UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

Open-File Report 79-1418

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE DINOSAUR QUADRANGLE RIO BLANCO AND MOFFAT COUNTIES, COLORADO AND UINTAH COUNTY, UTAH

By

AAA Engineering and Drafting, Inc.
Salt Lake City, Utah

Prepared for the U.S. Geological Survey
under contract No.14-08-0001-17457

1980

CONTENTS

ILLUSTRATIONS

TABLES

INTRODUCTION

Purpose

These maps were compiled to support the land-use planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in the Lower White River Known Recoverable Coal Resource Area (KRCRA) in response to the land-use planning requirements of the Federal Coal Leasing Amendments Act of 1976.

Published and unpublished non-proprietary data sources were used for this study. No new drilling or field mapping was done to supplement this study. No confidential or proprietary data were used.

Location

The Dinosaur quadrangle is located in Rio Blanco and Moffat Counties in northwestern Colorado and Uintah County in northeastern Utah. The city of Craig, the county seat of Moffat County, is 80 miles (128 km) northeast of the quadrangle. The city of Meeker, the county seat of Rio Blanco County, is approximately 58 miles (93 km) east-southeast of the quadrangle. The town of Rangely is 11 miles (18 km) southeast of the quadrangle and the Colorado-Utah state line runs through the central part of the quadrangle. The Colorado-Wyoming state line is 52 miles (84 km) north and the city of Vernal, Utah is 25 miles (40 km) northwest of the quadrangle.

Accessibility

Colorado State Highway 64 runs southward from the town of Dinosaur in the northeast corner of the quadrangle toward the town of Rangely. U.S. Highway 40 passes through the town of Dinosaur and provides access to Vernal, Utah and Craig, Colorado. Utah State Highway 45 runs through

part of the west-central side of the quadrangle and connects U.S. Highway 40 and Bonanza, Utah. A medium-duty paved road crosses the southeastern quarter of the quadrangle and connects Colorado State Highway 64 and Bonanza. Numerous unimproved dirt roads and jeep trails provide access to other parts of the quadrangle.

The nearest railhead is at Craig. This is the western terminus of a branch line of the Denver and Rio Grande Western Railroad connecting to Denver, Colorado. An airport is maintained near the town of Rangely.

Physiography

The general topography in the Dinosaur quadrangle includes gently sloping alluvial plains and rolling hills dissected by shallow washes. The most rugged features in the quadrangle are two long bedrock-controlled hogback ridges called Raven Ridge and Squaw Ridge. These hogbacks extend from the northwest corner of the quadrangle to the southeast corner and range from 200 to 500 ft (61 to 152 m) in height. The relief in the quadrangle is approximately 1,050 ft (320 m). The high point is 6,409 ft (1,953 m) above sea level on a prominance on Squaw Ridge in the northwest part of the quadrangle. The elevation of the low point is approximately 5,360 ft (1,634 m) in the broad gently-sloping Coyote Basin the southwest corner of the quadrangle.

The northeast part of the quadrangle is an area of low hills dissected by Snake John Wash and Dripping Rock Creek. In the northeast corner of the quadrangle a narrow hogback called Snake John Reef projects into the quadrangle approximately 1.3 miles (2.1 km) from the adjoining quadrangle to the north. This feature is a single-crested ridge up to 300 ft (91 m) high.

There are no perennial streams or rivers in the quadrangle but numerous shallow washes wind through the lowland areas in the southwest and northeast parts of the quadrangle. Most of these washes, such as Dripping Rock Creek and Coyote Wash, drain southward into the White River. Snake John Wash and other small washes in the northwest part of the quadrangle drain northward into Cliff Creek and the Green River.

Climate

The dinosaur quadrangle has a mid-latitude steppe climate and semi-arid conditions prevail in the area. The normal annual precipitation for the quadrangle is approximately 10 inches (25 cm) (U.S. Department of Commerce, (1964)).

The nearest weather data recording station is at Rangely where a record high temperature of 104^{o} (40^{o} C) and a record low of -37^{o} F (-38^{o} C) were recorded (National Weather Service Forecast Office, personal communication). The mean annual temperature at Rangely is 45.6^{o} F (7.6^{o} C). The temperatures in Dinosaur quadrangle are probably a few degrees cooler than those at Rangely (elevation 5,240 ft (1,597 m)) because of higher altitudes in the quadrangle area.

Land Status

The Dinosaur quadrangle lies at the west end of the Lower White River Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 4,807 acres (1,945 ha) of the quadrangle. The areas of non-Federal land and the KRCRA boundary are shown on plate 2 and a comparison of the area of unleased Federal coal ownership and the non-Federal land in the quadrangle area is shown in table 1.

Table 1.--Comparison of Federal and non-Federal land areas in the Dinosaur quadrangle, Rio Blanco and Moffat Counties, Colorado, and Uintah County, Utah.

Category	Approximate area (acres)[1]	Percent of quadrangle area
Non-Federal land	3,272	9
Unleased Federal coal ownership	33,093[2]	91
Total	36,365	100

[1]To convert acres to hectares, multiply acres by 0.4047.
[2]Coal is known to be present in only part of this area.

Previous Work

Gale (1910) described the coal fields of northwestern Colorado and northeastern Utah including the Lower White River field. The latest coal geology study of the quadrangle was done by Barnum (1978). Cullins (1968 and 1969) mapped the geology and coal exposures of the adjoining Banty Point and Mellen Hill quadrangles.

GENERAL GEOLOGY

Stratigraphy

Due to the lack of geologic data for the Dinosaur quadrangle the general stratigraphy described below has been adapted by Barnum (1978) from the adjoining Mellen Hill quadrangle as described by Cullins (1969). Nearly all of the sedimentary rocks exposed in the Dinosaur quadrangle are Late Cretaceous and Tertiary in age. The Upper Cretaceous rocks include the Buck Tongue of the Mancos Shale and the overlying

Mesaverde Group. The important coal beds in the quadrangle occur in the Mesaverde Group which is subdivided into the following units in ascending order: Sego Sandstone, minor coal unit, main coal unit, and upper unit. The Wasatch Formation of Eocene age unconformably overlies the upper unit of the Mesaverde Group.

The Buck Tongue of the Mancos Shale generally consists of brownish-gray, mainly noncalcareous, marine shale. The Buck Tongue contains a thin brownish-gray, orange-weathering, very fine-grained sandstone and the top 85 ft (26 m) is gypsiferous. The Buck Tongue is approximately 300 ft (91 m) thick.

The Sego Sandstone is approximately 250 ft (76 m) thick and consists of grayish-tan, brownish-gray, and very light-gray, fine- to very fine-grained sandstone interbedded with brownish-gray shale. Minor local coal beds may occur in this unit.

The minor coal unit of the Mesaverde Group consists primarily of brown to yellowish-gray, fine- to very fine-grained, limy, sandstone interbedded with gray to light-brownish-gray and brown carbonaceous shale. This unit may contain a few thin, lenticular coal beds and is approximately 750 ft (229 m) thick.

The main coal unit of the Mesaverde Group is approximately 400 ft (122 m) thick and consists of yellowish-gray to dirty-orange, very fine- to fine-grained, limy sandstone interbedded with gray and brown carbonaceous shale and coal beds. The thickest coal beds are found in the lower part of the member which is designated as the main coal zone (Barnum, 1978).

The upper unit of the Mesaverde Group is composed of brown to yellowish-gray, fine- to very fine-grained, limy, massive sandstone interbedded with yellowish-gray shale. This unit is approximately 1,100 ft (335 m) thick and contains some minor thin coal beds in the upper part.

The Wasatch Formation consists of green, grayish-green, purple, and red claystone and shale, and white to ash-gray, fine- to medium-grained sandstone. The Wasatch is approximately 300 ft (91 m) thick in the quadrangle.

Structure

The axis of the Rangely anticline plunges northwestward through the central part of section 31, T. 3 N., R. 103 W. on the east side of the quadrangle, as projected westward from the adjoining Mellen Hill quadrangle (Cullins, 1969). The Rangely anticline is asymmetric with the steeper flank to the southwest. Rocks on the northeast flank dip gently toward the axis of the Red Wash syncline which is projected to trend east-west into the northeast quarter of the quadrangle near the boundary between sections 18 and 19, T. 3 N., R. 103 W. Raven Ridge and Squaw Ridge are the surface expressions of steeply southwestward dipping beds along the monoclinal fold which forms the edge of the Uinta structural basin. A lack of geologic data prevents an extensive discussion of the structural features of the quadrangle.

COAL GEOLOGY

The thickest coal beds in the Dinosaur quadrangle occur in the main coal zone of the main coal unit of the Mesaverde Group. The main coal unit crops out in a north-south trending line in the eastern part of the

quadrangle (pl. 1). The coal beds strike north and northwest and dip from 4^{o} to 24^{o} to the west and southwest. The most persistent coal bed in the adjoining Mellen Hill quadrangle occurs at the base of the main coal zone. Other coal beds in the main coal unit are very thin, highly lenticular, and cannot be correlated for any great distance. The main coal unit is approximately 400 ft (122 m) thick.

The datum shown on plate 3 is the base of the most persistent coal bed in the main coal zone mapped by Barnum (1978), and is called coal bed 1 of the main coal zone in this report (symbol MCZ 1). The thinner coal beds in the main coal unit are lenticular and are called "local" (L) coal beds. The vertical positions of the local coal beds shown on plate 3 are only approximate. Because of the highly lenticular nature of the coal beds in this quadrangle and the uncertainty of continuity, some of the correlation lines and the datum shown on plate 3 are dashed.

Main Coal Zone, Coal Bed 1

Coal bed 1 of the main coal zone has been given the symbol MCZ 1 on plates 1 and 3. The correlation of this bed over the considerable distance between index numbers 2 and 3 is tentative. The bed ranges from 4.6 ft (1.4 m) thick at index number 6 to a maximum thickness of 8.2 ft (2.5 m) thick at index number 2 (pl. 1). On the coal isopach map (pl. 4) an insufficient data line has been drawn approximately 1/4 mile (0.4 km) from the outcrop trace because of the sparseness of data and the lenticular nature of the coal beds in this area. The MCZ 1 bed possibly correlates with the Local 1 coal bed in the adjoining Mellen Hill quadrangle to the east (AAA Engineering and Drafting, Inc., 1980).

CHEMICAL ANALYSES OF THE COAL

No chemical analyses of coal samples from the Dinosaur quadrangle are available. However, analyses of coal taken from an 11.9 ft (3.6 m) thick coal bed in the small abandoned J. W. Rector mine in the Rangely quadrangle approximately 8 miles (12.8 km) east of the Dinosaur quadrangle were reported by Cullins (1971) and are shown in table 2.

Table 2.--Proximate analyses of coal samples from the J.W. Rector Mine, NW¼SE¼ section 14, T. 1 N., R. 102 W., Rangely quadrangle, Rio Blanco County, Colorado (Cullins, 1971)

Laboratory No.	5519	5520
Air Drying loss of sample received	3.1 percent	4.8 percent
Chemical analysis, air-dried basis		
Moisture	8.55 percent	9.77 percent
Volatile matter	33.40 Do.	33.43 Do.
Fixed carbon	49.99 Do.	51.27 Do.
Ash	8.06 Do.	5.53 Do.
Sulfur	0.46 Do.	0.40 Do.
Heat value	11,080 Btu/lb[1]	11,490 Btu/lb[1]

[1]To convert Btu/lb to Kj/kg multiply by 2.326.

On the basis of these analyses, the coal bed sampled in the J. W. Rector mine is ranked as high-volatile C bituminous coal (American Society for Testing and Materials, 1977). The coal in the Dinosaur quadrangle is probably of similar quality.

MINING OPERATIONS

Gale (1910, p. 190) briefly described the coal workings in an abandoned, unnamed mine located 600 ft (183 m) east of the Colorado-Utah state line in the southern part of section 10, T. 3 N., R. 104 W. The following measurements were made at the mine entrance:

	Ft.	In.
Sandstone, hard	2	0
Shale, brown and carbonaceous	6	0
Clay, white	0	4
Coal and bone, alternate beds	4	3
Coal, good quality, mine . . . . . Base not exposed	4+	
	16	7+

Gale (1910) reported that all of the above section below the brown shale had been mined in the workings. Other coal beds are exposed in the rocks above and below this horizon, but none of them are reported to have been prospected. Because the precise location of this mine could not be determined, the mine is not shown on plate 1 of this report and the coal thicknesses described above were not included in the compilation of the derivative maps.

COAL RESOURCES

The principal source of data used in the construction of the coal isopach, structure contour, and coal-data maps was Barnum (1978).

The coal isopach map was constructed by using a point-data net derived from coal-thickness measurements of an individual coal bed obtained from surface exposures within the quadrangle boundary and a 3-mile (4.8-km)-wide zone around the quadrangle. Measured coal thickness values were used directly in the point-data net and the principle of uniform variation in thickness between data points was used to establish the position of the isopach lines.

The structure contour map was constructed by using a point-data net derived from surface exposures. The elevation of the top of the contoured coal bed was based on surface altitude referenced to mean sea level.

The overburden isopach map was based on a point-data net derived from the stratigraphic-interval thicknesses measured from the ground surface to the top of the isopached coal bed. A set of data-net points was generated by laying the structure contour map over the topographic contour map of the quadrangle and then calculating the apparent overburden thickness values at the intersections of structure contour lines and surface topographic contour lines.

Coal thickness data was obtained from the coal isopach map (pl. 4) for resource calculations. The coal-bed acreage (measured by planimeter) multiplied by the average isopach thickness of the coal bed multiplied by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons of coal per hectare-meter) for bituminous coal yields coal resources in short tons. Reserve Base and Reserve values for the MCZ 1 coal bed are shown on plate 5 and are rounded to the nearest tenth of a million short tons.

The following criteria for coal resource determinations are given in U.S. Geological Survey Bulletin 1450-B: "Measured.--Resources are computed from dimensions revealed in outcrops, trenches, mine workings, and drill holes. The points of observation and measurement are so closely spaced and the thickness and extent of coals are so well defined that the tonnage is judged to be accurate within 20 percent of true tonnage. Although the spacing of the points of observation necessary to demonstrate continuity of the coal differs from region to region according to the character of the coal beds, the points of observation are no greater than ½ mile (0.8 km) apart. Measured coal is projected to extend a ¼ mile (0.4 km) wide belt from the outcrop or points of observation or measurement.

"Indicated.--Resources are computed partly from specified measurements and partly from projection of visible data for a reasonable distance on the basis of geologic evidence. The points of observation are ½ (0.8 km) to 1½ miles (2.4 km) apart. Indicated coal is projected to extend as ½ mile (0.8 km) wide belt that lies more than ¼ mile (0.4 km) from the outcrop or points of observation or measurement.

"Inferred.--Quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and where few measurements of bed thickness are available. The estimates are based primarily on an assumed continuation from Demonstrated coal [a collective term for the sum of coal in both Measured and Indicated Resources and Reserves] for which there is geologic evidence. The points of observation are 1½ (2.4 km) to 6 miles (9.5 km) apart. Inferred coal is projected to extend as a 2¼ mile (3.6 km) wide belt that lies more than 3/4 (1.2 km) from the outcrop or points of observation or measurement." (U.S. Bureau of Mines and U.S. Geological Survey, 1976, p. B6 and B7).

Coal resource tonnages were calculated for measured, indicated, and inferred categories in the unleased areas of Federal coal land where the coal is 5 ft (1.5 m) or more thick and lies within 3,000 ft (914 m) of the surface. The criteria cited above were used in calculating Reserve Base and Reserve data in this report and differ from those stated in U.S. Geological Survey Bulletin 1450-B, which calls for a minimum thickness of 28 in (70 cm) for bituminous coal and a maximum depth of 1,000 ft (300 m).

In this study, coal 5 ft (1.5 m) or more thick lying between the ground surface and a depth of 200 ft (61 m) is considered amenable to surface mining methods; coal 5 ft (1.5 m) or more thick lying between 200 ft (61 m) and 3,000 ft (914 m) below ground level in beds having dips of less than 15^{o} is considered minable by conventional subsurface methods. Coal 5 ft (1.5 m) or more thick lying between 200 ft (61 m) and 3,000 ft (914 m) below ground level with dips greater than 15° is assumed to be suitable for in situ coal gasification methods.

Reserve Base tonnages of Federal coal per section for all isopached coal beds are shown on plate 2 and total approximately 7.3 million short tons (6.6 million metric tons) for the unleased Federal coal lands within the quadrangle. Reserve Base (in short tons) in the various development potential categories for surface and subsurface methods are shown in tables 3 and 4.

AAA Engineering and Drafting, Inc. has not made any determination of economic recovery for any of the coal beds described in this report.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn (pl. 6 and 7) 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 (U.S. Bureau of Land Management), approximate 40 acre (16-ha) parcels have been used to show the limits of high-, moderate-, or low-development-potential areas.

The designation of coal-development-potential classification is based on the highest rated coal-bearing area that may occur within any fractional part of a 40-acre (16-ha) BLM land-grid area, lot, or tract of unleased Federal coal land. For example, a certain 40-acre (16-ha) parcel is totally underlain by a coal bed of "moderate-" development-potential.

Table 3.--Coal Reserve Base data (in short tons) for surface mining methods for Federal coal lands in the Dinosaur quadrangle, Rio Blanco and and Moffat Counties, Colorado and Uintah County, Utah

Coal Bed Name	High development potential (0-10 mining ratio)	Moderate development potential (10-15 mining ratio)	Low development potential (>15 mining ratio)	Total
MCZ 1 coal bed	4,400,000	- 0 -	*	4,400,000

(To convert short tons to metric tons, multiply by 0.9072)
*Reserve Base tonnage is less than 50,000 short tons and is not added into the total Reserve Base tonnage.

Table 4.--Coal Reserve Base data (in short tons) for subsurface mining methods and in situ coal gasification methods for Federal coal lands in the in the Dinosaur quadrangle, Rio Blance and Moffat Counties, Colorado and Uintah County, Utah.

Coal Bed Name	Conventional Subsurface Methods			In Situ Coal Gasification	Total
	High development potential	Moderate development potential	Low development potential	Low development potential	
MCZ 1 coal bed	600,000	- 0 -	- 0 -	2,300,000	2,900,000

(To convert short tons to metric tons, multiply by 0.9072)

If a small corner of the same 40-acre (16-ha) area is also underlain by another coal bed of "high-" development-potential, the entire 40-acre (16-ha) area is given a "high-" development potential rating even though most of the area is rated "moderate".

Development Potential Using Surface Mining Methods

Areas where the coal beds 5 ft (1.5 m) or more in thickness are overlain by 200 ft (61 m) or less of overburden are considered to have a surface mining potential and were assigned a high-, moderate-, or low-development-potential on the basis of the mining ratio (cubic yards of overburden per ton of recoverable coal). The following formula is used to calculate mining ratios:

$$MR = \frac{t_o\ (0.896)}{t_c\ (rf)}$$

Where MR = mining ratio (cubic yards of overburden per ton of recoverable coal)

t_o = thickness of overburden (in feet)

t_c = thickness of coal (in feet)

rf = recovery factor

0.896 = factor for bituminous coal.

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 here defined as areas underlain by coal beds having mining-ratio values of 0 to 10, 10 to 15, and greater than 15, respectively. 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 (1979, unpublished data).

The coal development potential using surface mining methods is shown on plate 6. Approximately 3 percent of the unleased Federal land area in this

quadrangle is classified as having a high-development-potential and less than 1 percent has a low-development-potential using surface mining methods. The remaining Federal land in the quadrangle is unclassified because of insufficient data.

The tonnage of Reserves recoverable by surface mining methods are calculated on a recoverability factor of 85 percent (specified by the U.S. Geological Survey, unpublished data, 1979) of the Reserve Base tonnage.

Development Potential Using Subsurface Mining and In Situ Coal Gasification

The coal development potential for areas in which subsurface development of coal is assumed possible is shown on plate 7. In this quadrangle, areas where coal beds dip 15^{o} or less, are 5 ft (1.5 m) or more thick and are overlain by 200 to 1,000 ft (61 to 305 m) of overburden are considered to have a high-development-potential for conventional subsurface mining methods. Approximately 1 percent of the unleased Federal land in the quadrangle is assigned a high classification. Areas where such beds are overlain by 1,000-2,000 ft (305-610 m) and 2,000-3,000 ft (610-914 m) of overburden are rated as having moderate- or low-development-potentials, respectively. In this quadrangle there are no areas classified with a moderate- or low-development-potential using conventional subsurface mining methods. Federal coal lands not assigned a subsurface mining or in situ coal gasification development potential in this quadrangle are areas where the geologic information is insufficient and no development potential classification could be determined.

Reserve Base tonanges have been calculated for all areas where the coal beds are 5 ft (1.5 m) or more thick. Reserves are based on a recoverability factor of 50 percent (specified by the U.S. Geological Survey, unpublished data, 1979) and have been calculated for only that part of the

Reserve Base considered to be suitable for conventional subsurface mining methods. An arbitrary dip limit of 15^{o} is assumed to be the maximum dip suitable for conventional subsurface mining methods, and Reserves have not been calculated for those areas where the dip of the coal beds exceeds 15^{o}.

Areas that contain beds dipping in excess of 15^{o} beyond the stripping limit are considered to have potential for development only by in situ coal gasification methods. Such areas are rated as low development potential where the coal beds exceed 5 ft (1.5 m) in thickness and occur between 200 and 3000 ft (61-914 m) below the ground surface.

The recoverability of resources from coal beds with dips greater than 15 degrees is unknown; therefore, coal Reserves have not been calculated for those beds, but the Reserve Base tonnages have been determined and are shown on plate 5. These tonnages are included in the Reserve Base figures on plate 2.

REFERENCES

AAA Engineering and Drafting, Inc., 1980, Coal resource occurrence and coal development potential maps of the Mellen Hill quadrangle, Rio Blanco and Moffat Counties, Colorado: U.S. Geol. Survey Open-File Report 79-1420.

American Society for Testing and Materials, 1977, Standard specifications for classification of coals by rank, in Gaseous fuels, coal, and coke; atmospheric analysis: ASTM Publication D 388-77.

Barnum, B. E., 1978, U.S. Geol. Survey unpublished map and field notes, Dinosaur Quadrangle, Rio Blanco and Moffat Counties, Colorado and Uintah County, Utah.

Cullins, H. L., 1968, Geologic map of the Banty Point quadrangle, Rio Blanco County, Colorado: U.S. Geol. Survey Geologic Quadrangle Map GQ-703.

Cullins, H. L., 1969, Geologic map of the Mellen Hill quadrangle, Rio Blanco and Moffat Counties, Colorado: U.S. Geol. Survey Geologic Quadrangle Map GQ-835.

Cullins, H. L., 1971, Geologic map of the Rangely quadrangle, Rio Blanco County, Colorado: U.S. Geol. Survey Geologic Quadrangle Map GQ-903.

Gale, H. S., 1910, Coal fields of northwestern Colorado and northeastern Utah: U.S. Geol. Survey Bull. 415.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geol. Survey Bull. 1450-B.

U.S. Department of Commerce, (1964), Normal annual precipitation, 1931-1960, Colorado: Environmental Science Services Admin., Weather Bureau.