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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BEAR CREEK SCHOOL QUADRANGLE, POWDER RIVER COUNTY, MONTANA

(Report includes 59 plates)

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This report has not been edited
for conformity with U.S. Geological
Survey editorial standards or
stratigraphic nomenclature.

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COAL RESOURCE OCCURRENCE

Introduction

Purpose

This text is for use in conjunction with the Coal Resource Occurrence (CRO) maps (plates 1-58) and the Coal Development Potential (CDP) map (plate 59) of the Bear Creek School quadrangle, Powder River County, Montana (U.S. Geological Survey Open-File Report 79-106). The maps are intended to support land-use planning and coal leasing activities of the Bureau of Land Management as required by their Energy Mineral Activities Recommendation System (EMARS), and to provide information leading to a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. The only coal beds considered are those 5 feet (1.5 m) or more thick, and under less than 1,000 ft (305 m) of overburden (Reserve Base for subbituminous coals); thinner or deeper beds are not shown on the maps or included in the resource estimation.

Location

The Bear Creek School 7 1/2-minute quadrangle is in the southwestern part of Powder River County, Montana, within the drainage of Bear Creek, a west fork tributary of Otter Creek. The nearest town is Ashland, about 40 miles (64 km) to the north.

Accessibility

An all-weather graveled road to Ashland along Bear and Otter Creeks leads to secondary ranch roads that provide access to most parts of the quadrangle. The paved east-west highway, Montana 212, passes through Ashland.

Physiography

Most of the quadrangle is dissected by tributaries of Bear Creek. Elevation of the southern part of the quadrangle is about 4,200 feet (1,280 m), and Bear Creek in the northern part of the quadrangle is about 3,700 feet (1,128 m).

Climate

The quadrangle is in a semiarid climate with an average rainfall of about 14 inches (35 cm). Annual range in temperature is from 100°F to -39°F (38°C to -34°C).

Land Status

The quadrangle is in the central part of the Powder River Basin KRCRA, Montana. Except for a strip less than a quarter section in area and three sections of state land, the coal rights in the quadrangle belong to the Federal Government.

In 1977 the Bear Creek School quadrangle did not contain any Federal coal leases, prospecting permits, or licenses.

General Geology

Sources of Information

Bryson and Bass (1973) mapped the quadrangle at a scale of 1:63,360 as part of the Moorhead Coal Field, Montana. McKay mapped the quadrangle on a scale of 1:24,000 and a report is in preparation. This map is the principal source for coal-bed outcrops and boundaries showing the extent of burning of near-surface coals (CRO pl. 1).

The sources of private and government agency drill information is given on the top of graphic logs shown on CRO pl. 3.

Coal bed names are from Baker (1929), Bryson and Bass (1973), Bass (1924) and Culbertson and Klett (unpublished map). Use of some names was made by Matson and Blumer (1973). Some of the stratigraphic control for coal beds are from Culbertson (oral communication) in the adjacent Quietus quadrangle.

Stratigraphy

Most of the coal-bearing rocks exposed in the quadrangle, and those present to depths of 1,000 feet (305 m), are in the Tongue River Member of the Fort Union Formation of Paleocene age. The overlying Wasatch Formation of Eocene age contains the Arvada coal bed.

Tongue River Member is about 2,000 feet (610 m) thick in the quadrangle and consists of interbedded lenticular beds of yellowish-gray to light-gray, fine- to very fine grained mostly friable sandstone, light- to dark-gray siltstone and clayey siltstone, gray shale and claystone, brown and black carbonaceous shale, and persistent coal beds. The environment of deposition of rocks comprising the Tongue River was one of shifting streams, flood plains, and swamps in a region of low relief draining toward the Cannonball Sea in northeastern Montana and North Dakota.

Representative samples of the sedimentary rocks adjacent to 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 U.S. Department of Agriculture and others (1974) and by Swanson (in Mapel and others, 1977, pt. A, p. 42-44). These results show that the rocks contain no greater amounts of trace elements of environmental concern than do similar types of rocks found throughout other parts of the United States.

Structure

The quadrangle is on the east side of the Powder River structural basin axis. Regional dip is southwestward at less than 90 feet per mile (17 m per km). Structural relief within the quadrangle, as exemplified by the Canyon coal bed, is about 300 feet (91 m), as shown on CRO plate 35.

Coal Geology

Eighteen coal beds ranging in the thickness from 3 feet (1 m) to 33 feet (9.5 m) were identified on the surface or in the subsurface in the Bear Creek School quadrangle (CRO pls. 1 and 3). The highest coal bed, the Arvada, occurs in limited areas on the divide in the southern part of the quadrangle. The Arvada is underlain by a noncoal interval about 75 feet (23 m) thick; the Roland of Baker (1929) coal bed or beds; a noncoal interval about 100-150 feet (18 m) thick; a split bed designated the Local and Waddle; an interval of 74 feet (23 m); the Smith bed; a noncoal interval of 150 feet (46 m); the Anderson bed; a noncoal interval 30-40 feet (9-12 m) thick; a Local bed; a noncoal interval 40 feet (12 m) thick; the Dietz bed; a noncoal interval 65 feet (19 m) thick; the Canyon bed; a noncoal interval 40 feet (12 m) thick; a noncoal interval 140-200 feet thick; the Cook bed; a noncoal interval 35 feet (11 m) thick; the Otter bed; a noncoal interval 100 feet (30 m) thick; a Local bed; a noncoal interval 100 to 250 feet (30-76 m) thick; the Brewster-Arnold bed; a noncoal interval more than 300 feet (91 m) thick; the Knobloch bed; an interval 250 feet (76 m) thick locally containing a thin coal bed; the Flowers-Goodale or Roberts bed; an interval 175 to 380 feet (53-107 m) thick; and the Kendrick bed. The last two coal beds are below the 1,000 foot (305 m) Reserve Base limit for most of their occurrence in this quadrangle.

Coal bed thicknesses shown on the CRO maps are the bed thicknesses reported at outcrops or in drill holes, rounded to the nearest foot, excluding partings.

Many of the coal beds have caught fire at the outcrop in the past, and have burned underground for varying distances, some for a mile 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). In this quadrangle, clinker is as much as 100 feet (30 m) thick.

Published analyses of the Anderson, Dietz and Canyon coal beds in the quadrangle (Matson and Blumer, 1973, p. 59-60) indicate that their apparent rank is in the range of subbituminous B and C; and the trace element content of these coals contain, in general, lesser amounts of most elements of environmental concern than do coals in other areas of the United States (Hatch and Swanson, 1977, pl. 47).

Arvada coal bed

(CRO pls. 4-8)

The name Arvada bed as used in the Bear Creek School quadrangle follows that of Bryson and Bass (1973, p. 64). Mining potential of the Arvada is considered only fair considering its thickness range of 5 to 7 feet (1.5-2 m) its relatively thin overburden cover, and limited areal extent. Its exposure to oxidation by weathering probably lowers its heat content so its use would probably be as a blend with lower coals.

Roland of Baker (1929) coal bed

(CRO) pls. 9-13)

The Roland bed of Baker (1929) was mapped by Bryson and Bass (1973, p. 65) and the name is used in the Bear Creek School quadrangle. It ranges from 5 to 13 feet (1.5-4 m) in thickness, has a low to moderate mining ratio, and probably has only a fair potential for mining.

(CRO pls. 14-18)

The Local coal bed 19 feet above the Waddle is 9 feet (5.5 m) thick in one drill hole (plate 14) and has a low mining ratio (plate 16).

Waddle coal bed

(CRO pls. 19-23)

The Waddle bed was named by Culbertson and Klett (unpublished map) for a coal bed outcrop in Waddle Creek in the Forks Ranch quadrangle, Montana. The name is applied to a bed apparently restricted to the southwestern part of the quadrangle. An inferred thickness from gamma-ray log of 9 feet (5.5 m) in the Clark Canadian No. 1 Federal hole (locality 26) remains to be confirmed. A drilled thickness in the Amax hole (#20) of 5 feet (1.5 m) places the mining potential between low and not proved.

Anderson coal bed

(CRO pls. 24-28)

The usage of the name Anderson bed as used in the Bear Creek School quadrangle follows that of Bryson and Bass (1973) and Matson and Blumer (1973). It ranges in thickness from 10 to 33 feet (3-10 m) has a moderate to high mining ratio (pl. 26), and probably has the best mining potential of all coal beds in the quadrangle.

Dietz coal bed

(CRO pls. 29-33)

The name Dietz is used for a coal bed in the Bear Creek School quadrangle as applied by Bryson and Bass (1973) and Matson and Blumer (1973). The Dietz is generally less than 5 feet (1.5 m) thick, ranges to 12 feet (3.6 m) thick, and has a moderate to low mining ratio.

Canyon coal bed

(CRO pls. 34-38)

The Canyon coal bed is the coal referred to by that name by Bryson and Bass (1973) and Matson and Blumer (1973). It ranges in thickness from 16 to 25 feet (5-8 m) has a moderate mining ratio, and has good mining potential in limited areas.

Cook coal bed

(CRO pls. 39-43)

The name Cook coal bed was used by Warren (1959) for a persistent coal bed in the Birney-Broadus coal field which he apparently believed to be correlative with a bed of that name on Cook Creek Mountain in the Ashland coal field (Bass, 1932). The name was also used by Bryson and Bass (1973) in the Moorhead coalfield. Although the Cook ranges in thickness from 5 to 18 feet, (1.5-5.5 m) the area within the stripping limit, 200 feet (61 m) is very small and here the bed is 5 or 6 feet (1.5 m) thick, and consequently has a low mining ratio.

Otter coal bed

(CRO pls. 44-48)

The Otter coal bed is a name applied by Bryson and Bass (1973) for a coal exposed in the vicinity of the Otter Post Office. Within the small area where overburden is less than 200 feet (61 m) the coal is 8 to 9 feet (2.4-2.7 m) thick and has little or no mining potential.

Brewster-Arnold coal bed

(CRO pls. 49-53)

The Brewster-Arnold coal bed was named by Bass (1924) for a coal bed exposed at the Brewster-Arnold coal mine on the Tongue River. In this quadrangle the bed ranges in thickness from 5 to 11 feet (1.5-4 m), is overlain by a minimum of 400 feet (122 m) of overburden, and has poor development potential.

Knobloch coal bed

(CRO pls. 54-58)

The Knobloch coal bed (spelled Knoblock in early reports) was named by Bass (1924) for exposures along the Tongue River about 10 miles (16 km) south from Ashland. The coal bed called Knobloch in this report was identified as the middle bench of the Knobloch by Matson and Blumer (1973, pls. 11A and 33).

The Knobloch is 5 to 10 feet (1.5-3 m) thick in the quadrangle, is below 700 feet (204 m) or more of overburden, and has no development potential for surface mining.

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 more than 5 feet (1.5 m), thick and under less than 1000 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 1/4 miles (0.4 km) of a measurement. Indicated coal is 1/2 mile (0.8 km) beyond Measured coal, and Inferred coal is 2 1/4 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 reserve is 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 is estimated to be about 3.94 billion short tons (3.57 billion metric tons) as shown listed by section on CRO plate 2 and by individual coal bed and resource category on table 1. About 5 percent of this large amount is classified as Measured, 29 percent as Indicated, and 66 percent as Inferred as summarized in the tabulation below:

Summary of estimated Reserve Base for Federal coal lands according to reliability of the estimate, Bear Creek School quadrangle

(To convert short tons to metric tons, multiply by 0.907)

	Millions of short tons		
	Overburden 0-200 feet	Overburden 200-1,000 feet	Percent of total
Measured---	133.80	81.12	5
Indicated--	516.95	631.42	29
Inferred---	218.25	2357.12	66

Table 1.--Estimated Reserve Base for surface-mining (0-200 feet overburden) and underground-mining (200-1,000 feet overburden) methods for Federal coal lands in the Bear Creek School quadrangle, Powder River County, Montana.

[in millions of short tons, rounded. Multiply by 0.907 to convert to metric tons.]

Coal bed name	Overburden 0-200 feet (0-61 m)				Overburden 200-1,000 feet (61-305 m)				Grand Total (rounded)
	Measured	Indicated	Inferred	Total	Measured	Indicated	Inferred	Total	
Arvada	2.72	7.69	1.84	12.25	----	----	----	-----	12.25
Roland of Baker	14.46	52.18	36.60	103.24	----	----	----	-----	103.24
Local Bed 19 feet above Waddle	.05	4.65	8.80	13.50	2.04	9.85	22.02	33.91	47.40
Waddle	.12	5.76	24.53	30.41	2.94	15.46	47.44	65.84	97.25
Anderson	63.03	272.37	71.32	406.72	18.77	179.40	393.54	591.71	998.43
Dietz	18.40	76.19	55.79	150.38	11.05	64.00	214.01	289.06	439.44
Canyon	33.37	94.61	18.06	146.04	26.99	214.59	788.07	1029.65	1175.69
Cook	.90	1.16	.78	2.84	9.34	74.58	493.41	577.33	580.17
Otter	.75	2.34	.53	3.62	6.26	47.50	260.57	314.33	317.95
Brewster-Arnold	-----	-----	-----	-----	2.35	16.88	126.94	146.17	146.17
Knobloch	-----	-----	-----	-----	1.38	9.16	11.12	21.66	21.66
Total	133.80	516.95	218.25	869.00	81.12	631.42	2357.12	3069.66	3938.66

COAL DEVELOPMENT POTENTIAL

Development potential for surface mining methods

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

$$MR = \frac{t_o\,(0.91)}{t_c\,(r_f)}$$

Where MR = mining ratio

t_o = thickness of overburden (in feet)

t_c = thickness of coal (in feet)

r_f = 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, and 36. These mining ratio values for each development-potential category are based on economic and technological criteria; they are applicable to this quadrangle, 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 0.9 billion short tons, as shown in table 2.

Table 2.--Estimated Reserve Base by development potential for surface mining methods (0-200 feet overburden) for Federal coal lands in the Bear Creek School quadrangle, Powder River County, Montana.

[In millions of short tons. Development potentials are based on mining ratios (cubic yards of overburden/short ton of recoverable coal). To convert short tons to metric tons, multiply by 0.9072; to convert mining ratios in yd^3/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)	Total (rounded)
Arvada	10.76	1.49	----	12.25
Roland of Baker (1929)	72.52	26.19	4.53	103.24
Local bed 19 feet above Waddle	-----	-----	13.50	13.50
Waddle	.92	1.84	27.65	30.41
Anderson	380.96	25.76	----	406.72
Dietz	46.99	38.44	64.95	150.38
Canyon	139.43	6.61	----	146.04
Cook	-----	-----	2.84	2.84
Otter	-----	-----	3.62	3.62
Brewster-Arnold	-----	-----	----	-----
Knobloch	-----	-----	----	-----
Total	651.58	100.33	117.09	869.00

Development potential for 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 3.1 billion short tons (2.8 billion metric tons), table 1. Coal at these depths is available for underground mining, but recovery factors have not been established, and coal is not presently being mined underground in the Powder River Basin. Consequently, the development potential was not evaluated.

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