

GEOLOGICAL SURVEY CIRCULAR 251



RESULTS OF RECONNAISSANCE FOR
URANIFEROUS COAL, LIGNITE,
AND CARBONACEOUS SHALE
IN WESTERN MONTANA

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

UNITED STATES DEPARTMENT OF THE INTERIOR
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W. E. Wrather, Director

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ABSTRACT

A reconnaissance search for uraniferous lignite and carbonaceous shale was made in western Montana and adjacent parts of Idaho during the summer of 1951. Particular emphasis in the examination was placed on coal and carbonaceous shale associated with volcanic rocks, as volcanic rocks in many areas appear to have released uranium to circulating ground water from which it was concentrated in carbonaceous material. Twenty-two areas in Montana and one area in Idaho were examined. The coal in five of these areas is of Cretaceous age. The coal and carbonaceous shale in the remaining 18 areas occur in Tertiary "lake-bed" deposits of Oligocene and younger age. Both the Cretaceous and Tertiary coal and carbonaceous shale are associated with contemporaneous or younger volcanic rocks and pyroclastic sequences.

A sample of carbonaceous shale from the Prickly Pear Valley northeast of Helena, Mont., contained 0.013 percent uranium. A sample of carbonaceous shale from the Flint Creek Valley southwest of Drummond, Mont., contained 0.006 percent uranium. All other samples of both Cretaceous and Tertiary coal and carbonaceous shale were essentially nonradioactive.

INTRODUCTION

A reconnaissance search for uraniferous lignite and carbonaceous shale in western Montana (see accompanying index map, pl. 1) was made during the summer of 1951 as part of the Geological Survey program of reconnaissance for uranium deposits in the Rocky Mountain region. The work was sponsored by the Division of Raw Materials of the Atomic Energy Commission.

Uraniferous lignite and coal in South Dakota were studied by Denson, Bachman, and Zeller (1950), who showed that the uranium in Cretaceous and Tertiary coal seemed to have been derived by leaching from the slightly radioactive White River formation that unconformably overlies the coal-bearing formations. Both Cretaceous and Tertiary coal-bearing formations in western Montana contain volcanic rocks or tuffs or are associated with them and this association was used as a primary guide for reconnaissance prospecting.

CRETACEOUS COAL

Upper Cretaceous coals in the Livingston-Trail Creek and Electric coal fields and the Ryegate district were examined and tested for radioactivity. The tuffaceous and volcanic rocks of the Livingston formation of Late Cretaceous and Paleocene age, which overlies the coals in the Livingston-Trail Creek and Electric fields, and interbedded tuffs in the Judith River formation in the Ryegate district, might have served as potential source beds for uranium. No appreciable radioactivity was detected, however, in the field examination of the coals. The bulk of the volcanic material in the Livingston formation is basic in composition rather than acidic. Radioactive elements seem to occur more commonly in acidic volcanic rocks.

The petrologic type of the tuffs in the Judith River formation was not determined. Cretaceous coals at other localities also were sampled, but the samples did not contain significant amounts of uranium.

DESCRIPTION OF DISTRICTS EXAMINED

Livingston-Trail Creek coal field, Park, Gallatin, and Sweetgrass Counties

The Livingston-Trail Creek coal field covers an area of approximately 300 square miles (Calvert, 1912, p. 29) and lies in the southern part of Montana 40 miles north of Yellowstone National Park. Rocks from pre-Cambrian to Paleocene age are exposed in the area, and all are deformed by faulting and folding. The Upper Cretaceous coal-bearing strata in the area are more than 750 feet thick and are overlain by over 5,000 feet of tuffaceous and agglomeratic sediments of the Livingston formation.

The Livingston-Trail Creek coal field has been subjected to pronounced folding and faulting that closely parallels the mountain uplift to the south. The coal beds are exposed along the limbs of sharply folded anticlines and synclines, and at many places are vertical or overturned.

Four beds ranging from 1 to 6 feet in thickness have been prospected or mined in the area. The coal is of bituminous rank and has been used in

the past for coking. At present, all of the mines are abandoned and most cannot be entered.

Over 20 localities were examined radiometrically with a Geiger-Müller counter, and coal samples for

chemical analysis were collected at 12 localities in Tps. 1 to 4 S., and Rs. 6 to 8 E., Park and Gallatin Counties. No abnormal radioactivity was detected in the coals in the field, nor did any sample contain more than 0.002 percent uranium in the ash upon chemical analysis.

Table 1.--Samples collected in the Livingston-Trail Creek coal field

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU ¹	U	U in ash	Ash	
62081	MM-37	a ²	---	---	34.9	34, 1 S., 6 E., 1.1' coal bed.
62052	MM-8	a	---	---	36.4	21, 2 S., 7 E., 2.0' coal bed.
62053	MM-9	a	---	---	39.7	21, 2 S., 7 E., 2.8' coal bed.
62054	MM-10	a	---	---	56.9	21, 2 S., 7 E., 1.3' coaly shale.
62055	MM-11	a	---	---	21.3	27, 2 S., 7 E., upper 2.6' of 8' coal bed.
62056	MM-12	a	---	---	20.0	27, 2 S., 7 E., middle 2.6' of 8' coal bed.
62057	MM-13	a	---	---	12.0	27, 2 S., 7 E., lower 2.6' of 8' coal bed.
62074	MM-30	a	---	---	17.5	26, 2 S., 7 E., 5.0' bed of 20.0' coal zone.
62075	MM-31	a	---	---	8.82	26, 2 S., 7 E., 7.0' bed of 20.0' coal zone.
62076	MM-32	a	---	---	11.6	26, 2 S., 7 E., 3.0' bed of 20.0' coal zone.
62077	MM-33	a	---	---	17.6	26, 2 S., 7 E., 5.0' bed of 20.0' coal zone.
62071	MM-27	a	---	---	14.4	33, 2 S., 7 E., 2.5' coal bed.
62072	MM-28	a	---	---	15.1	33, 2 S., 7 E., upper 2' of 4.0' bed.
62073	MM-29	0.001	---	0.001	22.7	33, 2 S., 7 E., lower 2.0' of 4.0' bed.
62045	MM-1	a	---	---	40.8	NW $\frac{1}{4}$ 26, 2 S., 8 E., 3.0' coal bed.
62046	MM-2	a	---	---	37.8	NW $\frac{1}{4}$ 26, 2 S., 8 E., 3.2' coal bed.
62070	MM-26	a	---	---	17.4	N $\frac{1}{2}$ 31, 2 S., 8 E., 4.0' coal bed.
62059	MM-15	a	---	---	34.3	27, 3 S., 8 E., 1.9' coal bed.
62060	MM-16	.001	---	---	33.0	27, 3 S., 8 E., 2.2' coal bed.
62061	MM-17	a	---	---	26.4	27, 3 S., 8 E., 2.6' coal bed.
62062	MM-18	a	---	---	35.8	27, 3 S., 8 E., 6.0' coal bed.
62063	MM-19	a	---	---	30.9	27, 3 S., 8 E., 4.6' coal bed.
62064	MM-20	.001	---	.001	38.6	27, 3 S., 8 E., 4.0' coal bed.
62065	MM-21	.001	---	.002	17.9	NW $\frac{1}{4}$ 28, 3 S., 8 E., 3.0' coal bed.
62066	MM-22	.001	---	---	53.5	NW $\frac{1}{4}$ 28, 3 S., 8 E., 3.0' coaly shale.
62067	MM-23	a	---	---	16.6	NW $\frac{1}{4}$ 28, 3 S., 8 E., upper 2.0' of 4.0' coal bed.
62068	MM-24	a	---	---	17.0	NW $\frac{1}{4}$ 28, 3 S., 8 E., lower 2.0' of 4.0' coal bed.
62069	MM-25	a	---	---	20.7	NW $\frac{1}{2}$ 4, 4 S., 8 E., 1.5' coal bed.

¹eU=equivalent uranium.

²"a" in this and subsequent tables indicates an equivalent uranium content or uranium content of less than 0.001 percent.

Electric coal field, Park County

The Electric coal field is in the southwestern corner of Park County, Mont., just north of Yellowstone National Park. The coals in this field probably are of Late Cretaceous age (Calvert, 1912, p. 55) and may be direct correlatives of those exposed in the Livingston-Trail Creek coal field about 40 miles to the north. The general stratigraphy of the area is essentially the same as that of the Livingston-Trail Creek area.

Three to four coals ranging in thickness from 6 inches to 4 feet or more are present in the Electric coal field. All mining has ceased in this area, and good exposures of the coal are difficult to find. Six localities were examined radiometrically, and at four of these, samples were collected for chemical analysis. None of the coals examined contained significant amounts of uranium.

Table 2.--Samples collected in the Electric coal field

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
62080	MM-36	a	---	---	11.6	NE $\frac{1}{4}$ 8, 9 S., 7 E., 2.2' coal bed.
62078	MM-34	a	---	---	13.5	36, 9 S., 7 E., upper 3.0' of 6.0' coal bed.
62079	MM-35	a	---	---	21.5	36, 9 S., 7 E., lower 3.0' of 6.0' coal bed.
62047	MM-36	a	---	---	14.3	6, 9 S., 8 E., upper 2.5' of 5' coal bed.
62048	MM-4	a	---	---	8.57	6, 9 S., 8 E., lower 2.5' of 5' coal bed.
62049	MM-5	a	---	---	29.3	6, 9 S., 8 E., 0.8' coal bed.
62050	MM-6	a	---	---	75.4	6, 9 S., 8 E., 1.5' coaly shale.

Ryegate district, Golden Valley, Wheatland,
Yellowstone, and Stillwater Counties

Lignite and carbonaceous shale interbedded with volcanic ash and tuffaceous sandstone is present in the Judith River formation of Late Cretaceous age in Golden Valley and adjacent counties (Ellis and others, 1924). The best exposures occur at locality 1 (pl. 1), about 10 miles north of Ryegate, where 12 beds of lignite and carbonaceous shale ranging in thickness from 0.5 to 5 feet, and interbedded with thin tuffaceous sandstone and siltstone, occur in a stratigraphic interval of about 48 feet. The stratigraphically highest lignite bed, 1.7 feet thick, directly underlies a 4-foot bed of silty volcanic ash. The lignites and associated

carbonaceous shales were sampled as was the 4-foot bed of volcanic ash. The ash contained 0.001 percent equivalent uranium but the lignite and carbonaceous shale were not radioactive.

The eight lignite samples from the four other localities visited contained less than 0.001 percent equivalent uranium.

It is believed that the tuffaceous beds interbedded with the lignites and carbonaceous shales in the Judith River formation are too thin to be effective source beds for uranium. It seems unlikely that potential uranium-bearing coal or carbonaceous shale occurs in the Judith River formation in the Ryegate district.

Table 3.--Samples collected in the Ryegate district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66731	MM-139	0.001	---	---	82.5	18, 6 N., 18 E., 1.1' lignitic shale.
66719	MM-127	.001	---	---	67.9	NE $\frac{1}{4}$ 6, 6 N., 20 E., 1.0' lignitic shale.
66720	MM-128	a	---	---	26.0	SW cor. of 6, 6 N., 20 E., 1.5' lignite.
66721	MM-129	a	---	---	36.5	SW cor. of 6, 6 N., 20 E., 2.5' lignite.
66726	MM-134	.001	---	---	---	21, 8 N., 20 E., 4.0' volcanic ash.
66727	MM-135	a	---	---	18.0	21, 8 N., 20 E., 1.7" lignite.
66728	MM-136	a	---	---	40.0	21, 8 N., 20 E., 3.6' lignite.
66729	MM-137	a	---	---	48.5	21, 8 N., 20 E., 1.4' lignite.
66730	MM-138	a	---	---	27.9	21, 8 N., 20 E., 5.2' lignite.
66722	MM-130	.002	---	---	---	31-32, 8 N., 20 E., 1.8' bed volcanic ash.
66723	MM-131	a	---	---	28.9	31-32, 8 N., 20 E., 1.7' lignite.
66724	MM-132	a	---	---	27.9	31-32, 8 N., 20 E., 2.8' lignite.
66725	MM-133	.001	---	---	62.5	31-32, 8 N., 20 E., 1.1' lignitic shale.

Silver Bow Valley district, Silver Bow and
Deer Lodge Counties

At two localities near Anaconda, thin impure Cretaceous coals are exposed. At locality 11 (pl. 1), sec. 10, T. 4 N., R. 11 W., half a mile south of Anaconda, 2 feet of coaly shale is exposed and contains

0.002 percent equivalent uranium. At locality 12, sec. 33, T. 5 N., R. 11 W., about $1\frac{1}{2}$ miles west of Anaconda, a total of 4 feet 4 inches of impure coal is exposed. Two channel samples of two beds were submitted for chemical determinations. Both samples had an equivalent uranium value of 0.002 percent and contained less than 0.001 percent uranium in the ash.

Table 4.--Samples collected in the Silver Bow Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63967	MM-90	0.002	---	---	---	33, 5 N., 11 W., 2.9' coaly shale.
63968	MM-91	.002	---	---	45.6	33, 5 N., 11 W., 1.5' coal
63966	MM-89	.002	---	---	86.6	10, 4 N., 11 W., 2.0' coaly shale.

Upper Ruby River district, Madison and
Beaverhead Counties

Coal of Late Cretaceous age is exposed along the course of the upper part of the Ruby River in the valley between the Snow Crest Mountains on the west, and the Gravelly Range on the east.

The coal beds are interbedded with brown and gray shale and siltstone. Several old prospect pits, and one mine, the Basin Creek mine (sec. 28, T. 11 S., R. 3 W.), are present in the area. Most

of the coal beds are less than 1 foot thick, although the coal bed in the Basin Creek mine is $2\frac{1}{2}$ feet thick.

Tertiary and Cretaceous volcanic rocks in the vicinity of these prospects and the mine may at one time have been a potential source for uranium. However, the coal beds are separated from the volcanic rocks by several hundred feet of impervious sediments, and the geologic conditions for mineralization by downward percolation of ground water are not favorable. Five samples

were collected for analysis. Only one showed any radioactivity, and this sample of a bed 1 foot

thick contained only 0.002 percent equivalent uranium.

Table 5.--Samples collected in the Upper Ruby River district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63271	MM-44	a	---	---	17.5	20, 10 S., 3 W., 1.0' coal bed.
63272	MM-45	0.002	---	---	74.3	N $\frac{1}{2}$ 28, 10 S., 3 W., 1.0' coaly shale.
63274	MM-47	a	---	---	5.35	NE $\frac{1}{4}$ 28, 11 S., 3 W., 1.3' coal bed.
63275	MM-48	a	---	---	12.6	NE $\frac{1}{4}$ 28, 11 S., 3 W., 1.2' coal bed.
63273	MM-46	a	---	---	14.1	NE $\frac{1}{4}$ 29, 11 S., 3 W., 0.8' coal bed.
63276	MM-49	.002	---	---	93.8	SE $\frac{1}{4}$ 28, 11 S., 1 E., 6.0' volcanic ash.

TERTIARY LIGNITE AND CARBONACEOUS SHALE

Basinlike depressions that separate the various mountain ranges in western Montana and adjacent parts of Idaho are filled with poorly to well-indurated light-gray, tan, and buff clays, shales, siltstones, and volcanic ash. The deposits range in age from Oligocene to Miocene and perhaps Pliocene. The deposits are commonly known as "lake beds" and are so called in this report although little evidence of typical lacustrine conditions of deposition was noted. Numerous poorly consolidated tuffaceous sands and gravels are common. A few 6- to 30-inch lenticular beds of lignite are exposed at several places along the margins of the basins.

Remnants of volcanic rocks in the form of flows and ash beds occur throughout the Tertiary basins of southwestern Montana but in general are poorly exposed. Tertiary volcanic ash, rhyolite, and basalt flows are common in the mountain ranges that bound the basins and are generally better exposed than their counterparts in the adjacent basins.

Pleistocene and Recent gravel mantles all of the basin deposits, and good natural exposures are rare. The lignites are thin and lenticular and are exposed at few places. All of the Tertiary lake beds examined

are deformed by gentle folding and normal faulting. The areas in which reconnaissance work was done are shown on the accompanying index map (pl. 1).

DESCRIPTION OF DISTRICTS EXAMINED

Lombard coal field, Broadwater County

A brief reconnaissance was made in Tps. 4 and 5 N., Rs. 2 and 3 E., Broadwater County, Mont., at the approximate site of the Lombard coal field as discussed in U. S. Bureau of Mines Technical Paper T529 and summarized by Combo and others (1950). Surface outcrops and mines discussed in the above papers were not found. Local residents knew of no coal-mining operations in the area in the past but pointed out an entry 1,000 feet long that was made along a bed of block shale in an attempt to locate coal.

Smith River Valley district, Meagher County

No significant deposits of lignite or carbonaceous shale were found in the poorly exposed Tertiary beds near White Sulfur Springs in the Smith River Valley district.

Analyses of samples of volcanic ash collected in the district are shown in table 6.

Table 6.--Samples collected in the Smith River Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66701	MM-109	0.003	---	---	93.0	8-9, 6 N., 7 E., grab sample volcanic ash.
66702	MM-110	.002	---	---	91.1	9, 7 N., 7 E., grab sample volcanic ash.
66700	MM-108	.002	---	---	91.1	12-13, 9 N., 5 E., grab sample volcanic ash.
66698	MM-106	.002	---	---	---	W $\frac{1}{2}$ 14, 10 N., 5 E., grab sample volcanic ash.
66699	MM-107	.002	---	---	92.5	SW $\frac{1}{4}$ 26, 11 N., 4 E., grab sample volcanic ash.

Townsend Valley district, Broadwater County

Only one small deposit of lignite was found in the Tertiary lake beds in the Townsend Valley (locality 2,

pl. 1). The lignite is in sec. 17, T. 5 N., R. 3 E. and is overlain by several hundred feet of Oligocene tuffaceous shales, clays, and sandstones that are exposed south of Sixmile Creek in T. 5 N., R. 3 E. The lignite consists of two beds having a total thickness

of about 5 feet, interbedded with about 7 feet of dark-brown carbonaceous shale. Two samples of the lignite

and two samples of tuffaceous shale or argillaceous ash contained less than 0.001 percent uranium.

Table 7.--Samples collected in the Townsend Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66756	MM-164	0.001	---	---	38.2	17, 5 N., 8 E., 3.0' lignite.
66757	MM-165	a	---	---	45.8	17, 5 N., 8 E., 2.1' lignite.
66755	MM-163	.003	---	---	---	17, 5 N., 8 E., 2.0' volcanic ash.
66758	MM-166	a	---	---	27.7	17, 5 N., 8 E., grab sample of lignite.
66753	MM-161	a	---	---	---	12, 5 N., 2 E., grab sample Pardee Unit 2.
66754	MM-162	.002	---	---	---	12, 5 N., 2 E., grab sample Pardee Unit 3.

Gallatin Valley district, Gallatin County

The Tertiary lake deposits that floor the Gallatin Valley district are well exposed along the east side of the Madison River south of Logan, Mont. The deposits in this vicinity are composed of tan to buff tuffaceous shales, siltstones, sandstone, and gravel. Volcanic

ash beds are present in places. A sample of a volcanic ash from locality 3, sec. 9, T. 1 N., R. 2 E. (pl. 1) contained 0.002 percent equivalent uranium and 0.001 percent uranium. In general, the Tertiary lake beds are poorly exposed and at most places are covered with a heavy mantle of gravel. No lignite or carbonaceous shale beds were found.

Table 8.--Samples collected in the Gallatin Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
62082	MM-38	0.002	0.001	---	---	9, 1 N., 2 E., 0.9' volcanic ash.
62083	MM-39	.002	---	---	---	9, 1 N., 2 E., 0.9' tuffaceous sandstone.

Prickly Pear Valley district,
Lewis and Clark County

The Prickly Pear Valley district includes parts of the drainage basins of Sevenmile Creek, Ten-mile Creek, and Prickly Pear Creek, adjacent to the Missouri River. Exposures of the Tertiary lake beds in this district are restricted to the broad flat or rolling interstream areas and are poor. It was possible to obtain samples at only two of the localities visited. A sample of weathered lignite, obtained from a mine dump on the west side of Silver Creek (locality 4, pl. 1), contained less than 0.001 percent uranium.

few thin bentonitic ash beds are also present. The adjacent areas are under cultivation, and exposures are poor. At locality 5 (pl. 1) in the NW $\frac{1}{4}$ sec. 28, T. 11 N., R. 2 W., bentonitic ash and one 6-inch bed of carbonaceous shale is exposed. A sample of the carbonaceous shale contained 0.014 percent equivalent uranium and 0.013 percent uranium. The overlying bentonitic ash contained 0.003 percent equivalent uranium. The devitrification of this ash, accompanied by leaching, may account for the high uranium content of the underlying carbonaceous shale. The uranium content of 0.013 percent is the highest determined for any sample of lignite or carbonaceous shale obtained in this reconnaissance examination. Additional examination of the immediate vicinity was hampered by the extent of cover.

West of Houser Lake, beds of Oligocene age are exposed in a series of low rolling hills (Lorenz and others, 1951, p. 16). In this area the beds are predominantly light-tan to buff tuffaceous shales and siltstones. A

Reconnaissance throughout the remainder of this district did not detect other abnormally radioactive lignite or carbonaceous shale beds.

Table 9.--Samples collected in the Prickly Pear Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66750	MM-158	0.003	---	---	---	NW $\frac{1}{4}$ 28, 11 N., 2 W., 2.0' volcanic ash.
66751	MM-159	.014	0.013	---	---	NW $\frac{1}{4}$ 28, 11 N., 2 W., 0.5' carbonaceous shale.
66752	MM-160	.001	---	---	32.2	SW $\frac{1}{4}$ 8, 11 N., 4 W., grab sample of lignite.

Avon Valley district,
Powell County

The Tertiary lake beds in the Avon Valley district are poorly exposed and no evidence of appreciable deposits of lignite or carbonaceous shale was found. A

carbonaceous shale zone 5.5 feet thick was examined and sampled at locality 6 (pl. 1), sec. 21, T. 11 N., R. 8 W., but the shale did not contain significant quantities of uranium. Further exploration of the Tertiary lake beds of this district failed to discover other deposits of carbonaceous shale.

Table 10.--Samples collected in the Avon Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63949	MM-72	0.002	---	---	---	21, 11 N., 8 W., upper 2.8' carbonaceous shale.
63950	MM-73	.001	---	---	---	21, 11 N., 8 W., lower 2.8' carbonaceous shale.

Blackfoot Valley district, Powell, Granite,
and Missoula Counties

Reconnaissance of the poorly exposed Tertiary lake beds in the Blackfoot Valley district near Helmsville, Mont. did not reveal significant deposits of lignite or carbonaceous shale. Abnormal radioactivity was not detected in any of the Tertiary lake beds examined in this district.

Müller counter did not detect significant radioactivity, but one sample of carbonaceous shale contained 0.006 percent uranium. Uranium was absent in all other samples. The sample containing 0.006 percent uranium represents a 4-foot channel sample of the uppermost carbonaceous shale.

It is possible that other uraniferous beds may be in the area, but the poor condition of outcrop made their presence difficult to ascertain. Additional investigation of this immediate vicinity with more sensitive instruments might prove to be of value. Numerous other localities were visited in the area, but no significant radioactivity was detected.

Flint Creek Valley district,
Granite and Powell Counties

The Tertiary lake beds are poorly exposed in the Flint Creek Valley district and are covered at most places by a thick mantle of stream gravels. At locality 7 (pl. 1), NW $\frac{1}{4}$ sec. 35, T. 11 N., R. 13 W., about 40 feet of lignitic and carbonaceous shales is exposed. Radiometric examination of the outcrop with a Geiger-

Locality 8 (pl. 1), in the NW $\frac{1}{4}$ sec. 18, T. 9 N., R. 12 W., is a coal prospect in steeply dipping Cretaceous beds. Examination and sampling of the thin impure coal at this locality failed to reveal any radioactivity.

Table 11.--Samples collected in the Flint Creek Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63951	MM-74	0.004	0.006	---	---	NW $\frac{1}{4}$ 35, 11 N., 13 W., 4.0' carbonaceous shale.
63952	MM-75	a	---	---	29.9	NW $\frac{1}{4}$ 35, 11 N., 13 W., 1.5' lignite.
63953	MM-76	a	---	---	32.8	NW $\frac{1}{4}$ 35, 11 N., 13 W., 2.5' lignite.
63954	MM-77	a	---	---	26.0	NW $\frac{1}{4}$ 35, 11 N., 13 W., 1.8' lignite.
63955	MM-78	a	---	---	28.9	NW $\frac{1}{4}$ 35, 11 N., 13 W., 0.3' lignite.
63956	MM-79	a	---	---	35.9	NW $\frac{1}{4}$ 35, 11 N., 13 W., 2.5' lignite.
63957	MM-80	a	---	---	50.6	NW $\frac{1}{4}$ 35, 11 N., 13 W., 3.0' lignite.
63958	MM-81	a	---	---	88.6	NW $\frac{1}{4}$ 35, 11 N., 13 W., 4.0' coal ash.
63959	MM-82	a	---	---	57.2	NW $\frac{1}{4}$ 18, 9 N., 12 W., 1.0' coaly shale.

Deer Lodge Valley district,
Deer Lodge and Powell Counties

Reconnaissance in the Deer Lodge Valley district did not find any appreciable deposits of radioactive lignite or carbonaceous shale. At

locality 9 (pl. 1), in sec. 24, T. 9 N., R. 11 W., two beds of carbonaceous shale, each about 1 foot thick, are overlain by an undetermined thickness of light-gray tuffaceous shale and volcanic ash. Samples of carbonaceous shale contained less than 0.001 percent uranium.

Table 12.--Samples collected in the Deer Lodge Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63946	MM-69	0.002	a	---	---	18, 6 N., 10 W., 2.0' volcanic ash.
63947	MM-70	.001	---	---	---	24, 9 N., 11 W., 1.0' carbonaceous shale.
63948	MM-71	.002	---	---	---	24, 9 N., 11 W., 1.2' carbonaceous shale.
63945	MM-88	a	---	---	---	24, 9 N., 11 W., 2.0' volcanic ash.

Missoula Valley district,
Missoula County

Extensive reconnaissance was made of the Tertiary lake beds in the Missoula Valley district. Exposures of coal-bearing sediments are very poor in this district, and a majority of samples had to be collected from abandoned mine dumps. Samples were collected at 6 localities and 15 other localities were examined but not sampled. Significant radioactivity was not detected at any of the localities examined.

Most of the samples came from the immediate vicinity of Missoula near the Hell Gate mine, locality 15 (pl. 1) where small scale mining activity was carried on prior to 1940 (Pardee, 1913, pp. 240-241). In this area, four coal beds from 1 to 6 feet thick and overlain by volcanic ash have been reported; three of these four beds were sampled. None of the samples submitted contained more than 0.001 per cent uranium.

Table 13.--Samples collected in the Missoula Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66737	MM-145	a	---	---	15.5	E $\frac{1}{2}$ 4, 14 N., 19 W., grab sample lignite.
66738	MM-146	0.002	---	---	67.7	E $\frac{1}{2}$ 4, 14 N., 19 W., upper 2.0' of 4.0' lignitic shale.
66739	MM-147	.002	---	---	70.3	E $\frac{1}{2}$ 4, 14 N., 19 W., lower 2.0' of 4.0' lignitic shale.
66740	MM-148	.003	---	---	---	E $\frac{1}{2}$ 4, 14 N., 19 W., 3.0' volcanic ash.
66741	MM-149	.001	---	---	26.2	SE $\frac{1}{4}$ 33, 14 N., 19 W., grab sample lignite.
66742	MM-150	a	---	---	11.2	SE $\frac{1}{4}$ 33, 14 N., 19 W., grab sample lignite.
66743	MM-151	a	---	---	24.0	C. 33, 14 N., 19 W., grab sample lignite.
66744	MM-152	a	---	---	39.0	C. 33, 14 N., 19 W., grab sample lignite.
66734	MM-144	a	---	---	---	NW $\frac{1}{4}$ 26, 14 N., 22 W., grab sample lignite.
66745	MM-153	.001	---	---	38.6	SW $\frac{1}{4}$ 4, 15 N., 22 W., grab sample lignite.
66694	MM-102	a	---	---	28.0	21, 16 N., 23 W., grab sample lignite.

Bitterroot Valley district, Ravalli County

Lignite and carbonaceous shale were found at only one place in the poorly exposed Tertiary lake beds in the Bitterroot Valley district south of Hamilton, Mont. At locality 10 (pl. 1), in the NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 4 N., R. 21 W., near Darby, more than 20 feet of lignite and carbonaceous shale is exposed (Pardee,

1913, p. 242). Channel samples were taken of six of the most lignitic beds in the sequence, and the entire section was examined radiometrically. None of the beds indicated significant radioactivity in the field, and of the six samples analyzed only one contained as much as 0.002 percent uranium in the ash. The remaining five samples contained less than 0.001 percent uranium.

Table 14.--Samples collected in the Bitterroot Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
66688	MM-96	a	---	---	27.4	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 2.0' lignite.
66689	MM-97	a	---	---	18.3	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 0.7' lignite.
66690	MM-98	a	---	---	21.6	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 0.5' lignite.
66691	MM-99	a	---	---	26.1	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 1.1' lignite.
66692	MM-100	a	a	0.002	23.5	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 1.9' lignite.
66693	MM-101	0.002	---	---	56.2	NW $\frac{1}{4}$ NE $\frac{1}{4}$ 34, 4 N., 21 W., 0.1' lignitic shale.

Big Hole Valley district,
Beaverhead County

Reconnaissance of the Big Hole Valley district in the vicinity of Wisdom, Jackson, and Fishtrap, Mont., did not find lignite or carbonaceous shale. Although exposures of significant thickness of Tertiary lake beds are poor or non-existent, except along the margins of the valley, it is doubtful whether carbonaceous beds of appreciable thickness are present.

Silver Bow Valley district, Silver Bow
and Deer Lodge Counties

The Silver Bow Valley district includes the towns of Anaconda and Butte and the adjacent county to the south of Anaconda. The lake beds are poorly defined in this district, and the occurrence of Tertiary lignite deposits is unknown.

Jefferson Valley district, Silver Bow
and Madison Counties

Reconnaissance of the Jefferson Valley district south of Whitehall, Mont., did not discover any significant deposits of lignite or carbonaceous shale in the Tertiary lake beds. Exposures in the valley are poor.

Beaverhead Valley district, Beaverhead
and Madison Counties

No deposits of lignite or carbonaceous shale were found in the reconnaissance of the Beaverhead Valley district in the immediate vicinity of Dillon, Mont. The Tertiary lake beds, which are restricted to the valley proper, are poorly exposed and it is unlikely that they contain uraniferous lignite.

Madison Valley district, Madison County

Tertiary lake beds are poorly exposed in the Madison Valley district, and appreciable deposits of lignite or carbonaceous shales are not evident.

Centennial Valley district, Beaverhead County

The Tertiary beds in the vicinity of Lima and Dell, Mont., in the Centennial Valley district, are

quite unlike those of other districts. These beds are composed of red poorly consolidated conglomerate, sandstone, siltstone, shale with some interbedded basalt, and rhyolite. Lignite and carbonaceous shales were not found.

Medicine Lodge Creek Valley district,
Beaverhead County

In this general district at least three beds of lignite are interbedded with light-gray to brown shales, siltstones, and thin sandstones. The lignite beds range from 2 to 5 feet in thickness, and at many places contain numerous thin partings of carbonaceous shale which contribute to the high ash content of the lignite. These beds are part of the best exposures of coal-bearing Tertiary lake deposits examined in southwestern Montana. Small-scale mining has been intermittently active in this district for more than 30 years. Operations were discontinued during the winter of 1949-50 because of the local labor conditions and a poor market for high-ash lignite.

Seven localities were examined and 12 samples taken. Two of the mines can still be entered and sampling of moderately fresh coal was possible. Of the 12 samples submitted for analysis, 4 contained 0.003 percent equivalent uranium, 1 contained 0.002 percent equivalent uranium, and 1 contained 0.001 percent equivalent uranium. The remaining samples contained less than 0.001 percent equivalent uranium.

Table 15.--Samples collected in the Medicine Lodge Creek district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63294	MM-67	a	---	---	44.7	C 6, 10 S., 12 W., grab sample lignite.
63277	MM-50	0.003	---	---	64.2	SW $\frac{1}{4}$ 18, 11 S., 11 W., 1.5' lignitic shale.
63278	MM-51	.003	---	---	---	SW $\frac{1}{4}$ 18, 11 S., 11 W., 1.5' carbonaceous shale.
63279	MM-52	.003	---	---	71.5	SW $\frac{1}{4}$ 18, 11 S., 11 W., 1.5' lignitic shale.
63284	MM-57	.003	---	---	79.7	SW $\frac{1}{4}$ 30, 11 S., 11 W., 3.0' lignitic shale.
63285	MM-58	.002	---	---	73.5	SW $\frac{1}{4}$ 30, 11 S., 11 W., 1.6' lignitic shale.
63282	MM-55	a	---	---	19.1	SE $\frac{1}{4}$ 2, 11 S., 12 W., grab sample lignite.
63283	MM-56	a	---	---	15.4	C 14, 11 S., 12 W., grab sample lignite.
63286	MM-59	.001	a	0.001	24.5	SW $\frac{1}{4}$ 35, 11 S., 12 W., upper 2.5' of 5.0' lignite.
63287	MM-60	a	---	---	28.3	SW $\frac{1}{4}$ 35, 11 S., 12 W., lower 2.5' of 5.0' lignite.
63280	MM-53	a	---	---	19.6	S $\frac{1}{2}$ 35, 11 S., 12 W., upper 2.8' of 4.9' lignite.
63281	MM-54	a	---	---	21.0	S $\frac{1}{2}$ 35, 11 S., 12 W., lower 2.1' of 4.9' lignite.

Lemhi Valley district,
Lemhi County, Idaho

Tertiary beds are extensively exposed along the Salmon River in the vicinity of the town of Salmon. Exposures of these beds are poor except along the river where there are cliffs 200 to 300 feet high. The lake beds consist of tan to buff shale, siltstone, and sandstone, with thin beds of carbonaceous shale. Lignite in this area seems to be restricted to the western part of the valley.

In Pollard Canyon, $1\frac{1}{2}$ miles west of Salmon, a 6-foot bed of impure lignite is mined from time to time (locality 13, SW $\frac{1}{4}$ sec. 2, T. 21 E.). (See pl. 1.) The lignite was examined radiometrically,

and two channel samples of the fresh lignite were taken. These samples contained less than 0.001 percent equivalent uranium.

At locality 14, sec. 15, T. 23 N., R. 20 E., 18 miles northwest of Salmon, more than 200 feet of coal-bearing strata are exposed along the east bank of Moose Creek. These coal-bearing beds are restricted to a small, high intermountain basin that is estimated to cover 600 acres and is bounded by granitic rocks on all sides. Fifteen to twenty thin beds of lignite are interbedded with soft tan shales and unconsolidated arkosic sands. The lignite is predominantly woody, weathers rapidly, and is probably younger than the lignites in the Tertiary beds near Salmon.

No radioactivity was detected in any coal bed. Two channel samples of a 5-foot bed, the uppermost in the exposed section, contained less than 0.001 percent equivalent uranium.

Examination of the Lemhi Valley district has not revealed any uraniferous lignite of

potential commercial grade. Additional investigation of this area does not seem worthwhile, except to the south in the vicinity of Challis, Idaho, where reconnaissance was not made in 1951 because of lack of time. Reconnaissance examinations will be made of these rocks when feasible.

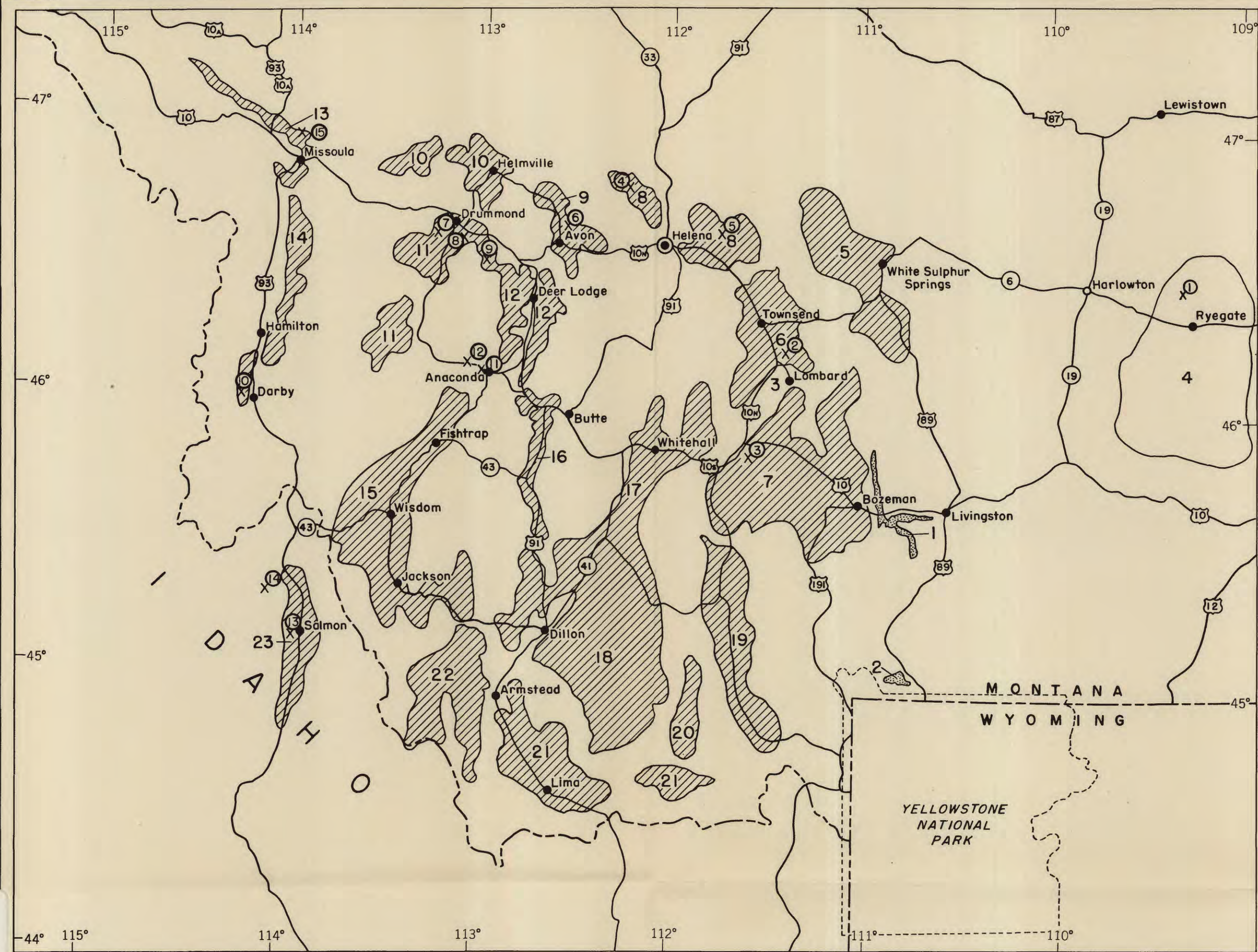
Table 16.--Samples collected in the Lemhi Valley district

Lab. no.	Field no.	Percent				Location (Section, Township, Range) and description
		eU	U	U in ash	Ash	
63960	MM-83	a	---	---	43.6	SW $\frac{1}{4}$ 2, 21 N., 21 E., upper 3.0' of 6.0' lignite.
63961	MM-84	0.001	a	0.001	42.6	SW $\frac{1}{4}$ 2, 21 N., 21 E., lower 3.0' of 6.0' lignite.
63962	MM-85	a	---	---	16.2	15, 23 N., 20 E., upper 2.5' of 5.0' lignite.
63963	MM-86	a	---	---	12.1	15, 23 N., 20 E., lower 2.5' of 5.0' lignite.



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EXPLANATION

-  Tertiary lake bed deposits
-  Coal fields

Areas examined listed below

- | | |
|--------------------------------------|---------------------------------|
| 1. Livingston-Trail Creek Coal Field | 12. Deer Lodge Valley |
| 2. Electric Coal Field | 13. Missoula Valley |
| 3. Lombard Coal Field | 14. Bitterroot Valley |
| 4. Ryegate District | 15. Big Hole Valley |
| 5. Smith River Valley | 16. Silver Bow Valley |
| 6. Townsend Valley | 17. Jefferson Valley |
| 7. Gallatin Valley | 18. Beaverhead Valley |
| 8. Prickly Pear Valley | 19. Madison Valley |
| 9. Avon Valley | 20. Upper Ruby River Valley |
| 10. Blackfoot Valley | 21. Centennial Valley |
| 11. Flint Creek Valley | 22. Medicine Lodge Creek Valley |
| | 23. Lemhi Valley |

X^⑤ Locality referred to in text

0 5 10 20 30 40 MILES

Modified after Andrews et al, 1944, Combo et al, 1950
and Pardee, 1911

INDEX MAP OF SOUTHWESTERN MONTANA SHOWING AREAS PROSPECTED FOR URANIUM-BEARING LIGNITE