Some Glacial Features at the Inland Ice Margin South of Sdr. Strømfjord

by

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Abstract

A short description is given of the glacial morphology of an area on the Inland ice margin of the Sdr. Strømfjord area, West Greenland. Morphological changes during the period 1936–52 are recorded on the basic of aerial photographs and the occurence of a pre-historic glacial stage deduced by photo-interpretation of glacial deposits.

Introduction

The area here described, situated about 66°20' N. L. and about 49°40' W., i. e. about 90 km south of Sdr. Strømfjord air base (see location map fig.

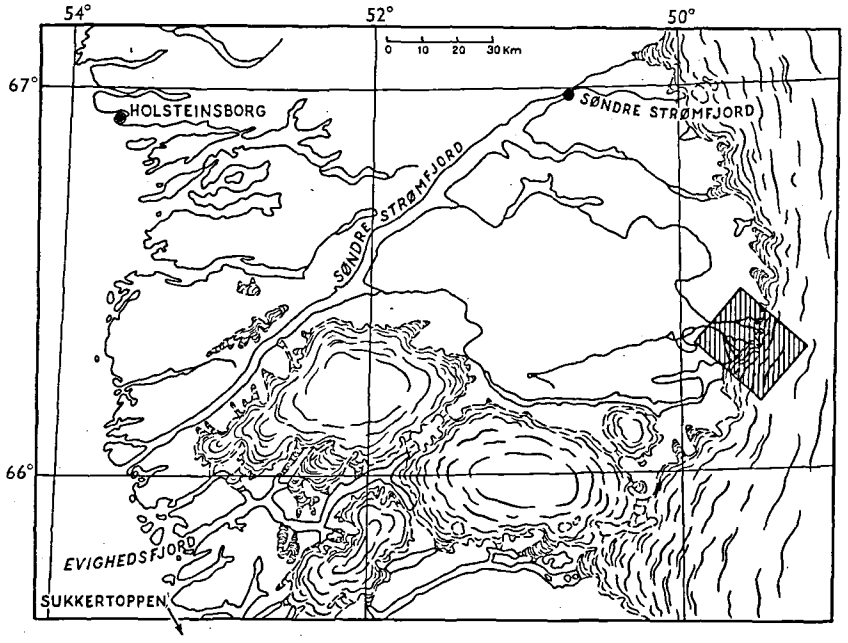

Fig. 1. Location map. Hatched area indicates that part of the Inland ice margin described.

1), has not been visited by the writer and all features described have been observed only on aerial photographs.

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General morphology

In the area the boundary between the Inland ice and the ice-free land is often gradational, the ice margin having no steep termination. The ice margin proper, which is mostly obscured by dead ice landscape, is situated at altitudes between 800 and 1050 m. a. s. l..

In a petrological sense the ice-free landscape probably belongs to the Kangamiut or Ikertôq Gneiss complex in which the dominant foliation strike is expressed topographically as low ridges trending WNW-ESE. This structural direction is characteristic of this part of the Basement complex, as described in the notes to the preliminary structural map of Greenland, compiled by the Geological Survey of Greenland.

Glacial development has formed an undulating roches-moutonnées landscape, where the above mentioned low ridges have been rounded. The direction of movement of the earlier ice cover, which has smoothed the landscape was generally toward W or WNW, i. e. parallel to the preglacial structure.

From the present surface of the Inland ice, so smooth that numerous big melt water streams run for great distances on the surface, it can be seen that the movement of the ice surface must be of a small order of magnitude, and that the ice cover has a small thickness. This is also shown by the results of the Victor expedition (A. BAUER and J.-J. HOLTZSCHERER 1954, pp. 23 and 24).

The substratum of the Inland ice in the area must be considered as a continuation of the landscape at the Inland ice margin, i. e. smooth roches moutonnées landscape with minor ridges and humps running in WNW-ESE direction.

Holocene deposits

Deposits of an earlier, more extensive ice cover can be seen in the area. The most characteristic feature is a ground moraine which can often be seen in the aerial pictures as a "film" obscuring the details of the bed-rock morphology (fig. 3b and 4). The boundary of this ground moraine is at some km distance from and is parallel to the present ice margin and the bed-rock topography is sharply defined distal to this boundary. The limit of this moraine cover must in higher parts of the landscape be described as "attenuated drift border" (R. FLINT 1947, p.157), and in the lowermost parts, the valleys, as real marginal and terminal moraines, sometimes developed in recessional series.

The attenuated drift border and the terminal moraines are both deposits of a single glacial stage. The big difference in appearance of the drift distal and proximal to the "attenuated drift border" indicates furthermore a great difference in age between the moraine deposits of the two areas.

The altitudinal situation of the drift border margin of this stage in relation to the present Inland ice margin indicates a certain conformity with the "Narssarssuaq stage" from the Julianehåb district (A. WEIDICK 1963). Possibly it can be correlated with the "Mount Keglen stage" in the Sdr. Strømfjord base area, described by T. W. BØCHER 1949, p. 60, 1956, p. 30, 1959, pp. 60–66). In the area under consideration the limit of the stage shows a $\Delta h = 100–150$ metres above the present ice surface of the Inland ice margin. This is in accordance with the height difference between the "Narssarssuaq stage" ice cover and the present Inland ice cover in the Julianehåb district at altitudes around 1000 m a. s. l.. Until a more detailed mapping and survey of the area is made, this correlation must only be considered as tentative.

The present Inland ice margin

The limit of the present Inland ice margin is partly obscured by great shear moraines. The development of these moraines can sometimes be followed by means of aerial photographs of the Geodetic Institute, Copen-

Fig. 2. Aerial photograph of the area from 18/7 1948. Geodetic Institute's route 505 I 1, no. 40. Copyright: Geodetic Institute.

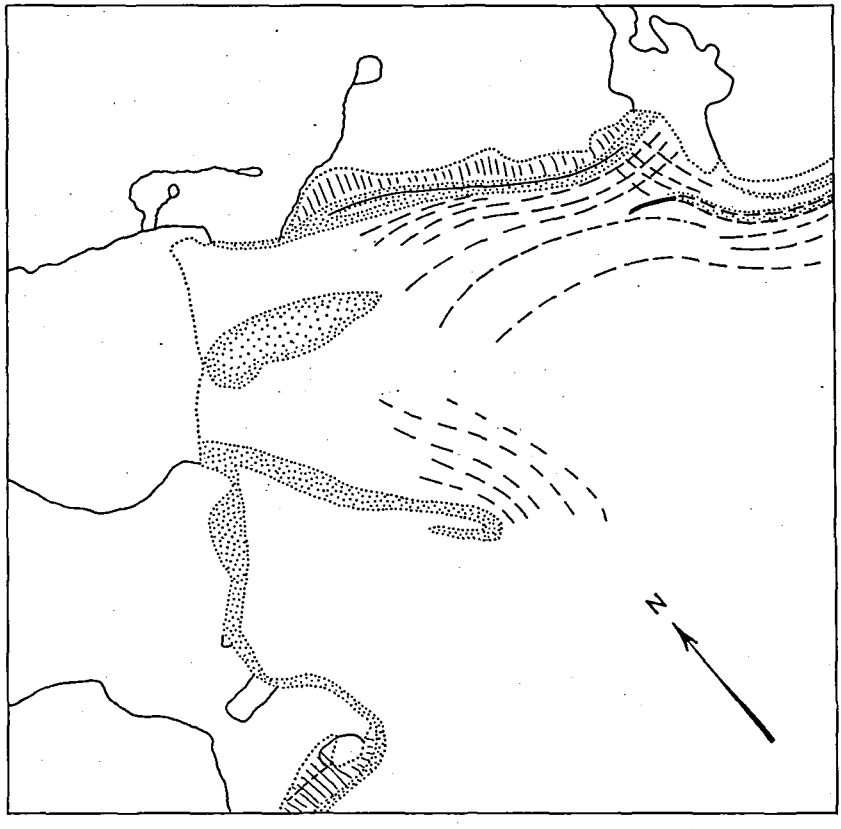

Fig. 3a: Sketch map of the area based on the information 1948 photographs. Broken lines: foliation trends.

hagen. The area is covered by aerial pictures from the years 1936, 1948 and 1952. The pictures from the different years are taken very near the same season, making comparisons easier.

The Inland ice margin proper seems not to have changed essentially between the 3 points of time, and generally the same can be said of the shear moraines. However, in the 16 years coverage of the photographs, the following observations can be made in the different sectors of the Inland ice margin of the area (see fig. 2, 3 and 4):

1936:

July 13. Geodetic Institute's routes 742 E, no. 24149 and 751, no. 28861. Oblique photographs, size about 13×13 cm.

The Inland ice margin is seen at a relatively great distance, so only a few details can be observed. The surface of the Inland ice is smooth, crevasse areas are few, and the surface is dominated by numerous rivers and lakes.

Immediately east of the area α can be observed weak relict structures

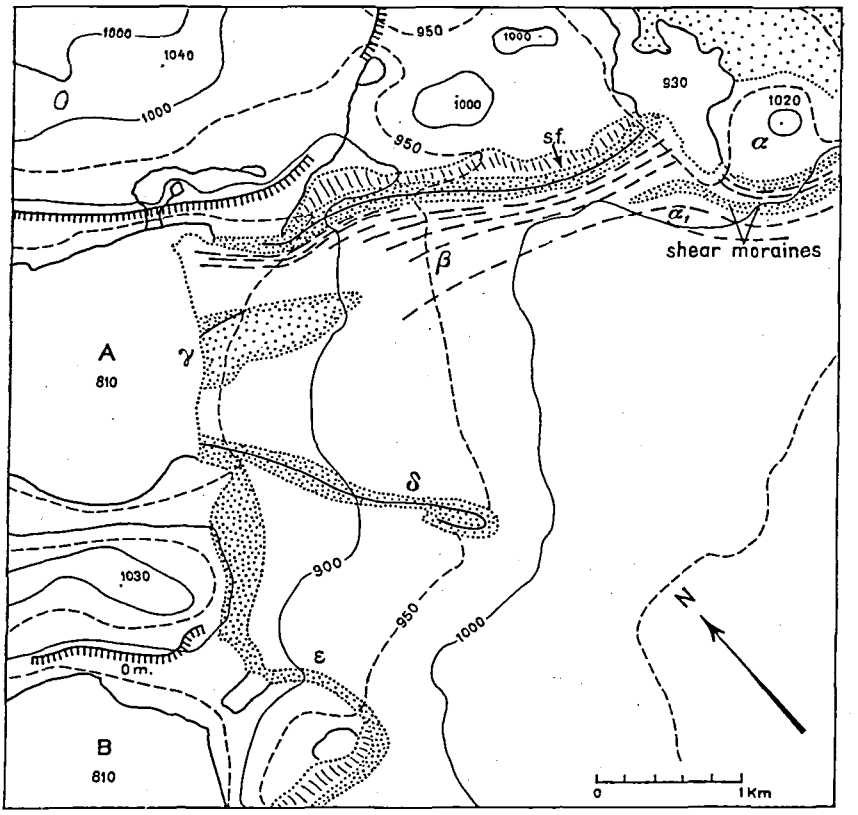

Fig. 3b: Sketch map of the area based on the information 1952 photographs. Contour lines drawn on basis of the Geodetic Institute's map 1: 250.000 of the area. "Comb lines": Prehistorial ice margin deposits; s.f. = snow banks.

in the sense of NOBLES (1960 pp. 42–43) and shear foliation. The disposition of these structures indicates that the ice flow just east of α is divided into two streams directed to the WSW and NW, the original SW flow direction being partly deflected to the NW around δ by the nunatak.

Ice margin features around sector α: In the marginal area around α can be observed 3 great "shear moraines". The 2 most proximally situated of these run very close and parallel to one another and towards the west merge into one. Further to the west of this confluence the moraine disappears. Both the configuration of the moraines and the surface of the Inland ice situated distally from the moraines indicate, that they must be shear moraines or Thule-Baffin moraines after Weertmann (1961, p. 965), and not marginal moraines bordered by superimposed ice. The moraines seem to be very alike those described from the Thule area by BISHOP (1957, p. 18).

Distally from the double shear moraine a possible marginal moraine can be seen, separated from the ice free land by snow banks. However here too

the structure of the surface of the Inland ice in the outermost eastern part of the sector α may indicate that this moraine too was originally shear moraine.

The trim lines in the lowermost parts of the sector, like the dead ice landscapes on the higher ground, presumably show the maximum extension of the Inland ice in historical time; for many glaciers in the Sukkertoppen and Holsteinsborg districts this took place in the years between 1890 and 1900 A. D..

Ice margin features around sector β: The sector includes the northernmost margin of the Inland ice lobe which flows towards the lake A on the maps in fig. 3. In this area the double shear moraines described from sector α disappear in an arc going towards or parallel with the ice margin. The possible continuation of these shear moraines as shear foliation further west cannot be established because of the lack of clarity the picture.

Distal to the ice-free land is a big shear moraine (or here marginal moraine?) separated from the ice free land by snow banks of glacier ice. Farthest west the moraine bifurcates to form two closely spaced parallel ridges.

Ice margin features around sector γ: The front of the ice lobe against lake A is only partly shown on the photograph, and none of the finer details can be seen. However, it can be seen that the surface has no shear moraine.

Ice margin features around sector δ: A median moraine and the form of the glacier seem to indicate that the median moraine partly defines a limit between two ice lobes, both running towards lake A, but parted by a NW-SE trending threshold under the ice.

The circular form of the proximal end of the median moraine appearing hook shaped on the photograph because of a snow fan, and the depression of the ice surface at this place indicate that the threshold or nunatak here must be only just below the ice surface. This circular moraine is very similar to the moraines around nunataks described by KORNERUP (1890, p. 133) from the Frederikshåb Isblink and the form of the ice surface similar to that described by RYDER (1889, p. 223) around nunataks in the Upernivik district. As described above, this subglacial ridge appears to divide the flow of ice.

Ice margin features around sector ε: At a small semi-nunatak in sector ε a marginal moraine can be seen, separated from the ice free land by snow fans or possibly by a zone of stagnant ice. This zone has a width of 200–300 metres.

1948:

July 18. Geodetic Institute's route 505 I 1, nos. 40–43. Oblique photographs, size about 23×23 cm. One is shown in fig. 2.

The Inland ice is seen at close range. All details in the marginal area and on the ice surface can be clearly observed. The form of the ice surface is the same as in 1937. Even the courses of the melt water streams seem to follow the same trends in both years. The essential difference in the ice surface between 1937 and 1948 is the existence of a big ring shaped shear

moraine in 1948. This shear moraine is shown both in fig. 2 and 3 and is situated near the glacier front at lake A.

The photographs of 1948 are so near to the ice margin that the "relict structures" cannot be seen so clearly as in the 1937 photographs. Instead of these structures ice foliation is clearly visible in the sectors α–β. The trend of these features is conformable with the relict structures observed on the 1937-photographs, i. e. parallel with the Inland ice margin. This can be seen on the original photograph to fig. 2. In contrast to this in the area around the embryonic nunatak at δ, the relict structure appear to cut the foliation structure at right angles. The ice foliation here runs parallel

Fig. 4. aerial photograph of the area from 8/8 1952. Geodetic Institute's route 207 V, no. 4766 — Copyright: Geodetic Institute.

with the median moraine, whereas the median moraine in its proximal parts appears discordant to the trend of the relict structures.

Ice margin at sector α: This sector is very distinct on fig. 2. The double shear moraines are in the same position as in 1937.

It can be observed, that the double moraines in the lobe of the Inland ice immediately north of α coalesce in a single ridge. This single ridge shear moraine forms a distinct boundary between a distal dead ice area and an active proximal part of the Inland ice.

At sector α and to the west of this sector, the double moraine, as in 1937, tapers out into a single moraine in the direction of the lake A. The ice foliation seen on the ice surface indicates that this is not superimposed ice but a part of the original Inland ice, which distally separate the double shear moraine from the ice free land.

The outermost (third) moraine ridge (marginal moraine) has the same position and extent as in 1937. The superimposed ice between this moraine and the ice free land also has the same extent as in 1937.

Ice margin at β: As described above, the southernmost part of the double shear moraine coalesces below α to one ridge, which since 1937 has been extended by about 300 metres to the south. The new part of the ridge (α_1 in fig. 3) shows a more westerly trend than the older part. The moraine is continued further west by shear foliation, the trend of which is seen as arcs on the glacier lobe against lake A further west. Farthest west the trend of the shear foliation, forming the continuation of the double shear moraines, approaches the ice front on lake A.

The marginal moraine has in this year the same extent and position as in 1937. The same can be said of the superimposed ice north of it.

Ice margin at γ: The position of the glacier front on lake A is the same as in 1937. On the glacier surface can be observed numerous shear foliae, running in great arcs across the lobe. As mentioned above the continuation of the double shear moraines of sectors α and β can be followed in shear foliation to near the glacier front on lake A. Here, this feature passes over into a ellipsoidal shear moraine feature, the size of this being: length (direction E-W): about 1.5 km, width: about 0.5 km. The connection by shear foliation trends suggests a genetic connection between this ellipsoidal moraine and the double shear moraine in sectors α-β.

The formation of the ellipsoidal moraine must have happened between 1937 and 1948.

Ice margin at sectors δ and ε: The position and the extent of the median moraine at δ and the marginal moraine at ε seem to be the same as in 1937.

1952:

August 8th. Geodetic Institute's route 207 V nos. 4764–4766. Vertical photographs, size about 23 × 23 cm. One is shown in fig. 4.

The Inland ice can be observed in great detail on a scale about 1 : 40.000. Surface features on the ice (water courses, foliation of the ice) seems in general to have the same trends and extents as in 1948.

Ice margin at sector α: The double shear moraine and its continuation

further north has the same extent as in 1948, and the position of the marginal moraine is also unchanged.

Ice margin at sector β: The continuation of the double shear moraine (α_1 in fig. 3), prolonging the double shear moraine with a single ridge of about 300 metres in the years 1936–1948, has in the period 1948–1952 been further extended 50–100 m westwards. In the period 1948–1952 the single ridge of α_1 has been transformed to a double ridge.

A small dark dot about 300 metres west of the outermost western tip of α_1 indicates a continued extending of this double moraine; the above men tioned dot, the double shear moraine and the ellipsoidal moraine all being situated along the trend of the same shear foliation.

The extend and trend of the "marginal moraine" in 1952 is the same as in 1948. However, between these times the dead ice landscape between the marginal moraine and the ice free land seems to have been reduced in extent. The dead ice must in this period have been covered with a great amount of superficial moraine.

Ice margin at sector γ: The position of the glacier front against lake A is the same as in 1948. Superficial features show the following alterations since 1948: The ellipsoidal moraine has shifted position, being situated 100–125 metres farther west than in 1948; this must indicate a movement of the glacier towards the lake of about 25 metres–30 metres pr. year. This is known to be a very normal rate of movement of the usual Inland ice margin (see also datas and references, compiled by KAYSER (1928, p. 410) and DANSGAARD (1961, p. 82)). As a result of this movement, the outermost western part of this moraine feature has disappeared. Hence, it must be supposed that the ellipsoidal moraine will disappear completely between 1965 and 1975.

About 500 metres south of the ellipsoidal moraine new patches (see fig. 4) of moraine appear on the surface of the ice; these are possibly situated on the same trend of shear foliation as the ellipsoidal moraine. However, in this area, close to the median moraine of sector γ, marginal crevasses obscure the pattern of shear foliation.

Ice margin at sector δ: The median moraine has the same extent and trend as in 1948. However, at the easternmost tip of it, it seems that the "hook form" of the moraine, supposedly with an embryonic nunatak below, seems to have collapsed to some degree since 1948. The partial snow cover of this area on the 1948 picture make this observation rather doubtful. The trends of the water courses on the surface of the inland ice in this sector are exactly the same in 1952 as in 1948, which must indicate that the alteration in the form of the surface must have been very little in the period between these times.

Ice margin at sector ε: The extent of the glacier lobe between the areas of sector δ and ε is the same in the years 1948 and 1952. However, here as in sectors α and β, the superimposed ice, separating the marginal moraine from ice free land, has become so dark that scarcely any white ice can be observed.

Conclusions

As can be seen from the description of the aerial photographs, the margin of the Inland ice in this area must in general be regarded as having been stationary throughout the period from 1936 to 1952. This is what must be expected, as the ice margin is situated at altitudes between 800 and 1050 m. a. s. l.. Melting of the Inland ice margin is a function of the altitude to such a degree, that even big alterations of the ice surface on ice lobes near sea level in the period here under consideration can scarcely be detected at altitudes over 500 metres a. s. l. (AHLMANN 1948 p. 40, WEIDICK 1963 p. 80). The trim line indicates, that change in height since the last "hochstand" in this area must be 10–40 metres. Here, as for many glaciers in the Holsteinsborg-Sukkertoppen area, most of this thinning out of the glaciers must be regarded as having taken place in the years between ca. 1920 and 1940 (ROSING 1958, p. 324, unpublished photographs in the GGU glacier archive). These factors explain why not much thinning out of the Inland ice margin can be observed during the period under consideration, i. e. 1937–1952. Only the stagnant ice between the marginal moraine and the ice free land shows a distinct tendency to diminish in this time.

Especially interesting is the appearance of the ellipsoidal moraine. The prolongation of the double moraine in the sectors α and β, the trends of shear foliation, and the appearance of minor dots in the same trends between 1948 and 1952 all point toward a causal connection between formation of the double shear moraine and the ellipsoidal moraine. The whole feature can be regarded as the surface expression of the group of the common type of spoon shaped shear planes (KLEBELSBERG 1948, pp. 62–64), emphasized by surface concentration of moraine material due to ablation.

Possibly the ellipsoidal moraine is due to the distortion of such morainic shear planes, forming a dome or culmination similar to those of structural geology and often due to multiple deformation of original layers. In the case described only a single distortion of the spoon shape surfaces would be necessary to produce such a culmination. Such a distortion would be due to an unevenness of the surface of the bedrock below the moving ice.

However, until observations have been made on the attitudes of the planar features now seen intersecting the ice surface, together with photographs of the profile in the glacier front on the lake A, no final conclusions can be drawn concerning the origin of the ellipsoidal moraine. As this interesting feature is likely to disappear within the next few years, it is hoped that before this happens at least new photographs of it will be obtained.

DANSK RESUME:

I det behandlede område ses israndsaflejringer, betegnende et stadium, der formodes at være identisk med det af T. W. BØCHER beskrevne ved Mt. Keglen, Søndre Strømfjord air base. Muligvis er disse også identiske med Narssarssuaq stadiet i Julianehåb distrikt.

Også israndsaflejringer afsat af et, muligvis flere fremstød af isranden i nyeste tid (d. v. s. formodentligt 1600–1900 e. Chr.) ses tydeligt. Der er derefter sket en afsmelt-

ning af isranden. I lighed med gletschernes tilbagetrækning andetsteds i distriktet må det antages, at største delen af denne afsmeltning er sket mellem 1920 og 1940. Grundet områdets beliggenhed i højder mellem 800 og 1050 m. o. h. er afsmeltningen dog af langt mindre omfang end ved de lavereliggende gletschertunger. Der haves om isranden oplysninger fra årene 1936, 1948 og 1952 (flyvefotografier, optaget af Geodætisk Institut). Israndens afsmeltning i tiden 1936–1952 er ringe, isranden må i det store og hele beskrives som stationær i dette tidsrum.

Observation af en linseformet "shear" moræne, opstået mellem 1936 og 1948, gør det muligt at angive størrelsesordenen af israndens bevægelse. Denne linseformede "shear" moræne flyttedes i årene 1948–1952 100–125 m mod vest. Den angivne størrelsesorden af israndens bevægelse, 25–30 m/år, overensstemmer med tidligere udførte målinger i de nordligere dele af Vestgrønland.

Den linseformede "shear" moræne ("forskydningsmoræne") synes dannet i forbindelse med normale "shear" moræner, som længere mod nord angiver grænsen mellem proximalt beliggende aktiv is og distalt beliggende dødis.

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