UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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1985

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

[Report includes 19 plates]

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CERRO ALESNA QUADRANGLE
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Cerro Alesna quadrangle

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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Cerro Alesna 7 1/2 minute quadrangle, McKinley County, New Mexico. These maps and report are part of an evaluation of fifty-six 7 1/2 minute quadrangles in northwestern New Mexico, which were completed under U. S. Geological Survey Contract No. 14-08-0001-17459 (see figs. 1 and 2).

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

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

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 Published and unpublished public information was used as the data base for this study.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

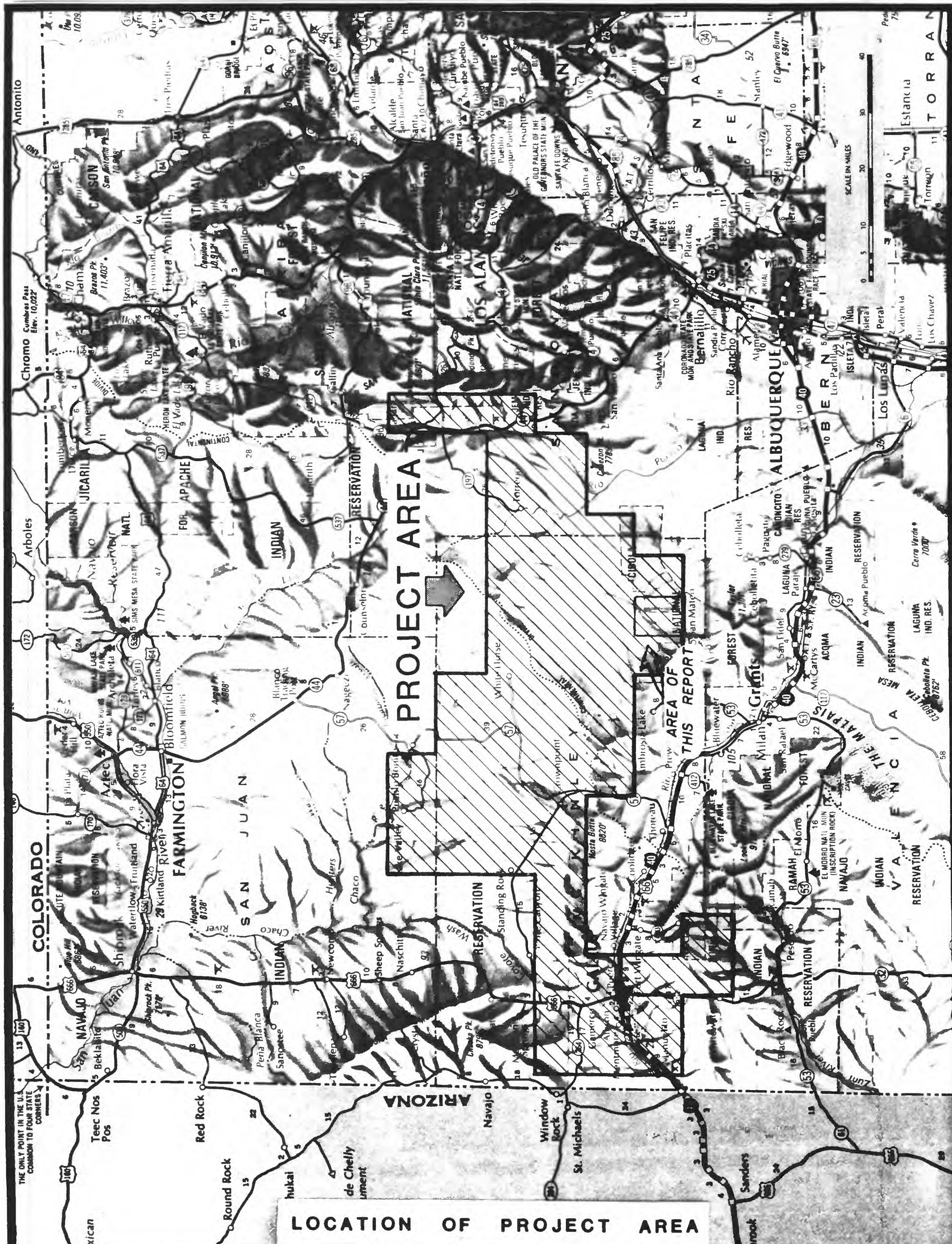
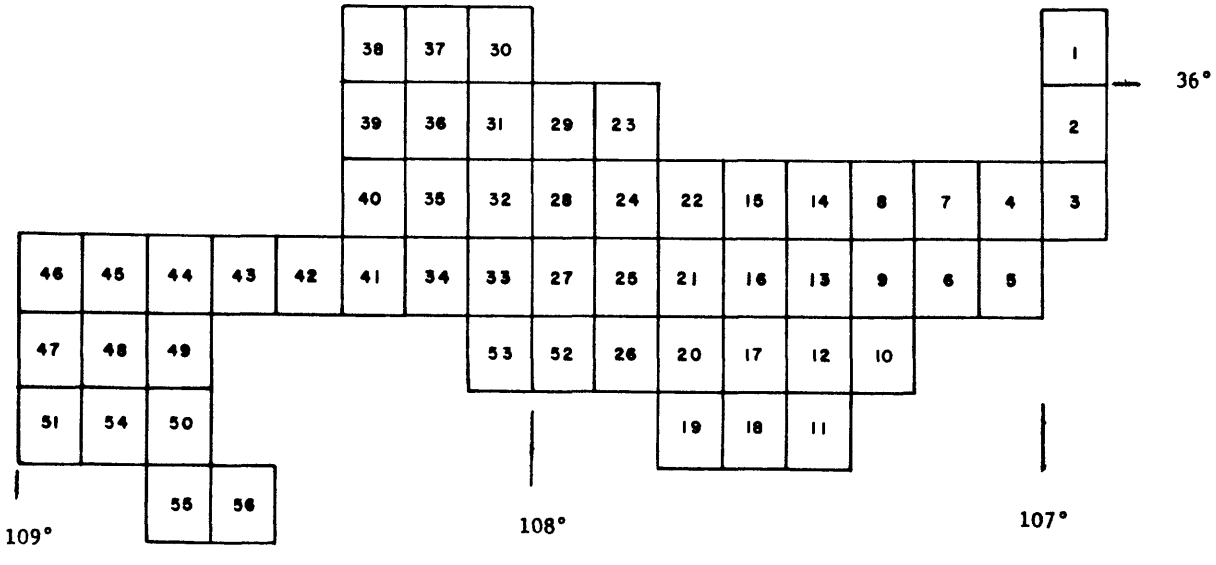

LOCATION OF PROJECT AREA
PROJECT AREA
AREA OF THIS REPORT
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Grants
SCALE IN MILES

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	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 Cerro Alesna 7 1/2 minute quadrangle includes acreage in Tps. 13, 14, and 15 N., Rs. 6 and 7 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2).

Accessibility

No paved roads pass through the Cerro Alesna quadrangle. Two light-duty maintained roads provide access to the town of San Mateo, 9 mi (14 km) southwest of the quadrangle. Unimproved dirt roads traverse most parts of the area. The Atchison, Topeka, and Santa Fe Railroad line passes about 22 mi (35 km) due south of the quadrangle (see fig. 1).

Physiography

The Cerro Alesna quadrangle is in the Navajo section of the southern-most part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The topography of the quadrangle is mesa-and-canyon. Cerro Alesna is a peak in the north-central part of the quadrangle.

No perennial streams are present in the quadrangle. Local drainage is provided by several intermittent arroyos which include San Miguel Creek, San Isidro Arroyo, and Cañon del Dado. Elevations within the quadrangle range from 6,620 ft (2,018 m) in the northeastern part to 8,560 ft (2,609 m) in the extreme southeastern 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 San Mateo Station. The Cerro Alesna quadrangle is about 8 mi (13 km) NE. of the San Mateo Station. Average total annual precipitation for ten of the previous fifteen years is 8.37 in. (21.26 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 four of the previous fifteen years is 48.8°F (9.3°C). The average daily temperatures in January and July are 28.3°F(-2.1°C) and 69.0°F (20.6°C), respectively.

Land status

The Federal Government holds coal rights to approximately 40 percent of the Cerro Alesna 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 20,000 acres (8,094 ha) in the western portion of the quadrangle are within the Bartolome Fernandez Land Grant. About 11,000 acres (4,452 ha) in the southeastern and east central parts of the quadrangle is Federal land within the Cibola National Forest. The northern one-fifth of the quadrangle is 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 Cerro Alesna quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Gardner (1910) who reported a 1.0 ft (0.3 m) thick coal bed in the northern part of the Cerro Alesna quadrangle. Hunt (1936) mapped and described several thin Cleary Coal Member outcrops. Shomaker, Beaumont, and Kottlowski (1971) reported Cleary Coal Member beds and estimated reserves of 20.88 million short tons (18.94 million t) at depths of less than 150 ft (46 m) in T. 15 N., R 7 W. Less than one-fourth of this area is within the Cerro Alesna 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 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 Cerro Alesna quadrangle include some of the sedimentary units of Upper Cretaceous age. Tertiary basalts, which are over 100 ft (30 m) thick in some areas, cap Mesa Chivato. There is Quaternary alluvium along drainages in the area. Coal beds have been identified in the Menefee and Crevasse Canyon Formations in this area.

The Dilco Coal Member is stratigraphically the lowest coal-bearing member of the Crevasse Canyon Formation. The Dilco Coal Member represents continental sediments which were deposited during a northeastward retreat of the Cretaceous seaways in the San Juan Basin. Medium to dark gray siltstone with interbedded tan sandstones, and coal beds comprise the lithologies of the Dilco Coal Member, which ranges from 90 to 120 ft (27 to 37 m) thick locally.

Increased rates of trough subsidence caused the regressive sequence to gradually slow, and finally stop. The seaways deepened and the shorelines advanced southwestward during the succeeding transgressive phase. The Mulatto Tongue of the Mancos Shale overlies the Dilco Coal Member and formed from the marine sands, silts, and muds, and is composed of light gray to tan silty shale with interbedded reddish-tan, very fine-grained sandstone. The Mulatto Tongue ranges from 380 to 415 ft (116 to 126 m) thick in the area. A transitional contact of the Mulatto Tongue with the overlying Dalton Sandstone Member of the Crevasse Canyon Formation indicates the gradual reversal from transgressive to regressive depositional conditions.

The Dalton Sandstone Member is composed of yellowish-gray, very fine-grained quartzose sandstone which formed in a nearshore environment and ranges from 100 to 150 ft (30 to 46 m) thick locally. The Gibson Coal Member of the Crevasse Canyon Formation represents the continental deposits which formed inland from the beach area during deposition of the Dalton Sandstone Member. Medium gray carbonaceous siltstone with interbedded gray to tan sandstone, and coal beds comprise the lithologies of the Gibson Coal Member, which ranges from 160 to 200 ft (49 to 61 m) thick in the area. Increased rates of trough subsidence resulted in the gradual reversal from regressive to transgressive depositional conditions, and the Hosta Tongue of the Point Lookout Sandstone

was deposited during the advancing shoreline sequence.

The Hosta Tongue overlies the Gibson Coal Member and is composed of light gray to reddish-brown, fine-to medium-grained sandstone with interbedded shales, and ranges from 100 to 150 ft (30 to 46 m) thick locally. As the transgression continued and the Cretaceous seaways deepened, the Satan Tongue of the Mancos Shale formed from the marine sand, silts, and muds. The Satan Tongue overlies the Hosta Tongue and is composed of light to dark gray silty shale with interbedded tan to buff sandstone, and averages 120 ft (37 m) thick locally. The Point Lookout Sandstone overlies the Satan Tongue, and represents nearshore or littoral deposits which formed during the extensive northeastward retreat prior to final withdrawal of the Cretaceous seaways in the San Juan Basin (Sears, Hunt, and Hendricks, 1941). Lithology of the Point Lookout Sandstone is identical to the Hosta Tongue. The Point Lookout Sandstone averages 120 ft (37 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 non-carbonaceous 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 partially eroded Cleary Coal Member ranges from 300 to 400 ft (91 to 122 m) thick in this area. The Allison Member is highly eroded in the area and only the lower 350 ft (107 m) of the member is present in the Cerro Alesna 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 rel-

atively sporadic in occurrence.

Structure

The Cerro Alesna quadrangle is in the Chaco Slope and Acoma Sag (Baltz, 1967) structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The San Mateo Dome is west of the Cerro Alesna quadrangle and influences dips of the rock units in the western portion of the area. The coal beds dip from 3^{o} to 7^{o} E. to NE. in the extreme western portion of the area, flattening to about 2^{o} N. to NW. in the eastern parts of the mapped areas. Tertiary basalt flows conceal potential coal-bearing rock units and structural features in the southeastern portion of the Cerro Alesna quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified five coal beds and three coal zones in oil and gas well logs and Hunt's (1936) surface mapping. These coals are within the Dilco and Gibson Coal Members of the Crevasse Canyon Formation and the Cleary Coal Member of the Menefee Formation. These beds and zone coals are here informally called the Crevasse Canyon Dilco coal zone, Crevasse Canyon Gibson No. 1 and No. 2 coal beds, Crevasse Canyon Gibson coal zone, Menefee Cleary No. 1, No. 2, and No. 3 coal beds, and the Menefee Cleary coal zone.

Stratigraphically, the Crevasse Canyon Dilco coal zone contains the lowest identified coals in the Cerro Alesna quadrangle. The zone

includes one to three beds with up to 7.0 ft (2.1 m) of total coal. The Gibson Coal Member occurs about 480 ft (146 m) above the Dilco Coal Member. The Crevasse Canyon Gibson No. 1 coal bed occurs 4 to 10 ft (1 to 3 m) above the Dalton Sandstone Member of the Crevasse Canyon Formation in this quadrangle. Up to 50 ft (15 m) seperate the Crevasse Canyon Gibson No. 2 coal bed from the Dalton Sandstone Member. The Crevasse Canyon Gibson coal zone contains as many as three beds which are 50 to 65 ft (15 to 20 m) above the Dalton Sandstone Member in this quadrangle.

The Menefee Cleary No. 1 coal bed is the first persistent coal occurring 1 to 2 ft (0.3 to 0.6 m) above the Point Lookout Sandstone as identified in two well logs. The Menefee Cleary No. 2 and No. 3 coal beds are the second and third persistent Cleary Coal Member beds which occur 12 ft (4 m) and 39 ft (12 m), respectively, above the Point Lookout Sandstone. All of the coal beds identified in this quadrangle are inferred to be continuous although they may be several different beds that are stratigraphically equivalent. The youngest coal beds identified in this quadrangle are grouped into the Menefee Cleary coal zone. The Menefee Cleary coal zone was identified in one well log and is present about 90 ft (27 m) above the Point Lookout Sandstone. The total coal thickness within the zone is less than 3.0 ft (0.9 m).

There are no published coal quality analyses for the Gibson or Cleary Coal Member beds from the Cerro Alesna quadrangle. An analysis of a Gibson Coal Member bed sampled at the abondoned Boone mine about 13 mi (21 km) southwest of the quadrangle has been reported by the U. S. Bureau of Mines (1936) and is shown in table 1. Rank of the Gibson Coal Member beds is probably high volatile C bituminous in this area. An analysis

of one Cleary Coal Member coal core sample taken about 17 mi (27 m) northwest of the quadrangle has been reported by Shomaker, Beaumont, and Kottlowski (1971) and is shown in table 2. The Cleary Coal Member bed analyzed is probably similar in quality to the Cleary Coal Member beds in this quadrangle. Rank of the Cleary Coal Member seams is probably subbituminous A in this area.

Menefee Cleary No. 3 coal bed and Crevasse Canyon Gibson No. 1 coal bed

The Menefee Cleary No. 3 and Crevasse Canyon Gibson No. 1 coal beds were both mapped on plates 4, 5, and 6 because the beds do not overlap where more than 3.0 ft (0.9 m) thick. Coal bed separation lines were used on the plates to prevent possible misinterpretation by the reader.

The Menefee Cleary No. 3 coal bed is 4.0 ft (1.2 m) thick where identified at data point 8 (plate 3). The bed has not been identified at any point nearby, and therefore its thickness and areal extent are approximated. It is inferred to pinch out to the west because Hunt (1936) did not map Menefee Cleary No. 3 coal in areas that structurally have potential for outcrop.

The Crevasse Canyon Gibson No. 1 coal bed ranges from 3.0 to 7.0 ft (0.9 to 2.1 m) in thickness in two of the three well logs in the quadrangle. At data point 9 on plates 1 and 3, the bed is split into two benches of 2.0 and 5.0 ft (0.6 and 1.5 m) thick. In compliance with U. S. Geological Survey directives, the bed is mapped as 5.0 ft (1.5 m) on subsequent maps because the 2.0 ft (0.6 m) bench is thinner than the 3.0 ft (0.9 m) rock parting. The bed is interpreted to be a lenticular pod which is limited

Table 1. - Analysis of a coal sample from the Gibson Coal Member of the Crevasse Canyon Formation.

(Boone Mine Sample from SE¼ sec. 6, T. 11 N., R. 8 W.)

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

from U. S. Bureau of Mines, 1936

Form of analysis	Proximate analysis (percent)				Sulfur (percent)	Heating Value (Btu/lb)
	Moisture	Volatile Matter	Fixed Carbon	Ash		
A	13.5	37.9	42.9	5.7	0.6	11,400
B	----	43.8	49.6	6.6	0.7	13,170
C	----	46.9	53.1	---	0.8	14,100

Remarks:

A moist, mineral-matter-free (MMMF) calculation, using the Parr formula (American Society for Testing and Materials, 1973), yields a heating value of 12,159 Btu/lb (28,282 kJ/kg). No agglomerating characteristics were included with the analysis.

Table 2. - Analysis of a coal sample from the Cleary Coal Member of the Menefee Formation.

(Core sample from NE¼ sec. 36, T. 17 N., R. 10 W)

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

from Shomaker, Beaumont, and Kottlowski, 1971

Form of analysis	Proximate analysis (percent)				Sulfur (percent)	Heating Value (Btu/lb)
	Moisture	Volatile Matter	Fixed Carbon	Ash		
A	16.5	33.4	40.4	9.7	0.6	10,070
B	----	40.0	48.3	11.7	0.7	12,060
C	----	45.3	54.7	----	0.8	13,650

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973), yields a heating value of 11,256 Btu/lb (26,181 kJ/kg). The free-swelling index of the analysis shows the sample to be nonagglomerating.

in areal extent by absence of the bed in both the western adjacent San Lucas Dam quadrangle and data point 8 (plates 1 and 3).

Menefee Cleary No. 2 coal bed

The Menefee Cleary No. 2 coal bed is 1.6 to 16.0 ft (0.5 to 4.8 m) thick at data points. In compliance with U. S. Geological Survey directives, a 0.5 ft (0.15 m) coal bench was discounted because its thickness was less than that of a rock parting in the bed (data point 6). The bed is inferred to pinch out north of the outcrop because Hunt (1936) did not map Menefee Cleary No. 2 coal in areas that structurally have potential for outcrops. The bed was not mapped in portions of the northern, southwestern, and eastern areas of the quadrangle because of insufficient data.

Menefee Cleary No. 1 coal bed

The Menefee Cleary No. 1 coal bed, present at the base of the Cleary Coal Member, is 4.0 and 7.5 ft (1.2 and 2.3 m) thick where identified in two well logs. At data point 8 on plates 1 and 3, the bed is split into two benches, 4.0 and 3.5 ft (1.2 and 1.1 m) thick. In compliance with U. S. Geological Survey directives, the bed is mapped as 4.0 ft (1.2 m) on subsequent maps because the 3.5 ft (1.1 m) bench is thinner than the 4.0 ft (1.2 m) rock parting. Plate 10 shows the bed to be a lenticular pod which is inferred to thicken to 5.0 ft (1.5 m). It is inferred to pinch out because Hunt (1936) did not map the bed in areas that structurally have potential for outcrop. The bed was not mapped in

the eastern or southwestern parts of the quadrangle because of insufficient data.

Crevasse Canyon Gibson No. 2 coal bed

The Crevasse Canyon Gibson No. 2 coal bed ranges from 3.0 to 6.0 ft (0.9 to 1.8 m) thick. At data point 9 on plates 1 and 3, a 2.0 ft (0.6 m) rock parting separates the 2.0 and 4.0 ft (0.6 and 1.2 m) coal benches. On subsequent maps, the bed is mapped as 4.0 ft (1.2 m) in compliance with U. S. Geological Survey directives. The bed is a lenticular pod which crops out in the western adjacent San Lucas Dam quadrangle. There is sufficient data for mapping the bed only in the southwestern part of the quadrangle.

COAL RESOURCES

The U. S. Geological Survey requested a resource evaluation of the Menefee Cleary No. 1, No. 2, 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 Crevasse Canyon Gibson No. 1 and No. 2 coal beds are not present in sufficient thickness within these lands to warrant resource evaluations.

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, 9, 10, and 12). The acreage in each category (measured by planimeter) multiplied by the average coal bed thickness and a subbituminous coal conversion factor (1,770 tons of coal per acre-ft) yields the reserve base for that category. Coal beds with 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B. Reserve figures are derived from reserve base totals by applying recovery factors of 85 percent and 50 percent for coal beds 0 to 200 ft (0 to 61 m) and 200 to 3,000 ft (61 to 914 m) deep, respectively. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Total reserve base data for the Menefee Cleary No. 1, No. 2, 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 16 and 17.

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 ovelain 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 are underlain by a coal bed 3.0 ft (0.9 m) or more thick and 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).

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) in the various development potential categories for surface and subsurface mining methods are shown in tables 3 and 4, respectively.

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

Development potential for surface mining methods

The coal development potential for surface mining methods in the Cerro Alesna quadrangle is shown on plate 18. Based on coal development potential criteria, all Federal coal lands have low or unknown development potentials for surface mining methods. Only the Menefee Cleary No. 1 coal bed has surface mining potential in the Cerro Alesna quadrangle. Refer to table 5 for reserves and planimetered acreage, by section, for Federal coal lands with surface mining potential.

Development potential for subsurface mining methods and in situ gasification

The coal development potential for subsurface mining methods in the Cerro Alesna quadrangle is shown on plate 19. The Menefee Cleary No. 2 and No. 3 coal beds have reserves in the moderate subsurface development potential category only. Refer to table 6 for reserves and planimetered

acreage, by section, for Federal coal lands with subsurface mining potential. All remaining Federal coal lands have unknown subsurface development potential in the Cerro Alesna quadrangle.

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

Table 3. - Reserve base data (in short tons) for surface mining methods for Federal coal lands in the Cerro Alesna quadrangle, McKinley County, New Mexico.

[Development potentials are based on mining ratios (cubic yards of overburden per 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/ton, 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. 1	---------	---------	130,000	130,000
Total	---------	---------	130,000	130,000

Table 4. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Cerro Alesna 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. 2	---------	6,900,000	---------	6,900,000
Menefee Cleary No. 3	---------	1,340,000	---------	1,340,000
Total	---------	8,240,000	---------	8,240,000

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

[To convert acres to hectares, divide acres by 2.471; to convert short tons to metric tonnes, multiply short tons by 0.9072].

Potential category	Coal bed	Sec.	T.	N.	R.	W.	Acres (planimetered)	Reserves (in short tons)
Low	Menefee Cleary No. 1	34	15		7		24.0	110,000

Table 6. - Reserves and planimetered acreage, by section, for Federal coal lands in the Cerro Alesna 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. 2	26	14	7	150.4	810,000
		35			351.8	1,580,000
		36			90.3	250,000
		2	13	7	216.5	770,000
		1			9.5	20,000
	Menefee Cleary No. 3	2	13	7	160.0	460,000
		11			55.0	190,000
		12			9.5	20,000

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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.