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

[Report includes 16 plates]

By

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

ILLUSTRATIONS

[Plates are in pocket]

Plates 1-15. Coal resource occurrence maps:

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2. Boundary and coal data map.
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4. Isopach and structure contour map of the Sawyer coal bed.
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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 Badger Peak quadrangle, Rosebud County, Montana, (16 plates; U.S. Geological Survey Open-File Report 79-002). 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 Badger Peak 7 1/2-minute quadrangle is in south-central Rosebud County, Montana, about 36 miles (58 km) south-southeast of Forsyth, the county seat. Forsyth is in the Yellowstone River valley about 44 miles (70 km) west-southwest of Miles City and 105 miles (169 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. The small town of Colstrip is located 9.5 miles (15.2 km) north of the northwest corner of the Badger Peak quadrangle. The southern half of the quadrangle is within the Northern Cheyenne Indian Reservation, and the town of Lame Deer, headquarters for the Reservation, is 2.5 miles (4 km) west of

the quadrangle. The quadrangle is 47 miles (75 km) east of Hardin, Montana, and 55 miles (88 km) west-northwest of Broadus, Montana.

Accessibility

By way of the paved State Highway 39, which passes through the northwest corner of the quadrangle, the quadrangle is 38 miles (61 km) south of U.S. Interstate Highway 94 near Forsyth, and 9 miles (14 km) south of Colstrip. By way of U.S. Highway 212, which passes through the southern part of the quadrangle, the quadrangle is about 44.5 miles (71 km) east of U.S. Interstate Highway 90 near Crow Agency, and 2.5 miles (4 km) east of Lame Deer. Also by way of U.S. Highway 212, the quadrangle is 12 miles (19 km) west of Ashland, and 60 miles (96 km) west of Broadus.

The nearest railroad is a spur of the Burlington Northern Railroad which runs south from the main route of the railroad in the Yellowstone Valley near Forsyth to the Big Sky coal mine in the Colstrip SE quadrangle 6 miles (9.6 km) north of the Badger Peak quadrangle.

Physiography

The Badger Peak quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The plateau, formed by nearly horizontal strata of unequal hardness, has been maturely dissected by tributaries of Rosebud Creek. The northwest corner of the quadrangle is within the valley of Rosebud Creek at an elevation of about 3,100 feet (945 m). The remainder of the quadrangle is extremely rough, mainly forested country. A maze of small ephemeral streams end in box canyons having nearly vertical walls 250 feet (76 m) or more high. The ridges are capped by irregularly

shaped and crenulated plateau remnants. These have been preserved from erosion by a cover of erosion-resistant clinker formed by the burning of coal beds. In the northern part of the quadrangle the plateau remnants form a level surface at an elevation of about 3,500 feet (1,065 m), and in the southern part of the quadrangle at about 3,950, 4,200, and 4,400 feet (1,205, 1,280, and 1,340 m).

The highest elevation in the quadrangle, 4,422 feet (1,348 m), is at the top of Badger Peak in the south-central part of the quadrangle. The lowest elevation, about 3,070 feet (936 m), is in the Rosebud Creek valley at the northwest corner of the quadrangle. Topographic relief is 1,352 feet (412 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 north half of the Badger Peak quadrangle is almost entirely within the Northern Powder River Basin Known Recoverable Coal Resource Area, as shown by the Boundary and Coal Data Map (pl. 2). The south half

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 of the Indian Reservation. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Dobbin (1930) mapped the area near the west edge of the quadrangle north of the Northern Cheyenne Indian Reservation as part of the Forsyth coal field. Bass (1932) mapped the rest of the north half of the quadrangle as part of the Ashland coal field. Kepferle (1954) mapped the northeast part of the quadrangle as part of the Miller Creek deposit. Matson and Blumer (1973) also mapped the northeast part of the quadrangle as part of the Greenleaf Creek-Miller Creek coal deposit.

Stratigraphy

A generalized columnar section of the coal-bearing rocks is shown on the Boundary and 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). The 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). The member probably attains this thickness in the Badger Peak quadrangle.

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 Badger Peak 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 Sawyer, the Upper and Lower Rosebud, and the Knobloch coal beds (pls. 4, 8, and 13), respectively. Some of the configurations in structure may be due to irregularities in the continental deposition.

COAL GEOLOGY

Five coal beds of consequence are exposed at the surface in the Badger Peak quadrangle. All five beds belong to the Tongue River Member

of the Fort Union Formation. 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 five coal beds is the McKay coal bed which is about 350 feet (107 m) above the base of the Tongue River Member. The McKay coal bed is overlain successively by a noncoal interval of about 20 feet (6 m), the Lower Rosebud coal bed, a noncoal interval of 90 to 100 feet (27 to 30 m), the Knobloch coal bed, a noncoal interval of 35 to 40 feet (10.7 to 12.2 m), the Upper Rosebud (Lee) coal bed, a noncoal interval of 120 to 140 feet (37 to 43 m), and the Sawyer coal bed.

The trace element content of coals in the Badger Peak 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).

McKay coal bed

The McKay coal bed was first described by Dobbin (1930, p. 27) from exposures on the McKay Ranch (Colstrip East quadrangle) in the Forsyth coal field. The McKay coal bed may be considered a split of the Rosebud coal bed because the interval between them in several places is less than 7 feet (2.1 m) (Dobbin 1930, p. 27).

In the Badger Peak quadrangle, the McKay coal bed crops out only in the extreme northeast corner of the quadrangle where it has a very limited exposure, lying about 20 feet (6 m) below the Lower Rosebud coal bed. The

McKay coal is not present in a drill hole less than 1 mile (1.6 km) to the south. Because of its limited occurrence and lack of measurements, the McKay coal bed has not been assigned coal resources in the Badger Peak quadrangle.

Lower Rosebud coal bed

The Rosebud coal bed was described by Dobbin (1930, p. 27) from outcrops along Rosebud Creek in the Forsyth coal field. A specific type locality was not given. In the Colstrip SE quadrangle, north of the Badger Peak quadrangle, the Rosebud coal bed splits into two coal beds. Dobbin (1930) mapped the upper split as the Lee coal bed and the lower split as the Rosebud coal bed. Test holes drilled later for coal correlation are known to confirm that the Lee coal bed is equivalent to the upper part of the Rosebud coal bed. Both the Upper Rosebud (Lee) and the Lower Rosebud coal beds are present in the Badger Peak quadrangle (pls. 1 and 3). The Lower Rosebud coal bed crops out along the stream valleys near the north edge of the quadrangle. The thickness of the Lower Rosebud ranges from about 4 to 13 feet (1.22 to 4 m), as shown by the isopach map, plate 7. Structure contours on top of the Lower Rosebud coal bed (pl. 8) show an eastward or southeastward dip of less than 1 degree. Overburden on the Lower Rosebud coal bed (pl. 11) ranges from zero at the outcrop to about 840 feet (256 m) in thickness.

A chemical analysis of the Rosebud coal bed from drill hole SH-70101, sec. 24, T. 1 S., R. 42 E. in the northeastern part of the Badger Peak quadrangle (Matson and Blumer, 1973, p. 125) shows ash 6.75 percent, sulfur 0.70 percent, and a heating value of 8,590 Btu per pound (19,980 kJ/kg) on

an as-received basis. This heating value converts to about 9,212 Btu per pound (21,427 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Lower Rosebud coal here is subbituminous C in rank.

Upper Rosebud (Lee) coal bed

The Upper Rosebud (Lee) coal bed crops out near the base of the steep hill slopes in the northwestern part of the quadrangle. The Upper Rosebud (Lee) bed has been mined to a limited extent at the Lynch mine in sec. 25, T. 1 S., R. 41 E. where only the upper 7 feet (2.1 m) of the bed is exposed, the lower part being concealed. On the slopes of the east branch of Downey Coulee in sec. 20, T. 1 S., R. 42 E., the Upper Rosebud (Lee) coal bed is replaced by sandstone and carbonaceous shale (Bass, 1932, p. 64). A bed at about this horizon to the east in sections 21, 22, 27, and 28 was mapped by Bass as the Lee coal bed, but could not be followed east of these sections. This bed has been called a local coal bed (L) in this series of maps (pls. 1 and 3), because of its local occurrence.

The thickness of the Upper Rosebud (Lee) ranges from about 7 to 11 feet (2 to 3.3 m), as shown by the isopach map, plate 7. Structure contours on top of the Upper Rosebud (Lee) coal bed (pl. 8) show a southward dip of less than 1 degree. Overburden on the Upper Rosebud (Lee) coal bed (pl. 9) ranges from zero at the outcrop to about 420 feet (128 m) in thickness.

There is no known published chemical analysis of the Upper Rosebud coal bed in the Badger Peak quadrangle. An analysis of the Lower Rosebud coal bed is given in the discussion of that coal bed. Because of the proximity

of the two coal beds, it is assumed that the Upper Rosebud coal is similar to the Lower Rosebud coal, and is subbituminous C in rank.

Knobloch coal bed

The Knobloch coal bed was described by Bass (1924) from a small mine on the Knobloch Ranch on the Tongue River in the Birney Day School quadrangle, 16 miles (26 km) southeast of the Badger Peak quadrangle. In the Badger Peak quadrangle the Knobloch coal lies about 470 feet (143 m) above the base of the Tongue River Member, and about 70 feet (21 m) above the Lower Rosebud coal bed. The westernmost known limit of the bed is in sec. 29, T. 1 S., R. 42 E. (Bass, 1932, pls. 3 and 13).

The Knobloch coal bed ranges from 1.7 to 22 feet (0.5 to 6.7 m) in thickness (pl. 13). Structure contours on top of the Knobloch coal bed (pl. 13) show an eastward dip of less than 1 degree. Overburden on the Knobloch coal bed (pl. 14) ranges from zero at the outcrop to about 800 feet (244 m) in thickness.

A chemical analysis of the Knobloch coal from drill hole SH-70100, sec. 36, T. 1 S., R. 42 E., in the Garfield Peak quadrangle about 0.25 mile (0.4 km) east of the Badger Peak quadrangle, shows ash 5.5 percent, sulfur 0.4 percent, and a heating value of 8,935 Btu per pound (20.783 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 124). This heating value converts to about 9,455 Btu per pound (21,992 kJ/kg) on a moist, mineral-matter-free basis, which indicates that the Knobloch coal is subbituminous C in rank.

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 10 miles (16 km) west of the Badger Peak quadrangle.

In the Badger Peak quadrangle the Sawyer coal bed has burned extensively, forming a clinker bed more than 100 feet (30 m) in thickness in places on top of the interstream divides (pls. 1 and 3). In the central part of the quadrangle, the Sawyer coal is less extensively burned. The isopach map of the Sawyer coal bed (pl. 4) shows that the coal bed ranges from about 5 to 18.7 feet (1.5 to 5.7 m) in thickness. Structure contours on top of the Sawyer coal bed (pl. 4) show a southward dip of less than 1 degree. Overburden on the Sawyer coal bed (pl. 5) ranges from zero at the outcrop to about 600 feet (183 m) in thickness.

There are no known published chemical analyses of the Sawyer coal bed in the Badger Peak quadrangle. A chemical analysis of the Sawyer coal bed from drill hole SH-7099, sec. 6, T. 2 S., R. 43 E., in the Garfield Peak quadrangle about 1.5 miles (2.4 km) east of the Badger Peak quadrangle, shows ash 5.89 percent, sulfur 0.02 percent, and a heating value of 8,805 Btu per pound (20,480 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 124). This heating value converts to about 9,356 Btu per pound (21,762 kJ/kg) on a moist, mineral-matter-free basis. This heating value indicates that the Sawyer coal here is subbituminous C in rank. Because of the proximity of this drill hole to the Badger Peak quadrangle,

it is assumed that the Sawyer coal in the Badger Peak quadrangle is similar and is subbituminous C in rank.

Local coal beds

A local coal bed occurs about 40 to 80 feet (12 to 24 m) above the Knobloch coal bed and about 120 feet (37 m) below the Sawyer coal bed in the northeastern part of the quadrangle in secs. 21, 22, 27, and 28, T. 1 S., R. 42 E. (pl. 1). Bass (1932, p. 64) mapped this bed as the Lee coal bed, but stated that it is replaced by sandstone and carbonaceous shale to the west and cannot be followed east of its local area of occurrence. Because of its limited occurrence, this coal bed has been mapped as a local coal bed in this series of maps and has not been assigned coal resources. This coal bed may correlate with the Upper Rosebud (Lee) coal bed in the northwestern part of the quadrangle (pl. 3).

Three other very thin, local coal beds, 55 to 120 feet (17 to 37 m) below the Lower Rosebud coal bed, were penetrated by a drill hole near the eastern border of the quadrangle (pls. 1 and 3), but have not been mapped on the surface and have not been assigned coal resources.

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 (1976).

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 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 resources in the Badger Peak quadrangle were calculated using data obtained from the coal isopach maps (pls. 4, 7, 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 (13,028 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 Sawyer, Upper Rosebud, Lower Rosebud, and Knobloch coal beds are shown on plates 6, 10, 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 Badger Peak quadrangle is calculated to be 205.06 million short tons (185.99 million t), and the total Hypothetical tonnage of surface-minable coal is calculated to be 14.27 million short tons (12.94 million t), as shown in table 1. The underground-minable Reserve Base tonnage is estimated to be 4.28 million short tons (3.88 million t), and the Hypothetical underground-minable tonnage is estimated to be 2.38 million short tons (2.16 million t), as shown in table 2. All numbers are rounded to the nearest one-hundredth

of a million short tons. About 4 percent of the Reserve Base tonnage is classed as Measured, 24 percent as Indicated, and 72 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 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, 9, 11, and 14 for the Sawyer, Upper Rosebud, Lower Rosebud, and Knobloch 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 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.

In areas of moderate to high topographic relief, the area of moderate development potential for surface mining of a coal bed (area having mining-ratio values of 10 to 15) is often restricted to a narrow band between the high and low development-potential areas. In fact, due to the 40-acre (16.2-ha) minimum size of coal development-potential increments, the narrow strip of moderate development-potential area often is included in the 40-acre (16.2-ha) tracts of high development-potential category. The Coal Development Potential (CDP) map then shows areas of low development potential abutting against areas of high development potential.

The coal development potential for surface-mining methods (less than 500 feet or 152 m of overburden) is shown on the CDP map (pl. 16). The Federal coal lands are in the north half of the quadrangle, north of the Northern Cheyenne Indian Reservation. Most of these Federal coal lands have a high development potential for surface mining. The high development potential is due to the superimposition of four coal beds, the Lower Rosebud, the Upper Rosebud, the Knobloch, and the Sawyer. Lands of high development

potential are present above these coal beds along the sides of valleys where the mining-ratio values are less than 10 (pls. 5, 9, 11, and 14). These lands of high development potential are adjacent and partially overlap so that each tract of Federal coal land contains some area of high development potential, and therefore, the entire tract is given a high development-potential rating.

In the north-central part of the quadrangle where the Rosebud coal beds are believed to be replaced by sandstone and shale, some Federal coal lands have no development potential. In the central part of the quadrangle, north of the Northern Cheyenne Indian Reservation, where the overburden is thick, a greater proportion of the Federal coal lands have a low or moderate development potential. Approximately 57 percent of the Federal coal lands in the quadrangle has a high potential for surface mining, 14 percent has a moderate potential, 21 percent has a low potential, and 8 percent has no 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 coal bed and by coal development potential category.

For economic reasons, coal is not currently being mined by underground methods in the Northern Powder River Basin, Montana. Therefore, coal beds found beneath more than 500 feet or 152 m (the stripping limit) but

less than 3,000 feet (914 m) of overburden in this area are considered to have a low development potential for underground-mining methods. A Coal Development Potential map for underground mining was not made for this quadrangle because the low development-potential category has been assigned to all of the coal present which is subject to underground mining.

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 Badger Peak 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				
Sawyer	18,890,000	5,870,000	12,410,000	37,170,000
Knobloch	17,310,000	17,670,000	61,610,000	96,590,000
Upper Rosebud	1,810,000	2,990,000	20,490,000	25,290,000
Lower Rosebud	11,270,000	4,840,000	29,900,000	46,010,000
Total	49,280,000	31,370,000	124,410,000	205,060,000
Hypothetical Resource tonnage				
Lower Rosebud	0	0	14,270,000	14,270,000
Total	0	0	14,270,000	14,270,000
Grand Total	49,280,000	31,370,000	138,680,000	219,330,000

Table 2. --Underground-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Badger Peak 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				
Sawyer	0	0	180,000	180,000
Knobloch	0	0	3,940,000	3,940,000
Lower Rosebud	0	0	160,000	160,000
Total	0	0	4,280,000	4,280,000
Hypothetical Resource tonnage				
Lower Rosebud	0	0	2,380,000	2,380,000
Total	0	0	2,380,000	2,380,000
Grand Total	0	0	6,660,000	6,660,000

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