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COAL RESOURCE OCCURRENCE MAP OF THE LITTLE THUNDER RESERVOIR QUADRANGLE, CAMPBELL COUNTY, WYOMING

[Report includes 13 plates]

By

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and

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COAL DEVELOPMENT POTENTIAL MAP OF THE LITTLE THUNDER RESERVOIR QUADRANGLE, CAMPBELL COUNTY, WYOMING

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INTRODUCTION

Purpose

This text is to be used in conjunction with two groups of maps: (1) Coal Resource Occurrence (CRO) Maps of the Little Thunder Reservoir quadrangle, Campbell County, Wyoming (13 plates; U.S. Geol. Survey Open-File Report 77-57), and (2) Coal Development Potential (CDP) Maps of the Little Thunder quadrangle, Campbell County, Wyoming (2 plates; U.S. Geol. Survey Open-File Report 77-58). These reports were compiled to support the land planning work of the Bureau of Land Management's EMARS (Energy Minerals Activities Recommendation System) program, and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States.

Location

The Little Thunder Reservoir 7½-minute quadrangle is in southeastern Campbell County, Wyoming, about 37 mi (60 km) south of Gillette and 71 mi (114 km) north of Douglas, Wyoming.

Accessibility

The area is accessible by State Route 59, which passes north-south through the quadrangle. State Route 59 connects with Interstate 90 at Gillette north of the quadrangle and with Interstate 25 at Douglas south of the quadrangle.

The Burlington Northern Railroad operates and maintains east-west routes through Gillette and Douglas. The line through Douglas is jointly operated by Burlington Northern and the Chicago and North Western, and these companies have planned a new north-south railroad that would link the existing line near Douglas with the existing line near Gillette. This proposed route would pass through or near the quadrangle.

Physiography

The quadrangle lies in the eastern part of a large topographic depression superposed over the eastern part of the Powder River structural basin. The eastern half of the quadrangle is characterized by small, shallow basins or depressions. The landscape is dominated by rolling, grass-covered prairie except for a dissected erosional escarpment in the northwestern part of the quadrangle. This escarpment is formed by clinker beds which resulted from the burning of the Felix coal bed. Local relief from stream valley floor to ridge top is about 300 ft (91 m).

Little Thunder Creek, the major drainage system of the area, is an intermittent stream which flows eastward.

Climate

The climate of the Powder River Basin in eastern Wyoming is directly influenced by major topographic features such as the Laramie Range to the south and the Bighorn Mountains to the west. Pacific air currents drop much of their moisture prior to entering eastern Wyoming; consequently, the climate is semiarid. Average annual precipitation is about 13 in. (33 cm); the greatest amount of precipitation occurs in the spring and early summer. Wind is a significant factor in the climate of the Powder River Basin, and the prevailing westerly winds increase in velocity during the colder months of November through March. Temperatures recorded at Douglas by the U.S. Department of Commerce vary from as much as 106°F in summer months to as low as -38°F in winter months.

Land Status

The quadrangle lies within the eastern half of the Powder River Basin Known Recoverable Coal Resource Area, and the Federal Government owns the coal rights for lands over most of the quadrangle, as shown on plate 2 of the Coal Resource Occurrence maps. No outstanding Federal coal leases, prospecting permits, or licenses occur within the quadrangle.

GENERAL GEOLOGY

Previous Work

Dobbin and Barnett (1928) mapped some surface exposures of clinker and coal beds in the northwestern part of the quadrangle; Schell and Mowat (1972) mapped the same area in a reconnaissance survey of the eastern part of the Powder River Basin.

Stratigraphy

Exposed rocks in the quadrangle are units of the Wasatch Formation of Eocene age. The Fort Union Formation of Paleocene age lies at shallow depths in much of the quadrangle. These two formations contain the major coal deposits of the Powder River Basin.

The Fort Union Formation is about 3,000 ft (914 m) thick and consists predominantly of medium- and dark-gray shale and claystone; varying amounts of interbedded siltstone; light-gray, fine- to coarse-grained sandstone; and brownish-gray carbonaceous shale and coal beds. In contrast, the rocks of the overlying Wasatch Formation are about 1,000 ft (305 m) thick and consist predominantly of yellowish-gray fine- to coarse-grained arkosic sandstone interbedded with siltstone, brown carbonaceous shale, gray clay-shale, and numerous coal beds which are generally thinner than those of the Fort Union Formation.

The contact between the Wasatch and the underlying Fort Union Formation in this area is arbitrarily placed at the top of the Wyodak coal bed, which underlies the quadrangle at depths ranging from about 400 ft (122 m) on the east to 900 ft (274 m) on the west, as shown on CRO plates 3 and 12.

Samples representative of the sedimentary rocks overlying minable coal beds in the eastern Powder River Basin have been analyzed in detail by the U.S. Geological Survey, and the results were reported by the Department of Agriculture and others (1974). 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.

During Paleocene and Eocene time, the Powder River Basin was a large area which subsided intermittently. Periods of structural stability promoted the deposition of laterally continuous coal beds that formed in large swamps adjacent to fluvial channels. A remarkable period of stability occurred near the end of Paleocene time and resulted in the formation of the thick, laterally continuous Wyodak coal bed. Sediments derived from surrounding source areas were deposited within fluvial depositional environments including stream channel, overbank, and flood plain.

Structure

The quadrangle is on the eastern flank of the Powder River structural basin, about 30 mi (48 km) northeast of the basin axis, which trends northwest. Regional dip is toward the west at less than 1°; structural relief on the Manning coal bed, owing to regional dip, is as much as 300 ft (91 m), as shown on CRO plate 11.

COAL GEOLOGY

Eight coal beds were either mapped on the surface or identified in the subsurface in this quadrangle (CRO plate 3). The Manning coal bed is the stratigraphically lowest recognized coal bed. It is successively overlain by a sequence of rocks, which includes two local coal beds and a noncoal interval, that averages about 720 ft (219 m) thick; the Wyodak coal bed; a noncoal interval about 220 ft (67 m) thick; the lower C coal bed; a noncoal interval about 160 ft (49 m) thick; the upper C coal bed; a noncoal interval about 360 ft (110 m) thick; the lower Felix coal bed; a noncoal interval about 50 ft (15 m) thick; and the upper Felix coal bed.

The coal beds of the Fort Union and Wasatch Formations in the eastern Powder River Basin are generally subbituminous C in rank and contain less than 1 percent sulfur and less than 10 percent ash. Coal analyses indicate that these coals contain about the same amounts of trace metal elements as coal beds in other areas of the United States, and contain no abnormally high contents of toxic trace elements.

Manning Coal Bed

The lowest identified coal bed, the Manning coal, was named by the author for its thick occurrence in the subsurface beneath the Manning Ranch in sec. 14, T. 38 N., R. 74 W., about 28 mi (45 km) south-southwest of the quadrangle. The Manning coal bed and the two overlying local coal beds have been tentatively correlated by N. M. Denson (oral commun., 1977) with the Cache and the lower and upper Pawnee coal beds of the Moorhead and Birney-Broadus coal fields in southeast Montana.

The Manning coal bed dips gently to the west at less than 1°, as shown on CRO plate 11. Overburden thickens from about 1,200 ft (366 m) in the east to more than 1,800 ft (549 m) along the western boundary of the quadrangle, as shown on CRO plate 13. The coal bed increases in thickness from about 4 ft (1.2 m) along the northern and eastern boundaries of the quadrangle to about 10 ft (3 m) in the southwest, as shown on CRO plate 5.

Chemical analysis of the Manning coal.--No known chemical analyses of the Manning coal bed have been made; it is assumed, however, that the quality of the coal is similar to other coal beds of the Fort Union Formation and is subbituminous C in rank.

Chemical analysis of the Wyodak coal.--No analyses have been made of the Wyodak coal from this quadrangle, but analyses of cores of the coal from the adjoining Reno Reservoir quadrangle to the east have been reported by the Department of Agriculture and others (1974) as follows:

	W1 Bed	W2 Bed	Wyodak Bed
Ash	7.01 percent	5.27 percent	4.75 percent
Sulfur	1.06 percent	0.34 percent	0.33 percent
Btu/lb (as-received)	8,669	8,519	8,662

The above analyses indicate that the coal is subbituminous C in rank.

C Coal Beds

The C coal beds of Dobbin and Barnett (1928) underlie most of the quadrangle. The lower C coal bed has been tentatively correlated with the Schoolhouse coal bed, and upper C coal bed tentatively correlated with the Badger coal bed of the Glenrock coal field in the southern Powder River Basin, Wyoming, by N. M. Denson (oral commun., 1977). The lower C bed overlies the Wyodak coal bed and is separated from it by a rock unit that ranges in thickness from about 200 to 300 ft (61 to 91 m). The lower C bed is as much as 14 ft (4 m) thick in the north-central part of the quadrangle, but is absent from the northeast and southeast corners. The upper C bed is separated from the lower C bed by a rock unit that is about 130-180 ft (40-55 m) thick. This upper C bed crops out along the eastern edge of the quadrangle, and ranges in thickness from 18 ft (5.5 m) in the southern part of the quadrangle to zero in the north-central part of the quadrangle. In the southwestern part of the quadrangle the upper C bed has a parting of as much as 15 ft (4.6 m) of rock. Each of the two coal splits are from 2 to 8 ft (0.6 to 2.4 m) in thickness.

Wyodak Coal Bed

The Wyodak coal bed, or the D coal of Dobbin and Barnett (1928), underlies the entire quadrangle and is the thickest coal bed in the quadrangle. The Wyodak has been named for the coal bed being mined at the Wyodak mine 5 mi (8 km) east of Gillette, Wyoming. The Wyodak lies less than 500 ft (152 m) below the surface along the eastern edge of the quadrangle, and progressively deepens to about 900 ft (274 m) along the northwestern edge, as shown on CRO plate 12. Throughout the southern two-thirds of the quadrangle, the Wyodak is a single coal bed with an average thickness of about 83 ft (25 m). In the northern part of the quadrangle the Wyodak splits into two coal beds or splits, and thickens to 169 ft (51.5 m) of coal, as indicated by information from a drill hole in sec. 7, T. 43 N., R. 71 W., as shown on CRO plate 4. The upper bed (the W1) ranges in thickness from about 10 to 30 ft (3 to 9 m), and the lower bed (the W2) ranges in thickness from about 80 to 130 ft (24 to 40 m), as shown on CRO plate 4. These two coal beds (splits of the Wyodak) are separated by generally less than 10 ft (3 m) of shale except along a narrow east-west trend that was mapped across the adjoining Reno Reservoir quadrangle to the east and extended into this quadrangle. Along this narrow trend the rock parting thickens to about 30 ft (9 m) of shale, siltstone, and sandstone, as shown on CRO plate 4. This rock parting is interpreted to be a channel-fill deposit along the thicker trend and an overbank or flood-plain deposit in the thinner areas.

Drill holes near the southwestern corner of the Little Thunder Reservoir quadrangle in adjoining quadrangles indicate that the Wyodak coal bed splits toward the southwest into two coal beds, each about 30-40 ft (9-12 m) thick.

Chemical analysis of the C coal.--The nearest localities from which analyses of the C coal bed have been made are two drill holes more than 20 mi (32 km) to the north in The Gap SW quadrangle (Grazis, 1974). In these two holes (US-7311 and US-7312) five cores were taken of three coal beds in the C zone and an average of the analyses of these cores yielded a heating value of 6,869 Btu/lb (as-received), an ash content of 18.78 percent and a sulfur content of 2.51 percent (U.S. Geological Survey and Montana Bureau of Mines, 1974). These sample locations are probably too distant to give much indication of the quality of the C coals in this quadrangle, but if these C coals are of a similar quality to those in this quadrangle, the ash and sulfur content would be anomalously higher than the other coals in this area.

Felix Coal Bed

The Felix coal bed, the B coal bed of Dobbin and Barnett (1928), was named by Stone and Lupton (1908) for the coal bed mined at the turn of the century at Felix, Wyoming, about 17 mi (27 km) northwest of Gillette. It is stratigraphically the highest coal bed in the quadrangle, and it occurs about 360 ft (110 m) above the upper C bed. In this quadrangle, the Felix is composed of two coal beds which crop out along the western and northwestern parts of the mapped area, as shown on plates 1 and 3 of the coal occurrence map. The lower Felix bed, the F2 bed, has an average thickness of about 8 ft (2.4 m), and is separated from the upper bed, the F1 bed, by a noncoal rock unit that is at least 75 ft (23 m) thick in sec. 22, T. 43 N., R. 72 W., and is absent in sec. 36, T. 44 N., R. 72 W. where the two beds merge to form a single bed approximately 30 ft (9 m) thick. The upper Felix bed ranges from about 10 to 18 ft (3.0 to 5.5 m) in thickness, according to thickness trends projected from adjoining quadrangles.

Chemical analysis of the Felix coal.--No analysis has been made of the Felix coal from this quadrangle, but an average of analyses from 42 cores of the Felix in other areas in the basin was reported by Glass (1975) to yield a heating value of 8,053 Btu/lb (as-received), an ash content of 7.8 percent, and a sulfur content of 0.89 percent.

COAL RESOURCES

Data from oil-and-gas and coal test holes, as well as surface mapping on color aerial photographs (1:24,000 scale), were used to construct outcrop, isopach, and structure-contour maps of the coal beds in the quadrangle. The coal-outcrop measurement in sec. 22, T. 43 N., R. 72 W., shown on CRO plate 3, is from Dobbin and Barnett (1928).

Coal resources were calculated using data obtained from the coal isopach maps (CRO plates 4 and 5). The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,770 short tons of coal per acre-foot for subbituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve values for the Wyodak coal bed, and Reserve Base for the Manning coal bed, are shown on CRO plates 6 and 7, and are rounded to the nearest tenth of a million short tons. Coal beds thicker than 4.0 ft (1.2 m) are included in Reserve Base and Reserve data rather than the usual 5.0 ft (1.5 m) minimum thickness as advocated in U.S. Geological Survey Bulletin 1450-B. Total coal Reserve Base data for all coal beds thicker than 4.0 ft (1.2 m) that lie less than 1,900 ft (579 m) below the ground surface are shown on CRO plate 2 and

total about 7 billion short tons. Reserve Base calculations for the Manning coal bed were made to provide an example of coal resources that might be exploited in the future by an in situ gasification process. Reserve Base (in short tons) in the various development-potential categories for surface and underground mining methods are shown in tables 1 and 2.

COAL DEVELOPMENT POTENTIAL

Areas where the coal beds are overlain by 500 ft (152 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 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

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 4.5, 4.5 to 6.5, and greater than 6.5, as shown on CRO plate 12. These mining-ratio values for each development-potential category are based on economic and technological criteria; they are applicable only to this quadrangle, and were derived in consultation with A. F. Czarnowsky, Area Mining Supervisor, U.S. Geological Survey.

Development Potential for Surface Mining Methods

The coal development potential for surface mining methods (<500 ft or 152 m of overburden) is shown on plate 1 of the Coal Development Potential map. The Wyodak coal bed, because of its extreme thickness in about 25 percent of the eastern part of the quadrangle, has mining-ratio values which place it in either the high or moderate development-potential category as far west as the arbitrary strippable limit of 500 ft (152 m) of overburden, as shown on plate 8.

The C coal beds, where they overlie areas of high or moderate development potential of the Wyodak coal, were assigned the same potential as the Wyodak based on the assumption that these thinner C beds would be strip mined as the overburden was removed to reach the Wyodak coal bed. Elsewhere the C coal zone has a low development potential, with the exception of one small area in the south where the upper C bed reaches a thickness of 18 ft (5.5 m) at a depth of 103 ft (31.4 m) and forms a small area having a moderate development potential, as shown on plate 1 of the Coal Development Potential map. Low development potential for surface mining occurs in about 60 percent of the mapped area owing to the great thickness of overburden in relation to the small thickness of the C coal zone.

The Felix coal has a high development potential over 15 percent of the area in the northwestern part of this quadrangle, as shown on plate 1 of the Coal Development Potential map.

Development Potential for Underground Mining and In Situ Gasification

The coal development potential for underground mining of coal is shown on plate 2 of the Coal Development Potential map. In this quadrangle, coal beds found below 500 ft (152 m) are considered as having a low development potential for underground mining, as shown on plate 2 of the Coal Development Potential map. The development potential for underground methods is rated as low inasmuch as there are no commercial underground mines operating in the Powder River Basin.

The Wyodak coal bed, which ranges in thickness from 70 to 170 ft (21 to 52 m), occurs more than 500 ft below the surface in much of the western part of the quadrangle, but along the eastern boundary it is shallower than 500 ft (152 m). Because of present economic and technological factors, coal beds of this great thickness of subbituminous rank are not amenable to extraction by underground mining methods currently practiced in the United States.

In situ gasification of coal on a commerical scale has not been done in the United States and criteria for rating the development potential of this method are unknown.

Table 1.--Strippable coal Reserve Base data for Federal coal lands (in short tons) in the Little Thunder Reservoir quadrangle, Campbell County, Wyoming

[Development potentials are based on mining ratios (cubic yards of overburden/ton of underlying coal). To convert short tons to metric tonnes, 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 (0-4.5 mining ratio)	Moderate development potential (4.5-6.5 mining ratio)	Low development potential (>6.5 mining ratio)	Total
Wyodak	1,071,800,000	373,300,000	0	1,445,100,000
Lower C	46,100,000	13,900,000	230,100,000	290,100,000
Upper C	47,700,000	47,000,000	426,000,000	520,700,000
F2	33,200,000	1,400,000	900,000	35,500,000
F1	31,300,000	0	0	31,300,000
TOTAL	1,230,100,000	435,600,000	657,000,000	2,322,700,000

Table 2.--Coal Reserve Base data for underground mining methods for Federal coal lands (in short tons) in the Little Thunder Reservoir quadrangle, Campbell County, Wyoming

[To convert short tons to metric tonnes, multiply by 0.9072]

Coal bed name	High development potential	Moderate development potential	Low development potential	Total
Wyodak	-0-	-0-	4,288,700,000	4,288,700,000
Manning	-0-	-0-	454,900,000	454,900,000
Total	-0-	-0-	4,743,600,000	4,743,600,000

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