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COAL RESOURCE OCCURRENCE AND
COAL DEVELOPMENT POTENTIAL MAPS OF THE
ASHLAND NE QUADRANGLE,
ROSEBUD COUNTY, MONTANA

[Report includes 19 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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<u>To convert</u>	<u>Multiply by</u>	<u>To obtain</u>
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 Ashland NE quadrangle, Rosebud County, Montana, (19 plates; U.S. Geological Survey Open-File Report 79-001). 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 Ashland NE 7 1/2-minute quadrangle is in southeastern Rosebud County, Montana, about 40 miles (64 km) southeast of Forsyth, Montana, a town in the Yellowstone River valley about 44 miles (70 km) west-southwest of Miles City and 105 miles (168 km) east of Billings. U.S. Interstate Highway 94 and the main east-west routes of the Chicago, Milwaukee, St. Paul, and Pacific Railroad and the Burlington Northern Railroad follow the Yellowstone River and pass through Forsyth.

Accessibility

The quadrangle is accessible by traveling south on local, improved Highway 447 from a point about 7 miles (11 km) east of Forsyth, Montana, on U.S. Interstate Highway 94, a distance of about 57 miles (91 km) to the

unimproved Greenleaf Creek Road, and then southeast on this road a distance of about 7 miles (11 km) to the northwest corner of the quadrangle.

The quadrangle is also accessible from Miles City, Montana, by traveling south on U.S. Highway 312 a distance of 13 miles (21 km) to the improved Tongue River Road (local Route 332), and then southwest on this road a distance of about 50 miles (80 km) to the north boundary of the quadrangle. The Tongue River Road continues southward across the approximate center of the quadrangle. A number of unimproved roads provide access to the rest of the quadrangle from the Tongue River and Greenleaf Creek Roads.

Physiography

The Ashland NE quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The land surface is maturely dissected by the Tongue River and its tributaries. The Tongue River flows northward through the approximate middle of the quadrangle and continues northeastward and northward to join the Yellowstone River at Miles City. The Tongue River has a flood plain reaching 1 mile (1.6 km) in width. The principal tributaries have narrower flood plains. The hills bordering the flood plains rise steeply 300 feet (91 m) or more. Some of the hills are capped by erosion-resistant, reddish-colored clinker beds. The highest elevations are in the southwest quarter of the quadrangle along an east-west ridge about 2 miles (3.2 km) north of the south boundary. Several points reach elevations of 3,320 feet (1,012 m). The lowest elevation, about 2,810 feet (856 m), is on the Tongue River where it leaves the north border of the quadrangle. Topographic relief is 510 feet (156 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). 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 covers above one-third of the northeast quarter of the quadrangle, and several other local areas, as shown by the Boundary and Coal Data Map (pl. 2). Approximately the southwest quarter of the quadrangle is within the Northern Cheyenne Indian Reservation in which the coal resources were not mapped. Plate 2 shows the land ownership status of lands north and east of the Indian Reservation. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Bass (1932) mapped that part of the Ashland NE quadrangle which is north and east of the Northern Cheyenne Indian Reservation, as part of the Ashland coal field, Rosebud, Treasure, and Big Horn Counties, Montana.

Matson and Blumer (1973) mapped a narrow strip along the east side of the quadrangle as part of the Ashland coal deposit.

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 Tongue River Member, the uppermost member, of the Fort Union Formation (Paleocene). This member consists of light-colored sandstone, sandy shale, and important coal beds. The thicker coal beds have burned along the outcrop and have fused the overlying rock into reddish-colored slag or clinker. The entire Tongue River Member is about 1,700 feet (518 m) thick in the Forsyth coal field (Dobbin, 1930, p. 16), but in the Ashland NE quadrangle, most of the member has been removed by erosion, so that only about 500 feet (152 m) remains.

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 Ashland NE quadrangle is in the north-central part of the Powder River structural basin. The strata in general dip southward at an angle of less than 1 degree. In places the regional structure is modified by low-relief folds, as shown by the structure contour maps on top of the coal beds, (pls. 4, 7, 10, 13, and 16). Some of the nonuniformity in structure may be due to irregularities in deposition of the coals and other beds as a result of their continental origin.

COAL GEOLOGY

Three principal coal beds and three additional local, thin coal beds are exposed at the surface in the Ashland NE quadrangle. They are shown in outcrop on the Coal Data Map (pl. 1) and in section on the Coal Data Sheet (pl. 3). All the coal beds belong to the Tongue River Member of the Fort Union Formation.

Only the three principal beds are thick enough to have economic coal resources. The lowermost of the three beds is the Terret coal bed (McKay) coal bed west of the Tongue River) which lies about 200 feet (61 m) above the base of the Tongue River Member. The Terret is overlain by a noncoal interval of about 40 feet (12 m), the Flowers-Goodale coal bed (Rosebud coal bed west of the Tongue River), a noncoal interval of about 100 feet (30 m), and the Knobloch coal bed. The Knobloch coal bed has been almost entirely burned.

The trace element content of coals in the Ashland NE 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
(McKay coal bed west of the Tongue River)

The Terret coal bed was described by Bass (1932, p. 51) from a small coal mine on the Terret Ranch (Cook Creek Reservoir quadrangle), about 4 miles (6 km) east of the Ashland NE quadrangle. The McKay coal bed was described by Dobbin (1930, p. 27) from exposures on the McKay Ranch (in Colstrip East quadrangle) in the Forsyth coal field, about 16 miles (26 km) northwest of the Ashland NE quadrangle. The McKay coal bed may be considered a lower split of the Rosebud coal bed because the interval between them in several places is less than 7 feet or 2.1 m (Dobbin, 1930, p. 27). The Terret coal bed east of the Tongue River is correlated with the McKay coal bed west of the river on the basis of position and intervals to other beds in the stratigraphic column.

In the north half of the Ashland NE quadrangle, the Terret and McKay coal beds crop out on either side of the Tongue River about 150 feet (46 m) above the river level (pl. 1). Regionally, the coal beds dip southward at an angle of less than 1 degree, but the dip is not uniform (pls. 13 and 16). The Terret and McKay coal beds range from 2 to 8 feet (0.6 to 2.4 m) in thickness (pls. 13 and 16), and the overburden ranges from zero at the

outcrop to about 280 feet (85 m) in thickness (pls. 14 and 17). There are no publicly available chemical analyses for the Terret or McKay coals in the Ashland NE quadrangle. An analysis of the Terret coal from the Holt Mine in the Ashland quadrangle (sec. 20, T. 3 S., R. 44 E.), about 4 miles (6.4 km) south of the Ashland NE quadrangle, shows ash 3.9 percent, sulfur 0.4 percent, and a heating value of 9,020 Btu per pound (20,980 kJ/kg) on an as-received basis (Gilmour and Dahl, 1967, p. 18). This heating value converts to about 9,390 Btu per pound (21,840 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Terret coal in the Ashland quadrangle is subbituminous C in rank. Because the quadrangles are adjacent and have a similar position in the basin, it is assumed that the Terret coal in the Ashland NE quadrangle is similar in rank and is subbituminous C.

Flowers-Goodale coal bed
(Rosebud coal bed west of the Tongue River)

The Flowers-Goodale coal bed was described by Bass (1932, p. 53) from two small mines located in the Brandenburg quadrangle, about 5 miles (8 km) northeast of the Ashland NE quadrangle. The Rosebud coal bed was described by Dobbin (1930, p. 27) from outcrops along Rosebud Creek in the Forsyth coal field, about 15 miles (24 km) northwest of the Ashland NE quadrangle. A specific type locality was not named. In the Ashland NE quadrangle, the Flowers-Goodale coal bed east of the Tongue River is correlated with the Rosebud coal bed west of the river.

In the north half of the Ashland NE quadrangle, the Flowers-Goodale and the Rosebud coal beds crop out on both sides of the Tongue River valley about 40 feet (12 m) above the Terret or the McKay coal beds, respectively.

Regionally the beds dip southward at an angle of less than 1 degree, but the dip is interrupted by local folding (pls. 7 and 10). The Rosebud coal bed, which crops out west of the Tongue River, increases in thickness westward from 8 to 20 feet (2.4 to 6.1 m), as shown by the isopach map, plate 10. The Flowers-Goodale coal bed, which crops out at about the same horizon on the east side of the Tongue River, decreases in thickness eastward and southward from 7 to 3 feet (2.1 to 0.9 m), as shown by the isopach map, plate 7. Overburden covering the Flowers-Goodale and Rosebud coal beds ranges from zero at the outcrops to about 250 feet (76 m) in thickness (pls. 8 and 11). There are no publicly available chemical analyses of the Rosebud or Flowers-Goodale coal in the Ashland NE quadrangle. However, the Montana Bureau of Mines and Geology cored the Rosebud coal in drill hole SH-70102 (sec. 16, T. 1 S., R. 43 E.) in the Hammond Draw SW quadrangle, about 4 miles (6.4 km) west of the northwest corner of the Ashland NE quadrangle. A chemical analysis of the Rosebud coal from a depth of 210 to 216 feet (64 to 65.8 m) in this hole showed ash 6.756 percent, sulfur 0.696 percent, and a heating value of 8,454 Btu per pound (19,660 kJ/kg), on an as-received basis (Matson and Blumer, 1973, p. 124). This heating value converts to about 9,070 Btu per pound (21,100 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Rosebud coal in the Hammond Draw SW quadrangle is subbituminous C in rank. Because the Hammond Draw and Ashland NE quadrangles have a similar position in the basin, it is assumed that the Rosebud coal in the Ashland NE quadrangle is similar to that in the Hammond Draw SW quadrangle and is subbituminous C in rank.

Knobloch coal bed

The Knobloch coal bed was described by Bass (1932). The coal bed was named from the Knobloch Ranch and coal mine located in the Birney Day School quadrangle about 16 miles (26 km) southwest of the Ashland NE quadrangle.

The Knobloch coal bed is about 100 feet (30 m) above the Flowers-Goodale coal bed (Rosebud coal bed west of the Tongue River). The coal outcrops on both sides of the Tongue River have been burned, forming an extensive clinker that caps most of the hills. Exposed sections of the clinker are up to 150 feet (46 m) thick. Small, unburned areas of the Knobloch coal bed are identified in the northeast and northwest quarters of the quadrangle. In these areas the Knobloch coal bed ranges from 9 to 14 feet (2.7 to 4.3 m) in thickness, and is covered by overburden ranging from near zero to about 75 feet (22.8 m) in thickness. There are no publicly available chemical analyses of the Knobloch coal from the Ashland NE quadrangle. However, the Montana Bureau of Mines and Geology cored the Knobloch coal in drill hole SH-7096 (sec. 28, T. 1 S., R. 43 E.), in the Garfield Peak quadrangle about 4 miles (6.4 km) west of the Ashland NE quadrangle. A chemical analysis of coal from depths of 59 to 67 feet (18 to 20.4 m) shows ash 6.755 percent, sulfur 0.422 percent, and a heating value of 8,510 Btu per pound (19,800 kJ/kg), on an as-received basis (Matson and Blumer, 1973, p. 124). This heating value converts to about 9,130 Btu per pound (21,230 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Knobloch coal at that location is subbituminous C in rank. Because of the proximity of that location to the

Ashland NE quadrangle, it is assumed that the Knobloch coal in the Ashland NE quadrangle is also subbituminous C in rank.

Local coal beds

Three local coal beds are mapped in the Ashland NE quadrangle, but all are too thin to be attributed economic coal resources (pl. 1). Two of the local coal beds are in the Tongue River Member below the Terret coal bed (McKay coal bed west of the Tongue River), and one lies about 40 feet (12 m) above the Flowers-Goodale coal bed (Rosebud coal bed west of the Tongue River), as shown in the columnar section, plate 3.

COAL RESOURCES

Data from all publicly available drill holes and from 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.

Coal resource tonnages shown in this report are the Reserve Base (RB) 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 of 0.75 mile 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, the stripping limit of multiple, thin (5 to 40 feet or 1.5 to 12 m thick) beds of subbituminous coal in this area.

Estimated resources in the Ashland NE quadrangle were calculated using data obtained from the coal isopach maps (pls. 4, 7, 10, 13, and 16). 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 each isopached coal bed. Reserve Base and Reserve tonnage values for the Knobloch, Flowers-Goodale, Rosebud, Terret, and McKay beds are shown on plates 6, 9, 12, 15, and 18, respectively, and are rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned, surface-minable coal in the Ashland NE quadrangle is calculated to be 119.77 million short tons (108.66 million t), as shown by 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, 25 percent as Indicated, and 69 percent as Inferred. There are no known resources of underground-minable coal.

COAL DEVELOPMENT POTENTIAL

Areas where coal beds are 5 feet (1.5 m) or more in thickness and are overlain by 500 feet (152 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:

$$MR = \frac{t_o (0.911)}{t_c (rf)} \quad \text{where } MR = \text{mining ratio}$$

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 maps, plates 5, 8, 11, 14, and 17 for the Knobloch, Flowers-Goodale, Rosebud, Terret, and McKay coal beds, respectively. 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 included in this series of maps pertains only to surface mining. It 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 500 feet or 152 m of overburden) is shown on the CDP map (pl. 19). Two areas of Federal coal lands in the Ashland NE quadrangle have a high potential for coal development. One area is in the northwest quarter of the quadrangle, north of the Northern Cheyenne Indian Reservation. The other area is in the eastern part of the quadrangle, east and northeast of the Northern Cheyenne Indian Reservation. The two areas are separated by an area of no development potential along the Tongue River where the coal beds have been removed by erosion.

The large area of high development potential in the northwest quarter of the quadrangle (pl. 19) is formed by the superimposed potentials of the McKay, Rosebud, and Knobloch coal beds. The lowest bed is the relatively thin (2.5 to 8 feet or 0.8 to 2.4 m thick) McKay coal bed, which has narrow, winding bands along the sides of Lay Creek and other tributaries of the Tongue River where the mining-ratio values are less than 10, and the coal development potential is consequently high (pl. 17). The McKay coal bed is separated from the overlying Rosebud coal bed by a noncoal interval of about 80 feet (24.4 m). The Rosebud coal bed is thicker, 8 to 20 feet (2.4 to 6.1 m), but has similar narrow, long bands on the sides of the tributary valleys where the

mining-ratio values are less than 10, and the development potential is high. The Knobloch coal bed is about 120 feet (36.6 m) above the Rosebud coal bed. It has a limited area of occurrence, but all of it has mining-ratio values less than 10 (pl. 7) and therefore a high development potential. Because of these three superimposed coal beds, most of the Federal lands north of the Northern Cheyenne Indian Reservation and west of the Tongue River have a high development potential for surface mining, as shown by plate 19. Only a few small tracts have a low or moderate development potential.

The area of high development potential east and northeast of the Northern Cheyenne Indian Reservation is formed by the superimposition of the Terret and Flowers-Goodale coal beds. Both are relatively thin, 1.6 to 8 feet (0.5 to 2.4 m) for the Terret, and 3.0 to 8 feet (0.9 to 2.4 m) for the Flowers-Goodale (pls. 7 and 13). Both coal beds form narrow but long bands along the sides of the tributary valleys where the mining-ratio values are less than 10, and the coal development potential is high. In the southeastern part of the quadrangle where the beds are very thin, there are Federal tracts of land having moderate, low, or even no coal development potential.

About 65 percent of the Federal coal lands in the quadrangle has a high development potential, 3 percent has a moderate development potential, 4 percent has a low development potential, and 28 percent has no development potential for surface mining.

Development potential for underground
mining and in situ gasification

All the identified economically minable coal resources in the Ashland NE quadrangle are within the stripping limit of 500 feet (152 m). There are

no known economic coal resources that would be mined by underground methods. For this reason a table of underground-minable coal resource tonnage was not prepared, and a coal development-potential (CDP) map for the underground mining of coal 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. --Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Ashland NE 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
Reserve Base tonnage				
Knobloch	31,330,000	0	0	3,330,000
Flowers-Goodale	5,280,000	2,120,000	8,930,000	16,330,000
Rosebud	43,250,000	14,270,000	5,980,000	63,500,000
McKay	4,410,000	2,640,000	19,690,000	26,740,000
Terret	3,940,000	1,130,000	4,800,000	9,870,000
Total	60,210,000	20,160,000	39,400,000	119,770,000

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