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COAL GEOLOGY OF THE WIBAUX-BEACH AREA, WIBAUX COUNTY, MONTANA, AND GOLDEN VALLEY COUNTY, 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 Wibaux-Beach area is located in eastern Montana and western North Dakota. It is situated on the northeastern flank of the Cedar Creek anticline and southwest of the center of the Williston structural basin. Fort Union Formation (Paleocene) strata, consisting of several hundred feet of interbedded nonmarine sandstone, siltstone, claystone, and lignite, dip to the northeast 50-100 ft/mi.

The Harmon bed is the thickest and most continuous of the several lignite beds in the area. It attains a maximum thickness of 33 ft, has a heating value of 5,063-6,390 Btu/lb, and a sulfur content of 0.4-1.5 percent.

INTRODUCTION

Location

The Wibaux-Beach study area is located in eastern Montana and western North Dakota between the Yellowstone and Little Missouri Rivers. It consists of parts of Wibaux (Montana) and Golden Valley (North Dakota) Counties and covers approximately 685 mi^2 (fig. 1).

Purpose

The purpose of this report is to provide maximum information concerning outcrop location, areal extent, and physical and chemical characteristics of the coal beds within the study area. It is one of a series of U.S. Geological Survey reports evaluating coal deposits in eastern Montana and western North Dakota.

Previous Investigations

The Wibaux-Beach area lies almost entirely within the boundaries of previously published reports (fig. 2). Leonard and Smith (1909), Stebinger (1912), Hance (1912), Leonard, Babcock, and Dove (1925),

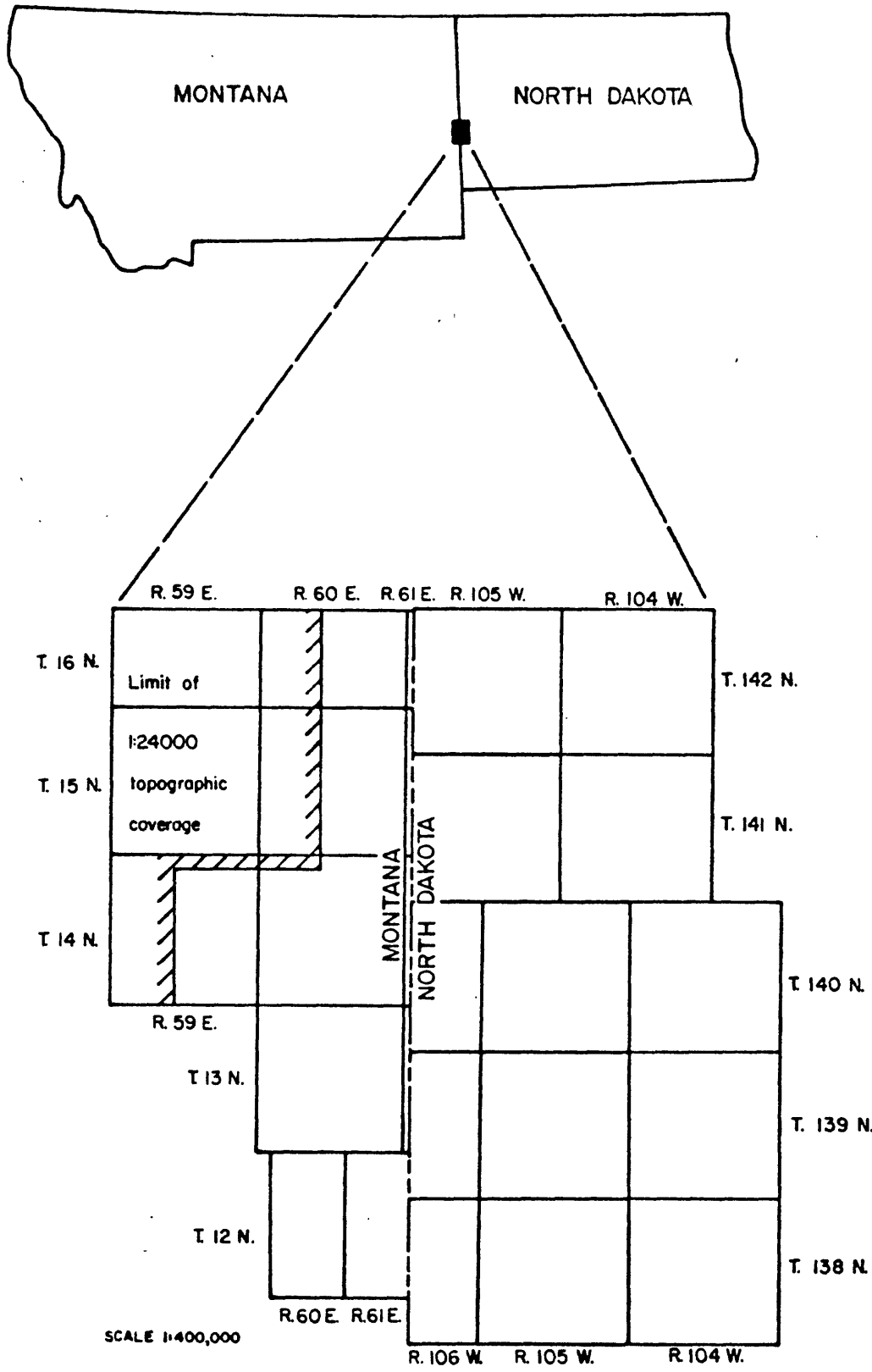

Figure 1. Index map showing location of Wibaux—Beach area; Wibaux County, Montana and Golden Valley County, North Dakota.

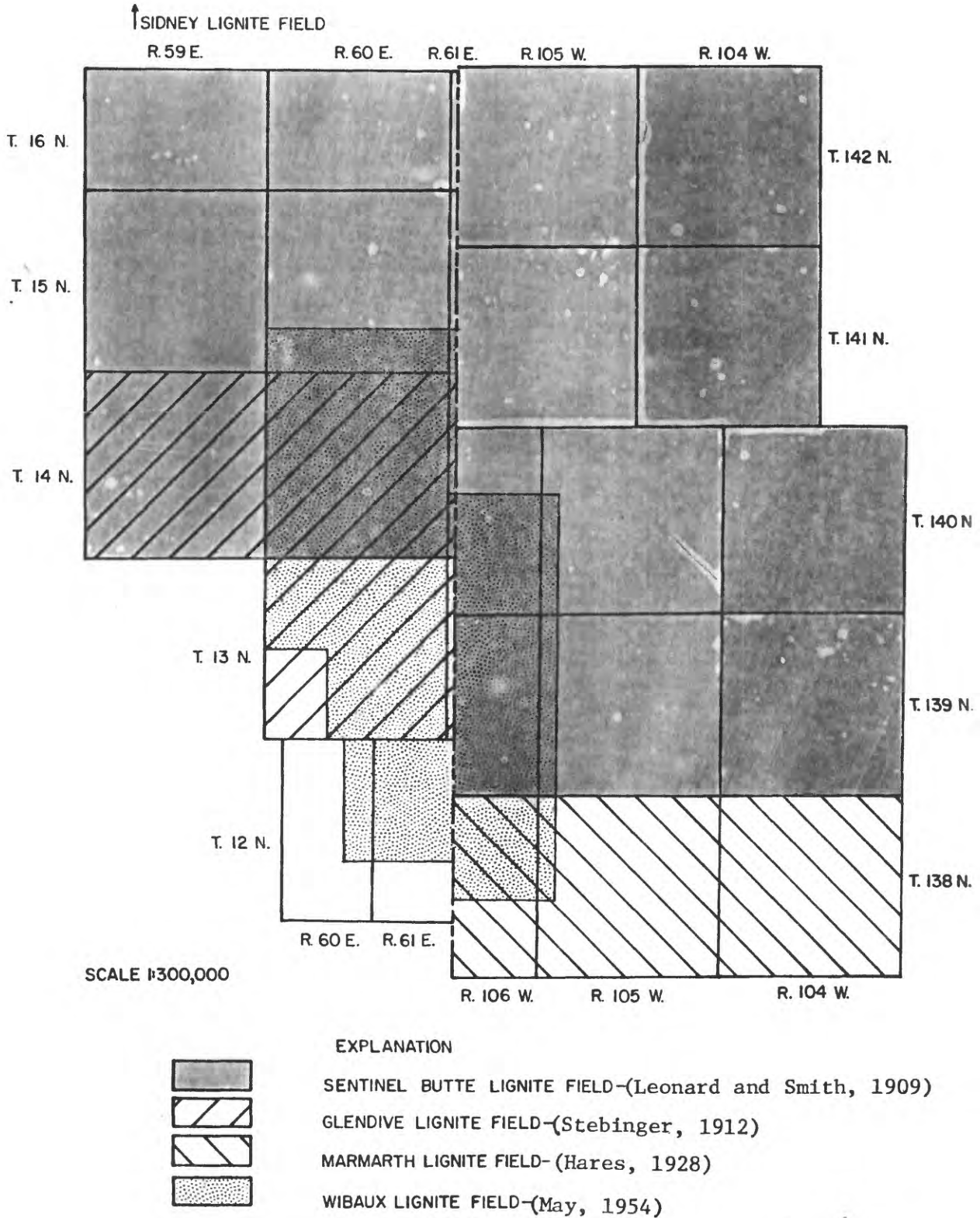

Figure 2. Index map of published reports in the Wibaux–Beach area

Hares (1928), and May (1954) published reports detailing the thicknesses and outcrop locations of coal beds in the respective coal fields.

Leonard and Smith (1909) published the first report describing and classifying coal-bearing lands in eastern Montana and western North Dakota. In the Sentinel Butte field, they identified nine workable and correlatable coal beds that could be traced over much larger areas than previously reported.

Stebinger (1912) mapped 11 coal beds in the Sidney coal field, immediately north of the present study area. He concluded that the G bed of the Sidney field was correlative to the C bed of the Wibaux-Beach field.

Hance (1912) examined data from water wells drilled in the Glendive field near Wibaux. He concluded that there were one to three unnamed coal beds within 200 ft of the surface.

Leonard, Babcock, and Dove (1925) described several coal beds in Billings and Golden Valley Counties, N. Dak. Bed I of the Great Bend group was estimated to cover at least 600 mi^2.

Hares (1928) described several Fort Union coal beds located in the Marmarth field in southwestern North Dakota. He correlated the Harmon bed in this area with the C bed of the Wibaux-Beach field.

May (1954) published the most comprehensive report about the lignite beds in the Wibaux-Beach area. He identified and correlated three principal coal beds with coal beds of adjacent areas. The C bed, the thickest and most continuous lignite bed, was ascertained to correlate with the I bed in the Sidney field and the Garner Creek and Burkey beds in the Marmarth field.

Present Investigations

The principal sources of data for this report are 139 geophysical logs obtained from oil wells, Harksen (1978), North Dakota State Water Commission, Montana Bureau of Mines and Geology, and the U.S. Geological Survey-Water Resources Division (B. Horak, written commun., 1978).

Interpretation of available geologic data reveals possible correlation errors by May (1954) and Stebinger (1912). Instead of correlating with the Garner Creek, Burkey, and G beds, the C bed in the Wibaux-Beach area probably correlates with the Harmon bed of the Marmarth field and the H bed of the Sidney field.

The outcrop trace of the C bed, hereafter referred to as the Harmon bed, was taken directly from May (1954, pls. 39, 40, and 43) and is the only map information from previous publications used in this report.

Geography

The Wibaux-Beach study area is located within the Great Plains physiographic province. The dominant topographic features of the area are unglaciated, semi-arid hills and plains, and large isolated buttes that rise several hundred feet above the general land surface. Total topographic relief is approximately 1,150 ft.

Development and Access

Several abandoned coal mines and excavation sites are located throughout the area (pl. 1). Coal from these locations was used by local residents, town power plants, and railroads.

Montana State Highway 7, North Dakota State Highway 16, U.S. Interstate 94, and the Burlington Northern, Inc., railroad, are the principal transportation routes through the area (pl. 1).

STRATIGRAPHY

Nonmarine strata of the Fort Union Formation (Paleocene) are exposed throughout the area with Holocene alluvium deposits along stream drainages. The Fort Union consists of three members: Ludlow, Tongue River, and Sentinel Butte. The Ludlow Member does not crop out in the area and the Sentinel Butte Member is restricted to the uppermost elevations of remnant buttes.

Jacob (1976, p. 28) and Bergstrom (1956) identified a possible White River Group (Oligocene) paleosol horizon on Sentinel Butte and Camels Hump Butte in T. 139 N., R. 104 W., and T. 140 N., R. 104 W., respectively.

The Tongue River and Sentinel Butte Members are very similar in lithology and depositional environments. Consisting of several hundred feet of interbedded sandstone, siltstone, claystone, and lignite beds, the members were deposited within a depositional environment of fluvial channels, backswamps, and flood plains (Rehbein, 1977, p. 14 and 15).

STRUCTURE

The Wibaux-Beach area is located southwest of the center of the Williston structural basin and on the northeastern flank of the Cedar Creek anticline (King, 1969). A structure-contour map of the top of the Harmon coal bed (pl. 1) shows the Fort Union Formation strata trending N. 30° W., and dipping to the northeast 50-100 ft/mi. Minor undulations and local anomalies are evident in many locations, but generally the strata trend approximately parallel to the Cedar Creek anticline and are coincident with a structure map of the Precambrian basement rock by Denson and Gill (1965, pl. 5).

COAL

The Hansen (pl. 3) and Harmon (pl. 2) coal beds are the principal beds in the Wibaux-Beach area. Numerous other coal beds are known to be present (pl. 4), but because of an absence of data, the continuity, thickness, and development potential are unknown. Subsurface chemical and physical data of the Hansen and Harmon beds are presented in tables 1 and 2. Coal beds in the area are described in ascending order.

T Cross bed.--The T Cross bed (pl. 4), stratigraphically the lowest coal bed in the area, is only tentatively named and correlated. More data are necessary to properly evaluate its thickness, continuity, and areal extent.

Hansen bed.--The Hansen bed (pl. 3) probably correlates with the lowest unnamed bed reported by May (1954, p. 271) and the G bed in the Sidney field. It may also correlate with an unnamed bed mapped by Hance (1912, pl. 20) that crops out along Beaver Creek south of Wibaux. A limited outcrop trace of the Hansen bed is projected from available 7.5-minute topographic maps (pl. 3 and fig. 1). Total measured thickness ranges from 1 to 15 ft.

Table 1.--Analyses of coal samples from the Wibaux-Beach area

[Values in percent, except heat value. A, as received; B, moisture free; C, moisture and ash free. Data supplied by U.S. Dept. of Energy, written commun., 1978]

Drill-hole No. and Location	Bed	Form of analysis	Proximate (percent)				Ultimate (percent)	Heat value
			Moisture	Volatile matter	Fixed carbon	Ash	Sulfur	Btu/lb
US-7704	Harmon	A	38.3	26.5	27.0	8.2	0.8	6,203
T. 138 N., R. 106 W.,		B	----	42.9	43.8	13.3	1.2	10,055
sec. 10		C	----	49.5	50.5	----	1.4	11,596
US-7705	Harmon	A	39.4	24.8	25.3	10.5	0.9	5,880
T. 12 N., R. 61 E.,		B	----	40.9	41.8	17.3	1.6	9,708
sec. 20		C	----	49.5	50.5	----	1.9	11,737
US-7707	Harmon	A	40.4	25.4	27.0	7.2	0.5	5,992
T. 138 N., R. 106 W.,		B	----	42.6	45.3	12.1	0.8	10,058
sec. 10		C	----	48.4	51.6	----	0.9	11,438
US-7713	Harmon	A	43.4	22.2	22.6	11.8	0.9	5,063
T. 139 N., R. 106 W.,		B	----	39.2	39.9	20.9	1.5	8,948
sec. 34		C	----	49.6	50.4	----	1.9	11,308
US-7725	Harmon	A	40.9	24.3	27.3	7.5	0.8	6,018
T. 139 N., R. 106 W.,		B	----	41.1	46.2	12.7	1.4	10,188
sec. 22		C	----	47.1	52.9	----	1.6	11,675
US-7730	Harmon	A	39.1	25.6	27.9	7.4	0.7	6,219
T. 13 N., R. 60 E.,		B	----	42.0	45.8	12.2	1.2	10,209
sec. 10		C	----	47.9	52.1	----	1.4	11,627
US-7737	Harmon	A	37.3	26.4	27.4	8.9	0.9	6,390
T. 14 N., R. 60 E.,		B	----	42.1	43.6	14.3	1.4	10,190
sec. 34		C	----	49.1	50.9	----	1.6	11,884
US-7739	Harmon	A	37.9	24.6	25.8	11.7	1.2	5,866
T. 14 N., R. 60 E.,		B	----	39.7	41.4	18.9	1.9	9,440
sec. 14		C	----	48.9	51.1	----	2.4	11,640
US-7739	Hansen$_1$	A	36.8	24.6	25.3	13.3	3.5	5,767
T. 14 N., R. 60 E.,		B	----	38.9	40.0	21.1	5.5	9,121
sec. 14		C	----	49.3	50.7	----	6.9	11,557
US-7739	Hansen$_2$	A	39.1	25.8	27.1	8.0	1.0	6,267
T. 14 N., R. 60 E.,		B	----	42.4	44.5	13.1	1.6	10,296
sec. 14		C	----	48.8	51.2	----	1.8	11,851
US-7754	Harmon	A	37.8	25.1	28.5	8.6	0.6	6,248
T. 141 N., R. 105 W.,		B	----	40.3	45.9	13.8	1.0	10,038
sec. 20		C	----	46.7	53.3	----	1.2	11,642
US-7755	Harmon	A	39.7	24.9	27.4	8.0	0.8	6,174
T. 141 N., R. 105 W.,		B	----	41.3	45.4	13.3	1.2	10,246
sec. 20		C	----	47.6	52.4	----	1.4	11,814
US-7759	Harmon$_1$	A	36.9	26.2	27.3	9.6	1.4	6,191
T. 15 N., R. 60 E.,		B	----	41.5	43.4	15.1	2.3	9,807
sec. 26		C	----	48.9	51.1	----	2.7	11,557
US-7759	Harmon$_2$	A	38.2	25.8	28.3	7.7	0.4	6,281
T. 15 N., R. 60 E.,		B	----	41.7	45.8	12.5	0.7	10,169
sec. 26		C	----	47.7	52.3	----	0.8	11,616
US-7782	Harmon	A	36.4	26.5	26.8	10.3	0.9	6,200
T. 15 N., R. 59 E.,		B	----	41.6	42.1	16.3	1.5	9,744
sec. 2		C	----	49.7	50.3	----	1.8	11,636
US-7786	Harmon	A	36.3	25.9	27.4	10.4	1.5	6,382
T. 15 N., R. 60 E.,		B	----	40.6	43.1	16.3	2.4	10,025
sec. 6		C	----	48.6	51.4	----	2.8	11,981
US-7788	Hansen	A	33.4	24.6	29.1	12.9	0.3	6,196
T. 16 N., R. 59 E.,		B	----	36.9	43.7	19.4	0.5	9,304
sec. 34		C	----	45.8	54.2	----	0.6	11,546

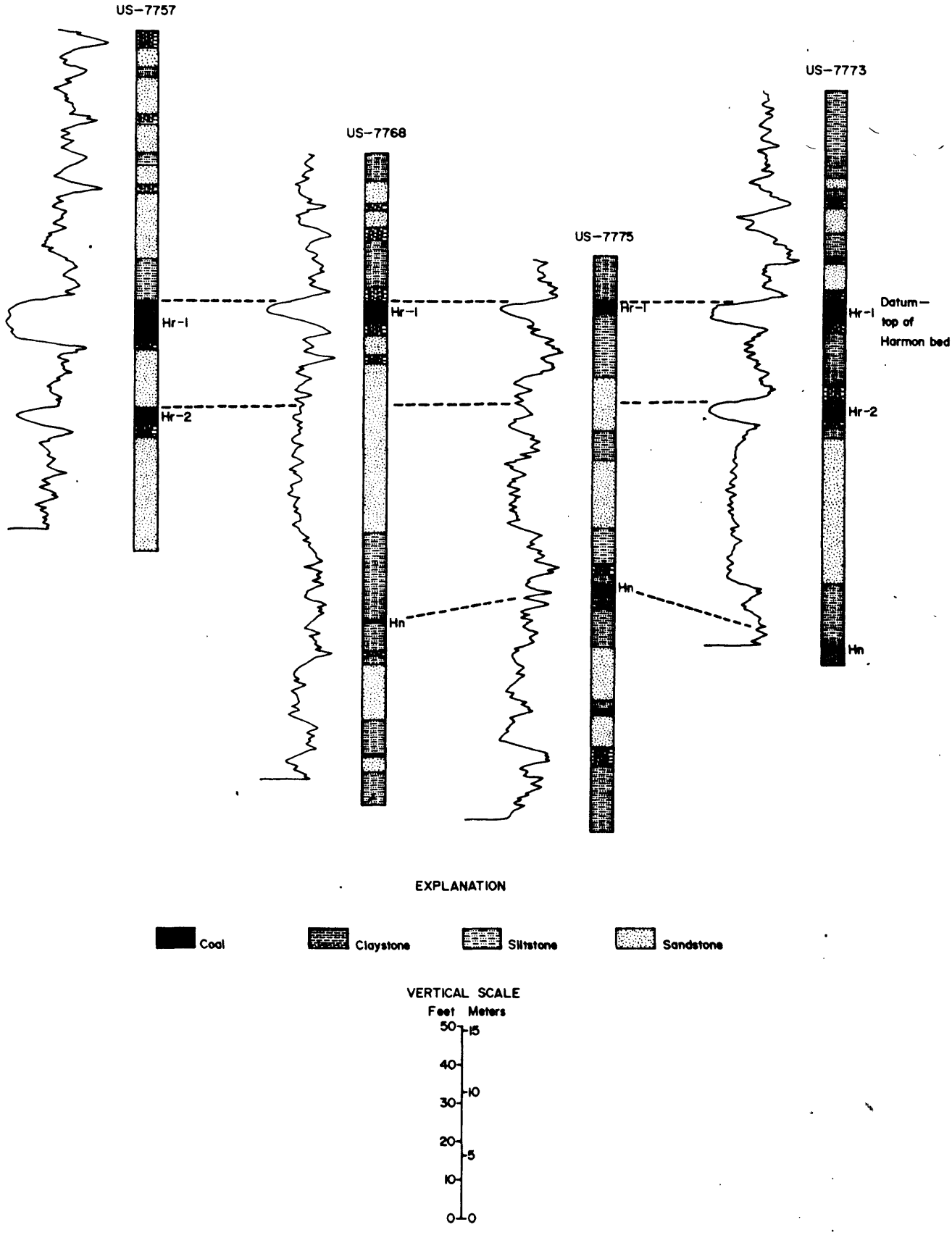

Figure 3. Gamma-ray logs and generalized lithologic column showing channeling of lower Harmon(Hr-2) split

Gamma-ray logs indicate that the Hansen bed separates into an upper (Hn_1) and lower (Hn_2) split in several areas (pl. 3). These logs give evidence that the Hansen bed has been channeled out in at least six different areas (pl. 3).

As-received chemical analyses show the Hansen bed has a heating value of 5,767-6,267 Btu/lb and the sulfur content is 0.3-3.5 percent (table 1).

Harmon bed.--The Harmon bed is the thickest, most continuous coal bed in the area (pls. 1, 2, and 4). It lies 15-122 ft above the Hansen bed and crops out along Beaver Creek and on the rolling prairie between Wibaux, Mont., and Golva, N. Dak. Total measured thickness of the bed ranges from 3 to 33 ft. A 150-ft overburden line delineates a large, possibly strippable, area (pl. 2).

Throughout the western part of the area, the Harmon bed exists as two splits. In the vicinity of drill-holes US-7737 and US-7738, a thin coal bed located close to the separated Harmon bed may be a lower third split (Hr_3).

About five miles northeast of Wibaux, the main Harmon bed is separated, and the lower split (Hr_2) is not present, probably because of channeling of the lower coal bed. Gamma-ray logs show a thick channel sand in the same horizon where the lower Harmon split would normally be located (fig. 3).

As-received chemical analyses show the Harmon bed has a heating value of 5,063-6,390 Btu/lb and the sulfur content is 0.4-1.5 percent (table 1).

Garner Creek bed.--The Garner Creek bed (pl. 4) correlates with the same coal-bed horizon of Hares (1928, p. 47). No attempt to further evaluate this bed was made because of insufficient data.

CONCLUSIONS

Numerous coal beds are present in the Wibaux-Beach area. The most continuous and thickest bed is the Harmon (C) bed. The thickness of the bed, large areas under less than 150 ft of overburden, nearness to transportation routes, and large sources of water make the Harmon bed potentially valuable for future coal development.

REFERENCES

Bergstrom, J. R., 1956, The general geology of uranium in southwestern North Dakota: North Dakota Geological Survey Report of Investigation No. 23, 1 sheet.

Denson, N. M., and Gill, J. R., 1965, Uranium-bearing lignite and carbonaceous shale in the southwestern part of the Williston basin--A regional study: U.S. Geological Survey Professional Paper 463, 75 p.

Hance, J. H., 1912, The Glendive lignite field, Dawson County, Montana: U.S. Geological Survey Bulletin 471-D, p. 271-283.

Hares, C. J., 1928, Geology and lignite resources of the Marmarth field, southwestern North Dakota: U.S. Geological Survey Bulletin 775, 110 p.

Harksen, J. C., 1978, Geophysical and lithologic logs for 1977 coal drilling in Wibaux County, Montana, and Golden Valley County, North Dakota: U.S. Geological Survey Open-File Report 78-251, 185 p.

Jacob, A. F., 1976, Geology of the upper part of the Fort Union Group (Paleocene), Williston basin, with reference to uranium: North Dakota Geological Survey Report of Investigation No. 58, 49 p.

King, P. B., compiler, 1969, Tectonic map of North America: U.S. Geological Survey Map, scale 1:5,000,000.

Leonard, A. G., Babcock, E. J., and Dove, L. P., 1925, The lignite deposits of North Dakota: North Dakota Geological Survey Bulletin No. 4, 240 p.

Leonard, A. G., and Smith, C. D., 1909, The Sentinel Butte lignite field, North Dakota and Montana: U.S. Geological Survey Bulletin 341-A, p. 15-35.

May, P. R., 1954, Strippable lignite deposits in the Wibaux area, Montana and North Dakota: U.S. Geological Survey Bulletin 995-G, p. 255-292.

Rehbein, E. A., 1977, Preliminary report on stratigraphy and depositional environments of the lignitesin the Fort Union Formation, west-central North Dakota: U.S. Geological Survey Open-File Report 77-69, 23 p.

Stebinger, Eugene, 1912, The Sidney lignite field, Dawson County, Montana: U.S. Geological Survey Bulletin 471-D, p. 284-318.

Table 2.--Drill-hole data for the Wibaux-Beach area

[1]Sources of drill-hole data:

US	United States Geological Survey
OW	Oil well geophysical log
NDWC	North Dakota State Water Commission
MBMG	Montana Bureau of Mines and Geology
WRD	United States Geological Survey - Water Resources Division

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

GC	Garner Creek
Hr	Harmon
Hn	Hansen
TC	T Cross

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7701	24-138-106	2890	140	13 R	
				1 C	
				21 R	
				1 C	
				16 R	
				10 C	Hr_1
				5 R	
				1 C	Hr_2
US-7702	22-138-106	3020	159	55 R	
				9 C	Hr_1
				4 R	
				1 C	Hr_2
				43 R	
				3 C	Hn

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7704 (US-7703)	10-138-106	2985	157	32 R	
				2 C	
				12 R	
				2 C	
				22 R	
				10 C	Hr
				38 R	
				1 C	
US-7705 (US-7706)	20-12-61 (E.)	2995	500	17 R	
				2 C	
				14 R	
				1 C	
				16 R	
				4 C	
				5 R	
				10 C	Hr
				51 R	
				2 C	Hn
				71 R	
				2 C	
				4 R	
				1 C	
				77 R	
				1 C	
				29 R	
				1 C	
				1 R	
				2 C	
				41 R	
				4 C	
				37 R	
				5 C	
				43 R	
				4 C	
US-7707 (US-77104)	10-138-106	2960	100	31 R	
				1 C	
				17 R	
				2 C	
				7 R	
				11 C	Hr
US-7708	10-138-106	2910	79	52 R	
				1 C	Hn
				9 R	
				2 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7709	6-138-105	no record			
US-7710	34-139-106	2910	51	18 R	
				2 C	
				6 R	
				16 C	Hr_1
				4 R	
				1 C	Hr_2
US-7711	2-138-106	2875	73	31 R	
				18 C	Hr_1
				16 R	
				1 C	Hr_2
US-7712	8-12-61 (E.)	2906	50	21 R	
				13 C	Hr
US-7713 (US-7714)	34-139-106	2920	83	15 R	
				1 C	
				37 R	
				18 C	Hr
US-7715	26-139-106	2845	60	29 R	
				1 C	Hn
US-7716	26-139-106	2880	99	36 R	
				1 C	
				11 R	
				16 C	Hr_1
				22 R	
				3 C	Hr_2
US-7717	26-139-106	2865	130	80 R	
				16 C	Hr_1
				13 R	
				2 C	Hr_2
US-7718	32-139-105	2840	800	7 R	
				1 C	
				16 R	
				1 C	
				67 R	
				2 C	
				36 R	
				10 C	Hr_1
				34 R	
				5 C	Hr_2
				61 R	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7718 (Continued)	32-139-105	2840	800	3 C	Hn
				207 R	
				2 C	
				47 R	
				3 C	
				29 R	
				4 C	
				6 R	
				2 C	
				63 R	
				9 C	
				37 R	
				4 C	
				26 R	
				5 C	
				73 R	
				4 C	
US-7719 (US-7720)	4-12-61 (E.)	2893	97	20 R	
				2 C	
				39 R	
				18 C	Hr_1
				3 R	
				1 C	Hr_2
US-7721	24-139-106	2875	199	17 R	
				3 C	
				3 R	
				2 C	
				56 R	
				3 C	
				51 R	
				23 C	Hr
US-7722	24-139-106	2870	258	66 R	
				1 C	
				91 R	
				14 C	Hr_1
				2 R	
				7 C	Hr_2
				74 R	
				3+C	Hn

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7723	24-139-106	2885	279	66 R	
				6 C	
				24 R	
				4 C	
				13 R	
				2 C	
				14 R	
				2 C	
				45 R	
				2 C	
				53 R	
				24 C	Hr
US-7725 (US-7724)	22-139-106	2850	77	45 R	
				21 C	Hr
US-7726	24-13-60 (E.)	2850	100	60 R	
				22 C	Hr_1
				3 R	
				2 C	Hr_2
US-7727	14-139-106	2860	650	57 R	
				1 C	
				10 R	
				2 C	
				11 R	
				2 C	
				22 R	
				26 C	Hr
				62 R	
				2 C	Hn_1
				3 R	
				3 C	Hn_2
				76 R	
				1 C	
				35 R	
				2 C	
				57 R	
				3 C	
				82 R	
				4 C	
				9 R	
				2 C	
				4 R	
				3 C	
				27 R	
				5 C	
				88 R	
				15 C	TC
				28 R	
				3 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7728	6-139-105	2780	300	27 R	
				4 C	
				2 R	
				1 C	
				9 R	
				4 C	
				8 R	
				2 C	
				130 R	
				2 C	
				20 R	
				3 C	
				4 R	
				25 C	Hr
				29 R	
				12 C	Hn
US-7729	12-13-60 (E.)	2820	160	48 R	
				28 C	Hr_1
				1 R	
				1 C	Hr_2
				42 R	
				3 C	Hn_1
				2 R	
				3 C	Hn_2
US-7730 (US-7731)	10-13-60 (E.)	2870	144	100 R	
				31 C	Hr_1
				1 R	
				2 C	Hr_2
US-7732		not drilled			
US-7733	12-13-60 (E.)	2835	470	66 R	
				28 C	Hr
				57 R	
				1 C	Hn_1
				1 R	
				3 C	Hn_2
				99 R	
				2 C	
				5 R	
				2 C	
				8 R	
				1 C	
				56 R	
				3 C	
				10 R	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7733 (Continued)	12-13-60 (E.)	2835	470	2 C	
				79 R	
				2 C	
				5 R	
				3 C	
				8 R	
				10 C	
US-7734	30-140-105	2750	385	28 R	
				3 C	
				170 R	
				1 C	
				5 R	
				28 C	Hr
				15 R	
				12 C	Hn
US-7735	2-13-60 (E.)	2855	207	100 R	
				1 C	
				8 R	
				33 C	Hr
				48 R	
				3 C	Hn
US-7737 (US-7736)	34-14-60 (E.)	2830	152	53 R	
				29 C	Hr_1
				2 R	
				3 C	Hr_2
				5 R	
				1 C	Hr_3?
				48 R	
				1 C	Hn_1
US-7738	28-14-60 (E.)	2860	500	83 R	
				20 C	Hr_1
				4 R	
				7 C	Hr_2
				2 R	
				2 C	Hr_3?
				77 R	
				5 C	Hn_1
				16 R	
				2 C	Hn_2
				52 R	
				2 C	
				38 R	
				1 C	
				20 R	

Table 2.--Drill-hole data for the Wibaux-Beach a... - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7738 (Continued)	28-14-60 (E.)	2860	500	1 C 7 R 3 C 9 R 5 C 8 R 1 C 6 R 1 C 33 R 7 C 18 R 1 C 17 R 2 C	
US-7739 (US-7740)	14-14-60 (E.)	2820	196	43 R 16 C 46 R 5 C 5 R 2 C 64 R 3 C	Hr Hn_1 Hn_2
US-7741	14-14-60 (E.)	2814	640	71 R 18 C 69 R 6 C 2 R 5 C 214 R 3 C 5 R 3 C 59 R 4 C 86 R 5 C 4 R 4 C 4 R 2 C 11 R 1 C	Hr Hn_1 Hn_2

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7742	2-140-106	2745	300	41 R	
				1 C	
				2 R	
				3 C	
				1 R	
				2 C	
				75 R	
				2 C	
				41 R	
				1 C	
				3 R	
				19 C	Hr_1
				5 R	
				14 C	Hr_2
				50 R	
				2 C	Hn
				18 R	
				2 C	
US-7743	10-14-60 (E.)	2770	139	24 R	
				15 C	Hr
				65 R	
				3 C	Hn
US-7744	2-14-60 (E.)	2825	239	48 R	
				4 C	
				6 R	
				5 C	
				59 R	
				1 C	
				54 R	
				17 C	Hr
US-7745	32-141-105	2745	218	115 R	
				18 C	Hr
				57 R	
				4 C	Hn
				19 R	
				2 C	
US-7746	32-141-105	2760	170	23 R	
				3 C	
				4 R	
				3 C	
				76 R	
				2 C	
				31 R	
				18 C	Hr

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7747	32-141-105	2715	131	101 R	
				2 C	
				3 R	
				15 C	Hr
US-7748	34-141-105	2755	700	30 R	
				3 C	
				18 R	
				3 C	
				32 R	
				2 C	
				47 R	
				2 C	
				103 R	
				18 C	Hr
				36 R	
				9 C	Hn
				95 R	
				8 C	
				62 R	
				2 C	
				45 R	
				1 C	
				103 R	
				3 C	
				19 R	
				7 C	
				13 R	
				2 C	
US-7749	28-141-105	2685	250	61 R	
				1 C	
				20 R	
				1 C	
				51 R	
				20 C	Hr
				40 R	
				10 C	Hn
				36 R	
				4 C	
US-7750	32-15-60 (E.)	2780	250	17 R	
				9 C	Hr_1
				9 R	
				7 C	Hr_2
				74 R	
				2 C	Hn
				62 R	
				6 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7751		not drilled			
US-7752	30-141-105	2740	162	62 R	
				2 C	
				56 R	
				18 C	Hr
US-7753	20-141-105	2725	156	58 R	
				1 C	
				9 R	
				1 C	
				14 R	
				1 C	
				47 R	
				19 C	Hr
US-7754 (US-77107)	20-141-105	2689	176	67 R	
				2 C	
				4 R	
				1 C	
				13 R	
				1 C	
				61 R	
				21 C	Hr
US-7755 (US-77103)	20-141-105	2670	600	31 R	
				2 C	
				20 R	
				1 C	
				38 R	
				21 C	Hr
				60 R	
				2 C	Hn
				52 R	
				2 C	
				57 R	
				2 C	
				140 R	
				2 C	
				56 R	
				3 C	
				72 R	
				2 C	
				7 R	
				4 C	
US-7756	32-15-60 (E.)	2740	50	29 R	
				2 C	Hr_1
				7 R	
				1 C	Hr_2

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7757	34-15-60 (E.)	2775	135	70 R	
				11 C	Hr_1
				17 R	
				4 C	Hr_2
US-7759 (US-7758)	26-15-60 (E.)	2750	584	36 R	
				6 C	
				17 R	
				11 C	Hr_1
				16 R	
				4 C	Hr_2
				54 R	
				4 C	Hn
				75 R	
				5 C	
				58 R	
				4 C	
				190 R	
				2 C	
				27 R	
				2 C	
				25 R	
				2 C	
US-7760	26-15-60 (E.)	2724	137	38 R	
				1 C	
				24 R	
				1 C	
				36 R	
				18 C	Hr
US-7761	24-15-59 (E.)	2700	168	55 R	
				10 C	Hn
				95 R	
				2 C	
US-7762	18-15-60 (E.)	2650	500	53 R	
				4 C	Hn
				100 R	
				8 C	
				121 R	
				2 C	
				75 R	
				2 C	
				48 R	
				3 C	
				34 R	
				8 C	
				23 R	
				2 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7763		not drilled			
US-7764	30-15-60 (E.)	2730	225	34 R	
				3 C	Hr_1
				15 R	
				1 C	Hr_2
				86 R	
				2 C	Hn
				9 R	
				1 C	
				37 R	
				3 C	
US-7765	28-15-60 (E.)	2740	252	29 R	
				5 C	Hr_1
				135 R	
				1 C	
				3 R	
				2 C	
US-7766	22-15-60 (E.)	2650	160	26 R	
				3 C	Hr_1
				85 R	
				1 C	
				8 R	
				2 C	
				4 R	
				1 C	
US-7767		not drilled			
US-7768	26-15-60 (E.)	2715	170	39 R	
				6 C	Hr_1
				77 R	
				1 C	Hn
				34 R	
				1 C	
US-7769	26-15-60 (E.)	2720	199	45 R	
				5 C	Hr_1
				51 R	
				2 C	Hn
				56 R	
				1 C	
US-7770	18-141-105	2680	118	51 R	
				2 C	
				36 R	
				18 C	Hr

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7771		not drilled			
US-7772	8-141-105	2670	280	44 R	
				1 C	
				23 R	
				2 C	
				26 R	
				18 C	Hr
				50 R	
				1 C	Hn
US-7773	14-15-60 (E.)	2680	150	55 R	
				7 C	Hr_1
				19 R	
				5 C	Hr_2
				59 R	
				1 C	Hn
US-7774	14-15-60 (E.)	2685	150	34 R	
				2 C	
				32 R	
				4 C	Hr_1
				17 R	
				4 C	Hr_2
				39 R	
				1 C	
US-7775	14-15-60 (E.)	2637	150	12 R	
				3 C	Hr_1
				71 R	
				1 C	Hn
				31 R	
				1 C	
US-7776	6-141-105	2680	250	59 R	
				6 C	Hr_1
				64 R	
				1 C	Hn_1
				1 R	
				1 C	Hn_2
				41 R	
				1 C	
US-7777	12-15-60 (E.)	2723	650	45 R	
				10 C	
				14 R	
				4 C	
				47 R	
				2 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7777 (Continued)		2723	650	14 R	
				3 C	
	12-15-60 (E.)			32 R	
				4 C	Hr_1
				3 R	
				3 C	Hr_2
				24 R	
				4 C	
				67 R	
				1 C	Hn
				165 R	
				3 C	
				44 R	
				3 C	
				49 R	
				1 C	
				54 R	
				3 C	
				12 R	
				4 C	
US-7778	6-15-61 (E.)	2670	252	15 R	
				4 C	
				8 R	
				3 C	
				37 R	
				2 C	
				21 R	
				3 C	
				23 R	
				6 C	Hr_1
				7 R	
				3 C	Hr_2
				41 R	
				2 C	Hn
US-7779	4-15-59 (E.)	2640	405	66 R	
				9 C	
				138 R	
				1 C	
				51 R	
				2 C	
				37 R	
				2 C	
				25 R	
				2 C	
				35 R	
				10 C	
				10 R	
				5 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No. [1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7780	4-15-59 (E.)	2770	140	81 R	
				11 C	Hn
US-7781	10-15-59 (E.)	2800	660	55 R	
				11 C	Hr
				102 R	
				9 C	Hn
				116 R	
				9 C	
				139 R	
				2 C	
				28 R	
				2 C	
				8 R	
				2 C	
				24 R	
				2 C	
				4 R	
				1 C	
				15 R	
				1 C	
				45 R	
				8 C	
US-7782 (US-7783)	2-15-59 (E.)	2747	155	42 R	
				3 C	
				27 R	
				15 C	Hr
				35 R	
				2 C	
US-7784	12-15-59 (E.)	2700	150	11 R	
				2 C	
				3 R	
				1 C	
				26 R	
				9 C	Hr_1
				20 R	
				3 C	Hr_2
				48 R	
				8 C	Hn
US-7786 (US-7785)	6-15-60 (E.)	2730	300	26 R	
				3 C	
				48 R	
				9 C	Hr_1
				122 R	
				2 C	Hn

Table 2.--Drill-hole data for the Wibaux-Beach area continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7788 (US-7787)	34-16-59 (E.)	2780	300	112 R 12 C 118 R 9 C	 Hr Hn
US-7789	28-16-59 (E.)	2600	88	41 R 11 C	 Hn
US-7790	30-16-60 (E.)	2740	200	47 R 3 C 33 R 7 C 4 R 7 C 72 R 9 C	 Hr
US-7791	20-16-59 (E.)	2610	200	148 R 10 C	 Hn
US-7792	20-16-59 (E.)	2500	140	39 R 11 C	 Hn
US-7793	28-16-59 (E.)	2575	403	91 R 10 C 193 R 2 C 29 R 4 C 68 R 4 C	 Hn
US-7794	22-16-59 (E.)	2580	199	112 R 1 C 1 R 6 C 57 R 1 C 11 R 1 C	 Hn_1 Hn_2
US-7795	24-16-59 (E.)	2590	200	59 R 13 C 71 R 2 C 28 R 1 C 1 R 6 C	 Hr Hn_1 Hn_2
US-7796	not drilled				

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-7797	24-16-59 (E.)	2700	401	30 R	
				1 C	
				1 R	
				2 C	
				11 R	
				1 C	
				45 R	
				4 C	
				9 R	
				5 C	
				118 R	
				11 C	Hr
				65 R	
				1 C	
				27 R	
				6 C	Hn
				48 R	
				2 C	
US-7798	18-16-60 (E.)	2640	600	66 R	
				2 C	
				50 R	
				2 C	
				22 R	
				5 C	
				127 R	
				11 C	Hr
				26 R	
				2 C	
				19 R	
				1 C	
				42 R	
				5 C	Hn
				135 R	
				1 C	
				30 R	
				2 C	
				42 R	
				4 C	
US-7799	14-16-59 (E.)	2500	172	50 R	
				12 C	Hr
				47 R	
				3 C	
				8 R	
				1 C	
				2 R	
				1 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-77100		not drilled			
US-77101		not drilled			
US-77102	28-138-105	2822	603	9 R	
				1 C	
				20 R	
				1 C	
				44 R	
				6 C	Hr_1
				8 R	
				1 C	Hr_2
				46 R	
				1 C	
				8 R	
				1 C	
				36 R	
				7 C	Hn
				143 R	
				1 C	
				33 R	
				4 C	
				47 R	
				1 C	
				1 R	
				1 C	
				35 R	
				2 C	
				6 R	
				2 C	
				94 R	
				8 C	TC
US-77103		see 55 for data			
US-77104		see 07 for data			
US-77105	12-138-106	2925	105	18 R	
				1 C	
				9 R	
				1 C	
				43 R	
				1 C	
				2 R	
				11 C	Hr

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
US-77106	12-138-106	2920	200	20 R	
				1 C	
				41 R	
				1 C	
				29 R	
				7 C	Hr
US-77107		see 54 for data			
US-77108		not drilled			
US-77109	20-15-60 (E.)	2730	99	24 R	
				7 C	Hr_1
				16 R	
				3 C	Hr_2
US-77110	10-15-60 (E.)	2680	149	64 R	
				9 C	Hr_1
				7 R	
				5 C	Hr_2
				62 R	
				2 C	Hn
US-77111	4-15-60 (E.)	2675	149	5 R	
				2 C	
				45 R	
				12 C	Hr_1
				14 R	
				3 C	Hr_2
				57 R	
				2 C	Hn
US-77112	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
				106 R	
				4 C	
				60 R	
				2 C	
				10 R	
				2 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
WRD-1	9-12-61 (E.)	2925	120	43 R	
				17 C	Hr
WRD-2	17-12-61 (E.)	2945	100	22 R	
				10 C	Hr
WRD-3	12-13-60 (E.)	2830	100	62 R	
				32 C	Hr
WRD-4	30-13-61 (E.)	2870	450	72 R	
				22 C	Hr
				74 R	
				6 C	Hn
				137 R	
				4 C	
				51 R	
				4 C	
WRD-5	11-14-60 (E.)	2740	76	56 R	
				18 C	Hr
WRD-6	12-14-60 (E.)	2755	112	93 R	
				16 C	Hr
WRD-7	35-14-60 (E.)	2830	472	58 R	
				32 C	Hr
				234 R	
				2 C	
				16 R	
				2 C	
				34 R	
				3 C	
WRD-8	19-14-61 (E.)	2765	198	56 R	
				8 C	
				98 R	
				19 C	Hr
WRD-9	31-14-61 (E.)	2860	227	38 R	
				3 C	
				143 R	
				28 C	Hr
WRD-10	14-15-60 (E.)	2640	204	204 R	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
WRD-11	35-15-60 (E.)	2770	550	104 R	
				18 C	Hr
				46 R	
				4 C	Hn
				87 R	
				3 C	
				10 R	
				4 C	
WRD-12	30-15-61 (E.)	2705	110	97 R	
				13+C	Hr
WRD-13	5-138-105	2865	204	140 R	
				10 C	Hr
WRD-14	7-138-105	2930	252	117 R	
				6 C	Hr
WRD-15	10-138-106	2925	264	15 R	
				10 C	Hr
				112 R	
				2 C	
WRD-16	8-139-105	2810	316	48 R	
				4 C	
				239 R	
				21 C	Hr
WRD-17	18-139-105	2860	274	16 R	
				2 C	
				198 R	
				2 C	
				11 R	
				21 C	Hr
				21 R	
				3+C	Hn
WRD-18	30-139-105	2860	594	149 R	
				13 C	Hr_1
				10 R	
				5 C	Hr_2
				59 R	
				6 C	Hn
				114 R	
				4 C	
				48 R	
				2 C	
				50 R	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
WRD-18 (Continued)	30-139-105	2860	594	2 C	
				28 R	
				4 C	
				31 R	
				2 C	
WRD-19	13-139-106	2880	225	28 R	
				4 C	
				34 R	
				2 C	
				123 R	
				23 C	Hr
WRD-20	6-140-105	2705	198	118 R	
				17 C	Hr
WRD-21	17-140-105	2745	305	21 R	
				4 C	GC
				221 R	
				30 C	Hr
WRD-22	30-140-105	2760	280	135 R	
				25 C	Hr
				54 R	
				12 C	Hn
WRD-23	2-140-106	2730	292	23 R	
				4 C	
				129 R	
				17 C	Hr_1
				2 R	
				13 C	Hr_2
WRD-24	24-140-106	2745	210	172 R	
				27 C	Hr
WRD-25	34-140-106	2820	308	138 R	
				26 C	Hr
				44 R	
				2 C	Hn_1
				1 R	
				1 C	Hn_2
WRD-26	7-141-105	2760	219	81 R	
				5 C	
				16 R	
				3 C	
				39 R	
				3 C	Hr_1
				63 R	
				6 C	Hn

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
WRD-27	7-141-105	2610	356	25 R	
				19 C	Hr
WRD-28	9-141-105	2740	260	101 R	
				6 C	
				89 R	
				4 C	
				11 R	
				3 C	
				22 R	
				19 C	Hr
WRD-29	14-141-105	2795	368	84 R	
				6 C	
				113 R	
				4 C	
				72 R	
				2 C	
				10 R	
				3 C	
				33 R	
				18 C	Hr
WRD-30	20-141-105	2700	112	90 R	
				16 C	Hr
WRD-31	28-141-105	2685	180	122 R	
				20 C	Hr
WRD-32	32-141-105	2720	142	116 R	
				20 C	Hr
NDWC-4924	14-140-106	2774	260	26 R	
				2 C	GC_1
				17 R	
				4 C	GC_2
				128 R	
				31 C	Hr
NDWC-4925	6-14-61 (E.)	2739	200	108 R	
				19 C	Hr
NDWC-4926	10-14-60 (E.)	2755	60	33 R	
				15 C	Hr
NDWC-4927	26-14-60 (E.)	2804	120	98 R	
				15 C	Hr

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
NDWC-4928	18-13-61 (E.)	2815	67	36 R	
				27 C	Hr
NDWC-4929	1-139-106	2852	220	10 R	
				3 C	GC_1
				16 R	
				4 C	GC_2
				154 R	
				25 C	Hr
NDWC-4930	30-139-105	2879	200	24 R	
				3 C	
				61 R	
				2 C	
				62 R	
				15 C	Hr_1
				20 R	
				4 C	Hr_2
NDWC-4932	8-12-61 (E.)	2915	120	18 R	
				10 C	Hr
NDWC-4933	11-138-106	2887	60	38 R	
				10 C	Hr
OW-1	15-140-105	2857	12,690	315 R	
				5 C	
				130 R	
				28 C	Hr
				32 R	
				5 C	Hn_1
				5 R	
				10 C	Hn_2
				200 R	
				6 C	
				77 R	
				6 C	
				66 R	
				11 C	TC
				59 R	
				10 C	

Table 2.--Drill-hole data for the Wibaux-Beach area - continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
OW-2	33-140-105	2803	9,450	137 R	
				6 C	GC
				202 R	
				23 C	Hr
				24 R	
				5 C	Hn_1
				1 R	
				7 C	Hn_2
				211 R	
				4 C	
				6 R	
				4 C	
				28 R	
				3 C	
				32 R	
				3 C	
				29 R	
				5 C	
				24 R	
				4 C	
				48 R	
				14 C	TC
				29 R	
				12 C	
OW-3	23-139-104	2754	9,420	172 R	
				6 C	
				192 R	
				7 C	
				98 R	
				15 C	Hr
OW-4	31-139-104	2732	11,350	100 no record	
				62 R	
				8 C	GC
				139 R	
				11 C	Hr
				92 R	
				3 C	Hn
				75 R	
				5 C	
				10 R	
				5 C	
				66 R	
				8 C	
				43 R	
				4 C	
				66 R	
				12 C	TC
				8 R	
				5 C	

Table 2.--Drill-hole data for the Wibaux-Beach area continued

Hole No.[1]	Location Sec.-T.N.-R.W.(E.)	Surface elevation (feet)	Total depth (feet)	Rock-coal thickness (feet)	Bed name
OW-5	25-141-104	2681	12250	98 R	
				2 C	
				29 R	
				4 C	
				71 R	
				3 C	
				34 R	
				2 C	
				6 R	
				5 C	
				42 R	
				9 C	GC
				113 R	
				15 C	Hr
				106 R	
				7 C	
				182 R	
				5 C	
				96 R	
				7 C	
				106 R	
				11 C	
				5 R	
				2 C	
				6 R	
				6 C	
MBMG-7194	36-15-60 (E.)	2760	209	15 R	
				3 C	
				2 R	
				4 C	
				115 R	
				17 C	Hr
				40 R	
				5 C	Hn

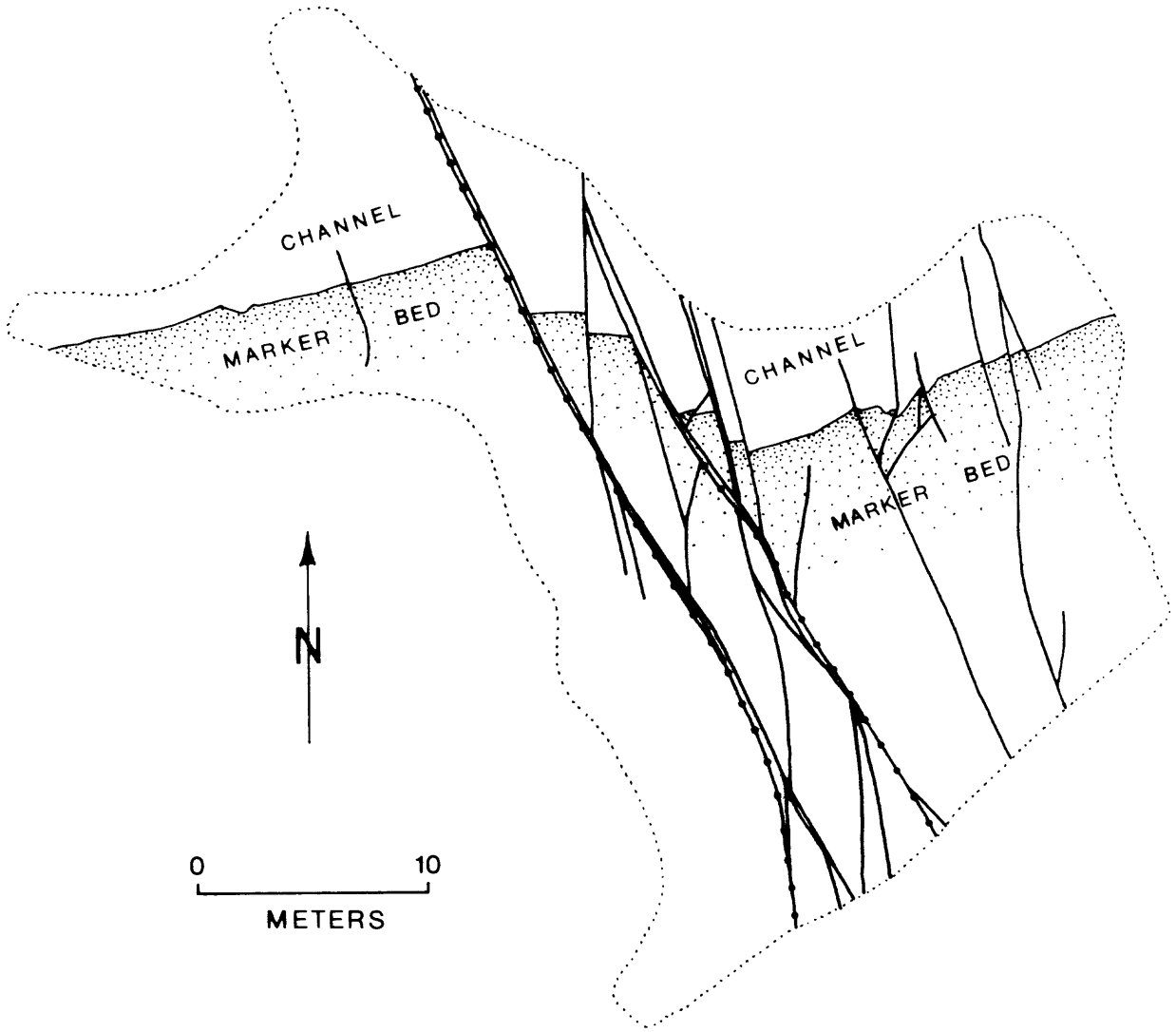

FIG. 5

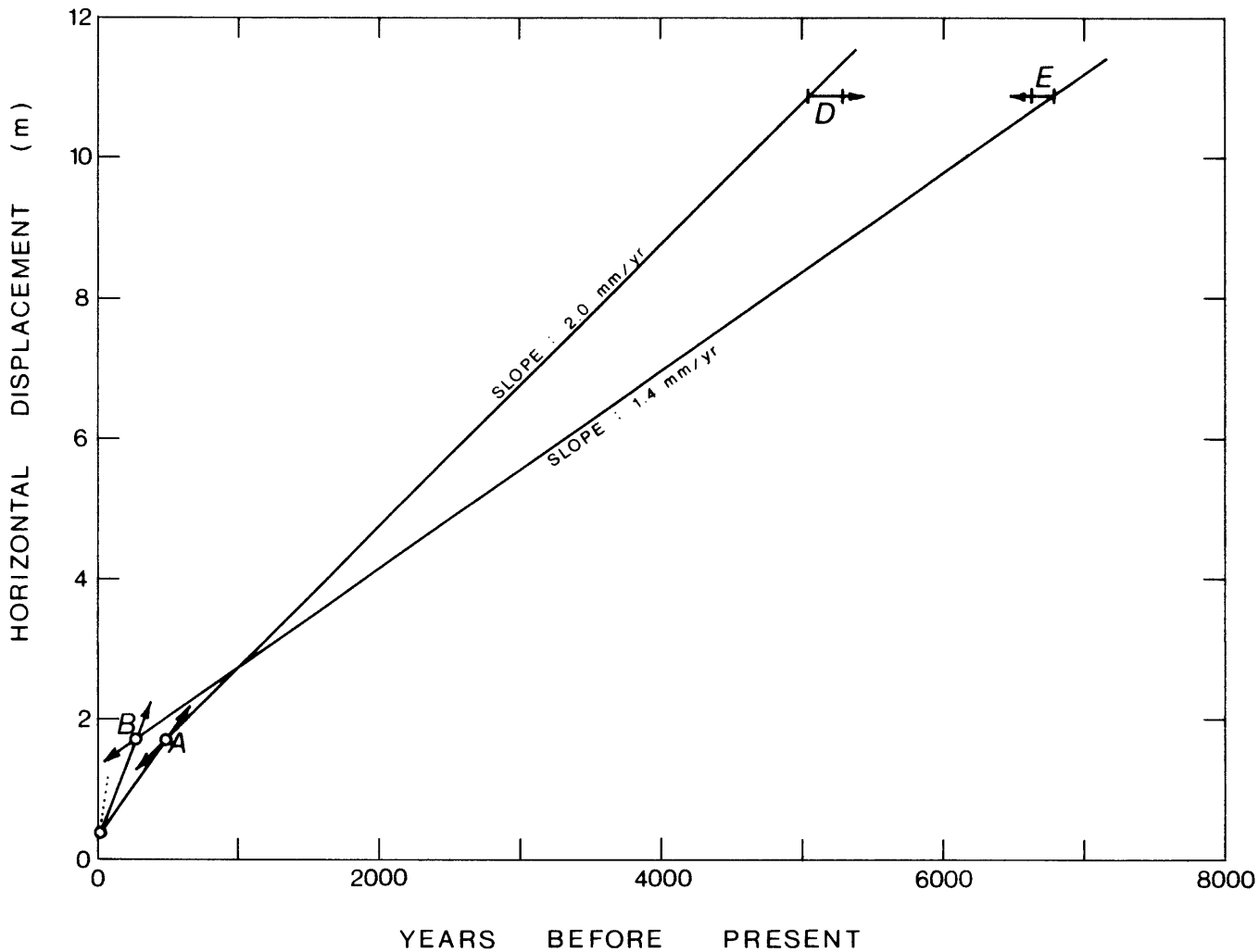
HORIZONTAL DISPLACEMENT (m)
12
10
8
6
4
2
0
0
2000
4000
6000
8000
YEARS BEFORE PRESENT
SLOPE = 2.0 mm/yr
SLOPE = 1.4 mm/yr
D
E
B
A

FIG 6