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

[Report includes 26 plates]

Prepared by Berge Exploration, Inc.

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RINCON MARQUEZ QUADRANGLE
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INTRODUCTION

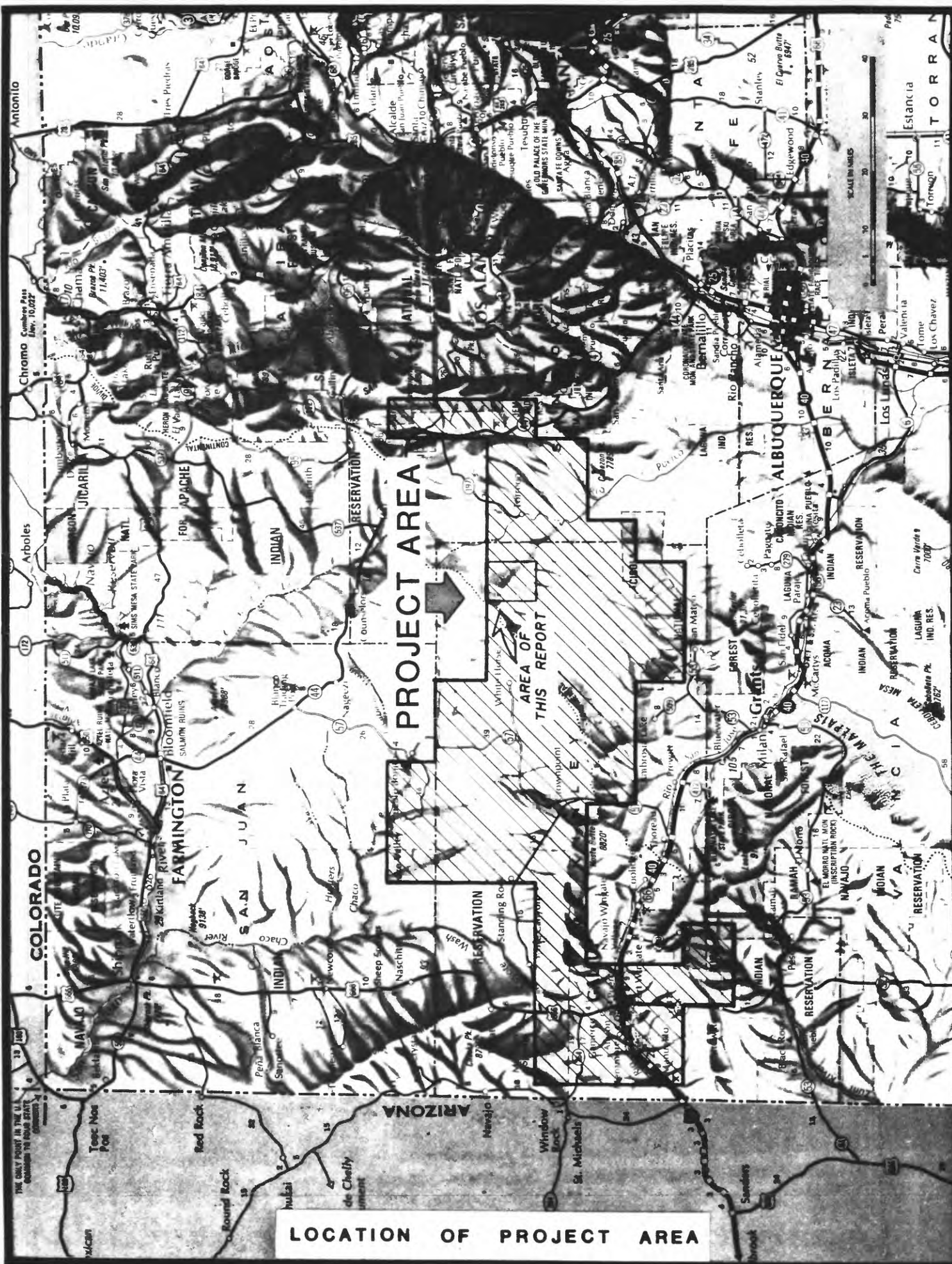
Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Rincon Marquez 7 1/2 minute quadrangle, McKinley County, New Mexico. These maps and report are part of an evaluation of fifty-six 7 1/2 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 Published and unpublished public information was used as the data base for this study.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.

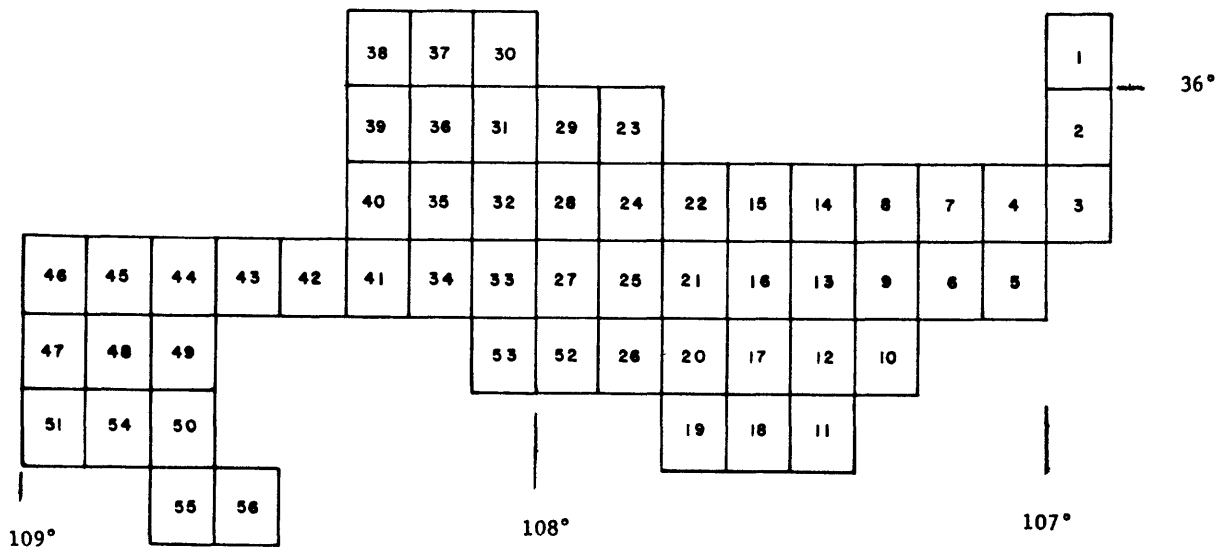


LOCATION OF PROJECT AREA

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



Location

The Rincon Marquez 7½ minute quadrangle includes acreage in Tps. 18 and 19 N., Rs. 5 and 6 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

No paved roads pass through the Rincon Marquez quadrangle. A light-duty maintained road in the northeast corner of the quadrangle provides access to the Torreon Trading Post on State Route 197, 9 mi (14 km) east of the quadrangle. An unimproved dirt road in the southwestern part of the quadrangle provides access to the town of Whitehorse, 14 mi (23 km) west of the area. Other unimproved dirt roads traverse most parts of the quadrangle. The Atchison, Topeka, and Santa Fe Railroad passes about 40 mi (64 km) southwest of the Rincon Marquez quadrangle (see fig. 1).

Physiography

The Rincon Marquez 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 rugged, vegetated mesas dissected by numerous arroyos. The Continental Divide passes through the northwest corner of the quadrangle. Chaco Mesa is a prominent topographic feature in the southern part of the area.

No perennial streams are present in the quadrangle. Local drainage is provided by several intermittent arroyos including Arroyo Rincon Marquez, Daniel Wash, and Vincente Arroyo. Elevations within the quadrangle range

from less than 6,580 ft (2,006 m) in the northeast corner to 7,475 ft (2,278 m) on Chaco Mesa near the western 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 Star Lake Station. The Rincon Marquez quadrangle is about 3 mi (5 km) S of the Star Lake Station. Average total annual precipitation for thirteen of the previous fifteen years is 8.78 in. (22.30 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 thirteen of the previous fifteen years is 46.4°F (8.0°C). The average daily temperatures in January and July are 23.7°F (-4.6°C) and 69.4°F (20.8°C), respectively.

Land status

The Federal Government hold the coal mineral rights to approximately 40 percent of the Rincon Marquez 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. About 135 acres (55 ha) near the northern quadrangle boundary are within the San Juan Basin Known Recoverable Coal Resource Area. Most of the remainder of the quadrangle is within the La Ventana and Hospah Known Recoverable Coal Resource Areas. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the Rincon Marquez quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include reconnaissance mapping by Gardner (1910) who reported coal measurements in the vicinity of the Rincon Marquez quadrangle. Dane (1936) mapped Menefee Allison coal outcrops in the central southern and southeastern parts of the quadrangle. He noted that the Cliff House Sandstone contains coal beds in this area. Shomaker, Beaumont, and Kottowski (1971) outlined the potential for stippable reserves in the area and noted that the lenticularity and insufficient coal thicknesses would preclude surface mining 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 sequences.

Exposed rock units in the Rincon Marquez quadrangle include some of the sedimentary units of Upper Cretaceous age. Quaternary deposits include alluvium and terrace gravels from the Arroyo Rincon Marquez, Vincente Arroyo, and Daniel Wash.

The Point Lookout Sandstone is a prominent sandstone marker in most of the San Juan Basin and represents nearshore or littoral deposits which formed during the most extensive northeastward retreat prior to the final withdrawal of the Cretaceous seaways (Sears, Hunt, and Hendricks, 1941). Light gray to reddish-brown, fine-to medium-grained sandstone with interbedded shales comprise the lithologies of the Point Lookout Sandstone, which averages 100 ft (30 m) thick locally. The continental sediments deposited inland from the beach area during the deposition of the Point Lookout Sandstone compose the overlying Menefee Formation.

The Menefee Formation consists of dark gray to brown, carbonaceous to noncarbonaceous shales, light gray sandstones, and coal beds, and is divisible into the basal Cleary Coal Member and upper Allison Member. A massive channel sandstone sequence defines the boundary between the two members. Thickness of the Cleary Coal Member ranges from 350 to 400 ft (107 to 122 m) locally, and the Allison Member is up to 1,300 ft (396 m) thick. The Allison Member contains the only coals exposed at the surface in this quadrangle.

The Cliff House Sandstone overlies the Allison Member and represents transgressive marine sandstone deposits. Light gray, medium-grained, calcareous sandstone with interbedded shales, and local coal beds comprise the lithologies of the unit. In the southern part of the quadrangle, the Cliff House Sandstone is up to 350 ft (107 m) thick. However, near the northern quadrangle boundary, the Cliff House Sandstone is about 90 ft (27 m) thick, indicating more rapid transgressive depositional conditions in that area.

As the transgression proceeded, the Lewis Shale was deposited over the Cliff House Sandstone. Dark gray to black, silty shales with interbedded

light gray to buff, very fine-to fine grained, calcareous sandstones, and bentonite marker beds comprise the lithologies of the Lewis Shale. The Lewis Shale has been highly eroded on Chaco Mesa, and is approximately 450 ft (137 m) thick where the full section is present.

During the final northeastward retreat of the Cretaceous seaways in the San Juan Basin, the Pictured Cliffs Sandstone was deposited in a near-shore or littoral environment. Brown to yellow, thinly bedded, fine-to medium-grained sandstone comprises the lithology of the unit, which is up to 100 ft (30 m) thick where exposed near the northern boundary of the Rincon Marquez 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 Rincon Marquez quadrangle is on the border between the Central Basin and the Chaco Slope structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). Local folding and several faults with low displacements affect structure in the area. An east-west trending fault mapped by Dane (1936) at the northern edge of the quadrangle causes local dip reversals. Dips of the rock units average 2° N to NW in the Rincon Marquez quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified four coal beds and two coal zones from oil and gas well logs and Dane's (1936) surface mapping. These coal beds and coal zones are here informally called the Menefee Cleary No. 1 and No. 4 coal beds, Menefee Cleary coal zone, Menefee Allison No. 2 and No. 3 coal beds, and the Menefee Allison coal zone.

The Menefee Cleary No. 1 coal bed is the first persistent bed above the Point Lookout Sandstone. It occurs directly above the Point Lookout Sandstone in this area, although it is present up to 15 ft (5 m) above the Point Lookout Sandstone in nearby areas. The Menefee Cleary No. 4 coal bed was not identified from drill hole data in this quadrangle, but is inferred to be present based on Menefee Cleary No. 4 coal data from the western adjacent Whitehorse Rincon quadrangle. The bed is inferred to be up to 5.0 ft (1.5 m) thick, and to occur about 150 ft (46 m) above the Point Lookout Sandstone in this quadrangle. Up to seven beds comprise the Menefee Cleary coal zone, which occur from 15 to 380 ft (5 to 116 m) above the Point Lookout Sandstone.

About 650 ft (198 m) above the base of the Allison Member, the Menefee Allison No. 2 coal bed was identified in one oil and gas well log. The Menefee Allison No. 3 coal bed occurs 1,135 ft (346 m) above the base of the Allison Member, and is the only coal bed which crops out in this quadrangle. These coal beds are inferred to be continuous although they may be several individual coal beds which are stratigraphically equivalent. The Menefee Allison coal zone contains up to ten beds which occur from 500 to 1,100 ft (152 to 335 m) above the base of the Allison Member. The Menefee Allison and Menefee Cleary coal zones contain coals which may be continuous and correlative in portions of the area, but they lack sufficient continuity with poorly defined stratigraphic position and cannot be designated as persistent coal beds.

A coal quality analysis of the bed identified as the Menefee Allison No. 3 coal bed in this quadrangle was taken at an outcrop in the southeastern corner of the Rincon Marquez quadrangle. The U. S. Bureau of Mines

(1936) reported the analysis which is shown in table 1. This outcrop sample is probably weathered due to the low heating value compared with other Allison Member coal quality analyses in this area. Shomaker and Whyte (1977) sampled Allison Member coals in a core test hole about 4.5 mi (7.2 km) east of the quadrangle, which are also shown in table 1. Rank of the Allison Member coals is probably subbituminous A to high volatile C bituminous in this area.

Menefee Allison No. 3 coal bed

The Menefee Allison No. 3 coal bed was identified in seven measured sections and one oil and gas well log. Menefee Allison No. 3 coal data from the western adjacent Whitehorse Rincon quadrangle were used to infer that the bed thickens to 5.0 feet (1.5 m) along the western edge of the Rincon Marquez quadrangle. Based on the discontinuous outcrops, the coal bed is shown to occur as four individual lenses in the quadrangle.

Menefee Allison coal zone

The Menefee Allison coal zone was identified in two oil and gas well logs in the northern half of the quadrangle. The eastern most well log (data point 2, plate 1) was cased into the upper part of the Allison Member, and is therefore shown as a partial data point on plates 7 and 9, and not used as control on the structure contour map (plate 8). More than the 20 feet (6 m) of coal shown on the isopach map (plate 7) may be present at this point. Existence and character of the Menefee Allison coal zone are unknown in the southern half of the quadrangle because of insufficient data.

Table 1. - Analyses of coal samples from the Allison Member of the Menefee Formation

(Samples 1, 2, and 3 from core test hole in NE $\frac{1}{4}$ NE $\frac{1}{4}$ Sec. 11, T. 18 N.,

R. 5 W.; sample 4 from outcrop in Sec. 19, T. 18 N., R. 5 W.)

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

Samples 1, 2, and 3 from Shomaker and Whyte, 1977

Sample 4 from U. S. Bureau of Mines, 1936

Proximate analysis (percent)

Sample	Form of Analysis	Proximate analysis (percent)			Sulfur	Heating Value (Btu/lb)
		Moisture	Volatile matter	Fixed carbon		
1	A	12.0	34.1	39.9	14.0	10,410
	B	-----	38.7	45.4	15.9	11,830
	C	-----	46.1	53.9	-----	14,070
2	A	13.0	34.7	33.8	18.5	9,550
	B	-----	39.8	39.0	21.2	10,980
	C	-----	50.6	49.4	-----	13,940
3	A	11.0	34.4	35.1	19.5	9,800
	B	-----	38.7	39.4	21.9	11,020
	C	-----	49.5	50.5	-----	14,100
4	A	13.6	36.2	42.6	7.6	8,660
	B	-----	41.9	49.3	8.8	10,030
	C	-----	45.9	54.1	-----	10,990

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973), yields heating values of 12,270 Btu/lb (28,540 kJ/kg; sample 1), 11,940 Btu/lb (27,772 kJ/kg; sample 2), 12,432 Btu/lb (28,917 kJ/kg; sample 3) and 9,437 Btu/lb (21,950 kJ/kg; sample 4). No agglomerating characteristics were included with the analyses.

Menefee Allison No. 2 coal bed

The Menefee Allison No. 2 bed was identified in only one oil and gas well log in this quadrangle. It is inferred to pinch out to the south based on drill hole data from the eastern adjacent Tinian quadrangle and pinches out to the west as shown at data point 1 (plates 1 and 10).

Menefee Cleary coal zone

The Menefee Cleary coal zone was identified in three oil and gas well logs. It is inferred to thicken to 25.0 ft (7.6 m) at the western edge of the quadrangle, based on Menefee Cleary coal zone data from the western adjacent Whitehorse Rincon quadrangle. The zone is also inferred to pinch out in a band between the two 2.0 ft (0.6 m) data points (plate 13). Existence and character of the zone are unknown near the southern quadrangle boundary because of insufficient data.

Menefee Cleary No. 4 coal bed

The Menefee Cleary No. 4 coal bed is inferred to be up to 5.0 ft (1.5 m) thick based on its occurrence in three oil and gas well logs in the western adjacent Whitehorse Rincon quadrangle. The bed is inferred to pinch out in the eastern part of the Rincon Marquez quadrangle (see plate 16). Existence and character of the Menefee Cleary No. 4 coal bed are unknown in the southwestern corner of the quadrangle because of insufficient data.

Menfee Cleary No. 1 coal bed

The Menfee Cleary No. 1 coal bed is the most persistent coal bed in the quadrangle and is identified in three oil and gas well logs. Existence and character of the Menfee Cleary No. 1 coal bed are unknown in the southwestern corner of the quadrangle because of insufficient data.

COAL RESOURCES

The U. S. Geological Survey requested resource evaluations of the Menefee Allison No. 3 and No. 2, and the Menefee Cleary No. 4 and No. 1 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 and hypothetical resource categories. Reserve base was calculated for each category, by section, using data from the isopach and overburden maps (plates 4, 6, 10, 12, 16, 18, 19, and 21). The acreage in each category (measured by planimeter) multiplied by the average coal bed thickness and subbituminous coal conversion factor (1,770 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 for the Menfee Allison No. 3 and No. 2, and the Menfee Cleary No. 4 and No. 1 coal beds, which include all reserve base categories, are shown by section on plate 2. Because of the limited areal extent of the Menfee Cleary No. 4 coal bed, the areal distribution and identified resources map is included in this text as a page-sized map (fig. 3). Reserve base and reserve data in the various categories are shown on fig. 3 and plates 22, 23, and 24.

The U. S. Geological Survey also requested resource evaluations of the Menfee Allison and Menfee Cleary coal zones, where the total coal thickness is 5.0 ft (1.5 m) or greater. Total identified Menfee Allison and Menfee Cleary coal zone resources are 163.63 and 17.76 million short tons (148.45 and 16.11 million t), respectively. Total hypothetical resources are tabulated separately on plate 2 and in table 3.

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.

Figure 3

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE MENELEE CLEARY NO. 4 COAL BED

(See explanation p. 17)

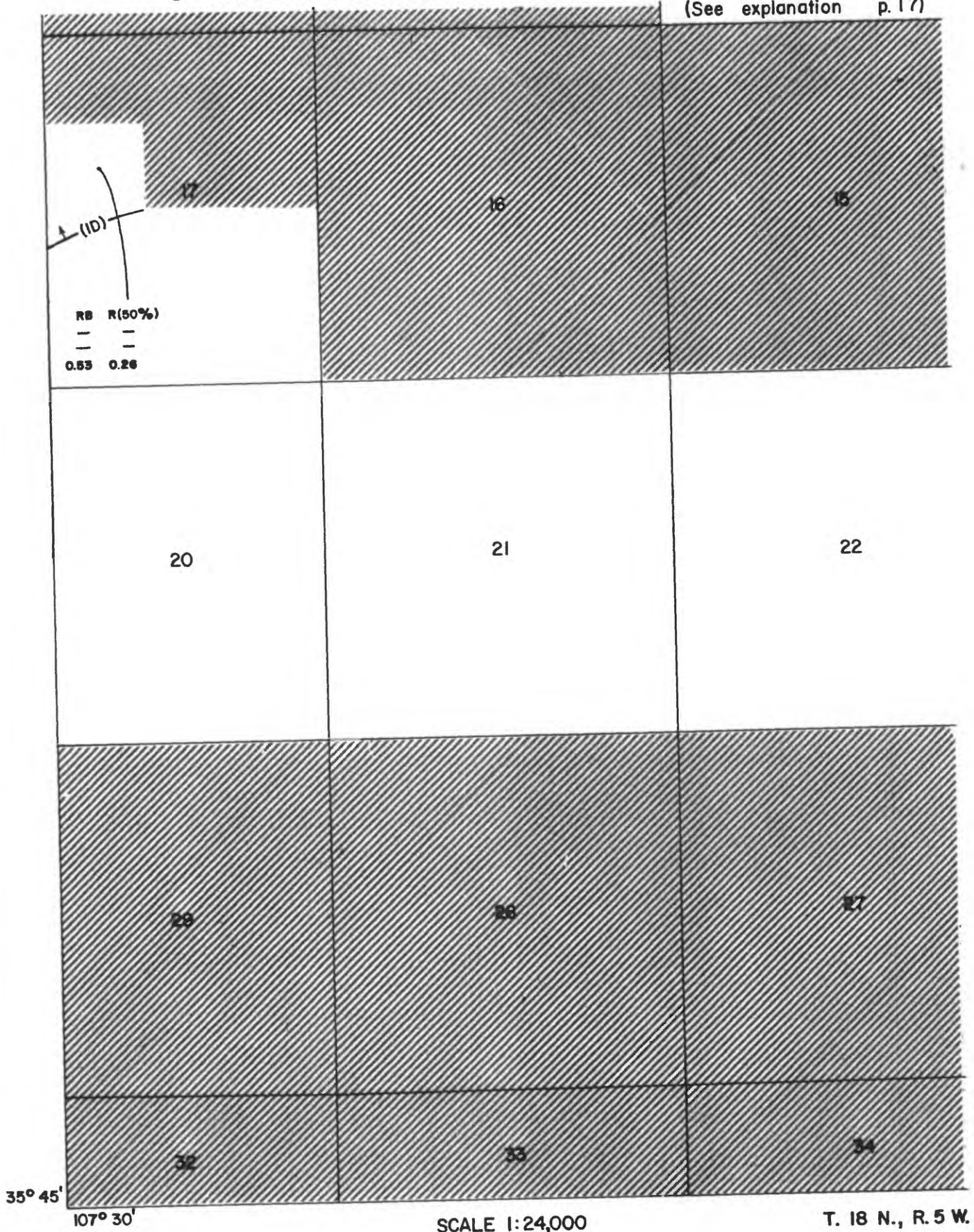


Figure 3

EXPLANATION

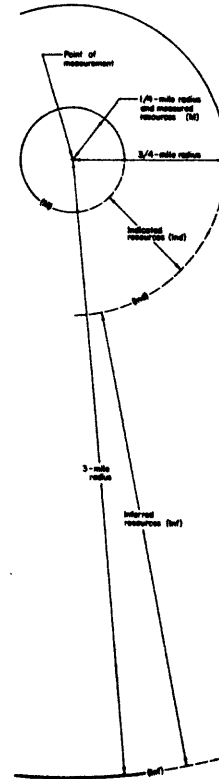


NON-FEDERAL COAL LAND—Land for which the Federal Government does not own the coal rights.

BOUNDARY OF IDENTIFIED RESERVE BASE COAL—Drawn along the insufficient data line (ID). Arrow points toward area of identified Reserve Base coal.

RB R (50%)	
--	(Measured resources)
--	(Indicated resources)
0.53 0.26	(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.

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 strip-ping 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 yd³/short ton for bituminous coal)

(.911 yd³/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 mining methods (plate 25) are defined at the contact of the coal-bearing Allison Member of the Menefee Formation with the overlying noncoal-bearing Cliff House Sandstone. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Reserve base (in short tons) in the various development potential categories for surface and subsurface mining methods are shown in tables 1 and 3, 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 Rincon Marquez quadrangle is shown on plate 25. All Federal coal lands, where the Menefee Allison No. 3 coal bed is 3.0 ft (0.9 m) or more thick, has mining ratios greater than 15 and have low development potential for

surface mining methods. In this quadrangle, the Menfee Allison No. 3 coal bed is the only bed with less than 200 ft (61 m) of overburden. Refer to table 4 for reserves and planimetered acreage, by section for Federal coal lands with development potential for surface mining methods. The remainder of the Federal coal land in the Rincon Marquez quadrangle has unknown or no development potential for surface mining methods.

Development potential for subsurface mining
methods and in situ gasification

The coal development potential for subsurface mining methods in the Rincon Marquez quadrangle is shown on plate 26. Based on coal development potential criteria, all Federal coal lands have high, moderate, low or unknown development potential for subsurface mining methods. Refer to table 5 for reserves and planimetered acreage, by section, for Federal coal lands with development potential for subsurface mining methods.

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 surface mining methods for Federal coal lands in the Rincon Marquez 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,³ multiply by 0.9072; to convert mining ratios in yds³/ton coal to m³/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
Menefee Allison No. 3	---	---	1,270,000	1,270,000
Total	---	---	1,270,000	1,270,000

Table 3. - Reserve base data (in short tons) and hypothetical resources for subsurface mining methods for Federal coal lands in the Rincon Marquez 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
Menefee Allison No. 3	3,730,000	---	---	3,730,000
Menefee Allison No. 2	---	35,230,000	---	35,230,000
Menefee Allison No. 4	---	530,000	---	530,000
Menefee Cleary No. 1	---	24,810,000	12,480,000	37,290,000
Total	3,730,000	60,570,000	12,480,000	76,780,000
<u>Hypothetical Resources</u>				
Menefee Cleary No. 1	---	4,040,000	470,000	4,510,000
Total	---	4,040,000	470,000	4,510,000

Table 4. - Reserves and planimetered acreage, by section, for Federal coal lands in the Rincon Marquez 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)
Low	Menefee Allison No. 3	12 18 6	42.0	200,000
		18 18 5	10.9	40,000
		19	33.8	160,000
		20	9.5	30,000
		30	108.3	610,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Rincon Marquez 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	Menefee Allison No. 3	12 18 6	224.6	650,000		
		17 18 5	106.9	290,000		
		18	25.7	70,000		
		19	13.5	40,000		
		20	144.8	410,000		
		30	102.8	310,000		
		20 19 6	34.9	90,000		
		Moderate	Menefee Allison No. 2	12 18 6	21.6	60,000
				16 19 5	51.0	150,000
				17	207.0	860,000
18	213.8			1,180,000		
20	642.7			2,960,000		
21	151.5			500,000		
28	151.5			630,000		
32	642.8			3,250,000		
4 18 5	148.8			560,000		
5	618.4			2,690,000		
6	636.0			2,670,000		
7	324.7			1,000,000		
8	257.1			800,000		
9	69.3	200,000				
	Menefee Cleary No. 4	17 18 6	54.1	260,000		

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Rincon Marquez quadrangle with subsurface mining potentials (continued).

[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)		
Moderate	Menefee Cleary No. 1	7	66.3	180,000		
		18	144.8	400,000		
		19	625.1	1,760,000		
		20	182.7	500,000		
		21	37.9	100,000		
		28	120.0	330,000		
		29	500.7	1,410,000		
		30	306.8	890,000		
		31	205.7	620,000		
		33	27.1	80,000		
		2	18	1,430,000		
		10	6	500,000		
		12		740,000		
		13		130,000		
		17		250,000		
		23		620,000		
		24		1,950,000		
		25		460,000		
		26		70,000		
		Low	Menefee Cleary No. 1	7	28.4	70,000
				18	304.4	840,000
				19	27.0	60,000
				20	295.0	810,000
				21	28.4	80,000
				28	28.4	80,000
				29	139.4	380,000
30	175.9			510,000		
31	5.4			10,000		
33	16.2			40,000		
2	18			60,000		
10	6			320,000		
12				1,050,000		
13				1,300,000		
24				80,000		
20				520,000		

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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 foreseeable 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.