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COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT
POTENTIAL MAPS OF THE
NORTHWEST QUARTER OF THE
MT. PENNELL 15-MINUTE QUADRANGLE,
GARFIELD COUNTY, UTAH
[Report includes 14 plates]

Prepared for
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

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This report has not been edited
for conformity with U.S. Geological
Survey editorial standards or
stratigraphic nomenclature.

CONTENTS

	<u>Page</u>
Introduction.....	
Purpose.....	
Location.....	
Accessibility.....	
Physiography.....	
Climate and vegetation.....	
Land status.....	
General geology.....	
Previous work.....	
Stratigraphy.....	
Structure.....	
Geologic history.....	
Coal geology.....	
Chemical analyses of Emery zone coal.....	
Coal resources.....	
Isolated data points.....	
Coal development potential.....	
Development potential for surface mining methods.....	
Development potential for subsurface mining methods....	
References.....	
Bibliography.....	

ILLUSTRATIONS

- Plates 1-14 Coal resource occurrence and coal development potential maps:
1. Coal data map
 2. Boundary and coal data map
 3. Coal data sheets
 4. Isopach and structure contour map of the Emery 1 coal bed and isopach map of the Emery 3 coal bed
 5. Overburden isopach and mining ratio maps of the Emery 1 and Emery 3 coal beds
 6. Areal distribution and identified resources map of the Emery 1 coal bed
 7. Isopach and structure contour map of the Emery 2 coal bed
 8. Overburden isopach and mining ratio map of the Emery 2 coal bed
 9. Areal distribution and identified resources map of the Emery 2 coal bed
 10. Isopach and structure contour map of the Emery 3 coal bed and isopach map of the Emery 9 coal bed
 11. Overburden isopach and mining ratio maps of the Emery 3 and Emery 9 coal beds
 12. Areal distribution and identified resources maps of the Emery 3 and Emery 9 coal beds
 13. Coal development potential map for surface mining methods
 14. Coal development potential map for subsurface mining methods

FIGURES

Figures 1-7 Isolated data point maps:

	<u>Page</u>
1. Explanation for Figures 2 through 7	16a
2. Isolated data point map of the Emery 4 coal bed	16b
3. Isolated data point map of the Emery 5 coal bed	16c
4. Isolated data point map of the Emery 6 coal bed	16d
5. Isolated data point map of the Emery 7 coal bed	16e
6. Isolated data point map of the Emery 8 coal bed	16f
7. Isolated data point map of the Emery 10 coal bed	16g

TABLES

Tables 1-3

	<u>Page</u>
1. Average proximate analyses of coal samples.....	14
2. Coal Reserve Base Data for surface mining methods for Federal coal lands...	21
3. Coal Reserve Base Data for subsurface mining methods for Federal coal lands...	22

INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Northwest Quarter of the Mt. Pennell 15-minute quadrangle, Garfield County, Utah. These maps and report were compiled to support the land planning work of the Bureau of Land Management and to provide a systematic coal resource inventory of Federal coal lands in the Henry Mountains Known Recoverable Coal Resource Areas (KRCRA's), Utah. Consequently, only those geologic features relevant to coal occurrences are described herein.

This investigation was undertaken by Dames & Moore, Salt Lake City, Utah at the request of the U.S. Geological Survey under contract number 14-08-0001-17489. The resource information gathered for this report is in response to the Federal Coal Leasing Amendments Act of 1976 (P.L. 94-377). Published and unpublished public information available through June, 1979, was used as the data base for this study. Neither drilling nor field mapping was performed; nor were any confidential data used.

Location

The Northwest Quarter of the Mt. Pennell 15-minute quadrangle is located in east-central Garfield County, Utah, about 30 miles (48 km) southwest of Hanksville and 30 miles (48 km) north of the Lake Powell resort of Bullfrog. Boulder, Utah is roughly 20 (32 km) miles west of the area.

Accessibility

No roads cross the map area. An unimproved dirt road follows Bullfrog Creek, bordering the east side of the map area, but access to the interior is limited to hiking and horse-back trails. The Bullfrog Creek road connects eventually to the towns of Notom to the north and Boulder to the west.

Physiography

Topography in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle is dominated by Tarantula Mesa in the north, rising above low relief benchlands on Swap Mesa and Cave Flat to the south. Both the margins of Tarantula Mesa and the benchlands are well dissected by a dendritic pattern of streams which have cut narrow steep walled canyons into poorly resistant sedimentary rocks.

Elevations range from 5,080 ft (1,548 m) along Muley Creek in the south to a high of 7,119 ft (2,170 m) in the northeast corner of the map area. Total relief is about 2,039 ft (621 m).

Drainage from most of the area is southward through Muley Creek, Bullfrog Creek and Swap Canyon to Lake Powell. Runoff from the northern portion of Tarantula Mesa flows northward through Sweetwater Creek to the Fremont River. Drainages carry only intermittent stream flow.

Water quality and stream flow reflect seasonal climatic changes. Most surface water is saline due to high evaporation rates and streams are typically dry in the late summer.

Climate and Vegetation

Climate in the quadrangle is arid. Average annual precipitation is approximately 10 inches (25 cm), but amounts vary widely from year to year due to the erratic nature of desert rainfall. Droughts lasting three or more years are common. Localized, late summer thundershowers and light, winter snows and rains bring most moisture to the area.

Temperatures range from over 100°F (38°C) in the late summer months to less than 0°F (-18°C) during the winter. Temperatures drop and precipitation increases with increased elevation. Winds generally blow from the west and southwest. The highest seasonal velocities occur in the spring and early summer months.

Principal types of vegetation in the area include grass, sagebrush, pinon, juniper, salt brush and greasewood (U.S. Bureau of Land Management, 1978).

Land Status

Nearly three-quarters of the map area is within the central portion of the Henry Mountains Known Recoverable Coal Resource Area. The Federal government owns the coal rights for most lands, as shown on plate 2 of the Coal Resource Occurrence Maps. Coal underlies the bulk of the map area. The Bureau of Land Management supervises the 86.1 percent surface portion of the map area owned by the Federal government; the state of Utah

controls 13.9 percent of the land. A Preference Right lease Application (PRLA U6740) is outstanding in T. 33 S., R. 8 E. (unsurveyed), in the southwest quarter (PRLA U9238) and in T. 33 S., R. 9 E. (unsurveyed) on the southeast side of the Northwest Quarter of the Mt. Pennell 15-minute quadrangle.

GENERAL GEOLOGY

Previous Work

John Wesley Powell, one of the first explorers of the region, named the Henry Mountains in 1869 and made some of the first geologic comments (Gilbert, 1877) on the area. G. K. Gilbert (Gilbert, 1877) studied the Henry Mountains in 1875 and 1876. His report is considered one of the classics of geological literature. Gregory and Moore (1931) and later Smith and others (1963) and Davidson (1967) reported on parts of the Waterpocket Fold in the region.

The first investigation of coal resources in the Henry Mountains was undertaken by C. B. Hunt, who commenced work on the area in 1935, completed field studies in 1939 and published the results in 1953 as U.S. Geological Survey Professional Paper 228. More recently coal studies were completed by Doelling (1972) of the Utah Geological and Mineralogical Survey and Law (1977) of the U.S. Geological Survey. The results of these later investigations provided most of the data used in this coal resource evaluation. Additional publications which describe geologic features in the region are included in the bibliography.

Stratigraphy

The oldest known coal bearing unit in the Henry Mountains coal field is the Cretaceous Dakota Sandstone. Overlying this are the Tununk Shale, Ferron Sandstone, Blue Gate Shale, Emery Sandstone and Masuk Shale members of the Mancos Shale, all of

Cretaceous age. A composite columnar section accompanied by lithologic description on CRO plate 3 illustrates the stratigraphic relationships of these units.

Only the Blue Gate Shale, Emery Sandstone and Masuk Shale members of the Mancos Shale are exposed in the map area. The nearest outcrop of the underlying Ferron Sandstone and Tununk Shale members of the Mancos Shale and the Dakota Sandstone are around the flanks of Mt. Pennell, four miles (6.4 km) north of the map area. Over Tarantula Mesa, in the north half of the area, the Mancos Shale is capped by cliff-forming sandstones of the Cretaceous Mesa Verde Formation.

The Dakota Sandstone, exposed elsewhere in the region, represents a westward transgressing littoral sequence and lies unconformably atop the Brushy Basin member of the Jurassic Morrison Formation. It consists of sandstone, conglomerate, gray shale, carbonaceous shale and minor coal (Hunt, Averitt, and Miller, 1953). The formation rarely exceeds 50 feet (15 m) in thickness and in many places is missing.

The Mancos Shale lies conformably over the Dakota Sandstone and essentially fills the Henry Mountains sedimentary basin. The lowermost, Tununk Shale member of the Mancos Shale is gradational and interfingering with the underlying Dakota Sandstone. It is about 525 ft (160 m) thick in the region and represents a continuation of the first westward transgression of

the Cretaceous sea in which the Dakota Sandstone was deposited (Peterson and Ryder, 1975).

The Tununk Shale member, not exposed in the map area, is a blue-gray, fissile shale with subordinate, mostly thin-bedded, medium-grained sandstones. The sandstones are brown and become more abundant toward the top of the member, where it is transitional with the overlying Ferron Sandstone member.

The Ferron Sandstone member of the Mancos Shale, a significant coal bearing horizon elsewhere in the region, is a regressive sequence composed of littoral and coastal plain facies. A lower, littoral unit is characterized by massive, brown to gray, medium-grained sandstone. The middle portion of the member is a coastal plain deposit of interbedded sandstone and shale which is locally carbonaceous. An upper unit, again possibly of coastal plain origin, is composed of tanish-gray to brown, medium-grained, massive sandstone with thin shale interbeds and a central, coal bearing, carbonaceous shale (Hunt, Averitt, and Miller, 1953). In the adjacent Northeast Quarter of the Mt. Pennell quadrangle the Ferron Sandstone member is an average 130 feet (40 m) thick.

The Ferron Sandstone member is unconformably overlain by the Blue Gate Shale member. The contact between the Ferron Sandstone and the Blue Gate Shale members, not exposed in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle, is an erosional surface from which an estimated 50 to 100 feet (15 to 30 m) of upper Ferron Sandstone member strata have been removed.

The Blue Gate Shale member of the Mancos Shale is the oldest sedimentary unit exposed in the map area and represents a transgressive period of marine deposition. It is composed of blue-gray, finely laminated shale with thin beds of shaly sandstone and shaly limestone in the upper one third of the unit. The average thickness of the Blue Gate Shale member in this area is 1,540 feet (469 m). The member weathers easily to form smooth valleys or broad benches. The lower part is often concealed by alluvium, but the upper part is generally well exposed in cliffs that are capped by Emery Sandstone. The upper contact between the Blue Gate Shale member and the overlying Emery Sandstone member is interfingering and gradational (Hunt, Averitt, and Miller, 1953).

The Emery Sandstone member of the Mancos Shale is the only coal bearer exposed in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle and, like the Ferron Sandstone member, is a regressive sedimentary sequence. The Emery Sandstone member can be divided into four units. The lowermost unit consists of light brown, medium-grained, massive sandstone. The strata are even bedded to ripple laminated and typically form cliffs. The next higher unit is composed of yellowish-gray to brown, lenticular sandstone separated by shale partings or thin beds of sandy shale. The overlying unit contains gray shale, coal and some lenticular sandstone beds. The uppermost unit is a white to tan,

medium-grained, massive cliff forming sandstone (Doelling, 1972). The average thickness of the Emery Sandstone member in this quadrangle is 245 feet (75 m).

The Emery Sandstone member is conformably overlain by the Masuk Shale member of the Mancos Shale. Most exposures of Masuk Shale member appear as a bench around Tarantula Mesa in the north half of the map area.

The Masuk Shale member of the Mancos Shale is composed of sandy gray shale, sandy carbonaceous shale and sandstone. The environment for this member was one of a constantly shifting shoreline; more specifically, a sand and mudflat that was subjected to repeated marine flooding. Beach deposits did not accumulate until near the end of Masuk Shale deposition and are reflected by a gradual increase in littoral sandstone units which are transitional with the overlying Mesa Verde Formation (Hunt, Averitt, and Miller, 1953). The Masuk Shale member exhibits an average thickness of 800 feet (244 m) in the map area and is overlain by the Cretaceous Mesa Verde Formation atop Tarantula Mesa.

Structure

The Northwest Quarter of the Mt. Pennell 15-minute quadrangle lies largely on the east side of the Henry Mountains structural basin. The axis of the Henry Mountains syncline trends north-northwesterly through the extreme southwest corner of the map area, turns due north and parallels the quadrangle's boundary just beyond the CRO map edge (Doelling, 1972).

Strata in the area are nearly horizontal; dips are generally less than 3 degrees westward.

No faults of consequence have been discovered in the map area and none are shown on extant geologic maps.

Geologic History

Most pre-Cretaceous Mesozoic rocks in this part of the Colorado Plateau are continental in origin. Permian through the Jurassic continental deposition was along coastal plains adjacent to principal seaways. The major types of depositional environments that existed during this period were eolian, intertidal mudflats, lacustrine, fluvial and flood plains (Hunt, Averitt, and Miller, 1953).

The Cretaceous history of the Henry Mountains coal field is similar to that of coal fields throughout central Utah and in the Colorado Plateau in general. The region is one in which classic transgressive and regressive sedimentation provided an environment for coal deposition.

During the early Cretaceous, the Henry Mountains region lay on a lowland plain over which neither subsidence nor uplift were occurring. However, sufficient erosion took place to remove lower Cretaceous strata and plane off the top of the Jurassic Morrison Formation.

Subsidence then resumed in the region and a sheet of fluvial sand and clay was deposited to form the Dakota Sandstone. Broad flood plains with swamps, lakes and flourishing vegetation also

developed. Resulting accumulations of carbonaceous material formed local, thin coal seams which are exposed elsewhere in the region.

In the meantime, as subsidence increased, a sea in which the Mancos Shale was to be deposited began its encroachment from the east. The sea eventually covered all the Henry Mountains region and extended westward to the present-day Wasatch Plateau area. The shoreline remained there throughout Mancos Shale deposition except for two dramatic regressions which deposited the Ferron and Emery Sandstone members. Orogenic pulses to the west supplied clastics for these sandstone members faster than the area could subside (Doelling, 1972). Shale deposition changed to nearshore sand and finally to lagoonal and fluvial sand and shale. Forests flourished, dead vegetation accumulated and, in places, coal was produced. All of the thick coal seams in the Henry Mountains Basin were deposited during these two events.

After deposition of the Mancos Shale the Cretaceous sea retreated permanently eastward. Although sedimentation undoubtedly continued in the Henry Mountains region, continental rather than marine beds were deposited and these were later removed by erosion.

According to Hunt and others (1953) the Henry Mountains structural basin was formed between the close of Cretaceous time and the Eocene epoch. Eocene deposits cover structures related to basin formation at places in the region.

Emplacement of the Henry Mountains intrusives may have occurred anytime after early to mid-Tertiary. Thereafter the Colorado Plateau began its uplift and erosion instead of deposition dominated. This activity has continued to the present day.

COAL GEOLOGY

The Dakota Sandstone and Ferron Sandstone member of the Mancos Shale, both coal bearing elsewhere in the region, are not exposed nor have they been penetrated by drill holes in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle. However, extensive, nearly continuous outcrops of the Emery coal zone appear in the southern part of the area.

Emery coal exposures rim Cave Flat and Swap Mesa. Both plateaus owe their existence to erosion resistant sandstone in the Emery Sandstone member.

Two coal bearing zones occur in the Emery Sandstone member, separated by 50 to as much as 100 feet (15 to 30 m) of sandstone and shale. The upper zone is discontinuous. It outcrops principally at the heads of Muley and Swap Canyons, but was also intersected in drill holes further to the northwest, along Bullfrog Creek. Individual coal seams in the upper zone average only 1.5 ft (46 cm). The largest single seam, 5.1 ft (1.6 m) thick, occurs in Section 25, T. 35 S., R. 8 E., at the head of Swap Canyon. At the head of Muley Canyon, in sections 17 and 18, T. 33 S., R. 9 E., several seams in the upper zone aggregate an average 5.2 ft (1.6 m) of coal containing .7 foot (21 cm) of rock partings.

Thicker Emery coals occur in the lower coal zone. Coals in the zone beneath north Cave Flat average 6.5 ft (2 m). Towards the south the beds thin to about 1.5 ft (46 cm). The lower zone

is persistent around the Muley Creek drainage and contains several beds with up to 12.3 ft (3.8 m) of coal. The thickest single bed occurs in section 32, T. 33 S., R. 9 E. and measures 9.0 ft (2.7 m) of coal. The overall average coal seam thickness in the lower zone is 2 ft (61 cm).

Chemical Analyses of Emery Zone Coal

Four coal samples from drill holes in the map area have been analyzed by Doelling (1972) (table 1). These analyses show the coal to be subbituminous A in rank (ASTM, 1966).

Table 1 -- Average proximate analyses of coal samples in percent

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Btu/lb
1. Outcrop Emery Coal Bed Sec. 2 T.33S., R.9E.	10.48	42.30	49.99	6.33	0.83	11,468
2. Outcrop Emery Coal Bed Sec. 11, T.33S., R.9E.	11.34	40.65	49.40	9.27	0.49	10,856
3. Outcrop Emery Coal Bed Sec. 14, T.33S., R.9E.	12.29	41.02	50.91	5.96	0.59	11,147
4. Outcrop Emery Coal Bed Sec. 11, T.33S., R.9E	13.70	42.01	49.89	5.30	0.51	11,121
Average	11.95	41.50	50.05	6.72	0.61	11,148

Doelling (1972)

COAL RESOURCES

Data from 10 coal test holes and 104 measured surface sections and surface mapping by Doelling (1972) of the Utah Geological and Mineralogical Survey and Law (1979) of the U.S. Geological Survey were used to construct outcrop, isopach and structure contour maps of coal zones and beds in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle (CRO plates 1 through 11).

Coal resources were calculated using data obtained from the coal isopach maps (CRO plates 4, 7 and 10). The coal-bed acreage (measured by planimeter) multiplied by the average isopached thickness of the coal bed times a conversion factor of 1,770 short tons of coal per acre-foot for subbituminous coal yielded the coal resources in short tons of coal for each isopached coal bed. Reserve Base for the Em-1, Em-2, Em-3 and Em-9 coal beds are shown on CRO plates 6, 9 and 12, and are rounded to the nearest tenth of a million short tons. Only that coal equal to or thicker than the 5.0 ft (1.5 m) minimum advocated in U.S. Geological Survey Bulletin 1450-B is included in the Reserve Base. Thinner beds presently being mined or for which there is evidence that they could be mined commercially at this time are not included in the Reserve Base calculation. Coal Reserve Base for all coal beds thicker than 5.0 ft (1.5 m), as shown on CRO plate 2, total about 61.09 million short tons. Reserve Base (in short tons) in the various development-potential categories for surface and underground mining methods is shown in tables 2 and 3.

Isolated Data Points

In instances where isolated measurements of coal beds of Reserve Base thickness or greater are encountered, the standard criteria for construction of isopach, structure contour, mining ratio and overburden isopach maps are not available. The lack of data concerning these coal beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known coal beds. For this reason, isolated data points are mapped separately. The isolated points mapped in this quadrangle are listed below and are shown on figures 2 through 7.

<u>Source</u>	<u>Location</u>	<u>Coal Bed</u>	<u>Millions</u>	
			<u>Short Tons</u>	<u>Thickness</u>
LAW (1979)	Section 25 T.33S., R.8E.	Em-4	5.26	5.1 ft (1.5 m)
LAW (1979)	Section 36 T.33S., R.8E.	Em-5	0.99	5.1 ft (1.5 m)
LAW (1979)	Section 25 T.32S., R.8E.	Em-6	3.53	7.5 ft (2.3 m)
LAW (1979)	Section 33 T.32S., R.9E.	Em-7	4.45	7.2 ft (2.2 m)
LAW (1979)	Section 26 T.32S., R.9E.	Em-8	5.66	6.3 ft (1.9 m)
LAW (1979)	Section 12 T.33S., R.8E.	Em-10	6.33	7.1 ft (2.2 m)

○ (2)
C 7.2(Em)[7]

DRILL HOLE - Showing thickness of coal, in feet. Index number refers to hole on plate 1 of CRO map. Letters designate name of coal bed as listed below. Bracketed number identifies coal bed named on plates 1 or 3.

▲ (101)
C 5.1(Em)[4]

POINT OF MEASUREMENT - Showing thickness of coal, in feet. Includes all points of measurement other than drill holes. Index number refers to hole on plate 1 of CRO map. Letters designate name of coal bed as listed below. Bracketed number identifies coal bed named on plates 1 or 3.

Em - Emery coal zone

COAL BED SYMBOL AND NAME - Coal bed identified by bracketed number is not formally named, but is numbered for identification purposes in this quadrangle only.

—▲— Em ———

TRACE OF COAL ZONE OUTCROP - Showing symbol of name of coal zone as listed above. Arrow points toward coal-bearing area. Dashed where inferred.

—▲— SL ———

STRIPPING-LIMIT LINE - Boundary for surface mining (in this quadrangle, the 100-foot-overburden isopach). Arrow points toward area suitable for surface mining.

—▲— A ———

BOUNDARY OF IDENTIFIED RESERVE BASE COAL - Drawn along the coal bed outcrop, an arc (A) drawn 2,640 feet from the nearest point of Reserve Base coal bed measurement, the PRLA boundary (P), the quadrangle boundary (Q), and the non-Federal coal ownership boundary (N). Arrow points toward area of identified Reserve Base coal.

RB
— (Measured)
— (Indicated)
0.13 (Inferred)

IDENTIFIED COAL RESOURCES - Showing totals for Reserve Base (RB), in millions of short tons, for each section or part(s) of section of non-leased Federal coal land, either within or beyond the stripping-limit. Dash indicates no resources in that category.

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

To convert feet to meters, multiply feet by 0.3048.

SCALE - 1:24,000 (1 inch = 2,000 feet)

FIGURE 1. - Explanation for FIGURES 2 through 7.

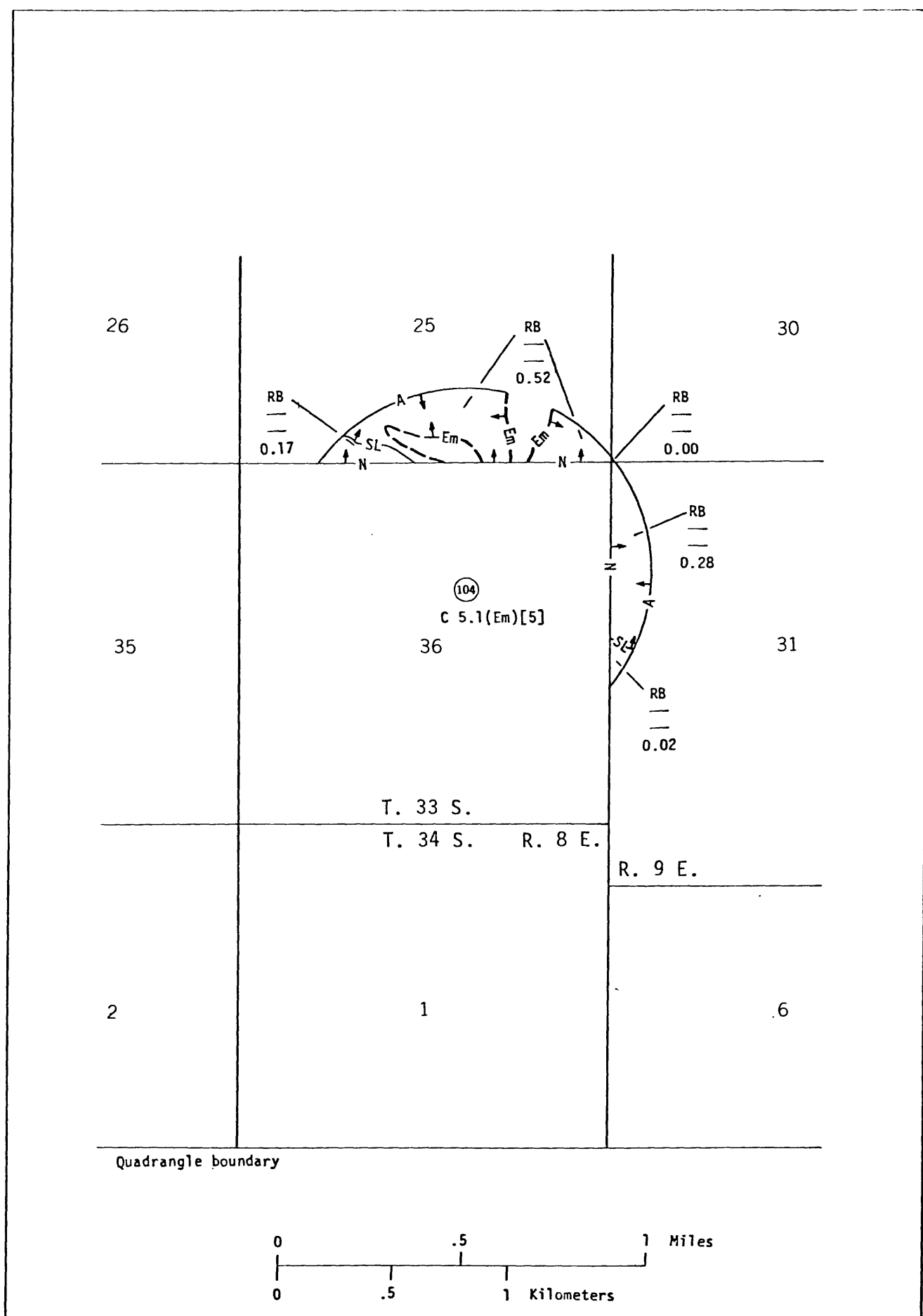


FIGURE 3. - Isolated data point map of the Emery [5] coal bed.

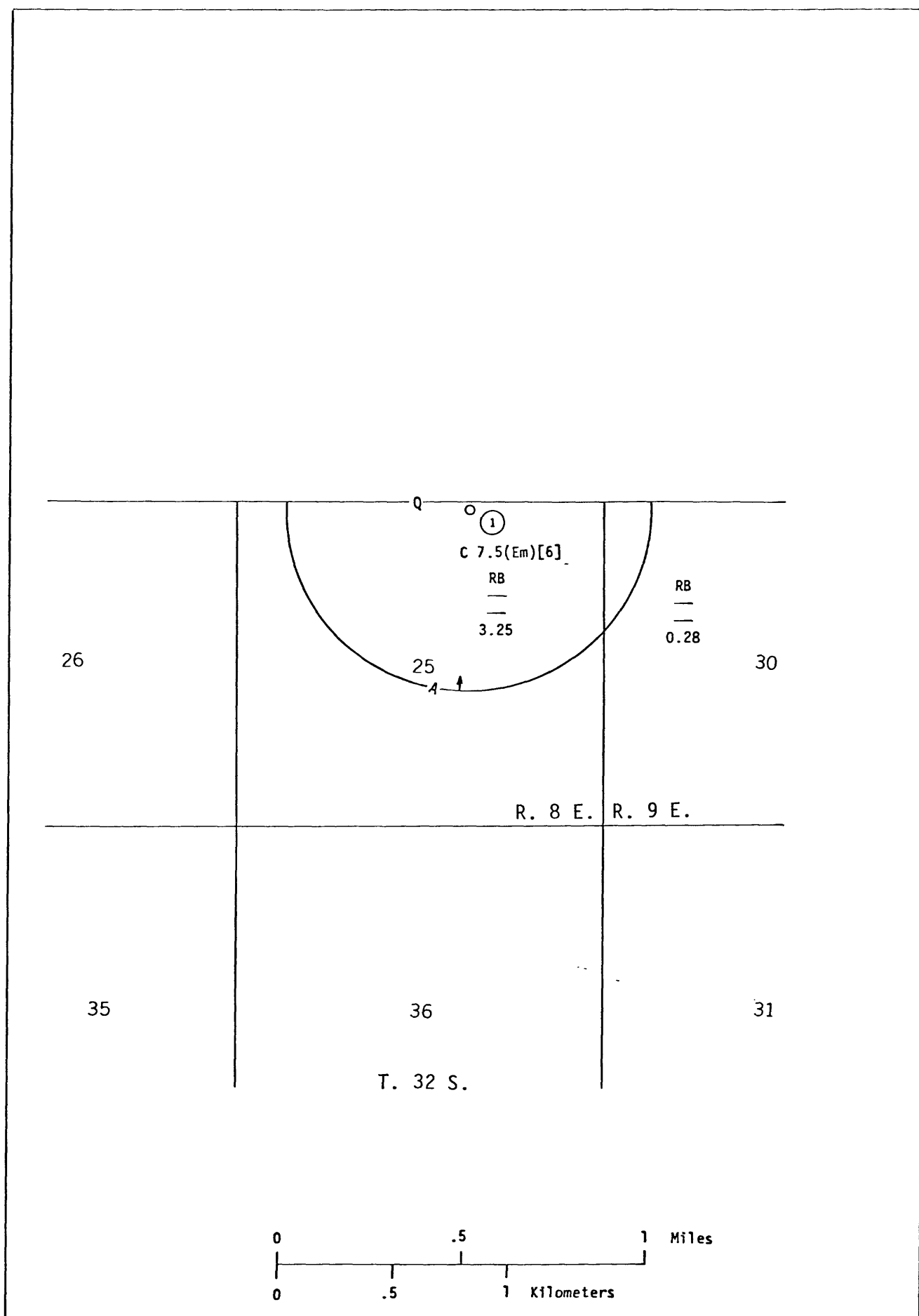


FIGURE 4. - Isolated data point map of the Emery [6] coal bed.

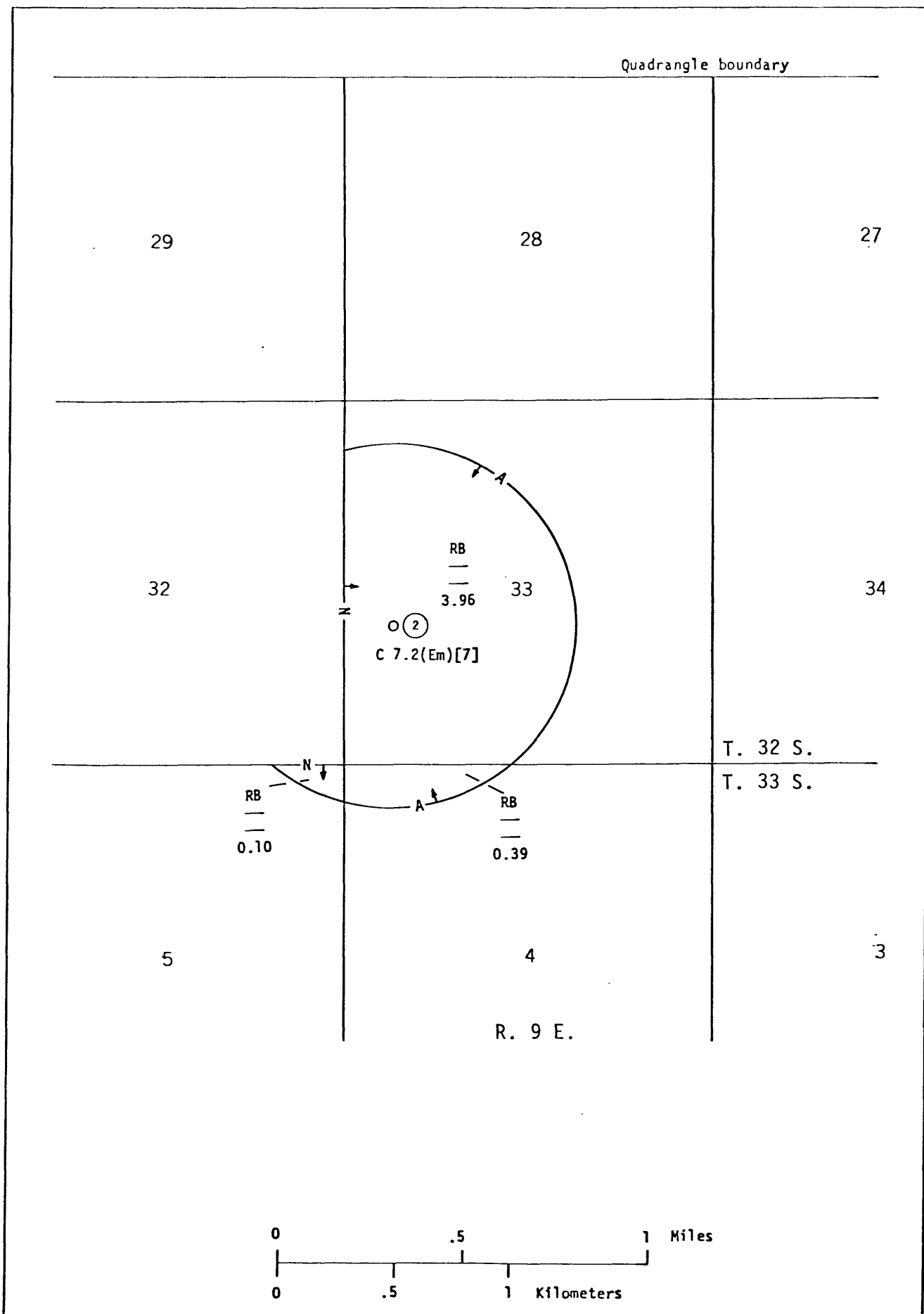


FIGURE 5. - Isolated data point map of the Emery [7] coal bed.

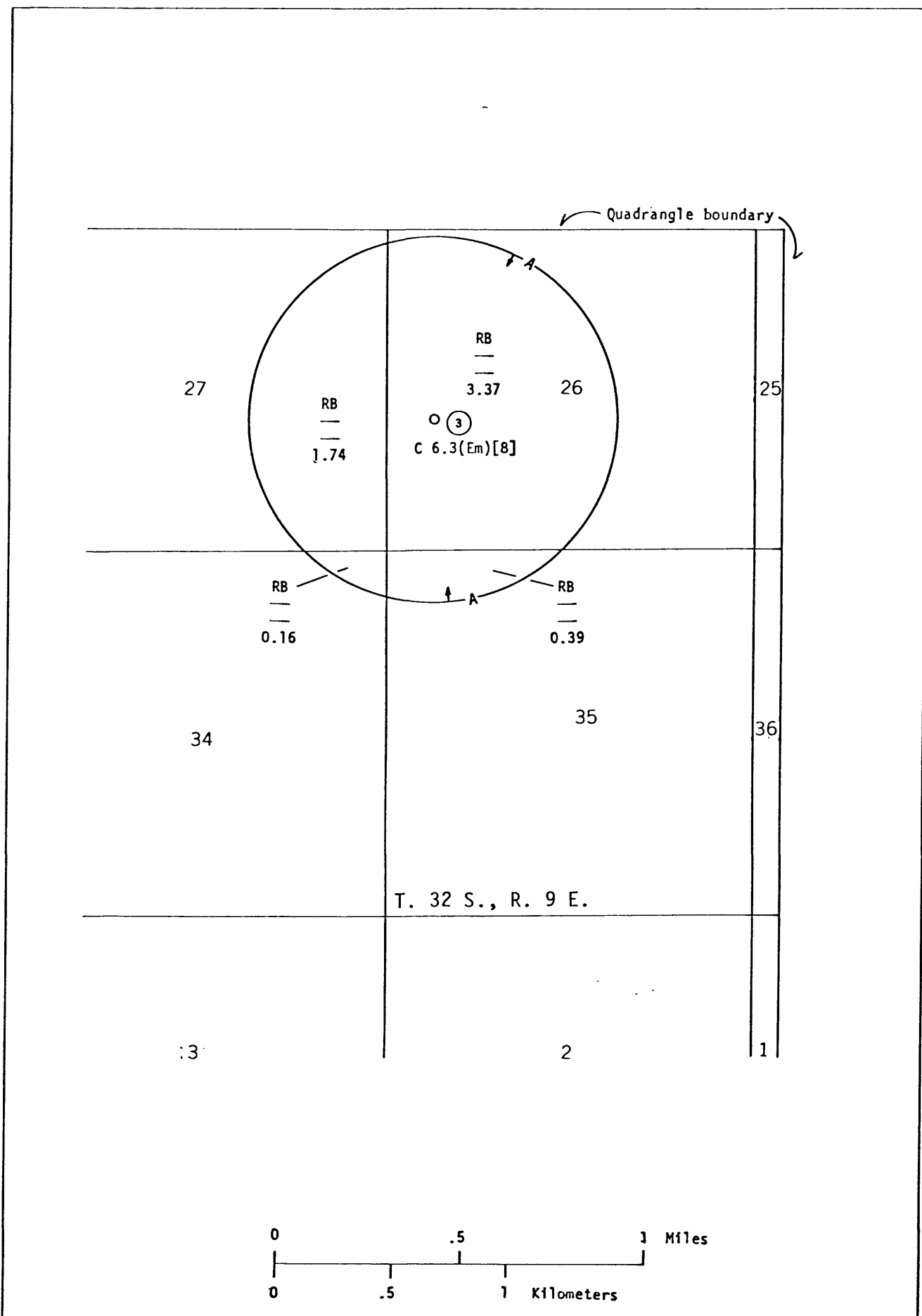


FIGURE 6. - Isolated data point map of the Emery [8] coal bed.

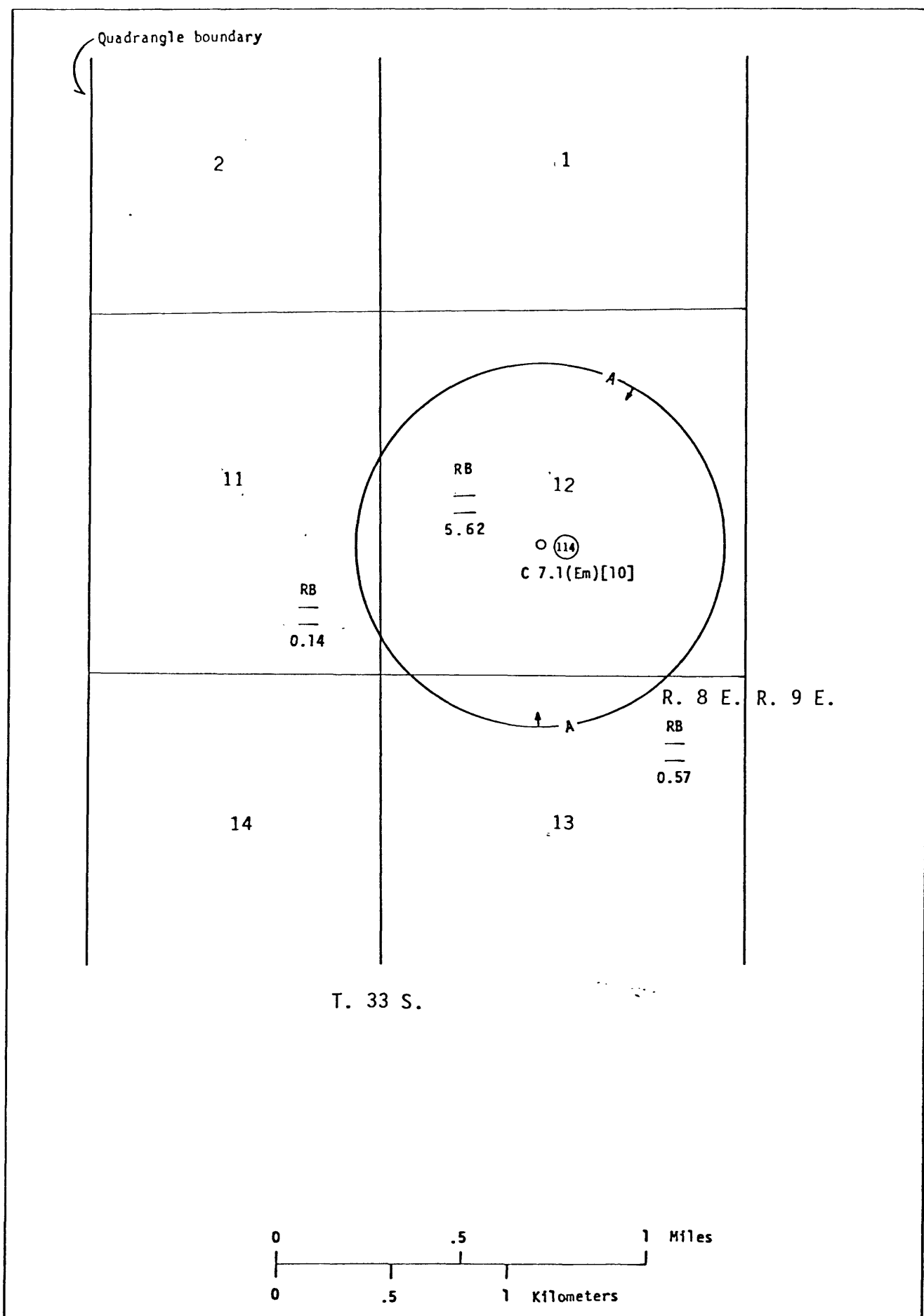


FIGURE 7. - Isolated data point map of the Emery [10] coal bed.

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn so as to coincide with the boundaries of the smallest legal land subdivisions shown on plate 2. In sections or parts of sections where no land subdivisions have been surveyed by the BLM, approximate 40-acre (16-ha) parcels have been used to show the limits of the high, moderate, or low development potentials. A constraint imposed by the BLM specifies that the highest development potential affecting any part of a 40-acre (16-ha) lot, tract, or parcel be applied to that entire lot, tract, or parcel. For example, if 5 acres (2 ha) within a parcel meet criteria for a high development potential, 25 acres (10 ha) a moderate development potential, and 10 acres (4 ha) a low development potential, then the entire 40 acres (16 ha) are assigned a high development potential.

Development Potential for Surface Mining Methods

Areas where the coal beds of Reserve Base thickness are overlain by 100 ft (30 m) or less of overburden are considered to have development potential for surface mining and were assigned a high, moderate or low development potential based upon the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios is as follows:

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

where MR = mining ratio

t_o = thickness of overburden in feet

t_c = thickness of coal in feet

rf = recovery factor (85 percent for this quadrangle)

cf = conversion factor to yield MR value in terms of cubic yards of overburden per short ton of recoverable coal:

0.911 for subbituminous coal

Note: To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply MR by 0.8428.

Areas of high, moderate, and low development potential for surface mining methods are defined as areas underlain by coal beds having respective mining-ratio values of 0 to 10, 10 to 15, and greater than 15. These mining-ratio values for each development-potential category are based on economic and technological criteria; they are applicable only to this quadrangle and were derived in consultation with J. Moffit, Area Mining Supervisor, U.S. Geological Survey.

Areas where the coal data are absent or extremely limited between the 100-foot (30-m) overburden line and the outcrop are assigned unknown development potentials for surface mining methods. This applies to those areas where no known coal beds 5 feet (1.5 m) or more thick occur or where coal exceeds 5 feet (1.5 m) but data is insufficient to properly evaluate coal development

potential. Limited knowledge pertaining to the areal distribution, thickness, depth and attitude of the coal beds prevents accurate evaluation of the development potential in the high, moderate or low categories.

The coal development potential for surface mining methods is shown on plate 13. Of the Federal land areas assigned a development potential for surface mining methods, 51 percent are rated high, 26 percent are rated moderate, 8 percent are rated low and 15 percent are rated unknown. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface Mining Methods

Areas considered to have a development potential for conventional subsurface mining methods include those areas where the coal beds of Reserve Base thickness are between 100 and 3,000 feet (30 and 914 m) below the ground surface and have dips of 15° or less. Coal beds lying between 100 and 3,000 feet (30 and 914 m) below the ground surface, dipping greater than 15° , are considered to have a development potential for in-situ mining methods.

Areas of high, moderate and low development potential for subsurface mining methods are defined as areas underlain by coal beds at depths ranging from 100 to 1,000 feet (30 to 305 m), 1,000 to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), respectively.

Areas where the coal data are absent or extremely limited between 100 and 3,000 feet (30 and 914 m) below the ground surface are assigned unknown development potentials. Even though these areas may contain coal thicker than 5 feet (1.5 m), limited knowledge pertaining to the areal distribution, thickness, depth and attitude of the coal beds prevents accurate evaluation of the development potential in the high, moderate or low categories.

The coal development potential for subsurface mining methods is shown on plate 14. Of the Federal land areas assigned a development potential for conventional subsurface mining methods, 37 percent are rated high and 63 percent are rated unknown. The remaining Federal land is classified as having unknown development potential for conventional subsurface mining methods.

Table 2 -- Coal Reserve Base Data for surface mining methods for Federal coal lands (in short tons) in the Northwest Quarter of the Mt. Pennell 15-minute quadrangle, Garfield County, Utah

[Development potentials are based on mining ratios (cubic yards of overburden/ton of underlying coal). To convert short tons to metric tons, multiply by 0.9072; to convert mining ratios in yd³/ton coal to m³/t, multiply by 0.842]

Coal bed (0-10 mining ratio)	High development potential (10 - 15 mining ratio)			Moderate development potential (>15 mining ratio)			Low development potential (>15 mining ratio)			Unknown development potential	Total
	High development potential (0-10 mining ratio)	Moderate development potential (10 - 15 mining ratio)	Low development potential (>15 mining ratio)	High development potential (0-10 mining ratio)	Moderate development potential (10 - 15 mining ratio)	Low development potential (>15 mining ratio)	High development potential (0-10 mining ratio)	Moderate development potential (10 - 15 mining ratio)	Low development potential (>15 mining ratio)		
Em-1	2,620,000			1,270,000			350,000			--	4,240,000
Em-2	7,030,000			3,540,000			750,000			--	11,320,000
Em-3	80,000			120,000			330,000			--	530,000
Em-3*	70,000			50,000			30,000			--	150,000
Em-4	--			--			--			2,150,000	2,150,000
Em-5	--			--			--			800,000	800,000
Em-6	--			--			--			--	--
Em-7	--			--			--			--	--
Em-8	--			--			--			--	--
Em-9	--			--			--		190,000	--	190,000
Em-10	--			--			--		--	--	--
Total	9,800,000	4,980,000	1,650,000	2,950,000	19,380,000						

*Projected from Northeast Quarter of the Mt. Pennell 15-minute quadrangle

Table 3 -- Coal Reserve Base Data for subsurface mining methods
for Federal coal lands (in short tons) in the North-
west Quarter of the Mt. Pennell 15-minute quadrangle,
Garfield County, Utah.

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

Coal Bed Name	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Em-1	6,340,000	--	--	--	6,340,000
Em-2	6,440,000	--	--	--	6,440,000
Em-3	1,000,000	--	--	--	1,000,000
Em-4	--	--	--	3,110,000	3,110,000
Em-5	--	--	--	190,000	190,000
Em-6	--	--	--	3,530,000	3,530,000
Em-7	--	--	--	4,450,000	4,450,000
Em-8	--	--	--	5,660,000	5,660,000
Em-9	--	--	--	--	--
Em-10	--	--	--	6,330,000	6,330,000
Total	13,780,000	--	--	23,270,000	37,050,000

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