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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE RANGELY NE QUADRANGLE RIO BLANCO AND MOFFAT COUNTIES, COLORADO

By

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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

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Published and unpublished non-proprietary data sources were used for this study.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

Location

The Rangely NE quadrangle is located in Rio Blanco and Moffat Counties in northwestern Colorado. The city of Craig, the county seat of Moffat County, is 66 miles (106 km) northeast of the quadrangle. The city of Meeker, the county seat of Rio Blanco County, is approximately 45 miles (72 km) east-southeast of the quadrangle. The town of Rangely is 3 miles (5 km) south of the quadrangle and the Colorado-Utah state line 9 miles (14 km) west. The Colorado-Wyoming state line is 52 miles (84 km) north of the quadrangle. The city of Vernal, Utah is 37 miles (60 km) northwest of the quadrangle.

Accessibility

U.S. Highway 40 crosses the extreme northwest corner of the quadrangle and provides access to Vernal, Utah and Craig, Colorado. A paved county road traverses the western edge of the quadrangle in a north-south direction and provides access to the town of Rangely from U.S. Highway 40. A light-duty road crosses the northeast quarter of the quadrangle and connects U.S. Highway 40, 500 ft (152 m) north of the quadrangle, with State Highway 65 in the central part of the adjoining Cactus Reservoir quadrangle. Numerous light-duty roads in the Rangely oil field occur in the southwest corner of the quadrangle. Several unimproved 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, and from Craig rail connections can be made to Denver, Colo. An airport is maintained near the town of Rangely.

Physiography

The general topography in the Rangely NE quadrangle is hilly but not extremely rugged. The relief in the quadrangle is approximately 1,260 ft (384 m). The high point is 6,521 ft (1,988 m) above sea level on top of one of the mountains in the east central part of the quadrangle. The elevation of the low point is about 5,255 ft (1,602 m) in the southwest corner where Stinking Water Creek leaves the quadrangle.

The study area contains a series of resistant rims or escarpments formed by northeastward dipping beds of resistant sandstone on the northeast flank of the Rangely anticline. The southernmost escarpment is known

as the Coal Oil Rim. This rugged feature has a relief of up to 400 ft (122 m) and trends northwest-southeast. The dip slope on the northeast side of the escarpment extends about 1 mile (1.6 km) to the base of the next escarpment north of Coal Oil Rim. This second escarpment is not as high and is more irregular than Coal Oil Rim. A third sandstone escarpment crosses the center of the quadrangle in a northwest-southeast direction. A prominent hogback lies along the north edge of the quadrangle and is formed by steeply dipping sandstone beds on the north flank of the Red Wash syncline.

The main drainages of the quadrangle are Nate Spring Draw and Stinking Water Creek. These intermittent stream chanels drain southerly through the western half of the quadrangle into the White River about 4 miles (6.0 km) south of the quadrangle.

Climate

The Rangely NE quadrangle has a mid-latitude steppe climate and semiarid conditions prevail in the area. The normal annual precipitation for the quadrangle ranges from 4 inches (10 cm) in the central area of the quadrangle to 10 inches (25 cm) in the northeast corner and the north part of the quadrangle (U.S. Department of Commerce, (1964)).

The nearest weather data recording station is at Rangely where a record high temperature of 104° F (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 Rangely NE quadrangle are probably a few degrees cooler than temperatures at Rangely (elevation, 5,240 ft (1,597 m)) because of the higher altitudes in the quadrangle area.

Land Status

The Rangely NE quadrangle lies in the north-central part of the Lower White River Known Recoverable Coal Resource Area (KRCRA). The KRCRA covers approximately 13,970 acres (5,654 ha) of the quadrangle. Several preference right lease application areas occur in the quadrangle and are shown on plate 2 along with the areas of non-Federal land and the KRCRA boundary. A comparison of the areas of leased and unleased Federal coal ownership and the non-Federal land in the quadrangle area are shown in table 1.

Table 1.--Comparison of Federal and non-Federal land areas in the Rangely NE quadrangle, Rio Blanco and Moffat Counties, Colorado

Category	Approximate area (acres)[1]	Percent of quadrangle area
Non-Federal land	4,020	11
Leased Federal coal ownership	2,730	7
Unleased Federal coal ownership[2]	29,700	82
Total	36,450	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. Gaskill and Horn (1961) mapped the surface exposures of coal beds and the principal coal zones in and around the Rangely NE quadrangle. The latest and most complete coal geology study of the quadrangle was done by Garrigues and Barnum (1980). A series of coal test holes was described by Barnum and others (1977) and Garrigues (1976).

GENERAL GEOLOGY

Stratigraphy

The important coal beds in the Rangely NE quadrangle occur in rocks of the Mesaverde Group of Late Cretaceous age. The Mesaverde Group has been divided, in ascending order, into the Sego Sandstone, lower unit, coal unit, and upper unit (Garrigues and Barnum, 1980). The Wasatch Formation of Paleocene and Eocene ages overlies the Mesaverde Group in some of the adjoining areas but is not present in this quadrangle.

The Sego Sandstone consists of a light yellowish-brown to light-brown, fine-grained, poorly sorted, massive, locally crossbedded, relatively resistant sandstone. It is typically separated into two ledges by a medial gray marine shale interbedded with thin sandstone beds and light-brown carbonaceous shale. The upper ledge is persistant throughout most of the quadrangle, has a distinctive white top and is the highest known unit of marine origin in the mapped area. The lower ledge is less persistant, contains interbedded shale, and is variable in thickness. In the northwest corner of the quadrangle the Sego Sandstone grades into the lower unit of the Mesaverde Group to the point of being barely distinguishable as a separate unit. The Sego Sandstone ranges in thickness from 131 ft to 243 ft (40 m to 74 m).

The lower unit of the Mesaverde Group is approximately 720 ft (219 m) thick and consists of light yellowish-brown, fine-grained, massive, friable to resistant, lenticular sandstone interbedded with light-gray to gray shale and mudstone, brown to dark-brown carbonaceous shale and thin lenticular coal beds. The upper contact with the coal unit is gradational and difficult to map.

The coal unit of the Mesaverde Group consists of coal interbedded with brown to dark-brown carbonaceous shale (or mudstone), light-gray to gray shale (or mudstone) and light yellowish-brown, thin, very fine-

grained, lenticular sandstone, and siltstone. The coal unit ranges in thickness from 364 ft to 515 ft (111 m to 157 m). The coal marker bed lies at the base of the main coal zone and consists of very light-gray to white, very fine-grained, clean, well sorted, and ripple-marked sandstone. This sandstone is very continuous and is located 174 ft. to 305 ft (53 m to 93 m) above the base of the main coal unit.

The main coal zone generally contains the thickest coal beds of the coal unit. One to four beds ranging from 3 to 15 ft (1 to 4.6 m) thick are usually present in the coal unit.

The upper unit of the Mesaverde Group is light-brown to grayish-brown, very fine- to fine-grained, massive, friable, lenticular sandstone interbedded with light-gray shale, thin grayish-brown carbonaceous shale and thin lenticular coal beds less than 3 ft (1 m) thick. The lower contact of this unit is gradational and difficult to locate in the field. The thickness of the upper unit is approximately 1,740 ft (530 m) thick with about 400 ft (120 m) exposed in the quadrangle (Garrigues and Barnum, 1980).

Structure

The axial trace of the Red Wash syncline crosses the northern part of the quadrangle in an east-west direction (pl. 1). The syncline plunges eastward and is asymetric with a steep north flank and a gently dipping south flank (4^{o} - 10^{o}). The area south of the synclinal axis is the north flank of the Rangely anticline whose axis crosses the adjoining Rangely quadrangle to the south.

No faults are known to occur in the coal-bearing area of this quadrangle.

COAL GEOLOGY

The important coal beds in the Rangely NE quadrangle occur in the coal unit of the Mesaverde Group (pl. 3). Generally, the coal beds are concentrated in the main coal zone which ranges up to 165 ft (50 m) above the base of the coal unit and contains one to six coal beds 3 ft (1 m)

or more thick. In the quadrangle the base of the main coal zone generally coincides with the top of a persistant, white, ripple-marked, very fine-grained, well-sorted sandstone flecked by carbonaceous fragments. The upper surface of this sidespread sandstone is called the "coal marker" and was mapped by Garrigues and Barnum (1980).

The datum shown on plate 3 corresponds with the "coal marker" of Garrigues and Barnum (1980). The correlation lines shown between the columns on plate 3 are dashed, because of the lenticular nature of some of the coal beds and the uncertainty of correlation.

For convenience in this report the coal beds have been given numbers from 1 to 3 and 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. Local coal beds that occur within the main coal zone have been named MCZ L (main coal zone, local coal bed) on plates 1 and 3. The local coal beds that occur above or below the main coal zone have been labeled "L". In this quadrangle three local coal beds have been correlated over small areas and have been called the L1, L2, and L3 beds.

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 are less than 3,000 ft (914 m) below the ground surface are called Reserve Base coals and are used in calculating Reserve Base and Reserve tonnages discussed below under Coal Resources.

Main Coal Zone
Coal Bed 1

Coal bed 1 of the main coal zone is symbolized as the MCZ 1 coal bed on plates 1 and 3. The bed is of Reserve Base thickness in a small area in the east central part of the quadrangle (fig. 1) where it ranges from 1.8 ft (0.6 M) thick at index number 21 to a maximum thickness of 7.1 ft (2.2 m) at index number 9 (pl. 1). In that area the bed dips less than 5^{o} to the northeast and is not faulted. The coal isopach map (fig. 1) shows that the bed is lenticular along its outcrop where it thickens and thins within short distances. The areal distribution and identified resources map (fig. 7) shows that only a small area of Reserve Base coal occurs in unleased Federal land and contains approximately 600,000 short tons (544,320 metric tons) between the outcrop trace and a coal lease boundary.

Coal Bed 2

Coal bed 2 of the main coal zone is symbolized as the MCZ 2 coal bed on plates 1 and 3. This bed is the most persistent bed in the quadrangle; its outcrop trace continues for more than nine miles (14.5 km). The bed ranges in thickness from 0.7 ft (0.2 m) at index number 34 to 15.8 ft (4.8 m) at index number 58 (pl. 1).

The coal isopach map (pl. 4) indicates that the MCZ 2 bed thins eastward on the east side of the quadrangle, and southward toward the eroded area on the south side of the quadrangle. On the south side of the Red Wash synclinal axis the coal bed dips less than 5^{o} northeastward. Much of the coal in this area lies between the outcrop trace and the stripping limit line (pl. 6). The dip is much steeper on the north side of the synclinal axis where it exceeds 15^{o}.

The areal distribution and identified resources map (pl. 7) for this coal bed shows the Reserve Base and Reserve tonnages for surface and subsurface mining methods where the bed is not covered by Federal coal leases and non-Federal land.

Coal Bed 3

Coal bed 3 of the main coal zone is symbolized as the MCZ 3 coal bed on plates 1 and 3. This bed has a localized occurrence in the east central part of the quadrangle with most of the points of measurement located in section 36, T. 3 N., R. 102 W.

In this area the bed ranges in thickness from 2.6 ft (0.8 m) at index number 28 to 13.6 ft (4.1 m) at index number 35 (pl. 1).

Isolated Data Points

The standard criteria for construction of isopach, structure contour, mining ratio, 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, isolated data points maps are not included in this report but are in U.S. Geological Survey files. Reserve Base tonnages were calculated for these non-isopached coal beds and shown in table 2.

CHEMICAL ANYALYSES OF THE COAL

Although no analyses of coal from the Rangely NE quadrangle are available, several analyses of coal from two adjoining quadrangles, Rangely and Cactus Reservoir, have been reported (tables 3, 4, and 5).

Table 2.--Isolated Data Points, Rangely NE quadrangle, Rio Blanco and Moffat Counties, 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]
15	SE¼SE¼ sec. 6 T. 2 N., R. 101 W.	Outcrop	MCZ L	8.0	3	*
15	SE¼SE¼ sec. 6 T. 2 N., R. 101 W.	Do.	MCZ L	5.3	10	100,000
25	SE¼SE¼ sec. 36 T. 3 N., R. 102 W.	Do.	MCZ L	5.6	38	400,000
33	NE¼NE¼ sec. 36 T. 3 N., R. 102 W	Drill hole	MCZ L	6.5	102	1,200,000
57	NW¼SW¼ sec. 23 T. 3 N., R. 102 W.	Outcrop	L	7.4	46	600,000
71	SE¼NE¼ sec. 16 T. 3 N., R. 102 W.	Do.	L3	6.6	25	300,000
84	NW¼NW¼ sec. 13 T. 3 N., R. 102 W.	Do.	MCZ L	5.1	13	100,000
91	NE¼NW¼ sec. 18 T. 3 N., R. 101 W.	Do.	MCZ L	5.2	10	100,000
92	NW¼NE¼ sec. 18 T. 3 N., R. 101 W.	Do.	MCZ L	5.6	38	400,000
92	NW¼NE¼ sec. 18 T. 3 N., R. 101 W.	Do.	MCZ L	5.4	48	500,000

Table 2.--Isolated Data Points, Rangely NE quadrangle, Rio Blanco and Moffat Counties, 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]
92	NE¼NE¼ sec. 18 T. 3 N., R. 101 W.	Outcrop	MCZ L	6.6	49	600,000
				Total tonnage		4,300,000

[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

*Resource tonnage is less than 50,000 short tons and is not added into the total resource tonnage figure.

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 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 valve	11,080 Btu/lb	11,490 Btu/lb

(To convert Btu/lb to Kj/kg multiply by 2.326)

The above samples were taken from an 11.9-ft (3.6 m) thick coal bed in the abandoned 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 the abandoned Staley-Gordon mine, NW¼ SW¼ NW¼ sec. 11, T. 2 N., R. 101 W., are listed in table 4.

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

	Moisture (percent)	Volatile matter (percent)	Fixed carbon (percent)	Ash (percent)	Heating value (But/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	50.5	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 a 3.7-ft (1.1-m) thick local coal bed in an unnamed mine located in SW¼NE¼ sec. 11, T. 2 N., R. 101 W.. The sample was analyzed and the following results were reported.

Table 5.--Chemical analysis of coal sample from the mine between the mouths of Red Wash and Scullion Gulch, 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	8.02 percent
Moistrue	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 in the bed sampled is ranked as high-volatile C Bituminous coal (American Society for Testing and Materials, 1977).

MINING OPERATIONS

There are two abandoned, unnamed coal mines in the Rangely NE quadrangle. One is located in the SE¼NE¼ sec. 16, T. 3N., R. 102 W. The 6-ft (1.8-m) thick coal bed mined here is apparently a local coal bed which occurs below the coal marker mapped by Garrigues and Barnum (1980). The other coal mine is located in the SW¼SE¼ sec. 10, T. 3 N., R. 102 W. A 12-ft (3.7-m) thick coal bed found in this mine has been correlated with the MCZ 2 coal bed as shown on plate 3. The periods of operation for these mines are unknown and no production figures are available.

COAL RESOURCES

The principal sources of data used in the construction of the coal isopach, structure contour, and coal-data maps were Garrigues and Barnum (1980), Barnum and others (1977), and Gaskill and Horn (1961).

Coal isopach maps were constructed using point-data nets derived from coal-thickness measurements of individual beds obtained from surface exposures and correlated well logs within the quadrangle boundary and within a 3-mile (4.8-km)-wide border extending beyond the quadrangle boundary if any data was available. The principle of uniform variation in thickness between data points was used to establish the position of the isopach lines.

Structure contour maps were constructed using point-data nets derived from well logs and surface exposures. Elevations for the top of each contoured coal bed are based on surface altitudes and measured depths to the tops of designated coal beds and referenced to a mean sea level datum.

Each overburden isopach map was based on a point-data net derived from 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 (pl. 4 and fig. 1 and 2) 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, MCZ 2, and MCZ 3 coal beds are shown on plate 7 and figures 7 and 8 and are rounded to the nearest tenth of a million 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 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 is 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. Meausred 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 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 (9.6 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. (71 cm) for bituminous coal and a maximum depth of 1,000 ft (305 m).

In this study, coal of Reserve Base thickness lying between the ground surface and a depth of 200 ft (61 m) is considered amenable to surface mining methods; coal of Reserve Base thickness lying between 200 ft (61 m) and 3,000 ft (914 m) below ground level in beds having dips of less than 15° is considered minable by conventional subsurface methods. Coal of Reserve Base thickness lying between 200 ft (61 m) and 3,000 ft (914 m) below ground level with dips greater than 15° is assumed to be minable by 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 72.8 million short tons (66.0 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 & 7.

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 4.3 million short tons (3.9 metric tons). In this quadrangle the unknown development potential resources are projected to extend as a ¼ mile (0.4 km) wide belt from the outcrop or points of measurement at the isolated data points.

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. 8 and 9) 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 (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 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,

Table 6.--Coal Reserve Base data for surface mining methods for Federal coal lands in the Rangely NE quadrangle, Rio Blanco and Moffat 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 1 coal bed	600,000	-0-	-0-	600,000
MCZ 2 coal bed	12,100,000	4,000,000	4,700,000	20,800,000
MCZ 3 coal bed	5,400,000	600,000	-0-	6,000,000
TOTALS	18,100,000	4,600,000	4,700,000	27,400,000

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

Table 7.--Coal Reserve Base data for subsurface and in situ coal gasification mining methods for Federal coal lands in the Rangley NE quadrangle, Rio Blanco and Moffat Counties, Colorado

(in short tons)[1]

Coal Bed Name	Conventional Subsurface Methods			In Situ Methods	Total
	High development potential	Moderate development potential	Low development potential	Low development potential	
MCZ 1 coal bed	-0-	-0-	-0-	-0-	-0-
MCZ 2 coal bed	45,200,000	-0-	-0-	200,000	45,400,000
MCZ 3 coal bed	-0-	-0-	-0-	-0-	-0-
TOTALS	45,200,000	-0-	-0-	200,000	45,400,000

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

the entire 40-acre (16-ha) area is given a high-development-potential rating even though most of the area is rated "moderate" because of the lower rated coal bed.

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 respective 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 8. Approximately 9 percent of the unleased Federal land area in this quadrangle is classified as having a high-development-potential, 2 percent a moderate-development-potential, and 4 percent a low-development-potential using surface mining methods. The remaining Federal land in the quadrangle is classified as having a unknown surface mining development potential or no development potential. Areas of unknown surface mining development potential are those not known to contain coal beds 5 ft (1.5 m) or more thick that are within 200 ft (61.0 m) of the surfaces; however, coal beds 5 ft (1.5 m) or more thick could be present in the area. Lands where it is known that no coal beds occur within 200 ft (61.0 m) of the surface have no surface-mining potential.

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 date, 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 9. In this quadrangle, areas where coal beds dip 15° 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 13 percent of the unleased Federal land in this quadrangle has 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- and low-development-potentials, respectively. In this quadrangle there are no areas classified with a moderate- or low-development-potential using subsurface mining methods. Areas that contain no known coal in beds 5 ft (1.5 m) or more thick but do contain coal-bearing units at depths between 200 to 3,000 ft (61-914 m) are classified as areas of unknown coal development potential. Areas where it is known that no coal beds occur or where coal beds are present at depths greater than 3,000 ft (914 m) have no coal-development potential.

Reserve Base tonnages have been calculated for all areas of unleased Federal land 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.

Reserves have not been calculated for the nonisopached coal beds at isolated data points. The areas controlled by those points have been assigned in unknown development potential. Resource tonnages included in the unknown potential category for areas within ¼ mile (0.4 km) of isolated data points total 4.3 million short tons (3.9 million metric tons) as shown in table 2. No distinction has been made between surface and subsurface mining resources in the areas controlled by isolated data points.

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}. Such areas are rated with a low development potential where the coal beds exceed 5 ft (1.5 m) in thickness, and occur between 200 and 3,000 ft (61-914 m) below the ground surface.

The recoverability of resources from coal beds with dips greater than 15 degrees is unknown; therfore, coal Reserves have not been calculated for those beds, but the Reserve Base tonnages have been determined and are shown on plate 7 and figures 7 and 8. The total Reserve Base tonnages per Federal section are shown on plate 2.

Table 8.--Sources of data used on plate 1

Source	Plate 1 Index No.	Drill hole or measured section in reference source
Garrigues and Barnum, 1980	1	(No number used)
Do.	2	Do.
Do.	3	1
Do.	4	2
Do.	5	3
Gaskill and Horn, 1961	6	11 (p. 33)
Garrigues and Barnum, 1980	7	4
Do.	8	5
Do.	9	6
Do.	10	(No number used)
Do.	11	7
Do.	12	9
Gaskill and Horn, 1961	13	12 (p. 34)
Garrigues and Barnum, 1980	14	(No number used)
Do.	15	10
Do.	16	11
Do.	17	(No number used)
Do.	18	Do.
Do.	19	8
Barnum and others, 1977	20	LW-2A-RN
Garrigues and Barnum, 1980	21	12
Do.	22	13
Do.	23	14
Do.	24	15
Do.	25	16
Do.	26	(No number used)
Do.	27	17
Do.	28	18
Do.	29	19
Do.	30	20
Gaskill and Horn, 1961	31	9 (p. 32)
Garrigues and Barnum, 1980	32	(No number used)
Barnum and others, 1977	33	LW-26-RN
Garrigues and Barnum, 1980	34	21
Do.	35	22
Gaskill and Horn, 1961	36	7 (p. 30)
Garrigues and Barnum, 1980	37	23
Do.	38	24
Do.	39	28
Gaskill and Horn, 1961	40	4 (p. 67)
Garrigues and Barnum, 1980	41	25
Do.	42	26
Do.	43	(No number used)
Do.	44	Do.
Do.	45	27

Table 8.--Sources of data used on plate 1 (Continued)

Source	Plate 1 Index No.	Drill hole or measured section in reference source
Do.	46	25
Do.	47	(No number used)
Do.	48	Do.
Do.	49	Do.
Garrigues and Barnum, 1980	50	29
Do.	51	30
Barnum and others, 1977	52	LW-9A-RN
Garrigues and Barnum, 1980	53	31
Do.	54	32
Do.	55	33
Do.	56	34
Do.	57	35
Do.	58	36
Do.	59	37
Do.	60	38
Do.	61	39
Do.	62	40
Do.	63	41
Do.	64	42
Do.	65	43
Barnum and others, 1977	66	LW-21-RN
Garrigues and Barnum, 1980	67	(No number used)
Do.	68	44
Do.	69	45
Do.	70	46
Do.	71	47
Do.	72	48
Do.	73	(No number used)
Do.	74	50
Do.	75	49
Do.	76	51
Do.	77	52
Do.	78	53
Do.	79	54
Do.	80	55
Do.	81	56
Barnum and others, 1977	82	LW-22-RN
Garrigues and Barnum, 1980	83	57
Do.	84	58
Do.	85	59
Do.	86	60
Do.	87	61
Do.	88	62
Barnum and others, 1977	89	LW-23-RN
Gaskill and Horn, 1961	90	26 (p. 40)
Do.	91	27 (p. 41)
Garrigues and Barnum, 1980	92	63
Do.	93	64

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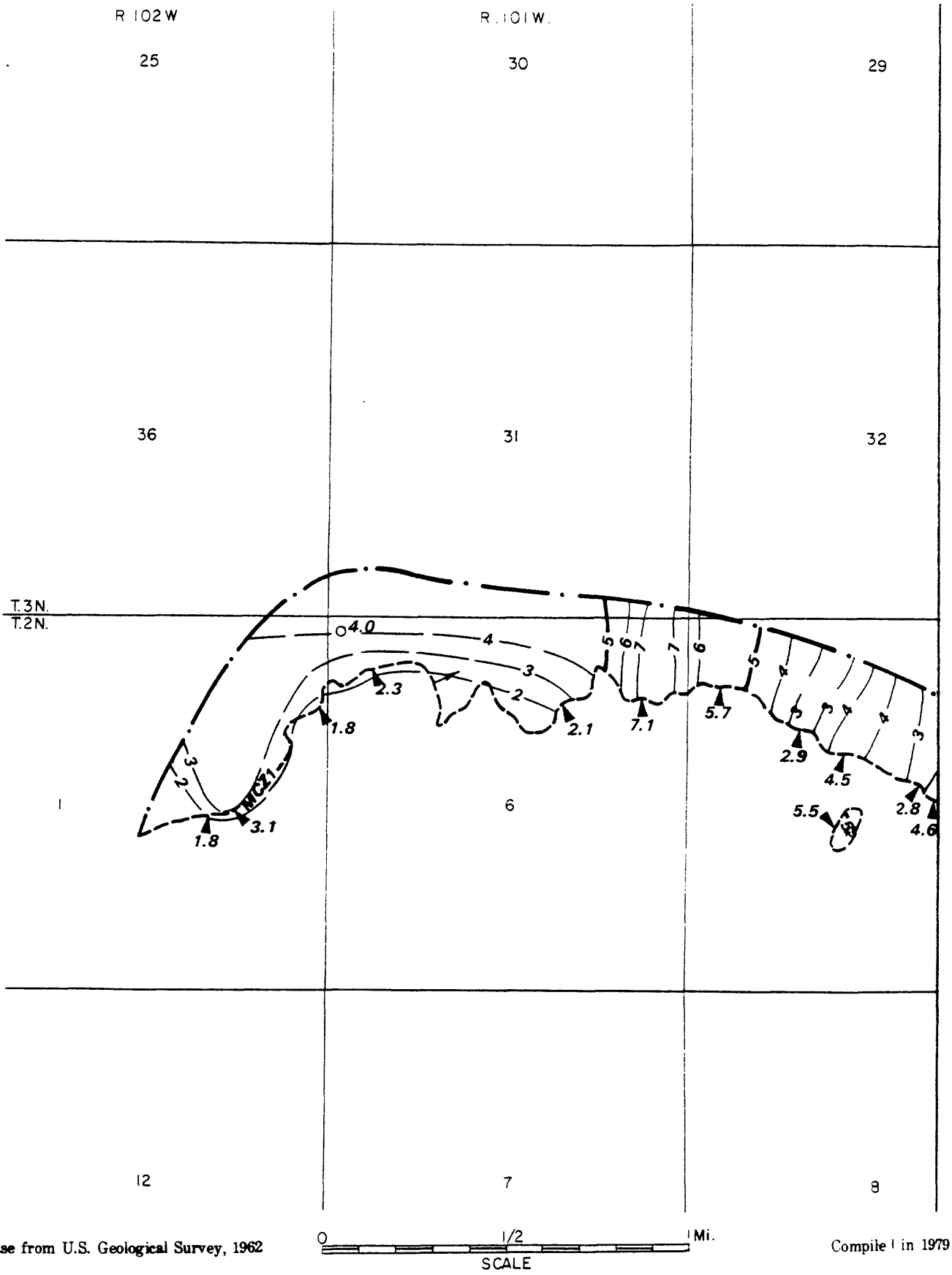


Figure 1.--Isopach map of coal bed 1, main coal zone

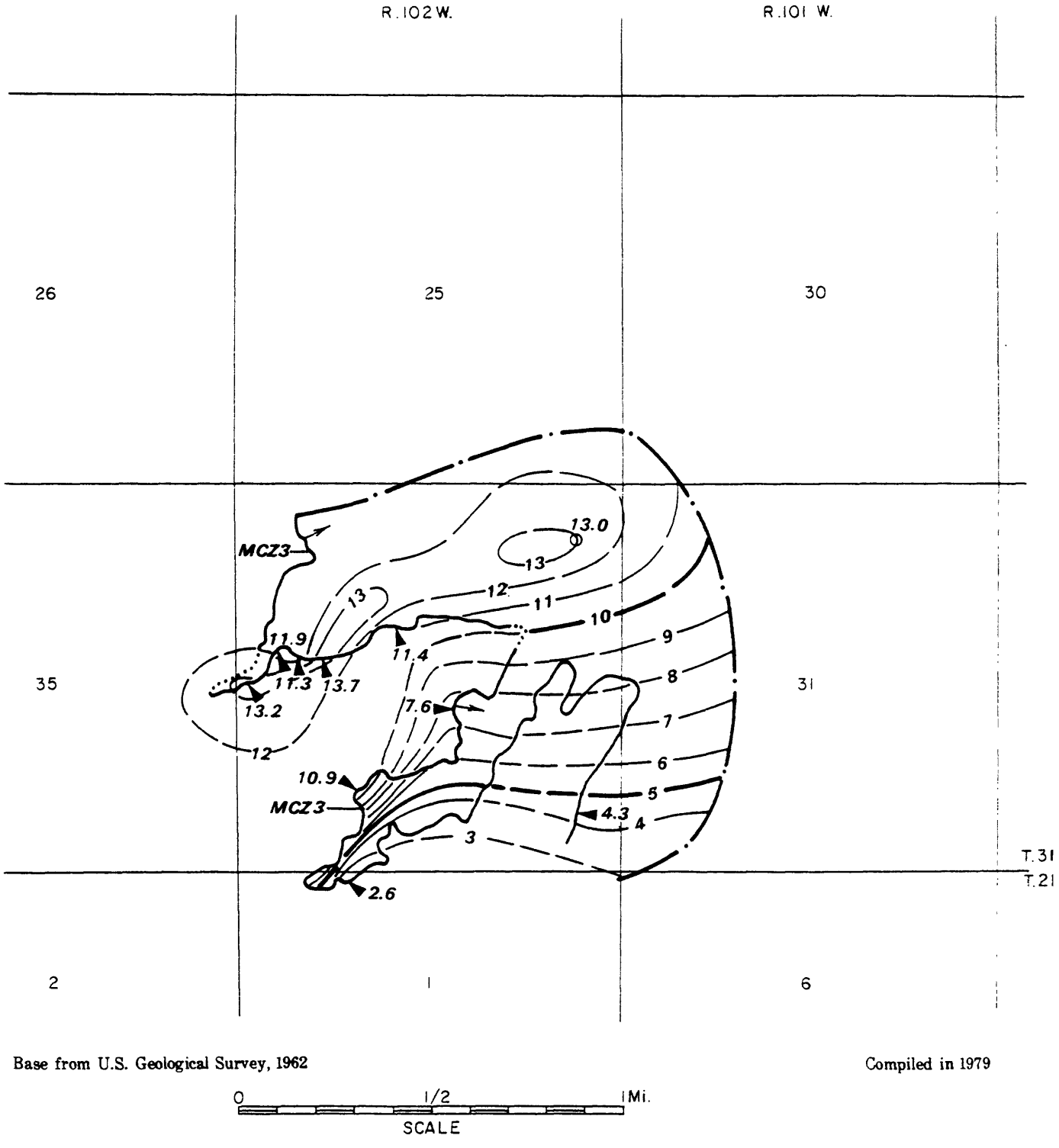
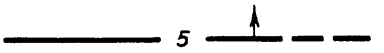
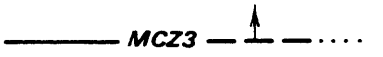


Figure 2.--Isopach map of coal bed 3, main coal zone

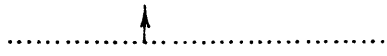


ISOPACHS–Showing thickness of coal, in feet. Long dashed where inferred, short dashed where projected above land surface. Isopach interval 1 foot.



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

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



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

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

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.

To convert feet to meters, multiply feet by 0.3048.

Explanation for coal isopach maps (figures 1 and 2)

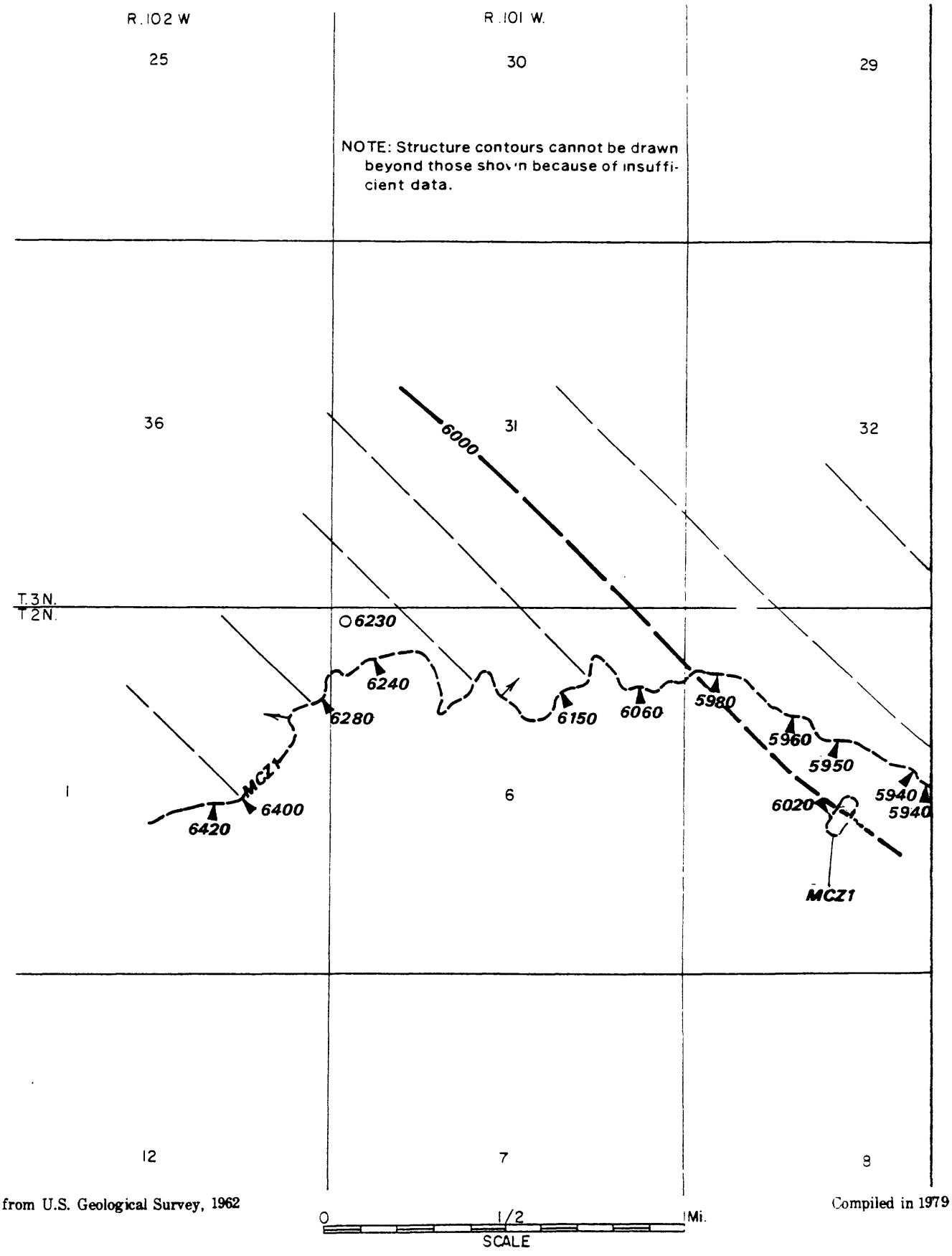


Figure 3.--Structure contour map of coal bed 1, main coal zone

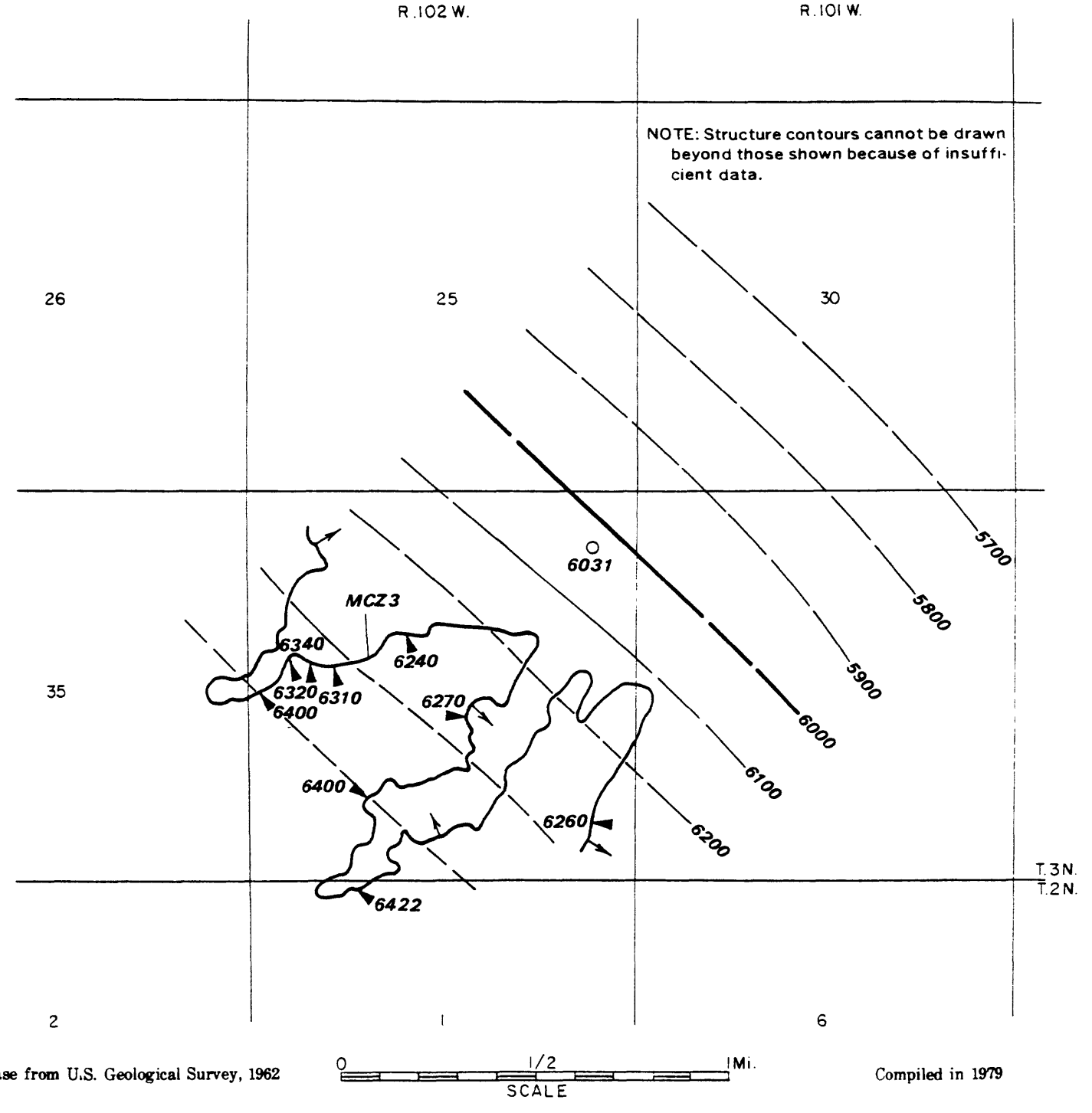
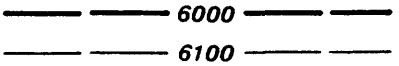
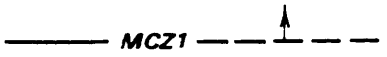


Figure 4.--Structure contour map of coal bed 3, main coal zone



STRUCTURE CONTOURS–Drawn on top of coal bed. Solid where vertical accuracy within 50 feet; long dashed where vertical accuracy possibly not within 50 feet; short dashed where projected above land surface. Contour interval is 100 feet (30.5m) Datum is mean sea level.



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 – Showing altitude of top of coal bed, in feet.

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.

To convert feet to meters, multiply feet by 0.3048.

Explanation for structure contour map (figures 3 and 4)

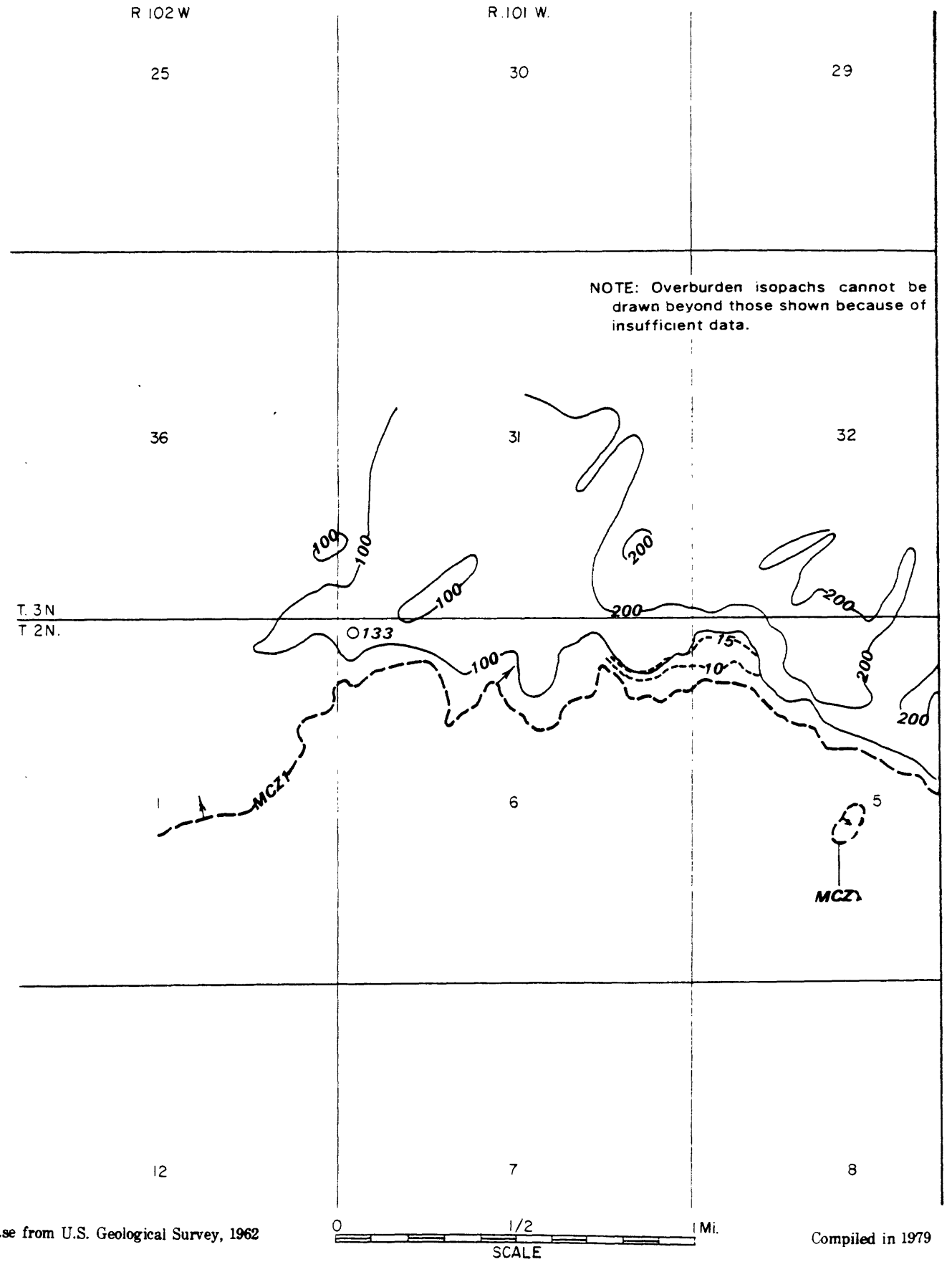


Figure 5.--Overburdern isopach map of coal bed 1, main coal zone

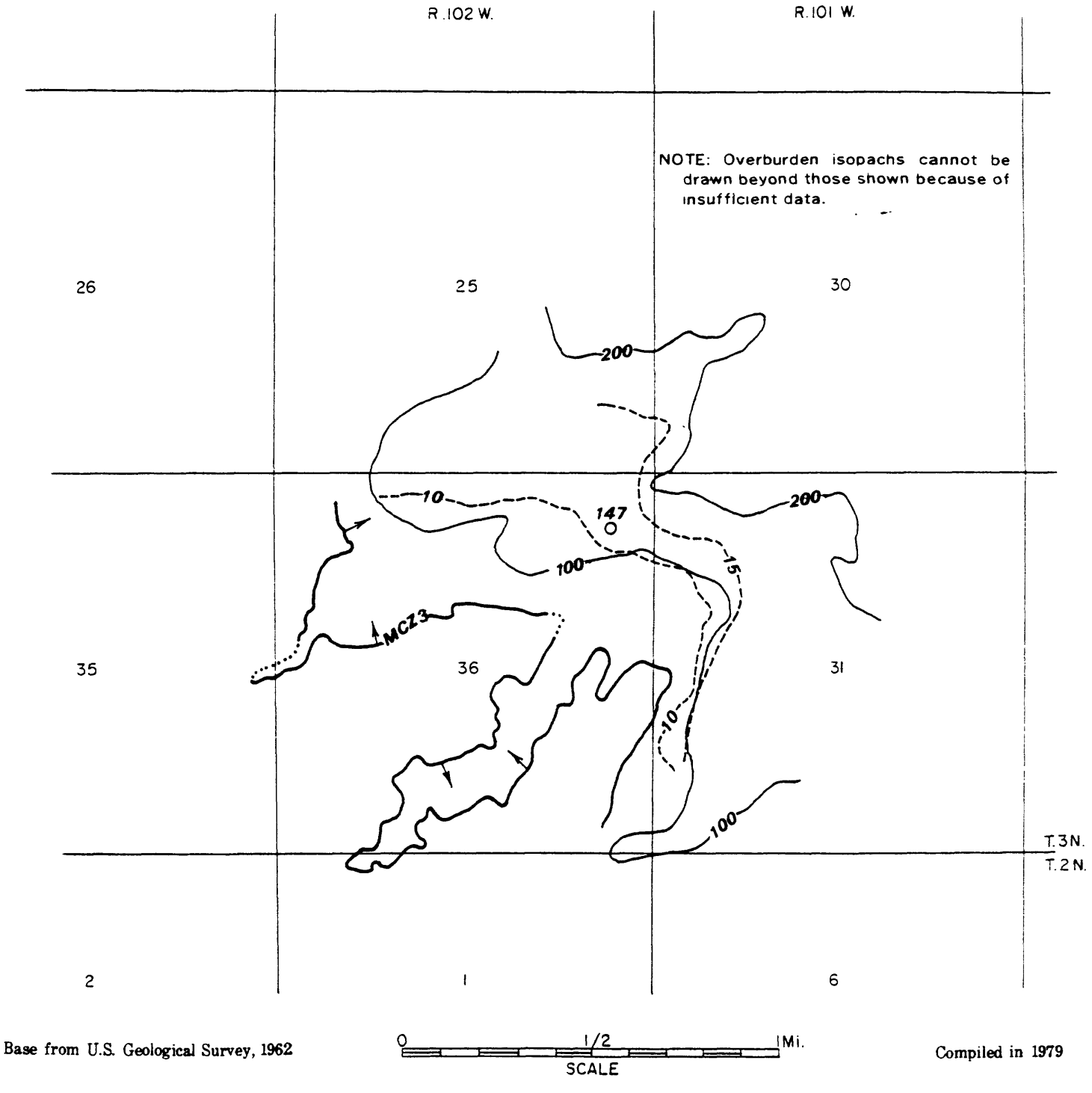
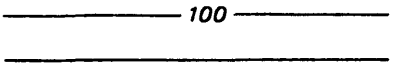
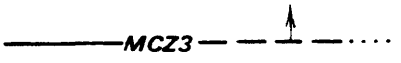


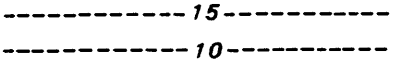
Figure 6.--Overburdern isopach map of coal bed 3, main coal zone



OVERBURDEN ISOPACHS – Showing thickness of overburden, in feet, from the surface to top of the coal bed or zone. Isopach interval 100 feet (30.5 m).



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



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.

DRILL HOLE–Showing thickness of overburden, in feet, from the surface to top of the coal bed or zone.

To convert feet to meters, multiply feet by 0.3048.

Explanation for overburden isopach maps (figures 5 and 6)

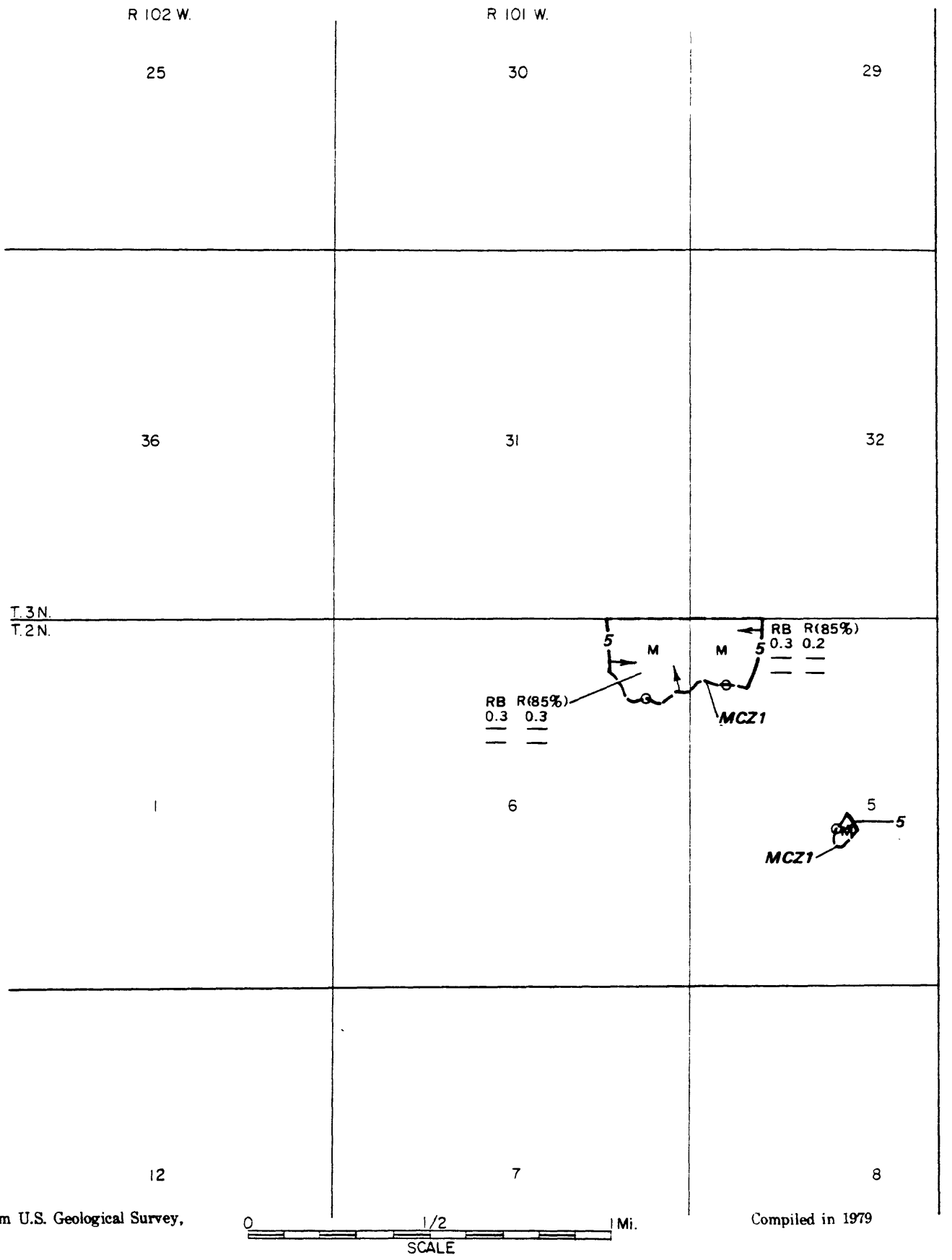


Figure 7.--Areal distribution and identified resources map of coal bed 1, main coal zone

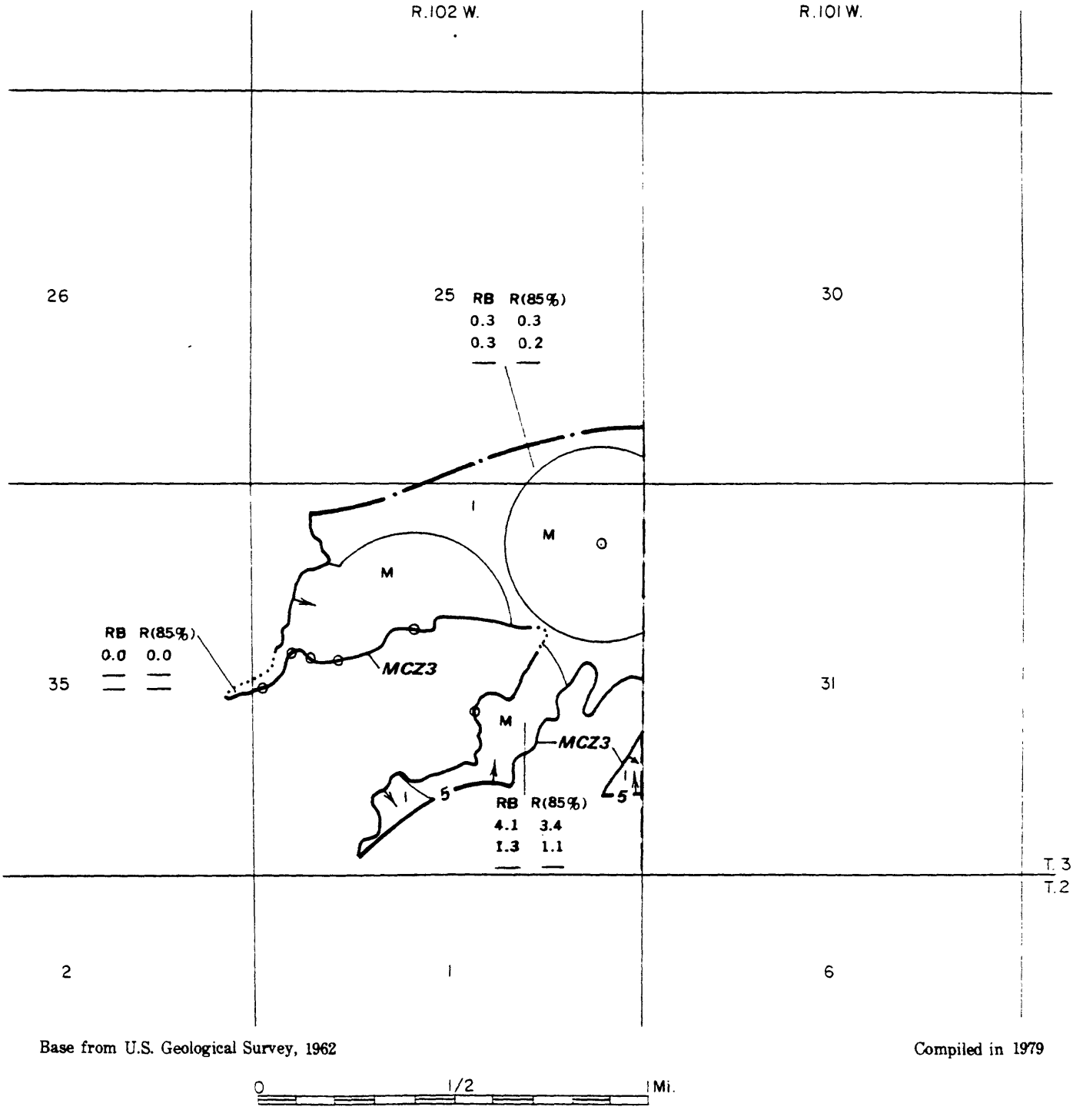
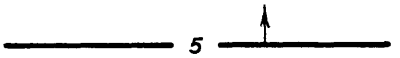
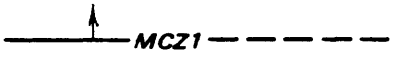


Figure 8.--Areal distribution and identified resources of coal bed 3, main coal zone

FEDERAL COAL LEASE BOUNDARY



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.

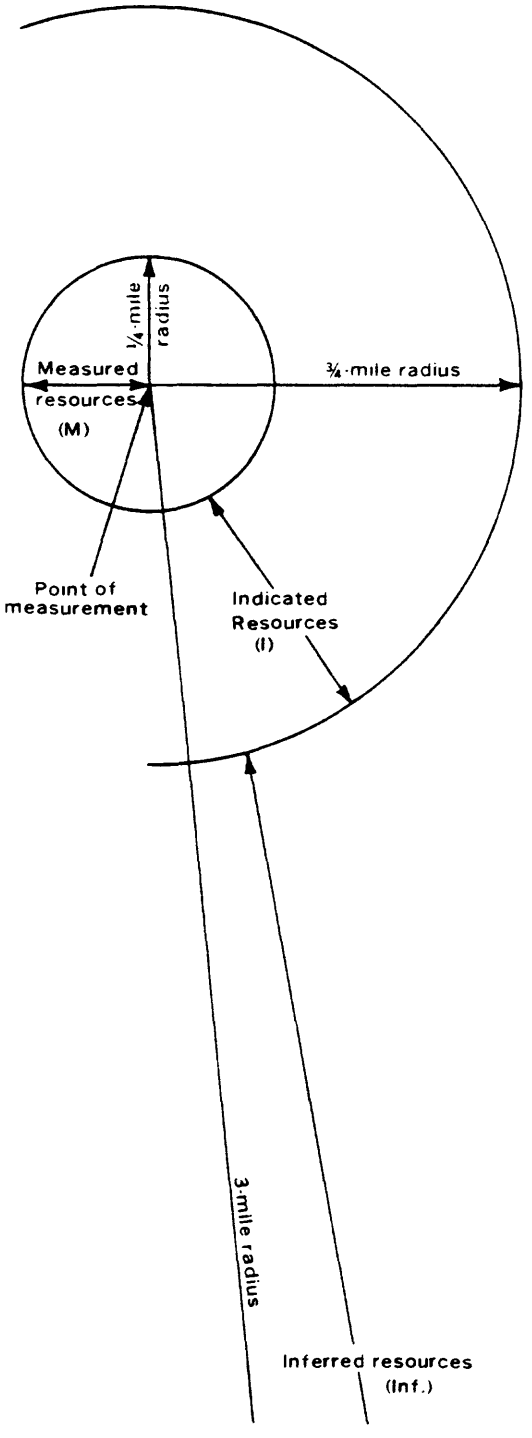
INSUFFICIENT DATA LINE–Coal resources were not calculated for areas beyond line shown because of insufficient data.

RB	R(85%)	
0.3	0.3	(Measured)
—	—	(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.

NOTE:
Reserve base figures are rounded off to the nearest 100,000 short tons, therefore, 0.0 represents a section with less than 50,000 short tons.

Explanation for areal distribution and identified resources maps (figures 7 and 8)



BOUNDARY LINES—Enclosed areas of measured, indicated, and inferred coal resources of the coal bed.

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 maps (figures 7 and 8)--(Cont.)

APPENDIX A

Coal and rock thicknesses for the measured sections and drill holes shown on CRO Data Map, plate 1, Rangely NE quadrangle, Rio Blanco and Moffat Counties, Colorado.

30	31	33	34
		GL 6178 (est.)	
R 6.1	R 5.0	R 46.5	R 7.1
NR 1.8	C 4.0 (MCZ 2)	C 5.0 (MCZ L)	NR 2.0
R 3.8	R 5.6	R 41.5	R 5.1
NR 6.6	NR 6.0	C 6.5 (MCZ L)	NR 2.0
C 3.8 (MCZ 3)	C 0.8 (MCZ L)	R 47.5	R 3.0
R <0.5	R 5.6	C 4.5 (MCZ 3)	NR 1.6
C 3.8 (MCZ 3)		R 11.0	R 3.0
NR 9.7		C 8.5 (MCZ 3)	C 1.3 (MCZ L)
C 2.1 (MCZ L)		R 7.5	R <0.5
R 2.0		C 5.0 (MCZ 2)	C 1.3 (MCZ L)
C 1.5 (MCZ 2)		R 22.5	R <0.5
R <0.5		C 3.0 (MCZ L)	C 0.8 (MCZ L)
C 1.3 (MCZ 2)		R 14.5	R 4.8
R <0.5		C 2.0 (L)	NR 22.6
C 1.5 (MCZ 2)		R 171.5	R 11.0
R 12.5		TD 397	NR 17.7
C 1.1 (MCZ L)			R 11.8
BC 0.7 (MCZ L)			NR 6.9
R 8.3+			R 4.1
			C 3.0 (MCZ 3)
			R 0.5
			C 8.4 (MCZ 3)
			R 1.1
			NR 2.1
			R 4.6
			C 0.7+ (MCZ 2)
			NR

35	36	37	38
R 16.6	R 14.2	R 2+	R 5.1
NR 31.2	C 3.0 (MCZ 3)	C 5.9 (MCZ 3)	NR 1.6
R 7.9	R 0.4	R <0.5	R 3.6
NR 11.2	C 8.3 (MCZ 3)	C 6+ (MCZ 3)	C 3.0 (MCZ 3)
R 55.1	R 14.0	NR	R 1.1
C 3.4 (MCZ 3)	C 3.7 (MCZ 2)		C 10.2 (MCZ 3)
R <0.5	R 1.0		R 4.9
C 10.2 (MCZ 3)	C 1.5 (MCZ 2)		NR 7.4
R 7.9	R 1.1		R 2.6
C 7.5 (MCZ 2)	C 1.8 (MCZ 2)		C 4.6 (MCZ 2)
R 1.1	R 23.5		R 1.1
NR 7.5			C 1.3 (MCZ 2)
R 18.0			R 1.5
NR 3.8			C 2.0 (MCZ 2)
R 7.2			R 1.6
NR 6.6+			NR 5.7

38 (Cont.)

R 8.4
NR 10.8
R 8.2+

39

NR 10.2
C 2.3 (MCZ 2)
R 5.1
C 1.1 (MCZ 2)
R 4.9
NR 2.1
R 5.2
NR 10.2
R 3.0
C 0.3 (MCZ L)
R 103.0
C 1.3 (L)
R 30.7
C 0.8 (L)
R 24.3
C 1.6 (L)
R 43.1+

40

R 38.0
C 1.9 (MCZ L)
R 15.9
C 1.0 (MCZ L)
R 15.5
C 0.9 (MCZ L)
R 7.0
BC 1.0 (MCZ L)
R 18.0
C 1.0 (MCZ L)
R 7.6
C 5.0+ (MCZ 2)
NR

41

R 11.2
NR 6.6
R 6.9
C 0.3 (MCZ L)
R 6.9
NR 7.1
R 17.6
C 3.3 (MCZ L)
R <0.5
C 2.0 (MCZ L)
R 6.6
C 0.7 (MCZ L)
R 3.1
NR 1.8
R 7.9
NR 3.4
R 20.2

41 (Cont.)

C 1.1 (MCZ L)
R 23.6
C 2.0 (MCZ 2)
R 1.6
C 1.1 (MCZ 2)
R 1.8
NR 5.2
R 2.1
C 4.3 (MCZ 2)
R 1.1
NR 3.3
R 5.7+

42

R 2.1+
C 1.0 (MCZ 2)
R 1.3
C 1.1 (MCZ 2)
R 15.3
C 2.5 (MCZ 2)
R 0.5
C 1.3 (MCZ 2)
R 4.8

45

R 8.2
NR 6.4
R 8.7
C 1.6 (L 1)
R 1.0
C 1.0 (L 1)
R 2.0
NR 3.3
R 2.6
C 0.8 (L)
R <0.5
C 0.8 (L)
R 6.6
C 0.7 (L)
R 9.8

50

R 102.7
C 2.1 (MCZ L)
R 4.1
C 1.0 (MCZ 2)
R 1.1
C 0.5 (MCZ 2)
R 1.3
C 7.2 (MCZ 2)
R 3.1
C 1.8 (MCZ L)
BC 2.6 (MCZ L)
R 15.4
BC 2.0 (MCZ L)
C 1.5 (MCZ L)
R 92.7
NR 65.6
R 22.1
C 0.5 (L)
R 146.0+

51

R 64.5
C 3.8 (MCZ L)
R 121.2
C 3.0 (MCZ L)
R 2.8
NR 4.3
BC 1.0 (MCZ L)
R 4.4
C 4.8 (MCZ 2)
R 4.1
C 2.8 (MCZ 2)
R 29.5

51 (Cont.)

C 2.3 (MCZ L)
R 14.8
NR 3.1
R 6.6
NR 14.6
R 33.5
C 1.0 (L)
R 5.4
C 1.6 (L)
R 3.8
NR 56.8
R 3.4
C 0.8 (L)
R 3.6+

52

GL 6008 (est.)
R 108.0
C 1.5 (MCZ L)
R 4.0
C 2.5 (MCZ L)
R 67.0
C 7.0 (MCZ 2)
R 1.5
C 3.0 (MCZ 2)
R 97.5
C 1.5 (L)
R 72.5
TD 366

53

R 6.2
NR 20.0
R 22.1
C 0.5 (MCZ L)
R 24.4
C 0.7 (MCZ L)
R 37.9
C 0.5 (MCZ L)
R 1.0
NR 3.4
R 5.1
NR 4.3

53 (Cont.)

R 3.1
C 0.3 (MCZ L)
R 1.0
C 0.7 (MCZ L)
NR 1.6
R 4.8
NR 6.6
R 1.3
C 2.8 (MCZ 2)
R 1.5
C 2.0 (MCZ 2)
R 1.3
C 2.5 (MCZ 2)
R 7.1
C 1.1 (MCZ 2)
R 0.8
C 1.1 (MCZ 2)
R 37.7+

54

R 15.6
NR 16.7
R 0.8
C 0.3 (MCZ L)
R 0.7
NR 16.4
R 1.5
C 0.3 (MCZ L)
R 1.1
NR 13.3
R 16.1
C 2.0 (MCZ L)
R 1.3
C 0.3 (MCZ L)
R 35.6
NR 3.0
R 4.9

54 (Cont.)

NR 1.8
R 1.6
C 2.6 (MCZ 2)
R 1.3
C 2.0 (MCZ 2)
R 1.8
C 2.5 (MCZ 2)
R 1.8
NR 8.2
R 1.8
NR 3.3
R 1.1
C 0.3 (MCZ 2)
R 14.1
C 0.5 (MCZ L)
R <0.5
C 0.8 (MCZ L)
R <0.5
C 0.5 (MCZ L)
R 11.8

55

R 5.7+
C 1.0 (MCZ L)
R <0.5
C 2.0 (MCZ L)
R 3.3
NR 2.1
R 13.1
NR 1.8
R 11.5
NR 2.0
R 4.8
NR 3.1
R 25.4
C 0.5 (L)
R 2.1
NR 2.3
R 6.7
NR 18.0
R 15.6

56

R 2.0
C 1.6 (MCZ L)
R 25.0
C 0.5 (MCZ L)
R 3.0
C 1.0 (MCZ L)
R 15.1
C 0.7 (MCZ L)
R 23.0
NR 11.0
R 4.4
C 3.6 (MCZ 2)
R <0.5
C 2.5 (MCZ 2)
R 3.6
C 2.3 (MCZ 2)
R 8.0
C 1.0 (MCZ 2)
R <0.5
C 1.0 (MCZ 2)
R 9.4
C 1.0 (MCZ 2)
R 38.2
C 1.0 (L)
NR 5.9
R 15.4
C 1.0 (L)
R 10.8

57

R 11.5
NR 7.4
R 7.9
C 1.0 (L)
R 1.1
C 7.4 (L)
R 4.9+

58

R 11.8
NR 6.4
R 14.6
NR 6.2
R 10.8
NR 3.0
R 3.4
C 1.0 (MCZ L)
R 4.1
NR 3.3
R 21.0
NR 11.8
C 0.7 (MCZ L)
R 11.2
NR 4.4
R 3.8
C 0.8 (MCZ L)
R 5.6
NR 11.6
R 21.0

58 (Cont.)

C 3.6 (MCZ 2)
R <0.5
C 4.3 (MCZ 2)
R <0.5
C 1.1 (MCZ 2)
R <0.5
C 1.1 (MCZ 2)
R 1.1
C 1.1 (MCZ 2)
R <0.5
C 1.0 (MCZ 2)
R 1.1
C 1.5 (MCZ 2)
R 4.9
C 1.1 (MCZ 2)
R 3.0
C 1.0 (MCZ L)
R 4.4
NR 4.4
R 4.1

59

R 5.6
C 3.3 (MCZ 2)
R <0.5
C 4.4 (MCZ 2)
R 0.7
C 2.0 (MCZ 2)
R 2.1
C 1.3 (MCZ 2)
R 5.6
NR 4.3
R 8.2+

60

R 10.2
C 0.7 (MCZ 2)
R <0.5
C 1.5 (MCZ 2)
R 11.2
C 1.1 (MCZ 2)
R 37.7
C 2.6 (L 2)
R 28.7
C 0.7 (L)
R 6.1
C 0.7 (L)
R 55.3
C 0.3 (L)
R 10.3
C 1.0 (L)
R 137.1

61

R 49.0
C 0.8 (MCZ L)
R 30.8
C 0.5 (MCZ L)
R 30.0
NR 18.0
R 72.6
NR 4.6
R 31.2
C 2.0 (L 2)
R 17.7
C 0.5 (L)
R 45.3
C 1.0 (L)
R 34.8
C 0.8 (L)
R 52.5+

62

R 23.8
C 2.3 (L 2)
R 83.7
C 0.5 (L)
R 79.1
NR 7.1
R 18.0

63

R 32.6
C 3.6 (MCZ L)
R <0.5
C 1.0 (MCZ L)
R 8.0
C 10.3(MCZ 2)
R <0.5
C 3.3 (MCZ 2)
R 41.2
C 1.8 (L 2)
R 15.1
C 1.1 (L)
R 12.5
C 0.5 (L)
R 41.2
C 0.8 (L)
R 44.9
C 0.7 (L)
R 105.0

64

R 22.1
NR 11.0
R 2.0
C 1.0 (MCZ L)
R 19.7
NR 7.7
R 11.2
C 3.4 (MCZ L)
R 3.1
C 0.7 (MCZ L)
R 20.7
C 12.0 (MCZ 2)
R 30.7
C 2.5 (L 2)
R 42.3
BC 1.8 (L)
R 135.0
NR 22.8
R 33.0

65

NR 13.3+
R 2.0
C 3.9 (MCZ 2)
R <0.5
C 0.8 (MCZ 2)
R 1.6
C 6.6 (MCZ 2)
R 37.7
C 2.0 (L 2)
R 35.8
NR 7.5
R 15.6
NR 36.1
R 16.4+

66

GL 6049 (est.)
R 87.0
BC 1.5 (MCZ L)
R 78.0
C 2.5 (MCZ L)
R 21.5
C 3.5 (MCZ 2)
R 1.0
C 11.0 (MCZ 2)
R 38.0
C 1.5 (L 2)
R 11.0
C 2.0 (L)
R 141.5
TD 400

68

R 2.3
C 11.0 (MCZ 2)
R 53.8
C 1.0 (L 3)
R <0.5
C 0.8 (L 3)
R 11.2
C 1.6 (L)
R 23.3
C 0.8 (L)
R 24.0
C 0.3 (L)
R 13.1
NR 4.1
R 10.5

69

R 6.2
C 8.9 (MCZ 2)
BC 1.0 (MCZ 2)
C 2.0 (MCZ 2)
R 22.3

70

NR 9.8
R 23.3
NR 21.3
R 5.4
C 2.0 (L 3)
R <0.5
C 0.3 (L 3)
R 5.7
NR 4.9
R 4.4
NR 3.1
R 55.6

71

R 1.5
NR 6.2
R 4.6
NR 4.9
R 17.1
NR 6.2
C 6.6 (L 3)
R 3.4
C 0.5 (L)
R 3.0+

72

R 9.5
C 1.0 (MCZ L)
R 10.8
C 1.1 (MCZ L)
R 1.6
C 1.1 (MCZ L)
R 6.7
C 1.6 (MCZ L)
R 4.8+

74

R 41.3
C 1.0 (MCZ L)
R 18.9
C 11.5 (MCZ 2)
R <0.5
C 0.5 (MCZ 2)
R 28.7
C 1.0 (L)
R 8.7
C 1.8 (L 3)
R 9.5
C 1.3 (L)
R 1.3
C 0.7 (L)
R 94.2
C 0.7 (L)
R 11.0+

75

R 25.1
C 0.7 (L)
R 10.7
C 1.8 (L 3)
R 1.8
NR 2.5
R 2.0
C 1.6 (L)
R 23.3
NR 2.8
R 4.3
NR 8.5
R 4.1

76

R 13.5
NR 6.9
R 17.2
NR 17.6
R 20.6
NR 1.6
R 19.8
NR 23.3
R 11.3
C 2.6 (MCZ L)
R <0.5
C 0.8 (MCZ L)
R <0.5

76 (Cont.)

C 0.6 (MCZ L)
R 15.1
NR 14.4
R 21.7
NR 7.7
R 8.5
BC 1.0 (MCZ L)
C 1.6 (MCZ L)
R 3.8
C 0.7 (MCZ L)
R 14.8
C 13.1 (MCZ 2)
R <0.5

76 (Cont.)

C 1.5 (MCZ 2)
R 5.1
NR 6.2
R 6.9+

77

R 4.6+
C 12.5 (MCZ 2)
R <0.5
C 0.5 (MCZ 2)
R <0.5
C 0.5 (MCZ 2)
R 14.8

78

R 86.9
C 2.5 (L)
R 5.9
C 0.8 (L)
R 1.1
C 0.7 (L)
R 11.8
C 3.1 (L)
R 19.7
C 2.1 (MCZ L)
R 86.8
NR 10.8
R 3.1
NR 24.6
R 3.1
C 5.9 (MCZ 2)
R <0.5
C 8.2 (MCZ 2)
R <0.5
C 1.3 (MCZ 2)
R 24.6+

79

R 14.3
C 10.0 (MCZ 2)
R 1.3
NR 11.8
R 77.4
C 1.3 (L)
R 27.1
C 0.7 (L)
R 65.8
C 1.6 (L)
R 142.6

80

R 18.4
NR 79.1
R 19.8
NR 16.4
R 12.5
NR 12.1
R 1.1
C 4.3 (MCZ 4)
R 10.2
C 9.2 (MCZ 2)
R 55.4
C 1.5 (L)
R 6.9
C 0.8 (L)
R 3.0
NR 20.0
R 11.5
NR 1.8
R 4.1+

81

R 44.6
C 2.3 (MCZ L)
R 5.1
NR 3.6
R 4.8
NR 6.9
R 14.4
C 3.8 (MCZ L)
R 3.0
NR 3.6
R 38.4
NR 13.1
R 6.6
NR 28.1
R 10.2
C 5.6 (MCZ 2)
R <0.5
C 3.4 (MCZ 2)
R 19.4

82

GL 6070 (est.)
R 89.5
C 2.0 (MCZ L)
R 1.0
BC 1.0 (MCZ L)
R 22.5
C 3.5 (MCZ L)
R 64.0
C 4.0 (MCZ 4)
R 14.0
C 8.5 (MCZ 2)
R 62.0
C 2.0 (L)
R 11.0
C 1.0 (L)
R 64.0

83

R 11.5+
NR 88.6
R 15.9
NR 29.9
R 8.4
C 1.5 (MCZ L)
R 1.6
C 0.5 (MCZ L)
R 1.3
C 0.2 (MCZ L)
R 7.5
C 4.6 (MCZ L)
R 8.4
NR 6.1
R 23.0
NR 31.0
R 13.0
BC 1.3 (MCZ 4)
C 0.3 (MCZ 4)
R 0.9
C 3.1 (MCZ 4)
R 12.8
C 5.6 (MCZ 2)
R 1.5
C 3.3 (MCZ 2)
R 25.0
NR 3.3
R 6.6

83 (Cont.)

NR 8.2
R 14.9
NR 10.1
R 2.1
C 1.6 (L)
R 1.5
NR 6.6
R 9.8
NR 16.1
R 6.6
NR 6.6
R 2.0
NR 1.3
R 6.9
NR 2.6
R 8.2
NR 19.7
R 3.3
C 1.5 (L)
R 3.6
C 1.0 (L)
R 3.8
NR 6.4
R 3.3
NR 44.3
R 34.4
NR 34.9
R 13.3

84	85	86	87
NR 4.9+	R 9.5	R 15.9	NR 10.2+
R 76.9	C 0.8 (MCZ L)	NR 80.7	R 6.9
C 1.0 (L)	R 1.1	R 18.4	NR 16.1
R 11.8	C 1.0 (MCZ L)	NR 38.7	R 3.3
NR 13.9	R 12.3	R 14.1	C 1.5 (MCZ 2)
R 6.6	C 0.7 (MCZ L)	C 1.1 (MCZ L)	R 9.4
C 1.1 (MCZ L)	R 17.7	R 16.1	C 1.0 (MCZ 2)
R 8.4	NR 6.1	C 1.0 (MCZ L)	R <0.5
NR 23.1	R 1.8	NR 6.9	C 1.5 (MCZ 2)
R 12.8	C 3.3 (MCZ L)	R 7.4	R 16.2
C 5.1 (MCZ L)	R <0.5	NR 8.2	NR 2.0
R 14.8	C 0.7 (MCZ L)	R 2.6	R 6.4
C 2.6 (MCZ L)	R 1.6	C 1.6 (MCZ L)	NR 3.0
R 15.7	NR 1.5	R 3.6	R 3.3+
C 3.1 (MCZ L)	R 14.4	NR 3.3	
R 4.1	NR 4.6	R 6.2	
NR 14.8	R 7.1	C 2.3 (MCZ L)	
R 15.3	NR 1.8	R 4.4	
C 6.7 (MCZ 2)	R 6.9	NR 8.2	
R 32.5	NR 5.9	R 7.1	
NR 24.4	R 6.7	NR 4.9	
C 0.7 (L)	C 2.3 (MCZ 4)	R 8.2	
NR 9.8	R 18.4	NR 2.8	
C 0.8 (L)	C 3.3 (MCZ 2)	R 3.3	
NR 63.5	R 1.1	C 2.1 (MCZ 2)	
R 4.8	C 1.1 (MCZ 2)	R 4.8	
NR 39.4	R <0.5	C 2.3 (MCZ 2)	
R 2.5	C 1.1 (MCZ 2)	R 2.1	
NR 14.8	R 16.4	NR 2.3	
R 36.9+		R 7.6	
		NR 3.1	
		R 2.8	
		NR 14.6	
		R 21.3	
		NR 26.2	
		R 11.2	
		NR 18.9	
		R 3.1	
		NR 11.0+	

88

NR 11.2
R 7.4
NR 29.7
C 2.3 (MCZ L)
R 3.1
NR 5.9
R 4.1
C 2.3 (MCZ L)
R 3.4
NR 26.4
R 21.3
C 1.0 (MCZ 2)
R 11.2
C 2.0 (MCZ 2)
R 4.6
NR 3.3
R 13.5
NR 1.3
R 9.8
NR 37.7
R 6.7
NR 9.0

89

GL 5817 (est.)
R 22.5
BC 2.0 (MCZ L)
R 6.0
C 2.5 (MCZ L)
R 5.0
C 4.5 (MCZ L)
R 10.0
C 3.5 (MCZ L)
R 26.0
C 2.0 (MCZ L)
R 97.5
BC 1.0 (L)
R 3.0
C 1.5 (L)
R 94.5
BC 1.5 (L)
R 35.0
TD 318

90

R 1.0
C 1.5 (L)
R 146.6
BC 1.0 (L)
R 59.0
C 1.5 (L)
R 1.5

91

R 1.0
C 1.7 (MCZ L)
R 1.5
C 3.2 (MCZ L)
R 3.8
C 5.2 (MCZ L)
R 2.7
C 2.8 (MCZ L)
R 7.1
C 1.8 (MCZ L)
R 19.3

92

R 3.3+
NR 2.0
R 13.3
C 1.3 (MCZ L)
R 2.1
C 0.2 (MCZ L)
R 1.5
C 5.4 (MCZ L)
R 11.6
C 6.6 (MCZ L)
R 2.6
C 1.1 (MCZ L)
R 5.1
C 5.4 (MCZ L)
BC 2.0 (MCZ L)
R 45.1
C 3.9 (MCZ L)
R 32.6
NR 2.0
R 16.4
NR 25.4
R 6.9
NR 9+

93

NR 6.4+
R 5.9
C 0.7 (MCZ L)
R 10.2
C 4.1 (MCZ L)
R 3.8
NR 10.7
R 7.1
C 0.7 (MCZ L)
R <0.5
C 1.6 (MCZ L)
R 13.9
C 4.3 (MCZ L)
R 4.9
NR 6.2
R 25.9
C 1.1 (L)
R 21.3
C 1.3 (L)
R 10.0
C 1.0 (L)
R 11.0
NR 6.6
R 6.2+