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GRØNLANDS GEOLOGISKE UNDERSØGELSE
BULLETIN No. 18.

GLACIAL VARIATIONS IN
WEST GREENLAND IN HISTORICAL TIME

PART I
SOUTHWEST GREENLAND

BY

A. WEIDICK

WITH 58 FIGURES IN THE TEXT

Reprinted from
Meddelelser om Grønland Bd. 158, Nr. 4

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI A/S
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CONTENTS

	Page
Introduction	5
Written Sources and Conclusions Regarding the Individual Glaciers.....	11
Julianehaab District	
Region 1: Tasermiut fjord—Ilimausaq	12
Sermitsiaq in Tasermiut fjord.....	12
Sermeq in Tasermiut fjord.....	21
The glaciers on Sermersôq.....	28
Sermeq in Søndre Sermilik	30
Kujatdleq valley glacier and Jespersen glacier.....	33
Qôroq glacier.....	36
Kiagtût sermia	41
Ilimausaq ice cap and Narssaq glacier.....	45
Region 2: Nordre Sermilik—Illoka (Illorro).....	51
Eqalorutsit kangigdlit sermia and Eqalorutsit kitdlit sermia	51
The glaciers in Kangerdluarssuk	64
Inland-ice front between Kangerdluarssuk and Sermilik (Sermitsialik) ..	68
Sermilik glacier.....	71
Inland-ice front north of Illoka (Illorro) area	75
Frederikshaab District	
Qipisarqo glaciers	77
Qôrnoq glaciers.....	82
Arsuk glacier.....	92
Sermiligârssuk and Sioralik glaciers.....	102
Sermilik glacier.....	106
The glaciers in Kvanefjord	112
Frederikshaabs Isblink	118
Godthaab District	
Nakaissorssuaq	134
The glaciers on Kitdlavât	136
Sermilik glacier.....	137
Inland-ice front at Austmannadalen	140
The glaciers on Sadlen	151
Qingâq glacier.....	155
Kangersuneq glacier	156
Qamanârssúp sermia	163
Narssap sermia	165
Ujaragsuit glacier	170
Summary of evidence of Southwest Greenland's glacial variations	175
Index of localities	185
Bibliography	191

INTRODUCTION

The present work is an exposition of a study made of the situation of the ice front in the glaciers of West Greenland, based on the information in the literature, diaries and in picture material. It is also a comparative study of that material for the purpose of forming a picture, fragmentary though it may be, of the ice shrinkage along the margin of the inland ice and at certain isolated glaciers in the various regions investigated.

All the glaciers are within the stretch of coast between Tasermiut fiord in the Julianehaab District and Kangersuneq fjord in the Godthaab District, i. e. the country between lat. 60° N. and lat. 65° N on the West coast of Greenland.

It has been impossible, of course, to give a collective description of the entire long ice front through the districts of Julianehaab, Frederikshaab and Godthaab; the only localities considered here are those where measurable changes were to be found and about which the literature contains earlier information.

First and foremost, these localities are those ice lobes which extend from the inland ice down into the valleys and fiords of the coastal land and therefore are most liable to melt in periods of extra climatic warmth, as was the case in the period about 1900—1950. In addition to the information discovered on the margin of the inland ice and its offshoots, some particulars have become available about changes in smaller, isolated glaciers, for which reason the latter are included in the survey when the appropriate districts are being dealt with.

A number of the glaciers have already been described by the French geographer CHARLES RABOT; in his work "Variations de Longueur des Glaciers", 1897, he summarized what information was then available about the glaciers of Greenland. In the following account I have supplemented Rabot's descriptions of the glaciers in the Julianehaab, Frederikshaab and Godthaab districts with recent material and brought it all up to the year 1955.

The information was obtained from aerial photographs, both Danish before and after the war and American from the Second War, and also from reports of both glaciological and non-glaciological surveys in

these districts as well as private photographs as mentioned below in the description of the various localities.

In contrast to other parts of Greenland from which there are expedition reports stating clearly whether or not the glaciers were surveyed or photographed, it is a remarkable fact about these three districts that, although they were amongst the first parts of Greenland to be colonized, they did not attract the interest of large expeditions before and after the great cartographical period from 1876 to about 1900. As a consequence, the material has had to be gleaned from a variety of sources.

On the other hand, the other ancient Danish colonized region, Disko Bugt, has furnished a very copious material for evaluating the glacial changes, simply because there it was much easier to gain access to most of the glaciers from the sea than in the more southerly parts of West Greenland, where a strip of land, often from 100 to 150 kilometres in width, separates the margin of the inland ice from the sea. Only in the Julianehaab district, the southernmost described in the following, does the ice margin again come within easy reach, which is the reason why that district has produced more observations. Another circumstance connected with that district is that the old Norse "Øster Bygd" was situated within it, wherefore the entire region has been under exploration for many years in the search for Norse ruin-sites.

With regard to measurements taken direct from early maps, it will be wise to deal circumspectly with conclusions drawn from them as to the situation of the glacier fronts. These maps were often drawn from some elevated point, with the result that the outlines not immediately adjacent to that point are distorted. The most reliable indication of the position of the ice front is that given by photographs or by a record of its height. The old district maps 1:1,000,000 (Atlas til Mindeudgaven for 200 Aaret for Hans Egedes Landing, Medd. o. Gr., Vols. 60—61) are quite inadequate for the purpose, firstly because of their scale, the inaccuracy of their outlines, and because we are ignorant of the spot from which the various areas were sketched, and we do not know the date of the ice-front position indicated. I have made use of the maps only when drawn to a larger scale or when there is some guarantee of more accurate outlines.

Historically, there are two groups of information about West Greenland: 1) The Norse literature, treating of the period from about 1000 to about 1300, and 2) the accounts from periods of discovery and colonization from 1721 up to the present time. It may be said at once about the former group, the Norse Period, that the written sources tell us almost nothing about the glaciers and the inland ice of Greenland. An oft-quoted source (e. g. Gr. Hist. Mindesmærker III, p. 329 and



Fig. 1. General map of localities described in the text. The locality numbers on the map refer to the numbers in the text.

Medd. o. Gr., Vol. 4, p. 71) is a passage in "The King's Mirror", stating that only a small part of the land on the West coast of Greenland is accessible, the remainder being concealed by ice—on the whole the same conditions as those prevailing now. However, the situation of remote Norse ruins in Kangersuneq, Godthaab District, seems to suggest a milder climate then than now, and something similar may be inferred from the large herds of livestock then kept on the Greenland farms.

The well-preserved grave finds at Ikigait (Herhjulfs Næs)¹⁾ likewise suggest that a colder period must have set in after the Norse period, lasting until the close of last century, as was also the case in Europe. However, nothing is known of the position of the glaciers in the Norse period, and we can only reckon that most of them occupied the same withdrawn situation as they do now.

The period from about 1400 to about 1700 is a blank. The disappearance of the Norsemen has been attributed to a deterioration of the climate, but it is possible that other factors played a part: Isolation from Scandinavia, destruction of crops by larvae and re-invasion by Eskimos²⁾. From what we know of the Norse period we must assume that the glaciers were in an advanced position.

After the landing of Hans Egede in 1721 and onwards there is some information about the glaciers, but it is only from about 1877, with the appointment of "Kommissionen for Ledelsen af de Geografiske og Geologiske Undersøgelser i Grønland", and the appearance of its publication "Meddelelser om Grønland", that we have any real material to draw upon. The writer has endeavoured particularly to obtain material from the period between about 1800 and 1955, but where earlier material has been found the fact is stated, and, as will be seen from the recapitulation on pp. 175—184, the changes in the glaciers generally may be surmised back to about 1750. As a consequence, the present publication can only point to a rough conformity with the fluctuations from other glaciated regions.

The following series of periodicals have been systematically examined for information of value to the present investigation:

- 1) Meddelelser om Grønland (abbreviated everywhere in this work to Medd. o. Gr.), Vols. 1—151 (1876—1955).
- 2) The periodical "Atuagagdliutit" 1861—1952 and its continuation: "Atuagagdliutit/Grønlandsposten" 1953—1955.
- 3) The periodical "Avangnamioq", 1913—1950.
- 4) Nordisk Tidsskrift for Oldkyndighed 1832—1836 (Vols. 1—3) and its continuations: *Annaler for Nordisk Oldkyndighed og Historie* 1837—1863, and *Aarbøger for Nordisk Oldkyndighed og Historie* 1866—1936.
- 5) *Geografiske Tidsskrift*, Vols. 1—54 (1877—1955).
- 6) *Grønlandske Selskabs Aarsskrift* 1906—1952 and its continuation "Grønland" 1953—1956.
- 7) *Meddelelser fra dansk Geologisk Forening* 1894—1955.
- 8) *Meddelelser fra Norges Svalbard og Ishavs-Undersøkelser* Vols. 1—59, 1926—1944.

Furthermore, articles and handbooks, listed in the Bibliography pp. 191—196 have been consulted.

¹⁾ P. NØRLUND 1927.

²⁾ T. MATHIASSEN 1935, p. 84 and pp. 122—123.

The following collections of pictorial material have also been examined:

- 1) Mineralogisk Museum picture archives.
- 2) Det Kongelige Bibliotek collection of pictures and maps including John Møller's pictures and Rink's maps.
- 3) Nationalmuseets Etnografiske Samling picture archives.

It is likely that in addition to the information already secured, there are expedition diaries and photographs still in private ownership that may be of value to this investigation; the writer hopes to be able to discover the whereabouts of this supplementary information.

I extend most sincere thanks to all those individuals and public institutions who have been unstinting in their help and good advice. It is not possible for me to name all, but a perusal of the text will show how important the contribution of others has been and necessarily must have been towards completing the task. But I would like to address special thanks to Professor A. NOE-NYGAARD, Ph.D., to the Carlsberg Foundation, and to Grønlands Geologiske Undersøgelse¹⁾, for making it possible for me to perform the work, and to Colonel J. V. HELK of the Photogrammetric Section of the Geodaetic Institute for his never-failing kindness in permitting me to make use of its photographic material. Thanks are also due to Dr. H. WIENBERG RASMUSSEN, Mr. C. PULVERTAFT, and Magister P. GRAFF-PETERSEN for reading and reviewing my manuscript. The text was translated by Mr. W. E. CALVERT. The draughtsman is Mr. N. MADSEN.

The Greenland Place-names.

It is a reasonable assumption that some readers are unfamiliar with the naming of the Greenland localities; it will therefore help to prevent misunderstandings briefly to enumerate the difficulties which these Greenland names may cause. It will not pretend to be an exhaustive exposition of the subject, being merely a corollary to the descriptions of the glaciers. The principal works on the subject, in German and English, are listed at the end of this section.

1) Greenland place-names are purely descriptive. The people living in one place talk only of "the big lake", "the little glacier", "the ice fiord", etc. situated within their own area, with the result that very often there is a profusion of the same locality names along the coast. For example, on five occasions in the following text there are localities named Sermilik (which means fiord with glacier, ice-fiord). Consequently it is frequently necessary to couple the name with the latitude of the place, as CH. RABOT did in his work (see above), or the name of the

¹⁾ Greenland Geological Survey.

district, as in this paper. In addition, I have adhered to the principle of numbering all the glaciers and referring to them in succession from south to north, regardless of whether they are isolated glaciers or lobes from the inland ice.

2) Place-name orthography. As is the case with other languages, the orthography of Greenlandic has undergone development with the passing of time. Prior to about 1860 it was very haphazard and, as will be seen from the passages quoted in the following pages, often very free and variable. In the latter half of last century, however, it became more consistent as a result of the efforts of the philologist and missionary S. KLEINSCHMIDT. But a good deal of uncertainty still prevails as regards the frequently occurring uvular sound of κ , which is pronounced like the Arabic Qoff, or almost like the Dutch *g*. According to Kleinschmidt's spelling the sound is designated by this special letter, which, by the way, is still used in all Greenlandic literature, whereas on the Geodaetic Institute maps of Greenland we find the letter Q(*q*), in conformity with the international phonetic spelling. I have used this latter form. In some quotations moreover, the Q-sound is spelt with an ordinary K(*k*), as, for example, in the common, internationally employed Eskimo words *kajak*, *nunatak* and *anorak* (properly *qajaq*, *nunataq* and *anorâq*). As a consequence, the quotations must often be written with Q(*q*) = K(κ) = K(*k*).

In the quotations I have employed the spelling of the original texts. In the list of place-names pp. 185—190 both old and new names are shown. Where the old place-names are given those now in use are shown in italics.

3) Some place-names include the expression *sermia* ("its glacier"). Glacier is actually called *sermeq*, and the suffix—a merely signifies that the glacier is associated with another name. I mention this merely because in literature on the West Greenland region the word is often used synonymously with European terms, e.g. *Narssap sermia*: the glacier at *Narssaq* or *Narssaq glacier*.

Literature:

- KLEINSCHMIDT, S.: *Grammatik der grönländischen Sprache*, Berlin 1851.
 "Greenland", 1929: *Etymological Glossary*, Vol. 3, pp. 450—57.
 SCHULTZ-LORENTZEN, C. W.: *Dictionary of the West Greenland Eskimo Language*, Medd. o. Gr., Vol. 69, 1927.
 SCHULTZ-LORENTZEN, C. W.: *A Grammar of the West Greenland Language*, Medd. o. Gr., Vol. 129, 1945.
 THALBITZER, W.: *Die grönländischen Ortsnamen in Gieseckes Reisejournal*, Medd. o. Gr., Vol. 35, 1910.
 THALBITZER, W.: *Eskimo*, in *Handbook of American Indian Languages*, Bureau of American Ethnology, Bulletin 40, Part 1, pp. 969—1069, 1911.

WRITTEN SOURCES AND CONCLUSIONS REGARDING THE INDIVIDUAL GLACIERS

Julianehaab District.

The glaciers in this district will be dealt with in two well-defined groups: 1) the region south of Ilimaussaq peninsula, and 2) the region from Sermilik to the Illorro area at the boundary between Julianehaab and Frederikshaab Districts.

I have made this separation on account of the lobes running from the inland ice and on the assumption that in the marginal region of the inland ice north and south of the Ilimaussaq peninsula there are two different forms of terrain to be considered¹⁾: 1) southwards the broad foreland with the deep fiords, the vigorous alpine relief and, in the inland ice, the many nunataqs, 2) northwards there are the narrow strip of land, the flat gneiss terrain and only few nunataqs emerging through the inland ice.

It is extremely probable that both forms of ground continue under the inland ice and that in some way or other they are of importance to its drainage.

For the sake of clarity the glaciers of Nordre Sermilik fjord (i.e. the ice tongues Eqalorutsit kangigdlit sermia and Eqalorutsit kitdlit sermia) are dealt with under Group 2, even though the terrain there must be characterized as alpine, or at any rate lies midway between the two forms.

Of ice tongues (outlet-glaciers) the following are productive:

Tasermiut fjord's northern glacier (Sermeq): only slightly.

Søndre Sermilik glacier: only slightly.

Qôroq glacier: only slightly.

Eqalorutsit kangigdlit sermia: profusely.

Eqalorutsit kitdlit sermia: profusely.

Small glaciers in Nordre Sermilik: only slightly.

Sermilik (Sermitsialik): profusely.

¹⁾ On the terrain forms in Julianehaab District, see also WEGMANN: Geological Investigations in Southern Greenland, Medd. o. Gr., Vol. 113, 2, 1938, pp. 124—130.

REGION 1:

The glaciers between Tasermiut fjord and the Ilimaussaq peninsula.

Locality 1:

Tasermiut fjord. The southernmost fiord considered in the present investigation; Tasermiut, cuts 65 km inland northeastwards from the town Nanortalik. At the head of the fjord are two lobes stretching down to the fiord from the inland ice or highland ice. The inner one, Sermeq (qingua), called the east glacier by the geologist K. J. V. STEENSTRUP, and the north glacier by the geologist A. JESSEN, drops very steeply and has almost the characteristics of an icefall. This is fed by the southern part of the inland ice proper, whereas the outer glacier; Sermitsiaq, which both K. J. V. Steenstrup and A. Jessen call the southern glacier in Tasermiut fjord, emerges from the plateau ice south of the line Kangerdlugssuatsiaq—Tasermiut and has a very slight slope. As early as in 1876 K. J. V. Steenstrup and the geologist A. KORNERUP measured the rate of movement of Sermeq glacier and recorded a maximum value at the middle of the glacier of 3.75 metres in 24 hours (Medd. o. Gr., Vol. 2, p. 24).

1. A: Sermitsiaq:

1778: In this year both glaciers in Tasermiut fjord were described by ANDREAS BRUUN, the storekeeper at Julianehaab, in the following manner (Norges Svalbard og Ishavsundersøkninger Vol. 58, p. 48): "Then proceeded onwards and for a short distance the landscape was beautiful; but thereafter nothing but high and terrible mountains for a distance of two (Danish) miles,¹⁾ which brought us to one mile from the head of the fiord, wherein on both sides there was nothing to be seen other than steep and peaked mountains and two large iceblinks (where the Greenlanders who go there in the autumn are said to shoot a number of harbour seals)".

1833: In this year both glaciers are described by Assistant JACOB ARØE, whose diary is reproduced in extract by the geologist C. PINGEL in Nordisk Tidsskrift for Oldkyndighed II, pp. 314—48 and III, pp. 214—21. The diary for Sept. 1833 is also quoted by H. OSTERMANN in Geografisk Tidsskrift Vol. 24, 1917, pp. 75—80. According to Ostermann, the text quoted by Pingel differed somewhat from the original, which was found by Ostermann in the National Archives at Godthaab and then published in its entirety for 25th September 1833 in Geografisk Tidsskrift.

¹⁾ 1 Danish mile = 7532.48 m. Present author's note.

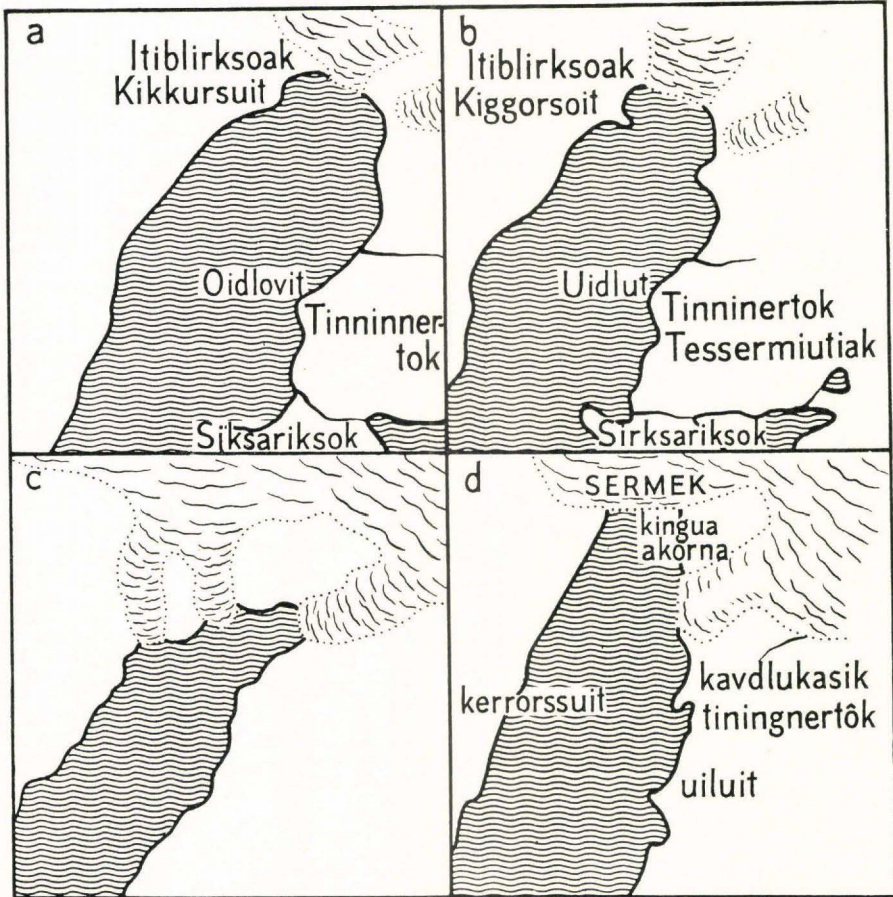


Fig. 2. Map of the head of Tasermiut Fjord.

- a) Detail from J. ARØE's map. Original in *Norges Svalbard og Ishavsundersøkelers Medd.*, Vol. 52, p. 136.
 b) Detail from *Grønlands Historiske Mindesmærker*, Vol. III, pl. XI.
 c) Detail from H. RINK: "Grønland", Vol. II.
 d) Detail from E. DORF. Original in "Atuagagdliutit" No. 12, Marse 1878.

As regards the description of the glaciers, however, both texts are the same, so that only the one given in *Geografisk Tidsskrift* (page 80) need be given here: "From a headland north of here, called Oidlovit¹⁾ (from a kind of small mussel there) I examined the direction of the head of the fjord."

"Just below here a bay runs in, into which falls a river with salmon-trout, and here is birchwood, much of which has been felled. This place is called Tinninnertok²⁾, i.e. the out-falling beach, because here a long

¹⁾ Uiluvik: oysters.

²⁾ Tiningertok.

sand reef runs out into the fiord. From here the iceblink is about $\frac{3}{4}$ (Danish) mile E.N.E., where in two places it runs into the fiord. The smaller glacier, Sermilitiak¹), proves to be a point running evenly into the water and, according to what the Greenlanders say, has grown considerably in size in the past few years. However, as far as is known it calves very little ice yet. West of the iceblink there is said to be a portage to Sermiliks-Fjord”.

1844: In “Grønlands Historiske Mindesmærker” there is no mention of “Sermetsiaq”. The map of Julianehaab District in the same work (Oldskriftsselskabet’s map) was drawn from Lieutenant W. A. GRAAH’s survey 1828—31, with subsequent corrections by J. ARØE, J. F. GRAM, J. F. JØRGENSEN, O. KIELSEN, J. P. LUND, and V. MÜLLER. This map shows Sermitsiaq, but without much accuracy.

1857: In H. RINK’ publication “Grønland”, Vol. 2, there is not much mention of Tasermiut. On examining the map of Julianehaab District drawn by Rink (here reproduced in fig. 2 c), we find that there are three ice tongues in the fiord! Why three of them suddenly appear on this map and not on others made before or after 1855 it is difficult to say. As will be seen later under Sermeq, there is a possibility of a lateral tributary from the one shown. Rink’s map is a revised edition of the Oldskriftsselskabet’s map of 1844, which in turn, as far as Tasermiut fjord is concerned, seems to be a copy of Jacob Arøe’s map of 1833. The revision was presumably made by Rink, but there are no notes of it in his map collection in the Royal Library.

1874: A well-drawn map of the head of Tasermiut fjord is contained in the Greenland periodical “Atuagagdliutit”, No. 12, Marse 18, 1878. It was made by E. DORF in 1874 and is reproduced here in fig. 2 d. The accompanying text is confined to the vegetation in Tasermiut fjord, however, and gives no indication of the extent of the ice; it is merely possible to establish the fact that Sermitsiaq reaches down to the fiord along its entire breadth.

1876: This year both glaciers in Tasermiut fjord were examined by the geologists K. J. V. Steenstrup and A. Kornerup. In the report of the expedition, Medd. o. Gr. Vol. 2, p. 23, the following description is given of Sermitsiaq: “The southern glacier rises slowly inland but the view is obstructed by the many mountain peaks jutting up through the ice, one behind the other”, and later (p. 24): “On the southern glacier Steenstrup and I on Sept. 5th. walked up along its east margin, where there lay a moraine of large, subangular stones of a diameter of 5—15 feet. Once across the moraine and on to the glacier itself, we

¹) Sermilitiaq: a place with a rather large glacier.



Fig. 3a.



Fig. 3b.

Fig. 3. Sermitsiaq in Tasermiut.

- a) A. KÖRNERUP'S drawing. From *Geografisk Tidsskrift* Vol. 4, p. 4.
b) P. ROUSSELL'S photograph, from *Medd. o. Gr.* Vol. 89, 1, p. 59.

proceeded about one and a half "fjerdingsvej"¹⁾ over it and found the going rather smooth, slightly undulating but without large crevasses. Farther out in the middle, however, the ice was considerably fissured and jagged, as it also was farther up where it joined another glacier, a fjerdingsvej from the point we had reached. This point was 1160 feet above sea level. Several times we observed that the ice on which we were walking was in constant but slow downward movement, for we heard a dull creaking and crashing within the ice mass, and now and then felt a sudden jerk in it. The surface of the glacier had a more picturesque appearance than the others we had seen; everywhere there were pale green and light blue lakes, in which the strangely shaped ice pinnacles were mirrored; we encountered many small brooks rippling away over the ice, carrying clay, gravel and small stones, and at two places we saw the larger streams end in splendid waterfalls falling down into azure-blue crevasses or gloomy, bottomless wells".

After recording the measurements of the ice movement the report continues with a description of both Sermitsiaq and Sermeq: "At their mouths both glaciers were furnished with magnificent blue ports, under which tremendous masses of water flowed into the fiord; on the sides too there were rushing streams carrying clay, mud, and gravel along".

The picture of the south glacier, drawn by A. Kornerup and published in *Geografisk Tidsskrift* Vol. 4, Plate II, was probably from the same expedition. It is reproduced here as fig. 3 a and is referred to again under the year 1926.

1881: After having been in Tasermiut fjord in that year, Commodore G. HOLM in *Medd. o. Gr.*, Vol. 6, p. 173 reports on Sermitsiaq: "In the inner part of Tasermiut (mentioned pp. 132—136) two large glaciers debouch. The one to the south comes down with a slight gradient through a valley, in whose background one can see a wild alpine landscape with sharp, peaked mountains. The glacier as usual is much fissured except at its outermost part, which is undulating and covered with gravel and small stones. Outside the margin there are a considerable number of mounds and hillocks of gravel and stone which had formerly covered the now melted ice. This glacier reached out to the fiord at only one place, where it thus could still calve. On the sides are fairly extensive moraines. According to the Greenlanders, the place now occupied by the glacier was once a cemetery from the time of the Norsemen".

1889: In that year the botanist N. HARTZ refers to Sermitsiaq in the following words: (*Medd. o. Gr.*, Vol. 15, p. 24): "On September

¹⁾ Fjerdingsvej = $\frac{1}{4}$ Danish mile = 1883.121 m. Pres. author's note.



Fig. 4 a.



Fig. 4 b.

Fig. 4. Sermeq in Tasermiut.

- a) Photo. A. JESSEN. Original in *Medd. o. Gr.* Vol. 16, pl. XVI, fig. 1.
 b) Photo. P. NØRLUND. Original in National Museum archives.

8th I went in to Kingua¹⁾; there in a tent I stood at the foot of a large moraine, close by one of the big glaciers which reached right down to the water." In other words, in that year too the glacier reached down to the fjord at any rate at one place.

¹⁾ Kingua: head (of a fjord, a cave). Pres. author's note.

1894: A. Jessen the geologist visited the glacier in that year and wrote a detailed description of both this and Sermeq. It reads (Medd. o. Gr., Vol. 16, pp. 143—144): “The south glacier is fed by several branches coming down from NE., E. and SE. among numbers of tall nunataks.¹⁾ The glacier is much fissured and jagged at the middle; in particular the big transverse crevasses are very prominent where the glacier at two places drops, as it were, in cascades over steep slopes in the rock bed. From each nunatak, where two glacier arms converge, a medial moraine forms and down towards the glacier terminus collects into large surface moraines, one almost along the centre line of the glacier and the other covering the northern part of it, whereby it resembles more a gravelly plain with large heaps of stones than a glacier. Along both sides of the glacier and separated from them are lateral moraines lying in high, sharp ridges. On the surface of the glacier were several gravel-covered ice-cones, 1—2 metres high, reminiscent of anthills, originating from the fact that quantities of gravel and clay accumulated at these spots and protected the underlying ice from melting and evaporating.²⁾ Only a small part of the glacier extends out into the shallow fiord in front, the greater part of it lying on land with considerable heaps of moraine before it (Pl. XVI, fig. 1 in the foreground). Some of these are arranged in ridges, other are lying like irregular hummocks jumbled together. They consist mainly of stone and gravel, but also of finer sand and clay as a filling between the stones. The latter are generally much rounded, though there are also stones with fresh, sharp edges (from the surface moraine). Where the glacier front lies in the water it calves with small falls. It was only in the most northerly section of the vertical ice wall, under the large, northern surface moraine, that the ice was seen to be stratified with streaks of sand and dust. There were several glacier ports where slightly milky streams emerged.

“A comparison with the descriptions of Kornerup, Steenstrup and Holm³⁾ seems to show that these two glaciers at the head of Tasermiut fjord have not changed in the past 15—20 years.”

Comparing A. Jessen's photograph and description of 1894, it is curious that Jessen writes that on the basis of earlier descriptions he could see no alteration in the position of the glacier in the period 1876—1894, whereas the comparison of Kornerup's and Jessen's illustrations seems to show a retreat. True, Kornerup's drawing and Jessen's photo-

¹⁾ cf. KORNERUP's illustration: “Mountain view in Tasermiut” in *Geografisk Tidsskrift* vol. II, 1878, supplement.

²⁾ Cf. KORNERUP's illustration of Frederikshaab's iceblink. *Medd. o. Gr.* Vol. I, p. 127.

³⁾ *Medd. o. Gr.* II, pp. 23—24. Supplement B to *Rigsdagstidende* 1877—78, p. 12. *Medd. o. Gr.* VI, p. 173.

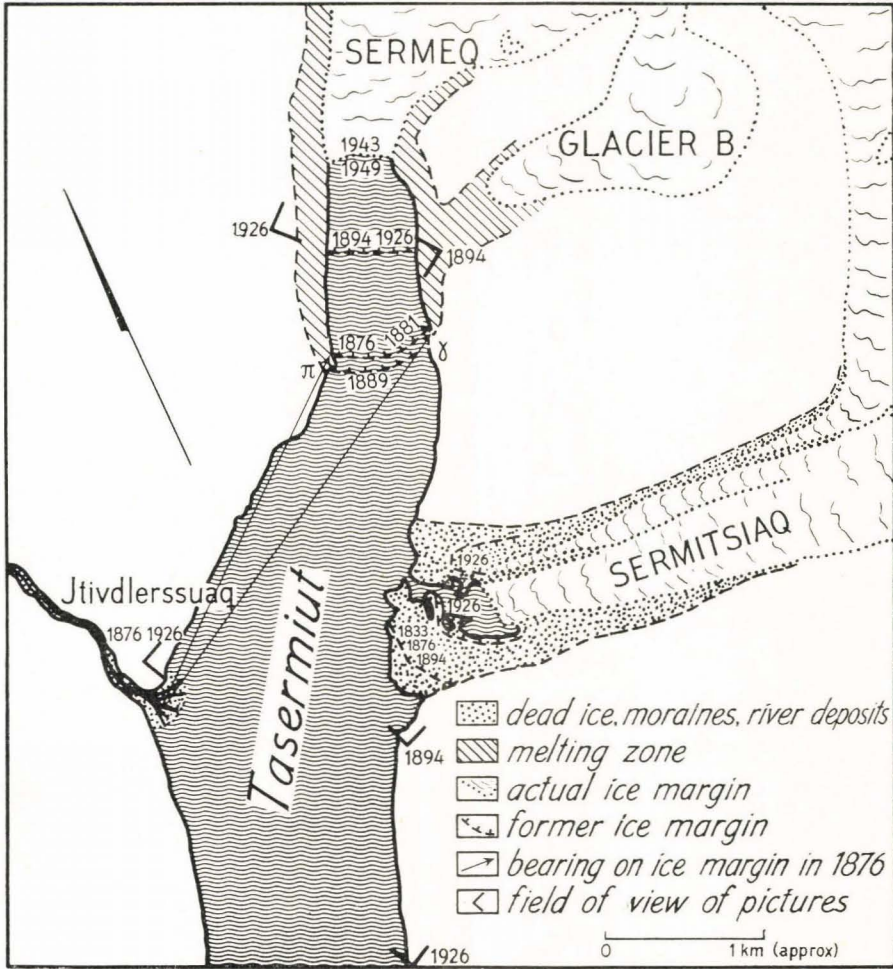


Fig. 5. Head of Tasermiut fiord. Sketch-map, made from aerial photo. Marked with melting zones, presumably the former positions of the ice margin, K. J. V. STEENSTRUP's bearings 1876 and his angle of view.

graph are difficult to compare because the glacier is viewed from two different places. But as Jessen was familiar with Kornerup's drawing, it is presumable that Sermitsiaq was in fact stationary in the 1876—1894 period.

A. JESSEN's photograph of the glacier was taken from the locality Qagdhlukasik, just SW of the glacier. It will be useful for determining changes in the position of the glacier front when compared with new photographs from the same spot.

1926: Dating from this year is a photograph of Sermitsiaq in Dr. AGE ROUSSELL's book "Farms and Churches in the Mediaeval

Norse Settlements of Greenland" (Medd. o. Gr. Vol. 89, 1, p. 59). The picture was taken from the very spot where Kornerup's drawing was made in 1876. The following details emerge from a comparison between Kornerup's drawing, ROUSSELL'S photograph and an aerial photograph taken in 1943:

- 1) Kornerup's drawing is very true to nature, except that the heights are somewhat exaggerated.
- 2) On it the glacier is more swollen than in Roussell's photograph. The lateral moraines, which are distinctly visible in the 1926 picture, are completely lacking in Kornerup's drawing; but according to the report by Kornerup and Steenstrup there must have been a lateral moraine along the east side of the glacier, though its extent cannot be determined from the description.
- 3) Kornerup's drawing shows a calving front of wide extent. On Roussell's photograph there is instead an outwash plain lying in front of almost the whole width of the glacier.
- 4) The 1926 photograph shows the glacier to be bearing a surface moraine of small extent on its lower part, whereas the 1943-map, fig. 5, shows that a large part of this lower section is now covered with moraine.

1943: Aerial pictures possibly of this year (Rute A 6 B, vertical exposure) show that Sermitsiaq is by now well covered with moraine on its outer section, as stated above, and that it no longer calves into the fiord. The glacier now has an extensive melting zone, which, compared with A. Jessen's picture, also suggests shrinkage in the course of the present century. This was confirmed on inquiring from ISAK LUND, the sheepfarmer at Agdluitsup pâ; asked whether any changes had been observed in recent time at the glacier in Tasermit fjord, he answered that both glaciers in the fiord had retreated. He could give no date for the beginning of the retreat.

On the sketch-map, made after aerial photo and here reproduced in fig. 5 I have marked the melting zones, photographic angles and the limits of the white glacier ice in 1943. A comparison with A. Jessen's photograph shows that the white glacier surface, now appearing about 1 km. inland, on Jessen's picture reaches out to the fjord, at any rate in part. In fact Jessen writes that the northern part of the glacier "is more like a gravel plain with large stone heaps than a glacier", and that only a short length of it reaches out to the fjord; but in any case we must assume that there was a shrinkage and probably a retreat of the glacier-snout, amounting to about 500 metres, between 1894 and 1943.

Conclusion:

1778: From Andreas Bruun's description it is impossible to determine the position of the glacier front in that year.

?—1833: At the earliest in the years prior to 1833, it was advancing but as yet calving only little ice. The description of the glacier as a headland running out into the fjord seems to agree well with the later descriptions in Medd. o. Gr., so it is perhaps justifiable to conclude that in the period 1833—1876 the glacier was stationary.

1833—1876: There is no definite information about the position of the glacier in this period. DORF's 1874 map indicates merely the approximate extent of it. On ARØE's map Sermitsiaq is not shown as a headland jutting into Tasermiut fjord, though he mentions "the naze" in the text.

1876—1894: For this period (from Steenstrup's to Jessen's visits) we may either take it from Jessen's statement that the glacier was stationary, or from the illustrations in Kornerup and Jessen: that Sermitsiaq was melting. To this information may be added Holm's report that the glacier had buried a Norse ruin. That report is not established chronologically and there is a possibility that this "burial" was a legend that had been handed down through generations, and perhaps transferred from another locality.

1894—1926: In this period a retreat is beyond question; this is shown by a comparison between Kornerup's and Roussell's pictures.

1926—1943: The aerial photograph shows that the melting continued in this period.

Summary:

- ?—1833: Advance.
 1833—1876: Stationary?
 1876—1894: Stationary or slightly retreating.
 1894—1926: Retreating.
 1926—1943: Retreating.

1. B: Sermeq:

On the whole the information concerning this glacier came from the same travellers who visited Sermitsiaq, and therefore, in order to avoid too many repetitions I shall indicate only those names and illustrations that directly refer to Sermeq; for descriptions and names concerning both glaciers the reader is referred to the corresponding dates under Sermitsiaq.

1778: A. Bruun: The same description as under Sermitsiaq. It contains no indication of the terminal front of the glacier or of any movement of it.

1833: J. Arøe's report: Same description as under Sermitsiaq. It contains no particular information about Sermeq.

1844: Oldskriftsselskabet's map: Sermeq is shown as reaching out to the fiord. No more exact limitations to its extent can be discerned.

1857: H. Rink's map. See also under Sermitsiaq. The three tongues (glaciers) on the map may perhaps be explained by the fact that Glacier B on the sketch map fig. 5 had reached the fiord water. The melting zones around Glacier B make this not improbable, but, as stated under Sermitsiaq, it has been impossible to establish when this revision of the map of Tasermiut fjord was made, and if it was made according to information from another person or on the spot. As previously stated, it is peculiar that Glacier B has not been shown on other maps of the period. Moreover, the situation of Glacier B out to the fiord presupposes that the main arm of Sermeq (see fig. 5) at about the year 1855 had its front at the same spot as in 1943, i. e. about 1 km. behind the 1894 position.

1874: E. Dorf's map shows merely that the glacier reaches the fiord along its whole front.

1876: K. J. V. Steenstrup and A. Kornerup: The expedition report *Medd. o. Gr.*, Vol. 2, p. 23, says about Sermeq in contrast to Sermitsiaq: "The northern glacier, on the other hand, is very steep and it is especially here that one sees the considerable height of the ice. As one comes out from the fiord the inner, distant ice can be seen not only level with the mountains at the side but even high above the nunataks, about 3000 feet high, which project up through the foremost, downward-sloping surface of the ice."

This passage provides no evidence for a determination of the position of the glacier front, but in Steenstrup's diary for that year, now in the custody of the Mineralogical Museum, Copenhagen, there is a sketch-map with bearings to the glacier front from a base situated around inner Itivdlerssuaq. Thus it should be possible to determine accurately the position of the glacier front in 1876 by making a new survey on the spot. In 1876 the front seems to have been very close to the extreme limits of the melting zones; from his base around inner Itivdlerssuaq Steenstrup gives an angle of $9^{\circ}45'$ between the point γ at the glacier front and the headland π (see fig. 5) on the northwest side of the fiord. Even if the position of the base is not wholly certain in the delta at inner Itivdlerssuaq, this value seems clearly to show the advanced position of the front at that time.

1881: G. Holm writes of Sermeq (*Medd. o. Gr.*, Vol. 6, p. 173) that "describing a large angle it comes down between high mountains,

and several sharp nunataks project up over its surface. It has a vertical fracture surface standing out in the fiord and rises to a height of at least 5000', a height which it reaches about $1\frac{1}{4}$ (Danish) miles behind the front. Steenstrup's measurements of its daily movement at the middle gave about 12' in 1876".

This says nothing about the limit of the front. The height of 5000' about $1\frac{1}{4}$ miles behind the front may establish its position when a new map of Tasermiut fjord is available.

GUSTAV HOLM's map of 1881 shows that at this time Glacier B had merged with the main glacier Sermeq 1—2 km. behind the terminal front, so the natural assumption is that the front was approximately in the same place in 1881 as in 1876.

1889: From a journey in South Greenland that year N. HARTZ (Medd. o. Gr., Vol. 15, p. 25) reports: "At the northern glacier, which closes the fiord kingua¹), the heather moor reached right up to the glacier; there was no barren zone between the glacier and the vegetation like that referred to by Dr. N. O. HOLST at the Frederikshaab iceblink and Kipisako". Accordingly the outermost position occupied by the glacier in recent time is that indicated by the melting zone.

1894: The geologist A. Jessen gives a very comprehensive description of this glacier; it is quoted below in its entirety (Medd. o. Gr., Vol. 16, p. 140—142): "The boundary between the white, slightly undulating inland ice and the northern glacier (Pl. XVI, fig. 1) is rather sharp, for the ice at once breaks and becomes crevassed as it begins to drop down through the valley. At a distance below its boundary against the inland ice the glacier is divided by two large nunataks and one quite small one, scarcely visible, between these two. Before reaching the nunataks there is no moraine on the glacier surface, whereas below them are three dark stripes, medial moraines, of which two persisted distinctly down to the end of the glacier. Moreover, below the nunataks the ice changes colour, turning greyish on account of drifting rock dust. There are large lateral moraines, especially on the west side, in part covering the mobile glacier and in part lying motionless along by the mountain. From the east side a small glacier comes down from two converging glacier arms from the NE. It is very steep, much fissured and covered with wind-blown dust. It has no distinct median moraine but two lateral moraines which, especially at the lower end, are very large. Its end lies at the side of and slightly higher than the main glacier, which it does not overrun but is merely connected with it by a mass of almost dead ice covered with sand, gravel and stones. At its lowest

¹) Kingua = qingua: head (of a fiord, a cave). Author's note.

part the main glacier has a relatively slight slope, whereas farther back it is very steep, which is also to be seen from the fact that, according to Holm, 5 "kvartmil"¹⁾ from the end it reaches a height of 5000' (about 1600 m.). Two small streams were observed on the glacier surface, but only out at the side alongside the lateral moraines. The glacier front (pl. XVI, fig. 2) stands in the form of a vertical wall, 950 m long, across the fiord. Like the lower part of the glacier it is very uneven and broken. The height averaged 26 m, the highest peaks were 34 m above sea level. There being hardly any calf ice in front of the glacier, Lieut. PETERSEN sounded the depth of the fiord close up to it. At equal intervals from east to west the depths were 1, 9, 18, 34, 37, 37, 33, 24, 12, and 2 fathoms. In other words, the glacier end rests on the bottom of the fiord and calves by means of falls. The pieces formed by the rather frequent calvings were too small to be called icebergs, and the fiord was practically free of them. Nevertheless, the movement of the glacier is greater than one would think from this. For points lying 500' (157 m), 650' (204 m) and 1300' (408 m) from the front. Steenstrup's measurements showed the movement in 24 hours to be 1.5' (0.48 m), 11.8' (3.43 m) and 13.4' (3.75 m)²⁾. In the east side of the glacier front was a beautiful port, formed by a stream which probably came from the small, steep, lateral glacier. The water in the fiord was muddy and turbulent, not at the surface alone but right through, which suggests that a large stream emerges from under the glacier at the bottom of the fiord, whence the lighter, fresh water ascends and disperses itself and its transported mud evenly through the whole.

"Observed from a boat along the glacier front, the ice appears as a white, homogeneous and amorphous mass, in which not a suggestion of ice crystals is to be seen. But if one approaches it closely, or ascends to the top of the glacier, it is seen to be composed entirely of such crystals, which are of a size between a hazel nut and a walnut. In the broken surface of the glacier with its many cracks they were easy to examine, especially as the melting under the strong heat of the sun had made them more distinct and less compact. Their surfaces were not plane but irregular, but in such a manner that hollows and projections fitted one within the other. In the uppermost, considerably melted part of the ice the granules were not close together, but between the facets there was a small gap full of meltwater and carrying fine mud in small quantities. That the granules did not form a rigid mass was also demonstrated by the fact that some sharp and narrow ice ridges were somewhat elastic and could be bent slightly—, and the ice which was hewn off proved to be tough and strongly cohesive, not hard and

¹⁾ Kvartmil = nautical mile = 1852 m.

²⁾ l. c., p. 12.

crisp. There was not the slightest sign of blaublätter-structure or stratification from the original firn. It was only in the western part of the glacier front, below the lateral moraines, that we saw stratification and dust strips, of which the innermost were almost vertical, the others dipping more and more outwards to the side of the glacier; the stratification, however, was probably formed at a late juncture on the last stages of the glacier's journey."

Here, as in the case of Sermitsiaq (see under the latter), Jessen considers there was no change in the period 1876—94. His text is accompanied by two photographs (Medd. o. Gr., Vol. 16, pl. XVI, figs. 1 and 2) of the glacier. They distinctly show that there is a melting zone around the glacier and that Glacier B, as Jessen himself reports, is now separated from the main glacier. In addition, five years before Jessen's visit, Hartz found that the vegetation extended right up to the glacier. What Kornrup and Steenstrup as well as G. Holm write cannot provide Jessen with much support in his view as to the stationary condition of the glacier throughout the period 1876—94. Moreover, Jessen was not acquainted with Hartz's description of his journey, because Medd. o. Gr., Vol. 15, in which it appeared was not published until 1898, four years after Jessen's expedition and two years after the publication of Medd. o. Gr., Vol. 16, in which Jessen's own description appears.

It would thus seem most probable that there was a retreat and shrinkage of the glacier between 1889 and 1894.

1926: Two photographs of Sermeq, taken in 1926 by Dr. P. NØRLUND, have been found in the archives of the National Museum. One of them is reproduced in P. NØRLUND: "Silarssup isuane q'avdlunatsiait nunaqarfikue", (1937), and in the Danish edition of the same book, "De gamle Nordboygder ved Verdens Ende", 1934. That picture, taken from a point at Tiningnertôq, shows that in 1926 Sermeq still stretched beyond Glacier B, and it would seem on comparing the picture with one of A. Jessen's from 1894, as if the gap between Glacier B and Sermeq (the moraine) had become larger; this must lead to the assumption that there had been a retreat by Glacier B, a lowering of Sermeq's surface, or both. In 1926 the front of Sermeq seems to occupy approximately the same position as in 1894.

The other picture is of the glacier as seen from a point west of its front and shows only the upper part of the border of Sermeq and Glacier B against surrounding mountains. Up to the present there is nothing on which to base a comparison with this picture.

1943: On an aerial photograph from about this date (see fig. 5), Sermeq is to be seen with its front still calving, in contrast to Sermitsiaq. The glacier is surrounded by a marked melting zone and the front can

be seen to lie behind Glacier B.: It is not quite clear to the author whether the commonly-used term "trim line" is to be used to describe the boundary between the old vegetation-clad area and the glacier-cleared land nearest the glacier or the whole zone between this boundary and the ice. In the following text "trim line" is interpreted as the outermost frontier for the glacier-cleared land and the "melting zone" as the zone between the trim line and the present glacier's surface (for definition of trim line, see Heusser, Calvin J. 1954).

1949: A picture taken by fishery biologist JØRGEN NIELSEN, B.A. in that year, looking towards the glacier Sermeq from the fiord, on comparison with the 1894 and 1926 photographs by Jessen and Nørlund respectively shows that this glacier retreated considerably in the period 1926—49. The front is now behind Glacier B's front.

From the present material no change in the position of the glacier can be ascertained between 1943 and 1949.

Conclusion:

1778: No determination of the position of the Sermeq glacier front is possible from ANDREAS BRUUN's description.

1833—1876: The position of the glacier front cannot be determined from the descriptions and maps.

1876—1881: No direct comparison is possible with the aid of the texts in Steenstrup's and Kornerup's description of 1876 and G. Holm's of 1881. Nevertheless, Steenstrup's measurements and G. Holm's map make it probable that the glacier front did not change much between the two visits and that it had almost its maximum extent (which cannot be indicated exactly).

1881—1889: The glacier must have had its maximum extent in this period. In 1889 it is stated that the glacier had no melting zone, and for 1881 too it is reasonable assumption that it was at or near its extreme position, so that for this period the verdict must be, that the glacier was stationary, or possibly advanced lightly to the maximum position.

1889—1894: Jessen's photographs show a melting zone around the glacier, therefore in this period we must assume that there was a retreat. The presumed position of the glacier front in 1894 is plotted on fig. 5 according to Jessen's photographic evidence.

1894—1926: A comparison between the photographs by A. Jessen and P. Nørlund seems to indicate that the glacier shrank in volume in this period, Glacier B being separated from Sermeq by a very broad



Fig. 6. General map of Sermersôq island. Drawn from aerial photos. Marked with most prominent glaciers and with picture angles. From Geodetic Institute's working sheet 1:100,000.

stretch of moraine. In 1926 the glacier front seems to have been approximately at the same place as in 1894.

1926—1943: Between these years the glacier retreated and in 1943 was behind Glacier B's front.

1943—1949: No change can be observed between aerial photograph A. 6. B. and JØRGEN NIELSEN's photograph.

Summary:

- 1876—1881: Stationary.
- 1881—1889: Stationary, or slight advance.
- 1889—1894: Retreating.
- 1894—1926: Stationary, melting.
- 1926—1943: Retreating.
- 1943—1949: Stationary?



Fig. 7a. Section of A. Jessen's panorama. Photo A. JESSEN 4th Aug., 1894. Showing the Napassorsuaq glacier with surrounding mountains. Original photo in Arktisk Institut. Panorama continued on opposite page-

Locality 2:

Sermersôq. The largest of the islands between the outpost Sydprøven (Agdluitsup pâ) and the town of Nanortalik. In the northeast part of this island (see survey map fig. 6) are a number of small glaciers, the island having been named after them; Sermersôq meaning "the glacier-clad". None of these glaciers have been described in any detail and only few illustrations can serve for a close study of their oscillations.

1806: The geologist K. L. GIESECKE, who was on the island that year (K. L. Giesecke's Mineralogisches Reisejournal über Grønland" 1806—13, Medd. o. Gr., Vol. 35, pp. 24—25) mentions simply the everlasting snow, "der hier in den Klüften und Hölungen liegen bleibt".

1828—31: On his voyage to the east coast of Greenland Lieut. W. A. GRAAH R.N. also refers to the island in the words: "Sighted the tall island of Sermesok, with its many black sharp peaks and iceclad valleys (1932-edition, p. 38) and later (p. 49): "Sermesok's mountains, especially eastwards, are very high and mostly covered with eternal ice, over which a number of naked sharp peaks jut forth, appearing to the imagination as old castles with many spires and towers".

1857: R. RINK has nothing particularly to say of the island in "Grønland", but an illustration ("Grønland", Vol. 2, pp. 356/357) shows



Fig. 7b. Continuation of Jessen's panorama on opposite page.

a single glacier at "Kukasik" on the east side of the island. The picture is hardly very accurate.

1876: After being on Sermersôq in 1876, K. J. V. STEENSTRUP writes (*Medd. o. Gr.*, Vol. 2, p. 21) that the island "at present is completely free of glaciers". It is almost inconceivable that the glaciers could have disappeared in the course of about 40 years, so the assumption is that Steenstrup merely failed to observe them. This assumption is confirmed by the geologist A. JESSEN, who writes about a visit in 1894 (*Medd. o. Gr.*, Vol. 16, pp. 159—160): "Where there is the possibility of a glacier in the higher, south side of the land, one is certain to find one. On the stretch travelled by the expedition the island of Sermersok and the inner part of Tasermiut fiord distinguish themselves in this respect. On LAUBE's geological map the interior of Sermersok is shown as being covered with "inland ice". This is by no means the case, even if the island is uncommonly desolate, wild and barren, but there is certainly no lack of small glaciers. Everywhere, in every cleft and on every hill side the snow can lie, there is also a firn with its glacier. That they are glaciers, which move quite considerably, can be seen from the many crevasses and fissures, their easily-visible blue colour, from the often large terminal moraines lying like ramparts in front of their lower end or lower down the slope, and from the milky streams coming down in the valleys. The largest is probably a glacier which, from an area south of the highest peak in Sermersok's Kitdlavat, shoots past it northwards out towards the coast and finally calves in a lake,

480 m above sea level, which is still frozen over in August. The total length of firn and glacier may be estimated at 5—6 nautical miles. In the vertical end of the glacier were a number of distinct layers of dark, dust-laden ice, but no moraines were seen on the glacier surface; they are probably covered by new snow. Especially towards the end the glacier was somewhat fissured, chiefly by longitudinal crevasses."

In conjunction with this description Jessen took a fine panorama of the glacier in question, partly, shown as fig. 7 in the present work. Later photographic records taken at the same spot should make it easy to determine any change in the volume of the glacier since 1894.

1936: The geologist C. E. WEGMANN in that year drew a sketch of Sermersôq, seen from the inner part of Ûnartoq fjord (Medd. o. Gr., Vol. 113,2, p. 126), but neither the illustration nor the accompanying text provides a clue to the position of the glacier fronts.

1943: A comparison between A. Jessen's 1894 photographs and aerial pictures taken in 1943 reveals nothing as regards changes in the position of the glacier front.

Conclusion:

From the information available today it is impossible to say anything regarding changes of the glaciers on Sermersoq. The Jessen pictures of 1894 and the aerial photographs of 1943 provide the best foundation for a future examination of the spot.

Locality 3:

Sermeq in Søndre Sermilik. Søndre Sermilik fjord extends 46 km northeast from Sermersôq in a tongue from the inland ice, here called Sermeq in accordance with the local custom. The glacier is described by Commodore G. HOLM in 1881 (Medd. o. Gr., Vol. 6, p. 174) as being 1450 m wide and having a vertical front about 50 m high. Between the front and the nunataks about 6 km behind the incline was 3.5° ; from the foot of the nunataks inwards towards the inland ice it was much greater.

1838: For that year there is a travel record from the fiord. The journey was made by trade assistant O. Kielsen, and his report is given in "Annaler for Nordisk Oldkyndighed" 1842—43, p. 339, by the geologist C. PINGEL in the following manner: "From Iglorsoit Mr. Kielsen continued his journey up the fiord along its west shore. On this side the mountains are mostly so precipitous that landing is possible only at certain places; on the other side of the fiord the land is more accessible. At the head of the fiord Mr. Kielsen came to the permanent

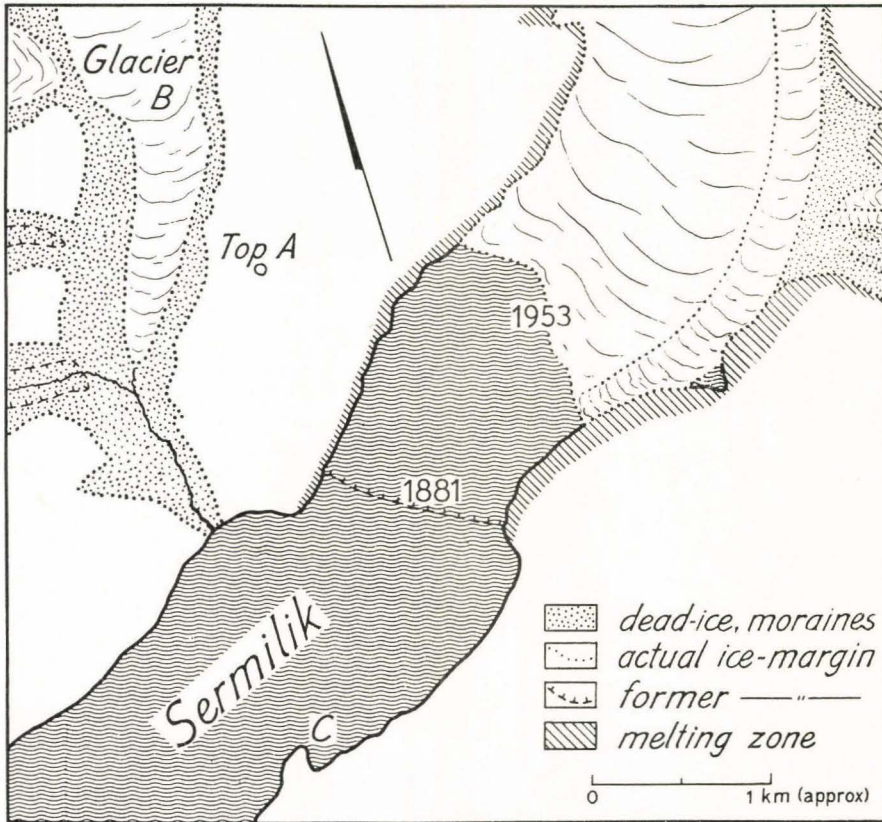


Fig. 8. Søndre Sermilik Glacier. Melting zones and supposed frontal line 1881 added. After the Geodetic Institute's aerial photos 21st Aug., 1953.

iceblink, which here is washed by the sea. On the return journey he followed the east shore and there, a good half (Danish) mile from the iceblink, found an extensive grassy plain cut through by two good-sized rivers. As there is a portage from there to Tessermtut Fiord, so densely populated in antiquity, one had so much the more reason for expecting to find Norse ruins here".

1845: The fiord is referred to in "Grønlands Historiske Mindesmærker", Vol. 3, p. 805. Here again the source was O. Kielsen, therefore the text reveals nothing new.

The map in the same work merely indicates the glacier at the head of the fiord, so the only evidence on which to determine the position of the front is the vague statement that according to Kielsen the front lies "a good half (Danish) mile", i.e. about 4 km from the pass to Tasermtut fiord.

1856: H. RINK's map of 1856 also indicates the glacier, but is no more informative than the 1845 map.

1881: In that year the glacier was examined by G. Holm, who, after his description referred to above, adds that "an old Greenlander told that when a child he had plucked crowberries on the middle one of the present nunataks, which then stood outside the margin of the ice". This location cannot be true: it would mean that about 1820—30 the front of the glacier lay 10 km behind the present one, and neither O. Kielsen's report nor the maps of that time, uncertain as they may be, indicate that this was the case. As will be seen below, Kielsen in fact places the glacier too far forward. Nevertheless, the statement suggest that about 1881 the people had an impression of an advance by the glacier.

1953: G. Holm states nothing definite about the position of the glacier, but as regards the inner part of Sermilik fjord, his map of 1880—81 agrees so well with the outlines of the coast on the new aerial photographs of 1953 that the conclusion which must be drawn is that the glacier front has altered its position since 1881. Fig. 8, reproducing a sketch-map from the aerial picture, shows that the glacier must have retreated since 1881,¹⁾ because the front, after being to the south of Peak ("Top") A, has now gone back so far that the peak is west of the front. It will also be noticed that the distances from the front to the small glacier B and to the headland C are now greater than on Holm's map. The melting zone on fig. 8 also indicates a much more advanced earlier position, but it also seems as if the melting zone extends beyond the presumed 1881-position of the glacier front.

Conclusion:

1838—81: The 1838 indication of the distance (from Itivdlerssuaq) to the glacier front is very uncertain. O. Kielsen must have underestimated the distance, for, measured on aerial photographs, it cannot be less than about 14 km. The melting zone extends only 1½ to 2 km out before the present glacier front and doubtless also gives the possible extreme position of the glacier for 1838. In other words, the position of the front cannot be determined from Kielsen's information, so that any change between 1838 and 1881 cannot be defined.

The 1845 and 1856 maps show Sermilik fjord but, as already stated, are useless for determining the position of the glacier front.

1881—1953: From G. Holm's map and the aerial photograph 201 J No. 39 it is possible to record a retreat in this period, measuring

¹⁾ HOLM's map in Medd. o. Gr. Vol. 6.

about 2 km. Holm's report of an advance by the glacier prior to 1881 is perhaps an indication that it was still advancing in 1881, whereafter at some unknown time between 1881 and 1953 it retreated.

Summary:

? —1881: Advancing?
1881—1953: Retreating.

Locality 4:

Kujatdleq valley and Jespersens Dal. These two valleys run side by side from the inland ice to Qagssiarssuk bay (= Sdr. Igaliko) in Igaliko Fjord. Lobes from the inland ice debouch at the heads of both valleys. These glaciers are called after the valleys in which they make their appearance, the Kujatdleq valley glacier and the Jespersen glacier.

The valleys were briefly described by the Rev. E. JESPERSEN (Medd. o. Gr., Vol. 50) and Dr. H. ØDUM (Medd. o. Gr., Vol. 74), the Kujatdleq valley there called "Østfjordsdal". Jespersen visited the locality in 1911 and Ødum in 1926.

One of the glaciers (only an inspection on the spot can decide whether it was the Kujatdleq valley or the Jespersen) is mentioned by H. RINK, who in "Grønland" Vol. 2, p. 93 writes of Qagssiarssuk: "In its innermost arm lies Kaksiarsuk or the old Garde¹), near which place a large stream pours into the fiord, coming from the interior of the country and having strikingly clayey, turbid water which changes the colour of the fiord a good distance out in front of the mouth. But on ascending the nearest hills around Garde one discovers that the great continental ice is quite close, that not far from there its outer margin sinks down into a valley and there probably supplies the aforesaid large stream with water, for its dirty colour conforms exactly to the kind of streams that come from glaciers." Thus the glacier front was not observed. Any more recent change of volume may possibly have the effect that the glacier is no longer visible from the hills, but this can only be decided by personal inspection.

1860: In that year the Kujatdleq valley glacier was probably visited by Dr. RAE and Col. SCHAFFNER of the Fox Expedition. The visit is referred to in TH. ZEILAU's book: "Fox Expedition 1860", pp. 155—156, but nothing is said of the limits of the glacier.

4. A: Kujatdleq valley glacier:

1911: Jespersen's report provides no information regarding the position of the glacier front. The map accompanying it seems to suggest

¹) Norse name for the locality. Present author's note.

that immediately before it is a moraine area about 500 "alen"¹⁾ wide. But in the first place Jespersen himself says the sketch map is rather inferior, and in the second he did not see the glacier himself, therefore that measurement is useless for determining the position of the glacier front.

1926: A photograph accompanying H. ØDUM's description of the valley (fig. 6 in Medd. o. Gr., Vol. 74) shows the glacier seen from the mountain peak Qôrorssûp ilulequtâ. On the photograph the glacier front in Kujatdleq valley lies behind the top of a rock, but both the glacier behind and the plain ahead are seen distinctly. The description gives no clue to the position of the front, and the accompanying map, though better than Jespersen's, is also too sketchy for our purpose.

1953: On comparing the 1926 photograph and aerial photograph 201 J, No. 1245, 21/8-53 the glacier cannot be seen to have changed much. On the 1953 photograph there is a lighter zone on the rock sides around the glacier which might suggest an alteration in the position of the glacier front constituting a retreat of about 200 metres.

Conclusion:

1911—1926: Nothing can be deduced about this period from the maps or descriptions by E. JESPERSEN and H. ØDUM.

1926—1953: For this the best basis of comparison is H. ØDUM's photograph and the 1953 aerial photograph. As already stated, no change in the glacier front can be determined for the period because the front is not shown on Ødum's photograph, fig. 6 in Medd. o. Gr., Vol. 74, and the front is only very faintly visible on the photograph fig. 3 l. c. Nevertheless it would seem as if the glacier had but little, if any, melting zone in 1926, for nothing of the kind can be seen on Ødum's photographs. As the aerial photograph (see fig. 9) shows a pronounced melting zone, it is therefore reasonable to assume a shrinkage and probably a retreat between 1926 and 1953.

Summary:

1911—1926: No information.

1926—1953: Retreat.

4. B: Jespersen glacier:

1911: E. JESPERSEN says nothing about the position of the glacier front, although the route to Ruin Group 64 b lay across the ice. It is

¹⁾ 1 Alen = 2 feet. Pres. author's note.



Fig. 9. Jespersen's Dal and Østfjordsdal (Kujatdleq valley): Showing the glaciers and the moraine systems. Added details: melting zones, supposed position of ruin group 64 b, and angles of view. Copyright Geodetic Institute.

indeed curious that as the route is otherwise described in some detail, not a word is said of any passage over the moraine area before the glacier was reached. It is probable that Jespersen's map of this valley was drawn with more accuracy than that of Kujatdleq valley, for Jespersen was in the valley himself. Still, as already stated the map is highly schematic. The scale indicates that the distance between Ruin Group 64 b, which Jespersen visited, and the glacier front is about 3000 metres.

1926: In a photograph taken of the pass where the stream in Jespersens Dal flows down into Kujatdleq valley, H. Ødum states that the glacier can be seen right behind the point on the left, which must be the first three points on the north side of the valley (fig. 4 in Medd.

o. Gr., Vol. 74, p. 49). A visit to the place will decide whether or not it is still to be seen from there. It is also stated that Enoch's Ruins (Ruin Group 64 b) are about 3.5 km from the present front of the glacier.

1939: Dr. AAGE ROUSSELL, who inspected the ruins in 1926, in his book "Farms and Churches in the Mediaeval Norse Settlements of Greenland", Medd. o. Gr., Vol. 89, 1, states merely that the group was excavated in 1939 by Dr. C. L. VEBÆK. Dr. VEBÆK's book: "Inland Farms in the Norse East Settlement", Medd. o. Gr., Vol. 90, 1, which communicates the results of the expedition that year, contributes nothing towards fixing the position of the glacier front.

1953: According to the aerial photograph for that year (see fig. 9), the distance between Ruin Group 64 b and the glacier front must approach 4—4.5 km, which, combined with the terminal moraines in front of the glacier and the melting zone along its sides, would suggest a shrinkage between 1926 and 1953. All the distance figures being approximate, the extent of the retreat cannot be definitely evaluated.

Conclusion:

1911—1926: Jespersen's map gives the distance between Ruin Group 64 b and the glacier front as being about 3000 m, whereas Ødum in 1926 puts it at 3.5 km. The outer moraines lie about 3 km from the ruin group according to the 1953 aerial photograph, and this, together with the absence of a description of any moraines by Jespersen and the distance of 3 km on his map, seems to indicate that in 1911 the glacier front was close to the outer moraines, whereafter it retreated in the period 1911—1926. The measurements given for both 1911 and 1926 are estimates.

1926—1953: Aerial picture fig. 9 shows that the distance between glacier front and Ruin Group 64 b is now between 4 and 4.5 km; it is therefore probable that in the period 1926—1953 the glacier retreated still more. The distance in 1926 has merely been estimated.

Summary:

1911—1926: Retreating?

1926—1953: Retreating.

Locality 5:

Qôroq glacier (Qôrqup sermia): This glacier is a 15 km tongue of the inland ice reaching right out to the sea in the small fiord of Qôroq, a branch of Tunugdliarfik fjord. In Qôroq fiord the glacier forms a

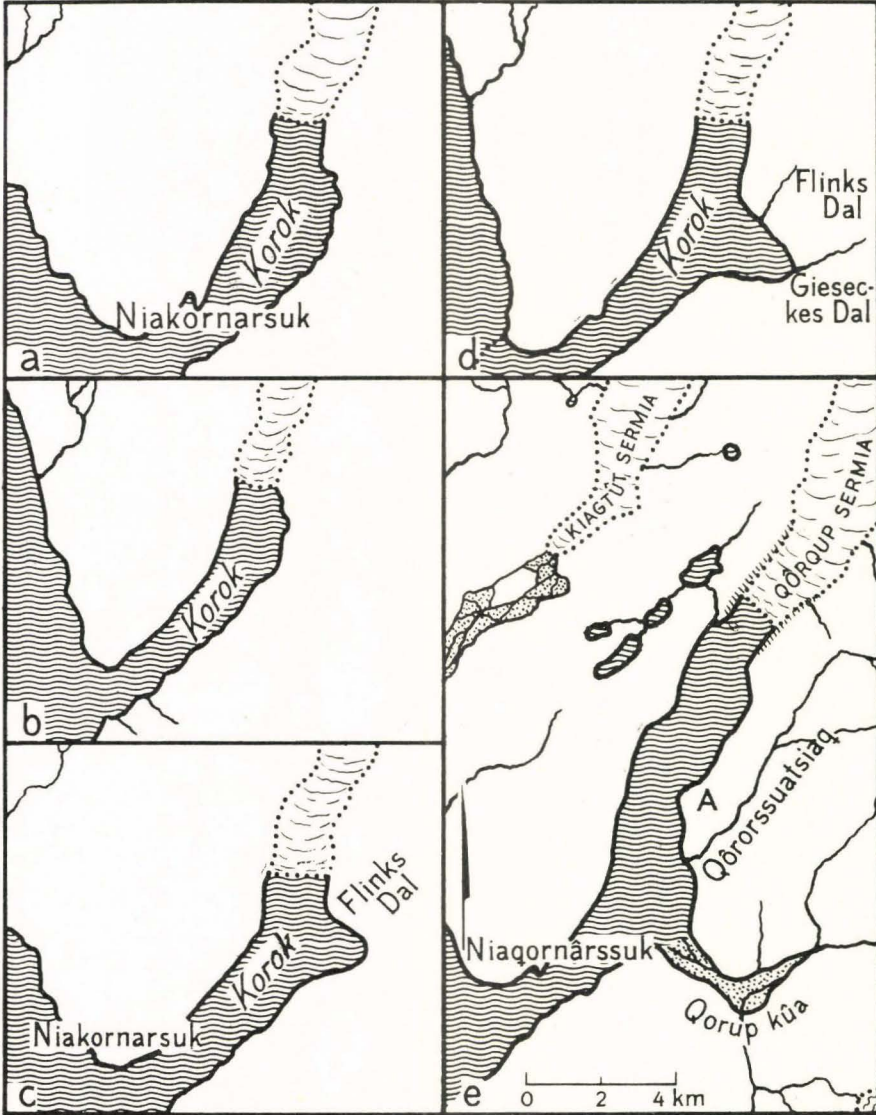


Fig. 10. Qôroq Fjord and Qôrqup sermia.

- a) Detail from K. J. V. STEENSTRUP's map, *Medd. o. Gr.* Vol. 2, pl. 1.
 b) Detail from A. JESSEN's map, *Medd. o. Gr.* Vol. 16, pl. 18.
 c) Detail from G. FLINK's map, *Medd. o. Gr.* Vol. 14, pl. 8.
 d) Detail from N. V. USSING and O. B. BØGGILD's map, *Medd. o. Gr.* Vol. 38, pl. 4.
 e) Detail from Aerial photographs. From Geodetic Institute's working sheet 1:100,000

productive front about 1.5 km wide. The large icebergs coming from it seldom get out into Tunugdliarfik fjord, but strand upon an iceberg bank between that fiord and Qôroq. This iceberg bank, it may be noted, is an ancient terminal moraine of the Qôroq glacier.

1809: The geologist K. L. GIESECKE visited the Qôroq fiord on 28th July, 1809 (Medd. o. Gr., Vol. 35, pp. 216—17). He states that he climbed the glacier from the east side of his starting point (Niaqornaq¹), but does not mention the position of the glacier front.

1857: On RINK's map of the Julianehaab District in "Grønland", Vol. 2, the glacier is seen lying well into Qôroq fiord, but on page 348 he writes of Tunugdliarfik fjord: "An eastern arm of it, named Poruk, reaches up to the continental ice which ejects a quantity of calf ice through it, so that its inner part is said to be inaccessible". This means that Rink himself was not there but drew the map from what information he could get, principally from the Oldskriftsselskabet's map of 1844; for this reason Rink's map should not be credited with much value in the present context. It should be added, that on Rink's map Qoroq fiord is reproduced much more correctly than on the Oldskriftsselskabet's, but there is nothing to show who made the correction.

Incidentally, Rink localizes "Gamla and Grimma's Farm" of the sagas to this fiord.

1876: The expedition in that year (G. HOLM, A. KORNERUP and K. J. V. STEENSTRUP) made five abortive attempts to force the fiord, and thus led Kornerup to the conclusion that the glacier must have been in less active motion in Giesecke's time than in 1876 (Medd. o. Gr., Vol. 2, pp. 7—8). On one of its attempts to penetrate the fiord the expedition tried to reach the glacier on foot, but were stopped by deep crevasses; nevertheless they did make their way so far in, and the close conformity of the coast lines indicated on the 1876 map with those shown on present-day aerial photographs makes it permissible to assume that this map, despite its small scale, is a fairly reliable picture of the position of the ice front.

1894: On Jessen's and Bruun's maps of 1894 (Medd. o. Gr., Vol. 16, pls. 18 and 19), the outlines are more approximate than on Steenstrup's map, but the position of the ice front seems to be little changed since 1876.

A sketch from the same year, drawn by D. BRUUN from the top of the mountain Igdlerfigssalik on the southwest shore of Qôrnoq fiord (Medd. o. Gr., Vol. 16, p. 188, and 57, p. 200), together with any photographs taken from the same spot, would undoubtedly provide acceptable information on changes in the position of the glacier front since 1894.

As already stated, on the 1894 maps the front does not seem to have changed much since 1876. If the 1876 and 1894 maps are compared with aerial photographs (vertical exposures) there seems to have been

¹) Now Niaqornârssuk. Author's note.

a retreat. Consequently it is possible that the ice front was stationary from 1876 to 1894, after which it retreated, but as we cannot know how much of the early maps was based upon recent observation and how much was taken from still earlier material, and as the scales of the maps are very small, all we can say is that the glacier may have been in a more advanced position at the end of last century than it is now. It is even possible that the front was still in that advanced position as recently as in 1926 (see under 1926).

1897: A map of that year by the mineralogist G. FLINK also shows the front in an advanced position. Flink himself went up the fiord and his map bears the imprint of personal observations: he made the bay in "Giesecke Valley" larger and on the whole amended the coastal outlines to some extent, but without the resulting map becoming more accurate than Steenstrup's.

As will be seen below from his report of the expedition, the glacier front in any case is placed too far forward on the map, for in his "Berättelse om en Mineralogisk Resa i Sydgrönland sommaren 1897" (Medd. o. Gr., Vol. 14, pp. 255—256) he writes, after quoting Giesecke and Kornerup, that the Greenlanders refused stubbornly to go into the fiord, as nobody had been in there in their lifetime. In the end, Flink got them persuaded and they rowed along the east side to a wide and "beautiful" valley (Giesecke Valley on the map fig. 10 d). In the bay was a large delta. On the north the bay was bounded by a stately mountain shaped like a house gable. At the head of the bay was a still larger mountain of the height of Igdlérfigssalik, conical in shape (reference to D. Bruun's panorama in Medd. o. Gr., Vol. 16, pl. 20). He goes on: "Korok may be divided into two parts, one outer, wider, and one inner, narrower, and the border between them can be placed right at the bay where we were. The inner part, down which the glacier comes, does not run in direct continuation of the outer one, as already said, but bends slightly northwards. Therefore, when one is at the middle of the outer valley one cannot see the iceblink, but centrally in the background rises a rounded mountain". In other words, the line of sight from the spot Flink names must indicate the extreme possibility for the glacier and the map must give an incorrect (too advanced) position for the glacier front.

Flink's report is accompanied by a photograph of the inner part of Qôroq fiord seen from the locality at the foot of Igdlérfigssalik. The picture is rather indistinct and can tell us nothing about the position of the glacier front.

1899: An indication of its position is also contained in K. J. V. Steenstrup's unpublished diary of 1899, in which he writes: "Wednes-

day 30th August, 6.15 am: 9 am, to Korok. After two hours' rowing we came to the east side of the big valley behind "Kisten"¹⁾. Just at the turn on the west side of this valley the north end of the Korok glacier disappears behind the Akuliarusek.

"Two small glaciers lie on the east side of Kisten and two on the mountain in direct connection with them.

"18×24 No. 29:²⁾ The back of Kisten with fluvial terraces. Wet mist. The red syenite as a sharp line in the mountain; here the east side of Flink Valley is red syenite, the west side grey.

"A large number of dykes run obliquely through the mountain wall on the north side of Koruk. East of Niakornarsuk the syenite seems to dominate. The valley between the glacier arm and Flink Valley runs east by north (magn.).

"29'88: Water level at Niakornarsuk 758 m } 77.3
 "29'60: Top of Niakornarsuk ? + 8': 751 m }

"13×18 No. 34: On the left, Koruk glacier, on the right Flink Valley. The rock here is syenite, just as on the opposite shore 29'73: 755, 1: 40,1'."

The diary also contains a sketch of "Flink Valley", but not reaching out to the fiord. The negative of the photograph mentioned, 13×18 No. 34, is in the Mineralogical Museum, unfortunately so stained that nothing can be seen on it. However, there is another picture showing a small part of the glacier, photographed from right out at the foot of Igdlertfigssalik. Later photographs from this spot should show any change in volume.

The Akuliaruseq mentioned by Steenstrup must also provide a clue. According to SCHULTZ-LORENTZEN'S Greenlandic dictionary, Akuliaruseq (from the root *ako*: space, gap) means a prominent mountain between two fiords or two valleys. This can scarcely mean anything but the mountain between "Flink Valley" and Qôroq Fiord. If Steenstrup was able to see the glacier from the west side of the large valley ("Giesecke Valley"), it must have been in a more advanced position than it is now. Flink's description in 1897 is so vague that it can neither deny nor confirm this.

1900: The map by N. V. USSING and O. B. BØGGILD of that year, in *Medd. o. Gr.*, Vol. 38, like the earlier ones shows the glacier in a far advanced position, but, like Flink's map of 1897, is devoid of details and also distorted in the inner part of the fiord.

¹⁾ A name sometimes used in Greenland for a mountain of a massive, coffin-like form. The Greenlandic name for this mountain is Igdlertfigssalik.

²⁾ Number of photo. Present author's note.

1923: An excellent photograph of the Qôroq glacier, taken by "The Second Vaux-Academy mineralogical Expedition" 1923 and reproduced in an expedition report in "Natural Sciences of Philadelphia" 1923, shows the glacier viewed from Narssârssuk. The glacier front is quite distinct and the picture must have been taken from very close to the viewpoint of Flink's 1897 picture. The latter is so blurred, however, as to make comparison impossible.

1926: Dating from that year is a map of Qôroq fiord in Medd. o. Gr., Vol. 74, p. 54. It was drawn by Dr. H. ØDUM and, like the earlier maps, seems to show the glacier front at a more advanced position than now.

1939: From a spot in the vicinity of Niaqornarssuk the geologist R. BØGVAD took a picture in 1939, showing part of the glacier front. It may possibly be of use for comparison with later pictures and is therefore mentioned here. It was not taken from exactly the same place as Steenstrup's in 1899, or from the viewpoint of the 1923 photograph, so that comparison is impracticable.

1953: The aerial photographs of 1953 show a white border on the mountain sides, which may denote the shrinkage since 1926 when the glacier front, according to Ødum's map, last seems to have been in an advanced position.

Conclusion:

1876—1926: All the maps of that period suggest that the glacier front was more advanced then. An inspection on the spot, however, is very desirable for verifying that assumption.

1926—1953: It is probable that in that period the Qôroq glacier retreated 1 or 2 km, because the melting zones extend that far out in front. Here again, however, it must be added that further material is highly necessary for supporting this conclusion.

Summary:

1876—1926: Stationary?

1926—1953: Retreating?

Locality 6:

Kiagtût sermia (Narssarssuaq glacier, Kiagtût glacier or the glacier at "B. W. I"): The glacier lies behind the present airbase B. W. I., the

runway being sited on the outwash plain from the glacier, as is shown in a photograph in "Grønlandsbogen" Vol. 1, p. 313 and in "Grønlandske Selskabs Aarsskrift" 1946, p. 49. The glacier was first described under the name of "Kiagtut glacier" but is now called after the airbase, usually Narssarssuaq glacier. The present authorized name is Kiagtût sermia.

The rate of movement of the Narssarssuaq glacier was measured by Commodore G. HOLM in 1876 (Medd. o. Gr., Vol. 2, pp. 11—12), by sighting two easily recognizable points on the glacier from a base at least 500 feet long. For a point 147 m from the left side of the glacier the result was: 0.10 m/24 hrs. and for a point 240 m from the west side of the glacier: 0.21 m/24 hrs.

1806: The spot was visited by K. L. GIESECKE, who in his diary (Medd. o. Gr., Vol. 35, p. 37) on 1st September 1806 records that he visited "Akuliaralek": "einer ziemlich grossen Fläche, wo der Eisblink mit Niviersietkakak ganz nahe zu liegen scheint"—and nothing more.

1876: In that year K. J. V. STEENSTRUP and G. HOLM were at the glacier. In the expedition report, Medd. o. Gr., Vol. 2, p. 8, they say that in that year it reached down to a smaller lake.

1894: On the 1894 map by A. JESSEN and D. BRUUN (Medd. o. Gr., Vol. 16) the glacier is shown reaching out into a lake. This map is on such a small scale, however, that a slight change would be impossible to trace.

1899: On that year K. J. V. Steenstrup writes the following in "Geologiske og Antikvariske Iagttagelser i Julianehaab District", Medd. o. Gr., Vol. 34, pp. 131—132: "In 1876 I visited this glacier for the first time and in 1899 the second time and found, with the aid of photographs from 1876, that the glacier had altered somewhat in the intervening 23 years; but of course I do not know whether this alteration had been spread evenly over these years or the glacier had possibly pushed its way forward and retreated several times. In front of the glacier lies a small lake, and whereas in 1876 the glacier ran out into it with a considerably overhanging front, so that it calved and formed small icebergs, in 1899 it had shrunk and was so covered with clay

Fig. 11. Kiagtût sermia:

- a) Photo K. J. V. STEENSTRUP 1876. Negative owned by Mineralogical Museum.
- b) Photo K. J. V. STEENSTRUP 1899. Negative owned by Mineralogical Museum.
- c) Photo B. SØNDERGAARD 1950. Negative owned by B. SØNDERGAARD.

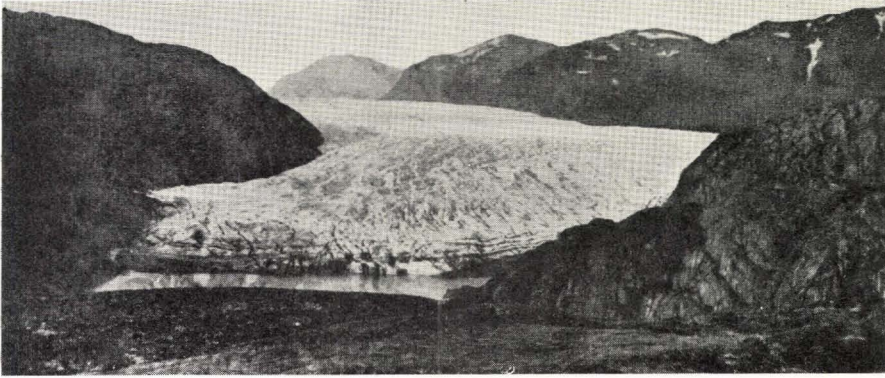


Fig. 11 a.

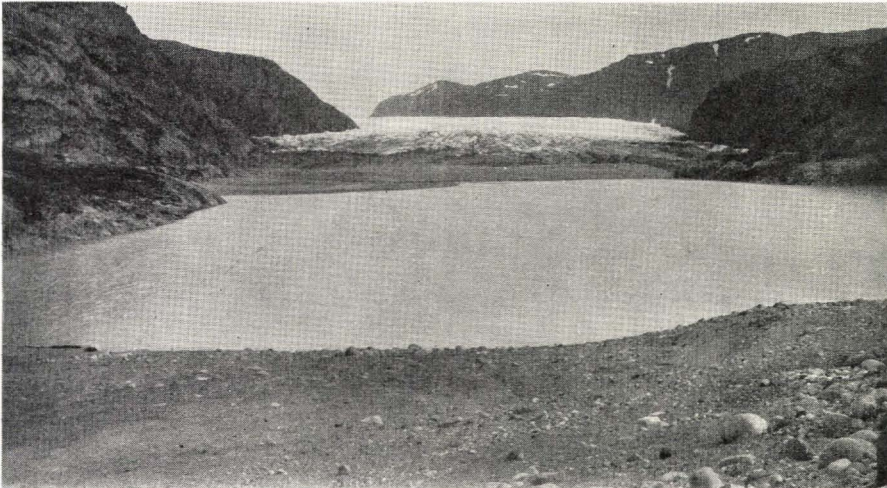


Fig. 11 b.



Fig. 11 c.

and gravel that it could hardly be distinguished from the moraine. In the clayey water in front of the glacier end the subglacial river rose like a furiously boiling spring. The glacier's retreat in itself was not particularly great, and cannot be determined exactly. If I take my photographs along, the change next time will be estimated more easily, as two of them were taken from a cairn that will scarcely be hard to find again."

Two photographs of the glacier, dated 1876, have been found in the archives of the Mineralogical Museum, and are both of the glacier seen from a locality 500 m due west of the glacier's present front. The pictures show the glacier quite bare of surface moraines right out to the front which, as Steenstrup describes, drops steeply into the lake. One of these pictures is given in fig. 11 a. These are probably the pictures of 1876 to which Steenstrup refers in his description in *Medd. o. Gr.*, Vol. 34.

Two 1899 photographs have also been found at the Museum. One was taken from near the same locality as the 1876 photograph and is reproduced here fig. 11 b, the other being taken from the mountain side along the north side of Narssarssuaq glacier, due west of the glacier front. These pictures show the marked shrinkage of the front, but the foremost terminal moraines might indicate an advance between 1876 and 1899.

A comparison of fig. 11 a with fig. 11 b shows that the retreat of the glacier between 1876 and 1899 was only slight, as Steenstrup remarked, scarcely more than about 100 m as far as can be judged; on fig. 11 b one observes the widespread moraine covering of the glacier front, making it difficult to ascertain the extreme limit of the ice. On the 1899 picture taken from the mountain side north of Narssarssuaq glacier, however, the Scherflächen can be seen through the thin moraine covering just behind the moraine mounds surrounding the northwest part of the glacier front.

1919: It is curious that O. BENDIXEN, in the jubilee publication "Grønland", *Medd. o. Gr.*, Vol. 61, p. 398, writes that the Narssarssuaq glacier "debouches into a small lake with clayey water in which it used to calve", when back in 1899 Steenstrup had already drawn attention to the fact that it had retreated from the lake. The probability is that Bendixen merely made use of Steenstrup's description, and as he did not visit the glacier there is no evidence that the glacier was at the edge of the lake around 1919.

1950: For that year there is a photograph of the glacier, taken by the geologist B. SØNDERGAARD and reproduced here as fig. 11 c. It was taken from the west bank of the river draining the glacier and,

like Steenstrup's pictures of 1876 and 1899, will undoubtedly be useful for evaluating future changes of the glacier front. It is impossible to make direct comparisons between Steenstrup's and Søndergaards' photographs, for they represent two different sections of the front photographed from two different places.

1953: Aerial photograph. The only Steenstrup photograph comparable with this is the view from the northwest mountain side in 1899. It is seen that since 1899 the glacier has retreated still more. The presence of being a larger number of terminal moraines before the front, seems to indicate a small re-advance between 1899 and 1953. These terminal moraines must signify the limit of the extreme end of the glacier which, as was the case in 1899, is covered with a thick layer of moraine. The moraine deposit is now so thick that Scherflächen structures are no longer visible.

Conclusion:

1876—1899: Steenstrup's text and photographs of 1876 and 1899 are evidence of an indubitable retreat by the glacier between these years. The extent of the retreat is estimated as of the order of 100 m. Terminal moraines suggest one or more advances in the period.

1899—1953: A comparison between Steenstrup's 1899 picture and aerial photograph of 1953 suggests further retreating and shrinking. Again on the aerial picture the terminal moraines which have become visible since 1899 seem to show that there were one or more small re-advances between 1899 and 1953.

Summary:

1876—1899: Retreating.

1899—1953: Retreating.

Locality 7:

Ilimaussaq plateau ice with Narssaq glacier. Like Sermersôq island, this region does not form part of the inland-ice margin proper, but it may be of interest as an example of plateau ice there, so much the more as the place, by Greenland standards, is well covered by several meteorological stations surrounding the Ilimaussaq massif on the southeast and west sides. The stations are Narssarsuaq, Narssaq and Simiutaq (with observations since about 1942) and Igaliko and Julianehaab (more casual observations of the period between 1920 and 1930). All this may possibly have some bearing on a future evaluation of the glacial economy there.

1853: The Narssaq glacier is shown on a map of that year, possibly drawn by H. RINK, or by trading assistant P. MOTZFELDT of Qagssimiut. The glacier is represented as a lobe stretching from the highland of Ilimaussaq and continuing to the river running to Narssap Ilua.¹⁾ The position of the glacier front cannot be determined, however, the map being too sketchy.

1857: H. RINK's account in "Grønland" does not permit of any estimate of the extent of the glacier; he merely writes that high and steep, ice-clad mountains border the mouth of Eriksfjord (Tunugdliarfik fjord) and that the outer part of Ilimaussaq peninsula consists of high and ice-covered land which farther inland passes into lower and more regular hills ("Grønland", Vol. 2, pp. 344—345).

1876—77: K. J. V. STEENSTRUP's map of 1876 shows only an ice-cap on the mountains around Ilimaussaq. The mountain NW of Ilimaussaq peak is recorded as having been first ascended by Steenstrup in 1877 (the date given in Steenstrup: "Geologiske og Antikvariske Iagttagelser i Julianehaab District", Medd. o. Gr., Vol. 34, p. 121, whereas USSING in Medd. o. Gr., Vol. 38, p. 417 gives the year as 1875). However, Steenstrup reports no more about that expedition than the height of the peak he climbed (1376 m) nor are any details of the ascent to be found in his diaries. Ussing called the peak "Steenstrup Fjeld".

1894: For that year there is a photograph of the Cirque glaciers, on the north side of the Ilimaussaq plateau. It was taken on 19th June, 1894, by A. JESSEN, and the glaciers are so thickly covered with snow that later photography would be to little purpose for comparison.

1900: The first and only really comprehensive description of the plateau is contained in N. V. USSING's: "Geology of the Country around Julianehaab", Medd. o. Gr., Vol. 38. Professor Ussing visited the region at Taseq and the Narssaq glacier from the town Narssaq, and also climbed Steenstrups Fjeld from Nordre Sermilik fjord. His observations then and the already existing maps of 1900 (i. e. Steenstrup's map and the chart) formed the material for his geological map. On comparing Ussing's map with the Geodaetic Institute's new map, Ilimaussaq in 1900 is seen covered by one continuous firn, whereas now there are five separate firn regions. Ussing wrote distinctly (Medd. o. Gr., Vol. 38, p. 421): "The entire upper plateau on Ilimaussaq is firn-covered. The height of this mountain plateau may be estimated at about 1150 m (the firn is considerably higher)". The question now is whether Ilimaussaq actually was covered with snow in Ussing's time or it merely appeared like it from Ussing's point of view? However, it can be seen from a

¹⁾ A large bay about 2 km north of the town of Narssaq.

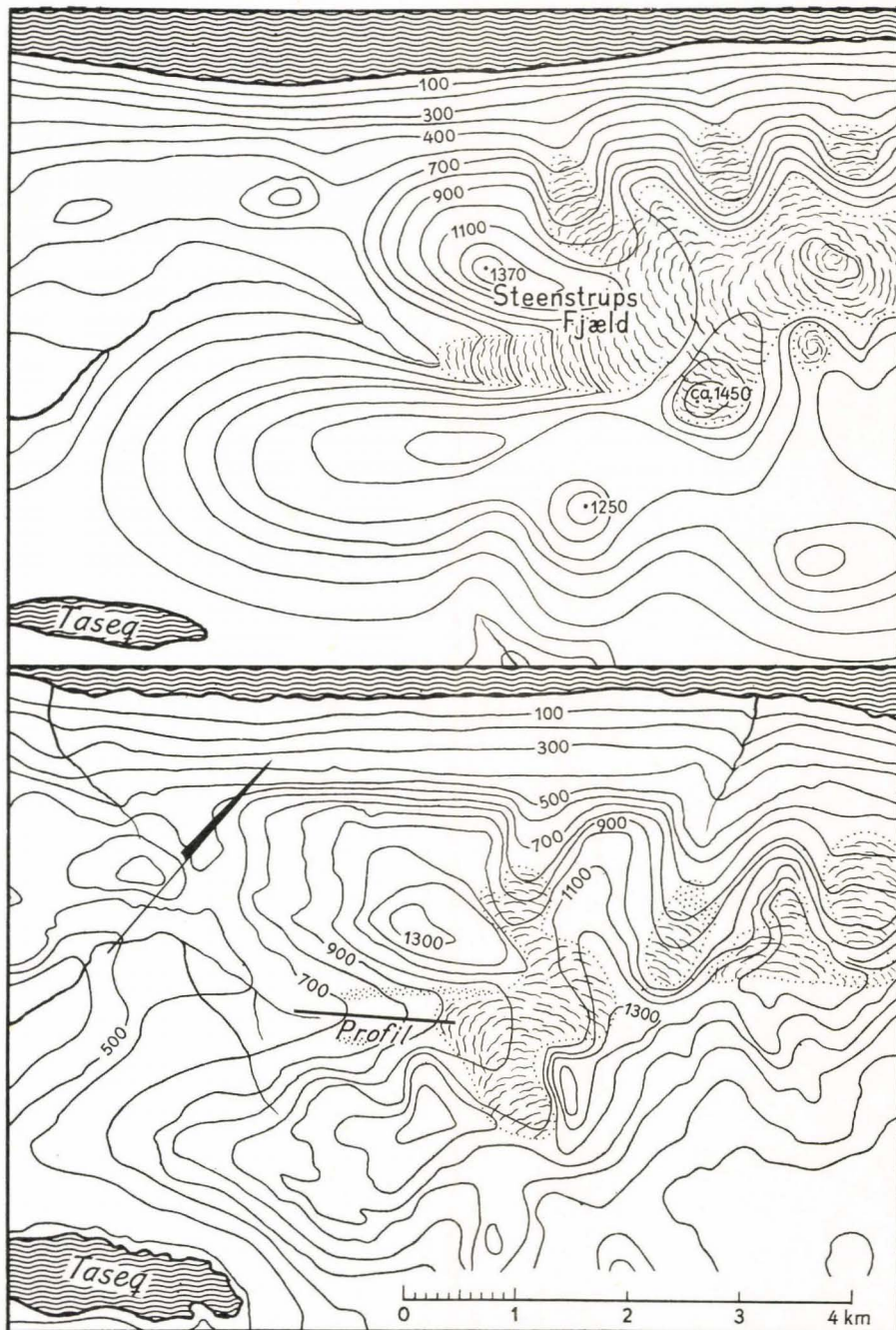


Fig. 12. Narssaq glacier and Ilimanssaq.

a) Detail added from N. V. Ussing's map of Ilimaussaq area. Original in *Medd. o. Gr.* Vol. 38, pl. III.

b) Detail map of same area, partly according to Geodetic Institute map. Glacier limits according to aerial photographs of 1953.

drawing in the same book, representing the North side of Ilímaussaq seen from Nordre Sermilik fjord, that the uppermost plateau was completely covered by a snow-cap, whereas now the Ilímaussaq peak is much more snow-free than on the drawing. It should be added that Ussing's observations were made in the month of August, i. e. when melting culminated. Consequently it is very probable that at any rate, the firn region of the Narssaq glacier and that of the middle cirque glacier which are now separate, were one in 1900. The 1894 picture can neither refute nor affirm this, because it was taken from such an unfortunate angle that the ridges between the cirques on the North side of Ilímaussaq conceal the plateau snow; furthermore, the picture was taken so early in the year that the lower limits of the glacier are also partly covered with snow.

On Ussing's map the lower limit of the east cirque glacier seems to be about 500 m, of the middle one about 500 m and of the westerly one about 550 m; on the Geodaetic Institute map the corresponding values are 650, 700, and 750 m, so that, regardless of any errors, for the westerly glacier we must reckon with a retreat from at any rate contour line 600 m to that at 700 m. As regards the Narssaq glacier a more definite determination should be possible: Ussing places this glacier at much more than 1 km long; it can be measured on his map, where it is found to be about 1.5 km long. In the Geodaetic Institute map the ice front is at the 800 m level and the length of the glacier is 500 m. If the glacier were drawn on the present maps with a length of about 1.5 km, it would in fact reach a height of 6—700 m as on Ussing's map.

1932: A photograph for that year appears in *Medd. o. Gr.*, Vol. 88,1, p. 11, fig. 4 (P. NØRLUND and MÅRTEN STENBERGER: Brattahlid). The picture was taken a considerable distance from the glacier (from Ilua bay at Narssaq) and it is difficult to distinguish any outlines round about the Narssaq glacier; nevertheless the lateral moraine, marked a on fig. 13, is fairly distinct. The height of that lateral moraine above the glacier might justify the assumption that the ice had shrunk since 1900. What change the front had undergone in the same period cannot be stated exactly from the photograph. This lateral moraine is also described by Ussing (*Medd. o. Gr.*, Vol. 38, p. 417) as follows: "Another interesting feature is the considerable lateral moraine to be seen in the picture, showing that the glacier has retreated quite recently". Ussing's illustration shows this lateral moraine at the same level as the glacier surface, but extending out beyond the front.

1953: Aerial photograph. The glacier front seems to be in the same place as in 1952 and 1955 (see below).

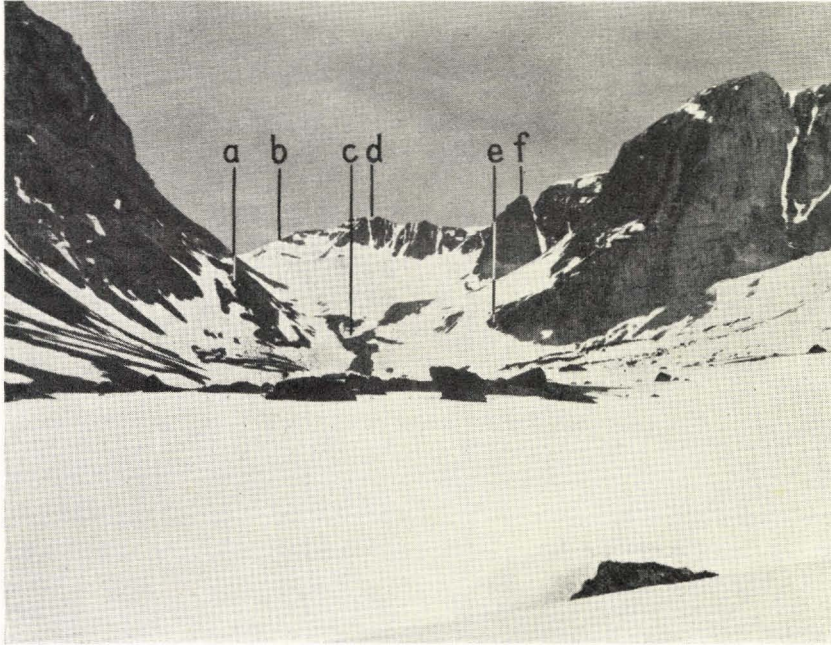


Fig. 13. Narssaq glacier. (On the left is Steenstrups Fjeld)

Photo. A. WEIDICK 8th June 1955.

1952 and 1955: The writer was at the glacier in these years, but no change was observed to have taken place in the interval between them. Fig. 13 is a photograph taken in 1955 from about the same spot as Ussing's of 1900. On account of the snow in the 1955 picture there is no good basis for comparison, but it could be observed that between 1900 and 1955 the glacier had shrunk considerably: in 1900 it passed beyond the projection *e*, whereas now the position is occupied by a terminal moraine and it would seem that the glacier has retreated from the projection. The lateral moraine *a*, which indicated the height of the glacier in 1900, is now judged to lie about 150 m above its surface. Moraine *c* is not visible in the 1900 picture and may possibly represent an advance between 1900 and 1955. At the peaks *d* and *f* there is also a distinct shrinkage so that, notwithstanding the snow covering on the glacier in the 1955 picture, there can hardly be any doubt about a considerable retreat since 1900. An attempt at showing the shrinkage and retreat has been made in the longitudinal section of the glacier fig. 14, this has been drawn partly from the Ussing's and the Geodaetic Institute's maps, and partly from the photographs of the Narssaq glacier in 1900 and 1955.

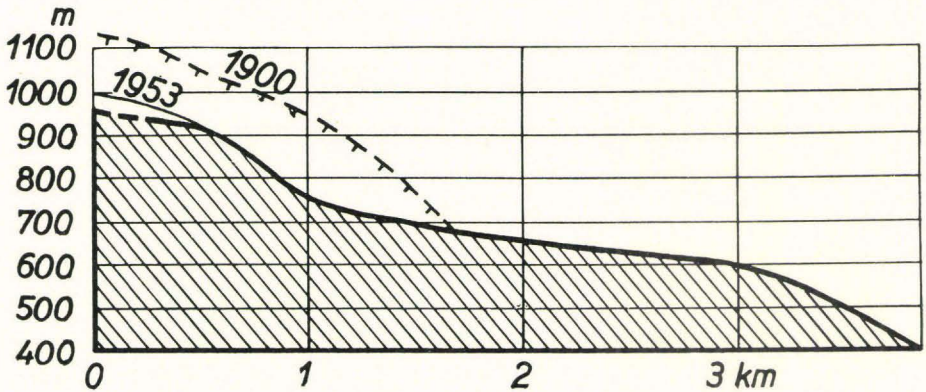


Fig. 14. Longitudinal section through Narssaq glacier. Drawn from the maps Fig. 12 a and b. Glacier height in 1900 also estimated from lateral moraines on N.V. USSING'S photo.

Conclusion:

1853—1900: Of the pre-1900 information available, only the 1853 map tells anything: the Narssaq glacier is seen forming a lobe which, as on Ussing's 1900 map, is very long, from which perhaps the conclusion may be drawn that in 1853, as in 1900, the glacier extended farther forward than now, but this is a most uncertain supposition.

1900—1932: It is presumable that lateral moraine a was formed in that period. A comparison between the 1932 and 1900 photographs provides no reliable information of a retreat of the glacier front. However, the aforesaid lateral moraine seems to extend beyond what can be seen of the glacier front in the 1932-picture, and from this we must assume a retreat.

1932—1952: No comparison is possible between the pictures taken in 1932 and 1952. One can only say that between 1900 and 1952 the glacier retreated.

1952—1955: A comparison between photographs of 1952 and 1955 shows that there was no change at the glacier in that period.

Summary:

1900—1932: Retreating.

1932—1952: ?

1952—1955: Stationary.

REGION 2:

**The glaciers between Nordre Sermilik
and Illoka (now: Illorro) area.**

Localities 8 and 9:

Eqalorutsit kangigdlit sermia and Eqalorutsit kitdlit sermia. In accordance with the geographic subdivision in Medd. o. Gr., Vol. 61, p. 395, we must reckon with an outer boundary of the icefiord to these glaciers, known from ancient times as Nordre Sermilik, to a line Narssap qáqâ-Niaqornaq, whereas the westward continuation of the icefiord is called Ikerssuaq or Bredefjord. It is only in Sermilik fjord proper that navigation is difficult throughout the greater part of the year owing to the great quantity of calf-ice from the two big glaciers at the head of the fiord. These glaciers are called Eqalorutsit kangigdlit sermia and Eqalorutsit kitdlit sermia (the east and west, "poor salmon place" glaciers respectively). On the production of the glaciers there are two reports, one by the archaeologist D. BRUUN and one by the geologist A. JESSEN and 2nd. Lieut. C. MOLTKE. Both reports are published in Medd. o. Gr., Vol. 16, but they differ slightly. Bruun's description (pp. 202—203) says that fiord and calf ice drift away early, often as early as the month of April, after which there is open water for about 14 days. During this period the Greenlanders from Narssaq in their umiaks come right up to Tasiussaq to fetch firewood and shoot seals. After this there is a vigorous production of calf ice right up to September, when the fiord freezes over. In Jessen and Moltke's report (p. 94) they state that production usually begins in March, but this depends upon the blowing of the fohn (the nigeq) during the winter. In 1894 production did not begin until the early part of May. Of the two glaciers the eastern one is later in producing than the other, but its output is greater.

The velocity of the western glacier was measured by JESSEN in 1894, when the most rapidly moving point had a speed of 21 m/24 hours.

Up to 1894 the glaciers will be described together, as prior to that year there is not sufficient exact information for use in determining their oscillations. That section is therefore of more historical than glaciological value.

1777: The east glacier was visited as early as in 1777 by the archaeologist AARON ARCTANDER, but he mentions nothing of its limits or the position of its front. After describing his arrival at Qordlortoq on 27th August (Norges og Svalbard- og Ishavsundersøkelsen Meddelelser Vol. 58, 1944, p. 82), Arctander writes in his diary: "On the 29th August the day had scarcely given us its light when I with several Greenlanders, male and female, started up into the mountains. First

we proceeded NW, then N. until about noon, when we came to the iceblink which reaches down to Sermilik fjord, whence our course was NE.

“Soon our path led across steep, high and chaotic mountains where at almost every step one was in danger either of falling right down or at any rate breaking feet and legs; then soon we crossed valleys again. At other places we had the old, hard ice which, covered with new-fallen snow, was the more difficult for us to negotiate. Such was the way we had to go today.

“Darkness no longer permitting us to travel this evening we had to sit down by a hill to await with longing the dawn, which, after a long, cold and palpitating darkness, we had scarcely reached when we on 30th August began to go on. The going today was rather better than yesterday. Finally in the evening we reached our destination”. The report continues with a description of a mountain of mica which had been described before Arctander and for which he had sought. The glacier is described only in the passage quoted above and with no particulars of its extent.

Later, under the date 2nd September, Arctander also reports that he visited two Norse ruins a day's journey from the head of Tunugdliarfik fjord towards the iceblink.

Neither of the two reports tells us more than that Arctander visited and walked on the glacier Eqlorutsit kangigdlit sermia, and, unfortunately, the accompanying map of the region shows no glaciers; indeed, Sermilik is merely shown as extending a little beyond the town of Narssaq, although Arctander knew the isthmus at Qagssiarssuk and therefore also the ice fiord on the other side of it.

1788: POUL EGEDE's map of that year (see illustration in “Greenland” 1928, Vol. 1, p. 160), credits Sermilik fjord with a much greater length than Arctander's map, but the glaciers are not shown here either.

1806: In this year GIESECKE wrote the following about the ice fiord (Medd. o. Gr., Vol. 35, p. 39, 4th September): “Wir giengen ein Stück in Sermiliksfjord, mussten aber des vielen Treibeises wegen wieder zurück. Hier standen einige Heidnische Grönländer”.

1809: On 2nd August Giesecke reports, after having described what is now the town of Narssaq (Medd. o. Gr., Vol. 35, p. 220): “Das Volk, meistens Heiden, liegt hier gewöhnlich auf dem Sommerfange, weil die Seehunde, des vielen Treibeises wegen, welches von Sermilik heraustritt, in grosser Menge sich hier einfänden. — Die Norischen Rudera, welche hier standen, sind nun durch den zunehmenden Eisblink ganz zugedeckt”. On the same day he writes that the syenite region stretches from Narssaq through Tunugdliarfik fjord in under the iceblink at Sermilik, at the same time referring to page 212 of the diary

(which in the edition *Medd. o. Gr.*, Vol. 35 is page 213), where we find: "Der obengedachte Syenite ist in dem nördlich angränzenden Tunugliar-bikfjord auf der nördlichen und südlichen Seite desselben ebenfalls in grosser Menge angelagert zieht sich hinter dem Berge Narksak gegen Norden hin und reicht bis nach Sermilik oder grossen Eisblink, unter welchem er sich verliert". The report that syenites extend right in under the glaciers in Sermilik is incorrect at any rate, because subsequent investigation by the geologist A. Jessen (1894) showed that there was nothing but granite in this locality. It is possible that granite may have been mistaken for syenite, but as the diary does not leave the impression that Giesecke was farther into this fiord than Niaqornaq, his reports of the syenite and of the Norse ruins buried under the encroaching ice are assumed to be hearsay. There remains only the central fact that the report of the buried ruins illustrates a general impression in the district that the glacier front had moved forward. That has undoubtedly been told Giesecke by the hunters going into the fiord for seals. Sealing there is an ancient tradition, so it is not improbable that oscillations at the glaciers had been observed. Giesecke's report does not reveal which of the glaciers covered the Norse remains, but as Eqalorutsit kitdlit sermia is bounded by very high, precipitous mountain walls, it cannot have been that one. The east glacier; Eqalorutsip kangigdlit sermia, had no melting zones in 1955 and must therefore be assumed to have been in a state of culmination, one which it has not exceeded in the past century or so. Nevertheless there is a luxurious valley, where ruins may well have been observed bordering upon this glacier and connecting with Norse ruins in a bay but few km's farther south (see under Eqalorutsit kangigdlit sermia, 1955).

1832: In that year Sermilik fjord was visited by trading assistant OVE KIELSEN. A handwritten report of his journey reposes in the archives of the National Museum. Extracts of the report were also published in *Nordisk Tidsskrift for Oldkyndighed* Vol. 2, p. 319. The journey was made for the purpose of surveying some of the ruins in Tasiussaqaq bay in Sermilik fjord. The text states merely that the boat journey to Tasiussaqaq through Sermilik was extremely difficult on account of the quantities of calf ice "thrown out by the many iceblinks around there" and that consequently it is better to approach the spot overland from the outpost Qagssiarsuk in Tunugdliarfik fjord.

1844: In "Grønlands Historiske Mindesmærker", Vol. 3, p. 829, there is the following passage on Sermilik fjord: "The head of Sermilik Fiord is covered by a large iceblink, besides which there are said to be two smaller ones towards the middle of the fiord's northwest side. South of them are a number of ruins which continue right down in

Ikersoak or Bredefjord". Three "iceblinks" are shown on the map in the same work. In all probability, according to the description of the large iceblink, the most easterly one was Eqlorutsip kangigdlit sermia, therefore the two on the west must be Eqlorutsit kitdlit sermia. This, however, presupposes that at that time, as in 1955, the glacier was divided into two arms by the lower of the two nunataks described in 1894 by A. Jessen. This is a bold conclusion, but it is the only means by which map and description can be made to agree with the facts.

1857: In H. RINK's compendious work "Grønland", Vol. 2, p. 345, the ice fiord is given but brief notice: "this fiord produces no small quantity of calf ice and is therefore a genuine ice-fiord, and also the inland ice at several places goes down into the bays along the north side, where almost everywhere it hangs as it were over the lower land and threatens to cover it".

For the inner part of Sermilik fjord, Rink's map of Julianehaab District is much more accurate than the 1844 map, as the land separating the western glacier from the eastern one, Akuliaruserssuaq, is plotted with fairly exact outlines. It is uncertain whether this part of Sermilik fjord was drawn on the map from observations by Rink or from information by others (possibly P. MOTZFELDT's), but a sketch map of Sermilik fjord by Motzfeldt, dated 1854, seems to have served as a model for Rink's map, so much the more so because for the outer part of the fiord Rink refers to P. Motzfeldt in "Grønland", Vol. 2, p. 348.

However, in this region of the fiord Motzfeldt's map is not so accurate that the position of the glacier fronts can be determined from it.

1876: During the expedition of 1876 (G. HOLM, K. J. V. STEENSTRUP and A. KORNERUP) it was possible to row up Sermilik fjord as far as the settlement of Igdlumiut; the remainder of the inner fjord, shown on the expedition map Medd. o. Gr., Vol. 2, was drawn partly from earlier maps and partly no doubt from the mountains on the outer end of Ilimaussaq peninsula. Steenstrup, by the way, refers to a sketch map, published by the Hydrographic Department in 1863, but adds that this map too was compiled from earlier maps and with some rather unfortunate corrections to them.

Locality 8:

Eqlorutsit kangigdlit sermia (East Glacier in Nordre Sermilik, according to A. JESSEN) as the foregoing shows was visited by ARCTANDER in 1777, and possibly by MOTZFELDT in 1854. The next visit was made in 1894.

1894: On this visit the geologist A. Jessen makes the following entry in his diary for Sunday, 23rd September, after having inspected

the ruins at Tasiussaq: "Rose 6 am., b. = 748. Weather very good. Surveyed the ruin together with Lieut. BRUUN, struck tents and rowed from Tasiussak northwards towards the glaciers.

"Passed the mountain Ulunguarsuak, which, like all other tall mountains in the vicinity, was white with the autumn snow. Rather much calf ice; crawled along by the shore and turned into the fiord arm leading to the east glacier. There encountered a strong nieq.¹⁾ ²⁾ Rowed some way along the shore; scattered icebergs and calf ice out on the fiord. Landed on the east bank and climbed some way up where we had a view over the glacier, which Petersen and Bruun sketched.

"The glacier front stood out clean and distinct, its westerly part vertical with fresh fracture surfaces, the easterly part sloping down to the water. Along the east side of the glacier a very large lateral moraine which spread a good distance out over the glacier. From the west two glaciers come down towards the main glacier, the lower one crowding hard up and bringing very large lateral moraine which, in the form of a distinct, black surface moraine runs down along the west side of the main glacier.

"The icebergs in the fiord usually contained much earth and stones, almost all more or less dirty.

"Back to the boat and rowed across the fiord directly across the headland of Akuliarusersuak over the fiord arm to the west glacier. There we approached the glacier as close as we could get and took a sounding of 200 fthm. However, the nieq coming out of the east glacier pressed icebergs and all the loose calf ice down upon us, so that before we knew it we were quite shut in. The wind blew strongly, the ice pressed on, but by hard work with ice-axes and by hauling the boat over the ice we succeeded in escaping, crawled across under the east bank and headed southwards with a good breeze."

For Tuesday, 12th June of that year, there is the following passage regarding Eqalorutsit kangigdlit sermia in A. JESSEN's diaries: "Little (east) Sermilik glacier was seen on the other side of the fiord. It was absolutely crowded with calf ice which together with icebergs hid the glacier front at several places. There seemed to be no typical median moraines, but through the glasses a small glacier could be seen, a tributary, from the north pushing down over the main glacier and there presenting moraines. I could not see it quite definitely".

In the official report, however, there is not much on the subject of Eqalorutsit kangigdlit sermia; all it (Medd. o. Gr., Vol. 16, p. 87, Lieut. C. MOLTKE) says is: "The last days of September were spent

¹⁾ A. JESSEN in his diary sometimes, as here, makes use of q, but writes it in accordance with the Greenlandic spelling k. (Present author's note).

²⁾ = Nigeq: föhn wind. Present author's note.

visiting Nordre Sermilik Fiord again. As the new ice was already beginning to form, further examination was impossible". In the same volume of *Meddelelser om Grønland*, p. 196, Captain D. BRUUN writes on that trip: "On arriving at Julianehaab Lieut. MOLTKE suggested that next day I should accompany him and his companions into Sermilik Fiord, where they intended to make some final surveys at the glacier. This might provide me with an opportunity to visit some ruin groups which had not previously been described. I accepted the offer with pleasure and in a wooden boat we made this fiord journey from September 21st to the 27th".

Information of much importance is given in the same work, p. 92, where it is stated that "the geological map (Pl. XVIII) is a combination of Captain HOLM's surveys of 1880—81 and our survey of the coastal stretch between Julianehaab and Nanortalik.

"Moreover, on the earlier map we have made corrections in Nordre Sermilik Fiord from Niakornak in to the glaciers at the head of the fiord". The copy of the 1894 geological map clearly shows the alteration vis-à-vis Motzfeldt's map.

On making a comparison between A. JESSEN's map and the description in the diary, so much reliance may be placed on what the map shows that there is a basis for an evaluation of the position of the glacier front in 1894. On the whole, Jessen's description agrees with the appearance of the glacier at the present writer's visit in 1955, except that the very large moraine on the east side of the glacier is now lacking. It is reasonable to assume, with a margin of uncertainty of about 200 m, that the glacier front was in the same place in 1894 as in 1955.

The drawings which Jessen states were made by D. BRUUN and F. PETERSEN near the glacier might possibly verify this assumption, but so far it has been impossible to find them.

1932: The next known visit to the glacier was in 1932, when Professor G. HATT and the geologist K. MILTHERS proceeded up to it from the head of Tunugdliarfik fjord. From that excursion we have two excellent pictures of the glacier, reproduced here in fig. 15 a. These photographs were taken by Professor HATT from the southern mountain wall bordering on the glacier.

1947 and 1953: Aerial photographs were taken of the glacier in these years. The photographs show in both 1947 and 1953 the front was in the same position.

1955: In this year the glacier was visited by the writer, who spent the period from 29th June to 8th July there together with the teachers' college master MARIUS ABELSEN, of Godthaab, and the sheep-farmer JENS JUSENIUS, of Qagssiarssuk. Before proceeding to the glacier



a) Photo G. HATT. 1932.



b) Photo WEIDICK. 6th July 1955.

Fig. 15. Eqalorutsit kangigdlit sermia. The glacier front.

the people of Qagssiarssuk were questioned regarding it and its surroundings, and the following information resulted: Several people had fox traps (putdlatit) on the edge of the south side of Eqalorutsit kangigdlit sermia in the winter of 1954—55. When the close season for foxes arrived (the 21st March, author's note) they went to the traps to arrange them, but the ice had widened and buried them. About Niviarsiat

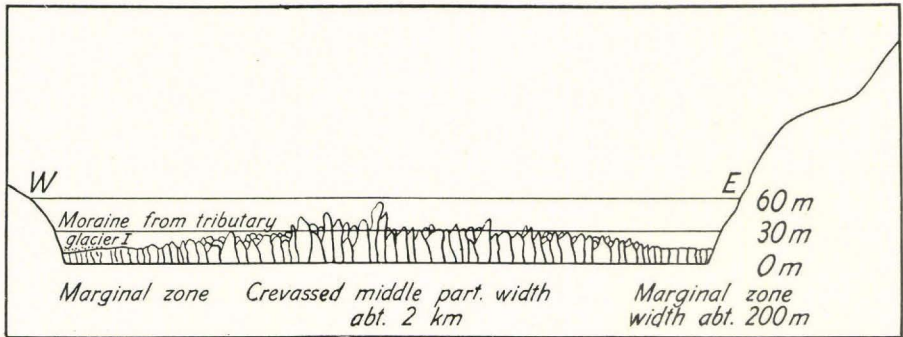


Fig. 16. Eqalorutsit kangigdlit sermia. The glacier front with heights above sea level. The width of the marginal zone on the glacier's west side not actually measured but plotted from aerial photo.

qáqát, north of Eqalorutsip kangigdlit sermia, the writer was told that these mountains were no longer nunataks but had become connected with the coastland, from which they were now separated only by a river. The time of the retreat could not be stated.

With the exception of very narrow marginal zones 100 to 350 m wide, the glacier along its entire length is considerably fissured like other large glaciers such as the classical Jakobshavn glacier. As it appears on the picture fig. 15 a and b, the greater part of its surface consists of isolated ice pinnacles, and for that reason it is impassable along its entire length.

The following measurements, which are based only upon the use of a hand level, can be given for the thickness of the glacier front (see fig. 16): The flat marginal zone extends at the glacier front about 200 metres from the glacier edge on the south side, and the frontal height of this marginal zone above sea level is about 16 m.

Outside this flat marginal zone the front increases rapidly from about 25 metres above sea level for the pinnacles nearest the marginal zone to about 40 m for those in the middle of the front. The great majority of the front pinnacles have a height of between 27 and 46 m, and only a few reach about 60 m above the sea.

On the south side (but not the north) of the glacier front the rock walls turned towards the front presented fresh overhangs and screes of heights up to about 30 m. These must have been the result either of packing ice or the waves caused by the calvings from the glacier. A retreat by the glacier is hardly an acceptable explanation, as nothing of the kind can be seen on the photographs of 1932; and as the glacier right behind the front could also be seen to have stripped old vegetation, which could only have been the result of an advance.

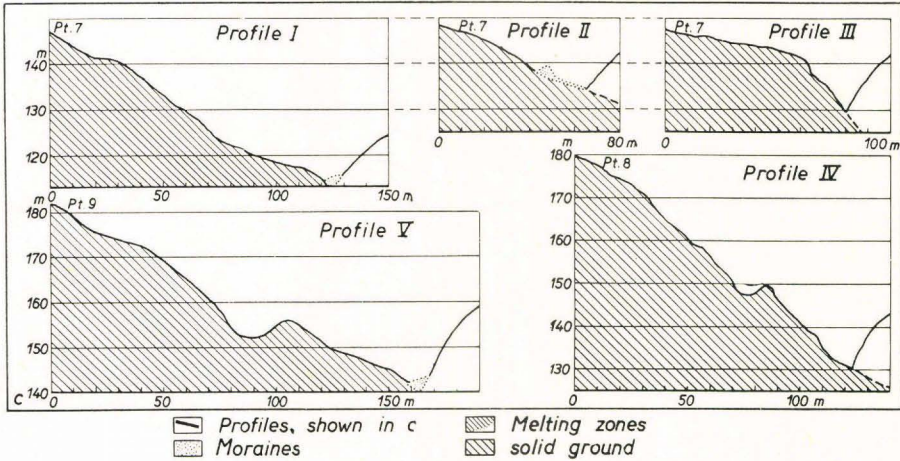
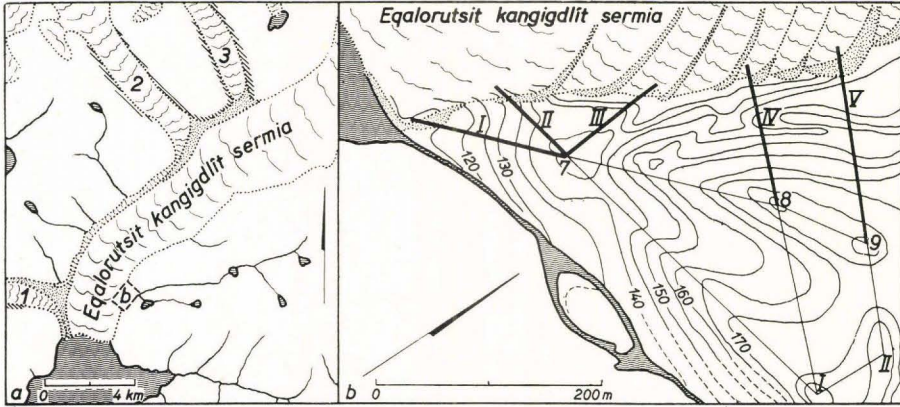


Fig. 17 a. General map of Eqalorutsit kangigdlit sermia. Compiled from aerial photographs, here on the basis of the Geodetic Institute working sheet 1:100,000. Melting zones added. Note that only the lateral glaciers have melting zones. Apart from a few areas around ice-dammed lakes (not shown on the map) the main glacier has no such zone.

b) Sketch map of the area near the glacier margin described in the text, also shown on the general map fig. 17 a. Heights calculated from point I, whose height was determined by altimeter at 180 metres above sea level. Sights from Points I and II to topographical points as well as sections and moraines.

c) The sections shown directionally on sketch map fig. 17 b.

The glacier was observed calving during the visit of 6th July. The phenomenon consisted of incessant falls of lumps of ice, first from one part of the front, then from another.

On its outermost stretch (the last kilometre behind the front) the glacier inclined 4.5° , whereafter it "flattened out" and had very little rise.

Along its entire length the south side of the glacier showed signs of a swelling of the ice. The signs of this were 1) mounds of displaced earth with old willows, 2) the grass nearest the glacier side but in the crevasses was still growing, and 3) the sheep tracks ended abruptly in the glacier at places now inaccessible even for sheep. As aerial photographs show melting zones around Niviarsiat qáqát, we intended inspecting the transitional area between that mountain region and Eqalorutsit kangigdlit sermia, but fogs and snowstorms prevented us from following the southern margin of the glacier as far as Niviarsiat qáqát.

In order to determine whether the glacier would continue to advance, and to what extent, some sections were drawn with the aid of measuring tape and hand-level; they are reproduced here in fig. 17 c. The directions of the sections and one end-point were fixed from the highest points in the vicinity of the base camp. Point I alone is marked by cairn and a bronze shield, but with the aid of the sketch map fig. 17 b; it should not be difficult to identify the other points in the area too.

As regards the front, the only photograph taken is that shown in fig. 15. The glacier is seen from a small headland just off the front at a height of about 30 m.

On the south side of the glacier the only moraines were a few very small lateral moraines, formed by the passage of the marginal crevasses along the rock sides, as shown in the photograph fig. 18. These moraines consisted partly of the material melted out of the glacier and forced up by the passage of the ice along the rock sides, and partly of the former permanent vegetation. The boulders were chiefly greenstone and gneiss. We had hoped to find sandstone and syenite as did A. Jessen 1894 at the west Sermilik glacier (Eqalorutsit kitdlit sermia), but the result of a protracted search was negative. The rock on the south side of the glacier, from the front to the inland ice, is gneiss exclusively.

On the accessible east surface of the glacier there were only a few sub-angular boulders, some up to 0.2 cbm. in size. In nearly every case they were greenstone, there being but few of gneiss like the ground moraine.

Because the medial part of the main glacier was impassable, we could not visit the three lateral glaciers coming down from the north; the observations recorded below were therefore made from the south side of the main glacier.

Lateral glacier 1 (see general map fig. 17 a) seems to have its lower part far below the level of the main glacier, from which it is separated by the latter's thick marginal moraine. This contrasts with A. Jessen's report above, where this lateral glacier is stated to be above the main stream. A zone of about 100 m in height might suggest that this glacier has shrunk considerably. The upper boundary of the melting zone



Fig. 18. Crevasses and moraines at the foot of point 7, between Sections II and III. The vegetation torn up by the ice. Photo WEIDICK. 1955.

seems to lie at the same level as the present surface of the main glacier. The surface of the lateral glacier is even and, apart from a thick marginal moraine, no moraines are to be seen on it.

Lateral glacier 2 is only a little inclined and has a melting zone of not much height. It joins flush with the main glacier and there is no difference in the levels of their surfaces. Like Lateral glacier 1, both 2 and 3 are delimited from the main glacier by the latter's large marginal moraines.

Lateral glacier 3 had a large melting zone analogous to No. 1.

Conclusion:

1894—1932: A. Jessen's 1894 map must be considered as fairly accurate for the region around the glacier front. A comparison with G. Hatt's photographs is impossible as long as the drawings by PETERSEN and BRUUN cannot be found; but as the vertical photograph of 1953 shows the glacier front at the same place as on the 1932 photographs, and also by comparison with Jessen's 1894 map is also in the same position as on that map, the assumption is that in the period 1894—1932 the front did not move to any demonstrable extent.

1932—47: On comparing Prof. Hatt's photographs with an oblique picture of 1947, no difference can be discerned in the position of the glacier. These two photographs lend themselves to comparison, because each shows on the north side opposite the front a small headland for use in identification.

1947—1953: The aerial pictures of these years indicate that there had been no change in the position of the front.

1953—1955: The 1953 aerial picture and the writer's photograph of 1955 show that no change had taken place. The people date the advance of the glacier to the spring of 1955, but still no demonstrable change in the position of the front could be seen in the summer of that year.

Summary:

1894—1932: Stationary.

1932—1947: "

1947—1953: "

1953—1955: " . The glacier expands in 1955.

Locality 9:

Egalorutsit kitdlit sermia (the west glacier, in Nordre Sermilik, according to A. JESSEN) is separated from Egalorutsit kangigdlit sermia by the large partial nunatak Akuliaruserssuaq. Like the latter glacier it is highly productive and, according to A. Jessen, the calving process is one of detachment (Medd. om Gr., Vol. 16, p. 97). In that volume G. MOLTKE and A. Jessen give a detailed description of the glacier with data of glacial incline, melting and external limits.

1894: The glacier is described by A. Jessen in 1894 as being in a state of rapid retreat (Medd. o. Gr., Vol. 16, p. 100), a statement that is based upon what was said by the inhabitants of the nearest outpost Niaqornaq: 1) In their lifetime the nunatak (see fig. 19) had become much larger, and 2) the glacier front had been much farther forward. Moreover, the rock walls along the glacier are polished and bare almost up to the edge of the plateau and have a very distinct boundary against the lichened flat ground above; that boundary is marked by the west side of a 1300-foot high lateral moraine devoid of vegetation.

The general conclusion stated in Medd. o. Gr., Vol. 16, pp. 106—7 is that over a broad front the ice from Kangerdluarssuk in the west to Egalorutsit kitdlit sermia in the east is retreating, there being a vegetation-free zone (marginal moraines) on this entire stretch along the margin of the inland ice. The zone is about 1000 feet wide on the west, narrowing eastwards on account of the steepness of the rock walls at Egalorutsit kitdlit sermia.

It appears from analyses of river water from the inland ice, made by Dr. K. RØRDAM, that over 50 per cent. of the substances suspended

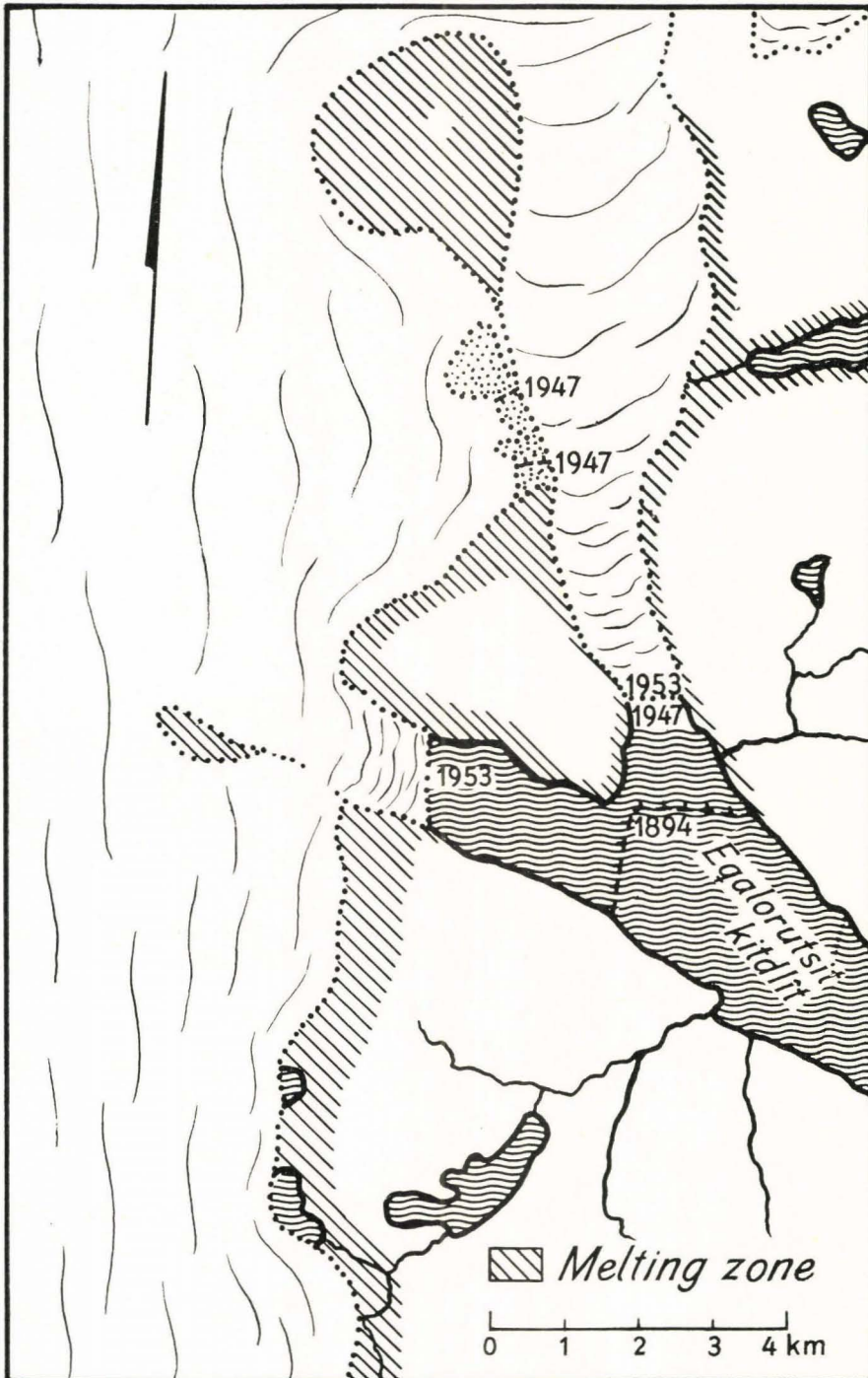


Fig. 19. General map of Eqalorutsit kitdlit sermia. Compiled from aerial photos and Geodetic Institute's working sheet 1:100,000. The glacier fronts of 1894, 1947 and 1953 added, as well as melting zones.

in a sample from a river from the glacier are humus, i. e. that the inland ice had been advanced over an area of vegetation (in 1894 the vegetation was about 1000 feet from the ice margin) at least 1000 feet wide, and simultaneously there had been an advance and retreat over an area of 1000 feet wide and in connection herewith an increase and a decrease in the thickness of the glacier amounting to 1200—1300 feet. A. JESSEN considers it impossible to define the period by the aid of the vegetation, but it must have taken place within a relatively short period.

1947—1953: Aerial pictures from these years show a marked change in the position of the glacier front since 1894. The situation of the ice margin in the years 1894, 1947 and 1953 is drawn into the sketch-map fig. 19. It can be seen that in 1953 the glacier was divided into two branches by a nunatak. In the western branch the ice retreated about 3 km between 1894 and 1953, in the eastern branch about 1.5 km. From 1947 to 1953 the glacier front of the eastern branch was almost stationary, whereas in 1947 it could not be observed from aerial pictures.

It is a remarkable fact that from 1947 to 1953 a change can be seen in the northern area of the nunatak: in this period it merged together with a smaller, more northerly nunatak.

Conclusion:

1894—1947: A comparison between Jessen's photograph and map and the 1947 aerial pictures shows a considerable retreat by the glacier front, for the eastern branch about 1.5 km, whereas nothing is known about the other branch. Nevertheless, although the front of the western branch could not be seen on the aerial picture, it is likely that this western arm retreated at any rate about 2 km and perhaps right back to the 1953 position, that is to say 3 km back.

1947—1953: For the eastern branch the aerial photographs show that the front was in the same position as in 1947, whereas nothing can be said about the western branch, as it does not appear on the 1947 photograph. Either it retreated about 1 km (see above) or in 1947 it was the same position as in 1953.

Summary:

1894—1947: Retreating and shrinking.

1947—1953: Stationary? or retreating? Shrinking.

Locality 10:

Kangerdluarssuk fjord. This is a lateral arm to Nordre Sermilik fjord, (running) northwest from the outpost Niaqornaq northwest almost

to the margin of the inland ice. In former days three glaciers debouched at its head, and of two of them we know that they still terminated at the fiord at the close of the last century.

1854—1856: In the cartographic material up to and including H. Rink: "Grønland", Vol. 2, p. 348 ff., Ikerssuaq is drawn very indistinctly. For these parts H. Rink's own map is reputed to have been made from sketches by P. MOTZFELDT. The shore-lines are not very accurate, but a peculiarity about the fiord is that only one glacier is shown reaching down to it.

1876: A. KORNERUP records the following after visiting the fiord (Medd. o. Gr., Vol. 2, p. 16): "On 29th July we rowed from Narsak in order to try to get over to the north side of Sermilik to Kangerdluarsukfjord. There was brilliant sunshine with clear, cloudless sky, its pure blue reflecting in the calm surface of the water together with Ilimausak's fiery-red and brown-striped rock wall and the white and bluish icebergs surrounding us on all sides with their incredible shapes. It was by no means without risk to move about in this labyrinth of icebergs, in which every moment we had to row close by one of these tottering ruins, which a gunshot or even a shout suffices to bring out of their unstable balance, to shatter as by an explosion and fall with a rush and a din into the fiord, where they caused a swell that could easily cause an umiak to capsize. However, we got across the fiord to Nia-kornak without incident, and from there rowed into Kangerdluarsuk, a rather pretty little fiord arm with steep rocky sides, where we pitched our tent near the ancient Norse ruins at Igdlorssuit. Here one can see three glaciers running direct from the inland ice, but only two of them reach right down to the water. In front of them all is very shallow, clayey water with extensive shoals of gravel and mud washed out from the glaciers, and landing was only possible at the middle one. This one is much more steep than Kragtut glacier and, according to Lieutenant HOLM's measurements, also moves a good deal faster, two points at a distance of 397 feet (125 m) and 860 feet (270 m) having velocities of 1.00' (0.32 m) and 1.63' (0.51 m) in 24 hours. The width of the glacier here is 1400 feet (440 m). Light coloured, completely naked belts on the rock sides along its margins indicated that a short while before it had spread much farther out than it did now. Had it been merely a couple of years ago that it retreated there would probably have been lichen or moss on the rock faces which it had left; but there was not a trace of vegetation to discover, wherefore perhaps that same spring it had been farther forward and only retreated during the summer. Now at the end of July it was pushing forward again. Notwithstanding its greater declivity and more rapid movement, this glacier was less

fissured than the Kiagtut glacier, and with greater ease than on the latter STEENSTRUP and a Greenlander walked across the ice to the rocks on the other side”.

As Steenstrup saw all three glaciers from the sea, we must presume that they are all correctly placed on the map.

1880—1881: To all appearances, Holm’s map of the region, dated 1880—81, is merely a copy of Steenstrup’s as far as this area is concerned.

1894: The same must be the case with that of JESSEN and BRUUN, 1894, which moreover is less accurate than Steenstrup’s. For that reason neither of these maps can be used for determining the position of the fronts of these glaciers. D. BRUUN visited the locality in 1894 and from Igdlorssuit at the head of the fiord had a sketch made of the fiord (the sketch was drawn by N. P. JØRGENSEN). Unfortunately, the sketch is so drawn as to show the fiord looking from its head. The sketch is published in *Medd. o. Gr.*, Vol. 57, p. 203. Bruun says nothing about the glacier in his text, but any other pictures and diaries from that expedition may perhaps provide better results. It would perhaps be rash to conclude from the 1894 map that, because of its similarity to Steenstrup’s of 1876, it indicates that the glacier was in the same position in 1894 as in 1876. A. Jessen (*Medd. o. Gr.*, Vol. 16, p. 106) states that as at Eq. kitdlit sermia, he observed wide melting zones around the glaciers in Kangerdluarssuk fjord but gives no indication of their extent.

1953: Fig. 20 shows Kangerdluarssuk fjord with glaciers and melting zones around them. On comparing with Steenstrup’s map, one observes that the melting zones very distinctly show the greater extent of the glaciers in 1876 according to Steenstrup. The latter says that only two glaciers (they must be the western and middle ones) reach down to the water, whereas now none of them extend so far. As it is also stated about the middle glacier that even in 1876 it had a melting zone, the necessary conclusion must be that in 1876 this glacier had already retreated somewhat, and that it went back still more in the period 1876 to 1953.

1955: The middle glacier was visited by the writer in June 1955. It was in the same position as in 1953. Its lower end is now about 20 m above the fiord. The height of the melting zone on Nûgâtsiarssuânguaq was about 70 m. Its height above the glacier surface decreased slightly towards the inland ice. It was not possible to see the fronts of the other two glaciers from the fiord.

Conclusion:

1854—1876: The sparse map material furnishes no clue to any changes in the position of the glaciers in that period.

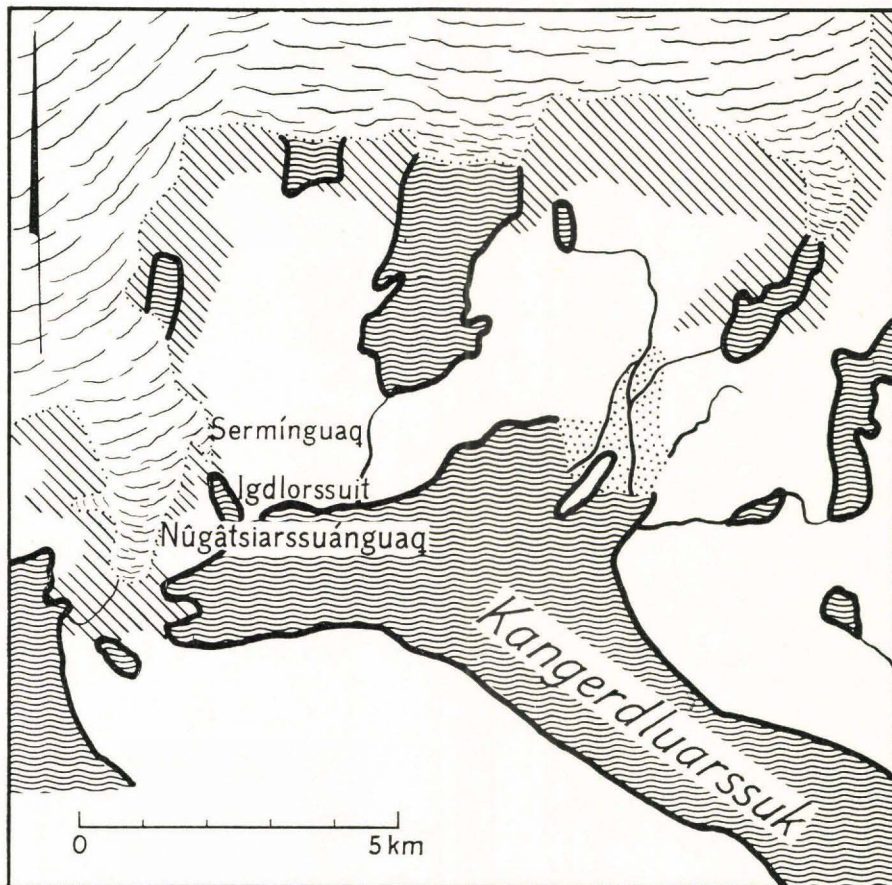


Fig. 20. General map of Kangerdluarssuk Fjord area, compiled from aerial photos and from Geodetic Institute working sheet 1:100,000. Melting zones added.

1876—1953: The dates 1880—1881 and 1894 are omitted here, it having already been stated that for the present nothing can be said about the position of the glaciers in those years. The following deductions may be made on comparing the positions in 1876 and 1953: As regards the western glacier the retreat is very great; in Steenstrup's time it reached out to the fiord, whereas now it lies about 1 km away from it; Niaqornaq peninsula, the neck of which was delimited by the inland ice in 1876, has now become connected with the rest of the land as a result of the retreat of this glacier. The retreat of the middle glacier is difficult to define. The record of its steepness and the shallow water in front of it suggests that its extreme end just touched the water at the head of the fiord. On this basis the retreat may be estimated at about 30 m. As regards the eastern glacier, all that can be said is that Steenstrup reported it as being in a much advanced position on his

map, whereas now its snout cannot be seen from the fiord; the supposition must be that this glacier made a long retreat between 1876 and 1953. The melting zones extend 2.5 km in front of its present limit, and Steenstrup's map would seem to indicate that in 1876 the glacier was very near the outer limit of the melting zone.

Summary:

For western, middle and eastern glaciers:

1876—1953: Retreating.

For the middle one (Sermínguaq):

1953—1955: Stationary.

Locality 11:

The ice margin between Kangerdluarssuk and Sermilik (Sermit-sialik): According to the work "Grønland", Medd. o. Gr., Vol. 61, p. 390, there are three bays north of Ikerssuaq fjord: "Kaleragdlit", (Qaleragdlit imâ), "Manitsup tunua" and "Kangerdlua", which in all have six small glaciers, all of them producing a little calf ice. Nothing much is said about the glaciers themselves, and what little there is provides hardly any information. The map material is also slender, and therefore it is impossible to say much about their oscillations. The six glaciers will be dealt with as one in the following. As there is no known name for them all, I have simply numbered them as on the general map fig. 21 e.

1853: For that year there is a sketch map of the north side of Ikerssuaq in H. RINK's collection of maps in the Danish Royal Library (Rinks Kortsamling No. 50). The map is so primitively drawn that no information can be given of the extent of the glaciers.

1854: Sketch map of Ikerssuaq, made by P. MOTZFELDT (Rinks Kortsamling No. 53). This map is reproduced in fig. 21 a. Like the above map, it is most crudely executed, but a few details may be singled out. The ice cap on *c* is probably Glacier No. 4, which does just debouch at the northern point of Manitsaq. The long fiord running northwestwards must be the river running southeast from the inland ice on Akuliaruseq. Only one glacier is shown east of Manitsaq, whereas now there are two, but the outlines of this section are so rough that a comparison with more recent maps is impossible.

1856—1857: On this stretch H. Rink's map is also distorted so much that it is difficult to make a comparison with later maps and aerial photographs, although the map shows all the ice fiords plotted in conformity with their present situation (see fig. 21 b). On this locality Rink, in Grønland II, 1857, p. 345, after describing the town Narssaq,

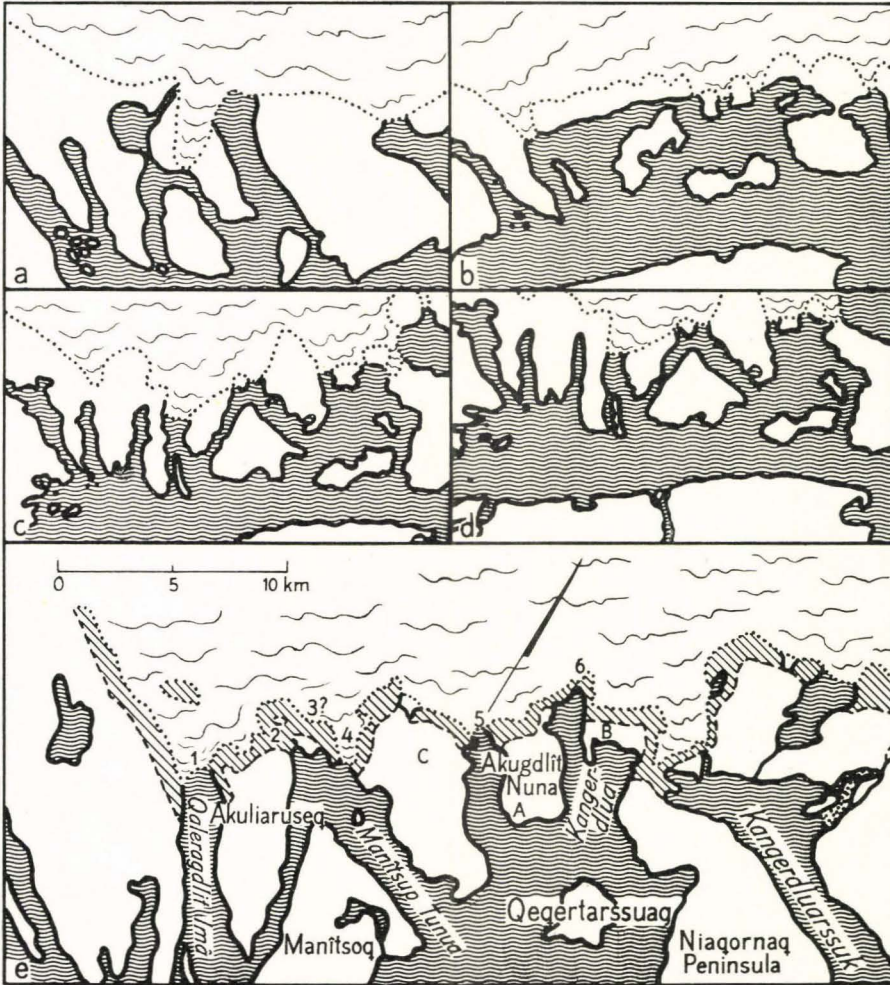


Fig. 21. The area north of Ikersuaq.

- a) Taken from P. MOTZFELDT'S map of 1854. Original owned by Royal Library.
 b) Detail from H. RINK'S map. "Grønland", Vol. II.
 c) Detail from J. C. D. BLOCH'S map. Medd. o. Gr. Vol. 7, pl. IX.
 d) Detail from K. STEPHENSEN'S map. From Medd. o. Gr. Vol. 51.
 e) Detail from aerial photographs.

writes: "moreover the district included Sisardlutok on the opposite island of Tuktotook, with 21 inhabitants, and five places on the north side of Sermilik, with in all 67 inhabitants, namely Nettoralik, Okevisokak, Toogdleronæt and Iglo. This fiord produces no small quantity of calf-ice and is therefore a genuine icefiord, and also the inland ice at several places goes down into the bays along the north side, where almost everywhere it overhangs the lower land as it were and threatens to cover it".

1890: In that year the region was mapped by Lieut. J. C. D. BLOCH, who writes in *Medd. o. Gr.*, Vol. 7, p. 160: "North of Tugtotok, Ikersuak extends right in to the inland ice, which at five places runs out through the narrow foreland to the sea, but without calving. Nothing but small pieces fell down from the ice, but these would sometimes be very trying, as the night frost at that time of year, the end of August, bound them together into an impenetrable mass". Thus Bloch was in these ice fiords, and his map, which despite its scale is fairly accurate in its outlines, shows the following noteworthy differences from the appearance of the region today:

1) There is no nunatak north of Glacier 1. Aerial photographs taken in September 1953 show that this nunatak is of the same pale shade as the melting zones along the margin of the inland ice. It is therefore highly probable that the nunatak has been left bare by the melting ice since Bloch's visit.

2) The region north of Manitsog, where now there is only one glacier (marked "4" on fig. 21 e), has three on Bloch's map. The melting zones on aerial photographs plotted on to the general map fig. 21 e, show that it is probable that Bloch's map is correct. Judging from the melting zones there are only two earlier outlets, but it is very probable that in some stage of the shrinkage the western arm was split into two. Provided Bloch's map is correct in this matter, the supposition is that already before Bloch's time the ice was melting in this region. This is not improbable since the neighbouring glaciers in Kangerdluassuk, as already described, seem to have been on the wane even prior to 1876.

3) The region north of "Kapitaq" (now Qeqertarsuaq): For this area the coast lines on Bloch's map are somewhat distorted, but here again the extent of the inland ice on this map agrees on the whole with what is indicated by the melting zones as to the former extent of the inland ice. For instance, Region B in fig. 27 must have been almost a nunatak in Bloch's time, whereas now it is merged together with the Niaqornaq peninsula.

1912: This year the region was visited by the ethnographer K. BIRKET-SMITH and the zoologist K. H. STEPHENSEN. On Glacier No. 1 the latter writes (*Medd. o. Gr.*, Vol. 51, p. 88): "Right at the head of the bay cutting in north of the island of Nûk and ending in a large glacier, are two kittiwake cliffs; the first (on the left side) is not very large, but the second (on the east side, almost adjacent to the glacier) is the home of immense numbers of kittiwakes".

It is possible that the inner limitation of the glacier by this bird cliff may be useful for future comparison. The map accompanying STEPHENSEN's paper in *Meddelelser om Grønland*, Vol. 51, has nothing

new to tell us, being very similar to Bloch's of 1890, except that there is one small deviation from that map: A small nunataq between Glaciers 3 and 4 has now disappeared. This may be an error, or possibly an actual observation.

1953: There are aerial photographs for that year; they were referred to under the year 1890.

Conclusion:

It is presumable that the entire stretch between Kangerdluarssuk fjord on the west to the region north of the beginning of Torssukátak strait has retreated considerably since 1890, and probably much earlier. The region more to the west, from Torssukátak to Sermilik (Sermitsialik), is also shown on aerial photographs dated 1953 to have a wide melting zone in front of the ice margin, but there are no data for that shrinkage.

Summary:

1890—1953: The margin of the inland ice throughout the region is retreating.

Locality 12:

Sermilik or Sermitsialik. In Sermilik fjord, north of the trading station Qagssimiut, is a lobe of the inland ice which will here be called the Sermilik glacier. It is one of the most productive in Julianehaab District. The name Sermilik is used by the local people of Qagssimiut, the name Sermitsialik is much older and has been employed by all travellers since the days of HANS EGEDE up to the present.

Almost all these travellers mention the glacier, but only few people have visited the fiord. During an expedition in 1777—79 ANDREAS BRUUN and AARON ARCTANDER planned to travel up the fjord but had to abandon the attempt on account of the large masses of ice (Norges Svalb. og Ishavsundersøkelsers Meddelelser No. 58, 1944, p. 9). Even right up to 1854 the place had not been mapped by Europeans.

1845: In "Grønlands Historiske Mindesmærker", Vol. 3, p. 831, we read: "It is true that the Greenlanders tell that there are no small number of remains of European houses in the two fiords Immartinek and Sermitsialik, which cut into the land west of Ikersoak. But although an inspection of these two unknown fiords was promised, it is not possible to communicate any news about them, either antiquarian or of any kind. It would seem that the natives only very rarely visit these *ice-fiords*¹⁾ and that perhaps no European has ever penetrated them

¹⁾ Italics by the present author.

since the country became recolonized" a somewhat negative description. The information that Imartuneq alongside Sermilik (Sermitsialik) is called ice-fiord is interesting. The inland ice now lies about 3 km from the head of the fiord and one might be tempted to assume that it had retreated. However, the melting zones show that in recent time the inland ice has never got so far as to the head of the fiord. The inference therefore is that the expression ice-fiord here must be interpreted as meaning that the fiord is sometimes full of calf-ice from Sermilik.

1854: A map of Sermilik fjord, astonishingly well drawn for those days, was made only a few years after the above negative description. It is contained in RINK's map collection in the Royal Library and is marked: "Sermetzialik by MOTZFELDT 1854". At that time P. Motzfeldt was an assistant at Qagssimiut and travelled a good deal with H. RINK in the northern part of Julianehaab district. In Rink's book "Grønland", Vol. 2, this area was drawn from Motzfeldt's sketches.

The outlines of Motzfeldt's map are very distinct and accurate and one can see the small headland a few hundred metres from the glacier front (at Bloch's 1890 base). The position of the ice front on this map will be referred to below under "Conclusions".

1890: In that year the glacier was visited by Lieut. J. C. D. BLOCH, the only author to give a more detailed description of it (Medd. o. Gr., Vol. 7, pp. 153—158). He measured the rate of movement of the ice and found it to be about 18 feet/24 hours (about 6 m/24 hours) at the maximum point. The fiord being very shallow, calving proceeded by means of falls.

In addition to the description of the glacier Bloch's report contains a detailed map of it, providing useful clues for a determination of the front in 1890.

Bloch states that the Greenlanders at that time spoke of the glacier as advancing, indeed they were afraid it would reach Qagssimiut in twenty years! That it was at any rate stationary was evidenced by the thick, loose earth layers extending to the glacier front, and the vegetation was also right up to it. In other words, in contrast to the front more to the east, in Nordre Sermilik, the Sermitsialik glacier in 1890 was stationary or advancing.

1894: DANIEL BRUUN's "Arkæologiske Undersøgelser i Julianehaabs District 1894" (Medd. o. Gr., Vol. 16, p. 249) contains the following information about the situation of the glacier: "Below Ligkistefjældet in Sermitsialik, about half a Danish mile (about 3¹/₂ km) from the glacier and on the left side of the fiord, lies a ruin. It is not situated near any stream but 200 m from the shore of a small bay, on evenly

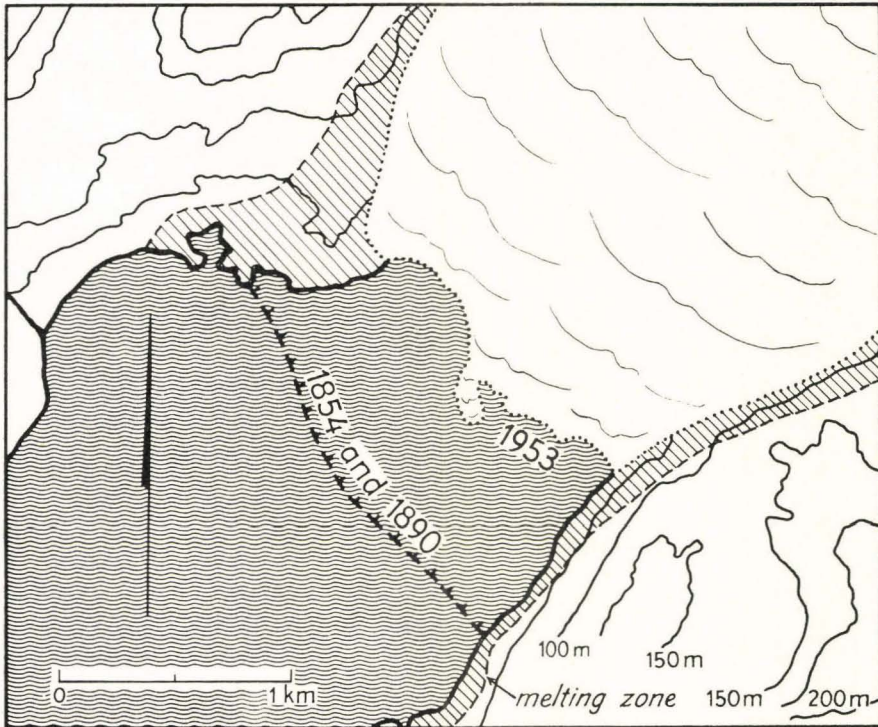


Fig. 22. Sermilik (Sermitsialik). Sketch map drawn from Geodetic Institutes map. Presumed position of glacierfront in 1854, 1890 and 1953 added, as well as melting zones.

sloping ground, with Ligkistefjældet rising behind" . . . and farther down on the same page: "In Sermitsialikfjord there is another ruin on the right hand as one sails into the fiord. The place is called Aularat (meaning: "where it shakes") and is on the northwest corner of the large island between Sermitsialik and Immartunekfjord and about $1\frac{1}{2}$ Danish miles from the glacier". These particulars of the distance of the glacier from the ruin groups are scarcely exact, so it is doubtful whether they can be used for determining the position of the glacier front.

1947 and 1953: Aerial photographs dated 1947 and 1953 reveal a considerable change in the position of the glacier front since Bloch's time. It will be seen that the ice front has retreated about 700 m since 1890, the small headland at Bloch's base now being farther forward in front of the glacier. Bloch reported in 1890 that the vegetation reached right down to the glacier and that it was to be considered as advancing then. If we examine the extent of the melting zone (plotted on the sketch map fig. 22) it will be seen to exceed the headland used by

Bloch in 1890, the assumption now being that the glacier was advancing even after that year, after which it retreated to its present position.

1955: When the writer passed Qagssimiut in July 1955 on the way to Qôrnoq fjord, the 65-year old hunter GUSTAF JENSEN imparted the following information about the Sermilik glacier:

1) The front had twice retreated in his time, but he was unable to give dates.

2) The lumps of ice produced by calving had become larger of late, but the glacier front itself was now retreating.

3) In the vicinity of the glacier front moraines are now lying far from the present front (the glacier had previously been nearer to them). Moreover, vegetation (herbaceous plants) had begun to grow where formerly there was ice.

This information accordingly confirms that the ice is now retreating, but there is nothing to show when the retreat began. The story of two retreats is very interesting and it is possible that more extensive information would give a better result. This, however, would mean staying at the outpost station long enough to ensure that all the older people were questioned.

Conclusion:

1854—1890: A comparison between Motzfeldt's and Bloch's maps shows the glacier front at the same place. The glacier being in an advancing phase in 1890, it is presumable that between 1854 and 1890 it retreated as from 1854, then before 1890 advanced again and returned the 1854 position in 1890.

1890—1947: A comparison between an aerial photograph for the latter year and Bloch's map indicates a retreat of 6—800 metres. The most probable explanation is a continuous advance after 1890 to the extreme limit of the melting zone, followed by a retreat, followed again by a new advance and retreat.

1947—1953: According to aerial photographs: Stationary.

Summary:

1854—? : Retreating.
?—1890: Advancing.
1890—? : Advancing.
?—? : Retreating.
?—? : Advancing.
?—1947: Retreating.
1947—1953: Stationary.

Locality 12 a:

The ice margin north of the Illoka (now authorized: Ilorro) area: The literature has not much to say about the long stretch between Sermilik fjord and the glaciers at Qipisarqo; but there are one or two details that may be of importance:

1) The ice-dammed lake at Isortoq:

1855: A map, labelled Julianehaab's Northwest District, drawn by MOTZFELDT in 1855, shows that here the inland ice reaches down to and calves into a lake. RINK's 1856 map is a copy of Motzfeldt's and consequently shows the same position.

1890: BLOCH's map of that year also indicates that the ice runs out to the lake. As Bloch himself was in the neighbourhood of the lake, having visited the spot marked Point 823' on his map, the probability is that the map is a reflection of his own impression and not a copy of earlier ones. Unfortunately, Bloch's account of his journey, in *Medd. o. Gr.*, Vol. 7, does not describe the lake. On the ice margin in its vicinity he writes (page 158): "At the middle of Sermitsialik a fiord runs northwards, dividing itself into three arms. The eastern arm is Siorak, which runs northwards to $\frac{1}{4}$ mile from the inland ice, from which several streams flow out and fill Siorak with so much silt that it is impossible to reach the head of it. A mile more to the west the fiord Isortok runs northwards. Its entrance is only 100 feet wide, with the result that the stream becomes so rapid that entry is only possible at the turn of the tide; but inside the mouth the fiord widens and several rivers debouch at its head, the largest, coming from a lake a $\frac{1}{2}$ mile more to the east, contains no less than 1,140 gr. silt to a cubic metre, so it is no wonder that the adjacent waters silt up in the course of time. From a peak south of the lake we had an excellent view over the lake and the surrounding country. Here the inland ice, which with a slight incline slopes down towards the coast land, has not the impressive thickness of farther north, and its only outlet of any importance is in Sermitsialik; otherwise the margin everywhere is stationary. Round about low rocks peep up at the outer edge of the ice, so that its slight thickness can be seen; that there nevertheless are so few nunataks is due to the fact that the land under the ice is of the same nature as the coast land there, where only few peaks of 1000—1500 feet project in the fiord and lake-filled lowland". The whole report gives an impression of a marginal zone in a melting condition, with no seracs and no steep inclination. The only exact measurement given in the report is that from the inland ice to Sioraq, stated as being a quarter mile (2 km). On present-day maps the distance from the ice to Sioraq seems to be about 1 mile (7 km). Presumably Bloch's estimate was in error: aerial

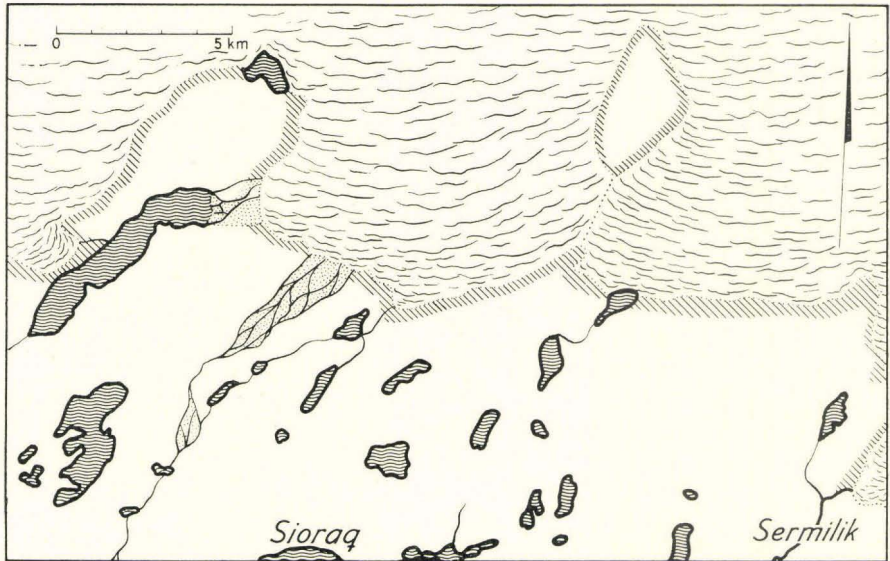


Fig. 23. General map of area between Qipisarqo and Sermilik glacier. Drawn from aerial photos of 1953. Melting zones inserted.

pictures do not show such a wide melting zone as to make it a reasonable assumption that the glacier has only been a quarter mile from Sioraq in recent time.

Regarding the lake, it is quite probable that the ice formerly ran into it, because the aerial pictures of 1950 and 1953 show a melting zone such as that in fig. 23. The inland ice is still only a few hundred metres from the lake.

2) The region just east of the Sermilik glacier:

Motzfeldt's map of 1855 can furnish us with no information about this region. It became the starting point of C. MOLTKE and T. V. GARDE's inland ice expedition of 1893, and they describe the ice margin as follows in *Medd. o. Gr.*, Vol. 16, p. 20: "From a peak about 1400 feet high we had a fine view over the glacier itself and the section of the land and the ice immediately west of it, and could carefully select the point most suitable for an ascent of the ice. This point lay half a mile west of the glacier and about 1000 feet above sea level. The approach to it lay across a rather rough hilly terrain but did not seem to present much difficulty, and as the surface of the ice farther in seemed to be fairly passable, though dark streaks and shadows round about suggested the presence of more difficult conditions, we determined to try our luck there. So we rowed along the NW-land as far in to the glacier as we dared". It will be seen that this report tells us nothing

about the position of the margin of the inland ice. Nor does it say anything about the terrain and the ice margin. It is possible that the picture of the region, Medd. o. Gr., Vol. 16, Pl. V, when compared with later photographs from the same spot will show any changes at the ice front. Aerial photographs all along this part of the ice margin show melting zones, but at present nothing can be said of their age.

Frederikshaab District.

The district will be described as one unit, the landscape being of uniform character. Apart from an alpine region around Sánerut, it may be divided, like the Godthaab District, into the low coast land ("the strandflat") and the higher, but smoothly rounded and hilly interior. Both forms of landscape attain wider dimensions in the Godthaab District, for there the ice-free border is much broader than in the Frederikshaab District. At both the southern and the northern boundaries of the latter the inland ice reaches out to the sea (Qipisarqo on the south and Frederikshaabs Isblink on the north).

All the glaciers to be described are lobes from the inland ice reaching the sea, though they may, as in the case of Frederikshaabs Isblink and Sioralik in the Sermiligårssuk fjord, be separated from it by a "sandr" (outwash plain). Of the glaciers the following are productive:

- Nordre Qôrnoq glacier: Only slightly.
- Arsuk glacier: Only slightly.
- Sermiligårssuk glacier: Very productive.
- Sermilik glacier: Highly productive.
- Avangnardleq in Kvanefjord: Very productive.
- Nigerdlikasik glacier in Kvanefjord: Only slightly.

Locality 13: Qipisarqo.

This is actually the name of the narrow, winding channel between the island of Sánerut and the Kînâlik area. As the glaciers, that is to say the two tongues of the inland ice near the channel, have no names, they are called the Qipisarqo glaciers in the following account.

These two glaciers form tongues from the inland ice, and in appearance they strongly resemble Frederikshaabs Isblink, for there is a large outwash plain in the front of both. Only one of them, here called Nordre Qipisarqo glacier, is described in the earlier literature. Although of the same size as the Sermilik and Sermiligårssuk glaciers in the district, they are rarely more than mentioned, being difficult to approach owing to the outwash plains.

13 A: Nordre Qipisarqo glacier:

1751: PEDER OLSEN WALLØE in his diary (Peder Olsen Walløes *Dagbøger 1739—1753*, Grønlandske Selskabs Skrifter V, p. 67) refers to this glacier with the quite brief remark that the iceblink “has grown right down to the sea” and otherwise is not unlike the one at Frederikshaabs Isblink. Presumably the expression “grown down to the sea” means merely that the glacier extends down to the sea and not that the glacier was advancing at that time. However, later on (p. 68) Walløe writes on the same locality: “On the 8th the wind humoured us; we sailed all day long between large and small islands; the whole day we kept in sight of the aforesaid iceblink, which has conquered a large part of the land on a stretch of 5 or 6 (danish) miles (time will show how long it will be before it covers the rest), which as yet consists of only some short and narrow headlands. The Greenlanders say that the ice increases greatly every year, which is mostly recognizable from the fact that some tracts where the Greenlanders used to go hunting are now quite overridden and covered by ice, and, as far as may be concluded from their simple chronometry, the change that has taken place in a score of years is very considerable”. It will be seen that this text gives only an impression of a general advance by the glaciers and the inland ice in the period between 1730 and 1750, but nothing specifically about Nordre Qipisarqo glacier.

1809: On the Qipisarqo channel and glacier the mineralogist K. L. GIESECKE writes for the dates 19th—20th June, 1809 (*Medd. o. Gr.*, Vol. 35, p. 204): “Wir setzten über Senneruts südliche Bucht, und blieben eines zunehmenden Südstürmens und Regens wegen zu Itiblingoak liegen. Dies ist eine Stelle, wo man, um sich den Weg zu verkürzen, den Umiak über einen schmalen Landstrich aus einem Fahrwasser in das andre tragen kann” . . . and some sentences later in the diary: . . . “Dieser Trageplatz ist der schmaleste, den ich im ganzen Lande getroffen habe; denn er ist in der Flutzeit nur 30 Schritte breit, und heisst daher Itiblingoak. Man hält an solchen Stellen gewöhnlich Nachtquartier, um das doppelte Löschen und Laden zu ersparen. Die herrschende Gebirgsart in dieser Gegend ist Urgrünstein; der Eisblink ist nur eine Meile von hier entfernt.—

“Dienstags, den 20 Junius mussten wir wegen Südwesturm den ganzen Tag stille liegen. Ich gieng auf Excursion in das östliche feste Land, gegen den Eisblink zu—”. If it was on Nyeboe’s Kanal (Itivdliatsiaq) Giesecke spent the night, however, a mile is too short a distance. We must suppose that the “mile” was a very approximate measure and therefore unsuitable for determining the position of the glacier front.

The subsequent travellers also mention the glacier “en passant”, thus:

1828: W. A. GRAAH in his diary: "Undersøgelsesreise til Østkysten af Grønland 1828—31" merely writes on pages 42—43: "Around the bay between Sennerut and Itibleitsiak isthmus, which forms the border between the districts of Julianehaab and Frederikshaab, the mainland almost everywhere is covered with glaciers, which in some places stretch down to the sea".

1857: H. RINK ("Grønland" Vol. 2, p. 334) states only that near Qipisarqo the inland ice reaches out to the sea at several places "and rivers emerge from it, which by their dirty water have filled the bays with a clayey bottom which dries at low water, so that the channel can only be passed at high water in a boat". Both Nordre and Søndre Qipisarqo glaciers are plotted on Rink's 1857 map, but too indistinctly for exactly determining the position of the glacier fronts.

1880: In that year the geologist N. O. HOLST reports in his book "Berättelse om en resa till Grönland" (S. G. U. Series C, No. 81, p. 32) in somewhat greater detail that the moraine north of Qipisarqo's northern glacier had a barren belt of only 30 feet wide on September 17th. He believes that the melting zone was due either to the melting of the ice that summer or the cold from the glacier, and then writes: "Thus whereas in this phenomenon I considered I had no safe measurement of the latest melting of the ice, I thought I could find one in the distance between the ice and the terminal moraine lying before it. That distance may vary, but on the whole the moraine is not far from the ice. On the other hand it may also be that the inland ice had pushed forward over the terminal moraine. This, which was the state of affairs at Kippisakko's glacier, must be assumed to mean that the ice here has advanced".

1890: In that year Lieut. J. C. D. BLOCH writes about the glacier (Medd. o. Gr., Vol. 7, p. 152): "South of Kinalik there is another stationary glacier of much greater thickness than the one described above (i. e., Søndre Qôrnoq glacier. *Present author's note*). Here the ice is pressed down between the high Kinalik and the nunatak half a mile to the east. The foreland here being very low, the ice has the opportunity of spreading out and presenting a larger surface to the influences of sun and rain, so that melting keeps pace with supply. At this southerly latitude and in such a rainy climate the melting must be very considerable, and this is aided by the dust from the moraine plain in front which, with the prevailing northwest winds, is carried up over the ice which it covers in a thin layer suitable for absorbing the rays of the sun. In former days the ice here extended far out, for the island of Umanak was striated everywhere, as was the west part of Sanerut up to a height of 1500 feet. On the large moraine plain extending three quarters of

a mile from the ice front, there were no large stones any more than on the surrounding terrain, such as is the case at Frederikshaab iceblink. Here and there on the plain the rock cropped out like small islands, all polished and striated in the direction S. 75° W. Along the many streams running through the plain were the beginnings of fairly luxurious vegetation. In front of the ice was a double terminal moraine with an interval of 100—200 feet between; the innermost one was 45 feet high and 100 feet wide and was often cut by glacial streams, which there contained 380 grammes of silt per cubic metre. Up on the ice there were several of the ice cones which KORNERUP mentions at Frederikshaabs Isblink; but they reached only a height of 5 feet above the ice”.

On Bloch's map of the region, which is on a large scale, the details around the glacier are fairly clear. Allowing an error of about half a kilometre on the map, the conclusion is warranted that the glacier was of the same extent as it is now. The only difference is that on Bloch's map, between Søndre and Nordre Qipisarqo glacier, there is a nunatak which cannot be discerned in aerial photographs of 1943 and 1947. However, as will be seen in fig. 24, the melting zones at the glacier sides show that there had been such a nunatak between Nordre and Søndre Qipisarqo glacier, but that now with the melting of the glaciers it has merged with the surrounding terrain.

1943? and *1947:* Aerial photographs from the Geodetic Institute for those years show very distinct melting zones, here plotted on fig. 24. No change in the position of the glacier between 1943 and 1947 can be seen on the pictures.

Conclusion:

1809—1880: Giesecke's estimate of about a (danish) mile as the distance between Nyeboe's Kanal and the glacier is certainly incorrect. There is now at least two miles between them, and the melting zones give no indication that either of the glaciers were formerly more than 7—800 metres ($\frac{1}{10}$ th mile) ahead of their present position. It should be added that the text is not clear as to whether Giesecke visited the Søndre or the Nordre Qipisarqo glacier region. Neither W. A. Graah's description of 1828, nor H. Rink's of 1857, provides any clue as to the extent of the glacier.

1880—1890: M. O. Holst's description makes it reasonable to suppose that in the former year the glacier was in its extreme position. It is also told how it was pushing out over its terminal moraines, but without stating how large the melting zone was. Presumably the glacier was advancing. Holst's description cannot be used for a direct comparison with Bloch's of 1890, but as Bloch states that in 1890 there were

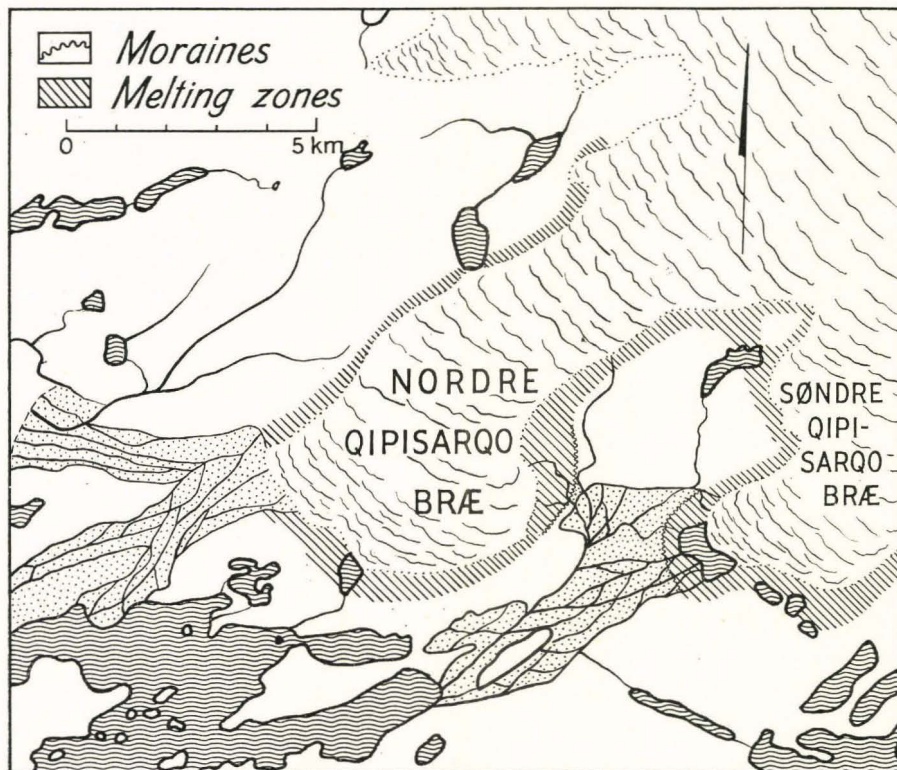


Fig. 24. General map of Nordre and Søndre Qipisarqo glaciers. Drawn from aerial photos. Melting zones added, as well as the outer moraines observed in the aerial pictures, possibly indicating the maximum of the glaciers around 1890.

two terminal moraines, whereas Holst records an advance over *the* terminal moraine (italics by the present writer), the assumption is that there was a retreat between 1880 and 1890—if the two reports deal with the same region.

1890—1943?: Bloch's map of 1890 shows that between Nordre and Søndre Qipisarqo glaciers there was a nunatak, whereas on the aerial photographs of 1943? nothing but land is to be seen. As the melting zones also indicate a former nunatak at this spot (see fig. 24), we must presume that in the period from 1890 to 1943 the glacier shrank and probably retreated too.

1943?—1947: On aerial photographs of the glacier from these two years there is no trace of any change in the position of the glacier.

Summary:

1880—1890: First a small advance, then retreat.

1890—1943: Retreating.

1943—1947: Stationary.

Locality 13 B:

Søndre Qipisarqo glacier: There are no written reports about this glacier, unless, as suggested above, it was this and not the northerly glacier that GIESECKE approached in 1809.

1890: As with Nordre Qipisarqo glacier, BLOCH's map suggests that, with a margin of error of about half a kilometre, the glacier looked the same in 1890 as it does now.

1943 and 1947: Aerial pictures taken in those years show distinct melting zones around Søndre Qipisarqo glacier. As at the other glacier, no change can be seen in the position of the front between 1943 and 1947.

1955: Dr. HANS PAULLY, of the Cryolite Company, flew over the region in 1955 and has kindly given the writer a picture taken on this flight. A comparison with the 1943 and 1947 photographs shows no change in the position of the glacier.

Conclusion:

1890—1943: The nunatak shown on Bloch's map, discussed under Nordre Qipisarqo glacier, indicates a shrinkage here too and with it a probable retreat of Søndre Qipisarqo glacier in that period.

1943—1947—1955: As already stated, aerial pictures of these years show no difference in the position of the glacier front, and so it was presumably stationary during this period.

Summary:

1890—1943: Retreating.

1943—1947: Stationary.

1947—1955: Stationary.

Locality 14:

The Qôrnoq glaciers: These two glaciers form tongues from the inland ice and in the available literature are called merely the North and the South Qôrnoq glaciers. They are separated by a partial nunatak, partial in the sense that it faces and is delimited by Qôrnoq fjord along a short distance and thus is not surrounded by ice on all sides.

The glaciers are not described much in the literature, notwithstanding the fact that the ancient calm-water route between Arsuk and Julianehaab passes close by the south glacier.

1809: For example, GIESECKE on 9th August 1809 writes merely than he "sezzen hierauf über Sennerutsfiord, den Eisblink, und die Insel Kornok vorbei".



Fig. 25 a.

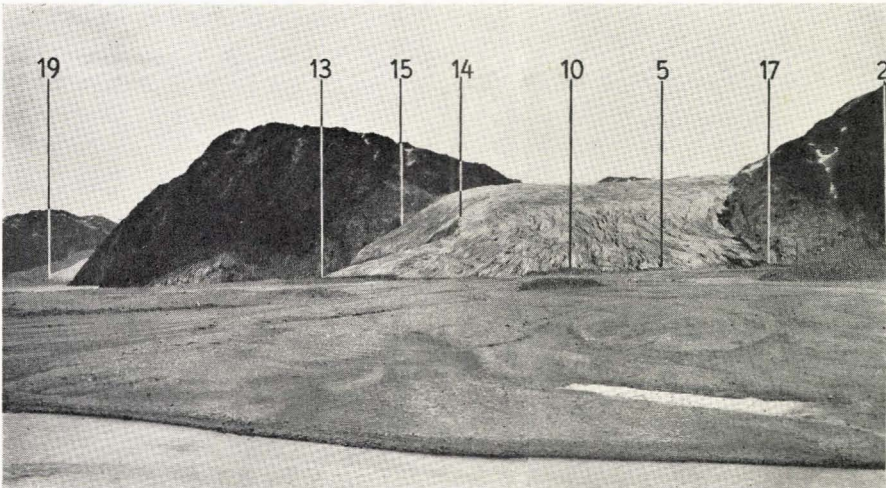


Fig. 25 b.

Fig. 25. Qôrnoq glaciers, seen from Nûk peninsula.

a) Photo. J. C. D. BLOCH 1890. Negative owned by Arktisk Institut.

b) Photo. A. WEIDICK. 24th July, 1955. The numbers refer to the sights alluded to in the text.

1829—1833: In RINK's collection of maps in the Royal Library there is one marked: "Map of Ross' journey 1828—33". The scale is small and it is only possible to see that both glaciers reach the sea. The map will be described in greater detail under Arsuk glacier.

1857: Rink's map in "Grønland", Vol. 2, is inferior to the Ross map in respect to the outlines of this section; one sees only that there are two glaciers, but their margins are impossible to discern.

From 1880 we are better informed about the glaciers and therefore they will be dealt with separately in the following.

14 A: Søndre Qôrnoq glacier:

1880: In that year N. O. HOLST (S. G. U., Series C, No. 81, p. 56) writes: "At Kornok's south glacier the terminal moraines had a height of about 30 feet and surrounded the ice rather completely, almost like a rampart". The ice must have lain behind that rampart, but there is no indication of how far behind. If there had been a large stretch as is the case today, however, something would surely have been said about it in the description. Presumably the ice lay close behind the largest moraines, which were in fact about 10 metres high and in 1955 lay in a large arc around the glacier, about 400—800 m from the glacier front itself.

1890: Lieut. J. C. D. BLOCH describes the glacier in some detail (Medd. o. Gr., Vol. 7, pp. 151—152). The inclination of the upper part of the glacier surface is given as about 30°, at its lowest part about 10°: in other words, it flattened out on the outwash plain before it, which is not the case now when the glacier rises very steeply from the plain towards the inland ice. Bloch also states that as it presses its way between the Kinâlik side and the nunatak it becomes fissured at its narrowest part in two directions, whereas at its lowest part it is spread out like a fan and therefore noticeably fissured only in a radial direction.

Block's chart shows the glacier on a scale so small that details cannot be seen. But negatives of two photographs of the glacier, both probably taken by Bloch in 1890,¹⁾ have been found at the Mineralogical Museum in Copenhagen. One is reproduced here as fig. 25 a. These negatives were mixed up with others taken by Lieutenants C. H. RYDER, J. A. D. JENSEN and C. P. O. MOLTKE. As they all date from the period 1890—94, and as Bloch, as far as can be seen, was the only one of these travellers to visit the Qornoq glaciers, the two negatives in question must be his. Both photographs show the ice which, as Bloch describes, flattens out towards the margin, and also that the moraines in front

¹⁾ Copies of the photographs were later found with information, confirming that these photos were taken by HOLST 1890.



Fig. 26. Søndre and Nordre Qôrnoq glaciers. Aerial photo 23rd July, 1948. Marginal positions 1880, 1890, 1903 and 1938 added. Copyright Geodetic Institute.

of the glacier are almost covered by it. Presumably, therefore, in the period between 1880 and 1890 the glacier moved forward to some extent.

1903: For that year there is a picture drawn by D. BRUUN; it is reproduced in both *Medd. o. Gr.*, Vol. 56, p. 116 and Vol. 57, p. 215, and was drawn from a photograph. The glacier is seen from almost the same spot as in one of Bloch's 1890 photographs. It does not seem to have changed much since that year. Bruun himself describes the glacier in his survey of Norse ruins in the districts of Frederikshaab and Godthaab (*Medd. o. Gr.*, Vol. 56, p. 117), where each small area is prefaced by a geographical description. Describing the glaciers of Qôrnoq fjord he writes: "Between the two glaciers stands a tall and, facing the fiord, very precipitous mountain which, on account of its position between the two glaciers and the water, is called "Nunatak". It is the breeding place of kittiwakes and glaucous gulls. The southerly glacier is almost "dead", for it is melting on the aforesaid narrow foreland; the northerly one, however, calves into the fiord. As the south glacier almost blockades the fiord, the ice masses produced cannot get away but strand as a rule just north of the mouth of the narrow stream, where they then melt". On the same page he also says that "Of these two glaciers, the southern one protrudes almost over to the west bank of the fiord, but leaves a narrow and shallow channel, 150 metres wide at most, open between the west bank and the narrow moraine accumulation of clay, sand, gravel and stones below the glacier".

1938—1949: The geologist R. BØGVAD, of the Cryolite Company, took some photographs of the glacier in 1938 and 1949; on being compared with Bruun's pictures of 1903 the change especially between 1903 and 1938 is very apparent. It can be seen that the light-coloured melting zone on the surrounding mountains indicates the extent of the 1903 glacier fairly accurately. Plotted on to a detailed map of the glacier it can therefore be used for a good indication of the difference between the two phases of 1903 and 1938.

Between 1938 and 1948 the retreat is not so conspicuous, but it can be seen that 1) the glacier shrank somewhat in the period, and 2) the area north of the ridge now dividing the south glacier into two parts, north and south, has shrunk and melted farther back (see sketch on aerial picture, fig. 26).

1948: An aerial photograph of 1948 shows, as already said, that, when a comparison is made with the 1938 photograph, the northern part of the glacier front continued to retreat. From 1948 to 1949 the front presumably remained stationary.

1955: The writer during his visit to the glacier in 1955 was unable to see any change in the position compared with the 1949 pictures.

Having regard to the possibility of future observations of the glacial changes here, two bronze shields were set out. The bronze shields are covered with cairns and marked GGU5501 (measuring point 1) and GGU 5506 (measuring point 2). Time and weather permitted the taking of only few sights with the theodolite from Point 1 to characteristic features on the glacier. These are plotted on the photograph fig. 25 b and the angles reckoned from sight to measuring point 2 are shown in the following table:

Sight to point	Angle	
19	64° 37.2'	The values refer to one single set
13	48° 28.9'	
15	45° 09.7'	
14	39° 56.0'	
10	33° 24.9'	
5	24° 31.2'	
17	20° 18.9'	
M. point 2	0° 00.0'	

The height of the melting zones above the present surface of the glacier (which thus must express the loss of volume in the period 1903—1949) is about 100 m at the glacier front. It lessens only very gradually towards the inland ice.

Conclusion:

1880—1890: As the glacier front at the time of Holst's visit in 1880 must have been just behind the moraine mound, whereas on Bloch's photograph it can be seen almost covering the large, outer moraine, an advance of 30—50 metres between these two dates must be assumed.

1890—1903: A comparison between Bloch's photographs of 1890 and Bruun's drawings of 1903 reveals no change in the position of the front.

1903—1938: A considerable retreat is indicated by a comparison between Bruun's drawing of 1903 and Bøgvad's 1938 photographs. The distance from the outermost moraine to the ice front in 1938 varies between 400 and 800 metres. Before the ice front is a small line of moraines suggesting one slight re-advance between 1903 and 1938.

1938—1949: The southern part of the glacier (south of the mountain ridge) does not appear to have retreated in this period and the shrinkage of this part of it is slight: it is not visible at the lower part but becomes clear above 200 metres.

On the other hand, the eastern part of the glacier (north of the ridge) continued its retreat and in the period 1938—49 went back another

100 metres. The mountain side here provides evidence of considerable glacial shrinkage in the same period.

1949—1955: A comparison of the 1955 photographs with these of 1949 reveals no sign of further retreat or shrinkage.

Summary:

1880—1890: Advance.

1890—1903: Stationary.

1903—1938: Retreating.

1938—1949: Partly stationary, partly retreating.

1949—1955: Stationary.

14 B: Nordre Qôrnoq glacier:

1880: Like the south glacier, this one was visited by N. O. Holst in 1880 but he merely describes some moraines at the margin of the inland ice north of the actual glacier (S. G. U., Series C, No. 81, p. 55). According, this description cannot provide any impression of the position of the glacier front in that year.

1890: Neither Blech's map nor his description indicates anything of the extent of Nordre Qôrnoq glacier. One of the photographs referred to under Søndre Qôrnoq glacier shows, in addition to that one, a part of the north glacier: It appears in a well advanced position.

1903: In Daniel Bruun's description of the Qôrnoq glaciers, Medd. o. Gr., Vol. 56, pp. 116—122, his observations are accompanied by two good drawings of the northern one. One drawing shows it as seen from Nûk, the peninsula on the west side of Qôrnoq fjord, and includes both glaciers. This picture has already been dealt with under the south glacier. The other shows the north glacier viewed from Norse Ruin Group 1 innermost in Taserssuaq bay at the head of Qôrnoq fjord. Both drawings were made in 1903. The glacier is depicted in the same advanced position as in 1890.

In the same work Bruun also has a map of the Norse ruins near North Qornoq glacier, showing the glacier front in its advanced position. In fact, the position of the front is well known for the year 1903.

1948: On the aerial photograph reproduced here as fig. 26, it can be seen that the glacier front had retreated considerably between 1903 and 1948.

1949: A photograph taken by R. Bøgvad in that year shows the glacier viewed from Nûk peninsula. It is dealt with under Nordre Qôrnoq glacier. A comparison with Bruun's pictures shows that the melting zone on the rock faces around the glacier indicate the limits of the ice

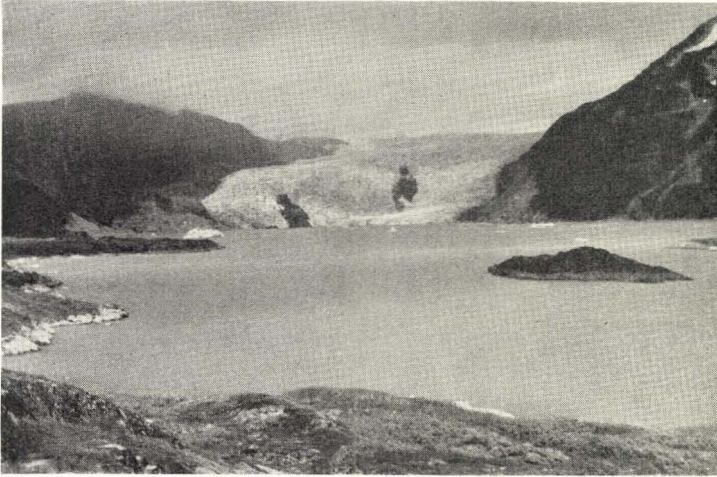


Fig. 27 a.

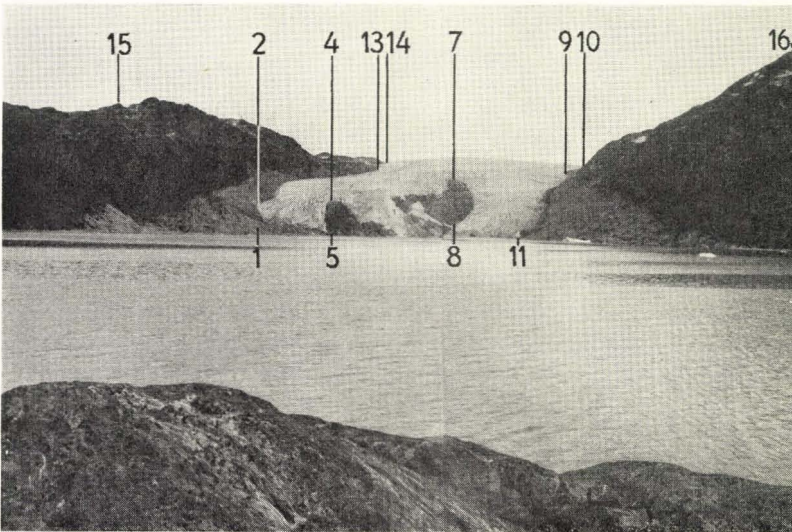


Fig. 27 b.

Fig. 27. Front of Nordre Qôrnoq glacier.

a) Seen from the head of Qôrnoq Fjord. Phot. L. VEBÆK 1951.

b) Seen from a skerry in the head of Qôrnoq Fjord. The numbers indicate the sighting points shown in the table on p. 91. The photograph was taken on 31st July 1955 and comparison with VEBÆK's photo shows a distinct retreat. Phot. A. WEIDICK.

in 1903, where the glacier must have rested in its extreme position in recent time.

1951: Four photographs, taken in July 1951 by Dr. L. VEBÆK, of the National Museum, provide a good basis for comparison with regard

to the change in the south side of the glacier front. The pictures were taken from exactly the same viewpoint as Bruun's picture in *Medd. o. Gr.*, Vol. 56, p. 117 (and *Medd. o. Gr.*, Vol. 57, p. 215), but in 1951 the glacier cannot be seen from that spot. The glacier front is seen, however, in another of Vebæk's photographs which was taken from a spot west of Nûk's outer point, here shown in fig. 27 a.

1955: At the writer's visit to this glacier in 1955 it appeared that there had been a further retreat since 1951. Two small rocks seen projecting on one of Vebæk's photographs of 1951 had now become so large that the glacier was calving only on the south side of the front. As these small rocks, which are now prominent, will serve as good indicators for determining subsequent changes in the glacier front, some bearings were taken from a small rock opposite the glacier front to the glacier and to a number of points on its sides. The photograph fig. 27 b shows the glacier viewed from that spot. A cairn indicates the place from which the survey was made. The photograph fig. 27 b shows the position of the points on which bearings was taken.

Upon the glacier itself some measurements were taken of the height of the trim line above the ice, that is the amount of shrinkage since 1903. The front part of the glacier forms an ice-fall 75 to 100 metres high. Here the melting zone is 130 m high. After the ice-fall the glacier flattens out to a plateau about 300 m above sea level. There the height of the melting zone is only about 20—25 m, but further inland its height again increases until at a peak 480 m it was 70 m high. The melting zone seems to remain this high up to the beginning of another ice-fall at the upper part of the glacier. The heights are approximately the same on both side walls, but this is merely an estimate. The measurements of the melting zone on the north side were made with altimeter and hand-level and, owing to the convexity of the glacier at the middle, it was impossible to get exact measurements of the opposite (west) side. The glacier emerges from the inland ice at the "nunatak" about 600 m and here too the height of the melting zone seems to be about 70 m. Along the south side of the glacier a large moraine was observed on its upper part.

The table on page 91 gives the bearings from the cairn to the glacier and its surroundings. They are measured from a peak, marked 15 on the photograph fig. 27 b, as zero.

Conclusion:

1880—1890: As N. O. Holst in his 1880 description of the glacier gives no indication of the position of the front, it is impossible to say anything about its having moved between that year and 1890.

Table

Sight to point	Angle	
15	0° 00.0	
2	7° 20.0'	
4	12° 52.0'	
13	15° 43.6'	The values refer only to a single set.
14	16° 18.3'	
8	20° 36.9'	
7	20° 44.2'	
11	25° 27.4'	
9	29° 52.1'	
10	30° 04.0'	

1890—1903: On comparing Bloch's 1890 photograph and Bruun's drawing of 1903, both showing the glacier front viewed from Nûk peninsula, one may assume that in both years it was in the position indicated by the melting zones as that of maximum advance.

1903—1949: A comparison between Bruun's 1903 drawing and Bøgvad's 1949 photograph, which also shows the glacier seen from Nûk, reveals that between 1903 and 1949 the front retreated about 600 m. At the same time the glacier surface had subsided considerably, presumably between 100 and 150 m.

1949—1951: One of Vebæk's 1951 photographs showing the glacier from a place west of Nûk's extreme point, is comparable with Bøgvad's 1949 photograph, also taken from Nûk. In that period the glacier front retreated still more; in 1951 rocks can be seen protruding through the front where in 1949 there was nothing but ice. The amount of retreat is not directly visible on the photographs but probably amounts to between 20 and 40 metres.

1951—1955: A comparison of Vebæk's aforesaid photograph of 1951 with the writer's 1955 photographs shows further retreat, because the rock surfaces coming through the ice are now larger. The linear retreat cannot be stated accurately but is estimated to have been about 10 metres.

Summary:

- 1890—1903:* Stationary.
1903—1949: Retreating.
1949—1951: do.
1951—1955: do.

Locality 15:

Arsuk glacier (sermeq). This glacier, lying at the head of Arsurk Fjord and sending a little calf-ice into it, is not referred to in the early literature. On one of his journeys K. L. GIESECKE was almost at the head of the fiord (12th August 1809), presumably near to the present airbase Grønnedal, but makes no mention of the glacier at all. From the period after Giesecke's visit up to 1869 the material consists chiefly of maps, and from 1869 to 1955 of photographs and descriptions.

The period from about 1830 to 1869.

1829—1833: Probably dating from this time is a map (regarding which see also the Qôrnoq glaciers) found in the Royal Library and marked "Kort til Ross Rejse 1829—1833". The technique of the work might well suggest that it was done at about the beginning of last century. The coastlines are fairly accurate, but the scale is not the same everywhere on the map. With the considerable elements of uncertainty attached to a determination of this kind, however, it is doubtful, even with a margin of 2 km, if the conclusion may be drawn that the glacier was in the same position at the beginning of the 19th century as round about 1860.

The map is much better than GRAAH's of the same time, which is so inaccurate that Arsurk Fjord cannot be seen at all in detail.

1856: In RINK's "Grønland" there is no information about the Arsurk glacier, nor can anything be gleaned from his map, which with respect to this fiord is more inaccurate than the one of Ross's journey. To judge from his map of the Julianehaab District, Rink must have been in the fiord, or at any rate was well informed about the region, for the district map reproduces the external details of Arsurk Fjord with fair exactitude. However the inner parts are not shown on this map. In other words, there is a chance of finding information likely to help in fixing the position of the glacier round about 1856.

1862: A map, bearing the title "Omrids af Arksuks Fjorden, Kryolithbruddet Ivigtok 61° 13 m n. B. 48° 9 m v. L. for D'hr Thbd. Weber og Co., Kjøbenhavn. Efter Peilinger af Daniel Schmidt" (Outline of Arksukfjord, the cryolite Mine Ivigtok lat. 61° 13' N., long. 48° 8' W. for Messrs. Thbd. Weber & Co., Copenhagen, from bearings by Daniel Schmidt), shows the inner part of the fiord rather accurately. It is on the scale of about 1:100,000; the directions of the coastline are somewhat distorted compared with the Geodetic Institute map. The various distances agree very well for the inner fiord, however, and it appears that at the time when the map was made the glacier front was between 2 and 4 km ahead its present position.

1863: Another map, published in 1866 and made by Lieuts. E. BLUHME and F. FALBE, R. N. in 1863, places the glacier front at between 1 and 2 km ahead of its present position. But judging from a photograph of 1869 (see under that year) and from the melting zone which places the 1869 position as the glacier's maximum extent, with a front about 2 km beyond the present, there is no reason for supposing that the glacier at any time during the last century was more than 2 km ahead of the position in 1955. It must be assumed that in the period 1862—63 the glacier occupied its maximum position (the same as the 1869 position).

The period from 1869 to 1955:

Changes in the glacier-front position during this period are much better known than in the 1830—69 period, because there is excellent photographic material as from 1869. To a large extent this is due to the Cryolite Company, because people working at the quarry and visitors to it often went to this easily accessible glacier. Naturally, the photographs were not all taken from the same point but they fall into the following groups (see map, fig. 30): I: those taken from the headland round Bjørnefjeld; II: from the south side of the glacier front; III: from the north side of the front, and IV: from the south side of the glacier near the margin of the inland ice. Reliable comparisons of the positions of the front can only be made within each of these groups, and even then it is occasionally difficult when the photographers' positions were not exactly the same. Nevertheless the various groups (when there are representatives for the same year) can mutually verify the position of the glacier front.

In the following summary of information regarding changes in the front I have proceeded in chronological order; I have also inserted travellers' accounts at three places.

Unfortunately it has been impracticable to reproduce all the photographs mentioned, but I hope that the text given will suffice.

1869: Four photographs, all belonging to the files of the Cryolite Company: Group I: phot. marked 14th June 1869. Taken from Fox Havn, showing the Fox Fall and the north part of the glacier front. The picture is not clear enough to show details at the glacier front, but it can be seen that the front is far ahead of its present (1955) position, and that there is no melting zone.

Group II: photo. marked "14th June 1869". Taken from the south side of the glacier looking north. A system of fissures in the rock is clear. The first fissures on fig. 28 are marked with letters, being recognizable on later photographs and making it possible to fix changes in the

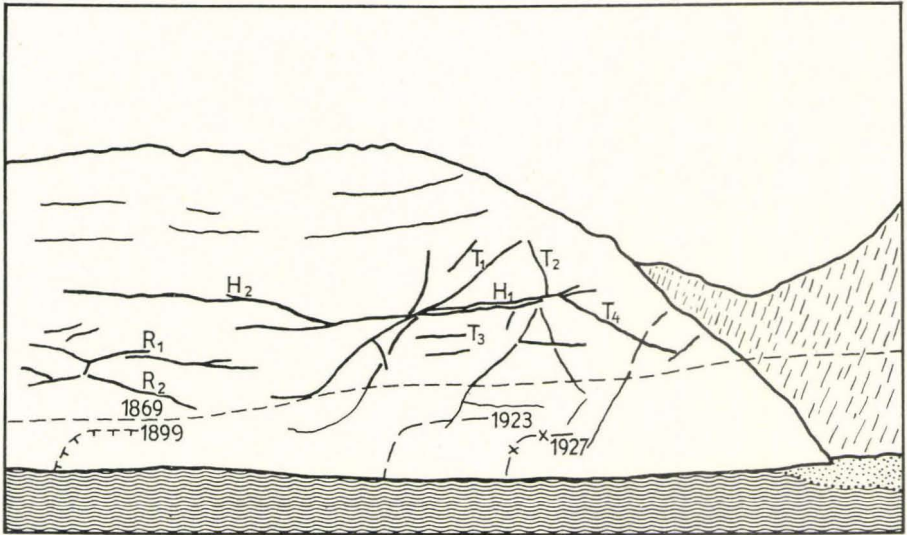


Fig. 28. Drawing showing the north shore of Arsuk Fjord at the glacier front, seen from the south. The various positions of the front inserted, judged by the marked system of fissures in the rocky wall.

glacier front. It will be seen 1) that the ice extends along the north side of the fjord past fissures R1 and R2, and 2) that there is no outwash plain ahead of the ice on the south side of the fjord.

Group IV: photo. marked "14th June 1869:" taken near the margin of the glacier on its south side, some kilometres behind the front. The photograph is comparable with one dated 1923 (see below).

Group I: photo. marked "1869". From a spot between Fox Havn and Ellerslie Havn. It is not clear and merely shows the advanced position of the glacier.

1871: Group I: photo. marked "Arsukbræ 21/8 1871". From Fox Havn (belonging to the Cryolite Company). It is sharp and details can be discerned both at the glacier front and at its inner part.

1880: In that year the glacier was visited by the Swedish geologist N. O. HOLST, who made several excursions on it, one as far as the inner nunatak B (see the map, fig. 30). His report, however, is accompanied by neither maps nor illustrations and the text gives little in the way of clues to support an evaluation of any changes at the glacier. The text reads (S. G. U. Series C, No. 81, p. 7): "... "and later on June 7th went up to the head of Arsukfjord. From there in the course of a week I made several excursions on the inland ice and in particular examined a horseshoe-shaped moraine which was already visible from the sea off Arsukfjord; it lies on the ice north of the glacier debouching

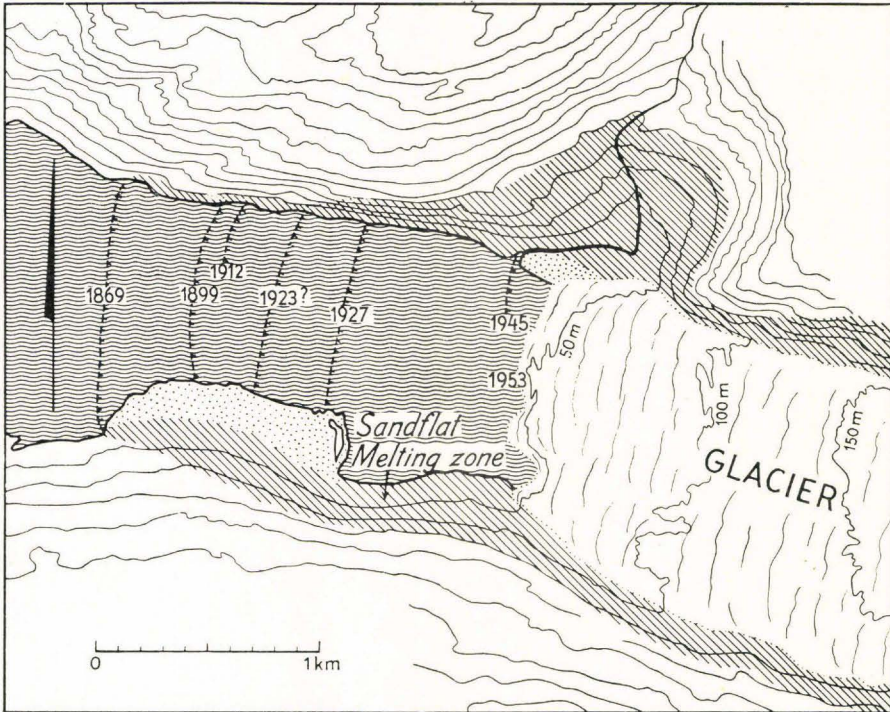


Fig. 29. Arsuk glacier. Front positions 1869—1955. Map compiled from Geodetic Institute's map 1:20,000.

into the fiord and crescent-like lies around a headland projecting into the ice from land. Later on I encountered several moraines of this kind, and the horseshoe-formed moraine mentioned by A. KORNERUP¹⁾ is thus merely one instance of a very ordinary phenomenon”.

In the same work, page 56, he writes: “Terminal moraines occur in front of all glaciers which do not end in the sea, for instance ahead of Frederikshaabs Isblink, the one in Arsukfjord, Kornok's southern and Kipsisakko's glaciers”. In this case Holst must be referring to the remnants of a moraine at Fox Havn described earlier in his report, that is to say a moraine which may be of morphological but not historical interest, for the reason that it cannot be dated.

The horseshoe-shaped moraine at the old nunatak was no longer to be seen in 1955 at any rate. This would suggest a change in the position of the glacier. Holst mentions only a headland projecting into the ice north of Arsuk glacier, not a nunatak; as will be seen later, it is very probable that the “nunatak A” on the map fig. 30 was not visible in Holst's time.

¹⁾ Meddelelser om Grønland, Part I, Kjöbenhavn, 1879, p. 133.

1882: A description of the cryolite quarry at Ivigtut, by S. FRITZ, *Geografisk Tidsskrift*, Vol. 6, p. 45, states that the fiord ends about 3 miles behind Ivigtut, and that there it is bounded by a glacier about 3500 feet wide which, as an outlet from the inland ice, sends its icebergs out through it.

The distance of "above 3 miles" is too large and inaccurate to provide a basis for conclusions regarding the position of the glacier front. Nor does the indication of its width (3500 feet) tell us anything about that position, because along this part of Arsuk Fjord the sides are almost parallel.

Some photographs which may date from the 1880's are deposited in the picture collection of the Royal Library. They are mentioned here merely because it may be possible some day to discover when they were taken.

Group I: Photo. marked "1951—526/6", picture of Fox Havn. A boat in the foreground may possibly indicate the age of the photograph. The glacier is markedly advanced and its northern flank is relatively distinct.

Group II: Photo. marked "1951—596/3. Arsukbræ". The picture was taken near the glacier front from a rather narrow, deep bay.

1890: J. C. D. BLOCH's map. This map is drawn on such a small scale to make it impossible to decide the position of the glacier front, but I would draw attention to the small nunataks north and south of the inner part of the glacier: the one on the north may quite well be the old nunatak A, which according to the photographs (described elsewhere) now begins to appear. The one on the south may be part of the mountains near to Camp 1955 on the map fig. 30.

1899: Group II: photograph by K. J. V. STEENSTRUP marked "Arsukbræ". Negative in the Mineralogical Museum. Taken from the south side of the fiord. Fissures R1 and R2 as well as H2 can be seen again and there is now a wide outwash plain ahead of the south part of the glacier front: the ice must have retreated in the period 1869—1899. In 1899 the northern margin is opposite the convergence of fissures R 1 and R 2.

1900: In his diary for that year Professor N. V. USSING makes no note of the glacier, though he was working in the Ivigtut region. But in the files of the Cryolite Company there is a photograph from that year, taken from the vicinity of Fox Havn (Group I) and very distinct: the glacier front and the old nunatak appear clearly. The photograph was taken from the same spot as one later by K. STEPHENSEN in 1912 (see below).

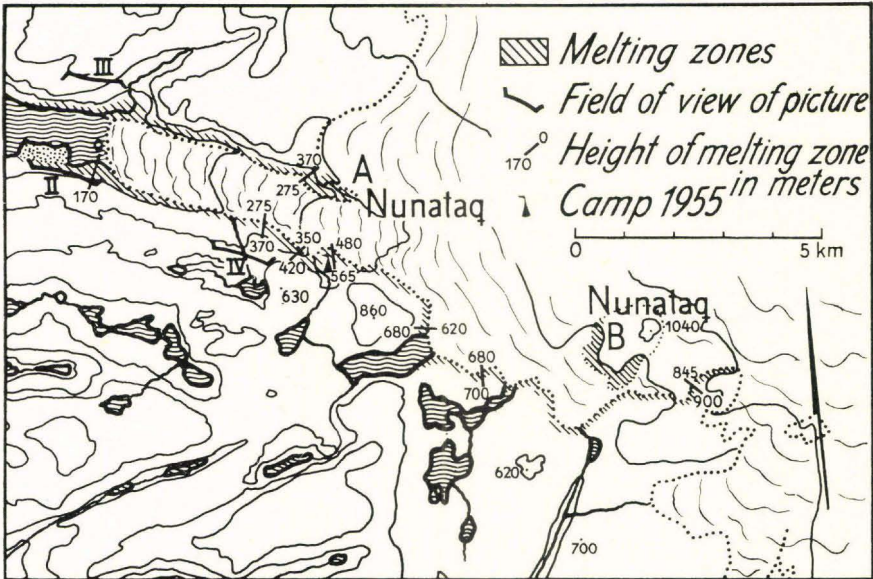


Fig. 30. General map of Arsurk glacier, Arsurk Fjord and margin of inland ice at Arsurk glacier. Heights of melting zones in metres and field of view of pictures added.

1903?: In *Medd. o. Gr.*, Vol. 57, p. 25 is a photograph from Fox Havn (Group I). The date is unknown and it is placed here in the text merely because the archaeologist D. BRUNN, the author of that volume of "*Meddelelser*", visited this part of Greenland in that year. The old nunatak A appears distinctly in the photograph; only its upper part projects up through the glacier.

1908: On a visit to Arsurk glacier in that year Professor Ussing writes in his diary: "11/6 Trip together with Akunit to the iceblink: the glacier does not seem to be expanding at present, on the contrary it can be seen to have withdrawn, though scarcely quite recently". No reasons are advanced to explain why the glacier had not retreated quite recently, but a trained observer like Professor Ussing would probably have a reason for his supposition; it is just not stated in his diary.

1912: Group I: photograph in the National Museum Ethnographical Department archives marked "Arsurkfjordens Isstrøm, Frederikshaab Distrikt, Juli 1912, fotografi taget af cand. mag. K. Stephensen 1912". The exposure was made from near Ellerslie Havn, at the same spot as the Cryolite Company's photograph of 1900. On comparing these two pictures one can see:

1) The glacier front has moved back somewhat since 1900 and mainly the lower part of the glacier surface has sunk considerably.

That the surface nearer the inland ice has also sunk is certain, but the dimensions of that subsidence cannot be judged owing to lack of comparable material.

2) At the old nunatak A there is a marked difference between 1900 and 1912. In 1912 there are three, well-delimited, ice-free areas of the nunatak. The surface of the ice must have subsided considerably since 1900.

1919: In *Medd. o. Gr.*, Vol. 61, p. 352 there is a photograph of the Arsuk glacier, taken from a boat. The picture is no help in discovering any change in the position of the front.

1923: In the files of the Cryolite Company a number of photographs are contained in an album marked "1923?". Thus the year is not certain, but one judges from the persons portrayed and their clothing that the pictures were taken in the early 1920's.

Group IV: Picture marked "Arsuk Glacier, leading to ice field". It was taken from the upper part of the glacier's south shore looking north, so that the join of the glacier with the inland ice can be seen. The viewpoint is almost the same as that of the photograph taken on 14th June 1869. It being impossible to distinguish definite points on the rock wall on the north side, all that can be said is that the "1923?" picture shows an apparent subsidence of the glacier surface, a large part of the north wall now being visible. However, it is impossible to say if the two photographs were taken from exactly the same height; if not, nothing can be said of any change in the height of the glacier surface. No melting zone can be distinguished on the "1923?" picture, though this may be due to blur or unsuitable light on the rock.

Group II: Two photographs of the glacier front, taken from the south shore looking north. Here the glacier front is situated below the convergence of fissures T 1, H 1 and T 3, meaning that the glacier retreated far back in the period 1899—1923?

1927: There are two photographs of that year, both taken by NIELS SØRENSEN, foreman at the Cryolite Mine. Both are from the south side of the glacier front (Group II). Since "1923?" the front had gone back still more and was opposite the convergence of fissures H 1—T 2—T 4. It had retreated so much that the outwash plain ahead of the south part of the front was now free of ice.

1945—1950: No pictures of the glacier taken in the 1930's have been found, but many from 1945 and onwards have. But they were all taken from the north side looking south (Group III) and thus are not comparable with the earlier photographs. The explanation is that in earlier times, i. e. up to about 1930, it was easier for anyone intending

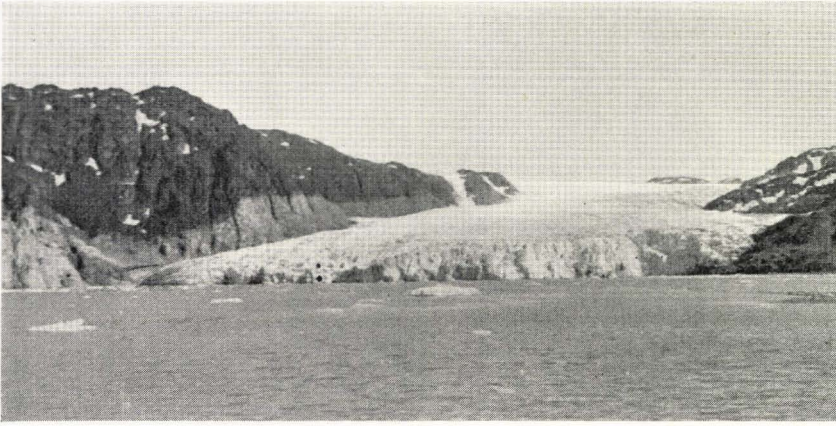


Fig. 31. Arsuk glacier, seen from Arsuk Fjord. Photo. R. BØGVAD 1945.

to get up to the glacier to go ashore on the south side of the fjord at the outwash plain below the glacier front. When the front retreated so far that the gravel plain became isolated from the ice, and at the same time a new outwash plain formed at the north shore of the fjord, right in front of the glacier almost out to the northern lateral valley, most excursions during this period were to the north side of the glacier and therefore the majority of the photographs belong to Group III.

The photographs dating from 1945 to 1950, all taken by BØGVAD, reveal no change in the position of the glacier front in these 5 years: They all show the front opposite the northern lateral valley, which indicates a long retreat since 1927.

All these 1945—1950 photographs also show a sharply delimited melting zone, extending from the upper part of the glacier down past its front to about 2 km along Arsuk Fjord, which on the south side of the fjord, means right down to the west side of the outwash plain. As already stated, the trim line indicates the extent of the glacier in the years prior to 1890. This can best be seen on comparing the photograph marked "21/8—1871" from Fox Havn and photograph marked "4506, No. 30 (1945), R. BØGVAD. fot". (fig. 31). The zone coincides fairly closely with the extent of the glacier in 1871, though it should be added that the pictures were taken at such a distance from the glacier as to preclude exact determination. The 1871-phase of the glacier is not so different from the 1869-phase as to be of any importance in this context.

1950—1955: When the writer was at the glacier in 1955 little change in its position was observable since 1950. The front occupied the same place as on Bøgvad's 1950 photographs; there may have



Fig. 32. Upper part of Arsuk glacier, seen from a point about 150 m west of the camp shown in fig. 30. Photo WEIDICK, 19th July, 1955.

been a change of about 100 metres (retreat) at the north part of the glacier front, but it could not be established positively.

Conclusion:

1830—1862: Stationary? A comparison was made between the Ross and the 1862-map, but the scales are so small that any movement of the front would be impossible to determine, nor do we know definitely that the map of Ross's journey actually dates from before 1830.

1862—1863: The glacier front may have retreated but in all probability was stationary. Falbe and Bluhme's map must be considered the most correct because it most resembles the conditions in 1869. It is scarcely credible that the glacier retreated ca. 2 km in the period 1862—63, especially as the melting zone around the glacier shows its limits in 1869. If the glacier had extended farther out the 1869 photographs would have shown a melting zone. We cannot assume that the glacier was farther back than the 1869 phase: none of the maps indicate an outwash plain on the south side of the fiord. For the same reasons it is presumable that in the following period:

1863—1869: the glacier was stationary.

1869—1871: A comparison between the photographs referred to above indicates a retreat of the order of 200 m in this period, and some slight shrinkage of the glacier is likely. It is not known whether or not the retreat was spread evenly over the period 1869—71.

1871—1899: Comparison between the photographs referred to in this period is fruitless. The assumption is that the glacier front moved back still more. In 1899 it was opposite the convergence of fissures R 1 and R 2, i. e. about 400 m behind the 1869 position; in that case, the retreat in the 1871—99 period must have been about 200 m.

1899—1900: The glacier probably did not move much in this period, but direct comparison between the photographs of 1899 and 1900 is useless. The glacier surface must have sunk considerably between 1880, when N. O. Holst observed no nunatak, and 1900 when it is seen distinctly in the photograph of that year.

1900—1908: Glacier stationary? This supposition is based solely on Ussing's remark, in the 1908 diary, that the glacier had not retreated just recently.

1908—1912: Retreated, according to a comparison between the two photos of 1900 and 1912 from Fox Havn. If the glacier was not stationary in 1900—1908 the above must be amended: 1900—1912: Retreating. The retreat between 1900 (1908) and 1912 was in the region of about 100 metres.

1912—1923: Retreating. The only proper comparison to be made is between Steenstrup's photograph of 1899 and those of 1923: the retreat between these two years was about 400 m, so that between 1912 and 1923 it must have been about 300 m.

1923—1927: The photographs of these years indicate a retreat of 350—400 m during this period.

1927—1945: A retreat of about 700 m is indicated by a comparison between the 1927 and 1945 photographs: the north side of the glacier front now only reaches to the mouth of the large river from the lateral valley on the north side. This river forms a wide delta which today makes access to the glacier easiest from the north side of the fiord, whereas in 1927 the approach was easiest across the outwash plain ahead of the glacier front on the south side of the fiord.

1945—1955: Stationary or slight retreat: A retreat seems observable on the north part of the glacier front, amounting to about 100 m.

In keeping with the retreat of the glacier front it is possible, on the photographs chiefly of Groups I and IV, to observe a sinking of the glacier surface, so that the nunatak A gradually appears and in 1955 is merged with the other ice-free region at the upper, northern part of the Arsuk glacier. The melting zone along the glacier shows the subsidence since 1869. The height of the trim line at various places along the glacier is shown on the map fig. 30; it will be seen that it decreases

from about 170 m at the glacier front to about 60 m at the inner nunatak. These heights, however, are very variable.

Summary:

- 1862—1863: Stationary?
 1863—1869: Stationary?
 1869—1871: Retreating.
 1871—1899: Retreating.
 1899—1908: Stationary?
 1908—1912: Retreating.
 1912—1923: Retreating.
 1923—1927: Retreating.
 1927—1945: Retreating.
 1945—1955: Stationary or retreating.

Locality 16:

Sermiligârssuk Fjord. This fiord stretches about 40 km inland from the mountain Kingigtoq on the west coast as far as two lobes of the inland ice, each debouching into fiord arms. The fiord is divided by a large nunatak into a main arm, here called Sermiligârssuk, and a lateral arm, called Sioralik by the population at the trading station of Narssalik. As stated, the inland ice has a lobe into both these fiord arms, but only the one to Sermiligârssuk produces calf ice. Ahead of the end of the Sioralik arm, here called "Sioralik glacier", is an outwash plain about 2 km wide.

Of the ice-fiord we know that as far back as in 1733 it was visited by MATTHIS IOCCHIMSEN (recorded in "Greenland" Vol. 1, p. 27), but he was unable to penetrate far into the fiord owing to calf-ice. He assumed that the fiord was only seasonally choked with ice and that there was also a "Frobisher Strait" to the East Coast. A similar assumption of a former "Frobisher Strait" there occurs in E. THORHALLESEN'S "Beskrivelse over Missionerne i Grønlands Søndre Distrikt", p. 12.

1809: An excellent description of the productivity of the ice-fiord is to be found in Giesecke's diary for 17th August 1809, where he records: "passirten Kangarsuk und setzten über Sermiliarsuk, des hier vorstehenden mächtigen Eisblink wegen so genannt, wo man eigentlich die Frobisherstrasse oder die ehemalige Durchfahrt nach der Ostseite vermuthet. Das ganze feste Land ist bis in die See hinaus mit ewigem Eise bedeckt".

The same prolific calving is reported by Lieut. W. A. GRAAH (Undersøgelsesreise til Östkysten af Grønland 1828, p. 41), who writes about this fiord: "The entrance to Smallesund lies in about lat. 61° 34'.

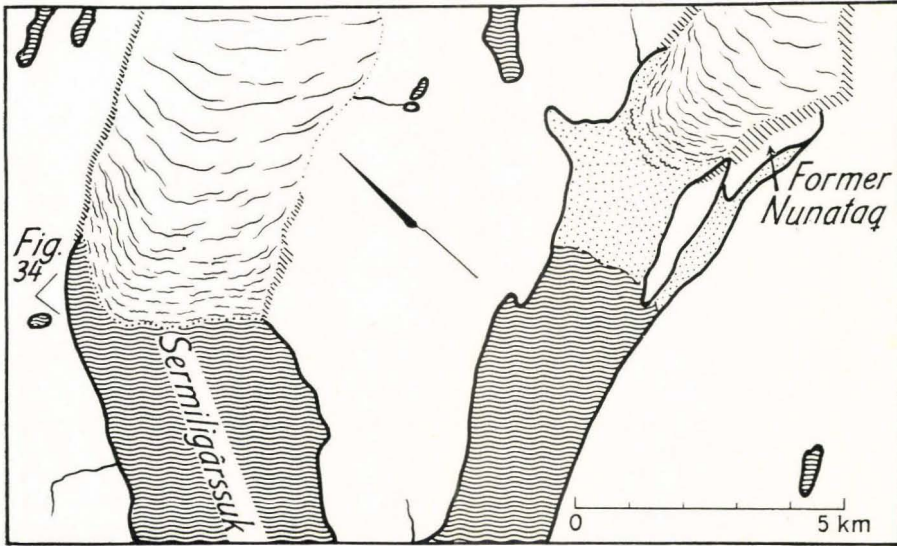


Fig. 33. General map of inner part of Sermiligårssuk fiord. Left: Sermiligårssuk glacier, right Sioralik glacier. Melting zones, moraines and perspective angle of fig. 34 added.

long. $49^{\circ} 18'$. A little to the south the tall mountain, which the sailors frequenting these coasts call "Tindingen", rises 1400 to 1600 feet above the sea. From there the fiord Sermiliarsuk runs eastwards or E.N.E. This fiord calves too, and is remarkable in that all the icebergs which owe their origin to it have a beautiful, semi-transparent blue colour". Graah's map of that expedition indicates merely the fiord, but shows nothing of its inner section.

1857: H. RINK's map of 1857, like Graah's, is very schematic and shows nothing but a fiord arm: in 1857 the fiord cannot yet have been thoroughly explored by any traveller. In 1860 Rink says he has received a sketch map of the Sermiligårssuk fiord from the Greenlander STEPHEN MØLLER. There is no record of where that map was reproduced or where the original was deposited (see under Sermilik, Frederikshaab District 1860).

1877: The stretch of coast at Sermiligårssuk fjord was surveyed in 1877 by Lieut. J. A. D. JENSEN, but no more exact description of the fiord has been found. Jensen's map is reproduced in *Medd. o. Gr.*, Vol. 7, pl. IX. Both arms of the fiord are shown, as also the outwash plain in front of the Sioralik glacier. One can also discern a small "nunatak" close behind the Sioralik glacier front, in its southern half.

1880: In that year Sermiligårssuk fjord was described by the geologist N. O. HOLST (Sveriges Geologiska Undersökning, Afhandlingar

och Uppsatser, Series C, No. 81, p. 6). Holst observed the fiord from a mountain in the vicinity of Tindingen (perhaps that mountain itself, although Holst gives the height at 2270, whereas Tindingen is 2835 feet high, according to the chart). The description is inadequate for determining the position of the ice, for it says merely: "From here one has a fine outlook over Sermiligatsiakfjord (a long, evenly narrow fiord just north of Tigssaluk) and over the inland ice behind it. Some distance out in the glacier debouching into the fiord lies a peak bare of ice, a so-called "nunatak". Its position is northeast of the mountain at Tigssaluk. The ice seemed to be much fissured, both in the glacier and behind the nunatak. Apart from the fissures and the nunataks the whole of the inland ice looked like one monotonous snowfield. Slightly more to the north is another nunatak, which appeared on the horizon where it seemed to project quite a way up over the inland ice. This peak must be of no inconsiderable height".

1889: The entomologist WILL. LUNDBECK visited the region around Sermiligârssuk fjord in this year, but was unable to get up to the head of the fiord because of all the calf-ice. In his account of his journey Lundbeck (Medd. o. Gr., Vol. 7, pp. 123—124) says nothing about the glaciers.

1955: The southern arm of the ice-fiord, Sioralik, and its glacier, Sioralik glacier, were visited in this year by the writer. The following details can be given about the glacier:

There is no nunatak now on the south side of the glacier near its front, but the melting zone on a small rocky knoll here suggests that the knoll from NW was once like a "nunatak". This can only have been so when the glacier extended to its extreme limit in recent time, as indicated by the melting zone. It is therefore a reasonable assumption that the melting zone shows the extent of the glacier in the year 1877. On the map in Medd. o. Gr., Vols. 60—61, Atlas, Frederikshaab District, this nunatak is shown farther out towards the glacier front. As it is not known who corrected the 1877 map in this matter, or if it is merely a drawing error (in all other respects the chart is a copy of the 1877 one), nothing can be concluded as to what changes the glacier front has undergone.

When the writer saw the Sioralik glacier in 1955 the outwash plain in front of the glacier was exceedingly flat, and finds of "Marlekor"¹⁾ suggest an advance by the glacier in recent geological time. No more than about 300 m in front of the glacier was a row of terminal moraines, which lie only about 5 m above the outwash plain. The glacier front itself passed smoothly into the moraine in a belt about 2 m wide. The

¹⁾ "Marlekor": concretions with fossils of caplin, starfishes, etc., to be found on most outwash plains in the Frederikshaab district.



Fig. 34. Sermiligârssuk glacier from the north side of the fiord. Photo H. MICHEESEN, 1955.

glacier flattens out considerably at its extreme end and then rises inwards as a very slight inclination. Along the front is a row of dirt cones up to 2 m in height, consisting of gravel and coarse sand with ice cores. The melting zone along the sides of the glacier had a height of about 60 m, decreasing only slightly in the first two kilometres inland. The extreme terminal moraines are undoubtedly contemporaneous with the outermost position of the glacier, presumably reached in about the year 1876, whereas an inner arc of terminal moraines must mark an advance between 1876 and 1955. On enquiry at the trading station Narssalik, the people of which go to the Sioralik to fish for salmon, elderly people confirmed that the glacier has retreated in recent time, though they could give no date for that retreat.

In the same year (1955) the Sermiligârssuk glacier was visited by the geologist HARRY MICHEESEN, who took some photographs of the glacier from the north side of the fiord. One of them is reproduced in fig. 34. The people of Narssalik asserted that that glacier had also retreated in recent time.

Conclusion:

It will have been observed that the information so far obtained about this glacier is very sparse. It must be assumed that:

Sioralik glacier:

1877—1955: The “nunatak” on the south side of the glacier has become exposed in the period and at the same time the glacier front has moved back about 300 m. The inner arc of moraines indicates a short advance in the same period.

Sermiligârssuk glacier:

1877—1955: The map of 1877 can give us no information of the former extent of the glacier in relation to the present. In O. BENDIXEN'S description of the fiord, *Medd. o. Gr.*, Vol. 61, p. 307, he says that there is a luxuriant valley about 6 km from the glacier front and that 2 km nearer the mouth of the fiord is a good harbour. The distance of 6 km, however, is so uncertain a measurement that nothing can be said about the situation of the glacier front, particularly as there are several such valleys to choose from.

Accordingly, all we have about the variations of the glacier front is the statement of the Narssalik people that it had retreated in recent time. On aerial photographs of 1948 the melting zone around the glacier can be seen to be exceedingly narrow and it indicates a maximum retreat of about 50 m in recent time.

Summary:

Sioralik glacier:

1877—1955: Retreating.

Sermiligârssuk glacier:

?—1955: Retreating.

Locality 17:

Sermilik glacier (Narssalik glacier). According to the description in *Medd. o. Gr.*, Vol. 61, p. 306, this glacier is the largest and most productive one in the Frederikshaab district, and consequently it will be of much interest some day to measure its velocity. But it is accessible only overland from either Kvanefjord, north of Sermilik fjord, or from Tasiussaq on the south of it, on account of its great production of calf-ice. The ice-fiord itself has been mentioned by all travellers in this section of the coast right from the days of Hans Egede. Of these records, the most interesting is P. O. WALLØE'S statement that in 1751 the ice was possibly increasing (Peder Olsen Walløe's diaries of his journeys in Greenland 1739—51, pp. 63—64).

1751: He writes: "On the 28th August the morning began with calm weather, but it did not last long and we reckoned we were only 1 (Danish) mile forward when we came into a bay or fiord, where we encountered a large quantity of drift-ice which prevented us from proceeding, wherefore we had to land and pitch the tent. The place where we landed is called Nakselik and was inhabited. It is at this height of about lat. 60° that the charts place the so-called Frobisher Strait, which is said in days gone by to have run right through the

country from West to East. Moreover, some charts say that about 63°, that is between Godthaab and Frederikshaab, at the well-known Fiske Fjord, there was a similar river or passage,—but as regards these straits, I can assert quite trustworthily that none of them are to be found now in the said latitudes, nor has Greenland any such strait cutting through the land before one comes to between latitude 60 and 61. It is just north of the south end of the country, or what is called Statenhuk,¹⁾ that there is such a strait, on which shall be related in detail in the following. But that many years ago there ever were rivers or the like of straits in the latitudes stated I dare not deny with certainty, as it is possible that the ice, which has its origin at the North Pole and, as we learn, has a constant considerable growth and expands time after time over the whole country, may also have covered these straits so that they have become quite concealed, and that the water has turned to perpetual ice, whereby they are unknown and destroyed.

“Here in this fiord where we now were, and whose name is Sermilik, the ice reaches down to its head and the large pieces of ice falling down from the mountains on both sides maintain the drifting ice in this fiord, of which it is never free, although many pieces often drift out to sea and unite with the drift-ice there, of which a part I believe comes east and north from Spitzbergen etc. and passes about Cape Farvel or the south point of the country and drifts up here”.

1774—75: E. THORHALLESEN mentions the glacier but briefly and, like P. O. Walløe, says nothing about its limits (E. Thorhallesen: “Beskrivelse over Missionerne”, p. 13).

1857: In “Grønland” H. RINK writes nothing of the actual position of the glacier but records, after describing the other ice-fiords in the district (“Grønland”, Vol. 2, p. 329): “As far as is known they all reach up to the inland ice and the two in the middle are not inconsiderable ice-fiords. Narksaliksfiord especially produces a large quantity of calf-ice every year, at certain times lying packed close together a mile or two out to sea, so that as a rule, when travelling by boat, one has to wait a couple of weeks at this place until the ice is dispersed. However, the largest icebergs emerging from these fiords seem not to exceed a height of 60 feet above the sea, or a mass of one million cubic ells, and thus could not compare with the North Greenland ones. Moreover, almost all seem to consist of the coarse granulated blue ice with frequent intermixture of stone and gravel”.

Ca. 1860: A map drawn by the Greenlander STEPHEN MØLLER gives a good picture of the outlines of the fiord. It is reproduced in an

¹⁾ Kap Farvel area, present author's note.

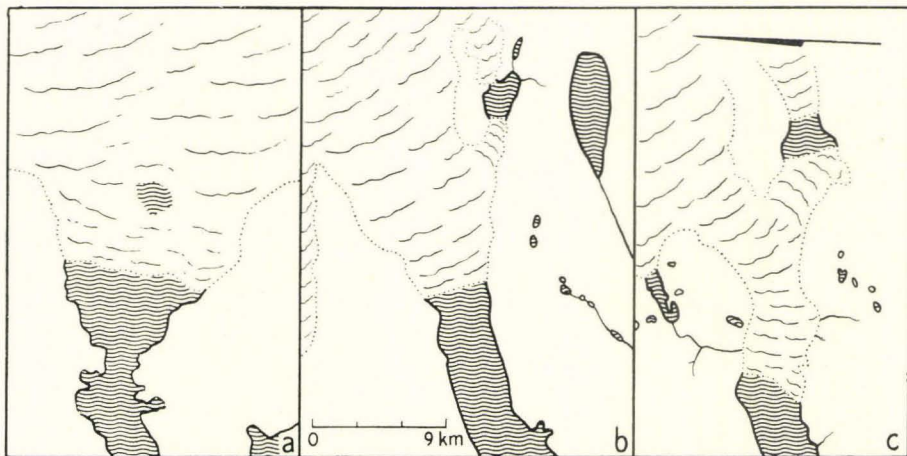


Fig. 35. Sermilik.

- a) Sketch from ST. MØLLER'S map of 1862, from *Naturhistorisk Tidsskrift* 3. Rk., Vol. 1.
 b) Sketch from J. A. D. JENSEN'S 1877 map. From *Medd. o. Gr.* Vol. 7, pl. IX.
 c) General map, compiled from aerial photographs.
 The ice-dammed lake in the illustration is *Imaersârtoq*.

article by H. Rink in *Naturhistorisk Tidsskrift*, 3. Række, Vol. 1, 1862 ("Om Vandets Afløb fra det Indre af Grønland ved Kilder under Isen")¹). The map is given here in fig. 35 a. As the description of the fiord in the text accompanying the map is the best obtainable from that time it is quoted here in toto (p. 16—17): "After having recorded the above¹) I have received two more interesting ground-plans of the icefiords: Sermiliarsuk and Narsalik in the latitude of 61 to 62° N., both drawn by a native by the name of Steffen Møller, partly from what he has seen, partly from what his brothers have observed on reindeer hunts, which are carried on just in this stretch of the mainland. Narsalikfjord is the most active ice-fiord in South Greenland, the only one whose calf-ice places serious obstacles to navigation along the coast. In summer it frequently produces massed groups of icebergs which sometimes reach a couple of miles from the mouth of the fiord out to sea and thus form a barrier which it is sometimes very dangerous to pass through or about in a boat. The fiord describes a large bend, so that from the sea it is quite closed off. It is a good four miles from its mouth up to the edge of the permanent land ice, whose outer part, as in all ice-fiords, must be assumed to extend several hundred feet down into the sea and therefore is more or less borne by it. Owing to the great mass of calf-ice and the movement of the ice itself after the calvings, this innermost part of the fiord is totally inaccessible, but one can walk there by land on

¹) i. e. on the efflux of the water from the interior of Greenland by subglacial springs. Author's note.



Fig. 36. Sermilik glacier. Note the melting zones around Imaersartog, and the melting zones, narrow here and there but mostly lacking, around the glacier itself. Aerial photo Copyright G. I.

both sides. Just in front of the calving ice edge there are two very large springs from the sea-floor; in the usual manner they are recognizable by the flight of the birds over them and the whirling movement of the water which keeps the drift-ice clear of these spots. Up on the solid ice, about half a mile from its outer edge, there is a basin about a quarter mile in diameter.

“At a certain time during the summer this basin fills with water, to be emptied again suddenly, the edge of the ice being raised somewhat higher above the level of the sea, and one observes a commotion in the fiord, the calf-ice drifting outwards. Sermiliarsuk, which lies more to the south, is a less active ice-fiord though this too produces icebergs of rather considerable dimensions. Here too large springs have been seen ahead of the calving ice-front and rather far inland a lake in the

inland ice itself, which, as in the case of the lake near Godthaabsfjord, is alternately filled and then emptied through channels in the ice.

“Finally, I am fortunate enough to be able to add two instructive small maps, drawn and printed by a young Greenlander whom I have taken home¹⁾ in order to have him taught printing and lithography. These maps are his first attempt”.

One of the maps to which Rink refers is reproduced in fig. 35 a, the other is a map of the ice lobes showing the supposed streams under the ice. It will be seen that the map pictures the fiord in some distortion and that the outlines are somewhat exaggerated, but it will be observed that any changes in the ice front must lie within about 5 km. The large funnel-shaped section of the fiord, shown to be entirely occupied by the glacier on a later map by J. A. D. JENSEN 1877, is ice-free on Steffen Møller's map, with the ice front lying east of this funnel-shaped stretch. There is thus a possibility that in the period about 1860—1877 the glacier advanced.

1860: “Fox Expedition i 1860” (Zeilau) on page 149 records having observed icebergs from Sermilik, but otherwise merely refers to Rink's description of the calvings.

1877: J. A. D. Jensen writes nothing about Sermilik fjord or glacier, but in 1877, as already stated, made a chart of the fiord. It shows very distinctly the region around Imaersartoq lake with water-courses, inlets in the fiord etc. (see fig. 35 b).

1948: The map of the region (a preliminary working map on the scale of 1:100,000, drawn from aerial pictures) does not extend back to the ice-dammed lake Imaersartoq referred to above, but it is to be seen on two aerial pictures, marked “503 DV No. 247” and “504 D²N No. 4006 (26/7 1948)”. The outlines on J. A. D. Jensen's 1877 chart do not quite agree with those on the aerial photograph. On aerial picture 503 DV the lake is bounded by the inland ice and one notices that if J. A. D. Jensen's chart is correct, the lake as a whole seems to have moved eastwards. However, there is some inexactitude in the chart, the headland south of the eastern ice-branch into the ice-dammed lake, on this chart bordered by the glacier front and the lake, being rather exaggerated. Both on Jensen's chart and the aerial photographs the glacier front lies at the narrowest part of the lake between the nunatak and the land. In this matter the chart, despite its otherwise good drawing of the lake, is merely rather exaggerated as to the outlines and the lake was in the same place and of almost the same dimensions in 1877 as in 1948.

¹⁾ Taken to Denmark. Present author's note.

One peculiarity of both aerial photographs is the absence of a distinct melting zone along the greater part of the glacier margin: the only one to be seen is around Imaersartoq lake. There the explanation of the melting zone must be the subsidence of the glacier surface caused by the subglacial tapping of the lake.

On looking at the front of Sermilik glacier it seems that a melting zone is lacking. The assumption therefore must be that the glacier is either stationary or advancing.

1955: On inquiring in 1955 from the people at Narssalik, the trading station at the mouth of Sermilik fjord, the writer obtained no information regarding changes in the condition of the glacier, but it was stated that in 1955 the glacier had not yet produced in its customary manner (the inquiry was made on August 10th) and that there was still winter ice between the floes. It was furthermore added that: 1) with the years the lumps of ice had become smaller, and 2) the glacier can usually be visited by going overland from Kvanefjord. The point that the glacier had not yet produced is mentioned here because it may have some connection with the emptying of Imaersartoq lake and with changes in the volume of the glacier.

Conclusion:

ca. 1860—1877: Fig. 35 a, b and c show Stephen Møller's map, J. A. D. Jensen's chart and a map drawn from aerial photographs of 1948 for comparison. The outlines on the earlier maps (1860 and 1870) are unsuitable for determining the changes in the glacier front in the period 1860—1877. But, as mentioned above, a comparison between the two maps indicates that the glacier front advanced within the period. Rink's distances also suggest that the glacier moved forward in that time. Rink states that Imaersartoq is about a quarter (Danish) mile in diameter, which agrees with the lake's present size; as this measurement is correct, it is possible that the distance of a half mile from the glacier front to Imaersartoq is also correct. For comparison I may add that the glacier front on Jensen's map lies about two miles, and on the map based on aerial photographs about 18 km ($2\frac{1}{2}$ miles) from Imaersartoq.

1877—1948: A comparison between Jensen's map and the 1948 aerial photographs seems to indicate a continuous advance, the glacier now lying far beyond the funnel-shaped section of the fiord shown in fig. 35 a. The absence of a distinct melting zone around Sermilik glacier may be interpreted in the same manner. Judging from the maps the advance seems to have been one of between 2 and 4 km. It should be observed, however, regarding both periods 1860—77 and 1877—1948,

that the map material permits of only a very uncertain estimate of the changes.

Summary:

ca. 1860—1877: Advancing??

1877—1948: Advancing?

Locality 18:

The glaciers in Kvanefjord. Kvanefjord (Greenlandic: Kuánersôq) extends from the colony of Frederikshaab at its mouth to about 40 km to the east, where it divides into three arms, each about 10 km long, according to Medd. o. Gr., Vol. 61, p. 305. The three arms are called Avangnardleq ("the northernmost") or Sermilik, Akugdleq ("the middle one") and Nigerdleq ("the southernmost") or Nigerdlikasik. It is only in Avangnardleq and Nigerdleq that the inland ice runs out to the water with a calving glacier, but the former alone produces calf-ice on a large scale. In Akugdleq a glacier from the inland ice is separated from the fiord arm by a stretch of land about 7 km wide. E. THORHALLESEN in his "Beskrivelse over Missionerne i Grønlands Søndre Distrikt", p. 14, records that a glacier debouches into Avangnardleq, but says nothing of the glacier in Nigerdleq.

The information about the various glaciers in Kvanefjord is very slender, and, as they are all dealt with by the same authors, I have treated these three together.

1809: K. L. GIESECKE writes as follows about Kvanefjord on June 9th of that year: "Wir sezzen um 8 Uhr Morgens über den Quannefiord, grönländisch Kwannetsok, welcher voller Treibeis lag. Dieses kömmt aus dem Fiord selbst, weil der Eisblink in demselben seit einigen Jahren so sehr zugenommen hat, dass er nun bis in die See hinabreicht, und also von Zeit zu Zeit sich, eines Theils seiner Bürde entledigen kann. Vor 20 bis 25 Jahren konnte dieser Fiord nach des alten Zimmermanns, Ole Østerberg, des Vormanns Pehr Ohlsen und anderer Erfahrung noch kein Eis auswerfen. Ein hinlänglicher Beweis, wie sehr das Eis des festen Landes von Jahr zu Jahr zunimmt. Die Stücke haben oft schon eine Höhe von 20 Ellen und drüber". All this leaves no impression of where the glacier front was situated in 1809, but it establishes the fact that there had been an advance of one of the glaciers in Kvanefjord and gives the idea that the population on the West coast of Greenland at that time felt there had been a "climatic deterioration".

It is impossible to say which of the glaciers is referred to when the report speaks of the ice now being so far forward that it is calving; in all probability it was Nigerdleq, which, in contrast to Avangnardleq,

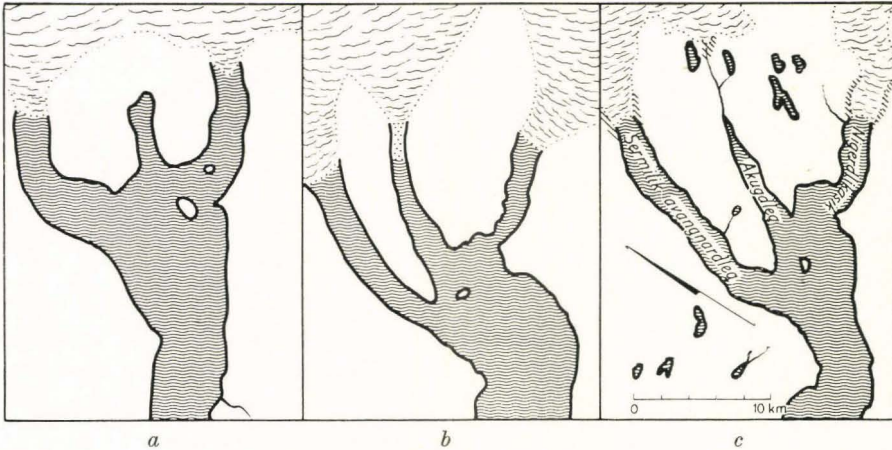


Fig. 37. Map of Kvanefjord.

- a) Sketch from H. RINK'S 1868 map. Original in Royal Library.
 b) Sketch from J. A. D. JENSEN'S map. Original in Medd. o. Gr. Vol. 7, pl. IX.
 c) General map of interior of Kvanefjord. Partly from Geodetic Institute's map-sheet 1:250,000, 62 VI. Frederikshaab Isblink. Melting zones around the glacier fronts added.

is easily approached and, as will be seen later, in the present century has again withdrawn so far that only part of it calves into the fiord. Avangnardleq is much larger and there is no apparent sign that its front was once on land. However, the size of the calf-ice in Giesecke's report suggests pieces from Avangnardleq, and it seems improbable that the calf-ice from the smaller ice-fiord Nigerdleq has ever exceeded the size of the calf-ice from Avangnardleq, even when the entire front of Nigerdleq debouched into the fiord. Possibly in Giesecke's report there was a confusion of information about both glaciers.

1857: In "Grønland" H. RINK says nothing about this fiord.

1868: The map fig. 37 a was drawn by Rink after travelling in Kvanefjord that year (in July). It cannot indicate any change in the position of the glacier front, but it is remarked that both Avangnardleq and Nigerdleq glaciers are productive and that there is no glacier in Akugdleq.

Another map of Kvanefjord is also found in Rink's map collection in the Royal Library, Copenhagen. It was drawn by the Greenlander Josua Petersen (Rink's Kortsamling No. 113), but its outlines are too rough to provide more information than is given on Rink's map.

1877: J. A. D. JENSEN'S map (Medd. o. Gr., Vol. 7, pl. IX) is also lacking in clues for determining the positions of the glacier fronts.

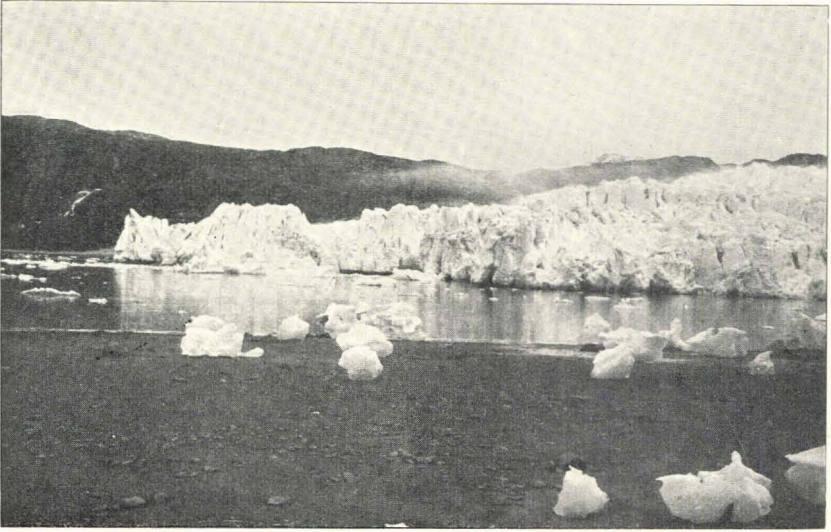


Fig. 38 a. Nigerdlikasik glacier. Photo O. BENDIXEN 1919. From *Medd. o. Gr. Bd. 61. Pl. CXXV, fig. 3.*



Fig. 38 b. Nigerdlikasik glacier, seen from the south side of the fiord arm Nigerdlikasik. Photo. WEIDICK, 11th Aug. 1955.

On it the middle fiord-arm, Akugdleg, is shown with an ice lobe extending almost down to the fiord; as will be shown below, this lobe cannot have been of such an extent in historical times.

1912: K. BIRKET-SMITH writes on a visit that year (*Geogr. Tidskr.*, Vol. 22, p. 20) that of the three ice lobes debouching into the fiord



Fig. 39. Nigerdlikasik glacier. Detail of the glacier front. Photo WEIDICK 11th August 1955.

only one is alive. As it appears from his report that the expedition was unable to penetrate far into the fiord, the author probably means that only the Avangnardleq glacier was producing to any great degree. As stated above, Rink's map of 1868 shows that in that year there were two calving glaciers.

1919: The only geographical description of the fiord was given by Inspector O. BENDIXEN (Medd. o. Gr., Vol. 61, p. 305), who writes that the Avangnardleq glacier is very productive, whereas the Nigerdleq glacier produces only little. A photograph loc. cit. marked "Nigerdleq-bræen 27/6 1919, O. Bendixen fot." will be useful for a later examination of changes in the glacier front. It is reproduced here fig. 38 a, together with a more recent one of the Nigerdleq glacier from almost the same spot (fig. 38 b).

In the same report there is a photograph of the head of Akugdleq fiord, and it can be seen that there is no ice-tongue in the valley such as that given in J. A. D. JENSEN's map of 1877.

1955: At the writer's visit to Kvanefjord on August 11th—13th 1955, the following facts were established as far as Nigerdleq glacier is concerned. The glacier has retreated since 1919. The exact spot from which O. Bendixen's photograph was taken could not be found. However in Bendixen's picture the lower part of the waterfall on the north

shore of the fiord is in line with peak A, as shown in fig. 38 b, and this fact enabled the author to take a new photograph from the same direction as Bendixen. It will be seen on comparing the two photographs fig. 38 a and b that the glacier has clearly retreated. Nowadays it calves only in the south part of the fiord. There the glacier front is about 25 m high and bears tidal marks. The northern part of the front is resting on a rock socle which is low, but about two hundred metres wide.

A photograph taken from the socle towards the glacier is shown on fig. 39; this photograph might be useful later for determining any changes in the position of the glacier front.

On Bendixen's photograph it is possible to discern a little of the melting zone on the north shore of the fiord, just ahead of the glacier's extreme point. This means that the glacier was already melting in 1919. In 1955 the height of the melting zone was found to be about 40 metres right abreast of the glacier front on the south shore. On the north shore it seemed to be of a similar height. Both zones are seen to continue back towards the inland ice with the same height.

At Akugdleg no lobe from the inland ice could be seen, which is the case in Bendixen's 1919 photograph. But a light-coloured zone extending like a tongue from the margin of the inland ice a short distance down into the valley leading to the head of Akugdleg fjord might suggest that there actually had been a lobe in it; however, it could not have been nearly so large as that indicated on the old chart of 1877, where it is shown falling right down to the lowland at the head of Akugdleg.

On visiting Avangnardleg it was possible to get only as far as half way to the glacier front. There the boat was stopped by the brash, which was very dense. Approach to the glacier overland from the fiord is impossible, the shores being very precipitous. A very distinct melting zone was observed from the front to the margin of the inland ice itself (see fig. 37 c). The zone appeared to be very high, and was estimated as about 150 metres at the glacier front, at which height it continued to the inland ice.

Conclusion:

A. *Nigerdleg glacier* (= *Nigerdlikasik glacier*).

ca. 1785—1809: As this is perhaps the glacier to which Giesecke refers in his diary on 9th June 1809, there is a possibility that for 20—25 years before his visit to Kvane Fjord the glacier was advancing. This assumption requires verification, however, because there is a chance that he was referring to Avangnardleg glacier.

1868—1877: Rink's map of 1868 indicates that the glacier is less productive than Avangnardleg, but the position of the glacier front is

not specified; all the same, it looks as if it was near to its present position. From the map it would seem that the glacier calved along its entire front, which leads to the supposition that the front was rather ahead of its present line. The same may be said of the 1877 map, but one cannot see whether the front in 1868 was in a position identical with that of 1877.

1877—1919: As stated, the exact position in 1877 cannot be determined, but it may be presumed that it was in advance of the 1955 position. By means of Bendixen's 1919 photograph the position in that year can be defined more exactly, even if in the picture the end of the front on the north side of the fiord is concealed by a projection from the glacier. In 1919 the front seems to have been near to the limit indicated by the melting zone as the maximum in recent time, presumably only about 75 metres behind this limit. Accordingly, for 1877 and 1919 it may be established that in both years the front was ahead of the 1955 position.

1919—1955: The comparison between Bendixen's photograph and the writer's shows that in the period from 1919 to 1955 the glacier front retreated a good distance, presumably about 500 metres.

B. *Akugdleq glacier:*

1877—1919: The 1877 map must be wrong, because the melting zone around the little glacier in the valley running from the inland ice eastwards to the head of Akugdleq fjord gives no indication of any earlier, large lobe. On the other hand it is possible that this map is a record of the glacier front in a more advanced position than now, because the fact that the height of a mountain top near the head of the fiord was given as 3150'—a fairly accurate figure (it has later been put at 1030 metres)—suggests that the fiord was carefully explored in 1877. The 1919 photograph indicates that in that year the glacier at the head of the fiord did not reach far down the valley. From the available material it is impossible to draw an exact conclusion as to any changes of the glacier front.

1919—1955: In both 1919 and 1955 the glacier seems to have been melting. The melting zone, which was distinctly observed in 1955, suggests a retreat. The 1919 photograph is not clear, but it does show that the retreat began before 1919.

C. *Avangnardleq glacier:*

ca. *1785—1809:* As in the case of the Nigerdleq glacier, there seems to have been an advance in this period—but we need verification

for the assumption that it was this glacier, not the Nigerdleq glacier (or possibly both), which was advancing.

1955: A melting zone around the glacier indicates a retreat of the glacier front of about 2 km, but the time of the beginning of this retreat cannot be stated.

Summary :

A. *Nigerdleq*:

- ca. 1785—1809: Advancing??
 1868—1877: Stationary?
 1877—1919: Stationary? or retreating slightly?
 1919—1955: Retreating.

B. *Akugdleq*:

- 1877—1919: Retreating??
 1919—1955: Retreating?? Stationary??

C. *Avangnardleq*:

- ?—1955: Retreating?

Locality 19: Frederikshaabs Isblink (Siorqap sermia).

This is the largest glacier within the three districts under review. On account of its size and extension to the sea it is the inland-ice lobe most often described. Nevertheless, the front has not often been visited because of the wide outwash plain separating the glacier from the sea. For chronological reasons the present description of the glacier will be kept in two parts, the first dealing with the chief sources in the literature, the second (conclusion) with the various sections of the glacier.

1723: Hans Egede's description of the glacier of 9th September 1723 (Medd. o. Gr., Vol. 54, p. 102) is still a valid one. It says: "The entire land for three or four miles is quite low and flat and, which is remarkable, covered with ice and snow; outside among the islands and far out to sea it is very shallow and the sea thick and muddy with sand and clay". ERICH LARSSØN, who accompanied Hans Egede on his expedition, uses the same expressions almost verbatim in his diary (Erich Larssøns Dagbog om Rejsen til Østerbygd 1723, printed in Grønlandske Selskabs Aarsskrift 1942, l. c. p. 107).

1743: In his diary the merchant POUL JOCHUMSEN MOLTZAU (Moltzaus Dagbog 1743—44, Norges Svalbard og Ishavsundersøkelers Medd. Vol. 33, 1935, pp. 55—56) writes merely that it is dangerous to pass the iceblink on account of having to stay well out in the open sea, a danger that is familiar to masters of vessels in Greenland to this day.

1751: In this year the merchant LARS DALAGER of Frederikshaab made his famous excursion on the southern part of Frederikshaabs Isblink. Dalager's account is quoted below in toto except for the latter part (Lars Dalager: "Grønlandske Relationer indeholdende Grønlandernes Liv og Levned". Det Grønlandske Selskabs Skrifter II, MCMXV, pp. 68—71), "September 2nd. In the morning early we tied our food-bags together as well as light equipment for resting at night, whereupon the girl shouldered the lot, a rather heavy load for her.

"We others each took his kayak (small Greenland boat) on his head and shouldered our flint-locks and, staff in hand, we began the march with great solemnity.

"The man went ahead as chief and guide, whereas I brought up the rear as sergeant. The first half mile was even and good, through a valley, along by a river, so that we passed through at a good pace.

"But then we had to cross a mountain which not only was high but also very rough, causing us with the boats on our heads to tumble more than once.

"Finally, to cut a long story short, with the setting of the sun we got down the far side of the mountain.

"I would guess that this day's journey of ours was not longer than about a mile and a half (Danish), although if I had had to charge for the distance according to Sjælland standards, I would with an easy conscience have taken payment for ten (Danish) miles; at our camping place we found a large fiord, a stiff day's journey for a kayak-man in to the head.

"In former days the Greenlanders could sail right from the sea in here.

"But at the mouth the iceblink in the course of time has overgrown both shores for a depth of half a mile; nowadays the Greenlanders have to cross this to hunt in the fiord.

"In the evening we lay down to sleep, and then on

"Sept. 3rd in the morning we paddled our kayaks three quarter mile straight across the fiord to the north side, where we laid our boats on the shore, covered with stones. Then, shouldering our packs we began our march across the mountain N.-E.-wards; that evening we reached the permanent ice.

"September 4th. In the morning we went out on the ice in order to reach the first peak, which is at the middle of the iceblink, about a mile away. The going there was just as flat and smooth as in the streets of Copenhagen, the only difference seeming to be that this was rather more slippery, but on the other hand I was not compelled to venture out to the sides into the dirt for fear of being overturned by the post-master's horse and carriage. An hour after sunrise we reached the

mountain top; there we ran up and down that day after the reindeer, but only one was shot, of which the Greenlanders received enough to eat, but as there were neither twigs, heather nor grass on the ground with which to make a fire for cooking, I had to resort to my slender food-bag in which were a peice of cheese and some rusks, which I washed down with a drink of water.

“September 5th. In the morning we again marched out on the ice to reach the uppermost mountain on the iceblink, called Omertlok, again a distance of about a (Danish) mile, but this stretch took us seven hours because of the unevenness of the ice and its many crevasses around which we had to make many detours.

“At 11 o'clock we came to the mountain and, after resting an hour or so, began to ascend the peak, which after much sweat and labour we reached about 4 o'clock.

“There we began to marvel at the great prospect on all sides, principally the extensive ice-mountain along the land, and across to the Øster Bygd, whose mountains like these were covered with snow.

“At first it seemed the distance there could not be more than four to six miles.

“But as I could clearly see the mountains at Godthaab Colony which looked just as big, and when I considered the distance between me and them, common sense bade me make another guess.

“We remained at the top of the mountain until 7 pm, but I had made the best use of my eyes, both with and without the aid of magnifying glasses, and finally concluded with a talk to the Greenlanders, dealing with the bygone inhabitants of the Øster Bygd, their physical and mental health.

“Meantime the sun went down, and therefore we descended the mountain for some distance and lay down to sleep.

“I for my part slept little that night, partly because of my thoughts, partly on account of the severe cold.

“September 6th. In the morning at sunrise I became at once aware of a reindeer near our camp; I shot it, and as I had not tasted hot food for five days, I drank a good portion of blood from the still warm animal, without it disagreeing with me at all. The Greenlanders also made a good breakfast of it and took a piece of leg with them, leaving the remainder for the birds of the sky, we being unable to carry much with us on account of the difficult going.

“Although I would have liked to go a day's journey farther over the ice in order to make a rough calculation of the distance, for many reasons we had to remember our journey back, one of them being very important, viz. that we were walking almost bare-footed.

“For, although each of us was provided with two pairs of good

boots for the journey, they were already quite worn out by the sharpness of the ice and the stones.

“And as the young woman with us had had the misfortune to lose her sewing needles we were unable to get patched up, which was rather perplexing, but we cheered each other up by laughing when we regarded the naked toes creeping out of our boots.

“By the way, I had almost forgotten to describe the part of the Øster Bygd which I could see from the mountain; I would first like to say that I had no compass and therefore am unable to give any reliable bearing. But so much is certain:

“The place on which we stood lies in the latitude of $62^{\circ} 16'$. From here to the NE or ENE I seem to have seen the nearest mountains on the Eastcoast.¹⁾ Though, they were much smaller than the mountains to the SW, which I concluded because they have less snow covering.

“At the place where I guessed Frobisher Strait to be, everything seemed to be practically flattened out to eternal ice.

“And I can scarcely say whether I saw two or three small hummocks, which might signify land.

“But N.E., or perhaps somewhat more N.W., as already stated, the mountains rose straight above the ice, and some summits were completely bare of snow.

“Especially interesting was a longish mountain that lay between two enormous mountains, its whole ridge having the ordinary natural colour of land; this is the most important information of which my humble pen is capable”.

The account then concludes with some remarks about the perils of the glacier crevasses and about the cold on the inland ice. The team got back to lake Taserssuaq on September 7th and continued at once on to Frederikshaab Colony, where Dalager arrived on September 10th.

1765: DAVID CRANTZ: *Historie von Grönland*, pp. 10 and 28—31. In that work is a description similar to Hans Egede's of 1723. The iceblink is described mostly by means of an extract from Lars Dalager's 1751 diary.

1777: In that year THORHALLESEN, in his work “Efterretninger om Rudera eller levninger af de gamle Nordmænds og Islænderes Bygninger paa Grønlands Vesterside, tilligemed et Anhang om deres Undergang sammsteds,” Kjøbenhavn 1777, writes about the Norsemen on p. 19: “Another tall mountain on the West side they called Snæfjeld, perhaps the iceblink between Fiskerlogen and Fridrichshaab, which on the Dutch charts is called Witte-Blink”. In his “Beskrivelse over

¹⁾ The mountains observed were not on the East-coast of Greenland as Dalager presumed, but probably “Jensen Nunatakker”. Present author's note.

Missionerne i Grønlands søndre District" 1774—1775 Thorhallesen had already written a good description of the outwash plain in front of the iceblink (p. 14), but without giving any indication regarding the boundary of the iceblink on it.

1805: In his diary for that year MARCUS NISSEN MYHLENPORT, district inspector for Julianehaab, says no more than Moltzau did earlier; that it is dangerous for shipping to sail near the iceblink (Myhlenports Dagbøger, 1786—1812, Norges Svalbard og Ishavsundersøkelers Medd. Vol. 33, 1935, p. 185).

1809: On May 26th of that year the iceblink was visited by K. L. GIESECKE, who made his way from the harbour of Tulugartalik to the glacier front and from there up on to the glacier itself. The excursion is described by Giesecke (Medd. o. Gr., Vol. 35, p. 196): "Die grossen flachen Sandbänke liegen von dem Eisblinke an über 3 Meilen in die See hinaus, und fallen, einige kleine Kanäle abgerechnet, welche die Flut abwechselnd von Zeit zu Zeit im Sande bildet, bis an den Eisblink hin, in der Ebbe ganz trocken, so dass man nach dem Eisblinke gehen kann. Ich versuchte disse beschwerliche Wanderung auf meiner ersten Reise und wagte es auch, den Eisblink zu erklettern, und über denselben ein Stück weit ins Land hineinzugehen. Der Anblick dieses fürchterlichen Eismeeres mit allen seinen glimmernden spiegelglatten Klippen, mit seinen unabsehbaren Spalten un Schlünden, die Aussicht rund umher, so weit das Auge ins Land hineinreichen kann, in die erstarrte erstorbene Natur, wo kein lebendes Wesen, kein Vogel, kein Insekt, kein Wurm sichtbar ist, und nur das Schlagen der empörten Wellen, das Knittern des gefrorenen Schnees, oder der Donner berstender Eisberge die schauerliche Stille unterbricht, fesselt den Reisenden in sprachlosem Erstaunen, und wirkt auf seine gespannten Sinne so lebendig, wie die reizendste Gegend Italiens.—Dorten ewige Freude hier ewige Trauer in der Natur!—Und doch—die unbeschreibliche schönen Reisingrotten, welche die Sonne und die See mit vereinten Kräften, bald in saphirblaue, bald in smaragdgrüne, bald in silberweise kristallklare Eisklippen am Strande gebohrt hat, welche der Ewigkeit zu trotzen scheinen, und doch oft augenblicklich in Trümmer zusammenstürzen, erfüllen die Seele mit einer gewissen bange Freude.—Ein schönes Nordlicht, welches in farbichten Stralen bereits über diesen Schauplatz schwermüthiger ängstlicher Wohllust zu blitzen begann, erinnerte mich, dass es Zeit sey, diese schlüpfrige Bahn zu verlassen, und in meinem thranigen Zelte bey rauchender Lampenwärme Schutz vor der Kälte der Nacht zu suchen".

1828: Lieut. W. A. GRAAH describes the iceblink itself in but few words (W. A. Graah: "Undersøgelses-Reise til Østkysten af Grønland

ved KAJ BIRKET-SMITH, 1932, p. 40). "Some miles north of Frederikshaab is what the Dutch called Witte Blink, where the permanent land ice or the glacier has spread right out to the sea, forming a tall, steep ice-coast which conceals all the land except an insignificant point or two".

1855: In a map, marked "Kysten fra 62° til 63°", drawn by KLEINSCHMIDT, it can be seen that the southern part of the iceblink had practically the same limit as now.

1857: Rink's map is too poor to indicate the position of the ice-margin. To a great extent it seems to be based upon Kleinschmidt's map of 1855.

On the iceblink he writes in "Grønland", Vol. 2, p. 96: "At the boundary of the Fiskernæs District the land ice again reaches right out to the sea, separated only by a flat, swampy area, most of which is flooded at high tide and undoubtedly has been deposited of the clay particles carried by the rivers from the ice. It has practically no islands in front and it can be seen from a long distance at sea, wherefore it is a good landmark, known by the name of Frederikshaab Iceblink". Later, on page 328 of the same book, Rink writes: "The mainland ice only gets right out to the sea in the form of the so-called Frederikshaab Iceblink; this conspicuous place is a good landmark; along a stretch of about two miles there is nothing but a flat, clayey and sandy stretch in front of the ice, mostly flooded at high water and of the same appearance as in the inner part of the icefjords. It has been thought that the ice itself, its outer edge if not exactly precipitous, at any rate cut off sharply, continues in under the frontal plain of clay and mud and right out over the sea-floor, but this seems scarcely credible; the peculiar colour of the sea front of the iceblink must undoubtedly be caused by the clay-bearing fresh water flowing from its margin".

1866: FALBE's map of the West Coast of Greenland in that year only shows the iceblink very schematically: the lakes Majorarissat to the north and Taserssuaq to the south were subsequently added to a map belonging to H. RINK's map collection in the Royal Library; this may have been done after J. A. D. JENSEN's expedition to the iceblink in 1878 (see that year).

1878: In that year J. A. D. Jensen's expedition made its way in over Frederikshaabs Isblink to J. A. D. Jensens Nunatakker. As the account of this journey in Medd. o. Gr., Vol. 1 may be described as a monograph on the iceblink, only a brief extract will be made of it here. The expedition may be divided into two separate trips:

1) A reconnaissance in the period 30th June till 7th July to the region about DALAGERS Nunatakker and retracing Dalager's 1751 route.

Jensen, by the way, concluded from Dalager's report that conditions at this part of the iceblink were constant and wrote the following in *Geografisk Tidsskrift* Vol. 32, 1929, in his article "Om Grønland i Forhold til Aeronautik": "It occupies a horizontal ice plateau (about $5 \times 2\frac{1}{2}$ nautical miles, about 590 m above s. l.) that is smooth and uncrevassed, its monotony broken only by a few very low moraines, no more than about 30—40 paces wide, consisting of gravel and stone, connecting the nunataks in perfectly regular curves (fig. 2)¹). The conditions there must be assumed to be constant, because in 1878 we found them exactly as Dalager described them on his visit in 1751".

In the expedition report *Medd. o. Gr.*, Vol. 1, p. 43, in the account of the reconnaissance Jensen mentions the existence of an ancient tradition that in former times Taserssuaq was a fiord, which could be reached by umiak through Tiningnertoq Sound. There is nothing in the text to show whether Jensen, in addition to Dalager's report, heard of the tradition from the Greenlanders. The addition that the proof of this former easy access to Taserssuaq lay in a number of Greenland graves in the eastern part of the lake, is not contained in Dalager's report and therefore must have been related to Jensen by the natives. Thus the oral tradition of this glacial advance had lived for over a hundred years among the Greenlanders on the spot. In Jensen's opinion, however, these traditions must be handled with caution, even if they doubtless embody a certain amount of truth. In any case, this advance cannot be dated except that it happened before 1751. As already stated, at this part of the glacier Jensen found the conditions to correspond exactly to those described in Dalager's report, which suggests that the glacier as a whole had remained stationary during the 127 years that elapsed between the two visits to Dalagers Nunatakker. It should be noted that FRIDTJOF NANSEN ("Paa Ski over Grønland" 1890 p. 398) denies that Dalager's Omertlok and Jensen's Nasausaq are identical nunataks.

On the reconnaissance, one of the glaciers running to Taserssuaq was timed and was found to move about 10' per 24 hours. The report contains no actual data of the position of the glacier front, but the illustration Pl. VII. showing the inland ice, and some of Dalagers Nunatakker seen from the nunatak Nasausaq, fig. 22, p. 134 showing the area south of Dalagers Nunatakker, also seen from Nasausaq, as well as a map of the region of Dalagers Nunatakker on Pl. V of the report, provide a basis for judging the situation of the ice margin.

2) The second journey, was undertaken in the period from 11th July until 5th August from the area north of Frederikshaab Iceblink, at Majorarissat across the iceblink to Jensen's nunataks and back by approximately the same route. Here again it is not so much the text as the map

¹) This fig. 2 is the sketch fig. 22 in *Medd. o. Gr.*, Vol. 1. Pres. auth. note.

and illustration material that provide a basis for judging the position of the ice margin at some points of the iceblink. For example there are the drawing Pl. VII, showing the Majorarissat lake and its surroundings, seen from a mountain north of that lake, the illustrations Pl. IV and fig. 6, the maps Pl. V, all showing Jensen's nunataks, and, for both journeys, the general map C. In addition to these illustrations from *Medd. o. Gr.*, Vol. 1, there are few more in an article on J. A. D. Jensens' travels in the Greenland periodical "Atuagagdliutit", *Nuvfimpare* 13, 1878, under the heading: "Sermerssualiarnermik (saku-tût nâlagâta Jensen-ip agdlagai nugtigkat)" and in *Geografisk Tidsskrift*, Vol. 3, Pls. VI—VIII and in the book J. A. D. Jensen: "Om Inlandsisen" etc. 1880

1880: In that year the geologist N. O. HOLST visited the southernmost part of the front of the iceblink. The account of his journey: "Berättelse om en år 1880 i geologiskt syfte företagen resa till Grönland" indicates that Holst was at the iceblink on two separate occasions. On the first trip, lasting from 3rd July till 9th July, he visited Dalagers Nunatakker and the marginal region of the iceblink north of Sarqarigsoq-Tiningnertôq. The route travelled was by way of lake Taseq atdleq across the inland ice to Kangarssuk and Dalagers Nunatakker. The only details recorded on this trip are that the first 500 feet of the ice inclined 15—20° towards the shore, after which it was more horizontal. For several thousand feet inwards from land the marginal region of the inland ice was covered with moraine which, from Taseq atdleq, continued westwards along the margin. It was Holst's intention to inspect a number of nunataks in the region of Dalagers Nunatakker, but owing to shortage of provisions and lack of confidence in his companion, who wished to return, he succeeded only in visiting the southernmost one. No particulars are given of the boundary of this nunatak against the ice. After returning by the same route to Avangnardleq Holst visited the frontal region of the iceblink at Tiningnertôq, about which he reports: "At Sarkarigsok the Frederikshaab iceblink is a slight incline. The three thousand feet nearest land has a gradient of 1:11. In over the ice it gradually becomes even less". He also states that the extensive moraine covering observed at Taseq atdleq does not continue to Sarqarigsoq: in this locality the moraine on the outer part of the ice is only very thin. At Sarqarigssok it ends about 3000 feet from land at a height of 275 feet above the ice margin, but here again there are many rounded blocks and concretions to a distance of about 150 feet from land and to a height of about 35 feet.

After this visit to the southern part of the Frederikshaabs Isblink Holst went to the Sukkertoppen District on 13th July, but towards

the end of August returned to the iceblink, this time visiting the front facing Davisstrædet (at the place where J. A. D. Jensen began his journey across the ice to J. A. D. Jensens Nunatakker in 1878), and also the Sarqarigsoq-Tiningnertôq area once more. Among the data from that journey Holst states (page 32 of the work referred to above) that on 23rd August at Frederikshaabs Isblink there was a barren belt 100 feet wide, whereas at the nordre side of Nordre Qipisarqo glacier this belt was only about 30 feet wide (see under Qipisarqo glaciers, Locality 12). On page 51 is the following summary of Holst's observations:

"The largest internal moraine that I saw while in Greenland is the one on the south side of Frederikshaab iceblink, which certainly deserves special mention. This moraine has its eastern boundary immediately to the east of the aforesaid lake Tasek atdleq and then follows the entire south side of Frederikshaab iceblink. Thus it has a length of about two miles. Not far from its east end the moraine was about one-eighth of a mile wide, but near the middle it is almost twice as wide and continues at about the same width westwards. It narrows off again only at its west end.

"The thickness of the moraine is by no means inconsiderable. It is thickest close to land, and there the covering is so unbroken and thick that it would be difficult to believe it lies on the inland ice, if the latter did not show itself here and there in the crevasses. According to whether the moraine is more or less thick, the ice is more or less protected from melting. As a consequence the moraine gets piled up in mounds and hummocks, usually small in size but sometimes reaching a height of about 50 feet. At first one is inclined to ascribe these varying heights exclusively to the different thicknesses of the moraine, but one is soon convinced that the hummocks and ridges, at any rate the majority of them, have a more or less considerable core of ice.

"Gradually as one moves away from land the moraine covering becomes thinner and thinner, to cease entirely at last. At the aforesaid place where the width of the moraine could be estimated at a quarter mile, the moraine covering at a distance of 3000 feet from land had mostly a thickness of several inches, though the ice peeped out here and there. At 4000 feet the ice was still completely covered with moraine. Thereafter, however, the covering became more and more incomplete and at a distance of 8,300 feet from the ice margin the moraine came to an end with a fairly distinct boundary against the almost clean ice. But some few hundred feet higher up on the otherwise perfectly clean ice there were scattered patches of sand and gravel a few square feet in size.

"Near the east end of the moraine I essayed an estimate of its average thickness across its entire breadth, and found that it could

be put at 1—2 feet. However, the difficulty of discovering the true thickness where the moraine is thickest nearest land makes this estimate highly approximate.

“The boundary between the moraine-covered ice and the cleaner ice lay at a varying but very considerable height above the margin of the inland ice. At the latter place the height was 2—300 feet, and at the aforesaid place where the boundary was only found at a distance of 8,300 feet from land, it lay at a height of no less than 550 feet above the edge of the inland ice.

“The internal moraine consists of stones, gravel and sand mixed together. The blocks rarely reached a cubic fathom in size, most of them being smaller and fairly even in size. The stones generally were angular or subangular. Quite exceptionally I observed stones belonging to the ground moraine. At one place moreover I could walk across the middle of the moraine and find only one glaciated stone, although I made a special search for these. Accordingly, the moraine material is angular and consists of so-called drift.

“Here and there was pure sand, washed out by the meltwater and rain into the fissures and the lower parts of the ice margin. When it has accumulated in some quantity it protects the ice from melting, whereby the lower parts might become the higher ones. It looks as if the sand in this manner could be repeatedly washed out and redeposited. It is probable that some of the fine sand which in Sweden is not uncommonly found together with glacial drift, in some provinces called “Mjele” or “Mjelsand”¹⁾ is produced in that manner.

“Of much less importance was the internal moraine on the west side of Frederikshaab iceblink, at Sarkarigsok. It was only up to about 450 feet from land that the moraine covered the ice anything like completely, and even there it was not very thick. From there it gradually lessened and the moraine could be seen to cease 3,030 feet from land and at a height of 275 feet. Farther inland there were only sporadic patches of gravel and solitary stones. The moraine material was generally angular, of the same nature as the internal moraine just described on the south side of the iceblink. But as I have already said (page 51) one here encountered stones and concretions belonging to the ground moraine, and they were relatively numerous”.

In the foregoing, Holst's report is cited to such an extent that almost all his data on the Frederikshaabs Isblink are included. This is because his report, together with J. A. D. JENSEN and A. KORNERUP's description of 1878 are the principal sources so far available on the iceblink, and as Holst has no illustrations, I have judged it necessary

¹⁾ = silt. Present author's note.

to quote him at such length as some of his data may be useful in the case of later visits to this glacier.

?: Among the collection of photographs at the Royal Library are three of the iceblink. They are long-range shots and will probably be of little use in helping future determinations of changes in the ice margin, especially because the date of the exposures is unknown.

In *Medd. o. Gr.*, Vol. 57, p. 21 is a drawing by the printer LARS MØLLER of Godthaab, showing the northern part of the ice front. Here again the date is unknown, and anyway the drawing is not very accurate.

1890: J. C. D. BLOCH's description of the iceblink in *Medd. o. Gr.*, Vol. 7, p. 150, states that generally there was only one principal terminal moraine, lying close to the ice margin, and that along a short stretch there were two moraines with an interval of 60' between them: The outer one was old and overgrown. At a few places in the hollows the ice has retired about 30' behind the principal inner moraine. The principal moraine had a height of 20' and a width of 10'. The vegetation extended right in to the moraine in front of the ice margin, from which Bloch concluded that for a long time the ice had not moved backwards. It is not clear from Bloch's text at what point he visited the iceblink, but in all probability it was a place inside Tulugartalik at the ice front towards Davis Strait.

1894: For this year there is a photograph by Doctor THOMAS NEERGAARD KRABBE, reproduced in his book "Greenland, its Nature, Inhabitants and History", Pl. 139, with the following caption: "Frederikshaab iceblink, seen from Tulugartalik". The picture will be useful for comparison with subsequent photographs taken from the same spot; it is also comparable with some of the photographs of K. GRIPP and S. HANSEN (see below).

1930: For this year there is a large collection of photographs, taken by State-geologist S. Hansen and Professor K. Gripp. These depict the ice margin, viewed from the small knolls between Tulugartalik, and also the glacier front seen from the mountains flanking the strait between Majorarissat and Ikátoq on the northeast part of the glacier front.

When compared later with more recent pictures this collection of photographs will provide a useful basis for evaluating any changes in the front. The same expedition compiled a map of the glacier's western marginal region, on the scale of 1:10,000.

1950: P. GRAFF-PETERSEN, M.A., in this year photographed the northern region at the ice margin. The glacier is viewed from the same spot as one of S. Hansen's photographs of 1930.

1947—1948: For these years there are a number of aerial photographs of the glacier. However, it is difficult to make a comparison of many of them with the information from the earlier sources, as only a small part of the wide expanse of ice margin is bounded by mountain, the remainder bordering upon the large outwash plain in front of the glacier. As the changes in the ice during the past two hundred years are only small compared with its vast expanse, it is difficult to see any changes on the aerial pictures compared with the older information.

The few aerial photographs which seem to show evidence of a change of the ice margin, when compared with the previous material, will be referred to under the various sections in the following. Some mention is made of the Geodetic Institute map 1:250,000; this map was compiled from the above aerial pictures.

The glacier margin is divided into the following regions:

- A) Kangârssuk area
- B) Front of iceblink facing Davisstrædet.
- C) Majorarissat area.
- D) J. A. D. Jensens Nunatakker.

Conclusion:

A. Kangârssuk area:

?—*1751:* The record by P. Dalager, and later by J. A. D. Jensen, of the Greenlanders' statement that Taserssuaq (now Kangârssûp taserssua) was formerly in communication with Tiningnertôq, might be interpreted as indicating an advance of the glacier margin at that spot. Beyond the fact that the advance took place prior to 1751, nothing can be said as to the size or the exact time of that advance.

1751—1878: For this period we have nothing but J. A. D. Jensen's statement in *Geografisk Tidsskrift*, Vol. 32, that what the expedition observed in 1878 agreed with what Dalager wrote in 1751; the assumption therefore is that in this area the margin of the inland ice was constant. However, Dalager's description forms no good basis for ascertaining the position of the ice margin in 1751, so that "constant" in this connection must be evaluated as a highly approximate term.

(1878—1880): As Holst's account is solely a description, unaccompanied by illustrations, his data can be utilized only in conjunction with an examination on the spot. One thing may be said, however. Both Holst and Jensen laid their route along the river from Taseq atdleq to Avangnardleq. Lake Taseq atdleq is reported as having the same water level in 1878 as in 1880. As Holst was familiar with J. A. D. Jensen's map of the area, it is presumable that Holst would have drawn more



Fig. 40. Frederikshaabs Isblink. Portion of Geodetic Institute's map-sheet 1:250,000 62 VI. The four areas shown on the map are the four sections of the description of the iceblink.

attention to the lake if the glacier front, which borders along the north side of it, had occupied another line in 1880 to what it did in 1878. As he did not, we must take it that the ice front there was in the same position in 1880 as in 1878.

1878—1947: On comparing the Geodetic Institute's oblique exposures 503, DV No. 293, 1947 and the map on 1:250,000 scale 62V1 printed in 1956, with Kornerup's map of 1878, it appears that no important changes have taken place in the area around the north side of Kangårssuk (now Kangårssûp nunâ) during this period. On the other hand, when the aerial pictures are compared with Kornerup's drawing of Dalagers Nunatakker, one observes the following, adopting the terms used by Kornerup in *Medd. o. Gr.*, Bd. 1, illustration p. 32: m_1 the broad moraine between Kangårssûp nunâ and the nunatak Nasaussaq east of nunataq Amârtoq (Tikuarseritsoq). m_2 another bowformed moraine, connecting Amârtoq with Kangårssûp nunâ and m_3 , a moraine connecting Amârtoq with Qáqaq.

Moraine m_1 was larger in 1947 (consisting of two moraine mounds) than in 1878, and moraines m_2 and m_3 are now merged together in the area south of Amârtôq. And yet, the drawing by Kornerup shows that moraines m_2 and m_3 lay close together in 1878 too. On the aerial picture Sagdliata nunâ can be seen stretching northwards parallel with Amartôq much farther than Kornerup could see from Nasaussaqa, where he sketched his map. Nunataks Qâqaq and Sagdliata nunâ now form one nunatak which, had it been the case in 1878, would have been discernible from Nasaussaqa. Accordingly this must be regarded as definite evidence of an emergence here since 1878. Vertical exposures over this stretch confirm that there is now a broad connection between these two nunataks.

Ice margin around Kangârssuk and Taserssuaq: As regards Taseq atdleq, on comparing the Geodetic Institute map with J. A. D. Jensen's it is observed that only a small part of the inland ice now projects down into Taseq atdleq, whereas on the 1878 map it reaches the lake along a wide front; provided Jensen's map is correct, this seems to indicate a retreat of about 300 m.

A similar retreat is also to be seen on comparing the two maps at the west glacier front at Taserssuaq, but of how much it is impossible to say. As regards Taserssuaq's east part the 1878 map is so inaccurate that no comparison is possible.

Summary:

Prior to 1751: Advance at Taserssuaq???

1751—1878: Stationary?

1878—1947: Dalagers Nunatakker: Melting, nunataks Qaqaq and Sagdliata nunâ merging.

Border zone at Kangârssuk (now Kangârssup nunâ): Stationary.

The front facing Taserssuaq (now Kangârssûp taserssua) and Taseq atdleq: Retreating.

Ice margin facing Tiningnertôq: nothing known.

B. *Inland-ice front to Davisstrædet:*

1878—1880: N. O. Holst's account states that, like Kornerup and J. A. D. Jensen in 1878 he found a terminal moraine at a distance of about 100 feet from the ice margin, therefore we must assume that in 1878—1880 the ice was stationary at this place. Regarding the distance between moraine and ice margin Kornerup (Medd. o. Gr., Vol. 1, p. 127) writes: "As the large ice pyramids shown in fig. 21 were outside the ice margin, the foremost part of the iceblink must have melted recently, at least as much as corresponds to the height of the pyramids, so its

seems as if the margin has retreated somewhat, which was also observed by the fact that there was a terminal moraine at a distance of 100 feet from the present margin. The melting may perhaps have taken place during the spring and summer of 1878 so that during the following winter the ice margin was able to resume its former position, as is the case with other glaciers. There are no records of the movement of this ice, because the place is very rarely visited by those sailing by, but from the opinions of the population it is reasonable to assume that Frederikshaab Iceblink has not undergone any great change for a long time, or, in other words, it may be regarded as stationary, in that movement and melting offset each other". However, as Holst remarks (not included in the present quotation of his text) that he was unable to find the large ice cones mentioned by Kornerup in 1878, but considers their size must have been exaggerated, there is a possibility that the melting observed by Kornerup was not a seasonal variation in its entirety but partly also a secular variation, whereby the ice cones outside the ice margin melted partly in the course of 1878—80. In that case, prior to 1878 there must have been a tendency to melt (retreat) in this section of the ice margin. The fact that the population in 1878 considered the ice to be stationary need mean nothing more than that the changes in the position of the margin were not so great that they were noticed; after all, it was only a difference of 30 metres.

The other information given by A. Kornerup and J. A. D. Jensen about this part of the ice margin, taken together with Holst's description tells us nothing about any change in the position of the ice.

(1878—1947): It has not been possible to ascertain any change when comparing the descriptions in Medd. o. Gr., Vol. 1 and the sketch maps and illustrations there with the material dating from 1930 and 1947—48.

1880—1890: N. O. Holst records in 1880 that nearest the ice is a barren zone about 100 feet wide, whereas in 1890 Bloch states that the vegetation extended right up to the moraine in front of the ice margin itself, and that only here and there the ice lay about 30' behind the principal moraine. From this it would be tempting to suppose that between 1880 and 1890 the ice moved forward about 70 feet. However, in the first place, Bloch does not state distinctly that it was the same part of the ice margin that Holst visited, and secondly, we do not know what the annual variation (seasonal variation) in the position of the ice front is. No conclusions can therefore be drawn as regards changes in the position of the ice.

1894—1930: T. N. Krabbe's photograph of the Tulugartalik area, when compared with photographs by S. Hansen and K. Gripp, seems

to suggest that the ice was stationary between these two dates. The comparison is not wholly reliable, however.

1930—1947: I have not found more information on the area dated after 1930. Aerial photographs of 1947 indicate no change since 1930.

Summary:

?—1878: Retreating.

1878—1880: Stationary, or retreating slightly.

1880—1890: ?

1890—1947: Stationary?

The foregoing applies only to the northern part of the ice front in the area (at the place where J. A. D. Jensen ascended the inland ice). On the whole, up to 1947 the Frederikshaabs Isblink within the area in question may be considered as having been stationary, if we regard changes of less than 100 metres as undeterminable.

C. Majorarissat area:

1930—1952: Two photographs, one taken by State geologist SIGURD HANSEN in 1930 and one by Magister Graff Petersen in 1952, show that in that period there were considerable changes in the ice front at the small headland which separates Majorarissat from the Itivdleg delta. The 1930 picture shows the front steep and productive, whereas in 1952 it has shrunk and is dark in colour on account of moraine. In the east the front has moved about 200 metres back, and west about 100—150 metres.

Not much is known about the remainder of the Majorarissat area: A comparison between J. A. D. Jensen's 1878 map and that of the Geodetic Institute reveals that the position of the margin has not changed sufficiently to be visible on the map.

Summary: (the Itivdleg section of the ice front):

1878—1930: Stationary?

1930—1952: Retreating.

D. J. A. D. Jensens Nunatakker:

1878—1948: The Geodetic Institute's oblique photograph 514 HN, No. 8950, 1948, shows that there is now one large nunatak south of the lake described by Jensen and Kornerup, whereas in 1878 there were several. The other nunataks agree completely as to shape with the 1878 map. Accordingly there is a possibility that some of the nunataks have emerged as a result of the ice melting since Jensen and Kornerup were

there. Emergence by the northernmost nunataks is more uncertain, as they cannot be seen distinctly on the aerial picture.

Summary:

1878—1948: Emergence from melting ice?

Godthaab District.

In a physical-geographic sense this district is very like Frederikshaab, but the land (i. e. the ice-free belt of land) is much wider, about twice the width of the belt in the Frederikshaab District. This has meant that the interior of the country was not visited much in former days except by reindeer hunters. Access to the interior is easier only in the region around Godthaabsfjord, the most northern part of the District, for which reason there is a certain amount of information from there. Only three fiords in the District reach right back to the inland ice: Bjørnesund, Sermilik fjord and Godthaabsfjord. The values of movements of the glacier in these fiords have never been measured. In two of the fiords, Godthaabsfjord and Bjørnesund, the glaciers are productive, but only on a small scale: the calf-ice rarely gets outside the fiords.

Locality 20.

Nákaiissorssuaq (the glacier in Agdlumersat (Bjørnesund)).

Bjørnesund stretches from Ravns Storø, north of Frederikshaabs Isblink, northeast to the inland ice, which has a single tongue running into the head of the fiord. The Greenlandic name of the glacier, *Nákaiissorssuaq* (i. e. "the busily calving") refers to its productivity, though this is only slight compared with that of other glaciers.

1801: On this fiord J. CHR. MØRCH, merchant, writes (Afhandling om Grønland 1799—1801, published by H. OSTERMANN, Norges Svalbard og Ishavs-Undersøkelers Meddelelser, Vol. 52, 1942, p. 67), having voiced a theory of the origin of the inland ice through the freezing up to the fiords, which were once supposed to have cut through Greenland from east to west: "that under the glacier from Adlomersok not only pieces of timber—not necessarily from the east side—but even Greenlander implements have come drifting, which are spoken of by some Greenlanders but not sufficiently verified; it is possible that the fiord now is closed at the head"¹).

¹) So it is not possible to go to the East coast. Present author's note.

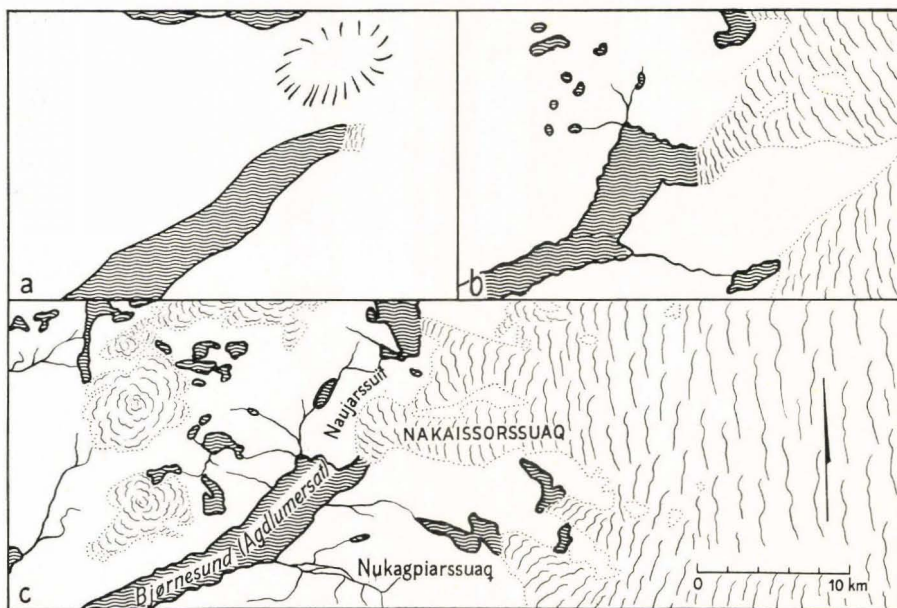


Fig. 41. Agdlumersat (Bjørnesund), inner part.

- a) Detail from B. PETER'S map 1859. Original in Royal Library.
 b) Detail from J. A. D. JENSEN'S map. From Medd. o. Gr. Vol. 1, Kaart A.
 c) Detail from Geodetic Institute's map 1:250,000 63 V2, Fiskeneset.

Apart from the correctness of the theory, the account of the drifting implements may mean that in the close of the 18th century the glaciers were advancing. On the other hand we cannot dismiss the possibility that this, like other Greenlander reports elsewhere, was a long-lived legend.

1809: In that year K. L. GIESECKE visited the fiord and described the Norse ruins there. He did not quite reach the head of the fiord, which at that time (24th May) was covered with winter ice. Giesecke also refers to Bjørnesundet as a former passage to the East Coast, now choked by ice.

1856: The fiord is plotted on H. RINK'S map, but the shore outlines are extremely schematic.

1859: A map dated to that year, drawn by S. KLEINSCHMIDT from particulars supplied by the reindeer hunter B. PETERS and others (see fig. 41 a), seems to have been compiled from a very good knowledge of the region. It will be seen that Agdlumersat ends close to the line SSE of the mountain Qaqatsiaq and that its termination is before the fiord bends south of Naujarssuit. The position of the glacier front

cannot be defined more accurately, but the possible error in its position is of the order of 2 kilometres.

1878: The fiord was visited that year by JENSEN and KORNERUP. The expedition proceeded into the fiord to a place about a quarter mile from the glacier front, where they were stopped by the calf-ice. However, a large area at the head of Bjørnesund was explored on foot and the mountains Nukagpiarsuaq and "Sisiseratek", south and north of the glacier respectively, were climbed. The shore outlines on Jensen's map agree well with those on a new map of the area, published by the Geodetic Institute in 1955. Whereas on the 1878 map the glacier front reaches the south side of Naujarssuit, where the foot of that mountain forms a naze in the fiord, on the 1955 map it is northeast of that naze, which can only mean a retreat in the period 1877 to 1948, the year in which the Geodetic Institute's aerial photos of this area were taken (see below).

1948: Aerial photographs of that year show a broad melting zone, to be seen for instance on one published in the periodical "Grønland", 1956, p. 26. The extreme limit of that zone is very like the limit of the glacier on Jensen's map.

Conclusion:

1859—1878: A comparison between Peter's map of 1859 and Jensen's of 1878 seems to show that in both 1878 and 1859 the glacier front was due south of Naujarssuit. However, the 1859 map is so inaccurate that the position of the front cannot be determined with any exactitude, and it is with all possible reserve that I put the position of the front in 1859 as being identical with that in 1878.

1878—1948: The comparison of the Geodetic Institute's aerial photographs with Jensen's map seems to indicate that the trim-line approximately reproduces the position of the glacier front in 1878. In this period there was a retreat of about 2.5 to 3 kilometers.

Summary:

- ?—1801: Advance.
 1859—1878: Stationary.
 1878—1948: Retreating.

Locality 21: The Kitdlavât glaciers.

These glaciers are not lobes from the inland ice, but lie on the north side of the mountain Kitdlavât (about 1300 metres high) on the south side of Sermilik fjord.

1878: From that year J. A. D. JENSEN reports the following about one of the glaciers (Medd. o. Gr., Vol. 1, p. 32): "On the north

side of Mount Kitdlavat is a glacier which reaches right down to the fiord, where it forms an ice wall about 70 feet high and 800 feet long".

1930: The mountain area was photographed in 1930 by Professor GRIPP. The photograph shows that the lower of the glaciers no longer reaches the sea, but is separated from it by the large terminal moraine. A distinct melting zone is visible at all the Kitdlavât glaciers.

1955: For this year there is a photograph by the writer. The glaciers are shown from almost the same spot in the fiord as in the 1930 photograph. This new picture, taken on 19th August, shows the upper parts of the mountain and the glaciers partly hidden by new snow.

Conclusion:

1878—1930: For that period only the changes in the position of the lowest of the glaciers can be determined. Whereas in 1878 it was calving into the fiord, in 1930 it was situated at the water edge but behind a large terminal moraine. The linear retreat seems to be no more than about 100 metres, but the melting zones along the glacier sides, which must show the approximate position in 1878, indicate considerable shrinkage. As large melting zones are also to be seen on the other glaciers, it is presumable that they also retreated in the same period.

1930—1955: Comparison between 1930 and 1955 photographs shows the following changes in the glacier in this period: a. In the firn area new knolls protude in 1955, and a considerable shrinkage since 1930 is observable. The sinking of the surface is estimated to 10—20 m. b. The lowermost glacier tongue, the front of which in 1878 and 1930 was situated at sea-level, is in a retreated position. The linear retreat is estimated at between 100 and 200 m and in the same period the glacier surface lowered 25—50 m.

Summary:

1878—1930: Retreating.

1930—1955: Retreating.

Locality 22. Sermilik Glacier.

This glacier is separated from Sermilik fjord by an outwash plain about 3 km wide. The length of the glacier itself is impressive: from the margin of the inland ice to the glacier front it is 50 km and is therefore the longest lobe of the inland ice in the districts within the scope of the present work.

ca. *1800:* Concerning information of S. KLEINSCHMIDT about this year, see 1878.

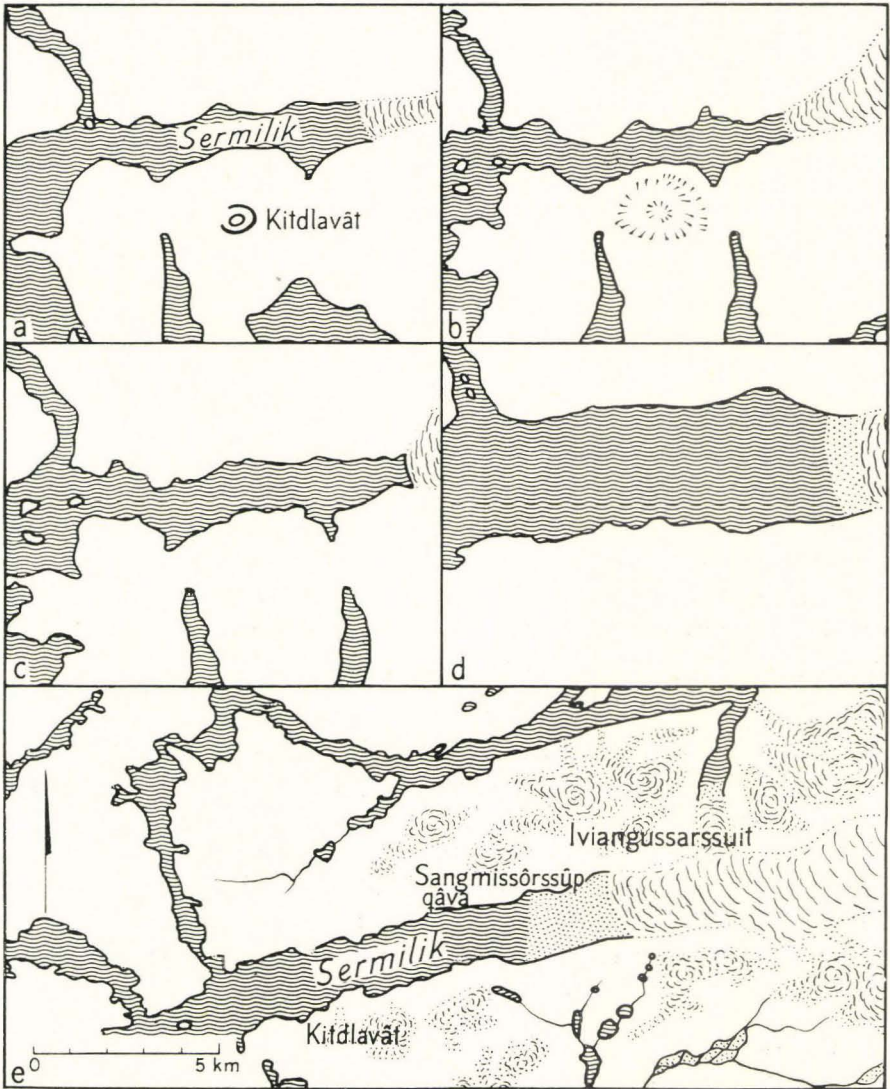


Fig. 42. Sermilik fiord. Details from maps.

- a) S. KLEINSCHMIDT's map 1855. Original in Royal Library.
- b) B. PETER's map 1859.
- c) C. V. M. FALBE's map 1863.
- d) J. A. D. JENSEN's map. From *Medd. o. Gr.* Vol. 1.
- e) From Geodetic Institute's map 1:250,000, sheets 63 VI, Færingehavn and 63 V2, Fiskernæsset.

1855—1866: There is not much early information about this glacier. About the trading station Sermilik, H. RINK writes in "Grønland", Vol. 2, p. 328, that "the latter place lies near the mouth of a large

ice valley which seems to be a ramification of the inner continental ice". Rink's map does not contain any definite indication of the limits of the glacier. Of other maps of that period there are those of Kleinschmidt, 1855, BENJAMIN PETER, 1859 and FALBE-BLUHME, 1866 (from a journey made in 1863—64), all in Rink's map collection at the Royal Library. Sections of these maps showing Sermilik fjord are reproduced in fig. 42. It will be seen that the distance from Kitdlavât to the Sermilik glacier front on all the early maps is shorter than that from Kitdlavât to the mouth of Sermilik fjord at Simiutarssuaq. That the entrance to the lateral fiord Alangordlia on the north side is not shown need not mean that the inner part of Sermilik was not explored; the entrance to this lateral fiord is very oblique and from the fiord might easily be mistaken for a creek. It would be tempting to draw the conclusion that the glacier front at that time was in advance of its present position, but in the first place the determination of the front is highly uncertain, and in the second, it may be an error on the earliest map which has been copied on to the others.

1878: J. A. D. JENSEN's map also seems to show that in 1878 the glacier was in a more advanced position than was seen in 1955: the outwash plain in front of the early map is smaller than now, and the glacier front was farther from the entrance to Alángordlia; it looks moreover as if the glacier was due south of the mountain Sangmissoq (now called Sangmissôrssûp qâva). Jensen measured the depth of the fiord itself. He reports that neither the glacier in Sermilik nor the one in Alángordlia to the north produces calf-ice. A broad strip of clayey land separates Sermilik glacier from the fiord. According to Samuel Kleinschmidt (quoted by J. A. D. Jensen), at the beginning of that century boats could still pass through the valley east of the mountain Iviangussat (now called Iviangussarsuit), whereas now it is choked by the glacier. A. KORNERUP, who took part in J. A. D. Jensen's expedition, considered that the wide clay flat in front of the glacier was evidence that the Sermilik glacier front was stationary or practically so, like Frederikshaab Iceblink.

1930: The Danish Geological Survey has photographs of Ujaragssuit and the Sermilik glacier, taken by K. GRIPP, including the following of the glacier: 1) Front of Sermilik glacier, looking towards Sermilik fjord, and 2) Front of Sermilik glacier, looking towards Alangordlia fjord.

1955: In that year Sermilik was visited by the writer. He succeeded only in exploring the glacier's offshoot into Alángordlia fjord, whereas

a planned inspection of the Sermilik glacier front was prevented by bad weather.

Conclusion:

ca. 1800: As to Kleinschmidt's tale of the advancing of the glacier since the beginning of the 19th century, the distance sounds fantastic. No doubt he was given the account by Greenlandic hunters, and it may be that the impression of the glacier having advanced became exaggerated. The story cannot be disproved, but as there has not been much change in the glacier since the 1850's up to the present day, the probability is that the same is true of the period before 1850. It was on account of that report that Rabot in "Les variations de longueur des glaciers etc." p. 29 reckoned with an advance of about 42 km in the 19th century.

1855—1878: The earlier maps and J. A. D. Jensen's 1878 map all seem to show the glacier front at a more advanced position than in 1955: the implications are thus that in that period the glacier was farther forward. However, the melting zones around the glacier in 1955 are so narrow that the advanced position of those days would not be visible on Jensen's map, the distance being one of only a few metres.

1878—1930: No comparison between the two dates is possible, but the narrow melting zone to be seen on the 1930 photographs shows that, as already stated, the glacier can have retreated only very little.

1930—1955: In this period the glacier seems to have been stationary too.

Summary:

1878—1930: Stationary?

1930—1955: Stationary?

Locality 23:

Margin of the inland ice at Austmannadalen. This valley, lying at the head of Ameralik fjord, runs in a straight line East-West to the inland ice. The valley bottom contains no actual offshoot from the inland ice, but merely a section of its margin between the two large glaciers Kangaussarssûp sermia on the south and Kangersuneq glacier (Kangianunâta sermia) on the north. This part of the inland ice was the first to be visited by Europeans in more recent times, Major PAARS in 1729 having attempted to ascend the inland ice there. It was also there that FRIDTJOF NANSEN in 1888 terminated his expedition across the inland ice from Greenland's East Coast.

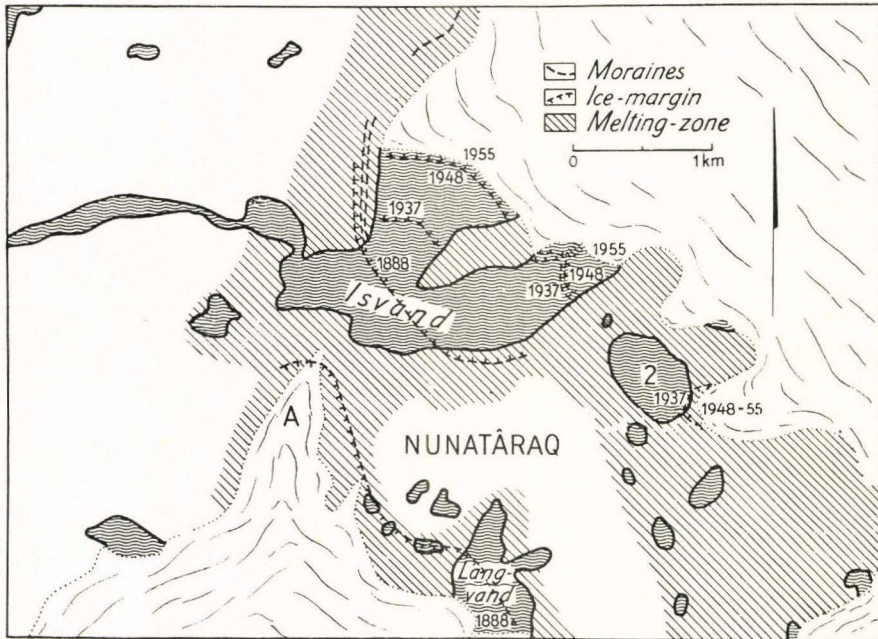


Fig. 43. Part of area around head of Austmannadal at the inland ice. Marginal lines 1888, 1937, 1948 and 1955 inserted. Map compiled from Geodetic Institute's map 1:50,000.

1729: On his visit to the margin of the inland ice on 13th July of that year Major Paars recorded the following (Medd. o. Gr., Vol. 55, p. 186) after he and his companions had arrived in Ameralik Fjord on 24th April: "After we had marched for two days we came about noon on the third up below the ice-field, but when we had made our way up about two hours, at great risk of our lives, all further progress was forbidden us on account of the great cracks we found, running along by where the ice had either been split far apart or cut by streams and watercourses, though the former seemed to be the more likely; some of these cracks were 2 fathoms wide, other 3 fathoms, and they were so deep and so straight down that it was as if we had stood on the highest church wall and looked down, and as it was in severe wintertime, the snow lying in these scracks prevented us from seeing whether water was flowing below or not. Three of our ice-picks, which we carried for helping us up the mountain, we tied together in order to see how deep the cracks were, but they could not get through the snow to the bottom. As we could see no further progress for us, we sat down on the ice, discharged our muskets in a Danish salute of nine rounds, and in a glass of brandy drank the health of His Gracious Majesty at a place where it had never been drunk before, an honour which had never before been done to the

field either; after resting an hour or so we went back again. The most remarkable thing to see was, first, that there were large stones lying on the ice as well as other small ones, of which I took two with me and which I send herewith in order to show Your Majesty what was found on the ice mountain, and which is very strange, for such stones have first to be transported by hard winds and weather, a most incredible thing, because looking at the ice mountain is like a man looking out over the wild ocean where no land is in sight, nor is there here anything in sight than the sky and the shining ice; next, the ice on which we walked was as sharp-edged as white sugar-candy, so that if any progress were to be made over this ice mountain, one must have iron soles under one's shoes, so bad was this ice to walk upon. Some distance away from us on our right we saw a waterfall dropping from the ice mountain, to which we were unable to get, but when we returned we took another route and came down into the same wide valley where the same water from the ice mountain had its course between two mountains, which stood a good 4 (Danish) miles down to a fiord".

This account tells us little of the margin of the inland ice against the land. It is possible that the sentence that a waterfall was descending from the ice mountain is not to be taken too literally, but it suggests that Paars observed the source of the river Austmannedal from the ice. There is no mention of a lake at the source of that river, although nowadays there is a large ice-dammed lake between river and ice (see map fig. 43); this may best be explained by a change in the position of the ice margin since 1729, which then must have stood at the threshold where now the water in two waterfalls drops down through the Austmannadalen, which lies at a lower level. This cannot be more than conjecture, but it is not refuted either by the Nansen Expedition map (see under 1888) or by the extent of the melting zone (see aerial photographs fig. 45). On the other hand some doubt is cast on this estimate of the position of the ice margin by Hans Egede's account of 1723, in which we read (*Medd. o. Gr.*, Vol. 54, p. 104) that on passing in from Ameralik fjord towards the inland ice they saw not only the ice but "on top of the rock great waters under the ice mountain wherein were drifting large icebergs which had fallen from the ice mountain; the entire fiord in the aforesaid Ujarachsuaach was full of such icebergs, all of which had fallen from the same ice mountain at the edge of the sea". As the only large ice-dammed lake is Isvandet, and as Egede's report refers expressly to a large lake on top of the rock, the probable explanation is (if it is the same lake) that between 1723 and 1729 the lake became covered by the advancing ice. As appears from THORHALLESEN'S description below, the inland ice in 1750 at any rate was advancing.

It should be added that the determination of the position of the ice margin in 1729 on the above premises is highly uncertain.

1776: The clergyman Egil Thorhallesen, who was sent out to Greenland in 1765, relates the following about Ameralik fjord in his survey of the Norse ruins in Greenland: "Efterretninger om Rudera eller Levninger af de gamle Normænds og Islanderes Bygninger etc.", 1776, p. 37: "The eastern inlet at the end of this fiord extends much farther into the interior and turns southwards; here are also two large ruins; near the ruin to the south is a large salmon river, which falls from a freshwater lake high up inland over which the glacier ice has laid itself in recent time. The Greenlanders believe that the old Europeans lived there and put up a large building, which conclusion they draw from their observation that the river flowing under the ice sometimes brings large trunks of trees of a kind otherwise not growing in Greenland; it is hard and is most like what the present-day Kablunæts¹⁾ use for fuel, i. e. beech. This is the Greenlanders' account.

"They also speak of other ruins, of which some are still to be seen, and some are already in under the ice which has laid itself over the entire hinterland, indeed over the highest mountains and filled the valleys in between them".

It is possible that the report refers to the Norse ruins by the big lake Isortuarssuk, near the glacier Kangaussarssûp sermia south of Austmannadal. However, there is no melting zone at this lake to suggest that it was covered by the inland ice in recent time; as Thorhallesen clearly gives the direction as southwards, it cannot be Austmannadal. It is possible that there has been some confusion of data; the lake in Austmannadal being the only large ice-dammed water in the vicinity of Norse ruins, the probability is that this is the nucleus of the legend of the covering of a lake. Also in Thorhallesen's "Beskrivelser over Missionerne i Grønlands søndre Distrikt", 1774—75, p. 52, he again says quite briefly that some of the Norse ruins now were stated to have been overridden by ice.

1840: For this year it is recorded that the land between Ameralik and Kapisigdlit was visited by the theological student H. P. C MØLLER (Annaler for Nord. Oldkynd. 1842, p. 344) but there are no particulars of his route or of the limits of the inland ice.

1845: "Grønlands Historiske Mindesmærker": There is no mention of the inland ice margin in this locality and the accompanying map is too roughly drawn to be useful for determining its position.

¹⁾ Qavdlunaq: Greenlandic for European, pres. author's note.

1856—1860: Map of Godthaab District by S. KLEINSCHMIDT (reproduced here in fig. 44). The same map was printed in 1860 by Godthaab Bogtrykkeri, where to it was added: "Compiled from various observations and from drawings and reports by Greenlanders, particularly ABRAHAM and ARON of Kangek". Here again the ice margin is not very distinct, but between Austmannadal and the inland ice can



Fig. 44. Detail from a map marked (in translation): "map of the interior of Godthaab District, especially as regards the early Scandinavian settlements. Compiled from various observations and from drawings and reports by Greenlanders, particularly Abraham and Aron of Kangeq. By S. Kleinschmidt Godthaab 1860." Original in the Royal Library.

be seen a lake exactly as is the case now. From the map nothing can be deduced as to its size.

1866: C. V. M. FALBE and H. E. BLUHME's map from an expedition in 1863—64 seems, for this locality, to be merely a copy of Kleinschmidt's map.

1878: On his expedition that year J. A. D. JENSEN visited the head of Ameralik fjord and it would seem that the expedition was also in the area of Austmannadalen. In his work "Om Inlandsisen i Grønland", p. 65, Jensen reproduced a sketch by E. T. GROTH, a member of the expedition, showing the section at the margin of the inland ice in the

head of Ameralik fjord. The drawing is too indistinct for comparison with photographs, and the map from the same expedition has the inner part of Austmannadal stippled, no doubt signifying that this part was compiled from information received from S. Kleinschmidt (see *Medd. o. Gr.*, Vol. 1, p. 23).

1885: J. A. D. Jensen's map of that year again shows the lake where the valley begins at the inland ice. It will also be seen that Nunatâraq is shown as "Nunatak". The name Nunatâraq in fact suggests that the mountain was once a nunatak (Nunatâraq: "little nunatak") and the melting zones on the aerial pictures fig. 45 do not contradict that possibility. Regarding the area around the ice-dammed lake, Jensen gives no particulars. The map was drawn from peaks far from Austmannadal.

1888: Nansen terminated his famous journey across the inland ice at this spot. In his books he says nothing about the position of the margin, and the illustrations in the same works are not so distinct, or lack such well-defined objects, as to help in determining it. However, the expedition's map of Austmannadal, drawn by O. DIETRICHSON, seems to show—but inaccurately—the ice in a more advanced position than today. On fig. 43 I have compared the Geodetic Institute map 1:50,000 with a copy of part of Dietrichson's map on the same scale. The following points are to be noted:

1) It is observable from the watercourses that the drainage has changed somewhat and that the large moraine shown by Dietrichson as debouching between lakes Langvand and Austmannatjern now debouches in Langvand. Both changes would suggest a difference in the position of the ice margin.

2) Lake Langvand, which on Dietrichson's map is a very narrow water (hence the name) has become almost as broad as long. The Isvandet, which on Dietrichson's map is shown without the now very characteristic headland, must also indicate that the ice margin was more advanced in 1888. On the other hand, it seems that Glacier A, by which in 1888 Nansen and his companions passed very close, still retains its advanced position, even if aerial photographs show that the map illustration of the glacier undoubtedly places it somewhat too far forward, as will appear from the text below.

The ice limits on the map fig. 43 for the year 1888 were plotted solely from Nansen's map together with the above conclusions, and are undoubtedly very inexact. The wide melting zone in the aerial photographs, and undoubtedly observable in 1888, suggests that even before 1888 the inland ice was waning or had not attained its maximum. This latter possibility is improbable, as Nansen's illustrations seem to

show an evenly inclining glacier at the point of his descent, which probably was melting.

1934—1937: The National Museum Expeditions of 1934, 1936 and 1937. From these there are some descriptions of the region in "Fra Nationalmuseets Arbejdsmark 1938" and in Medd. o. Gr., Vol. 89, 1, and also in Grønlandske Selskabs Aarsskrift 1944. Both E. KNUTH's and AA. ROUSSELL's articles are accompanied by maps, but they are too sketchy to permit of a close study of the ice margin. Of more use is a photograph taken by Roussel at Norse Ruin 53 d, innermost in Austmannadal and given in both Medd. o. Gr., Vol. 89, 1, p. 67, and in "Fra Nationalmuseets Arbejdsmark", p. 59. The aforesaid ice-lobe A appears clearly in the background.

Of aerial photographs of the region some, of the inner part of Austmannadalen, are given in the same works (Fra Nationalmuseets Arbejdsmark. p. 57, and Grønlandske Selskabs Aarsskrift pp. 98—99). These photographs, together with one in L. BOBÉ: "Hans Egede og Grønland", p. 57, to some extent supplement the aerial photograph of 1937 reproduced in the present work. Thus for the years 1936—37 the position of the ice margin is well "covered", but no direct comparison can be made between the information dating from 1888 and 1936—37. In fig. 45 a, where one of the 1937 photographs is shown, the headland in Isvandet is now seen to be projecting, which means that at this spot the ice must have retreated since 1888. The approximate position of the margin, determined by the aforesaid aerial pictures, is shown in fig. 43.

The Geodetic Institute map 1:50,000, which is an enlargement of the 1:250,000 map, shows the position of the ice margin nearest Isvandet in the years 1936—37.

1948: Taking the 1948 aerial photographs for comparison (506 BS, No. 04819), one of which appears in fig. 45 b, a distinct change in the position is visible. A lake shown on the Geodetic Institute map north of Isvandet is there no longer, and the large moraines to be seen on 506 BS, 4819 north of Isvandet seem to characterize the situation up to 1936-37. The very presence of the moraines, stretching in a continuous line from the surroundings of Kangersuneq Fjord to Isvandet, seems to indicate two advances between 1888 and 1936.

No great changes seem to have taken place in the region south of Isvandet (Nunatâraq) between 1937 and 1948, though Lake No. 2 can be seen to be without calf-ice, now that the glacier has retreated from the lake. The Geodetic Institute map of this locality must represent the situation round about 1948, for, as will be seen in fig. 43, it shows the glacier delimited from the lake by a narrow strip of land.



Fig. 45a.



Fig. 45b.

Fig. 45. Upper part of Austmannadal. Oblique exposures looking from north to south.

a. 1937. Copyright Geodetic Institute.

b. 1948, Copyright Geodetic Institute.

Glacier A on the map fig. 43 does not appear to have changed between 1936 and 1948, though it is likely that the glacier is shown too far forward. On the aerial photographs it seems to be more rounded in shape than on the map, and for both 1937 and 1948 the glacier terminates on a lake which between the two dates has not changed in size or shape. Nor can any change in Langvand be observed between 1937 and 1948.

1955: On exploring the area north of Isvandet in that year the author was able to establish the fact that the margin immediately north of Isvandet had not changed within the period 1948—1955, whereas at Isvandet itself the margin had retreated slightly. No change could be observed in other parts of the ice margin.

Conclusion:

A. Region around Isvandet.

1729—ca. 1760: C. E. Paar's description of the river emerging from the inland ice, and E. Thorhallesen's account of the advance of the inland ice in this region must indicate that in this period the ice reached its maximum. Egede's report, which like Thorhallesen's is second-hand, seems to establish the existence of Isvandet in 1723.

Ca. 1760—ca. 1885: Most of the maps of the period 1850—60 show what is possibly a lake or possibly merely a branch of the inner part of Austmannadal river, therefore nothing can be said about Isvandet from these maps. J. A. D. Jensen's map of 1885 is the first to show Isvandet distinctly. On this map the length of the lake is about 2 km, its width about the same, whereas in 1955 it had a length of about 2 km and a width of 0.8 km. The size of the lake on Jensen's map is improbable, and as he observed it only from a distance and did not explore the area, all that may be said here is that the lake was observed in 1885 but not in the years around 1760, and that presumably there was a retreat by the ice, of unknown dimensions, between the two dates.

1885—1888: The material permits of no comparison.

1888—1937: A pronounced retreat is observable on comparing Dietrichson's map of 1888 and the aerial photographs of 1936—37. For the ice front on the lake in the southern half of the glacier terminus (south of the headland) the retreat was one of about 800 m, whereas in the northern half (north of the headland) it was about 400 m. Around the lake the retreat of the ice margin was presumably one of about 200 m. Two marginal moraines to be seen just north of the lake (see the aerial photo fig. 45 b) indicate that between 1888 and 1937 there must have been two advances. More to the north, towards Kangersuneq



Fig. 46 a.



Fig. 46 b.

Fig. 46. Upper part of Austmannadal. Panorama, showing Isvandet and the ice margin nearby. Photo WEIDICK 1955.

glacier, these two moraines merge into one, situated behind the large moraine that indicates the maximum advance of the ice.

1937—1948: A comparison between the aerial photographs of 1937 and 1948 shows a further retreat of the front facing the lake. For the southern half of the front the retreat is one of about 100 m, whereas for the northern half it is about 400 m. At the ice margin

facing the land the change was not big enough to register on the aerial photographs.

1948—1955: The retreat of the glacier front facing Isvandet continues. For this period the withdrawal is one of about 50 m for the northern half and about 200 m for the southern half. The ice margin facing land also seems to have retreated a few metres here and there, but nothing definite could be determined from a comparison between the aerial photographs and conditions on the spot in 1955.

Summary:

Ca. 1729—1760: The maximal extent of the inland ice stationary.

Possibly advance 1723—29.

1760—1885: Retreating.

1885—1888: Nothing known.

1888—1936: Retreating.

1937—1948: Retreating.

1948—1955: Retreating.

B. The region around Lake No. 2.

1937—1948: A comparison of the aerial photographs of these years shows a retreat by the glacier debouching in to the lake.

C. The region south of Isvandet.

1885—1888: J. A. D. Jensen described the area as a nunatak (Nunatâraq), whereas Dietrichson's map of 1888 showed the area merged with the rest of the land; for this reason—providing that Jensen's observation was correct—we must assume a retreat between 1885 and 1888 in the area.

1888—1936/37: A retreat by the ice margin becomes apparent on comparing Dietrichson's map and the aerial photographs. Around Langvand the retreat was presumably about 200 m. A pair of double moraines is also to be seen in the area, indicating an advance between 1888 and 1937. The glacier marked "A" on the map fig. 43 does not seem to have retreated so much as the ice margin in its vicinity, if we compare Dietrichson's map with the aerial photographs, but the melting zone around the glacier suggests that the glacier must have retracted considerably before 1888, whereas the comparison between the situation in 1888 and in 1936 must indicate if anything that the glacier was stationary.

1937—1948: No change seems to have taken place in the position of the ice margin in this period and it is therefore recorded as stationary.

1948—1955: No change in the position could be observed between these dates.

Summary:

1885—1888: Retreating.

1888—1936: Retreating.

1937—1948: Stationary.

1948—1955: Stationary.

Locality 24.

The glaciers on Sadlen (Sermitsiak). Sometimes the name Sermitsiak is used of the island on which the mountain Sadlen stands. The mountain just east of Godthaab, is familiar to all who have visited the town, being a very characteristic landmark. The glaciers are not visible from Godthaab, as they are on the east side of the ridge. The information on the glaciers is highly sporadic and only one of them, the lowest one, has been described several times, therefore the expression "the glacier" in the following refers to that one. As the locality lies on the sea-route between Godthaab, the "capital" of Greenland, and the trading stations of Qôrnoq and Kapisigdlit in Godthaabsfjord, there are good opportunities of obtaining new information of the oscillations of the glacier in addition to what is given below.

1810: In that year K. L. GIESECKE writes in his diary for Friday, 29th June: "Wir reisten um Mittag ab, und sezzten von Karosut nach der Insel Sermitsiak oder Sadelen über.—Das Aussehen des höchsten Berges derselben hat den Dänischen Namen Sadelen (der Sattel) veranlasst.—Er dient den Schiffern bey der Einseegelung in den Fiord zum Warzeichen.—Die Grönländer nennen ihn des vielen Eises wegen, mit welchem seine Thäler und Klüfte gefüllt sind, Sermitsiak, von Sermek: Eis.

"Auch dieser Eisblink hat in diesem Frühjahre (1810) zum erstenmale angefangen zweymal Eisberge von den niedrigsten Punkten seiner hochliegenden Eismasse abzustossen.—Als wir vorbeyfuhren, gieng so eben auch eine grosse Steinmasse nieder". Thus at that time the glacier was advancing.

1828: A description by the geologist CHR. PINGEL, from a journey in Godthaabsfjord in that year, has little information about the glacier: on 29th June he writes ("Tritogenia", Vol. 6, pp. 78—79):

"So we came about 2 p.m. to Sadlen, a high, peaked mountain most picturesquely crowning the background of Godthaab as one arrives at that colony from the sea.

“Sadlen was still covered with large masses of snow. This never thaws, but on the north side in fact forms a genuine little iceblink which prompted the Greenlandic naming of this beautiful mountain, Sermetsiak. Up on the ice, from which one large and several smaller rivers gushed over the steep rock wall down into the fiord, we heard a thunderous roar just when we were close up under the mountain, but happily with no fall”. The description, which is contained in Pingel’s article in “Tritogenia”, Nov. 29th, entitled “En Udflugt fra Godthaab til Ujararsoak”, leaves little impression of any change since 1810, but it may be inferred from the text that the ice does not reach down to the sea and that it is fairly active; the “thunderous roars” afterwards ceased about the year 1914 (see below).

1857: H. RINK writes of Sadlen merely that “the north side of this island, despite its steepness, is covered with a shell of permanent ice, but this is not visible from Godthaab” (“Grønland”, Vol. 2, p. 313).

1885: On 7th September of that year J. A. D. JENSEN made an attempt to ascend Sermitsiaq. In the report of this venture, Medd. o. Gr., Vol. 8, p. 96, it is mentioned that there is a plateau on the mountain, 2500 feet up (the ascent was made from the NW side of Sadlen) where there was a small glacier. This elevation still holds good of the southwest (lower) glacier and therefore contains no information of any change in the position of the glacier, the report giving neither the upper nor the lower limit of the glacier.

1914: O. BENDIXEN writes about Sadlen in Medd. o. Gr., Vol. 61, p. 184: “The south, or rather the east side of the northern arm of Godthaab Fiord is bounded by two islands. Southernmost lies the steep, magnificent Sadlen (Sermitsiaq), whose top with the long, sharp ridge is familiar to all who have been to Godthaab. The north side of the island is covered with an enormous glacier which only a few years ago often produced lumps of ice with a roar that could be heard right to Godthaab”. This statement was confirmed to the writer by former training-college students at Godthaab, who also told that the calving had stopped in the time round about the start of the First World War.

1930: From that year dates the photograph shown in fig. 47, taken by Professor K. GRIPP. On this picture the glacier seems to be melting.

1947—1951: The Geodetic Institute map of the region, surveyed and corrected in these years, seems to indicate no change for the glacier compared with the 1955 photograph.

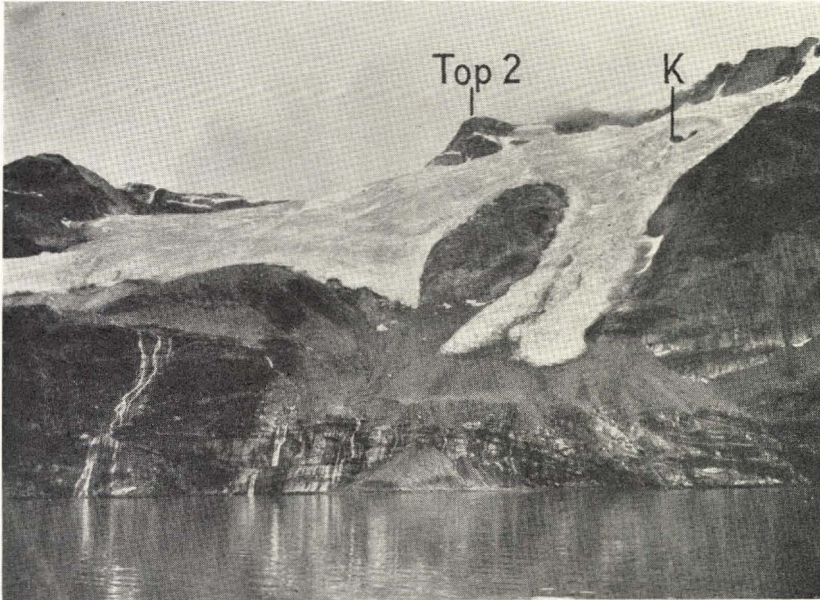


Fig. 47. Sadlen (Sermitsiaq). Photo K. GRIPP 1930.

1955: A photograph dates from 15th September of that year. A quantity of new snow made comparison with the 1930 picture difficult, but it was observed that all the lower parts of the glacier had withdrawn markedly since 1930, and Peak (“Top”) 2 had emerged more from the firn. It is also to be seen that a small rock area (nunatak), just visible in 1930 (K in fig. 47), has now become a large flat rock. Regarding this rock Mr. RAPHAEL JØRGENSEN of Qôrnoq (a trading station in Godthaabsfjord) stated that this nunatak, which he called Atungaussaq (“that like a boot sole”) had become larger in recent years.

Conclusion:

As the sources quoted above deal chiefly with the lower, sometimes calving glacier, that alone is dealt with in the conclusion.

1810—?: Giesecke’s report embodies evidence of an advance of the glaciers in the years prior to 1810. According to Giesecke’s information, the front of the lower glacier seems to have occupied a position below the present front, as it is unable to calve from its present position.

1828: The only information of that year is that calving apparently was still common, seeing that when passing the glacier Pingel seemed to fear it. Accordingly, in that year too the glacier must have been somewhat more advanced than it is now.

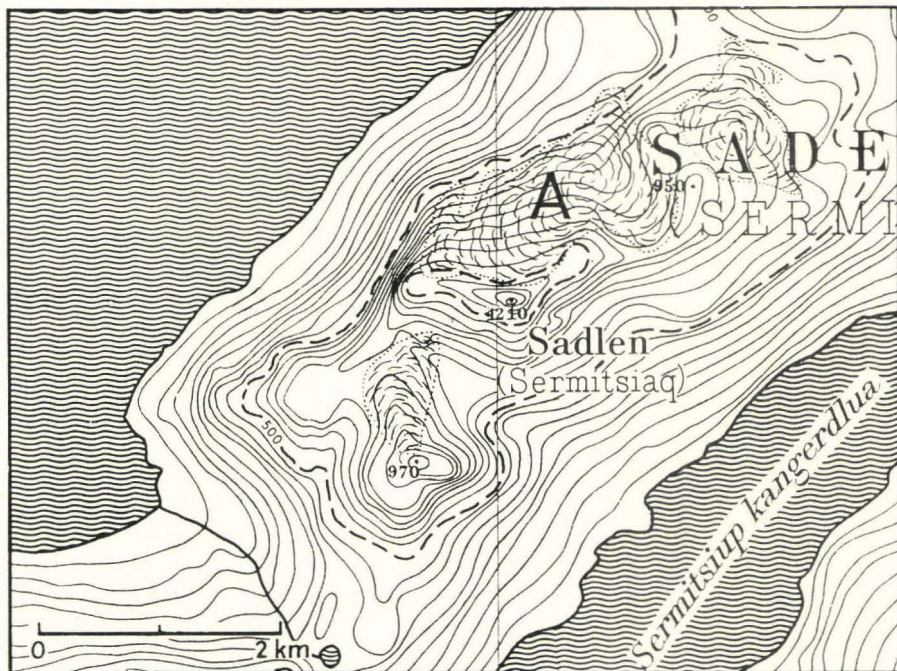


Fig. 48. The glaciers on Sadlen. The glacier described is marked A on the map. From Geodetic Institute's map 1:50,000. 64 V1, L.

1828—1885: Pingel's and Jensen's descriptions provide no basis for a comparison between the frontal positions.

1885—1914: Nothing can be discovered from the available material regarding any changes.

1914—1930: The glacier must have been waning even before 1914, and it continued to do so, because no calving is reported after that year. The melting zones on K. GRIPP's photograph of 1930 are evidence of considerable waning prior to 1930. Earlier in the calving period, the glacier terminus must have lain at about 100 metres above sea level; in 1930 it was about 400 metres above s. l.

1930—1955: A comparison between the photographs of those two dates indicates that the glacier must have retreated a good deal. The withdrawal of its lower part was presumably from about 400 metres to about 500 metres above sea level.

Summary:

- about 1810:* Advancing.
- ?—1914:* Retreating.
- 1914—1930:* Retreating.
- 1930—1955:* Retreating.

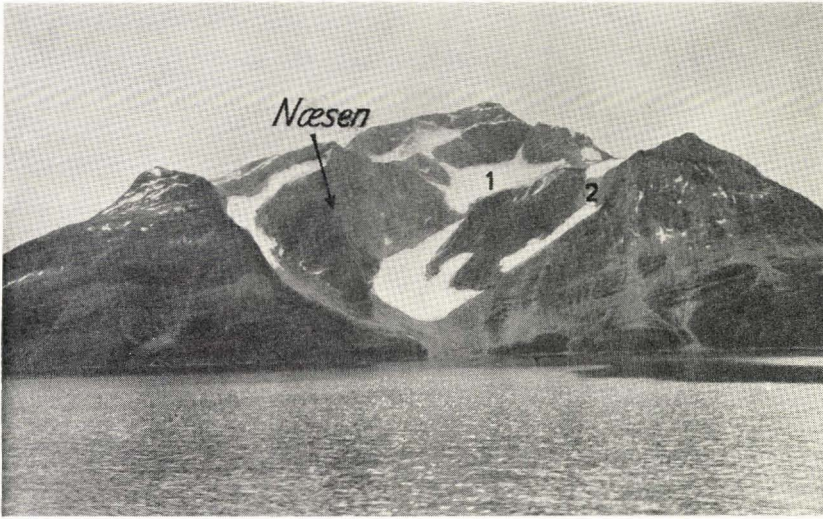


Fig. 49. The glacier at Qingaq. Photo K. GRIPP 1930.

Locality 25: Qingaq Glacier:

The glacier lies behind the mountain of the same name in the central part of Storø (Qeqertarsuaq) near the trading station of Qôrnoq, almost midway in Godthaabsfjord. In addition to this glacier, which extends almost down to the sea, there are several small glaciers on the easternmost part of the island, but there is no information about them.

1919: Qingaq glacier is only mentioned by name by O. BENDIXEN in his description of the Godthaab District in *Medd. o. Gr.*, Vol. 61, p. 185.

1930: From this year there is a photograph of the glacier, taken by Professor K. GRIPP and reproduced in fig. 49. It bears the inscription: "Hängegletscher und regenerierter Gletscher".

1955: In this year the glacier was again photographed by the writer. It seemed to be in the same position as in 1930. There may possibly be a change (a shrinkage) in the surface of the firn between the two dates, but this is uncertain, because of the new snow shown on the 1955 photograph and the indistinctness of the one from 1930. Section 2 of the glacier (see fig. 49) provides a good common basis for comparison on account of all its irregularities. Another is the crevasse in Section 1. The lowest part of the front is still slightly below the headland "Næsen" and some distance behind a large terminal and lateral moraine. The glacier must undoubtedly be regarded as having been stationary in the period 1930—1955.

On the new Geodetic Institute maps of the region (1:50,000) the glacier can be seen to reach right down to the sea, whereas neither the 1930 nor the 1955 photograph records such an extent. There must have been an error in compiling the maps, as none of the people at Qôrnoq seem to be aware of any advance at this place within the past generation. It is to be supposed that the aerial photographs used in the cartographic work showed a landscape well covered with snow.

Conclusion:

From the available material the extent of the glacier can be indicated only from the 1955 and 1930 photographs, which seem to show that the glacier is stationary.

Inner Part of Godthaabsfjord.

About 120 km from Godthaab the inner part of Godthaabsfjord continues southwards in the Kangersuneq fjord. In it debouch four large glaciers, all lobes from the inland ice. From south to north these glaciers are called: Kangersuneq glacier (Kangia-nunâta sermia and Akugdlerstûp sermia) Qamanârstûp sermia, Narssap sermia and, northernmost, the Ujaragssuit glacier. Kangersuneq glacier includes here Akugdlerstûp sermia, formerly regarded as a branch of Kangersuneq glacier proper (Kangia-nunâta sermia), and in recent years almost separated as an independent glacier on account of the retreat.

Of the four named glaciers only two are productive, Kangersuneq and Narssap sermia, whereas the other two, Ujaragssuit and Qamanârstûp sermia, are separated from Kangersuneq Fjord by large outwash plains.

On the calving of the producing glaciers there is a report by O. BENDIXEN in *Medd. o. Gr.*, Vol. 61, p. 186, stating that "the icefjord usually produces in the month of June, the process being promoted by the internal pressure in conjunction with the large rivers which from Nunatarssuak wash in under the ice. In the course of the summer the fjord is cleared several times, especially when the wind is SE, and as a rule is ice-free for most of August". The calf-ice normally reaches out only to Qôrnoq.

There are no measurements of the rate of the glacier's movement.

Locality 26: Kangersuneq Glacier.

It is situated at the head of Kangersuneq fjord and is the more productive of the two glaciers reaching out to the fjord. It is interesting on account of the large melting zones, which from the present front

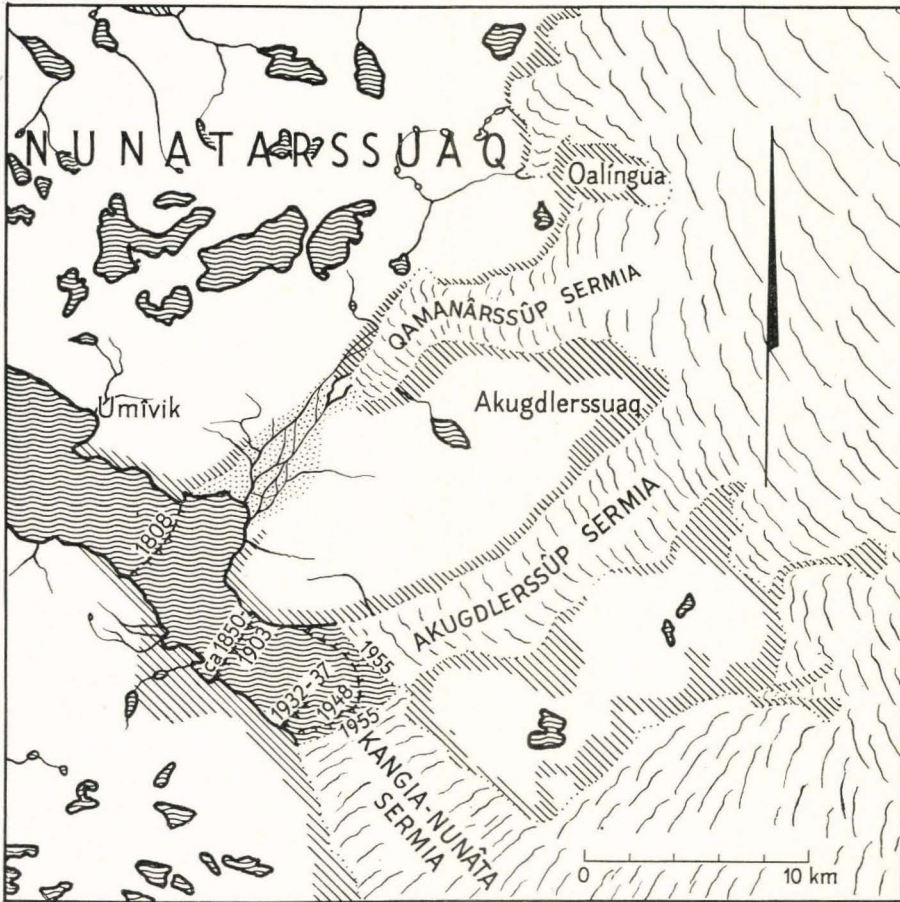


Fig. 50. The glacier front at Kangersuneq and the extent of the melting zones. Map compiled from Geodetic Institute's map 1:250,000, sheet 64 V 2, Kapisigdlit.

extend about 20 km out along the fiord to the headland south of Umivik. Nothing is known of when the glacier was in that advanced position but, as stated below, it was presumably before the beginning of the 19th century, possibly in the middle of the 18th century. The archaeologist AAGE ROUSSELL (Medd. o. Gr., Vol. 89,1, p. 16—17, considers this to be evidence of a climatic deterioration since the Middle Ages, because in its later maximum the glacier cut off some of the ancient Norse ruins from the other farms. Even nowadays, when the glaciers have retreated, the innermost of these old Norse farms can only be visited with the greatest difficulty.

1808: On 12th August of that year K. L. GIESECKE wrote of a journey in Kangersuneq fjord: "Vormittags um 10. Uhr reisten wir

ab.—Wir mussten uns im ewigen Zickzack durch die ungeheuren Eisberge arbeiten. Ein der Gegend kundiger Grönländer von Sadlok, namens Christoffer begleitete uns im Kajak. Wir kamen nach und nach gegen den Eisblink zu auf die entgegengesetzte Seite dieses Armes des Fiords, welcher Kangersunæt heisst, und kamen in der Berggegend Nunatarsoak bey Iglorsoit, dem Ende des längsten oder östlichen Arms von Godthaabsfiord Nachmittags um 2. Uhr an". — Later he describes the ruin localities in the vicinity (i. e. Umivik and Sarqarssuaq. These were probably not far from the glacier front, especially as on 13th August of the same year Giesecke records that he walked to the iceblink from the camp at Igdlorssuit. The report reads: "Sonabendts d. 13. August, Blies ein warmer Sturm aus Südost, bey vielem Nebel und dichtem Regen, wodurch viel Eis vom Eisblink losbrach. Ich gieng nach den Gebirgen am Strande, und von da nach dem Eisblink auf Excursion, und fand die nemliche Hauptgebirgsart, bloss dass hier mehr Glimmerschiefer eingelagert ist. Ich traf auf meinem Wege mehrere Rennthiere. Am Ufer gegen den Eisblink findet sich grauer Thon. Ich wagte es nach der majestätischen Eisbrücke hinunter zu steigen, un sah, dass diese Masse, welche von ferne so glatt wie ein Spiegel zu seyn scheint, äusserst höckerig und uneben ist, welches das Gehen um so beschwerlicher macht. — Die Oberfläche sieht so wellenförmig wie ein stürmisches gefrorenes Meer aus. Ich war kaum ein Viertelstunde darauf fortgegangen, als auf einmal eine breite Kluft mir den Weg abschnitt. — Ich legte mich auf den Bauch nieder, um diesen Schwindel erregenden Abgrund hinunter zu sehen, konnte aber, so weit mein doch ziemlich scharfes Auge reichte, nichts als Eis bemerken." The possibility that the glacier was Qamanârssûp sermia is precluded by the fact that Giesecke himself describes the glacier as calving. That it was Narssap sermia is ruled out by the description of a Norse ruin near the iceblink, one that was in a very good state of preservation, which is not the case with Ruin Group 12 at Narssap sermia, according to D. BRUUN, *Medd. o. Gr.*, Vol. 56, p. 77. Giesecke also adds that this iceblink is "grösser, steiler und gefährlicher als der nordöstliche". Thus the north-east iceblink must be Narssap sermia, which is mentioned in contrast to the iceblink where Giesecke was at that moment. The group of ruins which Giesecke surveyed was, according to Roussel, *Medd. o. Gr.*, Vol. 89,1, pp. 78—79, identical with Sarqarssuaq. Giesecke writes on its situation near the glacier: "Hier ganz nahe an dem Eise fand ich ein deutliches, noch über das kleine Gesträuche hervorragendes Überbleibsel von einem alten Normännischen Gebäude. Es war vollkommen 4 eckicht, hielt an jeder Seite nicht volle 50 Fuss".

Accordingly, in 1808 the Kangersuneq glacier must have been about 6 km behind the limit of its maximum.

1850's: On the difference in the position of the glacier front then Aage Roussel writes in *Medd. o. Gr.*, Vol. 89,1, pp. 16—17, regarding the headland at Umivik: "In the same fjord it is clearly to be seen that the principal glacier once extended much farther out (fig. 8); the lower part of the rock sides is as if were divided into two parts along a line which slants evenly down from the present upper edge of the ice to the water about 10 km down the fjord. Above this line the fells have the usual brownish-green vegetation, but below it they are bare and barren, as if the ice had left them only recently. Now there are ruins inland behind the place which would then have been the front margin of the glacier, which seems somewhat incredible; can it be, then, that in the time between 1360 and now the glacier advanced and then retreated? A photograph taken by RINK¹⁾ in the 1850's shows that conditions were exactly as they are today". The picture by H. Rink was kindly secured for the writer by Dr. Roussel; it shows that the glacier apparently must have had its front somewhat ahead of its present position, with its northwest side delimited by Akugdlerssuaq. The presumed position of the glacier is shown on the map fig. 50.

1859—1860: Kleinschmidt's maps of these years shows the glacier occupying almost the same position as on J. A. D. JENSEN's 1885 map (see figs. 52 and 55). As on the latter, glaciers are to be seen forming a straight, unbroken front from Akugdlerssuaq's westernmost point to the opposite shore of Kangersuneq fjord, i. e. a position about 8 km ahead of that in 1955. Nunartarsuaq is also in the map, though somewhat distorted in shape. Perhaps the northwest corner of the nunatak actually was more covered by ice then than it is now.

1885: In "Undersøgelse af Grønlands Vestkyst 1884—85", J. A. D. Jensen writes (*Medd. o. Gr.*, Vol. 8, p. 88): "Our journey in Godthaabsfjord extended to all its large-sized ramifications with the exception of the innermost, Kangersunek, which was so full of calf ice from the glacier projecting into it that all hope of making our way in had to be abandoned. It is said that in recent years the ice here has increased so considerably that the Greenlanders now are rarely able to travel in it, though previously that was quite common. From several tall mountains in its vicinity, however, we obtained a good view of this fiord arm as well as over the land east of it and over the nunataks on the inland ice. On the north side of the Nunatarsuaq area are two lakes, Iluliartok and Ujaragtok, which are dammed by the large glacier moving past and therefore are emptied periodically".

As has been described under 1859—60, the glacier on Jensen's map is on a line from the southern point of Akugdlerssuaq to Kapisi-

¹⁾ National Museum archives.

lik peninsula, with its front almost at right angles to the direction of the fiord.

1888: NANSEN's map of 1888 shows the glacier front in a position similar to that on the 1885 map; it may or may not be a copy of Jensen's.

1903: In *Medd. o. Gr.*, Vol. 56, p. 75, published 1918, Daniel Bruun who visited the area in 1903 writes as follows on the fiord: "Kangersunek or the innermost arm of Godthaab Fjord, pointing southeast, is bounded on the east by the high land Nunatarssuak, which drops precipitously to the fiord. On the west it is also bordered by rather steep fells, whose height is least on the isthmus over to Pisigsarfik.

"At the head of the fiord a glacier debouches from the inland ice, and close by it another comes down from the east. The latter fails to reach the fiord, however, but melts on a clay plain.

"According to the Greenlanders, the glaciers used not to be so high as now and were flatter, and the ice did not reach so far forward, which can also be seen from the fact that it has now reached a Norse ruin (16) which previously lay untouched (on 12th August 1808 Giesecke mentions this ruin group, *Medd. o. Gr.*, Part 35)."

Later in the same work, p. 77, Bruun says, however: "The situation of Ruin Groups 12—16 referred to below is not quite certain. The Greenlanders have proved to be somewhat vague in their information and Bendixen did not have an opportunity to visit all the places they indicated". Thus neither O. Bendixen on his 1916 trip nor D. Bruun in 1903 visited Ruin Group 16, about which D. Bruun in fact merely quotes Giesecke's diary and information from Greenlanders (see later under Qamanârssûp sermia, where the passage about Ruin Group 16 is quoted in extract). E. KNUTH, who was in the locality in 1932, denies that this ruin group exists at all on this place.

Daniel Bruun's work also contains a photograph of the front of Kangersuneq, taken by JOHN MØLLER in 1903 and marked: "Head and south part of Kangersuneq, seen from the isthmus between that fiord and Pisigsarfik". The original photograph, filed in the National Museum, shows that in 1903 the glacier front was in the same position as in 1885 and 1850. This determination is only approximative, however.

D. Bruun's survey map of the Norse ruins in Godthaab District, *Medd. o. Gr.*, Vol. 56, Pl. I, shows no change in the glacier front since 1885. It is a reasonable assumption, however, that the map is a copy of J. A. D. Jensen's 1885 map, although Bruun himself in a paper read to the Grønlandske Selskab in 1907 (see *Grønlandske Selskabs Aarsskrift* 1908, pp. 28—40 with corresponding copy of a map of Norse ruins, and in *Medd. o. Gr.*, Vol. 56, p. 58), stated that the map was made with corrections according to Greenlandic information.

1909: O. NORDENSKJÖLD, who was in West Greenland in 1909, in "Einige Züge der physischen Geographie etc.", Geografische Zeitschrift 1914, pp. 638—39, writes: "An zahlreichen Orten in Grönland hat man während einer Reihe von Jahren die Veränderungen in der Masse und der Lage der Gletscher und dabei auch der grossen Abflusströme des Inlandseises studiert, und man hat gefunden, das diese hier, wie in fast allen anderen Gebieten, bedeutende Variationen sowohl durch Vorrücken wie auch durch Zurückgehen erleiden, an verschiedenen Punkten in nahe bei einander liegenden Distrikten oft mit verschiedener Fazies. Während man vielleicht öfter von einem Zurückgehen reden hört, haben J. A. D. Jensen am südlichen Stromfjorde (1884) und A. JESSEN in Süd-Grönland ein Vorrücken der Gletscher nachgewiesen¹⁾. Dieselben Veränderungen innerhalb eines kleinen Gebietes begegnen uns auch bei den grossen Eisausläufern im Godthaabsfjorde. Nach zuverlässiger Kunde, die ich über diese erhalten habe, ist der südlichste Arm bei Nunatarssuak zurückgegangen, während der nördlichere Zweig bei Narssak sich während der ersten Jahre des 20. Jahrhunderts in schnellem Vorrücken befunden hat, so dass durch ihn schon mehrere der Lagerplätze, welche die Renntierjäger zu benutzen pflegten, zugedeckt worden sind und nun erzählt wird, dass ein Teil des Distriktes, in welchem die alten Nordländer hier gewohnt haben, jetzt vom Eise bedeckt sei". In other words, at the beginning of the present century Kangersuneq glacier was considered to be retreating, though nothing is known of how far it retreated or since when the retreat took place.

1932: In that year the region around Umivik was explored by the archaeologists E. KNUTH and Aa. Roussell. The quotation given under years 1850—60, states that there was no great change to be observed in the position of the glacier front since the 1850's, but to the writer it would seem that on two pictures taken in 1932 by E. Knuth the front is in a more southerly position than in the 1850 and 1903 pictures. However, direct comparison cannot be made, as the 1932 photograph (reproduced Medd. o. Gr., Vol. 89,1, p. 79) shows the front viewed from the Umivik area on the east side of the fiord, whereas the earlier pictures portray it from the portage between Kapisigdlit kangerdluat and Kangersuneq on the west side of the fiord.

1937: Aerial photographs of that year also show the glacier occupying a more advanced position than in 1932. It is between the 1885 and 1932 positions, as seen in the general map fig. 50. Between the years 1932 and 1937 the glacier front seems to have occupied

¹⁾ Man vergleiche auch: CH. RABOT, Revue de Glaciologie, Nr. 3, Mitt. d. Naturf. Ges. in Freiburg V (1909), 327.

approximately the same position, although direct comparison between the information from 1932 and 1937 is difficult.

1948: The aerial photographs of that year show that the glacier was then almost split into two arms: one from the south, the main arm from Kangersuneq (the Kangersuneq glacier) and the now almost independent glacier Akugdlerssúp sermia. The Geodetic Institute map 1:250,000 64 V 2 Kapisigdlit, 1954, gives the position of the glacier front as these aerial pictures show it.

1955: In this year the glacier front was observed from the area north of the beginning of Austmannadal and seemed to be completely divided into the two arms Kangersuneq glacier and Akugdlerssúp sermia.

Conclusion:

1808—1850's: Giesecke's report of 1808 is comprehensible only if we assume that in that year the Kangersuneq glacier was about 6 km behind its maximum, whereas Rink's photograph from the 1850's shows the front in a position about 12 km behind that maximum.

1850's—1903: The photographs of about 1850 and 1903, the maps dated 1885, 1888 and 1859—60 all seem to show that the glacier was almost stationary in those years, situated opposite the southwest corner of Akugdlerssuaq. Judging from J. A. D. Jensen's report, however, it is possible there was an advance in the years prior to 1885, unless he merely refers to greater glacial productivity. D. Bruun's record of an advance may perhaps be the same as that reported by Jensen.

1903—1909: No comparison can be made of the material of these two years, and nothing can be said about the 1909 position of the glacier, except that presumably it was behind the 1903 position, having been retreating in those years.

1909—1932: No comparison can be made, as we know nothing of the position of the front in 1909, but presumably the front continued to retreat with the result that in 1932 it was about 4 km behind the 1903 position. However, as mentioned under Austmannadal, the moraines at Austmannadal may suggest that this retreat was interrupted by one or two small advances there between 1888 and 1937; but we know nothing of this as regards Kangersuneq glacier.

1932—1937: The photographs of these years show the front in approximately the same position.

1937—1948: Comparison between the photographs shows a retreat of about 1.5 km.

1948—1955: The retreat continued in this period and must be estimated at about $\frac{1}{2}$ km for Kangia-nunâta sermia, and for Akugdleressûp sermia varying between about 1 km for the south part and $\frac{1}{4}$ km for the north part of the front.

Summary:

1809—1850: Retreating.
1850—1903: Stationary.
1903—1934: Retreating.
1934—1937: Stationary?
1937—1948: Retreating.
1948—1955: Retreating.

Locality 27: Qamanârssup sermia.

This glacier seems to have been closely inspected but once, in 1932 by E. KNUTH, so there is little information about changes in its front.

1808: K. L. GIESECKE has no record of the glacier, but if the front of Kangersuneq glacier in 1808 was situated at Umîvik, the rivers from Qamanârssûp sermia must have flowed under the outer part of it into the fiord. The melting zones along the sides of Qamanârssûp sermia indicate that this glacier too was once larger in extent, and possibly the conclusion may be drawn that its maximum was contemporaneous with that of the Kangersuneq glacier; that was possibly about 1750.

1855—1885: The Godthaab District maps of this period have nothing exact about the limits of the glacier except that throughout the thirty years it was separated from the Kangersuneq fiord by the broad outwash plain lying in front. It can be seen from some of the maps (figs. 50 and 54) that the glacier encloses a land area (Qalingua). The melting zones indicate that this area was once a nunatak, which would mean that since about 1863 the inner part of the glacier had shrunk to some extent. However, J. A. D. JENSEN's 1885 map suggests that Qalingua was ice-free, but it also shows some nunataks south of Qamanârssûp sermia which, to judge from the melting zones, may very well be the northeast part of Akugdleressuaq. Accordingly, if the maps are to be relied upon the conclusion to be drawn would be that Qalingua became ice-free between 1863 and 1885, and that the northeast part of Akugdleressuaq was still covered with ice in 1885 and has only been freed since then.

1903: On a ruin group said to be close to the glacier D. BRUN writes in Medd. o. Gr., Vol. 56, p. 78: "The Greenlanders say that at Sarkarssuak, close up to the glacier, there is a large inhabitable place

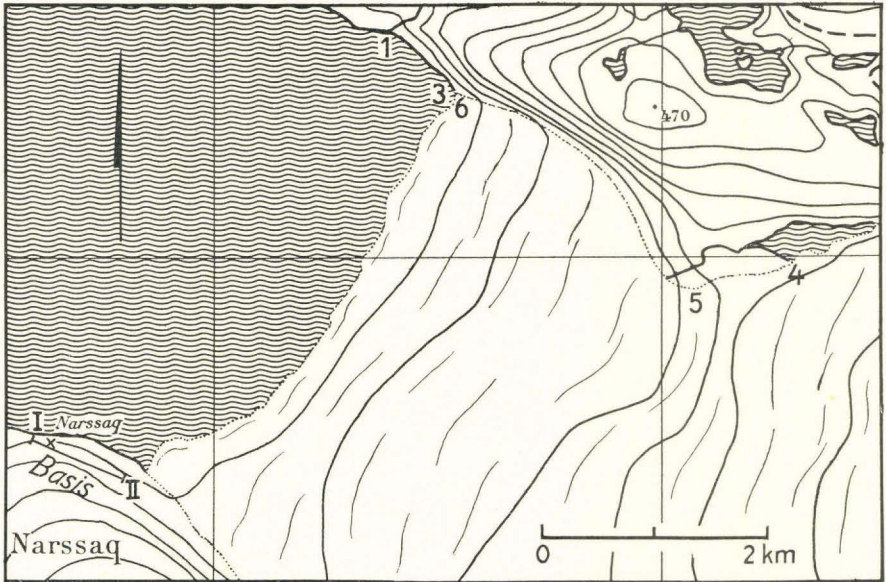


Fig. 51. General map of Narssap sermia. Sights from points I and II inserted. Compiled from Geodetic Institute's map 1:50,000, 64 V 2, F. ×: Ruin group 12.

where (1903) in fact there is nothing but a not over-large ruin, but where there have once been more which are thought to have been washed away by a river or destroyed by the ice".

In the opinion of the archaeologist E. Knuth however (*Grønlandske Selskabs Aarsskrift* 1944, p. 100), the ruin is not to be found at all at the place indicated by Bruun, which means that any changes cannot be determined in this manner.

1932: In the course of the search for this ruin group the glacier was visited in 1932 by E. Knuth. A sketch of the glacier front made on that trip may come in useful in future studies of changes at the front.

1937—1942: Aerial photographs of these years show that the glacier did not change in the period 1937—1942.

Conclusion:

1809—1885: The melting zone around the glacier shows that the front was once about 1 km ahead of its present position, and there is a possibility that this was at the middle of the 18th or the beginning of the 19th century. Melting seems to have freed the land area of ice between 1855 and 1885. This assumption concerning emergence, however, is based solely upon very inaccurate sketch maps.

1885—1937: The northeast part of Akugdlerssuaq may have emerged in this period; but, as with Qalingua, the material is very slender. As

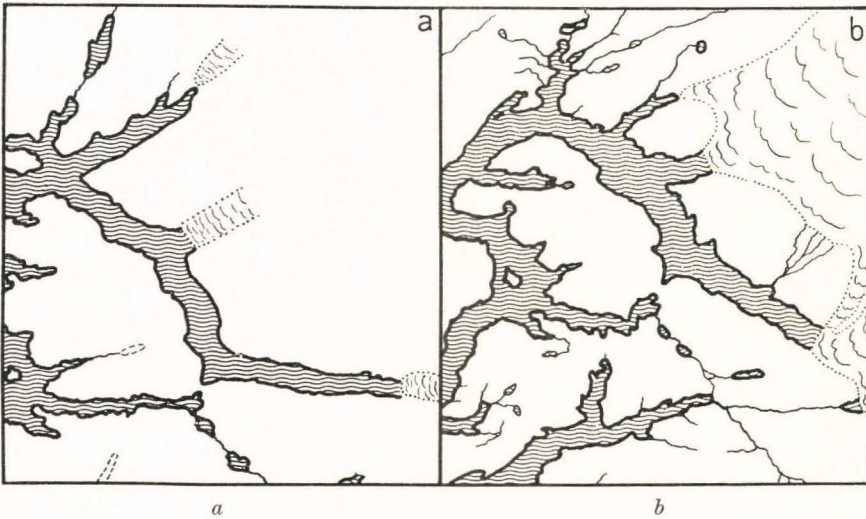


Fig. 52 a. Detail from S. KLEINSCHMIDT'S map of Godthaab District 1855. Original in Royal Library.

b. Detail from S. KLEINSCHMIDT'S map of Godthaab District 1859. Original in Royal Library.

regards the glacier front itself, there is insufficient material for deciding as to what changes have taken place.

1937—1942: A comparison of the aerial photographs for these years shows that the glacier front was stationary.

Summary:

1937—1942: Stationary.

Locality 28:

Narssap sermia: this is the other calving glacier in Godthaabsfjord. It is not so productive as the Kangersuneq glacier, and in the month of August, when Kangersuneq fjord is usually free of ice, the area can be approached without difficulty from around Narssaq, just south of the glacier.

1723: In his diary for 2nd May, 1723, HANS EGEDE records, after inspecting Ruin Group 7 in Ujaragssuit, that "In one of these fiords not far away we saw a large, high and long ice mountain, which the Greenlanders told me never thaws in summer, except that large pieces of it fall from it". Unfortunately, Egede made no record of the point from which he made this observation, so his information is useless for our purpose. The glacier can be seen from the fjord on the way from Ivnujagtoq to Ujaragssuit, so the observation may have been made from there and not from a visit near the locality.

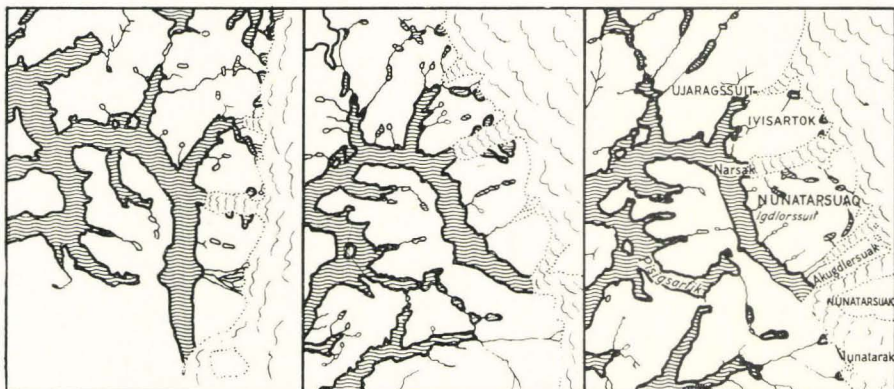


Fig. 53.

Fig. 54.

Fig. 55.

Fig. 53. Detail from JOHANNES POULSEN'S map of Godthaab District. Original in Royal Library.

Fig. 54. Detail from C. V. M. FALBE'S map of Godthaab District 1863. Original in Royal Library.

Fig. 55. Detail from J. A. D. JENSEN'S map of Godthaab District 1885. From Medd. o. Gr. Vol. 8, pl. X.

1855: KLEINSCHMIDT'S map fig. 52. The glacier front is here shown very close to the area around D. BRUUN'S Ruin Group 12 (for more about this group see below under 1903).

1859—1860: A map by Kleinschmidt shows the glacier front in a more retired position than on the 1855 map, but the outlines are very vague and there are no localities to act as guides for determining the position of the front. This map is useless for our purpose, especially because on another of the same time, JOHANNES POULSEN'S map, the glacier front is shown to be close to Bruun's Ruin Group 12, i. e. in a more advanced position.

1863: Like Kleinschmidt's 1859 map, FALBE and BLUHME'S map shows the glacier in a more retreated position than now; but here again the map contains no features at the glacier front to assist in localizing its position.

1885: On J. A. D. JENSEN'S map the glacier is to be seen in a very advanced position: the front is due south of Jensen's Peak 2960', which must correspond to Point 995 on the modern map, and it looks as if the glacier filled the bay at Bruun's Ruin Group 11. Apparently this group was not visited by Jensen personally, for he writes (Medd. o. Gr., Vol. 8, p. 110) in his summary of the ruin groups: "11. Said to be on

the south side of the Ivisartok area¹), and in the vicinity a trap similar to the one at Kugsangarsorsuak”.

This would suggest that the ruin was clear of the glacier even at that time, and the melting zone around the glacier does not indicate any such advanced position in recent time.

1903: The archaeologist D. Bruun writes as follows about Ruin Groups 11 and 12 near the glacier margin (Medd. o. Gr., Vol. 56, p. 75): “Bendixen says (1916): In front of the glacier front two rather narrow valleys form inlets into the steeply falling coastal land. In both valleys are ruins on the bank of a stream running through each valley.

“Ruin Group No. 12: The ruin shown on the map in Medd. o. Gr., Vol. 8 did not exist, the Greenlanders thought (1903), but it was no doubt the one Bendixen found a little more to the east, about which he writes: At Narssak between a precipitous headland and the glacier end lies a small ruin on the slope just above the fiord. Part of the ruin has slipped into the water”.

The latter observation, in particular, that about Ruin Group 12, can provide information about the position of the glacier when Bendixen was there in 1916.—The ruin group still lies between a precipitous headland and the glacier front.

Daniel Bruun's work contains a number of pictures of the inner part of Godthaabsfjord, all photographed in 1903. In the Royal Library there is also a photograph of the same region, the glacier front at Narssapsermia, in all probability taken by JOHN MØLLER; there is every reason for assuming that this picture was also taken in 1903, so much the more as John Møller together with O. BENDIXEN took part in D. Bruun's expedition and in that year were in the outer part of Kangersuneq (see Kangersuneq glacier, 1903). Nevertheless, this dating is nothing more than a suggestion; we know nothing definite. The picture shows the glacier front and its boundary against the north side of the fiord arm, seen from the south side of that arm. It is seen from a comparison with other photographs, dating from 1930 and 1955 respectively, that there has been no change in the position of the glacier; it should be added, however, that a change of about 10 metres in the frontal position could not be checked on the pictures.

1907: From that year we have a map of the Norse ruins in a paper published in Grønlandske Selskabs Aarsskrift 1908 (D. Bruun's paper). It is also reproduced in “Atuagagdliutit”, May 1909, and is said to be a map of the area revised by Greenlanders. No change is observable

¹) Supposedly the same as is reported in “Grøn. hist. Mindesmærker” III, p. 841, situated at Irisartok.

for Narssap sermia; as on the original J. A. D. Jensen map of 1885, the front is in an advanced position. (On this same map, see under Kangersuneq, 1903).

1909: As was mentioned under Kangersuneq glacier, O. NORDENSKJÖLD reported that at the beginning of this century Narssap sermia was advancing and that several camping places were now covered. From John Møller's photograph of 1903, however, the glacier seems to have remained unchanged up to the present day. Moreover, the rock sides along the glacier are so steep that one can scarcely imagine traces of a former camp there. It is possible that a slight advance here as elsewhere has been the cause of some exaggeration.

1916: This is the date of the information of O. Bendixen, quoted above under 1903. In 1916 too the glacier seems to have occupied the same position as in 1955.

1930: Photographs by the geologists K. GRIPP and S. HANSEN date from this year. Besides one of the glacier front there are pictures of the glacier's south side at the large ice-dammed lakes. One of the latter photographs is reproduced in "Naturens Verden", Vol. 16, 1932 (S. Hansen).

1937—1942: Aerial photographs of those years show the front in the same position as in 1930.

1955: In that year the glacier front was photographed by the writer, who endeavoured to take pictures from approximately the same place as S. Hansen and J. Møller, and also by means of sights to determine the front with a view to future surveys.

a) Comparison between photographs of 1930 and 1955: There is a greyish area on the northern mountain side near the glacier front, showing that in 1955 the front was at the same place as in 1930. The writer had the 1930 photograph with him in 1955, and by observing the north side point by point under various lights in the course of an afternoon it was quite evident that, with a possible error of a few metres the glacier had been stationary in the period 1930—1955.

b) Survey: From two stations at the south end of the glacier front, separated by 902.2 metres (marked Station I, registered by bronze shield 55009 under a cairn, and Station II, registered by bronze shield 55010 under a cairn) a series of sights were taken to localities on the glacier and in its environs. The map 51 shows the symbols for the sights. The measured angles are given below; for both stations the values given refer to one single set.

Sights from Station I		Sights from Station II	
to:	angle:	to:	angle:
1 (river mouth)	00° 00.01'	1	00° 00.0'
3 (trim-line)	09° 07.9'	3	09° 34.6'
4	36° 14.6'	4	43° 05.6'
5	37° 14.1'	5	42° 30.5'
6 (glacier front)	10° 37.3'	6	11° 14.1'
Station II	73° 32.2'	Station I	- 95° 46.0'

The distance from Station I to Station II was not measured directly but by means of an "auxiliary base", 35.5 metres in length, laid out from I; from its other end-point sights were taken to Stations I and II. Regarding the positions of the cairns, these are given on the map fig. 51. Station II is quite close to the low melting zone at the margin of the glacier (the height of this melting zone is only a few metres and it extends only a short distance ahead of the glacier front).

Conclusion:

1855—1903: The material for that period consists solely of maps and, as will have been observed from the above, the glacier front is plotted quite arbitrarily, sometimes a little ahead of the present position of the glacier (the small extent of the melting zones shows that this must be wrong), sometimes slightly behind. Presumably the glacier has never at any time in that period been much farther back than it is now, and the melting zone shows that it has never been much farther forward either.

(As will be seen from the following, the glacier seems to have made a slight advance prior to 1903).

1903—1955: All the photographs from 1903, 1930, 1937, 1942 and 1955 show that the glacier was stationary at these dates. O. Bendixen's report from 1916 indicates the same. O. Nordenskjöld reports an advance at the beginning of the present century, but the glacier seems already to have occupied its present position in 1903. It is possible that this small advance should be dated prior to 1903, but in any case the dating must be very doubtful.

Summary:

1855—1903: Stationary?
1903—1916: Stationary.
1916—1930: Stationary.
1930—1937: Stationary.
1937—1942: Stationary.
1942—1955: Stationary.

Locality 29:

Ujaragssuit glacier: Situated on the border between Godthaabsfjord proper and the icefiord Kangersuneq. The place has been fairly well known since early times, reindeer hunting being good here. The place is described rather often by Danes on account of the Norse ruins there. Moreover, access to the glacier is much easier than to the other Kangersuneq glaciers because of its greater distance from the calf ice of Kangersuneq glacier.

1721—1728: HANS EGEDE reports both ruins and a glacier. On 13th August 1724 after having been up a mountain in the region he writes: "At the very top of the mountain we could see far in over the land and saw the aforesaid terrible ice mountain which extends over the entire country north and south like a great ocean. In the fiord Ujarachsuaach, where the said ice mountain reaches down to the sea, we saw many large icebergs drifting, which had fallen out of the ice mountain and had completely filled the sea there".

On 15th November of that year (Medd. o. Gr., Vol. 54, p. 151) Hans Egede says that he observed a quantity of drift ice coming out of Godthaabsfjord, and then adds: "out from the fiord Ujarachsuaack, where the terrible, great ice mountain stretches down to the sea". These passages would seem to suggest that Egede meant Kangersuneq when he wrote Ujaragssuit: it is scarcely possible that Ujaragssuit was productive at that time.

1774—1775: There is also a confusion of Ujaragssuit with Kangersuneq in THORHALLESEN'S "Beskrivelse over Missionerne i Grønlands Søndre Distrikter" 1774—75, p. 46. The locality Ujaragssuit is only very briefly described.

1808: For this year during a visit to Ujaragssuit fjord on 15th August, GIESECKE gives a very accurate description of the fiord and the outwash plain in front of the glacier, but the glacier is only mentioned en passant (6th August). (Medd. o. Gr., Vol. 35, pp. 145—147).

1828: The naturalist C. PINGEL in that year was in the region around Ujaragssuit. A description of his journey appears in the periodical "Tritogenia", Nov. 1829, pp. 91—92, where he depicts the valleys near the inland ice and the ice margin itself, but his description is very little help in determining the position of the front, even if one had been on the spot. There are not many locality names in the vicinity of the ice margin in West Greenland, and so we have nothing but the bare description to guide us. On the Ujaragssuit glacier itself he writes: "After leaving the iceblink proper we followed one of its enormous arms which, enclosed between two vertical walls of rock, extends through a deep

and narrow valley to the fiord. It brought us to a bay, surrounded by very high mountains, which the natives call Najæt (Maagebugten). The glacier itself did not reach down to the fiord but ended on a flat and clayey ground over which its turbid, muddy water flowed into the bay. On the mountains around the Najæt, which gave a view over the whole inner part of the fiord arm, I could trace the outflow from the iceblink far out in the fiord: the glacier water ran like a river through the clear water of the fiord without mixing with it. From Maagebugt the mountains fell very abruptly towards Ujararsoak". This appearance of the glacier agrees exactly with that of today.

1855: KLEINSCHMIDT's map of Godthaab District. The glacier is only roughly sketched (fig. 52 a) but can be seen to have its front at about the same place as now.

1859—1866: The other maps of the Godthaab District (Kleinschmidt 1859, Aron and Abraham of Kangeq, 1860, JOHANNES POULSEN's, the age of which is not known exactly but is probably of the same period, and BLUHME-FALBE's of 1866, after their journey 1863—64), seem to show the glacier front in the same position as now. And yet, the Johannes Poulsen and Bluhme-Falbe maps have the peculiar feature that the water from the big system of lakes south of Ujaragssuit glacier (on Geodetic Institute map 64 V 2, Kapisigdlit lakes 650 m and 630 m) has its outlet in front of the glacier, whereas nowadays it runs into an ice-dammed lake nearby, but behind the glacier front. The region around Ujaragssuit is traditional reindeer-hunting territory for the people of Godthaabsfjord, as Hans Egode long ago recorded, and therefore there is every probability that this efflux from the lakes was common knowledge and that its position is correctly plotted on the maps. Neither Kleinschmidt's map of 1859 nor Abraham and Aron's of 1860 shows any of the rivers in the area and therefore cannot verify or refute this assumption. It will also be seen that Johannes Poulsen's map generally seems to be very correct for the whole ice margin from Narssap sermia on the south to Taserssuaq on the north, for which reason it is probable that the Ujaragssuit glacier must have occupied a more retired position in the middle of last century than it does now.

1885: J. A. D. JENSEN's map of the area seems to be less accurate than Poulsen's: the lake complexes around the great lakes south of the Ujaragssuit glacier are quite distorted. On the glacier and Ruin Group 8 J. A. D. Jensen writes as follows (Medd. o. Gr., Vol. 8, p. 109): "(Ruin group) 8: reported to be on the north side of Ujaragssuit's northeast arm, in which the inland ice now projects far forward, carrying large masses of clay which are deposited in the fiord, with the result

that it is dry at low water. Present-day Greenlanders recall that up to 1840 or thereabouts it was possible to travel in an umiak a good way up this fiord arm to a bird-cliff on the south side, but the ice is now far beyond that spot". This report of a glacial advance in the middle of last century actually agrees well with the above information from Johannes Poulsen's map, to the effect that around about 1863 the glacier was still in a more retired position than now, but was already advancing.

1903: DANIEL BRUUN's map in *Medd. o. Gr.*, Vol. 56, published in 1918 after his visit in the area 1903, Pl. 1 is merely a copy of J. A. D. Jensen's map. The same is the case with the maps accompanying Bruun's papers in *Grønlandske Selskabs Aarskrift 1908* and in the Greenland periodical "Atuagagdliutit" No. 12, May 1909. None of the Greenlandic corrections to J. A. D. Jensen's map, reported by Bruun in *Medd. o. Gr.*, Vol. 56, p. 58, seem to have been inserted at the Ujaragssuit glacier. Regarding Ruin Group 8 on D. Bruun's map, supposed to be situated near the ice margin east of Ruin Group 7 and marked "?", Bruun merely quotes J. A. D. Jensen that ruins were to be found there earlier and are now covered by the ice, but he also adds that other Greenlanders assert, according to O. BENDIXEN (1916), that there are no ruins at this spot.

1916: Regarding O. Bendixen's report on the ruins at Ujaragssuit, see above under 1903.

1930: From that year we have a series of very distinct photographs, taken by Dr. S. HANSEN and Professor K. GRIPP. The pictures show both the glacier front, viewed from the island of Qeqertat near the church ruin, Ruin Group 7, and from the Puillasoq area. Also the region around the ice margin at a lake north of the source of the glacier from the inland ice, as well as the nunatak, plotted on the Geodetic Institute map between the inland ice itself and its outlet to Ujaragssuit at the height of 850 m were photographed. One of these photographs, taken by Professor Gripp, is reproduced on fig. 56.

1934: In that year Dr. AA. ROUSSELL explored the Puillasoq area and in his article, *Medd. o. Gr.*, Vol. 89.1, p. 76, is an illustration of Ruin Group 8 and the glacier. On comparing this with S. Hansen's 1930 photographs it is seen that in the period 1930—34 the glacier was stationary.

1937—1942: Judging from aerial photographs of these years the glacier front had the same extent and maximum as on the 1930 and 1934 photographs.

1955: A photograph taken in that year shows the glacier viewed at long range from Peak 670 at Igdlorssuit. The picture is not very



Fig. 56. Ujaragssuit glacier. Photo. 25th Aug., 1930. K. GRIPP.

clear, but the glacier front apparently occupies the same position as on the photographs taken in the period 1930—1942.

Conclusion:

1808—1855: In the reports of this period the glacier is stated to be separated from the sea by a wide outwash plain. Its actual extent cannot be given. According to J. A. D. Jensen the glacier began to move forward about 1840.

1855—1866: The only fairly positive indication of the position of the glacier front is to be found on the maps of 1860 and 1866 where, behind the aforesaid efflux of the river to the now ice-dammed lake, the front must have been about 3 km behind its position today. There is also J. A. D. Jensen's account of the Greenlander's former fowling at the bird-cliff, now lying behind the glacier front. On the other hand, it is rather unlikely that the Greenlanders were able to sail their umiaks so far up the fiord, unless the sedimentation ahead of the glacier increased in volume with the advance of the ice in the middle of the 19th century. Quite apart from any question of heavy sedimentation in Ujaragssuit, I may add that I was informed in 1955 by deacon RAPHAEL JØRGENSEN at Qôrnoq that in bygone days one could sail much farther into Ujaragssuit, but that now the sand was "moving outwards". In any case, it would seem that in the middle of the 14th century Ujaragssuit fjord was less choked by the outwash plain it is today, for Norse

farm No. 8, Puilassoq, now lies far behind the plain (see also Aa. Rous-
sell: Medd. o. Gr., Vol. 89,1 pp. 75—77).

1866—1930: From the information available for these years it is impossible to draw conclusions regarding the position of the glacier front. In 1930 it was probably approximately in the same place as in 1955. The trim line, which extends no more than about 100 metres ahead of the glacier, shows that in historical time the front cannot have been more than 100 metres in advance of its position now. In 1885, according to J. A. D. Jensen's report, the glacier must have been advancing and probably reached the maximum indicated by the melting zones, whereafter in the 20th century it retreated slightly, to become stationary as from about 1930.

1930—1955: The photographs from 1930, 1934, 1937, 1942, and 1955 all seem to show that the glacier was stationary throughout these years.

Summary:

1840—1885: Advancing.
1885— ? : Advancing.
?—1930: Retreating.
1930—1955: Stationary.

SUMMARY OF EVIDENCE OF SOUTHWEST GREENLAND'S GLACIAL VARIATIONS

In fig. 57 I have attempted to summarise the changes at the termini of the glaciers in the period 1800—1955 wherever it is possible to give an approximate estimate of the oscillations within the region under consideration. As a basis for comparison I have also shown the changes in a few of the glaciers in Northwest Greenland. The latter will be discussed in greater detail in a forthcoming volume, but I may say here that in Northwest Greenland the glaciers seem to have fluctuated according to the same time-table as those in Southwest Greenland. For individual glaciers the extent of the tongue is shown in accordance with the latest information, that is my own observations in 1955 or, in their absence, aerial photographs of the period 1948—1953. The variation of the length of each glacier is shown graphically as the maximum fluctuation. Regarding the margin of error in this summary the reader is referred to the foregoing analysis of the literature, where an account of the evaluation of the fluctuations of each glacier may be obtained. A comparison with the diagrammatic summary of the glacial fluctuations in H. W:SON AHLMANN'S book: "Glacier Variations and Climatic Fluctuations" 1953, fig. 11 (here reproduced as fig. 58). reveals close conformity between the behaviour of glaciers in other regions and that of the majority of the glaciers in the districts dealt with in this paper. As is the case with the 18th century, information for the period 1800 to 1850 is very slender, but, as will be seen below, there are also signs that the "hochstands" of about 1750 and 1800 occurred in Greenland. For this country, it is possible to adduce the following regarding periods of maximum advances ("hochstands").

Hochstand 1750: There is no concrete evidence of this phase for any of the Greenland glaciers, but the following information suggests that such a hochstand did in fact occur in Greenland: 1) In "Brudstykker af en Dagbog holden i Aarene 1770—78" HANS EGEDE SAABYE writes on Jacobshavns Isfjord and its glacier (Medd. om Gr., Vol. 129,2 p. 8). "This strange fiord runs between Claushavn and the Jakobshavn area;

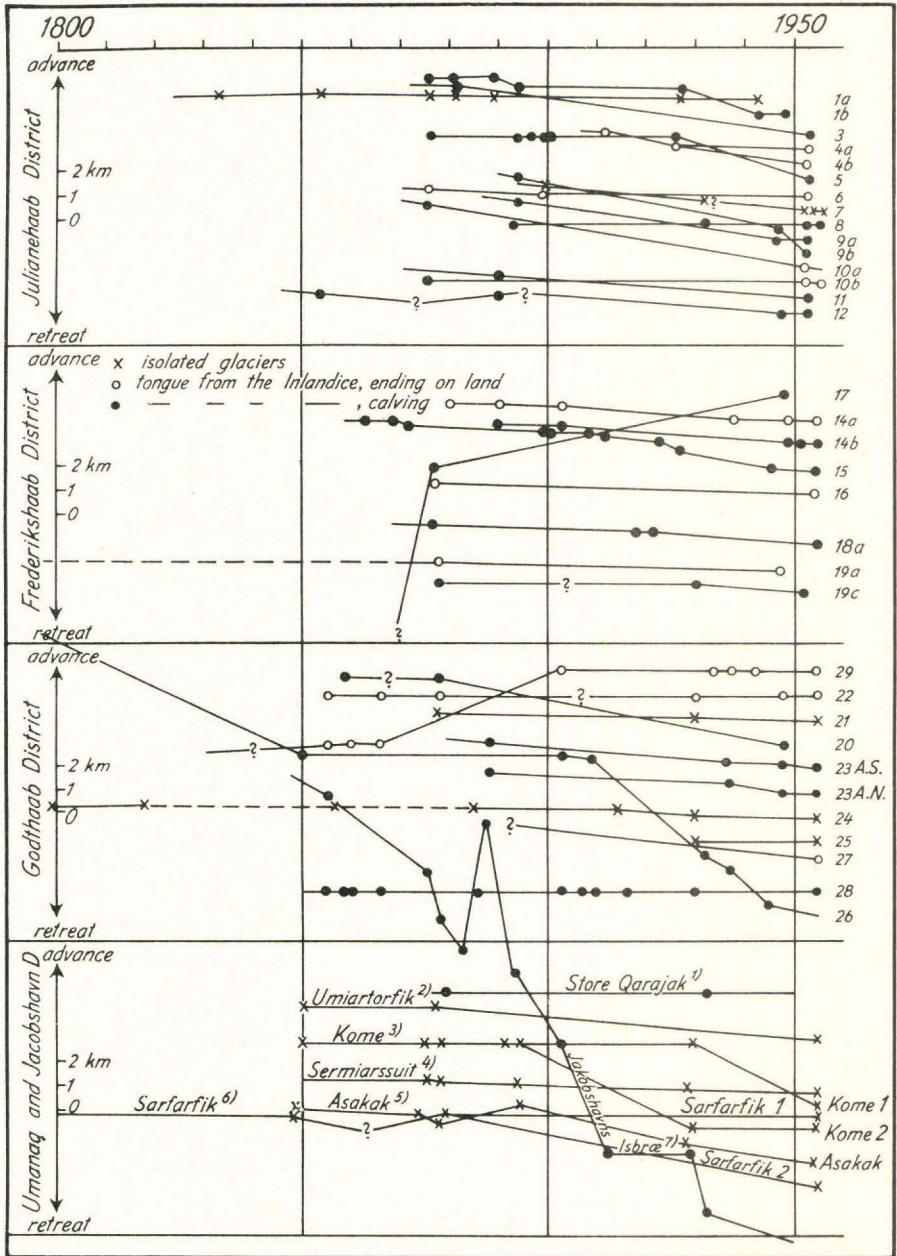


Fig. 57. Diagram of the frontal fluctuations of the glaciers referred to in the text. Some measured fluctuations of Northwest Greenland are shown for comparison. Numbers on the figure refer to locality numbers in the text. For some localities there are more than one glacier; these localities are: 1 a: Sermitsiaq, 1 b Sermeq in Tasermitut, 4 a: Kujatleq valley glacier, 4 b: Jespersen glacier, 9 a: Eqalorutsit kitdlit sermia, eastern branch, 9 b do. western branch, 10 a western glacier in Kangerdluarsuk, 10 b middle glacier in Kangerdluarsuk, 14 a, Søndre Qôrnoq glacier, 14 b, Nordre

(cont. p. 177)

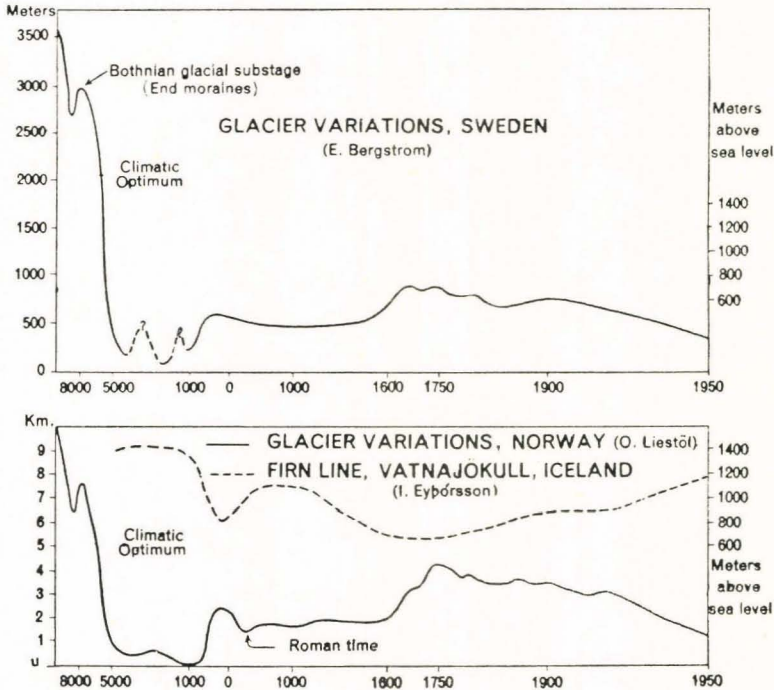


Fig. 58. Examples of frontal variations in regions outside of Greenland. From H. W:SON AHLMANN: *Glacier Variations and Climatic Fluctuations* 1953, p. 38, fig. 11.

its length is five to six (Danish) miles and its breadth a quarter to a half (Danish) mile. In earliest times it is said to have been free of icebergs and navigable; indeed, old Greenlanders, quoting their forefathers, say that they could once travel along it through the range of mountains which are now covered with perpetual ice as far as to the east side, Østerbygd”.

2) Regarding the region of Austmannadalen, there is an account of an advance by the inland ice in E. THORHALLESEN’s book: “Efterretninger om Rudera etc.”, 1776, quoted here on page 143.

3. In his paper “Om Driv-Isen i de Nordlige Vande og fornemmelig i Davis-Strædet” the naturalist and theologist O. FABRICIUS writes on

Fig. 57 (cont.).

Qôrnoq glacier, 18 a, Nigerdlikasik glacier in Kvanefjord, 19 a, Frederikshaabs Isblink, sector A, 19 c, Frederikshaabs Isblink sector C, 23 AS: Austmannadalen, Southern part of the ice margin against the lake of Isvand, 23 AN: do. Northern part. The names for the Northwest Greenland glaciers are taken from E. DRYGALSKI 1897: these names are not authorized by the Geodetic Institute. The curve no. 11 is a mean for the retreat of the ice margin North of Tugtotoq in the period 1890—1953, and the melting before 1890 is assumed to have been negligible.

pages 69—70 of the inland ice: "This ice spreads more and more every year, grows both from the ground upwards and from the middle to the sides and has already eliminated most of the land. Where it encounters high mountains it must stop until it overgrows them in height, whereafter it goes on without hindrance. The experiment has been tried of erecting a post on the bare land a good distance from the ice, and next year it was found to be overtaken by it. So swift is this growth that present-day Greenlanders speak of places where their parents hunted reindeer among naked hills which now are all ice. I myself have seen paths running up towards the interior of the country and worn in bygone days, but now broken off at the ice, which confirms the Greenlanders' statement. The glacier advances especially in the valleys and, where these reach the sea and the heads of the fiords (I mean the inner ends of the fiords) it becomes so dominating as to have great floes hanging over the water. Apparently part of the glacier, especially at the middle, is even and smooth, but part of it is most uneven, particularly where it borders upon the still bare land and at places where small hills are covered".

As Fabricius was incumbent of the parish of Frederikshaab Colony from 1768 to 1773, his observations were undoubtedly made from that locality.

4) The reports of P. OLSEN WALLØE, quoted here on pages 78 and 106, also give the impression of a general advance by the Southwest Greenland glaciers.

5) A general advance also seems to be indicated by L. DALAGER's account of the closing of Kangårssúp taseressua at Frederikshaabs Isblink by a glacial advance.

Of these five reports, that of Hans Egede Saabye seems decidedly exaggerated. Like certain other authors of those days he must have been influenced by the legend of one or more "Frobisher straits" across Greenland. The origin of that idea dates back to MARTIN FROBISHER's account of a "strait" which he discovered in the North American archipelago but which later on were mistakenly placed in Greenland. This is also the case with Greenlanders' tales of enormous advances, for instance at Søndre Sermilik in Julianehaab District, Sermilik in Godthaab District or Agdlumersat, also in the latter district. It would seem that the Greenlanders had assumed responsibility for the myth and associated it with nearby fiords; this would be natural for them as the glaciers in them were probably advancing then. The unreliability of Hans Egede Saabye's report may be underlined by recalling the generally widespread view in the 18th century that the Norsemen's Østerbygd was situated on Greenland's East coast.

Thorhallesen's and Fabricius's accounts sound more trustworthy, the latter's especially bearing the impress of personal experience. These two records leave no room for doubt that there was a general advance in West Greenland in the middle of the 18th century. This conclusion may also be drawn, though with somewhat less certainty, from P. O. Walløe's report, quoted on pages 78 and 106, and in L. Dalager's text, page 119 in this paper.

Nothing is known of when this "hochstand" began, nor can anything be said of whether it was succeeded by a less general retreat towards the close of that century. It is possible that there was a continuous hochstand until the beginning of the 19th century.

Hochstand circa 1800. Our sources concerning this hochstand are K. L. GIESECKE (see under the glaciers Eqalorutsit kangigdlit sermia, Kvanefjord, Sadlen, Nakaissorssuaq and Kangia-nunâta sermia), I. CHR. MØRCH (Nakaissorssuaq) and S. KLEINSCHMIDT (Sermilik in Godthaab District). None of these accounts are based upon personal experience, however, but upon verbal communications. It would seem that in this period Kangia-nunâta sermia was at its maximum within historical times, and in North Greenland the glaciers at Sarfarfik and Sermiarssuit are also known to have occupied a similarly advanced position then, whereas the Sermitsiaq glacier in Tasermiut was in a retreated position. Some of the reports from South Greenland were influenced by the tradition of a recently glaciated Frobisher Strait through Greenland.

However, notwithstanding the doubtful documentation of the 1800 hochstand, we must assume that it did occur in Greenland. As will be seen from the diagram fig. 58, there seems to be no visible delimitation between the hochstand of about 1750 and about 1800 at the Scandinavian glaciers, and possibly the same was the case with the Southwest Greenland glaciers, so that the period circa 1750—circa 1800 on the whole was characterized by advancing glaciers or stationary glaciers in an advanced position.

Otherwise, it appears from the photographic material (now in possession of the Geodetic Institute) covering most of the inland ice margin in the three districts under consideration that in recent time the margin of the inland ice has retreated (see e. g. the illustrations fig. 9, 26 and 45 a—b), for it is possible to find melting zones almost everywhere. Hitherto it has not been possible to date the formation of these zones in various sections of the ice margin. Some of them, especially in the region of Godthaabsfjord, and perhaps in the Julianehaab District, seem to date from the period around 1750 or 1800, in analogy with the maxima of the glaciers determined in the North Atlantic region by H. W:son Ahlmann (Ahlmann 1948, 1953). But at the glacier

fronts some of the zones are found to have their origin in a shrinkage between about 1900 and 1955.

The period circa 1800—circa 1850: This period is even less documented than that around 1800. A single glacier, Sermitsiaq in Tasermiut, was reported to be advancing in 1833, and the Sermitsiaq glacier (Sadlen) in Godthaabsfjord was presumably in an advanced position.

About 1850 the observations of the glacier fronts become much more numerous and it will be seen from the diagram fig. 57 that one of the glaciers had an advance (Sermitsiaq in Tasermiut) while some others were in an advanced position. However, we do not know whether that position was the result of a new advance after 1800 or it had been maintained after an earlier advance, as in the case of Nakaissoarsuaq, Arsuk glacier and Kangersuneq. North of the region under review it will be noted on fig. 57 that the glaciers on the north side of Nûgssuaq peninsula, with the exception of Sarfarfik, also seem to have been in an advanced position by the close of the same half century.

The period circa 1850—circa 1900: Regarding the positions of the glacier fronts this period is well documented compared with earlier periods. On the whole, compared with the situation around 1850 the glaciers seem to have been stationary or retreating. Nevertheless there were some advances, for example, Sermeq in Tasermiut, Sermeq in Søndre Sermilik, Kiagtût sermia, the Qipisarqo glaciers (not shown in fig. 57), Søndre Qôrnoq glacier and Sermilik glacier (Sermitsialik glacier), all of which registered an advance in about 1890. Something similar in North Greenland may be indicated by Jakobshavn glacier (according to M. C. ENGELL, *Medd. o. Gr.*, Vol. 26, p. 33, but somewhat doubtful), and by the Asakak and Sarfarfik glaciers on the north side of Nûgssuaq peninsula; for these advances seem to have been right forward to the extreme limit of the glaciers in recent time as marked by melting zones. For the West Greenland glaciers, as for Alpine and Scandinavian glaciers, the period 1850—1900 is characterized by varying reports of frontal advance or retreat, but with a tendency to retire dominant throughout most of the period except around the year 1890 when the aforesaid advances took place.

The Period circa 1900—1955: Almost all the glaciers are seen to have been retreating in this period, a withdrawal which for some of them is a continuation of that between 1850 and 1900, except that in the course of the 20th century it becomes more pronounced. Small advances occurred twice in the 20th century. For example, Sermitsiaq

in Tasermiut, Sermilik (Sermitsialik) glacier, Søndre Qôrnoq glacier, glacier and the glaciers in Austmannadal all recorded one or two minor readvances in the first half of the present century. None of these small advances are dated in the literature. If conditions were the same as those in Iceland (S. THORARINSSON 1943) it may be assumed that these advances occurred at about 1910 and 1920.

On comparing fig. 57 with fig. 58 a conformity as to their fronts will be seen between the Southwest Greenland glaciers and, on the one hand, the glaciers in the North Atlantic region, and on the other hand the glaciers in the North Greenland region. The frontal changes in North Greenland shown in fig. 57 have been subjected merely to a preliminary survey. The conformity seems to continue up to the Thule region (e. g. for the Upernivik area, see W. S. CARLSSON 1939), where the climatic variations are not of the same extent or character, according B. FRISTRUP (B. Fristrup 1952). In the border region around Thule a number of glaciers are reported (L. KOCH 1928, J. W. WRIGHT 1939 and A. KILLERICH 1929) to have been advancing until the middle of the 1920's after which a general retreat began. Regions of a distinctly different character are to be found in the Canadian archipelago (R. BENTHAM 1941, P. D. BAIRD 1954—55) and in Peary Land (B. Fristrup 1952, H. W:son Ahlmann 1953).

Concerning the rate of retreat through the last 10 years attention should be paid to the tendency of the gradients to be lower today. The climate in West-Greenland should from now become cooler. However, the available material is too small to permit an absolute conclusion.

Exceptions from general behaviour: The following glaciers in Southwest Greenland seem to differ from the general diagram showing retreat or any rate stationary conditions with shrinkage and formation of dead ice during the past hundred years, apart from the local advances in about 1890 and perhaps 1910 and 1920.

1) Eqalorutsit kangigdlit sermia in Julianehaab District. In 1955 the terminus of this glacier was in the same position as in 1894 and in 1955 was advancing (expansion). To a great extent the inland ice around the glacier has been waning in this century and a possible explanation of the advance is a shrinkage, lower velocity and consequently lower transport capacity in the other lobes along the margin of the inland ice, whereby this glacier is compelled to take on the drainage of a larger area than before. It must be added, however, that an examination of the ground under the ice and of the movement of the inland ice will be necessary before it is possible to make any reasonable kind of attempt to explain the conditions at this glacier.

2) Sermilik glacier in Frederikshaab District. Hitherto this glacier has not been subjected to any examination and the reports of its changes are rather doubtful. From 1860 it seems to have been advancing. The conditions are very similar to those of Eqalorutsit kangigdlit sermia; viz: a highly productive glacier apparently draining a large area of the inland ice. Any explanation of the behaviour of this glacier is subject to the same reservations as for the above, especially as all calving glaciers in the three districts behave in accordance with the normal pattern with the exception of this one, the glacier referred to above, 1) and that below, 3).

3) Narssap sermia in Kangersuneq ice fiord, Godthaab District: This glacier, which, like Sermilik in Frederikshaab District and Eqalorutsit kangigdlit sermia in Julianehaab District is productive, though on a smaller scale, has been stationary since 1903, and is stated to have been advancing prior to the end of the 19th century. Conditions in the area around Kangersuneq ice fiord in the Godthaab District are therefore very like those in the Julianehaab District. A productive glacier maintains its maximum extension, at any rate in the last 100 years, whereas the adjoining southern ice margin is waning. The best evidence of this shrinkage in Kangersuneq area is expressed in the retreat of the southernmost calving glacier in Kangersuneq: Kangia-nunâta sermia, which in the last 150 years has retired circa 20 km. As noted under 4) the behaviour of the northern neighbour tongue from the inland ice: Ujaragssuit glacier, is also abnormal.

4) Ujaragssuit glacier in Godthaab District. In the period 1840 to (possibly) about 1900 this glacier moved forward about 3 km. This assumption of an advance is based upon old maps and a Greenlander report. The melting zone ahead of it shows that the glacier, which incidentally was stationary between 1930 and 1955, formerly had its front about 100 metres ahead of its present position. The time when the glacier occupied this advanced position cannot be established; the immediate impression from the surroundings and from the reports of the glaciers to the south at the head of Kangersuneq give the outermost position of the ice margin in 1750 or in 1850, which can not be correlated with information about an advance of Ujaragssuit after ca. 1840. As shown above, the nearest neighbour to it, Narssap sermia, may also have varied from the normal pattern of behaviour.

There are also deviations from the standard pattern in North Greenland. A number of highly productive glaciers (lobes from the inland ice) have been astonishingly stationary for about a hundred years (E. v. DRYGALSKI 1897, F. LOEWE, 1935).

It is possible that on the whole calving glaciers as examples of

typical glacial variations must be viewed with some reserve, especially when, as in this paper, one compares glaciers terminating on land with calving glaciers.

Regarding the tremendous advance of the Asakak glacier, North Greenland, in about the year 1893, Drygalski, who visited the glacier that year, says the cause was an avalanche some years earlier from the highland ice, from which it emanates and which surrounds it on both sides of Asakak valley. It is possible that similar conditions exert their influence at the Qingaq glacier in Godthaab Fjord, which did not share in the general retreat in the period 1930—1955.

Variations of different Glacier Types: In the following I shall differentiate only between three types: 1) lobes from inland ice, terminating on land, 2) lobes from inland ice, terminating in water (productive glaciers) and 3) tongues from isolated firn regions. Of the 34 glaciers in the three Southwest Greenland Districts shown in fig. 57, 11 are lobes ending on land, 18 are calving lobes (in Austmannadal into a lake) and 5 are glaciers or tongues from isolated firns. One of the latter, Sermitsiaq in Julianehaab District, is regarded as a tongue from an isolated firn region because it emanates from the plateau ice south of the line Kangerdlugssuatsiaq-Tasermiut.

1) Lobes from the inland ice, terminating on land. In these glaciers we observe the closest conformity with the recorded pattern of the Atlantic region generally. The sole exceptions are Ujaragssuit in Godthaabfjord, the Sermilik glacier in Godthaab District and possibly certain parts of Frederikshaabs Isblink. The last two glaciers are abnormal only in the sense that they did not participate in the waning of the last 100 years, but there is not, as in the case of the Ujaragssuit glacier, evidence of pronounced advances in the beginning of the last century. Of the above-mentioned three lobes, only one, the Frederikshaabs Isblink, has any substantial surface moraine indicative of stagnation, and this is restricted to the southern part of the Iceblink.

2) Productive glaciers: These may be divided into two groups, the first group has been subject to the same changes as the lobes terminating on land, except that the frontal changes are much greater: it is not a matter of a hundred metres or so, but several kilometres. The best known representatives of this group are in North Greenland Jakobshavn glacier (concerning the history of this, see H. LARSEN and J. MELDGAARD 1957), and in South Greenland Eqalorutsit kitdlit sermia, Arsuq glacier and Kangersuneq glacier. The second group behaves in a manner contrary to what might be expected, having advanced or remained stationary during the general retreat. Typical representatives of this group in Southwest Greenland are Eqalorutsit kangigdlit sermia, Sermilik glacier

in Frederikshaab District and Narssap sermia. However, the material is not representative enough to permit any conclusion to be drawn as to the cause of these advances beyond what is stated above concerning deviations. In North Greenland too, there are some stationary lobes. In any case, it is true here that, as in Alaska and Spitzbergen, the movements of these glaciers seem to differ owing to changes in the feed routes or other circumstances not directly reflecting climatic changes, for which reason these glaciers as indicators of climatic changes must be regarded with some scepticism.

3) The few representatives of isolated glaciers instanced here (a total of 5) all seem to have taken part in the general retreat in the present century with the exception of one (Qingaq glacier in Godthaabsfjord).

Changes of Volume: Neither the cartographic material nor the slender information presented here can tell us much about volume changes at the margin of the inland ice. The one thing certain is that everywhere within the three districts conditions at the margin suggest a waning of the inland ice and that for the surfaces of most of the reported glaciers below 600 metres the shrinkage according the melting zones must be put at about 100 metres. Between about 600 metres and about 1.000 metres altitude the melting zones thin out. This might be interpreted as meaning that the regime of the inland ice is negative, as indeed A. Bauer found by other methods (A. BAUER 1955). In contrast F. LOEWE (1936) assumed that the regime was stationary.

INDEX OF LOCALITIES

Names in italics are those of the place names authorized. The names in the index are given in the order: place name (in brackets synonymeous names of the locality used in this paper), district and page. If necessary neighbouring place is given to avoid confusion owing to the duplication of many names. The name of this neighbouring place are inset between place name and district.

Abbreviations:

Jhb. D. = Julianehaab District.
Frhb. D. = Frederikshaab District.
Ghb. D. = Godthaab District.

A

Adlomersok, see *Agdlumersat* or *Bjørnesund*, Ghb. D.
Agdluitsup pá, Jhb. D., 20, 28.
Agdlumersat or *Bjørnesund* (Adlomersok), Ghb. D., 134, 136, 178.
Akugdleg, *Kvanefjord*, Frhb. D., 112-118.
Akugdlerssuaq, *Kangersuneq*, Ghb. D., 159, 162, 163, 164.
Akugdlerssúp sermia, *Kangersuneq*, Ghb. D., 156, 162, 163.
Akuliaraleq(?), Jhb. D., 42.
Akuliarusek, see *Akuliaruseq*, *Qóroq*, Jhb. D.
Akuliaruseq, *Manítsoq*, Jhb. D., 68.
Akuliaruseq (Akuliarusek), *Qóroq*, Jhb. D., 40.
Akuliaruserssuaq, see *Akuliaruserssuaq*, Jhb. D.
Akuliaruserssuaq (Akuliaruserssuaq), Jhb. D., 54, 55, 62.
Alángordlia, Ghb. D., 139.
Alaska, 184.
Amártog (Omertlok?), Frhb. D., 120.
Ameralik, Ghb. D., 141, 142, 143, 144, 145.
Arksuks Fjord, see *Arsuk Fjord*, Frhb. D.
Arsuk, Frhb. D., 82.
Arsuk Fjord or *Ilorput* (Arksuks Fjord), Frhb. D., 92-102.
Arsuk glacier, see *Sermeq*, Frhb. D.

Asakak (Agsakait?) glacier, *Núgssuaq* peninsula, 180, 183.
Atarngup tasia or *Blindtarmen* (Taserssuaq), Frhb. D., 88.
Atungaussaq, Ghb. D., 153.
Aularat, Jhb. D., 73.
Austmannadalen, Ghb. D., 140-151.
Austmannatjern, Ghb. D., 145.
Avangnardleg, *Frederikshaabs Isblink*, Frhb. D., 125, 129.
Avangnardleg, see *Sermilik avangnardleg*, Frhb. D.

B

Bjørnefjeld, Frhb. D., 93.
Bjørnesund or *Agdlumersat* (Adlomersok), Ghb. D., 134-136, 178.
Bjørneo or *Qórnup qeqertarsua*, Ghb. D., 151.
Blindtarmen or *Atarngup tasia* (Taserssuaq), Frhb. D., 88.
"Blui West One" (BW I), see [Narssarssuaq, Jhb. D.
Brattahlid (*Qagssiarssuk*), Jhb. D., 48.
Bredebjerg or *Ikerssuaq* (Ikersoak, Ikerssuaq), Jhb. D., 51, 65, 68, 71.

C

Canadian archipelago, 181.
Claushavn, 175.
Copenhagen, 119.

D

Dalagers Nunatakker, Frhb. D., 123, 124, 125, 130, 131.
Davisstrædet, 126, 131.

E

Ellerslie Havn, Frhb. D., 94, 97.
Eqalorutsit kangigdlit sermia, Jhb. D., 51-62, 179, 181, 182, 183.
Eqalorutsit kitdlit sermia, Jhb. D., 51-54, 62-64, 183.
Eriksfjord, se *Tunugdliarfik*, Jhb. D.

F

Fiskenæsset (Fiskerlogen), Ghb. D., 121, 123.
Fiske Fjord, see *Fiskenæssfjorden* or *Qeqertarssuatsiait kangerdluat*, Ghb. D.
Fiskenæssfjorden or *Qeqertarssuatsiait kangerdluat* (Fiske Fjord), Ghb. D., 107.
Fiskerlogen, see *Fiskenæsset*, Ghb. D.
Flinks Dal (Flink valley), see *Qórorssuatsiaq*, Jhb. D.
Fox fall (*Fox Fald*), Frhb. D., 93.
Fox Havn, Frhb. D., 93, 94, 95, 96, 97, 99, 101.
Frederikshaab, Frhb. D., 119, 121, 123, 178.
Frederikshaabs Isblink (Snæfjeld, Witteblink), Frhb.-Ghb. D., 77, 80, 95, 118-134, 178.
Frobisher Strait, 102, 106, 121, 178.

G

Garde (Høfdi or Qagssiarssuk), *Igaliko Fjord*, Jhb. D., 33.
Gieseckes Dal (Giesecke valley), see *Qórqup kúa*, Jhb. D.
Godthaab, Ghb. D., 107, 120, 144, 151, 152.
Godthaabsfjord, Ghb. D., 134, 151-174, 184.
Grønnedal, Frhb. D., 92.

H

Høfdi, see *Garde*, Jhb. D.

I

Igaliko, Jhb. D., 45.
Igaliko Fjord or *Igalikup kangerdlua*, Jhb. D., 33.

Igdlerfigssalik, Jhb. D., 38, 39, 40.
Igdlo (Iglo), Jhb. D., 69.
Igdlorssuit, Jhb. D., 65, 67.
Igdlorssuit (Iglorsoit), *Nunatarssuaq*, Ghb. D., 158.
Igdlorssuit, *Ujaragssuit pávat*, Ghb. D., 172.
Igdumiut, Jhb. D., 54.
Iglorsoit, see *Igdlorssuit*, *Nunatarssuaq*, Ghb. D.
Iglorsoit (Igdlorssuit equals present *Sarqarssuaq?*), Sdr. Sermilik, Jhb. D., 30.
Iglo, see *Igdlo*, Jhb. D.
Ikátoq, Ghb. D., 128.
Ikersoak, see *Ikerssuaq*, Jhb. D.
Ikersuak, see *Ikerssuaq*, Jhb. D.
Ikerssuaq or *Bredefjord* (Ikersoak, Ikersuak), Jhb. D., 51, 54, 65, 68, 70, 71.
Ilimausak, see *Ilimaussaq*, Jhb. D.
Ilimaussaq (Ilimausak), Jhb. D., 45-50, 54, 65.
Illoka, see *Ilorro*, Jhb. D.
Ilorro (Illoka), Jhb. D., 51, 75-77.
Ilua, *Narssaq*, Jhb. D., 46, 48.
Imaersartoq, Frhb. D., 110, 111.
Imartinek, see *Imartuneg*, Jhb. D.
Imartuneg (Imartinek), Jhb. D., 71, 72.
Ipatit kuá (Itivdlerssuaq), Sdr. Sermilik, Jhb. D., 32.
Irisartok, see *Ivisártoq*, Ghb. D.
Isortok, see *Isortog*, *Ilorro*, Jhb. D., 75.
Isortog (Isortok), *Ilorro*, Jhb. D., 75.
Isortuarssuk, Ghb. D., 143.
Isvand, Ghb. D., 145, 146, 148, 150.
Italien, 122.
Itibleitsiak, see *Itivdliatsiaq*, Jhb. D.
Itiblingoak (Itivdliatsiaq?), Jhb. D., 78.
Itivdleg, see *Majorariaq*, Ghb. D.
Itivdlerssuaq, *Tasermiut*, Jhb. D., 22.
Itivdlerssuaq, see *Ipatit kuá*, Sdr. Sermilik, Jhb. D.
Itivdliatsiaq or *Nyeboes Kanal* (Itibleitsiak, Itiblingoak?), Jhb. D., 78, 79.
Iviangusat, see *Iviangussarssuit*, Ghb. D.
Iviangussarssuit (Iviangusat), Ghb. D., 139.
Ivigtok, see *Ivigtút*, Frhb. D.
Ivigtút (Ivigtok), Frhb. D., 92, 96.
Ivisártoq (Irisartok), Ghb. D., 167.
Ivnajuagtoq, Ghb. D., 165.

J

- J. A. D. Jensens Nunatakker*, Ghb. D., 123, 124, 125, 126, 133-134.
Jakobshavn, 175.
Jakobshavns Isbræ (Jakobshavn glacier), 58, 175, 180, 183.
 Jespersen glacier (*Jespersens Bræ*), Jhb. D., 33, 34-36.
Jespersens Dal (Jespersen valley), Jhb. D., 33, 34-36.
Julianehaab, Jhb. D., 45, 56, 82.

K cfr. Q

- Kaksiarssuk, see *Qagssiarssuk*, Jhb. D.
 Kaleragdliit, see *Qaleragdliit ima*, Jhb. D.
 Kangarsuk, see *Kangárssuk*, *Sermiligárssuk*, Frhb. D.
Kangárssuk, see *Kangárssup nunâ* Frhb. D.
Kangárssuk (Kangarsuk), *Sermiligárssuk*, Frhb. D., 102.
Kangárssup nunâ (Kangárssuk), *Frederikshaabs Isblink*, Frhb. D., 125, 129-131.
Kangárssup taserssua (Taserssuaq), Frhb. D., 121, 123, 124, 129, 131.
Kangaussarssup sermia, Ghb. D., 140, 143.
Kangeq, Ghb. D., 144.
Kangerdlua, Jhb. D., 68.
Kangerdluarssuk (Kangerdluarsuk), Jhb. D., 62, 64-68, 70.
Kangerdlugssuatsiaq, Jhb. D., 12, 183.
Kangersuneq (Kangersunæt), Ghb. D., 140, 146, 148, 156-174, 180, 182, 184.
 Kangersuneq glacier (*Kangia nunâ sermia* and *Akugdlerssup sermia*), Ghb. D., 140, 148, 149, 156-163, 165, 167, 180, 182, 184.
 Kangersunæt, see *Kangersuneq*, Ghb. D.
Kangia-nunâta sermia, see *Kangersuneq* glacier, Ghb. D.
Kap Farvel (Statenhuk), Jhb. D., 107.
Kapisigdlit (Kapisilik), Ghb. D., 143, 151, 159, 161, 171.
Kapisigdlit kangerdluat, Ghb. D., 161.
 Kapisilik, see *Kapisigdlit*, Ghb. D.
 Kapitaq, see *Qeqertarsuaq*, Jhb. D.
 Karosut, see *Qârusuk*, Ghb. D.
 Kiagtût glacier, see *Kiagtût sermia*, Jhb. D.
Kiagtût sermia (Kiaagtût glacier, Narssarsuaq glacier), Jhb. D., 41-45, 65, 180.
Kinâlik, Frhb. D., 77, 79, 84.
 Kingigtoq, see *Tindingen*, Frhb. D.
 Kingua, see *Qingua*, *Tasermiut*, Jhb. D.
 Kipsisako, see *Qipisarqo*, Frhb. D.
 Kippisakko, see *Qipisarqo*, Frhb. D.
Kiudlavât, Ghb. D., 136-137, 138, 139.
Kiudlavât, *Sermersôq*, Jhb. D., 29.
 Kornok, see *Qôrnoq*, Frhb. D.
 Korok, see *Qôroq*, Jhb. D.
 Koruk, see *Qôroq*, Jhb. D.
Kuânersôq or *Kvanefjord* (Kwannetsok, Quanneffjord), Frhb. D., 77, 106, 111, 112-118, 179.
Kugssangassôq (Kugsangasorsuak), Ghb. D., 167.
 Kugssangasorsuak, see *Kugssangassôq*, Ghb. D.
Kujatdliup kûa (Kujatdleq valley, Østfjordsdal), Jhb. D., 33.
Kûkasik, *Sermersôq*, Jhb. D., 29.
Kvanefjord or *Kuânersôq* (Kwannetsok, Quanneffjord), Frhb. D., 77, 106, 111, 112-118, 179.
 Kwannetsok, see *Kvanefjord* or *Kuânersôq*, Frhb. D.

L

- Langvand*, Ghb. D., 145, 148, 150.
 Ligkistefjældet, *Qagssimiut*, Jhb. D., 72.

M

- Maagebugten (*Naujat kingingnerat?*), Ghb. D., 171.
Majorariaq (Itivdleq), *Frederikshaabs Isblink*, Ghb. D., 133.
Majorarissap ilua (Majorarissat), *Frederikshaabs Isblink*, Frhb. D., 123, 124, 125, 128, 133.
Majorarissat, see *Majorarissap ilua*, *Frederikshaabs Isblink*, Frhb. D.
Manitsôq, Jhb. D., 68, 69, 70.
Manitsup tunua, Jhb. D., 68, 69.

N

- Nagtoragdliit* (Nettoralik), Jhb. D., 69.
 Najæt, see *Naujat kingingnerat*, Ghb. D.
Nâkaiissorssuaq, *Bjornesund*, Ghb. D., 134-136, 179, 180.
 Nakselik, see *Narssalik*, Frhb. D.
Nanortalik, Jhb. D., Jhb. D., 12, 28, 56.
 Narksak, see *Narssaq*, Jhb. D.

Narksaliksfiord, see *Sermilik*, Frhb. D.
 Narssak, see *Narssaq*, Ghb. D.
Narssalik (Nakselik), Frhb. D., 105, 106, 108, 111.
 Narssalikfiord, see *Sermilik*, Frhb. D.
Narssap qáqá, Jhb. D., 51.
Narssap sermia, Ghb. D., 156, 158, 165–169, 171, 182, 184.
Narssaq (Narksak), Jhb. D., 45, 52, 53, 65, 68.
Narssaq (Narssak), Ghb. D., 161, 165, 167.
 Narssarssuaq (“Blui West One”), Jhb. D., 41–45.
 Narssarssuaq glacier, see *Kiagtút sermia*, Jhb. D.
 Narssarsuk, see *Narssárssuk*, Jhb. D.
Narssárssuk (Narssarsuk), Jhb. D., 41.
*Nasaussa*q (Omertlok?), Frhb. D., 120, 124, 130.
Naujarssuit, Ghb. D., 135, 136.
Naujat kingingnerat (Najæt, Maagebugten?), Ghb. D., 171.
 Nettoralik, see *Nagtoragdliit*, Jhb. D.
 Niakornak, see *Niaqornaq*, Jhb. D.
 Niakornarsuk, see *Niaqornárssuk*, Jhb. D.
Niaqornaq (Niakornak), Jhb. D., 51, 53, 56, 62, 64, 65, 69, 70.
Niaqornárssuk (Niakornarsuk), Jhb. D., 37, 38, 40, 41.
 Nigerdleg, see *Nigerdlikasik*, Frhb. D.
Nigerdlikasik (Nigerdleg), Kvanefjord, Frhb. D., 112–118.
Niviarsiat (Niviersietkakak), Jhb. D., 42, 57, 60.
 Niviersietkakak, see *Niviarsiat*, Jhb. D.
Nûgâtsiarssûanguaq, Jhb. D., 66, 67.
Nûgssuaq, 180.
Nûk, Jhb. D., 70.
Nûk, *Qôrnoq*, Frhb. D., 88, 90, 91.
Nukagpiarssuaq, Ghb. D., 136.
Nunatâraq, Ghb. D., 145, 146, 150.
 Nunatarsoak, see *Nunatarssuaq*, Ghb. D.
Nunatarssuaq (Nunatarsoak, Nunatarsoak), Ghb. D., 156, 157, 158, 160, 161.
 Nunatarsuak, see *Nunatarssuaq*, Ghb. D.
Nyeboes Kanal or *Itivdliatsiaq* (Itibleit-siak, Itiblingoak?), Jhb. D., 78, 79.

O

Oidlovet, see *Uiluit kuat*, Jhb. D., 13.
 Okevisokak, see *Ukîvisoaq*, Jhb. D.

Omertlok (*Amârtoq?*, *Nasaussa*q?), Frhb. D., 120.

P

Peary Land, 181.
Pisigsarfik, Ghb. D., 160.
 Poruk, see *Qôroq*, Jhb. D.
Puilassoq, Ghb. D., 172, 174.

Q cfr. K

Qagdhlukasik, Jhb. D., 19.
Qagssiarssuk (Brattahlid), Jhb. D., 48, 52, 53, 56, 57.
Qagssiarssuk (Kaksiarssuk, Garde), *Igaliko Fjord*, Jhb. D., 33.
Qagssimiut, Jhb. D., 46, 72, 74.
Qaleragdliit imâ (Kaleragdliit), Jhb. D., 68.
Qalingua, Ghb. D., 164.
Qamanârssûp sermia, Ghb. D., 156, 158, 160, 163–165.
Qaqatsiaq, Ghb. D., 135.
Qârusuk (Karosut), *Bjørneø*, Ghb. D., 151.
Qeqertarssuaq (Kapitak), Jhb. D., 70.
Qeqertarssuaq or *Store*, Ghb. D., 155.
Qeqertarssuatsiait kangerdluat or *Fiskenæsfiorden* (Fiske Fjord), Ghb. D., 107.
Qeqertat, *Ujaragssuit pâvat*, Ghb. D., 172.
Qingaq, Ghb. D., 155–156, 183, 184.
Qingua (Kingua), *Tasermiut*, Jhb. D., 17, 23.
Qipisargo (Kipisako, Kippisakko), Frhb. D., 23, 75, 77–82, 95, 180.
Qordlortoq, Jhb. D., 51.
Qôrnoq, Ghb. D., 151, 153, 155, 156, 173.
Qôrnoq (Kornok), Frhb. D., 77, 79, 82–91, 95, 180, 181.
Qôrnup qeqertarssua or *Bjørneø*, Ghb. D., 151.
Qôroq (Korok, Koruk, Poruk), Jhb. D., 36–41.
 Qôroq glacier, see *Qôrqup sermia*, Jhb. D.
Qôrorssuatsiaq (Flinks Dal, Flink valley), Jhb. D., 40.
Qororssûp ilulegutâ, Jhb. D., 34.
Qôrqup kûa (Gieseckes Dal, Giesecke valley), 39, 40.
Qôrqup sermia (Qôroq glacier), Jhb. D., 36–41.
 Quannefjord, see *Kuânersôq* or *Kvaneffjord*, Frhb. D.

R

Ravns Storø, Ghb. D., 134.

S

Sadelen, see *Sadlen* or *Sermitsiaq*, Ghb. D.
Sadlen or *Sermitsiaq* (Sadelen, Sermeitsiak, Sermetsiak), Ghb. D., 151-154, 179.

Sadlok, see *Sárdloq*, Ghb. D.

Sánerut (Sennerut), Frhb. D., 77, 78, 79, 82.

Sangmissoq, see *Sangmissorssúp qáva*, Ghb. D.

Sangmissorssúp qáva, (Sangmissoq), 139.

Sárdloq (Sadlok), Ghb. D., 158.

Sarfarfik glacier, *Núgssuaq* peninsula, 180.

Sarkarigsok, see *Sarqarigssooq*, *Frederikshaabs Isblink*, Frhb. D.

Sarkarssuak, see *Sarqarssuaq*, Ghb. D.

Sarqarigssooq (Sarkarigsok), *Qegka*, *Frederikshaabs Isblink*, Frhb. D., 125, 126, 127.

Sarqarssuaq (Sarkarssuak), Ghb. D., 158, 163.

Sennerut, see *Sánerut*, Frhb. D.

Sermeitsiak, see *Sadlen* or *Sermitsiaq*, Ghb. D.

Sermeliarsuk, see *Sermiligárssuk*, Frhb. D.

Sermeq (Arsuk glacier), Frhb. D., 77, 92-102, 180, 183.

Sermeq, Sdr. Sermilik, Jhb. D., 30-33.

Sermeq (Sermilik glacier), Frhb. D., 106-112.

Sermeq, *Tasermiut*, Jhb. D., 11, 12-27, 180.

Sermersok, see *Sermersóg*, Jhb. D.

Sermersóg (Sermersok, Sermesok), Jhb. D., 28-30, 45.

Sermesok, see *Sermersóg*, Jhb. D.

Sermetsiak, see *Sermitsiaq* or *Sadlen*, Ghb. D.

Sermiliarsuk, see *Sermiligárssuk*, Frhb. D.

Sermiligárssuk (Sermeliarsuk, Sermiliarsuk, Sermiligatsiakfjord?), Frhb. D., 102-106, 108, 109.

Sermiligatsiakfjord (*Sermiligárssuk?*), Frhb. D., 104.

Sermilik, Ghb. D., 134, 136, 137-140, 183.

Sermilik (Narksaliks fjord, Narssaliks fjord), Frhb. D., 106-112.

Sermilik (Nrdr. (northern) Sermilik, Sermiliks fjord, Sermilikfjord), Jhb. D., 48, 51, 52, 53, 54, 56, 64, 65, 68, 69.

Sermilik (Sdr. (southern) Sermilik), Jhb. D., 14, 30-33, 178.

Sermilik (Sermitsialik), Jhb. D., 68, 71-74, 75, 181.

Sermilik, trading station, Ghb. D., 138.

Sermilik avangnardleq (Avangnardleq), *Kvanefjord* or *Kúanersóg*, Frhb. D., 77, 112-118.

Sermilik glacier, see *Sermeq*, Frhb. D.

Sermilikfjord, see *Sermilik* (Nrdr. Sermilik), Jhb. D.

Sermiliks fjord, see *Sermilik* (Nrdr. Sermilik), Jhb. D.

Sermilitiak, see *Sermitsiaq*, Jhb. D.

Sermitsialik, see *Sermilik*, Jhb. D.

Sermitsiaq or *Sadlen*, (Sadelen, Sermeitsiak, Sermetsiak), Ghb. D., 151-154, 179.

Sermitsiaq (Sermilitiak), *Tasermiut*, Jhb. D., 12-27, 179, 181, 183.

Sigsardlugtoq (Sisardlutok), Jhb. D., 69.

Simiutaq, Jhb. D., 45.

Simiutarssuaq, Ghb. D., 139.

Siorak, see *Sioraq*, Jhb. D.

Sioralik, *Sermiligárssuk*, Frhb. D., 77, 102-106.

Sioraq (Siorak), Jhb. D., 75-76.

Sisardlutok, see *Sigsardlugtoq*, Jhb. D.

Sisiserateq(?), Ghb. D., 136.

Snæfjæld, see *Frederikshaabs Isblink*, Frhb.-Ghb. D.

Spitzbergen, 107, 184.

Statenhuk, see *Kap Farvel*, Jhb. D.

Steenstrups Fjæld, Jhb. D., 46, 47.

Storø or *Qegertarssuaq*, Ghb. D., 155.

Søndre(Sdr.)Sermilik, see *Sermilik*, Jhb. D.

Søndre Strømfjord, 161.

Sukkertoppen, 125.

Sweden, 127.

T

Taseq atdleq, Frhb. D., 125, 126, 129, 131.

Taseq, *Ilmaussaq*, Jhb. D., 46, 47.

Tasermiut (Tessermiut), Jhb. D., 11, 12
-27, 31.
Taserssuaq, see *Atarngup tasia*, or *Blind-
tarmen*, Frhb. D.
Taserssuaq, see *Kangárssúp taserssua*,
Frederikshaabs Isblink, Frhb. D.
Tasiussak, see *Tasiussaq*, Jhb. D.
Tasiussaq (Tasiussak), Jhb. D., 51, 53,
55.
Tessermiut, see *Tasermiut*.
Thule, 181.
Tigssaluk, Frhb. D., 104.
Tindingen (Kingigtoq), Frhb. D., 102,
103, 104.
Tiningnertôq (Tinninnertok), Jhb. D., 13.
Tiningnertôq, Frhb. D., 124, 125, 126,
129, 131.
Tinninnertok, see *Tiningnertôq*, Jhb. D.
Toogdleronæt, see *Tugdlerúnat*, Jhb. D.
Torssukatak, Jhb. D., 71.
Tugdlerúnat (Toogdleronæt), Jhb. D., 69.
Tugtôtôq (Tugtutok, Tuktotook), Jhb. D.,
69, 70.
Tugtutok, see *Tugtôtôq*, Jhb. D.
Tuktotook, see *Tugtôtôq*, Jhb. D.
Tulugartalík, Frhb. D.-Ghb. D., 128,
132.
Tunugliarbik, see *Tunugdliarfik*, Jhb. D.
Tunugdliarfik (Eriksfjord, Tunugdliar-
bik), Jhb. D., 36, 46, 52, 53, 56.

U

Uiluit kuat (Uiluvik, Oidlovet), Jhb. D.,
13.
Uiluvik, see *Uiluit kuat*, Jhb. D.
Ujarachsuach, see *Ujaragssuit pávat*,
Ghb. D.
Ujarachsuack, see *Ujaragssuit pávat*,
Ghb. D.
Ujaragssuit, see *Ujaragssuit pávat*, Ghb.
D.
Ujaragssuit pávat (Ujarachsuach, Uja-
rachsuack, Ujaragssuit, Ujararsoak),
Ghb. D., 139, 142, 152, 156, 165, 170-
174, 182, 183.
Ujararsoak, see *Ujaragssuit pávat*, Ghb. D.
Ukívisoqaq (Okevisokak), Jhb. D., 69.
Ulúnguarssuaq, Jhb. D., 55.
Umanak, see *Ūmánaq*, Frhb. D.
Ūmánaq (Umanak), Frhb. D., 79.
Umívik, Ghb. D., 157, 158, 161, 163.
Ūnartoq, Jhb. D., 30.

W

Witte Blink, see *Frederikshaabs Isblink*,
Frhb.-Ghb. D.

Ø

Østerbygd, Jhb. D., 6, 120, 121, 178.
 Østfjordsdal, see *Kujatdliup kúa* (Ku-
jatldeq valley), Jhb. D.

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