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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE HAMILTON DRAW QUADRANGLE, ROSEBUD, BIG HORN, AND POWDER RIVER COUNTIES, MONTANA

(Report includes 54 plates)

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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 Hamilton Draw quadrangle, Rosebud, Big Horn, and Powder River Counties, Montana (plates 1-53); and (2) a coal development potential (CDP) map of the Hamilton Draw quadrangle, Rosebud, Big Horn, and Powder River Counties, Montana (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 Resources 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 Hamilton Draw 7½-minute quadrangle lies on the divide between Hanging Woman and Otter Creeks, in southeastern Rosebud County and adjacent parts of Big Horn and Powder River Counties, Montana. It is about 25 miles (40 km) south of Ashland, Montana, about 10 miles (16 km) southeast of the settlement of Birney, and about 3 miles (4.8 km) west of the store and post office at Otter.

Accessibility

All-weather county roads cross the central and southwestern parts of the quadrangle. These roads are part of a network of graded roads connecting Ashland, Birney, and Otter with other points in southeastern Montana and northeastern Wyoming. The graded roads and unimproved trails that branch from them provide good access to most parts of the quadrangle.

The Burlington-Northern Railroad maintains major east-west routes through Forsyth, Montana, to the north, and Sheridan, Wyoming, to the southwest.

Physiography

A chain of low rounded hills and low buttes that forms the crest of the Hanging Woman Creek--Otter Creek divide bisects the Hamilton Draw quadrangle from southwest to northeast. These hills rise inconspicuously from a broadly rolling upland surface that occupies much of the quadrangle. The upland surface is dissected along its northwestern and eastern sides by the larger streams tributary to Hanging Woman and Otter Creeks. Principal among these are the North and South Forks of Lee Creek in the northwestern part of the quadrangle, which flow generally westward to Hanging Woman Creek, and Little Bear Creek and its larger tributaries in the east-central part of the quadrangle, which flow generally eastward to Otter Creek.

The maximum local relief in the quadrangle is about 400 feet (122 m) in the valley of the North Fork of Lee Creek. The maximum altitude is about 4,180 feet (1,274 m) along the southern edge of the quadrangle in sec. 21, T. 8 S., R. 44 E.

Climate

Southeastern Montana in the vicinity of the Hamilton Draw 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 south-central part of the Powder River Basin KRCRA. About 17 square miles (44 sq. km) in the northern part of the quadrangle are within the Custer National Forest. 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

Bryson and Bass (1973) mapped the area of the Hamilton Draw quadrangle at a scale of 1:63,360 as part of the much larger Moorhead coal field, which lies mostly to the southeast. Matson and others (1973, pls. 8 and 9) described strippable coal deposits in the Anderson and Dietz coal beds in the northern part of the quadrangle on the basis of additional mapping and shallow drilling done by them in 1969 and 1970. Their work also was published at a scale of 1:63,360.

Outcrop traces of coal beds and the distribution of clinker formed by the burning of the coal were transferred by inspection from the published 1:63,360-scale maps in the reports cited above to a 1:24,000-scale topographic base map for use in the present work. The 1:24,000-scale map, augmented by information from the logs of some additional holes drilled in the quadrangle to the end of 1977, is the basis of the present work (CRO pls. 1 and 3).

Information on coal-bed thicknesses is from measurements at outcrops reported by Bryson and Bass (1973), measurements in 14 shallow coal test holes, and measurements from the resistivity log of one oil and gas test well. Information on the deeper coals in the quadrangle, below the level of the Cook coal bed, is exclusively from the log of the one oil and gas test hole. Resistivity logs such as the one available for this well are useful for identifying coal because coal beds typically have high resistivity; however, some other types of rocks, such as limestone and some kinds of sandstone also have high resistivity, so identification of coal based solely on resistivity is 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 Hamilton Draw 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. The top of the Tongue River Member of the Fort Union Formation is the top of the Roland coal bed of Baker (1929).

A sequence about 100 feet (30 m) thick, consisting of sandstone, shale, and minor amounts of fresh-water limestone, conformably overlies the Tongue River Member of the Fort Union Formation in two small areas along the southern edge of the quadrangle and is assigned to the Wasatch Formation of Eocene age. The Wasatch and underlying Fort Union Formations are lithologically similar except that in the Hamilton Draw quadrangle the Wasatch lacks coal.

Rocks comprising the Fort Union and Wasatch Formations 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.

Structure

The Hamilton Draw quadrangle is in the trough of the Powder River structural basin near the basin axis, which in the surface rocks is very indefinitely located. The regional dip is generally southwestward or southward at less than 1°.

Accurate elevations for use in depicting minor structural irregularities of coal beds in the Hamilton Draw quadrangle are sparse, and structure contour maps prepared for the quadrangle are correspondingly highly generalized. Available data indicate that the structural relief within the quadrangle is about 350 feet (105 m) as measured on the Upper Canyon coal bed (CRO pl. 20).

A west-trending fault probably extends from the adjacent Otter quadrangle on the east a short distance into sec. 18, T. 8 S., R. 45 E., where it rapidly dies out westward. The maximum displacement along the fault within the Hamilton Draw quadrangle is unknown, but is probably only a few feet, upthrown to the north (CRO pl. 1).

Coal geology

General features

Twenty coal beds ranging in thickness from 1 to 36 feet (0.3-11.0 m) have been identified on the surface or in the subsurface in the Hamilton Draw quadrangle (CRO pl. 3). Of these, twelve are thick and extensive enough, and under sufficiently shallow cover, to be included in estimates of the Reserve Base. The others are thin coals of limited extent.

The uppermost coal is the Roland coal bed of Baker (1929). This coal is successively underlain by a noncoal interval about 250 feet (76 m) thick; the Smith coal bed; an interval 80-120 feet (24-37 m) thick containing a local coal bed in the lower part; the Anderson coal bed; a noncoal interval about 60-90 feet (18-27 m) thick; the Dietz coal bed; an interval about 120-150 feet (37-46 m) thick containing two local coal beds; the Upper Canyon coal bed; a noncoal interval about 4-25 feet (1.2-7.6 m) thick; the Lower Canyon coal bed; an interval about 110-130 feet (34-40 m) thick containing a local coal bed; the Cook coal bed; an interval about 30 feet (9 m) thick containing a local coal bed; the Otter coal bed; a noncoal interval about 115 feet (35 m) thick; a local coal bed; a noncoal interval about 115 feet (35 m) thick; the Poker Jim coal bed; a noncoal interval about 55-75 feet (17-23 m) thick; the Brewster-Arnold coal bed; a noncoal interval about 280 feet (85 m) thick; the Knobloch coal bed; an interval about 285 feet (87 m) thick containing two local coal beds; and the Flowers-Goodale coal bed.

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 Bryson and Bass (1973).

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 commonly is 50 feet (15 m) or more thick and covers large areas on interstream divides in the Hamilton Draw quadrangle.

Analyses have been made of samples of drill cores collected from the Anderson, Dietz, and Upper Canyon coal beds in the Hamilton Draw quadrangle (Matson and others, 1973, p. 50-55). Based on these analyses, and on analyses of coal samples collected at nearby localities outside the quadrangle, the rank of the coal in the Hamilton Draw quadrangle varies from high in the range of subbituminous C to low in the range of subbituminous B.

The trace element content of coals in the Hamilton Draw quadrangle has not been determined; however, coals in the Northern Great Plains, including those in the Fort Union Formation in Montana, have been found to contain, in general, lesser amounts of most elements of environmental concern than coals in other areas of the United States (Hatch and Swanson, 1977, p. 147).

Roland coal bed of Baker (1929)

(CRO pls. 4-8)

The Roland coal bed was named by Taff (1909) in the Sheridan coal field, Wyoming. A coal assumed to be the same bed was called the Roland bed by Baker (1929) in the northward extension of the Sheridan coal field, Montana. Detailed work in the Sheridan coal field, Wyoming, has shown that the Roland bed of Baker (1929) lies about 125 feet (38 m) above the originally named Roland bed of Taff (1909) (B. E. Law, personal communication, 1972). Baker's (1929) use of the name Roland has been accepted by most other mappers in southeastern Montana and it is followed in this report.

The top of the Roland bed of Baker (1929) is generally used in southern Montana as the contact between the Fort Union and overlying Wasatch Formations.

The Roland bed of Baker (1929) crops out on high ridges in the extreme southern part of the Hamilton Draw quadrangle. It is 8 feet (2.4 m) thick in sec. 22, T. 8 S., R. 44 E. (CRO pl. 4) at the one place in the quadrangle where it has been measured. The coal is everywhere beneath less than 200 feet (61 m) of overburden (CRO pl. 6). Areas underlain by coal are small, however, and resources of coal having potential for surface mining are correspondingly small.

Analyses have not been made of coal in the Roland coal bed of Baker (1929) in the quadrangle.

Smith coal bed

(CRO pls. 4-8)

The Smith coal bed was named by Taff (1909) in the Sheridan coal field, Wyoming, and was traced from the Sheridan area into the area of the Hamilton Draw quadrangle by Baker (1929) and Bryson and Bass (1973). The Smith bed is 6 feet (1.8 m) thick in the drill hole at locality 1 (CRO pl. 1 and 4) in the northern part of the Hamilton Draw quadrangle. The coal is less than 5 feet (1.5 m) thick where recognized in outcrops elsewhere in the quadrangle.

The Smith bed is beneath less than 200 feet (61 m) of overburden where mapped in the northeastern part of the quadrangle in the vicinity of the drill hole at locality 1 (CRO pl. 6); however, resources available for surface mining are small.

Analyses have not been made of coal in the Smith bed in the Hamilton Draw quadrangle.

Anderson coal bed

(CRO pls. 9-13)

The Anderson coal bed was named by Baker (1929) in the northward extension of the Sheridan coal field to the west. The bed is extensively burned, but it is preserved in the southern part of the quadrangle, and a narrow band of unburned coal extends northward in the northern part of the quadrangle beneath the highest part of the Hanging Woman Creek-Otter Creek divide. The bed is at least 30 feet (9.1 m) thick almost everywhere in the quadrangle (CRO pl. 9), and attains a maximum measured thickness of 36 feet (11.0 m) in a drill hole at locality 10, sec. 3, T. 8 S., R. 44 E.

Coal in the Anderson bed is beneath less than 200 feet (61 m) of overburden and has high potential for surface mining in broad areas in the northern and central parts of the quadrangle (CRO pl. 11). Resources of surface-minable coal are large. Maximum depth to the coal is slightly more than 400 feet (122 m), locally, at the south edge of the quadrangle (CRO pl. 11).

Matson and others (1973, p. 50-54) have reported the analyses of 14 samples of coal from the Anderson bed collected from drill holes at 5 localities in the quadrangle (locs. 4, 8, 10, 12, and 13, CRO pl. 1). For 13 of the samples, sulfur was in the range of 0.13-0.78 percent, ash in the range of 3.2-6.4 percent, and heat value in the range of 7,865-9,259 Btu per pound on an as-received basis. The remaining sample contained 2.1 percent sulfur, 18.4 percent ash, and had a heat value of 6,751 Btu per pound on an as-received basis.

Dietz coal bed

(CRO pl. 14-18)

The name Dietz is used in this report for the coal called the Dietz bed by Bryson and Bass (1973) in the western part of the Moorhead coal field. The Dietz bed underlies most of the Hamilton Draw quadrangle (CRO pl. 14). The coal is 17 feet (5.2 m) thick at loc. 5 in sec. 27, T. 7 S., R. 44 E., and may be slightly thicker locally along the western edge of the quadrangle based on drilling in the Stroud Creek quadrangle to the west. The bed probably thins to less than 5 feet (1.5 m) in the northwestern corner of the quadrangle, and it contains 6 feet (1.8 m) of coal at an outcrop near the eastern boundary of the quadrangle in sec. 19, T. 7 S., R. 45 E. (CRO pl. 14).

Coal in the Dietz bed has high potential for surface mining in large areas in the northern part of the quadrangle and along the eastern side (CRO pl. 16).

Analyses have been made of three samples of coal from the Deitz bed collected from drill holes at localities 5 and 11 (CRO pl. 1) (Matson and others, 1973, p. 53, 55). The analyses show sulfur in the range of 0.27-0.30 percent, ash in the range of 3.7-4.3 percent, and heat value in the range of 7,911-8,707 Btu per pound on an as-received basis.

Upper Canyon coal bed

(CRO pls. 19-23)

The name Upper Canyon is used in this report in the sense of Culbertson and Klett (1976) for the coal that was called the Canyon bed by Bryson and Bass (1973) and Matson and others (1973) in the area of the Hamilton Draw quadrangle. The Upper Canyon bed underlies nearly all of the Hamilton Draw quadrangle with a thickness everywhere estimated to be greater than 15 feet (4.6 m), and at most places to be greater than 20 feet (6.1 m). The coal attains a maximum measured thickness of 33 feet (10.1 m) near the head of the South Fork of Lee Creek in the northwestern part of the quadrangle (locs. 6 and 7, CRO pl. 1).

The Upper Canyon bed is overlain by more than 200 feet (61 m) of overburden in most parts of the Hamilton Draw quadrangle, and, at most places, is considered too deeply buried for surface mining. Areas that are beneath less than 200 feet (61 m) of overburden comprise irregular and relatively narrow bands on the valley sides and in the valley bottoms of the North and South Forks of Lee Creek in the northwestern part of the quadrangle, and along the sides and in the bottoms of the Little Bear Creek and some of its large tributaries in the eastern part (CRO pl. 21).

Matson and others (1973, p. 53, 55) reported the analyses of two samples of coal collected from the Upper Canyon bed (Canyon bed of their nomenclature) at locality 6, sec. 28, T. 7 S., R. 44 E. These samples showed an average sulfur content of 0.42 percent, an average ash content of 6.1 percent, and an average heat value of 8,487 Btu per pound, on an as-received basis.

Lower Canyon coal bed

(CRO pls. 24-28)

The Lower Canyon coal bed was named by Culbertson and Klett (1976) in the adjoining Browns Mountain quadrangle to the northwest. The bed has been identified in three drill holes in the Hamilton Draw quadrangle (locs. 1, 3, and 9, CRO pl. 1), and it is present in drill holes and outcrops in the quadrangles to the west, northwest, and north. On the basis of the sparse information available, coal in the Lower Canyon bed is presumed to be 5 feet (1.5 m) or more thick in the subsurface in two lenses, one that projects southward for about 2 miles (3.2 km) into the northern part of the Hamilton Draw quadrangle, and the other that projects southeastward for about 3 miles (6.4 km) into the southwestern part of the quadrangle (CRO pl. 24). The maximum thickness of coal measured in the Lower Canyon bed in the quadrangle is 6 feet (1.8 m) at locality 9; however, the coal may be slightly thicker than 6 feet (1.8 m) at the northern edge of the quadrangle, based on information from a drill hole in the adjacent Poker Jim Butte quadrangle to the north.

Coal in the Lower Canyon bed is probably under less than 200 feet (61 m) of overburden and available for surface mining in small areas in the northwestern part of the Hamilton Draw quadrangle as shown on CRO plate 27.

Analyses have not been made of coal from the Lower Canyon bed in the Hamilton Draw quadrangle.

Cook coal bed

(CRO pls. 29-33)

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

Information from surrounding areas indicates that the Cook bed is a widespread coal and that it underlies all of the Hamilton Draw quadrangle (CRO pl. 29). Two drill holes have penetrated the bed in the quadrangle; in the hole at locality 3, the Cook bed is 21 feet (6.4 m) thick, and in the hole at locality 9, the Cook bed is 12 feet (3.7 m) thick. The coal may attain a thickness of about 25 feet (7.6 m) in the northeast corner of the quadrangle (CRO 11-29), based on its thickness in a drill hole in the adjacent Otter quadrangle to the east.

Coal in the Cook bed may be under less than 200 feet (61 m) of overburden and available for surface mining in small areas of a few hundred acres in the northwestern corner and along the eastern edge of the quadrangle (CRO pl. 31).

Analyses have not been made of coal in the Cook bed in the Hamilton Draw quadrangle.

Otter coal bed

(CRO pls. 34-38)

Bryson and Bass (1973) named the Otter coal bed for exposures of the coal along Otter Creek, a few miles east of the Hamilton Draw quadrangle.

Coal in the Otter bed is 5 feet (1.5 m) or more thick only along the northern edge of the Hamilton Draw quadrangle, based on information from widely scattered drill holes, mostly in areas outside the quadrangle (CRO pl. 34). The coal is at depths greater than 200 feet (61 m) where mapped in the quadrangle (CRO pl. 36), and is not readily available for surface mining.

Analyses have not been made of coal from the Otter bed in the 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 Hamilton Draw quadrangle to the northwest.

The bed was identified in the drill hole at locality 9 (CRO pl. 1) where it is estimated to be 9 feet (2.7 m) thick. Information from this hole, and from other distant points in adjacent quadrangles, suggests that the bed underlies a large area in the Hamilton Draw quadrangle (CRO pl. 39). Because of the scarcity of data about the bed, however, the distribution of the coal as shown on the CRO maps (CRO pls. 39-43) is highly generalized.

Coal in the Poker Jim bed is everywhere under more than 200 feet (61 m) of overburden; in the southern part of the quadrangle, the thickness of overburden exceeds 1,000 feet (305 m) (CRO pl. 41). The bed is too deeply buried to have potential for surface mining.

Analyses have not been made of coal from the Poker Jim bed in the Hamilton Draw 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 Hamilton Draw quadrangle.

Coal 9 feet (2.7 m) thick was tentatively identified at the horizon of the Brewster-Arnold bed on the log of the drill hole at locality 9 (CRO pl. 1). This identification, and information from widely scattered drill holes outside the quadrangle, have been used to define a broad, generally eastward thinning belt of coal comprising the Brewster-Arnold bed that extends entirely across the Hamilton Draw quadrangle. The part of this belt estimated to be thicker than 5 feet (1.5 m) is shown by CRO plate 44. Because coal has been identified at only one place in the quadrangle, details of the distribution and thickness of the coal are largely unknown.

Coal in the Brewster-Arnold bed is deeply buried in the Hamilton Draw quadrangle (CRO pl. 46), and the bed does not have potential for surface mining.

Analyses have not been made of coal from the Brewster-Arnold bed in the Hamilton Draw quadrangle.

Knobloch coal bed

(CRO pls. 49-53)

The Knobloch coal bed (spelled Knoblock in early reports) was named by Bass (1924) for outcrops along the Tongue River several miles northwest of the Hamilton Draw quadrangle. The Knobloch bed is 6 feet (1.8 m) thick in the drill hole at locality 9 in the southwestern part of the Hamilton Draw quadrangle. It is about 20 feet (6.1 m) thick in a drill hole in the northwestern part of the Otter quadrangle to the east (E. J. McKay, personal communication, 1977), and is probably this thick in the adjacent northeastern corner of the Hamilton Draw quadrangle. Information from these two drill holes, and from other holes outside of the Hamilton Draw quadrangle, suggests that the Knobloch coal forms a southwestward thinning wedge in the subsurface in the Hamilton Draw quadrangle (CRO pl. 49). The coal is under less than 1,000 feet (305 m) of overburden only in the northern part of the Hamilton Draw quadrangle and at places along the east side (CRO pl. 51). It is everywhere too deeply buried to have potential for surface mining.

Analyses have not been made of coal from the Knobloch bed in the Hamilton Draw quadrangle.

Flowers-Goodale coal bed

(CRO pl. 4-8)

The Flowers-Goodale coal bed was named by Bass (1932) in the Ashland coal field several miles north of the Hamilton Draw quadrangle.

The coal is nearly everywhere beneath more than 1,000 feet (305 m) of overburden, except in the northwestern corner of the quadrangle under the valley bottom of the North Fork of Lee Creek in sec. 17, T. 7 S., R. 44 E. (CRO pl. 4). The thickness of this coal in this area is estimated to be slightly less than 15 feet (4.6 m). The coal does not have potential for surface mining.

Analyses have not been made of coal from the Flowers-Goodale bed in the Hamilton Draw 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.) Reserve Base subbituminous coal is more than 5 feet (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 within ¼ mile (0.4 km) of a point of 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 point and Inferred coal extends 2¼ miles (3.6 km) beyond Indicated coal to a distance of 3 miles (4.8 km) from the measurement point.

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 Hamilton Draw quadrangle is estimated to be about 4.8 billion short tons (4.4 billion t) as shown listed by section on CRO plate 2 and by individual coal bed and resource category in table 1. About 3 percent of this large amount is classified as measured, 16 percent as indicated, and 81 percent as inferred.

Table 1.--Estimated Reserve Base for Federal coal lands in the Hamilton Draw quadrangle.

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

	Overburden 0-200 feet (0-61 m)				Overburden 200-1,000 feet (61-305 m)				
Coal bed name	Measured	Indicated	Inferred	Total (rounded)	Measured	Indicated	Inferred	Total (rounded)	Grand total (rounded)
Roland of Baker (1929)	200	---------	1,000	1,200	---------	---------	---------	---------	1,200
Smith	470	680	---------	1,200	---------	---------	---------	---------	1,200
Anderson	50,000	210,000	370,000	630,000	---------	7,200	280,000	290,000	920,000
Dietz	20,000	150,000	290,000	460,000	1,800	8,000	200,000	210,000	670,000
Upper Canyon	12,000	67,000	203,000	280,000	24,000	230,000	990,000	1,200,000	1,500,000
Lower Canyon	400	1,000	1,000	2,400	1,500	14,000	96,000	110,000	110,000
Cook	---------	---------	17,000	17,000	7,400	63,000	880,000	950,000	970,000
Otter	---------	---------	---------	------	---------	---------	11,000	11,000	11,000
Poker Jim	---------	---------	---------	------	2,100	15,000	260,000	280,000	280,000
Brewster-Arnold	---------	---------	---------	------	2,000	15,000	230,000	250,000	250,000
Knobloch	---------	---------	---------	------	---------	---------	60,000	60,000	60,000
Flowers-Goodale	---------	---------	---------	------	---------	---------	500	500	500
Total (rounded)	83,000	430,000	880,000	1,400,000	39,000	350,000	3,000,000	3,400,000	4,800,000

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, and 31. 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 about 1,400 million short tons, distributed by bed as shown in table 2.

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

Table 2.--Potential for surface mining of coal in the estimated Reserve Base, Hamilton Draw 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 name	High development potential (0-10 mining ratio)	Moderate development potentail (10-15 mining ratio)	Low development potential (>15 mining ratio)
Roland of Baker (1929)-------	860	330	-------
Smith-------------	990	150	-------
Anderson----------	630,000	-------	-------
Dietz-------------	300,000	140,000	24,000
Upper Canyon------	270,000	1,700	-------
Lower Canyon------	-------	30	2,400
Cook--------------	10,000	7,200	-------
Total (rounded)------	1,200,000	150,000	26,000

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 3,400 million short tons, as shown in table 1. 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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