UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

Text to Accompany:

COAL RESOURCE OCCURRENCE MAP OF THE EMMET SW QUADRANGLE, MERCER AND MCLEAN COUNTIES, NORTH DAKOTA

[Report includes 2 plates]

By

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This report has not been edited for conformity with U.S. Geological Survey editorial standards or stratigraphic nomenclature.

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INTRODUCTION

The occurrence, extent, and preliminary geologic evaluation of coal beds in the Emmet SW quadrangle in west-central North Dakota are described in this report. Since no detailed data are available for this quadrangle, the geological mapping has been entirely dependent on knowledge of the regional geology as well as the geology of adjacent and surrounding quadrangles. In surrounding quadrangles, subsurface data consisting of oil and gas well and exploration drill hole logs, and surface data comprised of measured sections were compiled for study and presentation. Federal coal ownership is presented on the Boundary and Coal Data Map, Plate 2. A composite section of the projected geology of this quadrangle is shown on Figure 1. Derivative maps which consist of coal isopachs, structure contours, overburden, mining ratios, reserve categories, and Reserves and Reserve Base, have not been prepared for this quadrangle, because of insufficient data.

This work has been performed under contract with the Conservation Division of the U.S. Geological Survey (Contract No. 14-08-0001-17118).

The resource information gathered in this program is in response to the Federal Coal Leasing Amendments Act of 1975 and

COMPOSITE COLUMNAR SECTION, EMMET SW

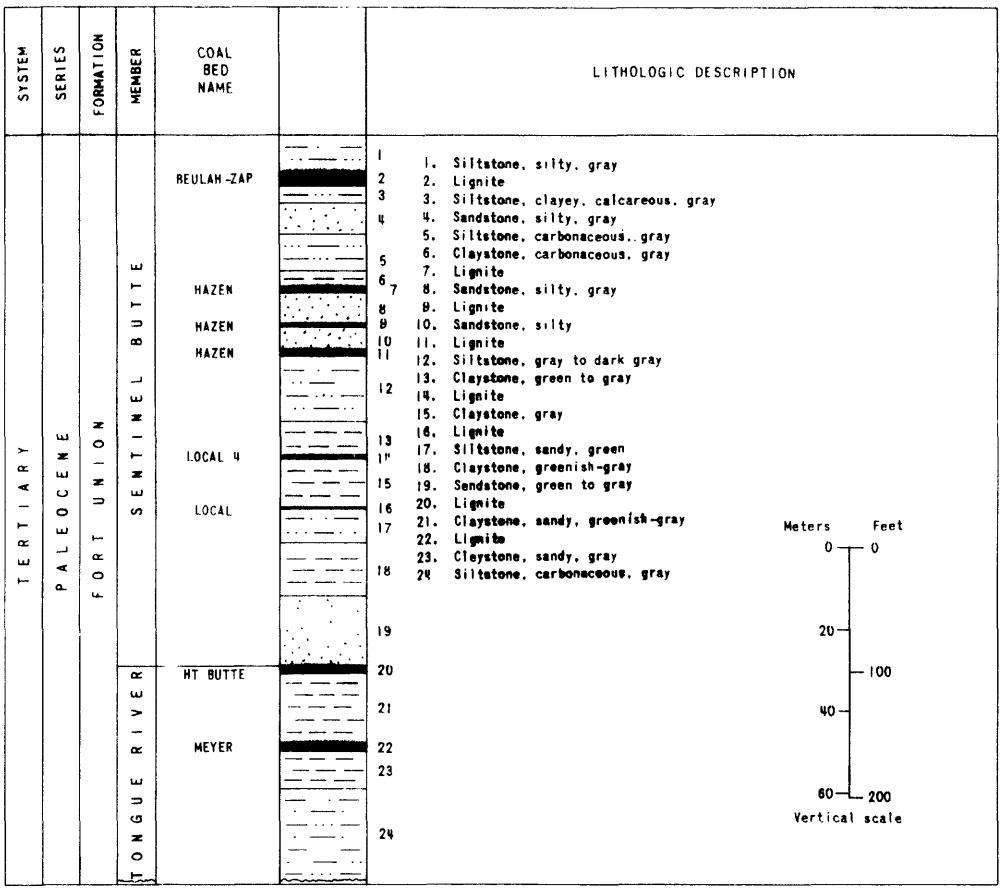

FIG. 1

is part of the U.S. Geological Survey's (USGS) coal program. This information is intended to provide basic data on coal resources for land-use planning purposes by the Bureau of Land Management, state and local governments, and the public.

LOCATION

The Emmet SW 7 1/2 minute quadrangle is located in northern Mercer County and southern McLean County, North Dakota about 1.5 miles (2.4 km) south of Emmet and 12 miles (19.3 km) west of Riverdale.

ACCESSIBILITY

The area is accessible by county road to State Highway 37 at Emmet, 1.5 miles (2.4 km) to the north of the quadrangle. State Highway 37 connects with State Highway 83, 19 miles (30.6 km) to the east which connects with Interstate 94 at Bismarck, 66 miles (106.2 km) to the south.

The Soo Line Railroad operates and maintains a north-south route which extends through Garrison and Underwood about 11 miles (17.7 km) east of the quadrangle. No railroad lines currently pass through or closer to the quadrangle than the existing Soo Line route to the east.

PHYSIOGRAPHY

The quadrangle lies in the central portion of a large topographic high known as the Missouri Plateau, which is being

dissected by the Knife, Heart, Cannonball and Cedar Creek Rivers. In the eastern portion of the plateau the topography is generally hilly and along the Missouri River there are bluffs 500-600 feet (152-183 m) high. The western part of the Missouri Plateau is characterized by more irregular topography than that which is prevalent throughout the remainder of the plateau. This area which is known collectively as "the Badlands" comprises an intricate maze of narrow ravines, sharp crested ridges and pinnacles.

The topography of the Emmet SW quadrangle may be characterized as gently rolling to hilly in the northern section of the quadrangle, and strongly dissected by streams in the southern section ("Badlands"). The maximum relief across the quarangle is 200 feet (61.0 m). The Missouri River is dammed in the southern section of the quadrangle forming Lake Sakakawea. Numerous shallow drainages feed into Lake Sakakawea throughout the quadrangle. The vegetation is mixed prairie grasses and some of the land is cultivated.

CLIMATE

North Dakota's climate may be characterized as semi-arid; the average annual precipitation is 17.2 inches (43.7 cm) at Beulah which is located 17 miles (27.4 km) southwest of the quadrangle.

Maximum precipitation occurs during the late spring and early summer with slightly over half the total annual precipitation occurring during May, June and July. Although the mean annual temperature is about 43°F (6.1°C) temperatures as recorded at the Beulah weather station by the U.S. Department of Commerce can range from 105°F (40.6°C) in summer months to -27°F (-32.8°C) in winter months. The prevailing northerly winds increase in velocity during the colder months of November through March.

LAND STATUS

The quadrangle lies in the northern one-half of the Knife River Known Recoverable Coal Resource Area (KRCRA). The Federal Government owns the coal rights to approximately 5 percent of the quadrangle as shown on Plate 2 of the coal occurrence map. In addition, the Federal Government has restricted coal rights on less than two percent of the area incorporated in the quadrangle. Approximately one-fourth of the area covered by this quadrangle, the west central portion, is controlled by the Bureau of Indian Affairs (Plate 2). Coal resources on lands included in Indian Reservations are not evaluated.

PREVIOUS WORK

This report has drawn on a number of basic data reports on

the coal occurrences in the Knife River, KRCRA, including: Law (1977), Benson (1953), and the United States Geological Survey (USGS) and North Dakota Geological Survey (NDGS) (1976, 1977). Ground water data reports in the Knife River area were also used, including: Croft (1970) and Klausing (1971, 1974, 1976).

METHOD OF STUDY

No records of drill holes in this quadrangle were found. Lithologic and geophysical logs from drill holes and measured sections in adjacent quadrangles provided the basic data for this study. The quality of the available coal information is variable. Lithologic and geophysical logs from exploration holes drilled by the North Dakota Geological Survey, North Dakota State Water Commission and private coal companies generally provide the most detailed and reliable subsurface data. Lithologic logs of private water wells are less detailed and less reliable, but they provide usable information in some cases. Where the data for a specific coal bed appeared to be inaccurate or inconsistent with surrounding drill hole data, it was not included in the data base that was used for construction of derivative maps for that coal bed.

Projected coal outcrop traces from previous investigations (Law, 1977) were plotted on the coal data map, Plate 1.

GEOLOGY

STRATIGRAPHY

The stratigraphy in the Emmet SW quadrangle is based on geologic data from the Emmet SE and Hazen NW quadrangles. The oldest rocks present in the uppermost 600 feet (182.9 m) of stratigraphic section in the Emmet SW quadrangle are the coal-bearing Tongue River and Sentinel Butte members of the Paleocene age Fort Union Formation (Rehbein, 1977). Sandstones, siltstones and shales of this formation are locally mantled by Quaternary glacial, eolian, and alluvial deposits.

Fort Union Formation - Paleocene.

Tongue River member - this member ranges from 350 to 900 feet (107 to 274 m) thick and consists of an alternating sequence of fluvially deposited sandstone, siltstone and shale, and lignite. It conformably overlies the marine Cannonball member and the time equivalent nonmarine Ludlow member. The Tongue River member is similar to the overlying Sentinel Butte member, and in places cannot be distinguished from it. The contact between the Tongue River and Sentinel Butte members, which has been arbitrarily set at the top of the HT Butte lignite, is conformable.

Sentinel Butte member - this member averages 500 feet (152 m) in thickness and consists of an alternating sequence of fluvially deposited sandstone, siltstone, shale, carbonaceous shale, and lignite. In general, the sandstones are fine

grained and poorly cemented. Shales range from soft plastic clay to moderately indurated claystone. Locally, there are thin, calcareous or silicious concretions. Shale and siltstone zones readily break down and form gentle slopes beneath the sandstone ledges.

Channel Deposits - Pleistocene.

Sand and gravel channel deposits of an indeterminate thickness underlie early Wisconsinan glacial till and Quaternary alluvium in the area.

Glacial Till - Pleistocene.

The glacial till is a heterogeneous mixture of clay, silt, sand, gravel, cobbles, and boulders which was deposited during Wisconsinan episodes of continental glaciation.

Eolian Deposits - Pleistocene and Recent.

Unconsolidated dune and loess-like deposits from several inches to more than five feet thick, mantle most of the study area. The loess-like deposits consist of silty clays, clayey silt, and silty to clayey sands, and are probably of late Pleistocene to Recent age. Recent dunes, consisting of silts and very fine grained uniform sand, have been deposited on the lee side of knobs and ridges.

Alluvium - Recent.

Alluvium consisting of clay, silt, sand, and gravel mantles valley floors in the study area.

STRUCTURE

Regionally the Knife River KRCRA is located on the southeastern flank of the Williston Basin, approximately 60 miles (97 km) from the basin center. Generally, the sedimentary units are flat lying or gently undulating, with a northward to northeastward regional dip ranging from less than 10 feet per mile (1.9 m per km) to 180 feet per mile (34 m per km). Upper strata have been warped into a gentle syncline with a northeast to southwest trending axis located approximately 10 miles (16 km) east of the town of Dodge. The dips on the flanks of the syncline are approximately 18 feet per mile (3.4 m per km). Major faulting has not been observed in the area (Menge, 1977). Surficial materials generally mask most of the older stratigraphic units, making it difficult to assess the importance of minor faulting.

COAL GEOLOGY

Four major coal beds and several local coal beds are either mapped at the surface or identified in the subsurface in quadrangles surrounding and adjacent to the Emmet SW quadrangle. Because of the laterally continuous nature of the Knife River lignites, the coal beds in this quadrangle can reasonably be expected to be the same. The Meyer coal bed is stratigraphically the lowest recognized coal bed. It is successively overlain by a sequence of non-coal bearing rocks

approximately 55 feet (16.8 m) thick; the HT Butte coal bed; rock approximately 250 feet (76.2 m) thick containing two local coal beds (a local coal bed, and Local 4, a local bed correlatable between several quadrangles); the Hazen coal bed; a sequence of non-coal bearing rocks approximately 80 feet (24.4 m) thick; and the Beulah-Zap coal bed. Table 1 and Figure 1 show the coal bed names and their stratigraphic position.

The coal beds of the Fort Union Formation in the Knife River area are lignite in rank and contain 0.4 to 1.2 percent sulphur, less than 10 percent ash (Table A-1) and between 5910 and 7330 BTU /lb. Coal analyses indicate that these coals have less than or about the same amount of trace elements as coal beds in other areas of the northern Great Plains coal province (Tables A-2 through A-4).

COAL DEVELOPMENT POTENTIAL

Coal development potential for all mining methods (surface, subsurface) and in situ gasification methods in this quadrangle is rated unknown, because of insufficient data for their evaluation.

Table 1 -- Coal Bed Names and Stratigraphic Position

Bed Name	Stratigraphic Equivalent
Beulah-Zap	Dunn Center, Herman
↑	
80 ft	
↓	
Hazen	Spear, Hazen "B", Kruckenberg, Red Butte
↑	
80 ft	
↓	
Local 4	
↑	
170 ft	
↓	
HT Butte	Hazen "A", Garrison Creek, Yeager, Hagel, Berg Keuther, Stanton
↑	
55 ft	
↓	
Meyer	-----

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APPENDIX A

PROXIMATE AND ELEMENTAL ANALYSES

Table A-1 Proximate Analyses (as received)

Bed Name	No. of Samples	Moisture %	Volatile Matter %	Fixed Carbon %	Ash %	Sulphur (Ultimate) %	Btu/lb*	Data Source
HT Butte	2	36.6	27.9	29.5	5.9	0.7	6970	Pollard et al., 1972
HT Butte	2	32.4	31.6	30.3	5.9	0.7	7024	Brant, 1953
HT Butte	3	35.5	28.6	31.1	4.9	0.5	7150	Johnson & Kunkel, 1959
Hazen	1	41.0	25.9	28.9	4.2	0.5	6290	Johnson & Kunkel 1959
Beulah-Zap	15	36.1	26.9	30.7	6.2	0.73	6890	Sondreal, Kube Elder, 1968
Beulah-Zap	3	34.0	29.0	29.0	8.0	0.8	6800	Pollard, et al., 1972
Beulah-Zap	1	39.5	28.3	25.3	6.9	0.4	5910	Johnson & Kunkel, 1959
Beulah-Zap	2	35.7	28.5	30.8	4.9	0.6	7018	Brant, 1953
Beulah-Zap	2	35.88	27.66	30.18	6.27	1.00	6566	Leonard, et al., 1925
Beulah-Zap	4	36.3	28.1	29.6	6.0	1.16	7028	USGS & Mont.Bur. of Mines & Geol. 1976
Beulah-Zap	10	29.6	29.6	34.2	6.7	0.5	7330	Swanson et al., 1976
Schoolhouse	1	35.8	26.9	31.7	6.6	1.0	6910	Pollard, et al., 1972
Schoolhouse	3	38.1	27.5	28.7	5.7	1.2	6720	Johnson & Kunkel 1959
Ave. Dunn Co.	-	40.6	-	-	7.0	0.6	6310	USDI, 1977
Ave. N.D.	-	36.0	28.0	29.0	6.0	0.7	6600	Leonard, et al., 1925

* To convert Btu/lb to Kilojoules/Kilogram, multiply by 2.326

Table A-2 -- Elemental Analysis of HT Butte Coal Bed

Element	Concentration in % Sample No.* D-80824	Sample No.* D-80825	Sample No.* D-80823
Sulphur	0.6	0.4	0.4
Hydrogen	6.8	6.9	6.9
Carbon	41.5	43.1	42.3
Nitrogen	0.7	0.6	0.7
Oxygen	44.0	45.0	45.5

*Johnson and Kunkel, 1959.

Table A-3 -- Elemental Analysis of Hazen Coal Bed

Element	Concentration-in % Sample No.* D-55178	Sample No.* 49875
Sulphur	0.5	
Hydrogen	7.0	
Carbon	38.0	
Nitrogen	0.6	
Oxygen	49.7	
U		0.0001
Ge**		ND
Ga**		0.002
V**		0.005
Cu**		0.004
Cr**		0.002
Zn**		0.01
Ni**		0.005
Co**		0.002
Be**		0.0003
Y**		0.01
La**		0.02
Mo**		ND

* Johnson and Kunkel, 1959
** Results in percent of ash

Table A-4 -- Elemental Analysis of Beulah-Zap Coal Bed

Element	Concentration in % Sample No.* 49879	Sample No.*** ND-KR-Bu	Sample No.**** ND-TT-DS	Sample No.***** D175930 to D17539
Sulphur				0.5
Hydrogen				6.2
Carbon				44.6
Nitrogen				0.7
Oxygen				41.3
U	0.0003			0.00005
Ge**	ND	0.001	ND	ND
Ga**	0.002	0.002	0.004	0.0015
V**	0.008	0.005	0.007	0.0035
Cu**	0.005	0.007	0.02	0.0055
Cr**	0.006	0.005	0.004	0.0025
Zn**	ND	ND	ND	0.0025
Ni**	0.005	0.003	0.006	0.0020
Co**	0.002	0.001	0.002	0.0010
Be**	0.0002	0.0008	0.0008	0.0003
Y**	0.01	0.004	ND	0.0025
La**	0.01	0.004	ND	0.01
Mo**	ND	0.002	0.004	0.0010
B**		0.24		0.110
Ti**		0.2		0.70******
Sn**		ND		---

* Johnson and Kunkel, 1959
** Results in percent of ash
*** Zubovic et al., 1961, average of 4 samples
**** Zubovic et al., 1961, average of 2 samples
***** Swanson et al., 1976
****** as TiO_2