PEAT DEPOSITS OF LIGHT GROUND POCOSIN, PAMLICO COUNTY, NORTH CAROLINA

Prepared for
North Carolina Energy Institute
and
U.S. Department of Energy

by
Roy L. Ingram and Lee J. Otte
Department of Geology, University of North Carolina
Chapel Hill, N.C. 27514

June 1980

ABSTRACT

The Light Ground Pocosin peat deposit is located in south central Pamlico County, 13 miles east of New Bern. Except for a narrow channel 8 to 12 feet deep, and two small areas of thin peat over highs on the sub-peat surface, the peat lies in a broad shallow depression and increases in thickness to about 7 feet in the center. The deposit occupies an area of 5930 acres and has a total of 5.171 million tons of moisture-free peat. The peat, greater than 4 feet thick, occupies an area of 2790 acres and has 3.478 million tons of dry peat.

The peat lies just to the east of the Arapahoe sand ridge - Suffolk Scarp. The normal surface elevation in the area around the peat (the Pamlico terrace or surface) is 15 to 20 feet; however, the surface of the peat is a broad dome reaching an elevation of over 20 feet.

Two main types of peat are present:

(1) a brown, decomposed fibrous peat usually restricted to the infilled channel, and (2) a black, fine-grained, highly decomposed humic peat. Stumps and logs of white cedar and cypress are common throughout the black peat.

The moisture content increases with depth from an average of 74% in the top foot to 90% at 9 feet. The bulk density increases from about 180 tons of dry peat per acre-foot in the top foot to 270 tons at 3 feet and then decreases to 125 tons at a depth of 9 feet. Within the main body of the peat the ash content is almost always below 10% and is usually below 5%; and the heating value ranges from 9,800 to 10,900 btu/lb with a median of 10,500. The nitrogen content ranges from 0.9 to 2.0% with a median of 1.4%. The sulfur content ranges from 0.2 to 0.3% with a median of 0.2%.

CONTENTS

I. INTRODUCTION

A. Location

The Light Ground Pocosin peat deposit is located in south central Pamlico County, 13 miles east of New Bern (Fig. 1). The entire peat deposit is on the Arapahoe 7½' topographic and orthophotographic quadrangles. The pocosin is bounded by N.C. Highway 306 on the west, N.C. 55 on the north and east, and County Road 1005 on the south. Access to the pocosin is by means of several private roads connected to the roads listed above. The towns of Alliance, Bayboro, and Stonewall are just north of the deposit.

B. Methods

1. Field Methods

Soils maps were used as quides in locating potential peat deposits. All areas mapped as histosols (organic soils) were investigated. As the soils scientists define a histosol as a soil containing more than 30% organic matter, a histosol may or may not be a peat (greater than 75% organic matter).

In areas where peat was found, samples were taken at one-foot vertical intervals using a Davis peat samplier, a Macaulay peat sampler, or a screw auger from the surface down into the underlying mineral sediment. Samples were taken at 97 locations.

At selected sites, larger samples (about 1 pint) were taken for proximate and ultimate chemical analyses and for heating value determinations. At other selected sites samples of known volumes were taken with the Macaulay sampler for bulk density determinations.

FIG. 1.-- Index map showing location of Light Ground Pocosin Peat deposit, Pamlico County, North Carolina. Thickness of peat shown in 4 foot intervals.

2. Laboratory Methods

The moisture and ash contents of nearly all samples were determined by heating about 10 grams in a crucible at 105°C for at least 16 hours and by heating at 550°C until all organic material was burned (about 1 hour).

Samples for bulk density determination (dry weight per unit volume) were collected with a Macaulay sampler with an inside diameter of 1 5/8 inches (4.13 cm). One-foot sections of the Macaulay cores (199 cc) were placed in pre-weighed containers and then heated at 105°C to constant weight (about 3 days).

Proximate analyses (moisture, volatile matter, fixed carbon, and ash), ultimate analyses (carbon, hydrogen, oxygen, nitrogen, and sulfur), and heating value (btu/lb) were made by the Coal Analysis Laboratory, U.S. Department of Energy, Pittsburgh, Pennsylvania.

II. TOPOGRAPHY AND DRAINAGE

Just west of the peat deposit is the north-south trending Arapahoe sand ridge (Fig. 2) (Daniels and others, 1977) with an elevation of 40 to 50 feet. The eastern front of the sand ridge is the Suffolk scarp with a toe elevation of about 20 feet. East of the Suffolk scarp the Pamlico surface slopes gently eastward to an elevation of 15 feet east of the peat. The surface of the peat, however, rises as a broad dome above the Pamlico surface reaching an elevation of over 20 feet. The area of the peat is a true pocosin (Indian word for "swamp-on-a-hill".

Before the digging of ditches and canals, the drainage of the peatlands was very poor. No natural streams penetrate the peat. Before man water pro-

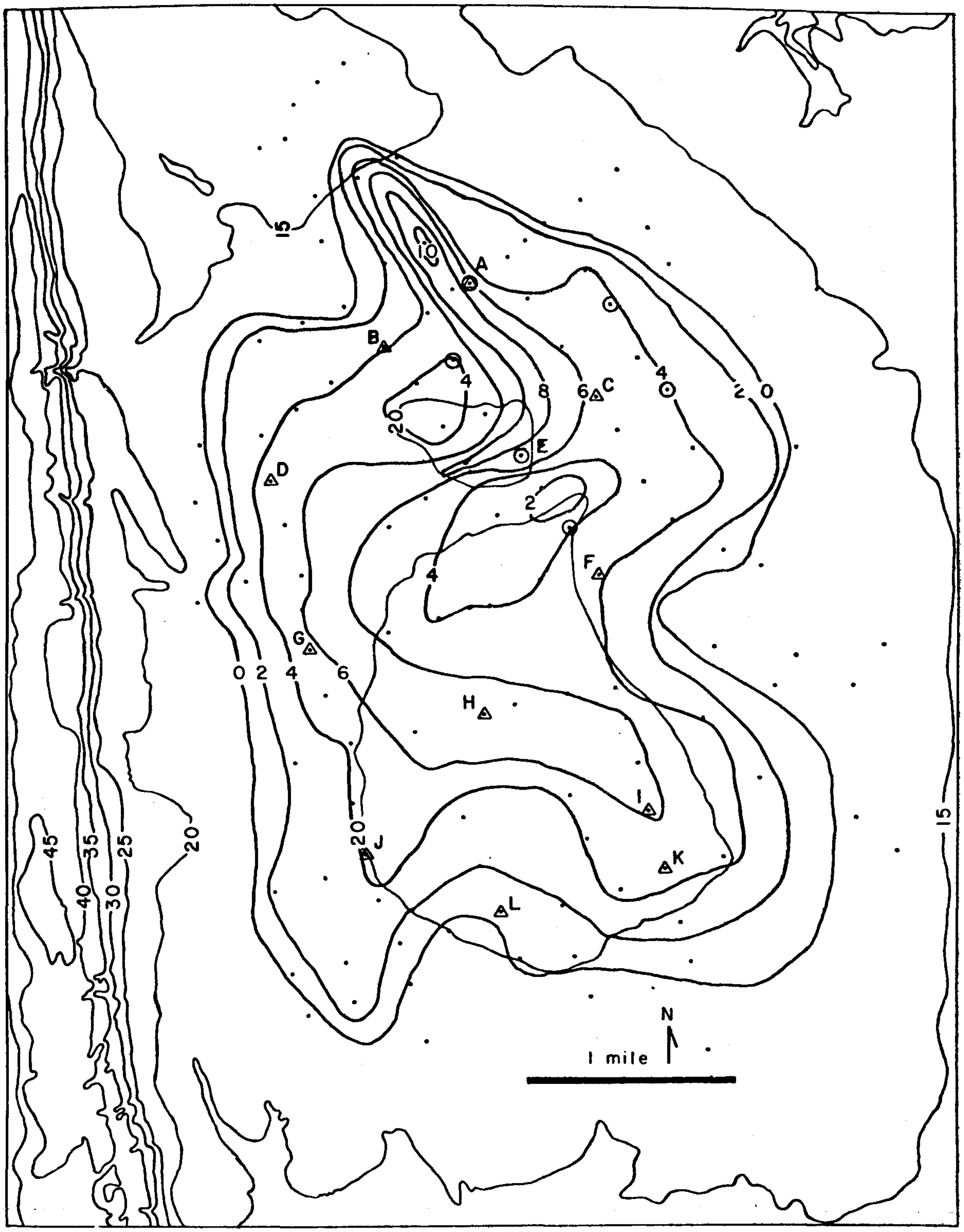

FIG. 2.-- Isopach map of peat, and topography of area. The thickness of the peat is shown by heavy lines (isopach interval of 2 ft.). The light lines are contour lines (contour interval of 5 ft.). Sites samples are indicated by dots. Sites samples for chemical analyses are marked by triangles. Sites sampled for bulk density are marked by triangles.

bably drained down the Suffolk scarp and then percolated very slowly into the minor creeks to the north, east, and south.

Approximately 35 miles of drainage ditches and canals now dissect the Light Ground Pocosin. Almost all cut through the peat into the underlying mineral sediments. The ditches were dug at varying times. Modifications in vegetation patterns along the ditches show that drainage is increasing the rate of water outflow and is lowering the water table in the immediate vicinity of the ditches.

III. VEGETATION

Before drainage canals were dug in the pocosin most of the area underlain by two or more feet of low ash peat had the water table at the ground surface, and was covered by a low pocosin ecosystem with shrubs from two to four feet high, pond pines (*Pinus serotina*) from 10 to 15 feet high, and an almost continuous sphagnum mat up to one foot thick. The low pocosin shrubs consist of varying mixtures of *Ilex glabra*, *Lyonia lucida*, *Sorbus arbutifolia*, *Kalmia angustifolia*, *Cassandra calyculata*, and *Zenobia pulverulenta*. Along the outer fringes of the Light Ground Pocosin, where the peat is less than two feet thick or the sediment is only peaty sand, the vegetation is either pond pine woodland or pond pine forest. Both contain 25 to 30 feet tall pond pines and a solid mass of 10 feet tall shrubs dominated by varying mixtures of *Lyonia lucida*, *Cyrilla racemiflora*, *Ilex glabra*, *Myrica cerifera*, and *Vaccinium arboreum*. A pond pine woodland contains an open canopy of pond pine, while a pond pine forest has a closed canopy and a slight thinning in the density of the shrub undergrowth. *Persea borbonia* (red bay), *Magnolia virginiana* (sweet bay), and *Gordonia lasianthus* (loblolly bay) are found scattered throughout the pocosin. These three species range in size from short trees up to 30 feet tall in the woodland and forest and along drainage canals to small shrubs about 2 feet high in low pocosins.

Disturbance by man, in the form of drainage canals and canal maintenance roads, has modified the vegetational pattern of the Light Ground Pocosin. Canal maintenance roads and adjacent strips of disturbed land have provided a substrate that is drier and better drained than the surrounding peatland. This substrate allows a variety of species not typical of pocosin habitats to become established, including *Andropogon virginicus*, *Rubus hispidus*, and others. Thus far, however, these species are restricted to the disturbed sites and are not invading the natural pocosin ecosystem.

Improved drainage in the pocosin, at least in the immediate vicinity of the canals, has produced localized changes in vegetation; and the older the canal, the more profound the change. The drawdown of the water table in the immediate vicinity of a canal, and whatever other environmental factors accompany this drawdown, commonly allow local shrubs and pines to more than double their height and often results in a change in shrub species dominants.

The west, south, and east border of the pocosin is underlain by a saturated, clayey sand on which grows a hardwood forest dominated by mixtures of *Acer rubrum*, *Liquidambar styraciflua*, and *Nyssa sylvatica*. In both the northeast corner and in the southwest corner of the pocosin, approximately one square mile of shallow peat and peaty sand is now under cultivation. Active clearing will eliminate an additional one or two square miles of peat in the next several years.

IV. PEAT RESOURCES

A. Nature and Origin of the Peat

Following the retreat of the sea that formed the Arapahoe sand ridge and the Suffolk scarp, a broad shallow depression on the old sea floor was exposed. This depression was dissected by stream erosion resulting in a channel being cut across the shallow depression (Fig. 2). Initial peat development began in a blocked, northward flowing stream that appears to have been the original headwaters of the South Prong of Bay River. As this peat-filled channel is followed northward out of the pocosin, the peat becomes sandier; and the peat is eventually lost in an area of peaty sand. The origin of this blockage is unknown, but Whitehead and Oaks (1979) suggest the possibility of beaver dams for similar blockages in the Dismal Swamp.

Two main types of peat are present:

(1) a brown, decomposed fibrous peat usually restricted to the infilled stream channel, and (2) a black, fine-grained, highly decomposed humic peat. The fibrous peat, which appears to have been formed from an assortment of aquatic vegetation, grades upward and outward into the black peat. Near the top of the brown peat is found a distinctive stump layer. This level of stumps marks the stage when the channel became filled with peat, and the flooding of the low-lying adjacent area began. This flooding created a large, flat wetland on which a swamp forest became established. The presence of cypress and white cedar logs and stumps throughout the black peat to within a foot of the present surface indicates that most of the peat did indeed form

in a forested swamp. The change from this cypress-cedar forest to the present pond pine-mixed shrub pocosin was late in the overall history of the development of the peat deposit. The warm humid climate of the area has resulted in the peat vegetation becoming decomposed to highly decomposed. The vertical and lateral succession of peat types and vegetation is consistent with the model developed by Whitehead (1972) for the Dismal Swamp.

B. Bulk Density

In the calculation of the amounts of peat, the bulk density (weight of dry peat per unit volume) must be known. At 5 locations in the Light Ground Pocosin (Fig. 2), bulk densities were determined in triplicate for each one-foot interval to the base of the peat. When bulk density is plotted against the moisture content (Fig. 3), an almost linear relation is revealed with the bulk density going from about 130 tons/acre-foot at 90% moisture to about 300 tons/acre-foot at 80% moisture.

Unfortunately the total relationship between moisture content and bulk density is not this simple. Bulk density-moisture relations determined for all pocosin peats in North Carolina, although showing the same general linear relationship, have many points that fall below the curve (Fig. 4). Undoubtedly if more bulk density determinations had been made in the Light Ground Pocosin, this same more complex pattern would have been shown. Most of the points that fall below the curve are for near-surface (0 to 3 ft.) samples that have been drained of part of the water without concurrent compaction. Nevertheless, the moisture content is a very good measure of the bulk density, especially for samples from below the water table.

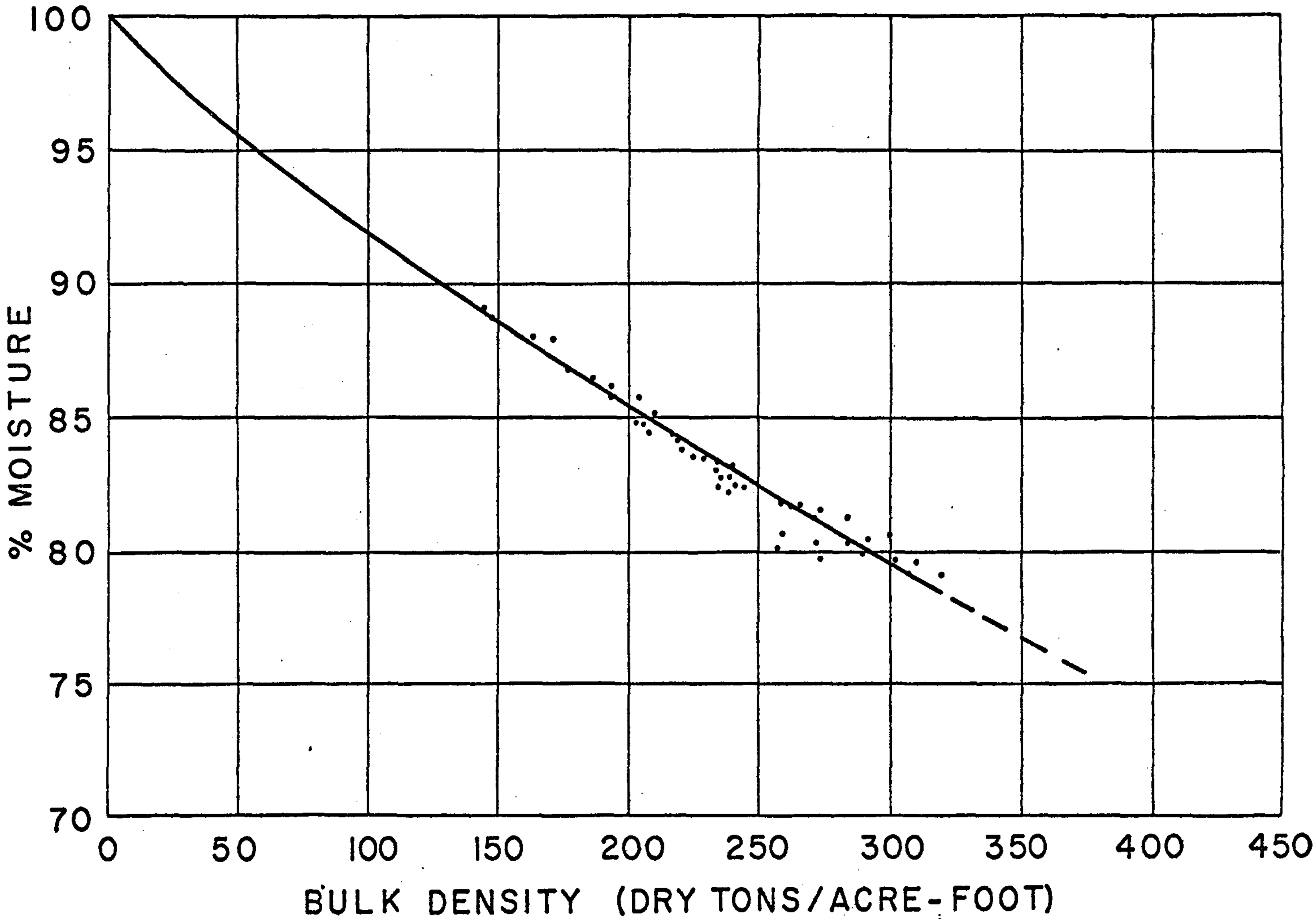

FIG. 3.-- Bulk density - moisture relation of Light Ground Pocosin peats.

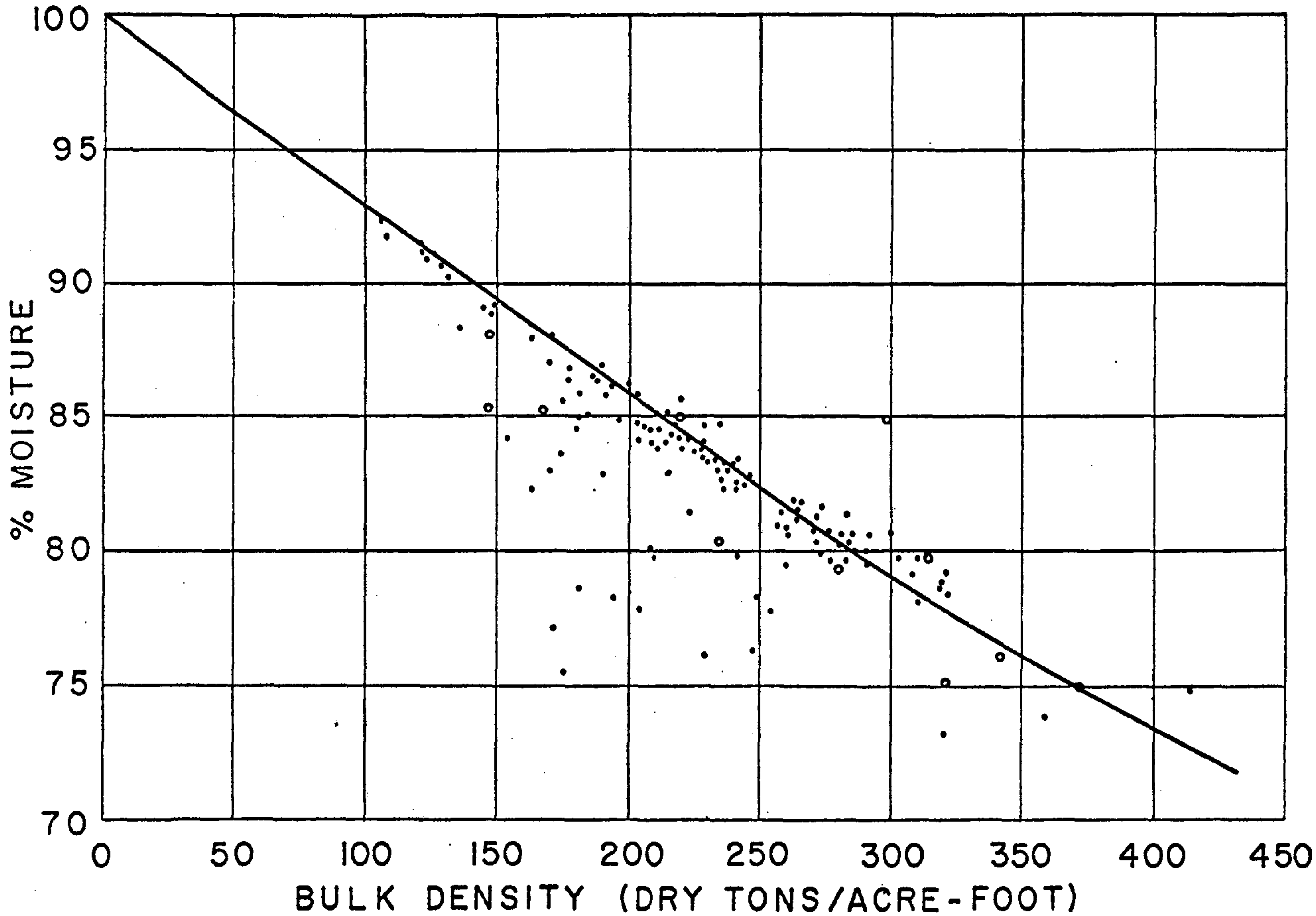

FIG. 4.-- Bulk density - moisture relation of all pocosin peats in North Carolina.

Table 1 shows how the bulk densities for calculating the weight of dry peat in the Light Ground Pocosin were determined. Column A shows the median bulk density in dry tons/acre-foot for all analyses (126) of pocosin peats for each one-foot interval. Column B shows the median bulk density for the 45 samples taken in Light Ground Pocosin. Column C shows the median moisture content of 332 samples for each one-foot interval, and Column D shows the bulk density corresponding to the moisture content read from the smooth curve on Figure 4. Column E is the best estimate of the bulk density of Light Ground Pocosin peats. Because peats in the upper 3 to 4 feet show erratic moisture-bulk density relations, more weight was given to the actual bulk density determinations. Below 4 feet it is believed that the moisture content is the best guide to the bulk density.

Bulk densities increase down to a depth of 3 to 4 feet, the zone of variable position of the water table, and decrease below 3 to 4 feet as the moisture content of the decomposed peat increases.

The bulk densities used in calculating tons of dry peat in Table 2 are the averages of the foot by foot bulk densities for the appropriate isopach intervals: 0-2 ft., 215 tons/acre-foot; 2-4 ft., 240 tons; 4-6 ft., 225 tons; 6-8 ft., 210 tons; 8-10 ft., 195 tons; 10-12 ft., 180 tons.

TABLE 1--Data for Determination of Bulk Densities of Light Ground Pocosin Peats

	A	B	C	D	E
Depth	Median Bulk Density all N.C. peats (126 samples)	Median Bulk Density Lt. Gr. Pocosin (45 samples)	Median H_2O Lt. Gr. Pocosin (332 samples)	Bulk Density Lt. Gr. Pocosin from H_2O-Density curve (Fig. 4)	Best Estimate Bulk Density Lt. Gr. Pocosin
ft.	tons/acre-foot	tons/acre-foot	%	tons/acre-foot	tons/acre-foot
0-1	180		74	390	180
1-2	240	270	78	320	250
2-3	260	270	80	285	270
3-4	235	235	80	270	250
4-5	210	205	84	225	220
5-6	170	170	87	185	180
6-7	120		87	185	180
7-8	120		89	155	150
8-9			90	140	140
9-10					125

C. Quantities of Peat

Figure 2 is an isopach map showing the variations in thickness of the peat. Except for a narrow channel 8 to 12 feet deep and two small thin areas over highs on the sub-peat surface, the peat lies in a broad shallow depression and increases in thickness from 0 feet at the margin to about 7 feet in the center.

Areas within each isopach interval were measured with a polar planimeter on a map of scale 1:24,000. Volumes and weights were calculated as shown on Table 2. The total deposit occupies an area of 5930 acres and has a total of 5.171 million tons of dry peat. The peat greater than 4 feet thick occupies an area of 2790 acres and has 3.478 million tons of dry peat.

TABLE 2--Areas, Volumes, and Weights of Peat in the Light Ground Pocosin.

Isopach Interval	Area	Avg. Thk.	Volume	Bulk Density	Weight-Dry	Cumulative weight	Cumulative area
ft.	acres	ft.	acre-feet	$\frac{\text{tons}}{\text{acre-foot}}$	10^6 tons	10^6 tons	acres
0-2	1117	1	1117	215	0.240	5.171	5930
2-4	2018	3	6054	240	1.453	4.931	4810
4-6	1912	5	9560	225	2.151	3.478	2790
6-8	774	7	5418	210	1.138	1.327	880
8-10	98	9	909	195	0.177	0.189	107
10-12	6	11	66	180	0.012	0.012	6

D. Composition and Heating Value

Table 3 summarizes and Table 4 gives details of the proximate and ultimate analyses of Light Ground Pocosin peats.

TABLE 3--Summary of Composition and Heating values
of Light Ground Pocosin Peats
(20 samples with less than 10% ash)

	Low	Median	High
BTU/LB*	9,800	10,500	10,900
% H_2O	75	81	90
PROXIMATE ANALYSIS*			
% Volatiles	55	60	65
% Fixed Carbon	32	36	43
% Ash	2	4	10
ULTIMATE ANALYSIS*			
% C	58	62	66
% H	4.6	5.1	5.9
% O	25	28	30
% N	1.0	1.5	2.0
% S	0.2	0.2	0.3
% Ash	2	4	10

* Moisture-Free basis

TABLE 4-- Proximate and Ultimate Analyses of Light Ground Pocosin Peats and Sediments.

Site No.	Depth	H_2O	Moisture-Free								Heating Value
			Proximate Analysis			Ultimate Analysis					
			Volatile Matter	Fixed Carbon	Ash	H	C	N	S	O	
	ft	%	%	%	%	%	%	%	%	%	btu/lb
A	0-2	80.3	56.9	40.4	2.7	4.8	63.0	1.7	0.2	27.6	10,410
	2-4	84.3	58.8	37.5	3.7	5.2	64.0	1.5	0.2	25.5	10,850
	4-6	90.3	53.5	32.0	14.5	4.6	53.5	1.5	0.3	25.6	9,190
B	0-2	72.7	59.6	34.0	6.4	5.2	60.8	1.7	0.2	25.9	10,440
	2-4	75.0	56.4	30.9	12.7	5.1	57.6	1.4	0.2	23.0	9,910
C	0-2	75.0	58.8	37.6	3.6	5.0	59.9	1.7	0.2	29.6	10,000
	2-4	78.9	55.2	42.3	2.5	4.7	64.3	1.3	0.2	27.1	10,660
	4-6	82.9	54.8	31.0	14.2	4.3	55.9	1.1	0.2	24.3	9,520
D	0-2	72.7	62.6	33.5	3.9	5.6	61.2	1.7	0.2	27.4	10,300
	2-4	78.2	65.4	31.7	2.9	5.9	62.0	1.5	0.2	27.5	10,890
E	0-2	76.0	60.6	37.1	2.3	5.1	61.5	1.7	0.2	29.2	10,310
	2-4	83.1	55.6	42.1	2.3	4.6	63.5	1.5	0.2	28.0	10,500
	4-6	87.1	61.5	36.0	2.5	5.3	62.5	1.4	0.2	28.1	10,580
	6-8	88.2	57.7	33.1	13.2	4.5	55.0	1.3	0.3	25.7	8,700
F	0-2	78.6	59.0	35.8	5.2	4.9	58.5	2.0	0.2	29.3	9,800
	2-4	76.2	46.7	36.6	16.7	4.0	55.2	1.4	0.2	22.4	9,180
G	0-2	80.6	62.1	34.7	3.2	5.4	61.1	1.3	0.2	28.7	10.460
	2-4	83.6	61.0	34.9	4.1	5.8	63.0	1.2	0.3	25.5	10,970
	4-6	80.2	54.8	28.5	16.7	4.9	53.4	0.9	0.3	23.9	9,390

TABLE 4 continued.

			Moisture-Free									
			Proximate Analysis			Ultimate Analysis					Heating Value	
Site No.	Depth ft	H_2O %	Volatile Matter %	Fixed Carbon %	Ash %	H %	C %	N %	S %	O %	btu/lb
H	0-2	82.4	60.2	36.7	3.1	4.7	62.4	1.3	0.2	28.2	10,430
	2-4	81.4	54.7	42.8	2.5	5.0	65.5	1.1	0.2	25.8	10,860
	4-6	85.5	60.0	34.9	5.1	5.2	61.1	1.0	0.3	27.3	10,500
	6-8	85.8	40.1	25.4	34.5	3.9	39.8	1.2	0.2	20.5	6,810
I	0-2	81.3	58.3	37.8	3.9	5.0	59.8	1.5	0.2	29.6	10,040
	2-4	82.4	57.4	40.0	2.6	4.9	62.6	1.3	0.2	28.4	10,540
	4-6	86.9	53.5	30.3	16.2	4.8	53.4	1.5	0.3	23.8	9,270
J	0-2	71.5	55.1	35.1	9.8	4.9	58.5	1.4	0.2	25.3	9,900
	2-4	74.1	60.4	33.1	6.5	5.5	60.6	1.3	0.2	25.9	10,600
	4-6	81.0	39.1	24.4	36.5	3.5	39.1	1.0	0.3	19.6	6,720
K	0-2	76.2	52.9	31.7	15.4	4.5	52.7	1.7	0.2	25.5	8,760
	2-4	76.2	55.2	29.4	15.4	5.1	55.6	1.4	0.2	22.3	9,600
L	0-2	77.7	53.4	32.5	14.1	4.6	53.6	1.2	0.2	26.3	9,060

1. Moisture

Although there is much variation, the moisture content increases with depth, from an average value of 74% in the first foot to 90% at a depth of 9 feet. Above a depth of 4 feet the variation is markedly greater, reflecting the depths through which the water table fluctuates (Table 5 and Fig. 5).

TABLE 5--Moisture Content of Light Ground Pocosin Peats

Depth	Low	Average	High	No. Samples
0-1	58%	74%	86%	85
1-2	68	78	88	76
2-3	68	80	88	65
3-4	69	81	88	60
4-5	80	84	90	28
5-6	83	87	88	11
6-7	84	87	89	5
7-8		89		1
8-9		90		1

2. Ash

Within the main body of the peat, the ash content is almost always below 10% and usually below 5%. An ash content of 1½ to 3% is very common.

Normally there is a transition zone about a foot thick between the peat and the underlying mineral sediment (sand and clayey sand) in which the ash content increases rapidly. The ash content is also greater around the edges of the deposit.

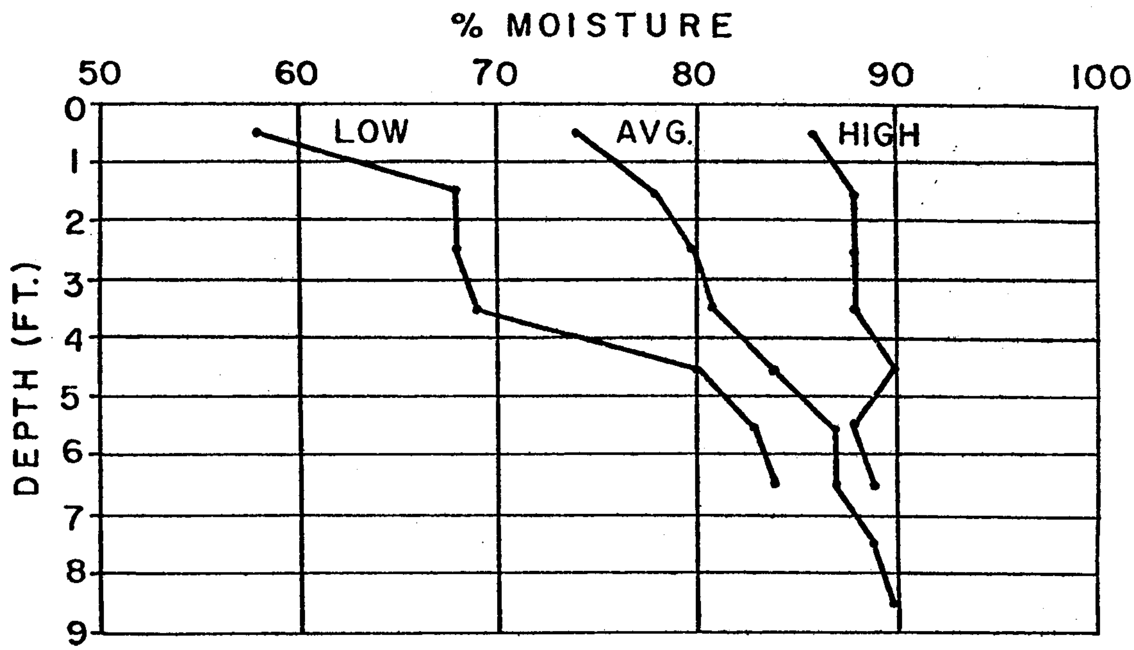

FIG. 5.-- Relation of depth to moisture content of Light Ground Pocosin peats.

3. Heating Value

The heating values of 32 samples at varying depths from 12 sites were determined (Fig. 6 and Tables 3 and 4). Within the main body of the peat where the ash content is less than 10%, the btu/lb ranges from 9,800 to 10,900 with a median value of 10,500. As the peat becomes diluted with ash components, the heating value declines; but all peats with less than 25% ash have heating values greater than 8,000 btu/lb.

4. Proximate Analyses (See Tables 3 and 4)

For the peats with less than 10% ash, the volatile matter ranges from 55 to 65% with a median of 60%; and the fixed carbon ranges from 32 to 43% with a median of 36%. Both volatile matter and fixed carbon decreases as ash increases.

5. Ultimate Analyses (See Tables 3 and 4)

The major elements (carbon, hydrogen, and oxygen) in the peat decrease as ash increases. For the peats with less than 10% ash, the carbon content ranges from 58 to 66% with a median of 62%; the hydrogen content ranges from 4.6 to 5.9% with a median of 5.1%; the oxygen content ranges from 25 to 30% with a median of 28%.

The amount of potential environmental pollutants (nitrogen and sulfur) is independent of the ash content. The nitrogen content of all the peats ranges from 0.9 to 2.0% with a median of 1.4%, and the sulfur content ranges from 0.2 to 0.3% with a median of 0.2%.

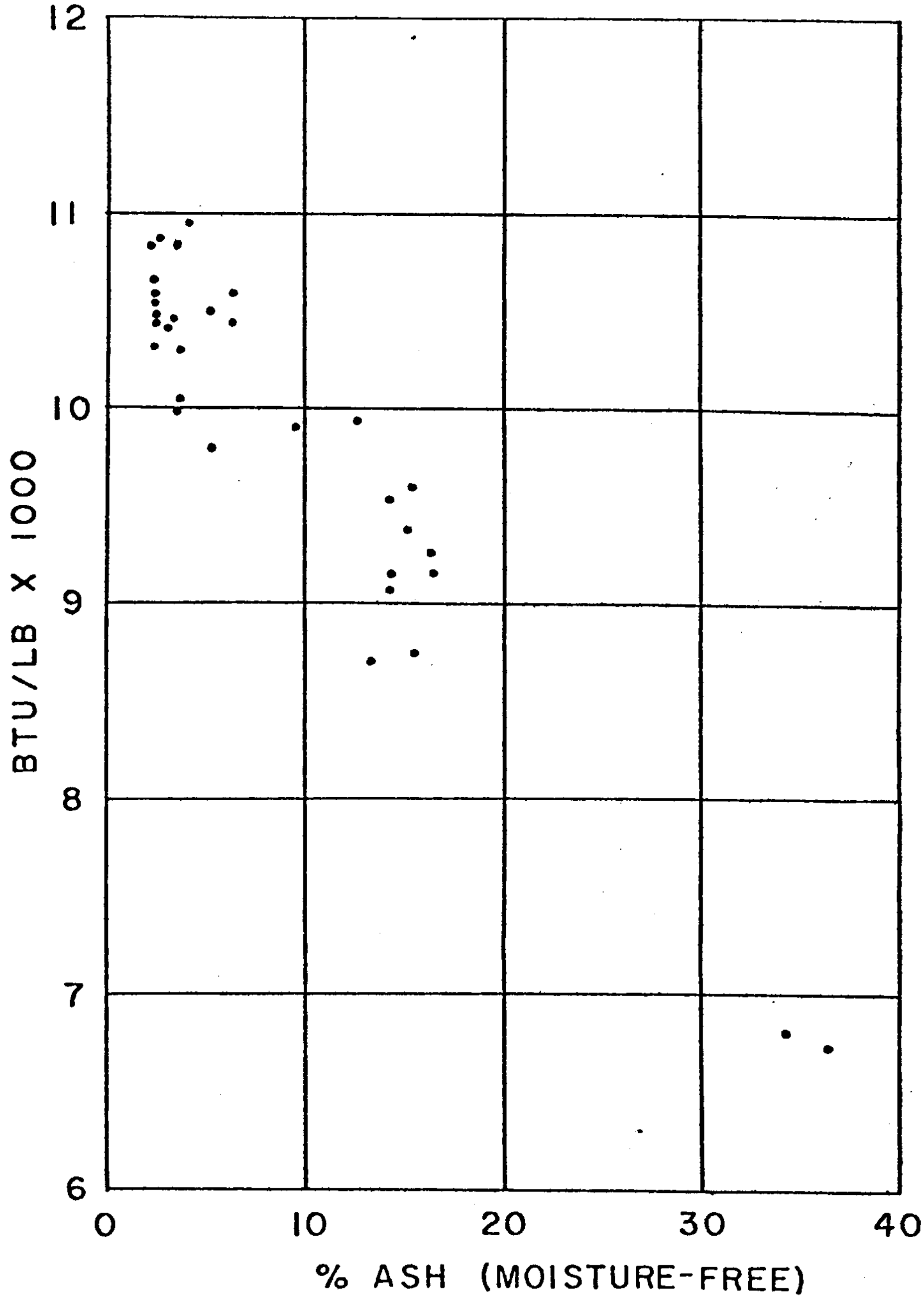

FIG. 6.-- Relation of heating value (but/lb) to ash content of Light Ground Pocosin peats.

REFERENCES CITED

Daniels, R. B., E. E. Gamble, W. H. Wheeler, and C. S. Holyhey, 1977, The Arapahoe Ridge-A Pleistocene Storm Beach: Southeastern Geology, v. 18, p. 231-247.

Whitehead, D. R., 1972, Developmental and environmental history of the Dismal Swam: Ecol. Mongr., v. 42, p. 301-315.

Whitehead, D. R. and R. Q. Oaks, 1979, Developmental history of the Dismal Swamp, p. 25-43, in P. W. Kirk, ed., The Great Dismal Swamp: Charlottesville, University Press of Virginia, 427 p.