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Quaternary geology of the area between Frederikshåbs Isblink and Ameralik

by

Anker Weidick

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Abstract

The margin of the Inland Ice between Frederikshåbs Isblink and Ameralik is nearly stationary. An estimate of the average ablation is higher here than that reported from Disko Bugt 700 km farther north.

The Pleistocene history of this area indicates at least one complete glaciation of the coastland with the Inland Ice cover reaching to the offshore banks. This must predate or be contemporaneous with the Early Wisconsin. Recession of the Inland Ice margin behind the extent of the Frederikshåbs Isblink took place around 22 000 B.P. Undisturbed shell beds at Sanerâta timâ with an age of 13 380 B.P. indicate the possibility that parts of the outer coasts were ice-free during the Late Wisconsin.

In the early parts of the Holocene time there was a recession of the Inland Ice from the coastland. The most important moraine stage is here dated to 8300 B.P. (the Fjord stage) and in a small sector at Marraq – Sanerâta timâ this stage marks the maximum extent of the Inland Ice during the Late Wisconsin.

The Holocene recession continued beyond the present extent of the Inland Ice, and subsequent stabilisation took place, presumably at 6000–5000 B.P., involving limited sectorial readvances. It is possible that the lobe of Frederikshåbs Isblink was first formed during this stabilisation.

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PREVIOUS WORK

Short descriptions of the Quaternary deposits of the area between Frederikshåbs Isblink and Ameralik were given by Kornerup in 1890. He described fossil-bearing marine sediments at Frederikshåbs Isblink, Serfat qáqâ (in Bjørnesund) and Sanerâta timâ near the fjord Sermilik. On the basis of occurrence of glacial striae he concluded that the area between Ameralik and Buksefjorden was covered by ice to at least 1300 m above sea level at 52°W, whereas the ice cover in Fiskenæsfjorden at 50°36'W reached at least 1000 m and at the head of Bjørnesund reached up to 1100 m. Between Fiskenæsfjorden and Frederikshåbs Isblink the ice cover over the outer coast only reached an altitude of 250–660 m above sea level.

Concretions containing a marine fauna were found at the front of the present glacier lobes of Frederikshåbs Isblink, Sermilik and in Godthåbsfjord by S. Hansen

Fig. 1. Height of the glaciation limit in hundred metres above sea level over the coastal areas (thick lines). On the Inland Ice ablation zone (dotted areas) and altitudinal conditions marked by 300 m contour lines.

and K. Gripp (Gripp, 1932). Investigation of the pollen content in these concretions from Frederikshåbs Isblink and Godthåbsfjord was made by M. Bryan (1954). On the basis of the occurrence of *Picea mariana* pollen in these concretions she concluded that the sediments were formed during an interglacial age since this plant has not grown in Greenland in post-glacial time. However, this argumentation is invalid if the pollen occurrence is due to long-distance transport.

Geomorphological investigations (Graff-Petersen, 1952) in the southernmost parts of the area show a system of older glacial striae on the higher land indicating an older ice movement nearly independent of the topography and with a direction of movement due west. Younger and lower systems of glacial striae follow the direction of valleys and fjords.

PRESENT CLIMATIC AND GLACIAL CONDITIONS

The mean temperatures of Godthåb and Marraq for January are -7° to -8°C, and for July +7° to +8°C and that for the year 0° to -2°C. The precipitation at Godthåb (mean 1925–1941) was 50 cm and at Marraq (1943–1948) 82 cm (Blinkenberg, 1952). Both stations are situated at the outer coast and it is presumed that more continental conditions with higher summer temperatures, lower winter temperatures and smaller precipitation prevail in the inland areas near the Inland Ice margin. Since the accumulation over the adjoining Inland Ice sector (Benson, 1961) increases from 40–50 cm water equivalent at the margin to a maximum of over 70 cm at 2200 m elevation a precipitation of scarcely 40 cm is expected in the inland lowland areas.

The relatively dry inland areas and the increase of precipitation (snow accumulation) with altitude on the Inland Ice is considered as a typical rain shadow effect due to the coastal mountains. Vertical variation of the precipitation is therefore expected in the coastal region so that the precipitation values from Godthåb and Marraq are not representative for the region.

No investigation of the mass balance of the glaciers has been undertaken in the area. Aerial photographs from August 11–16 1968 show a firn line close to the glaciation limit, i.e. with an increase from 700–800 m above sea level over the outer coast to 1500 m above sea level 100 km from the coast. Since the area narrows to the south, the firn line of the Inland Ice drops in altitude from around 1500 m above sea level at the head of Ameralik and Sermilik fjords to around 1000 m above sea level at Frederikshåbs Isblink.

The occurrence of the numerous glaciers and local ice caps in the area facilitates the determination of the glaciation limit (fig. 1).

Only at the head of Bjørnesund and in Kangersuneq (head of Godthåbsfjord) is there some calf ice production from the Inland Ice. On the basis of estimate of calf ice production from aerial photographs and a comparison to calf ice production from investigated lobes in Disko Bugt and the Umanak district further north (Bauer *et al.,* 1968) it seems that the production from the lobe in Bjørnesund scarcely exeeds 0.5 km^3/year and that of Kangersuneq might go up to a few cubic kilometres a year.

According to the considerations above calving is a negligible component of the ablation in the area, therefore an estimate of the ablation on the Inland Ice will also give an order of magnitude of the ablation condition for the local glaciers in the area.

Since the flow lines of the Inland Ice can be approximately determined as at right angles to the contour lines of the surface, a sector limited by the ice divide and the flow lines to the head of Buksefjorden–Kangerdluarssungûp taserssua and to Frederikshåbs Isblink is considered. The total area of this sector is approximately 24 650 km^2 of which the accumulation area is 21 000 km^2 and the ablation area 3650 km^2. Using the accumulation values on the map of Benson (1961) which are between 50 and 75 $\times$ 10^{-5} km water equivalent per year over the accumulation area, the total gain must be between 12 and 13 km^3/year water equivalent. At present the ice margin is nearly stationary so that the average ablation over the ablation area nearly compensates for the accumulation over the accumulation area whicw furnishes an average ablation of 3 m/year water equivalent. It should be added that 44 % of the ablation area is situated inside the interval of 900–1200 m above sea level. In spite of the calculation being little more than a guess it indicates that the ablation is greater than that measured on the Inland Ice in the Umanak district and Disko Bugt (Loewe, 1934) and that in order of magnitude it is comparable to that measured in South Greenland (Larsen, 1973).

TOPOGRAPHY

The offshore banks are situated on a ridge running parallel to the outer coast at a distance of 30–40 km (fig. 2). Their surfaces reach altitudes of -28 to -43 m and from their surface forms they must be interpreted as marginal moraines laid down during the maximum extent of the Inland Ice. The banks are separated from the ice-free mainland by troughs and marginal channels with depths from 400 to over 600 m.

The land itself between the coast and the Inland Ice decreases in width from over 100 km at Ameralik in the north to a few kilometres at Frederikshåbs Isblink in the south. A narrow strandflat is developed in a zone 10–20 km wide at the outer coast. East of the strandflat the mountains reach altitudes over 1200 m at several places. The maximum altitudes occur in a zone from the central parts of Ameralik to J. A. D. Jensens Nunatakker (fig. 2). In general upland areas of 600–900 m

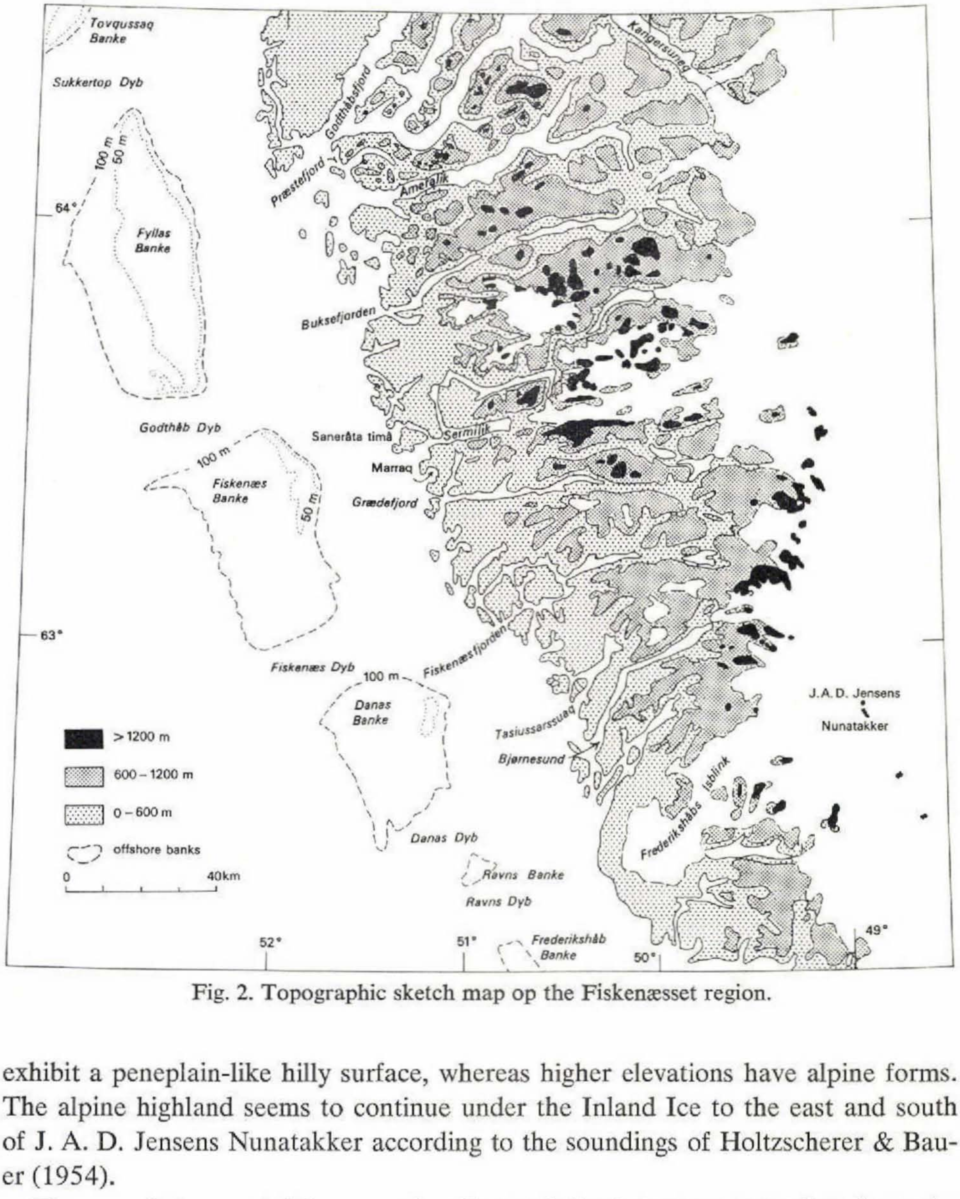


Fig. 2. Topographic sketch map op the Fiskenæsset region.

exhibit a peneplain-like hilly surface, whereas higher elevations have alpine forms. The alpine highland seems to continue under the Inland Ice to the east and south of J. A. D. Jensens Nunatakker according to the soundings of Holtzscherer & Bauer (1954).

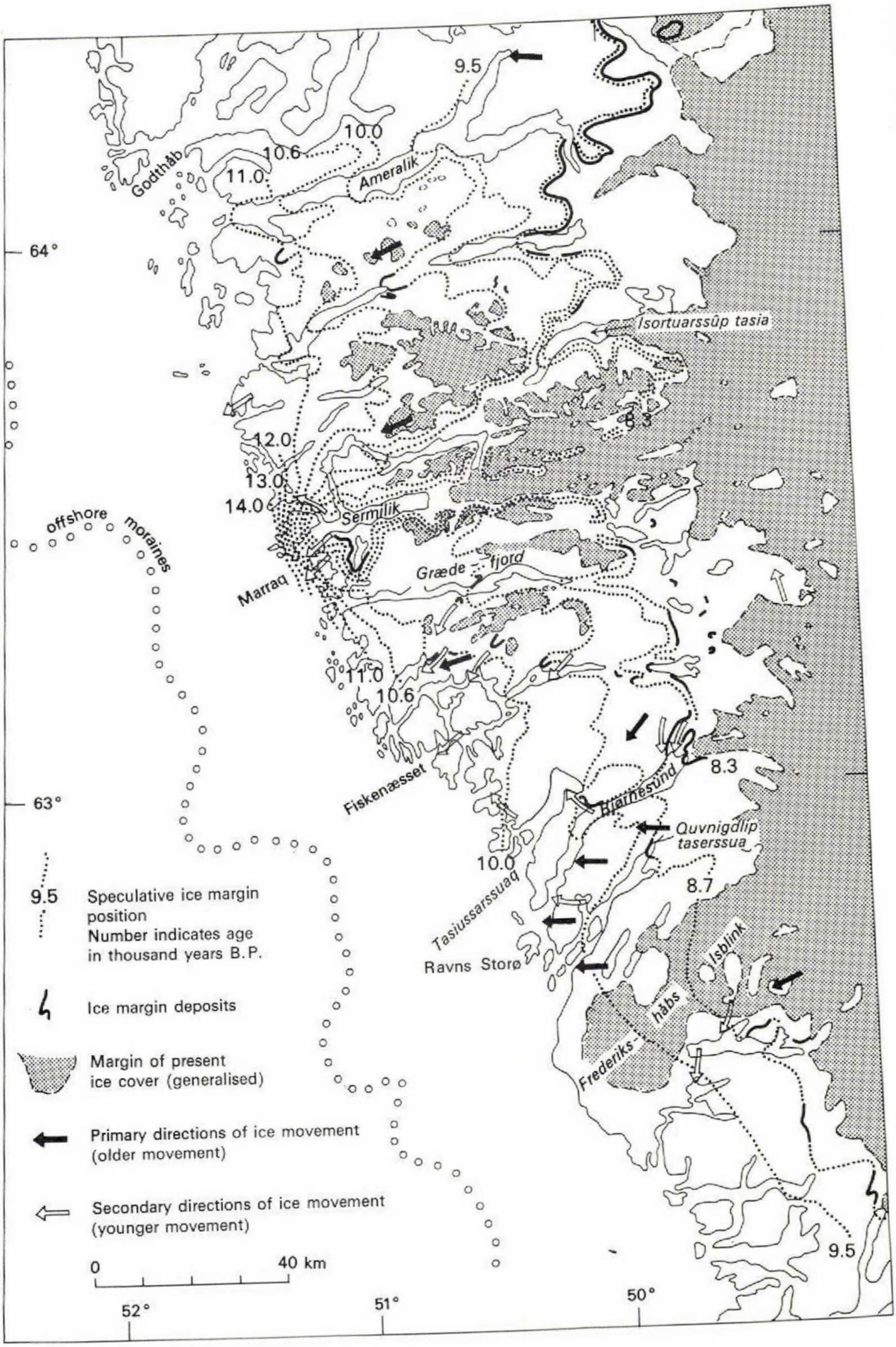
The area is transected by several valley and fjord systems extending from the outer coast to the present Inland Ice margin. Soundings in the fjords are scarce but reveal that maximum depths occur in troughs situated in a zone 15–30 km inside the outer coast and that the greatest depths here occur to the north (over 600 m) and presumably gradually decrease to the south. These glacial overdeepenings must be due to glacial abrasion of long duration, possibly at the maximum extent of the Inland Ice.

Glacial landforms such as cirques and U-shaped valleys occur frequently and several examples are described by Kornerup (1890) and Graff-Petersen (1952). The same authors also give examples of cirques that have been overridden by the Inland Ice after their formation since glacial striae occur in them. A lower cirque level is pronounced in Godthåbsfjord and Ameralik and can also be traced in Sermilik and Bjørnesund. For all the fjords this level increases from 200 ± 200 m above sea level near the outer coast to 900 ± 200 m at the head of the fjords. It is believed that this level marks the altitudes of the glaciation limit during the initial stages of the ice ages when the pleniglacial climatic conditions had not yet fully developed continental glaciers. The evidence for the subsequent continental glaciation is seen by the overridging of the cirques by the Inland Ice. If the cirque levels are compared to the present altitude of the glaciation limit (shown in fig. 1) it is seen that the depression of the glaciation limit (and other snow lines as well) was around 600 m during pleniglacial conditions. This is in agreement with estimates from other parts of Greenland (Weidick, 1968) and from the Arctic parts of Eurasia (Kaiser, 1969).

DIRECTIONS OF FORMER ICE FLOW

Supplementary measurements to those of Kornerup (1890) and Graff-Petersen (1952) of former ice flow by means of glacial striae were especially related to the problems of flow from one fjord to another in order to obtain a relative age determination of the deglaciation phases in the area. A compilation of the information is shown in fig. 3. The oldest and highest glacial striae show an overall trend towards the outer coast that is nearly independent of the topography as already shown by Graff-Petersen for the southern areas. This flow must be related to the moraine stages on the banks. If so, the present profile of the Inland Ice is not comparable to the offshore one, since the offshore one is a kind of piedmont glaciation over the strandflat and beyond the outer coast. An idea of its form can be given by the present Frederikshåbs Isblink which after passing a relatively narrow passage through the highland, spreads over the strandflat of which a few rock knolls peep up through the modern alluvial plain in front of the glacier lobes. Since the aprons of modern piedmont glaciers in Greenland are very sensitive to climatic variations (Weidick, 1968) the same might be expected of an ice age Inland Ice margin between the banks and the outer coast.

Fig. 3. Speculative ice margin positions (dotted lines) and their age in thousand years B.P. This also funishes a tentative correlation to ice margin deposits (thick lines). Movement of the Inland Ice as inferred from glacial striae also shown on the map. Solid arrows older movements, open arrows younger movement.



Godthåb
Ameralik
Isortuarssûp tasia
offshore moraines
Sermilik
Marraq
Græde fjord
Fiskenæsset
Bjørnesund
Quvnigdlip taserssua
Tasiussarssuaq
Ravns Storø
Isblink
Frederikshåbs
9.5
10.0
10.6
11.0
12.0
13.0
14.0
8.3
8.7
64°
63°
52°
51°
50°
9.5 Speculative ice margin position
Number indicates age in thousand years B.P.
Ice margin deposits
Margin of present ice cover (generalised)
Primary directions of ice movement (older movement)
Secondary directions of ice movement (younger movement)
0
40 km

Intersecting systems of ice flows can usually be demonstrated by older systems of chatter marks or concoidal fractures which are polished and grooved by younger ice. The direction of the younger striae indicate that the ice from Nigerdleq (at the head of Tasiussarsuaq) and Grædefjord was directed to the area around Fiskenæsfjorden and that of Bjørnesund and Sermilik towards Tasiussarsuaq and Grædefjord respectively (fig. 3). Thus the deglaciation must have started with the Fiskenæsset area as the first ice-free nucleus and from here spread towards the north and the south. The present glaciers of Frederikshåbs Isblink and Sermilik glacier might thus be considered as relicts of this deglaciation though their final formation through a subsequent readvance cannot be excluded (see later).

Glacial striae are usually made by the Inland Ice. Striations from local glaciers do not seem to occur frequently and local glaciers must only to a small degree have contributed to the general glaciation of the country. At Ilivertalik, on the north side of the central part of Fiskenæsfjorden, glacial striae from the Inland Ice were observed at several places between 920 m and 490 m above sea level (direction 270° to 242°) whereas striations from a presumed local glacier on the southeastern flank of the mountain could be observed at altitudes between 540 and 380 m above sea level with directions gradually changing from 217° at 540 m to 188° at 380 m.

GLACIAL, FLUVIOGLACIAL AND ICE LAKE DEPOSITS AND FEATURES

The hilly and alpine landscape of the area contains scattered and fragmentary deposits of glacial origin. Continuous moraine cover is met with in the inland upland areas at Kangerdluarssungûp taserssua at the head of Buksefjorden and to a greater extent between the head of Fiskenæsfjorden and the margin of the Inland Ice. A southern continuation of this occurs north of the head of Bjørnesund and the whole zone must be connected to a down-wasting of an ice margin over a period of halt or slow recession. At least the younger, inner parts of the zone seem to be connected to moraines of the Fjord stage (Weidick, 1972a) which in Godthåbsfjord are dated to 8300 B.P. and further north to 8100–8400 B.P.

Moraine landscapes occur closer to the outer coast in the Tasiussarsuaq area south of Bjørnesund and at the head of Kangnaitsoq on the northern side of the entrance to Fiskenæsfjorden; the first locality has earlier been described by Graff-Petersen (1952).

The inland moraine areas mentioned above are mainly supposed to be a southern continuation of the Fjord stage, most other prehistoric moraines occur either at the entrance to or at the heads of the fjords. Those at the entrance to the fjords are due to the large changes in mass balance of the glacier lobes when an extended glacier surface shrinks to a narrow fjord entrance, and those at the head of the fjords are due to the shift of the glacier lobes from calving to land-based conditions. Good examples of terminal moraines at the head of a fjord are found at Quvnigdlip taserssua, Bjørnesund, Grædefjord, Buksefjorden, Præstefjord and Ameralik. Marraq is an example of a long halt at the entrance of a fjord (Sermilik). The main moraines and ice margin deposits are shown in fig. 3.

Many moraines mentioned above are cut by marine shorelines or connected to shorelines by terraces, indicating that they were formed during recession of the Inland Ice and before the present period of stability of the relative sea level during the last 4000 years (Weidick, 1972b). The height of the former sea levels can be seen by comparing fig. 3 to fig. 4.

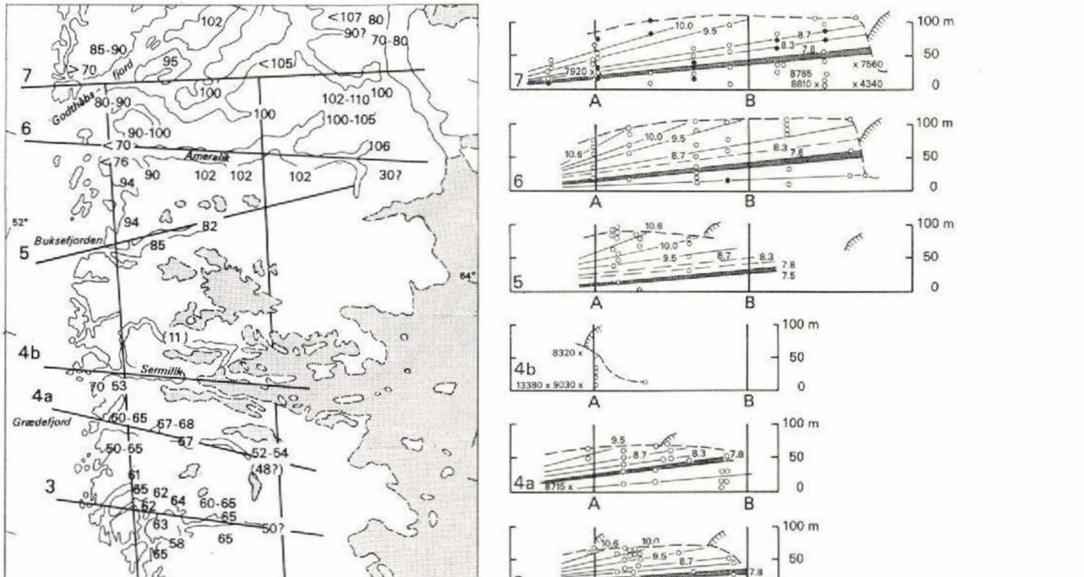


Fig. 4. *Left:* Height of marine limit in metres and location of the profiles shown to the right. *Right:* Shoreline diagrams of the sections 1–7 on the map to the left. Shaded areas are zones of major occurrence of strandlines. Dates according to the emergence curves of fig. 5.

Prehistoric moraines of local glaciers seem only to occur close to those laid down by the readvance in historical time.

The glaciofluvial sediments are an important part of the valley fillings and gradual transitions occur between ice margin deposits, glaciofluvial and marine sediments.

An example of glaciofluvial infill in marine sediments can be seen at Marraq. The Marraq plain consists essentially of marine silt deposits built up under the contact to an ice margin at the entrance of Sermilik. The marine sediments are truncated by infill of sands and gravels and the whole covered by a thin veneer of glaciofluvial gravel.

Ice marginal lakes occur at several places along the margin of the present Inland Ice. The largest occur on the northern side of Frederikshåbs Isblink (Taserssuaq, Taserakasak), in the sector east of Fiskenæsfjorden and Grædefjord (lakes 833 and 820 m) and at Isortuarssûp tasia (on the northern flank of the Inland Ice lobe). Trim lines indicate that most of these lakes have had higher water levels. The present levels are due to either thinning of the limiting ice margin or tapping under the ice or both. At a few places shorelines can be seen around these lakes.

The present rate of sedimentation in lakes connected to the Inland Ice margin is estimated by Heling (1974) to be around 50 m in two to six thousand years.

MARINE DEPOSITS AND MARINE FEATURES

Marine deposits

Shell-bearing depostis have only been found at Qeqertaq in Fiskenæsfjorden, Qôrnoq at the entrance of Grædefjord, Marraq and Sanerâta timâ at the entrance of Sermilik and at the head of the northern branch of Ameralik (Itivdleq). Shells have also been found in the moraines on the northern part of Frederikshåbs Isblink. The age and description of the occurrences are given in table 1.

The oldest dates are obtained from shells in the moraines at Frederikshåbs Isblink, with ages of 21 710 years B.P. The occurrence of the shells in the moraine and their worn state indicate that they have been transported from deposits under the present ice margin. Thus during an interstadial period Frederikshåbs Isblink had an extent less than now. The age suggests an interstadial period (Upton Warren, Plum Point) deposits of which are also described from Inglefield Land, North Greenland (Tedrow, 1970) and from the outer coasts of central East Greenland (Funder & Hjort, 1973). Of these the age of the deposits of Inglefield Land has later been questioned by Blake (1974). In East Greenland it has been observed at several localities and is named the Milne Land Interstadial. Outside Greenland an interstadial of this age is described from North America (Goldthwait *et al.*, 1965; Prest, 1968), Scandinavia (Mangerud, 1972) and the Alps (Fliri *et al.*, 1970) indicating that the retreat of several, unrelated ice sheets must have been the result of a widespread climatic change.

The date of 13 380 B.P. from shells in clayey silt in the north-west facing cove of Sanerâta timâ surrounded by low roches moutonnées provide evidence for the long duration of the ice margin at the mouth of Sermilik fjord. The marine deposits are laminated silt without signs of being overridden by ice. The formation of the Marraq plain immediately south of Sanerâta timâ with 60–70 m of sands and silt mostly deposited between 9030 and 8320 B.P. occurred in contact with an ice margin that must have been stationary during this period at the entrance of the fjord. Whereas the younger dates mark the end of the sedimentation and the greatest part of it, its onset is unknown. The dates at Sanerâta timâ open the possibility that the stay of the ice margin was older and may also indicate the position of the ice margin during the last part of the Wisconsin-Weichsel. This would explain why the sedimentation was slow during the pleniglacial conditions and first increased during the Holocene warm-up.

The other dates from the area are not connected to glacial stand-stills or specific marine levels but furnish a minimum date of the deglaciation of the sample areas.

Marine shorelines

Coastal terraces, deltas and beach ridges are found at several localities and the maximum altitude of the marine invasion (transgression), i.e., the marine limit, could be determined in many places by the occurrence of perched boulders a few metres above this limit (as well as by the uppermost occurrence of the marine outwash). The altitudes of the essential features are plotted on the diagrams of fig. 4.

In the Fiskenæsset area, the marine limit decreases from north to south according to the general trend along the West Greenland coast (Weidick, 1968). Here it is nearly a rule-of-thumb that the maximum height of the marine limit in metres equals the width of the land rim in kilometres. A slight increase in the altitude inland can also be traced, especially in the northern parts of the area described.

An attempt at morphological correlation of the shorelines is shown in fig. 4. The most pronounced level is the lowermost shaded one close to that already regarded by Vogt (1933) as equalling the *Tapes* line of Scandinavia.

Little information can be obtained from the radiocarbon dates of the area for the dating of the lines. The dates from Marraq indicate that the marine plain was build up to a sea level close to 70 m above present sea level at 8300 B.P. Further information on the emergence of the land can be obtained from the emergence

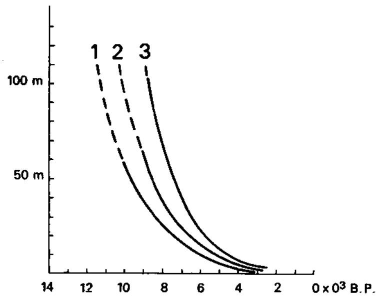


Fig. 5. Emergence curves. *1* Frederikshåb area, *2* Julianehåb area (Kelly, 1974), *3* Kapisigdlit (Weidick, 1972b).

curves published by Kelly (1974) of the area just south of Frederikshåbs Isblink. An emergence curve is also given (Weidick, 1972b) for the Kapisigdlit area north of the head of Ameralik and a single shoreline is also dated in Godthåb town, where marine algae in sand, overlain by freshwater deposits, gave an age of 7920 years B.P. (Kelly *in* Weidick, 1968). This age indicates an uplift close to that given for the Julianehåb district by Kelly (1974). With this date (fig. 5) and the tentative morphological correlation of the levels given in fig. 4, the deglaciation is given by the intersection of the strandlines with the marine limits. None of the dates obtained in the Fiskenæsset area disagree with this result.

AEOLIAN DEPOSITS

Stone plains and dune landscapes, the result of wind action, are connected to the marine, fluviatile and ice margin deposits. The most impressive features are developed on the top of the marine deposits at Marraq, Sanerâta timâ and the land east of Sanerâta timâ. A dune landscape is widespread in Grædefjord; in the lower parts of Kûgssûp alángua on the north side of the fjord.

GLACIER FLUCTUATIONS IN HISTORICAL TIME

Most of the lobes of local glaciers as well as those from the Inland Ice are surrounded by fresh moraines or trim lines on rock surfaces indicating a recent recession of the lobes. The age of this last fluctuation is unknown in the area but in accordance with radiocarbon dates from other areas of Greenland it is assumed that a readvance began around or after 1500 and that glaciers overrode hypsithermal marine deposits and vegetation from the 17th century (Weidick, 1972a). Historical information from the Frederikshåb district also hints at a readvance during the 18th century (Weidick, 1959). Historical time is understood as the time since A.D. 1500.

The subsequent recession took place in this century and especially in the decades around 1930. This is documented from the Inland Ice margin at Frederikshåbs Isblink (position in 1878 by A. Kornerup; 1930 by S. Hansen; 1952 by Graff-Petersen) and Bjørnesund (position in 1878 by A. Kornerup, and in 1936 by J. Helk); that at Bjørnesund is shown in fig. 6. On the visit by the author to the northern flank of the Nakaissorssuaq lobe in the head of Bjørnesund in 1973, the trim line zone and the moraine area had a height of 108 m over the glacier with a sharp limit to the prehistoric moraine terrain above. The historical documentation reveals that the ice margin at 1878 was close to the maximum for historical time whereas already by 1936 it was close to its present extent (fig. 6). That it has been stationary since or is under a slight re-expansion since that time is indicated by the diameters of the thalli of lichens (*Umbilicaria* and *Alectoria* species) up to 2.4 cm on boulders adjacent to the present ice. During its maximum extent in historical time the front of Nakaissorssuaq extended about 2 km further out into the fjord. The front is now stationary on a threshold.

Information from the local glaciers of Kitdlavat in Sermilik also indicates an extent close to maximum in 1878 and a subsequent retreat in this century (Weidick, 1968).

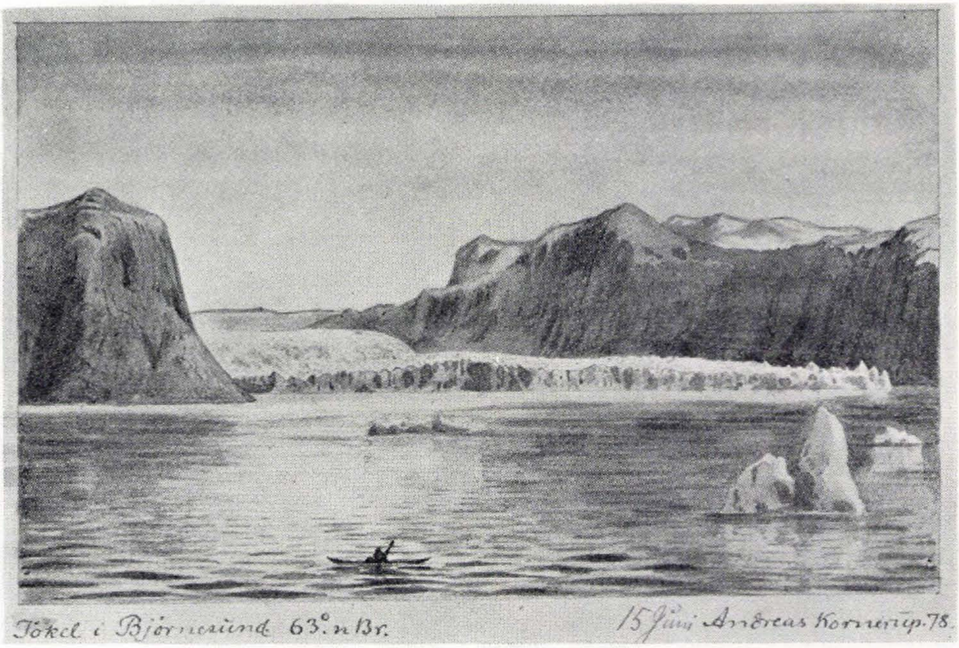
INFERRED GLACIAL HISTORY OF THE FISKENÆSSET AREA

Pre-Wisconsin and Early Wisconsin-Weichsel

The age of the offshore banks is unknown. Possible terraces seem to have been formed on the banks connected to moraines at the proximal parts. Envisaging the old age of the deposits at Sermilik and Frederikshåbs Isblink, it seem likely that the moraines on the banks must be ascribed an Early Wisconsin-Weichsel age or older.

The interstadial at Frederikshåbs Isblink

In spite of only a single date of this age, the age itself and the occurrence of contemporaneous interstadials elsewhere in Greenland (Inglefield Land, Milne Land) substantiate the possibilities of a general shrinkage of the Inland Ice during an interval comparable to that of Plum Point in Canada (Prest, 1969).



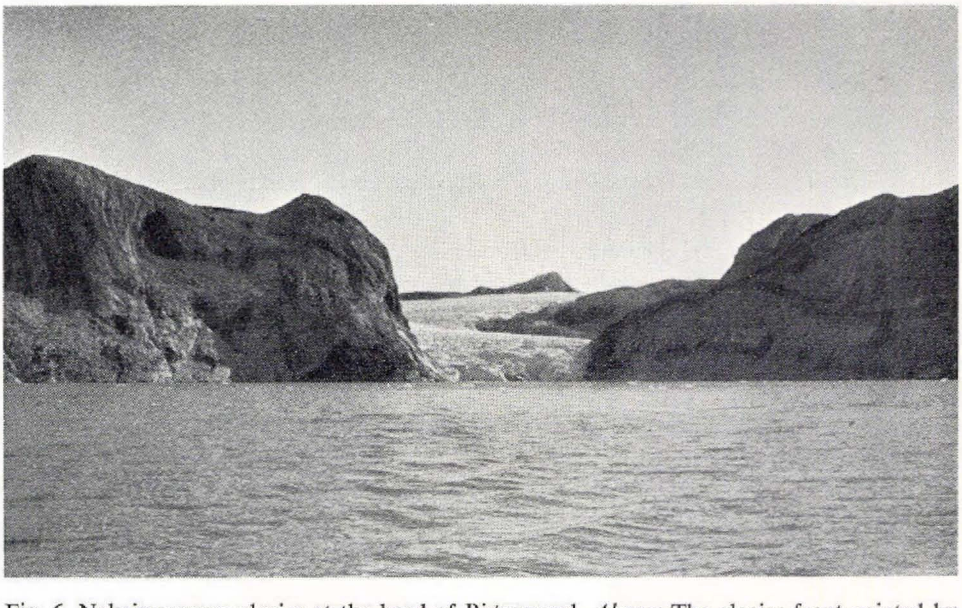


Fig. 6. Nakaissorssuaq glacier at the head of Bjørnesund. *Above:* The glacier front painted by A. Kornerup and dated 15th June 1878. Copyright Arktisk Institut, Copenhagen. *Below:* The glacier front photographed 26th July 1936 by J. Helk. Copyright Arktisk Institut, Copenhagen.

The Late Wisconsin-Weichsel

At least at Sermilik, the ice margin at 14 000 B.P. was close to the same position as marked by the Fjord stage at 8100–8400 B.P. and it is believed that the ice margin stayed at this position throughout the period between the two ages. This may be the maximum for the Late Wisconsin-Weichsel extent of the Inland Ice at this locality but it has to be confirmed by older dates. Whereas in Baffin Island the Cockburn substage of 8000 years B.P. marks the general maximum for the Late Wisconsin extent of the ice cover (Andrews, 1973), the equivalent in Greenland (Fjord stage) only marks the maximum extent of the ice at Sermilik. But the deglaciation trends of fig. 3. indicate that the Late Wisconsin-Weichsel maximum was generally of greater age. The long standstill of the Inland Ice margin at the mouth of Sermilik fjord might therefore be a topographically controlled exception from the general trend of deglaciation of the area.

The Holocene retreat

The trend of the retreat is given in fig. 3 as a conclusion based on the following premises:
(1) The direction of younger glacial striae indicates deglaciation starting in the area around Fiskenæsset, spreading from there to the north and the south (i.e. to Sermilik and Frederikshåbs Isblink).
(2) The morphological correlation of the Fjord stage ice margin deposits according to their extent, form and frequency occur in a zone 35 km to the north and around 10 km to the south from the present Inland Ice margin. The southern continuation of this zone beyond Frederikshåbs Isblink indicates a continuous decrease in the distance to the present Inland Ice margin (see below).
(3) The age of deglaciation is given from the marine limit as dated by emergence curves and strandline diagrams (cf. fig. 4).
(4) The C_{14} dates made on shells in sediments in contact with the Fjord stage at Marraq (in Sermilik) is the age of the moraines at Marraq and that of other dates of marine sediments in the area are minimum dates of deglaciation.

That the deglaciation began in the Fiskenæsset area can be explained by its situation in the lee of the eastern highlands as shown in fig. 1. A southern continuation of the trends of deglaciation south of Frederikshåbs Isblink is shown in fig. 3. Here, Kelly & Funder (1974) describe undisturbed beds, 9580 years old, close to the Inland Ice margin in Kvanefjord. Thus the deglaciation of this area must have occurred early in Holocene time. The early deglaciation of the areas south of Frederikshåbs Isblink seems to fit into a continuation of the deglaciation trends north of the glacier lobe. The interruption of the trends by the Frederikshåbs Isblink itself leaves the question open, whether this glacier lobe is a relict from the general retreat or whether it protruded in Holocene time as a consequence of the shift of drainage in this sector of the Inland Ice during the general retreat and subsequent stabilisation of the Inland Ice.

Hypothermal glacier fluctuations

Little is known about the oscillations of the ice margin during this period. The observation of shell-bearing concretions at Sermilik glacier may be referred to a coverage of Holocene hypsithermal marine beds as in other regions of Greenland. However, the dating of Frederikshåbs Isblink still leaves the possibility open that these concretions might be of interstadial age.

The records of glacier fluctuations in historical time is in accord with the general scheme of glacier fluctuations in the northern hemisphere, where a cooling initiated a readvance (or a period of readvances) in the 16th and 17th centuries. This initial period of readvance is not dated from the area, but the subsequent small recession occurring in this century can be substantiated by the evidence from Frederikshåbs Isblink and from Bjørnesund (cf. fig. 6).

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Table 1. Radiocarbon dates on material collected in the Fiskenæsset area in 1973

GGU 157313: I–7622. Front of northern part of Frederikshåbs Isblink, 62°37′N; 50°08′W. **21 710±400 B.P.**
Shells of *Mya truncata* and *Pecten islandicus*. Found in the moraine and on the alluvial plain in front of the present ice margin. The shells are very fragmented and rounded and must therefore originate from marine deposits under the present glacier lobe. Collected by D. Heling.

GGU 157312: I–7621. Qeqertaq island in Fiskenæsfjorden, 63°12.3′N; 50°20′W. **7835±110 B.P.**
Shells of *Mya truncata*. Found in folded and laminated fine sand-silt in a 3–4 m high cliff resting on gneiss skerries close to sea level. The silt layers are overlain by sand and gravel at 3–4 m to 10 m above sea level. Collected by A. Weidick.

GGU 157314: I–7623. Qôrnoq, south side of entrance to Grædefjord, 63°20′N; 51°06.5′W. **8715±120 B.P.**
Shells of *Mya truncata*. Found in gravelly-sandy parts of shell bank in pond 4 m above sea level. Extensively worn shells indicate a secondary layering. Collected by A. Weidick.

GGU 157303: I–7616. Marraq at Sermilik, 63°25.7′N; 51°12.1′W. **9030±125 B.P.**
Shells of *Mya truncata*. Found in cliff section on south-west side of the plain at 5 m above sea level in a transition zone between underlying clay and overlying laminated sand-silt. Collected by A. Weidick.

GGU 157307: I–7617. Marraq at Sermilik, 63°25.8′N; 51°07.7′W. **8810±120 B.P.**
Shells of *Balanus* sp. Found in a gully in a cliff in inner eastern corner of the plain at 60 m above sea level in a transition zone between overlying reddish sandy gravel (surface at 65 m above sea level) and underlying laminated fine sand-silt. In the transition zone packed great boulders with bottom plates of the barnacles. Collected by A. Weidick.

GGU 157309: I–7619. Marraq at Sermilik, 63°25.8′N; 51°08′W. **8905±120 B.P.**
Shells of *Balanus* sp. found in a gully in the terrace at eastern part of the plain at 55 m above sea level in transitional layer between underlying clay-silt and overlaying sand–fine sand. Top of the terrace at approximately 60 m above sea level. Collected by A. Weidick.

GGU 157308: I–7618. Marraq at Sermilik, 63°25.6′N; 51°08.5′W. **8525±115 B.P.**
Shells of *Balanus* sp., *Mya truncata* and *Pecten islandicus*. Found in coastal cliff at south side of the plain. Shells are found at 10 m above sea level in upper part of clay, overlain by clayey silt. Collected by A. Weidick.

GGU 157310: I–7620. Marraq at Sermilik, 63°25.8′N; 51°07.8′W. **8320±115 B.P.**
Shells of *Mya truncata*. Shells found below upper 5 m of terrace sand at 55–60 m above sea level in silt and clay. Collected by A. Weidick.

GGU 157315: I–7624. Sanerâta timâ at Sermilik, 63°30.8′N; 51°19′W. **13 380±175 B.P.**
Shells of *Mya truncata*. Found in clayey silt in coastal cliff just above high tide. The silt terrace is situated in a west-facing cove surrounded by gneiss knolls and has a surface a few metres above sea level, locally overlain by windblown sand. The silt is extremely rich in shell material (*Balanus* sp., *Mya truncata, Macoma calcarea* (often drilled by *Natica*) and *Astarte* sp.). Collected by A. Weidick.

GGU 157316: I–7665. Eqalugialik in Itivdleq, Ameralik fjord, 64°20′N; 50°24′W.

8785±120 B.P.

Shells of *Mya truncata* and *Balanus* sp. Shells are found in 5–7 m high terrace cut in moraine-like deposits rich in silt and red sand between boulders. Basal plates indicate that the deposits were found in place. In the cliff section numerous well conserved shells of *Pecten islandicus, Saxicava arctica, Mya truncata* and barnacles. The sample is from a sandy part of the cliff. Collected by A. Weidick.

GGU 157317: I–7666. Eqalugialik in Itivdleq, Ameralik fjord, 64°20′N; 50°24′W.

8810±120 B.P.

Shells of *Pecten islandicus, Saxicava arctica* and *Balanus* sp. Same cliff as above and height, at about 4 m above sea level from a very grey silty part of the cliff. Collected by A. Weidick.

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