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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE McKERLICH CREEK QUADRANGLE, ROSEBUD COUNTY, MONTANA

[Report includes 10 plates]

By

Colorado School of Mines Research Institute

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

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ILLUSTRATIONS

[Plates are in pocket]

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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 McKerlich Creek quadrangle, Rosebud County, Montana, (10 plates; U.S. Geological Survey Open-File Report 78-641). 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 McKerlich Creek 7 1/2-minute quadrangle is in south-central Rosebud County, Montana, about 10 miles (16.1 km) southeast of Forsyth, Montana, a town on the Yellowstone River about 100 miles (161 km) northeast of Billings and 45 miles (72 km) west-southwest of Miles City. The Burlington Northern Railroad and U.S. Interstate Highway 94 follow the valley of the Yellowstone River and pass through Forsyth. The eastern boundary of the quadrangle is from 2 to 5 miles (3.22 to 8.05 km) west of Rosebud Creek, a northward-flowing tributary of the Yellowstone River.

Accessibility

The McKerlich Creek quadrangle is accessible by unimproved roads and trails which intersect the partially paved, graveled County Highway 447

along Rosebud Creek from 11 to 17 miles (17.7 to 27.4 km) south of Interstate Highway 94. A branch line of the Burlington Northern Railroad passes within 2 miles (3.2 km) of the southwestern corner of the quadrangle as it extends up East Fork of Armells Creek to the Rosebud (Colstrip) coal mine located in the Colstrip East quadrangle about 9 miles (14.4 km) to the south.

Physiography

The McKerlich Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The plateau surface, however, has been totally and intricately dissected by eastward- or northeastward-flowing ephemeral tributaries of Rosebud Creek. The valleys are steep sided, and in places the narrow-topped interstream ridges have been carved into badlands.

The lowest elevations in the quadrangle, just under 2,760 feet (841.25 m), are along Sawmill and Cottonwood Creeks on the east border of the quadrangle. The highest elevation, 3,598 feet (1,096.7 m), is on a drainage divide in the northwestern part of the quadrangle. Topographic relief is about 838 feet (255.4 m).

Climate

The climate of Rosebud 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) a year. 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) extends into only the southeastern part of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts, the land ownership status, and the total reserve base (RB) of coal per section for each section of Federal coal land. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Dobbin (1930) mapped the western part of the McKerlich Creek quadrangle as part of the Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana. Pierce (1936) mapped the eastern part of the quadrangle as part of the Rosebud coal field, Rosebud and Custer Counties, 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. Pierce (1936) considered the Tullock as a member of the Lance Formation, but since 1949 the

U. S. Geological Survey has considered the Tullock to be the lowermost member of the Fort Union Formation in Montana.

The Tullock Member forms the lowest outcrops in the quadrangle, occurring as the lowermost beds exposed along the tributaries of Rosebud Creek. The Tullock Member is approximately 300 feet (91 m) thick and is made up of alternating beds of sandstone and shale, and contains several unimportant local coal beds (Pierce, 1936, p. 55).

The overlying Lebo Shale Member is 155 to 220 feet (47 to 67 m) thick and consists of dark-gray and yellowish-green shale, a few thin lenticular sandstones, and one thin dirty coal bed at its base. This unit crops out on the high slopes of the valleys.

The Tongue River Member of the Fort Union Formation is exposed on the interstream divides in the western and southern parts of the quadrangle. This unit is made up mainly of yellow sandstone, sandy shale, carbonaceous shale, and two mappable coal beds, the Burley and Terret-Robinson coal 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 lower 400 feet (122 m) remains (Pierce, 1936, p. 61).

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 McKerlich Creek quadrangle is in the north-central part of the Powder River structural basin. The strata are nearly flat or in places dip southward or eastward at an angle of a fraction of 1 degree. Structure contours on top of the Burley coal bed (pl. 4) show a local dip of less than 1 degree to the southeast.

COAL GEOLOGY

Three coal beds have been mapped on the surface of the McKerlich Creek quadrangle (pl. 1) and are shown in section on plate 3: the Big Dirty coal bed in the Lebo Shale Member of the Fort Union Formation, the Burley coal bed, about 160 feet (49 m) above the base of the Tongue River Member, and the Terret-Robinson coal bed, about 50 feet (15 m) above the Burley coal bed. The Terret-Robinson coal bed has not been assigned coal resources because it is present only in a very small area in the south-central part of the quadrangle and is only about 2 feet (0.6 m) thick.

The trace element content of coals in the McKerlich Creek 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).

Burley coal bed

The Burley coal bed was named by Dobbin (1930, p. 27) from outcrops in the Forsyth coal field at the Burley Ranch (Colstrip East quadrangle) immediately south of the McKerlich Creek quadrangle.

The Burley bed crops out in the southwestern part of the McKerlich Creek quadrangle where it occurs about 130 feet (39.6 m) above the base of the Tongue River Member. The bed varies from 4 to 8.5 feet (1.2 to 2.6 m) in thickness and dips about 0.5 degree southeastward (pl. 4). The overburden on the Burley bed ranges from 0 to 100 feet (0 to 30.5 m), and the mining-ratio values range from 0 to 15, but almost everywhere are less than 10 (pl. 5).

There are no known published chemical analyses of the Burley coal bed; 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.

Big Dirty coal bed

Pierce (1936, p. 77) correlates the coal bed at the base of the Lebo Shale Member with a bed at the same position in the Forsyth coal field which Dobbin (1930, p. 26) named the Big Dirty coal bed. This bed crops out along tributaries of Rosebud Creek in the northeastern two-thirds of the McKerlich Creek quadrangle (pl. 1). Pierce (1936, p. 88-90) describes the Big Dirty coal bed in Tps. 3 and 4 N., R. 42 E. as containing dirty coal, shale, and

bone. In a few places it carries coal that is clean enough to burn, but as a whole this bed is so dirty that it is questionably classified as a fuel. The isopach and structure contour map of the Big Dirty coal bed (pl. 7) shows the coal to range from 2.8 to 5.7 feet (0.85 to 1.74 m) in thickness and to be almost flat or to dip southeastward at a small fraction of 1 degree. The overburden on the Big Dirty bed ranges from zero to slightly over 200 feet (0 to 61 m) and the mining ratio from zero to slightly over 15 (pl. 8).

There are no known published chemical analyses of the Big Dirty coal bed; it is assumed, however, that the rank of the coal is similar to other coal beds of the Fort Union Formation and is impure subbituminous C.

COAL RESOURCES

Data from oil-and-gas and coal test holes, as well as all publicly available surface mapping by others (see list of references), were used to construct 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 subbituminous coal is coal that is 5 feet (1.5 m) or more thick, under 3,000 feet (914 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 mile (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, thin (5 to 40 feet or 1.5 to 12 m thick) beds of subbituminous coal in this area. Although there are two minable beds of coal in the McKerlich Creek quadrangle, the beds are not superimposed, but occur in separate areas (see isopach maps, pls. 4 and 8) requiring that they be mined separately.

Coal resources in the McKerlich Creek quadrangle were calculated using data obtained from the coal isopach maps (pls. 4 and 7). 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 (13,028 t/ha-m) for subbituminous coal yields the coal resources in short tons of coal for each isopached coal bed. Reserve Base and Reserve tonnage values for the Burley and Big Dirty coal beds are shown on plates 6 and 9 and are rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned coal in the McKerlich Creek quadrangle is calculated to be 4.81 million short tons (4.36 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 29 percent of the Reserve Base tonnage is classed as Measured, 38 percent as Indicated, and 33 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 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 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
0.911 = 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, as shown on plate 5 for the Burley coal bed and plate 8 for the Big Dirty coal bed. These mining-ratio values for each development-potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey. Estimated tonnages in each development-potential category (high, moderate, and low) for surface mining are shown in table 1.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map included in this series of maps depicts the highest coal development-potential category which occurs within each smallest legal subdivision of 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). In the McKerlich Creek quadrangle, 62 percent of the surface-minable coal resource on Federal lands has high development potential, 18 percent has moderate development potential, and 20 percent has low development potential (see table 1).

Development potential for underground mining and in situ gasification

All known minable coal in the McKerlich Creek quadrangle is within surface-minable depths. Because there are no known underground coal resources below the stripping limit, no Coal Development Potential map for underground mining or estimates of underground resources were made.

In situ gasification of coal on a commercial scale has not been done in the United States. Therefore, the development potential for in situ gasification of coal found below the surface-mining limit in this area is rated as low.

Table 1.--Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the McKerlich Creek quadrangle, Rosebud County, 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
Burley	1,800,000	40,000	0	1,840,000
Big Dirty	1,070,000	800,000	1,100,000	2,970,000
Total	3,870,000	840,000	1,100,000	4,810,000

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