UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-078

1979

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

[Report includes 16 plates]

By

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ILLUSTRATIONS

[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 Ashland quadrangle, Rosebud County, Montana, (16 plates; U.S. Geological Survey Open-File Report 79-078). 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 7 1/2-minute quadrangle is in southeastern Rosebud County, Montana, about 59 miles (95 km) south-southeast of Miles City, a town in the Yellowstone River valley of eastern Montana. 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 Miles City. The small town of Colstrip is 22 miles (35.4 km) northwest of the quadrangle. Approximately the western two-thirds of the quadrangle, that part west of the Tongue River, is within the Northern Cheyenne Indian Reservation. The town of Lame Deer, headquarters for the Reservation, is 12 miles (19.3 km) west of the quadrangle. The St. Labre Mission and the small town of Ashland are in the northeastern part of the quadrangle outside of the Indian Reservation.

Accessibility

The Ashland quadrangle is accessible from Miles City by going southeast on U.S. Highway 312 about 15 miles (24 km) to the partly paved, local Highway 332, the Tongue River Road, and thence southeast and south on this road about 61 miles (98 km) to the town of Ashland. The Tongue River Road continues southwestward through the quadrangle.

The Ashland quadrangle is also accessible from the east and the west by way of U.S. Highway 212, which passes through the northern part of the quadrangle. On this highway the quadrangle is about 40 miles (64 km) west of Broadus, and 13 miles (21 km) east of Lame Deer, Montana.

The nearest railroad is a spur of the Burlington Northern Railroad, which runs southward up the valley of Armells Creek about 38 miles (61 km) from the main line in the Yellowstone River valley, terminating at the Big Sky coal mine in the Colstrip SE quadrangle, about 17 miles (27.3 km) northwest of the Ashland quadrangle.

Physiography

The Ashland quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The plateau area, formed by nearly horizontal strata of differential resistance to erosion, has been maturely dissected by the Tongue River and its tributaries. The Tongue River runs northeastward through the central part of the quadrangle and joins the Yellowstone River at Miles City. The flat flood plain of the meandering Tongue River cuts a swath 0.75 to 1.25 miles (1.2 to 2 km) wide through the quadrangle. Otter Creek, in a flood plain 0.5 mile (0.8 km) wide, flows into the Tongue River near Ashland from the southeast. The sides of the valleys rise steeply 150 to 200 feet (46 to 61 m) to the relatively flat crests of the intertributary ridges. Except for the flood plains and ridge tops, the topography is quite rough.

The highest elevation, about 3,720 feet (1,135 m), is in the Custer National Forest near the southeast corner of the quadrangle. The lowest elevation, about 2,900 feet (884 m), is along the Tongue River at the north border of the quadrangle. Topographic relief is about 820 feet (251 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

Much of the eastern part of the Ashland quadrangle (east of the Tongue River) is within the Northern Powder River Basin Known Recoverable Coal Resource Area, as shown by the Boundary and Coal Data Map (pl. 2). The western part of the quadrangle west of the Tongue River is within the Northern Cheyenne Indian Reservation where the coal resources have not been evaluated. Plate 2 shows the ownership status of lands 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 most of the eastern part of the Ashland quadrangle, that part outside of the Northern Cheyenne Indian Reservation, as part of the

Ashland coal field. Warren (1959) mapped a little of the southern part of the quadrangle as part of the Birney-Broadus coal field. Matson and Blumer (1973) mapped the eastern part of the quadrangle as part of the Ashland coal deposit and part of the Poker Jim Creek-O'Dell Creek 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, which is 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. In the Ashland quadrangle the upper part of the Tongue River Member has been removed by erosion; about 1,000 feet (305 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 quadrangle is in the north-central part of the Powder River structural basin. The strata, in general, dip southward or southwestward at an angle of less than 1 degree, as shown by the structure contour maps of the coal beds, plates 4, 7, 10, and 13.

COAL GEOLOGY

Ten named coal beds crop out in the Ashland quadrangle. In addition to these, a few thin, local beds crop out for short distances or were penetrated in drill holes. All of the coal beds belong to the Tongue River Member of the Fort Union Formation (Paleocene). They are shown in outcrop on the Coal Data Map (pl. 1) and in section on the Coal Data Sheet (pl. 3).

The lowermost of the 10 named coal beds in the Ashland quadrangle is the Terret coal bed. It is about 200 feet (61 m) above the base of the Tongue River Member, and is overlain successively by a noncoal interval of about 40 to 60 feet (12 to 18 m), the Flowers-Goodale coal bed, a noncoal interval of about 60 to 100 feet (18 to 30 m), the Knobloch coal bed, a noncoal interval of about 160 to 200 feet (49 to 61 m), the King coal bed, a noncoal interval of 25 to 50 feet (7.6 to 15 m), the Sawyer coal bed, a noncoal interval of about 20 feet (6 m), the Odell coal bed, a noncoal interval of about 20 feet (6 m), the C and D coal beds, a noncoal interval of about 160 feet (49 m), the Pawnee coal bed, a noncoal interval of about 100 feet (30 m), and the Wall 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).

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), just northeast of the Ashland quadrangle. 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 relationships to other beds in the stratigraphic column.

The Terret coal bed is greater than 5 feet (1.5 m) thick only in two small areas in the northeast part of the Ashland quadrangle, as shown by the isopach and structure map, plate 13. The bed dips southward less than 1 degree. The overburden ranges in thickness from zero to 140 feet (43 m). An analysis of the Terret coal from the Holt Mine in the Ashland quadrangle (sec. 20, T. 3 S., R. 44 E.) 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 9,386 Btu per pound (21,832 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Terret coal in the Ashland quadrangle is subbituminous C in rank.

Flowers-Goodale coal bed

The Flowers-Goodale coal bed was described by Bass (1932, p. 53) from two small mines located in the Brandenberg quadrangle, about 9 miles (14 km) northeast of the Ashland quadrangle. The Flowers-Goodale coal bed east of the Tongue River is correlated with the Rosebud coal bed west of the river on the basis of position and relationships to other beds in the stratigraphic column.

The Flowers-Goodale coal bed crops out on the east side of the Tongue River in the northeastern part of the Ashland quadrangle (pl. 1). The coal has been extensively burned, and is believed to be greater than 5 feet (1.5 m) thick only in the eastern border area of the quadrangle, as shown by the

isopach and structure map, plate 10. Overburden covering the Flowers-Goodale coal bed ranges from zero at the outcrop to about 550 feet (168 m) in thickness (pl. 11). There are no publicly available chemical analyses of the Rosebud or Flowers-Goodale coal in the Ashland quadrangle. However, the Montana Bureau of Mines and Geology cored the Flowers-Goodale coal in drill hole SH-7076 (sec. 14, T. 1 S., R. 45 E.) in the Cook Creek Reservoir quadrangle, about 10 miles (16 km) northeast of the Ashland quadrangle. A chemical analysis of the Flowers-Goodale coal from a depth of 53 to 62 feet (16 to 19 m) in this hole showed ash 8.144 percent, sulfur 0.961 percent, and a heating value of 8,102 Btu per pound (18,845 kJ/kg), on an as-received basis (Matson and Blumer, 1973, p. 121). This heating value converts to about 8,820 Btu per pound (20,515 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Flowers-Goodale coal in the Cook Creek Reservoir quadrangle is subbituminous C in rank. Because the Cook Creek Reservoir and Ashland quadrangles have similar positions in the basin, it is assumed that the Flowers-Goodale coal in the Ashland quadrangle is similar to that in the Cook Creek Reservoir quadrangle and is subbituminous C in rank.

Knobloch coal bed

The Knobloch coal bed was named by Bass (1924) from a small coal mine on the Knobloch Ranch in the Tongue River valley in the Birney Day School quadrangle, just southwest of the Ashland quadrangle. In the Ashland quadrangle, the Knobloch coal bed is about 40 to 100 feet (12 to 30 m) above the Flowers-Goodale coal bed. The Knobloch coal bed crops out extensively in the northern and eastern parts of the Ashland quadrangle; however, it is believed to have been entirely burned except in the southeastern quarter of the quadrangle. Here the Knobloch coal is estimated to range from about 20 to 50 feet (6 to 15 m) in thickness (pl. 7). Structure contours on top of the Knobloch coal bed

(pl. 7) show a southward dip of less than 1 degree except where there were abrupt changes in deposition near the southern border of the quadrangle. Overburden on the Knobloch coal bed (pl. 8) ranges from zero at the outcrop to about 660 feet (201 m) in thickness.

A chemical analysis of the Knobloch coal from drill hole SH-7059, sec. 34, T. 3 S., R. 44 E., in the southeastern part of the quadrangle, shows ash 3.669 percent, sulfur 0.095 percent, and a heating value of 9,005 Btu per pound (20,945 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 64). This heating value converts to about 9,350 Btu per pound (21,748 kJ/kg) on a moist, mineral-matter-free basis, which indicates that the Knobloch coal is subbituminous C in rank.

King coal bed

The King coal bed was first described by Warren (1959, p. 571) after outcrops "in and near the base of steep valley walls along the Tongue River and Otter Creek," probably in the Green Creek quadrangle to the south, and the King Mountain quadrangle to the southeast of the Ashland quadrangle. The King coal bed crops out in the southeast quarter of the Ashland quadrangle about 155 to 200 feet (47 to 61 m) above the Knobloch coal bed (pl. 1). As the King coal bed is only 3.6 to 4.9 feet (1.1 to 1.5 m) thick, it has not been assigned economic coal resources in this quadrangle.

Sawyer coal bed

The Sawyer coal bed was described by Dobbin (1930, p. 28) from exposures in the foothills of the Little Wolf Mountains in the Forsyth coal field (Rough Draw and Black Spring quadrangles), about 15 miles (24 km) northwest of the Ashland quadrangle. The Sawyer coal occurs 25 to 50 feet (7.6 to 15 m) above the King coal bed (pls. 1 and 3) in the southeast quarter of the Ashland quadrangle. The Sawyer coal here is split into two beds 15 to 20 feet (4.6 to 6.1

m) apart. Since neither bed is more than 3.3 feet (1.0 m) thick, economic coal resources have not been assigned to the Sawyer coal.

Odell coal bed

The Odell coal bed was first described by Warren (1959, p. 572) from outcrops in the northwestern part of the Birney-Broadus coal field, probably in the Green Creek quadrangle just south of the Ashland quadrangle. The Odell coal bed has been mapped in the southeast quarter of the Ashland quadrangle about 20 feet (6.1 m) above the Sawyer coal bed. The Odell coal bed ranges from 1.5 to 4.5 feet (0.5 to 1.4 m) in thickness. Because of its thinness the Odell coal bed has not been assigned economic coal resources in this quadrangle.

C and D coal beds

The C and D coal beds, named by Bass (1932, p. 55) are two closely spaced coal beds that occur near the southeast corner of the Ashland quadrangle about 20 feet (6.1 m) above the Odell coal bed. They are less than 5 feet (1.5 m) in thickness and consequently have not been assigned coal resources.

Pawnee coal bed

The Pawnee coal bed was described by Warren (1959, p. 572) from outcrops in the Birney-Broadus coal field. The bed crops out near the southeast corner of the quadrangle about 160 feet (48.8 m) above the C and D coal beds. The Pawnee coal bed ranges from about 5.5 to 9.8 feet (1.7 to 3.0 m) in thickness and dips westward at an angle of about 1 degree (pl. 4). Overburden on the Pawnee coal bed ranges from zero at the outcrops to about 180 feet (55 m) in thickness, as shown on plate 5. There is no known publicly available chemical analysis of the Pawnee coal bed in the Ashland quadrangle. It is assumed that the Pawnee coal is similar to other coals in this quadrangle and is subbituminous C in rank.

Wall coal bed

The Wall coal bed was described by Baker (1929, p. 37) from exposures in the northern extension of the Sheridan coal field, probably in the southern part of the Birney and Birney SW quadrangles, about 18 miles (29 km) southwest of the Ashland quadrangle. The Wall coal bed normally occurs about 100 feet (30 m) above the Pawnee coal bed. Near the southeast corner of the Ashland quadrangle there is a clinker bed at about this position which is believed to have been formed by the burning of the Wall coal bed. Because of the burning of the coal, coal resources have not been assigned to the Wall coal bed in this quadrangle.

Local coal bed

There is a local coal bed 20 to 50 feet (6.1 to 15 m) below the Knobloch coal bed. This local coal bed has a limited areal extent, and since it is less than 5 feet (1.5 m) thick, it has not been assigned economic coal resources. Because of its position, this bed may correlate with the Flowers-Goodale coal bed.

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 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 of 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 extrapolation 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 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 coal resources in this quadrangle were calculated using data obtained from the coal isopach maps (pls. 4, 7, 10, and 13). 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 (13,018 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 Pawnee, Knobloch, Flowers-Goodale, and Terret coal beds are shown on plates 6, 9, 12, and 15, 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 quadangle is calculated to be 167.03 million short tons (151.50 million t), and the Hypothetical tonnage of surface-minable coal is calculated to be 5.13 million short tons (4.65 million t), as shown in table 1. The underground-minable Reserve Base tonnage is 3.55 million short tons (3.22 million t), and the Hypothetical underground-minable tonnage is 0.23 million short tons (0.21 million t), as shown in table 2. All numbers are rounded to the nearest one-hundredth of a million short tons. About 5.9 percent of the Reserve Base tonnage is classed as Measured, 15.3 percent as Indicated, and 78.8 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 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 for surface-mining methods are here defined as areas underlain by coal beds having less than 500 feet (152 m) of overburden and having respective mining-ratio values of zero to 10, 10 to 15, and greater than 15. Mining-ratio contours and the stripping-limit overburden isopach which serve as boundaries of these development-potential areas are shown on plates 5, 8, 11, and 14, for the Pawnee, Knobloch, Flowers-Goodale, and Terret coal beds, respectively. The mining-ratio values of 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), of both Reserve Base and Hypothetical coal, for surface mining are shown in table 1. Estimated tonnages for underground mining are shown in a like manner in table 2.

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 of federally owned coal land is shown on the CDP map (pl. 16). There is a considerable area of high development potential in the southeastern part of the Ashland quadrangle. The Knobloch coal bed here has an area of high development potential extending from the boundary of the unburned Knobloch coal to the 10 mining-ratio contour

near the arbitrarily assigned stripping limit at the 500-foot overburden isopach near the southeast corner of the quadrangle (pl. 8). There is a small area of moderate development potential between the 10 mining-ratio contour and the 500-foot overburden isopach.

In the east-central part of the Ashland quadrangle east of the Northern Cheyenne Indian Reservation is an area in which most of the Federal coal lands have no development potential. Here the Knobloch coal bed is believed to be entirely burned, and the other coal beds are less than 5 feet (1.5 m) thick.

In the northeastern part of the quadrangle, three small isolated tracts of Federal coal land have a high development potential. Two of these are results of small, isolated areas of high development potential in the Terret coal bed (pl. 14). The third is a result of a small isolated area of high development potential in the Flowers-Goodale coal bed (pl. 11).

About 61 percent of the Federal coal land in the Ashland quadrangle has a high development potential, 1 percent has a moderate development potential, 7 percent has a low development potential, and 31 percent has no development potential for surface mining.

Development potential for underground mining and in-situ gasification

Coal beds 5 feet (1.5 m) or more in thickness lying more than 500 feet (152 m) but less than 3,000 feet (914 m) below the surface of this quadrangle are considered to have development potential for underground mining. Estimates of the tonnage of underground-minable coal are listed in table 2 by development-potential category for each coal bed. Coal is not currently being mined by underground methods in the Northern Powder River Basin because of poor economics. Therefore, the coal development potential for all underground

mining of these resources is rated as low, 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.--Surface-minable coal resource tonnage (in short tons) by development-potential category for Federal coal lands in the Ashland 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				
Pawnee	390,000	310,000	110,000	810,000
Flowers-Goodale	80,000	40,000	5,960,000	6,080,000
Knobloch	153,880,000	4,540,000	0	158,420,000
Terret	550,000	890,000	280,000	1,720,000
Total	154,900,000	5,780,000	6,350,000	167,030,000
Hypothetical Resource tonnage				
Flowers-Goodale	0	0	5,130,000	5,130,000
Total	0	0	5,130,000	5,130,000
Grand Total	154,900,000	5,780,000	11,480,000	172,160,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Ashland quadrangle, Rosebud 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				
Knobloch	0	0	3,550,000	3,550,000
Total	0	0	3,550,000	3,550,000
Hypothetical Resource tonnage				
Flowers-Goodale	0	0	230,000	230,000
Total	0	0	230,000	230,000
Grand Total	0	0	3,780,000	3,780.000

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