Text to Accompany:

Open-File Report 79-1022

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BLACK BUTTES QUADRANGLE, SWEETWATER COUNTY, WYOMING

[Report includes 32 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

By

DAMES & MOORE

DENVER, COLORADO

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

CONTENTS

ILLUSTRATIONS

Illustrations--Continued

TABLES

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Black Buttes quadrangle, Sweetwater County, Wyoming. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-17104. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through May, 1978, was used as the data base for this study. No new drilling or field mapping was performed, nor was any confidential data used.

Location

The Black Buttes quadrangle is located in central Sweetwater County, Wyoming, approximately 25 miles (40 km) east of the city of Rock Springs, approximately 5 airline miles (8.0 km) southeast of the town of Point of Rocks, and approximately 5 airline miles (8.0 km) west of the town of Bitter Creek. Hallsville and Black Buttes are abandoned loading stations on the Union Pacific Railroad located within the quadrangle. The quadrangle is unpopulated.

Accessibility

An improved light-duty road from the town of Point of Rocks follows the Union Pacific Railroad and the old Overland Trail southeast along Bitter Creek to the abandoned Black Buttes loading station in the south-central part of the quadrangle. There, the road branches east to the town of Bitter Creek and southwest to join Wyoming Highway 430 west of the quadrangle boundary. Several other unimproved dirt roads and trails provide access through the remainder of the quadrangle. Interstate Highway 80 passes east-west through southern Wyoming approximately 2 miles (3.2 km) north of the quadrangle.

The main east-west line of the Union Pacific Railroad runs northwesterly across the quadrangle following the Bitter Creek valley. This line provides railway service across southern Wyoming, connecting Ogden, Utah to the west with Omaha, Nebraska to the east.

Physiography

The Black Buttes quadrangle lies on the eastern flank of the Rock Springs uplift. The landscape is characterized by steep, westerly-facing escarpments with gently dipping eastern slopes. Altitudes range from approximately 6,540 feet (1,993 m) on Bitter Creek in the northwestern corner of the quadrangle to 7,080 feet (2,158 m) along the west-central edge of the quadrangle.

Bitter Creek flows northwesterly across the quadrangle, draining into the Green River west of the city of Rock Springs. All of the streams in the quadrangle are intermittent and flow mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of southwestern Wyoming is semiarid and is characterized by low precipitation, rapid evaporation, and large daily temperature changes. Summers are usually dry and mild, and winters are cold. The annual precipitation averages 9 inches (23 cm), with approximately two thirds falling during the spring and early summer months.

The average annual temperature is 42°F (6°C). The temperature during January averages 18°F (-8°C), with temperatures ranging from 8°F (-13°C) to 28°F (-2°C). During July temperatures range from 54°F (12°C) to 84°F (29°C), with an average of 69°F (21°C) (U.S. Bureau of Land Management, 1978, and Wyoming Natural Resources Board, 1966).

Winds are usually from the west-southwest and southwest with an average velocity of 11 miles per hour (18 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the area include sagebrush, saltbush, greasewood, rabbitbrush, and grasses (U.S. Bureau of Land Management, 1978).

Land Status

The Black Buttes quadrangle lies in the eastern part of the Rock Springs Known Recoverable Coal Resource Area (KRCRA). Approximately 99 percent of the quadrangle lies within the KRCRA boundary with the Federal government owning the coal rights for less than half of this area. One active coal lease is present within the KRCRA boundary, as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Schultz included the Black Buttes quadrangle in a description of the geology and coal resources of the northern part (1909) and the southern part (1910) of the Rock Springs coal field. Dobbin (1944) mapped and described the Superior coal district located a few miles to the northwest of the quadrangle. In 1950 and 1955, Hale described the stratigraphy and depositional history of the formations cropping out on the flanks of the Rock Springs uplift. Yourston (1955) described the structure and stratigraphy of the coal-bearing formations in the Rock Springs coal field and reported chemical analyses for coals in the Rock Springs area. Weimer (1960), Smith (1961 and 1965), Lewis (1961), Burger (1965), and Keith (1965) described the stratigraphy and discussed the depositional environment of Late Cretaceous-age formations in the Rock Springs area. The depositional environment was also described by Weimer (1961), Douglass and Blazzard (1961), and Ritzma (1968). Land mapped the Fox Hills Sandstone and associated formations on the eastern flank of the Rock Springs uplift in 1972 and described their stratigraphy and depositional history. Madden mapped the geology and coal resources of the adjacent Point of Rocks (1977a) and Bitter Creek NW (1977b) quadrangles. Roehler and others (1977) described the geology and coal resources of the Rock Springs uplift. Roehler has prepared geologic maps of the Black Buttes quadrangle (1977d) and adjacent quadrangles (1977a, 1977c, and

1977e); and a generalized geologic map of the Rock Springs uplift (1977b).

Stratigraphy

The formations exposed in the Black Buttes quadrangle range in age from Late Cretaceous to Paleocene and crop out in north- to northeast-trending bands across the quadrangle. The Almond Formation, the Fox Hills Sandstone, and the Lance Formation of Late Cretaceous age, and the Fort Union Formation of Paleocene age contain coal in this quadrangle.

The Mesaverde Group of Late Cretaceous age is subdivided into four formations which are, in ascending order, the Blair Formation, the Rock Springs Formation, the Ericson Sandstone, and the Almond Formation. Only the Almond Formation crops out in the quadrangle. The remainder occur in the subsurface.

The Blair Formation is approximately 740 feet (226 m) thick where measured in the Forest Oil Corporation No. 25-1 Overland Trail well located in sec. 25, T. 19 N., R. 101 W. It is composed of a thick sequence of intertonguing near-shore sandstones and silty to sandy offshore marine shales (Hale, 1950, 1955, Douglass and Blazzard, 1961, Smith, 1961, 1965, and Keith, 1965).

The Rock Springs Formation conformably overlies the Blair Formation and ranges in thickness from approximately 1,720 to 1,840 feet (524 to 561 m) where measured in the oil and gas wells drilled in this quadrangle. It consists of dark-gray silty to sandy marine shale and thin, very fine grained interbedded marine sandstone (Hale, 1950, 1955, Smith, 1961, 1965, and Keith, 1965). Although it is coal-bearing in the quadrangles to the west and northwest, the Rock Springs Formation is not known to contain coal in this quadrangle.

The Ericson Sandstone conformably overlies the Rock Springs Formation and ranges in thickness from approximately 1,030 to 1,150 feet (314 to 351 m) where measured in the oil and gas wells drilled in the quadrangle. The upper and lower sections of the formation consist of light-gray, massive fine- to medium-grained sandstone and gray siltstone. These are separated by a middle section of interbedded gray shale, siltstone, and rusty-weathering sandstone. This middle section, often referred to as the "rusty zone," is approximately 400 feet (122 m) thick to the west in the Point of Rocks SE quadrangle (T. 18 N., R. 101 W.). The Ericson Sandstone was deposited in a stream and floodplain environment (Hale, 1950, 1955, Smith, 1961, 1965, Douglass and Blazzard, 1961, and Roehler, 1977a).

The Almond Formation conformably overlies the Ericson Sandstone and crops out in the western part of the quadrangle (Roehler, 1977b and 1977d). It is approximately 250 to 360 feet (76 to 110 m) thick where measured in the oil and gas wells drilled in this quadrangle. The lower section of the formation consists of gray shale, brown carbonaceous shale, gray limy siltstone, and gray very fine grained sandstone alternating with coal beds of variable thickness and quality. The upper section of the formation is predominately a buff-colored to light-gray, thick-bedded to massive fossiliferous sandstone interbedded with gray shale (Hale, 1950, 1955, and Roehler, 1977b). The Almond Formation reflects deposition in fresh-water coastal swamps, brackish-water lagoons and shallow-water marine environments (Hale, 1950).

The Lewis Shale of Late Cretaceous age conformably overlies the Almond Formation and crops out in the northwestern part of the quadrangle, in a fault block on the northwestern edge of the quadrangle in the west-central part of the quadrangle along the Bitter Creek valley, and in the southwestern part of the quadrangle (Roehler, 1977b and 1977d). It ranges in thickness from approximately 900 to 1,050 feet (274 to 320 m) in the oil and gas wells drilled in the quadrangle. The Lewis Shale consists of dark-bluish-gray gypsiferous silty shale with occasional thin interbeds of sandy limestone and siltstone and a number of thin, widespread bentonite beds. Zones of calcareous concretions are found near the middle of the section with thin ripple-marked sandstones common near the base and top. The neritic shale and siltstone of the Lewis Shale were deposited in water depths ranging from a few tens of feet to several hundred feet (Hale, 1950, 1955, and Land, 1972).

The Fox Hills Sandstone of Late Cretaceous age crops out in a narrow northerly-trending band through the central part of the quadrangle (Roehler, 1977b and 1977d) where it conformably overlies and intertongues with the Lewis Shale. The formation ranges in thickness from approximately 150 to 260 feet (46 to 79 m) where measured in the oil and gas wells drilled in the quadrangle. The Fox Hills Sandstone is composed of a lower light-brown, very fine to fine-grained, thin-bedded, cross-bedded silty sandstone overlain by a light-gray, fine- to medium-grained, massive cliff-forming sandstone. The two types of sandstone are separated by a marked erosional or scour surface (Land, 1972). Tongues of the overlying Lance Formation containing interbedded carbonaceous shale and coal may be present within the Fox Hills Sandstone. The lower finer-grained sandstone was deposited in littoral and near-shore marine environments while the upper coaser-grained sandstone was deposited in an estuarine or tidal river channel environment. The shale and coal unit was deposited in a brackish-water environment (Land, 1972).

The Lance Formation of Late Cretaceous age conformably overlies and intertongues with the Fox Hills Sandstone. It crops out in a fault block in the northwestern part of the quadrangle and in a broad northerly-trending band through the central part of the quadrangle (Roehler, 1977b and 1977d). It is approximately 630 to 790 feet (192 to 241 m) thick where measured in the oil and gas wells drilled in the quadrangle. The formation thins to the south where it is truncated by pre-Fort Union Formation erosion in T. 17 N., R. 101 W., to the southwest of the quadrangle (Land, 1972, and Roehler, 1977a). The Lance Formation consists of dark-gray shale interbedded with gray very fine grained sandstone, dark-gray carbonaceous shale, coal, and silty dolomite (Hale, 1950, 1955, Land, 1972, and Roehler, 1977a). It consists of swamp, lagoonal, floodplain and channel sand deposits formed on the landward side of the

Cretaceous sea shoreline as the sea retreated to the east (Gosar and Hopkins, 1969, and Roehler and others, 1977).

The Fort Union Formation of Paleocene age unconformably overlies the Lance Formation and crops out in a wide northeast-trending band across the eastern half of the the quadrangle (Roehler, 1977b and 1977d). It consists of gray mudstone and interbedded brown to black carbonaceous shale, gray very fine grained sandstone, siltstone, gray carbonaceous claystone, coal and gray shale (Roehler, 1977c). A total formation thickness is not available in the Black Buttes quadrangle; however, the formation is approximately 1,300 to 1,650 feet (396 to 503 m) thick in the Sand Butte Rim NW quadrangle to the south (Roehler, 1977a). The lower part of the formation contains at least one intra-formational unconformity, as indicated by a fossil soil horizon. The formation was deposited in a non-marine, moist lowland environment (Ritzma, 1968).

Recent deposits of alluvium cover the stream valleys of Bitter Creek and its tributaries.

Structure

The Black Buttes quadrangle lies on the eastern flank of the Rock Springs uplift adjacent to the Great Divide structural basin. The Rock Springs uplift is a doubly punging asymmetric anticline with the west limb having the steeper dips (5° to 30° to the west). Dips along the east limb are from 5° to 8° to the east (Roehler and others, 1977).

The strike of the beds in the quadrangle is generally northerly with the beds dipping 4° to 7° to the east. In the northern half of the quadrangle, several normal faults perpendicular to the strike of the beds have formed down-dipped blocks (Roehler, 1977b and 1977d). Horizonal displacement of these faults can be as great as 3 miles (4.8 km) with vertical displacement of several hundred feet (Yourston, 1955).

COAL GEOLOGY

Four formations that contain coal have been identified in the Black Buttes quadrangle. The coal beds of the Almond Formation are the lowest, stratigraphically, of the identified coal beds within the quadrangle. Minor coal beds of the Fox Hills Sandstone occur approximately 1,300 feet (396 m) above the Almond coal beds. Several coal beds are found in the lower part of the Lance Formation, which overlies the Fox Hills Sandstone, and the important Deadman coal bed of the Fort Union Formation is located approximately 700 feet (213 m) above these Lance coal beds.

Chemical analyses of coal.--Chemical analyses for coal beds in the Almond, Lance, and Fort Union Formations are listed in table 1 (Dobbin, 1944, Yourston, 1955, Glass, 1975, 1976). In general, coal beds in this quadrangle are low in sulfur and rank as subbituminous A or B on a moist, mineral-matter-free basis according to ASTM standard specification D 388-77 (American Society for Testing and Materials, 1977).

Coal Beds of the Almond Formation

Approximately 20 coal beds in this formation have been named and mapped, mostly by Roehler and others (1977), in the extreme southeastern part of the Rock Springs coal field. To the north of this quadrangle, the Almond coal beds have not been adequately explored and relatively little information is available. Logs of oil and gas wells and mapping by Roehler (1977d) indicate that several coal beds greater than 5 feet (1.5 m) thick occur in this quadrangle. The coal beds crop out along the western half of quadrangle and dip approximately 5° to the southeast.

Lebar and Lebar Rider Coal Beds

The Lebar coal bed, as named by the Black Butte Coal Company, crops out near the western edge of the quadrangle (plate 1). The coal bed attains a maximum measured thickness of 7.7 feet (2.3 m) in this quadrangle. Roehler (1977e) indicates a measured thickness of 12.7 feet (3.9 m) just outside the Black Buttes quadrangle boundary in the Point of Rocks SE quadrangle to the west. The coal bed is faulted just north of

Roehler's (1977d) measured section located in sec. 6, T. 18 N., R. 100 W., but it can be traced southward into the Point of Rocks SE quadrangle. The coal is burned along much of the outcrop.

A coal bed 4.8 to 5.0 feet (1.4 to 1.5 m) thick that is located 15 to 20 feet (4.6 to 6.1 m) above the Lebar coal bed has been named the Lebar Rider (Roehler and others, 1977). It crops in this and the adjacent quadrangle to the west.

Almond [4], [5], [6], and [9] Coal Beds

Several Almond Formation coal beds have been penetrated in oil and gas wells drilled within the quadrangle. These coal beds have not been formally named but have been assigned informal bracketed numbers for identification purposes in this quadrangle only. Coal beds in the Almond Formation tend to be thin, lenticular and of limited areal extent. Thicknesses of each bed are shown on plates 4, 7, 10, and 12. The maximum thickness reported for any of the Almond coal beds is 8 feet (2.4 m). The beds mapped are quite deep, approximately 1,370 to 3,000 feet (418 to 914 m) below the surface.

Coal Beds of the Lance Formation

In the Black Buttes quadrangle, the coal beds in the Lance Formation occur in the lower part of the formation and are named, in ascending order, the Hall, Maxwell, Black Butte, Gibralter, and Overland coal beds. They are frequently channeled out or split (Roehler and others, 1977) and sometimes difficult to correlate.

Hall Coal Bed

The Hall coal bed, located near the base of the Lance Formation, has been mapped across much of the quadrangle (plate 18). The coal bed is approximately 8 feet (2.4 m) thick in sec. 4, T. 18 N., R. 100 W., near the center of the Black Buttes quadrangle. It thins to the south, but is 6 feet (1.8 m) thick in sec. 22, T. 17 N., R. 101 W. At the old Hall (or Hallville) Mine located in sec. 29, T. 19 N., R. 100 W., a coal bed 8.7 feet (2.7 m) thick has been mined (Schultz, 1910). Another coal bed 5.5 feet (1.7 m) thick lies 12 feet (3.7 m) above the Hall coal bed and it may have also been mined. Further north, the Hall coal bed is 4.9 feet (1.5 m) thick in sec. 15, T. 21 N., R. 101 W. (Roehler and others, 1977).

Maxwell Coal Bed

The Maxwell coal bed is located approximately 70 feet (21.3 m) above the base of the Lance Formation and thickens to 9.5 feet (2.9 m) at the abandoned Maxwell mine near the town of Black Buttes. The Maxwell coal bed "thins irregularly in outcrops to the south of Black Butte, but is 4.7 feet (1.4 m) thick in sec. 22, T. 17 N., R. 101 W., where it wedges out below the Fort Union Formation" (Roehler and others, 1977). The Maxwell coal bed can be traced to the north along the flanks of the Rock Springs uplift for several miles, usually ranging from 2.5 to 6 feet (0.8 to 1.8 m) in thickness.

Black Butte Coal Bed

The Black Butte coal bed is located approximately 35 to 55 feet (10.7 to 16.8 m) stratigraphcally above the Maxwell coal bed. It was mapped in the subsurface using data from oil and gas wells near the eastern boundary of the quadrangle (plate 24) where it attains a thickness of 6 feet (1.8 m) in sec. 2, T. 18 N., R. 100 W. The coal bed thins irregularly in outcrops and is not as persistent as the Hall, Maxwell or Gibralter coal beds (Roehler and others, 1977).

Gibralter Coal Bed

The Gibralter coal bed lies approximately 175 feet (53.3 m) above the base of the Lance Formation and has been mapped in the southeastern part of the quadrangle using surface and subsurface data. The coal bed thickens to 9.7 feet (3.0 m) along the southern quadrangle boundary but "wedges out (to the south) and is missing in outcrops in sec. 20, T. 18 N., R. 100 W." (Roehler and others, 1977). Northward, the Gibralter coal bed can be traced into T. 21 N., R. 101 W.

Overland Coal Bed

The Overland coal bed crops out in secs. 3 and 10, T. 18 N., R. 100 W., where measured thicknesses of up to 8 feet (2.4 m) were recorded (Roehler, 1977d, and Schultz, 1910). The Overland coal bed thins irregularly and is usually less than 5 feet (1.5 m) thick.

Coal Beds of the Fort Union Formation

Several coal beds of the Fort Union Formation crop out in the eastern half of the quadrangle. Among these are the thick and extensive Deadman, the Hail, the Nuttal (Big Burn), and the Leaf coal beds. Because the Fort Union Formation thickens considerably to the east, especially the section below the Deadman coal bed, several more coal beds exist to the east below the Deadman than is evident from the outcrop exposures in this quadrangle.

Fort Union [2] Coal Bed

The informally named FU[2] coal bed was penetrated by oil and gas wells in the southeastern part of the Black Buttes quadrangle (plate 30) and in the adjacent Bitter Creek quadrangle to the east where this coal bed is identified as the Fort Union [4] coal bed. The coal bed does not exceed 7 feet (2.1 m) in thickness in this quadrangle but thickens to 8 feet (3.1 m) in the Sand Butte Rim NW quadrangle to the south. The FU[2] coal bed is located approximately 50 feet (15.2 m) below the Deadman coal bed. Because of intraformational thinning, the FU[2] coal bed pinches out and is lost as it is traced to the west. Where the lower section of the Fort Union Formation crops out within the quadrangle, only the Deadman coal bed outcrop can be located.

Deadman Coal Bed

The Deadman coal bed is the thickest and most extensive coal bed located along the east flanks of the Rock Springs uplift. It can be found as far south as T. 14 N., R. 102 W., where it is called the Little Valley coal bed (Roehler, 1977b), and as far north as T. 22 N., R. 102 W. This important coal bed is mined at the Jim Bridger strip mine in T. 21 N., R. 100 W., where it is approximately 30 feet (9.1 m) thick.

In the Black Buttes quadrangle, the Deadman coal bed is 21.8 feet (6.6 m) thick where measured at the abandoned Sioux City Mine in sec. 28, T. 19 N., R. 100 W., and thickens to the east. Near the southern boundary of the quadrangle, the coal bed is approximately 13 feet (4.0 m) thick. In the Bitter Creek quadrangle to the east, oil and gas well logs have been used to project the Deadman coal bed and splits to depths of 2,000 feet (610 m) or more, with thicknesses ranging from 5 to 15 feet (1.5 to 4.5 m).

Isolated Data Points

In instances where isolated measurements of coal beds thicker than 5 feet (1.5 m) are encountered, the standard criteria for construction of isopach, structure contour, mining ratio, and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. For this reason, isolated data points are included on a separate sheet (in U.S. Geological Survey files) for non-isopachable coal beds. The isolated data points used in this quadrangle are listed below. Coal beds identified by bracketed numbers are not formally named, but are numbered for identification purposes in this quadrangle only.

Source	Location	Coal Bed	Thickness
Chandler & Simpson Inc.	sec. 8, T. 18 N., R. 100 W.	Al[8]	6.0 ft (1.8 m)
Phillips Petroleum Co.	sec. 22, T. 18 N., R. 100 W.	Al[2]	6.0 ft (1.8 m)
Chandler & Simpson Inc.	sec. 26, T. 18 N., R. 100 W.	FH[1]	6.0 ft (1.8 m)
Chandler & Simpson Inc.	sec. 26, T. 18 N., R. 100 W.	Al[7]	9.0 ft (2.7 m)

COAL RESOURCES

Data from oil and gas wells, as well as surface mapping by Schultz (1909, 1910) and Roehler (1977d) were used to construct outcrop, isopach, and structure contour maps of the coal beds in this quadrangle. The source of each indexed data point shown on plate 1 is listed in table 3.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 7, 10, 12, 15, 18, 21, 24, 27, and 30). The coal bed acreage (measured by planimeter) multipled by the average isopached thickness of the coal bed, and by a conversion factor of 1,770 short tons of coal per acre-foot (13,018 metric tons per hectare-meter) for subbituminous coal, yields the coal resources in short tons for each isopached coal bed. Reserve Base and Reserve tonnages for the isopached beds are shown on plates 6, 9, 14, 17, 20, 23, 26, and 29 and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a maximum depth of 1,000 feet (305 m) for subbitiminous coal. Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by the isolated data points in this quadrangle.

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 128.13 million short tons (116.24 million metric tons) for the entire quadrangle, including tonnages from the isolated data points. Reserve Base tonnages in the various development potential categories for subsurface mining methods are shown in table 2.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any portion of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where coal beds of Reserve Base thickness 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 coal). The formula used to calculate mining ratios is as follows:

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

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short tons of recoverable coal:
0.911 for subbituminous coal
0.896 for bituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining ratio values of 0 to 10, 10 to 15, and greater than 15. 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.

The coal development potential for surface mining methods (less than 200 feet or 61 meters of overburden) is shown on plate 34. All of the Federal lands having a known development potential for surface mining methods are rated low. The remaining Federal lands that would usually have been depicted as having surface potential are either non-Federal coal lands or are lands where the Federal coal has already been leased.

Reserve Base tonnages in the low development potential category total 1.25 million short tons (1.13 million metric tons) and are derived wholly from the Deadman coal bed.

Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods include those areas where the coal beds of Reserve Base thickness are between 200 and 3,000 feet (61 and 914 m) below the ground surface and have dips of 15° or less. Coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have a development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for subsurface mining methods are defined as areas underlain by coal beds at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited. Even though these areas may contain coal thicker than 5 feet (1.5 m), limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of the development potential in the high, moderate, or low categories. Areas influenced by isolated data points are considered to have unknown development potential. The areas influenced by the isolated data points in this quadrangle contain approximately 14.63 million short tons (13.27 million metric tons) of coal available for conventional subsurface mining.

The coal development potential for conventional subsurface mining methods is shown on plate 32. Of the Federal land areas classified as having known development potential for conventional subsurface mining methods, 97 percent are rated high and 3 percent are rated moderate. The remaining Federal land is classified as having unknown development potential for conventional subsurface mining methods.

Because the coal beds in this quadrangle have dips less than 15°, the development potential for in-situ mining methods is rated as unknown for all Federal lands within the KRCRA boundary.

Table 1. Chemical analyses of coals in the Black Buttes quadrangle, Sweetwater County, Wyoming.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
Sec. 20, T. 21 N., R. 100 W., Jim Bridger Mine (Glass, 1975)	Deadman	A	19.5	32.6	42.0	5.9	0.5	-	-	-	-	-	9,270
		C	0.0	40.5	52.1	7.4	0.6	-	-	-	-	-	11,520
Average analysis from Black Buttes area (Glass, 1976)	Fort Union Fm, undifferentiated	A	17.7	30.9	43.9	8.4	0.4	-	-	-	-	-	9,730
Typical analysis from Black Buttes area (Glass, 1976)	Gibraltar	A	20.6	-	-	4.7	0.5	-	-	-	-	-	9,900
Typical analysis from Black Buttes area (Glass, 1976)	Black Butte	A	20.7	-	-	5.0	0.6	-	-	-	-	-	9,650
Typical analysis from Black Buttes area (Glass, 1976)	Maxwell	A	21.0	-	-	6.0	0.8	-	-	-	-	-	9,670
Typical analysis from Black Buttes area (Glass, 1976)	Hall	A	20.8	-	-	4.6	1.1	-	-	-	-	-	9,900
SW¼, sec. 16, T. 18 N., R. 100 W., Rock Springs - Gilbraltar Mine (Yourston, 1955)	Lance, undifferentiated	A	20.8	28.4	47.1	3.7	0.4	-	-	-	-	-	9,910
		C	0.0	35.8	59.5	4.7	0.5	-	-	-	-	-	12,510
Typical analysis from Black Buttes area (Glass, 1976)	Lebar	A	17.5	-	-	7.6	0.6	-	-	-	-	-	10,000
SW¼, sec. 26, T. 20 N., R. 101 W., Point of Rocks Mine (Dobbin, 1944)	Almond, undifferentiated	A	17.9	29.5	49.3	3.3	0.5	-	-	-	-	-	10,220
		C	0.0	36.0	60.0	4.0	0.6	-	-	-	-	-	12,450

Form of Analysis: A, as received
B, air dried
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the Black Buttes quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Deadman	70,810,000	4,500,000	-	-	75,310,000
Fort Union {2}	3,420,000	2,960,000	-	-	6,380,000
Gibraltar	2,790,000	12,000,000	-	-	14,790,000
Black Butte	-	1,200,000	-	-	1,200,000
Maxwell	-	3,600,000	-	-	3,600,000
Hall	370,000	3,130,000	-	-	3,500,000
Almond {9}	-	-	4,190,000	-	4,190,000
Almond {5}	-	-	3,540,000	-	3,540,000
Almond {4}	-	-	990,000	-	990,000
Isolated Data Points	-	-	-	14,630,000	14,630,000
Total	77,390,000	27,390,000	8,720,000	14,630,000	128,130,000

NOTE: To convert short tons to metric tons, multiply by 0.9072.

Table 3. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Chandler & Simpson, Inc.	Oil/gas well No. 1 Verbrugge-Govt.
2	Union Pacific Railroad Co.	Oil/gas well No. 11-3 U.P.R.R.
3	Roehler, 1977d, U.S. Geological Survey, unpublished data	Measured Section No. 3276
4		Measured Section No. 3376
5	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
6	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 231	Measured Section
7	Roehler, 1977d, U.S. Geological Survey, unpublished data	Measured Section No. 3476
8	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 231	Measured Section
9	Newmont Exploration, Ltd.	Oil/gas well No. 3 R.S.
10	Chandler & Simpson, Inc.	Oil/gas well No. 1 Black Buttes-Govt.
11	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
12		Measured Section
13	Roehler, 1977d, U.S. Geological Survey, unpublished data	Maxwell Mine
14		Measured Section No. 3176

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
15	Schultz, 1910, U.S. Geological Survey, Bulletin 381-B, p. 231	Measured Section
16	Chandler & Associates, Inc.	Oil/gas well No. 1 Kelly-Govt.
17	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
18	Amoco Production Co.	Oil/gas well No. 1 Champlin 295-Amoco "A"
19	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 239	Measured Section
20	Chandler & Associates, Inc.	Oil/gas well No. 1-B Verbrugge-Govt.
21	Chandler & Simpson, Inc.	Oil/gas well No. 1 Wolf-Govt.
22	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 276	Morgan's Mine
23	Padon Co.	Oil/gas well No. 1 Blair-Hayland-Livestock
24	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
25	↓	Measured Section
26	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233 and 276	Gibralter Mine
27	Roehler, 1977d, U.S. Geological Survey, unpublished data	Measured Section No. 2876

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
28	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
29	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 234	Measured Section
30	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 239	Measured Section
31	Lion Oil Co. and Monsanto Chemical Corp.	Oil/gas well No. 1 Kelly
32	Phillips Petroleum Co.	Oil/gas well No. 1 "A" Sweetwater
33	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 239	Measured Section
34	Mountain Fuel Supply Co.	Oil/gas well No. 1-24 Sand Butte
35	Chandler & Simpson, Inc.	Oil/gas well No. 1 Holbeck-Govt.
36	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 233	Measured Section
37	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 234	Measured Section
38		Measured Section
39		Measured Section
40		Measured Section
41		Measured Section
42	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 239	Measured Section

Table 3. -- Continued

Plate 1 Index Number	Source	Data Base
43	Roehler, 1977d, U.S. Geological Survey, unpublished data	Measured Section
44		Measured Section
45	Chandler & Simpson, Inc. and Monsanto Chemical Corp.	Oil/gas well No. 3 Husky-State
46	Chandler & Simpson, Inc.	Oil/gas well No. 1 Magagna
47		Oil/gas well No. 1 Anderson-Govt.
48	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 277	Mine Section
49	Union Pacific Railroad Co.	Oil/gas well No. 43-28 U.P.R.R.
50	Schultz, 1910, U.S. Geological Survey Bulletin 381-B, p. 276	Hall (Hallville) Mine
51	Schultz, 1909, U.S. Geological Survey Bulletin 341-B, p. 264	Measured Section
52		Measured Section
53	Roehler, 1977d, U.S. Geological Survey, unpublished data	Measured Section No. 3676
54	Schultz, 1909, U.S. Geological Survey Bulletin 341-B, p. 264	Measured Section
55	Chandler & Simpson, Inc.	Oil/gas well No. 1 State-B
56	Forest Oil Corp.	Oil/gas well No. 25-1 Overland Trail

REFERENCES

American Society for Testing and Materials, 1977, Standard specification for classification of coals by rank, in Gaseous fuels; coal and coke; atmospheric analysis: ASTM Standard Specification D 388-77, pt. 26, p. 214-218.

Bradley, W. H., 1961, Geologic map of a part of southwestern Wyoming and adjacent states: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-332, scale 1:250,000.

Burger, J. A., 1965, Cyclic sedimentation in the Rock Springs Formation, Mesaverde Group, on the Rock Springs uplift, in Rock Springs uplift, Wyoming, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 55-63.

Dobbin, C. E., 1944, The Superior district of the Rock Springs Coal Field, Sweetwater County, Wyoming: U.S. Geological Survey unpublished report.

Douglass, W. B., Jr., and Blazzard, T. R., 1961, Facies relationships of the Blair, Rock Springs, and Ericson Formations of the Rock Springs uplift and Washakie Basin, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 81-86.

Glass, G. B., 1975, Analyses and measured sections of 54 Wyoming coal samples (collected in 1974): Wyoming Geological Survey Report of Investigation No. 11, p. 16-17, 104-114.

______ 1976, Review of Wyoming coal fields, 1976: Geological Survey of Wyoming, Public Information Circular 4, 21 p.

Gosar, A. J., and Hopkins, J. C., 1969, Structure and stratigraphy of the southwest portion of the Rock Springs uplift, Sweetwater County, Wyoming, in Geologic Guidebook of the Uinta Mountains, Intermountain Association of Geologists and Utah Geological Association Guidebook, 16th Annual Field Conference, September 4, 5, and 6, 1969: p. 87-90.

Hale, L. A., 1950, Stratigraphy of the Upper Cretaceous Montana group in the Rock Springs uplift, Sweetwater County, Wyoming, in Southwestern Wyoming, Wyoming Geological Association Guidebook, 5th Annual Field Conference, 1950: p. 49-57.

______ 1955, Stratigraphy and facies relationship of the Montanan group in south-central Wyoming, northeastern Utah and northwestern Colorado, in Green River Basin, Wyoming, Wyoming Geological Association Guidebook, 10th Annual Field Conference, 1955: p. 89-94.

References--Continued

Heppe, W. C., 1960, A brief summary of the stratigraphy of the Almond and Lewis Formations of the Washakie Basin, Sweetwater County, Wyoming, in Symposium on the Overthrust Belt of southwestern Wyoming, Wyoming Geological Association Guidebook, 15th Annual Field Conference, 1965: p. 147-151.

Keith, R. E., 1965, Rock Springs and Blair Formations on and adjacent to the Rock Springs uplift, Sweetwater County, Wyoming, in Rock Springs uplift, Wyoming, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 42-53.

Land, C. B., Jr., 1972, Stratigraphy of Fox Hills Sandstone and associated formations, Rock Springs uplift and Wamsutter Arch area, Sweetwater County, Wyoming: A shoreline-estuary sandstone model for the late Cretaceous: Colorado School of Mines Quarterly, v. 67, no. 1, 69 p.

Lawson, D. E., and Crowson, C. W., 1961, Geology of the Arch Unit and adjacent areas, Sweetwater County, Wyoming, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 280-289.

Lewis, J. L., 1961, The stratigraphy and depositional history of the Almond Formation in the Great Divide Basin, Sweetwater County, Wyoming, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 87-95.

______ 1965, Measured surface sections of the Almond Formation on the east flanks of the Rock Springs uplift, Sweetwater County, Wyoming, in Rock Springs uplift, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 101-111.

Lindeman, H. B., 1947, Map of the Rock Springs coal field - northern part, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:60,000.

Madden, D. H., 1977a, Geology of the Point of Rocks quadrangle, Sweetwater County, Wyoming, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

______ 1977b, Geology of the Bitter Creek NW quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished report and map, scale 1:24,000.

Ritzma, H. R., 1968, Geology and occurrence of gas, Wamsutter Arch, Sweetwater County, Wyoming, in Natural gases of North America: American Association of Petroleum Geologists Memoir 9, v. 1, p. 817-827.

References--Continued

Rocky Mountain Energy Company, (no date), Unpublished drill hole data from the Union Pacific coal inventory of 1969.

Roehler, H. W., 1961, The Late Cretaceous-Tertiary boundary in the Rock Springs uplift, Sweetwater County, Wyoming, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 96-100.

______ 1977a, Geologic map of the Cooper Ridge NE quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey Geologic Quadrangle Map GQ-1363, scale 1:24,000.

______ 1977b, Geologic map of the Rock Springs uplift and adjacent areas, Sweetwater County, Wyoming: U.S. Geological Survey Open-File Report 77-242, scale 1: 126,720.

______ 1977c, Geological map of the Sand Butte Rim NW quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey Geologic Quadrangle Map GQ-1362, scale 1:24,000.

______ 1977d, Geologic map and coal resource data of the Black Buttes quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

______ 1977e, Geologic map of the Point of Rocks SE quadrangle, Sweetwater County, Wyoming: U.S. Geological Survey, unpublished map, scale 1:24,000.

Roehler, H. W., Swanson, V. E., and Sanchez, J. D., 1977, Summary report of the geology, mineral resources, engineering geology and environmental geochemistry of the Sweetwater-Kemmerer area, Wyoming, part A, geology and mineral resources: U.S. Geological Survey Open-File Report 77-360, 80 p.

Schultz, A. R., 1909, The northern part of the Rock Springs coal field, Sweetwater County, Wyoming, in Coal fields of Wyoming: U.S. Geological Survey Bulletin 341-B, p. 256-282.

______ 1910, The southern part of the Rock Springs coal field, Sweetwater, Wyoming, in Coal Fields in Wyoming: U.S. Geologic Survey Bulletin 381-B, p. 214-281.

______ 1920, Oil possibilities in and around Baxter Basin, in the Rock Springs uplift, Sweetwater County, Wyoming: U.S. Geological Survey Bulletin 702, 107 p.

References--Continued

Smith, J. H., 1961, A summary of stratigraphy and paleontology in upper Colorado and Montanan Groups in south-central Wyoming, northeastern Utah, and northwestern Colorado, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 101-112.

______ 1965, A summary of stratigraphy and paleontology, Upper Colorado and Montanan groups, south-central Wyoming, northeastern Utah, and northwestern Colorado, in Rock Springs uplift, Wyoming, Wyoming Geological Association Guidebook, 19th Annual Field Conference, 1965: p. 13-26.

Swann, C. E., 1930, The geology of the Rock Springs coal field: Mining Congress Journal, v. 16, no. 2, p. 96-99.

U.S. Bureau of Land Management, 1978, Draft environmental statement, proposed development of coal resources in southwestern Wyoming: U.S. Department of the Interior, v. 1 to 3.

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.

Weichman, B. E., 1961, Regional correlation of the Mesaverde Group and related rocks, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 29-33.

Weimer, R. J., 1960, Upper Cretaceous stratigraphy, Rocky Mountain area: American Association of Petroleum Geologists Bulletin, v. 44, no. 1, p. 1-20.

______ 1961, Uppermost Cretaceous rocks in central and southern Wyoming, and northwest Colorado, in Symposium on the Late Cretaceous rocks of Wyoming and adjacent areas, Wyoming Geological Association Guidebook, 16th Annual Field Conference, 1961: p. 17-28.

Wyoming Natural Resources Board, 1966, Wyoming weather facts: Cheyenne, p. 34-35.

Yourston, R. E., 1955, The Rock Springs coal field, in Green River Basin, Wyoming, Wyoming Geological Association Guidebook, 10th Annual Field Conference, 1955: p. 197-202.