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COAL GEOLOGY OF THE BOWMAN-GASCOYNE AREA, ADAMS, BILLINGS, BOWMAN, GOLDEN VALLEY, AND SLOPE COUNTIES, NORTH DAKOTA

By

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To convert English units	Multiply by	To obtain metric units
Feet	0.3048	meters
$Miles^2$	2.589	$kilometers^2$
Feet/mile	.1894	meters/kilometer
Tons (short)	.9072	metric ton

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ABSTRACT

The Bowman-Gascoyne area is located in southwestern North Dakota. It is situated on the southwestern edge of the Williston structural basin and the northeastern flank of the Cedar Creek anticline. Strata of the Fort Union Formation (Paleocene), consisting of nonmarine claystone, sandstone, and lignite, dip to the northeast 25-50 ft/mi.

Seven correlatable coal beds of varying thicknesses and areal dimensions occur in the area. The thickest and most persistent of these beds is the Harmon bed which attains a maximum thickness of 38 ft in T. 134 N., Rs. 101 and 102 W. Analyses show a heating value of 5,915-6,680 Btu/lb and a sulfur content of 0.6-1.4 percent.

Two areas of high-coal-development potential are located near Gascoyne and Amidon. The Harmon bed in these two areas contains a total of 740,000,000 and 650,000,000 tons, respectively, and is under less than 150 ft of overburden.

INTRODUCTION

Location

The Bowman-Gascoyne area includes parts of Adams, Billings, Bowman, Golden Valley, and Slope Counties (fig. 1). The study area covers approximately 1,990 mi^2.

Purpose

The purpose of this report is to evaluate data from several coal beds in the Bowman-Gascoyne area and to update a previously published report of the area (Lewis, 1977). It is one of a series of U.S. Geological Survey reports assessing coal deposits in North Dakota and eastern Montana.

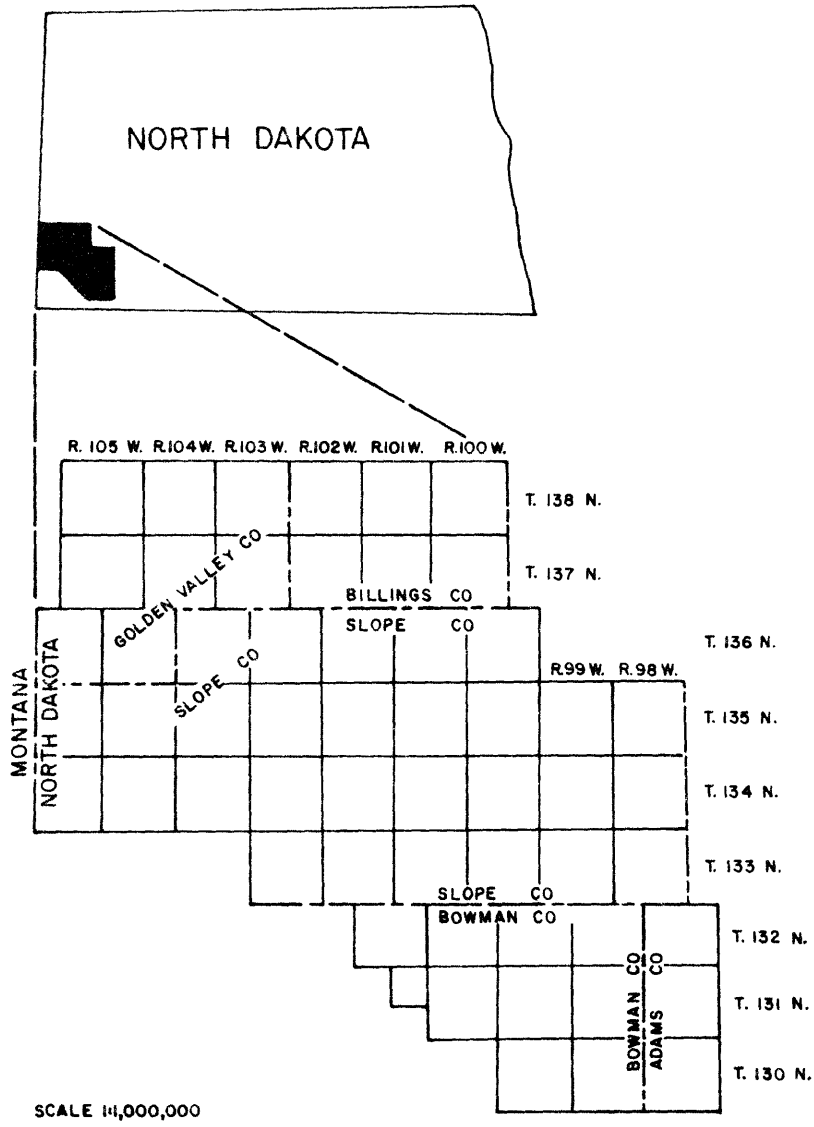

Figure 1. Index map showing location of Bowman—Gascoyne area; Adams, Billings, Bowman, Golden Valley, and Slope Counties, North Dakota

Previous Investigations

The lignite deposits of southwestern North Dakota were originally described by Darton (1896, p. 603-694). Leonard, Babcock, and Dove (1925, p. 31-77) listed several measured rock-coal intervals from various coal beds in this area. The first detailed map showing the outcrops, area dimensions, and thicknesses of several Fort Union coal beds was published by Hares (1928, pls. 8-14). Kepferle and Culbertson (1955, pls. 14-20) used surface and subsurface data to determine the coal thickness, areal extent, and reserves of the Harmon bed from Gascoyne to north of Bowman. Lewis (1977) used previously reported coal data and lithologic and geophysical logs to evaluate the Hansen and Harmon coal beds in the southern part of the Bowman-Gascoyne area.

Present Investigations

The principal sources of data for this report were surface mapping by the author, geophysical logs from drilling by the North Dakota Geological Survey in cooperation with the U.S. Geological Survey (U.S. Geological Survey and North Dakota Geological Survey, 1976, 1978), oil-well geophysical logs, lithologic water-well logs from the North Dakota State Water Commission (Croft, 1974), and rock-coal thicknesses from Kepferle and Culbertson (1955), which could be verified by geophysical or lithologic logs.

Coal-thickness data and outcrop locations from Leonard, Babcock, and Dove (1925) and Hares (1928) were not incorporated in this report because positive correlation of coal data could not be made with recently acquired surface and subsurface data.

Geography

The dominant topographic features of this unglaciated, semiarid region are a zone of badlands along the Little Missouri River and its tributaries, low-lying grass-covered plains and hills, and large isolated buttes that rise several hundred feet above the general land surface. Total relief in the area is approximately 1,200 ft.

Development and access

Many small excavation sites are located throughout the area. These are very small abandoned mines which supplied coal to area residents.

The Gascoyne mine (pls. 1, 3, and 3a) is the only strip mine in the study area. It is operated by the Knife River Coal Company which has mined approximately 17,530,000 tons of coal from this area since 1956. Most of this coal has been used in power plants in South Dakota and Minnesota.

U.S. Highways 12 and 85, North Dakota State Highways 21 and 67, and the Chicago, Milwaukee, St. Paul, and Pacific Railroad are the primary transportation routes through the area (pl. 1).

STRATIGRAPHY

Rocks belonging to the Fort Union Formation (Paleocene) and White River Group (Oligocene) crop out within the study area (Hares, 1928, pl. 14). The Fort Union Formation consists of the following members: Ludlow, Tongue River, and Sentinel Butte. The White River Group includes the Chadron and Brule Formations (Moore and others, 1956).

The Fort Union Formation consists of 650-850 ft of nonmarine, cyclic rock units composed of gray claystone and siltstone, lignite, and cross-bedded sandstone deposited in a fluvial, delta plain environment (Jacob, 1973, p. 1038).

The nonmarine White River Group is about 300 ft thick and consists of white calcareous claystone, locally conglomeratic sandstone, bentonitic claystone, and isolated lenses of freshwater limestone (Kepferle and Culbertson, 1955, p. 136).

STRUCTURE

The Bowman-Gascoyne area is located on the southwestern edge of the Williston structural basin and the northeastern flank of the Cedar Creek anticline. A structure-contour map drawn on the base of the Harmon bed (pl. 1) shows the underlying strata trending approximately N. 30° W., and dipping to the northeast 25-50 ft/mi. Except for local anomalies, the Harmon structural trend is approximately parallel to the Cedar Creek anticline (Hares, 1928, p. 45).

The structure-contour map of the Harmon bed (pl. 1) is the only structure map included in this report, although preliminary structure-contour maps were drawn for each coal bed in the study area. Except for small localized anomalies, the structural orientation of the other coal beds is very similar to and consistent with the Harmon bed.

The author mapped a normal fault located in the northeastern part of T. 134 N., R. 102 W., (pls. 1, 2, 3, and 3b). This fault disrupts the Harmon outcrop with an estimated displacement of 60 ft and is downthrown to the east.

COAL

Outcrop and subsurface data show seven principal Fort Union coal beds in the Bowman-Gascoyne area (pl. 9). Several stratigraphically lower coal beds are known to exist but incomplete data preclude any definitive evaluation. Subsurface chemical- and physical-coal data are presented in tables 1 and 2, respectively.

Hansen bed.--The Hansen bed (pls. 2 and 9) is stratigraphically the lowest coal bed discussed in this report (pl. 9). It lies 45-90 ft above the base of the Tongue River (Kepferle and Culbertson, 1955, p. 143) and crops out along the valley bottoms of Deep and Sand Creeks and the Little Missouri River. The Hansen bed averages about 4 ft in thickness but, locally, pods of coal occur which attain thicknesses of 8-15 ft.

Harmon bed.--The Harmon bed (pls. 1, 3, 3a, 3b, and 9) is the thickest, most continuous coal bed in the area. It lies 8-106 ft above the Hansen bed and crops out along Buffalo, Deep, and Sand Creeks and the Little Missouri River. Southwest of Amidon the bed attains a maximum thickness of 38 ft. Minimum measured thickness of the Harmon bed is 1 ft.

Two areas of high-development potential are located near Gascoyne (pl. 3a) and Amidon (pl. 3b). Maps of these two areas have been enlarged to provide greater detail about the coal thickness, outcrop location, and 150-ft overburden limits of the Harmon bed.

Table 1.--Analyses of coal samples, as received, from the Bowman-Gascoyne area

Location	Bed	Proximate (percent)				Ultimate (percent)	Heating value	Source
		Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Btu/lb	
T.131 N.,R.99 W., Gascoyne Mine	Harmon	43.1	24.5	25.3	7.1	0.8	6,110	Kepferle and Culbertson (1955, p. 139)
T.131 N.,R.100 W., sec. 24	Harmon	41.2	24.8	26.9	7.1	1.4	6,510	Do.
T.131 N.,R.100 W., sec. 25	Harmon	39.2	24.2	28.7	7.9	1.2	6,620	Do.
T.132 N.,R.102 W., sec. 14	Harmon	43.0	27.3	25.3	4.4	.6	5,915	Do.
T.132 N.,R.102 W., sec. 15	Harmon	41.1	25.6	27.5	5.8	.7	6,680	Do.
T.132 N.,R.102 W., sec. 15	Harmon	44.5	24.8	25.5	5.2	.7	6,062	Brant (1953, p. 5)
T.133 N.,R.101 W., sec. 1	Hansen[1]	42.5	27.2	24.0	6.3	1.4	5,952	Do.
T.135 N.,R.101 W., sec. 31	Harmon	43.8	26.1	26.3	3.8	.6	5,970	Magnusson (1960)
T.138 N.,R.100 W., sec. 5	Fryburg	40.3	25.2	26.4	7.6	.5	5,975	Do.

[1]Coal bed correlations indicate this to be the Harmon bed.

Identified resources of the Harmon bed under less than 150 ft of overburden in the Gascoyne and Amidon areas are 740,000,000 tons and 650,000,000 tons, respectively.

As-received analyses show the heating value of the coal in the Harmon bed is 5,915-6,680 Btu/lb and it contains 0.6-1.4 percent sulfur (table 1).

Local bed.--A local bed (pls. 4 and 9) lies 19-166 ft above the Harmon bed. Hares (1928, p. 61) mapped this unnamed coal bed only in T. 138 N., R. 102 W., but subsequent drilling shows it to be more widespread but quite erratic in its occurrence. Coal-thickness measurements range from 1 to 12 ft.

Garner Creek bed.--The Garner Creek bed (pls. 5 and 9) lies 18-138 ft above the local bed. This bed crops out in the central and northern plateau areas and occurs in most areas as a single bed but locally separates into multiple splits. Total coal thickness ranges from 2 to 18 ft.

Meyer bed.--The Meyer bed (pls. 6 and 9) lies 20-225 ft above the Garner Creek bed. Except for a narrow elongate parting, the bed occurs as a single seam with a maximum thickness of 15.5 ft. In drill holes 20, 30, 32, and 108, the thickness of the Meyer bed closely approximates that of the lower split in drill-holes 8, 33, 109, and 110. An alternative interpretation to the one presented (pl. 6) is that the upper split has pinched out rather than merged with the lower split to form a single coal bed.

HT Butte bed.--The HT Butte bed (pls. 7 and 9) lies 25-108 ft above the Meyer bed and marks the stratigraphic boundary between the Tongue River and Sentinel Butte Members (Royse, 1967). Except for local isolated splits separated by claystone partings, the bed occurs as a single seam and has a maximum thickness of 11 ft.

Fryburg bed.--The Fryburg bed (pls. 8 and 9) lies 33-136 ft above the HT Butte bed and is stratigraphically the highest coal bed to crop out in the study area. Restricted to a small area in the northeast, the bed reaches a maximum thickness of 12 ft in T. 138 N., R. 100 W.

As-received analysis shows the heating value of the coal in the Fryburg bed to be 5,975 Btu/lb and the sulfur content is 0.5 percent.

CONCLUSIONS

Seven principal coal beds occur within the Bowman-Gascoyne area. The most continuous and thickest bed is the Harmon bed, which is currently being mined near Gascoyne. The thickness of the bed, large areas under less than 150 ft of overburden, and nearness to transportation routes make the Harmon bed particularly attractive for future coal development.

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Table 2.--Drill-hole data for the Bowman-Gascoyne area

[Unk, unknown]

Explanation

Sources of drill-hole data:

USGS	United States Geological Survey
O.W.	Oil-well geophysical log
NDSWC	North Dakota State Water Commission
Baukol-Noonan	Baukol-Noonan, Inc.
W.W.	Water-well lithologic log

Abbreviation of coal bed names; beds are listed in descending stratigraphic order:

Fb	Fryburg
HT	HT Butte
Mr	Meyer
GC	Garner Creek
Lo	A local bed
Hr	Harmon
Hn	Hansen

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
1	USGS	34-132-98	2820	300	128 R	
					2 C	GC
					39 R	
					2 C	Lo
					49 R	
					10 C	Hr
					51 R	
					2 C	Hn_1
					6 R	
					2 C	Hn_2

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
2	USGS	14-132-99	2830	346	54 R	
					7 C	Mr
					57 R	
					3 C	GC
					55 R	
					3 C	Lo
					57 R	
					9 C	Hr_1
					3 R	
					4 C	Hr_2
					56 R	
					2 C	Hn_1
					10 R	
					5 C	Hn_2
3	USGS	8-132-101	2997	200	23 R	
					5 C	GC
					27 R	
					4 C	Lo
					34 R	
					18 C	Hr
					33 R	
					7 C	Hn_1
					7 R	
					2 C	Hn_2
4	USGS	22-132-101	2915	180	22 R	
					3 C	Lo
					33 R	
					5 C	Hr
5	USGS	26-132-101	3007	200	9 R	
					5 C	Lo
					59 R	
					10 C	Hr
6	USGS	8-132-102	2957	100	72 R	
					2 C	Hn_1
					13 R	
					3 C	Hn_2
7	USGS	12-132-102	3070	200	31 R	
					4 C	GC
					74 R	
					10 C	Lo
					47 R	
					25 C	Hr

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-Coal thickness (feet)	Bed name
8	USGS	14-133-98	2760	520	20 R	
					2 C	HT_1
					10 R	
					2 C	HT_2
					61 R	
					5 C	Mr_1
					9 R	
					3 C	Mr_2
					123 R	
					1 C	Lo_1
					14 R	
					2 C	Lo_2
					16 R	
					1 C	Lo_3
					7 R	
					3 C	Lo_4
					34 R	
					3 C	Hr_1
					13 R	
					3 C	Hr_2
9	USGS	30-133-98	2734	400	80 R	
					3 C	GC_1
					28 R	
					3 C	GC_2
					51 R	
					3 C	Lo
					88 R	
					4 C	Hr_1
					14 R	
					3 C	Hr_2
					59 R	
					2 C	Hn_1
					5 R	
					2 C	Hn_2
10	USGS	6-133-100	3112	460	108 R	
					6 C	HT
					25 R	
					5 C	Mr
					116 R	
					2 C	GC_1
					18 R	
					2 C	GC_2
					132 R	
					2 C	Hr

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
11	USGS	14-133-100	2938	460	100 R	
					4 C	HT
					59 R	
					3 C	Mr
					20 R	
					4 C	GC
					98 R	
					3 C	Lo
					78 R	
					3 C	Hr
12	USGS	30-133-100	2884	220	86 R	
					5 C	Lo
					79 R	
					8 C	Hr
13	USGS	4-133-101	2965	200	8 R	
					4 C	GC
					135 R	
					20 C	Hr
14	USGS	14-133-101	2945	220	120 R	
					17 C	Hr
					59 R	
					10 C	Hn
15	USGS	18-133-101	2975	260	82 R	
					26 C	Hr
					24 R	
					7 C	Hn
16	USGS	24-133-101	2916	280	115 R	
					2 C	
					4 R	
					13 C	Hr
					52 R	
					15 C	Hn
17	USGS	14-133-102	2881	120	22 R	
					8 C	Hn
18	USGS	22-133-102	2921	120	18 R	
					4 C	Hn_1
					7 R	
					3 C	Hn_2

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
19	USGS	24-133-102	2906	120	32	R	
					11	C	Hn
20	USGS	14-134-99	2791	660	24	R	
					3	C	Mr
					188	R	
					2	C	Lo
					97	R	
					10	C	Hr
					52	R	
					4	C	Hn
21	USGS	4-134-101	2818	220	85	R	
					4	C	Hr_1
					6	R	
					31	C	Hr_2
					74	R	
					5	C	Hn
22	USGS	8-134-101	2870	240	144	R	
					38	C	Hr
					40	R	
					1	C	Hn_1
23	USGS	32-134-101	2939	200	12	R	
					5	C	GC
					83	R	
					23	C	Hr
					47	R	
					8	C	Hn_1
					8	R	
					2	C	Hn_2
24	USGS	12-134-102	2941	300	116	R	
					26	C	Hr_1
					7	R	
					12	C	Hr_2
					51	R	
					2	C	Hn_1
					2	R	
					3	C	Hn_2
25	USGS	26-134-102	2886	200	5	R	
					5+	C	Hr_1
					62	R	
					10	C	Hr_2
					48	R	
					4	C	Hn_1
					14	R	
					1	C	Hn_2

Table 2.-- Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
26	USGS	6-134-103	3043	240	62	R	
					8	C	Hr_1
					34	R	
					6	C	Hr_2
					68	R	
					2	C	Hn
					25	R	
					5	C	
27	USGS	20-134-103	3048	200	32	R	
					3+	C	Hr_1
					28	R	
					6	C	Hr_2
					61	R	
					3	C	Hn
					22	R	
					3	C	
28	USGS	32-134-103	3122	180	44	R	
					20	C	Hr
					44	R	
					4	C	Hn
					44	R	
					2	C	
29	USGS	1-134-104	3100	180	56	R	
					8	C	GC
					91	R	
					6	C	Hr
30	USGS	22-135-98	2771	540	177	R	
					4	C	Mr
					76	R	
					2	C	GC
					101	R	
					4	C	Lo
					78	R	
					13	C	Hr
31	USGS	34-135-99	2850	500	56	R	
					5	C	Fb
					319	R	
					4	C	Lo
					79	R	
					14	C	Hr
					15	R	
					3+	C	Hn

Table 2.-- Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
32	USGS	14-135-100	2785	500	28	R	
					7	C	HT
					98	R	
					3	C	Mr
					67	R	
					3	C	GC_1
					13	R	
					5	C	GC_2
					138	R	
					6	C	Lo
					23	R	
					25	C	Hr
					63	R	
					2	C	Hn_1
					14	R	
					5+	C	Hn_2
33	USGS	30-135-100	2939	520	100	R	
					2	C	Mr_1
					2	R	
					5	C	Mr_2
					70	R	
					2	C	GC_1
					28	R	
					2	C	GC_2
					4	R	
					2	C	GC_3
					25	R	
					2	C	GC_4
					130	R	
					2	C	Lo
					22	R	
					24	C	Hr
					70	R	
					2	C	Hn_1
					5	R	
					3	C	Hn_2
34	USGS	12-135-102	2767	500	82	R	
					6	C	Lo
					57	R	
					3	C	Hr1
					9	R	
					10	C	Hr2
					30	R	
					4	C	Hn1
					2	R	
					5	C	Hn_2
					22	R	
					5	C	

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
35	USGS	18-135-101	2835	340	129 R	
					7 C	Lo
					66 R	
					18 C	Hr
					64 R	
					6 C	Hn
					18 R	
					5 C	
36	USGS	28-135-101	2874	360	136 R	
					2 C	Lo
					52 R	
					28 C	Hr
					57 R	
					5 C	Hn
					29 R	
					2 C	
37	USGS	8-135-102	2720	180	9 R	
					4 C	Lo
					26 R	
					9 C	Hr_1
					3 R	
					14 C	Hr_2
38	USGS	4-135-103	2770	160	69 R	
					20 C	Hr
					35 R	
					5 C	Hn
39	USGS	7-135-103	2880	240	60 R	
					4 C	GC
					18 R	
					2 C	Lo
					52 R	
					21 C	Hr
					47 R	
					8 C	Hn
40	USGS	20-135-103	2950	240	58 R	
					6 C	GC
					53 R	
					4 C	Lo
					30 R	
					11 C	Hr_1
					4 R	
					4 C	Hr_2
					55 R	
					3 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
41	USGS	28-135-103	2854	160	22 R	
					10 C	Hr_1
					3 R	
					2 C	Hr_2
					62 R	
					4 C	Hn
42	USGS	3-135-104	2775	400	10 R	
					10 C	Hr
					30 R	
					7 C	Hn
43	USGS	23-135-104	2853	160	30 R	
					7 C	Hr
					60 R	
					4 C	Hn
44	USGS	25-135-104	2930	160	22 R	
					8 C	Hr
					83 R	
					4 C	Hn
45	USGS	20-136-100	2830	660	41 R	
					4 C	Fb
					60 R	
					7 C	HT
					90 R	
					9 C	Mr
					125 R	
					12 C	GC_1
					3 R	
					5 C	GC_2
					58 R	
					1 C	Lo
					60 R	
					13 C	Hr
					62 R	
					15 C	Hn
46	USGS	21-136-101	2750	460	52 R	
					8 C	GC_1
					24 R	
					4 C	GC_2
					168 R	
					12 C	Hr_1
					10 R	
					6 C	Hr_2
					16 R	
					2 C	Hn_1
					9 R	
					4 C	Hn_2

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
47	USGS	13-136-102	2589	160	70 R	
					7 C	Hr_1
					3 R	
					9 C	Hr_2
					24 R	
					3 C	Hn_1
					10 R	
					6 C	Hn_2
48	USGS	20-136-102	2700	470	141 R	
					25 C	Hr
					8 R	
					9 C	Hn
49	Not drilled					
50	USGS	31-136-102	2710	200	56 R	
					22 C	Hr
					28 R	
					2 C	Hn
51	USGS	8-136-103	2876	500	217 R	
					5 C	Lo
					29 R	
					6 C	Hr
					32 R	
					3 C	Hn
					27 R	
					3 C	
52	USGS	22-136-103	2680	160	46 R	
					24 C	Hr
53	USGS	3-136-105	2804	260	21 R	
					5 C	Hr
					66 R	
					4 C	Hn
54	USGS	11-136-104	2690	200	26 R	
					6 C	Hr
					65 R	
					2 C	Hn
55	USGS	26-136-104	2874	240	112 R	
					2 C	Lo
					54 R	
					6 C	Hr
					14 R	
					10 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
56	USGS	26-136-105	2730	160	42 R	
					2 C	Hn
					20 R	
					8 C	
57	USGS	34-137-101	2560	500	42 R	
					8 C	Hr_1
					8 R	
					10 C	Hr_2
					51 R	
					5 C	Hn
58	USGS	2-137-102	2580	600	26 R	
					4 C	GC
					149 R	
					8 C	Hr_1
					2 R	
					4 C	Hr_2
					152 R	
					5 C	
					8 R	
					6 C	
59	USGS	24-137-102	2498	200	40 baked rock	Hr
					135 R	
					4 C	
60	USGS	28-137-102	2668	600	21 R	
					6 C	Mr
					97 R	
					2 C	GC
					125 R	
					14 C	Hr
					26 R	
					6 C	Hn
					49 R	
					2 C	
					37 R	
					2 C	
61	USGS	2-137-103	2445	440	No coal in Tongue River Member	
62	USGS	23-137-103	2760	260	128 R	
					4 C	GC
					32 R	
					4 C	Lo
					49 R	
					7 C	Hr
					11 R	
					1 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
63	USGS	31-137-103	2750	260	34	R	
					2	C	Lo
					32	R	
					4	C	Hr
					57	R	
					9	C	Hn
64	USGS	20-137-104	2782	200	38	R	
					2	C	Lo
					19	R	
					3	C	Hr
					80	R	
					6	C	Hn
65	USGS	26-137-104	2750	500	34	R	
					4	C	Lo
					36	R	
					5	C	Hr
					56	R	
					7	C	Hn
66	USGS	4-137-105	2798	200	33	R	
					5	C	Lo
					40	R	
					2	C	Hr
67	USGS	12-137-105	2773	420	21	R	
					7	C	Lo
					26	R	
					2	C	Hr
68	USGS	15-138-100	2749	760	60	R	
					12	C	Fb
					136	R	
					7	C	HT_1
					29	R	
					4	C	HT_2
					108	R	
					2	C	Mr
					44	R	
					2	C	GC_1
					29	R	
					3	C	GC_2
					191	R	
					3+	C	Hr

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
69	USGS	23-138-101	2662	520	78 R	
					9 C	HT
					168 R	
					6 C	GC
					190 R	
					3 C	Hr_1
					8 R	
					2 C	Hr_2
70	USGS	4-138-102	2620	400	132 R	
					4 C	GC
					84 R	
					2 C	Lo
					124 R	
					16 C	Hr
71	USGS	22-138-102	2570	300	97 R	
					7 C	GC
					138 R	
					8 C	Hr
72	USGS	12-138-103	2515	240	145 R	
					8 C	Hr
					57 R	
					2 C	Hn
73	USGS	30-138-103	2800	600	172 R	
					2 C	GC_1
					10 R	
					4 C	GC_2
					46 R	
					2 C	Lo
					58 R	
					7 C	Hr
					27 R	
					2 C	Hn
74	USGS	8-138-104	2738	500	37 R	
					4 C	GC_1
					17 R	
					4 C	GC_2
					132 R	
					8 C	Hr
					64 R	
					6 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
75	USGS	10-132-101	2986	220	20 R	
					6 C	Mr
					40 R	
					4 C	GC
					64 R	
					5 C	Lo
					61 R	
					11 C	Hr
76	USGS	20-132-101	3085	200	104 R	
					6 C	Lo
					49 R	
					18 C	Hr
77	USGS	26-133-101	2976	200	42 R	
					6 C	GC
					79 R	
					3 C	Lo
					36 R	
					17 C	Hr
78	USGS	26-133-101	2905	220	54 R	
					3 C	GC
					46 R	
					3 C	Lo
					27 R	
					12 C	Hr
					41 R	
					12 C	Hn
79	USGS	30-133-101	2995	200	43 R	
					9 C	GC
					59 R	
					27 C	Hr
					26 R	
					11 C	Hn
80	USGS	32-133-101	2997	200	79 R	
					27 C	Hr
					30 R	
					10 C	Hn
81	USGS	34-133-101	2995	200	29 R	
					3 C	Mr
					50 R	
					8 C	GC
					74 R	
					26 C	Hr

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
82	USGS	4-134-101	2850	280	154 R	
					4 C	Hr_1
					15 R	
					27 C	Hr_2
					60 R	
					2 C	Hn_1
					6 R	
					2 C	Hn_2
83	USGS	8-134-101	2848	492	131 R	
					36 C	Hr
					55 R	
					1 C	Hn_1
					7 R	
					4 C	Hn_2
84	USGS	18-134-101	2850	240	83 R	
					36 C	Hr
					47 R	
					2 C	Hn_1
					22 R	
					3 C	Hn_2
85	USGS	6-134-101	2898	300	129 R	
					21 C	Hr_1
					4 R	
					15 C	Hr_2
					66 R	
					6 C	Hn
86	USGS	8-135-101	2832	300	165 R	
					6 C	Lo
					45 R	
					15 C	Hr
87	USGS	20-135-101	2835	260	156 R	
					28 C	Hr
					66 R	
					4 C	Hn
88	USGS	30-135-101	2761	160	34 R	
					7 C	Hr_1
					5 R	
					16 C	Hr_2
					77 R	
					6 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
89	USGS	30-135-101	2760	160	28 R	
					4 C	Hr_1
					5 R	
					29 C	Hr_2
					74 R	
					5 C	Hn
90	USGS	32-135-101	2805	200	73 R	
					4 C	Hr_1
					2 R	
					28 C	Hr_2
					64 R	
					5 C	Hn
91	O.W.	1-138-102	2630	8150	200 no record	
					202 R	
					8 C	Hr
92	O.W.	10-138-102	2517	9300	44 R	
					4 C	GC_1
					12 R	
					6 C	GC_2
					221 R	
					11 C	Hr
93	O.W.	9-137-100	2914	8275	608 no record	
					35 R	
					12 C	Hr
					70 R	
					7 C	Hn
94	O.W.	15-137-100	2841	9375	577 no record	
					10 R	
					11 C	Hr
					76 R	
					8 C	Hn
95	O.W.	22-137-100	2843	8250	53 R	
					5 C	
					45 R	
					10 C	Fb
					69 R	
					5 C	HT
					45 R	
					9 C	Mr
					104 R	
					11 C	GC
					52 R	
					4 C	Lo
					166 R	
					12 C	Hr
					84 R	
					15 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
96	O.W.	1-136-100	2724	8015	110 R	
					7 C	HT
					26 R	
					8 C	Mr
					97 R	
					11 C	GC
					89 R	
					5 C	Lo
					163 R	
					16 C	Hr
					21 R	
					12 C	Hn
97	O.W.	2-136-100	2757	8050	95 R	
					4 C	Fb
					63 R	
					6 C	HT
					25 R	
					8 C	Mr
					126 R	
					9 C	GC
					83 R	
					5 C	Lo
					148 R	
					14 C	Hr
					20 R	
					13 C	Hn
98	O.W.	2-136-100	2780	8105	139 no record	
					8 R	
					7 C	Fb
					61 R	
					8 C	HT
					32 R	
					6 C	Mr
					118 R	
					12 C	GC
					52 R	
					6 C	Lo
					159 R	
					16 C	Hr
					15 R	
					14 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
99	NDSWC	31-136-100	2850	1705	75 R	
					11 C	Fb
					74 R	
					4 C	HT
					168 R	
					12 C	GC_1
					6 R	
					4 C	GC_2
					8 R	
					2 C	GC_3
					72 R	
					16 C	Hr
					64 R	
					5 C	Hn_1
					9 R	
					6 C	Hn_2
100	O.W.	23-136-101	2792	11,510	142 no record	
					70 R	
					5 C	Lo
					87 R	
					10 C	Hr
					78 R	
					4 C	Hn_1
					8 R	
					5 C	Hn_2
101	O.W.	2-135-98	2643	8480	198 no record	
					77 R	
					3 C	Lo
					85 R	
					13 C	Hr
102	Baukol-Noonan	4-135-99	2740	240	29 R	
					5 C	Fb
					48 R	
					7 C	HT
					65 R	
					8 C	Mr

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
103	USGS	4-135-99	2757	618	13	R	
					3	C	Fb
					33	R	
					5	C	HT_1
					6	R	
					3	C	HT_2
					101	R	
					5	C	Mr
					53	R	
					3	C	GC_1
					18	R	
					2	C	GC_2
					3	R	
					6	C	GC_3
					67	R	
					5	C	Lo
					108	R	
					16	C	Hr
					58	R	
					3	C	Hn_1
					10	R	
					7	C	Hn_2
104	Baukol-Noonan	13-135-99	Insufficient data				
105	NDSWC	4-134-101	2905	Unk	191	R	
					4	C	Hr_1
					3	R	
					15+	C	Hr_2
106	NDSWC	17-134-101	2900	180	129	R	
					20	C	Hr_1
					4	R	
					11	C	Hr_2
107	O.W.	24-134-104	3100	1300	45	R	
					12	C	Hr
					27	R	
					6	C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)		Bed name
108	USGS	24-134-98	2760	500	29	R	
					3	C	Mr
					225	R	
					3	C	GC
					91	R	
					3	C	Hr_1
					7	R	
					5	C	Hr_2
					106	R	
					2	C	Hn
109	USGS	30-134-99	2880	500	22	R	
					3	C	Mr_1
					3	R	
					4	C	Mr_2
					287	R	
					15	C	Hr
					67	R	
					3	C	Hn
110	O.W.	5-133-98	2769	10.760	41	R	
					6	C	Mr_1
					5	R	
					3	C	Mr_2
					315	R	
					7	C	Hr
					53	R	
					8	C	Hn
111	Baukol-Noonan	7-133-98	2740	Unk	25		
					15.5	C	Mr
112	Baukol-Noonan	17-133-98	2755	140	29	R	
					13.5	C	Mr
113	O.W.	32-133-101	2961	5410	69	R	
					26	C	Hr
					33	R	
					9	C	Hn
114	NDSWC	14-132-100	2820	60	51	R	
					9	C	Lo
115	O.W.	12-132-101	2819	450	72	R	
					5	C	Hr
					40	R	
					7	C	Hn

Table 2.---Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
116	NDSWC	12-132-101	2886	600	81 R	
					6 C	Hr
					31 R	
					7 C	Hn
117	NDSWC	10-132-101	2825	360	75 R	
					5 C	Hr
118	NDSWC	24-132-102	3040	580	86 R	
					30 C	Hr
119	NDSWC	18-132-102	2959	126	43 R	
					5 C	Hn_1
					4 R	
					8 C	Hn_2
120	NDSWC	1-131-98	2761	190	126 R	
					6 C	Hr
121	NDSWC	7-131-98	2959	387	46 R	
					6 C	Mr
					150 R	
					3 C	Lo
					46 R	
					13 C	Hr_1
					6 R	
					3 C	Hr_2
					33 R	
					2 C	Hn
122	W.W.	36-132-101	2936	450	30 no record	
					38 R	
					3 C	Hn
123	USGS	8-131-99	2915	500	242 R	
					10 C	Hr_1
					5 R	
					4 C	Hr_2
					11 R	
					5 C	Hn
124	USGS	17-131-99	2845	180	134 R	
					13 C	Hr_1
					8 R	
					6 C	Hr_2

Table 2.-- Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
125	USGS	19-131-99	2840	160	112 R	
					21 C	Hr_1
					5 R	
					9 C	Hr_2
126	NDSWC	19-131-99	2790	80	25 R	
					20 C	Hr_1
					7 R	
					10 C	Hr_2
127	NDSWC	20-131-99	2770	140	15 R	
					20 C	Hr_1
					5 R	
					12 C	Hr_2
128	NDSWC	21-131-99	2810	200	70 R	
					18 C	Hr_1
					7 R	
					10 C	Hr_2
129	NDSWC	21-131-99	2827	242	128 R	
					8 C	Hr_1
					9 R	
					3 C	Hr_2
130	NDSWC	22-131-99	2788	180	81 R	
					8 C	Hr_1
					3 R	
					17 C	Hr_2
131	NDSWC	23-131-99	2809	200	64 R	
					7 C	Hr_1
					3 R	
					12 C	Hr_2
132	NDSWC	25-131-99	2846	460	127 R	
					6 C	Hr_1
					5 R	
					13 C	Hr_2
133	NDSWC	24-131-99	2970	262	210 R	
					12 C	Lo
134	NDSWC	26-131-99	2830	127	99 R	
					7 C	Hr_1
					4 R	
					10 C	Hr_2

Table 2. --Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
135	NDSWC	26-131-99	2815	78	45 R	
					9 C	Hr_1
					5 R	
					10 C	Hr_2
136	USGS	35-131-99	2785	Unk	37 R	
					8 C	Hr_1
					4 R	
					15 C	Hr_2
137	USGS	26-131-99	2791	Unk	60 R	
					9 C	Hr_1
					5 R	
					18 C	Hr_2
138	USGS	26-131-99	2782	Unk	31 R	
					10 C	Hr_1
					3 R	
					20 C	Hr_2
139	USGS	28-131-99	2789	Unk	48 R	
					8 C	Hr_1
					4 R	
					20 C	Hr_2
140	USGS	28-131-99	2815	Unk	45 R	
					9 C	Hr_1
					1 R	
					23 C	Hr_2
141	NDSWC	29-131-99	2794	142	47 R	
					22 C	Hr_1
					4 R	
					8 C	Hr_2
142	USGS	28-131-99	2804	Unk	46 R	
					31 C	Hr
143	NDSWC	33-131-99	2780	153	34 R	
					10 C	Hr_1
					4 R	
					19 C	Hr_2
144	NDSWC	34-131-99	No record			
145	NDSWC	35-131-99	2760	Unk	16 R	
					9 C	Hr_1

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
146	USGS	28-131-99	2770	Unk	9 R	
					5 C	Hr_1
					12 R	
					20 C	Hr_2
147	NDSWC	36-131-99	2788	Unk	27 R	
					9 C	Hr_1
148	NDSWC	1-130-99	2768	Unk	19 R	
					9 C	Hr_1
149	USGS	36-131-99	2780	Unk	22 R	
					11 C	Hr_1
150	USGS	36-131-99	2805	Unk	48 R	
					7 C	Hr_1
151	USGS	36-131-99	2795	Unk	30 R	
					8 C	Hr_1
152	NDSWC	4-130-98	2840	95	69 R	
					9 C	Hr_1
					7 R	
					9 C	Hr_2
153	USGS	12-130-98	2875	500	73 R	
					5 C	Hr_1
					8 R	
					4 C	Hr_2
154	USGS	10-131-100	2840	160	33 R	
					3 C	Hr_1
					13 R	
					4 C	Hr_2
					61 R	
					3 C	Hn
155	USGS	11-131-100	2802	Unk	28 R	
					9 C	Hr_1
156	NDSWC	9-131-100	2845	1068	32 R	
					5 C	
					3 R	
					8 C	Hr_1
					7 R	
					3 C	Hr_2
					67 R	
					5 C	Hn

Table 2. -- Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
157	NDSWC	29-131-100	2856	193	75 R	
					5 C	Hr_1
					12 R	
					1 C	Hr_2
158	NDSWC	23-131-100	2780	124	40 R	
					19 C	Hr_1
					11 R	
					6 C	Hr_2
159	W.W.	24-131-100	2770	Unk	13 R	
					15 C	Hr_1
					14 R	
					12 C	Hr_2
160	USGS	25-131-100	2787	Unk	8 R	
					19+ C	Hr
161	NDSWC	2-130-100	2828	103	38 R	
					4 C	Hr
162	NDSWC	2-130-100	2805	107	23 R	
					8 C	Hr
					48 R	
					2 C	Hn
163	NDSWC	24-130-100	2820	270	51 R	
					4 C	Hr_1
					2 R	
					5 C	Hr_2
164	NDSWC	19-130-99	Insufficient data			
165	NDSWC	23-130-99	2770	412	9 R	
					10 C	
166	USGS	20-132-100	2845	500	35 R	
					3 C	Hr_1
					9 R	
					3 C	Hr_2
167	USGS	20-133-100	2944	500	30 R	
					3 C	Mr_1
					3 R	
					3 C	Mr_2
					225 R	
					11 C	Hr
					37 R	
					2 C	Hn

Table 2.--Drill-hole data for the Bowman-Gascoyne area - continued

Hole No.	Source	Location Sec.-T.N.-R.W.	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
168	USGS	28-138-105	2822	603	74 R	
					6 C	Hr
					102 R	
					7 C	Hn
169	USGS	6-138-105	2925	236	198 no record	