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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE MOON CREEK SCHOOL 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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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 to be used in conjunction with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Moon Creek School quadrangle, Custer County, Montana, (7 plates; U.S. Geological Survey Open-File Report 78-636). 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 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 Moon Creek School 7 1/2-minute quadrangle is in southwestern Custer County, Montana, about 14 miles (22.4 km) southwest of Miles City, Montana, and 7 miles (11.2 km) south of Horton, a small town on 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. The quadrangle is 4.2 miles (6.7 km) south of the Interstate highway.

Accessibility

The area is accessible from Horton by traveling south on Moon Creek Road, an improved state road that crosses the central part of the quadrangle from north to south and intersects a number of unimproved roads and trails.

Physiography

The Moon Creek School 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 and Yellowstone Rivers. In the west half of the quadrangle, there are flat-topped buttes and mesas capped by resistant beds of clinker formed by burning of coal beds. The buttes and mesas have elevations above 3,100 feet (945 m); the highest elevation in the quadrangle, 3,200 feet (975 m), occurs here. In the east half of the quadrangle, the bedrock is composed of lower Fort Union strata found below the level of the significant coal beds. Here the land surface is composed of rounded hills and broad, gently sloping valleys. The lowest elevation, 2,740 feet (835 m), is in this area on Cottonwood Creek, at the north border of the quadrangle. Topographic relief in the quadrangle is about 460 feet (140 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) does not extend into the Moon Creek School quadrangle; however, the Boundary and Coal Data Map (pl. 2) shows the locations of a few small tracts of government coal lands. The Burley coal bed underlies parts of some of these tracts. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Pierce (1936) mapped the Moon Creek School 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 lowest member of the Fort Union Formation.

The oldest outcropping beds belong to the Lebo Shale Member, the Tullock Member being below the surface throughout the quadrangle. The Lebo Shale Member crops out in stream valleys in the central part of the west border, the central part of the east border, and in the northern quarter

of the quadrangle (Collier and Smith, 1909). The Lebo Shale Member is 160 to 200 feet (49 to 61 m) thick and consists mainly of gray shale and some lenticular, locally thick sandstone beds, but no significant coal beds.

The overlying Tongue River Member crops out in the remainder of the quadrangle. This unit is composed 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, forming thick 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 Moon Creek School quadrangle is in the north-central part of the Powder River structural basin. The strata are practically flat. The structure contour map and data points on top of the Burley coal bed (pl. 4) show only a very slight southward dip. There are no known faults or folds of consequence.

COAL GEOLOGY

Most of the Tongue River Member of the Fort Union Formation has been removed from the quadrangle by erosion. Only the lower part of the member remains. This contains the Burley coal bed and a local bed about 40 feet below it (pl. 1).

The Burley is the only significant coal bed, as the local coal bed is only 3 feet (0.9 m) or less in thickness. The Burley bed lies about 250 to 300 feet (76 to 91 m) above the base of the Tongue River Member.

The trace element content of coals in the Moon Creek 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 the 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) for outcrops at the Burley Ranch in the Forsyth coal field (Colstrip East quadrangle) 20 miles (32 km) southwest of the Moon Creek School quadrangle.

The Burley bed crops out near the tops of high plateau remnants in the west half of the quadrangle. The thickness of the bed ranges from 3.2 to 9.0 feet (1.0 to 2.7 m), as shown on the isopach map (pl. 4). The bed is practically flat; data points on top of the coal (pl. 4) show only a very slight dip southward. Overburden thickness on the Burley coal bed varies from zero to 100 feet (30 m), as shown on plate 5. There are no known published chemical analyses of coal from the Burley coal bed; it is assumed, however, that the quality of this coal is similar to that of other coal beds of the Fort Union Formation in nearby areas and that it is subbituminous C in rank.

COAL RESOURCES

Only the Burley coal bed is judged to have Reserve Base coal in the Moon Creek School quadrangle, and outcrop data only were used in estimating the resources because there are no drill holes in the limited occurrences.

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, the stripping limit for single, thin (5 to 40 feet or 1.5 to 12 m thick) beds of subbituminous coal in this area.

Estimated 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 metric tons per hectare-meter) for subbituminous coal yields the coal resources in short tons of coal for the 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 2.49 million short tons (2.26 million metric 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 3 percent of the Reserve Base tonnage is classed as Measured, 53 percent as Indicated, and 44 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas where coal beds are more than 5 feet (1.5 m) 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. 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 (pl. 7) included in this series of maps depicts the highest coal development 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 to the high development 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).

Each coal-bearing 40 acre (16.2 ha) tract of government-owned coal land in this quadrangle contains some coal having a high development potential for surface mining. Consequently, all such tracts are shown in the high development potential category on the CDP map (pl. 7). On the basis of coal resource tonnages (table 1), 90 percent is rated as high, 8.8 percent as moderate, and 1.2 percent as low development potential.

Development potential for underground mining and in situ gasification

All known minable coal in the Moon Creek School quadrangle is in the Burley coal bed within surface-minable depths. Because there is no known Resource Base coal at depths below the stripping limit of the Burley coal bed, 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 Moon Creek School 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	2,240,000	220,000	30,000	2,490,000
Total	2,240,000	220,000	30,000	2,490,000

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