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

[Report includes 8 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 for use in conjunction with the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Jack Creek quadrangle, Custer County, Montana (8 plates; U.S. Geological Survey Open-File Report 78-639). This set of maps was compiled to support the land planning work of the Bureau of Land Management's Minerals Activities Recommendation System (EMARS) program, 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 Jack Creek 7 1/2-minute quadrangle is in southwestern Custer County, Montana, about 19 miles (30.4 km) south of Miles City, Montana, which is in the valley of the Yellowstone River. The Burlington Northern Railroad and U.S. Interstate Highway 94 follow the valley of the Yellowstone River.

Accessibility

The area is accessible by Tongue River Road, Route 332, a paved county road that follows the Tongue River northeastward across the northwest quarter of the quadrangle and intersects U.S. Highway 312 at a point 9 miles (14.4 km) northeast of the Jack Creek quadrangle and 13 miles (20.8 km) southeast of Miles City. A few unimproved roads and trails traverse the quadrangle.

Physiography

The Jack Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The plateau surface, however, has been totally dissected by the Tongue River and its tributaries. The northeastward-flowing Tongue River meanders across the northwest corner of the quadrangle and then northward for about 20 miles (32 km) to join the Yellowstone River at Miles City. The valley of the Tongue River lies 200 to 250 feet (61 to 76 m) below the tops of the surrounding hills, is steep sided, and has a flood plain 0.5 to 1 mile (0.8 to 1.6 km) wide. A series of northwestward-flowing, ephemeral streams dissect the remainder of the quadrangle forming steep-sided interstream divides, which in places are carved into badlands.

The lowest elevation in the quadrangle, about 2,510 feet (765 m), is along the Tongue River at the north border of the quadrangle. The highest elevation, 3,230 feet (984.5 m), is at the Haddow triangulation station in the southeastern part of the quadrangle. Topographic relief is about 720 feet (219.5 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). 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 southern part of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts, and land ownership status, and the total reserve base (RB) of coal per section for each section of Federal land. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Pierce (1936) mapped the Jack 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 lowest 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 Tongue River and its tributaries in the northern two-thirds 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, p. 55).

The overlying Lebo Shale Member (Pierce, 1936, p. 57-60) is 167 to 220 feet (51 to 67 m) thick and consists of shale and a few thin, lenticular sandstones. This unit crops out in a large area in the central and southern parts of the quadrangle. A local coal bed, 3.3 feet (1.0 m) thick has a limited extent in the Lebo Shale Member in the southwestern part of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed on the higher parts of the stream divides in the southern part 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, forming 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 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 Jack 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 less than 1 degree. Structure contours on top of the Terret coal bed (pl. 5) show a local northwestward-plunging anticline having at least 80 feet (24 m) of structural relief.

COAL GEOLOGY

Four coal beds in the Tongue River Member of the Fort Union Formation were mapped on the surface in the Jack Creek quadrangle (pl. 1) and are shown in section on plate 3. The Foster coal bed (Pierce, 1936, p. 79) is the stratigraphically lowest of the four beds, occurring about 60 to 90 feet (18 to 27 m) above the base of the Tongue River Member. This bed underlies a small area in the eastern part of T. 3 N., R. 47 E. and the western part of T. 3 N., R. 48 E. The thin Foster coal is usually in two beds occurring from 1.5 to 5 feet (0.5 to 1.5 m) apart; the coal in each of the two beds is generally between 1.5 and 2.5 feet (0.5 and 0.75 m) in thickness. The

Terret coal, the next higher bed, is separated from the Foster coal by 16 to 60 feet (5 to 18 m) of interbedded sandstone and shale. The Terret bed is overlain by about 60 feet of interbedded sandstone and shale and then by the Haddow coal bed. The thin Haddow bed has a small areal extent near the south boundary of the map and is only about 2 feet (0.6 m) thick. The Haddow bed (Pierce, 1936, p. 80) is overlain by 35 to 60 feet (10.7 to 18.3 m) of interbedded sandstone and shale and then by the Flowers coal bed. The Flowers bed is the uppermost coal bed in the Tongue River Member and correlates with the Flowers-Goodale coal bed found in quadrangles to the south. The Flowers coal bed crops out in small areas near the south border of the quadrangle. This bed is as much as 7.9 feet (2.4 m) thick, but in most places it has been burned. Because of the burning and its small areal extent, Reserve Base coal tonnages have not been calculated for the Flowers bed. Only the Terret coal bed has sufficient extent and thickness to be assigned Reserve Base coal status in the Jack Creek quadrangle.

The trace element content of coals in the Jack 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).

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, some 23 miles (37 km) to the southwest. In the Jack Creek quadrangle, the Terret bed crops out on the interstream divides in the south-central part of the quadrangle and is extensively burned along the narrower divides (pl. 1). The Terret coal ranges in thickness from 1.7 to 9.0 feet (0.3 to 2.7 m) as shown on the isopach map (pl. 4). The bed is gently folded into a small anticline as shown on the structure map, plate 5. Overburden on the Terret coal bed ranges in thickness from 0 to slightly over 100 feet (30.5 m) and the mining ratios range from 0 to over 15, as shown on plate 6.

There are no known published chemical analyses of the Terret coal in the Jack Creek quadrangle. The nearest published analysis is from drill hole FC-16 located in sec. 17, T. 1 N., R. 48 E. in the Foster Creek School quadrangle some 12 miles (19 km) to the south. Gilmour and Williams (1969, p. 5) report a coal analysis of 5.14 percent ash, 0.21 percent sulfur, a heat value of 7,820 Btu per pound as received, and a rank of lignite A (heat value below 8,300 Btu on a moist, mineral-matter-free basis). Since the Foster Creek School and Jack Creek quadrangles have similar structural and stratigraphic positions in the coal basin, it is assumed that the coal in the Jack Creek quadrangle is also lignite A in rank.

COAL RESOURCES

Data from 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 the Jack Creek 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 lignitic 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 beds of lignitic 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 1,750 short tons of coal per acre-foot (12,880 metric tons per hectare-meter) for lignite yields the resources in short tons of lignite for the isopached bed. Reserve Base and Reserve tonnage values for the Terret coal bed are shown on plate 7 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 3.51 million short tons (3.18 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 13 percent of the Reserve Base tonnage is classed as Measured, 59 percent as Indicated, and 28 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 ratios for lignitic coal is as follows:

$$MR = \frac{t_o\ (0.922)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden

t_c = thickness of coal

rf = recovery factor = 0.85

0.922 = 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 6. These mining-ratio values for each development-potential category are based on current 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 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. 8). All the Federal 40-acre-tracts shown on plate 8 contain areas of high development potential, and are therefore assigned to the high development potential category. Some of these tracts may also contain areas of moderate and low development potential.

Development potential for underground mining and in situ gasification

All known economically minable coal in the Jack Creek quadrangle is contained in the Terret coal bed within surface minable depths. Because there is no known coal of Reserve Base thickness beneath the Terret coal bed, the development potential for underground mining in the Jack Creek quadrangle is rated as unknown or none. Therefore, no estimates of underground coal resources and no Coal Development Potential map for underground mining 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 Jack 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
Terret	3,100,000	380,000	30,000	3,510,000
Total	3,100,000	380,000	30,000	3,510,000

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