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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BOX ELDER CREEK QUADRANGLE, POWDER RIVER COUNTY, MONTANA

[Report includes 16 plates]

By

Colorado School of Mines Research Institute

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

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ILLUSTRATIONS

[Plates are in pocket]

TABLES

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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 Box Elder Creek quadrangle, Powder River County, Montana, (16 plates; U.S. Geological Survey Open-File Report 79-081). 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 Box Elder Creek 7 1/2-minute quadrangle is in north-central Powder River County, Montana, about 45 miles (72 km) south-southeast of Miles City, a town in the Yellowstone River valley of eastern Montana. Miles City is on U.S. Interstate Highway 94 and the main east-west routes of the Burlington Northern Railroad and the Chicago, Milwaukee, St. Paul, and Pacific Railroad. The quadrangle is about 17 miles (27 km) northwest of Broadus, Montana, a small town on U.S. Highway 212.

Accessibility

The quadrangle is accessible from Miles City, Montana, by going south on U.S. Highway 312 a distance of 51 miles (82 km) and then west 3 miles (4.8 km) and south 3 miles (4.8 km) on the graveled Pumpkin Creek Road to the north border of the quadrangle. The quadrangle is also accessible from Broadus by going northwest from Broadus on U.S. Highway 212 about 22 miles (35 km) to the

Pumpkin Creek Road and then northeastward on the graveled Pumpkin Creek Road 12 miles (19 km) to the western border of the quadrangle. The Pumpkin Creek Road goes through the northwestern part of the quadrangle and intersects a number of unimproved roads and trails which provide access to the remainder of the quadrangle. The nearest railroad is about 46 miles (74 km) north-northwest in the Yellowstone River valley.

Physiography

The Box Elder Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface, however, has been maturely dissected by Pumpkin Creek and its tributaries. Pumpkin Creek flows northeastward through the northwest quarter of the quadrangle on a flood plain about 0.5 mile (0.8 km) wide, and its westward-flowing intermittent tributaries drain all but the southeast extremity of the quadrangle. Pumpkin Creek joins the Tongue River about 35 miles (56 km) north of the quadrangle and 13 miles (21 km) south of Miles City.

The relief of the northern half of the quadrangle is moderate. Here the flood plain of Pumpkin Creek is at an elevation of 3,100 to 3,200 feet (945 to 975 m). The land surface rises gradually 200 to 300 feet (61 to 91 m) in grass- and brush-covered, rounded hills. The southern half of the quadrangle is more rugged as the land surface rises to the base of cliffs or very steep slopes at an altitude of about 3,300 to 3,400 feet (1,006 to 1,036 m). The steep slopes are produced by erosion-resistant, reddish-colored rock which has been fractured, baked, and partially fused by the burning of coal beds. The steep slopes are 100 to 200 feet (30 to 61 m) high and are capped by a relatively smooth plateau floored by the clinker beds. The plateau surface rises gradually from about 3,500 feet (1,067 m) in the central part of the quadrangle to 3,700 feet (1,128 m) in the southeastern part. The highest elevation, 3,800 feet (1,158 m), is on a butte near the southern border of the quadrangle. The lowest elevation, about 3,050 feet (930 m), is on Pumpkin Creek at the north border of the quadrangle. Topographic relief is 750 feet (229 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 (KRCRA) covers most of the south half and most of the east half of the northeast quarter of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts and the land ownership status. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Bass (1932) mapped the western tier of sections in the quadrangle as part of the Ashland coal field. Brown and others (1954) mapped most of the southern third of the quadrangle as part of the Pumpkin Creek Area, in a description of strippable coal in Custer and Powder River Counties, Montana. Bryson (1952) mapped all of the quadrangle except the western tier of sections as part of the Coalwood coal field. V. W. Carmichael (in Matson and Blumer, 1973, pl. 15) mapped most of the quadrangle as part of the Pumpkin Creek coal deposit. E. H. Gilmour and L. A. Williams (in Matson and Blumer, 1973, pl. 16A) mapped the southwestern part of the quadrangle as part of the Foster Creek coal deposit.

In areas where the coal beds are concealed by surficial deposits, and their locations are therefore uncertain, the inferred positions of the coal beds in places have been shown differently by the previous workers. This compilation, in general, has followed the most recent mapping. However, in some cases the map of an earlier worker has been followed where the earlier mapping appears to fit better the present structural interpretation which is in part based on recent information from drilling in this and adjacent quadrangles. Traces of coal bed outcrops shown by previous workers on planimetric maps that lack topographic control have been modified to fit the modern topographic maps 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, which is the uppermost member of the Fort Union Formation (Paleocene). This member consists of light-colored sandstone, sandy 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. In the Box Elder Creek quadrangle, the upper part of the Tongue River Member has been removed by erosion; about the lower 1,100 feet (335 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 rivers, 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 content of trace element 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 rock types found throughout other parts of the western United States.

Structure

The Box Elder Creek quadrangle is in the northeastern 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

The coal beds in the Box Elder Creek 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 coal beds belong to the Tongue River Member of the Fort Union Formation.

The lowermost of the coal beds in the Box Elder Creek quadrangle is the Patton coal bed. It is about 140 feet (43 m) above the base of the Tongue River Member, and is overlain successively by a noncoal interval of about 20 feet (6 m), the Broadus coal bed, a noncoal interval of about 25 feet (7.6 m), the Allen coal bed, a noncoal interval of about 65 feet (19.8 m), a local coal bed, a noncoal interval of about 50 to 70 feet (15 to 21 m), the Knobloch coal bed, a noncoal interval of 100 to 120 feet (30 to 36.6 m), the Sawyer coal bed, a noncoal interval of 50 to 90 feet (15 to 27 m), the Mackin-Walker coal bed, a noncoal interval of about 160 feet (49 m), the Stump coal bed, a noncoal interval of about 75 feet (23 m), and the X coal bed. Four coal beds, the Broadus, Knobloch, Sawyer, and Mackin-Walker have been assigned economic coal resources. Maps of these individual coal beds have been prepared utilizing data from points within this quadrangle and in adjacent quadrangles to control the configuration of isopachs and structure contours.

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. Lignite A is a coal that has a heating value of 6,300 to 8,300 Btu per pound (14,654 to 19,306 kJ/kg) on a moist, mineral-matter-free basis. Subbituminous C coal has a heating value of 8,300 to 9,500 Btu per pound (19,306 to 22,097 kJ/kg) on a moist, mineral-matter-free basis. All coal analyses available at the present time for this and adjacent quadrangles were considered in making our decision to assign a rank of lignite to the coal in this quadrangle. The lignite-subbituminous boundary may be within the quadrangle, but not enough data are presently known to allow us to determine that boundary line through the quadrangle with certainty. Therefore, a rank of lignite has been arbitrarily assigned by us to all of the coal in the entire quadrangle. Additional data to be obtained in the future may make a more precise determination of the location of this boundary possible.

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).

Patton coal bed

The Patton coal bed crops out in the northeast quarter of the Box Elder Creek quadrangle about 140 feet (43 m) above the base of the Tongue River

Member and 20 feet (6 m) below the Broadus coal bed (pls. 1 and 3). This coal bed has a limited extent and is less than 4 feet (1.2 m) in thickness. Because of its thinness it has not been assigned economic coal resources. Because of its stratigraphic relation to other beds, the Patton coal bed may be approximately equivalent to the Volborg coal bed in the Mizpah coal field.

Broadus coal bed

The Broadus coal bed, first described by Warren (1959, p. 570), was named from the town of Broadus in the Broadus quadrangle about 15 miles (24 km) south-southeast of the Box Elder Creek quadrangle. The Broadus coal bed does not crop out in the Box Elder Creek quadrangle, but is penetrated by a test hole. It is projected into the subsurface of the quadrangle from the east and south. The isopach and structure contour map of the Broadus coal bed (pl. 13) shows that the Broadus coal bed ranges from 5 to 20 feet (1.5 to 6.1 m) in thickness, and dips westward or southwestward at an angle of less than 1 degree. Overburden on the Broadus coal bed ranges from about 220 to 660 feet (67 to 201 m) in thickness (pl. 14).

There is no known publicly available chemical analysis of the Broadus coal in the Box Elder Creek quadrangle. However, a chemical analysis of the Broadus coal from a depth of 92 to 117 feet (28 to 36 m) in drill hole BR-6C, sec. 7, T. 3 S., R. 50 E., in the Olive quadrangle about 2 miles (3.2 km) east-southeast of the Box Elder Creek quadrangle shows ash 6.90 percent, sulfur 0.24 percent, and heating value 7,550 Btu per pound (17,560 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 91). This heating value converts to about 8,110 Btu per pound (28,864 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Broadus coal at this location is lignite A in rank. Because of the proximity of this location to the Box Elder Creek quadrangle, it is assumed that the Broadus coal in the Box Elder Creek quadrangle is similar and is also lignite A in rank.

Allen coal bed

The Allen coal bed crops out in the northeastern part of the Box Elder Creek quadrangle about 25 feet (7.6 m) above the Broadus coal bed (pls. 1 and 3). Because this coal bed is limited in extent and is thin, only 2.0 to 5.2 feet or 0.61 to 1.6 m in thickness, it has not been assigned economic coal resources. Bryson (1952, p. 82) states that the Allen coal bed may be equivalent to the Terret coal bed which is found to the northwest.

Local coal bed below the Knobloch coal bed

A local coal bed, 50 to 70 feet (15 to 21 m) below the Knobloch coal bed, crops out in the central part of the Box Elder Creek quadrangle (pls. 1 and 3). This local bed was mapped by Bryson (1952, pl. 1) as the Flowers-Goodale coal bed. The Flowers-Goodale coal bed was first described by Bass (1932, p. 53) after two small coal mines in the Brandenberg quadrangle about 20 miles (32 km) west-northwest of the Box Elder Creek quadrangle. However, Bryson (1952, p. 83) also believes that this local bed correlates with the Broadus coal bed in the Birney-Broadus coal field to the south. Because this coal bed is of limited areal extent, is discontinuous and thin, and its correlation is uncertain, we have called it a local bed. This coal bed is less than 5 feet (1.5 m) thick or is split into two beds by a shale parting that is thicker than the coal. Because of its thinness economic coal resources have not been assigned to it in the Box Elder Creek quadrangle.

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, about 32 miles (51 km) southwest of the Box Elder Creek quadrangle.

In the Box Elder Creek quadrangle, the Knobloch coal bed is about 50 to 70 feet (15 to 21 m) above the local or "Flowers-Goodale" coal bed and about 150 feet (46 m) above the Broadus coal bed. The Knobloch coal bed crops out extensively in the central part of the Box Elder Creek quadrangle (pl. 1). As shown by the isopach and structure contour map, the Knobloch coal bed ranges from 2.4 to about 14 feet (0.7 to 4.3 m) in thickness (pl. 10), and dips southwestward and/or southwestward at an angle of less than 1 degree except in the southern part of the quadrangle where this dip is modified by gentle warping. Overburden on the Knobloch coal bed (pl. 11) ranges from zero at the outcrop to about 500 feet (152 m) in thickness.

There is no known publicly available chemical analysis of the Knobloch coal in the Box Elder Creek quadrangle. However, a chemical analysis of the Knobloch coal in drill hole FC-6, sec. 29, T. 1 S., R. 48 E., in the Elk Ridge quadrangle, about 3.5 miles (5.6 km) west of the Box Elder Creek quadrangle shows ash 6.66 percent, sulfur 0.37 percent, and a heating value of 7,380 Btu per pound (17,166 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 86). This heating value converts to about 7,907 Btu per pound (18,392 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Knobloch coal at this location is lignite A in rank. Because of the proximity of this location to the Box Elder Creek quadrangle, it is assumed that the Knobloch coal in this quadrangle is similar and is also lignite A in rank.

Sawyer coal bed

The Sawyer coal bed was first described by Dobbin (1930, p. 28) after exposures in the foothills of the Little Wolf Mountains in the Forsyth coal field (Rough Draw and Black Spring quadrangles) about 47 miles (76 km) west of the Box Elder Creek quadrangle.

The Sawyer coal bed crops out in the southern half of the Box Elder Creek quadrangle (pl. 1) where it is 100 to 120 feet (30 to 36.6 m) above the Knobloch coal bed (pl. 3). Much of the Sawyer coal has been burned near the outcrops (pl. 1). As shown by the isopach and structure contour map (pl. 7), the Sawyer coal bed ranges in thickness from about 19 to 33 feet (5.8 to 10.1 m) and dips southwestward at an angle of less than 1 degree. Overburden on the Sawyer coal bed (pl. 8) ranges from zero at the outcrops to about 340 feet (103.6 m).

A chemical analysis of the Sawyer coal bed from a depth of 123 to 115.5 feet (37.5 to 35.2 m) in drill hole PC-3, sec. 28, T. 2 S., R. 49 E., in the Box Elder Creek quadrangle shows ash 6.81 percent, sulfur 0.30 percent, and heating value 7,490 Btu per pound (17,422 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 83). This heating value converts to about 8,037 Btu per pound (18,694 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Sawyer coal bed in the Box Elder Creek quadrangle is lignite A in rank.

Mackin-Walker coal bed

The Mackin-Walker coal bed was named by Bryson (1932, p. 76) after the coal bed at the Mackin-Walker mine, sec. 28, T. 2 S., R. 49 E. in the Box Elder Creek quadrangle. The Mackin-Walker coal crops out in the southern part of this quadrangle (pl. 1) about 50 to 90 feet (15 to 27 m) above the Sawyer coal bed (pl. 2). As shown by the isopach and structure map (pl. 4), the Mackin-Walker coal bed ranges from about 3 to 8 feet (0.9 to 2.44 m) in thickness, and dips westward and southwestward at an angle of less than 1 degree, although the dip is modified somewhat by minor folding. Overburden on the Mackin-Walker coal bed (pl. 5) ranges from zero at the outcrops to slightly over 200 feet (61 m) in thickness.

A chemical analysis of the Mackin-Walker coal bed from a depth of 68 to 73 feet (20.7 to 22.2 m) in drill hole PC-3, sec. 28, T. 2 S., R. 49 E. in the Box Elder Creek quadrangle shows ash 11.3 percent, sulfur 1.18 percent, and heating value 7,310 Btu per pound (17,003 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 83). This heating value converts to about 8,225 Btu per pound (19,131 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Mackin-Walker coal in the Box Elder Creek quadrangle is lignite A in rank.

Stump coal bed

The Stump coal bed was first described by Bryson (1952, p. 76) from exposures in the Coalwood coal field in the Box Elder Creek quadrangle or the Leslie Creek quadrangle just to the south. The Stump coal bed is characterized by the presence in it of silicified, partly carbonized tree stumps. Because of the abundance of stumps and its relation to other beds, the Stump coal bed is correlated with the C coal bed in the Ashland coal field to the southwest. In the Box Elder Creek quadrangle, the Stump coal bed crops out on two high ridges near the southern border of the quadrangle. Because the Stump coal bed is only about 3 feet (0.9 m) thick, economic coal resources have not been assigned to it.

X coal bed

The X coal bed occurs about 75 to 80 feet (23 to 42 m) above the Stump coal bed at the crest of one hill near the southern border of the Box Elder Creek quadrangle. It is thin and does not contain economic coal resources.

COAL RESOURCES

Data from all publicly available drill holes and from surface mapping by others (see list of references) in this and adjacent quadrangles were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle.

Coal resource classifications have been established by the U.S. Bureau of Mines and the U.S. Geological Survey and published in U.S. Geological Survey Bulletin 1450-B (1976). Coal resource is the estimated 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 lignite are in lignite beds which are 5 feet (1.5 m) or more thick, under less than 1,000 feet (305 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 1,000 feet (305 m) of overburden for lignite.

Reserve Base coal may be either surface-minable coal or underground-minable coal. In this report, surface-minable Reserve Base coal is lignite that is under less than 200 feet (61 m) of overburden. In this report, underground-minable Reserve Base coal is lignite that is under more than 200 feet (61 m), but less than 1,000 feet (305 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 1,750 short tons of lignite per acre-foot (12,870 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, 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 180.47 million short tons (163.72 million t). There is no federally owned, surface-minable Hypothetical coal. As shown by table 2, the total federally owned, underground-minable Reserve Base coal is estimated to be 113.63 million short tons (103.09 million t). There is no federally owned, underground-minable Hypothetical coal. The total tonnage of surface- and underground-minable Reserve Base coal is 294.10 million short tons (266.81 million t).

About 15 percent of the Reserve Base tonnage is classed as Measured, 51 percent as Indicated, and 34 percent as Inferred. None of the underground-minable Reserve Base tonnage is Measured, 4 percent is Indicated, and 96 percent 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 federally owned coal land 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, or where lignite beds of the same thickness are overlain by 200 feet (61 m) or less of overburden. This last thickness of overburden is the assigned stripping limit for surface mining of lignite 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 lignite is:

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

where MR = mining ratio

t_o = thickness of overburden, in feet

t_c = thickness of lignite, in feet

rf = recovery factor = 0.85 in this area

cf = conversion factor = 0.922 cu. yds./ short ton for lignite

The mining-ratio values are used to rate the 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. 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 map (pl. 16) shows the areas of high, moderate, low, and no development potential for surface mining. Most of the Federal coal lands in the central and southern parts of the quadrangle have a high development potential for surface mining. The areas of high development potential are due primarily to the Sawyer and Knobloch coal beds, and to a lesser extent to the Mackin-Walker and Broadus coal beds. The Federal coal lands in the northern part of the quadrangle have no development potential because the coal beds there are thin or have been removed by erosion.

The Sawyer coal bed (pl. 8) has a high development potential in the wide area between its boundary and the 200-foot overburden isopach, the arbitrarily assigned stripping limit for beds of lignite.

The Knobloch coal bed (pl. 11) has modest areas of high development potential in the ephemeral stream valleys between the coal boundary and the 10 mining-ratio contour. Upslope from these areas is a narrow band (between the 10 and 15 mining-ratio values) which has a moderate coal-development potential. Upslope from this narrow band is a wider band of low development potential extending from the 15 mining-ratio contour to the 200-foot overburden isopach which is the arbitrarily assigned stripping limit for beds of lignite, and above which here is no development potential for surface mining.

The Mackin-Walker coal bed (pl. 5), which occurs in the southeast quarter of the quadrangle, has limited areas of high development potential between the coal boundary and the 10 mining-ratio contour. There is a narrow band of moderate development potential between the 10 and 15 mining-ratio contours, and a wider area of low development potential extending from the 15 mining-ratio contour to the 200-foot overburden isopach.

The Broadus coal bed (pl. 14) is considered to have no development potential for surface mining because all of the Broadus coal where it is more than 5 feet (1.5 m) thick is beyond the arbitrarily assigned stripping limit of 200 feet (61 m) for lignite beds.

About 43 percent of the Federal coal lands in the Box Elder Creek quadrangle has a high development potential for surface mining, 5 percent has a moderate development potential, 3 percent has a low development potential, and 49 percent has no development potential.

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 Box Elder Creek 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				
Mackin-Walker	6,150,000	1,580,000	2,590,000	10,320,000
Sawyer	124,720,000	110,000	0	124,830,000
Knobloch	16,950,000	10,240,000	18,130,000	45,320,000
Total	147,820,000	11,930,000	20,720,000	180,470,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Box Elder Creek 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
Reserve Base tonnage				
Sawyer	0	0	2,990,000	2,990,000
Knobloch	0	0	39,400,000	39,400,000
Broadus	0	0	71,240,000	71,240,000
Total	0	0	113,630,000	113,630,000

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