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UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WASHINGTON 25, D. C.

SEP 30 1954

AEC - 136/5

Dr. Phillip L. Merritt, Assistant Director
Division of Raw Materials
U. S. Atomic Energy Commission
16th and Constitution Avenue, N. W.
Washington 25, D. C.

Dear Phil:

Transmitted herewith are three copies of TEI-437, "Reconnaissance for uranium-bearing carbonaceous materials in southern Utah," by Howard D. Zeller, June 1954.

We are asking Mr. Hosted to approve our plan to publish this report as a Geological Survey circular.

Sincerely yours,

Dwight M. Lemmon
for W. H. Bradley
Chief Geologist

Geology and Mineralogy

This document consists of 27 pages.
Series A

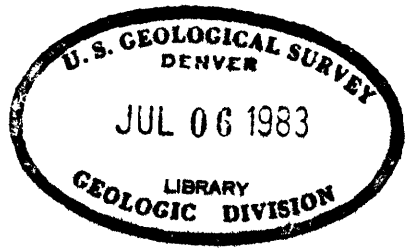
UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

RECONNAISSANCE FOR URANIUM-BEARING CARBONACEOUS MATERIALS IN SOUTHERN UTAH*

By

Howard D. Zeller



June 1954

Trace Elements Investigations Report 437

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

USGS - TEI-437
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RECONNAISSANCE FOR URANIUM-BEARING CARBONACEOUS MATERIALS IN SOUTHERN UTAH

By Howard A. Zeller

ABSTRACT

A reconnaissance investigation for uranium-bearing carbonaceous materials was made in three major areas of southern Utah: Kaiparowits Plateau, Henry Mountains, and Kolob Terrace. No uranium deposits of economic interest were found. A few 1- to 2-foot beds of carbonaceous shale in the Dakota (?) sandstone contain 0.006-0.007 percent uranium. Other carbonaceous sediments that were examined contain 0.002 percent or less uranium.

INTRODUCTION

During the summer of 1953 a reconnaissance investigation was made in parts of southern Utah in search of new deposits of uranium-bearing carbonaceous rocks. Coals and carbonaceous shales of Cretaceous age were systematically sampled in three major areas: Kaiparowits Plateau, Henry Mountains, and Kolob Terrace (fig. 1). Eighty samples were submitted for uranium analyses and radioactivity measurements. The materials analyzed included 53 samples of coal, 10 of carbonaceous shale, 10 of volcanic rock, 2 of sandstone, 4 of water, and 1 of evaporite. The radioactivity measurements and chemical analyses of the samples are given at the end of this report.

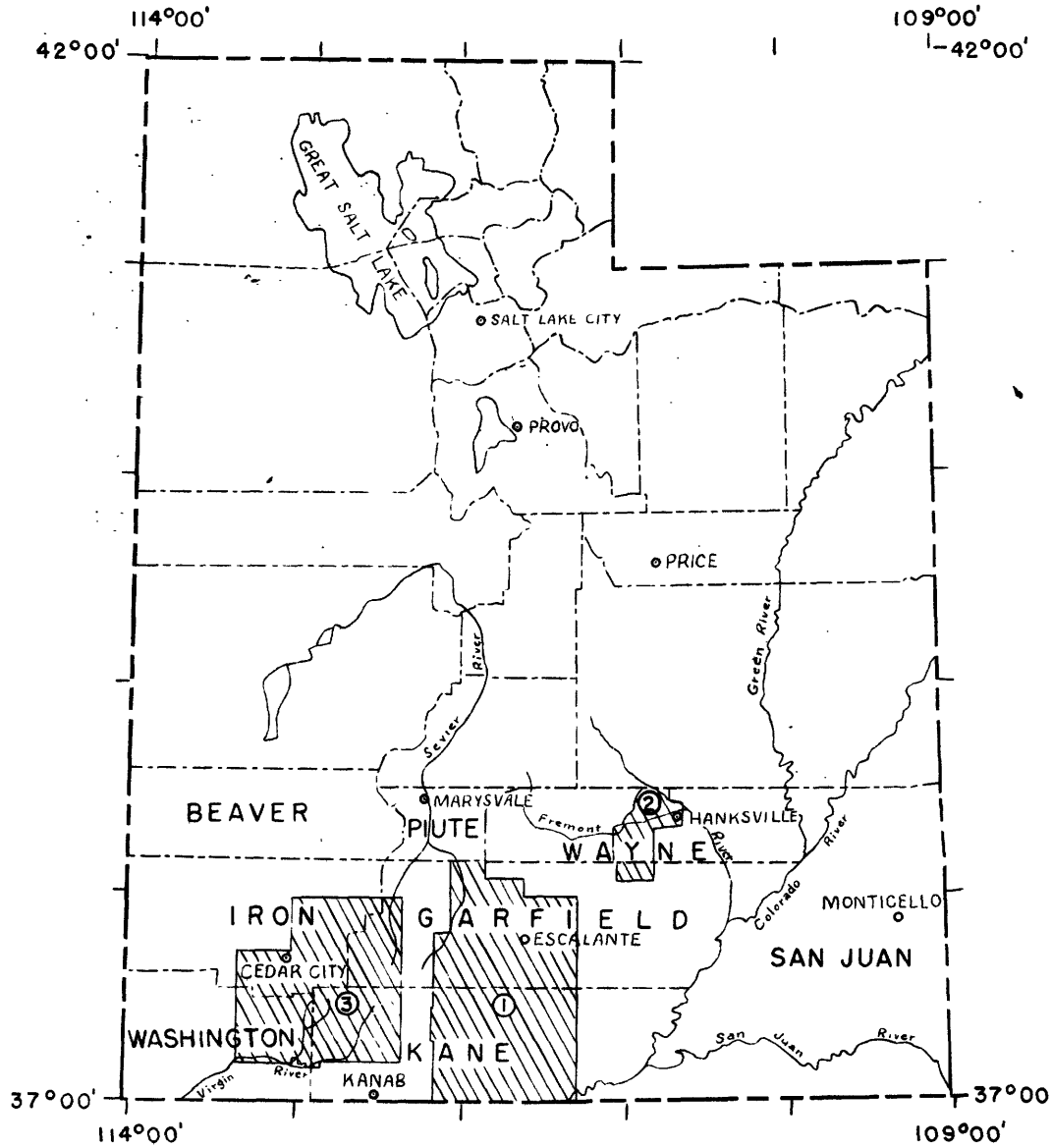


Figure 1. INDEX MAP OF UTAH SHOWING AREAS DESCRIBED IN THIS REPORT

1. Kaiparowits Plateau 2. Henry Mountains 3. Kolob Terrace

The samples are not appreciably radioactive nor do they contain uranium in amounts of economic importance. The only rocks with a uranium content that could be considered above normal for their type of lithology were a few thin beds of carbonaceous shale.

Field radioactivity measurements indicated a higher equivalent uranium content than was determined by the laboratory analyses. This may be due to the contamination from "fall out," which was very heavy in southern Utah during the entire period of investigation. Background readings with the field Geiger and scintillation counters were so high at some localities in the Kolob Terrace that the instruments could be used only in mines or freshly dug pits.

Purpose and scope of the investigation

The reconnaissance in southern Utah was undertaken in an attempt to locate deposits of uranium-bearing carbonaceous materials, especially coals, that might be used as byproduct sources of uranium.

The areas in southern Utah were chosen for study because they contain bedrock favorable for possible concentration of uranium and are overlain in part by volcanic and tuffaceous sequences that might be source beds for some of the uranium. Coal having as much as 0.1 percent uranium in the ash content was found during similar reconnaissance in South Dakota, North Dakota, Wyoming, Colorado, New Mexico, Nevada, Idaho, and Montana (Denson and others, 1952).

Acknowledgments

The writer was assisted in the field by Don M. George. The reconnaissance in western Kane County, Utah, was greatly facilitated by the help of W. B. Cashion of the U. S. Geological Survey. Radioactivity measurements and uranium analyses were made by the Geological Survey laboratories in Denver and Washington. The work was done on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission.

AREAS EXAMINED

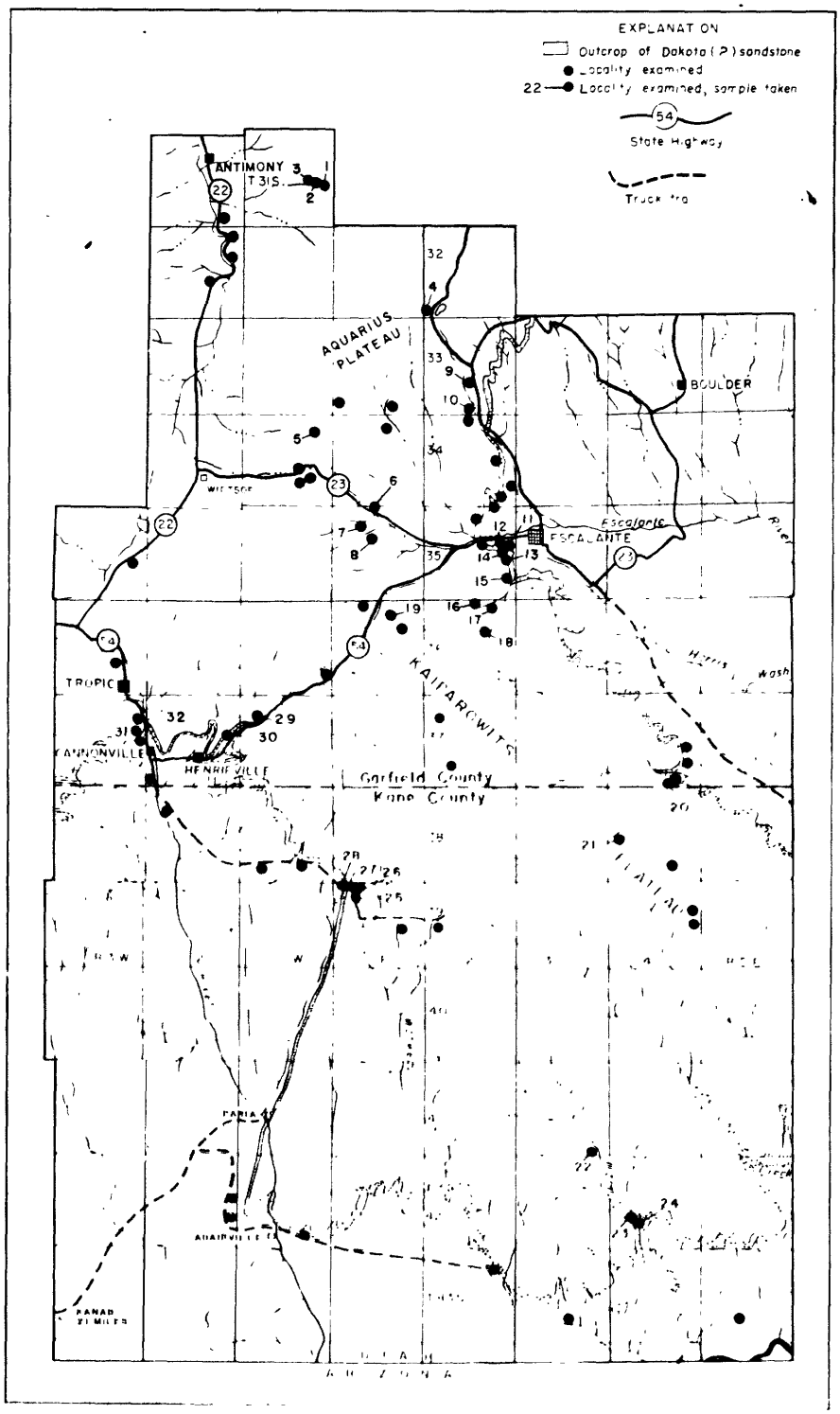
Kaiparowits Plateau

The Kaiparowits Plateau is located in Garfield and Kane Counties, south-central Utah. Escalante, the principal town in the area, located near the north-eastern corner of the Plateau, can be reached from Utah State Highway 54 by way of Tropic. (See fig. 2).

The Plateau area covers about 1,500 square miles; much of it is accessible only on foot or horseback. The nearest railhead is Marysvale, about 85 miles by road to the northwest of Escalante.

The Kaiparowits Plateau is composed of Jurassic and Cretaceous rocks that have been preserved from erosion because they lie in a shallow syncline that is capped by resistant sandstone (Gregory and Moore, 1931, p. 134).

The following generalized section of Cretaceous rocks in the Plateau is modified from Gregory and Moore (1931, p. 36) and from Gregory (1951, p. 23):



Map modified from Gregory and Moore

FIGURE 2 MAP OF THE KAIPAROWITS AREA SHOWING LOCALITIES EXAMINED FOR CARBONACEOUS MATERIALS

Tertiary	Wasatch formation	
	UNCONFORMITY	
	Kaiparowits formation	Bluish-drab fine-grained to medium coarse-grained arkosic sandstone and sandy shale.
	Wahweap sandstone	Yellowish-gray massive sandstone with some sandy shale. A prominent cliff-former.
	Straight Cliffs sandstone	Yellowish-gray to brown irregularly bedded medium- to massive sandstone. Contains coal beds. Forms prominent escarpment.
Cretaceous	Tropic shale	Bluish-drab argillaceous to sandy shale. Fossiliferous sandstone at base contains Gryphaea newberryi.
	Dakota (?) sandstone	Yellow to nearly white sandstone, conglomeratic in part. Irregularly bedded. Contains thin beds of coal.
	UNCONFORMITY	
Jurassic	Morrison formation or Winsor formation	

Carbonaceous rocks that contain more than 0.002 percent uranium were found only at one locality on the northwest flank of the East Kaibab monocline (locality 28, fig. 2), and at another locality near Collet Creek on the northeast edge of the Kaiparowits Plateau (locality 20, fig. 2). The uranium content at these localities is 0.006 to 0.007 percent and the uranium occurs in beds of carbonaceous shale 1 to 2 feet thick in the Dakota (?) sandstone. The carbonaceous shale at locality 28 is 2 feet thick and lies 15 feet above the unconformity between the Dakota (?)

sandstone and the Winsor formation.

Other localities where carbonaceous rocks contain as much as 0.002 percent equivalent uranium were: locality 14 in natural coal ash in the Dakota (?) sandstone; locality 24 in carbonaceous shale of the Dakota (?) sandstone, and locality 29 in carbonaceous shale of the Straight Cliffs sandstone. (See fig. 2.)

Samples of carbonaceous material from localities 9, 16, 21, 25, and 27 (fig. 2) contained 0.001 percent equivalent uranium.

A bed of ferruginous sandstone in the Dakota (?) sandstone at locality 11 contains 0.002 percent equivalent uranium and 0.0017 percent uranium. A 2-foot bed of bentonite at locality 31 near Cannonville at the base of the Dakota (?) sandstone contains 0.001 percent equivalent uranium and 0.0007 percent uranium. (See fig. 2.)

Several samples of volcanic flow rocks of Tertiary age collected on the nearby Aquarius Plateau show relatively high contents of equivalent uranium. A porphyritic flow rock at locality 3 at the head of Coyote Creek near Antimony contains 0.0054 percent equivalent uranium and 0.0009 percent uranium. Another samples from locality 5 on Escalante Mountain contains 0.006 percent equivalent uranium and 0.001 percent uranium. A third sample from locality 4 near Cyclone Lake contains 0.003 percent equivalent uranium but only 0.0005 percent uranium. (See fig. 2.)

A field radiometric survey was made of some beds of limestone in the Wasatch formation along the edge of the Aquarius Plateau (fig. 2), but no radioactivity anomalies were found.

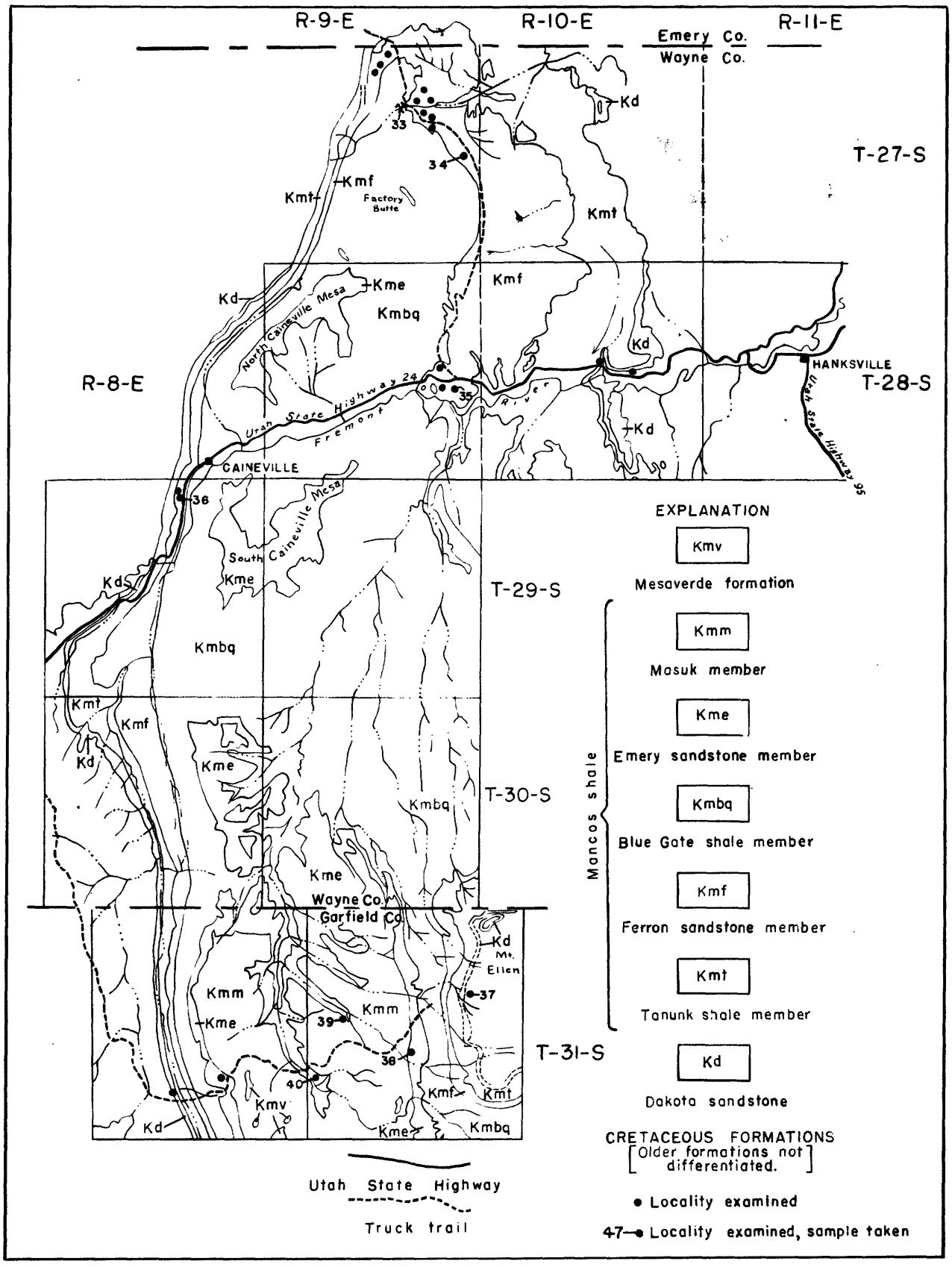
Samples from the other localities examined in the Kaiparowits Plateau region contain less than 0.001 percent equivalent uranium. (See appendix.)

Henry Mountains

The Henry Mountains area is located in Wayne and Garfield Counties, southeastern Utah. Reconnaissance work was restricted to the northern part of the Henry Mountains extending from the west flank of Mt. Ellen northward to the boundary between Emery and Wayne Counties (fig. 1). The town of Hanksville is located near the northeastern corner of the area. Green River, Utah, the nearest railhead, is 60 miles to the northeast on Utah State Highway 24.

The geologic map (fig. 3) was taken from the northern part of a map by Hunt and others (1952). It shows localities that were examined and sampled during one week of reconnaissance work. Coal beds in the Henry Mountains area occur in the Dakota sandstone, the upper part of the Ferron sandstone member of the Mancos shale, and the upper part of the Emery sandstone member of the Mancos. Additional information on the geology of the area is given by Hunt (1946) and Hunt and others (1954).

The carbonaceous material examined in this area contained less than 0.002 percent equivalent uranium. Carbonaceous clay shale in the Ferron sandstone at locality 36 (fig. 3), near Caineville indicated an estimated 0.01 percent equivalent-uranium content after careful field Geiger counter readings, but laboratory analyses showed only 0.002 percent equivalent uranium in the rock.



Map modified after C.B.Hunt, U.S.G.S. OM 131

FIGURE 3. MAP OF PART OF THE HENRY MOUNTAINS AREA SHOWING LOCALITIES EXAMINED FOR CARBONACEOUS MATERIALS.

SCALE

0 5 10 Miles

A bed of coal 8 inches thick in the Ferron sandstone at locality 35 contains 0.001 percent equivalent uranium. This bed, like the one at locality 36, indicated a higher equivalent-uranium content in the field. It is at about the same stratigraphic position as the bed at the Factory Butte Coal mine (locality 33, fig. 3). The coal at the mine is 7 feet thick but contains less than 0.001 percent equivalent uranium.

All of the coal beds examined in the Emery sandstone contain less than 0.001 percent equivalent uranium. (See appendix.) These beds occur only in the deepest part of the Henry Mountains structural basin west of Mt. Ellen and Mt. Pennell (Hunt and others, 1954).

Kolob Terrace Area

The Kolob Terrace area is located in parts of Kane, Washington, and Iron Counties in southwestern Utah (fig. 1). Cedar City, located near the northwest corner of the area, is the main railhead. Numerous secondary county roads give access to most of the region, but deep narrow canyons tributary to Virgin River make traversing difficult.

The Kolob Terrace, a bench cut on the south flank of the Markagunt Plateau, extends from Coal Creek Canyon near Cedar City southward and southeastward to the vicinity of Glendale, Utah (fig. 4), lying between the Hurricane fault on the west and the Sevier fault on the east (Gregory, 1950a, p. 5-6). The Kolob Terrace ranges in altitude from 8,000 to 9,000 feet and is an area of rounded hills, swales and gentle slopes with recent volcanic cones and lava flows scattered over the surface (Gregory, 1950b,

p. 134-136).

The main coal beds in this area occur in the Upper Cretaceous Tropic formation (Gregory, 1950b, p. 146). Some layers of carbonaceous rock also occur in the Dakota (?) sandstone and in the Straight Cliffs sandstone of Cretaceous age.

Beroni and others (1953) describe an occurrence of uranium in the lower part of the Dakota sandstone and upper part of the Summerville formation at the Bullock claims in T. 40 S., R. 9 W., Kane County, Utah. Fragments of carbonized wood and clay that occur in a conglomeratic sandstone were found to contain finely disseminated uranium compounds. This zone, near the Cretaceous-Jurassic contact, was examined at many places during this present reconnaissance, but no radioactivity was detected.

The only sample collected in the area that contains more than 0.001 percent uranium is coal ash on the waste dump of the Southern Utah Power Company plant near Cedar City, Utah (locality 60, fig. 4). The ash contains 0.004 percent equivalent uranium and 0.002 percent uranium. The ash came from three nearby mines in the Tropic formation, and approximately 100 tons of coal averaging about 12 percent ash are mined out per day. One of these mines (the Webster, locality 55) is in Right Hand Canyon and has a 6-foot coal bed. The radioactivity detected in the mine was twice background, but samples collected from the mine contain only 0.001 percent equivalent uranium or less. Samples of coal from the other mines (localities 54 and 57, fig. 4) contain less than 0.001 percent

equivalent uranium.

Near New Harmony, Utah, at locality 61 (fig. 4) a 1-foot bed of semi-anthracite coal in the Tropic formation lies adjacent to an intrusion of andesite (Richardson, 1909, p. 384) and contains 0.004 percent equivalent uranium and 0.0012 percent uranium. The andesite contains 0.003 percent equivalent uranium but only 0.0003 percent uranium.

A 6-inch thick bed of carbonaceous shale (locality 52, fig. 4) in the Tropic formation near Pryor Peak on Kolob Terrace contains 0.003 percent equivalent uranium but only 0.0003 percent uranium.

Samples of coal at localities 43, 44, 46, 51, 55, 56, 58 (fig. 4, and Appendix) contain 0.001 percent equivalent uranium.

A rhyolitic lava at the top of the Brian Head formation of Miocene (?) age (Gregory, 1950b, p. 26) was sampled on Markagunt Plateau to determine whether uranium might be present in volcanic rocks on the plateau. The sample contains 0.003 percent equivalent uranium and 0.001 percent uranium.

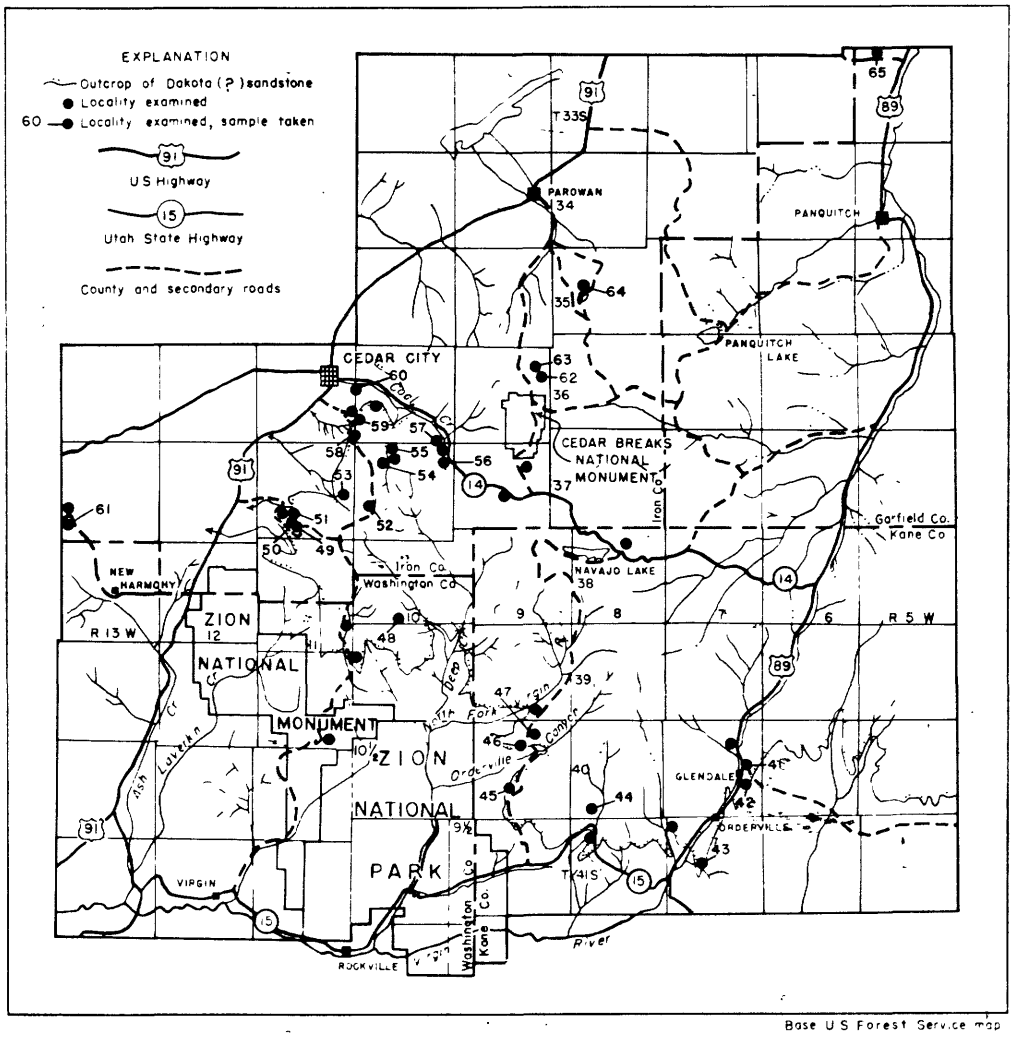


FIGURE 4. MAP OF THE KOLOB TERRACE AREA SHOWING LOCALITIES EXAMINED FOR CARBONACEOUS MATERIALS.

SCALE

0 0 10 Miles

LITERATURE CITED

Beroni, E. P., McKeown, F. A., Stugard, F., Jr., and Gott, G. B., 1953, Uranium deposits of the Bulloch group of claims, Kane County, Utah: U. S. Geol. Survey Circ. 239.

Gregory, H. E., 1951, The geology and geography of the Paunsaugunt region, Utah: U. S. Geol. Survey Prof. Paper 226, 116 p.

_____, 1950a, Geology and geography of the Zion Park region, Utah and Arizona: U. S. Geol. Survey Prof. Paper 220, 200 p.

_____, 1950b, Geology of eastern Iron County, Utah: Utah Geol. Mineralog. Survey Bull. 37, 153 p.

Gregory, H. E., and Moore, R. C., 1931, The Kaiparowits region: U. S. Geol. Survey Prof. Paper 164, 161 p.

Hunt, C. B., 1946, Guidebook to the geology and geography of the Henry Mountains region, Utah: Utah Geol. Soc. Guidebook no. 1, 51 p.

Hunt, C. B., and others, 1952, Geologic map of the Henry Mountains region Utah: U. S. Geol. Survey, Oil and Gas Invest. Map OM 131.

_____, 1954, Geology and geography of the Henry Mountains region, Utah: U. S. Geol. Survey Prof. Paper 228, 234 p.

Richardson, G. B., 1909, The Harmony, Colob, and Kanab coal fields, southern Utah: U. S. Geol. Survey Bull. 341, p. 384-386.

UNPUBLISHED REPORT

Denson, N. M., and others, 1952, Summary of uranium-bearing coal, lignite, and carbonaceous shale investigations in the Rocky Mountain region during 1951: U. S. Geol. Survey Trace Elements Memo. Rept. 341.

APPENDIX

Radioactivity measurements and chemical analyses of samples from southern Utah

Radioactivity measurements and chemical analyses of samples from southern Utah 1/

Map locality number	Laboratory serial number	Location Section-township-range-county		Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
	1. KAIPAROWITS PLATEAU AREA						
1	D-98328	24-31S-1W	Garfield County	0.0008	0.0002	---	White volcanic tuff interbedded with lava flows of Tertiary age on west slope of Aquarius Plateau.
2	D-98346	23-31S-1W	------do------	---	$<1x10^{-7}$	---	Water sample from spring issuing from volcanic rocks in Coyote Canyon.
3	D-98329	23-31S-1W	------do------	.0054	.0009	---	Tertiary volcanic flow rock at head of Coyote Canyon.
4	D-95980	31-32S-2E	------do------	.003	.0005	---	Tertiary volcanic flow rock near Cyclone Lake on Aquarius Plateau.
5	D-95977	11-34S-1W	------do------	.006	.0010	---	Tertiary volcanic flow rock on Aquarius Plateau.
6	114298	4-35S-1E	------do------	a 2/	---	---	Upper 3 feet of a 12-foot bed of coal in the Straight Cliffs sandstone at an abandoned mine on Birch Creek.
7	114302	8-35S-1E	------do------	a	---	---	12-foot bed of coal at the Frandsen Coal mine in the Straight Cliffs sandstone on Upper Cherry Creek.

1/ Analyses by Trace Elements Denver and Washington Laboratories, Geochemistry and Petrology Branch, U. S. Geological Survey. "D" prefixes from Denver Laboratory. Analysts: Denver--S. Furman, W. Mountjoy, and J. Meadows; Washington--E. Campbell, B. A. McCall, and J. Goode.

2/ (a) Equivalent uranium less than 0.001 percent.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location Section-township-range-county	Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
7	114303	8-35S-1E Garfield County	a	---	---	1-foot coal rider bed 3 feet above the coal at locality 7.
8	114301	9-35S-1E ------do------	a	---	---	Upper 3.2 feet of a 6.4 foot coal bed on Cherry Creek in Straight Cliffs sandstone.
9	114328	27-33S-2E ------do------	0.001	---	---	2-foot bed of coal near base of Tropic formation.
10	114316	34-33S-2E ------do------	a	---	---	6-inch bed of coal near base of Tropic formation.
11	D-95979	13-35S-2E ------do------	.002	0.0017	---	Ferruginous sandstone near base of the Dakota (?) sandstone.
12	114311	13-35S-2E ------do------	a	---	---	1-foot bed of coal in the Dakota (?) sandstone 40 feet above contact with Morrison formation.
13	114299	24-35S-2E ------do------	a	---	---	2-foot bed of coal in Dakota (?) sandstone.
14	114300	24-35S-2E ------do------	.002	---	---	Natural ash from same horizon as the 2-foot coal at locality 13.
15	D-95975	25-35S-2E ------do------	.015	.0002	---	White evaporite in Alvey Wash.
16	114305	3-36S-2E ------do------	.001	.0005	49.9	2-inch bed of coal in the Straight Cliffs sandstone in Coal Bed Canyon.
16	114306	3-36S-2E ------do------	a	---	---	6-inch bed of coal 9 feet below sample 114305.

Radioactivity measurements and chemical analyses from southern Utah--Continued

Map locality number	Laboratory serial number	Location Section-township-range-county		Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
16	114307	3-36S-2E	Garfield County	a	---	---	2.5-foot bed of coal 10.7 feet below the top coal.
17	114308	2-36S-2E	------do------	a	---	---	11-foot bed of coal in the Straight Cliffs sandstone at the Abandoned Christensen Mine.
18	114304	10-36S-2E	------do------	a	---	---	Grab sample from 8-foot bed of coal in the Straight Cliffs sandstone at an abandoned mine.
19	114320	3-36S-1E	------do------	a	---	---	Upper 2.7 feet of a 5.4-foot bed of coal in Straight Cliffs sandstone in Upper Potato Valley.
19	114321	3-36S-1E	------do------	a	---	---	Lower 2.7 feet of the 5.4-foot coal bed.
20	114322	35-37S-4E	------do------	0.005	0.007	---	Upper 1-foot of a 2-foot bed of carbonaceous shale in the Dakota (?) sandstone.
20	114323	35-37S-4E	------do------	.002	---	---	3-foot of carbonaceous shale at same horizon.
21	114312	19-38S-4E	Kane County	.001	---	---	5-foot of weathered coal in the Straight Cliffs sandstone.
22	114326	36-41S-3E	----do----	a	---	---	2-inch coal rider in the Straight Cliffs sandstone in Middle Warm Creek
22	114327	36-41S-3E	----do----	a	---	---	3-foot bed of coal 1 foot below rider.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location Section-township-range-county		Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
23	114325	29-42S-4E	Kane County	a	---	---	8-inch bed of coal in the Dakota (?) sandstone in Middle Warm Creek.
24	114324	29-42S-4E	----do----	0.002	---	---	1-foot bed of carbonaceous shale in the Dakota (?) sandstone.
25	114319	8-39S-1E	----do----	.001	---	---	Upper 1-foot of a 10 foot bed of coal in the Straight Cliffs sandstone.
26	114318	5-39S-1E	----do----	a	---	---	6-foot bed of coal in the Straight Cliffs sandstone.
27	114317	5-39S-1E	----do----	.001	---	---	4-foot bed of carbonaceous shale in the Straight Cliffs sandstone.
28	114313	6-39S-1E	----do----	.003	0.002	---	2-foot bed of carbonaceous shale in the Dakota (?) sandstone about 15 feet above the top of the Winsor formation.
28	114314	6-39S-1E	----do----	.007	.006	83.6	1-foot bed of carbonaceous shale 2 feet below the shale of sample 114313.
28	114315	6-39S-1E	----do----	.002	---	---	Lower 1 foot of a 2-foot bed of impure coal about 22 feet stratigraphically above the shale of sample 114313.
29	114329	8-37S-1W	Garfield County	.002	---	---	8-inch bed of carbonaceous shale in the Straight Cliffs sandstone.
29	114330	8-37S-1W	------do------	a	---	---	3-foot bed of carbonaceous shale 40 feet above shale of sample 114329.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location (Section-township-range-county)		Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
30	114309	13-37S-2W	Garfield County	a	---	---	4.2-foot bed of coal near the contact of the Tropic shale and Dakota (?) sandstone.
31	D-95978	13-37S-3W	------do------	0.001	0.0007	---	Bentonite 2 feet thick at base of Dakota (?) sandstone.
32	114310	12-37S-3W	------do------	a	---	---	1.7-foot bed of coal in the Dakota (?) sandstone 2 miles north of Cannonville, Utah.
	2. HENRY MOUNTAINS AREA						
33	D-95983	11-27S-9E	Wayne County	a	---	9.8	Upper 3.5 feet of the 7-foot Factory Butte Coal bed in the Ferron sandstone member of the Mancos shale.
33	D-95984	11-27S-9E	-----do-----	a	---	14.8	Lower 3.5 feet of the Factory Butte Coal bed of sample D-95983.
34	D-95985	24-27S-9E	-----do-----	.001	---	79.0	6 inches of natural ash from the Factory Butte Coal bed.
35	D-95986	24-28S-9E	-----do-----	.001	---	18.1	8-inch bed of coal in Ferron sandstone member of Mancos shale.
36	D-95987	3-29S-8E	-----do-----	.002	---	---	2-foot bed of carbonaceous shale in the Ferron sandstone.
36	D-95988	3-29S-8E	-----do-----	.001	---	43.5	1-foot bed of coal 20 feet stratigraphically below the shale of sample D-95987.
37	D-95981	11-31S-9E	Garfield County	.001	.0001	---	Volcanic laccolithic rock on west flank of Mt. Ellen (Henry Mountains).

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location Section-township-range-county		Equivalent Uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
38	D-95989	21-31S-9E	Garfield County	a	---	1.9	2.5-foot bed of coal in Emery sandstone member of the Mancos shale.
39	D-95990	17-31S-9E	------do------	a	---	46.0	Upper 8 feet of a 14-foot bed of coal in an operating mine in the Emery sandstone.
40	D-95991	30-31S-9E	------do------	a	---	36.4	Upper 2 feet of a 7-foot bed of coal in the Emery sandstone at an abandoned mine.
	3. KOLOB TERRACE AND VICINITY						
41	D-95993	13-40S-7W	Kane County	a	---	21.9	Upper 1 foot of a 5-foot bed of coal in the Tropic formation at an abandoned mine.
42	D-95994	23-40S-7W	----do----	a	---	4.6	Upper 2 feet of a 5-foot bed of coal in the Tropic formation.
43	D-96000	21-41S-7W	----do-----	0.001	---	25.8	5-foot bed of coal in a slump block of Tropic formation adjacent to the Sevier fault.
44	D-95996	32-40S-8W	----do-----	.001	---	8.9	5-foot upper coal bed in the Tropic formation.
45	D-95999	28-40S-9W	----do-----	a	---	10.9	3-foot lower coal bed in the Tropic formation.
46	D-95997	10-40S-9W	----do-----	.001	---	32.5	Stringers of coal above lower coal bed in Tropic formation.
47	D-95998	3-40S-9W	----do-----	a	---	8.1	4-foot upper coal bed in Tropic formation.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map location number	Laboratory serial number	Location (Section-township-range-county)	Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
48	D-98325	32-38S-10W Washington County	0.0016	0.0002	---	Volcanic cinder near an old volcano on Thorley Ranch.
49	D-98343	33-37S-11W Iron County	---	$3x10^{-7}$	---	Water from spring issuing from abandoned coal mine near Graff Point.
50	D-98334	33-37S-11W ----do----	a	---	---	Upper 2 feet of a 10-foot bed of coal in Tropic formation at abandoned mine near Graff Point.
51	D-98340	28-37S-11W ----do----	.001	---	---	Upper 1 foot of a 14-foot bed of coal at the abandoned Kleen Koal Mine in Tropic formation.
52	D-98336	20-37S-10W ----do----	.003	.0003	---	6-inch carbonaceous shale in Tropic formation near Pryor Peak.
53	D-98337	24-37S-11W ----do----	a	---	---	Coal dump at Burns Coal Company Mine on Shurtz Creek.
54	D-96005	5-37S-10W ----do----	a	---	17.0	Coal dump from Tucker Mine in Tropic formation in Right Hand Canyon.
55	D-96002	5-37S-10W ----do----	a	---	21.9	6-foot bed of coal and shale from Webster Mine in the Tropic formation in Right Hand Canyon.
55	D-96003	5-37S-10W ----do----	.001	---	7.4	Grab sample of commercial coal from mine.
56	D-98338	1-37S-10W ----do----	.001	---	---	4-inch bed of coal in the Straight Cliffs sandstone in Coal Canyon.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location Section-township-range-county	Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
57	D-96001	36-36S-10W Iron County	a	---	7.7	Grab sample of commercial coal in Tropic formation from mine in Coal Canyon.
58	D-98339	36-36S-11W ----do----	0.001	---	---	Upper 1 foot of an 8-foot bed of impure coal at abandoned mine in Tropic formation.
59	D-98335	30-36S-10W ----do----	a	---	---	Coal dump at abandoned and caved mine.
60	D-96004	13-36S-11W ----do----	.004	0.002	89.7	Grab sample of ash from coal of 3 mines in Tropic formation at Southern Utah Power Companies plant in Coal Canyon.
61	D-96006	30-37S-13W ----do----	.001	---	49.7	Impure coal on dump of mine in Tropic formation near igneous intrusion.
61	D-98341	30-37S-13W ----do----	.004	.0012	---	1-foot bed of coal from abandoned mine in Tropic formation.
61	D-95982	30-37S-13W ----do----	.003	.0007	---	Grab sample of igneous intrusive rock (andesite) in contact with coal.
62	D-98344	13-36S-9W ----do----	---	3×10^{-7}	---	Water sample from spring issuing from tuff in Brian Head formation of Miocene (?) age.
62	D-98345	13-36S-9W ----do----	---	1×10^{-7}	---	Water sample from a larger spring higher in the section.
63	D-98326	12-36S-9W ----do----	.0030	.0010	---	Grab sample of rhyolitic lava on Brian Head in Brian Head formation.

Radioactivity measurements and chemical analyses of samples from southern Utah--Continued

Map locality number	Laboratory serial number	Location (Section-township-range-county)		Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Description of samples
64	D-98327	20-35S-8W	Iron County	0.0004	0.0003	---	White volcanic tuff near Yankee Reservoir in Brian Head formation.
65	D-98331	5-33S-5W	----do----	.0019	.0002	---	Greenish-white tuffaceous sandstone.