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Uranium-Bearing Coal in the Red Desert, Great Divide Basin, Sweetwater County, Wyoming

By Harold Masursky and George N. Pipiringos

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Trace Elements Memorandum Report 601

UNITED STATES DEPARTMENT OF THE INTERIOR
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U. S. Atomic Energy Commission
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Dear Phil:

Transmitted herewith are six copies of TEM-601, "Uranium-bearing coal in the Red Desert, Great Divide Basin, Sweetwater County, Wyoming," by Harold Masursky and George N. Pipiringos, March 1953.

Sincerely yours,

W. H. McKelvey

for W. H. Bradley
Chief Geologist

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Geology - Mineralogy

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UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

URANIUM-BEARING COAL IN THE RED DESERT, GREAT DIVIDE BASIN, SWEETWATER COUNTY, WYOMING*

By

Harold Masursky and George N. Pipiringos

U.S. GEOLOGICAL SURVEY
DENVER
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March 1953

Trace Elements Memorandum Report 601

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	56

CONTENTS

ILLUSTRATIONS

TABLES

URANIUM-BEARING COAL IN THE RED DESERT, GREAT DIVIDE BASIN, SWEETWATER COUNTY, WYOMING

By Harold Masursky and George N. Pipiringos

ABSTRACT

Uranium-bearing coal in the Wasatch formation occurs in a zone extending 30 miles north of U. S. Highway 30 and the Union Pacific Railroad at Wamsutter, Sweetwater County, Wyoming. The Wasatch formation intertongues with the Green River formation and the beds are nearly flat lying.

Preliminary estimation of total reserves in the area indicates the presence of 610,000,000 tons of subbituminous coal containing 14,800 tons of uranium in beds more than 30 inches thick and overlain by less than 75 feet of overburden. The uranium content of the coal ash ranges from 0.010 percent to 0.020 percent throughout most of the area included in the reserves. Locally, the uranium content ranges from 0.001 percent to 0.047 in the coal and 0.005 percent to 0.14 percent in the ash.

INTRODUCTION

Uranium-bearing coal in the Red Desert, Great Divide Basin, Sweetwater County, Wyo. (fig. 1) was investigated in 1951 by the Geological Survey as part of the program of exploration for radioactive materials in behalf of the Division of Raw Materials of the U. S. Atomic

Energy Commission. The purposes of the study were to outline the reserves of minable coal, to determine the uranium content of the coal, and to obtain data on the origin of the uranium as a guide to exploration of other areas where uranium in coal might be expected to occur.

Preliminary results of investigations in the Red Desert were presented by Masursky and Pipiringos in Trace Elements Memorandum Report 341 (Denson and others, 1951). In September and October, 1952, exploratory drilling was undertaken on the basis of this information. Preliminary results of the core drilling have been presented (Masursky, 1952). The final results of the drilling will be transmitted as soon as analyses are available and can be evaluated. A subsequent report will describe in detail the geology of the Red Desert area and the uranium-bearing coal.

Uranium analyses of coal and interbedded sediments were made in the Trace Elements Section Washington laboratory of the Geological Survey. Analyses of uranium in other kinds of rock were made in the Trace Elements Section Denver laboratory of the Geological Survey.

Uranium-bearing coal in the Red Desert was discovered by Slaughter and Nelson (1946) and subsequently was studied by Wyant, Sharp, and Sheridan (1951).

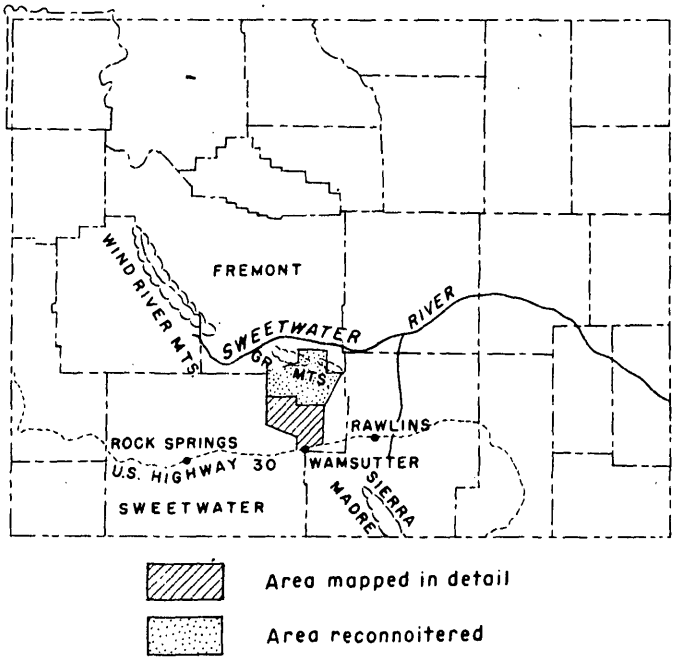


FIGURE 1.-- INDEX MAP OF WYOMING SHOWING RED DESERT AREA

REGIONAL SETTING

The Red Desert area is in a structural and topographic basin between the Rawlins and Rock Springs uplifts on the east and west. The area is flanked on the north by the Green Mountains and continues southward into the Washakie Basin.

The Rawlins uplift is a north-northwest trending feature along which rocks ranging in age from pre-Cambrian to Tertiary are exposed. The Rock Springs uplift is a large, north-trending anticlinal fold involving Cretaceous and Tertiary rocks. The Green Mountains are part of a zone of complex structure just south of the so-called Granite or Sweetwater Range. The rocks there range in age from pre-Cambrian to Tertiary and are folded and faulted, the Tertiary rocks much less intensely than the older rocks.

STRATIGRAPHY

The Wasatch and Green River formations of early Eocene age are the only stratigraphic units studied in detail in the mapped area and discussed in this report. These rocks have an exposed thickness of about 1,200 feet. Younger rocks of Eocene, Oligocene (?), Miocene, and Pliocene (?) age were examined in reconnaissance adjacent to the mapped area. Pleistocene and recent lake deposits, delta fans, and alluvium are prominent features of the Red Desert area.

The Hiawatha member of the Wasatch formation and a higher member, informally called the Table Rock member, contain most of the

uranium-bearing coal in the Red Desert. These members interfinger to the southwest with the lower part of the Green River formation. These relationships have been described by Schultz (1907), Sears and Bradley (1924), Bradley (1926 and 1945), Nightingale (1930), and Nace (1939). The relations of the tongues of the Wasatch and Green River formations are shown in the restored section on the geologic map (fig. 2) and in the composite stratigraphic section (table 1).

The Wasatch formation in the northeastern part of the Red Desert area consists of fluviatile sandstone interbedded with minor amounts of finer-grained rocks. Tongues from this body of the Wasatch formation extend southwestward into the lower part of the Green River formation. The coarse fluviatile Wasatch tongues change facies to the southwest and become fine-grained and coal-bearing.

The upper part of the Green River formation lies to the south and west outside the map area, but the lower part of the formation, the Tipton member, is represented by tongues of lacustrine rocks separating tongues of Wasatch fluviatile rocks. Most of the tongues in the lower part of the formation consist of brown fissile shale and soft brown siltstone which have a combined average thickness of about 550 feet. Brown limy sandstone containing abundant fresh-water fossils is common and constitutes most of one of the Green River tongues distinguished. Two remarkably persistent and useful key horizons are present. Calcareous algal balls averaging 0.5 feet in diameter occur in the upper part of the highest Green River tongue in the area. The algal balls are onion-layered

Table 1. --Composite Geologic Section of the Coal-bearing Wasatch and Green River formations, Red Desert area.

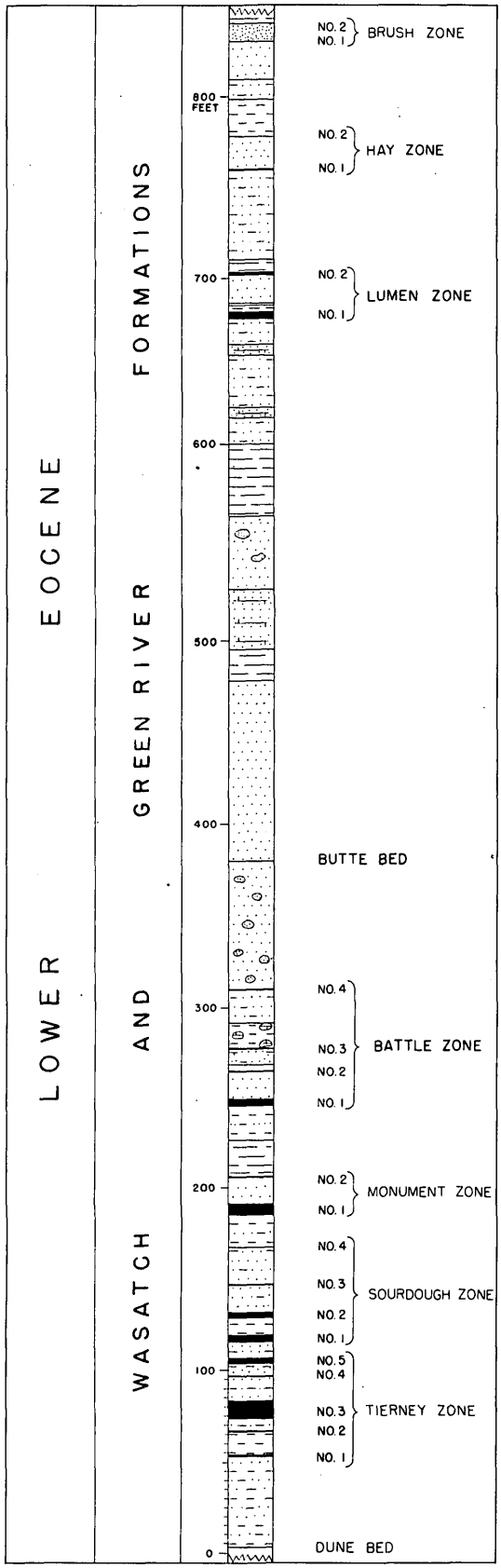
AGE	FORMATION	MEMBER		THICKNESS
EOCENE	LOWER AND MIDDLE?	GREEN RIVER FORMATIONS	Cath. Bluffs	Sandstone (Twcb ss-2) very coarse-grained, gray and green-white locally variegated. Poorly consolidated, locally conglomeratic, contains thin beds of red-brown clay that thicken westward. Basal 100' contain thin beds of dark green paper shale.	200'
			Tipton	Shale (Tgt sh-5), papery, olive-green to brown, with minor fine-grained highly fossiliferous sandstone ledges. A persistent bed of algal balls occurs about 20' below top. This unit contains a reddish sandstone tongue of the Cathedral Bluffs (Twcb ss-1) typically developed at Eagle's Nest.	180'
			Table Rock	Shale, siltstone, and coal (Twtr-c), predominantly gray-green, contains brown-weathering limy sandstone ledges. Interfingers eastward with the coarse facies of the Hiawatha member (Twh ss) and with Tipton shale and sandstone westward. Contains the Lumen, Hay, and Brush coal zones.	235'
			Tipton	Shale (Tgt sh-4) papery, olive-brown with local brown calcareous fine-grained fossiliferous sandstone ledges.	40-60'
			Hiawatha	Sandstone (Twh ss-3) pale green to yellow-tan, fine- to very coarse-grained, contains irregular calcareous concretionary zones weathering into spheroidal forms ("cannon balls"). Minor amounts of green clay present which contain angular, fine- to coarse-size quartz grains.	40-60'
			Tipton	Sandstone (Tgt sh-3) yellow-tan, very fine- to medium-grained with thin-bedded calcareous, highly fossiliferous ledge-makers in upper part. Shale, papery, olive-brown, locally contains gypsum crystals and resembles carbonaceous shale in lower 20'.	46-60'
			Hiawatha	Sandstone (Twh ss-2) pale yellow to green-gray, fine- to very coarse-grained. Where calcareous, it weathers into irregularly rounded ledges and "cannon ball" concretions. Includes a few beds of dark green claystone, shale, and one coal, the Butte bed.	170'
			Tipton	Shale (Tgt sh-2) papery, olive-brown, siltstone, and sandstone. Contains a persistent 14' zone of pastel-weathering black limestone concretions, directly overlying Battle coal bed No. 3.	45-60'
	WASATCH		Hiawatha	Shale gray-green, bone-gray siltstone, fine-grained sandstone and coal (Twh c). Contains irregular calcareous cross-bedded sandstone channels. This facies contains the main coal zones of the area (Tierney, Sourdough, Monument zones, and the lower three beds of the Battle coal zone). At Tipton Buttes an additional 60' of section is exposed below Tierney-1 which contains the Dune coal bed near its base. The Hiawatha coal-bearing sequence interfingers eastward with coarse sandstone facies (Twh ss). Locally, the lowest shale unit of the Tipton (Tgt sh-1) is present 15' to 35' above Monument no. 2. Laterally this shale unit grades into beach sand with contorted laminations.	255'

and occur in a zone 1 to 10 feet thick. A 4- to 5-foot zone containing limestone concretions, which average 1 to 2 feet in diameter, is present at the base of the lowest tongue of Green River shale. These concretions weather to pastel shades of brown, yellow, pink, and purple.

COAL

The coal beds are thickest in a northwest-trending zone about 30 miles long in the central part of the area and the beds there range in thickness from 5 to 20 feet (fig. 3). Both northeast and southwest of this zone, the coal beds become thinner and are replaced by carbonaceous shale which in turn is replaced by green clay shale. The coal was considered to be subbituminous in rank by Smith (1907) although this determination was based on an analysis of weathered coal. Fresh samples adequate for determining the rank of the coal could not be obtained in the present field work. Proximate and ultimate analyses were made of samples of coal from auger holes. The coal was contaminated by wall rock in the augering process so the analyses (table 2) do not completely reflect the character of the coal. However, the analyses indicate that the coal is subbituminous in rank but near the boundary between subbituminous coal and lignite.

The coal on the outcrop ranges in physical characteristics from hard, banded, and black with conchoidal fracture to light-weight, soft and porous with many carbonized wood fragments. The coal checks on weathering and slacks rapidly to small fragments. The coal has burned



GENERALIZED COLUMNAR SECTION SHOWING RELATIVE POSITIONS OF PRINCIPLE COAL BEDS, RED DESERT AREA, SWEETWATER COUNTY, WYOMING

FIGURE 3

Table 2. --Analyses of auger samples of coals from the Red Desert area, Sweetwater County, Wyoming 1/

Map locality	Thickness	Lab. No.	Air-Dry loss	Condition 2/	PROXIMATE Moisture	Volatile matter	Fixed carbon	Ash 3/	ULTIMATE Hydrogen	Carbon	Nitrogen	Oxygen	Sulphur	British thermal units
103	6'	D-78125	23.5	1	7.6	42.4	33.4	16.6	4.3	46.9	1.6	27.8	2.8	7,660
				2	29.3	32.5	25.5	12.7	5.9	35.9	1.2	42.1	2.2	5,860
				3	-	45.9	36.2	17.9	3.8	50.8	1.7	22.7	3.1	8,290
				4	-	56.0	44.0	-	4.6	61.9	2.1	27.7	3.7	10,100
189	16'	D-78128	16.6	1	6.4	29.7	28.6	35.3	3.9	41.7	1.0	15.3	2.8	7,300
				2	21.9	24.7	24.0	29.4	5.1	34.8	.8	27.6	2.3	6,090
				3	-	31.7	30.6	37.7	3.4	44.5	1.1	10.3	3.0	7,790
				4	-	50.8	49.2	-	5.4	71.4	1.7	16.7	4.8	12,500
192	20'	D-78126	15.4	1	8.1	32.1	29.4	30.4	4.2	42.6	1.0	19.7	2.1	7,260
				2	22.3	27.2	24.8	25.7	5.3	36.0	.9	30.3	1.8	6,140
				3	-	34.9	32.1	33.0	3.6	46.4	1.1	13.6	2.3	7,900
				4	-	52.2	47.8	-	5.4	69.2	1.7	20.3	3.4	11,790
196	12'	D-78127	15.8	1	7.4	29.5	30.8	32.3	4.0	41.5	.9	18.9	2.4	7,090
				2	22.1	24.8	25.9	27.2	5.1	34.9	.7	30.1	2.0	5,970
				3	-	31.8	33.3	34.9	3.4	44.8	1.0	13.3	2.6	7,660
				4	-	48.9	51.1	-	5.2	68.8	1.5	20.5	4.0	11,760

1/ Analyses supplied by U. S. Bureau of Mines, Central Experiment Station, Pittsburgh, Pa., Roy F. Abernethy, Chemist in charge.

2/ Condition 1 air dried
2 as received
3 moisture free
4 moisture and ash free

3/ Due to contamination of the coal cuttings with wall rock during augering, the ash content of samples collected at map localities 189, 192, and 196 is double that of adjacent surface sections.

along the outcrop at a number of places but the burning did not extend far behind the outcrop. The soft siltstones that overlie the coal at most places evidently caved and smothered the fires.

DISTRIBUTION OF URANIUM IN COAL

The distribution of uranium in individual coal beds is shown in figures 4 to 9. Each figure shows stratigraphic sections of the coal beds in a tier of townships extending east across the mapped area, with figure 4 illustrating the coal in the northernmost tier of townships, figure 5, the next tier to the south, etc. The individual coal sections are arranged in lines of correlated sections extending in general from west to east across the area.

The uranium content of a given coal bed is highest in the most northeasterly part of its extent where it is interbedded with increasingly greater amounts of coarse fluviatile sediments. The Battle No. 1 bed contains 0.001 percent uranium at locality 19 (figs. 2 and 5); at successive localities 25, 35, and 44 farther to the east, the uranium content increases from 0.002 percent to 0.005 percent.

In a given area coal highest in the stratigraphic section will have the highest uranium content. In section 98 (fig. 7) the uppermost coal has a uranium content of 0.013 percent, the next bed down, 0.007 percent, and the next lower, less than 0.001 percent. Where the coals occur on topographic highs capped unconformably by conglomerates or coarse-grained sandstones, this relationship is especially noticeable. At Bison

Basin, 40 miles north of the mapped area the uppermost coal bed contains 0.056 percent uranium, the next bed 9 feet lower contains 0.005 percent, and a third bed 100 feet lower, 0.001 percent.

The association of high uranium content with stratigraphic and topographic highs pertains only if impermeable units are not present in the stratigraphic sequence. If impermeable shales occur in the section and are underlain by permeable sandstones, the coals associated with the shales will have a low uranium content whereas the coals associated with the sandstones will have a high uranium content. Locations 7, 8, 9, and 10 on figure 4 show that the Lumen coal zone is radioactive whereas the overlying Brush and Hay coal zones are inert. The original discovery of the Lumen zone was made by searching for coals associated with permeable zones even though they underlie Green River shale beds. Subsequent drilling and analysis of coal cores demonstrated that the uranium content of the Lumen zone was higher than the overlying coal beds and that the uranium content increased from 0.002 percent on the west to 0.010 percent on the east. The uranium content of the Lumen coal appears to be directly related to the tongues of increasingly coarser and more permeable sandstone which interfinger from the northeast.

At Eagles Nest in the northeast corner of the mapped area (fig. 2) beds of Green River shale are interbedded with coarse-grained permeable sandstones. At the contact of the shale with the sandstone there is a four-fold increase in the uranium content of the shale. North of Eagles Nest along Lost Creek, beds of sandy clays are in contact with sandstone

channels in the Cathedral Bluffs formation. At these contacts there is a three to four fold increase in the uranium content of the sandy clays.

The widespread relationship of coals with relatively high uranium content associated with topographic and stratigraphic highs and with permeable zones appears to indicate a downward and lateral movement of uranium from a widespread overlying source subsequent to the deposition and deformation of the coal-bearing rocks.

Further exploration in this area will be guided by search for potential deposits associated with topographic and stratigraphic highs and with permeable zones.

RESERVES

Reserves of uraniferous coal were computed on a township basis. Blocking out of promising individual deposits will depend on analysis of samples from the core drilling and surface sampling done in 1952.

With the exception of the Lumen No. 2, only coal more than 30 inches thick is included in the reserves estimate; carbonaceous shale, clay, and thin beds of coal were excluded, although the uranium content of these materials at some places is greater than that of the coal. The Lumen No. 2 bed, although only 24 inches thick, was included in the coal reserves because it probably could be recovered in removing overburden to get at the Lumen No. 1 bed, which is about 35 feet below the Lumen No. 2 bed. Only coal with 75 feet or less of overburden is included in the reserve estimate. Tonnage figures were based on 1,700

tons per acre foot for subbituminous coal. Grade was determined by averaging chemical analyses of samples from surface sections because samples obtained by augering are contaminated by cuttings of wall rock.

Based on these assumptions and data, a total reserve of 610,000,000 short tons of coal containing about 14,800 short tons of uranium is estimated. The estimates for the individual townships are presented in Table 3.

The average uranium content of uraniferous coal in the area is approximately 0.003 percent. The ash content of the uraniferous coal ranges from 7 to 40 percent and averages about 20 percent. Uranium content of the ash thus would average about 0.015 percent.

PLANS

Plans for the future cannot be stated explicitly until results of the drilling and sampling done in the field season of 1952 can be evaluated. Such plans will be included in the report on the results of the drilling. Further work may consist of additional exploratory drilling over the area as a whole to delimit the places with the best possibilities for development.

Table 3. --Inferred reserves of uranium-bearing coal, Red Desert area, Sweetwater County, Wyoming

Township and range	Name of bed	Area (acres)	Thickness (feet)	Uranium (percent)	Coal 1/ (short tons)	Uranium (short tons)
T. 24 N., R. 95 W.	Lumen No. 2	320	2.0	0.013	1,088,000	141
	Lumen No. 1	800	4.0	0.010	5,440,000	544
T. 23 N., R. 96 W.	Battle No. 1	640	2.5	0.001	2,720,000	27
T. 23 N., R. 95 W.	Battle No. 1	640	5.0	0.002	5,440,000	109
T. 23 N., R. 94 W.	Battle No. 1	1,570	6.0	0.003	16,014,000	480
	Battle No. 1	211	5.2	0.003	1,865,240	56
	Monument No. 2	1,440	8.0	0.003	19,584,000	587
	Sourdough No. 2	2,260	4.1	0.006	15,752,200	945
T. 22 N., R. 95 W.	Battle No. 2	640	2.5	0.001	2,720,000	27
	Battle No. 1	810	3.0	0.003	4,131,000	124
	Monument No. 1	1,440	6.5	0.001	15,912,000	159
	Sourdough No. 2	1,340	3.5	0.001	7,973,000	80
	Sourdough No. 1	1,528	4.5	---	11,689,200	---
	Tierney No. 5	1,080	3.0	0.002	5,508,000	110
T. 22 N., R. 94 W.	Battle No. 1	2,080	3.0	0.001	10,608,000	106
	Monument No. 1	2,720	11.0	0.001	50,864,000	509
	Monument No. 1	1,720	9.0	0.001	26,316,000	263
	Monument No. 1	1,427	9.5	0.002	23,046,000	461
	Monument No. 1	282	9.5	0.001	4,560,000	46
	Monument No. 1	557	3.5	0.001	3,317,000	33
	Monument No. 1	13	9.3	0.004	205,700	8
	Sourdough No. 2	2,560	4.0	0.003	17,408,000	522
	Sourdough No. 2	2,840	4.0	0.001	19,312,000	193
	Sourdough No. 2	6,227	8.6	0.003	91,038,740	2,731
	Tierney No. 5	3,248	4.0	0.001	22,086,400	220

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Table 3.--Inferred reserves of uranium-bearing coal, Red Desert area, Sweetwater County, Wyoming (Cont.)

Township and range	Name of bed	Area (acres)	Thickness (feet)	Uranium (percent)	Coal 1/ (short tons)	Uranium (short tons)
T. 22 N., R. 93 W.	Sourdough No. 2	877	5.0	0.003	7,454,500	224
T. 21 N., R. 95 W.	Sourdough No. 1	205	2.5	0.001	871,250	8
	Tierney No. 5	528	5.0	0.002	4,488,000	90
T. 21 N., R. 94 W.	Monument No. 1	653	3.0	0.010	3,330,300	333
	Sourdough No. 2	5,165	4.3	0.001	37,756,150	378
	Sourdough No. 2	70	9.0	0.001	1,047,000	10
	Sourdough No. 2	440	4.0	0.002	2,992,000	60
	Tierney No. 5	760	5.0	0.001	6,460,000	65
T. 21 N., R. 93 W.	Battle No. 1	934	4.5	0.006	7,145,100	429
	Monument No. 1	3,939	5.4	0.009	36,160,020	3,250
	Sourdough No. 2	2,095	5.2	0.002	18,519,800	370
T. 21 N., R. 92 W.	Monument No. 1	640	4.0	0.003	4,352,000	131
T. 20 N., R. 93 W.	Monument No. 1	256	4.5	0.002	1,958,400	39
	Tierney No. 5	2,285	16.0	0.001	62,150,000	622
T. 20 N., R. 92 W.	Tierney No. 5	488	16.0	0.001	13,273,600	133
	Tierney No. 3	1,798	5.7	0.001	17,422,620	174
	TOTALS (rounded)				610,000,000	15,000

1/ Tonnage estimates based on 1,700 tons of coal per acre foot. Estimates include only those beds 2.5 feet or more in thickness and overlain by 75 feet or less of overburden.

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