

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

Text to accompany:
OPEN-FILE REPORT 79-1123

1985

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

[Report includes 10 plates]

Prepared by Berge Exploration, Inc.

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

SEVEN LAKES NW QUADRANGLE CONTENTS

	Page
Introduction	1
Purpose	1
Location	4
Accessibility	4
Physiography	4
Climate	5
Land status	5
General geology	6
Previous work	6
Stratigraphy	6
Depositional environments	8
Structure	9
Coal geology	9
Menefee Cleary coal zone	12
Menefee Cleary No. 1 coal bed	12
Coal resources	13
Coal development potential	17
Development potential for surface mining methods	18
Development potential for subsurface mining methods and in situ gasification	19
Selected references	21
Glossary	22

ILLUSTRATIONS

Plates 1-9. Coal resource occurrence maps:

1. Coal data map.
2. Boundary and coal data map.
3. Coal data sheet.
4. Isopach map of the total coal of the Menefee Cleary zone.
5. Structure contour map of the Menefee Cleary coal zone.
6. Isopach map of overburden and interburden of the Menefee Cleary coal zone.
7. Isopach map of the Menefee Cleary No. 1 coal bed.
8. Structure contour map of the Menefee Cleary No. 1 coal bed.
9. Isopach map of overburden of the Menefee Cleary No. 1 coal bed.

10. Coal development potential map:

10. Coal development potential for subsurface mining methods.

	Page
Figure 1. Location of project area	2
2. Index to USGS 7 1/2-minute quadrangles and coal resource occurrence/coal development potential maps in the southern San Juan Basin area, New Mexico	3
3a, 3b. Areal distribution and identified resources of the Menefee Cleary No. 1 coal bed	14-15
Explanation for figures 3a and 3b	16

TABLES

Table 1.	Analysis of coal samples from the Allison Member of the Menefee Formation	11
2.	Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Seven Lakes NW quadrangle.....	20
3.	Reserves and planimetered acreage, by section, for Federal coal lands in the Seven Lakes NW quadrangle with subsurface mining potential	20

INTRODUCTION

Purpose

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

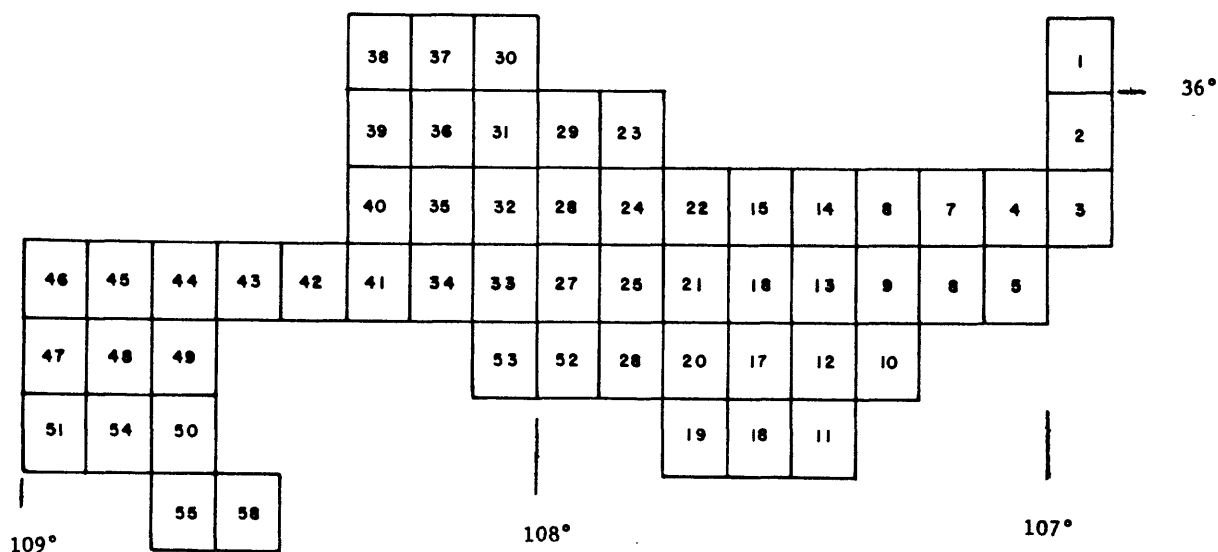
The purpose of this Coal Resource Occurrence-Coal Development Potential program, which was conceived by Congress as part of its Federal Coal Leasing Amendments Act of 1976, is to obtain coal resource information and to determine the geographical extent of Federal coal deposits. In addition, the program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

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

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

FIGURE 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	Tse 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 Seven Lakes NW 7½ minute quadrangle includes acreage in Tps. 19 and 20 N., Rs. 10 and 11 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

State Highway 57 passes through the quadrangle and provides access to Chaco Canyon National Monument, about 1.5 (2 km) north, and to Interstate Highway 40, 47 mi (76 km) south of the quadrangle. Unimproved dirt roads traverse most parts of the area. The Atchison, Topeka, and Santa Fe Railroad line passes about 36 mi (58 km) south of the quadrangle (see fig. 1).

Physiography

The Seven Lakes NW quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). Gently rolling flat land topography characterizes the area.

No perennial streams are present in the quadrangle. Local drainage is provided by several intermittent arroyos including Fajada Wash and Kin Klizhin Wash. Elevations within the quadrangle range from less than 6,200 ft (1,890 m) along Fajada Wash at the northern quadrangle boundary to over 6,820 ft (2,079 m) in the northeast corner.

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 Chaco Canyon National Monument Station. The Seven Lakes NW quadrangle is about 4 mi (6 km) south of the Chaco Canyon National Monument Station. Average total annual precipitation for thirteen of the previous fifteen years is 8.75 in. (22.23 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 eleven of the previous fifteen years is 48.4⁰ F (9.1⁰ C). The average daily temperatures in January and July are 26.3⁰ F (-3.2⁰ C) and 72.5⁰ F (22.5⁰ C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 5 percent of the Seven Lakes NW 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 3,100 acres (1,255 ha) in the southern portion of the quadrangle are within the Hospah 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 Seven Lakes NW quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Dobbin (1932) who mapped the area and reported outcrops of Allison Member coals, although no coal measurements were included with his work. Shomaker, Beaumont, and Kottlowski (1971) noted an Allison Member coal outcrop along Chaco Mesa. They did not estimate any strippable coal reserves in this area because of the excessive overburden and insufficient coal thicknesses. Shomaker and Whyte (1977) estimated Menefee Formation coal resources overlain by less than 500 ft (152 m) of overburden as 2.3 million short tons (2.1 million t) for T. 19 N., R. 10 W., 39.4 million short tons (35.7 million t) for T. 20 N., R. 10 W., and 18.0 million short tons (16.3 million t) for T. 20 N., R. 11 W. Portions of these areas are within the Seven Lakes NW quadrangle.

Stratigraphy

Within the San Juan Basin, the shoreline positions of the Cretaceous seaways changed innumerable times. The overall regional alignment of the shorelines trended N. 60° W.-S. 60° E. (Sears, Hunt, and Hendricks, 1941). The transgressive and regressive shoreline migrations are evidenced by inter-tonguing relationships of the 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 Seven Lake NW quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium along drainages in the area. The Menefee Formation is exposed at the surface over most of the quadrangle.

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 final withdrawal of the Cretaceous seaways in the San Juan Basin (Sears, Hunt, and Hendricks, 1941). The Point Lookout Sandstone is composed of light gray to reddish-brown, fine to medium grained sandstone with interbedded shales and is 100 to 115 ft (30 to 35 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. The Cleary Coal Member contains the most important coal beds in this area, and is 400 to 500 ft (122 to 152 m) thick locally. The Allison Member represents continued continental sedimentation. Erosion has reduced the Allison Member to about 870 ft (265 m) thick in some areas, although the full thickness of the member is about 1,250 ft (380 m). Intertonguing of the Allison Member with the overlying Cliff House Sandstone indicates the instability of the Cretaceous shorelines during transition from regressive to transgressive depositional conditions in this area.

The Cliff House Sandstone formed in a nearshore marine environment as the Cretaceous seaways advanced southwestward during the final transgression in the San Juan Basin. The Cliff House Sandstone crops out in the extreme northeast corner of the quadrangle and consists of light gray, medium grained, locally calcareous sandstone with interbedded shales and local coal beds. Erosion has reduced the unit to about 150 ft (46 m) thick locally. Where the full section is present, the Cliff House Sandstone is about 360 ft (110 m) thick in this area.

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 Seven Lakes NW quadrangle is in the Central Basin and Chaco Slope structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). No major structural features are present in the quadrangle. The rock units dip from 1° to 2° N. to NE. Dobbin (1932) did not map any faults in the area.

COAL GEOLOGY

In this quadrangle, the authors identified one coal bed and two coal zones in oil and gas well logs. The bed and zones are here informally called the Menefee Cleary No. 1 coal bed, Menefee Cleary coal zone, and Menefee Allison coal zone.

The Menefee Cleary No. 1 coal bed is the lowest, stratigraphically, identified coal bed in the Seven Lakes NW quadrangle. It is the first persistent coal bed above the Point Lookout Sandstone. In this quadrangle,

the Menefee Cleary No. 1 bed occurs up to 5 ft (1.5 m) above the Point Lookout Sandstone, although in nearby areas it is up to 15 ft (5 m) above the Point Lookout Sandstone. The bed is inferred to be continuous although it may be several individual beds that are stratigraphically equivalent.

Up to five beds which occur from 15 to 310 ft (5 to 94 m) above the Point Lookout Sandstone comprise the Menefee Cleary coal zone. Beds of the Menefee Allison coal zone occur from 760 to 1,415 ft (232 to 431 m) above the Point Lookout Sandstone. These zone beds 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.

There are no published coal quality analyses for the Cleary Coal Member or Allison Member beds from the Seven Lakes NW quadrangle. An analysis of Allison Member coal from the abandoned Pueblo Bonito mine, about 4 mi (6 km) north of the quadrangle, has been reported by the U. S. Bureau of Mines (1936) and is shown in table 1. The Allison Member bed analyzed is probably similar in quality to the Allison Member and Cleary Coal Member beds in this quadrangle. Rank of the Allison Member and Cleary Coal Member is probably subbituminous A to high volatile C bituminous in this area.

Table 1. - Analysis of a coal sample from the Allison Member of the Menefee Formation.

(Mine sample from Sec. 14, T. 21 N., R. 11 W.)

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

from U. S. Bureau of Mines, 1936

Form of Analysis	Proximate analysis (percent)					Heating Value (Btu/lb)
	Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	
A	14.4	34.8	42.3	7.5	1.5	10,220
B	-----	40.7	50.5	8.8	1.8	11,940

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973), yields a heating value of 11,139 Btu/lb (25,909 kJ/kg). No agglomerating characteristics were included with the analysis.

Menefee Cleary coal zone

The Menefee Cleary coal zone was identified in four of the six drill holes in this quadrangle and contains up to 11.5 ft (3.5 m) of coal in five individual beds. Each zone bed ranges from 2.0 to 3.0 ft (0.6 to 0.9 m) thick. No Menefee Cleary zone coals were identified in drill holes #3 and #4 (see plate 3), and these data points were used to infer that the zone pinches out to the east.

Menefee Cleary No. 1 coal bed

The Menefee Cleary No. 1 bed was identified in all six of the drill holes in this quadrangle and ranges in thickness from 2.0 ft (0.6 m) to 3.5 ft (1.1 m) including a 1.5 ft (0.5 m) rock parting. The bed is inferred to thicken to 6.0 ft (1.8 m) in the southeast corner of the quadrangle based on Menefee Cleary No. 1 data in the southern adjacent Seven Lakes quadrangle. In the southwest corner of the Seven Lakes NW quadrangle, the Menefee Cleary No. 1 bed is inferred to thicken to 4.0 ft (1.2 m) also based on data from the Seven Lakes quadrangle. The bed is inferred to pinch out in the northeastern corner of the quadrangle based on Menefee Cleary No. 1 coal data from the eastern adjacent Seven Lakes NE quadrangle.

COAL RESOURCES

The U. S. Geological Survey requested a resource evaluation of the Menefee Cleary No. 1 coal bed, where the bed is 3.0 ft (0.9 m) or more thick. The evaluation is restricted to Federal coal lands.

The following procedures were prescribed by the U. S. Geological Survey for the calculation of reserve base. Criteria established in U. S. Geological Survey Bulletin 1450-B were used to areally divide the bed into measured, indicated, and inferred reserve base categories. Reserve base was calculated for each category, by section, using data from the isopach and overburden maps (plates 7 and 9). 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 a 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B. Reserve figures are derived from reserve base totals by applying a recovery factor of 50 percent for coal beds 200 to 3,000 ft (61 to 914 m) deep. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Total reserve base data for the Menefee Cleary No. 1 coal bed, which include all reserve base categories, are shown by section on plate 2. Reserve base and reserve data in the various categories for the Menefee Cleary No. 1 coal bed are shown in figures 3a. and 3b.

Figure 3a

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE
MENEFFEE CLEARY NO.1 COAL BED

(See explanation p. 16)

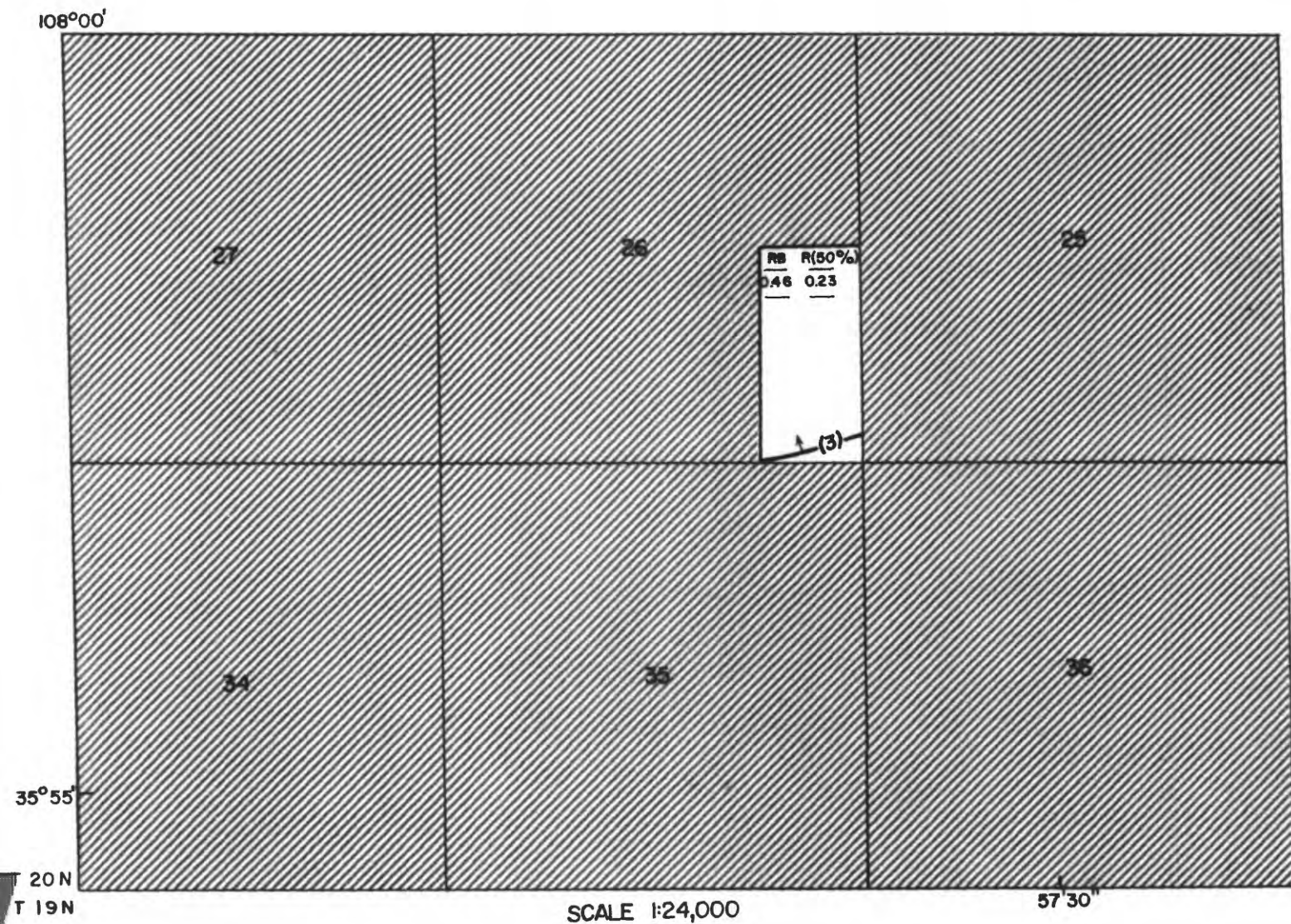
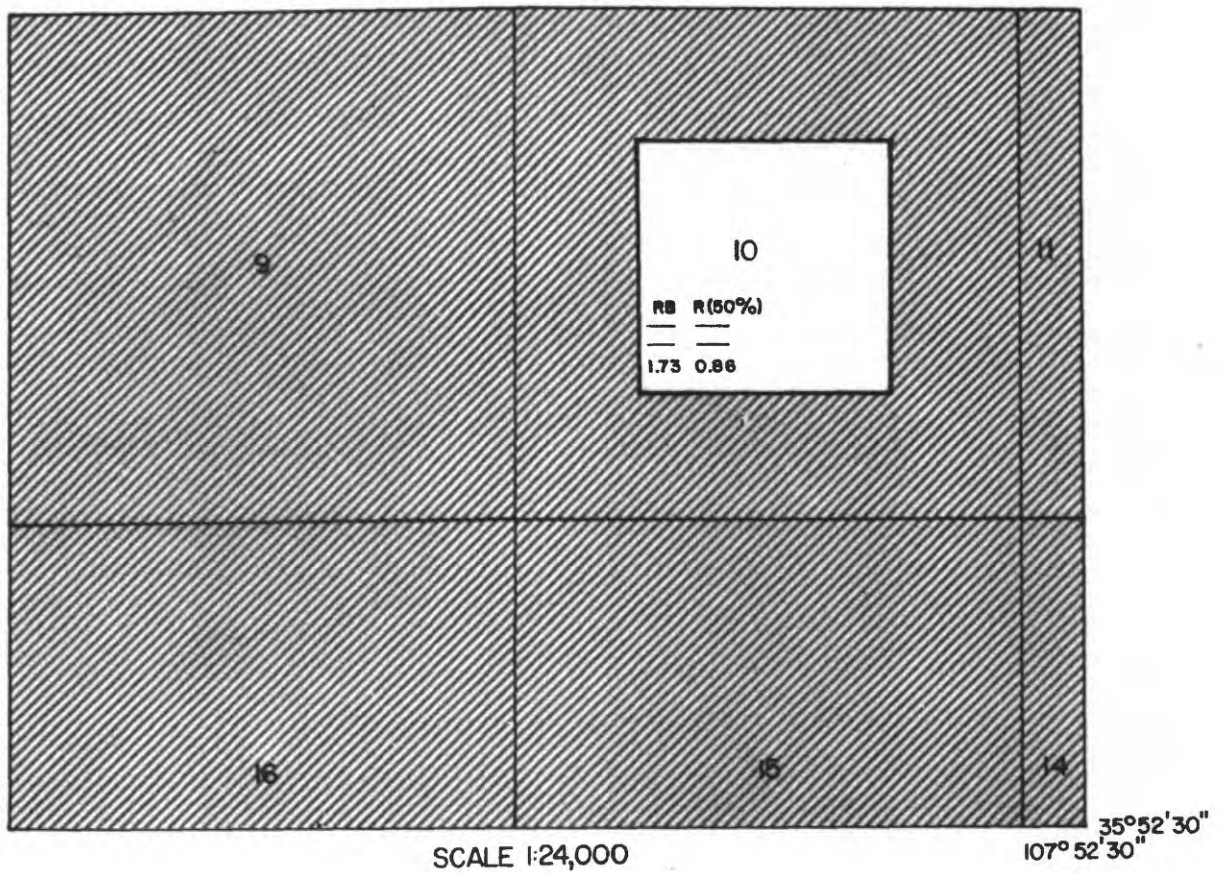


Figure 3b

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE
MENEFFEE CLEARY NO.1 COAL BED

(See explanation p. 16)



Figures 3a-3b

EXPLANATION

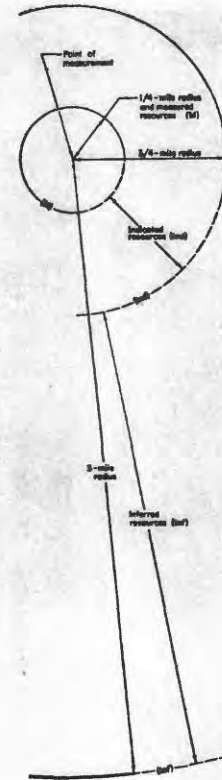


NON-FEDERAL COAL LAND—Land for which the Federal Government does not own the coal rights.

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%)	
—	—	(Measured resources)
0.46	0.23	(Indicated resources)
1.73	0.86	(Inferred resources)

IDENTIFIED COAL RESOURCES—Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section or part of section of 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 miles to kilometers, multiply miles by 1.609.

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

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

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

The U. S. Geological Survey also requested a resource evaluation of the Menefee Cleary coal zone. Total identified resources were calculated only where the total coal thickness is 5.0 ft (1.5 m) or greater. The Menefee Cleary coal zone has total identified resources of 11.13 million short tons (10.10 million t).

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 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.

Any area underlain by a potentially coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining.

Areas where a potentially coal-bearing formation is overlain by more than 3,000 ft (914 m) of overburden have no subsurface mining potential.

Development potential for subsurface mining is unknown where a potentially coal-bearing formation within 200 to 3,000 ft (61 to 914 m) of the surface contains no identified correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) thick. High, moderate, and low development potential areas have respective overburden values of 200 to 1,000 ft (61 to 305 m), 1,000 to 2,000 ft (305 to 610 m), and 2,000 to 3,000 ft (610 to 914 m).

Boundaries of coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acre 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) for the Menefee Cleary No. 1 coal bed for subsurface mining methods is shown in table 2.

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

Development potential for surface mining methods

Based on coal development potential criteria, all Federal coal land has unknown development potential for surface mining methods in the Seven Lakes NW quadrangle.

Development potential for subsurface mining
methods and in situ gasification

The coal development potential for subsurface mining methods in the Seven Lakes NW quadrangle is shown on plate 10. Based on coal development criteria, all Federal coal lands have subsurface mining potentials of moderate or unknown. Refer to table 3 for reserves and planimetered acreage, by section, for Federal coal lands with subsurface mining potential.

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

Table 2. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Seven Lakes NW 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 Cleary No. 1	-----	2,190,000	-----	2,190,000
Total	-----	2,190,000	-----	2,190,000

Table 3. - Reserves and planimetered acreage, by section, for Federal coal lands in the Seven Lakes NW 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)
Moderate	Menefee Cleary No. 1	10 19 10	160.0	860,000
		26 20 11	79.0	230,000

SELECTED REFERENCES
(SEVEN LAKES NW QUADRANGLE)

#29

- 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.
- Dobbin, C. E., 1932, U.S. Geological Survey unpublished mapping.
- 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.
- O'Sullivan, R. B., Repenning, C. A., Beaumont, E. C., and Page, H. G., 1972, Stratigraphy of the Cretaceous rocks and the Tertiary Ojo Alamo Sandstone, Navajo and Hopi Indian Reservations, Arizona, New Mexico, and Utah: U.S. Geological Survey Professional Paper 521-E, 65 p.
- 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., 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.
- 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 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.