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Some peat deposits in Penobscot County, Maine

by

Cornelia C. Cameron
U.S. Geological Survey
Reston, Virginia 22092

and

Walter A. Anderson
Maine Geological Survey
Augusta, Maine 04330

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Abstract

Twenty of the peat deposits in Penobscot County, Maine contain an estimated 29,282,000 short tons air-dried peat. The peat is chiefly sphagnum moss and reed-sedge of high quality according to ASTM standards for agricultural and horticultural use.

Analyses show that this same volume has high fuel value, low sulfur and high hydrogen contents compared with lignite and sub-bituminous coal, which may indicate that it also has potential for fuel use.

On the basis of the metallic trace element content, one area within the region containing the 20 deposits has been delineated for further bedrock studies.

Introduction

General nature of peat

Peat is a light brown to dark brown or almost black residuum formed by the partial decay and disintegration of plants that grew in marshes and swamps or in damp places such as heaths. It may be (1) fibrous, matted material composed of mosses, ferns, grasses, rushes, reeds, sedges and woody material from trees and shrubs; (2) finely divided plants so decomposed that its biological identity is lost; or (3) nonfibrous, plastic, colloidal, and macerated material deposited at the bottom of lakes or other bodies of water. The U.S. Bureau of Mines classifies peat in three general types. Material derived from moss is moss peat; whereas that from reed, sedge, shrub, and tree groups is classified as reed-sedge peat. Humus peat is material so decomposed that its botanical identity is obscured and further oxidation of the material has been impeded. The American Society for Testing and Materials refined these definitions in 1969 to include only that which has an ash content of not more than 25 percent.

Uses of peat and outlook for peat industry

Virtually all peat sold in the United States in 1978 was used for agricultural and horticultural purposes. It was marketed through nurseries, garden centers, and chain stores chiefly in suburban areas of North Central, Northeast, Middle Atlantic States and Florida. Production during the past year is estimated (Singleton, 1979) at 840 thousand short tons of which 70 percent was reed-sedge peat, 18 percent humus peat, and the remaining 22 percent moss and unclassified peat. Value of the 1978 production is about $15,000,000 f.o.b. mine with average value per ton of about $18.30. Apparent consumption of peat during this year, however, was 1.15 million tons of which imports comprised 29 percent on a tonnage basis and 70 percent on a value basis.

Importance of peat in other fields

Events and trends point to an expanded demand for peat in the United States. A program of experimental studies on the gasification of peat sponsored by the U.S. Department of Energy has already begun in the Midwest. A large agricultural corporation in North Carolina is investigating and promoting the possible commercial generation of electrical power using humus peat as a fuel. Demand for peat for agricultural and horticultural use increased by about 10 percent in 1978 and is expected to increase at an average rate of about 2.5 percent to 0.9 million tons in 1985, using a 1977 basis (Singleton, 1979).

Peat deposits occur in a variety of geologic and physiographic settings. Studies of these settings are being made by the U.S.G.S. and some State Surveys in connection with hydrology and biology studies for use in preparation of environmental impact statements on land use.

A peat deposit acts as a sponge for collecting trace elements as shown in Figures 7 and Table 5. The use of trace elements in peat appears promising as a tool in geochemical prospecting for metals such as copper, zinc, lead, and nickel.

Scope of report and acknowledgements

The purpose of this report is to provide information for use in the exploration and exploitation of peat deposits in Penobscot County, Maine. It is an expansion of the study begun in Washington and southeastern Aroostook Counties (Cameron, 1975)and Hancock County (Cameron and Massey, 1978). Twenty-one peat bogs and bog complexes (see locations Figure 1 and Table 1) were investigated

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Figure 1 near here.

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by hand auger holes along pace and compass traverses across marshes and heaths. The amount of peat was estimated from the data collected and from the surface area measured on topographic maps and air photos. In calculating tonnages, one

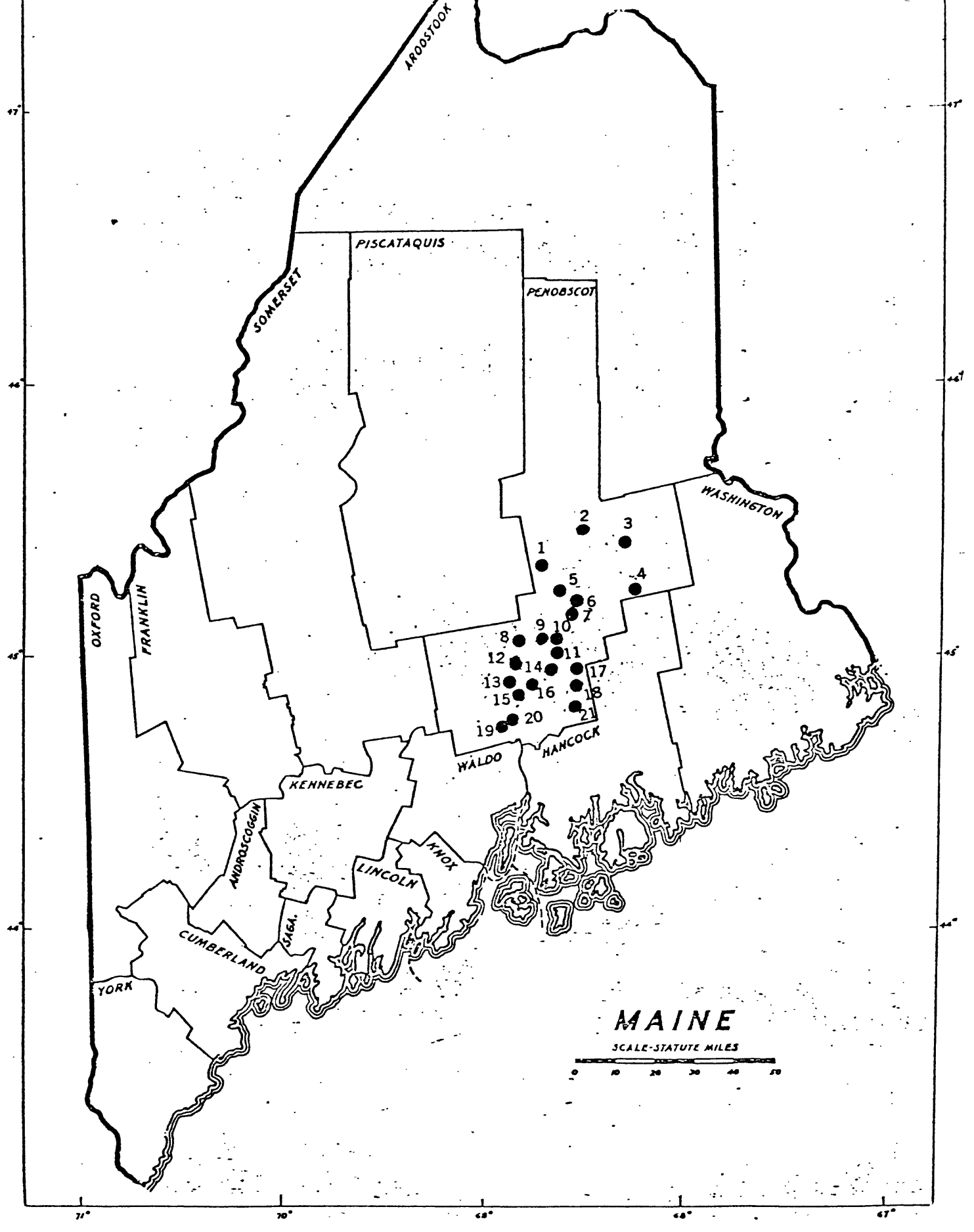

Figure 1.— Index map showing location of the 21 peat bogs and bog complexes in Penobscot County, Maine which are described in this report.

Table 1. Estimated peat resources in each of the 21 peat bogs and bog complexes shown on index map, figure 1.

Number of bog or bog complex shown on index map	Location as shown on 1:62,000 scale topographic quadrangles	Estimated Resources: Acres of commercial quality peat e.g. peat at least 5 feet thick with ash content not exceeding 25 percent	Estimated Resources: Short tons of air-dried peat (1 acre-foot = 200 tons)
1	Sweat Bog, Maxwell and Seboeis Twps. See Schoodic Quadrangle	640 with average thickness of 10 feet	1,280,000
2	Keene Bog, Chester Twp. See Lincoln Quadrangle	205 with average thickness of 8 feet	328,000
3	Bog along Mattakeunk stream SW of East Winn, Lee Twp. See Winn Quadrangle	320 with average thickness of 5 feet	320,000
4	Thousand Acre Heath, T3R1. See Springfield and Nicatous Lake Quadrangles	1,338 of which 245 have average thickness of 17 feet and 1,093 have average thickness of 7 feet (See map, Figure 2.)	2,363,200
5	Swamps, marshes and heaths along Cold Stream, Passadumkeag and Lowell Twps. See Passadumkeag Quadrangle	1,050 with average thickness of 5 feet	1,050,000
6	Heath 4 miles SW of Lowell, Lowell Twp. and 1 1/2 miles west of Passadumkeag River. See Passadumkeag Quadrangle	320 with average thickness of 5 feet	320,000
7	Heath South of Rocky Rips on Passadumkeag River in TIND. See Passadumkeag Quadrangle	565 with average thickness of 10 feet	1,133,000
8	Fitz Bog crossed by Bangor and Aroostook R.R. track, Alton Twp. See Boyd Lake Quadrangle	100 with average thickness of 10 feet	200,000
9	Sargent Bog, west side Route #16, 2.5 miles SE of South Lagrange. See Boyd Lake Quadrangle	400 with average thickness of 8 feet	640,000

10	Heat east side of Route #16 South of Porcupine Ridge. See Boyd Lake Quadrangle	80 with average thickness of 14 feet	224,000
11	Bog adjacent to Holland Pond east of Route #16. See Boyd Lake Quadrangle	200 with average thickness of 12 feet	480,000
12	Call Bog, 2 miles NNE of Hudson, Hudson Twp. See Boyd Lake	280 with average thickness of 12 feet	672,000
13	Heath on South side of Pushaw stream 1 mile WSW of Hudson. See Bangor Quadrangle	87 with average thickness of 10 feet	174,000
14	Alton bog 4 miles north of Oldtown, average thickness 2 feet throughout 12,000 acres of heath and swamp.	Not applicable because of shallow depth	0
15	Heath adjacent to NW end of Pushaw Lake mostly in Hudson Twp. See Bangor Quadrangle	160 with average thickness of 7 feet	224,000
16	Caribou Bog, 7 miles north of Bangor. See Bangor Quadrangle	2,567 total of which 1,045 have average thickness of 16 feet; 1092 have average thickness of 10 feet; 110 have average thickness of 7 feet, and 320 have average thickness of 9-5 feet. (See map, figure 3)	6,002,000
17	Heaths along Sunkhaze stream and tributaries, Milford Twp., northeast of Oldtown Maine. See Orano Quadrangle	3,301 total of which 661 have average thickness of 15 feet; 785 have average thickness of 13 feet; 1,115 have average thickness of 10 feet, and 740 have average thickness of 5 feet (See map, figure 4)	6,994,000
18	No. 16 swamp along Great Works Stream, Bradley Twp. See Orano Quadrangle	270 with average thickness of 15 feet	870,000

19	Marsh and heath between George and Hammond Ponds along Soudabscook Stream. See Bangor 15' Quadrangle	200 with average thickness of 5 feet	200,000
20	Hermon Bog, west of Bangor International Airport. See Bangor Quadrangle	704 acres with average thickness of 16 feet (See map, figure 5)	2,252,800
21	Chemo Bog, Bradley Twp. See Orano Quadrangle	1230 of which 590 have average thickness of 20 feet; 290 have average thickness of 13 feet; 215 have average thickness of 7 feet, and 140 have average thickness of 5 feet. (See map, figure 6)	3,555,000

Total -- 29,282,000 Tons

acre-foot of peat in place was considered equivalent to 200 short tons of air-dried peat. Commercial quality of the peat was assessed by standards set forth by the American Society of Testing and Materials (1969).

The Maine Geological Survey investigated and supported this study with assistance of the Maine office of Energy Resources, Agusta, Maine. Laboratory support by the Maine Geological Survey and logistical support by both of these organizations were greatly appreciated. Appreciation is also extended to Forest E. Walker, Chemist in Charge of the Coal-Analysis Division for the U.S. Department of Energy (sample analyses shown on table 3). Cuts of each of these samples were analyzed for the data in tables 2 and 5 in the laboratories of the U.S. Geological Survey by Fred O. Simon, Roosevelt Moore, Elena Silk, James D. Mountjoy, and Danold W. Golightly to which appreciation is likewise extended. Finally, the excellent field assistance by George H. Swihart and Donald B. Kale is gratefully acknowledged.

Physiography and composition of Penobscot County deposits

The evolution, physiography and stratigraphy of peat deposits in Penobscot County are generally similar to the deposits described by Cameron (1975) in Washington and Aroostook Counties. Most of the deposits considered in this report are, at least in part, raised sphagnum bogs covered by heath vegetation which grades outward to marsh or forest borders. Thousand Acre Heath (Figure 2,2a)

Figure 2 near here.

Hermon Bog (Figure 5, 5a) and Chemo Bog (Figure 6, 6a) show typical three dimensional configurations and stratigraphies. The bogs in Figures 3 and 4

Figures 3 and 4 near here.

Table 2. Samples from 20 peat bogs shown on index map, figure 1, together with their ash content and pH analyses. Type of peat and the depth below bog surface at which each sample was collected is also shown.

Number of bog or bog complex (see index map, fig. 1)	Sample Identification	Type of peat in sample and its depth in drill hole	Percent ash of the fraction of sample used for trace element determination	pH
1	CC-78-41	Sphagnum at 5 ft depth	2.9	4.8
	CC-78-42	Sphagnum at 9 ft depth	4.0	6.2
2	CC-78-43	Sphagnum at 5 ft depth	1.9	4.4
3	CC-78-40	Reedge-sedge at 5.5 ft depth at contact with gray clay	30.2	5.7
4	CC-78-8	Reed-sedge at 5 ft depth	1.7	4.9
	CC-78-9	Sphagnum at 5 ft depth	1.9	5.1
	CC-78-10	Reed-sedge at 5 ft depth	4.9	5.0
5	CC-78-38	Reed-sedge at 5 ft depth	1.6	4.4
	CC-78-39	Reed-sedge at 9 ft depth	5.6	4.9
6	CC-78-34	Humus at 5 ft depth on silt	51.2	5.3
	CC-78-35	Humus at 5 ft depth near base of bog	55.9	5.8
7	CC-78-36	Sphagnum at 5 ft depth	0.7	4.6
	CC-78-37	Reed-sedge at 9 ft depth	0.7	4.9
8	CC-78-26	Sphagnum at 5 ft depth	1.6	4.2
9	CC-78-27	Reed-sedge peat at contact with gray clay	81.5	4.8
10	CC-78-28	Sphagnum at 5 ft depth	8.6	4.4
	CC-78-29	Reed-sedge at 13 ft depth	9.6	5.8
11	CC-78-30	Sphagnum moff at 5 ft depth	1.6	4.4
12	CC-78-23	Sphagnum at 5 ft depth	3.2	6.1
	CC-78-24	Sphagnum at 9 ft depth	6.3	5.8
	CC-78-25	Reed-sedge at 5 ft depth	8.4	5.5

Table 2 (cont'd)

Number of bob or bog complex (see index map, fig. 1)	Sample Identification	Type of peat in sample and its depth in drill hole	Percent ash of the fraction of sample used for trace element determination	pH
13	CC-78-31A	Reed-sedge at 5 ft depth	2.8	4.9
	CC-78-32	Reed-sedge at 9 ft depth	4.0	5.5
15	CC-78-31	Reed-sedge at 5 ft depth	5.8	5.2
16	CC-78-14	Sphagnum at 5 ft depth	1.3	4.7
	CC-78-15	Sphagnum at 5 ft depth	1.0	4.5
	CC-78-16	Sphagnum at 5 ft depth	2.7	4.6
17	CC-78-17	Sphagnum at 5 ft depth	3.2	4.6
	CC-78-18	Sphagnum at 5 ft depth	3.8	5.0
	CC-78-19	Reed-sedge at 5 ft depth	12.1	5.1
18	CC-78-21	Sphagnum at 5 ft depth	0.6	4.6
	CC-78-22	Reed-sedge at 22 ft depth	19.5	5.0
19	CC-78-33	Reed-sedge at 5 ft depth at contact with olive gray clay	63.1	5.4
20	CC-78-10H	Sphagnum at 5 ft depth	0.9	4.7
	CC-78-11	Reed-sedge at 9 ft depth	4.0	5.6
	CC-78-12	Reed-sedge at 13 ft depth	11.5	-
	CC-78-13	Sphagnum at 5 ft depth	1.2	4.6
21	CC-78-20	Sphagnum at 5 ft depth	0.7	4.5

Table 3. Fuel analyses of the samples from 20 bogs shown on index map, figure 1.

Bog No.	Sample Identification	Heating value (BTU/lb.)	Proximate analysis (dry basis)			Ultimate analysis (dry basis)				
			Volatile matter(%)	Fixed carbon(%)	Ash (%)	Hydrogen (%)	Carbon (%)	Nitrogen (%)	Sulfur (%)	Oxygen (%)
1	CC-78-41	9854	65.8	31.3	2.9	5.3	58.2	1.7	0.2	31.6
	CC-78-42	9878	67.3	28.6	4.1	5.4	56.9	1.3	0.2	32.2
2	CC-78-43	10224	72.2	26.8	1.0	6.1	58.0	1.6	0.2	33.3
3	CC-78-40	7921	56.0	22.0	22.0	4.4	46.3	2.3	0.9	24.2
4	CC-78-8	10408	70.3	27.3	2.4	6.0	60.3	1.5	0.2	29.7
	CC-78-9	9802	72.5	26.5	1.0	5.8	56.4	1.2	0.1	35.5
	CC-78-10	9946	65.6	30.4	4.0	5.3	58.2	2.0	0.5	30.0
5	CC-78-38	9608	70.6	27.9	1.5	5.6	56.0	1.4	0.2	35.3
	CC-78-39	9704	64.5	30.0	5.5	5.1	57.6	1.7	0.5	29.7
6	CC-78-34	5402	38.0	14.5	47.5	3.2	30.6	1.6	0.5	16.6
	CC-78-35	4581	32.2	13.7	54.1	2.6	26.6	1.4	0.4	15.0
7	CC-78-36	8997	74.1	25.2	0.7	5.4	53.7	0.9	0.1	39.3
	CC-78-37	9658	71.2	27.6	1.2	5.7	56.5	1.2	0.1	35.2
8	CC-78-26	9520	71.4	27.5	1.1	5.7	56.3	0.9	0.2	35.8
9	CC-78-27	9838	71.8	26.9	1.3	5.8	57.1	1.8	0.2	33.8
10	CC-78-28	9082	71.4	27.3	1.3	5.3	53.3	0.9	0.1	39.1
	CC-78-29	9348	63.0	28.8	8.2	5.0	55.3	2.4	0.4	28.6
11	CC-78-30	9053	70.6	28.8	0.6	5.3	54.6	0.8	0.2	38.6
12	CC-78-23	9737	65.1	29.9	5.0	5.2	57.1	1.7	0.2	30.8
	CC-78-24	9405	65.7	29.2	5.1	5.1	55.3	1.9	0.6	32.0
	CC-78-25	9327	64.3	29.5	6.2	4.8	56.2	1.6	0.6	30.5
13	CC-78-31A	9478	64.7	30.0	5.3	5.0	56.1	2.4	0.9	30.4
	CC-78-32	9792	67.2	29.6	3.2	5.4	57.4	1.7	0.5	31.7
15	CC-78-31	9840	68.8	29.5	1.7	5.5	58.4	1.1	0.2	33.1
16	CC-78-14	9231	72.2	26.8	1.0	5.4	55.1	1.0	0.2	37.3
	CC-78-15	9463	69.7	28.8	1.4	5.5	57.1	1.0	0.2	34.7
	CC-78-16	9941	68.3	29.7	2.0	5.3	57.9	1.7	0.2	32.9
17	CC-78-17	9573	63.9	32.1	4.0	5.0	57.0	1.6	0.4	32.1
	CC-78-18	9719	64.9	31.6	3.5	5.0	56.9	1.7	0.2	32.6
	CC-78-19	9268	63.2	28.8	8.0	4.9	54.3	2.1	0.4	30.4
18	CC-78-21	9208	71.7	27.4	0.9	5.4	55.3	0.8	0.2	37.4
	CC-78-22	7859	54.8	22.7	22.5	4.6	45.0	2.4	0.8	24.7

Table 3 (cont'd)

Bog No.	Sample Identification	Heating value (BTU/lb.)	Proximate analysis (dry basis) Volatile matter(%)	Fixed carbon(%)	Ash (%)	Ultimate analysis (dry basis) Hydrogen (%)	Carbon (%)	Nitrogen (%)	Sulfur (%)	Oxygen (%)
19	CC-78-33	7671	54.0	21.1	24.9	4.5	44.2	2.5	1.2	22.8
20	CC-78-10H	9207	73.1	25.9	1.0	5.5	55.1	0.8	0.2	37.4
	CC-78-11	9637	65.3	28.4	6.3	5.0	57.4	1.6	0.3	29.5
	CC-78-12	9120	62.8	25.7	11.5	4.8	53.8	2.9	0.9	26.0
	CC-78-13	9226	68.6	30.2	1.2	5.3	56.3	0.8	0.1	36.3
21	CC-78-20	8895	72.6	26.7	0.7	5.4	53.8	0.6	0.2	39.3

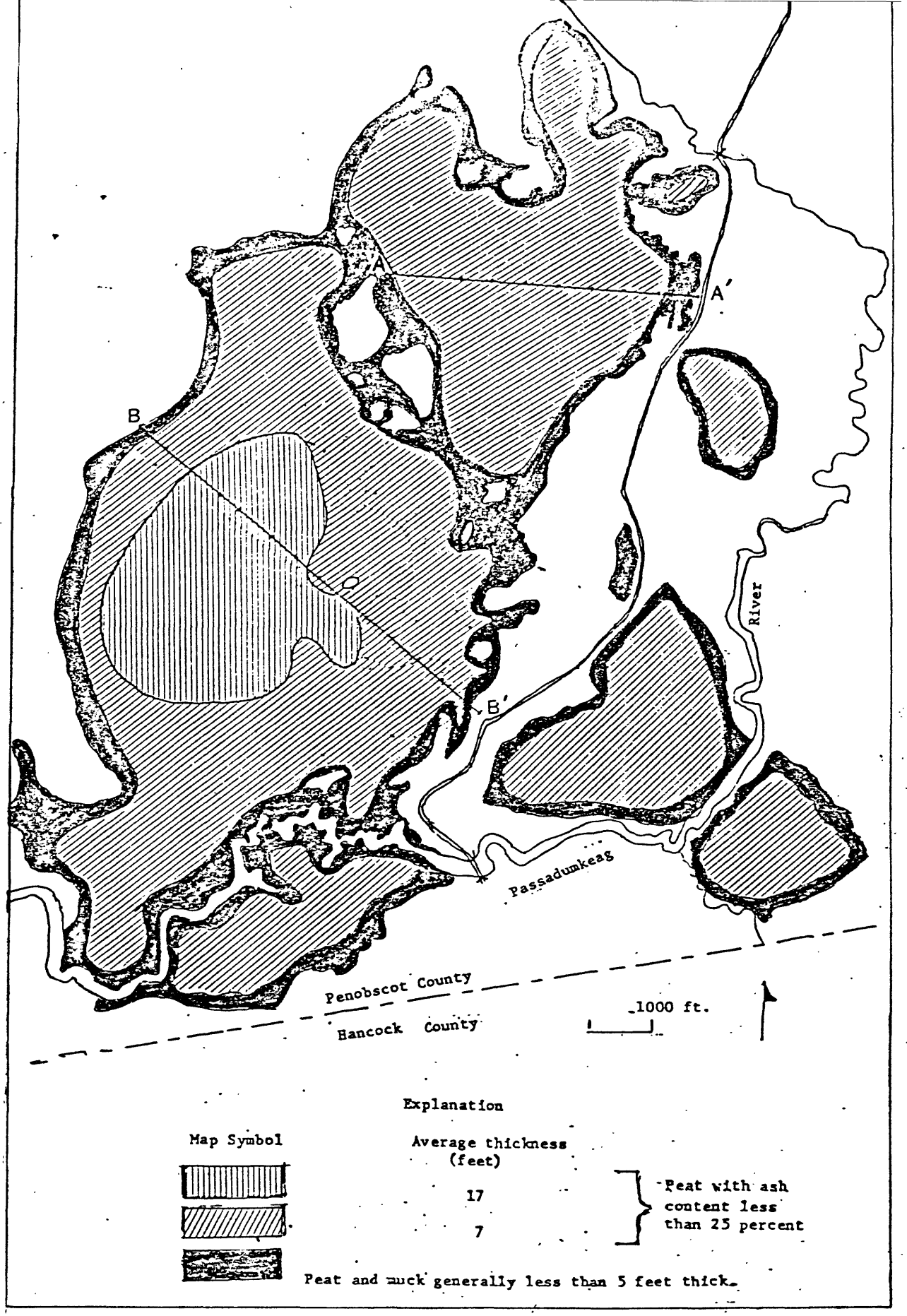

Figure 2.--Sketch map of Thousand Acre Heath (No. 4 on index map) showing extent and average thickness of commercial quality peat.

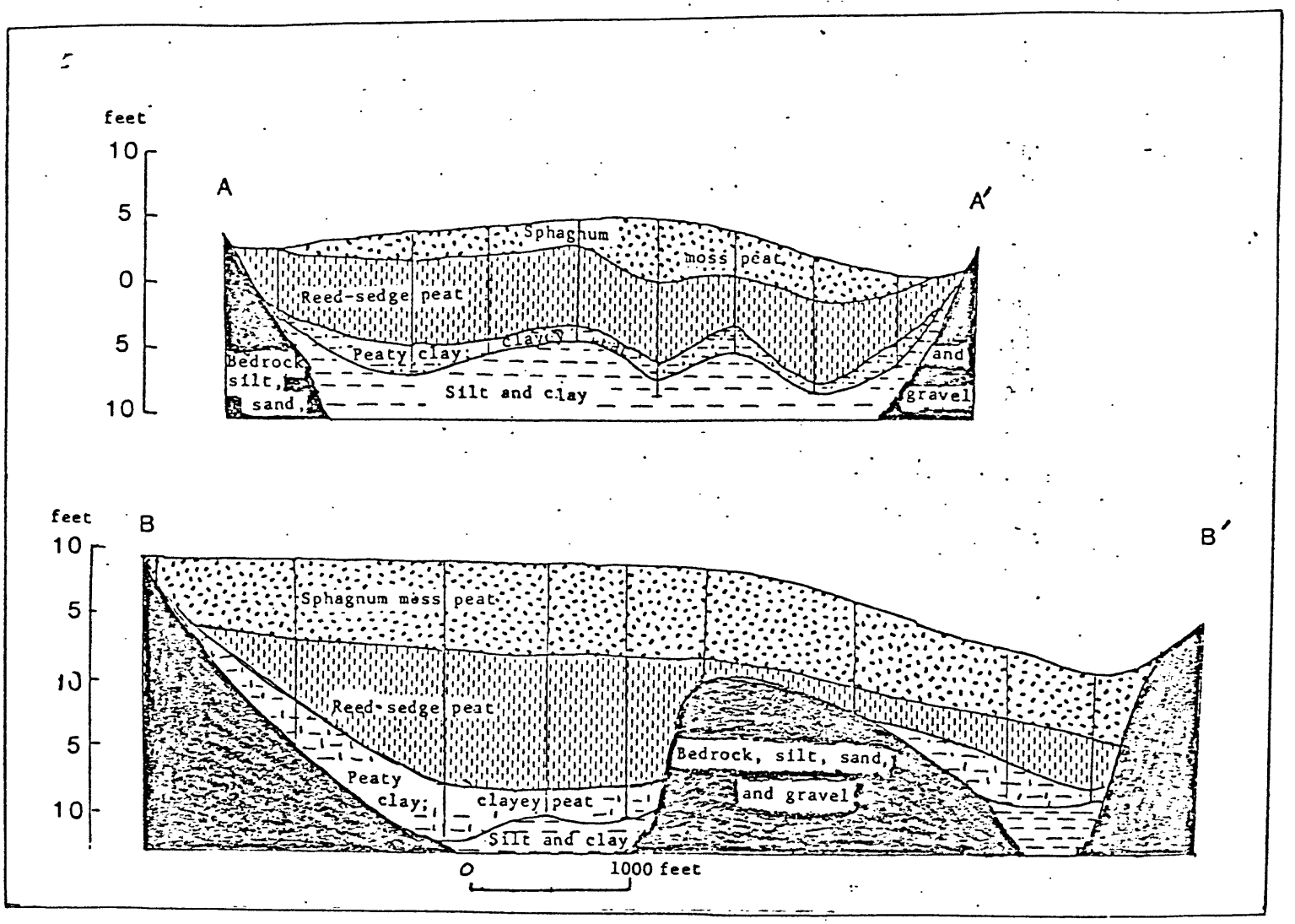

Figure 2a.--Profiles A - A' and B - B', Thousand Acre Heath

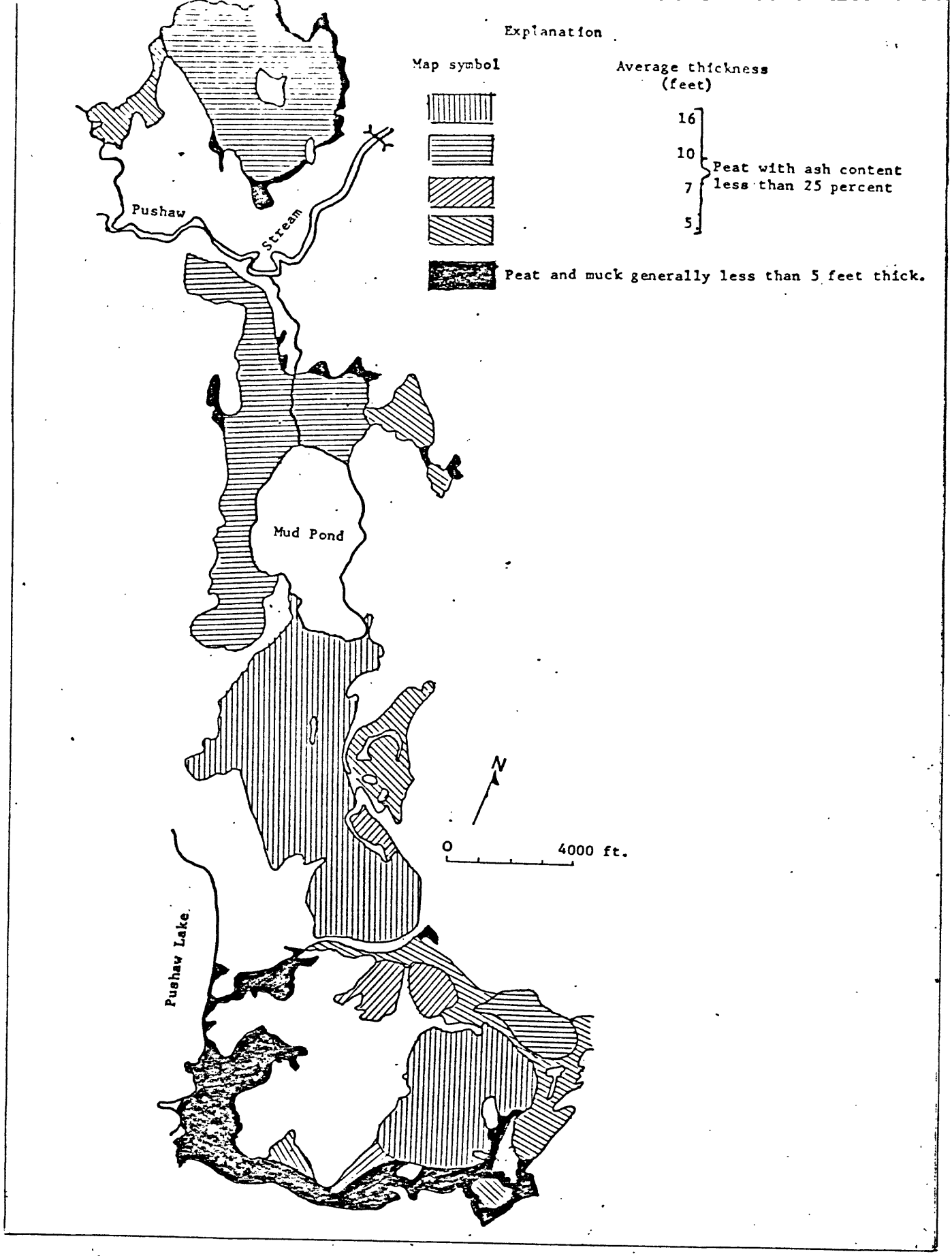

Figure 3.--Sketch map of Caribou Bog (No. 16) on index map) showing extent and average thickness of commercial quality peat.

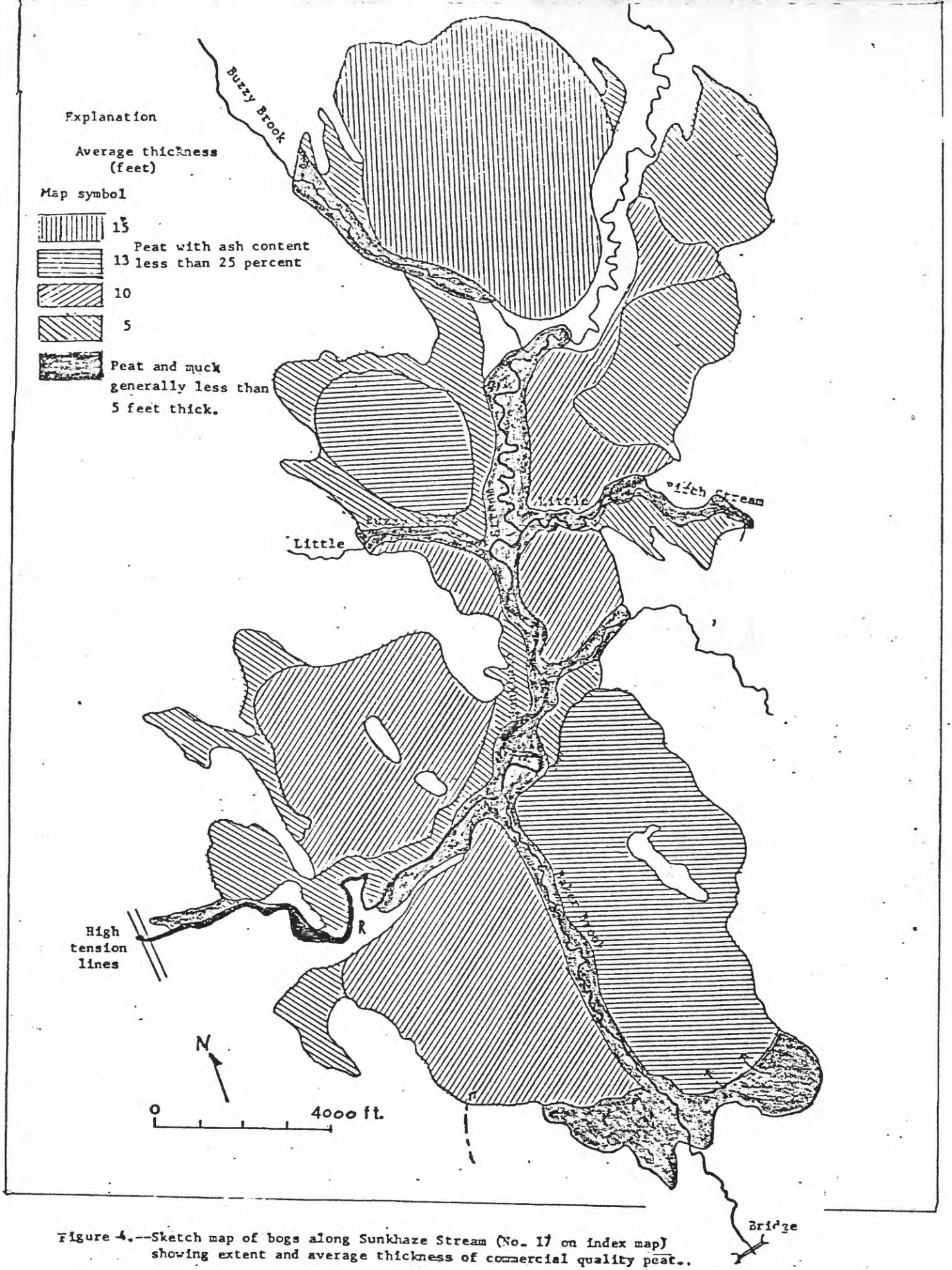

Figure 4.--Sketch map of bogs along Sunkhaze Stream (No. 17 on index map) showing extent and average thickness of commercial quality peat.

Figures 5 and 6 near here.

are examples of varying thicknesses within large bog complexes. Although average thicknesses are mapped, maximum thicknesses of commercial quality peat may reach 20 to 25 feet.

Resources

The resources of commercial quality peat in the 21 deposits augered and sampled in Penobscot County are estimated at 29,282,000 short tons air-dried peat (table 1). The location of each deposit is shown on the index map, figure 1. Those numbered 1, 5, and 7 contain between one and two million tons air-dried peat. Thousand acre Heath (number 4) contains two to three million tons, and Caribou Bog, number 16 and the Sunkhaze Stream complex, number 17, each contain more than 6,000,000 tons air-dried peat.

These resources are high quality sphagnum moss and reed-sedge peat with very low ash content. Most have less than 10 percent ash and many have less than 5 percent; pH is mostly between 4 and 5 as shown by analyses of samples (table 2).

These resources not only are valuable from an agricultural and horticultural standpoint, but are also worth investigating for their fuel potential. Heating values as well as proximate and alternate analyses for volatile matter, fixed carbon, ash, and percents of hydrogen, carbon, nitrogen, sulfur and oxygen for samples representing the 29,282,000 tons air-dried peat of commercial quality are shown in table 3 and averages of the Maine peat samples are compared with averages of lignite and sub-bituminous coal (table 4). The BTU of the peat is not substantially lower in comparison. Salient features are low sulfur content of the peat and high hydrogen content compared with lignite and sub-bituminous coal. The low sulfur is favorable to air quality standards, and the high hydrogen favors gasification because less hydrogenization is required.

Table 4. Analyses of Penobscot County, Maine peat samples compared with lignite and subbituminous coal samples. All data is reported on a "dry" basis.

	BTU/lb.	Volatile matter	Fixed carbon	Ash	Hydrogen	Carbon	Nitrogen	Sulfur	Oxygen
Maine peat	9401.08	67.20	28.09	4.84	5.27	55.40	1.54	0.35	32.60
Average of 36 samples from bogs 1-5, 7-13, and 15-21 (see index map, figure 1)									
Lignite 1/	10765.19	41.76	46.73	11.51	4.35	64.97	1.07	1.00	18.66
Average of 709 samples mostly from North Dakota and NE Wyoming									
Subbituminus coal 1/	12374.82	40.88	51.20	7.94	4.91	70.30	1.38	0.75	15.00
Average of 4028 samples from the Rocky Mountain area									

1/ U.S. Bureau of Mines analyses obtained from the U.S. Geological Survey National Coal Resources Data System

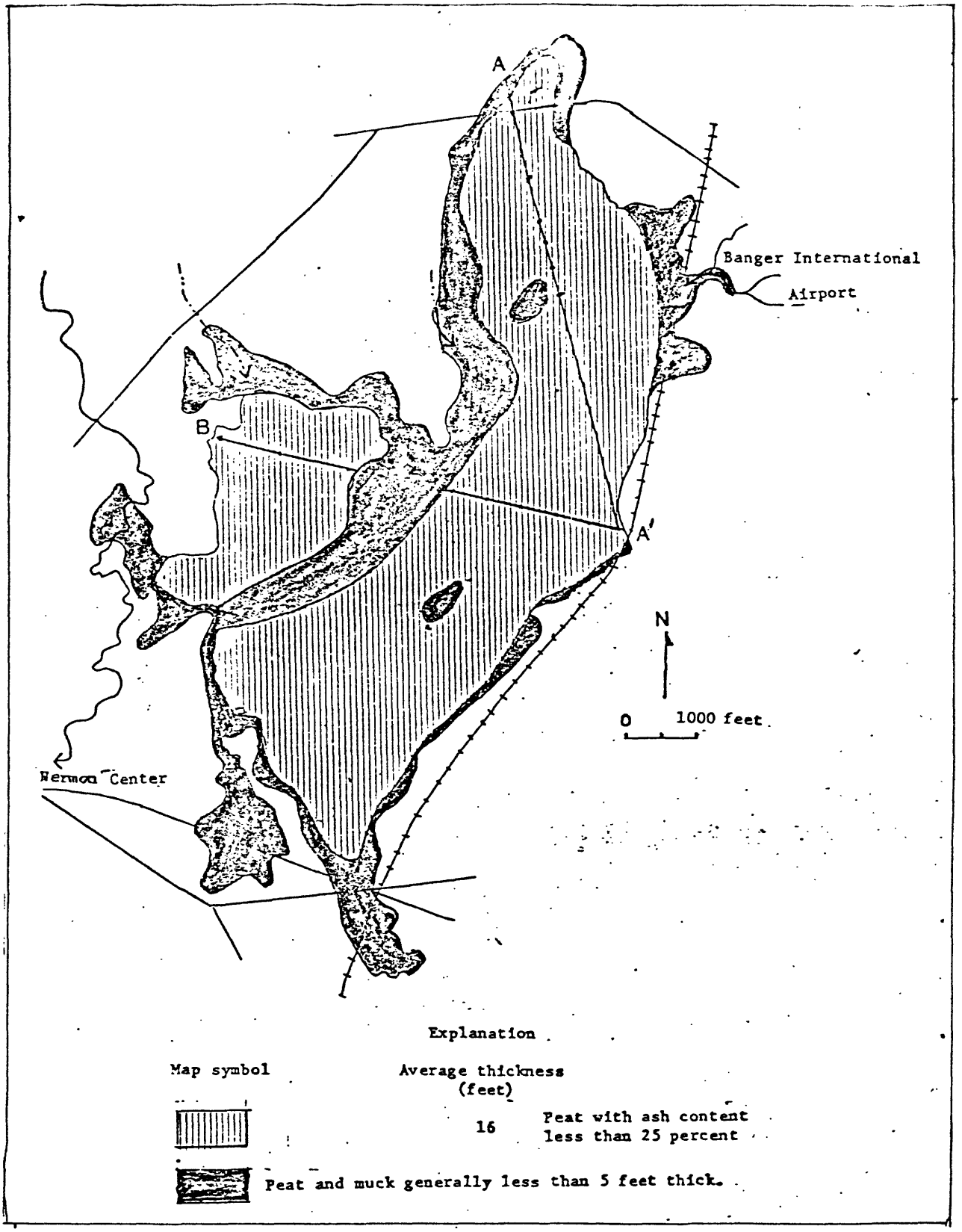

Figure 5.--Sketch map of Hermon Bog (No. 20 on index map) showing extent and average thickness of commercial quality peat.

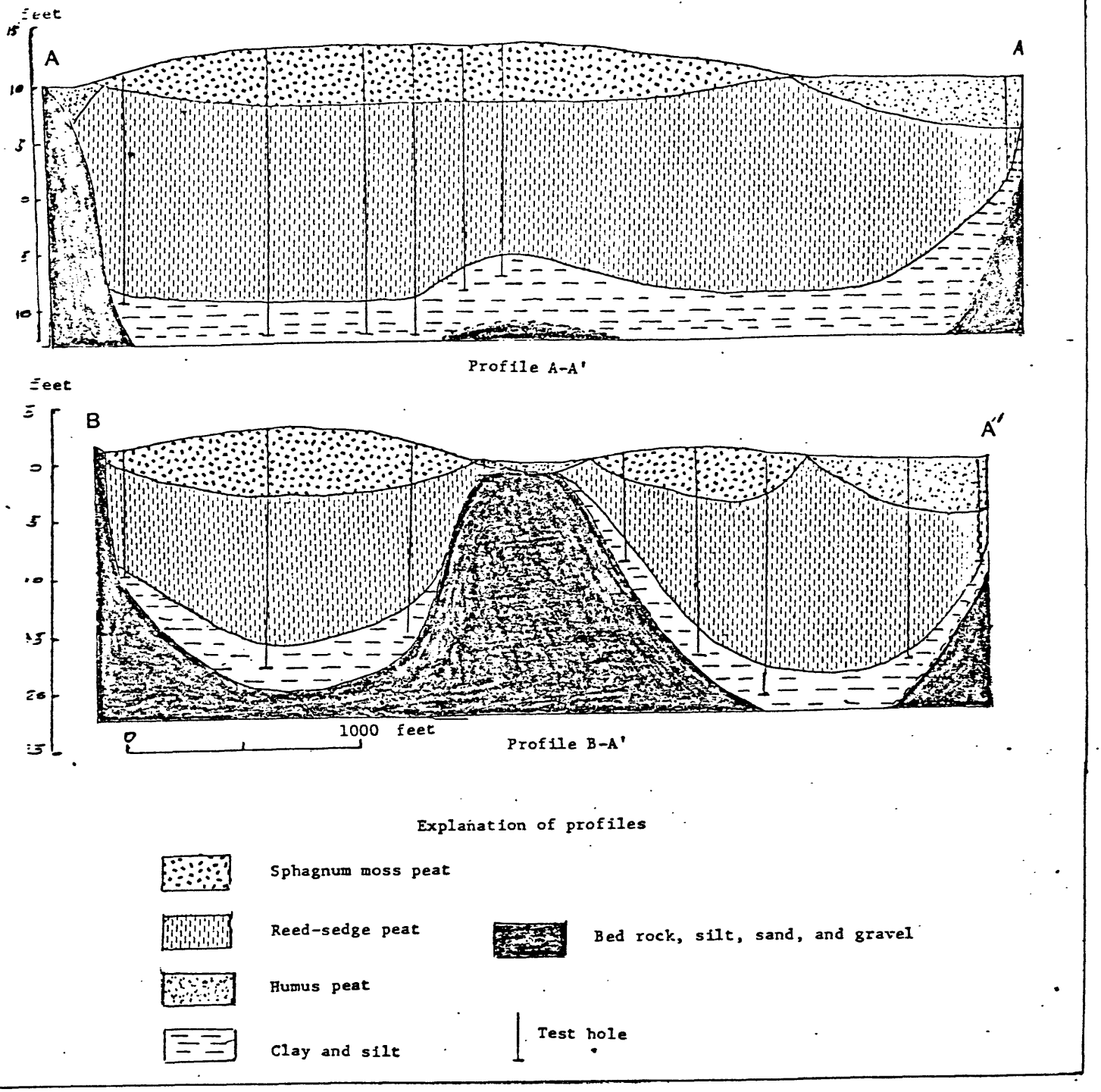

Figure 5a.--Profiles A - A' and B - B', Hermon Bog.

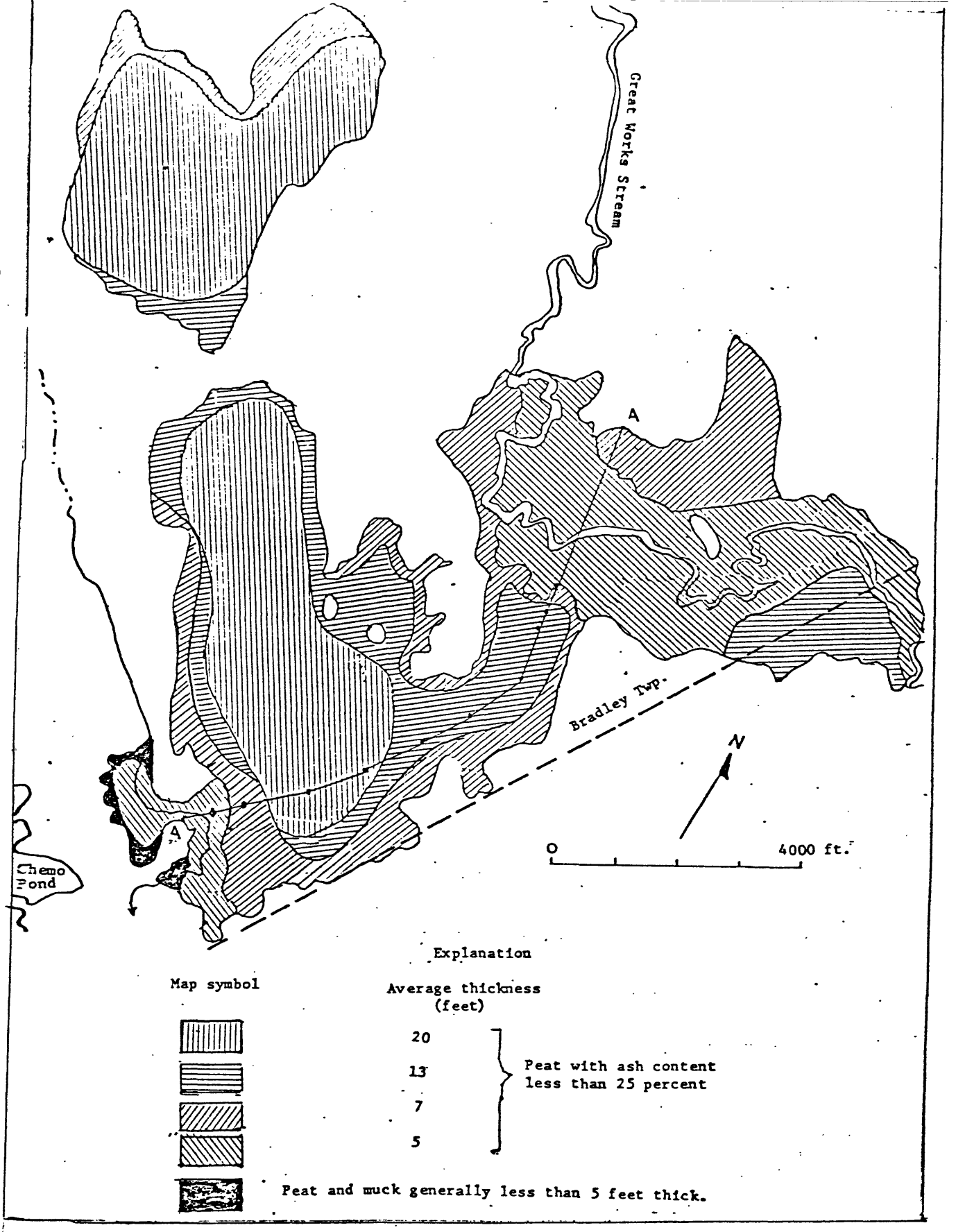

Figure 6.--Sketch map of Chemo Bog (No. 21 on index map) showing extent and average thickness of commercial quality peat.

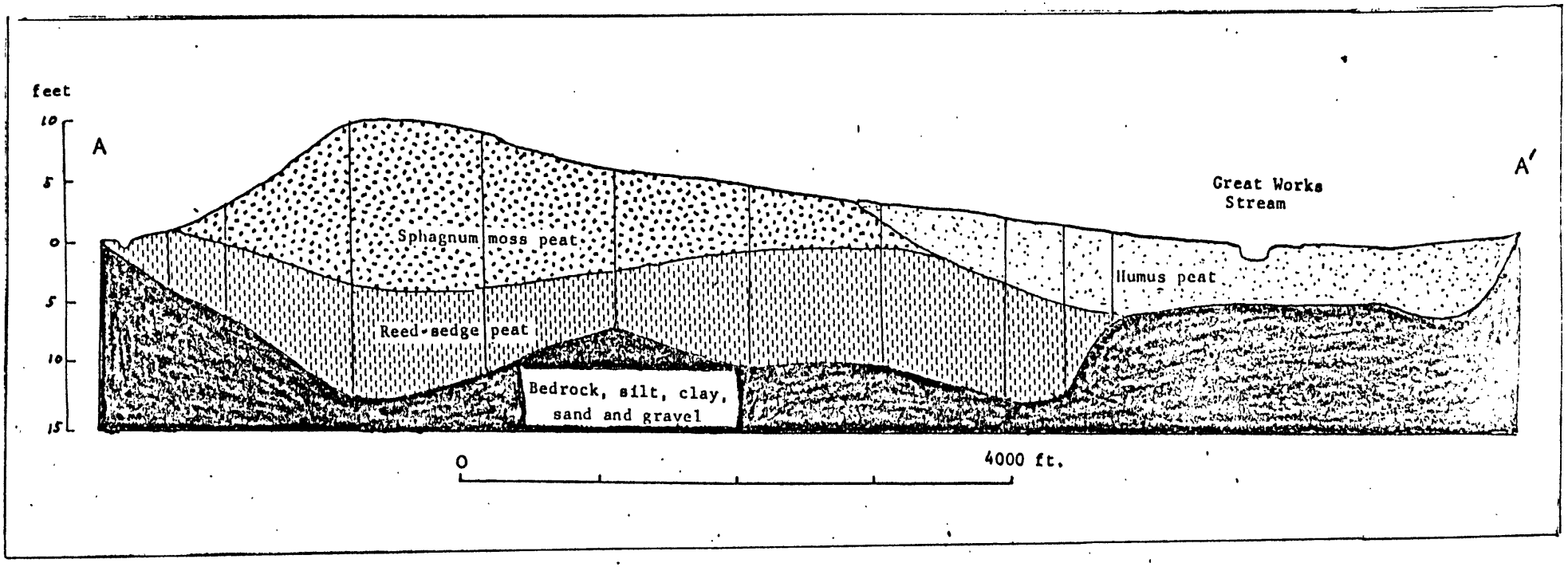

Figure 6a.--Profile A - A' Chemo Bog.

Trace elements

Trace element determinations were made on the ash fractions of the 37 samples from the 20 deposits containing commercial quality peat. Amounts of each trace element were computed on a whole sample basis for comparison. Figure 7 shows parts per million of chromium, nickel, copper, lead, and zinc

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Figure 7 near here.

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in graphs which isolate samples with anomalies of each element. Anomalous samples are identified in table 5 and related to specific bogs located in table 1 and on the index map. Differences in amounts of the several metallic elements exist in samples and bogs which point to areas in Penobscot County where bedrock and geophysical data may prove valuable correlations necessary in establishing geochemical prospecting tools.

The amount of Cu, Pb, Zn, and Cr in the peat samples shown in table 5 may be compared with amount of these elements in living moss tissue collected at two Canadian sites (table 6). The peat samples contain appreciably more Cu, Zn, and Cr than the living moss. The Pb content of one peat sample far exceeds the Pb content of the living moss. Possibly, ground water laden with high metal content derived from metal-rich rocks entered the bogs (listed in Table 5) during various stages of their development.

Table 5. Bogs and samples containing the greatest amount of Cu, Pb, Zn, Ni, and Cr based on analyses of 37 samples from 20 bogs.

Numbered bog (see index map, fig. 1	Sample Identification	Elements and their ppm anomalies (Computed for whole peat sample) Cu	Pb	Zn	Ni	Cr
1	CC-78-43	80				
3	CC-78-40			88		20
4	CC-78-9	67				
6	CC-78-34		8		38	58
	CC-78-35		9			42
9	CC-78-27	916	158	391	81	77
10	CC-78-28	267	20	112		
13	CC-78-32				96	
16	CC-78-15	65		>190		
	CC-78-16	73				
18	CC-78-22	63	8	102		20
19	CC-78-33	56	14	156	75	59

Table 6. Cu, Pb, Zn, and Cr in living moss from two sites in Canada (after Glooschenko, W.A. and Capobianco, J.A., 1978).

Site	Cu (ppm)	Pb (ppm)	Zn (ppm)	Cr (ppm)
Kinoje Lake	12-15	19-32	34-40	1.8-4.6
Ontario Canada	14 average	23 average	37 average	3.5 average
Porter Lake	13-15	5-8	24-51	2.1-3.6
Northwest Territories Canada	13 average	7.1 average	45 average	2.8 average

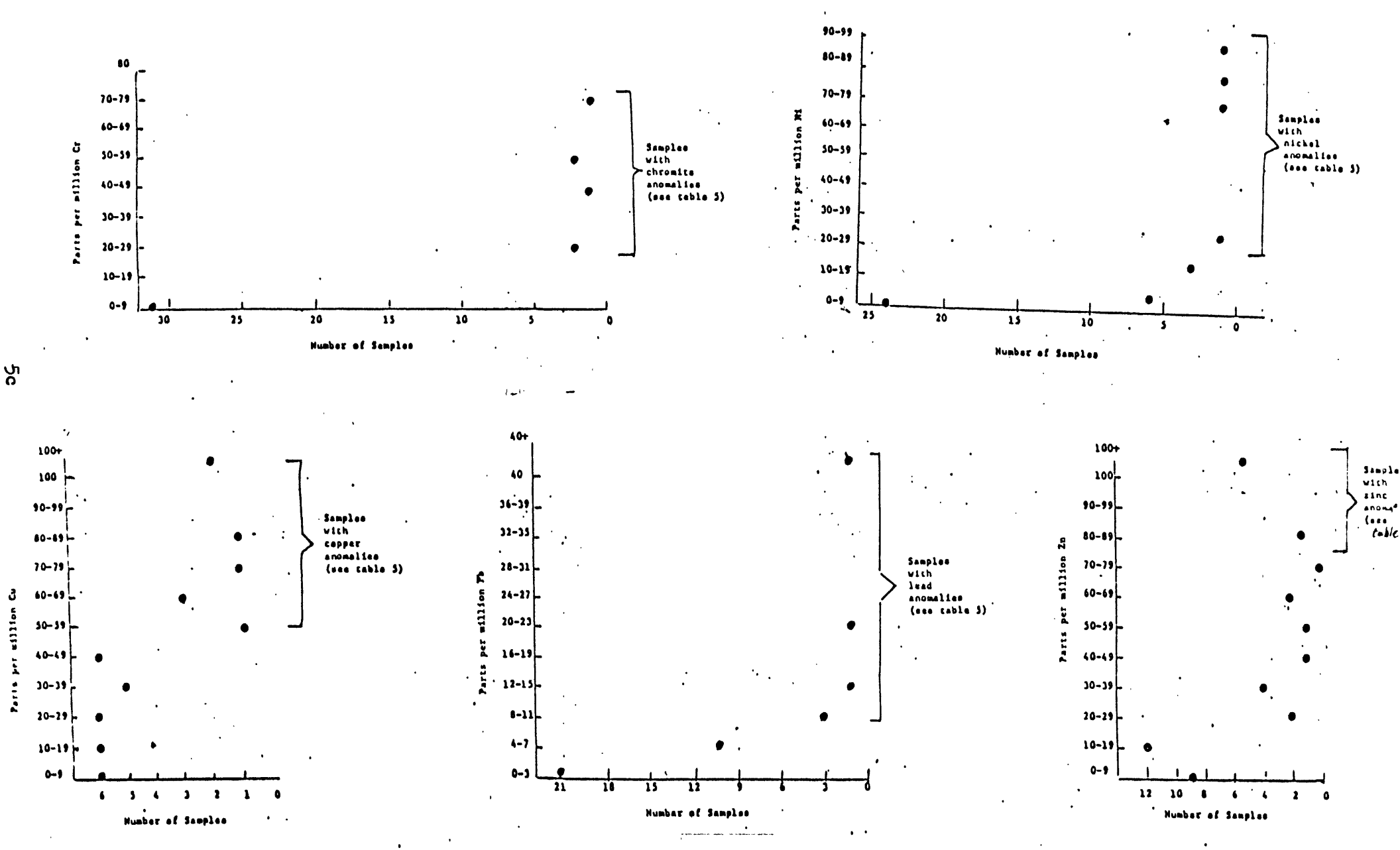

Figure 7. Parts per million computed on whole peat sample basis of chromium, nickel, copper, lead, and zinc in 37 samples from 20 peat bogs in Penobscot County, Maine (see index map, fig. 1).

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