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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SAVERY QUADRANGLE, CARBON COUNTY, WYOMING

[Report includes 14 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 Savery quadrangle, Carbon County, Wyoming, and Moffat County, Colorado. 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 Published and unpublished public information available through June, 1979, was used as the data base for this study.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 Savery quadrangle is located in southwestern Carbon County, Wyoming, approximately 46 airline miles (74 km) southwest of Rawlins and 9 miles (15 km) east of Baggs, Wyoming. With the exception of Savery, located near the southern edge of the quadrangle, and the townsite of Slater in the southeastern corner, the quadrangle is relatively unpopulated.

Accessibility

Wyoming Highway 70 runs east-west across the southern third of the quadrangle and intersects Wyoming Highway 789 at Baggs. Wyoming Highway 789 intersects Interstate Highway 80 approximately 50 airline miles (80 km) to the north. The rest of the quadrangle is accessible by two improved light-duty roads running north from Savery (the Browns Hill Road and the road along Savery Creek), and numerous other secondary dirt roads and trails.

The Denver and Rio Grande Western Railroad line, 33 airline miles (53 km) to the south, connects Craig and Denver, Colorado. The main east-west Union Pacific Railroad line across southern Wyoming passes 43 airline miles (69 km) to the north. This line connects Ogden, Utah, to the west with Omaha, Nebraska, to the east.

Physiography

The Savery quadrangle lies on the southeastern rim of the Washakie Basin and on the western flank of the Sierra Madre uplift. The landscape within the quadrangle is characterized by mesa-like topography with deeply incised stream valleys. Dolan Mesa dominates the southwestern corner of the quadrangle. Altitudes range from approximately 6,400 feet (1,951 m) on the Little Snake River in the southwestern corner to 7,800 feet (2,377 m) along the northern border of the quadrangle.

The Little Snake River, the main drainage system in the area, crosses east-west along the southern edge of the quadrangle. Savery Creek flows southwesterly across the eastern part of the quadrangle to join the Little Snake River near the town of Savery. Cottonwood and Dutch Joe Creeks drain the northwestern part of the quadrangle and flows into the Little Snake River west of the quadrangle boundary. With the exception of the Little Snake River and Savery Creek, the streams in the quadrangle are intermittent and flow mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of south-central Wyoming is semiarid, characterized by low precipitation, rapid evaporation, and large daily temperature variations. Summers are usually dry and mild, and winters are cold. The annual precipitation in the area averages approximately 10 inches (25 cm), and approximately two thirds of this precipitation falls in the spring and summer during a seven-month period from April through October (Wyoming Natural Resources Board, 1966).

The average annual temperature in the area is 43°F (6°C). The temperature during January averages 21°F (-6°C) and typically ranges from 12°F (-11°C) to 31°F (-0.6°C). During July the average temperature is

68°F (20°C), and the temperature typically ranges from 51°F (11°C) to 84°F (29°C) (Wyoming Natural Resources Board, 1966).

Winds are usually from the southwest and the west-southwest with an average annual velocity of approximately 12 miles per hour (19 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include cottonwood, willow, juniper, aspen, grasses, sagebrush, greasewood, serviceberry, bitterbrush, saltbush, rabbitbrush, and other desert shrubs.

Land Status

The Savery quadrangle lies on the southern edge of the proposed Rawlins (Little Snake River) Known Recoverable Coal Resource Area (KRCRA). Approximately two fifths of the quadrangle lie within the proposed KRCRA boundary and the Federal government owns the coal rights for half of this land. Seven preference right lease application (PRLA) areas are present within the KRCRA boundary in this quadrangle as shown on plate 2.

GENERAL GEOLOGY

Previous Work

Ball and Stebinger described the geology and mineral resources of the eastern part of the Little Snake River coal field in 1910. Beer and Repp (1955) identified the Savery anticline in the northern part of the quadrangle. The stratigraphy and depositional environments of Upper Cretaceous rocks in Wyoming and adjacent areas were described by Hale (1961), Haun (1961), Lewis (1961), and Weimer (1961). Welder and McGreevy (1966) conducted a ground-water reconnaissance of the Great Divide and Washakie Basins of southwestern Wyoming and their report contains a geologic map of the region. Gill and others (1970) described the stratigraphy and nomenclature of some of the Upper Cretaceous and Lower Tertiary rocks found in south-central Wyoming, and Land (1972) discussed the depositional environments of the Fox Hills Sandstone and the Lance Formation. Barclay and Shoaff (1978), in their report on coal-drilling by the U.S. Geological Survey in the southern part of the proposed Rawlins (Little Snake River) KRCRA during 1977, presented a correlation diagram for Almond Formation coal beds and described the stratigraphy of the Mesaverde Group. In a report on the minutes of the proposed revision of the Rawlins (Little Snake River) KRCRA, Barclay and others (1978) included a brief description of the stratigraphy and coal geology of the KRCRA. Beaumont (1979) described the depositional environments of the Fort Union sediments in northwestern Colorado. Detailed geologic mapping of the Savery quadrangle by Barclay of the U.S. Geological Survey is in progress and preliminary results of his work have been used extensively in this report.

Stratigraphy

Rock formations exposed in the Savery quadrangle range in age from Late Cretaceous to Miocene and crop out in bands around the Savery anticline in the northern part of the quadrangle. The Almond and Allen Ridge Formations of Late Cretaceous age are the only formations within this quadrangle where measured thickneses of coal beds have been reported.

The Steele Shale is present in the subsurface of this quadrangle. In south-central Wyoming, the Steele Shale generally consists of dark-gray marine shale with sparse layers of gray-weathering limestone concretions and thin beds of very fine grained sandstone and siltstone (Gill and others, 1970; Gill, 1974; Barclay, 1976). The upper part of the Steele Shale was encountered at depths ranging from approximately 900 to 2,400 feet (274 to 732 m) in oil and gas wells drilled in this quadrangle.

The Steele Shale is conformably overlain by and laterally intertongues with the Mesaverde Group of Late Cretaceous age. In most of the Little Snake River coal field the Mesaverde Group can be subdivided into four formations which are, in ascending order, the Haystack Mountains, the Allen Ridge, the Pine Ridge Sandstone, and the Almond (Gill and others, 1970). In the southeastern part of the coal field where this quadrangle is located, the Pine Ridge Sandstone is believed to be missing (Barclay and Shoaff, 1978).

The Haystack Mountains Formation is found only in the subsurface in this quadrangle. Lithologic information on the formation given below was obtained primarily from sections by Gill (1974) and Barclay (1976) in the adjacent Browns Hill and Tullis quadrangles, respectively. The thickness data for the formation and its various members that are cited are estimates made by Barclay (1979, written communication) and are based on studies of geophysical logs from nine gas wells and test holes in the quadrangle.

The Haystack Mountains Formation, which underlies the quadrangle, has an average thickness of 935 feet (285 m) and can be subdivided into the Deep Creek Sandstone Member, the Espy Tongue, the Hatfield Sandstone Member, and an upper unnamed member as defined by Hale (1961) and Gill and others (1970) in the Atlantic Rim area south of Rawlins, Wyoming.

The Deep Creek Sandstone Member averages approximately 125 feet (38 m) thick and generally consists entirely of grayish-orange-weathering glauconitic sandstone. In some drill holes in the Savery quadrangle and on a few outcrops in the Tullis quadrangle, a clayey, shaly interval of variable thickness occurs 25 to 45 feet (8 to 14 m) below the top of the Deep Creek. Petroleum Information well-data cards show that some workers restrict the use of the term Deep Creek to the sandstone below the clayey break and apply the informal term "Boyer" to the sandstone above the break.

The Espy Tongue, genetically a part of the Steele Shale, is approximately 325 feet (100 m) thick and consists of dark-gray marine shale, a few thin limestone-concretion horizons, and a few thin grayish-orange-weathering glauconitic sandstone beds. The Espy Tongue has a sharp contact with the Deep Creek Sandstone Member and a gradational contact with the overlying Hatfield Sandstone Member. The average thickness of the Hatfield Sandstone Member in the quadrangle is 155 feet (47 m), and it consists of yellowish-gray-weathering cliff-forming sandstone and, near the middle, a minor amount of gray shale. The upper unnamed member of the Haystack Mountains Formation is composed of about 335 feet (102 m) of thickly interbedded gray shale and yellowish-gray-weathering cliff-forming sandstone.

In this quadrangle, the Allen Ridge Formation conformably overlies the Haystack Mountains Formation, crops out along Savery Creek in the northeastern quarter of the quadrangle, and is about 1,180 feet (360 m) thick in the oil and gas test holes in sec. 3, T. 12 N., R. 89 W. (Barclay, 1979, written communication). Barclay and Shoaff (1978) describe the composition of the formation as consisting largely of continental fluviatile sequences of sandstone, siltstone, mudstone, and thin carbonaceous shale and coal beds. In those parts of the Little Snake River coal field where the Pine Ridge Sandstone occurs, about 200 feet (61 m) of marginal-marine lagoonal-paludal deposits of thick, bioturbated organic-rich brown shale, thin sandstone beds and coal, which are included in the Almond Formation in this quadrangle, are assigned to an upper informal marine member of the Allen Ridge Formation (Barclay and Shoaff, 1978).

In the central and northern parts of the Little Snake River coal field, the Pine Ridge Sandstone is composed of continental fluviatile sandstone and a subordinate amount of interbedded carbonaceous siltstone and mudstone and ranges from approximately 50 to 100 feet (15 to 30 m) in thickness (Barclay and Shoaff, 1978). Barclay and Shoaff (1978) indicate that the drilled interval from 726 to 748 feet (221 to 228 m) in drill hole S-D3A (indexed data point No. 8 on plate 1) may be the Pine Ridge Sandstone.

The Almond Formation crops out in the central part of this quadrangle and is the most important coal-bearing formation (Barclay, 1979). It consists predominantly of marginal-marine, beach and coastal -plain paludal deposits (Barclay, 1979, written communication). Most of the coal beds are found in the lower part of the formation. Barclay and Shoaff (1978) use an areally-persistent marine sandstone, informally named the sandstone of Loco Creek, as the basal unit of the Almond Formation in the southeastern part of the Little Snake River coal field. This sandstone becomes the base of the marine member of the Allen Ridge

Formation where it can be traced into areas where the Pine Ridge Sandstone is identified. The Almond Formation may be as much as 930 feet (283 m) thick in this quadrangle (Barclay and Shoaff, 1978).

The Lewis Shale of Late Cretaceous age conformably overlies the Almond Formation and only a portion of the lower part of the Lewis crops out near the southern edge of the quadrangle (Barclay, 1979). A representative thickness of 160 feet (49 m) is shown on plate 3 to indicate that the formation is present in the quadrangle. To the west, in the southeastern quarter of the Baggs 15-minute quadrangle, the Lewis Shale averages approximately 2,265 feet (690 m) thick where measured in oil and gas wells. In south-central Wyoming, the shale of the Lewis is gray to olive-gray, silty to sandy, and, locally, contains fossiliferous limestone or siltstone concretions (Gill and others, 1970). According to Gill and others, the middle and upper parts of the Lewis Shale contain a distinctive and widespread unit of interstratified sandstone and sandy shale called the Dad Sandstone Member, a tongue of the overlying Fox Hills Sandstone. The upper part of the Lewis Shale, including the Dad Sandstone Member, is believed to be in the subsurface below a thick late Tertiary (Browns Park Formation) cover in the southwestern portion of the quadrangle (Barclay, 1979, written communication).

The Fox Hills Sandstone of Late Cretaceous age intertongues with the underlying marine Lewis Shale and with the overlying brackish-water and fluviatile sandstone and shale of the Lance Formation. The Fox Hills is not exposed in this quadrangle but is probably in the subsurface below the Browns Park Formation in the southwestern part (Barclay, 1979, written communication). Measurements taken from geophysical logs of oil and gas test holes indicate that the Fox Hills is approximately 160 feet (49 m) thick in the southeast quarter of the Baggs 15-minute quadrangle. This formation consists of thick units of pale-yellowish-gray, very fine to fine-grained friable sandstone, and thin units of olive-gray to dark-gray shale (Gill and others, 1970).

The Lance Formation conformably overlies the Fox Hills Sandstone. Like the Fox Hills, the Lance is not exposed in the quadrangle but is believed to be in the subsurface below the Browns Park Formation in the southwestern part of the quadrangle (Barclay, 1979, written communication). Information from oil and gas test holes indicate the average thickness of the Lance is 920 feet (280 m) in the southeast quarter of the Baggs 15-minute quadrangle. According to Barclay (1979, oral communication), the formation in the Baggs quadrangle consists of a brackish-water to non-marine sequence of carbonaceous shale, siltstone, and sandstone, commonly with one or two thick coal beds near the base.

The Fort Union Formation of Paleocene age unconformably overlies the Lance Formation. The upper part of the Fort Union is exposed in bluffs south of the west-northwest-trending fault in the southwestern corner of the quadrangle. The remainder of the formation is in the subsurface below Browns Park Formation cover on the north side of the fault. The total stratigraphic thickness of the Fort Union Formation present in this quadrangle is not known, but oil and gas well data indicate that at least 1,090 feet (332 m) of the formation is present in the southeast quarter of the Baggs 15-minute quadrangle.

The Browns Park Formation of Miocene age is present in most areas of the quadrangle and unconformably overlies older formations. The maximum thickness of the formation is approximately 520 feet (158 m) in this quadrangle. It consists of pebble and cobble conglomerate and conglomeratic sandstone in the lower part and sandstone in the upper part (Barclay, 1979, written communication).

Flood-plain alluvium and alluvial fan deposits of Holocene age cover the valleys of Cottonwood Creek, Dutch Joe Creek, Savery Creek, the Little Snake River, and their tributaries. Extensive Pleistocene deposits of gravel occur in the bluffs and mesas bordering Savery Creek and the Little Snake River (Barclay, 1979, oral communication).

The Upper Cretaceous formations in the Savery 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 sea and reflect the location of the shoreline. More particularly, the formations of the Mesaverde Group reflect the many fluctuations of the shoreline in a series of marine, marginal-marine, and non-marine beds deposited on or near eastwardly-prograding deltas (Weimer, 1961).

In south-central Wyoming, the thick marine sandstones (the Deep Creek and Hatfield Sandstone Members) found in the Haystack Mountains Formation of the Mesaverde Group were deposited in nearshore and offshore environments as marine beach or barrier bar deposits. These alternate with marine shale (Espy Tongue) deposited in a deeper-water marine environment. In most of the Little Snake River coal field, the upper unnamed member of the Haystack Mountains Formation contains deposits of marine shale, beach sandstone, and lagoonal sandstone and mudstone (Gill and others, 1970). In this quadrangle and adjacent areas, lagoonal sequences have been largely replaced by shale deposits in a more open-marine environment (Barclay, 1976; Barclay, 1979, oral communication).

All of the Allen Ridge Formation in this quadrangle was deposited in a non-marine fluvial environment (Barclay, 1979, oral communication).

The Almond Formation in this quadrangle consists of a basal transgressive-regressive sandstone beach deposit; a middle lagoonal or bay-fill sequence of carbonaceous shale, coal, and channel sandstone deposits; and an upper sequence of thick sandstone beach deposits, lagoonal deposits of carbonaceous shale and channel-filling sandstone, and open-marine shale deposits (Barclay, 1979, written communication).

Deposition of the Lewis Shale generally marks a landward progression of the Lewis sea, the final marine transgression of the Cretaceous. An exception is the Dad Sandstone Member which probably represents a later growth stage of the Rawlins delta within the Lewis Shale (Weimer, 1961, p. 27).

The Fox Hills Sandstone represents a transitional depositional environment between the deep-water marine environments of the Lewis Shale and the lagoonal and continental environments of the Lance Formation (Gill and others, 1970). Deposition of the Fox Hills Sandstone occurred in shallow marine, barrier bar, beach, estuarine, and tidal channel environments.

During the gradual recession of the last Cretaceous sea, marking the close of Cretaceous time, carbonaceous shales, mudstones, and coal beds of the Lance Formation were deposited in broad areas of estuarine, marsh, lagoonal, and coastal swamp environments (Land, 1972).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older formations were deposited as the Fort Union Formation. The conglomerates, sandstones, shales, and coals were deposited in braided-stream, flood-plain, and backswamp environments (Beaumont, 1979).

The Browns Park Formation is a continental formation consisting mostly of fluvial and eolian deposits. It once covered the entire quadrangle, but has been deeply dissected as a result of late Cenozoic uplift and erosion (Barclay, 1979, written communication).

Structure

The Savery quadrangle is located to the west of the Sierra Madre uplift and to the east of the Washakie Basin. Beer and Repp (1955) reported the location of the Savery anticline in the northern part of this quadrangle. They describe the anticline as being the east end of the Cherokee Ridge Arch, a broad west-plunging structure found to the west of the quadrangle. Dips in the quadrangle generally reflect this structure, striking northeast in the northwest part of the quadrangle with dips averaging approximately 15° northwest, and, in the southern part of the quadrangle, striking east to southeast with an average dip of approximately 9° south to southwest.

Numerous faults occur encircling the anticline, generally paralleling the strike of the beds. Displacement of one of the major faults in the southern part of the quadrangle, just north of the Little Snake River, was reported to be 160 feet (49 m) (Barclay, 1979, written communication).

COAL GEOLOGY

The Almond Formation is the principal coal-bearing formation in this quadrangle but coal also occurs in the Allen Ridge Formation and probably in the Lance and Fort Union Formations. The coal in the Almond Formation is discussed in detail on the following pages. Because of lack of data, and because the coal beds are few, thin, very lenticular, and/or deeply buried, discussion of coal in the other formations is confined to the few brief remarks below.

Coal in the Allen Ridge, Lance, and Fort Union Formations

Only a few coal beds occur in the Allen Ridge Formation in the Savery quadrangle and most are 1 to 4 feet (0.3 to 1.2 m) thick, lenticular, and occur near the base of the formation as in the Tullis quadrangle (Barclay, 1976; Barclay, 1979, oral communication). According to Barclay (1979, oral communication) the thickest outcrop of Allen Ridge coal in the Savery quadrangle is that of a bed 4 feet (1.2 m) thick occurring near the entrance to a caved and abandoned mine in the SW 1/4 sec. 14, T. 13 N., R. 89 W. Electric logs of several oil and gas test holes in the quadrangle show a couple of probable coal beds, 2 to 4 feet (0.6 to 1.2 m) thick near the base of the Allen Ridge, and on logs of a few holes, restivity excursions suggest thicker coals higher in the formation (Barclay, 1979, written communication). Because of the lack of the proper nuclear or sonic logs for the intervals containing the probable coals, the existance of these coals in the subsurface cannot be substantiated.

Thick coal beds occur in the Lance and Fort Union Formations in the Baggs quadrangle and probably occur in these formations in the subsurface in the southwestern part of this quadrangle (Barclay, 1979, oral communication). A drill hole (Kirby Royalties Montgomery No.1) in the SW 1/4 NW 1/4 sec. 18, T. 12 N., R. 90 W., in the southeast quarter of the Baggs quadrangle, intersected at least three coals, 1 to 4 feet (0.3 to 1.2 m) thick, in the lower part of the Lance Formation and six coals, 2 to 16 feet (0.6 to 4.9 m) thick, in the Fort Union Formation.

Chemical analyses of coal.--Chemical analyses were not available for coals in the Almond Formation in this quadrangle, but an average analysis from other parts of the Rawlins (Little Snake River) KRCRA is listed in table 1. An analysis of coal from the Allen Ridge Formation is included in table 1 because some coal beds in the lower part of the Almond Formation may actually be part of what is defined as the Allen Ridge Formation to the north (see the stratigraphy section of this report). In general, coals of the Allen Ridge Formation rank as high-volatile C bituminous, and coals of the Almond Formation rank subbituminous A on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Dotted lines shown on some of the derivative maps represent a limit of confidence beyond which isopach, structure contour, overburden isopach and mining ratio, and areal distribution and identified resources maps are not drawn because of insufficient data, although it is believed that the coal beds may continue to be greater than Reserve Base thickness beyond the dotted lines.

Coal beds of the Almond Formation

Data sufficient to describe the coal beds of the Almond Formation are available in only the south-central and northwestern parts of this quadrangle. Data from U.S. Geological Survey drill holes (Barclay and Shoaff, 1978) were used to project identified coal beds from the southeast quarter of the Baggs 15-minute quadrangle into the northwestern part of the Savery quadrangle. Measured sections by Ball and Stebinger (1910) and by Barclay (1979), and data from U.S. Geological Survey drill holes (Barclay and Shoaff, 1978) were used to identify the Almond coal beds in the south-central part of the Savery quadrangle.

With the exception of the Darling and Pioneer coal beds, bracketed numbers are used to identify coal beds greater than Reserve Base thickness (5 feet or 1.5 meters) in this quadrangle. The same bracketed numbers used to identify the Almond coal beds in the northwestern part of this quadrangle have been used to identify correlative coal beds in the southeast quarter of the Baggs 15-minute quadrangle.

Darling Coal Beds

The Darling coal beds are located in the south-central part of the quadrangle. The coal beds were named after the Darling mine located in sec. 5, T. 12 N., R. 89 W., as suggested by Barclay (written communication, 1979). The lower coal bed is named the Darling No. 1, and the upper coal bed is named the Darling No. 2. It is not apparent from the data available whether the Darling Nos. 1 and 2 coal beds are actually split or just two closely spaced beds. The coal beds are separated by a non-coal interval ranging in thickness from 13.5 feet (4.1 m) in a measured section near the Darling mine to 19 feet (5.8 m) in a drill hole in NE 1/4 sec. 17 (Wyoming), T. 12 N., R. 89 W. The Darling No. 1 coal bed (plate 4) ranges in thickness from 5.5 to 6 feet (1.7 to 1.8 m) where measured along the outcrop and in a drill hole, respectively. At the Darling mine, the Darling No. 2 coal bed (plate 7) has a cumulative thickness of 14.5 feet (4.4 m) and contains a rock parting 1.0 feet (0.3 m) thick. The coal bed ranges in thickness from 13.4 to 16 feet (4.1 to 4.9 m) where measured in an outcrop and a drill hole and does not contain partings at those locations.

Almond [1] Coal Bed

The Almond [1] coal bed (plate 4) was identified in one drill hole in the northwestern part of the quadrangle where it is 4 feet (1.2 m) thick. Based on drill-hole data from the southeast quarter of the Baggs 15-minute quadrangle, this coal bed is believed to be more than 10 feet (3.0 m) thick along the quadrangle boundary south of the drill hole.

Almond [2] Coal Bed

The Almond [2] coal bed (plate 7) was identified in the drill hole located in the northwestern part of the quadrangle. It lies approximately 96 feet (29 m) stratigraphically above the Almond [1] coal bed and is 6 feet (1.8 m) thick. To the west in the southeast quarter of the Baggs 15-minute quadrangle, the Almond [2] coal bed has a maximum measured thickness of 7 feet (2.1 m).

Almond [3] Coal Bed

The Almond [3] coal bed (plate 10) occurs 11.5 feet (3.5 m) stratigraphically above the Almond [2] coal bed where penetrated by a drill hole in the northwestern part of the quadrangle. At that location, the coal bed is 4.5 feet (1.4 m) thick and contains a rock parting 1 foot (0.3 m) thick. In the southeast quarter of the Baggs 15-minute quadrangle to the west, the Almond [3] coal bed ranges in thickness from 9 to 11 feet (2.7 to 3.4 m) where encountered in drill holes.

Pioneer Coal Bed

The Pioneer coal bed (plate 10) occurs approximately 225 feet (69 m) stratigraphically above the Darling coal beds in the south-central part of the quadrangle. The name of the bed was suggested by Barclay (written communication, 1979) and was derived from the Pioneer mine located in sec. 8, T. 12 N., R. 89 W. The coal bed ranges in thickness from 8 to 12 feet (2.4 to 3.7 m) where measured along the outcrop. It is 10 feet (3.0 m) thick where penetrated in two drill holes approximately 1.5 and 2 miles (2.4 and 3.2 km) south of the Pioneer mine.

COAL RESOURCES

Information from oil and gas wells, coal test holes drilled by the U.S. Geological Survey, and measured sections by Ball and Stebinger (1910) and Barclay (in preparation), were used to construct outcrop, isopach, and structure contour maps of the coal beds in the Savery quadrangle.

Coal resources were calculated using data obtained from the coal isopach maps (plates 4, 7, and 10). 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, 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 maximum depth of 1,000 feet (305 m) for subbituminous coal.

Reserve Base and Reserve tonnages for the isopached beds are shown on plates 6, 9, and 12, 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 51.30 million short tons (46.54 million metric tons) for the entire quadrangle. Reserve Base tonnages in the various development potential categories for surface and subsurface mining methods are shown in tables 2 and 3. The source of each indexed data point shown on plate 1 is listed in table 4.

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 are 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 shown below:

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

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 coal beds 5 feet (1.5 m) or more thick are not known, but may occur. Limited knowledge pertaining to the areal distribution, thickness, depth, and attitude of the coals in these areas prevents accurate evaluation of the development potential in the high, moderate, or low categories.

The coal development potential for surface mining methods is shown on plate 13. Of the Federal land areas having a known development potential for surface mining methods, 83 percent are rated high and 17 percent are rated moderate. The remaining Federal lands within the proposed 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. This applies to the areas where no known coal beds of Reserve Base thickness are not known, but may occur.

The coal development potential for subsurface mining methods is shown on plate 14. Of the Federal land areas having a known development potential for conventional subsurface mining methods, 85 percent are rated high, and 15 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°, areas within the proposed KRCRA boundary have been rated as having unknown development potential for in-situ mining methods.

Table 1. -- Chemical analyses of coals in the Savery quadrangle, Carbon County, Wyoming, and Moffat County, Colorado.

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 of 21 samples from Little Snake River coal field (Hatch and Barclay, 1979)	Almond Formation, undifferentiated	A	15.4	28.6	37.6	18.7	0.6	5.1	49.4	1.1	25.1	4,731	8,510
Southeastern part of the Rawlins KRCRA (Ball and Stebinger, 1910)	Allen Ridge Formation, undifferentiated	A	-	-	-	6.94	2.25	-	-	-	-	-	11,218

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 Savery quadrangle, Carbon County, Wyoming and Moffat County, Colorado.

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Pioneer	2,050,000	1,970,000	160,000	-	4,180,000
Almond [3]	-	-	-	-	-
Almond [2]	-	-	-	-	-
Almond [1]	-	-	-	-	-
Darling No. 2	380,000	1,010,000	-	-	1,390,000
Darling No. 1	-	-	200,000	-	200,000
Totals	2,430,000	2,980,000	360,000	-	5,770,000

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 Savery quadrangle, Carbon County, Wyoming and Moffat County, Colorado.

Coal Bed	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Pioneer	210,000	1,790,000	-	-	2,000,000
Almond [3]	10,210,000	190,000	-	-	10,400,000
Almond [2]	11,150,000	2,100,000	-	-	13,250,000
Almond [1]	12,510,000	360,000	-	-	12,870,000
Darling No. 2	4,830,000	-	-	-	4,830,000
Darling No. 1	2,180,000	-	-	-	2,180,000
Totals	41,090,000	4,440,000	-	-	45,530,000

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	Woodward and Company	Oil/gas well No. 1 Gov't
2	Ball and Stebinger, 1910, U.S. Geological Survey Bulletin 381-B	Measured Section No. 6
3	↓	Measured Section No. 7
4	Barclay, 1979, U.S. Geological Survey open-file report, in preparation	Measured Sections
5	↓	Measured Section
6	Ball and Stebinger, 1910, U.S. Geological Survey Bulletin 381-B	Measured Section No. 5
7	Barclay and Shoaff, 1978, U.S. Geological Survey Open-File Report 78-660	Drill hole, Grieve Water Well
8	↓	Drill hole No. S-D3A
9	↓	Drill hole No. S-D3
10	↓	Drill hole No. S-D6
11	Westrans Petroleum, Inc.	Oil/gas well No. 14-5 Federal
12	Sun Oil Co.	Oil/gas well No. 1 Unit Sun-Roden and McRae Gov't
13	Luff-Martinets-Alpine-Granada Oil. Co.	Oil/gas well No. 1 Blair
14	Luff, Martinets, and Alpine Oil Co.	Oil/gas well No. 1 Blair
15	↓	Oil/gas well No. 1 Gov't

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
16	Savery Oil and Gas Co.	Oil/gas well, A and H State No. 1
17	Carter Oil Co.	Oil/gas well No. 1 Unit
18	Texas Oil and Gas Corp.	Oil/gas well, Anderson B No. 1
19	Brownlie, Wallace, Armstrong, and Bander-Tom Brown, Inc.	Oil/gas well No. 2 Anderson
20	Brownlie, Wallace, Armstrong, Bander, and Tom Brown, Inc.	Oil/gas well No. 1 Anderson
21	Carter Oil Co.	Oil/gas well No. 2 Unit
22	Petroleums Explorations, Inc.	Oil/gas well No. 1 Wren
23	Luff, Martinets, Alpine, Granada Oil Co.	Oil/gas well No. 2 Taylor
24	Mountain Fuel Supply Co.	Oil/gas well No. 1 Dixon
25	Texas Oil and Gas Co.	Oil/gas well No. 1 Wren
26	Petroleums Explorations, Inc.	Oil/gas well No. 1 Lapin
27	Barclay and Shoaff, 1978, U.S. Geological Survey Open-File Report 78-660	Drill hole No. S-D1
28	↓	Drill hole No. S-D4
29	↓	Drill hole No. S-D5
30	↓	Drill hole No. S-D2

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