UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-788

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE REANUS CONE QUADRANGLE, POWDER RIVER COUNTY, MONTANA

[Report includes 38 plates]

By

Colorado School of Mines Research Institute

CONTENTS

ILLUSTRATIONS

[Plates are in pocket]

TABLES

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 Reanus Cone quadrangle, Powder River County, Montana, (38 plates; U.S. Geological Survey Open-File Report 79-788). 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 Reanus Cone 7 1/2-minute quadrangle is in southwestern Powder River County, Montana, about 32 miles (51 km) southwest of Broadus, Montana, a small town in the Powder River valley, about 25 miles (40 km) south-southeast of Ashland, Montana, and about 46 miles (74 km) northeast of Sheridan, Wyoming. Broadus is on U.S. Highway 212 near its interchanges with U.S. Highway 312 and State Highway 59. Ashland is 44 miles (71 km) west of Broadus on U.S. Highway 212. Sheridan is on U.S. Interstate Route 90, U.S. Highways 87 and 14, and a main east-west line of the Burlington Northern Railroad (formerly the Chicago, Burlington and Quincy Railroad).

Accessibility

The Reanus Cone quadrangle is accessible from Ashland, Montana, by traveling eastward from Ashland about 4 miles (6.4 km) on U.S. Highway 212 to the improved Otter Creek Road, then traveling southward on this road about 20 miles (32 km) to the intersection with the Taylor Creek Road. Turn southeastward on the Taylor Creek Road about 5 miles (8 km) to the northern border of the quadrangle. The quadrangle can also be reached from Sheridan by traveling northward to Decker, Montana, and then northeastward on an improved road to the intersection with the Taylor Creek Road, then southeastward to the northern border of the quadrangle for a total distance of about 62 miles (100 km). Access to most areas within the quadrangle is provided by an extensive network of improved and unimproved roads and trails.

Physiography

The Reanus Cone quadrangle lies within the Missouri Plateau division of the Great Plains physiographic province. Virtually all of the quadrangle lies on the northeast side of the drainage basin of Otter Creek, a major tributary of the Tongue River. Otter Creek flows northwestward across a very small part of the southwest corner of the quadrangle. The quadrangle is drained by several northwestward-flowing tributaries of Otter Creek, including Pasture Creek, Bradshaw Creek, Indian Creek, and South Fork Taylor Creek. Pasture Creek and Bradshaw Creek are perennial streams in this quadrangle.

The landscape in the Reanus Cone quadrangle mostly comprises a series of narrow, fairly linear, flat-bottomed valleys divided by broad upland areas. The upland areas are only partly dissected, and include relatively broad, level areas. Locally the flatter upland areas are surmounted by smaller, short, steep, and narrow ridges. Slopes in the quadrangle vary widely in steepness. Steep slopes occur beside some of the major streams and where dissection of the uplands has been most intense. Gradual slopes occur along some of the valley bottoms, around the flatter upland areas, and in the nondissected headwater basins of the major streams.

The highest point in the quadrangle, with an elevation of about 4,220 feet (1,286 m), is a ridge top near the southeast corner of the quadrangle. The lowest point, with an elevation of about 3,400 feet (1,036 m), is along Indian Creek near the northwest corner of the quadrangle. Relief in the quadrangle is about 820 feet (250 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 Boundary and Coal Data Map (pl. 2) shows the land ownership status within the Reanus Cone quadrangle. All of the quadrangle is within the Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA). The north half of the quadrangle is within the Custer National Forest. The Federal government owns most of the coal rights. As of 1977 there were no coal leases or prospecting permits on the Federal coal lands.

GENERAL GEOLOGY

Previous work

Bryson and Bass (1973, pl. 1) mapped the Reanus Cone quadrangle as part of the Moorhead coal field. Matson (1971, pls. 1, 3, and 3) mapped the Canyon, Dietz, and Anderson coal beds in this quadrangle as part of the Moorhead coal field, and Matson and Blumer (1973, pls. 10A, 10B, and 10C) mapped the same three beds in this quadrangle as part of the West Moorhead coal deposit.

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

Stratigraphy

A generalized columnar section of the coal-bearing rocks of the Reanus Cone quadrangle is shown on the Coal Data Sheet (pl. 3) of the CRO maps. The exposed bedrock units belong to the Tongue River Member, the uppermost member, of the Fort Union Formation.

The Tongue River Member consists of interbedded, lenticular beds of gray, fine- to very fine-grained sandstone, light- to dark-gray silstsone, gray shale, and claystone, brown carbonaceous shale, and coal beds. The thicker coal beds have burned along the outcrops, baking the overlying sandstone and shale and forming thick, reddish-colored clinker beds. The upper part of the Tongue River Member has been removed from the quadrangle by erosion, but about 2,200 feet (671 m) of the member 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 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 Reanus Cone quadrangle is in the north-central part of the Powder River structural basin. Regionally the strata dip southwestward at an angle of 1 degree or less, but in the Reanus Cone quadrangle this dip has been modified by low-relief folding (pls. 4, 7, 10, 13, 16, 19, 22, 25, 28, 31, and 34). Some of the nonuniformity in structure may be caused by differential compaction and by irregularities in deposition of the coals and other beds as a result of their continental origin.

COAL GEOLOGY

The coal beds in the Reanus Cone 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 coals are known to exist below the Tongue River Member.

The lowermost recognized coal bed is the Broadus coal bed which occurs about 300 to 350 feet (91 to 107 m) above the base of the Tongue River Member. The Broadus coal bed is overlain successively by a mostly noncoal interval of about 50 to 240 feet (15 to 73 m) including a local coal bed 100 feet (30 m) above the Broadus coal bed, the lower split of the Flowers-Goodale coal bed, a mostly noncoal interval of about 40 to 200 feet (12 to 61 m) including a local coal bed 97 feet (30 m) below the upper split of the Flowers-Goodale coal bed, the upper split of the Flowers-Goodale coal bed, a mostly noncoal interval of about 140 to 300 feet (43 to 91 m) including the Nance coal bed 100 feet (30 m) above the upper split of the Flowers-Goodale coal bed, the upper split of the Knobloch coal bed, a mostly noncoal interval of about 180 to 360 feet (55 to 110 m) including the King coal bed 119 feet (36 m) above the upper split of the Knobloch coal bed, the Odell coal bed, a noncoal interval of about 100 to 240 feet (30 to 73 m), the Dunning (Pawnee) coal bed, a mostly noncoal interval of about 160 to 280 feet (49 to 85 m) including the Elk coal bed about 100 feet (30 m) above the Dunning (Pawnee) coal bed, the lower split of the Cook coal bed, a noncoal interval of about 20 to 120 feet (6 to 37 m), the upper split of the Cook coal bed, a mostly noncoal interval of about 60 to 200 feet (18 to 61 m) including three local coal beds, the Canyon coal bed, a mostly noncoal interval of about 40 to 160 feet (12 to 49 m) including several local coal beds, the Dietz coal bed, a mostly noncoal interval of about 40 to 100 feet (12 to 30 m) including a local coal bed 38 feet (12 m) below the Anderson coal bed, the Anderson coal bed, a noncoal interval of about 160 feet (49 m), a local coal bed, and a noncoal interval of about 100 feet (30 m).

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.

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).

Broadus coal bed

The Broadus coal bed is the lowest coal bed recognized in the Reanus Cone quadrangle. The Broadus coal bed was first described and named by Warren (1959, p. 570) from exposures near the town of Broadus in the Broadus quadrangle, which is about 29 miles (47 km) northeast of the Reanus Cone quadrangle. The Broadus coal bed does not crop out in the Reanus Cone quadrangle but has been recognized in five oil-and-gas test holes. The isopach and structure contour map of the Broadus coal bed (pl. 34) shows that the Broadus coal bed ranges from about 5 to 15 feet (1.5 to 4.6 m) in thickness and dips generally southwestward at an angle of about half a degree. This dip is modified by local folding, and the bed is fractured by one fault. Overburden on the Broadus coal bed (pl. 35) ranges in thickness from about 900 to 1,700 feet (274 to 518 m).

There is no known, publicly available chemical analysis of the Broadus coal from the Reanus Cone quadrangle. A chemical analysis of the Broadus coal from a core in sec. 18, T. 9 S., R. 48 E., about 7 miles (11.3 km) southeast of the Reanus Cone quadrangle in the Bradshaw Creek quadrangle, shows a content of 4.5 percent ash, 0.8 percent sulfur, and a heating value of 8,590 Btu per pound (19,980 kJ/kg) on an as-received basis (Gilmour and Dahl, 1967, p. 16). This heating value converts to about 8,995 Btu per pound (20,922 kJ/kg) on a moist, mineral-matter-free basis. These heating values indicate that the Broadus coal in the Bradshaw Creek quadrangle is subbituminous C in rank. Because of the proximity of that location to the Reanus Cone quadrangle, the rank of the Broadus coal in the Reanus Cone quadrangle is probably also subbituminous C.

Upper and lower splits of the Flowers-Goodale coal bed

The Flowers-Goodale coal bed was first described by Bass (1932, p. 53) from two small mines in the Brandenberg quadrangle, about 40 miles (64.4 km) north of the Reanus Cone quadrangle. In the Reanus Cone quadrangle, two closely associated coal beds are mapped as the upper and lower splits of the Flowers-Goodale coal bed. The upper split of the Flowers-Goodale coal bed does not crop out in the Reanus Cone quadrangle but was penetrated by five oil-and-gas test holes. It is this split which corresponds to the Flowers-Goodale coal bed of Bass (1932). The lower split of the Flowers-Goodale coal bed does not crop out in the quadrangle either, but was penetrated by three of the five oil-and-gas test holes at depths of 44, 64, and 83 feet (13.4, 19.5, and 25.3 m) below the upper split. The upper split occurs throughout the quadrangle but the lower split is present only in the western and south-central parts of the quadrangle. The available data does not indicate that these so-called splits combine into a single coal bed, and they are mapped as separate beds.

The lower split of the Flowers-Goodale coal bed occurs about 60 to 240 feet (18 to 73 m) above the Broadus coal bed. The isopach and structure contour map of the lower split of the Flowers-Goodale coal bed (pl. 31) shows that the bed ranges from about 5 to 10 feet (1.5 to 3.0 m) in thickness and dips southward and southwestward at an angle of about half a degree. The bed is fractured by a single fault. Overburden on the lower split of the Flowers-Goodale coal bed (pl. 32) ranges from about 750 to 1,500 feet (229 to 457 m) in thickness.

The upper split of the Flowers-Goodale coal bed occurs about 40 to 200 feet (12 to 61 m) above the lower split of the Flowers-Goodale coal bed. The isopach and structure contour map of the upper split of the Flowers-Goodale coal bed (pl.

28) shows that this bed ranges in thickness from about 7 to 13 feet (2.1 to 4 m) and dips generally southwestward at an angle of about half a degree. Locally this dip is modified by folding and a fault. Overburden on the upper split of the Flowers-Goodale coal bed (pl. 29) ranges from about 700 to 1,450 feet (213 to 442 m) in thickness.

There is no known, publicly available chemical analysis of coal of either the upper or lower splits of the Flowers-Goodale coal bed in or near the Reanus Cone quadrangle. However, because other closely associated coals in this quadrangle are subbituminous C in rank, we have assigned the rank of subbituminous C to the coals of both splits of the Flowers-Goodale coal bed.

Nance coal bed

The Nance coal bed was named by Mapel and Martin (1978, p. 21) for its ocurrence, at a depth of 242 feet (74 m) in the Nance and Hayes M11-2 drill hole, sec. 25, T. 5 S., R. 42 E., in the Browns Mountain quadrangle, about 20 miles (32.2 km) west-northwest of the Reanus Cone quadrangle. The Nance coal bed does not crop out in the Reanus Cone quadrangle but was penetrated by one oil-and-gas test hole, sec. 30, T. 7 S., R. 47 E., at a depth of 871 feet (265 m). In this hole the Nance coal bed is 100 feet (30.5 m) above the upper split of the Flowers-Goodale coal bed. Because the Nance coal bed has been recognized in only one drill hole, where the bed is only 2 feet (0.6 m) thick, the Nance coal bed has not been assigned economic resources in this quadrangle.

Knobloch coal bed

The Knobloch coal bed was named by Bass (1924) from exposures at the small mine on the Knobloch Ranch in the Tongue River valley in the Birney Day School quadrangle, about 19 miles (30.5 km) northwest of the Reanus Cone quadrangle. The coal bed identified as the Knobloch in this report was called the middle bench of the Knobloch by Matson and Blumer (1973, pls. 11A and 33) and the

Middle Knobloch by Culbertson and Klett (1976) in the Browns Mountain quadrangle, which is about 12 miles (19.3 km) west-northwest of the Reanus Cone quadrangle.

The Knobloch coal bed does not crop out in this quadrangle but was penetrated by five oil-and-gas test holes. The Knobloch coal bed occurs from 140 to 300 feet (43 to 91 m) above the upper split of the Flowers-Goodale coal bed and 110 feet (33.5 m) above the Nance coal bed in the one drill hole in which the Nance coal bed has been identified. The isopach and structure contour map of the Knobloch coal bed (pl. 25) shows that this bed ranges in thickness from about 4 to 26 feet (1.2 to 7.9 m) and dips south to southwest at an angle of less than 1 degree. The dip is modified by very broad, low-relief folds, and the bed is fractured by one fault. Overburden on the Knobloch coal bed (pl. 26) ranges from about 400 to 1,050 feet (122 to 320 m) in thickness.

A chemical analysis of the Knobloch coal from a depth of 178 to 187 feet (54.3 to 57.0 m) in coal test hole SH-7044, sec. 30, T. 5 S., R. 46 E., about 8 miles (12.9 km) north of the Reanus Cone quadrangle in the Goodspeed Butte quadrangle, shows 5.423 percent ash, 0.157 percent sulfur, and a heating value of 8,515 Btu per pound (19,806 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 68). This heating value converts to about 9,003 Btu per pound (20,942 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Knobloch coal at that location is subbituminous C in rank. Because of the proximity of that location to the Reanus Cone quadrangle, it is assumed that the Knobloch coal in this quadrangle is similar and is also subbituminous C in rank.

King coal bed

The King coal bed was first described by Warren (1959, p. 571), probably from exposures along King Creek about 21 miles (33.8 km) northwest of the Reanus Cone quadrangle in the Ashland and Green Creek quadrangles. In the Reanus Cone quadrangle, the King coal bed has been recognized in one oil-and-gas test hole, sec. 11, T. 8 S., R. 46 E., at a depth of 817 feet (249 m). In this hole the King coal bed is 119 feet (36.3 m) above the Knobloch coal bed. Because the King coal bed has been recognized in only one drill hole, where it is only 5 feet (1.5 m) thick, it has not been assigned economic resources in this quadrangle.

Odell (Cache) coal bed

The Odell coal bed was first described by Warren (1959, p. 572) presumably from exposures of coal along O'Dell Creek about 18 miles (29 km) northwest of the Reanus Cone quadrangle in the Green Creek quadrangle. McKay (1976) mapped the Cache coal bed in the same stratigraphic position in the King Mountain quadrangle, immediately east of the Green Creek quadrangle, about 10 miles (16.1 km) north-northwest of the Reanus Cone quadrangle. The Cache coal bed was also named by Warren (1959, p. 572) from exposures along Cache Creek, which is centered about 20 miles (32.2 km) northeast of the Reanus Cone quadrangle in the Yarger Butte and Lonesome Peak quadrangles. Preliminary regional mapping indicates that the Cache and Odell coal beds are equivalent. McKay and Robinson (1979) mapped the Brewster-Arnold coal bed at this stratigraphic level in the Otter quadrangle immediately to the west of the Reanus Cone quadrangle.

The Odell (Cache) coal bed does not crop out in the Reanus Cone quadrangle but was penetrated by three oil-and-gas test holes in the eastern and southern parts of the quadrangle. The Odell coal bed occurs 180 to 360 feet (55 to 110 m) above the Knobloch coal bed, and 122 feet (37.2 m) above the King coal bed in the oil-and-gas test hole where the King coal bed was recognized. The isopach and structure contour map of the Odell coal bed (pl. 22) shows that the bed ranges from about 4 to 8 feet (1.2 to 2.4 m) in thickness and dips generally southwestward at an overall angle of less than half a degree. The regional dip has been modified, however, by folding along a northwest-southeast axis that has produced about 100 feet (30 m) of relief on the top of the coal bed and locally more than doubled its dip. The coal bed has also been slightly affected by a fault. Overburden on the Odell coal bed (pl. 23) ranges from about 350 to 1,000 feet (107 to 305 m) in thickness.

There is no known, publicly available chemical analysis of the Odell (Cache) coal in or near the Reanus Cone quadrangle. However, because other closely associated coals in this quadrangle are subbituminous C in rank, the Odell coal has been assigned a rank of subbituminous C.

Dunning (Pawnee) coal bed

The Dunning coal bed was first described by Warren (1959, p. 572) from exposures of coal in the western part of the Birney-Broadus coal field, which includes the Goodspeed Butte quadrangle, which is just north of the Reanus Cone quadrangle. Bryson and Bass (1973, pl. 1) mapped the Dunning (Pawnee) coal bed in the extreme northern part of this quadrangle, where the bed crops out along the floor of the valley of South Fork Taylor Creek. The Dunning (Pawnee) coal bed was also recognized in two oil-and-gas test holes in the eastern part of the quadrangle. The Dunning (Pawnee) coal bed occurs about 100 to 240 feet (30 to 73 m) above the Odell (Cache) coal bed. The isopach and structure contour map of the Dunning (Pawnee) coal bed (pl. 19) shows that the bed ranges in thickness from about 4 to 16 feet (1.2 to 4.9 m) and dips generally southwestward at an angle of less than half a degree. The coal bed has also been fractured by a fault. Overburden on the Dunning (Pawnee) coal bed (pl. 20) ranges in thickness from 0 to about 800 feet (0-244 m).

We have used the name Dunning for this coal bed in the Reanus Cone, Threemile Buttes, Yager Butte, and Goodspeed Butte quadrangles based upon usage in early day geological reports on those areas by previous authors (Warren, 1959; and others). However, in twenty-one adjacent quadrangles surrounding these four quadrangles we have mapped a coal bed at this same stratigraphic horizon which we, and others, have called the Pawnee coal bed. The Pawnee coal bed was first described by Warren (1959, p. 572) from exposures in the Birney-Broadus coal field, Montana, which includes the Goodspeed Butte quadrangle just north of the Reanus Cone quadrangle. Based upon our present-day coal isopachs and structure contours, the Dunning and Pawnee appear to be the same coal bed.

A chemical analysis of the Dunning (Pawnee) coal from a depth of 106 to 110 feet (32.3 to 33.5 m) in drill hole SH-7146, sec. 20, T. 4 S., R. 46 E., about 15 miles (24.1 km) north of the Reanus Cone quadrangle in the Yager Butte quadrangle, shows 4.356 percent ash, 0.210 percent sulfur, and a heating value of 7,991 Btu per pound (18,587 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 105). This heating value converts to about 8,355 Btu per pound (19,434 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Dunning (Pawnee) coal at that location is subbituminous C in rank. Because of the proximity of that location to the Reanus Cone quadrangle, it is assumed that the Dunning (Pawnee) coal in the Reanus Cone quadrangle is similar and is also subbituminous C in rank.

Elk coal bed

The Elk coal bed was first described by Warren (1959, p. 573) from exposures along Elk Creek in the northern part of the Goodspeed Butte quadrangle about 7.5 miles (12.1 km) north of the Reanus Cone quadrangle. Bryson and Bass (1973, p. 1) mapped the Elk coal bed in the Reanus Cone quadrangle where it crops out along the lower slopes of the valleys in the northwestern part of the quadrangle. The Elk coal bed occurs about 100 feet (30 m) above the Dunning (Pawnee) coal bed where both beds are exposed in a single section. Because the Elk coal bed is less than 5 feet (1.5 m) thick in the Reanus Cone quadrangle, it has not been assigned economic resources in this quadrangle.

Upper and lower splits of the Cook coal bed

The Cook coal bed was first described by Bass (1932, p. 59-60) from exposures of coal on Cook Mountain in the Cook Creek Reservoir quadrangle, about 29 miles (46.7 km) north of the Reanus Cone quadrangle. Matson and Blumer (1973, pls. 23B and 21) mapped both an upper and lower bench of the Cook coal bed in the Goodspeed Butte coal deposit immediately north of the Reanus Cone quadrangle and in the Phillips Butte quadrangle, which is immediately northeast of the Reanus Cone quadrangle. Bryson and Bass (1973, pl. 1) mapped a Cook coal bed, equivalent to the upper bench of the Cook coal bed of Matson and Blumer (1973), and an Otter coal bed, equivalent to the lower bench of the Cook coal bed of Matson and Blumer (1973), in the Birney-Broadus coal field, which includes the Reanus Cone quadrangle.

The lower split of the Cook coal bed crops out on the sides of valleys over all but the southeastern part of the Reanus Cone quadrangle, and it was penetrated by three oil-and-gas test holes and one coal test hole. The lower split of the Cook coal bed occurs about 50 to 100 feet (15 to 30 m) above the Elk coal bed, and 160 to 280 feet (49 to 85 m) above the Dunning (Pawnee) coal bed. The isopach and structure contour map of the lower split of the Cook coal bed (pl. 16) indicates that the bed is about 4 to 11 feet (1.2 to 3.4 m) thick and dips generally westward and southward at an angle of less than half a degree. This dip is widely modified, however, by irregular folding and a fault. Overburden on the lower split of the Cook coal bed (pl. 17) ranges from 0 to 600 feet (0-183 m) in thickness.

A chemical analysis of the coal of the lower split of the Cook coal bed from a depth of 137 to 142 feet (41.8 to 43.3 m) in coal test hole SH-7135, sec. 29, T. 6 S., R. 48 E., about 7 miles (11.3 km) northeast of the Reanus Cone quadrangle in the Hodsdon Flats quadrangle, shows 3.485 percent ash, 0.349 percent sulfur, and a heating value of 7,491 Btu per pound (17,424 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 99). This heating value converts to about 7,761 Btu per pound (18,053 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal of the lower split of the Cook coal bed at that location is lignite A in rank. Because of the proximity of that location to the Reanus Cone quadrangle, the rank of the coal of the lower split of the Cook coal bed may also be lignite A. However, because the Reanus Cone quadrangle is located in a deeper part of the basin than the Hodsdon Flats quadrangle, the Cook coal in the Reanus Cone quadrangle should have a slightly higher rank than in the Hodsdon Flats quadrangle.

The upper split of the Cook coal bed crops out on the sides of valleys in the same areas as the lower split of the Cook coal bed and was recognized in two oil-and-gas test holes and one coal test hole. The upper split of the Cook coal bed occurs about 20 to 120 feet (6 to 37 m) above the lower split of the Cook coal bed. The isopach and structure contour map of the upper split of the Cook coal bed (pl. 13) shows that this bed ranges from 3 to 14 feet (0.9 to 4.3 m) in thickness and dips westward and southwestward at an angle of less than half a degree. This dip is modified, however, by irregular folding and a fault. Overburden on the upper split of the Cook coal bed (pl. 14) ranges from 0 to 450 feet (0-137 m) in thickness.

A chemical analysis of coal of the upper split of the Cook coal bed from a depth of 48 to 50 feet (14.6 to 15.2 m) in coal test hole SH-64, sec. 10, T. 7 S., R. 46 E., in the Reanus Cone quadrangle, shows of 3.130 percent ash, 0.151 percent sulfur, and a heating value of 7,948 Btu per pound (18,487 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 59). This converts to a heating value of about 8,204 Btu per pound (19,083 kJ/kg) on a moist, mineral-matter-free basis, indicating that the coal of the upper split of the Cook coal bed in high lignite A in rank.

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, Montana, probably along Canyon Creek in the northern part of the Spring Gulch quadrangle about 28 miles (45 km) west of the Reanus Cone quadrangle. Bryson and Bass (1973, p. 1), Matson (1971, pl. 1), and Matson and Blumer (1973, pl. 10C) mapped the Canyon coal bed in the Reanus Cone quadrangle. The Canyon coal bed crops out on ridge tops throughout the quadrangle and was penetrated by two oil-and-gas test holes and several coal test holes. It is partly burned. It occurs about 60 to 200 feet (18 to 61 m) above the upper split of the Cook coal bed. The isopach and structure contour map of the Canyon coal bed (pl. 10) shows that this bed ranges in thickness from about 5 to 24 feet (1.5 to 7.3 m) and dips westward and southwestward at an angle of less than half a degree. This dip is modified by irregular folding, and the bed is fractured by a fault. Overburden on the Canyon coal bed (pl. 11) ranges from 0 to about 350 feet (0-107 m) in thickness.

Five chemical analyses were performed on the Canyon coal in the Reanus Cone quadrangle, and the results for all tests were generally comparable. A typical analysis, from a depth of 134 to 143 feet (40.8 to 43.6 m) in drill hole SH-61, sec. 33, T. 7 S., R. 46 E., showed 4.784 percent ash, 0.323 percent sulfur, and a heating value of 8,281 Btu per pound (19,262 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 59). This heating value converts to about 8,697 Btu per pound (20,229 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Canyon coal in this quadrangle is subbituminous C in rank.

Dietz coal bed

The Dietz coal bed was named by Taff (1909, p. 139-140) from exposures of coal about 44 miles (70.8 km) southwest of the Reanus Cone quadrangle near the old coal-mining town of Dietz in the Sheridan coal field, Wyoming. In the Reanus Cone quadrangle, the Dietz coal bed was mapped by Bryson and Bass (1973, pl. 1), Matson (1971, pl. 2), and Matson and Blumer (1973, pl. 10B). The Dietz coal bed and its clinker crop out on ridge tops in the eastern part of the Reanus Cone quadrangle, and the bed was penetrated by one coal test hole in sec. 14, T. 7 S., R. 46 E.

The Dietz coal bed occurs about 40 to 160 feet (12 to 49 m) above the Canyon coal bed. The isopach and structure contour map of the Dietz coal bed (pl. 7) shows that the bed ranges in thickness from about 8 to 14 feet (2.4 to 4.3 m) and dips irregularly southward at an angle of less than half a degree. This dip is modified, however, by faulting and folding that locally increases the dip of the bed to as much as 2 degrees. Overburden on the Dietz coal bed (pl. 8) ranges from 0 to about 300 feet (0-91 m) in thickness.

A chemical analysis of the Dietz coal from a depth of 43 to 52 feet (13.1 to 15.8 m) from drill hole SH-7043, sec. 24, T. 8 S., R. 45 E., about 1.3 miles (2.1 km) west of the Reanus Cone quadrangle in the Otter quadrangle, shows 3.800 percent ash, 0.660 percent sulfur, and a heating value of 8,080 Btu per pound (18,794 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 59). This heating value converts to about 8,399 Btu per pound (19,536 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Dietz coal at that locality is subbituminous C in rank. Because of the proximity of that locality to the Reanus Cone quadrangle, it is assumed that the Dietz coal in the Reanus Cone quadrangle is similar and is also subbituminous C in rank.

Anderson coal bed

The Anderson coal bed was first described by Baker (1929, p. 35) from exposures of coal in the northward extension of the Sheridan coal field, Montana, probably along Anderson Creek in the southern part of the Spring Gulch quadrangle, about 29 miles (46.7 km) west of the Reanus Cone quadrangle. In the Reanus Cone quadrangle, the Anderson coal bed was mapped by Bryson and Bass (1973, pl. 1), Matson (1971, pl. 3), and Matson and Blumer (1973, pl. 10A). In the Reanus Cone quadrangle, the Anderson coal bed and its clinker bed crop out only near the tops of the highest ridges, mostly in the southeastern corner of the quadrangle. The Anderson coal bed occurs about 40 to 100 feet (12 to 30 m) above the Dietz coal bed. The isopach and structure contour map of the Anderson coal bed (pl. 4) shows that the bed ranges in thickness from about 20 to 25 feet (6.1 to 7.6 m) and dips southward at an angle of about 1 degree, although this dip is modified by folding. Overburden on the Anderson coal bed (pl. 5) ranges in thickness from 0 feet to about 200 feet (0-61 m).

An analysis of the Anderson coal from a depth of 86 to 115 feet from drill hole SM-4, sec. 27, T. 8 S., R. 47 E., about 2.5 miles (4 km) southeast of the Reanus Cone quadrangle in the Bradshaw Creek quadrangle shows a content of 5.1 percent ash, 0.4 percent sulfur, and a heating value of 8,150 Btu per pound (18,957 kJ/kg) on an as-received basis (Matson and Blumer, 1073, p. 60). This converts to about 8,588 Btu per pound (19,976 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Anderson coal at that location is subbituminous C in rank. Because of the proximity of that location to the Reanus Cone quadrangle, it is assumed that the Anderson coal in the Reanus Cone quadrangle is similar and is also subbituminous C in rank.

Local coal beds

Local coal beds in the Reanus Cone quadrangle (pl. 3, composite columnar section) occur between the Broadus coal bed and the lower split of the Flowers-Goodale coal bed, the lower and upper splits of the Flowers-Goodale coal bed, the upper split of the Cook coal bed and the Canyon coal bed, the Canyon coal bed and the Dietz coal bed, and the Dietz coal bed and the Anderson coal bed. Because these beds are thin and of limited areal extent, economic resources have not been assigned to them.

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 1,502.16 million short tons (1,362.7 million t). The total tonnage of federally owned, surface-minable Hypothetical coal is estimated to be 68.03 million short tons (61.72 million t). As shown by table 2, the total federally owned, underground-minable Reserve Base coal is estimated to be 2,354.18 million short tons (2,135.7 million t). The total federally owned, underground-minable Hypothetical coal is estimated to be 8.38 million short tons (7.60 million t). The total tonnage of surface- and underground-minable Reserve Base coal is 3,856.34 million short tons (3,498.47 million t), and the total of surface- and underground-minable Hypothetical coal is 76.41 million short tons (69.32 million t).

About 5 percent of the surface-minable Reserve Base tonnage is classed as Measured, 29 percent as Indicated, and 66 percent as Inferred. About 3 percent of the underground-minable Reserve Base tonnage is Measured, 29 percent is Indicated, and 83 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 ratios (cubic yards of overburden per short ton of recoverable coal).

Although the coals of the upper and lower splits of the Cook coal bed appear to be lignite A in rank in the Reanus Cone quadrangle, these beds were assigned a stripping limit of 500 feet (152 m) of overburden rather than the stripping limit of 200 feet (61 m) of overburden which would ordinarily be used when evaluating resources of lignite. In this quadrangle, the 500-foot (152-m) stripping limit is appropriate for use with the splits of the Cook coal bed for several reasons. The coals of both splits of the Cook coal bed are nearly subbituminous C in rank, and coals from both overlying and underlying beds are subbituminous C in rank. The slight difference in heating values between the coals of the splits of the Cook coal bed and the other coals in the Reanus Cone quadrangle is probably not enough to justify the large difference in stripping limits that would result if the normal criteria were followed. Also, it is reasonable to assume that where splits of the Cook coal bed have from 200 to 500 feet (61 to 152 m) of overburden they are surface minable, at least where lower beds of subbituminous coal are surface minable or where surface mining of higher beds reduces the overburden on the splits of the Cook coal bed to less than 200 feet (61 m).

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 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 <u>high</u>, <u>moderate</u>, and <u>low development potential</u>, 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. 37). All of the Federal coal lands in the Reanus Cone quadrangle have development potential for surface mining.

The Broadus coal bed and upper and lower splits of the Flowers-Goodale coal bed (pls. 36, 33, and 30) have no development potential for surface mining because the overburden on these beds is greater than 500 feet (152 m) thick and, consequently, these coal beds lie beyond the stripping limit assigned in this region to quadrangles with thin, multiple beds of subbituminous coal.

The Knobloch coal bed (pl. 27) has two narrow areas of low development potential for surface mining (mining-ratio values greater than 15) in the northwestern part of the quadrangle in the bottoms of the valleys of Indian Creek and South Fork Taylor Creek where the overburden is less than 500 feet (152 m) thick.

The Odell coal bed (pl. 24) has several areas of low development potential for surface mining (mining-ratio values greater than 15) in the bottoms of several valleys in the southern and eastern parts of the quadrangle where the overburden is less than 500 feet (152 m) thick.

The Dunning (Pawnee) coal bed (pl. 21) has broad areas with development potential for surface mining, including most of the quadrangle except for areas beneath the higher ridges, found mostly in the southern and eastern parts of the quadrangle where the overburden is thicker than 500 feet (152 m). Most of the area that is suitable for surface mining has low development potential (mining-ratio values greater than 15). Comparatively small areas of high and moderate development potential for surface mining (mining-ratio values of less than 10 and between 10 and 15, respectively) occur in the valleys of Indian Creek and North Fork Taylor Creek.

The lower split of the Cook coal bed (pl. 18) has extensive areas of development potential for surface mining. Narrow areas of high development potential occur in the major valleys between the outcrops and the 10 mining-ratio contour. Very narrow areas of moderate development potential occur upslope of the areas of high development potential between the 10 and 15 mining-ratio contours. Broad areas of low development potential occur beneath the upper valley slopes and ridge tops between the 15 mining-ratio contour or coal boundary and the stripping limit of 500 feet (152 m) of overburden. Within the boundary of coal only a few small areas beneath the highest hills in the southeastern part of the quadrangle have no development potential for surface mining.

The upper split of the Cook coal bed (pl. 16) has development potential for surface mining elsewhere within its boundaries in this quadrangle, including most of the southern and northeastern parts of the quadrangle. High development potential occurs in very narrow areas along the sides of valleys and in somewhat broader areas on the floors of valleys between the outcrops and 10 mining-ratio contours. Moderate development potential occurs in a similar pattern on valley sides and floors, upslope of the areas of high development potential, between the 10 and 15 mining-ratio contours. The remainder of the area of coal has low development potential. Within the boundary of coal deposit there are no areas of no development potential for surface mining.

All of the Canyon coal bed (pl. 11), found mostly in the southern part of the quadrangle, has development potential for surface mining. Most of the area of the coal bed has high development potential extending from the boundary of coal to the 10 mining-ratio contour. Fairly extensive areas of moderate development potential occur beneath the higher hills and ridge tops between the 10 and 15 mining-ratio contours. Mostly small areas of low development potential occur beneath the highest hills where the mining-ratio values are greater than 15. Within the boundary of coal deposit there are no areas of no development potential for surface mining.

All of the Dietz coal bed (pl. 8), found beneath the higher areas mostly in the eastern part of the quadrangle, has development potential for surface mining. Most of the area of the coal bed, between the outcrops and 10 mining-ratio contours, has high development potential. Small areas, between the 10 and 15 mining-ratio contours on the slopes and beneath the tops of the lower ridges, have moderate development potential. A few very small areas beneath the crests of the highest hills, where the mining-ratio values are greater than 15, have low development potential. There are no areas of the Dietz coal bed with no development potential for surface mining.

All of the Anderson coal bed (pl. 5), found only in the southeastern part of the quadrangle, has development potential for surface mining. Almost all of the area of the coal bed has high development potential (mining-ratio values less than 10). A small area, beneath the highest hill, has moderate development potential (mining-ratio values between 10 and 15). There are no areas where the Anderson coal bed has low or no development potential for surface mining.

About 86 percent of the Federal coal lands in the Reanus Cone quadrangle have high development potential for surface mining, 5 percent have moderate development potential for surface mining, and 9 percent have low 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 Reanus Cone 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				
Anderson	32,240,000	270,000	0	32,510,000
Dietz	70,640,000	14,110,000	2,650,000	87,400,000
Canyon	301,050,000	37,660,000	3,880,000	342,590,000
Upper Cook	46,760,000	43,150,000	220,120,000	310,030,000
Lower Cook	26,270,000	17,870,000	232,070,000	276,210,000
Dunning (Pawnee)	10,180,000	15,090,000	348,920,000	374,190,000
Odell (Cache)	0	0	29,320,000	29,320,000
Knobloch	0	0	49,910,000	49,910,000
Total	487,140,000	128,150,000	886,870,000	1,502,160,000
Hypothetical Resource tonnage				
Upper Cook	0	0	10,000	10,000
Dunning (Pawnee)	0	290,000	67,730,000	68,020,000
Total	0	290,000	67,740,000	68,030,000
Grand Total	487,140,000	128,440,000	954,610,000	1,570,190,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Reanus Cone 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				
Lower Cook	0	0	2,040,000	2,040,000
Dunning (Pawnee)	0	0	144,750,000	144,750,000
Odell (Cache)	0	0	121,830,000	121,830,000
Knobloch	0	0	694,340,000	694,340,000
Upper Flowers-Goodale	0	0	644,300,000	644,300,000
Lower Flowers-Goodale	0	0	204,730,000	204,730,000
Broadus	0	0	542,190,000	542,190,000
Total	0	0	2,354,180,000	2,354,180,000
Hypothetical Resource tonnage				
Dunning (Pawnee)	0	0	7,750,000	7,750,000
Knobloch	0	0	60,000	60,000
Upper Flowers-Goodale	0	0	40,000	40,000
Lower Flowers-Goodale	0	0	420,000	420,000
Broadus	0	0	90,000	90,000
Total	0	0	8,380,000	8,380,000
Grand Total	0	0	2,362,560,000	2,362,560,000

REFERENCES

Baker, A. A., 1929, The northward extension of the Sheridan coal field, Big Horn and Rosebud Counties, Montana: U.S. Geological Survey Bulletin 806-B, p. 15-67.

Bass, N. W., 1924, Coal in Tongue River valley, Montana: U.S. Geological Survey Press Memoir 16748.

______1932, The Ashland coal field, Rosebud, Powder River, and Custer Counties; Montana: U.S. Geological Survey Bulletin 831-B, p. 19-105.

Bryson, R. P., and Bass, N. W., 1973, Geology of Moorhead coal field, Powder River, Big Horn, and Rosebud Counties, Montana: U.S. Geological Survey Bulletin 1338, 116 p.

Culbertson, W. C., and Klett, M. C., 1976, Geologic map and coal sections of the Browns Mountain quadrangle, Rosebud County, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-814.

Gilmour, E. H., and Dahl, G. G., Jr., 1967, Montana coal analyses: Montana Bureau of Mines and Geology Special Publication 43, 21 p.

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., and Martin, B. K., 1978, Coal resource occurrence and coal development potential maps of the Browns Mountain quadrangle, Rosebud County, Montana: U.S. Geological Survey Open-File Report 78-039, 29 p.

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., 1971, Strippable coal in the Moorhead coal field, Montana: Montana Bureau of Mines and Geology Bulletin 83, 18 p.

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.

McKay, E. J., 1976, Preliminary geologic map and coal sections of the King Mountain quadrangle, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Miscellaneous Field Studies Map MF-817.

McKay, E. J., and Robinson, L. N., 1979, Coal resource occurrence and coal development potential maps of the Otter quadrangle, Powder River County, Montana: U.S. Geological Survey Open-File Report 79-105, 16 p., 59 pl.

Taff, J. A., 1909, The Sheridan coal field, Wyoming: U.S. Geological Survey Bulletin 341, p. 123-150.

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.

Warren, W. C., 1959, Reconnaissance geology of the Birney-Broadus coal field, Rosebud and Powder River Counties, Montana: U.S. Geological Survey Bulletin 1072-J, p. 561-585.