UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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

[Report includes 29 plates (31 sheets)]

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GALLUP WEST QUADRANGLE
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INTRODUCTION

Purpose

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 Published and unpublished public information was used as the data base for this study.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

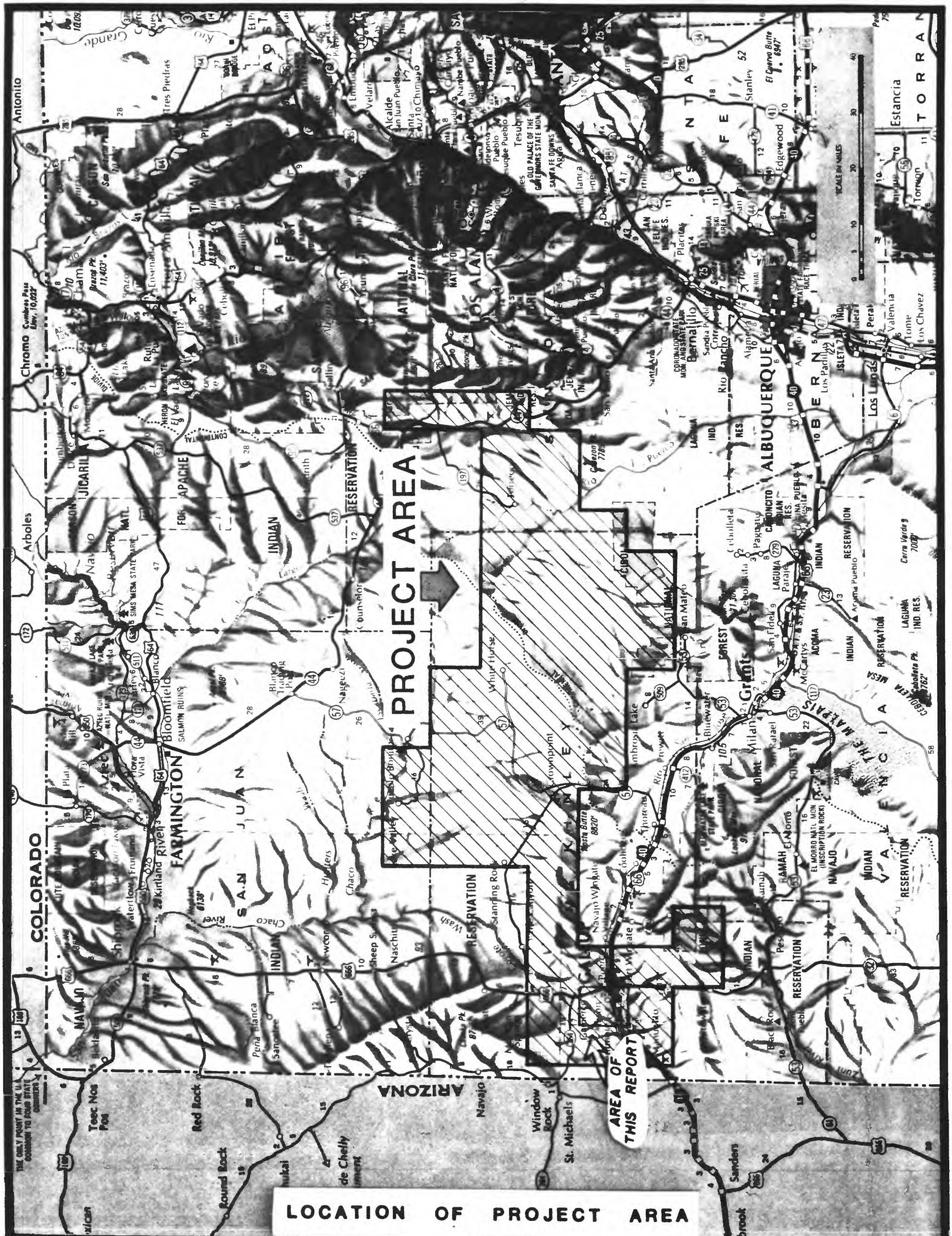
LOCATION OF PROJECT AREA
PROJECT AREA
AREA OF THIS REPORT
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Grants
Bloomfield
Gallup

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
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9	Canada Calladita	79- 626
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11	El Dado Mesa	79- 628
12	Mesa Cortada	79- 629
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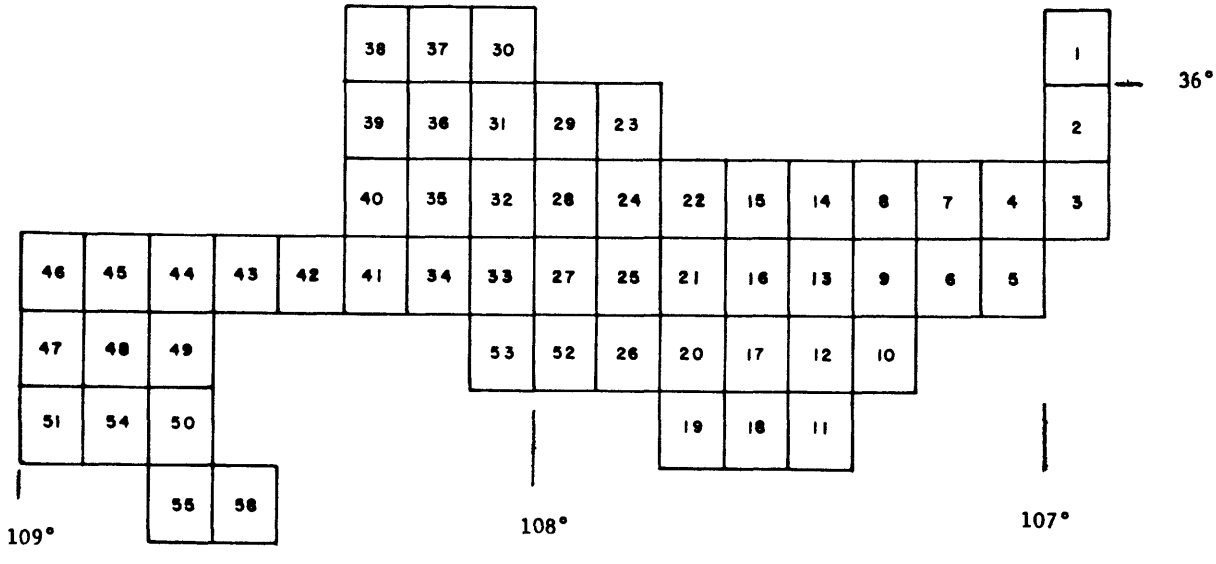
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
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 Gallup West 7½ minute quadrangle includes acreage in Tps. 15 and 16 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 Gamerco, Mentmore, Allison, Twin Buttes, and the western part of the city of Gallup are within the quadrangle.

Accessibility

Interstate Highway 40 and U. S. Highway 66 pass through the southern part of the quadrangle, and provide access to the town of Thoreau, 32 mi (51 km) southeast, and to the town of Manuelito, 11 mi (18 km) southwest of the quadrangle. U. S. Highway 666 passes approximately north-south and provides access to the town of Shiprock, 85 mi (137 km) north of the quadrangle. Light-duty maintained and unimproved dirt roads traverse most parts of the quadrangle. The main line of the Atchison, Topeka, and Santa Fe Railroad passes through the southern part of the quadrangle. Two spur lines of the Atchison, Topeka, and Santa Fe Railroad provide railway services to the town of Gamerco, and to the Pittsburg and Midway McKinley coal mine in the adjacent Samson Lake quadrangle (see fig. 1). The Gallup-McKinley County Airport in the southern part of the quadrangle provides small plane access to the area.

Physiography

The Gallup West 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 alluvial valley floors, eroded mesas, and rugged badlands. Mining activities within the past 100 years have contributed various mine dumps and tailings ponds to the surface of the quadrangle.

No perennial streams are present in the quadrangle. Local drainage is provided by the Puerco River and several intermittent arroyos. Elevations within the quadrangle range from less than 6,360 ft (1,939 m) along the Puerco River in the southwest to over 6,980 ft (2,128 m) in the northeast.

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 Gallup West quadrangle is about 5 mi (8 km) W 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°F (9.3°C). The average daily temperatures in January and July are 29.0°F (-1.7°C) and 71.3°F (21.8°C), respectively.

Land status

The Federal Government holds coal rights to approximately 25 percent of the Gallup West 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 except about 2,600 acres (1,052 ha) in the southwest is within the Gallup Known Recoverable Coal Resource Area. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the Gallup West quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include detailed coal mapping by Sears (1925) for most of the Gallup West quadrangle. He reported numerous coal thicknesses from outcrop measurements and drill holes for the Gallup Sandstone and Dilco and Gibson Coal Member beds. Dobbin (1932) mapped the northwestern part of the area and reported coal outcrop thicknesses of the Gibson Coal Member. Shomaker, Beaumont, and Kottlowski (1971) reviewed the area and noted that the Gibson and Dilco Coal Members crop out and underlie large portions of the quadrangle. They outlined small areas of strippable coal but noted that parts of the minable coal reserves which were present at strippable depths have been previously mined out. Hackman and Olson (1977) compiled surface mapping and structural data from many previous workers 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° 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 sequence.

Exposed rock units in the quadrangle include some of the sedimentary units of the Upper Cretaceous age. There is Quaternary alluvium and terrace gravels along the Puerco River and other drainages in the area.

The "main body" of the Mancos Shale is stratigraphically the lowest exposed Upper Cretaceous rock 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 unit, which averages 530 ft (162 m) thick locally, although only the upper 200 ft (61 m) is represented on plate 3.

A major northeastward retreat of the Cretaceous seaways followed and resulted in the 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 coarse-grained, massive sandstone with interbedded gray shales, and coal beds. Thickness of the unit ranges from 300 to 350 ft (91 to 107 m) in this area. 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 by the Dalton Sandstone Member of the Crevasse Canyon Formation into upper and lower portions of 145 ft (44 m) and 160 ft (49 m) thick, respectively.

The Dalton Sandstone Member formed during a regression of the Cretaceous seaways and is composed of yellowish-gray, very fine-to coarse-grained, quartzose sandstone. Thickness of the unit ranges from 0 to 62 ft (0 to 18 m) locally. The Bartlett Barren Member of the Crevasse Canyon Formation overlies the upper unit of the Dilco Coal Member in this area, and consists of yellowish-brown to olive-gray siltstone, light gray shales, white to brown locally calcareous sandstones, and thin coal beds. Thickness of the unit ranges from 280 to 375 ft (85 to 114 m) in this area.

The Crevasse Canyon Gibson-Menefee Cleary undifferentiated unit 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 siltstones with interbedded gray to tan sandstones, gray shales, and coal beds comprise the lithologies of the Crevasse Canyon Gibson-Menefee Cleary unit, which ranges from 500 to 600 ft (152 to 183 m) thick locally. Overlying the Crevasse Canyon Gibson-Menefee Cleary unit, the Allison Member of the Menefee Formation represents continued continental sedimentation. Dark gray to brown, carbonaceous to noncarbonaceous shales, light gray sandstones, and thin coal beds comprise the lithologies of the Allsion Member, which is about 250 ft (76 m) thick locally.

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 Gallup West quadrangle is in the Gallup Sag structural division in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). Hackman and Olson (1977) mapped the northwest-plunging Allison Syncline in the eastern part of the quadrangle. Sears (1925) identified several low displacement faults in the southwestern part of the Gallup West quadrangle.

The rock units dip from 2^{o} to 3^{o} NE in the western part of the area, and 15^{o} to 27^{o} NW to SW along the eastern quadrangle boundary.

COAL GEOLOGY

In this quadrangle, the authors identified thirteen coal beds, five coal zones, and two local coal beds in an oil and gas well log, water well log, coal test holes, and surface mapping by Sears (1925) and Dobbin (1932). These coal beds and coal zones are here informally called the Gallup coal zone, Gallup No. 1 coal bed, Crevasse Canyon Dilco No. 2 coal bed, Crevasse Canyon Dilco coal zone, Crevasse Canyon Dilco No. 3, No. 4, No. 5, No. 6, No. 7, and No. 8 coal beds, local coal beds, Crevasse Canyon Gibson No. 4 coal bed, Crevasse Canyon Gibson coal zone, Crevasse Canyon Gibson No. 5, No. 6, No. 7, and No. 8 coal beds, and the Crevasse Canyon Gibson-Menefee Cleary coal zone.

Stratigraphically, the Gallup coal zone contains the lowest identified coal beds in the Gallup West quadrangle. Up to two beds which occur from 35 to 95 ft (11 to 29 m) below the top of the Gallup Sandstone comprise the Gallup coal zone. The Gallup No. 1 coal bed ranges from 2.0 to 3.5 ft (0.6 to 1.1 m) thick and occurs from 70 to 80 ft (21 to 24 m) below the top of the Gallup Sandstone.

The Crevasse Canyon Dilco No. 2 coal bed is the lowest identified Dilco Coal Member bed and has a thickness of 2.0 ft (0.6 m) of coal. The bed occurs from 25 to 40 ft (8 to 12 m) above the top of the Gallup Sandstone in this quadrangle. Up to six individual coal beds comprise the Crevasse Canyon Dilco coal zone which occur from 65 to 220 ft (20 to 67 m) above the top of the Gallup Sandstone. The Crevasse Canyon Dilco No. 3, No. 4, No. 5, No. 6, No. 7, and No. 8 coal beds occur from 43 to 65 ft (13 to 20 m), 80 to 105 ft (24 to 32 m), 125 to 165 ft (38 to 50 m), 185 to 270 ft (56 to 82 m), 200 to 300 ft (61 to 91 m),

and 230 to 340 ft (70 to 104 m), respectively, above the top of the Gallup Sandstone. The interburden of the Dilco Coal Member beds vary because of the presence of the Dalton Sandstone Member in the eastern part of the quadrangle.

Two local coal beds occur in the upper portion of the Bartlett Barren Member. These local beds are very limited in areal extent. The Crevasse Canyon Gibson No. 4 coal bed occurs up to 20 ft (6 m) above the top of the Bartlett Barren Member in this quadrangle. The Crevasse Canyon Gibson coal zone contains up to seven individual coal beds that occur from 26 to 170 ft (8 to 52 m) above the top of the Bartlett Barren Member. These zone coals, as with all zone coals identified 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 Crevasse Canyon Gibson No. 5, No. 6, No. 7, and No. 8 coal beds occur from 40 to 60 ft (12 to 18 m), 85 to 120 ft (26 to 37 m), 125 to 160 ft (38 to 49 m), and 150 to 190 ft (46 to 58 m) above the top of the Bartlett Barren Member, respectively. These coal beds, as with all numerically designated coal beds in this quadrangle, are inferred to be continuous, although they may be several individual coal beds that are stratigraphically equivalent. Up to two individual coal beds that occur from 15 to 440 ft (5 to 134 m) above the Crevasse Canyon Gibson No. 8 coal bed comprise the Crevasse Canyon Gibson-Menefee Cleary coal zone. Stratigraphically, the Menefee Allison coal zone contains the youngest identified coal beds in this quadrangle. Up to two individual coal beds that are 1.0 to 2.5 ft (0.3 to 0.8 m) thick and occur from 480 to 660 ft (146 to 201 m) above the Crevasse Canyon Gibson No. 8 coal bed comprise the Menefee Allison coal zone.

There are several published coal quality analyses for coal beds from the Gallup West quadrangle. Four analyses of Gibson Coal Member beds have been

reported by the U. S. Bureau of Mines (1936) and are shown in table 1. Two of the mine samples are within the Gallup West quadrangle (sample 1 - author's Crevasse Canyon Gibson No. 6 coal bed; Gibson No. 3 or Clark bed of Sears, 1925, and sample 2 - author's Crevasse Canyon Gibson No. 7 coal bed; Gibson No. 2 or Aztec bed of Sears, 1925). Samples 3 and 4 are each within 0.3 mi east of the quadrangle (sample 3 - author's Crevasse Canyon Gibson No. 5 coal bed; Gibson No. 5 bed of Sears, 1925, and sample 4 - author's Crevasse Canyon Gibson No. 8 coal bed; Gibson No. 1 bed of Sears, 1925). Rank of the Gibson Coal Member beds is high volatile C bituminous in this area.

A published coal quality analysis for Dilco Coal Member beds from the Gallup West quadrangle (sample 1 - author's Crevasse Canyon Dilco No. 8 coal bed; Dilco 1 or Defiance bed of Sears, 1925) has been reported by the U. S. Bureau of Mines (1936) and is shown in table 2. Two additional analyses of Dilco Coal Member mine samples from 0.2 to 1.8 mi (0.3 to 2.9 km) east of the Gallup West quadrangle (sample 2 - author's Crevasse Canyon Dilco No. 5 coal bed; Black Diamond bed of Sears, 1925, and sample 3 - author's Crevasse Canyon Dilco No. 4 coal bed; Otero bed of Sears, 1925) are also shown in table 2. Rank of the Dilco Coal Member beds is high volatile C bituminous in this area.

Crevasse Canyon Gibson No. 8 coal bed

The Crevasse Canyon Gibson No. 8 coal bed was identified in several coal test holes and outcrop measured sections by Sears (1925) and Dobbin (1932). Thickness of the bed ranges from 0.3 to 7.0 ft (0.1 to 2.1 m). The bed contains rock partings at several of the data points. The mine sample from the Navajo mine (sample 4, table 1) is from the same coal bed as the author's Crevasse Canyon Gibson No. 8 coal bed. A fault in sec. 13, T. 15 N., R. 18 W., displaces the

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 Sec.	T. N.	R. W.	Form of analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
1	mine sample (Clark mine)	NE¼ 14	15	19	A	14.0	38.4	42.1	5.5	0.54	-
					B	-	44.7	48.9	6.4	0.63	-
					C	-	47.7	52.3	-	0.67	-
2	mine sample (Allison-Diamond mine)	SW¼ 18	15	18	A	15.2	38.1	40.6	6.1	0.58	10,950
					B	-	44.9	47.9	7.2	0.68	12,920
					C	-	48.4	51.6	-	0.73	13,910
3	mine sample (Navajo No. 1 mine)	SE¼ 33	16	18	A	13.7	38.5	41.3	6.54	0.56	11,120
					B	-	44.6	47.8	7.58	0.65	12,880
					C	-	48.2	51.8	-	0.70	13,930
4	mine sample (Navajo mine)	SE¼ 33	16	18	A	12.5	38.9	39.4	9.17	0.43	10,800
					B	-	44.4	45.1	10.49	0.49	12,350
					C	-	49.7	50.3	-	0.55	13,800

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yields heating values of 11,731 Btu/lb (27,286 kJ/kg; sample 2), 11,975 Btu/lb (27,854 kJ/kg; sample 3) and 11,995 Btu/lb (27,900 kJ/kg; sample 4). 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.	T. N.	R. W	Form of analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
1	mine sample (Defiance mine)	SE¼ 16	15	19	A	10.6	40.9	41.4	7.1	0.79	11,510
					B	-	45.7	46.4	7.9	0.88	12,880
					C	-	49.7	50.3	-	0.96	13,990
2	mine sample (Gallup South-western mine)	SE¼ 21	15	18	A	11.4	39.9	42.2	6.5	0.75	11,640
					B	-	45.0	47.7	7.3	0.85	13,140
					C	-	48.5	51.5	-	0.92	14,180
3	mine sample (Caretto mine)	SW¼ 14	15	18	A	10.6	40.6	44.4	4.40	0.59	12,100
					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 12,482 Btu/lb (29,033 kJ/kg; sample 1), 12,534 Btu/lb (29,154 kJ/kg; sample 1), and 12,716 Btu/lb (29,577 kJ/kg; sample 3). No agglomerating characteristics were included with the analyses.

bed a small distance. Quaternary alluvium covers the outcrop of the bed in several areas within the quadrangle. Existence and character of the Crevasse Canyon Gibson No. 8 coal bed are unknown in most of the northern part of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 7 coal bed

The Crevasse Canyon Gibson No. 7 coal bed was identified in several coal test holes and outcrop measured sections. Thickness of the bed ranges from 0.3 to 9.0 ft (0.1 to 2.7 m). Rock partings are present between benches of the coal bed at several data points. The mine sample from the Allison (Diamond) mine (sample 2, table 1) is from the same coal bed as the author's Crevasse Canyon Gibson No. 7 coal bed. Quaternary alluvium conceals the coal bed outcrop in various areas within the quadrangle. Existence and character of the Crevasse Canyon Gibson No. 7 coal bed are unknown in most of the northern part of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 6 coal bed

The Crevasse Canyon Gibson No. 6 coal bed was identified in several coal test holes and outcrop measured sections in this quadrangle. Thickness of the bed ranges from 0.5 to 5.7 ft (0.2 to 1.7 m). The bed is inferred to thicken to 6.0 ft (see plate 10). The mine sample from the Clark mine (sample 1, table 1) is from the same coal bed as the author's Crevasse Canyon Gibson No. 6 coal bed. Quaternary alluvium conceals the coal bed outcrop in various areas of the quadrangle. Existence and character of the Crevasse Canyon Gibson No. 6 coal bed

are unknown along the eastern quadrangle boundary and in most of the northern part of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 5 coal bed

The Crevasse Canyon Gibson No. 5 coal bed was identified in several coal test holes and outcrop measured sections. The bed is the thickest coal bed in the quadrangle with up to 11.2 ft (3.4 m) of coal. The mine sample from the Navajo No. 1 mine (sample 3, table 1) is from the same coal bed as the author's Crevasse Canyon Gibson No. 5 coal bed. Outcrops of the bed are confined to the central southern and eastern parts of the Gallup West quadrangle. Existence and character of the Crevasse Canyon Gibson No. 5 coal bed are unknown in the central eastern and most of the northern parts of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 4 coal bed

The Crevasse Canyon Gibson No. 4 coal bed was identified in several coal test holes and outcrop measured sections within the quadrangle. The bed is interpreted to occur as isolated pods in the central and northern parts of the area (see plate 16). Thickness of the bed ranges from 0.2 to 5.6 ft (0.1 to 1.7 m). Quaternary alluvium conceals the coal bed outcrop in secs. 13 and 14, T. 15 N., R. 19 W. Existence and character of the Crevasse Canyon Gibson No. 4 coal bed are unknown in the central eastern and most of the northern parts of the quadrangle because of insufficient data.

Crevasse Canyon Dilco No. 8 coal bed

The Crevasse Canyon Dilco No. 8 coal bed crops out in the southwestern part of the quadrangle and contains up to 6.2 ft (1.9 m) of coal. Several low displacement faults offset the coal bed outcrop (see plate 19). The mine sample from the Defiance mine (sample 1, table 2) is from the same coal bed as the author's Crevasse Canyon Dilco No. 8 coal bed. Existence and character of the Crevasse Canyon Dilco No. 8 coal bed are unknown in most of the quadrangle because of insufficient data.

Crevasse Canyon Dilco No. 5 coal bed

The Crevasse Canyon Dilco No. 5 coal bed was identified in a coal test hole and at five outcrop measured sections in the Gallup West quadrangle. Maximum thickness of the bed is 6.5 ft (2.0 m). The bed is inferred to thicken to 9.0 ft (2.7 m) based on Crevasse Canyon Dilco No. 5 coal data from the eastern adjacent Gallup East quadrangle. The bed is inferred to pinch out toward the west (see plate 22). The mine sample from the Gallup Southwestern mine (sample 2, table 2) is from the same coal bed as the author's Crevasse Canyon Dilco No. 5 coal bed. Existence and character of the Crevasse Canyon Dilco No. 5 coal bed are unknown in the western part of the quadrangle because of insufficient data.

Crevasse Canyon Dilco No. 4 coal bed

The Crevasse Canyon Dilco No. 4 coal bed was identified in four outcrop measured sections and two coal test holes. The coal test hole in NW¼ NW¼ NE¼ Sec. 5, T. 15 N., R. 18 W., contains 8.0 ft (2.4 m) of Crevasse Canyon Dilco No. 4

coal, although rock partings are present between the coal benches (see plates 1 and 3). The procedure prescribed by the U. S. Geological Survey regarding rock partings in coal beds overlain by greater than 200 ft (61 m) of overburden is the rock parting must be thicker than the coal bench to discount that coal bench from the total coal thickness. At this data point, coal benches of 1.3 and 1.1 ft (0.4 and 0.3 m) were discounted, so the thickness isopached was 5.6 ft (1.7 m) (see plate 25). The mine sample from the Caretto mine (sample 3, table 2) is from the same coal bed as the author's Crevasse Canyon Dilco No. 4 coal bed. Existence and character of the Crevasse Canyon Dilco No. 4 coal bed are unknown in most of the quadrangle because of insufficient data.

COAL RESOURCES

The U. S. Geological Survey requested resource evaluations of the Crevasse Canyon Gibson No. 5, No. 6, and No. 8, and the Crevasse Canyon Dilco No. 4 and No. 5 coal beds, where the beds are 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 (plates 4, 6, 10, 12, 13, 15, 22, 24, 25, and 27). 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 recovery factors of 85 percent and 50 percent for coal beds 0 to 200 ft (0 to 61 m) and 200 to 3,000 ft (61 to 914 m) deep, respectively. 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 for the Crevasse Canyon Gibson No. 8, No. 6, and No. 5 coal beds and the Crevasse Canyon Dilco No. 5 coal bed are shown on figs. 3A-3B, 4A-4B, and 5, respectively. Reserve base and reserve data for the Crevasse Canyon Dilco No. 4 coal bed are shown on plate 28.

COAL DEVELOPMENT POTENTIAL

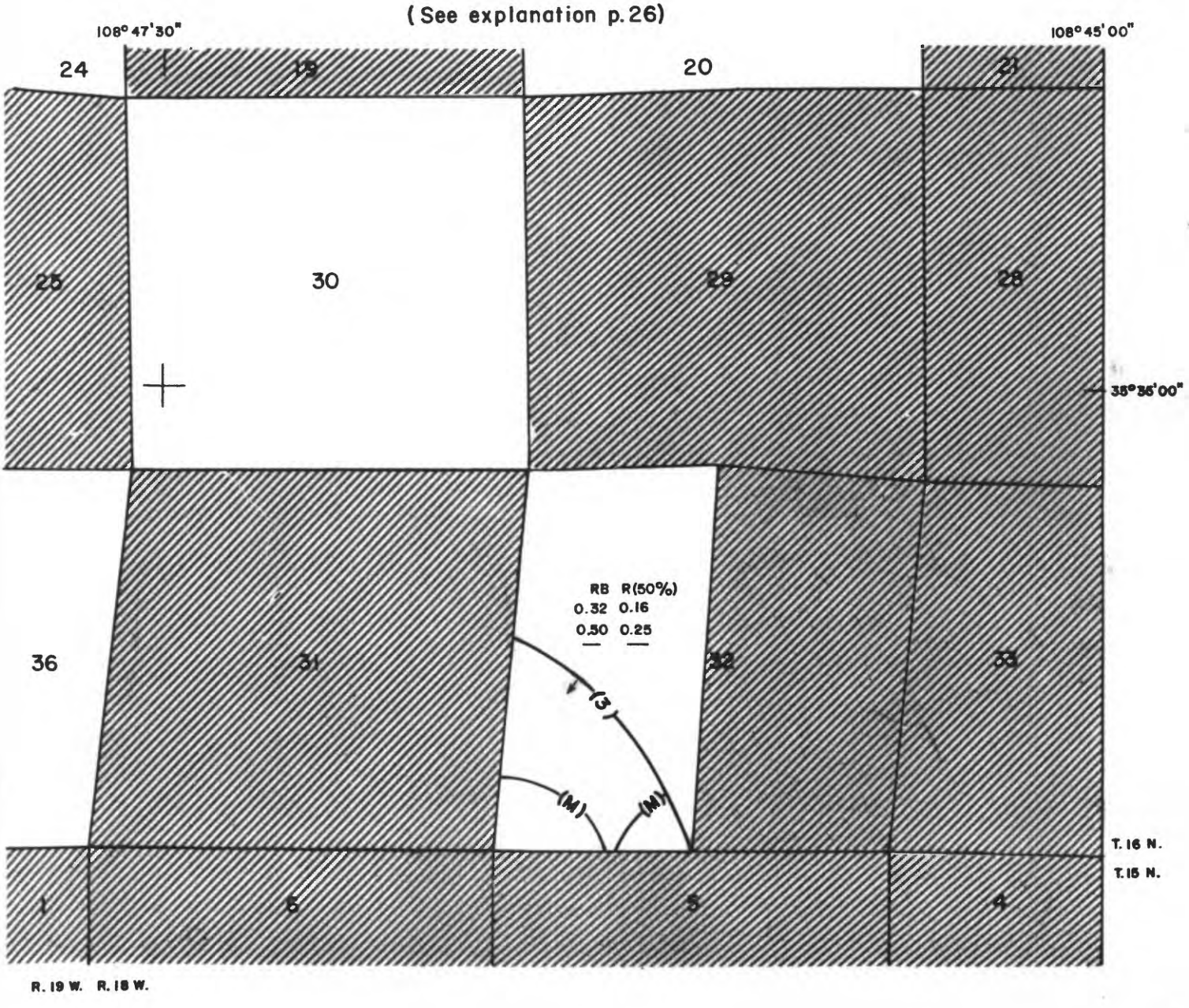
The factors used to determine the development potential are the presence of a potentially coal-bearing formation, and the thickness and overburden of correlative coal beds. The U. S. Geological Survey supplied the criteria to evaluate the coal development potential for Federal lands in this quadrangle. 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

Figure 3

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON GIBSON NO. 8 COAL BED

(See explanation p. 26)

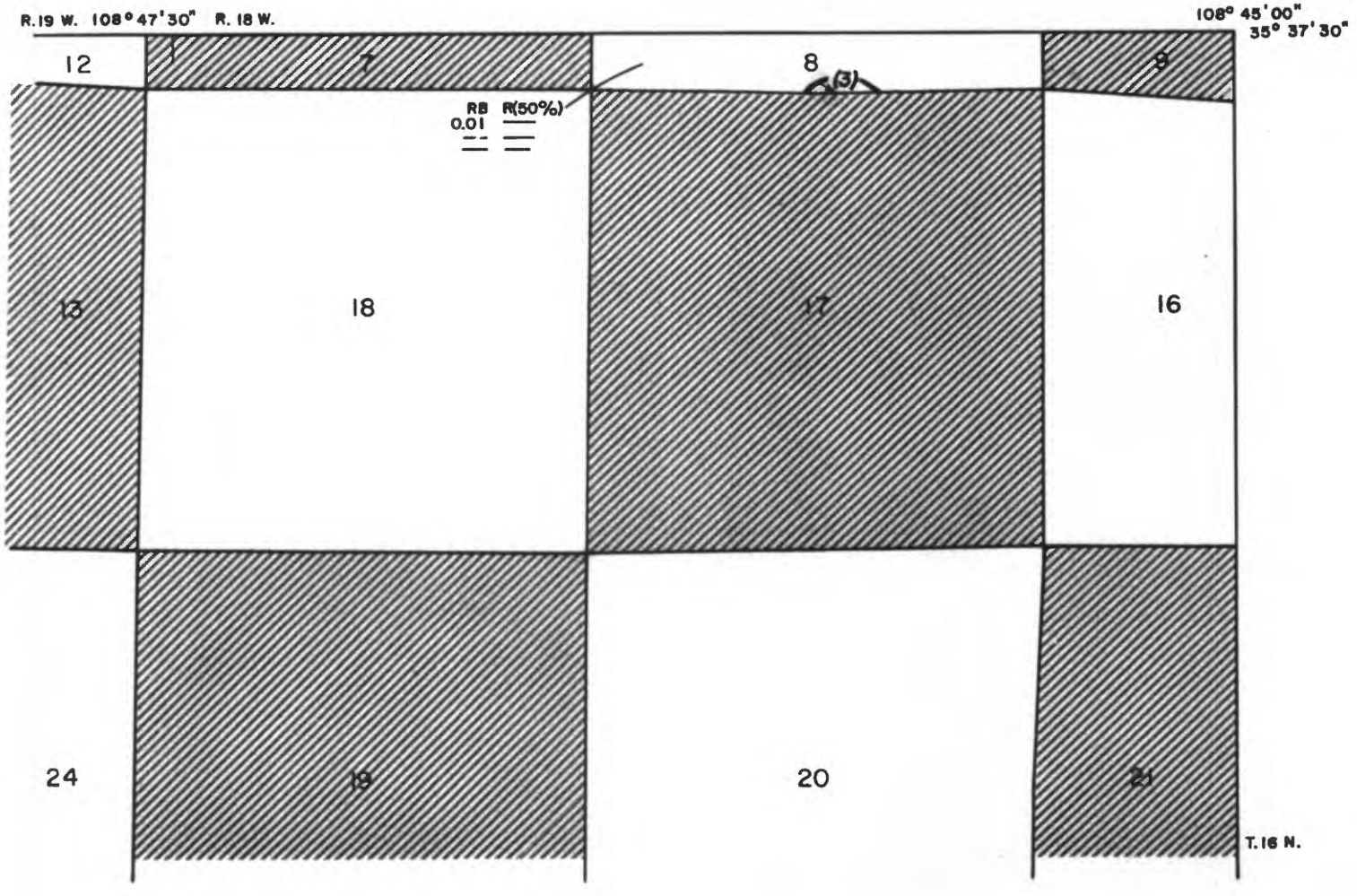


SCALE 1:24,000

Figure 4A

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON GIBSON NO.6 COAL BED

(See explanation p. 27)

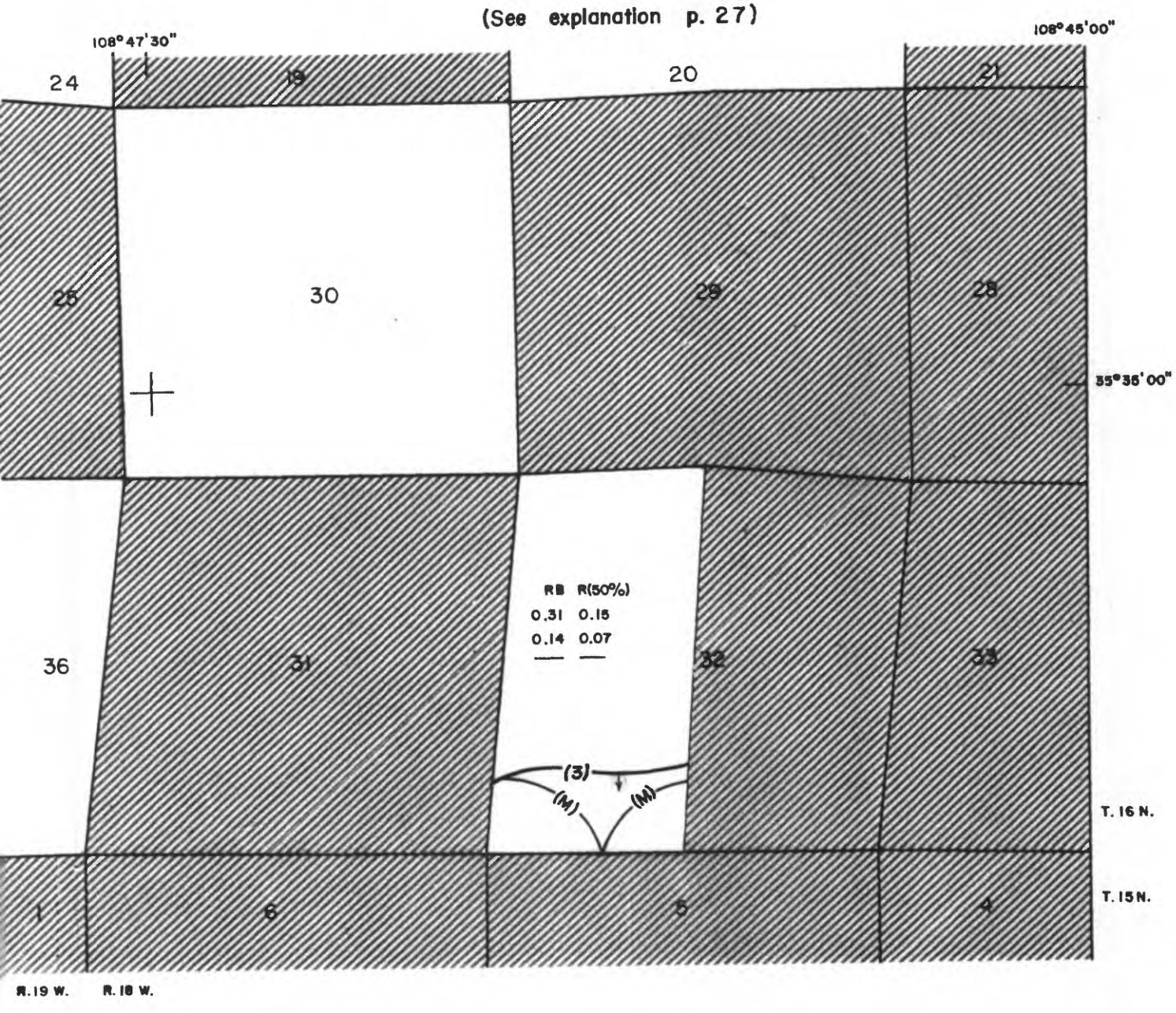


SCALE 1:24,000

Figure 4B

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON GIBSON NO. 6 COAL BED

(See explanation p. 27)



SCALE 1:24,000

Figure 5A

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

(See explanation p. 28)

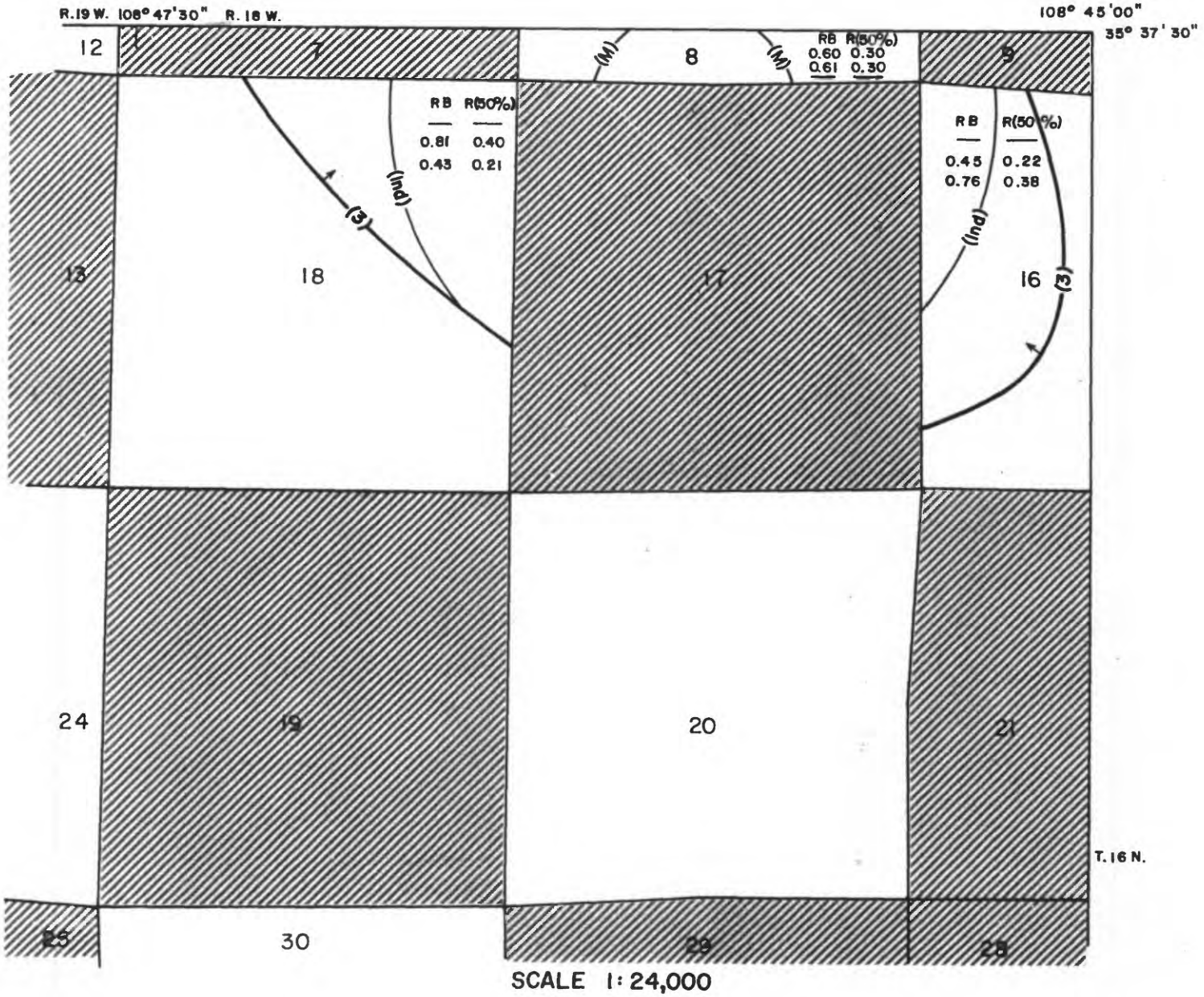
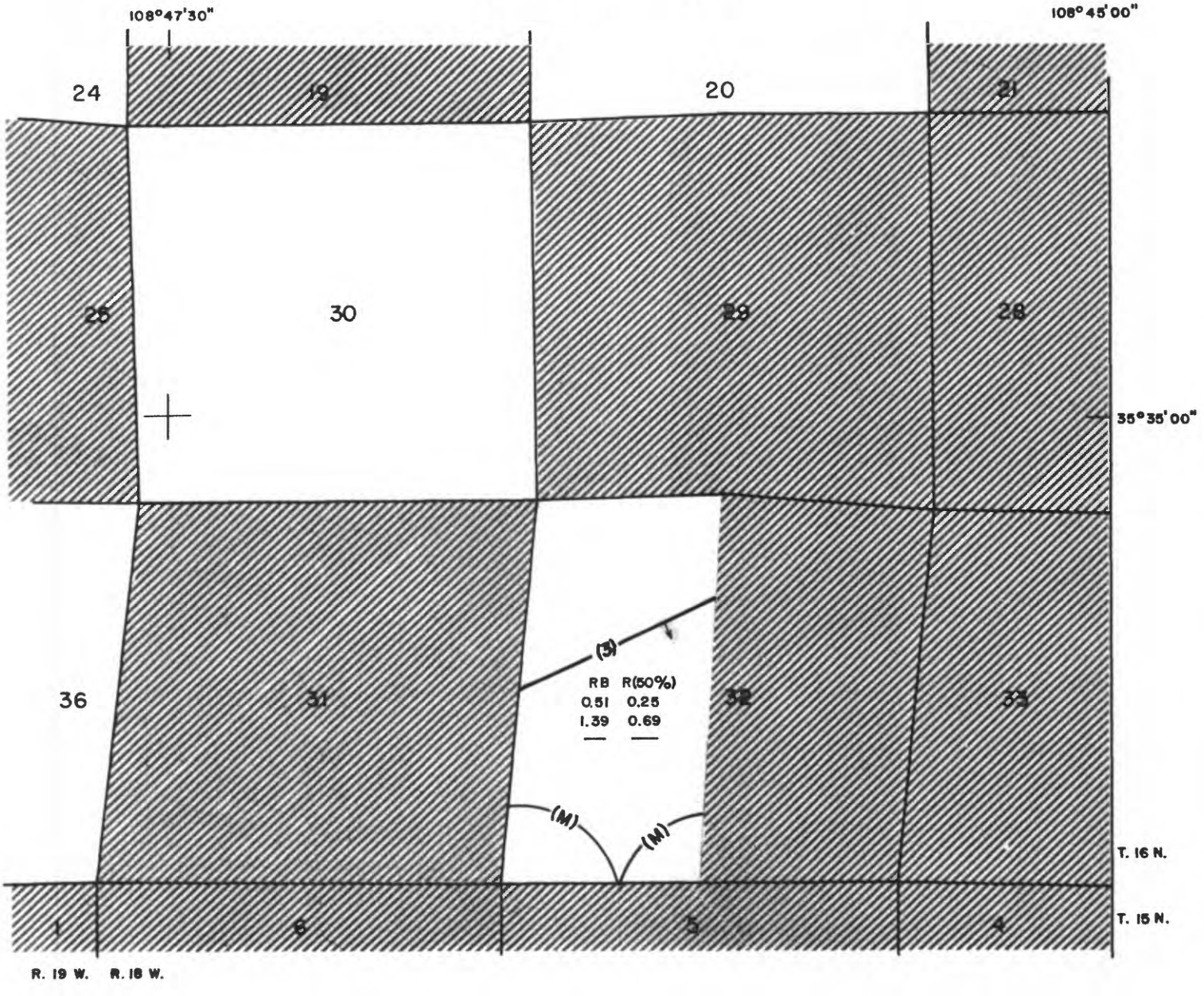


Figure 5B

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

(See explanation p. 28)

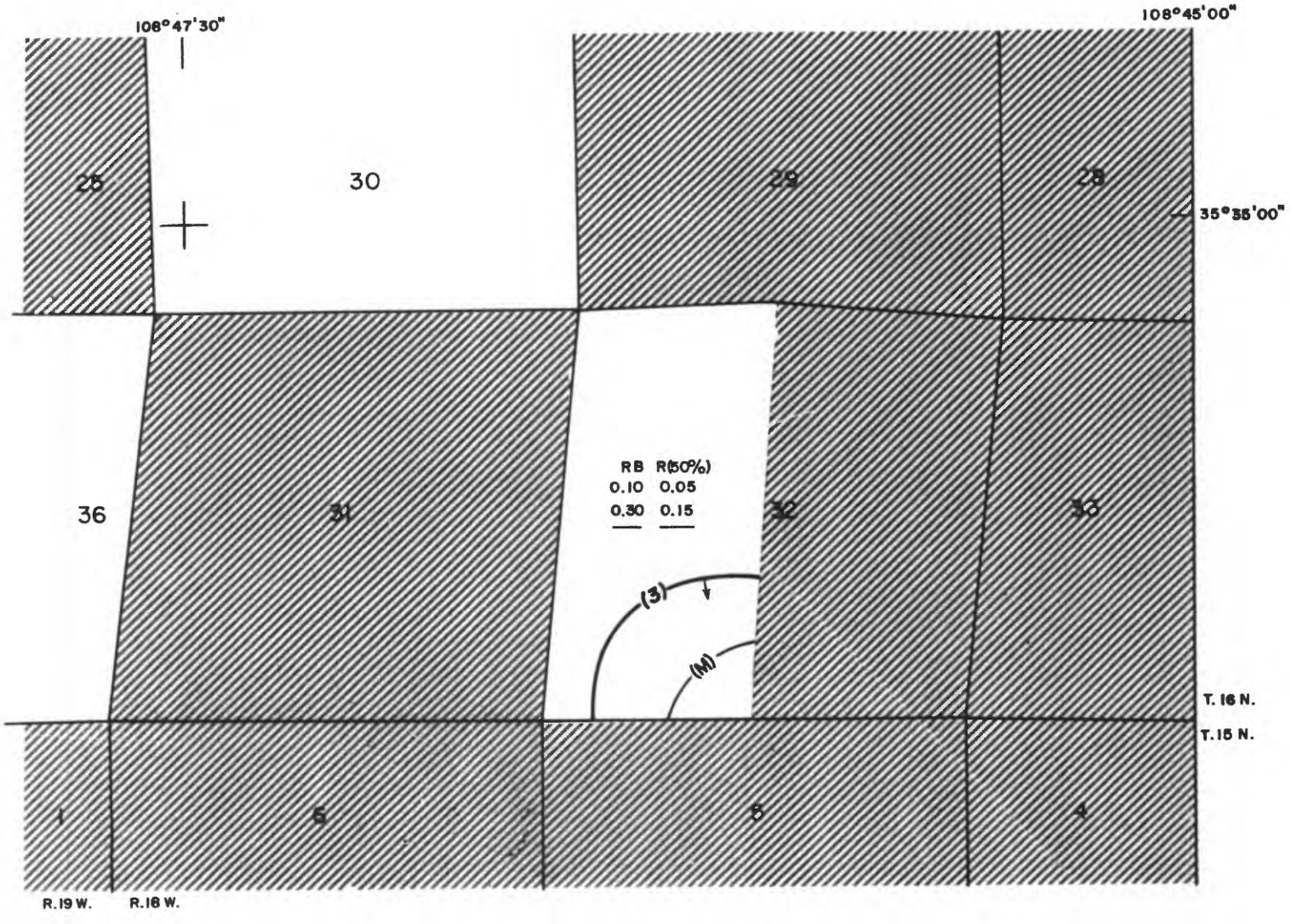


SCALE 1: 24,000

Figure 6

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

(See explanation p. 29)



SCALE 1:24,000

Figure 3

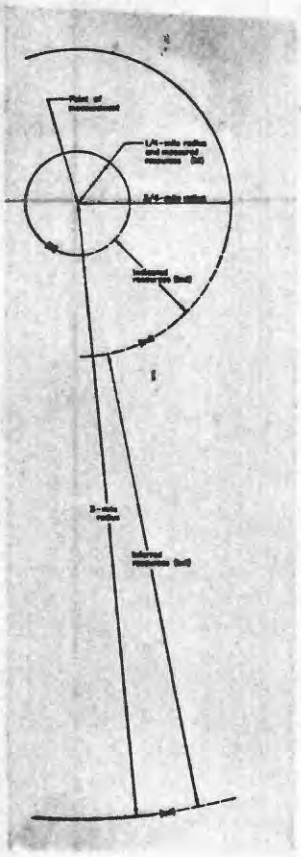
EXPLANATION

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	R(50%)	
0.32	0.16	(Measured resources)
0.50	0.25	(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 outside the stripping limit line. Dashed indicates no resources in that category. Reserve Base (BB) x the Recovery Factor (50 percent) = Reserve (R).



BOUNDARY LINES-Enclosed areas of measured (M), indicated (Ind) and inferred (Inf) coal resources.

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 figure does not show the areal distribution or quantity of subeconimic resources present in this quadrangle.

Figure 4A and Figure 4B

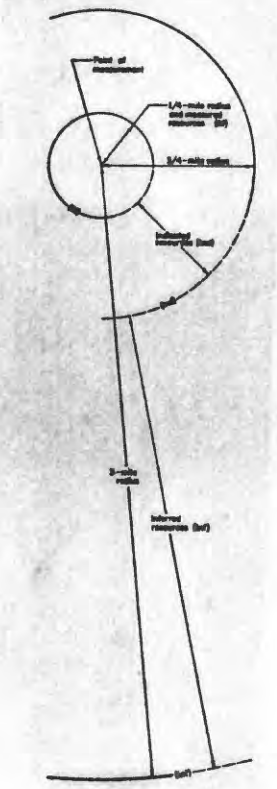
EXPLANATION

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	R(50%)	
0.31	0.15	(Measured resources)
0.14	0.07	(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 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. 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 figure does not show the areal distribution or quantity of subeconomic resources present in this quadrangle.

Figure 5A and Figure 5B

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	R(50%)	
0.51	0.25	(Measured resources)
0.81	0.40	(Indicated resources)
0.43	0.21	(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. 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 figure does not show the areal distribution or quantity of subeconomic resources present in this quadrangle.

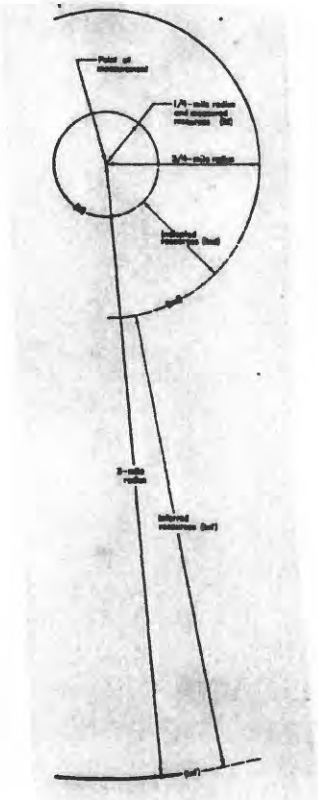


Figure 6

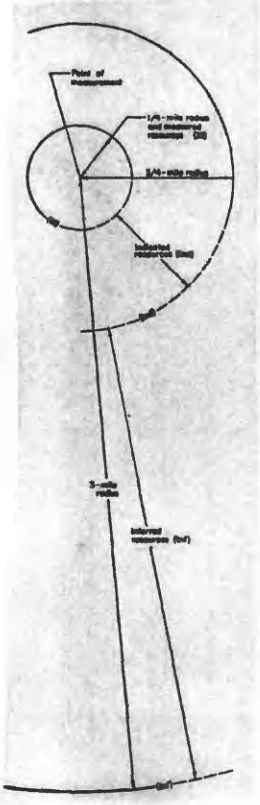
EXPLANATION

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	R(50%)	
0.10	0.05	(Measured resources)
0.30	0.15	(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 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. 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 figure does not show the areal distribution or quantity of subeconomic resources present in this quadrangle.

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 ratio 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. 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).

The no and unknown development potential boundaries for surface and subsurface mining methods (figure 6 and plate 29, respectively) are defined at the contact of the coal-bearing Gallup Sandstone with the underlying noncoal-bearing Mancos Shale. For coal development potential evaluations, the Dakota Sandstone is not considered potentially coal-bearing in this area by the U. S. Geological Survey. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Boundaries of the 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 and subsurface mining methods are shown in tables 3 and 4, respectively.

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.

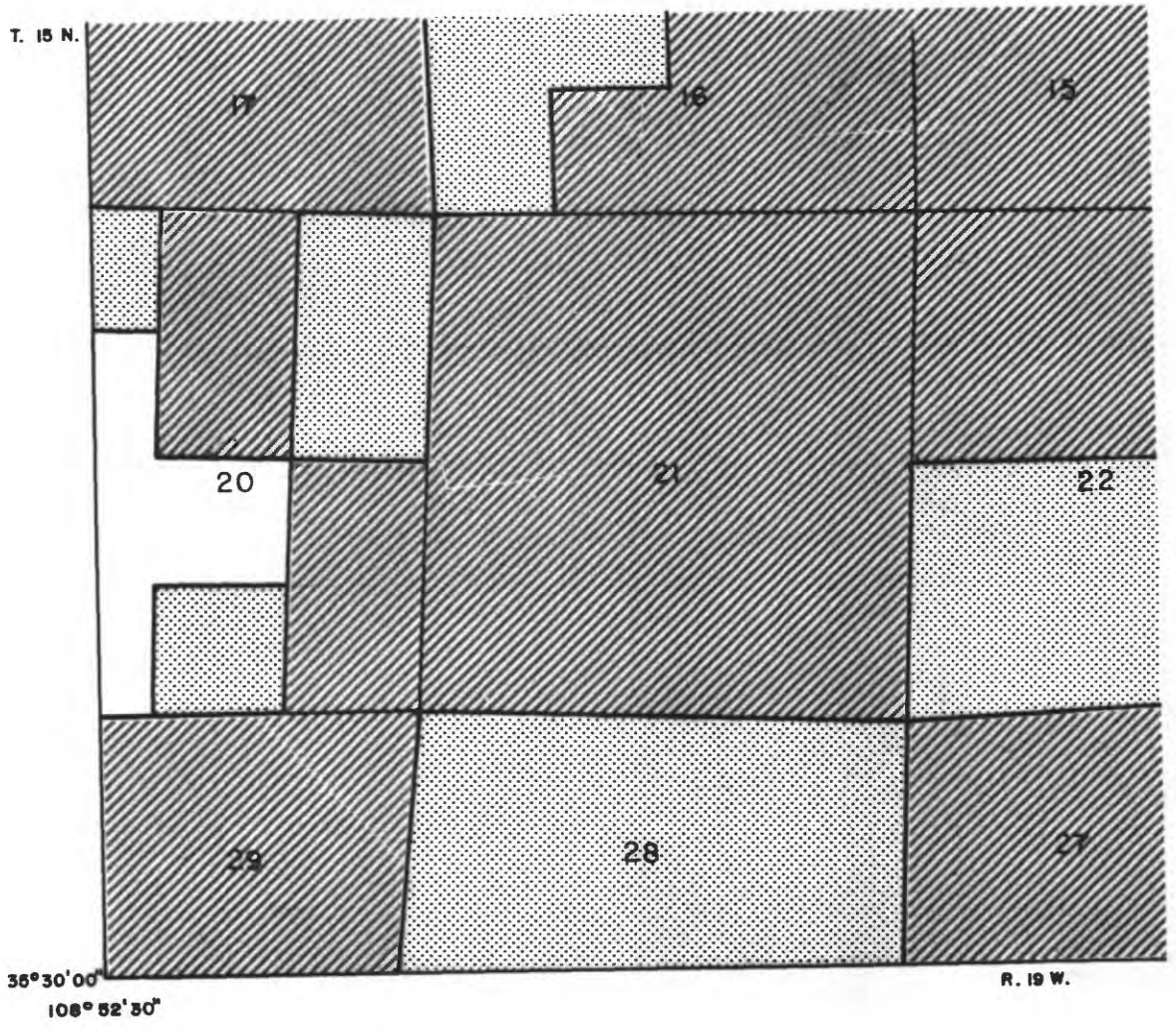
Development potential for surface mining methods

The coal development potential for surface mining methods in the Gallup West quadrangle is shown in fig. 6. Based on coal development criteria, all Federal coal lands have high, unknown or no surface mining potentials. The area of high potential is not shown in fig. 6, however, since it occupies less than half of a 40 acre lot. The Federal lands not included in fig. 6 have unknown surface

Figure 7

COAL DEVELOPMENT POTENTIAL FOR SURFACE MINING METHODS

(See explanation p. 33)

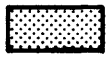


SCALE 1:24,000

Figure 7

EXPLANATION

NON-FEDERAL COAL LAND-Land for which the Federal Government does not own the coal rights, and for which the coal development potential is not rated.



AREA OF UNKNOWN COAL DEVELOPMENT POTENTIAL FOR SURFACE MINING METHODS-Includes areas within the stripping limit (200 feet-61 meters-overburden) coal thickness less than 3.0 feet (0.9 meters), areas with insufficient data, areas outside the coal outcrop or limit of coal beds within the Crevasse Canyon, Menefee, and Gallup Ss. Formations.

AREA OF NO COAL DEVELOPMENT POTENTIAL FOR SURFACE MINING METHODS-Includes areas outside the Crevasse Canyon, Menefee, and Gallup Ss. Formations.

To convert feet to meters, multiply feet by 0.3048.

mining potential. Refer to table 5 for reserves and planimetered acreage, by section, for Federal coal lands in the Gallup West quadrangle with surface mining potential.

Development potential for subsurface mining methods and in situ gasification

The coal development potential for subsurface mining methods in the Gallup West quadrangle is shown on plate 29. Based on coal development potential criteria, all Federal coal lands have high, moderate, unknown or no subsurface mining potentials. Refer to table 6 for reserves and planimetered acreage, by section, for Federal coal lands in the Gallup West quadrangle 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 3. - Reserve base data (in short tons) for surface mining methods for Federal coal lands in the Gallup West 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. 4	40,000	-	-	40,000
Total	40,000	-	-	40,000

Table 4. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Gallup West 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. 8	820,000	-	-	820,000
Crevasse Canyon Gibson No. 6	450,000	-	-	450,000
Crevasse Canyon Gibson No. 5	4,560,000	1,000,000	-	5,560,000
Crevasse Canyon Dilco No. 5	-	400,000	-	400,000
Crevasse Canyon Dilco No. 4	-	11,460,000	-	11,460,000
Total	5,830,000	12,860,000	-	18,690,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Gallup West quadrangle with surface mining potential.

[To convert acres to hectares, divide acres by 2.471; to 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 Dilco No. 4	16	15	19	6.1	30,000

Table 6. - Reserves and planimetered acreage, by section, for Federal coal lands in the Gallup West quadrangle with subsurface mining potential.

[To convert acres to hectares, divide acres by 2.471; to 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. 8	32	16	18	108.0	410,000
	Crevasse Canyon Gibson No. 6	8	16	18	2.0	less than 10,000
		32			68.4	220,000
	Crevasse Canyon Gibson No. 5	32	16	18	180.5	940,000
		16			106.4	370,000
		18			132.3	540,000
		8			53.2	400,000
Moderate	Crevasse Canyon Gibson No. 5	16	16	18	62.3	220,000
		18			18.2	70,000
		8			33.4	190,000
	Crevasse Canyon Dilco No. 5	32	16	18	68.4	200,000
	Crevasse Canyon Dilco No. 4	18	16	18	79.0	230,000
		8			42.5	120,000
		16			76.0	250,000
		20			640.0	2,590,000
		30			337.4	1,180,000
		32			282.8	1,340,000

SELECTED REFERENCES
(GALLUP WEST QUADRANGLE)

American Society for Testing and Materials, 1973, Standard specification for classification of coals by rank, in American Society for Testing and Materials Standards for coal and coke: Designation D388-66, p. 54-57.

Baltz, E. H., 1967, Stratigraphy and regional tectonic implications of part of Upper Cretaceous and Tertiary rocks, east-central San Juan Basin, New Mexico: U.S. Geological Survey Professional Paper 552, 101 p.

Chapman, Wood, and Griswold, Inc., 1977, Geologic map of the Grants uranium region: New Mexico Bureau of Mines and Mineral Resources Geologic Map 31.

Dobbin, C. E., 1932, U.S. Geological Survey unpublished mapping.

Hackman, R. J., and Olson, A. B., 1977, Geology, structure, and uranium deposits of the Gallup 1°x2° quadrangle, New Mexico and Arizona: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-981, scale 1:250,000.

Kelley, V. C., 1950, Regional structure of the San Juan Basin, in New Mexico Geological Society Guidebook of the San Juan Basin, New Mexico and Colorado, 1st Field Conference, 1950: p. 101-108.

Keroher, G. C., and others, 1966, Lexicon of geologic names of the United States for 1936-60: U.S. Geological Survey Bulletin 1200, 4341 p.

National Oceanic and Atmospheric Administration, 1964-78, Climatological data, New Mexico: National Climatic Center, Asheville, N.C., v. 68-82.

Petroleum Information Well Log Library: Denver, Colo.

Rocky Mountain Well Log Service, 1974, Catalog of electrical, radioactivity and hydrocarbon surveys: Electrical Log Services, 1974, 819 p.

Sears, J. D., 1925, Geology and coal resources of the Gallup-Zuni Basin, New Mexico: U.S. Geological Survey Bulletin 767, 54 p.

Sears, J. D., 1934, The coal field from Gallup eastward toward Mount Taylor, part 1 of Geology and fuel resources of the southern part of the San Juan Basin, New Mexico: U.S. Geological Survey Bulletin 860-A, p. 1-30.

Sears, J. D., Hunt, C. B., and Hendricks, T. A., 1941, Transgressive and regressive Cretaceous deposits in southern San Juan Basin, New Mexico: U.S. Geological Survey Professional Paper 193-F, p. 101-121.

Shomaker, J. W., Beaumont, E. C., and Kottlowski, F. E., 1971, Strippable low-sulfur coal resources of the San Juan Basin in New Mexico and Colorado: New Mexico Bureau of Mines and Mineral Resources Memoir 25, 189 p.

Shomaker, J. W., and Whyte, M. R., 1977, Geologic appraisal of deep coals, San Juan Basin, New Mexico: New Mexico Bureau of Mines and Mineral Resources Circular 155, 39 p.

Tabet, D.E., and Frost, S. J., 1978, Coal fields and mines of New Mexico: New Mexico Bureau of Mines and Mineral Resources Resource Map 10.

U.S. Bureau of Mines, 1936, Analyses of New Mexico coals: U.S. Bureau of Mines Technical Paper 569, 112 p.

U.S. Bureau of Mines and U.S. Geological Survey, 1976, Coal resource classification system of the U.S. Bureau of Mines and U.S. Geological Survey: U.S. Geological Survey Bulletin 1450-B, 7 p.

U.S. Geological Survey, 1965, Mineral and water resources of New Mexico: New Mexico Bureau of Mines and Mineral Resources Bulletin 87, 437 p.

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.