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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE RAGAN QUADRANGLE, UINTA COUNTY, WYOMING

[Report includes 20 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 Ragan quadrangle, Uinta 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 Published and unpublished public information available through July, 1978, was used as the data base for this study.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 Ragan quadrangle is located in west-central Uinta County approximately 11 airline miles (18 km) east of the town of Evanston and 11 airline miles (18 km) southwest of the town of Carter, Wyoming. The quadrangle is unpopulated. Ragan and Spring Valley, located on the Union Pacific Railroad in the southeastern corner of the quadrangle, are former stations on the railway.

Accessibility

Interstate Highway 80 crosses east-west through the central part of the quadrangle connecting Evanston, approximately 13 miles (21 km) to the west, and the town of Fort Bridger, approximately 13 miles (21 km) to the east. Wyoming Highway 189, a paved medium-duty road crossing northeasterly through the northern half of the quadrangle connects Interstate Highway 80 with the town of Kemmerer approximately 33 miles (53 km) to the northeast. An improved light-duty road crosses east-west through the southern half of the quadrangle, and a branch of this road connects with Wyoming Highway 189 at Interstate Highway 80 in the west-central part of the quadrangle. Numerous unimproved dirt roads and trails provide access throughout the remainder of the quadrangle (U.S. Bureau of Land Management, 1971; Wyoming State Highway Commission, 1978).

The main east-west line of the Union Pacific Railroad crosses the southeastern corner of the quadrangle. This line provides railway service across southern Wyoming, connecting Ogden, Utah, to the west with Omaha, Nebraska, to the east (U.S. Bureau of Land Management, 1978).

Physiography

The Ragan quadrangle lies on the southeastern edge of the Wyoming Overthrust Belt. The landscape within the quadrangle is characterized by northeasterly-trending ridges and valleys. The Hogsback (Oyster Ridge), located in the northeast quarter of the quadrangle, rises approximately 600 feet (183 m) above the valley of Cumberland Flats to the west. Bald Knob in the east-central part of the quadrangle rises to an elevation of 7,232 feet (2,204 m) above sea level. Altitudes in the quadrangle vary from over 7,820 feet (2,384 m) on a ridge in the south-central part of the quadrangle to less than 6,700 feet (2,042 m) on Toms Draw along the north-central edge of the quadrangle.

Big Muddy Creek and its tributaries, Soda Hollow, Antelope Creek, Byrnes Draw and Richardson Draw, drain the southeastern half of the quadrangle and flow northeasterly into Blacks Fork and the Green River east of the quadrangle boundary. The northwestern half of the quadrangle is drained by Albert Creek and its tributaries, Felton Creek, Hinshaw Creek, Litte Byrne Creek and Byrne Creek. They flow northerly into Little Muddy Creek, a tributary of the Hams Fork and the Green River. With the exception of Big Muddy Creek and Albert Creek, which flow year-round, all streams in the quadrangle are intermittent and flow mainly in response to snowmelt in the spring. Numerous springs occur throughout the quadrangle (U.S. Bureau of Land Management, 1971 and 1978; Wyoming State Highway Commission, 1978).

Climate and Vegetation

The climate of southwestern 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 averages approximately 10 inches (25 cm) and is fairly evenly distributed throughout the year (Wyoming Natural Resources Board, 1966).

The average annual temperature of the area is 39° F (4° C). The temperature during January averages 17° F (-8° C) and typically ranges from 4° F (-16° C) to 30° F (-1° C). During July, the average temperature is 62° F (17° C), and the temperature typically ranges from 43° F (6° C) to 82° F (28° C) (Wyoming Natural Resources Board, 1966; U.S. Bureau of Land Management, 1978).

Winds are usually from the west and west-southwest with an average annual velocity of approximately 15 miles per hour (24 km per hr) (U.S. Bureau of Land Management, 1978).

Principal types of vegetation in the quadrangle include grasses, sedges, sagebrush, mountain mahogany, greasewood, saltbush, rabbitbrush, serviceberry, and juniper. The area near the junction of Albert Creek and Felter Creek is utilized as cropland (U.S. Bureau of Land Management, 1978).

Land Status

The Ragan quadrangle lies on the southeastern edge of the Kemmerer Known Recoverable Coal Resource Area (KRCRA). Approximately the western two thirds of the quadrangle lie within the KRCRA boundary and the Federal government owns the coal rights for approximately 35 percent of this land, as shown on plate 2. No outstanding Federal coal leases, prospecting permits, or licenses occur within the KRCRA boundary.

GENERAL GEOLOGY

Previous Work

Veatch (1907) mapped the geology and economic resources of a large part of Lincoln and Uinta counties in southwestern Wyoming including this quadrangle. Hale (1960) described the stratigraphy of the Frontier Formation in southwestern Wyoming and Utah. Oriel and Tracey (1970) described the stratigraphy of the Evanston and Wasatch Formations present in the Kemmerer area. Coal analyses and measured sections of Adaville Formation coals in the Kemmerer coal field were reported by Glass in 1975, and Rubey and others (1975) described the stratigraphy and structure in the Kemmerer and Sage 15-minute quadrangles to the north. Myers (1977) reported on the stratigraphy of the Frontier Formation in the Kemmerer area. Roehler and others (1977) described the geology and coal resources of the Hams Fork coal region, including the Kemmerer coal field. Glass (1977) also reported analyses and described the coal-bearing formations and coal beds present in the Hams Fork coal region. Schroeder mapped the surface geology and coal resources of the Ragan quadrangle (1976a), the Meadow Draw quadrangle (1976b), the eastern half of the Guild Hollow quadrangle (1977a), and the Sulphur Creek Reservoir quadrangle (1977b). Schroeder and Lunceford (1977) mapped the geology and coal resources of the western half of the Bridger quadrangle. Schroeder (1978) prepared geophysical logs of coal test holes drilled by the U.S. Geological Survey in the Kemmerer coal field. Unpublished data from Rocky Mountain Energy Company (RMEC) provided coal thickness information.

Stratigraphy

The formations cropping out in the Ragan quadrangle range in age from Jurassic to Eocene. The Frontier and Adaville Formations, of Late Cretaceous age and cropping out in northeasterly-trending bands across the quadrangle, are coal-bearing. The Eocene-age Wasatch Formation unconformably overlies and covers parts of most of the formations in the quadrangle.

The Triassic(?)-Jurassic(?)-age Nugget Sandstone and the Late Jurassic-age Twin Creek Limestone occur within the subsurface along the eastern edge of the quadrangle where they are unconformably overlain by the Wasatch Formation. The Nugget Sandstone, approximately 700 feet (213 m) thick, consists primarily of buff-colored to pinkish-tan massive fine- to medium-grained sandstone. The Twin Creek Limestone consists of approximately 800 feet (244 m) of dark-gray thin-bedded argillaceous limestone and calcareous siltstone (Rubey and others, 1975; Schroeder, 1976a).

The oldest formations cropping out within the quadrangle have been mapped as a single unit (Schroeder, 1976a) and include the Late Jurassic Preuss Red Beds and Stump Sandstone, and the Early Cretaceous Gannett Group. Approximately 1,200 feet (366 m) of this unit occurs in the eastern part of the quadrangle and crops out in the northeastern part of the quadangle, but is completely covered by the Wasatch Formation in the southeastern part of the quadrangle (Schroeder, 1976a).

The Preuss Red Beds consist of dull-reddish- to purplish-gray sandstone, sandy siltstone, and silty claystone. The Stump Sandstone contains alternating gray to greenish-gray glauconitic fine-grained sandstone, limestone, siltstone and claystone (Furer, 1970; Rubey and others, 1975).

The basal part of the Gannett Group, the Ephraim Conglomerate, contains brick-red to dull-maroon mudstone, sandy siltstone, muddy claystone, and interbedded light-gray, red and brown sandstone with red to brown chert-bearing conglomerate lenses. The upper part of the formation consists of alternating gray limestone, red siltstone, mudstone and claystone (Eyer, 1969; Furer, 1970; Rubey and others, 1975).

The Bear River Formation of Early Cretaceous age conformably overlies the Gannett Group and crops out in a narrow band across the eastern part of the quadrangle although it is generally covered by the Wasatch Formation in the southeastern part of the quadrangle. It consists of interbedded dark-gray to black shale and claystone, olive to tan-weathering fine-grained sandstone and thin beds of fossiliferous limestone. It is approximately 500 to 600 feet (152 to 183 m) thick (Rubey and others, 1975; Schroeder, 1976a and 1976b).

The Aspen Shale of latest Early Cretaceous age conformably overlies the Bear River Formation. It crops out in a narrow band across the northeastern quarter of the quadrangle and in isolated patches within the southeastern quarter of the the quadrangle. It is composed of approximately 900 to 1,000 feet (274 to 305 m) of light- to dark-gray siltstone and shale, gray quartzitic sandstone and ridge-forming porcelanite. The porcelanite forms vegetation-bare silver-gray ridges in the lower part of the formation (Rubey and others, 1975; Schroeder, 1976a and 1976b).

The Frontier Formation of early Late Cretaceous age conformably overlies the Aspen Shale and crops out in a northeasterly-trending band through the north-central part of the quadrangle. Except for a few isolated outcrops, it is covered by the Wasatch Formation over most of the southern half of the quadrangle. Schroeder (1976a and 1976b) has subdivided the formation into lower and upper units. The lower unit consists of approximately 1,000 feet (305 m) of dark-gray shale, tan siltstone and brown sandstone which is less resistant than the remainder of the formation. The Spring Valley coal zone is in the lower part of this unit. The upper unit consists of approximately 1,200 feet (366 m) of shale and gray sandstone. The middle part of the unit, the Oyster Ridge Sandstone Member, is a prominent hogback-forming white to light-gray-weathering, oyster-bearing sandstone approximately 85 to 100 feet (26 to 30 m) thick (Schroeder, oral communication, 1979). It is underlain by a thick shale interval and overlain by shale and thin beds of gray sandstone containing the Kemmerer coal zone near the top.

The Frontier Formation is conformably overlain by the Hilliard Shale of early Late Cretaceous age. It crops out in a broad band across the western half of the quadrangle and consists of a very thick sequence of dark-gray to dark-brown marine shale, siltstone and sandy shale with a few conspicuous light-gray to light-tan fine-grained resistant sandstone beds in the upper part. The Hilliard Shale is covered by the Wasatch Formation in the southern part of the quadrangle. It is approximately 6,000 feet (1,829 m) thick in this quadrangle (Rubey and others, 1975; Schroeder, 1976a and 1976b).

The Adaville Formation of Late Cretaceous age conformably overlies the Hilliard Shale and crops out along the northwestern edge of the quadrangle. It consists of approximately 2,700 feet (823 m) of gray-brown-weathering carbonaceous shale and mudstone containing yellowish-brown to reddish-brown sandstone and siltstone and numerous coal beds. The Lazeart Sandstone Member comprises the lower 200 to 400 feet (61 to 122 m) of the formation. This prominent ledge- and cliff-forming unit is composed of light-gray to white, fine- to coarse-grained sandstone (Rubey and others, 1975; Schroeder, 1976a and 1976b).

The Evanston Formation unconformably overlies the Adaville Formation, cropping out across the northwestern corner of the quadrangle. The Hams Fork Conglomerate Member of latest Cretaceous age comprises the lower part of the formation. This member ranges up to 1,000 feet (305 m) thick and consists of boulder-conglomerate beds interbedded with white to brown calcareous sandstone. The main body of the Evanston Formation, which is Paleocene in age, consists of over 200 feet (61 m) of gray siltstone, carbonaceous claystone, shaly mudstone, quartzitic siltstone and gray carbonaceous sandstone (Schroeder, 1976a and 1976b).

The Wasatch Formation of Eocene age unconformably overlies portions of all of the formations cropping out in the quadrangle. It consists of as much as 2,000 feet (610 m) of red, maroon, yellow, and gray mudstone; yellow, brown, and gray fine- to coarse-grained sandstone; and some stream-channel conglomerates (Schroeder, 1976a and 1976b).

Holocene deposits of alluvium cover the stream valleys of Albert Creek and Big Muddy Creek and their tributaries.

The Nugget Sandstone was probably deposited in a nearshore and beach environment while the overlying Twin Creek Limestone is marine in origin (Furer, 1970; Kamis, 1977). The Preuss Red Beds and Stump Sandstone are shallow-marine in origin. The Gannett Group sediments accumulated in fluvial and lacustrine environments (Eyer, 1969; Furer, 1970).

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

The interbedded claystones, sandstones, and limestones of the Bear River Formation were deposited in a predominantly marine environment (Eyer, 1969). According to Roehler and others (1977), the formation thickens to the north, where it was deposited in mixed fluvial, paludal, and marine environments.

Deposition of the Aspen Shale marked a westward or landward movement of the sea. According to Hale (1960), the marine shales and sandstones of the Aspen Shale were deposited in water depths up to 120 feet (37 m).

Sediments of the Frontier Formation were deposited during two major transgressions and regressions of the sea. The coal beds in the upper and lower parts of the formation were deposited in coastal swamps during periods when the sea retreated eastward. The Oyster Ridge Sandstone Member is a littoral or beach deposit marking the retreat of the Cretaceous sea from the area (Hale, 1960; Myers, 1977; Roehler and others, 1977).

The marine sequence of shales and sandstones of the Hilliard Shale were deposited during a transgression of the Cretaceous sea and indicate the fluctuations of the shoreline (Roehler and others, 1977).

The Lazeart Sandstone Member at the base of the Adaville Formation is a beach deposit marking a transition from the marine deposition of the Hilliard Shale to the continental coastal plain deposition of the Adaville Formation. The sediments of the Adaville Formation were deposited in flood plains and swamps along the coastal plain (Roehler and others, 1977).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits to the west, were deposited by large streams as the conglomerates of the Hams Fork Conglomerate Member of the Evanston Formation. Environments of deposition for the main body of the Evanston Formation included streams, marshes, and, probably, ponds (Oriel and Tracey, 1970).

The Wasatch Formation is composed of continental sediments. The bright-colored mudstones were probably deposited on a flood plain and then cut by stream channels now filled with well-sorted conglomerate (Oriel and Tracey, 1970).

Structure

The Ragan quadrangle is located on the southeastern edge of the structurally complex Wyoming Overthrust Belt. Folded Paleozoic and Mesozoic rocks are thrust eastward over folded older-Cretaceous rocks with younger Cretaceous and Tertiary rocks resting unconformably on top of the older rocks. Coal-bearing strata crop out in eroded limbs of folds as long north-south trending belts bounded on the west by major thrust faults (Roehler and others, 1977). In the Ragan quadrangle, Cretaceous formations dip to the west at approximately 28°.

The Round Mountain thrust fault crosses the northwestern and southwestern corners of the quadrangle, but in both areas it is concealed by Tertiary formations. Stratigraphic displacement on the Round Mountain thrust fault may be as much as 7,000 feet (2,134 m) in the Ragan quadrangle (Cook, 1977).

COAL GEOLOGY

Coal-bearing formations in the Ragan quadrangle include the Frontier and Adaville. The Frontier Formation contains two major coal zones, the Spring Valley coal zone located near the base of the formation, and the Kemmerer coal zone located above the Oyster Ridge Sandstone Member near the top of the formation. The Willow Creek coal zone is sometimes found between the two zones in the northern half of the Kemmerer coal field, but it is not mapped as far south as the Ragan quadrangle.

The Adaville coal beds are usually located in the lower 1,200 feet (366 m) of the Adaville Formation (Glass, 1977) with the thickest coal beds resting almost directly on top of the Lazeart Sandstone Member. Several Adaville Formation coal beds are present in the Ragan quadrangle although Adaville coals are thicker and more numerous north of the Ragan quadrangle.

Coal thicknesses shown on the isopach maps accompanying this report are cumulative and do not include rock partings. The thicknesses have been corrected for dip in drill holes where the dip exceeds 25°.

Chemical analyses of coal.--An analysis of coal from the Spring Valley zone (Frontier Formation) in the Ragan quadrangle is included in table 1. Representative analyses of coal from both the Adaville Formation and Kemmerer coal zone (Frontier Formation) in the Kemmerer 15-minute quadrangle are also included.

In general, coals in the Spring Valley and Kemmerer coal zones rank as high-volatile B bituminous, and coal from the Adaville No. 1 coal bed ranks as subbituminous A. Coal from other Adaville coal beds are either subbituminous B or C (Glass, 1975). These coals have been ranked on a moist, mineral-mater-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Frontier Formation Coal Zones

The Frontier Formation coal zones occupy a belt approximately one mile (1.6 km) wide trending northeasterly in the central part of the quadrangle. Dips average 29° to the west (Schroeder, 1976a).

Spring Valley Coal Zone

Three coal beds in the Spring Valley coal zone have been isopached in the Ragan quadrangle. These coal beds have been informally named with bracketed numbers for identification purposes in this quadrangle only.

The Spring Valley [1] coal bed is, stratigraphically, the lowest coal bed isopached in this quadrangle (plate 4). The coal bed has a maximum recorded thickness of 6.5 feet (2.0 m) with 0.5 feet (0.2 m) of rock partings in sec. 18, T. 16 N., R. 117 W. It is of Reserve Base thickness (5 feet or 1.5 meters) in only a few locations in this quadrangle. In the adjacent Meadow Draw quadrangle to the north, the Spring Valley [1] coal bed attains a maximum thickness of 8 feet (2.4 m).

The Spring Valley [2] coal bed is located in the southern part of the quadrangle and lies stratigraphically above the Spring Valley [1] coal bed. It has a maximum reported thickness of 5.3 feet (1.6 m) where measured in sec. 13, T. 15 N., R. 118 W., but thins to the north and south (plate 8).

The Spring Valley [3] coal bed has been isopached in the northern part of the quadrangle, as shown on plate 8. It attains a maximum cumulative coal thickness of 6.9 feet (2.1 m) with a rock parting 2 feet (0.6 m) thick in sec. 30, T. 16 N., R. 117 W. The Spring Valley [3] is a local coal bed that thins rapidly to the north and south.

Kemmerer Coal Zone

Coal beds in the Kemmerer coal zone have not been mapped individually because they can not be correlated positively with well-known Kemmerer coal beds in other quadrangles. Therefore, cumulative thicknesses of the Kemmerer coal beds have been combined and the coal beds are isopached as a zone. Coal beds in the isopached zone usually include those coal beds that are equal to or greater than Reserve Base thickness. However, in some instances coal beds less than Reserve Base thickness have been included in the zone. Thin coal beds separated from the coal beds of Reserve Base thickness by 3 feet (0.9 m) of rock or less and equal to or greater than the thickness of the parting are included. Also, where two coal beds are less than Reserve Base thickness and separated from one another by a rock parting that is thinner than either coal bed, the cumulative thickness of the coal beds, excluding the rock parting, has been included. The isopach map of the Kemmerer coal zone is shown on plate 11.

The maximum recorded thickness for the Kemmerer coal zone is 7.9 feet (2.4 m) with 0.3 feet (0.1 m) of rock partings measured at the outcrop in sec. 24, T. 16 N., R. 118 W. The Kemmerer coal zone has not been reported in the southern part of the Ragan quadrangle. To the north in the Meadow Draw quadrangle, the Kemmerer coal zone thickens to a maximum of 18.7 feet (5.7 m).

Adaville Formation Coal Zone

Coal beds in the Adaville Formation crop out in a thin northeasterly-trending band in the northwestern corner of the quadrangle. The Adaville coals are usually numbered consecutively from the lowermost bed upward (RMEC), but where formal names are not known, the Adaville coal beds have been designated with bracketed numbers for identification purposes in this quadrangle. Dips of the Adaville coal beds is approximately 28° to the west.

The Adaville No. 1, generally the most persistent of the thick Adaville coal beds, overlies the Lazeart Sandstone Member. In this quadrangle, the Adaville No. 1 coal bed is split within an area that lies in secs. 28, 29, 32, and 33, T. 16 N., R. 118 W., and in secs. 4, and 5, T. 15 N., R. 118 W. Where the Adaville No. 1 is split, the upper coal bed is designated the Adaville No. 1A and the lower bed the Adaville No. 1B. These designations differ from those used in the Meadow Draw quadrangle where the upper split of the Adaville No. 1 is named the Adaville

No. 1B and the lower split is named the Adaville No. 1A.

The Adaville No. 1 coal bed and its upper split, the Adaville No. 1A coal bed, are shown on plate 4. The Adaville No. 1B coal bed is shown on plate 15. Maximum cumulative thickness for the Adaville No. 1 coal bed is 33.5 feet (10.2 m) with a rock interval 16.3 feet (5.0 m) thick in sec. 5, T. 15 N., R. 118 W. The maximum recorded thickness of the Adaville No. 1 coal bed in areas where it is not split is 30 feet (9.1). To the north in the Meadow Draw quadrangle, the Adaville No. 1 coal bed thickens to a maximum of 62 feet (18.9 m). The Adaville No. 1 coal bed thins to the west in the Guild Hollow quadrangle.

The Adaville [1] coal bed lies above the Adaville No. 1 coal bed in a small area in sec. 5, T. 15 N., R. 118 W. (plate 8). It has a maximum measured thickness of 9.5 feet (2.9 m), but pinches out to less than Reserve Base thickness within 1,000 feet (305 m) in all directions.

The Adaville [2] coal bed is a minor bed mapped in the northern half of the quadrangle as shown on plate 8. It is 7 feet (2.1 m) thick in sec. 28, T. 16 N., R. 118 W., but averages less than 4 feet (1.2 m) thick in most areas where the coal bed occurs.

The Adaville [3] coal bed is 11 feet (3.4 m) thick where penetrated by a drill hole in sec. 5, T. 15 N., R. 118 W. It is reported to be the thickest coal bed that lies above the Adaville No. 1 coal bed (plate 11).

The Adaville No. 4 coal bed occurs in the northern half of the quadrangle and its maximum reported thickness of 7 feet (2.1 m) was measured in sec. 21, T. 16 N., R. 118 W. This coal bed thins to the north and south (plate 11).

COAL RESOURCES

Information from coal test holes provided by RMEC and Schroeder (1978), as well as coal bed measurements by Veatch (1907) and Schroeder (1976a), were used to construct maps of the coal beds in the Ragan quadrangle. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources were calculated using data obtained from coal isopach maps (plates 4, 8, 11, and 15). 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 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 subbituminous and bituminous coal.

Reserve Base and Reserve tonnages for the coal beds in the Ragan quadrangle are shown on plate 7, 14, and 18, 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 40.32 million short tons (36.58 million metric tons) for the entire quadrangle. Reserve Base tonnages in the various development potential categories for surface and in-situ mining methods are listed 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 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 those areas where coal beds of Reserve Base thickness are not known, but may occur.

The coal development potential for surface mining methods is shown on plate 19. All of the Federal land areas within the KRCRA boundary having known development potential for surface mining methods are rated high. 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 ordinarily considered to have a development potential for conventional subsurface mining methods include those areas where the coal beds of Reserve Base thickness are between 200 feet (61 m) and 3,000 feet (914 m) below the ground surface and have dips less than 15°. Areas of high, moderate, and low development potential for conventional subsurface mining are defined by the U.S. Geological Survey as areas underlain by coal beds of Reserve Base thickness at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively. Unknown development potentials are assigned to those areas where coal data is absent or extremely limited.

All Federal lands within the KRCRA boundary in this quadrangle have been classified as having an unknown development potential for conventional subsurface mining methods because the coal beds have dips greater than 15°.

Unfaulted 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. Based on criteria provided by the U.S. Geological Survey, coal beds of Reserve Base thickness dipping between 35° and 90° with a minimum Reserve Base of 50 million short tons (45.4 million metric tons) for bituminous coal and 70 million short tons (63.5 million metric tons) for subbituminous coal have a moderate potential for in-situ development; coal beds dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61-m) overburden line and the outcrop is not included in the total coal tonnages available as it is needed for cover and containment in the in-situ process.

Because the dips of the coal beds range from 22° to 32° and the total Reserve Base tonnage available for in-situ mining is less than 50 million short tons (45.4 million metric tons), all Federal land areas within the KRCRA boundary having known development potential for in-situ mining methods have been rated low as shown on plate 20. The remaining Federal lands are classified as having unknown development potential for in-situ mining methods.

Table 1. Chemical analyses of coals in the Ragan quadrangle, Uinta 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
SW¼, SW¼, sec. 11, T. 21 N., R. 116 W., Elkol Mine (Glass, 1975)	Adaville No. 1	A	16.7	36.5	42.8	4.0	1.3	-	-	-	-	-	10,530
		C	0.0	43.8	51.4	4.8	1.5	-	-	-	-	-	12,640
SW¼, NE¼, sec. 12, T. 21 N., R. 116 W., Kemmerer No. 1 Mine (U.S. Bureau of Mines, 1931)	Kemmerer No. 1	A	5.9	37.6	49.0	7.5	1.4	-	-	-	-	-	12,370
		C	0.0	39.9	52.1	8.0	1.5	-	-	-	-	-	13,140
NW¼, sec. 12, T. 15 N., R. 118 W., Richardson Mine (U.S. Bureau of Mines, 1931)	Spring Valley	A	6.9	35.6	43.8	13.7	0.9	-	-	-	-	-	11,350
		C	0.0	38.2	47.1	14.7	1.0	-	-	-	-	-	12,180

Form of Analysis: A, as received
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 Ragan quadrangle, Uinta County, Wyoming.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Total
Adaville {3}	10,000	10,000	40,000	60,000
Adaville {2}	10,000	10,000	10,000	30,000
Adaville No. 1	3,480,000	250,000	40,000	3,770,000
Adaville No. 1A	390,000	90,000	40,000	520,000
Adaville No. 1B	330,000	90,000	90,000	510,000
Spring Valley {3}	20,000	10,000	20,000	50,000
Spring Valley {2}	20,000	10,000	40,000	70,000
Spring Valley {1}	90,000	70,000	270,000	430,000
Totals	4,350,000	540,000	550,000	5,440,000

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

Table 3. -- Coal Reserve Base data for in-situ mining methods for Federal coal lands (in short tons) in the Ragan quadrangle, Uinta County, Wyoming.

Coal Bed or Zone	Moderate Development Potential	Low Development Potential	Total
Adaville {3}	-0-	540,000	540,000
Adaville {2}	-0-	-0-	-0-
Adaville No. 1	-0-	25,510,000	25,510,000
Adaville No. 1A	-0-	3,800,000	3,800,000
Adaville No. 1B	-0-	4,470,000	4,470,000
Spring Valley {3}	-0-	-0-	-0-
Spring Valley {2}	-0-	30,000	30,000
Spring Valley {1}	-0-	530,000	530,000
Totals	-0-	34,880,000	34,880,000

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. 1, line A
2	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 132
3	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 5
4	↓	Drill hole No. 4
5	↓	Drill hole No. 3
6	↓	Drill hole No. 2
7	↓	Drill hole No. 1
8	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 2
9	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 8, line A
10	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Mine Section (Junction Mine)
11	↓	Measured Section No. 1
12	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 133
13	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
14	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 134

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
15	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, line A
16	↓	Drill hole No. 1 Offset No. 2
17	↓	Drill hole No. 1, line A
18	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 128	Measured Section No. 120
19	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 6
20	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 128	Measured Section No. 121
21	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 8
22	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 128	Measured Section No. 119
23	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 2, line A
24	↓	Measured Section
25	↓	Drill hole No. 1, line A
26	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 128	Measured Section No. 122
27	↓	Measured Section No. 123
28	↓	Measured Section No. 124

Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
29	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 7
30	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 128	Measured Section No. 125
31	↓	Measured Section No. 126
32	↓	Measured Section No. 127
33	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, line A
34	↓	Measured Section
35	↓	Measured Section
36	↓	Drill hole No. 1
37	↓	Drill hole No. 4
38	↓	Drill hole No. 5
39	↓	Drill hole No. 1
40	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 128
41	↓	Measured Section No. 129
42	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 5
43	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
44	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 130

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Table 4. -- Continued

Plate 1 Index Number	Source	Data Base
45	Rocky Mountain Energy Co., (no date), unpublished data	Measured Section
46	↓	Measured Section
47	↓	Measured Section
48	↓	Measured Section
49	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 4
50	Veatch, 1907, U.S. Geological Survey Professional Paper 56, p. 129	Measured Section No. 131
51	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1, line A
52	Schroeder, 1978, U.S. Geological Survey Open-File Report 78-658	Drill hole No. R-1
53	↓	Drill hole No. R-2
54	↓	Drill hole No. R-3
55	↓	Drill hole No. R-4
56	Schroeder, 1976a, U.S. Geological Survey, unpublished data	Measured Section No. 3
57	Rocky Mountain Energy Co., (no date), unpublished data	Drill hole No. 1
58	↓	Drill hole No. 1
59	↓	Drill hole No. 1, line A

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