Text to Accompany:

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1979

COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE SOUTHEAST QUARTER OF THE CITADEL PLATEAU 15-MINUTE QUADRANGLE, MOFFAT COUNTY, COLORADO

[Report includes 4 plates]

Prepared for

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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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Purpose

This text is to be used in conjunction with Coal Resource Occurrence and Coal Development Potential Maps of the southeast quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado. This report was compiled to support the land planning work of the Bureau of Land Management (BLM) and to provide a systematic coal resource inventory of Federal coal lands in Known Recoverable Coal Resource Areas (KRCRA's) in the western United States. This investigation was undertaken by Dames & Moore, Denver, Colorado, at the request of the U.S. Geological Survey under contract number 14-08-0001-15789. 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 Published and unpublished public information available through February, 1979, was used as the data base for this study. No new drilling or field mapping was performed as part of this study, nor was any confidential data used.

Location

In this report, the term "this quadrangle" refers only to the southeast quarter of the Citadel Plateau 15-minute quadrangle which is located in south-central Moffat County in northwestern Colorado, approximately 15 airline miles (24 km) north-northwest of the town of Meeker and approximately 26 airline miles (42 km) southwest of the town of Craig. There are no major highways within the quadrangle area. With the exception of the town of Price Creek (in the southwestern corner of the quadrangle) and several ranches, the area within the quadrangle is unpopulated.

Accessibility

The southeast quarter of the Citadel Plateau 15-minute quadrangle is approximately 14 to 16 miles (23 to 26 km) south of U.S. Highway 40, via several improved light-duty roads which connect with Price Creek, and approximately 21 miles (34 km) north of Colorado Highway 64 via an improved light-duty and medium-duty road. An improved light-duty road connecting with Colorado Highway 13 (also known as Colorado Highway 789) approximately 15 miles (24 km) to the east serves the Maudlin Gulch oil field in the southeast corner of the quadrangle. The remainder of the quadrangle is accessible along a number of unimproved dirt roads and trails.

Railway service for the quadrangle is provided by the Denver and Rio Grande Western Railroad from Denver to the railhead at Craig approximately 25 airline miles (40 km) northeast of this quadrangle. The railroad is the major transportation route for coal shipped east from northwestern Colorado (U.S. Bureau of Land Management, 1977).

Physiography

The southeast quarter of the Citadel Plateau 15-minute quadrangle lies in the western part of the southern Rocky Mountains physiographic province, as defined by Howard and Williams (1972), and is approximately 74 miles (119 km) southwest of the Continental Divide. The quadrangle lies within the Danforth Hills.

The landscape within the quadrangle is characterized by steep slopes and narrow canyons. Coyote Basin, in the southwestern part of the quadrangle, is a low, flat valley at the junction of Price Creek and Deep Channel Creek. Altitudes range from approximately 8,316 feet (2,535 m) on Coal Mountain in the east-central part of the quadrangle to less than 6,520 feet (1,987 m) on Deep Channel Creek in the southwest corner.

The southwestern quarter of the quadrangle is drained by Deep Channel Creek and its tributaries, which flow into the White River approximately 14 miles (23 km) southwest of the quadrangle. The northeastern three fourths of the quadrangle is drained by northeast-flowing creeks, including Maudlin Gulch, Jesse Gulch, Hale Gulch, and Temple Canyon. These creeks drain into the Yampa River northeast of the quadrangle. With the exception of Deep Channel Creek, all streams in the quadrangle are intermittent, flowing mainly in response to snowmelt in the spring.

Climate and Vegetation

The climate of northwestern Colorado is semiarid. Clear, sunny days prevail in the Citadel Plateau quadrangle area, with daily temperatures typically varying from 1° to 36° F (-17° to 2°C) in January and from 46° to 88°F (8° to 31°C) in July. Annual precipitation averages about 12 inches (30 cm). Snowfall during the winter months accounts for the major part of the precipitation in the area, but rainfall from thundershowers during the summer months also contributes to the total. Winds, averaging approximately 3 miles per hour (5 km per hour), are generally from the west, but wind directions and velocities vary greatly depending on the local terrain (U.S. Bureau of Land Management, 1977).

Mountain shrub, including serviceberry, Gambel oak, and rabbitbrush, are characteristic of the higher areas in the quadrangle. The typical vegetation in the northeastern part of the quadrangle is sagebrush. Vegetation in the Coyote Basin includes pinyon, Utah juniper, and Rocky Mountain juniper. Several small areas of grassland occur in the northwestern and central parts of the quadrangle (U.S. Bureau of Land Management, 1977).

Land Status

The southeast quarter of the Citadel Plateau 15-minute quadrangle lies in the northwestern part of the Danforth Hills Known Recoverable Coal Resource Area (KRCRA). Approximately one third of the quadrangle lies within the KRCRA boundary and the Federal government owns the coal rights for approximately 85 percent of this area as shown on plate 2. There are no active coal leases within the quadrangle.

GENERAL GEOLOGY

Previous Work

The first geologic description of the general area in which the this quadrangle is located was reported by Emmons (1877) as part of a survey of the Fortieth Parallel. The decision to build a railroad into the region stimulated several investigations of coal between 1886 and 1905, including papers by Hewett (1899), Hills (1893), and Storrs

(1902). Gale (1910) reported on the coal fields and geology of northwestern Colorado and Sears described the geology of this area in 1924. Relatively little recent work has been done in this quadrangle and surrounding areas. Reheis (1975) compiled a generalized geologic map of the Danforth Hills KRCRA, which includes only the area within and immediately adjacent to the KRCRA boundary. Pipiringos and Rosenlund (1977) prepared a preliminary geologic map of the White Rock quadrangle to the south, and Rowley and others (1978) compiled a preliminary geologic map of the Vernal 1° x 2° quadrangle that includes the Citadel Plateau area.

Stratigraphy

The rock formations cropping out in the southeast quarter of the Citadel Plateau 15-minute quadrangle range in age from Late Cretaceous to Eocene and include the Mancos Shale, the coal-bearing Iles and Williams Fork Formations of the Mesaverde Group, the Fort Union Formation, and the Wasatch Formation.

The Mancos Shale of Late Cretaceous age crops out in the northeast and northwest corners of the quadrangle (Rowley and others, 1978) and is composed of gray shale interbedded with thin layers of sandstone and sandy shale near the top (Tweto, 1976). According to Tweto (1976), the Mancos Shale is approximately 5,000 feet (1,524 m) thick in northwestern Colorado; however, its total thickness in this quadrangle is unknown.

The Mesaverde Group of Late Cretaceous age conformably overlies the Mancos Shale and contains two formations, the Iles and the Williams Fork.

The Iles Formation crops out in the northern, central, and southeastern parts of the quadrangle. It consists of massive sandstone interbedded with shaly sandstone, sandy shale, and black carbonaceous shale. In the adjacent Meeker quadrangle to the southeast, Hancock and Eby (1930) report that the Iles ranges in thickness from approximately 1,350 to 1,600 feet (411 to 488 m), and it is believed that the formation is probably within that range in this quadrangle. The Tow Creek Sandstone Member (Bass and others, 1955), the basal unit of the Iles Formation, is a light-brown to white massive sandstone approximately 90 feet (27 m) thick where measured in the Tennessee Gas Transmission No. 1 USA Chorney well drilled in sec. 11, T. 3 N., R. 95 W., in the White Rock quadrangle. The Trout Creek Sandstone Member caps the formation and consists of about 120 feet (37 m) of massive white sandstone. Two coal-bearing sequences, the "lower" coal group and Black Diamond coal group (Hancock and Eby, 1930), occur in the Iles below the Trout Creek Sandstone Member in the Meeker area, but these coal groups have not been identified in this quadrangle.

The Williams Fork Formation crops out in the northeast corner and in a northwest-trending band across the southeast corner of the quadrangle. It is approximately 3,400 feet (1,036 m) thick (Sears, 1924) where measured in Freeman and Bob Hughes (Swan Draw) Gulches in the northern half of the southwest quarter of the Citadel Plateau 15-minute quadrangle to the west, and Pipiringos and Rosenlund (1977) estimate that it about 4,000 feet (1,219 m) thick in the northeastern part of the quadrangle to the south. The formation is generally divided into three units: a lower coal-bearing unit, the Lion Canyon Sandstone Member, and an upper unit that also contains coal. Individual thicknesses of these three units are not known in this quadrangle, but they have been estimated based on geologic data projected from the White Rock quadrangle (Pipiringos and Rosenlund, 1977), the Devils Hole Gulch area (Hancock and Eby, 1930), and the preliminary geologic map by Rowley and others (1978).

The lower unit extends from the top of the Trout Creek Sandstone Member of the Iles Formation to the base of the Lion Canyon Sandstone Member, and may possibly be from 1,700 to 2,100 feet (518 to 640 m) thick in this quadrangle. It consists of interbedded sandstone, siltstone, sandy shale, carbonaceous shale and coal beds. The sandstone is white to tan, light gray to brown, and fine to medium grained. Two coal groups, the Fairfield coal group and the Goff coal group, occur in the lower unit of the Williams Fork Formation (Hancock and Eby, 1930).

The Lion Canyon Sandstone Member is a light-gray to white, thick-bedded, fine-grained sandstone and may contain, locally, thin beds of shale and siltstone (Pipiringos and Rosenlund, 1977). It is estimated to be at least 150 feet (46 m) thick in this quadrangle.

The upper unit of the Williams Fork Formation, which may be a Lance equivalent (Pipiringos and Rosenlund, 1977), is probably between 1,100 and 1,800 feet (335 and 549 m) thick, consisting of a series of light-gray to brown massive and shaly sandstone, brown to black sandy and carbonaceous shale, and coal beds. Coal beds in this unit that crop out above the Lion Canyon Sandstone Member have been designated the Lion Canyon coal group by Hancock and Eby (1930).

Unconformably overlying the Williams Fork Formation, the Fort Union Formation of Paleocene age crops out in a northwest-trending band across the southwestern corner of the quadrangle (Rowley and others, 1978). In the White Rock quadrangle to the south, the formation is composed predominantly of light-gray to brown sandstone with minor amounts of interbedded siltstone, claystone, carbonaceous shale, and thin coal beds. Several conglomerate beds occur in the basal 40 to 70 feet (12 to 21 m) of the formation (Pipiringos and Rosenlund, 1977). The total thickness of the formation in this quadrangle is not known, but it ranges from about 1,200 to 1,400 feet (366 to 427 m) on the surface in the White Rock quadrangle.

The Wasatch Formation of Eocene-Paleocene age crops out in a north-west-trending band across the southwestern part of the quadrangle (Rowley and others, 1978). The contact between the Wasatch and the underlying Fort Union strata is probably unconformable (Gale, 1907) in this area. In general, the Wasatch is composed of variegated shale, light-gray to tan sandstone with minor amounts of conglomerate, and it is estimated that its thickness may as much as 2,300 feet (701 m).

Holocene and Pleistocene deposits of stream alluvium cover the valleys and gulches in this quadrangle.

The Cretaceous sedimentary rocks in the quadrangle accumulated close to the western edge of a Late Cretaceous epeirogenic seaway which covered part of the western interior of North America. A major regressive cycle caused the deposition of a series of marine, near-shore marine, and non-marine sediments in the Citadel Plateau area (Masters, 1959; Ryer, 1977).

The Mancos Shale was deposited in an offshore marine environment which existed east of the shifting strand line. Deposition of the Mancos Shale in the quadrangle area ended with the eastward migration of the shoreline and the subsequent deposition of the Iles Formation (Kucera, 1959).

The interbedded sandstone, shale, and coal of the Mesaverde Group were deposited as a result of minor changes in the position of the shoreline. Near-shore marine, littoral, brackish tidal, brackish and fresh water supratidal, and fluvial environments existed during the deposition of the Iles and Williams Fork Formations. The major sandstone members of the Iles and Williams Fork Formations, including the Trout Creek and Lion Canyon Sandstone Members, were deposited in shallow marine and near-shore marine environments as the shoreline fluctuated. Coal beds of limited areal extent, such as those in the Fairfield, Goff, and Lion Canyon coal groups, were generally deposited in environments associated with fluvial systems, such as back-levee and coastal plain swamps, interchannel basin areas, and abandoned channels (O'Boyle, 1955; Konishi, 1959).

After the final withdrawal of the Cretaceous sea, thick sections of detrital material, eroded from older deposits, were deposited as the Fort Union Formation. The conglomerates, sandstones, shales, and coals were deposited in braided-stream, flood-plain and backswamp deposits (Beaumont, 1979).

The coarse sediments at the base of the Wasatch Formation were deposited in a fluvial environment and the upper sediments were deposited in alternating swamp, lake and stream environments (Beaumont, 1979).

Structure

The Danforth Hills KRCRA lies in the northern part of the Piceance structural basin of west-central Colorado. The Danforth Hills area is bordered on the northeast by the Axial Basin anticline and on the west by the Yampa Plateau, approximately 15 miles (24 km) west-northwest of the quadrangle. The northeast corner of the quadrangle lies on the southwestern edge of the Axial Basin.

The Danforth Hills anticline trends northwest across the center of the quadrangle. Paralleling this anticline to the north is the Collom syncline (Sears, 1924). Reheis (1975) indicates that the coal beds within the KRCRA boundary in the southwestern part of the quadrangle are on the southwestern limb of the Danforth Hills anticline and dip from approximately 21° to 40° to the southwest. Dips of the coal beds along the eastern edge of the quadrangle range from about 9° northeast and southeast to nearly horizontal.

The structure contour maps of the isopached coal beds are based on a regional structure map of the top of the Trout Creek Sandstone Member by Reheis (1975) and it is assumed that the structure of the coal beds nearly duplicates that of the Trout Creek Sandstone Member.

COAL GEOLOGY

Coal beds in the Fairfield, Goff, and Lion Canyon coal groups of the Williams Fork Formation have been identified in the southeast quarter of the Citadel Plateau 15-minute quadrangle. The Fairfield coal group includes all coal beds in the lower part of the Williams Fork Formation and the Goff coal group is applied to the coal-bearing strata that underlie the Lion Canyon Sandstone Member (Hancock and Eby, 1930). Coal beds of the Lion Canyon coal group occur in the upper Williams Fork Formation above the Lion Canyon Sandstone Member. Coal beds exceeding Reserve Base thickness (5 feet or 1.5 meters) are known to occur in the Lion Canyon coal group in this quadrangle, but not in the Fairfield or Goff coal groups. Coal beds in the Lion Canyon coal group are not formally named, but have been given bracketed numbers for identification purposes. In instances where coal beds exceeding Reserve Base thickness are measured at one location only and cannot be correlated with other coal beds, they are treated as isolated data points (see Isolated Data Points section of this report).

Chemical analyses of coal.--Chemical analyses were not available for coals from the Fairfield and Lion Canyon coal groups in this quadrangle. However, it is believed that these coals are similar in rank to coal from the Fairfield and Lion Canyon coal groups mined, respectively, at the Ed Collum mine in the Easton Gulch quadrangle to the east and at the Montgomery mine in the Meeker quadrangle to the southeast. Analyses of these coals are listed in table 1. In general, these coals are ranked as high-volatile C bituminous on a moist, mineral-matter-free basis according to ASTM Standard Specification D 388-77 (American Society for Testing and Materials, 1977).

Fairfield Coal Group

None of the coal beds in the Fairfield coal group identified in this quadrangle are known to exceed Reserve Base thickness. However, based on outcrop measurements in the adjacent Easton Gulch quadrangle to the east, two coal beds in the Fairfield coal group have been projected into this quadrangle and have been isopached.

The Fairfield [27] coal bed is believed to exceed Reserve Base thickness over a small area outside of the KRCRA in sec. 36, T. 5 N., R. 95 W., near the east-central part of this quadrangle. In the Easton Gulch quadrangle, the coal bed ranges in thickness from 4.9 to 9.5 feet (1.5 to 2.9 m) where measured along the outcrop, and it may be as much as 6.0 feet (1.8 m) thick in this quadrangle as shown in figure 1. (Figures are presented on pages 15 through 20.)

The Fairfield [34] coal bed (figure 3) has been projected into the southeast corner of the this quadrangle based on outcrop data in the Easton Gulch quadrangle. In that quadrangle, the coal bed ranges from 6.6 to 8.9 feet (2.0 to 2.7 m) in thickness where measured at several locations along the outcrop. In the small area where the coal bed is believed to be present in sec. 1, T. 3 N., R. 95 W., of this quadrangle, the coal bed is inferred to be more than 7 feet (2.1 m) and less than 8 feet (2.4 m) thick.

Lion Canyon Coal Group

The Lion Canyon coal group is located above the Lion Canyon Sandstone Member in the upper part of the Williams Fork Formation, and six coal beds, the Lion Canyon [1], [2], [3], [4], [5], and [6], exceed Reserve Base thickness in this quadrangle. Since each of these coal beds has been identified at one location only and cannot be correlated with accuracy, they have been treated as isolated data points.

Isolated Data Points

In instances where single or isolated measurements of coal beds thicker than 5.0 feet (1.5 m) 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 point maps are included on a separate plate for non-isopached coal beds. The areas influenced by the isolated data points occurring in this and the adjacent Horse Gulch quadrangle are shown on plate 4.

COAL RESOURCES

Data from outcrop measurements (Reheis, 1975) were used to construct outcrop, isopach, and structure contour maps of the coal beds in the southeast quarter of the Citadel Plateau 15-minute quadrangle. Where coal beds of Reserve Base thickness are located outside of the KRCRA, areal distribution and identified resources maps are not constructed and Reserve Base tonnages are not calculated. The source of each indexed data point shown on plate 1 is listed in table 4.

Coal resources on Federal land were calculated using data obtained from the coal isopach map (figure 3), the areal distribution and identified resources map (figure 5), and the isolated data point maps (plate 4). The coal bed acreage (measured by planimeter), multiplied by the average isopached thickness of the coal bed and by a conversion factor of 1,800 short tons of coal per acre-foot (13,238 metric tons per hectare-meter) for bituminous coal, yields the coal resources in short tons of coal for each coal bed. Coal beds thicker than 5 feet (1.5 m) that lie less than 3,000 feet (914 m) below the ground surface are included. These criteria differ somewhat from those stated in U.S. Geological Survey Bulletin 1450-B which call for a minimum thickness of 28 inches (70 cm) and a maximum depth of 1,000 feet (305 m) for bituminous coal.

Reserve Base and Reserve tonnages for the Fairfield [34] coal bed are shown on figure 5, and are rounded to the nearest 10,000 short tons (9,072 metric tons). Only Reserve Base tonnages (designated as inferred resources) are calculated for areas influenced by the isolated data points (plate 4).

Coal Reserve Base tonnages per Federal section are shown on plate 2 and total approximately 4.71 million short tons (4.27 million metric tons) for the entire quadrangle, including the tonnages for the isolated data points. Reserve Base tonnages in the various development potential categories for surface, subsurface and in-situ mining methods are shown in tables 2 and 3.

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

COAL DEVELOPMENT POTENTIAL

Coal development potential areas are drawn 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 200 feet (61 m) or less of overburden are considered to have potential for surface mining and are 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
0.896 for bituminous 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 less than 200 feet (61 m) of overburden and 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.

Unknown development potentials have been assigned to those areas where coal data is absent or extremely limited, including the areas influenced by isolated data points. Even though these areas may contain coal thicker than 5 feet (1.5 m), limited knowledge of the areal distribution, thickness, depth, and attitude of the coal beds prevents accurate evaluation of development potential in the high, moderate, and low categories. The areas influenced by the isolated data points contain approximately 2.30 million short tons (2.09 million metric tons) of coal available for surface mining.

The coal development potential for surface mining methods is shown in figure 6. Of those Federal land areas having a known development potential for surface mining, 50 percent are rated high and 50 percent are rated moderate. The remaining Federal lands within the KRCRA boundary are classified as having unknown development potential for surface mining methods.

Development Potential for Subsurface and In-Situ Mining Methods

Areas where the coal beds of Reserve Base thickness lie between 200 and 3,000 feet (61 and 914 m) below the ground surface, having dips of 15° or less, are considered to have development potential for conventional subsurface mining methods. Unfaulted coal beds lying between 200 and 3,000 feet (61 and 914 m) below the ground surface, dipping greater than 15°, are considered to have development potential for in-situ mining methods.

Areas of high, moderate, and low development potential for conventional subsurface mining are defined as areas underlain by coal beds of Reserve Base thickness at depths ranging from 200 to 1,000 feet (61 to 305 m), 1,000 feet to 2,000 feet (305 to 610 m), and 2,000 to 3,000 feet (610 to 914 m), below the ground surface, respectively.

Areas where the coal data is absent or extremely limited between 200 and 3,000 feet (61 and 914 m) below the ground surface are assigned unknown development potentials. This applies to the areas influenced by the isolated data points and to those areas where coal beds of Reserve Base thickness are not known, but may occur. The areas influenced by the isolated data points in this quadrangle contain only approximately 20,000 short tons (18,000 metric tons) of coal believed to be available for conventional subsurface mining.

All of the Federal lands within the KRCRA boundary have been rated as having unknown development potential for conventional subsurface mining methods since the isopached coal beds are at depths less than 200 feet (61 m) below the ground surface.

Based on criteria provided by the U.S. Geological Survey, coal beds greater than Reserve Base thickness dipping from 15° to 35°, regardless of tonnage, and coal beds dipping from 35° to 90° with less than 50 million short tons (45.4 million metric tons) of coal have a low development potential for in-situ mining methods. Coal lying between the 200-foot (61 m) overburden line and the outcrop is not included in the total coal tonnages available as it is needed for cover and containment in the in-situ process.

Areas where faulted coal beds of Reserve Base thickness dip greater than 15° between 200 and 3,000 feet (61 and 914 m) below the ground surface are classified as having an unknown development potential for in-situ mining methods. These criteria also apply to those areas influenced by isolated data points where the coal beds dip greater than 15° and are not faulted. The areas influenced by isolated data points in this quadrangle contain approximately 1.97 million short tons (1.79 million metric tons) of coal available for in-situ mining.

Because all tonnages available for in-situ mining methods have been derived from isolated data points, all of the Federal lands within the KRCRA boundary in this quadrangle have been classified as having unknown development potential for in-situ mining methods.

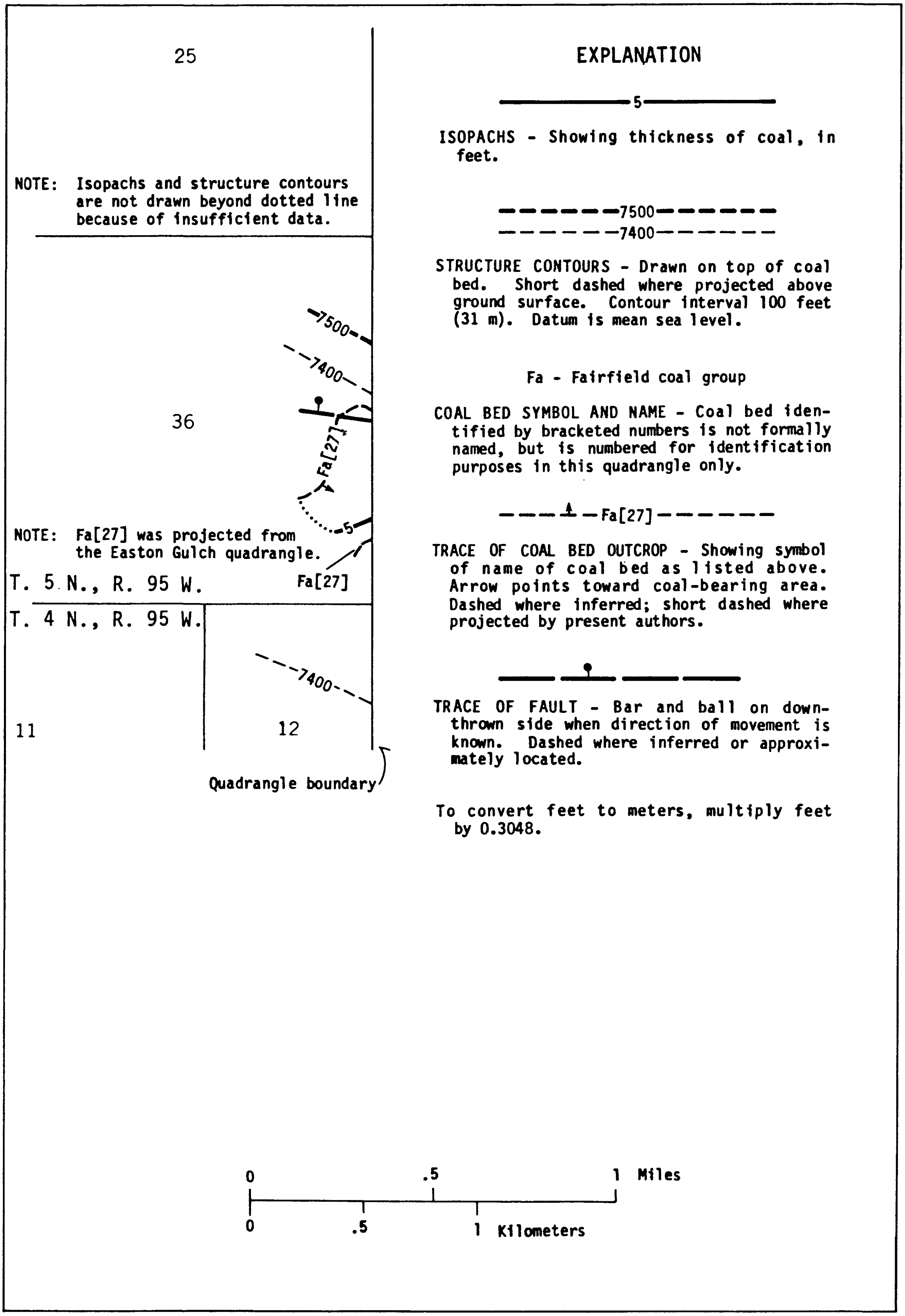
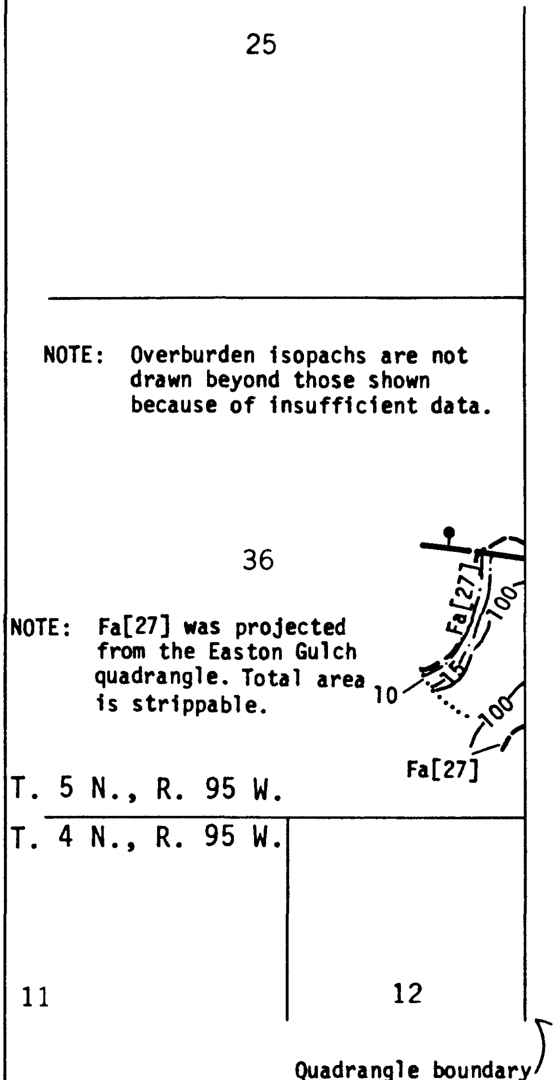


FIGURE 1. — Isopach and structure contour map of the Fairfield coal group, coal bed [27].



EXPLANATION

—— 100 ——

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet. Isopach interval 100 feet (31 m).

—— · 10 · ——

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Fa - Fairfield coal group

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

– – – – Fa[27] – – – –

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where projected by present authors.

TRACE OF FAULT - Bar and ball on downthrown side when direction of movement is known. Dashed where inferred or approximately located.

To convert feet to meters, multiply feet by 0.3048.

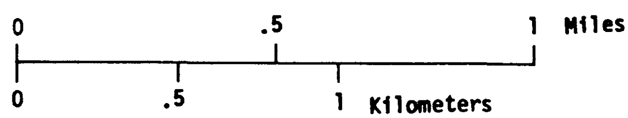
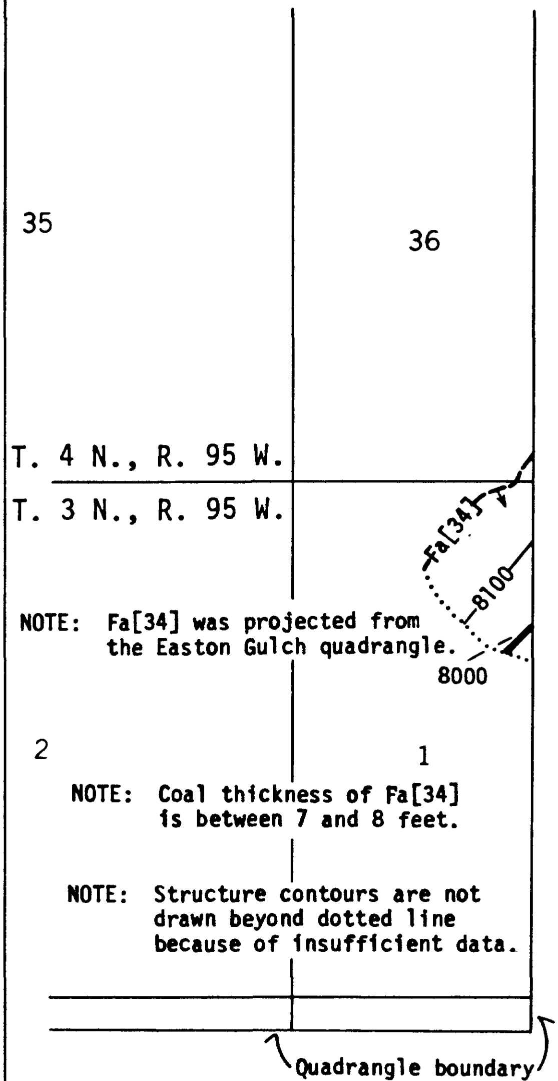


FIGURE 2. — Overburden isopach and mining ratio map of the Fairfield coal group, coal bed [27].



EXPLANATION

8000

8100

STRUCTURE CONTOURS - Drawn on top of coal bed. Long dashed where vertical accuracy possibly not within 40 feet. Contour interval 100 feet (31 m). Datum is mean sea level.

Fa - Fairfield coal group

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

Fa[34]

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where projected by present authors.

To convert feet to meters, multiply feet by 0.3048.

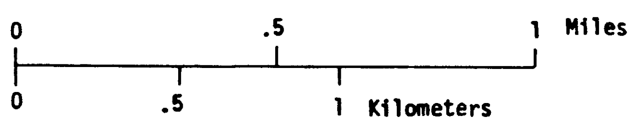
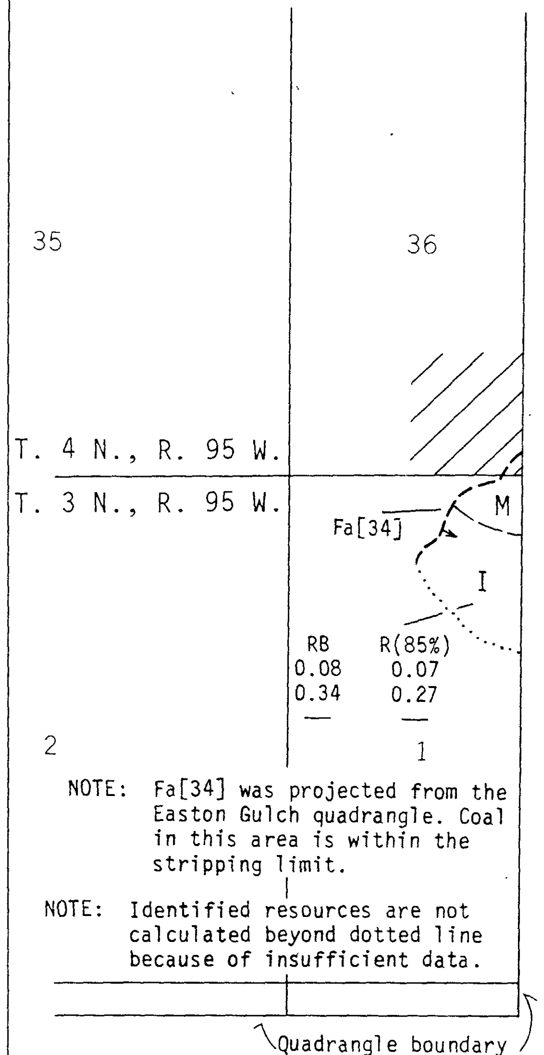


FIGURE 3. — Isopach and structure contour map of the Fairfield coal group, coal bed [34].



EXPLANATION

NON-FEDERAL COAL LAND - Land for which the Federal Government does not own the coal rights.

Fa - Fairfield coal group

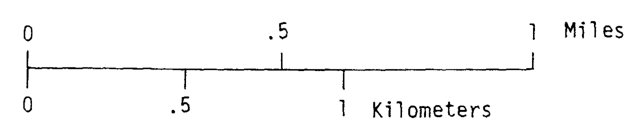
COAL BED SYMBOL AND NAME - Coal bed identified by bracketed numbers is not formally named, but is numbered for identification purposes in this quadrangle only.

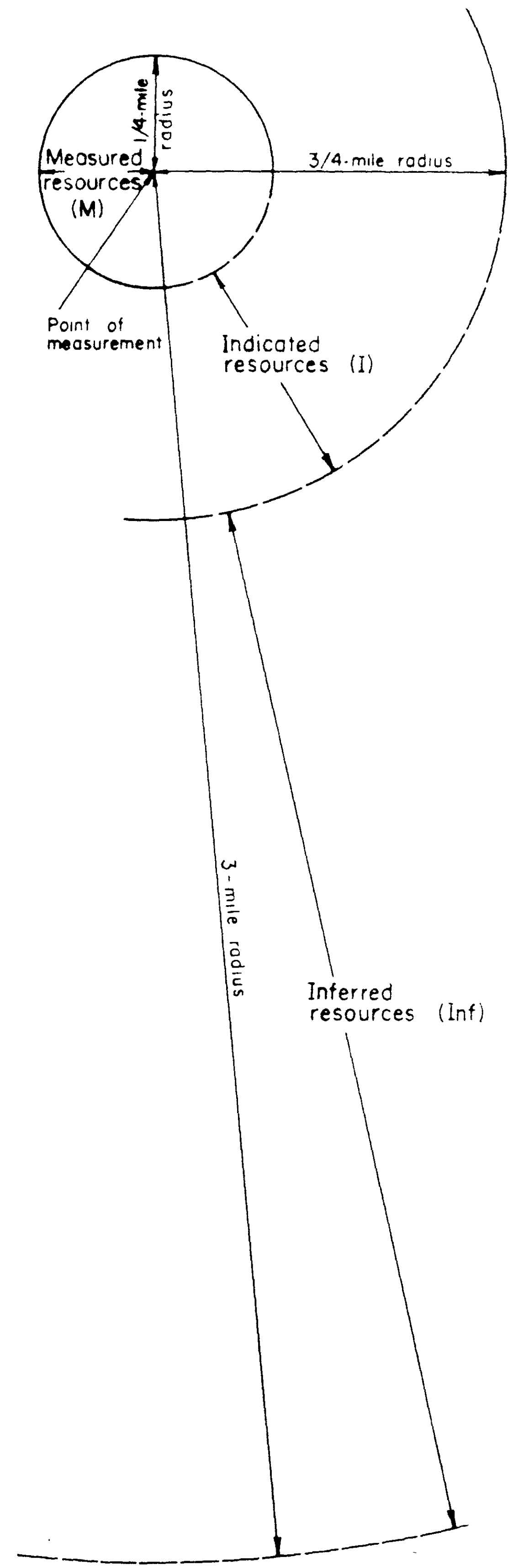
— — — — —Fa[34]— — — — — —

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Arrow points toward coal-bearing area. Short dashed where projected by present authors.

RB	R(85%)	
0.08	0.07	(Measured)
0.34	0.29	(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, within the stripping-limit line. Reserve (R) tonnage is calculated by multiplying the Reserve Base (RB) tonnage by the appropriate recovery factor. Dash indicates no resource in that category.





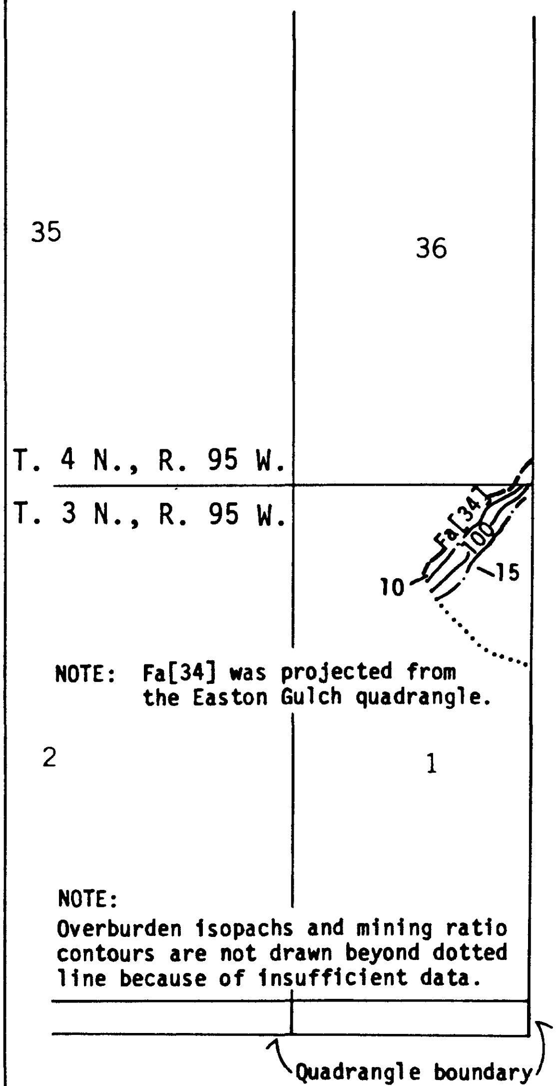
BOUNDARY LINES - Enclosing areas of measured (M), indicated (I), and inferred (Inf) coal resources. Dashed where projected from adjacent quadrangles.

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

To convert feet to meters, multiply feet by 0.3048.

To convert miles to kilometers, multiply miles by 1.6093.

FIGURE 5. — Areal distribution and identified resources map of the Fairfield coal group, coal bed [34].



EXPLANATION

——— ——— 100 ——— ———

OVERBURDEN ISOPACHS - Showing thickness of overburden, in feet, from surface to top of coal bed. Dashed where vertical accuracy possibly not within 40 feet. Isopach interval 100 feet (31 m).

——— · ———10——— · ———

MINING-RATIO CONTOUR - Number indicates cubic yards of overburden per ton of recoverable coal by surface mining methods. Contours shown only in areas underlain by coal of Reserve Base thickness within the stripping-limit (in this quadrangle, the 200-foot-overburden isopach). To convert mining ratio to cubic meters of overburden per metric ton of recoverable coal, multiply mining ratio by 0.8428.

Fa - Fairfield coal group

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

– – – – – – Fa[34] – – – – – –

TRACE OF COAL BED OUTCROP - Showing symbol of name of coal bed as listed above. Short dashed where projected by present authors.

To convert feet to meters, multiply feet by 0.3048.

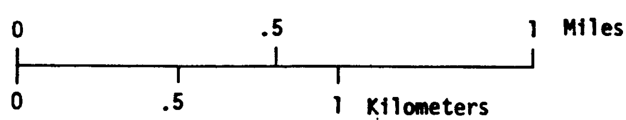


FIGURE 4. — Overburden isopach and mining ratio map of the Fairfield coal group, coal bed [34].

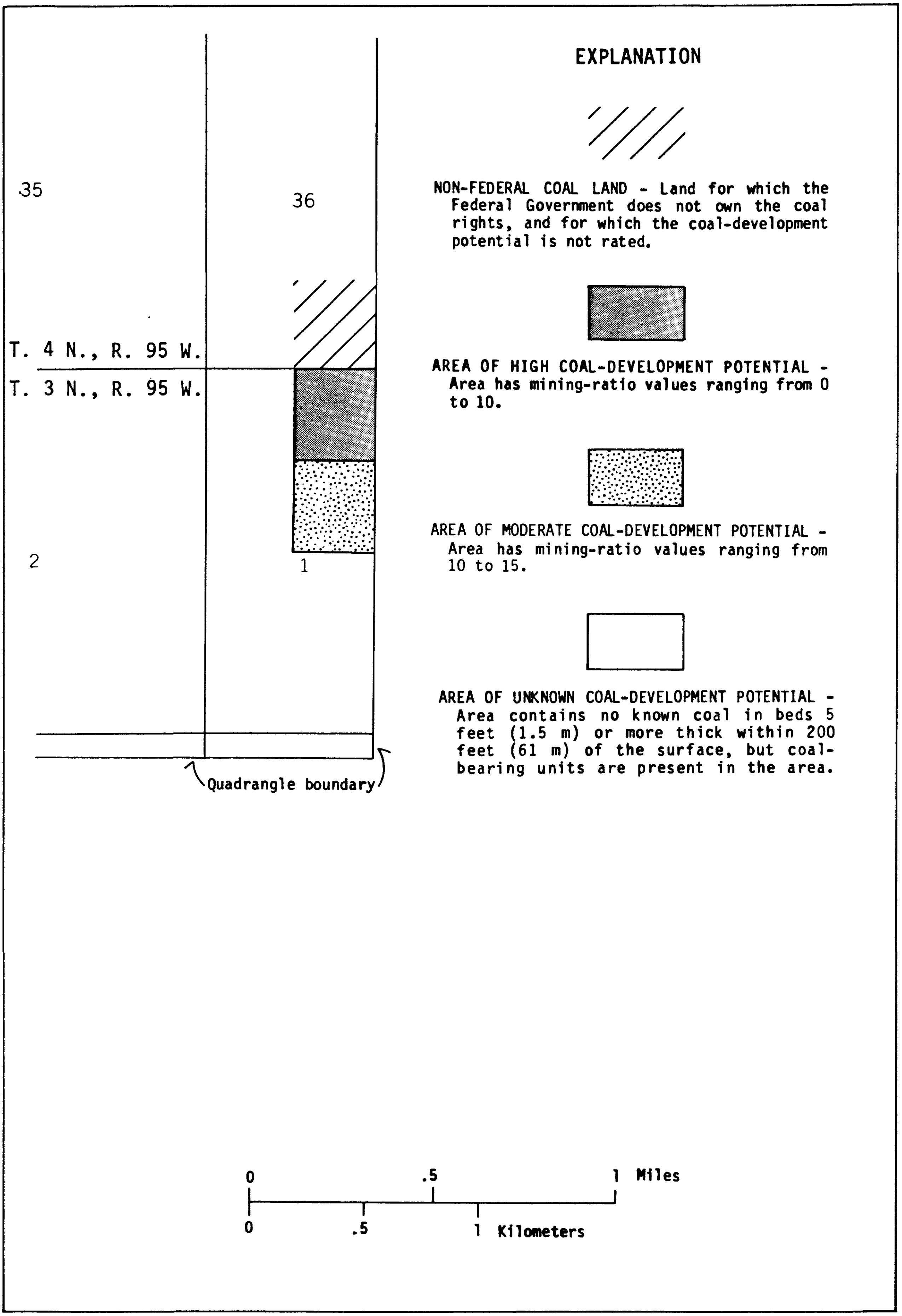


FIGURE 6. — Coal development potential map for surface mining methods.

Table 1. -- Chemical analyses of coals in the southeast quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Location	COAL BED NAME	Form of Analysis	Proximate				Ultimate					Heating Value	
			Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Hydrogen	Carbon	Nitrogen	Oxygen	Calories	Btu/Lb
SW¼ sec. 13, T. 4 N., R. 94 W., Ed Collum Mine (Hancock, 1925) from Easton Gulch quadrangle	Fairfield coal group coal bed {33}	A	14.8	38.7	42.7	3.82	0.66	-	-	-	-	-	10,780
		B	13.1	39.5	43.5	3.90	0.67	-	-	-	-	-	11,000
		C	-	45.4	50.1	4.49	0.78	-	-	-	-	-	12,660
NW¼ sec. 29, T. 1 N., R. 94 W., Montgomery Mine (Hancock and Eby, 1930) from Meeker quadrangle	Lion Canyon coal group	A	12.4	38.6	42.9	6.1	0.71	-	-	-	-	-	10,790
		B	10.6	39.4	43.7	6.3	0.72	-	-	-	-	-	11,010
		C	-	44.1	48.9	7.0	0.81	-	-	-	-	-	12,320

Form of Analysis: A, as received
B, air dried
C, moisture free

Note: To convert Btu/pound to kilojoules/kilogram, multiply by 2.326

Table 2. -- Coal Reserve Base data for surface mining methods for Federal coal lands (in short tons) in the southeast quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Fairfield {34}	50,000	90,000	280,000	-	420,000
Isolated Data Points	-	-	-	2,300,000	2,300,000
Totals	50,000	90,000	280,000	2,300,000	2,720,000

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

Table 3. -- Coal Reserve Base data for subsurface and in-situ mining methods for Federal coal lands (in short tons) in the southeast quarter of the Citadel Plateau 15-minute quadrangle, Moffat County, Colorado.

Coal Bed or Zone	High Development Potential	Moderate Development Potential	Low Development Potential	Unknown Development Potential	Total
Fairfield {34}	-	-	-	-	-
Isolated Data Points	-	-	-	1,990,000*	1,990,000
Totals	-	-	-	1,990,000	1,990,000

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

*Includes 1,970,000 short tons dipping greater than 15°.

Table 4. -- Sources of data used on plate 1

Plate 1 Index Number	Source	Data Base
1	Reheis, compiler, 1975, U.S. Geological Survey, unpublished map	Measured Section
2		Measured Section
3		Measured Section
4		Measured Section
5		Measured Section
6		Measured Section
7		Measured Section
8		Measured Section
9		Measured Section
10		Measured Section
11		Measured Section
12		Measured Section

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