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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE HAMMOND DRAW NW QUADRANGLE, ROSEBUD COUNTY, MONTANA

[Report includes 10 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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[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 Hammond Draw NW quadrangle, Rosebud County, Montana, (10 plates; U.S. Geological Survey Open-File Report 78-645). 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 Hammond Draw NW 7 1/2-minute quadrangle is in eastern Rosebud County, Montana, about 40 miles (64 km) southwest of Miles City and 22 miles (35 km) south of Rosebud, Montana. The main east-west route of the Burlington Northern Railroad and Interstate Highway 94 pass through both Miles City and Rosebud.

Accessibility

The Hammond Draw NW quadrangle is accessible from Rosebud, Montana, south on County Improved Secondary Highway 447, a distance of 22 miles (35 km). The highway continues southward just inside the east boundary of the quadrangle along Rosebud Creek. Unimproved roads in tributary stream valleys provide access westward into the quadrangle.

Physiography

The Hammond Draw NW quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. In the Hammond Draw NW quadrangle, this upland plateau surface has been eroded extensively by the northward-flowing Rosebud Creek and its tributaries. East-west drainage divides separate the main tributaries, Sprague, Spring, West Snider, and Pony Creeks. The highest elevations, just over 3,300 feet (1,006 m), are south of Pony Creek near the southwest corner of the quadrangle. The lowest elevation, about 2,730 feet (832 m), is just west of the northeast corner, where Rosebud Creek leaves the quadrangle. Topographic relief is about 570 feet (174 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) covers the southwest quarter of the quadrangle excepting the bottoms of West Snider and Pony Creeks. 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 Hammond Draw NW quadrangle as part of the Rosebud coal field, Rosebud and Custer Counties, Montana. Ayler Smith, and Deutman (1969) mapped the Burley deposit, a small area in the southern part of the Hammond Draw NW quadrangle, in a summary of strippable coal reserves of 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 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 bottoms of Rosebud Creek and its tributary Sprague Creek near the northeast 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 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 important coal beds. This unit crops out in irregular areas conforming to the drainage patterns of tributary valleys of Rosebud Creek, located mostly in the northeast part of the quadrangle.

The Tongue River Member of the Fort Union Formation is exposed throughout most of the southwest part of the quadrangle. 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 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 Hammond Draw NW 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 40 feet per mile (7.6 m per km).

COAL GEOLOGY

Four coal beds (not counting two thin, local beds), all in the Tongue River Member of the Fort Union Formation, were mapped in this quadrangle on the surface (pl. 1) and are shown in section on plate 3. The massive clinker which caps the plateaus in the southwest quarter of the quadrangle is evidence that a fifth coal bed, the Rosebud, was present at one time, but practically all of it has burned. The presence of the McKay coal bed about 30 feet (9 m) below the base of the Rosebud clinker is apparent from a number of ourcrops, but it is largely obscured by the resistant clinker plateau. Below the McKay is a 130 foot (40 m) noncoal interval, the Terret coal bed, another 70 foot (21 m) noncoal interval, the Burley coal bed, another 30 foot (9 m) noncoal interval, and the Trail Creek coal bed, which lies about 20 feet (6 m) above the base of the Tongue River Member. Only the McKay and

the Burley coal beds are sufficiently thick and continuous to contain economic coal resources.

The trace element content of coals in the Hammond Draw 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).

Burley coal bed

The Burley coal bed was described by Dobbin (1930, p. 27) after outcrops at the Burley Ranch in the Forsyth coal field (Colstrip East quadrangle) about 4 miles (6.4 km) west of the Hammond Draw NW quadrangle.

The Burley coal bed crops out around the valley slopes of West Snider and Pony Creeks, in the southwest quarter of the quadrangle. Along the outcrop much coal has burned, leaving broad areas of clinker. Surface erosion has removed the clinker in a number of places, exposing the coal bed. On the basis of these outcrops, the thickness of the Burley coal bed is seen to vary only slightly, from 7.5 to 9.3 feet (2.3 to 2.8 m), as shown on plate 7. There are no publicly available data from drill holes which penetrate the coal bed. The Burley coal bed dips gently southward about 40 feet per mile (7.6 m per km), as shown on plate 7. The overburden on the Burley coal bed ranges in thickness from zero to more than 300 feet (91 m). It contains the McKay coal bed and the Rosebud clinker where present (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 closely associated coal beds of the Fort Union Formation nearby, and is subbituminous C in rank.

McKay coal bed

The McKay coal bed was first described by Dobbin (1930) after occurrences near the old McKay Ranch (T. 2 N., R. 42 E., Colstrip East quadrangle) in the Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana. Bass (1932) mapped the coal bed in the Ashland coal field, Powder River and Custer Counties, Montana, (Hammond Draw SW quadrangle) immediately south of its occurrences in this quadrangle (Hammond Draw NW) as usually concealed by clinker of the Rosebud ash of the burned Rosebud bed. Pierce (1936) projected the McKay coal bed into the southwest corner of the Rosebud coal field, Montana, (Hammond Draw NW quadrangle, pl. 1) with an areal distribution corresponding approximately to that of the Rosebud clinker, and lying about 30 feet (9.1 m) below it. The McKay coal bed in the Hammond Draw NW quadrangle is shown to dip southward about 40 feet per mile (7.6 m/km) and to range from 4.5 to 7 feet (1.37 to 2.13 m) in thickness (pl. 4). Where the coal is more than 5 feet (1.5 m) thick, the overburden ranges to somewhat more than 100 feet (30.5 m) in thickness (pl. 5), and consists largely of clinker of the burned Rosebud coal bed.

No coal analyses are available for the McKay coal bed in the Hammond Draw NW quadrangle; however, the Montana Bureau of Mines and Geology drilled, cored, and reported the analysis of the McKay coal in hole RB-46 about 6 miles (9.6 km) to the southwest in the Colstrip SE quadrangle. At

a depth of 100 to 108 feet (30.5 to 32.9 m) the analyses indicated a heating value of 9,060 Btu per pound, ash 7.75 percent, and sulfur 1.87 percent, as received (Matson and Blumer, 1973, p. 78). The coal is subbituminous B in rank (about 9,820 Btu per pound, moist and mineral-matter free). It is assumed that the McKay bed coal in the Hammond Draw NW quadrangle is similar in rank and is subbituminous B.

Other coal beds

Two thin, local coals and the Terret and Trail Creek coal beds are mapped or shown in section on plates 1 and 3. None of these has sufficient continuity or thickness to contain economic Reserve Base coal.

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 Hammond Draw NW 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 maps (pls. 4 and 7). 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 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 McKay 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 the Hammond Draw NW quadrangle is calculated to be 45.51 million short tons (41.29 million metric t). The Reserve Base tonnage totals per section are shown in the northwest corner of each section on 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 6 percent of the Reserve Base tonnage is classed as Measured, 33 percent as Indicated, and 61 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
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 plate 5. 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 with 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). The Burley and McKay coal beds have a high development potential over most of their areas of occurrence in the quadrangle (about 3,300 acres or 1,337 ha). The development potential is shown to be moderate under about 60 acres (24 ha) and low under about 20 acres (8 ha). The rest of the quadrangle has no coal development potential for surface mining (pl. 10).

Development potential for underground mining and in situ gasification

All known economically minable coal in the Hammond Draw NW quadrangle is contained in the Burley and McKay 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 Hammond Draw NW 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 Hammond Draw NW 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
McKay	1,850,000	2,300,000	1,250,000	5,400,000
Burley	32,610,000	3,260,000	4,240,000	40,110,000
Total	34,460,000	5,560,000	5,490,000	45,510,000

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