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GEOMORPHIC AND VEGETATIONAL STUDIES IN THE MESTERS VIG DISTRICT, NORTHEAST GREENLAND

GENERAL INTRODUCTION

BY

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WITH 8 FIGURES IN THE TEXT
5 TABLES AND 5 PLATES

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Abstract.

The research program, to which the present report is the general introduction, was conducted in the Mesters Vig district of Northeast Greenland from 1956 to 1961. The research stressed repetitive observations of geomorphic processes, especially mass-wasting, and the interaction between these processes and vegetation in an arctic environment. Floristic studies and investigations dealing with glacial geology and deleveling were also important elements of the program. The results of these various studies will be published in separate numbers of the *Meddelelser om Grønland.*

As a general introduction to the report series, the present report describes the program and summarizes the general nature of the Mesters Vig district—its topography, vegetation, climate, and geology. The report also includes several previously published items, in order to bring together into a single report series all the data resulting from the Mesters Vig program. These items, mostly abstracts, deal with slushflows, instrumental observations of frost creep and gelifluction, and deleveling. Much fuller discussion of these and other subjects will appear in the subsequent reports.

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FOREWORD

The basic objective of the Mesters Vig geomorphic research program was to study an arctic area in some detail for several years in order to obtain an insight into the geomorphic processes characterizing it. The establishment of a number of experimental sites from which quantitative data could be obtained, in some cases in great detail, was an essential element of the program. Because the break-up period in the spring and freeze-up period in the autumn are critical for many processes, and the writer had other obligations during the winter, it was necessary to choose an area where air transport permitted year-around access. An additional requirement was the availability of medical assistance in an emergency, since the writer's family was to accompany him. The Mesters Vig district where the Nordisk Mineselskab A/S was operating a lead-zinc mine proved to be ideally suited as described later.

The program was started with a hasty reconnaissance in the summer of 1955. The reconnaissance was continued and several experimental sites were established the following year, and the first instrumental observations of significance were made in 1957. The program was then continued each year through 1961 and in 1964, although the writer himself did not visit the area in 1959 and 1961. For varying periods in 1956–1958, 1960, and 1964 Professor HUGH M. RAUP, Director of the Harvard Forest, and Mrs. RAUP collaborated in the program and were responsible for its botanical phases. Separate numbers of the *Meddelelser om Grønland* will be devoted to the results of their work. Except for the presence of the writer's own family, the participation of Professor and Mrs. RAUP has meant more to the writer than he can adequately express. Independent studies were also carried out by Dr. FIORENZO UGOLINI then of the Department of Soils at Rutgers University, who investigated the soils of Mesters Vig district in 1961 and 1964, and to whom the writer is also much indebted for collaborating in the program.

The botanical studies resulting from the program will cover the flora, the problem of turf hummocks, and interrelations between vegetation, site gradients, and geomorphic processes. These interrelations will be approached from several points of view. The soil studies will cover morphology as well as provide detailed analytical data. The geomorphic studies will discuss weathering, frost action, patterned ground, mass-wasting, glacial geology, and deleveling. It is anticipated that each of the above studies will be issued as one or more individual numbers of the *Meddelelser om Grønland*, and that the first numbers to be issued, aside from the present general introduction, will cover the flora, turf hummocks, and instrumental observations of mass-wasting.

The metric system is used throughout and all temperatures are in degrees centigrade unless otherwise indicated. The designation "MS" stands for "map summit" and the accompanying figures refer to summit altitudes given on the map of the Mesters Vig district. This procedure was adopted as a convenient means of identifying unnamed features; the altitudes are the best available but errors of up to about 20 m were noted in some contours and are probably also inherent in some summit altitudes and spot altitudes on the Mesters Vig map series. In general this series, prepared by the Geodetic Survey of Denmark on a scale of 1:15,000 on basis of plane tabling and air photographs, proved to be remarkably accurate and greatly facilitated the work. Paulin altimeter surveys by the writer provided supplementary altitude data in places and, where critical, are specified in the text. The attempt has been made to avoid introducing new names. In the few places where a name has been used that does not appear on official maps, it has been put in quotation marks.

The magnetic declination at the Mesters Vig airfield in 1952 was 33°30′W. and in 1959 it was 30°30′W., according to airfield records. In 1961 it was 30°W. (Statens Luftfartsvæsen, written communication, 28 June 1961). To allow for the decrease, Brunton compass readings have been corrected to the nearest degree by interpolation.

Colors specified by chroma and hue (in parentheses) are based on the rock-color chart distributed by the Geological Society of America in 1951.

In general definitions of terms are given only if they are not listed in the American Geological Institute "Glossary of geology and related sciences" (Howell, 1960) or if they differ from the listed definitions.

The following are some of the abbreviations (singular and/or plural forms) used in this report.

ES	Experimental site(s)
MS	Map summit(s)
MW	Mass-wastingmeter(s)
T	Target(s)
TC	Thermocouple(s)
TCS	Thermocouple string(s)
TG	Thermograph(s)

ACKNOWLEDGMENT

First and foremost the program participants are deeply indebted to the Danish Government authorities and to the Nordisk Mineselskab A/S for permission to work in the Mesters Vig district and for helpful cooperation without which the program would have been impossible. Particular gratitude is due to Director Eske Brun of the Ministeriet for Grønland, to General Manager Viggo Brinch and the staff of the Nordisk Mineselskab A/S, and to the Statens Luftfartsvæsen and its staff at Mesters Vig. The Geodætisk Institut furnished maps and air photographs, and the Kgl. Danske Flyvevåben kindly provided space on several flights with its ice-reconnaissance unit at Mesters Vig. Dr. Lauge Koch and personnel of his Danske Expeditioner til Østgrønland were most helpful in many ways. Danish Consul-General Ludvig Storr and Mrs. Storr in Iceland greatly facilitated arrangements there.

Dr. Horace G. Richards of the Philadelphia Academy of Natural Sciences, and Percy A. Morris of the Yale Peabody Museum identified the molluskan collections. The Yale Radiocarbon Laboratory under the Directorship of Dr. Minze Stuiver carried out the radiocarbon-age determinations. William A. Briesemeister of the American Geographical Society, and Charles H. Wilson, an instructor in the Department of Art at Yale, prepared many of the maps and diagrams, some of which were subsequently redrafted under the aegis of the *Meddelelser om Grønland* to assure uniformity.

In the field the writer was assisted by John E. Cotton in 1955; Stephen M. Winslow in 1956; Dr. Robert W. Galloway, David Fletcher, and Laurence Lyons in 1957; and by David Fletcher, Fred Pessl, Jr., and John Scully in 1958. In 1959 Scully continued the observational program in the writer's absence, with the part-time aid of Pessl and G. A. Jarre, who were in the vicinity in connection with Pessl's own program in the Sortebjerg area (Funddal-Deltadal area). Scully returned to the field with the writer in 1960, and in 1961 he and Dr. Fiorenzo Ugolini continued the observational work in the writer's absence. Fred Pessl, Jr. and an assistant, Norman Lasca, who were continuing the work in the Sortebjerg area, also assisted with several of the observations in 1961. Norman Lasca who carried out an independent

geomorphic and glacial research program in Skeldal in 1962 and 1963, again made several observations for the writer in the latter's area. Both he and Dr. UGOLINI returned to the Mesters Vig district with Professor RAUP and the writer in 1964. When not in the field, SCULLY worked on data reduction. The program owes much to all these participants. Grateful acknowledgment to those who assisted more specific phases of the work will be made in the number of the *Meddelelser om Grønland* covering that work. Professor RICHARD F. FLINT of Yale very kindly read the manuscript of the present number.

Finally the program is deeply indebted to the Arktisk Institut of Denmark. The Institute's founder, Dr. EJNAR MIKKELSEN offered much helpful advice and encouragement, as did Dr. HELGE LARSEN, its former Director and present Chairman of the Board, who made it possible for the results of the Mesters Vig program to appear in the *Meddelelser om Grønland*.

SETTLEMENTS AND LOGISTICS

The Mesters Vig district[1]) is located on the south side of Kong Oscars Fjord, about 50 km from its entrance, in the heart of the fjord region of East and Northeast Greenland (figs. 1–2).[2]) The coordinates of the Danish Government station are lat 72°14′N., long 23°55′W. Mesters Vig, translated, is Mesters bay and is employed for the settlement as well as the bay. Where the latter is specifically meant, the term Mesters Vig (bay) will be used.

The settlement, which included several habitation sites and numbered some 150 persons during the summer when the population was at maximum, was by far the largest in Northeast Greenland but is now reduced to the government station. The settlement arose in connection with the lead-zinc mining and the mineral-exploration activity of the Nordisk Mineselskab A/S (Northern Mining Company) of København, which began operations in 1952 (Astlind and Fahlström, 1957; Raitt and Fraser, 1958; Reece and Mather, 1961), and terminated them in 1962. The airfield was constructed to assist the mining operations and is maintained by the Statens Luftfartsvæsen (Government Air Service). The staff there is also responsible for radio communication and for weather observations and forecasting. Since termination of the lead-zinc mining, the Danish Government station is the only habitation site.

There is no other year-around settlement in the Kong Oscars Fjord region. Ella Ø was used for many years as the headquarters for Dr. Lauge Koch's Geological Survey of East Greenland summer program, and is now occupied for parts of some years by the East Greenland Sledge Patrol. Isolated hunters' huts are scattered through the region and a

[1]) The term district here carries no administrative implication.

[2]) "There is no official definition of the terms East Greenland and Northeast Greenland. However, you are absolutely safe in naming everything north of Scoresbysund as Northeast Greenland. Personally, I make the following distinction: Southeast Greenland from Kap Farvel to Angmagssalik; East Greenland from Angmagssalik to Scoresbysund; Northeast Greenland from Scoresbysund to Nordostrundingen [northeast tip of Greenland]." (Personal communication from Dr. Helge Larsen, then Director of Arktisk Institut, København, 21 May 1962). Usage varies and others include the Kong Oscars Fjord region as part of East Greenland.

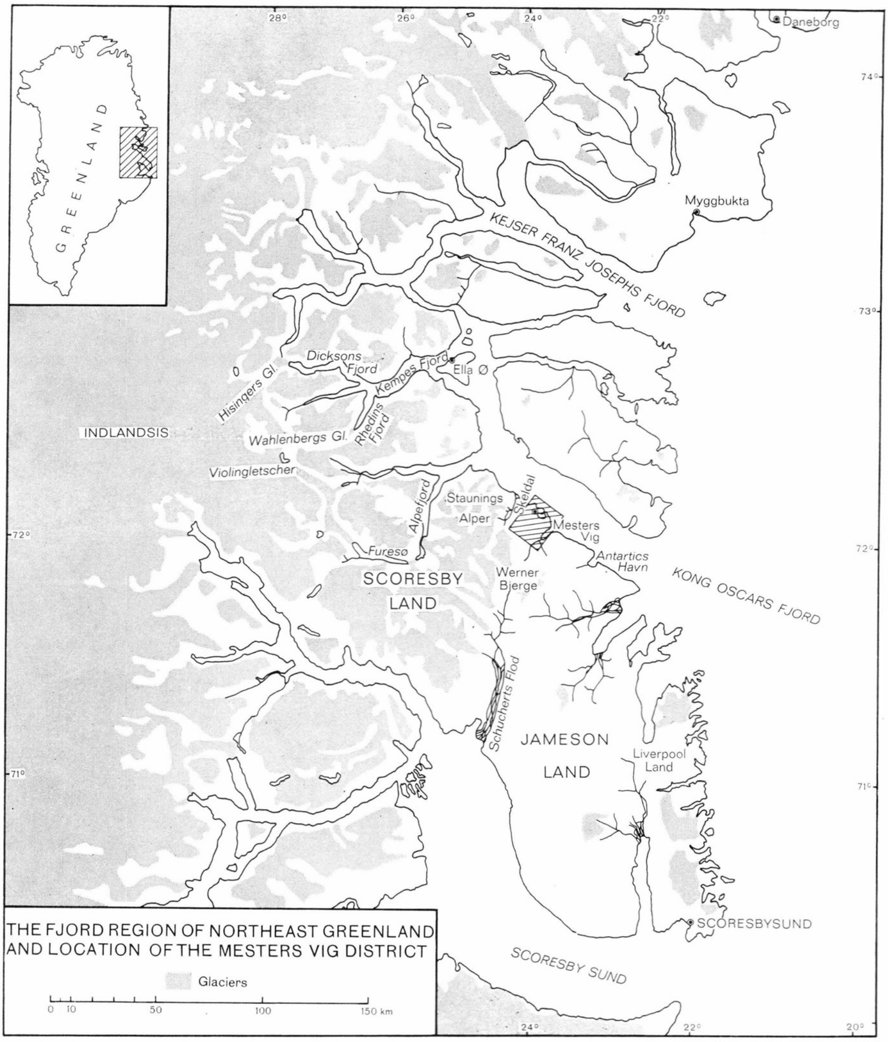

Fig. 1.

few hunters and trappers have lived there the year around. The main base for this activity in the Kong Oscars Fjord region was at Antarctics Havn.

The location of the government station at the "Flyveplads" (airfield), and of the former habitation sites — Blyklippen (or "Minebyen" — mine town), Nyhavn (harbor), and "Camp Tahoe" — is shown on plates 1–2. A geomorphic diagram of the district is reproduced in plate 3. "Camp Tahoe" was program headquarters and was on an abandoned section of the road from Nyhavn to Minebyen. The map location is between the 240- and 250- m contours near the east base of Hesteskoen, but the actual altitude of "Camp Tahoe" as determined by averaging a number of Paulin-altimeter traverses is 221 m.

Logistics has always been a major problem in Northeast Greenland because of the menace to shipping of a belt of southward-moving pack ice along the coast. This belt includes heavy polar ice and may exceed 150 km in width and completely block access to the Kong Oscars Fjord — Kejser Franz Josephs Fjord complex (Koch, 1945). It has earned the reputation of being more dangerous to ships, including icebreakers, than most antarctic ice. However, the establishment of the airfield at Mesters Vig has greatly alleviated the problem. Not only did transport aircraft help to supply the Nordisk Mineselskab mining operation, but routine aerial ice reconnaissance could be carried out during the shipping season.

The ice of Kong Oscars Fjord generally breaks up by the end of July, and, with favorable ice conditions, ice-strengthened freighters of the J. L. Lauritzen Line could operate to Mesters Vig (Nyhavn) from then until about mid-September. The airfield is normally operational the year around except from about mid-May until early July during the spring thaw.

TOPOGRAPHY

The Mesters Vig district (fig. 1, pl. 1–3) as here considered is bounded on the north by Kong Oscars Fjord trending northwest-southeast; on the east by the bay of Mesters Vig and its continuation, Deltadal running northeast-southwest; on the south by Nedre Funddal and Schéeles Bjerg, and on the west by Skeldal trending north-south and northeast-southwest.

Several regional relationships need emphasis. The Staunings Alper immediately west of the Mesters Vig district are spectacular jagged peaks with maximum altitudes near 2800 m and many summits in the vicinity of 2000 m; they comprise the highest mountains in Northeast Greenland. South of the Mesters Vig district there are also alpine peaks, which in the Werner Bjerge rise to maximum altitudes of about 1500 m and locally constitute the main divide between drainage north to Kong Oscars Fjord and south to Scoresby Sund. But toward the Indlandsis where the rocks have had a protecting carapace of ice the longest (Ahlmann, 1941 a, p. 148–162), the topography becomes increasingly less dissected and more plateaulike.

In the Kong Oscars Fjord region (i.e. excluding Kejser Franz Josephs Fjord), Hisingers Gletscher at the head of Dicksons Fjord is the sole outlet glacier reaching tidewater, and the only other outlet glaciers of note are Wahlenbergs Gletscher near the head of Rhedins Fjord and Violingletscher, which almost reaches Furesø at the head of Alpefjord. Thus an extensive fringe of land some 150 km wide near lat 72° N. is free of indlandsis, although covered locally by plateau ice caps or, as in the Staunings Alper, by systems of valley glaciers.

The mountains of the Mesters Vig district include both alpine and more subdued forms with maximum altitudes near 1100 m. The mountains of particular importance to this study are in the northern part. On the west there is Hesteskoen (1118 m), a horseshoe-shaped ridge (whence the name) concave eastward. Korsbjerg lies to the east; it is a U-shaped ridge opening northwest and has several summits of which the sharp peak of Domkirken (1025 m) is the most prominent, although both Fyrtaarnet (1043 m) and an unnamed summit (1053 m) 1 km southwest of Fyrtaarnet are mapped as slightly higher. East of the Korsbjerg massif

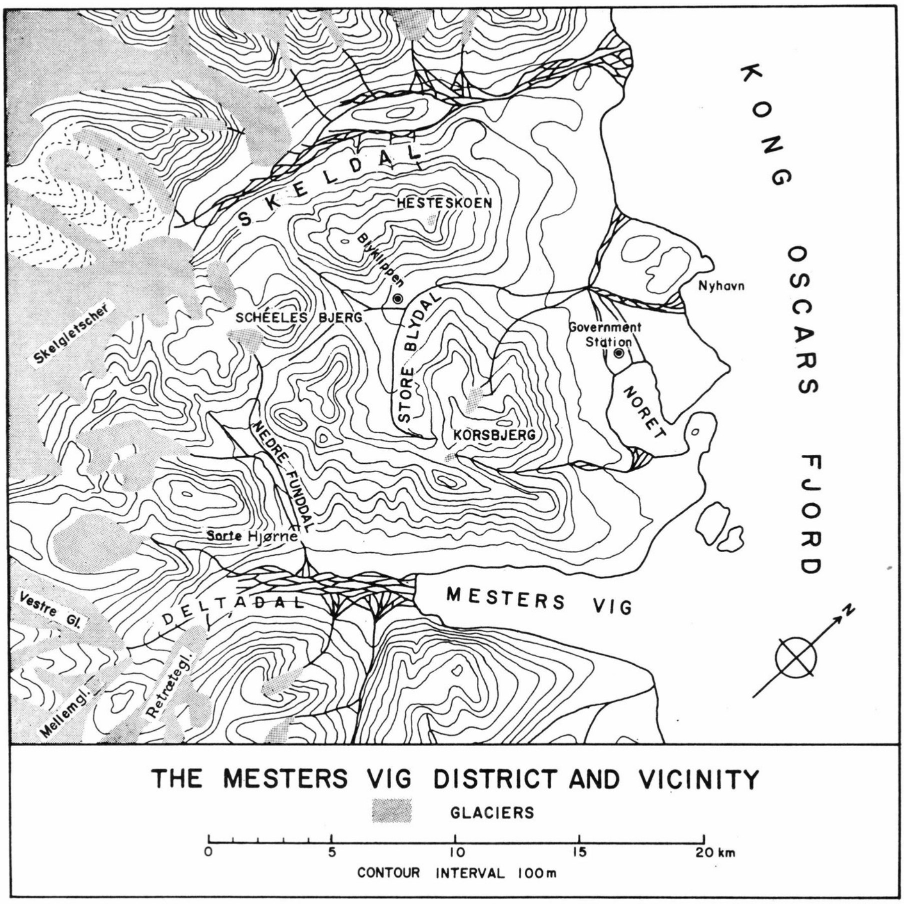

Fig. 2.

is Blyryggen, a long narrow ridge rising to about 1000 m and forming the west side of the bay of Mesters Vig. To the north a series of trap knobs fringe the fjord. Of these the Nyhavn hills to the west front the harbor of Nyhavn and rise to a maximum mapped altitude of 182 m. Southeast of Nyhavn the Labben hills with altitudes up to 120 m form a tongue of land (whence the name) partially enclosing the shallow bay of Noret. East of Labben is Fuglevarden (103 m) and southeast are the Danevirke hills, which rise to 175 m.

The largest valleys of the Mesters Vig district are Skeldal on the west, Store Blydal draining the central part, and Deltadal on the east. Skeldal, which separates the Mesters Vig district from the Staunings Alper and receives much glacial meltwater, is one of the largest valleys on the south side of Kong Oscars Fjord. Store Blydal heads in Blyryggen and the Korsbjerg massif and sweeps to the fjord in a broad curve that changes direction from west to north from head to mouth. Tunnelelv drains Store Blydal, the most important tributaries being Nedre Gefionelv from the south and Øvre Gefionelv from the west (which meet just before joining Tunnelelv), and Rungsted Elv from the southeast and south (which joins Tunnelelv just above where the latter begins its distributary pattern). Tunnelelv used three different distributary routes prior to construction of the Mesters Vig airfield; one was directed northwest between Hesteskoen and the Nyhavn hills, one northeast between these hills and the Labben hills, and one southeast to Noret between Labben and Korsbjerg. Deltadal (formerly also known as Sieburgerdal, or Siborgdal, and Storedal), on the eastern boundary of the Mesters Vig district is, like Skeldal, the escape route for considerable glacial meltwater; its largest tributary valley from the west is Nedre Funddal on the southern boundary of the district. The major drainage pattern is completed by Lille Blydal and its stream, Calamiteselv, which flows northeast between Korsbjerg and Blyryggen to Noret. Only a short narrow pass divides the opposing heads of Lille Blydal and Store Blydal.

There are no glaciers in the northern part of the district where most of the field work was done, although a small glacieret occurs at the head of Lille Blydal and another at the head of Rungsted Dal, and perennial névé occupies several niches on Hesteskoen. A few small valley glaciers lie south of Øvre Gefionelv in the southern part of the district. Glaciers from Staunings Alper enter Skeldal to the south and west, and the Vestre-, Mellem-, and Retræte (formerly Øster) Gletscher are tributary glaciers to the upper part of Deltadal on the south and southeast.

Several very small lakes occur in the district, most of them nameless. Myggesø (map altitude 211 m), one of the larger lakes, is located at Hestepas, a saddle between Blyryggen and the Danevirke hills.

VEGETATION

Tundra vegetation is commonly well developed in the glacier-free lowlands of Northeast Greenland. Glacier-free slopes at higher altitudes are comparatively barren, especially where steep. In general, coastal sectors have a more complete vegetation cover than inland areas because of increasing aridity away from the coast. Vegetation distribution is well described by SØRENSEN (1933) and by OOSTING (1948) among others.

The vegetation of the Mesters Vig district was studied in detail by Professor HUGH M. RAUP as an essential part of the Mesters Vig research program. As already indicated, his full reports will appear in the numbers of the *Meddelelser* that cover this program. A preliminary discussion of turf hummocks was prepared for the International Conference on Permafrost at Purdue University (RAUP, 1963).

The vegetation of the Mesters Vig district is characterized by Professor RAUP as follows: The vegetation is arctic tundra of low stature. Coverage of the ground surface by plants is extremely variable, ranging from none to nearly complete cover. A casual glance at any landscape shows large areas of pale gray or brown sandy, silty, or stony ground that appear at a distance to have no vegetation at all. These are interspersed with the bright greens of wet meadows or the darker greens of shrubby heaths. In late summer the meadows are commonly turned white by the fruiting heads of *Eriophorum*.

The vascular flora of the district is composed of 154 species and lesser taxa of vascular plants. The tallest ligneous species are dwarf birch (*Betula nana*), white heather (*Cassiope tetragona*), and arctic willow (*Salix arctica*). The tallest herbs are grasses and sedges (*Calamagrostis purpurascens*, *Arctagrostis latifolia*, *Eriophorum triste*). Nearly all the vascular plants are perennial, and about two thirds of them have circumpolar world ranges. In their occupation of habitats a relatively large proportion of them have wide tolerances with regard to gradients of moisture, coverage of the ground, and physical disturbance of the soil.

Most of the plant roots, both woody and herbaceous, are found in surficial humus or in the upper 10–15 cm of the mineral soil. Only occasional roots have penetrated to greater depths, and many of these are dead. Observations on the longevity of the plants are scanty, but an individual of *Salix arctica* 236 years old was found, and one of *Betula nana* 106 years old. Mortality usually is high in tundra of low to medium ground coverage (1–50 percent).

Moderately to well-drained uplands and slopes have vegetation ranging from relatively dense heath shrub mats or grass-sedge meadows, to a thin lichen-moss cover with only scattered herbaceous or woody plants. Wet moss-sedge meadows are in areas supplied with surface water throughout all or most of the summer by melting snow or thawing ground. Turf hummocks up to 50 cm high, composed primarily of living and dead mosses, are commonly developed on wet ground. Several species of woody and herbaceous vascular plants grow on these hummocks, some rooted in the turf and others in the mineral soil beneath. Although there are several shallow ponds and small lakes in the district, lakeshore vegetation, both emergent and submerged aquatic, is poorly represented. Likewise the seastrand flora is scantily represented, and widely scattered on the beaches. A few areas of sand dunes, formed on ancient and contemporary beaches or deltas, have a small flora made up of species from the neighboring tundra capable of withstanding the unstable habitat. Rock faces are well supplied with crustose and foliose lichens. No introduced plants were seen in the Mesters Vig district, and the copious ruderal vegetation around habitations and along roadsides is formed entirely of native plants.

CLIMATE[1])

Mesters Vig.

The Mesters Vig climate is truly polar. The mean temperature of the warmest month lies between 0° and 10°, and the climate is thus classed as a tundra (ET) climate in the Köppen system (cf. TREWARTHA, 1954, p. 234–235, 381–383). Meteorological records have been kept at the Danish Government station since 1952, and the monthly summaries of temperature, precipitation, and wind from then through 1961 are given in table 1. This record is summarized in table 2. Daily temperature and precipitation records covering the field seasons in 1956–61 are reproduced in graph form (fig. 3).

The mean annual temperature for the period of record is −9.7°. The mean temperature of the coldest month is −24.3°; this month is usually February but may be either January or March. The mean temperature of the warmest month is 5.9°, the month being August except in 1958 when it was July. There is thus an annual temperature range of 30.2°. The absolute minimum is −44.2° (4 Feb. 1955; 2 Mar. 1960), the absolute maximum 21.0° (19 July 1958), a range of 65.2°. Usually only June, July, and August have mean temperatures above freezing, and maximum daily temperatures are above freezing from May through October only, although exceptionally above-zero temperatures have been recorded in November (1953), December (1959), February (1954 and 1960) and April (1957 and 1958). Freezing temperatures can occur in any month of the year.

The Mesters Vig district is within the permafrost zone, whose southern boundary along the east coast of Greenland is mapped as just south of Scoresby Sund (BLACK, 1954, fig. 1, p. 841). North of Scoresby Sund, permafrost 220 m thick has been reported in the upper part of Schuchert Dal (KIRCHNER, 1963). In the Mesters Vig district, thicknesses up to about 125 m were reported from the lead-zinc mine by BONDAM (MÜLLER, 1959, p. 56; 1963, p. 34–35). In general in the Mesters Vig district, the depth to permafrost ranges from about half a meter to somewhat over 2 m, depending on the nature of the mineral soil and the vegetation cover.

[1]) The writer is grateful to ANDREW D. HASTINGS, Jr. of the U.S. Army Natick Laboratories and to Dr. ERIC B. KRAUS of the Woods Hole Oceanographic Institution for helpful suggestions in connection with the preparation of this section.

All temperatures are centigrade unless otherwise indicated.

The mean annual precipitation is 372.5 mm (measured as water), the minimum being 256.1 mm in 1955, the maximum 517.8 mm in 1953. Most of it occurs as snow. Because of drifting and the difficulty of accurately measuring precipitation when it falls as snow, the precipitation data are subject to considerable error. Maximum precipitation occurs commonly in autumn and winter, and the minimum in spring. However, there was considerable rain in the summers of 1953, 1955, 1956, and 1960. The year 1958 was exceptional with a precipitation maximum in April.

The predominant wind directions are westnorthwest and eastsoutheast parallel to Kong Oscars Fjord. Westnorthwest winds, with occasional departures to west or northwest, prevail in the autumn, winter, and early spring. Commencing with June, the most frequent wind direction is eastsoutheast, and it remains so during July and August and, exceptionally, September. It then generally becomes westnorthwest again, but during the transition period there is a tendency for westsouthwest winds to become important. The latter direction may even predominate in September and/or October of some years (as 1955, 1956, and 1958), and it probably reflects in part the topographic influence of Store Blydal. The westnorthwest winds are katabatic winds off the Indlandsis that are channeled by Kong Oscars Fjord. In late spring and in summer the heating of the ice-free coastal fringe, up to 200 km wide in places, creates a seasonal sea-breeze effect that produces the wind reversal from westnorthwest to eastsoutheast. (For a regional discussion, cf. Hovmøller, 1947, p. 11–15, 23–28, 71–72). One effect of the eastsoutheast winds is to bring extensive fog banks from the outer coast to the Mesters Vig district. In the autumn the controlling conditions change back and the wind reverses again to westnorthwest as described.

The greatest frequency of strong winds (those exceeding 20 knots–10 m/sec) is in the autumn and the first half of winter. The maximum recorded velocity is 57 knots (29 m/sec) (3 Mar. 1958), but the annual maximum (excepting gusts) exceeded 45 knots (23 m/sec) in only two years (1957 and 1958) and monthly maxima are usually much less. In fact the outstanding characteristic of the Mesters Vig wind regime is the predominance of calms except during the summer and early autumn. They account for more than half (57 percent) of the total number of observations for wind, and the combination of calms and winds of less than 6 knots (3 m/sec) predominates three quarters of the time.

Temperature records were kept at Blyklippen (alt. 288 m) in 1953. These indicate appreciable differences between the temperature regime here in Store Blydal and that just 9 km away and some 270 m lower at the government station on the coast. As illustrated by figure 4 the mean monthly temperature at Blyklippen was consistently higher than at the government station from late autumn through early summer, the greatest difference being 7.5° in February; in late summer and early autumn it was almost the same at both places. Monthly minimum temperatures followed the same pattern with departures up to 11.5°. Monthly maximum temperatures at Blyklippen were consistently higher from late winter to autumn, the greatest departure being 7° in March, and they remained the same in the autumn and early winter. The overall pattern suggests a persistent low-level inversion at Blyklippen during the dark season. Since the principal experimental sites were located in the immediate vicinity of the coast, they were under the same general climatic regime as the government station. Temperature records at experimental sites 7–8, confirming this, are discussed in connection with the research at these sites.

Comparison with Other Stations in Northeast Greenland.

Conditions at Mesters Vig differ appreciably from those at LAUGE KOCH's former headquarters on Ella Ø, 80 km farther up Kong Oscars Fjord near its head. Meteorological observations here cover the period 1931–50 for temperature and 1948–50 for wind (table 3); data on precipitation are lacking. Thus the Mesters Vig and Ella Ø records do not overlap and are not directly comparable. Nevertheless they confirm the prevalent impression that the Ella Ø district is an "Arctic Riviera" by comparison with Mesters Vig. Mean temperatures at Mesters Vig are uniformly lower: the mean annual temperature by 2.1°, the mean of the coldest month by 3.8°, and the mean of the warmest month by 2.6°. Other records show that the incidence of fogs is much greater at Mesters Vig, reflecting its position nearer the outer coast. On the other hand, the frequency of calms at Mesters Vig is about twice that at Ella Ø. As already indicated, calms occur over half the time at Mesters Vig; at Ella Ø they occur slightly less than one fourth the time. Winds of all velocity classes are less frequent at Mesters Vig than at Ella Ø. The same type of seasonal change in winds occurs at Ella Ø, but the directions are different as the result of strong topographic control by Kempes Fjord. The comparison between Mesters Vig and Ella Ø conforms to AHLMANN's (1941b, p. 189–190) description of the climate of Northeast Greenland as becoming increasingly continental toward the interior of the fjords during the summer, resulting in higher summer temperatures (and lower precipitation) than near the outer coast.

The effect of latitude on the climate can be judged in part by comparing Mesters Vig and Ella Ø with Daneborg (lat 74°18′ N., long 20°14′ W.), Myggbukta (lat 73°29′ N., long 21°34′ W.) and Scoresbysund (lat 70°29′ N., long 21°58′ W.). Although related to major fjords, these stations differ from Mesters Vig and Ella Ø in being on the outer coast. The data for Ella Ø in table 3 and for Daneborg in table 4 were very kindly furnished by the Statens Luftfartsvæsen in København. The data for Myggbukta and Scoresbysund, except as noted below, are derived from Hovmøller (1947, tables 5–6, p. 26 — wind; table 7, p. 33, and table 17, p. 62 — temperature; table 29, p. 88 — precipitation). Precipitation data for Scoresbysund are derived from Ahlmann (1941 b, table 3, p. 191). The Mesters Vig and Ella Ø data are from tables 1 and 3. As in the case of Ella Ø, the records for Myggbukta and Scoresbysund do not overlap the Mesters Vig record, and the following comparisons are subject to the influence of climatic changes between the record periods. Nevertheless, the comparisons are probably of about the right order of magnitude, although precipitation data are suspect because of difficulties of measurement.

As indicated in table 4, the mean annual temperature at Mesters Vig is within 1° of that at Daneborg and Myggbukta and 3.5° lower than at Scoresbysund. The mean of the warmest month is 1–2° higher than at Daneborg and Myggbukta and 0.4° higher than at Scoresbysund. The mean of the coldest month, although about the same as at Daneborg, is considerably lower than at Myggbukta (by about 3°) or Scoresbysund (by 9.2°). The recorded precipitation at Mesters Vig is much greater than at Myggbukta (by about 150 mm) and appreciably greater than at Scoresbysund (by 56 mm). Whereas calms at Mesters Vig prevail 57 percent of the time, the frequency at Myggbukta is 16 percent and at Scoresbysund 37 percent. At Kap Tobin (lat 70°25′ N., long 21°58′ W.), near the settlement of Scoresbysund and the successor meteorological station since 1949, the frequency of calms for the period 1949–58 is 38 percent (Danske Meteorologiske Institut, 1958, p. 79; 1961, p. 176), and therefore similar to the Scoresbysund record.

In explanation of the regional climatic relationships, it seems logical that Mesters Vig should have a higher summer temperature than Scoresbysund in spite of the difference in latitude, because of Mesters Vig's more interior location, yet have a lower summer temperature than Ella Ø, which is still farther removed from the maritime influence. The continental influence would also explain why Mesters Vig has a lower winter temperature than Daneborg or Myggbukta, the former 2° farther north. On the other hand this explanation can not account for the fact that the winter temperature is also lower than at Ella Ø; the explanation here seems to be that the prevalence of calms at Mesters Vig favors stagnation of the air and temperature inversions, whereas the winds at Ella Ø promote mixing of the air layers (Hovmøller, 1947, p. 53–54). Also there may be more foehn winds at Ella Ø.

As noted, the precipitation recorded at Mesters Vig is abnormally high compared with neighboring regions. In fact the district has the reputation for being a "snow hole", where sledging is made difficult by deep soft snow. This heavy precipitation does not fit the regional pattern in which precipitation decreases northward along the coast and toward the interior (AHLMANN, 1941 b, p. 190). However the discrepancy may be more apparent than real and a direct result of favorable observational conditions caused by the prevalence of calms and low wind speeds at Mesters Vig. In windier regions much less snow would accumulate, and measurement by normal methods would result in correspondingly low figures.

The lack of snow removal by wind at Mesters Vig is comparative only as shown by the records of occasional high winds (up to 57 knots – 29 m/sec) in winter and by comments in the meteorological reports regarding such removal. Although blowing away of snow is most common on exposed slopes above the valleys, the comments clearly indicate that it is by no means restricted to these slopes. The reason for the prevalence of calms does not appear to be established. As compared with Ella Ø, it may be due to Mesters Vig's being farther from the Indlandsis and from fjord junctions. As compared with Daneborg, Myggbukta, and Scoresbysund, it may reflect Mesters Vig's position some distance from the mouth of Kong Oscars Fjord and north of where the trend of the outer coast changes from northeast to north — a combination that would tend to protect the district from the influence of storms passing up the coast between Iceland and Greenland.

Regional Climatic Trends.

Precipitation.

Information regarding precipitation trends in East and Northeast Greenland is very meager. Records from Myggbukta compiled and discussed by AHLMANN (1941 b, p. 191–192) show a marked increase in precipitation from 1932 to 1938 compared with the previous 10 years, but AHLMANN thought that the change is spurious and reflects different observation procedures. As reported by DIAMOND (1956, 1958), precipitation at Upernavik at lat 72°47′ on the west coast of Greenland shows an upward trend from about 1910 to 1921 and a downward trend from 1921 to at least 1932, and stratigraphic studies on the Indlandsis indicate a downward trend since about 1920 to at least 1954. On the other hand the recent temperature increase discussed below has been attributed to increased atmospheric circulation (AHLMANN, 1948, p. 76–78), which should favor more rather than less precipitation. AHLMANN (1948, p. 77)

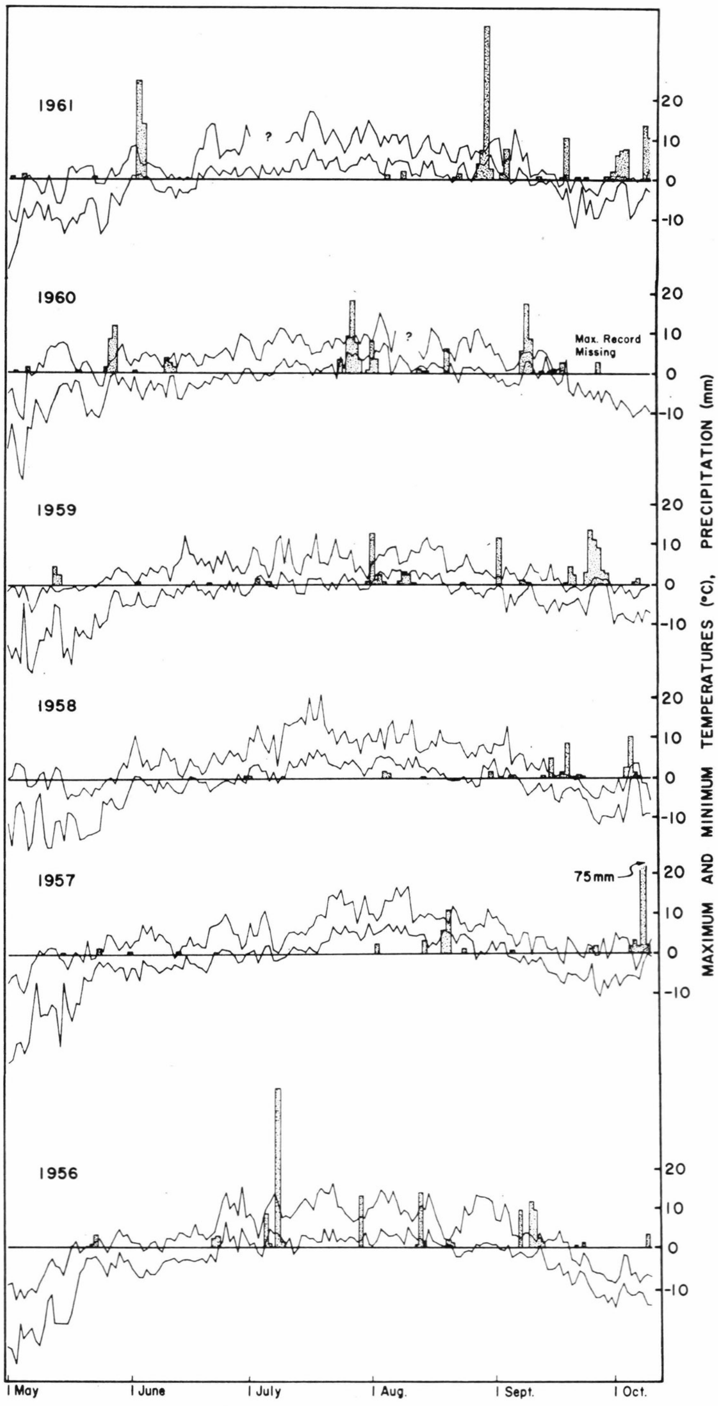

Fig. 3. Precipitation (bar graphs) and daily maximum and minimum temperatures at Mesters Vig, May-October 1956–61.

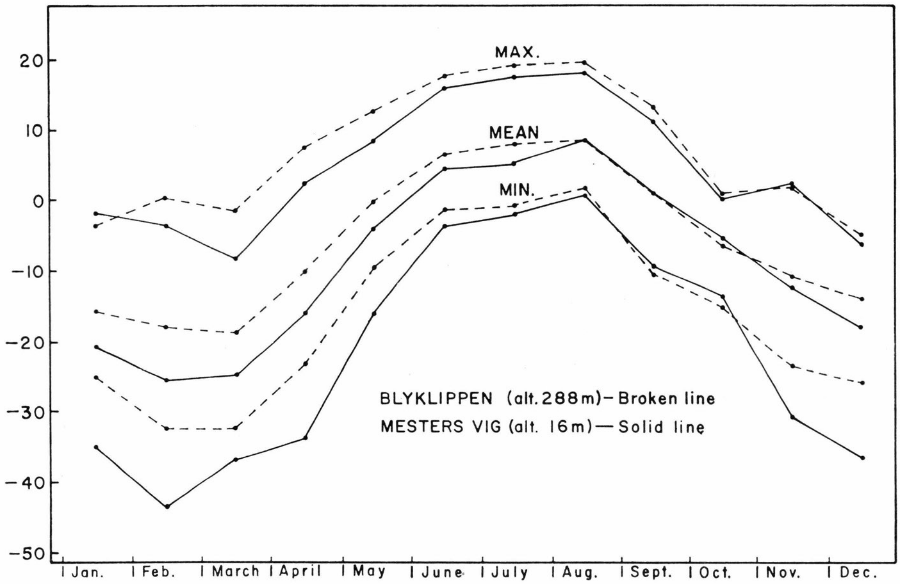

Fig. 4. Monthly temperatures at Blyklippen and Mesters Vig, 1953.

cited increased precipitation in high latitudes, although he regarded it as rather irregular and insignificant as compared with the temperature increase.

Temperature.

Significant temperature increases are well documented (Fristrup, 1952). Glaciers on the North Atlantic coasts have retreated to a marked extent during the past 100 to 200 years, depending on location. According to Ahlmann (1941 b, p. 198–207; 1948, p. 72–73), local glaciers in Northeast Greenland retreated after a maximum dating from between the middle of the 18th and middle of the 19th centuries, probably about 1750 (Ahlmann, 1953, p. 16). The cause of the retreat is believed to be due almost entirely to higher temperatures in Greenland as elsewhere in the Northern Hemisphere.

Variations in the amount and distribution of drift ice along the east and southeast coast of Greenland and in the vicinity of Iceland also provide evidence of climatic trends. Koch (1945, p. 264, 347) assumed that the variations are due to climatic fluctuations affecting the thickness of ice in the Polar Basin, in part by influencing the thickness of the cold-water layer, so that warm temperatures and decreased thickness of ice result in the melting of much of the ice before it reaches southern Greenland. Decrease in the amount of ice therefore is correlated with increased warmth. For the southern half of Greenland, Koch (1945, p. 354) concluded that during summers in A.D. 800–1200 "there was hardly any ice", in 1200–1400 "there was somewhat more ice", in 1400–1600 "the ice decreased in quantity", in 1600–1900 "there were exceptionally large quantities", and in 1920–1939 "there was hardly any ice". Taking ice quantities by decades, he also found that the ice around southern Greenland and between Greenland and Iceland increased from 1840 to 1889 with particularly small amounts in 1840–1849, and decreased from 1889 to 1939 with particularly small amounts in 1920–1939 (Koch, 1945, p. 233–234; fig. 104, p. 235). Slight departures from these dates are given in his summary (Koch, 1945, p. 347).

Weather records show that a pronounced general warming has occurred in the Arctic. Hovmøller (1947, p. 80–87) took as his base the normal temperature for the record periods and found that the mean temperature in Greenland for the period 1882–1889 was generally below the normal, with negative deviations up to 3–4°, and for the period 1923–1937 was uniformly higher with positive deviations up to 4°. By 1938 the temperature was approaching the normal. In general the deviations are much greater in winter and spring than in summer and autumn. Willett (1950) reported a world trend of temperature increase since 1885. According to Willett's (1950, fig. 6, p. 202) map, this increase is on the order of 2.2° (4° F) in Northeast Greenland for the 20-year period centered on 1930, but this figure is interpolated from widely scattered stations, none of which appear to be in Northeast Greenland. On the basis of additional information, Willett (1961, fig. 8, p. 100; fig. 11, p. 103) subsequently indicated an increase of about 2° in winter temperature, but little if any change of summer temperature in Northeast Greenland for the period 1920–1939 compared with the period 1900–1919. According to Mitchell's (1963, figs. 5(a)–5(b), p. 168–169) analysis for the same periods, the annual change in the region including Mesters Vig was about 2.2° (4° F), and the winter change about 2.8° (5° F). Since then there seems to have been a global cooling (Mitchell, 1961, p. 238; fig. 2, p. 239) that in the same region, and for the period 1940–1959 compared with the period 1920–1939, may be on the order of 0.3° (0.5° F) (Mitchell, 1963, figs. 5 (c)–5 (d), p. 170–171). The recent climatic cooling in high latitudes is also noted by Kosiba (1962, 1963).

GEOLOGY

Bedrock Geology.

Almost all that is known about the bedrock geology of Northeast Greenland has resulted from the work of Dr. LAUGE KOCH and his associates, whose reports fill many volumes of the *Meddelelser om Grønland.* East and Northeast Greenland are characterized by the north-south trending East Greenland geosyncline, in which pre-Devonian sediments were generally strongly deformed by Caledonian orogeny (KOCH, 1929, p. 286–297; 1935, p. 136–139 and fig. 12, p. 151; FRÄNKL, 1956; HALLER, 1958, fig. 9, p. 22; 1961; HALLER and KULP, 1962, p. 34–41, 58–61).

The Staunings Alper immediately west of the Mesters Vig district are in the Caledonian zone. They comprise Greenlandian (late Precambrian) sedimentary rocks, metamorphosed in part to gneisses during Caledonian orogeny, and several varieties of synorogenic and postorogenic granitic rocks (HALLER, 1958). The rather distinctive lithologic assemblage is important in considering the source of erratics in the Mesters Vig district. Liverpool Land in the extreme east beyond the Mesters Vig district is another region of crystalline rocks believed to be related to Caledonian orogeny (KRANCK, 1935, p. 114–118). Jameson Land, and the east part of Scoresby Land in which the Mesters Vig district is located, represent a tectonic depression between the Staunings Alper and Liverpool Land; with few exceptions the rocks are post Devonian and are little deformed compared with those of the Caledonian zones (STAUBER, 1940; pl. 4 *in* KOCH, 1950). However, they are characterized by considerable post-Devonian faulting, which also affected regions north of those mentioned. The principal faulting strikes roughly north-south and comprises step faults dipping steeply east, as a result of which increasingly younger rocks tend to be exposed in this direction; a less important fault system strikes roughly northwest-southeast (BIERTHER, 1941, p. 18–19; STAUBER, pl. 4 *in* KOCH, 1950). Igneous rocks are locally important. South of the Mesters Vig district the Werner Bjerge, in which considerable prospecting for molybdenum has been carried out by the Nordisk Mineselskab, provide a distinctive assemblage of syenites and alkalic granites (BEARTH, 1959), and alkalic rocks are also exposed immediately east of the Mesters Vig district (KAPP, 1960).

The bedrock geology of the Mesters Vig district was mapped by WITZIG (1954), and the mapping somewhat revised by BONDAM (1955). Subsequent to publication of WITZIG's report, DUNBAR (1955) described Permian brachiopods from Northeast Greenland, including collections from the Mesters Vig district (Deltadal (Sieburgerdal) area collections in part — DUNBAR, 1955, p. 15–17). More recently, KEMPTER (1961, p. 56–61; table 14, p. 108) summarized a manuscript by BIERTHER and commented on some aspects of the geology in the light of additional observations of his own. The geology of the Blyklippen lead-zinc occurrence has been discussed by BONDAM and GRAFF-PETERSEN (1954), BROWN (1955a, 1955b), and GROSS (1956).

The district is separated from the Staunings Alper by a major post-Devonian fault trending about north-south near the west side of Skeldal (FRÄNKL, 1953, p. 47–50, pl. 1; HALLER, 1958, p. 123–138, 149).

The following summary of the geology of the Mesters Vig district is quoted from WITZIG (1954, p. 24–25), and his map, as modified by BONDAM (1955) and subsequently brought up-to-date and redrafted for the present report, is reproduced as plate 4.[1])

Stratigraphy.

"On the basis of fossil plant-remains, the mostly continental sediments, ranging from Upper Carboniferous into possibly Lower Permian, have been divided into three local series: the Blyklippen-, Lebachia- and Domkirken-Series. (The major plant determinations have already been published by the author (WITZIG, 1951a)).

"The Blyklippen-Series are formed by a sequence of 800–1000 m of light-green-greyish, seldom multicoloured, fine- to coarse-grained sandstones, including lenses of grey sandy shales and conglomerates. Their pebbles consist of white quartz, coloured quartzites and, rarely, red granites.

"The flora of this lowest formation has its main occurrence in the Westphalian (middle Pennsylvanian)***

"The Lebachia-Series includes, within reddish-brown arkoses, sandstones, and conglomerates, a large number of marine beds: black limestones and limy shales, argiles and marls with limestone concretions. Fossil fishes (Palaeoniscidae) and fairly well preserved plants are found***

"Although the plants belong to the uppermost Upper Carboniferous as well as to the lowermost Permian, it has been admitted that the Lebachia Series are of Autunian, i.e. lowermost Permian, age. Reference is made to similar deposits in Norway (HOLTEDAHL, 1931, HÖEG, 1936). *Callipteris*, the only plant definitely characteristic of the lower Permian, has not been found so far, though a couple of fragmentary pinnae from Skeldal may belong to it (HALLE, unpublished).

"The Domkirken Series are completely continental sediments: 200 m of pink to dark-red arkoses and conglomerates, including quartzites as well as Cambro-Silurian sediments. This formation is regarded as an equivalent of the New Red Sandstone (Saxonian; Lower Permian).

[1]) The writer is much indebted to Mag. BONDAM for his kindness in supplying this newly revised map.

"The formations described here are not strictly delimited, but are connected by gradual transitions.

"The Upper Permian, which is a marine deposit, rests with an angular unconformity of 8–12° upon the Domkirken Series. It has already been described in detail by Maync (1942).

"The Triassic sequence, formed by a basal conglomerate, brown-green shales with small black limestone beds (Ophiceras-beds), and multicoloured, sandy limestones, has only been found on the top of Domkirken and Ansgar.

Structures.

"One fold of possibly late Carboniferous to early Permian age has been observed in the eastern Blyryggen range. Its prolongation to the south has been disturbed by younger faults. Between two fault systems, one striking N–S, the other NW–SE, a Permo-Triassic Graben, with a probably vertical displacement of several 100 m up to 1000 m crosses the Korsbjerg mountain from Mesters Vig to Blyklippen.

Intrusives.

"Several basalt dykes, generally of the Dolerite-, Olivinebasalt- and Diabase-Type, are predominant west of and in the Graben, whereas sills cover the adjacent region of Kong Oscars Fjord, east of the Graben.

"One quartz porphyry of possibly young Palaeozoic age was recognized near Sortebjerg.

"Some Quartz-baryte veins follow the NW–SE faults. They are partly mineralised with galena, sphalerite, and chalcopyrite. In the upper levels of the continental sediments, but especially near the Upper Permian, the veins change gradually into barren calcium carbonate veins. Considering the progressing investigations of The Northern Mining Co., Copenhagen, no further details on the veins are mentioned.

"Faults and intrusives may be of Tertiary age, for the reasons discussed in chapter 4".

The following points are included in Bondam's discussion of the geology. The upper part of the Blyklippen Series includes multicolored beds. "As a whole the distinction between the Blyklippen series and the Lebachia series is very difficult to observe, if not impossible, in many cases. There has not been any break in sedimentation, only the mode of sedimentation has gradually changed from purely freshwater or terrigene to a sedimentation with brackish water intercalations" (Bondam, 1955, p. 12). Some of the coarse-grained red beds in the upper part of the Blyklippen Series are much like the Domkirken arkose, but Bondam regarded the intermixing of shale beds as diagnostic of the former. Although he designated the Blyklippen Series as Lower Pennsylvanian, and the Lebachia Series and Domkirken Series as Upper Carboniferous, he granted the possibility of the dating suggested by Witzig (Bondam, 1955, p. 13–15). The northwest outlet of Tunnelelv is mapped as bounded by faults on both sides (Bondam, 1955, fig. 2, p. 8; p. 15). Neither of these faults is shown by Witzig. Another addition to the mapping is that Bondam showed a series of basalt outcrops immediately east of Thyres Spids.

Bierther described 5 lithologic units, 3 of which correspond at least in part to Witzig's Blyklippen Series, Lebachia Series, and Domkirken Series, if allowance is made for considerable variations in reported thicknesses (Kempter, 1961, p. 56–61; table 14, p. 108). Bierther's lowest and uppermost units were named, respectively, the Skeldal-Schichtglied and Aggersborg-Schichtglied by Kempter; they were described from places near, but not in, the Mesters Vig district as delimited in the present report. The Lebachia Series he renamed the Profilbjærg-Schichtglied because of the lack of proof that *Lebachia parvifolia* occurs in the rocks of the Mesters Vig district. Kempter believed that the term Schichtglied (member) was more appropriate than series, and he grouped the Skeldal, Blyklippen, Profilbjærg, Domkirken, and Aggersborg Members as the Mesters Vig Formation. Kempter emphasized that most of the rocks previously described as sandstones or quartzites were in fact arkoses.

Although the rocks generally have small dips, numerous faults, and rapid changes of texture laterally in the Blyklippen, Profilbjærg, and Domkirken Members make mapping much more difficult than might first appear. The present writer did not study the bedrock geology but he gained the impression from observation and from conversation with other geologists who visited the area that a real distinction between the Blyklippen and Profilbjærg Members remains to be established. The basalt mapped by Witzig as extending between MS 694 m and MS 702 m on the east side of Rungsted Dal is nonexistent. Bondam's (1955, fig. 2, p. 8) mapping here is ambiguous because of the scale difference. The bedrock is mainly shale and sandstone, much disintegrated at the surface; at the southeast end of MS 702 m, purplish conglomerate dips steeply northwest, probably in response to faulting. The basalt outcrops that Bondam mapped immediately east of Thyres Spids were not observed, although there is a prominent moraine here that appears similar to a partially drift-covered basalt outcrop farther east on the same slope near Lille Blydal.

Surficial Geology.

General.

Geomorphic and glacial investigations in the vicinity of the Mesters Vig district have been lacking until very recently. Notes relative to the writer's work (Washburn, 1960, 1962a, 1962b; Washburn and Stuiver, 1962) are discussed in connection with deleveling and the geomorphology of the Mesters Vig district in the following. Fred Pessl, Jr. studied the Sortebjerg area at the head of Mesters Vig (bay) in 1959 and 1961 (Pessl, 1962), after serving as a field assistant to the writer in 1958. Norman Lasca carried out a similar geomorphic and glacial study in

Skeldal immediately west of the Mesters Vig district in 1962 and 1963. A brief statement regarding patterned ground is due to ENZMANN (1960). A recent discussion of strandlines in Alpefjord, the first fjord west of the Mesters Vig district, has been published by SUGDEN (1962).

Glacial Geology.

No glaciers occur now in the Mesters Vig district, although they are widespread in the Staunings Alper immediately to the northwest and among the mountains to the southwest beyond the head of Mesters Vig (bay). Within the district there is a glacieret at the head of Rungsted Dal and another at the head of Lille Blydal. Glacial deposits are widespread and are ultimately derived from at least 3 main sources: (1) The Staunings Alper and other regions to the northwest farther up Kong Oscars Fjord, (2) the Werner Bjerge and other mountains beyond the head of Mesters Vig (bay), and (3) the highlands within the district itself.

The glacier that occupied Kong Oscars Fjord carried a distinctive assemblage of granitic rocks from the Staunings Alper. The distribution of these erratics indicates that the ice reached altitudes of at least 850 m on the northeast side of Hesteskoen (1118 m), of at least 460 m on the north slope of Korsbjerg (highest peak 1053 m), and of at least 400 m at the northeast end of Blyryggen farther southeast. No evidence of glaciation was found above 850 m anywhere in the district, and the rock of the highest summits, generally sandstone, is thoroughly shattered. It is very probable that these summits were nunataks for a long time, perhaps throughout the maximum of the last major glacial episode. The Sortebjerg area (PESSL, 1962, p. 75–76) and the peaks on the west side of Skeldal (NORMAN LASCA, personal communication, 1963) appear to be similar in this respect, as may other high points in Northeast Greenland (BRETZ, 1935, p. 161–162, 222).

Well-developed moraines containing erratics from the Staunings Alper occur on the north and northeast slopes of Hesteskoen and Korsbjerg. On the Korsbjerg slopes, especially, they are in prominent discontinuous tiers of benches up to an altitude of about 350 m. There are morainal remnants at higher altitudes but the topographic contrast between the lower well-developed moraines and the higher debris-covered slopes with isolated erratics and morainal patches is very marked. In places the surface material of the well-developed moraines and their even crests indicate that ice-marginal streams were an important factor in their development. One prominent ice-marginal channel runs between Thyres Spids and the adjacent Korsbjerg slope. The profusion of erratic boulders in the moraines between Rungsted Dal and Thyres Spids indicates that the Kong Oscars Fjord glacier, probably including a tributary from Skeldal, bulged into Store Blydal and impinged against this slope. The down-valley slope of the moraine benches and the apparent lack of lacustrine deposits up-valley from here suggest that Store Blydal was occupied by a relatively weak tributary glacier at the time that the Kong Oscars Fjord glacier bulged into it. Staunings Alper erratics become much fewer farther up Store Blydal but are still present one kilometer above Gefionelv. However, these erratics may be related to Skeldal ice that overflowed into Store Blydal via Gefionelv and do not prove that the Kong Oscars Fjord glacier ever penetrated this far up Store Blydal.

Ice from the mountains southwest of the head of Mesters Vig (bay) carried distinctive syenite erratics and reached altitudes of at least 390 m on the northwest side of Mesters Vig (bay). In the vicinity of Myggesø, where this ice must have been once tributary to the Kong Oscars Fjord glacier, there is a moraine complex of probably interlobate origin.

A local glacier with its sources at the head of Rungsted Dal advanced into Store Blydal following retreat of the Kong Oscars Fjord ice, as shown by crosscutting relationships of moraines. This advance may have been the direct result of retreat of the Kong Oscars Fjord glacier in that the Rungsted Dal glacier could then have spread into the vacated area.

The topographic contrast between the well-developed moraines on Hesteskoen and Korsbjerg and the higher debris-covered slopes suggests two ice advances, one responsible for the higher erratics and a later one related to the well-developed moraines. The moraine tiers on Korsbjerg are consistent with the possibility of still later but smaller advances. However, their location appears to be topographically controlled, at least in part, and there does not appear to be any great difference in their degree of preservation, so that they may be parts of a single recessional sequence. Radiocarbon dating of younger marine deposits proves that the lowest tier is older than 8500 ± 250 B.P. (Before Present). Their general appearance is fully consistent with a late Wisconsin age. The Rungsted Dal glacieret is fringed by at least 2 small fresh-appearing moraines.

Directions of glacier movement are clearly indicated by striae and by stoss-and-lee slopes in many places where trap rocks occur. The other exposed rocks of the district are mostly too greatly weathered to retain striae, and even the trap, where coarse grained, is commonly disintegrated into grus. Relative ages of striae on the Nyhavn trap knobs show that ice from the northwest parallel to Kong Oscars Fjord was succeeded by ice with a more westerly component. This later ice presumably reflected a greater influence of ice from the Staunings Alper, which must have been an important center of ice dispersal.

On each side of Tunnelelv a maze of kames and massive delta deposits with ice-contact faces indicate stagnation of the last ice. The emerged delta remnants extend to altitudes a little above 100 m, and the highest ones are pitted with kettles. The highest marine shells and undoubted marine strandline observed in the district are at altitude 76 m on the east side of the Danevirke hills, and the radiocarbon age of these and other shells proves that the Mesters Vig district was open to the sea by about 9000–8500 B.P. if not earlier, and that by this time deglaciation was well under way. Following deglaciation massive fans were built in some of the areas vacated by the ice.

In summary: (1) Ice from at least three different major sources affected the Mesters Vig district in complex fashion. (2) No evidence of glaciation was found above an altitude of 850 m. (3) Hesteskoen and the highest Korsbjerg summits may have been nunataks during the maximum of the last major glaciation. (4) There is evidence of a lesser glacial advance following the last major glaciation. (5) The degree of preservation of moraines related to this possible lesser advance is consistent with a late Wisconsin age. (6) Following retreat of ice derived from outside the district local glaciers advanced in places. (7) This local advance may have been a direct result of such retreat rather than of climatic "deterioration". (8) Deglaciation was characterized in places by stagnation of ice. (9) Deglaciation was well under way by 9000–8500 B.P.

Deleveling.

Evidence of deleveling is widespread and includes deltas, strandlines, marine deposits, marine fossils, and driftwood at altitudes above present sealevel. The marine limit is not precisely fixed. Emerged delta remnants extend to altitudes a little above 100 m, and the highest ones are pitted with kettles. Delta treads in the vicinity of 100 m are common and, because of their prevalence and similar altitude in a number of different topographic situations, suggest that the marine limit is near this altitude. A well-exposed contact between fore-set beds and overlying fluvial gravel in a remnant below the highest delta surface west of Tunnelelv is at an altitude of about 85 m. However, pending further data, an origin in glacier-dammed lakes can not be excluded for these high deltas. The minimum marine limit is 76 m on the east side of the Danevirke hills, where a well-developed boulder strand and nearby shells occur at this altitude.

The following preliminary review of changes in the relative level of land and sea in the Mesters Vig district is extracted from a preliminary note in *Arctic* (Washburn and Stuiver, 1962). The Arctic Institute of North America has kindly permitted republication of this material here. The only changes, aside from the omission of introductory information already covered in the present number of the *Meddelelser*, were to adapt the style to conform with that of the present number (including illustrations) and to make several minor corrections. Republication seemed desirable in order both to make all the Mesters Vig reports available within the *Meddelelser* series and to round out this discussion of the surficial geology. A full report on deleveling is planned for a subsequent issue of the *Meddelelser*.

A number of studies of emerged strandlines have been made in the fjord region of Northeast Greenland (BRETZ, 1935, p. 204–222; FLINT, 1948, p. 162–192), but information on absolute dating of emergence has been lacking. Radiocarbon dating of driftwood and shells from emerged marine deposits was therefore essential. A related problem was to determine whether a widespread and locally till-like deposit, containing in places numerous well-preserved shells, had been transported by a glacier, or whether it was an emerged fjord-bottom deposit. A till-like aspect of a fjord-bottom deposit could be due to deposition from debris-loaded icebergs as they floated past sites colonized by mollusks, and solifluction following emergence could have contributed to it. Lithologic criteria were useless, for material carried and deposited by a glacier could have been picked up from the fjord bottom. Even the presence of uncrushed, paired mollusk valves need not be diagnostic in some situations (DONNER and WEST, 1957, p. 25–26). However, if the till-like deposit was laid down during a major glacier advance it should be (1) significantly older than fossiliferous delta beds deposited after the ice retreated, and (2) much more nearly of one age and lack any systematic correlation between age and altitude. Radiocarbon dating of the shells should therefore cast light on the origin of the deposit as well as on emergence, without involving a circular argument in fitting the deposit into the deleveling history on the basis of the same dates.

Shells were collected from a number of places and were dated at the Yale Radiocarbon Laboratory; a few driftwood specimens were included. The localities (fig. 5), shell identifications, and radiocarbon ages are summarized in table 5. The ages are plotted against altitude in figures 6–8 together with suggested curves.

Several points deserve comment: (1) The plotted altitudes in figure 6 are field altitudes (i.e., altitudes uncorrected for eustatic rise of sealevel). The altitudes in figures 7–8 are adjusted to allow for eustatic rise of sealevel of 0.9 m per 100 yr prior to 6000 B.P. (Before Present) (FAIRBRIDGE, 1961a, fig. 14, p. 156; 1961b, p. 556–557; cf. also GODWIN, SUGGATE, and WILLIS, 1958; SHEPARD, 1961, fig. 1, p. 31). Table 5 and figure 6 will facilitate application of alternative corrections, based on different interpretations of the rate of rise of sealevel (cf. GRAUL, 1959). Comparison of figure 6 with figure 7 demonstrates that the break in the

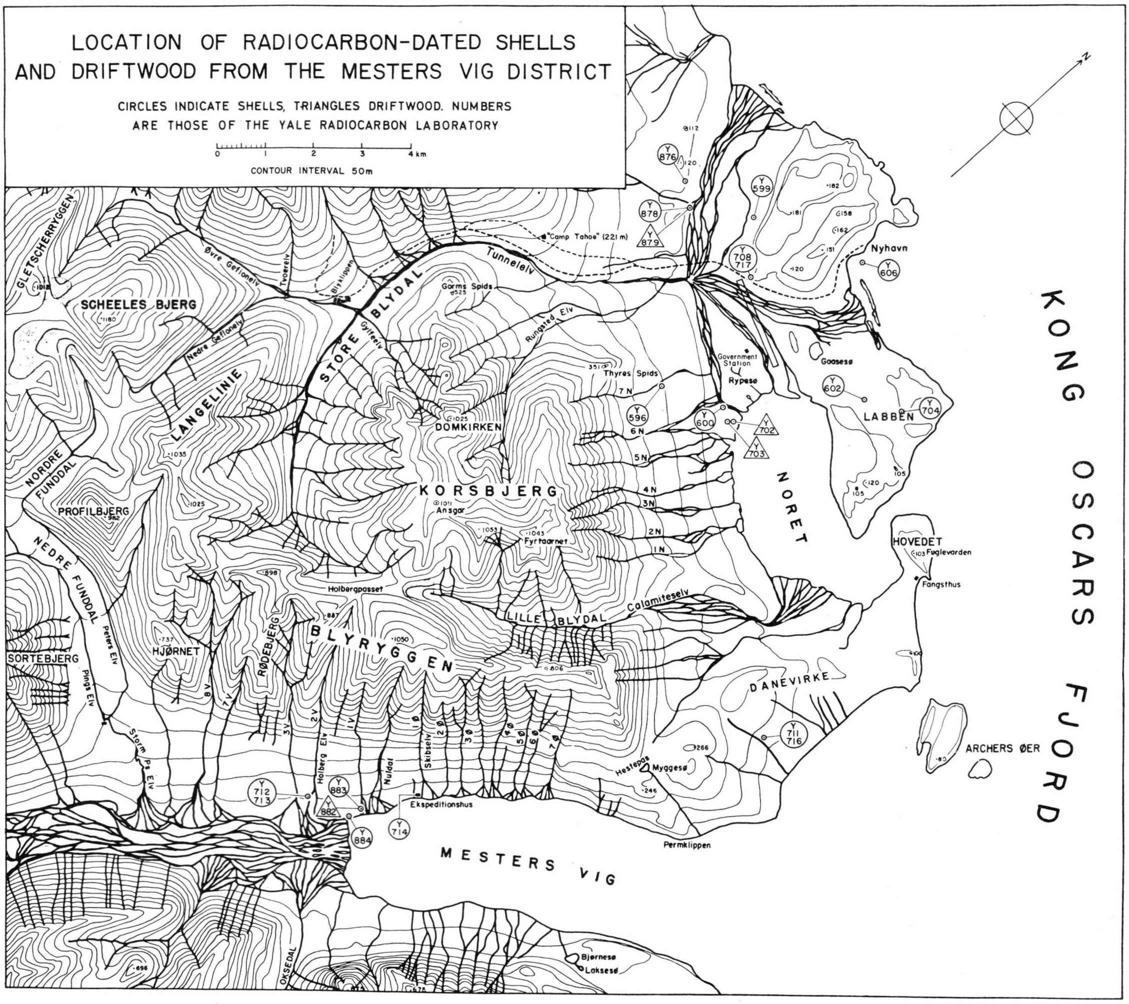

Fig. 5.

curve at about 6000 B.P. is not significantly affected by the correction for rise of sealevel in figure 7. (2) The shell dates have been corrected for an apparent age of 550 yr, based on modern shells (Y 606) collected in the district and used as a standard. (3) As with most shell dates, there is uncertainty as to the depth at which a mollusk died, and a correlation of the date with a former sealevel may involve a significant error. (4) Field altitudes were determined largely by Paulin altimeter, corrected for changes of pressure and temperature. Since the tidal range is of the order of only 1 m no attempt was made to distinguish between high-tide and mean-tide levels in computing altitude. Accuracy of measurement for altitudes less than 5 m is estimated to be $\pm {}^1/_2$ m; for those between 5

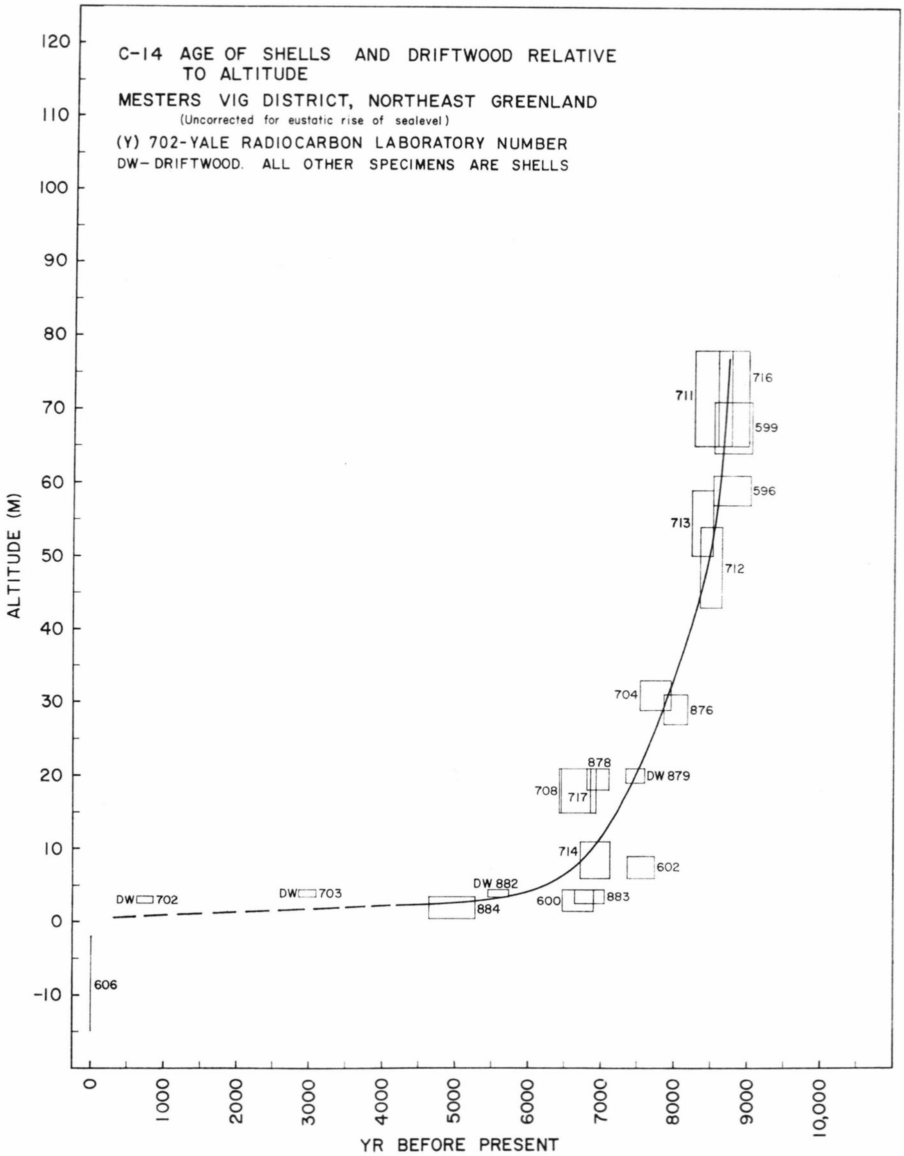

Fig. 6.

and 25 m ± 1 m; and for those above 25 m ± 2 m. (5) The vertical sides of the rectangles associated with the specimens as plotted in the figures represent the altitude range (corrected in figures 7 and 8 for eustatic rise of sealevel) within which the specimens were collected; the horizontal sides represent the statistical error of the age. (6) Four dates are derived from driftwood, but only two of these (Y 702 and Y 703) represent

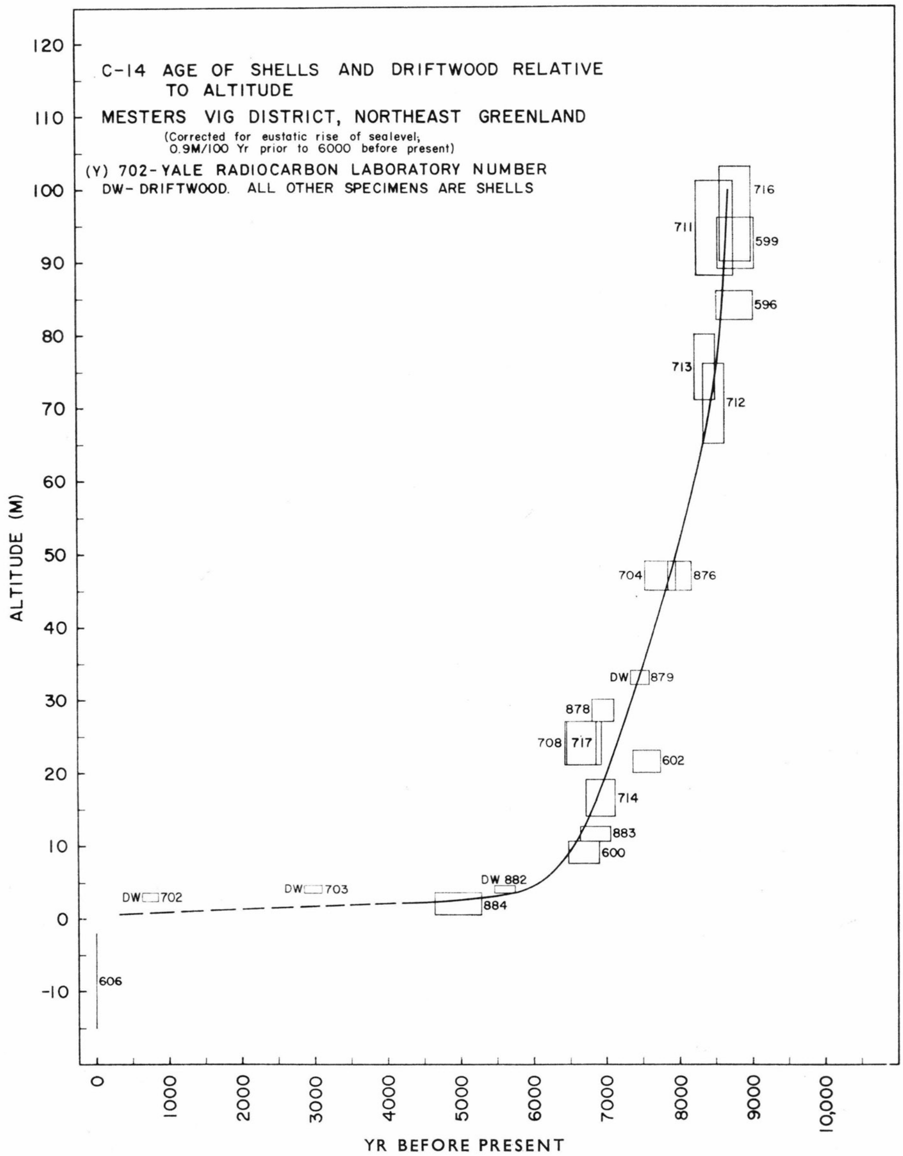

Fig. 7.

driftwood clearly related to emerged strandlines. In these two cases the wood was from logs lying at, and parallel to, the inner ridge of the strandlines. However, the strandlines were low nips in unconsolidated material, and because they may have been associated with storms, they may have been formed a little above the high-tide level of the time. This may account for the slightly anomalous position of Y 702 and Y 703

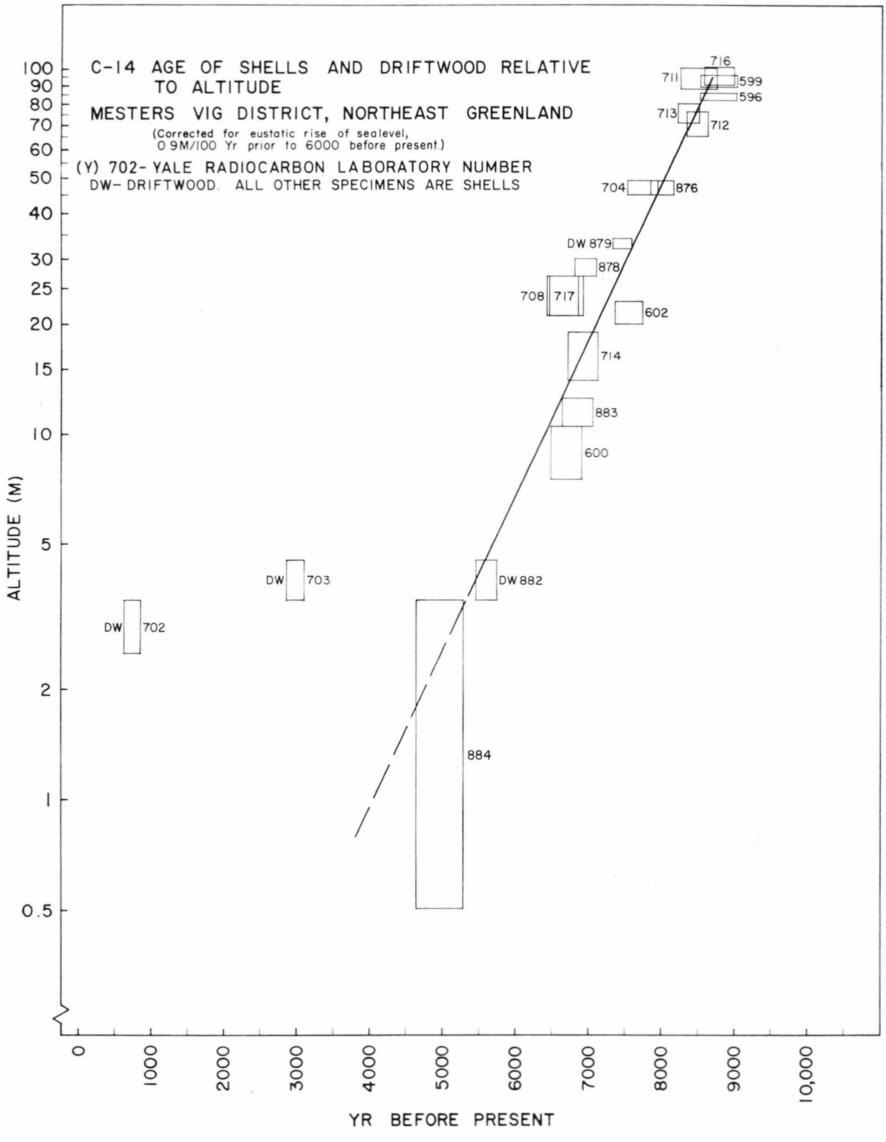

Fig. 8.

above the curve in figures 6 and 7. In figure 8 their position is grossly exaggerated by the use of the logarithmic altitude scale. The other two wood specimens (Y 879 and Y 882) may have been derived from somewhat higher altitude by mass-wasting.

The following conclusions can be drawn from figures 6–8:

(1) The fossiliferous till-like material is an emerged fjord-bottom deposit. The points of the curve line up too well, and are internally too

consistent as between the altitudes and associated ages of the till-like material on the one hand and of fossiliferous delta deposits of similar age and altitude on the other, to permit the interpretation that the till-like deposit was laid down by an advancing glacier prior to deglaciation.

(2) The Mesters Vig district was open to the sea and therefore deglaciated, at least in part, by 9000–8500 B.P.

(3) The Mesters Vig district has remained largely free of glaciers since about 8500 B.P. This is significant in view of the fact that valley glaciers, fringed by old moraines, occur nearby today. A sizeable glacier near the head of Mesters Vig (bay) is only about 8 km from an emerged delta with shells dated 8480 ± 140 B.P. (Y 712). Therefore, the climate since about 8500 B.P. could not have been very much more conducive to glaciation than at present.

(4) Deglaciation of the Mesters Vig district is closely related in time and effect to the Hypsithermal (DEEVEY and FLINT, 1957).

(5) It follows from (4) that probably emergence in the Mesters Vig district is primarily related to ice thinning and deglaciation and is therefore probably due to isostatic adjustment.

(6) The rate of emergence was high initially of the order of 9m/100 yr and decreased approximately exponentially, to about 0.6 m/100 yr, for the interval 9000 B.P. to 6000 B.P. It should be emphasized that the absolute value of rate of emergence for the exponential part of the curve depends on the altitude, and comparison with other curves should take this into consideration. Compared with curves of other regions showing post-glacial deleveling, the Mesters Vig district has one of the highest rates of emergence. For the interval 6000 B.P. to the present the exponential character of the curve disappears, with rates of emergence of perhaps as little as 7 cm/100 yr. However, pending further investigations, this rate must be regarded as highly tentative.

(7) The general aspect of the curve in figures 6–8 is very similar to that deduced for northern Canada (FARRAND, 1962), and for Spitsbergen (FEYLING-HANSSEN and OLSSON, 1960, fig. 1, p. 123; BLAKE, 1961, fig. 9, p. 143).

Geomorphology.

The geomorphic history of Northeast Greenland has been discussed, among others, by BRETZ (1935), ODELL (1937), ÅHLMANN (1941 a), and FLINT (1948). Most of the pre-Pleistocene aspects are speculative and have little bearing on the geomorphic and vegetational studies that were carried out in the Mesters Vig district. According to FRÄNKL (1953, p. 52–54), the Staunings Alper represent a domed and dissected peneplain, whose doming is post-Jurassic and pre-Pleistocene. However, the Staunings Alper are alpine peaks lacking any tablelands, and although widespread erosion surfaces can be demonstrated in some other parts of Northeast Greenland this is not true for the Staunings Alper. The Mesters Vig district, too, is thoroughly dissected. AHLMANN (1941 a) concluded that most of the major dissection of Northeast Greenland was of pre-Pleistocene fluvial origin but that glaciation had strongly modified the valley systems. The present writer believes this holds for the Mesters Vig district.

The major topographic features of the Mesters Vig district have already been discussed, as have some of the geomorphic aspects of the glacial geology and deleveling history. Since detailed reports are planned on these and other geomorphic questions, only a few further comments will be made here.

The influence of lithology and structure on the topography warrant special mention. Shaly beds are generally obscured by mass-wasting sediments, whereas resistant sandstone or conglomerate beds form marked outcrops in places. Where there is deep incision sheer rock walls are prominent, as along Tunnelelv and on the upper parts of some slopes such as the northwest slope of Blyryggen and the south slope of Heste-skoen. On more gentle slopes strata of varying degrees of resistance produce lithologic benches, which because of the prevailing low dip of the strata might be mistaken in places for fluvial or marine terraces. The most striking lithologic control, however, is exerted by the trap bedrock, which is responsible for precipitous slopes wherever sizeable bodies have been dissected. Generally the most gentle slopes are associated with the surficial deposits, especially those that are silty.

Permafrost is present at depths ranging from about half a meter to somewhat over 2 m, depending on the mineral soil, vegetation cover, moisture conditions, and other variables. Patterned ground is prominent in a number of places. Fluvial action is very prominent in connection with the construction of massive fans, and is most effective when the streams break up in the late spring.

Slushflow is a characteristic process during the break-up period. The following description of the process (WASHBURN and GOLDTHWAIT, 1958) is included in line with the policy of incorporating in this general introduction all previously published information derived from the Mesters Vig research program, and the writer is grateful to the Geological Society of America for permission to quote it.

"Slushflow is a little-known geologic process consisting of mudflowlike flowage of water-saturated snow along stream courses. It occurs in spring, in places annually, in a single outburst following intense thawing producing more meltwater than can drain through the snow. It is common locally in the Arctic but is not confined to it.

Near Mesters Vig, Northeast Greenland, slushflow is an important process of erosion and deposition and the characteristic method of stream break-up. It is also known from the thaw zone of some glaciers such as the Barnes Ice Cap of Baffin Island.

"Slushflows, sometimes called "slushers", start suddenly and run their course in seconds to hours, leaving natural levees of compacted snow $^1/_2$–2 m high, and a free-flowing stream in their wake. Their width is generally several to many times greater than that of the stream channel. Some merely ream out snow from sections of stream courses without transporting appreciable load. Others carry many tons of rock debris from valleys and contribute to, and may be largely responsible for, extensive boulder-strewn fans, as illustrated by the Lejrelv slushflow near Mesters Vig in 1958. This slushflow scattered stones up valley slopes 20 m above the bed of the stream and deposited bouldery debris and fragmented tundra vegetation over one third of the Lejrelv fan, which is $^3/_4$ km wide at the toe; yet the stream could be stepped across in the summer".

Mass-wasting is a particularly significant process and much time was devoted to studying it, especially frost creep and gelifluction[1]). Earthflow is also widespread. An abstract of some of the results of the mass-wasting study has already appeared (Washburn, 1962a, 1962b), and the writer is indebted to the Eastern Snow Conference for permission to reproduce (with minor changes), in accord with the policy noted above, the abstract published by that organization.

"The following conclusions are based on theodolite observations of lines of targets at Mesters Vig, Northeast Greenland. The lines were controlled by end points on bedrock, and target movement was measured with respect to the vertical plane through the end points. Most of the experimental sites were on stony loam. At these sites:

(1) Frost creep and gelifluction (solifluction associated with frozen ground) can be quantitatively distinguished from each other.

(2) The average magnitudes of frost creep and of gelifluction tend to be similar[2]), but locally one or the other may predominate.

(3) On a slope of about 10° to 14° the combined rate of movement by gelifluction and creep ranged from 0 cm/yr to 6 cm/yr.

(4) Moisture exerts a dominant influence on rate of movement for both frost creep and gelifluction, and is far more important than presence or absence of vegetation, as shown by the fact that the greatest movement is in the generally wettest sections of the experimental sites regardless of presence or absence of vegetation.

(5) In the wettest sections, the average rate of frost creep and gelifluction combined is probably roughly proportional to slope gradient.

(6) There appears to be a boundary condition, determined by moisture, above which gelifluction is active and below which it is negligible. The range of this condition approximates the range of the Atterberg liquid limit for the mineral soil***

[1]) Baulig's (1956, p. 50–51; 1957, p. 926) term gelifluction is more precise here than solifluction, since frozen ground is present.

[2]) Further data incorporating later observations show that frost creep commonly exceeds gelifluction although, as indicated, the one or the other may predominate locally.

(7) Frost creep is almost entirely due to annual, rather than diurnal, freeze-thaw cycles.

(8) A retrograde movement with respect to the vertical reference plane is common during summer and lessens downslope movement. This movement is mainly the result of desiccation and reflects a tendency of the thawed layer to settle back against the slope, as originally reported by DAVISON in 1889 (Geol. Mag., Decade 3, v. 6, p. 255–261). It seems probable that capillary pressure is an important factor in this movement.

"The above conclusions reflect conditions at the experimental sites. However, at least (1), (4), and (8) are believed to be much more widely applicable. Also, it follows from (8) that creep due to wetting and drying in any environment is probably less per cycle of volume expansion and contraction than is commonly supposed, for, with a few notable exceptions, it seems to be generally assumed that such creep involves purely vertical settling".

EXPERIMENTAL SITES

A number of experimental sites (ES) were established in the Mesters Vig district to study frost action, mass-wasting, and patterned ground. For ease of reference, the sites are numbered, the number reflecting the order in which the sites were established. However, certain sites combine to form natural units dealing with various aspects of an area or process. Thus at Labben, ES 1, 11–12 were devoted to the same area of sorted nets, ES 2–3, 9 were associated with the same area of nonsorted circles and related features, and ES 4–5 were on the same gelifluction slope. In the Nyhavn hills, ES 7–8, 15 were set up to study comprehensively the various aspects of a single gelifluction slope. In the vicinity of "Camp Tahoe", ES 20–21 were concerned with frost action and mass-wasting, and ES 22–24 were devoted to weathering. The sites are indicated in plate 5.

Detailed information on the instrumentation at the various experimental sites will be found in the number of the *Meddelelser* that covers instrumental observations of mass-wasting. The cone targets mentioned below were orange-colored wood cones alined across a slope to measure mass-wasting. They were 10 cm high and in basal diameter, and were mounted on pegs that were 10 or 20 cm long to permit this variation in depth of insertion. The individual experimental sites are listed below and their location is shown in plate 5. Full descriptions will be found in the numbers of the *Meddelelser* that discuss the resulting data.

Experimental site 1 was at Labben. It comprised two thermocouple strings associated with patterned ground. One string was in the mesh of a sorted net, the other in the stony border.

Experimental site 2 was also at Labben. It represented an attempt to measure pressures within a nonsorted circle by means of cryostatic gages, but the gages turned out to be unsatisfactory and the site was soon abandoned.

Experimental site 3 was at Labben. It comprised two thermocouple strings associated with a nonsorted circle in shell-bearing stony silt. One thermocouple was in the central area of the circle, the other in the bordering tundra-covered ground.

Experimental site 4, also at Labben, was a target line of 30 cones and a steel rod alined across a gentle gelifluction slope that was characteristically very dry during the summer. For lack of nearby bedrock, the theodolite station for the target line was on a large boulder. Subsequent observations indicated that the boulder was subject to movement and that the site was unsatisfactory for precise observations of mass-wasting. However, heaving of individual targets provided useful information on frost action.

Experimental site 5 was in the same area as ES 4 and downslope from it. It comprised a target line of 27 cones and a steel rod alined across a very gentle gelifluction slope similar to the one at ES 4. The theodolite station was on a very large block, which turned out to be unstable like the boulder at ES 4, so that the resulting data are more significant with respect to frost heaving than to mass-wasting.

Experimental site 6 was in the easternmost part of the Nyhavn hills. It was represented by a target line of 43 cones alined across a very gentle gelifluction slope that was commonly wet in contrast to the characteristically dry slope at ES 4–5. Supporting instrumentation consisted of a mass-wastingmeter and two thermocouple strings. The theodolite station and end reference point for the target line were on bedrock, and the resulting data provide important information on gelifluction as well as frost heaving.

Experimental site 7 was in the Nyhavn hills about $^1/_2$ km west of ES 6. It was on moderate but much steeper slope than those at ES 4–6. There was a target line of 40 cones and a steel rod, and additional instrumentation including a mass-wastingmeter, and 5 thermocouple strings. The theodolite station and end reference point for the target line were on bedrock. The mineral soil of the slope is a stony loam. The moisture and vegetation conditions ranged from generally dry and barren in the east part to generally wet and vegetated in the west part of the slope, so that it was possible to study the effect of these contrasting conditions.

Experimental site 8 was on the same slope as ES 7 but slightly lower. The instrumentation comprised a target line of 34 cones, associated with a short line of dowels, a mass-wastingmeter, 2 thermocouple strings, 5 soil-thermograph installations, and an instrument shelter with maximum-minimum thermometers and an air thermograph. The latter instrumentation was established to permit correlations with the meteorological records at the Danish Government station at the airfield and to allow certain extrapolations from them with respect to ES 7–8. The theodolite station for the target line was on bedrock, and the end reference point was the same as that for the target line at ES 7.

Experimental site 9 was at Labben and in the same area as ES 2–3. It was represented by a nonsorted circle similar to those at ES 2–3, but instead of being instrumented with cryostatic gages or thermocouples it had a grid pattern of 137 dowels. This arrangement permitted the study of frost-action effects as revealed by the heaving of individual dowels and the deformation of the grid pattern.

Experimental site 10 reflected an attempt to instrument a small sorted step, but the ground was too stony for the available instrumentation and the attempt was soon abandoned.

Experimental site 11 was at Labben, in the same area as ES 1. It comprised a grid pattern of 87 dowels in a sorted net similar to the patterned ground at ES 1.

Experimental site 12 was adjacent to ES 11. It, also, consisted of a dowel grid associated with a sorted net, but the instrumented area within the mesh of the net had a different appearance than that at ES 11.

Experimental site 13, like ES 2 and 10, was an abortive effort that was soon abandoned.

Experimental site 14 was at Labben, a short distance west of ES 1, 11–12. It was a small lobate area of gelifluction instrumented with two lines of dowels. Since there was no good location for a theodolite station in the immediate vicinity, the lines were laid out with reference to end posts. These were driven as deeply as possible into the ground but were obviously subject to movement. The resulting data are useful mainly in connection with frost heaving.

Experimental site 15 was in the Nyhavn hills and at the crest of the same slope on which ES 7–8 were located. It comprised a small gelifluction lobe, instrumented with 65 dowels in two intersecting target lines. As at ES 14, these lines were not controlled by bedrock end points, so that only relative movement could be studied in addition to the frost heaving of individual dowels.

Experimental site 16 was on the side of a small dell some 200 m northwest of ES 15. In contrast to all the foregoing sites, it was on a steep slope of grus from disintegrating trap bedrock. It was instrumented with a target line of 68 dowels, a mass-wastingmeter, and a thermocouple string. The target line was controlled by bedrock end points.

Experimental site 17 was on the east slope of Hesteskoen at an altitude of about 750 m. It was a massive gelifluction lobe of stony debris, and was instrumented with 15 cones alined across the lobe. Although lack of bedrock exposures and of suitable drill equipment prevented adequate control of the target lines, the arrangement was such that it provided useful data on relative movement as between the axial area and the margins of the lobe.

Experimental sites 18–19 were originally set up as independent units within ES 7–8, but these designations were soon discontinued.

Experimental site 20 was near the east base of Hesteskoen, about $^1/_2$ km southwest of "Camp Tahoe". It comprised two intersecting lines of dowels in the bare central area of a large nonsorted polygon in very sandy material that contrasted with the generally much finer mineral soil of Labben and the Nyhavn hills. Here, again, the lack of stable end points restricted information from the dowels to data on frost heaving and relative movement of the lines.

Experimental site 21 was about 130 m west of ES 20. It consisted of two intersecting lines of dowels on a moderate slope of sandy material similar to that at ES 20 but lacking the patterned-ground features. It was established to obtain further information on frost action.

Experimental site 22 was on the northeast side of Hesteskoen, 150 m north of "Camp Tahoe". It was a disintegrating trap boulder, strongly weathered and with much grus at its base. In order to obtain quantitative data on the rate of disintegration, a sheet was spread around the base to collect such grus as might be subsequently shed from the boulder.

Experimental site 23 was about 130 m southeast of ES 20. Like ES 22 it was a disintegrating trap boulder around which a sheet was spread to collect the weathering products.

Experimental site 24 was about 350 m north of "Camp Tahoe". It was a granitic boulder that was treated in the same way as ES 22–23 in order to provide comparative data on weathering.

TABLES

Table 1. Meteorological Table, Mesters Vig, Northeast Greenland.

	Temperature °C			Precipitation	Snow depth range exclusive of drifts	Wind							
						No. of							
	Mean	Max	Min	mm	cm	NNE	NE	ENE	E	ESE	SE	SSE	S
1952													
Oct.	−8.0	−1.0	−17.0	21.1	. .	. .	0	. .	1	. .	7	. .	2
Nov.	−17.2	−3.0	−28.0	4.6	. .	. .	2	. .	0	. .	0	. .	1
Dec.	−20.8	−8.0	−32.0	0.0	. .	. .	0	. .	0	. .	6	. .	0
1953													
Jan.	−20.6	−2.0	−36.0	21.7	. .	. .	1	. .	2	. .	1	. .	1
Feb.	−25.9	−5.0	−44.0	17.6	. .	. .	3	. .	1	. .	4	. .	1
Mar.	−24.8	−10.0	−37.0	11.2	. .	. .	0	. .	1	. .	8	. .	2
Apr.	−16.3	−2.0	−35.0	0.2	. .	. .	1	. .	4	. .	3	. .	0
May	−3.3	9.0	−17.0	4.2	. .	. .	1	. .	17	. .	18	. .	0
June	3.9	15.5	−4.3	95.8	. .	. .	5	. .	17	. .	18	. .	4
July	4.8	17.0	−2.5	3.6	. .	. .	7	. .	65	. .	50	. .	0
Aug.	7.8	17.6	0.0	77.1	. .	. .	5	. .	39	. .	30	. .	3
Sept.	0.6	10.6	−10.3	23.3	. .	. .	0	. .	15	. .	13	. .	6
Oct.	−6.0	−0.1	−14.6	70.8	. .	. .	0	. .	3	. .	7	. .	2
Nov.	−12.7	1.7	−31.6	127.0	. .	. .	0	. .	2	. .	6	. .	6
Dec.	−17.5	−6.7	−37.2	65.3	. .	. .	0	. .	4	. .	8	. .	10
Annual . .	−9.2	17.6	−44.0	517.8	. .	. .	23	. .	170	. .	166		35
1954													
Jan.	−22.4	−8.0	−37.0	42.4	115–150	4	0	1	0	0	1	0	5
Feb.	−20.5	0.2	−40.6	79.2	142–205	0	2	3	1	2	6	2	3
Mar.	−27.0	−12.0	−42.6	2.5	180–200	0	0	0	0	0	0	0	1
Apr.	−14.7	−2.3	−31.7	4.3	190–205	0	0	0	0	5	4	1	1
May	−3.9	6.3	−24.4	8.1	126–190	0	0	0	5	9	11	1	0
June	0.7	6.2	−5.7	35.8	40–126	0	1	1	4	15	6	1	2
July	3.6	13.9	−3.4	7.6	0– 38	1	0	0	12	77	15	3	0
Aug	4.9	14.3	−1.3	18.9	0– 0	1	1	2	28	68	7	0	0
Sept.	−0.7	7.8	−10.0	5.7	0– 4	3	0	0	0	24	4	4	2
Oct.	−8.4	2.7	−22.0	16.0	0– 20	1	0	0	1	3	2	1	1
Nov.	−11.2	−0.6	−27.4	58.3	11– 75	0	1	0	1	2	6	5	0
Dec.	−16.6	−0.6	−43.5	39.5	68–100	1	1	0	0	5	0	1	0
Annual . .	−9.7	14.3	−43.5	318.3	. .	11	6	7	52	210	62	19	15
1955													
Jan.	−25.6	−10.9	−43.2	6.5	86– 87	1	0	2	1	2	3	0	1
Feb.	−26.8	−0.1	−44.2	1.7	86– 87	0	0	0	2	1	2	1	1
Mar.	−19.4	−1.7	−38.3	2.7	85– 87	2	0	2	0	1	2	0	1
Apr.	−12.3	−0.7	−30.1	10.9	85– 92	0	0	1	3	3	3	1	1
May	−5.9	6.8	−24.2	0.0	68– 91	0	0	1	7	7	1	4	0
June	0.7	8.0	−4.8	0.0	7– 60	1	1	0	10	28	20	1	0
July	5.0	13.6	−0.2	57.0	0– 7	2	2	1	11	58	18	5	2
Aug.	5.4	12.3	−0.7	32.7	0– 0	3	4	2	15	46	14	1	0
Sept.	1.1	7.7	−6.1	121.3	0– 10	2	3	1	6	17	1	4	1
Oct.	−6.9	7.4	−16.2	8.5	7– 16	0	0	0	3	5	6	1	1
Nov.	−16.1	−4.6	−30.4	2.7	?– 16	0	0	0	0	3	1	1	0
Dec.	−19.0	−3.5	−31.5	12.1	12– 24	0	0	0	0	0	1	1	1
Annual . .	−10.0	13.6	−44.2	256.1	. .	11	10	10	58	171	72	20	9

Lat. 72°14 N. Long 23°55 W. Station alt. 16 m.

direction									Wind speed (Knots)						
observations								Most frequent	No. of observations					Most frequent	Max
SSW	SW	WSW	W	WNW	NW	NNW	N		Calm	1–5	6–20	> 20	Total		
..	12	..	58	..	22	..	0	W	85	..	..	..	187	?	?
..	0	..	16	..	18	..	3	NW	140	..	..	..	180	Calm	?
..	2	..	30	..	15	..	1	W	132	..	..	..	186	Calm	?
..	1	..	12	..	38	..	0	NW	128	..	..	..	184	Calm	?
..	2	..	16	..	17	..	2	NW	124	..	..	..	170	Calm	?
..	2	..	44	..	12	..	1	W	118	..	..	..	188	Calm	?
..	0	..	9	..	11	..	1	NW	153	..	..	..	182	Calm	?
..	2	..	7	..	4	..	1	SE	136	..	..	..	186	Calm	?
..	1	..	14	..	21	..	6	NW	94	..	..	..	180	Calm	?
..	0	..	5	..	6	..	3	E	55	..	..	..	191	?	?
..	0	..	21	..	23	..	5	E	60	..	..	..	186	?	?
..	7	..	54	..	21	..	2	W	62	..	..	..	180	?	?
..	36	..	75	..	40	..	0	W	26	..	..	..	189	?	?
..	9	..	24	..	62	..	4	NW	66	..	..	..	179	?	?
..	4	..	48	..	44	..	2	W	66	..	..	..	186	?	?
..	64	..	329	..	299	..	27	W	1088	..	..	..	2201	..	?
1	0	11	20	11	19	2	5	W	106	57	21	1	186	Calm	21
3	1	5	17	8	22	0	2	NW	91	47	27	3	168	Calm	29
0	0	5	26	28	11	1	1	WNW	113	55	18	0	186	Calm	13
2	0	2	12	32	16	17	1	WNW	114	72	19	2	207	Calm	24
0	0	1	3	6	8	6	0	ESE	133	41	11	0	185	Calm	12
0	0	1	2	9	11	2	0	ESE	127	47	8	0	182	Calm	?
1	0	3	4	3	7	2	1	ESE	76	97	32	0	205	1–5	17
0	0	0	2	0	1	0	1	ESE	77	63	48	0	188	Calm	15
0	3	11	7	4	18	18	2	ESE	80	?	?	9	180	Calm	30
2	6	5	13	15	19	4	0	NW	113	38	29	6	186	Calm	25
1	1	2	27	17	37	5	1	NW	74	46	48	12	180	Calm	35
0	0	0	36	18	20	11	0	W	89	50	41	6	186	Calm	35 (50)
10	11	46	169	151	189	68	14	ESE	1193	..	..	39	2239	Calm	35 (50)
1	4	8	11	18	13	2	3	WNW	116	35	33	2	186	Calm	22
0	1	1	3	18	9	0	2	WNW	127	21	20	0	168	Calm	20
3	1	4	7	19	16	2	2	WNW	124	31	29	2	186	Calm	21
0	1	1	9	21	16	0	0	WNW	122	34	25	1	182	Calm	23
0	1	1	1	9	1	0	0	WNW	155	26	7	0	188	Calm	15
0	0	0	1	6	5	0	0	ESE	109	62	11	0	182	Calm	9
0	0	0	3	4	15	5	7	ESE	53	64	71	0	188	6–20	17
0	0	1	3	10	11	9	0	ESE	67	47	72	0	186	6–20	20
0	0	4	17	20	18	6	0	WNW	86	47	53	0	186	Calm	17
2	2	32	21	6	5	6	2	WSW	94	48	39	5	186	Calm	25
1	2	2	12	21	24	15	0	NW	98	30	41	11	180	Calm	27
1	2	5	12	24	13	4	1	WNW	122	31	32	2	187	Calm	27
8	14	59	100	174	146	49	17	WNW	1273	476	433	23	2205	Calm	27

(continued)

Table 1

	Temperature °C			Pre-cipita-tion	Snow depth range exclusive of drifts	Wind — No. of							
	Mean	Max	Min	mm	cm	NNE	NE	ENE	E	ESE	SE	SSE	S
1956													
Jan......	-23.2	-6.9	-35.6	24.2	21– 55	0	1	0	0	0	0	0	0
Feb.	-21.3	-0.6	-36.5	16.7	55– 65	0	0	0	4	3	1	2	0
Mar	-20.6	-8.3	-43.7	24.5	63–101	0	1	0	2	2	2	1	0
Apr.	-17.4	-3.0	-38.7	0.1	63– 98	0	0	0	0	0	0	0	0
May.....	-7.6	4.3	-28.7	4.1	24– 63	0	0	0	1	6	0	1	0
June	1.1	15.3	-7.5	5.6	0– 24	0	0	1	6	23	8	2	0
July	5.8	16.0	-2.2	64.5	0– 0	6	1	1	11	45	15	2	1
Aug	5.9	14.4	-2.3	19.7	0– 0	4	2	1	25	58	6	1	1
Sept	-2.5	10.9	-13.8	37.0	0– 30	1	0	2	2	18	10	2	0
Oct......	-9.5	-0.4	-20.3	26.7	15– 35	0	1	0	0	4	3	1	2
Nov.	-14.9	-2.6	-28.1	55.6	110–160	1	0	0	2	3	2	2	0
Dec.	-12.5	-1.1	-33.5	90.0	200–250	1	0	1	1	1	2	0	2
Annual ..	-9.7	16.0	-43.7	368.7	..	13	6	6	54	163	49	14	6
1957													
Jan......	-17.1	-0.6	-38.4	194.4	350–400	0	2	0	2	4	2	2	3
Feb	-27.5	-1.6	-43.5	37.2	230–250	0	0	0	0	1	0	0	0
Mar......	-22.3	-5.6	-41.8	18.8	200–235	1	0	0	0	0	0	0	2
Apr.	-15.1	1.5	-30.2	10.1	180–225	0	1	0	2	0	0	0	0
May.....	-5.2	4.6	-27.0	1.9	140–180	0	1	1	1	3	2	1	1
June	1.3	10.0	-6.4	0.6	8–135	1	1	0	4	16	5	0	0
July	5.9	16.0	-2.3	0.1	0– 8	3	2	3	2	30	65	3	0
Aug.	7.3	16.4	-1.8	22.9	0– 0	4	4	3	2	57	47	1	1
Sept.	-0.6	8.8	-10.9	3.5	0– 5	1	3	0	4	29	23	4	2
Oct.	-6.8	4.8	-22.3	91.7	0– 75	3	1	1	0	3	9	1	1
Nov.	-13.7	-0.8	-27.2	4.8	40– 50	1	0	0	1	2	5	0	0
Dec.	-20.9	-5.5	-38.3	119.0	50–175	0	0	1	0	1	1	2	2
Annual ..	-9.6	16.4	-43.5	505.0	..	14	15	9	18	146	159	14	12
1958													
Jan......	-19.4	-4.8	-35.4	71.7	175–200	2	0	0	2	0	1	0	0
Feb.	-24.8	-5.9	-43.0	25.1	175–200	0	2	0	0	1	4	1	1
Mar......	-17.0	-1.5	-33.3	107.5	175–225?	0	0	0	0	1	1	4	1
Apr.	-12.9	2.8	-34.2	117.0	175–225?	1	1	1	1	3	4	4	0
May.....	-4.2	4.2	-17.4	0.0	175–225	1	1	1	1	8	4	1	0
June	1.7	11.0	-3.5	0.6	0–175	0	1	2	3	29	23	2	0
July	8.2	21.0	-1.0	0.4	0– 0	8	7	2	7	69	26	4	0
Aug......	6.3	14.5	-2.0	5.4	0– 0	6	8	3	13	74	12	1	0
Sept.	-0.7	13.0	-11.3	18.3	0– 20	0	0	8	5	27	0	3	1
Oct.	-11.1	3.6	-25.7	19.4	10– 20	0	0	0	3	7	2	1	0
Nov.	-21.1	-8.0	-38.8	40.3	20–100	0	0	0	1	4	0	0	0
Dec.	-20.3	-2.0	-35.6	7.4	50–100	0	2	0	0	4	2	1	0
Annual ..	-9.6	21.0	-43.0	413.1	..	18	22	17	36	227	79	22	3

continued).

irection									Wind speed (Knots)						
observations								Most frequent	No. of observations					Most frequent	Max
SSW	SW	WSW	W	WNW	NW	NNW	N		Calm	1–5	6–20	>20	Total		
0	1	2	10	31	13	2	1	WNW	125	25	36	0	186	Calm	?
2	1	0	14	23	14	3	1	WNW	106	33	31	4	174	Calm	40
1	1	2	9	20	6	3	1	WNW	126	35	25	0	186	Calm	15
0	0	1	7	12	3	0	0	WNW	157	17	6	0	180	Calm	9
1	0	1	2	12	15	7	0	NW	140	30	15	1	186	Calm	28
0	0	0	3	6	8	0	1	ESE	122	35	23	0	180	Calm	20
0	0	0	5	8	4	3	6	ESE	88	53	55	0	196	Calm	14
0	0	2	11	6	4	3	3	ESE	121	74	53	0	248	Calm	25
4	22	48	18	18	11	3	1	WSW	80	62	98	0	240	6–20	39
1	7	23	24	27	15	8	0	WNW	86	47	46	23	202	Calm	35
3	3	2	20	27	17	7	0	WNW	91	39	33	17	180	Calm	45
2	0	5	19	41	20	6	2	WNW	83	37	46	20	186	Calm	34
14	35	86	142	231	130	45	16	WNW	1325	487	467	65	2344	Calm	?
2	1	1	22	28	25	6	3	WNW	83	38	38	27	186	Calm	39
1	0	4	11	11	9	2	0	WNW	129	12	14	13	168	Calm	42
1	0	2	24	15	4	1	0	W	136	20	26	4	186	Calm	30
0	0	2	20	21	7	3	0	WNW	124	24	28	4	180	Calm	35
0	1	2	4	8	4	2	3	WNW	152	26	8	0	186	Calm	18
1	2	1	6	4	2	0	2	ESE	134	40	4	2	180	Calm	27
0	1	0	1	7	3	2	0	SE	95	72	51	0	218	Calm	18
0	1	3	2	11	18	1	4	ESE	89	77	80	2	248	Calm	35
1	1	0	4	6	4	7	1	ESE	135	55	32	4	226	Calm	31
6	8	27	15	17	34	3	0	NW	57	52	57	20	186	Calm	40
3	3	10	18	19	16	2	0	WNW	100	35	40	5	180	Calm	35
1	2	1	7	23	37	4	1	NW	103	25	30	28	186	Calm	55
16	20	53	134	170	163	33	14	WNW	1337	476	408	109	2330	Calm	55
1	4	4	14	22	35	6	0	NW	95	27	44	20	186	Calm	37
0	2	1	12	21	15	3	1	WNW	104	28	30	6	168	Calm	36
0	2	1	12	44	27	6	2	WNW	85	41	37	23	186	Calm	57
1	1	5	8	30	30	1	0	WNW	89	37	47	7	180	Calm	25
1	4	1	1	5	14	5	0	NW	138	28	14	6	186	Calm	38
0	0	1	3	3	7	3	2	ESE	101	42	37	0	180	Calm	18
0	0	0	1	8	13	4	2	ESE	63	79	86	0	228	Calm	20
0	0	5	7	9	7	2	3	ESE	83	86	79	0	248	1–5	16
1	0	28	2	25	0	1	1	WSW	118	58	44	0	220	Calm	14
3	2	30	11	19	0	1	0	WSW	99	49	37	1	186	Calm	25
1	0	4	12	26	0	2	0	WNW	131	31	17	1	180	Calm	23
0	0	4	10	10	7	0	0	WNW	138	15	16	8	177?	Calm	35
8	15	84	93	222	155	34	11	ESE	1244	521	488	72	2325?	Calm	57

(continued)

Table

	Temperature °C			Precipitation	Snow depth range exclusive of drifts	Wind							
						No. of							
	Mean	Max	Min	mm	cm	NNE	NE	ENE	E	ESE	SE	SSE	S
1959													
Jan.	-25.1	-9.5	-36.6	16.8	60– 70	0	0	2	0	1	0	0	0
Feb.	-22.7	-1.8	-43.2	18.7	40– 90	0	0	0	0	3	0	0	0
Mar.	-20.9	-6.2	-39.8	44.8	90–160	0	0	1	0	0	0	0	0
Apr.	-17.5	-6.8	-36.0	13.1	100–160	1	0	1	0	5	0	0	0
May	-4.9	4.2	-21.8	7.3	30–100	0	0	0	1	7	0	0	0
June	1.3	12.8	-5.8	0.8	0– 30	0	0	0	5	45	2	1	1
July	3.5	12.4	-2.4	3.2	0– 0	4	7	5	58	60	14	0	0
Aug.	4.0	11.9	-3.3	23.4	0– 0	1	4	4	10	58	38	1	2
Sept.	-0.9	5.2	-7.8	63.0	0– 30	0	2	1	1	8	5	0	3
Oct.	-6.0	2.3	-20.3	45.4	25– 70	0	0	0	0	5	4	5	1
Nov.	-17.2	-6.6	-27.2	26.6	70–110	0	0	0	0	0	2	2	1
Dec.	-20.7	0.7	-43.8	87.8	120–150	0	0	0	0	0	0	0	0
Annual	-10.6	12.8	-43.8	350.9	..	6	13	14	75	192	65	9	8
1960													
Jan.	-18.0	-0.5	-37.8	57.8	150–175	0	1	1	0	3	5	1	2
Feb.	-24.4	5.7	-40.8	21.5	150–175	0	0	1	0	0	0	1	1
Mar.	-18.9	-4.6	-44.2	23.7	150–183?	0	0	0	0	1	0	1	0
Apr.	-12.7	-0.5	-28.3	20.0	183–185	0	0	0	0	6	2	3	2
May	-3.3	7.3	-26.4	23.8	115–185	0	0	1	2	13	8	1	2
June	0.7	9.8	-6.6	8.3	25–115	1	0	1	2	14	5	4	0
July	4.3	11.0	-2.0	42.1	0– 25?	2	1	0	6	30	28	7	3
Aug.	5.5	14.9	-2.4	19.9	0– 0	2	2	1	29	79	11	3	0
Sept.	-0.1	6.7?	-7.0	37.7	0– 5	1	2	0	1	19	4	2	0
Oct.	-8.8	-1.5?	-20.9	2.2	?– 12	0	0	0	3	2	4	0	1
Nov.	-16.7	-1.2?	-31.3	7.5	?– 20	0	0	0	1	0	1	0	2
Dec.	-21.3	?	-36.7	17.4	?– 45	0	2	0	0	0	0	0	0
Annual	-9.5	14.9	-44.2	281.9	..	6	8	5	44	167	68	23	13
1961													
Jan.	-21.5	-3.7?	-40.1	21.2	?– 67	0	0	0	0	0	2	1	0
Feb.	-24.9	-7.4	-43.2	24.5	?– 90	0	0	0	1	0	0	1	0
Mar.	-25.5	-10.0	-43.0	12.7	?–102	0	1	1	0	2	2	0	0
Apr.	-17.8	-6.3	-35.2	2.8	?– 95	0	1	0	0	1	1	0	1
May	-4.8	5.0	-22.2	2.5	0– 35	0	0	3	0	14	7	2	1
June	2.8	13.8	-4.5	39.8	0– 35	0	0	0	5	24	12	3	1
July	7.2	17.3?	0.3	<0.1	0– 0	9	3	4	25	68	13	0	0
Aug.	6.0	12.8	-0.5	56.9	0– 0	1	1	0	25	74	17	1	0
Sept.	-0.1	12.7	-12.2	21.3	0– 15	3	0	0	16	14	15	6	0
Oct.	-5.3	-2.9	-18.5	100.0	?– 68	0	0	0	2	3	1	1	2
Nov.	-13.9	-0.8	-28.4	26.6	?– 94	0	1	1	5	2	3	3	1
Dec.	-21.9	-1.3	-41.0	28.8	?–140	0	0	1	1	6	5	0	5
Annual	-10.0	17.3?	-43.2	337.2	..	13	7	10	80	208	78	18	11

(continued).

direction									Wind speed (Knots)						
observations								Most frequent	No. of observations					Most frequent	Max
SSW	SW	WSW	W	WNW	NW	NNW	N		Calm	1–5	6–20	> 20	Total		
1	1	2	6	17	4	0	0	WNW	155	20	15	0	190	Calm	20
2	0	5	10	22	0	1	0	WNW	120	23	24	0	167?	Calm	20
0	0	3	8	48	0	2	0	WNW	123	33	29	1	186	Calm	23
0	0	0	2	9	1	0	0	WNW	169	21		0	190	Calm	15
0	0	6	5	13	0	0	0	WNW	153	20	13	0	186	Calm	12
0	0	1	5	10	1	0	0	ESE	110	46	24	0	180	Calm	17
0	0	1	0	1	4	4	6	ESE	51	95	70	0	216	1–5	15
0	0	0	5	16	15	8	4	ESE	92	96	60	0	248	1–5	15
2	2	3	16	32	36	3	4	NW	110	71	47	0	228	Calm	20
1	2	8	18	21	27	5	1	NW	88	53	42	3	186	Calm	30
1	0	1	8	21	13	3	0	WNW	128	22	29	1	180	Calm	30
2	0	0	14	15	26	5	0	NW	124	36	26	0	186	Calm	20
9	5	30	97	225	127	31	15	WNW	1423	?	?	5	2343	Calm	30
1	0	1	12	31	12	2	1	WNW	111	37	40	0	188	Calm	18
1	0	1	25	17	13	4	3	W	109	35	25	7	176	Calm	35
0	2	0	14	31	17	2	1	WNW	117	32	37	0	186	Calm	20
0	0	0	17	31	9	6	2	WNW	102	36	37	5	180	Calm	35
0	0	2	11	17	7	3	0	WNW	119	50	17	0	186	Calm	13
0	1	3	5	6	2	1	0	ESE	135	35	10	0	180	Calm	12
0	1	1	6	8	5	0	4	ESE	116	71	31	0	218	Calm	16
0	0	1	5	8	6	3	2	ESE	96	89	63	0	248	Calm	14
0	4	4	16	20	5	1	1	WNW	135	56	26	0	217	Calm	?
2	3	6	14	7	5	0	0	W	139	36	11	0	186	Calm	?
0	0	6	12	14	10	0	1	WNW	133	30	17	0	180	Calm	?
0	1	4	25	43	7	1	0	WNW	103	42	40	1	186	Calm	?
4	12	29	162	233	98	23	15	WNW	1415	549	354	13	2331	Calm	?
2	0	7	20	35	19	2	0	WNW	98	41	37	10	186	Calm	?
11	1	2	9	25	8	4	0	WNW	106	23	39	0	168	Calm	?
0	1	7	11	14	5	1	0	WNW	141	20	24	1	186	Calm	?
0	0	0	5	4	3	8	0	WNW	156	22	0	0	178	Calm	?
0	1	1	6	19	9	0	0	WNW	123	42	19	2	186	Calm	22
0	2	0	12	28	3	1	0	WNW	89	53	38	0	180	Calm	15
0	0	0	2	7	4	1	3	ESE	83	88	51	0	222	1–5	14
0	0	3	4	24	15	0	2	ESE	81	87	76	4	248	1–5	23
2	3	12	27	15	16	5	3	W	92	94	40	3	229	1–5	25
1	5	12	35	35	15	4	0	WNW	64	42	70	1	177	6–20	21
0	4	2	30	20	12	8	6	W	82	38	50	10	180	Calm	27
1	4	4	17	19	8	2	3	WNW	110	51	25	0	186	Calm	20
17	21	50	178	245	117	36	17	WNW	1225	601	469	31	2326	Calm	?

Table 2. Meteorological summary, Mesters Vig, Northeast

	Temperature °C 1953–61			Precipitation (mm) 1953–61			Snow depth (cm) 1954–61						
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	NNE	NE	ENE	E
Jan. ...	–21.4	–0.5('60)	–43.2('55)	50.7	194.4('57)	6.5('55)	151	400('57)	55('56)	<1	1	<1	<1
Feb.....	–24.3	5.7('60)	–44.2('55)	26.9	79.2('54)	1.7('55)	145	250('57)	65('56)	0	1	<1	1
Mar. ...	–21.8	–1.5('58)	–44.2('60)	27.6	107.5('58)	2.5('54)	162	235('57)	87('55)	<1	<1	<1	<1
Apr.....	–15.2	2.8('58)	–38.7('56)	20.3	117.0('58)	0.1('56)	161	225('57)	92('55)	<1	<1	<1	<1
May ...	–4.8	9.0('53)	–28.7('56)	5.8	23.8('60)	0.0('55'58)	134	225('58)	35('61)	<1	<1	<1	2
June ...	1.6	15.5('53)	–7.5('56)	20.8	95.8('53)	0.0('55)	88	175('58)	24('56)	<1	1	<1	5
July....	5.4	21.0('58)	–3.4('54)	19.8	64.5('56)	<0.1('61)	10	38('54)	0('56'58' '59'61)	4	3	2	17
Aug. ...	5.9	17.6('53)	–3.3('59)	30.8	77.1('53)	5.4('58)	0	0	0	3	3	2	18
Sept. ...	–0.4	13.0('58)	–13.8('56)	36.8	121.3('55)	3.5('57)	15	30('56'59)	4('54)	1	1	2	4
Oct.....	–7.6	7.4('55)	–28.0('54)	42.3	100.0('61)	2.2('60)	40	75('57)	12('60)	<1	<1	<1	2
Nov. ...	–15.3	1.7('53)	–38.8('58)	38.8	127.0('53)	2.7('55)	78	160('56)	16('55)	<1	<1	<1	1
Dec. ...	–19.0	0.7('59)	–43.8('59)	51.9	119.0('57)	7.4('58)	123	250('56)	24('55)	<1	<1	<1	<1
Annual..	–9.7	..	..	372.5	..	..	..	..	..	12	11	10	52
Extremes	..	21.0('58)	–44.2('55,'60)	..	..	..	..	400('57)	0	..	..	..	..

Table 3. Meteorological summary, Ella Ø, Northeast

	1931–50		Wind direction 1948–50 Mean no. of observations									
	Temperature °C Mean	Precipitation mm	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW
Jan. ...	–19.6	No records for period	3	1	3	2	<1	1	<1	2	8	22
Feb.....	–20.5		1	3	0	1	<1	<1	0	3	8	18
Mar.....	–18.1		1	3	<1	2	<1	<1	<1	1	6	13
April ...	–14.0		1	2	1	1	<1	<1	<1	3	3	6
May....	–2.6		2	8	5	5	2	<1	1	<1	3	5
June ...	4.6		7	29	6	7	<1	<1	0	<1	1	2
July....	8.4		13	32	5	5	1	<1	0	0	0	1
Aug	8.5		8	14	7	3	3	1	1	2	4	10
Sept. ...	1.9		3	5	3	4	3	1	<1	4	4	13
Oct.....	–7.5		<1	3	3	2	2	1	<1	3	3	11
Nov	–14.6		<1	8	3	2	<1	<1	2	2	7	9
Dec.....	–17.7		<1	1	3	1	<1	0	0	0	5	13
Annual .	–7.6		40	108	40	35	12	8	7	21	52	123

Greenland. Lat. 72°14′ N., Long 23°55′ W. Station alt. 16 m.

Wind direction 1954–61													Wind speed (Knots) 1954–61						
Mean no. of observations												Most frequent	Mean no. of observations					Most frequent	Max
ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N		Calm	1–5	6–20	>20	Total		
1	2	<1	1	1	1	5	14	24	18	3	2	WNW	111	35	33	8	187	Calm	39('57)
1	2	1	<1	3	<1	2	13	18	11	2	1	WNW	112	28	26	4	170	Calm	42('57)
<1	<1	<1	<1	<1	<1	3	14	27	11	2	<1	WNW	121	33	28	4	186	Calm	57('58)
3	2	1	<1	<1	<1	1	10	20	11	4	<1	WNW	129	?	?	2	185	Calm	35('57, 60)
8	4	1	<1	<1	<1	2	4	11	7	3	<1	WNW	139	33	13	1	186	Calm	38('58)
24	10	2	<1	<1	<1	<1	5	9	5	<1	<1	ESE	116	45	19	<1	181	Calm	27('57)
55	24	3	<1	<1	<1	<1	3	6	7	3	4	ESE	78	77	56	0	211	Calm	20('58)
64	19	1	<1	0	<1	2	5	11	10	3	2	ESE	88	77	66	<1	232	Calm	35('57)
20	8	3	1	1	4	14	13	18	14	6	2	ESE	105	?	?	2	216	Calm	39('56)
4	4	1	1	2	4	18	19	18	15	4	<1	W	93	46	41	7	187	Calm	40('57)
2	3	2	<1	1	2	4	17	21	16	5	1	WNW	105	34	34	7	180	Calm	45('56)
2	1	<1	1	<1	1	3	18	24	17	4	<1	WNW	109	36	32	8	185	Calm	55('57)
186	79	17	10	11	17	55	135	207	142	40	15	WNW	1306	?	?	45	2306	Calm	..
..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	57('58)

Greenland. Lat. 72°54′ N., Long. 25°06′ W. Station alt. 8 m.

							Wind speed (Knots) 1948–50						
						Most frequent	Mean no. of observations						Most frequent
WSW	W	WNW	NW	NNW	N		Calm	1–7	8–21	22–40	>40	Total	
12	12	2	0	0	2	SW	23	33	32	4	<1	93	1–7
13	16	<1	<1	<1	1	SW	19	29	31	5	<1	85	8–21
26	15	2	2	<1	3	WSW	15	35	38	7	0	95	8–21
10	9	1	1	1	2	WSW	20	22	18	4	0	64	1–7
14	5	0	1	1	4	WSW	33	32	21	3	0	89	Calm
3	4	0	1	1	4	NE	23	45	20	2	0	90	1–7
3	3	0	1	2	8	NE	13	43	28	3	0	87	1–7
2	5	<1	<1	1	5	NE	12	33	29	5	0	79	1–7
9	17	0	<1	0	2	W	24	23	34	10	<1	92	8–21
14	27	8	2	<1	1	W	25	32	43	6	0	106	8–21
17	22	9	3	<1	4	W	21	54	33	3	<1	112	1–7
14	29	2	3	2	<1	W	36	36	33	4	0	109	1–7
137	164	25	15	11	37	W	264	417	360	56	1	1101	1–7

Table 4. Abbreviated meteorological summary for selected stations in Northeast Greenland.

	Temperature °C Mean			Precipitation mm	Wind
	Annual	Warmest month	Coldest month	Mean annual	Percent calms
Mesters Vig Lat 72°14′ N., Long 23°55′W. Station Altitude 16 m					
1953–61	–9.7	5.9	–24.3	..	..
1954–61	..	..	..	373	57
Daneborg Lat 74°18′ N., Long 20°14′W. Station Altitude 12 m					
1948–55	–10.4	4.1	–24.7	..	..
1949–58	..	..	..	..	31
Ella Ø Lat 72°54′ N., Long 25°06′W. Station Altitude 8 m					
1931–50	–7.6	8.5	–20.5	..	..
1948–50	..	..	..	..	24
Myggbukta Lat 73°29′N., Long 21°34′ W. Station Altitude 3 m					
1922—37	–10.0	3.9	–21.6	..	..
1932—37	–9.2	4.7	–21.4	220	16
Scoresbysund Lat 70°29′N., Long 21°58′W. Station Altitude 17 m					
1924–37	–6.2	5.5	–15.1	..	..
1926–30	..	..	..	317	37

Table 5. Radiocarbon-dated shells and driftwood from the Mesters Vig district, Northeast Greenland.

Yale Radiocarbon Laboratory no.	Locality	Species	Field altitude (m)	Altitude (m) corrected for eustatic rise of sealevel	C-14 age (yr B. P.)[2]
Y 596	Korsbjerg, NE slope, deltaic? bench. At surface of stony sand, abundant	*Mya truncata* L.	59 ± 2	84 ± 2	8760 ± 250
Y 599	Nyhavn hills, NW side trap knob MS[1]) 112 m. At surface of till-like deposit, abundant	*Mya truncata* L. *Hiatella arctica* L.	$66-69 \pm 2$	$91-94 \pm 2$	8780 ± 250
Y 600	Korsbjerg, NE slope, cut bank of emerged delta at Noret outlet of Tunnelelv. *In situ* in silt, shells with both valves	*Mya truncata* L.	$2-4 \pm 1/2$	$8-10 \pm 1/2$	6690 ± 210
Y 602	Labben hills, cut bank of stream adjacent to experimental site 5. In stony silt	*Hiatella arctica* L.	$7-8 \pm 1$	$21-22 \pm 1$	7540 ± 180
Y 606	Nyhavn, S. cove. Dredged, modern shells used for standard	*Astarte borealis* SCHUMACKER *Astarte crenata* GRAY *Cardium ciliatum* FABRICIUS *Hiatella arctica* L. *Margarites undulata* SOWERBY *Mya arenaria* L.? *Mya truncata* L.	− 2 to − 15 (estimated)	..	0 ± 70
Y 702	Korsbjerg, NE slope, inner edge of emerged strandline on delta at Noret outlet of Tunnelelv	(Driftwood)	$3 \pm 1/2$	$3 \pm 1/2$	735 ± 110
Y 703	Same locality as Y 702 but inner edge of another emerged strandline 1 m above Y 702	(Driftwood)	$4 \pm 1/2$	$4 \pm 1/2$	2980 ± 120
Y 704	Labben hills, adjacent to experimental site 3. In clayey silt containing stones, abundant shell fragments (frost-worked?) in patterned ground	*Mya truncata* L.	31 ± 2	47 ± 2	7730 ± 210
Y 708	Nyhavn hills, cut in deltaic beds at SW base trap knob MS 78 m. At surface	*Mytilus edulis* L.	$16-20 \pm 1$	$22-26 \pm 1$	6670 ± 250

(continued)

1) MS (map summit) identifies by altitude knobs and hills lacking a name in figure 5.
2) The radiocarbon half life used for calculations is 5570 yr.

Table 5 (continued).

Yale Radio-carbon Labora-tory no.	Locality	Species	Field altitude (m)	Altitude (m) corrected for eustatic rise of sealevel	C-14 age (yr B. P.)
Y 711	Danevirke hills, cut in deltaic beds 1/2 km SE of trap knob MS 125 m. At surface of sand	*Hiatella arctica* L. *Mya truncata* L.	67 – 76 ± 2	90 – 99 ± 2	8500 ± 250
Y 712	Blyryggen, SE slope, cut bank of emerged delta, SW side Holberg Elv. At surface of stony sand, abundant, some shells with both valves	*Mya truncata* L.	45 – 52 ± 2	67 – 74 ± 2	8480 ± 140
Y 713	Same locality as Y 712. Abundant, upper limit 3 m below delta tread	*Mya truncata* L.	52 – 57 ± 2	73 – 78 ± 2	8360 ± 140
Y 714	Blyryggen, SE slope, cut bank of bench on which Expeditionshus is located. At surface of till-like stony sand and silt, abundant	*Hiatella arctica* L. *Mya truncata* L. *Serripes groenlandica* Bruguiere	7 – 10 ± 1	15 – 18 ± 1	6910 ± 200
Y 716	Same locality as Y 711. Part of same collection but independent C–14 check	*Hiatella arctica* L. *Mya truncata* L.	67 – 76 ± 2	92 – 101 ± 2	8780 ± 210
Y 717	Same locality as Y 708. At surface, profuse	*Mya truncata* L.	16 – 20 ± 1	22 – 26 ± 1	6650 ± 200
Y 876	Hesteskoen, NE slope, cut bank in deltaic beds at E base trap knob MS 90 m. *In situ* in sand, shells with both valves	*Hiatella arctica* L. *Mya truncata* L.	29 ± 2	47 ± 2	8000 ± 160
Y 878	Hesteskoen, NE slope, cut bank at N tip 2d large delta sector NW of Tunnelelv. *In situ* in sand, shells with both valves	*Hiatella arctica* L. *Mya truncata* L.	19 – 20 ± 1	28 – 29 ± 1	6950 ± 150
Y 879	Same as Y 878. At surface	(Driftwood)	20 ± 1	33 ± 1	7460 ± 130
Y 882	Blyryggen, SE slope, channel of 1 V Elv. Partly in till-like deposit	(Driftwood)	4 ± 1/2	4 ± 1/2	5590 ± 140
Y 883	Same locality as Y 882. At surface of till-like deposit, abundant	*Astarte borealis* Schumacker *Clinocardium ciliatum* Fabricius *Hiatella arctica* L. *Mya truncata* L. *Mytilus edulis* L.	3 – 4 ± 1/2	11 – 12 ± 1/2	6840 ± 210
Y 884	Blyryggen, SE slope, cut bank by 1st small stream SW of 1 V Elv. *In situ* in sand, shells with both valves	*Astarte borealis* Schumacker	1 – 3 ± 1/2	1 – 3 ± 1/2	4960 ± 320

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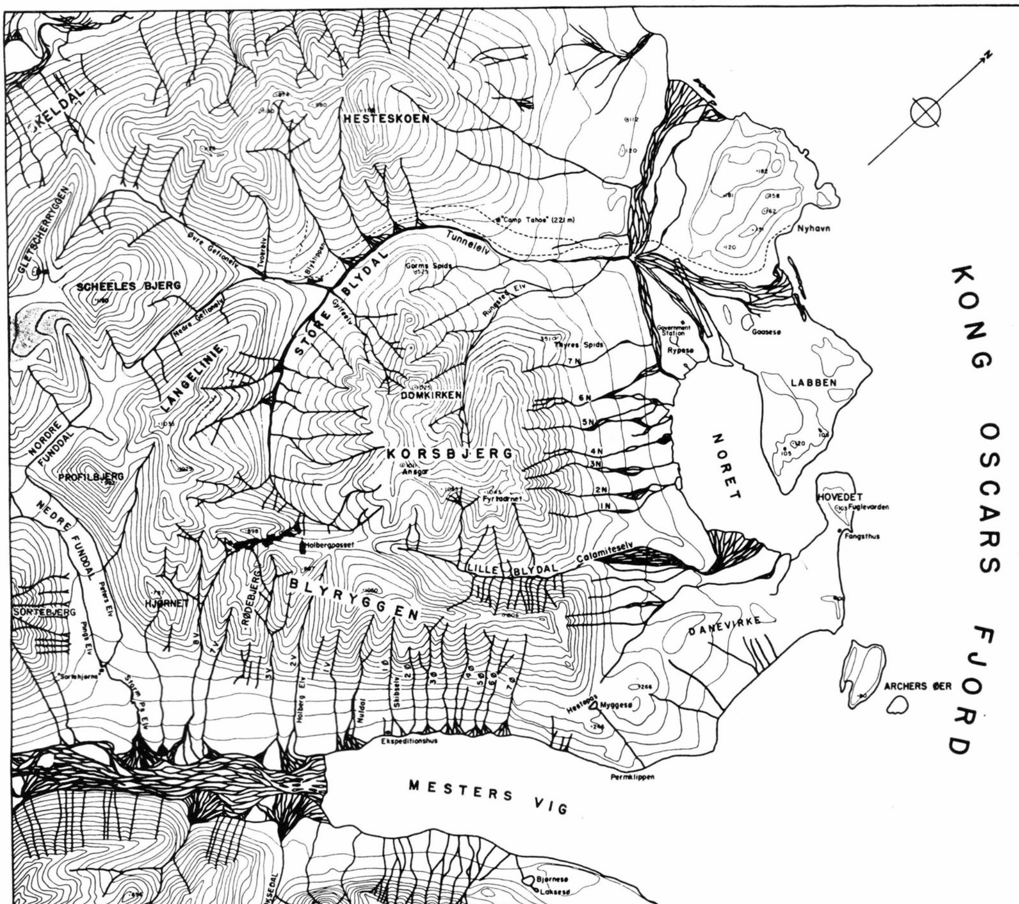
Færdig fra trykkeriet den 3. december 1965.



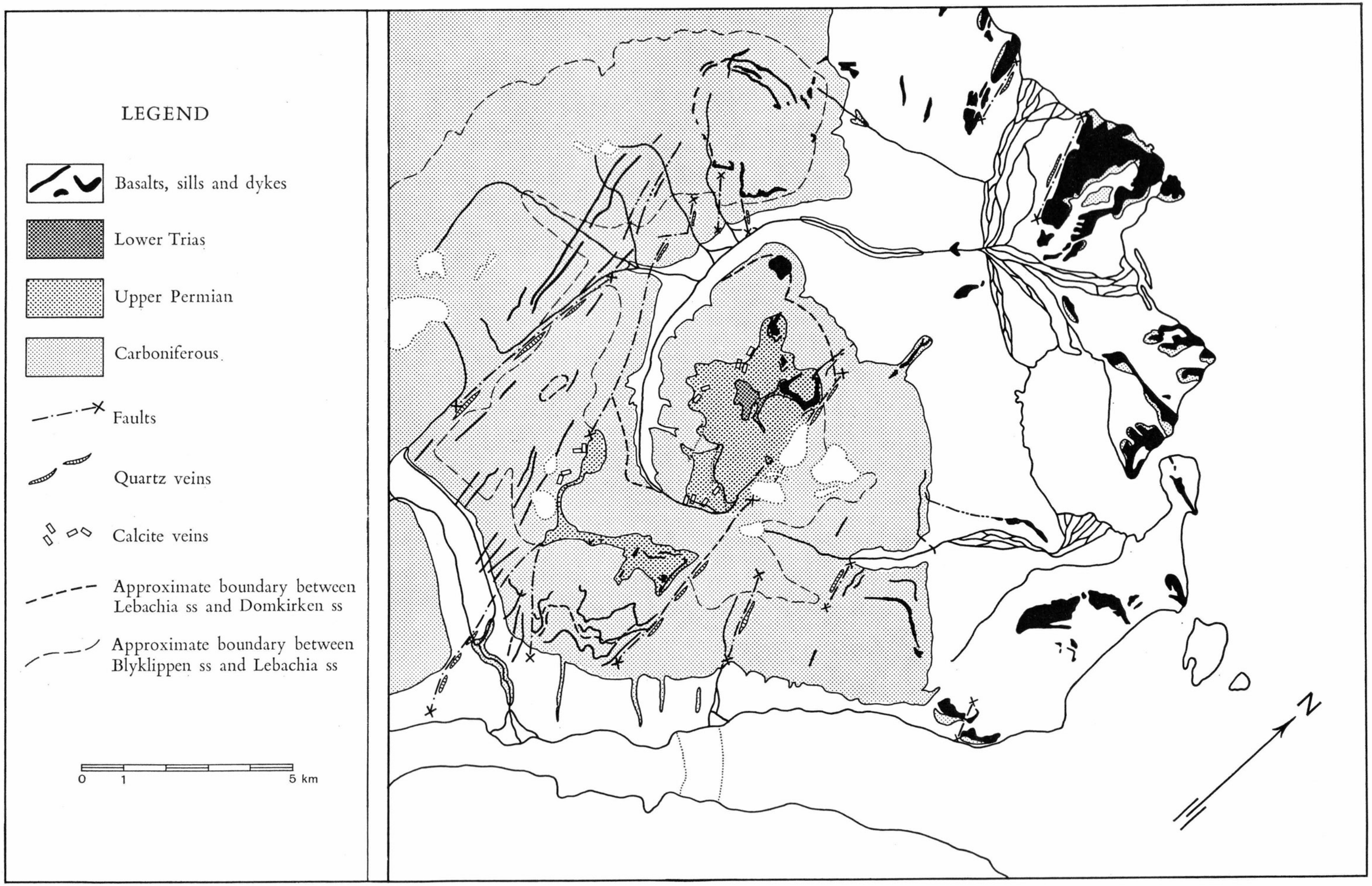
TOPOGRAPHIC MAP OF THE MESTERS VIG DISTRICT, NORTHEAST GREENLAND

0 1 2 3 4 km

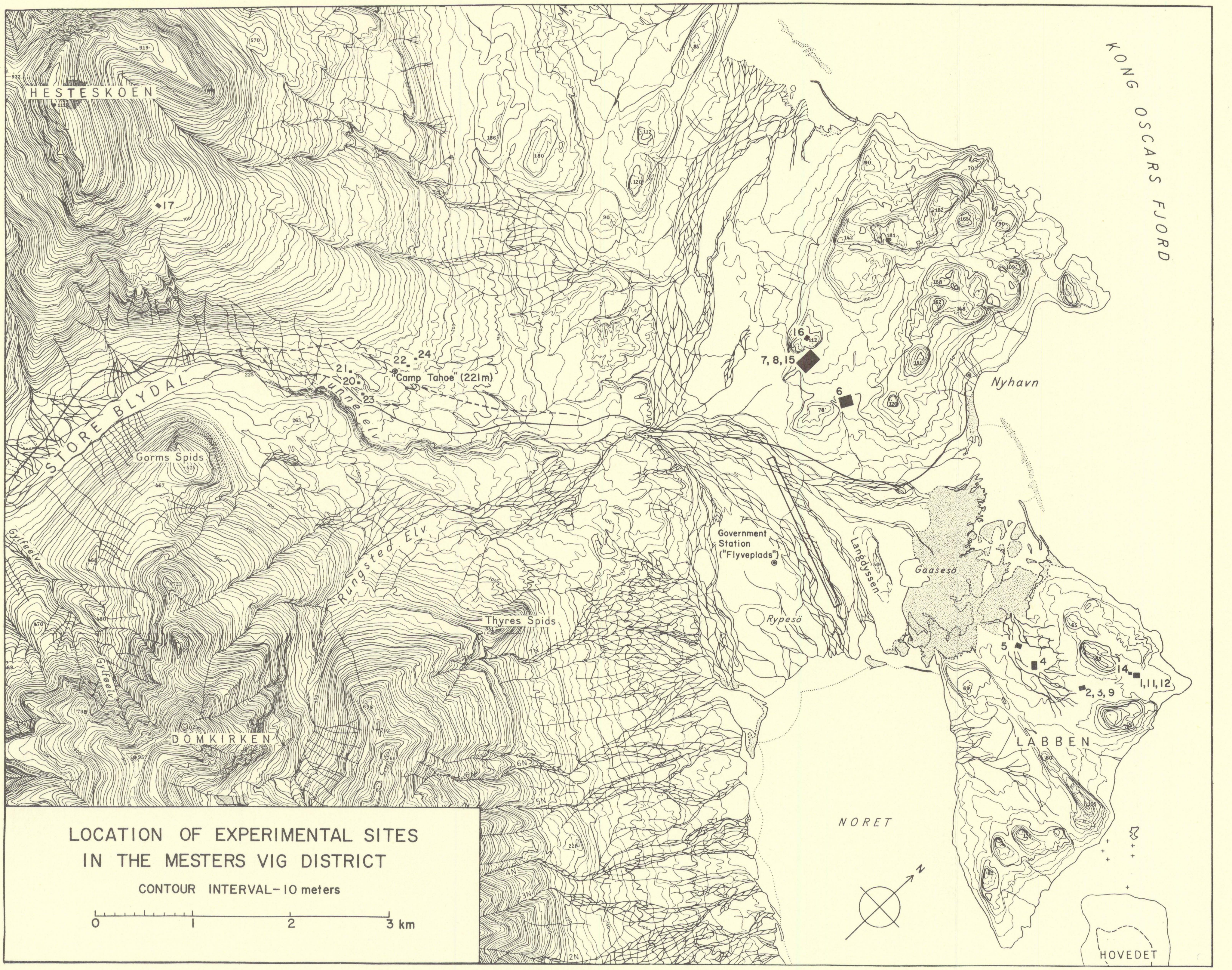
CONTOUR INTERVAL 50m

Air view of the Mesters Vig district. View southeast. BK-Blyklippen, BR-Blyryggen, CT-"Camp Tahoe", D-Domkirken, DD-Deltadal, GS-Government station, H-Hesteskoen, K-Korsbjerg, KOF-Kong Oscars Fjord, L-Lejrelv, MV-Mesters Vig (bay), N-Noret, ØG-Øvre Gefionelv, NG-Nedre Gefionelv, R-Rungsted Elv, S-Skeldal, SB-Store Blydal, T-Tunnelelv, WB-Werner Bjerge. Photo courtesy of the Geodetic Institute of Denmark.

Geomorphic diagram of the Mesters Vig district.



Bedrock geology of the Mesters Vig district. After WITZIG (1954) as revised by BONDAM (1955: 1964).



Map of Mesters Vig district, showing location of experimental sites.