Short Papers and Notes

RADIOCARBON-DATED POSTGLACIAL DELEVELLING IN NORTHEAST GREENLAND AND ITS IMPLICATIONS

Mesters Vig, Northeast Greenland lies at 72°N. 24°W. on the south side of Kong Oscars Fjord, about 50 km. from the entrance (Fig. 1.). As part of a geomorphic study of the district it was necessary to reconstruct the local history of postglacial delevelling. The following preliminary report summarizes some of the results; a detailed report is planned for publication in *Meddelelser om Grønland*. The radiocarbon dating was carried out by Stuiver, the field work by Washburn.

A number of studies of emerged strandlines have been made in the fiord region of Northeast Greenland (ref. 1, p. 204-22; ref. 2, p. 162-92), 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 fiord-bottom deposit. A till-like aspect of a fiord-bottom deposit could be due to deposition from debris-loaded icebergs as they floated past sites colonized by molluscs, 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 fiord bottom. Even the presence of uncrushed, paired mollusc valves need not be diagnostic in some situations (ref. 3, p. 25-6). However, if the till-like deposit was laid down during a major glacier advance it should be (1) significantly older than fossiliferous deltaic 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 delevelling history on the basis of the same dates.

Shells were collected from a number of places and were dated at the Yale Geochronometric Laboratory; a few driftwood specimens were included. The localities, shell identifications, and radiocarbon ages are summarized in Table 1. The ages are plotted against altitude in Figs. 2-4, together with suggested curves.

Several points deserve comment: (1) the plotted altitudes in Fig. 2 are field altitudes (i.e., altitudes uncorrected for eustatic rise of sea-level). The altitudes in Figs. 3 and 4 are adjusted to allow for eustatic rise of sea-level of 0.9 m. per 100 years prior to 6,000 B.P. (ref. 4, Fig. 14, p. 156; ref. 5, pp. 556-7; cf. also ref. 6; ref. 7, Fig. 1, p. 31). Table 1 and Fig. 2 will facilitate application of alternative corrections, based on different interpretations of the rate of rise of sea-level (cf. ref. 8). Comparison of Fig. 2 with Fig. 3 demonstrates that the break in the curve at about 6,000 B.P. is not significantly affected by the correction for rise of sea-level in Fig. 3. (2) The shell dates have been corrected for an apparent age of 550 years, based on modern shells (Y 606) collected in the district and used as a standard. (3) As with all shell dates, there is uncertainty as to the depth at which a mollusc died, and a correlation of the date with a former sea-level involves a possible error of several metres. (4) Field altitudes were determined largely by Paulin aneroid, 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

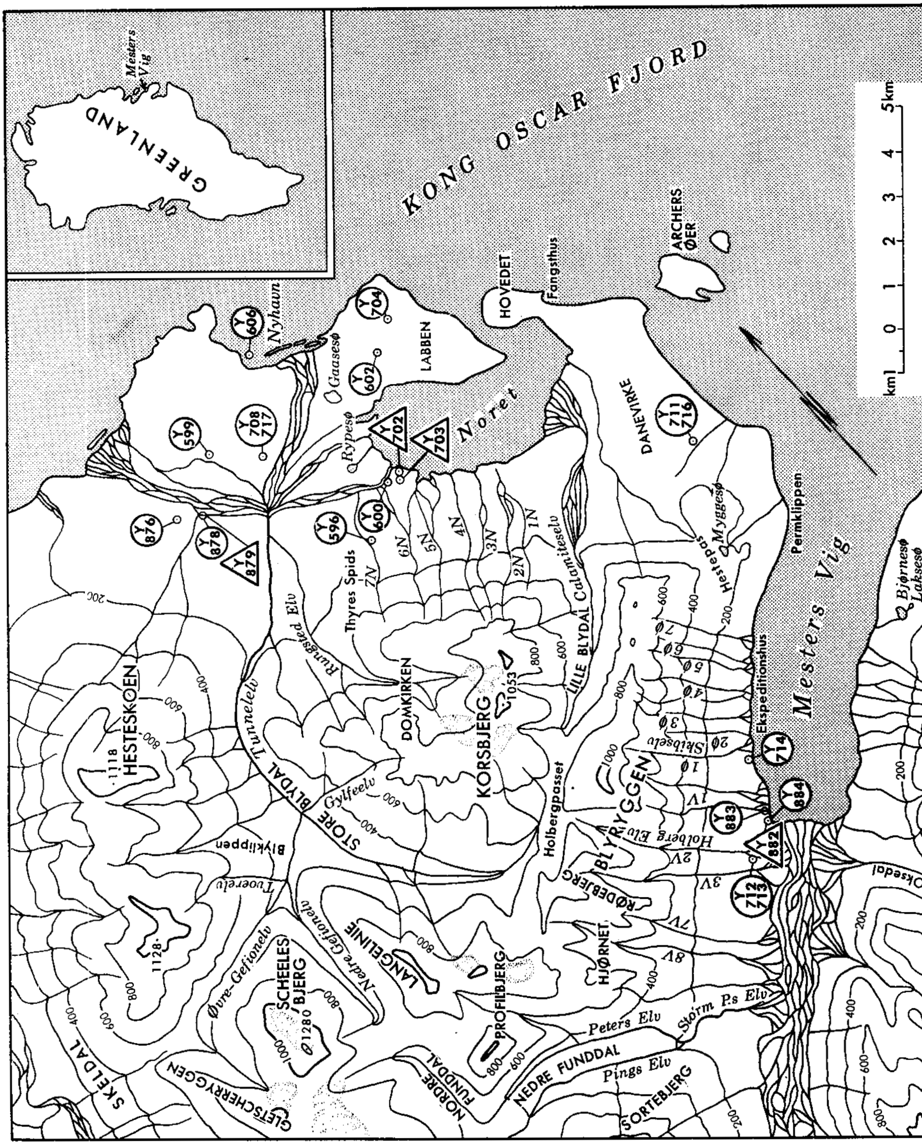

Fig. 1. Map of the Mesters Vig district, Northeast Greenland, showing locations of specimens. Circles indicate shells, triangles driftwood. Numbers are those of the Yale Geochronometric Laboratory.

in computing altitude. Accuracy of measurement for altitudes less than 5 m. is estimated to be ±0.5 m.; for those between 5 and 25 m. ±1 m.; and for those above 25 m. ±2 m. (5) The vertical sides of the squares associated with the specimens as plotted in the figures represent the altitude range (corrected in Figs. 3 and 4 for eustatic rise of sea-level) 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 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

Table 1. **Radiocarbon-dated shells and driftwood from the Mesters Vig district, Northeast Greenland.**

No.	*Locality*	*Species*	*Field altitude* m.	*Altitude* (m.) *corrected for eustatic rise of sea-level*	*C-14 age years B.P.*†
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* 112 m. At surface of till-like deposit, abundant	*Mya truncata* L. *Hiatella arctica* L.	66-69 ± 2	91-94 ± 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 ± 0.5	8-10 ± 0.5	6690 ± 210
Y 602	Labben hills, cut bank of stream adjacent to experimental site 5. In stony silt	*Hiatella arctica* L.	7-8 ± 1	21-22 ± 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 undalata* 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 ± 0.5	3 ± 0.5	735 ± 110
Y 703	Same locality as Y 702 but inner edge of another emerged strandline 1 m. above Y 702	(Driftwood)	4 ± 0.5	4 ± 0.5	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 edilus* L.	16-20 ± 1	22-26 ± 1	6670 ± 250
Y 711	Danevirke hills, cut in deltaic beds 0.5 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 2nd 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	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 ± 0.5	4 ± 0.5	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 ± 0.5	11-12 ± 0.5	6840 ± 210
Y 884	Blyryggen, SE slope, cut bank by first small stream SW of 1 V Elv. *In situ* in sand, shells with both valves	*Astarte borealis* Schumacker	1-3 ± 0.5	1-3 ± 0.5	4960 ± 320

*ms (map summit) identifies by altitude knobs and hills lacking a name in Fig. 1.
†The radiocarbon half life used for calculation is 5570 years.

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 above the curve in Figs. 2-4. In Fig. 4 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 Figs. 2-4:

(1) The fossiliferous till-like material is an emerged fiord-bottom deposit. The points of the curve line up too well, and are internally too consistent between the altitudes and associated ages of the till-like material on the one hand and of fossiliferous deltaic 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.

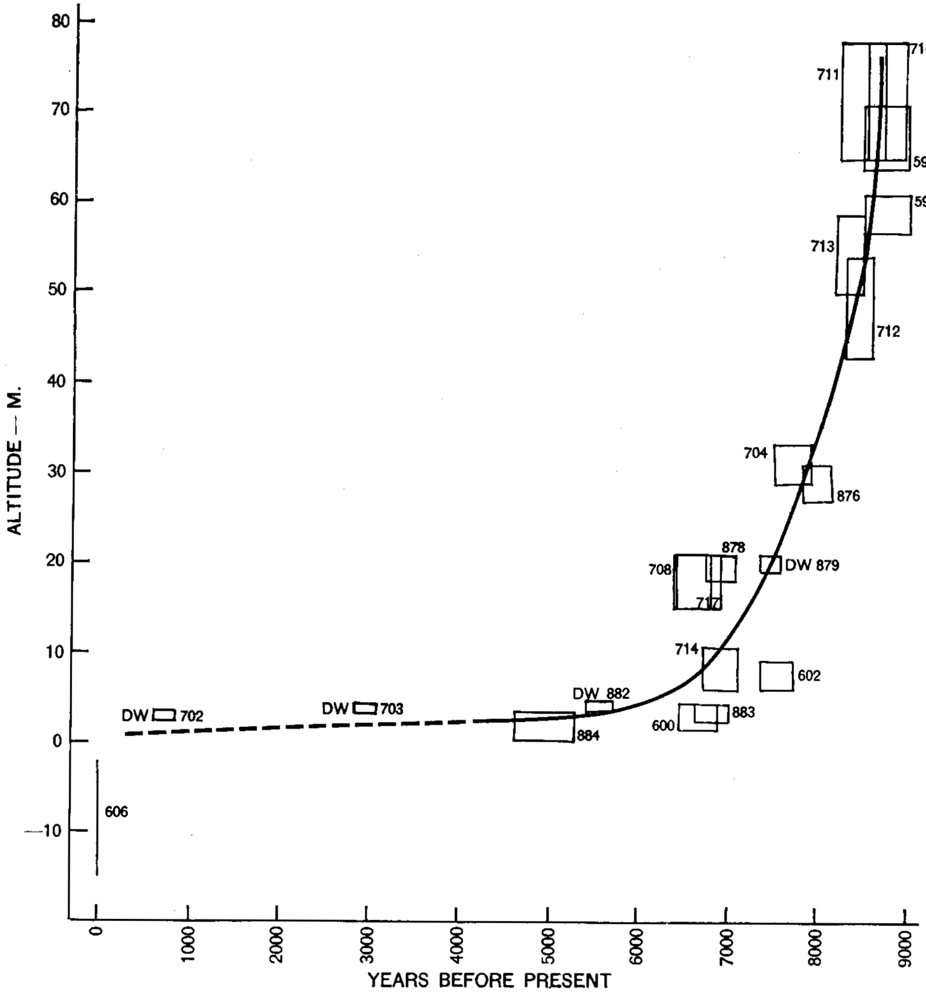

Fig 2. Radiocarbon age of shells and driftwood relative to altitude, Mesters Vig district, Northeast Greenland. Altitudes not corrected for eustatic rise of sea-level. [Y] 884—Yale Geochronometric Laboratory Number. DW—Driftwood. All other specimens are shells.

(2) The Mesters Vig district was open to the sea and, therefore, deglaciated at least in part by 9,000-8,500 B.P.

(3) The Mesters Vig District has remained largely free of glaciers since about 8,500 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 8,500 B.P. could not have been very much more conducive to glaciation that at present.

(4) Deglaciation of the Mesters Vig district is closely related in time and effect to the Hypsithermal[9].

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

(6) The rate of emergence was high

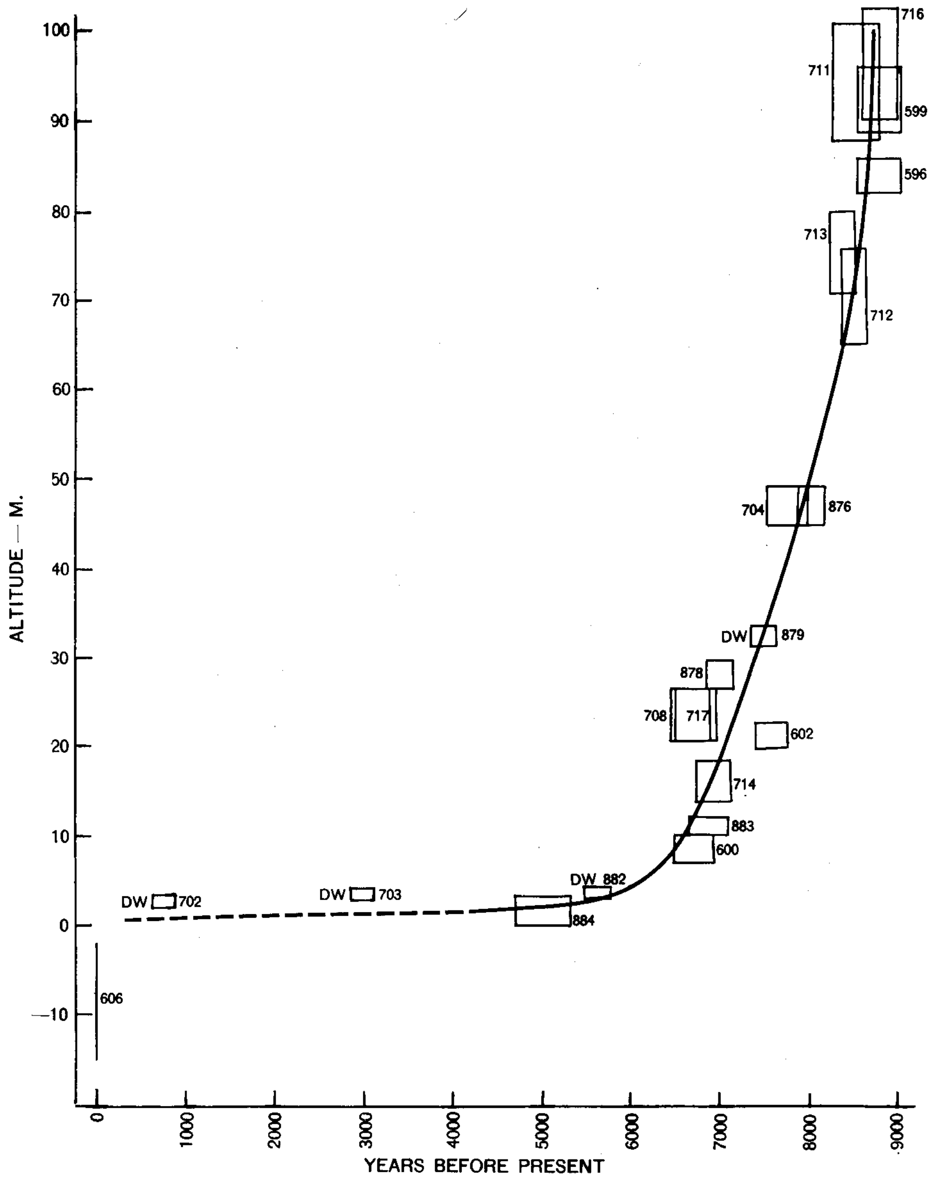

Fig. 3. Radiocarbon age of shells and driftwood relative to altitude, Mesters Vig district, Northeast Greenland. Altitudes corrected for eustatic rise of sea-level; 0.9 m/100 years prior to 6,000 B.P. [Y] 884 — Yale Geochronometric Laboratory Number. DW — Driftwood. All other specimens are shells.

initially, of the order of 9 m./100 years, and decreased approximately exponentially to about 0.6 m./100 years, for the interval 9,000 B.P. to 6,000 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

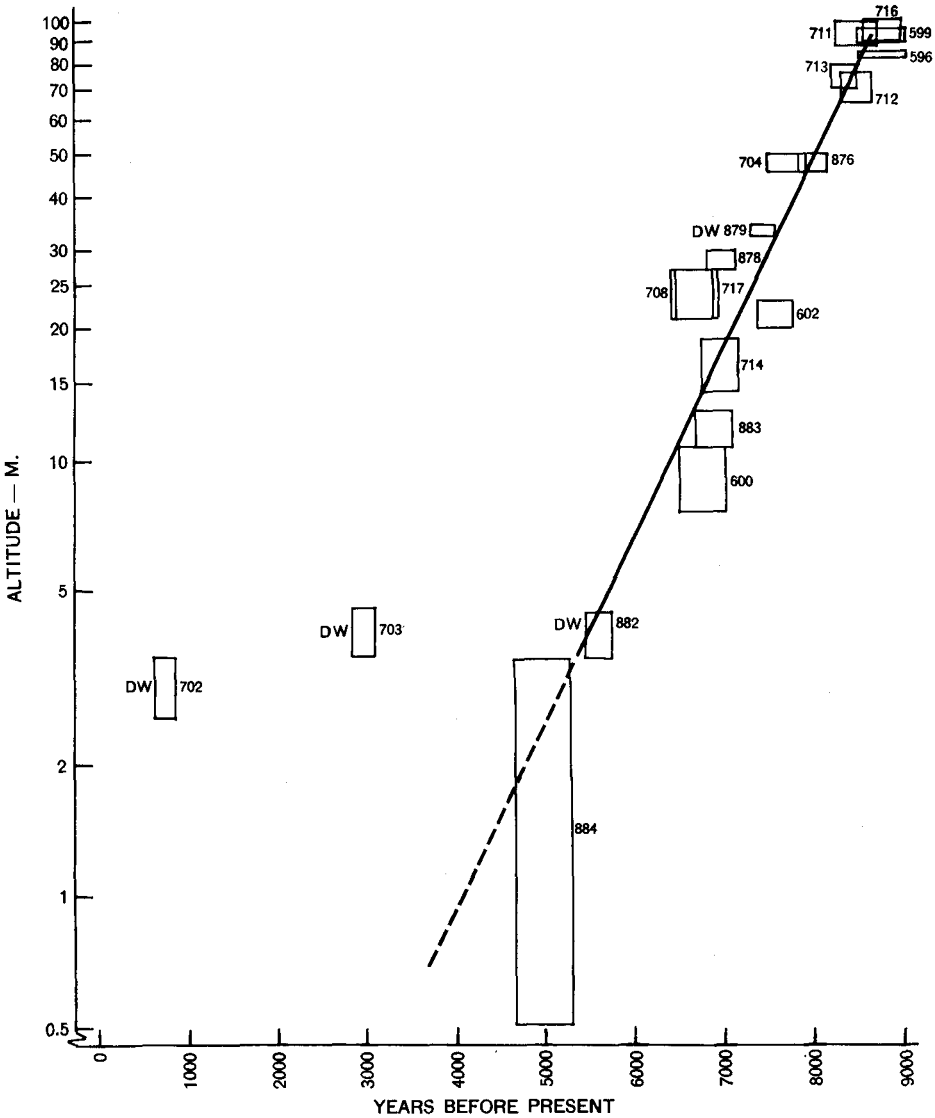

Fig. 4. Semi-logarithmic graph of Fig. 3. Altitudes corrected for eustatic rise of sea-level; 0.9 m./100 years prior to 6,000 B.P. [Y] 884 — Yale Geochronometric Laboratory Number. DW — Driftwood. All other specimens are shells.

regions showing postglacial delevelling, the Mesters Vig district has one of the highest rates of emergence. For the interval 6,000 B.P. to the present the exponential character of the curve disappears, with rates of emergence of perhaps as little as 7 cm./100 years. However, this rate must be regarded as highly tentative pending further investigations.

(7) The general aspect of the curve in Figs. 2 and 3 is very similar to that deduced for northern Canada[10], and for Spitsbergen (ref. 11, Fig. 1, p. 123; ref. 12, Fig. 9, p. 143).

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[1]Bretz, J H. 1935. Physiographic studies in East Greenland, *in* Boyd, L. A. The fiord region of East Greenland. Am. Geog. Soc. Spec. Pub. 18:159-245.

[2]Flint, R. F. 1948. Glacial geology and geomorphology, *in* Boyd, L. A. The coast of Northeast Greenland. Am. Geog. Soc. Spec. Pub. 30:91-210.

[3]Donner, J. J., and R. G. West. 1957. The Quaternary geology of Brageneset, Nordaustlandet, Spitsbergen. Norsk Polarinstitutt skr. 109, 29 pp.

[4]Fairbridge, R. W. 1961. Eustatic changes in sea level, *in* Ahrens, L. H., *et al.*, Physics and chemistry of the earth. New York: Pergamon Press, Vol. 4:99-185.

[5]Fairbridge, R. W. 1961. Convergence of evidence on climatic change and ice ages, *in* Solar variations, climatic change, and related geophysical problems. New York Acad. Sci. Ann. 95:542-79.

[6]Godwin, H., R. P. Suggate, and E. H. Willis. 1958. Radiocarbon dating of the eustatic rise in ocean-level. Nature 181:1518-19.

[7]Shepard, F. P. 1961. Sea level rise during the past 20,000 years. Z. Geomorph., Suppl. 3:30-5.

[8]Graul, Hans. 1959. Der Verlauf des glazialstatistischen Meeresspiegelanstieges, berechnet an Hand von C-14 Datierungen, *in* Tagungsbericht und wissenschaftliche Abhandlungen, Deutscher Geographentag Berlin. Wiesbaden: Franz Steiner, pp. 232-42.

[9]Deevey, E. S., and R. F. Flint. 1957. Postglacial hypsithermal interval. Science 125:182-4.

[10]Farrand, W. R. 1962. Postglacial uplift in North America. Am. J. Sci. 260:181-99.

[11]Feyling-Hanssen, R. W., and Ingrid Olsson. 1960. Five radiocarbon datings of post-glacial shorelines in Central Spitsbergen. Norsk geog. tidsskr. 17:122-31.

[12]Blake Jr., Weston. 1961. Radiocarbon dating of raised beaches in Nordaustlandet, Spitsbergen, *in* Raasch, G. O., ed., Geology of the Arctic. Toronto: Univ. of Toronto Press. Vol. 1:133-45.

GLACIAL GEOLOGY AND GEOMORPHOLOGY OF THE SORTEHJORNE AREA, EAST GREENLAND

The 1961 field season was the second and final season of a two-year program to study glacial geology and geomorphology in the Sortehjorne Area, East Greenland. The program was initiated in 1959, when the author, his wife, and Mr. Guntram A. Jarre, University of Wyoming, spent from July 8 to September 9 in the field. In April 1961, the author returned to the Sortehjorne area with Mr. Norman P. Lasca, University of Michigan, and completed the field program on September 1, 1961.

Access to the Sortehjorne area is available from Reykjavik, Iceland through charter flights of Nordisk Mineselskab A/S which operates a lead and zinc mine in the Mesters Vig region. Supplies and logistical support were obtained from the mine.

The area studied includes the main Mesters Vig valley, Storedal, and three major tributary valleys, Fundal and Nidsdal on the northwest side of Storedal, and Oksedal on the southeast side. Traverses were made on foot to the divides at the valley heads and the ridge crests, as well as along the valley floors and lower slopes. Aerial photo coverage and topographic maps on a scale of 1:15000 were obtained from the Geodetic Institute, Copenhagen. Altitudes were measured by aneroid type altimeters. The maximum altitude in the either the force of crystallization or the force of expansion — caused doming of the ice lens and overlying silt. Yielding was upward because of the direction of crystal growth (ref. 3, p. 1528) or because expansion forces were confined by adjacent frozen ground (Sumgin, ref. 1, pp. 111-5) and in part perhaps by aufeis. At a later stage accumulated lateral as well as vertical stresses formed by the growth of ice from below rather than from above may have reached a point where the final uplift of the mound and concurrent cracking along the apex occurred explosively. The fact that the exposed ice layer appears to be sharply bent rather than gently domed suggests that uplift was violent. Such violent explosive heaving of ice mounds in other parts of the Arctic have been noted by Chekotillo (ref. 1, p. 123), Taber (ref. 4, p. 249), and others.

In the final uplift of the mound hydrostatic pressure may also have played a part as suggested by Taber (ref. 4, p. 249) and Sumgin (ref. 1, pp. 11-5). The formation of aufeis in the river bed below the site of the mound may have formed an ice dam, which restricted and eventually stopped the flow of water through the meander channel. Any water that may have continued to flow into the cavity may have been trapped between the ground-ice lens and the permafrost and the resulting pressure helped to raise the mound and cause fracturing of the ice and frozen silt. Some of the ice around the periphery of the northern part of the mound may be the remnants of icing formed from outflow from the fractures.

The Sadlerochit icing mound is probably ephemeral; when seen, part of the mound had already collapsed and the ice lens was melting slowly. Furthermore, a slight rise in river level would allow water to flow through the cavity and hasten collapse of the mound. Aerial photographs taken 9 years before show the suggestion of a mound in this location, however; thus the old meander channel may be a site of recurring ground-ice formation. Because of wide-spread general similarity of hydrologic and geologic conditions in the valleys of most major rivers, icing mounds may be expected to occur frequently in association with aufeis fields on the Arctic Slope of Alaska.

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[1]Chekotillo, A. M. 1940. Naledi y borba s nimi (Icings and countermeasures). Dor. Izdat. NKVD, SSSR, Moscow. 133 pp. (Detailed abstract translated in Part II, Investigations of airfield drainage, arctic and subarctic regions, prep. by St. Anthony Falls Hydraulic Lab., Univ. of Minnesota for Office of the Chief of Engineers, U.S. Army. 1950, pp. 99-148).

[2]Leffingwell, E. de K. 1919. The Canning River region, northern Alaska. U.S. Geol. Surv. Prof. Paper 109, 251 pp.

[3]Taber, S. 1943. Perennially frozen ground in Alaska; its origin and history. Bull. Geol. Soc. Am. 54:1433-548.

[4]Taber, S. 1943. Some problems of road construction and maintenance in Alaska. Public Roads 23:247:51.

[5]Porsild, A. E. 1938. Earth mounds in unglaciated arctic northwestern America. Geog. Rev. 28:46-58.

[6]Sharp, R. P. 1942. Ground-ice mounds in tundra. Geog. Rev. 32:417-23.

[7]Müller, F. 1959. Beobachtungen über Pingos: Detailuntersuchungen in Ostgrönland und in der kanadischen Arktis. Medd. om Grønl. 153, 3, 127 pp. In German with English summary.

Correction. In redrafting the map on page 67 of No. 1, Vol. 15, three errors were introduced, which should be corrected as follows: for "Kong Oscar Fjord" read "Kong Oscars Fjord"; the altitude of Scheeles Bjerg should read 1180 m., not 1280 m.; the 1200-metre contour line surrounding the peak should be deleted. In the table on page 68 the following asterisks should be replaced by question marks: under Y 596, after "deltaic"; under Y 606, after "*Mya arenaria* L."; under Y 704, after "frost-worked".