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

[Report includes 32 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Reliance 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 Published and unpublished public information available through April, 1978, was used as the data base for this study.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

The Reliance quadrangle is located in central Sweetwater County, Wyoming, approximately 3 miles (4.8 km) north of the city of Rock Springs, Wyoming. The town of Reliance lies in the south-central part of the quadrangle. East Plane, Dines, and Winton are abandoned coal camps located on former spurs of the Union Pacific Railroad. Gunn, in the southeastern part of the quadrangle, is also an abandoned coal camp (U.S. Bureau of Land Management, 1978; Wyoming State Highway Commission, 1978). Stansbury, also an abandoned coal camp, is the site of the Stansbury Coal Company's active underground Stansbury No. 1 coal mine (Mining Information Services, 1978).

Accessibility

U.S. Highway 187 crosses through the southwestern part of the quadrangle connecting the city of Rock Springs to the south of the quadrangle with the town of Eden, Wyoming to the northwest of the quadrangle. A paved medium-duty road connects the town of Reliance with U.S. Highway 187 and Rock Springs. Several improved light-duty roads cross the quadrangle. One, the Winton Cutoff, crosses east-west through the northern part of the quadrangle. A second light-duty road, running north-south in the western half of the quadrangle, connects the Winton Cutoff with the Reliance road. Branches of these light-duty roads extend to the Stansbury No. 1 mine and to the abandoned coal camps of Winton, Dines, and East Plane. A third light-duty road extends north from the Winton Cutoff along the Killpecker Creek valley. Numerous unimproved dirt roads and trails provide access through the remainder of the quadrangle (U.S. Bureau of Land Management, 1971 and 1978; Wyoming State Highway Commission, 1978).

The main east-west line of the Union Pacific Railroad passes through the city of Rock Springs 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 at Rock Springs extends northward through the western half of the quadrangle. It is privately owned north of Winton Junction by the U.S. Steel Corporation and connects with South Pass City, Wyoming, northeast of the quadrangle (U.S. Bureau of Land Management, 1978).

Physiography

The Reliance quadrangle lies in the northwestern part of the Rock Springs uplift and on the northwestern edge of the Baxter Basin. The quadrangle is characterized by the relatively flat-lying valley of Killpecker Creek along the western third of the quadrangle and the flat-lying North Baxter Basin along the eastern quarter of the quadrangle. The remainder of the quadrangle consists of escarpments and dip-slope topography cut by numerous gulches and ravines. Altitudes range from less than 6,300 feet (1,920 m) on Killpecker Creek in the southwestern corner of the quadrangle to over 7,220 feet (2,201 m) in the northeaster quarter of the quadrangle.

Killpecker Creek drains the western three quarters of the quadrangle. It flows south along the western edge of the quadrangle joining Bitter Creek near the city of Rock Springs. The eastern quarter of the quadrangle is drained by Bitter Creek and unnamed creeks that flow into the North Baxter Basin. 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 typically ranging from 8°F (-13°C) to 28°F (-2°C). During July temperatures typically range from 54°F (12°C) to 84°F (29°C), with an average of 69°F (21°C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west-southwest and southwest with an average annual 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, mountain mahogany, serviceberry, and grasses (U.S. Bureau of Land Management, 1978).

Land Status

The Reliance quadrangle lies in the west-central part of the Rock Springs Known Recoverable Coal Resource Area. Approximately, the western three quarters of the quadrangle lies within the KRCRA boundary with the Federal government owning the coal rights for approximately 40 percent of this land. One active coal lease is present, as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Schultz described the geology and coal resources of the northern (1909) and the southern (1910) parts of the Rock Springs coal field, and the geology and structure of the Baxter Basin and surrounding area (1920). Dobbin (1940) mapped the Gunn-Quealy and Lindeman (1947) mapped the northern part of the Rock Springs coal field. Hale (1950 and 1955) described the stratigraphy and depositional history of the formations cropping out on the flanks of the Rock Springs uplift, and Yourston (1955) described the structure and stratigraphy of the coal-bearing formations in the Rock Springs coal field and included analyses for Rock Springs area coals. Weimer (1960), Smith (1961), Weichman (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 history of these Late Cretaceous-age formations was also described by Weimer (1961) and Douglas and Blazzard (1961). Roehler (1961) described the Late Cretaceous-Tertiary unconformity present in the Rock Springs area. Gosar and Hopkins (1969) summarized the structure and stratigraphy of Late Cretaceous- and Tertiary-age formations in the southwestern part of the Rock Springs uplift. Roehler and others described the geology and coal resources of the Rock Springs coal field in 1977. Roehler (1977) prepared a generalized geologic map of the Rock Springs uplift and reported correlations of coal beds in formations present on the western flank of the uplift in 1978. Unpublished drill hole data from Rocky Mountain Energy Company (RMEC) also provided coal thickness information.

Stratigraphy

The formations exposed in the Reliance quadrangle range in age from Late Cretaceous to Paleocene and crop out in north-south trending bands across the quadrangle. The Rock Springs and Almond Formations, both of Late Cretaceous age, and the Fort Union Formation of Paleocene age contain significant amounts of coal.

The Baxter Shale of Late Cretaceous age, cropping out on the eastern edge of the quadrangle, is composed of soft, slightly sandy, dark-gray gypsiferous shale with thin-bedded sandstone and limestone. The non-coal-bearing marine Baxter Shale, which may be up to 3,600 feet (1,097 m) thick, forms the floor of Baxter Basin (Hale, 1950 and 1955; Smith, 1961; Keith, 1965).

The Mesaverde Group of Late Cretaceous age conformably overlies and laterally intertongues with the Baxter Shale. The Mesaverde Group is subdivided into four formations which are, in ascending order, the Blair, Rock Springs, Ericson Sandstone and Almond Formations.

The Blair Formation crops out in the eastern part of the quadrangle (Roehler, 1977) where it is approximately 1,300 feet (396 m) thick. The lower part of the formation is composed of a thick series of light brown, thin-bedded, very fine grained sandstone; light-brownish-gray arenaceous siltstone; and brownish-gray silty to sandy shale with a basal layer of massive to thick-bedded, light-brown to brown, very fine to fine-grained sandstone which grades downward into the Baxter Shale. The upper part of the formation consists of light-brown sandy shale, occasional thin coal beds and thin brown sandstone which grades upward into the sandstone of the overlying Rock Springs Formation (Hale, 1950 and 1955; Smith, 1961; Keith, 1965).

The coal-bearing Rock Springs Formation, conformably overlying the Blair Formation, is approximately 1,600 to 1,800 feet (488 to 549 m) thick and crops out in a north-south trending band across the center of the quadrangle (Roehler, 1977). The Rock Springs Formation consists of a sequence of coal beds; brown, black and gray carbonaceous shale; siltstone; claystone and sandstone. These paludal sedimentary rocks intertongue to the south with massive white to light-gray, fine- to medium-grained littoral sandstone (Hale, 1950 and 1955; Smith, 1961; Weichman, 1961; Keith, 1965).

The Ericson Sandstone, approximately 500 feet (152 m) thick, crops out in a narrow band across the center of the Reliance quadrangle where it unconformably overlies the Rock Springs Formation (Roehler, 1977 and 1978; Roehler and others, 1977). The upper and lower sections of the Ericson Sandstone consist of light-gray, massive, cliff-forming, cross-bedded, fine- to coarse-grained sandstone and conglomerate containing chert pebbles. These are separated by a middle section of shale and rusty-weathering sandstone (Hale, 1950 and 1955; Smith, 1961). This middle section, often referred to as the "rusty zone," is approximately 75 feet (23 m) thick in the northern part of the quadrangle (Roehler, 1978).

The Almond Formation, conformably overlying the Ericson Sandstone, is exposed in a narrow band across the western half of the quadrangle. Because of the unconformable contact with the overlying Fort Union Formation of Paleocene age, the Almond Formation thins from north to south (Hale, 1950). Roehler (1978) reported a thickness of 600 feet (183 m) for the formation in the northern part of the quadrangle. In the Mountain Fuel Supply Company Firehole Unit No. 1 well located in sec. 12, T. 16 N., R. 106 W., southwest of the Reliance quadrangle, the Almond Formation is only 170 feet (52 m) thick where truncated and overlapped by the Fort Union Formation sediments (Gosar and Hopkins, 1969). The Almond Formation consists of carbonaceous shale, siltstone, mudstone and sandstone alternating with coal beds of variable thickness and quality (Hale, 1950 and 1955).

The Fort Union Formation unconformably overlies the Almond Formation and crops out along the western edge of the quadrangle. Hale (1950) reports that approximately 1,500 feet (457 m) of alternating micaceous sandstone, variegated shale and coal crop out in sec. 22, T. 19 N., R. 105 W., resting on the middle of the Almond Formation.

Holocene deposits of alluvium cover the stream valleys of Killpecker Creek and its tributaries.

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

Deposition of the Baxter Shale marked a westward or landward movement of the sea as shale, sandstone, and limestone were deposited in an offshore marine environment (Hale, 1950; Douglass and Blazzard, 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; Gosar and Hopkins, 1969).

Both marine and continental deposits occur 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 mostly 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 (Douglass and Blazzard, 1961; Burger, 1965; Gosar and Hopkins, 1969).

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

The Almond Formation reflects deposition in fresh-water coastal swamps, brackish-water lagoons and shallow-water marine environments (Hale, 1950).

After the final withdrawal of the Cretaceous sea, the Fort Union Formation was deposited mainly in paludal or intermonane swamp environments across the Rock Springs uplift. South of Rock Springs, thick sections of detrital material were deposited in fluvial environments surrounding a topographic high present in that area during Paleocene time (Roehler, 1961 and 1978).

Structure

The Reliance quadrangle is located on the western flank of the Rock Springs uplift which separates the Great Divide and Green River structural basins. The Rock Springs uplift is a doubly plunging 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 10° to the east. Approximately 11,000 feet (3,353 m) of sedimentary rocks of Late Cretaceous age are exposed in the core of the uplift (Gosar and Hopkins, 1969, and Yourston, 1955).

The strike of the coal beds in the Reliance quadrangle is generally to the north, with the beds dipping 5° to 17° to the west. The steeper dips are present in the northern part of the quadrangle. Bradley (1961) has mapped faults in the Blair Formation and Baxter Shale in the southeastern part of the quadrangle.

COAL GEOLOGY

Coal beds were identified in four formations in the Reliance quadrangle. A single coal bed, 1 foot (0.3 m) thick, in the Blair Formation was encountered in the subsurface and is, stratigraphically, the lowest coal bed found within the quadrangle. Several thick coal beds have been identified in the Rock Springs Formation which overlies the Blair Formation. A few coal beds have also been identified in the upper part of the Almond Formation near the unconformable contact at the bottom of the overlying Fort Union Formation. One major coal bed was penetrated by drill holes in the Fort Union Formation that is approximately 800 feet (244 m) above the unconformable contact with the underlying Almond Formation.

Chemical analyses of coal.--Analyses of representative samples of Rock Springs Formation coal from the Rock Springs quadrangle are shown in table 1. An analysis of Almond Formation coal from the Point of Rocks quadrangle, and an average analysis of Fort Union Formation coal from the Black Buttes area on the east flank of the Rock Springs uplift are also listed in the table.

In general, coals in the Rock Springs Formation are high-volatile C bituminous, the Almond Formation coal is subbituminous B, and the Fort Union coal ranks subbituminous A 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 Rock Springs Formation

Eight coal beds of Reserve Base thickness (5 feet or 1.5 meters) or greater were mapped in the quadrangle. Several other coal beds identified in drill holes and measured sections were not isopached because they were less than Reserve Base thickness.

A number system adopted by the Union Pacific Railroad is most commonly used (Schultz, 1909) to name the coal beds in the formation. The coal beds mined in the Rock Springs coal field are numbered, in ascending order, the Nos. (21), 19, 17, (15, 13), 11, 10, 9, 8, 7, 7 1/2, 1, 3, and 5. The same nomenclature is used across the field although recent stratigraphic investigations suggest that the coal beds were commonly miscorrelated (Roehler and others, 1977).

Although Schultz (1910) mapped the outcrop traces of the Rock Springs Formation coal beds in this quadrangle, more recent drill-hole data obtained from RMEC have been used to project outcrop traces on plate 1 and all subsequent plates.

Rock Springs No. 15 Coal Bed

The Rock Springs No. 15 coal bed is, stratigraphically, the lowest isopached coal bed in the Reliance quadrangle. This coal bed has a localized maximum measured thickness of 14 feet (4.3 m) in sec. 18, T. 20 N., R. 104 W. However, it is less than 5 feet (1.5 m) thick over much of the quadrangle (plate 4).

In the adjacent Rock Springs quadrangle to the south, the Rock Springs No. 15 coal bed reaches a maximum cumulative coal thickness of 10 feet (3.0 m) with 16 feet (4.9 m) of rock partings. However, the average thickness of the coal bed is only approximately 4 feet (1.2 m). The Rock Springs No. 15 coal bed becomes quite trashy to the north in the southwest quarter of the Boars Tusk 15-minute quadrangle where the coal bed has been mapped as a coal zone. Individual coal beds contained within the zone range from 2 to 7 feet (0.6 to 2.1 m) thick in that quadrangle.

Rock Springs No. 9 Coal Bed

The Rock Springs No. 9 coal bed is located approximately 140 feet (43 m) above the Rock Springs No. 15. Measured thicknesses of the coal bed (plate 6) range from 2 to 12 feet (0.6 to 3.7 m), thinning to the south. This coal bed was not isopached in the adjacent Rock Springs quadrangle because of the thin nature of the coal, but the coal bed thickens to 12.5 feet (3.8 m), locally, in the southwest quarter of the Boars Tusk 15-minute quadrangle.

Rock Springs No. 8 Coal Bed

The Rock Springs No. 8 coal bed, located approximately 35 to 70 feet (11 to 21 m) above the Rock Springs No. 9 coal bed, has been isopached on plate 10. The coal bed thickens to 10 feet (3.0 m) in the north-central part of the quadrangle and has a maximum thickness of 13 feet (4.0 m) where measured in the southwest quarter of the Boars Tusk 15-minute quadrangle. South of the Reliance quadrangle, the Rock Springs No. 8 coal bed thins considerably and does not reach Reserve Base thickness.

Rock Springs No. 7 Coal Bed

The Rock Springs No. 7 coal bed, one of the more extensive coal beds in the formation, is used as a datum on plate 3. The Rock Springs No. 7 coal bed has been isopached over much of the central part of the quadrangle (plate 13) and has a maximum measured thickness of 12 feet (3.7 m) in sec. 18, T. 20 N., R. 104 W. In the Rock Springs quadrangle, this coal bed is not as extensive, but thickens to 7.4 feet (2.3 m) where measured in drill holes in secs. 2 and 15, T. 18 N., R. 105 W. In the southwest quarter of the Boars Tusk 15-minute quadrangle, cumulative coal thicknesses ranging from 4 to 11 feet (1.2 to 3.4 m) and rock partings up to 6 feet (1.8 m) have been reported.

Rock Springs No. 7 1/2 Coal Bed

The Rock Springs No. 7 1/2 coal bed, isopached on plate 16, is located approximately 120 feet (37 m) above the Rock Springs No. 7 coal bed. The Rock Springs No. 7 1/2 coal bed thickens locally to 13 feet (4.0 m) in the north-central part of the quadrangle. In the general area of sec. 24, T. 20 N., R. 105 W., the coal bed is split by as much as 16 feet (4.9 m) of rock. To the north in sec. 11, T. 21 N., R. 104 W., in the southwest quarter of the Boars Tusk 15-minute quadrangle, the Rock Springs No. 7 1/2 coal bed thickens locally to 8 feet (2.4 m), excluding a rock parting of 2 feet (0.6 m). The coal bed thins as it is traced south from the Reliance quadrangle and it is believed to be less than Reserve Base thickness in the Rock Springs quadrangle.

Rock Springs No. 1 Coal Bed

The Rock Springs No. 1 coal bed (plate 20), generally one of the thicker and more persistant Rock Springs Formation coal beds, lies approximately 250 to 300 feet (76 to 91 m) stratigraphically above the Rock Springs No. 7 coal bed. A maximum thickness of 18 feet (5.5 m) for this coal bed was measured in sec. 24, T. 20 N., R. 105 W., the coal bed thinning gradually to the north and south of this location. In the adjacent quadangle to the north, the Rock Springs No. 1 coal bed is 13.5 feet (4.1 m) thick in sec. 15, T. 21 N., R. 104 W. In the Rock Springs quadrangle, the coal bed averages 7 feet (2.1 m) in thickness, thickening to 11 feet (3.4 m) in sec. 25, T. 19 N., R. 105 W.

The Rock Springs No. 1 coal bed commonly splits into as many as 5 distinct coal beds in many areas where it has been isopached. In some cases, thinner, less desirable coal beds were not included in the total coal isopach thickness so as not to overestimate subsurface resources. Rock partings, if any, that are present within the coal bed are shown on plate 20.

Rock Springs No. 3 Coal Bed

The Rock Springs No. 3 coal bed is separated from the Rock Springs No. 1 coal bed by approximately 150 feet (46 m) of carbonaceous shale and sandstone. The maximum measured thickness of the Rock Springs No. 3 coal bed is 8 feet (2.4 m) in sec. 24, T. 20 N., R. 105 W., and where isopached in the central part of the quadrangle (plate 24) the average thickness of the coal bed is approximately 5 feet (1.5 m). This coal bed commonly contains a rock parting that is usually less than 5 feet (1.5 m) in thickness.

In the Rock Springs quadrangle, the Rock Springs No. 3 coal bed averages approximately 5 feet (1.5 m) in thickness, thinning toward the northern boundary of the quadrangle. In the southwest quarter of the Boars Tusk 15-minute quadrangle, the coal bed is thin and trashy, thickening to a reported 6.6 feet (2.0 m) in sec. 27, T. 21 N., R. 104 W.

Rock Springs No. 5L and Rock Springs No. 5U Coal Beds

Two coal beds, located approximately 165 and 290 feet (50 and 88 m) above the Rock Springs No. 3 coal bed, have been labeled the Rock Springs No. 5L (lower split) and Rock Springs No. 5U (upper split), respectively, for descriptive purposes. The Rock Springs No 5L coal bed is less than Reserve Base thickness and has not been isopached. The Rock Springs No. 5U is usually split and commonly consists of four or more coal beds. To minimize the amount of rock partings contained within the Rock Springs No. 5U coal bed, thinner, less desirable coal beds have been excluded from some of the reported coal bed thicknesses shown on plate 28. As isopached, the coal bed attains a maximum thickness of 13 feet (4.0 m), excluding 3 feet (0.9 m) of rock partings.

The Rock Springs No. 5U coal bed is believed to be present in the Rock Springs quadrangle (mapped as the Rock Springs No. 5), where a single coal bed 11.8 feet (3.6 m) thick was measured in sec. 15, T. 18 N., R. 105 W. From this location, the coal bed thins to less than Reserve Base thickness in all directions. The Rock Springs No. 5U coal bed also thins north of the Reliance quadrangle and has not been isopached in the southwest quarter of the Boars Tusk 15-minute quadrangle.

Coal Beds of the Almond Formation

Informal names have been given to the coal beds of the Almond Formation in this quadrangle because the coal beds have not been previously named (Roehler and others, 1977). Three coal beds of Reserve Base thickness or greater, in a zone approximately 130 feet (40 m) thick, have been identified in the Reliance quadrangle and have been named, in ascending order, the Almond A, Almond Lower B, and Almond B coal beds. This zone of coal beds has also been located west of Winton in secs. 32 and 33, T. 21 N., R. 104 W., where four coal beds have an aggregate thickness of 21.3 feet (6.5 m) (Roehler and others, 1977; Roehler, 1978). Because of the lack of subsurface and surface data, and the lagoonal nature of the coal beds, Almond Formation coal beds mapped in this quadrangle have not been correlated with others found in surrounding quadrangles.

Almond A Coal Bed

The Almond A coal bed is the lowest, stratigraphically, of the coal beds isopached in the Almond Formation. It has a maximum reported thickness of 16 feet (4.9 m) in sec. 35, T. 20 N., R. 105 W., as shown on plate 29.

Almond Lower B Coal Bed

The Almond Lower B coal bed lies approximately 60 feet (18 m) stratigraphically above the Almond A coal bed and thickens to 6.5 feet (2.0 m) in sec. 25, T. 20 N., R. 105 W., as shown on plate 4.

Almond B Coal Bed

The Almond B coal bed is located, stratigraphically, approximately 60 to 100 feet (18 to 30 m) above the Almond A coal bed and ranges from 5 to 9 feet (1.5 to 2.7 m) thick where measured in the northern part of the quadrangle (plate 4).

Coal Beds of the Fort Union Formation

Only one coal bed in the Fort Union Formation greater than Reserve Base thickness, located approximately 990 feet (302 m) above the Almond Lower B coal bed, was identified in RMEC drill holes in this quadrangle. Roehler (1977) has named this coal bed, called the Fort Union No. 1 in this report, the White Mountain coal bed.

The Fort Union No. 1 (White Mountain) coal bed crops out along the western edge of the quadrangle where it averages approximately 10 feet (3 m) in thickness (plate 4). This coal bed is quite extensive and has been mapped in the Rock Springs quadrangle and in both the northwest and southwest quarters of the Boars Tusk 15-minute quadrangles. However, in these latter two quadrangles, the Fort Union No. 1 coal bed is called the B coal bed. Further south along the western flank of the Rock Springs uplift, a coal bed mapped as the D coal bed in the Firehole Basin 15-minute quadrangle may correlate with the Fort Union No. 1 coal bed in this quadrangle (Roehler, oral communication, 1979).

Oil and gas wells drilled west and northwest of the Reliance quadrangle have penetrated thick coal beds in the Fort Union Formation at depths greater than 3,000 feet (914 m). One of these is believed to be the Fort Union No. 1 coal bed. Correlations between the shallow test holes in this quadrangle and adjacent oil and gas wells are made difficult because of the rapid thickening of the Fort Union Formation to the west and the scarcity of subsurface information.

COAL RESOURCES

Information from oil and gas wells, coal test holes by RMEC, and measured sections from Schultz (1910) were used to construct isopach and structure contour maps of the coal beds in the Reliance quadrangle. 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 holes have been used to construct the derivative maps. These data may be obtained by contacting RMEC. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 6, 10, 13, 16, 20, 24, and 28). 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 thicker than 5 feet (1.5 m) 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 minimum thickness of 28 inches (70 cm) for bituminous coal and a maximum depth of 1,000 feet (305 m) for both bituminous and subbituminous coal.

Reserve Base and Reserve tonnages for the isopached coal beds are shown on plates 9, 19, 23, 27, and 30, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 47.93 million short tons (43.48 million metric tons) for the entire quadangle. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3.

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 so as 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 areas where no coal beds 5 feet (1.5 m) or more thick are known, but may occur

The coal development potential for surface mining methods is shown on plate 31. Of the Federal land areas having a known development potential for surface mining methods, 72 percent are rated high, 17 percent is rated moderate, and 23 percent are rated low. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods are 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. 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.

The coal development potential for subsurface mining methods is shown on plate 32. All of the Federal land areas classified as having known development potential for conventional subsurface mining methods are rated high. The remaining Federal land is classified as having unknown development potential for conventional subsurface mining methods.

Because all known coal beds greater than Reserve Base thickenss 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 Reliance 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
Average from Black Buttes area (Glass, 1976)	Fort Union Fm, undifferentiated	A	17.69	30.93	43.85	8.48	0.41	-	-	-	-	-	9,728
SW¼, SW¼, sec. 26, T. 20 N., R. 101 W., Point of Rocks Mine (Yourston, 1955)	Almond Formation, undifferentiated	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. 26, T. 19 N., R. 105 W., Union Pacific Old No. 5 Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 5	A	10.9	30.8	42.7	15.6	1.0	-	-	-	-	-	9,990
		C	0.0	34.6	47.9	17.5	1.1	-	-	-	-	-	10,540
NW¼, NW¼, sec. 2, T. 18 N., R. 105 W., Blairtown Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 3	A	11.5	36.8	50.1	1.6	0.8	-	-	-	-	-	12,220
		C	0.0	41.6	55.6	1.8	0.9	-	-	-	-	-	13,810
Sec. 35, T. 19 N., R. 105 W., Union Pacific No. 1 Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 1	A	8.5	35.6	50.4	5.5	0.8	-	-	-	-	-	11,830
		C	0.0	38.9	55.1	6.0	0.9	-	-	-	-	-	12,940
Sec. 26, T. 19 N., R. 105 W., Sweetwater No. 2 Mine (U.S. Bureau of Mines, 1931)	Rock Springs No. 7	A	9.8	32.6	48.6	9.0	0.9	-	-	-	-	-	11,300
		C	0.0	36.2	53.8	10.0	1.0	-	-	-	-	-	12,530

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 Reliance quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Fort Union No. 1	6,690,000	2,600,000	3,750,000	-	13,040,000
Almond Lower B	130,000	100,000	1,010,000	-	1,240,000
Almond A	300,000	740,000	1,410,000	-	2,450,000
Rock Springs Upper No. 5	-	10,000	10,000	-	20,000
Rock Springs No. 7½	430,000	20,000	20,000	-	470,000
Rock Springs No. 9	850,000	150,000	30,000	-	1,030,000
Totals	8,400,000	3,620,000	6,230,000	-	18,250,000

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 Reliance quadrangle, Sweetwater County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Fort Union No. 1	16,260,000	-	-	-	16,260,000
Almond Lower B	1,590,000	-	-	-	1,590,000
Almond B	60,000	-	-	-	60,000
Almond A	2,540,000	-	-	-	2,540,000
Rock Springs No. 3	390,000	30,000	-	-	420,000
Rock Springs No. 1	2,230,000	470,000	-	-	2,700,000
Rock Springs No. 7½	300,000	300,000	-	-	600,000
Rock Springs No. 8	-	690,000	-	-	690,000
Rock Springs No. 9	260,000	4,560,000	-	-	4,820,000
Totals	23,630,000	6,050,000	-	-	29,680,000

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. 1AS
2		Drill hole No. 5-54
3		Drill hole No. 5-55
4		Drill hole No. 5-56
5		Drill hole No. 5-3-8
6		Drill hole No. 2AS
7		Drill hole No. 5-6-8
8		Drill hole No. 3AS
9		Drill hole No. 1AS
10		Drill hole No. 6As
11		Drill hole No. 6-2-75
12		Drill hole No. 3AS
13		Drill hole No. 4AS
14		Drill hole No. 6-3-75
15		Drill hole No. 6-10-3
16		Drill hole No. 2AS
17		Drill hole No. 5AS
18		Drill hole No. 6-4-75
19		Drill hole No. 7-1-1

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
20	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 7-2-75
21	↓	Drill hole No. 7-4-1
22		Drill hole No. 1AS
23		Drill hole No. 1AS-1
24		Drill hole No. 7-9-31
25		Drill hole No. 7-4-75
26		Drill hole No. 4AS
27		Drill hole No. 17-1-75
28		Drill hole No. 5AS
29		Drill hole No. 17-1-11
30		Drill hole No. 18-1-3
31		Drill hole No. 18-1-1
32		Drill hole No. 1AS
33		Drill hole No. 3AS
34		Drill hole No. 2AS
35		Drill hole No. 18-1-75
36		Drill hole No. 83
37		Drill hole No. 1AS
38		Drill hole No. 1AS
39		Drill hole No. 2AS
40		Drill hole No. 3AS

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
41	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS
42	↓	Drill hole No. 5AD
43		Drill hole No. 4AD
44		Drill hole No. 3AD
45		Drill hole No. 2AD
46		Drill hole No. 1AD
47		Drill hole No. 1AS
48		Drill hole No. 3AS
49		Drill hole No. 2AS
50		Drill hole No. 1AD
51		Drill hole No. 5AD
52		Drill hole No. 4AD
53		Drill hole No. 3AD
54		Drill hole No. 2AD
55		Drill hole No. 1AD
56		Drill hole No. 1AS
57		Drill hole No. 2AS
58		Drill hole No. 3AS
59		Drill hole No. 1AS
60		Drill hole No. 4AS
61		Drill hole No. 2AS

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
62	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3AS
63	↓	Drill hole No. 4AS
64	↓	Drill hole No. 1AS
65	↓	Drill hole No. 2AS
66	↓	Drill hole No. 3AS
67	↓	Drill hole No. 2AS
68	↓	Drill hole No. 1AS
69	↓	Drill hole No. 3AS
70	↓	Drill hole No. 2AS
71	↓	Drill hole No. 1AS
72	Kenneth D. Luff, Inc.	Oil/gas well No. 2-21C Amoco-Champlin
73	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1AS(A)
74	↓	Drill hole No. 1AS(B)
75	↓	Drill hole No. 3AS
76	↓	Drill hole No. 2AS
77	↓	Drill hole No. 1AS
78	↓	Drill hole No. 3AS
79	↓	Drill hole No. 2AS
80	↓	Drill hole No. 1AS
81	↓	Drill hole No. 4AD

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
82	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 3AD
83		Drill hole No. 2AD
84		Drill hole No. 2AS
85		Drill hole No. 1AD
86		Drill hole No. 5AD
87		Drill hole No. 4AD
88		Drill hole No. 3AD
89		Drill hole No. 2AD
90		Drill hole No. 1AD
91		Drill hole No. 4AD
92		Drill hole No. 3AD
93		Drill hole No. 2AD
94		Drill hole No. 1AD
95		Drill hole No. 1AS
96		Drill hole No. 2AS
97		Drill hole No. 1AS
98		Drill hole No. 2AS
99		Drill hole No. 1AS
100		Drill hole No. B-1AS
101		Drill hole No. B-2AS
102		Drill hole No. 2AS

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
103	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. B-3AS
104	↓	Drill hole No. 1AS
105		Drill hole No. 2AS
106		Drill hole No. 1AS
107		Drill hole No. 2AS
108		Drill hole No. 1AS
109		Drill hole No. 2AS
110		Drill hole No. 1AS
111		Drill hole No. B-1AS
112	↓	Drill hole No. 2AS
113	Davis Oil Co. and Southland Royalty Co.	Oil/gas well No. 1 NE Pilot Butte
114	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. B-2AS
115	↓	Drill hole No. 2AS
116		Drill hole No. 3AD
117		Drill hole No. 2AD
118		Drill hole No. 1AD
119		Drill hole No. 2AD
120		Drill hole No. 1AD
121		Drill hole No. 1AS
122		Drill hole No. 2AS
123	↓	Drill hole No. 2AS

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