Some peat deposits in Washington and southeastern Aroostook Counties, Maine

By Cornelia C. Cameron

U.S. GEOLOGICAL SURVEY OPEN-FILE REPORT

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Figure 1.--Study area showing location of selected peat deposits, Washington and southeastern Aroostook counties, Maine.

lie. The amount of peat was estimated from auger-hole data and from the surface area measured on topographic and air-photo maps. In calculating tonnages (table 1), 1 acre-foot of peat in place was considered equivalent to 200 tons of air-dried peat. Samples from the deposits were analyzed by the U.S. Geological Survey for moisture, ash, organic content, water-holding capacity, fiber size (exceeding 0.15 mm), and acidity. An additional 21 deposits, from which samples were not analyzed, are included in the study.

The help of several people is gratefully acknowledged. Mr. Glen Jordan, U.S. Department of Agriculture, Machias, Me., loaned aerial photographs, and Mr. Milford Savage, Island Falls, Me. and Mr. Ted Lougee, Smyrna Mills, Me., gave logistical support during the study of several heaths in Aroostook County.

Thanks are especially due Richard S. Rhodes, James K. Watson, and Joseph C. Sarnecki who gave valuable support as field assistants.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Previous studies

Attention was directed to the economic potential of Maine's peat deposits as early as 1909 by Bastin and Davis, who considered the deposits a source of fuel; they investigated 22 localities in Washington and southeastern Aroostook Counties. Soper and Osbon (1922) included this area in their study, listing an estimated 420,000 tons of air-dried peat at 7 localities in Aroostook County and 6,519,000 tons at 24 localities in Washington County. Finally, as late as 1944, use of peat primarily as a fuel was considered by the Maine Geological Survey (Trefethen and Bradford, 1944), although at this time large bogs in Washington County at Centerville, Jonesport, Sullivan, Franklin, and Deblois were being mined by hand labor for agricultural and horticultural purposes.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Composition and physical properties of peat

The properties and composition of peat vary considerably in different deposits and even in different parts of the same deposit because peat is derived from different types of vegetation and is accumulated and preserved under varying conditions. The commercial characteristics and properties of peat vary widely, and the Cooperative Extension Service at Michigan State University (Lucas and others, 1966) has published a guide for users. The principal factors that determine the commercial value are water-holding capacity, organic and ash content, fiber content, and acidity. The American Society for Testing Materials (1969) has published standard methods of testing each of these factors (ASTM Committee D-29 on peats, mosses, humus, and related products, effective September 20, 1971 in the Annual Book of ASTM Standards[1/]).

[1/] The following reprints may be obtained from the American Society for Testing Materials, 1916 Race St., Philadelphia, PA 19103:

ASTM D2980 - 71 Standard method of test for volume weights, water-holding capacity, and air capacity of water-saturated peat materials.

ASTM D2974 - 71 Standard method of test for moisture, ash, and organic matter of peat materials.

ASTM D2976 - 71 Standard method of test for pH of peat materials.

ASTM D2977 - 71 Standard method of test for size range of peat materials.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Water-holding capacity

Peat as a soil conditioner and horticultural material must have the ability to behave like a sponge--to reabsorb water after initial drying. Water-holding capacity, which is measured in percentage by weight, depends upon botanical character, the degree of decomposition, and the degree of drying to which the peat has been subjected. Moss peat will hold water 15-50 times its own dry weight. A good grade of reed-sedge peat will hold water 10-20 times its own dry weight. Humus, which is highly decomposed peat, will hold considerably less water. Peat generally tends to reabsorb less water when oven-dried than when it is dried in the open air.

Water-holding capacity of representative peat samples from a depth of 5 feet in each of the 57 sampled deposits ranged from 640 to 4,920 percent (table 2). Samples from only 3 deposits had water-holding capacities of less than 1,000 percent; samples from 17 deposits had capacities ranging from 1000-2000 percent; samples from 12 deposits had capacities ranging from 2000-3000 percent; samples from another 17 deposits had capacities ranging from 3000-4000 percent; samples from 8 deposits had capacities greater than 4000 percent.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Organic and ash content

Regulations established by the Federal Trade Commission in 1950 make it unlawful to label a product "peat" unless 75 percent of the material by dry weight is organic. In practice, organic content is equal to the loss in weight when dry peat is heated to 550°C; the solids remaining constitute the ash.

The organic content in samples from a depth of 5 feet in the 57 Maine deposits ranged from 78-99 percent (table 2). In 37 of the deposits the organic content at this depth ranged from 95-99 percent; in 17 of the deposits it ranged from 90-94 percent; and in only 3 of the deposits did it fall below 90 percent.

Fiber Content

Fiber content refers to the proportion of stem, leaf, or other plant fragments that make up peat. Because peat with a high percentage of fibers more than 0.15 millimeters long tends to have high water-holding capacity (a desirable characteristic) and because fiber content influences weight per unit volume (a basis for determining the market value of peat), the standard classification of peats, mosses, humus, and related products which was adopted in 1969 and described in ASTM D2607-69 is based largely on fiber content.

Thirty two of the 57 deposits contained samples having fiber content (table 2) greater than 66 2/3 percent; 22 deposits contained samples having fiber content between 33 1/3 and 66 2/3 percent, and the remaining 3 deposits contained samples having fiber content less than 33 1/3 percent.

In situ pH of natural peats

In situ pH of natural peat is normally acidic and ranges from 3.2 to 7.5. Very acid peats have a pH of 3.2-4.2, acid peats have a pH of 4.2-5.0, and peats having a pH between 5.0 and 7.0 are low in acidity. Peat having a pH of less than 5.0 is calcium deficient; that having a pH above 5.0 is calcium sufficient, which includes alkaline peats having a pH as great as 7.5. Most of the Maine deposits are calcium deficient (table 2). The calcium sufficient peat which is present is largely restricted to the Aroostook County deposits in the limestone belt.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-884

Commercial classification of peat

Because peat is formed from many kinds of plant material under a wide range of conditions, the different varieties are suitable for particular uses. Many different modes of classification have, therefore, been proposed. The most practical classifications are based on the following factors: (1) physical or chemical characteristics such as texture, organic and mineral composition, and water content; (2) the soil-like nature of peat and the vegetation that grows upon it; (3) origin, mainly by the type of vegetation represented; (4) environment of formation; and (5) marketable uses, such as fuel, as a source of chemical and other manufactured products, and as a soil conditioner.

For statistical purposes, the U.S. Bureau of Mines classifies peat into three general types: moss peat, reed-sedge peat, and peat humus.

Moss peat is formed principally from sphagnum, hypnum, and other mosses. Sphagnum moss peat is light tan to brown, light in weight, porous, high in water-holding capacity, high in acidity, and low in nitrogen content; "top moss" is the living part of the sphagnum plant and should not be confused with moss peat which has aged and partially decomposed. Hypnum moss peat is darker brown, of low acidity, and physically similar to reed-sedge peat.

Reed-sedge peat is formed principally from reeds, sedges, marsh grasses, cattails, and associated plants. Fibrous, partially decomposed reed-sedge peat is brown to reddish brown but more decomposed peats are darker. The water-holding capacity and the nitrogen content of reed-sedge peat are of medium values.

Peat humus is derived from peat so decomposed that the original plant remains are not identifiable. It is dark brown to black, has low water-holding capacity, and has medium to high nitrogen content.

Most peat produced commercially in the United States and peat in most of the unexploited deposits in southeastern New York is either reed-sedge or humus type. Peat of any type may contain a considerable amount of woody material.

In addition to the three major types of peat defined above, other materials high in organic matter should be mentioned. Sedimentary peat is derived from such aquatic organisms as algae, plankton, pond weeds, and organic material washed into the waterbody. It occurs in the bottom of lakes and ponds and in the lower levels of most peat deposits. Such peat usually contains considerable mineral impurities and in this report it is referred to as peaty clay or clayey peat, depending upon the organic content. It is too fine for most soil improvement purposes and shrinks and swells greatly with varying

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 457-084

moisture content; some has a sheetlike structure and hardens upon drying. Muck is highly weathered peat that has been modified greatly by soil micro-organisms and is usually granular in structure. It has low water-holding capacity and is poorly suited for soil-improvement purposes.

Use of peat as a soil conditioner and as a horticultural material prompted the U.S. Bureau of Mines to devise specifications governing the purchase of peat by the Federal Government. Federal Specification Q-P-166e, dated May 10, 1961, covers four general types of peat for agricultural use and includes the following specifications:

	Sphagnum moss peat	Other moss peat	Humus peat	Reed-sedge peat
Moisture content as normally marketed, percentage by weight -----	35-45	1/ 55	1/ 55	1/ 50
Maximum ash content, percentage by weight -----	10	20	20	15
Acidity 2/ ----------	3.2-4.5	3-2-7.0	4.0-7.5	4.0-7.5
Minimum water-holding capacity at 1 gravity on oven-dry basis, percentage by weight ----------	800	400	200	400

1/ Maximum

2/ The approximate pH shall be specified by the purchaser

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

The need for a more specific classification has been recognized by the peat industry, and the ASTM Committee on Peat consequently proposed a standard classification. According to the ASTM Committee D-29 (ASTM D2607-69), the term "peat" may be used commercially only with respect to organic matter of geological origin, except lignite or other coal. Peat forms mainly from dead plant remains through the agency of water in the absence of air; it occurs in a bog, swampland, or marsh and has an ash content not exceeding 25 percent on a dry-weight basis. The classification below is based on five major peat types determined by kind of plant material and fiber content. Fiber is defined as plant material retained on a No. 100 (ASTM) sieve (that is, 0.15 mm or larger) and includes stems, leaves, or fragments of bog plants but no wood particles larger than 0.5 inch (12.7 mm) in greatest dimensions; it excludes inorganic fragments, such as shells, stones, sand, and gravel. Percentages of fiber are based on oven-dry weight at 105°C, not on volume.

Sphagnum moss peat (peat moss).--The oven-dried peat contains a minimum of 66 2/3 percent sphagnum moss fiber of the total content by weight. These fibers shall be stems and leaves of sphagnum in which the fibrous and cellular structure is recognizable.

Hypnum moss peat.--The oven-dried peat contains a minimum of 33 1/3 percent fiber content by weight of which hypnum moss fibers shall compose more than 50 percent. These fibers shall be stems and leaves of various hypnum mosses in which the fibrous and cellular structure is recognizable.

Reed-sedge peat.--The oven-dried peat contains a minimum of 33 1/3 percent fiber by weight of which reed-sedge and other non-moss fibers shall compose more than 50 percent.

Peat humus.--The oven-dried peat contains less than 33 1/3 percent fiber by weight.

Other peat.--All forms of peat not herein classified.

According to this ASTM classification, 32 of the 57 Maine deposits contained sphagnum moss peat, 22 deposits contained peat composed of moss and other plant fragments, and the remaining 3 deposits contained peat humus.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Vegetation, climate, geology and physiography of eastern Maine peat deposits

Heaths

Peat deposits in eastern Maine may be recognized by their covering of low shrubs and scattered trees. Heaths, as they are called locally, are generally surrounded by trees of normal height. The heath family (Ericaceae) includes the common leatherleaf (Chamaedaphne calyculata), lambkill (Kalmia angustifolia), pale laurel (Kalmia polifolia), bog rosemary (Andromeda glaucophylla), Labrador tea (Ledum groenlandicum); rhodora (Rhododendron canadense), hoary alder (Alnus incana), winterberry (Ilex verticillata) and sweetgale (Myrica gale) are commonly associated with the heath shrubs. The most conspicuous herbaceous flowering plants include cranberries (Vaccinium oxycocus and V. Macrocarpon), pitcher plant (Saracenia purpurea), sundew (Drosera rotundifolia), cotton grasses (Eriophorum spp.), sedges (Carex, Scirpus, Rhynchospora, etc.), and orchids (Pogonia, Calopogon, Calypso, Arethusa, etc.). Several mosses, such as sphagnums (Sphagnum spp.) and haircaps (Polytrichum spp.), are abundant. Lichens are abundant, especially reindeer moss (Cladonia rangiferina) and red-tipped moss (Cladonia cristatella). Stunted forms of black spruce (Picea mariana) and tamarack (Larix laricina) occur on the heath generally, but white pine (Pinus strobus) and arbor-vitae or northern white cedar (Thuja occidentalis) may grow on the driest parts of the heath.

This rather definite and restricted group of plants is typical of the heath or raised-bog type of peat deposit; it tolerates the conditions which promote the continuous growth of sphagnum moss which is, in turn, responsible for the development of the convex surface of the heath. Lack of drainage and consequent lack of oxygen permit accumulation of organic acids. Not only does the soil become low in nutrients, but the acidic water is toxic to most plants. A ring of tall trees grows at the margin of the heath because drainage is better. The forest encroaches on the heath as surface drainage improves. Thus, some heaths have been changed to forest, which becomes the vegetative cover of the peat deposit.

Excellent botanical descriptions of Denbow Heath (deposit 42, fig. 1) and deposits 39 and 40 near South Trescott and Boot Cove, Washington County, given by Hugo Osvald (1970, pp. 48-55) illustrate the vegetation of coastal and inland bogs in the area of study. Coastal bogs differ from inland bogs in that the former have much greater dwarf-shrub communities with bottom layer lichens.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Climate

Peat accumulates in many climates. Temperature is not a limiting factor; just as plants grow from the Arctics to the Tropics, peat deposits also form. The peat bogs of northern latitudes have long been studied and exploited, but the great peat deposits of Florida (Davis, 1946) are not as well known. High temperature is important in stimulating plant growth, but it also increases the rate of decay. Moisture is the most critical climatic factor in promoting plant growth and inhibiting decay, and thus it largely controls the formation of peat. The anaerobic conditions in the lower parts of nearly stagnant ponds, swamps, and marshes provide maximum opportunity for preservation (Waksman, 1942, and Waksman and Stevens, 1929, 1932). In cool areas of high rainfall and humidity and, consequently, low evaporation, deposits of sphagnum moss may accumulate and form peat on flat or sloping land, as along the coast of Maine; under these conditions some peat deposits have been built up more than 20 feet above the surrounding area.

The climate of Washington County and southeastern Aroostook County is characterized by summer temperature averages of less than 70° F., mean annual percipitation of 40 in. inland to 48 in. along the coast, and humidity averages of 70-80 percent. The most favorable period for peat development was during the cooler and more moist conditions following the melting of glacial ice; today, the most favorable climate for growth of sphagnum moss is in the coastal fog belt.

Regional geology and physiographic history

The bedrock of the study area consists of a folded and faulted complex of metamorphic and igneous rocks of Ordovician, Silurian, and Devonian age. Marble is largely restricted to eastern Aroostook County, where it weathers to a soil that is favorable to large-scale potato culture and where it furnished large quantities of lime to the glacial drift. The entire area was severely dissected by streams prior to glaciation.

The last ice sheet to cover these bedrock hills stood along the present Maine coast approximately 13,500 years ago. Ground and recessional moraines associated with kames and eskers formed at this time, and the multitude of ponds and lakes on the poorly drained deglaciated surface became potential peat forming sites. Deglaciation of coastal Maine was followed by widespread marine invasion starting between 12,100 and 12,800 years B.P.(Borns & Calkin, 1970). During the early stage of transgression, sea level was 180 feet lower than present sea level. At maximum, the marine invasion reached a level of 400 feet above the present sea level. Radiocarbon ages of the deepest portion of bogs in small kettles on former islands within the marine limit

U. S. GOVERNMENT PRINTING OFFICE: 1972 O - 457-084

indicate an average time lag of 800 years between deglaciation and the onset of the earliest organic growth. This means that all the peat in the study area is younger than 12,700 years B.P. The deposits rest on either marine or fresh-water clay and silt.

Evolution of the peat deposit

The most common type of peat deposit in the United States is the filled-basin type. The built-up or raised-bog deposit on flat or gentle slopes is more common in northern Europe than in America. The third or composite type, consisting of built-up deposits underlain by peat of the filled-basin type, is common in southern Canada and northern United States, especially in Maine.

Development of a typical Maine peat deposit (fig. 2) begins with deposition over the inorganic gray bottom clay of floating types of

---

Figure 2 near here.

---

plants such as algae and pond weeds that lived in the shallow water (fig. 2, Stage 1). This organic sediment is an amorphous material with high colloidal content. It fills the depression to a depth permitting growth of rooted plants such as pond lilies and bulrushes (fig. 2, Stage 2). As vegetal remains accumulate and pond area decreases (fig. 2, Stage 3), water of the vestigial pond is eventually replaced by grass, reeds, sedge, and moss, and the deposit grows upward and outward beyond the margin of the original water body; the water table also rises (fig. 2, Stage 4). As soon as sphagnum moss dominates the vegetation, the convex surface, or dome, with perched water table begins to develop (fig. 2, Stage 5).

Peat growth within a basin displaces its own volume of water until it reaches the level at which inflow and outflow are balanced. Further peat growth creates a reservoir which holds a volume of water against drainage. There are two types of peat reservoirs. The first, composed of sedimentary organic material and reed-sedge peat, acts as a physical barrier to ground water, causing the water to back up. In this process of lateral paludification, the peat mass in the original basin, acting as a dam, produces newly flooded areas in which more peat can develop. In suitable topography this peat can grow in thickness on bedrock or soil surface beyond the margin of the original pond or lake. The second type of peat reservoir, composed of moss peat in the raised bog acts as a second reservoir above the regional level of the groundwater, producing a perched water table which is held against gravity within the peat moss by capillarity. This process is vertical paludification and is responsible for development of the domed sphagnum peat deposits so common in Washington and southeastern Aroostook Counties.

Figure 2.--Diagrammatic maps and cross section of five stages in the development of the composite type of peat deposit based on a gradual change of surface and ground water regimes.

The terrestrialization of a shallow lake having inflow and outflow streams illustrates the hydrologic regime typical of the Maine deposits (fig. 2). Five stages of evolution are recognized (Bellamy, 1968). During Stage 1 water from the inflowing stream moves over and through the developing peat deposit and leaves at the outlet. Movement is chiefly over the peat if much allochthonous material is being brought into the lake; the abundant oxygen decomposes the organic material to form a heavy peat. However, if the rate of flow is low, less allochthonous material collects, less oxidation or decomposition occurs, and the water flow is directed largely below a floating mass of relatively light peat. The accrual of peat (Stage 2) tends to canalize the main flow of water. Continued peat growth (Stage 3) diverts the stream to the margin of the filled lake. The water supply to the deposit is restricted to rain falling directly on the surface and seepage from the surrounding catchment. Portions of the deposit lying in the main drainage tracts within the basin, however, may be subject to a slow continuous flow of ground and/or surface water. Further accrual of peat (Stage 4) leaves large areas of the deposit surface unaffected by moving water but subject to inundation when the water level of the basin rises during periods of rainfall. Because of continued peat growth, the deposit or bog surface rises above the effect of the vertical oscillations of the groundwater. The convex surface or dome so produced possesses its own water table fed by rain falling directly on it (Stage 5).

Basic physiographic forms of the deposits

David J. Bellamy of Durham University, England, introduced (1972) the concept of templates for interpreting mires in terms of conservation and exploitation. He defined templates for peat formation as places where water collects on its way down from the catchment to the sea. By this definition, templates are all forms of natural basins from valley heads to those in deltaic flood plains. Although it is difficult to apply the European system of classifying mires to the Maine peat deposits in raised and composite bogs, the idea of grouping them into basic forms with common physiographic features and origins is useful. Accordingly, five basic forms of peat deposits, which more or less resemble European mires, are recognized in the area of study. Diagrams of each form are shown in figure 3. Location, physiographic form and size of all deposits in the study area are given by quadrangle in tables 1 and 3.

Figure 3 near here.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Figure 3.--Diagrammatic maps and cross sections of the physiographic forms of peat deposits.

The deposit shown in figure 3a lies in a valley occupied by a stream which flows over peat composed chiefly of marsh and forest plants. The peat developed over sediments deposited in the initial pond or ponds occupying dammed parts of the valley. One or more heath-covered domes of moss peat may extend along the stream. Water is brought into the deposit by the stream. Ground water also enters the deposit as seepage along the valley walls above the basal clay aquiclude and moves toward the stream and down the valley. Eighteen of the 78 deposits studied generally have this physiographic form. They range in size from 30 to 320 acres, have maximum thickness of 7 to 21 feet, and contain an estimated 20,000 to 640,000 tons of commercial-quality air-dried peat, chiefly sphagnum moss and other peat (ASTM classification).

The deposit shown in figure 3b lies in a closed basin. Floating mats of moss peat extend over open water of the vestigial lake or pond. The vegetation cover is heath surrounded by tall forest grading inward to stunted trees and bushes. Water enters the deposit as rainfall and as seepage along the basin walls above the basal clay aquiclude. Most of the deposits in the study area which have this physiographic form occur in sink holes in the limestone belt of the potato region in eastern Aroostook County and are composed of thin layers of moss peat over marl and associated sediments. They are very small, only 10 to 15 acres in extent, have maximum depth of 7 to 12 feet, and contain 10,000 to 15,000 tons of commercial-quality sphagnum moss peat.

The deposit shown in figure 3c lies on a gentle surface of sand, gravel, or clay in the form of a broad moss peat dome or plateau. Surface drainage has been diverted around the deposit and growth of the deposit is sustained by rainfall and ground water entering from below, chiefly through the sand and gravel. The heath-covered dome or plateau is invaded by trees from the sloping edge. Half of all the deposits studied have this physiographic form. Although the range in size and thickness is great, all the deposits of this form contain less than 500,000 short tons of commercial quality air-dried peat classified as sphagnum moss and other peat (ASTM classification). This common broad-dome or plateau form is typified by Runaway Pond Heath in Washington County (deposit 50 on fig. 1; fig. 4).

Figure 4 near here.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Figure 4.--Contour map and diagrammatic profile sections of Runaway Pond Heath (deposit 50 on fig. 1). Map shows location of lines of traverse and sections, as well as auger hole sites (solid dots). Contour lines (in feet above sea level) within the Heath boundary indicate shape of the dome. Zero elevation on the sections is approximate base of sphagnum peat.

When developed on any of the foundations described above, large moss-peat plateaus form undulating surfaces due to subsurface water and rainwater moving down the slope or toward depressions made by compaction under snow drifts. Water gathers in these depressions, which are made larger by oxidation and which frequently are arranged in concentric bands (fig. 3d). Ponds such as these characterize thick deposits of moss peat. Deposit 11 in Aroostook County and deposits 27, 42, and 43 in Washington County all exhibit this form (fig. 3d) and are among the largest deposits in the area of study. Three of the above deposits range in area from 1,125 to 4,000 acres, are as much as 20 feet thick, and contain 2,250,000 to 8,000,000 tons of air-dried peat, most of which is sphagnum-moss peat. The fourth deposit covers 320 acres, is as much as 25 feet thick, and contains 640,000 tons of peat.

The most complex peat deposits in the area are those in which the domes of moss peat coalesce over divides which separate basins that contain peat developed above and below the original pond surfaces (fig. 3e). The divides covered by the moss peat are most likely areas of groundwater exchange between the deposit and the country rock. Fourteen of the studied deposits have this physiographic form, some of which are combined with other forms, for example in deposits 14 (table 3), 11 (table 1), 27, 42, and 43 (table 1). Thousand Acre Bog (deposit 11 of table 1) in Aroostook County (figs. 5, 6) is typical of the dome-and-pond and coalesced-dome forms shown in figures 3d and e, respectively.

Figures 5 and 6 near here.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

Figure 5.--Map of Thousand Acre Bog (deposit 11 on fig. 1) showing location of lines of traverse and auger hole sites. Profile sections are shown on fig. 6.

Figure 6.--Profile sections of Thousand Acre Bog. See figure 5 for location of sections. Zero elevation is approximate base of sphagnum peat.

Stratigraphy

Physiographic forms reflect the stratigraphy of a peat deposit which, in turn, is reflected in quality factors, especially ash content (see table 2). For purpose of discussion, the deposit may be divided into two parts, (1) that part below the level of the original pond surface and (2) that part above the level. In the ideal section, the basal zone of part (1) is clay and peaty clay containing more than 50 percent ash. Ash content in the overlying clayey peat ranges from greater than 25 percent to less than 25 percent, depending on the pond environment. Algae and pond weeds living in clear water produce peat with low ash content; a clayey peat layer quite low in ash may be produced in a pond obliterated by floating mats of marsh and moss vegetation which continually sink and mix with pond sediments until the level of the original pond is reached.

The basal zone of part (2) usually contains less than 25 percent ash, unless a period of oxidation and decay has interrupted plant growth, and consists of a variety of plants such as marsh, perhaps forest growth, moss and heath plants. Because moss becomes the dominant plant type as the dome increases in height, ash content decreases to less than 2 percent, the percent of fibers that are 0.15 mm long increases to greater than 66 2/3, and water holding capacity increases to several thousand percent. However, as soon as oxidation begins to destroy peat, a layer of humus develops at the surface, expecially near the margin of the dome where oxygenated water moves most freely. As humus develops, ash content increases, fibers become shorter, water-holding capacity decreases, and forest invades the heath from the margin and migrates toward the center of the dome.

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 417-084

Resources

The resources of peat in the 19 deposits that were augered and analyzed in southeastern Aroostook County are estimated at about 5,100,000 short tons; in the 38 deposits augered and analyzed in Washington County resources are estimated at about 20,041,000 tons (table 1). The location, size and quality of each of these deposits are given in table 1. Twenty-one additional deposits, augered but not analyzed, contain an estimated 5,257,000 tons and are described in table 3. Estimates are for air-dried peat on a basis of 200 tons of peat per acre-foot in place. In addition to the number of deposits examined, it is estimated that there are at least as many more deposits of similar size and quality elsewhere in the study area and in other parts of eastern Maine; in effect, the resources calculated above can be doubled.

Size of the peat deposits in the study area ranges from less than 100 to 4,000 acres; almost half cover 100 acres or more. Thickness of peat of commercial quality in these deposits ranges as high as 25 feet and most average at least 5 feet. Much is moss peat with sphagnum predominating in the upper parts of the deposit. Moss peat rests on peat classed as other peat in the ASTM classification. Peat classed as reed-sedge is practically absent in the area of study.

Peat mining

Maine produced 2,903 short tons of air-dried peat in 1972 at 4 plants, two of which are near Jonesport in Washington County, and sold 2,083 packaged tons at an average price of $47.60 per ton (Sheridan, 1974). Both production and sales doubled those of 1970, when 1,223 short tons of air-dried peat were produced and 1,000 tons sold at an average price of $39.00 per ton (Sheridan, 1972).

Moss peat is cut into blocks which are stacked and dried in the field or in a kiln. Until very recently mining was by hand labor; today modern machinery clears the surface of the deposit, cuts and stacks the peat blocks, hauls, shreds, and bags the product, which is then distributed by truck.

U. S. GOVERNMENT PRINTING OFFICE : 1973 O - 457-084

Impact on environment

Exploitation during the past 75 years has made little impact on the vegetation of Denbow Heath (deposit 42) and other heaths in Washington County described by Osvald (1970). This is because sphagnum moss peat was removed from the domes which are above the regional water tables, and the remaining heath plants regenerated new peat. Deposits most suitable for exploitation today are the plateaulike-dome, dome-and-pond, and coalesced-dome physiographic forms (see figs. 3c, d, and e, 4-6) in which the peat of best quality lies above the regional water table. Streams have been diverted around these deposits in the manner diagrammed in figure 2.

As long as regional ground water tables are little changed, by keeping drainage ditches at minimum depth, and as long as some patches of heath flora are left undisturbed, peat mining might not cause permanent change. However, since the advent of modern machinery for rapid clearing of the heath surface and for ditching, preliminary studies of drainage, physiographic form of the deposit, and its biology are imperative in order to prevent unnecessary damage.

Outlook for the area

Transportation and marketing are the chief factors which will influence the long-range outlook for the area. Construction of Interstate 95 as far north as Houlton links southeastern Aroostook County to the excellent road network of the eastern United States. In addition, the large pulp companies have changed from the use of streams to the use of trucks for log transport, thus providing roads which make accessible new areas for peat exploration and possible exploitation.

Decarlo (1971) forecasts the national demand for peat for the year 2000 will reach 1,200,000 to 2,400,000 short tons, compared to 917,169 tons used in 1972. Although most peat is presently used for agricultural and horticultural purposes, technology is introducing new uses as environmental control. For example, D'Hennezel and Coupal (1972) have shown that moss peat, because of its very high water-holding capacity, can be used on a large scale in combatting pollution caused by oil spills from offshore drilling, freighters, and barges. Sheridan (1972) states that Finland has begun production of oil-absorbent compressed peat in 170-liter packs for sale to oil companies and port authorities. He also reports research in Switzerland on the use of peat as a filter for decontamination of radioactively contaminated water. Research conducted at Sherbrooke in Quebec, Canada, has revealed the high efficiency of moss peat in the filtration of pigments and dyes in wastes from textile plants and in the filtration of mercury and other metals in wastes from

industrial plants.

The future for a peat industry in eastern Maine is bright in that good quality moss-peat deposits are available and have become increasingly accessible by a developing road network which includes the eastern United States market with its growing demand for peat and peat products.

U. S. GOVERNMENT PRINTING OFFICE : 1972 O - 457-084

References cited

American Society for Testing Materials, 1969, D 2607-69, standard classification of peats, mosses, humus, and related products: 1916 Race St., Philadelphia, Pa. 19103, 1 p.

Bastin, E. S., and Davis, C. A., 1909, Peat deposits of Maine, U.S. Geol. Survey Bull. 376, 125 p.

Bellamy, D. J., 1968, An ecological approach to the classification of European mires: Internat. Peat Cong., 3rd., Quebec, Canada, Proc., p. 74-79.

_____1972, Templates of peat formation: Internat. Peat Cong., 4th, Otaniemi, Finland, Proc., v. 1, p. 7-18.

Borns, H. W., Jr., and Calkin, P. E., 1970, Quaternary history of northwestern Maine, in New England Intercollegiate Geol. Conf., 62nd ann. mtg., Rangeley, Me., Oct. 2-4, 1970, Guidebook for field trips in the Rangeley Lakes-Dead River basin region, western Maine: /Syracuse, N.Y., Syracuse Univ., Dept. Geol./, variously paged.

Cameron, C. C., 1970a, Peat deposits in northeastern Pennsylvania: U.S. Geol. Survey Bull. 1317-A, 90 p.

_____1970b, Peat deposits of southeastern New York: U.S. Geol. Survey Bull. 1317-B, 32 p.

Davis, J. H., Jr., 1946, The peat deposits of Florida, their occurrence, development, and uses: Florida Geol. Survey Bull. 30, 247 p.

U. S. GOVERNMENT PRINTING OFFICE : 1959 O - 511171
867-100

Decarlo, J. A., 1971, Peat in Mineral facts and problems: U.S. Bureau of Mines, U.S. Government Printing Office, Washington, D.C., p. 137-146.

D'Hennezal, F., and Coupal, B., 1972, Peat Moss--a natural absorbent for oil spills: Canadian Mining and Metall. Bull., vol. 65, no. 717, p. 51-53.

Lucas, R. E., Rieke, P. E., and Farnham, R. S., 1966, Peats for soil improvement and soil mixes: Michigan State Univ. Coop. Ext. Service, Ext. Bull. no. 516, Farm Sci. Ser., 11 p.

Osvald, Hugo, 1970, Vegetation and stratigraphy of peatlands in North America: Nova Acta Regiae Societatis Scientiarum Upsaliensis Ser. V:C. vol. 1, 96 p.

Sheridan, E. T., 1970, Peat in U.S. Bureau of Mines minerals yearbook 1970: Washington, D.C., U.S. Government Printing Office, p. 803-810.

_____1972, Peat in U.S. Bureau of Mines minerals yearbook 1972: Washington, D.C., U.S. Government Printing Office, preprint p. 1-5.

Soper, E. K., and Osbon, C. C., 1922, The occurrences and uses of peat in the United States: U.S. Geol. Survey Bull. 728, 207 p.

Trefethen, J. M., and Bradford, R. B., 1944, Domestic fuel possibilities of Maine peat: Maine Geol. Survey Bull. 1, 47 p.

U. S. GOVERNMENT PRINTING OFFICE : 1959 O - 511171
867-100

Waksman, S. A., 1942, The peats of New Jersey and their utilization: New Jersey Dept. Conserv. and Devel., Geol. ser. Bull. 55, pt. A, 155 p.

Waksman, S. A., and Stevens, K. R., 1929, 1932, Contribution to the chemical composition of peat, V--The role of microorganisms in peat function and decomposition: Soil Science, v. 28, p. 315-340; v. 32, p. 95-113.

U. S. GOVERNMENT PRINTING OFFICE : 1959 O - 511171
867-100

Table 2.--Typical section and analytical data (physical properties) for peat deposits of Maine

Deposit No. (fig. 1)	Typical section (cumulative thickness in feet)	Ash (percent dry weight)	Water-holding capacity (percent)	Fiber > 0.15 mm (percent)	pH
	Aroostook county				
1.	Peat, 0-9 Clayey peat, 9-12	12.2	1890		5.4