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Volume 2
(Maps)

TERRAIN STUDY OF THE ARMY TEST AREA, FORT GREELY, ALASKA

A contribution to Project 8-97-10-004
Military Evaluation of Geographic Areas

Prepared for:
Waterways Experiment Station
Corps of Engineers, U. S. Army
Vicksburg, Mississippi

By:
G. William Holmes and William S. Benninghoff,
Military Geology Branch
U. S. Geological Survey
Washington, D. C.

Based on field investigations by:
G. William Holmes, Daniel Sokol, and William S. Benninghoff,
Military Geology Branch, U. S. Geological Survey
Troy L. Péwé and Russell A. Paige, Alaskan Geology Branch,
U. S. Geological Survey

1957

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TERRAIN STUDY OF THE ARMY TEST AREA, FORT GREELY, ALASKA

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I-B	Physiographic Provinces of Interior Alaska and Index to Maps of Fort Greely and Vicinity
I-C	Index Map, Fort Greely Area, Alaska
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U. S. Geological Survey

1957

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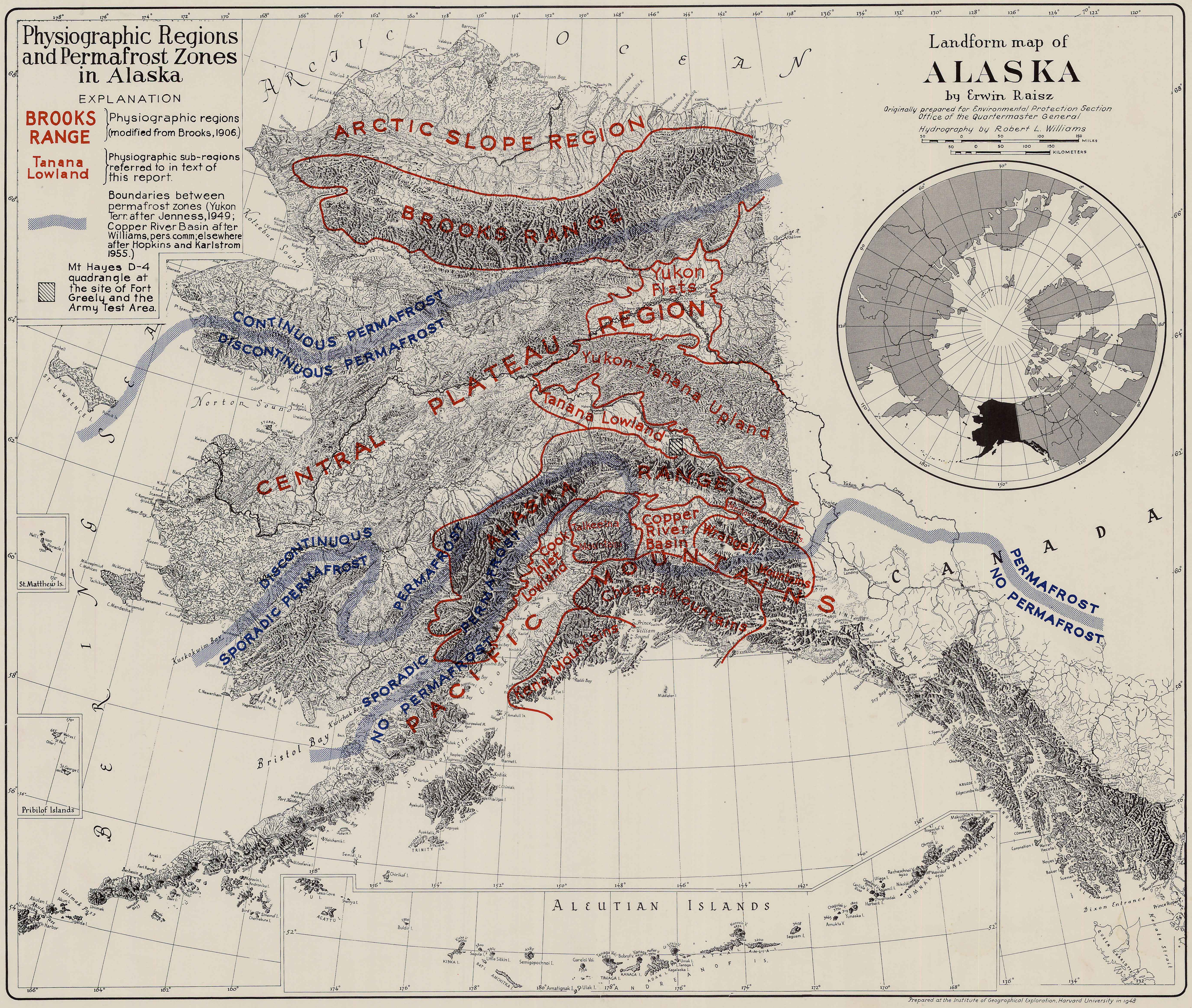
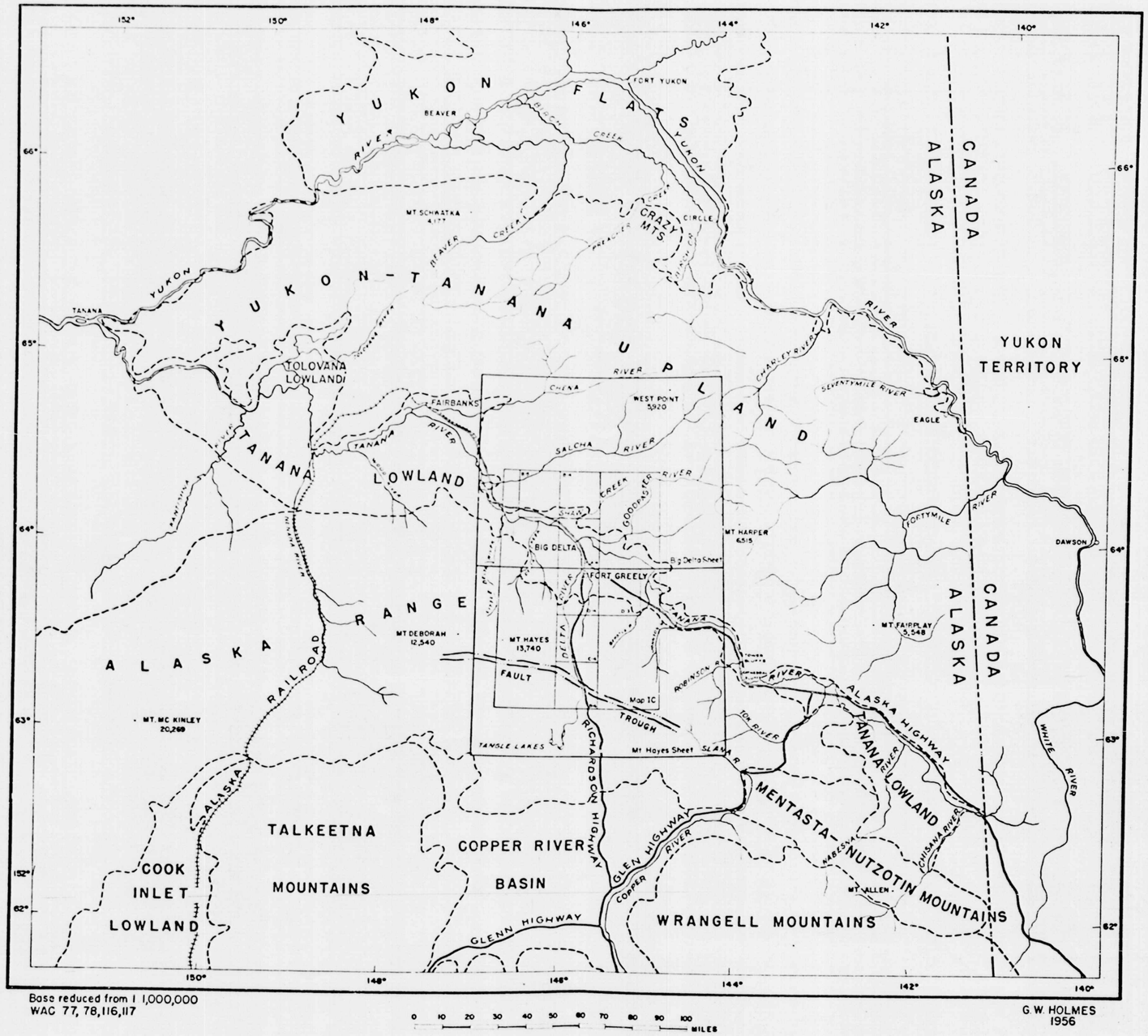
Terrain Study of the Army Test Area, Fort Greely, Alaska
Map 1-A



Prepared at the Institute of Geographical Exploration, Harvard University in 1948

U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

TERRAIN STUDY OF ARMY TEST AREA,
FORT GREELY, ALASKA
MAP I-B



Base reduced from 1 1,000,000
WAC 77, 78, 116, 117

G.W. HOLMES
1956

PHYSIOGRAPHIC PROVINCES OF INTERIOR ALASKA
AND INDEX TO MAPS OF FORT GREELY AND VICINITY

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain Study of Army Test Area,
Fort Greely, Alaska
Map I-C

Base map reduced from AMS Q501 1:250,000 series
Big Delta (NQ 5, 6-16) and Mt. Hayes (NP5, 6-4)

G.W. Holmes

INDEX MAP
FORT GREELY AREA, ALASKA
Quadrangle boundaries shown in purple

5 0 5 10 15 20 25 Statute Miles
5 0 5 10 15 20 25 30 35 40 Kilometers
5 0 5 10 15 Nautical Miles

CONTOUR INTERVAL 200 FEET
AREAS NOT SURVEYED IN DETAIL ARE INDICATED BY BROKEN LINES
TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: 1927 NORTH AMERICAN DATUM
BLACK NUMBERED LINES INDICATE THE 10,000 METER UNIVERSAL TRANSVERSE MERCATOR GRID, ZONE 6
THE LAST FOUR DIGITS OF THE GRID NUMBERS ARE OMITTED

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Tarrain Study of the Army Test Area
Fort Greely, Alaska
Map 1-D

PRINCIPAL SOURCES

Brookman-Jerosch, H., (1932?), Vegetation der Erde, 1:20,000,000 Justes Perthes, Gotha.

Sochava, V. B., 1954, Geobotanical map of the USSR (in Russian): Prioda vol. 10, p. 36-42.

Canada, Dept of Resources and Development, 1950, Native trees of Canda Forestry Branch Bull. 61, 4th ed., 293 p., illus., map.

Sigafoos, R.S., (in press), Vegetation of northwestern North America U.S. Geol. Survey Bull. 1061.

BOREAL VEGETATION

- 1 Vegetation absent; perennial snow and ice
- 2 Tundra; predominantly rock desert type
- 3 Tundra; predominantly sedge sod, tussock, and small shrub types of lowland habitats
- 4 Tundra; predominantly shrub--moss and rock desert types of mountain habitats
- 5 Boreal forest; evergreen, mixed, deciduous forest types and inclusions of shrub, meadow, bog, and marsh types
- Approximate southern limit of continuous boreal forest (i.e. the northern belt of coniferous forest, in which species of spruce, fir, pine, or larch and birch or poplar are dominant)

NOTE: These map units are based on growth forms of conspicuous elements in the vegetation and gross appearance of vegetation in regional landscapes. Species composition is not considered in this scheme.

Base redrawn from National Geographic magazine map, "The Top of the World", 1:14,000,000, Washington, 1949; copyright 1949 by the National Geographic Society.

Vegetation by W.S. Benninghoff 1956.

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain Study of the Army Test Area
Fort Greely, Alaska
Map I-E

VEGETATION OF ALASKA AND ADJACENT CANADA

MAP UNIT	EXPLANATION
1	Vegetation absent, bare rock, or perennial snow and ice
(2)	[Tundra; predominantly rock desert type] Does not occur in Alaska and adjacent Canada except as its alpine counterpart, which is included in map unit 3. Compare with Map I-D
3	Tundra; predominantly sedge sod, tussock, and small shrub types, mostly in lowland habitats
4	Tundra; predominantly shrub-moss and rock desert types, mostly in mountain habitats
5	Boreal forest, predominantly white spruce (evergreen) and white birch (deciduous) types or mixtures with black spruce, aspen, balsam poplar, or larch (including lodgepole pine and Engelmann spruce in southeasternmost part of unit) and with inclusions of shrub, meadow, bog and marsh types
6	Pacific coast forest, predominantly Sitka spruce and hemlock (evergreen) types, with pine, fir, and Alaska white cedar in southeastern part and local inclusions of shrub and bog types
	Mt. Hayes D-4 quadrangle in area of terrain study

NOTE: These map units are based on growth forms of conspicuous elements in the vegetation and gross appearance of vegetation in regional landscapes. Species composition is considered only in regard to the major trees that distinguish unit 5 from unit 6

SOURCES

Forest boundaries generalized from Sigafoos, R. S., Vegetation of Northwestern North America: U.S. Geological Survey Bull. 1061 (in press).

Tundra boundaries in northern Alaska from Lloyd A. Spetzman, personal communication.

Non-forest areas mapped by W.S. Benninghoff.

50 0 50 100 150 Miles

ARCTIC OCEAN

BERING SEA

PACIFIC OCEAN

ALEUTIAN ISLANDS

Base map redrawn and reduced from
Geological Survey Alaska Map E, 1:2,500,000, 1954

W.S. Benninghoff 1956

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain study of the Army Test Area
Fort Greely, Alaska
Map III-A

MAJOR LANDFORMS OF THE MT. HAYES D-4 QUADRANGLE

G.W. Holmes, 1956

SCALE 1:63360

1/2 0 1 2 3 4 MILES

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain study of the Army Test Area
Fort Greely, Alaska
Map III-B

146°00′ 64°15′ 50′ (BIG DELTA B-4) 40′ 145°30′ 64°15′

ALLUVIUM-FILLED LOWLAND
BANANA CREEK FLATS
ALLUVIUM-FILLED LOWLAND
BEDROCK HILLS
Quartz Lake
Cabin
Lost Lake
ALLUVIUM-FILLED LOWLAND
Indian Creek
Thompson Lake
Cabin
Progressive Creek
ALLUVIUM-FILLED LOWLAND
BEDROCK HILLS
FLOOD PLAIN
TANANA RIVER
RICHARDSON HIGHWAY
Mile 280
BEDROCK HILLS
Cabin
Jollys Cabin
ALLUVIUM-FILLED LOWLAND
GOODPASTER RIVER
Bert & Marys Roadhouse
Cabin
Big Delta
Airstrip
Post Office
BEDROCK HILL
Fourmile Hill
BEDROCK HILLS
Cabin
TANANA RIVER
FLOOD PLAIN
TERRACE
BM 1006
Airstrip
BM 1019
RICHARDSON HIGHWAY
TERRACE
GOODPASTER FLATS
TANANA RIVER
BM 1101
BM 1118
BM 1132
Mile 270
Cabin
Cabin
Clearwater Lake
Clearwater Creek
DELTA MORAINE
DELTA OUTWASH
BM 1134
VABM 1305 Clearwater
Delta Junction
Gas Tanks
BM 1175
Buffalo Center
ALASKA HIGHWAY
OUTER DELTA MORAINE
BM K1196
BM K1218
BM 1241
TERRACE
DONNELLY OUTWASH
DONNELLY OUTWASH
TERRACE
DONNELLY OUTWASH
Big Delta Airport
ALASKA HIGHWAY
MICHIGAN CREEK

(BIG DELTA A-5)

64°00′ 146°00′ 50′ (MT. HAYES D-4) 40′ 145°30′ 64°00′

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.

G.W. Holmes, 1956, after T.L. Péwé, 1953

MAJOR LANDFORMS OF THE BIG DELTA A-4 QUADRANGLE

SCALE 1:63360

1 1/2 0 1 2 3 4 MILES

TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-C

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

MT. HAYES (C-4) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION
1:63 360 SERIES (TOPOGRAPHIC)

(MT. HAYES D-5)

146°00′ — 50′ — (MT. HAYES D-4) — 40′ — 145°30′
63°45′
40′
35′
63°30′

BIG DELTA 31 MI.
DELTA JUNCTION 22 MI.

VABM 3525 Ober
VABM 2218 △Buffalo
BM 2320
Cabin
Mile 240
Donnelly
BM 1769
VABM 173 △Donnelly
Cabin
VABM 3838 ARevell
VABM 4927 △Darling
Mile 230
VABM 2109 Rapids Airstrip
Rapids Roadhouse
2129
VABM 4522 △Mon

Granite Creek
McGinnis Creek
Ober Creek
Jarvis Creek
Moose Pasture Creek
Ruby Creek
Riley Creek
Little Gold Creek
Darling Creek
Onemile Creek
Gunnysack Creek
Clear Creek
Black Rapids Glacier

DELTA RIVER
RICHARDSON HIGHWAY

PAXSON 39 MI.
GULKANA 99 MI.

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by multiplex methods
Aerial photographs taken August 1949

Universal Transverse Mercator projection, zone 6
1927 North American datum

Unchecked elevations shown in brown and blue

30°
TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1951

SCALE 1:63360

1 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface	None	Improved dirt	None
Other		Unimproved dirt	
		Trails	

TOPOGRAPHIC MAP

MT. HAYES (C-4), ALASKA
N6330-W14530/15X30

EDITION OF 1952

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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-D

MT. HAYES (B-4) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION
1:63 360 SERIES (TOPOGRAPHIC)

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

146°00′ 63°30′ — 50′ — (MT. HAYES C-4) — 40′ — 145°30′ 63°30′

FAIRBANKS 137 MI.
DELTA JUNCTION 40 MI.

25′ — 20′ — 63°15′ 146°00′ — 50′ — (MT. HAYES A-4) — 40′ — 145°30′ 63°15′ — (MT. HAYES A-3)

PAXSON 18 MI.
GULKANA 78 MI.

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Topography from aerial photographs by multiplex methods
Aerial photographs taken September 1948 and August 1949

Universal Transverse Mercator projection, zone 6
1927 North American datum

Unchecked elevations shown in brown and blue

APPROXIMATE MEAN DECLINATION, 1951

SCALE 1:63360

1 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 100 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
AREAS NOT SURVEYED IN DETAIL INDICATED BY BROKEN LINES
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface	None	Improved dirt	None
Other		Unimproved dirt	
Trails	None		

MT. HAYES (B-4), ALASKA
N6315-W14530/15X30

EDITION OF 1952

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INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA

MAP III-E

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

MILITARY GEOLOGY BRANCH

BIG DELTA (B-4) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION

1:63 360 SERIES (TOPOGRAPHIC)

146°00′ — 50′ — 40′ — 145°30′

64°30′ — 25′ — 20′ — 64°15′

(BIG DELTA B-5) — (BIG DELTA A-5) — (BIG DELTA A-4)

VABM 4084 Mid
VABM 3572 Cotton
VABM 3570 Peak
VABM 2510 Feat
VABM 2503 Gilles
VABM 2064 Caribou
△2496

Gilles Creek
Caribou Creek
Shaw Creek
Cottonwood Creek
SHAW CREEK FLATS
Flat Creek
Rapid Creek
Corda Cr
Eagle Creek

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Control by USGS

Topography from aerial photographs by multiplex methods 1953
Aerial photographs taken July 1950

Universal Transverse Mercator projection, zone 6
1927 North American datum

Unchecked elevations are shown in brown and blue

TRUE NORTH
31°
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1953

SCALE 1:63360

1 ½ 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface	None	Improved dirt	None
Other	None	Unimproved dirt	None
Trails	None		

ALASKA
QUADRANGLE LOCATION

TOPOGRAPHIC MAP

BIG DELTA (B-4), ALASKA
N6415-W14530/15X30

1953

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TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-F

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

BIG DELTA (B-5) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION
1:63 360 SERIES (TOPOGRAPHIC)

(BIG DELTA C-6)

146°30′ 20′ 10′ 146°00′
64°30′ 25′ 20′ 64°15′

(BIG DELTA B-6) (BIG DELTA B-4)

(BIG DELTA A-6) (BIG DELTA A-5) (BIG DELTA A-4)

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Topography from aerial photographs by multiplex methods
Aerial photographs taken August 1949

Universal Transverse Mercator projection, zone 6
1927 North American datum

Dashed land lines indicate approximate location

Unchecked elevations shown in brown and blue

APPROXIMATE MEAN DECLINATION, 1951
TRUE NORTH
MAGNETIC NORTH
30°

SCALE 1:63360

1 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

TOPOGRAPHIC MAP

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1955

BIG DELTA 10 MI.
DELTA JUNCTION 19 MI.

ROAD CLASSIFICATION

ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface		Improved dirt	None
Other	None	Unimproved dirt	
Trails			

BIG DELTA (B-5), ALASKA
N6415-W14600/15X30

1949

TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-G

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

MT HAYES (D-4) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION

1:63 360 SERIES (TOPOGRAPHIC)

(BIG DELTA A-5)

146°00′ — 50′ — (BIG DELTA A-4) — 40′ — 145°30′

64°00′

55′

50′

63°45′

(MT. HAYES D-5)

BIG DELTA 13 MI.
DELTA JUNCTION 27 MI.

BIG DELTA 15 MI.
DELTA JUNCTION 4.7 MI.

TANACROSS 90 MI.
TOK JUNCTION 100 MI.

GULKANA 117 MI.

(MT. HAYES C-4)

CAA Station
BM 1270
Big Delta Airport
Big Delta Arctic Training Center
BM 1254
ALASKA HIGHWAY
Allrich
BM 1325
BM 1236
Beales North Base
BM 1314
Beales South Base
VABM 1392
Rifle Range
HIGHWAY
VABM 1753
Lakes
RIVER
CREEK
Mile 260
Rifle Range
RICHARDSON
Beales Cache
VABM 1754
Beales South Base
Bolio Lake
BM 1751
JARVIS
DELTA
Big Lake
MEADOWS ROAD
HIGHWAY
Airstrip
Cabin
1770 Butch Lake
Granite Creek
BM 2103
RICHARDSON
OLD
RICHARDSON
Donnelly
VABM 3910
Pillsbury Dome
Mile 250
Ober Creek
CREEK
Granite Mtn
BM 2735
BM 2611

SCALE 1:63360

1 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

ALL WEATHER ROADS		DRY WEATHER ROADS	
Hard-surface	None	Improved dirt	
Other		Unimproved dirt	
		Trails	

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Topography from aerial photographs by multiplex methods
Aerial photographs taken August 1949

Universal Transverse Mercator projection, zone 6
1927 North American datum

Unchecked elevations shown in brown and blue

TRUE NORTH
30°
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION, 1951

TOPOGRAPHIC MAP

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MT HAYES (D-4), ALASKA
N6345-W14530/15X30

EDITION OF 1952

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

TERRAIN STUDY OF THE ARMY TEST AREA
FORT GREELY, ALASKA
MAP III-H

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
MILITARY GEOLOGY BRANCH

BIG DELTA (A-4) QUADRANGLE

ALASKA-FOURTH JUDICIAL DIVISION

1:63 360 SERIES (TOPOGRAPHIC)

(BIG DELTA B-5) (BIG DELTA B-4) (BIG DELTA A-5) (MT. HAYES D-5) (MT. HAYES D-4)

146°00′ 50′ 40′ 145°30′ 64°15′ 10′ 5′ 64°00′

FAIRBANKS 81 MI.
RICHARDSON 14 MI.

SHAW CREEK FLATS
TANANA RIVER
DELTA RIVER
GOODPASTER RIVER
GOODPASTER FLATS
Quartz Lake
Lost Lake
Thompson Lake
Clearwater Lake
Indian Creek
Progressive Creek
Liscum Slough
Fourmile Hill
Bluff Cabin
Jollys Cabins
Bert & Marys Roadhouse
Big Delta
Post Office
Airstrip (Aband'd)
Delta Junction
Gas Tanks
Buffalo Center
Big Delta Airport
Jarvis Creek
Clearwater Creek
Cabins
Cabin
RICHARDSON HIGHWAY
ALASKA HIGHWAY
Mile 280
Mile 270
VABM 2435 △ Indian
VABM 1946 △ Liscum
VABM 1820 △ Bert
VABM 1172 △ Tanana
VABM 1239 △ Brush
VABM 1352 △ Ridge
VABM 1305 △ Clearwater
BM 995
BM 1006
BM 1019
BM 1093
BM 1101
BM 1118
BM 1132
BM 1134
BM 1175
BM 1196
BM 1218
BM 1241
BM 1999
T 9 S
T 10 S
R 9 E
R 10 E

GULKANA 137 MI.
COPPER CENTER 163 MI.
TANACROSS 95 MI.
TOK JUNCTION 105 MI.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by multiplex methods
Aerial photographs taken August 1949

Universal Transverse Mercator projection, zone 6
1927 North American datum

Dashed land lines indicate approximate location

Unchecked elevations shown in brown and blue

APPROXIMATE MEAN DECLINATION, 1951
TRUE NORTH
MAGNETIC NORTH
30½°

SCALE 1:63360

1 ½ 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 50 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
DATUM IS MEAN SEA LEVEL

TOPOGRAPHIC MAP

ROAD CLASSIFICATION

ALL WEATHER ROADS	DRY WEATHER ROADS
Hard-surface	Improved dirt
Other	Unimproved dirt
	Trails

BIG DELTA (A-4), ALASKA
N6400-W14530/15X30

EDITION OF 1952

FOR SALE BY U. S. GEOLOGICAL SURVEY, FEDERAL CENTER, DENVER, COLORADO OR WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

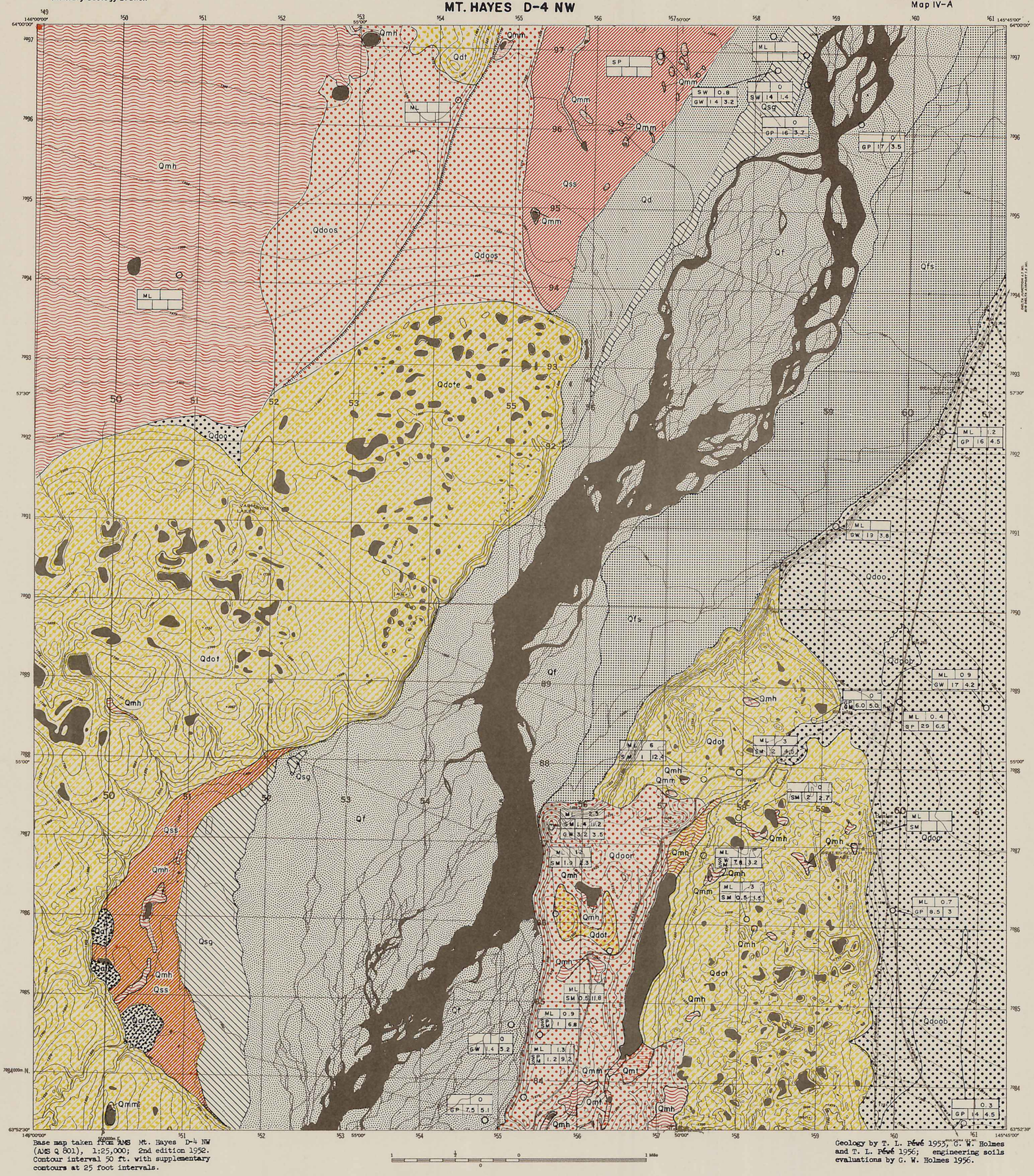
Delta - 1.8
do - 1.9

U.S. Department of the Interior
Geological Survey
Military Geology Branch

GEOLOGY AND SOILS

MT. HAYES D-4 NW

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IV-A



Base map taken from AMS Mt. Hayes D-4 NW (AMS Q 801), 1:25,000; 2nd edition 1952. Contour interval 50 ft. with supplementary contours at 25 foot intervals.

Geology by T. L. Péwé 1953; G. W. Holmes and T. L. Péwé 1956; engineering soils evaluations by G. W. Holmes 1956.

GEOLOGY AND SOILS

Summary and General Evaluations

Silt and silty-sand, 2 or more feet thick. Frost-susceptible with shallow permafrost table, commonly 2 to 4 feet deep. Poor surface for cross-country movement in summer; poor for roads, airfields and foundations. Marked seasonal changes in soil moisture and strength.

Till. Sandy and gravelly; generally frost-susceptible, but locally non-frost susceptible. Permafrost table usually 3 or more feet below surface. Silt mantle ranges from 0 to more than 3 feet thick. Fair to poor for cross-country movement in summer; fair to good for roads and foundations. Topography normally too rough for airfields. Moderate to minor seasonal variations in soil moisture and strength.

Gravel, talus, rubble, outwash, sand, bedrock. Non-frost-susceptible. Permafrost table low, and/or permafrost does not affect surface or stability. Except where slope and roughness are limiting factors, these miscellaneous units are good to excellent for cross-country movement in summer; good to excellent for foundations for airfields, roads and buildings (except flood plains). Little or no seasonal variations in moisture and strength as far as engineering and military aspects are concerned.

Quaternary Deposits, Undifferentiated as to Age, Resting on Glacial and Alluvial Deposits and on Bedrock

Qc

Qc, Solifluction deposits: silt and rock fragments. Mantles Delta till or bedrock hills. Solifluction deposits on bedrock hills are a mixture of angular frost-riven schist or granite; on till, similar to till, but contain more silt and are more well-graded (poorly sorted). SM. In festoons, lobes, or poorly defined terraces.

Qt

Qt, Talus. Angular boulders and smaller fragments of bedrock in fans and sheets on cirque walls and canyon sides. Large talus fans only in Granite Range.

Qd

Qd, Dune sand, mantled by silt. Medium and coarse poorly graded (well sorted) sand. SW and SP. In low sand sheets or composite dunes and sand hills, 6-20 feet thick. Sand dune field on west side of Delta River is pocked by sub-parallel depressions.

Qr

Qr, Rubble. Angular boulders and smaller fragments of bedrock resting on flat and gently inclined upland surfaces, e.g., summits of Granite Mts. or Ober Dome.

Qmm **Qmt** **Qmh** **Ql**

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Qmt, Silt (ML) overlain by peat and sedge tussocks. Peat typically 0.5 foot thick between tussocks which are commonly surrounded by water in summer. Tussocks are 1-2 feet high and 1 foot in diameter. Permafrost 2-3 feet below peat.

Qmh, Silt (ML) overlain by peat, covered by moss, sedge, and heath shrub; forming hummocks 1-2 feet high and 2-5 feet in diameter. Peat up to 1.0 foot thick.

Ql, Lake silt (ML) in drained lake basins. No micro-relief; no peat. Permafrost more than 3 feet below surface.

Sample location ⊙

Lithologic Data Model

	Classification	Thickness	
Mantle →			
Underlying unconsolidated material →	Classification	Median size (mm)	Sorting coefficient

Symbols

- Terrace scarp
- Transitional contact
- Fault

Qf **Qfs**

Qf, Flood plain gravel and sand of bare braided flood plains of glacial streams and Granite Creek. GP and GW.

Qfs, Silt and sand-covered flood plains. Channeled, covered by forest or shrub. Sand and silt 1-3 feet thick, with shallow permafrost in places. SW and SP covering GW or GP.

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Qsg, Alluvial silt and sand, 2 to more than 14 feet thick, covering gravel. In younger composite terrace 3 to 8 feet above the flood plain. Permafrost in places 3 to 4 feet below surface. ML covering GW or GP.

Qss, Alluvial silt and sand, up to 15 feet thick on older composite terrace, 15 to 25 feet above flood plain. ML covering GW or GP.

Qab

Qab, Bouldery gravel. Rounded boulders 5 or more feet in diameter in coarse sand and pebble matrix, forming boulder terrace. Surface is littered with boulders, and is channeled. Terrace rises in irregular flights to about 45 feet above flood plain. Matrix is GP.

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Qaf, Alluvial fan. Sand, silt, and gravel. Silt cover up to 18 feet thick. Deeply gullied, and truncated. ML over GW or GP.

Qafc

Qafc, Alluvial sand and gravel on Granite Mt. piedmont and within the mountains. Coalescent fans from alluvial and glacial sources. SW on GW or GP.

Qdot **Qdotc** **Qdote**

Qdot, Donnelly till. Slightly weathered, gray to yellowish sandy till with rounded and angular rock fragments. Permafrost probably 10 or more feet below surface. Mantled by 0 to 3 feet of eolian silt. Moraines are rough, with numerous kettle depressions and few bogs. 100 or more feet thick in frontal sectors. Mostly SM plus GW, GP and GM, with ML cover.

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Qdto

Qdto, Delta outwash. Aprons attached to Delta moraines. 2 to 13 feet of silt (ML) over GP, or rarely GW or SW-SM.

T

Clay, sand, shale, coal, and conglomerate.

br

Crystalline bedrock: grano-diorite in the Granite Range; Birch Creek schist on Ober Dome, Donnelly Dome, and West Donnelly.

QUATERNARY

Donnelly Glaciation

Delta Glaciation

PRE-TERTIARY

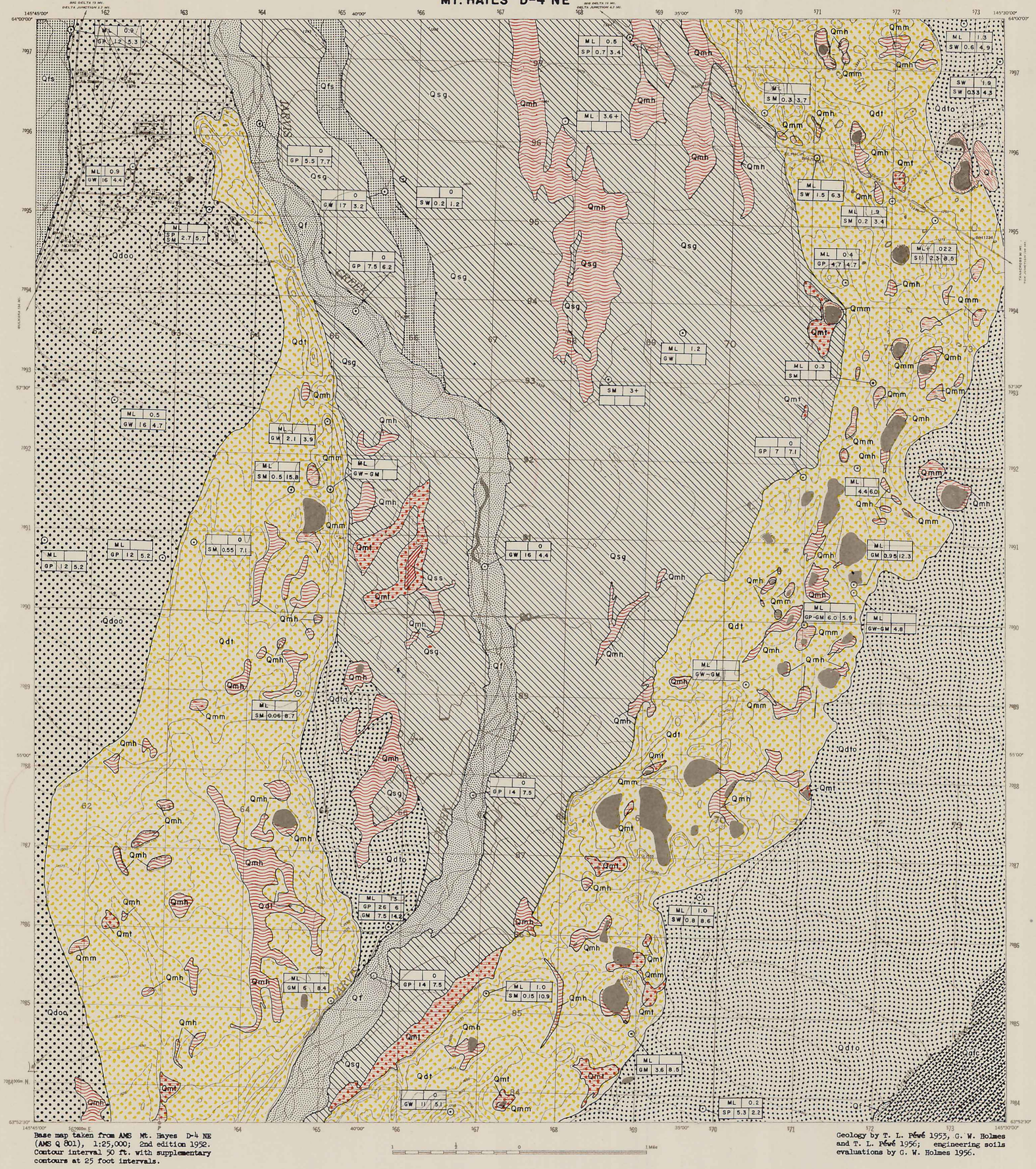
TERTIARY

U.S. Department of the Interior
Geological Survey
Military Geology Branch

GEOLOGY AND SOILS

MT. HAYES D-4 NE

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IV-B



Base map taken from AMS Mt. Hayes D-4 NE (AMS Q 801), 1:25,000; 2nd edition 1952. Contour interval 50 ft. with supplementary contours at 25 foot intervals.

Geology by T. L. Péwé 1953, G. W. Holmes and T. L. Péwé 1956; engineering soils evaluations by G. W. Holmes 1956.

GEOLOGY AND SOILS

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Sample location ⊙

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QUATERNARY

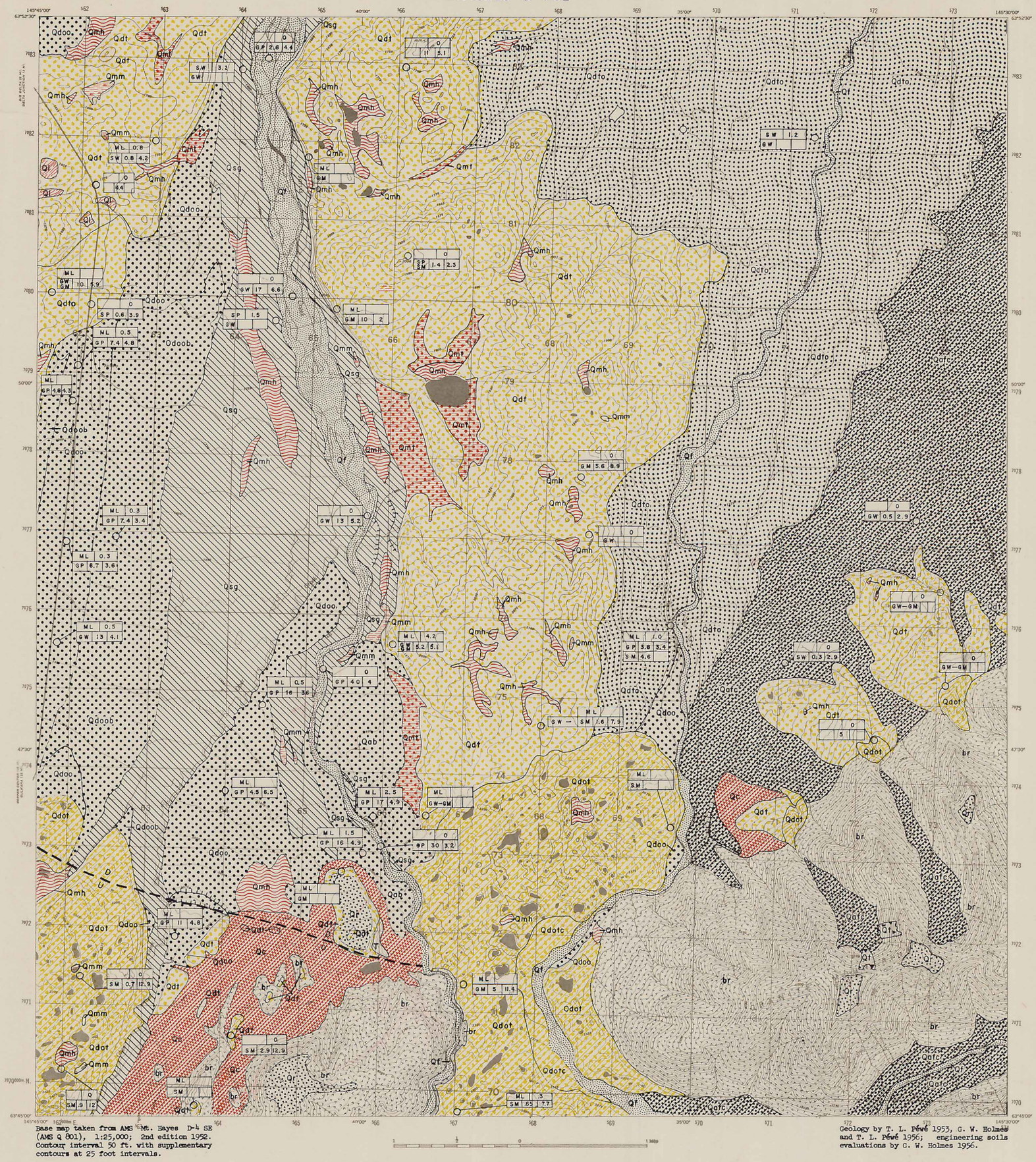
Q — Glaciation — Donnelly — Delta

PRE-TERTIARY

U.S. Department of the Interior
Geological Survey
Military Geology Branch

GEOLOGY AND SOILS
MT. HAYES D-4 SE

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IV-C



Base map taken from AMS Mt. Hayes D-4 SE (AMS Q 801), 1:25,000; 2nd edition 1952. Contour interval 50 ft. with supplementary contours at 25 foot intervals.

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GEOLOGY AND SOILS

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Donnelly Glaciation
Delta Glaciation
Q
TERTIARY
PRE-TERTIARY

U.S. Department of the Interior
Geological Survey
Military Geology Branch

GEOLOGY AND SOILS

MT. HAYES D-4 SW

Terrain Study of the Army Test Area,
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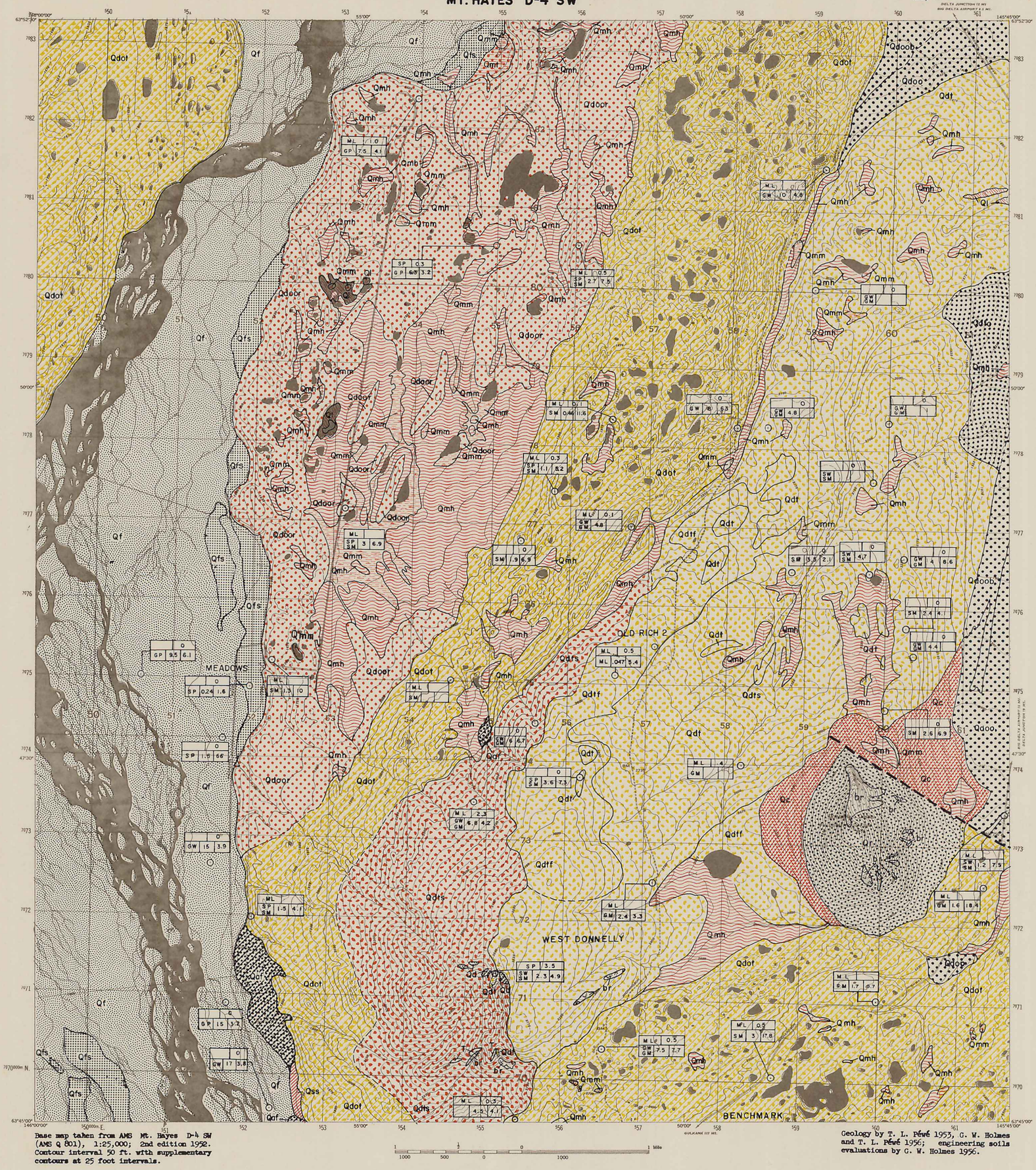
Map IV-D



Base map taken from AMS Mt. Hayes D-4 SW (AMS Q 801), 1:25,000; 2nd edition 1952. Contour interval 50 ft. with supplementary contours at 25 foot intervals.

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Qmm, Silt (ML) overlain by peat and marsh vegetation. Peat up to 0.5 foot thick, usually covered by standing water in summer. Permafrost 3 or more feet below peat; no micro-relief features.

Qmt, Silt (ML) overlain by peat and sedge tussocks. Peat typically 0.5 foot thick between tussocks which are commonly surrounded by water in summer. Tussocks are 1-2 feet high and 1 foot in diameter. Permafrost 2-3 feet below peat.

Qmh, Silt (ML) overlain by peat, covered by moss, sedge, and heath shrub; forming hummocks 1-2 feet high and 2-5 feet in diameter. Peat up to 1.0 foot thick.

Ql, Lake silt (ML) in drained lake basins. No micro-relief; no peat. Permafrost more than 3 feet below surface.

Sample location ⊙

Lithologic Data Model

	Classification	Thickness	
Mantle →			
Underlying unconsolidated material →	Classification	Median size (mm)	Sorting coefficient

Symbols

- Terrace scarp
- Transitional contact
- Fault

Qf **Qfs**

Qf, Flood plain gravel and sand of bare braided flood plains of glacial streams and Granite Creek. GP and GW.

Qfs, Silt and sand-covered flood plains. Channeled, covered by forest or shrub. Sand and silt 1-3 feet thick, with shallow permafrost in places. SW and SP covering GW or GP.

Qsg **Qss**

Qsg, Alluvial silt and sand, 2 to more than 14 feet thick, covering gravel. In younger composite terrace 3 to 8 feet above the flood plain. Permafrost in places 3 to 4 feet below surface. ML covering GW or GP.

Qss, Alluvial silt and sand, up to 15 feet thick on older composite terrace, 15 to 25 feet above flood plain. ML covering GW or GP.

Qab

Qab, Bouldery gravel. Rounded boulders 5 or more feet in diameter in coarse sand and pebble matrix, forming boulder terrace. Surface is littered with boulders, and is channeled. Terrace rises in irregular flights to about 45 feet above flood plain. Matrix is GP.

Qaf

Qaf, Alluvial fan. Sand, silt, and gravel. Silt cover up to 18 feet thick. Deeply gullied, and truncated. ML over GW or GP.

Qafc

Qafc, Alluvial sand and gravel on Granite Mt. piedmont and within the mountains. Coalescent fans from alluvial and glacial sources. SW on GW or GP.

Qdot **Qdotc** **Qdote**

Qdot, Donnelly till. Slightly weathered, gray to yellowish sandy till with rounded and angular rock fragments. Permafrost probably 10 or more feet below surface. Mantled by 0 to 3 feet of eolian silt. Moraines are rough, with numerous kettle depressions and few bogs. 100 or more feet thick in frontal sectors. Mostly SM plus GW, GP and GM, with ML cover.

Qdotc, Donnelly till, channeled and terraced by Granite Creek.

Qdote, Donnelly till, possible early phase (?) represented by low terminal lobe in front of main moraine west of Delta River.

Qdoo **Qdoor** **Qdoob** **Qdoos** **Qdesk**

Qdoo, Donnelly outwash. Coarse gravel and sand with some silt. Well-graded (poorly sorted). Mostly GP and GW, with some SP-SM. Estimated to be at least 400 feet thick. ML cover 0 to 4 feet thick.

Qdoor, Donnelly outwash recessional phase. Silt-covered, channeled, and in places thinly mantled by till. ML covering GP, GW or SP-SM.

Qdoob, Donnelly outwash bare of silt or with silt mantle less than 0.3 foot. GW and GP.

Qdoos, Donnelly outwash with thick silt and organic silt mantle, estimated to be 10 or more feet thick. Frozen at 1 to 2 feet. ML over GP or GW.

Qdesk, Donnelly outwash esker gravel on Qdoor.

Qdt **Qdtf** **Qdts**

Qdt, Delta till. Moderately weathered yellowish sandy till with angular and rounded rock fragments. Rolling moraines with a few ponds and many bogs. Silt cover 0-1.8 feet. ML covering GM, SM, GW-GM, and other sand and gravel soils.

Qdtf Delta till, with frost scars; pits 1 foot deep, 2-5 feet in diameter on north slope of West Donnelly. Permafrost shallow. Associated with congeliturbate and solifluction lobes.

Qdts, Delta till, mantled by eolian silt and solifluction deposits on the west slope of West Donnelly.

Qdto

Qdto, Delta outwash. Aprons attached to Delta moraines. 2 to 13 feet of silt (ML) over GP, or rarely GW or SW-SM.

T

Clay, sand, shale, coal, and conglomerate.

br

Crystalline bedrock: grano-diorite in the Granite Range; Birch Creek schist on Ober Dome, Donnelly Dome, and West Donnelly.

QUATERNARY

Donnelly Glaciation

Delta Glaciation

PRE-TERTIARY

U.S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain study of the Army Test Area
Fort Greely, Alaska
Map VIII

146°00′ 50′ (BIG DELTA A-4) 40′ 145°30′
64°00′ 55′ 50′ 63°45′

(MT. HAYES D-5) (MT. HAYES C-4)

Big Delta Airport
CAA Station
Big Delta Arctic Training Center
Beales North Base
Beales South Base
Rifle Range
Alrich
Beales Cache
Big Lake
Donnelly Dome
Butch Lake
Granite Mt.
Granite Creek
Obet Creek
Richardson Highway
Delta River
Jarvis Creek
Bolio Lake
Meadows
Old Richardson Road
Gaging Station
Cabin
Airstrip
Mile 260
Mile 250
Lakes
Hill
Tower (Z)
Op Center
Sawmill
Range
Comm
Ammo #1
Ammo #2
Beale's #1
Beale's #20
(AA Range)
Bolio #1
Bolio #2
Oldrich #1
Oldrich #2
Holland
Burn
Machado
Unburned
Burned
Firebreak
Drop Zone
Bench Mark
West Donnelly
VABM 1753
VABM 1392
VABM 1754
BM 1270
BM 1314
BM 1325
BM 1751
BM 2103
BM 2735
BM 1451
BM 1246
BM 1770
BM 3995

PENETROMETER DIAL READINGS, SOIL MOISTURE, AND DEPTH TO PERMAFROST

Mt. Hayes D-4 Quadrangle

1 0 1 2 3 Miles

STATION
⊙
A

DIAL READINGS
(0 to 0.5′)=Early summer - Late summer
(0.5 to 1.0′)=Early summer - Late summer

THICKNESS OF MANTLE (In Feet)
(2.5)

DEPTH TO PERMAFROST
FT.
(Ft.)

SOIL MOISTURE
%
Early summer - Late summer
Data not avaliable for all stations.

NOTE: All but 3 penetrometer stations mantled by silt or sand. Many, as indicated, have mantle less than a foot thick, covering till, outwash or alluvium. For thickness at other stations, see maps IV - A. B. C. and D.

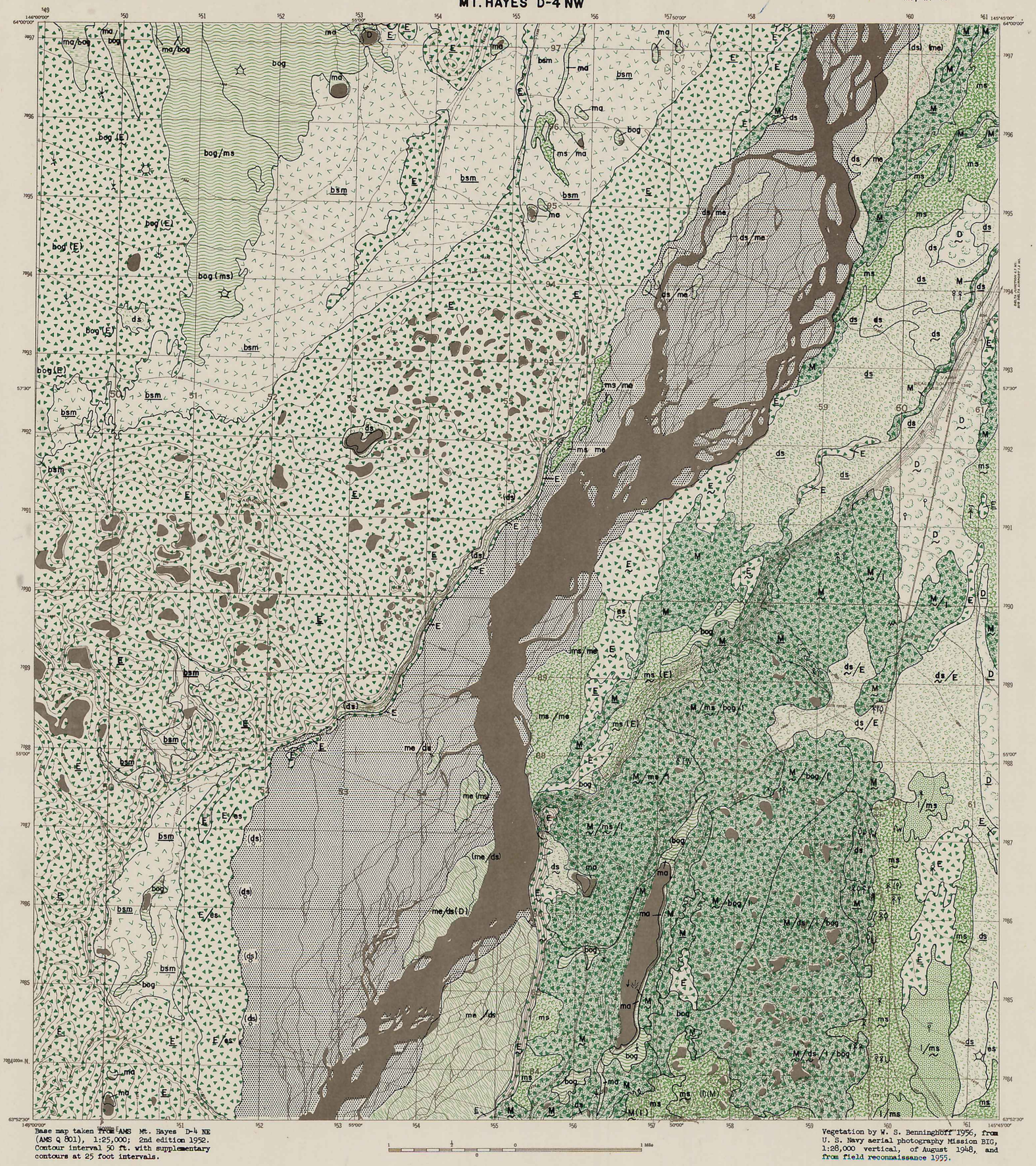
G.W. HOLMES, 1956

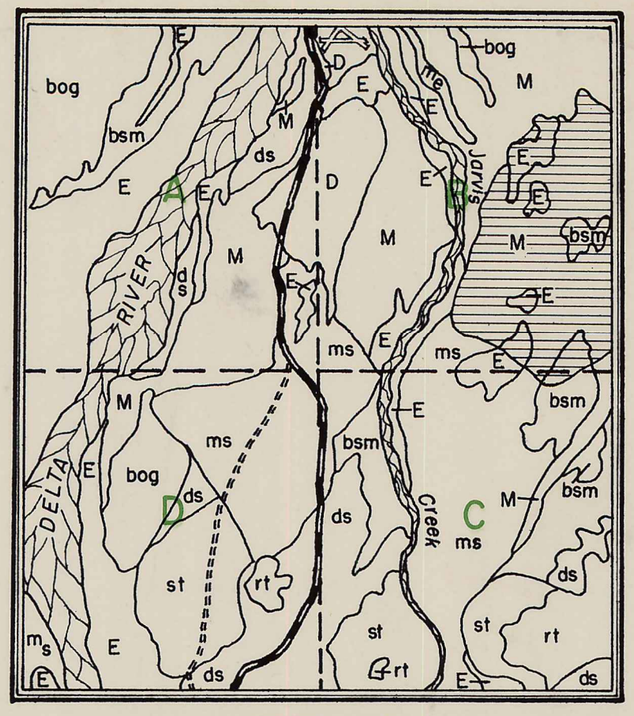
U.S. Department of the Interior
Geological Survey
Military Geology Branch

VEGETATION

MT. HAYES D-4 NW

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IX-A





INDEX MAP

Base map taken from AMS Mt. Hayes D-4 (AMS Q801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from U.S. Navy aerial photography, Mission BIG, 1:25,000 vertical, of August 1948, and from field reconnaissance, 1955.

Vegetation structure:

- M — Dense stand (of mixed evergreen--deciduous forest); trees no farther apart than average height.
- M — Open stand (of mixed evergreen--deciduous forest); trees farther apart than average height.
- M — Stand of variable density (mixed evergreen--deciduous forest); some trees farther apart than average height, others closer than average height.
- / — Used between 2 unit symbols to indicate that those 2 vegetation units occur intermingled in patterns too small to map at this scale. The first (left) symbol determines map unit pattern.
- ( ) — Vegetation represented by symbol in parentheses occurs as an unmappable inclusion within the map unit indicated to the left of the parenthesis.
- Tree (e.g., black spruce) less than 6 feet tall.
- Isolated individuals (of white spruce) as inclusions within a map unit.
- Polygonal patterns in vegetation.
- Stripe patterns in vegetation.
- Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

White spruce	White birch	Juniper
Black spruce	Aspen	Alder
Larch	Balsam poplar	Willow
Glandular birch	Grass	Mosses
Dwarf birch	Tall grass	Sphagnum moss
Heath shrub	Sedge	Lichens
	Tussock-forming sedge	A Dense aquatic vegetation

Extent of "Granite Mountain Burn", a forest fire of August 1954.

MAP UNITS

NOTE: In some localities vegetation units overlap the water tint of the Delta River, indicating a change in the channel courses by 1949 when the base map photography was flown. Water tint of certain lakes is overlapped by vegetation units, for the most part bog or marsh, indicating areas intermittently inundated.

FOREST

Plant communities in which trees (tree species more than 6 feet tall) are a dominant growth form.

E — Evergreen forest. Composed of needle-leaved, evergreen, coniferous trees (white spruce and black spruce).

M — Mixed evergreen--deciduous forest. composed of both evergreen coniferous trees and deciduous broad-leaved trees, the smaller components constituting at least 10 percent of the trees. In Tanana Valley includes some larch (deciduous needle-leaved conifer).

D — Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

SCRUB and/or SHRUB

Plant communities in which woody plants 1 - 6 feet tall are primary components; includes scrub (tree species less than 6 feet tall) and/or shrubs (low, woody, bushy plants, usually with multiple stem axes).

es — Evergreen scrub. White spruce or black spruce trees either in young stands or stunted (as those near the altitudinal limit of trees).

ms — Mixed evergreen--deciduous scrub and/or shrub. Young white spruce or black spruce mixed with deciduous scrub and/or shrub.

ds — Deciduous scrub and/or shrub. Deciduous scrub (young, stunted, or severely browsed deciduous trees) and/or shrubs (willows, alders, glandular birch, and heath shrubs).

TUNDRA

Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

st — Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.

rt — Rock desert. Incomplete cover consisting of mosses and lichens (in mats or cushions), sedges and grasses (in tufts), forbs (in rosettes or cushions) and shrubs (low, creeping or matted).

MEADOW

Plant communities primarily of herbaceous forms (grasses, sedges, and erect forbs), producing a lawn, sod, or fibrous turf.

me — Meadow. Grasses and erect forbs, sometimes with thin soil cover of lichens and mosses; luxuriance varies from sparse lawn to tall lush hay meadow.

ma — Marsh. Sedges, and less commonly grasses, in relatively uniform stands on wet or seasonally inundated sites; forms heavy sod or fibrous turf that usually is waterlogged.

bsm — Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

bog — Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

VEGETATION OF LOCAL SIGNIFICANCE

I — Lichen barrens. Plant communities of fruitcose (and in places including some crustose) lichens, forming incomplete cover on gravel surfaces; locally accompanied by scattered mat shrubs (bearberry) or tufted plants (small grasses, etc.)

A — Aquatic communities. Submersed vegetation (Nitella, bladderwort, pondweeds, etc.) and emergent vegetation (water knotweed, yellow pond lily, etc.) in localities observed on the ground or where aquatic vegetation could be observed in aerial photographs.

AREAS NOT MAPPED WITH RESPECT TO VEGETATION

Barren flood plain areas. Areas on flood plains where no significant vegetation was observed.

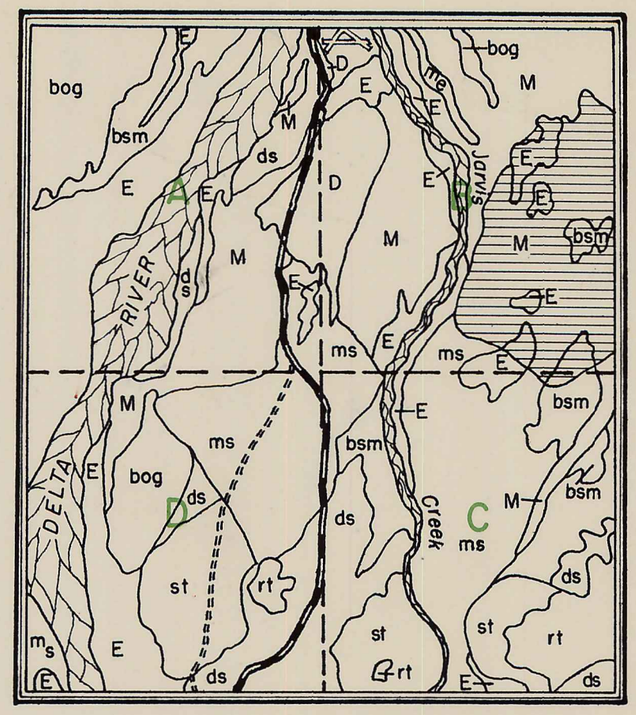
Areas disturbed by culture. No significant vegetation present (bare areas) or patterns too complex to map at this scale.

U.S. Department of the Interior
Geological Survey
Military Geology Branch

VEGETATION

MT. HAYES D-4 NE

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IX-B



INDEX MAP

Base map taken from AMS Mt. Hayes D-4 (AMS Q801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from U.S. Navy aerial photography, Mission BIG, 1:25,000 vertical, of August 1948, and from field reconnaissance, 1955.

Vegetation structure:

M — Dense stand (of mixed evergreen--deciduous forest); trees no farther apart than average height.

M — Open stand (of mixed evergreen--deciduous forest); trees farther apart than average height.

M — Stand of variable density (mixed evergreen--deciduous forest); some trees farther apart than average height, others closer than average height.

/ — Used between 2 unit symbols to indicate that those 2 vegetation units occur intermingled in patterns too small to map at this scale. The first (left) symbol determines map unit pattern.

( ) — Vegetation represented by symbol in parentheses occurs as an unmappable inclusion within the map unit indicated to the left of the parenthesis.

Tree (e.g., black spruce) less than 6 feet tall.

Isolated individuals (of white spruce) as inclusions within a map unit.

Polygonal patterns in vegetation.

Stripe patterns in vegetation.

Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

White spruce	White birch	Juniper
Black spruce	Aspen	Alder
Larch	Balsam poplar	Willow
Glandular birch	Grass	Mosses
Dwarf birch	Tall grass	Sphagnum moss
Heath shrub	Sedge	Lichens
	Tussock-forming sedge	A Dense aquatic vegetation

Extent of "Granite Mountain Burn", a forest fire of August 1954.

MAP UNITS

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Plant communities in which trees (tree species more than 6 feet tall) are a dominant growth form.

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D — Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

SCRUB and/or SHRUB

Plant communities in which woody plants 1 - 6 feet tall are primary components; includes scrub (tree species less than 6 feet tall) and/or shrubs (low, woody, bushy plants, usually with multiple stem axes).

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Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

st — Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.

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bsm — Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

bog — Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

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Barren flood plain areas. Areas on flood plains where no significant vegetation was observed.

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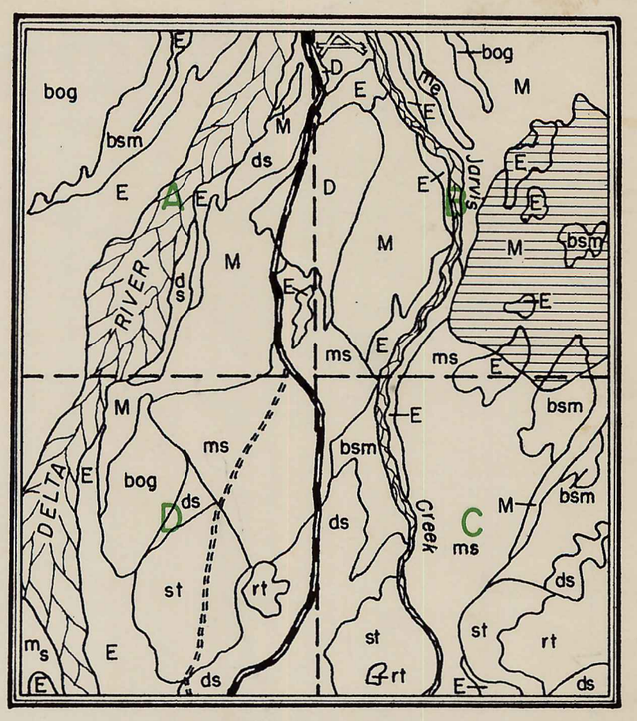
U.S. Department of the Interior
Geological Survey
Military Geology Branch

VEGETATION

MT. HAYES D-4 SE

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IX-C



INDEX MAP

Base map taken from AMS Mt. Hayes D-4 (AMS Q801), 1:25,000, 2nd edition, 1952.

Mapped by W. S. Benninghoff, 1956, from U.S. Navy aerial photography, Mission BIG, 1:25,000 vertical, of August 1948, and from field reconnaissance, 1955.

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D Deciduous forest. Composed of deciduous broad-leaved trees (white birch, aspen, balsam poplar). Includes willows of tree stature.

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TUNDRA

Treeless vegetation of high latitudes and high altitudes; in this area, plant communities with matted turf of mosses, lichens, sedges, grasses, forbs (especially cushion and rosette forms), and low (less than 1 foot) or creeping shrubs.

st Shrub tundra. Matted or tussocky turf of mosses, lichens, small sedges and grasses, and forbs, in which low or creeping or mat-like shrubs are rooted.

rt Rock desert. Incomplete cover consisting of mosses and lichens (in mats or cushions), sedges and grasses (in tufts), forbs (in rosettes or cushions) and shrubs (low, creeping or matted).

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bsm Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

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U.S. Department of the Interior
Geological Survey
Military Geology Branch

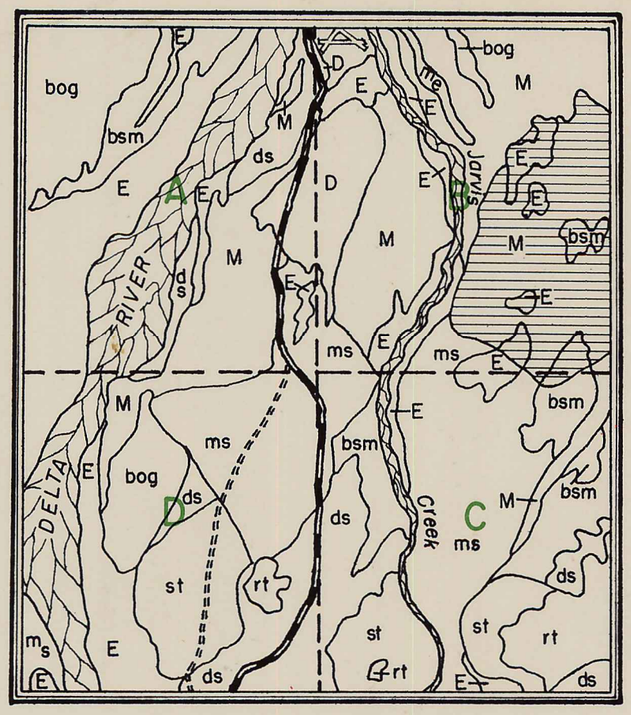
VEGETATION

MT. HAYES D-4 SW

Terrain Study of the Army Test Area,
Fort Greely, Alaska
Map IX–D

Base map taken from AMS Mt. Hayes D-4 SW (AMS Q 801), 1:25,000; 2nd edition 1952. Contour interval 50 ft. with supplementary contours at 25 foot intervals.

Vegetation by W. S. Benninghoff 1956, from U. S. Navy aerial photography Mission BIG, 1:28,000 vertical, of August 1948, and from field reconnaissance 1955.



INDEX MAP

Base map taken from AMS Mt. Hayes D-4 (AMS Q801), 1:25,000, 2nd edition, 1952.

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ma — Marsh. Sedges, and less commonly grasses, in relatively uniform stands on wet or seasonally inundated sites; forms heavy sod or fibrous turf that usually is waterlogged.

bsm — Black spruce muskeg. Community characterized by black spruce in swamp forest structure or scrub with spongy moss-lichen bog-like ground cover.

bog — Bog. Nearly continuous ground cover of mosses in which characteristic low shrubs (heath shrubs, glandular birch, dwarf birch, crowberry) and/or sedges and a few species of grasses are rooted; humus beneath the ground cover perennially waterlogged.

VEGETATION OF LOCAL SIGNIFICANCE

l — Lichen barrens. Plant communities of fruitcose (and in places including some crustose) lichens, forming incomplete cover on gravel surfaces; locally accompanied by scattered mat shrubs (bearberry) or tufted plants (small grasses, etc.)

A — Aquatic communities. Submersed vegetation (Nitella, bladderwort, pondweeds, etc.) and emergent vegetation (water knotweed, yellow pond lily, etc.) in localities observed on the ground or where aquatic vegetation could be observed in aerial photographs.

AREAS NOT MAPPED WITH RESPECT TO VEGETATION

Barren flood plain areas. Areas on flood plains where no significant vegetation was observed.

Areas disturbed by culture. No significant vegetation present (bare areas) or patterns too complex to map at this scale.

Vegetation structure:

M — Dense stand (of mixed evergreen--deciduous forest); trees no farther apart than average height.

M — Open stand (of mixed evergreen--deciduous forest); trees farther apart than average height.

M — Stand of variable density (mixed evergreen--deciduous forest); some trees farther apart than average height, others closer than average height.

/ — Used between 2 unit symbols to indicate that those 2 vegetation units occur intermingled in patterns too small to map at this scale. The first (left) symbol determines map unit pattern.

( ) — Vegetation represented by symbol in parentheses occurs as an unmappable inclusion within the map unit indicated to the left of the parenthesis.

Tree (e.g., black spruce) less than 6 feet tall.

Isolated individuals (of white spruce) as inclusions within a map unit.

Polygonal patterns in vegetation.

Stripe patterns in vegetation.

Orientation of wind-formed patterns in vegetation (arrow points downwind).

Composition (used only to record field observations):

White spruce	White birch	Juniper
Black spruce	Aspen	Alder
Larch	Balsam poplar	Willow
Glandular birch	Grass	Mosses
Dwarf birch	Tall grass	Sphagnum moss
Heath shrub	Sedge	Lichens
	Tussock-forming sedge	A Dense aquatic vegetation

Extent of "Granite Mountain Burn", a forest fire of August 1954.

CROSS – COUNTRY MOVEMENT

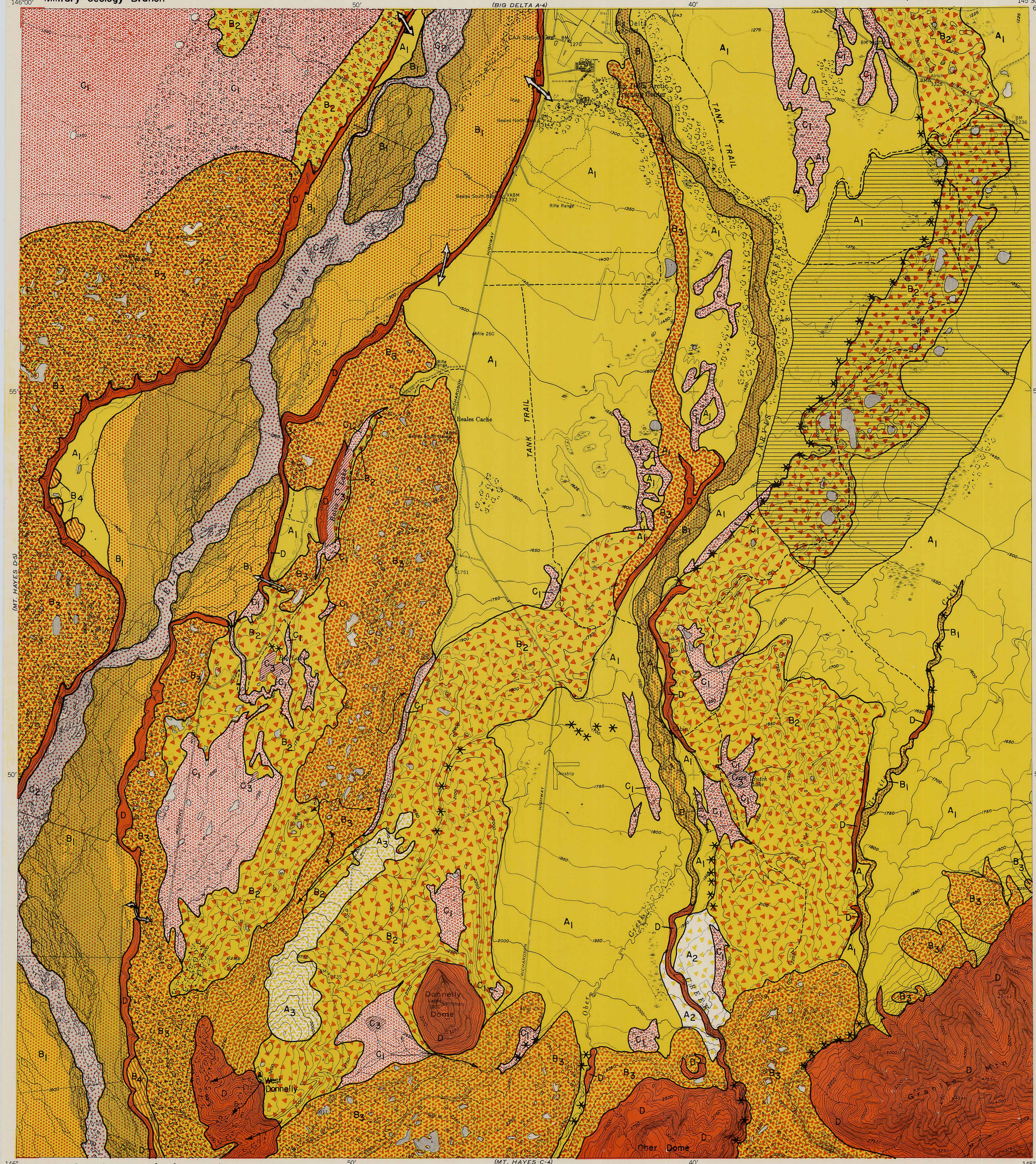
Mt Hayes D-4

SCALE 1:63360

1/2 0 1 2

U. S. Department of the Interior
Geological Survey
Military Geology Branch

Terrain study of the Army Test Area
Fort Greely, Alaska
Map XIII



SPECIAL SYMBOLS

Roadway or trail cut through impassable area.

Fairly good unprepared route in rough terrain; ease of movement equal in both directions.

Possible unprepared one-way route in rough or impassable area.

Trail.

Very dense forest. Stands of trees (most commonly spruce) with trunks 3-10 inches d.b.h. and spaced less than 10 feet apart.

Areas of deep snow. Snow accumulation commonly 2-6 feet deeper than elsewhere in Fort Greely area.

Area of 1954 burn. Almost bare ground, as result of 1954 fire. Charred spruce and aspen poles falling to ground; and willows, aspen, and herbaceous plants growing up in the area.

Base map Geological Survey 1:63,360 series (Topographic), Mt. Hayes (D-4) Quadrangle, Alaska, edition of 1952.

Cross-Country Movement Evaluation by G. W. Holmes, 1956.

Legend Analysis and Evaluation of Cross-Country Movement in the Test Area accompanies Map XIII

EXPLANATION

PASSABLE AT ALL SEASONS *

A1 Some moraine surfaces; outwash plains; younger composite terrace; portions of older composite terrace; coalescent alluvial fans of Granite Mts.

A2 Boulder terrace.

A3 Moraine-covered surface of West Donnelly Hill.

LOCALLY IMPASSABLE IN ONE OR MORE SEASONS *

B1 Flood plains and channels of Jarvis Creek and Granite Creek.

B2 Most Delta moraines; sections of Donnelly moraines; Donnelly recessional outwash plains of Big Lake; dune-covered older composite terrace. south

B3 Most Donnelly moraines; parts of Delta moraines.

B4 Individual alluvial fans and older composite terrace.

ENTIRE UNIT IMPASSABLE IN ONE OR MORE SEASONS *

C1 Large bogs, muskegs, and marshes.

C2 Delta River.

C3 Lakes.

IMPASSABLE AT ALL SEASONS *

D Bedrock hills; Granite Mts.; stream bluffs; narrow or boulder-choked valleys.

* General evaluation is basis of map units, and refers to feasibility of cross-country movement by a tactical unit which includes tanks, light tracked vehicles, and foot soldiers.

ANALYSIS AND EVALUATION OF CROSS-COUNTRY MOVEMENT IN THE TEST AREA

(to accompany Map XIII Cross-Country Movement)

GENERAL EVALUATION *	Symbol	MAP UNITS Mesgnostic Landforms	PERSISTENT GROUND CONDITIONS AFFECTING CROSS-COUNTRY MOVEMENT		SEASONAL CONDITIONS AFFECTING CROSS-COUNTRY MOVEMENT				VEGETATION AFFECTING CROSS-COUNTRY MOVEMENT								Means of ** Movement **	EVALUATION BY SEASONS **			
					Summer		Freeze-up		Winter		Break-up		Summer		Freeze-up		Winter			Summer	Freeze-up	Winter	Break-up
Passable at all seasons	A1	Some moraine surfaces, outwash plains, younger portions of older composite terraces, poorly terraced, coalescent alluvial fans of Granite Mts.	No important irregularities.		Flat, relatively dry surfaces, except for a few small bogs and muskegs.		Same as summer.		Snow cover relatively uniform. Barely more than 1.5 feet. Snow-free in places exposed to wind.		Soft snow, slush, sheet floods, running water in gullies. Ground firm.		No important irregularities in the terrain.		Same as summer.		No hindrance by vegetation.		Medium tracked Light tracked Foot	P P	P P	P P	P P
	A2	Boulder terrace.	Irregular swales 5-10 feet deep on terrace.		Flat dry surfaces, boulders up to 7 feet diameter exposed.		Snow cover partly hides boulders.		Soft snow, slush, many boulders exposed. Water in swales. Ground firm.		No hindrance by vegetation.		Same as summer.		Snow cover uniform on inter-stream surfaces. Some gullies drifted over.		Soft snow, slush, and ground firm.		Medium tracked Light Foot	S S	S S	S S	S S
	A3	Moraine-covered surface of West Donnelly Hill.	Broad solifluction terrace pormarfrost at shallow depth.	very gently sloping or level,	Pits and hummocks exposed, locally boggy. Ground firm.		Thin snow over generally firm ground, locally saturated.		Snow cover, strength, and thickness variable.		Soft snow, slush, small rills. Ground firm.		Pits and hummocks exposed, locally boggy. Ground firm.		Thin snow over generally firm ground, locally saturated.		Soft snow, slush, small rills. Ground firm.		Medium tracked Light Foot	P P S S	P P S S	P P S S	P P S S
Passable at all seasons in one Locally impassable	B1	Flood plains and channels of Jarvis Creek and Granite Creek.	Shallow abandoned channels - maximum depth 3-5 feet.	rolling	Flat dry gravel surfaces. Few narrow, deep channels. Numerous channels. Boulders in places.		Thin ice, thin snow.		Soft snow, slush, very thin ice on channels. Gravel bars.		Soft snow, gravel-covered sections: Except for driftwood, no hindrance by vegetation on gravel-covered sections.	Silt and sand-covered sections: Dense stands of mixed forest; local thickets.	Flat dry gravel surfaces. Migrating sand dunes. Driftwood. Numerous channels. Boulders in places.		Open water. Most pools 4 feet deep		Soft snow and weak ice.		Medium tracked Light Foot	I I	I I	S, L S, L	I I
	B2	Most delta moraines; sections of Donnelly moraines; Donnelly recessional outwash plains of Mt Imay; dune-covered older composite terrace.	Moderate slopes typically 5-10 percent, rarely more than 30 percent; approximately 1-5 hill summits or depressions and 2 bogs per square mile.	rough topography; closely spaced	Flat dry ridges and summits; muskegs on some lower slopes, bogs, marshes, muskegs, and pools in depressions.		Same as summer, except bogs, marshes, muskegs, and partly frozen.		Snow cover non-uniforms; deep drifts in lee of knobs, ridges, ponds, bogs, wind-hardened drifts. Snow partly covers boulders.		Soft snow, slush; pond ice soft. Imbedge net not developed; local ponding. Bogs, marshes flooded;hill tops and ridges may be firm if bare in winter. Ground firm.		Flat dry ridges and summits; muskegs on some lower slopes, bogs, marshes, muskegs, and pools in depressions.		Same as summer, except bogs, marshes, muskegs, and partly frozen.		Soft snow, slush; pond ice soft. Imbedge net not developed; local ponding. Bogs, marshes flooded;hill tops and ridges may be firm if bare in winter. Ground firm.		Medium tracked Light Foot	P, L P, L	P, L P, L	S S	S, L S, L
	B3	Most Donnelly moraines; parts of Delta moraines.	Slope typically 10-20 percent, rarely more than 60 percent; approximately 5-15 hill summits or depressions and 1 bog per square mile.	hilly, ridged, dissected and spaced	Same as Bg unit, except bogs smaller, fewer, ponds more numerous. Boulders exposed on ridges. Most commonly west slopes silt-covered.		Same as summer, except bogs, marshes, muskegs more difficult when partly frozen.		Snow cover non-uniforms; deep drifts in lee of knobs, ridges, ponds, bogs, wind-hardened drifts. Snow partly covers boulders.		Soft snow, slush; pond ice soft. Imbedge net not developed; local ponding. Bogs, marshes flooded;hill tops and ridges may be firm if bare in winter. Ground firm.		Same as Bg unit, except bogs smaller, fewer, ponds more numerous. Boulders exposed on ridges. Most commonly west slope silt-covered.		Same as summer, except bogs, marshes, muskegs more difficult when partly frozen.		Soft snow, slush; pond ice soft. Imbedge net not developed; local ponding. Bogs, marshes flooded;hill tops and ridges may be firm if bare in winter. Ground firm.		Medium tracked Light Foot	P, L P, L	P, L P, L	S S	S, L S, L
	C1	Large bogs, muskegs and marshes.	Fibrous, compressible vegetation mat; thin peat over silt with high moisture content. Permafrost 2-4 feet below surface.		Uneven surface in hummock and tussock bogs and muskegs. Low bearing strength and poor traction.		Same as summer. More difficult when surface is frozen and submerged. Ice still thawed.		Uneven to smooth snow-covered surfaces depending on exposure to wind and snowfall.		Soft snow, slush, pondling, but ground is firm.		No hindrance by slush or scrub. Plant parts lodge and accumulate in snowshoes and hummocks slow foot travel.		Medium tracked Light Foot	I to S P S	I to S P S	P P S	S S S
	C2	Delta River.	On broad flood plain, exposed to winds. Inclosed by steep, high bluffs; location on flood plain above is generalized. River channels frequently shift.		Many channels, all sizes up to 15 feet deep, shifting and changing shape.		Fewer channels. Some forchable. Thin channel ice and lcings.		Broad icings, irregular snow cover, uneven surface, open channels; ice up to 3 feet thick.		Soft snow, persistent ridges, open channels widely distributed.		No hindrance by vegetation. No hindrance by vegetation. No hindrance by vegetation.		Medium tracked Light Foot	I I	I to S I	S, L S, L	I I
	C3	Lakes.	Isolated by granite to steep slopes; nearly connected to streams.		Open water. Most pools 4 feet deep		Thin ice, thin snow.		Uniform strong ice typically 3 feet thick. Snow cover depends on wind exposure.		Soft snow and weak ice.		No hindrance by vegetation. Pond borders marshy or boggy. No hindrance by vegetation. Pond borders marshy or boggy. No hindrance by vegetation. Pond borders marshy or boggy.		Medium tracked Light tracked Foot	I I	I I	P P	I I
	D	Bedrock Hills; Granite Mountains; stream Buffsy narrow or boulder-choked valleys.	Includes slopes from 60 percent to vertical.		Surface uneven because of talus, solifluction deposits, pits, gullies and rubble, alluvial fans, alluvium, and ground moraine.		Same as summer, with possibility of uneven snow cover.		Uneven snow cover depending on slope, exposure, elevation.		Soft snow, slush; rapid runoff in gullies and streams.		Local shrub and scrub thickets and small stands of dense forest. Local shrub and scrub thickets and small stands of dense forest. Local shrub and scrub thickets and small stands of dense forest.		Medium tracked Light tracked Foot	I I	I I	I I	I I

* General evaluation is basis of map units and refers to feasibility of cross-country movement by a tactical unit, which includes medium tanks, light tracked vehicles, and foot soldiers.

** Wheeled tracked refers to medium tanks and equivalent. Light tracked refers to vehicles or equivalent. Foot includes ski and snowshoe travel.

*** P - Passable, also I - Impassable L - Impassable locally