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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE JEANS FORK NE QUADRANGLE, BIG HORN COUNTY, MONTANA

[Report includes 6 plates]

By

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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 Jeans Fork NE quadrangle, Big Horn County, Montana, (6 plates; U.S. Geological Survey Open-File Report 79-014). 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 1976, 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 Jeans Fork NE 7 1/2-minute quadrangle is in northeastern Big Horn County, Montana, about 38 miles (61 km) south of Hysham, Montana, a town in the Yellowstone River valley about 71 miles (114 km) west-southwest of Miles City and 78 miles (125 km) east of Billings. U.S. Interstate Highway 94 and the main east-west route of the Burlington Northern Railroad follow the Yellowstone River and pass through Hysham.

Accessibility

The Jeans Fork NE quadrangle is accessible from the north or west by way of the Sarpy Road, an unimproved, graveled road that connects the town of Hysham, Montana, 38 miles (61 km) to the north with the town of Hardin, 24 miles (38.4 km) to the west. The quadrangle is accessible from

an intersection 4 miles (6 km) east of Hysham on U.S. Interstate Highway 94, then south on the Sarpy Road about 33 miles (52.8 km) to the Absaloka Coal Mine Road intersection, and then south and east about 5 to 7 miles (8 to 11 km) on any one of several roads, mostly unimproved, to the north border of the quadrangle. The quadrangle is accessible from an intersection 2 miles (3.2 km) east of Hardin on U.S. Interstate Highway 90, then east on the Sarpy Road about 27 miles (43.2 km) to the Absaloka Coal Mine Road intersection, and then south and east to the north border of the quadrangle. Additional roads, most of them unimproved, lead to other parts of the quadrangle.

The nearest railroad is a spur which runs south from the main line of the Burlington Northern Railroad Near Hysham, parallel with the Sarpy Road, about 24 miles (38 km) to the Absaloka coal mine located in the Wolf School quadrangle about 4 miles (6 km) north of the Jeans Fork NE quadrangle.

Physiography

The Jeans Fork NE quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. Most of the quadrangle has been dissected by tributaries of Sarpy Creek and East Fork Tullock Creek which flow northwestward across the quadrangle. The two streams are separated by a drainage divide which extends diagonally southeast-northwest across the quadrangle.

The highest elevation in the Jeans Fork NE quadrangle, about 4,618 feet (1,408 m), is on the divide near the southeast corner of the quadrangle. The lowest elevation, just below 3,420 feet (1,042 m), is near the center of

the west border, where East Fork Tullock Creek flows out of the quadrangle. The topographic relief is 1,200 feet (366 m).

Climate

The climate of Treasure and Big Horn 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). 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 is drawn along the borders of the Crow and Northern Cheyenne Indian Reservations, as shown by the Boundary and Coal Data Map (pl. 2). This map also shows the ownership status of the nonreservation lands. There were no outstanding Federal coal leases or prospecting permits as of 1977.

Specific coal bed maps and coal resource determinations in this report are limited to the Federal lands east and north of the reservation lands.

GENERAL GEOLOGY

Previous work

Thom and others (1935) mapped the Jeans Fork NE quadrangle as part of their study of the geology of Big Horn County and the Crow Indian Reservation, 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 Paleocene Fort Union Formation which is composed of three members: the upper Tongue River Member, the middle Lebo Shale Member, and the lower Tullock Member. Thom and others (1935, p. 29) represented the Tullock to be a member of the Tertiary(?) Eocene(?) Lance Formation, but since 1949 the U.S. Geological Survey has considered the Tullock in Montana to be the lowermost member of the Fort Union Formation.

The Tullock Member does not crop out in the quadrangle. The lowest outcropping member is the Lebo Shale.

The upper part of the Lebo Shale Member crops out in the bottoms of Jeans Fork and East Fork Tullock Creek on the west border of the quadrangle. The Lebo Shale Member is 800 to 1,000 feet (244 to 305 m) thick (Thom and others, 1935, p. 29) and consists of soft, gray to olive-gray and black shale with a few thin beds of sandstone and many ferruginous concretions. The strata weather into treeless slopes and badlands. A thick bed of carbonaceous shale or impure coal is commonly present at the base of the Lebo

(Thom and others, 1935, p. 64). This bed is probably equivalent to the Big Dirty coal bed mapped in quadrangles northeast of the Jeans Fork NE quadrangle.

The Tongue River Member forms the exposed bedrock units throughout most of the quadrangle. The Tongue River Member consists of light-colored sandstone, sandy shale, and several important coal beds. The thicker coal beds have burned along the outcrop and have fused the overlying rock into reddish-colored clinker. Rogers and Lee (1923, p. 41) report that the Tongue River Member is at least 1,275 feet (389 m) thick in the Little Wolf Mountains, several miles (several km) to the northeast. However, in the Jeans Fork NE quadrangle some of the member has been removed by erosion so that only about 1,000 feet (305 m) remain.

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 Jeans Fork NE quadrangle is in the northwestern part of the Powder River structural basin. The strata in general dip eastward or southeastward at about 60 feet per mile (11.4 m per km) or less. In places the regional structure is modified by low-relief folds (Thom and others, 1935, pl. 1).

COAL GEOLOGY

Five named coal beds, all in the Tongue River Member, are mapped on the surface in this quadrangle (pl. 1) or are shown in section on plate 3. Only one is sufficiently thick and continuous to contain economic reserves within the area of Federal lands in the quadrangle. The stratigraphically lowest of the beds mapped is the Burley coal bed, which is about 130 feet (39.6 m) above the base of the Tongue River Member. Above the Burley bed are a noncoal interval of about 60 feet (18 m), the Robinson coal bed, a noncoal interval of about 80 feet (24.4 m), the Rosebud-McKay coal bed, a noncoal interval of about 160 feet (48.8 m), the Q coal bed, a noncoal interval of about 70 feet (21.3 m), and the Lee coal bed. In addition, three local coal beds are shown in section on plate 3, but none has economic reserves of coal. One local bed, about 50 feet (15.2 m) above the Rosebud-McKay coal bed, is probably a split of that bed. The remaining two local beds are about 300 feet (91 m) and 450 feet (137 m), respectively, above the Lee coal bed (pl. 3).

A clinker bed which is assumed to be remains of the Sawyer coal bed lies about 100 feet (305 m) above the Lee coal bed.

The trace element content of coals in this 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 lowermost recognized coal bed in the Jeans Fork NE quadrangle, the Burley coal bed, was named by Dobbin (1930, p. 27) from exposures on the Burley Ranch about 26 miles (41.8 km) northeast of the Jeans Fork NE quadrangle in the northern part of the Colstrip East quadrangle. The Burley coal is estimated to occur about 130 feet (49.6 m) above the base of the Tongue River Member. Thom (1935, pl. 14) sketched the outcrop of the Burley coal bed in the western part of the Jeans Fork NE quadrangle (pl. 1). Because the Burley coal bed is thin, economic coal resources have not been assigned to it.

Robinson coal bed

The Robinson coal bed was first described by Dobbin (1930, p. 27) from outcrops on the Robinson Ranch in the McClure Creek quadrangle about 15 miles (24 km) north-northeast of the Jeans Fork NE quadrangle. The Robinson coal bed does not crop out within the area of Federal lands in the east half of the northeast quarter of the Jeans Fork NE quadrangle. The thickness and depth measurements for the Robinson coal bed have been

projected from data points in the Crow and Northern Cheyenne Indian Reservations, and from adjacent quadrangles to the north and northeast.

Within the Federal coal area the Robinson coal bed is projected to dip gently eastward, about 40 feet per mile (7.6 m per km), and to decrease from 12 to 4 feet (3.7 to 1.2 m) in thickness southward (pl. 4). The overburden on the Robinson coal bed ranges from somewhat less than 400 feet (122 m) to more than 800 feet (244 m) in thickness (pl. 5).

There are no known published chemical analyses of the Robinson coal. It is assumed that the Robinson coal is similar to other closely associated coal beds in the area on which analyses are available, and is subbituminous B in rank.

Rosebud-McKay coal bed

The Rosebud coal bed and the underlying McKay coal bed were first described by Dobbin (1930, p. 27) from exposures in the Forsyth coal field. Specific type localities were not given. Dobbin (1930, p. 27) considered the McKay coal bed to be a lower split of the Rosebud coal bed because many measurements showed that the interval between them in some areas is less than 7 feet (2.1 m). They have been considered as one bed in this quadrangle.

Thom and others (1935, pl. 14) sketched the outcrop of the Rosebud-McKay bed in the central and western parts of the Jeans Fork NE quadrangle. A preliminary isopach map of this coal bed based on thickness measurements shown on plate 1 indicates that the Rosebud-McKay coal bed thins eastward to less than 5 feet (1.5 m) in thickness under the Federal coal lands in the northeastern part of the quadrangle. The bed thickens again farther east in

the Chalky Point quadrangle. Because the coal bed is less than 5 feet (1.5 m) thick in the Federal coal land area, additional maps for this coal bed were not made and economic resources were not assigned to it.

Other coal beds

The Q coal bed extends southward from the Wolf School quadrangle a short distance into the northern part of the Jeans Fork NE quadrangle (pl. 1). Because the Q bed here is less than 5 feet (1.5 m) thick, economic coal resources have not been assigned to it.

Thom and others (1930, pl. 14) mapped an unnamed coal bed in the northeast quarter of the Jeans Fork NE quadrangle. We believe that this bed correlates with the Lee coal bed as first described by Dobbin (1930, p. 28) in the Forsyth coal field. Three measurements (pls. 1 and 3) indicate that this coal bed is less than 5 feet (1.5 m) thick, and consequently economic coal resources have not been assigned to it.

A thick clinker bed, formed during the burning of the Sawyer coal bed, occurs on a high ridge in the northeastern part of the quadrangle. There are no measurements of coal here, and it is assumed that the Sawyer coal has been entirely burned.

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 this quadrangle; there are no publicly available drill hole data.

Coal resource tonnages shown in this report are the Reserve Base (RB) part of Identified Resources and the Hypothetical (HYP) part of the Undiscovered 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.

Hypothetical Resources are undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, Hypothetical Resources are located in broad areas of coal fields where no points of observation are present, and the evidence for the coal's existence is from distant outcrops, drill holes, or wells that are more than 3 miles (4.8 km) away. Hypothetical Resources are located beyond the outer boundary of the Inferred part of Identified Resources in areas where the assumption of continuity of the coal bed is supported only by a projection of geologic evidence. For purposes of this report, tonnages were calculated for only those Hypothetical coal resources in beds that are estimated to be 5 feet (1.5 m) or more thick and to be under less than 3,000 feet (914 m) of overburden.

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 the Jeans Fork NE 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/hectare-meter) for subbituminous coal yields the coal resources in short tons of coal for the Robinson coal bed. The Reserve tonnage values for the beds are shown on plate 6 and are rounded to the nearest one-hundredth of a million short tons. All tonnages lie below the 200 foot (61 m) stripping limit, and are classed as underground minable. Those tonnages lying more than 3 miles (4.8 km) from a measurement point are classed as hypothetical (HYP).

The total Reserve Base tonnage of federally owned coal in the Jeans Fork NE quadrangle is estimated to be 1.46 million short tons (1.32 million t). The total hypothetical (HYP) coal is estimated to be 9.12 million short tons (8.27 million t). The resource 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.

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 are 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. 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.

Development potential for surface-mining methods

All the coal resources of minable thickness under Federal lands in this quadrangle are below the stripping limit of 200 feet (61 m) and have a mining ratio greater than 15. The development potential by surface-mining methods for this coal is rated as none. For this reason a Coal Development Potential map for surface mining was not made, and a table of surface-minable coal resource tonnage was not made.

Development potential for underground mining and in-situ gasification

All the coal resources under Federal lands known to be of minable thickness in the Jeans Fork NE quadrangle are below the stripping limit of 200 feet (61 m), and are classified as underground minable. A further classification of the resources by development potential is shown in table 1. Underground mining of coal in the Northern Powder River Basin is not currently being done because of poor economics. For this reason the coal development potential for underground mining is rated as low for all these deep resources, and a Coal Development Potential map for underground mining was not 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.--Underground-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Jeans Fork NE quadrangle, Big Horn 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
Reserve Base tonnage				
Robinson	0	0	1,460,000	1,460,000
Total	0	0	1,460,000	1,460,000
Hypothetical Resource tonnage				
Robinson	0	0	9,120,000	9,120,000
Total	0	0	9,120,000	9,120,000
Grand Total	0	0	10,580,000	10,580,000

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