UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to accompany:

OPEN-FILE REPORT 79-1125

1985

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

[Report includes 7 plates]

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CROWNPOINT QUADRANGLE
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INTRODUCTION

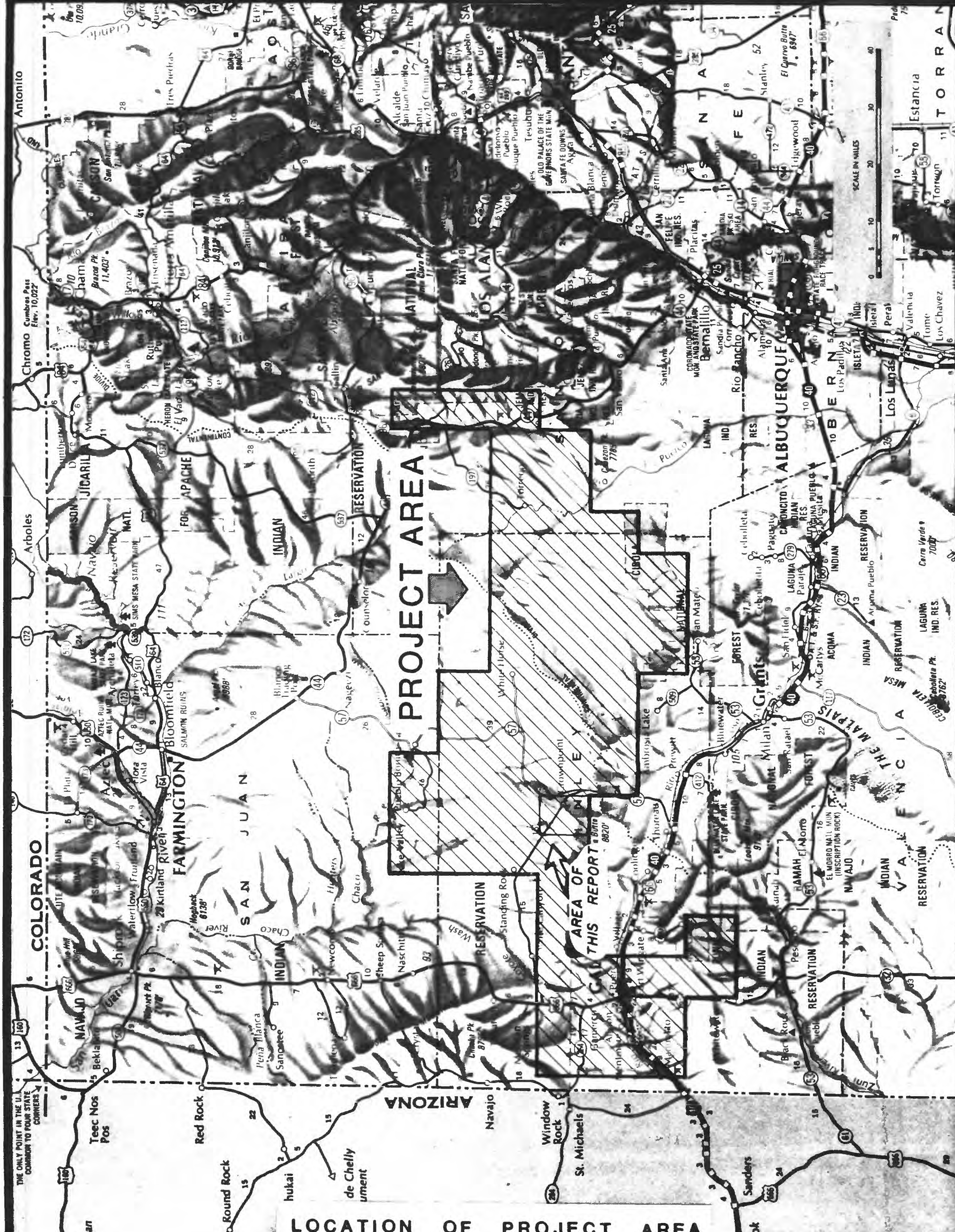
Purpose

This text complements the Coal Resource Occurrence (CRO) and Coal Development Potential (CDP) maps of the Crownpoint 7 1/2 minute quadrangle, McKinley County, New Mexico. These maps and report and 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 Published and unpublished public information was used as the data base for this study.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

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
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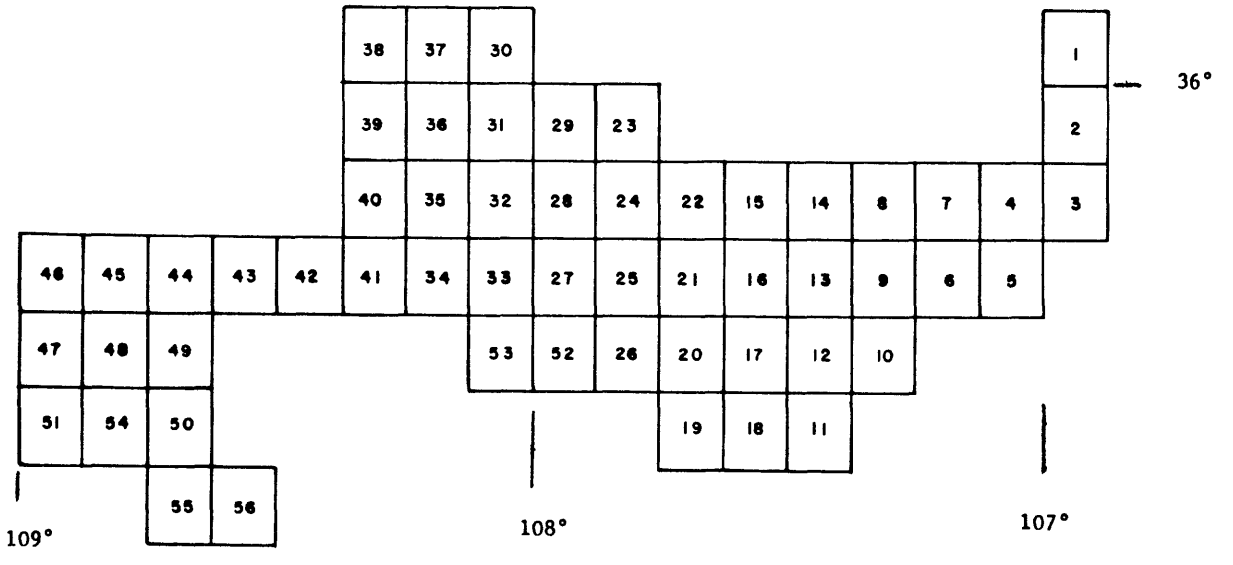
14	Rincon Marquez	79- 631
15	Whitehorse Rincon	79- 632
16	Mesita Americana	79- 633
17	El Dado	79- 634
18	Cerro Alesna	79- 635
19	San Lucas Dam	79- 636
20	Piedra de la Aguila	79-1039
21	Hospah	79- 637
22	Whitehorse	79-1040
23	Seven Lakes NE	79- 638
24	Kin Nahzin Ruins	79- 639
25	Orphan Annie Rock	79-1041
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 Crownpoint 7 1/2 minute quadrangle includes acreage in Tps. 16, 17, and 18 N., Rs. 12 and 13 W. of the New Mexico Principal Meridian, McKinley County, northwestern New Mexico (see figs. 1 and 2). The town of Crownpoint is located in the east central part of the quadrangle.

Accessibility

State Highway 57 passes through the quadrangle and provides access from the town of Crownpoint to the town of Thoreau, 23 mi (37 km) south of the quadrangle. Light duty and unimproved dirt roads traverse much of the remainder of the area. The Atchison, Topeka, and Santa Fe Railroad line passes through the town of Thoreau (see fig. 1).

Physiography

The Crownpoint quadrangle is in the Navajo section of the southernmost part of the Colorado Plateau physiographic province (U. S. Geological Survey, 1965). The quadrangle is an area of relatively low relief with the exception of a mesa which dominates its southern quarter.

No perennial streams are present in the quadrangle. Local drainage is provided by the Puerco River and numerous other intermittent arroyos. Elevations within the quadrangle range from about 6,510 ft (1,984 m) at the northwest corner to 8,102 ft (2,469 m) in the southwest.

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 Thoreau 5 ENE Station. The Crownpoint quadrangle is about 11.5 mi (18.5 km) north of the Thoreau 5 ENE Station. Average total annual precipitation for thirteen of the previous fifteen years is 10.84 in. (27.53 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 thirteen of the previous fifteen years is 49.4° F (9.7° C). The average daily temperatures in January and July are 30.8° F (-0.7° C) and 70.9° F (21.6° C), respectively.

Land status

The Federal Government holds the coal mineral rights to approximately 60 percent of the Crownpoint quadrangle. For specific coal ownership boundaries, see plate 2. It is not within the scope of this report to provide detailed land-surface ownerhip. All but 1,800 acres (728 ha) in the southern and 1,050 acres (429 ha) in the northeastern portions of the quadrangle are within the Crownpoint 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 Crownpoint quadrangle.

GENERAL GEOLOGY

Previous work

Early reports on the area include that of Gardner (1909) who mapped the area and measured Crevasse Canyon Gibson coals south of the quadrangle. Sears (1934) also mapped Gibson Coal Member beds in the southern part of the quadrangle. Shomaker, Beaumont,and Kottlowski (1971) discussed the Gibson Coal Member beds, noting that few of the individual beds exceed 3.0 ft (0.9 m) in thickness. They did not estimate any strippable coal reserves in the area and report that most coals are overlain by 100 to 300 ft (30 to 91 m) of sandstone overburden. Robertson (1978) mapped the surface geology of the 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 Crownpoint quadrangle include some of the sedimentary units of Upper Cretaceous age. Various Quaternary deposits including alluvium, eolian sands, pediment gravels, and colluvium are present at the surface in this 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 siliceous sandstone with interbedded dark gray to black carbonaceous shales and coal beds, and averages 270 ft (82 m) thick locally. The "main body" of the Mancos Shales 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 is about 600 ft (183 m) thick locally.

A major northeastward regression of the Cretaceous seaways followed, and resulted in deposition of the Gallup Sandstone in a beach or littoral environment. The Gallup Sandstone is composed of pink to gray, fine to medium grained massive sandstone with interbedded gray shales, and averages 170 ft (52 m) thick locally. The Dilco Coal Member of the Crevasse Canyon Formation overlies the Gallup Sandstone and represents the continental deposits which formed 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 160 to 200 ft (49 to 61 m) thick in the area. Robertson (1978) reports that only the uppermost 30 ft (10 m) of the Dilco Coal Member is exposed in this quadrangle.

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 which 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. Thickness of the Mulatto Tongue ranges from 180 to 220 ft (55 to 67 m). 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 180 ft (30 to 55 m) thick locally. The Gibson Coal Member of the Crevasse Canyon Formation overlies the Dalton Sandstone Member and represents the continental sediments deposited inland from the beach area during deposition of the Dalton Sandstone. Medium gray, carbonaceous siltstone with interbedded gray to tan sandstone and coal beds comprise the lithologies of the Gibson Coal Member, which ranges from 250 to 300 ft (76 to 91 m) thick in the area. Increased rates of trough subsidence resulted in the gradual reversal from regressive to transgressive 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 averages 100 ft (30 m) thick locally.

As the transgression proceeded and the Cretaceous seaways deepened, the Satan Tongue of the Mancos Shale was deposited over the Hosta Tongue. The Satan Tongue is composed of light to dark gray, silty shale with interbedded tan to buff sandstone, and ranges from 200 to 300 ft (61 to 91 m) thick locally. The Point Lookout Sandstone overlies the Satan Tongue, and represents nearshore or littoral deposits which formed during the most extensive northeastward retreat prior to the final withdrawal of the Cretaceous

seaways in the San Juan Basin (Sears, Hunt, and Hendricks, 1941). Lithology of the Point Lookout Sandstone is identical to the Hosta Tongue and is 130 ft (40 m) thick locally. The continental sediments deposited inland from the beach area during the deposition of the Point Lookout Sandstone compose the overlying Menefee Formation.

The Menefee Formation consists of dark gray to brown carbonaceous to noncarbonaceous shales, light gray sandstones, and coal beds, and is divisible into the basal Cleary Coal Member and upper Allison Member. A massive channel sandstone sequence defines the boundary between the two members. The Cleary Coal Member contains only thin coals less than 6 in. (15 cm) thick in this quadrangle, as reported by Robertson (1978). Only the lower 50 ft (15 cm) of the unit is exposed in this area. The Allison Member outcrops north of the Crownpoint quadrangle.

Depositional environments

The Cretaceous System sedimentary units in the quadrangle represent transgressive and regressive depositional conditions. There were innumerable minor cycles of widely varying duration and extent within the major sedimentary sequences. The paucity of data in this quadrangle and the intended scope of this report permit only general interpretations of the depositional environments.

The Cretaceous coal deposits of the San Juan Basin are products of former coastal swamps and marshes. These swamps and marshes were supported by heavy precipitation and a climate conducive to rapid vegetal growth in moderately fresh water. Due to the relatively low sulfur contents of the San Juan Basin coals, Shomaker and Whyte (1977) suggest the coals formed in fresh water environments.

Most of the coal-bearing units were deposited in coastal plain environments. The majority of the peat deposits formed in a transition zone between lower and upper deltaic sediments during periods of relative shoreline stability. Coals also formed in lake margin swamps inland from the coastal area. Shoreline oscillations and the subsequent influx of continental or marine debris upon the peat accumulations produced the vertical buildup or "stacking" of peat deposits. This sediment debris represents variable ash contents, rock partings, and splits within the coal seams.

The peat accumulated in lenses or pods which were generally parallel to the ancient shorelines. The coals in the lower portions of the coal-bearing units represent regressive depositional conditions (Sears, Hunt, and Hendricks, 1941). The coals in the upper portions of these units are relatively sporadic in occurrence.

Structure

The Crownpoint quadrangle is in the Chaco Slope structural division in the southern portion of the structural depression known as the San Juan Basin (Kelley, 1950). The rock units dip about 2^{o} to 3^{o} N. Sears (1934) recognized no faults in the area, whereas Robertson (1978) mapped several low displacement faults in the Crownpoint quadrangle. Minor, locallized folding is apparent in the southern part of the quadrangle.

COAL GEOLOGY

In this quadrangle, the authors identified three coal zones in oil and gas well logs and Sear's (1934) surface mapping. These zones are here informally called the Dakota coal zone, Crevasse Canyon Dilco coal zone, and the Crevasse Canyon Gibson coal zone.

A single 2.0 ft (0.6 m) thick bed which occurs near the base of the Dakota Sandstone represents the Dakota coal zone. About 1,020 ft (311 m) above the Dakota coal, the Crevasse Canyon Dilco coal zone contains up to four individual zone coal beds which range in thickness from 2.0 to 2.5 ft (0.6 to 0.8 m). The Crevasse Canyon Gibson coal zone contains up to twenty coal beds which range in thickness from 0.2 to 4.8 ft (0.1 to 1.5 m). These zone beds may be correlated for limited distances in portions of the area but they lack sufficient continuity with poorly defined stratigraphic position and cannot be designated as persistent coal beds.

There is a published coal quality analysis for coal beds from the Crownpoint quadrangle. An analysis of a mine sample of Gibson Coal Member beds taken from the Crownpoint mine about 0.5 mi (0.8 km) south of the town of Crownpoint has been reported by the U. S. Bureau of Mines (1936) and is shown in table 1. Rank of the Gibson Coal Member seams of this quadrangle is probably high volatile C bituminous.

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

(Crownpoint mine sample from sec. 30, T. 17 N., R. 12 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	Heating value (Btu/lb)
	Moisture	Volatile matter	Fixed carbon	Ash		
A	15.4	36.1	39.0	9.5	1.3	10,520
B	----	42.7	46.1	11.2	1.5	12,440
C	----	48.0	52.0	----	1.7	14,010

Remarks:

A moist, mineral-matter-free (MMMF) calculation using the Parr formula (American Society for Testing and Materials, 1973) yields a heating value of 11,744 Btu/lb (27,317 kJ/kg). No agglomerating characteristics were included with the analysis.

Crevasse Canyon Gibson coal zone

The Crevasse Canyon Gibson coal zone was identified in two drill hole logs and fourteen outcrop measured sections by Sears (1934). The zone crops out in the southern part of the quadrangle and dips to the north-northeast. Total zone coal thickness at each data point ranges from 2.6 to 30.5 ft (0.8 to 9.3 m). A barren interval which ranges from 0.2 to over 100 ft 0.1 to 30+ m) thick separates the coal beds. Existence and character of the zone beds are unknown in the northern one-third of the quadrangle because of insufficient data.

COAL RESOURCES

No reserve base or reserves were calculated in the Crownpoint quadrangle because no persistent, correlative coal beds were identified. The U. S. Geological Survey requested a resource evaluation of the Crevasse Canyon Gibson coal zone, where the total coal thickness is 5.0 ft (1.5 m) or greater. Total identified Crevasse Canyon Gibson coal zone resources are 86.44 million short tons (78.42 million t).

COAL DEVELOPMENT POTENTIAL

The factors used to determine the development potential are the presence of a potential 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 underlain by a potential 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 stipping limit. Areas where a potential 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. The no and unknown development potential boundaries for surface mining methods (plate 7) are defined at the contact of the coal-bearing Gibson Coal Member of the Crevasse Canyon Formation with the overlying noncoal-bearing Hosta Tongue of the Point Lookout Sandstone and the underlying noncoal-bearing Dalton Sandstone Member of the Crevasse Canyon Formation. These contacts are approximated due to the inaccuracies of adjusting old geologic maps to modern topographic bases.

Any area underlain by a potential coal-bearing formation with 200 to 3,000 ft (61 to 914 m) of overburden has potential for subsurface mining.

Areas where a potential 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 potential 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.

Boundaries of coal development potential areas coincide with the boundaries of the smallest legal land subdivision (40 acre or lot). When a land subdivision contains areas with different development potentials, the potential shown on the map is that of the areally largest 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 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 Crownpoint quadrangle is shown on plate 7. No correlative coal bed 3.0 ft (0.9 m) thick or greater has been identified in this quadrangle. Based on coal development potential criteria, all Federal coal lands have either unknown or no development potential for surface mining methods.

Development potential for subsurface mining methods and in situ gasification

No subsurface coal development potential evaluation was performed for the Crownpoint quadrangle because no correlative coal beds have been identified. Based on coal development potential criteria, all Federal coal lands have unknown development potential for subsurface mining methods.

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

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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.