UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-643

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BAR V RANCH QUADRANGLE, BIG HORN COUNTY, MONTANA

[Report includes 25 plates]

By

Colorado School of Mines Research Institute

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

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 Bar V Ranch quadrangle, Big Horn County, Montana, (25 plates; U.S. Geological Survey Open-File Report 79-643). 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 Bar V Ranch quadrangle is in southeastern Big Horn County, Montana, about 15 miles (24 km) north-northwest of Sheridan, Wyoming. Sheridan is on U.S. Interstate Highway 90 and on the Burlington Northern Railroad. The quadrangle is about 7 miles (11.3 km) west of Decker, Montana.

Accessibility

The quadrangle is accessible from Sheridan, Wyoming, by traveling north on U.S. Interstate Highway 90 about 6 miles (9.7 km) to the Tongue River Road, thence northeast on the Tongue River Road about 5 miles (8 km) to the Ash Creek Road, thence northwest on the Ash Creek Road about 1 mile (1.6 km) to the Youngs Creek Road, thence north and northwest on the Youngs Creek Road about 7 miles (11.3 km) to the eastern border of the quadrangle. The Youngs Creek Road continues northwestward across the quadrangle and intersects local roads and trails which provide access to most parts of the quadrangle.

Physiography

The Bar V Ranch quadrangle is within the Missouri Plateau division of the Great Plains physiographic province. The quadrangle is 2 to 3 miles (3.2 to 4.8 km) east of the crest of the Wolf Mountains. The land is dissected and drained by Squirrel, Tanner, Youngs, and Ash Creeks. All are southeastward-flowing tributaries of the Tongue River which is 5 to 10 miles (8.1 to 16.1 km) east of the quadrangle. These streams have narrow flood plains, generally less than 0.25 mile (0.4 km) wide. From the flood plains the valley slopes rise steeply about 400 feet (122 m) to near the tops of the interstream divides. These divides, which are 0.5 to 1 mile (0.8 to 1.6 km) wide, are flat-topped remnants of the plateau surface which slope gently southeastward. Timber is limited to a few narrow strips along the streams in places or along the steep slopes of a few of the tributary arroyos.

The highest elevation, 4,920 feet (1,500 m), is on one of the interstream divides at the western border of the quadrangle. The lowest elevation, 3,800 feet (1,158 m), is along Youngs Creek at the eastern border of the quadrangle. Topographic relief is about 1,120 feet (341 m).

Climate

The climate of Big Horn 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

As shown by the Boundary and Coal Data map (pl. 2), all of the Bar V Ranch quadrangle is within the Crow Indian Reservation except a strip 0.25- to 0.75-mile (0.4- to 1.2-km) wide along the eastern border of the quadrangle. All of this strip is within the Northern Powder River Basin Known Recoverable Coal Resource Area (KRCRA), and the Federal Government owns most of the coal rights. There are no Federal coal lands within the Crow Indian Reservation. As of 1977 there were no outstanding Federal coal leases or prospecting permits.

GENERAL GEOLOGY

Previous work

Baker (1929, pl. 28) mapped the area east of the Crow Indian Reservation as part of the northward extension of the Sheridan coal field. Matson and Blumer (1973, pl. 1) remapped this area as part of the Decker coal deposit. Galyard and Murray (U.S. Geological Survey unpublished report) still later mapped this area as well.

Traces of coal bed outcrops shown by previous workers on planimetric maps that 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 is shown on the Coal Data Sheet (pl. 3). The uppermost strata in the Bar V Ranch quadrangle belong to the Wasatch Formation (Eocene). It is estimated that about 175 feet (53 m) of Wasatch strata cap the interstream divides in the mapped eastern part of the quadrangle. However, they do not contain known economic coal resources.

All of the coal beds described in this report belong to the Tongue River Member, the uppermost member of the Fort Union Formation (Paleocene). The Fort Union Formation is about 1,600 feet (488 m) thick in the eastern part of the quadrangle (Lewis and Roberts, 1978). This member consists of light-colored sandstone, sandy shale, carbonaceous shale, and coal beds. The thicker coal beds have burned along the outcrop and have baked and fused the overlying rock into reddish-colored slag or clinker.

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 Bar V Ranch quadrangle is on the western flank of the Powder River structural basin. Regionally the strata dip eastward, but this dip has been modified considerably by low-relief folding and by faulting in the southern part of the mapped area (pls. 4, 7, 10, 13, 16, 19, and 22).

COAL GEOLOGY

The recognized coal beds in the Bar V Ranch 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 belong to the Tongue River Member of the Fort Union Formation (Paleocene).

The lowermost recognized coal in the Bar V Ranch quadrangle is the Wall coal bed which is 500 to 600 feet (152 to 183 m) above the base of the Tongue River Member. The Wall coal bed is successively overlain by a noncoal interval of about 40 to 120 feet (12 to 37 m), the Cook coal bed, a noncoal interval of 135 to 185 feet (41 to 56 m), a local coal bed, a noncoal interval of about 5 feet (1.5 m), the Canyon coal bed, a noncoal interval of about 90 feet (27.4 m), the combined Dietz 2 and 3 coal beds, a noncoal interval of about 60 feet (18 m), the Anderson (Dietz 1) coal bed, a noncoal interval of as much as 200 feet (61 m), the Smith coal bed, a noncoal interval of about 100 feet (30.5 m), and the Roland of Baker (1929) coal bed.

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).

Wall coal bed

The Wall coal bed was named by Baker (1929, p. 37) probably from exposures along Wall Creek, a tributary of the Tongue River, about 21 miles (33.8 km) northeast of the Bar V Ranch quadrangle in the Birney quadrangle. The Wall coal bed does not crop out in the Bar V Ranch quadrangle, but it is projected into the subsurface of the quadrangle from the Pearl School quadrangle to the east. The isopach and structure contour map (pl. 22) shows that the projected thickness of the Wall coal bed ranges from about 5 to 25 feet (1.5 to 7.6 m), and that the bed, in general, dips southeastward at an angle of 1 degree or less. This dip is modified by minor folding in the southern part of the mapped area. Overburden on the Wall coal bed (pl. 23) ranges from about 620 to 1,120 feet (189 to 341 m) in thickness.

There is no known, publicly available chemical analysis of the Wall coal bed in or close to the Bar V Ranch quadrangle. It is assumed that the Wall coal is similar to other closely associated coals in this quadrangle and is subbituminous B in rank also.

Cook coal bed

The Cook coal bed was named by Bass (1932, p. 59-60) for exposures in the Ashland coal field, probably in the Cook Creek Reservoir quadrangle which is about 52 miles (84 km) northeast of the Bar V Ranch quadrangle. The Cook coal bed occurs about 40 to 120 feet (12 to 37 m) above the Wall coal bed. This coal bed does not crop out in the mapped part of the Bar V Ranch quadrangle, but it has been projected into the subsurface of the quadrangle from the Pearl School quadrangle to the east. The isopach and structure contour map (pl. 19) shows that the Cook coal bed ranges from about 5 to 10 feet (1.5 to 3.0 m) in thickness and dips southeastward at an angle of less than 1 degree. Overburden on the Cook coal bed (pl. 20), where it is more than 5 feet (1.5 m) thick, ranges from about 460 to 960 feet (140 to 293 m) in thickness.

There is no known, publicly available chemical analysis of the Cook coal in or close to the Bar V Ranch quadrangle. It is assumed that the Cook coal is similar to other closely associated coals in this quadrangle and is subbituminous B in rank also.

Local coal bed

The local coal bed, a few feet below the Canyon coal bed, was penetrated by a coal test hole in the northeastern part of the quadrangle (pls. 1 and 3). The coal bed is only 2 feet (0.61 m) thick. Therefore, it has not been assigned economic coal resources.

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. Although a type locality was not given, it probably is along Canyon Creek in the Spring Gulch quadrangle about 17 miles (27.4 km) to the northeast. This coal bed occurs 140 to 190 feet (43 to 56 m) above the Cook coal bed. The Canyon coal bed does not crop out in the quadrangle, but it has been penetrated by a coal test hole in the northeastern part of the quadrangle (pls. 1 and 3). The isopach and structure contour map (pl. 16) shows that the Canyon coal bed ranges from about 10 to 30 feet (3.0 to 9.1 m) in thickness and dips southeastward at an angle of less than 1 degree. Overburden on the Canyon coal bed (pl. 17) ranges from about 300 to 760 feet (91 to 232 m) in thickness.

A chemical analysis of the Canyon coal from a depth of 106 to 116 feet (32 to 35 m) in coal test hole SH-703, sec. 26, T. 8 S., R. 40 E., in the Decker quadrangle (Matson and Blumer, 1973, p. 20) shows ash 16.966 percent, sulfur 0.017 percent, and heating value 8,081 Btu per pound (19,796 kJ/kg) on an as-received basis. This heating value converts to about 9,732 Btu per pound (22,637 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Canyon coal at that location is subbituminous B in rank. It is assumed that the Canyon coal in the Bar V Ranch quadrangle is similar and is also subbituminous B in rank.

Dietz 2 and 3 coal beds

The Dietz 1, 2, and 3 coal beds were first described by Taff (1909, p. 139-140) from exposures in the Sheridan coal field, Wyoming. In the Bar V Ranch quadrangle, the Dietz 1 coal bed of Taff is equivalent to the Anderson coal bed. The Dietz 2 and 3 coal beds do not crop out in the mapped part of the quadrangle, but they have been penetrated by a coal test hole in the northeastern part of the quadrangle where they occur as a combined coal bed 87 feet (26.5 m) above the Canyon coal bed. The isopach and structure contour map (pl. 13), based mainly on data from the Pearl School quadrangle to the east, shows that the combined Dietz 2 and 3 coal beds range from about 40 to 60 feet (12 to 18 m) in thickness and dip southeastward at an angle of less than 1 degree. Overburden on the combined Dietz 2 and 3 coal beds (pl. 14) ranges from about 80 to 760 feet (24 to 232 m) in thickness.

A chemical analysis of the Dietz coal from a depth of 240 to 247 feet (73.2 to 75.3 m) in coal test hole BMC-727, sec. 36, T. 8 S., R. 38 E., in the Bar V Ranch quadrangle (Matson and Blumer, 1973, p. 20) shows ash 2.836 percent, sulfur 0.008 percent, and heating value 9,305 Btu per pound (21,643 kJ/kg) on an as-received basis. This heating value converts to about 9,575 Btu per pound (22,276 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Dietz coal in the Bar V Ranch quadrangle is subbituminous B in rank.

Anderson (Dietz 1) coal bed

The Anderson coal bed was first described by Baker (1929, p. 35) from exposures in the northward extension of the Sheridan coal field. The type locality probably is along Anderson Creek in the southern part of the Spring Gulch quadrangle, about 14 miles (22.5 km) east-northeast of the Bar V Ranch quadrangle. The Dietz 1 coal bed was named by Taff (1909, p. 129) for exposures at the abandoned No. 1 mine at the old mining town of Dietz, in the Sheridan coal field, Wyoming, about 9 miles (14.5 km) south-southeast of the Bar V Ranch quadrangle in the Acme quadrangle. The Dietz 1 coal bed is equivalent to the Anderson coal as mapped by Baker (1929, pl. 28) and Matson and Blumer (1973, pl. 1).

The Anderson (Dietz 1) coal bed has been extensively burned near the surface of the land so there are no surface measurements of this coal bed in the Bar V Ranch quadrangle. The isopach and structure contour map of the Anderson coal bed (pl. 10), based on measurements in the Pearl School quadrangle to the east, shows that this coal bed ranges from about 20 to 40 feet (6.1 to 12.2 m) in thickness, and, in general, dips southeastward at an angle of 1 degree or less. Overburden on the Anderson (Dietz 1) coal bed (pl. 11) ranges from 0 feet at the outcrops to about 440 feet (0-134 m) in thickness.

A chemical analysis of the Anderson (Dietz 1) coal from a depth of 116 to 127 feet (35.4 to 38.7 m) in coal test hole BMC-729, sec. 29, T. 9 S., R. 39 E., about 0.8 miles (1.3 km) east of the Bar V Ranch quadrangle in the Pearl School quadrangle (Matson and Blumer, 1973, p. 20) shows ash 3.881 percent, sulfur 0.016 percent, and heating value 9,306 Btu per pound (21,646 kJ/kg) on an as-received basis. This heating value converts to about 9,682 Btu per pound (22,520 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Anderson (Dietz 1) coal at that location is subbituminous B in rank. Because of the proximity of that location to the Bar V Ranch quadrangle, it is assumed that the Anderson coal in this quadrangle is similar and is also subbituminous B in rank.

Smith coal bed

The Smith coal bed was first described by Taff (1909, p. 130) for exposures in the Sheridan coal field in the northern part of the Sheridan quadrangle, Wyoming, about 11 miles (17.7 km) south-southeast of the Bar V Ranch quadrangle. In the Bar V Ranch quadrangle, the Smith coal bed occurs about 100 to 200 feet (30.5 to 61 m) above the Anderson (Dietz 1) coal bed. The isopach and structure contour map of the Smith coal bed (pl. 7) shows that this coal bed ranges from about 5 to 20 feet (1.5 to 6.1 m) in thickness and, in general, dips to the south at an angle of about 1 degree, although this dip is modified in places by low-relief folding and faulting. Overburden on the Smith coal bed (pl. 8) ranges from zero at the outcrops to about 320 feet (98 m) in thickness.

There is no known, publicly available chemical analysis of the Smith coal bed in or close to the Bar V Ranch quadrangle. It is assumed that the Smith coal is similar to other closely associated coals in the Bar V Ranch quadrangle and is also subbituminous B in rank.

Roland of Baker (1929) coal bed

The Roland coal bed was named by Taff (1909, p. 130 and 142) in the Sheridan coal field, Wyoming. A coal assumed to be the same bed was called the Roland coal bed in the northward extension of the Sheridan coal field, Montana, by Baker (1929). Subsequent work in the Sheridan coal field has shown that the Roland coal bed of Baker (1929) occurs about 125 feet (38 m) stratigraphically above the original Roland coal bed of Taff (1909).

The top of the Roland coal bed of Baker (1929) is generally used in southern Montana as the contact between the Fort Union Formation (Paleocene) and overlying Wasatch Formation (Eocene).

Baker (1929, pl. 28) mapped his Roland coal bed where it crops out near the eastern border of the quadrangle and measured two surface sections (pls. 1 and 3). The isopach and structure contour map (pl. 4) shows that the Roland of Baker (1929) coal bed ranges in thickness from about 4 to 10 feet (1.2 to 3.0 m) and dips regionally southeastward, although this dip is considerably modified by low-relief folding. Overburden on the Roland of Baker (1929) coal bed (pl. 5) ranges from 0 feet at the outcrops to about 200 feet (0-61 m) in thickness.

A chemical analysis of the Roland of Baker (1929) coal from a depth of 42 to 46 feet (12.8 to 14 m) in coal test hole SH-7035, sec. 20, T. 8 S., R. 39 E., about 0.5 mile east of the Bar V Ranch quadrangle in the Pearl School quadrangle (Matson and Blumer, 1973, p. 29) shows ash 3.508 percent, sulfur 0.292, and heating value 8,265 Btu per pound (19,224 kJ/kg) on an as-received basis. This heating value converts to about 8,565 Btu per pound (19,922 kJ/kg) on a moist, mineral-matter-free basis, indicating that the Roland coal at that location is subbituminous C in rank. Because of the proximity of that location to the Bar V Ranch quadrangle, it is assumed that the Roland of Baker (1929) coal in this quadrangle is similar and is also subbituminous C in rank.

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.

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.

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. 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.

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). 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 191.85 million short tons (174.05 million t). The total tonnage of federally owned, surface-minable Hypothetical coal is estimated to be 0.04 million short tons (0.04 million t). As shown by table 2, the total tonnage of federally owned, underground-minable Reserve Base coal is estimated to be 159.66 million short tons (144.84 million t). There is no federally owned, underground-minable Hypothetical coal in this quadrangle. The total tonnage of surface- and underground-minable Reserve Base coal is 351.51 million short tons (318.89 million t), and the total of surface- and underground-minable Hypothetical coal is 0.04 million short tons (0.04 million t).

About 1 percent of the surface-minable Reserve Base tonnage is classed as Measured, 24 percent as Indicated, and 75 percent as Inferred. None of the underground-minable Reserve Base tonnage is Measured, 12 percent is Indicated, and 88 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. This 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).

The formula used to calculate mining-ratio values for subbituminous coal is:

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

where MR = mining ratio
t_o = thickness of overburden, in feet
t_c = thickness of coal, in feet
rf = recovery factor = 0.85 in this area
cf = conversion factor = 0.911 cu. yds./short ton for subbituminous coal

The mining-ratio values are used to rate the degree of potential that areas within the stripping limit have for surface-mining development. Areas having mining-ratio values of 0 to 10, 10 to 15, and greater than 15 are considered to have high, moderate, and low development potential, respectively. This grouping of mining-ratio values was provided by the U.S. Geological Survey and is based on economic and technological criteria. Mining-ratio contours and the stripping-limit overburden isopach, which serve as boundaries for the development-potential areas, are shown on the overburden isopach and mining-ratio contour plates. Estimated tonnages of surface-minable Reserve Base and Hypothetical coal resources in each development-potential category (high, moderate, and low) are shown in table 1.

Estimated tonnages of underground-minable coal resources are shown in table 2. Because coal is not presently being mined by underground mining in the Northern Powder River Basin for economic reasons, for purposes of this report all of the underground-minable coal resources are considered to have low development potential.

Development potential for surface-mining methods

The Coal Development Potential (CDP) map included in this series of maps pertains only to surface mining. It depicts the highest coal development-potential category which occurs within each smallest legal subdivision of land (normally about 40 acres or 16.2 ha). For example, if such a 40-acre (16.2-ha) tract of land contains areas of high, moderate, and low development potential, the entire tract is assigned to the high development-potential category for CDP mapping purposes. Alternatively, if such a 40-acre (16.2-ha) tract of land contains areas of moderate, low, and no development potential, the entire tract is assigned to the moderate development-potential category for CDP mapping purposes. For practical reasons, the development-potential categories of areas of coal smaller than 1 acre (0.4 ha) have been disregarded in assigning a development potential to the entire 40-acre (16.2-ha) tract.

In areas of moderate to high topographic relief, the area of moderate development potential for surface mining of a coal bed (area having mining-ratio values of 10 to 15) is often restricted to a narrow band between the high and low development-potential areas. In fact, because of the 40-acre (16.2-ha) minimum size of coal development-potential tracts, the narrow band of moderate development-potential area often does not appear on the CDP map because it falls within the 40-acre (16.2-ha) tracts that also include areas of high development potential. The Coal Development Potential (CDP) map then shows areas of low development potential abutting against areas of high development potential.

The coal development potential of the Federal coal lands for surface mining is shown on the Coal Development Potential map (pl. 25). Most of the Federal coal lands in the Bar V Ranch quadrangle have a high development potential for surface mining. Small areas have moderate, low, and no potential.

The Wall coal bed (pl. 23) and the Cook coal bed (pl. 20) have no development potential for surface mining in this quadrangle because all of the coal in these beds 5 feet (1.5 m) or more thick is found below the arbitrarily assigned stripping limit of 500 feet (152.4 m).

All of the Canyon coal in the northeastern part of the quadrangle (pl. 17) likewise has no development potential because it also is below the stripping limit. In the southeastern part of the quadrangle, there is one very small area along Youngs Creek where the Wall coal has a high development potential (mining-ratio values less than 10). Elsewhere in the southeastern part of the quadrangle the Wall coal has mainly moderate development potential (mining-ratio values less than 10-15) or low development potential (mining-ratio values greater than 15).

The combined Dietz 2 and Dietz 3 coal beds (pl. 14) have a high development potential in the southern part of the quadrangle extending from the borders of the mapped area to the 500-foot (152-m) overburden isopach, the arbitrarily assigned stripping limit. In the central part of the mapped area, the Dietz 2 and 3 coal beds have no development potential because these beds here are below the stripping limit. In the northern part of the mapped area, there are areas of high development potential (mining-ratio values less than 10), narrow bands of moderate development potential between the 10 mining-ratio contour and the 500-foot (152-m) overburden isopach, and a wider area of no development potential above the 500-foot (152-m) overburden isopach.

In the southern part of the mapped area, all of the Anderson (Dietz 1) coal bed (pl. 11) has a high development potential (mining-ratio values less than 10). In the northern part of the mapped area, there are about equal areas of high, moderate, and low development potential for this coal bed.

The Smith coal bed (pl. 8) is about equally divided between areas of high, moderate, and low development potential.

The Roland of Baker (1929) coal bed (pl. 5) has only limited areas of high, moderate, and low development potential for surface mining in the mapped eastern part of the quadrangle.

About 80 percent of the Federal coal land in the Bar V Ranch quadrangle has a high development potential for surface mining, 11 percent has a moderate development potential, and 9 percent 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 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 Bar V Ranch quadrangle, Big Horn 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				
Roland of Baker (1929)	1,920,000	2,530,000	2,710,000	7,160,000
Smith	9,250,000	14,770,000	7,270,000	31,290,000
Anderson	41,310,000	20,510,000	10,520,000	12,340,000
Dietz 2 and 3	57,610,000	3,630,000	0	61,240,000
Canyon	1,440,000	6,520,000	10,980,000	18,940,000
Cook	0	0	880,000	880,000
Total	111,530,000	47,960,000	32,360,000	191,850,000
Hypothetical Resource tonnage				
Cook	0	0	40,000	40,000
Total	0	0	40,000	40,000
Grand Total	111,530,000	47,960,000	32,400,000	191,890,000

Table 2.--Underground-minable coal resource tonnage (in short tons) by development-potential category for Federal lands in the Bar V Ranch quadrangle, Big Horn 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				
Dietz 2	0	0	75,000,000	75,000,000
Canyon	0	0	32,640,000	32,640,000
Cook	0	0	17,760,000	17,760,000
Wall	0	0	34,260,000	34,260,000
Total	0	0	159,660,000	159,660,000

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, 1932, The Ashland coal field, Rosebud, Powder River, and Custer Counties, Montana: U.S. Geological Survey Bulletin 831-B, p. 19-105.

Galyardt, G. L., and Murray, F. N., Geologic map and coal deposits of Pearl School quadrangle and eastern portion of Bar V Ranch quadrangle, Big Horn County, Montana: U.S. Geological Survey. (Unpublished report, in press).

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.

Lewis, B. D., and Roberts, R. S., 1978, Geology and water-yielding characteristics of rocks of the northern Powder River Basin, southeastern Montana: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-487-D.

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.

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.