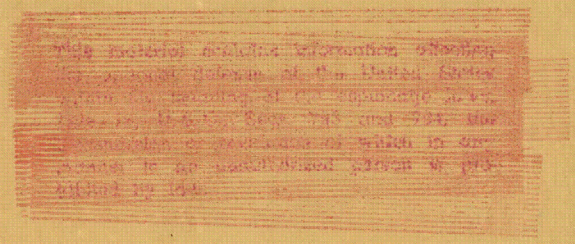
Radioactive Carbonaceous Shale and Lignite Deposits in the Goose Creek District, Cassia County, Idaho



Trace Elements Investigations Report 272

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Geology - Mineralogy

This document consists of 34 pages, plus 3 figures.
Series A

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RADIOACTIVE CARBONACEOUS SHALE AND LIGNITE DEPOSITS IN THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO*

By

W. J. Hail, Jr., and J. R. Gill

January 1953

Trace Elements Investigations Report 272

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

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	63

CONTENTS

	Page
Abstract	5
Introduction	6
Topography	7
Water supply	7
Accessibility	8
Stratigraphy	8
Pre-Tertiary rocks	8
Tertiary rocks	9
Early Miocene (?) rhyolite	9
Payette formation	10
Salt Lake formation	11
Structural setting	15
Mode of occurrence and origin of the uranium	15
Mode of occurrence	15
Origin	17
Extent of the radioactive beds	19
Estimate of inferred uranium reserves in the Goose Creek district	21
Plans	24
References cited	25
Appendix; Summary of analytical data, Goose Creek district. Analysed by Trace Elements Section Washington and Denver Laboratories	26

ILLUSTRATIONS

Figure 1. Diagrammatic sketch of southern half of Goose Creek district, Cassia County, Idaho ..... In envelope

2. Reconnaissance map showing areal distribution of radioactive lignite and carbonaceous shale zones, Goose Creek district, Cassia County, Idaho ..... In envelope

3. Distribution and concentration of uranium in lignite and carbonaceous shale zones, Goose Creek district, Cassia County, Idaho ..... In envelope

TABLES

Page

Table 1. Inferred uranium reserves in beds 3 feet or more in thickness containing 0.005 percent or more uranium, Goose Creek district, Cassia County, Idaho..... 22

2. Inferred uranium reserves in beds 1.5 - 3.0 feet in thickness containing 0.005 percent or more uranium, Goose Creek district, Cassia County, Idaho..... 23

RADIOACTIVE CARBONACEOUS SHALE AND LIGNITE DEPOSITS IN THE GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO

By William J. Hail, Jr., and James R. Gill

ABSTRACT

Uranium-bearing carbonaceous shale and lignite beds are exposed in the Goose Creek district of southern Cassia County, Idaho. The district includes about 150 square miles in Tps. 14 to 16 S., Rs. 20 to 22 E., Boise meridian.

The uranium-bearing beds occur in the Salt Lake formation of Pliocene age which is more than 1,900 feet thick in the Goose Creek district. The formation is composed chiefly of volcanic ash and welded rhyolitic tuffs, and subordinately of thin beds of carbonaceous shale, sandstone, and conglomerate. The Salt Lake formation lies unconformably on the Payette formation of Miocene age which is about 600 feet thick, and consists of clay shale, siltstone, sandstone, conglomerate, and thin beds of volcanic ash, carbonaceous shale, and lignite. The carbonaceous beds in the Payette generally are not radioactive. The Salt Lake and Payette formations unconformably overlap earlier Tertiary volcanics and limestones and quartzites of pre-Cambrian to Carboniferous age.

A north-trending anticline in the western part of the district, and a broad northeast-trending syncline in the eastern part of the district are the two major structural features. Minor folds and faults are superimposed on the major structures.

The highest concentration of uranium occurs in the lenticular carbonaceous shale beds of the Barrett zone in the Salt Lake formation. It is believed that uranium was concentrated in these beds by circulating ground

water which leached the uranium from tuff and volcanic ash.

Inferred reserves of uranium-bearing carbonaceous shale in beds 3 feet or more thick aggregate 17,400,000 short tons of shale containing 1,550 short tons of uranium. The average grade is estimated to be 0.009 percent uranium. Inferred reserves of uranium-bearing carbonaceous shale in beds 1.5 to 3.0 feet thick aggregate 8,900,000 short tons of shale containing 530 tons of uranium. The average grade is estimated to be 0.005 percent uranium.

INTRODUCTION

Uranium-bearing carbonaceous shale or lignite in the Goose Creek district is exposed in parts of six adjoining townships along Goose Creek and its tributaries in the southern part of Cassia County, Idaho (fig. 2). The district begins about 5 miles south of the town of Oakley (pop. 684), and extends about 15 miles southward. It includes about 150 square miles in Tps. 14 to 16 S., Rs. 20 to 22 E., Boise meridian.

C. F. Bowen (1913), and A. M. Piper (1923) noted that in the Goose Creek district, lignite and carbonaceous shale were associated with volcanic ash and tuffaceous rocks of rhyolitic appearance. Investigation of uranium-bearing lignite in North and South Dakota (Denson, Bachman, and Zeller, 1950) led to the conclusion that the uranium in the lignite there was leached from volcanic ash and extracted by the lignite from percolating ground water. The association of lignite or other carbonaceous material with volcanic ash thus seemed to provide favorable conditions for the concentration or uranium. The Goose Creek district was prospected for uranium on this basis, and significant deposits of uranium-bearing carbonaceous shale were discovered.

D. C. Duncan, U. S. Geological Survey, discovered uranium-bearing carbonaceous shale in the Goose Creek district in early September 1951. Field work of a preliminary nature was done on behalf of the U. S. Atomic Energy Commission by the writers from September 20 until November 20, 1951. The outcrops of beds of carbonaceous shale and lignite and the localities that were examined are shown on the accompanying geologic map, figure 2.

TOPOGRAPHY

The Goose Creek district occupies a broad basin bounded on the east, south, and west by mountain ranges, and on the north by the Snake River Plain. In the central and northern parts of the district, the ground surface is a high dissected plateau trenched by streams which flow in steep-walled canyons 200 to 600 or more feet deep. In the southern and southwestern parts of the district the surface is characterized by low rolling hills having moderate relief but which locally are gullied and rough. A hill half a mile east of Beaverdam Pass, with an altitude of about 7400 feet is the highest point in the area; the base of the Goose Creek dam, with an altitude of about 4,700 feet, is the lowest.

WATER SUPPLY

The annual water discharge into the Goose Creek reservoir from Goose and Trapper Creeks is 50,000 and 14,000 acre feet respectively (Piper, 1923, pp. 44-74). Numerous perennial springs occur throughout the district and a large potential supply of artesian water is believed to be present (Piper, 1923, p. 72). The annual precipitation is about 10 inches.

ACCESSIBILITY

Oakley is connected to Burley, 24 miles to the north, by an oiled highway and by a branch line of the Oregon Short Line (Union Pacific) railroad.

Two main roads extend across the Goose Creek district. Access to the district is fairly easy in the northern part, but somewhat difficult in parts of the south. Most of the district, however, is accessible by means of a jeep or other four-wheel-drive vehicle to within a mile or two of most of the outcrops. The radioactive beds in the southern part of the district can be reached by a good graded road which extends south from Oakley along Goose Creek. Outcrops of the radioactive beds east of the road, in the vicinity of the Idaho-Utah state line, can be reached easily. The outcrops west of this road, are difficult to reach because no improved roads cross Goose Creek, and the trails up the valleys of Beaverdam Creek, Dry Gulch, and Coal Banks Creek are deeply gullied at many places.

A fairly good graded road follows the valley of Trapper Creek and thence south along the valleys of Rodeo and Beaverdam Creeks to provide access to the northern part of the district. In this general area, the outcrops of the radioactive beds are mostly within a mile of the road.

STRATIGRAPHY

Pre-Tertiary rocks

Paleozoic and pre-Cambrian rocks crop out along the margins of the Goose Creek district on the east and west. On the east, the surface rocks are chiefly light-colored quartzite, schist, and marble in the Albion Range

group of pre-Cambrian age (Anderson, 1934, pp. 377-379). On the west side, the district is bounded by Paleozoic rocks of probable Carboniferous age. These are chiefly limestones that are massive blue-gray and highly fractured. Most of the limestones are cherty, and in some places they have been entirely replaced by chert (Anderson, 1931, p. 23).

Tertiary rocks

The Tertiary rocks of the district include a rhyolite of early Miocene (?) age and a sedimentary sequence of volcanic ash, shale, and conglomerate which is divided into the Payette formation of late Miocene age, and the Salt Lake formation of Pliocene age. The sedimentary rocks were deposited in a elongate north-trending basin in the older rocks on a surface of considerable relief. Exposures of exhumed pre-Tertiary hills are numerous in the vicinity of Beaverdam Pass and the upper part of Trapper Creek. For this reason, the thickness and continuity of the lower part of the sequence is irregular and the total thickness of sediments present is unknown. The exposed thickness of the Payette and Salt Lake formations in the Goose Creek Basin is estimated to be at least 2,500 feet.

Early Miocene (?) rhyolite

The oldest Tertiary formation exposed in the district is a rhyolite which Piper (1923, p. 26) believes to be early Miocene (?) in age. The rhyolite crops out along the eastern side of the district in the valleys of Bluff, Spring, Hurdister (Hardesty), Birch, and Pole Creeks between exposures of the Salt Lake formation and pre-Cambrian quartzites and limestones. At

most places, the contact between this rhyolite and the Salt Lake formation is a fault, but in the valley of Birch Creek, the rhyolite is unconformably overlain by the upper part of the Salt Lake formation. The rock is gray to red-brown and of porphyritic texture. Its composition is that of a tridymite-quartz latite similar to welded rhyolitic tuffs in the overlying Salt Lake formation.

Payette formation

The Payette formation of late Miocene age is best exposed along the axis of the Ibex anticline in the western part of the Goose Creek district. Only about 170 feet of the formation is exposed but its distribution in the district and general relations to older rocks suggest that the formation is at least 600 feet thick. The Payette formation consists of gray and tan clay shale, sandstone, siltstone, and volcanic ash, and includes at least one zone of carbonaceous shale and lignite. The carbonaceous shale and lignite show little or no radioactivity.

A generalized stratigraphic section of part of the Payette formation, the upper 120 feet of which was measured in sec. 2, T. 15 S., R. 20 E., and the lower 52 feet in sec. 11, T. 15 S., R. 20 E. is shown below:

Salt Lake formation: volcanic ash.

Payette formation:	Thickness (feet)
Siltstone; clayey, light gray to tan, contains Miocene plant fossils, unconformably overlain by volcanic ash in the Salt Lake formation	39
Sandstone; tuffaceous, light brown, friable, grades upward to siltstone	16
Clay shale; sandy, olive brown to gray	65
Lignite; shaly, top of Worthington zone	2
Carbonaceous shale; brown	2

Payette formation (cont.):	Thickness (feet)
Clay shale; silty, greenish gray	7
Carbonaceous shale; medium brown, lignitic at top	3
Clay; contains silty layers, greenish gray	6
Volcanic ash; sandy, friable, light gray	7
Carbonaceous shale; lignitic at top	2
Clay; silty, light gray	6
Sandstone; light gray	5
Carbonaceous shale; light brown	1
Lignite; shaly	1
Volcanic ash; sandy, covered below	10
Total thickness	172

A collection of fossil plants from the upper part of the Payette formation, near locality 34 in sec. 2, T. 15 S., R. 20 E. (fig. 2), was identified by Roland W. Brown of the U. S. Geological Survey as follows:

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

Brown assigns these forms to the late Miocene.

Salt Lake formation

The Salt Lake formation is at least 1,900 feet thick and it unconformably overlies the Payette formation.

The Salt Lake formation is composed almost entirely of volcanic material. The formation can be divided into two parts. The upper part, 950 feet thick, consists of five cliff-forming welded rhyolitic tuff beds, ranging from 28 to 115 feet in thickness, interbedded with volcanic ash. The aggregate thickness of welded rhyolitic tuff in the upper part of the formation is about 370 feet; that of the volcanic ash about 580 feet. The lower part of the formation, at least 950 feet thick, is predominantly

volcanic ash in which are at least two zones of thin bedded carbonaceous shale, lignite, and lignitic carbonaceous shale. Clay shale, sandstone, and conglomerate occur in the lower part of the formation. Locally, the ash has been devitrified and has a bentonitic appearance.

The general characteristics of the Salt Lake formation in the Goose Creek district (in part from Piper, 1923, p. 28) are described in the following section. The upper 940 feet of the formation was measured in secs. 5 and 6, T. 15 S., R. 21 E.; the next 570 feet (940-1510) in sec. 12, T. 15 S., R. 20 E.; the next 123 feet (1510-1633) in sec. 13, T. 15 S., R. 20 E.; and the lower 270 feet (1633-1903) (an estimated thickness) in secs. 11 and 12, T. 15 S., R. 20 E.

Salt Lake formation:	Thickness (feet)	Feet below top
Welded rhyolitic tuff; bluish gray at top, red brown at bottom	101	
Volcanic ash; gray to white, bedded friable	12	
Welded rhyolitic tuff;	115	
Volcanic ash; gray to white, stratified, locally cross bedded, poorly consolidated	132	
Welded rhyolitic tuff;	28	
Volcanic ash; locally cross bedded. One bed of buff sandy clay grading downward into typical ash	120	
Welded rhyolitic tuff;	68	
Volcanic ash; gray to white	310	
Welded rhyolitic tuff;	56	886-942
Volcanic ash;	7	
Carbonaceous shale; top of Barrett zone	9	949-958
Volcanic ash;	6	
Carbonaceous shale; light to dark brown	16	964-980
Volcanic ash;	239	
Carbonaceous shale; light to dark brown, "C" zone	6	1219-1225
Volcanic ash;	157	
Carbonaceous shale; light brown	4	
Volcanic ash;	110	
Carbonaceous clay; light brown	2	1496-1498
Volcanic ash;	11	
Carbonaceous shale; light to dark brown	4	1509-1513
Volcanic ash;	12	

Salt Lake formation (cont.):	Thickness (feet)	Feet below top
Conglomerate; Pebbles of limestone, chert, and quartzite	17	1525-1542
Volcanic ash;	88	
Clay;	3	
Volcanic ash; mostly covered, total thickness not known but estimated to be at least 270 feet	270	
Unconformity		

Total minimum thickness of Salt Lake formation (rounded): 1900

The lower part of the Salt Lake formation contains two or more massive conglomerate beds each 15 to 50 feet thick. The conglomerate is best exposed along Beaverdam Creek and its tributaries in the western part of the district, and in this report is referred to informally as the Beaverdam conglomerate (fig. 1). It is composed of cherty black limestone and white quartzite pebbles a half to 3 inches in diameter in a matrix of medium- to very coarse-grained sandstone. The materials that compose the conglomerate were derived from the pre-Tertiary rocks that bound the Tertiary rocks to the east and west. The conglomerate also contains small quantities of silicified fossil wood.

The upper of the two major zones of carbonaceous shale in the Salt Lake formation is 960 feet below the top of the formation and is known as the Barrett zone (Bowen, 1911, p. 257); the lower zone is about 1,220 feet below the top of the formation and is called the "C" zone in the field. The individual beds are lenticular and are not persistent throughout the district. In general, however, the carbonaceous shale zones persist despite abrupt lateral changes in thickness, and variation in the number of beds making up the zone. The Barrett zone is the most highly radioactive. It lies 10 to 20 feet below the lowest welded rhyolitic tuff at the base of the upper part

of the Salt Lake formation, except in the southeast part of the district where the lowest tuff is missing. The "C" zone is radioactive only along a quarter-mile exposure in the southeastern part of the district. No other carbonaceous shale was found to be radioactive with the exception of a single sample from a bed about 550 feet below the lowest rhyolite, and about 50 feet above the Beaverdam conglomerate (locality 31, fig. 3).

The welded rhyolitic tuff beds in the upper part of the Salt Lake formation presumably indicate a period of increased volcanic activity. The welded tuff is mostly brownish red, although shades of red, purple, brown, and gray are also present, and black obsidian is common. The composition of the welded tuff is that of a quartz latite (Piper, 1923, p. 10).

A collection of fossil mollusks from the Salt Lake formation near locality 33 in sec. 25, T. 16 S., R. 21 E. (fig. 2), was identified by T. C. Yen of the Smithsonian Institute, as follows:

Sphaerium 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 believes these fossils are lower Pliocene in age.

The unconformity at the base of the Salt Lake formation is marked by a sharp and irregular contact at the base of the formation, along which there was some channelling before the Salt Lake was deposited. Greenish gray shale and siltstone of the Payette formation contrast markedly with the overlying volcanic ash of the Salt Lake formation at this horizon. The unconformable contact is well exposed in sec. 2, T. 15 S., R. 20 E., east of Squaw Creek.

STRUCTURAL SETTING

A large gently dipping anticline and a broad syncline are the main structural features of the district. Minor faults and folds are superimposed on these major structures.

The major anticline trends north and occupies the western part of the district. In this report it is named the Ibex anticline for Ibex Peak. The rocks dip 10° to 15° along the east flank of the anticline in the canyon walls of Trapper Creek valley. Elsewhere, the dips are generally less than 10°.

The major syncline lies in the eastern part of the district and trends roughly north to northeast. Goose Creek occupies the approximate position of the axis of this syncline which in this report is referred to as the Goose Creek syncline.

Faults are most easily observed where the welded rhyolitic tuffs are offset. Few of the faults extend more than 2 or 3 miles. Vertical displacement along the faults exceeds 200 feet in only a few places, being considerably less than 200 feet at most places. The strata on the east limb of the Goose Creek syncline may be in fault contact with the pre-Tertiary rocks of the mountains bordering the Goose Creek Basin. Insufficient observations were made in this study to prove the existence of the fault or to show it on the map (fig. 2).

MODE OF OCCURRENCE AND ORIGIN OF THE URANIUM

Mode of occurrence

Uranium is concentrated in some of the carbonaceous shale and lignite beds. The chemical and physical nature of the occurrence is not known.

Figure 3 shows detailed sections of lignite and carbonaceous shale in the Goose Creek district. Localities 1, 7, 12, 14, 15, 24, and 31 are not shown on this chart. Carbonaceous shale beds in the Barrett zone are present at locality 7, but contain little or no radioactivity. The Barrett zone is absent at locality 1. It is burned and clinkered at localities 12, 14, and 15, and is mostly covered at locality 24. Only the "C" zone is present at locality 31, and shows no sign of radioactivity.

At most localities, the highest uranium content is in the upper part of the lignite or carbonaceous shale bed, although not necessarily right at the top. This suggests that the uranium may have been introduced into the lignite or carbonaceous shale from above by circulating ground water similar to the mechanism suggested for the origin of the uranium in the lignite deposits in the Dakotas described by Denson, Bachman, and Zeller (1950). Samples of the volcanic ash contain 0.001 to 0.004 percent uranium, and hence the ash is a potential source bed for the uranium as well as a good aquifer for the secondary distribution of uranium.

The Barrett zone in the Salt Lake formation contains from 2 to 11 carbonaceous shale beds. The "C" zone, about 260 feet below the Barrett zone generally contains only one bed. The Barrett zone contains by far the larger amount of uranium, most of which is in the carbonaceous shale in the southern part of the district. Uranium was found in the "C" zone only along an outcrop less than a quarter-mile long in the southeast corner of the district.

The uranium content of the carbonaceous shale beds is highly variable along the same bed and within different beds in the same zone. The zones

of carbonaceous shale are fairly persistent throughout the district, but individual beds in the zones are lenticular and discontinuous. Consequently no individual uranium-bearing beds could be traced throughout the district.

Zones of silicified wood in the upper foot of the Beaverdam conglomerate were tested for radioactivity with negative results. The wood has the appearance of weathered drift wood, and from microscopic examination it appears to have reached an advance state of decay prior to petrification. The silicified wood in this conglomerate may have been derived from trees killed by ash falls and incorporated with the conglomerate during a period of accelerated erosion.

Origin

All but twelve samples were radioactive out of a total of 189 analyzed samples of carbonaceous shale, lignite, and shale and sandstone associated with the carbonaceous shale zones. Most of the samples contained 0.001 - 0.003 percent equivalent uranium, or about the same amount as the volcanic ash. The presence of radioactivity in almost all of the carbonaceous shale and lignite irrespective of geographic or stratigraphic position, seems to indicate that some of the radioactive material was introduced at the time the beds were deposited. However, most samples with a uranium content of 0.005 percent or more represent the upper part of the bed. Furthermore, the beds containing 0.005 percent or more uranium at most of the places samples are overlain by permeable material, either porous tuff or volcanic ash. It is thus possible that additional radioactive material has been introduced into the carbonaceous shale and lignite beds from this tuff or

volcanic ash, probably by circulating ground water. If all the uranium in the carbonaceous shale beds had been deposited contemporaneously with these beds, then the lateral distribution of the uranium probably would have been fairly constant. The erratic distribution of uranium in highly radioactive carbonaceous shale and lignite beds seems best explained by post-depositional concentration by ground water with much of the uranium coming from the tuff and volcanic ash.

Ground-water circulation alone, however, is not the only factor affecting the concentration of uranium. The availability of uranium in source beds is also important. In the Goose Creek district, volcanic ash appears to be the source and most beds contain small amounts of uranium. The volcanic ash is made up chiefly of glass shards and the availability of uranium is probably dependent on the degree of weathering. Some of the richest uranium-bearing carbonaceous shale beds in the Goose Creek district underlie devitrified ash or bentonite. Most of the volcanic ash in the Goose Creek district appears to be relatively fresh. In general, devitrification does not seem to have advanced very far except locally. This fact may explain why the various carbonaceous shale and lignite beds are not more radioactive.

Local structural control may also affect the concentration of uranium inasmuch as small synclinal basins permit the accumulation and concentration of uranium-bearing ground water. There is at least one small synclinal structure in the Goose Creek district in which relatively rich uranium-bearing carbonaceous shale beds are present.

Another factor affecting the concentration of the uranium may be the carbon content of the bed. Carbon, as well as some clay minerals have affinity for uranium. A higher percent of carbon in a bed may enable it to contain more uranium. In the Goose Creek district most of the carbonaceous material is high-ash (average 89 percent) carbonaceous shale. There is very little actual lignite, and where lignite is present, the concentration of the uranium is controlled by still another factor, the permeability of the receptor bed. Both lignite and carbonaceous shale are relatively dense and impermeable if they have not been affected by fracturing, jointing, cleating, or weathering. One such lignite bed, 5 feet thick, in the Coal Banks Creek mine (locality 29, figs. 2 and 3) shows very little radioactivity below the top few inches.

Following is a summary of the factors favorable to a high concentration of uranium in the Goose Creek district: (1) Permeable aquifers immediately overlying carbonaceous beds permitting circulation of uranium-bearing ground water, (2) An adequate source of uranium available to the ground water, (3) Carbonaceous material to adsorb the uranium from the ground water, (4) Permeability of the carbonaceous beds, (5) Local synclinal structures that might serve as basins of accumulations of uranium-bearing waters.

EXTENT OF THE RADIOACTIVE BEDS

The underground extent of the uranium-bearing beds is conjectural. North of its outcrop along the valley of Trapper Creek, the Barrett zone may extend for 2 or 3 miles before it pinches out against the Paleozoic erosion surface (Bowen, 1911, p. 262). Only a small part of the Barrett

zone is radioactive in this area. It is overlain here by 300 to 600 feet of welded rhyolitic tuff and volcanic ash.

All but about 3 square miles of T. 15 S., R. 21 E. is underlain by the Barrett and "C" zones. However, the dips of 10° to 15° along Trapper Creek indicate that it is deeply buried throughout most of the area. The overburden is at least 300 feet thick above the line of outcrop of the Barrett zone along Ibex Hollow, and may be as much as 800 or 900 feet thick in the eastern part of the township. There is no evidence to indicate the degree of mineralization of the down-dip extensions of these zones to the east in T. 15 S., R. 21 E.

The extent of the beds in the southern part of the district is better known, although information is not adequate to appraise fully the potentialities of the area. The Barrett and "C" zones underlie the divide between Coal Banks Creek and Beaverdam Creek drainage. East of Goose Creek, beds in the Barrett zone are exposed in two small areas, one just south of Birch Creek, the other 5 miles to the north near the mouth of Little Pole Creek. A bed in the "C" zone is exposed about a mile above the mouth of Birch Creek. The eastward underground extent of the two zones, however, is limited within 2 or 3 miles by the rhyolite of early Miocene age, and the pre-Tertiary metamorphic rocks.

South of the state line, in Utah and Nevada, the Barrett and "C" zones thin, and where tested with a radiation counter showed no appreciable radioactivity.

ESTIMATE OF INFERRED URANIUM RESERVES IN THE GOOSE CREEK DISTRICT

Inferred reserves of uranium and carbonaceous shale or lignite are listed in tables 1 and 2. Table 1 shows all uranium-bearing beds 3 feet or more in thickness that contain 0.005 percent or more uranium. Table 2 gives all uranium-bearing beds between 1.5 and 3 feet thick that contain 0.005 percent or more uranium. The reserves are listed by geographic location (section, township, and range). The relative positions of the various uranium-bearing beds, or groups of beds in the Barrett zone are designated by numbers. The stratigraphically highest bed is designated bed number 1; the second highest bed, number 2; the third highest bed, number 3; and the lowest bed, number 4. Bed number 1 at a given locality is not necessarily the same bed as bed number 1 at other localities.

The weight of carbonaceous shale was determined to be 980 tons per acre-foot, based on a density determination by the Trace Elements Section Denver Laboratory. This figure has been used in calculating reserves.

Insufficient data have been collected to do more than estimate inferred reserves for the district.

Table 1. Inferred uranium reserves in beds 3 feet or more in thickness containing 0.005 percent or more uranium, Goose Creek district, Cassia County, Idaho

Barrett zone	Area (acres)	Average thickness (feet)1/	Grade (percent U)	Locality number	Location	Carb. shale (short tons)	Uranium (short tons)
Bed 2	80	5.2	0.007	6	Sec. 5, T. 15 S., R. 21 E.	408,000	29
Bed 2	100	3.0	0.006	8	Sec. 12, T. 15 S., R. 20 E.	294,000	18
Bed 2	600	3.7	0.005	18	Sec. 17, T. 16 S., R. 21 E.	2,175,000	109
Bed 2	680	3.0	0.011	20	Secs. 16 and 21, T. 16 S., R. 21 E.	1,999,000	220
Bed 2	200	10.7	0.007	21	Secs. 21, 28, and 29 T. 16 S., R. 21 E.	2,097,000	147
Bed 3	1,370	3.0	0.011	26	Secs. 10, 11, 14, 15, 22, 27, 28, 33, and 34 T. 16 S., R. 21 E.	4,028,000	443
Bed 2	600	5.7	0.012	23-25	Secs. 26, 27, 34, and 35 T. 16 S., R. 21 E.	3,352,000	402
Bed 3	600	5.2	0.006	22-25	Secs. 26, 27, 34, and 35 T. 16 S., R. 21 E.	3,058,000	183
					Total reserves (rounded)	17,400,000	1,550

1/ Sample intervals below the grade of 0.005 percent uranium are included with sample intervals above this grade if the resulting combined intervals are at least 0.005 percent uranium.

RESTRICTED SECURITY INFORMATION

Table 2. Inferred uranium reserves in beds 1.5 - 3.0 feet in thickness containing 0.005 percent or more uranium, Goose Creek district, Cassia County, Idaho

Barrett zone	Area (acres)	Average thickness (feet)1/	Grade (percent U)	Locality number	Location	Carb. shale (short tons)	Uranium (short tons)
Bed 2	300	2.1	0.013	27 and 29	Secs. 33 and 34, T. 15 S., R. 21 E. Secs. 3 and 4, T. 16 S., R. 21 E.	408,000	53
Bed 2	1,370	2.5	0.006	26	Secs. 10, 11, 14, 15, 22, 27, 28, 33, and 34, T. 16 S., R. 21 E.	3,357,000	201
Bed 4	1,370	2.9	0.005	26	Secs. 10, 11, 14, 15, 22, 27, 28, 33, and 34, T. 16 S., R. 21 E.	3,894,000	195
Bed 1	600	1.9	0.007	22-25	Secs. 26, 27, 34, and 35, T. 16 S., R. 21 E.	1,117,000	78
"C" Zone	70	2.0	0.006	33	Sec. 25, T. 16 S., R. 21 E.	137,000	8
					Total reserves (rounded)	8,900,000	530

1/ Sample intervals below the grade of 0.005 percent uranium are included with sample intervals above this grade if the resulting combined intervals are at least 0.005 percent uranium.

RESTRICTED SECURITY INFORMATION

PLANS

Detailed mapping is underway in the Goose Creek district. The mapping, accompanied by additional sampling, will assist in providing the data for an adequate appraisal of the resources of uranium in carbonaceous shale and lignite. However, because of the lenticularity of the beds of carbonaceous shale, and the variations in uranium content from place to place, an adequate appraisal of reserves cannot be made without data, obtained by core drilling, on the underground extent of the beds and their uranium content.

Funds for about 8,000 feet of exploratory drilling were included in the 1953 budget but are reserved in a contingent fund pending approval of drilling by the Commission. Drilling is considered essential for evaluation of the potentialities of the district, but will not be proposed until the results of the 1952 field season become available.

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APPENDIX

SUMMARY OF ANALYTICAL DATA, GOOSE CREEK DISTRICT. ANALYSES BY TRACE ELEMENTS SECTION WASHINGTON AND DENVER LABORATORIES.

Summary of analytical data, Goose Creek district.

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
1	MM 346	54772	0.003	-	-	-	Volcanic ash; grab sample
	MM 203	68272	0.002	-	-	-	Upper 1.0' of 4.3' carb. shale
2	MM 204	68273	0.001	-	-	-	Upper 1.0' of 11.0' carb. clay
	MM 205	28274	a	-	-	-	Carb. clay 5' above base 11.0' carb. clay; grab sample
	MM 206	28275	a	-	-	-	Lower 1.0' of 11.0' carb. clay
3	MM 186	68255	0.001	-	-	-	Total 3.0' carb. shale
	MM 331	54767	0.001	-	-	-	Volcanic ash; grab sample
	MM 185	68254	0.002	-	-	-	Upper 1.0' of 4' carb. shale
4	MM 184	68253	0.002	-	-	-	Carb. shale; grab sample
5	MM 183	68252	0.003	-	-	-	Upper 1.2' of 9' carb. shale
6	MM 178	68247	0.002	-	-	-	Upper 1.0' of 4.0' carb. shale
	MM 177	68246	0.010	88.7	0.016	0.014	Total 1.0', 7.5' above base of 8.5' carb. shale and lignite
	MM 176	68245	0.002	77.8	-	-	Total 1.0', 6.5' above base of 8.5' carb. shale and lignite
	MM 181	68250	0.018	85.2	0.060	0.045	Total 0.4', 5.2' above base of 8.5' carb. shale and lignite
	MM 175	68244	0.003	84.3	-	-	Total 1.5', 3.5' above base of 8.5' carb. shale and lignite
	MM 180	68249	0.003	86.8	-	0.005	Total 1.0', 2.5' above base of 8.5' carb. shale and lignite
	MM 179	68248	0.002	54.4	-	-	Total 1.0', 1.0' above base of 8.5' carb. shale and lignite
7	MM 312	54763	0.003	-	-	-	Lower 1.0' of 14.7' volcanic ash
	MM 221	68290	0.002	-	-	-	Upper 1.0' of 4.1' carb. shale

a = less than 0.001

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
7 (Cont.)	MM 220	68289	0.002	-	-	-	Lower 1.0' of 4.1' carb. shale
	MM 219	68288	0.002	-	-	-	Upper 2.0' of 11.5' carb. shale
	MM 218	68287	0.003	-	-	-	Lower 1.0' of 11.5' carb. shale
	MM 217	68286	0.004	-	-	-	Total 0.8' carb. shale
	MM 310	54762	0.004	-	-	-	Upper 1.1' of 2.5' volcanic ash
8	MM 192	68261	0.003	-	-	-	Total 3' carb. clay
	MM 340	54769	0.004	-	-	-	Total 1.0' at base of 12' volcanic ash
	D 123	52916	0.020	76.25	0.046	0.034	Upper 0.5' of 8.3' carb. shale
	MM 190	68259	0.010	-	-	0.015	Upper 0.4' of 8.3' carb. shale
	MM 191	68260	0.004	-	-	0.005	Next 0.4' of 8.3' carb. shale
9	MM 195	68264	0.002	-	-	-	Upper 1.0' of 8.6' carb. shale
	MM 196	68265	0.002	-	-	-	Middle 1.0' of 8.6' carb. shale
	MM 342	54770	0.005	-	-	-	Total 1.0' volcanic ash
	MM 197	68266	0.002	-	-	-	Upper 1.5' of 16.0' carb. shale
	MM 198	68267	0.001	-	-	-	Lower 2.0' of 16.0' carb. shale
	MM 194	68263	a	77.3	-	-	Upper 1.5' of 3.9' carb. shale
	MM 193	68262	0.003	92.1	-	-	Upper 1.0' of 3.7' carb. shale
10	MM 345	54771	0.003	-	-	-	Volcanic ash; grab sample
	MM 199	68268	0.003	-	-	-	Upper 1.0' of 3.5' carb. shale
	MM 200	68269	a	-	-	-	Upper 1.0' of 7.9' carb. shale
	MM 201	68270	0.001	-	-	-	Total 1.0', 4' below top of 7.9' carb. shale
	MM 202	68271	0.003	-	-	-	Total 1.9' carb. shale
11	MM 258	68326	0.001	-	-	-	Lower 1.5' of 3.0' carb. shale
	MM 259	68327	0.001	-	-	-	Upper 1.5' of 3.0' carb. shale
12	MM 250	68318	0.004	95.0	-	-	Lower 1.0' of 7.8' clinker
	MM 251	68319	0.002	-	-	-	Total 2.0' ash and black carb. clay

a = less than 0.001

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
13	MM 257	68325	0.004	-	-	-	Lower 1.0' of 2.0' carb. shale
	MM 256	68324	0.003	-	-	-	Upper 1.0' of 2.0' carb. shale
	MM 255	68323	0.003	-	-	-	Lower 1.5' of 3.0' carb. shale
	MM 254	68322	0.001	-	-	-	Upper 1.5' of 3.0' carb. shale
	MM 253	68321	0.002	87.0	-	-	Lower 0.6' of 1.2' carb. shale
	MM 252	68320	0.005	73.5	0.011	0.008	Upper 0.6' of 1.2' carb. shale
14	MM 245	68313	a	-	-	-	Lower 2.5' of 5.0' carb. shale
	MM 244	68312	0.002	-	-	-	Upper 2.5' of 5.0' carb. shale
	MM 243	68311	0.002	-	-	-	Total 3.5' carb. shale
	MM 242	68310	0.002	-	-	-	Upper 2.0' of 4.0' carb. shale
	MM 240	68309	0.005	-	-	0.007	Total 1.5' carb. shale
15	MM 222	68291	0.004	98.1	0.001	0.001	Coal ash; grab sample
	MM 223	68292	0.003	97.0	-	-	Coal ash; grab sample
16	MM 224	68293	0.002	-	-	-	Upper 2.0' of 4.5' carb. shale
	MM 225	68294	0.004	-	-	-	Total 2.5' carb. shale
	MM 226	68295	0.003	-	-	-	Total 3.4' carb. shale
17	MM 227	68296	0.001	-	-	-	Upper 1.0' of 2.1' carb. shale
	MM 228	68297	0.001	-	-	-	Upper 1.2' of 3.9' shaly lignite
	MM 229	68298	0.002	48.3	0.004	0.002	Middle 1.5' of 3.9' shaly lignite
	MM 230	68299	0.002	48.4	0.004	0.002	Lower 1.2' of 3.9' shaly lignite
	MM 313	54764	0.005	-	-	-	Total 0.5' volc. ash; 1.5' below top of 20' volcanic ash
18	DI 9	52902	0.005	-	-	0.001	Volcanic ash; grab sample
	DI 10	52903	0.005	-	-	0.004	Total 2.0' carb. shale
	DI 11	52904	0.004	-	-	0.001	Total 0.3' yellow sandstone
	DI 12	52905	0.017	84.35	0.034	0.032	Upper 0.7' of 7.5' carb. shale
	DI 13	52906	0.003	-	-	0.004	Next 2.3' of 7.5' carb. shale
	DI 14	52907	0.002	-	-	0.003	Next 2.6' of 7.5' carb. shale
	DI 15	52908	0.002	-	-	0.003	Lower 1.9' of 7.5' carb. shale

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
19	MM 233	68302	0.002	-	-	-	Total 2.5' carb. shale
	MM 231	68300	0.003	-	-	-	Upper 3.0' of 6.0' carb. shale
	MM 232	68301	0.004	-	-	-	Lower 3.0' of 6.0' carb. shale
20	MM 234	68303	0.003	-	-	-	Total 1.5' carb. shale
	MM 235	68304	0.006	-	-	0.011	Total 3.0' carb. shale
	MM 236	68305	0.002	-	-	-	Lower 1.7' of 8.4' carb. shale
	MM 237	68306	0.002	-	-	-	Total 2.1' carb. shale
	MM 238	68307	0.002	-	-	-	Total 3.0' carb. shale
	MM 239	68308	0.002	-	-	-	Total 2.6' carb. shale
	MM 314	54765	0.005	-	-	-	Total 3.0' welded tuff
21	MM 400	71640A	0.002	-	-	-	Upper 0.8' of 4.0' carb. shale
	MM 399	71640	0.002	-	-	-	Middle 0.8' of 4.0' carb. shale
	MM 398	71639	0.002	-	-	-	Lower 0.8' of 4.0' carb. shale
	MM 397	71638	0.002	-	-	-	Total 1.1' carb. clay-shale
	MM 396	71637	0.004	-	-	-	Total 0.8' clay
	MM 395	71636	0.004	-	-	-	Total 0.5' carb. clay
	MM 394	71635	0.005	-	-	-	Upper 0.8' of 5.1' carb. shale
	MM 393	71634	0.008	-	-	0.009	Next 0.8' of 5.1' carb. shale
	MM 392	71633	0.013	85.8	0.024	0.021	Next 0.8' of 5.1' carb. shale
	MM 391	71632	0.010	83.7	0.018	0.015	Next 0.8' of 5.1' carb. shale
	MM 390	71631	0.004	-	-	0.007	Next 0.8' of 5.1' carb. shale
	MM 389	71630	0.004	-	-	0.004	Lower 1.1' of 5.1' carb. shale
	MM 388	71629	0.002	-	-	-	Upper 0.9' of 7.6' carb. shale
	MM 387	71628	0.005	-	-	0.006	Next 0.9' of 7.6' carb. shale
	MM 386	71627	0.005	-	-	0.007	Next 0.9' of 7.6' carb. shale
	MM 385	71626	0.005	-	-	0.005	Next 0.9' of 7.6' carb. shale
	MM 384	71625	0.002	-	-	-	Next 1.0' of 7.6' carb. shale
	MM 383	71624	0.001	-	-	-	Next 1.0' of 7.6' carb. shale
	MM 382	71623	0.002	-	-	-	Next 1.0' of 7.6' carb. shale
	MM 381	71622	0.003	-	-	-	Lower 1.0' of 7.6' carb. shale
	MM 380	71621	0.002	-	-	-	Upper 0.9' of 1.8' carb. shale
	MM 379	71620	0.003	-	-	-	Lower 0.9' of 1.8' carb. shale

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
21 (Cont.)	MM 378	71619	0.003	-	-	-	Upper 1.1' of 2.2' carb. shale
	MM 377	71618	0.002	-	-	-	Lower 1.1' of 2.2' carb. shale
	MM 376	71617	0.002	-	-	-	Upper 0.9' of 2.7' carb. shale
	MM 375	71616	0.002	-	-	-	Middle .9' of 2.7' carb. shale
	MM 374	71615	0.003	-	-	-	Lower 0.9' of 2.7' carb. shale
	MM 373	71614	0.002	-	-	-	Upper 0.8' of 2.5' carb. shale
22	MM 299	71594	0.005	-	-	0.001	Total 0.5' carb. shale
	MM 300	71595	0.006	-	-	0.004	Total 0.9' carb. siltstone
	MM 353	71596	0.007	-	-	0.005	Total 0.7' carb. shale
	MM 354	71597	0.005	-	-	0.001	Upper 1.0' of 3.5' carb. siltstone
	MM 314	54765	0.005	-	-	-	Rhyolite; grab sample
23	MM 295	71590	0.007	-	-	0.002	Total 1.0' carb. shale
	MM 294	71589	0.012	90.0	0.010	0.009	Upper 0.9' of 1.9' carb. shale
	MM 293	71588	0.010	-	-	0.008	Lower 0.9' of 1.9' carb. shale
	MM 291	71587	0.013	-	-	0.014	Total 0.7' carb. shale
	MM 290	71586	0.022	67.2	0.035	0.024	
					0.038	0.026	Total 1.0' carb. shale
	MM 289	71585	0.007	-	-	0.003	Upper 2.0' of 2.8' carb. shale
	MM 288	71584	0.011	-	-	0.006	Lower 1.8' of 2.8' carb. shale
	MM 287	71583	0.009	-	-	0.005	Total 2.0' carb. shale
	MM 286	71582	0.010	-	-	0.005	Total 0.4' black shale
	MM 285	68353	0.006	-	-	0.008	Total 0.9' gray shale
	MM 284	68352	0.004	-	-	0.005	Total 0.9' gray shale
24	MM 301	54278	0.097	84.21	0.13	0.12	Upper 1.0' of 8.0' carb. shale
	MM 302	54279	0.062	86.95	0.085	0.081	Next 1.0' of 8.0' carb. shale
	MM 303	54280	0.040	89.70	0.045	0.047	Next 1.0' of 8.0' carb. shale
	MM 304	54281	0.019	94.93	0.016	0.019	Next 1.0' of 8.0' carb. shale
	MM 305	54282	0.015	94.84	0.013	0.016	Next 1.0' of 8.0' carb. shale
	MM 306	54283	0.019	93.78	0.016	0.016	Next 1.0' of 8.0' carb. shale
	MM 307	54284	0.024	93.58	0.021	0.020	Next 1.0' of 8.0' carb. shale
	MM 308	54285	0.020	94.11	0.018	0.017	Lower 1.0' of 8.0' carb. shale
	MM 309	54286	0.019	91.73	0.030	0.028	Top 5" of silicified carb. shale

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
25	MM 371	61612A	0.003	-	-	-	Lower 1.0' of 6.0' bentonite
	MM 370	71612	0.002	27.4	-	-	Upper 1.1' of 3.7' carb. shale
	MM 369	71611	0.008	-	-	0.007	Middle 1.1' of 3.7' carb. shale
	MM 368	71610	0.008	-	-	0.004	Lower 1.1' of 3.7' carb. shale
	MM 367	71609	0.005	-	-	0.003	Upper 0.9' of 4.1' carb. shale
	MM 366	71608	0.004	-	-	0.002	Middle 0.9' of 4.1' carb. shale
	MM 365	71607	0.005	-	-	0.001	Lower 0.9' of 4.1' carb. shale
	MM 364	71606	0.006	-	-	0.002	Total 1.1' shale
	MM 363	71605	0.006	-	-	0.004	Upper 1.0' of 2.0' carb. shale
	MM 362	71604	0.008	-	-	0.006	Lower 1.0' of 2.0' carb. shale
	MM 361	71603A	0.009	-	-	0.008	Total 1.7' sandstone
	MM 360	71603	0.021	-	-	0.035	Upper 1.1' of 3.3' carb. shale
	MM 359	71602	0.017	-	-	0.023	Middle 1.1' of 3.3' carb. shale
	MM 358	71601	0.013	-	-	0.013	Lower 1.1' of 3.3' carb. shale
	MM 357	71600	0.010	-	-	0.013	Upper 1.0' of 2.0' gray shale
26	MM 283	68351	0.001	-	-	-	Upper 1.5' of 4.3' carb. shale
	MM 282	68350	0.005	-	-	0.006	Lower 2.8' of 4.3' carb. shale
	MM 281	68349	0.002	83.8	-	-	Total 1.6' lignitic shale
	MM 280	68348	0.004	-	-	0.002	Total 1.0' coal ash
	MM 279	68347	0.003	-	-	-	Total 1.3' carb. shale
	MM 278	68346	0.008	-	-	0.010	Upper 1.0' of 3.0' carb. shale
	MM 277	68345	0.015	-	-	0.018	Middle 1.0' of 3.0' carb. shale
	MM 276	68344	0.006	-	-	0.005	Lower 1.0' of 3.0' carb. shale
	MM 275	68343	0.003	-	-	-	Upper 1.6' of 3.2' carb. shale
	MM 274	68342	0.003	-	-	-	Lower 1.5' of 3.2' carb. shale
	MM 273	68341	0.004	-	-	0.003	Total 1.7' carb. shale
	MM 272	68340	0.004	-	-	0.005	Total 0.9' carb. shale
	MM 271	68339	0.004	-	-	0.006	Total 1.4' carb. shale
	MM 270	68338	0.004	-	-	0.002	Total 1.0' carb. shale
	MM 269	68337	0.004	-	-	0.004	Total 2.6' carb. shale
27	MM 284	68352	0.004	-	-	0.005	Upper 0.4' of 13.7' carb. shale
	MM 285	68353	0.006	-	-	0.008	Next 2.0' of 13.7' carb. shale

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
28	MM 260	68328	0.003	-	-	-	Upper 1.5' of 2.9' carb. shale
	MM 261	68329	0.002	-	-	-	Total 1.0' carb. shale
	MM 262	68330	0.004	-	-	0.005	Upper 1.0' of 10.2' carb. shale
	MM 263	68331	0.002	-	-	-	Next 2.0' of 10.2' carb. shale
	MM 264	68332	0.001	54.7	-	-	Upper 1.1' of 4.0' carb. shale
	MM 265	68333	0.001	58.1	-	-	Upper 2.0' of 3.4' carb. shale
	MM 266	68334	a	-	-	-	Upper 1.0' of 1.1' carb. shale
	MM 267	68335	0.002	-	-	-	Upper 1.0' of 6.2' carb. shale
	MM 268	68336	0.002	-	-	-	Total 1.0', 2.2' below top of 6.2' carb. shale
29	MM 352	54773	0.004	-	-	-	Total 1.0' volcanic ash
	MM 216	68285	0.010	67.8	0.031	0.021	Total 1.7' lignite
	MM 215	68284	0.001	46.9	0.008	0.004	Upper 1.2' of 5.2' lignite
	MM 214	68283	a	34.4	-	-	Next 1.0' of 5.2' lignite
	MM 213	68282	a	42.4	-	-	Next 1.0' of 5.2' lignite
	MM 212	68281	a	37.5	-	-	Next 1.0' of 5.2' lignite
	MM 211	68280	0.001	38.9	0.001	a	Lower 1.0' of 5.2' lignite
30	MM 404	71644	0.004	-	-	-	Upper 0.8' of 2.3' carb. shale
	MM 403	71643	0.004	-	-	-	Middle 0.5' of 2.3' carb. shale
	MM 402	71642	0.005	-	-	0.002	Lower 1.0' of 2.3' carb. shale
	MM 401	71641	0.002, 0.003	-	-	-	Total 0.7' carb. shale
31	MM 246	68314	0.001	-	-	-	Upper 2.0' of 4.1' carb. shale
32	MM 355	71598	0.006	-	-	0.003	Upper 1.1' of 2.2' carb. shale
	MM 356	71599	0.006	-	-	0.004	Lower 1.1' of 2.2' carb. shale
33	MM 296	71591	0.012	81.7	0.011	0.009	Upper 1.0' of 3.0' carb. shale
	MM 297	71592	0.006	-	-	0.003	Middle 1.0' of 3.0' carb. shale
	MM 298	71593	0.004	-	-	0.001	Lower 1.0' of 3.0' carb. shale

a = less than 0.001

RESTRICTED SECURITY INFORMATION

Summary of analytical data, Goose Creek district (Cont.)

Locality number	Sample number	Lab. number	Percent eU	Percent ash	Percent U in ash	Percent U in sample	Description
34	MM 207	68276	0.003	61.3	-	-	Total 1.4' shaly lignite
	MM 208	68277	a	46.5	-	-	Upper 0.6' of 1.5' carb. shale
	MM 209	68278	0.001	38.3	0.001	a	Upper 0.6' of 2.7' carb. shale
	MM 210	68279	a	33.0	-	-	Upper 1.5' of 2.1' lignite
35	MM 187	68256	0.002	49.9	0.002	0.001	Total 1.9' of lignite
	MM 188	68257	0.001	-	-	-	Carb. shale; grab sample
36	MM 248	68316	a	20.0	-	-	Total 1.2' lignite
	MM 249	68317	0.001	29.3	a	a	Total 1.5' lignite
37	MM 247	68315	0.001	23.0	0.007	0.002	Lignite; grab sample

a = less than 0.001

RESTRICTED SECURITY INFORMATION

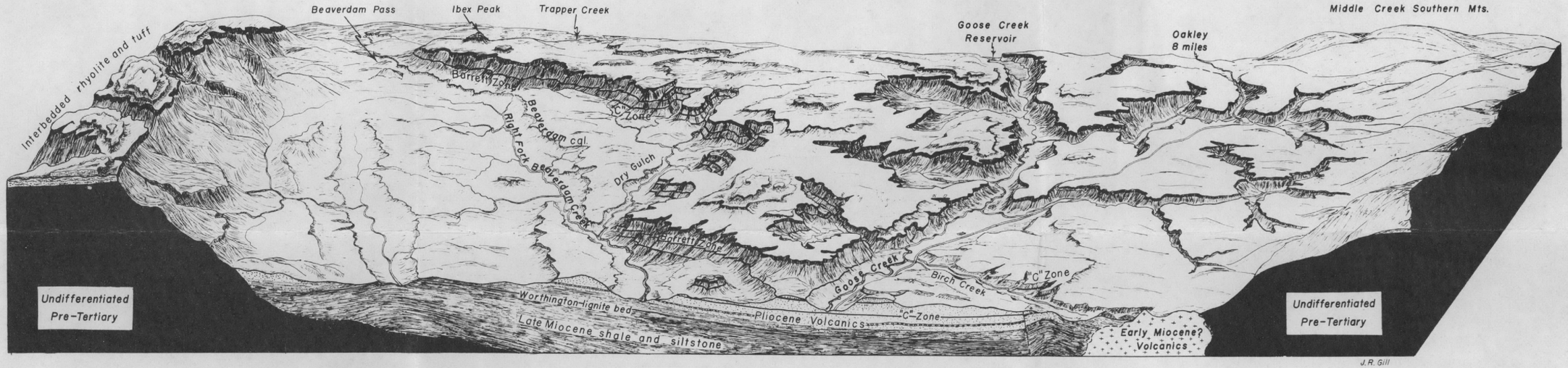
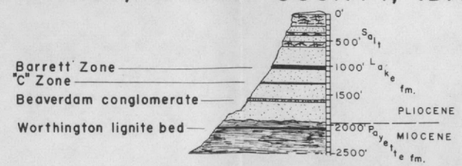


FIGURE I.--DIAGRAMMATIC SKETCH OF SOUTHERN HALF OF GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO

- Interbedded rhyolite and tuff
- Tuff
- Bentonite
- Lignite and carbonaceous shale zones
- Shale and siltstone
- Conglomerate

0.0 0.5 1.0 1.5 2.0 2.5 3.0 miles
Horizontal scale



U.S. DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

TRACE ELEMENTS INVESTIGATIONS
REPORT 272

R20E R21E R22E

T14S T15S T16S

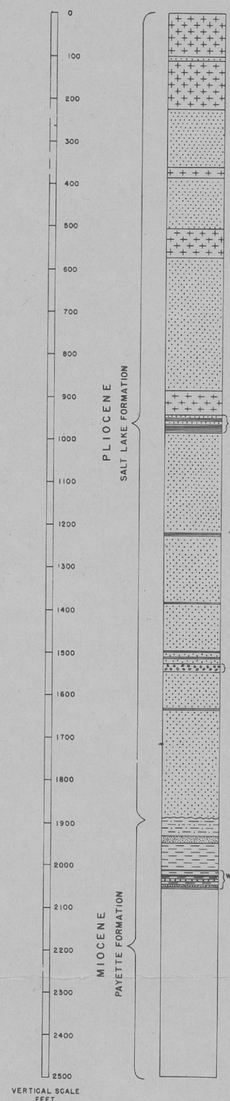
Oakley 5 miles

COTTONWOOD CREEK
HUDSON RIDGE
SOUTH COTTONWOOD CREEK
KITTLE SQUAW CREEK
IBEX ANTICLINE
SQUAW CREEK
WORTHINGTON LIGNITE BED
VIOLETS HOLLOW
TRAPPER CREEK
BARRETT ZONE
IBEX HOLLOW
GOOSE CREEK RESERVOIR
LOWER CEDAR CREEK
OWENS FOREST
CORRAL CREEK
BADGER GULCH
IBEX PEAK
COVE (CAVE) GULCH
NATIONAL
COAL (GOLD) CREEK
FALL CREEK
DRY CREEK
WORTHINGTON
RIGHT HAND FORK
LIGNITE
LEFT HAND FORK
MINIDOKA
COAL
BANKS
GOOSE CREEK SYNCLINE
LITTLE POLE CREEK
BEAVERDAM CREEK
JAY CREEK

CASSIA COUNTY
ELKO COUNTY
IDAHO
NEVADA | UTAH
CASSIA COUNTY
BOXELDER COUNTY

Base compiled from General Land Office township plats and U.S. Forest Service maps

COMPOSITE SECTION OF TERTIARY ROCKS IN THE GOOSE CREEK DISTRICT



ROCK SYMBOLS

- INDURATED RHYOLITIC TUFF
- VOLCANIC ASH
- LIGNITE
- CARBONACEOUS SHALE
- SHALE OR CLAY
- SILTSTONE
- SANDSTONE
- CONGLOMERATE
- COVERED

EXPLANATION

- TERTIARY ROCKS- INCLUDES PLIOCENE SALT LAKE FORMATION, MIOCENE PAYETTE FORMATION, AND OLDER MIOCENE (?) RHYOLITE
- PRE-TERTIARY ROCKS, UNDIFFERENTIATED
- OUTCROP OF LIGNITE OR CARBONACEOUS SHALE BED OR ZONE (DASHED WHERE CONCEALED OR INFERRED)
- LIGNITE BED BURNED AT OUTCROP
- 3 COLLECTING LOCALITY REFERRED TO IN TEXT
- U D FAULT (DASHED WHERE INFERRED)
- ANTICLINAL AXIS
- SYNCLINAL AXIS
- 18 DIP AND STRIKE OF BEDS
- GRADED ROAD
- UNIMPROVED ROAD

INDEX MAP

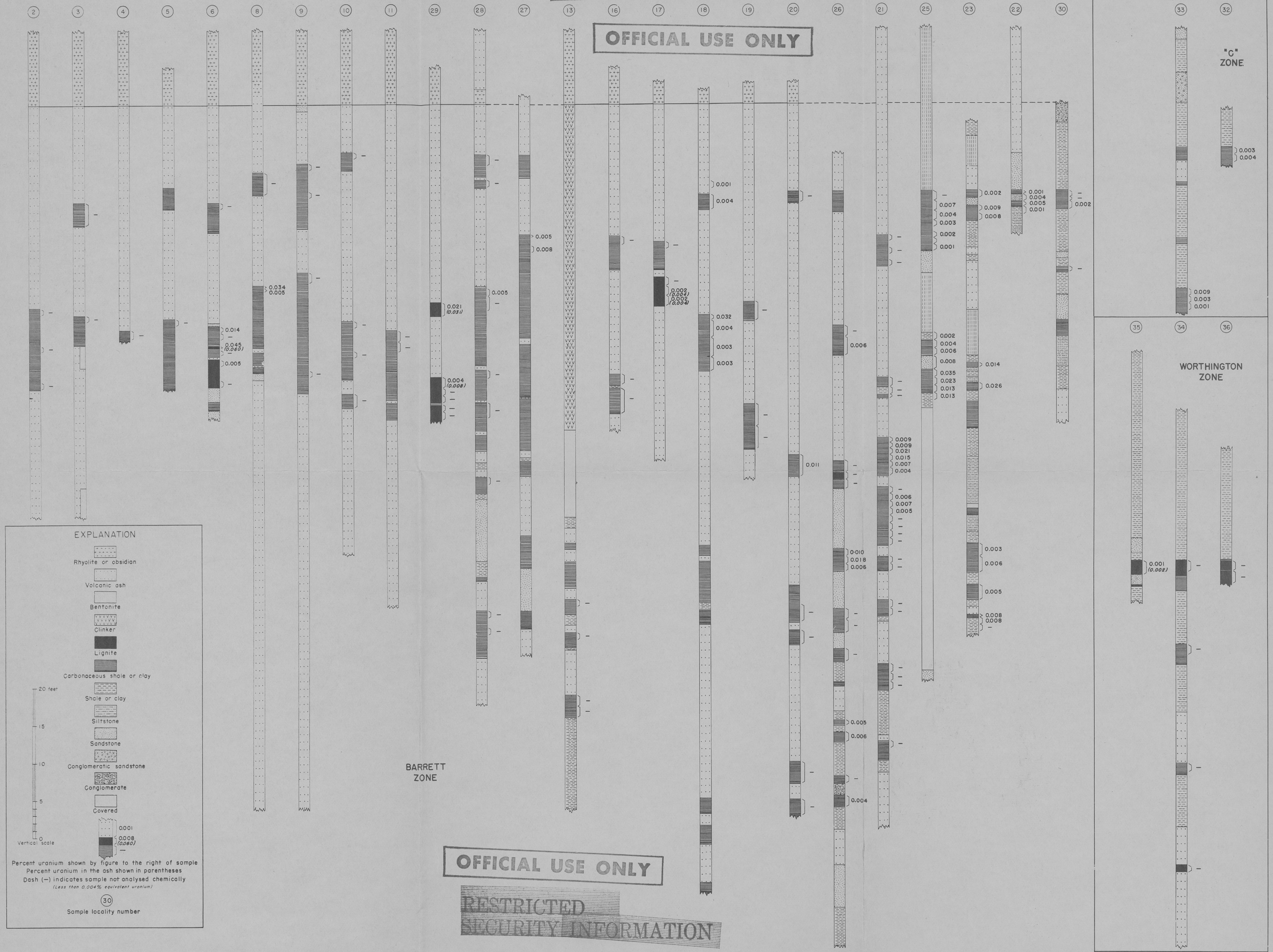
0 1 2 MILES

FIGURE 2

RECONNAISSANCE MAP SHOWING AREAL DISTRIBUTION OF RADIOACTIVE LIGNITE AND CARBONACEOUS SHALE ZONES, GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO

William J. Hail Jr. and James R. Gill

1953



DISTRIBUTION AND CONCENTRATION OF URANIUM IN LIGNITE AND CARBONACEOUS SHALE ZONES, GOOSE CREEK DISTRICT, CASSIA COUNTY, IDAHO

FIGURE 3