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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BRANDENBERG NW QUADRANGLE, CUSTER AND ROSEBUD COUNTIES, MONTANA

[Report includes 7 plates]

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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 Brandenberg NW quadrangle, Custer and Rosebud Counties, Montana, (7 plates; U.S. Geological Survey Open-File Report 78-642). 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 Brandenberg NW 7 1/2-minute quadrangle is in southwestern Custer and eastern Rosebud Counties, Montana, about 30 miles (48 km) southwest of Miles City, Montana, and 22 miles (35 km) southeast of Rosebud, a small town on U.S. Interstate Highway 94 located about 33 miles (53 km) west of Miles City. U.S. Interstate Highway 94 and the main east-west route of the Burlington Northern Railroad follow the valley of the Yellowstone River.

Accessibility

The east side of the Brandenberg NW quadrangle is accessible from Miles City, Montana, by going south on U.S. Highway 312 and local Route

332, a distance of 45 miles (72 km). The southwest corner of the quadrangle can be reached from the town of Rosebud, Montana, by going south up Rosebud Creek on local Route 447 and then the Snider Creek Road, a distance of 35 miles (56 km). Unimproved roads provide access to the rest of the quadrangle.

Physiography

The Brandenberg NW 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 Yellowstone River. The Tongue River crosses the southeast quarter of the quadrangle, and only northwest of the river are there remnants of the old plateau surface. These are present as ridges and flat-topped buttes which have elevations of about 3,260 to 3,300 feet (993 to 1,005 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 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 highest elevations in the quadrangle, about 3,300 feet (1,005 m), are near the northwest corner. The lowest elevation, just under 2,680 feet (816.6 m), is on the east border where the Tongue River leaves the quadrangle. Topographic relief is about 620 feet (189 m).

Climate

The climate of Custer and Rosebud 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) 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 northwest quarter of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the locations of the KRCRA tracts and the land ownership status. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Pierce (1936) mapped the Brandenberg NW quadrangle as part of the Rosebud coal field, Rosebud and Custer Counties, Montana. Bass (1932) mapped the southeast corner of the quadrangle, primarily that part southeast of the Tongue River, as part of the Ashland coal field, Rosebud, Powder River, 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 lowermost member of the Fort Union Formation in Montana.

The Lebo Shale Member forms the lowest outcrops in the quadrangle, occurring as the lowermost beds exposed along the Tongue River and its tributaries, mostly in the eastern half of the quadrangle. The 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.

The Tongue River Member caps the divides and ridges in the western half of the quadrangle and contains the coal beds of economic interest. The unit is made up mainly of yellow sandstone, sandy shale, carbonaceous shale, and coal. Considerable coal has burned along outcrops, fracturing and baking 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 Brandenberg NW 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. 4) show local dips east and south of about 50 feet per mile (9.52 m per km).

COAL GEOLOGY

Three coal beds, all in the Tongue River Member of the Fort Union Formation, were mapped on the surface in the Brandenberg NW quadrangle (pl. 1) and are illustrated in section on plate 3. The Trail Creek coal bed is stratigraphically the lowest, occurring about 60 feet (18 m) above the base of the Tongue River Member. It is overlain successively by a noncoal

interval 50 feet (15 m) thick, the Burley coal bed, another noncoal interval 50 to 90 feet (15.2 to 27.4 m) thick, and the Terret coal bed.

The Trail Creek coal bed is discontinuous, thin, and relatively unimportant. It ranges from zero to 4.5 feet (1.37 m) in thickness and is actually a zone consisting of more than one coal bed. An outcrop in sec. 35, T. 3 N., R. 44 E., described as 4.5 feet (1.37 m) of coal and bony coal, is labeled the Martin Mine, but there is no further information as to quantity or rates of production to indicate that mining was actually carried out (Pierce, 1936, p. 101). Because of its thinness and lack of continuity, no economic resources have been attributed to the Trail Creek bed.

The Burley coal bed crops out around the ridges and flat-topped hills in the west half of the quadrangle. Outcrop measurements indicate a thickness range of from 0.5 to 4.7 feet or 0.15 to 1.43 m (pls. 1, 3). The bed is probably not a continuous single bed, but is absent in some areas (Pierce, 1936, p. 101). Because it is thin and lacks continuity, no economic resources have been attributed to the Burley coal bed.

Terret coal bed

The Terret coal bed was described by Bass (1932, p. 51) from a small mine on the Terret Ranch (about 10 miles or 16 km to the south in the Cook Creek Reservoir quadrangle) in the Ashland coal field. The Terret bed occurs 50 to 90 feet (15 to 27 m) above the Burley coal bed in the lower part of the Tongue River Member and crops out around the tops of the high plateau remnants and ridges in the western half of the quadrangle. Along most of the

outcrop considerable coal has burned, leaving broad areas of clinker. In places the clinker has been removed by surface erosion, exposing the coal bed.

Based on data points in adjacent quadrangles as well as within the Brandenberg NW quadrangle, the Terret coal bed dips south and east about 50 feet per mile (9.52 m per km) away from a gentle anticline in the northwest corner of the quadrangle (pl. 4). Measured sections show that the Terret bed thickens westerly from 9 feet to 17 feet (2.7 to 5.2 m) within its area of occurrence in the northwest quarter of the quadrangle. Overburden above the bed ranges from zero to about 150 feet (46 m) in thickness (pl. 5).

No coal analyses are available for the Terret coal bed in the Brandenberg NW quadrangle. However, the Montana Bureau of Mines and Geology drilled, cored, and analyzed the Terret coal in State Hole SS-5C located in the Miller Creek SW quadrangle, about 3 miles (4.8 km) north of the Brandenberg NW quadrangle border. The coal is subbituminous C in rank. 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, as received (Matson and Blumer, 1973, p. 102).

The trace element content of coals in the Brandenberg NW 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).

COAL RESOURCES

Data from oil-and-gas and coal test holes, as well as 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 Brandenberg NW 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 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 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 single, relatively thin (5 to 40 feet or 1.5 to 12 m) beds of subbituminous coal in this area.

The acreage underlain by a coal bed was measured by planimeter. The coal resources in the quadrangle were computed using these acreage numbers 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 to yield the coal resources in short tons of coal for each isopached coal bed.

Reserve Base and Reserve tonnage numbers for the Terret coal bed are shown on plate 6, 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 9.38 million short tons (9.51 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, 5 percent as Indicated, and 92 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-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 (pl. 7) 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 or 16.2 ha). 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-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 Terret coal has a high development potential over its entire area of occurrence 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

All known minable coal in the Brandenberg NW quadrangle is contained in the Terret coal bed within surface-minable depths. Because there is no known Reserve Base thickness coal below the Terret coal bed, the development potential for underground mining in the Brandenberg NW quadrangle is rated as unknown or none. Therefore, no table of underground coal resource tonnage and no Coal Development Potential map for underground mining methods 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 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 Brandenberg NW quadrangle, Custer and Rosebud Counties, 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	9,380,000	0	0	9,380,000
Total	9,380,000	0	0	9,380,000

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