UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-082

1979

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

[Report includes 17 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 Coalwood quadrangle, Powder River County, Montana, (17 plates; U.S. Geological Survey Open-File Report 79-082). This set of maps was compiled to support the land planning work of the Bureau of Land Management in response to the Federal Coal Leasing Amendments Act of 1976, and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRAs) in the western United States. Coal beds considered in the resource inventory are only those beds 5 feet (1.5 m) or more thick and under less than 3,000 feet (914 m) of overburden.

Location

The Coalwood 7 1/2-minute quadrangle is in north-central Powder River County, Montana, about 48 miles (77 km) south of Miles City, a town in the Yellowstone River valley of eastern Montana. Miles City is on U.S. Interstate Highway 94 and the main east-west routes of the Burlington Northern Railroad and the Chicago, Milwaukee, St. Paul, and Pacific Railroad. The quadrangle is about 15 miles northwest of Broadus, Montana, a small town on U.S. Highway 212.

Accessibility

The quadrangle is accessible from Miles City, Montana, by going south on U.S. Highway 312 a distance of 55 miles (88 km) to the north border of the quadrangle. This highway continues through the central part of the quadrangle and intersects U.S. Highway 212 about 12 miles (19 km) south of the quadrangle and 3 miles (4.8 km) northwest of Broadus. U.S. Highway 312 intersects a number of unimproved roads and trails which provide access throughout the

quadrangle. The nearest railroads are the Burlington Northern Railroad and the Chicago, Milwaukee, St. Paul, and Pacific Railroad, both at Miles City.

Physiography

The Coalwood quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The upland plateau surface has been maturely dissected. The western border area of the quadrangle has been maturely dissected by northwestward-flowing tributaries of Pumpkin Creek. The remainder of the quadrangle is drained by eastward- and southeastward-flowing tributaries of Mizpah Creek, a northeastward-flowing tributary of the Powder River. The eastern part of the quadrangle has moderate relief. The intermittent streams here are in broad, grass- and brush-covered valleys between relatively wide, rounded, interstream areas which rise about 100 feet (30.5 m) above the valley bottoms. The western part of the quadrangle is more rugged. The streams here head between narrow, pine-covered ridges that rise about 300 feet (91 m) above the valleys and are capped by reddish-colored clinker beds formed by the burning of coal beds. The highest elevations, about 3,680 feet (1,122 m) are on these clinker-covered ridges in the western part of the quadrangle. The lowest elevation, about 3,100 feet (945 m), is on Hay Creek at the eastern border of the quadrangle. Topographic relief is about 580 feet (177 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 16 inches (41 cm). The heaviest precipitation is from April to August. The largest average monthly precipitation is during June. Temperatures in eastern Montana range from as low as -50°F (-46°C) to as high as 110°F (43°C). The highest temperatures

occur in July and the lowest in January; the mean annual temperature is about 45°F (7°C) (Matson and Blumer, 1973, p. 6).

Land status

The Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA) covers about a third of the quadrangle, much of the southwest and northwest quarters, and some of the central part. The Boundary and Coal Data Map (pl. 2) shows the location of the KRCRA tracts and the land ownership status. There were no outstanding Federal coal leases or prospecting permits recorded as of 1977.

GENERAL GEOLOGY

Previous work

Bryson (1952) mapped the Coalwood quadrangle as part of the Coalwood coal field, Powder River County, Montana. Matson and Blumer (1973) mapped part of the southwest quarter of the quadrangle as part of the Broadus coal deposit. Matson and Blumer's (1973, pl. 28) map of their Sand Creek deposit extends a slight distance into the northern part of the quadrangle. V. W. Carmichael (in Matson and Blumer, 1973) also mapped part of the quadrangle as part of the Pumpkin Creek coal deposit.

Stratigraphy

A generalized columnar section of the coal-bearing rocks is shown on the Coal Data Sheet (pl. 3) of the CRO maps. The exposed bedrock units belong to the two upper members of the Paleocene Fort Union Formation: the Tongue River Member and the underlying Lebo Shale Member. The light- to dark-gray and brown clays and carbonaceous clays of the Lebo Shale Member are exposed in limited areas near the bottoms of valleys along the east border of the quadrangle. The overlying light-colored sandstone, sandy shale, and coal beds of the Tongue River Member are at the surface throughout the rest of the

quadrangle. One of the coal beds in the western and southern parts of the quadrangle has burned extensively at and near the surface and has baked and fused the overlying rock into reddish-colored slag or clinker. Approximately the upper 80 feet (24 m) of the Lebo Shale Member is exposed in the quadrangle, and about the lower 500 feet (152 m) of the Tongue River Member is exposed. The upper part of the Tongue River Member has been removed by erosion.

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 flood plains, sloughs, swamps, and lakes that occupied the Northern Great Plains in Paleocene (early Tertiary) time.

Representative samples of the sedimentary rocks overlying and interbedded with minable coal beds in the eastern and northern Powder River Basin have been analyzed for the trace element content by the U.S. Geological Survey and the results summarized by the U.S. Department of Agriculture and others (1974) and by Swanson (in Mapel and others, 1977, pt. A, p. 42-44). The rocks contain no greater amounts of trace elements of environmental concern than do similar rock types found throughout other parts of the western United States.

Structure

The Coalwood quadrangle is in the northeastern part of the Powder River structural basin. The strata dip westward or southwestward at an angle of less than 1 degree. Structure contours on top of the Mackin-Walker, Sawyer, Knobloch, and Broadus coal beds (pls. 4, 7, 11, and 14) show that the regional dip is in places modified by gentle folding or interrupted by minor faulting.

COAL GEOLOGY

Six named coal beds, all in the Tongue River Member of the Fort Union Formation, have been mapped on the surface in this quadrangle (pl. 1) and are

shown in section on plate 3. In addition, there are at least four thin, local coal beds of very limited areal extent. Four of the named coal beds, the Broadus, Knobloch, Sawyer, and Mackin-Walker are 5 feet (1.5 m) or more in thickness and consequently have been assigned economic coal resources.

The lowermost of the coal beds is the Contact coal bed at the base of the Tongue River Member. The Contact coal bed is overlain by a noncoal interval of about 40 to 50 feet (12 to 15 m), the Terret coal bed, a noncoal interval of about 40 to 70 feet (12 to 21 m), the Broadus coal bed, a noncoal interval of 30 to 90 feet (9 to 27 m), the Knobloch coal bed, a noncoal interval of 80 to 150 feet (24 to 46 m), the Sawyer coal bed, a noncoal interval of 60 to 80 feet (18 to 24 m), and the Mackin-Walker coal bed. The noncoal intervals in places contain thin local coal beds of limited extent.

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).

Contact coal bed

The Contact coal bed was first described by Bass (1932, p. 53) after exposures in the Ashland coal field, Powder River, and Custer Counties, Montana, perhaps in either the Carey-Malone School quadrangle or the Kirkpatrick Hill quadrangle, both about 15 miles (24 km) northwest of the Coalwood quadrangle, although a type locality was not given. The Contact coal bed is at the base of the Tongue River Member in this quadrangle.

In the Coalwood quadrangle, the Contact coal bed crops out only near the northeast corner of the quadrangle. A few hundred feet east of the quadrangle along this same outcrop a measurement indicates that the Contact coal bed is

only about 2.2 feet (0.67 m) thick. Because it is less than 5 feet (1.5 m) thick, economic coal resources have not been assigned to the Contact coal bed.

Terret coal bed

The Terret coal bed was described by Bass (1932, p. 51) from a small mine on the Terret Ranch (Cook Creek Reservoir quadrangle) in the Ashland coal field about 20 miles (32 km) to the west of this quadrangle. In the Coalwood quadrangle, the Terret coal bed is about 40 to 50 feet (12 to 15 m) above the Contact coal bed or the base of the Tongue River Member, and crops out in the northeastern and east-central parts of the quadrangle. The Terret coal ranges from 2 to 5 feet (0.6 to 1.5 m) in thickness (pls. 1 and 3). Because of its thinness, economic coal resources have not been assigned to the Terret coal bed.

Broadus coal bed

The Broadus coal bed, first described by Warren (1959, p. 570), was named for coal bed exposures near the town of Broadus about 15 miles (24 km) south-southeast of the Coalwood quadrangle. The Broadus coal bed is about 40 to 70 feet (12 to 21 m) above the Terret coal bed. The Broadus coal bed crops out in the eastern half of the quadrangle (pl. 1). As shown by the isopach and structural contour map (pl. 14) the Broadus coal bed increases in thickness from about 2.2 feet (0.67 m) in the north to 25 feet (7.6 m) in the south, and in general dips westward or southward at an angle of less than 1 degree. The overburden on the Broadus coal bed (pl. 15) ranges in thickness from zero at the outcrops to about 350 feet (107 m).

A chemical analysis of the Broadus coal from depths of 89 to 104 feet (27 to 32 m) in drill hole BR-7C, sec. 16, T. 2 S., R. 50 E., in the Coalwood quadrangle shows ash 9.07 percent, sulfur 0.46 percent, and heating value 7,120 Btu per pound (16,561 kJ/kg) on an as-received basis (Matson and Blumer, 1973, p. 91). This heating value converts to 7,830 Btu per pound on a moist,

mineral-matter-free basis, indicating that the Broadus coal in this quadrangle is lignite A in rank.

Knobloch coal bed

The Knobloch coal bed was named by Bass (1924). The name was taken from the Knobloch Ranch and coal mine in the Birney Day School quadrangle about 43 miles (69 km) west-southwest of the Coalwood quadrangle. In this quadrangle, the Knobloch coal bed is 30 to 90 feet (9.1 to 27.4 m) above the Broadus coal bed. As shown by the isopach map (pl. 10), the Knobloch coal bed ranges from 2.3 to about 9 feet (0.7 to 2.7 m) in thickness. In the northern part of the quadrangle, the Knobloch splits into two coal beds. The Lower Knobloch crops out for a short distance in two places along the northern border of the quadrangle (pl. 1), but is less than 5 feet (1.5 m) thick (pl. 10). The Upper Knobloch is not present in the Coalwood quadrangle due to erosion, but is present in the Divide School quadrangle to the north. The structure contour map (pl. 11) shows a regional westward dip of less than 1 degree, but there is an anomaly of about 100 feet (30 m) of relief probably due to irregularities in deposition of the coal bed and surrounding sedimentary rocks. Overburden on the Knobloch coal bed (pl. 12) ranges in thickness from zero at the outcrop to about 300 feet (91 m) where the coal is more than 5 feet (1.5 m) thick.

There is no known published chemical analysis of the Knobloch coal in this quadrangle. It is assumed that the Knobloch coal is similar in rank to the associated coals in this quadrangle and is lignite A.

Sawyer coal bed

The Sawyer coal bed was described by Dobbin (1930, p. 28) from exposures in the foothills of the Little Wolf Mountains in the Forsyth coal field (Rough Draw and Black Spring quadrangles) about 55 miles (88 km) west of the Coalwood

quadrangle. The Sawyer coal bed is present in the western part of the Coalwood quadrangle 80 to 150 feet (24 to 46 m) above the Knobloch coal bed (pl. 1). Much of the Sawyer coal has burned close to the outcrops. The isopach and structure contour map (pl. 7) shows that the unburned coal ranges from about 5 to 25 feet (1.5 to 7.6 m) in thickness and dips westward or southwestward at an angle of less than 1 degree. Overburden on the Sawyer coal bed ranges from zero at the outcrops to about 195 feet (59 m) in thickness (pl. 8).

There is no known publicly available chemical analysis of the Sawyer coal in the Coalwood quadrangle. A chemical analysis of the Sawyer coal from the Ash Creek coal mine, sec. 35, T. 2 S., R. 49 E. in the Leslie Creek quadrangle about 1.5 miles (2.4 km) southwest of the Coalwood quadrangle, shows ash 4.0 percent, sulfur 0.3 percent, and heating value 6,930 Btu per pound (16,119 kJ/kg) on an as-received basis (Gilmour and Dahl, 1967, p. 16). This heating value converts to 7,219 Btu per pound (16,791 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Sawyer coal at this location is lignite A in rank. Because of the proximity of this location to the Coalwood quadrangle it is assumed that the Sawyer coal in the Coalwood quadrangle is similar and is lignite A in rank.

Mackin-Walker coal bed

The Mackin-Walker coal bed was first described by Bryson (1952, p. 76) from the Mackin-Walker mine in the Coalwood coal field in the Box Elder Creek quadrangle about 3 miles (4.8 km) west of the Coalwood quadrangle. The Mackin-Walker coal is present in a small area in the southwest quarter of the Coalwood quadrangle where it crops out near the top of a butte about 60 to 80 feet (18 to 24 m) above the Sawyer coal bed (pl. 1). The isopach and structure contour map (pl. 4) shows that the Mackin-Walker coal bed ranges in thickness from 3 to about 5.5 feet (0.9 to about 1.7 m) in thickness and dips southward at an

angle of less than 1 degree. Overburden on the Mackin-Walker coal bed where it is more than 5 feet (1.5 m) thick ranges from zero at the outcrop to about 80 feet (24 m) in thickness (pl. 5).

A chemical analysis of the Mackin-Walker coal bed from a depth of 68 to 73 feet in coal test hole PC-3, sec. 28, T. 2 S., R. 49 E. about 3.25 miles (5.2 km) west of the Coalwood quadrangle in the Box Elder Creek quadrangle (Matson and Blumer, 1973, p. 83) shows ash 11.13 percent, sulfur 1.18 percent, and heating value 7,310 Btu per pound (17,003 kJ/kg) on an as-received basis. This heating value converts to about 8,225 Btu per pound (19,131 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Mackin-Walker coal at this location is lignite A in rank. Because of the proximity of this location to the Coalwood quadrangle, it is assumed that the Mackin-Walker coal in this quadrangle is similar and is also lignite A in rank.

Local coal beds

There are a number of thin, local coal beds shown on plates 1 and 3. Because of their limited areal extent and thinness (less than 5 feet or 1.5 m), 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.

Coal resource tonnages shown in this report are the Reserve Base (RB) part of the Identified Resources and the Hypothetical (HYP) part of the Undiscovered Resources, as discussed in U.S. Geological Survey Bulletin 1450-B.

The Reserve Base for lignite is coal that is 5 feet (1.5 m) or more thick, under 1,000 feet (305 m) or less of overburden, and located within 3 miles (4.8 km) of a point of coal-bed measurement. Reserve Base is further

subdivided into reliability categories according to their nearness to measurement of the coal bed. Measured coal is coal within 0.25 mile (0.4 km) of a measurement, 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.

Hypothetical Resources are undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, Hypothetical Resources are located in broad areas of coal fields where no points of observation are present, and the evidence of the 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. For purposes of this report, tonnages were calculated for only those Hypothetical coal resources in beds that are estimated to be 5 feet (1.5 m) or more thick and to be under less than 1,000 feet (305 m) of overburden.

Reserves are the recoverable part of the Reserve Base coal. For surface-minable coal in this quadrangle, the coal reserves are considered to be 85 percent (the recovery factor for this area) of that part of the Reserve Base that is beneath 200 feet (61 m) or less of overburden, the stripping limit for beds of lignite in this area.

Estimated lignite resources in this quadrangle were calculated using data obtained from the coal isopach maps (pls. 4, 7, 10, and 14). The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,750 short tons of coal per

acre-foot (12,880 metric tons per hectare-meter) for lignite yields the lignite resources in short tons of coal for each isopached coal bed. Reserve Base and tonnage values for the Mackin-Walker, Sawyer, Knobloch, and Broadus coal beds are shown on plates 6, 9, 13, and 16, respectively, and are rounded to the nearest one-hundredth of a million short tons.

The total Reserve Base tonnage of federally owned, surface-minable lignite in this quadrangle is calculated to be 92.20 million short tons (83.64 million t). There is no Hypothetical Resource tonnage of surface-minable coal. The Reserve Base tonnage totals per section are shown in the northwest corner of each section of CRO plate 2 and by development-potential category in tables 1 and 2. All numbers are rounded to the nearest one-hundredth of a million short tons. About 7 percent of the surface-minable Reserve Base tonnage is classed as Measured, 38 percent as Indicated, and 55 percent as Inferred.

COAL DEVELOPMENT POTENTIAL

Areas where lignite beds are 5 feet (1.5 m) or more thick and are overlain by 200 feet (61 m) or less of overburden are considered to have potential for surface mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable lignite). The formula used to calculate mining-ratio values for lignite is as follows:

$$MR = \frac{t_o \; 0.922}{t_c \; (rf)}$$

where MR = mining ratio
t_o = thickness of overburden
t_c = thickness of lignite
rf = recovery factor = 0.85
0.922 = conversion factor (cu. yds./ton)

Areas of high, moderate, and low development potential for surface mining of coal are here defined as areas underlain by coal beds having less than 200 feet (61 m) of overburden and having respective mining-ratio values of zero to 10, 10 to 15, and greater than 15, as shown on CRO maps, plates 5, 8, 12, and 15 for the Mackin-Walker, Sawyer, Knobloch, and Broadus coal beds, respectively. These mining-ratio values for each development-potential category are based on economic and technological criteria and were provided by the U.S. Geological Survey. Estimated tonnages of Reserve Base coal in each development-potential category (high, moderate, and low) for surface mining are shown in table 1. Estimated tonnages for underground mining are shown in a like manner in table 2.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map, plate 17, 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). 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, etc.

In areas of moderate to high topographic relief, the area of moderate-development potential for surface mining of a coal bed (area having 10 to 15 mining-ratio values) is often restricted to a narrow band between the high and low development-potential areas. In fact, due to the 40-acre (16.2-ha) minimum size of coal development-potential increments, the narrow strip of moderate development-potential area often falls within the 40-acre (16.2-ha) tracts of high development-potential category. The Coal Development Potential (CDP)

map then shows areas of low development potential abutting against areas of high development potential.

The coal development potential for surface-mining on federally owned coal land (less than 200 feet or 61 m of overburden) is shown on the CDP map (pl. 17). There are areas of high development potential in the central and southwestern parts of the quadrangle. There are some tracts of moderate and low development potential in the southwestern part of the quadrangle. The coal lands in the remainder of the quadrangle have no development potential because the coal beds there are less than 5 feet (1.5 m) thick or have been removed by erosion. The areas of high development potential are due primarily to the Broadus coal bed and secondarily to the Sawyer coal bed.

The Broadus coal bed (pl. 15) in the southwestern quarter of the quadrangle has a wide area of high development potential extending from the boundary of the 5-foot (1.5-m) or more thick coal to the 10 mining-ratio contour or to the stripping limit at the 200-foot overburden isopach. There is a narrow to wide area of moderate development potential between the 10 and the 15 mining-ratio contours, and in places a narrow area of low development potential between the 15 mining-ratio contour and the 200-foot overburden isopach. There is a large area near the southwestern border of the quadrangle where the Broadus coal bed has been assigned no development potential for surface mining as the bed is below the arbitrarily assigned stripping limit of 200 feet (61 m).

Practically all of the unburned Sawyer coal (pl. 8) has mining-ratio values less than 10, and consequently has a high development potential for surface mining. There is a considerable area of unburned Sawyer coal in the northwest quarter of the quadrangle and a smaller area in the southwest quarter of the quadrangle. Both areas are mainly of high development potential for surface mining.

The Knobloch coal bed (pl. 12) has rather limited areas of high development potential (mining-ratio values 0-10) and even smaller areas of moderate and low development potential in the southwest quarter of the quadrangle.

The Mackin-Walker coal bed (pl. 5) has very small areas of high, moderate, and low development potential near the southwestern border of the quadrangle.

About 22 percent of the Federal coal land in the Coalwood quadrangle has a high development potential for surface mining, 4 percent has a moderate development potential, 5 percent has a low development potential, and 69 percent has no development potential.

Development potential for underground mining and in-situ gasification

Lignite beds of 5 feet (1.5 m) or more in thickness lying more than 200 feet (61 m) but less than 1,000 feet (305 m) below the surface of this quadrangle are considered to have development potential for underground mining. Estimates of the tonnage of underground-minable lignite are listed in table 2 by development-potential category for each lignite 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 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.

Table 1.--Surface-minable coal resource tonnage by development-potential category for Federal coal lands (in short tons) in the Coalwood quadrangle, Powder River County, Montana

[Development potentials are based on mining ratios (cubic yards of overburden/short ton of recoverable coal). To convert short tons to metric tons, multiply by 0.9072]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
Reserve Base tonnage				
Mackin-Walker	440,000	70,000	0	510,000
Sawyer	18,910,000	230,000	200,000	19,340,000
Knobloch	1,880,000	1,020,000	3,830,000	6,730,000
Broadus	52,510,000	7,640,000	5,470,000	65,620,000
Total	73,740,000	8,960,000	9,500,000	92,200,000

Table 2.--Underground-minable coal resource tonnage by development-potential category for Federal lands (in short tons) in the Coalwood 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				
Knobloch	0	0	1,530,000	1,530,000
Broadus	0	0	67,740,000	67,740,000
Total	0	0	69,270,000	69,270,000

REFERENCES

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., 1952, The Coalwood coal field, Powder River County, Montana: U.S. Geological Survey Bulletin 973-B, p. 23-106.

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

Gilmour, E. H., and Dahl, G. G., Jr., 1967, Montana coal analysis: 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., Swanson, V. E., Connor, J. J., Osterwald, F. W., and others, 1977, Summary of the geology, mineral resources, environmental geochemistry, and engineering geologic characteristics of the northern Powder River coal region, Montana: U.S. Geological Survey Open-File Report 77-292.

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

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

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

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.