of cyclic displacements of the cable on the mechanical and electrical strength was studied under laboratory conditions.

**TL 270**
**THERMAL INSULATION FOR PROTECTING COMMUNICATIONS CABLES FROM FROST HEAVE DAMAGE.**
Kulikov, IU.G., 1971, 6p., AD-724 643, For original Russian article see 23-4431. 4 refs.
26-2331
TRANSMISSION LINES, THERMAL INSULATION, FROST HEAVE.
The effect of the thermal insulation or fill varies depending on the climatic and frozen ground conditions as a result of which the optimal dimensions of the insulation will vary somewhat for each region.

**TL 271**
**DEVICE FOR STUDYING STRESSES AND DEFORMATION OF THAWING GROUND.**
Abekov, T.U., 1971, 6p., AD-724 644, For original Russian article see 25-2989.
26-2332
GROUND THAWING, STRESSES, DEFORMATION, STRAIN GAGES, THAWING, MEASURING INSTRUMENTS.
A compression-type device is described which has the possibility of measuring precipitation and the pore pressure in thawed and thawing ground by depth during the effect of static, dynamic (short-term and multiply-recurring) and during vibration loads.

**TL 272**
**NUMBER OF ICE PARTICLES FORMED BY HETEROGENEOUS NUCLEATION IN MIXING CHAMBER FOG.**
Pena, J.A., 1971, 8p., AD-884 616L, For original French article see 25-1818. 5 refs.
26-2741
HETEROGENEOUS NUCLEATION, SUPERCOOLED FOG, ICE NUCLEI, CLOUD CHAMBERS, FREEZING NUCLEI.
The number of ice particles produced by heterogeneous nucleation in the supercooled fog of a mixing chamber is calculated. In this calculation, the validity of the Bigg's law for the conditions of the droplets in the fog is assumed. Also assumed is that the obtained results from experiences of heterogeneous nucleation with droplets of monodistillated water, can be employed in the calculations for the fog droplets. The calculated concentration of the freezing nuclei is of the same order as the measured concentration of ice nuclei.

**TL 273**
**IN SITU EXPERIMENTAL DETERMINATION OF EFFECTIVENESS TEMPERATURE OF FOG DISPERSAL SYSTEM INSTALLED AT ORLY AIRPORT.**
Serpolay, R., et al, 1971, 7p., AD-884 617L, For original article see 25-1820.
Fabre, R.
26-2742
FOG DISPERSAL, THRESHOLD TEMPERATURES, SUPERCOOLED FOG, AEROSOL GENERATORS, EFFECTIVENESS.
An operation of fog dispersal conducted at Orly Airport in exceptional conditions confirmed that 0 C is the operational threshold of effectiveness for a ground-based device working with sprayers of liquid propane.

**TL 274**
**SNOW CONTROL ON ROOFS ON INDUSTRIAL BUILDINGS.**
Topolev, M.S., 1971, 16p., AD-725 876, Translation from Promyshlennoe stroitel'stvo, 1935, 13(2):23-27.
26-2342
SNOWDRIFTS, SNOW REMOVAL, ROOFS. INDUSTRIAL BUILDINGS.
The report discusses possible methods for combatting snowdrifts on roofs of industrial buildings, especially in regions of heavy snowfall.

**TL 275**
**STUDIES ON SEA WATER REFRIGERATION CONCENTRATION. REPORT 13: STUDIES ON THE NUCLEATION AND THE GROWTH OF ICE CRYSTAL IN SEA WATER.**
Umano, S., et al, U.S. Joint Publications Research Service, 1971, 37p., AD-885 376L, For original paper see SIP 18811. 15 refs.
Kawasaki, S.
26-2743
SEA WATER FREEZING, SEA ICE, ICE CRYSTAL GROWTH, ICE CRYSTAL NUCLEATION, SUPERCOOLING, ANALYSIS (MATHEMATICS).
A study on the supercooling and freezing of sea water is described. The degree of supercooling of sea water samples is determined by the nature of the nuclei and that of the container walls. The interrelationships between such parameters as degree of supercooling, quantity of ice produced, and velocity of crystal growth are shown mathematically.

**TL 276**
**STUDIES OF SEA WATER REFRIGERATION CONCENTRATION. I. FREEZING TEMPERATURE OF SEA BRINE.**
Umano, S., et al, U.S. Joint Publications Research Service, 1971, 9p., AD-885 377L, For original article see SIP 18837. 7 refs.
Kawasaki, S.
26-2744
SEA WATER FREEZING, BRINES, FREEZING POINTS, SALINITY.
The results of f.p. determinations of samples collected in April and June 1953, and Dec. 1956 on the coast at Öiso are reported. The f.p. of brine samples with a total salt content from 2.-18-17.38 percent by weight was -1.13 to -13.27 C, that of samples with a salt content of 3.41-20.05 percent ranged from -2.21 to -17.84 C, and that of samples with a salt content from 12.-83-24.80 percent (eutectic concentration) ranged from -8.225 to -22.927 C. The accuracy of the measurements was ±0.02 C.

**TL 277**
**STUDIES ON SEA WATER REFRIGERATION CONCENTRATION. II. CHANGE IN COMPOSITION THROUGH REFRIGERATION CONCENTRATION OF SEA BRINE.**
Umano, S., et al, U.S. Joint Publication Research Service, 1971, 5p., AD-885 309L, For original article see SIP 18838. 2 refs.
Kawasaki, S., Nakano, Yo., Hayano, I.
26-2745
SEA WATER FREEZING, BRINES, CHEMICAL COMPOSITION, SALINITY.
The authors measured the weight percentage of completely solid materials, the weight percentage of all chlorine, and the changes in the Mg, Ca and SO4 content in analyzing 25 samples of sea water refrigeration concentration materials. As a result, they found that Mg and Ca were concentrated exactly in proportion to the original concentration, but that SO4 was suddenly reduced from about 6 percent Cl.

**TL 281**
**AERIAL PHOTOGRAPHIC METHOD FOR STUDYING GROUND WATER.**
Meier, G.IA., 1969, FSTC-HT-23-479-68, 17p., AD-690 613, For original Russian article see 23-1294. 4 refs.
26-2297
GROUND WATER, AERIAL SURVEYS, AERIAL PHOTOGRAPHY.
This paper presents a general review of the use of the aerial photographic method in the search for ground water in various parts of the Soviet Union. The individual indicators of the presence of ground water shown on aerial photographs are discussed; these include such features as vegetation, relief, culture features, and many others. The article discusses the most useful scales of photography, cameras, light filters, aircraft, proper season for conducting the work, most suitable weather and best time of day. The various criteria used in different regions of the USSR are listed. The significant role of the geobotanical method is discussed, followed by some comments on the preparation of interpretation keys and photomosaics and the role played by black and white and color prints.

**TL 282**
**STEFAN'S PROBLEM.**
Kamenomostskaia, S.L., 1971, 50p., AD-725 877, Translation from Matematicheskiĭ sbornik, 53(95):-489-514, 1961.
26-2355
STEFAN PROBLEM, CONDUCTION, HEAT TRANSFER.
In the present work Stefan's problem in its general sense (multidimensional case, arbitrary number of initially unknown phase boundary surfaces, a thermal coefficient dependence of the phase on temperature) is analyzed. A determination of the general solution of the problem is introduced and it is shown, that the classical solution of the problem is general (theorem 1). Using the method of infinite differences the existence of solutions of the edge problem and the Cauchy problem are shown for an arbitrary segment of time. The uniqueness of the general solution is shown, from which in particular follows the uniqueness of the classical solution.

**TL 283**
**ZONALITY OF THE STRENGTH OF THE SEASONALLY THAWING LAYER AND ITS MAPPING IN WESTERN AND SOUTHERN YAKUTIYA.**
Solov'ev, P.A., 1971, 13p., AD-725 878, Translation from Seasonal thawing and freezing of ground in the Northeast Territory of the USSR. Moscow, Izd-vo Nauka, 1966. P.14-20. 5 refs.
26-2343
ACTIVE LAYER, FROZEN GROUND MECHANICS, SOIL MAPPING, CONSTRUCTION, USSR—YAKUTIA.
In practical terms one of the most important characteristics in the field of distribution of rocks [illegible]rzen for many years is the strength of the seasonally thawing layer. Its magnitude often determines both the conditions for excavating and the construction of parts of various equipment sunk into the ground. Areas that have not been studied are usually characterized by analogy to adjacent regions for which there are corresponding data. In this regard, essential inaccuracies can arise because it is not always possible to take the natural peculiarities of the area in question and the zonal changes in the depth of the seasonal thawing into account. The mapping of this characteristic of frozen layers has been called upon to play a sizable role in improving the accuracy of predictions.

**TL 285**
**EXPERIMENT ON THE EFFECTS OF FREEZING AND SUBSEQUENT THAWING ON CLAY STRENGTH.**
Shusherina, E.P., et al, 1971, 16p., AD-725 880, Translation from Materialy po laboratornym issledovaniiam merzlykh gruntov, 3:280-288, 1957. 2 refs.
Tsytovich, N.A.
26-2344
FROZEN GROUND STRENGTH, FROZEN GROUND MECHANICS, FOUNDATIONS, TESTS, CLAYS, FREEZE THAW CYCLES.
The report describes results of tests conducted of the variations in the strength of the Quaternary and Tertiary clays in the foundation of the building of a hydroelectric station after their freezing and thawing.

**TL 287**
**THERMAL ANALYSIS OF SEA WATER.**
Gitterman, K.E., 1971, 21p., AD-726 863, Translation of Vsesoiuznyĭ nauchno-issledovatel'skiĭ institut metallurgii. Trudy, 15(1):5-23, 1937.
26-2350
SEA WATER, CHEMICAL PROPERTIES, THERMAL ANALYSIS, SEA WATER FREEZING, EVAPORATION.
Ocean water is a dilute solution of salts entering its composition. The question of obtaining any combination of salts from ocean water requires its enrichment by salt and the crystallization of salt from the concentrate derived. However, in certain geographic zones, the natural evaporation cannot be achieved owing to unfavorable climatic conditions. The relatively low air temperature during the winter, its considerable duration, raises the question of the possibility in these regions of a winter concentration of sea water by a method of natural freezing. Results of a thermal analysis of sea water are given.

**TL 288**
**EXISTENCE OF A QUASILIQUID FILM ON THE SURFACE OF ICE.**
Kvlividze, V.I., et al, 1971, 5p., AD-726 864, For original Russian article see 24-3534. 12 refs.
Kiselev, V.F., Ushakova, L.A.
26-2351
ICE SURFACE, ICE MICROSTRUCTURE, SURFACE PROPERTIES, LIQUIDS, FILMS, CRYSTAL LATTICES.
The hypothesis of existence of a quasiliquid film on the surface of ice at temperatures below its melting point (T (melt)) was first stated by M. Faraday for explanation of a number of mechanical properties of ice. In this report the authors describe the use of nuclear magnetic resonance to discover the nature of the surface of ice. This method makes it possible to obtain the most complete information about the degree of mobility of the molecules.

**TL 289**
**EXPERIMENTAL STUDY OF THE STRESS-STRAIN STATE OF THAWING BEARING SOILS.**
Ponomarev, V.D., 1971, 18p., AD-726 865, Translation from Vsesoiuznoe mezhduvedomstvennoe soveshchanie po geokriologii (merzlotovedeniiu), 8th, Yakutsk, 1966. Materialy, No.5:37-50. 15 refs.
26-2352
FROZEN GROUND MECHANICS, GROUND THAWING, BEARING CAPACITY, STRUCTURAL CHANGES, FROZEN GROUND, DEFORMATION.
Several studies are described which investigated the structure of a thawing bearing soil and the effect of the structure's parameters on its stress-strain state.

**TL 290**
**INFLUENCE OF IMPURITIES AND DISLOCATIONS ON THE ORDER-DISORDER TRANSITION IN HEXAGONAL ICE.**
Sesselmann, I., et al, Jan. 1972, 14p., AD-866 102L, 39 refs. For original paper see 26-808.
Helmreich, D.
26-2746
ICE STRUCTURE, DOPED ICE, IMPURITIES.

**TL 291**
**INSTRUCTIONS FOR DETERMINING RELATIVE COMPRESSION IN FROZEN GROUND THAWING UNDER PRESSURE.** Jan. 1972, 17p., AD-737 821, Translation of Akademiia Stroitel'stva i arkhitektury SSSR. Institut osnovaniĭ i podzemmykh sooruzheniĭ, 1958, p.2-16.
26-3367
GROUND THAWING, COMPRESSIVE PROPERTIES, PRESSURE FACTORS, FROZEN GROUND MECHANICS, CLAY SOILS, FROZEN SAND, UNFROZEN WATER CONTENT, SETTLEMENT (STRUCTURAL).

**TL 292**
**TYPES OF GULLIES AND RAVINES IN TUNDRA IN THE NORTHERN PECHORA PLAIN AND GYDAN PENINSULA.**
Liubimov, B.P., Jan. 1972, 10p., AD-737 147, Translated by U.S. Joint Publications Research Service. For original Russian text see 26-274. 8 refs.
26-3564
TUNDRA SOILS, SOIL EROSION, GULLIES, SLOPE PROCESSES, SOIL STABILIZATION, TUNDRA VEGETATION.

**TL 293**
**ANOMALIES OF WATER AND THE CRYSTALLINE STRUCTURE OF ICE.**
Al'tberg, V.IA., Jan. 1972, 24p., AD-741 053, For Russian text see SIP 8740.
27-1272
ICE CRYSTAL STRUCTURE, WATER STRUCTURE, ANOMALOUS WATER.
The report gives a brief summary of new data concerning the surface of water and related anomalous properties, as well as the structure of crystalline ice. (Auth.)

**TL 294**
**ON THE CENTERS OR NUCLEI OF WATER CRYSTALLIZATION.**
Al'tberg, V.IA., Jan. 1972, 23p., AD-741 054, For Russian text see SIP U1186.
27-1271
ICE CRYSTAL FORMATION, SUPERCOOLED WATER, ICE NUCLEI.
The report reviews previous work on the crystallization of ice in supercooled water and then presents results on such crystallization where water was only slightly supercooled.

**TL 295**
**ICE CRYSTAL FORMATION.**
Al'tberg, V.IA., Jan. 1972, 8p., AD-737 807, For Russian text and abstract see SIP 10118.
26-3368
ICE CRYSTAL FORMATION, ICE NUCLEI, SUPERCOOLED WATER, TEMPERATURE EFFECTS.

**TL 296**
**ICE CRYSTALS.**
Bass, R., et al, Jan. 1972, 18p., AD-738 158, Translation of Eiskristalle. Die Naturwissenschaften, 43(10)p.213, 1956, by Arctic Institute of North America. 23 refs.
Magun, S.
26-3565
ICE CRYSTALS, ICE CRYSTAL GROWTH, ICE CRYSTAL STRUCTURE, X RAY ANALYSIS, CRYSTAL LATTICES.

**TL 297**
**NEW INSTRUMENTS AND THE METHODS OF STUDYING ICE PHENOMENA.**
Butiagin, I.P., et al, Jan. 1972, 11p., AD-737 813, For Russian text and abstract see SIP 25586. 4 refs.
Morgunov, V.K.
26-3369
ICE MECHANICS, INSTRUMENTS.

**TL 298**
**GROWTH OF ICE.**
Bydin, F.I., Jan. 1972, 10p., AD-737 820, For Russian text and abstract see SIP U5666.
26-3370
RIVER ICE, ICE COVER THICKNESS, ICE GROWTH, TEMPERATURE EFFECTS, SNOW COVER EFFECT, RIVER FLOW.

**TL 299**
**SNOW ICE AND ITS SIGNIFICANCE IN COMPUTING THE THICKNESS OF THE ICE COVER.**
Deriugin, A.G., Jan. 1972, 26p., AD-737 824, For Russian text see 23-1770. 13 refs.
26-3371
SNOW ICE, ICE COVER THICKNESS, CAPILLARY ICE, WATER FLOW, FLOODING.

**TL 300**
**OBSERVATIONS ON THE STRUCTURE OF THE ICE COVER OF NEUSIEDLER LAKE.**
Dirmhirn, I., Jan. 1972, 5p., AD-738 156, Translation of Über eine Beobachtung der Struktur der Eisdecke auf dem Neusiedler-See. Wetter und Leben, Vol.8, p.73, 1956, by Arctic Institute of North America. 2 refs.
26-3566
LAKE WATER, LAKE ICE, LIGHT TRANSMISSION, ICE COVER THICKNESS, ICE STRUCTURE, AIR ENTRAINMENT, BUBBLES.

**TL 301**
**MECHANICAL EFFECTS OF LAKE ICE.**
Goebeler, E., Jan. 1972, 12p., AD-741 055, Translation of Verhandlungen der Gesellschaft f. Erdkunde, Berlin, 18:176-184. For German original see SIP 14384. 3 refs.
27-1464
LAKE ICE, ICE DEFORMATION.
The causes for the formation of fissures, ridges, and rafting of lake ice and their effects are discussed on the basis of 5-yr. observations in Germany. Fissures occur in a homogeneous ice cover in Jan.-Feb. as a result of the differential expansion of ice layers at different temperatures and usually precede the formation of ridges. Ridges are independent of currents and winds, forming generally in areas where the shoreline directly or indirectly impedes the free expansion of secondary ice in the fissures. The overthrust of larger ice masses over smaller ones is explained by the fact that the greatest pressures act from the direction of the larger mass. Ice ramparts up to 0.6 m. high above the winter water level result from ice pressure.

**TL 302**
**HYDROCHEMISTRY OF NATURAL ICE.**
Golovkov, M.P., Jan. 1972, 11p., AD-752 130, For Russian text see SIP 11174. 12 refs.
27-1677
ICE PHYSICS, ICE COMPOSITION, HYDROGEOCHEMISTRY, WATER CHEMISTRY.

**TL 303**
**PHYSICS OF ICE.**
Granicher, H., et al, Jan. 1972, 15p., AD-738 154, Publication in honor of the 70th birthday of Prof. Scherrer, Feb. 3, 1960. Birkhauser Verlag, Basel and Stuttgart. Translated by Arctic Institute of North America. 42 refs.
Jona, F.
26-3567
ICE PHYSICS, ICE CRYSTAL FORMATION, CRYSTAL LATTICES, ICE CRYSTAL STRUCTURE, ELECTRICAL RESISTIVITY, ICE ELASTICITY, LABORATORY TECHNIQUES, BIBLIOGRAPHIES, RESEARCH PROJECTS.

**TL 305**
**EFFECTS OF WATER BODIES ON AIR TEMPERATURE AND HUMIDITY DURING THE PERIOD PRECEDING THEIR FREEZING OR OPENING.**
Konovalov, B.P., Jan. 1972, 63p., AD-741 056, Translation from Tsentral'nyĭ institut prognozov, Trudy, Vol.58:63-100. 29 refs.
32-4112
ICE CONDITIONS, LAKE EFFECTS, LAKE ICE, RIVER ICE, AIR TEMPERATURE, HUMIDITY, SEASONAL FREEZE THAW, ICE MELTING, ICE BREAKUP, WIND FACTORS.

**TL 306**
**INFLUENCE OF ICE STRUCTURE UPON ITS STRENGTH.**
Lavrov, V.V., Jan. 1972, 12p., AD-737 823, Translation of Problemy arktiki i antarktiki 20:61-67, 1965. 3 refs.
26-3372
ICE CRYSTAL STRUCTURE, ICE STRENGTH, CRYSTAL ORIENTATION, ICE DEFORMATION, FLEXURAL STRENGTH, COMPRESSIVE STRENGTH.

**TL 307**
**APPLICATION OF ATMOSPHERIC PRESSURE AND CIRCULATION TO FORECASTS OF THE SIMULTANEOUS REGIONAL ONSET OF ICE PHASES.**
Lebedeva, V.V., Jan. 1972, [17p.], AD-737 817, Translation of Leningrad. Glavnaia geofizicheskaia observatoriia. Trudy, Vol.111:182-192. 5 refs.
26-3373
FREEZEUP, ICE FORECASTING, ATMOSPHERIC CIRCULATION, ATMOSPHERIC PRESSURE, RIVER ICE, SYNOPTIC METEOROLOGY, CLIMATIC FACTORS.

**TL 308**
**THRUSTS, BREAKS AND MELTING PHENOMENA OF ICE COVERS ON INLAND WATERS.**
Lehmann, F.W.P., Jan. 1972, 4p., AD-738 155, Translation of Stauungs-, Zerreissungs- und Schmelzungserscheinungen auf dem Eise von Binnengewässern. Petermanns Geographische Mitt., Vol.68, p.188, by Arctic Institute of North America.
26-3568
RIVER ICE, LAKE ICE, ICEBOUND LAKES, ICEBOUND RIVERS, ICE COVER THICKNESS, ICE BREAKUP, ICE JAMS.

**TL 309**
**STRUCTURE OF LAKE ICE AND METEOROLOGICAL CONDITIONS.**
Molchanov, I.V., Jan. 1972, 29p., AD-737 822, For Russian text and abstract see SIP 11687.
26-3374
LAKE ICE, ICE STRUCTURE, ICE COVER THICKNESS, SNOW COVER EFFECT, METEOROLOGICAL FACTORS.

**TL 310**
**DYNAMICS OF ICE PRESSURE ON HYDRAULIC STRUCTURES.**
Petrunichev, N.N., Jan. 1972, 46p., AD-737 815, For Russian text and abstract see SIP 11757. 9 refs.
26-3375
ICE PRESSURE, DYNAMIC LOADS, HYDRAULIC STRUCTURES, ICE FLOES, ICE COVER THICKNESS, FLOW RATE.

**TL 311**
**USING AN INDEX OF ATMOSPHERIC CIRCULATION FOR LONG RANGE FORECASTING OF RIVER BREAKUP.**
Savchenkova, E.I., Jan. 1972, 7p., AD-737 805, For Russian text and abstract see SIP 15827. 3 refs.
26-3376
RIVER ICE, ICE BREAKUP, ATMOSPHERIC CIRCULATION, LONG RANGE FORECASTING, INDEXES (RATIOS).

**TL 312**
**DEFORMATION OF NATURAL SOIL WATER DISPERSION SYSTEMS UPON THAWING.**
Bakulin, F.G., et al, Jan. 1972, 10p., AD-738 183, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 12686. 10 refs.
Zhukov, V.F.
26-3569
FROZEN FINES, SOIL MOISTURE MIGRATION, GROUND WATER, FROST PENETRATION, GROUND ICE, FROST HEAVE, THAWING, FROZEN GROUND SETTLING.
Ground deformation with freezing and thawing as a function of soil composition, moisture content, initial soil density and speed of freezing is mathematically analyzed and investigations related to the problem are briefly discussed. Water dispersion and ice formation have important effects on the deformation and changes in the mechanical properties of soils. The freezing of soil-water dispersions causes not only heaving and increased volume but also compaction. These dispersions retain their porous structure after thawing of the ice, and conpaction is possible by destroying this structure.

**TL 313**
**BUILDING PLANS FOR HOUSING IN NORTHERN REGIONS REFINED.**
Dezhnova, V., Jan. 1972, 4p., AD-737 818, For Russian text see 26-0906.
26-3377
BUILDINGS, COLD WEATHER CONSTRUCTION.

**TL 314**
**THERMAL REGIME OF LARGE WINDOWS.**
Lupakov, I.A., Jan. 1972, 9p., AD-738 185, Translation from Vodoznabzhenie i sanitarnaia tekhnika, 1971, no.5:36-38. 2 refs.
32-4146
HEATING, BUILDINGS, THERMAL REGIME, WINDOWS, AIR TEMPERATURE, HEAT TRANSFER, MICROCLIMATOLOGY.
With the need for providing comfortable conditions in public buildings or the strict observance of a temperature-humidity regime in production areas of industrial buildings during the cold part of the year, it is recommended that hot-air heating with recircula- tion of the air be used using the inter-pane space in the windows. (Auth.)

**TL 315**
**SETTLING OF FROZEN GROUND DURING THAWING AT EXPERIMENTAL PLOTS.**
Bakulin, F.G., Jan. 1972, 8p., AD-738 186, Translation from Materialy k osnovam ucheniia o merzlykh zonakh zemnoĭ kory, 1960, No.6:132-142. 12 refs.
32-4110
FROZEN GROUND SETTLING, GROUND THAWING, EXPERIMENTATION.

**TL 317**
**STRENGTH INCREMENT OF CONCRETE POURED INTO HOLES DRILLED IN PERMAFROST.**
Berezovskiĭ, B.I., et al, March 1972, 8p., AD-737 187, Translated by U.S. Joint Publications Research Service. For original Russian text see 26-1038. 2 refs.
Pavlenko, O.I.
26-3570
CONCRETE CONSTRUCTION, CONSTRUCTION MATERIALS, FROST RESISTANCE, CONCRETES, CONCRETE PLACING, WINTER CONCRETING, CONCRETE HARDENING, CONCRETE PILES.

**TL 318**
**EFFECT OF CRYOGENIC PROCESSES ON THE STRENGTH OF GROUND AND THE STABILITY OF EMBANKMENTS DURING THAWING.**
Brediuk, G.P., et al, March 1972, 9p., AD-738 189, Translation from Komitet po zemlianomu polotnu, Vol.9, Sooruzhenie zemlianogo polotna zheleznoĭ dorogi Novokuznetsk-Abakan-Taĭshet, Moscow, Transport, 1970, p.135, by U.S. Joint Publications Research Service. For original Russian text see 26-1120.
Mikhaĭlov, G.D.
26-3571
SEASONAL FREEZE THAW, EMBANKMENTS, SLOPE STABILITY, SLOPE PROCESSES, CRYOGENIC PROCESSES, SOIL STABILIZATION.

**TL 319**
**PHASE COMPOSITION OF WATER IN FROZEN GROUND UNDER PRESSURE.**
Chumichev, B.D., March 1972, 9p., AD-738 190, Translated by U.S. Joint Publications Research Service. For original Russian text see 26-1281. 9 refs.
26-3572
FROZEN FINES, FROST PENETRATION, UNFROZEN WATER CONTENT, PRESSURE, LOW TEMPERATURE TESTS, LABORATORY TECHNIQUES, TEST EQUIPMENT.

**TL 320**
**MECHANICAL PROCESSES IN SOILS DURING THE FREEZING OF THE LIQUID PHASE.**
Fedosov, A.E., March 1972, 59p., AD-738 546, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 3851. 37 refs.
26-3573
SOIL MOISTURE MIGRATION, FROST PENETRATION, FROZEN FINES, FROZEN GROUND STRENGTH, FROST HEAVE, FROZEN GROUND SETTLING.
Soils with water-filled voids begin to freeze with the formation of crystallization centers usually within the largest voids. The expansion of ice compresses the unfrozen areas and forces out water. The pressures produced may be determined by standard calculations used in soil mechanics. Moscow clays produce pressures of about 1.6 kg./sq.cm. when freezing. A formula is introduced for the calculation of the settling of a foundation erected upon frozen clay soils. The amount of settling appears to be the function of the specific gravity of the dry ground, the coefficient of porosity, the moisture content prior to freezing, and the thickness of the thawing layer under the building.

**TL 321**
**PATHOLOGY OF TERRACE ROOFS AND BURIED STRUCTURES.**
Varlan, G.E., March 1972, 69p., AD-738 667, Translation of Pathologie des toitures-terraces et des ouvrages enterrés. Annales de l'Institut Technique du Batiment et de Travaux Publics, No.286, October 1971, p.97-121, by U.S. Joint Publications Research Service. 21 refs.
26-3574
FOUNDATIONS, ROOFS, WATERPROOFING, THERMAL INSULATION, CONSTRUCTION MATERIALS, FLOORS, VENTILATION.

**TL 322**
**SCIENTIFIC CONFERENCE ON THE PROBLEMS OF CALCULATING THE SETTLEMENT OF FOUNDATION BEDS ON THAWING.**
Bondarev, P.D., et al, March 1972, 3p., AD-738 668, Translation from Osnovaniia, fundamenty i mekhanika gruntov, No.1, 1959, p.28, by U.S. Joint Publications Research Service. .
Zhukov, V.F.
26-3575
SEASONAL FREEZE THAW, FOUNDATIONS, SETTLEMENT (STRUCTURAL).

**TL 323**
**EFFECTS OF FREEZING ON THE MECHANICAL PROPERTIES OF CLAY MORAINE.**
Evdokimov, P.D., et al, March 1972, 6p., AD-738 669, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 13347.
Zauerbreĭ, I.I.
26-3576
FREEZE THAW CYCLES, CLAY SOILS, MORAINES, FROZEN FINES, SOIL MOISTURE MIGRATION, SOIL MECHANICS, SOIL STRENGTH.
Samples of hard ground consisting of clay, sand, and rock fragments were repeatedly frozen in the laboratory to study the effects of freezing on strength. The samples loosened after freezing, and their shearing strength decreased as much as 10 times. The initial strength of the samples was nearly restored when they were loaded to at least 1 kg./sq. cm. after freezing.

**TL 324**
**COMPRESSIBILITY OF GROUND OF UNBROKEN STRUCTURE WHEN THAWING UNDER LAND.**
Ushkalov, V.P., March 1972, 19p., AD-738 670, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 14867. 6 refs.
26-3577
FROZEN GROUND COMPRESSION, GROUND THAWING, STATIC LOADS, SOIL COMPACTING, COHESION, FOOTINGS, FROZEN GROUND PHYSICS, ANALYSIS (MATHEMATICS).
The problem of the compressibility of various soils while thawing under load is examined in detail on the basis of numerous experiments in laboratories and under natural conditions since 1944. Two methods of calculating those values are described which consider compressibility as a function of the physical and mechanical properties of the frozen ground and the loading pressure. Parameters for the formulas given are tabulated for loading ranges of 0.5-2 kg./sq. cm. on sand and clay and 1-3 kg./sq. cm. on ground.

**TL 325**
**PHYSICAL PROCESSES IN THAWING GROUND.**
Bakulin, F.G., et al, March 1972, 13p., AD-738 672, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 16572.
Savel'ev, B.A., Zhukov, V.F.
26-3578
GROUND ICE, SOIL MOISTURE MIGRATION, FROZEN FINES, GROUND THAWING, FROZEN GROUND ANALYSIS, COMPOSITION, STRUCTURES, PHYSICAL PROPERTIES.
The deformation of dispersed soils on thawing is examined in detail on the basis of all available data, with emphasis on the thermal characteristics of ice melting and moisture migration in the thawing strata. The compaction of dispersed soils is a function of ground structure and surface loading. A high ice content favors compaction since macropore volume is reduced after ice melting. Mineral soils thaw without compaction unless heavy surface loading destroys their structure. Proper evaluation of the problem must await the results of further studies on the structure and composition of these soils.

**TL 326**
**FOUNDATION CONSTRUCTION ON PERMAFROST IN THE UNITED STATES AND CANADA.**
Vialov, S.S., March 1972, 7p., AD-738 678, Translation of Osnovaniia, fundamenty i mekhanika gruntov, No. 3, 1965, p.28-30.
27-363
FOUNDATIONS, COLD WEATHER CONSTRUCTION, PERMAFROST CONSTRUCTION, FROZEN GROUND MECHANICS.

**TL 327**
**STRENGTH OF ICE AND ICE COVER (NATURE RESEARCH ON THE RIVERS OF SIBERIA).**
Butiagin, I.P., Aug. 1972, 127p., AD-748 397, For Russian text see 23-3214. 111 refs.
27-1046
ICE COVER STRENGTH, RIVER ICE, MEASURING INSTRUMENTS, TEST EQUIPMENT.

**TL 328**
**BASIC REGULARITIES GOVERNING COMPRESSIBILITY OF THAWING GROUND UNDER PRESSURE.**
Ushkalov, V.P., March 1972, 13p., AD-739 952, Translated by U.S. Joint Publications Research Service. For original Russian text see 23-1541. 9 refs.
26-3579
FROZEN GROUND COMPRESSION, COMPRESSIVE STRENGTH, GROUND THAWING, STATIC LOADS, ANALYSIS (MATHEMATICS).

**TL 329**
**CHANGES IN SOIL PROPERTIES ON FREEZING AND THAWING.** 253
Tsytovich, N.A., April 1972, 31p., AD-739 [illegible], Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 16573. 109 refs.
26-3580
SOIL FREEZING, FROST PENETRATION, SOIL STRUCTURE, SOIL STRENGTH, SOIL MOISTURE MIGRATION, GROUND ICE, ICE FORMATION, GROUND THAWING, COMPRESSIVE STRENGTH, SOIL TESTS.
The effects of temperature, chemical composition, water content, structure, surface loading, and other external factors on the properties of frozen ground are examined in detail on the basis of data obtained at the Institute of Permafrostology and elsewhere. A number of formulas and tables for calculting numerical values of these effects are included. Changes in the thermal conditions of frozen strata can be useful for construction purposes. Frozen clay can be prevented from swelling by compaction with sufficient surface loading. Likewise, the artificial freezing of water-saturated sand can be used to diminish the rate of frost heaving by decreasing the water content.

**TL 330**
**SETTLING OF STRUCTURES ON THAWING GROUND.**
Lapkin, G.I., April 1972, 10p., AD-741 057, For Russian text see SIP 11846.
27-1288
SETTLEMENT (STRUCTURAL), FROZEN GROUND SETTLING, GROUND THAWING, ARTIFICIAL THAWING, PERMAFROST CONSTRUCTION.
During construction on permafrost the question concerning the amount of forthcoming settlings has unique significance. An estimation of these settlings can be made on the basis of experiments with hot punches. The study examines a procedure for testing with punches. According to this technique, the soils thawing is envisaged by means of heating the water poured into a test borehole for a depth of 20-30 cm above a sandy filling (20-30 cm) which covers the borehole bottom after the placement of the punch. Heating the water begins after loading the punch with the planned weight. Thawing continues until stabilization of the settlings. (Auth.)

**TL 331**
**DESIGN OF FOUNDATION BEDS ON THAWING GROUND ACCORDING TO DEFORMATIONAL LIMITS.**
Ushkalov, V.P., April 1972, 12p., AD-739 959, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 17989.
26-3581
GROUND THAWING, BEARING STRENGTH, SETTLEMENT (STRUCTURAL), FOUNDATIONS, DESIGN.
A new method, based on field and theoretical studies, for making design calculations for foundations on thawing ground, taking into account the interrelationship between the structure and its base, is discussed. The method permits the use of various types of soils as a natural foundation bed, including such highly compressible soils as thawing permafrost, provided that the proper structural rigidity is selected according to the compressibility of the ground, that the allowable rate of settling is calculated, and that measures are taken for regulating the rate of settling and adapting the structure to differential settling. Semi-rigid structures should be built on ground with a compressibility coefficient on thawing not exceeding 0.1 under a load of 1 kg./sq. cm. Higher coefficients call for perfectly rigid or completely flexible construction. The mean allowable settling for semi-rigid structures is 10-25 cm. and the rate of settling 3-10 cm./yr., while the values are 25-50 cm. and 8-18 cm./yr. for the rigid and flexible types.

**TL 332**
**FOUNDATION SETTLING IN THAWING GROUND.**
Ushkalov, V.P., April 1972, 47p., AD-741 854, For Russian text see SIP 14868.
27-176
FOUNDATIONS, SETTLEMENT (STRUCTURAL), FROZEN GROUND SETTLING, COLD WEATHER CONSTRUCTION, DESIGN CRITERIA, GROUND THAWING.
Results of studies on foundation settling for about 100 structures built on frozen ground at an industrial plant in the Asiatic USSR are described in detail. The observations lasted from April 1941-Jan. 1950. Data on settling are tabulated in detail for various elements of the foundations, and profiles of the foundations studied are diagrammed and described. The physical and mechanical properties of the permafrost bases varied greatly and were analyzed in the laboratory as to their composition, porosity, structure, and ice content. Structural deformations for buildings constructed on degrading permafrost and on frozen ground protected from thawing are compared.

**TL 333**
**SOME PROBLEMS IN STRENGTHENING THAWING SOILS IN IGARKA AND NORIL'SK.**
Zhukov, V.F., April 1972, 5p., AD-741 058, Translation of Trudy Igarskoĭ Nauchno-Issledovatel'skoĭ Merzlotnoĭ Stantsii, No.2:70-72, 1961. 2 refs.
27-1443
SOIL STRENGTH, GROUND THAWING, GROUND ICE, FOUNDATIONS.

**TL 334**
**CALCULATION OF GROUND THAWING ALLOWING FOR WATER SEEPAGE.**
Fel'dman, G.M., April 1972, 11p., AD-739 954, Translated by U.S. Joint Publications Research Service. For original Russian text see 26-1224. 2 refs.
26-3582
GROUND THAWING, SOIL MOISTURE MIGRATION, HEAT TRANSFER, POROSITY, PERMEABILITY, ANALYSIS (MATHEMATICS), FROZEN GROUND.

**TL 335**
**DETERMINING THE TYPE OF GROUND AND ITS CONDITIONS ACCORDING TO SETTLEMENT.**
Kovalenko, V.V., et al, April 1972, 18p., AD-739 955, For Russian text see 26-1229.
Shishkanov, F.G.
27-977
PERMAFROST STRUCTURE, GROUND ICE, ACTIVE LAYER, SETTLEMENT (STRUCTURAL).
An evaluation is made of the methodology used for establishing the relative subsidence based on two curves and at varying pressures. Recommendations are advanced for increasing the reliability of determining the parameters for the settling-type soils of Eastern Siberia.

**TL 336**
**STUDYING THE SETTLING OF FROZEN GROUND ON THAWING.**
Shusherina, E.P., April 1972, 13p., AD-739 956, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 13109. 7 refs.
26-3583
FROZEN GROUND SETTLING, GROUND THAWING, SOIL COMPACTING, SOIL TESTS, SAMPLERS, LABORATORY TECHNIQUES.
A special apparatus constructed by TSytovich for studies in frozen ground is described in detail, and the procedures for obtaining both exact and approximate characteristics of ground settling and compaction resulting from thermal effects at the soil surface are outlined. Studies on settling should be made with soil samples free of large deposits of ice and at laboratory temperatures below the f.p. The measurements are continued until hourly deformation in the samples decreases to 0.01 mm, or less. The recommended range of loading is from 0.1-5 kg./sq. cm. for sand samples and 0.1-2.5 kg./sq. cm. for loam.

**TL 337**
**CALCULATING THE SETTLING OF FROZEN GROUND ON THAWING TAKING LOAD INTO ACCOUNT.**
Zhukov, V.F., April 1972, 6p., AD-739 957, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 17110.
26-3584
FROZEN GROUND SETTLING, GROUND THAWING, STATIC LOADS, SOIL COMPACTING, ANALYSIS (MATHEMATICS).
The settling of dispersed soil on thawing is analyzed mathematically. Equations are derived for calculating the compression of soil under its own weight and as a result of the disappearance of ice and decreased soil porosity; the values of a coefficient expressing the instability of the cryogenic texture of frozen soil (which determines the settling of soil under its own weight) are tabulated for various soil types; and the variation of the coefficient of porosity of thawing soil as a function of load is graphed. Brief instructions for determining experimentally the various parameters involved are given.

**TL 338**
**DEVELOPMENT OF THE PROCESS OF PRECONSTRUCTION THAWING AND CONSOLIDATION OF PERMAFROST.**
Zhukov, V.F., et al, April 1972, 11p., AD-739 958, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 20760. 3 refs.
Frolov, I.I.
26-3585
COLD WEATHER CONSTRUCTION, GROUND THAWING, ARTIFICIAL MELTING, ELECTRIC HEATING, SOIL COMPACTING, PERMAFROST THERMAL PROPERTIES.
The thermodynamic aspects of the experiment in electric thawing and consolidation of a permafrost foundation reported in SIP 20759 are discussed. The thawing process is analyzed step by step and the observational results are tabulated. The second phase of the electric process, the consolidation of the thawed ground by electroosmosis, was checked with a GPP-4 gamma-ray density meter without extracting soil samples. The density meter results were checked against density measurements of samples taken from control pits and were found to agree well with the control measurements. After being heated, the ground did not become a liquid mass, but became denser and approached the density of mineral aggregates of frozen ground. It is suggested that the cost of the operations could be reduced by wider spacing of the electrodes and by salting the ground to reduce its electrical resistance.

**TL 339**
**DENSITY OF SANDY GROUND.**
Kiselev, M.F., April 1972, 3p., AD-739 960, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 10081.
26-3586
SANDS, LOAMS, FROZEN GROUND SETTLING, GROUND THAWING, STATIC LOADS, SOIL COMPACTING, DENSITY (MASS/VOLUME), ANALYSIS (MATHEMATICS).
The subsidence of sandy ground after thawing is considered as a function of density. The classification of thawed sandy soil into 3 degrees of density as given in the official norms is rejected since porosity factors are neglected. Formulas for computing the porosity coefficient and mechanical strength of sandy soil in both the frozen and thawed states are given.

**TL 340**
**EXPERIMENTAL METHODS OF DETERMINING THE SETTLING OF PERMANENTLY FROZEN SOILS ON THAWING.**
Porkhaev, G.V., et al, April 1972, 7p., AD-739 961, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 17111. 3 refs.
Tsvetkova, S.G.
26-3587
FROZEN FINES, FROZEN GROUND SETTLING, GROUND ICE, GROUND THAWING, SOIL COMPACTING, TESTS.
Laboratory investigations on the settling of frozen ground on thawing are described and evaluated by comparison with field studies. Laboratory tests on undisturbed samples of frozen clay and sandy soils were made by means of odometers (6.2-8 cm. in diam. and 4.5 cm. high) at temperatures from 10-13 degrees C and a load of 0.05 kg./sq. cm., and visually on large stratified samples 30 x 30 x 40 cm. placed in wooden boxes. The settling of clay soil of 30-50 percent moisture content recorded with the odometer reached 20-50 percent, while that of sandy loam and sand (16-32 percent moisture) did not exceed 1-12 percent, being practically 0 in certain cases. Settling proceeded more evenly in sandy than in clay soils, a fact which is attributed to the absence of ice inclusions in the former, and stability was reached after 3-5 hr. against 2-4 hr. for clay soil. Stratified samples consisting of clay and sand as well as clay, ice, and sand, settled an average of 12.5 percent and 23.5 percent, respectively, when subjected to surface thawing at 4-10 degrees C. The settling of soil in 6 x 6.5 m. plots in the field averaged 0.14 m. for a thawed depth of 0.56 cm., or a relative settlement of 25 percent. Good agreement was found between field and both laboratory tests only for sandy loam and sand not containing ice. Field and experimental settling values for clay soils with ice agreed, while odometer values were much higher.

**TL 341**
**VARIATIONS IN THE POROSITY OF FROZEN GROUND PRODUCED BY THAWING.**
Shusherina, E.P., April 1972, 19p., AD-739 962, Translated by U.S. Joint Publications Research Service. For original Russian text see SIP 8936. 2 refs.
26-3588
FROZEN GROUND ANALYSIS, FROZEN GROUND SETTLING, POROSITY, GROUND ICE, GROUND THAWING, SOIL COMPACTING.
Variations in the porosity of frozen quartz sand, loam and clay were studied in the laboratory of the Institute of Permafrostology during 1948-49. Frozen ground was thawed under pressures from 0.1-5.0 kg./sq. cm. The results confirmed TSytovich's conclusion that variations of ground porosity are a linear function of pressure.

**TL 342**
**ROAD ENGINEERING CONFRONTED WITH THE PROBLEM OF FREEZING AND THAWING.**
Berthier, J., 1972, 25p., AD-741 059, For French text see 26-1815.
27-1260
ROADS, FREEZE THAW CYCLES, FROST PROTECTION.
The economic consequences of the decisions taken by engineers with regard to the protection of roads against freezing are of considerable magnitude. But the entire protection against freezing of the total road network would be so costly that it would appear to be impossible to envisage, at least in the near future. The systematic use of thaw barriers has consequences which are much more difficult to evaluate but which are equally difficult to accept. One is therefore necessarily led to setting up a hierarchy within the road network and of providing an entire series of classes of roads ranging from those which will be totally protected from freezing to those upon which it will frequently be necessary to impose traffic restrictions. (Auth.)

**TL 343**
**MANUAL FOR THE STUDY OF THE PROPERTIES OF ICE.**
Savel'ev, B.A., April 1972, 225p., AD-741 870, For Russian text see SIF 22659. Numerous refs.
27-237
ICE STRUCTURE, SNOW COVER STRUCTURE, ICE COMPOSITION, LABORATORY TECHNIQUES, MANUALS, ICE STRENGTH, ICE THERMAL PROPERTIES.
Chapters in the manual deal with: (1) The study of the structure of ice and snow by a recommended crystal optical method. Procedure is given for preparing snow and ice sections, photographic reproduction, and comparative evaluation of the results. A method which summarizes many structural elements in a single diagram is presented. (2) Methods of investigating the chemical composition of ice, melt water and brine. (3) Study of the liquid and solid phases of saline ice. (4) Methods of determining density and porosity. Special attention is paid to the method of radioactive logging used by A.V. Krasnushkin in 1959 in Antarctica. (5) Methods of analysis of gas inclusions in ice. (6) Basic methods of testing the strength of ice. (7) Study of thermal and radiation properties of ice.

**TL 344**
**STABILITY OF FOUNDATIONS ON CLAYEY GROUND IN REGIONS WITH DEEP SEASONAL FREEZING.**
Dalmatov, B.I., et al, April 1972, 11p., AD-741 871, For Russian text see 23-4450. 7 refs.
Karpov, V.M.
27-209
FOUNDATIONS, SETTLEMENT (STRUCTURAL), FROZEN GROUND SETTLING, CLAY SOILS, SEASONAL FREEZE THAW, FROST PENETRATION, FROST HEAVE, SOIL MOISTURE CONTENT.

**TL 345**
**COMPRESSIBILITY OF THAWING FOUNDATION BEDS ACCORDING TO FIELD INVESTIGATIONS.**
Ushkalov, V.P., April 1972, 9p., AD-741 872, For Russian text see SIP 18378. 8 refs.
27-215
COMPRESSIVE PROPERTIES, GROUND THAWING, SOIL COMPACTING, FOUNDATIONS.
The results of studies from 1941-1950 at the Trans-Baikal Permafrost Station on various types of soil are reported and compared with laboratory data. The measurements were made in the field and under foundations of various types. Settling due to thawing was 2-3 times higher than that due to soil compression. At 3 kg./sq. cm. these values were nearly equal. Load and settling were not related linearly, but the relation between absolute settling on thawing and the relative settling under compression (at 1-3 kg./sq. cm.) was practically linear. Max. densification occurred at 1-3 kg./sq. cm.; further pressure increase to 5kg./sq. cm. caused only a small increase in density. For all soils tested, relative compression and the initial coefficient of porosity (frozen) were related linearly at 1-3 kg. per sq. cm. Laboratory thawing coefficients exceeded field values by 10-45 per cent; laboratory coefficients of densification were 6-19 per cent higher; and laboratory coefficients of compressibility were 10-30 per cent higher.

**TL 346**
**ICE PRESSURE ON SEPARATE SUPPORTING STRUCTURES IN THE SEA.**
Afanas'ev, V.P., et al, April 1972, 20p., AD-741 873, For Russian text see 26-1969. 10 refs.
Dolgopolov, IU.V., Shvaĭshteĭn, Z.I.
27-210
ICE PRESSURE, SEA ICE, OFFSHORE STRUCTURES, PIERS, DYNAMIC LOADS, LOADS (FORCES), ICE COVER STRENGTH, FLEXURAL STRENGTH, ICE FLOES.

**TL 347**
**DEVELOPMENT OF METHODS FOR DETERMINING ICE PRESSURE ON BRIDGE PIERS IN THE USSR.**
Korzhavin, K.N., April 1972, 16p., AD-741 855, For Russian text see 26-2378. 17 refs.
27-211
RIVER ICE, ICE PRESSURE, BRIDGES, ICE STRENGTH, DYNAMIC LOADS, ICE JAMS, FLOATING ICE, FLEXURAL STRENGTH.

**TL 348**
**DYNAMIC PRESSURE OF ICE ON HYDRAULIC STRUCTURES.**
Shadrin, G.S., et al, April 1972, 28p., AD-741 874, For Russian text see 26-1171. 16 refs.
Panfilov, D.F.
27-212
RIVER ICE, ICE PRESSURE, HYDRAULIC STRUCTURES, ICE STRENGTH, ANALYSIS (MATHEMATICS).
The article contains a critical survey of certain published formulas and the derivation of new formulas for finding the value

of dynamic ice pressure on the vertical and inclined starlings and walls, a comparison of calculated values and recommendations, as well as those observed in the experiment and in nature.

**TL 349**
**TURF (PEAT) HUMMOCKS OF KAMCHATKA.**
Babov, N.G., May 1972, 17p., AD-741 911, For Russian text see 23-1278. 20 refs.
27-213
PEAT, HUMMOCKS, GROUND ICE, PERMAFROST DEPTH, GROUND THAWING, ACTIVE LAYER, USSR—KAMCHATKA.

**TL 350**
**TURF HUMMOCKS IN THE LOWER COURSE OF THE INDIGIRKA RIVER.**
Tolstov, A.N., May 1972, 8p., AD-742 218, For Russian text see 23-1311. 7 refs.
27-214
HUMMOCKS, GROUND ICE, ARCTIC VEGETATION, FROST HEAVE.

**TL 351**
**NOMOGRAPHS FOR DETERMINING THE SPEED OF SNOW AVALANCHES.**
Kozik, E.M., May 1972, 17p., AD-746 257, For Russian text see SIP 15219. 2 refs.
27-673
AVALANCHES, FLOW RATE, AVALANCHE VELOCITIES, NOMOGRAPHS.
The problem of determining the parameters in Tushinskiĭ's formula for snow avalanches is discussed, and a modification to permit calculation of nomographic charts is given. Tables and nomographic charts were computed for a wide range of speed variations, which are considered as a function of the length of avalanche route and coefficients of steepness and accumulation area. The use of the charts is described.

**TL 352**
**DETERMINING THE SPEED OF SNOW AVALANCHES.**
Shakhuniants, G.M., May 1972, 10p., AD-748 398, For Russian text see SIP 14766. 4 refs.
27-1045
AVALANCHE VELOCITIES, MATHEMATICAL MODELS.
The problem of avalanche movement is mathematically analyzed in detail. The differential equations derived refine formulas developed at the Tiflis Research Construction Institute by G. G. Saatchan, who neglected wind resistance during movement as well as the resistance increase with time. Air resistance is considered as proportional to the square of avalanche speed and the cross-section normal to the direction of movement. The Chervinskiĭ investigations of snow avalanches at Khibiny are used to define the general characteristics of parameters employed in the formulas. Special surveys of local conditions are required for accurate calculations in specific cases.

**TL 353**
**FAST ICE DYNAMICS IN THE MIRNY AREA.**
Dubrovin, L.I., et al, June 1972, 6p., AD-748 399, For Russian text see 26-1195 and Ant. Bibl.Vol.5, F-9592. 6 refs.
Savatiugin, L.M.
27-1043
SEA ICE, ICEBERGS, FAST ICE, ICE CRACKS.
The conditions for formation and the morphological characteristics of fast ice in the Mirnyy region from March 21 to April 25, 1966 are described. Charts for the fast ice for several years show that deformations and fractures have occurred at the same places every year, seemingly caused by constant conditions of the same origin. A classification is given of tidal, wave, deflection, and horizontal tearing fractures caused by sea level fluctuations, sea swell, snow accumulation, glacier flow, icebergs, islands, and the coastal contour. The need for precise data on the fast-ice dynamics during ship unloading and cargo transportation from ship to base is discussed.

**TL 354**
**ON DETERMINING THE MELTED WATER CONTENT OF SNOW BY DIELECTRIC MEASUREMENTS.**
Ambach, W., June 1972, 7p., AD-747 943, For German text and abstract see SIP 16966. 7 refs.
27-1047
SNOW WATER CONTENT, SNOW DIELECTRICS, ELECTRICAL MEASUREMENT, MEASURING INSTRUMENTS.

**TL 355**
**SETTLING OF THAWING GROUND.**
Zhukov, V.F., July 1972, 3p., AD-748 157, For Russian text see 26-1881.
27-1048
GROUND THAWING, FROZEN GROUND SETTLING, GROUND ICE, PERMAFROST HYDROLOGY.

**TL 360**
**ON THE COMPUTATION OF FOUNDATION SETTLEMENTS ON THAWING SOIL BASES.**
Kiselev, M.F., Aug. 1972, 51p., AD-748 400, For Russian text see 26-3669. 16 refs.
27-1049
ACTIVE LAYER, FOUNDATIONS, FOOTINGS, SEASONAL FREEZE THAW, SETTLEMENT (STRUCTURAL), GROUND THAWING.

**TL 361**
**DISPOSAL OF RADIOACTIVE WASTE MATERIAL IN THE ICE CAPS OF THE WORLD.**
Philberth, B., Aug.1972, 19 refs., AD-748 401, Translation of Schweizerische Zeitschrift für Hydrologie, 23 (1) 1961, p.263-284. 4 refs.
27-1044
RADIOACTIVE WASTES, LAND ICE, GREENLAND, ANTARCTICA.
The problem of the disposal of wastes from fission materials is discussed in terms of preventing the scattering of these products in amounts harmful to human life. Highly active fission isotopes with short half life disintegrate swiftly and do not scatter. The few with long half life need only to be delivered into the general circulation—primarily the oceans— at rates slow enough to prevent local concentrations. Those isotopes with medium half life present the greatest danger and must be enclosed for a guaranteed period of 1500 years. The ice caps of Greenland and Antarctica are ideally suited for the disposal of these radioactive wastes. The areas involved are large: Greenland 2,000,000 sq km, Antarctica 14,000,000 sq km; there is little or no meltwater to enhance the scattering of waste materials; the temperature, viscosity, and plasticity of the ice are such that they could receive and store the dangerous materials safely for the necessary time periods. Finally, transporting the wastes to the ice caps is considered with regard to economics, technical feasibility, and safety. The transportation aspect is regarded as not insurmountable but requires additional study.

**TL 362**
**HOUSING CONSTRUCTION IN GREENLAND.**
Balanovskiĭ, L., Aug. 1972, 9p., AD-748 404, For Russian text see 26-3360.
27-1050
RESIDENTIAL BUILDINGS, COLD WEATHER CONSTRUCTION, CONSTRUCTION MATERIALS, GREENLAND.

**TL 363**
**ANCHORAGES IN SOILS FOR HYDROENGINEERING.**
Hückel, S., Sept. 1972, 214p., AD-749 464, Original publ. Gdansk, Polska Akademia Nauk, 1970. 71 refs.
27-1463
ANCHORS, SOIL MECHANICS, LOADS (FORCES).

**TL 364**
**ELECTROPHOTOMETER FOR RECORDING THE RATIO OF TWO LIGHT CURRENTS.**
Malyshev, G.M., Oct. 1972, 5p., AD-750 595, Translation of Pribory i tekhnika eksperimenta 6:98-100, 1957. 7 refs.
27-1444
PHOTOMETERS, ELECTRIC MEASURING EQUIPMENT, CURRENT RATIOS.
Described is an experimental model of an electrophotometer recording the ratio of two light currents. The electrophotometer consists of two photomultipliers, a double bridge amplifier and an automatic potentiometer recorder. All basic components of the photometer are described and examples of records are given.

**TL 365**
**NOTES ON A THERMAL PROBE FOR MEASURING THE TEMPERATURE OF ICE LAYERS.**
Philberth, K., Oct. 1972, 4p., AD-750 596, Translation of Comptes rendus de l'Académie des Sciences 255(22):3022-3024. 6 refs.
27-1445
HEAT MEASUREMENT, PROBES, ICE TEMPERATURE.
When a thermal probe is thrust down into ice, it disturbs ambient temperature. In order to measure the original temperature only 1 hour after such heating, a special device is suggested: the thermometer is placed in the point of a bar below the head of the probe.

**TL 366**
**METHOD OF PREDICTING THE STRENGTH PARAMETERS OF ROADBED STABILITY OF SILTY SOILS IN REGIONS I AND II OF ROAD CLIMATIC ZONES WITH AID OF A COMPUTER.**
Zolotar', I.A., Oct. 1972, 19p., AD-750 597, For Russian text see 26-3941. 17 refs.
27-1446
ROADBEDS, COLD WEATHER CONSTRUCTION, SOIL STRENGTH, SOIL STABILIZATION, FROST HEAVE, COMPUTER PROGRAMS.
In planning and building the main transport truck roads in regions I and II of the road-climatic zone, it is necessary to solve the question concerning the opportunity of applying the local cohesive soils for building a roadbed. To facilitate the evaluation of these soils (silty sandy loams and silty loams) and in planning the road designs, the author's method was converted to algorithm, programmed and solved on the Ural-4 computer for more than 150 points in the USSR territory. Averaged parameters for the two soils were established and formulas for transferring from soil moistness to its strength and stress indexes derived. The adoption of the computer into the planning of road designs in the regions of permafrost and severe climate will favor the formulation of planning the highways on a higher scientific level.

**TL 367**
**ESTIMATION OF HEIGHT AND SETTLEMENT OF FILL PLANNED IN PERMAFROST ZONE ASSUMING THAWING OF SOIL BASE.**
Malyshev, A.A., et al, Oct. 1972, 16p., AD-750 598, For Russian text see 26-3944. 15 refs.
Popov, B.I.
27-1462
ROADS, COLD WEATHER CONSTRUCTION, FROZEN GROUND SETTLING, SOIL STABILIZATION, EARTH FILLS.
Based on the studies conducted, the following conclusions are drawn: The stability of road structures in the permafrost zone depends on the carrying capacity of the base soils which is determined by the degree of their settlement. Settlement of soils depends on the type of moistness (ice content) of the soil. The schematic charts for the settlement of base soils provides a basis for selecting a principle for planning the road structures, specifying the height of fill and choosing the preliminary calculation of the scales of earth-moving operations. Selection of the method for estimating the final settling depends on the extent of moistness in the base soils, the presence or absence of mossy-vegetative interstratification, time of performing the work, and type of soils in the base. The possibility and feasibility of applying the theory of soil compaction to estimates of settling at moistness of base soils within the limits of Wrel < 0.7 is demonstrated. Appropriate formulas are suggested for calculating settling at 0.77 < Wrel < 1.0 and at Wrel > 1.0.

**TL 368**
**CALCULATING THE STRENGTH OF ROAD STRUCTURES UNDER PERMAFROST CONDITIONS IN THE FIRST ROAD-CLIMATE ZONE.**
Puzakov, N.A., et al, Oct. 1972, 10p., AD-750 599, For Russian text see 26-3945. 12 refs.
Davydov, V.A.
27-1447
ROADS, COLD WEATHER CONSTRUCTION, ACTIVE LAYER THICKNESS, SOIL STRENGTH, THAW DEPTH, PERMAFROST CONSTRUCTION.
We recommend that the calculation of the strength of a road structure functioning under permafrost conditions be performed in the following sequence: 1) Determine the thickness of the thawing soil (heat- engineering calculation system) with preliminary designation of a specific depth of covering. 2) Establish the required strength (Ereq.) of the structure, proceeding from the tolerable overall (SAURSRI method) or the elastic (MAHI method) deformation and load. 3) Refine by calculation the depth of covering assuring the strength needed. We do not explore the question of designating the thickness of structure based on conditions of tolerable heaving or permissible settling on thawing of soil.

**TL 369**
**EFFECT OF GROUND WATER ON STABILITY OF SLOPES AND STRUCTURES ERECTED ON THEM ON THAWING OF FROZEN SOILS.**
Savel'ev, V.S., Oct. 1972, 10p., AD-750 600, For Russian text see 26-3955. 3 refs.
27-1448
SLOPE STABILITY, GROUND WATER, SETTLEMENT (STRUCTURAL), GROUND THAWING, FROZEN GROUND SETTLING.
From many years' investigations of the stability of soil masses and structures on the solifluction slopes of Chukotka, it has been established that the stability reserves coefficient of the thawed layer can in no way be determined on the basis of only the physico- mechanical properties and displacement parameters of the soils. To a considerable extent, the stability of soil masses is determined by their filtration qualities and specific conditions of slope flooding caused by the freeze-thaw cycles. The stability of the seasonally thawed layer on the slopes formed of silty sands and sandy loams is usually disrupted during prolonged rains. The loams and clays start to move even without atmospheric precipitation, owing to the ground water forming during thawing of interbeddings of segregated ice. Here the typical conditions for the stability of wet soils lying on the surface of frozen ground are examined.

**TL 370**
**STABILIZING THE COURSE OF A THERMAL PROBE.**
Philberth, K., Oct. 1972, 4p., AD-751 136, Translation of Académie des sciences, Paris. Comptes rendus hebdomadaires des séances, 262(6);456-459, Feb. 1966. 3 refs.
27-1680
THERMAL DRILLS, ICE DRILLS, STABILIZATION.

For thermal drilling in ice, probes are used which sink into the ice as an independent mechanical system. However, such drills tend to lose their vertical direction and slant toward the horizontal. Satisfactory drilling can only be obtained if the drill is stable, i.e., if the direction of its axis returns to the vertical once it has been diverted from it. Various probe shapes are discussed in terms of maximum stability. Flat-headed probes are stable but not suitable for penetrating ice because they push small pebbles and other impurities in front of the device which heat the meltwater, thus decreasing the efficiency. Cone-shaped probes can be stabilized by increasing the heat flux emitted by the end of the cone. A probe with a constant temperature created by a heavy copper head has a large flux at its lower end and is so thermally controlled. Such probes are simple and sufficiently stable in temperate ice. In cold ice, a mercury heat-controlled probe should be used.

**TL 371**

**FORECASTING COMPRESSIBILITY AND SETTLEMENT OF LOESS SOILS ACCORDING TO THEIR PHYSICAL PROPERTIES.**

Razorenov, V.F., et al, Oct. 1972, 8p., AD-751 137, For Russian text see 26-3812. 8 refs.
IAkovlev, A.V.
27-1678

SOIL COMPACTING, SOIL STABILIZATION, LOESS, COMPRESSIVE STRENGTH.

The methods suggested for predicting the variation in compressibility and relative settlement factors of loess soils are based on the correlation between indexes of the cohesive soils' physical and mechanical properties and essentially represent a further development and generalization of the two-curve method. The most typical samples of loess soils are subjected to compression under conditions of natural moistness and at varying extent of water saturation. In distinction from the method of two curves, the coincidence of the initial values of the soil skeleton's volumetric weight is not mandatory in the given instance. The authors recommend the suggested method for generalizing and analyzing the compressibility and settlement tendency of cohesive soils (including the loess-type ones) for extensive production practice.

**TL 372**

**COLD WEATHER CONSTRUCTION OF RIGHTS-OF-WAY FOR ROADS.**

Kharkhuta, N.IA., Oct. 1972, 9p., AD-751 138, For Russian text see 26-3964.
27-1679

ROADS, COLD WEATHER CONSTRUCTION.

Recommendations for roadbed construction are made emphasizing the effects of high moisture content in frost heave, necessity for soil compaction, the stabilization enhancement of grass cover and the decrease of freezing depth by utilizing snow cover and cultivating the soil. Road coverings should be placed not earlier than a year following roadbed construction, and if the coverings are extremely sensitive to soil stresses, they should be laid only in summer.

**TL 373**

**WIRED PROBE FOR MEASURING THE TEMPERATURE PROFILE IN ICECAPS.**

Philberth, K., Oct. 1972, 3p., AD-751 903, Translated from Umschau, No.11, p.360, 1966.
27-2905

THERMAL DRILLS, ICE DRILLS, ELECTRIC HEATING, GREENLAND.

In recent years, the author has developed a new thermal probe system which promises to reach depths of more than 3 km. Heating is provided electrically from above via a pair of copper wires insulated from each other. However, these wires are not delivered from above downward but initially they are wound within the probe and unwind from here outward. Soon after its exit from the probe, the wire pair freezes into the ice. This provides additional electrical insulation. The copper wires are flexible enough so that they do not become broken from the steady deformation of the ice. The probe is cylindrical, about 10 cm in diameter and 2 m in length. The heating unit is located on the very bottom; above that is the chamber containing the measuring instruments (thermistors, geophone, manometer, inclinometer and so forth): both wire reels are mounted above this; they take up the most space. The heating current flowing through the wire reels develops resistive heat in them. This is proportioned in such a way that the side walls of the probe can not become frozen in. For measuring the ice temperature at the desired depth, electric heating is cut off, after which the probe freezes in. Accordingly, the disturbed temperature approximates a hyperbolic function of the original ice temperature, which it in effect attains after a few days. Switching from the thermistors to temperature measurement and from the the other measuring instruments occurs through a relay.

**TL 374**

**THERMAL DEEP DRILLING IN CENTRAL GREENLAND.**

Philberth, K., Oct. 1972, 4p., AD-751 904, Translated from Umschau, No.16, p.515-516, 1960.
27-2906

DRILLING, ICE SHEETS, THERMAL DRILLS, GREENLAND.

Drilling into ice represents essentially a different problem than geologic boring. From an engineering standpoint, the main problems involve the viscous deformation of the ice and the refreezing of the melted water, from which drilling rods or cables become jammed unless preventive measures are undertaken. In the deep ice drillings, one is interested primarily in the temperature profile. The author developed a thermal deep-drilling probe with which the deepest ice layer on earth (over 4000 m) can be pierced. Within the scope of the IGGE, two such probes were put into operation for drilling at the Jarl-Joset Expeditionary Station in summer, 1968. Apart from the heating element difficulty with the premature ending of the run, the operation proceeded according to plan and the measurement yield was copious.

**TL 375**

**FREEZE-THAW EFFECTS ON FOUNDATION SOIL.**

Mamulea, M.A., Oct. 1972, 11p., AD-751 905, For Rumanian original see 26-3933. 26 refs.
27-2904

FROST ACTION, FREEZE THAW CYCLES, FOUNDATIONS, ROADBEDS, GROUND ICE, ICE LENSES, CLIMATE, RUMANIA.

The dangerous problem is not a general and extended freezing, but rather the existence of possibilities for the water to migrate toward freezing nuclei. The effects of freezing and thawing are not very great in the severe winters when there are long, cold periods which cause uniform and deep freezing of the soil; the effects are greatest in moderate winters with many alternations of freezing and thawing. The formation of sheets and layers of ice causes the production of large accumulations of water in solid state in isolated points. As long as the freezing period lasts, apart from some surface swelling and a few cracks, no other damage is caused. When the thawing begins, areas are created which have extensive water and frequently the quantity of this water exceeds the flow-off limit of the ground rock and this results in a massive shifting embankment.

**TL 376**

**DEFINITION OF BEARING CAPACITY, STABILITY, AND FINE-PARTICLE CONTENT OF GRAVELS FOR SUBGRADES AND THEIR DETERMINATION IN THE LABORATORY.**

Recordon, E., et al, Oct. 1972, 11p., AD-753 033, French text 27-0562.
Rechsteiner, G.
27-2794

GRAVEL, FOUNDATIONS, BEARING CAPACITY, FREEZE THAW CYCLES, ROADBEDS, FROST PENETRATION.

The foundation materials should be insensitive to the action of frost, easily compacted, and low in fine-particle content. It is shown that sands and silts are the most sensitive because they contain a large amount of fine constituents and are rather permeable. The clays are less sensitive as they are very slightly permeable, and the gravels, mixtures of gravel and sand, are not sensitive at all if they contain less than 3 percent in fine constituents (gravel I). Gravels II (containing 3-10 percent of fine constituents) are slightly sensitive to freezing. It is for this reason that the new standard introduces new quality criteria and new tests which make it possible to establish that their loss in bearing capacity due to freezing will remain sufficiently slight to render them acceptable. The laboratory tests undertaken on these materials included compaction, CBR tests, and a test to determine fine-constituent content. Lastly, the selection of samples is discussed.

**TL 377**

**PERMAFROST EROSION IN YAMAL.**

Shamanova, I.I., Nov. 1972, 9p., AD-753 034, Russian text 27-0938. 4 refs.
27-2792

PERMAFROST HEAT TRANSFER, SOIL EROSION, ACTIVE LAYER, THERMOKARST DEVELOPMENT.

The region under study is a distinctly terraced, gentle rolling aggradation plain with erosion-thermokarst runoff belts and numerous thermokarst lakes. The climate in the region is severe; the average many years' air temperature is -9.5C. The thickness of the frozen layers in a large part of the territory exceeds 300 to 400 m; their most typical temperature at the base of the layer of annual heat exchanges is -6 to -7C. The thickness of the seasonally thawing soil layer will fluctuate from 0.25 to 0.3 m to 1.3 m. Observations indicated that in the region under study, the presence of low-temperature permafrost soils near the surface not only failed to obstruct the development of the erosion process, but in many cases, it intensifies the erosional effect.

**TL 378**

**EFFECT OF VEGETATION ON THERMAL REGIME OF TUNDRA SOILS IN WEST TAYMYR.**

Pospelova, E.B., et al, Aug. 1973, 6p., AD-766 593, For Russian text see 26-0133. 9 refs.
Zharkova, IU.G.
28-1661

SOIL TEMPERATURE, THERMAL REGIME, TUNDRA SOILS, VEGETATION FACTORS.

A study was made of the effect of vegetation on the temperature regime of soils in certain tundras of Western Taymyr in the estuarial region of Agapa River. The observations were conducted 11 to 24 July 1967 and 23 July to 28 August 1968.

**TL 379**

**ACTIVE LAYER DYNAMICS IN TUNDRA AND FOREST TUNDRA OF LOWER OB' REGION.**

D'iakonov, K.N., et al, Nov. 1972, 4p., AD-753 035, 5 refs. Translated from Geograficheskie soobshcheniia, No.3, p.59-62, 1966.
Reteium, A.IU.
27-2793

GROUND THAWING, SEASONAL FREEZE THAW, ACTIVE LAYER, SOIL MOISTURE, FOREST TUNDRA.

This report is devoted to the study of the seasonal thawing of soil and its relationship with the temperature, soil moistness, and meteorological conditions. The territory under study comprises a plains sector in the interfluve of the Ob' River and its tributary, the Poluy, formed of sands and and sandy-loamy fluvioglacial deposits. The texture of the latter is uniform. All of the natural territorial complexes in the interfluve are supported by frozen layers with depth of 200-300 m. The observations were conducted in five different natural complexes geochemically interconnected and differing in altitude and moisture conditions.

**TL 380**

**DETERMINING THE OPERATING CONDITIONS OF CUTTING TOOLS IN ROCK-CUTTING MACHINES.**

Belorusov, G.S., et al, Nov. 1972, 5p., AD-756 077, Translated from: Stroitel'nye i dorozhnuye mashiny, No.6, p.22-23, 1972.
Shaparnyĭ, L.N.
27-2848

ROCK CUTTING, MACHINE TOOLS.

In rockcutting machines, extensive use is made of multi-edge cutting tools: circular saws, chain cutters, milling tools, etc. The complex path of the cutter's motion in a notch, the irregular cutting depth and also the uneven load on the individual cutters owing to estimating the regime of their functioning during the operating process (depth of cut, feed, cutting capacity of sharpened and blunted cutters, power and energy reserve of engine). During the investigation process, mathematical relationships were developed and verified which aid in the fairly accurate establishment of operating regimes of cutting tools during both their planning and utilization. Based on the described methods, integrated graphs for the power consumption (in cutting rock of various strength) and for the power of the engine (to drive the cutter) can be compiled. The drive of the cutting tool for any conditions of its operation can also be easily and quickly calculated.

**TL 381**

**NATURAL CONDITIONS AND SOILS OF "AGAPA" STATION (WESTERN TAYMYR).**

Vasil'evskaia, V.D., et al, July 1973, 40p., AD-764 804, For Russian original see 27-1227. 38 refs.
Ivanov, V.V., Bogatyrev, L.G.
28-3473

SOIL MICROBIOLOGY, TUNDRA SOILS, TUNDRA TERRAIN, TUNDRA VEGETATION, SOIL FORMATION, SOIL SURVEYS, SOIL COMPOSITION.

The general features of western Taymyr soil formation include: gleying; slight differentiation of vertical profile of morphology and chemistry; slightly acid or neutral state and great saturation by the bases; scarcity of nutritive elements; great influence of cryogenic processes on morphology and chemistry; slight peatiness and shallowness of oceanogenic horizons during impregnation by organic matter of the active layer; astatic, distinctly fulvate humus with high content of nonspecific substances; lack of differentiation of silty fraction along the soil profile; preferential development of lateral flow at slight manifestation of vertical flushing. Specific soil features include: weak morphological expression of gleying with low content of oxalate-soluble slightly crystallized forms of ferric hydroxides; broad development of mottling with predominance, among cryogenic processes, of crack formation and denudation and the formation of fissured-nanopolygonal and not of heaving-hummocky forms of microrelief; absence of podsolization; hypothetical influence of subjacent permafrost marine sediments.

**TL 382**

**SOILS AT TAMBOV STATION.**

IAkushevskaia, I.V., et al, July 1973, 29p., AD-764 805, Translation of Pochvy i Produktivnost' Rastitel'nykh Soobshchestv, No.1, Izdatel'stvo Moskovskogo Universiteta, 1972, p.150-177, 26p.
Samoilova, E.M., Bugaevskiĭ, V.K.
28-3474

MEADOW SOILS, SOIL MOISTURE, SOIL STRUCTURE, SOIL COMPOSITION.

In the central flatland forest-steppe region of the Tambov Lowland, the soil cover is formed by paleohydromorphic chernozems, meadow chernozems, and an association of meadow soils. In the latter, chernozem-meadow, meadow crustal solonetzes, and meadow solods are dominant. All meadow soils are characterized by heavy texture, high humus content, high absorption capacity, and significant trace element content. Ground water, slightly mineralized (hydrocarbonate), is held at a depth of 1-3 m. Chernozem-meadow soils are characterized by a periodically elutriative subtype of water regime with slight intrasoil exudation, good water permeability, and extensive water supplies through the growing season; meadow crystal solonetzes by a nonflushing subtype with intrasoil exudation and summer desiccation, and poor water permeability; solods by a

flushing subtype with periodic supersaturation from surface water and slight intrasoil exudation, constantly high moisture supply, and great ground water fluctuations. Meadow soils' soil solution is, in comparison with water extracts (hydrocarbonate), enriched by sulfates. Genetic relationships are described, suggesting that chernozem-meadow and marshy soils preceded solod.

**TL 383**

**RECENT FINDINGS ON THE PROBLEM OF FROST IN BUILDING FOUNDATIONS.**

Klengel, K.J., July 1973, 13p., AD-912 546, For German original see 27-0846.

28-3475

FREEZE THAW TESTS, FOUNDATIONS, FROST HEAVE, FROZEN GRAVEL.

The changes caused by frost action in foundation soil are particularly important as regards fine-grain loose-rock and the degree of moisture penetration, since upon freezing it exhibits the simultaneous pecularities of its water content collecting into lenticular ice formations while the material expands. State transformation resulting from water absorption beyond the quantity present before freezing causes most structural damage, particularly in roads and railroads, normally termed "frost damage."

**TL 384**

**STATE OF THE ART IN INSULATION LAYERS IN ROAD CONSTRUCTION.**

Meffert, R., July 1973, 16p., AD-912 547, Translation of Strasse und Autobahn, Vol.23, No.3, March 1972, p.97-102.

28-3476

THERMAL INSULATION, ROADS, CELLULAR PLASTICS, PROTECTIVE COATINGS.

This article discusses the extent and level of investigation of research and testing in the FRG and other countries of thermal barriers developed for and used in highway construction. It includes installation in city streets, highways, and expressways. Installation techniques are discussed in the test and illustrated by using photographs and sectional drawings of actual installations.

**TL 385**

**REVIEW OF CONTAMINATION PROBLEMS IN MEASURING TRACE ELEMENTS.**

Pinta, M., July 1973, 11 leaves, ADA-009 060, Translation, from French, of a paper presented at CNRS Colloquium on Trace Elements in Rocks and Other Natural Mineral Substances, Nancy, 4-6 Dec. 1968. Published 1970. 15 refs.

29-4020

IMPURITIES, CHEMICAL ANALYSIS, TRACE ELEMENTS.

Every sample analyzed must reflect the makeup of the environment in its natural state; contamination hazards, particularly in relation to trace measurements, range from the taking of the sample to the physical or chemical measurement of the content of the particular element being sought. The sources of contamination are many, sometimes built-in or accidental, but nevertheless frequently overlooked. The effects of this on trace measurements are analyzed one by one, and an effort is made to calculate the resulting error; insofar as possible, the best remedy for the situation is suggested. The following factors are studied: sampling, bagging, transport; physical treatment: parting, griding, sifting; chemical treatment: acid or alkaline attack, solution; the influence of glassware, equipment, reagents, exposure to air, and handling by personnel. Ordinary practical examples are given to illustrate these sources of error. The main ways of measuring trace elements are reviewed, and the contamination hazards inherent in each are cited.

**TL 386**

**THERMAL REGIME OF TUNDRA SOILS IN WEST TAYMYR.**

Bogatyrev, L.G., et al, July 1973, 6p., AD-772 768, For Russian original see 26-3227. 11 refs.

Vasil'evskaia, V.D., Ivanov, V.V.

28-3029

TUNDRA SOILS, THERMAL REGIME, TEMPERATURE VARIATIONS, SEASONAL VARIATIONS, THAW DEPTH.

The authors have studied the thermal regime of mottled tundras (West Taymyr) during the 1968 and 1969 growing seasons differing in weather conditions. Significant differences have been established in the receipt of heat in the soil of denuded patches and adjoining sectors under vegetation. The differences in the temperature conditions during comparable seasons in effect were not reflected on the maximal depth of soil's thawing.

**TL 387**

**EFFECT OF VIBRATION ON THE SHEAR STRENGTH OF THAWED GROUND.**

Mikhaĭlov, G.D., July 1973, 6p., AD-772 767, For Russian original see 27-184. 4 refs.

28-3030

CLAY SOILS, SEASONAL FREEZE THAW, THIXOTROPY, VIBRATION, GROUND THAWING, SHEAR STRENGTH.

A railway bed experiences extensive effects from passing trains: a variable pulsating load acting on the main area and the vibrations acting on the main area and on the slopes. As is known, pulsating loads on clayey soils lead to fatigue phenomena and to weakening of the clayey soils [1]; while the vibration effect leads to the origination of thixotropic occurrences in the soils and to their thixotropic weakening [2, 3]. The softening of soils promotes the development of strains in the main area and slopes of the earth bed. In regions with deep seasonal freezing, these deformations are usually intensified in spring on the thawing of soils. Therefore it is considered that the dynamic effects are especially aggressive in thawing soils.

**TL 388**

**DEFORMATION OF CLAYS DURING FREEZING AND THAWING.**

Malyshev, M.A., July 1973, 6p., AD-772 766, Translation of Inzhenerno-Stroitel'nyĭ Institut, Sbornik Nauchnykh Trudov, 14:58-62, 1969.

28-3031

CLAY SOILS, DEFORMATION, FREEZE THAW CYCLES, SEASONAL FREEZE THAW, FOUNDATIONS.

The present investigations were aimed at studying the deformability of clay soils under the influence of repeated freezing and thawing in order to provide an allowance for their deformations in the limiting state for foundation base calculations when the foundations are layed in a seasonal freezing zone. The laboratory experiments were conducted with loess loam from the blanket sediment of the town of Tomsk and pastes of abraded argillite and clay fractions isolated from the loams by elutriation.

**TL 389**

**MATRIX EFFECTS UPON THE QUANTITATIVE ANALYSIS OF TRACE ELEMENTS BY ATOMIC ABSORPTION.**

Pinta, M., et al, July 1973, 18p., AD-772 765, Translation (from French) of a paper presented at the Colloquium on quantitative analysis of trace elements in rocks and other natural mineral substances, Nancy, France, December 4-6, 1968; Paris, CNRS, 1970. 11 refs.

Riandey, C.

28-3032

CHEMICAL ANALYSIS, ABSORPTION, TRACE ELEMENTS.

Matrix effects in atomic absorption are of several types: salinity, and physical properties of the analysis-solution, and the nature of the solvent modify the atomizing of the solution; the constituents of the matrix determine the physical reactions in the flame: evaporation, fusion and volatilization and thermochemical reactions: dissociation of molecules and atomization, inter-elemental reaction, atomic-ionic equilibrium. A knowledge of each of these phenomena permits determination of the proper method of correction. Finally, the matrix effect can be interpreted in terms of perturbations of spectral type which result from the superposition of molecular absorption bands on the atomic line being measured.

**TL 390**

**REPORT OF THE JAPANESE ANTARCTIC RESEARCH EXPEDITION IN DRY VALLEYS, VICTORIA LAND. 1. EVAPORITES FOUND IN MIERS VALLEY, VICTORIA LAND, ANTARCTICA.**

Torii, T., et al, Aug. 1973, 11p., AD-772 764, For Japanese text see Antarctic Bibliography E-7402. 4 refs.

Murata, S., Yoshida, Y., Ossaka, J., Yamagata, N.

28-3112

MINERALOGY, GEOCHEMISTRY, ROCKS.

During the summers of 1963-1964, 1964-1965, and 1965-1966, geochemical studies of several lakes in the wide regions of rock outcroppings in Victoria Land of Antarctica were carried out. In summer of 1964-65, Miers Valley and Lake Miers were specifically studied. This valley is one of the Dry Valleys and the deposits of evaporites are interesting with respect to the formation of salt lakes present in the Dry Valleys. This report describes the characteristics and the occurrence of these evaporites, as well as the climate and geographic features of Miers Valley.

**TL 391**

**MINERALOGICAL COMPOSITION OF WHITE EVAPORITES AND YELLOW SALTS FOUND AROUND SHOWA STATION, ANTARCTICA.**

Kaneshima, K., et al, Aug. 1973, 13p., For Japanese original see Antarctic Bibliography E-6996. 5 refs.

Torii, T., Miyahira, K.

28-2852

MINERALS, GEOCHEMISTRY, CHEMICAL ANALYSIS, X RAY DIFFRACTION.

Geochemical surveys were carried out during Summer 1966-67 near Showa Station. Specimens collected included evaporites which were widely distributed on the flat ground surface of a dried-up pond or deposited on the surfaces of rock outcroppings or in the shades of rocks. In this study, chemical analyses were carried out on a collection of white evaporites and yellow salts and the minerals were identified by X-ray powder diffraction. In order to study the yellow salts, the rocks on which white evaporites or yellow salts were found were analyzed and extraction tests were attempted to determine the state of the iron. Reported here are the results of these tests.

**TL 392**

**EXPERIMENTAL METHOD OF CLASSIFYING SOILS ACCORDING TO THE EXTENT TO WHICH THEY BREAK UP ON FREEZING.**

Aguirre-Puente, J., et al, Aug. 1973, 22p., AD-769 719, For French original see 28-2069. 19 refs.

Dupas, A., Philippe, A.

28-2853

SOIL FREEZING, PLASTIC DEFORMATION, FROST PENETRATION, FROST HEAVE, GROUND WATER, EQUIPMENT.

An experimental method, based upon a test of swelling upon freezing, permits relative classification of different soils with respect to one another according to a parameter brought to light by fundamental studies of swelling upon freezing, which is the slope of the straight line curve of swelling as a function of the square root of the frost index. An experimental installation was developed for this purpose, with which relative classification of eight soils covering a wide range in their extent of breaking up on freezing was accomplished. The studies have the objectives, in a first phase, of establishing an operating procedure, and in a second phase, relative classification of the greatest possible number of soils.

**TL 393**

**SIMULATION STUDY OF THE EFFECTS OF FROST UPON HIGHWAY PAVEMENTS AND SUPPORTING GROUND.**

Philippe, A., et al, Aug. 1973, 28p., AD-769 720, For French original see 28-2130. 6 refs.

Aguirre-Puente, J., Bertouille, H.

28-2854

SOIL FREEZING, FREEZE THAW CYCLES, PAVEMENTS, HEAT TRANSFER, FROST PENETRATION, SUBGRADE SOILS.

A station designed for studying the behavior upon freezing and thawing of highway pavement constructions and their foundations of soils which break up upon freezing was built at Caen so as to provide a connection between laboratory studies and observations made under natural conditions. The installation built consisted of an insulated hangar constructed above a trench in which was placed a mass of soil which breaks up upon freezing; on top of the latter, the highway pavements to be studied were laid. The installation included the apparatus necessary to obtain data on heat and mass transfer in the pavements and foundation soil as well as on the mechanical behavior of the pavements. This communication describes in detail the results, in the first two sets of experiments, related to the performance of the installation, the conditions of frost-front propagation, and the displacements of the pavement surfaces caused by freezing.

**TL 394**

**ISOSTATIC PHENOMENA ON ICE FLOES.**

Nazintsev, IU.L., Aug. 1973, 11p., AD-768 828, For Russian original see 26-1972. 3 refs.

28-2855

ISOSTASY, FLOATING ICE, ICE PLASTICITY, PLASTIC DEFORMATION, ICE COVER THICKNESS.

As is known, isostatic phenomena in drifting ice floes are caused by the uneven thawing and accretion of ice, by runoff of melt water, snow accumulation and other causes. The tendency of ice toward isostatic equilibrium is manifested not only in the variation in its settling compared to that generally for the ice field but also in the plastic deformations of ice, i.e. in the vertical displacements of one part of the field relative to another, associated with local disruptions in the isostatic equilibrium. These disruptions develop continuously; as a result, equilibrium is found only as a whole for the entire ice field or its large parts. By using supplemental data, we will attempt to show the possible application of an analysis of isostasy to certain ice calculations such as ice thickness and vertical movements of the ice.

**TL 395**

**BREAKING ICE WITH A JET OF GAS.**

IAkovlev, G.N., Aug. 1973, 16p., AD-768 827, For Russian original see 26-1977. 4 refs.

28-2856

ICE CUTTING, ICE BREAKING, THERMAL DRILLS, ROCK DRILLING, TEMPERATURE GRADIENTS, MELTING.

Thermodynamic methods are currently being applied successfully in industry for breaking rocks. These same methods have been examined for breaking ice. However, for large scale operations the use of a gas jet does not appear promising because of the large amount of energy required to melt ice.

**TL 396**

**CUTTING SEA ICE BY DIRECTED BLASTING.**

Nikolaev, S.E., Aug. 1973, 20p., AD-768 829, For Russian original see 26-1979. 5 refs.

28-2857

SEA ICE, ICE BLASTING, ICE NAVIGATION.

The utilization of directed blasting can prove a very effective means in solving a number of practical problems: the creation in the pripay (fast shore ice) of ice-free channels for the passage of ships with a weak hull, for laying pipes or cable from the ice surface, and so forth. Placing the charges according to a prescribed system and exploding them through brief time intervals in a fixed sequence can assure the directed removal of ice along the given direction.

**TL 397**
**CUTTING ICE WITH A CONTINUOUS HIGH-PRESSURE WATER JET.**
Shvaĭshteĭn, Z.I., Aug. 1973, 11p., AD-769 721, For Russian original see 26-1978. 8 refs.
28-2858
ICE CUTTING, SEA ICE, ICE BREAKING, HYDRAULIC JETS.
In a study of the possible techniques of cutting ice by an "icecutter", it was clarified that, in addition to the mechanical devices for cutting and breaking down the ice, it is feasible to utilize a high-pressure water jet. The possibility of the utilization of such jets is particularly important for cutting relatively thick ice (from 0.5m and more) since the mechanical means (disk cutters, etc.) are fairly complicated. During the movement of the ice-cutter, from a hydrocompressor mounted on the ship, through shaped nozzles, we feed continuous high-pressure jets with which a number of parallel blocks are cut.

**TL 398**
**VARIATION IN THICKNESS AND TEMPERATURE REGIME OF PERMAFROST BENEATH AREAS OF SEDIMENT ACCUMULATION AND DENUDATION.**
Balobaev, V.T., Aug. 1973, 12p., AD-769 722, For Russian original see 27-1140.
28-2859
PERMAFROST THERMAL PROPERTIES, PERMAFROST THICKNESS, ACTIVE LAYER, HEAT TRANSFER, GROUND THAWING.
The lack of a quantitative interpretation of the interrelationship between the condition of frozen layer and vertical displacements of the day surface favors the possibility of the appearance of various explanations for the anomalous thicknesses of the frozen soils, particularly in mountainous regions. A theoretical solution to the question concerning the dynamics of the frozen soil layer under conditions of sediment accumulation involves considerable difficulties. In this case, to the problem concerning freezing, there is added the additional condition of the displacement of the day surface, the temperature of which causes the existence of the frozen layer. This report attempts to solve this problem approximately and to analyze the consequences ensuing from the solution.

**TL 399**
**SIBERIAN NALEDS.**
Akademiia nauk SSSR. Institut merzlotovedeniia, April 1973, 300p., AD-764 806, Translation of Naledi Sibiri, Moscow, Nauka, 1969. For individual papers see: 28-1597 through 28-1619. 322 refs.
Alekseev, V.R., ed.
28-1596
NALEDS, CLASSIFICATIONS, TERMINOLOGY, ICE GROWTH, PERMAFROST HYDROLOGY, PINGOS, CRYOGENIC PROCESSES, GROUND WATER, TALIKS.

**TL 400**
**RECOMMENDED PRACTICE FOR COMBATTING ICE JAMS.**
Sinotin, V.I., Aug. 1973, 106p., AD-769 723, Translation of Metodicheskie ukazaniia po bor'be zatorami i zazhorami l'da, Leningrad, Energiia, 1970. 48 refs.
28-2860
RIVER ICE, ICE JAMS, DUSTING, EXPLOSIVES, AERIAL SURVEYS, BOMBING, HYDRAULIC STRUCTURES.
Because ice jams and floods resulting from them are dangerous and often economic disasters and because they are a part of the life cycle of most rivers in the USSR, methods have been developed to control them. Various measures can lessen the effects of these jams: eliminate the conditions which form the jams; accurately predicting the location and intensity of ice jams; destroying those already formed. Recommended practices for destroying or preventing jams are: dusting ice covers to weaken them; use of mechanical devices to cut or break the ice; straightening river channels; aerial surveys and bombing; use of explosives; protection and proper design of hydraulic structures; and controlling the flow and temperature of the currents to inhibit ice formation.

**TL 401**
**MELTING OF HUMMOCK ICE.**
Nazintsev, IU.L., Aug. 1973, 9p., AD-769 724, For Russian original see 26-1971. For another translation see 27-2063. 5 refs.
28-2861
SEA ICE, ICE MELTING, ICE SURVEYS, ICE REPORTING, HUMMOCKS, ICE COMPOSITION.
The summer thawing of sea ice is one of the main elements in ice forecasting. The polar stations in the Arctic have accumulated extensive data on the thawing and disintegration of ice. However, almost all of the data is related to the smooth surface of an ice cover rather than to hummocks. At the same time, the hummocking zones occupy such an appreciable area that in the continuous and concentrated ice formations, they comprise the main obstacle to the movement of vessels. In this connection, as estimation of the thawing and weakening of ice in the hummocks is of practical interest. Results obtained from measurements in the ice accumulations in the many years' field work of the North-Pole-13 station in 1966 are listed. A simple system for calculating the ice mass destroyed by thawing in the hummocks is suggested.

**TL 402**
**RELATIONSHIP BETWEEN THERMAL AND ELECTRICAL PROPERTIES OF ICE.**
Korennov, B.I., et al, Aug. 1973, 4p., AD-769 725, For Russian original see 27-1134. 3 refs.
Cherepanov, V.G.
28-3113
ICE ELECTRICAL PROPERTIES, ICE THERMAL PROPERTIES, ELECTRICAL RESISTIVITY.
The linear form of the dependence between the coefficients of thermal and electrical conductivity, and between the specific heat and dielectric constant of ice has been experimentally established for temperatures from -20 to -2 degrees. Establishing the existence of a firm link between the thermal and electrical properties of ice fulfills a prerequisite for developing methods for determining the thermal properties of ice and frozen rock using results of the study of their electrical properties.

**TL 403**
**NEW WAY OF DETERMINING THICKNESSES OF ANTARCTIC ICEBERGS.**
Buĭnitskiĭ, V.Kh., et al, Aug. 1973, 8p., AD-769 726, For Russian original see 26-1429 or F-10248. 10 refs.
Dmitrash, Zh.A.
28-2862
ICEBERGS, ICE COVER THICKNESS, FLOATING ICE, ALTITUDE, HEIGHT FINDING.
A new method of determination of the Antarctic iceberg's thickness is described in this paper. It is proved that if iceberg's altitude is known, its thickness may be found.

**TL 404**
**STATIC PRESSURE OF SEA ICE.**
Peschanskiĭ, I.S., Aug. 1973, 5p., AD-769 727, For Russian original see 26-1963.
28-2863
SEA ICE, ICE PRESSURE, TEMPERATURE EFFECTS, ICE COMPOSITION, STRESS ANALYSIS.
Static pressure in ice develops in an ice cover on sudden rise in the temperature. At this time, the ice expands, exerting pressure on the shore belt and the engineering structures located there. The more abruptly this occurs, the higher the pressure. This static pressure of sea ice depends not only on the value of temperature drop and speed of its effect, but also on the salinity of the ice and on its ultimate temperature. The effects of these changes in temperature, its speed and the salinity in sea ice and freshwater ice (and the differences between the two types of ice) is discussed as well as the pressure distribution through the ice's thickness.

**TL 405**
**ICE THRUST ON SHORES OF NORTH GERMAN LAKES AND ITS EFFECT.**
Laskar, K., et al, Aug. 1973, 7p., AD-769 728, For German original see SIP 8221. 8 refs.
Strenzke, K.
28-2864
LAKE ICE, FAST ICE, ICE PRESSURE, ICE RIDGES.
Beach ridges may be formed by ice pressure as the result of temperature variations and subsequent volume changes of the ice cover, or by ice thrusting due to wind action pushing the ice against the shore. The latter type predominates in Germany. A specific minimum basin area is a prerequisite for large-scale thrust action. Several cases of ice thrust on the Ploner Lake (Germany) are described. The ice blocks pile up parallel over each other along the shore and push inland.

**TL 406**
**STUDYING THE ICE DRILLING PROCESS.**
Nikolaev, A.F., et al, Aug. 1973, 5p., AD-769 729, For Russian original see 25-3693.
Trubina, E.A.
28-2865
ICE DRILLS, DRILLING, ROTARY DRILLING.
In order to clarify the interrelationships of basic drill rig parameters with the drilling regime, studies were made of torque, axial feed load, drilling speed, and a number of drill revolutions. In order to determine the qualitative and quantitative dependence of feed load and torque on the diameter of the working member and its feed per revolution, experiments were conducted with cyclic and continuous drilling and with two types of bits: with lobed tips and flat tips. The number of drill revolutions, penetration speed and feed per bit revolution were varied for each test, with two series of tests conducted for each form and type of bit. All tests were conducted on lake ice and Volga ice.

**TL 407**
**OPTIMAL RESISTANCE OF SOIL AND ROCK WORKING TOOLS.**
Abezgauz, V.D., Aug. 1973, 8p., Translation of Stroitel'nye i dorozhnye mashiny, No.11, 1972, p.8-11. 2 refs.
28-1537
EXCAVATING EQUIPMENT, SOIL STRENGTH, FROZEN GROUND, COLD WEATHER PERFORMANCE, COST ANALYSIS, TOOL LIFE.
The factors that influence the choice of operating time of a cutting tool before its replacement or sharpening, i.e. tool strength are examined and the operating cycle of the machine as the sum of time segments spent on productive work before cutter replacement and as the time spent on replacing worn cutters is defined.

**TL 408**
**SOILS OF THE MAIN TYPES OF TUNDRA BIOCOENOSES IN WESTERN TAYMYR.**
Ignatenko, I.V., Aug. 1973, 67p., AD-769 717, For Russian original see 27-1543. 27 refs.
28-2866
SOIL PATTERNS, TUNDRA SOILS, PATTERNED GROUND, SWAMPS.
The soil cover near the Taymyr Biogeocoenological Station is very complex. Here, just as in other regions of western Taymyr, three types of the soil cover structures can be clearly traced: (1) Comprises the frequent alternation of small elementary soil areas connected with the nanorelief in the hummocky-jointy and spatty-jointy tundras. The elements of the nanorelief and the associated soils are repeated systematically within the same element of microrelief. (2) Represents an alternation of the larger elementary soil areas associated with the microrelief. An example is represented by the soil cover of the polygonal marsh tundras, polygonal bogs in the watersheds and in Pyasina fluvial plain and also the bog tundras with thermokarst subsidences (mochezhiny). (3) Represents an alternation either of relatively large elementary soil areas or of relatively large elementary soil areas with microcombinations which usually are associated with various mesorelief forms, wherein the varying steepness and exposure of slopes can exert a distinct effect on the nature of the soil cover. The mesocomplexes for a soil cover of an entire ecological series, include the watershed, its slopes, depressions and valleys.

**TL 409**
**CORRELATION BETWEEN GEOTECHNICAL PROPERTIES OF SOME FOUNDATION SOILS AND COMPARISON OF RESULTS OF SOME BEARING CAPACITY CALCULATION METHODS.**
Bellotti, R., et al, Aug. 1973, 17p., Translation of Revista Italiana Geotecnica, 3(2):95-103, April-June 1969. 11 refs.
Selleri, G.
28-2867
SOIL STRENGTH, BEARING CAPACITY, COMPRESSIVE STRENGTH, PLASTICITY TESTS, SOIL COMPACTING.
This article deals with the geotechnical properties of some foundation soils, determined through laboratory and field tests. On the basis of subdivision of soils into two groups (in terms of their makeup characteristics), the authors particularly examined the parameters of cutting resistance, determined from triaxial tests of the nondrained type, performed on isotropically consolidated cylindrical samples; for each group, the authors give typical values of the cohesion and the friction angle and they determine some correlations between these parameters and the plasticity of the soils under examination. Finally, they take up various methods of permissible load value calculation and, by comparing them, they give the results obtained from determinations made on the basis of data from triaxial tests, from rupture loads derived from compression resistance tests with free transversal dilation and from parameters furnished by penetrometric tests conducted with the conical-point penetrometer of the type recommended by Terzaghi and Peck.

**TL 410**
**PROCESS OF ALTIPLANATION AND THE FORMATION OF MOUNTAIN TERRACES.**
Boch, S.G., et al, Sept. 1974, 20p., ADA-003 214, For Russian original see 27-1461. 47 refs.
Krasnov, I.I.
29-2717
ALPINE LAND FORMS, ALTIPLANATION, FROST WEATHERING, SOLIFLUCTION, SLOPE PROCESSES.
Peaks of mountains rising above the upper fringe of forest growth often form quite flat surfaces while their slopes form steps. In the scientific literature, these forms are called "altiplanation terraces." Several hypotheses have been advanced for explaining the origin of such stepped relief of the mountain peaks. Considerable advance in understanding the origin of altiplanation has occurred since a study in detail was begun in order to understand the processes of frost weathering and the displacement of clastic material under the effect of gravitational force, which is now combined under the name goletz denundation. The theory of "foothill stairway" stepped relief, created as a result of the goletz processes is possible but does not exist apparently in the Urals. Goletz denundation is capable of developing in the mountains relatively large elements of plane-horizontal limitation, which could be taken for partly preserved remnants of ancient denundation surface.

**TL 411**
**INVESTIGATION OF THE PHYSICAL NATURE OF SHIP ICING.**
Borisenkov, E.P., et al, Sept. 1974, 182p., ADA-003 215, Translation of Leningrad. Arkticheskiĭ i antarkticheskiĭ nauchno-issledovatel'skiĭ institut. Trudy, Vol.298, 1972. Refs. For Russian original see 27-1053 to 27-1072. For individual papers see 29-2642 through 29-2660.
29-2641
SHIP ICING, ICE ADHESION, ICING, NAVIGATION, ICE STRENGTH.

**TL 412**
**CONCERNING PHYSICAL SOIL RESEARCH.**
Atterberg, A., Sept.1974, 2p., AD-002 376, Translation of Internationale Mitteilungen für Bodenkunde, Vol. 1, 1911, p.7-9.
29-2400
SOIL SCIENCE, SOIL CLASSIFICATION.
Soil types can be studied in four different manners: geologic research concerned with the history of soil origin; petrographic investigation which attempts to identify the components, plus the mechanical and mineralogical-chemical properties of soils; physical research which investigates the external properties of soils; and plant-biological research dealing with the effects of soil on the development of the higher and lower flora and especially the effect on domestic plants.

**TL 413**
**PLASTICITY OF CLAYS.**
Atterberg, A., Sept. 1974, 28p., ADA-002 570, Translation of Internationale Mitteilungen für Bodenkunde, Vol. 1:10-43, 1911.
29-2709
CLAY SOILS, PLASTIC PROPERTIES, CLASSIFICATIONS, ADHESION.
The flow limit and plastic limit are the actual plasticity limits of clays. The difference between the data for the flow limit and plastic limit, i.e. the plasticity number, is the best measure of the degree of plasticity. According to the varying level of the plasticity numbers, the clays can be grouped into three or four plasticity classes. The adhesion limit is the normal consistency referred to by the clay technician. At the first plasticity class, the class of the highly plastic clays, the adhesion limit lies between both plasticity limits and thereby divides the plasticity for these clays into a sticking plasticity and a nonsticking plasticity. In the case of slightly plastic clays, for the most part the adhesion limit lies outside the plasticity range. A low position of the adhesion limit complicates the handling of clays both in agriculture and in industry. Through the addition of large amounts of sand or small quantities of organic matter, the relative position of the adhesion limit can be raised.

**TL 414**
**THERMAL DRILLING OF THE GLACIER.**
Zotikov, I.A., et al, Sept. 1974, 26p., AD-002 377, For Russian original see 28-208 or F-12311. 26 refs.
Kapitsa, A.P., Kudriavtsev, E.V., Sukhanov, L.A.
29-2401
THERMAL DRILLS, GLACIER ICE, ICE DRILLS, ICE TEMPERATURE, UNFROZEN WATER CONTENT.
Thermal drilling is one technique for drilling the ice in the Antarctic. The idea of obtaining boreholes in the layer of glaciers by thermal drilling has attracted the attention of researchers for a long time because of the tendency to utilize the low melting temperature of ice as a rock, forming the glaciers. This report attempts to classify the basic methods involved in thermal drilling of glaciers in the Antarctic, to present certain findings in the operations on the thermal drilling, and also to analyze theoretically the basic processes governing the thermal drilling conditions during passage through ice and typifying the conditions in the ice layer both ahead of the moving thermal drill as well as along the side walls of the borehole. Simple analytical equations and graphs for computing the basic parameters determining thermal drilling are presented. The data presented are useful both in the development of new thermodrills and in the selection of the optimum conditions of operating already existing equipment, and also in analyzing the disturbances which are being caused during the thermal drilling of ice.

**TL 415**
**CALCULATING SNOW COVER DENSITY IN THE KYZYLCHA MOUNTAIN RIVER BASIN.**
Sadvakasov, IU.B., et al, Sept. 1974, 8p., AD-002 066, For Russian original see 25-2886. 3 refs.
Kozik, E.M.
29-2383
SNOW SURVEYS, SNOW DENSITY, TEMPERATURE EFFECTS.
All information available on snow cover in the Kyzylcha Mountain River Basin was examined. Connections between density and values of meteorological elements were sought for each month between December and April. In most months, the maximum influence on density of snow cover is exerted by the sums of positive 13 hr temperatures and the total of precipitation computed from 1 December to the day of the snow survey. The results obtained permit us to consider that the calculations of the density of snow cover at the time of its bedding in the region of Kyzylcha Station in about 85% of the cases (and in 90% of the cases in the utilization of meteorological data) have an accuracy adequate for practical purposes.

**TL 416**
**DESIGN AND CONSTRUCTION OF HYDRAULIC STRUCTURES ON PERMAFROST.**
Gromov, A.I., Sept. 1974, 15p., ADA-003 317, For Russian original see 27-1738.
29-2720
HYDRAULIC STRUCTURES, PERMAFROST BENEATH BUILDINGS, DAMS, HYDROELECTRIC POWER GENERATION.
The construction standards currently used for planning and production of hydraulic structures on permafrost are explored briefly. The diversity of natural conditions and the limited knowledge of their features requires a fairly careful approach to a determination of the possibility of employing permafrost soils as a foundation for a structure. It is necessary to formulate special technical conditions for planning each building project in the Far North due to the present lack of information. The author deals with several possible conditions affecting the building of hydraulic structures. The construction of the Mamakanskaya Hydroelectric plant proved the effectiveness, economy, and engineering feasability of utilizing precaste ferroconcrete in a harsh climate.

**TL 417**
**ICE NAVIGATION QUALITIES OF SHIPS.**
Kheĭsin, D.E., ed, Aug. 1973, 281p., AD-764 807, Translation of Leningrad. Arkticheskiĭ i antarkticheskiĭ nauchno-issledovatel'skiĭ institut. Trudy, Vol.309, 1973. Refs. For individual papers see 28-1544 through 28-1568.
Popov, IU.N., ed.
28-1543
ICEBREAKERS, PROPELLERS, ICE NAVIGATION, SEA ICE, ICE BREAKING, SHIPS, ICE LOADS, METAL ICE FRICTION, WOOD ICE FRICTION, ICE COVER STRENGTH, ICE HARDNESS, MODELS.

**TL 418**
**ICEBREAKERS.**
Kashtelian, V.I., et al, Aug. 1973, 263p., AD-766 591, Translation of Ledokoly. Leningrad, Izdatel'stvo Sudostroenie, 1972. 44 refs.
Ryvlin, A.IA., Faddeev, O.V., IAgodkin, V.IA.
28-3033
ICEBREAKERS, SHIPS.
The book *Icebreakers* generalizes the experience that has been accumulated in the development and design of icebreakers, discusses methods of calculating their ice performance, design and arrangement features and points out paths toward further improvement. All present Soviet and foreign icebreakers are described, their operating conditions are analyzed, the basic ice performance characteristics of an icebreaker are examined (ice speed to power ratio, ice strength, maneuverability, jamming conditions), and methods of evaluating these qualities, developed by Soviet specialists, are set forth; the design features of the basic machinery and systems of icebreakers are noted; recommendations on their design are presented. A considerable part of the book is devoted to features of the choice of hull shape, main dimensions and power plant. Data on icebreakers hull design and relations for determining the strength dimensions of the framing and plating are presented. The operating conditions of the electric power plant are analyzed and diagrams of the electric power plants of icebreakers presently in operating are presented; requirements imposed on these diagrams are formulated. Features of the design and calculation of special icebreakers systems (list and trim systems, engine cooling systems, hydraulic systems) are discussed. Materials on certain general ship systems (towing, steering and helicopter systems) are presented. Features of an icebreaker control system are described and the prospects and trend of its development are discussed.

**TL 419**
**STUDYING SNOW STRUCTURE.**
Volodicheva, N.A., et al, 1975, 6p., ADA-016 093, FSTC-HT-23-75-68B, Translation of Akademiia Nauk SSSR. Institut Geografii. Materialy Gliatsiologicheskikh Issledovanii, no. 12 p.149-152, 1966. For Russian original see SIP 25876.
Troshkina, E.S.
30-3424
SNOW COVER STRUCTURE, SNOW RECRYSTALLIZATION, PHOTOGRAPHIC TECHNIQUES.
In the winters of 1961-62 and 1963-64 in the Botanical Garden of the Moscow State University (Lenin Hills), snow structure was studied. The authors included the observations of the atmospheric precipitation which was falling, and its conversion to a snow layer under the effect of the recrystallization processes. The snowflakes were caught at a height of around 100 m. The photographing was performed with the aid of the camera 'Zenith-S' with the lens Industar-49, which provided a fourfold magnification. The equipment was fastened on a special support of the device for the microphotography, MFA-7. The photographing was done on a film with a sensitivity of 180 units with exposures of 0.5-1.5 seconds in daylight.

**TL 420**
**STRENGTH CALCULATIONS OF ICE COVER.**
Panfilov, D.F., March 9, 1973, 9p., AD-762 105, 18 refs. For Russian original see 25-1594.
28-1485
STRESS ANALYSIS, ICE COVER STRENGTH, FLEXURAL STRENGTH, ICE COVER THICKNESS, TRANSPORTATION, ICE (CONSTRUCTION MATERIAL).

**TL 421**
**STRUCTURE, COMPOSITION AND PROPERTIES OF ICE COVER ON MARINE AND FRESH WATER BODIES.**
Savel'ev, B.A., April 18, 1973, U.S. Army Foreign Science and Technology Center. Technical translation, FSTC-HT-23-50-72, 547p., AD-765 896, For Russian text see SIP 22662. Numerous refs.
28-1662
SEA ICE, LAKE ICE, RIVER ICE, ICE STRUCTURE, ICE GROWTH, CHEMICAL COMPOSITION, SALT ICE, BRINES, ELASTIC PROPERTIES, PLASTIC PROPERTIES, TEMPERATURE EFFECTS, HEAT TRANSFER.
An examination is made of the mechanical and physical properties of ice covers on marine and fresh water bodies. The author attempts to explain the principal phenomena determining the most important physical properties of ice

**TL 422**
**INFLUENCE OF ICE UPON CONSTRUCTION, AND METHODS OF COMBATTING ICE PROBLEMS.**
Korzhavin, K.N., et al, Oct. 1974, 276p., ADA-012 005, Translation of Trudy koordinatsionnykh soveshchanii po gidrotekhnike, No. 17, NIIZhT, 1965. Numerous refs. For Russian original see 27-1576 through 27-1600. For individual papers in English see 30-914 through 30-938.
30-913
CONSTRUCTION, ICE LOADS, ICE CONTROL, HYDRAULIC STRUCTURES, RIVER ICE, SEA ICE.
This collection of articles deals with the variety of ice related factors which influences the specifications for building in an arctic environment. Based on the studies done concerning the effect of ice on completed structures, these articles present logical approaches to estimating effective ice loads and how to determine the necessary ice protective measures while building reservoirs, hydraulic structures, harbor ships, etc. Several articles concern how to weaken ice strength or increase the rate of thawing.

**TL 423**
**CONTRIBUTION TO THE CHEMISTRY OF ANTARCTIC SNOW: TRACE ELEMENT DOSAGE BY NEUTRON ACTIVATION.**
Echevin, M., Jan. 1975, 80p., ADA-007 106, Ph.D. thesis. For French original see 28-2656 or F-13126. 42 refs.
29-4021
SNOW COMPOSITION, TRACE ELEMENTS, ANTARCTICA—MIRNYY STATION, ANTARCTICA—VOSTOK STATION.
This paper describes a program of studies on impurities found in the polar snows, centering primarily on the Antarctic. The program was conducted along two avenues: spectrometric analysis of the atomic absorption of the elements, sodium, magnesium, calcium, potassium, manganese, and iron; and neutron actuation analysis of the elements, chlorine, sodium, and manganese. In order to obtain the largest possible quantity of data, these two studies were run in very close collaboration and both bear on the analysis of the same samples. The most abundant element in the Antarctic snows is chlorine. Most of the other elements are found in lesser concentrations.

**TL 424**
**CONTRIBUTION TO THE CHEMISTRY OF ANTARCTIC SNOW: DETERMINATION OF TRACE ELEMENTS AT THE PPB LEVEL BY ATOMIC ABSORPTION SPECTROMETRY.**
Boutron, C., Jan. 1975, 80p., ADA-007 112, Ph.D. thesis. For French original see 28-2657 or F-13127. 54 refs.
29-4022
SNOW COMPOSITION, SNOW ACCUMULATION, TRACE ELEMENTS, ANTARCTICA—MIRNYY STATION, ANTARCTICA—VOSTOK STATION.
The composition of the impurities contained in Antarctic snow has yet to be established. The published values have undergone repeated major revisions, and the concentration levels for a good many elements have yet to be determined. This work is based primarily on the study of geographical variations and on the establishment of a fallout table, backed up by some observations as to the identification of the various possible origins. Analysis by atomic absorption spectrometry of the elements sodium, magnesium, calcium, potassium and iron is performed as well as analysis by neutron activation of the elements chlorine, sodium, and manganese. The element most abundant in Antarctic snows is chlorine. Most of the other elements are found in lesser concentrations. Measuring these small concentrations thus presents special problems concerning sampling procedures on the ground and sample preparation, as well as with analytical techniques.

**TL 425**
**CALCULATION OF ICE-COVER BENDING ALLOWING FOR VISCOUS PROPERTIES OF ICE.**
IAkunin, A.E., Sept. 1974, 9p., AD-002 378, For Russian original see 26-2382. 4 refs.
29-2402
FLOATING ICE, VISCOELASTICITY, FLEXURAL STRENGTH, SIMULATION.
This paper considers the linear viscoelastic deflections and stresses of a floating ice sheet. Young's modulus is replaced with a Maxwell model in series with a Voight model. The resulting differential equation is solved when the applied load is independent of time and is linear with time. No numerical results are given but the author claims the resulting equations agree with experiments conducted on the Novosibirsk Reservoir.

**TL 426**
**INVESTIGATION OF THE INFLUENCE OF TIME OF WORKING LOAD ON BEARING CAPACITY OF ICE SHEET.**
IAkunin, A.E., Dec. 1974, 22p., ADA-004 004, Translation of Novosibirsk Institute of Railroad Transportation Engineers, Specialty 01.022. Resistance of Materials and Structural Mechanics, 1970, p.1-22. Author's abstract of his dissertation for Candidate of Technical Sciences Degree.
29-2972
ICE BEARING CAPACITY, LOADS (FORCES), TIME FACTOR, ICE DEFORMATION.
This dissertation summary deals with the deformation (strain) and stressed state of an ice cover with allowance for the time of load influence. The author analyzes the available experimental data and the existing mathematical concepts; discusses the results from theoretical and experimental studies; develops more rigorous relationships of load effect; and reviews the actual engineering problems originating during the employment of an ice cover as a construction-assembly area, for winter crossings and as main transportation lines.

**TL 427**
**PRESSURES OF THERMAL ORIGIN EXERTED BY ICE SHEETS ON HYDRAULIC STRUCTURES.**
Drouin, M., et al, Oct. 1974, 405p., ADA-014 938, Translation of: Laval University. Mechanics of Ice Laboratory. Report S-23. 112 refs.
Michel, B.
30-2074
LAKE ICE, RIVER ICE, HYDRAULIC STRUCTURES, ICE PRESSURE, ICE THERMAL PROPERTIES, HEAT TRANSFER.
The objective of this research is to study pressures of thermal origin exerted by an ice sheet as a function of meteorological conditions, physical characteristics of the ice cover and the topography of river and lake banks. This study begins with a bibliographic compendium of the principal theories elaborated from 1922 to 1968. The analysis and discussion of these investigations show the complexity of the problem and the importance of determining at the start the rheological characteristics of the principal types of ice. The paper discusses thermal properties of ice, heat transfer through ice sheets, analysis of rises in air temperature in the Quebec region, and rheological behavior of snow-pack ice and columnar ice deformed in simple compression. The results of these studies are used in calculations of pressures of thermal origin exerted by ice sheet restrained in one direction. Finally a discussion of the effects of biaxial conditions of restraint, of the presence of snow upon the ice, and of cracks in an ice sheet is presented.

**TL 428**
**STUDIES OF THE CONSOLIDATION OF THAWING ICE-SATURATED SOILS.**
Tsytovich, N.A., et al, 1970, 67p., FSTC-HT-23-833-70, For Russian original see SIP 25548.
Grigor'eva, V.G., Zaretskiĭ, IU.K.
33-529
GROUND THAWING, FROZEN GROUND SETTLING, SOIL STABILIZATION, SETTLEMENT (STRUCTURAL), PERMAFROST BENEATH STRUCTURES, THAWING RATE, SOIL CREEP, FROZEN GROUND MECHANICS.
Permafrost settlement is decisive in planning for permanent structures; therefore, consolidation studies were carried out. Consolidation depends more on ice content than on load. The process is dependent on the thawing rate in proportion to the square root of t. Secondary consolidation depends mainly on the type of soil. Residual pressure may be produced by filtration consolidation. Thawed soil deformation obeys laws of one-phase creep theory.

**TL 429**
**FINNISH AND RUSSIAN WINTER TACTICS.**
Meyerhoffer, A., Sept. 1974, 5p., AD-002 379, Translation of Ny militar tidskrift, 22:176-179, 1949.
29-2403
MILITARY OPERATION, COLD WEATHER OPERATION.
In comparison with the Swedes, the young Finnish armed forces have lagged behind in the matter of estimating the importance of forests and winter. Regardless of numerical inferiority, defective arms, and inadequate equipment, attack employing envelopment and forest warfare were prior to the Winter War the most important features of Finnish winter tactics. The Finns regarded the winter and the forest as their allies, while the Russians regarded them as obstructions to operations. This article serves as a book review of Finnish Colonel Jarvinen's book of Russian and Finnish tactics during the Winter War.

**TL 430**
**FREEZING OF AN EARTH DAM FROM THE DRY SLOPE SIDE.**
Tsvid, A.A., Dec. 1974, 16p., ADA-003 216, Translation of Dal'nevostochnyĭ nauchno-issledovatel'skiĭ institut po stroitel'stvu. Sbornik nauchnyk rabot, Vol. I, 1961, p.93-104. 6 refs.
29-2639
EARTH DAMS, SOIL FREEZING, SNOW REMOVAL, PERMAFROST PRESERVATION.
In the article the author discusses measures for increasing an earth dam's freezing rate by natural cold through the dry-slope side both during pouring the fill and during operation of the frozen dam. Among these measures, he includes: a) removal of snow from the dam surface; b) covering the surface of the dry slope with insulation during summer; c) installation of a permanent screen over the dam; and d) a shell arrangement of ice reserves on the dry slope's surface, with sub-dam tunnels which are ventilated in winter.

**TL 431**
**BIOLOGICAL RESOURCES OF THE NORTHERN USSR.** Oct. 1974, 6p., AD-002 372, For Russian original see 27-2005.
29-2404
TUNDRA REGIONS, NATURAL RESOURCES, ECOLOGY, RESEARCH PROJECTS.
The Presidium of the USSR Academy of Sciences has examined the main problems of the investigation of the biological resources of the dry land of the Russian Far North. The biosphere of polar regions is constantly under the influence of two factors: the low air temperature and the negative temperatures of the cryosphere—the permafrost. This dual press of the cold explains the low unstable productivity and slight functional activity of biogeocenoses of the Far North and at the same time development here of special species of plants and animals adapted to the extreme conditions, as well as the presence of the unique forms in which they coexist with each other and the environment—tundra biogeocenoses.

**TL 432**
**APPROXIMATE FORMULAS FOR THE DETERMINATION OF THE CARRYING CAPACITY OF ICE.**
Panfilov, D.F., 1972, 9p., AD-765 968/3, For preliminary citation see 28-2140. For Russian original see 25-559. 9 refs. .
30-1540
ICE BEARING CAPACITY, LOADS (FORCES), ANALYSIS (MATHEMATICS).

**TL 433**
**PROBLEMS OF CRYOLITHOLOGY.**
Popov, A.I., ed, Oct. 1974, 147p., AD-002 575, Russian text 27-1352 to 27-1367. Refs. passim. For individual papers see 29-2662 through 29-2677.
29-2661
GEOCRYOLOGY, CRYOGENIC PROCESSES, ICE FORMATION, FOSSIL ICE, ICE VEINS, SEDIMENTS.

**TL 434**
**ON THE SOIL-STATICS CALCULATION OF ANCHORAGE SYSTEMS IN LOOSE ROCK BUILT OF LOCAL MATERIALS ON PERMAFROST.**
Lendi, P., Oct. 1974, 57p., ADB-000 420L, Translation of Institut für bauwissenschaftliche Forschung. Stiftung Kollbrunner/Radio, March 6, 1969, p.1-66. 16 refs.
29-2405
SOIL MECHANICS, ANCHORS, SHEAR STRESS, TRACTION.
The author points out the great importance of the anchorage processes with respect to the actual construction industry. It is stated that an anchor consists of a traction element and the proper anchorage body. The traction forces applied on the traction element are gradually absorbed by the anchorage body and transferred on the surrounding soil. Depending on the free anchorage length it is possible to get the traction forces transferred to a pre-determined depth of the subgrade. Several formulas are presented concerning computing ultimate traction force.

**TL 435**
**PREDICTION OF THE TEMPERATURE STABILITY OF DAMS BUILT OF LOCAL MATERIALS ON PERMAFROST.**
Tsytovich, N.A., et al, Nov. 1974, 153p., ADA-002 571, For Russian original see 28-242. 117 refs.
Ukhova, N.V., Ukhov, S.B.
29-2721
DAMS, FROZEN GROUND TEMPERATURE, PERMAFROST THERMAL PROPERTIES, PERMAFROST PRESERVATION, HEAT TRANSFER.
Thawing of perennially frozen soils from the heat in reservoirs and buildings of electric power plants threatens the destruction of the surrounding earthen dams, levees, embankments and other structures. In this study a new approximate method has been described for predicting the temperature stability of dams made of earthen materials erected on permafrost. The method includes the idea that the problem reduces to solving a series of specific linear problems in the theory of heat conductance. The sections which are being calculated are established at the location sufficiently remote from the marginal effects in order that the lateral heat losses could be disregarded. The position of the zero isotherm from the side of the footing in the upper shell, in the nucleus and lower shell of the dam was determined by comparing the heat balance. Based on the solution of these problems, points corresponding to specific temperatures were established. With utilization of curvilinear interpolation, data for constructing the dam temperature field and the permafrost base were established. The pattern obtained provided the opportunity for judging the temperature stability of the dam and of its base through time.

**TL 440**
**DESIGN AND CONSTRUCTION EXPERIENCE IN CITIES IN THE EXTREME NORTH (USING NORIL'SK AS AN EXAMPLE).**
Nazarova, L.G., Sept. 1974, 154p., AD-002 047, For Russian original see 28-2308. 32 refs.
29-2384
COLD WEATHER CONSTRUCTION, URBAN PLANNING, RESIDENTIAL BUILDINGS, PERMAFROST BENEATH BUILDINGS, CLIMATE.
On the basis of generalizing the construction experience gained at Noril'sk, and in accordance with the principles of architectural climatology, the authors have substantiated the requirements for the planning and construction of cities and villages of the municipal type for high latitudes. The authors suggest methods of protection against snow, and ways to ameliorate the microclimate in an inhabited territory. Special attention is directed to increasing the degree of comfort in the living accomodations and in creating the conditions for proper physical development and education of children of pre-school and school age.

**TL 441**
**STRUCTURES OF LARGE PANEL ROOFS.**
Shteĭn, I.I., Sept. 1974, 174p., AD-002 059, For Russian original see 28-2003. 22 refs.
29-2385
ROOFS, PREFABRICATION, DESIGN, CLIMATIC FACTORS.
The author discusses the experiences gained in design, construction and operation of over 70 types of large-panel ferroconcrete roofs, built in climatic areas similar to the northwestern region of the Soviet Union. He describes special features, techniques of production and assembly, and testing methods. He evaluates individual designs, analyzes typical shortcomings and recommends the most feasible designs. Included are data on insulating properties, moisture conditions of fabricating materials being used in persistently moist-climate areas and the relationship of the humid climate to construction and operation. He makes recommendations for a system of ventilation and reviews technical and economic data involved in the set-up and operation of these roof types. Finally the author presents his views on the most efficient designs of large-panel roofs for persistently humid climatic conditions.

**TL 442** Record deleted.

**TL 443**
**RESEARCH CONCERNING THE RELATIONSHIP BETWEEN WEIGHT, POWER AND TIRES AS APPLIED TO TRACTORS USED IN AGRICULTURE.**
Achart, J., et al, Jan. 1975, 19p., ADB-000 419L, Transl. from French. Source unknown.
Remus, J.
29-2482
TRACTORS, TIRES, AGRICULTURE.
The authors define the existing relationship, for a tractor of given motor power, between the weight of the tractor and the true power that it can provide. They stress the role played by the tire in the improvement of this relationship. When the rated horsepower increases, it becomes apparent that new concepts are required in reference to the tractor and to the techniques for tilling the soil, and that there is a need for the creation or development of a new kind of tire. The authors point out the uncertainty felt by the manufacturers in defining the characteristics of this new kind of tire.

**TL 444**
**STABILITY OF BUILDINGS AND INSTALLATIONS IN THE ARCTIC.**
Velli, IU.IA., Dec. 1974, 148p., AD-001 974, For Russian original see 28-1332. 10 refs.
29-2386
COLD WEATHER CONSTRUCTION, SOIL STABILIZATION, BUILDINGS, SETTLEMENT (STRUCTURAL), PERMAFROST PRESERVATION.
The author analyzes a composite solution to the questions involved in stability of buildings; data are presented which are required for their planning and erection in the complex natural-climatic and permafrost-soil conditions in the Arctic; suggestions are also set forth on the provision of permafrost monitoring during the operational period. The book is oriented toward engineer-designers, builders and researchers.

**TL 445**
**CONCRETES WITH ANTIFREEZE ADMIXTURES.**
Golubov, A.V., et al, Oct. 1974, 4p., AD-001 975, For Russian original see 28-4294.
Samchenko, V.S., Melamed, E.E., Boĭko, P.U.
29-2387
WINTER CONCRETING, ANTIICING ADDITIVES, CONCRETE HARDENING, CONCRETE ADMIXTURES.
During the performance of concreting tasks in the winter of 1971-72, in the construction of facilities in the Kakhovskaya irrigation system and the Northern Crimean Canal, antifreeze admixtures were introduced, assuring the necessary conditions for its hardening at negative temperatures. The introduction into concrete, of both the combined and the single component antifreeze admixture promotes an appreciable prolonged improvement in the convenient pouring quality of the concrete mixture. The utilization of concrete with antifreeze admixtures made it possible to eliminate the seasonal nature in performing concrete operations and to lower the cost of pouring a cubic meter of concrete by 3.5 rubles as compared with the pouring methods involving heating.

**TL 446**
**VIBRATION METHODS IN CONSTRUCTION.**
Barkan, D.D., Nov. 1974, 330p., AD-001 976, Transl. from Russian.
29-2388
EXCAVATING EQUIPMENT, VIBRATION, FROZEN GROUND MECHANICS, BUILDINGS, FOOTINGS.
The book contains material summing up advances made in the use of the vibration method in placing footings of buildings and structures. Major emphasis is placed on the application of this method in various fields of construction and in geological engineering explorations. It also contains materials on theoretical and experimental investigations of the theory of the vibration method. The book is designed for constructions engineers—project planners, designers, scientific personnel, and job superintendents.

**TL 447**
**AGE OF SOME EIFEL CRATERS ACCORDING TO RECENT PERTROLOGIC, POLLEN-ANALYTIC AND RADIOCARBON INVESTIGATIONS.**
Erlenkeuser, H., et al, Jan. 1975, 22p., ADB-000 422L, Translation of Decheniana (Bonn), Vol. 125(1/2):113-129, Dec. 1972. 12 refs.
Frechen, J., Straka, H., Willkomm, H.
29-2483
VOLCANOES, MINERALS, AGE DETERMINATION, ROCKS.
The volcanic Tuffs in the craters of the Eifel volcano derive from the crater in which they are located today or from a neighboring crater. According to their petrologic structure they have not originated in the area of the Laach Lake. Their ages differ, according to C14 and pollen-analytic age determinations. It is believed that the latter corresponds more closely to the actual age: between around 12,500 and around 10,000 years ago.

**TL 448**
**NEW C-14 DATINGS OF THE AGE OF THE EIFEL CRATER.**
Erlenkeuser, H., et al, Jan. 1975, 8p., ADB-000 421L, Translation of Eiszeitalter und Gegenwart, Vol. 21:-177-181, Dec. 31, 1970. 19 refs.
Straka, H., Willkomm, H.
29-2484
VOLCANOES, ROCKS, MINERALS, AGE DETERMINATION.
This article discusses the origin and age of the tuff layers found in the bog-covered Eifel craters. Straka found the latter during his drillings in the years 1948-1968 and has attempted to date them pollen-analytically. Volcanological investigations have been carried out by Professor Frechen and are discussed in this paper. The radiocarbon datings done by Erlenkeuser and Willkomm are described and the data resulting are given in a table. The paper includes a brief bibliography.

**TL 449**
**THERMAL AND MECHANICAL INTERACTION OF FROZEN ROCK WITH ENGINEERING INSTALLATION.**
Grechishchev, S.E., Nov. 1974, 110p., AD/A-004 005/5GA, For Russian original see 28-1871 through 28-1881. Numerous refs.
29-3472
FROZEN ROCKS, ENGINEERING GEOLOGY, MINES (EXCAVATIONS), HEAT TRANSFER, THERMAL EFFECTS.

**TL 450**
**CALCULATING TEMPERATURE REGIME OF EARTH DAMS IN PERMAFROST REGIONS.**
Moiseev, I.S., Nov. 1974, 19p., ADA-010 826, Translation from Gidrotekhnicheskie sooruzheniia, 1959, Vol.29:281-193. 5 refs.
32-4109
PERMAFROST BENEATH STRUCTURES, EARTH DAMS, PERMAFROST HEAT BALANCE, THERMAL FACTORS, TEMPERATURE MEASUREMENT, ANALYSIS (MATHEMATICS), GROUND THAWING, RESERVOIRS.

**TL 451**
**OPTIMAL HEIGHT OF A DAM FOR PRESERVATION OF BEARING GROUND IN A FROZEN STATE.**
Kulikov, IU.G., Jan. 1975, 6p., ADA-003 318, For Russian original see 24-1047.
29-2719
DAMS, PERMAFROST PRESERVATION, ROADS, EARTH FILLS, EMBANKMENTS.
In the construction of earth beds on permafrost, we find instances of the thawing of the frozen bases under low fills because of changes in the heat exchange condition (disruptions of vegetative cover, evaporation, insolation, condensation, albedo) and also as a result of surface and ground water effects. To find the amount of settling of fills under such conditions, it is necessary to calculate the thawing depth of the permafrost base or to determine the height of fill at which the permafrost does not thaw. The thawing depth of a frozen base under a fill made of thawed ground is greater than under a fill formed of frozen ground. Accordingly, the optimal height of the former will be greater than the height of the latter. If the fill is comprised partly of frozen ground the height of fill should equal the calculated value for thawed fill.

**TL 452**
**BUILDING DAMS IN PERMAFROST REGIONS.**
Semenov, N.G., Nov. 1974, 5p., ADA-003 319, For Russian original see 23-1830. 3 refs.
29-2716
PERMAFROST BENEATH DAMS, ARTIFICIAL FREEZING.
The author has confirmed the possibility of erecting dams in permafrost regions on loose soils containing much ice and he has shown that the complete freezing of a dam by blowing cold air through (according to a special system built into the dam) occurs quite intensively. He details the procedures involved in planning and building the dam in permafrost regions.

**TL 454**
**FIRST RESULTS OF INVESTIGATIONS OF THE WATER BALANCE IN RIVERS IN THE UPPER KOLYMA BASIN.**
Kuznetsov, A.S., et al, Feb. 1975, 33p., ADA-004 006, Translation, from Russian, of Sbornik rabot magadanskoĭ gidrometeorologicheskoĭ observatorii, No.2, 1969, p.98-121. 8 refs.
Nasybulin, Sh.S., Ipat'eva, A.I.
29-4023
WATER BALANCE, RIVERS, PERMAFROST HYDROLOGY, WATER FLOW.
Water balance investigations were conducted for eight water-collecting areas in the upper Kolyma basin during 1967-1968. There is a very definite pattern in the change in individual water balance components and the relationship between them in dependence on the nature of the underlying surface and the extent of the water-collecting areas. There is a very distinct role of talus in the water balance as a factor causing an additional influx of moisture in the river balance. From these investigations they determined the need for developing a method for instrumental determination of evaporation and condensation from talus deposits, measurement of moisture reserves in peaty ground and measurement of evaporation from the soil applicable to the conditions of continuous occurrence of permafrost.

**TL 455**
**PECULIARITIES OF FORMATION OF RUNOFF OF THE UPPER KOLYMA BASIN.**
Kuznetsov, A.S., et al, Feb. 1975, 18p., ADA-003 320, Translation of Sbornik rabot Magadanskoĭ gidrometeorologicheskoĭ observatorii, No.3:52-65, 1970.
Nasybulin, Sh.S.
29-2710
MELTWATER, RUNOFF, ACTIVE LAYER, FLOODS, PERMAFROST HYDROLOGY.
The upper Kolyma basin is located in the zone of permafrost. The decisive factor in runoff is the quantity of precipitation falling in the basin. It has been established by a study of the water balance for the rivers of this region that runoff is dependent on the underlying surface. The greatest runoff is in rivers whose water collecting basins are covered by talus. Ice encrustations occur frequently in this area; these, however, do not increase runoff, but redistribute it in the course of a year. Where permafrost prevails, the losses of rain and meltwater have only a temporary effect in the active layer. In the upper Kolyma basin evaporation from the soil varies in the range 120-170 mm; this is approximately 1/2 to 1/3 of that from the soil at the same latitudes in European USSR.

**TL 456**
**PROTECTION OF NATURAL ENVIRONMENTS IN THE TUNDRA.**
Khantimer, I.S., Feb. 1975, 4p., ADA-003 218, Translation of Agricultural development of tundra regions, Leningrad, Nauka, 1974, Chapter 7, p.205-207.
29-2711
TUNDRA, VEGETATION PATTERNS, PROTECTION.
The tundra is a rapidly developing, yet exhaustible source of a variety of natural resources, the most important of which is the vegetation cover. The natural productivity of the vegetation cover is insignificant; it decreases significantly in a south to north direction. This pattern must not serve as a justification for a negligent attitude toward an exceptionally important problem involving the balance of matter and energy in the expanses of the tundra. A concerned attitude toward the vegetation cover and its rational use is the basic prerequisite for retention of their roles in the biological cycling of matter.

**TL 457**
**VARIATION OF GEOCRYOLOGICAL CONDITIONS BENEATH FILLS DEPENDING ON UPPER TEMPERATURE LIMITS.**
Zamolotchikova, S.A., Feb. 1975, 15p., ADA-003 209, For Russian original see 23-5910. 15 refs.
29-2712
EARTH FILLS, ROADBEDS, PERMAFROST THERMAL CYCLES, FREEZE THAW CYCLES.
In the northern USSR, a group of structures called earth beds, resulting from fills and excavations, is appearing. A compilation of forecasts indicating the variation in permafrost ground under fills and in excavations has rarely been made by calculation until now, because in each case, it is necessary to solve a two- or three-dimensional problem regarding the freeze-thaw cycles in soils. A prediction of the variation in permafrost conditions beneath fills can now be formulated based on the results of interdisciplinary permafrost surveying. This report discusses one of the first attempts at analyzing the influence of cutoff temperatures on the variation in permafrost ground under a fill.

**TL 458**
**REDUCING FOG OVER AIRFIELDS.**
Serpolay, R., Feb. 1975, 26p., ADB-001 178, Translation of Forces aeriennes françaises, No.161, July 1960, p.35-65.
29-4024
FOG DISPERSAL, AIRPORTS, ICE NUCLEI.
Several chapters of this article are devoted to examining the means capable to clear a limited volume of a runway and its approaches of fog by means of ice germs, etc. The creation of a vertical hot-air curtain along a runway by a thermal process is discussed as well as the possibility of using infrared radiation. A brief section is devoted to prevention of fog itself and finally progress in landing techniques is discussed.

**TL 459**
**EXAMPLE OF RUNOFF ANALYSIS.**
Yamaoka, I., Feb. 1975, 15p., ADB-001 081, Translation of Seppyo, 33(4):66-71, Dec. 1971. 12 refs.
29-2640
SNOW ACCUMULATION, RUNOFF, MATHEMATICAL MODELS.
This work is intended to present a proposal for a runoff model having not only an engineering foundation, but also a more theoretical (electrothermal and hydrodynamical) foundation. It differs from conventional empirical models using the degree factor method. It also demonstrates a calculation example from the Kanayama dam catchment area. The characteristic features of this runoff model are: 1) it uses the formula of Yoshida, et al. in which atmospheric temperature and wind velocity are employed in the melting model, 2) the refreezing of melted snow at the surface layer during snow accumulation is approximated by using Darcy's law and after the retreat of one snow line, the runoff model is further advanced with the general hydrodynamic model used at the lower snowless area. In applying the model to the Kanayama dam catchment area, analysis was made by dividing the 470 sq km into 3 areas.

**TL 460**
**MOLLIER DIAGRAMS FOR EVALUATING NUCLEAR HEAT PROCESSES FOR THE DISSOCIATION OF WATER.**
Knoche, K.F., et al, Feb. 1975, 18p., ADB-001 179, Translation, from German, of VDI-Forschungen, Heft 549, p.25-32, no date. 17 refs.
Schubert, J.
29-4025
CHEMICAL REACTIONS, WATER, ENTHALPY, ENTROPY, MOLLIER DIAGRAMS, DISSOCIATION.
With the expected use in power production based upon nuclear energy, new methods will open up for the aquisition of hydrogen from water dissociation by methods not depending on fossil fuels. These authors examine non-electrolytic procedures for the dissociation of water. A lengthy discussion of the restrictions imposed by the first and second laws of thermodynamics upon the thermal dissociation of water is presented. Chemical reactions at constant temperature and constant pressure in the Mollier Enthalpy-Entropy Diagram are discussed. The thermal dissociation of water by a two stage process, or a multistage of water by a two stage process with iron and chlorine is presented.

**TL 461**
**LATE-GLACIAL PUMICE DEPOSITS OF LAACH VOLCANISM IN THE REGION OF WESTERN SWITZERLAND AND THE DAUPHINE.**
Wegmüller, S., et al, Feb. 1975, 6 leaves, ADB-002 189, Translation, from German, of Eclogae geologicae Helvetiae, 66(3):533-541, Dec. 1973. 13 refs.
Welten, M.
29-4026
GLACIAL DEPOSITS, VOLCANIC ASH, AGE DETERMINATION, SWITZERLAND.
In the region of western Switzerland and the Dauphine, volcanic ashes have been found which on the basis of their mineralogical composition appear to have originated in the Laach basin. In the Bernese midlands and in the Voralps, there have been deposits of white pumice and in the area of Lake Geneva and in the Dauphine gray pumice. The pumice layers lie in the profiles at the end of Alleroed interstadial. From diagram position and from C14 age determination one gets a date of about 9000 B.C. for the deposit of the dark gray pumice.

**TL 462**
**FUNDAMENTAL METHODOLOGY OF PROGNOSIS OF TEMPERATURE STRESSES AND DEFORMATIONS IN FROZEN SOILS.**
Grechishchev, S.E., Feb. 1975, 48p., ADA-003 210, For Russian original see 27-1998. 29 refs. Also translated as National Research Council, Canada. Technical translation, TT-1886.
29-2713
SOIL MECHANICS, FROZEN GROUND COMPRESSION, TENSILE STRESS, ACTIVE LAYER.
The amount of moisture in the frozen ground exerts a very great effect on the temperature stress dynamics. Calculations are made by the author which show that in most cases at depth equalling about 2/3 of the active layer, during the first half of the cold season, the stresses should be the tensile type. At the same time the upper layers could also be compressive. However, within the limits of the active layer, it can develop that, at an identical time, in the upper horizons we will record compression while in the lower horizons, we will find tension. This is indicative of the important colclusion that part of the frost clefts could form at a certain depth and not emerge to the surface.

**TL 463**
**FOG CURTAIN RISES.**
Serpolay, R., March 1975, 9p., ADB-000 928L, Translated from Butane/Propane, No. 12, First Quarter 1960.
29-2714
FOG DISPERSAL, SUPERCOOLED FOG, NUCLEATING AGENTS, CLOUD SEEDING.
Forty propane diffusors were installed at Orly Airfield in 1959-60 for the purpose of fog dispersal. The author discusses the specifications for these diffusors and the results of experiments using propane. The conclusions seem to indicate that the process is not safe enough, reliable enough, or stable enough for commercial airfield use.

**TL 464**
**FROST INFLUENCE ON THE STABILITY OF RAILROADS.**
Bonnard, D., et al, May 1976, 12p., ADA-026 966, Translation of Bulletin technique de la Suisse romande 84(11):193-199, May 24, 1958.
Desponds, R., Recordon, E.
30-4408
RAILROADS, FROST HEAVE, FRANCE.
During the very cold periods of most winters, the Chemins de fer federaux observe, some swellings in various parts of the network give rise to important deformations of the rails. After the frost period, these heavings disappear and the rails return to their previous positions. This report discusses this phenomenon.

**TL 465**
**EXTREME ESTIMATIONS IN GEOTHERMY AND GEOCRYOLOGY.**
Sharbatian, A.A., et al, Dec. 1974, 140p., ADA-009 695, For Russian original see 29-1659. 198 refs.
Shumskiĭ, P.A.
29-4027
GEOTHERMY, GEOCRYOLOGY.
The monograph is devoted to extremal estimations of the variation in temperature and phase states of water in the lithosphere's upper layer. The author analyzes the changes in a normal geotemperature field under various climatic tendencies and he estimates a climatic correction to the geothermal gradient in classical form without consideration of sediment accumulation, denudation and hydrogeologic factors. He calculates the critical parameters of stationary and nonstationary cryolithic zones. He models the history of its development in the north of the Western Siberian Lowland.

**TL 466**
**CLASSIFICATION OF WINTERS BY SNOW COVER.**
Papinashvili, L.K., Jan. 1975, 11p., ADA-003 219, For Russian original see 29-1557. 7 refs.
29-2715
SNOW DEPTH, CLIMATOLOGY, CLASSIFICATIONS.
The author discusses four types of winters and the characteristics that define each type. A winter with much snow is considered to be one during which the mean 10-day depths of snow cover increase by more than 25% from the mean long-term 10-day values during the course of 2/3 of the winter. If the 10-day depth of the snow cover deviates from the long term 10-day values during the entire winter in any direction by less than 25% the winter is considered to be one with little snow. A winter with infrequent variations in depth of snow cover (from positive deviations to negative and vice versa) during the entire winter or between, its first and second halves was classified as unstably snowy. Thus, the classification of winters was based on the snow cover and on its changes during the course of the winter.

**TL 467**
**THERMAL PROPERTIES OF SEA ICE. IV. THERMAL CONSTANTS OF SEA ICE.**
Ono, N., Jan. 1975, 19p., ADB-000 929, For Japanese original see 24-168. 14 refs.
29-2718
SEA ICE, ICE THERMAL PROPERTIES, MATHEMATICAL MODELS.
A sea ice model is proposed for calculating the thermal constants of sea ice. The sea ice model consists of pure ice, brine at an equilibrium concentration and spherical air bubbles dispersed uniformly both in the pure ice and in the brine. These bubbly ice and bubbly brine models are arranged in parallel with the heat flow passing through the model of sea ice. Thermal constants of sea ice, namely density, thermal conductivity, specific heat, changes in heat contents, heat of fusion, and thermal diffusivity are theoretically defined and are calculated using this model as a function of temperature, salinity, and air bubble content of sea ice. The thermal diffusivity values derived from the observed temperature data were compared with theoretical values. Changes with the temperature in the derived values thermal diffusivity and the temperature dependency of the theoretical values were in fairly good agreement.

**TL 468**
**RELATIONS BETWEEN STRESS AND DEFORMATION OF ICE, CONSIDERING THE TIME FACTOR.**
Vialov, S.S., et al, April 1975, 10p., ADA-009 054, For Russian original see SIP 19172 or Antarctic Bibliography 1951-1961, 3008. 1 ref.
Chernigov, V.A.
29-4028
ICE DEFORMATION, ICE MECHANICS, COMPRESSIVE STRENGTH.
The stress deformation relationship is given by the exponential function, the parameters of which are dependent on the rate of loading. During compression the density of ice and its modulus of dynamic elasticity increase. Rules 1 and 2 are valid until a deformation limit is reached; after which intensive flow occurs and the modulus of dynamic elasticity sharpely decreases. The limiting deformation is load-rate and load-time independent and is constant for a given ice sample. However, the limiting compression is variable; it is rate and time dependent. The limiting deformation is a criterion for ice stability, characterizing an intensively progressing flow followed by pulverization, occurrence of microcracks and deterioration of the ice crystals.

**TL 469**
**RELATIVE IMPORTANCE OF PRECISION AND FIDELITY CRITERIA IN DOSAGES OF TRACE ELEMENTS.**
Lapadu-Hargues, P., March 1975, 6p., ADA-009 061, Translation of CNRS Colloques Nationaux, No. 923, 1970, p.41-67 (Dosages des éléments à l'état de trace).
29-4029
CHEMICAL ANALYSIS, EXPERIMENTATION, ACCURACY, TRACE ELEMENTS.
The paper discusses the relationship between accuracy and reproducibility. The question of whether 30 rather precise analyses or only one almost perfect analysis is most valuable is developed. It is concluded in this paper that the search for reproducibility should be placed before the search for accuracy. In fact, better reproducibility means an easy comparison of results between them and this might lead to the establishment of geochemical laws.

**TL 470**
**APPROXIMATE METHOD OF DETERMINING THE CARRYING CAPACITY OF ICE COVER.**
Korunov, M.M., Jan. 1973, FSTC-HT-23-1848-72, 11p., AD-766 171/3, Translation of Nauchno-Issledovatel'skiĭ Institut Lesnoĭ Promyshlennosti. Trudy, Vol.3:122-129, 1967.
28-2141
ICE BEARING CAPACITY, ICE COVER THICKNESS, DYNAMIC LOADS, VEHICLES, ANALYSIS (MATHEMATICS).

**TL 471**
**LOCAL CLIMATE OF PIENINY REGION AND THE PLANS TO BUILD DAMS ON DUNAJEC RIVER.**
Żych, S., et al, Jan. 1975, 22p., ADB-004 790, Translation from Acta geographica Lodziendzia, No.13, 1962, p.7-23.
Boniecka-Zolcik, H.
32-4103
DAMS, CLIMATIC CHANGES, ENVIRONMENTAL IMPACT, MICROCLIMATOLOGY, RESERVOIRS, ECOSYSTEMS.
A description is given of the characteristics of the local climate and the microclimates of the Pieniny region as well as the expected climatic changes and disturbances of biocoenose, which may be caused by the building of a water reservoir below Czorsztyn in that area. The building of artificial water reservoirs changes radically the conditions of the base in a given region by creating an environment in which the physical characteristics are different from those which existed previously. The topographic configuration of the area shapes the original and variable characteristics of the climate which prevails in that area. Under these natural conditions, a relatively small but sudden change in climatic parameters which operate on a continued basis may cause disturbances in the local biocoenose. A change in the amount of water flowing through the gap of the Dunajec River will also result in a change of the local climatic conditions of the area.

**TL 472**
**OPERATION AND SELECTION OF MACHINES FOR CLEARING SNOW ON ROADS.**
Bosnjakovic, P., March 1975, 25p., ADA-009 062, Translation, from Serbian, of Vojnoteknicki glasnik, 12:1089-1100, 1971.
29-4030
SNOW REMOVAL EQUIPMENT, ROADS, COLD WEATHER OPERATION.
The fact that there are a large number of different snow-clearing machines unambiguously indicates that manufacturers are interested in the most perfect and efficient maintenance of roads in the wintertime. The wide assortment of machines indicates that more attention should be paid to their selection so that one selects the machine which will best meet our specific conditions. The improvement of rotary snow-clearing machines and particularly recent success in designing cutter-type rotary snow-clearing machines, are putting greater emphasis on this type of machine when the selection is being made. The improvement in the quality of the machine, and especially the improved output, is giving the advantage to up-to-date machines in spite of their higher cost, since they ensure rapid and efficient clearing of the roads. Moreover, the possibility of diverse use of snow-clearing machines, not only on roads, but also on streets and at airports, also gives advantage to rotary snow-clearing machines. The only remaining question is what sort of machine, in terms of power and capacity, best corresponds to Yugoslav conditions, to our weather conditions, our roads, and our traffic.

**TL 473**
**INVESTIGATION AND CALCULATIONS OF ICE JAMS.**
Chizhov, A.N., et al, March 1975, 106p ., ADA-014 887, For Russian originals of individual papers see 29-1193 through 29-1198. Numerous refs.
Kozitskiĭ, E., Buzin, V.A., Berdennikov, V.P., Donchenko, R.V., Filippov, A.M., Molchanov, A.K., Vlasov, V.P.
30-2075
RIVER ICE, ICE JAMS, ICE COVER STRENGTH, MODELS, AERIAL PHOTOGRAPHY.
The collection is concerned with the questions of ice jam phenomena on rivers. The articles indicate the quantitative tendencies in the formation of ice jams on the Dnestr River based on materials obtained from observations of past years, full-scale and model investigations, the results from studying the tendencies in ice jam phenomena in the tailwaters of the HES, plus a procedure for calculating these occurrences; the authors also expound on the experience gained in modeling the movement of slush ice beneath an ice cover and the results obtained from aerial photographing of jams occurring on rivers. The compendium is intended for hydrologists and hydraulic engineers.

**TL 474**
**ARCTIC AND THE ANTARCTIC.** Aug. 1975, 70p., ADA-014 888, For Russian original of this excerpt see 29-2744, p.422-475.
30-2076
WATER BALANCE, WATER SUPPLY, GLACIER ICE, RUNOFF, CLIMATE.
This excerpt from a book on world water balance describes the arctic and antarctic water supply specifically. It describes in great detail the effect of glacier runoff, geographical and topographic characteristics as well as the climatological influence on water balance in these areas.

**TL 475**
**MODEL INVESTIGATIONS OF ICE ENTRAINMENT BENEATH EDGE OF AN ICE COVER.**
Filippov, A.M., May 1975, 8p., ADA-009 694, For Russian original see 28-1501. 4 refs.
29-4031
RIVER ICE, ICE JAMS, ICE MODELS, DRIFT, RIVER FLOW.

Model investigations of the drawing in of slush and ice under the edge of an ice sheet are a component part of the study of ice-dam and ice-jam formation processes in rivers, as well as a stage in the experimental development of methods for the hydraulic regulation of slush and ice movements. By using this type of research, it is possible to determine the conditions governing the drifting of ice blocks of various lengths, widths and thicknesses under an ice sheet for flows having different hydraulic parameters.

**TL 476**
**BEARING STRENGTH OF FROST SENSITIVE SOILS AFTER THAWING AS A PARAMETER FOR DIMENSIONING ROADS AND AS A MEASURE FOR EVALUATING FROST CRITERIA.**
Jessberger, H.L., May 1975, 25p., ADB-004 593L, For German original see 28-3611. Distribution limited to U.S. Government agencies only.
32-2761
FROST HEAVE, GROUND THAWING, BEARING STRENGTH, SUBGRADES.

**TL 477**
**TRANSPLANTING HERBACEOUS PERENNIALS TO THE ARCTIC NORTH.**
Golovkin, B.N., May 1975, 267p., ADA-030 111, For Russian original see 28-3188. 478 refs.
31-2583
PLANT ECOLOGY, GROWTH, TUNDRA VEGETATION, COLD TOLERANCE.
The author considers the basic features in the morphogenesis of plants introduced by the Arctic-Alpine Botanical Garden (city of Kirovsk, Murmanskaya Oblast), specifically the growth and development of above-ground and underground sprouts, the duration of the plants' life and of their individual organs, as well as resistance to various unfavorable environmental conditions. A calculation of the extent of correlation between the pattern of the meteorological processes and the phenodates permitted us to disclose among many introducents special critical periods in the sprouts' development during which the plants are most sensitive to fluctuations in the stresses of meteorological factors. These periods can be timed both to the blossoming year and to the preceding year. Stability of phenophases among transplants in the North is less than under natural conditions in their country of origin. The mesophytes and facultative skiophytes are ideal introducents for the North. Among the living forms the best viability was shown by the rosetted hemicryptophytes and the rhizome geophytes. Good acclimatization was noted among the edificators of the vegetative cover.

**TL 478**
**PLANNING AND CONSTRUCTION OF SETTLEMENTS IN THE FAR NORTH: DEFENSE AGAINST SNOW DRIFTS.**
Stepanov, K.V., May 1975, 21p., ADA-030 112, For Russian original see SIP 17798. 2 refs.
31-2715
SNOWDRIFTS, SITE SURVEYS, URBAN PLANNING, SNOW FENCES.
The difficulties caused by snow in settled areas in the Soviet Far North, where winter is 8-10 months long and snowdrifts of 30 m. or more are recorded, are described, and the planning of cities for maximum protection against snow is discussed. Effective control is achieved by proper site selection and planning, the erection of retention devices, and the use of mechanical snow-removal equipment. Houses at the periphery of a settlement should face 30 degrees into the prevailing wind. Small settlements should be built as a row, with streets parallel to the prevailing wind and clear. Cross streets must be short. Buildings must be tall with smooth walls and a minimum perimeter. Roads outside the settlements are best built on embankments. Snow-retaining structures both inside and outside the settlements should be designed in light of the fact that the bulk of the snow (95%) moves in the 50 cm. nearest the ground. The characteristics of various permanent and temporary snow-retaining structures are outlined and diagrammed, and methods of calculating the most effective type of structure under given conditions are described.

**TL 479**
**EXPERIMENTAL CONSTRUCTION OF A FROZEN-TYPE DAM IN IAKUTIIA.**
Lyskanov, G.A., May 1975, 53p., ADA-009 732, For Russian original see SIP 25465. 19 refs.
29-4032
PERMAFROST BENEATH DAMS, ARTIFICIAL FREEZING, COLD WEATHER CONSTRUCTION, EARTH DAMS.
Dams presently constructed of permafrost are divided into two basic types: thawed and frozen. Frozen dams exclude filtration. Frozen dams are created by means of a special artificial cooling system or are made in the course of constructing the cores by laminar freezing. The formation of an ice core is also possible, with natural freezing of a dam erected from thawed soil. There are many dams on the collective farms of Yakutia that were frozen during the period of operation. In winters, the reservoirs formed by these dams are completely or partially drained, converting the dams into piles of earth during this period, surrounded on three sides by cold air. This report investigates the characteristics of the construction of all types of frozen dams.

**TL 480**
**FROZEN SOIL: A MATERIAL TO SOLVE PROBLEMS IN CONSTRUCTION INDUSTRY.**
Careaga, J.A., et al, June 1975, 16p., ADA-012 170, Translation of Suelo congelado: un material para la solucion de problemas en la industria de la construccion, Mexico, Inter-American Conference on Materials Technology, Third, Proceedings, 1972, p.57-64. 10 refs.
Mayer, E.R.
30-831
SOIL FREEZING, ARTIFICIAL FREEZING, SOIL STABILIZATION, CONSTRUCTION, CIVIL ENGINEERING.
Digging a well, restoring the foundations of a building or digging a tunnel in the soils of big cities constitute difficult projects due to a large number of already existing pipelines and sewers. When the city has a clayey subsoil with some content of water and highly permeable sandy lenses, risks of settlement, water leaks, or erosion necessitate the employment of special expensive construction methods. The National Autonomous University of Mexico developed an accelerated soil freezing process for use in emergency work involving the direct injection of liquid nitrogen through the ground to be stabilized. This article presents the principal results obtained by this method as well as considerations of an economic nature on the applicability of the technique as well as a comparison with other conventional-type freezing methods.

**TL 481**
**INDICATORS FOR FORECASTING SHIP ICING.**
Borisenkov, E.P., ed, June 1975, 60p., ADA-30 113, For Russian original see 27-1072. 14 refs.
Pchelko, I.G., ed.
31-2716
SHIP ICING, METEOROLOGICAL FACTORS, ICE LOADS, ICE FORECASTING.

**TL 482**
**AEROMETHODS IN GEOCRYOLOGY.**
Protas'eva, I.V., July 1975, 184p., ADA-041 143, 199 refs. For Russian original See SIP 25,758.
30-15
PERMAFROST DISTRIBUTION, GEOCRYOLOGY, FROZEN GROUND, AERIAL SURVEYS, PHOTOINTERPRETATION, TERRAIN IDENTIFICATION, PHOTOGRAMMETRY, THEORIES.
The book presents the possibility of the application of aeromethods for studying the conditions in the development of permafrost soils (rocks) and permafrost phenomena connected with them. Theoretical and methodological conclusions have been drawn which can be utilized as a basis for a further broader adoption of aeromethods into the practice of regional and topical studies of the tendencies in the distribution, composition, structure and properties of permafrost soils. This is the first time that such a scientific-procedural handbook has been published for geocryological purposes. We have generalized fairly completely in it the experience gained in the application of aeromethods in permafrostology and related sciences and the problems of their future development are also reviewed. The book is meant for specialists conducting studies in the distribution of permafrost soil for the purpose of the economic development of its territory, i.e. the book is oriented toward geologists, engineer-geologists, prospectors, construction engineers, mining engineers and also for the scientific workers concerned with a study of the features in the terrain structure under the developmental conditions of permafrost soils (rocks).

**TL 483**
**GROWTH OF ICE CRYSTALS ON SOLID SURFACES.**
Shumskiĭ, P.A., July 1975, 39p., ADA-012 116, Translation of Voprosy Geologii Azii (Problems of Geology in Asia), Moscow, Akademiia nauk SSSR, 1955, p.565-595. 25 refs.
30-832
ICE CRYSTAL GROWTH, ICE CRYSTAL STRUCTURE, HISTORY, THEORIES.
This report discusses the general problem of the growth of crystals. It includes a short history of the phenomenon of accumulation of ice crystals. The processes of the structural formation of a polycrystalline unit are discussed in detail. The theory of a passive orienting influence of a surface on growing crystals is mentioned in some detail.

**TL 484**
**PERENNIAL CRYOLITHIC ZONE.**
Sharbatian, A.A., July 1975, 5p., ADA-014 147, Translation of Bol'shaia Sovetskaia Entsiklopediia, Vol. 16, 1974, columns 1098-1103. 11 refs.
30-2078
GEOCRYOLOGY.
The perennial cryolithic zone is an upper layer of the earth's crust characterized over a period of many years by a stable negative or zero temperature ensuring year-round and prolonged preservation of underground ice. This article briefly discusses this zone.

**TL 485**
**DESIGN FACTORS FOR RIVER ICE BOOMS ANALYZED.**
Latyshenkov, A.M., Sept. 1975, 13p., ADA-014 886, Translation of Gidrotekhnicheskoe stroitel'stvo, 15(4):13-19, 1946. For Russian original see SIP 13352.
30-2079
RIVER ICE, RIVER FLOW, ICE COVER THICKNESS, ICE BOOMS.
Model studies were made to determine hydraulic characteristics of structures for protecting ships wintering in rivers under conditions similar to those observed in European and Siberian rivers (ice-cover thickness up to 1.8m. and river depth to 12 m.). The experiments are described in detail, and data are mathematically analyzed. Formulas and graphs for calculating the stresses as a function of ice-cover thickness, flow speed, and width and depth of the river are suggested. The ice pressure on protective booms in a stream wider than 30m. was found to increase 85-90% due to the friction between the lower ice surface and flowing water. The friction coefficient is proportional to the ratio of ice thickness to flow depth.

**TL 486**
**PROTECTION AGAINST FROST DAMAGE PART VI: FLOORS LAID DIRECTLY ON GROUND, WITH REDUCED FOUNDATION DEPTH.**
Torgerson, P., Oct. 1975, 50p., ADA-016 912, Translation of Norges teknisk-naturvitenskapelige forskningsråd. Utvalg for frost i jord. Sikring mot teleskader, p.67-93, 1975.
31-2717
FLOORS, FROST PROTECTION, FROST HEAVE, HEAT TRANSFER, INSULATION.
This report presents research activities conducted in Norway on floors laid directly on ground, with reduced foundation depths. The Building Code of Norway has recently changed allowing this type of construction; therefore research in special test houses using this type of floor was initiated. This report describes these test houses and presents information on heat flow, floor temperatures, damp-proofing and frost-proofing.

**TL 487**
**TRANSFER OF HEAT, MOISTURE IN SEASONALLY FREEZING GROUND OF ROAD BEDS.**
Lukina, V.A., et al, Sept. 1975, 10p., ADA-015 553, For Russian original see 29-3779. 10 refs.
Uvarov, B.V.
30-2080
HEAT TRANSFER, ROADBEDS, SEASONAL FREEZE THAW, SOIL MOISTURE MIGRATION, COMPUTER APPLICATIONS.
In this article a method is furnished for solving differential equations in partial derivatives; the method describes in a unidimensional task the process of heat and moisture exchange taking place in roadbeds and road surfaces. The solution was obtained using a digital application of the Laplace conversion. Using an "Nairi-S" electronic computer, the method makes it possible to determine the winter redistribution of moisture in the ground of roadbeds and also the amount of heaving. The results of the specific computations carried out agrees rather well with the test results.

**TL 488**
**NATURAL METHODS OF PURIFYING SEWAGE AND ITS UTILIZATION IN AGRICULTURAL MANAGEMENT.**
Novikov, V.M., ed, Sept. 1975, 116p., ADA-014 971, Translation of Estestvennye metody ochistki stochnykh vod i ikh ispol'zovanie v sel'skom khoziaĭstve. Moscow, Vsesoiuznyĭ nauchno-issledovatel'skiĭ institut gidrotekhniki i melioratsii, 1972.
30-2081
SEWAGE DISPOSAL, FREEZE THAW CYCLES, WASTE TREATMENT, IRRIGATION.
This collection of articles discusses the theoretical and practical aspects of the agricultural use of sewage. The results of research on irrigation with sewage in various types of soil and on the effects of sewage on the yield and quality of fodder crops are presented and the suitability of various kinds of sewage for irrigation is evaluated.

**TL 489**
**STUDIES OF EXCAVATING EQUIPMENT.**
Basov, I.G., ed, Oct. 1975, 96p., ADA-016 914, For Russian original see 29-2942 through 29-2958. For translated individual papers see 31-3624 through 31-3640.
31-3623
EARTHWORK, EXCAVATING EQUIPMENT, COLD WEATHER CONSTRUCTION, DESIGN, FROZEN GROUND, COLD WEATHER PERFORMANCE.
This book presents seventeen studies on various types of excavating equipment. The emphasis is on equipment especially successful in excavating frozen ground.

**TL 490**
**ELECTRICAL POTENTIALS IN FREEZING SOLUTIONS AND THEIR EFFECT ON MIGRATION.**
Korkina, R.I., Oct. 1975, 15p., ADA-015 554, For Russian original see 23-409. 6 refs.
30-2082
ELECTRIC POTENTIAL, FROZEN GROUND CHEMISTRY, SOIL CHEMISTRY, SOIL MOISTURE MIGRATION, WATER STRUCTURE.
Electrical potential originating during gradual cooling of doubly distilled water, weak salt solutions, and clay suspensions was studied experimentally in relation to moisture migration in soil during freezing. The experimental procedure consisted of keeping the sample-filled flasks insulated on all sides but the bottom, under definite sub-freezing temperature conditions and observing the variation of the magnitude and sign of potential in time. Curves relating these variations to the distance between the measuring electrode and the cooling surface, and to cooling time were plotted from the reading obtained. Interpretation of the results indicated that a change in water structure preceeding its freezing was the cause of origin of electrical potential and that this effect on water migration in freezing soil is dependent on the concentrations of salts dissolved in the soil moisture, the mineralogical composition of colloidal particles suspended in the solution, and the composition of exchange cations on the surface of these particles.

**TL 491**
**NATURAL PURIFICATION OF SEWAGE AND THE ECONOMIC EFFECTIVENESS OF ITS UTILIZATION FOR IRRIGATION; A COLLECTION OF ARTICLES.**
Novikov, V.M., ed, Oct. 1975, 160p., Translation from Russian.
33-530
SEWAGE DISPOSAL, WATER TREATMENT, WASTE TREATMENT, IRRIGATION, AGRICULTURE.

**TL 492**
**RECONNAISSANCE IN MOUNTAIN TERRAIN.**
Siniaev, A.D., Apr. 1974, 85p., AD-781 242, FSTC-HT-23-1421-71, Russian original published Moscow, Military Publishing House, 1963.
32-4108
MILITARY OPERATION, MOUNTAINS, TERRAIN ANALYSIS, STREAMS, SURVIVAL, SURVEYS.

**TL 493**
**ENGINEER SUPPORT FOR COMBAT OPERATIONS AT NIGHT AND UNDER SPECIAL CONDITIONS.**
Shamshurov, V.K., Mar. 1972, 74p., AD-742 053, SFTC-HT-23-1600-71, Translation of Inzhenernoe obespechenie boevykh deĭstviĭ voĭsk noch'iu i v osobykh usloviiakh, 1969.
32-4107
MILITARY OPERATION, COLD WEATHER OPERATION, TRAFFICABILITY, ICE COVER STRENGTH, FOREST LAND.

**TL 494**
**ICING PROBLEMS ON HELICOPTER ROTOR BLADES.**
Bestek, H., Jan. 20, 1974, 9p., AD-923 397, FSTC-HT-23-440-74, Translation of DEVLR Nachrichten (West Germany), 1972, No.6:236-238.
32-4106
ICE FORMATION, HELICOPTERS, ICE PREVENTION, DEICERS, SURFACE TEMPERATURE, SUPERCOOLING, METEOROLOGICAL FACTORS.
Conditions necessary for icing helicopter rotor blades are given. Various types of ice coatings are described. The effects of these coatings on the aerodynamic and mechanical flight properties of the helicopter are discussed. Finally, ice-prevention and de-icing systems are described.

**TL 495**
**AERIAL PHOTOGRAPHIC SURVEYING OF THE SNOW COVER AT THE HEADWATERS OF THE ANGREN RIVER FOR HYDROLOGICAL PURPOSES.**
Chernogorov, V.P., 1968, 147p., FSTC-HT-23-742-68, No microfiche available. For Russian original see SIP 25965.
33-531
SNOW COVER DISTRIBUTION, AERIAL SURVEYS, AERIAL PHOTOGRAPHY, SNOW HYDROLOGY, USSR—ANGREN RIVER.

**TL 496**
**SNOW REMOVAL EQUIPMENT.**
Minic, J., Nov. 1971, 6p., ADB-007 018, FSTC-HT-23-263-72, Translation from Atom (Czechoslovakia), 1970, No.12:361-363.
32-4105
SNOW REMOVAL EQUIPMENT.
The author discusses various types of snow removal equipment used in Czechoslovakia.

**TL 497**
**FROSTPROOFING PIPES.**
Gundersen, P., Oct. 1975, 68p., ADA-030 115, Translation of Norges teknisk-naturvitenskapelige forskningsråd. Utvalg for frost i jord. Sikring mot teleskader, chapter 8, 1975.
31-2718
FROST PROTECTION, FROST PENETRATION, PIPELINE INSULATION, FROZEN GROUND TEMPERATURE, THERMAL INSULATION.
The report investigates new frost-proofing methods which, in addition to economic advantages inherent in laying shallower pipe networks, provide a great deal more freedom in the selection of pipe locations. This in turn opens new avenues for improved areal utilization, and the implementation of necessary environmental precautions will be facilitated.

**TL 498**
**FROST PROTECTIVE LAYERS FOR ROAD PAVEMENTS.**
Puzakov, N.A., Nov. 1975, 8p., ADA-018 071, For Russian original see SIP 20131.
30-1809
ROADS, FROST PROTECTION, FROST PENETRATION, SOIL MOISTURE, SOIL TEMPERATURE.
This report presents a method designed for calculation of frost-protective layer thickness under various conditions met in the construction of roadbeds. Frost protective layers are needed in those regions where the water and temperature conditions make their use imperative.

**TL 499**
**USE OF SEWAGE IN AGRICULTURE.**
Novikov, V.M., et al, eds, Oct. 1975, 196p., ADA-017 303, Translation of Trudy TsNISSV, Vypusk 1: Estestvennye metody ochistki stochnykh vod i ikh ispol'zovanie v sel'skom khoziaistve, Moscow, Ministry of Land Reclamation and Water Resources, 1969. For individual papers see 30-3207 through 30-3228.
30-3206
SEWAGE TREATMENT, WASTE TREATMENT, AGRICULTURE, WATER POLLUTION, IRRIGATION.
Research has shown that industrial sewage, as a rule, can be used for irrigation and that the limits to its use are dictated not so much by its content as by the absence of the necessary treatment as well as by natural-geographic and organizational-technical conditions (climate, soil, land contours, hydrogeological conditions, degree of salinity, presence of a water conservation zone, shortage of research on the part of health organs, etc.). The extensive utilization of sewage for irrigation and significant prospects for the development of this method has resulted in the necessity to elucidate existing achievements in published form and to exchange experience in this area. The present volume, prepared by the Central Scientific-Research Station for the Agricultural Utilization of Sewage (TsNISSV), has been assigned this task.

**TL 500**
**SUGAR PLANT WASTE WATER UTILIZED FOR IRRIGATION.**
Dodolina, V.T., et al, Nov. 1975, 9p., ADA-017 306, Translation of Sakharnaia promyshlennost', no.1:18-22, 1975. 7 refs.
Novikov, V.M., Sollogub, A.A.
30-3294
WATER TREATMENT, WASTE TREATMENT, AGRICULTURE, IRRIGATION.
Wastewater from sugar plants is used for irrigating fields in Russia. This contributes to obtaining large and stable harvests of agricultural crops and to increasing the fruitfulness of the soil and makes it possible to use marginal land for agricultural purposes.

**TL 501**
**SUGAR PLANT WASTE WATER SUITABLE FOR IRRIGATION.**
Dodolina, V.T., Nov. 1975, 5p., ADA-017 305, Translation of Sakharnaia Promyshlennost', no. 2:24-27, 1974.
30-3295
WATER TREATMENT, WATER CHEMISTRY, AGRICULTURE, IRRIGATION.
This report evaluates the suitability of waste water from a sugar plant for irrigation on the basis of studies of soil, climate, hydrogeology, and the composition of the waste water.

**TL 502**
**LIFE ON AN ICE ISLAND.**
Chilingarov, A., et al, Dec. 1975, 200p., ADA-018 072, For Russian original see 29-3221.
Sarukhanian, E., Evseev, M.
30-3296
ICE ISLANDS, EXPEDITIONS, DRIFT STATIONS.
This book was written and compiled by members of a komsomol-youth staff of scientific researchers on the drifting station "Severnyy Polyus-19". Their diaries, notes, log entries, telegrams, autobiographies, interviews with veteran Arctic explorers, photographs and reproductions of various documents are the content of this book. On the way to the North Pole the small youthful crew of the station experienced everything that could happen to man in the Arctic, including faults and cracks, disintegration of the ice and hasty moves from place to place, and encounters with bears. However, the scientific work was not interrupted for even an hour.

**TL 503**
**DESIGNING HIGHWAYS SITUATED IN AREAS OF DRIFTING SNOW.**
Norem, H., Dec. 1975, 141p., ADA-028 191, Translation of Utforming av veger i drivsnöomrader, Institute for Highway and Railroad Construction, Norway University of Technology, 1974. 64 refs.
31-403
ROADS, CONSTRUCTION, MOUNTAINS, SNOWDRIFTS, SNOW REMOVAL, WIND FACTORS.
This report describes the use of climatic data for the design of highways situated in areas with drifting snow. It also concentrates on the cross sectional design of such highways. Three methods for snow depth surveying are tested and described. The report concludes that a combination of tachymetric and botanical methods is generally recommended for the surveying of snowdepths when planning mountain highways.

**TL 504**
**MACHINES FOR MAINTENANCE OF ROADS DURING WINTER.**
Ingulstad, A., May 1976, 19p., ADA-028 064, Translation of Teknisk Ukeblad 122(1,2):5, 7-11, Jan. 1975.
31-404
SNOW REMOVAL EQUIPMENT, SALTING, SANDING, WINTER MAINTENANCE, ROADS.
This report is an overview of machines and equipment used to maintain roads during winter in Norway. Snowplows, snowblowers and their application are discussed. Salting and sanding techniques are also presented.

**TL 505**
**NATURAL METHODS OF PURIFYING WASTE WATERS AND UTILIZING THEM IN AGRICULTURE, BIBLIOGRAPHY, PARTS 1 & 2.**
L'vovich, A.I., Dec. 1975, 110p., ADA-019 105, Translation of Bibliografiia po estestvennym sposobam ochistki stochnykh vod i ispol'zovanie ikh v sel'skom khoziaĭstve.
30-1810
BIBLIOGRAPHIES, SEWAGE TREATMENT, WATER TREATMENT, AGRICULTURE.
This bibliography gives a list of Russian published material on agricultural utilization of waste waters and natural methods of purifying them on agricultural and municipal irrigation fields. Materials on questions of self-purification of the soil from pollutants and sanitary and hygienic evaluations of soil methods are presented as completely as possible. The bibliography was updated in 1971 to contain a total of 2,200 titles.

**TL 506**
**CHEMISTRY AND MICROBIOLOGY OF WATER.**
Dolivo-Dobrovol'skiĭ, L.B., et al, Dec. 1975, 333p., ADA-027 708, Translation of Khimiia i mikrobiologiia vody, Kiev, Vyshcha shkola, 1971.
Kul'skiĭ, L.A., Nakorchevskaia, V.F.
30-4453
MICROBIOLOGY, WATER POLLUTION, SEWAGE TREATMENT, WATER CHEMISTRY.
The book discusses the chemical and microbiological processes taking place in reservoirs and during purification of natural and sewage waters. Particular attention is devoted to problems of chemical and biological purification, intensification of the methods of treating natural and sewage waters, new reagents and improvement of the treatment method.

**TL 507**
**FREEZING AND THAWING OF ROADS.**
Rouques, G., et al, Dec. 1975, 51p., ADA-024 502, Translation of "Gel et dégel des chaussées". Laboratoire central des ponts et chaussées. Note d'information technique, 1975. 9 refs.
Caniard, L., LeFlaive, E., Philippe, A., Boutonnet, M., Faure, B.
30-3661
ROADS, SEASONAL FREEZE THAW, SOIL FREEZING, GROUND THAWING, CRACKING (FRACTURING), DAMAGE.
This report covers all aspects of the freeze phenomena on roads. It encompasses theoretical studies on the propagation of the freezing front to operational aspects (setting up and removal of thaw barriers), including experiments on roads in use, on experimental roads (Nancy), and at the Caen proving ground.

# MISCELLANEOUS PUBLICATIONS

**MP 1**
**SNOW REMOVAL AND ICE CONTROL RESEARCH.**
National Research Council. Highway Research Board, *National Research Council. Highway Research Board. Special report,* April 1970, No.115, 282p., Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970. Numerous refs.
U.S. Army Cold Regions Research and Engineering Laboratory.
25-1781
SNOW REMOVAL, ICE REMOVAL, ROADS, PAVEMENTS, COLD WEATHER OPERATION, SNOW REMOVAL EQUIPMENT, ICE REMOVAL EQUIPMENT.

**MP 2**
**INSTRUMENTED PROBES FOR DEEP GLACIAL INVESTIGATIONS.**
Aamot, H.W.C., *Journal of glaciology,* June 1968 , 7(50), p.321-328, 9 refs. For another version of this paper and abstract see 24-3153.
23-2949
PROBES, TELEMETERING EQUIPMENT, THERMAL PROBES.

**MP 3**
**A BUOYANCE-STABILIZED HOT-POINT DRILL FOR GLACIER STUDIES.**
Aamot, H.W.C., *Journal of glaciology,* Oct. 1968 , 7(51), p.493-498, In English, with French and German summaries. 4 refs. For another version of this paper and abstract see 24-3158.
23-4330
ICE CORING DRILLS, BUOYANCY STABILIZATION, DRILLING.

**MP 4**
**PENDULUM STEERED THERMAL PROBE.**
Aamot, H.W.C., July 2, 1968, U.S. Patent Office. Patent, 5p., USP-3,390,729, Includes diagrams of probe. 4 refs.
23-5323
THERMAL MEASURING INSTRUMENTS, STABILIZATION, GRAVITY CENTER, ICE.

**MP 5**
**SELF-CONTAINED THERMAL PROBES FOR REMOTE MEASUREMENTS WITHIN AN ICE SHEET.**
Aamot, H.W.C., *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.63-68, 3 refs.
25-941
GLACIER ICE, ICE CORING DRILLS, THERMAL DRILLS, HEAT TRANSFER.
Thermal probes are now available for penetrating polar ice sheets to depths as great as 3000 m for remote measurement of in situ temperature and stress conditions. The vertical course of a probe is assured through positive attitude stabilization, either by mercury steering or pendulum steering. Power equipments for penetration and for lateral transfer to avoid premature hole closure depend on the probe speed and the ice temperature and can vary from 5 to 15 kW. The sealed confinement in the ice, the low temperatures, and the high pressures present special problems. First results from a probe sent into the Greenland ice sheet at Camp Century and stopped at a depth of about 260 m gave a hyperbolic cooling curve approaching the final temperature to within 0.1 C after about six days and indicated a peak crystallization stress in the confined melt water during refreezing of about 88 bar above the overburden stress. Two probes reached 230 and 1000 m at Station Jarl Joset, providing valuable scientific and engineering information.

**MP 6**
**PENDULUM STEERING FOR THERMAL PROBES IN GLACIERS.**
Aamot, H.W.C., *Journal of glaciology,* Oct. 1967 , 6(48), p.935-938, French and German summaries. 2 refs. For another version of this paper and abstract see 24-3497.
25-2156
PROBES, ICE CORING DRILLS, THERMAL DRILLING, PENDULUMS.

**MP 7**
**DEVELOPMENT OF A VERTICALLY STABILIZED THERMAL PROBE FOR STUDIES IN AND BELOW ICE SHEETS.**
Aamot, H.W.C., *Journal of engineering for industry,* May 1970, Vol.92, p.263-268, 15 refs.
25-2238
PROBES, ICE CORING DRILLS, THERMAL DRILLING, PENDULUMS.
The pendulum probe described is an instrumented device that penetrates polar ice sheets for remote measurements of geophysical parameters. It can only move downward by melt penetration; its instrumentation is permanently installed, sealed in the ice. The power requirements and operating costs are derived from the heat transfer analysis. The pendulum steering principle, which assures a vertical probe attitude and course, also explains its performance flexibility. The results from the first trials verify the probe's feasibility and supply additional design information. The probe offers a unique opportunity for access to, and study of, the Antarctic Ocean waters under the Ross and Filchner ice shelves.

**MP 8**
**ICE TUNNELING IN GREENLAND.**
Abel, J.F., Jr., et al, *Mining engineering,* June 1959, 11(6), p.594-596, Microform No. SIP 17403.
Sulzbach, J.F., Walker, D.K.
25-2214
ICE TUNNELS, TUNNELING (EXCAVATION), EXCAVATING EQUIPMENT, GREENLAND—CAMP TUTO.
Ice tunneling by SIPRE at Camp Tuto from 1955-1958 is described. Tunneling was begun in 1955 at the base of a 110-ft. ice cliff. The periphery of the face was first excavated with the coal cutter, and the cut blocks were then drilled and blasted. Optimum fragmentation was achieved with 0.06 lb. of black powder per cu. yd. of ice. The coal cutter operated very satisfactorily in ice free debris, with difficulty in ice containing silt and fine sand, and could not cut through blocks containing rocks or pebbles. At depths of 200 ft. ice was flowing into the tunnel and rooms at rates up to 3 ft. of vertical closure a year. In 1958 a new tunnel was started at a higher elevation in the moraine-covered ice, the work being performed by modern highcapacity equipment. The actual mining was done by a Joy 3-JCM continuous miner, which discharged onto a 24-in. conveyor and from it onto an extensible belt conveyor.

**MP 9**
**PERFORMANCE TESTING OF AN AIR CUSHION VEHICLE ON THE GREENLAND ICE CAP.**
Abele, G., *Journal of terramechanics,* 1967 , 4(1), p.19-30, 3 refs. For another version of this paper and abstract see 24-3475.
23-1688
AIR CUSHION VEHICLES.

**MP 10**
**SNOW MECHANICS ASPECTS IN SNOW SAMPLING.**
Abele, G., International Conference of Soil Mechanics and Foundation Engineering, 7th, Aug. 29, 1969, Mexico. Specialty Session 1, Melbourne, Australia,, p.69-72, 11 refs.
25-2185
SNOW SAMPLERS, SNOW STRENGTH, SNOW MECHANICS, TEMPERATURE FACTORS, TIME FACTOR, VISCOELASTICITY, BEARING STRENGTH.
Although snow sampling apparatus and techniques are in many respects comparable to soil sampling, the aspects of snow mechanics are of a rather complex nature because of the pronounced effect of time and temperature, the snow's non-linear visco-elastic behavior under load and sensitivity to the rate of loading. The significant snow properties and their relevance to the mechanical behavior of snow under load are outlined, and the snow sampling apparatus and measurement techniques are discussed briefly.

**MP 11**
**PENETRATION OF VEHICLE TRACK GROUSERS INTO HARD SNOW.**
Abele, G., International Society for Terrain-Vehicle Systems. Third international Conference, July 9-12, 1969, Essen, W. Germany. Proceedings, Vol.2, Essen, W. Germany, 1969, p.1-24, 18 refs.
25-2376
TRACKED VEHICLES, SNOW HARDNESS, PENETRATION TESTS, TRAFFICABILITY.
The track shoe grouser pressure required to penetrate, hard compacted snow can be correlated with a snow hardness index, which is conveniently obtained with a manual, spring push-type Soil Penetrometer. Therefore, the ability of a grouser (with known contact pressure) to penetrate hard snow could be predicted reasonably well from snow hardness measurements. Density alone cannot be used as a reliable index of snow strength. Temperature has a significant influence on snow hardness or strength. Snow hardness and, therefore, its resistance to penetration by a track shoe grouser, increase linearly with a decrease in snow temperature in the range of -5 to -30 C. If grouser width is kept constant, no size effect is evident for a grouser length range of 5 to 80 cm, the required penetration load being proportional to grouser length.

**MP 12**
**DESIGN CRITERIA FOR SNOW RUNWAYS.**
Abele, G., et al, *Engineering journal,* May 1966, 49(5), p.19-24, 16 refs. Microform No. SIP 25133.
Ramseier, R.O., Wuori, A.F.
25-2104
RUNWAYS, SNOW MECHANICS, SNOW (CONSTRUCTION MATERIAL), SINTERING, SNOW COMPACTION, SNOW BEARING STRENGTH, DESIGN CRITERIA.
The paper combines knowledge of the snow sintering process with methods and procedures using snow as a construction material. The methods described apply to Greenland and Antarctica as well as to areas with an annual snow cover. To enable snow to support heavy wheel loads, processing by means of disaggregation and subsequent compaction is required. The rate of sintering increases with an increase in temperature towards the melting point, particularly at early stages of sintering. The supporting capacity can be estimated from an empirical relationship obtained from simulated tests using various tire contact pressures, wheel loads, and a number of repetitive wheel coverages.

**MP 13**
**ICE ADHESION STUDIES: PROPERTIES OF DEFECTS IN THE INTERFACIAL REGION.**
Ackley, S.F., et al, *National Research Council. Highway Research Board. Special report,* April 1970, No.115, Snow removal and ice control research. Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970, p.87-96, Includes discussion. 29 refs.
Itagaki, K.
25-1789
ICE ADHESION, ICE SOLID INTERFACE, SHEAR STRENGTH, ICE DIELECTRICS, DISLOCATIONS, DIFFUSIVITY.
Considerable work has been done on the surface chemical aspects of ice adhesion. Another point of view, however, is that ice adhesion may be primarily a function of the strength of ice in the interfacial region; i.e., ice sheared from a surface breaks away cohesively in the ice rather than adhesively at the substrate. The properties of ice in the interfacial region, especially those factors that influence the strength of ice (point and line defects), have been investigated this past year. Investigations, including Berg-Barrett and Lang X-ray topography, have revealed line defects in ice to be charged. The presence of this charge is considered in the devising of methods to weaken ice in this region. Other studies include surface self-diffusion, effects of ice-weakening impurities such as hydrofluoric acid, and microhardness investigations to determine the effects on ice dislocation mobility after the use of ice-release agents.

**MP 14**
**DISTRIBUTION OF ICING IN THE NORTHEAST'S ICE STORM OF 26-27 DECEMBER 1969.**
Ackley, S.F., et al, *Weatherwise,* Dec. 1970, 23(6), p.274-279, 9 refs.
Itagaki, K.
25-2888
ICE ACCRETION, ICE LOADS, CLASSIFICATIONS, ICE STORMS, ICING DISTRIBUTION, UNITED STATES—NEW ENGLAND.

**MP 15**
**REDUCTION OF FROST-HEAVE BY SURCHARGE LOADING.**
Aitken, G.W., *National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, Lafayette, Ind. Proceedings, p.319-324, 1 ref. Microform No. SIP 24865.
25-2105
FROST HEAVE, FROST PENETRATION, SOIL MECHANICS, PERMAFROST, CONSTRUCTION.
Seasonal frost-heave of fine-grained soils in a permafrost area may be reduced considerably by nominal surcharge loads. Field and laboratory data available indicate a definite relation between frost-heave rate and surcharge pressure on the subgrade, when frost-heave is essentially linear with time. Data also show the possibility of developing relationships between heave, frost penetration, and surcharge pressure. With additional field and laboratory data it will be possible to develop design criteria suitable for airfield and highway engineers. These criteria will assist the designer in his selection of optimum

nonfrost-susceptible base course thickness to assure reliable pavement performance.

**MP 16**
**TRANSPORT OF FROZEN SOIL.**
Aitken, G.W., Vermont Conference on Winter Construction, Oct. 30-31, 1969. Proceedings, Burlington, University of Vermont, 1970, p.50-68, 5 refs.
25-3028
FROZEN CARGO, EARTH HANDLING EQUIPMENT, SOIL PROPERTIES.
Several methods for transporting frozen materials and the importance of soil properties in frozen soil transport are discussed.

**MP 17**
**STRATIGRAPHIC STUDIES OF THE WINTER SNOW LAYER MOUNT LOGAN, ST. ELIAS RANGE.**
Alford, D.L., et al, *Arctic,* Dec. 1968 , 21(4), p.245-254, In English, with French and Russian summaries. 10 refs.
Keeler, C.M.
23-5555
SNOW COVER, GLACIERS, SNOW WATER EQUIVALENT, DENSITY (MASS/VOLUME), STRATIGRAPHY, CANADA—YUKON TERRITORY.
Results of a traverse study of near-surface snow properties in the King Trench area of Mount Logan, St. Elias Range, are presented. Based upon the assumption that these snow properties are related to thermodynamic processes operating during the depositional period, a climatological model of the King Trench is presented which relates the observed variations in snow properties along the traverse line to localized topographic obstruction or enhancement of katabatic air drainage. It is suggested that the near-surface climate of snow-covered slopes generally may be inferred partially from the interaction between local topography and katabatic wind flow.

**MP 18**
**POORLY DRAINED SOILS WITH PERMAFROST IN INTERIOR ALASKA.**
Allan, R.J., et al, *Soil Science Society of America. Proceedings,* July/Aug. 1969 , 33(4), p.599-605, 25 refs.
Brown, J., Rieger, S.R.
24-710
SOIL STRUCTURE, SOIL PROFILES, PERMAFROST DEPTH, CHEMICAL PROPERTIES, PHYSICAL PROPERTIES, SOIL CLASSIFICATION, UNITED STATES—ALASKA.
Physical, chemical, and mineralogical properties are presented for five soils with permafrost in interior Alaska. The soils are shallowly thawed, with permafrost usually at 60 cm or less, and with a thick accumulation of organic matter, usually about 25 cm deep, over a gleyed mineral soil. They are classified as Histic Pergelic Cryaquepts in the comprehensive soil classification system adopted by the US Department of Agriculture. Histic Pergelic Cryaquepts are the most extensive soils developed over permafrost in Alaska. In three of the five profiles, particle-size analyses reveal a slight increase (2-4 per cent) in clay content of the thawed mineral soil over that of the permafrost. The coarsest horizon in all five profiles contains only 48 per cent sand. The dominant texture is silt loam. In one of the profiles, base saturation increases (52-90 per cent) with the depth in the thawed mineral soil, then remains fairly constant in the permafrost. Percent Zr (0.02 per cent) remains constant in the coarse silt fraction of all horizons in all five profiles both above and in the permafrost. The dominant clay minerals in the thawed horizons were vermiculite and kaolinite.

**MP 19**
**THEORETICAL ANALYSIS OF SEA-ICE STRENGTH.**
Anderson, D.L., et al, *American Geophysical Union. Transactions,* Aug. 1958, 39(4), p.632-640, 15 refs. Microform No. SIP 16715.
Weeks, W.F.
25-2197
SEA ICE, TENSILE STRENGTH, SALINITY, TEMPERATURE FACTORS, MODELS, ANALYSIS (MATHEMATICS).
For the first time an attempt is made to derive a theoretical relationship between sea-ice strength and the controlling factors of salinity, temperature, and density. A geometric model of the ice-brine relationship is constructed from photographs and used to calculate tensile strength of warm (above -20C) sea ice. The theoretical results compare well with experimental data. The model developed can be extended to colder temperatures by considering the effect of solid salts.

**MP 20**
**ICE NUCLEATION AND THE SUBSTRATE-ICE INTERFACE.**
Anderson, D.M., *Nature,* Nov. 11, 1967 , 216(5115), p.563-566.
23-398
ICE SOLID INTERFACE, INTERFACES, ICE NUCLEI, NUCLEATION.
Embryo crystals form by enlargement of one of the normal components of the liquid. This is favored by reduced molecular motions and a tendency towards more open, hydrogen bonded regions near the interface.

**MP 21**
**INTERFACE BETWEEN ICE AND SILICATE SURFACES.**
Anderson, D.M., *Journal of colloid science,* Oct. 1967 , 25(2), p.174-191, 51 refs. For another version of this paper and abstract see 24-3361.
23-1843
ICE SOLID INTERFACE, FROZEN GROUND, CLAY SOILS.

**MP 22**
**UNDERCOOLING, FREEZING POINT DEPRESSION, AND ICE NUCLEATION OF SOIL WATER.**
Anderson, D.M., *Israel journal of chemistry,* May-June 1968 , 6(3), p.349-355, 15 refs.
23-3123
SOIL WATER, FREEZING POINTS, SUPERCOOLING, NUCLEATION.
Certain aspects of the phenomena of undercooling and ice nucleation in soils are discussed with respect to recently established properties of phase boundary water in soils. Nucleation temperature as a function of water content is given for representative clays. In view of the fact that silicate surfaces seem always to be separated from ice by an interfacial layer of unfrozen, liquid like water a new concept of heterogeneous nucleation is outlined. It is proposed that ice nucleation occurs in the undercooled interfacial water layer at some distance removed from the particle surfaces. This concept, in effect, suggests that heterogeneous nucleation (nucleation of ice due to the influence of a substrate) in all its essential aspects may be only a special case of homogeneous nucleation (no substrate present) of water.

**MP 23**
**GENERAL REPORT ON THERMAL CHARACTERISTICS OF SOILS, THERMODYNAMICS OF SOIL SYSTEMS, FLUID FLOWS, AND FROST ACTION.**
Anderson, D.M., *National Research Council. Highway Research Board. Special report,* 1969 , No.103, p.6-8, 3 refs.
24-2324
SOIL PATTERNS, THERMODYNAMIC PROPERTIES, FROST ACTION.

**MP 24**
**PHASE COMPOSITION OF FROZEN MONTMORILLONITE-WATER MIXTURES FROM HEAT CAPACITY MEASUREMENTS.**
Anderson, D.M., *Soil Science Society of America. Proceedings,* Nov.-Dec. 1966, 30(6), p.670-675, 15 refs.
25-2106
HEAT MEASUREMENT, FROZEN GROUND, CLAY SOILS, UNFROZEN WATER CONTENT.
Equations are written that form the basis of a method for determining the unfrozen water content of frozen clay-water mixtures from heat capacity measurements. The heat capacity of frozen sodium-montmorillonite water mixtures was determined at -4.7 and -9.6C with a Calve Microcalorimeter. The data were then used in conjunction with the method described to obtain the unfrozen water content of these clay water mixtures. The data obtained indicate that the method is applicable at temperatures below about -5C. The amount of unfrozen water found in frozen clay-water mixtures at -5 to -10C is equivalent to an interfacial surface layer of water from one to two molecular diameters in thickness. Most of this water can be accomodated and is thought to be located in interlamellar regions.

**MP 25**
**LATENT HEAT OF FREEZING SOIL WATER.**
Anderson, D.M., *National Academy of Sciences. National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Lafayette, Indiana, 1963. Proceedings, p.238-239, 11 refs.
25-4120
LATENT HEAT, SOIL MOISTURE, FREEZING.
It is concluded that the heat of fusion of soil water must always be somewhat lower than that of pure water. The difference, although different for every soil, becomes larger, the lower the unfrozen soil water content.

**MP 26**
**BENTONITE DEBRIS FLOWS IN NORTHERN ALASKA.**
Anderson, D.M., et al, *Science,* April 11, 1969 , Vol.164, p.173-174, 8 refs.
Reynolds, R.C., Jr., Brown, J.
24-837
ARCTIC TERRAIN, SOLIFLUCTION, AERIAL PHOTOGRAPHY, SEASONAL FREEZE THAW, UNITED STATES—ALASKA.
Seasonal freezing and thawing and the extreme cold of the Arctic lead to the development of a variety of characteristic geomorphic features. A new one, bentonite debris flow channels, has been identified near Umiat, Alaska. These flows form when bentonite-rich Cretaceous shales are exposed to surface water on slopes of 5 to 30 degrees. The characteristic landform developed is a U-shaped channel 1 to 2 meters deep and from 8 to 10 meters in width. The channel shows a fluted floor and walls and is commonly flanked by a levee. The flow material is apparently derived from the entire surface of the head portions of associated gullies. When this surface layer hydrates during snowmelt and runoff or during prolonged rain, the bentonite imbibes water and swells to a point at which its velocity is lowered sufficiently to initiate creep or viscous flow.

**MP 27**
**FROST PHENOMENA ON MARS.**
Anderson, D.M., et al, *Science,* Jan. 20, 1967 , Vol.155, p.319-322, 11 refs.
Gaffney, E.S., Philip, F.L.
24-1125
FROST HEAVE, SALINE SOILS, EXTRATERRESTRIAL ICE, MARS (PLANET), JUPITER (PLANET).
The hypothesis that the Martian wave of darkening might be a frost heaving phenomenon has been examined. Consideration of the water-vapor sorption characteristics of a silicate mineral surface at temperatures below freezing leads to the conclusion that, without strongly deliquescent salts to attract and retain liquid water in the Martian soil, frost heaving phenomena are not to be expected on Mars. On the other hand, frost heaving phenomena involving the freezing and thawing of ammonia may be common in the soils of Jupiter.

**MP 28**
**MIGRATION OF INTERLAMELLAR WATER DURING FREEZING AND THAWING OF WYOMING BENTONITE.**
Anderson, D.M., et al, *Soil Science Society of America. Proceedings,* Sept.-Oct. 1965, 29(5), p.498-504, 19 refs.
Hoekstra, P.
25-2069
GROUND ICE, SOIL MOISTURE MIGRATION, BENTONITE, FREEZE THAW CYCLES, SOIL FREEZING, CLAYS.
Homoionic, clay-water pastes of Wyoming bentonite were studied at near freezing temperatures by X-ray diffraction. On freezing, the

**MP 29**
**CRYSTALLIZATION OF CLAY-ADSORBED WATER.**
Anderson, D.M., et al, *Science,* July 16, 1965, 149(3681), p.318-319, 17 refs.
Hoekstra, P.
25-2070
ADSORBED WATER, CLAYS, ICE CRYSTAL STRUCTURE, EPITAXY, ICE CRYSTAL FORMATION, X-RAY DIFFRACTION.
The nature of crystalline water in frozen pastes made from representative clay minerals and water was studied by x-ray diffraction. Only the diffraction peaks corresponding to the normal hexagonal ice structure were detected. The relative intensities of the diffraction peaks revealed evidence of epitaxy in that the ice crystals appeared to be preferentially oriented with their c-axes perpendicular to the c-axes of the individual clay crystallites.

**MP 30**
**UMIAT BENTONITE : AN UNUSUAL MONTMORILLONITE FROM UMIAT, ALASKA.**
Anderson, D.M., et al, *American mineralogist,* Sept.-Oct. 1966, 51(5), p.1443-1456, 12 refs. For another version of this paper and abstract see 24-3365.
Reynolds, R.C., Jr.
25-2107
CLAY SOILS, X RAY DIFFRACTION, CLAY MINERALS, UNITED STATES—ALASKA—COLVILLE RIVER.

**MP 31**
**DIFFUSION OF THE DYES, EOSIN YELLOWISH, BROMOPHENOL BLUE, AND NAPHTOL GREEN BLUISH IN WATER ADSORBED BY MONTMORILLONITE.**
Anderson, D.M., et al, *Soil science,* April 1967 , 103(4), p.281-287, 14 refs.
Brown, R.L., Buol, S.W.
25-2157
CLAYS, ADSORPTION, WATER FILMS, DIFFUSIVITY, DYES, SOLUBILITY.

**MP 32**
**LOW-TEMPERATURE PHASES OF INTERFACIAL WATER IN CLAY-WATER SYSTEMS.**
Anderson, D.M., et al, *Soil Science Society of America. Proceedings,* Jan.-Feb. 1971, 35(1), p.47-54, 19 refs.
Tice, A.R.
25-3772
THERMAL ANALYSIS, CLAY SOILS, SOIL FREEZING, PHASE TRANSFORMATIONS, UNFROZEN WATER CONTENT, HEAT TRANSFER.

**MP 33**
**HIGH ALTITUDE, SIDE-LOOKING RADAR IMAGES OF SEA ICE IN THE ARCTIC.**
Anderson, V.H., Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings. Ann Arbor, , p.845-857.
25-2108
RADAR PHOTOGRAPHY, SEA ICE, AERIAL RECONNAISSANCE.
High altitude, side-looking radar was used to image sea ice patterns between Greenland and Ellesmere Island and within the Arctic Ocean, during the spring of 1962. Concurrent low altitude visual reconnaissance of sea ice patterns was conducted by the author over much of the same flight path flown by the radar aircraft. A comparison of the radar patterns with actual observed and photographed sea ice conditions is presented in this paper. A dramatic example of the eroding processes of polar ice as it moves southward to warmer environments is displayed by the radar imagery and is discussed in this paper. An example of radar imagery of sea ice in the Arctic Ocean, existing under a deteriorating environment during the summer of 1962, is also presented. Included is the radar image of Ice Island "T3" in the Beaufort Sea north of Alaska.

**MP 34**
**SEA ICE PRESSURE RIDGE STUDY: AN AIRPHOTO ANALYSIS.**
Anderson, V.H., *Photogrammetria,* Dec. 1970, 26(5/6), p.201-228, 16 refs.
25-3624
SEA ICE, ICE PRESSURE, ICE SURFACE FEATURES, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, PRESSURE RIDGES, ICE COVER THICKNESS.
Tested and proven techniques of terrain analysis using conventional aerial photography were applied to interpret the patterns associated with a sea ice environment. Ages and relative thicknesses of sea ice masses were determined from stereoscopic aerial photography. A classification scheme of sea ice pressure ridges is developed based upon their linear surface trace, their relative ages, their heights, widths and lengths, their location relative to recent ice movement, and the size of the material composing the ridges. The significance of sinuous ridges with respect to straight ridges is discussed relative to the forces involved in their formation. Estimates as to the underwater components of pressure ridges are deduced based upon elements of their surface configuration and pattern.

**MP 35**
**EXPERIMENTAL STUDIES OF FREEZING OF WATER.**
Arakawa, K., *International Association of Scientific Hydrology. Publication,* 1954, No.39, p.474-477, 5 refs. Microform No. SIP 13836.
25-2226
ICE CRYSTAL FORMATION, NUCLEATION, WATER FREEZING.
Cold chamber experiments with water in a state of complete rest are described, and data are tabulated and discussed on the temperature at the initiation of crystallization, duration of successive nucleation, and number of crystals formed. A time interval of 5- 10 sec. was observed between the initiation of crystallization and the first appearance of crystals. The crystals formed at the bottom of the vessel (lined with rubber, liquid mercury or glass) in the early stage of nucleation were feathery dendrites, which grew rapidly while ascending to the surface. In later stages the forms of the crystals were discoid. They grew slowly but did not assume a dendritic form. The ascending velocity of discs 2 mm. in diam. was 0.2 cm./sec. Two possible mechanisms for the separation of crystals are suggested: mechanical splitting by buoyance and splitting due to the instantaneous increase in water temperature around the crystals.

**MP 36**
**TWO INVESTIGATIONS OF RIVER ICE. PART 1. A FIELD INVESTIGATION OF THE FORMATION AND CHARACTERISTICS OF RIVER ICE. PART 2. PRELIMINARY LABORATORY INVESTIGATIONS OF ICE JAMS AND NAVIGATION CHANNELS IN ICE COVERS.**
Ashton, G.D., et al, *Iowa. University. Iowa Institute of Hydraulic Research. Report,* Oct. 1970, No.129, 44p., Contract No. DACW25-69-C-0098, AD-728 114, 9 refs.
Uzuner, M.S., Kennedy, J.F.
26-1557
RIVER ICE, ICE FORMATION, TEMPERATURE DISTRIBUTION, FLOW RATE, ICE JAMS, ICE THICKNESS, ICE BREAKING.

**MP 37**
**FLEXURAL AND OTHER PROPERTIES OF SEA ICE SHEETS.**
Assur, A., International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 1, Sapporo, , p.557-567, 5 refs.
23-1970
SEA ICE, FLEXURAL STRENGTH, ICE COVER STRENGTH, ICE MECHANICS, ANALYSIS (MATHEMATICS).

**MP 38**
**ANTARCTIC SEA ICE.**
Assur, A., *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.543, Abstract only.
25-983
SEA ICE, SALINITY, TENSILE STRENGTH, FLEXURAL STRENGTH.

**MP 39**
**MAXIMUM LATERAL PRESSURE EXERTED BY ICE SHEETS.**
Assur, A., International Association for Hydraulic Research. Proceedings, 8th Congress. Montreal,, p.22-SI-1 - 22-SI-5.
25-1258
ICE PRESSURE, ICE COVER STRENGTH, ICE SHEETS.

**MP 40**
**BREAKUP OF PACK-ICE-FLOES.**
Assur, A., Ice and snow; properties, processes, and applications. Ed. by W.D. Kingery, Cambridge, Mass., M.I.T. Press, 1963, p.335-347, Microform No. SIP 22059.
26-3532
SEA ICE, ICE DEFORMATION, ICE STRENGTH, ICE BREAKING, ICE CRACKS.
Long-wave cracks are mathematically analyzed on the basis of plate mechanics, and other forms of cracks are discussed. Long-wave cracks form with complete disregard of thickness and shape of the floes. They form instantaneously; the crack propagation is fast; there is no way to predict the location of a crack to be formed; and the ice floe, once split, drifts apart in a matter of minutes. Parallel-edge cracks running closely alongside existing edges are by far the most common. They form 12 to 15 m from the edge under combined bending and buckling originating from the pressure exerted from a neighboring floe. Perpendicular-edge cracks which form at fairly uniform distances of 50 to 100 m apart, are more dangerous for the existence of an intact ice floe. They may propagate beyond the parallel crack into the ice floe and give reason for concern and action on behalf of the occupants of an ice floe. The potential danger of perpendicular cracks lies in the forces created under the shearing action of adjacent ice floes. The moment originated by these forces may be enough to propagate a perpendicular crack (scissor crack) across an ice floe and separate a portion of it. Subsequent shear motion between the pieces of the ice floe may produce shearing cracks on the base of projecting corners.

**MP 41**
**BEARING CAPACITY OF FLOATING ICE SHEETS.**
Assur, A., *American Society of Civil Engineers. Engineering Mechanics Division. Journal,* June 1961, 87(EM 3), p.63-66, 3 refs. Microform No. SIP 19298.
26-3533
ICE BEARING CAPACITY, FLOATING ICE, ANALYSIS (MATHEMATICS).
Meyerhof's calculation of the collapse of ice sheets (See SIP 18826) is criticized on the basis of field and laboratory work conducted by USA CRREL. That the idealized stress distribution leading to the full plastic bending movement does not correspond to the actual stress in an ice sheet may hold for fresh ice and quick loading, but may be proper for prolonged loading and especially for sea ice. The assumption that the hydrostatic reaction is confined within the hinge circle is unfounded, since experiments indicate considerable deflection at the circumferential hinge until collapse occurs. The assumption that the hinge radius is equal to the radius of the deflection dish is also incorrect. The circumferential crack occurs well within the deflection radius and at the place where the elastic theory predicts max. radial stress. The conditions for this location are calculated and also considered on the basis of A. Johansen's concept of yield lines. Actual tests show a considerable deflection at the circumferential crack. Many other approximations were used even though more precise approaches can be derived.

**MP 42**
**GROWTH OF ICE IN THICKNESS.**
Assur, A., *Deutsche hydrographische Zeitschrift,* 1951, Vol.4, p.72-74, In German with English and French summaries. 6 refs. Microform No. SIP 3119.
26-3534
ICE COVER THICKNESS, ICE GROWTH.
It is shown that an incrorectly determined coefficient of the thermal conductivity of ice was used in various computations. A value of 0.0055 cal./cm./sec./C is suggested for use in practical calculations. The introduction of a reduction factor in equations used to determine ice thickness growth is suggested. The reduction factors calculated from various measurements varied between 0.3 and 0.8. The differences are chiefly ascribed to varying snow conditions on top of the ice.

**MP 43**
**TRAFFIC OVER FROZEN OR CRUSTED SURFACES.**
Assur, A., *International Conference on the Mechanics of Soil-Vehicle Systems. Proceedings,* June 1961, p.913-923, 6 refs.
26-3620
TRAFFICABILITY, CRACKING (FRACTURING), ICE COVER STRENGTH, ICE SHEETS, BEARING CAPACITY, FROZEN SURFACES, ICE WAVES.
Traffic over crusts is one of the problems encountered in off-the-road locomotion, in particular in polar regions and especially over ice sheets. Three failure stages of the crust and their relation to elastic theory for regular and plastic theory for emergency operations are outlined. Solutions of the differential equations for circular, elliptic and arbitrary loads are given. Failure under punching requires the computation of combined stresses. The location of the circumferential crack is analyzed and equations for the collapse load under plastic yielding are given. Large-scale loading tests show how the failure is related to the duration of loading and how much time elapses before final breakthrough occurs after circumferential cracking. A nomogram for the computation of the critical resonance speed is given. Then it is shown how to determine the stiffness modulus of crusts and how a variation in the profile of Young's modulus affects the flexural strength.

**MP 44**
**LOCOMOTION OVER SOFT SOIL AND SNOW.**
Assur, A., *Automotive Engineering Congress. Paper,* Jan. 1964, No.782F, 25p., 17 refs.
26-3621
TRAFFICABILITY, SNOW COVER, SNOW MECHANICS, SOIL MECHANICS.

**MP 45**
**SURFACING SUBMARINES THROUGH ICE.**
Assur, A., *Army Science Conference, U.S. Military Academy. Proceedings,* Sept. 1962, Vol.1, p.11-20, 8 refs.
26-3622
SEA ICE, STRAIN ANALYSIS, STRESS ANALYSIS, ICE COVER STRENGTH, ICE PLASTICITY, FLEXURAL STRENGTH.

**MP 46**
**GROWTH, STRUCTURE, AND STRENGTH OF SEA ICE.**
Assur, A., et al, *International Association of Scientific Hydrology. Publication,* 1963, No.61, p.95-108, French summary. 25 refs. For another version of this paper and abstract see 24-3284. Microform No. SIP 21891.
Weeks, W.F.
25-2028
SEA ICE, PHYSICAL PROPERTIES, ICE COVER STRENGTH.

**MP 47**
**THE PLASTIC LIMIT AS A BINARY PACKING PHENOMENON.**
Ballard, G.E.H., *Materials research and standards,* July 1964, 4(7), p.366-374, 8 refs. For another version of this paper and abstract see 24-3300.
25-2047
CLAY SOILS, PLASTIC PROPERTIES, WATER CONTENT, PARTICLE PACKING.

**MP 48**
**HUMAN FACTOR IN DETERMINING THE PLASTIC LIMIT OF COHESIVE SOILS.**
Ballard, G.E.H., et al, *Materials research and standards,* Sept. 1963, 3(9), p.726-729, 3 refs.
Weeks, W.F.
25-2029
PLASTICITY TESTS, SOIL MECHANICS, COHESIVE SOILS, HUMAN FACTORS ENGINEERING.
To investigate operator variance in the determination of the plastic limit of cohesive soils, a standard sample was prepared and tested for homogeneity. Random samples were then distributed to five zones of operators. Two operators from each group performed five replicate tests. No correlation was found between an operator's internal variance and his deviation from the grand mean. No reason exists to doubt that an untrained operator can obtain results comparable to those of professional operators. The major factor contributing to the total sample variance is the inconsistency between the individual operators who, although able to duplicate their own determination, do not call the same end point. To minimize between-operator variance, easily prepared standard samples should be provided so that any operator can calibrate his plastic limit determinations against the expected national average.

**MP 49**
**THEORY OF SNOW FAILURE.**
Ballard, G.E.H., et al, *International Association of Scientific Hydrology. Publication,* 1966, No.69, p.160-169, 6 refs. Microform No. SIP 23768. For another version of this paper and abstract see 24-3286.
McGaw, R.
25-2071
SNOW STRENGTH, POROSITY, SNOW MECHANICS.

**MP 50**
**EFFECTIVE PRESSURE ROOM SEAL IN ICE.**
Ballard, G.E.H., et al, *Journal of glaciology,* Oct. 1965, 5(42), p.869-871, French and German summaries. Microform No. SIP 23852.
Ramseier, R.O.
25-2072
ICE TUNNELS, ICE PRESSURE, ICE (CONSTRUCTION MATERIAL).
A small chamber was sealed for pressurizing in 1962 in the Camp Tuto ice tunnel in Greenland by using ice bricks and montmorillonite. A key-joint was used to assure contact during thermal shrinking and styrofoam (expanded polystyrene) pellets were introduced to prevent splitting during the phase-change expansion. Each phase of the construction is outlined and unsuccessful attempts are discussed. When the chamber pressure was raised to 2.1 kg/sq cm, the estimated overburdened pressure of the ice at this location, no splitting or fractures were noted in the ice walls or in the central poured plug. The styrofoam pellets crushed to provide the needed volume during freezing. The mortar remained plastic to -5C and no leaks were detected around the key.

**MP 51**
**THEORETICAL CONSIDERATION OF THE STRENGTH OF SNOW.**
Ballard, G.E.H., et al, *Journal of glaciology,* Feb. 1966, 6(43), p.159-170, French and German summaries. 12 refs.
Feldt, E.D.
25-2109
SNOW STRENGTH, SINTERING, ANALYSIS (MATHEMATICS), THEORIES.

**MP 52**
**SNOW AND ICE.**
Bender, J.A., *American Geophysical Union. Transactions,* June 1967 , 48(2), p.724-729, Bibliography p. 726-729.
23-11
SNOW, ICE, RESEARCH PROJECTS.

**MP 53**
**DEFORMATION OF EXCAVATIONS IN A HIGH POLAR NEVE.**
Bender, J.A., International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 2, Sapporo, , p.973-982, 12 refs.
23-1998
SNOW MECHANICS, SNOW TUNNELS, SNOW DEFORMATION, EXCAVATION.

**MP 54**
**DISCUSSION OF PREDICTED WATER TEMPERATURES FOR THE RAMPART DAM RESERVOIR ON THE YUKON RIVER.**
Bender, J.A., Science in Alaska. Alaskan Science Conference, 14th, Aug.27-30, 1963, Anchorage, Alaska. Proceedings, College, Alaska,, p.269-271, 3 refs.
25-2048
WATER TEMPERATURE, CLIMATIC CHANGES, PERMAFROST HEAT TRANSFER, DEGRADATION, RESERVOIRS.

**MP 55**
**LUCYBELLE BLEDSOE, 1923-1966.**
Bender, J.A., *Journal of glaciology,* June 1967 , 6(47), p.755-756.
25-2158
BIOGRAPHIES.

**MP 56**
**DEEP DRILLING IN ANTARCTICA.**
Bender, J.A., et al, *International Association of Scientific Hydrology. Publication,* 1961, No.55, Symposium on Antarctic Glaciology. General Assembly of Helsinki, 1960, p.132-141, 2 refs. Microform No. SIP 19743.
Gow, A.J.
25-2001
ICE CORING DRILLS, GLACIER ICE, DRILL CORE ANALYSIS, ICE TEMPERATURE, ANTARCTICA—BYRD STATION, ANTARCTICA—LITTLE AMERICA.
A modified rotary well drilling rig with compressed air as the drilling fluid was used successfully in the Antarctic to drill in snow and ice. Excellent cores were obtained down to 308 m. at Byrd Station and down to 254 m. in shelf ice at Little America V. Detailed analysis of the cores indicates the annual accumulation to be about 15 cm. of water equivalent at Byrd Station and 21 cm. at Little America V. Depth-density and depth-temperature curves for the two stations are presented. Temperature, closure and inclination measurements have been continued on the hole at Byrd Station. These indicate that over the past two years, the temperature with depth has not changed, that there has been no inclination, and that the drill hole is closing very rapidly with depth, and non-linearly with time.

**MP 57**
**POLAR REGIONS SNOW COVER.**
Benson, C.S., International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 2, Sapporo, , p.1039-1063, 45 refs.
23-2005
SNOW COVER DISTRIBUTION, METEOROLOGICAL FACTORS, TOPOGRAPHIC FACTORS, STORM TRACKS.

**MP 58**
**PHYSICAL PROPERTIES OF THE SNOW COVER IN THE FT. GREELY AREA, ALASKA.**
Benson, C.S., College, Alaska, , 47p., 11 refs.
23-4062
SNOW COVER, SNOW PHYSICS, TRAFFICABILITY, UNITED STATES—ALASKA.

**MP 59**
**ONSET OF SEASONAL THAW IN ALASKA.**
Berg, R., et al, Conference on Environmental Effects on Aircraft and Propulsion Systems, 7th, Sept. 25-27, 1967. Proceedings, Mt. Prospect, Ill., p.75-83, 22 refs.
Bilello, M.A.
25-2159
SEASONAL FREEZE THAW, AIR TEMPERATURE, SOIL TEMPERATURE, SNOWMELT, THAW DEPTH, UNITED STATES—ALASKA.
This preliminary study of the onset and progression of the thaw season in Alaska may aid pilots in evaluating remote landing areas. Determination of the start of the air thawing season was based on the date on which the daily air temperatures remains above 32F. Data from 39 stations, in northern and interior Alaska, and southeastern Alaska were used. The mean date of onset of thaw varies from mid-February in some southern stations (56N latitude) to mid-June in extreme northern sections (71N latitude). Investigation of soil temperature at six stations in central Alaska indicated that about 14 days after the thawing season begins 6 in. of soil has thawed, and about a week later the 12-in. depth has been reached. Time intervals vary from year to year, apparently due to factors such as precipitation, radiation and air temperatures; and from place to place because of exposure, surface cover, elevation and latitude.

**MP 60**
**SHEAR-STRESS MEASUREMENTS "IN SITU" OF SOILS SUBJECTED TO VIBRATORY LOADS.**
Bernhard, R.K., *Experimental mechanics,* April 1963, 3(4), p.1-7, 10 refs. For another version of this paper and abstract see 24-3072. Microform No. SIP 21834.
25-2030
SOIL STRENGTH, SOIL MECHANICS, SOIL TESTS, TEST EQUIPMENT.

**MP 61**
**RELATIONSHIPS BETWEEN CLIMATE AND REGIONAL VARIATIONS IN SNOW-COVER DENSITY IN NORTH AMERICA.**
Bilello, M.A., International Conference on Low Temperature Science, Sapporo, Aug. 14-19, 1966, Proceedings, Vol. 1, Part 1, Sapporo, , p.1015-1028, 26 refs.
23-2002
SNOW DENSITY, CLIMATE, METEOROLOGICAL FACTORS.
Snow-cover observations made during November through March at 27 stations in Alaska, Canada and the northern United States for a 2 to 11 year period were analysed. The analysis showed that the average snow density can be classified in four general categories: Category 1 (density 0.20 to 0.23 g/cu cm), inland stations reporting light winds; Category 2 (0.24 to 0.27 g/cu cm), stations generally reporting moderate winds; Category 3 (0.28 to 0.30 g/cu cm), inland and coastal locations with stronger winds; Category 4 (0.32 to 0.36 g/cu cm), cold and windy stations of the North American arctic. Skewness coefficients computed for each station showed bias toward lower densities for catagories 1 and 2, and bias toward higher densities for categories 3 and 4. A nomograph was developed to estimate the average snow-cover density for any location in the Arctic, Subarctic and North Temperate Zones. An average snow density map of North America was drawn using observed densities from the 27 original stations and the 10 test stations, and estimated densities for 61 other locations. The continent was then divided into areas based on the four categories.

**MP 62**
**WATER TEMPERATURES IN A SHALLOW LAKE DURING ICE FORMATION, GROWTH, AND DECAY.**
Bilello, M.A., *Water resources research,* Aug. 1968 , 4(4), p.749-760, 21 refs. For another version of this paper and abstract see 24-3356.
23-4333
LAKES, WATER TEMPERATURE, ICE FORMATION, ICE GROWTH, ICE DETERIORATION, HEAT TRANSFER.

**MP 63**
**FORMATION, GROWTH, AND DECAY OF SEA ICE IN THE CANADIAN ARCTIC ARCHIPELAGO.**
Bilello, M.A., *Arctic,* 1961, 14(1), p.2-24, 17 refs. For another version of this paper and abstract see 24-3223. Microform No. SIP 18568.
25-2003
SEA ICE, DEFORMATION, ICE GROWTH, ICE DISINTEGRATION, ICE FORMATION.

**MP 64**
**METHOD FOR PREDICTING RIVER AND LAKE ICE FORMATION.**
Bilello, M.A., *Journal of applied meteorology,* Feb. 1964, 3(1), p.38-44, 5 refs. Microform No. SIP 22923.
25-2049
LAKE ICE, RIVER ICE, ICE FORECASTING, ICE FORMATION, ANALYSIS (MATHEMATICS).
Two sets of curves are developed which can be used to forecast the dates of: 1)first appearance of ice in the fall; and 2) ice formation from shore to shore on the Mackenzie River at Fort Good Hope, Canada. Similar curves, based on the same method, can be derived for sheltered harbor, lake, and river locations. The numerical constants necessary to develop these curves were obtained from a relationship between mean daily air temperatures and previously observed dates of ice formation. To apply the curves, an adjusted temperature record, based on a numerical constant (N) and daily air temperatures, is maintained starting in early summer. Subsequently, this daily-adjusted temperature is applied to the family of curves to provide a day-to-day forecast of the date of ice formation.

**MP 65**
**USA CRREL'S PROGRAMS ON SNOW AND ICE OBSERVATIONS THROUGHOUT NORTH AMERICA.**
Bilello, M.A., U.S. Army Materiel Command. Army Meteorological Research and Development Coordination Committee, 15th Meeting, Nov. 1-3, 1966. Minutes. Hanover, N.H.,, p.11-15.
25-2110
WEATHER STATIONS, SNOW COVER, SNOW SURVEYS, ICE COVER THICKNESS, ICE REPORTING.

**MP 66**
**SURFACE OBSERVATIONS OF SNOW AND ICE FOR CORRELATION WITH REMOTELY COLLECTED DATA.**
Bilello, M.A., *U.S. Dept. of the Air Force. Air Weather Service. Technical Report,* July 1967 , No.196, Technical Exchange Conference, April 4-7, 1967. Proceedings, p.285-293, 12 refs.
25-2160
ICE COVER THICKNESS, SNOW COVER, METEOROLOGICAL DATA, MEASURING INSTRUMENTS, SPACEBORNE PHOTOGRAPHY, SNOW PHYSICS.
The seasonal extension of the earth's snow and ice cover is easily determined by aircraft and satellite reconnaissance. However, determination of the depth and physical properties of snow and the thickness of ice on lakes, rivers and along coastlines by these remote sensors is presently at an early stage of development. Correlations of the remote sensing data and actual surface conditions could well be accomplished through use of the observations being received from a network of snow and ice stations throughout North America. This network, comprising over 100 stations, is being conducted by USA CRREL in cooperation with other government agencies, including the Air Weather Service, and provides the most extensive and reliable data accumulation for such correlation studies.

**MP 67**
**SURVEY OF ARCTIC SNOW-COVER PROPERTIES AS RELATED TO CLIMATIC CONDITIONS.**
Bilello, M.A., *International Association of Scientific Hydrology. Publication,* 1958, No.46, p.63-77, 3 refs. Microform No. SIP 16500. For another version of this paper and abstract see 24-3197.
25-2203
SNOW DENSITY, TEMPERATURE DISTRIBUTION, CLIMATE, SNOW HARDNESS.

**MP 68**
**DURATION OF SURFACE WIND SPEEDS.**
Bilello, M.A., Conference on Aerospace Meteorology, 4th, May 4-7, 1970, Las Vegas, Nevada. Preprints, Boston, American Meteorological Society, 1970, [7p.], 9 refs.
25-2239
WIND VELOCITY, DATA PROCESSING.

**MP 69**
**FROZEN PRECIPITATION - ITS FREQUENCY AND ASSOCIATED TEMPERATURES.**
Bilello, M.A., *Eastern Snow Conference. Proceedings,* 1971, 28th, p.68-80, 15 refs.
26-1211
CLIMATOLOGY, SNOWSTORMS, ICE STORMS, TEMPERATURE VARIATIONS, RECORDS (EXTREMES).
Frozen precipitation is observed in various forms and its frequency varies by month and by region. Graphs showing the probable occurrence of frozen precipitation at eleven locations in the U.S. and Canada are presented as possible aids in devising methods for improving winter operations. Average temperatures observed at the time of precipitation occurrence are also given and related to long term mean air temperatures. These temperatures as well as some information on extremes in frozen precipitation may be helpful in determining the specifications required for developing heating systems for the control of ice and snow in large cities. For example, the information extracted from Figures 5 and 8 provides a potential user with knowledge of the maximum duration and probable concurrent air temperatures for freezing rain and/or freezing drizzle storms.

**MP 70**
**PREDICTION OF ICE FORMATION ON KNOB AND MARYJO LAKES, SCHEFFERVILLE, CANADA.**
Bilello, M.A., et al, *McGill University, Montreal. Subarctic Research Laboratory, Schefferville, Que. McGill sub-arctic research papers,* 1966 , No.21, p.213-225, 3 refs.
Adams, W.P., Shaw, J.B.
23-4077
ICE FORECASTING, STATISTICAL ANALYSIS, FREEZEUP, AIR TEMPERATURE, TEMPERATURE FACTORS, CANADA—QUEBEC—SCHEFFERVILLE.

**MP 71**
**SOME NEW OR EXPERIMENTAL EQUIPMENT FOR USE ON SNOW AND ICE.**
Bilello, M.A., et al, *Eastern Snow Conference. Proceedings,* Feb. 1967 , No. 24, p.1-4.
Parrott, W.H.
23-4649
SNOW DENSITY, NEUTRON PROBES, RUNWAYS, ICE CHIPPERS, SONISCOPES, RAMMSONDES, SNOW PERMEAMETERS.
The six instruments discussed in this paper have been newly developed, or modified from existing snow or ice equipment, by personnel at USA CRREL. The original concept and/or modifications of the equipment came as a result of field operation requirements or from a need to accurately measure certain physical characteristics of snow. A brief description and summary of the purpose of each insturment is presented in this paper. The individuals conducting the work are named and the specific reports from which additional information can be obtained are also given. Most of the discussion which follows was taken from these reports or from direct communication with the individuals named. Other unique equipment, such as the thermal ice coring drill and the snow shock tube, are currently under research and development at USA CRREL. However, limitation on the length of this report does not permit detailed discussion of these instruments.

**MP 72**
**ANALYSIS OF WHEEL LOAD LIMITS AS RELATED TO DESIGN.**
Boyd, K., *National Research Council. Highway Research Board. Proceedings,* Dec. 1942. vol.22, p.185-198, Includes discussion. 1 ref.
25-2186
BEARING TESTS, LOAD DISTRIBUTION, BEARING CAPACITY, SUBGRADES, VEHICLE WHEELS, PAVEMENT BASES, HIGHWAYS.
A method for controlling load limits and for design of bases, using a cone bearing test and the Boussinesq method of load distribution is presented. Based on cone bearing tests on the subgrades of a large number of pavements, some of which had failed and some were in good condition, a curve was developed that shows for any given bearing the thickness of base and mat required by present traffic loads. The cone bearing curve when plotted on log paper becomes a straight line that can be expressed by the equation T equals 65.7/B exp(0.388), wherein T is the total base and mat thickness and B is the cone bearing value in pounds per square inch. This offers a means of extrapolating for thickness required by heavier loads than those in the current highway range. Determinations of load bearing capacity aid in the design of pavement, in establishing legal load limits and in setting load limits during seasonal losses in stability. The effects of single and dual tires on load bearing capacity, and the limitations of load restrictions per inch of tire width are discussed. Maximum load limits per wheel are recommended.

**MP 73**
**PRESENCE OF BACTERIA IN PERMAFROST OF THE ALASKAN ARCTIC.**
Boyd, W.L., et al, *Canadian journal of microbiology,* July 1964, Vol.10, p.917-919, Microform No. SIP 23473. 7 refs.
Boyd, J.W.
25-4121
BACTERIA, CRYOBIOLOGY, DRILLING, UNITED STATES—ALASKA—POINT BARROW.
A series of holes 32 in. in diameter were drilled at random to depths of 8-15 ft in permafrost along a traverse between Elson Lagoon and the village of Barrow. Starting from the bottom of the hole, samples weighing between 50 and 80 gm were chipped into sterile containers. Throughout the depth of the soil section, the number of thermophilic bacteria was more or less constant; markedly fewer mesophilic forms were observed in the permafrost than in the active layer. In general, molds were restricted to the upper 6 in. of the soil and psycrophilic bacteria to the upper 12 in. A peat core, drilled from the permafrost in this same area, having a radiocarbon date of 10,525 plus or minus 280 yr at a depth of 10 ft, and sampled along its entire length, presented the same pattern. Therefore, bacteria are present in material of this age, although this does not necessarily mean that the organisms are of the same age nor that the peat has been frozen for the same period.

**MP 74**
**WATER SUPPLY AND SEWAGE DISPOSAL DEVELOPMENTS IN THE FAR NORTH.**
Boyd, W.L., et al, *American Water Works Association. Journal,* July 1965, 57(7), p.858-868, 12 refs.
Boyd, J.W.
25-4122
SEWAGE DISPOSAL, WATER SUPPLY, WATER CHEMISTRY, WASTE TREATMENT.

**MP 75**
**TUNDRA SOILS FORMED OVER ICE WEDGES, NORTHERN ALASKA.**
Brown, J., *Soil Science Society of America. Proceedings,* Sept./Oct. 1967 , 31(5), p.686-691, 17 refs.
23-363
TUNDRA SOILS, ICE WEDGES, UNITED STATES—ALASKA.
The physical and chemical properties of tundra soils overlying ice wedges are determined and the role of ice wedge growth in the genesis of these soils is evaluated. Ice wedges form in perennially frozen ground as a result of repetitive winter cracking of the ground and filling in by ice. A thin layer of soil is isolated over the enlarging wedge in narrow depressions which result in polygonal ground. The soil thaws seasonally from the surface downward and freezes from both the top and bottom. Accompanying moisture migration results in a dehydrated midsection. No significant migration of cations or mineral grains was observed in a 70-cm deep tundra soil. The ice wedges are subjected to melting which creates new soil environments. Evidence of these changes has been traced over a 14,000-year period at Barrow, Alaska.

**MP 76**
**MASSIVE UNDERGROUND ICE IN NORTHERN REGIONS.**
Brown, J., Army Science Conference, U.S. Military Academy. Proceedings, June 1966 , p.89-102, Includes diagrams and photos. 18 refs.
24-249
ICE WEDGES, FROZEN GROUND, GROUND ICE.

**MP 77**
**SOIL PROPERTIES DEVELOPED ON THE COMPLEX TUNDRA RELIEF OF NORTHERN ALASKA.**
Brown, J., *Biuletyn peryglacjalny,* 1969 , No.18 p.153-167, 7 refs.
24-2354
TUNDRA SOILS, PATTERNED GROUND, CRYOGENIC PROCESSES.

**MP 78**
**SOILS OF THE OKPILAK RIVER REGION, ALASKA.**
Brown, J., Péwé, T.L., ed. The periglacial environment, past and present, Ottawa,, p.93-128, In English with French summary. Also published as CRREL RR 188 (24-3335). Bibliog. p.126-128.
25-239
ARCTIC SOILS, FROST ACTION, PATTERNED GROUND, FROZEN GROUND, GEOCRYOLOGY, ICE WEDGES, SEASONAL FREEZE THAW, UNITED STATES—ALASKA—OKPILAK RIVER.

**MP 79**
**AN ORGANIC TERRAIN FROM A GLACIATED VALLEY, NORTHERN ALASKA.**
Brown, J., Science in Alaska. Alaskan Science Conference, 13th, Juneau, Aug.22-22, 1963. Proceedings, Juneau, Alaska,, p.159-160, Abstract of paper presented at the Conference.
25-2013
PATTERNED GROUND, FROZEN GROUND CHEMISTRY, ORGANIC SOILS, PERMAFROST.
Organic soils and patterned-ground features constitute a limited area of organic terrain in the Okpilak River Valley, northeastern Brooks Range, Alaska. Ice-wedge polygons dominate the tussock-covered tundra landscape. Peaty mounds and fen-like marshes form a mosaic on the wetter positions. Organic soils include moss peats, sedge peats, and depositional organic accumulations. Peaty polygons are covered by a dwarf shrub-heath vegetation, typical of high moor peats. Diagenesis of the organic landform is strongly influenced by the presence of perennially frozen ground. Extensive frost activity is evidenced by the extru- sion of highly organic silt oozes between tussocks, the finely divided composition of some mossy peats, and the presence of cobbles within the peaty substrate. Chemical analysis of the acid, high moor-type peat includes cation exchange capacity, loss on ignition, and total carbon, nitrogen, and phosphorus. Cation exchange capacities range from 31 to 116 meq/100 gm and are dependent upon ash content from vegetative composition. An overall C:N:P ratio is 400:35:1 for the moss peat soil.

**MP 80**
**RADIOCARBON DATING, BARROW, ALASKA.**
Brown, J., *Arctic,* March 1965, 18(1), p.36-48, 36 refs. Microform No. SIP 23906.
25-2073
RADIOCARBON DATING, SOILS, LANDFORMS, AGE DETERMINATION, UNITED STATES—ALASKA—BARROW.
Samples for dating include reworked woody and peaty materials found in horizontal layers or beds and deposited in on- and near-shore marine and lacustrine environments, frozen masses of organic matter interfingered with ice-rich mineral sediment, organic matter found in the vertical foliations of ice-wedge ice, organic matter derived from the surface horizons of a present-day soil, and several wooden artifacts, presumably derived from driftwood. The methodology is outlined. The discussion of the dates emphasizes polygon, beach ridge, spit, lake, Gubik, and archeological series, and topographic highs.

**MP 81**
**SOIL STUDIES AT BARROW, ALASKA.**
Brown, J., *Soil survey horizons,* Fall 1969, 7(3), p.12-16, 8 refs.
25-2111
TUNDRA SOILS, PATTERNED GROUND, PERMAFROST PHYSICS, HYDROLOGY, TOPOGRAPHIC MAPS, UNITED STATES—ALASKA—BARROW.

**MP 82**
**ICE-WEDGE CHEMISTRY AND RELATED FROZEN GROUND PROCESSES, BARROW, ALASKA.**
Brown, J., *National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, lafayette, Ind. Proceedings, p.94-98, 22 refs. Microform No. SIP 24842.
25-2112
PATTERNED GROUND, CHEMICAL ANALYSIS, FROZEN GROUND CHEMISTRY, STRATIGRAPHY, UNITED STATES—ALASKA—BARROW.
Chemical data were gathered from ice-wedges and associated soils. Hypotheses are formulated to explain the stratigraphic record of the sample site and the mechanisms by which the chemical compositions of the ice developed. The chemical results indicate that fossiliferous sediments are incorporated from the sides into the lower portion of some ice wedges. Possible mechanisms for this incorporation or accretion of sediment include addition of adjacent strata by folding into the the expanding wedge or simply by the growth of the wedge into the adjacent sediment. In addition, fractures may form along or traverse the lateral wedge-sediment interface. Ionic concentrations in the top meter of surface wedges are comparatively low because the wider crack near the surface is filled with more water per unit residue than is the narrower and lower portion of the crack.

**MP 83**
**ANTARCTIC SOILS AND SOIL FORMING PROCESSES.**
Brown, J., *Arctic,* Sept. 1967 , 20(3), p.216, Review of "Antarctic soils and soil forming processes" Tedrow, J.C.F., ed. Antarctic Research Series, vol.8. National Research Council. Publication No.1418, 1966, 177p.
Tedrow, J.C.F., ed.
25-2161
SOIL FORMATION, ANTARCTICA.

**MP 84**
**BURIED SOILS ASSOCIATED WITH PERMAFROST.**
Brown, J., Symposium on Pedology and Quaternary Research, May 13-14, 1969, Edmonton, Canada, Edmonton, University of Alberta, 1970, p.115-127, 33 refs.
25-2240
PERMAFROST STRUCTURE, SOILS, GROUND ICE, RADIOCARBON DATING, FROST HEAVE, DEGRADATION, UNITED STATES—ALASKA—BARROW.
Buried remnants of former soil surfaces are commonly associated with ice-rich permafrost and the lower portion of the overlying thawed soil. A combination of ice wedge stratigraphy, radiocarbon dating, and chemical analyses of the soil, permafrost and aquatic environments are employed to interpret the northern coastal plain of Alaska. Organic matter is buried by lake erosion and deposition, wind deposition, cryopedologic processes on slopes and by frost heaving. Chemically depleted zones in the permafrost are associated with former lakes and previous periods of permafrost degradation. Remnants of at least one post-Wisconsin buried soil are found between the 0.5 and 3.0 m depth (8,200 and 10,600 years B.P.). Buried peat of several other ages also occurs in the Barrow area. The most recent (1,8000-2,500 years B.P.) is associated with current ice-wedge activity. Similar techniques have been applied to the Fairbanks permafrost. The soils and permafrost of Recent age contain less extractable ions then the underlying Wisconsin-aged silts. Changes in upland soils during the two periods or differences in erosion and deposition are possible explanations.

**MP 85**
**MINERAL COMPOSITION OF SOME DRAINAGE WATER FROM ARCTIC ALASKA.**
Brown, J., et al, *Journal of geophysical research,* June 1962, 67(6), p.2447-2453, 7 refs.
Grant, C.L., Ugolini, F.C., Tedrow, J.C.F.
25-2012
WATER, CHEMICAL COMPOSITION, SAMPLING.
Columns of synthetic ion-exchange resin were used to sample the exchangeable cations in drainage waters of northern Alaske. Details of the sampling and analytical procedures are presented. For the elements Na, K, Mg, Ca, Sr, and Ba, an average recovery of 96 percent was realized on a typical sample. However, recoveries were quite low for most trace elements. Sampling was necessarily diversified, but results for major cations closely follow the lithology of the sample area. The concentrations observed were similar to those reported for many areas of North America.

**MP 86**
**RADIOCARBON DATING OF COASTAL PEAT, BARROW, ALASKA.**
Brown, J., et al, *Science,* July 15, 1966, 153(3733), p.299-300, 7 refs. Microform No. SIP 24698.
Sellmann, P.V.
25-2113
PEAT, RADIOCARBON DATING, UNITED STATES—ALASKA—BARROW.
A buried frozen section of peat from sea level yielded radiocarbon dates between 700 and 2600 B.C.; it suggests burial by a transgressing sea.

**MP 87**
**TUNDRA BIOME RESEARCH IN ALASKA. THE STRUCTURE AND FUNCTION OF COLD-DOMINATED ECOSYSTEMS.**
Brown, J., et al, *U.S. International Biological Program. Tundra Biome. Report,* Nov.1970, 70-1, 148p., ADA-012 083.
West, G.C.
25-2871
TUNDRA VEGETATION, SOIL PATTERNS, GROUND THAWING, ANIMALS, ECOSYSTEMS, SOIL MICROBIOLOGY, OIL SPILL EFFECTS, TUNDRA BIOME, PERMAFROST, PATTERNED GROUND, UNITED STATES—ALASKA.

**MP 88**
**STRUCTURE AND FUNCTION OF THE TUNDRA ECOSYSTEM AT BARROW, ALASKA.**
Brown, J., et al, Conference on Productivity and Conservation in Northern Circumpolar Lands, Edmonton, Alberta, 15-17 Oct. 1969. Proceedings, Morges, Switzerland, International Union for Conservation of Nature and National Resources, 1970, p.41-71, Bibliography p.62-71. Also partially included in 25-2871.
Pitelka, F.A., Coulombe, H.N.
25-3666
MODELS, TUNDRA SOILS, BIBLIOGRAPHIES, TUNDRA VEGETATION, TOPOGRAPHIC FEATURES, SOIL BIOLOGY, TUNDRA CLIMATE, ECOSYSTEMS, TUNDRA BIOME, PERMAFROST DEPTH, SEASONAL FREEZE THAW, PATTERNED GROUND.
The Tundra Biome Program of the U.S. International Biological Program is pursuing several objectives which are designed to establish a firm scientific platform from which questions concerning resource management and the quality of the tundra environment can be judged. This program is initiating its first year's research activities with a project designed to analyze and model the existing Barrow, Alaska environmental data. The following word model (Section 1) described the principle components of the wet tundra coastal ecosystem. The term structure refers to the physical, chemical, and biological characteristics of the plant and animal life. Particularly in case of the tundra, the structure and function of the ecosystem are intimately related to the abiotic substrata. In addition, this report outlines how and when this NSF supported analyses and modeling effort (Section 2) will be undertaken. Finally a more detailed account of the Barrow physical setting (Section 3) is presented along with the previously prepared and updated bibliography (Section 4).

**MP 89**
**THERMAL EXPANSION OF ICE.**
Butkovich, T.R., *Journal of applied physics,* March 1959, 30(3), p.350-353, 10 refs. For another version of this paper and abstract see 24-3198.
25-2204
ICE CRYSTALS, ICE THERMAL PROPERTIES, SNOW ICE, THERMAL EXPANSION, COEFFICIENTS.

**MP 90**
**FLOW LAW FOR ICE.**
Butkovich, T.R., et al, *International Association of Scientific Hydrology. Publication,* 1958, No. 47, p.318-327, 18 refs. Microform No. SIP 17384. For another version of this paper and abstract see 24-3214.
Landauer, J.K.
25-2205
GLACIER FLOW, ICE CREEP, CREEP PROPERTIES, DEFORMATION, SHEAR MODULUS.

**MP 91**
**FORMATION OF ICE AT WATER-SOLID INTERFACES.**
Camp, P.R., *New York Academy of Sciences. Annals,* Oct. 13, 1965 , 125(2), p.317-343, 9 refs. Includes discussion by J. Hallett. Microform No. SIP 24150.
25-2075
ICE CRYSTAL GROWTH, ICE CRYSTAL STRUCTURE, PHOTOGRAPHIC ANALYSIS.
As a part of a program to study ice formation at water-solid interfaces, the principle structures which appear in the temperature range 0 to -5 C for aluminum, lucite, and glass, and the growth velocities of these structures as a function of interface temperature were measured. The first experiment established the existence of an initial film which spreads rapidly across the interface before appreciable growth normal to the interface has occurred, and determines the form of the subsequent growth. The second type of experiment studied the initial layer of ice as it spread across the interface and permitted determination of initial growth and velocity. The freezing mechanism is described and the results are given. In a following discussion, J. Hallett discusses own experiments that sum to refute the idea that the surface acts merely as heat sink or as a site for renucleation.

**MP 92**
**ELECTRICAL EFFECT ON THE GROWTH OF ICE CRYSTALS.**
Camp, P.R., et al, *Nature,* Oct. 26, 1963, 200(4904), p.350-351, 2 refs.
Barter, C.F.
25-2031
ICE CRYSTAL GROWTH, NUCLEATION, ELECTRIC FIELDS.

**MP 93**
**RATE OF GROWTH OF ICE AT AN ALUMINUM-WATER INTERFACE.**
Camp, P.R., et al, *Nature,* May 1, 1965 , 206(4983), p.495-496, 1 ref. Microform No. SIP 23414.
Barter, C.F.
25-2074
ICE CRYSTAL GROWTH, ICE CRYSTAL STRUCTURE, PHOTOGRAPHIC ANALYSIS, NUCLEATION.
The dependence on temperature of the velocity of a freezing front advancing across an aluminum-water interface was measured as part of an investigation of the manner in which water freezes on solid surfaces. Two different sets of experiments were conducted, one with the aid of motion pictures and the other using still pictures. The results are graphed in cm/sec for the temperature range of -0.1 to -6.0C. The scattered results for the low-angle growth indicate the existence of at least two low-angle modes The low-angle growth dominates at high temperatures and the c perpendicular growth dominates at lower temperatures. It was found that the high-angle grains occur mostly between 75 and 85C to the interface, and that the low-angle grains occur mostly between 0 and 50C to the plate.

**MP 94**
**RATE GROWTH OF ICE AT WATER - METAL INTERFACES.**
Camp, P.R., et al, *Journal of chemical physics,* Oct. 1, 1966, 45(7), p.2709-2710, 4 refs. Microform No. SIP 24998.
Creamer, J.
25-2114
ICE GROWTH, WATER METAL INTERFACE.
The dependence of the velocity of interfacial growth of ice on supercooling was measured for substrates of gold, copper, steel, and lead in the temperature range 0 to -5C. Two growth modes were found for each surface. The results for copper and gold were similar to those for aluminum, the high-angle growth dominating over most of the temperature range. For lead and steel, the low-angle mode dominated over most of the range. An expression was derived which summarizes these measurements within the limits of experimental error. The thermal property of the substrate, which is rate controlling, cannot yet be assigned with certainty. For good conductors of heat at supercoolings of the order of 1C or more, the thermal properties of the substrate appear to play a major role in determining how the growth rate of a given mode varies with substrate temperature.

**MP 95**
**GEOCRYOLOGY AND ENGINEERING.**
Corte, A.E., Reviews in engineering geology, Vol.II, edited by D.J. Varnes and G. Kiersch., Boulder, Colorado, Geological Society of America, 1969, p.119-185, Bibliography p.174-185.
26-2755
FROZEN GROUND MECHANICS, FROST HEAVE, FREEZE THAW CYCLES, GROUND ICE, PERMAFROST DISTRIBUTION, PERMAFROST DEPTH, PERMAFROST CONSTRUCTION, PATTERNED GROUND, CLIMATIC CHANGES.

**MP 96**
**PARTICLE SORTING BY REPEATED FREEZING AND THAWING.**
Corte, A.E., *Science,* Oct. 25, 1963, 142(3591), p.499-501, 15 refs.
26-2872
PARTICLES, FREEZE THAW CYCLES, ICE WATER INTERFACE, PARTICLE SIZE DISTRIBUTION, MIGRATION, SOIL FREEZING, WATER CONTENT, FROST RESISTANCE.
If a heterogeneous mixture of particles of various sizes is frozen and thawed repeatedly, the particles are sorted into relatively uniform groups by size. The movement of particles depends on the amount of water between the ice-water interface and the particle, the rate of freezing, the distribution of the particles by size, and the orientation of the freeze-thaw plane.

**MP 97**
**RELATIONSHIP BETWEEN FOUR GROUND PATTERNS, STRUCTURE OF THE ACTIVE LAYER, AND TYPE AND DISTRIBUTION OF ICE IN PERMAFROST.**
Corte, A.E., *Biuletyn peryglacjalny,* 1963, No.12, p.7-90, For another version of this paper and abstract see 24-3244. Microform No. SIP 23078. 45 refs.
26-2873
PATTERNED GROUND, ACTIVE LAYER, GROUND ICE, ICE WEDGES, ICE LENSES, GREENLAND—THULE.

**MP 98**
**VERTICAL MIGRATION OF PARTICLES IN FRONT OF A MOVING FREEZING PLANE.**
Corte, A.E., *Journal of geophysical research,* March 1962, 67(3), p.1085-1090, For another version of this paper and abstract see 24-3257. Microform No. SIP 20010. 2 refs.
26-2874
SOIL FREEZING, FROST ACTION, ICE WATER INTERFACE, PARTICLE MIGRATION, TESTS, FREEZING.

**MP 99**
**EXPERIMENTAL FORMATION OF SORTED PATTERNS IN GRAVEL OVERLYING A MELTING ICE SURFACE.**
Corte, A.E., *Biuletyn peryglacjalny,* 1960, No.8, p.64-72, 265-272, 401-407, and 12 plates, In English, Polish and Russian. For another version of this paper and abstract see 24-3213. 3 refs.
26-2875
GLACIER ICE, ICE MELTING, PATTERNED GROUND, OUTWASH, GRAVEL, TESTS, GREENLAND—THULE.

**MP 100**
**STUDY OF FROZEN GROUND AND SOIL FREEZING.**
Corte, A.E., *Ciencia e investigación*, Sept. 1961, 17(9), p.357-379, In Spanish. 62 refs.
26-2877
FROZEN GROUND MECHANICS, PATTERNED GROUND, PERMAFROST DISTRIBUTION, FROST PENETRATION, SOIL FREEZING, FREEZE THAW CYCLES, GROUND ICE, LABORATORY TECHNIQUES, FROST RESISTANCE, TESTS.

**MP 101**
**RELEASE OF CARBON DIOXIDE FROM FROZEN SOIL TO THE ARCTIC ATMOSPHERE.**
Coyne, P.I., et al, *Nature*, Dec. 17, 1971, 234(5329), p.407-408, 4 refs.
Kelley, J.J.
26-2491
CARBON DIOXIDE, TUNDRA SOILS, FROZEN GROUND ANALYSIS, CORES, SOIL MOISTURE, THERMAL FACTORS, UNITED STATES—ALASKA.

**MP 102**
**EXCHANGE OF ATMOSPHERIC CARBON DIOXIDE OVER AN ARCTIC TUNDRA SURFACE.**
Coyne, P.I., et al, American Geophysical Union Meetings, San Francisco, 6-9 Dec. 1971 [Proceedings], Dec. 1971, 8p. plus figs., 9 refs.
Kelley, J.J.
26-3379
CARBON DIOXIDE, TUNDRA VEGETATION, AIR GROUND INTERACTIONS.
The net flux of CO2 represents the difference between total CO2 production by respiration in the plant/soil system and photosynthetic fixation by chlorophyllous tissue (Monteith, 1962). Combining peak season net daily CO2 flux (6-8 g/sq m/day) with limited peak season soil respiration data (6 g/sq m/day from IBP project 3115, V., Brown, 1971) yields a calculated net photosynthetic fixation of 12-14 g CO2/sq m/day. Corresponding in situ method values for peak season were 10-12 g/sq m/day (IBP project 3112, V., Brown, 1971) for vascular plants alone. As a first approximation comparison, carbon fixation by cryptogams may account for the relatively small discrepancy between these two independent approaches for assessing primary productivity.

**MP 103**
**PILE FOUNDATIONS IN PERMAFROST.**
Crory, F.E., *National Research Council. Publication*, 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.467-476, 25 refs. Includes discussion. Microform No. SIP 24888.
25-2115
PILE FOUNDATIONS, CONSTRUCTION, DESIGN CRITERIA, PERMAFROST.
Major considerations in the design of foundations in permafrost are: (a) minimizing disturbances in the thermal regime, and (b) providing for the heave and subsidence from the freeze and thaw cycles of the active layer and any degenerate thawing of the permafrost. Pile installation methods which can be selected to match the foundation requirements and the soil conditions are: (1) steam thawing a hole in permafrost either larger or smaller than the pile, and driving the pile in, (2) rotary drilled hole, (3) dry augering, (4) pile driving techniques, and (5) various combinations and modifications of the above. The results of pile tests conducted since 1952 are discussed with emphasis on the effect of rate of loading and temperature on adfreeze strength, and load settlement tests.

**MP 104**
**ARTIFICIAL RADIOACTIVITY REFERENCE HORIZONS IN GREENLAND FIRN.**
Crozaz, G., et al, *Earth and planetary science letters*, Jan. 1966 , 1(1), p.42-48, 14 refs. For another version of this paper and abstract see 24-3351.
Langway, C.C., Jr., Picciotto, E.
23-3768
FALLOUT, RADIOACTIVE ISOTOPES, CORING, FIRN, MEASUREMENT, GREENLAND.

**MP 105**
**DATING GREENLAND FIRN-ICE CORES WITH PB-210.**
Crozaz, G., et al, *Earth and planetary science letters*, July 1966, , 1(4), p.194-196, 7 refs.
Langway, C.C., Jr.
23-4320
ISOTOPES, RADIOACTIVE AGE DETERMINATION, CORES, ICE CORING DRILLS, GREENLAND.
The Pb210 dating method is applied to deep thermally recovered firn-ice cores from the North Greenland ice sheet. The Pb210 activity is found to decay exponentially with depth (expressed in water equivalent). The corresponding rate of snow accumulation, averaged over the past 150 years, is 32 g/sq cm yr, in good agreement with recent snow accumulation determined by different methods.

**MP 106**
**ONE THOUSAND CENTURIES OF CLIMATIC RECORD FROM CAMP CENTURY ON THE GREENLAND ICE SHEET.**
Dansgaard, W., et al, *Science*, Oct. 17, 1969 , 166(3903), p.377-381, 51 refs.
Johnsen, S.J., Moller, J., Langway, C.C., Jr.
24-1240
CORES, GLACIER ICE, ICE SAMPLING, ISOTOPE IMPURITIES, CLIMATIC CHANGES, RADIOACTIVE AGE DETERMINATION.
A correlation of time with depth has been evaluated for the Camp Century, Greenland, 1390 m deep ice core. Oxygen isotopes in approximately 1600 samples throughout the core have been analyzed. Long-term variations in the isotopic composition of ice reflect the climatic changes during the past nearly 100,000 yrs. Climatic oscillations with periods of 120, 940, and 13,000 yrs are observed.

**MP 107**
**OXYGEN ISOTOPE ANALYSIS OF A CORE REPRESENTING A COMPLETE VERTICAL PROFILE OF A POLAR ICE SHEET.**
Dansgaard, W., et al, *International Association of Scientific Hydrology. Publication*, 1970, No.86, p.93-94, Abstract with graph.
Johnsen, S.J., Moller, J., Langway, C.C., Jr.
25-944
ISOTOPE IMPURITIES, CLIMATIC CHANGES, ACCUMULATION, GREENLAND—CAMP CENTURY.

**MP 108**
**CLIMATIC RECORD REVEALED BY THE CAMP CENTURY ICE CORE.**
Dansgaard, W., et al, The late Cenozoic glacial ages, edited by Karl K. Turekian, New Haven and London, Yale University Press, 1971, p.37-56, 43 refs.
Johnsen, S.J., Clausen, H.B., Langway, C.C., Jr.
26-718
ICE CORES, ICE DATING, CLIMATIC CHANGES, PALEOCLIMATOLOGY, GREENLAND—CAMP CENTURY.

**MP 109**
**GRAVEL-FILL ROADS ON PERMAFROST AND GLACIER ICE.**
Davis, R.M., *National Academy of Sciences. National Research Council. Publication*, 1966, No.1287, International Conference on Permafrost, Lafayette, Indiana, 1963. Proceedings. p.535-537.
25-3161
COLD WEATHER CONSTRUCTION, ROADS, ICE (CONSTRUCTION MATERIAL), GRAVEL, PERMAFROST CONSTRUCTION.

**MP 110**
**CHARACTERISTICS OF SUMMER RUNOFF FROM A SMALL WATERSHED IN CENTRAL ALASKA.**
Dingman, S.L., *Water resources research*, 1966 , 2(4), p.751-754, 5 refs.
25-2116
RUNOFF, HYDROLOGY, UNITED STATES—ALASKA—FAIRBANKS.
Measurements of discharge from a drainage basin of about 0.7 sq mi area located 8 miles north of Fairbanks, Alaska, revealed runoff characteristics markedly different from those of similar sized basins in midlatitude regions. The stream hydrograph was greatly attenuated, with large lag times (as much as 21 hours), low peak discharges, and streamflow recessions drawn out in time. These features are probably due to the fact that storm runoff travels to the stream largely as interflow through a thick mat of mosses.

**MP 111**
**EFFECTS OF THERMAL POLLUTION ON RIVER ICE CONDITIONS.**
Dingman, S.L., et al, *Water resources research*, April 1968 , 4(2), p.349-362, 20 refs. Also in Army Science Conference, 1966, proceedings, Vol.3 p.87-101. For another version and abstract see 24-3349. For comment and reply see 23-4334 and 23-4335.
Weeks, W.F., Yen, Y.-C.
23-3380
RIVER ICE, POLLUTION, NAVIGATION, THERMAL EFFECTS, COMPUTER PROGRAMS.

**MP 112**
**REPLY.**
Dingman, S.L., et al, *Water resources research*, Aug. 1968 , 4(4), p.848, For original article and comment see 23-3380 and 23-4334. 2 refs.
Weeks, W.F., Yen, Y.-C.
23-4335
RIVER ICE, THERMAL POLLUTION, WATER TEMPERATURE, TEMPERATURE EFFECTS.

**MP 113**
**FLEXURE BY A CONCENTRATED FORCE OF THE INFINITE PLATE ON A CIRCULAR SUPPORT.**
Dundurs, J., et al, *Journal of applied mechanics*, Jan. 1962, No.62-WA-142, p.1-7, 12 refs.
Lee, T.-M.
25-2014
PLATES, ELASTIC PROPERTIES, FLEXURAL STRENGTH, BOUNDARY VALUE PROBLEMS.
Treated is the flexure of an infinite plate which is simply supported on a circle and subjected to a concentrated force at an arbitrary point. The portion of the plate inside the circular support is allowed to have elastic properties that are different from those of the outside part. The solution is exact within the framework of the classical theory of thin elastic plates and is in the form of a uniformly convergent series. Several previously known solutions appear as limiting cases of the results given here.

**MP 114**
**ANTARCTIC ICE SHEET: STABLE ISOTOPE ANALYSES OF BYRD STATION CORES AND INTERHEMISPHERIC IMPLICATIONS.**
Epstein, S., et al, *Science*, June 26, 1970, 168(3939), p.1570-1572, 23 refs.
Sharp, R.P., Gow, A.J.
25-587
CLIMATIC CHANGES, TEMPERATURE VARIATIONS, ICE SAMPLING, ISOTOPE ANALYSIS, ICE CORES, ANTARCTICA—BYRD STATION.

**MP 115**
**CLIMATOLOGICAL IMPLICATIONS OF STABLE ISOTOPE VARIATIONS IN DEEP ICE CORES, BYRD STATION, ANTARCTICA.**
Epstein, S., et al, *Antarctic journal of the United States*, Jan./Feb. 1971, 6(1), p.18-20, 4 refs.
Sharp, R.P., Gow, A.J.
25-3169
ICE SAMPLING, CORING, ISOTOPE IMPURITIES, PALEOCLIMATOLOGY, ANTARCTICA—BYRD STATION.

**MP 116**
**SIX-YEAR RECORD OF OXYGEN AND HYDROGEN ISOTOPE VARIATIONS IN SOUTH POLE FIRN.**
Epstein, S., et al, *Journal of geophysical research*, April 1965, 70(8), p.1809-1814, Microform No. SIP 23171. 15 refs.
Sharp, R.P., Gow, A.J.
25-4126
SNOW ACCUMULATION, FIRN STRATIFICATION, ISOTOPE ANALYSIS, ANTARCTICA—SOUTH POLE.
Repeated observations on a network of 36 accumulation stakes established on Jan. 27, 1958, near Amundsen-Scott Station were made in order to provide a means of checking the reliability of accumulation and annual-layer determinations by stratigraphic and isotopic methods. On Dec. 23, 1963, nearly 6 yr later, two stakes, 1200 m apart and 2 to 3 km grid NE of the station, were investigated. Firn stratigraphy as well as oxygen- and hydrogen-isotope studies were made continuously to depths of 119 and 128 cm. All three procedures show consistency and indicate an average annual accumulation of 7 cm of water over the 1958-63 interval. Isotope data suggest that depth-hoar formation may result in relative enrichment in O-18. This could come about through partial recondensation of vapor generated within the depth-hoar layer accompained by escape of residual vapor poor in O-18.

**MP 117**
**NONSTEADY COMPRESSIBLE FLOW THROUGH ANISOTROPIC POROUS MEDIUMS WITH PARTICULAR REFERENCE TO SNOW.**
Fan, S.S.T., et al, *Water resources research*, June 1968 , 4(3), p.597-606, 12 refs.
Yen, Y.-C.
23-3198
UNSTEADY FLOW, FLUID FLOW, POROSITY, SNOW PERMEABILITY.
The equations describing the unsteady flow of air through an anisotropic layer of snow are solved numerically. It has been found that even at a moderate boundary pressure of 2 atmospheres, the penetration of the pressure front becomes appreciably more damped, and the rate of propagation reduces in the case of van der Waal's gas as compared with the case of ideal gas. These differences are more pronounced for pressure of 5 and 50 atmospheres. The results point out the need of caution in making the assumption of ideal gas behavior for dealing with problems of compressible fluid flow through porous mediums.

**MP 118**
**THEORY OF THE CONSOLIDATION OF SNOW.**
Feldt, E.D., et al, *Journal of glaciology,* Feb. 1966, 6(43), p.145-157, French and German summaries. 21 refs.
Ballard, G.E.H.
25-2118
SNOW DENSITY, VISCOSITY, SNOW COMPRESSION, POROSITY, STRESS ANALYSIS, COMPRESSIVE PROPERTIES.

**MP 119**
**SEARCH FOR ALUMINUM-26 IN DUST FROM THE GREENLAND ICE SHEET.**
Fireman, E.L., et al, *Geochimica et cosmochimica acta,* 1965, 29(1), p.21-27, 10 refs. Microform No. SIP 22895.
Langway, C.C., Jr.
25-2089
GLACIER ICE, CHEMICAL ANALYSIS, IMPURITIES, DUST, GREENLAND.
About 20,000 l of water from the Camp Century, Greenland, water supply system were filtered in an attempt to obtain dust samples from glacier ice about 250 yr old. The amounts found are significant for determinations of the exposure age, the chemical composition, and the accretion rate of extraterrestrial dust. For an accretion rate for the earth of a million tons per year of silicates, the limit of 4 x 1/1.000.000 dpm/l corresponds to an exposure age of 4000 yr. Although the filter collections do not contain Al-26, they do contain radioactivities. The principal one is Tl-208, a Th decay product attributed to terrestrial material in the collection. There is also a small positron activity, which disappeared with the purification of Al.

**MP 120**
**MEASURING CLOUD HEIGHTS.**
Foskett, L.W., et al, *Electronic industries,* Sept. 1943, 2(9), p.90-92, 164-172, 3 refs. .
Hansen, B.L.
25-2189
CLOUDS (METEOROLOGY), CLOUD HEIGHT INDICATORS.

**MP 121**
**EQUATIONS FOR DETERMINING THE BRINE VOLUME OF SEA ICE FROM -0.5 TO -22.9 C.**
Frankenstein, G.E., *Journal of glaciology,* Oct. 1967 , 6(48), p.943-944, In English, with French and German summaries.1 ref.
23-1705
BRINES, SEA ICE, ICE SALINITY.
Brine volume of sea ice is a function of the salinity and temperature of the ice, and it is related to its strength. This paper gives three equations which can be used to compute the brine volume for three temperature ranges from -0.5 to -22.9C. A less accurate equation covering the total range is also presented.

**MP 122**
**STRENGTH OF ICE SHEETS.**
Frankenstein, G.E., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* March 1968 , No. 92, Ice pressures against structures, proceedings of a conference held at Laval University, Quebec, 10-11 November 1966, p.79-87, 11 refs.
23-4225
FLOATING ICE, ICE BEARING CAPACITY, LAKE ICE, ICE STRENGTH.
This paper describes the results of a number of large load tests performed on an Arctic Lake to gain further knowledge in determining the bearing capacity of floating ice sheets. The tests were two types: (1) distributed loads and (2) relatively concentrated loads. In the distributed load tests a 15-ft diameter aluminum tank, with a height adjustable to 20 ft, was placed directly on the surface. Lake water was pumped into the tank to load the ice. The concentrated load tests were conducted in the same manner as the distributed tests except that the tank was placed on a platform balanced on a 24 in. diameter wooden block. The deflection of the ice sheet was measured at the load and at various distances away from the load. A deflection profile for each test is included. The time of audible cracks and their position, if observed, were recorded. The elastic theory predicts the outer circumferential crack to be at a distance greater than 1.8L for a concentrated load. The observed location was inside 1.1L. In the concentrated tests a circumferential crack did not always form. There were always 13 radial type cracks present after each concentrated test.

**MP 123**
**FLEXURAL STRENGTH OF SEA ICE AS DETERMINED FROM SALINITY AND TEMPERATURE PROFILES.**
Frankenstein, G.E., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* Nov. 1970, No.98, p.66-73, 7 refs.
26-1251
SEA ICE, FLEXURAL STRENGTH, ICE SALINITY, TEMPERATURE EFFECTS, ANALYSIS (MATHEMATICS), ICE STRENGTH, ICE MECHANICS.
The paper discusses the results of large in place cantilever beam tests on sea ice whose strength values were used to compute the constant of the strength of the equation based on profile relationship. Profile relationships are based on change in brine volume.

**MP 124**
**ACOUSTIC REFLECTION MEASUREMENTS OF SEA ICE THICKNESS, BARROW, ALASKA.**
Frankenstein, G.E., et al, *Canada. Defence Research Board. Defence Research Establishment Ottawa. Technical note,* June 1971, No.71-14, p.29-41.
Abrams, W.R.
26-1886
SEA ICE, ICE COVER THICKNESS, ACOUSTIC MEASUREMENT, ICE SALINITY, ICE TEMPERATURE, UNITED STATES—ALASKA—POINT BARROW.
The sea ice thickness was more readily determined when using the 12 KHz system than the 3.5 KHz system. This followed from the better resolution inherent in the use of higher frequencies. There is a strong indication that the use of frequencies higher than 12 KHz will provide a useful operational tool for rapid determination of sea ice thickness.

**MP 125**
**FORT GREELY MILITARY RESERVATION SNOW SURVEYS, 1968-1969.**
Freeman, T.G., May 1969, 21p., No microfiche available.
33-588
SNOW SURVEYS, SNOWDRIFTS, SNOW DENSITY, SNOW DEPTH, UNITED STATES—ALASKA—FORT GREELY.
Measurements at four snow courses and 10 snow stakes within the Fort Greely, Alaska, Military Reservation were made once each month (except January) between November and May of 1968-69. The snow depths in Fort Greely ranged between 3M at a snow stake site in Nov. 1968 to 26M at another such site in Mar. 1969. Snow drifting was slight until after Feb. 1, and the snow cover densities were low (between 12 and 18 gm/cu c) until Mar. 1. Snowdrift patterns, except in the forested region in the northern section of the Reservation, began to develop after Feb. 1. In the exposed higher region where trees were sparse, the snow was blown clear but hard drifts were noted on the lee side of hill or behind brush. Twenty-four ice thickness measurements were made on Bolio Lake in Fort Greely during the winter of 1968-69. The thicknesses ranged from 7" in Nov. to 40-41" in Feb. and Mar. and because of exposure to the wind very little snow accumulated on the ice.

**MP 126**
**AERIAL PHOTOGRAPHY IN ARCTIC AND SUBARCTIC ENGINEERING.**
Frost, R.E., *American Society of Civil Engineers. Air Transport Division. Journal,* May 1960, 86(AT1), p.27-56, Microform No. SIP 18655.
25-2002
PERMAFROST INDICATORS, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION.
The use of aerial photographs as a means of getting information about surface materials and their condition, which will assist in solving scientific, engineering, or military problems in arctic, subarctic, and polar areas is discussed. The discussion is limited to a short review of problems related to permafrost and severe frost activity; the airphoto method of obtaining information; the determination and evaluation of the regional environmental aspects responsible for permafrost and severe frost action; the identity and significance of minute photo pattern features; and direct permafrost and frost activity indicators. An example of a typical analysis of aerial photographs is included.

**MP 127**
**PHOTOINTERPRETATION IN THE ARCTIC AND SUB-ARCTIC.**
Frost, R.E., et al, *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.343-348, 16 refs. Microform No. SIP 24867.
McLerran, J.H., Leighty, R.D.
25-2119
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, TERRAIN ANALYSIS, ARCTIC TERRAIN.
Successful use by engineers of remote and often inaccessible areas is contingent on knowing the identity, physical properties, and distribution of soils and rocks and their behavior when disturbed. Regions can be studied through small-scale areal photos, assembled either in mosaic or in photo-index form. Stereoscopic pairs of contact photos typical for each major pattern are studied to determine physical characteristics of the minute features. Data are correlated and areas of agreement or disagreement are determined. In Arctic and subarctic regions photoanalysis is significant not only because of regional remoteness and inaccessibility but also because of the problems of use, alteration, and disturbance of the frost or permafrost in the area, as well as giving the identity and distribution of the various soils and rocks.

**MP 128**
**SITE PROTECTION.**
Fulwider, C.W., Vermont Conference on Winter Construction, Oct. 30-31, 1969. Proceedings, Burlington, University of Vermont, 1970, p.17-34, 10 refs.
25-3026
COLD WEATHER CONSTRUCTION, CONSTRUCTION MATERIALS, SHELTERS.
A report on the protection of buildings and structures, excavation areas and individuals at construction sites through self supporting and structure-supported enclosures and through various other types of shelters.

**MP 129**
**EFFECT OF SURFACE COLOR ON THAW PENETRATION BENEATH AN ASPHALT SURFACE IN THE ARCTIC.**
Fulwider, C.W., et al, International Conference on the Structural Design of Asphalt Pavements, Aug. 20-24, University of Michigan. Proceedings (Preprint volume). Ann Arbor, Michigan,, p.605-610.
Aitken, G.W.
25-2015
RUNWAYS, PAVEMENTS, COLOR, THAWING, ACTIVE LAYER THICKNESS. GREENLAND—THULE.
The purpose of this paper is to present the results of a study conducted to determine the reduction in thaw penetration obtained by painting an asphalt runway pavement white at Thule Air Force Base, Greenland. A description of the site, complete with meteorological and soil data is furnished and the investigational program conducted to study the pavement at Thule is outlined. The results obtained in 1953-1954 from a small white-painted test area on an asphalt taxiway at Thule indicated that a substantial reduction in depth of thaw was effected by painting the surface. To reduce thaw penetration and to permit further study of a white-painted pavement surface, a deep-cut section of the runway, where thawing into the subgrade had caused pavement subsidence, was painted white in 1959. The results of this runway painting program are presented and discussed. It is concluded by the authors that the painting program was very effective in reducing thaw penetration with subsequent reduction in subsidence and required maintenance.

**MP 130**
**FILLING THE GAP IN COLD REGIONS ENVIRONMENTAL DATA.**
Gerdel, R.W., *Institute of Environmental Sciences. Proceedings,* April 1963, p.229-240, 31 refs. Microform No. SIP 21469.
25-2032
SNOW PHYSICS, SNOW (CONSTRUCTION MATERIAL), CLIMATOLOGY, SNOW MECHANICS, SNOW THERMAL PROPERTIES, COLD WEATHER CONSTRUCTION.
This review presents a few highlights of cold regions research and the CRREL program over the last 12 yr. Included is a survey of the present state of snow and ice physics in which the following topics are discussed; the physical and thermal properties of snow cover, the mechanics of snow as a material (deformation and strength properties), and the climatology of cold regions. The construction of Camp Century, Greenland, is also described. The camp provides an illustration of how research on the physical properties of cold regions materials and environmental phenomena has lead to design criteria, construction practices and operational procedures which have extended both military and civilian capabilities in cold regions.

**MP 131**
**INFLUENCE OF ARCTIC ENVIRONMENT ON MILITARY MOBILITY.**
Gerdel, R.W., Jan. 1963, No. 623C, Society of Automotive Engineers. Automotive Engineering Congress, Detroit, Mich., Jan. 14-18, 1963, 12 p., 33 refs.
25-2033
SNOW VEHICLES, MILITARY ENGINEERING, TRAFFICABILITY, COLD WEATHER OPERATION, SNOW COVER, ICE COVER STRENGTH.

**MP 132**
**THE NEED FOR COORDINATION AND DISSEMINATION OF INFORMATION FROM INTERDISCIPLINARY RESEARCH IN THE YUKON FLATS WATERSHED.**
Gerdel, R.W., Science in Alaska. Alaskan Science Conference, 14th, Aug. 27-30, 1963, Anchorage, Alaska. Proceedings. College, Alaska,, p.247-248.
25-2050
WATERSHEDS, RESEARCH PROJECTS, UNITED STATES—ALASKA—YUKON RIVER.

**MP 133**
**A CLIMATOLOGICAL STUDY OF THE GREENLAND ICE SHEET.**
Gerdel, R.W., *Folia geographica danica,* 1961, Vol.9, International Geographic Congress, 19th, Norden, 1960. Symposium SD2, p.84-106, Includes discussions. 21 refs. Microform No. SIP 19954.
25-2215
CLIMATOLOGY, METEOROLOGICAL DATA, ICE SHEETS, GREENLAND.

A climatological summary for the Greenland Ice Sheet has been prepared from available meteorological records and temperature profiles derived from stratigraphic studies on the inland ice. Map tables and histograms have been used to prevent a comprehensive climatological picture of the Ice Sheet. Some relationship between the topography and climatology is discussed.

**MP 134**
**SNOW DRIFTING AND ENGINEERING DESIGN.**
Gerdel, R.W., *American Meteorological Society. Meteorological monographs,* May 1960, 4(22), p.57-64, 6 refs.
25-2416
SNOWDRIFTS, SNOW (CONSTRUCTION MATERIAL), CONSTRUCTION, COUNTERMEASURES, DESIGN CRITERIA.
The results of field experiments and observations on drift snow accumulation in the vicinity of Arctic bases show that it is possible to design buildings and facilities and to lay out bases and depots in Polar regions which will largely control drifting snow. It is possible, also, to make use of drifting snow in the construction of some facilities. Design criteria for Arctic construction, which will reduce snow drifting to a minimum, include the following: (1) elevation of buildings above the ground surface to permit free flow of wind-borne snow beneath the structure, (2) orientation of buildings and base layout to minimize coalescence of drifts, and (3) elevation of roadways and air strips to provide self clearing of the traffic surface. Drifting snow may be accumulated by suitable catchment fences and utilized to construct elevated roads, air strips, and hardstands on the Polar ice Caps, where loss of seasonal precipitation by melting is negligible. Efforts are being made to develop snow-simulating materials suitable for scale-model tests in a wind tunnel. It appears that there must be a scaled relationship between the physical properties of the simulator and the prototype snow.

**MP 135**
**WHITE-OUT, A HAZARD TO ARCTIC FLYING.**
Gerdel, R.W., et al, *American Society of Civil Engineers. Air Transport Division. Journal,* July 1957, 83(AT1), p.1327-1—1327-15, 9 refs.
Diamond, M.
25-2187
WHITEOUT, FOG DISPERSAL, FORECASTING.
The studies on Arctic white-out reported in this paper were conducted at a field research station located on the Greenland Ice Cap, about 230 miles east of the Thule Air Base, and at an elevation of about 7,000 ft. The authors discuss five white-out phenomena, analyze the possibility of forecasting these phenomena, and suggest methods of dispersal.

**MP 136**
**SCALE MODEL SIMULATION OF A BLOWING SNOW ENVIRONMENT.**
Gerdel, R.W., et al, *Institute of Environmental Sciences. Proceedings,* April 1961, p.53-63, 11 refs. Microform No. SIP 20300.
Strom, G.H.
25-2188
MODELS, SNOWDRIFTS.
Scale factors for the simulation of drifting snow were determined in connection with wind tunnel studies of snow drift formation on the Greenland Ice Cap. Model structures on a scale of 1:10 were used and the parameters of the material for simulating snow were devised accordingly. The following factors were considered: diameter and velocity of the snow particle, its free fall velocity, the ambient air velocity at the particle, the acceleration due to gravity, and the coefficient of restitution (ratio of velocity of rebound to the velocity of impact). Of the various materials tested, commercial borax was found to be the most promising and has been used successfully in the scale model tests. Remarkable correlation was found between drift accumulation around one of the "Dye" site buildings on the S. Greenland Ice Cap and around a model of the same building in the wind tunnel. Wind tunnel tests lasting a few hours can provide information on drift characteristics that could not be acquired in less than 3-5 yr. under natural field conditions.

**MP 137**
**USE OF RADIOISOTOPES FOR THE MEASUREMENT OF THE WATER EQUIVALENT OF A SNOW PACK.**
Gerdel, R.W., et al, *American Geophysical Union. Transactions,* June 1950 , 31(3), p.449-453, 2 refs. Microform No. SIP U46.
Hansen, B.L., Cassidy, W.C.
25-2190
RADIOACTIVE SNOW GAGES, SNOW HYDROLOGY.
A radio-telemetering snow gage has been designed which uses the principle of absorption by water (liquid or solid phase) of the gamma emissions from an artificial radioactive isotope. The radioactive radiotelemetering snow gage has been used successfully to measure 55 water equivalent inches of snow by counting the pulses from a suitably located Geiger-Muller tube. These pulses have been successfully transmitted and relayed by radio. Further progress is dependent upon the development of a reliable radio communication system for use with the radioactive snow gage in remote high mountain areas.

**MP 138**
**WIND TUNNEL STUDIES WITH SCALE MODEL SIMULATED SNOW.**
Gerdel, R.W., et al, *International Association of Scientific Hydrology. Publication,* 1961, No.54, p.80-88, 8 refs. Microform No. SIP 19679. For another version of this paper see 25-2188.
Strom, G.H.
25-2420
SNOWDRIFTS, MODELS, BLOWING SNOW.
In Polar regions where little or no summer melting occurs, improperly designed structures may be quickly and permanently buried by drifting snow. In most wind tunnel studies on drifting snow no consideration is given to the relationship between the velocity of air in the tunnel and the physical and aerodynamic properties of the material selected to represent snow nor to the extent of saturation of the wind with the synthetic snow. Recognizing the deficiencies in knowledge on snow drifting and the advantages inherent in wind tunnel studies, the U. S. Army Snow Ice and Permafrost Research Establishment (now U. S. Army Cold Regions Research and Engineering Laboratory) has supported a research program leading to the selection and use of materials which might be used to suitably simulate snow in controlled investigations on scale models of structures within the range of 1/10 to 1/50 prototype size. Some of the results of the wind tunnel studies with a scaled, simulated snow are presented.

**MP 139**
**ELECTROLYTIC CONDUCTIVITY OF SNOW AND GLACIER ICE FROM ANTARCTICA AND GREENLAND.**
Gow, A.J., *Journal of geophysical research,* June 1968, 73(12), p. 3643-3649, 14 refs. For another version of this paper and abstract see 24-3383.
23-2277
ICE ELECTRICAL PROPERTIES, ELECTRICAL RESISTIVITY, SNOW ELECTRICAL PROPERTIES, GLACIER ICE, ANTARCTICA, GREENLAND.

**MP 140**
**BUBBLES AND BUBBLE PRESSURES IN ANTARCTIC GLACIER ICE.**
Gow, A.J., *Journal of glaciology,* June 1968 , 7(50), p.167-182, 19 refs. For another version of this paper and abstract see 24-3384.
23-2938
BUBBLES, ICE PRESSURE, DRILL CORE ANALYSIS, GLACIER ICE, ANTARCTICA—LITTLE AMERICA, ANTARCTICA—BYRD STATION.

**MP 141**
**PRELIMINARY ANALYSIS OF ICE CORES FROM BYRD STATION.**
Gow, A.J., *Antarctic journal of the United States,* July-Aug. 1968 , 3(4), p.113-114.
23-3113
CORES, DRILL CORE ANALYSIS, IMPURITIES, DENSITY (MASS/VOLUME), BUBBLES, ANTARCTICA—BYRD STATION.

**MP 142**
**ON THE RATES OF GROWTH OF GRAINS AND CRYSTALS IN SOUTH POLAR FIRN.**
Gow, A.J., *Journal of glaciology,* June 1969 , 8(53), p.241-252, In English, with summaries in French and German. 24 refs.
24-784
SNOW CRYSTAL GROWTH, FIRNIFICATION, GLACIERS, TEMPERATURE EFFECTS, ANTARCTICA.

**MP 143**
**CORE STUDIES AND RELATED GLACIOLOGICAL INVESTIGATIONS.**
Gow, A.J., *Antarctic journal of the United States,* July-Aug. 1969 , 4(4), p.124-125.
24-3612
DRILL CORE ANALYSIS, BOREHOLES, DEFORMATION, BUBBLES, CRACKING (FRACTURING), ANTARCTICA—BYRD STATION.
Core samples were taken from the drill hole at "Old Byrd" Station, analyzed for changes in ice structure since the observations made during IGY investigations. Current borehole configuration is compared to that of the IGY. Surface snow accumulation measurements are also compared with those made during the IGY and during the intervening time.

**MP 144**
**GLACIOLOGICAL STUDIES IN ANTARCTICA.**
Gow, A.J., *Antarctic journal of the United States,* July-/Aug. 1970, 5(4), p.113-114.
25-850
GLACIOLOGY, GLACIER ICE, ICE CRYSTAL NUCLEATION, ANTARCTICA.

**MP 145**
**PRELIMINARY RESULTS OF STUDIES OF ICE CORES FROM THE 2164M DEEP DRILL HOLE, BYRD STATION, ANTARCTICA.**
Gow, A.J., *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.78-90, 21 refs.
25-943
ICE DATING, STRATIGRAPHY, ICE TEMPERATURE, DRILL CORE ANALYSIS, ICE COVER THICKNESS, ICE CRYSTAL STRUCTURE, ELECTRICAL RESISTIVITY.
The Antarctic ice sheet at Byrd Station has been core drilled to bedrock. A core yield of more than 99 per cent was achieved. Liquid water was encountered at the bed. Horizontally banded debris is present in the basal ice. A temperature minimum of -28.9 C was recorded at 800 m depth and the heat flow through the bottom of the ice sheet is estimated at 1.8 micro cal/sq cm/sec. A maximum density of 0.9206 g/cu cm was measured at 1000 m. Layers of dirt between 1300 and 1700 m were tentatively identified as volcanic ash. Bubbly ice reverted to a bubble-free condition between 900 and 1200 m depth. A zone of deformed ice, comprising crystals with substantially vertically orientated c-axes and containing numerous cloudy (shear?) bands of very fine-grained ice, exists between 1200 and 1800 m. A very rapid increase in the size of crystals below 1800 m is attributed to annealing at elevated temperatures near the bottom of the ice sheet. Electrolytic conductivity measurements revealed very low levels of dissolved solids at all depths.

**MP 146**
**RESULTS OF MEASUREMENTS IN THE 309 METER BORE HOLE AT BYRD STATION, ANTARCTICA.**
Gow, A.J., *Journal of glaciology,* Oct. 1963, 4(36), p.771-784, French and German summaries. 19 refs.
25-2034
BOREHOLES, TEMPERATURE MEASUREMENT, TEMPERATURE GRADIENTS, GLACIER FLOW, INCLINOMETER MEASUREMENTS, HOLE CLOSURE MEASUREMENTS.
Temperature, inclination, and closure have been measured in a 309 m. deep drill hole at Byrd Station, Antarctica. The results of five series of measurements taken yearly since Feb. 1958 show that temperatures below 70 m. have remained constant since Dec. 1958, that the closure rate has accelerated, and that the hole has undergone negligible inclination from the vertical. Anomalous temperatures in the upper levels of the drill hole are attributed to the steel casing that was permanently emplaced to a depth of 36 m. during drilling in 1957-58. A positive temperature gradient was observed in the casing, but negative gradients exist below the casing and a constant gradient profile is developed below 170 m. Both ice motion and climatic changes at Byrd Station are thought to have contributed to the formation of the observed negative temperature gradients.

**MP 147**
**THE ICE SHEET.**
Gow, A.J., Antarctica; A New Zealand Antarctic Society Survey. T. Hatherton, ed., New York,, p.221-258, 72 refs. Microform No. SIP 23926.
25-2077
GLACIER ICE, ICE SHEETS, ANTARCTICA.
The Antarctic ice sheet, with an area of 13,500,000 sq km, covers about 98% of the continent and comprises 90% of the world's ice. It includes inland ice, ice shelves, valley glaciers, ice streams, and ice tongues. The average thickness of grounded ice is estimated to exceed 2000 m. The sheet is nourished primarily by snow precipitation; the methods used to measure net accumulation are outlined. Current estimates of the mass budget indicate a surplus of accumulation. Ice sheet movement results from sheet flow; stream flow; and ice shelf movement. The magnitude of glacial deformation, depends on the shape and dimensions of the glacier, ice temperatures, and the physical and mechanical properties of the ice. The surface movement is produced by both sliding of ice over its bed and by solid flow (continuous deformation) within the glacier. Antarctica is an example of a glacially controlled climate rather than a climatically controlled glacier.

**MP 148**
**ON THE ACCUMULATION AND SEASONAL STRATIFICATION OF SNOW AT THE SOUTH POLE.**
Gow, A.J., *Journal of glaciology,* Feb. 1965, 5(40), p.467-477, 7 refs. Microform No. SIP 23124.
25-2078
SNOW COVER DISTRIBUTION, SNOWFALL, ACCUMULATION, SNOW STRATIGRAPHY, SNOW PIT STUDIES, SNOW SURFACE, ANTARCTICA—SOUTH POLE.
The seasonal distribution of snow at the South Pole and its relationship to stratigraphy was investigated in pits dug beside several

**MP 149**
**ON THE ORIGIN OF BULLET CRYSTALS AT THE SOUTH POLE.**
Gow, A.J., *Journal of glaciology,* Feb. 1965, 5(40), p.461-465, French and German summaries. 9 refs. Microform No. SIP 23123.
25-2079
ICE CRYSTAL FORMATION, PRECIPITATION (METEOROLOGY), ANTARCTICA—SOUTH POLE.

An examination of bullet crystals in precipitation at the South Pole indicates that combinations of bullets originate as primary growth structures and that individual bullets are formed as a result of the disintegration of these primary growth forms rather than by independent crystallization of pyramidally terminated columns.

**MP 150**
**ANTARCTIC GLACIOLOGICAL STUDIES.**
Gow, A.J., *Antarctic journal of the United States,* July-Aug. 1967 , 2(4), p.121-122.
25-2162
GLACIER FLOW, ACCUMULATION, CONDENSATION NUCLEI, ANTARCTICA.

**MP 151**
**RELAXATION OF ICE IN DEEP DRILL CORES FROM ANTARCTICA.**
Gow, A.J., *Journal of geophysical research,* April 10, 1971, 76(11), p.2533-2541, 14 refs.
25-2378
ICE CORES, GLACIER ICE, RELAXATION (MECHANICS), ANTARCTICA—BYRD STATION.
Cores obtained to a depth of 2164 meters in the Antarctic ice sheet at Byrd station have undergone considerable relaxation since they were drilled. The greatest measurable relaxation, of the order 0.6 percent expansion, occurred in cores from around 800 meters' depth. Ice from 400-900 meters proved to be much more brittle than deeper ice and was characterized by an abundance of highly compressed air bubbles. These bubbles had disappeared completely by 1100 meters, and this, together with the formation below 1200 meters of an oriented crystal fabric is believed to be responsible for the greatly increased ductility of the deeper cores. Relaxation of ice from the brittle zone occurs primarily as a result of expansion of pressurized air bubbles. In deeper, bubble-free ice, however, relaxation can be attributed to the creation of new space, which become filled with gas derived from the air originally dissolved under pressure in the ice sheet.

**MP 152**
**INNER STRUCTURE OF THE ROSS ICE SHELF AT LITTLE AMERICA V, AS REVEALED BY DEEP CORE DRILLING.**
Gow, A.J., *International Association of Scientific Hydrology. Publication,* 1963, No.61, p.272-284, Microform No. SIP 21912. 11 refs.
25-4127
ICE SHELVES, DRILL CORE ANALYSIS, ICE STRUCTURE, ANTARCTICA—LITTLE AMERICA V.
The ice shelf is 257 m thick at the drill site, less than 3 km from its seaward edge. Cores obtained within 2 or 3 m of the bottom contained no traces of saline ice, and the drill hole temperature profile indicates that melting rather than accretion of sea ice is occurring on the bottom of the ice shelf. Studies of core stratigraphy to a depth of 39 m revealed 105 yr of accumulation at an average rate of 22 cm water/yr. Three thin layers of volcanic ash were observed at 172, 219, and 223 m which probably originated from volcanic sources in Marie Byrd Land. An anomalous increase in firn densification below 35 m is attributed to large horizontal stresses within the shelf. The transition from firn to glacier ice occurred at 52 m. Considerable strain was evident in the majority of crystals below 65 m, and oriented fabrics began to develop at this depth.

**MP 153**
**ANALYSIS OF ANTARCTIC ICE CORES.**
Gow, A.J., *Antarctic journal of the United States,* Sept./Oct. 1971, 6(5), p.205-206.
26-1750
ICE CORES, VOLCANIC ASH.

**MP 154**
**INTERNATIONAL SYMPOSIUM ON ANTARCTIC GLACIOLOGICAL EXPLORATION (ISAGE).**
Gow, A.J., ed, *International Association of Scientific Hydrology. Publication,* 1970, No.86, 543p., Papers and abstracts of papers presented at symposium held at Hanover, N.H., USA, September 3-7, 1968. For individual papers see 25-0933 through 25-0983. Numerous refs.
Keeler, C.M., ed, Langway, C.C., Jr., ed, Weeks, W.F., ed, Scientific Committee on Antarctic Research.
25-932
GLACIOLOGY, CHEMICAL COMPOSITION, SOUNDING, SEISMIC PROSPECTING, CORING, THERMODYNAMICS, GLACIER MASS BALANCE, ICE SHELVES, SEA ICE, SNOW PHYSICS, ANTARCTICA.

**MP 155**
**ANTRACTIC ICE SHEET: PRELIMINARY RESULTS OF FIRST CORE HOLE TO BEDROCK.**
Gow, A.J., et al, *Science,* Sept. 6, 1968 , 161(3845), P.1011-1013, 15 refs.
Ueda, H.T., Garfield, D.E.
23-3126
ICE CORING DRILLS, CORES, IMPURITIES, ICE TEMPERATURE, ICE CRYSTAL STRUCTURE, ANTARCTICA—BYRD STATION.
The Antarctic ice sheet at Byrd Station has been core-drilled to bedrock; the vertical thickness of the ice is 2164 meters. Liquid water-indicative of pressure melting-was encountered at the bed. Heat flow through the base of the ice sheet is estimated at 1.8 microcalories per square centimeter per second. The minimum temperature was - 28.8C at 800 meters; maximum ice density, 0.9206 at 1000 meters. Core studies reveal the existence of a chemically pure, structurally stratified sheet comprising bubbly ice to 900 meters that transforms to bubble-free deformed ice, with substantially vertically orientated c-axis structure, below 1200 meters. Below 1800 meters the deformed ice structure gives way to large annealed crystals. Several thin layers of dirt between 1300 and 1700 meters are tentatively identified as volcanic ash, and horizontally banded debris, including fragments of granite, is present in the basal ice.

**MP 156**
**AGE HARDENING OF SNOW AT THE SOUTH POLE.**
Gow, A.J., et al, *Journal of glaciology,* June 1963, 4(35), p.521-536, French and German summaries. 15 refs. Microform No. SIP 21072.
Ramseier, R.O.
25-2035
SNOW (CONSTRUCTION MATERIAL), SNOW COMPACTION, COMPRESSIVE STRENGTH, PRECIPITATION HARDENING, SNOW SAMPLERS, TEMPERATURE EFFECTS.
The age hardening of artificially and naturally compacted snow has been investigated at the South Pole. Results show that the age-hardening process is greatly retarded at low temperatures. Artificially compacted samples of density 0.55 cu cm attained a compressive strength of less than 3.0 sq cm after one yr. ageing at -49C. Exposure to solar radiation accelerated the age hardening. Irradiated samples attained a strength of 6.0 sq cm after 100 hr., increasing to a virtual maximum of 8.0 sq cm at the end of 600 hr. Compressive strengths increased with decrease in snow-particle size and with increasing angularity of the particles. Below 3 m. the strength of naturally compacted snow was found to increase rapidly with increase in density. Thin-section studies show that the age hardening can be correlated with the formation and growth of intergranular bonds, and that the bond growth falls off rapidly with decreasing temperature.

**MP 157**
**ON THE RELATIONSHIP OF SNOW ACCUMULATION TO SURFACE TOPOGRAPHY AT "BYRD STATION", ANTARCTICA.**
Gow, A.J., et al, *Journal of glaciology,* Oct. 1965, 5(42), p.843-847, French and German summaries. 5 refs. Microform No. SIP 23848.
Rowland, R.
25-2076
SNOWFALL, TOPOGRAPHY, ACCUMULATION.
Recent measurements (1963-65) of snow accumulation on undulating surfaces around Byrd Station indicate they are tending to be filled in. Two stake lines (one oriented parrallel to the prevailing wind direction and the other normal to it) show that the pattern and magnitude of accumulation are remarkably similar for the 3 yr, and accumulation rates are controlled by topography. Factors involved in forming and maintaining these undulations are discussed. Some might be explained by superimposing the effects of surface drift on standing waves formed on a sloping surface.

**MP 158**
**NEW LIGHT ON THE MODE OF UPLIFT OF THE FISH AND FOSSILIFEROUS MORAINES OF THE MCMURDO ICE SHELF, ANTARCTICA.**
Gow, A.J., et al, *Journal of glaciology,* Oct. 1965, 5(42), p.813-828, French and German summaries. 25 refs. Microform No. SIP 23845. For another version of this paper and abstract see 24-3320.
Weeks, W.F., Hendrickson, G., Rowland, R.
25-2080
ICE SHELVES, DRILL CORE ANALYSIS, FOSSILS, MORAINES, ANTARCTICA—MCMURDO ICE SHELF.

**MP 159**
**HIGH SNOWFIELDS OF THE ST. ELIAS MOUNTAINS.**
Grew, E., et al, Icefield ranges research project. Scientific results. Vol.1, edited by V.C. Bushnell and R.H. Ragle, New York, American Geographical Society, 1969, p.75-87, For another version of this paper and abstract see 24-3131. 18 refs.
Mellor, M.
25-4128
METAMORPHISM (SNOW), SNOW PHYSICS, SOLAR ACTIVITY.

**MP 160**
**A CORRELATION OF MICROPARTICLE CONCENTRATIONS WITH OXYGEN ISOTOPE RATIOS IN 700 YEAR OLD GREENLAND ICE.**
Hamilton, W.L. , et al, *Earth and planetary science letters,* Jan. 1968, , 3(4), p.363-366, 9 refs.
Langway, C.C., Jr.
23-4322
ICE, CORING, IMPURITIES, ISOTOPES, GREENLAND.

**MP 161**
**INSTRUMENTS FOR TEMPERATURE MEASUREMENTS IN PERMAFROST.**
Hansen, B.L., *National Research Council. Publication,* 1966, 1287, International Conference on Permafrost, Nov. 11-15, Lafayette, Ind. Proceedings, p.356-358, 12 refs. Microform No. SIP 24869.
25-2120
SOIL TEMPERATURE, TEMPERATURE MEASURING INSTRUMENTS, FROZEN GROUND TEMPERATURE.
Three temperature-measuring methods using probes in thermal equilibrium with media to be measured are discussed: resistance thermometers, thermocouples, and semiconductor techniques. The equipment described is suitable for use in a polar environment in that it is reasonably robust, portable, and accurate when subjected to and used over a wide range of ambient temperature.

**MP 162**
**CLEARING THE DEEP DRILL HOLE AT BYRD STATION.**
Hansen, B.L., et al, *Antarctic journal of the United States,* July/Aug. 1970, 5(4), p.113.
Garfield, D.E.
25-849
DRILLING, EQUIPMENT, ICE SHEETS, ANTARCTICA—BYRD STATION.

**MP 163**
**DEEP CORE DRILLING IN ICE AND CORE ANALYSIS AT CAMP CENTURY, GREENLAND, 1961-1966.**
Hansen, B.L., et al, *Antarctic journal of the United States,* Sept.-Oct. 1966, 1(5), p.207-208.
Langway, C.C., Jr.
25-2121
DRILL CORE ANALYSIS, ICE ANALYSIS, BOREHOLES, ICE CORING DRILLS, GREENLAND—CAMP CENTURY.

**MP 164**
**SOME RESULTS OF ICE CAP DRILL HOLE MEASUREMENTS.**
Hansen, B.L., et al, *International Association of Scientific Hydrology. Publication,* 1958 , No.47, p.313-317, 5 refs. Microform No. SIP 17383.
Landauer, J.K.
25-2191
BOREHOLES, GLACIER ICE, TEMPERATURE MEASUREMENT, DRILLING, ICE PHYSICS, GREENLAND.
The results of studies in the summer of 1957 on the temperature, inclination, and closure at various depths in a drill hole 1346 ft. deep at Site II, Greenland, are reported briefly. Temperatures were measured with a Cu resistance thermometer, the inclination with a Parsons Survey Co. small single-shot directional inclinometer with a range of 4 degrees, and the diam. of the hole with an electrical caliper. Closure was analyzed on the basis on Nye's theory, and the overburden pressure was obtained by integrating the depth-density curve for the site, assuming it to be hydrostatic. A slight inclination was detected at 600 ft., increasing to about 1/3 degree at 1160 ft. Data are tabulated and graphed on the calculated hydrostatic pressure, hole diam., and temperature at various depths.

**MP 165**
**ANTHROPOLOGY AND REMOTE SENSING.**
Harp, E., Jr., Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.727-729, 4 refs.
25-2122
REMOTE SENSING, AERIAL PHOTOGRAPHY, ANTHROPOLOGY.

**MP 166**
**TREE RING INDICES: A CIRCUMPOLAR COMPARISON.**
Haugen, R.K., *Science,* Nov. 10, 1967 , 158(3802), p.773-775, 18 refs. A critical review by A.R. Stage and Haugen's answer are published in Science, April 5, 1968, vol. 160, p.101.
25-2163
TREES (PLANTS), AGE DETERMINATION, CLIMATIC CHANGES.
A graphic and statistical comparison of major trends in tree ring indices representative of interior Alaska, northern Urals, northern Scandinavia, and Labrador indicates a highly significant correlation for most 50-year intervals between 1650 and the present. This is suggestive of similarities in trends of summer temperature on a circumpolar scale.

**MP 167**
**NATURAL AND MAN-INDUCED DISTURBANCES OF PERMAFROST TERRANE.**
Haugen, R.K., et al, Binghamton, State University of New York, 1971, p.139-149, Reprint from Environmental geomorphology, Donald R. Coates, ed. 7 refs.
Brown, J.
26-3380
PERMAFROST STRUCTURE, DEGRADATION, PERMAFROST ENGINEERING, ENVIRONMENTAL IMPACT, PERMAFROST DISTRIBUTION, GROUND ICE.
The extreme sensitivity of permafrost terrane to disturbance is particularly evident in the ice-rich permafrost regions of Alaska. Problems arise because of the fragile equilibrium between the surface cover and the underlying wet soils and permafrost. Both natural and man-made disturbances affect this balance. The susceptibility of permafrost terrane to degradation is primarily related to the insulation qualities of the surface layer, and the ice content of the frozen soil beneath it. In the north where the surface organic layer is the thinnest and the ice content of the soil is highest, sensitivity to disturbance is the greatest. In the southern permafrost zones, the organic mat is thicker, underground ice is discontinuous and often without surface expression, so the likelihood of degradation effects is more difficult to predict. Examples of long and short-term effects are cited. These include study plots where ground temperatures under various surface treatments have been measured over a period of years, as well as the present condition of disturbances which occurred many years ago. Finally, some engineering practices which permit human activity with minimum permafrost degradation are summarized, with the observation that man can live in harmony with permafrost terrane if appropriate knowledge and respect for the existing environmental equilibrium is applied.

**MP 168**
**STRESS EVALUATION IN LOW-MODULUS AND VISCOELASTIC MATERIALS USING PHOTOELASTIC GLASS INCLUSIONS.**
Hawkes, I., *Experimental mechanics,* Feb. 1969 , 9(2), p.58-66 (p.1-9), 11 refs.
24-2479
STRESS ANALYSIS, MEASURING INSTRUMENTS, COMPRESSIVE STRENGTH, FROZEN SAND, CREEP RATE.
This paper describes a technique by which the magnitude of the greatest principal stress in a biaxial-stress field can be determined from the isochromatic fringe pattern in a hollow-cylindrical-glass stressmeter. The influence of the moduli and Poisson's ratio of the meter and host material on the sensitivity of the meter are discussed in detail. It is shown that, for a wide range of rock and concrete-like materials, a glass stressmeter will enable the stresses to be determined directly from the meter readings. Experiments to investigate the behavior of photoelastic stressmeters in host materials which are creeping under stress are described. There is close agreement between the theoretical and experimental values for the meter sensitivity when it is assumed that the Poisson's ratio of the host materials falls to 0.5 during creep. When set in such materials the final sensitivity of the meter is also independent of the modulus of the meter provided that creep is continuous. Experiments are described which show that, in a material which is creeping, the stress can be determined by inserting a stressmeter and measuring the final steady reading.

**MP 169**
**THEORY OF THE PHOTOELASTIC BIAXIAL STRAIN GAUGE.**
Hawkes, I., *International journal of rock mechanics and mining sciences,* 1968 , Vol.5, p.57-63, 2 refs.
24-2877
STRAIN GAGES, PHOTOELASTICITY, BIREFRINGENCE.
An annular disk of photoelastic material, with a reflective backing, when bonded around its periphery to the surface of a body subsequently subjected to strain, forms a biaxial strain gauge when observed by a reflection polariscope. The birefringence demonstrated by the disk identifies major and minor principal strains both in magnitude and direction. Mathematical solutions for the calibration characteristics of such a gauge are described, for biaxial strains in tension. Close agreement exists between the theoretical sensitivity and that determined by experiment, previously reported.

**MP 170**
**UNIAXIAL TESTING IN ROCK MECHANICS LABORATORIES.**
Hawkes, I., et al, *Engineering geology,* July 1970, 4(3), p.177-285, 131 refs.
Mellor, M.
25-2235
ROCK MECHANICS, MECHANICAL TESTS, TEST EQUIPMENT, COMPRESSIVE PROPERTIES, TENSILE PROPERTIES.
Laboratory testing of rock specimens in uniaxial tension and compression is reviewed in detail, with the aim of selecting equipment, procedures and tolerances as a basis for test standardization. Major topics of the review include composition and preparation of test materials, theoretical background of deformation and fracture in rocks, detailed mechanics of uniaxial laboratory tests and practical test procedures.

**MP 171**
**THEORY OF THE DETERMINATION OF THE GREATEST PRINCIPAL STRESS IN A BIAXIAL STRESS FIELD USING PHOTOELASTIC HOLLOW CYLINDER INCLUSIONS.**
Hawkes, I., et al, *International rock mechanics and mining sciences,* 1969, Vol.6, p.143-158, 8 refs.
Fellers, G.E.
25-4123
MEASUREMENT, STRESS ANALYSIS, STRAIN GAGES.
This paper compares the theoretical distribution of stress in a photoelastic biaxial gage with the results of experiment on photoelastic inclusions. The sensitivity factor of such inclusions, when they are applied as a means of stress determination in biaxial stress fields, varies, within known limits, which the major/minor principal stress ratio. When the device is to applied as a practical tool in field investigations it is an advantage to use standard sensitivity factors' which can apply to all biaxial stress fields within an acceptable limit of error.

**MP 172**
**IMPROVING VISIBILITY NEAR AIRPORTS DURING PERIODS OF FOG.**
Hicks, J.R., *Journal of applied meteorology,* Feb. 1967 , 6(1), p.39-42, 5 refs.
25-2164
FOG DISPERSAL, ARTIFICIAL PRECIPITATION, NUCLEATING AGENTS, PROPANE.
Liquefied propane, released from ground-based dispensers, was used to seed twelve fogs during the period 6 October 1964 to 24 July 1965. Six of these tests were conducted at Camp Century, Greenland. Five were successful, i.e., glaciation of the supercooled droplets and subsequent precipitation occurred. The sixth test was made on an ice fog which was not amenable to this type of modification. The remaining six tests were made in the Hanover-Lebanon, N.H. area. Five of these tests were successful. The sixth experiment, conducted under a low stratus cloud, yielded no reaction. It is concluded that propane is safe and economical to use as a fog dispersing agent when used as described.

**MP 173**
**MOVEMENT OF SMALL ANGLE BOUNDARY OF ICE CRYSTAL.**
Higashi, A., et al, *Hokkaido Daigaku, Sapporo, Japan. Rigakubu. Journal of Faculty of Science, Hokkaido University. Series II Physics,* Dec. 1961, 5(5), p.221-237, 12 refs.
Sakai, N.
25-2227
ICE CRYSTALS, PLASTICITY TESTS, DEFORMATION, ICE CREEP, ICE MECHANICS.
The stress induced movement of small angle boundaries in ice crystals was investigated with specimens of natural single crystals. Boundaries made by bending bars of ice were observed under microscope through crossed polaroids. Dependence of the rate of movement upon temperature, applied stress and angle of misfit was obtained. The activation energy for the rate of movement takes a value of about 12 kcal/mol to 17 kcal/mol with changing angles between the direction of length and that of the crystal a-axis. This variation was semi-quantitatively interpreted by a simple dislocation model of the boundary in the ice crystal.

**MP 174**
**STUDIES OF PARTICLES FOR EXTRATERRESTRIAL ORIGIN. 3. ANALYSES OF DUST PARTICLES FROM POLAR ICE DEPOSITS.**
Hodge, P.W., et al, *Journal of geophysical research,* July 15, 1964, 69(14), p.2919-2931, 27 refs. Microform No. SIP 22176.
Wright, F.W., Langway, C.C., Jr.
25-2053
GLACIER ICE, DUST, CHEMICAL ANALYSIS, COSMIC DUST, IMPURITIES, CHEMICAL COMPOSITION, ACCUMULATION.
A total of 166 dust particles collected principally from Greenland and antarctic ice has been subjected to chemical analysis by the electron-beam microanalyzer technique. Several have Ni/Fe ratios indicative of a meteoritic origin. The remainder are also probably primarily cosmic in origin. The rate of deposit of opaque spherules is found to be nearly, but not exactly, the same at all geographical locations sampled.

**MP 175**
**STUDIES OF PARTICLES FOR EXTRATERRESTRIAL ORIGIN. 5. COMPOSITIONS OF THE INTERIORS OF SPHERULES FROM ARCTIC AND ANTARCTIC ICE DEPOSITS.**
Hodge, P.W., et al, *Journal of geophysical research,* Feb. 15, 1967 , 72(4), p.1404-1406, 5 refs. Microform No. SIP 25287.
Wright, F.W., Langway, C.C., Jr.
25-2166
GLACIER ICE, PARTICLES, CHEMICAL COMPOSITION, COSMIC DUST, CHEMICAL ANALYSIS.
The present paper reports results of chemical analysis of the sectioned and polished interiors of some particles. Among the particles are 7 from the South Pole and one designated only as Antarctic. Contrary to expectations, there are few significant differences in composition between the surface and the interior of a spherule, and the particles are rather homogeneous. The origin of the spherules cannot be determined from the data available.

**MP 176**
**MOISTURE MOVEMENT IN SOILS UNDER TEMPERATURE GRADIENTS WITH THE COLD-SIDE TEMPERATURE BELOW FREEZING.**
Hoekstra, P., *Water resources research,* 1966 , 2(2), p.241-250, 22 refs.
23-3645
FROST, SOIL MOISTURE MIGRATION, MOISTURE FACTORS, EXPERIMENTATION, METHODOLOGY.
Moisture movement to a freezing front in an unsaturated porous medium of Fairbanks silt was measured by gamma-ray attenuation. It was shown that the presence of an ice phase greatly enhances the amount of moisture transfer under temperature gradients. The chemical potential of soil water in the frozen soil as a function of temperature is calculated. The chemical potential of unfrozen absorbed water in frozen soils, if in equilibrium with ice, is independent of total water content (unfrozen water plus ice). Consequently, no equilibrium moisture content distribution is reached, and water content in the frozen soil changes continuously. Moisture flow in the frozen soil takes place under temperature gradients through the films of unfrozen water. Since the thickness of the unfrozen films decreases with temperature, the rate of water transport also decreases rapidly with decreasing temperatures below 0C.

**MP 177**
**MOISTURE MOVEMENT TO A FREEZING FRONT.**
Hoekstra, P., *International Union of Geodesy and Geophysics. Assemblée générale. Comptes rendus,* Oct. 1967 , 14th, p.411-417, In English, with French summary. 5 refs.
23-4890
SOIL MOISTURE MIGRATION, FROZEN GROUND, INTERFACES, TEMPERATURE GRADIENTS.
Moisture movement in an unsaturated clay, silt and sand caused by freezing is studied in a laboratory soil column by the attenuation of gamma-radiation. The cumulative water transport from the unfrozen part of the column into the frozen part is directly proportional to the root of time. The boundary between frozen and unfrozen soil can apparently be treated as a constant soil water tension boundary. By setting the warm plate at 0.1C and the cold plate at -10C a very small temperature gradient exists in the unfrozen part of the column. Nevertheless, moisture migration from the unfrozen into the frozen part of the soil occurs. The moisture movement in the unfrozen part of the column takes place under the influence of a water content gradient. Moisture is redistributed in the frozen part of the soil by movement of water through the liquid-like transitional layer on the particle surfaces. The amount of moisture migration during freezing is of such magnitude that it is of importance in engineering and agriculture.

**MP 178**
**WATER MOVEMENT AND FREEZING PRESSURES.**
Hoekstra, P., *Soil Science of America. Proceedings,* July/Aug. 1969 , 33(4), p.512-518, 14 refs.
24-709
FROST ACTION, ICE LENSES, SOIL MOISTURE MIGRATION, SOIL STRUCTURE, PRESSURE FACTORS.
Pressures develop when cylindrical columns of saturated soils are frozen unidirectionally under conditons of constant volume with an open water supply at the warm side. The value and behavior of these pressures depend on soil type. If water migration can take place in the frozen soil and ice lenses grow behind the freezing front the value of the pressure depends on the temperature at the ice lens. This process occurs in clayey soils, and the pressure is theoretically limited by the phase transition ice I - water. Values of 100 atm have been measured experimentally. In soils where water migration in the frozen soil does not occur and ice lenses form at the freezing front,

**MP 179**
**THE PHYSICS AND CHEMISTRY OF FROZEN SOILS.**
Hoekstra, P., *National Research Council. Highway Research Board. Special report,* 1969 , No.103, p.78-90, 26 refs.
24-2326
FROZEN GROUND CHEMISTRY, FROZEN GROUND PHYSICS, SOIL MOISTURE, SOIL TEMPERATURE, UNFROZEN WATER CONTENT.
The engineering properties of frozen soils-strength, thermal conductivity, dielectric constant, and electrical conductivityare affected by the phase composition of water in soil i.e., the ratio of unfrozen water to ice. The main factors determining the amount of unfrozen water are temperature, surface area, and salt content; minor factors are mineralogical composition, structure, and pressure. The amount of unfrozen water in frozen soils as a function of temperature and pressure can be calculated, using a thermodynamic treatment, for clays from swelling pressure date, and for granular soils from moisture characteristic curves at room temperature. The calculated data show good agreement with experimental data. The unfrozen film

conducts water and ions under the influence of temperature gradients, electrical gradients, and external pressure differences. The rate of migration depends on the surface area and the thickness of the film of unfrozen water. Since the thickness of the film decreases with decreasing temperature, the rate of migration of water through frozen soils rapidly increases as the freezing point is approached.

**MP 180**

**THERMO-ELECTRIC COOLING FOR FROST EFFECT TESTS.**

Hoekstra, P., *Soil Science Society of America. Proceedings,* Sept.-Oct. 1964, 28(5), p.716, Microform No. SIP 25301.

25-2051

ARTIFICIAL FREEZING, SOIL FREEZING, TEST EQUIPMENT, SOIL TESTS.

In work reported previously, freezing tests of soil were conducted in freezing cabinets. The top of a soil sample was cooled by the air temperature in the cabinet. This apparatus can be considerably simplified by use of thermoelectric cooling, in which a d.c. current is passed through the junction of 2 dissimilar semiconductors. The thermo-electric element can remove up to 40 watts of heat. In a laboratory soil column of 6 in. diam., this would correspond to a frost penetration of about 8 cm/hr. The apparatus was found to be very convenient.

**MP 181**

**CONDUCTANCE OF FROZEN BENTONITE SUSPENSIONS.**

Hoekstra, P., *Soil Science Society of America. Proceedings,* Sept.-Oct. 1965, 29(5), p.519-522, 12 refs. Microform No. SIP 24689.

25-2081

FROZEN GROUND PHYSICS, ELECTRICAL RESISTIVITY, BENTONITE.

The conductance of frozen Wyoming bentonite suspensions was measured. The magnitude of the observed conductance was consistent with an expression derived from the assumption that the films of unfrozen water on the clay particle surfaces are continuous through the frozen soil matrix. For the range of water contents used, the conductance per gram of clay was found independent of water content in the frozen suspensions. There was a large difference in conductance between frozen and unfrozen soil; this difference was larger for Na than for Ca-bentonite.

**MP 182**

**ON THE MOBILITY OF WATER MOLECULES IN THE TRANSITION LAYER BETWEEN ICE AND SOLID SURFACE.**

Hoekstra, P. , et al, *Journal of colloid science,* Oct. 1967 , 25(2), p.166-173, 13 refs.

Miller, R.D.

23-1842

ICE SOLID INTERFACE, SOIL MOISTURE MIGRATION, ELECTROOSMOSIS, FROZEN GROUND.

Experiments which demonstrate the existence of a mobile transition layer between ice and a solid surface are discussed. Water is shown to migrate in the transition layer under the influence of both electrical and temperature gradients. Particles embedded in ice are found to migrate to the warm side under the influence of a temperature gradient, and the same particles are under certain circumstances driven in front of an ice-water interface. The mobility of the transition layers could also be evaluated from water movement in frozen soils under temperature gradients, as well as from electroosmosis.

**MP 183**

**ELECTRO-OSMOSIS IN FROZEN SOILS.**

Hoekstra, P., et al, *Nature,* Sept. 26, 1964, 203(4952), p.1406-1407, 2 refs. Microform No. SIP 22507.

Chamberlain, E.

25-2052

ELECTROOSMOSIS, FROZEN GROUND PHYSICS, SOIL MOISTURE MIGRATION, PERMEABILITY.

The extent was measured to which water can be moved through the films of unfrozen water in a frozen soil. A rectangular slab of soil was frozen between two brass plates in a refrigerated room at -30C. The frozen slabs of soil were cut to size and placed in "Lucite" cells (1 cm x 5 cm). Electrodes were frozen to the sides of the sample. A thermistor was used to record the temperature, while an electrical potential gradient of 1 V/cm was applied accross the frozen soil. Water was transported toward the cathode. The initial and final water contents (unfrozen water and ice) of two soils after electro-osmosis are tabulated. The results indicate that considerable amount of water can be transported in frozen soil under an electric gradient.

**MP 184**

**MIGRATION OF LIQUID INCLUSIONS IN SINGLE ICE CRYSTALS.**

Hoekstra, P., et al, *Journal of geophysical research,* Oct. 15, 1965, 70(20), p.5035-5041, 18 refs. Microform No. SIP 23707.

Osterkamp, T.E., Weeks, W.F.

25-2082

ICE CRYSTALS, BRINES, MIGRATION, SEA ICE.

The migration of brine pockets of KCl and NaCl under the influence of a temperature gradient was investigated in single ice crystals. The observed migration velocities are compared with velocities calculated from a single diffusion model using the data on electrolytic solutions available in the literature. Although the relative movements of KCl and NaCl pockets were consistent with the diffusion theory, the observed velocities were always less than the calculated. It was also shown that the migration of solid KCl particles occurs at temperatures below the eutectic point. Two mechanisms are proposed that would impede the mechanical differentiation of salts that crystallize at high temperatures relative to salts that remain in the brine of sea ice. These mechanisms explain recent field observations that the SO4/Cl ratio of sea ice does not increase with the age of the ice.

**MP 185**

**PRESSURE EFFECTS ON CONDUCTANCE OF FROZEN MONTMORILLONITE SUSPENSIONS.**

Hoekstra, P., et al, Clay Minerals Society. Clays and clay minerals; proceedings of the conference, 15th, Oct. 10-13, 1966, Pittsburgh, Penna., Oxford,, p.215-225, 15 refs.

Keune, R.

25-2'65

CLAY SOILS, PRESSURE FACTORS, FROZEN GROUND MECHANICS, ELECTRICAL RESISTIVITY, UNFROZEN WATER CONTENT.

The influence of pressure on the conductance of frozen montmorillonite suspensions was measured in the temperature range from 0C to -12C on Na- and Ca-saturated samples. Pressures invariably increase the conductance of frozen suspensions. The change in conductance with pressure is postulated to be due to pressure melting of the ice in the frozen suspension. From swelling pressure data the increase in unfrozen water with pressure at constant temperature is calculated and shown to be consistent with the effect of pressure on conductance.

**MP 186**

**MICROWAVE DIELECTRIC MEASUREMENTS ON ANOMALOUS WATER.**

Hoekstra, P., et al, *Nature: physical science,* Jan. 18, 1971, 229(3), p.92-94, 16 refs.

Swinzow, G.K., Ackley, S.F., Doyle, W.T.

26-31

DIELECTRIC PROPERTIES, ANOMALOUS WATER, ICE DIELECTRICS.

**MP 187**

**DIELECTRIC PROPERTIES OF SEA AND SODIUM CHLORIDE ICE AT UHF AND MICROWAVE FREQUENCIES.**

Hoekstra, P., et al, *Journal of geophysical research,* July 10, 1971, 76(20), p.4922-4931, 20 refs.

Cappillino, P.

26-2334

SEA ICE, DIELECTRIC PROPERTIES, ICE DIELECTRICS, RADIO WAVES, SALT ICE, ATTENUATION, SALINITY, ANALYSIS (MATHEMATICS).

Sea ice differs from fresh water ice in physical behavior because of the entrapment of liquid inclusions of brine in the ice matrix. This difference is strongly evident in the dielectric properties of the two ice forms. The liquid inclusions in sea ice cause sea ice to be a lossy dielectric at microwave frequencies. The dielectric loss of sea ice at microwave frequencies is caused by two mechanisms, ionic conductivities and dipole rotations of the water molecules. The complex dielectric constant of sea ice was determined in various frequency ranges by measuring the changes in phase and amplitude when samples were placed in coaxial lines and waveguides. The measured values of the dielectric loss agree well with computations made using low-frequency conductivity, brine volume, and salinity as known parameters.

**MP 188**

**DIELECTRIC RELAXATION OF SURFACE ADSORBED WATER.**

Hoekstra, P., et al, *Journal of colloid and interface science,* Aug. 1971, 36(4), p.513-521, 27 refs.

Doyle, W.T.

26-3094

DIELECTRIC PROPERTIES, ADSORBED WATER, ICE FORMATION, ICE WATER INTERFACE, PLATES.

The dielectric behavior of water adsorbed on Na-montmorillonite and gamma-alumina oxide is determined. The dielectric data are correlated with results from previous experiments showing the changes that take place in the sample upon freezing. At temperatures below -10 degrees C all water in excess of two layers between the clay plates has formed ice. Nevertheless, when dielectric data at these temperatures are compared with measurements on similar samples at radiofrequencies, it becomes evident that a dispersion in two layer thick films of adsorbed water takes place at a frequency of about 10 sup 9 Hz. The variation of the log of the dielectric loss versus the reciprocal of the absolute temperature is linear, and enables one to make the calculation of the Arrhenius activation energy. At radiofrequencies the activation energy in the temperature region from -15 degrees C to -80 degrees C is approximately 12 kcal/mole; at microwave frequencies and in the temperature range from -15 degrees C to -52 degrees C the activation energy is 6 kcal/mole. Various models to explain the results are discussed.

**MP 189**

**RESONANT DRIVING IN PERMAFROST.**

Huck, R.W., et al, *Foundation facts,* 1971, 7(1), p.11-15.

Hull, J.R.

26-2911

PERMAFROST SAMPLERS, CORE SAMPLERS, ICE CORING DRILLS, EQUIPMENT, PERMAFROST PRESERVATION.

Article describes problems of obtaining core samples in permafrost areas and presents results of coring with the Bodine Resonant Driver in Alaska.

**MP 190**

**SOME SURFACE PHENOMENA OF ICE.**

Itagaki, K., *Journal of colloid science,* Oct. 1967 , 25(2), p.218-227, 12 refs.

23-1846

ICE SURFACE FEATURES, ICE VAPOR INTERFACE, INTERFACES, VAPOR DIFFUSION.

Two new phenomena are described which would indicate directly two mechanisms of mass transfer along an ice surface. One is the neck formation observed between an ice sphere and a plane placed close to but not in contact with it in an ice-saturated atmosphere. This indicated that mass transfer through the atmosphere is the major mechanism of sintering. Growth from both the ice sphere and plane was observed. The growth rate is of the same order as the calculation based on the theory of Hobbs and Mason. The other phenomenon is particle migration, without rolling, on a subliming ice surface. Glass beads, shards, clusters, or other particles scattered on a subliming ice surface migrate randomly. This seems to indicate the existence of mass flow in a relatively thick layer. Some possible mechanisms are discussed.

**MP 191**

**PARTICLE MIGRATION ON ICE SURFACES.**

Itagaki, K., International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 1, Sapporo, , p.233-246, 19 refs.

23-1944

IMPURITIES, ICE SURFACE, PARTICLE MIGRATION.

A novel phenomenon is described which could indicate a new mechanism of mass flow along an ice surface. Glass beads evenly and randomly scattered on an ice surface migrate and tend to form pronounced clusters when the ice surface is exposed to an unsaturated atmosphere. Time lapse motion pictures reveal two types of migration of glass beads, smooth continuous and inter- mittent. Both types of migration tend to form beads clusters. No movement is observed when the atmosphere is saturated with respect to ice. Conventional mechanisms of surface mass flow such as evaporation-condensation and surface diffusion do not appear to explain the migration. Volume diffusion in ice seems to be slow a process, and liquid film flow is a rather improbable mechanism. Enhanced diffusivity of the surface layer is one possible mechanism.

**MP 192**

**SELF-DIFFUSION IN SINGLE CRYSTAL ICE.**

Itagaki, K., *Physical Society of Japan. Journal,* Feb. 1969 , 22(2), p.427-431, 17 refs.

24-1126

ICE CRYSTALS, DIFFUSIVITY, IMPURITIES.

Measurement of self-diffusion in ice perpendicular (00,1) and perpendicular (10,0) were made by a tracer sectioning method using single crystals from Mandenhall Glacier, Alaska, U.S.A.. The activation energies of diffusion are 0.54eV and 0.65eV respectively. Among the several possible mechanisms the "free interstitial molecule mechanism" is the only mechanism which would give higher actvation energy of diffusion along perpendicular (10,0) than perpendicular (00,1).

**MP 193**

**SELF-DIFFUSION IN SINGLE CRYSTALS OF ICE.**

Itagaki, K., *Physical Society of Japan. Journal,* June 1964, 19(6), p.1081, 3 refs. Microform No. SIP 23746. For an enlarged version of this paper and abstract see 24-3325.

25-2202

ICE CRYSTALS, DIFFUSIVITY.

**MP 194**

**X-RAY TOPOGRAPHIC STUDY OF VIBRATING DISLOCATIONS IN ICE UNDER AN AC ELECTRIC FIELD.**

Itagaki, K., Advances in X-ray analysis, vol.13. Conference on Application of X-ray Analysis, Aug. 6-8, 1969. Proceedings, New York,, p.526-538, 19 refs.

25-2234

ICE CRYSTALS, DISLOCATIONS (MATERIALS), X RAY TOPOGRAPHY, FIELD STRENGTH, PLASTIC DEFORMATION.

X-ray topography is the most promising method for making direct observations of vibrating dislocations in ice. An estimate of the charge concentration can be made if the amplitude of vibrating charged dislocations is measured under a known electric field. The present study is aimed at establishing the charge concentration on the dislocation line by X-ray topography.

**MP 195**
**LIQUID-LIKE (TRANSITION) LAYER ON ICE.**
Jellinek, H.H.G., *Journal of colloid science,* Oct. 1967 , 25(2), p.192-205, 32 refs.
23-1844
ICE WATER INTERFACE, REGELATION.

**MP 196**
**ICE ADHESION AND ABHESION: A SURVEY.**
Jellinek, H.H.G., *National Research Council. Highway Research Board. Special report,* April 1970, No.115, Snow removal and ice control research. Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970, p.46-77, Includes discussion. 89 refs.
25-1787
ICE ADHESION, ICE AIR INTERFACE, ICE SOLID INTERFACE, CHEMICAL PROPERTIES, MECHANICAL PROPERTIES, RHEOLOGY.

**MP 197**
**LIQUID LAYERS ON ICE.**
Jellinek, H.H.G., *Journal of applied physics,* Sept. 1961, 32(9), p.1793, 11 refs. Microform No. SIP 19651.
25-2004
ICE ADHESION, WATER FILMS, TENSILE STRENGTH.
Theories on regelation are reviewed and analysed in the light of the results of laboratory experiments. The liquidlike layer postulated by Faraday (See SIP 12232) to exist between ice and any adjacent medium has been rejected by Kingery (See SIP 18430) who prefers to explain growth between two ice spheres by assuming a high surface mobility of molecules. The results of the currently reported tensile and shear experiments are understandable only when a liquidlike layer is assumed, however. These layers probably show a continual transition from a crystal-like solid to a fairly viscous liquid and are apparently dependent on the nature of the interface. Variations in the thickness of these layers were estimated from 1/100,000 to 1/1,000,000 cm., and in their viscosity from 70-700 poises on an ice-stainless steel interface and 15-140 poises on an ice-quartz interface. Kingery's experiments are thus felt to support the liquidlike theory inasmuch as the difference between the two viewpoints is only one of the degree of thickness of the mobile layer.

**MP 198**
**ICE ADHESION.**
Jellinek, H.H.G., *Canadian journal of physics,* Oct. 1962, 40(10), p.1294-1309, 27 refs. Microform No. SIP 20744.
25-2016
ICE ADHESION, MECHANICAL TESTS, ICE SOLID INTERFACE, SHEAR RATE, ADHESIVE STRENGTH, INTERFACIAL TENSION.
Results of shear tests for the system ice-stainless steel and ice-optically flat fused quartz as a function of the rate of shear and roughness of the steel surfaces are presented. The adhesive strength decreased with decreasing roughness of the steel surfaces, and the force vs. time curves for smooth steel plates resembled those of two solids sliding over each other with a liquid layer between them. This behavior was especially evident in the case of the optically flat quartz. The adhesive strength as a function of rate of shear was linear for both ice-stainless steel and ice-quartz, but these were indications of yield values. The results agree with the assumption of a liquid-like layer on ice. Ratios of viscosity coefficient to layer thickness were evaluated for both systems, and viscosity coefficients estimated. Shear experiments on thin water films between glass plates support the assumption of a liquid-like layer on ice. The importance of interfacial free energy considerations is pointed out.

**MP 199**
**SINTERING OF POWDERED ICE.**
Jellinek, H.H.G. , et al, *Journal of colloid science,* Oct. 1967 , 25(2), p.245-254, 13 refs.
Ibrahim, S.H.
23-1849
ICE SINTERING, PLASTIC FLOW.

**MP 200**
**FREEZING OF AQUEOUS POLYVINYLPYRROLIDONE SOLUTIONS.**
Jellinek, H.H.G. , et al, *Kolloid-Zeitschrift und Zeitschrift fuer Polymere,* 1967 , 220(2), p.122-133, AD-662 470, In English, with German summary. 18 refs.
Fok, S.Y.
23-5165
THERMAL ANALYSIS, ADSORPTION, FREEZING, POLYMER SOLUTIONS, VAPOR PRESSURE.

**MP 201**
**INFLUENCE OF FROST ACTION ON THE BEARING CAPACITY OF SOILS.**
Jessberger, H.L., et al, *Highway research record,* 1970, No.304, p.14-26, 17 refs.
Carbee, D.
26-438
FROST ACTION, SOIL TESTS, BEARING CAPACITY, SUBGRADES, FREEZE THAW CYCLES, FREEZING.
Seventeen different soils were tested by subjecting the remolded samples to several freeze-thaw cycles followed by the CBR test. The proposed test procedure is applicable to the most important soil types-dirty sands and gravels. If necessary, the method can also be used for clean sands and gravels as well as for silts, but not for clays. The influence of the duration of the freezing and thawing time as well as the number of cycles is lower than expected, except for clays. The influence of different temperatures is still to be investigated. It is possible to use the proposed test procedure for modifying the Casagrande criterion to take account of grain size above 0.02 mm as well as to verify or complete existing road design methods for frost action.

**MP 202**
**CLIMATIC OSCILLATIONS 1200-2000 AD.**
Johnsen, S.J., et al, *Nature,* Aug. 1, 1970, 227(5257), p.482-483, 14 refs.
Dansgaard, W., Clausen, H.B., Langway, C.C., Jr.
25-589
PALEOCLIMATOLOGY, ISOTOPIC LABELING, GLACIER ICE, CLIMATIC CHANGES.

**MP 203**
**MONITORING RADIOACTIVE CONTAMINATION TO VEGETATION.**
Johnson, P.L., *Photogrammetric engineering,* Nov. 1965, 31(6), p.984-990, 5 refs.
25-2083
PLANTS (BOTANY), AERIAL PHOTOGRAPHS, RADIATION EFFECTS.
Gamma radiation is an important consequence of our nuclear technology. Aerial photography was obtained of an experiment conducted to assess plant responses to various dosages of gamma radiation on Long Island. Panchromatic, infrared, color and false color films were studied and subjected to microdensitometry to provide quantitative expressions of the photographic image as a function of the gamma gradient, film type, leaf development, and species. Aerial monitoring of radiation damage to vegetation has the possibility of detecting this kind of disturbance.

**MP 204**
**CONSIDERATION OF METHODOLOGY IN PHOTO INTERPRETATION.**
Johnson, P.L., Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.719-725, 2 refs.
25-2123
REMOTE SENSING, PHOTOINTERPRETATION, ECOLOGY, METHODOLOGY.
Instruction in remote sensing and photo interpretation for biological purposes is just developing beyond the forestry curriculum. The need is immediate and crucial to develop this new technology for application to broad ecological problems involving food supply, waste disposal and pollution, resources inventory and management, and environmental manipulation. Methods of teaching interpretation and deriving inferences are discussed in terms of mechanical techniques, reasoning processes and technical examples. An entropy model for information extraction is offered. It is concluded that a theoretical foundation is needed as well as specific solutions to biological problems if remote sensing technology is to enter the arsenal of the ecologist.

**MP 205**
**REMOTE SENSING AS AN ECOLOGICAL TOOL.**
Johnson, P.L., Ecology of the subarctic regions, Vol.1 of Ecology and conservation, Paris, Unesco, 1970, p.169-187, In English with French summary. Includes discussion. 14 refs.
25-2650
REMOTE SENSING, ECOLOGY, FOREST STRIPS, AERIAL PHOTOGRAPHY, VEGETATION PATTERNS, PHOTOINTERPRETATION, SENSOR MAPPING, SUBARCTIC VEGETATION.
In interior Alaksa an extreme continental climate prevails in the latitudinal tension zone of tree growth. The present vegetation mosaic is a mixture of forest, shrub and herbaceous stands in various stages of plant succession. Their stability appears proportional to: (a) the stability of the permafrost and the resulting drainage condition; (b) the elapsed time since the last fire or flood disturbance and the intensity of the burn or duration of the flood; (c) the age of the organic or mineral substrate which is usually a function of topographic position. Examples of Alaskan subarctic vegetation were selected from a recent study of structure and standing crop in the Yukon Flats region to reveal the utility of aerial photography, radar and thermal imagery. The potential of synoptic ecological information from Earth-orbiting platforms is suggested as a realistic means of extrapolating local studies to management size units in resource planning.

**MP 206**
**ALPINE VEGETATION OF THE BEARTOOTH PLATEAU IN RELATION TO CRYOPEDOGENIC PROCESSES AND PATTERNS.**
Johnson, P.L., et al, *Ecological monographs,* Spring 1962, No.32, p.105-135, 57 refs. Microform No. SIP 22309.
Billings, W.D.
25-2224
ALPINE VEGETATION, PATTERNED GROUND, SNOW COVER EFFECT, ALPINE SOILS, CLIMATIC FACTORS, VEGETATION PATTERNS, SOLIFLUCTION.
The major alpine plant communities and environment on the Beartooth Plateau of Wyoming and Montana are described, and the patterned ground features are discussed in relation to soil frost action and vegetation. The relationships are evaluated between snow cover, and cryopedogenic processes. Four main vegetation types (Geum turf, Deschampsia meadow, Carex scopulorum bog, and Salix thicket) were found which intergrade with each other along environmental gradients. The dynamic nature of soil frost action is indicated by the abundance of cryopedogenic features which appear to have continued activity. Frost boils remain bare of vegetation, gray silt is exposed in polygon centers which are bordered by lichen-free rocks, and sod chunks fall away from the faces of solifluction terraces. During the summer, needle ice formation occurs below 30 C whereby rock particles are lifted as much as 2 in. off the slope.

**MP 207**
**NEW EXPERIMENTS TO SIMPLIFY FROST SUSCEPTIBILITY TESTING OF SOILS.**
Kaplar, C.W., *Highway research record,* 1968 , No. 215, p.48-59, 16 refs.
23-4064
EXPERIMENTAL DATA, FROST HEAVE, TEST EQUIPMENT, SOIL TESTS, FROST RESISTANCE, TESTS, FROZEN GROUND.
Experiments conducted in recent years indicate that frost susceptibility testing of soils can be shortened considerably from the 2 weeks or so previously required. Results of experiments show that useful frost-heaving data can be obtained in a matter of 2 or 3 days by a more rapid freezing technique. Results of experiments whereby soil specimens are exposed to a constantly maintained temperature are presented. Data show that heave rate in laboratory experiments is a variable and not a constant of a soil and is strongly dependent upon the heat extraction rate. The important role of frost susceptibility testing and soil evaluation for highway design is discussed. Comments are provided on suitability of equipment for use in conducting frost-heaving tests.

**MP 208**
**LABORATORY EVALUATION OF FROST HEAVE CHARACTERISTICS OF A SLAG-FLY ASH-LIME BASE COURSE MIXTURE.**
Kaplar, C.W., *National Research Council. Highway Research Board. Bulletin,* 1962, No. 331, p.1-20, 5 refs. Microform No. SIP 20792.
25-2017
CEMENTS, FROST HEAVE, POZZOLANS, TESTS.
Laboratory tests were made on 16 specimens of a slag-fly ash-lime base course mixture classified as frost susceptible to determine the frost behavior characteristics of artificial pozzolanic mixtures. Field-curing conditions were taken into consideration in order to evaluate frost susceptibility which is affected by the degree of cementation achieved at the time of freezing. Since the degree of cementation is usually dependent on the method and duration of curing, different methods of cure treatment were tried and the effect of aging on frost susceptibility was observed on 6-in. diam., 6-in. high specimens. Test results showed that oven-cured specimens heaved insignificantly, and "noncured" specimens heaved about 15 % and were classified as being of low frost susceptibility. Most moist-cured and soaked specimens were classified as negligibly frost-susceptible. The maximum measured heave of any of the cured specimens during any one freezing cycle was approximately 0.2 in. and about 3.3%.

**MP 209**
**SHEAR STRENGTH OF SOIL AFTER FREEZING AND THAWING.**
Kaplar, C.W., *American Society of Civil Engineers. Soil Mechanics and Foundations Division. Journal,* March 1965, 91(SM2), p.91-97, 15 refs. Discussion of a paper by Broms and Yao.
25-2084
SHEAR STRENGTH, FROZEN GROUND MECHANICS, FROST ACTION, SEASONAL FREEZE THAW, SOIL TESTS, SOIL WATER.

**MP 210**
**STONE MIGRATION BY FREEZING OF SOIL.**
Kaplar, C.W., *Science,* Sept. 24, 1965, 149(3691), p.1520-1521, 1 ref. Microform No. SIP 23513.
25-2085
FROST HEAVE, SOIL FREEZING, SOIL MECHANICS.
Observations were made in 1958 using time-lapse color photography which demonstrate the upward movement of a stone and simulated piles within a silt soil by frost action, when freezing is from the top down in an open-system test. The film showed

that the soil directly over a stone was lifted above the stone, leaving a void. A stone rises only when the adfreeze force around it is greater than the forces holding it in place. The total movement of the stone from its initial position depends upon the heaving rate of the soil and the time required for freezing to penetrate down to a level below the cavity formed under the stone. In saturated nonfrost-susceptible soils in a closed system, uplift by the expansion of water upon freezing is possible.

**MP 211**
**LABORATORY DETERMINATION OF THE DYNAMIC MODULI OF FROZEN SOILS AND ICE.**
Kaplar, C.W., *National Research Council. Publication,* 1966, 1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.293-301, 22 refs. Microform No. SIP 24864.
25-2124
FROZEN GROUND MECHANICS, ELASTIC PROPERTIES, DYNAMIC PROPERTIES, ICE MECHANICS, TEST EQUIPMENT, WAVE PROPAGATION.
Vibratory nondestructive techniques can be applied successfully in the laboratory to the study of dynamic elastic properties of frozen soils and ice. The dynamic moduli and wave transmission velocities of frozen soils increased with a decrease in temperature. Below 20 F, the dynamic properties of fine-grained soils were more temperature dependent than those of coarse-grained soils. Elastic moduli for coarser-grained soils were more than 4 times those for fine-grained soils and ice. The dynamic elastic properties of ice, including wave velocities, were consistent with findings of other investigators.

**MP 212**
**PHENOMENON AND MECHANISM OF FROST HEAVING.**
Kaplar, C.W., *Highway research record,* 1970, No.304, p.1-13, 22 refs.
25-4124
FREEZING, SOIL MOISTURE, FROST HEAVE, FROST PENETRATION.
This paper presents a mechanistic explanation of frost action in soils, based on the hypothesis that liquid films existing between particles and an ice lens are the focal centers of energy for having (work) process. Heave rate and work of heaving and their dependence on free energy generation during freezing are discussed in general terms. Typical experimental data are presented illustrating the reduction in heave rate with increased external (and internal) resistance. The role of soil structure in frost susceptibility is discussed. Changes in frost heaving rates can be effected by addition or removal of either, or both, the coarse aggregate or soil fines. Suggestions are offered for approaches to soil modification to reduce heaving.

**MP 213**
**VISUAL RANGE IN POLAR WHITEOUT.**
Kasten, F., *Polarforschung,* 1960 pub. Nov. 15, 1961, 30(1/2), p.41-44, In German with English summary. 12 refs. Microform No. SIP 19892.
25-2228
WHITEOUT, VISIBILITY.
The optical characteristics of whiteout were studied, and rules are given for determining the visual effects of this phenomenon. During whiteout, incident day-light becomes completely diffused due to the action of clouds, fog, or snow, and formation of shadows is completely suppressed. As a result all objects are equally light on all sides. This greatly complicates orientation, since natural or artificial targets simply disappear because of the absence of shadows. Rules are derived which interpret the relationships between the observer, the object viewed, and the environment. Dark objects can be distinguished very easily. An adverse influence in this regard is the possible milkiness of the air. Light objects disappear almost completely. A prerequisite is a high visual ground albedo, such as exists with snow cover and a densely covered sky. Turbidity due to fog, snow drifting, or precipitation may enhance the effect, but do not themselves cause whiteout.

**MP 214**
**CONTRIBUTION TO THE PROBLEM OF VISIBILITY IN CLOUDS.**
Kasten, F., *Archiv für Meteorologie, Geophysik und Bioklimatologie. Ser. A,* 1962, 13(1), p.117-121, In German with English and French summaries. 6 refs.
25-2229
VISIBILITY, CLOUD DROPLETS, PARTICLE SIZE DISTRIBUTION.
The discrepancy between measured (or estimated) visual range (Vg) and the one calculated from the drop size distribution (Vb), stated by Trappenberg on the basis of the measurements of Rittberger, is discussed. It is assumed that in the measurement of the drop size distribution the small droplets are discriminated. If the distributions are extrapolated to drop diameters of 2 or 1 micron, Vb turns out to be in agreement with Vg.

**MP 215**
**VISUAL RANGE AND ALBEDO, ESPECIALLY IN THE POLAR REGIONS. I. THEORY OF THE HORIZONTAL VISUAL RANGE OF NON SELF-LUMINOUS OBJECTS UNDER AN OVERCAST SKY.**
Kasten, F., *Beiträge zur Physik der Atmosphäre,* 1962, 34(3/4), p.234-258, In German with English and French summaries. 28 refs. Microform No. SIP 20109.
25-2230
VISIBILITY, ALBEDO, CLOUD COVER, WHITEOUT, ANALYSIS (MATHEMATICS), SNOW COVER.
The theory of the horizontal visual range of non self-luminous objects under an overcast sky and its dependence on the diameter and visual albedo of the object, the visual albedo of the ground, and the visual extinction coefficient of the air is treated. An equation is given for the dependence of the contrast threshold on the visual angle. A visual range function is derived from this theory and is defined. The results are applied to polar whiteout, when the sky is completely overcast and the sky radiation completely diffused. The contrast of bright objects disappears, but that of black objects is retained, except for fog whiteout, when the contrast of black objects is reduced.

**MP 216**
**VISUAL RANGE AND ALBEDO, ESPECIALLY IN THE POLAR REGIONS. 2. MEASUREMENTS OF METEOROLOGICAL-OPTICAL QUANTITIES IN CONNECTION WITH THE VISUAL RANGE, ESPECIALLY IN POLAR REGIONS.**
Kasten, F., *Beiträge zur Physik der Atmosphäre,* 1962, 35(1/2), p.18-42, In German with English and French summaries. 12 refs. Microform No. SIP 22227.
25-2231
ALBEDO, WHITEOUT, SNOW SURFACE, VISIBILITY, REFLECTIVITY, SOLAR RADIATION.
Measurements were made of quantities occurring in the theory of visual range, e.g., ground albedo, luminance distribution of sky and snow surface, the visual extinction coefficient of the air, and contrasts of artificial sight markers of different albedos at different distances from the observer. For comparison, measurements were also made of ground albedo and radiance distribution of sky and snow surface in the near infrared (IR) spectral range. The measurements were made at Mainz, at Lake Constance, and in the interior and on the border of the North Greenland Ice Plateau. The Greenland measurements were of special interest with regard to polar whiteout. The IR-albedo of the snow surface seemed to increase when the water content of the air increased. The IR-radiance distribution of sky and snow surface shows a break at the horizon during whiteout: at this time, the can be "seen" in the near-infrared spectral range as opposed to the visible one.

**MP 217**
**SNOW ACCUMULATION ON MOUNT LOGAN, YUKON TERRITORY, CANADA.**
Keeler, C.M., *Water resources research,* June 1969 , 5(3), p.719-723, 10 refs.
24-242
SNOW DENSITY, SNOW ACCUMULATION, TEMPERATURE FACTORS, CANADA—YUKON TERRITORY.
Measurement of snow accumulation for the year from summer 1967 to summer 1968 on Mt. Logan, St. Elias Mountains, Yukon Territory, Canada, indicates that annual precipitation is approximately 0.65 meters/yr/10 for elevations between 3350 and 5400 meters. This is less by factor of 5 than annual precipitation at sea level on the Gulf of Alaska. On a regional basis precipitation decreases inland from the Pacific Ocean at a rate of approximately 2x1/10,000 meters/km. Precipitation decreases on the windward and increases on the leeward sides of the St. Elias Mountains with respect to elevation.

**MP 218**
**GROWTH OF BONDS AND THE INCREASE OF MECHANICAL STRENGTH IN A DRY SEASONAL SNOW-PACK.**
Keeler, C.M., *Journal of glaciology,* Oct. 1969 , 8(54), p.441-450, In English, with French and German summaries. 21 refs.
24-2034
SNOW STRENGTH, SNOW DENSITY, ADHESIVE STRENGTH.
Simultaneous measurements were made of strength and structural properties of a dry seasonal snow-pack. The densities of the snow studied ranged from 126 to 407 kg/cu m. The mechanical strength of this snow as determined by in-situ shear wave test and a centrifugal tensile test increases exponentially with the increase in size of intergranular sands. Bonding increases at a rate substantially greater than predicted by the classical sintering equations. It is suggested that this is due to the wide variety of stresses present in snow with these relatively low densities.

**MP 219**
**RELATIONSHIP BETWEEN THE MECHANICAL AND OTHER PROPERTIES OF A MOUNTAIN SNOW COVER, ALTA, UTAH, 1967.**
Keeler, C.M., Montreal, Canada,, 15[illegible]p., Typescript of dissertation, PhD. Bibliography , 144-154.
24-2766
SNOW STRENGTH, GRAIN SIZE, SNOW DENSITY, SNOW CRYSTALS, HARDNESS TESTS, SHEAR STRENGTH, TENSILE STRENGTH, DIELECTRIC PROPERTIES.

**MP 220**
**SNOW AND ICE.**
Keeler, C.M., *American Geophysical Union. Transactions,* June 1971, 52(6), p.295-301, 217 refs.
26-2335
SNOW, ICE, RESEARCH PROJECTS, BIBLIOGRAPHIES.

**MP 221**
**INVESTIGATIONS INTO THE MECHANICAL PROPERTIES OF ALPINE SNOW-PACKS.**
Keeler, C.M., et al, *Journal of glaciology,* June 1968 , 7(50), p.253-271, 36 refs.
Weeks, W.F.
23-2944
SNOW PHYSICS, SNOW DENSITY, CLASSIFICATIONS, TEMPERATURE, SNOW MORPHOLOGY, SNOW STRENGTH, UNITED STATES—MONTANA.
Data on the physical properties of seasonal alpine snow have been collected from the Beartooth Mountains near Cooke City, Montana (elevation approx. 3 000 m) and the Bridger Range near Bozeman, Montana (elevation approx. 2 200 m). Systematic measurements of snow density, temperature, structure, ram and Canadian hardness, centrifugal tensile strength and shear strength measured with a shear box and several types of shear vanes are included. Test results were grouped according to gross snow types and whether the snow was wet or dry. A plot of ram number versus density for winter snow gave a log-linear similar to that suggested for polar snows. Both shear-vane and centrifugal-tensile results when plotted as a function of porosity are well described by the negative exponential relation suggested by Ballard and Feldt. Depth hoar and wet snow invariably have lower strength values at any given density. There is an excellent one-to-one agreement between values obtained with the shear vane and the shear box. Several field experiments were performed to study the sources of error in making in-situ mechanical tests of snow without utilizing a pit wall.

**MP 222**
**SOME PHYSICAL PROCESSES IN DRY SNOW AS SEEN IN LABORATORY EXPERIMENTS.**
Keeler, C.M. , et al, *Western Snow Conference. Proceedings,* July 1966, 34th annual meeting, Seattle, April 19-21, 1966, p.25-31, 16 refs.
Ramseier, R.O.
23-4580
SNOW, COMPRESSIVE STRENGTH, SNOW DENSITY, TEMPERATURE FACTORS, EXPERIMENTAL DATA, POROSITY, SINTERING, PHYSICAL PROPERTIES.

**MP 223**
**STUDY OF A NEW FOUNDATION MODEL.**
Kerr, A.D., *Acta mechanica,* 1965, 1(2), p.135-147, German summary. 11 refs. For another version of this paper and abstract see 24-3333.
25-2086
FOUNDATIONS, PRESSURE FACTORS, LOADS (FORCES), MODELS.

**MP 224**
**ON PLATES SEALING AN INCOMPRESSIBLE LIQUID.**
Kerr, A.D., *International journal of mechanical sciences,* 1966, 8(4), p.295-304, 10 refs.
25-2125
ICE COVER STRENGTH, ANALYSIS (MATHEMATICS), LOADS (FORCES), ELASTIC PROPERTIES.
Exact solutions are derived for a circular plate which seals an incompressible liquid, is clampled along the boundary and is subjected at an arbitrary point to a lateral concentrated force P. For the case when the plate is covered by a thin liquid layer the solution is obtained in closed form. When this liquid layer is absent, the solution is obtained as an infinite series.

**MP 225**
**VISCOELASTIC WINKLER FOUNDATIONS WITH SHEAR INTERACTIONS.**
Kerr, A.D., *American Society of Civil Engineers. Engineering Mechanics Division. Journal,* June 1961, 87(EM3), p.13-30, 6 refs. Microform No. SIP 20361. For another version of this paper and abstract see 24-3236.
25-2193
SNOW CREEP, VISCOELASTICITY, SNOW PLASTICITY, FOOTINGS, LOADS (FORCES).

**MP 226**
**FRAZIL ICE FORMATION IN TURBULENT FLOW.**
Müller, A., *Iowa. University. Iowa Institute of Hydraulic Research. Report,* June 1978, No.214, 93p., 42 refs. Sponsored by U.S. Army Cold Regions Research and Engineering Laboratory.
33-810
TURBULENT FLOW, ICE GROWTH, ICE NUCLEI, FRAZIL ICE, EXPERIMENTAL DATA.

**MP 227**
**LEAF REFLECTANCE AND IMAGE FORMATION ON COLOR INFRARED FILM.**
Knipling, E.B., Remote sensing in ecology. P.L. Johnson, editor, Athens,, p.17-29, 30 refs.
25-1196
INFRARED PHOTOGRAPHY, REFLECTANCE, VEGETATION, COLOR.
False color aerial photography with Ektachrome Infrared Aero film has been found useful for distinguishing vegetation types and assessing plant vigor. However, considerable misunderstanding exists about the process of color formation on this visible-and infrared-sensitive film and about the way changes in leaf reflectance in these spectral regions account for differences in the color imagery of plant foliage. Healthy green leaves have a low visible and high infrared reflectance and characteristically appear bright red on color infrared photographs. Physiological disturbances to plants generally are accompained by increases in the visible reflectance but the direction of change in infrared reflectance is quite variable. Thus, deviations from the red color on photographs are not always explained by a decline in infrared reflectance. Disease, damage, and physiological stresses in plants influence the extent of red coloration by changing the geometry and density of foliage as much as by changing the reflectance characteristics of individual leaves.

**MP 228**
**HEXAGONAL AND CUBIC ICE AT LOW TEMPERATURES.**
Kumai, M., *Journal of glaciology,* Feb. 1968 , 7(49), p.95-108, 23 refs.
23-2651
ICE CRYSTAL STRUCTURE, CUBIC ICE, LOW TEMPERATURE TESTS.
The formation of hexagonal and cubic forms of ice was studied by the use of a cold stage in an electron microscope within the temperature range -90 to -180C. Ice crystal specimens were made on cold substrates, i.e. a collodion film, gold foil, or copper grid on the specimen holder of the cold stage. The hexagonal form of ice formed on the cold substrates at temperatures from -90 to -100C. At -100 to -130C, both hexagonal and cubic forms of ice were detected. From -130 to -160C only cubic ice was found. At temperatures below -160C, minute crystals of cubic ice were detected. No transformation of the structural form of ice from hexagonal to cubic or from cubic to hexagonal occurred when the temperature of the specimens was varied in the range -90 to -160C. The lattice constants of hexagonal and cubic ice, and the coefficient of thermal expansion of ice were calculated from the experimental results.

**MP 229**
**FOG MODIFICATION ON THE GREENLAND ICE CAP.**
Kumai, M., National Conference on Weather Modification, 1st, Albany, New York, April 28 - May 1, 1968. Proceedings, American Meteorological Society, , p.414-422, 8 refs. For another version of this paper and abstract see 24-3392.
24-648
FOG DISPERSAL, SUPERCOOLED FOG, ICE CRYSTALS, NUCLEATION, GREENLAND.

**MP 230**
**ELECTRON MICROSCOPE STUDY OF ICE CRYSTALS AT LOW TEMPERATURES.**
Kumai, M., *European regional conference on electron microscopy. Proceedings,* 1969 , Vol.4, p.313-314, 2 refs.
24-2876
ICE CRYSTALS, ELECTRON MICROSCOPY.
Presents the result of measurements of the lattice constants and coefficients of the thermal expansion of ice crystals, and reports on the temperature dependence and the transformation of the structural form of ice.

**MP 231**
**PROPERTIES OF MARINE AIR AND MARINE FOG AT BARROW, ALASKA.**
Kumai, M., International Conference on Cloud Physics, May 24-June 1, 1965, Tokyo and Sapporo, Japan. Proceedings, Tokyo,, p.52-56, 10 refs.
25-2087
FOG, AEROSOLS, MARINE ATMOSPHERES, CONDENSATION NUCLEI, CLOUD PHYSICS, UNITED STATES—ALASKA—BARROW.

**MP 232**
**MICROSPHERULES IN SNOW AND ICE-FOG CRYSTALS.**
Kumai, M., *Journal of geophysical research.,* July 15, 1966, 71(14), p.3397-3404, 27 refs. Microform No. SIP 24622.
25-2126
PARTICLES, ICE CRYSTALS, SNOW CRYSTALS, ICE FOG, COSMIC DUST, PARTICLE SIZE DISTRIBUTION.
Spherules found in snow crystals, ice-fog crystals, fallout particles, and fly ash were studied with an electron microscope using the electron diffraction method. The central part of the residue of 1004 specimens of natural snow crystals from Greenland, the United States, and Japan were examined; 14 spherules 0.1 to 1.5 micron in radius were found among them. The residues of 658 artificial ice-fog crystals formed from water vapor in flue gases of coal-burning electric power plants at Fairbanks, Alaska, were also examined; 9 spherules were found. Spherules similar to those found in ice-fog residues were found in furnace-produced fly ash fallout. Electron and optical microscope examination of spherules found in Greenland snow reveals their size distribution. The properties of spherules and mean mass of snow crystals in Greenland are described. The electron microscope study indicated that less than 0.7% of the 1004 snow crystals contained spherules of possibly extraterrestrial origin.

**MP 233**
**ELECTRON MICROSCOPIC STUDY OF ICE-FOG AND ICE-CRYSTAL NUCLEI IN ALASKA.**
Kumai, M., *Meteorological Society of Japan. Journal,* June 1966, 44(3), p.185-194, Text in English, Japanese summary. 14 refs.
25-2127
ICE FOG, ICE CRYSTAL NUCLEI, SUPERCOOLED FOG, ICE CRYSTAL FORMATION, ELECTRON MICROSCOPY, TEMPERATURE FACTORS, UNITED STATES—ALASKA—FAIRBANKS.
At air temperatures around -40C in Fairbanks, Alaska, area, dense ice fog formed by freezing of water droplets condensed from water vapor in flue gases derived form the chimneys of power and heating plants, and the exhausts of automobiles. Ice fog at temperatures around -40C, -25C, and -10C respectively were collected in this area on electron microscope grids covered with collodion film. After sublimation or evaporation, the residues of these specimens were examined with an electron microscope. As there is no difference in composition between ice fog nuclei and supercooled fog nuclei in the Fairbanks area, it is concluded that the substances work first as condensation nuclei, then as freezing nuclei when cooled to about -25C or below. All stages in the process from water droplet formation to ice fog formation with falling temperatures were observed directly during the collection of these specimens. Ice fog crystals formed at around -40C were mainly spherical ice crystals of 2 to 15 micron diameter, the remainder being hexagonal and columnar crystals of 10 to 30 micron diameter. Ice sintering caused by collision of ice-fog crystals were found even at a temperature of -40C.

**MP 234**
**STUDY OF ICE-FOG CRYSTAL NUCLEI AND ICE FOG FORMATION.**
Kumai, M., International Congress for Electron Microscopy, 6th, Aug,28Sept.4, 1966, Kyoto, Japan. Vol.1, Tokoyo, Japan,, p.575-576, 2 refs.
25-2128
ICE FOG, ICE CRYSTAL NUCLEI, ICE CRYSTAL FORMATION.

**MP 235**
**SNOW CRYSTALS AND THE IDENTIFICATION OF THE NUCLEI IN THE NORTHERN UNITED STATES OF AMERICA.**
Kumai, M., *Journal of meteorology,* April 1961, 18(2), p.139-150, Microform No. SIP 20274. 22 refs.
25-4129
SNOW CRYSTAL STRUCTURE, FREEZING NUCLEI.
The following relations among snow crystals are discussed: crystal form, nucleus, and temperature and humidity of the mother cloud as determined by radiosonde measurements. Observations of snow crystal forms and mother cloud temperatures were made during 4 weeks in midwinter at the Keweenaw Field Station in Houghton, Michigan. Three hundred snow crystals were collected and electron micrographs of the center nucleus of 271 of these were obtained. Snow crystal nuclei can be classified as clay particles, hygroscopic particles, combustion products, microorganisms and unknown materials. A relationship was found between the sizes of the snow crystal nuclei and the snow crystal forms. The nuclei sizes of maximum frequency which were formed at warmer temperatures were larger than those formed at colder temperatures. No relationship was found between crystal forms and the substances of the nuclei.

**MP 236**
**ELECTRON-MICROSCOPE STUDY OF SNOW CRYSTAL NUCLEI.**
Kumai, M., *Journal of meteorology,* June 1951, 8(3), p.151-156, Also published in International Association of Scientific Hydrology. Publication No.39, 1954. p.468-473. Microform No. SIP U1950. 6 refs.
25-4130
SNOW CRYSTALS, ELECTRON MICROSCOPY, SNOW CRYSTAL GROWTH, CONDENSATION NUCLEI.
Experimental work was conducted chiefly in an igloo, half way up Mt. Taisetsu in Hokkaido, at an altitude of 1050 m. Snow crystals were received on the collodion film of the holder of an electron microscope, and left in a desiccator kept between -4 and -8 C. The crystals sublimed, and the supposed nuclei remained on the collodion film. These specimens were brought under ekectron-microscope investigation. One solid nucleus (center nucleus) was always observed in the central portion of a snow crystal. Numerous smaller condensation nuclei were observed in the other parts of the snow crystals, of nearly the same size as condensation nuclei in the free atmosphere. Forty-three photographs of center nuclei and 60 of condensation nuclei were obtained - and a frequency curve of size was made from 1200 data. The mechanism of snow crystal growth is discussed on the basis of these data.

**MP 237**
**ELECTRON-MICROSCOPE STUDY OF SNOW CRYSTAL NUCLEI II.**
Kumai, M., *Geofisica pura e applicata,* 1957, Vol.36, p.169-181, Microform No. SIP 15199. 13 refs.
25-4131
SNOW CRYSTAL NUCLEI, ELECTRON MICROSCOPY.
The results of investigations from 1952-1955 at elevations from 820-1050 m. in Hokkaido (Japan) are reported in detail. Snow crystals were collected on a clear glass slide, transferred on the collodion film of the sample holder of the electron microscope and allowed to evaporate. The materials of the nuclei were classified according to their microdiffusion patterns into 3 kinds: single crystals, polycrystals, and amorphous substances. About 6 percent of the nuclei were clay particles, 20 percent seasalt particles, and the rest consisted of chemicals and combustion products and rarely microorganisms. The ice formation on the single crystal nuclei occurred by oriented overgrowth, while in the case of polycrystalline and amorphous nuclei it formed by water vapor condensation and crystallization.

**MP 238**
**ELECTRON MICROSCOPE STUDIES OF SNOW AND FOG NUCLEI.**
Kumai, M., et al, Science in Alaska. Alaskan Science Conference, 12th, Aug.28-Sept.1, 1961., College, Alaska,, p.163-171, 4 refs.
Francis, K.E.
25-2018
SNOW CRYSTALS, FOG, ICE CRYSTAL NUCLEI, DROPLETS, NUCLEATION.

**MP 239**
**NUCLEI IN SNOW AND ICE CRYSTALS ON THE GREENLAND ICE CAP UNDER NATURAL AND ARTIFICIALLY SIMULATED CONDITIONS.**
Kumai, M., et al, *Journal of the atmospheric sciences,* Nov. 1962, 19(6), p.474-481, 17 refs. Microform No. SIP 20904.
Francis, K.E.
25-2019
SNOW CRYSTALS, ICE CRYSTAL NUCLEI, CRYSTAL GROWTH, ICE CRYSTAL FORMATION, NUCLEATION.
Natural snow crystals and artificially stimulated snow and ice crystals were collected on a mesh prepared for electron microscopy at Site 2, a research facility on the ice cap about 320 km. E. of Thule, Greenland. The nuclei were observed at about 10,000X magnification with an electron microscope. The procedures and results were: 1) Natural snow crystals which developed a cloud at the temp. between -5 and -20C were collected on the microscope grids. 2) Ice crystals were made by dry-ice seeding of a supercooled fog in a cold chamber. 3) A low-level supercooled stratus over the ice cap was seeded with dry ice. The electron microscope study indicates that the natural snow crystals occurring during the summer on the Greenland Ice Cap are formed mainly on clay mineral particles by heterogeneous nucleation. The ice and snow crystals with no observable nuclei which were produced by dry ice seeding in the aerosol-limited air may have been initiated by homogeneous nucleation.

**MP 240**
**CINEMATOGRAPHIC STUDY OF ICE CRYSTAL FORMATION IN WATER.**
Kumai, M., et al, *Hokkaido Daigaku, Sapporo, Japan. Rigakubu. Journal of the Faculty of Science, Hokkaido University. Series II Physics,* Nov. 1953, 4(4), p.235-246, 10 refs. Microform No. SIP 9163.
Itagaki, K.
25-2225
ICE CRYSTAL FORMATION, PHOTOGRAPHIC TECHNIQUES, SUPERCOOLED WATER, NUCLEATING AGENTS, ICE CRYSTAL GROWTH.

Investigations on the formation of ice crystals in water were carried out in the cold chamber of Hokkaido University. Applying the principle of shadow photography, a new method of cinematography was devised. The mode of growth of ice crystals in water was studied by the use of a lapse time movie. Various shapes of crystals were made in a cooled shallow vessel, by seeding with minute ice crystals and the mode of their growth was examined. The relations between the shape of crystal, the rate of growth and the degree of supersaturation of the water were studied. Silver iodide, kaolin, carbon, or clay particles were not found active for the nucleation but the minute ice crystals and splinters were active.

**MP 241**
**ELECTRON-MICROSCOPE STUDY OF CENTER NUCLEI OF SNOW CRYSTALS III.**
Kumai, M., et al, *Meteorological Society of Japan. Journal,* Nov. 1957, 75th Anniversary Vol., p.49-55, Microform No. SIP 16505. 5 refs.
Nakaya, U.
25-4132
SNOW CRYSTAL NUCLEI, ELECTRON MICROSCOPY.
The results of studies conducted in an igloo at an elevation of 1030 m. on Mt. Tokachi (Hokkaido) are reported. A total of 202 crystals were examined, 190 of which contained a solid central nucleus. The nuclei were approximately 60 percent soil particles, 20 percent salt particles, 10 percent combustion products, and 10 percent unidentified amorphous particles.

**MP 242**
**MEASUREMENT OF THE MASS AND NUMBER OF FALLING SNOW CRYSTALS IN THE ATMOSPHERE.**
Kumai, M, et al, *Meteorological Society of Japan. Journal,* Nov. 1952, 30(11), p.345-355, Microform No. SIP U5664. 13 refs.
Higushi, K.
25-4133
SNOW CRYSTALS, SNOWFALL.
Air temperature and crystal formation of falling snow varied remarkedly during the 12-hr. snowfall of March 2, 1951 which produced a 17-cm. snow cover with a 13-mm. water equivalent. Small sheets of black paper and clear glass slides momentarily immersed in a 1-3 percent solution of formvar in ethylene dichloride were exposed horizontally for 30 sec. to falling snow crystals. The total mass and the number of snow crystals in the atmosphere were calculated from the 34 most interesting specimens collected. The order of magnitude of the total mass was 0.1 gm./cu. m. coinciding with the liquid water content in cumulus clouds. The order of magnitude of the number of snow crystals was 100,000 particles/cu. m.

**MP 243**
**SHAPE AND FALL VELOCITY OF RAINDROPS.**
Kumai, M., et al, *Meteorological Society of Japan. Journal,* March 1954, 32(3), p.69-76, 9 refs.
Itagaki, K.
25-4134
RAINDROPS, PHOTOGRAPHY, DEFORMATION, FALLING BODIES, VELOCITY.
The shape and fall velocity of raindrops were observed by means of the photographs taken with a dark-field by electric sparks at 100 times/sec. 62 successful photographs of raindrops were obtained. Various waterdrops of known mass were taken in photograph after 11 m fall in the state of still air, and the relation among the mass, fall velocity and deformation were observed. Raindrops and waterdrops were compared with each other in shape and fall velocity. In the state of still air, the shapes and fall velocities of raindrops and waterdrops were similar. The maximum fall velocity was 980 cm/sec, and the largest diameter was 0.51 cm. The drag coefficient of raindrop is discussed on the basis of these data.

**MP 244**
**STRESS-STRAIN RELATIONS IN SNOW UNDER UNIAXIAL COMPRESSION.**
Landauer, J.K., *Journal of applied physics,* Dec. 1955, 26(12), p.1493-1497, 4 refs. Microform No. SIP 10800. For another version of this paper and abstract see 24-3173.
25-2194
SNOW COMPRESSION, STRAIN TESTS, STRESS ANALYSIS, SNOW MECHANICS.

**MP 245**
**REFRIGERATED FLUIDS FOR DRILLING AND CORING IN PERMAFROST.**
Lange, G.R., *National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, Lafayette, Ind. Proceedings, p.375-380, Includes discussion. 24 refs. Microform No. SIP 24872.
25-2129
PERMAFROST STRUCTURE, CORING, DRILLING FLUIDS.
The feasibility of refrigeration of drilling fluids was examined and design criteria were established from which the required refrigeration capacity could be calculated. These criteria were: (1) The system should be capable of cooling a flow of either diesel fuel or compressed air. (2) Maximum ambient air temperature of 70 F was assumed. (3) Flow rate and pressure of both compressed air and diesel fuel must be adequate for drilling and coring a 6-in. hole to 1000 ft. (4) A minimum subsurface temperature of 15 F was assumed, and thermal disturbance of hole wall and core were to be minimized. Based on calculations presented in this paper, the system should be capable of delivering 100 gal/min of diesel fuel at 400 psi at 15 F with an ambient air temperature of 70 F or 500 cu ft/min of compressed air at 100 psi at the same ambient temperatures.

**MP 246**
**SOME INVESTIGATIONS OF EXCAVATION OF FROZEN SOIL.**
Lange, G.R., Vermont Conference on Winter Construction, Oct. 30-31, 1969. Proceedings, Burlington, University of Vermont, 1970, p.69-81, 7 refs.
25-3029
EXCAVATION, DRILLING, FROZEN GROUND.
Discussed are data provided by laboratory experiments designed to measure the specific energy of disaggregation of frozen soils (and ice) by a variety of methods of attacks; analysis of data extracted from the engineering literature; field observations of a number of methods and machines in use on mining and construction projects; and, field trials of some novel and some conventional methods of excavation and drilling.

**MP 247**
**SATURATION, PHASE COMPOSITION, AND FREEZING-POINT DEPRESSION IN A RIGID SOIL MODEL.**
Lange, G.R., et al, *National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, Lafayette, Ind. Proceedings, p.187-192, Includes discussion. 12 refs. Microform No. SIP 24851.
McKim, H.L.
25-2130
SOIL MOISTURE, SOIL FREEZING, FROST PENETRATION, MODELS, TEMPERATURE FACTORS.
Results of experiments with an idealized soil model illustrate the separate and combined effects of temperature and saturation on phase composition of soil water. Phase composition of the water in a slab of unglazed porcelain was measured by the method of mixtures. A small piece of the slab was subjected to 20 freeze-thaw cycles at a constant freezing temperature. Distribution of pore sizes was determined in order to relate the data to natural soils. It is concluded that the amount of water that freezes in a frozen soil may be strongly influenced by the degree of saturation as well as temperature.

**MP 248**
**DEEP CORE DRILLING IN GLACIERS.**
Lange, G.R., et al, Army Science Conference, West Point, June 24-26, 1959. Proceedings, vol.2, Washington,, p.97-107, 6 refs.
Langway, C.C., Jr., Hansen, B.L.
25-2192
GLACIER ICE, DRILLING, DRILL CORE ANALYSIS, WELL LOGGING.

**MP 249**
**DEEP ICE CORE STUDY PROGRAM: GREENLAND.**
Langway, C.C., Jr., *Antarctic journal of the United States,* Sept./Oct. 1968 , 3(5), p.184-185.
23-3703
DRILL CORE ANALYSIS, ICE ANALYSIS, BOREHOLES, METHODOLOGY, ANTARCTICA—BYRD STATION, GREENLAND—CAMP CENTURY.

**MP 250**
**STUDIES ON DEEP ICE CORES FROM GREENLAND AND ANTARCTICA.**
Langway, C.C., Jr., *Antarctic journal of the United States,* Sept./Oct. 1969 , 4(5), p.218.
24-1305
DRILL CORE ANALYSIS, CHEMICAL COMPOSITION, ISOTOPE IMPURITIES.

**MP 251**
**ACCUMULATION AND TEMPERATURE ON THE INLAND ICE OF NORTH GREENLAND,1959.**
Langway, C.C., Jr., *Journal of glaciology,* Oct. 1961, 3(30), p.1017-1044, French and German summaries. 39 refs. Microform No. SIP 19508.
25-2005
METAMORPHISM (SNOW), SNOWFALL, ACCUMULATION, GLACIERS, ICE TEMPERATURE, ICE GROWTH, PITS (EXCAVATIONS).
Twelve deep pits (5 to 5.5 m.) revealed between 6 and 13 years of snow accumulation. The results show an average net accumulation of 18.5 g./sq. cm. per year. Accumulation of 18.5 g./sq.cm. per 100 m. rise in elevation. Temperature measurements at 10 m. in all pits give a mean temperature-altitude gradient of 0.77 C. per 100 m. Evidence of melt was observed in all pits, the most pronounced melt occuring in 1954. The mean density reflects the local climate. Other empirical correlations of these data show linear trends that vary systematically with surface slope and local climate.

**MP 252**
**SAMPLING FOR EXTRA-TERRESTRIAL DUST ON THE GREENLAND ICE SHEET.**
Langway, C.C., Jr., *International Association of Scientific Hydrology. Publication,* 1963, No.61, p.189-198, French summary. 32 refs. Microform No. SIP 21903.
25-2036
GLACIER ICE, COSMIC DUST, CHEMICAL ANALYSIS, PHYSICAL PROPERTIES.
Laboratory investigation results are given on the physical and chemical properties of the extraterrestrial dust content of the Greenland firn layers. Dust samples were obtained from stratigraphically determined snow layers and deep ice-cores. The size distribution of the black spherule component of this material ranges from 5 to 160 micr. in diameter and has a unimodal peak at approximately 20 micr. From this study the average deposit of black spherules in Greenland is 1.17 spherules (of mean mass)/sq cm/yr which amounts to a total deposit of 915,000 metric tons/yr for the entire earth. Results suggest some correlation between the number of black spherules larger than 5 micr. and seasonal snow deposits. Chemically, they are either Fe-rich or Si-rich.

**MP 253**
**SOME PHYSICAL AND CHEMICAL INVESTIGATIONS OF A 411 METER DEEP GREENLAND ICE CORE AND THEIR RELATIONSHIP TO ACCUMULATION.**
Langway, C.C., Jr., *International Association of Scientific Hydrology. Publication,* 1962, No.58, p.101-118, French summary. 20 refs. Microform No. SIP 24314.
25-2055
CHEMICAL ANALYSIS, GLACIER ICE, ACCUMULATION, ICE CORES, PHYSICAL PROPERTIES, GREENLAND.
A deep rotary core-drilling project on the Greenland ice sheet provided ice cores to a depth of 411 m. The investigations include systematic studies of the variations in stratigraphy in an attempt to define the limits of annual layering, using bulk density, structure, texture and fabrics, grain size, shape and distribution, oxygen and hydrogen isotopes, bubble pressures, ionic chemical constituents, gas composition, bacteria content, and particle debris. The results of these investigations suggest a nearly constant rate of net accumulation of about 34 gm/sq cm/yr for the lower 300 m, whereas independent pit studies extending back 60 yr, and stake measurements for a 6-yr period, show a net accumulation rate that averages about 40 gm/sq cm/yr, or an increase of about 20% during the last century. The age of the ice core from the bottom of the borehole is about 1000 yr.

**MP 254**
**STRATIGRAPHIC ANALYSIS OF A DEEP ICE CORE FROM GREENLAND.**
Langway, C.C., Jr., *Geological Society of America. Special paper,* 1970, No.125, 186p., Bibliography p.163-180.
25-3623
DRILL CORE ANALYSIS, STRATIGRAPHY, DUST, CHEMICAL ANALYSIS, ICE ANALYSIS, SNOW ACCUMULATION.
A deep rotary core drilling project in 1957 at Site 2 on the Greenland ice sheet (76 59 N., 56 04 W.) provided ice core to a depth of 411 m. The vertical variation in bulk density, macroscopic structure, oxygen isotope ratios, ionic constituents, and extraterrestrial dust (black spherules) was analyzed, using both field and laboratory techniques. The average total ionic concentration in the ice sheet ranges between 0.65 and 1.35 mg/liter. The annual global mass deposit of black spherules varies 210,000 metric tons in 700-year-old ice to 657,000 tons in 12-year-old firn. The oxygen isotope ratio variation indicates rates of net snow accumulation of 42.3, 34.2, 37.4, 41.1, and 41.6 g/sq cm-yr at the surface, A.D. 1773, 1513, 1233, and 934, respectively. The ice core record shows that snow accumulation and temperature in A.D. 934 were similar to that of today, followed by a gradual decrease in both to a minimum in accumulation about A.D. 1773 and in increase from A.D. 1773 to 1957 and following.

**MP 255**
**CARBON DATING OF ICE AT BYRD STATION, ANTARCTICA.**
Langway, C.C., Jr., et al, *Antarctic journal of the United States,* July-Aug. 1969 , 4(4), p.123-124, 5 refs.
Hansen, B.L., Oeschger, H., Stauffer, B.
24-3611
LAND ICE, BOREHOLES, CARBON DATING, RADIOACTIVE AGE DETERMINATION, EQUIPMENT, ANTARCTICA—BYRD STATION.
Described are the preliminary investigations related to carbon dating of ice from a deep liquid filled borehole and a shallow dry borehole at Byrd Station. The probe and its operation are given and some of the problems are mentioned. The carbon dating program is expected to further the understanding of the processes of air inclusions during transition from firn to glacier ice.

**MP 256**
**SOME CHARACTERISTICS OF BLACK SPHERULES.**
Langway, C.C., Jr., et al, *New York Academy of Sciences. Annals,* Nov. 11, 1964, 119(1), p.205-223, 28 refs.
Marvin, U.B.
25-2054
IMPURITIES, CHEMICAL COMPOSITION, GREENLAND.
Results of a comparative investigation of the chemical composition, mineralogy and physical properties of black spherules from the Greenland Ice Sheet and industrial black spherules.

**MP 257**
**SAMPLING POLAR ICE FOR RADIOCARBON DATING.**
Langway, C.C., Jr., et al, *Nature,* May 1, 1965, 206(4983), p.500-501, 6 refs. Microform No. SIP 23479.
Oeschger, H., Alder, B., Renaud, A.
25-2088
GLACIER ICE, RADIOCARBON DATING, SAMPLING.
The object of this research was to develop methods and techniques of sampling, handling, and processing unaltered glacier ice and to extract the carbon dioxide component of the occluded atmospheric gases for dating. The work was done in the Tuto Ice Tunnel, North Greenland, during March and April 1964. Duplicate ice samples were processed by two completely different methods for cross-checking results and evaluating the efficiencies of the various methods. The feasibility of using low-level counting devices developed at the University of Berne was investigated to develop a method of dating deep ice cores for use in research in both polar regions. Data from physical and chemical analyses of the ice samples are tabulated, and methods are described.

**MP 258**
**DRILLING THROUGH THE ICE CAP: PROBING CLIMATE FOR A THOUSAND CENTURIES.**
Langway, C.C., Jr., et al, *Bulletin of the atomic scientists,* Dec. 1970, p.62-66.
Hansen, B.L.
25-4125
GLACIER ICE, DRILL CORE ANALYSIS, DRILLING EQUIPMENT, PALEOCLIMATOLOGY, RESEARCH PROJECTS.
The value of investigating deep ice cores and boreholes has a considerable scientific value and the result of investigations have a bearing on many disciplines. From core studies one is able to investigate transporting processes of the atmosphere and interaction between hemispheres, to date ancient atmospheres, to study the changes in precipitation chemistry during historical times, to make compositional analyses of fossil atmospheric gases, to investigate high latitude pollution and the effect of industrial wastes, to study distribution of volcanic and cosmic dust as a function of time and to make climatological inferences. It is hoped that deep core drilling in ice will continue and progress will be made in the study of glacier ice.

**MP 259**
**DEEP DRILLING INTO POLAR ICE SHEETS FOR CONTINUOUS CORES.**
Langway, C.C., Jr., et al, Antarctic Research Symposium, Dallas, Dec. 1968. Research in the Antarctic., Washington, American Association for the Advancement of Science, 1971, p.351-365, 48 refs.
Gow, A.J., Hansen, B.L.
26-949
DRILL CORE ANALYSIS, DRILLING EQUIPMENT, GLACIER ICE, RESEARCH PROJECTS, ICE CORES, ICE COMPOSITION.
The value of investigating deep ice cores and boreholes is far reaching and has considerable scientific value. The results of the investigations have a bearing on many scientific disciplines —glaciology, meteorology, atmospheric chemistry, geochronology, hydrology, paleoclimatology, geothermometry, physical dynamics, ceramics, and rheology. From core and borehole investigations one is able to study transporting processes of the atmosphere and the interaction between the hemispheres, to date ancient atmospheres, to study the change in precipitation chemistry during historical times, to make compositional analyses of fossil atmospheric gases, to investigate high-latitude pollution and the effect of industrial wastes, to study the distribution of volcanic and cosmic dust as a function of time, and to make climatological inferences from the resultant data. The current studies by no means exhaust the avenues of search or the potential information that is sealed within the ice cores.

**MP 260**
**METHOD OF DETERMINING DYNAMIC PROPERTIES OF VISCOELASTIC SOLIDS EMPLOYING FORCED VIBRATION.**
Lee, T.-M., *Journal of applied physics,* May 1963, 34(5), p.1524-1529, 7 refs. For another version of this paper and abstract see 24-3273.
25-2038
VISCOELASTICITY, DYNAMIC PROPERTIES, VIBRATORY LOADS. ANALYSIS (MATHEMATICS).

**MP 261**
**VIBRATION OF SPHERE FOR DETERMINING THE DILATATIONAL CONSTANTS OF VISCOELASTIC MATERIALS.**
Lee, T.-M., *Journal of applied physics,* Aug. 1963, 34(8), p.2150-2153, 6 refs. For another version of this paper and abstract see 24-3282.
25-2039
VISCOELASTIC MATERIALS, DILATATIONAL CONSTANTS, FORCED VIBRATION, ANALYSIS (MATHEMATICS).

**MP 262**
**SPHERICAL WAVES IN VISCOELATIC MEDIA.**
Lee, T.-M., *Acoustical Society of America. Journal,* Dec. 1964, 36(12), p.2402-2407, 11 refs. For another version of this paper and abstract see 24-3305. Microform No. SIP 23110.
25-2056
VISCOELASTICITY, WAVE PROPAGATION, MECHANICAL PROPERTIES, SOLIDS, MATERIALS.

**MP 263**
**DILATATION CONSTANTS AND COMPLEX RATIO FROM FORCED VIBRATION OF A FREE VISCOELASTIC SPHERE.**
Lee, T.-M., *Acoustical Society of America. Journal,* March 1964, 36(3), p.458-462, 3 refs. For another version of this paper and abstract see 24-3296.
25-2057
VISCOELASTICITY, FORCED VIBRATION, DILATATIONAL CONSTANTS, ANALYSIS (MATHEMATICS).

**MP 264**
**METHODS OF DETERMINING COMPLEX POISSON'S RATIO AND DILATATIONAL CONSTANTS, USING FORCED VIBRATION OF A SPHERE.**
Lee, T.-M., et al, *Acoustical Society of America. Journal,* Jan. 1965, 37(1), p.54-58, 3 refs.
Smith, J.L.
25-2090
VISCOELASTICITY, FORCED VIBRATION, POISSON'S RATIO, DILATATIONAL CONSTANTS, ANALYSIS (MATHEMATICS).
Following previous investigations on forced-vibration methods of determining dynamic mechanical properties of viscoelastic materials, this article is proposing a similar technique for determining the complex Poisson's ratio and the complex dilatation constants. Through the study of forced vibration of a free viscoelastic sphere with internal harmonic oscillating source, it is found that the abovementioned properties of the test material are related to the ratio of the vibration amplitude of two measurable points. Thus, when using the criterion of this ratio approaching its maximum, the maximum amplitude ratio, these properties can be expressed in simple relationship with the laboratory-measurable quantities: namely, the maximum amplitude ratios and their corresponding vibration frequencies. Investigations have been carried out for three sphere sets.

**MP 265**
**USE OF AERIAL PHOTOGRAPHS AND FIELD RECONNAISSANCE FOR ICE CAP ROUTE LOCATION AT NARSSARSSUAQ, GREENLAND .**
Leighty, R.D., *Photogrammetric engineering,* March 1962, 28(1), p.147-153, 3 refs. Microform No. SIP 20099.
25-2020
AERIAL PHOTOGRAPHY, AERIAL RECONNAISSANCE, ROADS, SURVEYS, HIGHWAY PLANNING, PHOTOINTERPRETATION.
A report is given on the combined use of aerial photo-graphic interpretation techniques and field and aerial reconnaissance to obtain information on terrain conditions in order to solve highway engineering problems in mountainous areas. The purpose of the study was to locate and evaluate an access area from the sea to the ice cap in Southern Greenland. The Narssarssuaq area was agreed upon after the summer of 1957 had been devoted to verification of predictions made in a preliminary study of small-scale aerial photographs, from which a tentative route had been selected, and to a field survey of the proposed route. The use of aerial photographs in the preliminary study and in the field yielded a maximum amount of information in a minimum amount of time for location of the road and preparation of an engineering report.

**MP 266**
**TERRAIN MAPPING FROM AERIAL PHOTOGRAPHY FOR PURPOSES OF VEHICLE MOBILITY.**
Leighty, R.D., *Journal of terramechanics,* 1965, 2(3), p.55-67.
25-2091
PHOTOINTERPRETATION, TERRAIN ANALYSIS, PHOTOGRAMMETRY, TRAFFICABILITY.

**MP 267**
**SNOW DENSITY PROFILING BY NUCLEAR MEANS.**
Leighty, R.D., *Journal of glaciology,* Feb. 1966, 6(43), p.171-176, French and German summaries. 8 refs. Microform No. SIP 24603.
25-2131
SNOW DENSITY, NEUTRON PROBES, RADIOACTIVE SNOW GAGES, TEST EQUIPMENT.
During the period 8-19 May 1963 a preliminary field investigation was conducted in Greenland to determine the feasibility of using a nuclear technique to determine snow and ice density profiles. A standard nuclear soil-moisture depth probe was used with two modes of processing and recording the nuclear pulses. Example data are compared with snow densities obtained by the standard weighing technique. The nuclear method was found to be feasible; however, deficiencies related to poor resolution render the probe unusable for detailed profiling of snow stratigraphy in its present form, but expected progress in nucleonics should enable improved resolution and accuracy to be achieved by improvement of nuclear detectors.

**MP 268**
**TERRAIN INFORMATION FROM HIGH ALTITUDE SIDE-LOOKING RADAR IMAGERY OF AN ARCTIC AREA.**
Leighty, R.D., Symposium on Remote Sensing of Environment, 4th, Apr.12-14, 1966. Proceedings, Ann Arbor,, p.575-597, 6 refs.
25-2132
RADAR PHOTOGRAPHY, AERIAL PHOTOGRAPHY, TERRAIN ANALYSIS, RESEARCH PROJECTS.
Radar imagery was obtained at altitudes of 30,000 to 60,000 feet over arctic terrain with an AN/APQ56 (XAA) side-looking radar (high altitude) set during two flight programs (November-December 1960 and March 1962). Generalities of terrain information retrieval from radar imagery are presented with background information on the regional terrain characteristics in northwest Greenland and discussion of representative project imagery.

**MP 269**
**SEA ICE: SOME POLAR CONTRASTS.**
Lewis, E.L., et al, Symposium on Antarctic Ice and Water Masses, Tokyo, September 1970, edited by George Deacon, Cambridge, England, Scientific Committee on Antarctic Research, 1971, p.23-34, 44 refs.
Weeks, W.F.
26-3535
SEA ICE, ICE STRUCTURE, ICE PHYSICS, ICE MECHANICS.
It is difficult to think of any sea ice feature that occurs in the Antarctic which does not occur somewhere or at sometime in the Arctic. However, there are a number of interesting distinctions that can be made between the ice of the two polar regions. Many of these differences are caused by the land-locked nature of the Arctic Ocean as compared to the unrestricted Southern Ocean. In this paper we review these differences briefly and discuss both our current understanding of them and their importance.

**MP 270**
**MEASUREMENTS OF BACKGROUND RADIATION IN AQUATIC HABITATS IN ALASKA.**
Likens, G.E., et al, National Symposium on Radioecology, 2d, May 15-17, 1967. Proceedings, Ann Arbor,, p.319-328, 21 refs.
Johnson, P.L.
25-2168
RADIOACTIVITY, LAKES, ECOLOGY, RADIOBIOLOGY, MEASUREMENT, UNITED STATES—ALASKA.
Measurements of ionizing radiation, made during 1965 in 9 lakes, 3 rivers, 1 hot springs area and adjacent terrestrial substrates in Alaska, indicated that the background radiation in these habitats varied greatly. The lakes were characterized by a small amount of ionizing radiation at mid-depths and increasing quantities near the air and sediment boundaries. Moreover, the radioactivity of the sediments near the shore was up to 3.2 times as high as the sediment values near the center. A model for background radiation in freshwater lakes is proposed. Variations in this model were a function of local differences in geologic substrates and input of allochthonous materials. The radioactivity from sediments in ponds of the Arctic tundra was due to naturally occurring radionuclides.

**MP 271**
**SOIL SAMPLING IN FROZEN GROUND.**
Linell, K.A., *International Conference on Soil Mechanics and Foundation Engineering. Proceedings,* 1969, 7th, p.57-60, Specialty Session No.1, Soil Sampling. 13 refs.
25-4349
FROZEN GROUND MECHANICS, DRILLING, CORE SAMPLERS, SAMPLING.

**MP 272**
**DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS.**
Linell, K.A., et al, 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, Lafayette, Ind. Proceedings, p.481-487, 1 ref. Microform No. SIP 24890.
Kaplar, C.W.
25-2133
FROZEN GROUND, SOIL CLASSIFICATION, FROZEN GROUND MECHANICS.
The United Soil Classification System (USCS) is extended to classification of frozen soils. This system should be flexible enough to provide any desired degree of detail. The system can be used with any types of samples that show the natural structure of the material such as specimens recovered from drill holes or test pits, or frozen in the laboratory. The frozen soil is identified in 3 parts. Under part I the soil phase is identified independently of the frozen state using the USCS. Under Part II, the soil characteristics resulting from the frozen state of the material are added to the soil description. Under Part III important ice strata found in the soils are described. The recommended procedure for graphical presentation of frozen soil classification consists of showing the applicable letter symbols for the soil phase in accordance with the USCS.

**MP 273**
**CORPS OF ENGINEERS' PAVEMENT DESIGN IN AREAS OF SEASONAL FROST.**
Linell, K.A., et al, *Highway research record,* 1963, No.33, p.76-136, Includes appends and discussions. 12 refs.
Hennion, F.B., Lobacz, E.F.
25-2198
PAVEMENTS, FROST HEAVE, FROST ACTION, ACTIVE LAYER, AIRCRAFT LANDING AREAS, DESIGN CRITERIA, SUBGRADE SOILS, SOIL MECHANICS.
Definitions pertaining to design for frost conditions are presented. Conditions necessary for ice segregation and the need for considering the effects of frost action in pavement design are discussed. In addition, discussions are presented on frost-susceptible soils, the detrimental effects of frost action and investigational procedures for determining frost susceptiblity and its magnitude. Base course composition requirements are discussed and frost design procedures are presented with examples. Also, requirements for field control of construction for frost conditions and standard laboratory frost susceptibility test procedures are given.

**MP 274**
**THERMAL REGIME BENEATH BUILDINGS CONSTRUCTED ON PERMAFROST.**
Lobacz, E.F., et al, *National Research Council. Publication,* 1966, No.1287, International Conference on Permafrost, Nov.11-15, 1963, Lafayette, Ind. Proceedings, p.247-252, Microform No. SIP 24858.
Quinn, W.F.
25-2134
BUILDINGS, FOUNDATIONS, SEASONAL FREEZE THAW, PERMAFROST BENEATH BUILDINGS, TEMPERATURE MEASUREMENT.
Eleven test buildings were constructed by CRREL at Alaska Field Station to determine the effect of selected types of foundations on ground temperatures and on vertical movements of buildings. The data indicate that building foundations with an air space between the floor and natural ground prevented permafrost degradation. Foundation construction, combining both an air space and nonfrost-susceptible fill, is considered superior to construction with air spaces only and use of slabs or insulated builtup floors placed directly on fills without provision for air circulation. Buildings founded on piles with an air space above ground cause no appreciable degradation of permafrost.

**MP 275**
**EFFECT OF GROWTH PARAMETERS ON SUBSTRUCTURE SPACING IN NACL ICE CRYSTALS.**
Lofgren, G., et al, *Journal of glaciology,* Feb. 1969 , 8(52), p.153-164, Summaries in French and German. 31 refs. For another version of this paper and abstract see 24-3341.
Weeks, W.F.
23-5466
ICE CRYSTAL GROWTH, SALT WATER.

**MP 276**
**SOME THERMODYNAMIC RELATIONSHIPS FOR SOILS AT OR BELOW THE FREEZING POINT. 2. EFFECTS OF TEMPERATURE AND PRESSURE ON UNFROZEN SOIL WATER.**
Low, P.F., et al, *Water resources research,* June 1968 , 4(3), p.541-544, 9 refs. For another version of this paper and abstract see 24-3364.
Hoekstra, P., Anderson, D.M.
23-3200
UNFROZEN WATER CONTENT, SOIL WATER, FREEZING, TEMPERATURE FACTORS, PRESSURE FACTORS.

**MP 277**
**SOME THERMODYNAMIC RELATIONSHIPS FOR SOILS AT OR BELOW THE FREEZING POINT 1. FREEZING POINT DEPRESSION AND HEAT CAPACITY.**
Low, P.F., et al, *Water resources research,* April 1968 , 4(2), p.379-394, 16 refs. For another version of this paper and abstract see 24-3364.
Anderson, D.M., Hoekstra, P.
23-3381
FROZEN GROUND THERMODYNAMICS, SOIL MOISTURE, FREEZING POINTS, ICE.

**MP 278**
**SMALL FOUR-CAMERA SYSTEM FOR MULTI-EMULSION STUDIES.**
Marlar, T.K., et al, *Photogrammetric engineering,* Nov. 1967 , 33(11), p.1252-1257.
Rinker, J.N.
25-2169
AERIAL PHOTOGRAPHY, PHOTOGRAPHIC EQUIPMENT.
Aerial photography, with simultaneous exposure of different film/filter combinations, has proven to be very useful in photo interpretation. However, such photography is often expensive and beyond the facilities and budgets of many laboratories. For some of our work in environmental analysis, it was necessary to assemble a relatively inexpensive, small, four-camera airphoto system. The set has been successfully used on projects in arctic and temperate regions. It is light-weight, motor-driven, and has a self-contained power supply. It has a wide range of readily available accessories and features rapid interchangeability of film magazines, lenses, filters, and viewfinders. The set is not only suitable for aerial photography (vertical and oblique) but is also easy to disassemble to provide hand-held cameras for ground control photography.

**MP 279**
**BLASTING FROZEN GROUND WITH COMPRESSED AIR.**
McAnerney, J.M., et al, *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* Sept. 1969 , No.96, Canadian Conference on Permafrost, third, Jan. 14-15, 1969. Proceedings, p.39-58, Inc. illus., and diagrs. 6 refs.
Hawkes, I., Quinn, W.F.
24-2181
FROZEN GROUND, EXPLOSION EFFECTS, BLASTING, COMPRESSED AIR, TUNNELING (EXCAVATION), TRENCHING.

**MP 280**
**TERRAIN INTERPRETATION FROM RADAR IMAGERY.**
McAnerney, J.M., Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.731-750, 6 refs.
25-2135
TERRAIN ANALYSIS, RADAR PHOTOGRAPHY, PHOTOINTERPRETATION, AERIAL PHOTOGRAPHY.
The interpretation of physiographic and cultural terrain features from imagery obtained with high resolution, side-looking radar alone is demonstrated. Two areas in the central United States are used as examples. Through a deductive process similar to that used in interpretation of visual aerial photography, it is shown that a trained interpreter can describe the physiography, geology and soil of a land surface and provide a reasonable assessment of the geography of a populated region. The discussion includes an example of measuring terrain relief from radar shadows.

**MP 281**
**EARLY GOLD MINING IN FROZEN GROUND.**
McAnerney, J.M., *Polar notes,* Nov. 1967, p.37-44, 9 refs.
25-2170
MINING, FROZEN GROUND, GROUND THAWING, GOLD.

**MP 282**
**SEARCH FOR COSMIC DUST IN A LARGE COLLECTION OF PARTICULATE AND DISSOLVED MATERIAL FROM POLAR ICE.**
McCorkell, R.H., et al, *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.25-30, 24 refs.
Pinson, W.H., Fireman, E.L., Langway, C.C., Jr.
25-936
GLACIER ICE, CHEMICAL COMPOSITION, ION DIFFUSION, COSMIC DUST, ISOTOPE IMPURITIES.

**MP 283**
**ALUMINUM-26 AND BERYLLIUM-10 IN GREENLAND ICE.**
McCorkell, R.H., et al, *Science,* Dec. 29, 1967 , 158(3809), p.1690-1692, 20 refs.
Fireman, E.L., Langway, C.C., Jr.
25-2117
GLACIER ICE, ISOTOPES, COSMIC DUST, IMPURITIES, MEASUREMENT, GREENLAND.
Activities of beryllium-10 and aluminum-26 dissolved in 200-year-old Greenland ice were measured. From these values and the precipitation rate (30 milliliters of water per square centimeter per year), the production rates of these isotopes are calculated to be 3.6 (plus 1.6, -0.9) x 1/10 and 1.7 p/m 0.5 x 1/1000 atom per second per square centimeter. These rates agree with the rates calculated for the production of these isotopes by cosmic rays in the atmosphere. Probably all the Al 26 in the ice is accounted for by such atmospheric production; however, an upper limit for the influx of cosmic dust bearing aluminum-26 is calculated at 3.2 x 1,000,000 tons per year for Earth. Only upper limits could be found for Al 26 and Be 10 in the undissolved particulate matter in the ice; their addition to the activities in the dissolved material leaves our conclusions unchanged.

**MP 284**
**THERMAL CONDUCTIVITY OF COMPACTED SAND/ICE MIXTURES.**
McGaw, R., *Highway research record,* 1968 , No.215, p.35-47, 12 refs.
23-4063
THERMAL CONDUCTIVITY, SAND/ICE MIXTURES, MEASURING INSTRUMENTS, TEMPERATURE EFFECTS.
The thermal conductivities of 20-30 Ottawa sand and 30-100 Ottawa sand, compacted with 30-100 crushed ice, were measured by the probe method of transient heating. A commercially available probe, 0.02 in. in diameter with a length/diameter ratio of 412, was used. Temperatures were 18 and 23 F. Water contents ranged from air-dry to 100 percent by weight. As the percentage of ice was increased, thermal conductivity increased from the value for air-dry sand to the value for bulk ice. For similar mixtures, the conductivity of the finer sand was higher. For mixtures compared at constant porosity, thermal conductivity decreased with the percentage of sand. Since the conductivity of quartz is 3.5 times that of ice, it was concluded that contact resistance at the interface between sand and ice at 18 F must be high. Thermal conductivity at 23 F was higher than at 18 F. It appeared that a reduction in contact resistance with temperature was responsible. Kersten's 1949 data for sandy soils at 25 F compared favorably with the results for the sand/ice mixtures.

**MP 285**
**HEAT CONDUCTION IN SATURATED GRANULAR MATERIALS.**
McGaw, R., *National Research Council. Highway Research Board. Special report,* 1969, No.103, International Conference on Effects of Temperature and Heat on Engineering Behavior of Soils, Jan. 1969, p.114-131, 26 refs.
26-3619
HEAT TRANSFER, THERMAL CONDUCTIVITY, SOIL FREEZING, FOUNDATIONS.

**MP 286**
**INFRARED SENSING OF SOILS AND ROCKS.**
McLerran, J.G., *Materials research and standards,* Feb. 1968 , 8(2), p.17-21, 6 refs.
23-5721
INFRARED RECONNAISSANCE, TERRAIN IDENTIFICATION, REMOTE SENSING, SOIL SURVEYS.
Infrared imagery does show terrain features. However, to interpret the imagery one must be aware of the environmental factors that affect the ever-changing thermal pattern of a terrain. Infrared imagery is used to illustrate soil and rock features that have distinctive infrared signatures. Before infrared sensing becomes a useful technique, there must be considerably more study of the soil physical factors that influence the emissivity and thereby the radiation that is sensed.

**MP 287**
**AIRBORNE CREVASSE DETECTION.**
McLerran, J.H., Symposium on Remote Sensing of Environment, 3rd, Oct. 14-16, 1964, University of Michigan. Proceedings. Ann Arbor, Michigan,, p.801-802.
25-2058
CREVASSE DETECTION, REMOTE SENSING, INFRARED PHOTOGRAPHY, AERIAL PHOTOGRAPHY.
Experimental and theoretical work on the feasibility of aerial detection of crevasses by infrared sensing.

**MP 288**
**INFRARED SEA ICE RECONNAISSANCE.**
McLerran, J.H., Symposium on Remote Sensing of Environment, 3rd, Oct. 14-16, 1964. Proceedings, Ann Arbor,, p.789-799, 6 refs.
25-2093
SEA ICE, INFRARED PHOTOGRAPHY, AERIAL SURVEYS, ICE REPORTING.

Infrared sensing of sea ice has been studied over a four year period and has shown great promise. Infrared Sensing has shown some advantages over other imaging systems. It has nighttime capability and there is some relationship between thermal radiation and ice thickness. This paper presents a few illustrations of infrared imagery of sea ice with a discussion of the interpretation of each illustration. Applications and limitations are discussed briefly.

**MP 289**
**INFRARED THERMAL SENSING.**
McLerran, J.H., *Photogrammetric engineering,* May 1967 , 33(5), p.507-512, 3 refs.
25-2171
INFRARED PHOTOGRAPHY, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, TERRAIN ANALYSIS, SEA ICE.
In the past several years, much progress has been made in developing infrared thermal sensing and its application in terrain analysis. Infrared imagery does portray terrain features; however, to interpret the imagery properly it is necessary to know the time of day and conditions under which it is obtained. Diurnal changes can create thermal pattern reversals. Infrared imagery is useful in inventory of hot springs and water resources. Sea-ice reconnaissance can be conducted by use of infrared sensors during periods when visual observations and photography cannot be obtained.

**MP 290**
**REMOTE SENSING AND INTERPRETATION OF SEA-ICE FEATURES.**
McLerran, J.H., Oceans from Space; proceedings of a symposium on the status of knowledge, critical research needs, and the potential research facilities relating to the study of oceans from space, ed. by P.C. Badgley, L. Miloy, and L. Childs, Houston, Texas, Gulf Publishing Co., 1969, p.159-170, 5 refs.
25-3165
REMOTE SENSING, PHOTOINTERPRETATION, SEA ICE, ICE OBSERVATION, INFRARED PHOTOGRAPHY.

**MP 291**
**PHOTOGRAPHIC INTERPRETATION, ITS SIGNIFICANCE IN THE HIGHWAY PROGRAM.**
McLerran, J.H., *Photogrammetric engineering,* Sept. 1957, 23(4), p.755-762, 11 refs.
26-2870
PHOTOINTERPRETATION, AERIAL SURVEYS, HIGHWAY PLANNING, SOIL SURVEYS, ENGINEERING.
The impact of the new highway program will require development and utilization of time-saving methods to obtain information required for planning, location, design, and construction. The use or airphoto interpretation to evaluate soil and materials is a proven method that will save much time. Illustrations show the application of the technique to specific engineering uses, such as soil surveys and material prospecting. The use of airphoto interpretation and carefully planned field work should go hand in hand.

**MP 292**
**THERMAL MAPPING OF YELLOWSTONE NATIONAL PARK.**
McLerran, J.H., et al, Symposium on Remote Sensing of Environment, 3rd, Oct. 14-16, 1964. Proceedings, Ann Arbor,, p.517-530, 3 refs.
Morgan, J.O.
25-2092
INFRARED MAPPING, AERIAL PHOTOGRAPHS, UNITED STATES—WYOMING—YELLOWSTONE NATIONAL PARK.
In April 1961 infrared imagery was obtained over Yellowstone National Park. The purpose was to conduct a preliminary study of the usefulness of infrared imagery over terrain with natural high-temperature contrasts, and to determine if subsurface thermal anomalies could be imaged if they are not evident by surface hydrothermal features. This paper presents imagery from several areas of the Park and demonstrates that infrared sensing is useful for mapping hydrothermal features. The results from this study indicate that new studies should be conducted using new state-of-the-art infrared scanners and detectors.

**MP 293**
**PROCEEDINGS OF THE WORKSHOP ON SNOW AND ICE HYDROLOGY AT COLORADO STATE UNIVERSITY, AUGUST 18-22, 1969.**
Meiman, J.R., ed, International Hydrological Decade. United States contribution. Fort Collins,, 142p.
Colorado State University, Fort Collins. College of Forestry and Natural Resources, U.S. Army Cold Regions Research and Engineering Laboratory, U.S. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado, U.S. National Committee for the International Hydrological Decade.
25-583
RESEARCH PROJECTS, SNOW COVER DISTRIBUTION, MEASUREMENT, REMOTE SENSING, HYDROLOGY, SNOW WATER EQUIVALENT, MANAGEMENT, RUNOFF.
Contains the presentations and discussions in which progress in knowledge and problems remaining to be solved regarding snow and ice are identified, and research activities of various groups, committees and institutions are described, with emphasis on interdisciplinary aspects of snow and ice research and the need for cooperation among various disciplines.

**MP 294**
**LONG-CHAIN ALCOHOL SUPPRESSION OF SNOW EVAPORATION.**
Meiman, J.R., et al, *American Society of Civil Engineers. Hydraulics Division. Journal,* Nov. 1967, 93(HY6), p.271-279, Microform No. SIP 25779. 13 refs.
Slaughter, C.W.
25-4136
SNOW EVAPORATION, EVAPORATION CONTROL.
Results obtained from studies of hexadecanol distribution on a melting snow surface using isotopes and autoradiographs are given. In addition, investigations of complimentary pan evaporation studies describe the method of applying alcohols and give the effects of a specific mixture of long-chain alcohols on snow evaporation. The combined results indicate that long-chain alcohols can spread on a melting snow surface. Under the conditions of the study, 10 percent emulsion applications of a hexadecanol-octadecanol mixture were far superior to powder applications. An average reduction of 38.3 percent was obtained with this mixture in those runs having evaporation reductions significant at the 5 percent level.

**MP 295**
**ANTARCTIC ICE BUDGET (AND PLEISTOCENE VARIATIONS OF ICE VOLUME).**
Mellor, M., In Fairbridge, R.W. (ed.), Encyclopedia of atmospheric sciences and astrogeology. Encyclopedia of earth sciences series, Volume II., New York,, p.16-19, 9 refs.
23-3880
GLACIER MASS BALANCE, GLACIER FLOW, ICEBERGS, ABLATION, PLEISTOCENE, ANTARCTICA.

**MP 296**
**GREENLAND MASS BALANCE FLUX DIVERGENCE CONSIDERATIONS.**
Mellor, M., *International Association of Scientific Hydrology. Publication,* Jan. 1968 , No.79, p.275-281, In English, with French summary. 10 refs.
24-691
GLACIER MASS BALANCE, ICE COVER THICKNESS, STRAIN RATE.
An equation is presented, relating the fluctuations of glacier thickness with time to surface accumulation rate, principal flow velocity, and principal strain rates in the flow direction and cross-slope direction. Strain rates analyzed from measurements of structural deformation, together with other relevant data, indicate a strong positive balance at two sites in southern Greenland, and perhaps a weak negative balance at a site in northern Greenland. A new analysis of previously published data for central Greenland indicates a negative balance for that region. While the results to date are rather unconvincing, the flux divergence approach to mass balance studies appears to hold considerable promise.

**MP 297**
**BRIEF REVIEW OF SNOWDRIFTING RESEARCH.**
Mellor, M., *National Research Council. Highway Research Board. Special report,* April 1970, No.115, Snow removal and ice control research. Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970, p.196-209, Includes discussion. 45 refs.
25-1798
SNOWDRIFTS, BLOWING SNOW, WIND FACTORS, RESEARCH PROJECTS.
The blowing-snow phenomenon is described, and practical procedures for controlling deposition of windblown snow are reviewed. Field methods are given for measuring velocity, particle concentration, mass flux, particle size, and their distributions with respect to height. The analysis of steady-state wind transport over a plane surface is outlined, and difficulties in extending the treatment to cover complex flow perturbations are stressed. Wind tunnel studies are reviewed, and modeling criteria for snowdrift simulation are given. Suggestions for future work includes semi-empirical model and prototype studies for short-term benefits, and extension of fundamental analyses and field observations for progress over the long term.

**MP 298**
**OVERSNOW TRAVEL : FLYING.**
Mellor, M., *Polar notes,* June 1963, No.5, p.36-51, Microform No. SIP 21532.
25-2040
AIRPLANES, TRANSPORTATION, COLD WEATHER OPERATION.
Aircraft capable of taking off from, and landing upon, snow-covered surfaces are emphasized in the development of oversnow flying. Polar region expeditions, bush flying and other oversnow flying missions are described in chronological sequence showing the use of lighter-than-air craft and ski-planes. The information on plane types, pilots, and circumstances in the disasters and rescue work that occurred gives a good account of the experiences acquired which have fostered present-day successful flying. Problems of snow, cold, and high altitudes are discussed in relation to aircraft using ski and wheel landing gear, visibility factors, high altitude take-off, low temperatures and icing, and high-latitude navigation

**MP 299**
**ICE FORMATION IN POLAR REGIONS.**
Mellor, M., Encyclopaedic Dictionary of Physics. Supplementary Vol. 1, Oxford, England,, p.132-137, 7 refs.
25-2059
ICE FORMATION, GLACIER ICE.

**MP 300**
**SOME OPTICAL PROPERTIES OF SNOW.**
Mellor, M., *International Association of Scientific Hydrology. Publication,* 1966, No.69, p.128-140, 9 refs. French summary. For another version of this paper and abstract see 24-3316.
25-2094
LIGHT SCATTERING, ABSORPTIVITY, REFLECTANCE, SNOW DENSITY, SNOW OPTICS.

**MP 301**
**LIGHT SCATTERING AND PARTICLE AGGREGATION IN SNOW-STORMS.**
Mellor, M., *Journal of glaciology,* June 1966, 6(44), p.237-248, French and German summaries. Includes appendix. 5 refs.
25-2136
LIGHT SCATTERING, SNOWSTORMS, VISIBILITY, SNOW OPTICS.
Attenuation of visible radiation by falling snow was studied by a method based on brightness contrast between topographic features and the adjacent sky. Extinction coefficient and visual range are related to bulk snow density, and are compared with data for Antarctic blizzards. The process of particle aggregation and snow-flake formation during fall is considered by collision theory, and an expression describing aggregation effects is developed. This offers an explanation for the relative constancy of particle concentration observed at ground level during snowfalls of varying intensity. Since there is no strong justification for relating extinction coefficient to snow density, an empirical correlation between extinction coefficient and precipitation rate is given for practical use. It is shown that visual range estimated by eye in hilly terrain may be less than the true value, since the sky brightness is locally reduced over broad hill-tops with low albedo.

**MP 302**
**SNOW MECHANICS.**
Mellor, M., *Applied mechanics reviews,* May 1966 , 19(5), p.379-389, 87 refs.
25-2137
SNOW MECHANICS.

**MP 303**
**BUILDING ON POLAR ICE CAPS.**
Mellor, M., *Polar notes,* Nov. 1961, No.3, p.1-19, Microform No. SIP 21366.
25-2196
ENGINEERING, UTILITIES, BUILDINGS, SNOW (CONSTRUCTION MATERIAL), SNOW MECHANICS, CONSTRUCTION.
The development of building techniques to establish camps on polar snowfields and inland ice since 1900, to the present New Byrd Station, Camp Century, and radar stations is described. Investigations in Greenland and Antarctica have given information on the ice cap environment, surface, and snow as an engineering material. Principles of modern cold-regions construction are summarized in building concepts for movable buildings on skids, buildings elevated on stilts, load-resistant shells and buildings inside unrestrained undersnow tunnels or roofed trenches. Snow is considered as a visco-elastic building material with specific engineering properties for use in undersnow camps, structural elements, and foundations. Snow excavation, water supply, sewage disposal, and heating and ventilating are discussed as new and efficient systems.

**MP 304**
**ICE FLOW IN ANTARCTICA.**
Mellor, M., *Journal of glaciology,* March 1959, 3(25), p.377-385, German summary. 8 refs. Microform No. SIP 17342.
25-2216
GLACIER MOVEMENT, VELOCITY MEASUREMENT, CALVING, ANTARCTICA.
A number of measurements of ice flow in the coastal regions of Antarctica are given. Observations show that the general outward movement of the continental ice, termed "sheet flow", is locally accelerated where "ice streams" are formed. Estimates indicate that ice streams, which only occupy a small fraction of the total length of coast, are responsible for the removal of more ice from the continent than the "sheet flow" over the remaining length of coast. Further estimates suggest that the great bulk of Antarctica icebergs are produced by ice shelves, but that data on ice shelf movement are inadequate at the time of writing.

**MP 305**
**MASS BALANCE STUDIES IN ANTARCTICA.**
Mellor, M., *Journal of glaciology,* Oct. 1959, 3(26), p.522-533, French and German summaries. 28 refs. Microform No. SIP 17893.
25-2217
GLACIER MASS BALANCE, ACCUMULATION, ABLATION, SNOWDRIFTS, ANALYSIS (MATHEMATICS), ANTARCTICA.

The general characteristics of the coastal region from 45 - 80 E long. are described, and the results of measurements of accumulation, snow transport, ice flow, and ablation in 1957-58 are reported. These estimates are compared with old and new observations from other parts of Antarctica and the problem of bottom melting is examined. The mass budgets for the sector studied and the whole of Antarctica are estimated, indicating a surplus of accumulation over losses. The mean annual precipitation is determined as 14 cm. of water, a value lying between the estimates of Meinardus and Kosack.

**MP 306**
**CREEP TESTS ON ANTARCTICA GLACIER ICE.**
Mellor, M., *Nature,* Aug. 29, 1959, Vol. 184(Suppl. 10), p.717, 6 refs. Microform No. SIP 17735.
25-2218
GLACIER ICE, ICE CREEP, COMPRESSIVE PROPERTIES, STRAIN RATE, ANTARCTICA.
Glen's flow law of ice and supporting evidence are outlined, and the results of tests by the Australian National Antarctica Research Expedition I during the IGY are reported briefly. The compression creep tests were made in a stress range from 2-15 bars on randomly orientated antarctic ice of a density of about 0.87 gm/cc. at -30 C. The ice was characterized by air inclusions (0.6 mm. in diam.) under pressure. The exponent for flow of the ice was 4.2, suggesting that the cellular structure does not significantly alter the power in the relation between strain rate and stress. The coefficient K in the flow law was found to be 5x1/1000 at 30 C, or more than a magnitude larger than that of Glen. This indicates that the presence of numerous small air bubbles leads to easier deformation at a given stress and temperature. At a strain rate of 6 bars, the strain rate of the bubbly ice at -30 C was equal to the strain rate of the ice used by Glen at -10 C.

**MP 307**
**VARIATIONS OF THE ICE MARGINS IN EAST ANTARCTICA.**
Mellor, M., *Geographical journal,* June 1959, 125(2), p.230-235, 18 refs. Microform No. SIP 18724.
25-2219
GLACIER OSCILLATION, GLACIER MASS BALANCE, ANTARCTICA.
The results of personal studies based on aerial photographs taken in 1936 and 1957 and botanical evidence on the fluctuations of the ice margin at the coast of Mac-Robertson Land and Kemp Land during the past century and changes on a larger time-scale (post-Pleistocene) are reported. The photographic studies show that the ice has suffered neither thinning nor retreat to any detectable extent in the last 21 yr., and botanical evidence suggests that the volume of ice may have been constant for a longer period. Photographic evidence from McMurdo Sound shows that only negligible changes have occurred in that region in 46 yr. The evidence suggests that the major glacial recession was initiated not less than 10,000 yr. ago, and Russian estimates seem to indicate that the glacial decline from the Pleistocene max. and the onset of the Climatic Optimum in Antarctica occurred contemporaneously with these events in other parts of the world.

**MP 308**
**TEMPERATURE GRADIENTS IN THE ANTARCTICA ICE SHEET.**
Mellor, M., *Journal of glaciology,* Oct. 1960, 3(28), p.773-782, French and German summaries. 19 refs. Microform No. SIP 18891.
25-2220
ICE TEMPERATURE, TEMPERATURE GRADIENTS, TEMPERATURE MEASUREMENT, CLIMATIC CHANGES, ANTARCTICA—MAC. ROBERTSON LAND.
Measurements of ice temperature to depths of 30-40 m. are given for a number of points on the ice sheet in MacRobertson Land. Variations of mean surface temperature with elevation and with latitude, and the temperature gradients below a depth of 15 m. are compared with results from other parts of Antarctica and from Greenland. Surface ice velocities necessary for development of the observed temperature gradients are computed, and these values are then compared with ice velocities estimated independently from flow measurements at the coast and continuity considerations. It is found that, if negative gradients are attributed solely to the Robin effect, improbably high ice velocities are called for, and so climatic change is reconsidered. It is concluded that the measured temperature profiles can be explained reasonably by climatic amelioration.

**MP 309**
**GAUGING ANTARCTIC DRIFT SNOW.**
Mellor, M., Symposium on Antarctic Meteorology, Melbourne, 1959. Proceedings, London,, p.347-358, 8 refs. Microform No. SIP 18922.
25-2222
SNOWDRIFTS, SNOW GAGES, ANTARCTICA.
Two types of snow-traps designed to measure drifting snow density at various heights above the ground are described. These traps have rocket and airfoil shapes, respectively, and remove the snow from an air-stream by expanding the stream's cross-section and thus reducing its velocity approx, 50 per cent. The traps orient themselves into the direction of the wind and contain no impediments to the passage of air. The traps can be set at heights 4-400 cm. above the snow surface. The rocket-type trap was found to collect with complete efficiency, whereas the airfoil type allowed some drifting snow to pass through.

**MP 310**
**GLACIER OBSERVATIONS IN NORTH-WEST SPITSBERGEN.**
Mellor, M., *Journal of glaciology,* March 1957, 3(21), p.61-66, Microform No. SIP 15323. 6 refs.
25-4137
GLACIER MOVEMENT, GLACIER THICKNESS, VELOCITY, NORWAY—SPITSBERGEN.
The results of investigations in the summer of 1955 on several glaciers in the Kongsfjord area are reported and compared with Ahlmann's observations in 1934. Studies were made on accumulation, ablation, firn limit, ice movement, and frontal variations. Data on the thickness, sp. gr. and water equivalent of annual firn layers at Isachsenfonna down to the 1945 level, those measured by Ahlmann for 1924-1934, surface velocity of Blomstrandbre and Kongsbre from July-Aug., and frontal variations of the Kongsbre system from 1906-1955 are tabulated and graphed. The annual surplus accumulation in the region was found to have increased in recent years, and an overall drop in the recession of glaciers since 1936 was noted.

**MP 311**
**AUSTRALIAN GLACIOLOGICAL CONTRIBUTIONS IN ANTARCTICA.**
Mellor, M., *Journal of glaciology,* Oct. 1958, 3(24), p.279-285, Microform No. SIP 16812.
25-4138
SNOW SURVEYS, ICE SURVEYS, ANTARCTICA.
The results of studies from 1955-1958 by the ANARE on the coast of MacRobertson Land and on traverses are summarized. Annual net snow accumulation varied from 50 mm. of water to 200 mm. The total ice loss ranged from 220 mm. of water at 365 m. elevation to 535 mm. at 60 m. Melting was negligible above the firn line. The average rate of ice movement 14 km. from the sea was 5.75 cm./day. Pit studies revealed periodic variations in firn density with depth, and ice temperatures fell continuously with a gradient of less than 3 C/100 m. below the level of seasonal temperature changes at about 10 m. A big change in firn temperature was noted with elevation, while the latitude effect was small.

**MP 312**
**ANTARCTIC GEOPHYSICS.**
Mellor, M., *Tellus,* Nov. 1958, 10(4), p.498, 8 refs.
25-4139
ICE SUBLIMATION, EVAPORATION, ANTARCTICA.

**MP 313**
**PHOTOGRAMMETRIC FLOW MEASUREMENTS ON ANTARCTIC GLACIERS.**
Mellor, M., *American Geophysical Union. Transactions,* Dec. 1958, 39(6), p.1158, Microform No. SIP 16985.
25-4140
GLACIER FLOW, PHOTOGRAMMETRIC SURVEYS, FLOW MEASUREMENT, VELOCITY, ANTARCTICA.
The results of aerial photogrammetric measurements in 1957 of the movement of Jelbart Glacier in MacRobertson Land and Dovers and Hoseason Glaciers in Kemp Land are reported briefly, and the method is described. Comparison of 2 positions gave a direct measure of the displacement which had occurred between the 2 runs (a period of 120 days). The displacements at the scale of the prints ranged from 0.05-0.68 in., corresponding to velocities of 8.3-113 in./day. The method could be easily adapted to measure the movement of large inland ice streams having surface velocities more than 15 in./day.

**MP 314**
**ANTARCTIC ICE TERMINOLOGY: ICE DOLINES.**
Mellor, M., *Polar record,* Jan. 1960, 10(64), p.92, Microform No. SIP 18123.
25-4141
ICE, TERMINOLOGY.
The term "ice doline", as suggested by F. Loewe, is proposed for large steep-sided depressions found in glacier ice in Antarctica and Greenland. The earlier names used, such as ice calderas, crater-like formations, and ice volcanos, are inappropriate, since they are suggestive of volcanism; it seems better to draw a parallel with the subsidence which occurs in karst after the collapse of underground chambers. The depressions are believed to result from the collapse of surface ice after bodies of englacial water are drained.

**MP 315**
**POLAR SNOW A SUMMARY OF ENGINEERING PROPERTIES.**
Mellor, M., Kingery, W.D., ed. Ice and snow, properties, processes and applications, Cambridge, Mass., M.I.T., 1963, p.528-559, Microform No. SIP 22068. 33 refs.
25-4142
SNOW (CONSTRUCTION MATERIAL), SNOW MECHANICS, SNOW PHYSICS.
This review serves as an introduction to snow for the nonspecialist engineer and as a reminder of the many routine, but vital, experiments that are still required to define adequately the properties of snow. Included in the discussion are (1) the general characteristics of ice-cap snow (deposition, sublimatory metamorphism, densification, air permeability, and stratigraphy); (2) temperature changes within surface snow; (3) snow's response to loading; (4) elastic properties and ultimate strength; (5) elastic wave propagation (for sonic frequencies); (6) Poisson's ratio; (7) ultimate strength under rapid loading; (8) unconfined compressive strength; (9) tensile and shear strength; (10) snow hardness; and (11) viscoplastic, thermal, electrical, and frictional properties of snow.

**MP 316**
**PROMOTING THE DECAY OF SEA-ICE.**
Mellor, M., *Arctic,* June 1963, 16(2), p.142, Microform No. SIP 21372.
25-4143
SEA ICE, ICE MELTING.
Studies made on the flooded runway at McMurdo Sound show that the decay of sea-ice by hosing the ice surface with normal sea-water in the spring is possible. Surface salinity increases 20 to 30 percent, thus allowing a higher absorption of incident solar radiation. The net results of heat transfer processes reduce the treated ice to a low-strength porous condition early in the season. Hosing techniques may have application to free-flooding operations for thickening runways on sea-ice.

**MP 317**
**REMARKS CONCERNING THE ANTARCTIC MASS BALANCE.**
Mellor, M., *Polarforschung,* 1963 pub. Sept. 1964, 5(1/2), p.179-180, Microform No. SIP 22592.
25-4144
GLACIER MASS BALANCE, ANTARCTICA.
Recent studies have given a good outline of the Antarctic mass economy but the final state of the balance remains uncertain. A major source of error in estimates is the poor areal distribution of data, and therefore the possibility of correlating accumulation with a more widely measured parameter is examined. The accumulation data are used to predict the discharge of the Lambert Glacier after defining its drainage basin from surface form lines. Ice velocities for various parts of Antarctica are tabulated. The ice margins have shown no appreciable advance or retreat in recent decades. Transient temperature distributions in the ice reflect surface warming.

**MP 318**
**BRIEF REVIEW OF THE THERMAL PROPERTIES AND RADIATION CHARACTERISTICS OF SNOW.**
Mellor, M., *Polarforschung,* 1963 pub. Sept. 1964, 5(1/2), p.186-187, Microform No. SIP 22596.
25-4146
SNOW THERMAL PROPERTIES, REFLECTANCE.
In dry snow, with no forced convection, heat transfer can be analyzed by the standard heat conduction theory, utilizing a wide range of available solutions to the basic differential equation. Mathematical values are given for thermal conductivity, the diffusion coefficient for vapor diffusion in snow, apparent specific heat, latent heat of fusion and sublimation, thermal expansion, the spectral extinction coefficient for homogeneous snow, and the emissivity of snow. Reflectance depends on surface characteristics and sub-surface scattering and absorption. It varies appreciably with snow depth for thin snow covers. When deep snow is illuminated by diffuse light, spectral reflectance seems to decrease with increasing wave-length as required by the existing theory. In non-integrated direct sunlight, the converse occurs for some incidence angles. No correlation of reflectance with density has been found.

**MP 319**
**SOME GENERAL RELATIONSHIPS FOR IDEALIZED JET CUTTING.**
Mellor, M., *International Symposium on Jet Cutting Technology, 1st. Paper,* April 1972, A2, p.A2-25—A2-36, 4 refs.
26-3537
PRESSURE FACTORS PENETRATION, HYDRAULIC JETS, NOZZLES, ANALYSIS (MATHEMATICS).
An attempt is made to derive composite multi-variable relationships for penetration of semi-infinite materials by stationary jets and traversing jets. The required expressions relate penetration and specific energy to nozzle pressure, nozzle diameter, jet duration, and material properties for stationary jets, and to nozzle pressure, nozzle diameter, traverse speed and material properties for traversing jets. The procedure adopted involves systematic consideration of the general forms and boundary conditions of probable functional relationships, development of compatability between single-variable relationships, and dimensional considerations. The resulting equations can be fitted to experimental data to provide rational empirical relations.

**MP 320**
**JET CUTTING IN FROZEN GROUND.**
Mellor, M., *International Symposium on Jet Cutting Technology, 1st. Paper,* April 1972, G2, p.G2-13—G2-24, 7 refs.
26-3538
EXCAVATING EQUIPMENT, HYDRAULIC JETS, FROZEN GROUND, ICE CUTTING.
Results of experiments directed towards excavation of frozen ground by water jets are summarized and reviewed. Test results are analyzed, and an approach to design calculation is outlined. Several practical excavation problems are considered, and some estimates for the cutting of ice are given in an appendix.

**MP 321**
**ANTARCTIC SNOW AND ICE STUDIES.**
Mellor, M., ed., *American Geophysical Union. Antarctic research series,* 1964, Vol.2, 277p., Microform No. SIP 22616.
25-4145
GLACIOLOGY, SNOW COVER, GLACIER ICE, SURVEYS, ANTARCTICA.
Recent results are presented from Antarctic snow and ice research, including the work of the Ross Ice Shelf Survey. Since the IGY the U.S., by maintaining a vigorous Antarctic glaciological program, has made an impressive contribution of knowledge which is reflected in part by the 10 papers in this volume. New survey methods, geochemical techniques, and statistical data interpretations are some of the material presented.

**MP 322**
**CREEP OF SNOW AND ICE.**
Mellor, M., et al, International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 2, Sapporo, , p.843-855, Prepared as U.S. Army Cold Regions Research and Engineering Lab. RR 220. For abstract see 24-3362. 23 refs.
Smith, J.H.
23-1991
CREEP PROPERTIES, ICE CREEP, SNOW CREEP, STRESSES, STRAINS.

**MP 323**
**EFFECT OF TEMPERATURE ON THE CREEP OF ICE.**
Mellor, M., et al, *Journal of glaciology,* Feb. 1969 , 8(52), p.131-145, Summaries in French and German. 17 refs.
Testa, R.
23-5464
ICE CREEP, TEMPERATURE FACTORS, CREEP RATE, ICE CRYSTALS.
Creep tests on homogeneous, isotopic polycrystalline ice gave an apparent activation energy for creep of 16.4 kcal/mol (68.8 kJ/mol) over the temperature range -10 to -60 C. Above -10C the Arrhenius relation for temperature dependence is invalid, and creep rate becomes progressively more temperature dependent as the melting point is approached. Between -20 and -50C the apparent activation energy for creep of a single crystal of ice was found to be 16.5 kcal/mol). A complete creep curve for a single crystal loaded in uniaxial compression parallel to the basal plane was qualitatively similar to the classical creep curve; creep rate at all stages was very much faster than for polycrystalline ice under the same conditions. Creep tests on polycrystalline ice at 0C gave a stress/strain-rate relation for that temperature, but its precise meaning is unclear, since recrystallization complicated the results.

**MP 324**
**CREEP OF ICE UNDER LOW STRESS.**
Mellor, M., et al, *Journal of glaciology,* Feb. 1969 , 8(52), p.147-152, Summaries in French and German. 5 refs.
Testa, R.
23-5465
COMPRESSIVE PROPERTIES, ICE CREEP, STRAIN RATE.
Uniaxial compressive creep tests on fine-grained polycrystalline ice indicate that secondary strain-rate is proportional to sigma exp (1.8), where sigma is applied stress, for the range 0.1 smaller than sigma smaller than 0.5 kgf/sq cm (10 smaller than sigma smaller than 50 kN/sq m). On the basis of the present tests, earlier results suggesting linear viscous behaviour at low stress are believed to be invalid.

**MP 325**
**STRENGTH STUDIES ON SNOW.**
Mellor, M., et al, *International Association of Scientific Hydrology. Publication,* 1966, No.69, p.100-113, French summary. 13 refs. For another version of this paper and abstract see 24-3315.
Smith, J.H.
25-2095
SNOW STRENGTH, SNOW DENSITY, TEMPERATURE EFFECTS, COMPRESSIVE STRENGTH.

**MP 326**
**SOME PROPERTIES OF DRIFTING SNOW.**
Mellor, M., et al, Symposium on Antarctic Meteorology, Melbourne, 1959. Proceedings, London,, p.333-346, 11 refs. Microform No. SIP 18921.
Radok, U.
25-2221
SNOWDRIFTS, BLOWING SNOW, WIND FACTORS, MEASUREMENT.
Five sets of snow-drift measurements with new snow-traps were used for estimates of drift-snow density as a function of height. The expected drift densities at 4 and 200 cm. were computed from those observed at 100 and 400 cm. and compared with observations. The theoretical estimates and actual observations at the 200 cm. level were in reasonable agreement. At 4 cm., however, the observed values were substantially larger, indicating a different snow drift mechanism near the ground, similar to the "saltation" described for sand. The saltation drift transport is estimated at 10 per cent of the total

**MP 327**
**AMERY ICE SHELF AND ITS HINTERLAND.**
Mellor, M., et al, *Polar record,* Jan. 1960, 10(64), p.30-34, 10 refs. Microform No. SIP 18120.
McKinnon, G.
25-2223
ICE SHELVES, GLACIER MOVEMENT, ANTARCTICA.
The ice shelf, which occupies a large embayment consisting of Prydz and Mackenzie Bays, and neighboring areas are described in detail. The land boundaries of the ice shelf are well defined and large parallel crevasses mark the boundary between floating and landbased ice. Intense melting occurs on the slopes surrounding the shelf, so that big surface river systems develop over wide areas in summer. Around the S. edge of the ice shelf, a number of large, steep depressions ("ice dolines") were discovered on the glacier ice, one of which was oval in shape, 3 km. long, 1.3 km. wide, and 80 m. deep. Annual net accumulation, estimated from photographs of icebergs near the shelf, suggests that wind-blown snow provides a large portion of the net accumulation. The movement of the ice shelf, taking into account the ice streams discharging into it and surface accumulation, is estimated at 600 m./yr. or more.

**MP 328**
**MEASUREMENT OF TENSILE STRENGTH BY DIAMETRAL COMPRESSION OF DISCS AND ANNULI.**
Mellor, M., et al, *Engineering geology,* Oct. 1971, 5(3), p.173-225, 33 refs.
Hawkes, I.
26-2867
TENSILE STRENGTH, LOADS (FORCES), ROCK MECHANICS, COMPRESSIVE STRENGTH, ICE STRENGTH, MECHANICAL TESTS.
The validity of diametral compression tests for indirect measurement of tensile strength is investigated theoretically and experimentally. Linear elastic theory for diametral compression of discs and annuli by oppossed strip loads is reviewed, and the significance of failure criteria in fracture initiation and test interpretation is considered. Results of careful tests are given for three types of rock, two plastics, glass, and ice, and the experimental results are compared with theoretical expectations. While there are very serious objections to the ring test, the Brazil test is capable of giving a good measure of uniaxial tensile strength for Griffith-type materials. Practical problems involved in diametral compression testing are considered in some detail. Special attention is given to contact stresses under the applied loads, and a design is given for a loading jig that reduces contact stresses. Specimen dimension, size effects, loading rate, force readout, and specimen preparation are discussed, and some recommended practical procedures for Brazil tests are outlined.

**MP 329**
**REMOTE SENSING OF ICE AND SNOW THICKNESS.**
Meyer, M.A., Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.183-192, 2 refs.
25-2138
ICE COVER THICKNESS, REMOTE SENSING, SNOW DEPTH, RADAR ECHOES, DIELECTRIC PROPERTIES.
A high resolution monocycle v.h.f. radar has been developed and tested over lake ice. Tests were conducted with the U.S. Army Cold Regions Research and Engineering Laboratory using a boom as the antenna support in 1965, and using a moving helicopter as a support in 1966. Ice thickness and snow thickness were readily measured by visual data reduction. Thickness measurement accuracies of the order of 1 cm. are possible utilizing this technique. Results of measurements and the data taken are discussed as well as the expected results for such a measurement. The application of these measurements to the determination of dielectric constant is discussed.

**MP 330**
**ELECTRICALLY CONDUCTIVE ASPHALT FOR CONTROL OF SNOW AND ICE ACCUMULATION.**
Minsk, L.D., *Highway research record,* 1968 , No. 227, p.57-63, 7 refs.
23-4152
BITUMINOUS CONCRETES, ICE ACCRETION, HEATING, PAVEMENTS, ELECTRICAL RESISTIVITY, SNOW COVER, COUNTERMEASURES.

**MP 331**
**ICE PROPERTIES AND THEIR INFLUENCE ON AIRFIELD OPERATIONS.**
Minsk, L.D., *Rural and urban roads,* July 1967 , 5(7), p.72-73.
23-5405
ICE FORMATION, PAVEMENTS, GLAZE, ICE REMOVAL.

**MP 332**
**SHORT HISTORY OF MAN'S ATTEMPTS TO MOVE THROUGH SNOW.**
Minsk, L.D., *National Research Council. Highway Research Board. Special report,* April 1970, No.115, Snow removal and ice control research. Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970, p.1-7, 14 refs.
25-1782
SNOW REMOVAL EQUIPMENT, HISTORY, RAILROADS.

**MP 333**
**SNOW AND ICE PROPERTIES PERTINENT TO WINTER HIGHWAY MAINTENANCE.**
Minsk, L.D., *Highway research record,* 1965, No.94, p.28-44, 18 refs.
25-2096
ROAD MAINTENANCE, ICE FORMATION, SNOW MECHANICS, SNOW THERMAL PROPERTIES, ICE STRENGTH, MEASUREMENT.
The properties of snow important to highway maintenance engineers are density, temperature, hardness, and water content. Density is conveniently measured by removing samples of snow in 500-cu cm stainless steel tubes and weighing them on a spring scale. Temperature is measured in the field with a durable metal-stem dial thermometer. Hardness can be estimated from measurements of the penetration achieved by objects of various sizes, or more exactly by use of a ram penetrometer or Canadian hardness gage. Water content can also be estimated by a subjective test or measured more precisely by calorimetry. Details are included. A snow density kit developed by USA CRREL is described. The strength of snow varies and is very dependent on temperature and time. New snow will rapidly change its structure and become denser and harder, a process called metamorphism.

**MP 334**
**SOME SNOW AND ICE PROPERTIES AFFECTING VTOL OPERATION.**
Minsk, L.D., Symposium on Environmental Effects on VTOL Designs, Arlington Texas, 1970, New York, American Helicopter Society, [1970], 6p., 16 refs.
26-3378
ICE ADHESION, ICE STRENGTH, ICE ELECTRICAL PROPERTIES.
A number of properties of snow and ice directly influence operational characteristics of aircraft, and in particular VTOL's. The fact that icing conditions are most frequently encountered between 3,000 to 24,000 ft altitude means that the exposure of VTOL to incipient icing conditions will be high, seasonally and geographically. The most serious consequence of icing is the aerodynamic degradation of airfoils, propellers, and rotors. This paper will discuss the mechanism of ice adhesion, laboratory tests of the strength of adhesion of ice to various materials, and methods for reducing the adhesion. However, some other aspects of snow and ice are considered, such as the absorption of radiation by snow and ice, and the electrical properties of ice.

**MP 335**
**CALCULATED PATTERNS OF ACCUMULATION ON THE GREENLAND ICE SHEET.**
Mock, S.J., *Journal of glaciology,* Oct. 1967 , 6(48), p.795-803, In English, with French and German summaries. 15 refs. For another version of this paper and abstract see 24-3373.
23-1693
GLACIER MASS BALANCE, SNOWFALL, ACCUMULATION.

**MP 336**
**SNOW ACCUMULATION STUDIES ON THE THULE PENINSULA, GREENLAND.**
Mock, S.J., *Journal of glaciology,* Feb. 1968 , 7(49), p.59-76, 31 refs. For another version of this paper and abstract see 24-3377.
23-2648
SNOW COVER DISTRIBUTION, ACCUMULATION, GREENLAND—THULE.

**MP 337**
**TELLUROMETER TRAVERSE FOR A SURFACE MOVEMENT SURVEY IN N. GREENLAND.**
Mock, S.J., *International Association of Scientific Hydrology. Publication,* 1963, No.61, p.147-153, French summary. 3 refs. Microform No. SIP 21897.
25-2060
GLACIER ICE, GLACIER MOVEMENT, FLOW MEASUREMENT, GREENLAND—THULE.
During the summer of 1962, a surface movement study over a 130-mi profile was initiated on the Thule Peninsula lobe of the Greenland Ice Sheet. Forty-four stations were established. The traverse survey techniques used Wild T-3 theodolites for angle measurements and Tellurometer MRA-2 instruments for distances. Out stations were located by triangulation or traverse from main line stations. No statements as to the accuracy of the present survey can be made until the base points are connected to the existing control and the survey is adjusted. A resurvey of the necessary connections to control is scheduled

for 1965 and will be repeated at 2- or 3-yr intervals thereafter. A brief discussion of the problems and techniques of ice sheet surveying is presented.

**MP 338**
**FLUCTUATION OF THE TERMINUS OF THE HARALD MOLTKE BRAE, GREENLAND.**
Mock, S.J., *Journal of glaciology,* Oct. 1966 , 6(45), p.369-373, French and German summaries. 12 refs. For another version of this paper and abstract see 24-3133.
25-2139
GLACIER FLOW, GLACIER OSCILLATION.

**MP 339**
**CLASSIFICATION OF CHANNEL LINKS IN STREAM NETWORKS.**
Mock, S.J., *Water resources research,* Dec. 1971, 7(6), p.1558-1566, 6 refs.
26-2863
CHANNELS (WATERWAYS), CLASSIFICATIONS, STREAMS, MODELS, STATISTICAL ANALYSIS.
Differences in the length properties and occurrence frequencies among types of channel links occur in natural stream networks. We define six types of channel links: (1) S (source) links, (2) TS (tributary source) links, (3) B (bifurcating) links, (4) TB (tributary bifurcating) links, (5) CT (cis-trans) links, and (6) T (tributary) links. The topologically random model of channel networks provides the basis for a series of equations defining the probability of occurrence of each link type in a topologically random population of networks of any specified magnitude. Examination of interior link lengths from 12 stream networks supports the hypothesis that the interior link types defined here differ in their length properties.

**MP 340**
**GLACIOLOGICAL OBSERVATIONS IN NORTH-CENTRAL GREENLAND.**
Mock, S.J., et al, *Journal of glaciology,* June 1968 , 7(50), p.353-354, 2 refs.
Weeks, W.F.
23-2955
ACCUMULATION, TEMPERATURE VARIATIONS, GREENLAND.

**MP 341**
**DISTRIBUTION OF 10 METER SNOW TEMPERATURES ON THE GREENLAND ICE SHEET.**
Mock, S.J., et al, *Journal of glaciology,* Feb. 1966 , 6(43), p.23-41, French and German summaries. 25 refs. Microform No. SIP 24594.
Weeks, W.F.
25-2140
TEMPERATURE DISTRIBUTION, SNOW TEMPERATURE, ISOTHERMS, ANALYSIS (MATHEMATICS).
All available 10-m snow temperatures from the Greenland Ice Sheet have been analyzed using multiple regression techniques to develop equations capable of accurately predicting these temperatures. The analysis was conducted for all Greenland and for various sub-areas. The resulting equations show that 10-m snow temperatures can be accurately predicted from the latitude and elevation parameters. Longitude was found to be a further significant parameter in south Greenland. Gradients of 10-m snow temperatures versus elevation for north Greenland are close to the dry adiabatic lapse rate; for south Greenland and the Thule peninsula, they are markedly greater than the dry adiabatic lapse rate and are highly dependent upon elevation. An isotherm map, showing the distribution of 10-m snow temperatures on the Greenland Ice Sheet calculated from the prediction equations was prepared.

**MP 342**
**ERRORS IN SHORT-TERM ABLATION MEASUREMENTS ON MELTING ICE SURFACES.**
Mueller, F. , et al, *Journal of glaciology,* Feb. 1969 , 8(52), p.91-105, Summaries in French and German. 23 refs.
Keeler, C.M.
23-5462
GLACIER MASS BALANCE, ABLATION.

**MP 343**
**SELF-DIFFUSION OF SODIUM IONS IN FROZEN WYOMING BENTONITE-WATER PASTE.**
Murrmann, R.P., et al, *Soil Science Society of America. Proceedings,* July-Aug. 1968 , 32(4), p.501-506, 28 refs.
Hoekstra, P., Bialkowski, R.C.
23-3763
ION DIFFUSION, FROZEN GROUND CHEMISTRY, FROZEN GROUND, TEMPERATURE FACTORS.
Self-diffusion of sodium ions in frozen Na-Wyoming bentonite paste was studied at different subzero temperatures using a radioactive tracer technique. The value of the apparent self-diffusion coefficient decreased rapidly from 8.8 x 1/1,000,000 sq cm/sec at -0.6C to 4.3 x 1/1,000,000 sq cm/sec at -3.0C but then decreased slowly to 1 7 x 1/1,000,000 sq cm/sec at -15.0C. Thus, the rate of ion diffusion in the frozen bentonite paste was relatively high even at low temperatures. The reduction in ion mobility with decreasing temperature was primarily a consequence of a concurrent decrease in film thickness of the unfrozen water.

**MP 344**
**IONIC DIFFUSION AT THE ICE-SOLID INTERFACE.**
Murrmann, R.P., et al, *National Research Council. Highway Research Board. Special report,* April 1970, No.115, Snow removal and ice control research. Proceedings of an international symposium held at Dartmouth College, Hanover, New Hampshire, April 8-10, 1970, p.78-86, Includes discussion. 14 refs.
Anderson, D.M., Peek, J.W.
25-1788
ION DIFFUSION, ICE SOLID INTERFACE, ICE PREVENTION, ICE REMOVAL, DIFFUSIVITY.
Diffusion of 22NaCl at the ice-aluminum interface was determined in investigating the nature of water at this junction. The average value of the diffusion coefficient of sodium ions was determined at 6 different times ranging from 8 to 28 days after introduction of the ions to the interface. Comparison of this coefficient with that of the diffusion coefficient for ionic diffusion in bulk liquid water and with that expected for ionic diffusion in ice indicates that the properties of the interface are considerably different from those of either bulk liquid water or ice. Lack of any consistent time dependence of the diffusion coefficient suggests that the nature of the interface was little disturbed by the addition of sodium chloride. These observations support the view that a transition zone 5 to 10 Å thick with liquid-like properties exists at this interface. A model of this concept of the ice-solid interface is proposed.

**MP 345**
**DETERMINATION OF TRACE ELEMENTS IN SOILS AND CLAY MINERALS BY RESONANCE NEUTRON ACTIVATION ANALYSIS.**
Murrmann, R.P., et al, *Soil Science Society of America. Proceedings,* July-Aug. 1971, 35(4), p.647-652, 16 refs.
Winters, R.W., Martin, T.G.
26-904
CLAY MINERALS, SOIL CHEMISTRY, NEUTRON ACTIVATION ANALYSIS, ISOTOPIC LABELING, NEUTRON IRRADIATION.
Bentonites 23 and 25, Umiat bentonite, Koalinite 7, Halloysite 29, Illite 35, and Fairbanks, Barrow, and Suffield silts were irradiated with resonance neutrons by exposure of cadium shielded samples in a reactor for 40 hours in order to identify the elements having long half-life nuclides which could be quantitatively determined using nondestructive neutron activation analysis. By examination of the gamma-ray spectra obtained using a high resolution Ge(Li) detector, it was possible to identify Fe, Ti, Zn, Ni, Co, Cr, Sr, Ba, Cs, La, Eu, Tb, Hf, Ta, Th, and U in most of the samples. Although quantitative results were obtained only for Fe, Ti, Zn, Ni, Co, and Cr, this method appears suitable for nondestructive quantitative analysis of all the elements identified.

**MP 346**
**STATISTICAL METHOD FOR ANALYSIS OF DIFFUSION IN SOILS.**
Nakano, Y., et al, *Soil Science Society of America. Proceedings,* May-June 1971, 35(3), p.397-402, 20 refs.
Murrmann, R.P.
26-2336
ION DIFFUSION, FROZEN GROUND, STATISTICAL ANALYSIS, TEMPERATURE GRADIENTS, VAPOR DIFFUSION.
A special Monte Carlo method for use in investigating problems which involve random processes is developed. This approach differs from the usual Monte Carlo method for solution of differential equations in that the random process itself is constructed directly. The power of this approach is demonstrated by application of the method using two examples. In one case, the effect of thermal gradient on ionic diffusion through thin films of interfacial water in frozen clay is examined. The predicted ionic distribution is in agreement both with experimental data and with the result obtained by exact solution of the diffusion equation. In the second example, the distribution of acetone deposited in soil near the soil-atmosphere interface is calculated for a two-layer profile in which the adsorption coefficient and void-porosity vary between horizons.

**MP 347**
**EFFECT OF A FREEZING ZONE OF FINITE WIDTH ON THE THERMAL REGIME OF SOILS.**
Nakano, Y., et al, *Water resources research,* Oct. 1971, 7(5), p.1226-1233, 19 refs.
Brown, J.
26-2388
SOIL MOISTURE, SOIL TEMPERATURE, SOIL FREEZING, THERMAL REGIME, ANALYSIS (MATHEMATICS), UNFROZEN WATER CONTENT, ARTIFICIAL FREEZING.
The effect of a freezing zone of finite width on the thermal regime of soils is studied. For soils having a very thin freezing zone, the concept of an artificial freezing zone is introduced for computational simplicity. The computational method based on such a concept is found to be sufficiently accurate for practical applications. The classical method, which assumes the existence of a freezing boundary of infinitesimal width, produces a large error for soils retaining substantial amounts of unfrozen water at sub-zero temperatures.

**MP 348**
**MATHEMATICAL MODELING AND VALIDATION OF THE THERMAL REGIMES IN TUNDRA SOILS, BARROW, ALASKA.**
Nakano, Y., et al, *Arctic and alpine research,* Winter 1972, 4(1), p.19-38, 16 refs.
Brown, J.
26-3071
TUNDRA SOILS, THERMAL REGIME, COMPUTERIZED SIMULATION, SOIL TEMPERATURE, THAW DEPTH, FROZEN GROUND THERMODYNAMICS, THERMAL DIFFUSIVITY, TUNDRA BIOME, THERMAL CONDUCTIVITY.
Efforts were made to develop a mathematical model of the thermal regimes in tundra soils. The results of field investigations during the summer and fall of 1970 in the vicinity of Barrow, Alaska, were used for validation of the model. Accuracy in simulating the field observations by the model is found satisfactory. Effects of important factors affecting the thermal regime are also discussed.

**MP 349**
**LIFTING FORCES EXERTED BY ICE ON STRUCTURES.**
Nevel, D.E., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* March 1968 , No.92, Ice pressures against structures, proceedings of a conference held at Laval University, Quebec, 10-11 November 1966, p.155-161, 6 refs.
23-4235
ICE LOADS, THERMAL EXPANSION, STRUCTURES, FLOATING ICE.
If a floating ice sheet is connected to a structure when the water level is increased, the ice sheet will be bent and a lifting force will be exerted on the structure. In this paper, cylindrical bending of the ice sheet is considered such as occurs near a long structure and symmetrical bending such as occurs near an isolated pile. The ice sheet is considered as a homogeneous isotropic plate resting on an elastic foundation of the Winkler type. The deflections and thickness of the plate will be assumed to be small. The ice is considered as a linear viscoelastic material that has an indefinite bulk modulus and a shear model which obeys a Maxwell model. A solution is given of the problem when the rise in water level is composed of a linear combination of ramp functions of time which can be made to approximate any function. In order to easily determine the long time effects, the ice is considered viscous under shear. For this case solutions are given when the change of water level is a ramp function, a step function, and a sine function. In addition to the above subject, a brief note is presented on thermal stresses in a floating ice sheet when the ice is considered viscoelastic.

**MP 350**
**VIBRATION OF A FLOATING ICE SHEET.**
Nevel, D.E., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* Nov. 1970, No.98, p.57-65, 2 refs.
26-1250
FLOATING ICE, ICE ELASTICITY, ANALYSIS (MATHEMATICS).
The paper considers the forced and free vibrations of an infinite ice sheet floating on water and evaluates the solutions.

**MP 351**
**VOYAGE OF THE S.S. "MANHATTAN".**
Nevel, D.E., et al, *Military engineer,* March-April 1970, 62(406), p.80-82.
Weeks, W.F.
25-4147
ICEBREAKERS, ICE MECHANICS, S.S. MANHATTAN.
A series of tests of the icebreaking capacilities of the Manhattan were carried out in a homogeneous area of ice selected by helicopter reconnaissance, during which continuous measurements of thrust and vessel velocity were made. At the completion of each test, ice thickness, temperature and salinities as well as strength and Young's modulus were measured along the test track to characterize the state of ice.

**MP 352**
**VISIBILITY AND LIGHT ATTENUATION IN FALLING SNOW.**
O'Brien, H.W., *Journal of applied meteorology,* Aug. 1970, 9(4), p.671-683, 25 refs.
25-1053
LIGHT SCATTERING, ATMOSPHERIC ATTENUATION, VISIBILITY, SNOWFALL, OPTICAL PHENOMENA.
The attenuation of visible light by falling snow was studied by making simultaneous determinations of attenuation coefficients and snow concentration. The attenuation coefficients was calculated from photometric measurements and from visual observations. Snow concentration in the air was evaluated by two methods: Formvar replicas collected during the snowfall, and mass accumulation of snow in collecting pans. The snowflakes were arbitrarily classified by crystal types according to their

estimated fall velocity. It was found that the correlation between extinction coefficient and snow concentration was generally much higher by types than when all snowflakes were considered together regardless of crystal components and degree of riming. When no fog is present during the snowfall, the experimental results for some snow types coincide well with attenuation theory if a reasonable correction is applied to the values obtained in the measurement of snowflake diameters. Measurements of mass flux indicate that for a given intensity the attenuation caused by snow is an order of magnitude greater than that caused by the same mass flux of rain.

**MP 353**
**FORCES ON A SPHERE MOVING STEADILY ALONG A CIRCULAR PATH IN A VISCOUS FLUID.**
Odar, F., *Journal of applied mechanics,* June 1968 , 35(2), p.238-241.
23-3049
FLUID DYNAMICS, EXPERIMENTATION, DRAG.
Forces on a sphere moving steadily along a circular path in a viscous fluid are measured and it is found that within the experimental range both the tangential and normal forces are dependent on the Reynolds number and not on the radius of the path; and it is found that the conventional drag coefficient can also be applied to a rotational motion.

**MP 354**
**UNSTEADY MOTION OF A SPHERE ALONG A CIRCULAR PATH IN A VISCOUS FLUID.**
Odar, F., *Journal of applied mechanics,* Dec. 1968 , 35 Ser. E (4), p.652-654, 6 refs. For another version of this paper and abstract see 24-3389.
23-5237
FLUID MECHANICS, UNSTEADY FLOW, HYDRODYNAMICS, SPHERES, VISCOUS FLUIDS, ANALYSIS (MATHEMATICS).

**MP 355**
**FORCES ON A SPHERE ACCELERATING IN A VISCOUS FLUID.**
Odar, F., et al, *Journal of fluid mechanics,* 1964, 18(2), p.302-314, 8 refs.
Hamilton, W.S.
25-2061
FLUID MECHANICS, FLUID DYNAMICS, SPHERES, ANALYSIS (MATHEMATICS), ACCELERATION (PHYSICS).
A detailed equation is proposed for the force exerted on a sphere that accelerates rectilinearly in otherwise still fluid. In addition to the buoyant force, the fluid exerts forces that depend on (a) the velocity of the sphere, (b) the acceleration of the sphere and (c) the history of the motion. The equation reduces to the known theoretical solution for low velocity and large acceleration. The proposed equation was tested and found most satisfactory for a particular case in which the velocity was not small, viz. the case of simple harmonic motion along a straight line. The acceleration (added mass) and history coefficients in the equation were evaluated experimentally. They were found to depend on the ratio of the convective acceleration to the local acceleration as measured by the parameter V sq/aD, in which V, a and D are the velocity, acceleration and diameter of the sphere, respectively. The Reynolds numbers varied from 0 to 62 during the tests.

**MP 356**
**RADIOCARBON DATING OF ICE.**
Oeschger, H., et al, *Earth and planetary science letters,* March 1966 , 1(2), p.49-54, 7 refs.
Alder, B., Loosli, H., Langway, C.C., Jr., Renaud, A.
23-3769
RADIOCARBON DATING, ICE DATING, MEASURING INSTRUMENTS.
A counter for C14-dating is described, which allows measurements of samples containing only 20 to 100 mg of carbon. It has been used for dating of ice samples from the Tuto tunnel near Thule, Greenland. In addition to the generally used precipitation technique of carbon dioxide from the melting ice by NaOH, trapping by molecular sieves was successfully applied.

**MP 357**
**CARBON DATING OF ICE AND OTHER ISOTOPE STUDIES AT BYRD STATION, ANTARCTICA.**
Oeschger, H., et al, *Antarctic journal of the United States,* July/Aug. 1970, 5(4), p.112, 2 refs.
Stauffer, B., Langway, C.C., Jr.
25-848
ICE DATING, CARBON ISOTOPES, ICE SAMPLING, ISOTOPES, ANTARCTICA—BYRD STATION.

**MP 358**
**AN IN SITU GAS-EXTRACTION SYSTEM TO RADIOCARBON DATE GLACIER ICE.**
Oeschger, H., et al, *Journal of glaciology,* Oct. 1967 , 6(48), p.939-942, French and German summaries. 5 refs. Microform No. SIP 25936. For another version of this paper and abstract see 24-3376.
Alder, B., Langway, C.C., Jr.
25-2167
GLACIER ICE, RADIOCARBON DATING, BOREHOLES, GAS EXTRACTION.

**MP 359**
**HIGH-PRESSURE APPARATUS FOR OPTICAL STUDIES AT 77K.**
Offen, H.W., et al, *Journal of applied physics,* Dec. 1967 , 38(13), p.5245-5248, 19 refs.
Tanquary, R.L., Sterrett, K.F.
25-2173
ABSORPTION, LUMINESCENCE, OPTICAL MEASURING INSTRUMENTS, SOLIDS.
A high-pressure optical cell, modeled after the Drickamer cell I, has been developed for absorption and luminescence in the 0-40 kbar and in the 77-383K ranges. The windows consist of a NaCl-sapphire combination in order to retain transparency down to 77K. The window transmission varies as a function of temperature and/or pressure between tolerable limits. The largest contribution to nonreproducible errors in intensity measurements arises from the sample-salt interfaces. The pressure scale has been approximately determined at low temperatures by means of sudden changes in light transmission during the KCl phase transformation around 20 kbar. The liquid-solid phase transition in heptane is also studied.

**MP 360**
**INFLUENCE OF HIGH PRESSURES AND LOW TEMPERATURES ON THE ABSORPTION SPECTRA OF ALPHA, ALPHA-DIPHENYL-BETA-PICRYLYDRAZYL.**
Offen, H.W., et al, *Spectrochimica acta,* Jan. 1968, 24A(1), p.31-39, 30 refs.
Sterrett, K.F.
25-2180
SPECTROSCOPY, PRESSURE FACTORS, TEMPERATURE FACTORS, ABSORPTION SPECTRA, DPPH.
The absorption spectrum of DPPH has been studied in the 0-40 kbar range at 295k, 193K and 77K. The influence of these environmental pertubations was investigated for DPPH crystals dispersed in a sodium chloride matrix and for DPPH monomolecularly dispersed in cellulose acetate films. Near 30 kbar the broad absorption in the visible spectrum of isolated DPPH, attributed to orbital promotion of the odd electron, becomes broader and is displaced 300-600 cm/10 (in the 295-77K temperature range) toward longer wavelengths. For the crystalline material a small pressure dependence of the center of gravity of the visible band is observed. At the higher pressures two band peaks, separated by 900 cm/10 emerge from the nearly symmetric band. The second component manifests itself on the short wavelength side of the original, red-shifted peak. The ultraviolet absorption showed a comparable shift for DPPH and a larger shift for the corresponding parent hydrazine in plastics at relatively low pressures. The DPPH system exhibits some unusual environmental responses compared to other pi-systems. The crystal spectra suggest phase changes at higher pressures.

**MP 361**
**GRAVITY AND MAGNETIC OBSERVATIONS FROM ICE ISLAND ARLIS II OFF THE CHUKCHI SHELF.**
Ostenso, N.A., et al, Symposium on Arctic Drifting Stations, Warrenton, Va., April 12-15, 1966. Proceedings, Washington, , p.459-470, 8 refs.
DenHartog, S.L., Black, D.J.
24-870
GRAVIMETRIC PROSPECTING, MAGNETIC SURVEYS, DRIFT STATIONS, ARCTIC OCEAN.

**MP 362**
**BOTTOM TOPOGRAPHY OF GULKANA GLACIER, ALASKA RANGE, ALASKA.**
Ostenso, N.A., et al, *Journal of glaciology,* June 1965, 5(41), p.651-660, French and German summaries. 18 refs. Microform No. SIP 23351.
Sellmann, P.V., Péwé, T.L.
25-2099
GLACIER MOVEMENT, GRAVIMETRIC PROSPECTING, GLACIER THICKNESS, UNITED STATES—ALASKA—GULKANA GLACIER.
As an extension of an intensive study of Gulkana Glacier, a 42 station gravimeter survey was made to gain insight into its third dimension. This survey showed that the glacier's main tongue occupies a complex valley composed essentially of 2 parallel channels separated by a medial ridge which extends southward from rock bastions in the accumulation zone. At mid-glacier, the ice thickness in the larger eastern channel is 225 m, in contrast to 130 m in the western channel. The medial ridge degenerates down glacier probably disappearing within 2 km of the glacier terminus. The basic surface flow pattern of the glacier described by Moores can be adequately explained by this basal topography. Seasonal velocity variations are possibly caused by meltwater basal lubrication with one channel being favored over the other at different times of the year.

**MP 363**
**DETERMINATION OF THE RATE OF SNOW ACCUMULATION AT THE POLE OF RELATIVE INACCESSIBILITY, EASTERN ANTARCTICA: A COMPARISON OF GLACIOLOGICAL AND ISOTOPIC METHODS.**
Picciotto, E. , et al, *Journal of glaciology,* June 1968 , 7(50), p.273-287, 41 refs.
Cameron, R.L., Crozaz, G., Deutsch, S., Wilgain, S.
23-2945
ACCUMULATION, ANTARCTICA—POLE OF INACCESSIBILITY.

**MP 364**
**FOG MODIFICATION BY USE OF HELICOPTERS.**
Plank, V.G., et al, National Conference of Weather Modification, 2d, Santa Barbara, Calif., April 6-9, 1970. Preprints of papers, American Meteorological Society, p.117-121, 3 refs.
Spatola, A.A., Hicks, J.R.
25-2236
FOG DISPERSAL, HELICOPTERS, VISIBILITY.
Helicopter fog-clearing results observed during 35 hover experiments and 18 runway clearing experiments at the Greenbrier Valley Airport, West Virginia, have been described. The hover tests created cleared zones ranging from 500 to greater than 3000 foot size and produced appreciably visibility enhancement over zones even larger. Six helicopter landings were accomplished at the airport, during hover experiments, through fog layers 200-400 feet thick. The runway clearing experiments were successful in clearing the full 6000 foot extent of the runway on 2 occasions, were partially successful on 4 occasions and were unsuccessful on 12 occasions. Substantial visibility enhancement along the runways, or portions of it, frequently occurred during experiments classified unsucessful.

**MP 365**
**FOG MODIFICATIONS BY USE OF HELICOPTERS.**
Plank, V.G., et al, *U.S. Air Force. Cambridge Research Laboratories. Environmental research paper,* Oct. 28, 1970, No.335, 154p., AD-716 818, For a short version of this paper and abstract see 25-2236. 30 refs.
Spatola, A.A., Hicks, J.R.
25-4135
FOG DISPERSAL, HELICOPTERS, VISIBILITY, WEATHER MODIFICATION.

**MP 366**
**SUMMARY RESULTS OF THE LEWISBURG FOG CLEARING PROGRAM.**
Plank, V.G., et al, *Journal of applied meteorology,* Aug. 1971, 10(4), p.763-779, 8 refs.
Spatola, A.A., Hicks, J.R.
26-1130
HELICOPTERS, FOG DISPERSAL, WEATHER MODIFICATION, VISIBILITY, TESTS.
Results of helicopter clearing experiments conducted at the Greenbrier Valley Airport, Lewisburg, W. Va., during the period 7-29 September 1969, are presented and discussed. Thirty-five hover experiments and 18 runway-clearing experiments were performed on 10 separate days with fog layers from 125 to 525 ft in depth. The hover experiments, which were successful in virtually all cases, yielded clearings that varied from 400 to 2800 ft in length. The largest clearings occurred with the shallowest fog during tests conducted within 1 hr of the natural dissipation time of the fog. The runway-clearing experiments were successful in clearing the full 6000 ft extent of the runway on two occasions, were partially successful on four occasions, and were unsuccessful on 12 occasions. Six helicopter landings were accomplished through artificially created clearings. Particular, quantitative results of the hover experiments are described.

**MP 367**
**MEASUREMENT OF FROST FORMED SOIL PATTERNS USING AIRPHOTO TECHNIQUES.**
Poulin, A.O., *Photogrammetric engineering,* March 1962, 28(1), p.141-147, Microform No. SIP 20098.
25-2006
SOIL PATTERNS, FROST ACTION, AERIAL PHOTOGRAPHY, SOIL MAPPING, PHOTOGRAMMETRY.
Airphoto patterns in cold regions are greatly influenced, if not dominated, by the effect of frost action or, more specifically, by the motion imparted to soil particles during freezing and thawing cycles. In order to determine the rate of pattern development this motion is being measured with an accuracy of 2-3 mm. from maps at a scale of 1 to 4 with a contour interval of 0.02 ft. These maps are compiled photogrammetrically from photos obtained from scaffolding at distances of 10-20 ft. above the ground. Areas selected for study are in N. Greenland and the Colorado Rockies. All maps were prepared on Mylar base material. The design of a stable control point in permafrost is also presented. The intent of this research is to introduce a quantitative aspect to the interpretation of frost patterns and the frost susceptibility of soils.

**MP 368**
**INFRARED IMAGERY IN THE ARCTIC UNDER DAYLIGHT CONDITIONS.**
Poulin, A.O., et al, Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.231-141, 4 refs.
Harwood, T.A.
25-2141
INFRARED PHOTOGRAPHY, AERIAL PHOTOGRAPHY, LIGHT (VISIBLE RADIATION).
Infrared thermal imagery and concurrent aerial photography were obtained from various altitudes over a broad geographical area in Arctic North America and the Polar Basin prior to the start of the melt season. Solar altitudes during the periods of data collection varied from 2 to 27 degrees, and clear weather prevailed most of the time. It was found that some terrain features and conditions depicted in the infrared imagery were not apparent or were only weakly suggested in the conventional aerial photography and that solar irradiation produced both good and bad effects in the thermal imagery. Examples of a few of these findings are presented.

**MP 369**
**INFRARED MAPPING OF THERMAL ANOMALIES IN GLACIERS.**
Poulin, A.O., et al, *Canadian journal of earth sciences,* Nov. 1966 , 3(6), p.881-885, Microform No. SIP 25991.
Harwood, T.A.
25-2142
INFRARED MAPPING, GLACIERS, THERMAL PROPERTIES, AERIAL PHOTOGRAPHY.
All-season aerial reconnaissance of the Arctic has been advanced with the development of airborne, infrared scanners. The utility of such equipment for detecting and studying the progression of thermal anomalies of glaciological interest is discussed with reference to specific examples of imagery obtained during three seasons on Project "Bold Survey" under conditions of both daylight and darkness. Where possible, comparisons are made between infrared thermal imagery and conventional aerial photography.

**MP 370**
**SELF-DIFFUSION OF TRITIUM IN NATURAL AND SYNTHETIC ICE MONOCRYSTALS.**
Ramseier, R.O., *Journal of applied physics,* May 1967 , 38(6), p.2553-2556, 26 refs.
23-1628
TRITIUM, ICE CRYSTALS, DIFFUSION.
The self-diffusion of tritium in artificially and naturally grown ice monocrystals, parallel and perpendicular to the optical axis, was studied between -2.5 and -35.9C. The plane-source solution of Fick's second law was used in treating the data. An anisotropy of approx. 12 per cent was observed. Based on the experimental data, it is concluded that the diffusion takes place by a vacancy mechanism, and that entire water molecules are diffusing, i.e., molecular diffusion occurs. Theoretical calculations using the atomic-diffusion theory are in excellent agreement with the experimentally determined diffusion coefficient.

**MP 371**
**ZONE-MELTING APPARATUS FOR GROWING ICE MONOCRYSTALS.**
Ramseier, R.O., *Materials research bulletin,* Dec. 1966 , 1(4), p.293-297, 5 refs.
23-3386
ZONE MELTING, ICE CRYSTAL GROWTH, EQUIPMENT.
A zone-melting apparatus using an infrared heat lamp is described. Ice monocrystals can be grown from a polycrystalline charge without using a single crystal seed. The final orientation of the monocrystal will be determined by that original crystal whose a-axis shows the least deviation from the growth direction.

**MP 372**
**ORIGIN OF PREFERRED ORIENTATION IN COLUMNAR ICE.**
Ramseier, R.O., *Journal of crystal growth,* 1968, 3,4, International Conference on Crystal Growth, 2nd, Birmingham, U.K., 15-19 July, 1968. Proceedings, p. 621-624, 6 refs.
25-622
ICE CRYSTAL GROWTH, ORIENTATION, ICE CRYSTAL STRUCTURE, ICE WATER INTERFACE.

**MP 373**
**SOME PHYSICAL AND MECHANICAL PROPERTIES OF POLAR SNOW.**
Ramseier, R.O., *Journal of glaciology,* Oct. 1963, 4(36), p.753-769, French and German summaries. 21 refs. Microform No. SIP 21443.
25-2041
SNOW PHYSICS, SNOW COMPRESSION, COMPRESSIVE STRENGTH, SNOW DENSITY, CREEP TESTS, VISCOELASTICITY, PERMEABILITY.
Specimens of polar snow from the South Pole were tested to investigate air permeability, ultimate compressive strength and dynamic Young's modulus as a function of density. Anisotropy in a single layer of snow (snow between two summer crusts) was found in all three properties. Comparison with data for snow from Site 2, Greenland, showed an empirical relation for both areas. Air permeabilities are different at the two sites because of time and meteorological effects.

**MP 374**
**ROLE OF SINTERING IN SNOW CONSTRUCTION.**
Ramseier, R.O., *Journal of terramechanics,* 1966 , 3(3), p.41-50, 17 refs. For another version of this paper and abstract see 24-3357. Microform No. SIP 24985.
25-2143
SNOW (CONSTRUCTION MATERIAL), SNOW COMPACTION, RUNWAYS, SINTERING, METAMORPHISM (SNOW), AIRCRAFT LANDING AREAS.

**MP 375**
**UNCONFINED CREEP OF POLAR SNOW.**
Ramseier, R.O., et al, *Journal of glaciology,* Oct. 1964, 5(39), p.325-332, French and German summaries. 10 refs. Microform No. SIP 23136.
Pavlak, T.L.
25-2062
SNOW CREEP, COMPRESSIVE PROPERTIES, SNOW MECHANICS, STRAIN RATE, SNOW DENSITY.
Snow samples from Amundsen-Scott and Byrd Stations, Antarctica, and from Camp Century, Greenland, were tested for creep as a function of density under low stresses for various periods up to two years. Comparisons of compressive viscosities plotted against densities for all three sites showed three distinct regions representing three different mechanisms of densification. Viscosities increased up to densities of 0. 47 g/cu cm and above 0. 625 g/cu cm. Between these densities, compressive viscosities are nearly constant.

**MP 376**
**SINTERING OF SNOW AS A FUNCTION OF TEMPERATURE.**
Ramseier, R.O., et al, *International Association of Scientific Hydrology. Publication,* 1966, No.69, p.119-127, French summary. 19 refs. Microform No. SIP 25214.
Sander, G.W.
25-2097
TEMPERATURE EFFECTS, SINTERING, SNOW MECHANICS.
This paper shows that both the sintering of snow and the rate constant as a function of temperature can be represented satisfactorily by an exponential equation. The findings will probably apply over the entire density range from freshly fallen snow to about 0.55 gm/cu cm. The sintering process will also be affected strongly by densification. From the apparent activation energy obtained, it appears that the most probable mechanism is the one of evaporation, diffusion through the ambient atmosphere, and condensation. There is no indication that another mechanism takes over at any particular temperature.

**MP 377**
**SINTERING PROCESS IN SNOW.**
Ramseier, R.O., et al, *Journal of glaciology,* Oct. 1966 , 6(45), p.421-424, French and German summaries. 11 refs. For another version of this paper and abstract see 24-3367.
Keeler, C.M.
25-2144
SNOW SAMPLERS, COMPRESSIVE STRENGTH, SINTERING, ICE CRYSTALS, EVAPORATION, CONDENSING, MASS TRANSFER.

**MP 378**
**WATER SUPPLY IN ARCTIC REGIONS.**
Reed, S.C., *New England Water Works Association. Journal,* Dec. 1970, 84(4), p.372-392, 18 refs.
25-4373
WATER SUPPLY, SANITARY ENGINEERING, WATER TREATMENT, COLD WEATHER OPERATION.
The influence of a cold environment on sanitary engineering and service, and the special care and understanding required during design, construction and operation are outlined. Sources, distribution systems, treatment processes and storage of water supply in cold regions are discussed.

**MP 379**
**SEPARATION OF SEWAGE SOLIDS AT LOW TEMPERATURES.**
Reed, S.C., *Northern engineer,* Winter 1969, 1(5), p.8-10, 4 refs.
26-689
SEWAGE TREATMENT, SANITARY ENGINEERING, SLUDGES.

**MP 380**
**WASTEWATER DISPOSAL AND MICROBIAL ACTIVITY AT ICE-CAP FACILITIES.**
Reed, S.C., et al, *Water Pollution Control Federation. Journal,* Dec. 1968 , 40(12), p.2013-2020, 5 refs.
Tobiasson, W.
23-5238
COLD WEATHER CONSTRUCTION, SEWAGE DISPOSAL, WASTE DISPOSAL, WATER POLLUTION, BACTERIA, GREENLAND.
The purpose of this study was to define the physical development of ice-cap disposal sumps and their effect on adjacent structures and to determine the extent of low-temperature anaerobic activity. Two DEW Line radar stations located on the Greenland Ice Cap near the Arctic Circle were studied. Both 35-man facilities have been in continuous operation since late 1959. The ice cap in this area is approx. 6,000 ft thick, with a mean annual temp. of about 0F.

**MP 381**
**LOW TEMPERATURE ACTIVATED SLUDGE SETTLING.**
Reed, S.C., et al, *American Society of Civil Engineers. Sanitary Engineering Division. Journal,* Aug. 1969 , 95(SA 4), p.747-767, 21 refs.
Murphy, R.S.
24-1187
SEWAGE TREATMENT, COLD WEATHER OPERATION, SLUDGES.
Discusses the temperature influence upon activated sludge sedimentation theory. An equation for zone settling velocity of activated sludge based on experimental data, is developed. This equation provides a rational basis for the assessment of temperature influences in design. The influence of temperature on settling velocity decreases as the concentration increases. This tends to make a unit designed for operation at higher concentrations theoretically more efficient, while low concentration systems have excess capacity at higher temperatures. This factor, plus the capability for greater retention of the smaller particles, tends to favor upflow sludge blanket clarifiers for cold regions applications.

**MP 382**
**SINGLE TANK SECONDARY SEWAGE TREATMENT FOR THE ARCTIC.**
Reed, S.C., et al, Symposium on Cold Regions Engineering, Proceedings, College, University of Alaska, 1971, p.690-711, 13 refs.
Crowther, A.W.
25-4184
SEWAGE DISPOSAL, SEWAGE TREATMENT, SANITARY ENGINEERING.

**MP 383**
**EFFECT OF PARTICLE SIZE ON APPARENT LATTICE SPACINGS.**
Reynolds, R.C., Jr., *Acta crystallographica,* March 1968 , A24(2), p.319-320, 6 refs.
23-3429
CRYSTAL LATTICES, CLAYS.
Theoretical considerations suggest that particle-size effects can produce anomalous values for d 001 reflection in certain structures. The effect is explained here in terms of the Laue interference function. Experimental results on very fine-grained mica correlate well with the theoretical relation between particle thickness and d 001 reflection.

**MP 384**
**ORIENTATION OF ETHYLENE GLYCOL MONOETHYL ETHER MOLECULES ON MONTMORILLONITE.**
Reynolds, R.C., Jr., *American mineralogist,* March-April 1969 , 54(3-4), p.562-567, 7 refs.
24-3610
CLAY SOILS, X RAY DIFFRACTION, CLAY MINERALS, EGEE, MOLECULAR STRUCTURE, CHEMICAL COMPOSITION, ORIENTATION.
A study of the intensities of basal reflections from ethylene glycol monoethyl ether-montmorillonite indicates that the plane of symmetry of the aliphatic chain lies perpendicular to the clay oxygen surface. The complex appears to contain two layers, each of which has one-half the molecular density of ethylene glycol layers on montmorillonite. The value of d(001) equal to 16.0 Angstrom units makes this complex potentially useful for identification of expandable and mixed-layered expandable clays in cases where line interference is encountered on diffractograms from glycol or glycerine treated samples.

**MP 385**
**COBALT SORPTION ON SURFACE REACTIVE MINERALS IN THE GLACIAL ENVIRONMENT.**
Reynolds, R.C., Jr., AEC Contract AT(30-1)-3912. Mofidication No.2. Progress report. Dec. 8, 1969, 8p.
25-1514
SOIL CHEMISTRY, ION EXCHANGING, CHEMICAL REACTIONS, GLACIAL ENVIRONMENT, ADSORPTION.

**MP 386**
**X-RAY STUDY OF AN ETHYLENE GLYCOL-MONTMORILLONITE COMPLEX.**
Reynolds, R.C., Jr., *American mineralogist,* July-Aug. 1965, 5(4), p.990-1001, 19 refs. For another version of this paper and abstract see 24-3318.
25-2098
X RAY DIFFRACTION, SPECTROMETERS, SPECTROSCOPY, CLAY MINERALS, ETHYLENE GLYCOL, MOLECULAR STRUCTURE.

**MP 387**
**INTERSTRATIFIED CLAY SYSTEMS: CALCULATION OF THE TOTAL ONE-DIMENSIONAL DIFFRACTION FUNCTION.**
Reynolds, R.C., Jr., *American mineralogist,* May-June 1967 , 52(3), p.661-672, 9 refs.
25-2172
X RAY DIFFRACTION, CLAYS, SCATTERING.
Methods are described for calculating X-ray diffraction effects from two-component interstratified clay systems. Unlike previous work, the calculations for very thick crystallites include the scattering contributions from both types of interlamellar materials. A preliminary study of the system glycol-montmorillonite-illite indicates that, for very thick crystallites, calculated diffraction angles for most maxima are similar to those computed by other published methods; relative intensities show very large discrepancies. Calculations of the complete one-dimensional diffraction function indicate that randomly interstratified, illite-rich members of this system do not show a 001/001 diffraction maximum between about 6 and 8 deg 2 theta. It is suggested that many natural materials may not be randomly interstratified, therefore, the widespread use of the Hendricks-Teller equation for random interstratification may be unjustified.

**MP 388**
**CRISTOBALITE AND CLINOPTILOLITE IN BENTONITE BEDS OF THE COLVILLE GROUP, NORTHERN ALASKA.**
Reynolds, R.C., Jr., et al, *Journal of sedimentary petrology,* Sept. 1967 , 37(3), p.966-969, 16 refs.
Anderson, D.M.
24-1646
SEDIMENTS, ROCK PROPERTIES, LITHOLOGY, UNITED STATES—ALASKA—UMIAT.

**MP 389**
**HESS CREEK DAM.**
Rice, E.F., et al, *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.436-439, 12 refs. Microform No. SIP 24882.
Simoni, O.W.
25-2145
EARTH DAMS, CONSTRUCTION, PERMAFROST.
Dams are discussed whose stability requires frozen foundation material; particular emphasis is placed on the design, construction, operation, and performance of the Hess Creek Dam in Alaska. Earth dams are acceptably stable, even when founded on frozen ground of poor quality and near-thawing temperatures. Perhaps greater maintenance attention is required than is necessary in warmer areas. Stability of a dam, however, does not apply to control works and spillways. Where frozen stability is essential, artificial refrigeration must be considered. Spillways, in particular, must be built as if the ground were erodable, whether it is frozen at the time of construction or not. Study of the general problem of heat transfer through soils of varying composition helps establish criteria for future designs.

**MP 390**
**PERFORMANCE OF A FROST-TUBE FOR THE DETERMINATION OF SOIL FREEZING AND THAWING DEPTHS.**
Rickard, W., et al, *Soil science,* Feb. 1972, 113(2), p.149-154, 15 refs.
Brown, J.
26-3536
FROST PENETRATION, FREEZE THAW TESTS, SOIL TEMPERATURE, MEASURING INSTRUMENTS, ISOTHERMS, FREEZING INDEXES.
The original purpose of developing an accurate and inexpensive frost-thaw monitoring device has been fulfilled. The accuracy has been established and the technique appears quite sufficient to meet the requirements of most field investigations. There is a very sharp line in the freezing and thawing cycles. Reading of the tube can be accomplished by untrained persons with little difficulty. Suggested as potential uses for the forst tube are: 1) To determine freezing and thawing depths and rates in ecological studies, 2) To measure modifications in freezing and thawing depths as a result of construction, 3) To determine the time to turn on electric heating tapes around underground water pipes, 4) To establish load limits as a function of freezing and thawing depths for both regular and off-highway travel during spring and fall, and 5) To measure ice thicknesses on rivers and streams at ice bridge locations and other seasonal structures.

**MP 391**
**THE COMPLEXITIES OF THE THREE-DIMENSIONAL SHAPE OF INDIVIDUAL CRYSTALS IN GLACIER ICE.**
Rigsby, G.P., *Journal of glaciology,* June 1968 , 7(50), p.233-251, 7 refs.
23-2943
ICE CRYSTAL STRUCTURE, GLACIER ICE, CRYSTAL STUDY TECHNIQUES, UNITED STATES—WASHINGTON—BLUE GLACIER.
A block of ice from Blue Glacier, Washington, was successively sectioned at close intervals as a means of determining exact crystal shape in three dimensions. Two crystals occupying over 20 per cent of the entire sample are used as examples, and their volumes calculated. These crystals were found to be much larger and more complex in shape than expected from thin-section examination alone. The surface-to-volume ratio was calculated using a simple relationship between the length of lines in a grid crossing the crystal and grid-line intercepts with the crystal boundary. From this ratio the surface area of each crystal was calculated. A measurement of irregularity or jaggedness is introduced in order to compare crystals of different size with one another. This is necessary because surface-to-volume ratio of a body of the same shape decreases as the size increases.

**MP 392**
**RADIO ICE-SOUNDING TECHNIQUES.**
Rinker, J.N., et al, Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings, Ann Arbor,, p.793-800, 11 refs.
Evans, S., Robin, G. de Q.
25-2146
ICE COVER THICKNESS, RADIO ECHO SOUNDINGS, BEDROCK PROFILE.
During the summer of 1964 a cooperative research project team traversed some 450 miles of the Greenland Ice Cap to evaluate two VHF band radar systems for measuring ice thickness and contouring the bedrock profile at the ice/rock interface. A continuous radar trace of the bedrock was obtained for some 450 miles of traverse and through ice thicknesses of 4600 feet.

**MP 393**
**ENVIRONMENTAL ANALYSIS, REMOTE SENSING AND EDUCATION.**
Rinker, J.N., et al, Symposium on Remote Sensing of Environment, 4th, April 12-14, 1966. Proceedings. Ann Arbor,, p.709-711.
Frost, R.E.
25-2147
REMOTE SENSING, EDUCATION, ENVIRONMENTAL ANALYSIS.

**MP 394**
**APPLICATION OF REMOTE SENSING TO ARCTIC ENVIRONMENTAL STUDIES.**
Rinker, J.N., et al, Alaska remote sensing symposium, Anchorage, 1969, [Juneau], Alaska Department of Economic Development, 1969, p.105-116, No microfiche available. Bibliography p.114-116.
Frost, R.E.
26-732
PERMAFROST STRUCTURE, ELECTROMAGNETIC PROSPECTING, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, CIVIL ENGINEERING, REMOTE SENSING, ACTIVE LAYER.

**MP 395**
**BEARING CAPACITY OF THE ICE COVER ON ZURICH LAKE IN 1963.**
Roethlisberger, H., *Schweizerische Bauzeitung,* Aug. 1, 1968 , 86(31), p.565-569, In German. 13 refs.
23-4780
ICE COVER STRENGTH, CLIMATE, SWITZERLAND—ZURICH.

**MP 396**
**EROSIVE PROCESSES WHICH ARE LIKELY TO ACCENTUATE OR REDUCE THE BOTTOM RELIEF OF VALLEY GLACIERS.**
Roethlisberger, H., *International Association of Scientific Hydrology. Publication,* Jan. 1968 , No.79, p.87-97, In English, with French summary. Includes discussion and reply. 12 refs.
24-673
GLACIAL EROSION, GLACIER BEDS.

**MP 397**
**EVIDENCE FOR AN ANCIENT GLACIER SURGE IN THE SWISS ALPS.**
Roethlisberger, H., *Canadian journal of earth sciences,* Aug. 1969 , 6(4, Pt.2), p.863-865, Includes discussion. 2 refs.
24-2432
GLACIER ICE, GLACIER SURGES, ICE COVER THICKNESS, SWITZERLAND—ALPS.

**MP 398**
**SEISMIC REFRACTION SOUNDINGS IN PERMAFROST NEAR THULE, GREENLAND.**
Roethlisberger, H., International Symposium on Arctic Geology, 1st, 1961. Proceedings. Geology of the Arctic., Toronto,, Vol.2, p.970-980, 6 refs. Microform No. SIP 19464.
25-2007
PERMAFROST PHYSICS, SEISMIC REFRACTION, SOUNDING, SEISMIC VELOCITY.
The applicability of various seismic methods for engineering purposes has been investigated in the Thule area. Special attention has been given to the refraction method in the cases where shallow ice (up to 200 ft.) occurs overlying frozen ground (till), or where frozen ground (till, outwash) up to a few hundred ft. thick overlies bedrock. Seismic velocities have been measured in different types of sediments of the Thule formation and in the crystalline basement rock. Very high velocities were found for all types of rock; the temperature was about -10C., and most pores and cavities were probably filled with ice. It was discovered that for shallow soundings of a few hundred feet, the seismic methods can probably be used more elaborately in permafrost than in unfrozen material, as later pulses can be identified on the records shortly after first breaks. A negative velocity gradient in frozen ground is believed to be responsible for this.

**MP 399**
**ENVIRONMENTAL GUIDE FOR ARCTIC TESTING ACTIVITIES AT FORT GREELY, ALASKA.**
Sands, R.D., et al, *U.S. Army Natick Laboratories. Earth Science Division. Technical report,* May 1971, No.ES-69, 83p., AD-729 350, 25 refs.
Ohman, H.L., Sanger, F.J.
26-1731
COLD WEATHER TESTS, VEGETATION, CLIMATOLOGY, METEOROLOGICAL DATA, ICE FOG, MILITARY FACILITIES, TERRAIN ANALYSIS, SNOW COVER, UNITED STATES—ALASKA—FORT GREELY.
The physical environment of the Fort Greely area is analyzed and evaluated with special reference given to the significance of climate, terrain, and vegetation on testing activities at the various courses and ranges of the test site. Cold spells under -25 and -40 F are studied for their frequency and duration of occurrence at the test areas. The chance of a minimum of -25F, the uppermost temperature acceptable for cold tests, is only one in fifteen for any given date between 13 November and 18 March at the main station. Visibility restrictions such as ice fog, blowing dust, and snow are occasionally present during the winter season. Solar and lunar alignment are discussed and a table of the phases of the moon through 1980 is presented. A comparison of the climate at Fort Greely with other possible test locations in Alaska indicates that other locations are better temperaturewise, but possible difficulties associated with accessibility might make them impractical. Methods for dealing with snow and ice are discussed. Procedures for taking meteorological observations and for determining snow properties are outlined, and the test facilities at Fort Greely are described.

**MP 400**
**COMPUTATIONS ON FROST IN THE GROUND.**
Sanger, F.J., *New England Water Works Association. Journal,* March 1966 , 80(1), p.47-67, 1 ref.
23-5100
FROST PENETRATION, METEOROLOGICAL FACTORS, SOILS, PIPELINES, FREEZING INDEXES.

**MP 401**
**GROUND FREEZING IN CONSTRUCTION.**
Sanger, F.J., *American Society of Civil Engineers. Soil Mechanics and Foundations Division. Journal,* May 1969 , 95(SM3), p.884-886, Closure of discussion of author's original paper bearing same title for which see SIP 25911.
23-5946
ARTIFICIAL FREEZING, PIPES (TUBES), SOIL FREEZING, COST ESTIMATES, CONSTRUCTION.

**MP 402**
**COMPUTATION OF FROST IN THE GROUND.**
Sanger, F.J., *Maine Water Utilities Association. Journal,* May 1962, 38(3), p.33-49.
25-2021
FROST PENETRATION, SOIL FREEZING, WATER PIPES, FREEZING POINTS, ESTIMATING, FROST ACTION, SURFACE TEMPERATURE.

**MP 403**
**DEGREE-DAYS AND HEAT CONDUCTION IN SOILS.**
Sanger, F.J., *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.253-262, 5 refs. Microform No. SIP 24859.
25-2148
FROST PENETRATION, SOIL TEMPERATURE, THERMAL CONDUCTIVITY, PAVEMENTS, ANALYSIS (MATHEMATICS).

The degree-day concept is used for computing heat conduction in soils for engineering purposes, simple degree-day techniques permit rapid computations. The total (negative) degree days for a freezing period is a freezing index. The total (positive) degree days for a thawing period is a thawing index. A useful expression in ascertaining depth of penetration of the reference temperature (32F) is the modified Bergren equation. Soils are divided into 3 groups for computing the coefficient of thermal conductivity: coarse grained, fine grained, and highly organic soils. In designing pavements for frost conditions, the problem is to find the frost or thaw penetration through a pavement overlying layers of nonfrost-susceptible materials protecting a frost-susceptible subgrade by limiting the subgrade penetration of the 32F isotherm to a safe amount.

**MP 404**
**GROUND FREEZING IN CONSTRUCTION.**
Sanger, F.J., *American Society of Civil Engineers. Soil Mechanics and Foundations Division. Journal,* Jan. 1968, 94(SM1), p.131-158, 34 refs. Microform No. SIP 25911.
25-2179
ARTIFICIAL FREEZING, FROZEN GROUND MECHANICS, SHEAR STRENGTH, EXCAVATION, THERMAL FACTORS.
Artificial ground freezing is a valuable aid, and at times may be the only means possible, for excavation. The soil becomes stabilized to give shear strength for a retaining structure and a water stop. Design includes strength and deformation of a viscoelastic material in a structure, and of heat flow in a material in which water changes to ice causing radical changes in thermal parameters. Examples show how the rheological parameters of strain, temperature, stress and time for typical soils are related. Techniques and design data are given for the structural design of a cylindrical cofferdam. Thermal parameters and techniques, with assumptions and consequent equations for design, are provided with examples of two typical soils, straight and curved walls, for computing time of freezing, temperatures, energy and refrigeration-load from which cost estimates may be made for a particular job. Construction practices are discussed, with special attention to the hazards of the ground freezing technique.

**MP 405**
**COLD WEATHER CONCRETING AND MASONRY PLACEMENT.**
Sanger, F.J., Vermont Conference on Winter Construction, Oct. 30-31, 1969. Proceedings. Burlington, University of Vermont, 1970, p.82-94.
25-3030
COLD WEATHER CONSTRUCTION, WINTER CONCRETING, MASONRY, CONCRETE PLACING.
Report on the latest methods for cold weather concrete and masonry placement which, along with modern design practices for masonry and concrete structures, eliminate weather as a consideration in concrete construction.

**MP 406**
**PLASTIC DEFORMATION OF FROZEN SOILS.**
Sanger, F.J., et al, *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.305-315, 5 refs.
Kaplar, C.W.
25-2149
FROZEN GROUND MECHANICS, PLASTIC DEFORMATION, SOIL TESTS, TEST EQUIPMENT.

**MP 407**
**PROPERTIES AND DISTRIBUTION OF TWO CHARACTERISTIC PEAT ENVIRONMENTS IN ALASKA.**
Sellmann, P.V., International Peat Congress, 3rd, Aug. 18-23, 1968, Quebec. Proceedings, Ottawa,, p.157-162, In English with French summary. 9 refs.
25-1166
PEAT, SOIL STRUCTURE, SOIL MOISTURE, ENGINEERING, UNITED STATES—ALASKA.
For engineering purposes, Alaska can be divided into a southeastern and a central peat-forming zone. The characteristic differences between the peat in these areas are thickness, homogeneity, and presence or absence of perennially frozen peat. Deposits in the two peat environments are divided into topographic types having a set of predictable surface and subsurface conditions depending on location and physical setting. Other contrasts, particularly in the subsurface material, are based on moisture content, specific gravity, density, ice volume, and void ratio. Analysis of cores from the central zone indicates an average range for ice-volume between 85 and 93 per cent with only a slight increase with depth. The environments show little gross differences in moisture contents, although the basin type has more overall variability with depth. Based on dry density-depth relationships the southern zone shows greater homogeneity (range 0.05 - 0.13 gm/cc) compared with similar thicknesses in the central zone (range 0.025 - 0.26 gm/cc).

**MP 408**
**NEAR SURFACE LITHOLOGY OF THE BARROW, ALASKA AREA, A PRELIMINARY REPORT.**
Sellmann, P.V., et al, Science in Alaska. Alaskan Science Conference, 14th, Aug. 27-30, 1963, Anchorage, Alaska. Proceedings. College, Alaska,, p.231-232.
Brown, J.
25-2063
LITHOLOGY, SEDIMENTS, CRYOGENIC SOILS, UNITED STATES—ALASKA—BARROW.

**MP 409**
**NEAR-SURFACE STRATIGRAPHY, BARROW, ALASKA: CORE ANALYSIS.**
Sellmann, P.V., et al, Science in Alaska. Alaskan Science Conference, 15th, Aug.31-Sept.4, 1964. Proceedings. College, Alaska,, p.98.
Brown, J., Lewellen, R.I.
25-2100
CORES, STRATIGRAPHY, SEDIMENTS, UNITED STATES—ALASKA—BARROW.

**MP 410**
**PREDICTION OF STREAM FREQUENCY FROM MAPS.**
Sellmann, P.V., et al, *Journal of terramechanics,* 1970, 7(3/4), p.101-115, 13 refs.
Dingman, S.L.
25-2389
DRAINAGE, TOPOGRAPHIC MAPS, ANALYSIS (MATHEMATICS), STREAM FREQUENCY.
A theoretical relationship between stream frequency and drainage density was established, and supported by field determinations. The number of observations required to estimate mean stream frequency for a specified degree of accuracy was determined for various map scales. Since the standard deviation of stream frequency decreases as map scale decreases, the number of observations for a given degree of accuracy also decreases for smaller scales. The frequency values plotted for various scales of mapping and for areas of varying drainage density indicate a straight-line relationship on a semi-log base between N and map scale. There is little variation of the slope of this relationship for the different areas. This allows estimates of frequency to be made for scales for which no data are available.

**MP 411**
**TWO DIMENSIONAL APPROACH TO AVALANCHE PROBLEMS.**
Shen, H.W., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* Nov. 1970, No.98, p.140-152, 5 refs.
26-1260
AVALANCHE MODELING, AVALANCHE MECHANICS, AVALANCHE VELOCITY, AVALANCHE PRESSURE.

**MP 412**
**COMPARISON OF THE ADSORPTIVE PROPERTIES OF ACTIVATED CHARCOAL AND ALASKAN MONTMORILLONITE FOR SOME COMMON POISON.**
Smith, R.P., et al, *Toxicology and applied pharmacology,* Jan. 1967, 10(1), p.95-104, 22 refs.
Gosselin, R.E., Henderson, J.A., Anderson, D.M.
25-4148
ADSORPTIVITY, CLAY MINERALS, POISONS, ACTIVATED CARBON.
Activated charcoal and a preparation of Alaskan montmorillonite were compared in vitro with respect to the possible usefulness of the latter as a gastrointestinal adsorbent in acute poisoning. The two adsorbents have been compared with respect to their maximum adsorption capacities and apparent dissociation constants for six toxic agents commonly encountered in clinical medicine.

**MP 413**
**ORGANIC COMPOUNDS IN VOLCANIC GAS FROM SANTIAGUITO VOLCANO, GUATEMALA.**
Stoiber, R.E., et al, *Geological Society of America. Bulletin,* Aug. 1971, 82(8), p.2299-2302, 7 refs.
Leggett, D.C., Jenkins, T.F., Murrmann, R.P., Rose, W.I., Jr.
26-2864
VOLCANOES, GASES, GAS CHROMATOGRAPHY, CHEMICAL COMPOSITION, GEOCHEMISTRY, GUATEMALA—SANTIAGUITO VOLCANO.
Gas samples collected at Sapper fumarole, Santiaguito, Guatemala, on December 5, 1969, were analyzed by gas chromatography-mass spectrometry. A number of compounds were found, including saturated and unsaturated hydrocarbons, aldehydes, ketones, alcohols, aromatics, halogenated hydrocarbons, and inorganic sulfur compounds. The compounds are probably produced by heating of fossil soil or sedimentary layers by the magma.

**MP 414**
**ONSET OF CONVECTION IN A POROUS MEDIUM CONTAINING LIQUID WITH A DENSITY MAXIMUM.**
Sun, Z.S., et al, International Heat Transfer Conference, 4th, Versailles, France, Sept. 1970. Proceedings, Vol.4, Amsterdam, Netherlands, Elsevier, 1970, p.1-11, 15 refs.
Tien, C., Yen, Y.-C.
25-2409
CONVECTION, HEAT TRANSFER, POROUS MATERIALS, LIQUIDS, ANALYSIS (MATHEMATICS).
Linear stability analysis was used to study the convective stability of a horizontal liquid layer in a porous medium subjected to a temperature gradient. The liquid possesses a density maximum within the temperature range of interest and its density-temperature relationship is presented. The onset of convection occurs when the Rayleigh number for the porous medium exceeds its critical value which is dependent upon two parameters determined by the thermal conditions and the equation of state. Numerical values of the critical Rayleigh number are presented corresponding to perfectly conducting surfaces for both rigid-rigid and rigid-free boundaries.

**MP 415**
**CERTAIN ASPECTS OF ENGINEERING GEOLOGY IN PERMAFROST.**
Swinzow, G.K., *Engineering geology,* July 1969 , 3(3), p.177-215, 51 refs.
24-1393
PERMAFROST STRUCTURE, FROZEN GROUND MECHANICS, COLD WEATHER CONSTRUCTION, ENGINEERING GEOLOGY, FROST HEAVE, PINGOS, ICE WEDGES, PATTERNED GROUND.
Permafrost distribution reaches one-fifth of the dry land surface on the earth, and its occurrence is connected with many phenomena not found in other parts of the world. Patterned ground, ice wedges, pingos and icings are described in general terms. Strength of frozen ground and its rheology are discussed. The principal topics of engineering geology in permafrost are reviewed.

**MP 416**
**INVESTIGATION OF SHEAR ZONES IN THE ICE SHEET MARGIN, THULE AREA, GREENLAND.**
Swinzow, G.K., *Journal of glaciology,* June 1962, 4(32), p.215-229, French and German summaries. 9 refs. Microform No. SIP 20187.
25-2022
SHEAR PROPERTIES, GLACIER FLOW, GLACIAL EROSION.
The structure of silty ice bands and the formation of their resulting shear moraines are investigated in the light of new evidence provided by two ice tunnels and additional surface investigation in the general Thule area. Previous investigations are examined and discussed and a new interpretation of the phenomena is presented. The textbook concept of a "bulldozing" edge of an ice sheet is not borne out by conditions found in the Tuto area. With the exception of a few outlet glaciers, the ice sheet propagates without any bulldozing. The main action of the ice sheet on the ground surface appears to be glacial plucking, abrasion, and incorporation of debris along shear planes. Blocking by proglacial debris cannot possibly cause the formation of shear moraines in the Tuto area. Shear-plane distortion (upwarping), and therefore the formation of shear moraines on the ice, may be due to the unloading effect of ablation.

**MP 417**
**TUNNELING AND SUBSURFACE INSTALLATIONS IN PERMAFROST.**
Swinzow, G.K., *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.519-526, 9 refs.
25-2150
TUNNELING (EXCAVATION), EXPLOSIVES, PERMAFROST PHYSICS, PERMACRETE, EXPLOSION EFFECTS, GREENLAND—THULE.

**MP 418**
**CONSTANT LENGTH DEVICE IN A CHANGING TEMPERATURE ENVIRONMENT.**
Swinzow, G.K., *U.S. Patent Office. Patent,* Nov. 26, 1968, 3p., USP-3,412,551, 6 refs.
25-3951
THERMAL EXPANSION, CONSTANT LENGTH DEVICES.

**MP 419**
**IONIC MIGRATION AND WEATHERING IN FROZEN ANTARCTIC SOILS.**
Ugolini, F.C., et al, *U.S. National Aeronautics and Space Administration. Contractor report,* July 1973, NASA-CR-2283, 26p., N73-27326.
Anderson, D.M.
28-2028
SOIL CHEMISTRY, DESERT SOILS, FROZEN GROUND CHEMISTRY.

Soils of continental Antarctica are forming in one of the most severe terrestrial environments. Continuously low temperatures and the scarcity of water in the liquid state result in the development of desert-type soils. In an earlier experiment to determine the degree to which radioactive Na(Cl-36) would migrate from a shallow point source in permafrost, movement was observed. To confirm this result, a similar experiment involving (Na-22)Cl was conducted. Significantly less movement of the Na-22 ion was observed. Ionic movement in the unfrozen interfacial films at mineral surfaces in frozen ground is held to be important in chemical weathering in Antarctic soils. (Auth.)

**MP 420**
**ANALYSIS OF ICE LENS FORMATION.**
Takagi, S., *Water resources research,* June 1970, 6(3), p.736-749, 39 refs.
25-1344
ICE LENSES, ICE FORMATION, WATER CONTENT, HEAT TRANSFER, ADSORBED WATER, ANALYSIS (MATHEMATICS), COMPUTER APPLICATIONS.
A mechanism of ice lens formation is presented on the assumption that its main cause is the simultaneous flow of heat and water. The differential equations thus formulated are solved approx. by the use of a generalization of Goodman's integral method. The result is found to be not completely satisfactory when compared with an experiment. Six points of progress, however are made which together may lead to a solution of the long-standing problem of frost heaving.

**MP 421**
**FUNDAMENTALS OF THE THEORY OF FROST-HEAVING.**
Takagi, S., *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.203-216, Includes discussions and supplement. 75 refs.
25-2151
FROST HEAVE, SOIL FREEZING, ANALYSIS (MATHEMATICS).

**MP 422**
**THEORY OF FREEZING-POINT DEPRESSION WITH SPECIAL REFERENCE TO SOIL WATER.**
Takagi, S., *National Research Council. Publication,* 1966 , No.1287, International Conference on Permafrost, Nov. 11-15, 1963, Lafayette, Ind. Proceedings, p.216-224, Includes discussion. 31 refs. Microform No. SIP 24854.
25-2152
FREEZING POINTS, SOIL FREEZING, FROST PENETRATION, SOIL WATER, UNFROZEN WATER CONTENT, THEORIES.
The freezing-point depression of water forms such as capillary water, adsorbed water, and soil water cannot be explained without an extension of the classical concept of thermodynamics. This is done through the use of fugacity, a more convenient concept than Gibbs' free energy. Fugacity may be identified with vapor pressure, thus giving a physical concept to afford deeper insight into the phenomenon. In this way, an arbitrarily large freezing-point depression of any water form is expressed in terms of vapor pressure in equilibrium with the water form considered. Supercooling (metastable state) should be strictly distinguished from freezing-point depression (stable state). The distinction is shown through clarification of the meaning of freezing with freezing-point depression.

**MP 423**
**TENSOR CONCEPTS APPLIED TO PROJECTIVE GEOMETRY.**
Takagi, S., *U.S. Army Research Office. Report,* 1970, ARO-D 70-1, Conference of Army Mathematicians, 15th, Durham, N.C., 1969. Transactions, p.123-140, 7 refs.
25-2417
PROJECTIVE GEOMETRY, TENSOR PRODUCTS.
A point, instead of a line segment, may be chosen as a vector in a Euclidean space, which, when the linear transformation of point vectors is introduced, becomes a projective space. In addition to the usual operation of linear combination of vectors, a new product called a "tensor product" of vectors is introduced. The incidence product is then defined as a special tensor product expressing the incidence relationships among the geometric elements in the projective space.

**MP 424**
**CANONICAL FORMS OF GENERAL SECOND-ORDER TENSORS.**
Takagi, S., *U.S. Army Research Office. Report,* 1967, ARO-D 67-1, Conference of Army Mathematicians, 12th, Durham, N.C., 1966. Transactions, p.349-378, 8 refs.
25-2510
DEFORMATION, CONTINUUM MECHANICS, TENSORS.
The Gibbs tensor notation introduced recently for the study of continuum mechanics offers important concepts and techniques that neither mathematics nor mathematical physics presently enjoy. As an example, a unified treatment of theories of matrices and second-order tensors is given in this paper. A classification of deformation is introduced as a corollary. Off-diagonal elements in the Hamilton-Cayley canonical form of a deformation yield shear.

**MP 425**
**INITIAL SOLUTION FOR A TWO-PHASE STEFAN'S PROBLEM IN A FINITE REGION.**
Takagi, S., *U.S. Army Research Office. Report,* 1968, ARO-D 68-1, Conference of Army Mathematicians, 13th, Durham, N.C., 1967. Transactions, p.257-281, 2 refs.
25-2519
STEFAN PROBLEM, ANALYSIS (MATHEMATICS), HEAT TRANSFER, CONDUCTION.
Stefan's problem is a heat conduction problem accompained by a phase change. The exact solutions so far obtained for this problem are only for a semi-infinite region. A method for obtaining an exact solution for a finite region is presented in this paper. An innovation introduced in this paper is that the thickness h of the new phase is used in place of time. The innovation allows us to linearize not only the differential equations but also the boundary and interfacial conditions that change with h, however complicated the transformation that changes the moving boundary to a fixed boundary may be. The boundary and interfacial conditions are chosen as general as possible insofar as the method in this paper permits. The solution is given in a series form arranged in the ascending order of the powers of h. The first term coincides with the Neumann solution for the semi-infinite region.

**MP 426**
**GEOMETRIC INTERPRETATION OF THE THREE DIMENSIONAL YIELD CRITERION OF SOILS.**
Takagi, S., Asian Regional Conference on Soil Mechanics and Foundation Engineering, 2d, Tokyo, Japan, 1963. Proceedings, Vol.1, p.77-81, For another version of this paper and abstract see 24-3311. 8 refs.
25-4074
SOIL MECHANICS, PLASTIC DEFORMATION, STRAIN ANALYSIS, ANALYSIS (MATHEMATICS).

**MP 427**
**GIBBS-EINSTEIN TENSOR ANALYSIS WITH APPLICATION TO CONTINUE MECHANICS AND CANONICAL FORMS OF GENERAL SECOND ORDER TENSORS.**
Takagi, S., Society of Engineering Science. Recent advances in engineering science, Vol.3, New York, Gordon and Breach, 1968, p.255-284, For another version of this paper and abstract see 24-3363. 11 refs.
25-4080
ANALYSIS (MATHEMATICS), THERMODYNAMICS, STRAIN MEASUREMENT, DEFORMATION.

**MP 428**
**PLANE PLASTIC DEFORMATION OF SOILS.**
Takagi, S., *American Society of Civil Engineers. Engineering Mechanics Division. Journal,* June 1962, 88(EM3), p.107-151, For another version of this paper and abstract see 24-3243. 21 refs. Reproduced in Conference of Army Mathematicians, 9th, 1964. Transactions, p.131-176.
25-4081
SOIL MECHANICS, PLASTIC DEFORMATION, ANALYSIS (MATHEMATICS), COMPRESSIVE PROPERTIES.

**MP 429**
**THEORY OF PLASTIC POTENTIAL AND C-PHI MATERIAL.**
Takagi, S., *U.S. Army Research Office. Report,* 1965, ARO-D 65-2, Conference of Army Mathematicians, 10th, Durham, N.C., 1964. Transactions, p.361-400, 26 refs.
25-4095
SOIL MECHANICS, PLASTIC DEFORMATION, ANALYSIS (MATHEMATICS), YIELD CRITERION.
The theory of plastic potential is not valid for a material called c-phi material, whose yield criterion for plane deformation is the Coulomb yield criterion. The invalidity is evidenced by the stress strain-rate relationship for the plane deformation of c-phi material that is derived independently of the theory of plastic potential. The reason for the limitation to the applicability of the theory of plastic potential is clarified in this paper.

**MP 430**
**TENSOR ANALYSIS WITH TENSOR BASES.**
Takagi, S., *U.S. Army Research Office. Report,* 1966, ARO-D 66-1, Conference of Army Mathematicians, 11th, Durham, N.C., 1965. Transactions, p.131-168, 11 refs.
25-4100
DEFORMATION, TENSOR ANALYSIS, CONTINUUM MECHANICS, RIEMANNIAN MANIFOLDS.
Tensor analysis with tensor bases clarifies relations among concepts used independently in different branches of mathematical science. The examples mentioned in this paper are: (1) Exterior algebra or Grassmann algebra is a part of tensor algebra. Thus, combinatory topology may be studied by use of the theory of n - dimensional alternating tensors; and differential forms become a part of tensor analysis. (2) A matrix, when combined with the tensor bases, becomes a second-order tensor. Thus matrix theory contributes to the theory of second-order tensors. It appears from the evidence in this paper that tensor bases are the most convenient expression of physical and geometric quantities belonging to a complete space.

**MP 431**
**COMPARISON OF PLANE STRAIN AND TRIAXIAL TESTS ON SAND.**
Takagi, S., *American Society of Civil Engineers. Soil Mechanics and Foundations Division. Journal,* Nov. 1970, 96(SM6), p.2163-2167, 6 refs.
25-4357
STRAIN TESTS, STRESS ANALYSIS, PLASTIC DEFORMATION, SANDS, ANALYSIS (MATHEMATICS).

**MP 432**
**SOILS OF ARCTIC ALASKA.**
Tedrow, J.C.F., et al, International Association for Quaternary Research, Arctic and Alpine environments, Bloomington, , p.283-294, 32 refs.
Brown, J.
23-2055
ARCTIC SOILS, UNITED STATES—ALASKA.
During the past 12 years a genetic approach to soil distribution has evolved for the Arctic Slope of Alaska. The region includes three physiographic provinces: the northern Brooks Range, Foothills, and Coastal Plain. In addition to Arctic Brown, Tundra, and Bog soils, other soils have been described: Podzol-like, Rendzina, and Shungite soils. Ten soil zones are presently delineated on a mapping scale of 1:5,000,000. Zones are controlled largely by physiography and geology. More detailed soil mapping has been conducted at Pt. Barrow (Coastal Plain 1:20,000), Umiat (Foothills 1:10,000), Howard Pass (1:250,000), the Okpilak River (1:30,000), and other locations. An intricate aspect of soil mapping in northern Alaska is the ubiquitous occurrence of patterned ground. Ice-wedge polygons predominate on the low relief of the Coastal Plain. Sorted circles, nets, and polygons are major patterns on the bouldery valley and upland terrain of the mountains and foothills. Well-drained soils increase in areal coverage in areas of coarser-grained materials. Tundra and Bog soils occupy much of the Coastal Plain.

**MP 433**
**USER PARTICIPATION IN AN INFORMATION SYSTEM.**
Thuronyi, G.T., et al, *American Society for Information Science. Proceedings,* 1970 , Vol.7, 33rd Annual meeting, Philadelphia, Oct.11-15, 1970, p.141-146, 3 refs.
Pietkiewicz, W.
25-2242
BIBLIOGRAPHIES, RESEARCH PROJECTS, U.S. ARMY CRREL, LIBRARY OF CONGRESS.

**MP 434**
**ADDITIONAL NOTE ON THE MODIFIED LEVEQUE PROBLEM.**
Tien, C., et al, *Journal of geophysical research,* Apr. 15,1964, 69(8), p.1672-1673, 1 ref. Microform No. SIP 22125.
Yen, Y.-C.
25-2068
HEAT TRANSFER, ANALYSIS (MATHEMATICS), ICE MODELS, MELTING.
In an earlier paper (SIP 21848) the problem of laminar heat transfer over a melting plate was studied under the assumption that the flow near the interface could be considered as v(x) equals cy, where v(x) is the velocity along the plate, y is a coordinate normal to plate and c is a constant in velocity distribution. The assumption simplified the subsequent analysis but there is doubt as to the validity of the simplification. This note investigates the same problem without this arbitrary assumption. In this investigation c is considered to be a function of the longitudinal distance. It is concluded that the results obtained earlier on a restricted assumption are applicable to more realistic cases.

**MP 435**
**EFFECT OF MELTING ON FORCED CONVECTION HEAT TRANSFER.**
Tien, C., et al, *Journal of applied meteorology,* Aug. 1965, 4(4), p.523-527, 10 refs.
Yen, Y.-C.
25-2102
HEAT TRANSFER, MELTING, MASS TRANSFER.
The effect of melting on convective heat transfer between a melting body and surrounding fluid was studied quantitatively from the point of view of boundary layer theory, film theory and penetration theory. These studies indicate that melting retards the rate of heat transfer, and the decrease in heat transfer coefficient is found to be a unique function of the temperature difference between the fluid and melting body, the heat capacity of the fluid and the enthalpy change due to melting.

**MP 436**
**APPROXIMATE SOLUTION OF A MELTING PROBLEM WITH NATURAL CONVECTION.**
Tien, C., et al, *Chemical engineering progress. Symposium series,* 1966 , 62(64), p.166-172, 6 refs.
Yen, Y.-C.
25-2155
HEAT TRANSFER, LIQUID PHASES, HEAT BALANCE, CONVECTION, ANALYSIS (MATHEMATICS).
Approximate solutions of temperature distribution and melting rate have been obtained for cases where the mode of heat transfer is natural convection due to the hydrodynamic instability caused by the heated lower surface. Extensive numerical solutions are given for water-ice systems corresponding to various conditions.

**MP 437**
**PIGMENT STRUCTURE OF SOME ARCTIC TUNDRA COMMUNITIES.**
Tieszen, L.L., et al, *Ecology,* Early spring 1968 , 49(2), p.370-373, 16 refs.
Johnson, P.L.
24-390
TUNDRA VEGETATION, ARCTIC REGIONS, CHLOROPHYLLS.

**MP 438**
**ACCESS TO UNDERSNOW FACILITIES.**
Tobiasson, W., *Military engineer,* Nov.-Dec. 1967, 59(392), p. 425-426.
23-2197
UNDERSNOW FACILITIES, MAINTENANCE, GREENLAND—CAMP CENTURY, ANTARCTICA—BYRD STATION.

**MP 439**
**ENVIRONMENTAL FACTORS INFLUENCING THE DESIGN OF ICE CAP FACILITIES.**
Tobiasson, W., *Institute of Environmental Sciences. Proceedings,* April 1968 , 14th, p.129-135, 13 refs.
24-2879
COLD WEATHER CONSTRUCTION, SNOWDRIFTS, WIND FACTORS, TEMPERATURE FACTORS, EQUIPMENT, SUBSURFACE STRUCTURES, SNOW DENSITY.
With knowledge of the environmental factors present at an ice cap site, a designer can choose an appropriate type of facility to meet specified functions. Surface facilities are subjected to the harsh environment and unless periodically moved or elevated they are useful for short periods only. Elevation of large structures may be impractical except for special purposes such as surveillance or communication. Even then it may be advantageous to elevate only that portion of the facility containing the special equipment. Environmental stresses on and above the surface are reduced but not eliminated by selecting a subsurface facility. However, such benefits may be overshadowed by the rapid deformation rate of unrestrained cavities in snow which is due, in part, to heat losses from warm buildings. Restrained subsurface excavations must be capable of sustaining heavy snow loads which develop as snow accumulates above the facility and the adjacent snow densifies.

**MP 440**
**DETERIORATION OF STRUCTURES IN COLD REGIONS.**
Tobiasson, W., Symposium on Cold Regions Engineering, Proceedings, College, University of Alaska, 1971, p.425-448, 7 refs.
25-4170
ICING, HOUSES, FROZEN GROUND TEMPERATURE, FOUNDATIONS, CONSTRUCTION MATERIALS, SETTLEMENT (STRUCTURAL), PERMAFROST PRESERVATION, FROST HEAVE, WALLS, ROOFS, DEFORMATION, DETERIORATION, ARCTIC CLIMATE, FROST RESISTANCE.

**MP 441**
**HANGAR FLOOR SETTLEMENTS AT THULE AIR BASE, GREENLAND.**
Tobiasson, W., et al, *U.S. Air Force Weapons Laboratory. Technical report,* March 1970, No.AFWL-TR-69-122, 56p., AD-867 561, 6 refs.
Lowry, J., III.
26-2871
FLOORS, SETTLEMENT (STRUCTURAL), TEMPERATURE MEASURING INSTRUMENTS, PERMAFROST BENEATH BUILDINGS, COOLING SYSTEMS, FROZEN GROUND TEMPERATURE, FOUNDATIONS, GROUND THAWING, MAINTENANCE, GREENLAND—THULE.
An investigation has been made of hangar floor settlement problems at Thule Air Base, Greenland. Inspection of existing instrumentation and soil-cooling systems were accomplished. Results of this inspection are presented. Existing temperature sensors were found to be in excellent condition; however, readout capability was poor. Major cause of settlement was found to be thawing of permafrost under floors. Pumping of ground water has caused thawing which has contributed to settlement. Duct blockages in the soil-cooling system has also allowed thawing to occur resulting in settlement. Recommendations are made to control further hangar settlement, to improve instrumentation in order that effective operation and maintenance procedures for hangar foundations could be developed.

**MP 442**
**HOT-WIRE ENGINE TO PRODUCE PERIODIC GROOVES ON AN ICE SURFACE.**
Tobin, T.M., et al, *Journal of glaciology,* 1971, 10(58), p.139-142, In English with French and German summaries. 8 refs.
Itagaki, K.
25-4277
LABORATORY TECHNIQUES, ICE CUTTING, ELECTRIC HEATING.

**MP 443**
**TECHNIQUE FOR PRODUCING STRAIN-FREE FLAT SURFACES ON SINGLE CRYSTALS OF ICE.**
Tobin, T.M., et al, *Journal of glaciology,* Oct. 1970, 9(57), p.385-390, In English with French and German summaries. 6 refs.
Itagaki, K.
26-623
ICE CRYSTALS, ICE SURFACE, CRYSTAL STUDY TECHNIQUES.
The top surface of an accurately aligned ice crystal is melted by an aluminum surface and then frozen to a warm "Lucite" plate and tapped free. Etch-pit development shows that the dislocation density on the resulting surface is similar to the bulk dislocation density determined by X-ray topographic methods.

**MP 444**
**DEEP-CORE DRILLING PROGRAM AT BYRD STATION (1967-1968).**
Ueda, H.T., et al, *Antarctic journal of the United states,* July-Aug. 1968 , 3(4), p.111-112, 2 refs.
23-3112
DRILL CORE ANALYSIS, CORES, ICE TEMPERATURE, THERMAL DRILLS, ANTARCTICA.

**MP 445**
**USA CRREL DRILL FOR THERMAL CORING IN ICE.**
Ueda, H.T., et al, *Journal of glaciology,* June 1969 , 8(53), p.311-314, In English, with summaries in French and German. 8 refs.
Garfield, D.E.
24-789
ICE CORING DRILLS, THERMAL DRILLS.
The USA CRREL drill is an 80-kg, electrothermal unit designed for continuous coring in temperate or polar ice or snow. The drill melts a hole approximately 16.3 cm in diameter and retrieves a core approximately 12.2 cm in diameter at rates from 1.9 m/h in - 28 C ice to 2.3 m/h in temperate ice. The melt water formed is removed by a vaccum system and stored in a tank. Additional equipment includes 450 m of armored electrical cable, a hoist, a 6.7-m tower and a gasoline generator. The minimum time required to drill a 450-m hole is 435 h. All of the equipment has been designed to be assembled and operated by two men and has a gross shipping weight of 1180 kg. Some improvements were incorporated in two more drills built in 1966, one of which was used at Byrd Station, Antarctica, during the 1967-68 austral summer.

**MP 446**
**DEEP CORE DRILLING AT BYRD STATION, ANTARCTICA.**
Ueda, H.T., et al, *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.53-62, 4 refs.
Garfield, D.E.
25-940
ICE CORING DRILLS, DRILLING, ICE TEMPERATURE.
The Antarctic ice sheet was penetrated by deep core drilling at Byrd Station during the 1967-68 austral summer. Drilling was accomplished with a cable-suspended electro-mechanical rotary drill 26.5 m long and weighing 1100 kg. Cores 3 m to 6 m in length and averaging 10.8 cm in diameter were recovered throughout 99 per cent of the depth drilled. The overall penetration rate averaged 20 m/day. The drilling rate in ice varied from 3.5-20 cm/min at a total power input of 7.5-9.0 kw Liquid water, indicative of pressure melting at the bottom of the ice sheet was encountered at 2164 m depth. The hole began deviating from the vertical at 320 m depth and despite corrective measures the inclination increased to 15 deg. at the bottom of the ice sheet. Ice temperatures increased steadily from a minimum of -28.8 C at 800 m depth to -13.0 C at 1800 m. The heat flow for this location is estimated to be 1.8 micro cal/sq cm/sec.

**MP 447**
**INSTALLATION OF DEEP-CORE DRILLING EQUIPMENT AT BYRD STATION (1966-1967).**
Ueda, H.T., et al, *Antarctic journal of the United States,* July-Aug. 1967 , 2(4), p.120-121.
Hansen, B.L.
25-2174
DRILLING, ANTARCTICA—BYRD STATION.

**MP 448**
**EFFECT OF MAXIMUM DENSITY AND MELTING ON NATURAL CONVECTION HEAT TRANSFER FROM A VERTICAL PLATE.**
Vanier, C.R., et al, *Chemical engineering progress symposium series,* 1968, 64(82), p.240-254, 33 refs.
Tien, C.
26-2869
HEAT TRANSFER, CONVECTION, MELTING, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS), PHASE TRANSFORMATION, BOUNDARY LAYER.
A method has been indicated which gives accurate results for natural convection heat transfer to vertical plates in regions of anomalous density behavior. The particular case of water has been analyzed, and good agreement with existing experimental heat transfer data has been found. Two equations have been given which predict the onset of various flow regimes; these conditions remain to be experimentally verified. A physical rationale has been advanced for the effects of maximum density, and it is suggested that the boundary-layer assumptions are a good physical model except in two temperature zones. The effect of melting on the heat transfer was found to be small.

**MP 449**
**EVALUATION OF AN ECONOMICAL INSTRUMENT SHELTER FOR MICROCLIMATOLOGICAL STUDIES.**
Vogel, T.C., et al, *Forest science,* Dec. 1965, 11(4), p.434-435, 1 ref. For another version of this paper and abstract see 24-3468.
Johnson, P.L.
25-2101
MICROCLIMATOLOGY, SHELTERS, METEOROLOGICAL INSTRUMENTS, PROTECTION.

**MP 450**
**COMMENT ON 'THE EFFECTS OF THERMAL POLLUTION ON RIVER ICE CONDITIONS' BY S.L. DINGMAN, W.F. WEEKS, AND Y.C. YEN.**
Voigt, W., Jr., *Water resources research,* Aug. 1968 , 4(4), p.847, For original article and reply see 23-3380 and 23-4335. 1 ref.
23-4334
RIVER ICE, THERMAL POLLUTION, WATER TEMPERATURE, TEMPERATURE EFFECTS.

**MP 451**
**ICE MOVEMENT AND SHORELINE MODIFICATION, LAKE CHAMPLAIN, VERMONT.**
Wagner, W.P., *Geological Society of America. Bulletin,* Jan. 1970, 81(1), p.117-126, 34 refs.
25-2233
LAKE ICE, ICE PUSH, ICE SURVEYS, SHORELINE MODIFICATION, UNITED STATES—VERMONT—LAKE CHAMPLAIN.
Measurements and observations of ice movements and shoreline modifications were made in 1968 on Lake Champlain, with detailed study on Shelburne Bay, near Burlington, Vermont. These investigations showed that distinctive ice movements on Shelburne Bay were caused by lake level rises, ice and snow abalation, and ice temperature fluctuations during the period of complete ice cover, and by wind action during ice breakup. Measured ice expansion and contraction movements can be approximated by theoretically considering the ice cover as a uniformly heated plate. Shoreline modification, in particular ice rampart formation, is very limited on Lake Champlain due to the continuous snow cover, the development of numerous pressure ridges, the relatively short period of partial open water, and the weakened condition of the ice during ice breakup. Factors controlling ice-sediment interactions on Shelburne Bay are particle size, steepness of bottom slope, and shoreline configuration. Fine particle size, gentle bottom slope, and shoreline embayments together are associated with unrestricted ice movements and only minor ice ramparts.

**MP 452**
**RE-EVALUATION OF THE RAMMSONDE HARDNESS EQUATION.**
Waterhouse, R.W., *Journal of glaciology,* Oct. 1966 , 6(45), p.425-430, French and German summaries. 6 refs. For another version of this paper and abstract see 24-3483. Microform No. SIP 25086.
25-2153
SNOW STRENGTH, HARDNESS TESTS, SNOW SURVEY TOOLS, RAMMSONDES.

**MP 453**
**RECENT WORK ON PRESSURE RIDGES AT CRREL.**
Weeks, W.F., *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* April 1971, No.101, p.36.
26-1621
RESEARCH PROJECTS, PRESSURE RIDGES, U.S. ARMY CRREL.

**MP 454**
**IS-AGE SYMPOSIUM.**
Weeks, W.F., *Antarctic journal of the United States,* March/April 1969 , 4(2), p.53.
23-5471
GLACIOLOGY, ANTARCTICA.
Brief summation of the International Symposium on Antarctic Glaciological Exploration, held at Dartmouth College, Hanover, N.H., in Sept. 1968.

**MP 455**
**TENSILE STRENGTH OF NACL ICE: A SUMMARY.**
Weeks, W.F., *U.S. Air Force. Cambridge Research Laboratories. Research Notes,* 1961 , No.55, Arctic Planning Session, 3rd, Nov. 1960. Proceedings, p.95-101, 4 refs.
25-2008
SEA ICE, TENSILE STRENGTH, SALINITY, BRINES.

**MP 456**
**TENSILE STRENGTH OF NACL ICE.**
Weeks, W.F., *Journal of glaciology,* March 1962, 4(31), p.25-52, French and German summaries. 26 refs. Microform No. SIP 20000.
25-2024
SEA ICE, SALT ICE, TENSILE STRENGTH, ICE SALINITY.
Ice samples from fresh water and at salinities ranging from 1-22 per mill were prepared in a tank designed to simulate the one-dimensional cooling of natural water bodies. Phase and density relations were computed for these salinities in the temperature range 0 to -35C and a determination made of the dependence of ring-tensile strength of the ice samples on temperature, brine volume and thermal history. The results indicate that the strength of fresh water ice is essentially temperature independent in the temperature range -10 to -30C. The strength of salt ice at temperatures between -5C and the eutectic point (-21.2C) decreases with an increase in the volume of brine in the ice and can be considered a unique function of brine volume, independent of the individual temperature and salinity values. It is suggested that the strength of fresh water ice should be considered as a limit which is approached but not exceeded by salt ice.

**MP 457**
**SEA AND LAKE ICE.**
Weeks, W.F., *American Geophysical Union. Transactions,* June 1963, 44(2), p.588-592, 43 refs. Microform No. SIP 21206.
25-2042
SEA ICE, LAKE ICE, CHEMICAL ANALYSIS, PHYSICAL PROPERTIES, ICE COMPOSITION.
A large number of papers on the properties and behavior of sea ice appeared during 1960-1962, dealing with ice formation and the prediction of freeze-up, thickness, and decay. Studies on salinity distribution indicate that the rate of migration of an individual brine pocket is limited by the diffusion of the solute in the brine pocket. Several studies of the ring-tensile strength of sea ice have been completed, and its geophysical aspects have been considered. The mechanics of deformation of ice sheets and the technological problems associated with the utilization of snow and ice for operational needs have been studies.

**MP 458**
**REVIEW OF "THE PHYSICS OF ICE" BY E.R. POUNDER.**
Weeks, W.F., *American Meteorological Society. Bulletin,* Sept. 1967 , 48(9), p.735.
Pounder, E.R.
25-2175
SEA ICE, REVIEWS, ICE PHYSICS.

**MP 459**
**UNDERSTANDING THE VARIATIONS OF THE PHYSICAL PROPERTIES OF SEA ICE.**
Weeks, W.F., Symposium on Antarctic Oceanography, Sept. 13-16, 1966, Santiago, Chile, Cambridge,, p.173-190, 39 refs. Microform No. SIP 25593. For another version of this paper and abstract see 24-3494.
25-2181
SEA ICE, ICE GROWTH, ICE COVER STRENGTH, ICE CRYSTAL STRUCTURE, ICE DIELECTRICS, BRINES.

**MP 460**
**REVIEW OF "THE FREEZING OF SUPFR-COOLED LIQUIDS" BY C.A. KNIGHT.**
Weeks, W.F., *Journal of glaciology,* Feb. 1968, 7(49), p.127-128.
Knight, C.A.
25-2182
SUPERCOOLING, FREEZING, CRYSTAL GROWTH, NUCLEATION, LIQUIDS.

**MP 461**
**STRUCTURE OF SEA ICE: A PROGRESS REPORT.**
Weeks, W.F., *National Research Council. Publication,* 1958, No.598, Arctic Sea Ice Conference, Feb. 1958, Easton Md., p.96-98, 6 refs. Microform No. SIP 16909.
25-2199
SEA ICE, ICE CRYSTAL STRUCTURE.
The initial crystals forming in sea water vary from squarish discoids to hexagonal dendrites. From 10-90 per cent of the upper surface of the initial ice sheet formed in calm water consists of crystals with vertical c-axes, while in rougher waters the crystals tend to be pushed into a vertical position with the c-axes horizontal. The grain size increases linearly with depth. Inclusions are distributed in certain selected planes (0001) within individual crystals, so that sea ice consists of alternating layers of pure ice and brine. Ice platelets forming single crystals are completely separated by brine layers in the lower 2.8 cm., and ice bridges begin to interconnect these plates only above this level. The thermal conductivity in this skeleton layer is 25-50 per cent greater perpendicular than parallel to the c-axis as a result of the insulating effect of the brine layers.

**MP 462**
**ARCTIC COASTAL AND OCEAN ENGINEERING.**
Weeks, W.F., *Northern engineer,* Spring 1970, 2(1), p.2.
25-2347
SEA ICE, ICE MECHANICS, MARINE ENGINEERING.

**MP 463**
**UNITED STATES SEA ICE PHYSICS PROJECT, 1954-1959.**
Weeks, W.F., *Polar record,* Sept. 1959, 9(63), p.553-555, 12 refs. Microform No. SIP 17736.
25-4149
SEA ICE, ICE PHYSICS, TRAFFICABILITY.
Studies conducted at Hopedale (Labrador) and Thule (Greenland) by the Air Force Cambridge Research Center, USA SIPRE, and the Navy Hydrographic Office on factors related to the trafficability of sea ice are described. A theory on the variation in the strength of warm sea ice as a function of temperature and salinity was developed; seismic methods of determining ice thickness and elastic characteristics were established; and data on vehicular movement on sea ice under marginal conditions was accumulated. Preliminary measurements were also made on the physical properties of artificially flooded ice.

**MP 464**
**CRUISE OF THE S.S. MANHATTAN, 1969.**
Weeks, W.F., *Ice,* April 1970, No.32, p.14.
25-4150
ICEBREAKERS, S.S. MANHATTAN.

**MP 465**
**ARCTIC ICE DYNAMICS JOINT EXPERIMENT (AIDJEX).**
Weeks, W.F., *Ice,* April 1971, No.35, p.16-18, 9 refs.
26-2346
SEA ICE, ICE DYNAMICS, RESEARCH PROJECTS, REMOTE SENSING, ICE DEFORMATION.

**MP 466**
**EFFECTIVE SOLUTE DISTRIBUTION COEFFICIENT DURING THE FREEZING OF NACL SOLUTIONS.**
Weeks, W.F., et al, International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 1, Sapporo, , p.579-597, 49 refs.
Lofgren, G.
23-1972
SALT ICE, ICE GROWTH, SALINITY, ICE WATER INTERFACE, ANALYSIS (MATHEMATICS).
The variation in the effective solute distribution coefficient k (k equals salinity (ice)/salinity (solution)) is studied as a function of growth velocity (v equals 3x1/100 to 1/1000 cm/sec) and the solute concentration of the freezing NaCl solution (1 to 100 per mill). The data is from ice prepared by unidirectional freezing using controlled ice-surface temperatures of -20 and -70C. The data is in good agreement with a relation suggested by Burton, Prim and Slichter (BPS, 1953). When growth conditions are such that the solid-liquid interface becomes planar ("lake" ice forms), this relation still appears applicable. Substitution of the BPS relation in an ice growth equation allows the calculation of both the initial salinity and brine volume profiles for young salt ice assuming no brine drainage. The resulting profiles are in good agreement with observed young sea ice profiles and show appreciable salinity changes as a result of changes in the meteorological conditions during growth.

**MP 467**
**THE MECHANICAL PROPERTIES OF SEA ICE.**
Weeks, W.F., et al, *National Research Council, Canada. Associate Committee on Geotechnical Research. Technical memorandum,* March 1968 , No. 92, Ice pressures against structures, proceedings of a conference held at Laval University, Quebec, 10-11 November 1966, p.25-78, Bibliog. p.69-77. Discussion p.78. For another version of this paper and abstract see 24-3410.
Assur, A.
23-4224
SEA ICE, SHEAR STRENGTH, ICE CRYSTAL STRUCTURE, TENSILE STRENGTH, ELASTIC PROPERTIES, ICE STRENGTH, ICE MECHANICS.

**MP 468**
**PETROGRAPHIC CHARACTERISTICS OF YOUNG SEA ICE, POINT BARROW, ALASKA.**
Weeks, W.F., et al, *American mineralogist,* July-Aug. 1962, 47(7-8), p.945-961, 17 refs. For another version of this paper and abstract see 24-3254. Microform No. SIP 20843.
Hamilton, W.L.
25-2025
SEA ICE, ICE CRYSTAL STRUCTURE, ICE COVER THICKNESS, SLUSH.

**MP 469**
**SALINITY DISTRIBUTION IN YOUNG SEA-ICE.**
Weeks, W.F., et al, *Arctic,* June 1962, 15(2), p.92-108, 21 refs. For another version of this paper see 24-3251. Microform No. SIP 20356.
Lee, O.S.
25-2026
SEA ICE, ICE SALINITY, YOUNG ICE.

**MP 470**
**STRUCTURAL CONTROL OF THE VERTICAL VARIATION OF THE STRENGTH OF SEA AND SALT ICE.**
Weeks, W.F., et al, Kingery, W.D., ed. Ice and snow properties, processes, and applications, Cambridge, Mass., p.258-276, 16 refs. Microform No. SIP 22053.
Assur, A.
25-2043
SALT ICE, SEA ICE, SALINITY, TENSILE STRENGTH, BRINES, TEMPERATURE FACTORS, MECHANICAL TESTS.
This study demonstrates that in NaCl ice sheets the systematic increase in the plate width with depth produces significant changes in the ring-tensile strength of the ice. Field tests indicate that similar relations exist for sea ice. Thick one-year-old sheets of unrafted pack ice provide a maximum variation in plate width. The tests should be performed in the early summer when the near melting temperatures will produce large brine volumes that should result in an appreciable strength variation as a function of location in the ice sheet. In cold young sea ice the brine volume is commonly lower, while temperature and salinity gradients in the ice are quite pronounced. It therefore would be difficult to separate the effect of the change in substructure from other effects.

**MP 471**
**EXPERIMENTAL STUDY OF STRENGTH OF YOUNG SEA ICE.**
Weeks, W.F., et al, *American Geophysical Union. Transactions,* Aug. 1958, 39(4), p.641-647, 10 refs. Microform No. SIP 16716.
Anderson, D.L.
25-2200
SEA ICE, ICE BEARING CAPACITY, SALINITY, TESTS, FLEXURAL STRENGTH.
Results of in-place cantilever beam tests presented in this paper show a definite relationship between flexural strength and brine content. Values for Young's modulus are also experimentally determined. It is shown that the bearing capacity of a sea-ice sheet is dependent on the brine content and that thin ice sheets are capable of supporting a large 'super load' beyond the force necessary to form the first crack.

**MP 472**
**OBSERVATIONS ON THE PHYSICAL PROPERTIES OF SEA-ICE AT HOPEDALE, LABRADOR.**
Weeks, W.F., et al, *Arctic,* Sept. 1958, 11(3), p.135-155, 13 refs. Microform No. SIP 17187.
Lee, O.S.
25-2201
SEA ICE, ICE FORMATION, ICE PHYSICS, SALINITY, TEMPERATURE FACTORS, CANADA—NEWFOUNDLAND—HOPEDALE.
Results of field studies in 1955-56 on the general physical properties of sea ice are reported, and the methods of measurement are described. The characteristics of sea water during the freezing period are outlined, and the formation, structure, and salinity of the initial ice cover, the formation and characteristics of infiltrated snow-ice, the growth of the ice and influencing

factors, the density of the ice at various periods, and crack formation are discussed.

**MP 473**
**SEA ICE THRUST STRUCTURES.**
Weeks, W.F., et al, *Journal of glaciology,* March 1958, 3(23), p.173-175, 1 ref. Microform No. SIP 16291.
Anderson, D.L.
25-2350
SEA ICE, ICE STRUCTURE.
Unusual thrust structures in thin sea ice sheets were observed in Labrador and Greenland. These structures are the results of thin ice sheets being forced into each other by a combination of wind and waves. When thicker pack ice is subjected to these same forces pressure ridges result.

**MP 474**
**WINTERTIME DISSIPATION OF HEAT FROM A THERMALLY POLLUTED RIVER.**
Weeks, W.F., et al, *Water resources research,* Dec. 1971, 7(6), p.1529-1537, 11 refs.
Keeler, C.M., Parrott, W.H., Levine, D.
26-2862
THERMAL POLLUTION, RIVER FLOW, WATER TEMPERATURE, METEOROLOGICAL FACTORS, HEAT LOSS.
To test a method for predicting water temperature downstream from a source of thermal pollution on a cooling river, field observations were made below the Dave Johnson power plant at Glenrock, Wyoming, on the North Platte River. Roughly 30 percent of the average winter flow of 28 cubic meters per second is diverted through the plant, and the temperature of the cooling effluent is raised about 20 C. Meteorologic parameters were recorded at two sites on the river and water temperature profiles were measured at five cross sections located up to 28 km downstream from the plant. Above the plant, the river was ice covered and the water temperature was constant at 0 C. The observed temperature decreases below the plant were compared with the temperature decreases calculated by a previously developed method. Very satisfactory agreement between observed and calculated values was achieved when relations suggested by Rimsha and Donchenko were used to estimate the evaporative and convective heat losses.

**MP 475**
**COMPARISON BETWEEN MEASURED AND THEORETICAL TEMPERATURE PROFILES OF THE CAMP CENTURY, GREENLAND, BOREHOLE.**
Weertman, J., *Journal of geophysical research,* April 1968, 73(8), p.2691-2700, For another version of this paper and abstract see 24-3381.
23-2233
ICE TEMPERATURE, BOREHOLES, GREENLAND—CAMP CENTURY.

**MP 476**
**BUBBLE COALESCENCE IN ICE AS A TOOL FOR THE STUDY OF ITS DEFORMATION HISTORY.**
Weertman, J., *Journal of glaciology,* June 1968 , 7(50), p.155-159, 10 refs.
23-2936
BUBBLES, ICE DEFORMATION.
An analysis is made of the rate of bubble coalescence in an ice mass that is deforming. A total strain of at least 8 is required before appreciable coalescence occurs. The analysis has been applied to deformation of ice shelves and ice sheets. No appreciable coalescence is expected in ice shelves but coalescence should occur in ice sheets (or glaciers) if the shear strain-rate at the bottom surface is of the order of 0.075/year or larger. Measurements of bubble concentration are capable of setting limits on paleo-strain-rates of the present ice sheets. Bubble migration down temperature gradients presents complications to the study of bubble coalescence.

**MP 477**
**DIFFUSION LAW FOR THE DISPERSION OF HARD PARTICLES IN AN ICE MATRIX THAT UNDERGOES SIMPLE SHEAR DEFORMATION.**
Weertman, J., *Journal of glaciology,* June 1968 , 7(50), p.161-165, 12 refs. For another version of this paper and abstract see 24-3386.
23-2937
SHEAR FLOW, IMPURITIES, ICE DEFORMATION.

**MP 478**
**WATER LUBRICATION MECHANISM OF GLACIER SURGES.**
Weertman, J., *Canadian journal of earth sciences,* Aug. 1969 , 6(4, Pt.2), p.929-942, Includes discussion. 44 refs.
24-2441
WATER FILMS, ICE CREEP, FLOW RATE, GLACIER SURGES.
The author reviews and amplifies his theory of glacier surges. This theory is based on the premise that a glacier surge occurs when a water layer at the base of a glacier attains a thickness sufficient to drown the obstacles in the bed that offer the greatest hindrance to sliding. The following new result is presented: in the case of a glacier bed which is very smooth, the stress concentrations in the vicinity of obstacles in the bed are so high that the power-law creep equation is no longer valid. As a consequence, the size of the controlling obstacles is reduced and thus a surge is more likely to occur.

**MP 479**
**METHOD FOR SETTING A LOWER LIMIT ON THE WATER LAYER THICKNESS AT THE BOTTOM OF AN ICE SHEET FROM THE TIME REQUIRED FOR UPWELLING OF WATER INTO A BOREHOLE.**
Weertman, J., *International Association of Scientific Hydrology. Publication,* 1970, No.86, p.69-73, 4 refs.
25-942
GLACIER ICE, BOREHOLES, BOTTOM ICE, WATER TABLE, UPWELLING, ICE COVER THICKNESS.
When a borehole penetrates an ice sheet whose bottom surface is at the melting point, upwelling of water into the borehole will occur if the drilling fluid has a pressure less than the overburden pressure. The time required for half of the upwelling to be completed can be used to obtain an estimate of the thickness of the water layer that exists between the bottom ice surface and an impervious bed if the ice sheet is elastically and plastically undeformable. An equation is developed for estimating the water layer thickness beneath such an ice sheet.

**MP 480**
**STABILITY OF ICE-AGE ICE SHEETS.**
Weertman, J., *Journal of geophysical research,* Nov. 1961, 66(11), p.3783-3792, 12 refs. Microforn No. SIP 19626.
25-2009
GLACIER ICE, GLACIER FLOW, ICE GROWTH, PLEISTOCENE.
The stability of large ice sheets is investigated by using the present-day theory of the flow of ice in glaciers and ice sheets. The type of instability considered is that first mentioned by Bodvarsson (See SIP 14559). It is concluded that a small Arctic icecap can become unstable and expand into a large ice-age ice sheet as a result of moderate changes in the regime of the icecap. A large continental ice sheet can also become unstable and shrink to nothing if the snow accumulation is reduced or the ablation rate increased. The results obtained fit well into the Ewing-Donn theory of ice ages. There is the possibility that the inherent instability of ice-age ice sheets is in itself sufficient to explain both the formation and the disappearance of these ice sheets.

**MP 481**
**MECHANISM FOR THE FORMATION OF INNER MORAINES FOUND NEAR THE EDGE OF COLD ICE CAPS AND ICE SHEETS.**
Weertman, J., *Journal of glaciology,* Oct. 1961, 3(30), p.965-978, In English with French and German summaries. 24 refs. Microform No. SIP 19502.
25-2010
MORAINES, GLACIAL DEPOSITS, GLACIAL EROSION.
A new mechanism is described which explains the formation of moraines in the ablation areas of cold ice sheets. The mechanism involves the freezing of water onto the bottom surface of an ice sheet. This water comes from regions of the bottom surface where the combination of the geothermal heat and the heat produced by the sliding of ice over the bed is sufficient to melt ice. A number of criticisms are made of the hypothesis, which has been advanced to explain moraines occurring on Baffin Is. and near Thule, Greenland. It is concluded that this older hypothesis may be inadequate to account for these moraines. Although in theory the mechanism proposed in this paper undoubtedly will lead to the formation of moraines, the existing field data are in insufficient to prove conclusively that actual moraines have originated by means of this mechanism.

**MP 482**
**EQUILIBRIUM PROFILE OF ICE CAPS.**
Weertman, J., *Journal of glaciology,* Oct. 1961, 3(30), p.953-964, French and German summaries. 14 refs. Microform No. SIP 19501.
25-2011
PLASTIC PROPERTIES, GLACIER MOVEMENT, GLACIER FRICTION, GLACIER BEDS.
Nye's theory of equilibrium profile of two-dimensional icecaps (See SIP 3628, 3881, and 17891) is modified to include longitudinal stress and creep rate effects. A more generalized law for the sliding velocity of a glacier over its bed is introduced into the analysis in order to permit the inclusion of these additional complications. It is found that in the case of small icecaps (of the order of 30 km. in width), it is important to include the longitudinal stress. A somewhat "flatter" profile than that calculated by Nye is obtained. For ice sheets of the dimensions of the Greenland or Antarctic ice sheets, the additional stress causes essentially no modification in Nye's theory. Nye's theory also has been extended to include an isostatic sinking under the weight of the ice of the bedrock below an icecap.

**MP 483**
**THEORY OF GLACIER SLIDING.**
Weertman, J., *Journal of glaciology,* Oct. 1964, 5(39), p.287-303, French and German summaries. 13 refs. Microform No. SIP 23133.
25-2064
GLACIER FLOW, GLACIER FRICTION, SLIDING VELOCITY, THEORIES.
The theory of glacier sliding has been generalized (1) by taking into account the resistance of sliding offered by obstacles both smaller and larger than the controlling obstacles, and (2) by relaxing the assumption that ice is always in intimate contact with the bed at the down-stream side of an obstacle. The sliding velocities and controlling obstacle sizes which are found from the generalized theory are approximately the same as those found from the earlier theory. A new result obtained from the present theory is that a water layer an order of magnitude smaller in thickness than the height of the controlling obstacles can cause an appreciable increase in the sliding velocity. The generalized theory contains Lliboutry's sliding theory as an extreme limiting case. For certain thicknesses of a glacier sliding velocity is a double-valued function of the shear stress exerted at the bed.

**MP 484**
**RATE OF GROWTH OR SHRINKAGE OF NONEQUILIBRIUM ICE SHEETS.**
Weertman, J., *Journal of glaciology,* June 1964, 5(38), p.145-158, 20 refs. French and German summaries. Microform No. SIP 22362. For another version of this paper and abstract see 24-3294.
25-2065
GLACIER ABLATION, GLACIER MASS BALANCE, ICE GROWTH.

**MP 485**
**DISCUSSION ON KAMB AND LACHAPELLE'S PAPER "DIRECT OBSERVATION ON THE MECHANISM OF GLACIER SLIDING OVER BEDROCK.".**
Weertman, J., *Journal of glaciology,* Oct. 1964, 5(39), p.374-375, French and German summaries. 3 refs. Microform No. SIP 23146.
25-2066
GLACIER FLOW, CREEP RATE, SLIDING VELOCITY.
In their paper, Kamb and LaChapelle (SIP 22363) conclude that the observed velocity of cubes 1 cm on a side pulled through ice disagrees with the prediction made in the author's original paper on glacier sliding (SIP 15313). An argument is presented to show that Kamb and LaChapelle are in error, and that the author's theory and experiment agree reasonably well. Any discrepancy between the theoretical and experimental values can be attributed to the uncertainty in the experimental creep data which must be used in the theory.

**MP 486**
**EFFECT OF A BASAL WATER LAYER ON THE DIMENSION OF ICE SHEETS.**
Weertman, J., *Journal of glaciology,* June 1966 , 6(44), p.191-207, French and German summaries. 20 refs. For another version of this paper and abstract see 24-3348. Microform No. SIP 24721.
25-2154
GLACIER MOVEMENT, GLACIER FRICTION, GLACIAL FEATURES, PLASTIC FLOW, GROWTH, MODELS.

**MP 487**
**EXAMINATION OF THE LLIBOUTRY THEORY OF GLACIER SLIDING.**
Weertman, J., *Journal of glaciology,* Feb. 1967 , 6(46), p.489-494, French and German summaries. 8 refs. Microform No. SIP 25306.
25-2176
GLACIER FLOW, SLIDING VELOCITY, THEORIES.
An examination is made of the Lliboutry theory of glacier sliding. It is concluded that this theory is incompletely developed and therefore it is impossible at present to make meaningful predictions of the sliding velocity from it that might be compared with field data.

**MP 488**
**SLIDING OF NONTEMPERATE GLACIERS.**
Weertman, J., *Journal of geophysical research,* Jan. 15, 1967 , 72(2), p.521-523, 5 refs. Microform No. SIP 25258. For another version of this paper and abstract see 24-3358.
25-2177
PLASTIC FLOW, GLACIER MOVEMENT, TEMPERATURE DISTRIBUTION, MELTING POINTS, FRICTION, SLIDING VELOCITY, SHEAR STRESS.

**MP 489**
**RATE OF GROWTH OF FATIGUE CRACKS CALCULATED FROM THE THEORY OF INFINITESIMAL DISLOCATIONS DISTRIBUTED ON A PLANE.**
Weertman, J., *International journal of fracture mechanics,* 1966 , 2(2), p.460-467, French and German summaries. 18 refs.
25-2183
DISLOCATIONS (MATERIALS), CRACK PROPAGATION, CRACKING (FRACTURING), SHEAR STRESS, TENSILE STRESS, THEORIES, ANALYSIS (MATHEMATICS).
The Bilby, Cottrell and Swinden crack theory is applied to the problem of the growth of fatigue cracks. It is found that if a

total critical displacement is adopted as the fracture criterion, the theory leads to observed growth laws.

**MP 490**
**ON THE SLIDING OF GLACIERS.**
Weertman, J., *Journal of glaciology,* March 1957, 3(21), p.33-38, French summary. 9 refs. Microform No. SIP 15313.
25-2206
GLACIER MOVEMENT, PRESSURE FACTORS, MELTING, SLIDING VELOCITY.
A model is proposed to explain the sliding of any glacier whose bottom surface is at the pressure melting point. Two mechanisms are considered. One is pressure melting and the other is creep rate enhancement through stress concentrations. Neither of the mechanisms operating alone is sufficient to explain sliding. If both mechanisms operate together appreciable sliding can occur.

**MP 491**
**TRANSPORT OF BOULDERS BY GLACIERS AND ICE SHEETS.**
Weertman, J., *International Association of Scientific Hydrology. Bulletin,* June 1958, No.10, p.44, 3 refs.
25-2207
GLACIER MOVEMENT, TRANSPORTATION, ROCKS.
It is shown that glaciers and ice sheets may be expected to be able to move boulders up to 20 m in size in their beds.

**MP 492**
**TRAVELING WAVES ON GLACIERS.**
Weertman, J., *International Association of Scientific Hydrology. Publication,* 1958, No.47, p.162-168, 13 refs. Microform No. SIP 17369.
25-2208
GLACIER FLOW, SLIDING VELOCITY, TRAVELING WAVES, ANALYSIS (MATHEMATICS).
An analysis is made of traveling waves on glaciers. Wave solutions are obtained by slightly perturbing steady-state solutions of the equations of Nye's theory of glacier motion. It is found that glacier waves should travel at speeds three to eight times the surface velocity.

**MP 493**
**MECHANISM FOR CONTINENTAL DRIFT.**
Weertman, J., *Journal of geophysical research,* March 1962, 67(3), p.1133-1139, 15 refs.
25-2209
CONTINENTAL DRIFT, ICE SHELVES, TENSILE STRESS, ANALYSIS (MATHEMATICS).
The analysis of the gravitational spreading of floating ice shelves and continents has been extended to include the deformation of ocean basins. It is found that if a slight difference exists in the density of rock under two different oceans, and if this difference persists to depths of the order of 1000 km or more, stresses under the oceans may be great enough to cause one of these oceans to spread out and the other to contract. As a result of this process the center of any continent lying between the oceans will be shifted. The mechanism can be shown to be equivalent to a Vening Meinesz thermal convection cell.

**MP 494**
**CONTINUUM DISTRIBUTION OF DISLOCATIONS ON FAULTS WITH FINITE FRICTION.**
Weertman, J., *Seismological Society of America. Bulletin,* Aug. 1964, 54(4), p.1035-1058, 26 refs.
25-2210
DISLOCATIONS (MATERIALS), EARTHQUAKES, FRACTURE ZONES, FRICTIONAL STRESS, ANALYSIS (MATHEMATICS).
An analysis is made of continuous distributions of infinitesimal dislocations on faults with finite friction. The analysis was undertaken in an attempt to explain the fact that dislocations produced by earthquakes commonly lie at depths that are shallower than the average depth of earthquake foci in continents. (The depths of dislocations are determined from displacements around faults.) It is found that this discrepancy can be explained if, at some depth, there exists a region where the frictional stress on faults is anomalously low.

**MP 495**
**DISLOCATION-TANGLE FORMATION.**
Weertman, J., *Metallurgical Society of AIME. Transactions,* Dec. 1963, Vol. 227, p.1439-1442, 13 refs.
25-2211
DISLOCATIONS (MATERIALS), ANALYSIS (MATHEMATICS).
It is shown that conditions suitable for the conversion of straight dislocations into helices are common in crystals hardened either through long-range dislocation interaction or by jog formation on dislocation lines. For dislocations other than screw dislocations or dislocations nearly screw in orientation, helices can be formed with the aid of core diffusion at temperatures low relative to the melting point of the material. It is assumed that, once formed, helices will degenerate into dislocation tangles.

**MP 496**
**DISLOCATION CLIMB THEORY OF STEADY-STATE CREEP.**
Weertman, J., *American Society for Metals. Transactions,* Dec. 1968, 61(4), p.681-694, 81 refs.
26-1261
CREEP PROPERTIES, DISLOCATIONS (MATERIALS), SELF DIFFUSION, STRAIN ANALYSIS, TENSILE STRESS, ICE CREEP.

**MP 497**
**INCUBATION CREEP EFFECT IN ALPHA IRON.**
Weertman, J., et al, *Acta metallurgica,* Oct. 1963, 11(10), p.1119-1128, French and German summaries. 20 refs.
Arsenault, R.J.
25-2212
CREEP, IRON, AGING (METALLURGY), TEMPERATURE EFFECTS.
The present work is an extensive study of the incubation creep effect in alpha iron discovered by Gensamer and Mehl. The incubation effect was investigated as a function of temperature, aging time and magnitude of stress increment. It was established that an aging period is required before the incubation effect can occur. An activation energy of approximately 20 kcal/mole was found both for the incubation effect and for the aging period preceding the incubation period. It is suggested that the aging is caused by a diffusion of carbon atoms to dislocation lines and that during the incubation period dislocations slowly drift away from dislocation sources by dragging carbon atoms with them. When the back stress at sources is reduced sufficiently, new essentially carbon-free dislocations are created which produced the rapid increase in the creep rate.

**MP 498**
**STUDIES OF PARTICLES FOR EXTRATERRESTRIAL ORIGIN. 1. CHEMICAL ANALYSIS OF 118 PARTICLES.**
Wright, F.W., et al, *Journal of geophysical research,* Oct. 1, 1963, 68(19), p.5575-5587, 30 refs. Microform No. SIP 22174.
Hodge, P.W., Langway, C.C., Jr.
25-2037
ICE, COSMIC DUST, PARTICLE SIZE DISTRIBUTION, CHEMICAL ANALYSIS, DUST, CHEMICAL COMPOSITION.
Dust particles of probable or known extraterrestrial origin were gathered, for the purpose of comparison, from 750-year-old Greenland ice, 55-year-old Antarctic ice, the Antarctic atmosphere, a New Mexico mountain-top, glacial ice caves, and the place of fall of the Siberian Sikhote-Alin meteorite shower. Out of the wide variety of types of particles in these samples, 118 representative particles were subjected to detailed chemical analysis by the electron-beam microanalyzer technique. The Fe/Ni ratios of 5 particles point undoubtedly to their meteoritic origin. From their high Fe/Si ratio some 35 others are thought to be extraterrestrial. A few are of obvious terrestrial origin. The cosmic influx of dust on the earth's surface is computed to be more than 1,000,000 tons per year.

**MP 499**
**SNOW STABILIZATION STUDIES.**
Wuori, A.F., Kingery, W.D., ed. Ice and snow, properties, processes and applications, Cambridge, Mass., M.I.T., 1963, p.438-458, 8 refs. Microform No. SIP 22065.
25-4298
TRAFFICABILITY, SNOW COMPACTION, SNOW STABILIZATION, EQUIPMENT.
This paper describes some of the snow stabilization studies performed by USA Cold Regions Research and Engineering Laboratory (CRREL) during the past 5 yr. Several methods of stabilizing snow have been developed which are effective in producing a surface layer capable of supporting certain types of wheeled vehicles and aircraft. Included in the studies were rotary snow plows, a Swiss Peter snow miller, snow planers, rubber-tired rollers, and large vibratory compactors. The use of additives is also discussed. The results of the testing have shown that the ram hardness test is a fairly reliable indicator of snow strength up to a ram hardness of 800. Hardness profiles obtained by various stabilizing methods are given.

**MP 500**
**ONSET OF CONVECTION IN A LAYER OF WATER FORMED BY MELTING ICE FROM BELOW.**
Yen, Y.-C., *Physics of fluids,* June 1968 , 11(6), p.1263-1270, 11 refs.
23-5366
CONVECTION, MELTWATER, ICE WATER INTERFACE, HEAT TRANSFER.
The onset of convection, or the critical Rayleigh number in a layer of water formed continuously by melting ice from below, has been determined experimentally. Homogeneous, bubble-free ice was prepared, and used in all the experiments. The critical Rayleigh number for a fluid undergoing phase change and density inversion is not a single value but may be correlated empirically as a function of the warm plate temperature by the critical Rayleigh number. This relation is valid for warm plate temperature varying from 6.72-25.50C. The initial ice sample temperature was varied from -4.8 to -22.00C. The effect of the initial ice temperature was found to be insignificant.

**MP 501**
**RATE OF TEMPERATURE PROPAGATION IN MOIST POROUS MEDIUMS WITH PARTICULAR REFERENCE TO SNOW.**
Yen, Y.-C., *Journal of geophysical research,* Feb. 15, 1967 , 72(4), p.1283-1288, 5 refs.
24-1185
HEAT TRANSFER, SNOW THERMAL PROPERTIES, POROSITY, ANALYSIS (MATHEMATICS).
A heat transfer equation neglecting the effect of radiation and convection but including the effect of vapor diffusion in porous mediums has been formulated and solved numerically for snow, in density range from 0.1 to 0.45 g/cu cm. It has been found that the evaporation-condensation process in the moist medium has a significant effect on the rate of temperature propagation, especially for low-density snow. A method is suggested for evaluating the vapor diffusion coefficient D and the effect of vapor diffusion on the effectiveness of insulation materials of low density.

**MP 502**
**ON THE EFFECT OF DENSITY INVERSION ON NATURAL CONVECTION IN A MELTED WATER LAYER.**
Yen, Y.-C., *Chemical engineering progress symposium series,* 1969 , 65(92), p.245-253, 16 refs.
24-2875
HEAT TRANSFER, CONVECTION, ICE WATER INTERFACE, MELTING POINTS.
The effect of maximum density of water near 4 C. on natural convective heat transfer in the water layer resulting from continuous melting of ice has been studied. In one case the melting process was initiated by applying heat to the bottom surface of the cylindrical ice sample and in the other case by heating the top. Temperature profiles in the continuously increasing water layer and the amount of water flowing into the melting chamber to compensate for the shrinkage due to phase transition were recorded periodically. For the case of melting from the top with warm plate temperature ranging from 4.06 to 25.10 C., it was noted that there existed a constant temperature region of about 3.2 C. in the water layer independent of the warm plate temperature, and the heat flux at the interface had no dependence on the warm plate temperature but had a constant value of 1.68x1/10 cal./(sq.cm.)(sec.). On the other hand, when melting occurred from the bottom, it was found there also existed a constant temperature region which was dependent on the warm plate temperature. The heat flux was found to be strongly dependent on the warm plate temperature. A relation between Nusselt number and Rayleigh number was found to exist.

**MP 503**
**RECENT STUDIES ON SNOW PROPERTIES.**
Yen, Y.-C., Advances in hydroscience, Vol.5, V.T. Chow, ed., New York, Academic Press, 1969, p.173-214, 33 refs.
25-1685
SNOW PHYSICS, THERMAL CONDUCTIVITY, THERMAL DIFFUSIVITY, RADIATION BALANCE, HEAT TRANSFER, ALBEDO.

**MP 504**
**EFFECTIVE THERMAL CONDUCTIVITY OF VENTILATED SNOW.**
Yen, Y.-C., *Journal of geophysical research,* March 1962, 67(3), p.1091-1098, 7 refs. Microform No. SIP 20011.
25-2027
THERMAL CONDUCTIVITY, SNOW THERMAL PROPERTIES.
Thermal conductivities of unconsolidated snow particles through which air is flowing in a direction parallel but opposite to the energy flow have been measured. The results are interpreted as being the effective thermal conductivity of snow. For snow densities of 0.376-0.472 gm./cu. cm. and corresponding snow particle sizes of 0.07-0.22 cm. nominal diameter, the results can be represented well by a least-squares equation in which the effective thermal conductivity of snow in cal./cm. sec . deg. C is equal to 0.0014 plus 0.58 times G, the mass flow rate of dry air. The value of 0.0014 is in good agreement with the data reported by Kondrat'eva in 1945 (See SIP 888).

**MP 505**
**HEAT TRANSFER BY VAPOR TRANSFER IN VENTILATED SNOW.**
Yen, Y.-C., *Journal of geophysical research,* Feb. 15,-1963, 68(4), p.1093-1101, 4 refs. Microform No. SIP 20859.
25-2044
SNOW HEAT FLUX, HEAT TRANSFER, VAPOR TRANSFER, THERMAL CONDUCTIVITY, AIR FLOW, VAPOR DIFFUSION.
A method has been developed for determining the heat transfer due to vapor transfer in snow through which air is flowing in a direction parallel but opposite to the heat flow. The experimental technique consists in determining the effective diffusivity of water vapor through snow, which was subsequently used to calculate the extent of heat transfer due to vapor diffusion. The effective diffusivity is related to the mass flow rate of dry air, and the relationship indicates that if there is no air flow, the snow density will have no effect on the extent of water vapor diffusion and thus on the amount of heat transferred by this mechanism. However, vapor transfer contributes about 19% to the effective thermal conductivity at an air-flow rate of

10 x 1/1000 gm./sq.cm. sec. or a pore velocity of about 1.3 cm./sec. and, thus, vapor transfer processes make a significant contribution to the process of heat transfer associated with a natural snow cover.

**MP 506**
**EFFECTIVE THERMAL CONDUCTIVITY AND WATER VAPOR DIFFUSIVITY OF NATURALLY COMPACTED SNOW.**
Yen, Y.-C., *Journal of geophysical research,* April 15, 1965, 70(8), p.1821-1825, 3 refs. Microform No. SIP 24109.
25-2103
SNOW COMPACTION, THERMAL CONDUCTIVITY, HEAT TRANSFER, SNOW PERMEABILITY, ANALYSIS (MATHEMATICS).
The influence of air flow on effective thermal conductivity and water vapor diffusivity of naturally compacted snow has been determined experimentally. The technique consists of a system involving countercurrent flow of air and heat and the measurement of steady-state temperature distribution parallel to the axis of cylindrical samples. Empirical equations are presented in terms of snow densities varying from 0.50 to 0.59 g/cu cm and the mass flow rate of dry air in the range of 5 to 32 x 1/1000 g/sq cm sec. Values found are in agreement with previously reported experimental results.

**MP 507**
**FURTHER STUDIES ON A MELTING PROBLEM WITH NATURAL CONVECTION.**
Yen, Y.-C., *A.I.Ch.E. journal,* July 1967, 13(4), p.824-825, 5 refs.
25-2178
HEAT TRANSFER, MELTING, CONVECTION, ICE WATER INTERFACE, THERMAL CONDUCTIVITY, ANALYSIS (MATHEMATICS).

**MP 508**
**HARMONIC ANALYSIS OF SNOW TEMPERATURES.**
Yen, Y.-C., et al, *Journal of geophysical research,* June 20, 1969, 74(13), p.3443-3446, 8 refs.
Dotson, J.W.
24-194
HEAT TRANSFER, SNOW DENSITY, TEMPERATURE VARIATIONS, SNOW TEMPERATURE, PERIODIC VARIATIONS.

**MP 509**
**ONSET OF CONVECTION IN A WATER LAYER FORMED CONTINUOUSLY BY MELTING ICE.**
Yen, Y.-C., et al, *Physics of fluids,* March 1969, 12(3), p.509-516, 8 refs.
Galea, F.
24-2878
HEAT TRANSFER, CONVECTION, ICE WATER INTERFACE, MELTING.
The onset of convection, in a water layer continuously formed by melting ice from above, has been obtained by the experimental determination of the water layer depth d at which the mode of heat transfer changes from conduction to convection. This was accomplished both by determining the time at which the temperature profile of the water layer started to deviate from linear distribution and by locating the inflection point in the curve relating water-ice interface position and time. Experimental values of d (either for melting from above or below) were found with a mean deviation of 14.1 per cent from those by theoretical analysis of a similar problem. From the present and previous investigations (CRREL 23-5366), it can be concluded that the critical Rayleigh number for a horizontal layer of fluid with a density inversion is not a single value as for a normal fluid with a monotonic density-temperature relationship, but varies with boundary temperatures.

**MP 510**
**ON THE ISOTHERMAL FLOW OF AIR INTO A RECTANGULAR SNOW TRENCH.**
Yen, Y.-C., et al, *Journal of geophysical research,* Dec. 15, 1963, 68(24), p.6475-6480, 6 refs. For another version of this paper and abstract see 24-3293. Microform No. SIP 21602.
Fisher, D.
25-2045
PERMEABILITY, SNOW TRENCHES, FLUID FLOW.

**MP 511**
**LAMINAR HEAT TRANSFER OVER A MELTING PLATE, THE MODIFIED LEVEQUE PROBLEM.**
Yen, Y.-C., et al, *Journal of geophysical research,* June 15, 1963, 68(12), p.3673-3678, 3 refs. For another version of this paper and abstract see 24-3276.
Tien, C.
25-2046
HEAT TRANSFER, ICE WATER INTERFACE, ICEBERGS, MELTING, ANALYSIS (MATHEMATICS), FREEZING.

**MP 512**
**ISOTHERMAL FLOW OF AIR IN A POROUS MEDIUM INTO A RECTANGULAR SINK.**
Yen, Y.-C., et al, *Journal of geophysical research,* Oct. 15, 1964, 69(20), p.4211-4219, 7 refs.
Fisher, D.
25-2067
FLUID FLOW, PERMEABILITY, ANALYSIS (MATHEMATICS), POROUS MATERIALS.
In a previous paper the authors developed an expression for evaluating the quantity of air flowing into a partly cased rectangular porous trench of constant permeability, assuming isothermal, steady, and two-dimensional flow. The configuration factor in this earlier work was determined by considering the effects of depth of the impermeable layer, depth of the trench, and depth of the trench casing. In the present study the effect of trench width is also included. New values of the configuration factor are shown graphically for various geometrical arrangements. It is found that the effect of trench width is not negligible and should be considered in any practical analysis.

**MP 513**
**ON THE ISOTHERMAL FLOW OF AIR THROUGH A SNOW PACK WITH VARIABLE PERMEABILITY.**
Yen, Y.-C., et al, *International Association of Scientific Hydrology. Publication,* 1963, No.61, p.51-61, French summary. 4 refs. Microform No. SIP 21887. For another version of this paper and abstract see 24-3292.
Tien, C., Bender, J.A.
25-2213
FLUID FLOW, PERMEABILITY, SNOW COVER.

**MP 514**
**EVAPORATION OF WATER INTO A SUB-ZERO AIR STREAM.**
Yen, Y.-C., et al, *Water resources research,* April 1970, 6(2), p.430-439, 10 refs.
Landvatter, G.R.
25-2232
EVAPORATION, AIR TEMPERATURE, AIR WATER INTERACTIONS, MASS TRANSFER, EXPERIMENTAL DATA, ANALYSIS (MATHEMATICS).
Evaporation of water into sub-zero air stream to simulate water surface conditions during North American winters has been experimentally carried out. The study covers an air velocity range from 10 to 160 cm/sec and air temperatures up to 20 C below that of the water surface. The results can be well represented by a correlation of the Nusselt number for mass transfer and the Reynolds number based on the length of the evaporating surface. This correlation gives a value about two and one-half times higher than the result calculated from the Bowen ratio.

**MP 515**
**IMPACT OF SPHERES ON ICE.**
Yen, Y.-C., et al, *American Society of Civil Engineers. Engineering Mechanics Division. Journal,* Oct. 1970, 96(EM5), p.641-652, 5 refs.
Odar, F., Bracy, L.R.
25-2241
CRACKING (FRACTURING), IMPACT STRENGTH, ICE MECHANICS, COEFFICIENTS, TESTS, PLASTICS, STEELS.
An oscilloscopic method for determining the coefficient of restitution, e, by impact of spheres on ice was developed. Teflon, acrylic, nylon, and steel spheres having 1/4-in., 1/2-in., 3/4-in., and 1-in. diam were used. The experiments were conducted at -1 C, -10 C and -20 C, respectively. With the exception of Teflon spheres, the coefficient of restitution is found to decrease with the diameter of the sphere and increase as the temperature is lowered. All the data can be well represented by an exponential expression in terms of impact velocity V(i) in a form of e equals A exp (-B V(i)) with correlation coefficients in the range of 0.91 to 0.99. The occurrence and extent of ice cracking were found to depend on the sphere material, diameter, temperature, and impact velocity.

**MP 516**
**EXPERIMENTAL STUDY OF A MELTING PROBLEM WITH NATURAL CONVECTION.**
Yen, Y.-C., et al, International heat transfer conference, 3rd, Aug. 7-12, 1966, Chicago. Proceedings, Vol.4, New York, American Institute of Chemical Engineers, 1966, p.159-166, In English with German and Russian summaries. 13 refs.
Tien, C., Sander, G.W.
25-2699
TEMPERATURE EFFECTS, HEAT TRANSFER, CONVECTION, ICE WATER INTERFACE, MELTING RATES, PHASE TRANSFORMATIONS.
An experimental technique has been successfully developed to study the effect of natural convection (thermal instability) on the melting rate of ice. Reproducible results were obtained by using homogeneous, bubble-free ice samples for the melting process. The problem of volume change due to phase transition or separation of the ice-water interface encountered when melting from below was solved by continuously adding water at the same temperature as the constant temperature bath which supplied heat for melting. Under certain temperature conditions irregularities in the interface, a result of convective motion, became very apparent and could be observed by visual means. By periodically measuring the amount of water added and varying the initial temperature of the ice sample and that of the heat source extensive results were obtained demonstrating the effects of these temperatures on the melting rates. The results from this experimental investigation are compared with those obtained from an analytical solution of the same problem.

**MP 517**
**HEAT TRANSFER AT MELTING FLAT SURFACE UNDER CONDITIONS OF FORCED CONVECTION AND LAMINAR BOUNDARY LAYER.**
Yen, Y.-C., et al, *International journal of heat and mass transfer,* Nov. 1971, 14(11), p.1875-1876, 2 refs.
Tien, C.
26-2866
HEAT TRANSFER, ICE WATER INTERFACE, MELTING, ANALYSIS (MATHEMATICS).

**MP 518**
**THERMAL AND COMPOSITIONAL STRUCTURE OF THE KOETTLITZ ICE TONGUE, MCMURDO SOUND, ANTARCTICA.**
Zotikov, I.A., , International Conference on Low Temperature Science, Sapporo, Aug.14-19, 1966, Proceedings, Vol.1, Part 1, Sapporo, , p.469-478, 12 refs.
Gow, A.J.
23-1963
GLACIER ICE, ABLATION, THERMAL ANALYSIS, SEA WATER FREEZING, ICE SHELVES, CORES, ANTARCTICA—MCMURDO SOUND.

**MP 519**
**ROOFS FOR COLD REGIONS.**
Aamot, H.W.C., et al, *Military engineer,* May-June 1972, 64(419), p.158-160.
Schaefer, D.
27-705
COLD WEATHER CONSTRUCTION, ROOFS, PROTECTIVE COATINGS, THERMAL INSULATION.
The protected membrane roof system reverses the traditional practice which surfaces the roof with a waterproof membrane. It is designed to solve the particular problems facing roof systems in cold climates and is also attractive for temperature climates. The roof has two important features that make it uniquely suited for cold regions: First, the structural deck is insulated. Its temperature remains nearly constant throughout the year. Thermal movement is greatly reduced, resulting in design simplifications and probably reduced deterioration of the structure. Second, construction is less dependent on favorable weather conditions. There is no danger of accumulating moisture in the roof. It is self-drying, both upwards and downwards. The protective upper surface, no longer a fragile waterproof skin, offers greater flexibility in the design and opportunity for use.

**MP 520**
**MICROHARDNESS TESTING ON ICE SINGLE CRYSTALS.**
Ackley, S.F., Ottawa, Royal Society of Canada, 1973, p.382-386, In: Physics and chemistry of snow and ice, Ed., E.Whalley, S.J. Jones, and L.W. Gold. 12 refs.
28-3691
ICE MECHANICS, HARDNESS TESTS, TEMPERATURE EFFECTS.
Identation measurements have been made on various orientation of both zone-refined and glacier ice single crystals in the temperature range 0C to -20C using a pyramidal Knoop indenter. The results include a softening effect at temperatures above -8C that may be associated with a similar result found for polycrystalline ice identation experiments. The effects of surface treatment on the result are also discussed with microtomed surfaces having marked effects on the hardness value.

**MP 521**
**CRYSTAL STRUCTURE OF A NATURAL FREEZING RAIN ACCRETION.**
Ackley, S.F., et al, *Weather,* May 1974, 29(5), p.189-192, 5 refs.
Itagaki, K.
29-1139
ICE ACCRETION, ICE CRYSTAL GROWTH, FREEZING RAIN.

**MP 522**
**ANTARCTIC ANALOG OF MARTIAN PERMAFROST TERRAIN.**
Anderson, D.M., et al, *Antarctic journal of the United States,* July-Aug. 1972, 7(4), p.114-116, 2 refs.
Gatto, L.W., Ugolini, F.C.
27-1532
CRYOGENIC RELIEF, AERIAL PHOTOGRAPHS, PERMAFROST STRUCTURE, ANALOGIES, GEOLOGICAL SURVEYS, PHOTOINTERPRETATION, ANTARCTICA—BEACON VALLEY.
Identification of analogous regions on Mars and the Earth can be of significant benefit in the design of the instrumentation and

mission of Martian orbiters and landers. Based on studies of Mariner 6 and 7 imagery, the thermokarst topography of Yakutia (Siberia) is considered a possible genetic analog to "chaotic terrain" of Mars. The edges of the ice caps near Thule (Greenland) and in the Beacon Valley (Antarctica) are regarded as analogs to regions bordering the polar caps of Mars. Beacon Valley is considered the most apt analogy. Because snow accumulation is negligible and ablation occurs mainly by sublimation, liquid water there, as on Mars, is an ephemeral phase. Chemical weathering clearly is occurring, albeit slowly, and mechanical weathering and frost action are significant. Interpretation of the aerial photographs of Beacon Valley site taken from 6,250 m is given in detail.

**MP 523**

**EXAMINATION OF MARINER 6 AND 7 IMAGERY FOR EVIDENCE OF PERMAFROST TERRAIN ON MARS.**

Anderson, D.M., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.499-508, 30 refs.
Gatto, L.W., Ugolini, F.C.
28-851
MARS (PLANET), EXTRATERRESTRIAL ICE, CRYOGENIC RELIEF.

The Mariner 6 and 7 satellite imagery of Mars was processed by computer techniques for maximum discriminability and examined for geomorphic evidence of permafrost. Particular attention was given to the region lying between 10 - 70 long. and 20 N to 20 S lat., a region described as chaotic terrain by Leighton et al. For comparison, the alas thermokarst topography in Yakutia, Siberia, was identified as the best known terrestrial analog. The geomorphic features characteristic of the ice-cemented permafrost adjacent to receding portions of the polar ice caps at Thule, Greenland, and Beacon Valley, Antarctica, were also studied as analogous to Martian permafrost terrain. The environmental conditions characteristic of these areas were compared with those thought to be generally characteristic of Mars. The periglacial area at Thule receives 144 mm of precipitation yearly and has abundant surface water during the summer melt season. In contrast, Beacon Valley has little precipitation, drier air, and lower temperatures and, of the two, is considered the most apt analogy for the cold desert environment of Mars.

**MP 524**

**ERTS-1 IMAGERY ARCTIC AND SUBARCTIC ENVIRONMENTAL ANALYSIS.**

Anderson, D.M., et al, *Army research and development,* Dec. 1972, 13(8), p.29-30.
Haugen, R.K., Gatto, L.W., Slaughter, C.W., McKim, H.L., Marlar, T.L.
31-1897
ARCTIC TOPOGRAPHY, REMOTE SENSING, ERTS IMAGERY, ENVIRONMENTS, TOPOGRAPHIC SURVEYS, UNITED STATES—ALASKA.

**MP 525**

**PREDICTING UNFROZEN WATER CONTENTS IN FROZEN SOILS FROM SURFACE AREA MEASUREMENTS.**

Anderson, D.M., et al, *Highway research record,* 1972, No.393, p.12-18, 31 refs.
Tice, A.R.
27-862
SOIL MOISTURE, UNFROZEN WATER CONTENT, SOIL FREEZING, FROST PENETRATION, PHASE TRANSFORMATIONS.

An empirical equation relating the unfrozen water content of partially frozen soils to temperature and specific surface area has been devised. In spite of the simplifying assumptions involved, this prediction equation is of sufficient accuracy for normal engineering requirements. Predicted unfrozen water contents (phase composition) computed from this equation are compared with experimentally obtained values for nine soils and two surface-active soil constituents and are found to be in good agreement, particularly at temperatures below -5 C (23 F). Possession of this prediction equation permits more refined calculations of frost and thaw penetration under natural or disturbed conditions and calculation of the time-dependent temperature distributions associated with foundations, footings, production oil wells, and pipelines.

**MP 526**

**SEDIMENT DISTRIBUTION AND COASTAL PROCESSES IN COOK INLET, ALASKA.**

Anderson, D.M., et al, Symposium on significant results obtained from the Earth Resources Technology Satellite-1. Volume 1: Technical Presentations, Sections A and B. S.C. Fredan, E.P. Mercanti, and M.A. Becker, eds., Greenbelt, Md., Goddard Space Flight Center, 1973, p.1323-1339, N73-28348 (N73-28207).
Gatto, L.W., McKim, H.L., Petrone, A.
28-1762
REMOTE SENSING, TIDAL CURRENTS, SEDIMENT TRANSPORT, WATER FLOW.

Regional hydrologic and oceanographic relationships in Cook Inlet, Alaska have been recognized from sequential ERTS-1 MSS imagery. Current patterns are visible in the inlet because of differential concentrations of suspended sediment. The circulation patterns within Cook Inlet are controlled primarily by the interaction between the semi-diurnal tides and the counter clockwise Alaska current. In general, heavily sediment laden water is seen to be confined to portions of the inlet north of the Forelands and west of Kalgin Island. Tongues of clear oceanic water are observed to enter the inlet through Kennedy Channel along the east shoreline in the vicinity of Cape Elizabeth. A recurring counterclockwise circulation pattern observed around Kalgin Island seems to result from the interplay of the northerly moving water along the east shore and the southerly moving, sediment laden, water along the west side of the inlet. Prominent, fresh water plumes, heavily laden with sediment are visible at the mouths of all major rivers. Reflect plumes from as many as three tidal stages have been recognized.

**MP 527**

**UNFROZEN INTERFACIAL PHASE IN FROZEN SOIL WATER SYSTEMS.**

Anderson, D.M., et al, Ecological studies. Analysis and synthesis Vol. 4, Edited by A. Hadas et al. 34 refs. Berlin, Springer, 1973, p.107-124.
Tice, A.R.
29-798
UNFROZEN WATER CONTENT, HEAT MEASUREMENT, FROZEN GROUND THERMODYNAMICS, PHASE TRANSFORMATIONS, ICE WATER INTERFACE.

**MP 528**

**UNFROZEN WATER AND THE APPARENT SPECIFIC HEAT CAPACITY OF FROZEN SOILS.**

Anderson, D.M., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.289-295, 22 refs.
Tice, A.R., McKim, H.L.
28-825
FROZEN GROUND, SPECIFIC HEAT, UNFROZEN WATER CONTENT.

**MP 529**

**WATER-ICE PHASE COMPOSITION OF CLAY-WATER SYSTEMS: I. THE KAOLINITE WATER SYSTEM.**

Anderson, D.M., et al, *Soil Science Society of America. Proceedings,* Nov.-Dec. 1973, 37(6), p.819-822, 19 refs.
Tice, A.R., Banin, A.
28-3628
FROZEN GROUND HYDROLOGY, UNFROZEN WATER CONTENT, PHASE TRANSFORMATIONS, SOIL TEMPERATURE, CLAY SOILS, CALORIMETERS.

Previous work has indicated that when water-ice phase composition curves are normalized to unit surface area, unfrozen water content values at all temperatures are higher for the kaolinite-water system than for other clay-water systems. In addition, the water-ice phase composition curve for this system appeared to be the resultant of the superposition of two power curves relating unfrozen water content to sub-freezing soil temperatures. The measurements have been repeated using an improved isothermal calorimeter and the earlier results confirmed. Values of unfrozen water content per unit surface area for the kaolinite-water systems are more than twice as large as those for the montmorillonite-water systems. Addition of polyox (polyethylene oxide) to the kaolinite-water system had little effect on unfrozen water content in the range of sub-freezing temperatures less than -1.7 but diminished unfrozen water content significantly at values of sub-freezing temperatures colder than -1.7. The observations are explained qualitatively in terms of a domain model of clayimbibed water.

**MP 530**

**FIELD IMPLICATIONS OF THE FORMATION OF ICE RIPPLES.**

Ashton, G.D., 1972, (Vol.1), Symposium on Ice and Its Action on Hydraulic Structures, 2nd, Leningrad, Sept. 26-29, 1972. Papers. p.123-129.
28-3868
RIVER ICE, FLOW RATE, DRIFT, ICE BOTTOM SURFACE.

The results of a recent experimental and analytical study are used to predict the conditions under which ice ripples form on the underside of river ice covers. A relationship between the wavelength of the ripples and the flow velocity is proposed and compared with existing field data. The effect of flow depths on the wavelength-velocity relationship is examined and found to be small.

**MP 531**

**FROUDE CRITERION FOR ICE-BLOCK STABILITY.**

Ashton, G.D., *Journal of glaciology,* 1974, 13(68), p.307-313, In English with French and German summaries. 8 refs.
29-1003
RIVER ICE, FLOATING ICE, ICE COVER THICKNESS, FLOW RATE.

The conditions under which a floating fragment of ice is either entrained under the up-stream edge of a down-stream ice cover or accumulated up-stream are examined by means of dimensional analysis and a simplified analysis of the moments acting on an idealized ice fragment. The significant parameter descriptive of the critical conditions is found to be a Froude number based on block thickness. The influence of the ratio of thickness to flow depth is shown to be due to the effect of the block constricting the flow cross-section, thus amplifying the velocity in accordance with simple continuity. Under-turning instability occurs at a lower critical velocity than required for vertical submergence. Comparison of experimental data with the theoretical results shows good agreement and demonstrates the vital dependence on fragment thickness as well as providing a criterion readily applicable to special flow conditions where a Froude number based on flow depth is illogical.

**MP 532**

**HEAT TRANSFER TO RIVER ICE COVERS.**

Ashton, G.D., *Eastern Snow Conference. Proceedings,* 1973, 30th, p.125-135, 7 refs.
29-682
RIVER ICE, ICE BOTTOM SURFACE, HEAT TRANSFER, ICE COVER THICKNESS.

The importance of the convective transfer of heat to the underside of river ice covers is examined, and the results related to customary means of predicting the rate of thickening of the ice cover. It is shown that even small above-freezing water temperatures (a few hundredths deg C) have significant effects on the growth rate when associated with typical river flow velocities. The results are applicable both to natural rivers and rivers having an imposed heat influx.

**MP 533**

**RIPPLES ON UNDERSIDE OF RIVER ICE COVERS.**

Ashton, G.D., et al, *American Society of Civil Engineers. Hydraulics Division. Journal,* Sept. 1972, 98(HY9), p.1603-1624, 14 refs.
Kennedy, J.F.
27-909
RIVER ICE, ICE BOTTOM SURFACE, HEAT TRANSFER, THERMAL CONDUCTIVITY, TURBULENT FLOW, MATHEMATICAL MODELS.

A mathematical model is developed to predict the occurrence and describe the properties and behavior of ice ripples that form on the underside of river ice-covers. The local rate of freezing or melting at the ice-flow interface is related to the difference between the local heat transfer rates by conduction through the ice and by turbulent transfer from the flow to the ice. The local heat flux to the interface from the flow is expressed as a small perturbation expansion in terms of the steepness of the monochromatic interfacial wave, and is assumed to be shifted relative to the interface wave. The analysis yields a stability criterion and expressions for the amplification rate and celerity of the ripples. Laboratory data are used to obtain values for the constants introduced into the theory and to corroborate the analytical results. Field data are examined in the light of the laboratory results.

**MP 534**

**STABILITY OF FLOATING ICE BLOCKS.**

Ashton, G.D., *American Society of Civil Engineers. Hydraulics Division. Journal,* Nov. 1973, 99(HY11), p.2142-2144, 3 refs.
28-2268
FLOATING ICE, DRIFT, HYDRAULICS.

**MP 535**

**TURBULENT HEAT TRANSFER TO WAVY BOUNDARIES.**

Ashton, G.D., Heat transfer and fluid mechanics institute, 1972, Proceedings, Stanford University Press, 1972, p.200-213, 14 refs.
27-716
HEAT TRANSFER, TURBULENT FLOW, ICE WATER INTERFACE, FLOW RATE.

Experimental studies of the streamwise variation of the heat transfer rate from a turbulent flow to a small-amplitude wavy ice-water interface are reported. Representative results of the measurements are presented and related to the periodically varying acceleration of the flow. The results are compared with a correlation previously suggested in terms of the acceleration parameter, and a suggestion is made that the correlation should be between the rate of change with distance and the acceleration. In either case a lag in the response of the heat transfer rate to a varying acceleration must be introduced to fully reconcile experimental results with the correlations. The lag distance is found to be approximately inversely proportional to the flow velocity.

**MP 536**

**FORCES IN MOVING ICE FIELDS.**

Assur, A., *International Conference on Port and Ocean Engineering Under Arctic Conditions. Proceedings,* 1971, 1st, Vol.1, p.112-118, 5 refs.
27-1176
SEA ICE, ICE DYNAMICS, ICE PRESSURE, OFFSHORE STRUCTURES, ANALYSIS (MATHEMATICS), DESIGN CRITERIA.

Forces which moving ice fields exert on structures depend upon size and shape of the structure ranging from isolated piles to straight walls and sloping cones. Broken-up ice causes additional design difficulties. Ice properties and failure modes must be considered.

**MP 537**
**PLANE PLASTIC DEFORMATION OF SOILS.**
Takagi, S., *American Society of Civil Engineers. Engineering Mechanics Division. Journal,* June 1962, 88(EM3), p.107-151, 21 refs. For another version of this paper and abstract see 24-3243.
25-2023
PLASTIC DEFORMATION, SOIL MECHANICS, COMPRESSIVE PROPERTIES, ANALYSIS (MATHEMATICS).

**MP 538**
**SOME PASSIVE METHODS OF CONTROLLING GEOCRYOLOGICAL CONDITIONS IN ROADWAY CONSTRUCTION.**
Berg, R., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.581-586, 10 refs.
Aitken, G.W.
28-859
CRYOGENIC PROCESSES, PERMAFROST CONTROL, ROADS, DESIGN, THERMAL ANALYSIS.
Two different heat transfer computational techniques were shown to be applicable in evaluating thermal designs in permafrost areas. It is believed that the finite difference technique will have more widespread application in the future because of the flexibility it provides with regard to specification of boundary and initial conditions. In this study, the most effective technique for controlling permafrost degradation was that of painting the pavement surface white. This is in agreement with data obtained from a white-painted runway at Thule, Greenland. It is unfortunate that the highway test sections were not trafficked so that the effects of abrasion of the paint could have been evaluated. At Thule, repainting every few years has been adequate under aircraft traffic. Undoubtedly, highway traffic and maintenance procedures constitute a more severe environment for the paint, particularly the use of studded snow tires, which would reduce the interval required between repainting to maintain effective albedo control. However, research may yield other still longer lasting techniques for albedo control. Performance of the baled peat heat sink was not satisfactory and this approach should probably not be considered in an area having a thermal regime similar to that at Fairbanks.

**MP 539**
**USE OF THERMAL INSULATING MATERIALS IN HIGHWAY CONSTRUCTION IN THE UNITED STATES.**
Berg, R.L., *Norges teknisk-naturvitenskapelige forskningråds og Statensvegvesens Utvalg for frost i jord. Publikasjoner,* April 1972, No.6, p.19-23, 9 refs.
27-708
ROADS, THERMAL INSULATION, FROST PROTECTION, COMPRESSIVE STRENGTH, FREEZING INDEXES, UNITED STATES.
Insulated roadway sections have been installed in seasonal frost and permafrost areas of the United States. Extruded polystyrene boards have been the most commonly used type of insulation, however, molded polystyrene boards, foamed-in-place polyurethane, and cellular glass boards have also been tried. Use of extruded polystyrene boards to inhibit seasonal frost penetration into frostsusceptible soils is no longer considered experimental by the Bureau of Public Roads. Insulation has been used in repairing frostdamaged roads and in new road construction. The quantity of insulation used in highway and airport construction has increased annually for the past several years.

**MP 540**
**PREVAILING WIND DIRECTIONS IN ARCTIC OCEAN.**
Bilello, M.A., et al, *American Geophysical Union. Transactions,* Nov. 1972, 53(11), p.1014, Abstract only.
Langway, C.C., Jr.
31-3143
ARCTIC CLIMATE, WIND DIRECTION, SEASONAL VARIATIONS, METEOROLOGICAL CHARTS.

**MP 541**
**ENVIRONMENTAL CONSIDERATIONS FOR THE UTILIZATION OF PERMAFROST TERRAIN.**
Brown, J., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.587-590, 21 refs.
28-860
PERMAFROST DISTRIBUTION, LANDSCAPE DEVELOPMENT, ARCTIC TERRAIN, ARCTIC VEGETATION, PERMAFROST WEATHERING, HUMAN FACTORS, ENVIRONMENTAL ENGINEERING.

**MP 542**
**ENVIRONMENTAL SETTING, BARROW, ALASKA.**
Brown, J., 1968, 30p., Presented at the Conference on Productivity and Conservation in Northern Circumpolar Lands, 1968. No microfiche available.
33-589
ENVIRONMENTS, ARCTIC CLIMATE, TUNDRA VEGETATION, TUNDRA SOILS, PERMAFROST, GEOMORPHOLOGY, UNITED STATES—ALASKA—BARROW.

**MP 543**
**PERMAFROST AND COASTAL PLAIN HISTORY OF ARCTIC ALASKA.**
Brown, J., et al, Alaskan arctic tundra. Edited by M.E. Britton. Arctic Institute of North America. Technical paper No.25, Washington, D.C., Sept. 1973, p.31-47, Refs. p.42-47.
Sellmann, P.V.
28-3605
PERMAFROST STRUCTURE, PERMAFROST PHYSICS, RESEARCH PROJECTS.

**MP 544**
**HEAT BALANCE OF THE EARTH'S SURFACE.**
Budyko, M.I., Washington D.C., 1958, 259p., PB 131 692, Translation of Teplovoĭ balans zemnoĭ poverkhnosti, Leningrad, 1956. Refs. p.233-259.
30-4484
HEAT BALANCE, SOLAR RADIATION, RADIATION ABSORPTION, RADIATION BALANCE, ALBEDO, POLAR REGIONS, CLIMATOLOGY, METEOROLOGICAL FACTORS, TOPOGRAPHIC FACTORS, HYDROLOGY.

**MP 545**
**ELECTRICAL CONDUCTION IN ICE.**
Camp, P.R., et al, 1965, 64p., Unpublished manuscript. No microfiche available.
Kiszenick, W., Arnold, D.A.
33-433
ICE ELECTRICAL PROPERTIES, ICE RESISTIVITY, ELECTRICAL RESISTIVITY, CONDUCTION.

**MP 546**
**MECHANICAL PROPERTIES OF FROZEN GROUND UNDER HIGH PRESSURE.**
Chamberlain, E., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.295-305, 8 refs.
28-826
FROZEN GROUND MECHANICS, FROZEN GROUND COMPRESSION, GROUND ICE, ICE STRUCTURE, ICE COMPRESSION, TEST EQUIPMENT, LABORATORY TECHNIQUES.

**MP 547**
**MECHANICAL BEHAVIOR OF FROZEN EARTH MATERIALS UNDER HIGH PRESSURE TRIAXIAL TEST CONDITIONS.**
Chamberlain, E., et al, *Geotechnique,* Sept. 1972, 22(3), p.469-483, French summary. 23 refs.
Groves, C., Perham, R.E.
27-1428
PHASE TRANSFORMATIONS, COMPRESSIVE PROPERTIES, FROZEN GROUND MECHANICS, DEFORMATION, SHEAR STRESS, PRESSURE, UNFROZEN WATER CONTENT, SOIL COMPOSITION.
Effects of confining pressure on shear strength of frozen soil are described. Triaxial compression tests were conducted on two ice- saturated frozen soils to a confining pressure of 40 kip/sq. in. at -10C. The shear strength was observed to change with increasing mean stress in three distinct regions. At low mean stresses the shear strength remained constant or increased, at intermediate mean stresses the shear strength decreased, and at high mean stresses the shear strength increased. It is suggested that interparticle friction and particle interlocking, unfrozen water content, pressure melting, and the ice-water phase change are the factors that most influence the triaxial compression behavior of frozen soils.

**MP 548**
**THEORY OF WATER PERCOLATION IN SNOW.**
Colbeck, S.C., *Journal of glaciology,* 1972, 11(63), p.369-385, In English with French and German summaries. 20 refs.
27-2087
MOISTURE TRANSFER, SNOW PERMEABILITY, FLUID FLOW, POROUS MATERIALS.
A theory is developed to describe the vertical percolation of water in isothermal snow. The general theory of Darcian flow is reviewed to establish a reasonable physical basis for the construction of a model. It is shown that in simple gravity drainage, capillarity is negligible compared with gravity since values of water saturation are generally in the "mid-range". It is postulated that the permeability to the water phase increases as a certain function of the water saturation, and porosity is assumed to decrease linearly with depth. Ice layers and other inhomogeneities are treated in the theory by considering the permeability of the snow with the inhomogeneities included. A method by which this value of permeability can be calculated is presented using the method of characteristics. The theory is applied to the Seward Glacier firn where Sharp measured water fluxes at various depths. A periodic surface flux is assumed and the particular solution for water flux at any depth is given. From this solution the wave forms passing each depth are constructed and compared with the measured ones. Although the experimental data are affected by the presence of ice layers, the comparison between theory and experiment is favorable and the theory is thought to be essentially correct.

**MP 549**
**CAPILLARY EFFECT ON WATER PERCOLATION IN HOMOGENEOUS SNOW.**
Colbeck, S.C., *Journal of glaciology,* 1974, 13(67), p.85-97, In English with French and German summaries. 9 refs.
29-70
CAPILLARITY, MOISTURE TRANSFER, SNOWMELT, SNOW WATER CONTENT, WATER FLOW, ANALYSIS (MATHEMATICS).
A theoretical basis for introducing capillary effects into the theory of water percolation through snow is given. A capillary pressure liquid saturation relationship found in the laboratory is used together with the theory to make a quantitative examination of capillary effects. It is shown that capillarity accounts for less than 10% of the total force when water flux is 0.1 micron/sec although the percentage rapidly increases for smaller fluxes. The experiments suggest that the irreducible water content of dense snow is 7% of the pore volume. It is concluded that the wave-front diffusion seen in lysimeter studies is not the result of capillary action. Other possible causes are suggested.

**MP 550**
**WATER FLOW THROUGH SNOW OVERLYING AN IMPERMEABLE BOUNDARY.**
Colbeck, S.C., *Water resources research,* Feb. 1974, 10(1), p.119-123, 14 refs.
28-4211
SNOW HYDROLOGY, MODELS, SNOW WATER CONTENT, SNOW COVER EFFECT, MELTWATER, FIRN.
A two-layer model is constructed in order to describe water flow over an impermeable boundary. The model consists of vertical flow through an unsaturated layer and flow along a boundary in a saturated layer. The governing equations are solved for the nonsteady case, where the gradient of the thickness of the saturated layer is small compared with the slope of the impermeable boundary. It is shown that in most cases the discharge from shallow snowpacks will preserve the diurnal cycles of input at the surface, although for deep snowpacks (such as temperate glacier firn) the diurnal cycle is smoothed and only long-term responses are expected. The flow of a diurnal meltwater wave through a small (2.10 m deep by 100 m long) snowpack is calculated as an example. The case of steady flow is also described.

**MP 551**
**VARIATIONS IN CARBON DIOXIDE ACROSS AN ARCTIC SNOWPACK DURING SPRING.**
Coyne, P.I., et al, *Journal of geophysical research,* Feb. 1974, 79(6), p.799-802, 18 refs.
Kelley, J.J.
28-3533
SNOW COMPOSITION, SOIL COMPOSITION, ACTIVE LAYER, SNOW AIR INTERFACE, TUNDRA SOILS.

**MP 552**
**SALINITY VARIATIONS IN SEA ICE.**
Cox, G.F.N., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* March 1973, No.19, p.1-17, 13 refs.
Weeks, W.F.
28-173
ICE SALINITY, SEA ICE, ICE CORES, ICE COVER THICKNESS, PERIODIC VARIATIONS.
The salinity distribution in multiyear sea ice is dependent on the ice topography and cannot be adequately represented by a single average profile. The cores collected from the areas beneath surface hummocks generally showed a systematic increase in salinity with depth from 0 parts per mil at the surface to about 4 parts per mil at the base. The cores collected from areas beneath surface depressions were much more saline and displayed large salinity fluctuations. Salinity observations from sea ice of varying thicknesses and ages collected at various arctic and subarctic locations revealed a strong correlation between the average salinity of the ice, S bar, and the ice thickness, h. For salinity samples collected from cold sea ice at the end of the growth season, this relationship can be represented by two linear equations: S bar = 14.24 - 19.39h ($h < 0.4$ m); S bar = 7.88 - 1.59h ($h > 0.4$ m). It is suggested that the pronounced break in slope at 0.4 m is due to a change in the dominant brine drainage mechanism from brine expulsion to gravity drainage. A linear regression for the data collected during the melt season gives S bar = 1.58 + 0.18h. An annual cyclic variation of the mean salinity probably exists for multiyear sea ice. The mean salinity should reach a maximum at the end of the growth season and a minimum at the end of the melt season.

**MP 553**
**COMPARISON OF FLAME AND FLAMELESS ATOMIC ABSORPTION FOR THE DETERMINATION OF CALCIUM.**
Cragin, J.H., et al, *Atomic absortion newsletter,* Mar.-Apr. 1973, 12(2), p.37-38, 5 refs.
Herron, M.M.
31-1297
SNOW COMPOSITION, ATOMIC SPECTROSCOPY.

**MP 554**
**SETTLEMENT ASSOCIATED WITH THE THAWING OF PERMAFROST.**
Crory, F.E., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.599-607, 11 refs.
28-862
SOIL COMPACTING, FROZEN GROUND SETTLING, GROUND THAWING, SOIL MOISTURE MIGRATION.

**MP 555**
**SS MANHATTAN TESTS: A REVIEW OF THE ICE PROGRAM.**
DenHartog, S.L., *International Conference on Port and Ocean Engineering under Arctic Conditions. Proceedings,* 1971, 1st, Vol.1, p.101-111, 2 refs.
27-1177
SEA ICE, TENSILE STRENGTH, ICE BREAKING, ICE TEMPERATURE, ICE SALINITY, SS MANHATTAN.
The U. S. Army Cold Regions Research and Engineering Laboratory was contracted by Humble Oil Company to plan and supervise the ice testing aspects of their arctic tanker tests aboard the SS Manhattan. Since the prime purpose of the entire test program was to derive thrust and resistance values for varying ice types, USACRREL's responsibility was to define the ice conditions encountered. While the ship was underway in ice, a continuous description (log) of ice conditions, speed, propeller rpm, etc. was maintained. For formal tests ice thickness was measured at adequate intervals to define the sheet over the test section. Total channel width, size of cusps and other parameters were also noted. The major effort for formal tests was to measure the ice strength to enable comparison of tests in floes of equal thickness. Temperature and salinity profiles of the ice sheet were taken which could be used indirectly to measure ice strength. Brazil tensile tests were made to measure the strength directly but, as with all small sample ice testing, there was a large scatter in the results. A least squares fit of the Brazil data vs brine volume as determined from the temperature salinity measurements gives the following relationship: Brazil tensile strength in kg/sq cm is equal to 4.82 minus 5.68 times the square root of the brine volume. To compare the strength of one ice sheet to another for purposes of correlating ship tests it appears that brine volume measurements should be used rather than small sample tests. Although the relationship between brine volume and strength is not precisely known there is far less scatter in the brine volume measurements.

**MP 556**
**MOBILITY ENVIRONMENTAL RESEARCH STUDY: A QUANTITATIVE METHOD FOR DESCRIBING TERRAIN FOR GROUND MOBILITY. VOL. VI. SELECTED AIR-PHOTO PATTERNS OF TERRAIN FEATURES.**
Frost, R.E., et al, *U.S. Army Cold Regions Research and Engineering Laboratory,* May 1966, U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Technical report No. 3-726, 100+ c150p., AD-484 656, 11 refs. Includes c150p. of photographs and diagrams.
Johnson, P.L., Leighty, R.D., Anderson, V.H., Poulin, A.O., Rinker, J.N.
30-3939
TERRAIN ANALYSIS, AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, VEGETATION PATTERNS, THAILAND.
This volume contains a catalog of photographs of Thailand terrain features described in such a way that the information can be used in making estimations of their effects on the performance of ground vehicles. Results of a limited study to determine the effects of film emulsion and photo scale on the acquisition of terrain information from aerial photographs are also presented.

**MP 557**
**THERMAL REGIME IN AN ARCTIC EARTHFILL DAM.**
Fulwider, C.W., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.622-628, 1 ref.
28-864
EARTH DAMS, EARTH FILLS, THERMAL REGIME, ARCTIC REGIONS.

**MP 558**
**CONTROL OF CULVERT ICING.**
Gaskin, D.A., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.629-636, 4 refs.
Stanley, L.E.
28-865
DRAINAGE, ICING, ICE PREVENTION, CULVERTS.

**MP 559**
**GLACIOLOGICAL INVESTIGATIONS IN ANTARCTICA.**
Gow, A.J., *Antarctic journal of the United States,* July-Aug. 1972, 7(4), p.100-101.
27-1524
GLACIAL DEPOSITS, IMPURITIES, SNOW ACCUMULATION, ANTARCTICA—TAYLOR VALLEY, ANTARCTICA—BYRD STATION.
A number of glaciers along the southern foothills of the Royal Society Range were visited during Nov. 1971 to investigate the debris patterns in the glaciers and the mechanisms of their emplacement. The sites visited included Walcott, Adams, Miers, Joyce, Garwood, Hobbs, Blue, Commonwealth, and Taylor Glaciers. All of the glaciers contained laminations made up of fine sand and dust. Additionally, the Garwood, Blue, and Taylor Glaciers contained thick sequences of sand and gravel intercalated with bubbly glacial ice. Snow stakes were remeasured at Byrd Station. Snow accumulation within a 10-km radius of Byrd, measured over the past 10 yr, approximates a mean value of 11.7 gm per sq cm per yr.

**MP 560**
**LINEAR COMPRESSIBILITY OF ICE.**
Gow, A.J., et al, *Journal of geophysical research,* Nov. 10, 1972, 77(3), p.6348-6352, 7 refs.
Williamson, T.C.
27-1329
ICE MECHANICS, COMPRESSIVE PROPERTIES.
A novel technique of measuring the linear compressibility of ice at relatively low pressures (less than 0.5kb) is described. A cathetometer was used in conjunction with a window-equipped pressure chamber to measure changes in the lengths of ice specimens compressed hydrostatically to 0.31kb. A mean linear compressibility of 3.7mb exp -1 was obtained at -10C, and the compressibilities perpendicular and parallel to the C axis of single crystals of ice were found to agree within 10 per cent.

**MP 561**
**ON THE USE OF STABLE ISOTOPES TO TRACE THE ORIGINS OF ICE IN A FLOATING ICE TONGUE.**
Gow, A.J., et al, *Journal of geophysical research,* Nov. 20, 1972, 77(33), California Institute of Technology. Division of Geological and Planetary Sciences. Contribution No.2148, p.6552-6557, 20 refs.
Epstein, S.
27-1387
GLACIER ICE, SEA ICE, ISOTOPE ANALYSIS, ICE STRUCTURE, SEA WATER FREEZING.
Stable isotope analysis has been used successfully to distinguish between several different ice types in an ice tongue floating on sea water in Antarctica. At one critical location this technique has provided the only means of discriminating unambiguously between glacial ice and fresh-water ice formed from desalinated sea water. This part of the ice tongue is now underlain by a layer of desalted sea water thick enough to prevent any further accretion of sea ice at this location. (Auth.)

**MP 562**
**SNOW ACCUMULATION AT "BYRD" STATION, ANTARCTICA.**
Gow, A.J., et al, *Journal of glaciology,* 1972, 11(61), p.59-64, In English with French and German summaries. 11 refs.
De Blander, F., Crozaz, G., Picciotto, E.
27-64
SNOW ACCUMULATION, FALLOUT, ANTARCTICA—BYRD STATION.
The rate of snow accumulation at "Byrd" station, Antarctica, was measured by various methods. Surface measurements yield a mean accumulation of 117 kg/sq m/yr for the time interval 1962-70, within a 10 m radius of the station. The distribution of fission products with depth indicates a rate of 67 plus or minus 4 kg/sq m/yr for the period 1955-68 and of 100 plus or minus 10 kg/sq m/yr for the period 1965-68. The 210Pb method yields a 60 year average of 110 plus or minus 10 kg/sq m/yr.

**MP 563**
**HYDROLOGY AND COMPOSITIONAL STRUCTURE OF THE KOETTLITZ GLACIER TONGUE, MCMURDO SOUND, ANTARCTICA.**
Gow, A.J., *International Association of Scientific Hydrology. Publication,* 1973, No.95, Symposium on the Hydrology of Glaciers, Cambridge, Sep. 7-13, 1969. Proceedings, p.257, Abstract only. Unpublished full paper, 17p.
33-434
GLACIER TONGUES, GLACIER ABLATION, GLACIAL HYDROLOGY, ICE COMPOSITION, ANTARCTICA—KOETTLITZ GLACIER.

**MP 564**
**VOLCANIC ASH IN THE ANTARCTIC ICE SHEET AND ITS POSSIBLE CLIMATIC IMPLICATIONS.**
Gow, A.J., et al, *Earth and planetary science letters,* Dec. 1971, 13(1), p.210-218, 25 refs.
Williamson, T.C.
27-3057
ICE CORES, VOLCANIC ASH, PALEOCLIMATOLOGY, ISOTOPE ANALYSIS, ANTARCTICA—BYRD STATION.
Approximately 2000 individual ash falls are preserved in deep cores from Antarctica. The bulk of the debris is composed of dust-size particles of glass that can probably be attributed to volcanic sources in Antarctica, though sources outside Antarctica cannot be entirely discounted. A period of sustained infall of ash occurred during the interval 30,000 to 16,000 years ago, the isotopic (paleotemperature) data from the same cores indicate that a significant cooling of the atmosphere over Antarctica occurred at the same time. This cooling trend did not terminate until deposition of ash had virtually ceased, suggesting possibly a cause and effect relationship involving the solar-depleting effect of volcanic dust in the Antarctic stratosphere. It is conceivable that widespread eruption of volcanic ash in Antarctica during the latter part of the Wisconsin may also have triggered world-wide cooling during this period effectively intensifying the existing glacial regime. (Auth.)

**MP 565**
**AIRPHOTO ANALYSIS OF ICE DEFORMATION IN THE BEAUFORT SEA, MARCH 1971.**
Hartwell, A.D., *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* May 1972, No.13, p.1-34, 6 refs.
27-514
STRAIN ANALYSIS, ICE DEFORMATION, SEA ICE, AIRBORNE EQUIPMENT, BEAUFORT SEA.

**MP 566**
**DIELECTRIC RELAXATION SPECTRA OF WATER ADSORBED ON LYSOZYME.**
Harvey, S.C., et al, *Journal of physical chemistry,* 1972, 76(21), p.2987-2994, 25 refs.
Hoekstra, P.
27-1276
DIELECTRIC PROPERTIES, ADSORBED WATER, HYGROSCOPIC WATER, HYDROGEN BONDS, EGG ALBUMINS.
The dielectric properties of water adsorbed on chicken egg white lysozyme have been investigated over the frequency range from 10 exp. 7 to 2.5 x 10 exp. 10 Hz, using time domain reflectometry (TDR) and standing wave measurements (SWM) in wave guides and coaxial lines. Measurements were made on packed powders with water contents ranging from 0.0 to 0.6 g of H20/g of lysozyme. Two distinct dispersions are observed and are assigned to two layers of adsorbed water. The first layer is characterized by a single relaxation time near 10 exp. -9 sec. The relaxation process for this layer has a negative activation enthalpy and a negative activation entropy, indicating that the molecules in the first layer have a lesser degree of hydrogen bonding than in bulk water. A distribution of relaxation time about 2 x 10 exp. -11 sec characterizes the second layer.

**MP 567**
**COLD REGIONS ENVIRONMENTAL ANALYSIS BASED ON ERTS-1 IMAGERY.**
Haugen, R.K., et al, *International Symposium on Remote Sensing of Environment. Proceedings,* Oct. 1972, 8th, 12p., 15 refs.
McKim, H.L., Gatto, L.W., Anderson, D.M.
27-1258
REMOTE SENSING, PERMAFROST DISTRIBUTION, ARCTIC VEGETATION.
An overriding problem in arctic and subarctic environmental research has been the absence of long-term observational data and sparseness of geographical coverage of existing data. Studies of synoptic environmental events over regional-size areas have been either impossible or prohibitively expensive. The launching of ERTS-1 on July 23, 1972 provides for the first time a means of accomplishing many types of investigations that were not feasible previously. Presented here is an analysis of the Upper Koyukuk-Kobuk River area located in NW Alaska. The image analyzed (1003-21355-457) is a color composite made from data acquired in the green, red and infrared bands of the multispectral scanner. The area is devoid of cultural features except for several small villages and bush airstrips near the rivers. Documented information on the environment of the

area is limited, consisting largely of statewide coverage of geology, vegetation, permafrost and climate. Therefore, a substantial challenge is provided in the interpretation of regional permafrost distribution and regimes in Alaska.

**MP 568**
**DEFORMATION AND FRACTURE OF ICE UNDER UNIAXIAL STRESS.**
Hawkes, I., et al, *Journal of glaciology,* 1972, 11(61), p.103-131, In English with French and German summaries. 34 refs.
Mellor, M.
27-67
ICE STRENGTH, ICE DEFORMATION, STRESS ANALYSIS, STRESS STRAIN DIAGRAMS, FRACTURING.
Techniques for making precise uniaxial tests for strength and deformability of ice are described. Results are given for tests made in uniaxial tension and uniaxial compression at constant displacement rate, using bubbly polycrystalline ice. These results include stress/strain curves, elastic moduli, rupture or yield strengths, and failure strains, all for a range of stain-rates. A few results for ice doped with hydrogen fluoride are also given. The fracture mechanism for ice is discussed, and the test results are compared with data reported by previous investigators.

**MP 569**
**CORPS OF ENGINEERS TECHNOLOGY RELATED TO DESIGN OF PAVEMENTS IN AREAS OF PERMAFROST.**
Hennion, F.B., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.658-664, 8 refs.
Lobacz, E.F.
28-868
PAVEMENTS, FREEZE THAW CYCLES, FROST HEAVE, DESIGN.

**MP 570**
**MESOSCALE STRAIN MEASUREMENTS ON THE BEAUFORT SEA PACK ICE (AIDJEX 1971).**
Hibler, W.D., III, et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* May 1972, No.13, p.35-76, 20 refs.
Weeks, W.F., Ackley, S.F., Kovacs, A., Campbell, W.J.
27-515
PACK ICE, ICE DEFORMATION, DRIFT, AIDJEX.

**MP 571**
**POWER SPECTRUM ANALYSIS OF UNDERSEA AND SURFACE SEA-ICE PROFILES.**
Hibler, W.D., III, et al, *Journal of glaciology,* 1972, 11(63), p.345-356, In English with French and German summaries. 7 refs.
LeSchack, L.A.
27-2085
SEA ICE, PACK ICE, ICE BOTTOM SURFACE, PROFILES, POWER SPECTRA.
Under-ice sonar profiles and surface laser profiles of the Arctic pack have been analyzed using power-spectrum techniques to extract significant spectral peaks corresponding to spatial periodicities in the ice. The analysis suggests that, for a section of ice sampled by two intersecting under-ice profiles, the ridges are not randomly oriented. Moreover, the lineation or directionality of the ridges may be approximately determined from the two intersecting profiles. Also the spectra from surface profiles of multi-year ice and from surface profiles of first-year ice are of a much different nature, thus suggesting a technique for determining ice types from laser profiles.

**MP 572**
**REMOVAL OF AIRCRAFT ALTITUDE VARIATION FROM LASER PROFILES OF THE ARCTIC ICE PACK.**
Hibler, W.D., III, *Journal of geophysical research,* Dec. 20, 1972, 77(36), p.7190-7195, 5 refs.
27-2275
AERIAL RECONNAISSANCE, ALTITUDE, SEA ICE, PACK ICE, ICE SURFACE, SURFACE ROUGHNESS, LASERS.
Standard high-pass-filtering procedures are not in general adequate for removal of aircraft altitude variation from laser profiles of the arctic pack ice because of the spectral overlap between the surface roughness spectrum and the aircraft height variation spectrum. Owing to this overlap, a high-pass filter tends to depress high ridges and thus makes the resulting profile unsuitable for ridge height analysis. To bypass this difficulty, a straightforward three-step process is presented. The technique is first to carry out a conventional high-pass-filtering operation and then to estimate minimum points, which can then be used to estimate an ice roughness base line. The estimated ice roughness base line is then low-pass-filtered. This process can be used routinely for processing various profiles, since the filter cutoffs are not critical. The filtering operations are performed by small-error low-pass filters with guaranteed maximum errors of <0.9 percent outside the transition band.

**MP 573**
**STATISTICAL ASPECTS OF SEA-ICE RIDGE DISTRIBUTIONS.**
Hibler, W.D., III, et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Feb. 1972, No.12, p.117-162, 14 refs.
Weeks, W.F., Mock, S.J.
27-513
PACK ICE, SEA ICE DISTRIBUTION, ICE PRESSURE, ANALYSIS (MATHEMATICS).

**MP 574**
**STATISTICAL ASPECTS OF SEA-ICE RIDGE DISTRIBUTIONS.**
Hibler, W.D., III, et al, *Journal of geophysical research,* Oct. 20, 1972, 77(30), p.5954-5970, 13 refs.
Weeks, W.F., Mock, S.J.
27-1190
SEA ICE, ICE SURFACE, ICE BOTTOM SURFACE, STATISTICAL ANALYSIS, PRESSURE RIDGES.
A theoretical distribution function for pressure-ridge sail heights and keel depths is derived from fundamental assumptions about the randomness of the ridges. It is shown that the distribution function for ridge spacings (distance between ridges) can also be predicted from the assumption of spatially random occurrence. The suggested distribution functions are, in form, negative exponentials of the ridge height (or depth) squared and the ridge spacing, respectively. Extremely good fits were achieved to extensive data collected from sonar profiles of the lower surface. Using these models, it is possible to completely characterize the ridging, in a one-dimensional sense, by two parameters: (N), the mean number of ridges per unit lenght, and (h), the mean ridge height (or depth). In addition, there is a linear correlation between (N) and (h). This suggests that maps showing the distribution of (N) or (h) over an ocean covered with pack ice can be used to statistically characterize both the spacing and the height distribution of the ridges.

**MP 575**
**TOP AND BOTTOM ROUGHNESS OF A MULTI-YEAR ICE FLOE.**
Hibler, W.D., III, et al, 1972, [Vol.1], Symposium on Ice and Its Action on Hydraulic Structures, 2nd, Leningrad, Sept. 26-29, 1972. Papers, p.130-142, 4 refs.
Ackley, S.F., Weeks, W.F., Kovacs, A.
28-3869
RIVER ICE, ICE STRUCTURE, ICE FLOES, SNOW COVER EFFECT.
A spectral study of the snow and ice topography on a multi-year ice floe has shown that the snow cover, although attenuating the roughness amplitude of the ice surface, does not cover it completely. In general the snow surface variance is lower by a factor of 1/3 to 1/4 as compared to the ice surface variance. The correlation between snow and ice surface roughness is highly significant for long wavelengths (greater than 8 m), but fails to be significant for short wavelengths (less than 4 m). The results agree with what might be expected intuitively in that long wavelength variations are not masked appreciably while short wavelength variations are well hidden. Although the ice sheet as a whole is in free-floating, isostatic equilibrium, pronounced local deviations from isostatic equilibrium are common. The trend is for ice drafts to deviate more than expected from isostacy for thin ice and less than expected for thick ice. Estimates are also made of the number of ice thickness measurements required to obtain the mean thickness of the multi-year floe to any specified accuracy.

**MP 576**
**TWO DIMENSIONAL STATISTICAL ANALYSIS OF ARCTIC SEA ICE RIDGES.**
Hibler, W.D., III, International Conference on Sea Ice, Reykjavik, May 10-13, 1971. Proceedings, Reykjavik, Iceland, National Research Council, 1972, p.261-275, Includes discussion. 9 refs.
28-2496
ICE ACOUSTICS, PACK ICE, LASERS, PROFILES, SPECTRA, PRESSURE RIDGES, POWER SPECTRA.
From laser profile data taken over a region of sea ice with the profiles crossing in a star pattern, we have estimated the two dimensional auto-correlation function by using cubic spline techniques. From the two dimensional auto-correlation the two dimensional power spectrum is then calculated from which the lineation and directionality of pressure ridges is determined. In particular the two dimensional power spectrum gives the amount of variance for a given direction and frequency of ridge structure. It is also possible to obtain directionality for ridges which are randomly spaced (and thus have no dominant frequency components) because this type of structure yields a two dimensional power spectrum with lineations in frequency space perpendicular to the direction of ridge structure in real space. This two dimensional technique yields a great deal more information than taking only two intersecting profiles, as has been done previously. From the two dimensional power spectrum we also estimate the percentage of ice formed in ridges having a given lineation and thus estimate a net two dimensional anisotropy tensor for the ice. The advantage of the above technique is that the two dimensional characteristics of the ice may be estimated from a finite number of straight line intersecting profiles.

**MP 577**
**ARCTIC WHITEOUT: ITS CAUSES AND CURES.**
Hicks, J.R., *Polar notes,* 1972, No.12, p.1-10, 10 refs.
29-1365
WHITEOUT, VISIBILITY, ICE FOG, FOG DISPERSAL, OPTICAL PHENOMENA, ARTIFICIAL PRECIPITATION, HUMAN FACTORS.
There are five basic types of whiteout: blowing snow, ice fog, supercooled fog, overcast, and precipitating snow. The blowing and precipitating snow types are not currently amenable to modification by artificial means. Ice fog is slightly modified by helicopter downwash, but the main hope for its elimination is in reducing the moisture which causes it. Research along this line is now under investigation. Supercooled water droplets which comprise the overcast and fog whiteouts can be converted to ice crystals quite easily by the Dry Ice and propane methods, and routine clearing of airports is now being accomplished in the United States, Germany, Russia, Italy, and France.

**MP 578**
**BACKSCATTER FROM SNOW AND ICE SURFACES AT NEAR INCIDENT ANGLES.**
Hoekstra, P., et al, *IEEE transactions on antennas and propagation,* Nov. 1972, AP-20(6), p.788-790, 4 refs.
Spanogle, D.
27-1449
RADAR ECHOES, BACKSCATTERING, ICE COVER, SNOW COVER, REFLECTIVITY.
The radar backscatter of natural snow surfaces was measured at 10 GHz and 35 GHz and at grazing angles from 1 deg to 0.3 deg. For horizontal polarized radiation the terrain clutter per unit area (sq m) at 10 GHz of a flat snow terrain decreases from -50 dB at 1 deg to -70 dB at 0.4 deg. The return is approximately 10 dB lower for vertical polarized radiation. The terrain clutter was found to depend on the free water content of the snow. The radar cross sections of ice blocks placed on the snow surface is roughly proportional to the square of the area of the ice block facing the radar at 10 and 35 GHz and is approximately 20 dBsm below the return expected for a perfectly reflecting plane surface. At 95 GHz the ice blocks become diffuse reflectors.

**MP 579**
**ELECTROMAGNETIC PROBING OF PERMAFROST.**
Hoekstra, P., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.517-526, 16 refs.
McNeill, D.
28-853
PERMAFROST DISTRIBUTION, GEOPHYSICAL SURVEYS, FROZEN GROUND PHYSICS, ELECTROMAGNETIC PROPERTIES.

**MP 580**
**FROST-HEAVING PRESSURES.**
Hoekstra, P., et al, *Highway research record,* 1965, No.101, p.28-38, 16 refs. Microform No. SIP 24409.
Chamberlain, E., Frate, A.
31-3115
FROST HEAVE, SOIL PRESSURE, FROST ACTION, SOIL MECHANICS, SOIL FREEZING, ICE WATER INTERFACE, SOIL MOISTURE.
Considerable pressure develops on freezing a saturated soil in an open system from the top down. The pressure is the result of the surface energy of a curved ice-water interface. The curvature of the interface is necessary for ice to proliferate through the soil pores and is related to the pore size distribution of the soil. The test chamber used is designed to minimize the friction of the soil with the wall. An accurate control of heat removal is obtained by thermoelectric cooling. A load cell placed on top of the sample is used to measure the pressure developed and at the same time prevents heaving of the sample. Measurement of the pressure on a layered sample shows that the pressure develops at the freezing front. Results on several soils indicate that each soil develops a characteristic maximum pressure. For each soil used, the water content vs tension curve is given and the maximum pressure is related to this curve. (Auth.)

**MP 581**
**TERRESTRIAL OIL SPILLS IN ALASKA: ENVIRONMENTAL EFFECTS AND RECOVERY.**
Hunt, P.G., et al, Joint Conference on Prevention and Control of Oil Spills, March 13-15, 1973, Washington, D.C., American Petroleum Institute, 1973, p.733-740, 16 refs.
Rickard, W., Deneke, F.J., Koutz, F.R., Murmann, R.P.
28-1647
OIL SPILLS, ARCTIC VEGETATION, PERMAFROST PRESERVATION, SOIL MICROBIOLOGY, ENVIRONMENTAL IMPACT.
Damage and natural recovery of terrestrial ecosystems affected by refined petroleum spills along the Haines to Fairbanks military pipeline in Alaska have been investigated. Since the 20-cm-diameter, 1007-km-long pipeline was opened in 1956, there have been 40 reported ruptures along it. Mosses and trees were completely killed, and vegetation is now sparse in the drier

portions of the spill areas. Some new vegetation is growing in drainage pathways. Through laboratory studies on the rates of microbial respiration, it has been determined that microbial activity is increased by inoculation with mixed-culture oil-degrading microorganisms, increased pH, and phosphorus additions. Microbial activity also responds positively to nitrogen addition after an initial negative response.

**MP 582**
**MASS TRANSFER ALONG AN ICE SURFACE OBSERVED BY A GROOVE RELAXATION TECHNIQUE.**
Itagaki, K., et al, *Journal of glaciology,* 1973, 12(64), p.121-127, In English with French and German summaries. 19 refs.
Tobin, T.M.
27-2930
MASS TRANSFER, ICE SURFACE, ICE RELAXATION.
The mass transfer on an ice surface was measured using a groove decay technique. The evaporation-condensation and viscous flow terms in Mullins' theory were deduced from the change of decay constant as a function of groove wavelengths. A viscous flow term contributes the most to groove decay while an evaporation-condensation term contributes up to 31.5 percent of the mass transfer for the shortest wavelength measured and other terms were found to be negligible. Large discrepancies between the decay constants obtained from the measurements and constants calculated from theory indicate that other mechanisms not considered in Mullins' theory may be responsible for the groove decay. (Auth. mod.)

**MP 583**
**MASS SPECTRA OF ISOMERS OF TRINITROTOLUENE.**
Jenkins, T.F., et al, *Journal of chemical and engineering data,* 1973, 18(4), p.438-439, 9 refs.
Murrmann, R.P., Leggett, D.C.
29-1055
SPECTRA, DYNAMITE.
The mass spectra of the six isomers of trinitrotoluene are presented. The fragmentation pathways leading to the major fragment ions are outlined.

**MP 584**
**RECHARGE OF A CENTRAL ALASKA LAKE BY SUBPERMAFROST GROUNDWATER.**
Kane, D.L., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.458-462, 11 refs.
Slaughter, C.W.
28-846
PERMAFROST HYDROLOGY, PERMAFROST BENEATH LAKES, SWAMPS, TALIKS.

**MP 585**
**ICE SCORING MARKS FLOOR OF THE ARCTIC SHELF.**
Kovacs, A., *Oil and gas journal,* Oct. 23, 1972, 70(43), p.92, 97-98, 101, 103, 106, 26 refs.
27-1871
OCEAN BOTTOM, BOTTOM TOPOGRAPHY, ICE BOTTOM SURFACE, HUMMOCKS, SEA ICE, ICE RIDGE KEELS/SAILS.
Ice scoring on the Beaufort Sea shelf can be divided into three zones: 1) A coastal shelf zone where scoring may be very frequent but the resulting microrelief is shallow. 2) A mid-shelf zone with considerable contemporary scoring, which mixes the surface sediments to a depth of perhaps 5 ft, depending upon local sediments, destroying stratification, and oxygenating the sediemnts. 3) An outer shelf zone where scoring to 30 ft has occurred but the frequency of scores decreases very quickly beyond the 150-ft depth. While considerable overlapping of scores exists between the 100 and 150-ft depth range, many of these scores are not of recent origin. This is predicated upon the observation that many of the scores are partially filled with sediment and upon recent estimates of ice keel depth distributions in the Beaufort Sea. Resulting calculations indicate that the possibility of encountering an ice keel 110 ft deep at a given location is less than once every 100 years. Probability of encountering keels less than 100 ft deep increases exponentially with decreasing depth.

**MP 586**
**ON PRESSURED SEA ICE.**
Kovacs, A., International Conference on Sea Ice, Reykjavik, May 10-13, 1971. Proceedings, Reykjavik, Iceland, National Research Council, 1972, p.276-295, 11 refs.
28-2497
PACK ICE, ICE PRESSURE, ICE DEFORMATION, ICE BOTTOM SURFACE, PROFILES, PRESSURE RIDGES.
The formations and configurations of pressure-related sea ice structures are discussed. Cross-sectional profiles of five structures are presented and described. It has been determined that the depth of the below-water portions of a ridge appears to be 4 to 5 times the above-water height, that a single model can not be expected to represent the imperfect symmetry of all ridges, and that the slope of ridge keels was found to average 33 deg while that of the surface averaged 24 deg.

**MP 587**
**STUDY OF A MULTIYEAR PRESSURE RIDGE IN THE BEAUFORT SEA.**
Kovacs, A., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Feb. 1972, No.12, p.17-28, 12 refs.
Weeks, W.F., Ackley, S.F., Hibler, W.D., III.
27-508
PROFILES, ICE PRESSURE, ICE FLOES, SEA ICE, MELTWATER, SALINITY.

**MP 588**
**INVESTIGATION OF SAMPLING PERENNIALLY FROZEN ALLUVIAL GRAVEL BY CORE DRILLING.**
Lange, G.R., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.535-541, 5 refs.
28-855
PERMAFROST SAMPLERS, FROZEN GRAVEL, CORE SAMPLERS, DRILL CORE ANALYSIS.

**MP 589**
**LONG-TERM EFFECTS OF VEGETATIVE COVER ON PERMAFROST STABILITY IN AN AREA OF DISCONTINUOUS PERMAFROST.**
Linell, K.A., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.688-693, 10 refs.
28-872
DISCONTINUOUS PERMAFROST, DEGRADATION, VEGETATION FACTORS, SNOW COVER EFFECT.
A comparison of three 61-m square test sections near Fairbanks, Alaska—one kept in its natural tree-covered condition, a second cleared of trees but not stripped, and a third section stripped of all vegetative cover to a depth of about 0.4 m- has shown that only the original densely tree-covered section has remained free from permafrost degradation over an observation period of 26 years. In both the cleared and stripped sections, permafrost degradation is still continuing, though at a distinctly slower rate than in the area that was only cleared. It is concluded that in an environment like that at Fairbanks the maintenance or re-establishment of a random, mixed-type low vegetative cover cannot be counted on to stop or prevent permafrost degradation in an area subject to surface disturbance. If thermal stability under vegetative cover is to be accurately predictable for engineering purposes on other than an empirical basis, much additional research is still needed to achieve better quantitative information, understanding, and procedures.

**MP 590**
**RISK OF UNCONTROLLED FLOW FROM WELLS THROUGH PERMAFROST.**
Linell, K.A., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.462-468, 4 refs.
28-847
PERMAFROST HYDROLOGY, FLOW CONTROL, WELLS.

**MP 591**
**AIR CUSHION VEHICLE OPERATIONS IN ARCTIC AND SUBARCTIC TERRAIN.**
Liston, R.A., International Automotive Engineering Congress, Detroit, Michigan, January 8-12, 1973, New York, Society of Automotive Engineers, Inc., 1973, 14p., 7 refs.
29-1133
AIR CUSHION VEHICLES, COLD WEATHER OPERATION.
The potential of air cushion vehicles for operation in arctic and subarctic terrain is discussed and critical problem areas identified. The various programs conducted by the Cold Regions Research and Engineering Laboratory to obtain solutions to the problems are presented. The programs include the development of terrain data significant to air cushion vehicle design and operation, the study of the effect of air cushion vehicle operations on terrain, and the study of the effect of the arctic and subarctic environments on the air cushion vehicle.

**MP 592**
**AIR CUSHION VEHICLE: KEY TO AN ALASKAN TRANSPORTATION SYSTEM?.**
Liston, H.A., *High speed ground transportation journal,* 1973, 7(2), p.247-263, 5 refs.
29-1132
AIR CUSHION VEHICLES, ALL TERRAIN VEHICLES. TRANSPORTATION.
The potential value of air cushion vehicles to an Alaskan transportation system is analyzed. Problems involved in operations with this new vehicle form in Alaska are identified and the applications having the greatest potential success are singled out. It is proposed that the unique transportation problems of Alaska may be resolved with air cushion vehicles.

**MP 593**
**TIME-DEPENDENT CRACK GROWTH IN QUARTZ AND ITS APPLICATION TO THE CREEP OF ROCKS.**
Martin, R.J., III, *Journal of geophysical research,* March 10, 1972, 77(8), p.1406-1419, 28 refs.
27-396
ROCK MECHANICS, CREEP PROPERTIES, CRACK PROPAGATION, TEMPERATURE EFFECTS, STRESS ANALYSIS, WATER PRESSURE.
The time-dependent growth of an axial crack in single-crystal quartz tested in uniaxial compression with a constant load was studied as a function of temperature, stress, and partial pressure of water. Typically, as any one of the three variables was increased, the rate of crack growth increased. The data were analyzed by comparing the relative times required for two cracks, with the same initial length, to extend an arbitrarily selected increment of 0.20 mm as one of the parameters was varied. The experimental results indicate that the changes in the rate of crack growth due to a variation in any of three variables could be treated independently over the range studied. The relation between environment-sensitive time-dependent crack growth and creep in brittle rocks is discussed. The increase in the rate of creep strain in rocks due to an increase in temperature or stress is consistent with the explanation of creep in terms of crack growth. The static fatigue of glasses, brittle rocks, and quartz is shown to obey a dependence on stress, temperature, and moisture similar to the time-dependent crack growth in quartz.

**MP 594**
**FROST HEAVING VERSUS DEPTH TO WATER TABLE.**
McGaw, R., *Highway research record,* 1972, No.393, p.45-55, 5 refs.
27-865
SOIL FREEZING, FROST HEAVE, FROST PENETRATION, WATER TABLE.
A laboratory investigation of the influence of water table depth on the freezing characteristics of four soil types is described. The soils ranged from gravelly sand to sandy clay. Specimens were 42 in. long, with external water tables maintained at depths of 6, 18, 30, and 42 in. Specimens were frozen to a depth of 6 in. at rates of penetration between 0.10 and 0.50 in./day. The following relationships were obtained and are shown in the paper: rate of heave versus rate of penetration, rate of heave versus water table depth, and heave ratio versus water table depth. Portions of the data are extended graphically to give estimates of the influence of water table depths in excess of 3.5 ft. Rate of heave and heave ratio (ratio of heave rate to penetration rate) were observed to be functions both of water table depth and rate of penetration. With water table depth held constant, rate of heave increased with faster penetration rates. With freezing rate constant, rate of heave decreased with deeper water tables. With a single exception, heave ratio was reduced by increases in either penetration rate or water table depth. A reduction in heave ratio is shown to indicate a reduction in the water content of the frozen soil. A simple method is described by which heave ratio data may be used to obtain an estimate of the initial stability of a soil upon thawing.

**MP 595**
**IN-SITU MEASUREMENTS ON THE CONDUCTIVITY AND SURFACE IMPEDANCE OF SEA ICE AT VLF.**
McNeill, D., et al, *Radio science,* Jan. 1973, 8(1), p.23-30, 11 refs.
Hoekstra, P.
27-2522
SEA ICE, ICE RESISTIVITY, VERY LOW FREQUENCIES, ICE ELECTRICAL PROPERTIES.

**MP 596**
**CONTROLLED RELEASE OF AVALANCHES BY EXPLOSIVES.**
Mellor, M., *U.S. Forest Service. General technical report,* Sept. 1973, RM3, 13p., Also in: Advances in North American avalanche technology: 1972 symposium, Reno, Nevada, p.37-49. 17 refs.
28-3693
AVALANCHE TRIGGERING, EXPLOSION EFFECTS, STRESS WAVES, SNOW SLIDES, BLASTING.
The effects of explosives and blasting agents on snow are discussed from the viewpoint of rock-blasting technology. Airblast, crater formation, and ground motion are considered, and the characteristics of various types of explosives are outlined. Recent developments in the commercial manufacture of liquid and slurried explosives and blasting agents are described, and the possibilities for application of these materials in avalanche control are explored.

**MP 597**
**AMERY ICE SHELF AND ITS HINTERLAND.**
Mellor, M., et al, *Polar record,* Jan. 1960, 10(64), p.30-34, 10 refs. Microform No. SIP 18120.
McKinnon, G.
31-3116
ICE SHELVES, GLACIER ICE, GLACIER MELTING, FREEZEUP, GLACIER SURFACES, ANTARCTICA.
The ice shelf, which occupies a large embayment consisting of Prydz and Mackenzie Bays, and neighboring areas are de-

scribed in detail on the basis of investigations by the Australian National Antarctic Research Expeditions. The land boundaries of the ice shelf are well defined by the steep slopes of the surrounding continental ice and occasional nunataks and mountains, and large parallel crevasses mark the boundary between floating and land-based ice. A number of ice streams, including Lambert Glacier, push out into the shelf, causing pressure rolls at its surface. Intense melting occurs on the slopes surrounding the shelf, so that big surface river systems develop over wide areas in summer. Around the S. edge of the ice shelf, a number of large, steep depressions ("ice dolines") were discovered on the glacier ice, one of which was oval in shape, 3 km. long, 1.3 km. wide, and 80 m. deep. The ice dolines are believed to form when englacial water drains through cracks, possibly at the junction with the shelf, and the unsupported surface ice collapses. Annual net accumulation, as estimated from photographs of icebergs near the shelf, is 20 cm. of water as compared to 6.5 cm. at Davis 150 km. to the E. of the shelf, suggesting that wind-blown snow provides a large portion of the net accumulation. The movement of the ice shelf, taking into account the ice streams discharging into it and surface accumulation, is estimated at 600m./yr. or more.

**MP 598**
**MECHANICAL PROPERTIES OF ROCKS AT LOW TEMPERATURES.**
Mellor, M., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.334-344, 20 refs.
28-831
FROZEN ROCKS, WATER CONTENT, MECHANICAL PROPERTIES, THERMAL STRESSES, FROZEN GROUND COMPRESSION, FROZEN GROUND TEMPERATURE.

**MP 599**
**NORMALIZATION OF SPECIFIC ENERGY VALUES.**
Mellor, M., *International journal of rock mechanics and mining sciences,* Sept. 1972, Vol.9(4), p.661-663, 7 refs.
27-2037
ROCK EXCAVATION, FROZEN GROUND MECHANICS, COMPRESSIVE PROPERTIES.

**MP 600**
**USE OF LIQUID EXPLOSIVES FOR EXCAVATION OF FROZEN GROUND.**
Mellor, M., Quebec, Canada, Defence Research Establishment, Valcartier, 1972, p.329-340, In: Symposium on military applications of commercial explosives, Proceedings. Sponsored by the Technical Cooperation Program Working Panel 0-2 (Explosives), Aug. 28-29, 1972. 20 refs.
28-3692
BLASTING, EXPLOSION EFFECTS, FROZEN GROUND MECHANICS, EXPLOSIVES.

**MP 601**
**RIDGING INTENSITY VARIATIONS IN THE ARCTIC BASIN.**
Mock, S.J., et al, *American Geophysical Union. Transactions,* Nov. 1972, 53(11), p.1008, Abstract only.
Hibler, W.D., III.
31-3142
SEA ICE, ICE PRESSURE, ICE CONDITIONS, PRESSURE RIDGES, ICE COVER THICKNESS.

**MP 602**
**SPATIAL ASPECTS OF PRESSURE RIDGE STATISTICS.**
Mock, S.J., et al, *Journal of geophysical research,* Oct. 20, 1972, 77(30), p.5945-5953, 7 refs.
Hartwell, A.D., Hibler, W.D., III.
27-1189
SEA ICE, STATISTICAL ANALYSIS, PRESSURE RIDGES.
The spatial aspects of sea ice pressure ridge statistics have been examined by a census of all ridges in each of three small areas in the arctic basin. A model that predicts random orientation of ridges can be rejected at the 0.05 level of significance in each study area. Measurements of ridge spacings generally confirm the usefulness and validity of the probability density function. The estimator varies as a function of direction within the study areas, but a mean value is shown to be related to the ridge density (total length of ridges per unit area) by a simple equation.

**MP 603**
**SPATIAL ASPECTS OF PRESSURE RIDGE STATISTICS.**
Hartwell, A.D., et al, *Artic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Feb. 1972, No.12, p.93-116, 7 refs.
Mock, S.J., Hibler, W.D., III.
27-512
ICE PRESSURE, SEA ICE DISTRIBUTION, ICE FLOES, OCEAN CURRENTS, WIND FACTORS.

**MP 604**
**IONIC MOBILITY IN PERMAFROST.**
Murrmann, R.P., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.352-359, 20 refs.
28-833
FROZEN FINES, FROZEN GROUND CHEMISTRY, ION DIFFUSION, ELECTRICAL RESISTIVITY, UNFROZEN WATER CONTENT, THERMAL FACTORS, PERMAFROST, ACTIVE LAYER.

**MP 605**
**ACOUSTIC PROPERTIES OF FROZEN OTTAWA SAND.**
Nakano, Y., et al, *Water resources research,* Feb. 1973, 9(1), p.178-184, 14 refs.
Arnold, R.
27-2902
FROZEN SAND, ACOUSTIC PROPERTIES, WATER CONTENT, ULTRASONIC TESTS, SOUND WAVES.
Ultrasonic velocities of dilatational and shear waves as well as damping of dilatational waves of frozen Ottawa sand were measured as a function of water content by using the critical angle method at a frequency of 1 MHz. The dilatational velocity was found to vary with increasing water content from about 0.35 km/sec to 4.6 km/sec. The shear velocity also increases monotonically with increasing water content. The results of damping measurements showed a general trend for the quality factor Q to decrease monotonically with decreasing water content.

**MP 606**
**RIPPLES ON UNDERSIDE OF RIVER ICE COVERS.**
Ashton, G.D., et al, *American Society of Civil Engineers. Hydraulics Division. Journal,* March 1974, 100(HY3), p.479-480, Closure of 27-909. 1 ref.
Kennedy, J.F.
28-3447
RIVER ICE, ICE BOTTOM SURFACE, ICE STRUCTURE.

**MP 607**
**SOUND AND SHOCK TRANSMISSION IN FROZEN SOILS.**
Nakano, Y., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.359-369, 47 refs.
Froula, N.H.
28-834
FROZEN GROUND, FROZEN GROUND PHYSICS, SOUND TRANSMISSION, SHOCK WAVES, WAVE PROPAGATION, FROZEN GROUND COMPRESSION, ELASTIC PROPERTIES.

**MP 608**
**ULTRASONIC VELOCITIES OF THE DILATATIONAL AND SHEAR WAVES IN FROZEN SOILS.**
Nakano, Y., et al, *Water resources research,* Aug. 1972, 8(4), p.1024-1030, 19 refs.
Martin, R.J., III, Smith, M.
27-645
FROZEN GROUND PHYSICS, ACOUSTIC MEASUREMENT, SOUND WAVES, PHASE VELOCITY.
Ultrasonic velocities of the dilatational and shear waves in water-saturated frozen soils were measured as a function of temperature by both pulse first arrival and critical angle methods. A strong correlation exists between the dilatational wave velocities and the unfrozen water content. The observed hysteresis in the velocities of silt and clay during a freeze-thaw cycle is considered to be caused by hysteresis in the frozen water content. A general tendency for the shear wave velocity to decrease with ascending temperature exists, but the effect of temperature is not as pronounced as on the dilatational velocity. Calculations based on measured dilatational and shear velocities showed that the Poisson's ratios of sand are almost constant. However, the ratios of silt and clay decrease monotonically with ascending temperature.

**MP 609**
**ULTIMATE FAILURE OF A FLOATING ICE SHEET.**
Nevel, D.E., 1972, [Vol.1], Symposium on Ice and Its Action on Hydraulic Structures, 2nd, Leningrad, Sept. 26-29, 1972. Papers, p.17-22, 9 refs.
28-3851
ICE SHEETS, ICE ELASTICITY, ICE DEFORMATION, STRESS ANALYSIS, ICE BEARING CAPACITY.
When a floating ice sheet impinges on a sloping structure, the ice will fail in bending. To obtain a theoretical approach to this problem, a review is given of the way in which a vertical load will ultimately break through the ice. New theoretical equations are given for the breaking of wedges and the results compare favorably with published data on the ultimate load carrying capacity of ice sheets. For a sloping structure, a wedge with both vertically and horizontally applied loads has been solved, but numerical results are still being calculated.

**MP 610**
**USE OF A SNOW GUN FOR PRODUCTION OF A MODEL SNOW MATERIAL.**
O'Byrne, J.M., et al, *Eastern Snow Conference. Proceedings,* 1973, 30th, p.15-19.
Haynes, F.D.
29-673
SNOW MANUFACTURING, ARTIFICIAL SNOW.
Artificial snow can be generated as a model of natural snow whose properties have been evaluated on a limited basis. Grain size, density, and snow cover depth have been correlated with air/water ratio. Date indicate that grain size, density and accumulation increase in a rather linear fashion with increasing water rate of a snow gun, using compressed air at supersonic speed. Since the air and water are not mixed until after discharge from the gun, shock waves are minimized, and isentropic flow yields very cold process air temperatures, thereby realizing high efficiency. Ranges of test data of about 10 gpm of water and 120 scfm of air were limited by laboratory facilities. The ability to control the density of artificial snow demonstrates its potential for use as a model material.

**MP 611**
**FLOATING SETTLER FOR LOW COST CLARIFICATION.**
Reed, S.C., et al, International Conference on Pollution Engineering and Scientific Solutions, Tel Aviv, Israel, Society of Engineering Science, 1972, 11p., 4 refs.
Buzzell, T.D., Buda, S.
27-1259
WATER TREATMENT, WASTE TREATMENT, SLUDGES, SEDIMENTATION.

**MP 612**
**SEWAGE-TREATMENT CONCEPT FOR PERMAFROST AREAS.**
Reed, S.C., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.706-712, 10 refs.
Buzzell, T.D.
28-875
SEWAGE TREATMENT, SUBARCTIC REGIONS, SANITARY ENGINEERING.
A treatment concept developed by USA CRREL is described. It is compatible with the permafrost environment and still offers substantial savings in construction costs. The concept adopts the passive approach to construction in permafrost by protecting the supporting material from thermal stress. The unit is designed to be placed above ground on a gravel pad with the tank slightly elevated on cribbing to permit free air flow underneath. The configuration protects the underlying permafrost from thermal degradation but exposes the tank bottom to the low winter temperatures. A number of protective features are included to prevent freezing of tank contents. The key element is utilization of a floating tube settler, which provides the essential final clarification of the effluent prior to discharge. The compact nature of this USA CRREL settler permits installation directly in the aeration tank, thus avoiding the need and costs for separate clarifier tankage. The resulting single-tank-treatment system provides significant thermal and economic advantages for utilization in the permafrost regions of the world.

**MP 613**
**ACCELERATED SOIL THAW AND EROSION UNDER VEHICLE TRAILS IN PERMAFROST LANDSCAPES.**
Rickard, W., et al, 1973, p.263-266, Presented at the American Society of Agricultural Engineers. No microfiche available.
Slaughter, C.W.
33-435
GROUND THAWING, ARTIFICIAL THAWING, SOIL EROSION, PERMAFROST WEATHERING, VEHICLES, SOIL TRAFFICABILITY, ENVIRONMENTAL IMPACT.

**MP 614**
**TRIAXIAL AND CREEP TESTS ON FROZEN OTTAWA SAND.**
Sayles, F.H., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.384-391, 12 refs.
28-837
FROZEN SAND, STATIC LOADS, COMPRESSIVE PROPERTIES, COMPRESSIVE STRENGTH, CREEP PROPERTIES.

**MP 615**
**STRATIGRAPHY AND DIAGENESIS OF PERENNIALLY FROZEN SEDIMENTS IN THE BARROW, ALASKA, REGION.**
Sellmann, P.V., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.171-181, 37 refs.
Brown, J.
28-815
PERMAFROST DISTRIBUTION, STRATIGRAPHY, DIAGENESIS, QUATERNARY DEPOSITS, UNITED STATES—ALASKA—BARROW.

**MP 616**
**SNOWPACK MANAGEMENT POTENTIAL IN ALASKA.**
Slaughter, C.W., National Symposium on Watersheds in Transition, 1972, p.175-190, 39 refs.
27-1187
SNOWFALL, CLIMATE, TOPOGRAPHIC FEATURES, PERMAFROST DISTRIBUTION, SNOWPACK MANAGEMENT, UNITED STATES—ALASKA.
Snowpack management may be considered as action taken to modify input, distribution, physical characteristics, or ablation of snow, with a view to achieving specified management objectives. Snowpack management in any locale depends upon comprehension of the snow resource, its relation to climate, physiography, and vegetation of the region and understanding the physical processes and factors which affect snowpack regimen. Alaska is a high-latitude state encompassing 586,000 square miles. Major physiographic, climatic, hydrologic, and snowpack zones include the Arctic Slope (tundra), the Yukon or interior (taiga), and the Pacific Mountain System (South-Central, Southeast (maritime)). Alaska is in the zone of discontinuous permafrost south of the Brooks Range, and permafrost is continuous north of that zone. Three major snow environments are distinguished: tundra, characterized by extensive wind redistribution, high density, and low total snow input; taiga, characterized by little wind action, low densities, and intermediate snowfall amounts; and maritime, with high total inputs, warm temperatures, and higher snow densities than taiga snowpacks. Susceptibility of a "typical" small catchment in the uplands of the taiga to snowpack management has been briefly considered. Opportunity exists for snowpack manipulation; constraints include existence of thermally sensitive permafrost terrain, and southerly exposure of "manageable" sites. Potential environmental consequences of snowpack manipulation include alteration of mammal habitat, change in vegetative associations or succession, and alteration of the thermal "balance" of permafrost terrain. From consideration of Alaska's population, water usage, and water resources it is concluded that active snowpack management measures will be warranted only in isolated instances, and for precisely-defined goals.

**MP 617**
**ENCOUNTERING MASSIVE GROUND ICE DURING ROAD CONSTRUCTION IN CENTRAL ALASKA.**
Smith, N., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.730-736, 4 refs.
Berg, R.
28-878
ROADS, ROADBEDS, GROUND ICE, PERMAFROST WEATHERING, PERMAFROST CONTROL.

**MP 618**
**USE OF POLYURETHANE FOAM PLASTICS IN THE CONSTRUCTION OF EXPEDIENT ROADS ON PERMAFROST IN CENTRAL ALASKA.**
Smith, N., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.736-745, 1 ref.
Berg, R., Muller, L.
28-879
ROADS, ROADBEDS, FROST HEAVE, INSULATION, CELLULAR PLASTICS, PERMAFROST BENEATH ROADS.

**MP 619**
**VISCOELASTIC PROPERTIES OF FROZEN SOIL UNDER VIBRATORY LOADS.**
Stevens, H.W., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.400-409, 11 refs.
28-839
FROZEN GROUND MECHANICS, GROUND ICE, SATURATION, VISCOELASTIC MATERIALS, VIBRATION, MATHEMATICAL MODELS, THERMAL FACTORS, FOUNDATIONS.

**MP 620** Record deleted.

**MP 621**
**IN SITU CREEP ANALYSIS OF ROOM IN FROZEN SOIL.**
Thompson, E.G., et al, *American Society of Civil Engineers. Soil Mechanics and Foundations Division. Journal,* Sept. 1972, 98(SM9), p.899-915, 13 refs.
Sayles, F.H.
27-904
FROZEN GROUND MECHANICS, SOIL CREEP, SUBSURFACE STRUCTURES, SETTLEMENT (STRUCTURAL), FROZEN GROUND SETTLING, CREEP PROPERTIES.
Creep displacement measurements of the roof and walls of an underground room in permafrost are analyzed by the finite element method and it was found that the insitu creep characteristics of the frozen silt agree closely with those determined by laboratory unconfined compressive creep tests performed on undisturbed samples of the insitu soil. The creep rate of the frozen Fairbanks silt and frozen gravel encountered in the Fox, Alaska, room can be considered independent of time and strain. This is in contradiction to creep characteristics found for similar soils with higher unit weight and lower ice contents.

**MP 622**
**SHEAR STRENGTH AT A THAW INTERFACE.**
Thomson, S., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.419-426, 11 refs.
Lobacz, E.F.
28-841
FROZEN FINES, FROZEN GROUND ANALYSIS, ARTIFICIAL THAWING, INTERFACIAL TENSION, SHEAR STRENGTH, LABORATORY TECHNIQUES.

**MP 623**
**FREE CONVECTIVE HEAT TRANSFER IN A HORIZONTAL LAYER OF LIQUID — THE EFFECT OF DENSITY INVERSION.**
Tien, C., et al, *American Institute of Chemical Engineers. AIChE Symposium series,* 1972, 68(118), p.101-111, 13 refs.
Yen, Y.-C., Dotson, J.W.
27-2077
HEAT TRANSFER, CONVECTION, DENSITY (MASS/VOLUME), BOUNDARY VALUE PROBLEMS, TEMPERATURE DISTRIBUTION.
Theoretical and experimental investigation were conducted on the free convection heat transfer of a horizontal layer of liquid whose lower and upper surfaces are kept at different temperatures. The liquid is assumed to possess a maximum density at the maximum temperature within the range of temperature of the upper and lower surfaces. Based on a modified cellular boundary-layer model, the Nusselt number of heat transfer was found. Experiments were conducted on the heat transfer across a horizontal layer of water. The experimental data were in substantial agreement with the analytical results.

**MP 624**
**EFFECT OF DENSITY INVERSION ON THE STABILITY OF A HORIZONTAL LAYER OF SALINE SOLUTIONS.**
Tien, C., et al, *Chemical engineering science,* 1973, Vol.28, p.652-653, 9 refs.
Yen, Y.-C.
29-1135
FROZEN LIQUIDS, SALINITY, DENSITY (MASS/VOLUME).

**MP 625**
**PERFORMANCE OF THE THULE HANGAR SOIL COOLING SYSTEMS.**
Tobiasson, W., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.752-758, 13 refs.
28-881
PERMAFROST BENEATH BUILDINGS, ACTIVE LAYER, PERMAFROST PRESERVATION, HEAT TRANSFER, ARTIFICIAL FREEZING, FOUNDATIONS, SETTLEMENT (STRUCTURAL).

**MP 626**
**UTILITY TUNNEL EXPERIENCE IN COLD REGIONS.**
Tobiasson, W., *American Public Works Association. Special report,* 1971, No.41, p.125-138, 16 refs.
27-2079
UTILITIES, PERMAFROST CONSTRUCTION, UTILITY TUNNELS.
The cold regions can be divided into zones of seasonal frost, discontinuous permafrost and continuous permafrost. In each zone stable and unstable soils exist. Utility tunnels have been built in, on, and above both types of soil in all three zones. However, other methods of distributing utilities are also present for each situation. Direct burial (except in unstable permafrost) is common for water lines with recirculation, insulation and/or electric heaters used to provide additional thermal protection if needed. In areas of unstable permafrost above-grade insulated pipelines have been constructed since burial there can result in direct damage by freezing or indirect damage caused by thawing of the surrounding soil. Utilidors are frequently used when steam or hot water must be distributed from a central heating plant. Steam lines within a utilidor are easier to maintain and repair than lines buried in the ground. Exposed utilidors have also been constructed to avoid costly blasting of rock. Others serve as passageways. The elimination of snow control, traffic interference and esthetic problems and the combined use as a passageway are further justifications for buried utilidors. Since World War II few, if any, utilidors have been buried in unstable permafrost in North America but in Russia such systems have been built. They are ventilated to prevent progressive thawing of supporting soils. In North America several unventilated utilidors have been buried in stable permafrost. In unstable permafrost elevated utilidors are common. Where buildings are elevated above unstable permafrost, utilities are often routed in an insulated crawl space below the first floor. This space, which is warmed by heating system mains, not only prevents utility freeze-ups but also provides increased thermal comfort within the structure.

**MP 627**
**RADIOACTIVE WASTES ON ICE: FURTHER DISCUSSION.**
Weertman, J., et al, *Bulletin of the Atomic Scientists,* April 1973, 29(4), p.2, 3, 53-56, Responses by E.J. Zeller, D.F. Saunders, and E.E. Angino. 10 refs.
Sibert, J., Weeks, W.F., Sternig, J., Zeller, E.J., Saunders, D.F., Angino, E.E.
28-1628
ICE SHEETS, RADIOACTIVE WASTES, WASTE DISPOSAL, INTERNATIONAL COOPERATION.
Commenting on the recent proposal to store radioactive waste in the antarctic ice sheet, several correspondents voice their misgivings related mainly to unpredictable geophysical effects that may result from a disturbance of the thermal balance at the bottom of the ice sheet, and to the long period of time for which the biosphere must be protected (250,000 years). The proponents of the scheme agree that possible effects of the proposed disposal are not fully known and urge a feasibility study to be initiated as soon as possible. The possibility of launching wastes into the Sun with rockets is also discussed.

**MP 628**
**DIFFERENCES IN RADAR RETURN FROM ICE-COVERED NORTH SLOPE LAKES.**
Weeks, W.F., et al, *Journal of geophysical research,* Aug. 20, 1978, 83(C8), p.4069-4073, 7 refs.
Fountain, A.G., Bryan, M.L., Elachi, C.
32-4683
ICE WATER INTERFACE, ICE SOLID INTERFACE, RADAR ECHOES, FROZEN LAKES, BUBBLES, ICE DIELECTRICS, UNITED STATES—ALASKA—NORTH SLOPE.

**MP 629**
**CRREL-USGS PROGRAM AT CAMP 200: A POST-OPERATIONS SUMMARY.**
Weeks, W.F., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* May 1971, No.8, p.1-8.
Campbell, W.J.
27-497
SEA ICE, REMOTE SENSING, ICE DEFORMATION, AERIAL RECONNAISSANCE, MICROWAVES, EMISSIVITY.
The most intensive airborne remote sensing and ground truth investigations ever made of sea ice took place during the 1971 AIDJEX pilot expedition to the Beaufort Sea. Multiple missions over and around the AIDJEX site at 74 deg. N, 131 deg. W were performed by three remote-sensing aircraft: the NASA Convair 990, the U.S. Coast Guard Hercules, and the Navy "Birdseye" Constellation. The ground truth team succeeded in establishing a tellurometer deformation triangle and occupying it during all but two of the aircraft overflights. For the first time the following kinds of data were obtained: (1) sequential synoptic imagery of a given area of sea ice: (2) mesoscale deformations of sea ice; (3) microwave emissivities of sea ice. In short, we believe that this remote sensing and ground truth experiment was a success.

**MP 630**
**FRACTURE OF LAKE AND SEA ICE.**
Weeks, W.F., et al, Liebowitz, H. (ed). Fracture; an advanced treatise, Vol.7, New York, Academic Press, 1972, p.879-978, Refs. p.972-978. For another version see 25-990.
Assur, A.
31-3029
LAKE ICE, SEA ICE, FRACTURING, ICE COVER STRENGTH, ICE CRYSTAL STRUCTURE, ICE FORMATION, COMPRESSIVE STRENGTH, TENSILE STRENGTH, FLEXURAL STRENGTH.

**MP 631**
**ICEBERGS AS A FRESHWATER SOURCE: AN APPRAISAL.**
Weeks, W.F., et al, *Journal of glaciology,* 1973, 12(63), p.207-233, 36 refs. For preliminary version see 27-2530/F-12011.
Campbell, W.J.
28-1322
ICEBERGS, WATER SUPPLY, LOGISTICS, ICE MELTING, ICE WATER INTERFACE, ECONOMICS.

A history of the idea of transporting large icebergs to arid regions to provide a fresh-water source is presented. The problem is considered in four sections: location, towing, melting in transit, and economic feasibility. Only Antarctica could provide the large tabular icebergs. Distributional data suggests these are readily available. Steady-state towing velocities of different sized icebergs are calculated based on estimates of the drag of icebergs and bollard pull of tugs. Tugs capable of working at the necessarily slow speeds can presently be built. Melting rates are calculated to western Australia and the Atacama Desert and found acceptable. Transit times exceed 107 and 145 days respectively with over half the initial ice delivered. Ice can be delivered for 1.3 mills/cu m and 1.9 mills respectively. Water delivered by one supertug could irrigate 16,000 sq km. The concept is considered feasible and worthy of further analysis.

**MP 632**
**ICE MECHANICS AND MORPHOLOGY WORKING GROUP REPORT.**
Weeks, W.F., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Sep. 1970, No.1, p.30-34, AD-713 986, This article is included in 26-1068.
Wittman, W.
31-3113
SEA ICE, PACK ICE, ICE MECHANICS, RESEARCH PROJECTS, ICE STRUCTURE, ICE FORECASTING.

**MP 633**
**MESOSCALE STRAIN AND ICE MORPHOLOGY.**
Weeks, W.F., *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* July 1972, No.14, p.24-25.
27-1479
SEA ICE, ICE DEFORMATION, STRAIN MEASUREMENT, RESEARCH PROJECTS.

**MP 634**
**PRESSURE RIDGE CHARACTERISTICS IN THE ARCTIC COASTAL ENVIRONMENT.**
Weeks, W.F., et al, *International Conference on Port and Ocean Engineering under Arctic Conditions. Proceedings,* 1971, 1st, Vol.1, p.152-183, 12 refs.
Kovacs, A., Hibler, W.D., III.
27-1178
PACK ICE, SEA ICE, ICE DEFORMATION, PRESSURE RIDGES.
The Arctic ice pack is characterized by extreme irregularities in ice thickness which are produced by the motion and resulting deformation of the sea ice. Pressure ridges and hummocks, which are the largest of the ice relief features, present formidable problems to both the design of off-shore facilities and to the operation of surface and subsurface shipping. The mechanics of ridge and hummock formation are reviewed and it it shown that several distinct types of ice deformation features occur depending upon whether the formation mechanism is marginal crushing, overthrusting or shearing. Between 1969 and the present a number of both free-floating and grounded ridges have been examined by the authors in the Bering, Chukchi and Beaufort Seas. Profiles of the upper and lower surfaces of the ridges were determined by leveling and by drilling and sonar, respectively, and the internal structure of the ridges was investigated by coring. Ice temperatures, salinities, and densities were obtained and brine volumes were computed from the temperatures and salinities. Representative profiles are presented. Current data bearing on the general distribution of deformation features in time and space over the Arctic Ocean are also summarized.

**MP 635**
**REVIEW OF RESEARCH IN THE ANTARCTIC.**
Weeks, W.F., *Ice,* 1971, No.37, p.19, Review of 26-943.
31-3099
GLACIOLOGY, METEOROLOGY, ECOLOGY, RESEARCH PROJECTS, MEETINGS, ANTARCTICA.

**MP 636**
**SEA ICE PRESSURE RIDGES: FORMATION, PROPERTIES AND DISTRIBUTION.**
Weeks, W.F., et al, Ice cover; Technical Conference on the Naval Minefield, 14th, Proceedings, White Oak, Md., U.S. Naval Ordnance Laboratory, 1971, p.25-55, NOLTR 71-71, No microfiche available.
Hibler, W.D., III, Kovacs, A., Breslau, L.
33-436
PRESSURE RIDGES, SEA ICE DISTRIBUTION, ICE FORMATION.

**MP 637**
**CRREL-USGS ICE MECHANICS AND MORPHOLOGY PROGRAM.**
Weeks, W.F., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Feb. 1971, No.5, p.24-25.
Kovacs, A.
31-1819
ICE MECHANICS, REMOTE SENSING, STRAIN MEASURING INSTRUMENTS.

**MP 638**
**MORPHOLOGY AND PHYSICAL PROPERTIES OF PRESSURE RIDGES: BARROW, ALASKA, APRIL 1969.**
Weeks, W.F., et al, Symposium on Ice and its Action on Hydraulic Structures, Reykjavik, Iceland, Sept. 7-10, 1970. Papers and discussions, Reykjavik, Iceland, International Association for Hydraulic Research, 1970, 8p., In English with French summary. Session 3.9. 5 refs. Includes discussions.
Kovacs, A.
28-3988
ICE PRESSURE, SEA ICE, PRESSURE RIDGES.
Cross-sectional profiles, internal structures, temperatures, salinities and brine volumes have been obtained from eight pressure ridges off Barrow, Alaska. Two of these ridges are described in detail and underwater photographs of the ridge keels are shown. Ridges form by either marginal "crushing" or overthrusting. Lack of isostatic adjustment appears to be common. The degree of bonding between ice blocks in a ridge is related to the cold reserve of the blocks when they are incorporated into the ridge. Representative ridge salinities are 4 per mille and the keels are commonly at near melting temperatures (brine volumes between 40 and 120 per mille). The repose angles of the upper and lower parts of ridges appear similar.

**MP 639**
**THERMAL MODIFICATION OF RIVER ICE COVERS: PROGRESS AND PROBLEMS.**
Weeks, W.F., et al, The role of snow and ice in hydrology; proceedings of the Banff Symposia, Sept. 1972, Vol.2, Geneva, Switzerland, WMO-IAHS-Unesco, 1973, p.1427-1435, With French summary. 12 refs.
Dingman, S.L.
29-387
RIVER ICE, ICE CONTROL, WATER TEMPERATURE, THERMAL REGIME, THERMAL POLLUTION, MODELS.
The thermal modification of river ice is a relatively recent concept. Calculations show that in certain locations excess heat could be used to remove ice. Current attempts to model winter river temperatures are discussed. It is concluded that for most planning purposes we are able adequately to estimate water temperatures below thermal pollution sites. In many cases the most important factor in controlling the quality of the estimates is the adequacy of the meteorological data. On the other hand our ability to predict the time dependent behavior of the ice cover below artificially induced ice-free reaches is poor.

**MP 640**
**CLOSURE RATES EXPECTED FOR A ROSS ICE SHELF DRILL HOLE AT 166 DEG W. 82 DEG 30 MIN S.**
Weertman, J., *Antarctic journal of the United States,* Sept.-Oct. 1973, 8(5), p.310, 6 refs.
28-3095
ICE SHELVES, DRILLING, BOREHOLES, ICE CREEP, ANTARCTICA—ROSS ICE SHELF.
The expected closure rate for a drill hole in the Ross Ice Shelf has been calculated as a function of the depth from the upper surface. Calculations were made for an unpressurized hole, and for holes pressurized at 10 bars and at 20 bars. Hydrostatic pressure and temperature as a function of depth were estimated. The creep equation used is given.

**MP 641**
**POSITION OF ICE DIVIDES AND CENTERS ON ICE SHEETS.**
Weertman, J., *Journal of glaciology,* 1973, 12(66), p.353-360, 3 refs. French and German summaries.
28-2357
ICE SHEETS, ICE COVER THICKNESS, FLOW RATE.
In order to determine the position of ice divides and ice centers on the Antarctic and Greenland ice sheets model calculations are made of the magnitude of the shift of the portion of an ice divide on a two dimensional ice sheet and of the "center" (the position of highest elevation) of a circular ice sheet when the rate of accumulation is different on different sides or in different sectors of an ice sheet. It is concluded that gross changes in the accumulation pattern are required to cause an appreciable shift of the position of ice divides or ice centers if the positions of the edge of the ice sheet are fixed. (Auth. mod.)

**MP 642**
**MELTING HEAT TRANSFER WITH WATER JET.**
Yen, Y.-C., et al, *International journal of heat and mass transfer,* Jan. 1973, 16(1), p.219-223, 11 refs.
Zehnder, A.
27-2076
EXCAVATION, ARTIFICIAL MELTING, HEAT TRANSFER, EXPERIMENTAL DATA, WATER JETS.

**MP 643** Record deleted.

**MP 644**
**USE OF ERTS-1 IMAGERY IN THE REGIONAL INTERPRETATION OF GEOLOGY, VEGETATION, PERMAFROST DISTRIBUTION AND ESTUARINE PROCESSES IN ALASKA.**
Anderson, D.M., et al, Remote sensing of earth resources, Vol.2, Tullahoma, Tenn., University of Tennessee, Space Institute, March 1973, p.1049-1071, 13 refs.
McKim, H.L., Gatto, L.W., Haugen, R.K., Crowder, W.K.
31-1892
REMOTE SENSING, PERMAFROST DISTRIBUTION, GEOLOGICAL SURVEYS, VEGETATION PATTERNS, ESTUARIES, INFRARED MAPPING, UNITED STATES—ALASKA.
A preliminary study has been made of the value of satellite imagery in synoptic surveys of coastal sedimentation and related processes in Cook Inlet, Alaska, and of the distribution and environmental interrelationships of permafrost terrain. ERTS multispectral scanner (MSS) imagery was the primary data source for this investigation. Aerial underflight imagery and ground observations of selected sites were secondary data sources. Emphasis has been placed on evaluating the feasibility of mapping permafrost terrain from textural and tonal patterns related to surficial geology and vegetation. A mosaic of a 153,400-km2 area in north central Alaska has been prepared at a scale of 1:1,000,000. Seven surficial geology, eight vegetative cover and four permafrost terrain units were defined and delineated. Many geomorphic features were also recognized: thaw lakes, stream drainage patterns, glacial moraines, cirques, abandoned glacial valleys and volcanic cones. Preliminary analysis of the regional hydrologic and oceanographic processes in Cook Inlet has been accomplished. It is evident that the distribution of sediments and regional circulation patterns can be monitored using satellite imagery.

**MP 645**
**COMPOSITION OF SEA ICE AND ITS TENSILE STRENGTH.**
Assur, A., *National Research Council. Publication,* 1958, No.598, p.106-138, No microfiche available.
33-591
ICE COMPOSITION, SEA ICE, ICE STRENGTH, TENSILE STRENGTH.

**MP 646**
**UNITED STATES POLAR ICE AND SNOW STUDIES IN THE INTERNATIONAL GEOPHYSICAL YEAR.**
Bader, H., *American Geophysical Union. Geophysical monograph series,* July 1958, No.2, p.177-181, No microfiche available.
33-592
SNOW SURVEYS, ICE SURVEYS, POLAR REGIONS, UNITED STATES.

**MP 647**
**MODEL ANALYSIS OF VEHICLE TRAFFICABILITY WITH APPLICATION TO SURFACE EFFECT VEHICLES ON SEA ICE FIELDS.**
Smith, M., et al, *Journal of terramechanics,* 1973, 9(2), p.65-82, For another version see RR 298, 26-3382. 3 refs.
Nakano, Y.
32-4101
AIR CUSHION VEHICLES, SEA ICE, TRAFFICABILITY, STATISTICAL ANALYSIS, MODELS.

**MP 648**
**TOWING ICEBERGS TO IRRIGATE ARID LANDS: MANNA OR MADNESS?.**
Weeks, W.F., et al, *Bulletin of the Atomic Scientists,* May 1973, 29(5), p.35-39, 15 refs.
Campbell, W.J.
28-898
ICEBERGS, WATER SUPPLY, ICEBERG TOWING.
Recent ideas for supplying, via the towing of icebergs, large amounts of water in the form of ice to arid coastal areas in the Southern Hemisphere are discussed. Drag estimates, melting losses, transit routes, and the cost of transporting the icebergs to the delivery site are considered. It is suggested that the idea appears both technologically feasible and economically attractive and merits serious consideration.

**MP 649**
**THERMAL EFFICIENCY MEASUREMENTS ON A PROTECTED MEMBRANE ROOF.**
Aamot, H.W.C., International Symposium on Roofs and Roofing, Brighton, England, Sep. 9-13, 1974, Proceedings, Norwich, England, Page Bros., 1975, p.14/1-14/9, In English with French and German summaries. 1 ref.
31-3061
THERMAL INSULATION, ROOFS, HEAT LOSS, METEOROLOGICAL FACTORS, HEAT TRANSFER, THERMAL PROPERTIES, DESIGN CRITERIA.
The concept of the thermal efficiency of a roof is described as a measure to evaluate the thermal performance of a roof. A

protected membrane test roof, on which temperature and heat flow measurements were made over a one-year period, is described together with the relevant measurement program. Evaluations of three different months show results of cold, hot and intermediate climatic conditions. The influence of sunshine, rain, wind and snow on the thermal efficiency is analyzed and compared with observed results. Generally, sunshine as well as snow on the roof increase the efficiency while rain reduces it. The influence of wind, while important to the surface heat exchange, is small as far as the efficiency is concerned. The value of the thermal efficiency concept is in the means it offers for comparison of different designs and different climates because each roof has its own particular efficiency. Computer modelling permits design analysis and optimization during the planning stage of a construction project and the development of general design criteria for efficient roofs.

**MP 650**
**TECHNIQUES FOR MEASURING THE STRENGTH CHARACTERISTICS OF NATURAL AND PROCESSED SNOW.**
Abele, G., 1974, 8 leaves, For presentation at the Symposium on Physical Methods of Ice and Snow Studies, Leningrad, Oct. 1973. Unpublished manuscript. 14 refs.
31-1997
SNOW STRENGTH, SNOW BEARING STRENGTH, SNOW COMPACTION, SNOW COMPRESSION, MEASUREMENT, SNOW ROADS.

**MP 651**
**VISCOUS SEA ICE LAW AS A STOCHASTIC AVERAGE OF PLASTICITY.**
Hibler, W.D., III, *Journal of geophysical research,* Sep. 20, 1977, 82(27), p.3932-3938, 17 refs.
32-204
SEA ICE, ICE DEFORMATION, MODELS, PLASTICITY TESTS.

**MP 652**
**DESTRUCTION OF ICE ISLANDS BY EXPLOSIVES.**
Mellor, M., et al, Arctic Petroleum Operators' Association, July 1972, 40p., Refs. p.36-40.
Kovacs, A.
31-4112
ICE ISLANDS, ICE BLASTING, EXPLOSIVES, ICE MECHANICS, TESTS, ICE STRENGTH.

**MP 653**
**PREFERRED CRYSTAL ORIENTATIONS IN THE FAST ICE ALONG THE MARGINS OF THE ARCTIC OCEAN.**
Weeks, W.F., et al, *Journal of geophysical research,* Oct. 20, 1978, 83(C10), p.5105-5121, 62 refs.
Gow, A.J.
33-1046
ICE CRYSTAL STRUCTURE, CRYSTAL ORIENTATION, ICE CRYSTAL GROWTH, FAST ICE, OCEAN CURRENTS, BOUNDARY LAYER, SEA ICE, ICE WATER INTERFACE.
Field observations of the growth fabrics of the fast and near-fast ice along the coasts of the Beaufort and Chukchi seas show that at depths of more than 60 cm below the upper ice surface the sea ice crystals show striking alignments within the horizontal plane. In general, the *c* axes of the crystals were aligned roughly parallel to the coast, the outlines of the islands, and passes between islands. Our and similar observations can be explained if it is assumed that the *c* axes of the crystals are aligned parallel to the 'long-term' current direction at the sea ice-seawater interface. It is hypothesized that current flow in this direction reduces the thickness of the solute boundary layer as well as the salinity in the liquid at the interface. This lowered salinity allows crystals in the favored orientation to extend farther into the melt than neighboring crystals with less favored orientations. In addition, the current tends to induce a continuous flux of supercooled seawater against the sides of the crystals that extend ahead of the interface. This favors their lateral growth. The aligned crystal aggregate that forms has the overall characteristics of a single crystal. The development of such crystal alignments results in pronounced anisotropy in the mechanical, thermal, and electrical properties of fast ice. It is suggested that such crystal orientations can be used as an aid in determining current patterns in perennially ice-covered areas such as the Canadian Archipelago.

**MP 654**
**DELINEATION OF PERMAFROST BOUNDARIES AND HYDROLOGIC RELATIONSHIPS.**
Anderson, D.M., *U.S. National Aeronautics and Space Administration. Contractor report,* Sept. 29, 1972, NASA-CR-128055, 4p., N72-31344.
27-1436
REMOTE SENSING, PERMAFROST DISTRIBUTION, SPACEBORNE PHOTOGRAPHY.

**MP 655**
**MASS SPECTROMETRIC ANALYSIS OF ORGANIC COMPOUNDS, WATER AND VOLATILE CONSTITUENTS IN THE ATMOSPHERE AND SURFACE OF MARS: THE VIKING MARS LANDER.**
Anderson, D.M., et al, *Icarus,* Feb. 1972, 16(1), p.111-138, 32 refs.
Bieman, K., Orgel, L.E., Oro, J., Owen, T., Shulman, G.P., Toulmin, P., III, Urey, H.C.
28-1350
MARS (PLANET), SPECTROSCOPY, SOIL COMPOSITION, ATMOSPHERIC COMPOSITION.

**MP 656**
**PHYSICS, CHEMISTRY, AND MECHANICS OF FROZEN GROUND: A REVIEW.**
Anderson, D.M., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.257-288, 182 refs.
Morgenstern, N.R.
28-824
BIBLIOGRAPHIES, PERMAFROST PHYSICS, FROZEN GROUND MECHANICS, FROZEN GROUND CHEMISTRY, GROUND ICE.

**MP 657**
**SOIL AND WATER AND ITS RELATIONSHIP TO THE ORIGINS OF LIFE.**
Anderson, D.M., et al, *Origins of life,* 1975, 6, p.23-36, Numerous refs.
Banin, A.
30-1124
SOIL CHEMISTRY, CLAY SOILS, SOIL MOISTURE, MARS (PLANET), BIOGENESIS.
Soils of the terrestrial planets form at the boundaries between lithosphere, atmosphere and hydrosphere. Biogenesis occurred in these zones; thus, it is axiomatic that some, perhaps many, stages of biogenesis occurred in intimate association with the mineral constituents of soils. Because of a high surface to mass ratio and, consequently, a high surface reactivity, the layer lattice clay minerals are the most important of these. According to the geological record, clay minerals appeared very early on the primordial Earth. Recent investigations have confirmed their presence in carbonaceous meteorites and have indicated their occurrence on Mars. In this paper we collect pertinent physico-chemical data and summarize the organic reactions and interactions that are induced or catalyzed by clays. Many clay-organic reactions that do not occur readily at high water contents proceed rapidly at adsorbed water contents corresponding to surface coverages of one of two molecular layers. One or two monolayers of adsorbed water correspond to extremely dry or cold planetary environments. Some consequences of these facts vis à vis biogenesis on Mars are considered.

**MP 658** Record deleted.

**MP 659**
**ENTRAINMENT OF ICE BLOCKS—SECONDARY INFLUENCES.**
Ashton, G.D., International Symposium on River and Ice, Budapest, Jan.14-18, 1974. Proceedings. Contributions to subject A: Relationships of fluvial and ice hydraulics. Preprints, Budapest, 1974, p.83-89, 6 refs.
30-4270
FLOATING ICE, ICE COVER THICKNESS, FLOW RATE, RIVER ICE, ICE FLOES, MATHEMATICAL MODELS, CHANNELS (WATERWAYS).
The conditions under which a floating fragment of ice is either entrained under the upstream edge of a downstream ice cover or accumulated upstream are examined in detail. The effects of the geometry of the leading edge and of the arriving fragments on the critical Froude number for entrainment are determined and provide criteria for modelling studies, and for the design of stable channels in river ice covers. The mathematical model considers both flow depth and thickness Froude effects as well as the thickness-length ratio of the blocks and the specific gravity. Combination of an equilibrium moment analysis with hydrodynamic relations enables explicit determination of the effects of t/L and t/H (t = thickness, H = flow depth, L = block length) on the critical Froude number for entrainment. Analytical results are compared to experimental results.

**MP 660**
**HYDRAULIC ROUGHNESS OF ICE COVERS.**
Ashton, G.D., *American Society of Civil Engineers. Hydraulic Division. Journal,* Feb. 1974, 100(HY2), p.321-323, 2 refs.
28-3191
ICE WATER INTERFACE, HEAT TRANSFER, ICE BOTTOM SURFACE, ICE STRUCTURE, FLOATING ICE, ICE FRICTION.

**MP 661**
**ICEBREAKING BY TOW ON THE MISSISSIPPI RIVER WITH MV RENEE G.**
Ashton, G.D., et al, *International Conference on Port and Ocean Engineering under Arctic Conditons. Proceedings,* 1974, 2d, p.63-79, 4 refs.
DenHartog, S.L., Hanamoto, B.
29-3879
ICE BREAKING, RIVER ICE, ICE NAVIGATION, ICE RESISTIVITY, SHIPS, ICE FLOES, TESTS, UNITED STATES—MISSISSIPPI RIVER.

**MP 662**
**SIMILAR LAW MAY GOVERN WATER FREEZING IN MINERALS AND LIVING ORGANISMS.**
Banin, A., et al, *Nature,* May 15, 1975, 255(5505), p.261-262, 9 refs.
Anderson, D.M.
30-2520
ICE FORMATION, FREEZING POINTS, MINERALS, TISSUES (BIOLOGY).

**MP 663**
**EFFECTS OF SALT CONCENTRATION CHANGES DURING FREEZING ON THE UNFROZEN WATER CONTENT OF POROUS MATERIALS.**
Banin, A., et al, *Water resources research,* Feb. 1974, 10(1), p.124-127, 12 refs.
Anderson, D.M.
28-3630
POROUS MATERIALS, FREEZING POINTS, UNFROZEN WATER CONTENT, SALINITY.
By combining equations for salt concentration by water removal from porous bodies with those for freezing point depression in normal solutions, equations are developed for calculating freezing point depression shifts due to the gradual removal of water upon freezing in porous bodies. The same equations can be used for the calculation of shifts in the osmotic potential of the water in drying porous bodies by using a simple conversion factor. Graphs relating the remaining water content to the freezing point shift for various initial soluble salt contents are given. Good agreement is found between the measured freezing point depression shifts for a silty clay soil treated with three concentrations of sodium chloride and with dimethyl sulfoxide at various contents of unfrozen water and the calculated values. The order of magnitude of the shifts expected in various natural conditions is discussed.

**MP 664**
**STRATIGRAPHIC STUDIES IN THE SNOW AND FIRN OF THE GREENLAND ICE SHEET.**
Benson, C.S., *Folia geographica Danica,* 1961, Vol.9, p.13-37, 25 refs. Microform No. SIP 19951.
31-3117
SNOW COVER, SNOW STRATIGRAPHY, FIRN STRATIFICATION, SNOW PHYSICS, SNOW DENSITY, GLACIER MASS BALANCE.
Summary results are given of 19 mo. field work in Greenland during 1952, 1953, 1954, and 1955. During this 4-yr. period, 146 pit studies and 288 Rammsonde profiles were made along 1100 mi. of over-snow traverse. Temperature, density, ram hardness and grain size were measured and the results are discussed in detail. The mass balance of the Greenland ice sheet is discussed, and the densification of the snow and firn is described. (Auth.)

**MP 665**
**SURVEY OF THE URBAN AND SUBURBAN CLIMATE IN SOUTHEAST MICHIGAN, U.S.A.**
Bilello, M.A., Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.1, Paris, Organisation for Economic Co-operation and Development, 1973, p.23-43, 21 refs.
28-2075
CLIMATE, FREEZE THAW CYCLES, UNITED STATES—MICHIGAN.

**MP 666**
**ICE THICKNESS OBSERVATIONS ALONG THE COASTS OF EASTERN CANADA AND SOUTHERN GREENLAND.**
Bilello, M.A., et al, Ocean '74 IEEE International Conference on Engineering in the Ocean Environment, Halifax, Nova Scotia, Aug. 21-23, 1974. Record. Vol.1, New York, Institute of Electrical and Electronic Engineers, 1975, p.104-108, 6 refs.
Bates, R.E., Riley, J.
31-1884
ICE COVER THICKNESS, ICE CONDITIONS, STATISTICAL ANALYSIS, SNOW DEPTH, ICE SURFACE, SHORES.
Ice thickness measurements were made at 22 stations along the coasts of eastern Canada and southern Greenland and on nearby lakes and rivers during the period 1943 through 1951. This report provides a tabulation which exemplifies the type of ice thickness data collected and descriptions of surface conditions during ice formation, growth and decay. Maximum observed ice thicknesses ranged from 31 inches at Presque Isle, Maine to 94 inches in Sondre Strom Fjord, Greenland. Least

ice thicknesses at the end of the growth season ranged from 15 inches at Presque Isle to 47 inches at Cape Dan, Greenland. This report also gives the average number of days of ice cover for all stations. It ranged from about 100 days in southern Newfoundland to about 250 days in northern Baffin Island.

**MP 667**
**SURFACE MEASUREMENTS OF SNOW AND ICE FOR CORRELATION WITH DATA COLLECTED BY REMOTE SYSTEMS.**
Bilello, M.A., Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.283-293, AD-787 130, 17 refs.
29-2516
SNOW DEPTH, SNOW PHYSICS, MEASUREMENT, ICE COVER THICKNESS, OBSERVATION, REMOTE SENSING.
Reconnaissance by aircraft or satellite is one way to determine the areal extent of the earth's snow and ice cover. However, determining the depth and physical properties of the snow cover and the thickness of ice on lakes and rivers and along coastlines by this remote method is in an early stage of development. Data collected from such remote systems could be correlated with actual surface conditions by using an existing network of over 100 snow and ice observing satations located in North America above 45 N latitude. This network, established by the U.S. Army Cold Regions Research and Engineering Laboratory in cooperation with other U.S. and Canadian Government agencies, provides weekly snow and ice measurements during the winter. This paper indentifies the stations in the network, reviews the types of measurements made and equipment used, and summarizes the results of studies derived from the collected data. The 10 to 20 years of record, as well as the data currently being received, provide an extensive and reliable source of information for comparing or verifying observations obtained by other methods.

**MP 668**
**TUNDRA BIOME PROGRAM.**
Brown, J., et al, *Arctic bulletin,* Fall 1973, 1(2), p.56-60, 22 refs.
West, G.C.
28-3125
TUNDRA REGIONS, ECOSYSTEMS, RESEARCH PROJECTS, INTERNATIONAL COOPERATION, TUNDRA BIOME.

**MP 669**
**GRID TECHNIQUE FOR MEASURING ICE TUNNEL DEFORMATION.**
Butkovich, T.R., et al, *Journal of glaciology,* 1959, 3(26), p.508-511, 3 refs. Microform No.SIP 17892.
Landauer, J.K.
33-593
GLACIAL FEATURES, ICE TUNNELS, GLACIAL DEPOSITS, ICE PLASTICITY, ICE DEFORMATION, MEASUREMENT, MEASURING INSTRUMENTS.
A new method for measuring ice tunnel deformation and closure is described. It includes cutting slots into a smooth vertical wall, forcing wet dyed string into the slots, sand it in. Results of one year's installation are given for each of 13 grids installed throughout a 366 m. ice tunnel. Two important visual observations are reported. The first is that no differential shearing was found; and the second, that heavy dirt bands that occurred throughout the tunnel appeared to have extruded into the tunnel opening. A possible explanation is that dirty ice is more plastic than clear ice.

**MP 670**
**LOW TEMPERATURE EXTENDED AERATION THROUGH THE USE OF A FLOATING TUBE SETTLER AND WOOD STAVE TANKAGE.**
Buzzell, T.D., et al, Symposium on Wastewater Treatment in Cold Climates, March 1974, 1973, p.358-379, 12 refs.
Reed, S.C., Wilbur, P.F.
31-1299
WASTE TREATMENT, WATER TREATMENT, AERATION, LOW TEMPERATURE RESEARCH, WOODEN STRUCTURES, SEWAGE TREATMENT.

**MP 671**
**THE FREEZING OF WATER ON SOLID SURFACES.**
Camp, P.R., 25p. plus 19 figs., Unpublished ms. presented at Symposium on Interfacial and Surface Properties of Ice, Pittsburgh, March 22-31, 1966. Listed in Journal of Colloid and Interface Science, 25(2):130, Oct. 1967. 8 refs. For published Symposium papers see 23-1840 thru 23-1854.
24-2270
ICE CRYSTAL GROWTH, ICE WATER INTERFACE, METALS, HEAT FLOW, TEMPERATURE CONTROL.

**MP 672**
**MODEL FOR PREDICTING THE INFLUENCE OF CLOSED SYSTEM FREEZE-THAW ON THE STRENGTH OF THAWED CLAYS.**
Chamberlain, E., Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.3, Paris, Organisation for Economic Co-operation and Development, 1973, p.27-45, 19 refs.
28-2124
CLAY SOILS, SOIL MECHANICS, FREEZE THAW CYCLES, SOIL MOISTURE, MODELS, SOIL COMPACTING.

**MP 673**
**TRANSPORTATION FOR SUBARCTIC RESEARCH.**
Clark, E.F., et al, Fairbanks, University of Alaska, 1974, 6p., Presented at the 24th Alaska Science Conference, College, Alaska, Aug. 1973. Unpublished manuscript.
Slaughter, C.W.
31-1876
TRANSPORTATION, SUBARCTIC TERRAIN, ALL TERRAIN VEHICLES.

**MP 674**
**SEA ICE PRESSURE RIDGES AND ICE ISLANDS.**
Kovacs, A., et al, *Creare, Inc. (Hanover, N.H.). Technical note,* Aug. 1971, TN-122, 127p., 60 refs.
Mellor, M.
31-96
SEA ICE, PRESSURE RIDGES, ICE ISLANDS, ICE COVER STRENGTH, COMPRESSIVE STRENGTH, TENSILE STRENGTH, ICE SALINITY, AIR CUSHION VEHICLES.
The environmental conditions of ice-covered polar seas are described, with special emphasis on the pressure ridges and ice islands encountered in Mackenzie Bay and the Beaufort Sea. Techniques for determining the geometric configurations and the physical and mechanical properties of sea ice structures and ice islands are described. Profiles of pressure ridges were determined by surface surveys, drill hole probes, and side-looking sonar scanning; results are given for several multi-year ridges and one first-year ridge. Supplementary information obtained from dives under the ice is also given. Corresponding data are given for ice islands, with particular attention being given to contact between the ice and the sea bed. Measurements of temperature, salinity, tensile strength and compressive strength are given for ice taken from old pressure ridges, and factors influencing the interpretation of test data are discussed. The main report closes with a brief discussion of some of the findings. The appendices give complete diving reports, and a full report on the performance of the SR.N6 Hovercraft.

**MP 675**
**GRAIN AND BOND GROWTH IN WET SNOW.**
Colbeck, S.C., *International Association of Hydrological Sciences. IAHS-AISH publication,* 1975, No.114, Snow mechanics—proceedings of the Grindelwald symposium, April 1974, p.51-61, 11 refs., In English with French summary.
30-4582
SNOW CRYSTAL GROWTH, SNOW WATER CONTENT, SNOW DENSITY.
Grain growth, bond growth and the densification of wet snow are partly determined by the distribution of equilibrium temperature in the snow matrix. At high saturations, the equilibrium temperature decreases with grain size causing small particles to melt and large particles to grow. Melting also occurs at intergrain contacts, causing low strength and rapid densification. At low saturation the capillary pressure controls temperatures and particle size has a smaller effect. Grain growth proceeds slowly although melting at the contacts does increase with overburden pressure. At low saturations the water 'tension' causes large attractive forces and large bonding strengths occur.

**MP 676**
**THEORY FOR WATER FLOW THROUGH A LAYERED SNOWPACK.**
Colbeck, S.C., *Water resources research,* April 1975, 11(2), p.261-266, 11 refs.
29-3870
SNOW PERMEABILITY, SNOW HYDROLOGY, WATER FLOW, ICE LAYERS.
A natural snowpack with ice layers is described in terms of an equivalent anisotropic porous medium. The anisotropic permeability is represented as a diagonalized matrix whose principal values can be calculated from a small amount of information about the prototype snowpack. Ice layers increase the transit time for water movement by a factor equal to the ratio of the principal values of permeability. The flow path, volume flux, and wave speed are determined by the slope of the snowpack and principal values of permeability. When a snowpack is assumed to be isotropic, the error in calculating transit time increases with the difference between the principal values of permeability. Usual variations in slope introduce a small change in the transit time.

**MP 677**
**ON PREDICTING WATER RUNOFF FROM A SNOW COVER.**
Colbeck, S.C., Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.55-66, AD-787 130, 12 refs.
29-2497
SNOW COVER, RUNOFF FORECASTING, WATER FLOW, MOISTURE TRANSFER, SNOW HYDROLOGY.
The simultaneous development of remote sensing techniques and the theory of water flow through snow should help improve methods for predicting water runoff from snow-covered watersheds. The flow through snowpacks is considered to occur in two layers with different characteristics and mathematical descriptions. First, vertical seepage through the upper layers of unsaturated snow occurs followed by flow through a saturated layer at the base of the snowpack. Measurements of density and liquid water volume as functions of depth are necessary to provide an initial condition for calculation of flow through the unsaturated layer. In addition, the water flux across the surface must be known either from direct measurements or forecasts of meteorological parameters. Knowledge of the porosity and permeability of the saturated layer must be obtained from direct measurements of the ice content in order to calculate flow through that layer. For short term forecasts, it may be sufficient to know the thickness of the saturated layer, but for forecasts of more than a few hours, the influx from the overlying snow must also be known. Of the measurement techniques reviewed, only measurements of the dielectric properties by remote sensing can provide the necessary information. Such a system is possible with current technology although much work remains to be done before the scheme discussed here could be operational.

**MP 678**
**INTERHEMISPHERIC COMPARISONS OF CHANGES IN THE COMPOSITION OF ATMOSPHERIC PRECIPITATION DURING THE LATE CENOZOIC ERA.**
Cragin, J.H., et al, Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, 1974., 20p., Presented at the SCOR/SCAR Polar Oceans Conference, McGill University, Montreal, Canada, May 6-11, 1974. 27 refs.
Herron, M.M., Langway, C.C., Jr., Klouda, G.A.
31-1875
GLACIER ICE, ICE COMPOSITION, PRECIPITATION (METEOROLOGY), PALEOCLIMATOLOGY, DUST, ANTARCTICA—BYRD STATION.
Concentrations of Na, K, Mg and Ca measured from Greenland and Antarctic ice cores, rise gradually at the beginning of the Wisconsin Stage, peak during the Late Wisconsin Stage and drop to lows during the Holocene. Peak elemental concentrations are restricted to a well-defined time interval, 24,400 to 12,000 yrs B.P., and are much higher in the Camp Century core than in the Byrd Station core. Silicon concentrations increase by about a factor 3 during the late Wisconsin Stage, indicating a significant influx of eolian dust. At Byrd Station, the dust increase during the Wisconsin Stage is somewhat less pronounced, most likely because of the smaller land mass area in the southern hemisphere and poor interhemispheric mixing. Computed data on concentrations of chemical constituents in Greenland and Antarctic ice cores are tabulated.

**MP 679**
**MESOSCALE DEFORMATION OF SEA ICE FROM SATELLITE IMAGERY.**
Crowder, W.K., et al, Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.563-573, AD-787 130, 10 refs.
McKim, H.L., Ackley, S.F., Hibler, W.D., III, Anderson, D.M.
29-2536
SEA ICE, REMOTE SENSING, SPACEBORNE PHOTOGRAPHY, DRIFT, ERTS IMAGERY.
Sequential mesoscale movement and deformation in the pack ice approximately 90 km northeast of Point Barrow, Alaska, have been observed in the ERTS-1 multispectral imagery of 19 to 22 March 1973. At this latitude, sidelap of adjacent ground tracks of daily overpasses is about 75%. This sidelap, together with the coincidence of five cloud-free days and a major westward movement of the pack in the Beaufort Sea Gyre, permitted observation of drift and deformation in an area of about 14,000 sq km. Strain calculations using several 10-point arrays yielded shear and divergence rates as large as 0.5% per hour. Continuous deformation measurements through the fast ice/-pack ice boundary indicated a sharp change in the sign of the vorticity as the shear zone was crossed. Measured drift velocities varied from 0.24 m/sec to 0.4 m/sec (0.9 to 1.4 km/hr). These results indicate that detailed deformation and movement data can be obtained from sequential ERTS-1 images. Such data are useful for determining scaling effects in the ice velocity field and for testing existing mathematical models of the response of sea ice to meteorological and hydrodynamic stresses.

**MP 680** Record deleted.

**MP 681**
**SNOW PIT WORK ON LITTLE AMERICA-VICTORIA LAND TRAVERSE 1958-1959.**
DenHartog, S.L., *Ohio. State University, Columbus. Research Foundation. Report,* July 1959, No.825-2, Pt.2, p.1-107 + maps, For microform see SIP 22527.
31-1891
SNOW TEMPERATURE, SNOW STRATIGRAPHY, SNOW HARDNESS, SNOW CRYSTAL NUCLEI, PHOTOGRAPHY, TRAVERSES, ANTARCTICA.

**MP 682**
**EFFECTS OF PERMAFROST ON STREAM FLOW CHARACTERISTICS IN THE DISCONTINUOUS PERMAFROST ZONE OF CENTRAL ALASKA.**
Dingman, S.L., Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.447-453, 13 refs.
28-844
PERMAFROST DISTRIBUTION, DISCONTINUOUS PERMAFROST, STREAM FLOW, HYDROLOGIC CYCLE, SUBARCTIC TOPOGRAPHY, UNITED STATES—ALASKA.

**MP 683**
**RELATIONS AMONG VEGETATION, PERMAFROST, AND POTENTIAL INSOLATION IN CENTRAL ALASKA.**
Dingman, S.L., et al, *Arctic and alpine research,* Winter 1974, 6(1), p.37-47, 23 refs.
Koutz, F.R.
29-126
VEGETATION PATTERNS, DISCONTINUOUS PERMAFROST, INSOLATION, SOLAR RADIATION, TREES (PLANTS), MAPPING.
The distributions of vegetation types and discontinuous permafrost in a representative 1.8 sq km drainage basin in the Yukon-Tanana uplands were mapped in detail. A white spruce-birch forest is confined to the permafrost-free areas of the basin; other vegetation types are apparently underlain by permafrost at shallow depths. A solar-radiation index, based on the concept of equivalent latitude (a function of slope and aspect), was also mapped, and is closely related to the distributions of vegetation and permafrost. The boundary of permafrost in this area appears to coincide approximately with the isopleth of 265 cal/sq cm/day average-annual insolation. The thickness of the seasonally thawed zone above the permafrost is significantly correlated with the solar-radiation index, although vegetation characteristics appear to be at least as important in controlling this.

**MP 684**
**USA CRREL HIGHWAY PAVEMENT TEST SECTIONS, FIRST YEAR ANALYSIS, 1971-1972 WINTER.**
Eaton, R.A., et al, Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.3. Paris, Organisation for Economic Co-operation and Development, 1973, p.47-60.
Van Pernis, D.W.
28-2125
PAVEMENTS, FROST PENETRATION, SOIL TEMPERATURE, SOIL MOISTURE, FROST ACTION.

**MP 685**
**CLIMATOLOGICAL IMPLICATIONS OF STABLE ISOTOPE VARIATIONS IN DEEP ICE CORES FROM BYRD STATION, ANTARCTICA.**
Gow, A.J., et al, *Geological Society of America. Memoir,* 1973, No.136, p.323-326, 3 refs.
Epstein, S., Sharp, R.P.
28-3588
ICE CORES, ICE COMPOSITION, CLIMATIC CHANGES, ANTARCTICA—BYRD STATION.
Oxygen- and hydrogen-isotope analyses of ice cores from a hole drilled 2,164 m through the Antarctic Ice Sheet suggest that the Wisconsin cold interval began about 75,000 yrs B.P., reached its climax about 17,000 yrs B.P., and terminated about 11,000 yrs B.P. (Autn.)

**MP 686**
**CRYOCONITE OF THE THULE AREA, GREENLAND.**
Gerdel, R.W., et al, *American Microscopical Society. Transactions,* July 1960, 79(3), p.256-272, 7 refs.
Drouet, F.
31-3030
GLACIAL FEATURES, CRYOBIOLOGY, MICROBIOLOGY, MINERALS, ICE COMPOSITION, CRYOCONITES, WIND FACTORS, PHOTOSYNTHESIS, MELTWATER.
Samples of cryoconite from the Nuna ramp area in Northwest Greenland have been analysed for the mineral- and microbiota-content. The nonmineral-content of the blue-black gelatinous, drip-free cryoconite was found to be about 95 percent of the wet mass. After drying and ashing, the organic matter comprised 13.9 to 20 percent of the oven-dry sample. The mineral matter was predominately fine-grained, sharp-edged grains from one mm. or larger to microscopic in size and appeared to have been wind-borne from the adjacent nunataks and moraines. The organic matter was found to be largely algae with inclusion of fungi and a rotifer. Since algae utilize radiation primarily in the blue region between 0.40 micron and 0.65 micron, where ice has the greatest transmissivity, it is possible that the cryoconite holes are at least partly the product of energy released by photosynthetic and metabolic processes rather than by direct absorption of red or heat-wave lengths of solar radiation by the dark cryoconite. The uniformity in the pattern and dimensions of the cryoconite holes support the assumption that biological processes are dominant in their formation and growth.

**MP 687**
**TIME-TEMPERATURE DEPENDENCE OF SINTERING IN PERENNIAL ISOTHERMAL SNOWPACKS.**
Gow, A.J., *International Association of Hydrological Sciences. IAHS-AISH publication,* 1975, No.114, Snow mechanics—proceedings of the Grindelwald symposium, April 1974, p.25-41, 39 refs., In English with French summary.
30-4580
METAMORPHISM (SNOW), TEMPERATURE EFFECTS, SINTERING.
The time-temperature dependence of sintering in dry polar snowfields has been investigated at several locations in Antarctica and Greenland. This study, utilizing samples from deep holes and shafts that actually penetrated the snow-ice transition at a number of sites, has demonstrated (1) that density increases linearly with the logarithm of the age of the snow (sintering time), (2) that the mean crystal size of the snow increases linearly with age, and (3) that the unconfined compressive strength of the snow also increases linearly with age. Thin-section studies of the changes occurring in pore-crystal relationships during sintering show that the snow-ice transformation is entirely analogous with the full-scale isothermal sintering of powder compacts. The two processes differ mainly in the rates of change which occur very much more slowly in a dry polar snowpack. Most of this difference can be attributed to the much larger sizes of grains in snow, such grains generally being two to three orders of magnitude larger than the particles in powder compacts.

**MP 688**
**CUTTING ROCK WITH WATER JETS.**
Harris, H.D., et al, *International journal of rock mechanics, mining sciences and geomechanical abstracts,* 1974, 11, p.343-358, 7 refs.
Mellor, M.
29-2707
ROCK DRILLING, WATER JETS, HIGH PRESSURE TESTS.
Cutting tests were made with continuous high pressure water jets on three representative types of rock to obtain comprehensive data suitable for exploring basic jet-cutting relationships. Test materials were Berea sandstone, Indiana limestone and Barre granite, for which general properties have been fully determined. Nozzle pressures ranged from 1000 to 60,000 lbf/sq in, traverse speeds were in the range 0.002-5.5 ft/sec, and nozzle diameters were from 0.008 to 0.015 in. Dimensions of slots cut normally into the surfaces of thick blocks were measured, and specific energy values were calculated. Complete results are given in both tabular and graphical forms.

**MP 689**
**SOIL FAILURE UNDER INCLINED LOADS—PTS. 1 AND 2.**
Harrison, W.L., *Journal of terramechanics,* 1973, 9(4), 10(1), p.41-63, 11-50, For another version see 27-1185, RR 303. 29 refs.
32-4102
SOIL MECHANICS, SOIL STRENGTH, LOADS (FORCES), COMPUTER APPLICATIONS, THEORIES.

**MP 690**
**CLASSIFICATION AND RELIEF CHARACTERISTICS OF NORTHERN ALASKA'S COASTAL ZONE.**
Hartwell, A.D., *Arctic,* Sept. 1973, 26(3), p.244-252, French and Russian summaries. 15 refs.
28-2515
LANDSCAPE TYPES, ARCTIC TOPOGRAPHY, SHORE EROSION.

**MP 691**
**DEFORMATION OF ROCKS UNDER UNIAXIAL TENSION.**
Hawkes, I., et al, *International journal of rock mechanics and mining sciences and geomechanical abstracts,* 1973, Vol.10, p.493-507, 17 refs.
Mellor, M., Gariepy, S.
28-3279
ROCK MECHANICS, STRAIN MEASUREMENT, TENSILE STRENGTH, COMPRESSIVE STRENGTH, STRESS STRAIN DIAGRAMS, DEFORMATION.
Tensile tests were conducted on cylindrical rock specimens, cemented to end-caps attached to non-twist cables. In other tests the rock specimens were bonded to platens cycled between tension and compression. The results indicated that the initial tangent modulus of rock is similar, both in uniaxia tension and in compression, but in tension the modulus decreases with increase of applied load, whereas in comparison the modulus increases up to the stage of incipient failure. The value of the 50 per cent modulus in compression is usually greater than the value in tension. At very low stresses the Poisson's ratio of rock in tension can be greater than 0.5, but after load cycling the ratio is around or less than 0.1.

**MP 692**
**VIBRATING WIRE STRESSMETER.**
Hawkes, I., et al, Advances in rock mechanics. International Congress on Rock Mechanics, 3rd, Denver, Colo., Sep. 1-7, 1974, Proceedings, Vol.2, Pt.A, Washington, D.C., National Academy of Sciences, 1974, p.439-444, In English with German and French summaries. 3 refs.
Hooker, V.E.
33-534
ROCK MECHANICS, MEASURING INSTRUMENTS, STRESS CONCENTRATION, VIBRATION, STRAIN TESTS.
This paper describes an elastic inclusion type gauge developed to monitor stress changes around underground excavations. Deformation of the gauge body resulting from changes of stress in the surrounding rock mass is measured as a change in the vibration period of a highly tensioned wire strung diametrically across the body. It is shown that the gauge readings are relatively unaffected by rock modulus. Techniques for evaluating uniaxial and biaxial stress changes are described.

**MP 693**
**SEA ICE TERRAIN MODEL AND ITS APPLICATION TO SURFACE VEHICLE TRAFFICABILITY.**
Hibler, W.D., III, et al, *Journal of terramechanics,* Dec. 1975, 12(3/4), p.171-190, 16 refs. For this paper from another source see 29-186.
Ackley, S.F.
30-3386
SEA ICE, PRESSURE RIDGES, AIR CUSHION VEHICLES, TRAFFICABILITY, MODELS, TERRAIN ANALYSIS.
Pressure ridges are the primary obstacle to the movement of amphibious surface vehicles travelling over the Arctic ice pack. Ridge height and spacing data can now be obtained with remote sensing methods and used to construct a realistic three-dimensional ridge model for sea ice terrain. This model can be used to perform trafficability analyses. The results, when combined with vehicle characteristics, can be used to predict vehicle operational performance. There is good agreement between predictions from the model and from simulated routes through sea ice areas selected from aerial photographs. The terrain model is also useful for mapping regional variations in ridge characteristics throughout the Arctic Basin. The paper also discusses the nature of the rugged shear zone in the offshore region, and the presence of leads caused by dilation fo the ice pack in strong weather systems.

**MP 694**
**CLASSIFICATION AND VARIATION OF SEA ICE RIDGING IN THE WESTERN ARCTIC BASIN.**
Hibler, W.D., III, et al, *Journal of geophysical research,* June 20, 1974, 79(18), p.2735-2743, 18 refs.
Mock, S.J., Tucker, W.B.
29-123
SEA ICE, ICE PRESSURE, ICE MODELS, PRESSURE RIDGES.
A one-parameter model for pressure ridges is developed and compared, with good agreement, with over 3000 km of laser profile data taken from November 1970 to February 1973 in the Arctic basin. Comparisons are also made with a previously developed two-parameter model. The number of ridges per kilometer at any height level may be well predicted from the one-parameter model by using a parameter called ridging intensity, which may be determined for a region from the mean number of ridges per unit length and the mean ridge height. Regional and temporal variations in ridging intensity in the western Arctic basin are studies. Results indicate that although magnitudes of ridging intensity vary in time, the relative regional variations are similar. Consequently, three distinct regions of ridging intensity having relatively stable boundaries can be defined. Annual variation in new ice production due to ridging is sufficiently large to suggest that ridging plays an important role in the overall mass balance of the Arctic basin.

**MP 695**
**CLASSIFICATION OF SEA ICE RIDGING AND SURFACE ROUGHNESS IN THE ARCTIC BASIN.**
Hibler, W.D., III, et al, Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.244-254, AD-787 130, 11 refs.
Mock, S.J.
29-2513
SEA ICE, PRESSURE RIDGES, CLASSIFICATIONS, SURFACE ROUGHNESS, WIND FACTORS.
One- and two-parameter classification schemes for sea ice pressure ridging are reviewed. Using these classification schemes

the number of ridges above any height may be predicted. 500 km of processed laser profile data flown over the arctic ice pack in November 1970 is used to illustrate the agreement between models and observation. The key parameter relates the number of ridges per kilometer above a given height encountered along a straight line path, to the ridge height distribution shape parameter, uniquely determined by the mean ridge height. Surface roughness spectral characteristics are examined and it is found that ridging intensity correlates well with surface roughness throughout the frequency range. A specific relationship between high frequency roughness (< 13 m) and ridging intensity is shown. Wind form drag values due to pressure ridges are calculated and compared to empirical wind drag values obtained by other researchers for relatively unridged ice.

**MP 696**
**DIFFERENTIAL SEA-ICE DRIFT. I. SPATIAL AND TEMPORAL VARIATIONS IN SEA-ICE DEFORMATION.**
Hibler, W.D., III, et al, *Journal of glaciology,* 1974, 13(69), p.437-455, In English with French and German summaries. 17 refs.
Weeks, W.F., Kovacs, A., Ackley, S.F.
29-2419
SEA ICE, DRIFT, DEFORMATION, STRAINS, PERIODIC VARIATIONS.
Measurements of mesoscale sea-ice deformation over a region approximately 20 km in diameter were carried out over a five-week period in the spring of 1972 at the main AIDJEX camp in the Beaufort Sea. They have been analyzed to determine non-linearities in the ice velocity field (due to the discrete small-scale nature of the ice pack), as well as a continuum mode of deformation represented by a least-squares strain-rate tensor and vorticity. The deformation-rate time series between Julian day 88 and 112 exhibited net areal changes as large as 3% and deformation rates up to 0.16% per hour. In the principal axis co-ordinate system, the strain-rate typically exhibited a much larger compression (or extension) along one axis than along the other. Persistent cycles at 12 h wavelengths were observed in the divergence rate. A comparison of the average residual error with the average strain-rate magnitude indicated that strains measured on a scale of 10 km or greater can serve as a valid measure of the continuum motion of the sea ice. This conclusion is also substantiated by a comparison between the mesoscale deformation, and macroscale deformation measured over a 100 km diameter region. Regarding pack-ice rotation, vorticity calculations indicate that at low temporal frequencies, the whole mesoscale array rotates essentially as an entity and consequently the low-frequency vorticity can be estimated accurately from the rotation of a single floe.

**MP 697**
**DIFFERENTIAL SEA ICE DRIFT I: SPATIAL AND TEMPORAL VARIATIONS IN MESOSCALE STRAIN IN SEA ICE.**
Hibler, W.D., III, et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* July 1973, No.21, p.79-113, 14 refs.
Weeks, W.F., Kovacs, A., Ackley, S.F.
28-1436
SEA ICE, DRIFT, STRAIN ANALYSIS, ICE DEFORMATION.

**MP 698**
**DIFFERENTIAL SEA-ICE DRIFT. II. COMPARISON OF MESOSCALE STRAIN MEASUREMENTS TO LINEAR DRIFT THEORY PREDICTIONS.**
Hibler, W.D., III, *Journal of glaciology,* 1974, 13(69), p.457-471, In English with French and German summaries. 18 refs.
29-2420
SEA ICE, DRIFT, ATMOSPHERIC PRESSURE, WIND FACTORS, COMPRESSIVE PROPERTIES, VISCOELASTIC THEORY.
A comparison of mesoscale strain measurements with the atmospheric pressure field and the wind velocity field indicate that the ice divergence rate and vorticity follow the local pressure and wind divergence with significant correlation. For low atmospheric pressures and converging winds the divergence rate was found to be negative with the vorticity being counter-clockwise. The inverse behavior was observed for high pressures and diverging winds. This behavior was shown to agree with predictions based upon the infinite boundary solution of a linearized drift theory in the absence of gradient current effects and using the constitutive law proposed by Glen (1970) for pack ice. The best least-squares values of bulk and shear viscosity were derived. Using typical divergence rates these derived values yield compressive stresses which are similar to values suggested by the Parmerter and Coon (1972) ridge model. In general, the infinite boundary solution of the linear drift equation indicates that in a low-pressure region that is reasonably localized in space, the ice would be expected to converge for high compactness (winter) and diverge for low compactness (summer). Calculations were also carried out using a more general linear viscoelastic constitutive law that includes memory effects and which includes a generalized Hooke's law as well as the Glen law as special cases. A best fit of this more general calculation with strain measurements indicates overall a better agreement with viscous behavior than with elastic behavior, with the frequency behavior of the estimated "viscosities" similar to the Glen law behavior at temporal frequencies.

**MP 699**
**DIFFERENTIAL SEA ICE DRIFT II: COMPARISON OF MESOSCALE STRAIN MEASUREMENTS WITH LINEAR DRIFT THEORY PREDICTIONS.**
Hibler, W.D., III, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* July 1973, No.21, p.115-137, 18 refs.
28-1437
SEA ICE, DRIFT, STRAIN MEASUREMENT, ATMOSPHERIC PRESSURE, WIND VELOCITY.

**MP 700**
**ICE CORE STRATIGRAPHY AS A CLIMATIC INDICATOR.**
Hibler, W.D., III, et al, 1974, 15p. + figs., Ms copy of paper prepared for presentation at SCOR/SCAR Polar Oceans Conference, Montreal, May 1974. 11 refs.
Langway, C.C., Jr.
29-183
ICE CORES, ISOTOPE ANALYSIS, ICE SPECTROSCOPY, CLIMATIC CHANGES.
Ice core stratigraphic features in the Dye 3 Greenland ice core have been treated to a statistical time series analysis. A climatological time series was created by measuring the percentage of ice layers and other melt phenomena in each of the 1/8 year increments that the core was sampled for stable oxygen isotope ratios. This time series was treated to a spectral analysis and was compared to the oxygen isotope record by a cross spectral analysis. Optimal prediction to year 2020 of the lower frequency components of both time series was made using Wiener Filtering Theory. The analysis indicates that the melt feature time series represents a climatic record coherent with the isotope ratio record both at low frequencies (wavelengths > 50 years) and at higher frequencies (wavelengths < 2 years). Optimal prediction results are in general agreement with earlier predictions made by Dansgaard et. al. from the Camp Century core.

**MP 701**
**MESOSCALE STRAIN MEASUREMENTS ON THE BEAUFORT SEA PACK ICE (AIDJEX 1971).**
Hibler, W.D., III, et al, *Journal of glaciology,* 1973, 12(63), p.187-206, 21 refs. For another version see 27-515.
Weeks, W.F., Ackley, S.F., Kovacs, A., Campbell, W.J.
28-1321
PACK ICE, SEA ICE, STRAIN ANALYSIS, ICE DEFORMATION, BEAUFORT SEA.

**MP 702**
**ICE NUCLEATION IN CLOUDS BY LIQUEFIED PROPANE SPRAY.**
Hicks, J.R., et al, *Journal of applied meteorology,* Sept. 1973, 12(6), p.1025-1034, 34 refs.
Vali, G.
28-1819
CLOUD SEEDING, NUCLEATING AGENTS, ICE CRYSTAL FORMATION, ICE CRYSTAL GROWTH, PROPANE, NUCLEATING RATE, WATER CONTENT.

**MP 703**
**DIELECTRIC PROPERTIES OF SOILS AT UHF AND MICROWAVE FREQUENCIES.**
Hoekstra, P., et al, *Journal of geophysical research,* April 10, 1974, 79(11), p.1699-1708, 36 refs.
Delaney, A.J.
28-3778
SOIL MOISTURE, DIELECTRIC PROPERTIES, INDEXES (RATIOS), ELECTROMAGNETIC PROSPECTING, MICROWAVES, FROZEN GROUND PHYSICS, ULTRAHIGH FREQUENCIES.
The complex dielectric constant of four soils, including a sand, a silt, and two clays, was measured over a large frequency range. The water content of the soils was varied from 0.0 g $H_2O$/g soil to 0.15 g $H_2O$/g soils, and the temperature from 24 C to -20 C. The dielectric relaxation spectrum of water in soils was found to be displaced to lower frequencies than the dielectric relaxation spectrum of water in bulk. The results showed that the relation between volumetric water content and the complex dielectric constant is relatively independent of soil type. At temperatures above freezing the complex dielectric constant of water in soils, at the water contents investigated, decreases with temperature, a type of behavior normally found only in solids. Below the freezing point the phase composition of water in soils determines the temperature dependence of the complex dielectric constant.

**MP 704**
**FROST HEAVING PRESSURES.**
Hoekstra, P., *Copenhagen. Polyteknisk laereanstalt. Laboratoriet for elektromagnetisk feltteori. Report,* Sept. 1971, R 110, 19p., 18 refs.
28-1693
SOIL FREEZING, FROST HEAVE, SOIL MOISTURE MIGRATION, WATER CONTENT, SOIL PRESSURE.

**MP 705**
**SURFACE IMPEDANCE OF RADIO GROUNDWAVES OVER STRATIFIED EARTH.**
Hoekstra, P., et al, Conference on electromagnetic wave propagation involving irregular surfaces and inhomogeneous media. Pre-print No.144, Neuilly sur Seine, France, North Atlantic Treaty Organization, AGARD, [1973], p.23-1 - 23-8, 9 refs.
Delaney, A.J., Sellmann, P.V.
28-3673
ELECTRICAL RESISTIVITY, RADIO ECHO SOUNDINGS, FROZEN GROUND MECHANICS, ELECTROMAGNETIC PROSPECTING.
Ground and airborne techniques to obtain subsurface information, for geotechnical objectives, by measuring the surface impedance of radiowaves have been developed. The frequency range covered in these measurements is from 14.7 Khz (VLF) to 660 Khz (BCB). Measurements in the North America Arctic have shown that it is common to encounter changes in the effective resistivity with frequency from several thousand ohm-m at VLF to a few tenths of ohm-m at BCB. These changes are caused by a conductive organic layer over highly resistive frozen ground. Also large regional and local changes in surface impedance were observed. In the permafrost regions changes from 6000 ohm-m to 50 ohm-m at VLF were found to occur frequently over distances of about 100 m. Surveys at VLF on the ground resolve discontinuities in ground conditions over distances of a few meters.

**MP 706** Record deleted.

**MP 707**
**DEPARTMENT OF THE ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY.**
Anderson, D.M., *Biuletyn peryglacjalny,* 1976, No.26, p.148-152.
31-3220
COLD WEATHER CONSTRUCTION, EARTHWORK, CONSTRUCTION MATERIALS, BUILDINGS, AIRPORTS, TUNNELS, ICE (CONSTRUCTION MATERIAL), SNOW (CONSTRUCTION MATERIAL), ICE PHYSICS, PERMAFROST PHYSICS, SNOW PHYSICS, RESEARCH PROJECTS, U.S. ARMY CRREL, PERIGLACIAL RESEARCH, HUMAN FACTORS ENGINEERING.

**MP 708**
**ADHESIVE PROPERTIES OF ICE.**
Jellinek, H.H.G., *Journal of colloid science,* June 1959, 14(3), p.268-280, 20 refs. Microform No. SIP 17740.
31-3118
ICE ADHESION, ICE SOLID INTERFACE, TENSILE STRENGTH, TEMPERATURE EFFECTS.
Experiments on the adhesion of ice to stainless steel, polystyrene, and Lucite as a function of sample cross-sectional area, thickness, and temperature are described; the data are tabulated and graphed; and the results are examined theoretically. The tests were made in special tensile and shear apparatus on snow-ice samples and ice directly frozen to the solid surface. Shear tests on snow-ice/stainless steel yielded pure adhesive breaks changing abruptly to cohesive breaks at a temperature of about -13C. The adhesive strength of the system was a linear function of temperature and independent of the cross-sectional area and thickness of the samples in the ranges investigated. Ice/-polystyrene gave pure adhesive breaks on shear, the adhesive strength being a linear function of temperature down to -15C and independent of cross-sectional area. A linear relationship was found between adhesive strength and temperature from -2 to -25.5C in tensile tests with ice/polystyrene, the cross-sectional area and the rate of stress application having no effect on adhesive strength. Ice/Lucite showed a larger adhesive strength than ice/polystyrene. The results are explained by the assumption of a liquid-like layer at the ice-solid interface, the thickness and consistency of which is a function of temperature and the nature of the solid surface. Surface tension forces and frictional forces operative in the liquid-like layer are discussed.

**MP 709**
**INFLUENCE OF IMPERFECTIONS ON THE STRENGTH OF ICE.**
Jellinek, H.H.G., *Physical Society of London. Proceedings,* May 1, 1958, 71(461), p.797-814, 10 refs.
31-3059
ICE STRENGTH, TENSILE STRENGTH, ICE SOLID INTERFACE, ICE LOADS, THICKNESS, ICE TEMPERATURE, ICE VOLUME, METALS, ANALYSIS (MATHEMATICS).
Tensile strength measurements on ice cylinders adhering to stainless steel have been made as a function of rate of loading, thickness and cross-sectional area of specimens, and temperature. A rapid increase of tensile strength occurs as the volume is decreased. The data for a temperature of -4.5C can be represented over a thousandfold range of volumes. The experimental results are interpreted by means of a statistical treatment involving imperfections in the specimens. The statistics for a model consisting of a large number of parallel elements is elaborated. The final equation derived on statistical grounds approximates the equation found empirically. The conclusion is reached that due to imperfections the tensile strength is a statistical function of the volume and cross-sectional area of the specimens. Superimposed on the statistical effect is a stress

distribution effect, which becomes predominant for large volumes.

**MP 710**
**IS GRADED AGGREGATE BASE THE SOLUTION IN FROST AREAS.**
Johnson, T.C., 1975, p.IV/1-IV/19, 20 refs. Presented at the Conference on Utilization of Graded Aggregate Base, Oak Brook, Ill., March 25-26, 1974.
31-1993
SOIL AGGREGATES, PAVEMENT BASES, CONSTRUCTION, FROST PROTECTION, LOADS (FORCES), DRAINAGE, WATER PRESSURE.

**MP 711**
**NORTH AMERICAN PRACTICE IN DESIGN OF ROADS IN SEASONAL FROST AREAS.**
Johnson, T.C., Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.2, Paris, Organisation for Economic Co-operation and Development, 1973, p.175-195, 19 refs.
28-2106
SUBGRADES, PAVEMENTS, DESIGN CRITERIA, FROST PROTECTION, CONSTRUCTION.

**MP 712**
**STRUCTURE OF A MULTI-YEAR PRESSURE RIDGE.**
Kovacs, A., et al, *Arctic,* March 1973, 26(1), p.22-31, In English with French and Russian summaries. 12 refs.
Weeks, W.F., Ackley, S.F., Hibler, W.D., III.
28-62
SEA ICE, PACK ICE, ICE STRUCTURE, ICE NAVIGATION, PRESSURE RIDGES, BEAUFORT SEA.
Three transverse profiles across a large pressure ridge located in the Beaufort Sea are presented. The ridge sail extended 4 m above sea level and the ridge keel 13 m below. The cross-sections of the ridge keel can be described as roughly semi-circular. This suggests that form drag coefficients for flow transverse to the long axis of multi-year ridges may be as high as 0.8. Examination of several salinity, temperature and brine-volume profiles shows that much of the ice in the ridge has a very low salinity and is quite strong. All the inter-block voids that initially existed in the ridge at the time of its formation have been completely filled with ice. These observations, coupled with icebreaking experience indicate that multi-year ridges are, indeed, significant obstacles to even the largest icebreaking ship and should be avoided if possible. A very large first year ridge with a sail height of 12.8 m is also described. This is the largest free-floating ridge yet measured. (Auth.)

**MP 713**
**ARCTIC FOG DROPLET SIZE DISTRIBUTION AND ITS EFFECT ON LIGHT ATTENUATION.**
Kumai, M., *Journal of the atmospheric sciences,* May 1973, 30(4), p.635-643, 18 refs.
28-594
ADVECTION FOG, CLOUD DROPLETS, PARTICLE SIZE DISTRIBUTION, ELECTRON MICROSCOPY, LIGHT SCATTERING, VISIBILITY.
Arctic fog droplets were sampled on narrow glass plates precoated with chloride-sensitive gelatin film at Point Barrow, Alaska, in the summer of 1971. The relation between the radius of the fog droplet and the radius of the imprint on the film was determined experimentally. The collection efficiency of the fog droplet was determined. About 20,000 fog droplet radii were measured. The results of the analysis of the concentration and the size distribution of fog droplets are presented in the form of tables and figures. It is shown that the concentration and the size distribution changed rapidly with time and space; the droplet radii ranged widely between 3.3 and 6.5 microns; the maximum concentration was 24 droplets per cu cm and the liquid water content was 0.09 gm per cu m at a visibility of 250 m. Calculations were made of the attenuation by fog at wavelengths of 0.55 and 1.06 microns for the observed size distributions and concentrations of fog droplets. The values of the visual range calculated at a threshold constant of 5 per cent were closer to the observed values than those at a threshold constant of 2 per cent.

**MP 714**
**IDENTIFICATION OF SNOW CRYSTAL NUCLEI AND RELATIVE CONCENTRATIONS OF CHEMICAL SPECIES IN SNOW CRYSTALS AT THE SOUTH POLE.**
Kumai, M., International Conference on Nucleation, 8th. Proceedings, Leningrad, Akademiia nauk SSSR, 1973, p.60-61, Abstract only. No microfiche available.
33-684
SNOW CRYSTAL NUCLEI, SNOW COMPOSITION, CHEMICAL ANALYSIS, ANTARCTICA—AMUNDSEN-SCOTT STATION.

**MP 715**
**MONTMORILLONITE-BENZIDINE REACTIONS IN THE FROZEN AND DRY STATES.**
Lahav, N., et al, *Clays and clay minerals,* 1973, Vol.21, p.137-139, 17 refs.
Anderson, D.M.
28-612
FROZEN GROUND CHEMISTRY, CLAY MINERALS, UNFROZEN WATER CONTENT, FREEZE THAW CYCLES.

**MP 716**
**DRILLING, CORING, AND FROZEN-CORE ANALYSIS.**
Lange, G.R., et al, U.S. Committee on Environmental Studies for Project Chariot, Environment of the Cape Thompson region, Alaska, Oak Ridge, , p.97-114, 2 refs.
Smith, T.K.
23-3051
DRILL CORE ANALYSIS, DRILLING, NUCLEAR EXPLOSIONS, PROJECT CHARIOT, UNITED STATES—ALASKA—OGOTORUK CREEK.

**MP 717**
**EVIDENCE OF ICE-JACKING IN NORTHERN NEW HAMPSHIRE AND VERMONT.**
Fox, P.P., et al, *Geological Society of America. Bulletin,* Dec. 1957, 68(12), Pt.2, p.1729, Abstract only.
Lange, R.
31-3100
EXCAVATION, ICE REMOVAL, ELECTRIC POWER PLANTS.

**MP 718**
**DISCUSSION ON SUBSURFACE EXPLORATIONS IN PERMAFROST AREAS, BY J.R. CASS, JR.**
Lange, G.R., *American Society of Civil Engineers. Soil Mechanics and Foundation Division. Journal,* June 1960, 87(SM3), p.65, Discussion of SIP 17852.
31-3101
PERMAFROST PRESERVATION, FROZEN GROUND, DRILLING, CORING, THERMAL FACTORS.

**MP 719**
**CLIMATIC FLUCTUATIONS DURING THE LATE PLEISTOCENE.**
Langway, C.C., Jr., et al, *Geological Society of America. Memoir,* 1973, No.136, p.317-321, 26 refs.
Dansgaard, W., Johnsen, S.J., Clausen, H.B.
29-1130
ICE CORES, ISOTOPE ANALYSIS, CLIMATIC CHANGES, RADIOACTIVE AGE DETERMINATION, GREENLAND.
The oxygen-isotope ratio in polar snow is determined mainly by the temperature of formation of the precipitating clouds. A continuous core 1,390 m long through the ice sheet at Camp Century, Greenland, reveals a climatic record, inferred from those ratios, spanning possibly the last 100,000 yrs. The depth-age relationship of the core is calculated from present ice-flow patterns and simple assumptions; the paleoclimatic data are interpreted from the analysis of oxygen-isotope-ratio measurements on nearly 7,000 individual samples cut from the core. The ice-core record reveals that thw Wisconsin Stage started 73,000 yrs B.P. Many perturbations of the oxygen-isotope ratios are observed within the Wisconsin Stage that agree with climatic oscillations dated by radioactive methods. An 11 per thousand shift in the 0 isotope data shows that the Wisconsin Stage ended very rapidly, within a 2,500 yr interval, at about 13,000 yrs B.P. Spectral analyses of the data show oscillations with periods of 78, 181, 400, and 2,400 yrs.

**MP 720**
**UNDERMANNING AND ARCHITECTURAL ACCESSIBILITY.**
Ledbetter, C.B., Environmental Design Research Association Conference, 5th, University of Wisconsin, Milwaukee, May 30-June 1, 1974. Proceedings, [1974], p.281-288, For another version see 29-2351. 10 refs.
32-4153
MILITARY FACILITIES, BUILDINGS, HUMAN FACTORS ENGINEERING.

**MP 721** Record deleted.

**MP 722**
**ENGINEERING DESIGN AND CONSTRUCTION IN PERMAFROST REGIONS: A REVIEW.**
Linell, K.A., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.553-575, 190 refs.
Johnston, G.H.
28-857
BIBLIOGRAPHIES, PERMAFROST WEATHERING, HUMAN FACTORS, AIRPORTS, UTILITIES, DAMS, PIPELINES, ENVIRONMENTAL ENGINEERING, FOUNDATIONS, BUILDINGS, ROADS.

**MP 723**
**STRIP LOAD APPROXIMATION FOR A TRACK.**
Liston, R.A., American Society of Agricultural Engineers, Winter Meeting, 1973. [Proceedings], St. Joseph, Michigan, American Society of Agricultural Engineers, 1973, 47+15p., 8 refs.
29-1134
SOIL MECHANICS, SOIL STRENGTH, TRACKED VEHICLES, DYNAMIC LOADS, SETTLEMENT (STRUCTURAL).
This paper describes a laboratory and field study in which the behavior of a strip load under combined normal and tangential loading is analyzed to establish the relationship between sinkages induced by the separate loads. It is shown that the conclusion obtained from the laboratory study can be applied qualitatively to a tracked vehicle.

**MP 724**
**EFFECT OF VISIBILITY ON OPERATOR PERFORMANCE.**
Liston, R.A., *Journal of terramechanics,* 1973, 9(3), p.43-55.
29-1136
HUMAN FACTORS, COLD WEATHER PERFORMANCE, VISIBILITY, VEHICLES.

**MP 725**
**CORPS OF ENGINEERS' DESIGN OF HIGHWAY PAVEMENTS IN AREAS OF SEASONAL FROST.**
Lobacz, E.F., et al, Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.2, Paris, Organisation for Economic Co-operation and Development, 1973, p.197-217, 10 refs.
Gilman, G.D., Hennion, F.B.
28-2107
PAVEMENTS, DESIGN CRITERIA, FROST PROTECTION, GROUND ICE, CONSTRUCTION.

**MP 726**
**RESPONSE OF ALASKAN TERRESTRIAL PLANT COMMUNITIES TO THE PRESENCE OF PETROLEUM.**
McCown, B.H., et al, Alaska Science Conference, 23, Fairbanks, 1972. Proceedings of the Symposium on the Impact of Oil Resource Development on Northern Plant Communities, University of Alaska, 1973, p.34-43, 7 refs.
Deneke, F.J., Rickard, W., Tieszen, L.L.
28-2313
VEGETATION FACTORS, SOIL POLLUTION, CRUDE OIL, TUNDRA VEGETATION.

**MP 727**
**MACROSCOPIC INTERPRETATION OF FROZEN SOIL TEXTURE AS A FUNCTION OF FREEZING RATE.**
McGaw, R., 1974, 22p., Prepared for Symposium on Frost Action on Roads, Oslo, Norway, Oct.1-3, 1973, Session 3. 7 refs. Unpublished manuscript.
31-1990
FROZEN GROUND PHYSICS, SOIL TEXTURE, FREEZING INDEXES, FROST HEAVE, HEAT BALANCE, WATER CONTENT, FREEZE THAW CYCLES.
A schematic model of frozen soil texture has been described, and certain parameters relating to the manner in which frozen texture is physically developed have been defined. Two primary variables, the heave ratio and the textural ratio, have been derived and discussed in relation to freezing and thawing. The former is a measure of surface heaving, of water content gain, and of heat balance. The latter is a measure of the structural arrangement in a frozen soil. Both provide information on the probable stability of the thawed soil. It would be useful to be able to delineate the influence of these variables in experimental data presently available. As demonstrated, graphical representations of data such as were presented in Fig. 2 lend themselves to this purpose and provide a means of summarizing information on frozen texture.

**MP 728**
**USE OF ERTS-1 IMAGERY IN THE NATIONAL PROGRAM FOR THE INSPECTION OF DAMS.**
McKim, H.L., et al, *American Water Resources Association. Proceedings,* June 1973, No.17, p.120-137, 4 refs. For another version of this paper see 27-2528.
Marlar, T.L., Anderson, D.M.
29-1131
REMOTE SENSING, DAMS, PHOTOINTERPRETATION, ERTS IMAGERY.
ERTS imagery has been evaluated and found to be useful in locating circular water bodies over 152m (500 ft) in diameter. Dams on streams can be identified by an abrupt change in stream width. A linear termination on a water body is a reliable indication of a dam, particularly when it is inconsistent with the normal drainage pattern. Care must be exercised to avoid confusing cloud shadows with water bodies. However, the association of a cloud with its shadow usually can be accomplished since the sun angle is noted in the data given on each ERTS image. The following information generally can be derived from ERTS imagery: 1. The location of water bodies (exceeding about 5 acres in area). 2. The sizes and shapes of these water bodies. 3. The identification of dam sites on major rivers. 4. The direction of stream flow of major hydrologic networks. 5. Relative water depths and/or gross turbidity patterns. ERTS-1 imagery, in general, does not supply information suitable for determining: 1. Dam height. 2. Type of dam construction (concrete or earth fill). 3. Absolute depth of water bodies. 4. Location of water bodies less than about 5 acres.

**MP 729**
**AIRPHOTO INTERPRETATION FOR AIRFIELD SITE LOCATION.**
McLerran, J.H., *American Society of Civil Engineers. Air Transport Division. Journal,* May 1960, 86 (AT1), p.73-90, 10 refs.
31-696
AERIAL PHOTOGRAPHY, PHOTOINTERPRETATION, AIRPORTS, SITE SURVEYS, AIRCRAFT LANDING AREAS.

**MP 730**
**REVIEW OF BASIC SNOW MECHANICS.**
Mellor, M., *International Association of Hydrological Sciences. IAHS-AISH publication,* 1975, No.114, Snow mechanics—proceedings of the Grindelwald symposium, April 1974, p.251-291, 94 refs., In English with French summary.
30-4600
SNOW MECHANICS, SNOW DEFORMATION, SNOW STRENGTH, BIBLIOGRAPHIES, BOUNDARY FRICTION.
The review covers a broad spectrum of topics dealing with snow mechanics, ranging from defining the subject, outlining research goals, and placing it in historical perspective, through an appraisal of the major problems with snow mechanics and suggestions for research directions. In between, three major sections treat deformation, failure, and boundary friction, each section discussing upwards of a dozen specific topics all implicitly emphasizing the practical engineering aspects of snow mechanics.

**MP 731**
**CUTTING ICE WITH CONTINUOUS JETS.**
Mellor, M., International Symposium on Jet Cutting Technology, 2nd, Cambridge, England, April 2-4, 1974. Proceedings, 1974, p.G5/65-76, 14 refs.
31-1894
ICE CUTTING, ICE BREAKING, WATER PRESSURE, ICEBREAKERS, ROAD ICING, PIPE LAYING.
The practicality of cutting ice with continuous water jets has been investigated by laboratory experiments and field tests, using nozzle pressures from 2500 to 100,000 lbf/sq. in (17.2 to 690 MN/sq. m), traverse speeds from 0 to 357 ft/min (0 to 1.8 m/sec), and nozzle diameters from 0.008 to 0.023 in. (0.203 to 0.584 mm). Special emphasis has been given to a study of the feasibility of using water jets to supplement the performance of icebreaking vessels. While the "non-contact" aspect of a jet tool is attractive, power requirements for deep penetration at high traverse speeds are exorbitant by comparison with the power requirements for competing cutting systems. Application of test data in design calculation for other cutting applications is discussed.

**MP 732**
**HOW TO RATE A HARD-ROCK BORER.**
Mellor, M., et al, *World construction,* Sept. 1972, 25(9), p.21-23.
Hawkes, I.
30-2171
TUNNELING (EXCAVATION), EXCAVATING EQUIPMENT, ROCK EXCAVATION.

**MP 733**
**GEOCHEMISTRY OF PERMAFROST AND QUATERNARY STRATIGRAPHY.**
Péwé, T.L., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.166-170, 27 refs.
Sellmann, P.V.
28-814
QUATERNARY DEPOSITS, STRATIGRAPHY, FROZEN ROCKS, FROZEN GROUND CHEMISTRY, PERMAFROST, CORRELATION.

**MP 734**
**MEMBRANE ENCAPSULATED SOIL LAYERS (MESL) FOR ROAD CONSTRUCTION IN COLD REGIONS.**
Quinn, W.F., et al, Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.2, Paris, Organisation for Economic Co-operation and Development, 1973, p.417-438 (Vol.2), 71 (Vol.3), 15 refs.
Carbee, D., Johnson, T.C.
28-2121
THERMAL INSULATION, SOIL MOISTURE, SOIL COMPACTING, FROST PROTECTION, SUBGRADE PREPARATION, ARTIFICIAL FREEZING, SOIL FREEZING.

**MP 735**
**DELINEATION AND ENGINEERING CHARACTERISTICS OF PERMAFROST BENEATH THE BEAUFORT SEA.**
Sellmann, P.V., et al, Environmental assessment of the Alaskan continental shelf, Vol.2. Principal investigators' reports April-June 1976. Boulder, Colorado, Environmental Research Laboratories, 1976, p.640-651.
33-755
PERMAFROST DISTRIBUTION, SUBMARINE PERMAFROST, OFFSHORE DRILLING, DRILL CORE ANALYSIS.

**MP 736**
**DYNAMICS OF NEAR-SHORE ICE.**
Weeks, W.F., et al, Environmental assessment of the Alaskan continental shelf, Vol.2. Principal investigators' reports April-June 1976. Boulder, Colorado, Environmental Research Laboratories, 1976, p.781-789.
Kovacs, A.
33-760
SEA ICE, ICE MECHANICS, REMOTE SENSING.

**MP 737**
**EFFECTS OF VEHICLES ON ARCTIC TUNDRA.**
Rickard, W., et al, *Environmental conservation,* Spring 1974, 1(1), p.55-62, 28 refs.
Brown, J.
30-1126
TUNDRA TERRAIN, ALL TERRAIN VEHICLES, DAMAGE, GROUND THAWING.
Travel in the Arctic is nowadays predominantly by aircraft or by specifically disigned overland vehicles, as few roads exist. Terrain damage resulting from off-road vehicular movement in arctic areas is potentially serious—particularly in the wetter, ice-rich permafrost terrain. Detailed examinations of vehicle trails made in the 1940s indicate that natural recovery and stabilization of these trails has been relatively slow. Several recent controlled tests using a variety of vehicles suggest that long-term impact of the vehicles on the terrain is a function of time of year, type of substrate, vegetation, soil moisture, ground-contact pressure, type of vehicle propulsion (i.e. tracks, air-cushion, etc.), and operator technique.

**MP 738**
**THAW AND EROSION ON VEHICULAR TRAILS IN PERMAFROST LANDSCAPES.**
Rickard, W., et al, *Journal of soil and water conservation,* Nov.-Dec. 1973, 28(6), p.263-266, 15 refs.
Slaughter, C.W.
28-3629
PERMAFROST TRANSFORMATION, SOIL EROSION, GROUND THAWING, GROUND ICE, VEHICLES.
Two types of off-road access trails constructed on permafrost terrain in central Alaska were monitored to determine the environmental consequences of off-road vehicular travel for both recreational and business pursuits on such terrain. Tractor-cleared trails showed severe permafrost thaw and soil movement the first season after use. A hand-cleared controll-access trail was markedly more stable, showing lower levels of soil movement even after three seasons of frequent travel.

**MP 739**
**EXPANDING ROLE FOR SUBARCTIC WATERSHED RESEARCH.**
Slaughter, C.W., et al, *Water resources bulletin,* April 1974, 10(2), p.256-264, 21 refs.
Helmers, A.E.
29-1190
WATERSHEDS, ECOSYSTEMS, RESEARCH PROJECTS, TAIGA, PERMAFROST DISTRIBUTION.
It is increasingly recognized that natural resources research should in many cases be broadened in scope and oriented toward more general "environmental" problems. Locales with a history of "watershed" research can be eminently suited for development of comprehensive, environmental research programs. This is recognized in many research efforts of the International Biological Program (IBP), where watershed research sites have been successfully utilized for intensive investigations of process and function of selected ecosystems or ecosystem components. In the North American Subarctic there is almost no history of "watershed" studies. Basic data on hydrometeorologic parameters such as precipitation amounts and areal and seasonal distribution of runoff are scarce; the data framework within which environmental understanding can be structured is exceedingly sketchy. Opportunity exists in the discontinuous-permafrost settings of central Alaska to begin rectifying this situation. A basic program of multi-agency, multi-discipline research and data acquisition for the most significant hydrologic subregions is being developed, based around several existing environmental research areas (chiefly the Bonanza Creek Experimental Forest, the Caribou-Poker Creeks Research Watershed, the Wickersham Dome Fire Study Area, and a series of outlying sites).

**MP 740**
**COOPERATION IN WATER RESOURCES PROGRAMS: ALASKA'S EXAMPLE.**
Slaughter, C.W., et al, *Water resources bulletin,* Aug. 1974, 10(4), p.802-812, 9 refs.
Freeman, T.G., Audsley, G.L.
33-492
NATURAL RESOURCES, WATER SUPPLY, RESEARCH PROJECTS.
Alaska possesses a diversity and magnitude of water resources unmatched in any other state. With over 15% of the area of the whole United States, and 40% of the nation's total fresh water supply, but an extreme lack of basic hydrologic and climatologic data, cooperation among agencies and individuals concerned with evaluating, planning, and carrying out water resources programs is essential. Toward this end, the Inter-Agency Technical Committee for Alaska (IATCA) was established under charter from the Water Resources Council. Representation in IATCA includes virtually all Federal, State, and academic entities in Alaska having an interest in the water resources of the State. Existence of IATCA has permitted or facilitated numerous Alaskan water resources programs. Several are described briefly in this paper.

**MP 741** Record deleted.

**MP 742**
**ARCTIC AND SUBARCTIC SEASONAL SNOWPACK: RESEARCH AND MANAGEMENT APPROACHES IN ALASKA.**
Slaughter, C.W., et al, Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.273-282, 23 refs.
Crook, A.G.
29-2515
SNOW COVER DISTRIBUTION, RESEARCH PROJECTS.

**MP 743**
**UPLAND CLIMATIC PARAMETERS ON SUBARCTIC SLOPES, CENTRAL ALASKA.**
Slaughter, C.W., et al, Alaska Science Conference, 24th, University of Alaska, Aug. 15-17, 1973. Climate of the Arctic, Fairbanks, University of Alaska, 1975, p.276-280, 15 refs.
Long, K.P.
30-2576
CLIMATOLOGY, SUBARCTIC TERRAIN, SLOPES, SOIL TEMPERATURE, AIR TEMPERATURE, WATERSHEDS.

**MP 744**
**LABORATORY DEVELOPMENT AND FIELD TESTING OF A SULFUR/FOAMED POLYSTYRENE INSULATION COMPOSITE.**
Smith, N., et al, Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laborarory, 1973, "p., 2 refs. Paper presented at the Fourth Joint Chemical Engineering Conference sponsored by the Canadian Society of Chemical Engineering and the American Institute of Chemical Engineers, Sep. 9-12, 1973, Vancouver, British Columbia.
Pazsint, D., Karalius, J.A.
31-1301
THERMAL INSULATION, CONCRETE AGGREGATES, FLEXURAL STRENGTH, LABORATORY TECHNIQUES, SULFUR.

**MP 745**
**DISCUSSION ON SUBSURFACE EXPLORATIONS IN PERMAFROST AREAS, BY J.R. CASS, JR.**
Stevens, H.W., et al, *American Society of Civil Engineers. Soil Mechanics and Foundation Division. Journal*, June 1960, 87(SM3), p.65-67, Discussion of SIP 17852.
Verville, W.P.
31-3102
PERMAFROST PRESERVATION, FROZEN GROUND, SAMPLING, DRILLING, CORING, THERMAL FACTORS.

**MP 746**
**HEAT TRANSFER ANALYSIS OF AIR BUBBLER SYSTEM.**
Tien, C., et al, International Heat Transfer [Symposium], 5th, Tokyo, 1974, Proceedings. Vol.5, 1974, p.139-143, 10 refs.
Yen, Y.-C.
31-1991
HEAT TRANSFER, BUBBLES, WATER FLOW, ICE MELTING, MECHANICAL ICE PREVENTION, THERMAL DIFFUSIVITY, ANALYSIS (MATHEMATICS).
An analytical and experimental study was conducted on the heat transfer characteristics of air bubblers. Two models describing bubble induced water motion were proposed. Model I assumes that the liquid motion is one-dimensional, upward in the center and downward along the column wall. Model II assumes that the induced jet is axisymmetric and after impinging on an ice surface becomes a surface jet. The experimental study determines ice melting rate as a function of air bubbling rate and column dimensions. The results are expressed in terms of thermal diffusivity and Nusselt number as a function of Reynolds number. The experimental results agree reasonably well with the predictions from Model II, thus lending validity to this model.

**MP 747**
**PREDICTION OF UNFROZEN WATER CONTENTS IN FROZEN SOILS FROM LIQUID LIMIT DETERMINATION.**
Tice, A.R., et al, Symposium on Frost Action on Roads, Oslo, Norway, Oct. 1-3, 1973, Vol.1, Paris, Organisation for Economic Co-operation and Development, 1973, p.329-34[illegible] (Vol.1), 63-65 (Vol.3), 30 refs.
Anderson, D.M., Banin, A.
28-2094
SOIL MOISTURE, FROZEN GROUND HYDROLOGY, UNFROZEN WATER CONTENT.

**MP 748**
**ALASKAN SNOW LOADS.**
Tobiasson, W., et al, Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, 1973, 24p., Presented at Alaska Science Conference, Fairbanks, Alaska, Aug. 1973. Paper not published with proceedings. 25 refs.
Redfield, R.
31-1302
SNOW LOADS, SNOW DEPTH, SNOW WATER EQUIVALENT, STATISTICAL ANALYSIS, BUILDINGS.

**MP 749**
**ICE AND SHIP EFFECTS ON THE ST. MARYS RIVER ICE BOOMS.**
Perham, R.E., National Hydrotechnical Conference, 3rd (with the participation of the Municipal Section), Quebec, May 30-31, 1977. Proceedings, Université Laval, Canadian Society for Civil Engineering, 1977, p.419-433, In English with French summary. 5 refs.
31-3424
ICE BOOMS, RIVER ICE, ICE CONTROL, ICE PRESSURE, IMPACT STRENGTH, LOADS (FORCES), ICE NAVIGATION.
The St. Marys River connects Lake Superior with Lake Huron. It contains many navigation improvements which make it an important commercial shipping route. The operation of ships in winter under a federal program to extend the navigation season has led to troublesome ice movements and accumulations. To help counteract these effects, two ice booms with a 250 ft (76 m) wide navigation opening between their adjacent ends were installed at the southerly outlet from the habor at Sault Ste. Marie, Michigan and Ontario. The ice booms contained six force measuring devices. Records of these forces and pertinent data on the weather, water levels, ship passages and ice conditions were kept the following winter of 1975-76. The ice booms reduced the harbor ice losses to an acceptable level and provided much information about the interactions between itself and the ice cover and the ships. Ships and environmental effects kept the ice behind the west boom free from shore much of the winter. The maximum in the east boom was an impact load of about 160,000 lbs (712 kN). The forces associated with ship passeges averaged 25,000 lbs (111 kN).

**MP 750**
**IONIC MIGRATION IN FROZEN ANTARCTIC SOIL.**
Ugolini, F.C., et al, *Antarctic journal of the United States*, July-Aug. 1972, 7(4), p.112-113, 2 refs.
Anderson, D.M.
27-1530
CRYOGENIC SOILS, ION DIFFUSION, HYDROTHERMAL PROCESSES, ANTARCTICA—WRIGHT VALLEY.
Experiments were set up to monitor the movement of chlorine-36 and sodium-22 chloride in cold dry soils of the lower Wright Valley in the summers of 1968 and 1969-1970 respectively to establish whether 1) ionic migration takes place and 2) liquid films of water surrounding the minerals do exist. It was found that the negatively charged ions (chlorine-36) had moved 7 cm above the emplacement point after 25 days, while at the similar site, the positively charged ions (sodium-22) had moved a maximum distance of 5 cm in 2 years. The hydrothermal regime, measured during November for 1962, 1968, 1969, and 1971, has remained constant. The discrepancy of migration of opposite charged ions is explained on the basis of their charges. The study shows that minerals are surrounded by a film of unfrozen water and that weathering of silicates can be explained as a presently continuing phenomenon. During warmer and moister periods, the thickness of the film of unfrozen water should increase and thus increase the mobility of the ions.

**MP 751**
**SOIL DEVELOPMENT AND PATTERNED GROUND EVOLUTION IN BEACON VALLEY, ANTARCTICA.**
Ugolini, F.C., et al, Permafrost: North American contribution to the Second International Conference, Washington, D.C., National Academy of Sciences, 1973, p.246-254, 15 refs.
Bockheim, J.G., Anderson, D.M.
28-823
CRYOGENIC SOILS, SOIL FORMATION, PATTERNED GROUND, DESERT SOILS, ANTARCTICA—BEACON VALLEY.
Soil formation in Antarctica is restricted by the limited extent of ice-free areas, continuous low temperatures and the paucity of liquid water. The soils of Beacon Valley are of the desert type: devoid of organic surface layer, coarse textured, very dry, pulverulent, and show little color differentiation. Patterned ground, mostly of sand-wedge, nonsorted polygons, is ubiquitous throughout the Valley. Two mappable major soil units are distinguished in the northeast half of the valley. They are related to the age of the glacial deposits and to nonsorted polygons, which may be divided into well-developed and poorly-expressed types. The soils of the well-developed polygons appear immature in comparison to the more mature soils of the poorly expressed types. This distinction is valid morphologically, physically, and chemically. There is also a distinction between the soils formed in the troughs and more developed soils found in the centers of the polygons. Patterned ground evolution depends on structure and consistency of soils. Sand-wedge growth is greatly affected by the degree of soil development in the troughs. Once the soils in the troughs have acquired a compound structure, they are not able to flow and fill the contraction cracks. Thus, the rate of sand-wedge growth will be reduced since it depends on the availability of loose, free-moving materials. The lack of growth-rate uniformity may account for the observed discrepancy between the age of the wedges and the degree of soil development.

**MP 752**
**MOVEMENT OBSERVATIONS ON THE GREENLAND ICE SHEET.**
Wallerstein, G., *Journal of glaciology*, Mar. 1958, Vol.3, p.207-210, 5 refs. Microform No. SIP 16296.
31-3119
GLACIER MOVEMENT, VELOCITY MEASUREMENT, GREENLAND.
Certain positions on the Icecap, established by the French in 1951, were redetermined in 1955 by observations of the sun to measure the movement of the ice surface. A movement of 774 m. in 4 yr. in a S. direction (not with the surface slope) was noted for the Central Station, confirming French findings. The direction of the movement may be due to the deflection of the ice to the S. by a 20-mi. ridge (discovered by seismic measurements) rising 760 m. in 10 mi. W. of the station. A motion of 611 m. in a W. Direction was measured at Mile 100, indicating the importance of surface slope for ice movement at this point halfway between Central Station and the firn line. Assuming a constant velocity with depth, the total flow of ice per yr. in a 1-m. cross section is calculated as 36,000 cu. m., while accumulation over the 100 mi. between Mile 100 and Central Station is 82 m./yr. The uncertainty of the measures is large since the time scale is so short.

**MP 753**
**NAVIGATION ON THE GREENLAND ICE-SHEET.**
Wallerstein, G., *Navigation*, Dec. 1956, 5(4), p.181-182, 3 refs.
31-695
TRAVERSES, NAVIGATION, ICE SHEETS, GREENLAND.

**MP 754**
**ANTARCTIC ICEBERGS AS A FRESHWATER RESOURCE.**
Weeks, W.F., et al, *Polar record*, May 1973, 16(104), p.661-665, 3 refs.
Campbell, W.J.
28-1414
ICEBERGS, WATER SUPPLY, LOGISTICS, ICE MELTING, ECONOMICS.
In a recent study (Weeks and Campbell, F-12780) a rather complete examination was made of the idea that icebergs could advantageously be used as a source of fresh water. This note briefly outlines the authors' approach to analyzing the problem and their results. Iceberg sources, towing, in-transit melting, and the economics of the operation are discussed. The study suggests that an operational iceberg transportation scheme could allow the efficient utilization of some arid coastal areas in the Southern Hemisphere for large-scale agricultural and perhaps even agro-industrial complexes.

**MP 755**
**PROFILE AND HEAT BALANCE AT THE BOTTOM SURFACE OF AN ICE SHEET FRINGED BY MOUNTAIN RANGES.**
Weertman, J., *International Association of Scientific Hydrology. Publication*, 1963, Vol.61 p.245-252, 10 refs. Microform No. SIP 21909.
31-3120
GLACIER MASS BALANCE, STRATIGRAPHY, GLACIER HEAT BALANCE, THERMAL PROPERTIES, GLACIER MELTING, ICE SHEETS, MOUNTAINS.
A theory of ice sheet profiles is extended to cover the case in which the ice of an ice sheet moves through an encircling mountain range by flowing down outlet glaciers, as is the case in Greenland and Antarctica. The profile calculation concerns three cases: an outlet glacier, the drainage area at the head of an outlet glacier, and the central portion of the ice sheet. According to this theory, the profile of an ice sheet is little influenced by the presence of encircling mountains, provided that mature outlet glaciers drain the ice sheet through the mountains. As in the case of ice sheets, it is uncertain whether or not the bottom of a mature outlet glacier is at the melting point, since the heat of sliding is of the same order of magnitude as the heat conducted down the temperature gradient at the bottom surface. The bottom temperature of immature outlet glaciers ordinarily should be at the pressure melting point, thus enabling such glaciers to erode their beds. (Auth., mod.)

**MP 756**
**STABILITY OF THE JUNCTION OF AN ICE SHEET AND AN ICE SHELF.**
Weertman, J., *Journal of glaciology*, 1974, 13(67), p.3-11, In English with French and German summaries. 7 refs.
29-67
ICE SHEETS, ICE SHELVES, PLASTIC PROPERTIES, FLOW RATE, STABILITY.
An analysis is made of the steady-state size of a two-dimensional ice sheet whose base is below sea-level and which terminates in floating ice shelves. Under the assumption of perfect plasticity it is found that an ice sheet placed on a bed whose surface was initially flat cannot exist if the depth of the bed below sea-level exceeds a critical depth. If this depth is less than the critical level, the ice sheet extends out to the edge of the continental shelf. Similar results are found with more realistic assumptions about the laws governing the flow of ice. If the bed slopes away from the centre, the ice sheet can have a stable width that increases in value as the accumulation rate increases or as sea-level is lowered. It is not possible to decide whether or not the West Antarctic ice sheet is in stable equilibrium. It is entirely possible that this ice sheet is disintegrating at present, as suggested by Hughes. (Auth.)

**MP 757**
**MECHANICAL PROPERTIES OF SNOW RELATED TO ITS USE AS A CONSTRUCTION MATERIAL.**
Wuori, A.F., Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, 1973, 8p., Presented at the Symposium on Physical Methods of Ice and Snow Studies, Leningrad, USSR, October 1973. For Russian version of this paper see 30-3626. 10 refs.
31-1300
SNOW (CONSTRUCTION MATERIAL), SNOW COMPACTION, SINTERING, SNOW BEARING STRENGTH, MECHANICAL PROPERTIES.

**MP 758**
**CONDENSATION-MELTING HEAT TRANSFER IN THE PRESENCE OF AIR.**
Yen, Y.-C., et al, *A.I.Ch.E. Symposium series*, 1972, 69(31), p.23-29, 15 refs.
Zehnder, A., Zavoluk, S.
28-1664
HEAT TRANSFER, CONDENSING, ICE MELTING, EXPERIMENTAL DATA.
A theoretical and experimental investigation of steam condensing on a vertical ice plate is presented. For the experimental range of air mass fraction from 0.12 to 0.59 and a system pressure of 4 lb./sq. in. gauge, experimental and theoretical heat

transfer coefficients were found to be in good agreement. The theoretical study includes both melting and nonmelting systems containing air mass fractions from 0.001 to 0.7. Constant physical properties are assumed in the analysis. The effect of melting on condensation heat transfer is found to be negligible for air mass fractions above 0.01. However, below this value, the addition of melting reduces the heat transfer coefficient by as much as 60 percent.

**MP 759**
**EFFECTS OF DENSITY INVERSION ON FREE CONVECTIVE HEAT TRANSFER IN POROUS LAYER HEATED FROM BELOW.**
Yen, Y.-C., *International journal of heat and mass transfer,* 1974, Vol.17, p.1349-1356, In English with summaries in French, German, and Russian. 20 refs.
29-2348
HEAT TRANSFER, CONVECTION, TEMPERATURE DISTRIBUTION, DENSITY INVERSIONS.
A study was conducted to investigate the effects of density inversion on free convective heat transfer in a porous layer heated from below. Glass beads in water composed the porous medium. For upper boundary at 4 and 8C, thus eliminating the effect of density inversion on the onset of convection, the critical Rayleigh number was found to be 4 pi sq. The effect of density inversion was evaluated by maintaining the upper boundary temperature at 0C. The onset of convection was found to be dependent on two thermal parameters which are functions of the boundary temperatures and the coefficients representing the fluid density-temperature relation. The Nusselt number can be represented in terms of a modified Rayleigh number. The effect of density inversion on heat-transfer rate was found to be significant and to decrease as the temperature difference across the layer increases. For small temperature change, the effect of density inversion causes heat-transfer rate to be as much as 100 per cent less than under non-density inversion conditions.

**MP 760**
**QUANTITATIVE STUDIES ON THERMAL EXPANSION AND CONTRACTION OF LAKE ICE.**
Zumberge, J.H., et al, *Journal of geology,* July 1953, Vol.61, p.374-383, 14 refs. Microform No. SIP 5090.
Wilson, J.T.
31-3121
LAKE ICE, THERMAL PROPERTIES, ICE PRESSURE, TEMPERATURE EFFECTS, ICE PHYSICS, TENSILE PROPERTIES.
Field observations during the winter of 1951-1952 on Wamplers Lake in southeastern Mich. included measurements on the movement of the sheet of lake ice in response to air-temperature fluctuations. The following generalities resulted from the study. A temperature rise of 1F/hr. prolonged over a period of 12 hr. on an 8-in. sheet is sufficient to cause thrust on a shore composed of unconsolidated glacial outwash containing some boulders. The direction of ice thrust against the shore is not everywhere orthogonal to the trend of the shore line on an elongated lake but may be oblique at certain points. Tensional fracturing of the ice due to rapid cooling results in one set of cracks that radiate from the central part of the lake and another set roughly concentric with the shore line. (Auth.)

**MP 761**
**PERFORMANCE OF PROTECTED MEMBRANE ROOFS.**
Aamot, H.W.C., Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, 1975, 4p. + figs., Presented at the 4th National Conference on Roofing Technology.
31-1298
ROOFS, HEAT TRANSFER, INSULATION.

**MP 762**
**SOME USES FOR WASTE HEAT.**
Aamot, H.W.C., *The year (Dartmouth College, Hanover, N.H.),* Oct. 1974, 2(1), 5p., Based on Ph.D. thesis.
30-1125
HEAT RECOVERY, WASTES, ELECTRIC POWER GENERATION.
This article discusses alternative methods of waste heat disposal and presents two methods of disposal by utilization. The first of these is the use of a bottoming cycle to utilize waste heat from a combined heating and power plant system in order to generate electric energy. The second is the use of heat pumps to utilize the cooling water from an ordinary power plant for residential heating or cooling. Finally, the economics of the latter system is analyzed in an application to a municipal power plant and residential district in the city of Fairbanks, Alaska.

**MP 763**
**THERMAL PERFORMANCE OF PROTECTED MEMBRANE ROOFS.**
Aamot, H.W.C., Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, Feb. 1975, 2p. + figs., Presented at the Federal Workshop on Roofing Materials and Systems, National Bureau of Standards.
31-1793
ROOFS, THERMAL INSULATION, HEAT LOSS, THERMAL PROPERTIES, HEAT TRANSFER, METEOROLOGICAL FACTORS.

**MP 764**
**PERMAFROST TUNNEL.**
Abel, J.F., Jr., *Mines magazine,* Mar. 1960, 50(3), p.12-17, 5 refs.
31-3032
PERMAFROST STRUCTURE, GLACIAL TILL, TUNNELING (EXCAVATION), MINING, BLASTING, DRILLING, PERMAFROST PRESERVATION.

**MP 765**
**COMPRESSIBILITY CHARACTERISTICS OF UNDISTURBED SNOW.**
Abele, G., International Conference of the International Society for Terrain-Vehicle Systems, 5th, Detroit, Mich., June 2-6, 1975, Proceedings. Vol.2, Hoboken, N.J., [1976], p.379-399, 8 refs. For another version see 30-894.
33-439
SNOW COMPRESSION, SNOW LOADS, LOADS (FORCES), SNOW DEFORMATION, SNOW MECHANICS, SNOW DENSITY, STRESSES, TEMPERATURE EFFECTS.
Laboratory tests, using a modern 10,000 kg load capacity Materials Testing System, were conducted on shallow, undisturbed snow samples under uniaxial load to determine the stress vs. density and stress vs. deformation (pressure-sinkage) relationships as influenced by the rate of deformation, temperature and initial density in the pressure range of 0.1 to 75 kg/sq cm. The pressure-sinkage relationships of undisturbed snow on a rigid base are shown and discussed for various temperature, deformation rate, and initial density conditions.

**MP 766**
**INTRODUCTION TO AIR CUSHION VEHICLES.**
Abele, G., Hanover, N.H., U.S. Army Cold Regions Research and Engineering Laboratory, 1974, 11p., Presented at the American Society of Agricultural Engineers, Winter Meeting, 1974, Chicago, Ill. 13 refs.
31-1296
AIR CUSHION VEHICLES, ALL TERRAIN VEHICLES.

**MP 767**
**MEASUREMENT OF ARCTIC OCEAN ICE DEFORMATION AND FRACTURE PATTERNS FROM SATELLITE IMAGERY.**
Ackley, S.F., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* Sept. 1974, No.26, p.33-47, 12 refs. Also published in SCOR/SCAR Polar Oceans Conference, McGill University, Montreal, Canada, 1974.
Hibler, W.D., III.
29-1810
REMOTE SENSING, PHOTOINTERPRETATION, SEA ICE, ICE DEFORMATION, FRACTURING.
Imagery of sea ice was analyzed to (1) measure ice deformation by remote sensing techniques and (2) estimate correlation of the deformation with atmospheric driving forces so that the primary winter contribution to the atmosphere-ocean exchange can be calculated. The distribution of ice openings from VHRR infrared images obtained in March 1973 by the NOAA-2 satellite over the Beaufort Sea was compared with the changes in the atmospheric pressure field during this period. Measured divergence rates were an order of magnitude higher than previously seen in this area. The general divergence of the pack correlated with the presence of a prolonged high pressure system in the region. It is concluded that the passage of several systems of this type could significantly change the ice mass balance of a large region for a given year by increasing the amount of thin ice available that is subsequently piled up in pressure ridges.

**MP 768**
**THICKNESS AND ROUGHNESS VARIATIONS OF ARCTIC MULTI-YEAR SEA ICE.**
Ackley, S.F., et al, *Arctic Ice Dynamics Joint Experiment. AIDJEX bulletin,* July 1974, No.25, p.75-96, Paper prepared for presentation at IEEE Ocean '74 Conference in Halifax, Nova Scotia 21-23 August 1974. 31 refs.
Hibler, W.D., III, Kugzruk, F.K., Kovacs, A., Weeks, W.F.
29-1602
SEA ICE, ICE COVER THICKNESS, SURFACE ROUGHNESS, ICE DENSITY.
Three lines on a multi-year ice floe in the Beaufort Sea, 200 m, 110 m and 76 m long, were profiled by level to obtain ice surface elevation (freeboard) and snow depth, and drilled to obtain ice thickness at two meter intervals. Three models were then constructed to identify the relationship between surface elevation and ice thickness so that top roughness, bottom roughness and thickness could be obtained from a measure of the surface elevation alone. One model used the average observed ice density of 910 kg/cum. The second combined isostatic balance with the adjusted density. The third is basically the same as the Wittman-Markarov pressure ridge model. The first assumption overestimated the thicker ice and underestimated the thinner ice with errors in the estimate of thickness exceeding one meter. The last two models gave roughly similar results, with prediction errors of 0.40 m. The prediction accuracy is limited by the fact that the high-frequency roughness of the top ice surface (wave lengths less than 10 m) accounts for considerable variance which does not correlate with the bottom surface. An estimate is also made of the error in predicted ice thicknesses based only on the elevation of the upper ice surface as obtained by airborne laser. The error is predicted thicknesses only increased by about 10% over the error obtained from surface observations. Therefore, surface profiles obtained by an airborne laser may be a useful source of ice thickness information.

**MP 769**
**APPLICATIONS OF ERTS-1 IMAGERY TO TERRESTRIAL AND MARINE ENVIRONMENTAL ANALYSES IN ALASKA.**
Anderson, D.M., et al, Earth Resources Technology Satellite-1 Symposium, 3rd, Washington, D.C., 1974. Vol.1: Technical presentations, Sec.B, 1974, p.1575-1606, 32 refs.
McKim, H.L., Crowder, W.K., Haugen, R.K., Gatto, L.W., Marlar, T.L.
31-1893
REMOTE SENSING, GEOLOGICAL SURVEYS, OCEANOGRAPHIC SURVEYS, PERMAFROST DISTRIBUTION, ICE CONDITIONS, ARCTIC VEGETATION, MAPPING, UNITED STATES—ALASKA.
ERTS-1 imagery provides a means of distinguishing and monitoring estuarine surface water circulation patterns and changes in the relative sediment load of discharging rivers on a regional basis. The interpretation of geologic and vegetation features resulted in preparation of improved surficial geology, vegetation and permafrost terrain maps at a scale of 1:1 million utilizing ERTS-1 Band 7 imagery. This information will be further utilized in a route and site selection study for the Nome to Kobuk Road in central Alaska. Large river icings along the proposed Alaska pipeline route have been monitored. Sea ice deformation and drift northeast of Point Barrow, Alaska has been measured during a four day period in March and shorefast ice accumulation and ablation along the west coast of Alaska is being mapped for the spring and early summer seasons. These data will be used for route and site selection, regional environmental analysis, identification and inventory of natural resources, land use planning, and in land use regulation and management.

**MP 770**
**THEORY OF DENSIFICATION OF DRY SNOW ON HIGH POLAR GLACIERS, II.**
Bader, H., Kingery, W.D., ed. Ice and snow, Cambridge, Massachusetts Institute of Technology, 1963, p.351-376, 5 refs. Microform No. SIP 20845. For another version see 24-3260, RR 108.
31-3122
METAMORPHISM (SNOW), SNOW DENSITY, SNOW LOADS, SNOW DEPTH, ANALYSIS (MATHEMATICS).
The mathematical model for snow densification (See SIP 18431) is further developed to accommodate data from deep pits and corings. In the previous analysis, a linear relationship between snow load and rate of densification was used, but was considered applicable only if the snow load was smaller than 1000 gm./ sq. cm. To define the rate of densification at depths where the snow load exceeds this value, a hyperbolic sine function was substituted for the linear relationship, and a correction factor was added for the annual temperature cycle, which produces a higher rate of densification than would be the case at a constant mean temperature. Two equations are presented for calculating depth-density curves with computers, and a simplified equation is given for use with a desk calculator. Instructions are also given for determining function parameters on the basis of field data. Good correlations were obtained between field data and computed depth-density curves for 4 sites in Greenland and Antarctica.

**MP 771**
**SNOW AND ICE.**
Bender, J.A., *American Geophysical Union. Transactions,* June 1963, 44(2), p.585-588, 45 refs. Microform No. SIP 21205.
31-3123
SNOW PHYSICS, ICE PHYSICS, PERMAFROST PHYSICS, GEOPHYSICAL SURVEYS.
A majority of the physical properties of snow have been determined by many investigators, but the rapid growth of interest in this field has resulted in an incomplete coverage. The paper reviews several studies on snow metamorphism, thermal conductivity, drifting, and other fundamental properties of snow and ice. Ground ice has received new attention by investigators who studied thermal contraction cracks and their relation to ice wedges, and the relationship of various ground patterns and the type and distribution of ice in permafrost.

**MP 772**
**TESTING OF A COMPACTED SNOW RUNWAY.**
Bender, J.A., *American Society of Civil Engineers. Air Transport Division. Journal,* July 1957, 1(1324), p.1-20, 10 refs. Microform No. SIP 15649.
31-3124
SNOW COVER STRUCTURE, SNOW COMPACTION, SNOW ROADS, RUNWAYS, AIRCRAFT LANDING AREAS, SNOW DENSITY, SNOW STRENGTH.
The laboratory and field techniques used in 1955 for testing a 200 x 10,000 ft. deep-snow runway on the Greenland Icecap

(processed by modified pulvimixers using heat) are described, and the results are examined. A large number of ram-hardness readings were made systematically on the strip; the changes in snow temperature with depth were measured in pits; and core samples taken at various points along the strip were examined in the laboratory for structural characteristics, stratification, density changes with depth, strength, and stress-strain ratio. The runway consisted of 3 major snow layers: a hard processed top layer with high density and strength, a compacted layer with density and strength decreasing with depth, and a low-density, weak subgrade of virgin snow. Breakthroughs occurred where the pulvimixers had not sufficiently processed the snow or where, even though density was high, poor cohesion developed in the snow because large ice clumps had formed. Successful landings were made by C-47, C-54, and C-124 airplanes on wheels. Data are graphed on the ram hardness profile of the snow at various time intervals after processing, the sp. gr. and temperature of snow before processing, stress-strain curves, ram hardness vs. compressive strength, strength vs. temperature, and the temperature effect on the tensile strength of snow of varying grain sizes. The effects of temperature and age-hardening on the strength of snow are briefly discussed in the appendix.

**MP 773**
**FOUR HUNDRED METER DEEP ICE CORE IN GREENLAND.**
Benson, C.S., *Journal of glaciology,* Mar. 1959, 3(25), p.438, 3 refs. Microform No. SIP 17333.
31-3125
GLACIER ICE, ICE DENSITY, ICE CORES, ANALYSIS (MATHEMATICS).
An analytical expression given for representing the depth-density curve of Langway (SIP 16297) is presented using load, rather than depth, as the independent variable and specific volume in place of firn density as the dependent variable. The calculations are made under the assumptions that melt is negligible, densification is caused only by the load of overlying snow and firn applied at a constant rate, ice in firn remains at constant density, the change of volume produced by load is due to the elimination of pore space, and the rate of pore elimination with increasing load is proportional to the pore space itself. The deformation of ice is neglected. The equation agrees well with Landauer's depth-density data for a depth of 47.5 m., except for the top 10 m., where the rate of densification is much higher. For depths greater than 19 m. the resulting curve appears in general agreement with that of Langway.

**MP 774**
**DESIGN OF CIVIL AIRFIELD PAVEMENTS FOR SEASONAL FROST AND PERMAFROST CONDITIONS.**
Berg, R.L., *U.S. Federal Aviation Agency. Research and development report,* Oct. 1974, FAA-RD-74-30, 98p., ADA-006 284/4.
30-4049
AIRPORTS, PAVEMENTS, SEASONAL FREEZE THAW, FROST HEAVE, FROST PROTECTION.
The report describes the frost susceptibility of various FAA soil groups. The detrimental effects of the frost heaving of airfield pavements are controlled by using one of the following design methods: the complete protection method, the limited subgrade frost penetration method, or the reduced subgrade frost protection method. The detrimental effects of soil weakening due to thawing are minimized by applying the reduced subgrade strength design method. The modified Berggren equation and numerical methods for estimating frost and thaw depths are presented. Similar design methods are presented for airfield pavements in permafrost regions. A glossary of specialized terms used in the literature on frost and permafrost is included.

**MP 775**
**GLACIOLOGY OF THE BUDD COAST AND ITS HINTERLAND—A PROGRESS REPORT.**
Budd, W., *Glaciological notes,* Jan. 1963, No.13, p.33-38, 7 refs. Microform No. SIP 21392.
31-3126
GLACIER MOVEMENT, VELOCITY MEASUREMENT, GLACIER HEAT BALANCE, ICE TEMPERATURE, SNOW SURVEYS, SNOWDRIFTS, METEOROLOGY, ANTARCTICA.
Following the work of U.S. glaciologists in the region of Wilkes Station during the International Geophysical Year, glaciological measurements have been continued by the Australian National Antarctic Research Expeditions (A.N.A.R.E.). An outline of the newer results is given for the following: (1) topographic and elevation studies on the ice cap and the underlying bedrock in the vicinity of satellite station S2 (66 deg 31 min. S, 112 deg 13 min. E); (2) snow accumulation measurements made from the coast to S2 and to 480 km. south of S2; (3) ice movement studies on Vanderford Glacier, at Cape Folger and at S2; (4) ice temperature determinations in boreholes and derived temperature gradients for the coast to inland sites; and (5) drifting snow studies which confirmed that (a) for a given wind profile log drift density is proportional to log height, and (b) for different wind speeds the log of the ratio of the drift densities at the two levels varies as the reciprocal wind speed

**MP 776**
**STRENGTH STUDIES OF HIGH-DENSITY SNOWS.**
Butkovich, T.R., *American Geophysical Union. Transactions,* Apr. 1958, 39(2), p.305-312, 11 refs.
31-3027
SNOW STRENGTH, SNOW DENSITY, TENSILE STRENGTH, SNOW COMPRESSION, SHEAR STRENGTH.
Various strength properties of naturally compacted high-density snows, in the density range from 0.40 to 0.75 g/cm3 are reported. Test results are given for: unconfined compression; unconfined and confined double shear at various lateral pressures; ring, flexural, and centrifugal tensile strength, and torsional strength. The results of various tests measuring the tensile strength of the snow compare favorably with each other. An attempt to apply some of the known failure rules was unsuccessful. (Auth. mod.)

**MP 777**
**STUDY OF GLACIER FLOW FOR AN OPEN-PIT MINE: AN EXERCISE IN APPLIED GLACIOLOGY.**
Colbeck, S.C., *Journal of glaciology,* 1974, 13(69), p.401-414, In English with French and German summaries. 8 refs.
29-2416
GLACIER FLOW, MINING, EXCAVATION.
As part of the feasibility study for the development of an open-pit mine at the edge of the Greenland ice sheet, a study is made of the ice flow toward the proposed pit. The flow is analyzed by considering the two-dimensional flow along seven cross-sections. The most favorable profile is determined for each cross-section and its flow calculated. The excavation necessary to expose the ore is 106 million cu m of ice. 66 million cu m of ice will have to be removed in order to establish favorable profiles and an additional 7.9 million cu m of ice will have to be removed each year in order to prevent the glacier from thickening and advancing into the mine. Many other glaciological problems must be considered, and field work continues in order to provide more information about the area.

**MP 778**
**PILE FOUNDATIONS IN DISCONTINUOUS PERMAFROST AREAS.**
Crory, F.E., *National Research Council, Canada. Associate Committee on Soil and Snow Mechanics. Technical memorandum,* Sep. 1965, No.86, Canadian Regional Permafrost Conference, Dec. 1-2, 1964. Proceedings. Edited by R.J.E. Brown, p.58-76, Discussion. 16 refs. Microform No. SIP 23867.
31-3127
PILE FOUNDATIONS, DISCONTINUOUS PERMAFROST, PERMAFROST THERMAL PROPERTIES, FROST ACTION, FREEZE THAW CYCLES, THERMAL FACTORS, MAINTENANCE.
The inter-relationship of the many factors influencing foundation stability is discussed. Design considerations and construction methods and controls, to minimize disturbance of the delicate thermal balance of the permafrost, are included in a detailed evaluation of pile installation techniques. The importance of adequate site investigations and proper construction inspection and control is emphasized. Preconstruction temperature information is used with climatological records and theoretical methods to predict the freezing and/or thawing that will be experienced under the structure. Natural and artificial freezeback of piles are discussed in terms of construction schedules, costs installation methods and the volumetric heat capacity of the permafrost. The maintenance necessary for retention of the desired thermal equilibrium of the foundation media is presented as an integral part of design. (Auth.)

**MP 779**
**SPECULATIONS ABOUT THE NEXT GLACIATION.**
Dansgaard, W., et al, *Quaternary research,* Nov. 1972, 2(3), p.396-398, 4 refs.
Johnsen, S.J., Clausen, H.B., Langway, C.C., Jr.
29-819
CLIMATIC CHANGES, ICE CORES, ICE DATING, ISOTOPE ANALYSIS, PALEOCLIMATOLOGY.
A spectacular 10 per mille drop in the O-18/O-16 ratio (delta) in precipitation indicative of rapid cooling occurred at Camp Century, Greenland, 89,500 y.a. The timing is based upon and assumption of delta periodicity being constant in time. Onset of the Wisconsin pleniglacial is reflected by a 6 per mille O-18/O-16 drop at 73,000 BP. A similar event might have occurred 109,000 y.a., but the core at corresponding depth is missing. Could it also happen today? The deep ice core from Byrd Station, Antarctica, cannot be used for comparison, because it reaches continuously only some 80,000 yr backward in time. However, at Byrd the deepest 5 m of silty ice contains several sudden shifts (at higher but unknown ages) between two high O-18/O-16 levels, both of which reflect warmer climate and/or lower surface altitude prior to the Wisconsin than today. The reason for the sudden changes is unknown. Could ice surges from the Antarctic continent be responsible for an immediate and extreme cooling of the opposite Pole, in spite of the smoothing effect of the relatively slow coupling via the oceans? In the Byrd O-18/O-16 record an ice surge would seem to be reflected by a sudden increase due to the lowering of the altitude, followed by a slow decrease in O-18/O-16 during the build-up of the ice sheet.

**MP 780**
**FLOATING ICE FOR CROSSINGS.**
DenHartog, S.L., *Military engineer,* Mar.-Apr. 1975, 67(436), p.64-66, 6 refs.
31-3058
FLOATING ICE, ICE COVER STRENGTH, ICE (CONSTRUCTION MATERIAL), BRIDGES, TRAFFICABILITY.

**MP 781**
**APPROXIMATE ANALYSIS OF THE SOLAR REFLECTANCE AND TRANSMITTANCE OF A SNOW COVER.**
Dunkle, R.V., et al, *Journal of meteorology,* Apr. 1956, Vol.13, p.212-216, 11 refs. Microform No. SIP 13751.
Bevans, J.T.
31-3128
SNOW COVER, RADIATION ABSORPTION, REFLECTANCE, TRANSMISSIVITY, ALBEDO, MATHEMATICAL MODELS.
An analysis was made of the transmission and reflection of a mathematical model approximating a snow cover. The intent of the analysis was to obtain a more reliable picture of the factors influencing the albedo and the energy absorbed. The general case of a slab of finite thickness, irradiated from both sides, is solved and reduced to the case of a semi-infinite slab irradiated from one direction. Reflectance of a snow cover is fairly constant in the visible region but drops rapidly in the infrared region due to the increase in the absorption coefficient with wavelength. Additional data are required on radiation transmission in snow with different structural characteristics, on the correlation of transmittance with snow structure, and on the spectral reflectance of snow.

**MP 782**
**RESURVEY OF BYRD STATION DRILL HOLE.**
Garfield, D.E., et al, *Antarctic journal of the United States,* July-Aug. 1975, 10(4), p.160, 2 refs.
Ueda, H.T.
30-1655
ICE SHEETS, MEASURING INSTRUMENTS, BOREHOLES, ANTARCTICA—BYRD STATION.
A survey to determine amount and direction of inclination of the Byrd Station drill hole was conducted in the 1974-75 austral summer. The data when compared to similar data obtained during drilling of the hole, provided information for determining subsurface ice flow patterns at this location. Measurement techniques using a multiple-shot inclinometer housed in a sealed chamber are described. Preliminary results confirm previous reports of a complex ice flow pattern at Byrd Station.

**MP 783**
**ALASKAN THERMOKARST TERRAIN AND POSSIBLE MARTIAN ANALOG.**
Gatto, L.W., et al, *Science,* April 18, 1974, 188(4185), p.255-257, Numerous refs.
Anderson, D.M.
29-3755
REMOTE SENSING, THERMOKARST, MARS (PLANET), GROUND ICE, ERTS IMAGERY.

**MP 784**
**COOK INLET, ALASKA, BAY PROCESSES.**
Gatto, L.W., Remote Sensing for Environmental Analysis, Reference document for planners and engineers, Chap.4. Washington, D.C., Office of Chief of Engineers, n.d., p.33.
33-437
WATER INTAKES, COASTAL TOPOGRAPHIC FEATURES, HYDROLOGY, SEDIMENTATION, REMOTE SENSING, ERTS IMAGERY, ESTUARIES, UNITED STATES—ALASKA—COOK INLET.

**MP 785**
**SOME RESEARCH PROBLEMS IN SNOW MECHANICS AND THERMODYNAMICS.**
Gerdel, R.W., Western Snow Conference, Sacramento, Calif., April 1952. Proceedings, 1952, p.41-44, 14 refs. Microform No. SIP 4776.
31-3129
SNOW MECHANICS, SNOW THERMAL PROPERTIES, THERMODYNAMIC PROPERTIES, RESEARCH PROJECTS, SNOW STRENGTH.
The causes for discrepancies in the presently reported values for physical constants of snow are discussed. Snow strength is influenced by present and past temperatures and the frequency of temperature cycles. Some problems in snow mechanics are analogous to those in soils, but snow, particularly near the freezing point, may react oppositely for a given force. Releasing pressure on a soil increases its plasticity; releasing pressure on snow, near the ice point reduces its plasticity by causing free water between the grains to freeze. The derivation of a traction index from the measurable mechanical properties of snow or the forecastable degree of metamorphism is complicated by the inconsistency of the frictional resistance of the snow surface. Theories based on the narrow temperature range which separates the liquid, vapor, and solid phases of snow to account for the low but variable coefficient of friction for snow are discussed.

**MP 786**
**SNOW THERMODYNAMICS OFFERS BETTER UNDERSTANDING OF MECHANICAL PROPERTIES OF SNOW.**
Gerdel, R.W., *Civil engineering*, Dec. 1952, Vol.22, p.1022-1024, Microform No. SIP 4042.
31-3130
SNOW MECHANICS, SNOW THERMAL PROPERTIES, THERMODYNAMICS.
The important physical and mechanical properties of snow are summarized. Snow possesses the properties of hydrodynamic fluidity and of plastic deformability. Problems arising from the variable bearing capacity of snow are presented. Results of early research and a review of technical literature indicate that an unstable external environment and the associated phase instability within the snowpack may be chiefly responsible for the metamorphism of snow. The research program conducted by SIPRE, involving thermodynamic studies of snow, is outlined. Major emphasis is placed on a study of the micro-meteorological elements in the 50-ft. layer of air above a persistent winter snow pack. Studies are to be extended to field laboratories in the northern U.S., Alaska, and Canada.

**MP 787**
**DEVELOPMENT OF THE RADIOACTIVE SNOW GAGE.**
Gerdel, R.W., Eastern Snow Conference, 9th Annual Meeting, Feb. 14-15, 1952. Proceedings, 1952, p.1-12, 4 refs. Microform No. SIP 4422.
31-3131
RADIOACTIVE SNOW GAGES, RADIATION ABSORPTION, SNOW WATER EQUIVALENT.
The radioactive snow gage is based on the theory that the absorption coefficient is constant for any substance regardless of its state or phase. The number of gamma emissions absorbed from a radioactive isotope by a unit of water is also absorbed by an equal water equivalent of snow. Cobalt 60 was the most suitable radio-isotope available. A collimator was used to produce a narrow beam of rays and thus prevent scattered rays from being reflected toward the detector unit. A Geiger-Mueller tube was the most satisfactory detector for snow packs having a water equivalent up to 52 in. The cosmic ray problem is discussed and the diurnal variations in cosmic background count are plotted. A graph indicating the correction for the decay of cobalt 60 is given. Experimental field stations were constructed in the the Castle Creek watershed, Calif. One station was operated over a transmission line to central headquarters for the major portion of 1949-50 snow season; another, operated on a radio communication circuit at 2650 KC, proved that GM tube pulses could be transmitted and recorded. The records of the radioactive snow gage, a precipitation gage, and a snow-core sample indicate the practicability of the radioactive snow gage.

**MP 788**
**SIMULATION OF A BLOWING SNOW ENVIRONMENT IN A WIND TUNNEL.**
Gerdel, R.W., et al, Western Snow Conference, Spokane, Washington, April 1961. Proceedings, 1961, p.106-114, 4 refs. Discussion by C.C. Warnick. Microform No. SIP 20407.
Warnick, C.C.
31-3132
SNOWDRIFTS, WIND TUNNELS, SIMULATION, MODELS.
A research program has been undertaken at New York University to derive the essential scale parameters for a model snow and to select a material which would properly simulate snow when used with small scale models of structures and facility layouts. The problems associated with wind tunnel studies are discussed briefly, the criteria for a snow simulator are listed, and the wind tunnel operation and model tests are described. Some of the results are indicated.

**MP 789**
**STORAGE AND TRANSMISSION OF WATER IN SNOW.**
Gerdel, R.W., Eastern Snow Conference, 2nd. Proceedings, 1955, p.17-21, 6 refs. Microform No. SIP 10103.
31-3133
SNOW PERMEABILITY, SNOW COVER STRUCTURE, SNOW DENSITY, MOISTURE CONTENT, SNOW WATER CONTENT.
Investigations conducted over several years on the water holding and transmission capacity of snow are reviewed and results summarized. It appears that high transmission rates are associated with high density and ripe pack structure. The ultimate field moisture capacity of a ripe pack appears to be about 0.1 in. of water per ft. of snow.

**MP 790**
**WHITE-OUT IN GREENLAND: CAUSE AND POSSIBILITIES FOR CONTROL BY WEATHER MODIFICATION.**
Gerdel, R.W., Eastern Snow Conference, 5th. Proceedings, 1958, p.31-45, 6 refs. Microform No. SIP 17197.
31-3134
WHITEOUT, WEATHER MODIFICATION, CLOUD SEEDING, METEOROLOGICAL FACTORS.
The characteristics of various types of whiteout (overcast, fog, and precipitation whiteout) and related meteorological conditions are described; the results of studies by SIPRE since 1954 in Greenland are summarized; and possible countermeasures are discussed. An analysis of the formation of whiteout on the Greenland Icecap indicates that whiteout of the fog and overcast type may be dispersed by seeding with freezing nuclei. Seeding from ground installations rather than the air appears to be the best solution for improving visibility of landing strips on snow and ice. A map showing the relation between wind flow and whiteout in Greenland is included.

**MP 791**
**SURFACE CLIMATE OF THE ARCTIC BASIN. SELECTED CLIMATIC ELEMENTS RELATED TO THE PERFORMANCE OF SURFACE-EFFECT VEHICLES.**
Hastings, A.D., Jr., *U.S. Army Topographic Laboratories, Fort Belvoir, Virginia. Report*, Dec. 1971, ETL-TR-71-5, 103p., AD-738 796.
27-359
CLIMATOLOGY, AIR CUSHION VEHICLES, COLD WEATHER OPERATION, MAPS, ARCTIC BASIN.

**MP 792**
**TREE RING INDICES AND STATISTICS.**
Stage, A.R., *Science*, Apr.5, 1968, Vol.160, p.101, 3 refs. Comments on R.K. Haugen's paper (see 25-2163) and reply by R.K. Haugen.
Haugen, R.K.
31-1994
TREES (PLANTS), CLIMATIC CHANGES, AGE DETERMINATION.

**MP 793**
**ANALYSIS OF SHEAR ZONE ICE DEFORMATION IN THE BEAUFORT SEA USING SATELLITE IMAGERY.**
Hibler, W.D., III, et al, Symposium on Beaufort Sea Coast and Shelf Research, San Francisco, Jan. 7-9, 1974. Proceedings, Arlington, Va., Arctic Institute of North America, 1974, p.285-296, 11 refs.
Ackley, S.F., Crowder, W.K., McKim, H.L., Anderson, D.M.
30-351
SEA ICE, PACK ICE, DRIFT, ICE DEFORMATION, SHEAR STRESS, VELOCITY, REMOTE SENSING, ERTS IMAGERY, INFRARED PHOTOGRAPHY, METEOROLOGICAL FACTORS, BEAUFORT SEA.
A series of ERTS images from the coastal zone of Alaska are analyzed to give the deformation and drift of the nearshore pack ice. Points were followed for a 4-day period during March 1973 using sets on about a 15-km grid spacing. Least squares strain calculations yielded shear and divergence rates as large as 1.3/1,000,000/sec (0.5 percent per hour). Continuous deformation measurements through the fast ice-pack ice boundary indicated that the velocity profile has a maximum relatively close to the boundary and that the vorticity changes sign as the distance from the boundary increases. This effect was also verified by Very High Resolution Radiometer (VHRR) imagery. These deformation results suggest that, to a large extent, the arctic pack ice in the Pacific Gyre is behaving as a relative cohesive mass with slippage over a narrow region (about 50 km) at the boundaries. In terms of drift models, this means that the assumption of no slip at the boundary coupled with a single viscosity model is not tenable. However, either a two-viscosity model or a model allowing slip at the boundary provides a reasonable explanation for the observed behavior. As a corollary to such a slip model, shear stresses should be less for a given differential velocity near the shore than for the same differential velocity in the interior of the pack ice.

**MP 794**
**SEA ICE TERRAIN AND MOBILITY MODEL.**
Hibler, W.D., III, Army Science Conference, West Point, June 1974. Proceedings. Vol. 1, p.447-454, AD-785 631.
31-3114
AIR CUSHION VEHICLES, SEA ICE, PACK ICE, TRAFFICABILITY, ICE SURFACE, ICE PRESSURE.
With the advent of a new generation of air cushion vehicles the nature of the Arctic pack ice as a vehicle terrain has taken on military and commercial significance. The most formidable obstacles for any such vehicle traversing the pack are sea ice pressure ridges. In order to provide a usable classification scheme for ridges, a one parameter model for pressure ridge height distributions has been derived and compared with good agreement to extensive laser profile data taken over the Arctic pack ice. Using a single parameter called ridging intensity which may be determined from the mean number of ridges per unit length and the mean ridge height, the number of ridges per kilometer along a straight line path above any specified height may be predicted.

**MP 795**
**DESIGN AND INSTALLATION OF FENCES FOR CONTROL OF SNOW DRIFTING.**
Hicks, J.R., et al, Eastern Snow Conference, 7th. Proceedings, 1961, p.163-173, 3 refs. Microform No. SIP 20592.
Bolsenga, S.J.
31-3135
SNOW FENCES, SNOWDRIFTS, DESIGN.
Five-slat, metal snow fences, designed on the basis of simulated blowing-snow environment experiments (See SIP 20407), were tested first at a field station near Houghton, Mich. then at Camp Century, Greenland. The fence is easy to install, and is self-cleaning and portable, thus it is highly suitable for the Greenland Ice Cap or other Arctic regions with a persistent wind. Three trenches 50 x 18 x 8 ft were cut in the snow at Camp Century in July 1961. One trench was left unprotected, the other two were protected by V-shaped, vertical solid wall fences with different arrangements of the 5-slat portable metal fences installed upwind. During a minor 2-day storm, the unprotected trench became 45% filled with snow, the most protected trench only 0.5% filled. By Sept. the unprotected trench was 100% filled, the most protected 28% filled. In addition, the slat fences collected considerable amounts of snow (approx. 7500 gal./day), which was available for domestic water supply.

**MP 796**
**USE OF REGULATED-SET CEMENT IN COLD WEATHER ENVIRONMENTS.**
Hoff, G.C., et al, *U.S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi. Concrete Laboratory. Miscellaneous paper*, May 1975, C75-5, 19p., 10 refs.
Houston, B.J., Sayles, F.H.
31-1295
CONCRETE STRENGTH, CONCRETE CURING, CEMENT ADDITIVES, LOW TEMPERATURE TESTS.

**MP 797**
**ROADWAY DESIGN IN SEASONAL FROST AREAS.**
Johnson, T.C., et al, National Cooperative Highway Research Program. Synthesis of Highway Practice No.26, Washington, D.C., 1974, 104p., 207 refs.
Berg, R.L., Carey, K.L., Kaplar, C.W., National Research Council. Transportation Research Board.
29-3790
ROADS, FROST PENETRATION, PAVEMENTS, DESIGN CRITERIA, SEASONAL FREEZE THAW, ROAD MAINTENANCE.

**MP 798**
**BLUE ICE RUNWAY SITE SURVEY, PENSACOLA MOUNTAINS.**
Kovacs, A., et al, *Antarctic journal of the United States*, July-Aug. 1974, 9(4), p.175-177, 1 ref.
Abele, G.
29-1950
ICE RUNWAYS, AIRCRAFT LANDING AREAS, ICE DENSITY, ANTARCTICA—PENSACOLA MOUNTAINS.
Aerial reconnaissance of potential blue ice runway sites for heavy, wheeled aircraft revealed large blue ice areas east of Mt. Cross, west of Mt. Whillans, and at Mt. Bruns in the Patuxent Range, and to the north and the west of Rosser Ridge in the Cordiner Peaks. Topographic surveys were made of the blue ice surfaces north of Rosser Ridge and at the base of Mt. Lechner, and the data are presented. Considerations of the effects of elevation, temperature, grade, and wind indicate that the Rosser Ridge site is more suitable as a runway. Power spectral density analysis of the two sites' ice surfaces showed them to be similar to field runways.

**MP 799**
**BRINE INFILTRATION IN THE MCMURDO ICE SHELF, MCMURDO SOUND, ANTARCTICA.**
Kovacs, A., et al, *Journal of geophysical research*, May 20, 1975, 80(15), p.1957-1961, 13 refs.
Gow, A.J.
29-3788
ICE SHELVES, BRINES, FIRN, ANTARCTICA—MCMURDO SOUND.
In recent trials near Hut Point Peninsula an impulse radar profiler was used successfully to monitor the depth characteristics and lateral extent of brine soaking in the McMurdo Ice Shelf. The success of the profiler can be attributed in large part to the significant difference in dielectric properties of dry firn and firn that has become brine soaked by infiltrating seawater. In addition to furnishing a continuous trace of the top of the brine layer, the impulse radar profiler has also revealed the existence of cracks, relict brine horizons, and deformational features within the ice shelf. Data tend to favor lateral infiltration of seawater, either through the seaward edge of the ice shelf or via tensile cracks at the bottom of the ice shelf.

**MP 800**
**CREVASSE DETECTION USING AN IMPULSE RADAR SYSTEM.**
Kovacs, A., et al, *Antarctic journal of the United States,* July-Aug. 1974, 9(4), p.177-178.
Abele, G.
29-1951
CREVASSE DETECTION, RADAR ECHOES, ANTENNAS.
The design and operation of an impulse radar system for use as a crevasse detector are described. The system consists of a pulse transmitter, a transmit-receive switching section, a receiver, and a graphic recorder. The components are mounted inside a tracked vehicle and occupy about 1/2 cu m of space. The beam of the antenna is designed to be broadest in the forward and aft plane of the hull. The system appears to consistently detect crevasses or cracks at least 3 m ahead or to the side of the antenna and is therefore considered adequate for field party use. It is suggested, however, that the system be modified to include two antennas positioned 3 m apart and extended to distances at least 9 m in front of vehicles for better radar coverage of crevasses being approached at angles to travel routes.

**MP 801**
**SEA ICE MORPHOLOGY AND ICE AS A GEOLOGIC AGENT IN THE SOUTHERN BEAUFORT SEA.**
Kovacs, A., et al, Symposium on Beaufort Sea Coast and Shelf Research, San Francisco, Jan. 7-9, 1974. Proceedings, Arlington, Va., Arctic Institute of North America, 1974, p.113-164, Includes discussion by O.H. Löken. 80 refs.
Mellor, M., Löken, O.H.
30-342
SEA ICE, ICE CONDITIONS, BOTTOM TOPOGRAPHY, ICE SCOUR.
The paper gives a general account of ice conditions in the southern Beaufort Sea and makes a preliminary exploration of one of the important engineering problems created by ice over the continental shelf. Notes on the oceanic environment mention surface winds, currents, waves, temperature, salinity, bed relief, bottom sediments, and extent of ice cover. Three characteristic ice zones are defined (fast ice, seasonal pack ice, and polar pack ice), and for each zone the genesis, morphology, activity, and distribution of constituent ice types are discussed, with special reference to ice ridges and the configuration of pressured ice. The occurrence, movement, and size distribution of ice islands are considered, and ice scoring of bed sediments is described. The bed-scoring problem is examined. The authors conclude that most keels have ample strength for gouging, that necessary sustained forces can be developed by wind shear over reasonable areas, and that first-year ice can transmit the needed thrust to ice islands or pressure ridges. The momentum of isolated ice masses was determined to be insufficient to cause significant gouging.

**MP 802**
**INVESTIGATIONS OF ICE NUCLEATION PROCESSES.**
Kumai, M., Conference on Cloud Physics, Tucson, Arizona, Oct. 21-24, 1974. Preprint volume, Boston, American Meteorological Society, 1974, p.57-60, 20 refs.
29-1635
ICE NUCLEI, NUCLEATING AGENTS, CLAY MINERALS, ELECTRON MICROSCOPY.
The mechanism of ice nucleation on artificial nuclei was investigated. Dickite, a silicate mineral from San Juanito, was used as the seeding material in this experiment. The electron diffraction pattern of the dickite was a hexagonal net pattern, and the interplanar distance was determined to be a = 5.14 Å. The a-axis of the unit cell of ice crystal was found to be a = 4.52 Å. The misfit between ice and dickite was calculated to be 13.7% on the basal plane. The misfit calculated from the Moiré pattern period of 18.7 Å (Fernández - Morán, 1960) was also 13.7%.

**MP 803**
**USE OF SOOT FOR SNOW REMOVAL PURPOSES.**
Lang, W.A., Western Snow Conference, Sacramento, Calif., April 1952. Proceedings, [1952], p.29-37, 4 refs. Microform No. SIP 4774.
31-3136
SNOW REMOVAL, DUSTING, RADIATION ABSORPTION, SOLAR RADIATION, ROADS.
Eight test plots, 10 x 10 ft., covered with 10 in. of snow, were evenly spread with soot varying from 0-10 lb. per plot. Snow depth and and water content were measured with a sampler at the center of each plot before applying the soot and again 4 hr. later. The temperature ranged from 22-47 F during the experimental period. The greatest decrease in snow depth occurred in the plot covered with 1 lb. of soot. The rate of decrease in snow depth was almost twice as great on the sooted plots than on clear plots. No significant difference in the decrease of water content was found. Lampblack was applied experimentally on the Kaiser Pass road on March 30, 1951 at the rate of 10 lb./100 sq. ft. as a method of snow clearance in spring. The danger of spreading the soot too thickly and preventing melting is pointed out in the discussion.

**MP 804**
**ANTARCTIC ICE CORE STUDIES.**
Langway, C.C., Jr., *Antarctic journal of the United States,* July-Aug. 1975, 10(4), p.152-153.
30-1650
ICE SHELVES, ICE SHEETS, ICE CORES, ICE CORING DRILLS, FIRN, TEMPERATURE MEASUREMENT, ANTARCTICA—AMUNDSEN-SCOTT STATION, ANTARCTICA—ROSS ICE SHELF.
Observations of drilling operations conducted at Amundsen-Scott Station and at site J-9 on the Ross Ice Shelf using the U.S. Army Cold Regions Research and Engineering Laboratory's (CRREL) newly designed ice coring auger are reported. Core recovery was rapid with continuous core recovery at the South Pole to a depth of 100 m. Core recovery was less satisfactory at the RISP site. In addition to processing the two 100-m cores, surface pit investigations were carried out, including density measurements, temperature profiles, and stratigraphic observations, and bulk firn collections were made for chemical analyses. Additional studies to be made on the ice cores are summarized. The cores are in central storage and available for distribution for other research purposes.

**MP 805**
**CHEMICAL PROFILE OF THE ROSS ICE SHELF AT LITTLE AMERICA V, ANTARCTICA.**
Langway, C.C., Jr., et al, *Journal of glaciology,* 1974, 13(69), p.431-435, In English with French and German summaries. 15 refs.
Herron, M.M., Cragin, J.H.
29-2418
ICE SHELVES, ICE COMPOSITION, CHEMICAL COMPOSITION, ANTARCTICA—ROSS ICE SHELF.
Measurements of the cationic concentrations of Na, K, Mg, and Ca were made on 28 samples from the 255 m deep ice core from Little America V. All concentrations decrease sharply with depth from the firn-ice transition at 52 m to somewhere between 125 m and 150 m. From 150 m to 250 m the cationic concentrations are relatively constant. This is interpreted to indicate that the ice above 125 m fell as snow on the Ross Ice Shelf and the ice below 150 m originated inland on Marie Byrd Land. (Auth.)

**MP 806**
**ICE CORE STORAGE FACILITY.**
Langway, C.C., Jr., *Antarctic journal of the United States,* Nov.-Dec. 1974, 9(6), p.322-325, 2 refs.
29-2771
ICE CORES, COLD STORAGE.
The U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) has prime responsibility for storing and curating ice cores from U.S. arctic and antarctic research programs. CRREL handles, processes, catalogs, and distributes cores to qualified glaciologists the world over. Under an agreement with the National Science Foundation, the cores are stored at CRREL and at a nearby commercial facility at Littleton, N.H. A core data bank is maintained for information retrieval and exchange; starting with DYE 3 (Greenland) ice core, the information is being computerized. The storage facilities are illustrated and described. Recent developments in ice core research include a cooperative program utilizing analytical techniques and assets of three institutions, a core stratigraphy and logging routine, and a surface pit/ice correlation system. In addition, the Institute of Polar Studies is developing a particle analysis lab.

**MP 807**
**FUNDAMENTALS OF ARCTIC BLASTING.**
Livingston, C.W., *American Society of Civil Engineers. Construction Division. Journal,* Feb. 1960, 86(CO1), p.1-9, Microform No. SIP 18537.
31-3137
EXPLOSIVES, FROZEN GROUND, ICE BLASTING, DYNAMIC LOADS, EXPLOSION EFFECTS.
The results of experiments conducted by SIPRE since 1952 in shallow and deeply frozen ground (Houghton, Mich., and Fort Churchill, Can.), and snow and ice on the Greenland Icecap are discussed. The experiments included both military and commercial explosives in charges of various shapes ranging in weight from a few ounces to several tons, detonated below the surface and in the air. The behavior of materials subject to dynamic loading may be classified into the shock, shear, and viscous damping types, depending on the physical properties of the material and the geometric scale of the experiments. Shock type behavior is characteristic of brittle-acting solids and is a result of reflection of the shock wave from a free-face. Failure begins at the free-face and progresses in a series of stages back toward the explosion cavity by compaction and deformation. Viscous damping behavior is characteristic of porous and permeable solids and is due in part to the elastic behavior of the solid and in part to the air in the voids. Failure occurs in 2 phases: one resembles the shearing type failure of plastic-acting substances; the other resembles the elastic rebound of brittle-acting substances and is a result of reversal in direction of displacement after the top of the explosion cavity has failed in shear and the pressure in the medium exceeds that within the cavity. Blast effects are analyzed in relation to the weight of the explosive and to the stressed volume within which the event occurs.

**MP 808**
**NATURAL OIL SEEPS AT CAPE SIMPSON, ALASKA: LOCALIZED INFLUENCES ON TERRESTRIAL HABITAT.**
McCown, B.H., et al, Alaska Science Conference, 23, Fairbanks, 1972. Proceedings of the Symposium on the Impact of Oil Resource Development on Northern Plant Communities, University of Alaska, 1973, p.86-90, 6 refs.
Barsdate, R.J., Brown, J.
28-2319
SOIL POLLUTION, CRUDE OIL, MICROBIOLOGY, TUNDRA VEGETATION, PERMAFROST THERMAL PROPERTIES.
Natural oil seeps were studied in the vicinity of Cape Simpson on the Arctic Coastal Plain of Alaska. Inactive and active flows were observed and the resultant effects on the plant biota recorded. Plant communities invaded by such seeps showed alterations in community structure, but such changes were correlated with the thermal effects of the seeps on adjacent soil permafrost and active layer depth rather than with the presence of petroleum hydrocarbons in the soil. Adverse effect to terrestrial and emergent aquatic vegetation was limited and was apparent when fresh oil contacted the foliage. Revegetation of both active and inactive flows was apparent.

**MP 809**
**PLANT GERMINATION AND SEEDLING GROWTH AS AFFECTED BY THE PRESENCE OF CRUDE PETROLEUM.**
McCown, D.D., et al, Alaska Science Conference, 23, Fairbanks, 1972. Proceedings of the Symposium on the Impact of Oil Resource Development on Northern Plant Communities, University of Alaska, 1973, p.44-51, 9 refs.
Deneke, F.J.
28-2314
SOIL POLLUTION, ARCTIC VEGETATION, OIL SPILLS, GROWTH.
This research was designed to elucidate the effects of crude petroleum contaminated soils on seed germination and seedling growth. Experiments utilized both freshly oiled soils and crude contaminated soils that had been 'aged' for approximately 10 months. Test materials included native, introduced, herbaceous, woody, fibrous rooted and tap rooted species. Seed germination was species dependent, but all levels of fresh crude contamination tested depressed germination rates. The reduced germination probably resulted from a combination of several factors including toxicity (direct and indirect) and interference of the normal seed-water relationship. The effect of ageing the contaminated soils was a general increase in germination, which was most marked with the graminoid species. Seedling growth and development was also adversely affected by crude contamination.

**MP 810**
**INFLUENCE OF SOIL TEMPERATURE ON PLANT GROWTH AND SURVIVAL IN ALASKA.**
McCown, B.H., Alaska Science Conference, 23, Fairbanks, 1972. Proceedings of the Symposium on the Impact of Oil Resource Development on Northern Plant Communities, University of Alaska, 1973, p.12-33, 7 refs.
28-2312
SOIL TEMPERATURE, HOT OIL LINES, TUNDRA VEGETATION, VEGETATION FACTORS, GROWTH, PERMAFROST MASS TRANSFER.

**MP 811**
**EFFECTS OF AIR CUSHION VEHICLE OPERATIONS ON ORGANIC TERRAINS.**
Abele, G., American Society of Agricultural Engineers. Paper No. 73-135, St. Joseph, Mich., 1973, 15p. + 16p. appends., Presented at the American Society of Agricultural Engineers, Annual Meeting, June 17-20, 1973, Lexington, Kentucky. 3 refs.
31-1294
AIR CUSHION VEHICLES, TUNDRA VEGETATION, MUSKEG, DAMAGE.

**MP 812**
**GLACIOLOGY AT MELBOURNE UNIVERSITY, AUSTRALIA.**
Mellor, M., *Glaciological notes,* Jan. 1963, No.13, p.38-40, Microform No. SIP 21393.
31-3138
GLACIOLOGY, METEOROLOGY, RESEARCH PROJECTS, AUSTRALIA.
The Meteorology Department is permently engaged in glaciological research and polar meteorology. The department has been involved in the Antarctic studies of the Australian National Antarctic Research Expeditions since 1947, and has collaborated with Expéditions Polaires Françaises since 1950. Snow studies have been made in the Australian mountains since 1956. Under its new head, Dr. Radok, the department has gradually assumed full responsibility for the Australian glaciological program in Antarctica including the training of personnel and is also currently conducting research sponsored by the U.S Weather Bureau and the National Science Foundation.

**MP 813**
**MINIMIZING DEICING CHEMICAL USE.**
Minsk, L.D., National Research Council. Transportation Research Board. National Cooperative Highway Research Program. Synthesis of Highway Practice, No.24, Washington, D.C., 1974, 58p., 84 refs.
31-1896
DEICERS, CHEMICAL ICE PREVENTION, ICE CONTROL, ROADS, WINTER MAINTENANCE, SALTING.

**MP 814**
**DISLOCATION GENERATION RATE DURING SHOCK LOADING.**
Parameswaran, V.R., *Scripta metallurgica,* 1975, Vol.9, p.31-34, 4 refs.
31-1293
DISLOCATIONS (MATERIALS), SOUND WAVES, VELOCITY.

**MP 815**
**SERRATED YIELDING IN ICE SINGLE CRYSTALS.**
Parameswaran, V.R., *Scripta metallurgica,* 1975, Vol.9, p.931-934, 26 refs.
30-2134
ICE CRYSTALS, UNSTEADY FLOW, LOW TEMPERATURE TESTS.
Serrated yielding or discontinuous flow, known also as the Portevin-Le Chatelier effect, has been observed in many metallic alloys. The phenomenon has been attributed to dynamic strain aging. A cloud of impurity atoms, commonly known as'-'Cottrell atmosphere", associated with slowly moving dislocations cause the jerky flow in many metals and alloys. Repeated propagation of Lüder bands has also been associated with such jerky flow in some materials. In this paper some observations are reported on the serrated yielding or jerky flow observed in ice single crystals deformed by uniaxial compression at 263K.

**MP 816**
**HEAT FLUX DISTRIBUTION NEAR A CREVASSE.**
Pings, C.J., *Journal of glaciology,* Feb. 1963, 4(34), p.461-465, 6 refs. Microform No. SIP 20854.
31-3139
ICE THERMAL PROPERTIES, THERMAL CONDUCTIVITY, ICE HEAT FLUX, CREVASSES.
Previously reported experimental temperature data were used to compute the two components of the heat flux vector in the ice body adjacent to a crevasse in a glacier of the ice sheet of N. Greenland. Graphical differentiation techniques were employed. The computed components were used to synthesize values of the heat flux vector, including magnitude and direction. Improved accuracy was achieved over the previously reported technique of sketching heat flow lines orthogonal to the isotherms. (Auth.)

**MP 817**
**100-METER ICE CORES FROM THE SOUTH POLE AND THE ROSS ICE SHELF.**
Rand, J.H., *Antarctic journal of the United States,* July-Aug. 1975, 10(4), p.150-151.
30-1649
ICE SHELVES, ICE CORING DRILLS, FIRN, TEMPERATURE MEASUREMENT, ICE CORES, ANTARCTICA—ROSS ICE SHELF, ANTARCTICA—SOUTH POLE.
Drilling operations were successfully carried out to depths of 100 m at the South Pole and at site J-9 on the Ross Ice Shelf with continuous core being obtained using the U.S. Army Cold Regions Research and Engineering Laboratory's (CRREL) shallow drill. The electromechanical drill and drilling operations at the two sites are briefly described. The drill weighs 65 kg and is designed for continuous core drilling in firn and ice to a depth of 100 m. The drill bores a 14-cm-diam hole while obtaining a 10-cm-diam core at a penetration rate up to 1 m/min in -20C ice. A graph of the temperatures recorded in the 100-m hole is presented.

**MP 818**
**FLOW STRESS-GRAIN SIZE RELATIONSHIP IN ALUMINUM.**
Shiroor, V.S., et al, *Scripta metallurgica,* 1975, Vol.9, p.671-673, 7 refs.
Kulkarni, A.G., Prasad Rao, P., Parameswaran, V.R.
31-1292
ALUMINUM, PLASTIC FLOW, STRESSES, STRAINS.

**MP 819**
**SUMMARY OF SOIL PROPERTIES OF SUFFIELD SILTY CLAY, DROWNING FORD RANGE, SUFFIELD EXPERIMENTAL STATION (S.E.S.), RALSTON, ALBERTA, CANADA.**
Smith, N., Hanover, New Hampshire, U.S. Army Cold Regions Research and Engineering Laboratory, 1966, 5p., 9 refs. Manuscript of paper for presentation at Operation DISTANT PLAIN Symposium at Headquarters, Field Command, DASA, Albuquerque, New Mexico, 24-26 January 1967.
31-710
FROZEN GROUND, SOIL STRENGTH, CLAY SOILS, SOIL ANALYSIS, SOIL MOISTURE, SOIL PHYSICS, SOIL COMPACTING, SOIL TEMPERATURE, CANADA—ALBERTA—RALSTON.

**MP 820**
**SUGGESTED METHOD OF TEST FOR SOME VISCO-ELASTIC PROPERTIES OF MATERIALS, ESPECIALLY FROZEN AND NON-FROZEN SOILS, UNDER VIBRATORY LOADS.**
Stevens, H.W., American Society for Testing and Materials. Special procedures for testing soil and rock for engineering purposes. 5th ed, Philadelphia, 1970, p.530-546, ASTM special technical bulletin 479.
33-438
FROZEN GROUND MECHANICS, SOIL MECHANICS, VISCOELASTICITY, VISCOELASTIC MATERIALS, LOADS (FORCES), VIBRATION, TESTS.

**MP 821**
**FROST PENETRATION MEASUREMENTS AT THE USAF INTRUSION SENSOR SITE, GRIFFISS AIR FORCE BASE, NEW YORK, 1973-74.**
Tobiasson, W., et al, *U.S. Air Force Rome Air Development Center. Final technical report,* May 1975, RADC-TR-75-13, Vol.2, 74p., 3 refs.
Atkins, R.T.
31-1992
FROST PENETRATION, SNOW DEPTH, MEASURING INSTRUMENTS, SNOW COVER EFFECT.

**MP 822**
**EXPERIENCE WITH CENTRAL HEAT DISTRIBUTION SYSTEMS IN COLD REGIONS.**
Tobiasson, W., *U.S. National Bureau of Standards. Building science series,* [1975], No. 66, p.122-127 + figs., 5 refs.
30-128
UTILITIES, UNDERGROUND FACILITIES, GROUND THAWING, PERMAFROST PRESERVATION.
Design and performance data are presented in this paper for several central heat distribution systems in Alaska, Canada, Greenland and Siberia. Buried, on-grade and elevated central heat distribution systems have been built in the cold regions of the northern hemisphere. Heating lines are frequently routed along with water lines, sewers and other utilities in conduits known as utilidors. In areas where the ground is permanently frozen, systems are generally designed to prevent thaw and subsidence of the supporting soil as well as prevent freezing of liquids in the lines. One approach is to support the utilidor on piles. Such utilidors are often elevated several feet above the surface to minimize snow drifting problems. They can, however, be obstructions to the movement of individuals and vehicles in a community and when subjected to differential heave and settlement have developed gaps through which cold air infiltrated and caused freezeups. The bulb of thaw created around a buried conduit containing warm utilities can be a collecting point for ground water, especially in the spring. Flooding can result unless the conduit is watertight or provisions are made to redirect the ground water. Many large buried utilidors in Siberia are ventilated in the winter to annually refreeze the surrounding soil. Provisions for winter maintenance are important features of all central heat distribution systems in cold regions.

**MP 823**
**STILL NORTH IN MY HEART.**
Tobiasson, W., *The year (Dartmouth College, Hanover, N.H.),* Oct. 1974, 2(1), 4p., Based on ME thesis.
30-1169
UNDERSNOW FACILITIES, SNOW LOADS, PASSIVE ARCHING.

**MP 824**
**SEA ICE: SCALES, PROBLEMS AND REQUIREMENTS.**
Weeks, W.F., et al, Interdisciplinary Symposium on Advanced Concepts and Techniques in the Study of Snow and Ice Resources, Monterey, Calif., 1973, Washington, D.C., National Academy of Sciences, 1974, p.255-267, AD-787 130, 21 refs.
Hibler, W.D., III, Ackley, S.F.
29-2514
SEA ICE, RESEARCH PROJECTS, MEASURING INSTRUMENTS.
Sea ice can be examined on a variety of spatial scales that range over 10 orders of magnitude. The smallest scale, the microscale, is distinguished from other scales by the great importance of changes in the growth conditions on the structure of the resulting ice and the controlling effect of these structural variations on its small scale (< 10 m) property variation. The greatest need is for compact instrumentation that is capable of rapidly specifying, by non-destructive methods, the internal state of the sea ice. When observations on the mesoscale (100 m - 50 km) are considered, the micro-structural properties of the ice rapidly become of less importance as the scale length increases, being replaced by effects produced by ensembles of ice features such as floes, leads and pressure ridges. Instrumentation to accomplish most aspects of mesoscale experimentation is both expensive and relatively untested under Arctic conditions. The mesoscale is also the natural scale for the utilization of remote sensing systems operated from aircraft. However, for the results of such remote sensing flights to be useful techniques are needed for rapidly analyzing and distributing the data. The most important equipment development problem as related to mesoscale studies is the present lack of an instrument that remotely measures ice thickness. On the macroscale (< 100 km), most information would have to be provided by satellite based remote sensing systems coupled with arrays of data buoys sited in the ice. The problems with the satellite based remote sensing data are, as in the mesoscale, primarily related to difficulties in rapid analysis of the images in a format that can be used in current numerical efforts.

**MP 825**
**COMPRESSED AIR FOR SUPERCOOLED FOG DISPERSAL.**
Weinstein, A.I., et al, *U.S. Air Force Cambridge Research Laboratories. Technical report,* Oct. 22, 1975, AFCRL-TR-75-0561, U.S. Air Force. Cambridge Research Laboratories. Air Force surveys in geophysics no.329, 32p., 13 refs.
Hicks, J.R.
31-1494
SUPERCOOLED FOG, FOG DISPERSAL, WEATHER MODIFICATION, ICE CRYSTAL FORMATION, COMPRESSED AIR.
Series of controlled and free environment tests were conducted to determine the technical feasibility of using the cooling resulting from the adiabatic expansion of compressed air to initiate ice crystal production in a supercooled fog. It was found that approximately 1000 cc of air, when compresed to 60 psig and released through a supersonic nozzle, will produce the same number of ice crystals as does the evaporation of 1 cc of liquid propane.

**MP 826**
**FURTHER ANALYSIS OF THE HEAT TRANSFER CHARACTERISTICS OF A BUBBLE-INDUCED WATER JET IMPINGING ON AN ICE SURFACE.**
Yen, Y.-C., *Letters in heat and mass transfer,* July-Aug. 1975, 2(4), p.347-357, 4 refs.
30-2142
ICE COVER, BUBBLING, HEAT TRANSFER, ANALYSIS (MATHEMATICS).

**MP 827**
**HEAT-TRANSFER CHARACTERISTICS OF A BUBBLE-INDUCED WATER JET IMPINGING ON AN ICE SURFACE.**
Yen, Y.-C., *International journal of heat and mass transfer,* 1975, Vol.18, p.917-926, In English with French, German and Russian summaries. 12 refs.
31-1948
HEAT TRANSFER COEFFICIENT, ICE SURFACE, BUBBLING, HYDRAULIC JETS, ANALYSIS (MATHEMATICS).

**MP 828**
**ISOTHERMAL FLOW OF AIR THROUGH SNOW OF VARIABLE PERMEABILITY.**
Yen, Y.-C., et al, *International Association of Scientific Hydrology. Publication,* 1963, No.61, 15p., 5 refs. Microform No. SIP 21887. For another version see 24-3292, RR 143.
Bender, J.A.
31-3140
SNOW THERMAL PROPERTIES, THERMAL CONDUCTIVITY, SNOW HEAT FLUX, SNOW AIR INTERFACE, SNOW PERMEABILITY, ANALYSIS (MATHEMATICS).
A fan was used to create a lower than atmospheric pressure at the surface of a trench wall, causing a circulation of air through the snow pack. The top of the wall was covered to make the warm air pass as deeply into the snow as possible before being drawn into the trench. Assumptions made in the formulation of the mixed boundary problem are: (1) the trench is of sufficient length so that the end effect becomes insignificant; (2) the flow is steady and isothermal; (3) D'Arcy's law is valid; (4) at a given depth, the air permeability of the snow is zero; (5) flow is symmetrical with respect to the y-axis; (6) the permeability of snow is only a function of depth. Equations are given which (1) describe the problem, (2) consider boundary conditons, air density, and snow permeability and (3) can be solved by a numerical method, asymptotic solutions, and Rayleigh's estimate method. The expression for pressure distribution is given as a function of position, and the total air flow rate is obtained

in terms of operating variables. An illustrative example based on actual permeability data is given to explain the procedures. (Auth.)

**MP 829**
**APPLICATION OF SIMILITUDE TO SOIL-MACHINE SYSTEMS.**
Wismer, R.D., et al, St. Joseph, Michigan, American Society of Agricultural Engineers, 1975, 37p., Prepared for presentation at the Sixth Seminar on the Similitude of Soil Machine Systems, Feb. 4-5, 1975, USDA National Tillage Machinery Laboratory. 28 refs.
Freitag, D.R., Schafer, R.L.
30-96
ALL TERRAIN VEHICLES, TIRES, TRACTION, EARTH HANDLING EQUIPMENT, SOIL STRUCTURE, MODELS.

**MP 830**
**GROWTH CHARACTERISTICS OF ICE ON A TEMPERATE LAKE.**
Gow, A.J., Symposium on Snow and Ice Crystals, Aug. 25-Sep. 6, 1975. Abstracts. IUGG, 16th General Assembly, Grenoble, France. 1975, p.139.
79-111
LAKE ICE, ICE GROWTH.

**MP 831**
**CHARACTERIZATION OF COLD-REGIONS TERRAIN USING AIRBORNE LASER PROFILOMETRY.**
Hibler, W.D., III, *Journal of glaciology,* 1975, 15(73), Symposium on Remote Sensing in Glaciology, Cambridge, 16-20 September, 1974, p.329-347, 25 refs.
30-2347
AERIAL SURVEYS, LASERS, PROFILES, SEA ICE, PRESSURE RIDGES, ICE STRUCTURE.
This paper provides a review of the characteristics of airborne laser profilometry and its application to quantative characterization of cold-regions terrain. The limitations of profilometry due to the profiler instrumental characteristics and instability of the aircraft platform (resulting from variations in aircraft altitude and attitude) are discussed. For typical aircraft speeds of the order of 100 m/s these limitations restrict the accurately measured roughness content to the approximate wavelength range 2 m to 300 m. Digital filtering and hardware techniques for removing the aircraft motion, and hence extending the long wavelength validity of the profile, are discussed. Regarding terrain characterization, particular attention is given to Arctic sea ice. Ridge height and spacing distribution models for sea ice in conjunction with digitally processed laser profiles allow efficient characterization of sea-ice ridging using only a few parameters. In particular, a single ridging intensity parameter has been found to allow reasonable estimation of the number of ridges encountered at any height level along a straight-line path. Examination of spectral characteristics of first-year and multi-year ice suggest that laser profiles may be used to identify the ice type of floes and ridges. Comparisons of laser data and submarine sonar data are made which suggest that ratios of c.6.5:1 can be used to estimate ridge keel depths from laser data. Use of laser profilometry to characterize tundra and indirectly to measure variation in snow depth is briefly discussed.

**MP 832**
**GROUND AND AIRBORNE RESISTIVITY SURVEYS OF PERMAFROST NEAR FAIRBANKS, ALASKA.**
Hoekstra, P., et al, *Geophysics,* Aug. 1975, 40(4), p.641-656, 28 refs.
Sellmann, P.V., Delaney, A.J.
30-1291
DISCONTINUOUS PERMAFROST, PERMAFROST INDICATORS, ELECTRICAL RESISTIVITY, AERIAL SURVEYS, MAPPING.
In the vicinity of Fairbanks, Alaska, where the permafrost is discontinuous, ground and airborne methods of mapping electrical resistivity using radiowaves were tested as means of delineating permafrost. When the resistivity maps are compared with surficial geological data, the following conclusions are reached: (1) In areas of fine-grained sediments, where the near surface sediments are relatively uniform, VLF resistivity delineates permafrost. (2) In areas where surface sediments vary widely (flood plains), VLF resistivity shows little information on permafrost conditions but can provide other important geotechnical information, such as, depth to bedrock, surface soil type, and layering. Comparison of the apparent resistivity derived from a surface impedance measurement at VLF on the ground with the apparent resistivity derived from an airborne measurement of wave-tilt shows that the regional trends in the data agree, but the surface impedance measurements show much more local detail in ground conditions. When the surface layers are also frozen, the surface impedance method of measuring ground resistivity was found to have distinct advantages over conventional galvanic methods in terms of production and problems associated with probe contact resistance.

**MP 833**
**MEASUREMENTS OF INDEX OF REFRACTION AND SIGNAL LOSS DUE TO AN ICE FOG MEDIUM AT 97 GHZ USING A FABRY-PEROT RESONATOR.**
Straiton, A.W., et al, *IEEE transaction on antennas and propagation,* July 1974, AP-22(4), p.613-616, 21 refs.
Fannin, B.M., Perry, J.W.
30-2777
ICE FOG, RADIO WAVES.

**MP 834**
**REACTION OF NITROGEN DIOXIDE WITH LINEAR POLYURETHANE.**
Jellinek, H.H.G., et al, *Journal of polymer science,* Dec. 1973, 11(12), p.3227-3242, 15 refs.
Wang, T.J.Y.
31-3031
POLYMERS, CHEMICAL REACTIONS, TEMPERATURE EFFECTS, PRESSURE, DIFFUSION, EXPERIMENTATION.
Linear polyurethane has been exposed to nitrogen dioxide over a temperature range from 15 to 60C at pressures of 20 and 2 mm Hg, respectively. Normal random-chain scission of urethane links takes place accompanied by a limited amount of random cross-linking. These crosslinks are eventually irreversibly scissioned again. At the same time, carbon dioxide is evolved, and the infrared spectra of the polymer films change during exposure, indicating disappearance of urethane linkages and formation and decay of nitro and nitroso groups along the polymer backbone. The overall reaction is diffusion-controlled at least down to a film thickness of 10 microns. All energies of activation of the various processes are relatively small as expected for a diffusion controlled process. Tentative mechanisms have been proposed agreeing well with experimental results.

**MP 835**
**EXPERIMENTAL EVALUATION OF BUBBLE-INDUCED HEAT TRANSFER COEFFICIENTS.**
Ashton, G.D., International Symposium on Ice Problems, 3rd, Hanover, New Hampshire, 18-21 August 1975. Proceedings, International Association of Hydraulic Research, 1975, p.133-142, Includes discussion. 3 refs.
30-2719
BUBBLING, HEAT TRANSFER, ICE PREVENTION, COEFFICIENTS, ANALYSIS (MATHEMATICS).
The results of laboratory experiments to evaluate the heat transfer coefficients associated with flow induced by a line source bubbler system are discussed. The heat transfer coefficients, both in the impingement area and laterally outward from the axis of the impingement region, were evaluated by observation of melting rates induced at the underside of an ice cover formed in a large cold room. The experimental results are compared and interpreted in light of an analytical model previously developed. Implications for field applications of bubbler systems are discussed.

**MP 836**
**PROBLEMS IN ICE ENGINEERING.**
Assur, A., International Symposium on Ice Problems, 3rd, Hanover, New Hampshire, 18-21 August 1975. Proceedings, International Association of Hydraulic Research, 1975, p.361-372, 6 refs.
30-2740
ICE BREAKING, SHIPS, OFFSHORE STRUCTURES, ICE PRESSURE, METAL ICE FRICTION, ICE PILLOWS.
The design of large structures in ice infested water such as piers, off-shore terminals and platforms is subject to considerable uncertainties due to lack of suitable data and experience. However, observations on ships provide clues for some of the most serious problems to be solved. This paper discusses the effect of friction, adfreezing, side pressure and forces on random ice agglomerations. Horizontal ice pressure can stop ships, so can "ice pillows" under moderate ice conditions.

**MP 837**
**SNOW AND ICE CONDITIONS AND WINTER TEMPERATURES IN THE EAST KOOTENAI BASIN, BRITISH COLUMBIA, CANADA.**
Bilello, M.A., Canadian Association of Geographers, Annual Meeting 1976, Université Laval, May 23-27, 1976, Proceedings. 1976, p.10-14.
31-1899
SNOWFALL, SNOW DEPTH, ICE CONDITIONS, AIR TEMPERATURE, WINTER, FLOOD CONTROL, CANADA—BRITISH COLUMBIA—KOOTENAI RIVER.

**MP 838**
**U.S. TUNDRA BIOME SEMINAR/SYMPOSIUM.**
Brown, J., *Arctic bulletin,* 1975, 2(7), p.22-23.
30-2518
MEETINGS, TUNDRA BIOME.

**MP 839**
**ARCHING OF FRAGMENTED ICE COVERS.**
Calkins, D.J., et al, *Canadian journal of civil engineering,* Dec. 1975, 2(4), p.392-399, In English with French summary. 2 refs. For another version see 29-4015.
Ashton, G.D.
31-3839
ICE BOOMS, FLOATING ICE, ICE CROSSINGS, ICE NAVIGATION, ICE FLOES, BRIDGING, EXPERIMENTATION.
Among the problems associated with the extension of the winter navigation season on the Great Lakes and the St. Lawrence River, the obstruction of navigation posed by a continuous ice boom across a water body may possibly be solved by creating a gap or opening in the boom, through which vessels may pass, but which will promote retention of floating ice pieces by arching. A laboratory study of arching by fragmented ice floes across a gap in a surface obstacle was conducted in a 0.9 m wide hydraulic flume using simulated ice floes. Polyethylene blocks, 37 mm and 74 mm square by 6.4 mm thick, were used in both single-sized runs and combination-sized runs. The simulated ice was released upstream at a controlled rate and the occurrence or nonoccurrence of a stable arch was observed and recorded by time-lapse photography. In a corollary series of experiments an arch, once formed, was subjected to a disturbance simulating the passage of a vessel through the ice field. The area of ice floes released as a result of the disturbance before arching reoccurred was found to be, on average, equivalent to the square of the gap width. (Auth. mod.)

**MP 840**
**COST COMPARISONS FOR LOCK WALL DEICING.**
Calkins, D.J., et al, International Symposium on Ice Problems, 3rd, Hanover, New Hampshire, 18-21 August 1975. Proceedings, International Association of Hydraulic Research, 1975, p.59-67, Includes discussion. 1 ref.
Mellor, M.
30-2713
ICE REMOVAL, CHEMICAL ICE PREVENTION, ICE CUTTING, ELECTRIC HEATING, COST ANALYSIS, LOCKS (WATERWAYS).
Lock wall icing conditions on the Great Lakes and St. Lawrence Seaway are described, and possible solutions are listed. Operating assumptions are laid down as a basis for consistent cost estimates, and selected deicing methods are considered, using figures condensed from a more detailed report. The estimates cover wall heating by embedded electrical cables and embedded fluid circulation systems, repetitive surface coating with salt solutions, deicing with an inflatable boot, scraping with backhoes, cutting with large chain saws, and slicing with high pressure water jets.

**MP 841**
**GEOPHYSICAL STUDIES OF FLOATING ICE BY REMOTE SENSING.**
Campbell, W.J., et al, *Journal of glaciology,* 1975, 15(73), Symposium on Remote Sensing in Glaciology, Cambridge, 16-20 September, 1974, p.305-328, 54 refs., In English with French and German summaries. Includes discussion.
Weeks, W.F., Ramseier, R.O., Gloersen, P.
30-2346
REMOTE SENSING, FLOATING ICE, SPACECRAFT, RESEARCH PROJECTS.
This paper presents an overview of recent remote-sensing techniques as applied to geophysical studies of floating ice. The current increase in scientific interest in floating ice has occurred during a time of rapid evolution of both remote-sensing platforms and sensors. Mesoscale and macroscale studies of floating ice are discussed under three sensor categories: visual, passive microwave, and active microwave. The specific studies that are reviewed primarily investigate ice drift and deformation, and ice type and ice roughness identification and distribution.

**MP 842**
**SKYLAB FLOATING ICE EXPERIMENT FINAL REPORT.**
Campbell, W.J., et al, *U.S. National Aeronautics and Space Administration. Contractor report,* Dec. 1975, NASA-CR-147446, 67p., N76-18682.
Ramseier, R.O., Weaver, R.J., Weeks, W.F.
30-3875
FLOATING ICE, SEA ICE, LAKE ICE, INFRARED PHOTOGRAPHY, RADAR ECHOES.
Coupling of the aircraft data with the ground truth observations proved to be highly successful with interesting results being obtained with IR and SLAR passive microwave techniques, and standard photography. Of particular interest were the results of the PMIS system which operated at 10.69 GHz with both vertical and horizontal polarizations. This was the first time that dual polarized images were obtained from floating ice. In both sea and lake ice, it was possible to distinguish a wide variety of thin ice types because of their large differences in brightness temperatures. It was found that the higher brightness temperature was invariably obtained in the vertically polarized mode, and as the age of the ice increases the brightness temperature increases in both polarizations. Associated with this change in age, the difference in temperature was observed

as the different polarizations decreased. It appears that the horizontally polarized data is the most sensitive to variations in ice type for both fresh water and sea ice. The study also showed the great amount of information on ice surface roughness and deformation patterns that can be obtained from x-band SLAR observations.

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**FROST HEAVE**



**FROST PENETRATION**