UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

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1985

FEDERAL COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE BIG ROCK HILL 7 1/2-MINUTE QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

[Report includes 7 plates]

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BIG ROCK HILL QUADRANGLE
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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Big Rock Hill 7½ minute quadrangle, McKinley County, New Mexico. These maps and report are part of an evaluation of fifty-six 7½ minute quadrangles in northwestern New Mexico which were completed under U. S. Geological Survey Contract No. 14-08-0001-17459 (see figs. 1 and 2).

The purpose of this Coal Resource Occurrence-Coal Development Potential program, which was conceived by Congress as part of its Federal Coal Leasing Amendments Act of 1976, is to obtain coal resource information and to determine the geographical extent of Federal coal deposits. In addition, the program is intended to provide information on the amount of coal recoverable by various mining methods and to serve as a guide for land-use planning.

The U. S. Geological Survey initiated the program by identifying areas underlain by coal resources. These areas were designated Known Recoverable Coal Resource Areas based on the presence of minable coal thicknesses, adequate areal extent of these coal deposits, and the potential for developing commercial quantities of coal at minable depths.

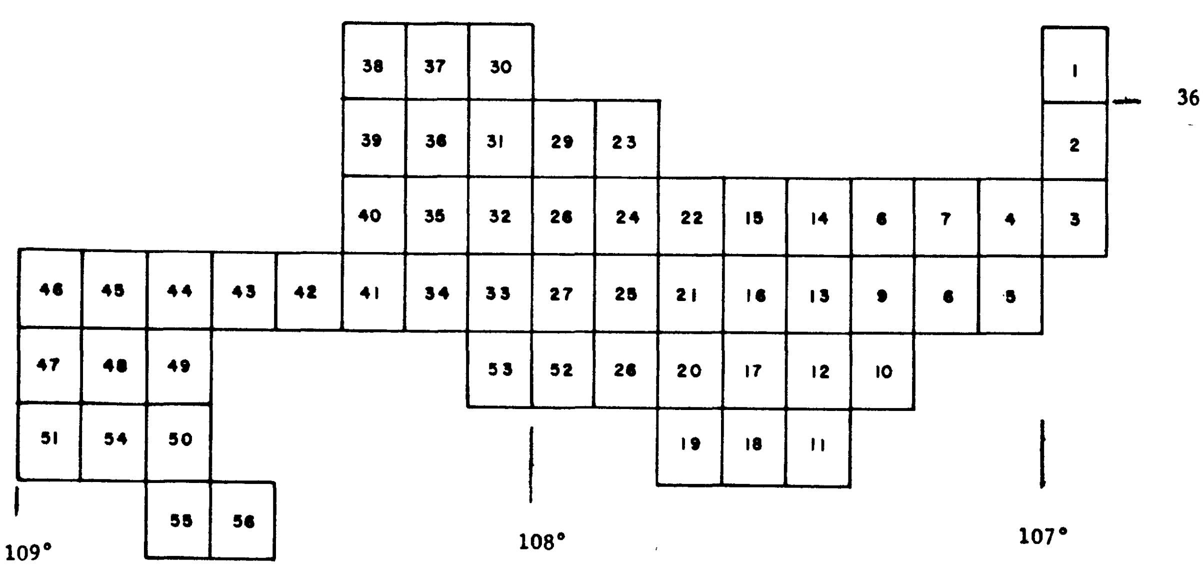
This report is limited to coal resources which are 3,000 ft (914 m) or less below ground surface. Published and unpublished public information was used as the data base for this study. No new drilling or field mapping was performed as part of this study, nor were any confidential data used.


PROJECT AREA
AREA OF THIS REPORT
LOCATION OF PROJECT AREA
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Grants
Bernalillo
Bloomfield
Window Rock
Gallup

FIGURE 1

FIGURE 2.--Index to USGS 7 1/2-minute quadrangles and coal resource occurrence/ coal development potential maps for the southern San Juan Basin area, New Mexico

Map No.	Quadrangle	Open-file report
1	Cuba	79- 623
2	San Pablo	79- 624
3	La Ventana	79-1038
4	Headcut Reservoir	79-1043
5	San Luis	79-1044
6	Arroyo Empedrado	79-1045
7	Wolf Stand	79-1046
8	Tinian	79- 625
9	Canada Calladita	79- 626
10	Cerro Parido	79- 627
11	El Dado Mesa	79- 628
12	Mesa Cortada	79- 629
13	Mesita del Gavilan	79- 630
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
26	Mesa de los Toros	79-1122
27	Laguna Castillo	79- 640
28	Seven Lakes	79-1042
29	Seven Lakes NW	79-1123
30	Kin Klizhin Ruins	79-1047
31	Nose Rock	79- 641
32	Becenti Lake	79-1124
33	Heart Rock	79- 642
34	Crownpoint	79-1125
35	Antelope Lookout Mesa	79-1376
36	Milk Lake	79-1377
37	La Vida Mission	79-1378
38	The Pillar 3 SE	79-1379
39	Red Lake Well	79-1380
40	Standing Rock	79-1381
41	Dalton Pass	80- 026
42	Oak Spring	80- 027
43	Hard Ground Flats	80- 028
44	Big Rock Hill	80- 029
45	Twin Lakes	80- 030
46	Tse Bonita School	80- 031
47	Samson Lake	80- 032
48	Gallup West	80- 033
49	Gallup East	80- 034
50	Bread Springs	80- 035
51	Manuelito	80- 036
52	Borrego Pass	80- 037
53	Casamero Lake	80- 038
54	Twin Buttes	80- 039
55	Pinehaven	80- 040
56	Upper Nutria	80- 041



Location

The Big Rock Hill 7½ minute quadrangle includes acreage in Tps. 16, 17, and 18 N., Rs. 17 and 18 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

A secondary, medium-duty paved road passes through the northwestern part of the Big Rock Hill quadrangle, and provides access to U. S. Highway 666, 1.4 mi (2.3 km) west of the quadrangle. Another light-duty, maintained road (Jack Johnson Road) in the central western part of the area provides access to U. S. Highway 666, 1.3 mi (2.1 km) west of the quadrangle. Several light-duty and unimproved dirt roads traverse most parts of the area. The Atchison, Topeka, and Santa Fe Railroad line parallels Interstate Highway 40 about 5.5 mi (8.8 km) south of the quadrangle (see fig. 1).

Physiography

The Big Rock Hill quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). Most of the quadrangle is characterized by mesa-and-canyon topography. The central northern and northwestern parts of the quadrangle are characterized by flatlands.

No perennial streams are present in the area. Local drainage is provided by several intermittent arroyos. Elevations within the quadrangle range from less than 6,160 ft (1,878 m) along the northern quadrangle boundary to over 7,460 ft (2,274 m) along the southern quadrangle boundary.

Climate

The climate of this area is semiarid to arid. The following temperature and precipitation data were reported by the National Oceanic and Atmospheric Administration for the Gallup 5E Station. The Big Rock Hill quadrangle is about 5 mi (8 km) north of the Gallup 5E Station. Average total annual precipitation for eleven of the previous fifteen years is 9.53 in. (24.21 cm). Intense thunderstorms in July, August, and September account for the majority of precipitation. The area is susceptible to flash flooding associated with these thunderstorms. Mean annual temperature for seven of the previous fifteen years is 48.8^{0} F (9.3^{0} C). The average daily temperatures in January and July are 29.0^{0} F (-1.7^{0} C) and 71.3^{0} F (21.8^{0} C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 12 percent of the Big Rock Hill quadrangle. For the specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownership. There is a discrepency between U. S. Geological Survey and Bureau of Land Management land data as to the boundary line between secs. 33 and 34, T. 17 N., R. 17 W. which has not been resolved (see plate 2). About 8,600 acres (3,480 ha) in the southern part of the quadrangle are within the Gallup Known Recoverable Coal Resource Area. The Navajo Indians own the coal mineral rights to the northern three-fourths of the quadrangle. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the Big Rock Hill quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include reconnaissance mapping by Gardner (1909) who measured the coal-bearing Mesaverde strata, from the central part of sec. 16, T. 16 N., R. 17 W. to sec. 6, T. 16 N., R. 17 W., which covers almost 1,000 ft (305 m) of section. Sears (1934) mapped and measured several coal beds within the Dilco and Gibson Coal Members of the Crevasse Canyon Formation, and within the Menefee Cleary-Crevasse Canyon Gibson undifferentiated unit. In this area, the Cleary Coal Member of the Menefee Formation has not been differentiated from the Gibson coal Member of the Crevasse Canyon Formation south and west of the depositional pinch-out of the Point Lookout Sandstone (Kirk and Zech, 1978). The unit is here informally called the Cleary-Gibson undifferentiated coal member. Shomaker, Beaumont, and Kottlowski (1971) reviewed the area and noted that most of the identified coal beds were less than 3.0 ft (0.9 m) thick. In sec. 14, 15, 22, 23, 26, and 27, T. 17 N., R. 17 W. (projected), they discuss an 11 to 12 ft (3 to 4 m) thick coal bed in the lower part of the Cleary-Gibson undifferentiated coal member in these areas. The bed is overlain by 200 ft (61 m) of overburden in these areas. They did not estimate any strippable reserves for the area. Kirk and Zech (1978) mapped the surface geology and compiled a structure contour map of the Big Rock Hill quadrangle.

Stratigraphy

Within the San Juan Basin, the shoreline positions of the Cretaceous seaways changed innumerable times. The overall regional alignment of the shorelines trended N. 60° W. - S. 60° E. (Sears, Hunt, and Hendricks, 1941). The transgressive and regressive shoreline migrations are evidenced by the intertonguing relationships of continental and marine facies. Rates of trough (geosynclinal) subsidence and the availability of sediment supplies are the major factors that controlled the transgressive-regressive shoreline sequences.

Exposed rock units in the Big Rock Hill quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium along drainages in the area.

The "main body" of the Mancos Shale is stratigraphically the lowest exposed unit in the quadrangle and represents transgressive marine deposits. Light to dark gray, silty shales with interbedded brown calcareous sandstones comprise the lithologies of the Mancos Shale, which is as much as 722 ft (220 m) thick locally (Kirk and Zech, 1978). Only the upper 200 ft (61 m), however, is shown in the stratigraphic columnar section on plate 3.

A major northeastward regression of the Cretaceous seaways followed, and resulted in deposition of the Gallup Sandstone in a nearshore or littoral environment. The Gallup Sandstone overlies the "main body" of the Mancos Shale and is composed of pink to gray, fine-to very course-grained, massive sandstone, interbedded gray shales, and coal beds. Thickness of the unit ranges from 90 to 150 ft (27 to 46 m) locally. The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents the continental deposits which formed inland from the beach area during the deposition of the Gallup Sandstone. Medium to dark gray siltstone with interbedded medium-grained, tan sandstones, and coal beds comprise the lithologies of the Dilco Coal Member, which ranges from 100 to 220 ft (30 to 67 m) thick in the area.

The Dalton Sandstone Member of the Crevasse Canyon Formation overlies the Dilco Coal Member and represents nearshore marine deposits which formed during a northeastward retreat of the Cretaceous seaways. Kirk and Zech (1978) note that the marine upper part of the Dalton Sandstone Member grades to the south and west into laterally equivalent fluvial deposits. Yellowish-gray, very fine-grained, moderately well to poorly sorted sandstone with abundant petrified wood comprise the lithologies of the unit, which ranges from 35 to 185 ft (11 to 56 m) thick locally. Overlying the Dalton Sandstone Member, the Bartlett Barren Member represents flood plain deposits and is composed of yellowish-brown to olive gray siltstone, light gray shales, white to brown calcareous sandstones, and thin local coal beds. Thickness of the unit ranges from 70 to 150 ft (21 to 46 m) in the area.

The Cleary-Gibson undifferentiated coal member overlies the Bartlett Barren Member, and was combined based on similar lithologies and stratigrahic continuity representing essentially continuous continental deposition. Light to medium gray, carbonaceous siltstone with interbedded gray to tan sandstone, gray shales, and coal beds comprise the lithologies of the Cleary-Gibson unit, which ranges in thickness from 180 to 410 ft (55 to 125 m) locally.

The Allison Member of the Menefee Formation is separated from the underlying Gibson-Cleary undifferentiated coal unit by a massive channel sandstone sequence. The Allison Member represents continued continental deposition and consists of dark gray to brown carbonaceous shale, light gray sandstones, and thin, lenticular coal beds. Thickness of the partially eroded Allison Member is estimated to be 820 ft (250 m) locally (Kirk and Zech, 1978), although only the lower 120 ft (37 m) is illustrated on plate 3.

Depositional environments

The Cretaceous System sedimentary units in the quadrangle represent transgressive and regressive depositional conditions. There were innumerable minor cycles of widely varying duration and extent within the major sedimentary sequences. The paucity of data in this quadrangle and the intended scope of this report permit only general interpretations of the depositional environments.

The Cretaceous coal deposits of the San Juan Basin are products of former coastal swamps and marshes. These swamps and marshes were supported by heavy precipitation and a climate conducive to rapid vegetal growth in moderately fresh water. Due to the relatively low sulfur contents of the San Juan Basin coals, Shomaker and Whyte (1977) suggest the coals formed in fresh water environments.

Most of the coal-bearing units were deposited in coastal plain environments. The majority of the peat deposits formed in a transition zone between lower and upper deltaic sediments during periods of relative shoreline stability. Coals also formed in lake margin swamps inland from the coastal area. Shoreline oscillations and the subsequent influx of continental or marine debris upon the peat accumulations produced the vertical buildup or "stacking" of peat deposits. This sediment debris is represented by variable ash contents, rock partings, and splits within the coal seams.

The peat accumulated in lenses or pods which were generally parallel to the ancient shorelines. The coals in the lower portions of the coal-bearing units represent regressive depositional conditions (Sears, Hunt, and Hendricks, 1941). The coals in the upper portions of these units are relatively sporadic in occurrence.

Structure

The Big Rock Hill quadrangle is in the Nutria Monocline, Chaco Slope, and Gallup Sag (Baltz, 1967) structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The rock units dip from 1.5^{0} to 6^{0} NNW to 2^{0} to 31^{0} WNW. Kirk and Zech (1978) mapped anticlinal and synclinal folds in the quadrangle, as well as monoclinal flexures in the area. "The Hogback" is a major structural feature that accounts for the steep dips in the southern part of the quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified seven coal beds, two coal zones, and a local coal bed in Sears' (1934) surface mapping. These coal beds and coal zones are here informally called the Crevasse Canyon Dilco No. 2, No. 2A, No. 3, and No. 4 coal beds, Crevasse Canyon Gibson No. 4, No. 6, and No. 7 coal beds, Crevasse Canyon Gibson coal zone, and the Menefee Cleary-Crevasse Canyon Gibson coal zone. Although the Gibson Coal Member is not differentiated from the overlying Cleary Coal Member in this area, many of the beds are still referred to as Gibson Coal Member beds or zones because they are correlative with beds which occur in the separate Gibson Coal Member east of the Big Rock Hill quadrangle. Those beds which occur above the highest correlative Gibson Coal Member bed are referred to as Menefee Cleary-Crevasse Canyon Gibson undifferentiated coals.

The Crevasse Canyon Dilco No. 2 bed is stratigraphically the lowest identified coal bed in the quadrangle, and occurs from 40 to 60 ft (12 to 18 m) above the Gallup Sandstone. The Crevasse Canyon Dilco No. 2A, No. 3, and No. 4 beds are approximately 70 to 90 ft (21 to 27 m), 130 to 150 ft (40 to 46 m), and 170 to 190 ft (52 to 58 m) above the Gallup Sandstone, respectively. These beds are inferred to be continuous, although they may be several individual beds that are stratigraphically equivalent.

The Crevasse Canyon Gibson No. 4 coal bed occurs from 15 to 35 ft (5 to 11 m) above the Bartlett Barren Member in this area, while the Crevasse Canyon Gibson No. 6 and No. 7 beds are approximately 130 to 150 ft (40 to 46 m) and 185 to 205 ft (56 to 62 m), respectively, above the top of the Bartlett Barren Member. Up to thirteen beds which occur from 40 to 240 ft (12 to 73 m) above the Bartlett Barren Member comprise the Crevasse Canyon Gibson coal zone. These zone coals, as with all zone coals in this quadrangle, may be correlated for limited distances in portions of the area but they lack sufficient continuity with poorly defined stratigraphic position and cannot be designated as persistent coal beds. The Menefee Cleary-Crevasse Canyon Gibson undifferentiated coal zone contains two beds which are approximately 260 to 280 ft (79 to 85 m) above the Bartlett Barren Member.

There is a published coal quality analysis of Gibson Coal Member beds within the Big Rock Hill quadrangle, This analysis was derived from coals from the abandoned Tohatchi Indian School mine (sample 1, table 1) reported by the U. S. Bureau of Mines (1936). Two additional Gibson Coal Member samples taken from the Navajo No. 2 mine (Gibson No. 5 bed of Sears, 1925; sample 2) and Heaton mine (Gibson No. 2 or Aztec (?) bed of Sears, 1925; sample 3), 3.6 mi (5.8 km) and 3.2 mi (5.1 km), respectively, south of the quadrangle have been reported by the U. S. Bureau of Mines (1936) and are shown in table 1. Rank of the Gibson Coal Memeber beds is probably high volatile C bituminous in this area.

There are no published coal quality analyses for Dilco Coal Member beds from the Big Rock Hill quadrangle. Analyses of Dilco Coal Member beds from the abandoned Otero mine (Thatcher bed of Sears, 1925; sample 1), Gallup Southwestern mine (Black Diamond bed of Sears, 1925; sample 2), and Caretto mine (Otero bed of Sears, 1925; sample 3) have been reported by the U. S. Bureau of Mines (1936) and are shown in table 2. The Dilco Coal Member beds analyzed are probably similar in quality to the Dilco Coal Member beds in this quadrangle. Rank of the Dilco Coal Member beds is probably high volatile C bituminous in this area.

Crevasse Canyon Gibson coal zone

The Crevasse Canyon Gibson coal zone was identified at twelve outcrop measurements and contains up to 16.5 ft (5.0 m) of coal. This thickness occurs on the Navajo Indian Reservation, however, and the maximum thickness shown on the isopach map (plate 4) is between 10 and 15 ft (3 and 5 m). Existence and character of the zone are unknown in the southwest corner of the quadrangle because of insufficient data.

Table 1. - Analyses of coal samples from the Gibson Coal Member of the Crevasse Canyon Formation.

[Form of analysis: A, as received; B, moisture free; C, moisture and ash free]

from U. S. Bureau of Mines, 1936

Sample	Type of Sample	Location			Form of analysis	Proximate analysis (percent)				Sulfur	Heating value (Btu/lb)
		Sec.	T. N.	R. W.		Mois-ture	Volatile matter	Fixed carbon	Ash		
	mine sample	NW¼			A	11.3	35.6	42.6	10.5	0.7	10,830
1	(Tohatchi Indian	22	17	17	B	----	40.2	48.0	11.8	0.7	12,220
	School mine)	(projected)			C	----	45.6	54.4	----	0.8	13,850
	mine sample	SW¼ SE¼			A	13.2	37.7	41.2	7.9	0.5	10,920
2	(composite of	33	16	18	B	----	43.5	47.3	9.2	0.6	12,580
	Navajo No. 2 mine)				C	----	47.9	52.1	----	0.6	13,850
	mine sample	NW¼			A	15.3	38.2	42.0	4.5	0.4	11,070
3	(Heaton mine)	35	16	18	B	----	45.1	49.6	5.3	0.5	13,060
					C	----	47.6	52.4	----	0.5	13,790

Remarks:

A moist, mineral-matter-free (MMMF) calculation, using the Parr Formula (American Society for Testing and Materials, 1973), yields heating values of 12,229 Btu/lb (28,445 kJ/kg; sample 1), 11,947 Btu/lb (27,789 kJ/kg; sample 2), and 11,641 Btu/lb (27,077 kJ/kg; sample 3). No agglomerating characteristics were included with the analyses.

Table 2. - Analyses of coal samples from the Dilco Coal Member of the Crevasse Canyon Formation.

[Form of analysis: A, as received; B, moisture free; C, moisture and ash free]

from U. S. Bureau of Mines, 1936

Sample	Type of Sample	Location Sec.	Location T. N.	Location R. W.	Form of analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
	mine sample	NW¼			A	9.7	41.4	40.8	8.1	1.55	11,620
1	(Otero mine)	14	15	18	B	----	45.9	45.2	8.9	1.72	12,870
					C	----	50.4	49.6	---	1.88	14,130
	mine sample	SE¼			A	11.4	39.9	42.2	6.5	0.75	11,640
2	(Gallup Southwestern	21	15	18	B	----	45.0	47.7	7.3	0.85	13,140
	mine)				C	----	48.5	51.5	---	0.92	14,180
	mine sample	SW¼			A	10.6	40.6	44.4	4.40	0.59	12,100
3	(Caretto mine)	14	15	18	B	----	45.4	49.7	4.92	0.66	13,530
					C	----	47.7	52.3	----	0.69	14,230

Remarks:

A moist, mineral-matter-free (MMMF) calculation, using the Parr Formula (American Society for Testing and Materials, 1973) yields heating values of 12,768 Btu/lb (29,698 kJ/kg; sample 1), 12,534 Btu/lb (29,154 kJ/kg; sample 2), and 12,716 Btu/lb (29,577 kJ/kg; sample 3). No agglomerating characteristics are available for these analyses.

Crevasse Canyon Dilco No. 2 coal bed

The Crevasse Canyon Dilco No. 2 coal bed was identified in four outcrop measurements by Sears (1934) in the southeastern part of the Big Rock Hill quadrangle. Thickness of the bed ranges from 1.4 to 3.5 ft (0.4 to 1.1 m). Existence and character of the Crevasse Canyon Dilco No. 2 coal bed are unknown in most of the quadrangle because of insufficient data. Because of the limited areal extent of the bed, the isopach, structure contour, and overburden isopach maps are included in this text as page-sized maps (figs. 3, 4, and 5).

The author's Crevasse Canyon Dilco No. 2 bed has locally been called the Dilco "C" bed (Sears, 1925). The Dilco "C" bed was prospected and mined for local use east of Gallup and south of the Puerco River during the early 1900's.

COAL RESOURCES

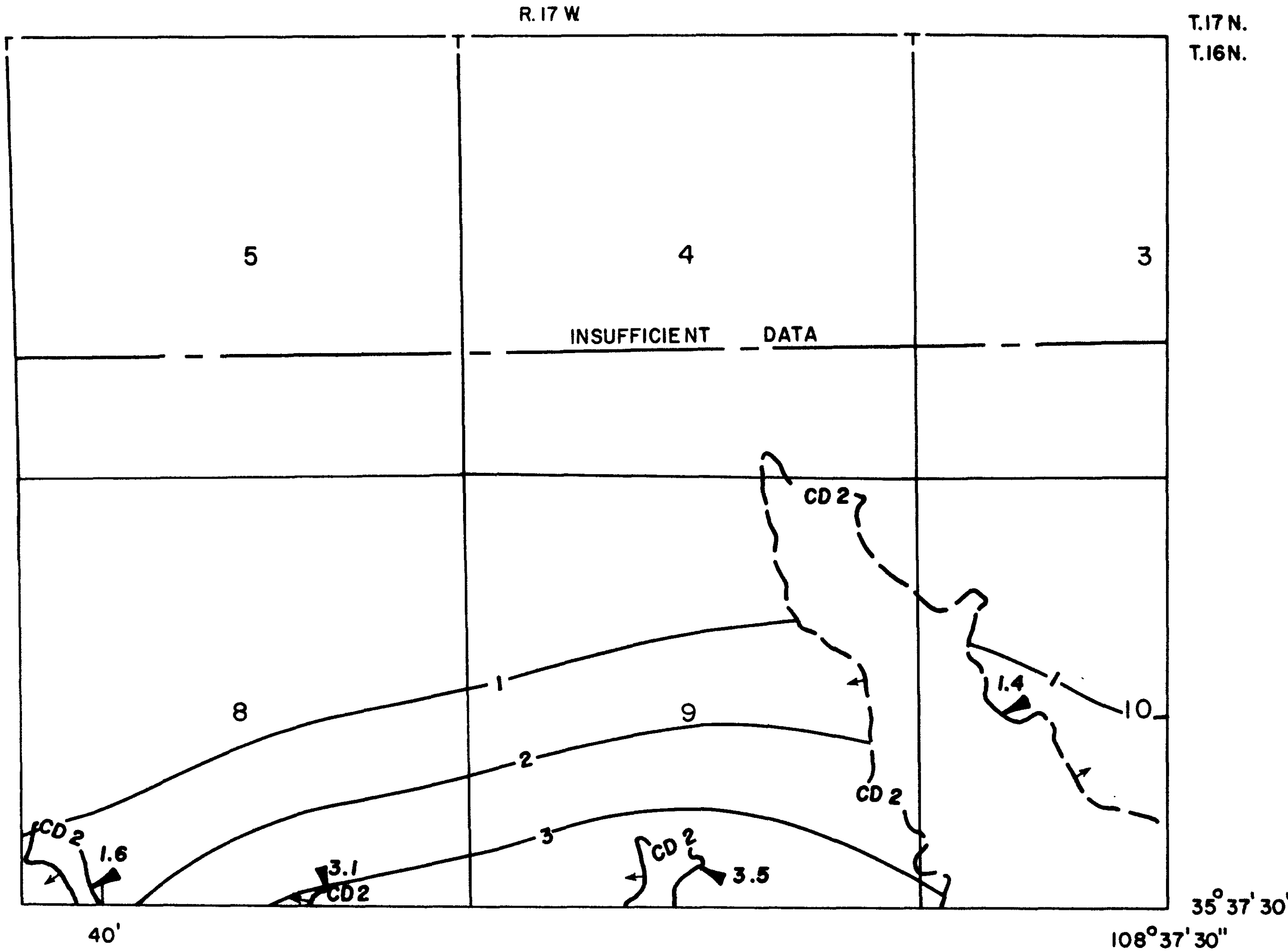
The U. S. Geological Survey requested a resource evaluation of the Crevasse Canyon Dilco No. 2 coal bed, where the bed is 3.0 ft (0.9 m) or more thick. The evaluation is restricted to Federal coal lands.

The following procedures were prescribed by the U. S. Geological Survey for the calculation of reserve base. Criteria established in U. S. Geological Survey Bulletin 1450-B were used to areally divide the beds into measured, indicated, and inferred reserve base categories. Reserve base was calculated for each category, by section, using data from the isopach and overburden maps (figures 3 and 5). The acreage in each category (measured by

Figure 3

ISOPACH MAP OF THE CREVASSE CANYON DILCO NO. 2 COAL BED

(See explanation p. 19)



SCALE 1:24,000

Figure 4

STRUCTURE CONTOUR MAP OF THE
CREVASSE CANYON DILCO NO.2 COAL BED

(See explanation p. 19)

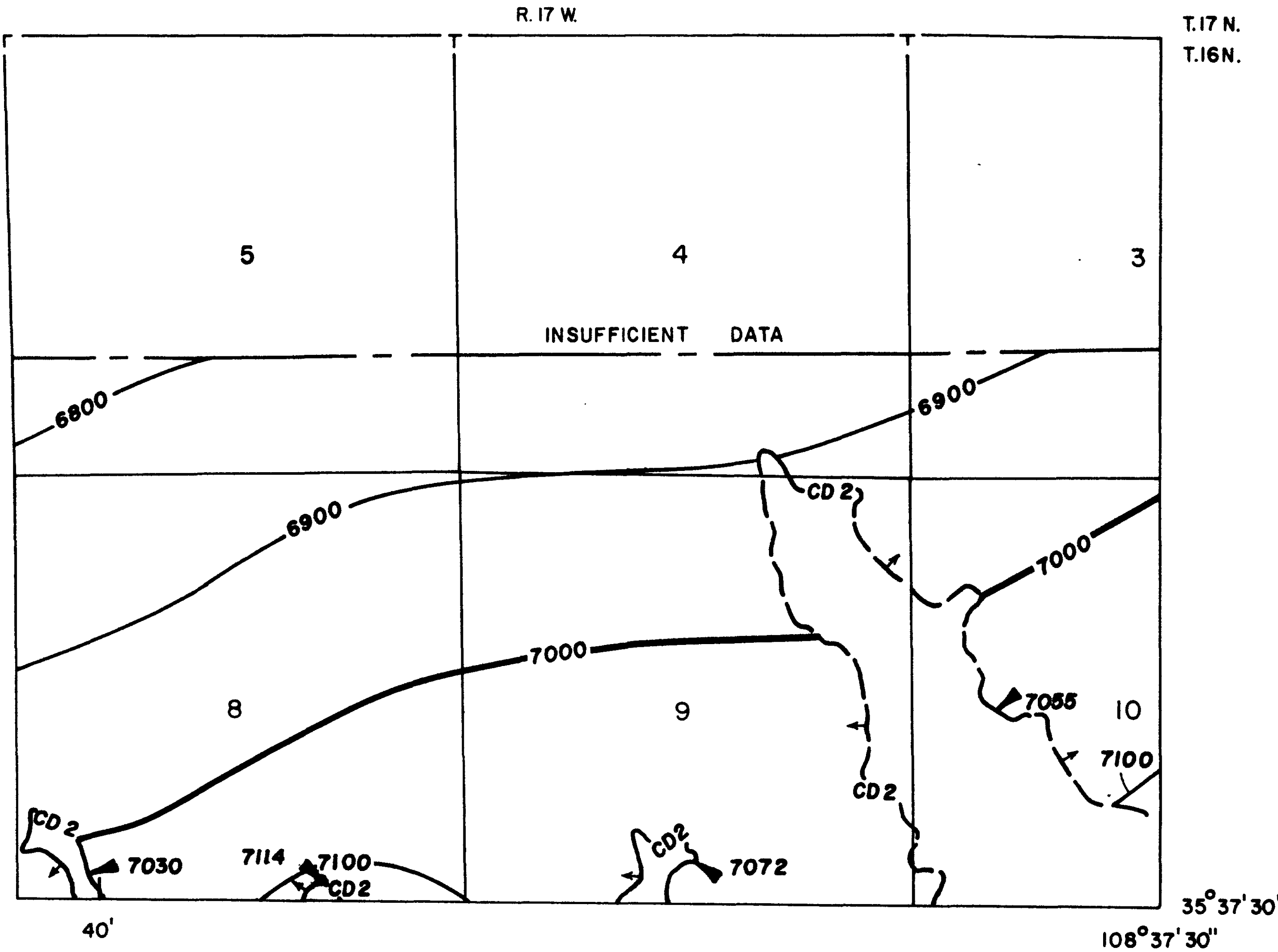


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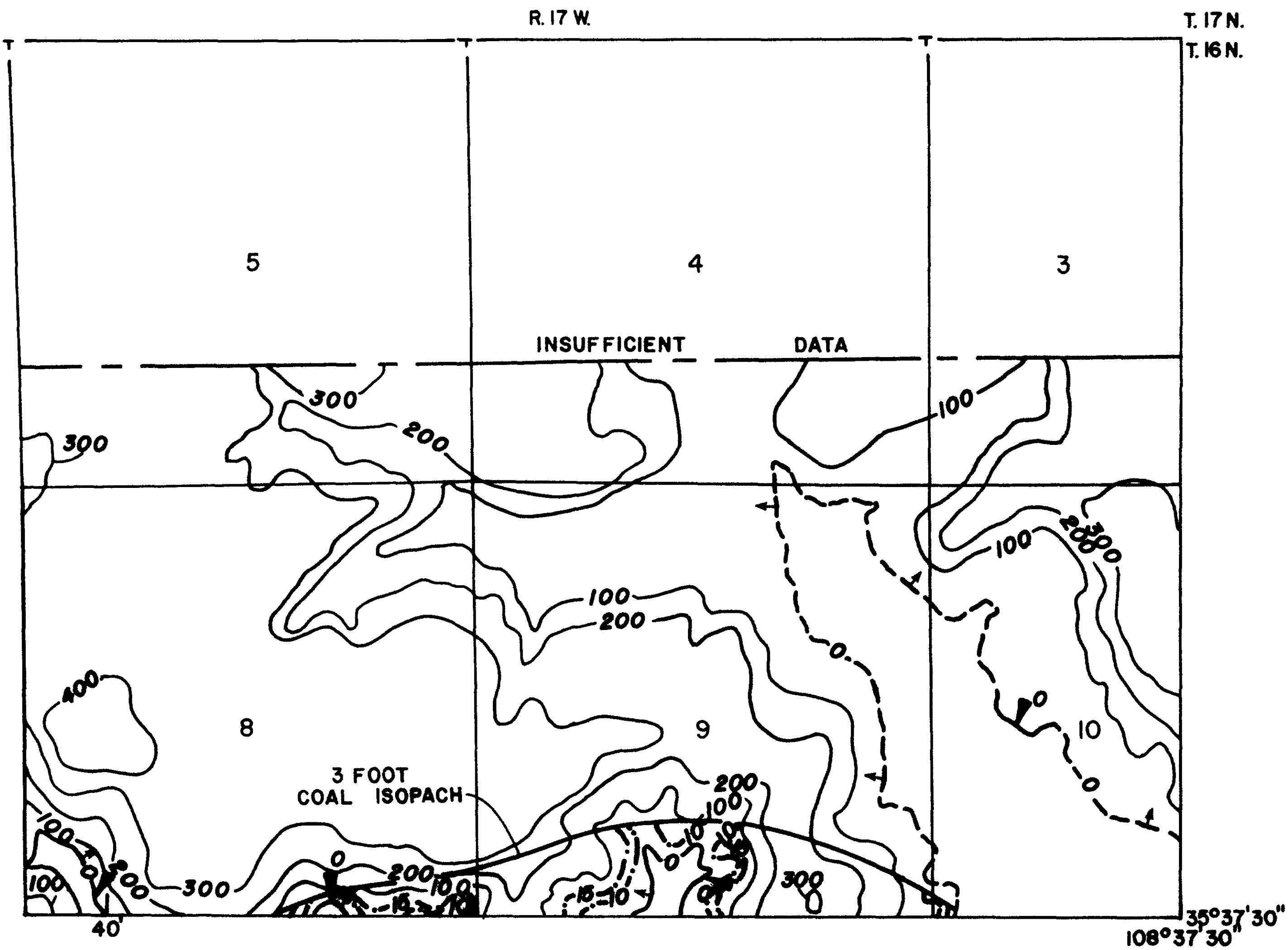
Figure 5

ISOPACH MAP OF OVERBURDEN OF THE CREVASSE CANYON DILCO NO. 2 COAL BED

(See explanation p. 20)



SCALE 1:24,000

Figure 3

EXPLANATION

3

ISOPACHS OF THE CREVASSE CANYON DILCO NO. 2 COAL BED-Showing thickness in feet. Isopach interval 1 foot (0.3 meter). Isopachs dashed where inferred.

3.5 CD 2

TRACE OF COAL BED OUTCROP-Showing coal thickness, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicated inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 4

EXPLANATION

7100

STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Dilco No. 2 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level. Contours dashed where inferred.

7072 CD 2

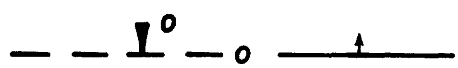
TRACE OF COAL BED OUTCROP-Showing altitude, in feet, measured at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

To convert feet to meters, multiply feet by 0.3048.

Figure 5

EXPLANATION

OVERBURDEN ISOPACHS-Showing thickness of overburden, in feet, from the surface to the top of the Crevasse Canyon Dilco No. 2 coal bed (refer to fig. 4). Isopach interval 100 feet (30.5 meters). Isopachs dashed where inferred. Stripping limit is 200 feet (61 meters).



TRACE OF COAL BED OUTCROP-Showing no overburden at triangle. Arrow points toward the coal-bearing area. Dashed line indicates inferred outcrop.

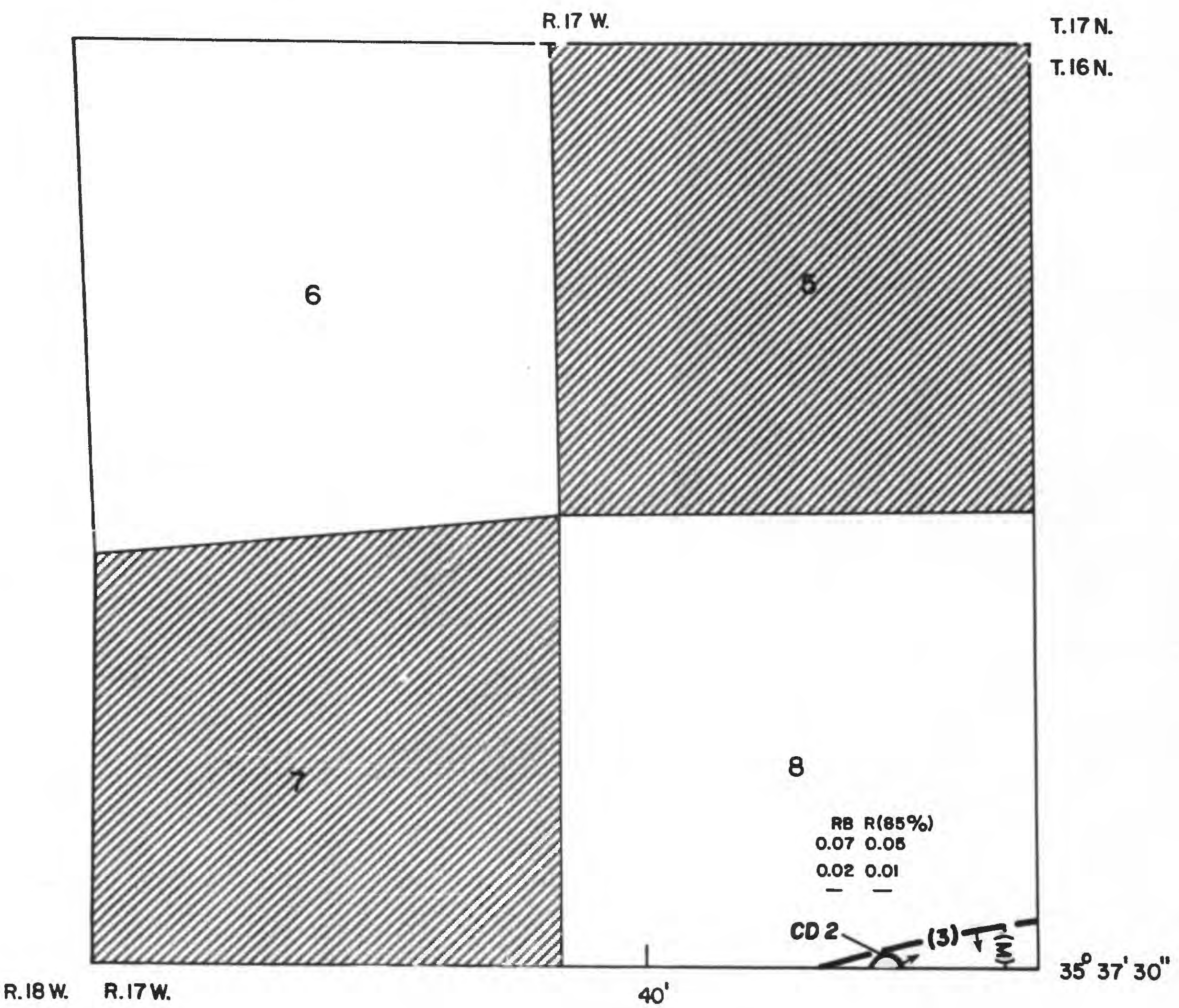
MINING RATIO CONTOUR FOR THE CREVASSE CANYON DILCO NO. 2 COAL BED-Number indicates cubic yards of overburden per ton of recoverable coal by surface-mining methods. Contours shown only in areas suitable for surface mining within the stripping limit, less than 200 feet (61 meters) of overburden.

To convert feet to meters, multiply feet by 0.3048.

Figure 6

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON DILCO NO. 2 COAL BED

(See explanation p. 22)



SCALE 1:24,000

Figure 6

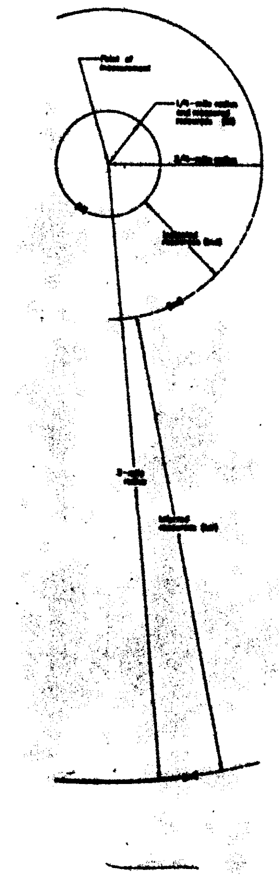
EXPLANATION

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

BOUNDARY OF IDENTIFIED RESERVE BASE COAL-Drawn along the coal outcrop (CD2) and the 3 foot (0.9 meter) coal isopach (3). Arrow points toward area of identified Reserve Base coal.

RB	R(85%)	
0.07	0.06	(Measured resources)
0.02	0.01	(Indicated resources)
—	—	(Inferred resources)

IDENTIFIED COAL RESOURCES-Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section of Federal coal land within the stripping limit line. Dash indicates no resources within that category. Reserve Base (RB) x the Recovery Factor (85 percent) = Reserves (R).



BOUNDARY LINES-Enclosed areas of measured (M), indicated (Ind) and inferred (Inf) coal resources. Diagram not to scale.

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

To convert miles to kilometers, multiply miles by 1.609.

NOTE: BLM coal ownership data current as of Oct. 26, 1978.

NOTE: This plate does not show the areal distribution or quantity of subeconomic resources present in this quadrangle.

planimeter) multiplied by the average coal bed thickness and a bituminous coal conversion factor (1,800 tons of coal per acre-ft) yields the reserve base for that category. Coal beds with 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B. Reserve figures are derived from reserve base totals by applying a recovery factor of 85 percent for coal beds 0 to 200 ft (0 to 61 m) deep. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Total reserve base data, which include all reserve base categories, are shown by section on plate 2. Reserve base and reserve data in the various categories are shown in fig. 6.

The U. S. Geological Survey also requested a resource evaluation of the Crevasse Canyon Gibson coal zone, where the total coal thickness is 5.0 ft (1.5 m) or greater. Total identified Crevasse Canyon Gibson coal zone resources are 5.28 million short tons (4.79 million t) in the Big Rock Hill quadrangle.

COAL DEVELOPMENT POTENTIAL

The factors used to determine the development potential are the presence of a potentially coal-bearing formation, and the thickness and overburden of correlative coal beds. The U. S. Geological Survey supplied the criteria to evaluate the coal development potential for Federal lands in this quadrangle. These criteria are based on current industry practice, U. S. Geological Survey Bulletin 1450-B, and anticipated technological advances.

All available data were utilized for the surface and subsurface coal development potential evaluations.

Any area underlain by a potentially coal-bearing formation with 200 ft (61 m) or less of overburden has potential for surface mining. The U. S. Geological Survey designated the 200 ft (61 m) maximum depth as the stripping limit. Areas where a potentially coal-bearing formation is overlain by more than 200 ft (61 m) of overburden have no potential for surface mining. Areas with no correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) in thickness and overlain by 200 ft (61 m) or less of overburden have unknown surface mining potential. Areas which have a correlative coal bed 3.0 ft (0.9 m) or more thick with surface mining potential are assigned a high, moderate or low development potential based on the mining ratio (cubic yards of overburden per short ton of recoverable coal). The formula used to calculate mining ratios is:

$$MR = \frac{t_o\ (C)}{t_c\ (Rf)}$$

Where MR = Mining ratio

t_o = Thickness of overburden in feet

t_c = Thickness of coal in feet

Rf = Recovery factor

C = Volume-weight conversion factor

(.896 yd^3/short ton for bituminous coal)

(.911 yd^3/short ton for subbituminous coal)

High, moderate, and low development potential areas have respective surface mining ratio values of 0 to 10, 10 to 15, and greater than 15.

Any area underlain by a potentially coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining. Areas where a potentially coal-bearing formation is overlain by more than 3,000 ft (914 m) of overburden have no subsurface mining potential. Development potential for subsurface mining is unknown where a potentially coal-bearing formation within 200 to 3,000 ft (61 to 914 m) of the surface contains no identified correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) thick.

The no and unknown development potential boundaries for surface mining methods (plate 7) are defined at the contacts of the coal-bearing Dilco Coal Member of the Crevasse Canyon Formation and Bartlett Barren Member of the Crevasse Canyon Formation with the intervening noncoal-bearing Dalton Sandstone Member. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Boundaries of coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acres or lot). When a land subdivision contains areas with different development potentials, the potential shown on the map is that of the areally largest component area. When an area is underlain by more than one bed, the potential shown on the map is that of the bed with the highest potential.

Reserve base (in short tons) in the various development potential categories for surface mining methods are shown in table 3.

The coal development potential map is subject to revision. Map boundary lines and reserve base values are based on coal resource occurrence map isopachs, overburden isopachs, and coal bed correlations that are interpretive and subject to change as additional coal information becomes available.

Development potential for surface mining methods

The coal development potential for surface mining methods in the Big Rock Hill quadrangle is shown on plate 7. Based on coal development criteria, all Federal coal lands have high, moderate, low, unknown or no surface mining potentials. The areas of high, moderate, and low potential are not shown on plate 7, however, because they occupy less than half of any 40 acre lot in which they occur. Refer to table 4 for reserves and planimetered acreage, by section, for Federal coal lands with surface mining potential.

Development potential for subsurface mining methods and in situ gasification

The coal development potential for subsurface mining methods was not mapped in the Big Rock Hill quadrangle because based on coal development potential criteria, all Federal coal land in the quadrangle has unknown development potential for subsurface mining methods. The Dilco Coal Member and Crevasse Canyon Gibson-Menefee Cleary undifferentiated unit underlie or are exposed at the surface over most of the quadrangle. These coal-bearing units contribute to the unknown development potential in the Big Rock Hill quadrangle.

In situ gasification of coal has not been done on a commercial scale in the United States and criteria for rating the development potential of this method are unknown.

Table 3. - Reserve base data (in short tons) for surface mining methods for Federal coal lands in the Big Rock Hill quadrangle, McKinley County, New Mexico.

[Development potentials are based on mining ratios (cubic yards of overburden/ton of underlying coal). To convert short tons to metric tonnes, multiply by 0.9072; to convert mining ratios in yds^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 (greater than 15 Mining Ratio)	Total
Crevasse Canyon Dilco No. 2	30,000	30,000	50,000	110,000
Total	30,000	30,000	50,000	110,000

Table 4. - Reserves and planimetered acreage, by section, for Federal coal lands in the Big Rock Hill quadrangle with surface mining potential.

[To convert acres to hectares, divide acres by 2.471; To convert short tons to metric tonnes (t), multiply short tons by 0.9072].

Potential Category	Coal bed	Sec.	T. N.	R. W.	Total Acres (planimetered)	Reserves (in short tons)
High	Crevasse Canyon Dilco No. 2	8	16	7	2.7	10,000
Moderate	Crevasse Canyon Dilco No. 2	8	16	7	5.3	10,000
Low	Crevasse Canyon Dilco No. 2	8	16	7	8.0	30,000

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GLOSSARY

coal bed--A stratified sequence of coal, composed of relatively homogeneous material, exhibiting some degree of lithologic unity and separated from the rocks above and below by physically rather well defined boundary planes.

coal bed separation line--A line on a map plate separating areas where different coal beds or zones are mapped.

coal bench--One of two or more divisions of a coal bed separated by rock.

coal conversion factor--A factor used to convert acre-feet of coal into short tons of coal; bituminous coal is 1800 tons/acre-ft; subbituminous coal is 1770 tons/acre-ft.

coal development potential--A subjective determination of the comparative potential of Federal coal lands for development of a commercially viable coal mining operation.

coal exploration license--An area of Federal coal lands in which the licensee is granted the right, after outlining the area and the probable methods of exploration, to investigate the coal resources. An exploration license has a term not to exceed 2 years and does not confer rights to a lease.

coal lease--An area of Federal coal lands in which the Federal Government has entered into a contractual agreement for development of the coal deposits.

coal split--A coal bed resulting from the occurrence of a noncoal parting within the parent coal bed which divides the single coal bed into two or more coal beds.

coal zone--A distinctive stratigraphic interval containing a sequence of alternating coal and noncoal layers in which the coal beds may so lack lateral persistence that correlating individual beds in the zone is not feasible.

Federal coal land--Land for which the Federal Government holds title to the coal mineral rights, without regard to surface ownership.

hypothetical resources--Undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, hypothetical resources are in broad areas of coal fields where points of observation are absent and evidence is from distant outcrops, drill holes or wells. Exploration that confirms their presence and reveals quantity and quality will permit their reclassification as a Reserve or Identified Subeconomic Resource.

identified resources--Specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

indicated--Coal for which estimates for the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

inferred--Coal in unexplored extensions of demonstrated resources for which estimates of the quality and quantity are based on geologic evidence and projections.

isopach--A line joining points of equal bed thickness.

Known Recoverable Coal Resource Area (KRCRA)--Formerly called Known Coal Leasing Area (KCLA). Area in which the Federal coal land is classified (1) as subject to the coal leasing provisions of the Mineral Leasing Act of 1920, as amended, and (2) by virtue of the available data being sufficient to permit evaluation as to extent, location, and potential for developing commercial quantities of coal.

measured--Coal for which estimates for rank, quality, and quantity can be computed, within a margin of error of less than 20 percent, from sample analyses and measurements from closely spaced and geologically well known sample sites.

mining ratio--A numerical ratio equating the in-place volumes, in cubic yards, of rocks that must be removed in order to recover 1 short ton of coal by surface mining.

overburden--A stratigraphic interval (composed of noncoal beds and coal beds) lying between the ground surface and the top of a coal bed. For coal zones, overburden is the stratigraphic interval lying between the ground surface and the structural datum used to map the zone.

parting--A noncoal layer occurring along a bedding plane within a coal bed.

Preference Right Lease Application (PRLA)--An area of Federal coal lands for which an application for a noncompetitive coal lease has been made as a result of exploration done under a coal prospecting permit. PRLA's are no longer obtainable.

quality or grade--Refers to measurements such as heat value; fixed carbon; moisture; ash; sulfur; phosphorus; major, minor, and trace elements; coking properties; petrologic properties; and particular organic constituents.

rank--The classification of coal relative to other coals, according to degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (Classification of coals by rank, 1973, American Society for Testing and Materials, ASTM Designation D-388-66).

recovery factor--The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the Reserve Base in the ground.

reserve--That part of identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base.

reserve base--That part of identified coal resource from which Reserves are calculated.

stripping limit--A vertical depth, in feet, measured from the surface, reflecting the probable maximum, practical depth to which surface mining may be technologically feasible in the forseeable future. The rock interval, expressed in feet, above the stripping limit is the "strippable interval."

structure contour--A line joining points of equal elevation on a stratum or bed.
