UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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FEDERAL COAL RESOURCE OCCURRENCE AND COAL DEVELOPMENT POTENTIAL MAPS OF THE ARROYO EMPEDRADO 7 1/2-MINUTE QUADRANGLE, SANDOVAL COUNTY, NEW MEXICO

[Report includes 13 plates]

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ILLUSTRATIONS

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INTRODUCTION

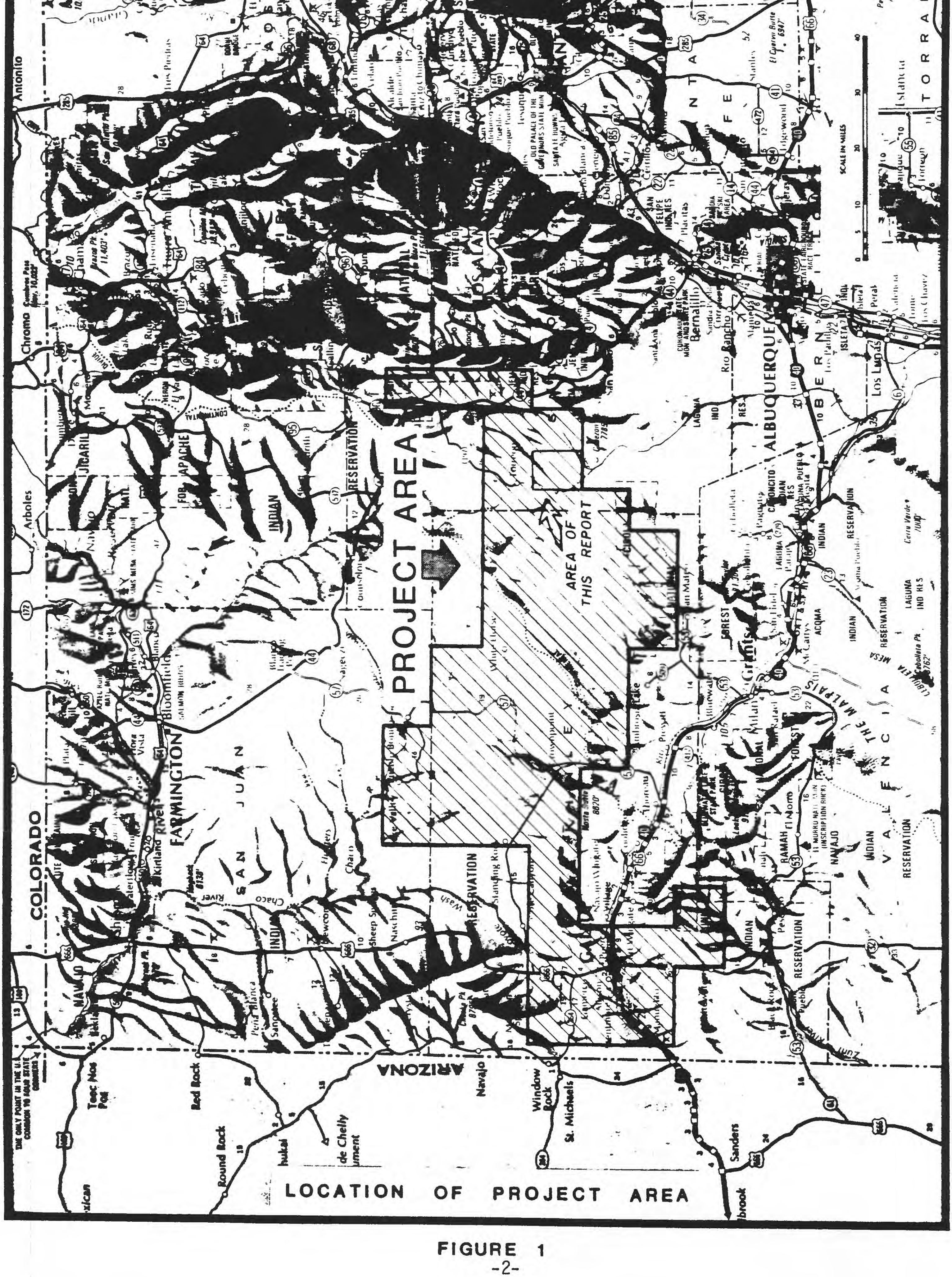
Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Arroyo Empedrado 7 1/2 minute quadrangle, Sandoval 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 Published and unpublished public information was used as the data base for this study.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.

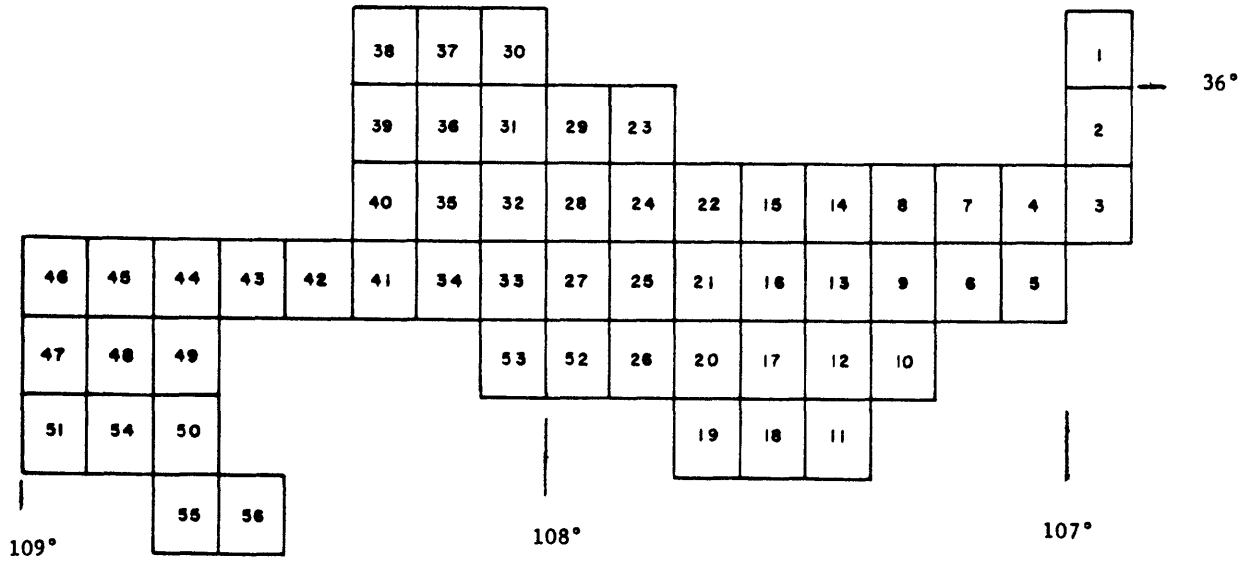


LOCATION OF PROJECT AREA
PROJECT AREA
AREA OF THIS REPORT
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Bernalillo
Rio Rancho
Grants
Bloomfield
Chromo
Arboles
Antonito
Window Rock
St. Michaels
Red Rock
Round Rock
Sanders
Navajo
Los Lunas
RESERVATION
INDIAN
SCALE IN MILES

FIGURE 1

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

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



Location

The Arroyo Empedrado 7 1/2 minute quadrangle includes acreage in Tps. 16, 17 and 18 N., Rs. 3 and 4 W. of the New Mexico Principal Meridian, Sandoval County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

No paved roads pass through the Arroyo Empedrado quadrangle. Unimproved dirt roads traverse some portions of the area, providing access to the towns of Torreon on State Highway 197, 2 mi (3 km) north of the quadrangle, and Guadalupe 9 mi (14 km) south. The Atchison, Topeka, and Santa Fe Railroad line passes about 40 mi (64 km) SE. of the quadrangle (see fig. 1). An abandoned railroad line which served coal mines in the La Ventana area during the 1920's and 1930's is about 8.5 mi (13.7 km) east of the Arroyo Empedrado quadrangle.

Physiography

The Arroyo Empedrado 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 mesas dissected by numerous arroyos and alluvial valley floors. San Luis Mesa is a prominent mesa in the southern part of the quadrangle.

No perennial streams are present in the quadrangle. Local drainage is provided by the Arroyo Chico, Torreon Wash, and other intermittent arroyos. Elevations within the quadrangle range from 5,980 ft (1,823 m) along Arroyo Chico in the southwest corner to 6,720 ft (2,048 m) along the eastern 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 Torreon Navajo Mission Station. The Arroyo Empedrado quadrangle is about 2 mi (3 km) south of the Torreon Navajo Mission Station. Average total annual precipitation for thirteen of the previous fifteen years is 9.94 in (25.25 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 49.5° F (9.7° C). The average daily temperature in January and July are 27.4° F (-2.6° C) and 72.7° F (22.6° C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 85 percent of the Arroyo Empedrado 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. The northern four-fifths of the quadrangle is within the La Ventana Known Recoverable Coal Resource Area. A small area of about 10 acres (4 ha) in the northwest corner of the quadrangle is within the San Juan Basin 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 Arroyo Empedrado quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Gardner (1910) who reported several coal measurements in the vicinity of the Arroyo Empedrado quadrangle. Hunt (1936) mapped Menefee Cleary coal outcrops traversing the south-central portion of the quadrangle. Shomaker, Beaumont, and Kottlowski (1971) reported Menefee Cleary coals and estimated 70 thousand short tons (60 thousand t) of strippable coal at a depth of less than 60 feet (18 m) for T. 17 N., R. 4 W. About 45 percent of T. 17 N., R. 4 W., is within the Arroyo Empedrado quadrangle. Tabet and Frost (1979) mapped the surface geology including coal outcrops in the northern three-fourths of the

Arroyo Empedrado quadrangle. Their study was completed after the compilation of these maps although some of their preliminary data were used in this quadrangle. Their open file report should be consulted for additional coal data in this 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 Arroyo Empedrado quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium and terrace gravels along drainages in the area.

The "main body" of the Mancos Shale is the oldest exposed rock unit in this quadrangle and represents transgressive marine deposits, consisting of light to dark gray silty shales with interbedded brown calcareous sandstones. The Arroyo Empedrado quadrangle is located in an area of the basin that had relatively stable, deep marine conditions, evidenced by the extremely thick Mancos Shale. The unit is over 1,000 ft (305 m) thick in the area and is represented on plate 3, in partial section, as 50 ft

(15 m). In other areas of the San Juan Basin, the Gallup Sandstone and various members of the Crevasse Canyon Formation were deposited atop the Mancos Shale. These units were not deposited in this area, so the Mancos Shale represents continued marine sedimentation.

The Hosta Tongue of the Point Lookout Sandstone was deposited over the Mancos Shale during a transgressive shoreline sequence, and consists of light gray to reddish-brown, fine to medium grained, massive sandstone with interbedded light gray shales. It formed in a nearshore environment and is about 50 ft (15 m) thick locally.

Overlying the Hosta Tongue is the Satan Tongue of the Mancos Shale, representing deeper marine conditions as the transgression to the southwest continued. The Satan Tongue is composed of a light to dark gray shale, interbedded with tan to buff, well sorted, calcareous sandstone and is 200 ft (61 m) thick locally.

In this quadrangle, the maximum northeastward development of the Hosta Tongue is evidenced. As a result, the Satan Tongue loses identity as a separate member of the Mancos Shale, causing a thickening of the Mancos section in the east-northeast portion of the quadrangle.

The Point Lookout Sandstone represents nearshore or littoral deposits which formed during the most extensive northeastward retreat prior to the final withdrawal of the Cretaceous seaways in the San Juan Basin (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. The unit averages 100 ft (30 m) thick locally. The continental sediments deposited inland from the beach area during 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 the upper Allison Member. A massive channel sandstone sequence defines the boundary between the two members. The Cleary Coal Member is 360 to 450 ft (110 to 137 m) thick locally. All of the identified coals in this quadrangle occur within the lower 230 ft (70 m) of the Cleary Coal Member. Erosion has reduced the Allison Member to about 400 ft (122 m) thick in this area. No Allison Member coals have been identified in the 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 represents 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 Arroyo Empedrado quadrangle is in the Chaco Slope structural division in the southeastern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The Nacimiento fault system is northeast of the quadrangle and influences strikes of the rock units in the northeastern corner of the Arroyo Empedrado quadrangle. Hunt (1936) mapped several low displacement faults in the area, which form horsts and grabens. The structure contour maps (plates 5 and 8) indicate dips of 1^{o} to 3^{o} N in the majority of the quadrangle and about 2^{o} W to NW in the northeast corner.

COAL GEOLOGY

In this quadrangle, the authors identified three coal beds and one coal zone from oil and gas well logs, coal test hole logs and Hunt's (1936) surface mapping. These beds and zone are here informally called the Menefee Cleary No. 1, No. 2 and No. 3 coal beds, and the Menefee Cleary coal zone.

The Menefee Cleary No. 1 coal bed is stratigraphically the lowest persistent bed identified and occurs 1 to 13 ft (0.3 to 4 m) above the Point Lookout Sandstone in this quadrangle. The Menefee Cleary No. 2 and No. 3 coal beds are the second and third persistent coal beds identified, and occur 20 ft (6 m) and 70 to 90 ft (21 to 27 m) above the Point Lookout Sandstone, respectively. The Menefee Cleary No. 2 was identified in only one well log and is of very limited areal extent. These beds are inferred to be continuous although they may be several individual coal beds that are stratigraphically equivalent.

The Menefee Cleary coal zone contains up to seven beds and ranges from 22 to 229 ft (7 to 70 m) above the Point Lookout Sandstone. These zone coals 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 coal beds from the Arroyo Empedrado quadrangle. Analyses of three coal samples from drill cuttings of beds which the authors correlated as the Menefee Cleary No. 1 bed taken about 4.5 mi (7.2 km) east of the quadrangle

have been reported by Woodward and Clyde (1977) and are shown in table 1. Two other Cleary Coal Member samples from the abandoned San Juan Mine (sample 4) and Wilkins No. 2 prospect (sample 5) taken about 12.5 and 16.5 mi (20.1 and 26.5 km), respectively, northeast of the quadrangle have been reported by the U. S. Bureau of Mines (1936) and are shown in table 1. The Cleary Coal Member beds in the quadrangle are probably similar in quality to the Cleary Coal Member beds analyzed. Rank of the Cleary Coal Member beds is high volatile C bituminous in this area.

Menefee Cleary No. 3 coal bed

The Menefee Cleary No. 3 coal bed was identified in seven outcrop measurements and four well logs with up to 3.9 ft (1.2 m) of coal. The bed is 2.0 ft (0.6 m) thick or less over the majority of the quadrangle. Some of the outcrop measurements contained more than one coal bench seperated by a rock parting.

The procedure prescribed by the U. S. Geological Survey regarding rock partings in coal beds with 200 ft (61 m) or less overburden, was to add the coal benches together as a total coal thickness.

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

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

Samples 1, 2 and 3 from Woodward and Clyde, 1977
Samples 4 and 5 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	Drill cuttings	NE¼ 16	17	2	A	13.80	34.76	36.77	14.67	1.28	9,973
2	Drill cuttings	NE¼ 16	17	2	A	16.65	33.96	41.11	8.28	0.59	10,508
3	Drill cuttings	NE¼ 16	17	2	A	13.99	34.55	37.19	13.67	0.55	10,052
4	Mine sample (San Juan Mine)	SW¼ 31	19	1	A	15.7	32.0	45.1	7.2	0.6	10,790
					B	---	38.0	53.5	8.5	0.7	12,800
					C	---	41.5	58.5	---	0.8	13,990
5	Prospect sample (Wilkins No. 2 prospect)	SW¼ 26	19	1	A	18.2	34.4	40.8	6.6	0.9	10,280
					B	---	42.0	49.9	8.1	1.0	12,570

Remarks:

A moist, mineral-matter-free (MMMF) calculation, using the Parr formula (American Society for Testing and Materials, 1973), yields heating values of 11,874 Btu/lb (27,619 kJ/kg; sample 1), 11,549 Btu/lb (26,863 kJ/kg; sample 2), 11,803 Btu/lb (27,454 kJ/kg; sample 3), 11,709 Btu/lb (27,235 kJ/kg; sample 4) and 11,080 Btu/lb (25,772 kJ/kg; sample 5). No agglomerating characteristics are available for these analyses.

Menefee Cleary No. 1 coal bed

The Menefee Cleary No. 1 coal bed is the thickest identifiable coal bed in the quadrangle. The bed was identified in eleven outcrop measurements and in all six of the test holes in this quadrangle. Plate 4 indicates large areal extent of the bed, thickening to 9.0 ft (2.7 m) in the northern portion of the quadrangle, based on coal bed data from the northern adjacent Wolf Stand quadrangle.

COAL RESOURCES

The U. S. Geological Survey requested resource evaluations of the Menefee Cleary No. 1 and No. 3 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 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 4, 6, 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 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 Meneree Cleary No. 1 and No. 3 coal beds, which include all reserve base categories, are shown by section on plate 2. Reserve base and reserve data in the various categories are shown on plates 10 and 11.

COAL DEVELOPMENT POTENTIAL

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

Any area underlain by a potentially coal-bearing formation with 200 ft (61 m) or less of overburden has potential for surface mining. The U. S. Geological Survey designated the 200 ft (61 m) maximum depth as the stripping limit. Areas where a potentially coal-bearing formation is overlain by more than 200 ft (61 m) of overburden have no potential for surface mining. Areas with no correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) in thickness and overlain by 200 ft (61 m) or less of overburden

have unknown surface mining potential. Areas which have a correlative coal bed 3.0 ft (0.9 m) or more thick with surface mining potential are assigned a high, moderate or low development potential based on the mining ratio (cubic yards of overburden per short ton of recoverable coal). The formula used to calculate mining ratios is:

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

Where MR = Mining ratio

t_o = Thickness of overburden in feet

t_c = Thickness of coal in feet

Rf = Recovery factor

C = Volume-weight conversion factor

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

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

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

Any area underlain by a potentially coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining. Areas where a potentially coal-bearing formation is overlain by more than 3,000 ft (914 m) of overburden have no subsurface mining potential. Development potential for subsurface mining is unknown where a potentially coal-bearing formation within 200 to 3,000 ft (61 to 914 m) of the surface contains no identified correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) thick. 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 (plates 12 and 13) are defined at the contract of the coal-bearing Menefee Formation with the underlying noncoal-bearing Point Lookout Sandstone. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Boundaries of coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acre or lot). When a land subdivision contains areas with different development potentials, the potential shown on the map is that of the areally largest of the component areas. 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 2 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 Arroyo Empedrado quadrangle is shown on plate 12. Based on coal development potential criteria, all Federal coal lands have high, moderate, low, unknown or no development potential for surface mining methods. Refer to table 4 for reserves and planimetered acreage, by section, for Federal coal lands with 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 Arroyo Empedrado quadrangle is shown on plate 13. Based on coal developemnt potential criteria, all Federal coal lands have high, unknown or no development potential for subsurface mining methods. Refer to table 5 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 surface mining methods for Federal coal lands in the Arroyo Empedrado quadrangle, Sandoval 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
Menefee Cleary No. 3	2,160,000	1,380,000	6,650,000	10,190,000
Menefee Cleary No. 1	3,100,000	1,880,000	9,960,000	14,940,000
Total	5,260,000	3,260,000	16,610,000	25,130,000

Table 3. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Arroyo Empedrado quadrangle, Sandoval 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' - 1000' overburden)	Moderate Development Potential (1000' - 2000' overburden)	Low Development Potential (2000' - 3000' overburden)	Total
Menefee Cleary No. 3	10,300,000	---	---	10,300,000
Menefee Cleary No. 1	133,360,000	---	---	133,360,000
Total	143,660,000			143,660,000

Table 4. - Reserves and planimetred acreage, by section, for Federal coal lands in the Arroyo Empedrado quadrangle with surface mining potential.

[To convert acres to hectacres, 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 Cleary No. 3	29	17	3	25.9	160,000
		30			37.1	200,000
		31			38.0	190,000
		25	17	4	68.6	440,000
		26			63.2	390,000
		35			77.5	410,000
	Menefee Cleary No. 1	6	16	3	48.5	250,000
		22	17	3	10.8	50,000
		26			2.1	less than 10,000
		27			21.6	100,000
		31			254.0	1,980,000
		25	17	4	3.5	10,000
		27			38.5	190,000
Moderate	Menefee Cleary No. 3	29	17	3	21.3	130,000
		30			41.2	240,000
		31			3.0	10,000
		25	17	4	52.2	330,000
		26			37.1	230,000
		35			31.9	180,000

Table 4. - Reserves and planimetered acreage, by section, for Federal coal lands in the Arroyo Empedrado quadrangle with surface mining potential (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	5	16	3	5.4	20,000
		6			2.5	10,000
		22	17	3	8.1	30,000
		27			10.8	50,000
		30	17	3	9.4	90,000
		31			120.8	940,000
		25	17	4	34.4	290,000
		27			24.7	120,000
Low	Menefee Cleary No. 3	29	17	3	95.8	600,000
		30			163.4	1,060,000
		23	17	4	51.7	270,000
		24			76.0	380,000
		25			232.1	1,580,000
		26			235.0	1,540,000
		35			25.7	150,000
	Menefee Cleary No. 1	21	17	3	72.9	340,000
		22			88.9	440,000
		27			17.5	70,000
		29			74.1	370,000
		30			169.7	1,410,000
		31			132.7	910,000
		22	17	4	152.4	1,070,000
		23			164.8	1,130,000
		25			160.7	1,320,000
		26			17.8	70,000
		27			221.2	1,240,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Arroyo Empedrado 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 Cleary No. 3	19	17		3		293.4	950,000
		20					104.9	330,000
		29					114.1	360,000
		30					398.3	1,600,000
		23	17		4		16.7	50,000
		24					103.3	310,000
		25					276.1	1,060,000
		26					115.4	390,000
	Menefee Cleary No. 1	4	17		3		639.9	3,090,000
		5					640.0	4,310,000
		6					639.5	5,140,000
		7					640.2	4,550,000
		8					633.2	3,500,000
		9					634.6	2,290,000
		10					56.6	160,000
		17					640 1	2,940,000
		18					640.0	3,920,000
		19					639.8	3,550,000
		20					636.0	2,300,000
		21					265.5	820,000
		29					219.6	720,000
		30					460.8	2,310,000
		3	17		4		472.9	2,570,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Arroyo Empedrado quadrangle with subsurface mining potential. (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)
High	Menefee Cleary No. 1	10					474.3	2,730,000
		13					639.0	4,300,000
		14					640.0	3,490,000
		15					475.6	2,390,000
		22					326.1	1,340,000
		23					475.2	2,130,000
		24					639.4	3,840,000
		25					440.9	2,250,000
		26					208.8	640,000
		27					67.3	220,000
		34	18		4		235.8	1,090,000

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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.
