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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE STROUD CREEK QUADRANGLE, ROSEBUD AND BIG HORN COUNTIES, MONTANA

(Report includes 54 plates)

By

W. J. Mapel, B. K. Martin, and B. A. Butler

Contents

Illustrations

(Plates are separate)

Tables

COAL RESOURCE OCCURRENCE

Introduction

Purpose

This text is for use in conjunction with two sets of maps: (1) Coal resource occurrence (CRO) maps of the Stroud Creek quadrangle, Rosebud and Big Horn Counties, Montana (CRO plates 1-53), and (2) a coal development potential (CDP) map of the Stroud Creek quadrangle, Rosebud and Big Horn Counties, Montana (CDP plate 54). The two sets of maps have been prepared as part of a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. They are intended to support land-use planning and coal leasing activities of the Bureau of Land Management as required by their Energy Minerals Activities Recommendation System (EMARS). Coal beds considered in the resource inventory are only those beds 5 feet (1.5 m) or more thick, and under less than 1,000 feet (305 m) of overburden (Reserve Base of subbituminous coals) thinner or deeper beds that are present are not shown by the maps (CRO plates 4-53) or included in the resource estimates.

Location

The Stroud Creek 7½-minute quadrangle lies along Hanging Woman Creek in southern Rosebud County and eastern Big Horn County, Montana. It is about 25 miles (40 km) south of Ashland, Montana, and about 5 miles (8 km) south of the settlement of Birney. Sheridan, Wyoming, is about 30 miles (48 km) to the southwest.

Accessibility

All-weather graded roads cross the southern and northeastern parts of the quadrangle. These two roads are part of a network of graded county roads that connect Birney and Ashland with points to the south, west, and east in Montana and northeastern Wyoming. The two roads, and unimproved trails that fork from them, provide good access to most parts of the quadrangle.

The Burlington Northern Railroad operates east-west routes through Sheridan, in Wyoming, and through Forsyth, in Montana.

Physiography

Hanging Woman Creek, a major tributary of the Tongue River, flows northward along the west edge of the quadrangle in a flat-floored valley about ½ mile (0.8 km) wide. The valley bottom is bordered by steep slopes and cliffs that rise several hundred feet to a rolling upland surface in most of the quadrangle east of Hanging Woman Creek. Westward or northwestward flowing tributaries of Hanging Woman Creek, most notably Lee Creek near the north edge of the quadrangle, Stroud Creek in the central part, and Horse Creek along the southern edge, cross the quadrangle in valleys that are deeply entrenched in this surface near their junctions with Hanging Woman Creek, but that are shallow and broad, and merge with the upland surface upstream to the east.

Maximum local topographic relief is about 750 feet (230 m) in the northwestern corner of the quadrangle. The highest point has an elevation of 4,081 feet (1,244 m) and is along the eastern edge.

Climate

Southeastern Montana in the vicinity of the Stroud Creek quadrangle has a semiarid climate. Average annual precipitation at Ashland is about 14 inches (36 cm), and the annual variation in temperature is commonly from $100^{\circ}F$ to $-30^{\circ}F$ ($38^{\circ}C$ to $-34^{\circ}C$).

Land status

The quadrangle lies in the central part of the Powder River Basin KRCRA. The Federal Government owns most of the coal rights.

In 1977, the quadrangle did not contain outstanding Federal coal leases, prospecting permits, or licenses.

General geology

Sources of information

The southwestern part of the Stroud Creek quadrangle was included by Baker (1929) in the northward extension of the Sheridan coal field, which lies mostly to the west, and the eastern and northern parts of the quadrangle were included by Bryson and Bass (1973) in the Moorhead coal field, which lies mostly to the southeast. The work of these men in these areas was published at scales of 1:62,500 and 1:63,360. Matson and others (1973) outlined by drilling and additional mapping the strippable coal deposits in the Anderson and Dietz coal beds in the central and southern parts of the quadrangle. Culbertson and others (1976) remapped the quadrangle on a topographic base at a scale of 1:24,000, incorporating the earlier work. Subsequently, an observation water well was drilled in the northern part of the quadrangle (loc. 4, CRO pl. 1), and four shallow coal exploratory holes were drilled in the southern part (locs. 15, 17, 19, and 20, CRO pl. 1). The map of Culbertson and others (1976), augmented by information from the later drilling, form the basis of the present report.

Information on coal bed thicknesses are from measurements at outcrops, measurements in 14 shallow coal test holes or water wells, and measurements from the resistivity logs of 3 oil and gas test wells. Resistivity logs are useful for identifying coal because coal beds generally have high resistivity; however, some other types of rocks, such as limestone and some kinds of sandstone also have high resistivity, so identifications of coal based solely on resistivity are uncertain.

Stratigraphy

Coal-bearing rocks exposed in the quadrangle, and those present to depths of several hundred feet, belong to the Tongue River Member of the Fort Union Formation and are Paleocene in age.

The Tongue River Member of the Fort Union Formation is about 2,100 feet (640 m) thick in the Lacey Gulch quadrangle and consists of interbedded lenticular beds of yellowish gray to light-gray, fine- to very fine grained sandstone, light- to dark-gray siltstone and clayey siltstone, gray shale and claystone, brown carbonaceous shale, and persistent beds of coal.

Rocks comprising the Fort Union Formation were deposited at elevations of perhaps a few tens of feet above sea level in a vast area of shifting flood plains, sloughs, swamps, and lakes that occupied the Northern Great Plains in early Tertiary time.

Representative samples of the sedimentary rocks overlying and interbedded with minable coal beds in the eastern and northern Powder River Basin have been analyzed for their trace element content by the U.S. Geological Survey and the results summarized by the Department of Agriculture and others (1974) and by Swanson (in Mapel and others, 1977, pt. A, p. 42-44). The rocks contain no greater amounts of trace elements of environmental concern than do similar rock types found throughout other parts of the western United States.

Structure

The quadrangle is in the trough of the Powder River structural basin near the basin axis, which in Montana trends generally northward. Regional dip is generally toward the south at less than 1°. Structural relief within the quadrangle on the Upper Canyon coal bed is about 360 feet (110 m) as shown on CRO plate 15.

Coal geology

Twenty-three coal beds ranging in thickness from 1 to 36 feet (0.3-11.0 m) were identified on the surface or in the subsurface in the Lacey Gulch quadrangle (CRO pl. 3). Of these, fourteen are thick and extensive enough, and under sufficiently shallow cover, to be included in calculations of the Reserve Base. The others are mostly thin coals of limited extent.

The uppermost coal is the Smith bed. This coal is successively underlain by a noncoal interval 120-130 feet (37-40 m) thick; the Anderson coal bed; a noncoal interval 0-60 feet (0-18 m) thick; the Dietz coal bed; a noncoal interval 60-100 feet (18-30 m) thick; an interval 120-240 feet (37-73 m) thick containing the thin Cox coal bed and at least one local coal bed; the Upper Canyon coal bed; an interval 90-150 feet (27-46 m) thick containing the Lower Canyon coal bed in the northern part of the quadrangle, and the White coal bed in the southern part; the Cook coal bed; a noncoal interval 30-40 feet (9-12 m) thick; the Upper Otter coal bed; a noncoal interval 20-20 feet (6-9 m) thick; the Lower Otter coal bed; a noncoal interval 40-60 feet (12-18 m) thick; the Wall coal bed; an interval 30-50 feet (9-15 m) thick containing a local coal bed; the

Pawnee coal bed; a noncoal interval 60-90 feet (18-27 m) thick; the Poker Jim coal bed; an interval 70-90 feet (21-27 m) thick containing a local coal bed; the Brewster-Arnold coal bed; an interval about 300 feet (91 m) thick containing at least two local coal beds; the Knobloch coal bed; a noncoal interval about 300 feet (91 m) thick; the Flowers-Goodale coal bed; an interval about 200 feet (61 m) thick containing a local coal bed in the upper part; and the Kendrick coal bed.

The Smith, Cox, and Upper Otter coal beds are not known to reach thicknesses of 5 feet (1.5 m) in the Stroud Creek quadrangle and are, thus, too thin to be considered in estimates of the Reserve Base. The Kendrick coal bed is everywhere beneath more than 1,000 feet (305 m) of overburden, and, thus, is too deep to be considered. The other named beds are depicted on CRO pls. 4-53.

Coal bed thicknesses shown on the CRO maps are the bed thicknesses reported at outcrops or in the drill holes rounded to the nearest foot, partings excluded. The coal beds generally are free of partings. For detailed measurements of beds exposed at the outcrop, see Culbertson and others (1976).

In the past, several of the thicker coal beds have caught fire at the outcrop and have burned under shallow cover for varying distances, some for a mile (1.6 km) or more. The heat from the burning coal has baked and fused the overlying rocks to form a resistant reddish rock called clinker (also called scoria, red shale, and other names locally). Clinker resulting from near-surface burning of the Anderson coal bed is as much as 100 feet (30 m) thick and caps large areas on high interstream divides in the Stroud Creek quadrangle.

Analyses have been made of samples collected from drill holes at two places from the Anderson bed (locs. 10 and 14, CRO pl. 1), and at one place from the Upper Canyon coal bed (loc. 7, CRO pl. 1) (Matson and others, 1973, p. 50-51, 53). In addition, an analysis has been made of a sample of the Dietz coal bed collected from a now abandoned mine in sec. 2, T. 8 S., R. 43 E. Analyses have been made of weathered coal collected from outcrops of the Cook and Wall coal beds at one place each (tables 1-3). Based on these analyses and on analyses of coal samples collected at nearby localities outside the quadrangle, the rank of the coal in the Stroud Creek quadrangle varies from high in the range of subbituminous C to low in the range of subbituminous B.

Coals in the Northern Great Plains, including those in the Fort Union Formation in Montana contain, in general, appreciably lesser amounts of most elements of environmental concern than coals in other areas of the United States (Hatch and Swanson, 1977, p. 147). The trace-element content of two samples of coal from the Stroud Creek quadrangle is given in table 2.

Table 1.--Description of two outcrop samples of coal collected for analyses, Stroud Creek quadrangle.

(Samples are channel samples of outcrops or chips from a dug pit.)

Sample No.	U.S. Bur. Mines Lab No.	Locality			Bed name	Bed thickness in feet	Part of bed sampled
		Sec.	T.	R.			
D177825	K-64933	Ctr 9	7 S.	43 E.	Cook	6.1	all
D177826	K-65480	SW 17	7 S.	43 E.	Wall	3.5	all

Table 2.--Major, minor, and trace element composition of two outcrop samples of coal, reported on the whole coal basis, Stroud Creek quadrangle.

(Values are in either percent or parts per million. Si, Al, Ca, Mg, Na, K, Fe, Mn, Ti, P, Cl, Cd, Cu, Li, Pb, and Zn values were calculated from analysis of ash. As, F, Hg, Sb, Se, Th, and U values are from direct determinations on air-dried (32° C) coal. The remaining analyses were calculated from spectrographic determinations on ash. L after a value means less than the value shown, N means not detected, and B means not determined.)

[1]Sample	Si %	Al %	Ca %	Mg %	Na %	K %	Fe %	Mn ppm	Ti %	P ppm
D 177825	1.7	.72	.62	.615	.427	.053	.16	39 L	.058	582
D177826	.72	.21	.33	.215	.307	.016	.13	29	.022	223 L

Sample	Cl %	As ppm	Cd ppm	Cu ppm	F ppm	Hg ppm	Li ppm	Pb ppm	Sb ppm	Se ppm
D177825	.020L	1	.10	9.2	90	.04	4.2	2.5	.5	.8
D177826	.010L	1	.05L	4.3	55	.02	2.4	1.3L	.5	.5

Sample	Th ppm	U ppm	Zn ppm	B ppm-S	Ba ppm-S	Be ppm-S	Ce ppm-S	Co ppm-S	Cr ppm-S	Ga ppm-S
D177825	3.0L	.7	18.0	30	500	.7	50 L	1.5	7	3
D177826	3.0L	.2L	13.4	50	300	1.5	N	1.5	3	2

Sample	Ge ppm-S	La ppm-S	Mo ppm-S	Nb ppm-S	Ni ppm-S	Sc ppm-S	Sr ppm-S	V ppm-S	Y ppm-S	Yb ppm-S
D177825	N	10 L	N	3	3	1.5	100	7	5	.5
D177826	1.5	N	.3	1.5	7	2	50	7	5	.5

Sample	Zr ppm-S
D177825	20
D177826	15

[1]See table 1 for description of the samples.

Table 3.--Proximate, ultimate, Btu, and forms-of-sulfur analyses of two outcrop samples of coal, Stroud Creek quadrangle.

(All analyses except Btu are in percent. Original moisture content may be slightly more than shown because samples were collected and transported in plastic bags to avoid metal contamination. Form of analyses: A, as received; B, moisture, free; C, moisture and ash free. All analyses by Coal Analysis Section, U.S. Bureau of Mines, Pittsburgh, Pa.)

		Proximate analysis				Ultimate analysis						Forms of sulfur		
[1]Sample No.	Form of analysis	Moisture	Volatile matter	Fixed carbon	Ash	H	C	N	O	S	Btu	Sulfate	Pyritic	Organic
D177825	A	34.7	30.1	28.6	6.6	6.0	38.5	1.0	47.3	0.6	5,190	0.27	0.01	0.31
	B	----	46.1	43.8	10.1	3.3	59.0	1.5	25.2	0.9	9,050	.41	.01	.48
	C	----	51.3	48.7	----	3.6	65.7	1.7	28.0	1.0	10,070	.45	.01	.54
D177826	A	26.2	33.7	36.0	4.1	6.0	48.3	1.0	40.1	0.5	8,010	0.02	0.02	0.47
	B	----	45.6	48.8	5.6	4.1	65.5	1.4	22.7	0.7	10,850	.02	.02	.64
	C	----	48.4	51.6	----	4.4	69.4	1.5	24.0	0.7	11,490	.02	.02	.68

[1]See table 1 for description of the samples.

Anderson coal bed

(CRO pl. 4-8)

The Anderson coal bed was named by Baker (1929) for outcrops in the northward extension of the Sheridan coal field. The bed is present in much of the southeastern part of the quadrangle, and clinker from burning of the coal caps high divides in most other parts. The Anderson bed is probably at least 29 feet (8.8 m) thick everywhere in the quadrangle, and it attains a thickness of 36 feet (11 m) in a drill hole at locality 14, sec. 10, T. 8 S., R. 43 E. (CRO pl. 4). For much of its extent, the coal is beneath less than 200 feet (61 m) of overburden (CRO pl. 6), and it has good potential for surface mining. Resources of coal available in the bed are very large.

Analyses have been made of five samples of coal from the Anderson bed from two drill holes in the quadrangle (loc. 10 and 14, CRO pl. 1) (Matson and others, 1973, p. 50-51). These samples show a range in sulfur of 0.20-0.33 percent, a range in ash of 3.2-4.8 percent, and a range in heat value of 8,266-8,780 Btu per pound, on an as-received basis.

Dietz coal bed

(CRO pls. 9-13)

The name Dietz was established in southern Montana by Baker (1929) who mapped the Dietz bed over large areas in the northward extension of the Sheridan coal field. The Dietz bed is widespread in the Stroud Creek quadrangle. Its thickness ranges from less than 5 feet (1.5 m) at places in the northern part of the quadrangle to a maximum measured thickness of 18 feet (5.5 m) in a drill hole at locality 10 in the east-central part. It is commonly 10 feet (3.0 m) or more in thickness in large areas in the quadrangle (CRO pl. 9).

Overburden is less than 200 feet (61 m), and the bed is available for surface mining, in an irregular band locally about a mile (1.6 km) wide adjacent to the outcrop, mainly in the western and central parts of the quadrangle (CRO pl. 11). The coal lies beneath a maximum of about 400 feet (122 m) of overburden beneath a few high hills in the southeastern part of the quadrangle.

The following analysis is attributed to the bed at the mine in sec. 2, T. 8 S., R. 43 E.

Form of analysis	Composition, percent[1] Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value, Btu per lb
As received-----	28.86	29.5	38.36	3.28	.32	8,231
Moisture and ash free------	-----	43.47	56.53	----	.47	12,129

[1]Lord, N. W., 1913, Analyses of coals in the United States: Bur. Mines Bull. 22, p. 135.

Upper Canyon coal bed

(CRO pls. 14-18)

The name Upper Canyon is used in this report in the sense of Culbertson and others (1976) for the coal that was called the Canyon bed by other workers in the area of the Stroud Creek quadrangle (Baker, 1929; Bryson and Bass, 1973; Matson and others, 1973). The Upper Canyon bed is a widespread coal in the Stroud Creek quadrangle. Information from outcrops along the northern and western sides of the quadrangle, and widely scattered drilling, including drilling in adjacent areas, indicates that the coal thickens from about 5 feet (1.5 m) in outcrops in the northernmost part of the quadrangle to more than 25 feet (7.6 m) along the northeastern border (CRO pl. 14). It is in excess of 15 feet (4.6 m) thick in the southern part of the quadrangle.

In most parts of the quadrangle, the Upper Canyon bed lies beneath more than 200 feet (61 m) of overburden, and is considered too deeply buried for surface mining. With a few exceptions, only relatively narrow areas on steep slopes immediately adjacent to outcrops of the coal are available for stripping. Areas that have the greatest potential include an area along the flood plain of Hanging Woman Creek in the southwestern corner of the quadrangle south of the point where the coal last crops out, and areas along the valley floor of Stroud Creek in the central part of the quadrangle (CRO pl. 16). Coal in the Canyon bed is beneath more than 600 feet (183 m) of overburden locally in the southeastern part of the quadrangle.

Matson and others (1973, p. 53) reported the analyses of two samples of coal collected from the Upper Canyon bed (Canyon bed of their nomenclature) at locality 9, sec. 19, T. 7 S., R. 44 E. These samples showed an average sulfur content of 0.40 percent, an average ash content of 6.7 percent, and an average heat value of 8,639 Btu per pound, on the as-received basis.

Lower Canyon coal bed

(CRO pls. 19-23)

The Lower Canyon coal bed was named by Culbertson and Klett (1976) in the adjoining Browns Mountain quadrangle to the north. The bed has been traced into the Stroud Creek quadrangle by Culbertson and others (1976). It crops out continuously along the northern and western edges of the Stroud Creek quadrangle (Culbertson and others, 1976), and is present in two drill holes in the northern part of the quadrangle (locs. 8 and 9, CRO pl. 3). At most places, the coal is less than 5 feet (1.5 m) thick; however, it locally attains a thickness of slightly more than 5 feet (1.5 m) in outcrops along Hanging Woman Creek in sec. 32, T. 7 S., R. 43 E., and it is about 7 feet (2.1 m) thick in a drill hole at locality 8 in sec. 25 of the same township. A small area in sec. 32, and a much larger area in the vicinity of sec. 25, T. 7 S., R. 43 E. are considered to contain coal at least 5 feet (1.5 m) thick in the Lower Canyon bed on the basis of this very limited information (CRO pl. 19).

Small amounts of coal in the Lower Canyon bed may be available for stripping in sec. 32, T. 7 S., R. 43 E., and in parts of secs. 35, T. 7 S., R. 43 E., and adjacent parts of secs. 1 and 2 of the township to the south, as shown by CRO plate 21.

Analyses have not been made of coal in the Lower Canyon bed in the Stroud Creek quadrangle.

White coal bed

(CRO pls. 19-23)

The name White was coined by W. C. Culbertson (personal comm., 1977) to identify a coal bed that lies between the Lower Canyon and Cook beds in the subsurface in parts of the Pine Butte School and Forks Ranch quadrangles, which are southwest and south of the Stroud Creek quadrangle, respectively. A coal at the horizon of the White bed, estimated to be 5 feet (1.5 m) thick, is tentatively identified on the resistivity log of the oil and gas test well at locality 15 in sec. 16, T. 8 S., R. 43 E. The White bed is extended northward into the southern part of the Stroud Creek quadrangle on this basis (CRO pl. 19).

Coal in the White bed is more than 200 feet (61 m) below the surface everywhere mapped in the Stroud Creek quadrangle; the bed is considered too deeply buried for surface mining.

Analyses are not available of coal from the White coal bed in the Stroud Creek quadrangle.

Cook coal bed

(CRO pls. 24-28)

The Cook coal bed was named by Bass (1932) for outcrops in the Ashland coal field, which lies several miles north of the Stroud Creek quadrangle.

The bed is less than 5 feet (1.5 m) thick in outcrops in the northwestern part of the Stroud Creek quadrangle. It thickens eastward along its outcrop to 15 feet (4.6 m) in the valley of Lee Creek in the northern part of the quadrangle, and southward to 14 feet (4.3 m) in the valley of Hanging Woman Creek in the western part. It is an estimated 17 feet (5.2 m) thick in the subsurface in the eastern part of the quadrangle (CRO pl. 24) as correlated in the drill hole at locality 8, sec. 25, T. 7 S., R. 43 E.

Areas having the best potential for surface mining are in the valley of Hanging Woman Creek in the southwestern part of the quadrangle, and in the upper valley of the Lee Creek in the northeastern part of the quadrangle (CRO pl. 26). At most other places, coal that is at depths shallow enough for surface mining is confined to a narrow band adjacent to the outcrops of the bed. In these areas the coal is generally thin.

The results of analyses of a sample of weathered coal collected from the Cook bed in the northeastern part of the Stroud Creek quadrangle are shown in tables 2 and 3.

Lower Otter and Otter coal beds

(CRO pls. 29-33)

Culbertson and others (1976) mapped two coal beds called by them the Lower and Upper Otter coal beds in outcrops along Hanging Woman and Lee Creeks in the northern part of the Stroud Creek quadrangle. In sec. 4, T. 7 S., R. 43 E., along Lee Creek, Bryson and Bass (1973) referred to these two coals as the Otter bed and an overlying local bed, respectively.

The Lower Otter coal bed of Culbertson and others (1976) crops out in the northern part of the Stroud Creek quadrangle and is present in the drill hole at locality 4 (CRO pl. 1). The bed attains a thickness of about 5 feet (1.5 m) in two small areas in the northwestern corner of the quadrangle (CRO pl. 29). Apparently coal is missing at the horizon of the Lower Otter bed in the drill hole at locality 8, sec. 25, T. 7 S., R. 43 E., in the eastern part of the quadrangle.

In the subsurface in the southern part of the quadrangle, only one coal bed, 6 feet (1.8 m) thick, was recognized at the horizon of the Otter coal beds (loc. 16, CRO pls. 1 and 29). This coal is referred to in this report as the Otter coal bed. It occupies about the same stratigraphic position as the Lower Otter coal bed of areas to the north, but its relation to the Upper and Lower Otter beds as recognized farther to the north is otherwise unknown.

Small amounts of coal are available for surface mining in the Lower Otter coal bed as mapped in the northwestern part of the quadrangle (CRO pl. 31).

Wall coal bed

(CRO pls. 34-38)

The Wall coal bed was named by Baker (1929) for exposures of the coal along Wall Creek a few miles northwest of the Stroud Creek quadrangle. The bed contains less than 5 feet (1.5 m) of coal where it crops out along Lee and Hanging Woman Creeks in the northern part of the quadrangle (Culbertson and others, 1976). It is probably present underground with a thickness greater than 5 feet (1.5 m) in the southwestern part of the quadrangle, based on the log of an oil and gas well in the Lacey Gulch quadrangle to the west (CRO pl. 34).

The Wall bed is estimated to be 5 feet (1.5 m) or more thick and under less than 200 feet (61 m) of overburden in a small area in secs. 29 and 32, T. 7 S., R. 43 E., where it may have potential for surface mining.

Tables 2 and 3 show analyses of a sample of weathered coal collected from the Wall bed in the northeastern part of the Stroud Creek quadrangle.

Pawnee coal bed

(CRO pls. 39-43)

The Pawnee coal bed as identified in the Stroud Creek quadrangle is the same coal bed that Warren (1959) and Bryson and Bass (1973) called the Pawnee bed in outcrops along the east side of Hanging Woman Creek a short distance north of the quadrangle. The coal locally is 6 feet (1.8 m) thick in outcrops in the northwestern part of the quadrangles (CRO pl. 39), but it is less than 5 feet (1.5 m) thick where identified elsewhere. Culbertson and others (1976) identified 10-20 feet (3.0-6.1 m) of coal in the Pawnee bed in the drill holes at localities 8 and 16; however, deflections on the resistivity logs interpreted by them as coal are interpreted here as sandstone.

Small amounts of coal in the Pawnee bed are available for surface mining in secs. 8, 9, and 17, T. 7 S., R. 43 E., in the northwestern corner of the quadrangle.

Chemical analyses have not been made of coal from the Pawnee coal bed in the Stroud Creek quadrangle.

Poker Jim coal bed

(CRO pls. 39-43)

The Poker Jim coal bed was named by Culbertson and Klett (1976) in the Browns Mountain quadrangle, which is adjacent to the Stroud Creek quadrangle to the north. The coal bed was identified in the subsurface in the drill holes at localities 4, 8, and 16 (CRO pl. 1). It is estimated to be 3 feet (0.9 m) thick in the drill hole at locality 4, and 10 feet (3.0 m) thick in each of the other two holes. A northeast trending lens of coal has been mapped in the subsurface in the southeastern part of the Stroud Creek quadrangle on the basis of the information from these three holes (CRO pl. 39). On the basis of the presently available information, the Poker Jim coal bed is everywhere under more than 200 feet (61 m) of overburden, and does not have potential for surface mining (CRO pl. 41).

Chemical analyses have not been made of coal from the Poker Jim coal bed in the Stroud Creek quadrangle.

Brewster-Arnold coal bed

(CRO pls. 44-48)

The Brewster-Arnold coal bed was named by Bass (1924) for the coal at the Brewster-Arnold mine a few miles northwest of the Stroud Creek quadrangle. Coal in the Brewster-Arnold bed ranges in thickness from

7-11 feet (2.1-3.4 m) where recognized in three drill holes in the quadrangle, and the bed is assumed to underlie most parts of the quadrangle with a thickness that is within this range (CRO pl. 44). The coal may be less than 5 feet (1.5 m) thick in the northwestern corner of the quadrangle, based on limited information from drilling in areas to the north.

The Brewster-Arnold bed is nowhere known to be at depths as shallow as 200 feet (61 m) within the quadrangle, and on this basis does not have potential for surface mining.

Chemical analyses have not been made of coal in the Brewster-Arnold bed in the Stroud Creek quadrangle.

Knobloch coal bed

(CRO pls. 49-53)

The Knobloch coal bed (spelled Knoblock in early reports) was named by Bass (1924) for outcrops several miles north of the Stroud Creek quadrangle. A coal bed 7 feet (2.1 m) thick in the drill hole at locality 16, sec. 16, T. 8 S., R. 43 E., is at about the stratigraphic position of the Knobloch coal bed, and is tentatively correlated with Knobloch on this basis (CRO pls. 3 and 49). The coal is at least 5 feet (1.5 m) thick and beneath 800-1,000 feet (244-305 m) of overburden in a small area mostly west of the drill hole in secs. 16, 17, 20, and 21, T. 8 S., R. 43 E. (CRO pl. 51). The coal bed was not recognized elsewhere in the quadrangle.

Chemical analyses have not been made of the Knobloch bed in the Stroud Creek quadrangle.

Flowers-Goodale coal bed

(CRO pls. 49-53)

The Flowers-Goodale coal bed was named by Bass (1932) for outcrops in the Ashland coal field several miles northeast of the Stroud Creek quadrangle. The coal is beneath less than 1,000 feet (305 m) of overburden only in the northern part of the quadrangle (CRO pl. 51). The coal may be as much as 20 feet (6.1 m) thick at places beneath the valley of Hanging Woman Creek in sec. 8, T. 7 S., R. 43 E. Available information indicates the coal is thinner elsewhere in the quadrangle as shown on CRO plate 49. The coal is everywhere too deeply buried to have potential for surface mining (CRO pl. 51).

Chemical analyses have not been made of coal from the Flowers-Goodale bed in the Stroud Creek quadrangle.

Coal resources

Coal resource estimates in this report are restricted to the Reserve Base part of the Identified Coal Resource, which is the part most likely to be developed in the foreseeable future. (See U.S. Geol. Survey Bull. 1450-B for a discussion of these terms.) The Reserve Base for subbituminous coal is coal that is 5 feet or more (1.5 m) thick, under less than 1,000 feet (305 m) of overburden, and within 3 miles (4.8 km) of a complete measurement of the coal bed. Reserve Base coal is further subdivided into categories according to its nearness to a measurement of the coal bed. Measured coal is coal with ¼ mile (0.4 km) of a measurement, Indicated coal extends ½ mile (0.8 km) beyond Measured coal to a distance of 3/4 mile (1.2 km) from the measurement, and Inferred coal extends 2¼ miles (3.6 km) beyond Indicated coal to a distance of 3 miles (4.8 km) from the measurement.

Reserves are the recoverable part of the Reserve Base. For strippable coal in this quadrangle, the coal reserves are considered to be 85 percent of the part of the Reserve Base that is under less than 200 feet (61 m) of overburden.

The total Reserve Base for federally owned coal in the Stroud Creek quadrangle is estimated to be about 2.9 billion short tons (2.6 billion t) as shown listed by section on CRO plate 2 and by individual coal bed and resource category in table 4. About 4 percent of this large amount is classified as measured, 21 percent as indicated, and 75 percent as inferred.

Table 4.--Estimated Reserve Base for Federal coal lands in the Stroud Creek quadrangle.

(In thousands of short tons, rounded. Multiply by 0.907 to convert to metric tons)

Coal bed name	Overburden 0-200 feet				Overburden 200-1,000 feet				Grand total (rounded)
	Measured	Indicated	Inferred	Total (rounded)	Measured	Indicated	Inferred	Total (rounded)	
Anderson	41,000	165,000	155,000	360,000	-------	15,000	64,000	79,000	440,000
Dietz	29,000	163,000	135,000	327,000	4,800	28,000	64,000	97,000	430,000
Upper Canyon	8,600	28,000	94,000	130,000	6,700	56,000	450,000	510,000	640,000
Lower Canyon	-------	-------	85	85	1,800	7,200	28,000	37,000	37,000
White	-------	-------	-------	-------	170	2,700	10,000	13,000	13,000
Cook	12,000	27,000	27,000	66,000	5,800	74,000	510,000	590,000	660,000
Lower Otter	2,400	3,700	15	6,100	560	3,300	-------	3,900	10,000
Otter	-------	-------	-------	-------	160	4,100	26,000	30,000	30,000
Wall	-------	-------	300	300	-------	------	27,000	27,000	27,000
Pawnee	1,100	580	-------	1,700	370	360	-------	730	2,400
Poker Jim	------	-------	-------	-------	2,100	17,000	190,000	210,000	210,000
Brewster-Arnold	------	-------	-------	-------	2,400	33,000	318,000	350,000	350,000
Knobloch	------	-------	-------	-------	-------	------	1,700	1,700	1,700
Flowers-Goodale	------	-------	-------	-------	3,000	7,900	59,000	70,000	70,000
Total (rounded)	94,000	390,000	410,000	890,000	28,000	250,000	1,700,000	2,000,000	2,900,000

COAL DEVELOPMENT POTENTIAL

Development potential of coal recoverable by surface mining methods

Areas where the coal beds are more than 5 feet (1.5 m) thick and are overlain by 200 feet (61 m) or less of overburden are considered to have potential for strip mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for subbituminous coal is as follows:

$$MR = \frac{t_o\ (0.911)}{t_c\ (rf)}$$

where MR = mining ratio
t_o = thickness of overburden
t_c = thickness of coal
rf = recovery factor (0.85)

Areas of high, moderate, and low development potential are here defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15, as shown on CRO plates 6, 11, 16, 21, 26, 31, 36, 41, and 46. Mining-ratio values for each development-potential category are based on economic and technological criteria, and were derived in consultation with A. F. Czarnowsky, Area Mining Supervisor, U.S. Geological Survey.

Reserve Base for federally owned coal beneath less than 200 feet (61 m) of overburden in the various development-potential categories totals slightly less than 900 million short tons, distributed by bed as shown in table 5.

Each quarter section or lot underlain by federally owned coal in the Stroud Creek quadrangle is classified according to its potential for surface mining on CDP plate 54.

Table 5.--Potential for surface mining of coal in the estimated Reserve Base, Stroud Creek quadrangle.

(In thousands of short tons, rounded. Development potentials are based on mining ratios (cubic yards of overburden/short ton of underlying coal). To convert short tons to metric tons, multiply by 0.907; to convert mining ratios in yd^3/short ton coal to m^3/t, multiply by 0.842.)

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)
Anderson	360,000	-------	------
Dietz	200,000	120,000	11,000
Upper Canyon	61,000	47,000	22,000
Lower Canyon	-------	-------	85
Cook	27,500	24,500	14,000
Lower Otter	1,500	1,300	3,200
Wall	-------	-------	450
Pawnee	1,500	320	560
Total (rounded)	650,000	190,000	52,000

Development potential of coal recoverable by underground mining methods

The Reserve Base for federally owned coal beneath 200-1,000 feet (61-305 m) of overburden is estimated to be about 2.0 billion short tons, as shown in table 4. Coal at these depths is available for underground mining. Coal is not now being mined underground in the Powder River Basin, and recovery factors have not been established. The development potential was not evaluated.

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