339

RESTRICTED
SECURITY INFORMATION

Uranium-Bearing Carbonaceous Shale and Lignite in the Goose Creek District, Cassia County, Idaho, Boxelder County, Utah, and Elko County, Nevada

By W. J. Mapel and W. J. Hail, Jr.

OFFICIAL USE ONLY

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

Trace Elements Investigations Report 339

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

OFFICIAL USE ONLY

RESTRICTED
SECURITY INFORMATION

RESTRICTED
SECURITY INFORMATION

Geology and Mineralogy

This document consists of 57 pages, plus 5 figures.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Classification changed to OFFICIAL USE ONLY
by authority of P. L. Merritt.
by Howard D. Zeller 2/12/54

URANIUM-BEARING CARBONACEOUS SHALE AND LIGNITE IN THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO, BOXELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA

By

W. J. Mapel and W. J. Hail, Jr.

June 1953

Trace Elements Investigation Report 339

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

This material contains information affecting the national defense of the United States within the meaning of the espionage laws, Title 18, U.S.C., Secs. 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

*This report concerns work done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

RESTRICTED
SECURITY INFORMATION

USGS - TEI-339

GEOLOGY AND MINERALOGY

Distribution (Series A)	No. of copies
American Cyanamid Company, Winchester	1
Argonne National Laboratory	1
Atomic Energy Commission, Washington	1
Battelle Memorial Institute, Columbus	1
Carbide and Carbon Chemicals Company, Y-12 Area	1
Division of Raw Materials, Butte	1
Division of Raw Materials, Denver	1
Division of Raw Materials, Grants	1
Division of Raw Materials, Hot Springs	1
Division of Raw Materials, New York	6
Division of Raw Materials, Richfield	1
Division of Raw Materials, Salt Lake City	1
Division of Raw Materials, Washington	3
Dow Chemical Company, Pittsburgh	1
Exploration Division, Grand Junction Operations Office	1
Grand Junction Operations Office	1
Technical Information Service, Oak Ridge	6
Tennessee Valley Authority, Wilson Dam	1
U. S. Geological Survey:	
Alaskan Geology Branch, Washington	1
Fuels Branch, Washington	3
Geochemistry and Petrology Branch, Washington	1
Geophysics Branch, Washington	1
Mineral Deposits Branch, Washington	1
E. H. Bailey, San Francisco	1
J. R. Cooper, Denver	1
N. M. Denson, Denver	1
C. E. Dutton, Madison	1
R. P. Fischer, Grand Junction	1
L. S. Gardner, Albuquerque	1
C. B. Hunt, Plant City	1
M. R. Klepper, Washington	1
A. H. Koschmann, Denver	1
R. A. Laurence, Knoxville	1
D. M. Lemmon, Washington	1
J. D. Love, Laramie	1
K. L. Buck, Denver	1
R. J. Roberts, Salt Lake City	1
J. F. Smith, Jr., Denver	1
R. W. Swanson, Spokane	1
A. E. Weissenborn, Spokane	1
TEPCO, Washington:	
Resource Compilation Section	2
Reports Processing Section (Including master)	3
	59

CONTENTS

ILLUSTRATIONS

TABLES

URANIUM-BEARING CARBONACEOUS SHALE AND LIGNITE IN THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO, BOXELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA

By W. J. Mapel and W. J. Hail, Jr.

ABSTRACT

The Goose Creek district includes about 260 square miles in southern Cassia County, Idaho, and adjacent parts of Boxelder County, Utah, and Elko County, Nev. The area comprises the northern and central parts of an intermontane basin drained by northward-flowing Goose Creek and its tributaries.

An essentially conformable sequence of fluviatile, lacustrine, and pyroclastic sediments of late Miocene (?) and early Pliocene age make up most of the rocks exposed in the district. These rocks include the Payette formation and the overlying Salt Lake formation. They unconformably overlie a sequence of limestone, quartzite, and shale, Carboniferous and older in age, exposed in the mountains to the west and northeast; and a thick body of rhyolite of Tertiary (?) age exposed in the mountains to the southeast. Surficial deposits of silt, sand, and gravel locally overlie the older rocks.

The Payette and Salt Lake formations have a general easterly dip of 4 to 12 degrees, modified locally by shallow folds. Many normal faults, some with displacement of several hundred feet, cut the Tertiary strata at various places in the district.

Concentrations of uranium occur in beds of carbonaceous shale and lignite in the middle part of the Salt Lake formation. The richest known occurrence in the district is 0.12 percent uranium in the upper part of an 8 foot bed of carbonaceous shale having an average grade of 0.042 percent uranium. Beds of carbonaceous shale 1 foot or more thick contain 0.01 percent or more uranium at 18 additional localities. Most of the concentrations of uranium are in the Barrett carbonaceous shale zone in T. 16 S., R. 21 E., Idaho, on the flanks and in the trough of a broad syncline.

The estimated reserves in the district total 900 short tons of uranium, in beds 2 feet or more thick containing 0.005 percent or more uranium; and 115 shorttons of uranium in beds 1 foot or more thick containing 0.01 percent or more uranium.

About 2,000 feet of core drilling is planned during the 1953 field season.

INTRODUCTION

The Goose Creek district includes about 260 square miles in southern Cassia County, Idaho, and adjacent parts of Boxelder County, Utah, and Elko County, Nev. A detailed geologic investigation of this area was undertaken in the summer of 1952 by the U. S. Geological Survey on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. The purposes of the work were to determine the tonnage and grade of uranium-bearing carbonaceous shale and lignite in the Tertiary rocks of the district, and to determine the structural and stratigraphic conditions that may have controlled uranium mineralization.

D. C. Duncan discovered radioactive carbonaceous shale in the district in September 1951. In September and October of the same year, W. J. Hail, Jr. and J. R. Gill made a reconnaissance survey of the area during which they sampled beds of carbonaceous shale and lignite at several localities, and determined the areas of greatest uranium concentration (Hail and Gill, 1953). During the summer of 1952, the writers, assisted by J. N. Babcock and J. E. Conkin, mapped the Tertiary rocks of the district on areal photographs at a scale of about 1:30,000, and completed the sampling of outcrops (Mapel and Hail, 1953).

Chemical and spectrographic analyses listed in this report were made by the Geological Survey Trace Elements Washington Laboratory, or by the Geological Survey Trace Elements Denver Laboratory.

Control for the base map on which the geology was compiled (fig. 1) was obtained photogrammetrically by a radial plot, which was controlled by a plane table triangulation net tied to U. S. Coast and Geodetic Survey triangulation points and Bureau of Land Management land corners. Land surveys, where considered reliable, are shown by solid lines on the geologic map. In these areas, many of the monuments marking land corners are preserved. In T. 15 S., R. 22 E., Idaho, and in T. 46 N., Rs. 69

and 70 W., Nevada, however, measurements between land corners as shown on the township plats cannot be reconciled with the measurements given on adjoining plats, nor are they in accord with the actual position of monuments marking land corners found on the ground. In these townships, the land lines are shown either by dashed lines or are omitted.

PREVIOUS INVESTIGATIONS

Previous geologic investigations in the Goose Creek district include a reconnaissance survey of the lignite beds of the area by C. F. Bowen in 1911; a study of the ground water resources of the Goose Creek drainage basin by A. M. Piper in 1923; and an investigation of the geology of the northeastern part of the district as a part of a geologic reconnaissance of eastern Cassia County, Idaho, by A. L. Anderson in 1931.

GEOGRAPHY

The Goose Creek district comprises the northern and central parts of an elongate northerly trending intermontane basin bordered on the west by an unnamed mountain range; on the south and east by the Goose Creek and South Mountains; and on the north by the Snake River plain.

The northern part of the area is a high, eastward-sloping, dissected plateau. Across it, streams have cut deep narrow canyons to form a series of irregularly shaped interconnecting buttes and mesas. This area of high, flat-topped buttes and deep canyons gives way in the southern part of the district to a gently rolling surface, which although in places is intricately dissected, has low relief. Altitudes range from about 7,450 feet on Hudson Ridge, a prominent topographic feature that crosses the northwest corner of the area, to about 4,600 feet where Goose Creek crosses the northern boundary of the area. Vegetation consists of sage brush, native grasses, and junipers.

Goose Creek, a large perennial tributary of the Snake River, flows northward across the area, emptying into the Goose Creek reservoir near the northern boundary. Other perennial streams in the district, all of which are tributary to Goose Creek, include Trapper, Jay, and Trout Creeks which feed Goose Creek from the west; and Cold, Little Pole, Birch, and Pole Creeks which feed it from the east. Beaverdam Creek in the west-central part of the district, and Hurdister Creek in the southern part, are the main intermittent streams.

The district is sparsely settled having few permanent residents and no towns. Oakley, Idaho, with a population of 813 in 1950, is 3 miles north of the district. Burley, Idaho, with a population of 5,924 in 1950, is 22 miles north of Oakley, and is the county seat of Cassia County.

A branch line of the Oregon Short Line (Union Pacific) Railroad, and a paved highway connect Oakley and Burley. Good graveled roads lead from Oakley up the valleys of Goose and Trapper Creeks. These roads, and dirt roads that branch from them, provide access to most parts of the district.

STRATIGRAPHY

General statement

The present investigation was devoted primarily to a study of the Tertiary strata of the Goose Creek district, inasmuch as all of the known concentrations of uranium in the area occur in carbonaceous shale or lignite in sedimentary rocks of Tertiary age. These Tertiary strata include the Payette formation of late Miocene or early Pliocene age, and the overlying Salt Lake formation of early Pliocene age. The two formations make up a thick, essentially conformable sequence consisting largely of volcanic ash and welded tuffs, but including in addition beds of shale, sandstone, and conglomerate derived from the disintegration and erosion of rocks exposed on adjacent highlands. Older rocks were examined only in so far as was necessary to determine their structural and stratigraphic relations to the Tertiary sequence. The older rocks include a massive rhyolite porphyry of Tertiary (?) age, exposed in the mountains bordering the district on the southeast; and pre-Tertiary limestone, quartzite, and shale, some of which are metamorphosed, exposed in the mountains bordering the district on the northeast and west. Younger sedimentary deposits of Quaternary age consist of alluvium along the present streams, gravels on high surfaces, and slope wash.

The thickness and character of the rock formations exposed in the district are summarized in table 1:

Table 1.--Rocks exposed in the Goose Creek district

System	Series	Formation		Character	Thickness (feet)
Quaternary	Recent and Pleistocene (?)	Alluvium and slope wash		Surficial deposits of silt, sand, and gravel on the flood plains of present streams, or adjacent to steep mountain slopes.	0-50±
		Gravel deposits on high surfaces		Surficial deposits of stream-worn pebbles and boulders, mainly of rhyolite and quartzite; lenses of sand and silt.	0-15
		Unconformity			
Tertiary	Pliocene	Salt Lake formation	Upper part	Interbedded white and grayish-orange volcanic ash, with a few lenticular beds of conglomerate. A thick, persistent bed of welded tuff is at the base.	700+
			Lower part	Mainly white volcanic ash containing a few beds of shale, sandstone, and conglomerate. Conspicuous beds of black to dark reddish-brown welded tuff are in the upper half. Lenticular beds of uranium-bearing carbonaceous shale and lignite occur in the lower half.	1600
Tertiary	Miocene (?)	Payette formation		Interbedded shale and volcanic ash with some thin beds of sandstone and conglomerate; contains a few lenticular beds of carbonaceous shale and lignite.	800+
		Unconformity			

Table 1.--Rocks exposed in the Goose Creek district (Cont.)

System	Series	Formation	Character	Thickness (feet)
Tertiary (?)		Rhyolite	Massive dark reddish-brown rhyolite porphyry.	--
Carboniferous and older		Pre-Tertiary rocks, undifferentiated	Bluish-gray and light gray cherty limestone; light gray quartzite, quartz-mica schist, and marble; some dark shale.	--

Pre-Tertiary rocks, undifferentiated

Anderson (1934, p. 377) assigns the rocks which crop out in the mountains along the northeastern margin of the district to the Albion Range group of pre-Cambrian age. North of Cold Creek, these rocks consist of well-stratified quartzite containing much muscovite. To the south, between Cold and Little Pole Creeks, the rocks are mainly light-gray limestone or marble. Light-tan and dark bluish-gray limestone containing much dark chert, tentatively assigned by Bowen (1911, p. 253) to the Brazer limestone of late Mississippian age, or the Wells formation of Pennsylvanian age, crops out in the hills and mountains on the western side of the district, and in the vicinity of Birch and Hurdister Creeks on the southeastern side.

Tertiary (?) rhyolite

A thick, massive rhyolite of porphyritic texture, much shattered by joints and fractures, crops out in the mountains southeast of the mapped area from the vicinity of Birch Creek southward almost to Hurdister Creek. Rhyolite is also exposed near the crest of a low hill in the southwestern part of the area between Jay and Trout Creeks. Samples collected from this formation by Piper were studied by E. S. Larsen who gives the following description (Piper, 1923, p. 27):

> "These specimens are rather dense red-brown banded tridymite-quartz latites... They carry about 20 percent of phenocrysts as much as 3 millimeters across, most of which are oligoclase feldspar. Quartz in resorbed crystals is abundant, and orthoclase, also resorbed, is less abundant. Dark minerals are absent, though they may have been present in small amounts but are now decomposed. Magnetite and zircon are fairly abundant, and apatite is present. The groundmass in one specimen from Pole Creek is mostly a very fine sponge-like intergrowth of feldspar and tridymite with some coarser intergrowths and some unusually large crystals of tridymite in the porous parts. A little quartz is closely associated with the coarse tridymite in the porous parts, and the two look as if they were contemporaneous."

The rhyolite probably intrudes pre-Tertiary limestones north of Birch Creek as evidenced by a sill of rhyolite in these older strata in secs. 22 and 27, T. 16 S., R. 22 E., Idaho. Peterson (1942, pp. 471-2) described the rhyolite as intrusive into Paleozoic and older rocks in the Ashbrook silver mining district, about 3 miles east of the mapped area in the northwestern part of T. 14 N., R. 17 W., Utah.

Tertiary system

Rocks of Tertiary age exposed in the Goose Creek district consist of a basal series of late Miocene or early Pliocene age made up mostly of shale and volcanic ash in about equal amounts, and an overlying predominantly pyroclastic series of early Pliocene age made up mostly of volcanic ash and welded rhyolitic tuff. On the basis of age and lithology, the lower sequence is correlated with the Miocene Payette formation as described by Kirkham (1931, pp. 232-234) in the Boise area of southwestern Idaho, and the upper pyroclastic sequence is tentatively correlated with the Pliocene (?) Salt Lake formation as described by Mansfield (1920, pp. 52-54; 1927, pp. 110-112) in and near the Fort Hall Indian Reservation in southeastern Idaho. Anderson (1931, pp. 41-44) has pointed out the similarity in lithology and stratigraphic position of the Tertiary rocks of the Goose Creek area to both the Payette and Salt Lake formations. According to Anderson, the welded tuffs in the upper part of the Tertiary sequence are part of an essentially continuous sheet of rhyolitic rocks that overlies the lacustrine and fluviatile sediments of the Payette formation near Boise, and are interbedded with volcanic ash in the upper part of the Salt Lake formation in the Fort Hall Indian Reservation.

Figure 2 shows the correlation of sections of the Payette and Salt Lake formations in the district.

Payette formation

The Payette formation crops out along the western side of the district in the valley of Trapper Creek, and in a wide band between the Right Hand Fork Beaverdam Creek and Jay Creek. A small patch is also exposed east of Goose Creek near the southern edge of the district. The formation consists of at least 800 feet of interbedded shale and volcanic ash, with lesser amounts of conglomerate, sandstone, and carbonaceous shale or lignite. Except for some of the beds of conglomerate, the formation erodes easily and forms gentle slopes or flats.

The Payette rests unconformably on pre-Tertiary rocks along the western side of the district on an irregular surface having a relief that locally may be as much as 300 feet in a mile.

Slabby light greenish-gray and yellowish-gray shale makes up about 50 percent of the formation. Interbedded with the shale are beds of white volcanic ash ranging in thickness from a few inches to more than 100 feet. Beds of sandstone or conglomerate, which locally are as much as 40 feet thick, occur at various horizons in the formation. The coarse fragments in these conglomerates are subround pebbles and cobbles of limestone and chert, commonly 1 to 4 inches in their longest dimension, which were derived from pre-Tertiary formations exposed to the west. Some of the conglomerates may be traced for several miles, although most are lenses that pinch out within a few hundred yards.

Fossil leaves, seeds, and fish remains are common in the shales of the Payette, and diatoms occur also in some beds. The following fossils were collected 5 to 75 feet stratigraphically below the top of the formation in the NE 1/4 sec. 12, T. 15 S., R. 20 E.:

Fossil leaves and seeds, identified by R. W. Brown of the U. S. Geological Survey:

Abies sp. (seed)
Picea sp. (seed)
Populus eotremuloides Knowlton
Quercus simulata Knowlton
Quercus browni Brooks
Alnus sp.
Acer bendirei Lesquereux

Fossil diatoms, identified by K. E. Lohman of the U. S. Geological Survey (C = common; F = frequent; R = rare):

Achnanthes lanceolata Brebisson	R
A. lanceolata var. *elliptica* Cleve	F
A. sp.	R
Amphora commutata Grunow	R
Cocconeis sp.	R
Coscinodiscus cf. *C. subaulacodiscoidalis* Rattray	C
C. sp.	C
Cymbella tumida (Brebisson) Van Heurck	F
Eunotia valida Hustedt	
Fragilaria construens (Ehrenberg) Grunow	F
F. pinnata Ehrenberg	F
F. sp.	R
Gyrosigma sp.	R
Melosira distans (Ehrenberg) Kützing	C
M. distans var. *alpigena* Grunow	R
M. distans var. *lineata* (Ehrenberg) Bethge	F
M. granulata (Ehrenberg) Ralfs	C
M. granulata var. *procera* (Ehrenberg) Grunow	F
M. italica (Ehrenberg) Kützing	R
M. sp.	R

Navicula dicephala (Ehrenberg) Wm. Smith	R
N. scutelloides Wm. Smith	F
N. subhexagona Hustedt	R
N. sp.	R
Opephera martyi Heribaud	F
Pinnularia sp.	R
Tetracyclus cf. T. javanicus Hustedt	R
T. lacustris Ralfs	F
T. cf. T. pagesi Heribaud	R
T. rupestris (Brun) Grunow	R

According to Brown (oral communication) the assemblage of leaves and seeds is common to the Payette formation of southwestern Idaho, and indicates a late Miocene age. Regarding the diatoms, Lohman states (memo to W. J. Hail, dated 4/16/53): "Based on comparisons with diatom floras from the Cedar Mountains...(Nye County, Nevada)...the shale represented by the sample submitted is Lower Pliocene."

Salt Lake formation

The Salt Lake formation forms the surface of most of the district. The formation is at least 2,300 feet thick and consists largely of friable volcanic ash with several beds of welded rhyolitic tuff near the middle, and at various horizons, lesser amounts of shale, sandstone, conglomerate, and limestone. For convenience in showing its distribution, the formation is divided into two parts at the base of the stratigraphically highest persistent bed of welded tuff; there is little difference in lithology between the two parts. The lower part of the formation is about 1600 feet thick.

Welded tuffs occur in four main beds in the Salt Lake formation. These beds range in thickness from 10 to 250 feet. They are resistant to erosion and crop out as ledges and steep escarpments in the northern and central parts of the mapped area, and as hogbacks in the southern part. The welded tuffs were referred to as rhyolite flows by previous writers; however, the rock is composed chiefly of glass shards, and its texture is similar in all respects to the welded rhyolitic tuffs near the Fort Hall Indian Reservation of southeastern Idaho described by Mansfield and Ross (1935, pp. 308-321). In their basal part, the welded tuffs have the glassy appearance and conchoidal fracture of obsidian. The obsidian commonly grades upward to a stony dark reddish-brown material that locally is highly vesicular. Fragments of feldspar and spherical aggregates of tridymite in both the glassy and stony phases have the appearance of phenocrysts.

The volcanic ash is white to light gray and fairly well stratified in the lower part of the formation, becoming predominantly grayish-orange and poorly stratified in the upper part. At some places the darker ash contains numerous angular fragments of welded tuff as much as 1 foot in the longest dimension. These fragments and the enclosing ash appear to be reworked debris from stratigraphically lower parts of the Salt Lake formation that may have been stripped by erosion from rising fault blocks to the east.

Lenticular beds of conglomerate ranging in thickness from a few inches to 50 feet occur in both the lower and upper parts of the Salt Lake formation. In general, the beds of conglomerate are thickest and most numerous, and their constituent rock fragments are largest, near the mountains bordering the district on the east. Pebbles of quartzite, limestone, and chert make up most of the conglomerates in the lower part of the formation; pebbles and cobbles of rhyolite predominate in conglomerates in the upper part.

Bentonite resulting from the devitrification of volcanic ash occurs in the lower part of the formation, particularly in the central and southern parts of the district. The bentonites range in thickness from a few inches to as much as 20 feet.

Beds of argillaceous limestone as much as 3 feet thick crop out locally in the lower part of the Salt Lake formation near Hurdister Creek. Limestone, however, is a very minor constituent of the formation.

The basal part of the Salt Lake formation in the vicinity of Trapper Creek is a thick sequence of friable white volcanic ash which rests on the underlying shales of the Payette formation with a slight angular unconformity. Southward from the Right Hand Fork Beaverdam Creek, the basal part of the Salt Lake becomes increasingly shaly and the position of the contact, which here appears conformable, was determined largely by the correlation of conglomerates. The Salt Lake overlaps the Payette formation along both the western and eastern sides of the district, and locally the middle or upper parts of the Salt Lake formation rest directly on pre-Tertiary rocks, or on Tertiary (?) rhyolite.

Fragments of vertebrate teeth and bones were collected from the lower part of the Salt Lake formation in sec. 1 (approximately) T. 46 N., R. 69 E., Nevada, on the lower slopes of a pair of gravel-capped buttes about 1 1/2 miles southwest of the Trout Creek ranch. The tooth fragments were identified by Jean Hough of the U. S. Geological Survey as parts of the upper molars of the horse Neohipparion, probably Neohipparion occidentale (Leidy), indicating an early or middle Pliocene age.

Fresh-water mollusks collected in SW 1/4 sec. 24, T. 16 S., R. 21 E., from beds of shale at the top of carbonaceous shale zone B in the Salt Lake formation were identified by T. C. Yen of the U. S. Geological Survey as follows:

Sphaerum sp. undet.
Pisidium sp. undet.
Valvata cf. V. incerta Yen
Campeloma sp. undet. probably new
Lymnaea cf. L. kingii Meek
Promenetus sp. undet.
Physa sp. undet.

Yen states (memo to W. J. Hail, 3/14/52) that the age of the above assemblage is probably early Pliocene.

Surficial deposits of Quaternary age

Surficial deposits of Quaternary age mapped during the present investigation include deposits of alluvium, slope wash, and gravels on high surfaces.

Alluvial deposits consist of silt, sand, and gravel that form the present flood plains of Goose Creek and some of its larger tributaries. At most places, the alluvium is probably less than 30 feet thick.

Slope wash consists of poorly sorted fragments of rock and soil that have accumulated at the base of steep mountain slopes. Such deposits occur in many parts of the area, but are shown on the accompanying geologic map (fig. 1) only in the northeastern corner where they are so thick and extensive as to make uncertain the character of the underlying bedrock.

Deposits of sand and gravel as much as 15 feet thick cover several high, broad surfaces in the southeastern part of the district. The surfaces extend from the mountains east of the mapped area toward Goose Creek with a gentle basinward gradient, and near Goose Creek are about 200 feet above the present stream level. Stream-worn pebbles and cobbles of rhyolite, quartzite, and limestone make up the coarser fragments in these deposits.

STRUCTURE

The Goose Creek district occupies a topographic and structural basin in the northern part of the Basin and Range province. The Tertiary rocks are gently folded and faulted, and rest unconformably on a complexly folded and faulted basement of Tertiary (?) and pre-Tertiary rocks. Both the Tertiary and pre-Tertiary rocks of the district plunge northward beneath relatively undisturbed Pliocene and Pleistocene basaltic lavas of the Snake River plain.

Figure 3 shows the structure of the Salt Lake and Payette formations by means of structure contours drawn at 100 foot intervals on the top of the Barrett carbonaceous shale zone. In general these Tertiary strata have an easterly dip of 4 to 12 degrees, modified by shallow folds or structural terraces, and disrupted at many places by normal faults. The structural relief of the Barrett carbonaceous shale zone is at least 3,700 feet; the structurally highest part is west of Ibex Peak in T. 15 S., R. 20 E., Idaho, and the structurally lowest is south of Pole Creek in the northeastern part of T. 14 N., R. 19 W., Utah.

Folds

The main structural feature in the northern part of the district is the Goose Creek syncline, a northerly trending fold the axis of which coincides roughly with the valley of Goose Creek. Near the south end of the Goose Creek reservoir, the syncline is a structural basin having a closure of nearly 200 feet. The upper welded tuff of the Salt Lake formation is the stratigraphically highest bed exposed in the trough of this fold. The Goose Creek syncline dies out southward in the vicinity of Little Pole Creek in a series of shallow cross folds trending about N. 60° E.

The Tertiary rocks are arched into a low anticlinal nose in the northwestern part of the district. The valley of Trapper Creek cuts across this fold exposing the Payette formation.

Along Hurdister Creek, in the southern part of the district, the welded tuff at the base of the upper part of the Salt Lake formation may be traced around a broad northerly trending syncline and sharply folded anticline that is faulted along its crest. Dips on the steep west flank of the anticline are as high as 50° W.

Undulating folds and local flattening of the general easterly dip are shown by the structure contour map (fig. 3) at various other places in the district.

Faults

Many normal faults, some with displacements of several hundred feet, cut the Salt Lake and Payette formations. Most of the larger faults trend northward or northeastward. A few may be traced for several miles.

The upper part of the Salt Lake formation is dropped against pre-Tertiary limestone and quartzite on the east side of a high-angle normal fault that borders the eastern side of the district from Birch Creek northward for at least 10 miles. Because of talus and slope wash which obscures exposures of bedrock along the fault trace, the fault surface was not observed. At several places along its inferred trace, however, the upper part of the Salt Lake formation dips eastward into pre-Tertiary rocks at angles ranging from 5° to 46°. The Salt Lake formation occurs on the upthrown side of the fault in sec. 22, T. 15 S., R. 22 E., where welded tuff at the base of the upper part of the formation rests directly on pre-Tertiary quartzite. The bed of tuff at this locality is about 300 feet topographically higher than the equivalent bed exposed on the opposite side of the fault half a mile to the west. Vertical movement along the fault, therefore, may have been at least 300 feet after deposition of the tuff.

Near Birch Creek, and extending from Birch Creek southward to Pole Creek, the upper welded tuff and associated rocks of the Salt Lake formation are preserved at the surface in a complex series of faulted wedges bounded by northerly or northeasterly trending normal faults. The rocks are dropped down to the east and the displacement across the faulted zone is at least 900 feet along Birch Creek in sec. 25, T. 16 S., R. 21 E. Bordering this faulted area on the east and extending from Birch Creek southward to Hurdister Creek, the middle and upper parts of the Salt Lake formation are faulted against Tertiary (?) rhyolite along an en echelon system of high-angle normal faults downthrown on the west. The displacement of any one of these faults could not be determined, but displacement across the fault system may be several hundred feet.

Several faults cut the Tertiary rocks in the central and western parts of the district. The largest of these, with the upthrown side on the west and a displacement of about 500 feet is near the junction of Idaho, Utah, and Nevada. The fault trace has a northeasterly trend and is about 3 miles long. Other faults in the Salt Lake or Payette formations generally have displacements of less than 250 feet.

CARBONACEOUS SHALE AND LIGNITE

Carbonaceous beds in both the Payette and Salt Lake formations are mostly fissile brown shale, which locally contain thin layers and streaks of dark brown or black lignite. The lignite contains 30 to 50 percent ash, the carbonaceous shale about 85 percent ash. Carbonaceous beds in the Salt Lake formation locally have burned along their outcrop and under shallow cover to form clinker.

Commonly, the carbonaceous beds are interbedded with volcanic ash, greenish-gray shale, sandstone, and conglomerate in fairly well defined zones, some of which may be traced for tens of miles. Individual beds of carbonaceous shale, however, are lenticular, and may pinch out or be replaced by non-carbonaceous material within a few hundred feet.

Two main beds or zones, and several less persistent lenses of carbonaceous shale and lignite occur in the Payette formation. The Grant zone, here named for the Grant prospect in sec. 2, T. 15 S., R. 20 E., crops out about 125 feet below the top of the formation in the valley of Trapper Creek. The zone contains as many as 6 thin lenticular beds of carbonaceous shale and lignite interbedded with shale, sandstone, and volcanic ash in a stratigraphic interval of as much as 60 feet. The Worthington bed, named by Bowen (1911, p. 257) for the Worthington prospect in sec. 23, T. 16 S., R. 20 E., crops out about 500 feet below the top of the formation near South Beaverdam Creek where it consists of a single bed of carbonaceous shale, locally lignitic, 2 to 5 feet thick.

Four main carbonaceous zones occur in the lower part of the Salt Lake formation. Their relative stratigraphic position and thickness are summarized below:

Generalized section showing the thickness and relative stratigraphic position of carbonaceous shale zones in the lower part of the Salt Lake formation

	Range in thickness (feet)	Average stratigraphic interval between zones (feet)
Top of the lower part of the Salt Lake formation		
Interval		500
Zone A	1-40	
Interval		250
Barrett zone	1-80	
Interval		160
Zone B	20	
Interval		70
Zone C	5-25	

Of these four zones, the Barrett zone is the thickest and most persistent. It was named by Bowen (1911, p. 257) for the Barrett prospect in sec. 5, T. 15 S., R. 21 E., where it crops out about 30 feet below the lowest bed of welded tuff in the lower part of the formation. The Barrett zone may be traced almost continuously from Trapper Creek southward to Hurdister Creek, for almost the length of the mapped area. It is thickest on the sides of the Beaverdam-Coal Banks Creeks divide in T. 16 S., R. 21 E. where the zone contains as many as 10 beds of carbonaceous shale and thin stringers of lignite ranging in thickness from less than 1 foot to 10 feet in a stratigraphic interval of 50 to 80 feet.

Residents of the district have mined the lignite for local consumption at a few places, but the lignite is too high in ash to be of much value for fuel.

URANIUM

Occurrence and distribution

Nearly all of the Tertiary rocks sampled in the Goose Creek district--including beds of volcanic ash, sandstone, bentonite, and carbonaceous and non-carbonaceous shale--are radioactive. Most of the rocks sampled contain 0.001 to 0.003 percent equivalent uranium. At some places, however, beds of carbonaceous shale, lignite, or lignite ash contain concentrations of uranium in amounts many times that of the enclosing strata.

Beds of carbonaceous shale 1 foot or more thick contain 0.01 percent or more uranium at 18 localities, and the top foot of an 8-foot bed of carbonaceous shale contains 0.12 percent uranium at one locality (loc. 62; fig. 1). No uranium minerals were identified and the mineralogic nature of the occurrences is unknown.

Figures 4 and 5 are graphic sections showing the thickness and uranium content of carbonaceous zones in the Payette and Salt Lake formations. Tables 6 and 7 are tabulations of the analytical data showing the uranium content of carbonaceous shale and other rocks at various places in the district.

Two carbonaceous shale zones are known to be uranium-bearing. The most important is the Barrett zone which contains nearly all of the known concentrations of uranium in the district in amounts greater than 0.005 percent. Zone B, about 160 feet stratigraphically below the Barrett zone, contains 0.009 percent uranium at one place (loc. 57) in the top foot of a 3-foot bed of carbonaceous shale.

The principal area in which the Barrett zone and Zone B are mineralized is a northeasterly trending strip about 4 miles wide and 6 miles long near Goose Creek in T. 16 S., R. 21 E., Idaho. Isolated concentrations of uranium also are known north of this area in the valley of Trapper Creek, where a carbonaceous bed in the Barrett zone contains as much as 0.045 percent uranium at loc. 6, and 0.034 percent uranium at loc. 8.

As shown by the structure contour map (fig. 3) the mineralized area in T. 16 S., R. 21 E. is on both flanks and in the trough of a syncline or structural terrace, the axis of which trends northeastward in the southeastern part of the township. The northwestern flank of this fold dips as much as 10° southeastward; the southeastern flank, which is somewhat undulating, dips generally less than 3° northward or northwestward.

The vertical distribution of uranium in the carbonaceous beds is irregular. In the thicker and more highly mineralized beds (3 feet or more thick, containing 0.01 percent or more uranium), however, the uranium content is greatest in the upper part of the bed and decreases downward (see secs. 6, 8, 21, 27, 28, 54, 62, and 65, fig. 5). Thinner, and less highly mineralized beds show no regular vertical distribution pattern.

Within the mineralized areas, the uranium content of the carbonaceous beds is highly variable at different places along the same bed, and in different beds in the same zone. For this reason, and because the carbonaceous beds themselves are lenticular, no individual uranium-rich beds could be traced continuously for any great distance.

Rarely, beds of sandstone or non-carbonaceous shale, where in contact with radioactive carbonaceous shales in the Barrett zone, are also radioactive. However, no persistent beds of these rock materials were found.

Fragments of silicified wood, which occur in conglomerates in the lower part of the Salt Lake formation, are not radioactive.

A grab sample of Tertiary (?) rhyolite, collected north of Birch Creek in the SE 1/4 sec. 31, T. 16 S., R. 22 E., contained 0.007 percent uranium. The rhyolite showed somewhat higher radioactivity than is common for the rhyolite elsewhere in the district and the sample, therefore, is probably not representative of the rhyolite as a whole.

Origin

The almost universal presence of small amounts of uranium in the great volume of volcanic ash and other Tertiary rocks in the Goose Creek district, irrespective of geographic or stratigraphic position, suggests that these strata were appreciably radioactive at the time they were deposited. The uranium in these rocks seems an adequate source for the enrichment of the carbonaceous shales through leaching and redistribution of uranium by ground water. The affinity of carbon for uranium is well known, and Moore (1953) has shown that coalified materials can extract and hold a large percentage of the uranium present in dilute cold water solutions. Inasmuch as ground water tends to accumulate and be trapped in synclinal structures, sedimentary structures of synclinal nature would be likely sites for the extraction of uranium from ground water. The principal mineralized area in the Goose Creek district is on the flanks and in the trough of a syncline.

Volcanic ash, present in large quantities in thick, relatively pure beds, and also as a constituent of the shale and sandstone, may have been the source for most of the uranium in the district. The availability of uranium to ground water would depend upon the degree of weathering of the ash. Most of the volcanic ash in the district is relatively fresh and unweathered. At some places, however, thin beds of ash are almost completely devitrified, and altered to bentonite. The richest uranium-bearing carbonaceous shale bed in the Goose Creek district (loc. 62, figs. 1 and 5) is directly overlain by 120 feet of bentonite.

Table 2 gives the uranium content of water from streams and springs at 18 localities selected at random in the district. The uranium content of the water ranges from less than 0.002 parts per million (3 samples) to 0.005 parts per million (3 samples), showing that present surface and ground waters are transporting small amounts of uranium. The data are too scanty to indicate which part of the rocks in the district is a principal contributor of uranium to the water.

RESTRICTED

Table 2.--Water samples analyzed for uranium, Goose Creek district.

Locality No. (fig. 1)	Lab. Serial No.	Location	Source of water	pH[1]	Analysis[2] uranium (ppm)
1	D-76199	SE¼ sec. 17, T. 14 S., R. 22 E., Cassia Co., Idaho	Main canal leading from the Goose Creek reservoir	6	0.002
2	D-72767	SW¼ sec. 27, T. 14 S., R. 22 E., Cassia Co., Idaho	Hot spring in pre-Tertiary quartzite (?)	7	3/
3	D-76196	E½ sec. 29, T. 15 S., R. 22 E., Cassia Co., Idaho	Spring at fault contact between pre-Tertiary limestone and the Salt Lake formation	6	0.003
4	D-76193	SW¼ sec. 14, T. 15 S., R. 21 E., Cassia Co., Idaho	Spring in the Salt Lake formation	6	3/
5	58073	SW¼ sec. 34, T. 15 S., R. 21 E., Cassia Co., Idaho	Water dripping from the roof of an adit in the Barrett zone, Salt Lake formation	-	0.004
6	D-76195	S½ sec. 12, T. 16 S., R. 21 E., Cassia Co., Idaho	Pole Creek (near its mouth) heads in Tertiary (?) rhyolite and flows for 3 miles across the Salt Lake formation above the place where sample was collected	6	0.004
7	D-76200	W½ sec. 15, T. 16 S., R. 21 E., Cassia Co., Idaho	Spring in the Salt Lake formation	6	0.002
8	D-72766	SW¼ sec. 23, T. 16 S., R. 21 E., Cassia Co., Idaho	Birch Creek (near its mouth) flows across Tertiary (?) rhyolite or the Salt Lake formation for at least 6 miles above the place where sample was collected	6-7	0.004

RESTRICTED

RESTRICTED

Table 2.--Water samples analyzed for uranium, Goose Creek district-Continued.

Locality No. (fig. 1)	Lab. Serial No.	Location	Source of water	pH[1/]	Analysis[2/] uranium (ppm)
9	D-76205	SE$\frac{1}{4}$ sec. 25, T. 16 S., R. 21 E., Cassia Co., Idaho	Spring in the Salt Lake formation	6	0.003
10	D-72765	SE$\frac{1}{4}$ sec. 31, T. 16 S., R. 22 E., Cassia Co., Idaho	Birch Creek (about $3\frac{1}{2}$ miles from its mouth) flows across Tertiary (?) rhyolite and the upper part of the Salt Lake formation above the place where sample was collected	6	0.003
11	D-76204	SE$\frac{1}{4}$ sec. 32, T. 15 N., R. 18 W., Cassia Co., Idaho	Spring in Tertiary (?) rhyolite	6	0.005
12	D-76202	SW$\frac{1}{4}$ sec. 35, T. 16 S., R. 21 E., Cassia Co., Idaho	Spring in the Salt Lake formation	6	0.003
13	D-72768	NE$\frac{1}{4}$ sec. 33, T. 16 S., R. 21 E., Cassia Co., Idaho	Beaverdam Creek (near its mouth) heads in pre-Tertiary rocks and flows across the Payette and Salt Lake formations for at least 6 miles above the place where sample was collected	6	0.005
14	D-76194	SW$\frac{1}{4}$ sec. 13, T. 16 S., R. 20 E., Cassia Co., Idaho	Beaverdam Creek (about 5 miles from its mouth) heads in pre-Tertiary rocks and flows across the Payette formation above the place where sample was collected	6	0.003

RESTRICTED

Table 2.--Water samples analyzed for uranium, Goose Creek district-Continued.

Locality No. (fig. 1)	Lab. Serial No.	Location	Source of water	pH 1/	Analysis 2/ uranium (ppm)
15	D-76193	SE¼ sec. 9, T. 16 S., R. 20 E., Cassia Co., Idaho	Spring in the Payette formation	6	3/
16	D-76198	NE part T. 47 N., R. 69 E., Elko Co., Nev.	Spring in the Payette formation	6	0.002
17	D-76197	SE part T. 47 N., R. 69 E., Elko Co., Nev.	Goose Creek	6	0.002
18	D-76203	W½ sec. 13, T. 14 N., R. 19 W., Boxelder Co., Utah	Spring near fault contact between the Salt Lake formation and Tertiary (?) rhyolite	6	0.005

1/ pH determined with pH indicator paper in the field.
2/ Analyses made by U.S.G.S. Trace Elements Denver Laboratory.
3/ Less than 0.002 parts per million.

RESTRICTED

Reserves

The estimated reserves of uranium in the Barrett carbonaceous shale zone are shown by tables 3 and 4, and the areas in T. 16 S., R. 21 E., for which the reserves were calculated are shown by figs. 6 and 7. The reserves are listed in two categories: (1) in beds 2 feet or more thick containing 0.005 percent or more uranium, and (2) in beds 1 foot or more thick containing 0.01 percent or more uranium. Reserves in the first category total 900 short tons of uranium in beds having an average grade of 0.007 percent, and in the second category, 115 short tons of uranium in beds having an average grade of 0.014 percent. Because of the lenticularity of the radioactive beds, and the abrupt lateral changes in their uranium content, the reserves in both categories are regarded as inferred.

The areas shown by figs. 6 and 7 were determined by drawing isopach and isograde maps of the radioactive portions of the Barrett zone. At localities where more than one bed or part of the zone is mineralized, the average thickness and weighted average grade of the radioactive beds or parts of the zone were calculated, and then combined; these arbitrary values were used in drawing the maps. Only that bed or part of the zone was considered that had a greater concentration of uranium than the cut-off chosen for the particular category. The reserves would be increased substantially by including with the higher-grade portions of the radioactive zone, material having uranium in amounts slightly less than the cut-off grade.

Table 3.--Inferred reserves of uranium in the Barrett carbonaceous shale zone:

In beds 2 feet or more thick, containing 0.005 percent or more uranium.1/

Area for which reserves are calculated 2/	Thickness (weighted average, in feet)	Area (acres)	Grade (weighted average, in percent)	Carb. shale (short tons rounded)	Uranium (short tons rounded)
1	2.5	320	0.009	880,000	79
2	6.4	16	.010	110,000	11
3	8.5	185	.007	1,730,000	121
4	2.7	1413	.007	4,200,000	294
	2.9	1020	.007	3,250,000	228
	3.0	34	.008	110,000	9
5	2.5	28	.005	75,000	4
6	3.7	329	.008	1,340,000	107
	3.6	32	.009	130,000	12
7	3.5	82	.008	315,000	25
8	2.5	40	.006	110,000	7
9	2.5	24	.007	65,000	5
Totals (rounded)	3.2	3520	.0073	12,300,000	900

1/ 1,100 short tons of carbonaceous shale per acre-foot used in all calculations (based on an average apparent specific gravity of 0.83 for 6 samples).

2/ See map, figure 6.

Table 4.--Inferred reserves of uranium in the Barrett carbonaceous shale zone:

In beds 1 foot or more thick, containing 0.010 percent or more uranium.1/

Area for which reserves are calculated 2/	Thickness (weighted average, in feet)	Area (acres)	Grade (weighted average, in percent)	Carb. shale (short tons rounded)	Uranium (short tons rounded)
10	2.5	115	0.012	320,000	38
11	6.1	18	.010	120,000	12
12	2.6	49	.012	140,000	17
13	2.5	14	.013	40,000	5
14	1.6	3	.013	6,000	1
15	1.7	51	.022	95,000	21
Sec. 5, T. 15 S., R. 21 E.	1.5	14	.024	24,000	6
Secs. 12 and 13, T. 15 S., R. 20 E.	1.0	66	.020	73,000	15
Totals (rounded)	2.2	330	.014	820,000	115

1/ 1,100 short tons of carbonaceous shale per acre foot used in all calculations (based on an average apparent specific gravity of 0.83 for 6 samples).
2/ See map, figure 7.

RESTRICTED

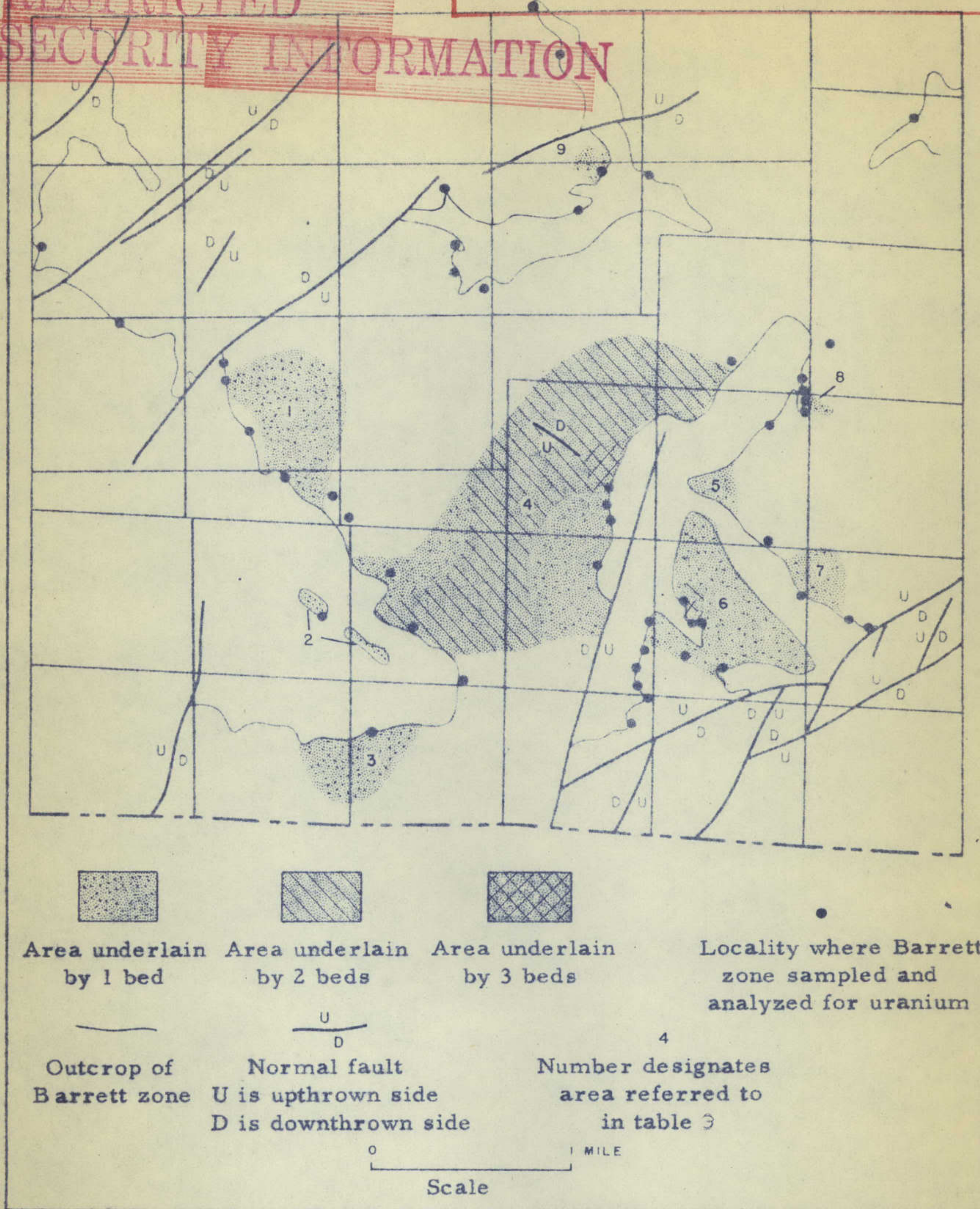


Figure 6.--Map of T. 16 S., R. 21 E., Idaho, showing the areas that may be underlain by carbonaceous shale in beds 2 feet or more thick containing 0.005 percent or more uranium.

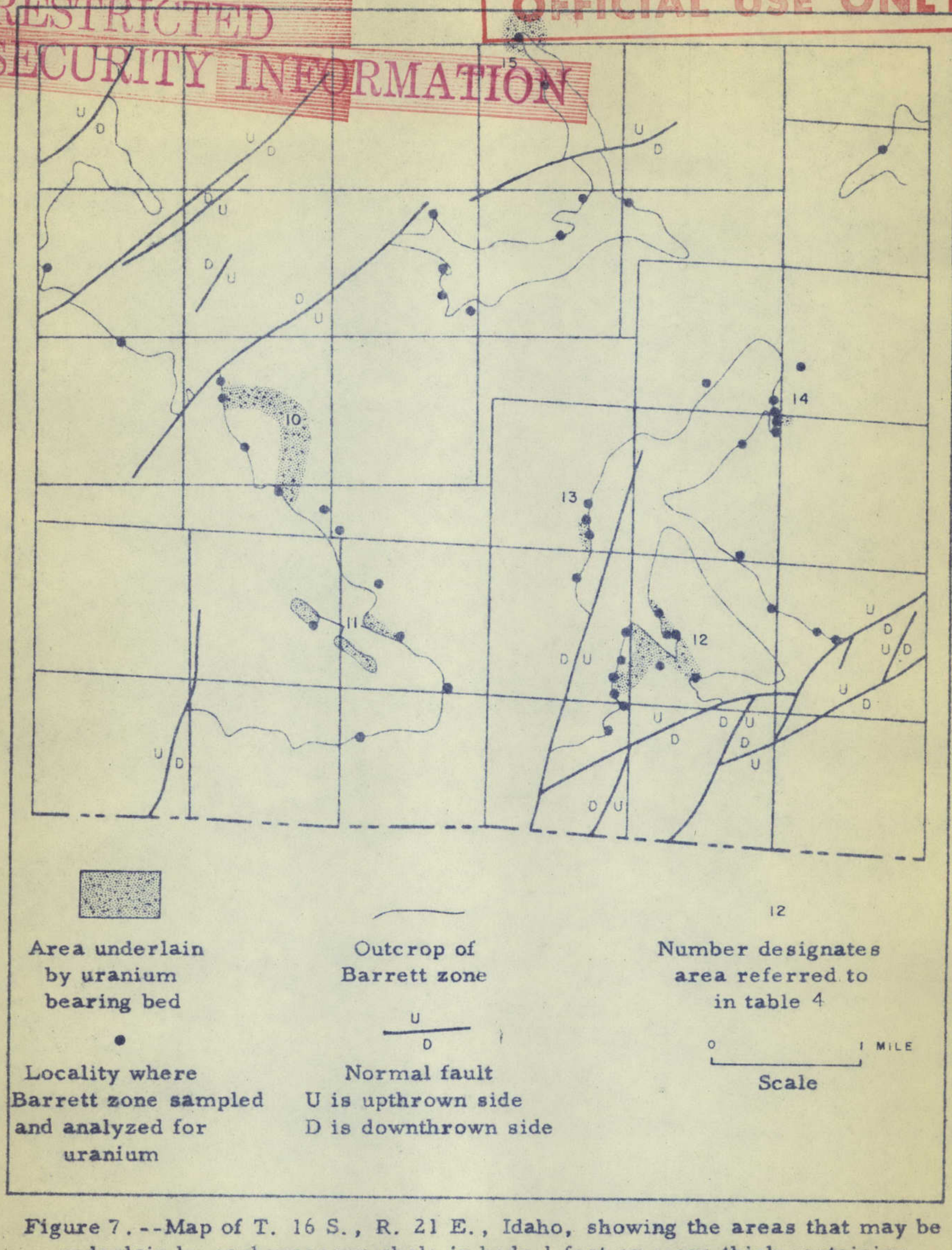


Figure 7.--Map of T. 16 S., R. 21 E., Idaho, showing the areas that may be underlain by carbonaceous shale in beds 1 foot or more thick containing 0.010 percent or more uranium.

OFFICIAL USE ONLY

RESTRICTED
SECURITY INFORMATION

PLANS

About 2,000 feet of core drilling in the Goose Creek district is planned during the 1953 field season with the objectives of (1) testing the Barrett carbonaceous shale zone underground in the area thought to be most favorable geologically, (2) testing stratigraphically lower zones of carbonaceous shale, not exposed at the surface in the areas most highly mineralized, and (3) obtaining fresh samples of carbonaceous shale for comparison of the distribution of uranium in fresh and weathered material.

TABULATION OF ANALYTICAL DATA

About 540 samples of carbonaceous shale, lignite, volcanic ash, sandstone, bentonite, limestone, and other rock materials were collected in the Goose Creek district and submitted for uranium analysis. Nearly 500 of these samples were collected from the measured stratigraphic sections shown by figs. 4 and 5. The remainder are samples of miscellaneous rock materials collected at various places in the district.

Table 5 shows the uranium content of samples containing 0.004 percent or more equivalent uranium, collected from measured stratigraphic sections. A few samples with less than 0.004 percent equivalent uranium are also listed where they represent thin partings in an otherwise more highly radioactive bed. The stratigraphic intervals represented by all of the samples collected from measured sections are shown on figs. 4 and 5.

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district.

Samples indicated by an asterisk (*) are grab samples; all others are channel samples.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
4	MM-631	100251	0.005	0.001	--	--	0.8 ft bed volcanic ash
6	MM-177	68246	.010	.014	88.7	0.016	1.0 ft taken 7.5 ft above base 8.5 ft carb. sh.
	MM-181	68250	.018	.045	85.2	.060	0.4 ft taken 5.2 ft above base 8.5 ft carb. sh.
7	MM-217	68286	.004	--	--	--	Bottom 1.0 ft of 14.7 ft volcanic ash
	MM-310	54762	.004	--	--	--	Top 1.0 ft of 4.1 ft. carb. sh.
8	MM-340	54769	.004	--	--	--	1.0 ft at base of 12 ft bed volcanic ash
	D-123	52916	.020	.034	76.25	.046	Top 0.5 ft of 8.3 ft carb. sh.
	MM-191	68260	.004	.005	--	--	Next 0.4 ft of 8.3 ft carb. sh.
10	MM-342	54770	.005	--	--	--	1.0 ft bed volcanic ash
14	MM-257	68325	.004	--	--	--	Bottom 1.0 ft of 2.0 ft carb. sh.
16	*MM-222	68291	.004	.001	98.1	.001	Upper part, bed of coal ash and clinker
18	MM-225	68294	.004	--	--	--	2.5 ft bed carb. sh.
19	MM-580	91575	.004	--	--	--	1.0 ft bed carb. sh.
20	*MM-313	54764	.005	--	--	--	1.5 ft below top 20 ft volcanic ash

1/ See figure 5 and geologic map, figure 1.

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
21	*DI-9	52902	0.005	0.001	--	--	Volcanic ash
	DI-10	52903	.005	.004	--	--	2.0 ft bed carb. sh.
	DI-11	52904	.004	.001	--	--	0.3 ft bed sandstone
	DI-12	52905	.017	.032	84.35	0.034	Top 0.7 ft of 7.5 ft carb. sh.
22	MM-232	68301	.004	--	--	--	Bottom 3.0 ft of 6.0 ft carb. sh.
23	MM-235	68304	.006	.011	--	--	3.0 ft bed carb. shl.
	MM-314	54765	.005	--	--	--	3.0 ft bed welded tuff
24A	MM-670	100290	.004	.003	--	--	4.0 ft bed carb. sh.
	MM-671	100291	.004	.002	--	--	Top 3.0 ft carb. sh. of 9.0 ft lignitic carb. sh.
	MM-672	100292	.006	.004	68.7	.006	Next 2.0 ft of 9 ft bed lignitic carb. sh.
26A	MM-686	100306	.002	--	--	--	2.5 ft carb. sh. 1.0 ft from top of 11.5 ft carb. sh.
	MM-687	100307	.003	--	--	--	Next 2.5 ft of 11.5 ft carb. sh.
	MM-688	100308	.005	.005	--	--	Next 2.5 ft of 11.5 ft carb. sh.
	MM-689	100309	.004	.004	--	--	Next 2.5 ft of 11.5 ft carb. sh.
	MM-696	100316	.004	.001	--	--	2.5 ft bed carb. sh.
27	MM-396	71637	.004	--	--	--	0.8 ft bed clay
	MM-395	71636	.004	--	--	--	0.5 ft bed carb. clay
	MM-394	71635	.005	--	--	--	Top 0.8 ft of 5.1 ft carb. sh.
	MM-393	71634	.008	.009	--	--	Next 0.8 ft of 5.1 ft carb. sh.
	MM-392	71633	.013	.021	85.8	.024	Next 0.8 ft of 5.1 ft carb. sh.

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district--Continued.

Locality number1/	Sample number Field	Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
27	MM-391	71632	0.010	0.015	83.7	0.018	Next 0.8 ft of 5.1 ft carb. sh.
Cont.	MM-390	71631	.004	.007	--	--	Next 0.8 ft of 5.1 ft carb. sh.
	MM-389	71630	.004	.004	--	--	Bottom 1.1 ft of 5.1 ft carb. sh.
	MM-388	71629	.002	--	--	--	Top 0.9 ft of 7.6 ft carb. sh.
	MM-387	71628	.005	.006	--	--	Next 0.9 ft of 7.6 ft carb. sh.
	MM-386	71627	.005	.007	--	--	Next 0.9 ft of 7.6 ft carb. sh.
	MM-385	71626	.005	.005	--	--	Next 0.9 ft of 7.6 ft carb. sh.
28	MM-531	91243	.005	.005	--	--	Top 1.6 ft of 9.6 ft carb. sh.
	MM-530	91242	.003	--	--	--	Next 1.6 ft of 9.6 ft silty carb. sh.
	MM-529	91241	.003	--	--	--	Next 1.6 ft of 9.6 ft silty carb. sh.
	MM-528	91240	.005	.006	--	--	Next 1.6 ft of 9.6 ft silty carb. sh.
	MM-527	91239	.003	--	--	--	Next 1.6 ft of 9.6 ft silty carb. sh.
	MM-526	91238	.004	--	--	--	Bottom 1.6 ft of 9.6 ft silty carb. sh.
	MM-525	91237	.010	.017	87.4	--	Top 1.4 ft of 2.9 ft lignitic carb. sh.
	MM-524	91236	.004	.005	84.4	--	Bottom 1.5 ft of 2.9 ft lignitic carb. sh.
	MM-516	91228	.004	.004	--	--	Bottom 1.3 ft of 2.6 ft carb. sh.
29A	MM-697	100317	.005	.003	--	--	3.0 ft bed carb. sh.
	MM-701	100321	.004	.001	--	--	Top 2.5 ft of 7.5 ft bed grayish-brown claystone
	MM-703	100323	.004	.001	--	--	Bottom 2.5 ft of 7.5 ft bed grayish-brown claystone

RESTRICTED

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
30	MM-473	87804	0.007	0.007	--	--	Top 1.0 ft of 7.5 ft brown claystone
	MM-472	87803	.006	.008	--	--	1.0 ft in upper middle part of 7.5 ft brown claystone
	MM-471	87802	.007	.007	--	--	1.0 ft in lower middle part of 7.5 ft brown claystone
	MM-470	87801	.004	.006	--	--	Bottom 1.0 ft of 7.5 ft brown claystone
	MM-469	87800	.005	.005	--	--	0.8 ft bed carb. sh.
	MM-468	87799	.006	.007	--	--	0.8 ft bed carb. sh.
	MM-467	87798	.004	--	--	--	1.0 ft bed carb. sh.
	MM-465	87796	.005	.007	--	--	Top 0.8 ft of 1.7 ft carb. sh.
	MM-464	87795	.004	--	--	--	Bottom 0.9 ft of 1.7 ft carb. sh.
	MM-460	87791	.004	.006	--	--	1.4 ft bed carb. sh.
31	MM-593	91586	.005	.005	--	--	1.0 ft in middle part of 6.3 ft carb. sh.
	MM-592	91585	.004	--	--	--	Bottom 1.6 ft of 6.3 ft carb. sh.
32	MM-480	91192	.007	.009	--	--	Lower 2.5 ft of 5.0 ft carb. sh.
	MM-479	91191	.004	.005	--	--	1.1 ft bed carb. sh.
33	MM-450	87781	.003	.003	--	--	Top 1.0 ft of 5.0 ft carb. sh.
	MM-449	87780	.002	--	--	--	Next 1.0 ft of 5.0 ft carb. sh.
	MM-448	87779	.004	--	--	--	Next 1.0 ft of 5.0 ft carb. sh.
	MM-447	87778	.004	--	--	--	Next 1.0 ft of 5.0 ft carb. sh.
	MM-444	87775	.012	.013	--	--	Top 1.1 ft of 3.3 ft carb. sh.
	MM-443	87774	.016	.020	--	--	Middle 1.1 ft of 3.3 ft carb. sh.
	MM-442	87773	.004	--	--	--	Bottom 1.1 ft of 3.3 ft carb. sh.

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number 1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
34	MM-282	68350	0.005	0.006	--	--	Bottom 2.8 ft of 4.3 ft carb. sh.
	MM-280	68348	.004	.002	--	--	1.0 ft bed coal ash
	MM-278	68346	.008	.010	--	--	Top 1.0 ft of 3.0 ft carb. sh.
	MM-277	68345	.015	.018	--	--	Middle 1.0 ft of 3.0 ft carb. sh.
	MM-276	68344	.006	.005	--	--	Bottom 1.0 ft of 3.0 ft carb. sh.
	MM-273	68341	.004	.003	--	--	1.7 ft bed carb. sh.
	MM-272	68340	.004	.005	--	--	0.9 ft bed carb. sh.
	MM-271	68339	.004	.006	--	--	1.4 ft bed carb. sh.
	MM-270	68338	.004	.002	--	--	1.0 ft bed carb. sh.
	MM-269	68337	.004	.004	--	--	2.6 ft bed carb. sh.
35A	MM-539	91251	.005	.011	--	--	1.1 ft bed carb. sh.
	MM-538	91250	.002	--	--	--	1.1 ft bed carb. siltstone
	MM-537	91249	.005	.007	--	--	Top 1.2 ft carb. sh.
	MM-536	91248	.002	--	--	--	Bottom 1.2 ft carb. sh.
	MM-642	100262	.004	--	--	--	Next 2.0 ft of 9.0 ft bed carb. sh.
	MM-647	100267	.004	.006	--	--	Top 2.0 ft of 7.0 ft bed carb. sh.
	MM-648	100268	.008	.008	--	--	Next 1.5 ft of 7.0 ft bed carb. sh.
	MM-649	100269	.005	.006	81.0	0.007	Bottom 2.0 ft of 7.0 ft bed carb. sh.
	MM-650	100270	.005	.005	--	--	2.0 ft bed carb. sh. and gray sh.
	MM-651	100271	.008	.008	--	--	2.0 ft bed carb. sh.
	MM-652	100272	.004	.001	--	--	2.0 ft bed greenish gray siltstone

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
36A	MM-721	100341	0.005	0.004	--	--	2.0 ft bed carb. sh.
37A	MM-704	100324	a	--	--	--	Top 2.5 ft of 30.0 ft bed carb. sh.
	MM-705	100325	.004	.001	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-706	100326	.002	--	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-707	100327	.002	--	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-708	100328	.004	.003	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-709	100329	.003	--	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-710	100330	.004	.003	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-711	100331	.004	.003	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-712	100332	.004	.003	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-713	100333	.004	.003	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-714	100334	.003	--	--	--	Next 2.5 ft of 30.0 ft bed carb. sh.
	MM-715	100335	.004	.003	--	--	Bottom 2.5 ft of 30.0 ft bed carb. sh.
38	MM-569	91564	.004	--	--	--	Top 1.0 ft of 2.0 ft carb. sh.
39A	MM-716	100336	.004	.003	--	--	Top 2.5 ft of 5.0 ft carb. sh.
	MM-717	100337	.004	.002	--	--	Bottom 2.5 ft of 5.0 ft carb. sh.
	MM-719	100339	.004	.001	--	--	2.5 ft bed volcanic ash and carb. sh.

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
40	MM-769	101827	0.005	0.004	--	--	0.8 ft bed lignite ash
	MM-768	101826	.004	.002	--	--	Top 0.9 ft of 1.9 ft bed clinker
	MM-767	101825	.004	.002	--	--	Bottom 1.0 ft of 1.9 ft bed clinker
	MM-766	101824	.011	.012	--	--	Top 0.7 ft of 2.7 ft bed coal ash
42	MM-284	68352	.004	.005	--	--	Top 0.4 ft of 13.7 ft carb. sh.
	MM-285	68353	.004	.008	--	--	Next 2.0 ft of 13.7 ft carb. sh.
43	MM-262	68330	.004	.005	--	--	Top 1.0 ft of 10.2 ft carb. sh.
44	MM-352	54773	.004	--	--	--	1.0 ft bed volcanic ash
	MM-216	68285	.010	.021	67.8	0.031	1.7 ft bed lignite
	MM-215	68284	.001	.004	46.9	.008	Top 1.2 ft of 5.2 ft lignite
45	MM-564	91559	.004	--	--	--	1.0 ft bed carb. claystone
	MM-563	91558	.005	.007	--	--	0.6 ft bed carb. sh.
	MM-561	91556	.004	--	--	--	Bottom 1.0 ft of 2.4 ft carb. sh.
	MM-559	91554	.008	.012	--	--	Bottom 0.7 ft of 1.7 ft carb. sh.
46	MM-574	91569	.004	--	--	--	0.7 ft bed brown siltstone
	MM-572	91567	.007	.002	--	--	Bottom 1.0 ft of 1.7 ft carb. sh.
	MM-571	91566	.012	.009	--	--	1.0 ft bed brown claystone
47A	MM-722	100342	.004	.002	--	--	5.0 ft bed brownish-black siltstone
48A	MM-487	91199	.004	--	--	--	1.0 ft bed carb. sh. and siltstone
	MM-486	91198	.004	--	--	--	0.7 ft bed carb. sh.
	MM-725	100345	.004	.001	--	--	2.5 ft bed of light brown claystone

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
49	MM-491	91203	0.004	--	--	--	0.3 ft bed carb. siltstone
	MM-490	91202	.006	.013	--	--	Top 2.5 ft of 7.4 ft carb. sh.
50	MM-497	91209	.013	.015	--	--	1.6 ft bed carb. sh.
51	MM-493	91205	.007	.004	--	--	0.7 ft bed carb. sh.
52	MM-441	87772	.006	.008	--	--	1.0 ft bed carb. sh.
	MM-438	87769	.004	--	--	--	Bottom 0.7 ft of 1.5 ft bed carb. sh.
53	MM-429	87760	.004	--	--	--	Middle 1 ft of 6.5 ft clay bed
	MM-474	87805	.007	.003	--	--	0.9 ft bed carb. sh.
	MM-475	87806	.004	--	--	--	Top 1 ft of 3 ft bed brown sandy claystone
54	MM-622	91614	.015	.015	--	--	Top 1.1 ft of 4.4 ft carb. sh.
	MM-621	91613	.008	.007	--	--	Next 1.1 ft of 4.4 ft carb. sh.
	MM-620	91612	.006	.006	--	--	Next 1.1 ft of 4.4 ft carb. sh.
	MM-619	91611	.004	.004	--	--	Bottom 1.1 ft of 4.4 ft carb. sh.
	MM-618	91610	.005	.005	--	--	0.7 ft bed carb. sh.
	MM-617	91609	.006	.005	--	--	0.4 ft bed silicified carb. sh.
55	MM-624	91616	.005	.003	--	--	0.3 ft bed carb. sh.
	MM-623	91615	.007	.004	--	--	0.5 ft bed carb. sh.
56	MM-625	91617	.004	.007	--	--	1.0 ft bed carb. sh.
57	MM-296	71591	.012	.009	81.7	0.011	Top 1.0 ft of 3.0 ft carb. sh.
	MM-297	71592	.006	.003	--	--	Middle 1.0 ft of 3.0 ft carb. sh.
	MM-298	71593	.004	.001	--	--	Bottom 1.0 ft of 3.0 ft carb. sh.

RESTRICTED

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
58	MM-355	71598	0.006	0.003	--	--	Top 1.1 ft of 2.2 ft carb. sh.
	MM-356	71599	.006	.004	--	--	Bottom 1.1 ft of 2.2 ft carb. sh.
59	MM-601	91594	.010	.009	--	--	Top 0.7 ft of 1.5 ft carb. sh.
	MM-600	91593	.014	.014	--	--	Bottom 0.8 ft of 1.5 ft carb. sh.
	MM-599	91592	.008	.009	--	--	0.4 ft bed carb. sh.
	MM-598	91591	.010	.012	--	--	0.6 ft bed carb. sh.
	MM-596	91589	.003	--	--	--	Upper 0.7 ft of 1.7 ft bed carb. sh.
	MM-595	91588	.010	.012	--	--	Lower 1.0 ft of 1.7 ft bed carb. sh.
60	MM-731	100351	.006	.002	--	--	1.1 ft bed carb. sh.
	MM-730	100350	.006	.002	--	--	1.2 ft bed volcanic ash
	MM-729	100349	.008	.002	--	--	1.2 ft bed carb. shl.
61	MM-295	71590	.007	.002	--	--	1.0 ft bed carb. sh.
	MM-294	71589	.012	.009	90.0	0.010	Top 0.9 ft of 1.9 ft carb. sh.
	MM-293	71588	.010	.008	--	--	Bottom 0.9 ft of 1.9 ft carb. sh.
	MM-291	71587	.013	.014	--	--	0.7 ft carb. sh.
	MM-290	71586	.022	.025	67.2	.037	1.0 ft bed carb. sh.
	MM-289	71585	.007	.003	--	--	Top 1.0 ft of 2.8 ft carb. sh.
	MM-288	71584	.011	.006	--	--	Bottom 1.8 ft of 2.8 ft carb. sh.
	MM-287	71583	.009	.005	--	--	2.0 ft bed carb. sh.
	MM-286	71582	.010	.005	--	--	0.4 ft bed carb. sh.
62	MM-309	54286	.019	.028	91.7	.030	0.5 ft silicified carb. sh.
	MM-301	54278	.097	.120	84.2	.130	Top 1.0 ft of 8.0 ft carb. sh.
	MM-302	54279	.062	.081	86.9	.085	Next 1.0 ft of 8.0 ft carb. sh.
	MM-303	54280	.040	.047	89.7	.045	Next 1.0 ft of 8.0 ft carb. sh.

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district-Continued.

Locality number 1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
62 Cont.	MM-304	54281	0.019	0.019	94.9	0.016	Next 1.0 ft of 8.0 ft carb. sh.
	MM-305	54282	.015	.016	94.8	.013	Next 1.0 ft of 8.0 ft carb. sh.
	MM-306	54283	.019	.016	93.8	.016	Next 1.0 ft of 8.0 ft carb. sh.
	MM-307	54284	.024	.020	93.6	.021	Next 1.0 ft of 8.0 ft carb. sh.
	MM-308	54285	.020	.017	94.1	.018	Bottom 1.0 ft of 8.0 ft carb. sh.
63	MM-369	71611	.008	.007	--	--	Middle 1.1 ft of 3.7 ft carb. sh.
	MM-368	71610	.008	.004	--	--	Bottom 1.1 ft of 3.7 ft carb. sh.
	MM-367	71609	.005	.003	--	--	Top 0.9 ft of 4.1 ft carb. sh.
	MM-366	71608	.004	.002	--	--	Middle 0.9 ft of 4.1 carb. sh.
	MM-365	71607	.005	.001	--	--	Bottom 0.9 ft of 4.1 ft carb. sh.
	MM-364	71606	.006	.002	--	--	1.1 ft bed shale
	MM-363	71605	.006	.004	--	--	Top 1.0 ft of 2.0 ft carb. sh.
	MM-362	71604	.008	.006	--	--	Bottom 1.0 ft of 2.0 ft carb. sh.
	MM-361	71603A	.009	.008	--	--	1.7 ft bed sandstone
	MM-360	71603	.021	.035	--	--	Top 1.1 ft of 3.3 ft carb. sh.
	MM-359	71602	.017	.023	--	--	Middle 1.1 ft of 3.3 ft carb. sh.
	MM-358	71601	.013	.013	--	--	Bottom 1.1 ft of 3.3 ft carb. sh.
	MM-357	71600	.010	.013	--	--	Top 1.0 ft of 2.0 ft gray sh.
64	MM-514	91226	.004	--	--	--	0.4 ft bed carb. sh.
65A	MM-653	100273	.004	.001	--	--	Top 2.0 ft of 5.0 ft carb. sh.
	MM-654	100274	.004	.001	--	--	Middle 2.0 ft of 5.0 ft carb. sh.
	MM-655	100275	.004	.001	--	--	Bottom 1.0 ft of 5.0 ft carb. sh.

RESTRICTED

Table 5.--Radioactivity and chemical analyses of samples containing 0.004 percent or more equivalent uranium from carbonaceous shale zones in Goose Creek district--Continued.

Locality number 1/	Sample number Field	Sample number Laboratory	Equivalent uranium (percent)	Uranium in sample (percent)	Ash (percent)	Uranium in ash (percent)	Description
66	MM-511	91223	0.005	0.004	--	--	0.3 ft bed carb. sh.
	MM-510	91222	.004	--	--	--	0.5 ft bed brown siltstone
	MM-509	91221	.005	.006	--	--	0.4 ft bed carb. sh.
	MM-506	91218	.004	--	--	--	0.4 ft bed carb. sh.
67	MM-504	91216	.011	.007	--	--	1.0 ft bed carb. sh.
68	MM-485	91197	.004	--	--	--	0.3 ft bed carb. sh.
	MM-483	91195	.005	.003	--	--	1.5 ft bed carb. sh. and siltstone
	MM-482	91194	.004	--	--	--	0.5 ft bed carb. sh.
69	MM-591	91584	.004	--	--	--	1.0 ft bed carb. sh.
70	MM-603	91596	.006	.005	--	--	1.1 ft bed gray and brown carb. sh.
73	MM-457	87788	.004	--	--	--	Top 0.8 ft of 2.1 ft carb. sh.
	MM-456	87787	.004	--	--	--	Bottom 1.2 ft of 2.1 ft carb. sh.
	MM-455	87786	.005	.005	--	--	Top 1.3 ft of 2.7 ft carb. sh.
	MM-454	87785	.004	--	--	--	Bottom 1.4 ft of 2.7 ft carb. sh.
	MM-451	87782	.005	.006	--	--	Bottom 1.1 ft of 2.3 ft bed carb. sh.
75	MM-662	100282	.004	.003	--	--	1.5 ft bed carb. sh.
76	MM-434	87765	.006	.008	--	--	0.6 ft bed carb. sh.
89	MM-667	100287	.004	.002	--	--	Bottom 1.1 ft of 3.1 ft carb. sh.

1/ See figure 5 and geologic map, figure 1.

Table 6 shows the uranium content of miscellaneous rock materials sampled at various places in the district other than at localities where detailed stratigraphic sections were measured. The samples are listed according to the formation they represent.

Table 7 shows quantitative spectrographic analyses of the ash of 5 samples of carbonaceous shale. The localities from which these samples came, and the intervals they represent, are shown by fig. 5.

Table 6.--Radioactivity and chemical analyses of samples from miscellaneous localities, Goose Creek district.

Locality (Sec., T., R.)	Sample number Field	Laboratory	Equivalent uranium (percent)	Uranium (percent)	Description
			Salt Lake formation, upper part		
35-15N-19W Utah	MM-734	D-76310	0.002	0.0003	Grayish-orange volcanic ash, upper 2 ft of 5 ft bed.
35-15N-19W Utah	MM-735	D-76311	.003	.0002	Light gray volcanic ash, grab sample.
35-15N-19W Utah	MM-736	D-76312	.002	.0001	White to gray-white volcanic ash, 2 ft channel.
35-15N-19W Utah	MM-737	D-76313	.002	.0001	Grayish-orange volcanic ash, 2 ft channel.
35-15N-19W Utah	MM-738	D-76314	.003	.0003	Grayish-orange volcanic ash, 2 ft channel.
			Salt Lake formation, lower part		
13-15S-20E Idaho	MM-193	68262	--	--	Carb. shale, top 1 ft of 3.7 ft bed.
7-16S-21E Idaho	MM-240	68309	.005	.007	Carb. shale, 1.5 ft bed.
25-15S-20E Idaho	MM-250	68318	.004	--	Clinker, bottom 1 ft of 7.9 ft bed.
25-15S-20E Idaho	MM-251	68319	.002	--	Carb. clay, 2 ft channel.
36-15S-20E Idaho	MM-252	68320	.005	.008	Lignitic shale, upper .6 ft of 1.2 ft bed.
36-15S-20E Idaho	MM-253	68321	.002	--	Lignitic shale, lower .6 ft of 1.2 ft bed

RESTRICTED

Table 6.--Radioactivity and chemical analyses of samples from miscellaneous localities, Goose Creek district-Continued.

Locality (Sec., T., R.)	Sample number Field	Laboratory	Equivalent uranium (percent)	Uranium (percent)	Description
6-15S-21E Idaho	MM-328	54766	0.004	--	Glassy welded tuff, grab sample.
1-15S-20E Idaho	MM-331	54767	.001	--	Light gray volcanic ash, grab sample.
5-15S-21E Idaho	MM-336	54768	.005	--	Light gray volcanic ash, grab sample.
5-15S-20E Idaho	MM-346	54772	.003	--	Light gray volcanic ash, grab sample.
25-16S-21E Idaho	MM-353	71596	.007	0.005	Carb. shale, 7 ft bed.
25-16S-21E Idaho	MM-354	71597	.005	.001	Carb. siltstone, top 1 ft of 3.5 ft bed.
26-16S-21E Idaho	MM-371	71612A	.003	--	Yellow gray bentonite, bottom 1 ft of 6 ft bed.
6-15N-18W Utah	MM-372	71613	.002	--	Lignite, grab sample.
12-16S-20E Idaho	MM-427	D-70178	.001	.0004	Yellow opal, grab sample.
23-16S-21E Idaho	MM-436	87767	.002	--	Light gray volcanic ash, upper 1 ft of 12 ft bed.
22-16S-21E Idaho	MM-445	87776	.002	--	Light gray volcanic ash, grab sample.
6-15S-21E Idaho	MM-630	100250	.002	--	Grayish yellow bentonite, 1.1 ft bed.
33-15N-19W Utah	MM-732	100352	.002	--	Light gray volcanic ash, bottom 1 ft of 2.3 ft bed.
33-15N-19W Utah	MM-733	100353	.001	.0001	Light gray volcanic ash, top .5 ft of 2.3 ft bed.
32-47N-70E Nevada	MM-739	D-76315	.003	.0001	Grayish white volcanic ash, grab sample.

RESTRICTED

Table 6.--Radioactivity and chemical analyses of samples from miscellaneous localities, Goose Creek district-Continued.

Locality (Sec., T., R.)	Sample number Field	Laboratory	Equivalent uranium (percent)	Uranium (percent)	Description
21-14N-19W Utah	MM-740	D-76316	0.005	0.0002	Grayish white volcanic ash, grab sample.
47N-70E Nevada	MM-741	D-76317	.004	.0003	Grayish white volcanic ash, grab sample.
47N-70E Nevada	MM-742	D-76318	.004	.0002	Black welded tuff, grab sample.
47N-70E Nevada	MM-743	76319	.003	.0005	Grayish white volcanic ash, 2 ft bed.
47N-70E Nevada	MM-745	76321	.004	.0006	Grayish white volcanic ash, grab sample.
47N-70E Nevada	MM-746	76322	.002	.0013	Yellowish gray bentonite, grab sample.
			Tertiary (?) rhyolite		
32-16S-22E Idaho	MM-459	87790	.005	.007	Light gray rhyolite.
			Pre-Tertiary rocks, undifferentiated		
9-15S-20E Idaho	MM-425	D-70176	.001	.0003	Gray limestone, grab sample.
15-15S-20E Idaho	MM-426	D-70177	.001	.0001	Gray limestone, grab sample.
47N-69E Nevada	MM-770	76326	.002	.0004	Gray shale, grab sample.
47N-69E Nevada	MM-771	76327	.001	.0001	Gray limestone, grab sample.

RESTRICTED

RESTRICTED

Table 7.--Semi-quantitative spectrographic analyses of the ash of 5 samples of carbonaceous shale, Goose Creek district.

Locality number 1/	Field	Laboratory	Over 10 percent	10-1 percent	1.0-0.1 percent	0.1-0.01 percent	0.01-0.001 percent	0.001-0.0001 percent	Uranium in sample percent 2/
6	MM-178	68247	Si	Al Fe	K Na Mg Ca Ti	Ba B Sr	Cu Mo Y Mn Ni Zr Cr V Ga Sc	Yb Be	0.002 eU
	MM-181	68250	Si Al	Ca Fe	K Na Mg Ti Ba	B Ni Sr Y	Mn Cu Co Cr La Pb Zr Ga V Yb Sc	Be	.045
33	MM-444	87775	Si Al	Fe K	Na Mg Ca Ti	Ba B Sr Zr Cu	Pb Cr Mn Ni Co V Ga Y Mo Sc	Yb Be	.013
	MM-443	87774	Si Al	Fe K Ca Na	Mg Ti Ba	Sr B Ni Zr Y Cu Co	Pb Cr Mn Mo La V Ga Sc	Yb Be	.020
	MM-442	87775	Si Al	Fe K	Na Mg Ca Ti Ba	Sr B Mn Ni	Pb La Co Y Zr Cr Ga V Sc	Yb Be	.004 eU

1/ See geologic map, figure 1, and stratigraphic sections of the Barrett zone, figure 5.
2/ Determined chemically unless number is followed by "eU", which signifies equivalent uranium, determined by radioactivity measurements.

Chemical Determinations of Ash

Sample No.	Lab. No.	Percent Ash
MM-178	68247	89.1
MM-181	68250	84.2
MM-444	87775	84.2
MM-443	87774	69.8
MM-442	87773	89.8

RESTRICTED

LITERATURE CITED

Anderson, A. L., 1931, Geology and mineral resources of eastern Cassia County, Idaho: Idaho Bur. of Mines and Geol. Bull. 14, pp. 1-169.

-----------, 1934, Contact phenomena and the Cassia batholith: Jour. Geol., vol. 42, no. 4, pp. 376-392.

Bowen, C. F., 1911, Lignite in the Goose Creek District, Cassia County, Idaho: U. S. Geol. Survey Bull. 531, pt. 2, pp. 252-262.

Kirkham, V. R. D., 1931, Revision of the Payette and Idaho formations: Jour. Geol., vol. 39, no. 3, pp. 193-239.

Mansfield, G. R., 1920, Geography, geology, and mineral resources of the Fort Hall Indian Reservation, Idaho: U. S. Geol. Survey Bull. 713, pp. 1-152.

-----------, 1927, Geography, geology, and mineral resources of part of southeastern Idaho: U. S. Geol. Survey Prof. Paper 152, pp. 1-453.

Mansfield, G. R., and Ross, C. S., 1935, Welded rhyolitic tuffs in southeastern Idaho: Trans. Am. Geoph. Union 1935, pt. 1, pp. 308-321.

Peterson, V. E., 1942, Geology and ore deposits of the Ashbrook silver mining district: Econ. Geol., vol. 37, no. 6, pp. 466-502.

Piper, A. M., 1923, Geology and water resources of the Goose Creek Basin, Cassia County, Idaho: Idaho Bur. of Mines and Geol. Bull. 6, pp. 1-78.

UNPUBLISHED REPORTS

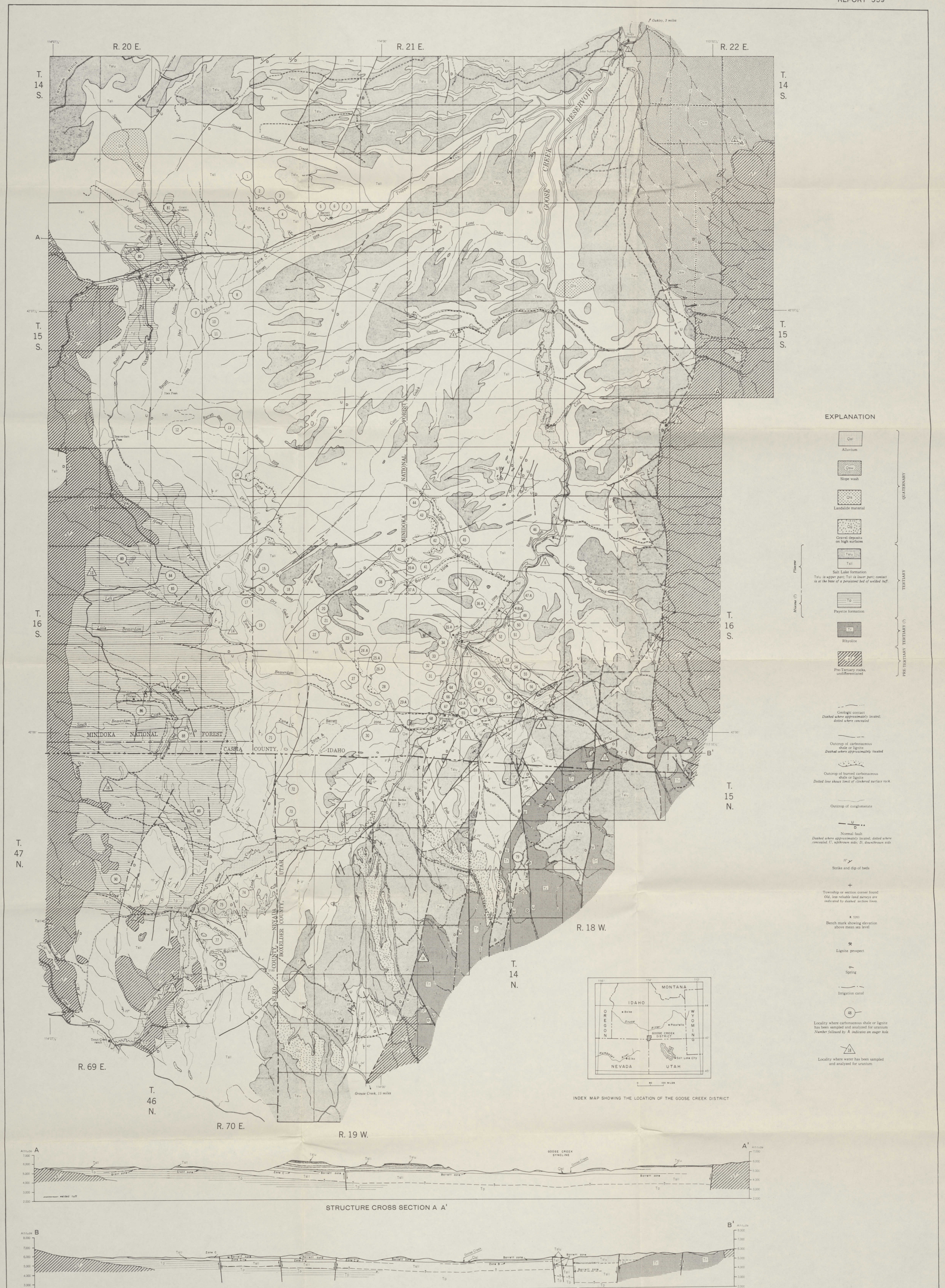
Hail, W. J., Jr., and Gill, J. R., 1953, Radioactive carbonaceous shale and lignite deposits in the Goose Creek District, Cassia County, Idaho: U. S. Geol. Survey Trace Elements Inv. Rept. 272.

Mapel, W. J., and Hail, W. J., Jr., 1953, Summary of preliminary results of field studies in 1952 in the Goose Creek District, Cassia County, Idaho, Boxelder County, Utah, and Elko County, Nevada: U. S. Geol. Survey Trace Elements Memo. Rept. 432.

Moore, G. W., 1953, Extraction of uranium from cold water solutions by coal and other materials: U. S. Geol. Survey Trace Elements Inv. Rept. (in preparation).

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TRACE ELEMENTS INVESTIGATIONS
REPORT 339



Base map prepared from plane table triangulation, aerial photographs, and Bureau of Land Management plats.

FIGURE 1.--GEOLOGIC MAP OF THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO, BOXELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA

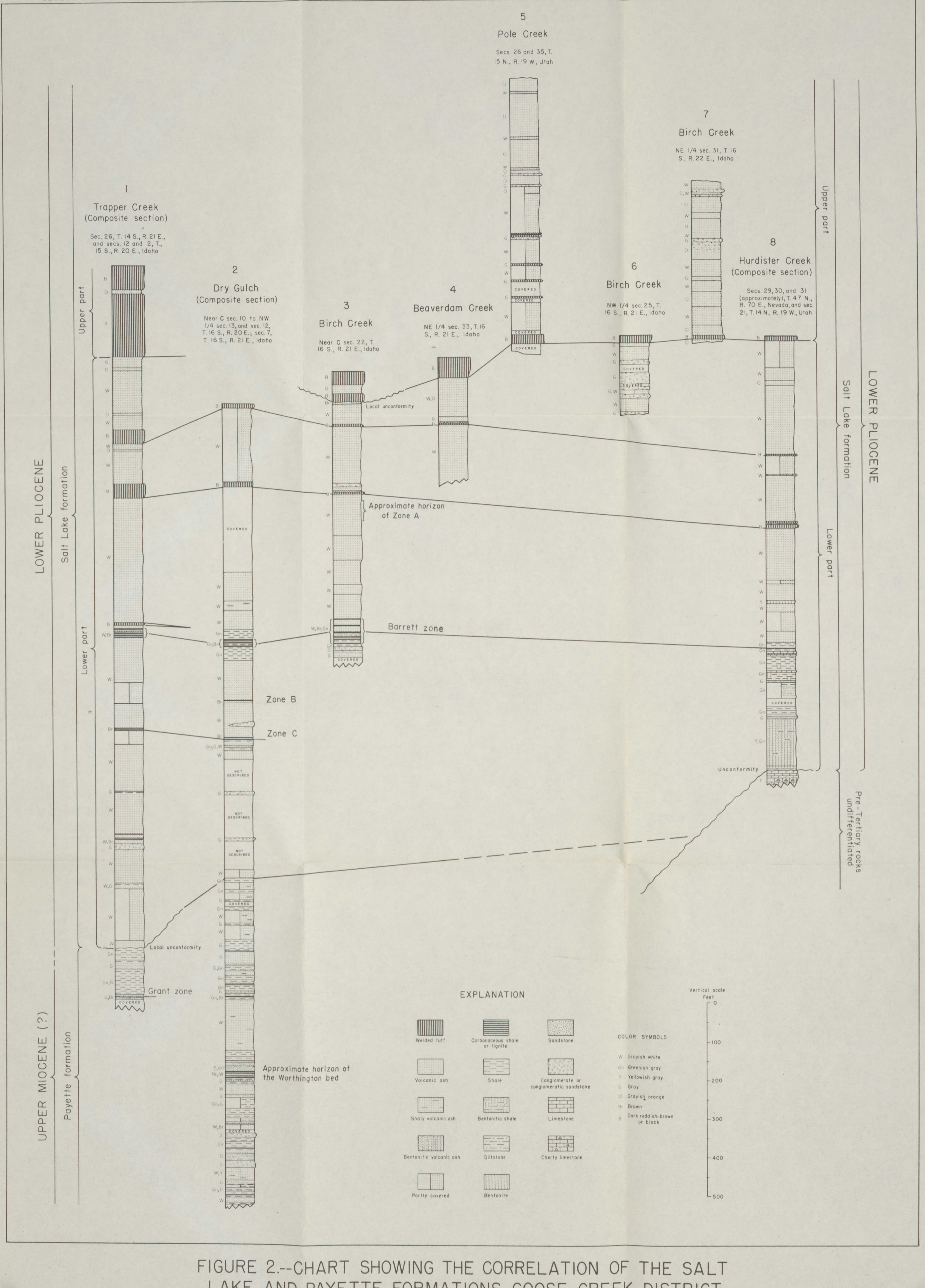


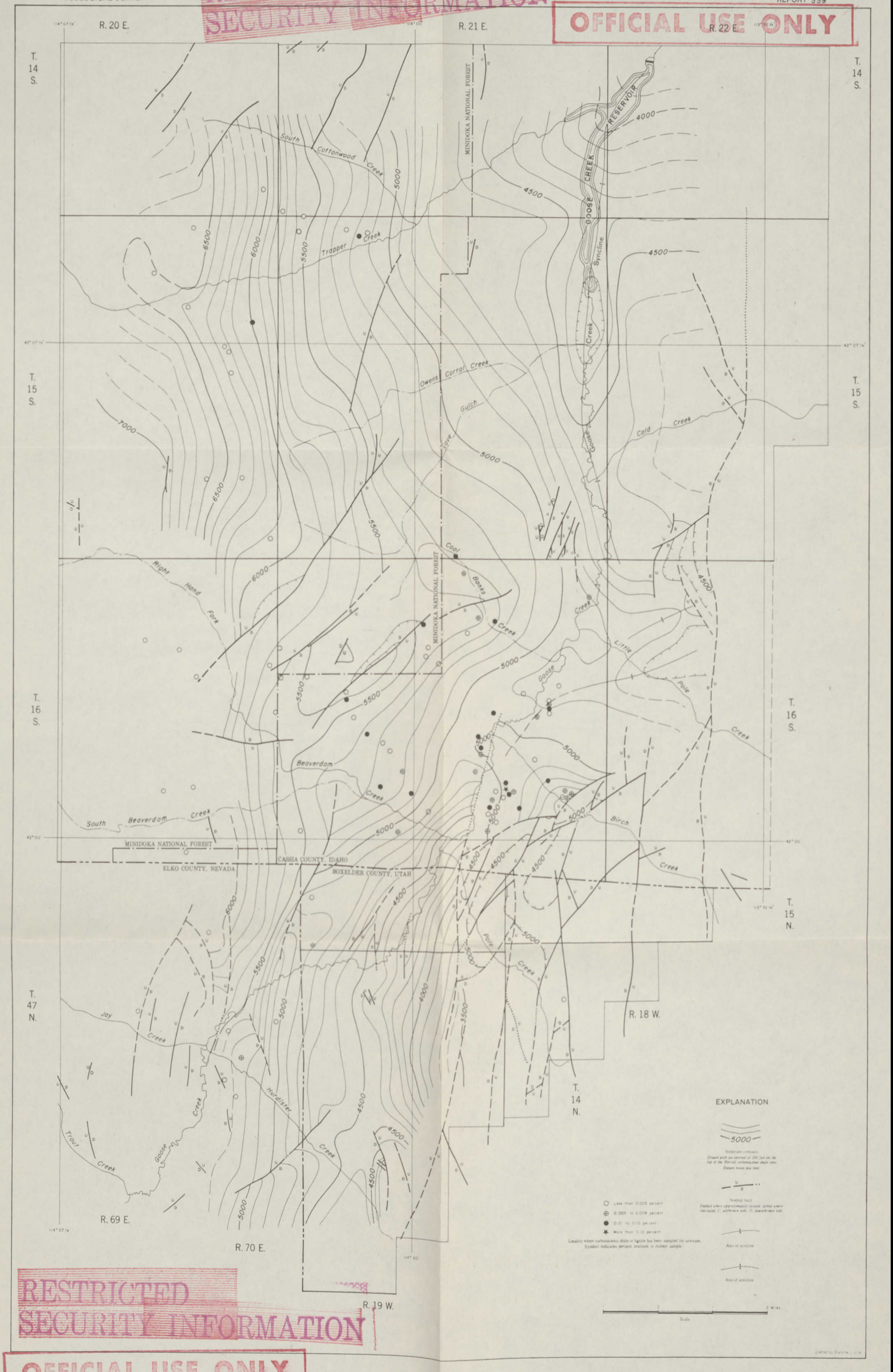
FIGURE 2.--CHART SHOWING THE CORRELATION OF THE SALT LAKE AND PAYETTE FORMATIONS, GOOSE CREEK DISTRICT

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TRACE ELEMENTS INVESTIGATIONS
REPORT 339

RESTRICTED
SECURITY INFORMATION

OFFICIAL USE ONLY



RESTRICTED
SECURITY INFORMATION

OFFICIAL USE ONLY

FIGURE 3.--STRUCTURE CONTOUR MAP OF THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO, BOXELDER COUNTY, UTAH, AND ELKO COUNTY, NEVADA

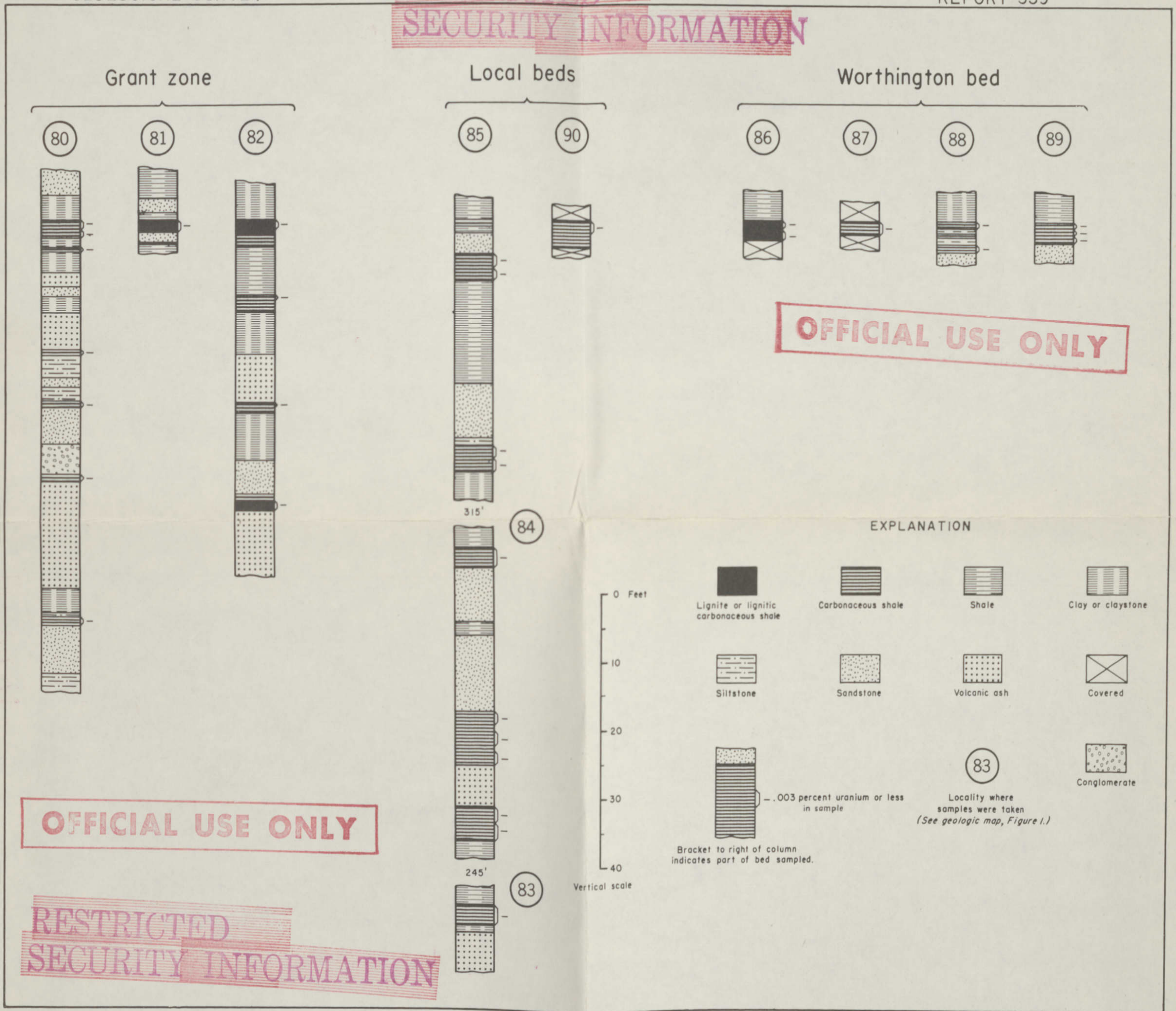


FIGURE 4.--STRATIGRAPHIC SECTIONS SHOWING THE THICKNESS AND URANIUM CONTENT OF CARBONACEOUS SHALE AND LIGNITE IN THE PAYETTE FORMATION, GOOSE CREEK DISTRICT

FIGURE 5.--STRATIGRAPHIC SECTIONS SHOWING THICKNESS AND URANIUM CONTENT OF CARBONACEOUS SHALE AND LIGNITE IN THE SALT LAKE FORMATION, GOOSE CREEK DISTRICT