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

[Report includes 12 plates]

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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 Miller Creek SW quadrangle, Rosebud and Custer Counties, Montana, (12 plates; U.S. Geological Survey Open-File Report 78-646). 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 Miller Creek SW 7 1/2-minute quadrangle is in southwestern Custer and eastern Rosebud Counties, Montana, about 24 miles (38.4 km) southwest of Miles City, Montana, and 18 miles (28.8 km) south-southwest of Horton, a small town on the main east-west route of the Burlington Northern Railroad about 11 miles (17.6 km) southwest of Miles City. Both the railroad and U.S. Interstate Highway 94 follow the valley of the Yellowstone River.

Accessibility

The area is accessible from Horton by Moon Creek Road, an improved state road that crosses the southeast corner of the quadrangle.

The northwest quarter of the quadrangle may be reached by the Sweeney Creek Road, an unimproved county road, by traveling 12 miles (19 km) south of Sweeney, which is 14 miles (22.4 km) west of Horton on U.S. Interstate Highway 94. There are a few unimproved roads and trails located mainly in the valleys which provide access to the remainder of the quadrangle.

Physiography

The Miller Creek SW quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The eastern and southern parts of the quadrangle have been intricately dissected by tributaries of the Tongue River, the dominant drainage stream of the area which flows northeastward about 5 to 10 miles (8 to 16 km) east of the quadrangle boundary and joins the Yellowstone River 23 miles (37 km) to the northeast. The tributaries of the Tongue River form a series of southeastward trending valleys and ridges which have steep sides that in places are eroded to badlands. The northwestern part of the quadrangle is less intricately dissected by Sweeney Creek which flows into the Yellowstone River about 12 miles (19.2 km) northwest of the quadrangle. The ridges in this part of the quadrangle are rounded, and the flood plains are up to 0.5 mile (0.8 km) wide.

The lowest elevation, just above 2,800 feet (860 m), is along Sweeney Creek near the northwestern corner of the quadrangle. The highest elevation, 3,386 feet (1,032 m), is at Sweeney triangulation station near the head of Sweeney Creek. The topographic relief is about 586 feet (179 m).

Climate

The climate of Rosebud and Custer 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 Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA) boundary within the quadrangle is shown on the Coal Data Map (pl. 2). It outlines and follows the higher elevations, encompassing about half the land area in the south half of the quadrangle. A large part of the lands within the KRCRA boundary is Federal coal land. 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 SW quadrangle as part of the Rosebud coal field, Rosebud and Custer Counties, Montana. The Terret coal bed around Sweeney Creek, in the northwest part of the quadrangle, was mapped by R. C. Kepferle (1954, p. 360-363). The Sweeney Creek area was covered in greater detail by Matson and Blumer (1973,

p. 101-103). Ayler, Smith, and Deutman (1969, p. 42-43) summarized the stripping coal deposits of the Sweeney Creek area.

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 outcrop, occurring in the lowest elevations in the extreme northwest 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 160 to 200 feet (49 to 61 m) thick and consists of shale and a few thin, lenticular sandstones, but no mappable coal beds. This unit crops out in a square-shaped area containing the Sweeney Creek valley in the northwest quarter of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed throughout the remaining three-quarters 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, fracturing and baking 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 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 SW 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 less than 1 degree. Excepting a faulted, anticlinal area in the southwest quarter of the quadrangle, structure contours on top of the Burley coal bed (pl. 9) show a local dip of less than 1 degree to the east.

COAL GEOLOGY

Three coal beds, the Trail Creek, Burley, and Terret beds, have been mapped on the surface in this quadrangle and are shown on the Coal Data Map (pl. 1). All are within the Tongue River Member of the Fort Union Formation.

The lowest, the Trail Creek, about 60 feet (18 m) above the base of the Tongue River Member, is thin and local, occurring only along a 2 mile (3.2 km) outcrop in the northwest quarter of the quadrangle where it is less than 1 foot (0.3 m) thick. No Reserve Base coal has been assigned to the Trail Creek bed.

The trace element content of coals in the Miller Creek SW 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 at the Burley Ranch in the Forsyth coal field 16 miles (26 km) west of the Miller Creek SW quadrangle. The Burley bed occurs about 110 feet (34 m) above the base of the Tongue River Member and about 50 feet (15 m) above the Trail Creek coal bed. It is the most widespread bed, being present in all but a small area near the south edge of the quadrangle along Cow Creek. The thickness of the Burley increases from 1.5 feet (0.46 m) at the southeast

border of the quadrangle to 9.5 feet (2.9 m) on the north border. However, only in the northeast quarter of the quadrangle is the Burley thickness greater than 5 feet (1.5 m), as shown on plate 8. Overburden on the bed in this area varies from near zero to 200 feet (61 m), as shown on plate 10.

No coal analyses are available for the Burley bed; it is assumed, however, that the quality of the coal is similar to other coal beds of the Fort Union Formation in this area and is subbituminous C in rank.

Terret coal bed

The Terret coal bed was named by Bass (1932, p. 51) for a small mine on the Terret Ranch (Cook Creek Reservoir quadrangle) in the Ashland coal field. The Terret bed is 70 to 90 feet (21 to 27 m) above the Burley bed and underlies ridges in the southwest quarter of the Miller Creek SW quadrangle. Where not burned or eroded it ranges from 2 feet (0.6 m) up to 18 feet (5.5 m) in thickness (pl. 4). It crops out along the drainages of Sweeney, South Miller, and Cow Creeks where much of the coal has burned, forming a belt of clinker occasionally 500 feet (153 m) or more wide (pl. 1). Where the Terret bed is 5 feet (1.5 m) or more thick, the overburden ranges from near zero to somewhat over 100 feet (31 m), as shown on plate 6.

The Terret bed is correlated with the Terret of the Ashland coal field and is very near the stratigraphic position of the Robinson of the Forsyth coal field (Pierce, 1936, p. 79).

One coal analysis is available for the Terret bed in the quadrangle. The Montana Bureau of Mines and Geology drilled State Hole SS-5C in

sec. 3, T. 3 N., R. 44 E., coring and analyzing the Terret bed from 109 to 127 feet (33.2 to 38.7 m). This analysis shows a heating value of 8,020 Btu per pound, ash 9.43 percent, and sulfur 1.18 percent as received (Matson and Blumer, 1973, p. 102). This analysis indicates that the Terret coal at this locality is subbituminous C in rank.

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 found within 3 miles (4.8 km) of a point of coal bed measurement (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 exteds 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 Miller Creek SW 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 were calculated using data obtained from the coal isopach maps (pls. 4 and 8). 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 Terret and Burley coal beds are shown on plates 7 and 11 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 42.17 million short tons (38.26 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 15 percent of the Reserve Base tonnage is classed as Measured, 64 percent as Indicated, and 21 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas in which 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 maps, plate 6 for the Terrett bed and plate 10 for the Burley 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. Calculated 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). 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. 2). Most coal-bearing quarter-quarter sections of federally owned coal land contain some coal of high development potential for surface mining as shown on the CDP map, plate 12. In the Terret coal area, the southwest quarter of the quadrangle, all the quarter-quarter sections are rated high development potential, although based upon mining-ratio contours, some of the coal may fall into the moderate development-potential category in table 1. In the Burley coal area, the north half of the quadrangle, most of the coal-bearing quarter-quarter sections of federally owned coal lands are rated high development potential, a few are rated moderate development potential, and very few are rated low development potential.

Development potential for underground mining and in situ gasification

A small quantity of Reserve Base coal, 230,000 short tons or 208,656 metric tons, which is below the 200-foot stripping limit, is considered to have a low development potential for underground mining, as shown in table 2, because there are currently no commercial underground mines in the Northern Powder River Basin. No CDP map for underground mining was 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 Miller Creek SW quadrangle, Custer and Rosebud 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
Terret	23,510,000	180,000	0	23,690,000
Burley	8,480,000	4,640,000	5,130,000	18,250,000
Total	31,990,000	4,820,000	5,130,000	41,940,000

Table 2. --Underground-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Miller Creek SW quadrangle, Custer and Rosebud Counties, Montana

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

Coal bed	High development potential	Moderate development potential	Low development potential	Total
Terrett	0	0	0	0
Burley	0	0	230,000	230,000
Total	0	0	230,000	230,000

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