UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

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

[Report includes 4 plates]

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MANUELITO QUADRANGLE
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INTRODUCTION

Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Manuelito 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 Published and unpublished public information was used as the data base for this study.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

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
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11	El Dado Mesa	79- 628
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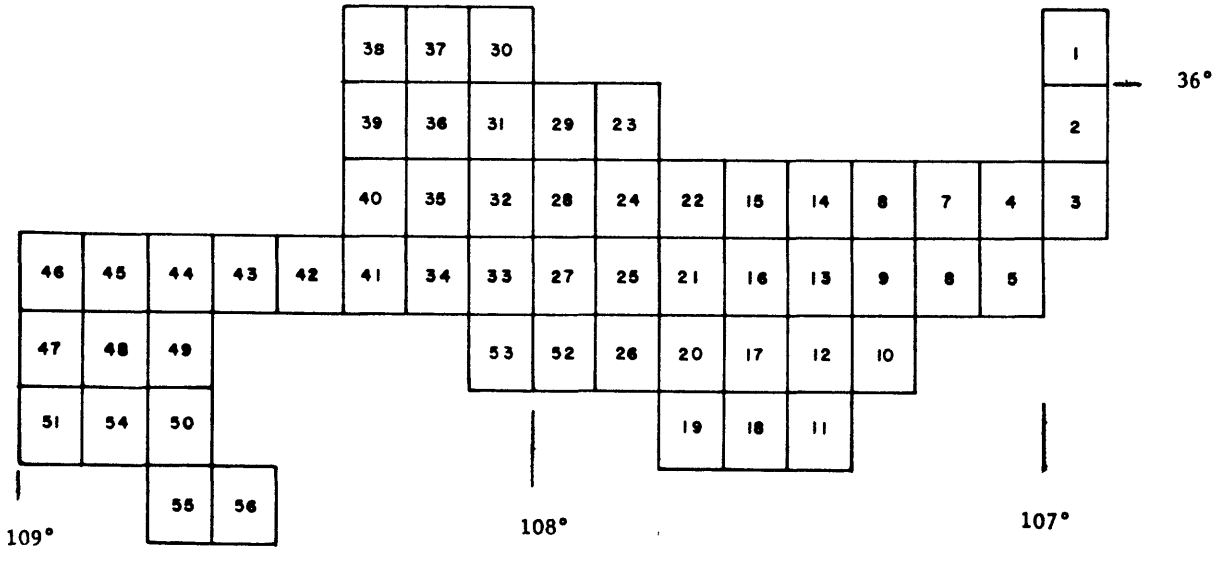
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
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 Manuelito 7 1/2 minute quadrangle includes acreage in Tps. 13, 14, and 15 N., Rs. 19 and 20 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2). The village of Manuelito is located in the central western part of the quadrangle.

Accessibility

Interstate Highway 40 and U. S. Highways 66-666 pass through the quadrangle and provide access to the city of Gallup, 8 mi (13 km) northeast, and to the town of Sanders, Arizona, 24 mi (39 km) southwest of the quadrangle. Light-duty maintained and unimproved dirt roads traverse most parts of the area. The main line of the Atchison, Topeka, and Santa Fe Railroad parallels Interstate Highway 40.

Physiography

The Manuelito 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, eroded mesas, and prominent canyons.

No perennial streams are present in the quadrangle. Local drainage is provided by the Puerco River and several intermittent arroyos. Elevations within the quadrangle range from less than 6,220 ft (1,896 m) along the Puerco River near the western quadrangle boundary to over 7,160 ft (2,182 m) in the southeast.

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 Gallup 5E Station. The Manuelito quadrangle is about 12 mi (19 km) SW of the Gallup 5E Station. Average total annual precipitation for eleven of the previous fifteen years is 9.53 in. (24.21 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 seven of the previous fifteen years is 48.8°F (9.3°C). The average daily temperatures in January and July are 29.0°F (-1.7°C) and 71.3°F(21.8°C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 83 percent of the Manuelito quadrangle. For specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownership. The quadrangle is not within the boundaries of any 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 Manuelito quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Sears (1925) who mapped the surface geology for T. 15 N., R. 19 W., which includes about 1250 acres (506 ha) in the northeast corner of the quadrangle. He did not report any coal outcrops in the specific area, although he identified coals within the Gallup Sandstone which crop out east of the Manuelito quadrangle. Dobbin (1932) mapped the area north of the Atchison, Topeka, and Santa Fe Railroad and reported Dilco Coal Member bed thicknesses. The U. S. Bureau of Mines reported an analysis of Fassett's (1969) 2.0 ft (0.6 m) thick coal outcrop sample of a Dilco Coal Member bed from N ½ NE ¼ Sec. 7, T. 14 N., R. 19 W. Shomaker, Beaumont, and Kottlowski (1971) reviewed the area and reported that the Gallup Sandstone and Dilco Coal Member crop out and underlie portions of the area. They report that identified coal beds in the area are generally less than 3.0 ft (0.9 m) thick.

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 Manuelito quadrangle include some of the sedimentary units of Upper Cretaceous age. Strata of Jurassic age crop out in the southwestern corner of the quadrangle. Quaternary deposits include alluvium and terrace gravels of the Puerco River and its tributaries.

The Dakota Sandstone crops out in the central western and southwestern parts of the quadrangle, and is the basal unit of the Upper Cretaceous section. The Dakota Sandstone represents coastal sands, fluvial deposits, and marine shales, and is composed of yellowish-brown to buff, fine-to medium-grained sandstone, interbedded dark gray to black, carbonaceous shales, and coal beds. Thickness of the unit ranges from 200 to 250 ft (61 to 76 m) in the area. The main body of the Mancos Shale overlies the Dakota Sandstone, and represents transgressive marine deposits. Light to dark gray, silty shales with interbedded brown, calcareous sandstones comprise the lithologies of the Mancos Shale, which ranges from 500 to 700 ft (152 to 213 m) thick locally.

A major northeastward retreat of the Cretaceous seaways resulted in the deposition of the Gallup Sandstone in a nearshore or littoral environment. Pink to gray, fine-to very coarse-grained, massive sandstone, interbedded gray shales, and coal beds comprise the lithologies of the unit, which ranges from 180 to 250 ft (55 to 76 m) thick locally. The Dilco Coal Member of the Crevasse Canyon Formation is stratigraphically, the highest Upper Cretaceous rock unit exposed in the quadrangle. The Dilco Coal Member overlies the Gallup Sandstone and represents the continental sediments which were deposited inland from the beach area during deposition of the Gallup Sandstone. Medium to dark gray siltstone with interbedded

medium-grained, tan sandstones, and coal beds comprise the lithologies of the Dilco Coal Member which ranges from 220 to 300 ft (67 to 91 m) thick locally. Portions of the Bartlett Barren Member may be exposed locally, although no previous workers in the area have mapped the unit in the Manuelito 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 Manuelito quadrangle is in the Gallup Sag structural division in the southwestern portion of the structural depression known as the San Juan Basin (Kelley, 1950). Sears (1925) mapped the northwest-plunging Torrivio Anticline in the northeast corner of the quadrangle. Dobbin (1932) mapped other anticlinal and synclinal (Torrivio Syncline) folds in the northern part of the Manuelito quadrangle. Dips of the rock units range from 15^{o} to 21^{o} SW on the western flank of the Torrivio Anticline and 2^{o} to 4^{o} NE in the southern and western parts of the area. Sears (1925) mapped a fault which may extend into the northeast corner of the quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified one coal bed and one coal zone in Dobbin's (1932) surface mapping. Fassett (1969) collected a coal outcrop sample from the author's informally designated Crevasse Canyon Dilco coal zone. The coal bed is here informally called the Crevasse Canyon Dilco No. 2 coal bed.

A single 2.0 ft (0.6 m) thick coal bed which occurs about 10 ft (3 m) above the top of the Gallup Sandstone comprises the Crevasse Canyon Dilco coal zone. The Crevasse Canyon Dilco No. 2 coal bed ranges in thickness from 0.5 to 3.0 ft (0.2 to 0.9 m) and occurs about 80 ft (24 m) above the top of the Gallup Sandstone in this quadrangle. Because the Crevasse Canyon Dilco No. 2 coal bed has not been identified with a thickness of 3.0 ft (0.9 m) or greater at more than one data point in this quadrangle, no additional Coal Resource Occurrence maps were constructed.

COAL RESOURCES

Although the Crevasse Canyon Dilco No. 2 coal bed is 3.0 ft (0.9 m) thick at data point #4 (see plate 3), the U. S. Geological Survey did not request reserve base or reserve calculations for the bed. The U. S. Geological Survey specified that only coal beds 3.0 ft (0.9 m) or more thick be 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.

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.

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.

The no and unknown development potential boundaries for surface and subsurface mining methods (combined on plate 4) are defined at the contact of the coal-bearing Gallup Sandstone with the underlying noncoal-bearing "main body" of the Mancos Shale. For coal development potential evaluations, the Dakota Sandstone is not considered potentially coal-bearing in this area by the U. S. Geological Survey. 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 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.

The coal development potential of this quadrangle is subject to revision. As further coal information becomes available, it is possible that correlative coal beds with sufficient thicknesses will be identified. These coal data will likely define areas of Federal coal lands with development potentials other than no or unknown.

Development potential for surface and subsurface mining methods and in situ gasification

The coal development potential for surface and subsurface mining methods in the Manuelito quadrangle is shown on plate 4. The surface and subsurface development potential maps were combined on the same plate because the no and unknown development potential boundaries are based on formation contacts which are identical for both the surface and subsurface mining criteria.

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.

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GLOSSARY

coal bed--A stratified sequence of coal, composed of relatively homogeneous material, exhibiting some degree of lithologic unity and separated from the rocks above and below by physically rather well defined boundary planes.

coal bed separation line--A line on a map plate separating areas where different coal beds or zones are mapped.

coal bench--One of two or more divisions of a coal bed separated by rock.

coal conversion factor--A factor used to convert acre-feet of coal into short tons of coal; bituminous coal is 1800 tons/acre-ft; subbituminous coal is 1770 tons/acre-ft.

coal development potential--A subjective determination of the comparative potential of Federal coal lands for development of a commercially viable coal mining operation.

coal exploration license--An area of Federal coal lands in which the licensee is granted the right, after outlining the area and the probable methods of exploration, to investigate the coal resources. An exploration license has a term not to exceed 2 years and does not confer rights to a lease.

coal lease--An area of Federal coal lands in which the Federal Government has entered into a contractual agreement for development of the coal deposits.

coal split--A coal bed resulting from the occurrence of a noncoal parting within the parent coal bed which divides the single coal bed into two or more coal beds.

coal zone--A distinctive stratigraphic interval containing a sequence of alternating coal and noncoal layers in which the coal beds may so lack lateral persistence that correlating individual beds in the zone is not feasible.

Federal coal land--Land for which the Federal Government holds title to the coal mineral rights, without regard to surface ownership.

hypothetical resources--Undiscovered coal resources in beds that may reasonably be expected to exist in known mining districts under known geologic conditions. In general, hypothetical resources are in broad areas of coal fields where points of observation are absent and evidence is from distant outcrops, drill holes or wells. Exploration that confirms their presence and reveals quantity and quality will permit their reclassification as a Reserve or Identified Subeconomic Resource.

identified resources--Specific bodies of coal whose location, rank, quality, and quantity are known from geologic evidence supported by engineering measurements.

indicated--Coal for which estimates for the rank, quality, and quantity have been computed partly from sample analyses and measurements and partly from reasonable geologic projections.

inferred--Coal in unexplored extensions of demonstrated resources for which estimates of the quality and quantity are based on geologic evidence and projections.

isopach--A line joining points of equal bed thickness.

Known Recoverable Coal Resource Area (KRCRA)--Formerly called Known Coal Leasing Area (KCLA). Area in which the Federal coal land is classified (1) as subject to the coal leasing provisions of the Mineral Leasing Act of 1920, as amended, and (2) by virtue of the available data being sufficient to permit evaluation as to extent, location, and potential for developing commercial quantities of coal.

measured--Coal for which estimates for rank, quality, and quantity can be computed, within a margin of error of less than 20 percent, from sample analyses and measurements from closely spaced and geologically well known sample sites.

mining ratio--A numerical ratio equating the in-place volumes, in cubic yards, of rocks that must be removed in order to recover 1 short ton of coal by surface mining.

overburden--A stratigraphic interval (composed of noncoal beds and coal beds) lying between the ground surface and the top of a coal bed. For coal zones, overburden is the stratigraphic interval lying between the ground surface and the structural datum used to map the zone.

parting--A noncoal layer occurring along a bedding plane within a coal bed.

Preference Right Lease Application (PRLA)--An area of Federal coal lands for which an application for a noncompetitive coal lease has been made as a result of exploration done under a coal prospecting permit. PRLA's are no longer obtainable.

quality or grade--Refers to measurements such as heat value; fixed carbon; moisture; ash; sulfur; phosphorus; major, minor, and trace elements; coking properties; petrologic properties; and particular organic constituents.

rank--The classification of coal relative to other coals, according to degree of metamorphism, or progressive alteration, in the natural series from lignite to anthracite (Classification of coals by rank, 1973, American Society for Testing and Materials, ASTM Designation D-388-66).

recovery factor--The percentage of total tons of coal estimated to be recoverable from a given area in relation to the total tonnage estimated to be in the Reserve Base in the ground.

reserve--That part of identified coal resource that can be economically mined at the time of determination. The reserve is derived by applying a recovery factor to that component of the identified coal resource designated as the reserve base.

reserve base--That part of identified coal resource from which Reserves are calculated.

stripping limit--A vertical depth, in feet, measured from the surface, reflecting the probable maximum, practical depth to which surface mining may be technologically feasible in the 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.