UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

OPEN-FILE REPORT 80-041

1985

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

[Report includes 5 plates]

Prepared by Berge Exploration, Inc.

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INTRODUCTION

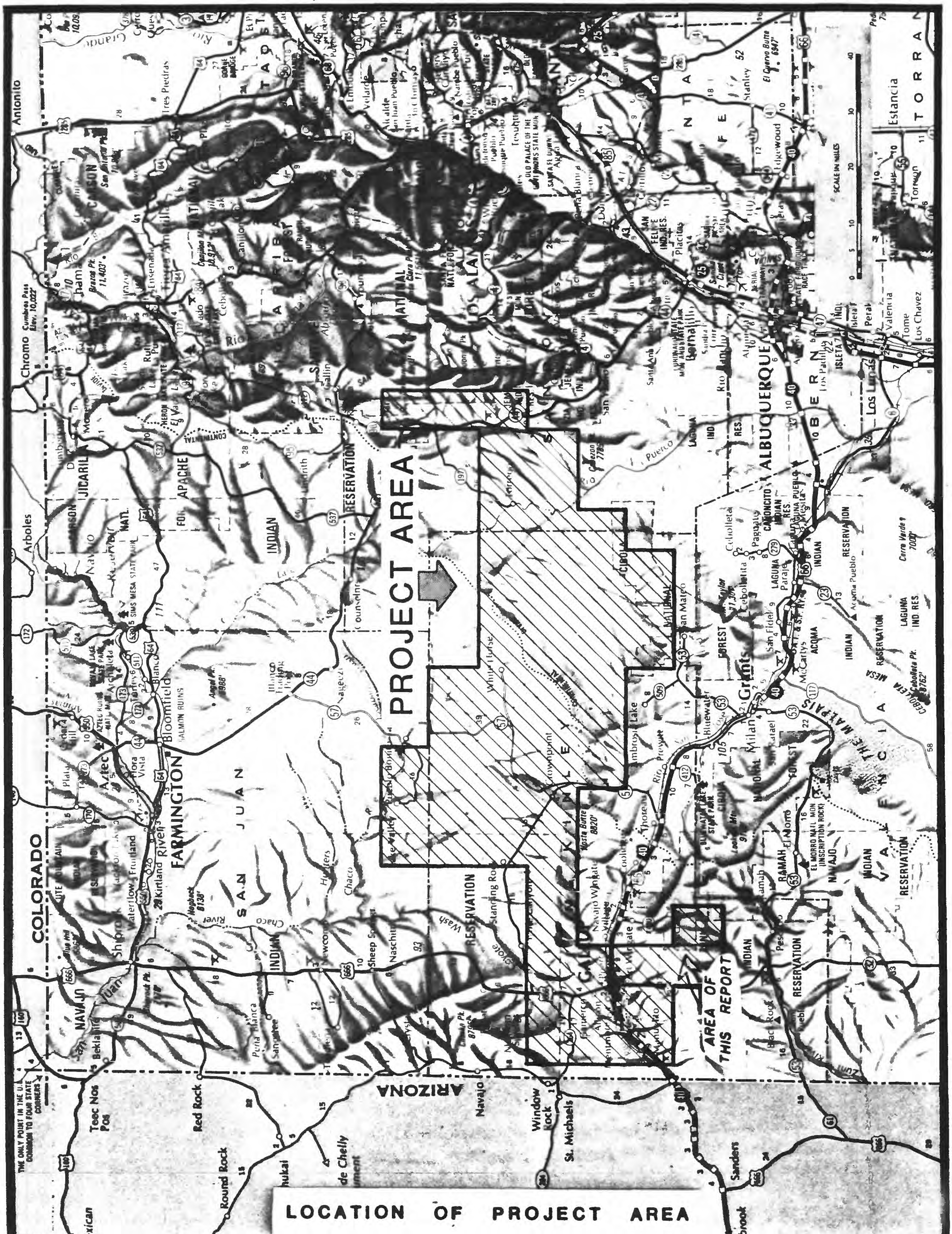
Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Upper Nutria 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. 14-08-001-17459 (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 Published and unpublished public information was used as the data base for this study.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.

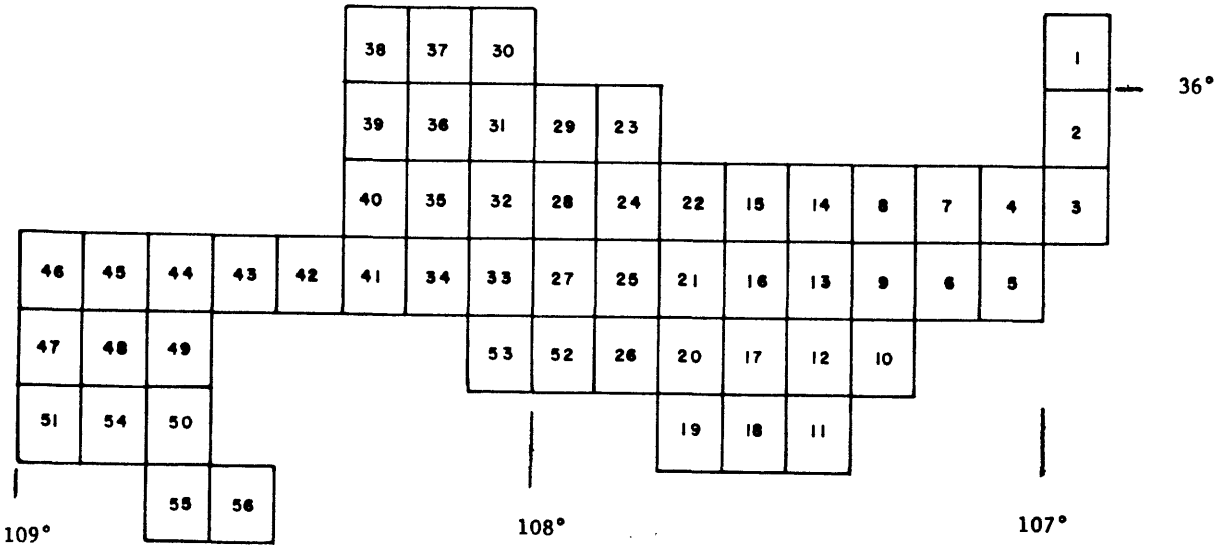


LOCATION OF PROJECT AREA
PROJECT AREA
AREA OF THIS REPORT
COLORADO
ARIZONA
FARMINGTON
ALBUQUERQUE
Grants

FIGURE 1

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

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



Location

The Upper Nutria 7 1/2 minute quadrangle includes acreage in Tps. 12 and 13 N., Rs. 16 and 17 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2). The villages of Upper Nutria and Lower Nutria are in the southern part of the quadrangle. The village of McGaffey is in the northeastern corner of the quadrangle.

Accessibility

State Route 400 passes through the extreme northeast corner of the quadrangle and provides access to Interstate Highway 40, about 12 mi (19 km) north of the quadrangle. A light-duty maintained road in the northern part of the area intersects State Route 32, 8 mi (13 km) west of the quadrangle. Another light-duty road in the southern part of the area provides access to State Route 53, 10 mi (16 km) south of the quadrangle. Unimproved dirt roads traverse most parts of the area. The main line of the Atchison, Topeka, and Santa Fe Railroad passes about 10 mi (16 km) north of the quadrangle (see fig. 1).

Physiography

The Upper Nutria quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U.S. Geological Survey, 1965). The Hogback and Oso Ridge are prominent topographic features in the quadrangle. The topography of the quadrangle is characterized by alluvial valley floors, eroded mesas, and rugged badlands in the western

part of the quadrangle. The Zuni uplift, which dominates the eastern half of the quadrangle, is characterized by mountainous terrain cut occasionally by steep walled drainages. The uplift is flanked on the east and west by hogbacks formed by steep dipping beds.

The Rio Nutria is a perennial stream in the quadrangle. Local drainage is provided by several intermittent arroyos. Elevations within the quadrangle ranges from less than 6,750 ft (2,057 m) southwest of the village of Lower Nutria to over 8,280 ft (2,524 m) along the northern quadrangle boundary.

Climate

The climate of this area is semiarid to arid except in the Zuni Mountains where a more humid climate predominates due to accumulation of greater amounts of moisture. The following temperature and precipitation data were reported by the National Oceanic and Atmospheric Administration for the McGaffey 4 SE Station. The Upper Nutria quadrangle is about 2 mi (3 km) W of the McGaffey 4 SE Station. Average total annual precipitation for thirteen of the previous fifteen years is 17.85 in. (45.34 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. In the Zuni Mountains winter snow accumulations provide additional moisture. Mean annual temperature for nine of the previous fifteen years is 42.3° F (5.7°C). The average daily temperatures in January and July are 23.6° F (-4.7°C) and 63.7° F (17.6°C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 66 percent of the Upper Nutria quadrangle. About 22 percent of the Federal coal lands are within the boundaries of the Zuni Indian Reservation. 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 6,250 acres (2,529 ha) in the northwest part of the quadrangle are within the Gallup Known Recoverable Coal Resource Area. Much of the Federal land in the eastern parts of the quadrangle is within the Cibola National Forest. As of October 26, 1978, there were no Federal coal leases, coal preference right lease applications or coal exploration licenses within the Upper Nutria quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include surface mapping with coal thicknesses from outcrop measured sections on the Zuni Indian Reservation by Winchester (Sears, 1925). Shomaker, Beaumont, and Kottlowski (1971) reviewed the potential for strippable coal reserves in the area. They reported that the coal beds within the Gallup Sandstone, and Dilco and Gibson Coal Members of the Crevasse Canyon Formation were generally less than 3.0 ft (0.9 m) thick in the area. They did not estimate any strippabable reserves within the Upper Nutria quadrangle. Lambert (1978) reported outcrops of Dilco Coal Member coals in the quadrangle. B. A. Livingston of Bokum Corporation (1979) supplied geophysical logs and lithologic descriptions of several uranium test holes drilled under a uranium prospecting permit. These data became available to Berge Exploration, Inc.,

because the prospecting permit had expired. Unfortunately, the suite of geophysical logs and lithologic descriptions of these test holes were not sufficient, in most cases, to identify coal beds.

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 (geosyclinal) subsidence and the availablity of sediment supplies are the major factors that controlled the transgressive-regressive shoreline sequences.

Exposed rock units in the Upper Nutria quadrangle include units of Permian, Triassic, Jurassic, Upper Cretaceous, and Quaternary age. Permian, Triassic and Jurassic rock units crop out along and east of The Hogback. All of the coal beds occur in Upper Cretaceous strata which are exposed along and west of the hogback. Quaternary deposits include alluvium and terrace gravels along the Rio Nutria and other drainages in the area.

The Dakota Sandstone represents coastal sands, fluvial deposits, and marine shales, and is the basal unit of the Upper Cretaceous section. The Dakota Sandstone is composed of yellowish-brown to buff, fine to medium-grained sandstone with interbedded dark gray to black carbonaceous shales, and coals. Thickness of the unit ranges from 200 to 250 ft (61 to 76 m) locally. 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 660 to 740 ft (201 to 226 m) thick locally.

Overlying the "main body" of the Mancos Shale, the Gallup Sandstone represents nearshore or littoral deposits that formed during a major northeastward retreat of the Cretaceous seaways in the San Juan Basin. 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 240 to 300 ft (73 to 91 m) thick locally.

The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents continental sediments which were deposited inland from the beach area during the 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 255 to 300 ft (78 to 91 m) thick in the area.

About 420 ft (128 m) of the Bartlett Barren Member overlies the Dilco Coal Member in this area. Yellowish-brown to olive-gray siltstone, light gray shales, white to brown calcareous sandstones, and thin local coal beds comprise the lithologies of the Bartlett Barren Member which represents flood plain deposits. The Crevasse Canyon Gibson-Menefee Cleary undifferentiated unit overlies the Bartlett Barren Member, and was combined based on similar lithologies and stratigraphic continuity representing essentially continuous continental deposition. Light to medium gray, carbonaceous siltstone with interbedded gray to tan sandstones, gray shales, and coal beds comprise the lithologies of the Crevasse Canyon Gibson-Menefee Cleary unit. The full thickness of the unit is not known in the Upper Nutria quadrangle, although the lower 150 ft (46 m) is represented on plate 3.

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 sediemntary sequences. The paucity of data in this quadrangle and the intended scope of this report permit only general interpretations of the depositional 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 Upper Nutria quadrangle is in the Gallup Sag, Nutria Monocline (Baltz, 1967), and Zuni Uplift structural divisions in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). Hackman and Olson (1977) mapped the Allison Syncline in the western part of the quadrangle. They also mapped several faults in the quadrangle, including the McGaffey Fault which is a major downthrown-to-the-west fault that formed Oso Ridge. Dips of the rock units range from less than 1^{o} W to 70^{o} SW along and west of The Hogback, and from 3^{o} to 6^{o} SE to SW in the eastern part of the quadrangle. Hackman and Olson (1977) also mapped additional anticlinal and synclinal folds in the area.

COAL GEOLOGY

In this quadrangle, the author has identified one coal bed and one coal zone in Winchester's (Sears, 1925) mapping, Lambert's (1978) compilation, and from uranium test holes (Bokum Corporation). This coal bed and coal zone is here informally called the Crevasse Canyon Dilco No. 5 coal bed and the Crevasse Canyon Dilco coal zone.

The Crevasse Canyon Dilco No. 5 coal bed was identified in three uranium test holes, and occurs from 195 to 220 ft (59 to 67 m) above the top of the Gallup Sandstone. The Crevasse Canyon Dilco coal zone contains one coal bed that ranges in thickness from 1.3 to 3.6 ft (0.4 to 1.1 m) and occurs from 240 to 260 ft (73 to 79 m) above the top of the Gallup Sandstone.

There are no known published coal quality analyses of coal beds from the Upper Nutria quadrangle. Analyses of three Dilco Coal Member beds have been reported by the U. S. Bureau of Mines (1936) and are shown in table 1. The Dilco Coal Member seams analyzed are probably similar in quality to the Dilco Coal Member beds in this quadrangle. Rank of the Dilco Coal Member beds is probably high volatile C bituminous in this area.

Crevasse Canyon Dilco No. 5 coal bed

The Crevasse Canyon Dilco No. 5 coal bed was identified in three uranium test hole logs and is split into three benches in each drill hole. Up to 13.9 ft (4.2 m) of coal comprises the thickness of the Crevasse Canyon Dilco No. 5 coal bed in this quadrangle. Because of the limited area in which the bed was identified in this quadrangle, the isopach, structure contour, and overburden isopach maps are included in the text as page-sized maps (figs. 3, 4, and 5). The bed is inferred to pinch out toward the southeast, south, and northwest (see fig. 3). The mine sample from the Gallup Southwestern mine (sample 2, table 1; Black Diamond bed of Sears, 1925) is from the same coal bed as the author's Crevasse Canyon Dilco No. 5 coal bed. Existence and character of the Crevasse Canyon Dilco No. 5 coal bed are unknown in most parts of the quadrangle because of insufficient data.

Table 1. - Analyses of coal samples from the Dilco Coal Member of the Crevasse Canyon Formation.

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

from U. S. Bureau of Mines, 1936

Sample	Type of sample	Location Sec.	T.	N.	R.	W.	Form of Analysis	Proximate analysis (percent) Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Heating value (Btu/lb)
1	mine sample (Defiance mine)	SE¼ 16	15		19		A	10.6	40.9	41.4	7.1	0.79	11,510
							B	---	45.7	46.4	7.9	0.88	12,880
							C	---	49.7	50.3	---	0.96	13,990
2	mine sample (Gallup Southwestern mine)	SE¼ 21	15		18		A	11.4	39.9	42.2	6.5	0.75	11,640
							B	---	45.0	47.7	7.3	0.85	13,140
							C	---	48.5	51.5	---	0.92	14,180
3	mine sample (Caretto mine)	SE¼ 14	15		18		A	10.6	40.6	44.4	4.40	0.59	12,100
							B	---	45.4	49.7	4.92	0.66	13,530
							C	---	47.7	52.3	---	0.69	14,230

Remarks:

A moist, mineral-matter-free (MMMF) caluclation using the Parr formula (American Society for Testing and Materials, 1973) yields heating values of 12,482 Btu/lb (29,033 kJ/kg; sample 1), 12,534 Btu/lb (29,154 kJ/kg; sample 2), and 12,716 Btu/lb (29,577 kJ/kg; sample 3). No agglomerating characteristics were included with the analyses.

Figure 3

ISOPACH MAP OF THE CREVASSE CANYON DILCO No.5 COAL BED

(See explanation p. 16)

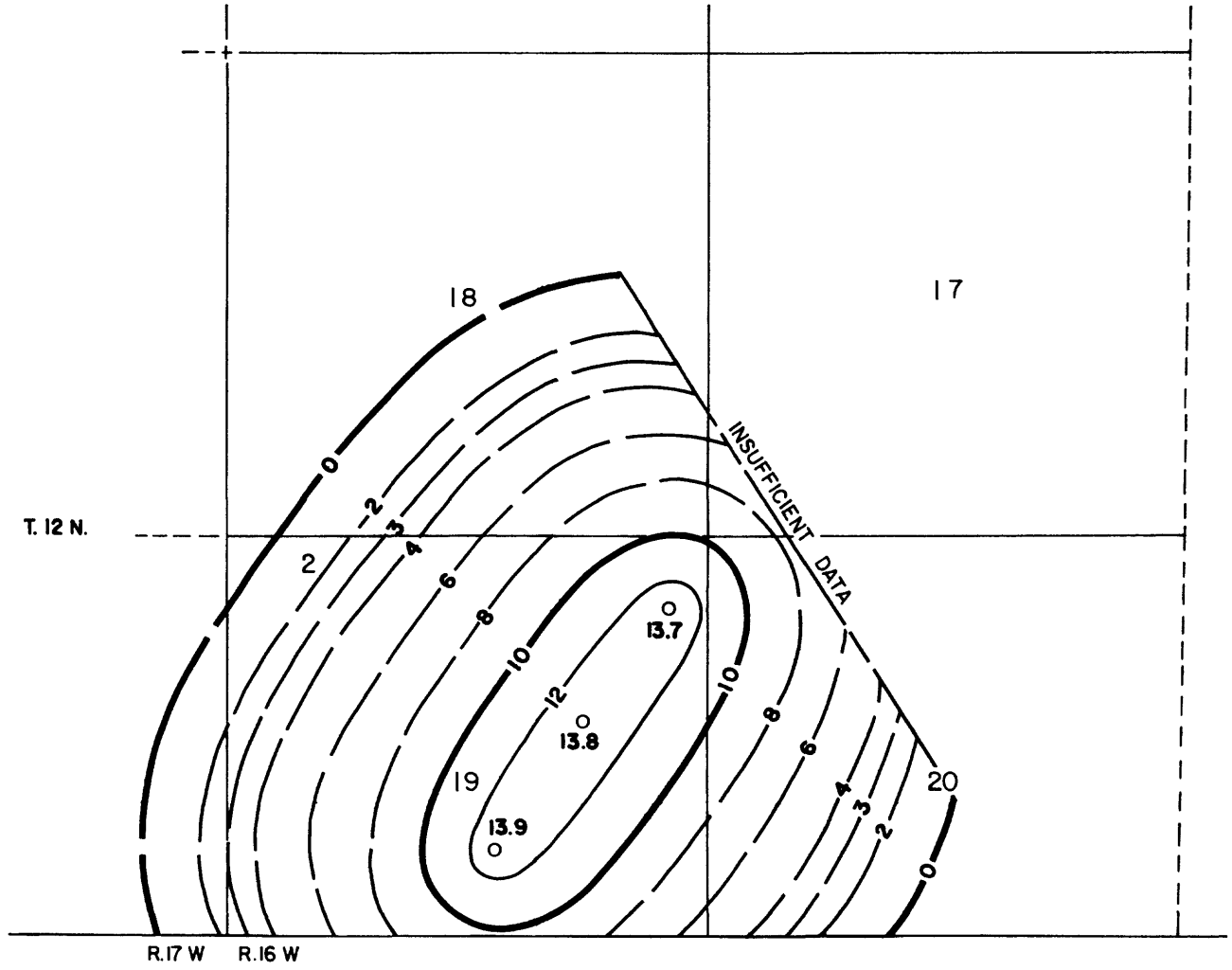


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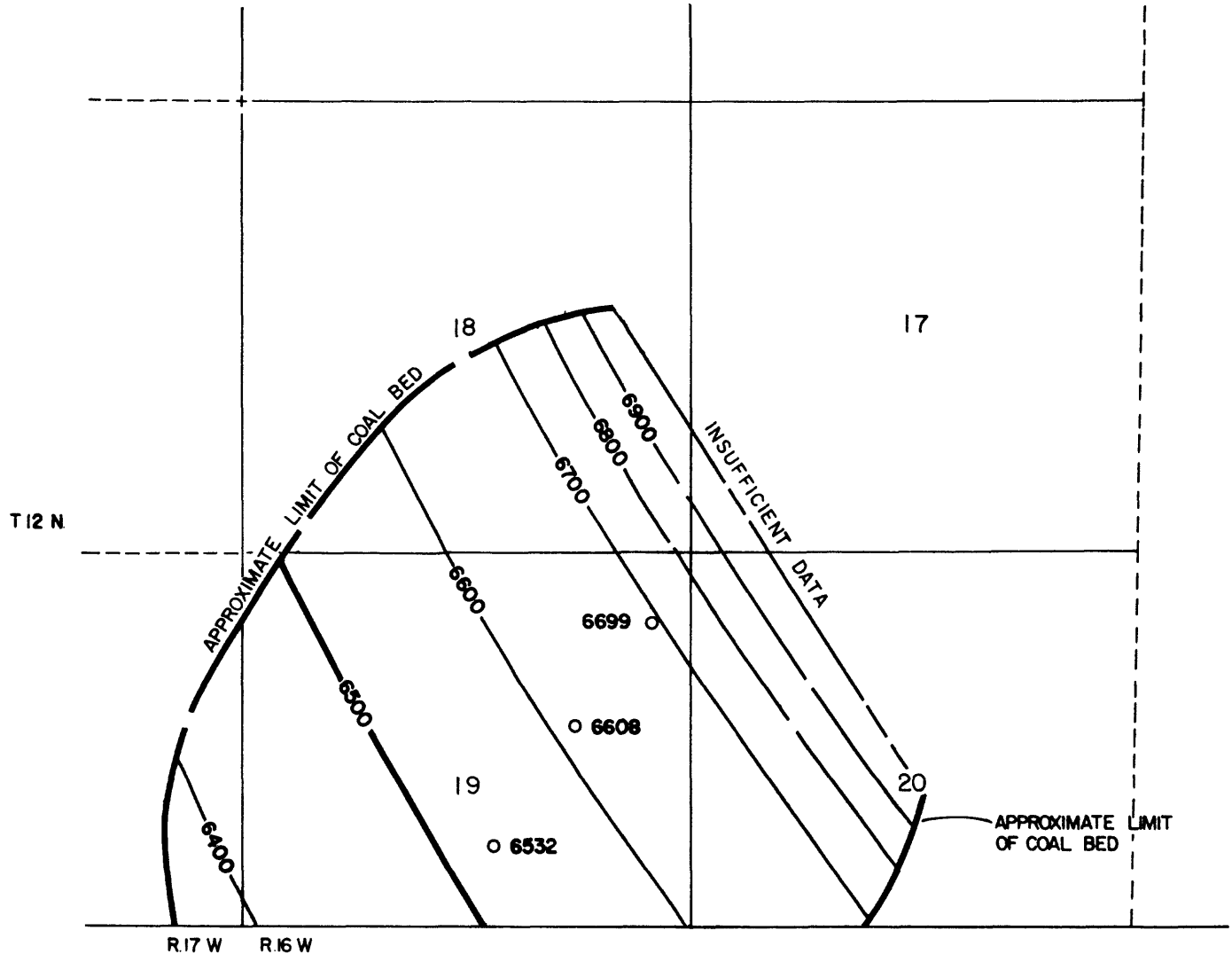
Figure 4

STRUCTURE CONTOUR MAP OF THE CREVASSE CANYON DILCO No.5 COAL BED

(See explanation p. 16)



SCALE 1:24,000

Figure 5

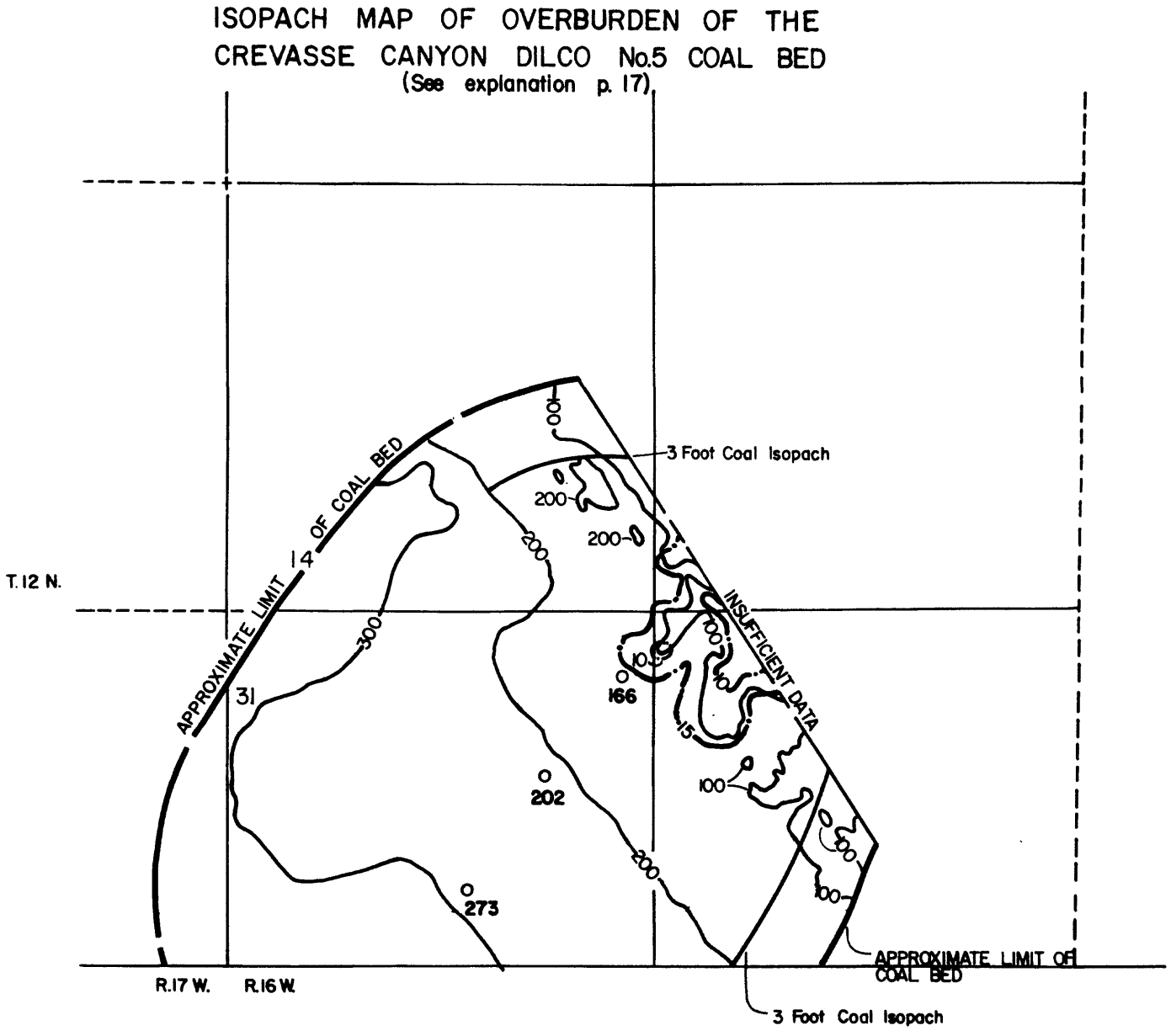
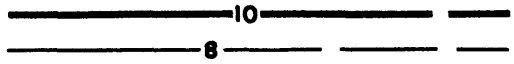

ISOPACH MAP OF OVERBURDEN OF THE
CREVASSE CANYON DILCO No.5 COAL BED
(See explanation p. 17)
T. 12 N.
R. 17 W.
R. 16 W.
APPROXIMATE LIMIT OF COAL BED
3 Foot Coal Isopach
INSUFFICIENT DATA
APPROXIMATE LIMIT OF COAL BED
3 Foot Coal Isopach
14
31
166
202
273
100
200
300
SCALE 1:24.000

Figure 3

EXPLANATION



ISOPACH OF THE CREVASSE CANYON DILCO NO. 5 COAL BED-Showing thickness in feet. Isopach inteval 2 feet (0.6 meters) with supplemental 3 foot (0.9 meter) isopach. Isopachs dashed where inferred.

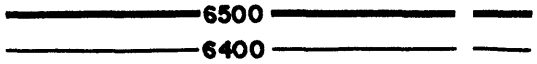
o 13.9

DRILL HOLE-Showing thickness of the Crevasse Canyon Dilco No. 5 coal bed in feet.

To convert feet to meters, multiply feet by 0.3048.

Figure 4

EXPLANATION



STRUCTURE CONTOURS-Drawn on top of the Crevasse Canyon Dilco No. 5 coal bed. Contour interval 100 feet (30.5 meters). Datum is mean sea level. Contours dashed where inferred.

o 6532

DRILL HOLE-Showing altitude at top of the Crevasse Canyon Dilco No. 5 coal bed in feet.

To convert feet to meters, multiply feet by 0.3048.

Figure 5

EXPLANATION

200

OVERBURDEN ISOPACHS-Showing thickness of overburden, in feet, from the surface to the top of the Crevasse Canyon Dilco No. 5 coal bed (refer to CRO figure 4). Isopach interval 100 feet (30.5 meters). Isopachs dashed where inferred. Stripping limit is 200 feet (61 meters).

o 273

DRILL HOLE-Showing thickness of overburden, in feet, of the Crevasse Canyon Dilco No. 5 coal bed.

10

MINING RATIO CONTOUR FOR THE CREVASSE CANYON DILCO NO. 5 COAL BED-Number indicates cubic yards of overburden per ton of recoverable coal by surface-mining methods. Contours shown only in areas suitable for surface mining within the stripping limit, less than 200 feet (61 meters) of overburden.

To convert feet to meters, multiply feet by 0.3048

COAL RESOURCES

The U. S. Geological Survey requested a resource evaluation of the Crevassee Canyon Dilco No. 5 coal bed, where the bed is 3.0 ft (0.9 m) or more thick. The evaluation is restricted to Federal coal lands.

The following procedures were prescribed by the U. S. Geological Survey for the calculation of reserve base. Criteria established in U. S. Geological Survey Bulletin 1450-B were used to areally divide the bed into measured, indicated, and inferred reserve base categories. Reserve base was calculated for each category, by section, using data from the isopach and overburden maps (figs. 3 and 5). The acreage in each category (measured by planimeter) multiplied by the average coal thickness and a bituminous coal conversion factor (1,800 tons of coal per acre-ft) yields the reserve base for that category. Coal beds with 3.0 ft (0.9 m) minimum thickness are included in reserve base and reserve data rather than the 28 in. (71 cm) minimum thickness prescribed in U. S. Geological Survey Bulletin 1450-B. Reserve figures are derived from reserve base totals by applying recovery factors of 85 percent and 50 percent for coal beds 0 to 200 ft (0 to 61 m) and 200 to 3,000 ft (61 to 914 m) deep, respectively. All reserve base and reserve values are rounded to the nearest 10,000 short tons (9,072 t).

Total reserve base data for the Crevasse Canyon Dilco No. 5 coal bed, 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 fig. 6.

Figure 6

AREAL DISTRIBUTION AND IDENTIFIED RESOURCES OF THE CREVASSE CANYON DILCO No.5 COAL BED

(See explanation p. 20)

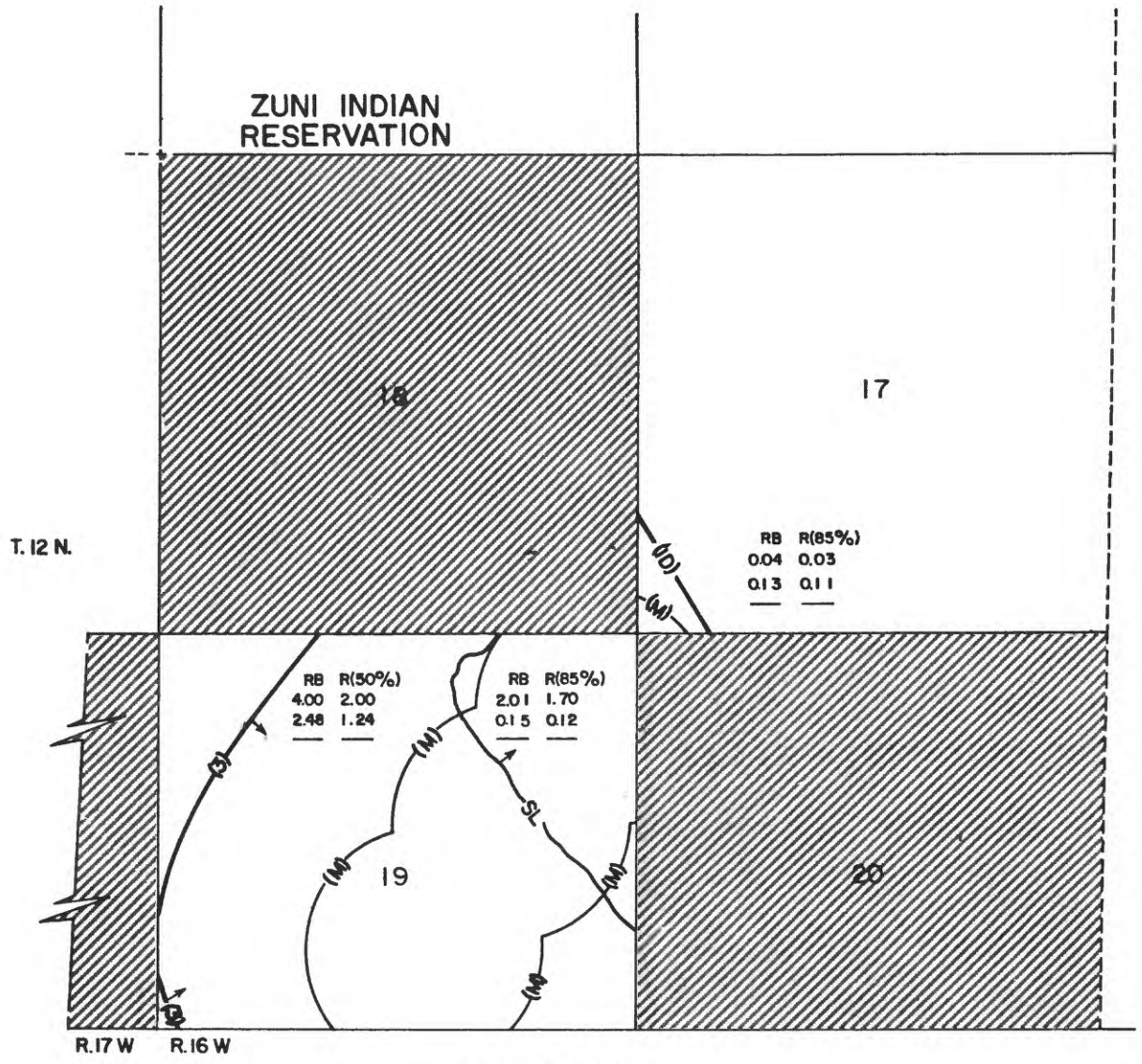


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Figure 6

EXPLANATION

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

SL

STRIPPING-LIMIT Line-Boundary for surface mining (in this quadrangle, the 200 foot-61 meter -overburden isopach). Arrow points toward the area suitable for surface mining. Recovery factor of 85 percent used within the stripping limit.

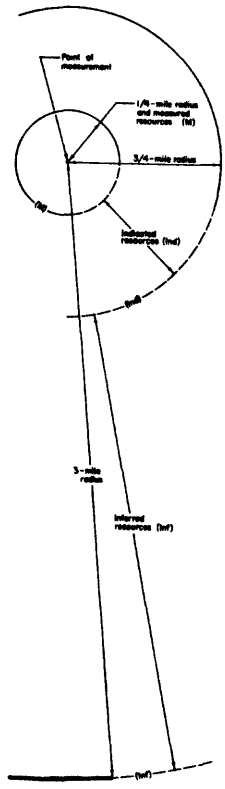
BOUNDARY OF IDENTIFIED RESERVE BASE COAL-Drawn along the 3 foot (0.9 meter) coal isopach (3), the insufficient date line (ID). Arrow points toward area of identified Reserve Base coal.

RB	R(85%)	
0.04	0.03	(Measured resources)
0.09	0.07	(Indicated resources)
—	—	(Inferred resources)

IDENTIFIED COAL RESOURCES-Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section of Federal coal land within the stripping limit line. Dash indicates no resources within that category. Reserve Base (RB) x the Recovery Factor (85 percent) = Reserves (R).

RB	R(50%)	
4.00	2.00	(Measured resources)
2.53	2.15	(Indicated resources)
—	—	(Inferred resources)

IDENTIFIED COAL RESOURCES-Showing totals for Reserve Base (RB) and Reserves (R), in millions of short tons, for each section of Federal coal land outside the stripping limit line. Dash indicates no resources in that category. Reserve Base (RB) x the Recovery Factor (50 percent) = Reserves (R).



BOUNDARY LINES-Enclosed areas of measured (M), indicated (Ind) and inferred (Inf) coal resources. Diagram not to scale.

To convert short tons to metric tons, multiply short tons by 0.9072.

To convert miles to kilometers, multiply miles by 1.609.

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 practices, U. S. Geological Survey Bulletin 1450-B, and anticipated technological advances. All available data were utilized for the coal development potential evaluations.

Any area underlain by a potentially coal-bearing formation with 200 ft (61 m) or less of overburden has potential for surface mining. The U. S. Geological Survey designated the 200 ft (61 m) maximum depth as the stripping limit. Areas where a potentially coal-bearing formation is overlain by more than 200 ft (61 m) of overburden have no potential for surface mining. Areas with no correlative coal bed or a correlative coal bed less than 3.0 ft (0.9 m) in thickness and overlain by 200 ft (61 m) or less of overburden have unknown surface mining potential. Areas which have a correlative coal bed 3.0 ft (0.9 m) or more thick with surface mining potential are assigned a high, moderate or low development potential based on the mining ratio (cubic yards of overburden per short ton of recoverable coal). The formula used to calculate mining ratios is:

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

Where MR = Mining ratio

t_o = Thickness of overburden in feet

t_c = Thickness of coal in feet

Rf = Recovery factor

C = Volume-weight conversion factor

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

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

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

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

The no and unknown development potential boundaries for surface and subsurface mining methods (plates 4 and 5, respectively) 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 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.

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 Upper Nutria quadrangle is shown on plate 4. Based on coal development potential criteria, all Federal coal lands in the Upper Nutria quadrangle have high, moderate, low, unknown or no surface mining potential. The areas of high and moderate potential are not shown on plate 4 because they occupy less than 50 percent of the smallest legal land subdivision. Refer to table 4 for reserves and planimetered acreage, by section, for Federal coal lands in the Upper Nutria quadrangle with surface mining potential.

Development potential for subsurface mining methods and in situ gasification

The coal development potential for subsurface mining methods in the Upper Nutria quadrangle is shown on plate 5. Based on coal development potential criteria, all Federal coal lands in the Upper Nutria quadrangle have high, unknown or no subsurface mining potential. Refer to table 5 for reserves and planimetered acreage, by section, for Federal coal lands in the Upper Nutria quadrangle with subsurface mining potential.

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

Table 2. - Reserve base data (in short tons) for surface mining methods for Federal coal lands in the Upper Nutria quadrangle, McKinley 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
Crevasse Canyon Dilco No. 5	10,000	270,000	2,050,000	2,330,000
Total	10,000	270,000	2,050,000	2,330,000

Table 3. - Reserve base data (in short tons) for subsurface mining methods for Federal coal lands in the Upper Nutria 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
Crevasse Canyon Dilco No. 5	6,480,000	---	---	6,480,000
Total	6,480,000	---	---	6,480,000

Table 4. - Reserves and planimetered acreage, by section, for Federal coal lands in the Upper Nutria 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)
High	Crevasse Canyon Dilco No. 5	17	12		16		0.5	less than 10,000
Moderate	C revasse Canyon Dilco No. 5	17	12		16		9.1	80,000
		19					7.6	130,000
Low	Crevasse Canyon Dilco No. 5	17	12		16		4.0	30,000
		19					85.1	1,690,000

Table 5. - Reserves and planimetered acreage, by section, for Federal coal lands in the Upper Nutria 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	Crevasse Canyon Dilco No. 5	19	12		16		384.6	3,230,000

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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.