UNITED STATES DEPARTMENT OF THE INTERIOR

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# COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE GILLAM DRAW QUADRANGLE RIO BLANCO COUNTY, COLORADO

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CONTENTS

## ILLUSTRATIONS

Plates 1-13 Coal resource occurrence and coal development potential maps:

1. Coal data map
2. Boundary and coal data map
3. Coal data sheet
4. Isopach map of coal bed 4, main coal zone
5. Structure contour map of coal bed 4, main coal zone
6. Overburden isopach map of coal bed 4, main coal zone
7. Areal distribution and identified resources map of coal bed 4, main coal zone
8. Isopach map of coal bed 3, main coal zone
9. Structure contour map of coal bed 3, main coal zone
10. Overburden isopach map of coal bed 3, main coal zone
11. Areal distribution and identified resources map of coal bed 3, main coal zone
12. Coal development potential map for surface mining methods.
13. Coal development potential map for subsurface mining methods

## FIGURES

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Published and unpublished non-proprietary data sources were used as data sources for this study.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

## Location

The Gillam Draw quadrangle is located in Rio Blanco County in northwestern Colorado. The city of Craig, the county seat of Moffat County, is about 66 miles (106 km) northeast of the quadrangle. The city of Meeker, the county seat of Rio Blanco County, is approximately 38 miles (61 km) east of the quadrangle. The town of Rangely is 1.7 miles (2.7 km) west of the quadrangle and the Colorado-Utah state line is 16 miles (26 km) west. The Colorado-Wyoming state line is 61 miles (98 km) north of the quadrangle. The city of Vernal, Utah is 47 miles (75 km) northwest of the quadrangle.

## Accessibility

Colorado State Highway 64 crosses the northwestern quarter of the quadrangle on the White River flood plain. This highway connects Meeker and Rangely. A light-duty road crosses the northeastern quarter of the quadrangle in a northwest-southeast direction and joins Colorado State Highway 64 to the north of the quadrangle. An unimproved dirt road follows the Gillam Draw drainage through the central part of the quadrangle. Several other unimproved dirt roads and jeep trails provide access to the more rugged areas 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 with connections to Denver, Colorado. An airport is maintained near the town of Rangely.

## Physiography

The general topography in the Gillam Draw quadrangle is hilly but not extremely rugged. The relief is approximately 2,380 ft (725 m) with the highest point in the quadrangle being slightly over 7,640 ft (2,329 m) above sea level on a mountain in the southeast corner of the quadrangle. The elevation of the low point is about 5,260 ft (1,603 m) where the White River leaves the northwest quarter of the quadrangle. The most rugged part is in the southeast quarter of the quadrangle where the West Fork of Spring Creek is 1,200 ft (366 m) below the high peak to the east.

## Climate

The Gillam Draw quadrangle has a mid-latitude steppe climate and semiarid conditions prevail in the area. The normal annual precipitation

for the quadrangle ranges from 9 inches (23 cm) in the northwestern part of the quadrangle to 13 inches (33 cm) in the southeast corner. (U.S. Department of Commerce, (1964)).

The nearest weather recording station is at Rangely where a record high temperature of 104° (40° C) and a record low temperature of -37° F (-38° C) were recorded (National Weather Service Forecast Office, personal communication). The mean annual temperature at Rangely is 45.6° F (7.6° C). The temperatures in the Gillam Draw quadrangle are expected to be a few degrees cooler than at Rangely (elevation, 5,240 ft (1,597 m)) because of the higher altitudes in the quadrangle area. A flood hazard exists along the flood plain of the White River.

## Land Status

The Gillam Draw quadrangle lies in the central part of the Lower White River Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 13,470 acres (5,451 ha) of the quadrangle. Plate 2 shows areas of non-Federal land and the KRCRA boundary. There were no Federal coal leases or preference right lease applications in this quadrangle at the date of the land check for this report shown on plate 2. A comparison of the Federal coal ownership and the non-Federal lands in the quadrangle area are shown in table 1.

Table 1.--Comparison of Federal and non-Federal land areas in the Gillam Draw quadrangle, Rio Blanco County, Colorado.

| Category | Approximate area (acres)[1] | Percent of quadrangle area |
|---|---|---|
| Non-Federal land | 1,400 | 4 |
| Unleased Federal coal ownership | 35,150 [2] | 96 |
| Total | 36,550 | 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 the northwestern Colorado and northeastern Utah including the Lower White River field. Barnum (1978) mapped and measured the surface exposures of coal beds in and around the Gillam Draw quadrangle and made a preliminary correlation of these beds. A series of coal test holes was described by Garrigues (1976) and by Barnum and others (1977). Barnum and Garrigues (1980) made a study of the coal deposits and geology of the adjoining Cactus Reservoir quadrangle.

# GENERAL GEOLOGY

## Stratigraphy

Sedimentary rocks exposed in the Gillam Draw quadrangle are Late Cretaceous and Tertiary in age. The important coal beds in the area occur in rocks of the Mesaverde Group of Late Cretaceous age. This group has been divided, in ascending order, into the Sego Sandstone, lower unit, coal unit, and upper unit by Barnum and Garrigues (1980). The Wasatch Formation of Paleocene and Eocene ages overlies the Mesaverde Group.

The Sego Sandstone consists primarily of grayish-yellow, mostly massive, fine-grained sandstone that is locally interbedded with brownish-gray shale. The Sego is approximately 200 ft (61 m) thick.

The lower unit of the Mesaverde Group may be equivalent to the Iles Formation and is approximately 800 ft (244 m) thick. It consists of light-yellow to brown, mostly massive, fine-grained sandstone interbedded with gray shale and brown carbonaceous shale with coal streaks.

The coal unit of the Mesaverde Group is approximately 400 ft (122 m) thick and consists of light yellowish-gray, fine- to very fine-grained sandstone interbedded with gray shale, brown carbonaceous shale, and coal. Commercially valuable coal occurs in this unit and some mines have operated in the coal beds.

The upper unit of the Mesaverde Group is composed of light-yellow, fine- to very fine-grained sandstone interbedded with light-gray to black shale. The upper unit is approximately 1,700 ft (518 m) thick.

The Wasatch Formation overlies the upper unit of the Mesaverde Group and consists of variegated shale and claystone interbedded with medium-grained sandstone. The Wasatch is approximately 500 ft (152 m) thick

## STRUCTURE

The Gillam Draw quadrangle lies on the southeast end of the Rangely anticline and west of the high escarpment known as "Cathedral Bluffs" where the anticline terminates in flat-lying beds. The gently-plunging southeastward nose of the Rangely anticline lies in the northern half of the quadrangle. The rocks in the southern half lie on the gently dipping east flank of the Douglas Creek arch. The dips of the rocks in the quadrangle are usually low (less than 10°) except on the flanks of the Rangely anticline.

## COAL GEOLOGY

The important coal beds in the Gillam Draw quadrangle occur in the coal unit of the Mesaverde Group (pl. 3). Most coal beds in this formation are highly lenticular and cannot be correlated any great distance. Generally, the coal beds are concentrated in the main coal zone, (Barnum and Garrigues, 1980) the base of which occurs within 200 ft (61 m) above the base of the coal unit. The main coal zone is approximately 120 ft (37 m) to over 200 ft (61 m) thick and contains 1 to 5 coal beds 3 ft (1 m) or more in thickness. Within the quadrangle the base of the main coal zone is generally at the top of a persistant, white, ripple-marked, very fine-grained, well sorted sandstone flecked by carbonaceous fragments. The upper surface of this widespread sandstone is called the "coal marker" and was mapped by Barnum (1978).

The datum shown on plate 3 is also the base of the main coal zone of Barnum (1978). Because of the highly lenticular nature of the coal beds and the uncertainty of correlation, the correlation lines shown between the columns on plate 3 are dashed. The vertical positions of isolated coal beds shown on plate 3 are only relative. The spatial relationships of the coal beds (pl. 3) were plotted using the best information available, but may not be accurate.

For convenience in this report the coal beds have been given numbers from 1 to 8 with the prefix MCZ (main coal zone). The numbered coal beds have been correlated over small areas, generally within the quadrangle, and the sequential numbering does not necessarily reflect the true stratigraphic position of one coal bed with respect to another. The thinner coal beds of very limited extent are called "local" coal beds. The local coal beds which occur within the main coal zone have been given the symbol MCZ L on plates 1 and 3.

The term "bony coal", as used in this report, may include material described in the data sources as "bony coal", "bone", "shaly coal", "dirty coal", "smutty coal", or other similar terms.

Coal beds 5 ft (1.5 m) or more thick that lie less than 3,000 ft (914 m) below the ground surface are herein called Reserve Base coals and are used in calculating Reserve Base and Reserve tonnages discussed below under Coal Resources.

Some information shown on plates 1 and 3 was obtained from unpublished drill-hole logs from the following sources: Jack Grynberg and Associates, Atlantic Richfield Company, and U.S. Geological Survey. Drill hole information from American Hydrocarbon Company was partly used as an aid in correlating some of the coal beds. The American Hydrocarbon drill holes

do not appear on plate 1 because the data were not considered reliable and were used only to determine the approximate depths of coal occurrences.

## MAIN COAL ZONE

### Coal Bed 3

Coal bed 3 (MCZ 3) of the main coal zone is Reserve Base thickness in the north-central part of the quadrangle. An insufficent data line was used for a large part of the coal boundary on the derivative maps (pls. 8-11) because of the lack of nonproprietary drilling data. The bed is over 16 ft (4.9 m) thick at index number 3 (pl. 1) and apparently thins in all directions from that point. The MCZ 3 coal bed dips $8^{o}$ or more to the northeast in the north-central part of the quadrangle and $5^{o}$ or more to the southeast in the central part of the quadrangle.

### Coal Bed 4

Coal bed 4 (MCZ 4) of the main coal zone ranges from less than 3 ft (1.0 m) to more than 8 ft (2.4 m) in thickness in the north-central part of the quadrangle. Based on the coal isopach map (pl. 4), the MCZ 4 coal bed apparently thins in all directions from its thickest point of measurement, 9.0 ft (2.7 m), at index number 10 (pl. 1). Because of a lack of data an insufficient data line was used for a large part of the coal bed boundary on the coal isopach map (pl. 4).

### Coal Bed 5

Coal bed (MCZ 5) of the main coal zone has a localized occurrence in the east-central part of the quadrangle. In that area the bed reaches a measured thickness of 6.5 ft (2.0 m) at index number 31 (pl. 1). The bed apparently thins southward and eastward from that point.

## Isolated Data Points

The standard criteria for construction of isopach, structure contour, and overburden isopach maps cannot be applied to some coal beds of Reserve Base thickness because measurements are few and isolated. The lack of data for these beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other better-known beds. For these reasons, separate maps of isolated data points are not included in this report but are in U.S. Geological Survey files. Reserve Base tonnages were calculated for these nonisopached coal beds and shown in table 2.

Table 2.--Isolated data points, Gillam Draw quadrangle, Rio Blanco County, Colorado.

| Index No. (pl. 1) | Location | Outcrop or drill hole | Coal bed name | Coal thickness (ft)[1] | Measured area (acres)[2] | Resource tonnage (s.t.)[3] |
|---|---|---|---|---|---|---|
| 2 | NW¼NW¼ sec. 31 T. 2 N., R. 100 W. | Outcrop | MCZ L | 5.7 | 78 | 800,000 |
| 8 | SE¼SE¼ sec. 5 T. 1 N., R. 100 W. | Drill hole | MCZ L | 6.0 | 126 | 1,400,000 |
| 10 | NE¼SW¼ sec. 1 T. 1 N., R. 101 W. | Drill hole | MCZ L | 6.5 | 126 | 1,500,000 |
| 12 | SW¼SW¼ sec. 36 T. 2 N., R. 101 W. | Outcrop | MCZ L | 5.9 | 58 | 600,000 |
| 13 | NE¼SE¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | MCZ L | 7.9 | 76 | 1,100,000 |
| 13 | NE¼SE¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | MCZ L | 5.9 | 73 | 800,000 |
| 14 | NE¼SW¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | L | 6.8 | 73 | 900,000 |
| 16 | NW¼SE¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | MCZ L | 7.9 | 63 | 900,000 |
| 17 | SE¼SW¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | MCZ L | 8.6+ | | |
| 18 | SW¼SW¼ sec. 2 T. 1 N., R. 101 W. | Outcrop | MCZ L | 6.6+ | 117 | 1,500,000 |
| 19 | NE¼NE¼ sec. 10 T. 1 N., R. 101 W. | Outcrop | MCZ L | 6.6 | | |
| 19 | NE¼NE¼ sec. 10 T. 1 N., R. 101 W. | Outcrop | MCZ L | 8.2 | 55 | 800,000 |

Table 2.--Isolated data points, Gillam Draw quadrangle, Rio Blanco County, Colorado.-- Continued

| Index No. (pl. 1) | Location | Outcrop or drill hole | Coal bed name | Coal thickness (ft)[1] | Measured area (acres)[2] | Resource tonnage (s.t.)[3] |
|---|---|---|---|---|---|---|
| 20 | NW¼NW¼ sec. 11 T. 1 N., R. 101 W. | Drill hole | MCZ L | 6.5 | 126 | 1,500,000 |
| 28 | NW¼NW¼ sec. 14 T. 1 N., R. 101 W. | Drill hole | MCZ L | 5.0 | 126 | 1,100,000 |
| 33 | NE¼NW¼ sec. 15 T. 1 N., R. 101 W. | Outcrop | MCZ L | 5.5 | | |
| 34 | NW¼NW¼ sec. 15 T. 1 N., R. 101 W. | Outcrop | MCZ L | 5.6 | 125 | 1,300,000 |
| 36 | NE¼NE¼ sec. 16 T. 1 N., R. 101 W. | Outcrop | MCZ L | 7.7 | | |
| 35 | NW¼NW¼ sec. 15 T. 1 N., R. 101 W. | Outcrop | MCZ L | 8.0 | 76 | 1,100,000 |
| 36 | NE¼NE¼ sec. 16 T. 1 N., R. 101 W. | Outcrop | MCZ L | 7.1 | 68 | 900,000 |
| 42 | SE¼NW¼ sec. 16 T. 1 N., R. 101 W. | Outcrop | MCZ L | 5.5 | 82 | 800,000 |
| 48 | SE¼NE¼ sec. 20 T. 1 N., R. 101 W. | Drill hole | MCZ 8 | 5.5 | | |
| 49 | SE¼NE¼ sec. 20 T. 1 N., R. 101 W. | Drill hole | MCZ 8 | 5.5 | 300 | 2,800,000 |
| 50 | SE¼SW¼ sec. 2 T. 1 N., R. 101 W. | Drill hole | MCZ 8 | 5.0 | | |

Table 2.--Isolated data points, Gillam Draw quadrangle, Rio Blanco County, Colorado. -- Continued

| Index No. (pl. 1) | Location | Outcrop or drill hole | Coal bed name | Coal thickness (ft)[1] | Measured area (acres)[2] | Resource tonnage (s.t.)[3] |
|---|---|---|---|---|---|---|
| 48 | SE¼NE¼ sec. 20 T. 1 N., R. 101 W. | Drill hole | MCZ 7 | 7.5 | 141 | 1,800,000 |
| 49 | SE¼NE¼ sec. 20 T. 1 N., R. 101 W. | Drill hole | MCZ 7 | 6.5 | | |
| 59 | NW¼NW¼ sec. 33 T. 1 N., R. 101 W. | Drill hole | MCZ L | 6.0 | 113 | 1,200,000 |
| 59 | NW¼NW¼ sec. 33 T. 1 N., R. 101 W. | Drill hole | MCZ L | 8.0 | 203 | 5,500,000 |
| 60 | NE¼NE¼ sec. 32 T. 1 N., R. 101 W. | Drill hole | MCZ L | 22.5 | | |
| 60 | NE¼NE¼ sec. 32 T. 1 N., R. 101 W. | Drill hole | MCZ L | 5.0 | 110 | 1,100,000 |
| 63 | SW¼SW¼ sec. 28 T. 1 N., R. 101 W. | Outcrop | MCZ L | 6.9 | 64 | 800,000 |
| | Total resource tonnage for isolated data points | | | | | 30,100,000 |

[1]To convert feet to meters, multiply feet by 0.3048
[2]To convert acres to hectares, multiply acres by 0.4047
[3]To convert short tons to metric tons, multiply short tons by 0.9072

## CHEMICAL ANALYSES OF THE COAL

Although no analyses of coal from the Gillam Draw quadrangle are available, several analyses of coal from two adjoining quadrangles, Rangely and Cactus Reservoir, have been reported and are shown in the following three tables.

Table 3.--Proximate analyses of coal samples from the J. W. Rector Mine, 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 analyses, 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.

Table 3 shows the analyses of two coal samples taken from a local coal bed 11.9 ft (3.6 m) thick exposed in the J. W. Rector mine. On the basis of the above analyses, the coal is ranked as high-volatile C bituminous coal (American Society for Testing and Materials, 1977).

Several analyses of coal from the Cactus Reservoir quadrangle were reported by D. V. Haines (unpublished report, 1974). The proximate analyses of four samples from the MCZ 15 (Staley or "D") coal bed in that quadrangle are listed in the following table.

Table 4.--Proximate analyses (as-received) of samples from the MCZ 15 (Staley or "D") coal bed in the Cactus Reservoir quadrangle, Rio Blanco and Moffat Counties, Colorado (From D. V. Haines, 1974, unpublished report.)

| | Moisture (percent) | Volatile matter (percent) | Fixed carbon (percent) | Ash (percent) | Heating value (Btu/lb[1]) | Sulphur (percent) |
|---|---|---|---|---|---|---|
| 1. | 11.09 | 36.97 | 46.65 | 5.29 | 11,361 | 0.34 |
| 2. | 11.7 | 33.5 | 49.2 | 5.6 | 11,210 | 0.4 |
| 3. | 10.8 | 34.5 | 50.2 | 4.2 | 11,450 | 0.5 |
| 4. | 13.2 | 36.6 | 45.3 | 4.9 | 11,070 | 0.4 |

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

On the basis of the analyses in table 4, the MCZ 15 (Staley or "D") coal is ranked as high-volatile C bituminous coal (American Society for Testing and Materials, 1977).

Gale (1910, p. 192) sampled the 3.7-ft (1.1-m) thick local coal bed in the Red Wash mine located in SW¼NW¼ sec. 11, T. 2 N., R. 101 W.. The sample was analyzed and the following results were reported.

Table 5.--Proximate analysis of coal sample from Red Wash mine, Cactus Reservoir quadrangle, Rio Blanco and Moffat Counties, Colorado (Gale, 1910, p. 250)

| | |
|---|---|
| Laboratory No. | 5516 |
| Air drying loss of sample received | 3.2 percent |
| Chemical analysis, air-dried basis | |
| Moisture | 8.02 percent |
| Volatile matter | 34.22 Do. |
| Fixed carbon | 48.61 Do. |
| Ash | 9.15 Do. |
| Sulphur | 0.75 Do. |
| Heat value | 11,040 Btu/lb[1] |

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

On the basis of this analysis, the coal bed sampled in the Red Wash mine is ranked as high-volatile C bituminous coal (American Society for Testing and Materials, 1977).

## MINING OPERATIONS

Gale (1910) briefly mentioned that some mining occurred in T. 1 N., R. 101 W., but gave no information as to the nature, extent, or production of any operations in the Gillam Draw quadrangle. Dickenson (1969) shows an 8-ft (2.6-m) thick coal bed measurement at an abandoned mine in the NW¼ sec. 15, T. 1 N., R. 101 W.. No other information about the mine is known.

## COAL RESOURCES

The principle sources of data used in the construction of the coal isopach, structure contour, and coal-data maps were Barnum (1978) and Barnum and others (1977).

Coal isopach maps were constructed by using a point-data net derived from coal-thickness measurements of an individual coal bed obtained from surface exposures and correlated well logs located 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. The principal of uniform variation in thickness between data points was used to establish the position of the isopach lines.

Structure contour maps were constructed by using a point-data net derived from well logs and surface exposures. The elevation of the top of each contoured coal bed was based on surface altitude and measured depths to the top of the designated coal bed encountered in drill holes referenced to mean sea level.

Each 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 secondary set of data-net points

was generated by laying a structure contour map over a topographic contour map and then calculating 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 maps (pls. 4 and 8; and fig. 1) for resource calculations. The coal bed acreage (measured by planimeter) multiplied by the average isopached 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 the coal resources in short tons. The Reserve values are based on a subsurface mining recoverability factor of 50 percent and a surface mining recoverability factor of 85 percent. Reserve Base and Reserve values for the MCZ 3 and MCZ 4 coal beds are shown on plates 7 and 11 and are rounded to the nearest tenth of a million short tons. Values for the MCZ 5 coal bed are shown in figure 4. Reserve Base values for isolated data points are shown by asterisks on plate 2 and are also 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 as 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 a ½ mile (0.8 km) wide belt that lies more than ¼ mile (0.4 km) from the outcrop or points of observation or measurements.

"Inferred.--Quantitative estimates are based largely on broad knowledge of the geologic character of the bed or region and where few measuremenst 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 (9.6 km) apart. Inferred coal is projected to extend as a 2¼-mile (3.6 km) wide belt that lies more than 3/4 mile (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).

Resource tonnages calculated for isolated data points (non-isopached coal beds) are classified as inferred coal and placed in the unknown development potential category. The coal resources for the isolated data points are shown in table 2 and total 30.1 million short tons (27.3 million metric tons). In this quadrangle the unknown development potential coal is projected to extend as a ¼ mile (0.4 km) wide belt from points of measurement at the isolated data points.

Reserve Base tonnages of Federal coal per section for all isopached coal beds are shown on plate 2 and total approximately 124.4 million short tons (112.9 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 mining methods are shown in tables 6 and 7.

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) (that is, having 200 ft (61 m) of overburden) 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 amenable to conventional subsurface 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 greater than $15^{o}$ is considered amenable to in situ coal gasification methods. Inasmuch as the dips of the coal beds in the isopached areas in this quadrangle are less than $15^{o}$ no coal resources fall into the in situ coal gasification category.

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

Table 6.--Coal Reserve Base data for surface mining methods for Federal coal lands in the Gillam Draw quadrangle, Rio Blanco Counties, Colorado.
(in short tons)[1]

| 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 3 coal bed | 10,900,000 | 100,000 | 200,000 | 11,200,000 |
| MCZ 4 coal bed | 5,700,000 | 200,000 | 300,000 | 6,200,000 |
| MCZ 5 coal bed | 1,900,000 | [2] | 100,000 | 2,000,000 |
| TOTALS | 18,500,000 | 300,000 | 600,000 | 19,400,000 |

[1]To convert short tons to metric tons, multiply by 0.9072
[2] Reserve Base tonnage is less than 50,000 short tons and is not added into the total Reserve Base tonnage.

Table 7.--Coal Reserve Base data for subsurface mining methods for Federal coal lands in the Gillam Draw quadrangle, Rio Blanco Counties, Colorado.
(in short tons)[1]

| Coal Bed Name | High development potential | Moderate development potential | Low development potential | Total |
|---|---|---|---|---|
| MCZ 3 coal bed | 66,600,000 | 1,100,000 | - 0 - | 67,700,000 |
| MCZ 4 coal bed | 36,700,000 | - 0 - | - 0 - | 36,700,000 |
| MCZ 5 coal bed | 600,000 | - 0 - | - 0 - | 600,000 |
| TOTALS | 103,900,000 | 1,100,000 | - 0 - | 105,000,000 |

[1]To convert short tons to metric tons, multiply by 0.9072

## COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn (pl. 12 and 13) to coincide with 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 (Bureau of Land Management), approximate 40-acre (16-ha) parcels have been used to show the limits of high-, moderate-, or low-development-potentials areas.

The designation of a coal-development-potential classification is based on the occurrence of 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. 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 area is rated as "high development potential".

### 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 potential for surface mining 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 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 (1979, written communication). The areas classified as high, moderate, or low development potential using surface mining methods are shown on plate 12.

Federal coal lands not classified with a high-, moderate-, or low-development-potential rating are areas with insufficient geologic information and no development potential for surface mining could be assigned them.

The percentages of Federal land areas in this quadrangle having known development potential using surface mining methods are: 6 percent, high development potential; less than 1 percent, moderate development potential; and 2 percent, low development potential. The remaining Federal land in the quadrangle, excluding those areas controlled by isolated data points, are 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. Reserves have not been calculated for the nonisopached coal beds at isolated data points because the development potential for those beds is unknown.

### Development Potential Using Subsurface Mining and In Situ Coal Gasification

The coal-development-potential for areas in which subsurface mining of coal is possible is shown on plate 13. In this quadrangle, areas where coal beds dip 15 degrees 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. Areas where such beds are overlain by 1,000 to 2,000 ft (305 to 610 m) and 2,000 to 3,000 ft (610 to 914 m) of overburden have a moderate and low development potential respectively. Approximately 17 percent of the unleased Federal land in the quadrangle has a high development potential, and 1 percent has a moderate development potential for subsurface mining methods. No lands are classified with a low development potential in this quadrangle. Federal coal lands not assigned a development potential rating in this quadrangle are areas where the geologic information is insufficient and no development potential rating could be determined.

Reserve Base tonnages have been calculated for all areas of unleased Federal coal land where coal beds are known to be 5 ft (1.5 m) or more thick. Reserve tonnages have been calculated for all areas of unleased Federal coal land where coal beds are known to be 5 ft (1.5 m) or more thick. Reserve tonnages are based on a recoverability factor of 50 percent (specified by the U.S. Geological Survey, written communication, 1979) and have

been calculated for only that part of the Reserve Base considered to be suitable for conventional subsurface mining methods. Reserves have not been calculated for the nonisopached coal beds at isolated data points. Those areas with only isolated data points have an unknown development potential. Resource tonnages in the unknown development potential category occur within ¼ mile of isolated data points and total 30.1 million short tons (27.3 metric tons) in this quadrangle as shown in table 2. No distinction has been made between surface and subsurface mining resources in the areas controlled by isolated data points and therefore these areas are not shown on plates 12 and 13, and the resource tonnages are not shown in tables 6 and 7.

An arbitrary dip limit of 15° is assumed to be the maximum dip suitable for conventional subsurface mining methods. Development potential using in situ coal gasification methods pertains to areas that contain coal beds dipping an excess of 15°. Inasmuch as no coal beds 5 ft (1.5 m) or more thick are known to occur in this quadrangle where the dip is more than 15°, no lands are rated for using in situ coal gasification methods.

Table 8. Sources of data used on plate 1.

| Source | Plate 1 Index No. | Drill Hole or Measured Section |
|---|---|---|
| Barnum and others, 1977 | 1 | LW-25-6D |
| Barnum, 1978 | 2 | R-4-24 |
| Do. | 3 | R-4-23 |
| U.S.G.S., 1978 | 4 | R-4-22 |
| Barnum and others, 1977 | 5 | LW-12-6D |
| Barnum, 1978 | 6 | R-4-93 |
| Do. | 7 | R-4-94 |
| Jack Grynberg and Assoc. | 8 | GOV'T. No. 1 |
| Barnum and others, 1977 | 9 | LW-13-6D |
| Do., 1977 | 10 | LW-14-6D |
| Barnum, 1978 | 11 | R-4-92 |
| Do. | 12 | R-4-37 |
| Do. | 13 | R-4-34 |
| U.S. Geological Survey | 14 | C-3818 |
| Do. | 15 | C-3818 |
| Barnum, 1978 | 16 | R-4-14E |
| Do. | 17 | R-4-20 |
| Do. | 18 | R-4-13E |
| Do. | 19 | R-4-30 |
| Barnum and others, 1977 | 20 | LW-15-6D |
| Barnum, 1978 | 21 | R-4-15E |
| Do. | 22 | R-4-88 |
| Do. | 23 | R-4-87 |
| Do. | 24 | R-4-86 |
| Do. | 25 | R-4-89 |
| Do. | 27 | R-4-82 |
| Barnum and others, 1977 | 28 | LW-16-6D |
| Barnum, 1978 | 29 | R-4-38 |
| Do. | 30 | R-4-84 |
| Do. | 31 | R-4-85 |
| Do. | 32 | R-4-16 |
| Do. | 33 | R-4-15 |
| Do. | 34 | R-4-98 |
| U.S. Geological Survey | 35 | C-3819 |
| Barnum, 1978 | 36 | R-4-79 |
| Do. | 37 | R-4-19 |
| Do. | 38 | R-4-18 |
| Do. | 39 | R-4-17 |

| | | |
|---|---|---|
| Barnum, 1978 | 41 | R-4-63 |
| Do. | 42 | R-4-74 |
| Do. | 43 | R-4-75 |
| Do. | 44 | R-4-77 |
| Barnum and others, 1977 | 45 | LW-17-6D |
| Barnum, 1978 | 46 | R-4-66 |
| Do. | 47 | R-4-64 |
| Barnum and others, 1977 | 48 | LW-18-6D |
| Atlantic Richfield Co. | 49 | DH No. 1 |
| Barnum and others, 1977 | 50 | LW-188-GD |
| Barnum, 1978 | 51 | R-4-67 |
| Do. | 52 | R-4-68 |
| Do. | 53 | R-4-73 |
| Do. | 54 | R-4-71 |
| Do. | 55 | R-4-70 |
| Do. | 56 | R-4-60 |
| Do. | 57 | R-4-61 |
| Do. | 58 | R-4-62 |
| Atlantic Richfield Co. | 59 | DH No. 2 |
| Barnum and others, 1977 | 60 | LW-19-6D |
| Barnum, 1978 | 61 | R-4-55 |
| Do. | 62 | R-4-56 |
| Do. | 63 | R-4-59 |
| Do. | 64 | R-4-58 |
| Do. | 65 | R-4-57 |

## REFERENCES

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

Barnum, B. E., 1978, Field map and measured coal sections of the Gillam Draw quadrangle, Rio Blanco County, Colorado: U.S. Geol. Survey unpublished map.

Barnum, B. E., and Garrigues, R. S., 1980, Geologic map and coal sections of the Cactus Reservoir quadrangle, Rio Blanco and Moffat Counties, Colorado: U.S. Geol. Survey Miscellaneous Field Studies Map MF-1179, scale 1:24,000, 2 sheets.

Barnum, B. E., and others, 1977, Coal sections of holes drilled in the lower White River coal field, Moffat and Rio Blanco Counties Colorado: U.S. Geol. Survey Open-File Report 77-378.

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

Dickinson, R. G., 1969, Compilation of geologic data, T. 1 N., R. 101 W. 6th P.M., Colorado: U.S. Geol. Survey unpublished map.

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

Garrigues, R. S., 1976, Geophysical logs of holes drilled in 1976 in the Lower White River coal field, Moffat and Rio Blanco Counties, Colorado: U.S. Geol. Survey Open-File Report 76-871.

Haines, D. V., 1974, Geologic evaluation of preference right coal lease application Colorado 0126669, Rio Blanco County, Colorado: U.S. Geol. Survey unpublished report.

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.

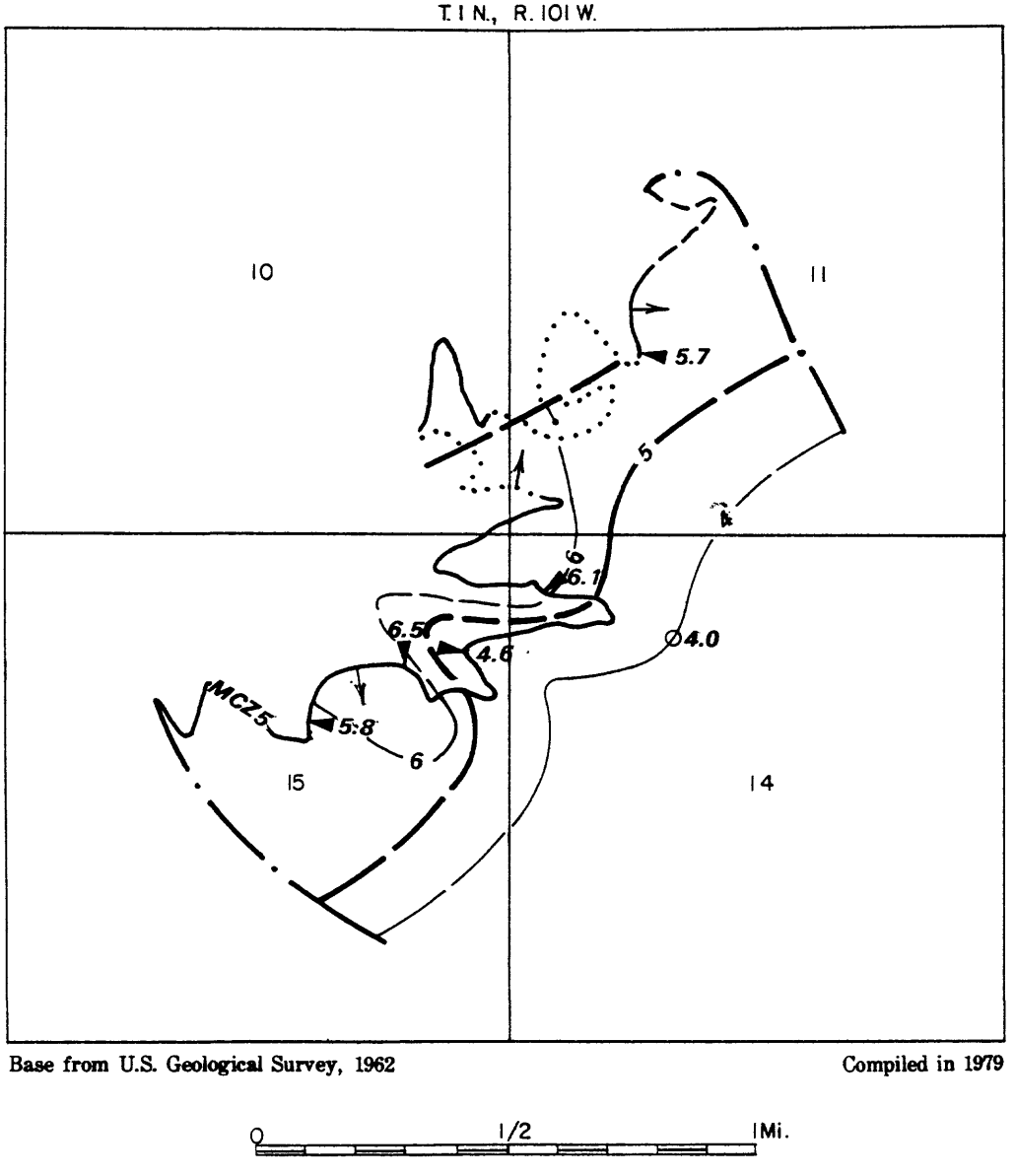
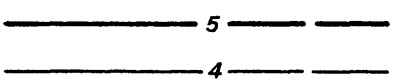



Figure 1. Isopach map of coal bed 5, main coal zone..

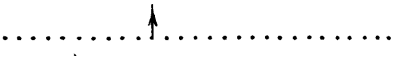



ISOPACHS–Showing thickness of coal, in feet. Long dashed where inferred, short dashed where projected above land surface. Isopach interval 1 foot.


DRILL HOLE–Showing thickness of coal, in feet. Drill holes which do not intersect the coal or from which a coal thickness could not be determined are not shown.


POINT OF MEASUREMENT–Showing thickness of coal, in feet. Includes all points of measurement other than drill holes.


TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Arrow points toward coal-bearing area. Dashed where inferred by present authors.



BURNED AND CLINKERED COAL BOUNDARY–Dotted line indicates the inferred limit of burning. Arrow points toward coal-bearing area.



INSUFFICIENT DATA LINE–Coal thickness cannot be determined beyond line shown because of insufficient data.

FAULT – Dashed where approximately located: bar and ball on downthrown side where direction of movement is known.

To convert feet to meters, multiply feet by 0.3048

Explanation for coal isopach map (fig. 1)

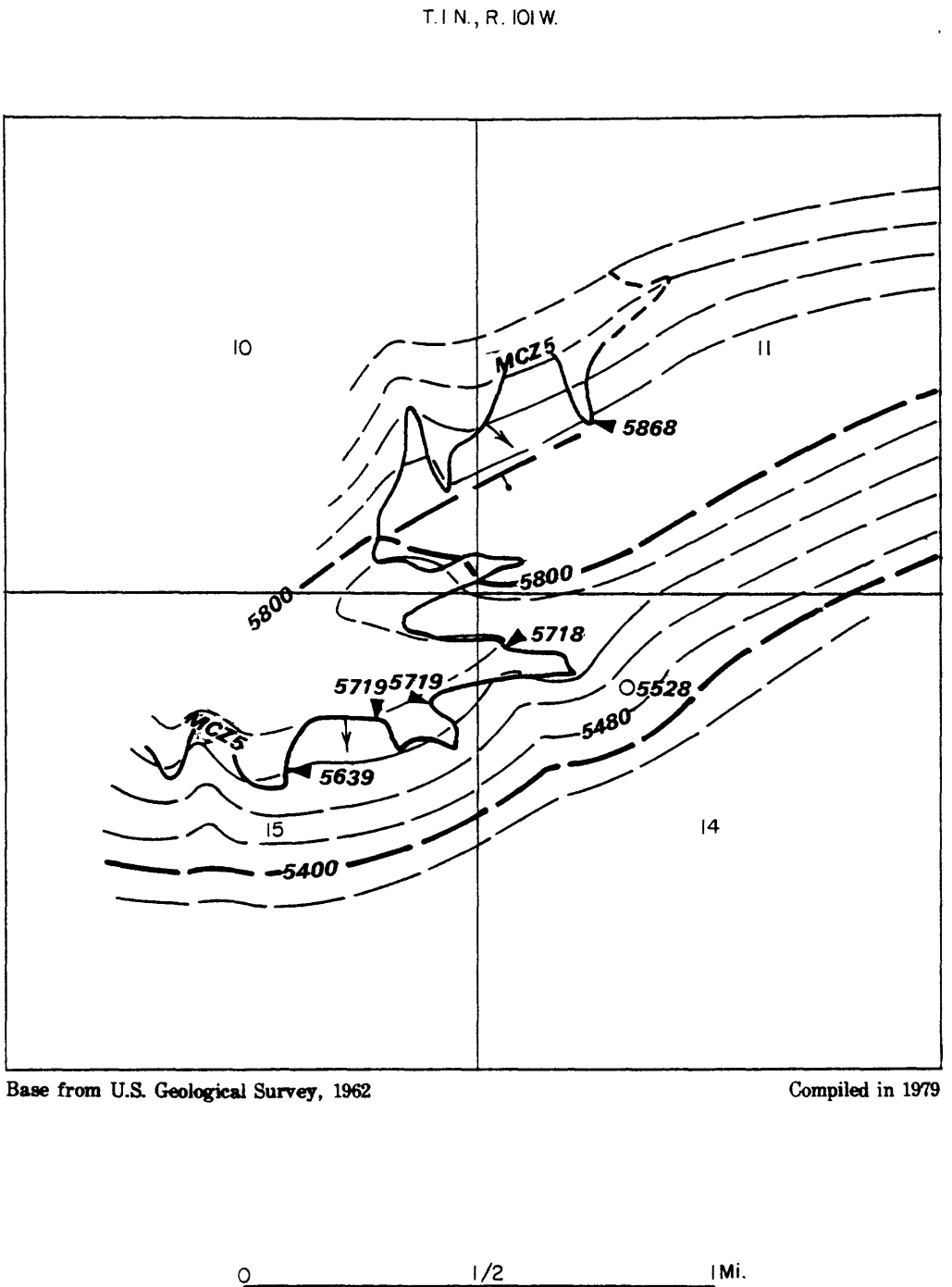
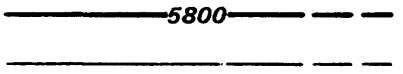


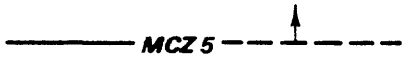

Figure 2. Structure contour map of coal bed 5, main coal zone.



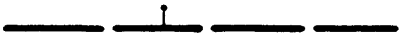

STRUCTURE CONTOURS–Drawn on top of coal bed. Solid where vertical accuracy within 40 feet; long dashed where vertical accuracy possibly not within 40 feet; short dashed where projected above land surface. Hachures indicate closed contours of basin. Contour interval is 80 feet (24.4 m). Datum is mean sea level.


DRILL HOLE–Showing altitude of top of coal bed, in feet. Drill holes which did not intersect top of coal bed or from which bed altitude could not be determined, are not shown.


POINT OF MEASUREMENT–Showing altitude of top of coal bed, in feet.




TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Arrow points toward coal-bearing area. Dashed where inferred by present authors.



FAULT –Dashed where approximately located: bar and ball on downthrown side where direction of movement is known.

To convert feet to meters, multiply feet by 0.3048

Explanation for structure contour map (fig. 2)

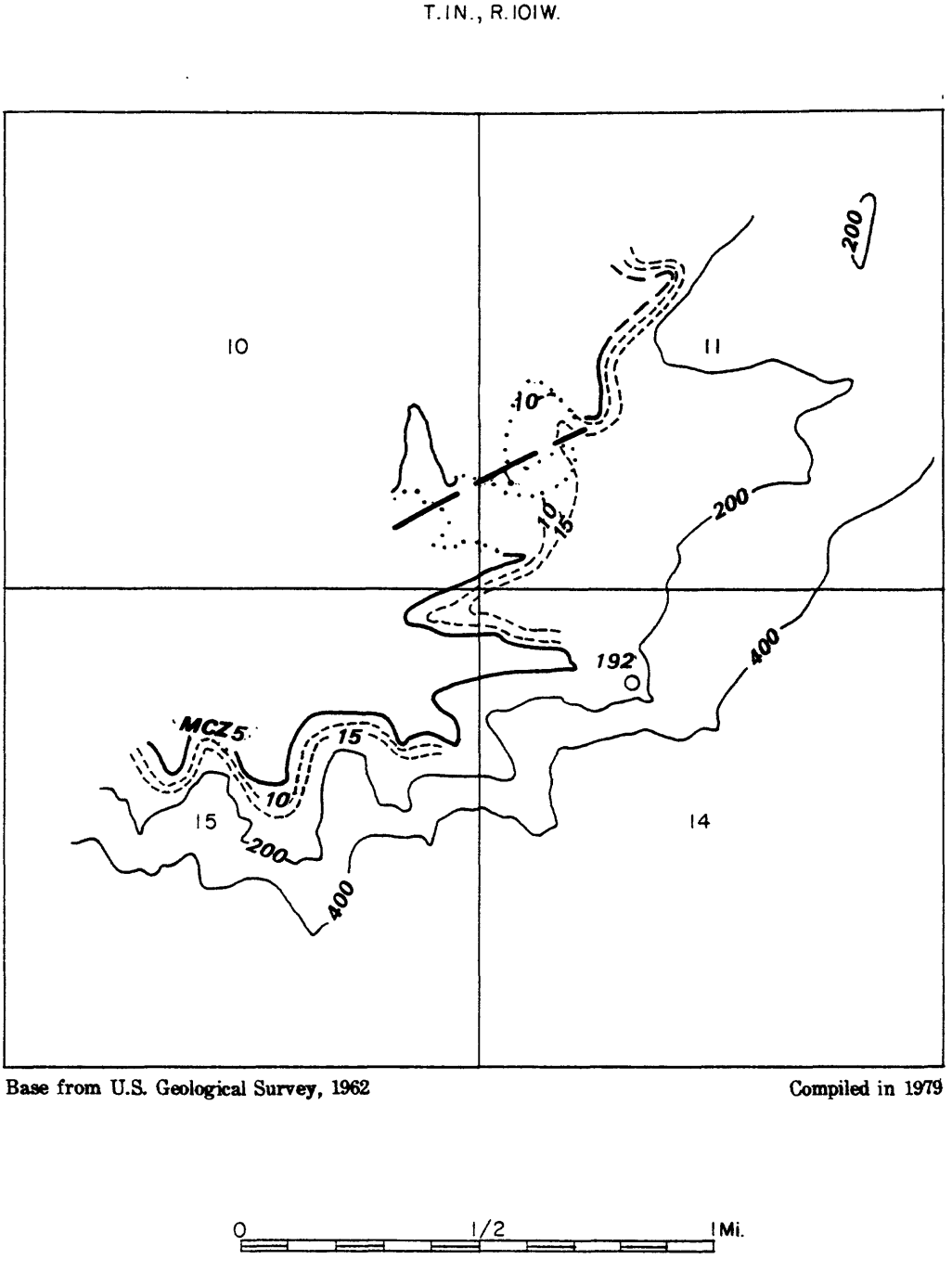
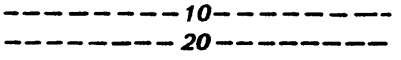



Figure 3. Overburden isopach map of coal bed 5, main coal zone.


OVERBURDEN ISOPACHS – Showing thickness of overburden, in feet, from the surface to top of the Main Coal Zone 5 coal bed. Isopach interval 200 feet (61.0 m).

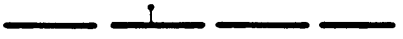

DRILL HOLE–Showing thickness of overburden, in feet, from the surface to top of the Main Coal Zone 5 coal bed.


TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Dashed where inferred by present authors.




MINING-RATIO CONTOURS–Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas suitable for surface mining within the stripping limit.

BURNED AND CLINKERED COAL BOUNDARY – Dotted line indicates the inferred limit of burning. Arrow points toward coal-bearing area.



FAULT – Dashed where approximately located: bar and ball on downthrown side where direction of movement is known.

To convert feet to meters, multiply feet by 0.3048

Explanation for overburden isopach map (fig. 3)

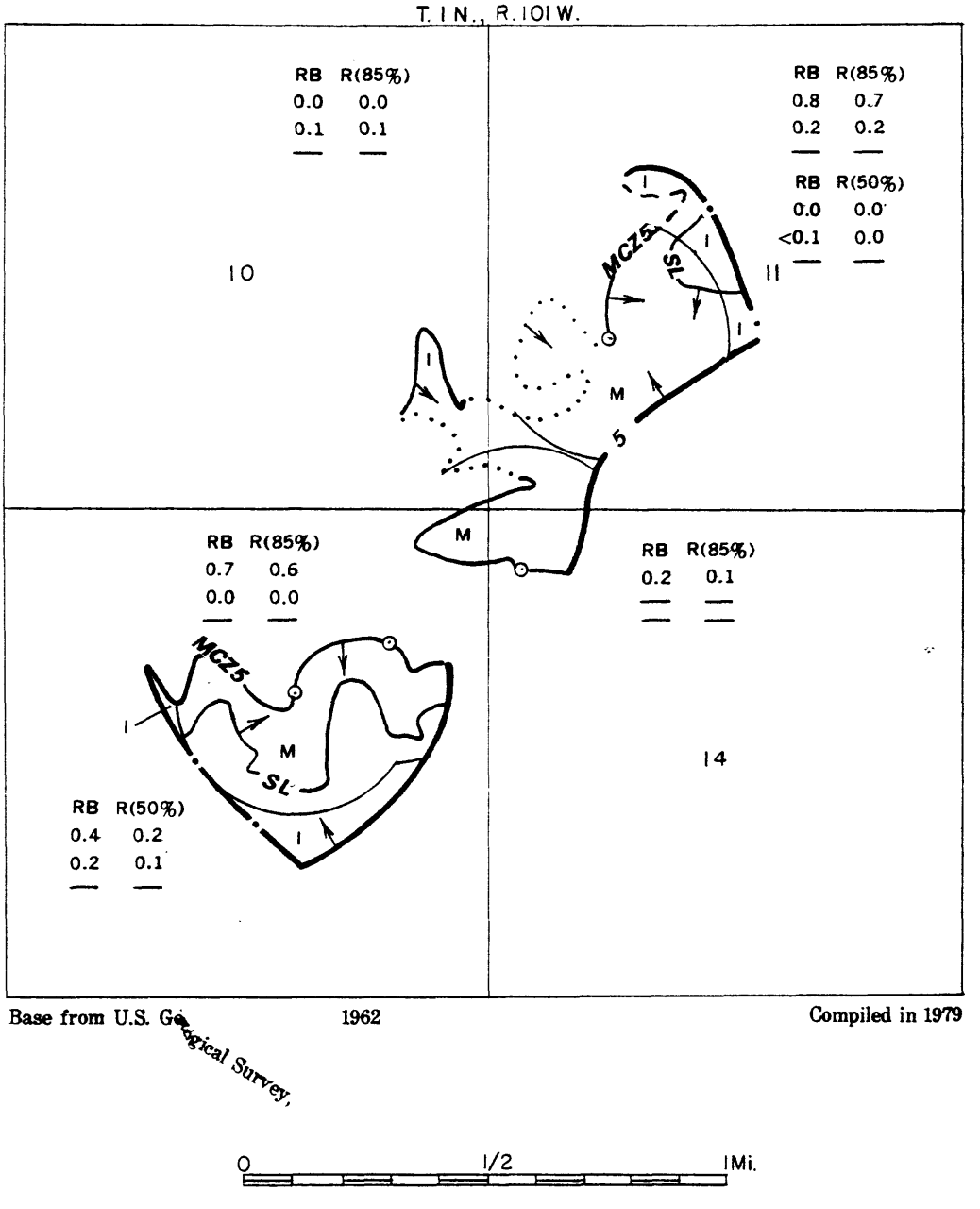
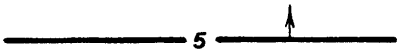


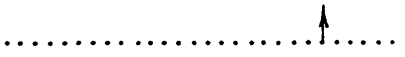

Figure 4. Areal distribution and identified resources map of coal bed 5, main coal zone




ISOPACH–Showing thickness of coal, in feet. Arrow points toward area where coal bed is 5 feet or more thick.


TRACE OF COAL BED OUTCROP–Showing symbol of name of coal bed. Arrow points toward coal-bearing area. Dashed where inferred by present authors.

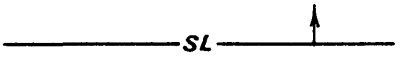
POINT OF MEASUREMENT–Point from which boundary lines for measured, indicated, and inferred coal resources were drawn.



BURNED AND CLINKERED COAL BOUNDARY–Dotted line indicates the inferred limit of burning. Arrow points toward coal-bearing area.



INSUFFICIENT DATA LINE–Coal resources were not calculated for areas beyond line shown because of insufficient data.

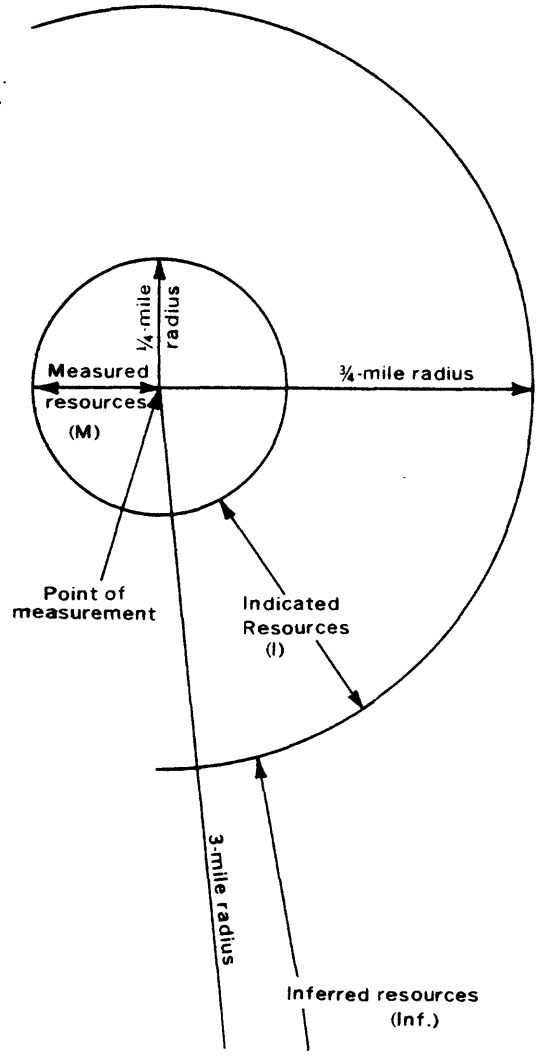



STRIPPING-LIMIT LINE–Boundary for surface mining (in this quadrangle, the 200-foot-overburden isopach). Arrow points toward the area suitable for surface mining where the recovery factor is 85 percent, and away from the area suitable for subsurface mining (down dip to the 3,000-foot-overburden isopach) where the recovery factor is 50 percent.

Explanation for areal distribution and identified resources map (fig. 4)

| RB | R(85%) | RB | R(50%) | |
|---|---|---|---|---|
| 0.7 | 0.6 | 0.4 | 0.2 | (Measured) |
| 0.0 | 0.0 | 0.2 | 0.1 | (Indicated) |
| — | — | — | — | (Inferred) |

IDENTIFIED COAL RESOURCES–Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of non-leased Federal coal land, both within and beyond the stripping-limit line. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.




BOUNDARY LINES–Enclosed areas of measured, indicated, and inferred coal resources of the coal bed. Dashed where projected from adjacent quadrangles.

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

To convert feet to meters, multiply feet by 0.3048.

Explanation for areal distribution and identified resources map (fig. 4) -- (Continued)