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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE MILLER CREEK NW QUADRANGLE, ROSEBUD AND CUSTER COUNTIES, MONTANA

[Report includes 7 plates]

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[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 Miller Creek NW quadrangle, Rosebud and Custer Counties, Montana, (7 plates; U.S. Geological Survey Open-File Report 78-637). 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 then 3,000 feet (914 m) of overburden.

Location

The Miller Creek NW 7 1/2-minute quadrangle is in eastern Rosebud and southwestern Custer Counties, Montana, about 20 miles (32 km) southwest of Miles City, Montana, and 2.5 miles (4 km) south of Hathaway, a small town on U.S. Interstate Highway 94 about 17 miles (27 km) southwest of Miles City. The main east-west route of the Burlington Northern Railroad also passes through Hathaway. Both the railroad and Interstate Highway 94 follow the valley of the Yellowstone River.

Accessibility

The area is accessible from Hathaway by the Graveyard Creek road, an improved road which extends southeastward across the northeast quarter

of the quadrangle. Unimproved roads, mostly in valley bottoms, provide access to the rest of the quadrangle.

Physiography

The Miller Creek NW quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface has been eroded extensively by the Yellowstone River and its tributaries. Only a few southeast-northwest trending, flat-topped ridges and knobs remain of the old surface.

The Yellowstone River flows eastward about 3 to 5 miles (4.8 to 8 km) north of the quadrangle border. Graveyard Creek, the largest stream in the quadrangle, flows northwestward across the northeast quarter of the quadrangle to join with the Yellowstone River. Sweeney Creek, another prominent stream, touches the southwest corner of the quadrangle on its northward-flowing course to the Yellowstone River through the adjacent Indian Creek quadrangle on the west.

The highest elevations are along ridges between the Graveyard Creek and Sweeney Creek drainages. Flat-topped ridges in the southwest quarter of the quadrangle have elevations reaching about 3,300 feet (1,006 m). Lowest elevations, just above 2,500 feet (762 m), are on the northern border where Graveyard Creek leaves the quadrangle, and in the northwest corner of the quadrangle in Iron Jaw Creek valley. Topographic relief is about 800 feet (244 m).

Climate

The climate of Custer and eastern Rosebud Counties 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 entire Miller Creek NW quadrangle lies north of the Northern Powder River Basin Known Recoverable Resource Area (KRCRA). However, there are Federal coal lands containing Reserve Base thickness coal in the quadrangle, and these are shown on the Boundary and Coal Data Map (pl. 2). There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

W. G. Pierce (1936) mapped the Miller Creek NW 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 to be 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 in Graveyard and Iron Jaw Creeks on the north border of the quadrangle, and in the bottom of Sweeney Creek in the southwest corner of the quadrangle. 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).

The overlying Lebo Shale Member is 163 to 200 feet (49 to 61 m) thick and consists of shale, a few thin lenticular sandstones, and a thin local coal bed near its base. This unit crops out in a wide, irregular belt extending across the northeast quarter and west half of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed throughout the center and southeast quarter of the quadrangle and contains the coal beds of greatest economic interest. This unit is made up mainly of yellow sandstone, sandy shale, carbonaceous shale, and coal. Much of the coal has burned along the outcrops, causing fracturing and baking of the

overlying sandstone and shale to form 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 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 Miller Creek NW 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 less than 1 degree. Structure contours on top of the Burley coal bed (pl. 4) show a local dip of less than 1 degree to the south and east along the south border of the quadrangle.

COAL GEOLOGY

Three coal beds, two in the Tongue River Member and one near the base of the Lebo Shale 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 coal bed stratigraphically is unnamed in this quadrangle. It occurs near the base of the Lebo Shale Member. Section measurements show that it is actually two coal beds, 5 to 15 feet (1.5 to 4.6 m) apart which were undifferentiated in the field (Pierce, 1936, p. 98). Each measures less than 1 foot to 2.3 feet (0.3 m to 0.7 m) thick.

The next higher coal bed is the Burley in the Tongue River Member about 250 to 300 feet (76 to 91 m) above the base of the member. It is successively overlain by a noncoal interval about 70 to 90 feet (21 to 27 m) thick and the Terret coal bed.

The trace element content of coals in the Miller Creek NW 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).

The unnamed coal bed in the Lebo Shale crops out in the drainage valleys of Graveyard and Iron Jaw Creeks. The quality is extremely variable, grading from coal to bony coal, to bone or carbonaceous shale in the short distance between measurements along the outcrop (Pierce, 1936, p. 98, 99). Because of its thinness and poor quality, no economic resources have been attributed to it.

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) 18 miles (28.8 km) southwest of the Miller Creek NW quadrangle.

The Burley coal bed crops out around the plateau remnants in the southeast quarter of the quadrangle (pl. 1). It dips very gently, less than 1 degree, to the east and south (pl. 4). It increases from 4 to 9 feet (1.2 to 2.7 m) in thickness from its northern outcrop to the south edge of the quadrangle (pl. 4). Bordering areas of fresh coal the Burley bed has been burned, converting the overlying shale and sandstone to reddish-colored clinker beds. The clinker is resistant to erosion and forms the tops of plateaus and ridges far beyond the coal occurrences.

Overburden on the Burley coal bed ranges from nearly zero to over 200 feet (61 m), as shown on plate 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 nearby coal beds of the Fort Union Formation and is subbituminous C in rank.

Terret coal bed

The Terret coal bed was named by Bass (1932) after a small mine on the Terret Ranch (Cook Creek Reservoir quadrangle) 26 miles (42 km) to the south of this quadrangle, in the Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana.

The Terret coal bed occurs 70 to 90 feet (21 to 27 m) above the Burley coal bed in the lower part of the Tongue River Member and crops out

near the top of a few high plateau remnants in the southeast quarter of the quadrangle. Here it is less than 4.5 feet (1.4 m) thick, and because of its thinness no reserve base coal has been assigned to it in this quadrangle.

COAL RESOURCES

Outcrop data only were used in constructing the maps and calculating the resources of the Burley coal bed in the Miller Creek NW quadrangle because there are no drill holes with coal data.

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 recover 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 subbituminous coal in this area.

Coal resources in this quadrangle were calculated using data obtained from the coal isopach map (pl. 4). 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 coal bed are shown on plate 6 and are rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned coal in this quadrangle is calculated to be 7.34 million short tons (6.66 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 5 percent of the Reserve Base tonnage is classed as Measured, 72 percent as Indicated, and 23 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 CRO plate 5. 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 (pl. 7) 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 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. 7). The Burley coal has a high development potential within its entire area of occurrence in the quadrangle. The rest of the quadrangle has no coal development potential for surface mining.

Development potential for underground mining and in situ gasification

All known economically minable coal in the Miller Creek NW quadrangle is contained in the Burley coal bed within surface-minable depths. Since there is no known Reserve Base coal at depths beneath the Burley coal bed, the development potential for underground mining in the Miller Creek NW quadrangle is rated as unknown or none. No table of coal resource tonnage by development-potential category for underground-mining methods was made. Neither was a Coal Development Potential map for underground mining 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 stripping 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 Miller Creek NW quadrangle, Rosebud and Custer 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
Burley	5,920,000	990,000	430,000	7,340,000
Total	5,920,000	990,000	430,000	7,340,000

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