UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-005

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE CHALKY POINT QUADRANGLE, BIG HORN AND ROSEBUD COUNTIES, MONTANA

[Report includes 9 plates]

By

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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 Chalky Point quadrangle, Big Horn and Rosebud Counties, Montana, (9 plates; U.S. Geological Survey Open-File Report 79-005). 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 Chalky Point 7 1/2-minute quadrangle is in northeastern Big Horn and western Rosebud Counties, Montana, about 40 miles (64 km) south-southeast of Hysham, Montana, a town in the Yellowstone River valley about 71 miles (114 km) west-southwest of Miles City and 78 miles (125 km) east of Billings. U.S. Interstate Highway 94 and the main east-west route of the Burlington Northern Railroad follow the Yellowstone River and pass through Hysham.

Accessibility

The north half of the Chalky Point quadrangle is accessible from the northwest by way of the Sarpy Road, an improved, graveled road that connects the town of Hysham, Montana, (40 miles or 64 km to the north-northwest) with the town of Hardin (34 miles or 54 km to the west). The quadrangle is accessible from an intersection 4 miles (6 km) east of Hysham on U.S. Interstate Highway 94, then south on the Sarpy Road about 33 miles (52.8 km) to the Absaloka Coal Mine Road

intersection, and then east and south about 14 miles (22.4 km) to the north border of the quadrangle. The quadrangle is also accessible from an intersection 2 miles (3.2 km) east of Hardin on U.S. Interstate Highway 90, then east on the Sarpy Road about 27 miles (43.2 km) to the Absaloka Coal Mine Road intersection, and then east and south about 14 miles (22.4 km) to the north border of the quadrangle. Additional roads or trails, all of them unimproved, lead to other parts of the north half of the quadrangle. The south half of the Chalky Point quadrangle lies within the Northern Cheyenne Indian Reservation, and is readily accessible only by private roads on the reservation.

The nearest railroad is a spur which runs southward from the main line of the Burlington Northern Railroad near Hysham, parallel with the Sarpy Road, about 35 miles (56 km) to the Absaloka coal mine located near the center of the Wolf School quadrangle, about 11 miles (17.6 km) northwest of the Chalky Point quadrangle.

Physiography

The Chalky Point quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The northwest quarter of the quadrangle has been dissected by East Fork Sarpy Creek and its tributaries which flow northwestward out of the quadrangle. The Little Wolf Mountains form a major drainage divide running northeastward from the center of the west border to the northeast corner of the quadrangle. The area southeast of the Little Wolf Mountains is drained by Indian Coulee and its tributaries, which flow southeast to Rosebud Creek, a larger northeastward-flowing stream south and east of the quadrangle. The highest elevation, 4,541 feet (1,384 m), is on a ridge known as the Sarpy Mountains about 1 mile (1.6 km) northeast of the southwest corner of the quadrangle. The lowest elevation, about 3,400 feet (347 m), is on the east border

of the southeast quarter, where Indian Coulee leaves the quadrangle. The topographic relief is about 1,140 feet (348 m).

Climate

The climate of Big Horn and Rosebud Counties 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 north half of the quadrangle lies within the Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA) boundary. The south half is in the Northern Cheyenne Indian Reservation in which coal resources were not mapped. The Coal Data Map (pl. 2) shows the land ownership status. There were no outstanding Federal coal leases or prospecting permits of record as of 1977.

GENERAL GEOLOGY

Previous work

Dobbin (1930) mapped the north half of the quadrangle as part of the Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana.

Stratigraphy

The Tongue River Member of the Fort Union Formation (Paleocene) is exposed throughout the Chalky Point quadrangle. The member consists of light-colored sandstone, sandy shale, and a number of important coal beds. The maximum thickness of the member, in the Little Wolf Mountains in the northeast quarter of the

quadrangle, is estimated to be about 1,450 feet (442 m); however, only the uppermost 700 feet (213 m) is exposed in the 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 Chalky Point quadrangle is in the northwestern part of the Powder River structural basin. The strata in general dip eastward at about 20 feet per mile (3.8 m per km) or less (pl. 3). In places the regional structure is modified by gentle anticlinal and synclinal folds (Dobbin, 1930, p. 23).

COAL GEOLOGY

Three coal beds, all in the Tongue River Member, occur in the Chalky Point quadrangle (fig. 1). The stratigraphically lowest of the three beds is the Robinson coal bed, which is about 240 feet (73 m) above the base of the Tongue River Member. Above the Robinson bed is a noncoal interval of about 180 feet (54.9 m), the Rosebud coal bed, a noncoal interval of about 180 feet (54.9 m), and the Sawyer coal bed. There are no points of measurement for the coal beds in the quadrangle except for the Robinson coal bed which has been penetrated by an oil and

gas test hole in the northern part of the quadrangle. Because of the general lack of data a Coal Data Sheet has not been prepared for the Chalky Point quadrangle, but a composite columnar section is shown by figure 1 on page 6.

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).

Robinson coal bed

The Robinson coal bed was first described by Dobbin (1930, p. 27) from outcrops on the Robinson Ranch in the McClure Creek quadrangle about 12 miles (19 km) north of the Chalky Point quadrangle. The Robinson coal bed does not crop out within the quadrangle, but has been penetrated by an oil and gas test hole (pl. 1). The isopach and structure contour map (pl. 6), based mainly on measurements in adjacent quadrangles, shows that the Robinson coal bed ranges from about 5 to 18 feet (1.5 to 5.5 m) in thickness and dips eastward at an angle of less than 1 degree. The overburden on the Robinson coal bed (pl. 7) ranges from about 440 to 1,200 feet (134 to 366 m) in thickness.

There are no known published chemical analyses of the Robinson coal in or close to the Chalky Point quadrangle. It is assumed that the Robinson coal is similar to other closely associated coal beds in the area for which analyses are available, and is subbituminous B in rank.

Rosebud coal bed

The Rosebud coal bed was named by Dobbin (1930, p. 27) for exposures along Rosebud Creek in the Forsyth coal field. A specific type locality was not given. The Rosebud coal bed does not crop out in the part of the Chalky Point quadrangle which has been mapped, and there is no data available from test holes. However,

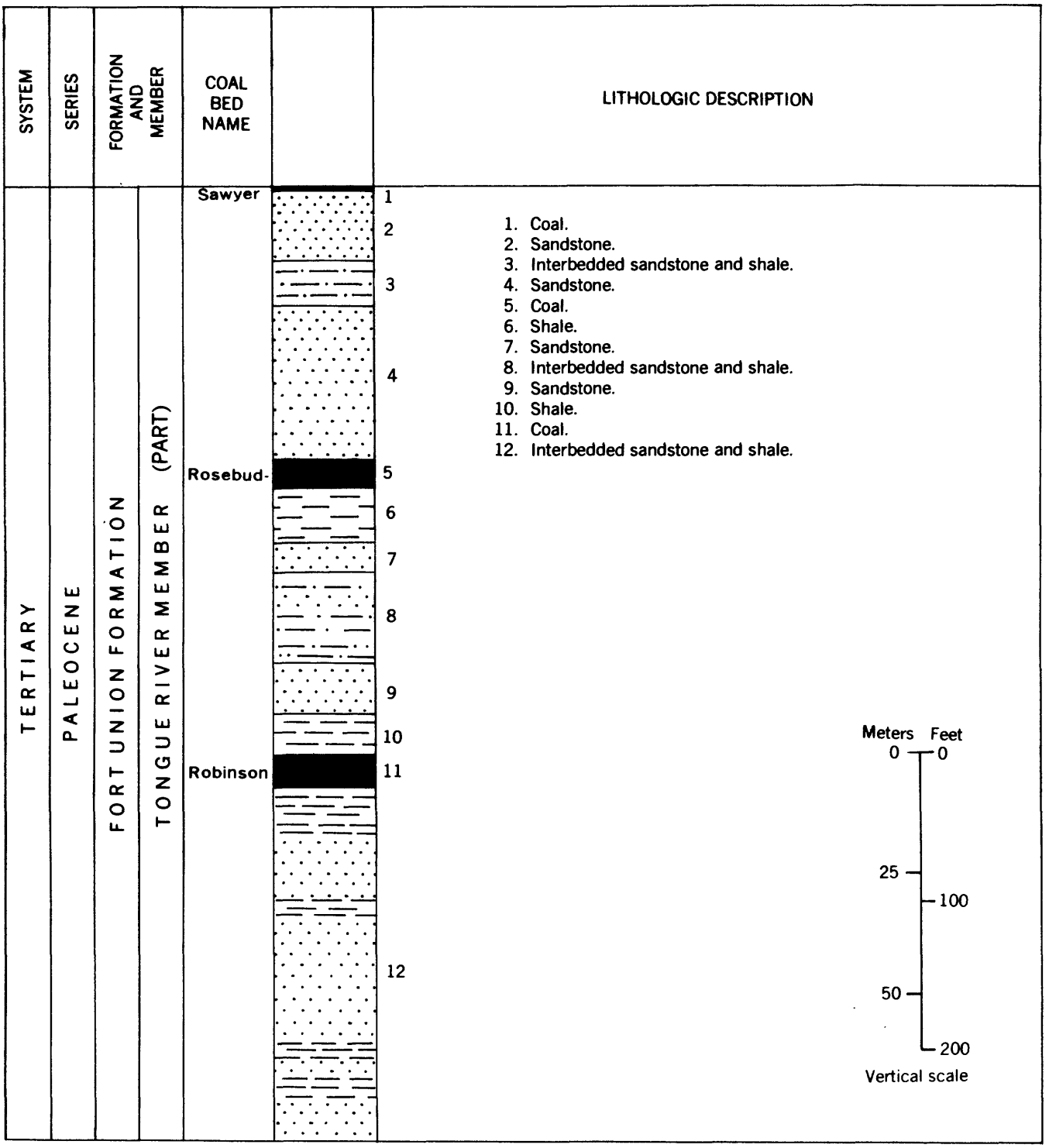

Figure 1.--Composite columnar section, Chalky Point quadrangle, Montana

this coal bed has been projected into the subsurface of the quadrangle from adjacent quadrangles. It is projected to occur about 180 feet (55 m) above the Robinson coal bed (fig. 1). The isopach and structure contour map (pl. 3) shows a projected thickness of 5 to 30 feet (1.5 to 9.1 m) and a dip of less than 1 degree to the northeast. Overburden on the Rosebud coal bed (pl. 4) ranges from about 20 to 1,000 feet (6.1 to 305 m) in thickness.

A chemical analysis of the Rosebud coal in coal test hole RB-54, sec. 27, T. 1 N., R. 40 E. about 8 miles (12.9 km) northeast of the Chalky Point quadrangle in the Colstrip SW quadrangle (Matson and Blumer, 1973, p. 78) shows ash 7.86 percent, sulfur 0.68 percent, and heating value 9,050 Btu per pound (21,050 kJ/kg) on an as-received basis. This heating value converts to about 9,822 Btu per pound (22,846 kJ/kg) on a moist, mineral-matter-free basis indicating that the Rosebud coal at this locality is subbituminous B in rank. Because of the proximity of this location to the Chalky Point quadrangle it is assumed that the Rosebud coal in this quadrangle is similar and is also subbituminous B 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 (Black Spring and Rough Draw quadrangles) just east and northeast of the Chalky Point quadrangle. An inferred outcrop of the Sawyer coal bed (pl. 1) has been projected into the Chalky Point quadrangle at about the elevation of its occurrence in the Black Spring quadrangle to the east. Measurements of the thickness of the Sawyer coal bed in the Black Spring quadrangle indicate that the Sawyer coal bed thins westward and is probably less than 3 feet (0.9 m) thick in the Chalky Point quadrangle. Because of its projected thinness in the Chalky Point quadrangle, maps have not been made for the Sawyer coal bed in this quadrangle, and economic coal resources have not been assigned to it.

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 and published 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. 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 3,000 feet (914 m) of overburden for subbituminous coal or 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 subbituminous coal that is under less than 500 feet (152 m) of overburden or lignite that is under less than 200 feet (61 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, or 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 1,770 short tons of subbituminous coal per acre-foot (13,018 metric tons per hectare-meter) or 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, 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 43.29 million short tons (39.27 million t). The total tonnage of federally owned, surface-minable Hypothetical coal is estimated to be 143.81 million short tons (130.46 million t). As shown by table 2, the total federally owned, underground-minable Reserve Base coal is estimated to be 207.74 million short tons (188.46 million t). The total federally owned, underground-minable Hypothetical coal is estimated to be 96.71 million short tons (87.74 million t). The total tonnage of surface- and underground-minable Reserve Base coal is 251.03 million short tons (227.73 million t), and the total of surface- and underground-minable Hypothetical coal is 240.52 million short tons (218.20 million t).

None of the surface-minable Reserve Base tonnage is classed as Measured, 7 percent is Indicated, and 93 percent is Inferred. None of the underground-minable Reserve Base tonnage is Measured, 0.5 percent is Indicated, and 99.5 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 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, or where lignite beds of the same thickness are overlain by 200 feet (61 m) or less of overburden. 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 (less than 500 feet or 152 m of overburden) is shown on the CDP map (pl. 9). The Federal coal lands in the southeastern part of the quadrangle north of the Northern Cheyenne Indian Reservation have mainly a high or moderate development potential for surface mining. The Federal lands in the remainder of the northern part of the quadrangle have a low development potential or no development potential.

The Robinson coal bed has no areas of high or moderate development potential for surface mining due primarily to its thick overburden. This coal bed has areas of low development potential in valleys in the southeastern and northwestern parts of the mapped area extending in places from the borders of the mapped area to the 500-foot overburden isopach, the arbitrarily assigned stripping limit.

The Rosebud coal bed (pl. 4) has two rather limited areas of high development potential in valleys in the southeastern part of the mapped area extending from the border of the mapped area to the 10 mining-ratio contour. The Rosebud coal bed also has fairly wide bands of moderate development potential on the slopes between the 10 and 15 mining-ratio contours. There are wider bands of low development potential higher on the slopes between the 15 mining-ratio contour and the 500-foot overburden isopach.

Approximately 10 percent of the Federal coal lands in the Chalky Point quadrangle have a high development potential for surface mining, 17 percent have a moderate development potential, 52 percent have a low development potential, and 21 percent have no development potential for surface mining.

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 Chalky Point quadrangle, Big Horn and Rosebud Counties, 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				
Rosebud	2,470,000	14,500,000	11,660,000	28,630,000
Robinson	0	0	14,660,000	14,660,000
Total	2,470,000	14,500,000	26,320,000	43,290,000
Hypothetical Resource tonnage				
Rosebud	2,920,000	43,330,000	92,000,000	138,250,000
Robinson	0	0	5,560,000	5,560,000
Total	2,920,000	43,330,000	97,560,000	143,810,000
Grand Total	5,390,000	57,830,000	123,880,000	187,100,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Chalky Point quadrangle, Big Horn and Rosebud Counties, 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				
Rosebud	0	0	34,870,000	34,870,000
Robinson	0	0	172,870,000	172,870,000
Total	0	0	207,740,000	207,740,000
Hypothetical Resource tonnage				
Rosebud	0	0	81,330,000	81,330,000
Robinson	0	0	15,380,000	15,380,000
Total	0	0	96,710,000	96,710,000
Grand Total	0	0	304,450,000	304,450,000

REFERENCES

Dobbin, C. E., 1930, The Forsyth coal field, Rosebud, Treasure, and Big Horn Counties, Montana: U.S. Geological Survey Bulletin 812-A, p. 1-55.

Hatch, J. R., and Swanson, V. E., 1977, Trace elements in Rocky Mountain coals, in Proceedings of the 1976 symposium, Geology of Rocky Mountain coal, 1977: Colorado Geological Survey, Resource Series 1, p. 143-163.

Mapel, W. J., Swanson, V. E., Connor, J. J., Osterwald, F. W., and others, 1977, Summary of the geology, mineral resources, environmental geochemistry, and engineering geologic characteristics of the northern Powder River coal region, Montana: U.S. Geological Survey Open-File Report 77-292.

Matson, R. E., and Blumer, J. W., 1973, Quality and reserves of strippable coal, selected deposits, southeastern Montana: Montana Bureau of Mines and Geology Bulletin 91, 135 p.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Department of Agriculture, Interstate Commerce Commission, and U.S. Department of the Interior, 1974, Final environmental impact statement on proposed development of coal resources in the eastern Powder River coal basin of Wyoming: v. 3, p. 39-61.