Text to Accompany

Open-File Report 80-111

1980

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE NORTHWEST QUARTER OF THE FACTORY BUTTE 15-MINUTE QUADRANGLE, WAYNE COUNTY, UTAH

[Report includes 13 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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

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INTRODUCTION

Purpose

This text is to be used in conjunction with Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) Maps of the Northwest Quarter of the Factory Butte 15-minute quadrangle, Wayne 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 Published and unpublished public information available through June 1979 was used as the data base for this study.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 confidential data used.

Location

The Northwest Quarter of the Factory Butte 15-minute quadrangle is located at the north end of the Henry Mountains coal field in north-central Wayne County, Utah. The north edge of Wayne County coincides with the north quadrangle boundary.

Hanksville, Utah is approximately nine miles (14 km) east and Utah Highway 24 passes approximately one mile (1.6 km) south of the map area. The Fremont River, flowing east-northeast, approaches to within about 1.5 miles (2.4 km) of the quadrangle's southern border. The area is unpopulated.

Accessibility

One unimproved dirt road and an off-road vehicle trail provide access to the Northwest Quarter of the Factory Butte 15-minute quadrangle. Extending north from Utah Highway 24, 8.6 miles (13.8 km), a light duty road reaches the Factory Butte Coal Mine in the east half of the map area and continues northward into the area of the San Rafael Swell in Emery County. A light duty road enters the southwestern corner of the map area, is downgraded to an offroad vehicle trail within a mile (1.6 km) and traverses northeasterly through the west half of the map area along the North Caineville Reef, terminating near the northern extent of the reef. Winter access into the quadrangle is limited by snow and wind.

Physiography

The Northwest Quarter of the Factory Butte 15-minute quadrangle is at the north end of the Henry Mountains structural and stratigraphic basin. Although located in a basin, the area is topographically higher than most of the surrounding region. Elevations within the quadrangle range from 6,358 feet (1,938 m) at the top of Factory Butte to 4,520 feet (1,377 m) in Neilson Wash channel. The total relief is 1,838 feet (560 m).

The North Caineville Reef, extending from the quadrangle's southwest corner in a north-northeast direction, forms the Henry Mountains' basin's western boundary. East of the North Caineville Reef, intermittent fluvial erosion of sedimentary strata has produced badland and mesa terrain. Within the quadrangle, low relief badlands contrast with two prominent features: Factory Butte and North Caineville Mesa, near the center and in the southwest quarter of the quadrangle, respectively. Resistant sandstone and conglomerate capping both of these features have prevented rapid dissection.

The quadrangle lies within the Colorado River drainage system. Tank Wash and Salt Wash drain the northern half of the map area and are tributary to Muddy Creek to the east. Neilson Wash collects runoff from the south half of the map area for diversion southward to the east flowing Fremont River. The Fremont River joins with Muddy Creek near Hanksville to form the Dirty Devil River which eventually flows into the Colorado River.

Surface water quality and stream flow reflect seasonal climatic changes. Surface water is often saline due to a high evaporation rate during the summer. Most streams in the quadrangle dry up in the late summer months.

Climate and Vegetation

Climate in the quadrangle is arid. Average annual rainfall is less than 15 inches (38 cm). However, annual precipitation varies from year to year due to the irregularity of desert rainfall. Drought periods of three or more years are common. Most precipitation occurs during localized late-summer thunderstorms and light winter snows and rains.

Temperatures within the quadrangle range from $0^{\circ}F$ ($-18^{\circ}C$) or less during the winter to greater than $100^{\circ}F$ ($38^{\circ}C$) in the summer. The yearly average for the region is $56^{\circ}F$ ($13^{\circ}C$) (U.S. Bureau of Land Management, 1978). Precipitation tends to increase and temperatures drop with increased elevation.

Winds typically blow from the west and southwest. Higher wind velocities generally occur during the spring and early summer months.

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

Land Status

The Northwest Quarter of the Factory Butte 15-minute quadrangle encompasses the northern portion of the Henry Mountains Known Recoverable Coal Resource Area. The Federal government owns the coal rights for lands over most of the map area, as shown on plate 2 of the Coal Resource Occurrence maps. State lands amount to 11.5 percent. About 57 percent of the map area may be considered coal land. No outstanding Federal coal leases, prospecting permits or licenses occur within the Northwest Quarter of the Factory Butte 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 on the area (Gilbert, 1877). G. K. Gilbert studied the Henry Mountains in 1875 and 1876. His report (Gilbert, 1877) 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 region in 1935, completed field studies in 1939 and published the results in 1953 as U.S. Geological Survey Professional Paper 228. More recently, Henry Mountains coals were studied in detail 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

A series of noncoaliferous Jurassic sandstones and shales are exposed in the northwest quarter of the Northwest Quarter of the Factory Butte 15-minute quadrangle.

The oldest known coal bearing unit in the map area is the Cretaceous Dakota Sandstone. Overlying this are the Tununk Shale, Ferron Sandstone, Blue Gate Shale and Emery Sandstone members of the Mancos Shale, all of Cretaceous age. A composite columnar section accompanied by lithologic descriptions on CRO plate 3 illustrates the stratigraphic relationships of these units.

The Dakota Sandstone is a westward trangressive littoral sequence and lies uncomformably atop the Brushy Basin member of the Jurassic Morrison Formation. The Dakota Sandstone consists of gray sandstone, conglomerate, gray shale and carbonaceous shale (Hunt, Averitt, and Miller, 1953). The formation rarely exceeds 50 feet (15 m) in thickness in the south half of the map area, lenses out near the center and is absent in the north half of the map area.

Conglomeratic, crossbedded sandstones which occur near the base of the Dakota Sandstone in this map area may have been derived by reworking of underlying Morrison Formation strata in a fluvial environment (Hunt, Averitt, and Miller, 1953). Minor interbeds of gray and carbonaceous shale reflect local marsh and lagoonal environments. A diagnostic bed of fossils containing Gryphaea, Exogyra and Inoceramus occurs at the top of the formation. Gryphaea are most abundant and commonly form reefs (Hunt, Averitt, and Miller, 1953).

The Dakota Sandstone weathers to form a thin series of ledges and slopes at the base of broad slopes developed upon the overlying Tununk Shale member of the Mancos Shale (Peterson and Ryder, 1975).

The Mancos Shale lies conformably over the Dakota Sandstone and fills the sedimentary basin in this part of the Henry Mountains. Only four of the five members of the Mancos Shale are present in the vicinity of Factory Butte; the uppermost Masuk Shale member has been completely removed by erosion.

The lowermost, Tununk Shale member of the Mancos Shale is gradational and interfingering with the underlying Dakota Sandstone. It is about 580 ft (177 m) thick in the map area 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 is a dark-gray, bentonitic shale with subordinate, mostly thin-bedded, medium-grained sandstones (Doelling, 1972). This member weathers to a bluish-gray, is generally poorly exposed and forms smooth, broad valleys (Peterson and Ryder, 1975). The lowest few feet of the member everywhere contains abundant oysters (Hunt, Averitt, and Miller, 1953). The sandstones in the Tununk Shale are gray to yellowish-gray and become more abundant toward the top of the member, where it is transitional with the overlying Ferron Sandstone (Doelling, 1972). The top of the Tununk Shale is placed beneath the first thick-bedded or massive sandstone ledge in the transition zone (Peterson and Ryder, 1975). A regressive sequence, partially the result of deltaic progradation, occurs in the upper part of the Tununk Shale (Hunt, Averitt, and Miller, 1953).

The first significant coal-bearing horizon in the map area, the Ferron Sandstone member of the Mancos Shale, is a regressive unit composed of littoral and coastal plain facies (Doelling, 1972). A lower, littoral unit is characterized by massive, yellowish-tan to tanish-gray, medium-grained sandstone. The upper portion of the member is a coastal plain deposit of interbedded light to dark brown lensoidal sandstone, shale which is locally carbonaceous and tanish-gray to brown, medium-to coarse-grained, massive sandstone with a central, coal-bearing, carbonaceous shale (Hunt, Averitt, and Miller, 1953). A section of Ferron Sandstone measured by Doelling (1972, p. 145) in the map area contained:

Coal Mine Wash measurement of Ferron Sandstone, secs. 11 and 12, T. 27 S., R. 9 E.

Blue Gate Shale member
Ferron Sandstone member

		Feet
1.	Coaly sandstone....................................	0.2
2.	Coal...	3.0
3.	Shale, gray, upper 0.5 feet carbonaceous...........	2.5
4.	Sandstone, tan to brown, medium-grained to coarse-grained, massive cliff, upper part limonite stained.............................	48.0
5.	Coal...	1.0

6.	Carbonaceous shale....................................	0.8
7.	Coal...	0.8
8.	Carbonaceous shale....................................	5.5
9.	Sandstone, gray, shaly, medium- to coarse-grained..................................	1.5
10.	Sandstone, tanish-gray, medium-grained, massive cliff, minor crossbedding..........................	53.0
11.	Shale, gray...	2.8
12.	Sandstone, yellowish-gray, coarse-grained, thick-bedded..	5.0
13.	Carbonaceous shale....................................	2.3
14.	Sandstone, tan, medium-grained, massive resistant cliff former..............................	27.0
15.	Shale, gray, interbedded with thin-bedded sandstone, contains occasional gypsum and coal seamlets, step-like ledges and slopes..	15.0
16.	Sandstone, tan, massive slope former...............	9.5
17.	Sandstone, tan, medium-grained, resistant ledge.....................................	4.0
18.	Sandstone, tan, shaly weathering...................	8.5
19.	Sandstone, yellowish-gray, medium-grained, ledge...	2.5
20.	Shale, gray interbedded with sandstone, thin-bedded and fine- to medium-grained............	21.0
21.	Sandstone, tanish-gray, medium-grained, thick-bedded to massive, cliff former with ripple marks and numerous worm burrows........	48.0
22.	Sandstone, shaly and thin-bedded sandstone, medium-grained..........................	3.5
23.	Sandstone, yellowish-tan, medium-grained, ledge....	2.0

Total Ferron Sandstone................................ 267.4

Tununk Shale member (base of section): shale, brown, sandy, interbedded with subordinate thin-bedded sandstone.

The Ferron Sandstone is locally capped by a thin sandstone bed which probably represents a transgressing beach deposit (Hunt, Averitt, and Miller, 1953). In this area the Ferron Sandstone is an average 265 ft (81 m) thick, and often forms a ridge or cliff.

The contact between the Ferron Sandstone and the overlying Blue Gate Shale is a sharp erosional unconformity. Detailed correlation of sandstone beds in the Ferron Sandstone suggests that 50 to 100 ft (15 to 30 m) or more of the top of the Ferron Sandstone have been removed at the unconformity in the region (Peterson and Ryder, 1975).

Above the hiatus, the Blue Gate Shale member of the Mancos Shale, like the Tununk Shale member, represents a transgressive period of marine deposition. It is composed of bluish-gray, finely laminated shale with thin beds of shaly sandstone and shaly limestone in the upper one-third of the unit (Hunt, Averitt, and Miller, 1953). The member weathers easily to form smooth valleys or broad benches. The lower part is concealed by alluvium in many places, but the upper part is generally well exposed in cliffs that are capped by Emery Sandstone (Peterson and Ryder, 1975).

The average thickness of the Blue Gate Shale in the Northwest Quarter of the Factory Butte 15-minute quadrangle is 1,400 ft (427 m). The upper contact between the Blue Gate Shale and the overlying Emery Sandstone is interfingering and gradational.

The Emery Sandstone member of the Mancos Shale, like the Ferron Sandstone, is a regressive sequence (Peterson and Ryder, 1975). Only the lower portion of the member occurs in the Northwest Quarter of the Factory Butte 15-minute quadrangle. It consists of gray to light brown, medium grained, massive sandstone (Doelling, 1972). The strata are evenly bedded to ripple laminated and typically form cliffs. Thin interbeds of shale occur in the lower part of the member, increasing toward the Blue Gate Shale-Emery Sandstone contact (Peterson and Ryder, 1975). The average thickness of the Emery Sandstone in the vicinity of Factory Butte is 220 ft (67 m). The upper shaly portion of the member is coal-bearing elsewhere in the Henry Mountains, but these shales have been removed by erosion throughout the Northwest Quarter of the Factory Butte 15-minute quadrangle.

Structure

The axis of the Henry Mountains syncline passes north-northeasterly through the center of the map area. Strata on the flanks of the fold dip 5 degrees or less toward the axis. Dips immediately west of the syncline axis are slightly greater than those east of the axis.

West of the Henry Mountains syncline, dips along the North Caineville Reef range from 20 to 30 degrees eastward. Further west, approximately 1.5 miles (2.4 km) beyond the North Caineville Reef, an eastward dipping monocline parallels the Henry Mountains syncline. The monocline creates the Moroni Slopes, which are composed of Jurassic Carmel Formation strata that exhibit apparent eastward dips ranging from 1 to 8 degrees.

Several faults cut strata and coal in the north part of the quadrangle, north of the Factory Butte Coal Mine. They trend roughly east-west and are rather closely spaced. The rocks between them do not appear to be shattered and displacements are usually less than 30 feet (9.1 m).

Geologic History

Most pre-Cretaceous Mesozoic rocks in this part of the Colorado Plateau are continental in origin. Permian through 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 in central Utah and throughout 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 and lakes provided an environment in which vegetation flourished. Resulting accumulations of carbonaceous material formed local, thin coal seams 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 Sandstone and Emery Sandstone members. Orogenic pulses to the west supplied clastics for these sandstone members faster than the area could subside (Doelling, 1972). Marine 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 related structures 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

Two coal zones, both within the Ferron Sandstone member of the Mancos Shale, occur within the Northwest Quarter of the Factory Butte 15-minute quadrangle. The coal bearing portion of the Emery Sandstone member has been removed from the area by erosion. Coal in the Dakota Sandstone is thin and lensoidal (Doelling, 1972). No measured sections are available.

The uppermost coal zone in the quadrangle is near the top of the Ferron Sandstone. Any seam which occurs below the first massive cliff-forming sandstone within the upper part of the Ferron Sandstone is designated the lower Ferron coal zone (Doelling, 1972). There may be several lenticular beds in the lower zone.

In the Factory Butte Coal Mine area the upper Ferron coal zone lies under shallow cover, mostly beneath 50 feet (15 m) of soft shale. In places, the depth increases to 100 feet (30 m). Only under Factory Butte and North Caineville Mesa does the overburden exceed 400 feet (122 m). Beneath the mesa the depth is assumed to be roughly 1,600 feet (487 m).

None of the coal beds in the map area exhibit significant lateral continuity and, as a consequence, bed correlations are tenuous. However, based upon available data, two correlatable beds, Fe-1 and Fe-2, have been identified in the upper Ferron coal zone.

The upper zone is best developed north of Factory Butte. Along the North Caineville Reef the zone and beds are thin. In section 16, T. 27 S., R. 9 E. and section 9, T. 27 S., R. 9 E. the main bed [Fe-1] thickens up to seven feet. However, in portions of the southeast quarter of section 9 and in section 10 the bed splits.

In sections 2 and 3 of T. 27 S., R. 9 E. the main bed [Fe-2] is lenticular and achieves a maximum thickness of 6.5 feet (2 m) in a drill hole near the southeast corner of section 3. In section 11 of T. 27 S., R. 9 E. the coal bed [Fe-2] achieves a maximum thickness of 6.9 ft (2.1 m), but generally contains at least .1 foot (3 cm) of rock partings. Maximum coal sections without partings in the vicinity of the Factory Butte Mine measure 6.3 to 6.5 ft (1.9 to 2.0 m). Farther south and east of Factory Butte the coal thins to an average one to two feet (30 to 61 cm).

The lower zone in the Ferron Sandstone has no coal bed that thickens to five feet in the map area. The maximum section measured is near the center of section 11, T. 27 S., R. 9 E., east of the Factory Butte Coal Mine, where the bed thickness is 3 feet (91 cm). When the bed can be located elsewhere in the quadrangle it is usually 1.5 ft (46 cm) thick.

Chemical Analyses of Ferron Zone Coal

One coal sample from the Ferron coal zone was collected and analyzed by the U.S. Geological survey in connection with Hunt's study (1953) of the Henry Mountains. The coal was presumably taken from the vicinity of the Factory Butte Mine. The sample was channeled from a seven foot (2.1 m) bed and included one inch of sandy shale in a split two feet (61 cm) above the base of the bed. The results of analyses are shown in table 1. This analyses indicates (ASTM, 1966) that the coal is subbituminous A in rank.

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

	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Btu/lb
1. Factory Butte Mine Area (?)	--	--	--	16.0	2.5	10,890

COAL RESOURCES

Data from two U.S. Geological Survey coal test holes and 54 measured surface sections and surface mapping by Doelling (1972) of the Utah Geological and Mineralogical Survey were used to construct outcrop, isopach and structure contour maps of coal zones and beds in the map area (CRO plates 1 through 9).

Coal resources were calculated using data obtained from the coal isopach map (CRO plates 4 and 8). 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 Fe-1 and Fe-2 coal beds are shown on CRO plates 7 and 11, 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. Total coal Reserve Base for all coal beds thicker than 5.0 ft (1.5 m), as shown on CRO plate 2, totals about 7.06 million short tons. Reserve Base (in short tons) in the various development-potential categories for surface and underground mining methods are shown in tables 1 and 2.

Dames & Moore has not made any determination of economic recoverability for any of the coal beds described in this report.

Isolated Data Points

In instances where isolated measurements of coal beds of Reserve Base thickness (greater than 5 feet or 1.5 meters) 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 beds limits the extent to which they can be reasonably projected in any direction and usually precludes correlations with other, better known, beds. For this reason, isolated data points are mapped separately. The isolated point mapped in this quadrangle is listed below and is shown on figure 2.

Source	Location	Coal Bed	Millions Short Tons	Thickness
Doelling (1972)	Section 11 T.27S., R.9E.	Fe-3	4.52	6.5 ft (2 m)

▲ 42

C 6.5(Fe)[3]

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.

Fe - Ferron 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.

Fe

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

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)
0.20 (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 FIGURE 2.

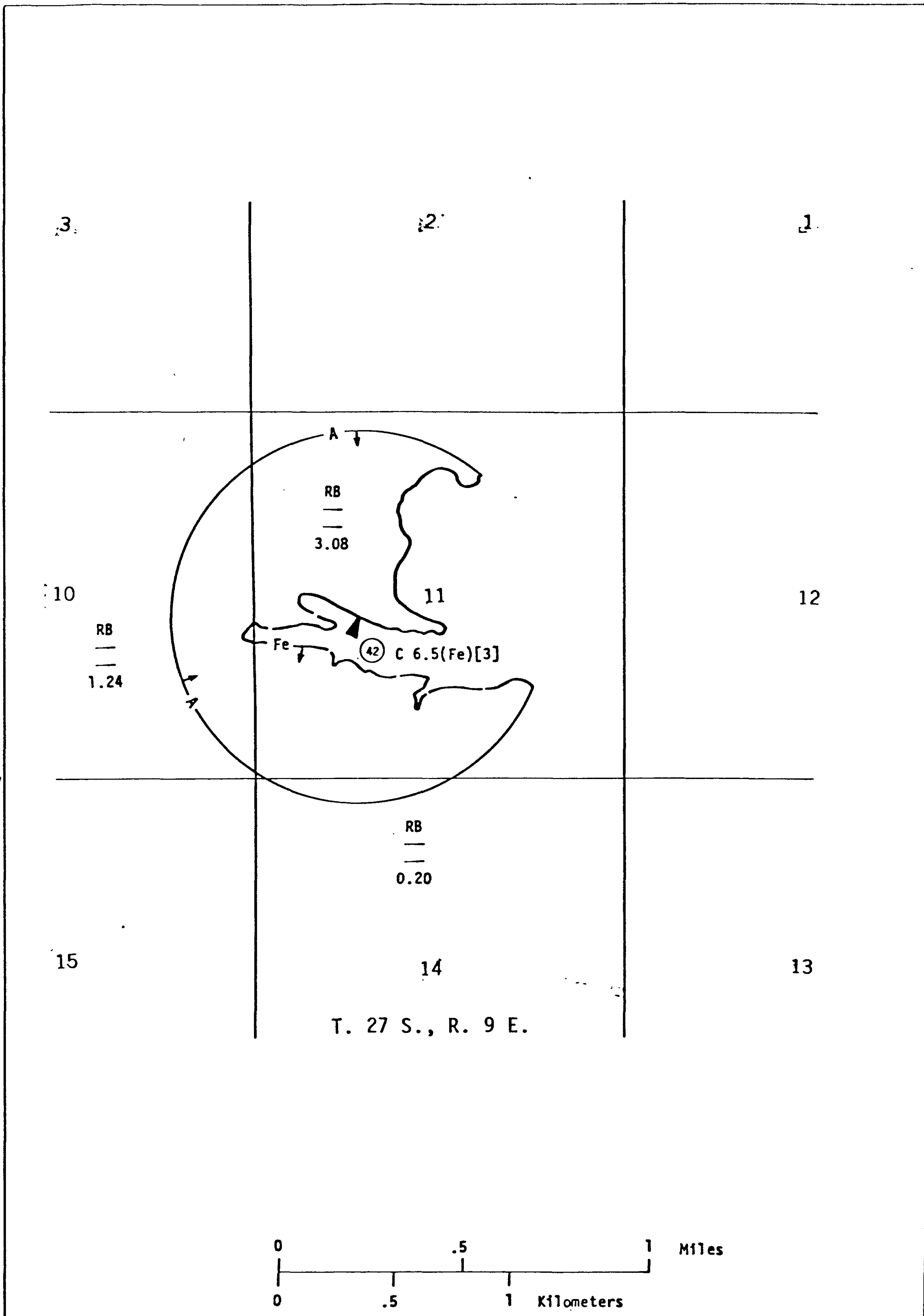

FIGURE 2. - Isolated data point map for the Ferron [3] coal bed.

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 potential for surface mining and were assigned a high, moderate, or low development potential based on the mining ratio (cubic yards of overburden per ton of recoverable coal). The formula used to calculate mining ratios for surface mining of coal is 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 tons 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 and were provided by the 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 12. Of the Federal land areas assigned a development potential for surface mining methods, 28.3 percent are rated high, 0.3 percent are rated moderate, and 71.4 percent are rated unknown. All 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.

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 13. All of the Federal land areas classified as having known development potential for conventional subsurface mining methods are assigned a high development potential. The remaining Federal land is classified as having unknown development potential for conventional subsurface mining methods.

Table 1 -- Coal Reserve Base Data for surface mining methods for Federal coal lands (in short tons) in the Northwest Quarter of the Factory Butte 15-minute quadrangle, Wayne 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 yd^3/ton coal to m^3/t, multiply by 0.842]

Coal bed	High development potential (0-10 mining ratio)	Moderate development potential (10 - 15 mining ratio)	Low development potential (>15 mining ratio)	Unknown development potential	Total
Fe-3 isolated	--	--	-	4,520,000	4,520,000
Fe-2 data point	1,790,000	20,000	0	-	1,810,000
Total	1,790,000	20,000	0	4,520,000	6,330,000

Table 2 -- Coal Reserve Base Data for subsurface mining methods for Federal coal lands (in short tons) in the Northwest Quarter of the Factory Butte 15-minute quadrangle, Wayne 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	Total
Fe-3	--	--	--	--
Fe-2	--	--	--	--
Fe-1	730,000	--	--	730,000
Total	730,000			730,000

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