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## CIVIL EFFECTS STUDY

# AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF THE NATIONAL REACTOR TESTING STATION AREA, IDAHO (ARMS-I)

Robert G. Bates





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**CIVIL EFFECTS TEST OPERATIONS**
**U.S. ATOMIC ENERGY COMMISSION**

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# AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF THE NATIONAL REACTOR TESTING STATION AREA, IDAHO (ARMS-I)

By

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March 1963

# NOTICE

This report is published in the interest of providing information which may prove of value to the reader in his study of effects data derived principally from nuclear weapons tests and from experiments designed to duplicate various characteristics of nuclear weapons.

This document is based on information available at the time of preparation which may have subsequently been expanded and re-evaluated. Also, in preparing this report for publication, some classified material may have been removed. Users are cautioned to avoid interpretations and conclusions based on unknown or incomplete data.

# ABSTRACT

An airborne radioactivity survey was made of the area around the National Reactor Testing Station near Idaho Falls, Idaho. The survey area is a square, 100 miles on a side, centered on the Testing Station reservation. Parallel flight lines were flown in an east-west direction with a flight line interval of 1 mile and at an altitude of 500 ft above the ground. The survey was made by the U. S. Geological Survey for the U. S. Atomic Energy Commission as part of its nationwide program of airborne radioactivity surveys of nuclear installations.

The area includes parts of three physiographic subdivisions. They are, from north to south, the Northern Rocky Mountains province, the Snake River Plain section of the Columbia Plateaus province, and the Great Basin section of the Basin and Range province. Owing to the rugged topography, only small parts of the Northern Rocky Mountains and the Great Basin sections within the survey area could be flown. In those parts flown, silicic volcanic rocks of Tertiary age have radioactivity levels as high as 2100 cps (counts per second). On the Snake River Plain radioactivity levels ranged from 200 to 1600 cps and averaged about 600 to 800 cps. Delineation of some Recent lava flows by the radioactivity data is excellent. Increase in radioactivity level toward the center of a lava flow may be indicative of successive flows from a differentiating magma source. The radioactivity level of blocky lava flows is 50 to 100 cps higher than that of adjacent ropy flows. This is probably due to a greater emitting surface area per unit volume on the blocky flows rather than to any difference in mineralogical content.

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# AERORADIOACTIVITY SURVEY AND AREAL GEOLOGY OF THE NATIONAL REACTOR TESTING STATION AREA, IDAHO (ARMS-I)

## 1. INTRODUCTION

### 1.1 Location and Purpose of Survey

The National Reactor Testing Station (NRTS) area is in east-central Idaho (Fig. 1). The survey area is a square with sides 100 miles long and is centered on the NRTS reservation. During the summer

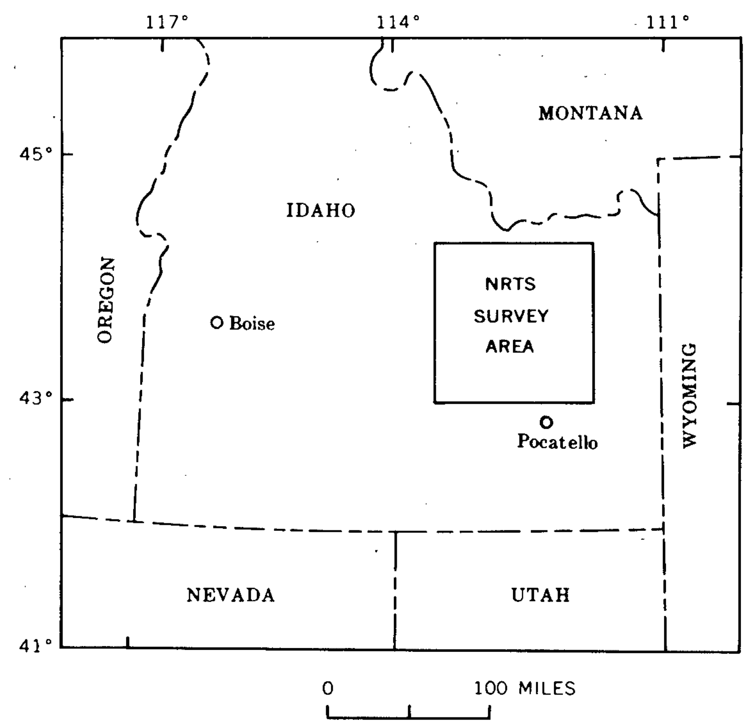


Fig. 1—Location of the National Reactor Testing Station area, Idaho.

of 1959, the U. S. Geological Survey on behalf of the Division of Biology and Medicine of the U. S. Atomic Energy Commission made an airborne radioactivity survey of the NRTS area. This survey was part of the Aerial Radiological Measurement Surveys (ARMS-I) program, a program of airborne radioactivity surveys of nuclear installations in the United States. The purpose of the survey was to determine the natural radioactivity background of the rocks and soils. This information will serve as a reference to determine the amount and extent of any possible future increase in radioactivity level of the area by the NRTS facility through normal operations or any accidents that may occur. Another purpose of the survey was to determine the relation between the distribution of radioactivity and the various geologic units within the area.

## 1.2 Airborne Survey Procedure

The survey was made with scintillation detection equipment installed in a DC-3 aircraft. Parallel east-west flight lines were flown at one-mile intervals. The plane maintained an approximate altitude of 500 ft above the ground and an air speed of 150 mph. Aerial photographs were used for pilot guidance. The flight path of the aircraft was recorded by a gyrostabilized continuous-strip-film camera, and the distance of the aircraft from the ground was measured by a continuously recording radar altimeter. Fiducial markings, providing a common reference for the radioactivity and altimeter data and the camera film, were made with an electromechanical edge-mark system operated by the observer when the aircraft passed over recognizable features on the ground.

The gamma-ray flux at 2000 ft above the ground, which comes from cosmic radiation and to a much lesser extent from radionuclides in the air, except after nuclear tests, is measured twice each day while surveying. This quantity is called the cosmic background at 2000 ft. Theoretically, the cosmic background at 500 ft is nine-tenths that at 2000 ft, and the compensated data have had this nine-tenths of the cosmic component removed. The cosmic background during the survey of the NRTS area ranged from 400 to 600 cps (counts per second).

## 1.3 Scintillation Detection Equipment

The scintillation detection equipment used by the Geological Survey was designed by the Health Physics Division of the Oak Ridge National Laboratory and has been described in detail by Davis and Reinhardt[1]. In describing the sensitivity of the equipment, they state (Ref. 1, p. 717): "With a microgram of radium at one foot from the crystals, the counting rate is roughly 2000 cps." Kermit Larsen[2] determined in 1958 that a count rate of about 77,000 cps would be recorded by the Geological Survey equipment 500 ft above an infinite area of fallout that produced a gamma-ray flux of 1 mr/hr 3 ft above the ground. Davis and Reinhardt[3] experimentally determined that the count rates at 500 ft equivalent to a ground reading of 1 mr/hr from $Cs^{137}$ and $Co^{60}$ semi-infinite plane sources are 25,000 and 18,000 cps, respectively. This seeming discrepancy between the data of Larsen and that of Davis and Reinhardt may be due to the fact that Larsen's data was obtained over an area of fallout which contained many isotopes with different gamma-ray energy levels, whereas Davis and Reinhardt obtained their data from an array of sources containing only one isotope at a time during the experiments.

A block diagram of the equipment is shown in Figure 2. The detecting element consists of six thallium-activated sodium iodide crystals, 4 in. in diameter and 2 in. thick, and six photomultiplier tubes connected in parallel. The signal from the detecting element is fed through amplification stages to a pulse-height discriminator, which is usually set to accept only pulses from gamma radiation with incident energies greater than 50 kev. The signal is then fed to two rate meters. One rate meter feeds a circuit that records total radioactivity on a graphic milliammeter. The signal from the other rate meter is recorded by a circuit from which the cosmic background has been removed. This circuit includes a variable resistance regulated by the radar altimeter servomechanism which compensates the radioactivity data for deviations from the 500-ft surveying altitude. Tests run to determine the area or cone of response of the detection equipment at an altitude of 500 ft indicate that 85 percent of the measured gamma radioactivity comes from a circular area on the ground having a radius of 500 ft.

## 1.4 Compilation of Aeroradioactivity Data

Flight-line and check-point locations from the strip film exposed during the survey were plotted on compilation base maps at a scale of 1 in. equals 1 mile (1:63,360). The altitude-compensated radioactivity profiles for each flight line were examined and points of change or breaks in radioactivity level were selected. These points of change in radioactivity level along the flight line were plotted on the base map. Corresponding changes on adjacent lines were connected to form radioactivity units; the units were assigned values, in counts per second, reflecting the range of fluctuations in radioactivity level within the unit. The compilation base maps were reduced to a scale of 1 in. equals about 4 miles (1:250,000), and the data were transferred to maps of the Geological Survey 1:250,000 topographic map series. The final map thus produced (Pl. 1) shows radioactivity levels and points of change in level as well as sufficient culture and drainage features for orientation in the field. This map, with a short text, has also been published by the Geological Survey[4].

## 1.5 Theoretical Considerations

From the standpoint of airborne radioactivity surveys, only three naturally occurring radioactive elements or isotopes and their daughter products are important. They are uranium, thorium, and $K^{40}$. Only those radionuclides that decay by gamma-ray emission can be detected and measured with scintillation equipment used in airborne surveys.

Sakakura[5] has developed equations that relate airborne radioactivity data, semiquantitatively, to the radioactivity of the ground surface underlying the aircraft.

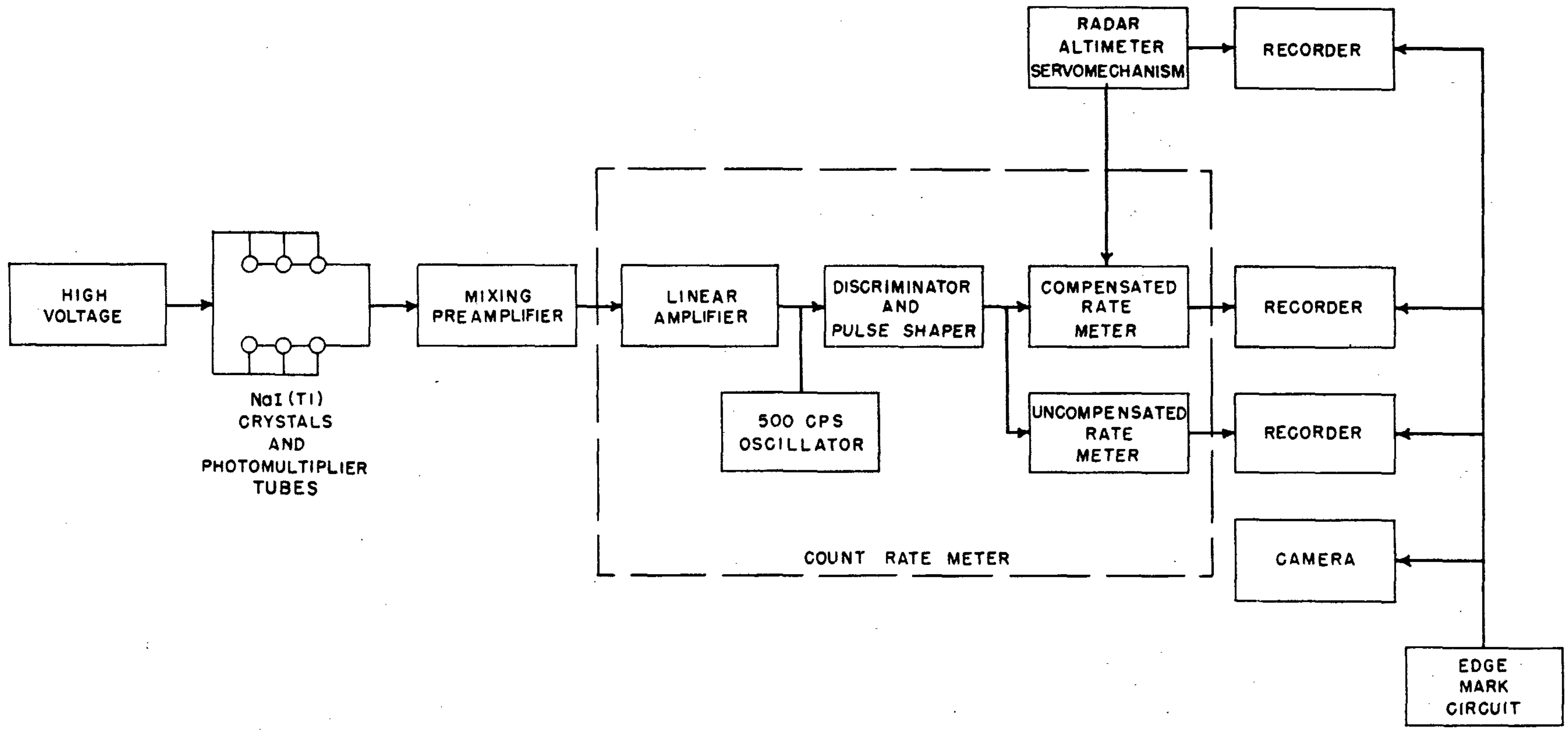


Fig. 2—Diagram of airborne radioactivity surveying equipment.

Radioactivity measured at the surveying altitude of 500 ft above the ground has three components:

1. Gamma-ray activity from radionuclides in or on the ground.
2. Gamma-ray activity from radionuclides in the air.
3. Cosmic-ray components.

The activity from radionuclides in air, such as radon, cannot always be separated from the activity of the radionuclides on the ground. The radon content of the air is variable. Minimum values occur on windy days, days with high barometric pressure, or very wet ground conditions. These radon values can increase by a factor of 10 under conditions of low barometric pressure and strong temperature inversion.

The ground component comes from the surface and the upper few inches of the ground; it consists of gamma rays from natural radionuclides and fission products in fallout. The distribution of fallout in the NRTS area, if present, is assumed to be uniform and small in amount.

## 2. GENERAL GEOLOGY

Most of Idaho is contained within three physiographic provinces[6]. They are, from north to south, the Northern Rocky Mountains, the Columbia Plateaus, and the Basin and Range provinces. Within the survey area the Columbia Plateaus province is represented by the Snake River Plain section, and the Basin and Range province by the Great Basin section; the Northern Rocky Mountains province is not subdivided. The rugged topography in the Northern Rocky Mountains and the Basin and Range provinces confined the airborne surveying almost entirely to the Snake River Plain. Therefore, only an outline of the geology of these two provinces will be given. However, single-line traverses were made in the valleys of Big Lost River, Little Lost River, and Birch Creek and across the Lost River Range through Double-spring Pass, all within the Northern Rocky Mountains province (Pl. 1).

The geologic information contained in this report is from Umpleby[7], Mansfield[8,9], Stearns and others[10,11], and Ross[12]. An outline report on the geology of Idaho by Ross and Forrester[13] was very useful in correlating the work of the other geologists. The geology shown in Figure 3 is modified from the Geologic Map of Idaho[14].

Rocks in the NRTS survey area range in age from Precambrian to Recent. The oldest rocks, slates and quartzites of the Belt Series of Precambrian age, are exposed in the Lemhi and Lost River ranges in the northern part of the area. The youngest rocks, basalt flows of earliest Pleistocene to Recent age, underlie the Snake River Plain.

In the Northern Rocky Mountains province complexly folded and faulted carbonate and clastic rocks of Paleozoic age unconformably overlie rocks of the Belt Series. Unconformably overlying the Paleozoic rocks are remnants of volcanic rocks, intermediate in composition, of middle Tertiary age. On the east flank of the Beaverhead Range, silicic rocks and unconsolidated lacustrine and fluviatile sediments of late Tertiary age are exposed. Several isolated areas of Quaternary basalt are present on the east flank of the Lemhi range. Quaternary alluvial deposits are present along the streams and form the surface of the major valleys.

The Great Basin section of the Basin and Range province contains a thick sequence of complexly folded and faulted Paleozoic and Mesozoic strata. These rocks are predominantly carbonate rocks with lesser amounts of quartzite and sandstone and minor amounts of shale. Unconformably overlying the Paleozoic and Mesozoic strata are areas of conglomerate, sandstone, shale, and marl with some interbedded volcanic ash and tuff, all of late Tertiary age. Rhyolitic and basaltic rocks are both contemporaneous with and later than the Tertiary sediments. Quaternary alluvium covers parts of the flats between the mountains and the Snake River and is present along most of the streams.

The Snake River Plain passes through the survey area from the southwest corner of the northeast corner and makes up more than one-half of the area. Because of the rugged topography in the rest of the survey area, nearly all of the flying was confined to this area. Over most of the central and southern parts of the area basalt flows are exposed or covered by only a few feet of unconsolidated deposits. In the northern part of the area exposures of basalt are less common, being covered by lake and eolian deposits. The age of the basalt ranges from earliest Pleistocene to Recent. The youngest basalt flows are in the Craters of the Moon National Monument and are probably less than 2000 years old. Rising above the level of the basalt flows are numerous small buttes and cones, some of which were sources of the flows. Three prominent buttes, East Butte, Middle Butte, and Big Southern Butte, tower 1000 feet or more above the surrounding flows. East Butte is composed of trachyte and rhyolitic rocks, Big Southern Butte is mostly rhyolite with some basalt, and Middle Butte is entirely basalt. These three buttes are older than the surrounding Quaternary basalt flows and are of middle Tertiary age. Well records indicate that the thickness of the basalt is in excess of 1500 ft in some places (Ref. 15, p. 85). The rocks of the Plain are remarkably free from faults and those present generally have displacements of 5 ft or less. Many of the flows erupted from fissures which may reflect buried faults or zones of weakness. The basalt flows contain both blocky and ropy type flows, the ropy flows predominating.

Lake beds consisting of unconsolidated clay, silt, and sand occur in the area south and east of Mud Lake and extend as far west as the Birch Creek and Lost River sinks opposite the entrance of the valley of Birch Creek. These deposits cover an area of at least 140 square miles, but in places they are covered by loess, other eolian deposits, and Recent alluvium. Other lake deposits of lesser areal extent occur in the area north and northwest of Roberts and along the west bank of the Snake River from the southern edge of the survey area northeast almost to Pingree. Recent alluvial deposits occur along the Snake River and opposite the valleys of Big Lost River, Little Lost River, and Birch Creek.

## 3. DISTRIBUTION OF AERORADIOACTIVITY

### 3.1 National Reactor Testing Station Survey Area

The natural gamma aeroradioactivity level within the NRTS survey area ranges from 200 to 2100 cps (Pl. 1 and Fig. 4). Owing to a lack of control information, it was necessary to assume that fallout, if present, was uniform throughout the survey area. The low level of radioactivity, 300 to 350 cps, of the lava flow southwest of Idaho Falls, indicates that fallout, if present, is a minor factor in the total radioactivity level.

The highest radioactivity levels (as much as 2100 cps) occur along the northeastern and eastern borders of the survey area. The lowest levels occur over the lava flow southwest of Idaho Falls (300 to 500 cps) and the low-lying area northeast of American Falls Reservoir (200 to 350 cps).

Because of the rugged topography only small portions of the Northern Rocky Mountains and Great Basin were flown. Over most of the portions flown radioactivity levels ranged from 400 to 800 cps. Higher levels, up to 2100 cps, were present over limited areas of siliceous volcanic rocks.

Radioactivity levels over the Snake River Plain generally ranged from 400 to 800 cps with values as high as 1600 cps noted around Big Southern Butte.

### 3.2 National Reactor Testing Station Reservation

The distribution of natural and facility-induced gamma radioactivity within the NRTS reservation is shown in Figure 5. It should be noted that some radioactivity readings shown on this map are higher than the range of values observed from similar geologic sources elsewhere within the NRTS survey area. These higher readings result from normal atomic-energy operations at the NRTS facility. Also, the Geological Survey equipment is extremely sensitive to small changes in radioactivity levels.

Information on radioactivity levels in the environs and outside the plant boundaries of AEC and contractor installations is reported in special periodic reports from each installation. Semiannual reports entitled <u>Environmental Levels of Radioactivity for the National Reactor Testing Station Area</u> are made available directly to the public by the AEC, and summaries are also published in the U. S. Public Health Service series titled <u>Radiological Health Data</u>, issued monthly and available from the Government Printing Office, Washington, D. C.

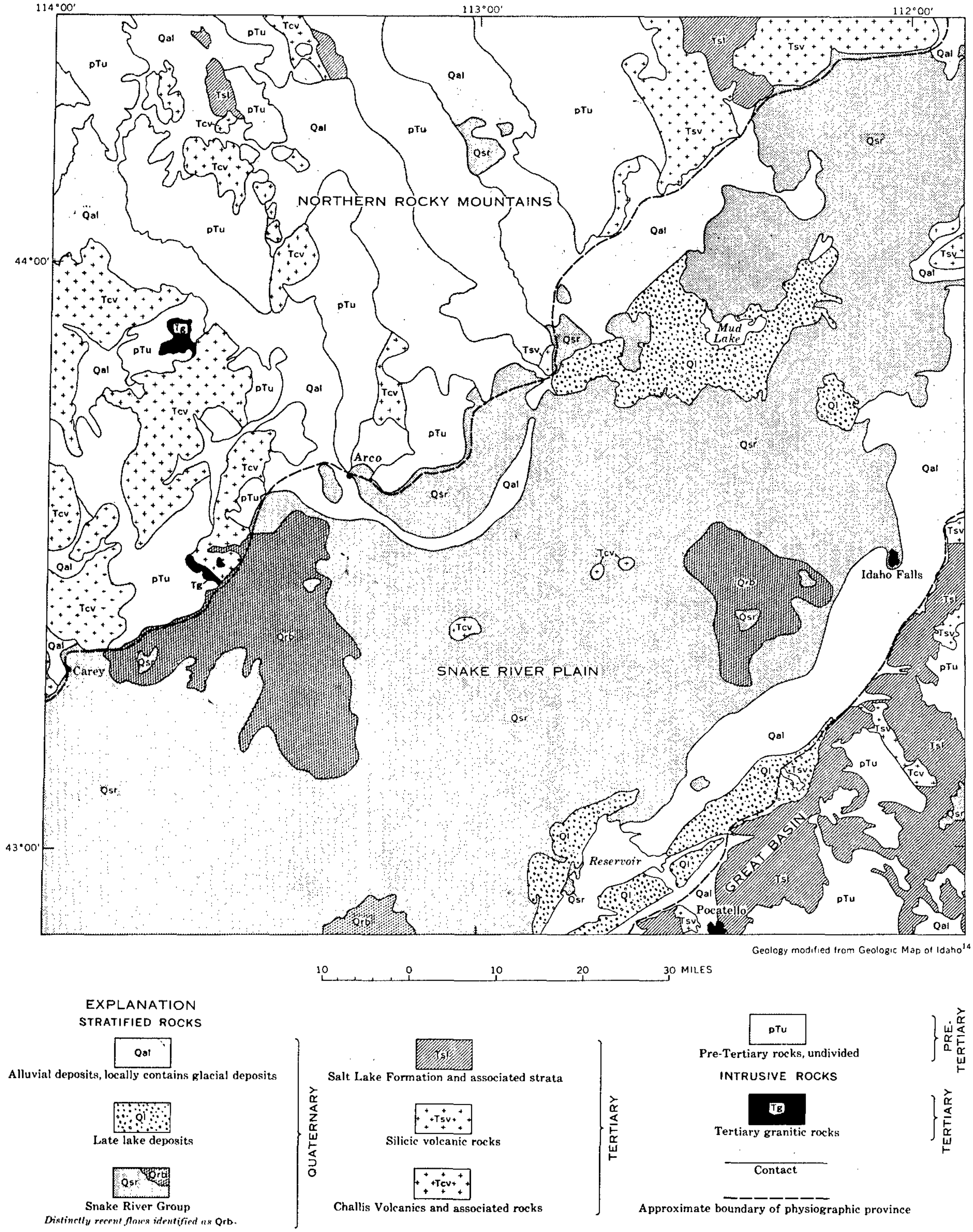


Fig. 3—Generalized geologic map of the National Reactor Testing Station area, Idaho.

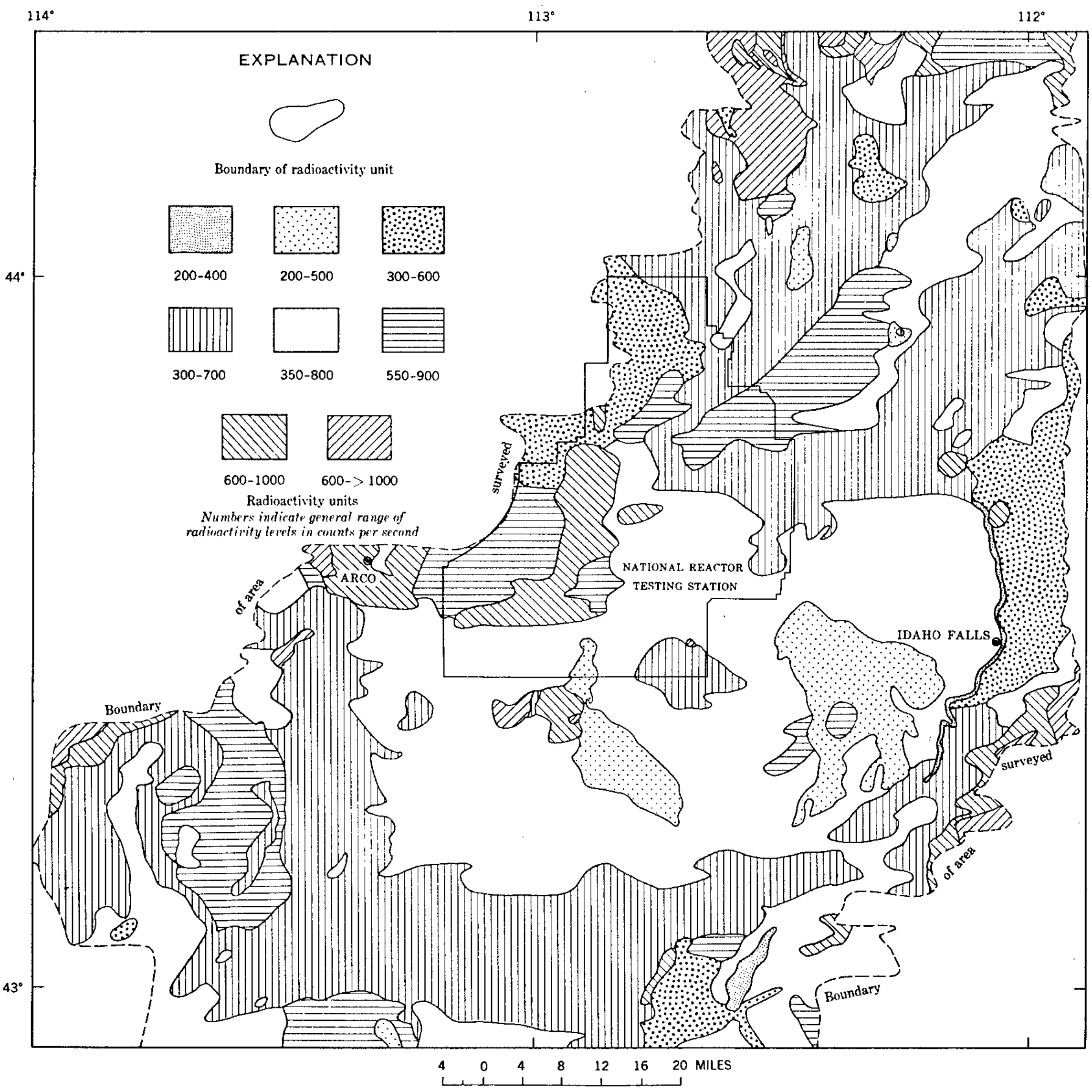


Fig. 4—Generalized aeroradioactivity map of the National Reactor Testing Station area, Idaho.

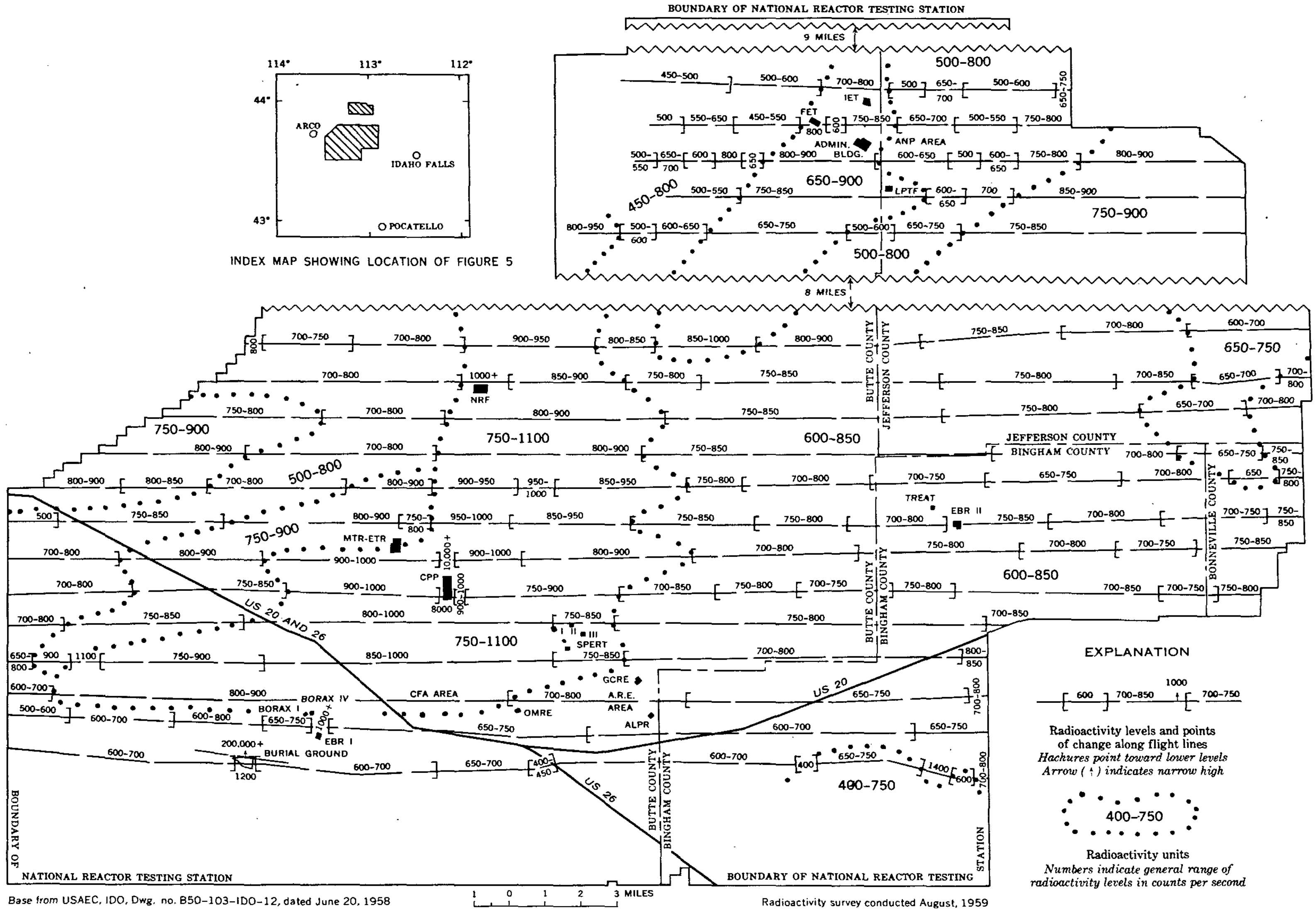


Fig. 5— Airborne radioactivity survey of part of the National Reactor Testing Station, Idaho.

## 4. RELATION OF AERORADIOACTIVITY DATA TO GEOLOGY

### 4.1 Northern Rocky Mountains Province

Radioactivity levels within the Northern Rocky Mountains province are a reflection of the geology of the province. High radioactivity levels, as much as 2100 cps, 15 miles northwest of Dubois in the northeastern part of the survey area, are associated with areas of siliceous volcanic rocks of Tertiary age and areas of alluvium derived from these rocks. The linear pattern of some of these anomalies is a reflection of the concentration of radioactive minerals in channels of intermittent streams which drain the area of siliceous volcanic rocks. A few miles north of Carey, along the western edge of the map (Pl. 1), a smaller, though equally intense, anomaly is associated with exposures of Challis Volcanics.

Owing to the rugged terrain of the remainder of the province within the survey area, parallel east-west traverse lines could not be flown. Single-line traverses were made, however, of Doublespring Pass and the valleys of Birch Creek, Little Lost River, and Big Lost River. The alluvial floor of the valley of Birch Creek was derived from arenaceous and carbonate rocks of the surrounding mountains and has a low radioactivity level. Some siliceous volcanic rocks are within the drainage area of Little Lost River and still more within the Big Lost River drainage area. This is reflected by the radioactivity data in that average radioactivity levels within the valley of Little Lost River (500 to 600 cps) are higher than those of Birch Creek (400 to 500 cps), and levels within the valley of Big Lost River are still higher (800 to 900 cps). Opposite the mouth of Antelope Creek, which drains an area of Challis Volcanics, the radioactivity level of the alluvium is 800 to 1000 cps.

### 4.2 Snake River Plain Section

Several different geologic units are present within the Snake River Plain and most are reflected in the radioactivity data. Around Mud Lake, along the northwest shore of American Falls Reservoir, and immediately north of Roberts, Quaternary lake beds have a radioactivity level of 600 to 900 or 1000 cps which is higher than the surrounding Snake River Group and Quaternary alluvium.

Alluvial deposits northwest of Mud Lake and along the Snake River range in level from 400 to 800 cps and average about 500 to 700 cps.

Sharp radioactivity highs (up to 1600 cps) are present over the Challis Volcanics at Big Southern Butte and East Butte. The radioactivity level is similar to that associated with silicic volcanic rocks to the north and east.

There is considerable variation in radioactivity level of the Snake River Group. Levels range from 300 to 350 cps for the lava southwest of Idaho Falls to 700 to 1100 cps over a serrate flow in the Craters of the Moon National Monument. Both of these are Recent flows. The remaining older flows have a narrower range and intermediate levels of radioactivity. During the survey it was noted that thin partial cover of alluvial and eolian material increased the radioactivity level by 50 to 100 cps over that of the adjacent bare basalt. It was also noted that the radioactivity level of blocky lava was 50 to 100 cps higher than that of nearby ropy lava. This probably does not indicate a difference in radioactive mineral content but rather is a reflection of the greater emitting surface area exposed, per unit volume, by the blocky lava.

The delineation of some lava flows by the radioactivity data is excellent. The large Recent flow southwest of Idaho Falls is almost perfectly outlined by a radioactivity low with a range of 300 to 500 cps. The 800 to 900 cps high within this low outlines a window through which older flows are exposed. Another Recent flow outlined by the radioactivity data extends north and south from Cedar Butte in the center of the Snake River Plain. The flow has a radioactivity level of 300 to 500 cps. Delineation of the flow by the radioactivity data is particularly good north of the Union Pacific tracks. The most recent flows are in the western part of the survey area and include the Craters of the Moon National Monument. The eastern and northern borders of these flows are accurately outlined by the eastern and northern edge of a 400 to 700 cps radioactivity unit. Unlike other Recent flows, these flows have an intermediate to high radioactivity level (400 to 1100 cps) and considerable variation in level from one part of the flow to another.

On the basis of the radioactivity data it is possible to draw some tentative conclusions regarding some of the Recent flows. The uniform radioactivity level of the flow to the north, east, and south of Cedar Butte suggests a flow or flows from a single vent or flows from several vents with a common magma source. Commonly, the later stages of a magma are higher in radioactive mineral content than earlier stages of the same differentiating magma. Therefore, if the lava body was formed by multiple flows, they were probably closely spaced in time. The 700- to 1000-cps radioactivity unit on the west flank of Cedar Butte may represent a later-stage differentiate of the same magma body.

The lava body southwest of Idaho Falls has a uniform radioactivity level of 300 to 350 cps except for the small southwest extension which has a radioactivity level of 300 to 500 cps. The differing radioactivity levels may indicate two different source magmas for the body of lava, or more likely may indicate a common source with a different time of outwelling, the southwest extension being a later differentiate.

The picture is more complicated in the Craters of the Moon area. There cinder cones, lava bombs, and other products of explosive eruption are present in addition to lava flows. The radioactivity level of this flow (Unit Qrb, Fig. 3) increases toward the center. The outer zone has a radioactivity level of 400 to 700 cps, the intermediate zone has a level of 700 to 900 cps, and along the northern edge of the monument boundary there is a 700 to 1000 cps radioactivity unit. This could indicate an increase in radioactive mineral content in each succeeding flow owing to differentiation of the magma. Considering the relatively small area involved, it probably does not indicate different magma sources. The 500 to 800 cps unit centered on the northern half of the monument is over an area in which explosive volcanic rock types predominate.

## 4.3 Basin and Range Province

Where flown, the Paleozoic and Mesozoic sedimentary rocks generally had a radioactivity level of 800 cps or less. All values in excess of this level are over areas of silicic volcanic rocks of Tertiary age or areas of alluvium derived in large part from these rocks.

## 4.4 Summary

Natural radioactivity levels within the NRTS area ranged from 200 to 2100 cps. Areas of silicic volcanic rocks had the highest radioactivity levels, and a low-lying area along the northeast shore of American Falls Reservoir the lowest.

Some areas of lake deposits and Recent basalt flows are well outlined by the radioactivity data. Uniform radioactivity levels of some basalt flows suggest a common magma source. Variation in radioactivity level over other basalt flows suggest differentiation of the source magma or different magma sources. The radioactivity level of blocky lava is 50 to 100 cps higher than that of ropy lava.

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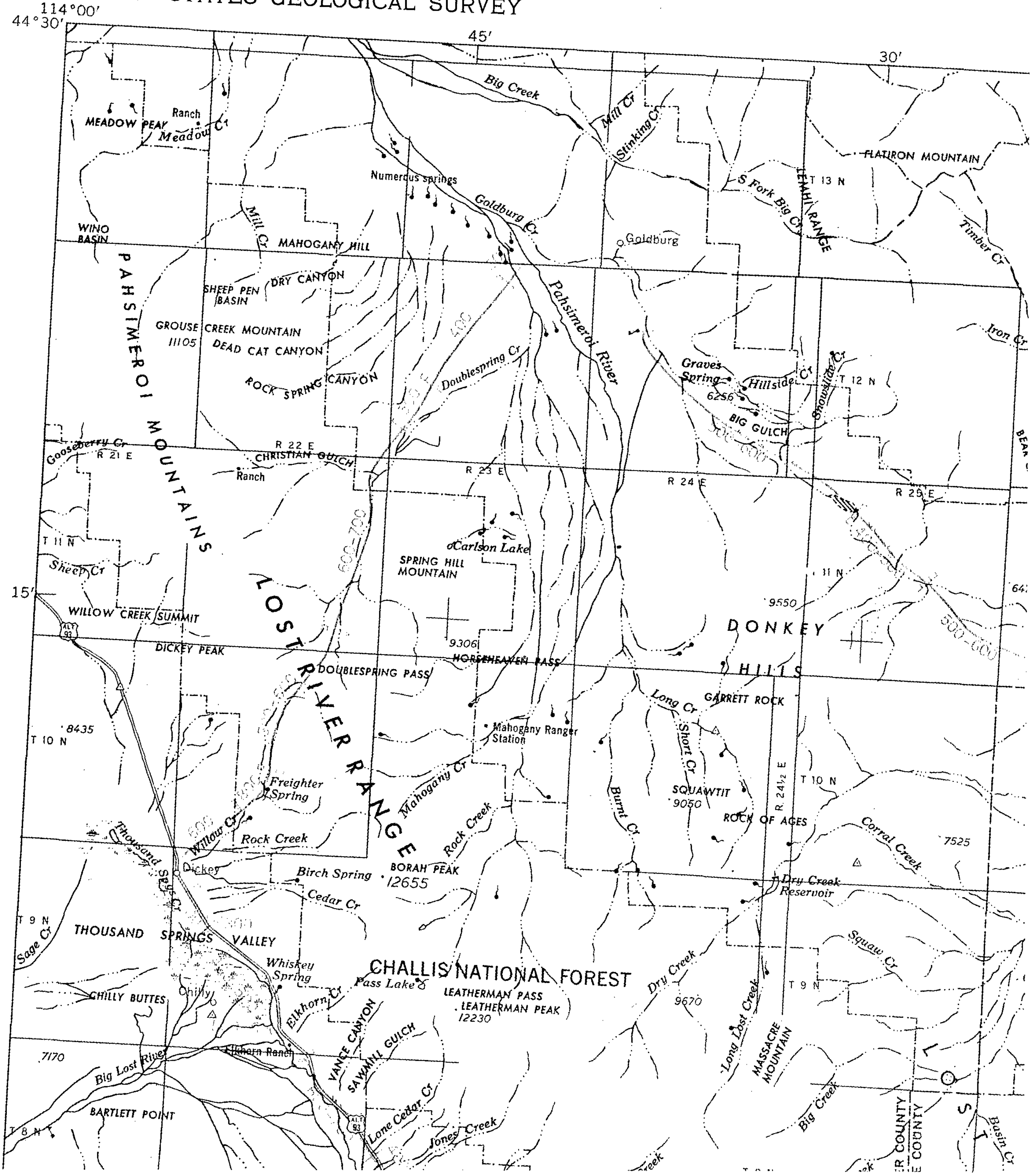

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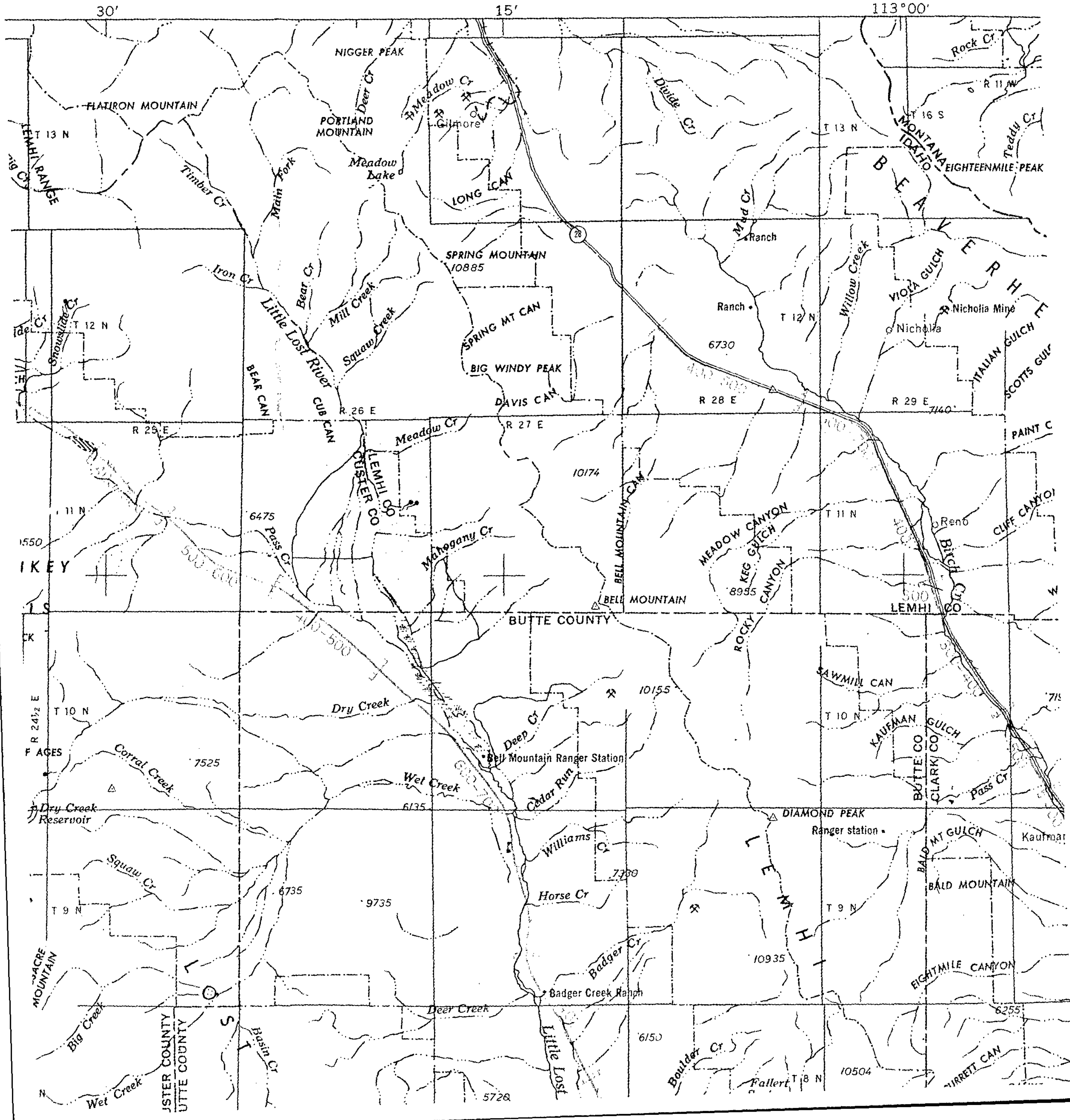

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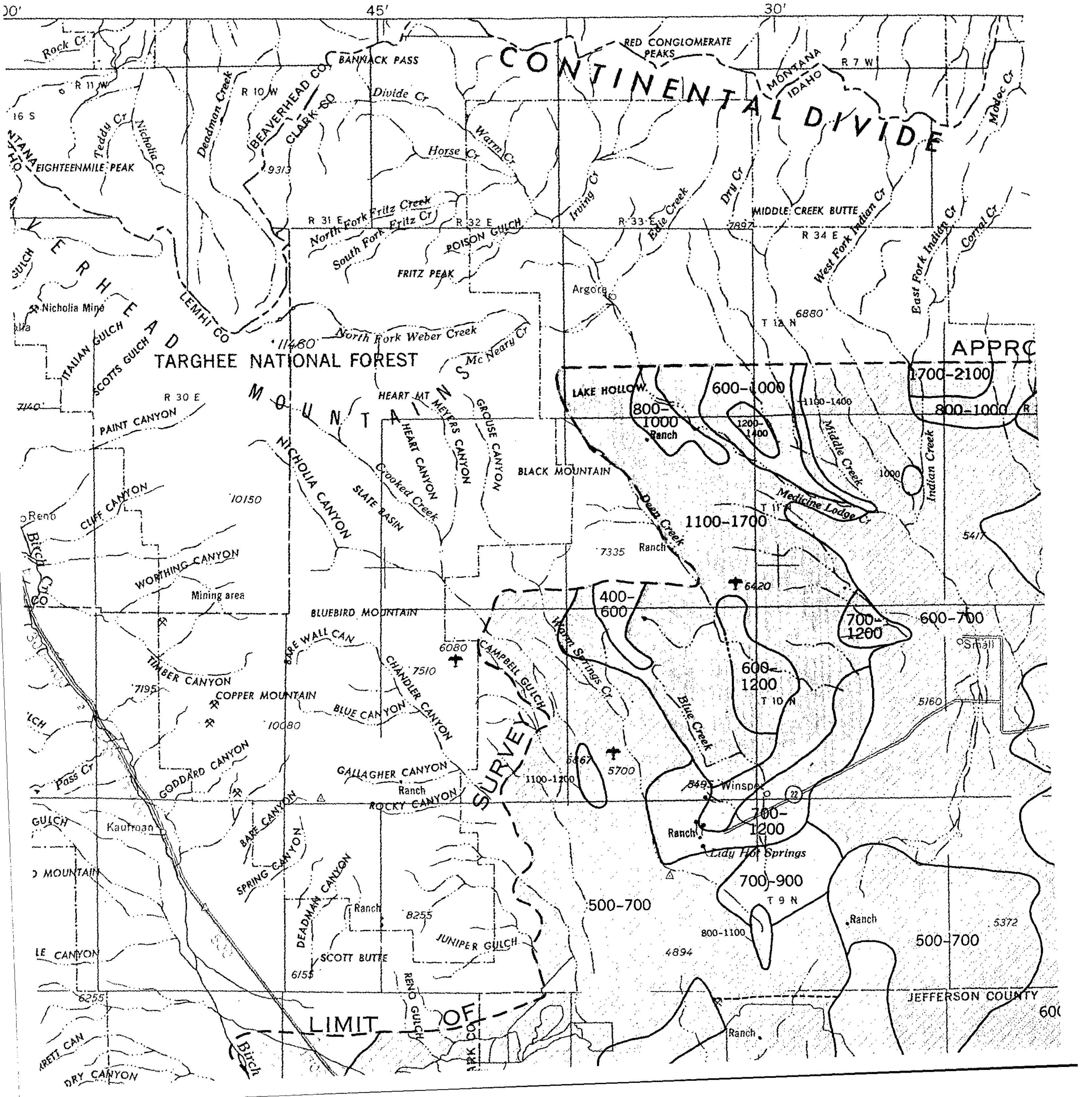

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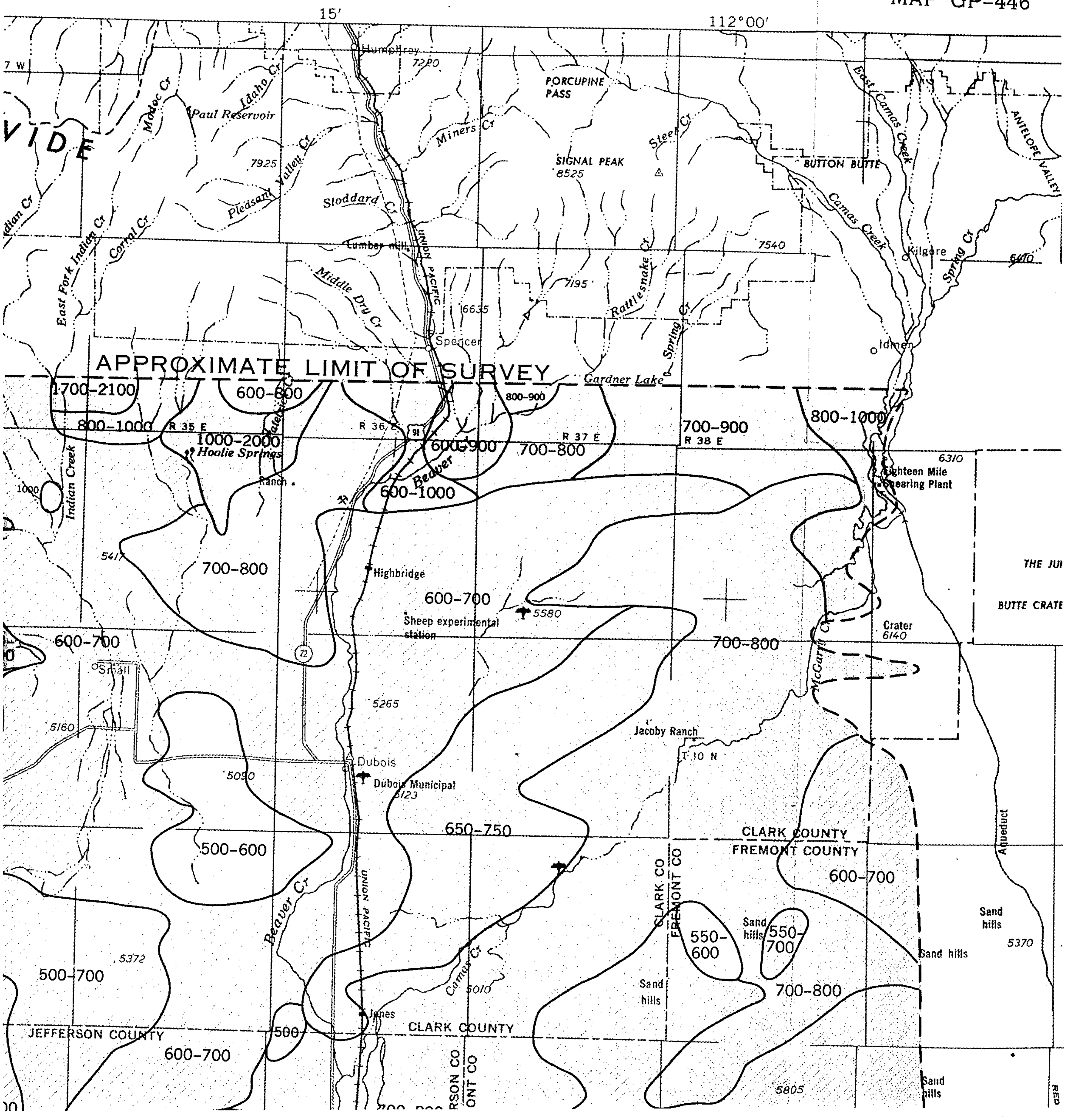
GEOPHYSICAL INVESTIG.
MAP GP-446



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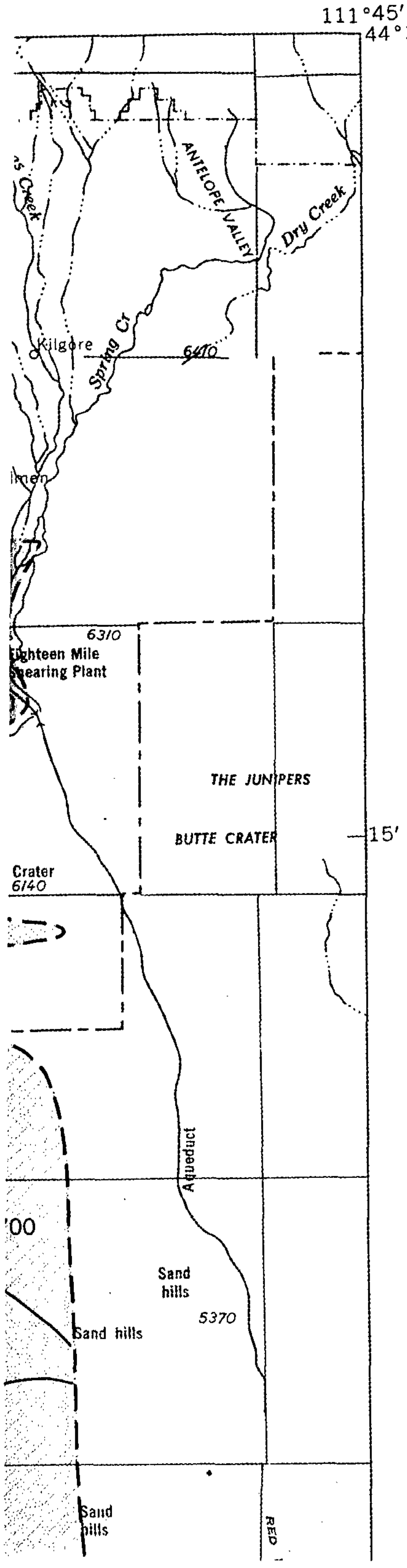
MAP GP-446




## EXPLANATION

500–800

Radioactivity unit boundary

*Numbers indicate general range of radioactivity levels in counts per second. Dashed where inferred*

Single-line traverse

*Radioactivity levels and points of change along flight line. Hachures point toward lower levels*

200–400

200–500

300–600

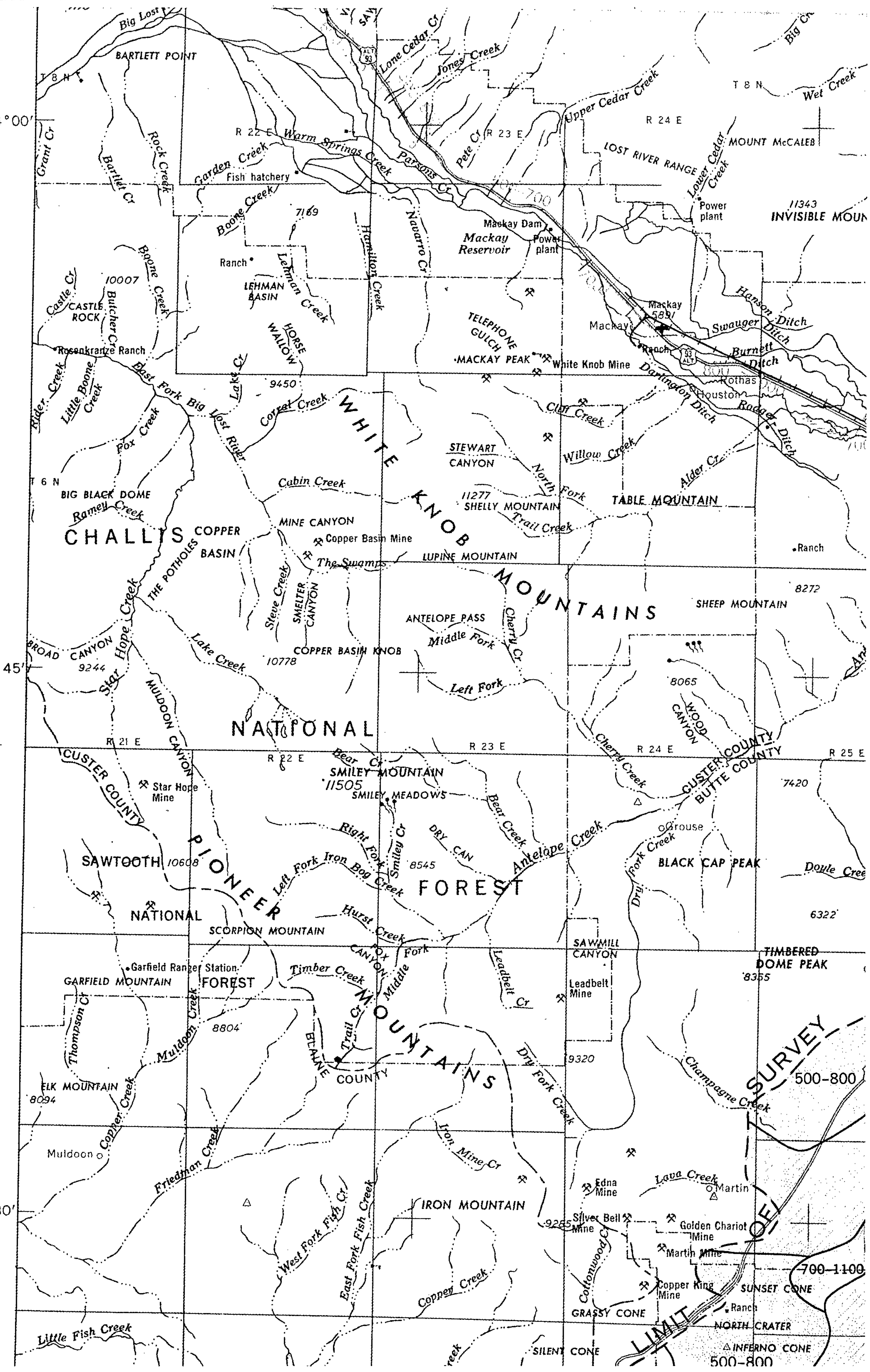
300–700

350–800

550–900

600–1000

6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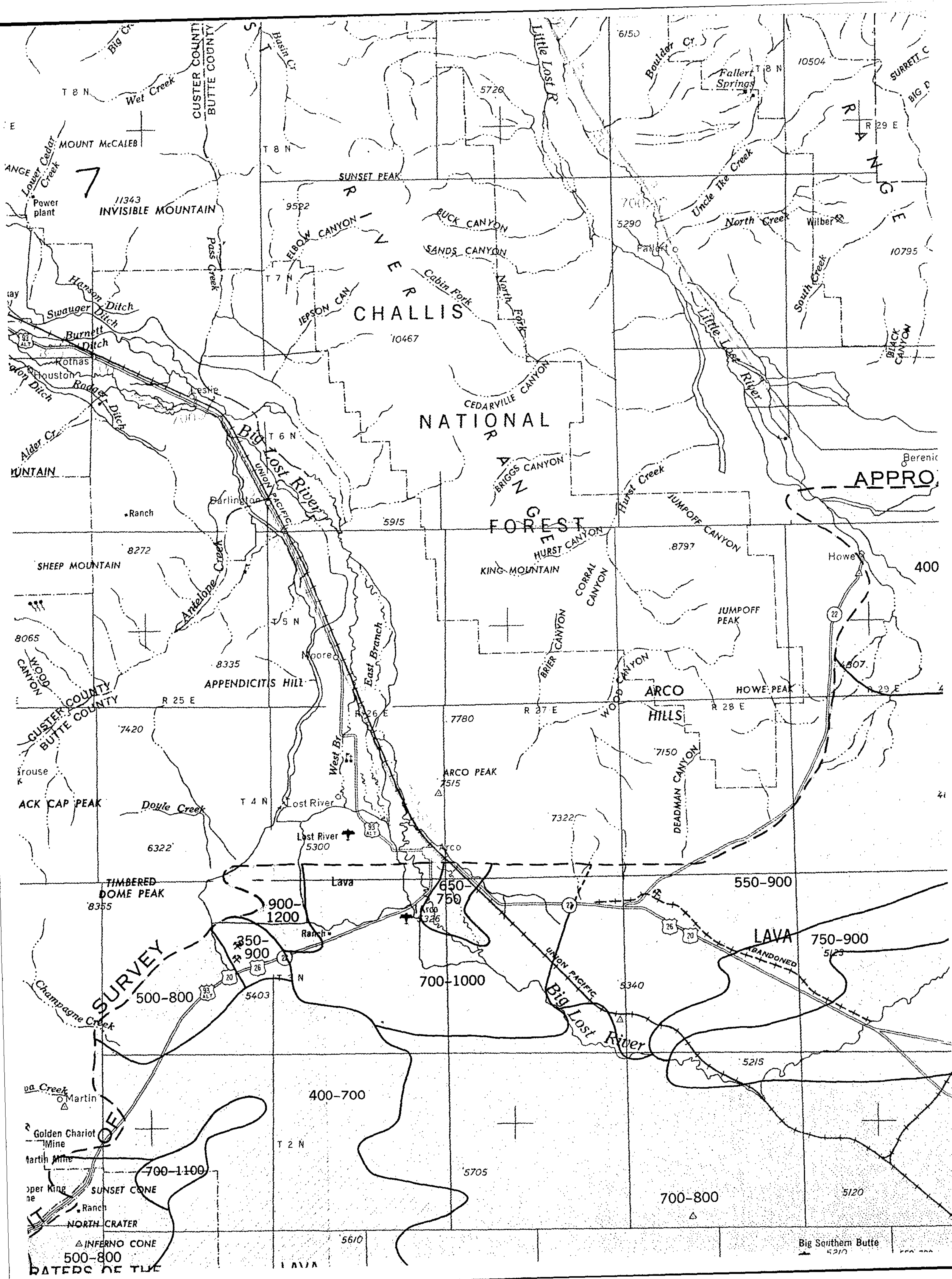
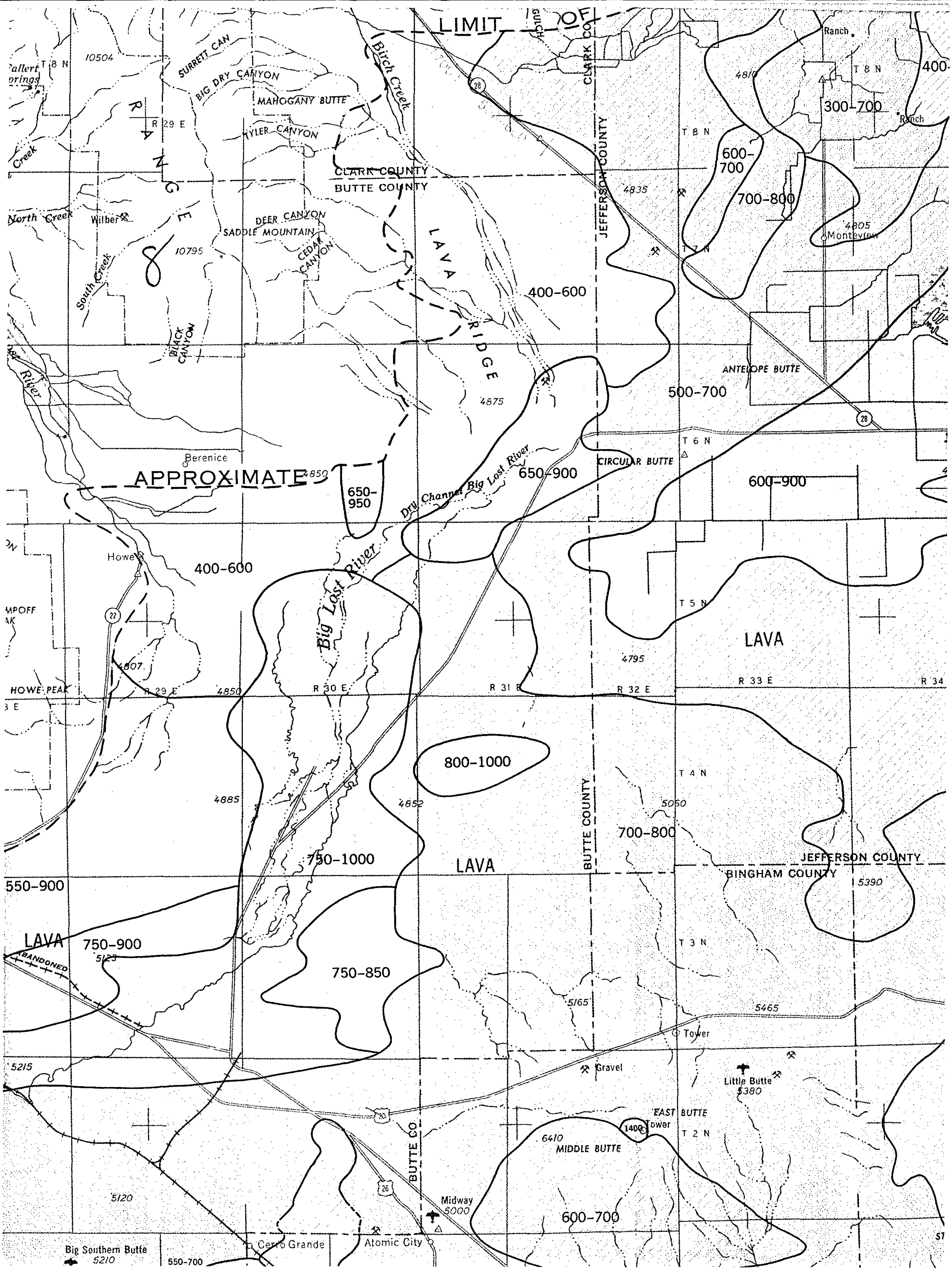
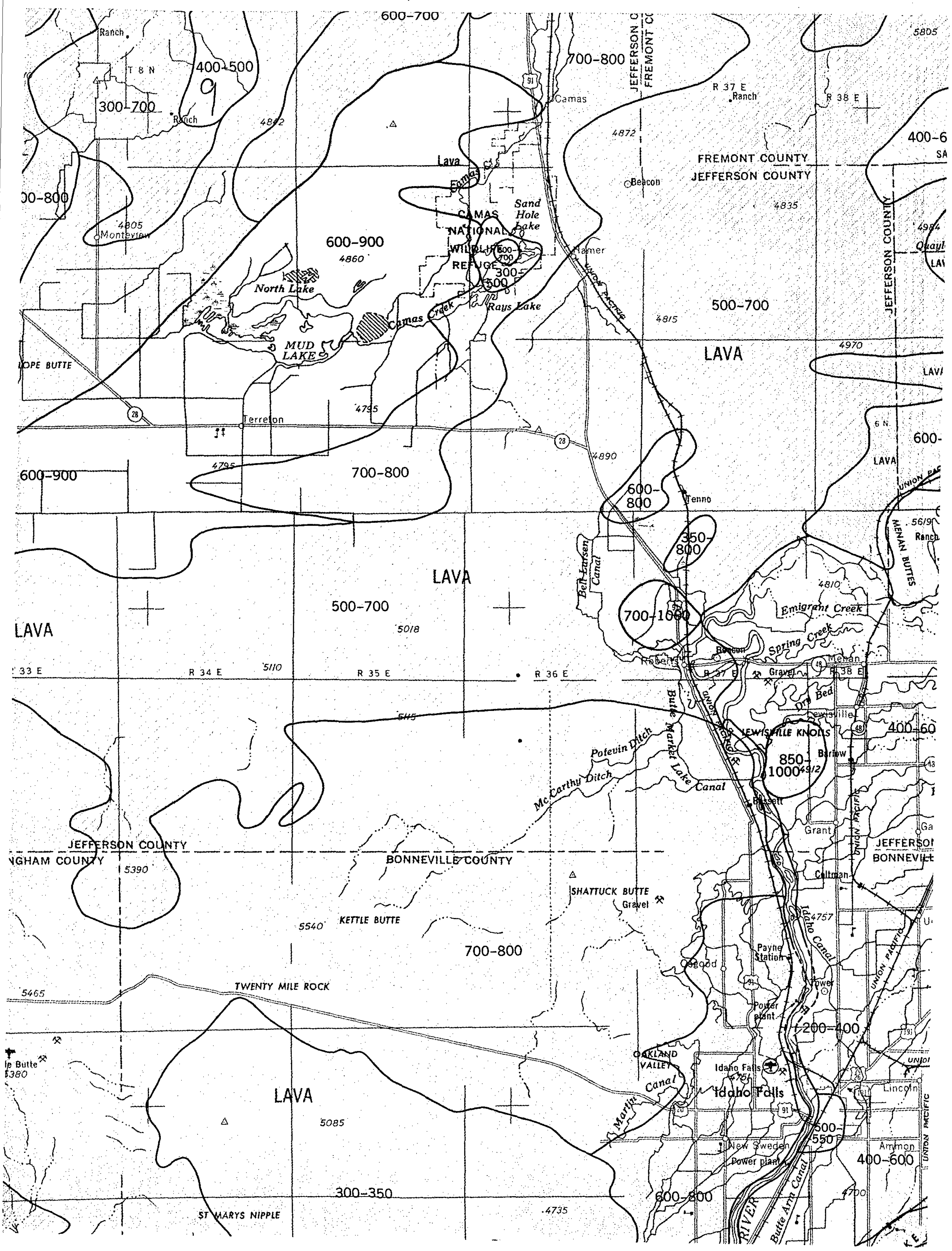
Grant Cr
Bartlett Cr
Rock Creek
R 22 E
Warm Springs Creek
Garden Creek
Fish hatchery
Lone Cedar Cr
Jones Creek
Upper Cedar Creek
Parsons Cr
Pete Cr
R 23 E
R 24 E
T 8 N
Wet Creek
MOUNT McCALEB
LOST RIVER RANGE
Lower Cedar Creek
Power plant
11343
INVISIBLE MOUN
Boone Creek
7169
Hamilton Creek
Navarro Cr
Mackay Dam
Mackay Reservoir
Power plant
Ranch
Lehman Creek
LEHMAN BASIN
Castle Cr
10007
Boone Creek
CASTLE ROCK
Butcher Cr
HORSE WALLOW
TELEPHONE GULCH
Mackay
5891
Mackay
Hanson Ditch
Swauger Ditch
Ranch
Burnett Ditch
Rosenkrantze Ranch
MACKAY PEAK
White Knob Mine
Darlington Ditch
Rothas
Houston
Rodgers Ditch
East Fork Big Lost River
Lake Cr
9450
Corral Creek
Rider Creek
Little Boone Creek
Fox Creek
Cliff Creek
Willow Creek
Alder Cr
STEWART CANYON
North Fork
T 6 N
Cabin Creek
BIG BLACK DOME
Ramey Creek
11277
SHELLY MOUNTAIN
TABLE MOUNTAIN
Trail Creek
MINE CANYON
CHALLIS
COPPER BASIN
Copper Basin Mine
Ranch
The Swamps
LUPINE MOUNTAIN
WHITE KNOB MOUNTAINS
THE POTHOLES
Steve Creek
SMELTER CANYON
Hope Creek
8272
SHEEP MOUNTAIN
ANTELOPE PASS
Cherry Cr
Middle Fork
BROAD CANYON
9244
Lake Creek
10778
COPPER BASIN KNOB
45′
Star Hope Creek
MULDOON CANYON
Left Fork
8065
WOOD CANYON
NATIONAL
R 21 E
R 22 E
Bear Cr
R 23 E
R 24 E
Cherry Creek
CUSTER COUNTY
BUTTE COUNTY
R 25 E
CUSTER COUNTY
Star Hope Mine
SMILEY MOUNTAIN
11505
SMILEY MEADOWS
Bear Creek
7420
Grouse
Right Fork
Smiley Cr
DRY CAN
Antelope Creek
Dry Fork Creek
BLACK CAP PEAK
SAWTOOTH
10608
PIONEER
Left Fork Iron Bog Creek
8545
FOREST
Doyle Cree
NATIONAL
Hurst Creek
6322
SCORPION MOUNTAIN
FOX CANYON
Fork
Leadbelt Cr
SAWMILL CANYON
TIMBERED DOME PEAK
Garfield Ranger Station
Timber Creek
Middle
GARFIELD MOUNTAIN
FOREST
Leadbelt Mine
8355
Thompson Cr
Muldoon Creek
8804
MOUNTAINS
Trail Cr
BLAINE COUNTY
9320
LIMIT OF SURVEY
500-800
Champagne Creek
ELK MOUNTAIN
8094
Copper Creek
Dry Fork Creek
Muldoon
Friedman Creek
Iron Mine Cr
Edna Mine
Lava Creek
Martin
30′
West Fork Fish Cr
East Fork Fish Creek
IRON MOUNTAIN
9265
Silver Bell Mine
Golden Chariot Mine
Cottonwood Cr
Martin Mine
700-1100
Copper Creek
Copper King Mine
SUNSET CONE
Ranch
GRASSY CONE
NORTH CRATER
Little Fish Creek
SILENT CONE
INFERNO CONE
500-800

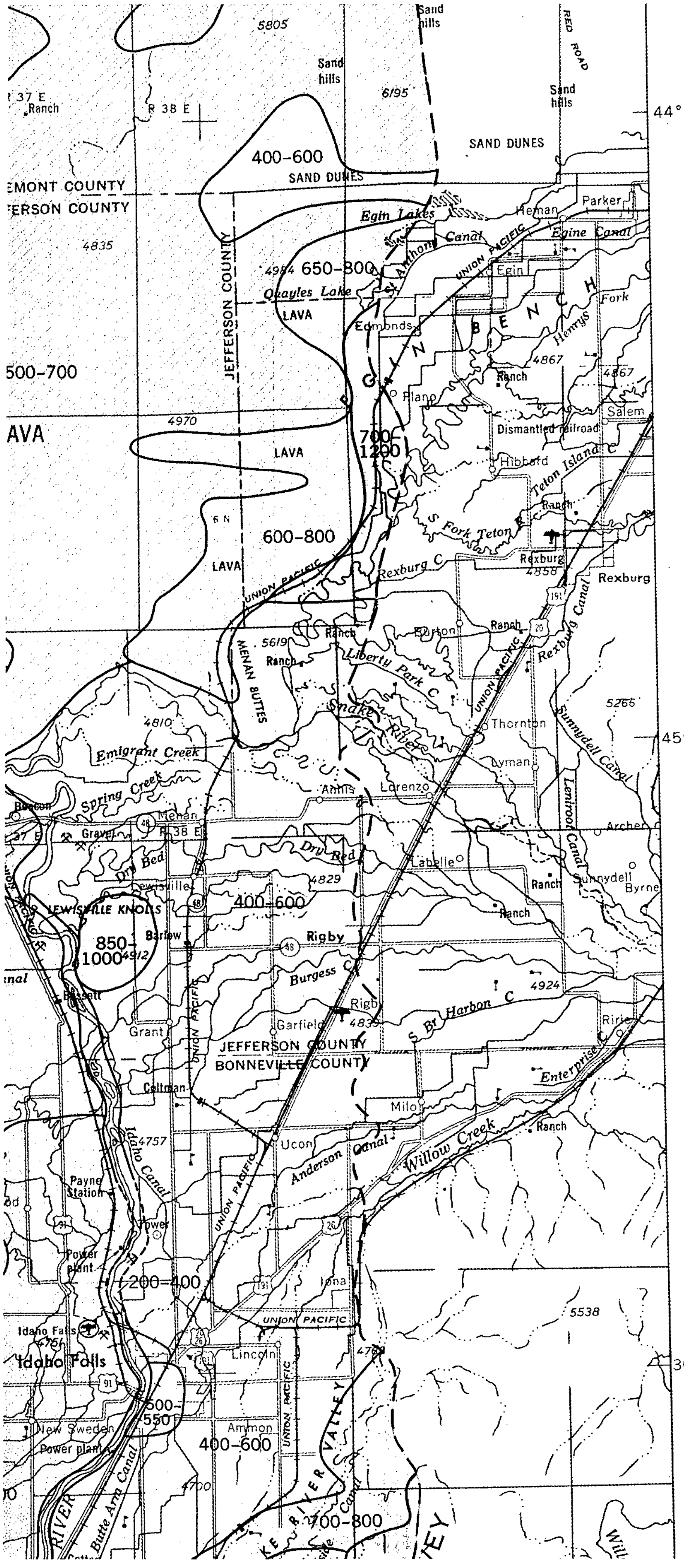


CUSTER COUNTY
BUTTE COUNTY
Wet Creek
T 8 N
MOUNT McCALEB
Lower Cedar Creek
7
Power plant
11343
INVISIBLE MOUNTAIN
Pass Creek
Basin Cr
Little Lost R
Boulder Cr
Fallert Springs
10504
SURRETT C
5720
SUNSET PEAK
9522
BUCK CANYON
ELBOW CANYON
SANDS CANYON
Cabin Fork
North Fork
JEPSON CAN
CHALLIS
10467
Uncle Ike Creek
North Creek
Wilber
5290
Fallert
10795
South Creek
R 29 E
RANGE
RIVER
Hanson Ditch
Swauger Ditch
Burnett Ditch
Rothas
Houston
Rodger Ditch
Leslie
Alder Cr
CEDARVILLE CANYON
NATIONAL
RANGE
Little Lost River
BLACK CANYON
Berenic
APPRO
Big Lost River
T 6 N
UNION PACIFIC
Darlington
Ranch
BRIGGS CANYON
Hurst Creek
JUMPOFF CANYON
5915
FOREST
HURST CANYON
8797
Howe
400
8272
SHEEP MOUNTAIN
Antelope Creek
KING MOUNTAIN
CORRAL CANYON
JUMPOFF PEAK
22
8065
T 5 N
Moore
East Branch
BRIER CANYON
WOOD CANYON
4807
WOOD CANYON
8335
APPENDICITIS HILL
ARCO
HOWE PEAK
R 29 E
CUSTER COUNTY
BUTTE COUNTY
R 25 E
R 26 E
7780
R 27 E
HILLS
R 28 E
7420
7150
West Br
DEADMAN CANYON
Grouse
ARCO PEAK
7515
ACK CAP PEAK
Doyle Creek
T 4 N
Lost River
7322
93 ALT
Lost River
5300
6322
Arco
TIMBERED DOME PEAK
8355
Lava
650-750
550-900
900-1200
Arco
5326
27
26
20
Ranch
350-900
LAVA
750-900
5123
ABANDONED
SURVEY
20
26
93 ALT
T 2 N
700-1000
UNION PACIFIC
5340
500-800
5403
Champagne Creek
Big Lost River
5215
Martin
400-700
Golden Chariot Mine
Martin Mine
T 2 N
700-1100
5705
SUNSET CONE
Ranch
700-800
5120
NORTH CRATER
INFERNO CONE
5610
500-800
Big Southern Butte


LIMIT OF
APPROXIMATE
GULCH
CLARK CO
CLARK COUNTY
BUTTE COUNTY
JEFFERSON COUNTY
BUTTE COUNTY
BUTTE CO
JEFFERSON COUNTY
BINGHAM COUNTY
SURRETT CAN
BIG DRY CANYON
MAHOGANY BUTTE
TYLER CANYON
Birch Creek
DEER CANYON
SADDLE MOUNTAIN
CEDAR CANYON
BLACK CANYON
LAVA RIDGE
R A N G E
North Creek
Wilber
South Creek
Creek
River
10504
10795
T 8 N
R 29 E
T 7 N
T 6 N
T 5 N
T 4 N
T 3 N
T 2 N
R 29 E
R 30 E
R 31 E
R 32 E
R 33 E
R 34
Ranch
Ranch
4810
4835
4805
Monteview
300-700
600-700
700-800
400-600
400-
ANTELOPE BUTTE
500-700
4875
Berenice
4850
650-950
Dry Channel Big Lost River
650-900
CIRCULAR BUTTE
600-900
Howe
400-600
Big Lost River
LAVA
4795
4807
HOWE PEAK
4850
800-1000
4885
4852
5060
700-800
750-1000
LAVA
5390
550-900
LAVA
750-900
5123
ABANDONED
750-850
5165
5465
Tower
5215
Gravel
Little Butte
5380
EAST BUTTE
1400
Tower
6410
MIDDLE BUTTE
5120
Midway
5000
600-700
Cerro Grande
Atomic City
Big Southern Butte
5210
550-700



600-700
400-500
300-700
700-800
JEFFERSON CO
FREMONT CO
Camas
R 37 E
R 38 E
FREMONT COUNTY
JEFFERSON COUNTY
Beacon
Lava
CAMAS
NATIONAL
WILDLIFE
REFUGE
Sand Hole Lake
Hamer
600-900
North Lake
Rays Lake
Camas Creek
MUD LAKE
500-700
LAVA
Terreton
700-800
600-900
600-800
Tenno
350-800
Bell-Larsen Canal
LAVA
500-700
700-1000
Emigrant Creek
Spring Creek
Roberts
Menan
R 34 E
R 35 E
R 36 E
LEWISVILLE KNOLLS
850-1000
Potevin Ditch
McCarthy Ditch
Market Lake Canal
JEFFERSON COUNTY
BONNEVILLE COUNTY
SHATTUCK BUTTE
KETTLE BUTTE
700-800
TWENTY MILE ROCK
Idaho Canal
200-400
Idaho Falls
LAVA
Martin Canal
500-550
400-600
300-350
600-800
ST MARYS NIPPLE
Butte Arm Canal

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Approximate range of radioa
radioactivity unit

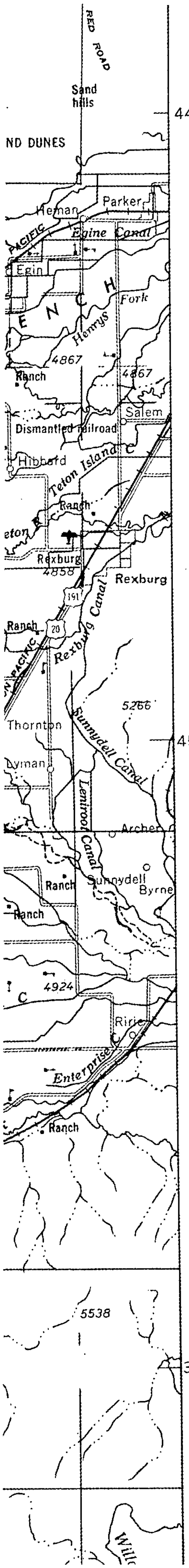
## EXPLANATORY

The survey was made wit detection equipment (Davis ; installed in a twin-engine east-west flight traverses intervals were flown at a 500 feet above the ground. the aircraft was recorded continuous-strip-film came: ity data were compensated the 500-foot surveying altitu mic-ray component.

The effective area of re: tillation equipment at an a: that encompassed by a ci 1000 feet in diameter, and t corded is the average radio The scintillation equipment from gamma radiation wi than 50 kev (thousand electr 137 source is used during p to assure uniformity of e

The gamma-ray flux at ground has three principa radiation, radionuclides in t daughter products), and r surficial layer of the ground ponent is determined twice at 2000 feet above the grou from the radioactivity data.

The component due to rac at 500 feet above the grounc ate. It is affected by meteo and a tenfold change in ra not unusual under conditio: perature inversion. Howev ditions are avoided, the ai considered to be fairly un in a particular area, and w ferences in radioactivity changes in the ground comp




600->1000

Approximate range of radioactivity within radioactivity units

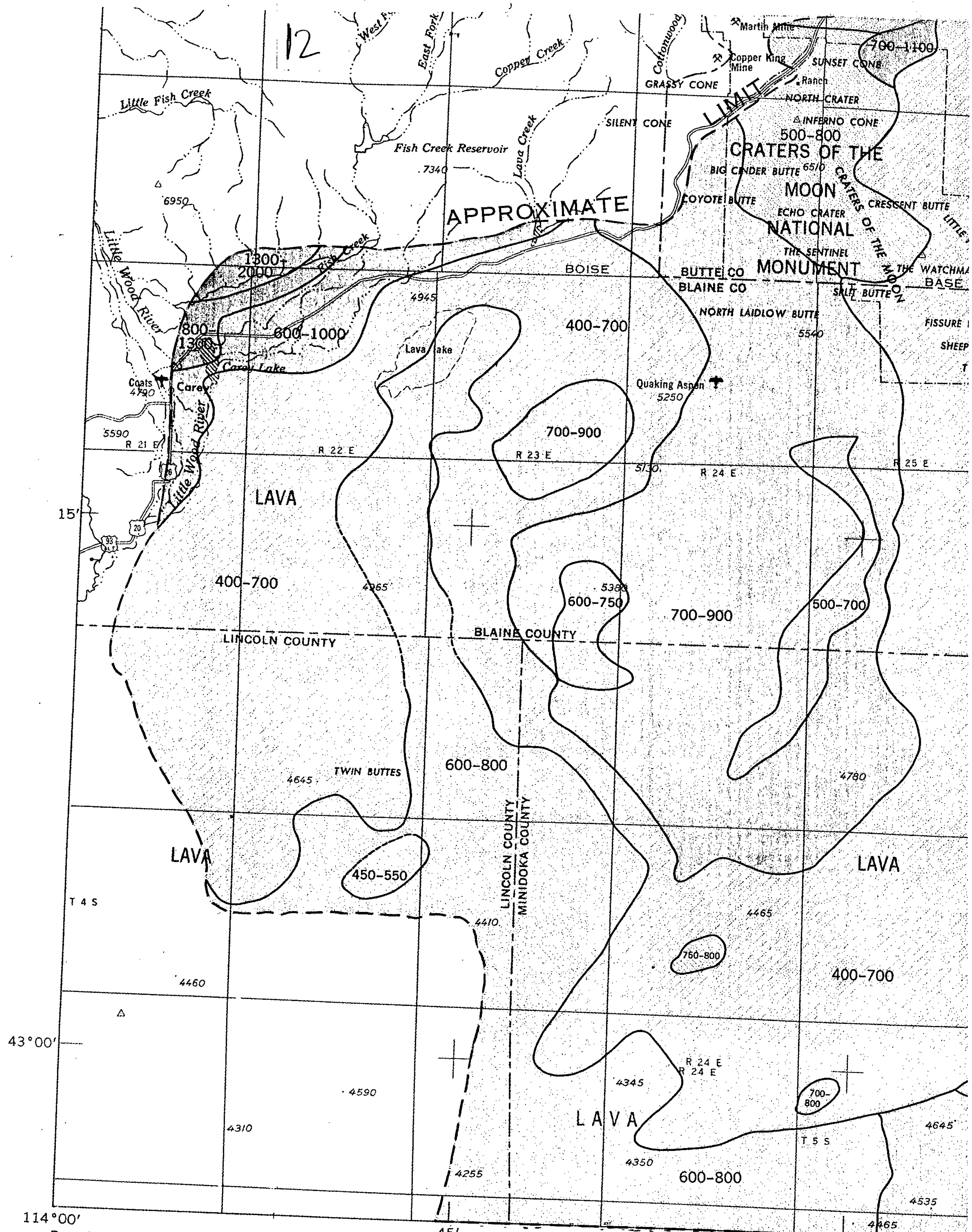
## EXPLANATORY TEXT

The survey was made with scintillation-detection equipment (Davis and Reinhardt, 1957) installed in a twin-engine aircraft. Parallel east-west flight traverses spaced at one-mile intervals were flown at a nominal altitude of 500 feet above the ground. The flight path of the aircraft was recorded by a gyrostabilized continuous-strip-film camera. The radioactivity data were compensated for deviations from the 500-foot surveying altitude, and for the cosmic-ray component.

The effective area of response of the scintillation equipment at an altitude of 500 feet is that encompassed by a circle approximately 1000 feet in diameter, and the radioactivity recorded is the average radioactivity of that area. The scintillation equipment records only pulses from gamma radiation with energies greater than 50 kev (thousand electron volts). A cesium-137 source is used during periodic calibrations to assure uniformity of equipment response.

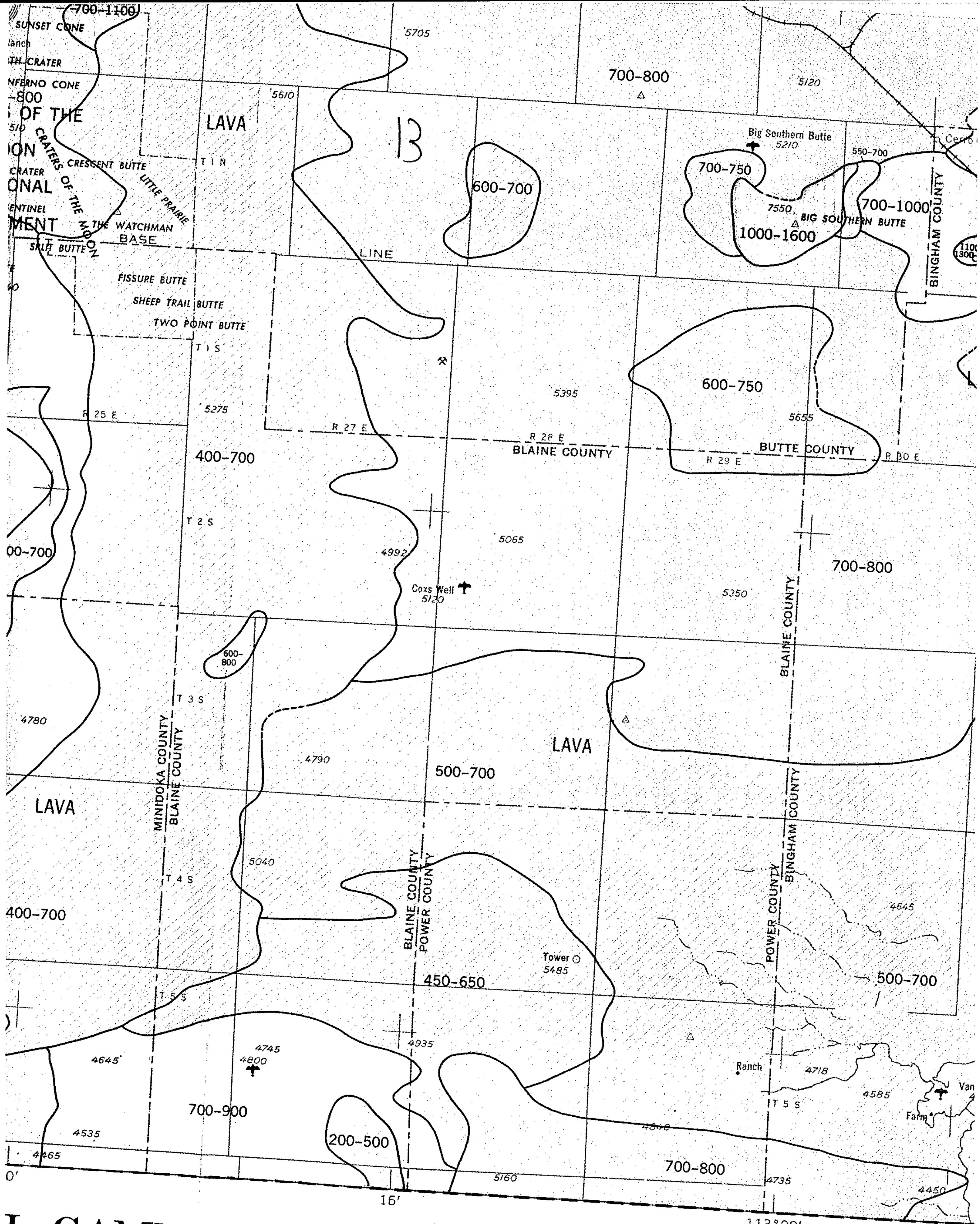
The gamma-ray flux at 500 feet above the ground has three principal sources: cosmic radiation, radionuclides in the air (mostly radon daughter products), and radionuclides in the surficial layer of the ground. The cosmic component is determined twice daily by calibrations at 2000 feet above the ground, and is removed from the radioactivity data.

The component due to radionuclides in the air at 500 feet above the ground is difficult to evaluate. It is affected by meteorological conditions, and a tenfold change in radon concentration is not unusual under conditions of extreme temperature inversion. However, if inversion conditions are avoided, the air component may be considered to be fairly uniform on a given day in a particular area, and will not mask the differences in radioactivity levels that reflect changes in the ground component.




Base from U.S. Geological Survey 250,000 series quadrangles: Ashton, 1958, Driggs, 1958; Dubois 1958; Idaho Falls, 1958; Pocatello, 1958; and Preston, 1958

NATURAL GA

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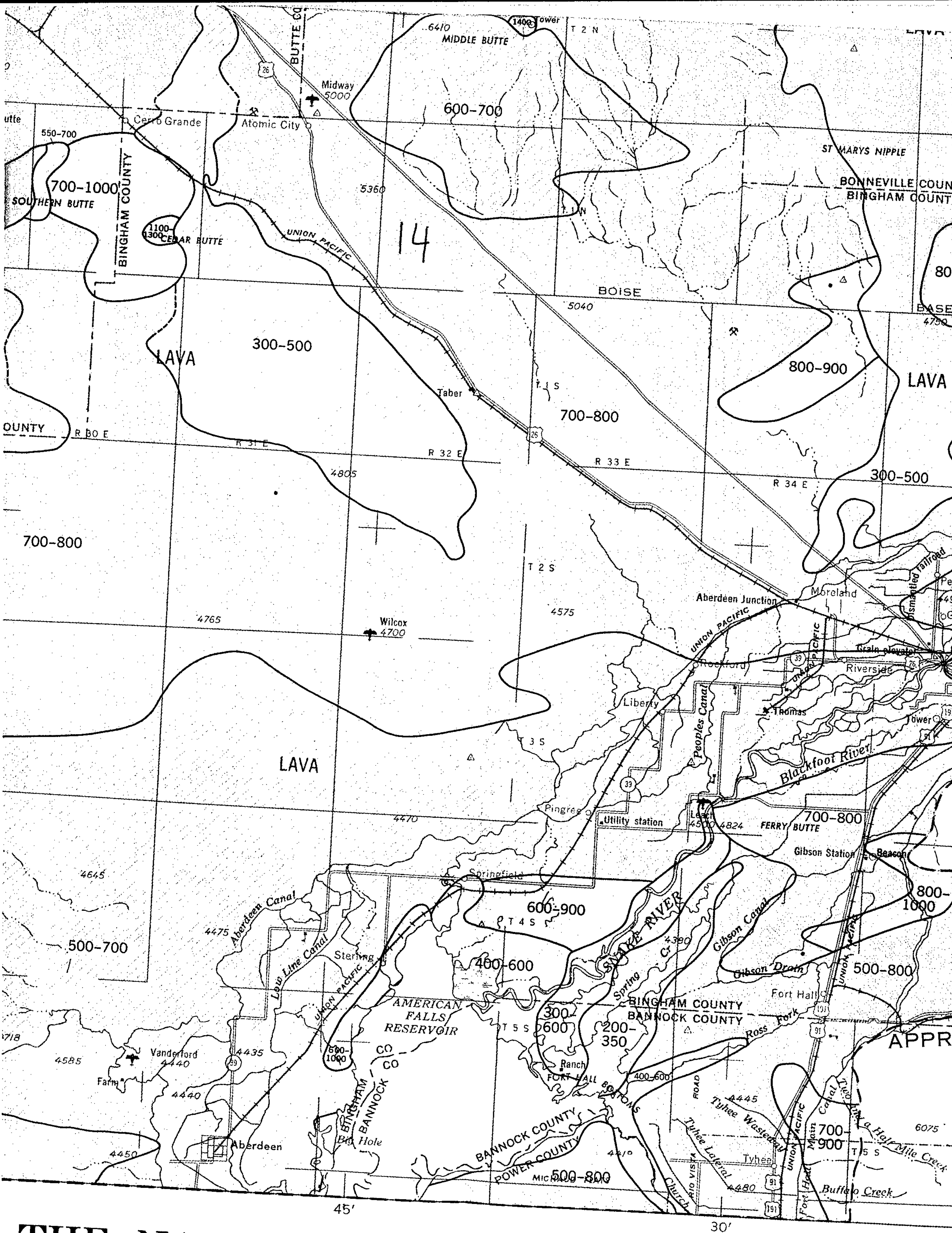


# THE NATIONAL REACTOR TESTING STATI

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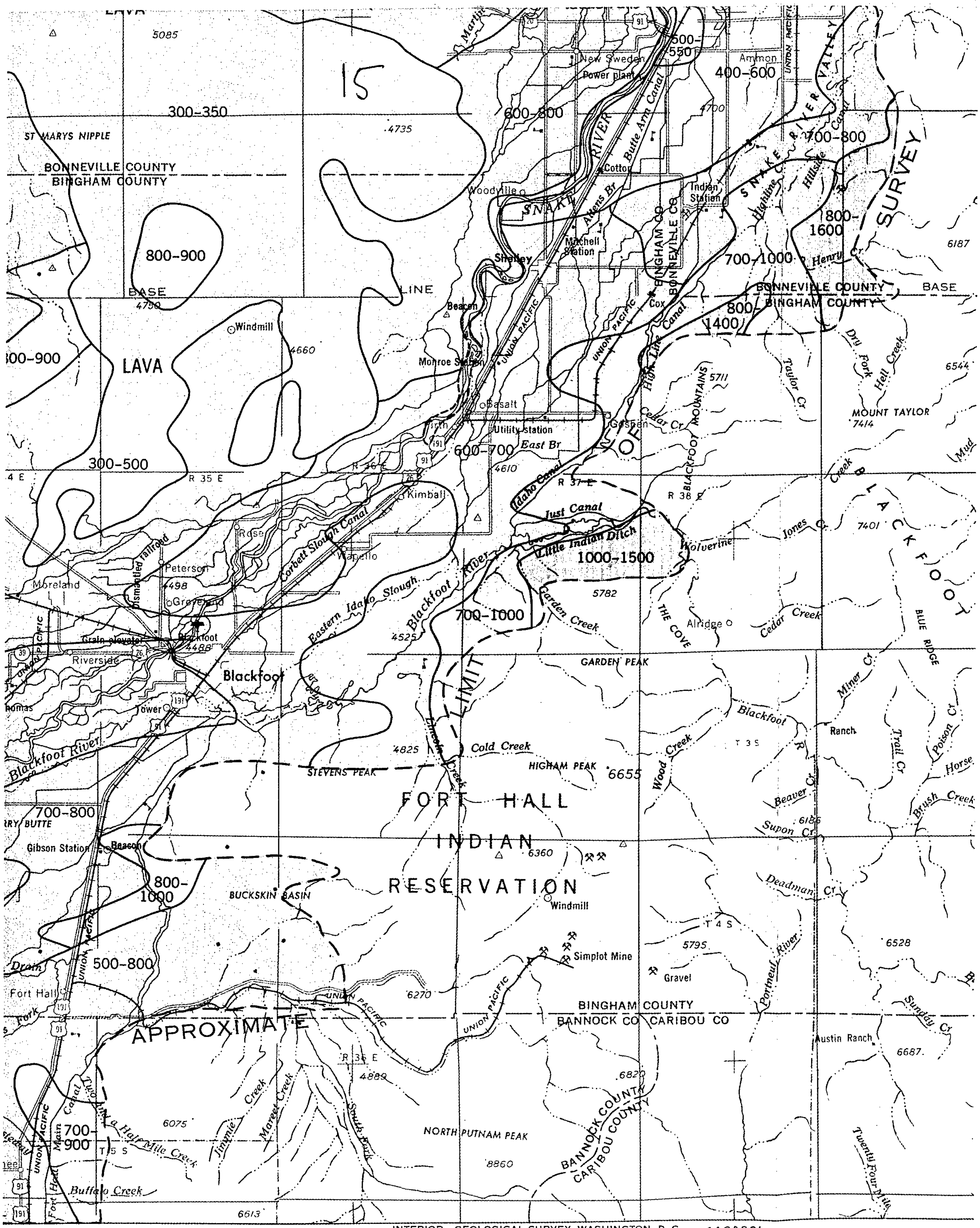


15′ INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C. 1964— G64090 112°00′

# NG STATION AREA IDAHO

Aeroradioactivity survey m
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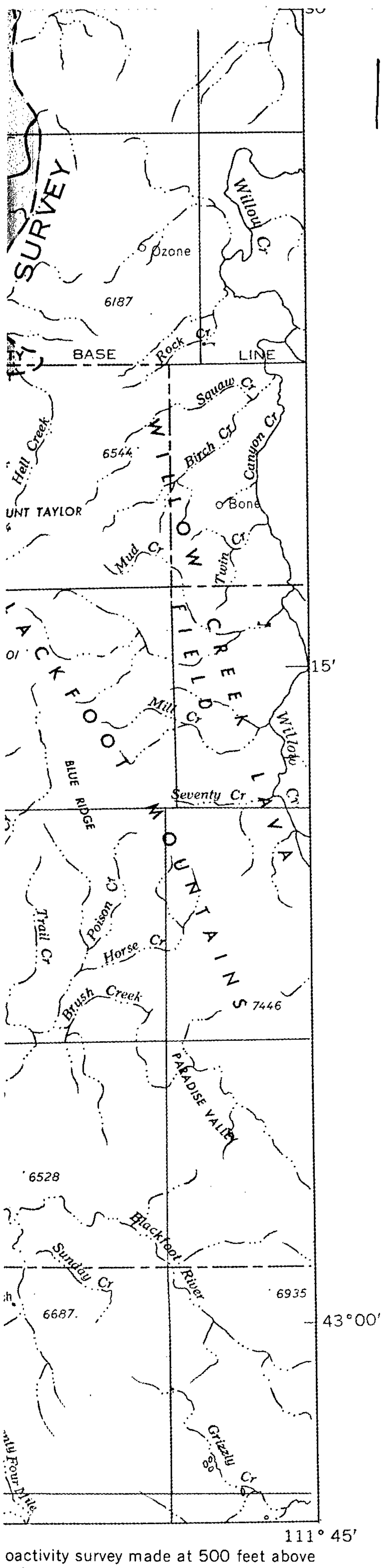
and P. W. Philbin, 1959




oactivity survey made at 500 feet above
ınd under the direction of J. L. Meuschke
V. Philbin, 1959

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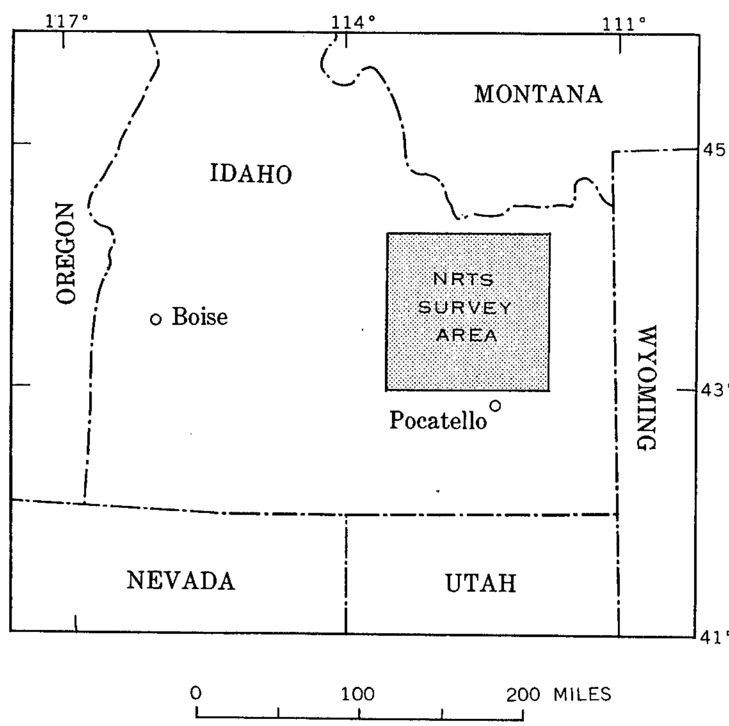
perature inversion. However, if inversion conditions are avoided, the air component may be considered to be fairly uniform on a given day in a particular area, and will not mask the differences in radioactivity levels that reflect changes in the ground component.

The ground component comes from the approximate upper few inches of the ground. It consists of gamma rays from natural radionuclides, principally members of the uranium and thorium radioactive decay series and potassium-40, and fallout of radioactive nuclear-fission products. Locally the amount of fallout, if present, must be small, as the lowest total radioactivity measured is 200 counts per second in areas not affected by absorption of gamma rays by water. The distribution of fallout in the area surveyed is assumed to be uniform.

Davis, F. J., and Reinhardt, P. W., 1957, Instrumentation in aircraft for radiation measurements: Nuclear Sci. and Eng., v. 2, no. 6, p. 713-727.




INDEX MAP