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

[Report includes 36 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 Bloom Creek quadrangle, Powder River County, Montana, (36 plates; U.S. Geological Survey Open-File Report 79-784). 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 Bloom Creek 7 1/2-minute quadrangle is in south-central Powder River County, Montana, about 21 miles (34 km) southwest of Broadus, a small town in the Powder River valley; about 79 miles (127 km) south of Miles City, a town in the Yellowstone River valley; and about 59 miles (95 km) north-northwest of Gillette, Wyoming. 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. Broadus is on east-west U.S. Highway 212. Gillette is on U.S. Interstate 90 and another branch of the Burlington Northern Railroad.

Accessibility

The quadrangle is accessible from Broadus by going southwest a distance of about 24 miles (38.6 km) on the graveled Powder River Road in the Powder River valley to the eastern boundary of the quadrangle. The quadrangle is also accessible from Sheridan, Wyoming, by going about 55 miles (88.5 km) eastward on U.S.

Highways 14 and 16 to the Powder River near Kendrick, Wyoming, and then about 31 miles (50 km) northeastward on the Powder River Road down the Powder River valley to the south boundary of the quadrangle. The nearest railroad, the Burlington Northern Railroad, is located about 35 miles (56 km) southwest of the quadrangle up the Powder River valley near Kendrick, Wyoming.

Physiography

The Bloom Creek quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The Powder River and its flood plain are the most prominent land forms in the quadrangle. The Powder River meanders northeastward across the southeast quarter of the quadrangle. From this quadrangle it flows northeastward to Broadus, Montana, and then generally northward until it meets the Yellowstone River about 103 miles (166 km) north-northeast of the quadrangle. The flood plain of the Powder River is about 0.75 to 1.25 miles (0.4 to 2.0 km) wide and about 6 miles (9.7 km) long within the Bloom Creek quadrangle. Between the valleys of its tributaries, the flood plain of the Powder River is bordered by moderate slopes capped by steeper bluffs that rise 250 to 600 feet (76 to 183 m).

About 80 percent of the Bloom Creek quadrangle lies northwest of the Powder River and drains southeastward into it. Only about 10 square miles (25.9 square kilometers) of the quadrangle lie southeast of the river and drain northwestward into it. The major tributaries of the Powder River are thus roughly aligned along a northwest-southeast axis, but the uplands dividing these streams are relatively broad and do not emphasize the linearity suggested by the streams. Northwest of the Powder River the major tributaries are Bloom Creek, Plum Creek, Dutch Gulch, and Spring Creek. Southeast of the river the major tributary is Three Bar Creek. All of these streams are intermittent.

Apart from the flood plain of the Powder River, the landscape of the Bloom Creek quadrangle is dominated by the moderately steep to precipitous slopes of the broad, deeply and thoroughly dissected uplands between the major streams. Only the lower slopes of the narrow valleys of these streams are relatively gradual. The slopes between the streams and the ridge tops typically rise 350 to 750 feet (107 to 229 m) over distances of 0.25 to 0.75 mile (0.4 to 1.2 km). The highest point in the quadrangle, with an elevation of 4,151 feet (1,265 m), is an unnamed peak on the divide between Dutch Gulch and Spring Creek near the southwest corner of the map. The lowest point in the quadrangle, with an elevation of about 3,240 feet (988 m), is along the Powder River at the east edge of the map. Topographic relief in the quadrangle is about 911 feet (278 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 Known Recoverable Coal Resource Area (KRCRA) covers all of the quadrangle except a small area along the Powder River near the eastern border of the quadrangle. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts and the land ownership status. The Custer National Forest covers the northwest quarter of the quadrangle. There were no outstanding Federal coal leases or prospecting permits as of 1977.

GENERAL GEOLOGY

Previous work

Bryson and Bass (1973) mapped the Bloom Creek quadrangle as part of the East Moorhead coal field. Matson and Blumer (1973) mapped the strippable reserves of the Cook, Pawnee, and Canyon coal beds in the northern part of the quadrangle.

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

Stratigraphy

The exposed bedrock units in the quadrangle belong to the Tongue River Member, the uppermost member of the Fort Union Formation (Paleocene).

The Tongue River Member is made up mainly of yellow to gray sandstone, sandy shale, carbonaceous shale, and coal. Much of the coal has burned, baking the overlying sandstone and shale and forming thick, reddish-colored clinker beds. The upper part of the Tongue River Member has been removed by erosion leaving as much as 1,300 feet (396 m) of the member remaining 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 Bloom Creek quadrangle is located near the eastern flank of the Powder River structural basin in Montana. Regionally the strata dip southwestward at an angle of less than 1 degree. In places the regional dip is modified by local folding (pls. 4, 8, 11, 14, 17, 20, 23, 26, 30, and 33). Some irregularities in dip may be caused by depositional variations as well as differential compaction, common in continental strata.

COAL GEOLOGY

The coal beds in the Bloom 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 mapped coal beds occur in the Tongue River Member of the Fort Union Formation (Paleocene). No commercial coal beds are known to exist below the Tongue River Member.

The lowermost coal bed identified in the quadrangle is the Number 9b coal bed which occurs about 300 feet (91 m) above the base of the Tongue River Member. The Number 9b coal bed is successively overlain by a noncoal interval of about 20 to 80 feet (6 to 24 m), the Number 9a coal bed, a noncoal interval of about 20 to 80 feet (6 to 24 m), the Cache coal bed, a noncoal interval of about 45 feet (14 m), the Number 8a coal bed, a noncoal interval of about 35 to 75 feet (11 to 23 m), the Number 8 coal bed, a noncoal interval of about 25 to 60 feet (8 to 18 m), the Number 7 coal bed, a noncoal interval of about 15 to 40 feet (5 to 12 m), the Pawnee coal bed, a predominantly noncoal interval of about 80 to 150 feet (24 to 46 m), the Number 5 coal bed, a noncoal interval of about 80 to 140 feet (24 to 43 m), the lower split of the Cook coal bed, a noncoal interval of about 20 to 150 feet (6 to 46 m), the upper split of the Cook coal bed, a noncoal interval of about 80 to 200 feet (24 to 61 m), the Canyon coal bed, a noncoal interval of about 60 feet (18 m), the lower split of the Dietz coal bed, a noncoal interval of 0 to 20 feet (0-6 m), the upper split of the Dietz coal bed, a noncoal interval of about 50 feet (15 m), and the Anderson 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. The rank of coal is controlled by the amount of compaction to which the coal is subjected. The compaction is a result of the original depth of burial of the coal (thickness of overlying overburden) and of the degree of tectonic (mountain-building) activity to which the coal has been subjected. The eastern flank of the Powder River Basin has not been subjected to very much squeezing of sediments produced by tectonic activity so that the rank of coal there is primarily related to the original depth of burial (thickness of overburden) to which the coal has been subjected. 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.

At the start of this mapping contract, what appeared to us to be all of the available analyses of the Broadus coal bed, the stratigraphically lowermost coal bed of importance in this area, were considered in making our decision to assign a rank of subbituminous C to the Broadus coal within the adjacent Huckins School and Sayle quadrangles which flank this quadrangle on the east and the west. Overlying coal beds in this quadrangle grade upward into increasingly lower ranks of coal (coal having lower Btu values per pound of coal on a moist, mineral-matter-free basis) as the coal is less and less compacted because of decreasing amounts of overburden. Several of the overlying coal beds in this quadrangle, which are stratigraphically higher than the Broadus coal bed, have been determined to be lignite A in rank. However, early in this mapping project to expedite the calculation of resource tonnage and the evaluation of development potential for surfacing mining of the near-surface coal beds, it was arbitrarily decided by us to assign a rank of subbituminous C to all of the coal beds above the Broadus in this quadrangle. Consequently, we have used the 500-foot (152-m) stripping limit (which the USGS has arbitrarily assigned for multiple beds of subbituminous coal in this area of Montana) in this quadrangle for all of the coal beds above the Broadus even though our subsequent detailed work has indicated that the 200-foot (61-m) stripping limit assigned for lignite beds in this area should have been used for the lignite beds.

It is recommended that the 200-foot (61-m) stripping limit and the lignite weight-conversion factor should be used in any future revisions of the maps and coal tonnage calculations of the lignite beds in this quadrangle. The use of the 200-foot (61-m) stripping limit will produce a more conservative and realistic picture of the surface-mining potential of the various coal beds in this quadrangle.

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).

Number 9b coal bed

The Number 9b coal bed was first mapped by Warren (1959, pl. 24) as a local coal bed and later named the 9b coal bed by Bryson and Bass (1973, p. 91). The Number 9b coal bed occurs about 300 feet (91 m) above the base of the Tongue River Member of the Fort Union Formation. The Number 9b coal bed crops out along the eastern part of the quadrangle. The isopach and structure contour map (pl. 33) shows that the Number 9b coal bed ranges from about 5 to 11 feet (1.5 to 3.3 m) in thickness and has a general southwestward dip of less than a half a degree. Overburden on the Number 9b coal bed (pl. 34) ranges from 0 feet to about 640 feet (0-195 m) in thickness.

There is no known, publicly available chemical analysis of the 9b coal in the Bloom Creek quadrangle. Because other deep coals in this area are subbituminous C in rank, the 9b coal in this quadrangle has also been assigned a rank of subbituminous C by us.

Number 9a coal bed

The Number 9a coal bed was first described by Bryson and Bass (1973, p. 91) from outcrops in the Moorhead coal field which includes the Bloom Creek quadrangle. The Number 9a coal bed occurs about 20 to 80 feet (6 to 24 m) above the 9b coal bed. The Number 9a coal bed crops out locally in the southeastern part of the quadrangle but is less than 5 feet (1.5 m) thick. Economic resources have not been assigned to this coal bed.

Cache coal bed

The Cache coal bed, first named by Warren (1959, p. 572), derives its name from exposures along Cache Creek in the Lonesome Peak and Yarger Butte quadrangles about 10 miles (16 km) north-northeast of the Bloom Creek quadrangle. In the Bloom Creek quadrangle, the Cache coal bed occurs about 20 to 80 feet (6 to 24 m) above the Number 9b coal bed. The isopach and structure contour maps (pls. 29 and 30) show that the Cache coal bed ranges from about 3 to 10 feet (0.9 to 3 m) in thickness and, in general, dips westward at an angle of less than half a degree. In places the general dip is modified by low-relief folding. Overburden on the Cache coal bed (pl. 31) ranges from 0 feet at the outcrops to about 560 feet (0-171 m) in thickness.

A chemical analysis of the Cache (T) coal from a depth of 50 to 60 feet (15 to 18 m) in drill hole SH-716, sec. 36, T. 8 S., R. 50 E., in the Bay Horse quadrangle about 11 miles (18 km) south-southeast of the Bloom Creek quadrangle, shows ash 5.213 percent, sulfur 0.360 percent, and heating value 7,592 Btu per pound (17,659 kJ/kg) on an as-received basis (Matson and Blummer, 1973, p. 93). This heating value converts to about 8,009 Btu per pound (18,630 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Cache coal at that locality is lignite A in rank. However, this heating value is very close to subbituminous C in rank. The Cache coal in the Bloom Creek quadrangle, which is closer to the center of the basin, is likely to have a higher heating value and may be subbituminous C in rank.

Number 8a coal bed

The Number 8a coal bed was first described by Bryson and Bass (1973, p. 82) from exposures along the valley of Pinto Creek in the northwest corner of the Huckins School quadrangle, about 0.2 mile (0.3 km) east of the Bloom Creek quadrangle. The Number 8a coal bed occurs about 45 feet (13.7 m) above the Cache coal bed. The Number 8a coal bed crops out locally in the southeastern part of the quadrangle but is less than 5 feet (1.5 m) in thickness within the quadrangle. Economic resources have not been assigned to this coal bed.

Number 8 coal bed

The Number 8 coal bed was first described by Bryson and Bass (1973, p. 82) from exposures in the northeastern corner of the Bloom Creek quadrangle. In this quadrangle, the Number 8 coal bed occurs about 20 to 100 feet (6.1 to 30 m) above the Cache coal bed. The isopach and structure contour map (pl. 26) shows that the Number 8 coal bed ranges from about 3 to 9 feet (0.9 to 2.7 m) in thickness and has a general westward dip of less than 1 degree. In places the general dip is modified by low-relief folding. Overburden on the Number 8 coal bed (pl. 27) ranges from 0 feet at the outcrops to about 540 feet (0-165 m) in thickness.

There is no known, publicly available chemical analysis of the Number 8 coal in the Bloom Creek quadrangle. Because other near-surface coals in this area are lignite A in rank, the Number 8 coal has also been assigned a rank of lignite A.

Number 7 coal bed

The Number 7 coal bed was first described by Bryson and Bass (1973, p. 82) from exposures on the divide between the Powder River and Bay Horse Creek to the east in the Huckins School quadrangle, about 1 mile (1.6 km) east of the Bloom Creek quadrangle. The Number 7 coal bed occurs about 25 to 60 feet (7.6 to 18 m) above the Number 8 coal bed in the Bloom Creek quadrangle. The isopach and structure contour map (pl. 23) shows that the Number 7 coal bed ranges from about 5 to 6 feet (1.5 to 1.8 m) in thickness and has a general southwestward dip of less than half a degree. Overburden on the Number 7 coal bed (pl. 24) ranges from 0 feet at the outcrops to 170 feet (0-52 m) in thickness.

There is no known, publicly available chemical analysis of the Number 7 coal in the Bloom Creek quadrangle. Because other near-surface coals in this area are lignite A in rank, the Number 7 coal has also been assigned a rank of lignite A.

Pawnee coal bed

The Pawnee coal bed was first named by Warren (1959, p. 572) from exposures in the Birney-Broadus coal field which is about 1 mile (1.6 km) north of the Bloom Creek quadrangle. The Pawnee coal bed occurs about 15 to 40 feet (4.6 to 12.2 m) above the Number 7 coal bed in the Bloom Creek quadrangle. The isopach and structure contour map (pl. 20) shows that the Pawnee coal bed ranges in thickness from about 4 to 23 feet (1.2 to 7 m) and has a general westward dip of less than 1 degree. In the southern part of the quadrangle, the general dip is modified by low-relief folding. Overburden on the Pawnee coal bed (pl. 21) ranges from 0 feet at the outcrops to about 660 feet (0-201 m) in thickness.

There is no known, publicly available chemical analysis of the Pawnee coal in the Bloom Creek quadrangle. However, Matson and Blumer (1973, p. 110) report that a chemical analysis of the Pawnee coal at a depth of 40 to 50 feet (12 to 15 m) in drill hole SH-7115, sec. 34, T. 4 S., R. 48 E., in the Sonnette quadrangle, about 13 miles (21 km) north of the Bloom Creek quadrangle, shows ash 3.877 percent, sulfur 0.191 percent, and heating value 7,228 Btu per pound (16,812 kJ/kg) on an as-received basis. This heating value converts to about 7,519 Btu per pound (17,490 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Pawnee coal at that location is lignite A in rank. Because of the proximity of that location to the Bloom Creek quadrangle, it is assumed that the coals are similar and that the Pawnee coal in this quadrangle is also lignite A in rank.

Number 5 coal bed

The Number 5 coal bed was first described by Bryson and Bass (1973, p. 91) from exposures in the Baldy Peak quadrangle about 9 miles (14.5 km) east of the Bloom Creek quadrangle. The Number 5 coal bed crops out in the eastern part of the quadrangle and occurs about 80 to 150 feet (24 to 46 m) above the Pawnee coal bed. The isopach and structure contour map (pl. 17) shows that the Number 5 coal bed ranges from less than 3 to about 6 feet (0.9 to 1.8 m) in thickness and has a general southwestward dip of less than 1 degree. The general dip is modified by two low-relief synclines. Overburden on the Number 5 coal bed (pl. 18) 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 Number 5 coal in the Bloom Creek quadrangle. Because other near-surface coals in this area are lignite A in rank, the Number 5 coal has also been assigned a rank of lignite A.

Upper and lower splits of the Cook coal bed

The Cook coal bed was named by Bass (1932, p. 59) for exposures on Cook Mountain in the Cook Creek Reservoir quadrangle which is about 31 miles (50 km) north-northwest of the Bloom Creek quadrangle. Warren (1959, p. 573) recognized the upper split of the Cook coal bed in the Birney-Broadus coal field about 1 mile (1.6 km) north of this quadrangle. Bryson and Bass (1973, pl. 1) mapped the Cook (Number 4) coal bed in the Moorhead coal field which includes the Bloom Creek quadrangle. A preliminary regional isopach map of the Cook coal bed shows that the Cook (Number 4) coal bed of Bryson and Bass (1973) is the upper split of the Cook coal bed.

In the Bloom Creek quadrangle, the lower split of the Cook coal bed occurs about 80 to 140 feet (24 to 43 m) above the Number 5 coal bed. The lower split of the Cook coal bed crops out in the western part of the quadrangle. The isopach and structure contour map (pl. 14) shows that the lower split of the Cook coal bed ranges from about 2 to 6.5 feet (0.6 to 2.0 m) in thickness and has a general southward dip of less than 1 degree. In the northwest part of the quadrangle, the general dip is modified by a low-relief north-trending anticline. Overburden on the lower split of the Cook coal bed (pl. 15) ranges from 0 feet at the outcrops to about 340 feet (0-104 m) in thickness.

The noncoal interval between the lower and upper splits of the Cook coal bed ranges from 20 to 150 feet (6 to 46 m) in thickness. The upper split of the Cook coal bed crops out over most of the quadrangle. The isopach and structure contour map (pl. 11) shows that the Cook coal bed ranges from about 7 to 16 feet (2.1 to 4.9 m) in thickness and has a general westward dip of less than 1 degree. In places, the general dip is modified by low-relief folding. Overburden on the upper split of the Cook coal bed (pl. 12) ranges from 0 feet at the outcrops to about 420 feet (0-128 m) in thickness.

There are no known, publicly available chemical analyses of the upper and lower splits of the Cook coal in the Bloom Creek quadrangle. However, the average of three chemical analyses of the Cook coal at depths of 115 to 125 feet (35 to 38.1 m), 125 to 133 feet (38.1 to 40.5 m), and 137 to 142 feet (41.8 to 43.3 m) in drill hole SH-7135 (Matson and Blumer, 1973, p. 99), sec. 29, T. 6 S., R. 48 E., about 2.5 miles (4 km) north of the Bloom Creek quadrangle in the Hodsdon Flats quadrangle, shows ash 3.894 percent, sulfur 0.330 percent, and an average heating value of 7,739 Btu per pound (18,001 kJ/kg) on an as-received basis. This average heating value converts to about 8,053 Btu per pound (18,731 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Cook coal at that location is high lignite A in rank. Because of the proximity of that location to the Bloom Creek quadrangle and the close stratigraphic relationship of the upper and lower splits of the Cook coal bed, it is assumed that they are similar and are also high lignite A in rank in the Bloom Creek quadrangle.

Canyon coal bed

The Canyon coal bed was first described by Baker (1929, p. 36) from exposures in the northward extension of the Sheridan coal field, probably along Canyon Creek in the northern part of the Spring Gulch quadrangle about 40 miles (64 km) west of the Bloom Creek quadrangle. The Canyon coal bed occurs about 80 to 200 feet (24 to 61 m) above the upper split of the Cook coal bed. The Canyon coal bed crops out in the western part of the Bloom Creek quadrangle.

The isopach and structure contour maps (pls. 7 and 8) show that the Canyon coal bed ranges from less than 5 to about 20 feet (1.5 to 6.1 m) in thickness and has a general westward dip of less than half a degree. The general dip is modified by a north-south trending anticline. Overburden on the Canyon coal bed (pl. 9) ranges from 0 feet at the outcrops to about 220 feet (0-67 m) in thickness.

There is no known, publicly available chemical analysis of the Canyon coal in the Bloom Creek quadrangle. However, a chemical analysis of the Canyon coal at a depth of 54 to 64 feet (16.5 to 19.5 m) in drill hole SH-7134 (Matson and Blumer, 1973, p. 96), sec. 29, T. 6 S., R. 48 E., about 2.8 miles (4.5 km) north of the Bloom Creek quadrangle in the Hodsdon Flats quadrangle, showed ash 5.157 percent, sulfur 0.523 percent, and heating value 7,296 Btu per pound (16,970 kJ/kg) on an as-received basis. This converts to 7,693 Btu per pound (17,893 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Canyon coal at that location is lignite A in rank. Because of the proximity of that location to the Bloom Creek quadrangle, it is assumed that the Canyon coal in this quadrangle is similar and is also lignite A in rank.

Upper and lower splits of the Dietz coal bed

The Dietz 1, 2, and 3 coal beds were first described by Taff (1909, p. 139-40) from exposures near the old coal-mining town of Dietz in the Sheridan quadrangle in the Sheridan coal field, Wyoming, about 56 miles (90 km) west-southwest of the Bloom Creek quadrangle. Matson and Blumer (1973, p. 67) recognized the Dietz (No. 2) coal bed and an upper split of the Dietz in the Sayle quadrangle about 2 miles (3.2 km) west of the Bloom Creek quadrangle.

In the Bloom Creek quadrangle, the Dietz coal bed occurs about 60 feet (18 m) above the Canyon coal bed and crops out in the western part of the quadrangle. In places the Dietz coal bed is marked by an extensive clinker bed formed by the burning of the coal. The noncoal interval between the Dietz and the upper split of the Dietz is only about 10 feet (3 m); therefore, the Dietz coal bed and upper split of the Dietz are shown on the same derivative maps. The isopach and structure contour map (pl. 4) shows that in the northwestern part of the quadrangle the Dietz coal bed is 1.1 feet (0.3 m) in thickness and that the upper split of the Dietz is 5.8 feet (1.8 m) in thickness. South of the split line, data projected in from the Sayle quadrangle to the west, show that the combined Dietz coal beds range from about 4 to 8 feet (1.2 to 2.4 m) in thickness and have a general southwestward dip of less than half a degree. Overburden on the combined Dietz coal beds (pl. 5) ranges from 0 feet at the outcrops to about 130 feet (0-40 m).

There is no known, publicly available chemical analysis of the Dietz coal in the Bloom Creek quadrangle. Because other near-surface coals in the area are lignite A in rank, the Dietz coal has also been assigned a rank of lignite A.

Anderson coal bed

The Anderson (Dietz 1) coal bed was first described by Baker (1929, p. 35) from exposures in the northward extension of the Sheridan coal field, probably along Anderson Creek in the southern part of the Spring Gulch quadrangle about 40 miles (64 km) west of the Bloom Creek quadrangle. The Anderson coal bed occurs about 50 feet (15 m) above the Dietz coal bed.

In the Bloom Creek quadrangle, the Anderson coal bed has been burned, forming an extensive clinker bed. Data indicate that virtually all of the Anderson coal has been burned; therefore, economic coal resources have not been assigned to this coal.

Local coal beds

Local coal beds occur at several places in the Bloom Creek quadrangle (pls. 1 and 3). Because the local beds are thin and of limited areal extent, they 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 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 877.66 million short tons (796.21 million t). The total tonnage of federally owned, surface-minable Hypothetical coal is estimated to be 1.23 million short tons (1.12 million t). As shown by table 2, the total federally owned, underground-minable Reserve Base coal is estimated to be 72.67 million short tons (65.93 million t). The total federally owned, underground-minable Hypothetical coal is estimated to be 0.45 million short tons (0.41 million t). The total tonnage of surface- and underground-minable Reserve Base coal is 950.33 million short tons (862.14 million t), and the total of surface- and underground-minable Hypothetical coal is 1.68 million short tons (1.52 million t).

About 6 percent of the surface-minable Reserve Base tonnage is classed as Measured, 32 percent as Indicated, and 62 percent as Inferred. None of the underground-minable Reserve Base tonnage is Measured, 5 percent is Indicated, and 95 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 (the stripping limit), or where lignite beds of the same thickness are overlain by 200 feet (61 m) or less of overburden (the stripping limit). This first 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-ratio values (cubic yards of overburden per short ton of recoverable coal).

The formula used to calculate mining-ratio values for 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 or 0.922 cu. yds./short ton for lignite

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 or 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 high development potential abutting against areas of low development potential.

The coal development potential for surface-mining methods on Federal coal lands is shown on the Coal Development Potential map (pl. 36). Most of the coal lands in the quadrangle have a high development potential for surface mining.

The surface-mining potential of the Number 9b coal bed (pl. 34) is limited to the northeastern part of the quadrangle. A rather large area of high development potential for surface mining extends from the outcrops up the stream valleys to the 10 mining-ratio contour. A relatively narrow band of moderate development potential occurs between the 10 and 15 mining-ratio contours. A wide area of low development potential extends from the 15 mining-ratio contour to the 500-foot (152-m) stripping limit. Very small areas of no development potential for surface mining occur under the crests of the highest hills.

The Number 9a coal bed has no development potential for surface mining because all of the Number 9a coal in the quadrangle is less than the minimum required thickness of 5 feet (1.5 m).

The Cache coal bed (pl. 31) has development potential for surface mining in the eastern part of the quadrangle. The Cache coal bed has small areas of high development potential extending from the outcrops up the valleys to the 10 mining-ratio contours. Small areas of moderate development potential occur as very narrow bands between the 10 and 15 mining-ratio contours. The remainder of the area has low development potential.

The Number 8 coal bed (pl. 27) has development potential for surface mining in the eastern part of the quadrangle. The Number 8 coal bed has small areas of high development potential extending from the outcrops up the valleys to the 10 mining-ratio contour. Small areas of moderate development potential occur as narrow bands between the 10 and 15 mining-ratio contours. Larger areas of low development potential extend from the 15 mining-ratio contour under the crests of the hills.

The development potential for surface mining of the Number 7 coal bed (pl. 24) is limited to several small, isolated areas in the southeastern part of the quadrangle. These isolated tracts contain insignificant areas of high, moderate, and low development potential for surface mining.

The Pawnee coal bed (pl. 21) has development potential for surface mining over most of the quadrangle. Very large areas of high development potential extend from the outcrops up the major stream valleys to the 10 mining-ratio contour. Large areas of moderate development potential occur as bands between the 10 and 15 mining-ratio contours. Extremely large areas of low development potential extend from the 15 mining-ratio contour to the 500-foot (152-m) overburden contour designated as the stripping limit. Relatively large areas of no development potential for surface mining underlie areas where the overburden is greater than 500 feet (152 m).

The Number 5 coal bed (pl. 18) has development potential for surface mining on several small tracts scattered along the eastern part of the quadrangle. These tracts contain insignificant areas of high, moderate, and low development potential.

Development potential for surface mining of the lower split of the Cook coal bed (pl. 15) is limited to two isolated tracts in the northwestern part of the quadrangle. Small areas of the high development potential extend from the outcrops up the stream valleys to the 10 mining-ratio contour. Small areas of moderate development potential occur as very narrow bands between the 10 and 15 mining-ratio contours. Larger areas of low development potential extend up the slopes from the 15 mining-ratio contour and the coal boundary.

The upper split of the Cook coal bed (pl. 12) has development potential for surface mining over much of the quadrangle. Very large areas of high development potential extend up the hill slopes from the outcrops to the 10 mining-ratio contour. Large areas of moderate development potential occur as narrow bands between the 10 and 15 mining-ratio contours. Very large areas of low development potential extend from the 15 mining-ratio contour under the crests of the highest hills.

The Dietz coal bed and the upper split of the Dietz coal bed (pl. 5) have development potential for surface mining on several isolated tracts along the western border of the quadrangle. Small areas of high development potential extend up the hill slopes from the outcrops to the 10 mining-ratio contour. Small areas of moderate development potential occur as narrow bands between the 10 and 15 mining-ratio contours and also extend up the hill slopes from the coal boundary to the 15 mining-ratio contour. Small areas of low development potential extend from the 15 mining-ratio contour under the highest hills.

About 86 percent of the Federal coal lands in the quadrangle has a high development potential for surface mining, 1 percent has a moderate development potential, and almost none has a low 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 Bloom 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				
Dietz	2,690,000	1,790,000	3,760,000	8,240,000
Canyon	112,860,000	12,960,000	1,670,000	127,490,000
Upper Cook	62,560,000	34,240,000	87,220,000	184,020,000
Lower Cook	1,180,000	1,230,000	6,290,000	8,700,000
Number 5	620,000	190,000	640,000	1,450,000
Pawnee	102,050,000	49,220,000	253,890,000	405,160,000
Number 7	1,370,000	350,000	430,000	2,150,000
Number 8	10,610,000	4,550,000	35,710,000	50,870,000
Cache	11,430,000	3,600,000	21,260,000	36,290,000
Number 9b	19,410,000	5,260,000	28,620,000	53,290,000
Total	324,780,000	113,390,000	439,490,000	877,660,000
Hypothetical Resource tonnage				
Canyon	250,000	0	0	250,000
Pawnee	0	0	980,000	980,000
Total	250,000	0	980,000	1,230,000
Grand Total	325,030,000	113,390,000	440,470,000	878,890,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Bloom 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				
Pawnee	0	0	65,840,000	65,840,000
Number 8	0	0	940,000	940,000
Cache	0	0	950,000	950,000
Number 9b	0	0	4,940,000	4,940,000
Total	0	0	72,670,000	72,670,000
Hypothetical Resource tonnage				
Pawnee	0	0	450,000	450,000
Total	0	0	450,000	450,000
Grand Total	0	0	73,120,000	73,120,000

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