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T67r
no. 444-A

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UNITED STATES GEOLOGICAL SURVEY

TEM-444-A

RESULTS OF RECONNAISSANCE FOR URANIUM IN NONMARINE CARBONACEOUS ROCKS IN PARTS OF CALIFORNIA, IDAHO, NEVADA, OREGON, UTAH, AND WASHINGTON DURING 1951 AND 1952

By
Donald C. Duncan

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March 1953

Prepared by the Geological Survey for the
UNITED STATES ATOMIC ENERGY COMMISSION
Technical Information Service, Oak Ridge, Tennessee

GEOLOGY AND MINERALOGY

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ABSTRACT

Nonmarine carbonaceous rocks, including lignitic shales, coal, and peat, were tested at about 30 localities in California, Idaho, Nevada, Oregon, Utah, and Washington. Rocks ranging in age from Carboniferous to Quaternary were examined, although the principal attention was given middle and late Tertiary lignites of the northern part of the Great Basin. Most carbonaceous rocks examined contained essentially no uranium, but lignitic shales in the Goose Creek district, Idaho, a thin carbonaceous shale near Hagerman, Idaho, and a small peat deposit in Davis County, Utah, contained more than 0.003 percent uranium.

INTRODUCTION

A reconnaissance search for uranium in carbonaceous rocks was conducted in western United States during 1951 and 1952 as part of the Geological Survey's general search for uranium deposits on behalf of the U. S. Atomic Energy Commission. Results of the part of the reconnaissance search in nonmarine coal, carbonaceous shales, and peat made by D. C. Duncan during August to October 1951 and by Duncan and J. I. Simmons in

August and September 1952 are included in this report. Results of concurrent examinations of marine black shales are included in another report (Duncan, 1953). The investigation was conducted under the general supervision of N. M. Denson.

Field examinations consisted of radiometric tests, mainly with a Geiger counter, in areas where coal, lignite, or carbonaceous shale were known or reported. Carbonaceous rocks that appeared to be radioactive according to the counter were sampled, and some essentially nonradioactive carbonaceous rocks were also collected for routine checks of field observations. Samples were tested radiometrically and some were analyzed chemically for uranium in the Geological Survey's Trace Elements laboratories.

In the reconnaissance investigations, attention was directed mainly toward finding radioactive materials in Tertiary lignites and carbonaceous shales, particularly those associated with effusive volcanics and tuffaceous sediments which were thought to provide favorable environment for low-grade concentration of uranium in the carbonaceous sediments. Some coal deposits in the generally less tuffaceous Cretaceous and Carboniferous sediments and a peat deposit of Quaternary age were also examined, although no systematic study of these older and younger carbonaceous rocks was undertaken.

PLATE I.--MAP OF NORTHWESTERN UNITED STATES SHOWING LOCALITIES EXAMINED FOR URANIUM-BEARING CARBONACEOUS ROCKS

RESULTS OF THE INVESTIGATION

Most of the deposits examined were essentially barren of uranium. Of the few that contained 0.003 percent uranium or more only two contained carbonaceous material whose ash yielded 0.01 percent or more uranium. These are (1) lignitic shales in Pliocene sediments of the Goose Creek district, Cassia County, Idaho, and (2) a small peat deposit in Davis County, Utah.

A thin carbonaceous shale in Pliocene lake beds near Hagerman, Twin Falls County, Idaho, contained 0.004 percent uranium, but the shale appeared to be too thin and too low grade to be of interest.

DESCRIPTION OF DEPOSITS

The record of deposits examined with comments on their geologic settings, the nature of examination, and results of radiometric tests or analyses are supplied to show the general coverage of the reconnaissance. Descriptions of the deposits are arranged alphabetically by state and county. Map locality numbers referred to in the text are shown on the index map, plate 1.

California

Modoc County

The Cedarville formation of middle Tertiary age is exposed in the intermountain basins of eastern Modoc County, Calif., and western Washoe

County, Nev. The formation consists of shales, tuffaceous sandstones and some interbedded rhyolite flows. It contains a carbonaceous shale zone a few feet thick, which in places contains thin streaks of lignite 1/2 to 2 inches thick. The carbonaceous shale zone and associated rocks were examined and tested radiometrically at Milk Canyon about 7 1/2 miles south of Cedarville, Calif., in sec. 5, T. 41 N., R. 16 E. (Map locality C-1). The stratigraphic sequence, including the carbonaceous zone, was essentially nonradioactive. One grab sample of the carbonaceous shale (Washington lab. no. 68054) assayed less than 0.001 percent equivalent uranium.

Idaho

Lignites and carbonaceous shales crop out in the Tertiary basin sediments associated with tuffaceous rocks in several localities in southern and central Idaho. These rocks, ranging from Eocene to Pliocene in age, are assigned to the Clarno formation (Eocene), the Germer member of the Challis volcanics (Oliogocene ?), the Payette formation (Miocene-Pliocene), and the Hagerman lake beds (Pliocene ?). Of the carbonaceous rocks examined in these Tertiary sediments, only a few in the younger (Pliocene) beds contained more than 0.003 percent.

Ada and Boise Counties

Lignite and subbituminous coal in the Clarno-Payette sequence (Eocene-Miocene) was examined briefly at a few localities in the Horseshoe

Bend area (the Henry mine, abandoned) and Jerusalem Valley coal field (Brainard gulch), both situated along the Payette River (locality I-1) north of Boise, Idaho (Bowen, 1911a). The coal beds examined in abandoned prospects and associated slightly carbonaceous shales examined along new roadcuts were nonradioactive and were not sampled. A reported thin coal in carbonaceous shale in Tertiary sediments about 1 mile east of Boise (locality I-2) was searched for but not found. The Tertiary sedimentary sequence in the latter area was essentially nonradioactive. The rocks were similar lithologically to those containing the lignites in the Horseshoe Bend-Jerusalem Valley area to the north.

Cassia County

The lignitic shales of the Goose Creek area, Cassia County, Idaho, described by C. F. Bowen (1911b) were examined briefly and one lignitic shale zone found to contain a small amount of uranium. The reconnaissance examination was followed shortly by a more detailed investigation described by W. J. Hail and J. R. Gill (1953). The gently folded Tertiary sediments, about 1,500 feet thick in the Goose Creek field, include a sequence of sandstone, conglomerate, shale, and lignitic shale with some interbedded volcanics which are more abundant in the upper part of the sequence. A lower lignitic zone known as the Worthington zone in rocks assigned to the Payette formation of Miocene age were essentially barren of uranium, but the upper lignitic shale zone, known as the Barrett lignite zone, which is in

rocks of Pliocene age, locally contained uranium in amounts up to about 0.04 percent according to the reconnaissance sampling. Results of the reconnaissance sampling of the lignitic beds and tuffs of the Goose Creek area (locality I-3) are shown on table 1.

Custer County

Several thin lignitic shale beds crop out along U. S. Highway 93 about 10 miles southwest of Challis in Custer County (locality I-4). The lignitic shales are in the Germer tuff member of the Challis volcanics and are thought to be of Oligocene age (Ross, 1937). A sequence about 300 feet thick of shale, sandstone, conglomerate, and tuff, and several lignitic shale beds exposed on the north side of the Salmon River, in sec. 7, T. 12 N., R. 19 E., was examined and tested radiometrically. Three samples of the lignitic shales collected from the upper part of the zone contained essentially no uranium, as indicated below.

Location	Denver Laboratory sample no.	Thickness represented	Equivalent uranium (percent)	Uranium (percent)	Remarks
Sec. 7 T. 12 N., R. 19 E.	D-74132	1.0 ft	0.002	<0.0001	Lignite. Top of exposure.
"	74133	1.0 ft	0.001	<0.0001	Lignite. 2 ft below top.
"	74134	3.0 ft	0.002	<0.0001	Lignitic shale base of upper bed.

The lignitic shales and tuffaceous rocks below those sampled were nonradioactive and were not sampled.

Table 1

Results of the reconnaissance sampling of the lignitic beds and tuffs of the Goose Creek area (locality I-3)

Location	Denver Lab. no.	Uranium (percent)	Moisture (percent)	Ash (percent)	Uranium in ash (percent)	Remarks
Sec. 5, T. 15 S., R. 21 E.	52894	0.016	3.45	89.65	0.018	Upper 1.5 ft of lignitic shale, Barrett prospect.
do	52895	.042		79.98	.056	Middle 1.3 ft same bed.
Sec. 2, T. 15 S., R. 20 E.	52896	.004	7.77			1.3 ft channel Worthington lignite.
Sec. 23, T. 16 S., R. 20 E.	52897	.001	7.70			2.7 ft channel Worthington lignite.
Sec. 2, T. 15 S., R. 20 E.	52898	.001	7.58			Worthington zone lignite. 2.1 ft channel.
do	52899	.002	8.07			Worthington lignite zone. 1 ft channel.
Sec. line 25-26, T. 15 S., R. 21 E.	52900	.004	0.61	93.48	.004	Tuffaceous sandstone above Barrett lignite zone.
Sec. 20, T. 16 S., R. 21 E.	52901	.001	.24	96.36	.001	Welded rhyolite tuff above Barrett zone. Grab sample.
do	52902	.001	.65			Tuffaceous sandstone 12 ft thick above Barrett lign. zone
do	52903	.004	3.40			Carbonaceous shale 2 ft Barrett zone.
do						14 ft white tuff not sampled, inert.
do	52904	.001	1.96			0.3 ft yellow tuffaceous sandstone.

Table 1.--Results of the reconnaissance sampling of the lignitic beds and tuffs of the Goose Creek area (locality I-3) Continued

Location	Denver Lab. no.	Uranium (percent)	Moisture (percent)	Ash (percent)	Uranium in ash (percent)	Remarks
Sec. 20, T. 16 S., R. 21 E.	52905	0.032		84.35	0.034	0.7 ft carbonaceous shale. Barrett zone.
do	52906	.004	3.50			Tan shale, 2.3 ft.
do	52907	.003	3.44			Brown, gray and black shale, 2.6 ft channel.
do	52908	.003	5.25			Carbonaceous shale, 3.3 ft channel. Sequence of 60 ft of tuffs and carbonaceous shale underlying sampled beds nonradioactive.
Sec. 10, T. 16 S., R. 21 E.	52909	.004	2.25			1.6 ft channel, Barrett zone, lignitic shale.
Sec. 3, T. 16 S., R. 21 E.	52910	.003	4.97			3.0 ft channel, Barrett zone, lignitic shale.
Sec. 12, T. 15 S., R. 21 E.	52911	.001	0.28			Welded rhyolitic tuff, above Barrett zone.
do	52912	.001	0.13			Rhyolite glass, above Barrett zone.
do	52913	.001	5.51			Greenish-yellow fracture fill in tuffaceous sandstone above Barrett zone.
do	52914	.005	3.85	85.14	.005	1.5 ft chip sample, brown and gray shale.
do	52915	.002	2.65			Yellow tuff. 0.4 ft overlying Barrett zone.
do	52916	.034		76.25	.046	Lignitic shale, Barrett zone, 0.5 ft.
do	52917	.007	5.24	88.11	.007	White clay parting 0.2 ft.
do	52918	.004	5.80			Brown shale, 0.9 ft; base of Barrett zone.

Lemhi County

A lignite prospect on the Pollard Ranch in T. 21 N., R. 21 E., 2 miles west of Salmon, Idaho (locality I-5) exposes about 3.8 feet of lignite, interbedded with about 1.1 feet of clay and tuffaceous sandstone partings. The lignite zone is generally poorly exposed in Middle Tertiary lake basin sediments which contain some interbedded volcanics.

Radiometric tests and channel samples of the lignite examined 175 feet in at face of the coal prospect showed essentially no radioactivity or uranium, as indicated by the sample data below.

Location	Denver Laboratory sample no.	Equivalent uranium (percent)	Uranium (percent)	Remarks
T. 21 N., R. 21 E.	D-74135	0.001	0.0005	Upper 0.3 ft of lignite bed.
"	74136	0.001	0.0002	Lower 3.5 ft of lignite bed.

Other surface examinations and radiometric tests of the tuffaceous sequence a few miles south of Salmon yielded negative results.

Owyhee County

The Payette formation consisting of interbedded volcanics, lake basin sediments and locally a few thin lignite beds of Middle and Late Tertiary age is extensively exposed in southwestern Idaho. Exposures of the formation were examined in Owyhee County on the south side of the Snake River and on the north and west sides of the Silver City Range.

A lignite, sandstone, and shale sequence about 60 feet thick, presumably in the lower part of the Payette formation was nonradioactive at an exposure about 1 mile west of Reynolds Creek, sec. 11, T. 2 S., R. 4 W. (locality I-6). A channel sample (Denver lab. no. 53141) of lignitic shale representing 1.7 feet of beds in the lower part of the exposure yielded 0.001 percent uranium.

A lignite prospect (locality I-7) on a tributary of Suckers Creek, 1.3 miles south of U. S. Highway 95 and 1 mile east of the Idaho-Oregon State boundary, is in Tertiary sediments tentatively assigned to the Payette formation. The lignite and exposed rock sequence in the vicinity of the prospect were examined and found to be nonradioactive. A sample of the lignite (Washington lab. no. 68042) from the prospect dump yielded less than 0.001 percent equivalent uranium.

Twin Falls County

Late Tertiary lake basin sediments underlying the Snake River basalts are exposed in the bluffs along the west side of Snake River near the town of Hagerman in T. 7 S., R. 13 E., Twin Falls County. Fossil mammal bones, presumably of Late Tertiary age, embedded in a tuffaceous matrix contained a small amount of uranium, but thin carbonaceous shale zones exposed below the fossil bone horizon contained too little uranium to be of interest. Analyses of samples collected from the area (locality I-8) are shown below:

Denver Laboratory sample no.	Equivalent uranium (percent)	Uranium (percent)	Remarks
53142	0.029	0.029	Bones exposed on weathered slope.
53143	0.073	0.082	Bones collected from fresh quarry face; same bed.
53144	0.002	0.002	Siliceous tuff matrix of fossil bone bed.
53145	0.004	0.004	Brown carbonaceous shale 0.3 ft thick, overlain by black granular ash bed 0.5 ft thick, about 150 feet below bone bed.

Several similar thin carbonaceous shale beds are exposed in the lower slopes along the river bluffs; except for the sampled bed all were essentially nonradioactive.

Nevada

Tertiary sediments are widely distributed in the intermountain basins in Nevada. These basin-fill sediments locally contain tuffaceous rocks interbedded with lignitic shales. One radioactive lignite, the Gamma lignite deposit in the Tertiary sediments of Churchill County, has been described by Staatz and Bauer (1951). Other Tertiary basin deposits containing lignitic beds were examined. One coal zone of Carboniferous age in White Pine County was also examined.

Elko County

Tertiary basin sediments assigned to the Humboldt formation are extensively exposed in Elko County. Carbonaceous rocks in the Humboldt formation, including lignite, oil shale, and carbonaceous shale occur as lenticular deposits in silty shale south of the town of Elko (locality N-1). Where they were examined in secs. 22, 23, 26, 27, and 36, T. 34 N., R. 55 E., all beds examined were essentially nonradioactive. The most radioactive bed, a carbonaceous shale (Denver lab. no. D-73101) in sec. 36, T. 34 N., R. 55 E., contains 0.003 percent equivalent uranium and 0.0006 percent uranium.

The lower part of the Humboldt formation was examined in sec. 16, T. 42 N., R. 66 E., in the Thousand Springs area in the eastern part of Elko County (map locality N-2). A single carbonaceous sandstone bed about 1 foot thick was found in the stratigraphic sequence which consisted mostly of light colored silty clays. Analyses of a grab sample of the carbonaceous sandstone (no. D-74112) show 0.002 percent equivalent uranium and 0.0005 percent uranium.

Another exposure of the lower part of the Humboldt formation, containing carbonaceous shale partings in marlstone, was examined in sec. 35, T. 39 N., R. 64 E. (locality N-3). Analyses of a grab sample (no. D-74113) of the organic rich marlstone and shale show 0.004 percent equivalent uranium and 0.0005 percent uranium.

Esmeralda County

Several lignite and lignitic shale beds are exposed in a sequence of tuffaceous sediments in the Esmeralda formation of Tertiary age, near Coaldale, Esmeralda County (Hance, 1911; Toenges, et al, 1946). The lignites and associated sediments were examined in secs. 28, 29, and 33, T. 2 N., R. 37 E. (locality N-4) where the lignitic beds were essentially nonradioactive and not sampled. A small uranium deposit in a welded rhyolitic tuff was found only a few hundred feet from the nearest lignite outcrop (Duncan, 1952). The uranium-bearing tuff is situated up-drainage from the lignite-bearing sequence in such a position that surface water run-off from the uraniferous tuff crosses the lignitic zone. The lignites, however, were less radioactive than adjacent stream gravels that were derived from the radioactive tuffs upstream.

Lyon County

A lignite deposit in Tertiary basin sediments is exposed in the valley of the East Walker River in sec. 36, T. 8 N., R. 27 E. at the portal of the abandoned Lewis coal mine (locality N-5). The lignite and associated fine-textured sediments were nonradioactive and were not sampled. Ash of lignite samples collected from the Lewis mine by Staatz and Bauer (1953) contained 0.002 percent uranium.

White Pine County

A thin coal-carbonaceous shale zone at the base of the Diamond Peak quartzite (Pennsylvanian) was examined in a prospect entry in sec. 24, T. 25 N., R. 62 E., in the Cherry Creek Mountains, White Pine County (locality N-6). The coal, carbonaceous shale, and associated quartzite were nonradioactive. Analyses of a sample (Denver lab. no. 53647) of black shale, representing 1.5 feet of beds at the base of the quartzite sequence, show 0.001 percent equivalent uranium and 0.001 percent uranium.

Pliocene sediments are exposed in the intermountain basin west of the Deep Creek Range near the Utah-Nevada line in White Pine County (locality N-7). The beds were examined west and northwest of the town of Ibapah, Utah. Radioactive fossil bones and slightly radioactive welded tuffs were found in the Pliocene beds, but no carbonaceous sediments were observed.

Oregon

Grant County

A lignite zone in the lower part of the Mascall formation of Miocene age is known from exposures along the John Day River in Grant County, Oreg. (Andrews, et al., 1947). The lignitic zone was examined in the abandoned John Day prospect, along U. S. Highway 28, 11.0 miles east of Dayville, in T. 13 S., R. 28 E. (locality 0-1). The exposed lignite shale

sequence, about 20 feet thick was nonradioactive. One sample of the lignite (Washington lab. no. 68046) representing 1 foot of beds in the upper part of the exposed lignitic zone contained less than 0.001 percent equivalent uranium.

Malheur County

Lignitic shales in the Payette formation of Miocene age are exposed along Suckers Creek and along the west side of the Owyhee River Reservoir in Malheur County.

The lignitic zone was examined along Suckers Creek, a few miles north and south of U. S. Highway 95, near the Idaho State line (locality O-3). The lignitic shale and associated tuffaceous siltstones were nonradioactive and were not sampled.

A well exposed sequence of beds, about 1,400 feet thick, in the Payette formation, including volcanic flows, sandstone, shale, and minor lignite was examined in sec. 2, T. 22 S., R. 44 E. (locality O-4) and found to be essentially nonradioactive. Analyses of three samples of lignitic shale collected from the exposure yielded the following results.

Washington laboratory sample no.	Equivalent uranium (percent)	Remarks
68043	0.001	Lignitic shale, 2.6 ft channel; top of lignitic zone.
68044	0.002	Lignitic shale, 2.9 ft channel, 8 ft below preceding sample.
68045	< 0.001	Lignitic shale 0.3 ft thick, in white tuff; 370 ft below preceding sample.

Morrow County

A subbituminous coal sequence in the Clarno formation of Eocene age is exposed in a small area along Willow Creek in sec. 34, T. 2 S., R. 33 E., Morrow County (Mendenhall, 1907). The coal-bearing sequence in Willow Creek underlies the Columbia River basalt flows. The coal zone and adjacent sandstone at two prospect entries were examined and found to be nonradioactive. Analyses of samples follow:

Map locality	Washington laboratory sample no.	Equivalent uranium (percent)	Remarks
O-2	68047	<0.001	Grab sample of coal from mine dump.
O-2	68048	<0.001	Top 0.5 ft of coal in prospect adit.

Utah

Random tests for uranium in Upper Cretaceous coals were made at several localities in Utah, with generally negative results. One small peat deposit examined in the Quaternary Lake Bonneville deposits contained a small amount of uranium. Coals in the Dakota sandstone (Cretaceous) of southeastern Utah and some early Tertiary coal near Coalville in northeastern Utah were not examined.

Carbon County

Several coals in the Mesaverde formation of Upper Cretaceous age were examined along the eastern edge of the Wasatch Plateau near the towns

of Helper and Hiawatha; approximately the same zone of coals was also examined along Soldiers Creek a few miles northwest of Sunnyside (localities U-1). These coals were nonradioactive and were not sampled.

Davis County

A peat deposit covering about one acre of bench land is exposed on the E. W. Pettit farm in sec. 2, T. 4 N., R. 1 W., Davis County (locality U-2). The deposit is crossed by U. S. Highway 89 about 1.7 miles south of the junction with U. S. Highway 30. The deposit was accumulated on the Provo level of the Lake Bonneville terrace deposits presumably during the Pleistocene epoch. The surrounding terrain is mainly cobble-gravels and sand. Peat mud has been scooped from trenches in the deposit and sold locally as fertilizer. About 3 feet of black humus, partly decomposed plant fragments, is exposed in the trenches. A grab sample of the peat mud representing about 3 feet of beds yielded the following analytical results.

Denver Laboratory sample no.	Equivalent uranium (percent)	Uranium (percent)	Moisture (percent)	Ash (percent)	Percent U in ash
52893	0.005	0.006	5.86	58.07	0.010

Assuming that the sample is representative of the deposit, it is estimated that it contains about 7,000 tons of peat, containing 0.006 percent uranium or about 0.4 ton uranium.

Iron and Kane Counties

Coals in the Tropic, Straight Cliffs, and Wahweap formations of Upper Cretaceous age were examined in Iron and Kane Counties. All of the coals examined were essentially nonradioactive and were not sampled.

The Cretaceous coal-bearing sequence was examined along State Highway 14 a few miles east of Cedar City in Iron County (locality U-3). Approximately the same sequence of coals was also examined in Kane County along the north fork of the Virgin River approximately in secs. 26 and 27, T. 40 S., R. 9 W. (locality U-4). Coal in the Tropic shale was examined in secs. 16 and 21, T. 40 S., R. 9 W. (locality U-4). There the Tropic shale overlies a conglomeratic unit of the Dakota (?) sandstone in which a series of small carnotite-autunite deposits in the Dakota are located (Beroni, et al., 1951). Coals in the Tropic shale were nonradioactive and were not sampled.

Sanpete County

A coal-bearing zone in the North Horn formation of Late Cretaceous or Early Tertiary age was examined at two localities along the east front of the Gunnison Plateau near Wales, in Sanpete County (locality U-5). The coal in an abandoned mine in Peach Canyon, sec. 2, T. 16 S., R. 2 E. showed little radioactivity, and a series of channel samples taken across the coal bed yielded the following analytical results.

Washington laboratory sample no.	Thickness of unit (feet)	Equivalent uranium (percent)	Uranium (percent)	Ash (percent)	Uranium in ash (percent)	Remarks
	2+		not sampled			Top: sandstone
63753	2.1	0.001	0.002	31.3	0.006	Coal
63754	2.2	0.002	0.002	35.4	0.006	Coal
	0.7		not sampled			Sandstone
63755	1.2	0.001	0.001	21.9	0.006	Coal
	0.6		not sampled			Base: shaly sandstone.

A coal prospect in the same zone of the North Horn formation on the south side of Wales Canyon in sec. 26, T. 15 S., R. 2 W., was examined and sampled. The coal was essentially nonradioactive as indicated by sample data below.

Washington laboratory sample no.	Thickness of bed	Equivalent uranium (percent)	Remarks
63756	2.0	< 0.001	Upper part of coal bed.
63757	1.9	< 0.001	Lower part of coal bed.

Washington

Early Tertiary coals and associated rocks in southwestern Washington were examined briefly with the guidance of Parke D. Snavely, Jr., of the Geological Survey. All rocks examined, including coals of Eocene and Oligocene (?) ages, lignite of Miocene age, and the associated tuffaceous sediments were nonradioactive. The localities and carbonaceous rocks examined are described in the table below.

Map locality	Washington laboratory sample no.	Equivalent uranium (percent)	Remarks
W-1 North bank Cowman River, 2 1/2 miles east of Kelso, Cowlitz Co.	68050	<0.001	Lignite bed 0.9 ft thick, in tuffaceous sandstone sequence; Eocene-Oligocene transition zone.
W-2 NE 1/4, sec. 12, T. 14 N., R. 2 W., Lewis Co.	68051	0.001	Carbonaceous shale at base of Lucas coal bed. Eocene-Oligocene transition zone. Overlying coal inert.
W-2 Sec. 23, T. 14 N., R. 2 W., Lewis Co.			Coal in Skookumchuck formation (Eocene), nonradioactive; not sampled.
W-3 Sec. 25, T. 14 N., R. 1 W., Lewis Co.			Lucas coal, Eocene-Oligocene transition zone, nonradioactive; not sampled.
W-4 Sec. 3, T. 14 N., R. 3 W., Lewis Co.			Thin uppermost coal of Skookumchuck formation (Eocene), nonradioactive; not sampled.
W-5 Sec. 1, T. 12 N., R. 4 E., at Morton, Lewis Co.			Coal and associated arkosic sandstone in Mackintosh fm. (Eocene), nonradioactive; not sampled.
W-6 Sec. 9, T. 11 N., R. 1 W., Lewis Co.	68052	<0.001	Woody lignite in Miocene beds above Columbia River basalts, 0.3 ft lignite sampled.
W-7 Sec. 23, T. 11 N., R. 1 E., Lewis Co.	68053	<0.001	Upper 1.2 ft of thick lignite, overlain by pumiceous tuff, in Eocene-Oligocene transition beds. Chevis prospect.
W-8 Sunburst mine Eatonville, T. 16 N., R. 4 E., Pierce Co.			Coals and associated sandstones in mine workings and prospects, nonradioactive; not sampled.

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