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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE JOHN HEN CREEK QUADRANGLE, ROSEBUD COUNTY, MONTANA

[Report includes 10 plates]

By

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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 John Hen Creek quadrangle, Rosebud County, Montana, (10 plates; U.S. Geological Survey Open-File Report 78-643). 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 John Hen Creek 7 1/2-minute quadrangle is in eastern Rosebud County, Montana, about 36 miles (58 km) southwest of Miles City and 20 miles (32 km) southeast of Rosebud, Montana. The main east-west route of the Burlington Northern Railroad and Interstate Highway 94 pass through both Miles City and Rosebud which are located in the Yellowstone River valley.

Accessibility

The northwest quarter of the quadrangle is accessible from Rosebud, Montana, by going south on County Improved Secondary Highway 447 and the Cherry Creek Road, a distance of 22 miles (35 km). The highway continues southward just west of the quadrangle and provides access to the southwest quarter of the quadrangle via Snider Creek Road, a distance of 28 miles

(45 km) from Rosebud, Montana. Unimproved roads provide access to the rest of the quadrangle.

Physiography

The John Hen Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. In the area of the John Hen Creek quadrangle, this upland plateau surface has been eroded extensively by two tributaries of the Yellowstone River, the Tongue River and Rosebud Creek. A major divide between these two drainages occupies the center of the quadrangle, trending generally from northeast to southwest. Trail Creek and Dry Creek are intermittent streams which flow eastward from this divide to the Tongue River. Cherry Creek, John Hen Creek, and Snider Creek are intermittent and flow westward from the divide to Rosebud Creek.

The highest elevations, just above 3,300 feet (1,006 m), are on the divide in the southwest and northeast corners, and near the center of the quadrangle. The lowest elevation, just below 2,800 feet (853 m), is near the northwest corner, where Cherry Creek leaves the quadrangle. Topographic relief is about 500 feet (152 m).

Climate

The climate of Rosebud 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 Resource Area (KRCRA) extends through the middle of the quadrangle north to south, following the major drainage divide, and covers about half the quadrangle area. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA boundary and the land ownership status. There were no outstanding Federal coal leases or prospecting permits of record in the quadrangle as of 1977.

GENERAL GEOLOGY

Previous work

Pierce (1936) mapped the John Hen Creek quadrangle as part of the Rosebud coal field, Rosebud and Custer Counties, Montana. Kepferle (1954) mapped the Snider Creek deposit, a local coal area in the southern part of the quadrangle, as part of his descriptions of selected deposits of strippable coal in central Rosebud County, Montana. Ayler, Smith, and Deutman (1969) mapped the quadrangle as part of their Rosebud Creek-Tongue River Divide deposit in a summary of strippable coal reserves of Montana. Matson and Blumer (1973) mapped the quadrangle as part of the Sweeney Creek-Snider Creek coal deposit in their review of strippable coal, selected deposits, southeastern 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 lower 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 the bottom of Cherry Creek near the 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 163 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 irregular areas conforming to the drainage patterns of Cherry Creek, John Hen Creek, and Snider Creek, located mostly in the west half of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed throughout the rest of the quadrangle, occupying much of the east two-thirds. It contains the coal beds of greatest economic interest. The 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, 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 the 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 John Hen Creek quadrangle is in the north-central part of the Powder River structural basin. The strata are nearly flat or in places dip southward at an angle of less than 1 degree. Structure contours on top of the Burley coal bed (pl. 7) show a south dip of about 20 feet per mile (3.8 m per km).

COAL GEOLOGY

Three coal beds, all in the Tongue River Member of the Fort Union Formation, were mapped in this quadrangle and are shown on the surface (pl. 1) and in section (pl. 3). The highest bed stratigraphically is the Terret coal bed. This is underlain successively by a noncoal interval of 40 feet (12 m), the Burley coal bed, another noncoal interval of 60 feet (18 m), the Trail Creek coal bed, and a noncoal interval of 60 feet (18 m), down to the base of the Tongue River Member.

Only the Terret and Burley coal beds are sufficiently thick and continuous to contain economic coal resources; the Trail Creek coal bed is nowhere more than 3 feet (0.9 m) thick.

The trace element content of coals in the John Hen 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. 5) after a small coal mine on the Terret Ranch in the Ashland coal field (Cook Creek Reservoir quadrangle) about 12 miles (19 km) southeast of the John Hen Creek quadrangle. The Terret coal bed crops out around the heads of the larger creek valleys of the quadrangle (Cherry, John Hen, Snider, Trail, and Dry Creeks), and underlies the high areas of the drainage divide which occupies

the east half of the quadrangle. Structure on the bed is almost flat, dipping southward about 20 feet per mile (3.8 m per km). Along most of the outcrops much coal has burned, leaving broad areas of clinker. In a number of places, the clinker has been removed by erosion exposing the coal bed. Based on these outcrops plus several drill holes, the thickness of the coal bed is seen to vary from 5 feet (1.5 m) to more than 18 feet (5.5 m) as shown on plate 4. The overburden covering the Terret coal bed ranges from zero to over 200 feet (60 m) in thickness.

Two coal mines, the Snider and Rockwall Mines, are located near the south border of the quadrangle, on the Terret coal bed (pl. 1). The Snider Mine is illustrated as 9.5+ feet (2.9+ m) of clean coal (Pierce, 1936, pl. 16, no. 83), and the Rockwall Mine is illustrated as 17 feet (5.2 m) of clean coal (Kepferle, 1954, p. 365, no. 5), but no information is presented as to the production or quality of coal from either mine. It may be assumed that only a small quantity of coal has been mined for local use.

No coal analyses are available for the Terret coal bed in the John Hen Creek quadrangle; however, the Montana Bureau of Mines and Geology drilled, cored, and analyzed the Terret coal in State Hole SS-5C about 5 miles (8 km) northeast in the Miller Creek SW quadrangle. At depths of 109 to 127 feet (33.2 to 38.7 m) the analysis indicated a heating value of 8,020 Btu per pound, ash 9.43 percent, and sulfur 1.18 percent, on an as-received basis (Matson and Blumer, 1973, p. 102). This analysis indicates that the coal is subbituminous C in rank.

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) about 10 miles (16 km) west of the John Hen Creek quadrangle.

The Burley coal bed lies about 40 feet (12 m) below the Terret coal and crops out around the major creek valleys of the quadrangle and underlies most of the major drainage divide which extends north-south through the center of the quadrangle.

Structure on the Burley coal bed is relatively flat, dipping less than 20 feet per mile (3.8 m per km) to the south (pl. 7). The coal thickness decreases from 6.2 feet (1.9 m) to about 3 feet (0.9 m) northward across the quadrangle (pl. 7). Where the Burley coal bed is of minable thickness (5 feet or 1.5 m or more), the overburden ranges from zero to more than 300 feet (91 m) in thickness, with the thickest overburden near the southwest corner of the quadrangle (pl. 8). There are no known published chemical analyses of coal from the Burley bed; however, it is assumed that the quality of the coal is similar to that of other coal beds of the Fort Union Formation and is subbituminous C in rank.

COAL RESOURCES

Data from drill holes as well as 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 John Hen Creek quadrangle.

Coal resource tonnages derived 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 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 500 feet (152 m) or less of overburden. This depth of overburden is the stripping limit for multiple, relatively 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 (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 metric tons per hectare-meter) 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 6 and 9, respectively, 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 80.98 million short tons (73.47 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 15 percent of the Reserve Base tonnage is classed as Measured, 50 percent as Indicated, and 35 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas where coal beds are 5 feet (1.5 m) or more thick and are overlain by 500 feet (152 m) or less of overburden in this quadrangle 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 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
r_f = 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 plates 5 and 8. 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 (pl. 10) depicts the highest coal development potential category which occurs within each smallest legal subdivision of Federal coal land, normally about 40 acres. If such a 40-acre tract of land contains areas of more than one category of high, moderate, and low development potential, the entire tract is assigned to the highest category for CDP mapping purposes.

The coal development potential for surface-mining methods (where there is less than 500 feet or 152 m of overburden) is shown on the Coal Development Potential map (pl. 10). Both the Terret and Burley coal beds have a high development potential over their 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 John Hen Creek quadrangle is contained in the Terret and Burley coal beds within surface minable

depths. Since there is no known Reserve Base coal at depths beneath these coal beds, the development potential for underground mining in the John Hen Creek quadrangle is rated as unknown or none. No table of coal resource tonnage by development potential category for underground mining methods was made, nor was a Coal Development Potential map for underground mining methods 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 John Hen Creek quadrangle, Rosebud 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	61,290,000	1,080,000	110,000	62,480,000
Burley	12,710,000	2,920,000	2,870,000	18,500,000
Total	74,000,000	4,000,000	2,980,000	80,980,000

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