Text to Accompany:

Open-File Report 79-125

1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHEAST QUARTER OF THE BOARS TUSK 15-MINUTE QUADRANGLE, SWEETWATER COUNTY, WYOMING

[Report includes 21 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 northeast quarter of the Boars Tusk 15-minute 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 Published and unpublished public information available through April, 1978, was used as the data base for this study.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

In this report, the term "quadrangle" refers only to the northeast quarter of the Boars Tusk 15-minute quadrangle which is located in north-central Sweetwater County, approximately 7 miles (11 km) northwest of the town of Superior and 20 miles (32 km) northeast of the city of Rock Springs, Wyoming. With the exception of Houghton Ranch, located along the western quadrangle boundary, the area is unpopulated.

Accessibility

No major highways provide access within the quadrangle. An improved light duty road runs east-west across the center of the quadrangle and joins U.S. Highway 187 approximately 12 miles (19 km) west of the quadrangle boundary. A few unimproved dirt roads and trails provide access through the remainder of the quadrangle. Interstate Highway 80 runs east-west approximately 16 miles (26 km) south of the quadrangle boundary. Wyoming Highway 371 extends north from Interstate Highway 80 and terminates at Superior.

The main east-west line of the Union Pacific Railroad passes approximately 17 miles (27 km) south of the quadrangle. This line provides railway service across southern Wyoming connecting Ogden, Utah to the west with Omaha, Nebraska to the east. A spur from the main line terminates approximately 7 miles (11 km) southeast of the quadrangle near Superior. Another spur from the main line at Rock Springs extends north to the town of Winton. North of the Winton turn-off, this spur is privately owned by the U.S. Steel Corporation. It extends north and passes 3 miles (5 km) west of the quadrangle boundary.

Physiography

The northeast quarter of Boars Tusk 15-minute quadrangle lies on the northern part of the Rock Springs uplift and within the Leucite Hills. The landscape is characterized by buttes and badland topography including a large area of migrating sand dunes located in the northern third of the quadrangle. North Table Mountain and South Table Mountain, 690 feet (210 m) and 1,050 feet (320 m) respectively, rise above Table Wash in the southeastern corner of the quadrangle. On the southwestern edge of Steamboat Mountain in the northeastern corner of the quadrangle, Steamboat Rim rises 640 feet (195 m) above the sand dune belt. The Continental Divide crosses the southeastern corner of the quadrangle. Altitudes range from approximately 6,840 feet (2,085 m) along Deer Canyon on the western edge of the quadrangle to 8,287 feet (2,526 m) on South Table Mountain.

Pine Canyon, Deer Canyon and Nitch Creek, all tributaries of Killpecker Creek, flow westerly through the west-central half of the quadrangle into the Green River Basin to the west. Table Wash drains the southeastern corner of the quadrangle into the Great Divide Basin to the east. All streams flow intermittently 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. 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), according to the U.S. Bureau of Land Management (1978).

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

Land Status

The northeast quarter of the Boars Tusk 15-minute quadrangle lies on the northern edge of the Rock Springs Known Recoverable Coal Resource Area (KRCRA). The entire quadrangle lies within the KRCRA boundary, with the Federal government owning the coal rights for approximately half of the land. Four active coal leases are present within the KRCRA boundary, as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Schultz described the geology and coal resources of the northern part of the Rock Springs coal field in 1909 and the geology and structure of the Baxter Basin and surrounding area in 1920. The Superior coal district to the southeast of the quadrangle was mapped and described by Dobbin in 1944. Hale described the stratigraphy and depositional history of the formations cropping out on the flanks of the Rock Springs uplift in 1950 and 1955. Yourston (1955) described the structure and stratigraphy of the coal-bearing formations in the Rock Springs coal field and published analyses for Rock Springs area coals. Carey reviewed the geology of the Leucite Hills area including the quadrangle in 1955.

Weimer (1960), Smith (1961), Weichman (1961), Lewis (1961), Burger (1965), and Keith (1965) described the stratigraphy and discussed the depositional environment of Upper Cretaceous sediments in the Rock Springs area. The depositional history of the Upper Cretaceous-age sediments exposed on the flanks of the Rock Springs uplift was also described by Weimer (1961) and Douglass and Blazzard (1961). Roehler (1961) described the Late Cretaceous-Tertiary unconformity present in the Rock Springs area. Lawson and Crowson (1961) described the stratigraphy of the Wasatch and Fort Union Formations in a paper on the geology of the Arch unit of the Patrick Draw field on the eastern flank of the Rock Springs uplift. Bradley (1964) discussed the stratigraphy of the Wasatch and Green River Formations in the Rock Springs uplift. Gosar and Hopkins (1969) summarized the structure and stratigraphy of Upper Cretaceous and Tertiary sediments in the southwestern part of the Rock Springs uplift. Land (1972) described the stratigraphy and depositional history and mapped the Fox Hills Sandstone and associated formations on the eastern flank of the Rock Springs uplift. Coal analyses and measured sections of coals in the Rocks Springs coal field were reported by Glass in 1975. Roehler, Swanson, and Sanchez described the geology and coal resources of the Rock Springs coal field in 1977. Roehler also prepared a geologic map of the Rock Springs uplift and adjacent areas in 1977. Unpublished data from the Rocky Mountain Energy Company (RMEC) also provided coal thickness information.

Stratigraphy

The formations in the northeast quarter of the Boars Tusk 15-minute quadrangle range in age from Late Cretaceous to Tertiary and crop out across the quadrangle in northwest-southeast-trending bands. The Blair, Rock Springs, Almond and Lance Formations, all of Late Cretaceous age, and the Fort Union Formation of Paleocene age are coal-bearing.

The Mesaverde Group of Late Cretaceous age is present in the southern half of the quadrangle and is subdivided into four formations which are, in ascending order, the Blair, the Rock Springs, the Ericson Sandstone, and the Almond.

The Blair Formation, present in the subsurface, ranges in thickness from approximately 925 to 1,040 feet (282 to 317 m) where measured in the oil and gas wells drilled in the quadrangle. The lower section of the formation is composed of a thick series of light-brown thin-bedded fine- to medium-grained sandstone occasionally containing thin coal beds. These are overlain by light-brownish-gray arenaceous siltstone and brownish-gray silty to sandy shales. The upper section of the formation consists of light-brown sandy shales, thin coals and thick brown littoral sandstones which grade upward into the sandstones of the Rock Springs Formation (Hale, 1950, 1955, Douglass and Blazzard, 1961, Smith, 1961, and Keith, 1965).

The Rock Springs Formation, conformably overlying the Blair Formation, ranges in thickness from approximately 1,440 feet to 1,830 feet (439 to 558 m) where measured in the oil and gas wells drilled in the quadrangle. Cropping out along the southern boundary of the quadrangle, the Rock Springs Formation consists of a sequence of interbedded thick coal, carbonaceous shale, siltstone, claystone, and sandstone. These paludal sediments intertongue southeast of the quadrangle with littoral sandstones and marine shales (Hale, 1950, 1955, Smith, 1961, Weichman, 1961, Keith, 1965, and Roehler, 1977).

In this quadrangle, the Ericson Sandstone is separated from the underlying Rock Springs Formation by a local unconformity (Roehler and others, 1977). The Ericson Sandstone ranges in thickness from approximately 665 to 780 feet (203 to 238 m) where measured in the oil and gas wells drilled in the quadrangle and crops out in the southern third of the quadrangle. The formation consists of light-gray, massive, cliff-forming, cross-bedded fine- to coarse-grained sandstone and conglomerate containing chert pebbles (Hale, 1950, 1955, Smith, 1961, and Roehler, 1977).

The Almond Formation, conformably overlying the Ericson Sandstone, is exposed in the southeastern, central and northwestern parts of the quadrangle. The Almond Formation, where measured in the Mesa Petroleum Company No. 1 Federal-Bass well in sec. 1, T. 23 N., R. 103 W., is approximately 720 feet (219 m) thick. The formation consists of carbonaceous shale, siltstone, mudstone and sandstone alternating with coal beds of variable thickness and quality. The upper section of the formation is predominately buff-colored to light-gray, thick-bedded to massive fossiliferous sandstone (Hale, 1950, 1955, and Roehler, 1977).

The Lewis Shale of Late Cretaceous age conformably overlies the Almond Formation and crops out along South Table and North Table Mountains in the southeastern corner of the quadrangle. This formation consists of dark-bluish-gray gypsiferous silty shale with occasional thin interbeds of sandy limestone and siltstone. Zones of calcareous concretions are found near the middle of the section with thin ripple-marked sandstones common near the base and top. The Lewis Shale is approximately 450 feet (137 m) thick where measured in the Mesa Petroleum Company No. 1 Federal-Bass well in sec. 1, T. 23 N., R. 103 W. The formation thins rapidly to the southwest. Hale (1950) reports that the Lewis Shale is 78 feet (23.8 m) thick in sec. 36, T. 23 N., R. 104 W., west of the quadrangle (Hale, 1950, 1955, Land, 1972, and Roehler, 1977).

The Fox Hills Sandstone of Late Cretaceous age conformably overlies the Lewis Shale and crops out in a narrow band west of South Table and North Table Mountains in the southeastern corner of the quadrangle. The Mesa Petroleum Company No. 1 Federal-Bass well penetrates the Fox Hills Sandstone in sec. 1, T. 23 N., R. 103 W., where it is approximately 50 feet (15 m) thick. The Fox Hills Sandstone is composed of a lower silty sandstone that is light-brown, very fine to fine-grained, and thin-bedded. This sandstone is overlain by a light-tan to very light gray, fine- to medium-grained sandstone (Land, 1972, and Roehler, 1977)

The Lance Formation of Late Cretaceous age conformably overlies the Fox Hills Sandstone. It crops out in the north-central part of the quadrangle and is approximately 400 feet (122 m) thick where measured in the Mesa Petroleum Company No. 1 Federal-Bass well in sec. 1, T. 23 N., R. 103 W. The formation thins rapidly to the southwest and wedges out across the quadrangle because of depositional thinning. The formation consists of thin beds of silty fine-grained sandstone interbedded with carbonaceous shale and coal (Hale, 1950, Land, 1972, Roehler, 1977, and Roehler and others, 1977).

The Fort Union Formation of Paleocene age, unconformably overlying the Lance Formation, crops out in the northeastern corner of the quadrangle. It consists of light-gray shale, sandy shale and siltstone, thick beds of gray-white to white coarse-grained unconsolidated sandstone, gray and brown carbonaceous shale, and thick beds of coal. The occurrence of coal and carbonaceous material is more pronounced in the lower half of the formation (Lawson and Crowson, 1961, Roehler and others, 1977, and Roehler, 1977).

The main body of the Wasatch Formation of Eocene age crops out in the northeastern corner of the quadrangle where it conformably overlies the Fort Union Formation. It consists of gray sandstone and siltstone with interbedded gray, green and red mudstone; gray and brown, partly carbonaceous shale; and sparce thin beds of gray limestone; (Bradley, 1964, Roehler, 1977, and Roehler and others, 1977).

The combined thickness of the Fort Union and Wasatch Formations where measured in the Mesa Petroleum Company No. 1 Federal-Bass well in sec. 1, T. 23 N., R. 103 W., is approximately 1,940 feet (591 m). Roehler and others (1977) state that the Fort Union Formation is between 1,000 feet (305 m) and 1,500 feet (457 m) thick in outcrops on the flanks of the Rock Springs uplift and that the Wasatch Formation may range in thickness from 1,500 (457 m) to 5,000 feet (1,524 m).

The Tipton Tongue of the Green River Formation of Eocene age conformably overlies the main body of the Wasatch Formation in the northeastern corner of the quadrangle. Bradley (1964) indicates that the Tipton Tongue is approximately 87 feet (26.5 m) thick in T. 24 N., R. 103 W. This member is characterized by numerous beds of algal deposits, oolite, and ostracod marl interbedded with buff-colored papery low-grade oil shale, platy marlstone, gray mudstone, and persistent beds of gray to brown sandstone (Bradley, 1964, and Roehler, 1977).

Extrusive igneous flows of Tertiary age (Carey, 1955, and Roehler, 1977) are exposed on Steamboat Mountain, North Table Mountain and South Table Mountain.

Recent deposits of alluvium cover the stream valleys of Nitch Creek, Deer Canyon, Pine Canyon, and Table Wash. Across the northern third of the quadrangle, a wide band of migrating sand dunes cover the Cretaceous and Tertiary deposits (Roehler, 1977).

The Upper Cretaceous formations in the northeast quarter of the Boars Tusk 15-minute quadrangle indicate the transgressions and regressions of a broad, shallow, north-south trending seaway that extended across central North America. These sediments accumulated near the western edge of the Cretaceous sea and reflect the location of the shoreline (Weimer, 1960 and 1961).

The Blair Formation, composed of intertonguing nearshore sandstones and offshore marine shales, was deposited in a shallow-water marine sequence as the Cretaceous sea regressed eastward (Douglass and Blazzard, 1961, and Gosar and Hopkins, 1969).

Both marine and continental deposits are contained in the Rock Springs Formation. Northwest of a strand line extending from approximately the southeastern corner of T. 16 N., R. 106 W., northeastward through T. 22 N., R. 100 W., the Rock Springs Formation consists of sediments deposited in swamp, deltaic and fluvial environments. Southeast of the strand line the Rock Springs Formation consists mainly of shallow-water marine deposits (Burger, 1965, Douglass and Blazzard, 1961, and Gosar and Hopkins, 1969).

Sandstones of the Ericson Sandstone were deposited in stream and floodplain environments with a source area to the northwest (Douglass and Blazzard, 1961, and Gosar and Hopkins, 1969).

Sediments of the Almond Formation reflect deposition in fresh-water coastal swamps, brackish-water lagoons and shallow-water marine environments (Hale, 1950).

The Lewis Shale is composed of neritic shale and siltstone deposited in water depths ranging from a few tens of feet to several hundred feet (Land, 1972).

The major depositional environments of the Fox Hills Sandstone include estuary, littoral and shallow neritic and were formed as the Cretaceous sea regressed eastward (Land, 1972).

The Lance Formation, consisting of swamp, lagoonal, floodplain and channel sand deposits, was deposited 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).

After the final withdrawal of the Cretaceous sea, Fort Union Formation sediments were deposited mainly in a paludal or fresh-water swamp environment across the Rock Springs uplift (Roehler, 1961, and Roehler and others, 1977) Sediments of the main body of the Wasatch Formation were deposited in an intermontane basin as fluvial and fresh-water swamp deposits (Bradley, 1964, Roehler, 1965, and Roehler and others, 1977) The Tipton Tongue of the Green River Formation contains lacustrine sediments from a deep, fresh-water lake which covered the Rock Springs uplift during the Eocene (Bradley, 1964, and Roehler, 1965). Volcanic activity resulted in leucite-rich surface lava flows which covered the fresh-water beds of the Green River Formation (Carey, 1955).

Structure

The northeast quarter of the Boars Tusk 15-minute quadrangle lies on the northern edge of the Rock Springs uplift which separates the Great Divide and Green River structural basins. The axial trace of the Rock Springs uplift, a doubly plunging asymmetric anticline, runs across the western third of the quadrangle. The anticline is asymmetric toward the west with beds on the west side of the axial trace striking northeasterly and dipping approximately 4° to 35° to the northwest. Beds on the east side of the axial trace strike northwesterly and dip approximately 5° to 8° to the northeast (Roehler and others, 1977).

Several normal faults, trending in a northeasterly direction, are located near the axial trace of the Rock Springs uplift.

COAL GEOLOGY

Coal beds of five formations were identified in the northeast quarter of the Boars Tusk 15-minute quadrangle. A single coal bed of the Blair Formation is, stratigraphically, the lowest coal bed found within the quadrangle. The Rock Springs Formation directly overlying the Blair Formation, contains several coal beds in its lower half. The coal beds of the Almond Formation are separated from the Rock Springs coal zone by approximately 1,800 feet (549 m) of sandstone and shale. A few thin coal beds of the Lance Formation, approximately 700 feet (213 m) stratigraphically above the Almond Coal Zone, and the Deadman coal bed of the Fort Union Formation were identified in the eastern part of the quadrangle.

Chemical analyses of coal.--Although no analyses were available for coal within the quadrangle, representative chemical analyses from the Rock Springs area are shown in table 1 (Glass, 1975, U.S. Bureau of Mines, 1931, Dobbin, 1944, and Yourston, 1955). No information was found on the coals of the Blair Formation.

In general, the Rock Springs Formation coals are high-volatile C bituminous in rank (Glass, 1976); the Almond Formation and Lance Formation coals are subbituminous B (Dobbin, 1944, and Yourston, 1955); and the Deadman coal bed of the Fort Union Formation is subbituminous B or C (Glass, 1975). The coals have been ranked on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Blair Coal Bed

A single oil and gas well in the north-central part of the quadrangle revealed a coal bed less than Reserve Base thickness (5 feet or

1.5 meters) within the upper section of the Blair Formation. Although the Blair Formation is known to be coal-bearing, no isopachable coal beds occur above a depth of 3,000 feet (914 m) in this quadrangle.

Rock Springs Coal Zone

Electric and radioactive logs from oil and gas wells drilled in the quadrangle have indicated coal beds, at depth, within the Rock Springs Formation. The data indicates that the coal beds vary up to 12 feet (3.7 m) in thickness, but lack of surface exposure of the coal beds put severe constraints on correlation. The bracketed numbers used in naming the coal beds are used for identification purposes in this quadrangle only and show the relative position of the coal beds within the stratigraphic sequence with higher number values indicating a higher stratigraphic position.

Rock Springs [1] through Rock Springs [29] Coal Beds

Coal beds of the Rock Springs Formation measured in the oil and gas wells drilled in the quadrangle have been identified at depths of 400 feet (122 m) to more than 3,000 feet (914 m) below the surface. Coal beds that are 5 feet (1.5 m) or more thick are shown on plates 4, 7, 10, 13 and 16. Average thicknesses of the Rock Springs coal beds range from 5 to 9 feet (1.5 to 2.7 m) although the Rock Springs [19] coal bed thickens to 11 feet (3.4 m) in sec. 30, T. 23 N., R. 103 W. Dips and dip directions vary widely in relation to the north-south-trending axis of the anticline that forms the backbone of the Rock Springs uplift.

Almond Coal Zone

Shallow coal test holes have encountered coal beds of the Almond Formation in this quadrangle. Three coal beds have been mapped and given letter names for identification purposes in this quadrangle only. Since the coal beds of the Almond Formation tend to be lenticular and limited in areal extent, correlations between these and other Almond coal beds in the quadrangles to the south cannot be made.

C Coal Bed

The C coal bed is the lowest, stratigraphically, of the mappable coal beds of the Almond Formation. Thicknesses range from 3 to 8 feet (0.9 to 2.4 m) as shown on plate 10. Thin partings ranging from 2 to 8 feet (0.6 to 2.4 m) thick may be present. Dips calculated from the structure contour map (plate 10) are less than 5° to the northeast.

B Coal Bed

The B coal bed overlies and is separated from the C coal bed by approximately 55 feet (16.8 m) of gray shale. Recorded thicknesses of the B coal bed range from 2 to 8 feet (0.6 to 2.4 m) and the coal bed dips less than 5° to the northeast.

A Coal Bed

The A coal bed is located approximately 230 feet (70 m) above the B coal bed. Mapped thicknesses of the A coal bed range from 5 to 8 feet (1.5 to 2.4 m) with 2 to 6.5 feet (0.6 to 2.0 m) of partings present. As derived from plate 16, the coal bed dips to the east at less than 5°.

Lance Coal Zone

The Lance Formation thins rapidly to the southwest in this quadrangle owing to the regional unconformity between it and the overlying Fort Union Formation. Although the coal beds in the Lance Formation are less than 5 feet (1.5 m) thick in this quadrangle, coal thicknesses tend to increase as the zone is traced southeastward in the Superior 15-minute quadrangle.

Fort Union Coal Beds

The Deadman coal bed of the Fort Union Formation was encountered in a drill hole in sec. 25, T. 23 N., R. 103 W. A drill hole in sec. 1, T. 23 N., R. 103 W., encountered two unnamed Fort Union coal beds but did not penetrate into the thick Deadman coal bed.

Deadman Coal Bed

Stratigraphically, the Deadman coal bed is located in the lower 100 feet (30 m) of the Fort Union Formation (Rochler and others, 1977, p. 31). An 11-foot (3.4 m) thickness was reported in sec. 25, T. 23 N., R. 103 W., in this quadrangle, but information from the northwest quarter of the Superior 15-minute quadrangle to the east indicates that the Deadman coal bed thins to 5 feet (1.5 m) or less as it is traced southeastward. The dip of the coal bed, as calculated from plate 16, is to the northeast at less than 5°.

The Deadman (or splits of the Deadman) coal bed can be traced for many miles along the eastern flanks of the Rock Springs uplift. This coal bed thickens significantly in the general area of the active Jim Bridger strip mine. To the north, the Deadman coal bed is difficult to trace owing to lack of reliable data, faulting, and thinning. None of the thick coal beds in the Fort Union Formation along the western edge of the uplift have been correlated with the Deadman coal bed.

Isolated Data Points

In instances where isolated measurements of coal beds of Reserve Base thickness (greater than 5 feet or 1.5 meters) 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 beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known, beds. For this reason, isolated data points are included on a separate plate for non-isopached coal beds (plate 19). The isolated points used in this quadrangle are listed below. Coal beds identified by bracketed numbers and letters are not formally named, but are used for identification purposes in this quadrangle only.

Source	Location	Coal Bed	Thickness
Union Pacific	sec. 31, T. 23 N., R. 103 W.	Al[2]	6 ft (1.8 m)
Mesa Pet.	sec. 1, T, 23 N., R. 103 W.	Al[1]	6 ft (1.8 m)

Source	Location	Coal Bed	Thickness
McBride Inc.	sec. 6, T. 23 N., R. 103 W.	RS[38]	6 ft (1.8 m)
Chandler & Associates	sec. 4, T. 22 N., R. 103 W.	RS[37]	6 ft (1.8 m)
Chandler & Associates	sec. 4, T. 22 N., R. 103 W.	RS[36]	11 ft (3.4 m)
Sohio Pet.	sec. 32, T. 23 N., R. 103 W.	RS[25]	7 ft (2.1 m)
Sohio Pet.	sec. 32, T. 23 N., R. 103 W.	RS[22]	6 ft (1.8 m)
Sohio Pet.	sec. 32, T. 23 N., R. 103 W.	RS[7]	6 ft (1.8 m)
Sohio Pet.	sec. 32, T. 23 N., R. 103 W.	RS[5]	7 ft (2.1 m)
CRA Inc.	sec. 16, T. 23 N., R. 103 W.	RS[24]	10 ft (3.0 m)
Ken Luff	sec. 31, T. 23 N., R. 103 W.	RS[31]	6 ft (1.8 m)
Ken Luff	sec. 31, T. 23 N., R. 103 W.	RS[26]	9 ft (2.7 m)
Ken Luff	sec. 31, T. 23 N., R. 103 W.	RS[18]	7 ft (2.1 m)
Ken Luff	sec. 31, T. 23 N., R. 103 W.	RS[16]	10 ft (3.0 m)
Amax Pet.	sec. 7, T. 23 N., R. 103 W.	RS[23A]	6 ft (1.8 m)
Superior Oil	sec. 29, T. 23 N., R. 103 W.	RS[18A]	8 ft (2.4 m)
Amax Pet.	sec. 18, T. 23 N., R. 103 W.	RS[17]	7 ft (2.1 m)
Amax Pet.	sec. 18, T. 23 N., R. 103 W.	RS[10]	6 ft (1.8 m)
Amax Pet.	sec. 18, T. 23 N., R. 103 W.	RS[3]	6 ft (1.8 m)
Sohio Pet.	sec. 29, T. 23 N., R. 103 W.	RS[16A]	6 ft (1.8 m)
Amax Pet.	sec. 8, T. 23 N., R. 103 W.	RS[12]	6 ft (1.8 m)

Source	Location	Coal Bed	Thickness
Sohio Pet.	sec. 6, T. 22 N., R. 013 W.	RS[11]	6 ft (1.8 m)
CRA Inc.	sec. 9, T. 23 N., R. 103 W.	RS[14]	9 ft (2.7 m)
CRA Inc.	sec. 9, T. 23 N., R. 103 W.	RS[8]	8 ft (2.4 m)
Trigood Oil	sec. 21, T. 23 N., R. 103 W.	RS[6]	6 ft (1.8 m)

COAL RESOURCES

Information from coal test holes drilled by RMEC and a measured section from Schultz (1909), as well as oil and gas well information, were used to construct isopach and structure contour maps of the coal beds in the northeast quarter of the Boars Tusk 15-minute quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4. At the request of RMEC, coal-rock data for some of their drill holes have not been shown on plate 1 or on the derivative maps. However, data from these drill holes have been used to construct the derivative maps. These data may be obtained by contacting RMEC.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 7, 10, 13, and 16) and the map of isolated data points (plate 19). The coal bed acreage (measured by planimeter) multiplied 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, or 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons for each isopached coal bed. 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 that used in calculating Reserve Base and Reserve tonnages as stated in U.S. Geological Survey Bulletin 1450-B which calls for a minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both subbituminous and bituminous coal.

Reserve Base and Reserve tonnages for the isopached coal beds are shown on plates 6, 9, 12, 15 and 18, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by isolated data points. Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 180.07 million short tons (163.36 million metric tons) for the entire quadrangle. This includes 118.58 million short tons (107.58 million metric tons) from the isolated data points. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown on tables 2 and 3.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds 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 part 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 the 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 for surface mining of coal 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.

Areas where the coal data is absent or extremely limited between the 200-foot (61-m) overburden line and the outcrop are assigned unknown development potentials for surface mining methods. This applies to the areas where no known coal beds of 5 feet (1.5 m) or more thick occur and to those areas influenced by isolated data points. Limited knowledge pertaining the to the areal distribution, thickness, depth, and attitude of the coals in these areas prevents accurate evalution of the development potential in the high, moderate, or low categories. The areas influenced by isolated data points in this quadrangle contain approximately 3.44 million short tons (3.12 million metric tons) of coal available for surface mining.

Areas classified as having coal development potential for surface mining methods are shown on plate 20. Of those Federal land areas having a known development potential, 31 percent are rated high, 16 percent are rated moderate, and 53 percent are rated low. The remaining Federal lands within the KRCRA are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

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

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to those areas influenced by isolated data points and to the areas where no known coal beds of Reserve Base thickness occur. The areas influenced by isolated data points in this quadrangle contain approximately 115.14 million short tons (104.46 million metric tons) of coal for available for subsurface mining.

Areas classified as having coal development potential for subsurface mining methods are shown on plate 21. Of those Federal land areas having known development potential for conventional subsurface mining methods, 37 percent are rated high, 31 percent are rated moderate, and 32 percent are rated low. The remaining Federal lands are classified as having unknown development potential for subsurface mining methods.

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

Table 1 -- Chemical analyses of coals in the northeast quarter of the Boars Tusk 15-minute 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
NW¼ NW¼ sec. 20, T. 21 N., R. 100 W., Jim Bridger Mine (Glass, 1975)	Deadman bed, Fort Union Formation	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
SW¼ sec. 16, T. 18 N., R. 100 W., R. S.-Gibraltar Mine (Yourston, 1955)	Lance Formation	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
SW¼ SW¼ sec. 26, T. 20 N., R. 101 W., Point of Rocks Mine (Dobbin, 1944)	Almond Formation	A	16.6	30.2	44.0	9.2	0.7	--	--	--	--	--	9,410
		C	0.0	36.3	52.7	11.0	0.8	--	--	--	--	--	11,290
sec. 3, T. 21 N., R. 103 W., Prospect Pits (U.S. Bureau of Mines, 1931)	Rock Springs Formation Undifferentiated	A	13.8	31.7	49.5	5.0	0.9	--	--	--	--	--	10,790
		C	0.0	36.8	57.4	5.8	1.0	--	--	--	--	--	12,520

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 surface mining methods for Federal coal lands (in short tons) in the northeast quarter of the Boars Tusk 15-minute quadrangle, Sweetwater County, Wyoming

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Deadman	30,000	640,000	1,920,000	0	2,590,000
Almond-A	0	210,000	560,000	0	770,000
Almond-B	0	0	620,000	0	620,000
Almond-C	0	0	200,000	0	200,000
Isolated data points	0	0	0	3,440,000	3,440,000
Total	30,000	850,000	3,300,000	3,440,000	7,620,000

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

Table 3. -- Coal Reserve Base data for subsurface mining methods for Federal coal lands (in short tons) in the northeast quarter of the Boars Tusk 15-minute quadrangle, Sweetwater County, Wyoming

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Deadman	5,070,000	0	0	0	5,070,000
Almond-B	470,000	0	0	0	470,000
Almond-C	9,660,000	0	0	0	9,660,000
Rock Springs {23}	0	2,960,000	0	0	2,960,000
Rock Springs {21}	0	1,970,000	0	0	1,970,000
Rock Springs {19}	0	5,020,000	0	0	5,020,000
Rock Springs {15}	0	2,690,000	0	0	2,690,000
Rock Springs {9}	0	930,000	0	0	930,000
Rock Springs {4}	0	8,080,000	0	0	8,080,000
Rock Springs {2}	0	0	17,570,000	0	17,570,000
Rock Springs {1}	0	0	2,890,000	0	2,890,000
Isolated data points	0	0	0	115,140,000	115,140,000
Total	15,200,000	21,650,000	20,460,000	115,140,000	172,450,000

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

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Rocky Mountain Energy Co., (no date) unpublished data	Drill hole No. 2AD
2	↓	Drill hole No. 1AS
3	Kenneth Luff, Inc.	Oil/gas well No. 1-3 Amoco Champlin
4	Chandler & Associates, Inc.	Oil/gas well No. 3-4 Federal
5	↓	Oil/gas well No. 15-4 So. Nitchie Gulch - Federal
6	Sohio Petroleum Co.	Oil/gas well No. 2 Pine Canyon Unit
7	Schultz, 1909, U.S. Geological Survey Bulletin 341-B, p. 263	Measured section
8	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
9	Kenneth Luff, Inc.	Oil/gas well No. 1-8 Anadarko Federal
10	↓	Oil/gas well No. 1-9 Champlin
11	Chandler & Associates, Inc.	Oil/gas well No. 5-10 So. Nitchie Gulch
12	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
13	↓	Drill hole No. 2-S, line A
14	↓	Drill hole No. 1AS
15	↓	Drill hole No. 2-D, line A

Page 1 of 3

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
16	J.M. Huber Corp.	Oil/gas well No. 1 State
17	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3-D, line A
18	↓	Drill hole No. 2-D, line A
19	Kenneth Luff, Inc.	Oil/gas well No. 1-17 Champlin
20	Mesa Petroleum Corp.	Oil/gas well No. 1 Federal - Bass
21	W.C. McBride, Inc.	Oil/gas well No. 1-5 Govt.
22	W. C. McBride, Inc. and Jack Grynberg	Oil/gas well No. 1 Govt. - Anderson
23	Amax Petroleum Co.	Oil/gas well No. 6-7 Nitchie Gulch Unit
24	↓	Oil/gas well No. 7-8 Pavkovich - Govt. "A"
25	C.R.A., Inc.	Oil/gas well No. 11-9 Nitchie Gulch Unit
26	↓	Oil/gas well No. 9-16 Nitchie Gulch Unit
27	Amerada Petroleum Corp.	Oil/gas well No. 1 Nitchie Gulch Unit
28	Amax Petroleum Co.	Oil/gas well No. 8-18 Pavkovich - Govt. "A"
29	Trigood Oil Co.	Oil/gas well No. 1B Chorney - Govt.

Page 2 of 3

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
30	Trigood Oil Co.	Oil/gas well No. 3 Nitchie Gulch Unit
31	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
32	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
33	Sohio Petroleum Co.	Oil/gas well No. 3 Pine Canyon Unit
34	Superior Oil Co.	Oil/gas well No. 1-29 Anderson
35	Sohio Petroleum Co.	Oil/gas well No. 10-30 Nitchie Gulch Unit
36	Kenneth Luff, Inc.	Oil/gas well No. 1-31 Champlin
37	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2AS
38	Kenneth Luff, Inc.	Oil/gas well No. 2-31 Champlin
39	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
40	Sohio Petroleum Co.	Oil/gas well No. 1 Pine Canyon Unit
41	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
42	↓	Drill hole No. 1AS

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., 1964, Geology of Green River Formation and associated Eocene rocks in southwestern Wyoming and adjacent parts of Colorado and Utah: U.S. Geological Survey Professional Paper 496-A, p. A1-A86.

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

Carey, B. D., Jr., 1955, A review of the geology of the Leucite Hills, in Green River Basin, Wyoming, Wyoming Geological Association Guidebook, 10th Annual Field Conference , 1955: p. 112-113.

Dobbin, C. E., 1944, The Superior district of the Rock Springs coal field, Sweetwater County, Wyoming: U.S. Geological Survey unpublished report, 29 p.

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.

Gosar, A. J., and Hopkins, J. C., 1969, Structure and stratigraphy of the southwest portion of the Rock Sprinsg 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

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, 16 Annual Field Conference, 1961: p. 87-95.

Rocky Mountain Energy Co., (no date), Unpublished drill hole data from the Union Pacific coal inventory of 1970.

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.

______ 1977, Geologic map of the Rock Springs uplift and adjacent areas, Sweetwater County, Wyoming: U.S. Geological Survey Open-File Report 77-242, scale 1:250,000.

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.

______ 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. 13-26.

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, 1931, Analyses of Wyoming coals: U.S. Bureau of Mines Technical Paper 484, pp. 68-75, 139-150.

Weichman, B. E., 1961, Regional correlation of the Mesaverde Group and related rocks, in Symposium on the Late Createceous 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.