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 TWIN LAKES 7 1/2-MINUTE QUADRANGLE, McKINLEY COUNTY, NEW MEXICO

[Report includes 4 plates]

Prepared by Berge Exploration, Inc.

This report was prepared under contract to the U.S. Geological Survey, and has not been edited for conformity with Geological Survey editorial standards or stratigraphic nomenclature. Opinions expressed herein do not necessarily represent those of the Geological Survey.

TWIN LAKES QUADRANGLE
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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Twin Lakes 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 Published and unpublished public information was used as the data base for this study.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.

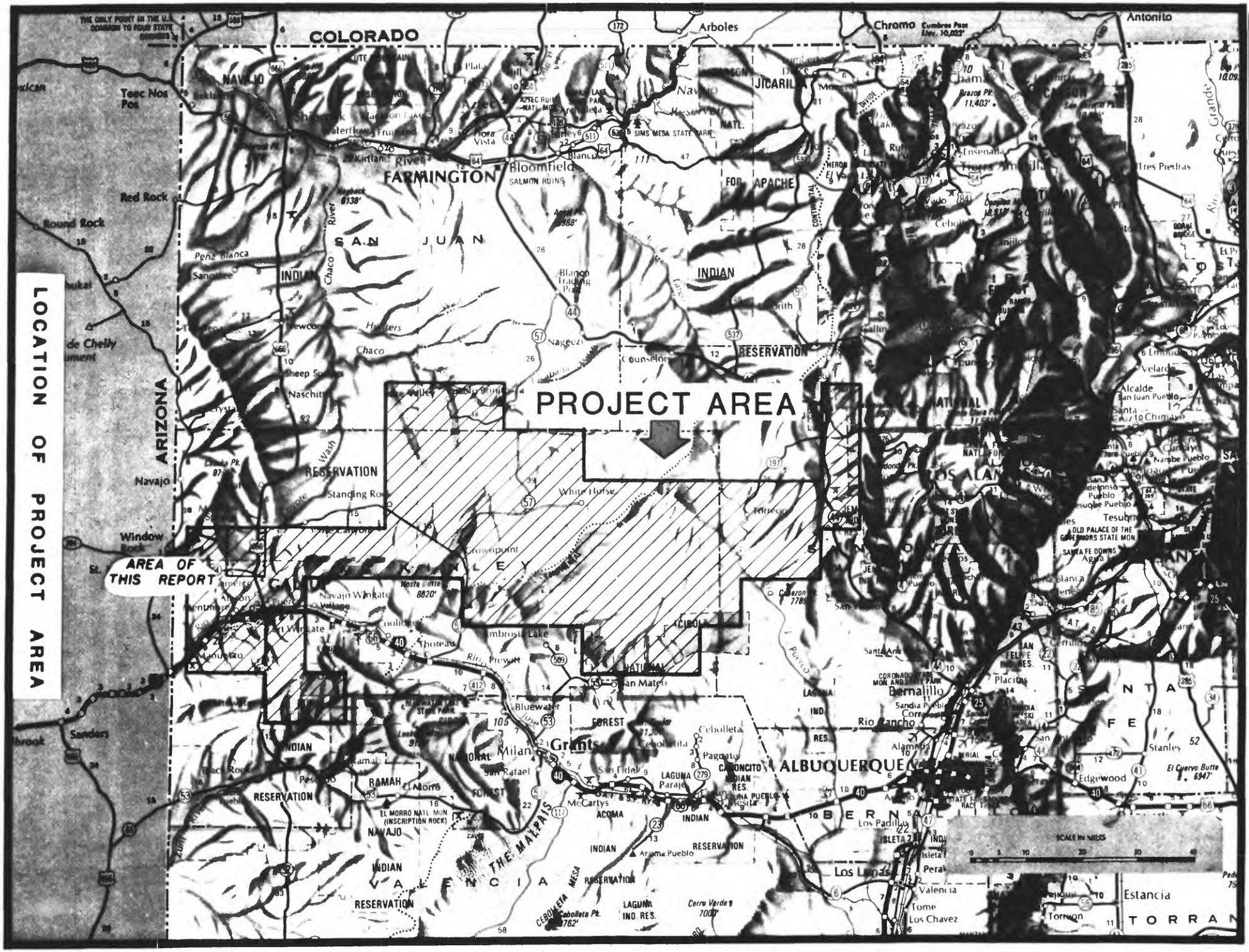
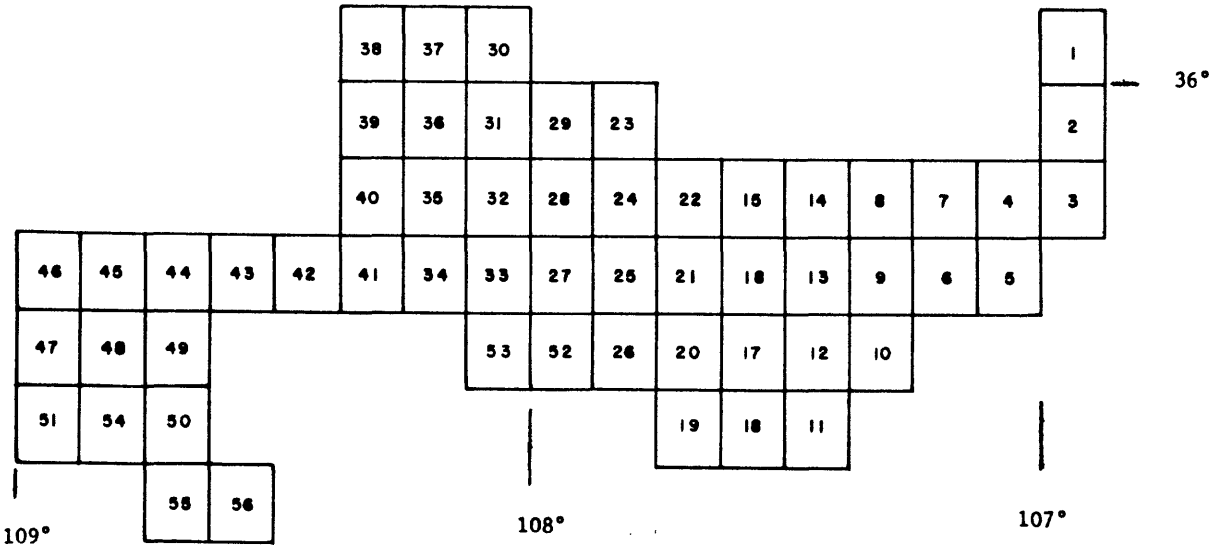


FIGURE 1
LOCATION OF PROJECT AREA

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

Map No.	Quadrangle	Open-file report
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 Twin Lakes 7½ minute quadrangle includes acreage in Tps. 16, 17, and 18 N., Rs. 18 and 19 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2). The towns of Twin Lakes and Yah-ta-hey are located within the quadrangle.

Accessibility

U. S. Highway 666 passes through the eastern part of the quadrangle and provides access to the city of Gallup, 9 mi (13 km) SE of the quadrangle. State Highway 68 intersects Highway 666 in the southern part of the quadrangle and provides access to the town of Window Rock, Arizona, 12 mi (19 km) west of the quadrangle. Unimproved dirt roads traverse most parts of the area. The Atchison, Topeka, and Santa Fe Railroad line passes through Gallup (see fig. 1).

Physiography

The Twin Lakes quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The topography of the quadrangle is characterized by flat lands in the northeast, and rugged badlands in the remainder of the area.

No perennial streams are present in the quadrangle. Local drainage is provided by intermittent arroyos which include Burned Death Wash, Black Ridge Wash, and Deer Springs Wash. Elevations within the quadrangle range

from less than 6,220 ft (1,896 m) in the northeast to over 7,240 ft (2,207 m) along the western edge of the quadrangle.

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 Twin Lakes quadrangle is about 7 mi (11 km) NW 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 thunderstorsm. Mean annual temperature for seven of the previous fifteen years is 48.8 F (9.3^{o} C). The average daily temperatures in January and July are 29.0^{o} F (-1.7^{o} C) and 71.3^{o} F (21.8^{o} C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 12 percent of the Twin Lakes 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. All of the quadrangle south of the Navajo Indian Reservation boundary is within the Gallup Known Recoverable Coal Resource Area. Coal mineral rights to the northern three-fourths of the quadrangle are held by Navajo Indians. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the Twin Lakes quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include reconnaissance mapping by Gardner (1909), who mapped the general surface geology and measured coal outcrops east of the quadrangle. Dobbin (1932) also mapped coals in the area, but did not report any coals within the Twin Lakes quadrangle. Shomaker, Beaumont, and Kottlowski (1971) mention coals within the Menefee Formation, Cleary Coal Member-Crevasse Canyon Formation, Gibson Coal Member undifferentiated unit (here informally called the Cleary-Gibson undifferentiated coal member). They estimated strippable coal reserves for five townships which contains the McKinley mine lease as 250 million short tons (227 million t) in the 10 to 150 ft (3 to 46 m) overburden category and 180 million short tons (163 million t) in the 150 to 250 ft (46 to 76 m) overburden category. Portions of five township area outlined above are within the Twin Lakes quadrangle. Hiss and Marshall (1975) describe the City of Gallup Ray #1 water well which was drilled to determine aquifer potential in the area.

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^{o} W. - S. 60^{o} 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 quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium along drainages in the area.

The Gallup Sandstone is a prominent sandstone marker in most of the San Juan Basin which represents nearshore or littoral deposits that formed during a major regression of the Cretaceous seaways. Pink to gray, fine-to very coarse-grained, massive sandstone, interbedded gray shales, and coal beds comprise the lithologies of the unit, which averages 355 ft (108 m) thick locally. Only the upper 150 ft (46 m) is shown on plate 3.

The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents continental sediments which were deposited 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 is locally divided into upper and lower units by about 50 ft (15 m) of the intervening Dalton Sandstone Member. The upper unit averages 93 ft (28 m) thick and the lower unit averages 100 ft (30 m) thick. The interpretation that the Dalton Sandstone Member splits the Dilco Coal Member into upper and lower units agrees with Sears' (1934) interpretation. Hiss and Marshall (1975) believe that the Dalton Sandstone Member consists of 75 ft (23 m) of fine-to medium-grained quartzarenite above the Dilco Coal Member. The authors have included the "Dalton Sandstone Member" of Hiss and Marshall into the lowermost part of the Bartlett Barren Member of the Crevasse Canyon Formation.

About 305 ft (93 m) of the Bartlett Barren Member overlies the Dilco Coal Member in this area. Yellowish-brown to olive-gray siltstone, light gray shales, white to brown calcareous sandstones, and thin local coal beds comprise

the lithologies of the Bartlett Barren Member which represents flood plain deposits. The Cleary-Gibson undifferentiated coal member overlies the Bartlett Barren Member, and was combined based on similar lithologies and stratigraphic continuity representing essentially continuous continental deposition. Light to medium gray, carbonaceous siltstone with interbedded gray to tan sandstones, gray shales, and coal beds comprise the lithologies of the Cleary-Gibson unit which averages 745 ft (227 m) thick locally.

The Allison Member of the Menefee Formation is separated from the underlying Cleary-Gibson undifferentiated coal member 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 eroded Allison Member is about 260 ft (79 m) in the southern part of the quadrangle, although the unit is probably over 800 ft (244 m) thick in some areas of the Twin Lakes quadrangle.

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 Twin Lakes quadrangle is in the Gallup Sag structural division in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The Nakabito Syncline is present in the eastern part of the quadrangle (Hackman and Olson, 1977). No faults have been mapped by any previous workers in the area. Dips of the rock units range from 1^{o} to

2^{o} NE to SE in the western part of the quadrangle and 1^{o} to 3^{o} E. to W near the eastern quadrangle boundary.

COAL GEOLOGY

In this quadrangle, the authors identified eight coal beds and four coal zones in a water well log. These beds and zones are here informally called the Crevasse Canyon Dilco coal zone, Crevasse Canyon Dilco No. 3, No. 5, and No. 8 coal beds, Crevasse Canyon Gibson No. 4, No. 5, No. 6, No. 7, and No. 8 coal beds, Crevasse Canyon Gibson coal zone, the Menefee Cleary-Crevasse Canyon Gibson undifferentiated coal zone, and the Menefee Allison coal zone.

Stratigraphically, the Crevasse Canyon Dilco coal zone contains the lowest identified coal beds in the Twin Lakes quadrangle. Six coal beds which occur in the lower and upper parts of the Dilco Coal Member contain 23.5 ft (7.2 m) of coal. These coals occur from 40 to 205 ft (12 to 62 m) above the Gallup Sandstone. The Crevasse Canyon Dilco No. 3 coal bed contains 4.5 ft (1.4 m) of coal, and occurs 95 ft (29 m) above the Gallup Sandstone. The Crevasse Canyon Dilco No. 5 and No. 8 coal beds occur 160 and 228 ft (49 and 69 ft), respectively, above the Gallup Sandstone. These coal beds, as with all alpha-numerically designated beds in this quadrangle, are inferred to be continuous, although they may be several individual coal beds that are statigraphically equivalent.

The Crevasse Canyon Gibson No. 4, No. 5, No. 6, No. 7, and No. 8 coal beds occur 13 ft (4 m), 75 ft (23 m), 182 ft (55 m), 234 ft (71 m), and 290 ft (88 m), respectively, above the top of the Bartlett Barren Member. Although

the Gibson Coal Member is not differentiated from the Cleary Coal Member in this area, many of the beds are referred to as Gibson Coal Member beds or coal zones because they are correlative eastward to beds which occur in the same stratigraphic position of the separate Gibson Coal Member. Coal beds which occur above the highest correlative Gibson Coal Member bed (the "CG8", plate 3) are referred to as Menefee Cleary-Crevasse Canyon Gibson coals. The Crevasse Canyon Gibson coal zone contains six coal beds which occur from 30 to 280 ft (9 to 85 m) above the top of the Bartlett Barren Member.

A single 3.0 ft (0.9 m) thick bed which occurs 367 ft (112 m) above the top of the Bartlett Barren Member comprises the Menefee Cleary-Crevasse Canyon Gibson coal zone. The Menefee Allison coal zone contains one bed which occurs about 246 ft (75 m) above the base of the Allison Member.

There are no published coal quality analyses for coal beds from the Twin Lakes quadrangle. Three analyses of mine samples of Gibson Coal Member beds sampled about 3.5 mi (5.6 km) south of the quadrangle have been reported by the U. S. Bureau of Mines (1936) and are shown in table 1. The Gibson Coal Member beds analyzed are probably similar in quality to the Gibson Coal Member beds in this quadrangle. Rank of the Gibson Coal Member beds is probably high volatile C bituminous in this area.

Crevasse Canyon Gibson No. 5 coal bed

The Crevasse Canyon Gibson No. 5 coal bed (the Gibson "No. 5" bed of Sears, 1925) was identified in the water well log as having a thickness of 3.0 ft (0.9 m) of coal. The mine sample from the Navajo No. 2 mine (sample 2, table 1) is from the same bed as the author's Crevasse Canyon Gibson No. 5 bed.

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.		Moisture	Volatile matter	Fixed carbon	Ash		
	Composite mine	SW¼			A	11.9	37.2	43.0	7.9	0.5	11,290
1	Sample	32	16	18	B	----	42.3	48.8	8.9	0.6	12,820
	(unnamed mine)				C	----	46.4	53.6	---	0.7	14,080
	Composite mine	SW¼ SE¼			A	13.2	37.7	41.2	7.9	0.5	10,920
2	Sample	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 12,353 Btu/lb (28,733 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.

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). Based on Crevasse Canyon Gibson No. 5 coal data from the southern adjacent Gallup West quadrangle, the bed was inferred to thicken to 9 ft (3 m) within the Twin Lakes quadrangle (see fig. 3).

COAL RESOURCES

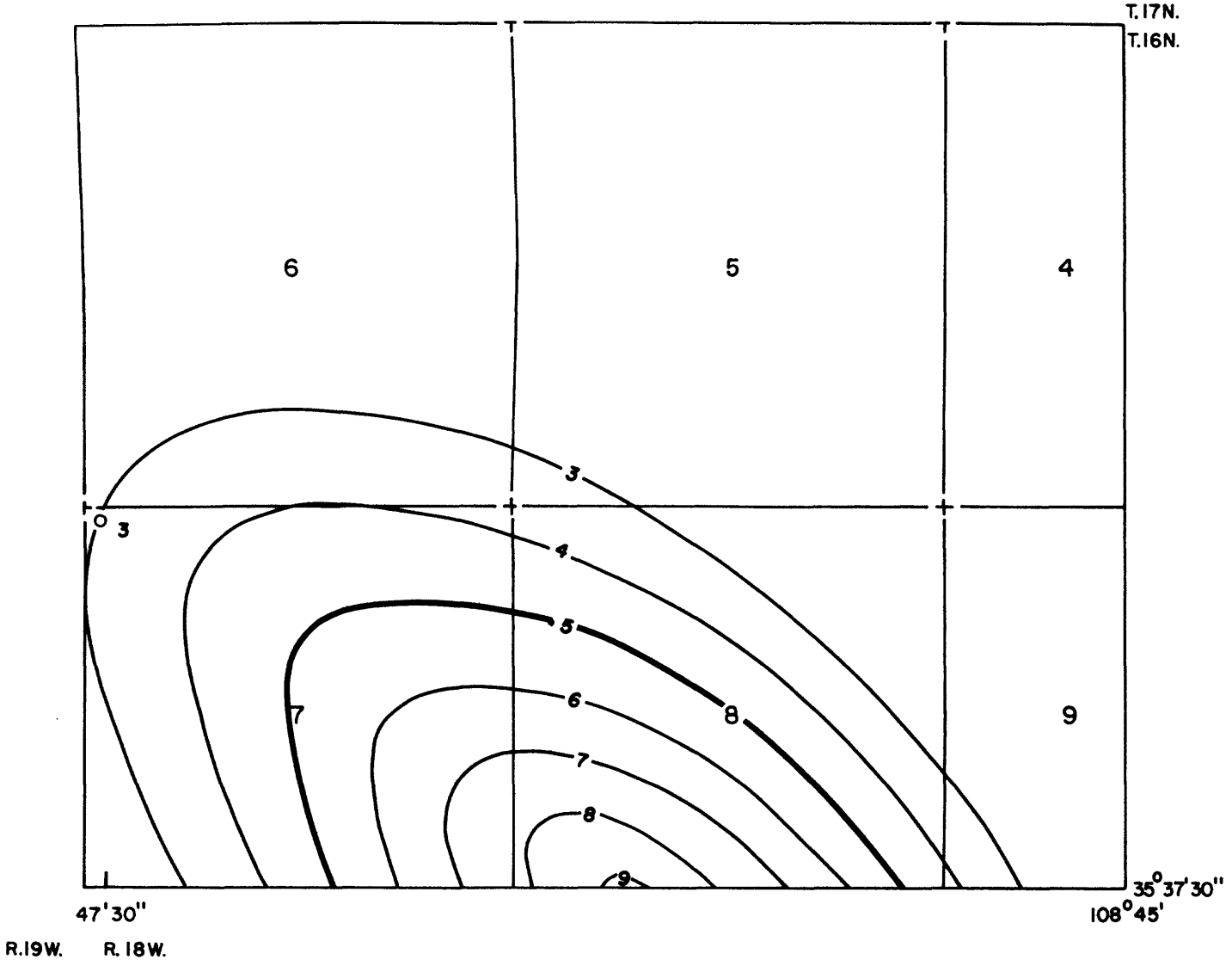
The U. S. Geological Survey requested a resource evaluation of the Crevasse Canyon Gibson No. 5 coal bed, where the bed is 3.0 ft (0.9 m) or more thick. The evaluation is restricted to Federal coal lands.

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 bed 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 (figs. 3 and 5). The acreage in each category (measured by 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 50 percent for coal beds 200 to 3,000 ft (61 to 914 m) deep. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Figure 3

ISOPACH MAP OF THE CREVASSE CANYON GIBSON NO.5 COAL BED

(See explanation p.17)



SCALE 1:24,000

Figure 4

STRUCTURE CONTOUR MAP OF THE CREVASSE CANYON GIBSON NO.5 COAL BED

(See explanation p.17)

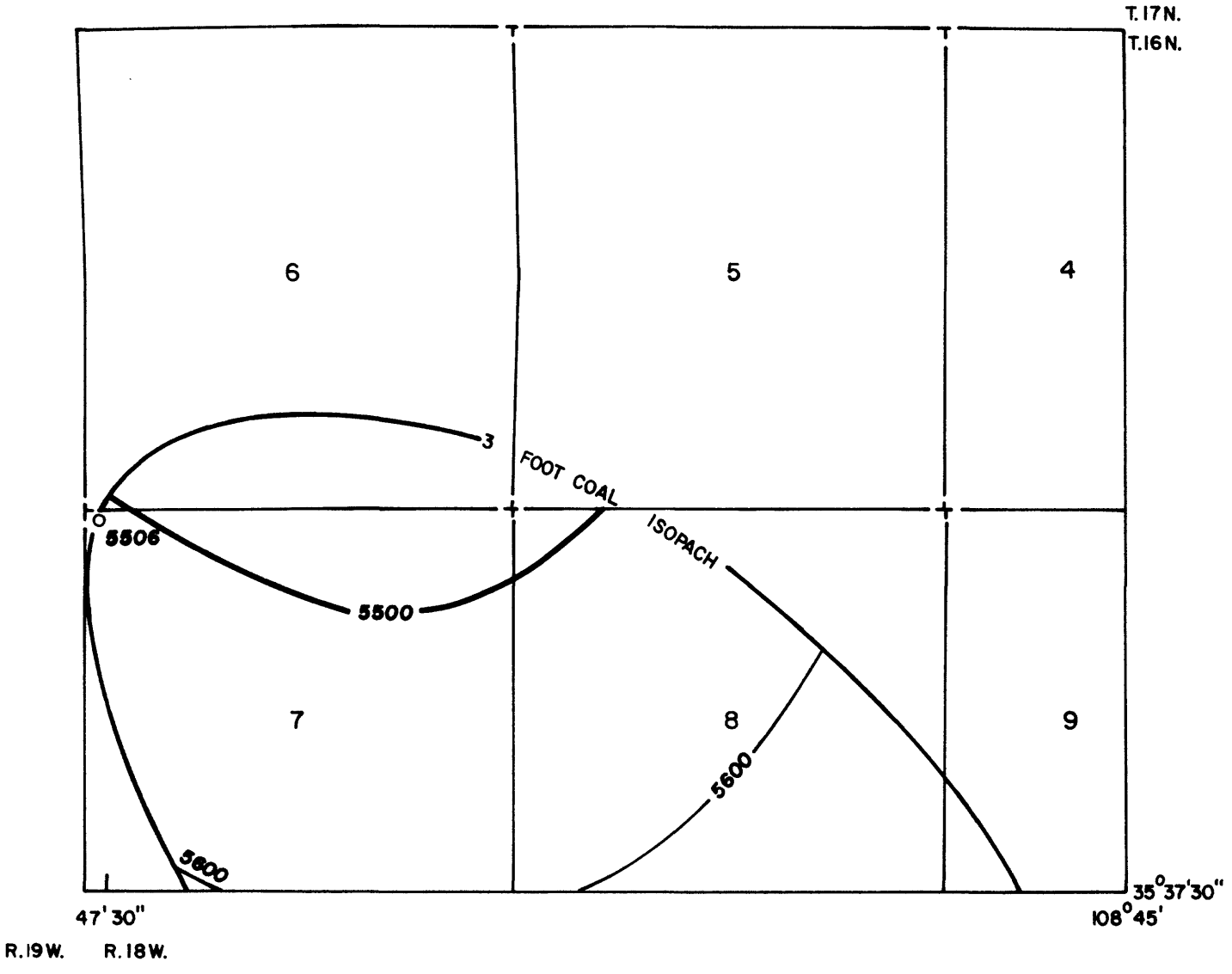


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Figure 5

ISOPACH MAP OF OVERBURDEN OF THE CREVASSE CANYON GIBSON NO.5 COAL BED

(See explanation p. 17)

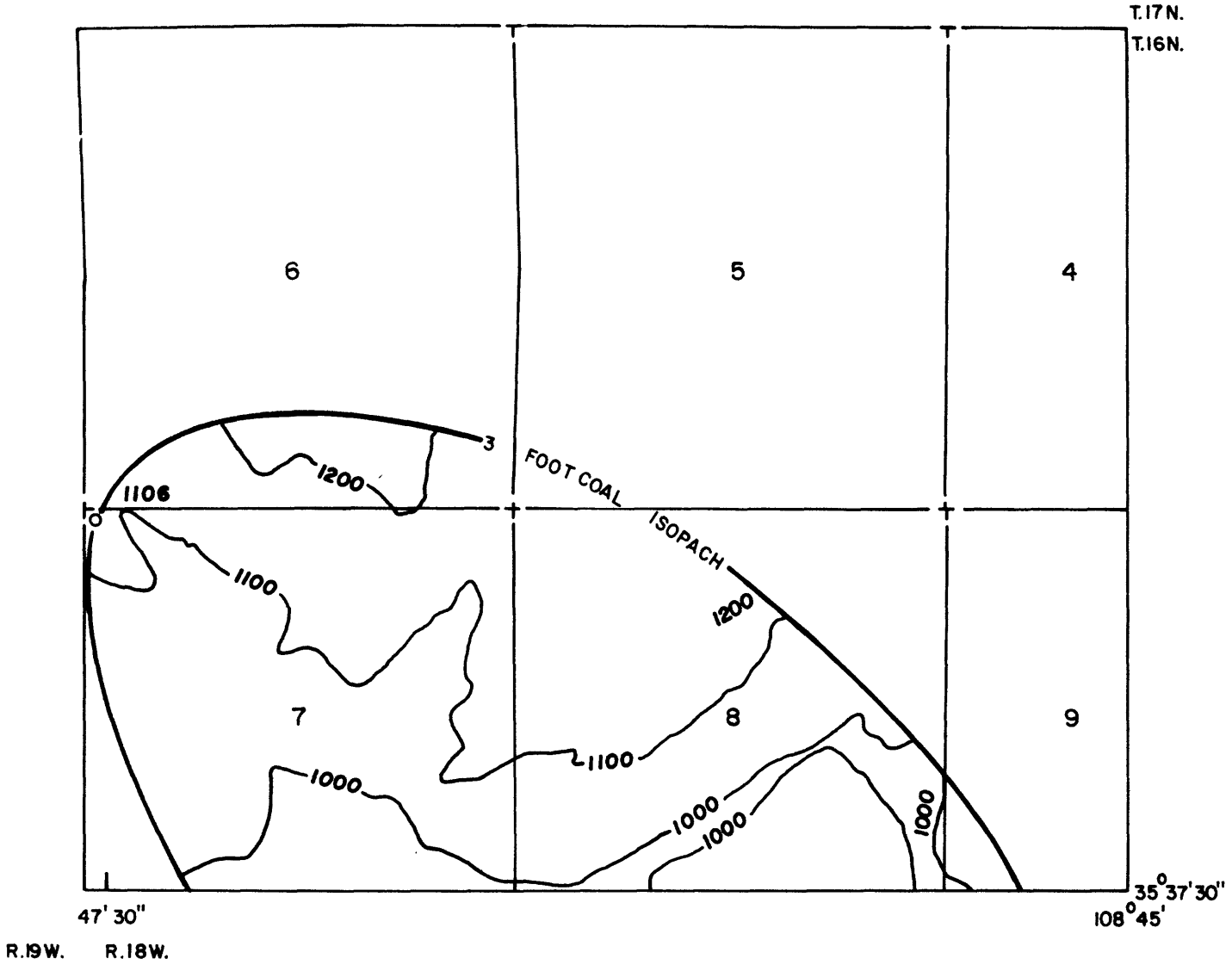

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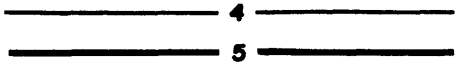
Figure 3

EXPLANATION



ISOPACHS OF THE CREVASSE CANYON GIBSON NO. 5 COAL BED-Showing thickness in feet. Isopach interval 1 foot (0.3 meter).

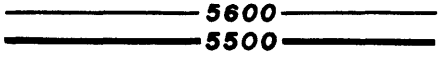
o 3

DRILL HOLE-Showing thickness of the Crevasse Canyon Gibson No. 5 coal bed in feet.

To convert feet to meters, multiply feet by 0.3048.

Figure 4

EXPLANATION



STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Gibson No. 5 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level.

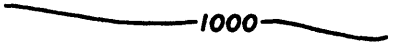
o 5506

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Gibson No. 5 coal bed in feet.

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 Gibson No. 5 coal bed (refer to CRO fig. 4). Isopach interval 100 feet (30.5 meters). Stripping limit is 200 feet (61 meters).

o 1106

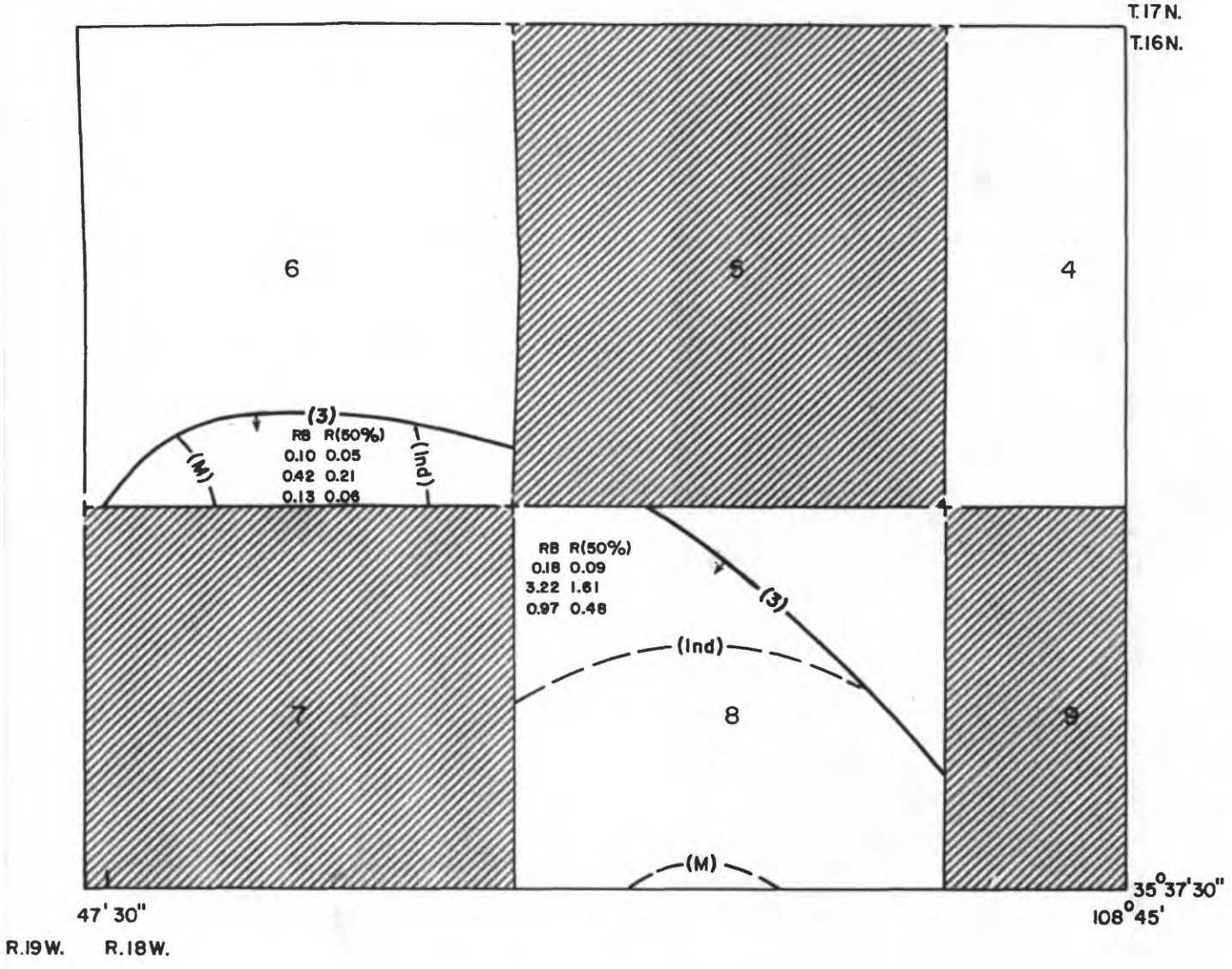
DRILL HOLE-Showing thickness of overburden, in feet, of the Crevasse Canyon Gibson No. 5 coal bed.

To convert feet to meters, multiply feet by 0.3048.

Figure 6

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON GIBSON NO.5 COAL BED

(See explanation p. 19)



SCALE 1:24,000

Figure 6

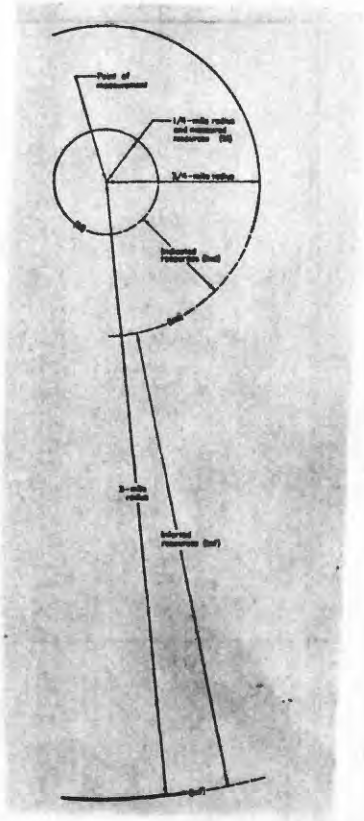
EXPLANATION

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 3 foot (0.9 meter) coal isopach (3). Arrow points toward area of identified Reserve Base coal.

RB	RB(50%)	
0.10	0.05	(Measured resources)
0.42	0.21	(Indicated resources)
0.13	0.06	(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 outside the stripping limit line. Dash indicates no resources in that category. Reserve Base (RB) x the Recovery Factor (50 percent) = Reserves (R).



BOUNDARY LINES-Enclosed areas of measured (M), indicated (Ind) and inferred (Inf) coal resources. Dashed where projected from adjacent quadrangle. 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.

Total reserve base data for the Crevasse Canyon Gibson No. 5 coal bed, which include all reserve base categories, are shown by section on plate 2. Reserve base and reserve data in the various categories are shown on fig. 6.

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 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.

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. High, moderate, and low development potential areas have respective overburden values of 200 to 1,000 ft (61 to 305 m), 1,000 to 2,000 ft (305 to 610 m), and 2,000 to 3,000 ft (610 to 914 m).

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 subsurface mining methods are shown in table 2.

The coal development potential maps are 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 has not been mapped in the Twin Lakes quadrangle because based on coal development potential criteria, all Federal coal lands have unknown surface mining potential.

Development potential for subsurface mining methods and in situ gasification

The coal development potential for subsurface mining methods in the Twin Lakes quadrangle is shown on plate 4. Based on coal development criteria, all Federal coal lands have high, moderate or unknown subsurface mining potentials. Refer to table 3 for reserves and planimetered acreage, by section, for Federal coal lands with subsurface mining potential.

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 2. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Twin Lakes quadrangle, McKinley County, New Mexico.

[Development potentials are based on thickness of overburden. To convert short tons to metric tonnes, multiply by 0.9072].

Coal bed	High Development Potential (200'-1,000' overburden)	Moderate Development Potential (1,000'-2,000' overburden)	Low Development Potential (2,000'-3,000' overburden)	Total
Crevasse Canyon Gibson No. 5	620,000	4,400,000	-------	5,020,000
Total	620,000	4,400,000	-------	5,020,000

Table 3. - Reserves and planimetered acreage, by section, for Federal coal lands in the Twin Lakes quadrangle with subsurface mining potential.

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

Potential Category	Coal bed	Sec.	T. N.	R. W.	Acres (planimetered)	Reserves (in short tons)
High	Crevasse Canyon Gibson No. 5	8	16	18	56.5	310,000
Moderate	Crevasse Canyon	6	16	18	106.5	320,000
	Gibson No. 5	8			390.2	1,870,000

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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.
