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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE COLEMAN DRAW QUADRANGLE, POWDER RIVER COUNTY, MONTANA

[Report includes 31 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)	0.9072	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 Coleman Draw quadrangle, Powder River County, Montana, (31 plates; U.S. Geological Survey Open-File Report 79-083). This set of maps was compiled to support the land-use planning work of the Bureau of Land Management in response to the Federal Coal Leasing Amendments Act of 1976 and to provide a systematic inventory of coal resources on Federal coal lands in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States. The inventory includes only those beds of subbituminous coal that are 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden and those beds of lignite that are 5 feet (1.5 m) or more thick and under less than 1,000 feet (305 m) of overburden.

Location

The Coleman Draw 7 1/2-minute quadrangle is in northwestern Powder River County, Montana, about 56 miles (90 km) south-southwest 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 Coleman Draw quadrangle is 7 miles (11 km) east of Ashland, Montana, a small town on east-west U.S. Highway 212.

Accessibility

The quadrangle is accessible from Ashland, Montana, by traveling east on U.S. Highway 212 for a distance of about 7 miles (11 km) to the west border of the quadrangle. The quadrangle is also accessible from Broadus, Montana, by traveling west on U.S. Highway 212 for a distance of about 31 miles (50 km) to the east border of the quadrangle. The nearest railroad is at the Big Sky coal mine in the Colstrip SE quadrangle, about 25 miles (40 km) to the northwest. A spur of the Burlington Northern Railroad connects this mine with the main east-west route of the railroad about 35 miles (56 km) farther north-northwest in the Yellowstone River valley.

Physiography

The Coleman Draw quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The quadrangle is drained by three westward-flowing tributaries of Otter Creek, which are, from north to south, East Fork Otter Creek, Home Creek, and Threemile Creek. Northward-flowing Otter Creek is 3 to 6 miles (4.8 to 9.6 km) west of the Coleman Draw quadrangle in the Willow Crossing quadrangle and is a tributary of the Tongue River, which flows northward and northeastward to join the Yellowstone River at Miles City. The three principal streams of the quadrangle have flood plains 0.25 to 0.33 mile (0.4 to 0.53 km) in width. The valley sides rise rather steeply to benches capped by clinker beds of the near-surface coal beds. The southeast quarter and the northeast third of the quadrangle have a rugged surface; the balance of the quadrangle is rolling to moderately dissected. The highest elevation, 4,006 feet (1,221 m), is on a clinker-capped mesa in the southeastern part of the quadrangle. The lowest elevation, 3,100 feet (945 m), is on Threemile Creek near the southwest corner of the quadrangle. Topographic relief in the quadrangle is about 906 feet (276 m).

Climate

The climate of Powder River 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 about 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 the entire Coleman Draw quadrangle. Most of the quadrangle lies within the Custer National Forest. Plate 2 shows the land ownership status. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Wagemann (1910) made notes on a few coal occurrences during a reconnaissance of the Custer National Forest. Bass (1932, pl. 3) mapped most of the Coleman Draw quadrangle as part of the Ashland coal field. Brown and others (1954, fig. 26) mapped some of the northern part of the quadrangle as the Home Creek deposit of strippable coal in the Sawyer coal bed. Warren (1959, pl. 19) mapped the southern part of the quadrangle as part of the Birney-Broadus coal field. Matson and Blumer (1973, pl. 12) mapped a little of the southern part of the Coleman Draw quadrangle as the Otter Creek coal deposit, and most of the quadrangle as part of the Ashland coal deposit (pls. 13A and 13B).

Traces of coal bed outcrops shown by previous workers on planimetric maps which lack topographic control have been modified to fit the modern topographic map of the quadrangle.

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, carbonaceous shale, and coal beds. The thicker coal beds have burned along the outcrop and have baked and fused the overlying rock into reddish-colored clinker or slag. The upper part of the Tongue River Member has been removed by erosion, but about 1,400 feet (427 m) remains in the Coleman Draw 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 rivers, flood plains, sloughs, swamps, and lakes that occupied the area of 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 content of trace elements by the U.S. Geological Survey, and the results have been 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 rocks found throughout other parts of the western United States.

Structure

The Coleman Draw quadrangle is in the north-central part of the Powder River structural basin. The strata, in general, dip southward to southwestward 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 (see list of illustrations). Some of the nonuniformity in structure may be due to differential compaction of the sediments and to irregularities in deposition of the coals and other beds as a result of their continental origin.

COAL GEOLOGY

The coal beds in the Coleman Draw quadrangle are shown in outcrop on the Coal Data Map (pl. 1) and in section on the Coal Data Sheet (pl. 3). All of the mapped coal beds occur in the middle and lower parts of the Tongue River Member of the Fort Union Formation (Paleocene). No commercial coals are known to exist in this quadrangle below the Tongue River Member.

The lowermost coal beds in the Coleman Draw quadrangle are local coal beds which occur below the Flowers-Goodale coal bed and which have been penetrated only by oil-and-gas test holes (pl. 3). The lowest major coal bed is the Flowers-Goodale coal bed which occurs 150 to 300 feet (46 to 91 m) above the base of the Tongue River Member. The Flowers-Goodale coal bed is overlain by a noncoal interval of 110 to 130 feet (33.5 to 40 m), the Knobloch coal bed, a noncoal interval of 110 to 190 feet (33.5 to 58 m), the Sawyer coal bed, a noncoal interval of about 130 to 150 feet (39.6 to 45.7 m), the Odell coal bed, a noncoal interval of about 30 feet (9.14 m), the C and D coal beds, a noncoal interval of about 55 feet (16.8 m), the X coal bed, a noncoal interval of about 35 to 60 feet (10.7 to 18.3 m), the E coal bed, a noncoal interval of about 100 to 135 feet (30.5 to 41 m), the Elk coal bed, a noncoal interval of about 80 to 130 feet (24.4 to 39.6 m), and the Ferry coal bed.

The coal found along the eastern flank of the Powder River Basin in Montana increases in rank from lignite in the east to subbituminous in the deeper parts of the basin to the west. All coal analyses available at the present time from this and from adjacent quadrangles indicate that all the coal in this quadrangle is subbituminous C in rank.

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).

Flowers-Goodale coal bed

The Flowers-Goodale coal bed was described by Bass (1932, p. 53) from two small mines in the Brandenberg quadrangle about 14 miles (22.5 km) north-northwest of the Coleman Draw quadrangle. The Flowers-Goodale coal bed occurs about 150 to 300 feet (46 to 91 m) above the base of the Tongue River Member. This coal bed does not crop out in the Coleman Draw quadrangle, but it has been penetrated by a few test holes (pls. 1 and 3). The isopach and structure contour map of the Flowers-Goodale coal bed (pl. 28) shows that the coal bed ranges from about 5 to 14 feet (1.5 to 4.3 m) in thickness and, in general, dips southwestward at an angle of less than 1 degree, although this dip is modified by low-relief folding. Overburden on the Flowers-Goodale coal bed (pl. 29), where it is more than 5 feet (1.5 m) thick, ranges from about 200 to 1,100 feet (61 to 335 m) in thickness.

There is no known, publicly available chemical analysis of the Flowers-Goodale coal in the Coleman Draw quadrangle. However, an analysis of this coal from a depth of 53 to 62 feet (16 to 19 m) in drill hole SH-7076 (sec. 14, T. 1 S., R. 45 E.) about 9 miles (14.4 km) north-northwest of the Coleman Draw quadrangle in the Cook Creek Reservoir quadrangle shows ash 8.14 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 the Coleman Draw quadrangles are adjacent and have similar positions in the basin, it is assumed that the Flowers-Goodale coal in the Coleman Draw quadrangle is similar and is subbituminous C in rank.

Knobloch coal bed

The Knobloch coal bed was named by Bass (1924) from the Knobloch Ranch and coal mine about 16 miles (25.7 km) southwest of the Coleman Draw quadrangle in the Birney Day School quadrangle. In the Coleman Draw quadrangle, the Knobloch coal bed is about 110 to 130 feet (33.5 to 39.6 m) above the Flowers-Goodale coal bed. Although a small burned area is mapped in the Home Creek drainage area along the western edge of the quadrangle, the Knobloch coal bed does not crop out. However, it has been penetrated by a number of test holes (pls. 1 and 3). The isopach and structure contour map of the Knobloch coal bed (pl. 25) shows that this coal bed ranges from about 42 to 68 feet (12.8 to 20.7 m) in thickness, and, in general, dips southwestward at an angle of less than 1 degree, although this dip is modified locally by minor, broad, low-angle folding. Overburden on the Knobloch coal bed (pl. 26) ranges from about 40 to 900 feet (12 to 274 m) in thickness.

A chemical analysis of the Knobloch coal from a depth of 141 to 149 feet (43 to 45 m) in test hole SH-7060, sec. 6, T. 4 S., R. 46 E., in the Coleman Draw quadrangle (Matson and Blumer, 1973, p. 69) shows ash 4.334 percent, sulfur 0.120 percent, and heating value 8,454 Btu per pound (19,664 kJ/kg) on an as-received basis. This heating value converts to about 8,837 Btu per pound (20,555 kJ/kg) on a moist, mineral-matter-free basis indicating that the Knobloch coal in the Coleman Draw quadrangle is subbituminous C in rank.

Sawyer coal bed

The Sawyer coal bed was first 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 37 miles (59 km) west-northwest of the Coleman Draw quadrangle. In this quadrangle, the Sawyer coal bed is about 110 to 190 feet (33.5 to 58 m) above the Knobloch coal bed. In the northern part of the quadrangle, the Sawyer is a single coal bed, but in the central part of the quadrangle it splits locally into two beds, the Upper and Lower Sawyer (pls. 1 and 19). The Lower Sawyer coal bed was originally mapped by Bass (1932, pl. 3) as the A coal bed. However, test holes drilled later in this and in other quadrangles indicate that the A coal bed splits off of the lower part of the Sawyer coal bed. In the southern part of the Coleman Draw quadrangle, Warren (1959, pl. 19) mapped the King coal bed at about the same position as the Sawyer coal bed was mapped by Bass in this quadrangle, and at about the same position as the Lower Sawyer was mapped by McKay (1976) in the Willow Crossing quadrangle to the west. The King coal bed of Warren is equivalent to the Lower Sawyer coal bed of this report.

The isopach map (pl. 19) shows that the unsplit Sawyer coal ranges in thickness from about 2 feet to more than 16 feet (0.6 to 4.9 m). Where the coal is split in the central part of the quadrangle, the Upper Sawyer ranges from about 6 to 8 feet (1.8 to 2.4 m) in thickness, and the Lower Sawyer from about 2 to 8 feet (0.6 to 2.4 m) in thickness. In the southern part of the quadrangle, both the Upper and Lower Sawyer coal beds are less than 5 feet (1.5 m) thick. The structure contour map of the Sawyer coal bed and its splits (pl. 20) shows that the coal, in general, dips southward at an angle of less than 1 degree, although this dip is modified by a broad, low-relief syncline in the west-central part of the quadrangle. Overburden on the Sawyer coal bed and its upper split (pl. 21) ranges in thickness from 0 feet at the outcrops to more than 500 feet (0-152 m).

A chemical analysis of the Sawyer coal (Matson and Blumer, 1973, p. 73) from a depth of 82 to 92 feet (25 to 28 m) in coal test hole SH-7066, sec. 36, T. 2 S., R. 45 E., in the Coleman Draw quadrangle shows ash 4.672 percent, sulfur 0.97 percent, and heating value 8,015 Btu per pound (18,643 kJ/kg) on an as-received basis. This heating value converts to 8,408 Btu per pound (19,557 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Sawyer coal at this location is subbituminous C in rank.

Odell coal bed

The Odell coal bed was first described by Warren (1959, p. 572) probably from exposures near O'Dell Creek in the Green Creek quadrangle, about 11 miles (17.7 km) southwest of the Coleman Draw quadrangle. Warren mapped the Odell coal bed in the southern part of the Coleman Draw quadrangle where it occurs about 100 to 120 feet (30.5 to 36.6 m) above his King coal bed (Lower Sawyer coal bed of this report). Bass (1932, pl. 3) did not map a coal bed at this stratigraphic position in the northern part of the quadrangle. The isopach and structure contour map of the Odell coal bed (pl. 16) shows that this coal ranges from 1.6 to 5.7 feet (0.49 to 1.74 m) in thickness and dips west-southwest at an angle of less than 1 degree. Overburden on the Odell coal bed where it is more than 5 feet (1.5 m) thick (pl. 17) ranges in thickness from 0 feet at the outcrops to about 200 feet (0-61 m).

There is no known, publicly available chemical analysis of the Odell coal bed in, or near, this quadrangle. However, it is reasonable to assume that the Odell is similar to other closely associated coals in this quadrangle and is subbituminous C in rank.

C and D coal beds

The C and D coal beds were first described by Bass (1932, p. 55) from exposures in the Ashland coal field, possibly in the Beaver Creek School and Cook Creek Reservoir quadrangles just north and northwest of the Coleman Draw quadrangle. Bass (1932, pl. 3) mapped these closely spaced coal beds in the northern part of the Coleman Draw quadrangle (pl. 1). According to Bass (1932, p. 55), the underlying C coal bed is of little economic importance because it contains an abundance of silicified, partly carbonized tree stumps and fragments of logs that destroy the value of the bed. The isopach and structure contour map (pl. 13) shows an area in the northern part of the quadrangle where the coal reaches a thickness of 5.2 feet (1.6 m). Overburden on the C and D coals (pl. 14) ranges in thickness from 0 feet at the outcrops to about 100 feet (0-30.5 m).

There is no known, publicly available chemical analysis of the C and D coals. For purposes of calculating reserves the C and D coals have been assigned a rank of subbituminous C in accordance with the rank of closely associated coals in this quadrangle.

X coal bed

The X coal bed was first described by Bass (1932, p. 55) from exposures in the Ashland coal field, probably in the Beaver Creek School quadrangle, just north of the Coleman Draw quadrangle, where it is well exposed. The X coal bed occurs about 55 feet (16.8 m) above the D coal bed and crops out in the northeastern and south-central parts of the quadrangle (pl. 1) where it was mapped by Bass (1932, pl. 3). The isopach and structure contour map (pl. 10) shows that the X coal bed ranges from about 3 to 5.2 feet (0.9 to 1.6 m) in thickness and dips southeastward at a gentle angle. Overburden on the X coal bed where it is over 5 feet (1.5 m) thick ranges from 0 feet at the outcrops to about 50 feet (0-15.2 m) in thickness.

There are no known, publicly available chemical analyses of the X coal. For purposes of calculating reserves the X coal has been assigned a rank of subbituminous C in accordance with the rank of closely associated coals in this quadrangle.

E coal bed

The E coal bed was first described by Bass (1932, p. 55) from exposures in the Ashland coal field. A type locality was not given. The E coal bed occurs about 35 to 60 feet (10.7 to 18.3 m) above the X coal bed and crops out in the northeastern and southeastern parts of the quadrangle (pl. 1) where it was mapped by Bass (1932, pl. 3). The isopach and structure contour map (pl. 7) shows that the E coal bed ranges from about 2.7 to 8.5 feet (0.8 to 2.6 m) in thickness and dips southward at an angle of less than 1 degree, although this dip is modified by low-relief folding. Overburden on the E coal bed (pl. 8) ranges in thickness from 0 feet at the outcrops up to about 340 feet (0-104 m).

There is no known, publicly available chemical analysis of the E coal in this region. It is assumed that the E coal is similar to closely associated coals in the Coleman Draw quadrangle and is subbituminous C in rank.

Elk coal bed

The Elk coal bed was first described by Warren (1959, p. 573) from exposures in the Birney-Broadus coal field, probably along Elk Creek about 9 miles (14.5 m) south of the Coleman Draw quadrangle in the northern part of the Goodspeed Butte quadrangle. In the southeastern part of the Coleman Draw quadrangle, Bass (1932, pl. 3) mapped an uncorrelated bed which we have correlated with the Elk bed of Warren because it occurs at about the same stratigraphic position. The isopach and structure contour map (pl. 4) shows that the Elk coal bed ranges from about 4 to 15 feet (1.2 to 4.8 m) in thickness and is practically flat-lying. Overburden on the Elk coal bed where it is more than 5 feet (1.5 m) thick ranges from 0 feet at the outcrops to about 300 feet (0-91 m) in thickness.

There is no known, publicly available chemical analysis of the Elk coal. It is assumed that the Elk coal is similar to closely associated coals in the Coleman Draw quadrangle and is subbituminous C in rank.

Ferry coal bed

The Ferry coal bed was first described by Warren (1959, p. 573) from exposures in the central and southwestern parts of the Birney-Broadus coal field. A type locality was not given. We are here applying the name Ferry to the coal bed which Bass (1932) called the F coal bed in his report on the Ashland coal field, which includes this quadrangle. We feel that Ferry is a better name for this coal bed of regional extent. In the Coleman Draw quadrangle, the Ferry coal bed is present at high elevations in the southeastern part of the quadrangle (pl. 1). However, the coal has been extensively burned, and there are no thickness measurements of the Ferry coal bed in this quadrangle. Coal resources have not been calculated for the Ferry coal bed.

Local coal beds

The local coal beds shown on plates 1 and 3 are thin and of limited areal extent, and consequently have not been assigned economic 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.

A coal resource classification system has been established by the U.S. Bureau of Mines and the U.S. Geological Survey in U.S. Geological Survey Bulletin 1450-B (1976). Coal resource is the estimated gross quantity of coal in the ground that is now economically extractable or that may become so. Resources are classified as either Identified or Undiscovered. Identified Resources are specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by specific measurements. Undiscovered Resources are bodies of coal which are surmised to exist on the basis of broad geologic knowledge and theory.

Identified Resources are further subdivided into three categories of reliability of occurrence: namely Measured, Indicated, and Inferred, according to their distance from a known point of coal-bed measurement. Measured coal is coal located within 0.25 mile (0.4 km) of a measurement point, 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.

Undiscovered Resources are classified as either Hypothetical or Speculative. Hypothetical Resources are those undiscovered coal resources in beds that may reasonably be expected to exist in known coal fields under known geologic conditions. In general, Hypothetical Resources are located in broad areas of coal fields where the coal bed has not been observed and the evidence of 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. Speculative Resources are undiscovered resources that may occur in favorable areas where no discoveries have been made. Speculative Resources have not been estimated in this report.

For purposes of this report, Hypothetical Resources of subbituminous coal are in coal beds which are 5 feet (1.5 m) or more thick, under less than 3,000 feet (914 m) of overburden, but occur 3 miles (4.8 km) or more from a coal-bed measurement.

Reserve Base coal is that economically minable part of Identified Resources from which Reserves are calculated. In this report, Reserve Base coal is the gross amount of Identified Resources that occurs in beds 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden for subbituminous coal.

Reserve Base coal may be either surface-minable coal or underground-minable coal. In this report, surface-minable Reserve Base coal is subbituminous coal that is under less than 500 feet (152 m) of overburden. In this report, underground-minable Reserve Base coal is subbituminous coal that is under more than 500 feet (152 m), but less than 3,000 feet (914 m) of overburden.

Reserves are the recoverable part of Reserve Base coal. In this area, 85 percent of the surface-minable Reserve Base coal is considered to be recoverable (a recovery factor of 85 percent). Thus, these reserves amount to 85 percent of the surface-minable Reserve Base coal. For economic reasons coal is not presently being mined by underground methods in the Northern Powder River Basin. Therefore, the underground-mining recovery factor is unknown and Reserves have not been calculated for the underground-minable Reserve Base coal.

Tonnages of coal resources were estimated using coal-bed thicknesses obtained from the coal isopach map for each coal bed (see list of illustrations). The coal resources, in short tons, for each isopached coal bed are the product of the acreage of coal (measured by planimeter), the average thickness in feet of the coal bed, and a conversion factor of 1,770 short tons of subbituminous coal per acre-foot (13,018 metric tons per hectare-meter). Tonnages of coal in Reserve Base, Reserves, and Hypothetical categories, rounded to the nearest one-hundredth of a million short tons, for each coal bed are shown on the Areal Distribution and Tonnage maps (see list of illustrations).

As shown by table 1, the total tonnage of federally owned, surface-minable Reserve Base coal in this quadrangle is estimated to be 2,962.10 million short tons (2,687.22 million t). The total tonnage of federally owned, surface-minable Hypothetical coal is estimated to be 112.07 million short tons (101.68 million t). As shown by table 2, the total federally owned, underground-minable Reserve Base coal is estimated to be 402.58 million short tons (365.14 million t). The total federally owned, underground-minable Hypothetical coal is estimated to be 167.31 million short tons (151.75 million t). The total tonnage of surface- and underground-minable Reserve Base coal is 3,364.68 million short tons (3,052.44

million t), and the total of surface- and underground-minable Hypothetical coal is 279.38 million short tons (253.45 million t).

About 7 percent of the surface-minable Reserve Base tonnage is classed as Measured, 33 percent as Indicated, and 60 percent as Inferred. All of the underground-minable Reserve Base tonnage is Inferred.

The total tonnages per section for both Reserve Base and Hypothetical coal, including both surface- and underground-minable coal, are shown in the northwest corner of the Federal coal lands in each section on plate 2. All numbers on plate 2 are rounded to the nearest one-hundredth of a million short tons.

COAL DEVELOPMENT POTENTIAL

There is a potential for surface-mining in the Northern Powder River Basin in areas where subbituminous coal beds 5 feet (1.5 m) or more thick are overlain by less than 500 feet (152 m) of overburden. This thickness of overburden is the assigned stripping limit for surface mining of multiple beds of subbituminous coal in this area. Areas having a potential for surface mining were assigned a high, moderate, or low development potential based on their mining ratios (cubic yards of overburden per short ton of recoverable coal).

The formula used to calculate mining-ratio values for subbituminous coal is:

$$MR = \frac{t_o\ (cf)}{t_c\ (rf)}$$

where MR = mining ratio

t_o = thickness of overburden, in feet

t_c = thickness of coal, in feet

rf = recovery factor = 0.85 in this area

cf = conversion factor = 0.911 cu. yds./ short ton for subbituminous coal

The mining-ratio values are used to rate the degree of potential that areas within the stripping limit have for surface-mining development. Areas having mining-ratio values of 0 to 10, 10 to 15, and greater than 15 are considered to have high, moderate, and low development potential, respectively. This grouping of mining-ratio values was provided by the U.S. Geological Survey and is based on economic and technological criteria. Mining-ratio contours and the stripping-limit overburden isopach, which serve as boundaries for the development-potential areas, are shown on the overburden isopach and mining-ratio contour plates. Estimated tonnages of surface-minable Reserve Base and Hypothetical coal resources in each development-potential category (high, moderate, and low) are shown in table 1.

Estimated tonnages of underground-minable coal resources are shown in table 2. Because coal is not presently being mined by underground mining in the Northern Powder River Basin for economic reasons, for purposes of this report all of the underground-minable coal resources are considered to have low development potential.

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). For example, 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. Alternatively, if such a 40-acre (16.2-ha) tract of land contains areas of moderate, low, and no development potential, the entire tract is assigned to the moderate development-potential category for CDP mapping purposes. For practical reasons, the development-potential categories of areas of coal smaller than 1 acre (0.4 ha) have been disregarded in assigning a development potential to the entire 40-acre (16.2-ha) tract.

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, because of the 40-acre (16.2-ha) minimum size of coal development-potential tracts, the narrow band of moderate development-potential area often does not appear on the CDP map because it falls within the 40-acre (16.2-ha) tracts that also include areas of high development potential. 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 in the Coleman Draw quadrangle is shown on the Coal Development Potential map (pl. 13). Almost all of the Federal coal lands in the quadrangle have a high development potential for surface mining. The coal beds that have a coal-development potential for surface mining, in ascending order, are: the Flowers-Goodale, Knobloch, Sawyer, Odell, C and D, X, E, and Elk coal beds.

The Flowers-Goodale coal bed (pl. 29) has a low development potential for surface mining throughout the quadrangle because the mining-ratio values are greater than 15, except in the northeastern part of the quadrangle where the Flowers-Goodale coal bed has no development potential because it is less than 5 feet (1.5 m) thick.

The Knobloch coal bed (pl. 26) has a high development potential for surface mining in most of the Coleman Draw quadrangle, extending in most places from the boundary of the unburned coal to the arbitrarily assigned stripping limit at the 500-foot (152 m) overburden isopach, or in places near the eastern border of the quadrangle to the 10 mining-ratio contour. In the northeastern and southeastern parts of the quadrangle, there are narrow bands of moderate development potential extending from the 10 mining-ratio contour to the stripping limit at the 500-foot (152 m) overburden isopach.

In the northern part of the quadrangle, the Sawyer coal bed and its upper split (pl. 21) have wide areas of high development potential extending from the boundary of the coal to the 10 mining-ratio contour. There are narrow areas of moderate development potential between the 10 and 15 mining-ratio contours. Wide areas of low development potential extend from the 15 mining-ratio contour to the crest of the divides or to the 500-foot (152 m) overburden isopach. The lower split of the Sawyer coal bed has only a very small area of development potential for surface-mining in the central part of the quadrangle (pl. 23).

The Odell coal bed (pl. 17) has only very small areas of high, moderate, and low development potential for surface mining of coal in the southeastern part of the quadrangle.

The C and D coal beds (pl. 14) have small areas of high, moderate, and low development potential for surface mining on the ridges near the northern border of the quadrangle.

The X coal bed (pl. 11) has even smaller areas of high, moderate, and low development potential on the crests of the ridges near the northern border of the quadrangle.

The E coal bed (pl. 8) has limited areas of high, moderate, and low coal development potential in the high, rugged hills in the southeastern quarter of the quadrangle. Most of this area has only a low coal development potential (mining-ratio values greater than 15).

The Elk coal bed (pl. 5) also has limited areas of high, moderate, and low coal development potential near the crests of the hills in the southeastern quarter of the quadrangle.

About 96.5 percent of the Federal coal lands in the Coleman Draw quadrangle have a high development potential for surface mining of coal. About 1.6 percent have a moderate development potential, 1.5 percent have a low development potential, and 0.4 percent have no development potential for surface mining of coal.

Development potential for underground mining and in-situ gasification

Subbituminous 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 and lignite beds of the same thickness lying more than 200 feet (61 m) but less than 1,000 feet (305 m) below the surface 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 underground mining of these resources for purposes of this report 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, and a Coal Development Potential map for in-situ gasification of coal was not made.

Table 1.--Surface-minable coal resource tonnage (in short tons) by development-potential category for Federal coal lands in the Coleman Draw quadrangle, Powder River 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				
Elk	11,780,000	3,680,000	10,840,000	26,300,000
E	4,960,000	2,200,000	10,050,000	17,210,000
X	390,000	130,000	40,000	560,000
C and D	1,660,000	710,000	590,000	2,960,000
Odell	250,000	180,000	390,000	820,000
Upper Sawyer	80,440,000	18,380,000	39,320,000	138,140,000
Lower Sawyer	1,800,000	360,000	230,000	2,390,000
Knobloch	2,512,780,000	45,080,000	0	2,557,860,000
Flowers-Goodale	0	0	215,860,000	215,860,000
Total	2,614,060,000	70,720,000	277,320,000	2,962,100,000
Hypothetical Resource tonnage				
Knobloch	48,460,000	14,940,000	0	63,400,000
Flowers-Goodale	0	0	48,670,000	48,670,000
Total	48,460,000	14,940,000	48,670,000	112,070,000
Grand Total	2,662,520,000	85,660,000	325,990,000	3,074,170,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Coleman Draw quadrangle, Powder River 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
Identified Resource tonnage				
Upper Sawyer	0	0	370,000	370,000
Knobloch	0	0	337,600,000	337,600,000
Flowers-Goodale	0	0	64,610,000	64,610,000
Total	0	0	402,580,000	402,580,000
Hypothetical Resource tonnage				
Knobloch	0	0	84,380,000	84,380,000
Flowers-Goodale	0	0	82,930,000	82,930,000
Total	0	0	167,310,000	167,310,000
Grand Total	0	0	569,890,000	569,890,000

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