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SOILS OF THE MESTERS VIG DISTRICT, NORTHEAST GREENLAND

1. THE ARCTIC BROWN AND RELATED SOILS

BY

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WITH 5 FIGURES IN THE TEXT
AND 1 PLATE

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Abstract

Pedological investigations conducted in the Mesters Vig district, Northeast Greenland, during the summers of 1961 and 1964 revealed well-drained soils that had previously been reported in Alaska under the name of Arctic Brown and in Siberia as Arctic Sod. The presence of Arctic Brown soil in Greenland is a link between the North American and Eurasian continents and establishes the Arctic Brown as a circumpolar soil. The areal distribution of the Arctic Brown and other well-drained soils is larger at Mesters Vig, because of well-drained conditions, than for some arctic areas of Alaska. It has been estimated that the Arctic Brown soil at Mesters Vig covers about ten percent of the area. The distribution and the properties of the Arctic Brown soil depend on drainage, texture of the substratum, stability of the site, and time. Physical and chemical data for a typical Arctic Brown indicate an accumulation of fines at the surface, an acid reaction, a concentration of organic matter at the surface, and an even distribution of free iron oxides throughout the profile. Podzol-like and Arctic Brown soils coexist in the district. An idealized latitudinal sequence of the zonal soils of the ice-free areas of Greenland should show from south to north the succession from Podzols to Arctic Brown to Polar Desert soils.

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INTRODUCTION

Recent studies in the arctic regions of Alaska (TEDROW and HILL, 1955; DREW and TEDROW, 1957; TEDROW *et al.*, 1958) have pointed out the limitations of previous pedological concepts accepted for the northern regions. The Arctic Brown, a weakly podzolized soil, is considered the zonal soil group for the Arctic; and Tundra, once considered at the level of zonal soil, is now classified as intrazonal (hydromorphic).

The major genetic soils of arctic are arranged along a catenary drainage sequence, moving from excessively dry to excessively wet conditions: Lithosols, Arctic Brown, Tundra, and Bog (TEDROW *et al.*, 1958).

Soils similar to the Arctic Brown, considered by TEDROW *et al.* (1958) as the northern expression of the Podzols of the boreal forest districts, have been reported under different names in Russia. FILATOV (1945) refers to Dry turf-lichen tundra while SVATKOV (1958) called similar soils Arctic Sod Soils. Until 1961, the year the writer visited Northeast Greenland for the first time, no reports were available on the extension of the Arctic Brown in the ice-free areas of Greenland. Recently, however, K. R. EVERETT disclosed the presence of Arctic Brown soils in the Taserssuaq area, southwest Greenland (*in* MIRSKY 1964). A pedological investigation in this region offered the possibility to close the gap between the American and Eurasian continent, and to test the zonality concept of the Arctic Brown on the circumpolar base.

During the summers of 1961 and 1964 the writer had an opportunity to visit Northeast Greenland when he joined a geomorphological project at Mesters Vig under the direction of Dr. A. L. WASHBURN, Yale University.

LOCATION AND PHYSIOGRAPHY

The Mesters Vig district in Northeast Greenland is a part of Scoresby Land, and is located along the south side of Kong Oscars Fjord at 72°14′ N and 23°55′W. Its natural boundaries are: on the north, Kong Oscars Fjord; on the south, Nedre Funddal; on the east, Mesters Vig (bay); and on the west, Skeldal (Plate 1).

The topography of the area is typical of a glaciated country with deep-cut and eroded valleys. A general discussion of the Mesters Vig district is given by Washburn (1965).

GEOLOGY

The Mesters Vig district is underlain mainly by predominantly continental Paleozoic sediments, which consist of shale, sandstone, and conglomerate, and also include estaurine and fluviatile deposits. Basaltic sills and dikes intruded the sediments during the Tertiary (Bondam, 1955; Washburn, 1965).

From the pedological point of view, the distribution of the different formations does not directly affect the formation of soils, because most of the area is mantled by glacial deposits of heterogeneous rock composition. The localities where the bedrock is exposed are generally steep slopes, ridge crests, and tops of mountains, on all of which only skeleton soils tend to occur.

The Mesters Vig district has been intensively glaciated, and glacial drift of different ages and provenance are now exposed. Colluvial, fluvial, and emerged marine deposits are also found in the district. The lateral moraines facing Kong Oscars Fjord are prominent among the glacial deposits. Emerged deltaic deposits consisting mainly of sand are distributed along the Fjord at altitudes of about 100 meters or less. In different localities below about 80 meters, there is an emerged fjord-bottom deposit (Washburn and Stuiver, 1962) rich in silt and clay with shells and erratics. Many of the slopes are affected by frost action and mass-wasting. Patterned ground (Washburn, 1956) is represented by sorted and non-sorted forms.

CLIMATE

The east coast of Greenland, because it is affected by ocean currents coming from the north, is colder than its counterpart to the west. The climate of Greenland above 70°N is influenced by arctic air masses. Precipitation and mean annual temperature in Greenland decrease northward. The district of Mesters Vig has a continental climate with a mean annual temperature of −9.7°C. Over a nine-year period the mean temperature of the coldest month was −24.3°C, and that of the warmest month was 5.9°C. Precipitation, including snow expressed as a water equivalent, averaged 373 mm per year over the same period (Washburn, 1965). Rainfall is most frequent during July and August. Fog is most common during the summer when the ice pack clogs the entrance of Kong Oscars

Fjord. During the summer the prevailing winds are east-southeast and in winter mainly west-northwest. The west-northwest winds originate from the ice cap. Darkness occurs between November and January and the midnight sun shines from the end of May to the middle of July. DIAMOND (1956) reports that an increase in temperature in Northern Greenland in the last 25 years has been followed by a decrease of precipitation on the ice cap. A more detailed report on Mesters Vig climate is provided by WASHBURN (1965).

VEGETATION

Only a broad picture of the botanical aspect of Mesters Vig is presented here. In addition to the numerous lichens and mosses, the vascular flora of the area consists of about 155 species (RAUP, 1965). The distribution of these plants varies; actual coverage of vascular plants ranges from one percent or less to ninety percent, with the most common coverage being twenty to forty percent. Barren and sparse cover is found on the emerged fjord-bottom expanses and on talus and rock-shattered peaks. The delta remnants are extensively covered with *Cassiope tetragona.* During the late summer patches of wet meadow display the typical white color of cottongrasses. In well-drained and stable sites, *Salix arctica*, *Vaccinium uliginosum*, *Arctostaphylos alpina*, *Dryas octopetela*, and *Betula nana* with grasses, sedges, mosses, and lichens are the most common plants. No peat deposits were observed with the exception of minor accumulations of partially decomposed organic matter associated with hummocks. A black organic crust ubiquitous to the district covers the surface of many Arctic Brown soils and other soils. It acquires a thickness of a few mm to 0.5 cm and it has a coriaceous consistency when dry. Under wet conditions the crust becomes pliable and thicker, with smooth labyrinth-like undulations. A thin layer of mineral soil is often attached under the crust. A well-developed crust may act as a mulch protecting the soil from rapid evaporation. RAUP (1965) regards the organic crust as consisting of a few lichens, numerous blue-green algae, and a considerable amount of dead organic matter.

SOILS

Arctic Brown soils occur in northern Alaska (TEDROW and HILL, 1955) and theoretically should occur in Northeast Greenland. The author's present investigation shows that Arctic Brown soils do occur, in fact, in the Mesters Vig district of Northeast Greenland as hypothesized.

Moreover, several other soils recognized in Alaska (Tedrow *et al.*, 1958; Brown and Tedrow, 1964) are found also in Northeast Greenland. They include the Podzol-like, the Upland Tundra, and the Meadow Tundra soils. Information regarding some soil characteristics may have been collected during geomorphological and botanical studies, but no pedological reports for the area are available. The main purpose of this paper is to report on the morphology and distribution of the Arctic Brown soils and on the factors effecting the occurrence of these soils. A single example of Podzol-like soils also is described.

Description of the Arctic Brown and Podzol-like soils of Mesters Vig District

Arctic Brown Soils

Commonly distributed in the well-drained vegetated sites of the district, the Arctic Brown soils (Fig. 1) display different morphologies and depths according to local differences in the physical and biological factors.

Occurrence. Arctic Brown is found predominantly on till, including lateral moraines, on kames, delta remnants, and on bedrock where enough fines have accumulated.

Profile Description. The profile described here is from a dissected lateral moraine oriented parallel to Kong Oscars Fjord at an altitude of 220 m. The predominant vascular plants near the profile consist of *Betula nana*, *Vaccinium uliginosum*, and *Salix arctica*. A black organic crust including some lichens covers the ground.

Data for this profile are presented in Table 1.

Table 1. *Some pedological parameters for an Arctic Brown soil, Mesters Vig, Greenland*

Horizons	Depth	Sand (2.0–0.05 mm)	Silt (0.05–0.002 mm)	Clay (< 0.002 mm)	Organic Carbon	Free Fe_2O_3	Electrical Conductivity Mmhos/ cm	pH
	cm	pct.	pct.	pct.	pct.	pct.		
A_1 (A1)	3– 7	58.6	35.4	6.0	9.1	1.30	0.2	5.6
B (B)	7–22	87.6	10.2	0.7	0.7	1.00	0.2	5.7
C_1 (C1)	22–40	89.6	7.2	0.7	0.7	0.75	0.1	5.7
C_2 (C2)	40–45	63.6	23.2	0.3	0.3	1.14	0.1	6.7

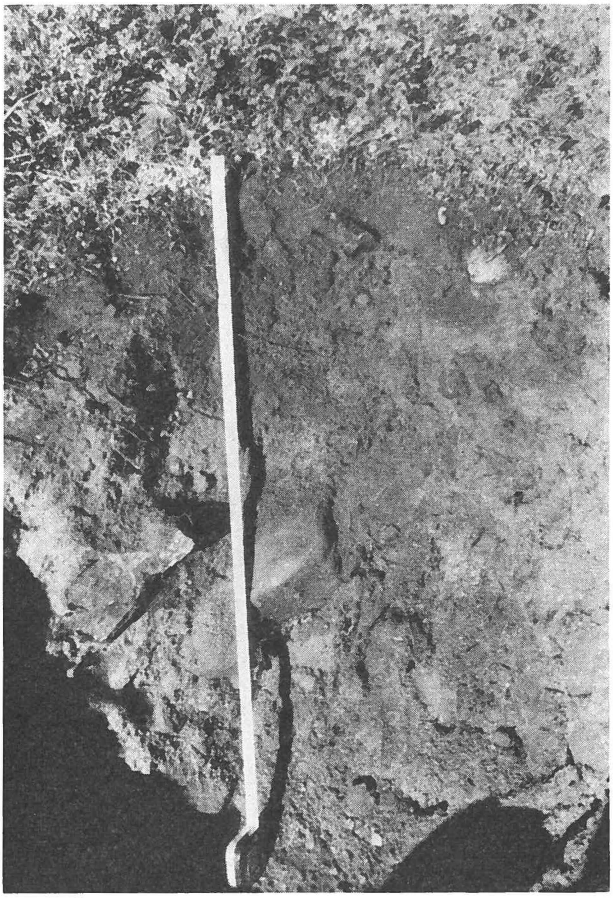


Fig. 1. Arctic Brown soil profile on a lateral moraine along the slopes of Hesteskoen.

Depth cm	Horizon	Morphology
0 to 1, 2	A_{00} (01)**	Black organic layer, fluffy discontinuous with woody and fibrous plant remains.
1, 2 to 3, 4, 5	A_0 (02)	Black mineral-organic horizon well humified with a fine texture and a gresasy feel. This horizon shows a pocket-like distribution suggesting a process of deposition between a microknobby topography.
3, 4, 5 to 5, 7, 13	A_1 (A1)	Very dark grayish-brown (10 YR 3/2)* sandy loam, single-grained and with roots. Pebbles and cobbles show staining; loose.
5, 7, 13 to 20, 22, 23	B (B)	Dark yellowish-brown (10 YR 4/4) loamy, single-grained and few roots.
15, 22, 23 to 40	C_1 (C1)	Grayish-brown (10 YR 5/2) sandy layer.
40 to 45	C_2 (C2)	Clayey material with a till-like appearance.

* Munsell Color Notation, Munsell Color Co., Inc., Baltimore, Md. Color determined under moist field conditions.

** New nomenclature of soil horizons (U.S.D.A. Supplement to Agriculture Handbook No. 18, issued May 1962).

Profile Description. This Arctic Brown profile is from the delta remnants. A carpetlike dense *Cassiope tetragona* covers the flat expanses of the delta with only few plants of *Salix arctica* and *Lycopodium Selago*.

This profile shows a mantle of wind-blown sand.

Depth cm	Horizon		Morphology
0 to 1	A_{00}, A_0	(01, 02)	Very dark gray (N 3/0) organic layer with lichens and a dry organic crust, dry.
1 to 9	A_1 (?)	(A1?)	Dark gray (5 YR 4/1) loamy sand dry with streaks of buried organic material parallel to the soil surface; single-grained; loose.
9 to 30	A_1	(A1)	Dark brown (7.5 YR 4/2) loamy sand with few streaks of organic material; single-grained; loose.
30 to 42	B	(B)	Weak red (2.5 YR 4/2) loamy sand, single-grained; loose.
42 to 65	C	(C)	Dark gray (5 YR 4/1) stony layer with a sand matrix.

Podzol-like Soils

Podzol-like soils are very limited in distribution and they were found only in one locality, a dissected lateral moraine along the north flank of Hesteskoen.

Profile Description. The profile described here occurs on a well-drained site with a very luxuriant vegetative cover of *Betula nana*, *Salix arctica*, *Dryas octopetala*, grasses, *Arnica alpina*, and mosses. The thickness of the organic cover is unique in comparison with other well-drained locations. Droppings of musk ox were present in the area. The topography of the site is conducive neither to late snow accumulation nor to surface water collection.

Depth cm	Horizon		Morphology
0 to 5	A_{00}	(01)	Reddish-brown (5 YR 4/4) horizon of partially decomposed litter, woody with an admixture of musk-ox droppings.
5 to 10	A_0	(02)	Very dark gray-brown (10 YR 3/2) horizon consisting of well-decomposed organic debris, powdery and fluffy. Mineral matter increases with depth.
10 to 14, 16	A_2(?)	(A2?)	Light gray (10 YR 7/2) silt loam with roots. Cobbles in this horizon are not stained but appear rather fresh; single grained; loose.
14, 16 to 25, 31	B	(B)	Strong brown (7.5 YR 5/8) pebbly with a sandy matrix. No visible structure. Loose.
25, 31 to 50	C	(C)	Pale yellow (2.5 YR 7/4) cobbly layer with a sandy and pebbly matrix; loose.

Factors Affecting the Distribution of the Arctic Brown Soils

The distribution and the properties of the Arctic Brown soils at Mesters Vig are a result of different factors: drainage, texture of the substratum, stability of the site, and time. The areal distribution of Arctic Brown soils at Mesters Vig is estimated to be only about ten percent, because of the limited occurrence of concomitant favourable conditions for their formation.

The texture of the Arctic Brown soils at Mesters Vig varies between loam and loamy sand. A thin cover of silt mixed with sand resting on more coarse textures occurs locally. Gravelly conditions are also encountered. The merged fjord-bottom of clay loam sediments, so widespread at Labben, does not show any indication of Arctic Brown profiles. However, where the marine clay loam becomes covered by coarse deposits, as at the edge of a talus slope, a miniature Arctic Brown is found on the coarse-textured material resting on the clay loam. A transect across these two types of materials shows a soil sequence starting with a Meadow Tundra soil on the marine deposits and ending with a miniature Arctic Brown, and having as intermediate an Upland Tundra soil and an incipient Arctic Brown. The texture of the substrata varies from sandy-clay loam to loamy sand. Gentle slopes having a sandy texture show no Arctic Brown where gelifluction processes are active.

Frost churning and frost heaving, depending on the degree of intensity, also become limiting factors in the formation of the Arctic Brown. An example of soil profile disruption was observed at Labben on a basaltic knob. Here the horizons of an Arctic Brown profile appear to be convoluted and distorted by a mass of fine and medium sand with cobbles and pebbles. Figures 2 and 3 show a lobe of intruded material that has disrupted the horizontal sequence of a normal Arctic Brown. Other examples can be cited where portions of an Arctic Brown profile have been affected by frost churning.

Similar disturbances are produced also by the melting of ground ice. Dr. Washburn showed the writer a case where the disappearance of ground ice has resulted in a subsidence with a consequent displacement of the soil horizons.

As active frost heaving and gelifluction processes can destroy or dismember a normal profile, so the cessation of these processes may allow the pedogenic processes to colonize areas which have become stable. Cross sections opened on a mesh of a sorted net complex (Washburn, 1956) show in the outer part of the mesh that areas of stability are now occupied by shallow and miniature Arctic Brown profiles. Also, the

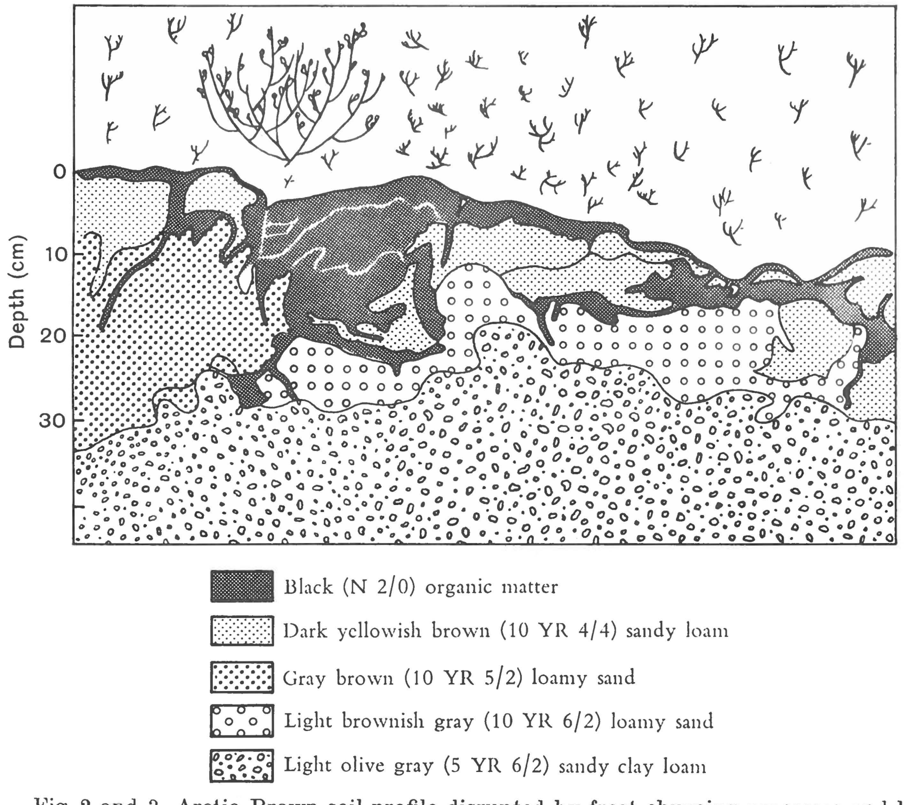


Fig. 2 and 3. Arctic Brown soil profile disrupted by frost churning processes and by the intrusion of lobes of frost-heaved material.

fronts of gelifluction lobes may, when stabilized, display miniature Arctic Brown soils. In patterned ground the Arctic Brown very often is limited in its expansion by frost-active lobes of moist massive silty material permeated with vesicles and incapable of developing Arctic Brown soils.

During the spring and the autumn, conditions are favorable for needle ice formation. Observations made during the early part of September 1964 revealed ice crystals with a maximum length of 0.9 cm formed preferentially on barren ground. No ice crystals were observed under a vegetative cover.

Denudation produced by needle ice has been reported by TROLL (1958) in differnet regions of the world; the turf cover undermined and detached by the growing ice crystals dries out and eventually is blown away. Locations where the Arctic Brown is found, even if sparsely covered, do not appear denudated by needle ice. To evaluate the effect of needle ice on the Arctic Brown and other soils, considerably more observations need to be made.

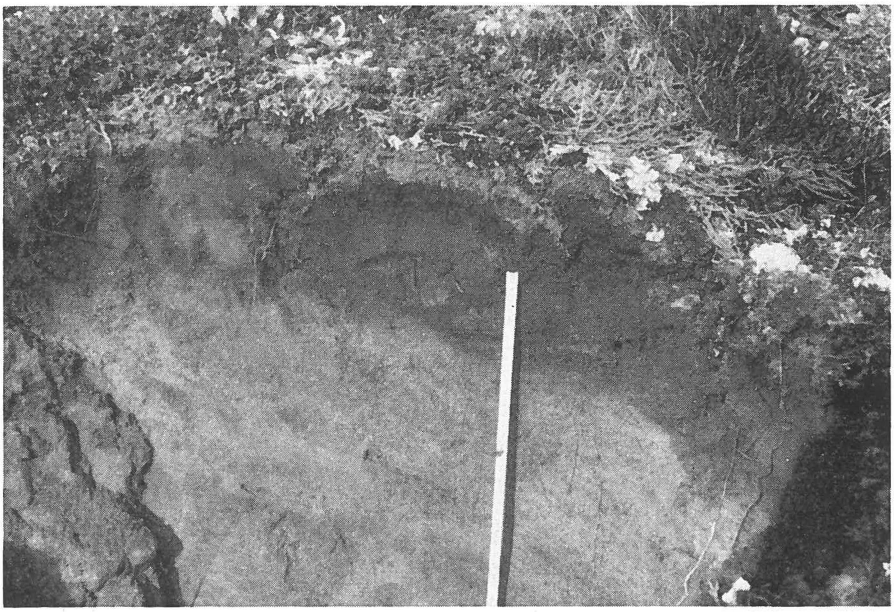
Another factor affecting the morphology of the Arctic Brown is the presence of extensive surficial cracking which is so widespread in the district. Surficial cracks seem to be common in other parts of Greenland. EVERETT (personal communication) observed similar phenomena in the well-drained sites of West Greenland. The exact mechanism of crack formation is not yet known. Some of the cracks may have been produced by desiccation, others by frost. The crack pattern is emphasized by a microrelief delineated by the fissures. In cross section, a crack, after following a more or less downward vertical direction, may become bifurcated. Generally the two arms of the fork are opened at an angle of 90° or more (WASHBURN, personal communication). Cracks are preferentially penetrated by roots, and the soil between the major and the secondary cracks once colonized by plants tends to accumulate organic matter. Organic substances also may be washed into the soil through the cracks. The progressive augmentation of organic material within the crack system tends to increase the thickness of the A1 horizon, which acquires a festoon-like appearance. The demarcation between the A1 and the B horizons is generally very distinct. Deep cracks as well as thick A1 horizons were found in the delta remnants, old beaches, and kame complex (Figs. 4 and 5). In the clay loam of the emerged fjord-bottom deposit, the cracks are probably deeper. However, there is not enough plant cover to build an extensive A1 horizon. In well-vegetated areas with well-developed cracks, the Arctic Brown may show an A C profile.

Accumulation of organic matter in many Arctic Brown soils is not restricted to the surface A1 horizon. Convoluted streaks of well-decomposed humic substances are found irregularly distributed at depth in many soil profiles of the delta remnants and river terraces. Some of the buried organic streaks may be traced to the surficial cracks, but others show no direct relation. MACKAY (1958) in discussing the origin of subsurface organic layers in permafrost areas points out that in sandy soils the permafrost is deeper and vegetation is less abundant than in silty substrata. Therefore, in sandy soils, the organic material is frozen at shallower depths and it does not get buried too easily; consequently, it occurs as streaks rather than layers. Some of the burial may have taken place when the permafrost table was closer to the surface and frost churning processes were more active.

The Arctic Brown profiles developed on top of delta remnants are buried in places by the progressive accumulation of eolian sand. The sand is derived from the unvegetated slopes below and flanking the delta remnants, and forms a mantle which may vary in thickness from a few centimeters to as much as a meter. The buried Arctic Brown soils are very similar to the exposed ones, indicating either a recent burial or a climate, prior to the burial, very similar to the present one. A similar phenomenon was observed along the slopes of Hesteskoen, but with a lesser degree of intensity.

From observations on the delta remnants, it was found that: (a) the thickness of sand mantle is a function of the distance from the source area, (b) a continuous addition of wind-blown sand coupled with paucity of water must be the cause for lack of profile development on the transported sand, (c) discontinuous increments of blown sand may allow an A1 horizon to develop on top of the original profile. Depending on the available moisture and on the rapidity of burial, a new A1 superimposed on the original soil may appear either as an homogenized mass or as lineated by dry organic layers. When the enlargement of the A1 horizon is due to wind-transported material, the buried old surfaces are normally visible. When, however, the enlargement is due to crackings and penetration of roots and plant material, no buried old surfaces are apparent.

In Mesters Vig, soil development on glacial deposits of different ages is especially significant. According to geomorphological and in some instances C-14 evidence, the glacial and fluvial deposits of the district can be arranged in a chrono-sequence (WASHBURN, personal communication). This sequence is in the main corroborated by pedological findings. However, a definite agreement between age of the land and soil development as exemplified by the depth of the soil profile is better obtained in the extreme cases; that is, on either very old or very young deposits. Evidently, differences in parent material, vegetation, and microclimate among the glacial features tend to overshadow the time factor. Thus,



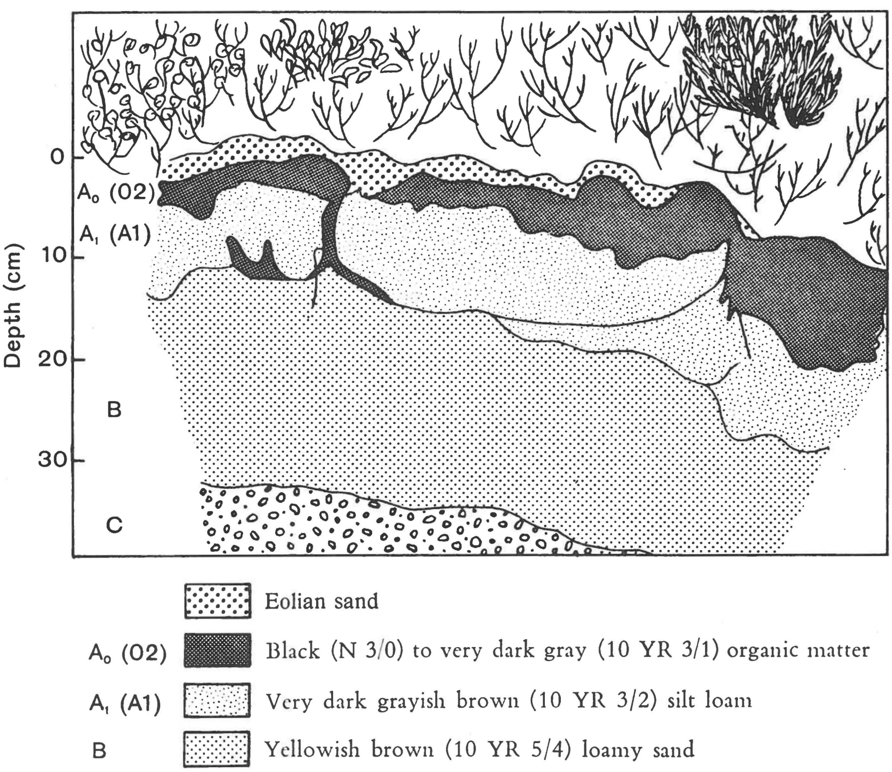


Fig. 4 and 5. Arctic Brown soil profile affected by surficial cracking. Note the concentration of organic matter in the cracks.

soil formation progresses more rapidly on young, loose, unconsolidated sand than on old, firm, compact till or on exposed bedrock. Consequently, some of the soils derived from the delta remnants appear well developed in spite of the relatively young age of the parent material. On the other hand, when examination is made of glacial deposits consisting of comparable parent material having similar topography but differing in age, distinctive differences in soil development are found. Such observations were made during a cursory investigation in the Skeldal.

The fluvial terraces along the northeast side of the northwest outlet of Tunnelelv offer a better example where time can be singled out as a determinative factor in soil formation. Here the terraces at elevations of 20, 23, and 26 m show soil profiles at different stages of development. The 20-m terrace, the lowest, displays a water-laid sand and gravel profile with a veneer of organic matter, while the 26-m terrace shows a shallow Arctic Brown soil with distinguishable horizons. The intermediate terrace shows a sandy Regosol with a very contorted humus layer. The three localities also show noticeable differences in vegetative cover and composition. The upper level appears more vegetated and supports a more mature flora.

Of special interest with respect to the morphology of the Arctic Brown are the areas occupied by birds. Nesting areas located on top of prominent features such as knobs on kames or deltas are particularly striking for localized luxurious growth of plants. In the first 16 cm, the Arctic Brown profile shows an intense accumulation of roots and rootlets, and fibrous organic debris. Because of exposure to wind, the soil profile is dry and the cobbles below the surface show accumulations of secondary carbonates. It is believed that these areas would not be covered by Arctic Brown soils if it were not for the fertilizing effect of the bird droppings.

Concerning the distribution of the Podzol-like soils, the limited occurrence of these soils in the district prevents a more detailed discussion. The genetic authenticity of these soils, amply discussed by Brown and Tedrow (1964), cannot be proven or disproven by the single profile of Mesters Vig. It is important to mention, however, that from field observations the A2 horizon of the Podzol-like soil at Mesters Vig probably was not of eolian origin. Numerous situations were encountered where a gray silty layer could have been mistaken for an A2 horizon; however, in all these cases the gray layer rested on an old 01 horizon. No traces of an old surface were found below the A2 of the Podzol-like profile. Even if the bleached horizon is not authigenic, with time it should have been stained by the above organic layer, as are many A1 horizons of the Arctic Brown soils. Moreover, the cobbles found in the A2 are fresh and bleached, and they lack the patina so common in the cobbles of the A1 of the Arctic Brown. This would indicate a bleaching potential typical of podzols.

Experimental Procedure

In the less than 2-mm soil fraction from the Arctic Brown profile described earlier, the following determinations were made: mechanical analysis, organic carbon, free iron oxides, electrical conductivity, and pH.

Mechanical analysis was carried out according to the hydrometer method (BOUYOUCOS, 1927). Organic carbon was estimated by the chromic acid reduction method (PURVIS and HIGSON, 1939), and the free iron oxides by KILMER's procedure (1960). The pH and electrical conductivity were determined in the 1:1 soil: water extract (RICHARDS, 1954).

Results

Table 1 shows a partial chemical analysis of the Arctic Brown profile. The mechanical analysis of this profile reveals an increase of clay and silt at the soil surface. An accumulation of the fine fractions at the surface may have resulted from different mechanisms: (1) eolian activity with consequent capture of the fines by plant roots; (2) dust on top of snow; (3) washing by streams during the spring melting.

Variations in texture from one horizon to another are probably more related to depositional processes than to pedological ones. Soil reaction indicates more acid conditions at the surface with values approaching neutrality in the C horizon. Free iron oxides are distributed almost evenly, a characteristic common to many Arctic Brown profiles of Alaska (BROWN and TEDROW, 1964). Organic carbon is concentrated at the surface and decreases markedly with depth. This condition suggests a minimal root system in the lower depths, and little translocation of organic compounds.

DISCUSSION

Consistent with the concepts used to designate mature or zonal soils for any given region (MARBUT, 1927), TEDROW *et al.* (1958) recognize Tundra soils formed under conditions of impeded drainage as intrazonal (hydromorphic), and the Arctic Brown derived from well-drained sites as the zonal soil for the arctic regions. In northern Alaska, and possibly in the wide expanses of arctic Siberia, Arctic Brown soils are limited in areal distribution (TEDROW and HILL, 1955), while the intrazonal Tundra soils are the more widespread. In the Mesters Vig district, however, due to the prevailing moderate to well-drained conditions, the Arctic Brown shows more extensive coverage than for comparable areas in northern Alaska. Many different factors may be involved in producing better drainage, one of the most obvious being that the frost table in similar materials is encountered at greater depth at Mesters Vig than in northern Alaska. In spite of the deeper active layer, the solum of the Arctic Brown in Mesters Vig does not always attain a greater thickness.

While the arctic Brown soils recognized in the Mesters Vig district conform in general to the description given for the Arctic Brown of northern Alaska, there are certain morphological characteristics, such as the enlargement of the A1 horizon due to cracking of the ground, which are as yet unreported in other arctic regions. The A1 horizon has in some cases extended to the point that the B horizon is only a few cm thick. If the expansion of the A1 horizon is a normal evolutionary process, then in some instances the Arctic Brown would change from an A, B, C to an A, C soil.

The occurrence of a Podzol-like soil in the prevailing Arctic Brown region of Mesters Vig is substantiated by findings of podzolized conditions in other regions of Greenland (Böcher, 1949; Everett *in* Mirsky, 1964). Podzols of northern latitudes probably are not purely accidental even if their origin and development are uncertain. The conjecture that the Arctic Brown is a weakly podzolized soil (Tedrow *et al.*, 1958) argues in favor of a concomitant occurrence of Arctic Brown and Podzol-like soils. Minor modifications in the micro-environment capable of inducing a more moist regime, an accumulation of humus, and possibly a more acidic reaction, are probably sufficient to provide those conditions under which a Podzol-like soil may develop. Although Podzol-like soils in the Brooks Range, Alaska, have been extensively discussed by Brown and Tedrow (1964), the genetic authenticity of these soils has been left open to question. If the Arctic Brown, however, is not a weakly podzolized soil, as Mikhaylov (1961) asserts, then the Arctic Brown and Podzol-like soils may not be members of the same genetic cycle. Whatever the explanation, Arctic Brown and Podzol-like soils still exist at 72°N latitude on the northeast coast of Greenland. This implies that at this latitude we are still in a transition zone where both the Arctic Brown and the Podzol-like soils may be found in association. Ratmanov (Joffe, 1949) observed weakly podzolic soils in Novaya Zemlya at 74°N latitude.

In well-drained sites in the Arctic regions, a progressive increase in latitude should result in a gradual suppression of Podzols, while the Arctic Brown at higher latitudes should in turn be replaced by Polar Desert soil (Tedrow, *et al.*, 1958). Tedrow and Brown (1962) reported Polar Desert soils as the last segment in an altitudinal soil sequence in the Brooks Range, Alaska, and following the suggestion of GORODKOV (1939) they imply a latitudinal distribution for the Polar Desert on a circumpolar basis.

Polar Desert soils, when zonal, are restricted to true polar regions, but have counterparts at lower latitudes. From the air, large areas in Jameson Land (71°31′N), for example, appear to be completely barren. The extreme continentality of many ice-free areas of Greenland may produce Polar Desert soils that are not different genetically from the zonal type. TEDROW and DOUGLAS (1964) record the presence of Polar Desert soils in Bank Island (72°23′N and 121°54′W) together with Arctic Brown and Tundra soils.

The occurrence of Arctic Sod soils and desert conditions in Bolshevik Island 78°15′ to 79°30′N latitude (MIKHAYLOV, 1960), shows that at this latitude a transition zone exists between Arctic Brown types of soils and Polar Desert.

Greenland, because of its geographical position extending from about 60°N to about 83°N latitude, provides an almost continuous latitudinal sequence from arctic to true polar conditions along its east and northeast coasts. Geological investigations in Northern Greenland, mainly in Peary Land (FRISTRUP, 1953), Polaris Forland and Jørgen Brønlund Fjord (DAVIES, 1961), reveal a true desert environment. Soil moisture measurements obtained by DAVIES (1961) show relatively dry conditions in both clayey and sandy substrata. The cold desert, as the dry cold expanses of the high Arctic in Greenland may be called, experiences a high degree of continentality with low temperatures and low precipitation. Although there is a lack of pedological information about the soils of this area, Polar Desert soils should be found here.

Observations made by the writer in the ice-free areas of McMurdo Sound, Antarctica, where true cold desert conditions exist, show that soil-forming processes are still operating and soils are forming. Salinization and oxidation have been considered as the major processes now acting in Antarctica (UGOLINI, 1963). Lack of pedological information prevents ascertaining whether the polar regions of Greenland are affected by processes similar to those reported in Antarctica.

CONCLUSION

The zonal soil for Mesters Vig area is the Arctic Brown, a well-drained soil previously recognized in northern Alaska and similar to the Arctic Sod soils found in Bolshevik Island. The Arctic Brown of Mesters Vig district is believed to be typical for all ice-free areas of Greenland within the climatic parameters required to produce an Arctic Brown.

A morphology, unreported elsewhere, is acquired by the Arctic Brown at Mesters Vig in areas affected by surficial cracks. Other factors such as texture, stability of the site, and time, also are prominent in dictating morphological features in the Arctic Brown profiles. Chemical and physical data for a single Arctic Brown profile show much resemblance to similar soils from northern Alaska. Prevailing well-drained conditions in Mesters Vig reduce the distribution of poorly drained soils, thus permitting Arctic Brown soils to cover more extensive areas. A single example of Podzol-like soil in a predominant Arctic Brown district may imply that at this latitude a transition zone exists between these two soils. The latitudinal limits of the Arctic Brown in Greenland are not known. In this connection it would be of great interest to establish the northernmost extension of the Arctic Brown into the Polar Desert. Desert conditions reported in Peary Land strongly suggest a climatic environment that is favorable only for soils similar to those found in the ice-free areas of Antarctica.

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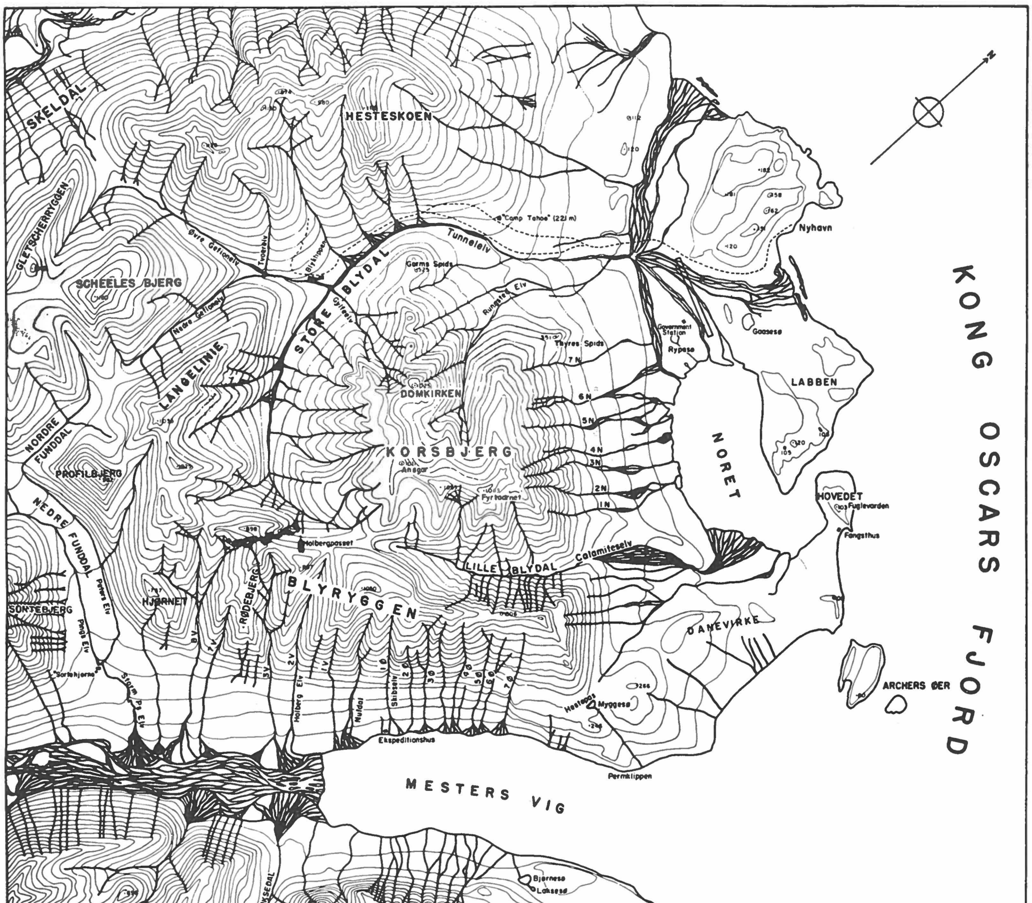

TOPOGRAPHIC MAP OF THE MESTERS VIG DISTRICT, NORTHEAST GREENLAND

0 1 2 3 4 km

CONTOUR INTERVAL 50m