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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE MILLER CREEK QUADRANGLE, CUSTER COUNTY, MONTANA

[Report includes 7 plates]

By

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

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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 quadrangle, Custer County, Montana, (7 plates; U.S. Geological Survey Open-File Report 78-635). 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 7 1/2-minute quadrangle is in southwestern Custer County, Montana, about 20 miles (32 km) southwest of Miles City, Montana, and 14 miles (22 km) south 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 western part of the quadrangle. There are a few unimproved roads and trails located mainly in the valleys in the southern half of the quadrangle.

Physiography

The Miller Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface, however, has been almost totally dissected by tributaries of the Tongue River. Only in the southwestern quarter of the quadrangle are there remnants of the old plateau surface which lie at elevations of about 3,100 feet (945 m). The topography is dominated by a series of southeastward trending valleys and ridges formed by tributaries of the Tongue River. The steep-sided divides have, in places, been carved into badlands. The Tongue River, which crosses the southeast corner of the quadrangle, flows northeastward and joins the Yellowstone River at Miles City. A flood plain having a width of about 0.5 to 1 mile (0.8 to 1.6 km) is developed along the Tongue River. The tributaries have narrower flood plains.

The lowest elevation in the quadrangle, just under 2,620 feet (799 m), is along the Tongue River. The highest elevation, 3,319 feet (1,012 m), is at Hansen triangulation station in the northwestern quarter of the quadrangle. Topographic relief is about 700 feet (213 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) 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 the southwest 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 50 percent of the land underlain by coal of Reserve Base thickness is federally owned. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Pierce (1936) mapped the Miller Creek 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 (Dobbin and Horn, 1949).

The Tullock Member forms the lowest outcrops in the quadrangle, occurring as the lowermost beds exposed along the Tongue River and its

tributaries in the southeastern quarter 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 wide irregular belt extending diagonally from the southwestern to the northeastern parts of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed throughout the northern and western parts 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 been 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 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. Structure contours on top of the Burley coal bed (pl. 4) show a local dip of less than 1 degree to the east.

COAL GEOLOGY

Two coal beds, both 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 Burley coal bed is the stratigraphically lowest coal bed, occurring about 250 to 300 feet (76 to 91 m) above the base of the Tongue River 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 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 22 miles (35 km) west of the Miller Creek quadrangle.

The Burley bed crops out along the plateau remnants in the western one-third of the quadrangle.

In the northwestern part of the quadrangle, the Burley bed dips southward about 40 feet per mile or 7.6 m/km (0.5 degree). In the central and southwestern part of the quadrangle, the bed is nearly flat (see pl. 4). As shown on plate 4, the Burley bed increases in thickness from less than 1 foot (0.3 m) at the southern outcrops to 8 feet (2.4 m) in the northwestern ones. Overburden on the Burley bed in the northwestern part of the quadrangle varies from zero to slightly over 200 feet (61 m), as shown on plate 5. In the remainder of the quadrangle, the bed is less than 4 feet (1.2 m) thick and the overburden was not considered.

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, p. 51) after a small mine on the Terret Ranch (Cook Creek Reservoir quadrangle) in the Ashland coal field. The Terret 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 western one-third of

the quadrangle. Here it is less than 3 feet (0.9 m) thick, and because of its thinness no reserve base coal has been assigned to it.

COAL RESOURCES

Outcrop data only were used in calculating the resources of the Burley coal bed because there are no drill holes in its limited occurrences.

Coal resources 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 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 coal measurement point. Reserves are the recoverable part of the Reserve Base. For surface-minable coal (the Burley bed in this quadrangle) the coal reserves are considered to be 85 percent of that portion of the Reserve Base that is beneath 200 feet (61 m) or less of overburden.

The total Reserve Base tonnage of federally owned coal in the Miller Creek quadrangle is calculated to be 13.14 million short tons (11.91 million t). The Reserve Base tonnage per section is shown in the northwest corner of each section on CRO plate 2 and by development-potential category

in tables 1 and 2. About 7 percent of the total is classed as Measured, 66 percent as Indicated, and 27 percent as Inferred. All numbers are rounded to the nearest one-hundredth of a million short tons.

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 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. 7). The Burley coal has a high development potential over 10 percent of the area in the northwestern part of this quadrangle. The rest of the quadrangle has no coal development potential for surface mining.

Development potential for underground mining and in situ gasification

Underground mining of coal is not being done nor is it planned for the future in the Powder River Basin, Montana. For this reason, coal beds 5 feet (1.5 m) or more thick found beneath 200 to 3,000 feet (61 to 914 m) of overburden in this quadrangle are rated as having a low development potential for underground mining. No Coal Development Potential map for underground mining was made because the development potential is uniformly low.

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 quadrangle, Custer 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	8,620,000	1,830,000	2,660,000	13,110,000
Total	8,620,000	1,830,000	2,660,000	13,110,000

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

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

Coal bed	High development potential	Moderate development potential	Low development potential	Total
Burley	0	0	18,000	18,000
Total	0	0	18,000	18,000

REFERENCES

Bass, N. W., 1932, The Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana: U.S. Geological Survey Bulletin 831-B, p. 19-105.

Dobbin, C. E., 1930, The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana: U.S. Geological Survey Bulletin 812-A, p. 1-55.

Dobbin, C. E., and Horn, G. H., 1949, Geology of the Mush Creek and Osage oil fields and vicinity, Weston County, Wyoming: U.S. Geological Survey Oil and Gas Investigations Map 103.

Hatch, J. R., and Swanson, V. E., 1977, Trace elements in Rocky Mountain coals, in Proceedings of the 1976 symposium, Geology of Rocky Mountain coal, 1977: Colorado Geological Survey, Resource Series 1, p. 143-163.

Mapel, W. J., Swanson, V. E., Connor, J. J., Osterwald, F. W., and others, 1977, Summary of the geology, mineral resources, environmental geochemistry, and engineering geologic characteristics of the northern Powder River coal region, Montana: U.S. Geological Survey Open-File Report 77-292.

Matson, R. E., and Blumer, J. W., 1973, Quality and reserves of strippable coal, selected deposits, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 91, 135 p.

Pierce, W. G., 1936, The Rosebud coal field, Rosebud and Custer Counties, Montana: U.S. Geological Survey Bulletin 847-B, p. 43-120.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Department of Agriculture, Interstate Commerce Commission, and U.S. Department of the Interior, 1974, Final environmental impact statement on proposed development of coal resources in the eastern Powder River coal basin of Wyoming: v. 3, p. 39-61.