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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE DIVIDE SCHOOL QUADRANGLE, CUSTER AND POWDER RIVER COUNTIES, MONTANA

[Report includes 10 plates]

By

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Conversion table

To convert	Multiply by	To obtain
feet	0.3048	meters (m)
miles	1.609	kilometers (km)
acres	0.40469	hectares (ha)
tons (short)	0.907	metric tons (t)
short tons/acre-ft	7.36	metric tons/hectare-meter (t/ha-m)
Btu/lb	2.326	kilojoules/kilogram (kJ/kg)

INTRODUCTION

Purpose

This text is for use in conjunction with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Divide School quadrangle, Custer and Powder River Counties, Montana, (10 plates; U.S. Geological Survey Open-File Report 79-008). This set of maps was compiled to support the land planning work of the Bureau of Land Management in response to the Federal Coal Leasing Amendments Act of 1975, and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States. Coal beds considered in the resource inventory are only those beds 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden.

Location

The Divide School 7 1/2-minute quadrangle is in southern Custer and northern Powder River Counties, Montana, about 45 miles (72 km) south-southeast of Miles City, Montana.

Accessibility

The quadrangle is accessible from the town of Coalwood, Montana, located on U.S. Highway 312 about 56 miles (89.6 km) south of Miles City, Montana. All parts of the quadrangle may be reached by going east from Coalwood 2 miles (3.2 km) on Hay Creek Road, an improved county road, and then north on unimproved roads into the quadrangle.

Physiography

The Divide School quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface, however, has been almost completely dissected by tributaries of the major streams of this region: Pumpkin, Sand, and Mizpah Creeks. The principal stream in the quadrangle is Sand Creek which flows northward across the middle of the quadrangle. Both east and west of Sand Creek are ridges and plateaus held up by erosionally resistant, reddish-colored clinker formed as a result of the burning of underlying coal beds. The highest elevation in the quadrangle, 3,580 feet (1,091 m), is in the southwest quarter about 1 mile (1.6 km) north of the south border of the quadrangle. The lowest elevation, about 3,035 feet (925 m), is 1 mile (1.6 km) south of the northwest corner of the quadrangle. Topographic relief is about 540 feet (164 m).

Climate

The climate of Custer County is characterized by pronounced variations in seasonal precipitation and temperature. Annual precipitation in the region varies from less than 12 inches (30 cm) to 16 inches (41 cm). The heaviest precipitation is from April to August. The largest average monthly precipitation is during June. Temperatures in eastern Montana range from as low as -50 °F (-46 °C) to as high as 110 °F (43 °C). The highest temperatures occur in July and the lowest in January; the mean annual temperature is about 45 °F (7 °C) (Matson and Blumer, 1973, p. 6).

Land status

The Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA) encompasses most of the southwest quarter and laps over into the northwest quarter of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts and the land ownership status. Approximately 45 percent of the coal land within the KRCRA boundary (about 3,000 acres) is federally owned. There were no outstanding Federal coal leases or prospecting permits of record as of 1977.

GENERAL GEOLOGY

Previous work

Parker and Andrews (1939) mapped the north two-thirds of the quadrangle as part of the Mizpah coal field, Custer County, Montana; and Bryson (1952) mapped the south one-third as part of the Coalwood coal field, Powder River County, Montana. Brown and others (1954) mapped the southwest part of the quadrangle as the Sand Creek deposit in their summary of strippable coal, Custer and Powder River Counties, Montana. Matson and Blumer (1973) reviewed the Sand Creek coal deposit in their summary of strippable coal, selected deposits, southeastern Montana.

Stratigraphy

A generalized columnar section of the coal-bearing rocks is shown on the Coal Data Sheet (pl. 3) of the CRO maps. The exposed bedrock units belong to the Fort Union Formation (Paleocene). The Fort Union Formation is composed of three members: the upper Tongue River Member, the middle Lebo Shale Member, and the lower Tullock Member. Parker and

Andrews (1939, p. 95) considered the Tullock (their lower Sandstone Member) to be a member of the Lance Formation of Tertiary(?) age, but since 1949 the U.S. Geological Survey has considered the Tullock in Montana to be the lowermost member of the Fort Union Formation.

The Lebo Shale Member makes up the lowest outcrops in the Divide School quadrangle. The Lebo consists of shale and a few thin, lenticular sandstones, but no mappable coal beds. A complete section is 160 to 200 feet (49 to 61 m) in thickness, but only the uppermost 100 feet (30.5 m) or less are exposed in the quadrangle. The Lebo Shale crops out in the valley bottoms of Sand, Road, Big Bobcat, and Dick Creeks on the north and east margins of the quadrangle.

The Tongue River Member underlies the higher elevations throughout the remainder of the quadrangle and contains the coal beds of economic interest. This unit is made up mainly of yellow sandstone, sandy shale, carbonaceous shale, and coal. Much coal has been burned along outcrops, fracturing and baking the overlying sandstone and shale, and forming thick reddish-colored clinker beds. Originally more than 1,000 feet (305 m) thick in this vicinity, most of the Tongue River Member has been removed by erosion so that only about the lowermost 380 feet (116 m) remains (Parker and Andrews, 1939, p. 103).

Coal and other rocks comprising the Tongue River Member were deposited in a continental environment at elevations of perhaps a few tens of feet (a few meters) above sea level in a vast area of shifting flood plains,

sloughs, swamps, and lakes that occupied the Northern Great Plains in Paleocene (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 U.S. 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 Divide School quadrangle is in the northeastern part of the Powder River structural basin. The strata dip northwestward about 40 to 50 feet per mile (7.6 to 9.5 m per km) as shown on plate 5. There are minor variations in the amount of dip, but no other significant structural features.

COAL GEOLOGY

Four coal beds, all in the Tongue River Member of the Fort Union Formation, were mapped on the surface in this quadrangle (pl. 1) and are shown in section on plate 3. The lowest of these is the Contact coal bed which lies at the base of the Tongue River Member. The Contact coal bed is overlain successively by a 40 foot (12 m) thick noncoal interval, the Volborg coal bed, a 50 to 90 foot (15 to 27 m) thick noncoal interval, the Knobloch coal bed, a 130 foot (40 m) thick noncoal interval, and a local coal bed.

The trace element content of coals in the Divide School 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, appreciably lesser amounts of most elements of environmental concern than coals in other areas of the United States (Hatch and Swanson, 1977, p. 147).

Contact coal bed

The Contact coal bed was described by Bass (1932, p. 53) after outcrops in the Kirkpatrick Hill quadrangle in the eastern part of the Ashland coal field, a few miles (a few kilometers) northwest of the Divide School quadrangle where it is defined as the basal bed of the Tongue River Member (Parker and Andrews, 1939, p. 111). The base of the coal bed serves as the contact between the Tongue River Member and the underlying Lebo Shale Member of the Fort Union Formation. The maximum thickness measured is 3.6 feet (1.1 m), as shown on plate 1, which is below the minimum of 5 feet (1.5 m) needed for economic Reserve Base coal. Coal resources have not been estimated for the Contact bed, and no individual coal-bed maps have been made.

Volborg coal bed

The Volborg coal bed was first described by Parker and Andrews (1939 p. 111) from exposures east of the Volborg post office in the Volborg quadrangle just to the west. The Volborg coal bed lies 25 to 40 feet (7.6 to 12.2 m) above the base of the Tongue River Member and crops out in the

northwest quarter of the Divide School quadrangle. Its maximum measured thickness is only 3.6 feet (1.1 m), as shown on plate 1, and coal resources have not been estimated for it. Individual coal-bed maps have not been made.

Knobloch coal bed

The Knobloch coal bed was first described by Bass (1924) after outcrops near the Tongue River in the Birney Day School quadrangle, about 48 miles (77 km) southwest of the Divide School quadrangle. The Knobloch coal bed lies 90 to 130 feet (27 to 40 m) above the base of the Tongue River Member (pl. 3), and the coal bed or its residual clinker crops out around the higher elevations over most of the Divide School quadrangle (pl. 1). The bed is usually split into two approximately equal parts called the Upper Knobloch (Kn_1) and Lower Knobloch (Kn_2) splits, with the separation ranging from nearly zero to about 45 feet (13.7 m), as shown on plate 3. The Knobloch coal bed and its splits dip regularly to the northwest about 40 to 50 feet per mile (7.6 to 9.5 m per km), as shown on plate 5, and aggregate as much as 32 feet (9.8 m) in thickness, as shown on plate 4. The overburden on the Knobloch coal bed and its splits ranges from zero near the outcrops to about 170 feet (52 m) in thickness, resulting in mining-ratio values consistently under 15, as shown on plate 8. The Montana Bureau of Mines and Geology cored the Knobloch coal in drill hole SC-1C (sec. 23, T. 1 N., R. 49 E.) in the Divide School quadrangle. An analysis of the Knobloch coal from depths of 51 to 68 feet (15.5 to 20.7 m) shows ash 8.28 percent, sulfur 0.29 percent, and heating value 7,220 Btu per pound (16,794 kJ/kg) on an as-received basis. This heating value converts to about 7,880 Btu per pound (18,329 kJ/kg) on a

moist, mineral-matter-free basis, indicating that the rank is lignite A. An analysis of the Lower Knobloch coal bed from the same drill hole at depths of 71 to 86 feet (21.6 to 26.2 m) shows ash 5.07 percent, sulfur 0.31 percent, and heating value 7,460 Btu per pound (17,352 kJ/kg) on an as-received basis. This converts to about 7,860 Btu per pound (18,282 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Lower Knobloch coal is also lignite A in rank.

Other coal beds

A local coal bed lying about 130 feet (40 m) above the Knobloch crops out in the southwest quarter of the quadrangle. It has a lateral extent of less than 0.25 mile (0.4 km) and a maximum thickness of 2.2+ feet (0.7+ m). Maps or resource estimates have not been made for this coal bed.

COAL RESOURCES

Data from oil-and-gas and coal test holes, as well as from all publicly available surface mapping by others (see list of references), were used to construct the outcrop, isopach, and structure contour maps of the coal beds in this quadrangle.

Coal resource tonnages shown in this report are the Reserve Base part of the Identified Resources (as discussed in U.S. Geological Survey Bulletin 1450-B). The Reserve Base for lignite is lignite that is 5 feet (1.5 m) or more thick, under 1,000 feet (305 m) or less of overburden, and located within 3 miles (4.8 km) of a point of coal-bed measurement. Reserve

Base is further subdivided into reliability categories according to their nearness to a measurement of the coal bed. Measured coal is coal within 0.25 mile (0.4 km) of a measurement, Indicated coal extends 0.5 miles (0.8 km) beyond Measured coal to a distance of 0.75 mile (1.2 km) from the measurement point, and Inferred coal extends 2.25 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 coal. For surface-minable coal in this quadrangle, the coal reserves are considered to be 85 percent (the recovery factor for this area) of that part of the Reserve Base that is beneath 200 feet (61 m) or less of overburden. This depth of overburden is the stripping limit for single, relatively thin (5 to 40 feet or 1.5 to 12 m thick) beds of lignitic coal in this area.

The acreage underlain by a coal bed was measured by planimeter. The coal resources in the quadrangle were computed using the acreage numbers multiplied by the average isopached thickness of the coal bed, times a conversion factor of 1,750 short tons of coal per acre-foot (12,880 metric tons per hectare-meter) to yield the coal resources in short tons of coal for each isopached coal bed.

Reserve Base and Reserve tonnage numbers for the Upper Knobloch and Lower Knobloch splits of the Knobloch coal bed are shown on plates 7 and 9, respectively, rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned lignite in this quadrangle is calculated to be 96.97 million short tons (87.97 million t).

The Reserve Base tonnage totals per section are shown in the northwest corner of each section on CRO plate 2 and by development-potential category in table 1. All numbers are rounded to the nearest one-hundredth of a million short tons. About 17 percent of the Reserve Base tonnage is classed as Measured, 63 percent as Indicated, and 20 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas where 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 surface mining in this quadrangle 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-ratio values for lignite is as follows:

$$MR = \frac{t_o\ (0.922)}{t_c\ (rf)}$$

where MR = mining ratio
t_o = thickness of overburden
t_c = thickness of lignite
rf = recovery factor = 0.85
0.922 = conversion factor (cu. yds./ton)

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. Mining-ratio contours and the stripping-limit overburden isopach which serve as boundaries for these development-potential areas are shown on plates 6 and 8. The mining-ratio values for each development-potential category are based on economic and technological criteria and

Development potential for surface-mining methods

The Coal Development Potential (CDP) map, plate 10, in this series of maps depicts the highest coal development-potential category which occurs within each smallest legal subdivision of Federal coal land (normally about 40 acres or 16.2 ha). If such a 40-acre (16.2 ha) tract of land contains areas of high, moderate, and low development potential, the entire tract is assigned to the high development-potential category for CDP mapping purposes, etc.

The coal development potential for surface-mining methods (less than 200 feet or 61 m of overburden) is shown on the Coal Development Potential map (pl. 10). Most of the Federal lands in the southwest quarter of the quadrangle have a high development potential due to the presence there of the unburned Knobloch coal bed. The Federal lands in the remainder of the quadrangle have no development potential because the Knobloch coal has been burned, or the coal beds are too thin (less than 5 feet or 1.5 m thick), or the coal beds have been removed by erosion.

The lower split of the Knobloch coal bed (pl. 8) has a wide area of high development potential between its boundary and the 10 mining-ratio contour. Above this wide area is a narrow band of moderate development potential (10 to 15 mining-ratio values) and a small area of low development potential (mining-ratio values greater than 15).

The Knobloch coal bed and/or the upper split of the Knobloch coal bed (pl. 6) have a high development potential (mining-ratio values 0-10) over their entire area of occurrence in the southwest quarter of the quadrangle.

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About 20 percent of the Federal coal lands in the quadrangle have a high development potential for surface mining, and about 80 percent have no development potential for surface mining.

Development potential for underground mining and in-situ gasification

All known economically minable coal in the Divide School quadrangle is contained in the Knobloch coal bed within surface-minable depths (200 feet or 61 m). Since there are no known coal beds of economic thickness below this depth, the development potential for underground mining in this quadrangle is rated as unknown or none. Therefore, a table of coal resource tonnage for underground-mining methods, and a Coal Development Potential map for underground mining were not made.

In-situ gasification of coal on a commercial scale has not been done in the United States. Because there is no coal found below the stripping limit, there is no development potential for in-situ gasification of underground coal in this quadrangle.

Table 1.--Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Divide School quadrangle, Custer and Powder River Counties, Montana

[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]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Reserve Base tonnage				
Knobloch	89,370,000	4,600,000	3,000,000	96,970,000
Total	89,370,000	4,600,000	3,000,000	96,970,000

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