UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

OPEN-FILE REPORT 79-1046

1985

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

[Report includes 23 plates (24 sheets)]

Prepared by Berge Exploration, Inc.

WOLF STAND QUADRANGLE
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INTRODUCTION

Purpose

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

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

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

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 Published and unpublished public information was used as the data base for this study.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

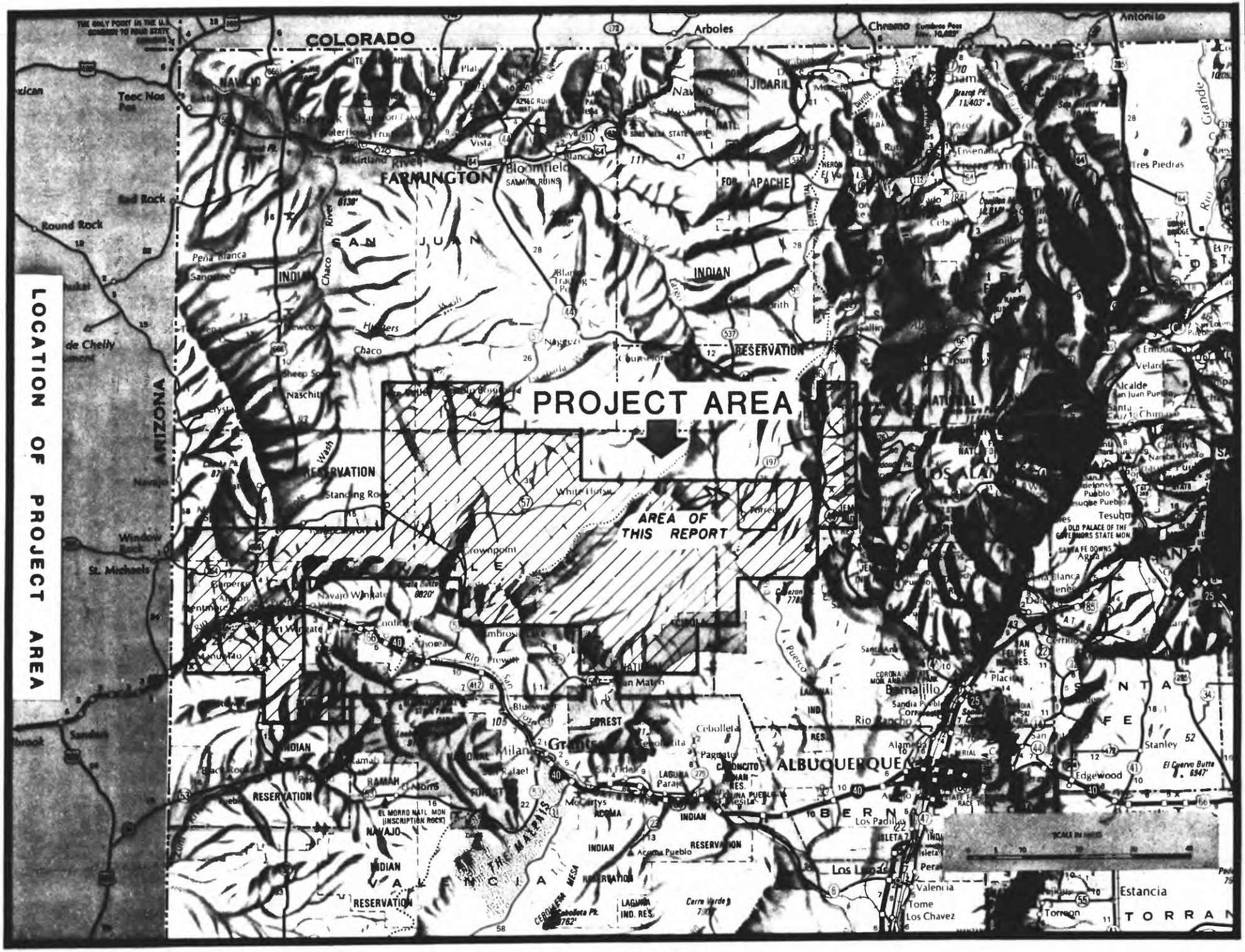
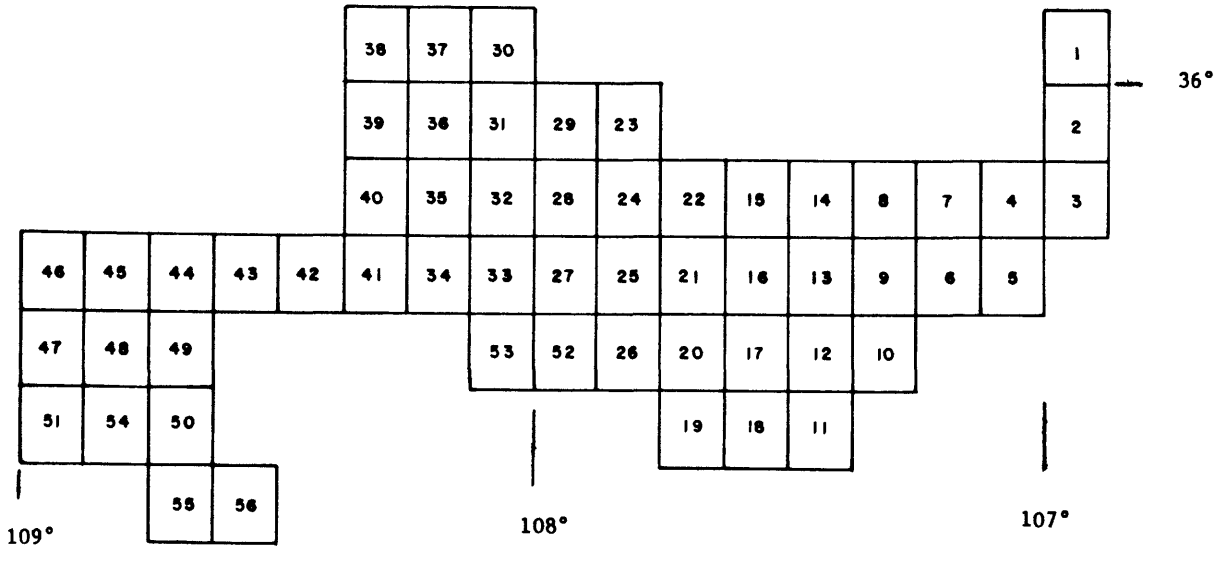


FIGURE 1

LOCATION OF PROJECT AREA

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

Map No.	Quadrangle	Open-file report
1	Cuba	79- 623
2	San Pablo	79- 624
3	La Ventana	79-1038
4	Headcut Reservoir	79-1043
5	San Luis	79-1044
6	Arroyo Empedrado	79-1045
7	Wolf Stand	79-1046
8	Tinian	79- 625
9	Canada Calladita	79- 626
10	Cerro Parido	79- 627
11	El Dado Mesa	79- 628
12	Mesa Cortada	79- 629
13	Mesita del Gavilan	79- 630
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
26	Mesa de los Toros	79-1122
27	Laguna Castillo	79- 640
28	Seven Lakes	79-1042
29	Seven Lakes NW	79-1123
30	Kin Klizhin Ruins	79-1047
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 Wolf Stand 7½ minute quadrangle includes acreage in Tps. 18 and 19 N., Rs . 3 and 4 W. of the New Mexico Principal Meridian, Sandoval County, northwestern New Mexico (see figs. 1 and 2). The town of Torreon is in the southwestern part of the quadrangle.

Accessibility

State Highway 197 provides access from the town of Torreon to the town of Cuba, about 27 mi (43 km) NW. of Torreon. Several unimproved dirt roads traverse most parts of the area. The Atchison, Topeka and Santa Fe Railroad line passes about 46.5 mi (74.8 km) SE. of the quadrangle (see fig. 1). An abandoned railroad line which served coal mines in the Cuba-La Ventana area in the 1920's and 1930's is about 9 mi (14 km) east of the Wolf Stand quadrangle.

Physiography

The Wolf Stand quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The topography of the quadrangle is characterized by alluvial valley floors and mesas dissected by numerous arroyos. Black Mountain is a prominent land form in the west-central part of the area.

No perennial streams are present in the quadrangle. Local drainage is provided by the Torreon Wash, San Isidro Wash and several intermittent

arroyos. Elevations within the quadrangle range from less than 6,240 ft (1,902 m) along Torreon Wash in the southwest corner to 6,969 ft (2,124 m) in the northeast corner.

Climate

The climate of the 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 Torreon Navajo Mission Station is within the Wolf Stand quadrangle. 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 temperatures 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 Wolf Stand quadrangle. For the specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownership. All of the quadrangle is within the La Ventana and San Juan Basin 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 Wolf Stand quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Gardner (1910) who reported coal outcrops in the area. Dane (1936) measured coal outcrops of the Allison Member and Hogback Mountain Tongue of the Menefee Formation in this quadrangle. Fassett and Hinds (1971) measured Fruitland Formation coals in the area. Shomaker, Beaumont, and Kottlowski (1971) describe Allison Member coals of limited areal extent cropping out in T. 18 N., Rgs. 3 and 4 W. They did not estimate any reserves with surface mining potential.

Beaumont and Shomaker (1974) discussed the stratigraphic relationship of the Cretaceous rock units, and estimated coal resources in the area. Tabet and Frost (1979) mapped the surface geology including coal outcrops and conducted exploration drilling in the southern three-fifths of the Wolf Stand quadrangle. Drill hole data were included in these maps, but no surface outcrops from Tabet and Frost were used. Their study was completed after the compilation of these maps and their open file report should be consulted for additional coal data in this 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^{o} W. - S. 60^{o} E. (Sears, Hunt, and Hendricks, 1941).

The transgressive and regressive shoreline migrations are evidenced by the intertonguing relationships of continental and marine facies. Rates of trough (geosynclinal) subsidence and the availability of sediment supplies are the major factors that controlled the transgressive-regressive shoreline sequences.

Exposed rock units in the Wolf Stand quadrangle include some of the sedimentary units of Upper Cretaceous age. There is Quaternary alluvium and terrace gravel deposits along the Torreon Wash and San Isidro Wash. The Point Lookout Sandstone and the overlying Cleary Coal Member of the Menefee Formation are present only in the subsurface in this area.

The Upper Cretaceous 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). The Point Lookout Sandstone is composed of light gray to reddish-brown, fine to medium grained sandstone with interbedded shales and is 100 to 170 ft (30 to 52 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. An upper coal-bearing unit is present in most of the quadrangle and is termed the Hogback Mountain coal zone. The Hogback Mountain coal zone represents continental deposits, which formed during a transgressive shoreline sequence, and is stratigraphically equivalent to the upper Allison Member further south.

Total thickness of the Menefee Formation is about 1,230 ft (375 m) in the area, composed of 350 to 450 ft (107 to 137 m) of the Cleary Coal Member, 425 to 600 ft (130 to 183 m) of the Allison Member and about 180 ft (55 m) of the Hogback Mountain Tongue. The Hogback Mountain Tongue is defined by intertonguing with the La Ventana Tongue of the Cliff House Sandstone, which represents nearshore and beach deposits. The La Ventana Tongue is composed of light gray, medium grained, occasionally calcareous, massive sandstone with interbedded shales and averages about 570 ft (174 m) thick in the quadrangle. In this quadrangle, the upper Allison Member is replaced northeastward by the La Ventana Tongue and associated Hogback Mountain Tongue.

The uppermost part of the La Ventana Tongue is stratigraphically equivalent to the Cliff House Sandstone farther west. The Cliff House Sandstone is commonly a massive sandstone unit, although it is represented by a more poorly defined unit of alternating sandstone and shale in this area. Beaumont and Shomaker (1974) note that the contact of the Cliff House Sandstone and overlying Lewis Shale is transitional in this area, indicating instability of the shorelines.

The Lewis Shale is composed of gray to black silty shale with interbedded light gray to buff, very fine to fine grained sandstones, and bentonite marker beds. Thickness of the unit ranges from 250 to 485 ft (76 to 148 m) in the area. The base of the Lewis Shale is arbitrary in the transition zone with the Cliff House Sandstone. Overlying the Lewis Shale, the Pictured Cliffs Sandstone represents nearshore or littoral deposits which formed during the final northeastward regression of the Cretaceous seaways in the San Juan Basin. Brown to yellow, thinly bedded, fine to medium grained

sandstone comprises the lithology of the Pictured Cliffs Sandstone, which averages about 100 ft (30 m) thick locally. The continental sediments deposited inland from the beach area during deposition of the Pictured Cliffs Sandstone compose the overlying Fruitland Formation.

The Fruitland Formation is composed of dark gray to brown, locally calcareous shale with irregularly bedded, fine grained, gray to buff sandstone and coal beds. The unit is the primary coal-bearing formation in the San Juan Basin. Only a partial thickness of the Fruitland Formation is represented in this 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 Wolf Stand quadrangle is in the Central Basin and Chaco Slope structural divisions in the southeastern part of the structural depression known as the San Juan Basin (Kelley, 1950). Hunt (1936) mapped several low displacement faults in the area. Dips in the area, as indicated on the structure contour maps (plates 5, 8, 11 and 14), range from 1^{o} to 2^{o} N. to NW.

COAL GEOLOGY

In this quadrangle, the authors identified seven coal beds and three coal zones from oil and gas well logs, coal test holes by Tabet and Frost (1979) and Hunt's(1936) surface mapping. These beds and zones are here

informally called the Menefee Cleary No. 1 and No. 3 coal beds, the Menefee Allison No. 1, No. 1A, No. 1B, and No. 2 coal beds, the Menefee Hogback Mountain No. 1 coal bed and Menefee Cleary, Menefee Allison and Menefee Hogback Mountain coal zones. Although a limited thickness of the coal-bearing Fruitland Formation does exist in this quadrangle, no coals were identified by the authors.

The Menefee Cleary No. 1 coal bed is stratigraphically the lowest persistent bed identified and occurs up to 6 ft (2 m) above the Point Lookout Sandstone in this quadrangle. The Menefee Cleary No. 3 is of limited thickness and extent within the quadrangle and is about 60 ft (18 m) above the Point Lookout Sandstone. These beds, as with all the coal beds described in this report, are inferred to be continuous although they may be several individual coal beds that are stratigraphically equivalent. Two to five beds were identified in the Menefee Cleary coal zone occurring from 15 to 330 ft (5 to 101 m) above the Point Lookout Sandstone.

The most persistent coal bed in the Allison Member is the Menefee Allison No. 1, occurring up to 400 ft (122 m) above the base of the Allison Member. The Menefee Allison No. 1A and No. 1B are of generally limited extent and locally occur approximately 60 ft (18 m) and 200 ft (61 m), respectively, above the Menefee Allison No. 1 bed. The Menefee Allison No. 2 coal bed, also of locally limited extent, is up to 310 ft (94 m) above the Menefee No. 1 bed. The remainder of the coal beds in the Allison Member are included in the Menefee Allison coal zone. Some of the individual coals within the zone achieve total thicknesses of up to 14 ft (4 m), but are of very limited extent.

The Menefee Hogback Mountain No. 1 coal bed is the only persistent coal within the Hogback Mountain Tongue and ranges from 354 to 406 ft

(108 to 124 m) above the base of the Hogback Mountain Tongue. The range of the above interval seems unusually large, but the apparent discrepancy in stratigraphic position is caused by the intertonguing nature of the Allison-Hogback Mountain contact and the subsequent thinning and thickening of the La Ventana Tongue. The remaining coals in the Hogback Mountain Tongue are included in the Hogback Mountain coal zone. The zone, which contains up to four beds, ranges from 185 to 690 ft (56 to 210 m) above the base of the Hogback Mountain Tongue. These zone coals, as with all identified 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 Wolf Stand quadrangle. Analyses of three core samples (from one coal test hole) of the Allison Member coals sampled about 5 mi (8 km) west of the Wolf Stand quadrangle, have been reported by Shomaker and Whyte (1977) and are shown in table 1. The Allison Member beds analyzed are probably similar in quality to the Cleary Coal Member and Hogback Mountain Tongue coal beds in this area. Rank of these seams is probably high volatile C bituminous.

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

(Core sample from NE¼ NE¼ sec. 11, T. 18 N., R. 5 W)

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

from Shomaker and Whyte, 1977

Sample	Form of Analysis	Proximate analysis (percent) Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	Heating Value (Btu/lb)
1	A	12.0	34.1	39.9	14.0	0.3	10,410
	B	----	38.7	45.4	15.9	0.4	11,830
	C	----	46.1	53.9	----	0.5	14,070
2	A	13.0	34.7	33.8	18.5	0.3	9,550
	B	----	39.8	39.0	21.2	0.4	10,980
	C	----	50.6	49.4	----	0.5	13,940
3	A	11.0	34.4	35.1	19.5	0.4	9,800
	B	----	38.7	39.4	21.9	0.5	11,020
	C	----	49.5	50.5	----	0.6	14,100

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) and 12,432 Btu/lb (28,917 kJ/kg; sample 3). No agglomerating characteristics are available for these analyses.

Menefee Hogback Mountain No. 1 and Menefee Allison No. 1A coal beds

The Menefee Hogback Mountain No. 1 coal bed was identified in two well logs in the Wolf Stand quadrangle and is inferred to pinch out to the west and south (plate 4), based partially on data from the eastern adjacent Headcut Reservoir quadrangle. The Menefee Allison No. 1A coal bed was identified in three logs. It is inferred to thicken to 4.0 ft (1.2 m) and to pinch out in all directions in the subsurface within 2 mi (3 km) of the data points. Both beds were mapped on the same plates (plates 4, 5, and 6) because no overlap of isopachs, structure contours or overburden isopachs occurred.

Menefee Allison coal zone

The Menefee Allison coal zone was identified in seven well logs and 12 measured sections. Some of the upper coals in the zone crop out as discontinuous beds throughout the southern half of the quadrangle. Two of the drill holes and all of the measured sections do not include the complete interval of the zone and therefore these data points have not been used in constructing the isopach map (plate 7). Because parts of the Menefee Allison coal zone crop out in the southern half of the quadrangle, the base of the Allison Member was used as a datum for the structure contour map (plate 8). The zone pinches out in the southeastern corner of the quadrangle. Existence and character of the Menefee Allison coal zone are unknown in the northwestern corner of the quadrangle because of insufficient data.

Menefee Allison No. 1 coal bed

The Menefee Allison No. 1 coal bed was identified in five well logs. It is inferred to exist as two lenses, both pinching out toward the center of the quadrangle, as shown on plate 10. Existence and character of the Menefee Allison No. 1 coal bed are unknown in the northwest corner of the quadrangle because of insufficient data.

Menefee Cleary coal zone

The Menefee Cleary coal zone was identified in seven well logs. It is inferred to pinch out in the northwestern corner of the quadrangle. Two well logs that could not be used to determine the existence and thickness of the coal zone with certainty were used to locate the top of the Cleary Coal Member for the structure contour map (plate 14). The structural datum used for the structure contour map (plate 14) is the top of the Cleary Coal Member.

Menefee Cleary No. 1 coal bed

The Menefee Cleary No. 1 coal bed was identified in four well logs. The bed is inferred to increase in thickness to 6.0 ft (1.8 m) at the southern edge of the quadrangle based on data from the southern adjacent Arroyo Empedrado quadrangle. The bed is inferred to pinch out to the north, locally reappearing in the northeastern corner of the quadrangle. Existence and character of the Menefee Cleary No. 1 are unknown in the northwestern corner of the quadrangle because of insufficient data.

COAL RESOURCES

The U. S. Geological Survey requested resource evaluations of the Menefee Cleary No. 1, Menefee Allison No. 1 and No. 1A and the Menefee Hogback Mountain 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 reserse base categories. Reserve base was calculated for each category, by section, using data from the isopach and overburden maps (plates 4, 6, 10, 12, 16, and 18). The acreage in each category (measured by planimeter) multiplied by the average coal bed thickness and 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 Menefee Cleary No. 1, Menefee Allison No. 1 and 1A and the Menefee Hogback Mountain No. 1 coal beds, which include all reserve base categories, are shown by section on plate 2. The Menefee

Hogback Mountain No. 1 and Menefee Allison No. 1A coal beds are incorporated on the same areal distribution and identified resources plate (plate 19). Reserve base and reserve data in the various categories are shown on plates 19, 20 and 21.

The U. S. Geological Survey also requested resource evaluations of the Menefee Allison and Menefee Cleary coal zones, where the total zone coal thickness is 5.0 ft (1.5 m) or greater. Total identified Menefee Allison and Menefee Cleary coal zone resources are 872.10 and 443.43 short tons (791.17 and 402.28 million t), respectively.

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 caluclate 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 mining methods (plate 22) are defined at the contact of the coal-bearing Allison Member of the Menefee Formation with the overlying noncoal-bearing Lewis shale. Additional no and unknown development potential boundaries for surface mining methods are defined at the contact of the coal-bearing Fruitland Formation with the underlying noncoal-bearing Pictured Cliffs Formation. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Boundaries of the coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acres or lot). When a land subdivision contains areas with different development potentials, the potential shown on the map is that of the areally largest 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 Wolf Stand quadrangle is shown on plate 22. Based on coal development criteria, all Federal coal lands have moderate, low, unknown or no coal development potential. 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 Wolf Stand quadrangle is shown on plate 23. Based on coal development potential criteria, all Federal coal lands have high, unknown or no coal development potential. 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 Wolf Stand 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 Allison No. 1A	---------	---------	220,000	220,000
Menefee Allison No. 1	---------	3,010,000	13,110,000	16,120,000
Total	---------	3,010,000	13,330,000	16,340,000

Table 3. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Wolf Stand 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' - 1,000' overburden)	Moderate Development Potential (1,000'-2,000' overburden)	Low Development Potential (2,000'-3,000' overburden)	Total
Menefee Hogback Mountain No. 1	54,450,000	------	------	54,450,000
Menefee Allison No. 1A	2,520,000	------	------	2,520,000
Menefee Allison No. 1	69,580,000	26,370,000	------	95,950,000
Menefee Cleary No. 1	11,540,000	12,140,000	------	23,680,000
Total	138,090,000	38,510,000	------	176,600,000

Table 4. - Reserves and planimetered acreage, by section, for Federal coal lands in the Wolf Stand 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)
Moderate	Menefee Allison No. 1	20	18	3	130.7	2,560,000
Low	Menefee Allison No. 1	14	18	3	31.6	150,000
		17			23.0	150,000
		18			104.7	790,000
		19			508.7	4,400,000
		20			289.6	3,370,000
		21			87.5	760,000
		28			36.9	220,000
		29			68.4	410,000
		30			27.4	130,000
		22	18	4	45.6	560,000
		23			4.3	20,000
		24			132.2	670,000
		27			1.5	less than 10,000
	Menefee Allison No. 1A	16	18	3	1.5	less than 10,000
		17			3.0	less than 10,000
		21			10.9	50,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Wolf Stand 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 Hogback Mountain No. 1	14	19		3		67.0	240,000
		15					213.3	950,000
		16					213.3	290,000
		17					215.9	930,000
		18					31.5	90,000
		19					30.1	80,000
		20					640.0	2,820,000
		21					637.3	4,070,000
		22					638.4	3,580,000
		23					190.2	850,000
		26					187.7	960,000
		27					638.9	3,620,000
		28					639.3	3,050,000
		29					380.0	1,300,000
		32					3.2	less than 10,000
		33					270.8	900,000
		34					547.4	2,000,000
		35					149.1	530,000
	Menefee Allison No. 1A	16	18		3		152.0	530,000
		17					4.6	10,000
		21					205.1	700,000
	Menefee Allison No. 1	3	18		3		606.9	3,520,000
		4					361.0	1,330,000
		9					320.8	1,180,000
		10					641.4	3,340,000
		11					190.1	1,310,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Wolf Stand 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 Allison No. 1	14	18	3	132.7	570,000
		15			470.6	1,830,000
		16			43.8	130,000
		17			28.1	160,000
		18			184.6	580,000
		19			136.2	640,000
		20			191.5	1,190,000
		21			205.1	1,190,000
		29			5.5	20,000
		10	18	4	7.4	20,000
		13			352.8	1,070,000
		14			426.7	1,610,000
		15			440.5	2,200,000
		22			380.0	2,310,000
		23			343.1	1,310,000
		24			161.4	520,000
		27			76.6	240,000
		22	19	3	27.4	150,000
		23			31.6	210,000
		26			177.8	1,210,000
		27			555.5	2,190,000
		28			57.4	190,000
		33			263.9	850,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Wolf Stand 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 Allison No. 1	34	19	3	635.4	3,490,000
		35			186.6	1,320,000
	Menefee Cleary No. 1	28	18	3	150.4	480,000
		29			296.4	1,200,000
		30			232.6	1,040,000
		31			210.6	1,080,000
		32			208.3	970,000
		33			196.1	690,000
		34			6.8	20,000
		25			4.1	20,000
		27			79.3	250,000
Moderate	Menefee Allison No. 1	14	19	3	62.4	450,000
		15			216.1	1,590,000
		16			217.4	970,000
		21			530.5	2,130,000
		22			616.1	5,290,000
		23			147.2	1,080,000
		26			9.0	60,000
		27			184.4	850,000
		28			226.8	760,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Wolf Stand 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)
Moderate	Menefee Cleary No. 1	10	18		3		83.5	230,000
		11					161.1	470,000
		14					2.7	10,000
		19					275.1	840,000
		20					79.0	230,000
		28					43.8	130,000
		29					317.3	1,000,000
		30					408.9	1,580,000
		23					2.7	10,000
		24					139.5	420,000
		25					225.6	870,000
		27					83.6	250,000

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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.