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A GEOLOGICAL RECONNAISSANCE OF THE SOUTHERN PART OF THE SVARTENHUK PENINSULA WEST GREENLAND

BY

ALFRED ROSENKRANTZ,
ARNE NOE-NYGAARD, HELGE GRY, SOLE MUNCK
AND DAN LAURSEN

WITH 32 FIGURES IN THE TEXT AND 5 PLATES

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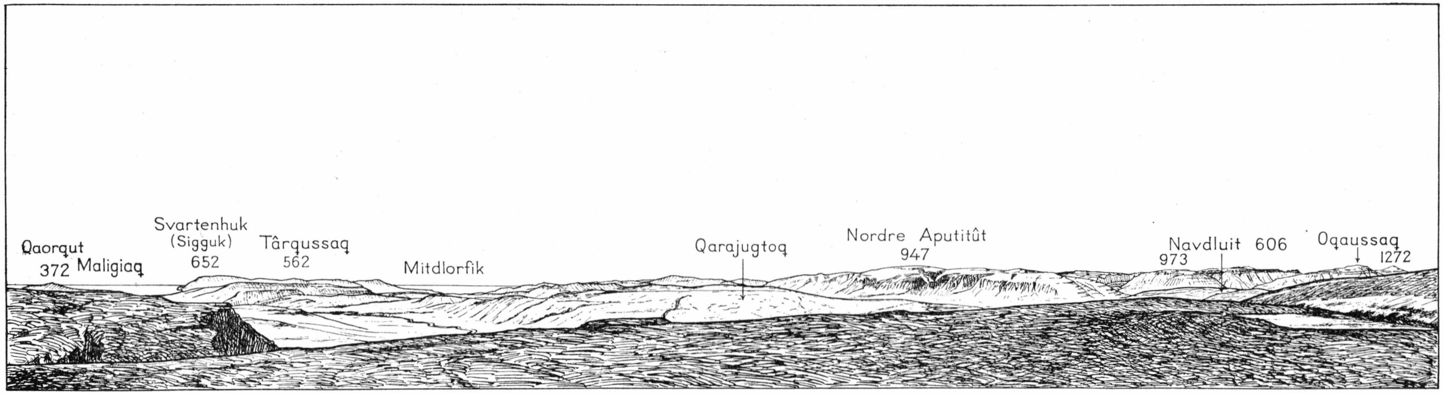


After a sketch by A. ROSENKRANTZ 13/8 1939.

Fig. 1. Panoramic view of the central part of the Svartenhuk peninsula seen from the southern slope of Søndre Aputitût at an altitude of about 700 m. The mountains all consist of plateau basalt.

INTRODUCTION

BY

ALFRED ROSENKRANTZ

The entirely uninhabited Svartenhuk peninsula, about 5000 km² in extent and situated between 71°20′ and 72°20′ lat. N., is one of the regions of West Greenland to which, from a geological point of view, least attention has been paid. The working program of the Danish Nûgssuaq Expedition, 1939, consequently included a reconnaissance of the southern part of this peninsula (south of 72°), a detailed topographical map of which (1:250.000) had before then been published by the Danish Geodetical Institute (71. V. I.). In the following the members of this reconnoitring trip will render an account of the results obtained in connection with the geological map accompanying the present publication.

The reconnaissance of southern Svartenhuk took place in the days August 11—15th, 1939. It was undertaken by SOLE MUNCK, M. Sc. and Dr. ARNE NOE-NYGAARD, who carried on investigations of the Pre-Cambrian phyllite formation round the Kangiussap imâ fjord and the basalt formation along the southern and eastern coasts of the peninsula and on Schades Øer. Dr. HELGE GRY, assisted by the Greenlander SVEN MARKUSSEN, studied the Pre-Quaternary sediments on the Itsako peninsula and collected samples of sand from delta deposits on the southern and eastern shores of Svartenhuk. DAN LAURSEN, M. Sc. carried on investigations of the Quaternary formation, particularly of elevated, marine shell beds in the Kugssineq valley in the south-western part of Svartenhuk; and also, together with the writer of this introduction and the Greenlander ANDREAS TOBIASSEN, walked through the interior of the peninsula from the mouth of the Kugssineq river across the mountain Søndre Aputitût to the large valley, which cuts through the central part of the peninsula in a direction west-east from the promontory Svartenhuk to the Umîvik bay, the great valley being traversed towards the east along the Usuit kûat river to Umîvik. The three parties of geologists were supported in their work by the motor boat of the expedition "C. C. G. Andræ", which was placed at our disposal by the Danish Geodetical Institute and was piloted by the mate Jens Olsen, assisted by the Greenlanders Ephraim Olsen and Søren Kleist.

The situation of anchorages and land-routes traversed appears from the map fig. 10. The geographical names used in the text are to be found on this map, on plate 4 or on the map 71. V. I. of the Danish Geodetical Institute; with a few exceptions the names in the text are in agreement with the nomenclature of the official map 71. V.I.

PREVIOUS INVESTIGATIONS

BY

ALFRED ROSENKRANTZ

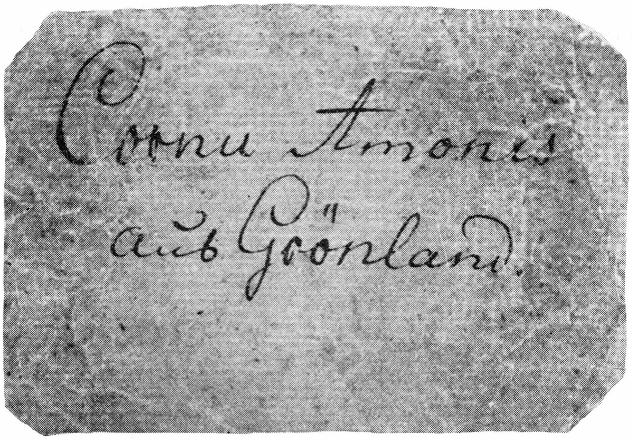
A number of expeditions have, in the course of years, been ashore at Svartenhuk, but only very few have brought home material which was of interest from a geological point of view. Still it seems as if the very first geological objects brought to Europe from Greenland originate from this peninsula.

In 1939 the Nûgssuaq Expedition succeeded in finding a marine series of beds (see p. 37) at the southern side of the Umîvik bay on the east coast of Svartenhuk, which beds contained an ammonite fauna in a peculiar state of preservation. This find threw light on a problem, which has repeatedly been made subject to literary treatment, viz. the problem of the place of origin of five ammonites (see plate 1), which for many years have been kept in the museums of Copenhagen, labelled "Cornu Amonis aus Grönland".

J. P. J. RAVN (**24**, p. 326) who has attempted to unravel the history of these ammonites points out that they originally belonged to a collection of shells brought together by the German malacologist SPENGLER. In 1804 it was purchased by the Royal Museum of Natural History at Copenhagen, and from here three of them were in 1853 transferred to the Mineralogical Museum, where they have been since then, while the remaining two were transferred to the same place in 1931. According to RAVN the original label (fig. 2) is undoubtedly written by SPENGLER, and Professor R. SPÄRCK, who has kindly examined it, is decidedly of the opinion that the writing is that of SPENGLER.

It is not possible to trace the history of these ammonites farther back than to prove that they belonged to the SPENGLER collection, into which they were presumably incorporated at some time towards the end of the 18th century. It is probable that, as suggested by RAVN, they have been brought to Europe by whalers. For that matter RAVN is not of the opinion that they originate from Greenland proper, but rather that they have been brought home from Spitzbergen, which in older times was frequently looked upon as forming part of Greenland.

TH. HOFF (**12**, p .295) regarded the ammonites as Jurassic. O. HEER ("Flora fossilis arctica" Zürich 1868. p. 45) was of the opinion that they were macrocephalites. VICTOR MADSEN (**15**, p. 49) hints at the possibility of their being scaphites. RAVN does not express any opinion on the subject. During a stay in London in 1932, I was able to establish with



CHR. HALKIER phot.

Fig. 2. SPENGLER's original label belonging to the Greenland ammonites collected in the 18th century or still earlier.

certainty that the ammonites belonged to the genus *Scaphites*, and Dr. L. F. SPATH, who was kind enough to review the ammonites, confirmed the correctness of my determination.

If the ammonites had been macrocephalites, areas such as East Greenland, Spitzbergen and Franz Joseph Land might be taken into consideration as their possible place of origin, but from here no beds carrying scaphites are known.

However, the finds made in 1939 on Svartenhuk bear out the truth of the label of SPENGLER. The state of preservation is exactly the same in the older and the new material, and further it may be proved that the ammonites collected more than a century ago, however incomplete, are specifically identical with the new material and belong to a species of the *Scaphites ventricosus* group.

From the Umîvik bay a sediment area comprising the Itsako peninsula extends in a north-westerly direction as far as the Umîarfik fjord, and the possibility can naturally not be precluded that ammonites of the same species and in the same state of preservation as those which we found at Umîvik may occur in several localities within this region. When I am nevertheless inclined to think that Umîvik is the place, where the SPENGLER ammonites were found, it is partly owing to the fact that this locality is easily accessible, and partly that there can hardly be any doubt that the bay was known and used by whalers of the olden times. Thus, the Greenland name Arfersiorfik, which is associated with the part of Umîvik situated along the coast of Itsako, means the whaling place.

Even though there is some uncertainty as to the exact locality, where the SPENGLER ammonites were found, there can hardly be any doubt that they originate from Svartenhuk. The other West Greenland areas with marine Cretaceous may be said to be very well known by now, and they have never supplied ammonites of the same species and in the peculiar state of preservation, which distinguishes the Svartenhuk finds.

The first literary record of the geology of Svartenhuk deals with the basalt formation, which plays a much greater part in the construction of the peninsula than the deposits of marine Cretaceous, the latter in reality only in 1939 attracting the attention of geologists.

The first to give information of the Svartenhuk basalt formation was K. L. GIESECKE, who in 1807 on July 11th and on the return journey on July 29th passed the Svartenhuk peninsula (**9**, p. 60 and p. 69) without making any landing. In a treatise from 1816 (**7**) GIESECKE, dealing with the Flætz-trap formation, writes that this formation i. a. "extends over a part of the continental coast of Greenland, viz., London Coast, Svartenhuk . ." In a paper published in 1821 GIESECKE (**8**, p. 2) however says: "Beyond the Bay of St. James, towards the great Northern Cape called Svartenhuk, the Flætz-trap is interrupted, either by the Primitive rocks, or by an immense plain covered with alluvial soil. Svartenhuk is composed of a granitic rock, with large beds of micaceous schistus, mixed with small garnets, In the adjacent bay, called Hytten, the Flætz-trap shows itself in small hills, resting on a bed of sandstone, in which bituminous wood occurs." GIESECKE's description[1]) of the cape Svartenhuk, the correctness of which has never been confirmed, can not have been founded upon personal inspection. Nothing is to be found in GIESECKE's diary (**9**) about the geology of this cape, and this also applies to the bay "Hytten" which, according to the description, may be the bay Maligiaq.

H. RINK, who however did not go ashore on the peninsula, but

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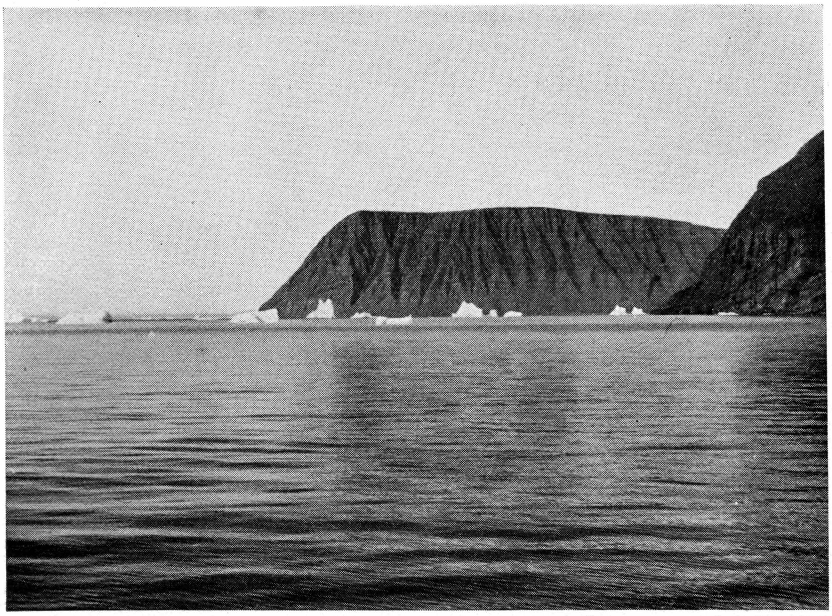
[1]) A somewhat similar description, which likewise has not been confirmed, has been given by GIESECKE in his diary (**9**, p. 347) concerning the outermost point of the land at the outpost Nûgssuaq on the Nûgssuaq peninsula.

studied it, when passing by on a vessel in 1848 and 1849, published in 1852 (**26**) the first existing geological map of Svartenhuk (fig. 3), which shows that the whole peninsula consists of basalt with subordinate

Fig. 3. RINK's map published 1852 showing the Svartenhuk peninsula to the north. The text on the map runs as follows: General map of the Geology. The hatching indicates trap connected with sandstones containing coal beds. The remaining part of the country consists of gneiss and granitic rocks.

strata of sandstone and coal beds; these strata RINK regards as being closely associated with the basalt formation. In the text (p. 20) he observes that (translation) "the peninsula is almost entirely occupied by the trap formation; in the whole of the southern part it does not attain any considerable heights, but as viewed from the sea practically no ice is visible along the shore south of and round Svartenhuk [i. e. the cape marking the westernmost point of the peninsula]. The mountains slope down gradually, leaving room for large valleys which extend into



A. ROSENKRANTZ phot. 11/8 1939.

Fig. 4. Kap Cranstown at the southwestern corner of the Svartenhuk peninsula. Plateau basalt dipping towards southwest.

the interior of the country; not until Skaløen and to the north of the same considerable ice-covered plateaux again make their appearance along the coast." Whereas RINK, as already mentioned, did not study the conditions on Svartenhuk at close quarters, he visited the peninsula of Ingnerit, just north of Svartenhuk, where the basalt formation overlies beds of coal-bearing sediments, and other regions north of Svartenhuk.

P. C. SUTHERLAND (**34**, p. 296) in 1853 mentions, among other localities, that in the neighbourhood of the Black Hook (= Svartenhuk cape) on the 72nd parallel of latitude coal (lignite) has been found, thus confirming the statement of GIESECKE 1821. Coal occurences at the Svartenhuk cape has not been mentioned by later explorers, but the occurrences may possibly be intrabasaltic. Coal beds in this position are known from the island of Hareøen and the north-western part of the Nûgssuaq peninsula. In the same treatise SUTHERLAND reports: "At Cape Cranstoune [the south-western point of the Svartenhuk peninsula, see fig. 4], situated on the north side of North-east Bay (Omenak Fjord) .... the trap-rocks again occur, and thence extend northward apparently in one unbroken series, as far as Proven, in lat. 72°20′."

In the years 1878 and 1879 K. J. V. STEENSTRUP (**31**, **32** and **33**) investigated and mapped all the coast stretches of Svartenhuk, which he traversed in a Greenland umiak (ɔ: women's boat). Thus, the first detailed survey of the geology of the country was brought into being, and on this solid foundation we were able to carry on our work in 1939.

Starting from the outpost Igdlorssuit on Ubekendt Ejland STEENSTRUP in the days of July 18th—August 7th traversed Schades Øer and the east coast of Svartenhuk from Manîserqut to the head of Uvkusigssat Fjord, and from there he made a long trip on foot in a northern direction. STEENSTRUP found the mountains along the banks of Uvkusigssat Fjord to be composed of phyllites and gneiss, in the northern part overlain by plateau basalt. On the peninsula of Itsako the phyllites at Serfarssuit were overlain by coal-bearing sandstones and shales, and somewhat farther south in the uppermost bed of sediments he found a flora, which HEER (**10**, p. 188) regarded as contemporaneous with the Upper Atanikerdluk flora from Nûgssuaq. At the head of the Umîvik bay STEENSTRUP found a mountain, 2640′ high and entirely composed of basalt breccia, which in its lower parts seems to overlie shales. On the map of the Geodetical Institute this mountain is named Firefjæld (after its four distinct peaks (see fig. 23, p. 49)). It was possible to trace the basalt breccia along the south coast of Umîvik and farther south, as far as Igpik; along the whole of this distance it is overlain by plateau basalt. Moreover he found basalt breccia on the small islands Schades Øer.

On June 27th 1879 STEENSTRUP left Igdlorssuit and arrived via Schades Øer at Uvdlisaut on the southern coast of Svartenhuk. From here he passed along the coast in a westerly direction round Kap Cranstown (Qingnivik) and the promontory of Svartenhuk (Sigguk) and farther on as far as the head of the Umîarfik fjord, where he achieved a contact with the investigations of 1878, only a narrow strip of land dividing the head of Umîarfik from the head of the Uvkusigssat fjord. Along the whole of this stretch of land, as far as some distance into the Umiarfik fjord, STEENSTRUP ascertained that the country was composed of plateau basalt, which as a rule has a southwestern or western dip. In the valley which debouches into the Umîarfik fjord, and through which the river Simiútap kûa flows, STEENSTRUP observed, under the plateau basalt, sediments which seemed to be of the same kind as those on Itsako, but he could not subject them to a closer investigation, as the route followed lay along the northern coast of the fjord. Farther into the Umîarfik fjord the plateau basalt rests on gneiss, conditions thus being entirely identical with those on the eastern coast of Svartenhuk. On July 20th STEENSTRUP left the Umîarfik fjord and continued northwards.

K. J. V. STEENSTRUP's map from 1883 has made the foundation of a number of geological maps of Greenland. Of these may i. a. be men-

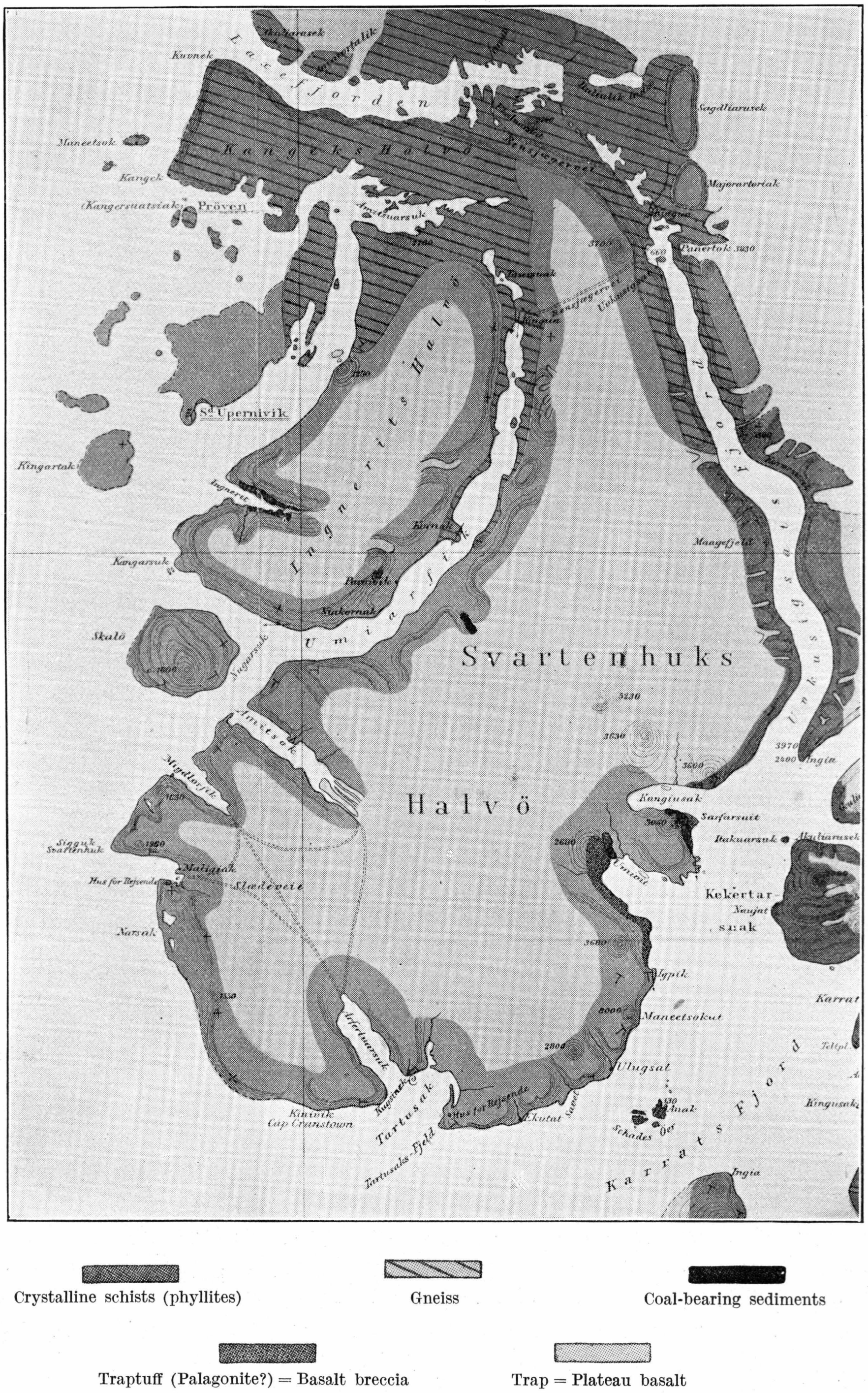


Fig. 5. Part of the geological map published by K. J. V. Steenstrup in 1883 showing the Svartenhuk peninsula and surroundings.

tioned the maps published by O. B. BØGGILD: 1917 (**1**, p. 24), 1921 (**2**, plate II) and 1928 (**3**, p. 244), and further the map published by H. K. E. KRUEGER 1928 (**14**). These presentations of the geology of Svartenhuk, however, offer nothing new.

In 1928 LAUGE KOCH visited the Umanak fjord, as well as the waters east of Svartenhuk. In the course of this journey he succeeded in proving the existence of a new sediment area on the eastern coast of the island of Qeqertarssuaq, but further details regarding the voyage in this area are lacking. It is doubtful whether KOCH has undertaken investigations ashore on Svartenhuk. Two maps which were published by him in 1929 (**13**, p. 301), and which are here reproduced as figs. 6 and 7 deviate on certain points from STEENSTRUP's maps, but our investigations in 1939 did not confirm the alterations made. The maps must consequently, as far as Svartenhuk is concerned, presumably be regarded as less careful reproductions of STEENSTRUP's map. The following deviations from this map may be mentioned:

1) A sediment area immediately north of Kangiussap imâ.
2) No sediments recorded from Itsako.
3) Basalt breccia at the south-eastern corner of Itsako.
4) No basalt breccia and sediments at the head of Umîvik.

Otherwise, in accordance with RINK's map, the interior of Svartenhuk has been mapped as consisting of plateau basalt. Besides the signature of the geological formations a Cretaceous coast line (see fig. 6) and a fault line (see fig. 7) have been drawn in on KOCH's map, both lines cutting right across the peninsula. The justification of these lines will be discussed in a subsequent chapter (see p. 69).

In 1929 the German geologist H. K. E. KRUEGER, accompanied by the petrologists F. K. DRESCHER and H. NIELAND and the Danish interpreter J. BJARRE, made a trip on foot across Svartenhuk from Umîvik to Arfertuarssuk Fjord. The exact route of this expedition, which was part of the Second Hessian Greenland-Expedition, is not indicated in NIELAND's account of the journey (**19**), but the line followed was probably somewhat like the one indicated on fig. 10.

The journey itself is described in the following words:

"Am 22. Juni wurde der Umivik-Fjord an der Ostküste der Halbinsel Svartenhuk erreicht und vom 24.—28. die in diesem Teil wohl noch nie von Europäern betretene Halbinsel nach dem Arfertuarsuak-Fjord hin durchquert. Es würde hierbei ein Stickmarsch bis in Sicht der W-Küste eingeschaltet. Das Unternehmen war schwierig, da uns die Schneeschmelze überraschte und ungezählte Wasserläufe zu reissenden Eisströmen wurden, die durchquert mussten. Fast unerträglich war die Moskitoplage. Der mittlere Teil der Halbinsel weist viele Aehn-

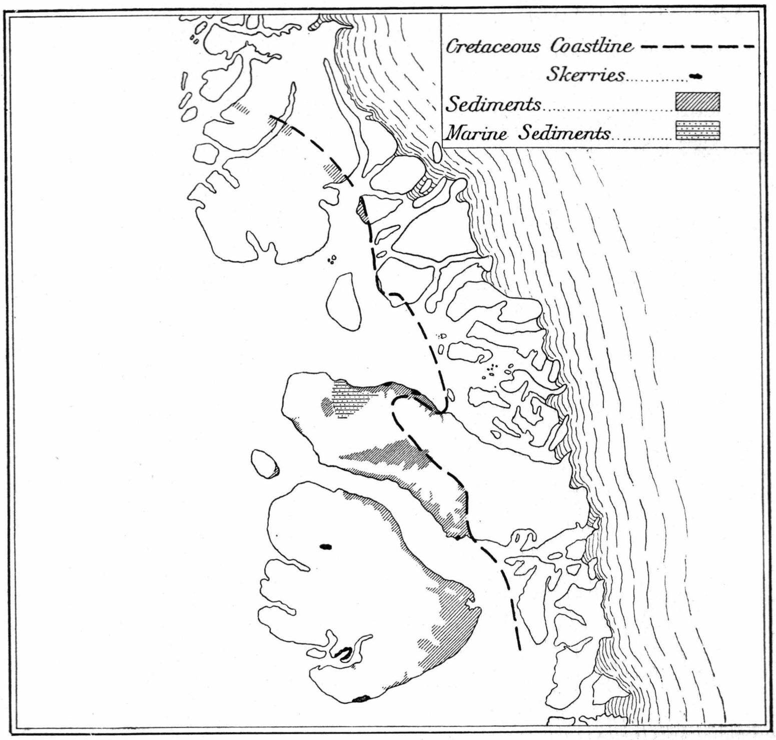


Fig. 6. Geological map of Disko and the Umanak district with the Svartenhuk peninsula to the north. After Lauge Koch 1929.

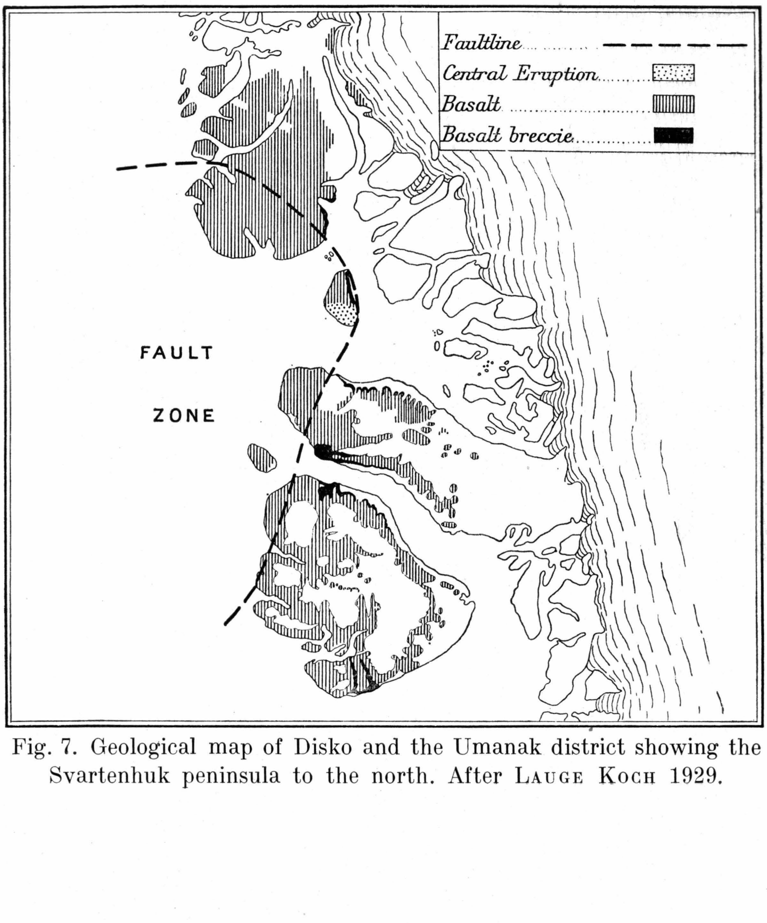


Fig. 7. Geological map of Disko and the Umanak district showing the Svartenhuk peninsula to the north. After Lauge Koch 1929.

lichkeiten mit Disko auf, beide sind von Basaltströmen aufgebaut. Der Moränenboden der Täler gab gute Gelegenheit zum Studien von Struckturböden."

Besides this report the only information as to the geological results of this expedition consists in two rock analyses, published by NIELAND (**20**).

This completes the list of all the geological data concerning the geology of Svartenhuk which were on record until 1939, when the Danish Nûgssuaq Expedition continued the geological exploration of the peninsula.

A. ROSENKRANTZ phot. 14/8 1939.

Fig. 8. The mountain Navdluit seen from the east. It does not appear as regular as it is shown in the topographical map and consists of plateau basalt dipping southwest. In the background the mountain Nordre Aputitût.

INVESTIGATIONS IN 1939

BY

ALFRED ROSENKRANTZ

The plan which we followed in our work, and which was based upon all the information available regarding the geology of Svartenhuk and the new topographical map (71. V. 1.), consisted of a thorough investigation of the east coast. Here we knew from STEENSTRUP's investigations that many formations were represented, and consequently an investigation of this kind would materially help towards a comparison with the corresponding formations on the Nûgssuaq peninsula, which was the chief working area of the expedition. In connection with these investigations an exploration of the south coast and Schades Øer was undertaken, as well as a walking trip through the interior of the peninsula. In 1939 we did not know the exact travelling route followed by the Second Hessian Expedition; if we had known it, we would probably have laid the east-westerly part of our own route through the region north of the Usuit kûat valley, but in that case we would hardly have discovered two things, which seem to have escaped the attention of the Germans, viz. the marine Cretaceous on the south side of the

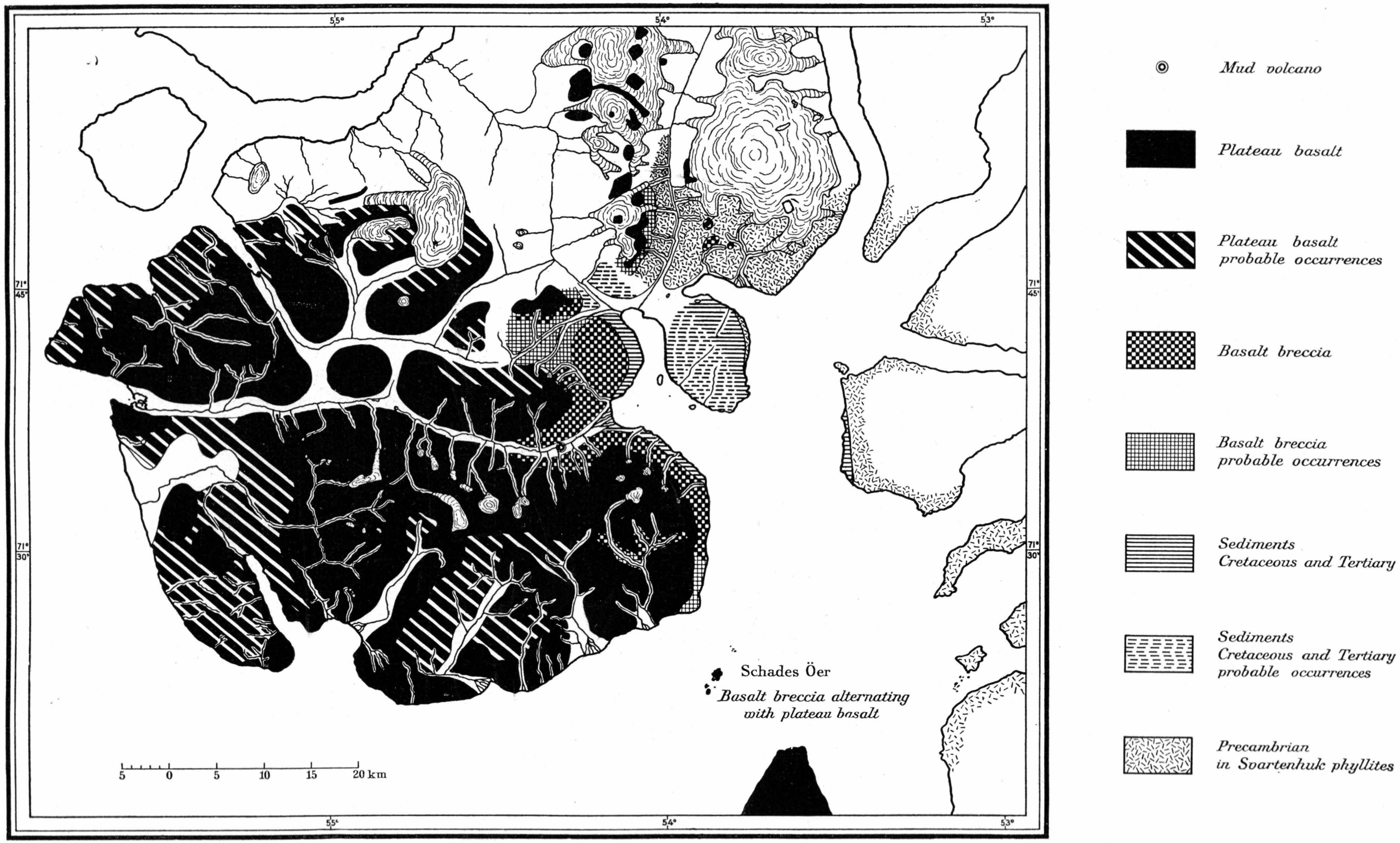

55°
54°
53°
71° 45'
71° 30'
Schades Öer
Basalt breccia alternating with plateau basalt
5 0 5 10 15 20 km
Mud volcano
Plateau basalt
Plateau basalt probable occurrences
Basalt breccia
Basalt breccia probable occurrences
Sediments Cretaceous and Tertiary
Sediments Cretaceous and Tertiary probable occurrences
Precambrian in Svartenhuk phyllites

Fig. 9.

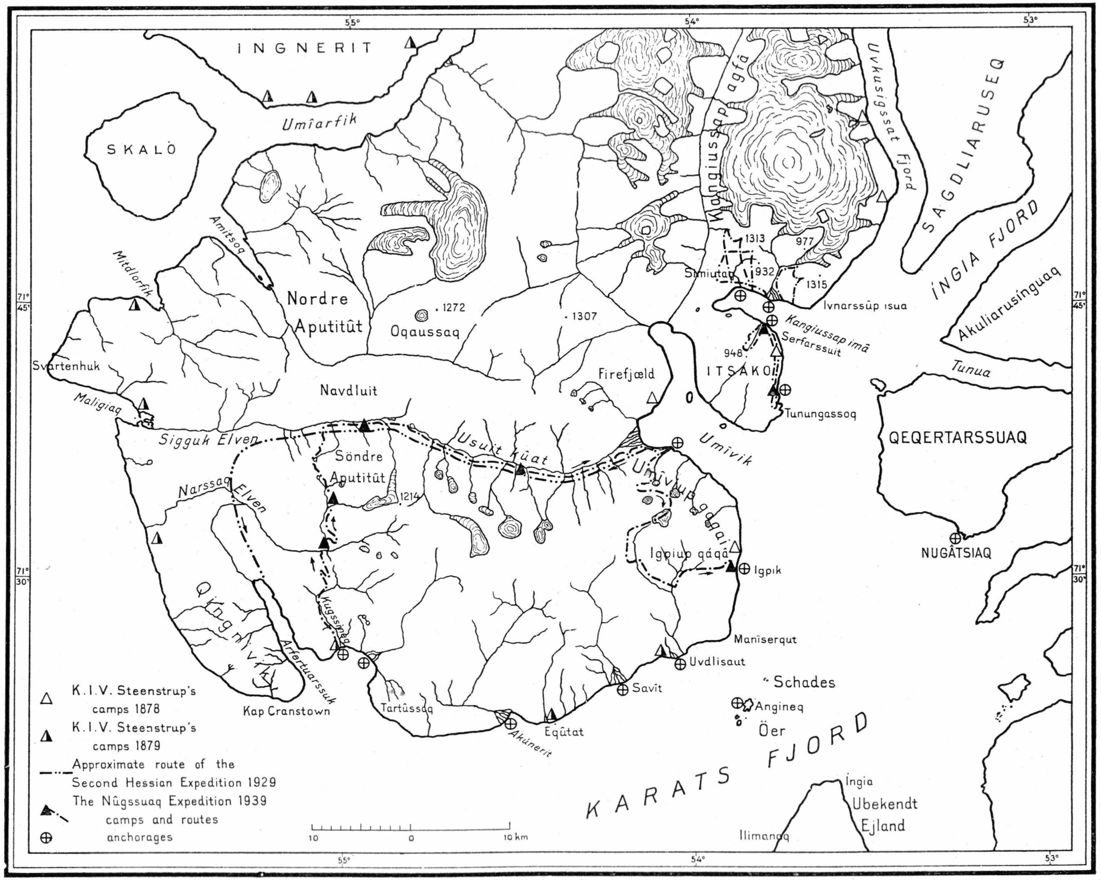


Fig. 10.

Fig. 9. Geological map of southern Svartenhuk, compiled by the members of the Nûgssuaq Expedition 1939, drawn by A. Rosenkrantz.

Fig. 10. Map showing the travelling routes, camps and anchorages of the Nûgssuaq Expedition 1939.

Umîvik bay and a mud volcano in the Usuit kûat valley. The object of the trip on foot through the interior of the peninsula was partly to find out, whether in the valleys sediments were visible under the basalt, partly to obtain a sample series of the basalt sheets and information as to the structure of the basalt plateau. As a special aim may be mentioned an investigation of the mountain Navdluit in the central part of the peninsula, on the topographical map appearing as a regularly shaped cupula, which might be presumed to be a lava dome. Our investigations, however, proved that the mountain consists of normal plateau basalt (fig. 8). A number of detail problems are still awaiting their solution, but the result of the reconnaissance made gives a general picture of the geological structure of the southern part of Svartenhuk, an account of which will be rendered in the following.

THE PRE-CAMBRIAN PHYLLITE FORMATION

BY

ARNE NOE-NYGAARD

Introduction.

In the preliminary report on the results of the Nûgssuaq Expedition, 1939, (**27**) a brief account has been rendered of conditions in the Pre-Cambrian formations in the Umanak fjord area. The object of the following pages is not to treat them more exhaustively, the work carried on in the field being still too sporadic for that purpose, but only to describe a single area of south-eastern Svartenhuk, which lies within the scope of our map, and which was exclusively composed of the phyllite formation discovered and described by K. J. V. STEENSTRUP (**31**). This is all the more requisite, because microscopical data from this section of the North-west Greenland Pre-Cambrian have hitherto been lacking, while the southern part of the formation has been described in somewhat greater detail by H. KRUEGER (**14**).

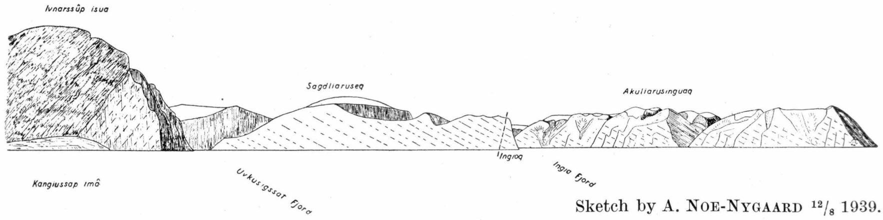
According to STEENSTRUP (**31**) the Pre-Cambrian of the Umanak fjord is divided into three sections, viz. 1) a southerly section of gneiss with amphibolite bands and marble; 2) north of this, and presumably overlying the latter section, a phyllite series several thousand metres thick, and 3) farthest north—in the Uvkusigssat fjord—the phyllite passes into gneiss which STEENSTRUP regards as younger than the phyllite, and so also presumably younger than the southern gneiss section. The "Agpat formation", which was at a later period established by KRUEGER, consists, as far as we have been able to ascertain, only of a part of the southerly gneiss section, and he neither deals with the phyllite series nor with the northern gneiss section. The signatures of phyllite represented on his map, and also the signatures of dip and strike have been adopted from STEENSTRUP's map (p. 13).

Our investigations comprise in the main the area between Ivnarssûp isua and Kangiussap agfâ on the northern side of Kangiussap imâ: further, we were ashore on the north-eastern corner of the Itsako peninsula at Serfarssuit.

Erratic material originating from the phyllite series—presumably washed-out morainic material—has been met with in the delta of the Kugssineq river at the south-western corner of Svartenhuk, at Uvdlisaut in the south-eastern corner, in the Usuit kûat valley and on Schades Øer, in other words, in most of the places visited by us.

Sagdliaruseq-Akuliarusinguaq.

Even though the time set apart for the reconnaissance of Svartenhuk did not permit us to extend our area of investigation, we were able to take a number of long-distance observations on these peninsulas, which, as far as we could judge, have a structure which quite corresponds



Sketch by A. NOE-NYGAARD 12/8 1939.

Fig. 11. Panoramic view showing the cape Ivnarssûp isua (Svartenhuk) and the Sagdliaruseq and Akulíarusinguaq peninsulas seen from Kangiussap imâ due north of Serfarssuit. The mountains consist of phyllite dipping in a southerly direction.

with that of the area north of Kangiussap imâ. The sketch fig. 11 is taken from a place between Ivnarssûp isua and Serfarssuit towards the east. The mountains are composed of rocks of uniform appearance, with a distinct southerly (southwesterly?) dip. Right behind the promontory Íngioq on Sagdliaruseq there is a smaller fault. The signatures of dip and strike indicated by STEENSTRUP (**31**) are confirmed by our observations.

The northern coast of Kangiussap imâ.

The rocks are very uniform in character from the most westerly point of observation in the western flank of the 1313 m mountain (fig. 19, p. 45) in the Kangiussap agfâ valley via Simiutaq, the 932 m mountain (fig. 18, p. 44), to Ivnarssûp isua (fig. 11). The dip in the 1313 m mountain is 58° due west, in the pass between this mountain and Simiutaq 54° west, in Simiutaq about 40° west and in the southern side of the 932 m mountain about 30° west.

The great valley, which divides the 932 m mountain from Ivnarssûp isua, follows the strike; thus its western side, with the finely and regularly bedded heads of the beds, reminds at a distance very much of plateau basalt; this is presumably the obvious reason, why the area west of the above-mentioned valley on STEENSTRUP's map (fig. 5, p. 13) has been marked with signatures of plateau basalt.

The mountain face in the north-eastern side of the same valley shows strata with a south-westerly dip, and the same holds good of Ivnarssûp isua. The angle of dip is between 30° and 40° S.W.

The total thickness of beds within the area investigated has an order of magnitude of about 4 km.

The rocks vary from more quartzitic to more phyllitic, and the colours change from light grey, greyish blue and brownish of various shades to nearly black. The schistocity is everywhere very pronounced. In the 932 m mountain it is possible to observe a grey to greyish blue rock, weathering in beds of from 25—30 cm up to several metres, these rocks being quartz-sericite-schists. In Ivnarssûp isua, where more phyllitic rocks predominate, the colours are generally black or brownish (as the result of the weathering of the grains of ore). Farthest west, in Simiutaq and in the 1313 m mountain, frequently interchanging, psammitic and pelitic beds are found; here also carbonatic strata play a part. As the series of rocks cannot be divided into natural divisions but interchange quite continuously, I shall give a description of the principal occurring types.

No. 2256. Quartz-actinolite-biotite-schist. Simiutaq.

This rock consists mainly of quartz grains of a size of about 0.1 mm—a few individuals attain 0.3 mm in length—and a mineral of the actinolite-tremolite group, which may attain a length of about 2 mm; this mineral is generally very irregular in shape and full of rounded quartzes. The plane of the optic axes is parallel to (010) and $c \Lambda \gamma$ varies from 14°—16°. α = pale yellow, β = pale yellowish green and γ = pale green. Biotite is found either as isolated grains or in parallel intergrowth with the actinolite. α = straw yellow and $\beta = \gamma$ = dark brown; the biotites seldom exceed 0.2 mm in length. The rock carries a considerable amount of titanite, generally with irregular outlines, and single grains attain a length of 0.4 mm. Also small irregular individuals of black ore and a few apatite-needles are found.

No. 2253. Quartz-actinolite-carbonate-schist. Simiutaq.

The rock is similar to no. 2256, but carries a considerable amount of calcite. The main constituents are quartz, actinolite and calcite, but a few individuals of microcline and plagioclase are also met with. Subordinate biotite, titanite, apatite and black ore occur. The actinolite attains a length of about 2 mm and has the same character as in no. 2256; the other constituents are considerably smaller, quartz about 0.1 mm and calcite varying from 0.1 to 0.4 mm.

No. 2261. Quartz-sericite-schist. North side of Kangiussap imâ.

The rock consists almost exclusively of quartz and sericite, but single individuals of microcline occur. The quartz grains, as a rule with an undulatory extinction, attain a length of 0.3—0.4 mm, the sericite-scales only about 0.2 mm; single scales of about 0.5 mm are, however, met with. A pronounced parallel arrangement of the composing minerals is seen. Of a considerably larger size, viz. up to 2 mm, are a few big, rounded microclines, which are penetrated by quartz-veins; the big microclines are generally encircled by parallel-grown sericite. Except for very little black ore the whole slide is colourless.

No. 2255. Quartz-actinolite-schist. North side of Kangiussap imâ.

The quartzes vary greatly in size, i. e. from less than 0.05 mm to about 0.4 mm. The fan-shaped actinolites have a parallel or sub-parallel arrangement in the rock, varying from 1.5 to 2.5 mm in length; they are pleochroic from almost colourless to pale green. The rock carries a good deal of titanite, generally automorphic, and some black ore of irregular shape.

No. 2254. Quartz-biotite-muscovite-schist.
East side of the 1313 m mountain.

The rock shows a pronounced schistosity. The biotites which are generally about 0.25 mm in size, may reach 0.5 mm in length; the biotite is pleochroic with α almost colourless and $\beta = \gamma =$ dirty brown; pleochroic haloes round minute zircones are common. The muscovites have a similar size, but are confined to certain layers. The greater part of the quartzes are less than 0.1 mm. The rock also contains some black ore, a few thin apatite-needles and a little chloritic material, which is colourless or exceedingly pale greenish.

No. 2266. Quartz-biotite-schist. Ivnarssûp isua.

The rock is rather fine-grained and has a marked schistosity; it contains a good deal of small carbonic particles and, locally, streaks of ore. The main constituents are quartz and biotite, but a little sericite occurs. Single bigger grains of quartz consist of a greater number of individuals.

The psammitic sediments predominate towards the west, the pelitic ones towards the east. In Ivnarssûp isua brownish and black colours are found predominating in the rocks, and further, in certain beds, there is here a rather pronounced impregnation of ore. Besides in the phyllite proper we find ore in white or brownish quartz veins, some metres in length and with a thickness varying from a few centimetres to about half a metre. The quartz veins have a very irregular course; they were particularly investigated in a rivulet flowing from the east, which debouches into the main river in the great valley in the central part of the northern side of Kangiussap imâ.

In the following a summary will be given of some of the most important species of rocks, first the phyllites impregnated with ore, and finally the ore-carrying quartz veins.

No. 2264. Ore-impregnated, phyllitic schist. Ivnarssûp isua.

A marked schistose, fine-grained phyllite with alternating bands of quartz, biotite and bands consisting of ore and carbonic matter; in the latter 0.5 mm long quartz-lenses consisting of several individuals are found. The biotite is pleochroic with α = colourless to straw-yellow and $\beta = \gamma$ = clear brown. A little sericite also occurs.

On polished slides in the ore-microscope the ore was identified as pyrrhotite with small grains of calcopyrite.

No. 2268. Ore-impregnated, phyllitic schist. Ivnarssûp isua.

Bands of quartz and biotite alternate with bands of ore and carbonic substance. In the ore reddish veins are seen. The biotite is of the same nature as in no. 2264, and also single grains of a dirty reddish garnet are seen. In places the quartzes are drawn out lenticularly. Besides in the bands with carbonic substance the ore is found as irregular lumps, together with biotite in the quartz-biotite layers. The ore is of the same nature as in no. 2264.

No. 2263. Ore-carrying quartz veins in phyllitic schists.
Ivnarssûp isua, east side.

The main constituent is quartz, further a good deal of biotite (fresh reddish brown) and a little reddish-brown garnet together with some chlorite is met with. The quartz has a pronounced undulatory extinction, and the larger individuals have a mortar structure. The ore, which in the cases investigated seems rather homogenous, is pyrrhotite.

Considered as a whole the phyllite-mica-schist series of south-eastern Svartenhuk gives the impression of being rather homogenous, and although it has been subjected to a regional-metamorphosis, it is remarkably well preserved as compared with the gneisses of the southern part of the Umanak fjord.

Whether the ore-impregnations have a more regional character or are only a local phenomenon, I do not venture to say; it is, however, evident that future investigators of these regions must have their attention directed also to this side of the geology of the area.

The Itsako peninsula.

As already indicated on Steenstrup's map (fig. 5, p. 13) the Pre-Cambrian strata crop out at the north-eastern corner of Itsako. Further, our photographs seem to open the possibility of similar rocks cropping out at the base of the peninsula towards north-northwest.

In the north-eastern corner of Itsako, at Serfarssuit, there is a series of beds of quite the same character as north of Kangiussap imâ. The dip is between 30° and 40° S.W. The rock here exposed is rich in quartz and contains a few grains of felspar and a good deal of carbonic matter. The colour is greyish.

There were no fixed igneous rocks whatsoever in the area investigated, but along the north coast of Kangiussap imâ there were numerous boulders of one and the same rock, viz. a coarse-grained diorite of a grey to a very pale reddish colour. The plagioclase of the diorite, which contains a small amount of quartz, is an andesine (the anorthite-contents vary from 34 to 40 $^0/_0$).

It is not improbable that this rock occurs intrusively in the folded Pre-Cambrian formations farther east and has been carried by the ice to the present locality.

At Uvdlisaut were further found a couple of boulders of the size of a fist, consisting of a red, conglomeratic sandstone, which neither resembles the Mesozoic sediments on Itsako nor the psammitic members of the phyllite formation. The rock is clearly stratified and contains fine-grained as well as coarse-grained beds; a specific character is a ferrugineous matrix. The conglomeratic beds contain small pebbles of granite of up to 1 cm in size. The chief part of the rock consists of quartz grains, slightly rounded, and in certain streaks there is a great number of parallel scales of sericite.

In this connection there is reason to call attention to a find of a similar kind of rock which Steenstrup made in the Qarajaq Icefjord (**32**, p. 11) and also in the Umanak fjord. He compares this species of rock with the red sandstone, which he knew from the Igaliko area. It seems to me an obvious conclusion that the three blocks originate from a larger or smaller remnant, left by the erosion of a possible continuation towards the south of the late Pre-Cambrian formation established by Lauge Koch (**13**), (see also S. Munck (**18**)), which formation occupies large areas to the north of the working field of the expedition. Whether such an area is hidden below the inland ice we cannot say for certain, but it seems more possible than that at any rate larger occurrences of rocks with the characteristic red colour are to be found within the ice-free parts of the numerous peninsulas and islands of the Umanak fjord.

THE CRETACEOUS AND TERTIARY SEDIMENTS ON ITSAKO

BY

HELGE GRY

The Itsako peninsula on the eastern side of Svartenhuk, which comprises about 100 km² and attains a height of 948 m, is composed of sediments overlying phyllites and traversed by numerous basalt dykes and sills.

Investigations were undertaken on the peninsula in the days August 12th—15th. During these days the east coast from Tunúngassoq to Serfarssuit and the north coast nearest Serfarssuit were visited. On the east coast the overlying of the phyllites by the series of sediments was observed, and on the north coast a section through the whole of the accessible part of the series of beds was made.

In this part of Itsako the series of sediments was traversed by 5—6 basalt sills (fig. 12) which, however, have a somewhat irregular course and, in some localities, cut through the beds of the series of sediments in the form of dykes. The Tunúngassoq headland in the southern part of the east coast of Itsako is composed of basalt, and it seems as if several basalt sills in this place descend to sea level.

The phyllite substratum is exposed in the north-eastern part of the peninsula. At the north-eastern headland, Serfarssuit, it reaches fully 150 m above sea level, and from here its surface dips both towards the south and towards the west. From a boat off the headland it is clearly visible that the phyllite surface—which here over a considerable distance is directly covered by a basalt sill—rather quickly inclines towards the west, down to sea level, so that no phyllite is exposed in the valleys, which cut inland on the north coast of Itsako (fig. 13). On the other hand, the phyllite seems to form a low foreland in front of the high sedimentary area farther northwest at the northern point of Itsako about the head of Kangiussap imâ. Also the small island in the centre of Kangiussap imâ, which is seen on fig. 13, seems to be composed of phyllite. It is to be presumed that these low phyllite areas have, in former times, been covered by sediments, later on eroded by the glacier, which has given Kangiusap imâ its present, form, and that the phyllite surface here more or less marks the position of the Pre-Cretaceous surface. A couple of kilometers south of Serfarssuit the phyllite has been observed in some ravines up to a height of about 140 m; on the other hand, the sediments farther south extend as far as sea level. North of Kangiussap imâ the phyllite attains a height of about 1300 m.

Observations of the altitudes of the phyllite surface on Itsako seems to suggest that the surface, on which the sediments were deposited,

Sketch by Helge Gry 12/8 1939.

Fig. 12. Western coast of Itsako viewed from Tunúngassoq towards the north as far as Serfarssuit. The foreground consists of dolerite, the phyllite at Serfarssuit being marked by crosses, sand and sandstone by dots, shales by lines. Basalt and dolerite sills stand out clearly.

has been faintly undulating, as was the case at Nûgssuaq (Heim (**11**, p. 185) and Gry (**27**, p. 656)). On the other hand there is, as will be mentioned later on, nothing in the character of the sediments which points towards Lauge Koch being right in his hypothesis that there has been a coast cliff north of the north coast of Kangiussap imâ (Koch (**13**, p. 300)).

The phyllite at Serfarssuit is dark-grey and fine-grained and contains quartz veins. The dip is 30—40° towards south and south-west.

The overlying of the phyllite by the sediments has been observed a couple of kilometers south of Serfarssuit. The series here begins with a bed of conglomerates, which is 10 m thick and is characteristic by its extremely large contents of phyllite and quartz pebbles. Moreover the lowermost part of the series of sediments chiefly consists of sand and sandstone, which in its general character suggests the fluviatile-lacustrine sediments at Kûk on the Nûgssuaq peninsula.

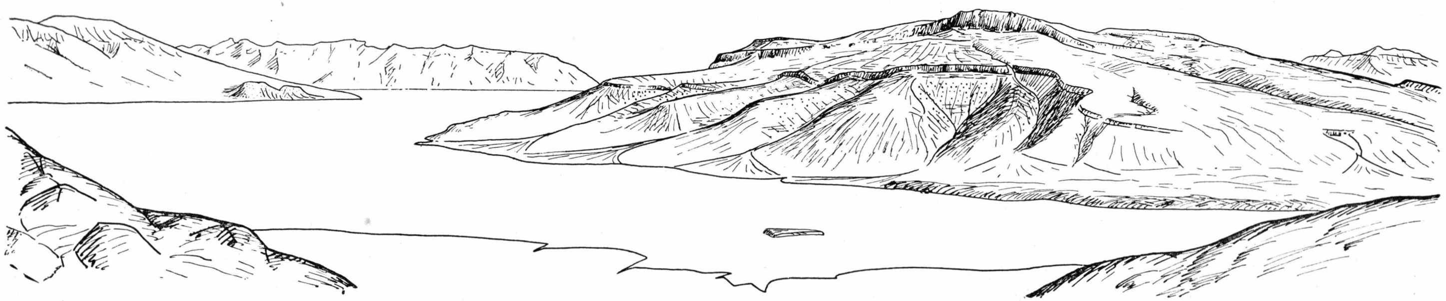
In the section which was measured on the northern side of Itsako the beds were nearly horizontal. The fluviatile-lacustrine series here reaches an altitude of 500 m and is, throughout the whole of its extent, characterized by the phyllite at the expense of which it is partly formed. The conglomeratic parts contain both phyllite and quartz pebbles, and the matrix between the grains of the sandstone contains phyllite rock-flour. The series mainly consists of sandstone with subordinate beds of shales. About five sixths of the sediments of this fluviatile-lacustrine series are loose sand and sandstone of a whitish-yellowish colour, partly with cross-bedding, a subordinate constituent being sandstone which is finer-grained and with a fine concordant stratification. One sixth of the series are greyish, more or less sandy shales, which in some places contain inconsiderable beds of coals. A few plant fossils have been found in the lower part of the series, partly about 100 to 120 m and partly about 190 m above sea level. Among the remains of plants there were some frequently occurring needles which I considered as belonging to *Pinus Crameri*; this form I was aquainted with from Kûk, the type locality of the Kome beds, where it is of frequent occurrence, and I consequently referred the lower series to Kome. Professor Fr. J. Mathiesen, who kindly undertook the determination of the plant finds, confirmed this suggestion and communicates that the few fossils which are found on Itsako show agreement with Heer's descriptions of the following species:

Pinus Crameri Hr.
Fasciculites grönlandicus Hr.
Gleichenia sp.

Pinus Crameri and *Fasciculites grönlandicus* have only been found in the Kome beds.

At an altitude of 500 m the fluviatile-lacustrine series was replaced by a black shale, which according to its general character must be looked upon as marine. In its lowermost parts were found rounded phyllite pebbles, but otherwise the shales are without coarse constituents up to an altitude of fully 700 m above sea level. From 705 to 740 m above sea level there is a 35 m thick zone, chiefly consisting of greenish sandstone, which in its turn is succeeded by black shale, in parts containing subordinate sandy beds. The shale could be traced up to an altitude of 900 m, where it was broken by a several hundred metres thick basalt sill, forming an almost perpendicular wall. In the very uppermost part of the black shale a series of volcanic tuffs a few metres thick and interchanging with shale, has been found.

The huge basalt sill, which here along the north coast constitutes the upper part of the peninsula, passes farther south nearer to the level



Sketch by Helge Gry.

Fig. 13. Itsako and its surroundings viewed from the north. From the phyllite area of the foreground a view of Itsako across a delta and Kangiussap imâ. Serfarssuit farthest left on Itsako and presumably the small island and the low foreland to the right consist of phyllite. To the left, part of Qeqertarssuaq with its sediment hills along the coast. In the background Upernivik island. Drawn by Helge Gry from a colour photo by Sole Munck (12/8 1939) and with indications of the author's observations on Itsako.

of the sea, and from the east coast it is possible to see that it is covered with dark shales. Whereas the lower boundary of the sill on the north coast is found at an altitude of about 800 m, south of Serfarssuit it lies probably at an altitude of 600 m, K. J. V. STEENSTRUP (**31**, p. 51) indicating "trap" from 600—850 metres altitude. At Tunúngassoq the sill seems to descend to sea level.

Starting from the east coast STEENSTRUP has reached the shales above this huge basalt sill, and at a height of 920 m he has collected plant fossils in hardened light-brown shale. The plants were determined by HEER (**10**, p. 188), who mentions the following five species by means of which the age of the shale is determined as Miocene:

Taxodium distichum miocenum HR.
Sequoia Sternbergi GOEPP.
Sequoia Langsdorfii BRGN.
Alnus Kefersteinii GOEPP.
Betula Brogniarti ETT.

Without going into details as regards the correctness of these determinations it is obvious that the flora comprises young types, but considering that the beds are older than the basalt formation they must rather be regarded as nearly contemporaneous with the Upper Atanikerdluk beds, which HEER also refers to the Miocene, and according to a statement by Professor FR. J. MATHIESEN they are at any rate not older than the Upper Atanikerdluk beds, which he considers as belonging to the early Tertiary (Paleocene or Lower Eocene) see: KOCH (**13**, p. 263).

From a petrographic point of view the fluviatile-lacustrine series is, as already mentioned, characterized by phyllite detritus high up in the series, but apart from this such thick sandy deposits must originate from more coarse-grained rocks than those which form the substratum of the series on Itsako proper, and which occur in its immediate neighbourhood. The heavy minerals also show that the far-derived material must have played a great part in the composition of the sediments.

In the phyllite from the substratum I have found a heavy mineral suite consisting of 41 $^0/_0$ zircon, 16 $^0/_0$ brown mica, 27 $^0/_0$ chlorite, 7 $^0/_0$ garnet and 9 $^0/_0$ tourmaline. Whereas the phyllite is here rather poor in garnets, the sediments contain very considerable quantities of this mineral, as much as 96 $^0/_0$ of the heavy mineral contents (ore not included). Besides they contain zircon, rutile, tourmaline, biotite and quite small amounts of other heavy minerals. Samples of Quaternary and recent sand from the neighbourhood (the north coast of Kangiussap imâ, Nûgâtsiaq) show mineral suites which, no more than the heavy minerals of the substratum, correspond with the suites of the sediments. In these samples of sand various amphiboles are by far the dominant heavy minerals; in smaller quantities typical metamorphic rock minerals, such as kyanite, staurolite, epidote and garnet occur, as well as brown biotite and zircon. Here also garnet plays a far less predominant part than in the Itsako sediments.

A few observations on the cross-bedding in the lower part of the Itsako series of sediments points towards their having been carried there from easterly regions, but the contents of heavy minerals, with the predominance of garnet and otherwise consisting of particularly resistant minerals, cannot be explained as a heavy mineral suite originating directly from Archæan rocks, as now occurring in the immediate and more remote surroundings of the sediment area. In this context the complete absence of amphiboles in the sediments is noteworthy. Furthermore the fact that part of the zircon grains in the sediments of Itsako are rather rounded seems to suggest that the material has in part been transported over considerable distances. The bulk of the sandy material must originate from gneisses or other metamorphic rocks rich in garnet, but an alteration of the original association of minerals must be supposed to have taken place, either by a weathering of the parent rocks or by a weathering in situ in the series of sediments themselves. It is probable that both processes have taken place.

The absence of amphiboles in the series of sediments must be supposed to be connected with a preceding, thorough weathering of the parent rocks, corresponding to the one proved in the substratum of the sediments on the northern side of the Nûgssuaq peninsula. The weathering crust, which has covered formations of Archæan rock in this part of Greenland, must thus have been very considerable in extent.

That a partial solution of heavy minerals has also taken place in the series of sediments after the deposition—or while it was going on—is shown by the character of the garnets. In the fluviatile-lacustrine series there are only the greatly corroded facetted grains of garnet of a very irregular shape (fig. 14, right), and these cannot have been carried there in the state, in which they are now found in the sediments. In the very uppermost beds of the fluviatile-lacustrine series the corrosion is often so far advanced that the garnet has almost entirely disappeared, ore, zircon, rutile and tourmaline thus constituting the chief mineral association.

In the sandy beds of the marine series the garnets are in the form of fragments (fig. 14 left) and only slightly corroded. This difference goes to show that the corroding process has chiefly taken place during and after the deposition of the fluviatile-lacustrine series, but before the deposition of the marine layers.

A parallelization of the beds on Itsako with those on Nûgssuaq can naturally not be undertaken with certainty on the basis of the comparatively few fossil finds on Itsako. The following parallelization can, therefore, only be taken as a possible correlation.

A reliable determination of ages is at hand for the lower part of the fluviatile-lacustrine series, which according to the plant finds made by the author must be referred to Kome, and for the very uppermost part of the series exposed on Itsako, which according to STEENSTRUP's plant finds are at any rate not older than the Upper Atanikerdluk beds.

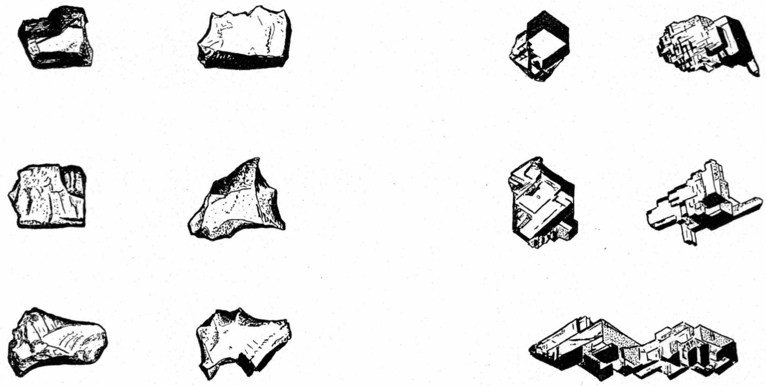


Fig. 14. Garnet from sandstone, Itsako (× 50). To the left fragments from the marine series, to the right etched, facetted grains from the fluviatile-lacustrine series.

Further, it is natural to parallelize the lower part of the series of marine shales with the fossiliferous shales, which ROSENKRANTZ and LAURSEN found at Umîvik on Svartenhuk. The age of the latter is Coniacian (see p. 38).

However, when comparing the series of sediments of Itsako with that of Nûgssuaq it appears that the other part of the series show the greatest agreement with conditions on the north coast of Nûgssuaq.

The fluviatile-lacustrine Kome beds and the slightly younger fluviatile-lacustrine beds are in both regions overlain with very fine-grained, black, cretaceous, marine shales. On the north coast of Nûgssuaq the boundary between the Senonian and the Danian (ROSENKRANTZ (27, p. 657)) is marked by a huge bed of conglomerates, which in its turn is overlain by black shales. The sandy, 35 m thick zone in the shale on Itsako may then possibly indicate the same phase of disturbances which on Nûgssuaq is shown by this huge conglomerate at Angnertuneq, and thus marks the boundary between the Senonian and the Danian. The tuff-beds on Itsako may be a little older than the Atanikerdluk beds and may thus be contemporaneous either with the

Upper Danian or the Palæocene tuff beds from the shales on Nûgssuaq (**27**, p. 657 & 658).

Figure 15 represents a section of Itsako and its environs, passing right across Itsako from north-east to south-west, that is at right angles to the usual strike of the southern part of Svartenhuk.

If one considers the lowermost part of the marine shales on Itsako as corresponding with the Umîvik shales, the result is an inclination of beds of 2—4° towards south-west, which dip is very probable, considering the observations made in the field. Observations from various parts of the peninsula point towards such a slight dip of the sediments, and both Rosenkrantz and Noe-Nygaard mention that the marine shales at Umîvik have a faint south-western dip.

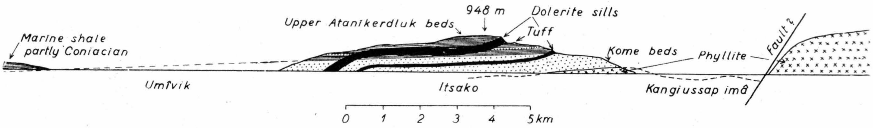
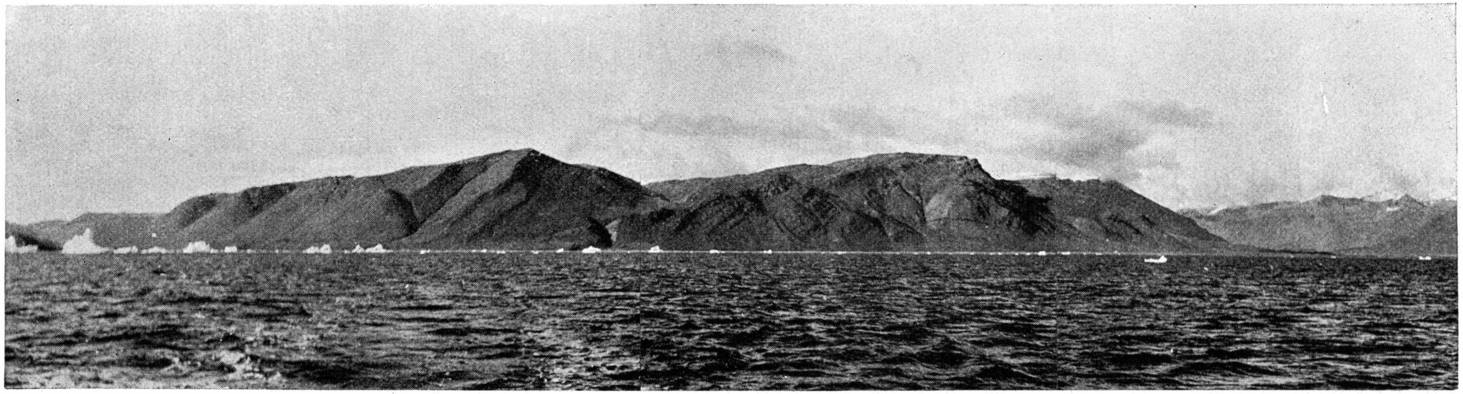


Fig. 15. Schematic section through Itsako and its surroundings from N. E. (on the right) to S.W. (on the left).

In the schematic section through the area (fig. 15) a fault zone is drawn in through the northern part of Kangiussap imâ. This fault zone has not been directly observed, but various conditions are in favour of its existence (see p. 35). As already mentioned, Lauge Koch has drawn a cretaceous coast line north of Kangiussap imâ, and so he has elaborated an idea which was in 1911 expressed by Heim (**11**, p. 185), to the effect that the boundary of the sediment and the gneiss areas at Kûk and at Sarqaq on Nûgssuaq represented a Pre-Tertiary cliff in the gneiss formation. Koch regards this cliff as a coast cliff, which he is able to trace from the region south of the Nûgssuaq peninsula as far as Svartenhuk, and he is of the opinion that the sediments are deposited on the strand flat in front of it, maintaining that the sediments in the vicinity of the cliff consist of coarse material, which has fallen down from the coast cliff.

However, my investigations in Nûgssuaq and at Itsako do not confirm the supposition of Koch. It must be maintained that the sediments near the "coast cliff" are not different from the sediments farther off, though one might expect a decrease in the sizes of the grains, the farther one got from this cliff. That there has been some sort of a relief in the Pre-Cretaceous surface has already been mentioned in this treatise, and it has also formerly been roughly stated how the relief appears in the lowermost parts of the series on Nûgssuaq (**27**, p. 656). Only a very few metres of the series of sediments are influenced by the character of the substratum. On Itsako the Kome-beds in the main consist of sandstone, chiefly composed of far-derived material, and the character of the sandstone is exactly the same at the north coast, which lies nearest the elevated phyllite area, as at Tunúngassoq, which lies about 10 km from the elevated phyllite.

As the character of the sediments does not suggest the presence of a great difference in levels between the regions, where the sediments were deposited, and the regions in their immediate vicinity, two interpretations of the varying altitudes of the phyllite are possible. Thus there is a possibility that the phyllite substratum has formed a rather evenly sloping plane between Serfarssuit and the phyllite area north of Kangiussap imâ, and that the sediments are gradually deposited against the latter which can, however, hardly have been so steep as indicated by a connecting plane between the phyllite at Serfarssuit and the most elevated part of the phyllite north of Kangiussap imâ. A tilting over has undoubtedly taken place on a later occasion. The formerly mentioned situation of the present phyllite surface (p. 27) seems, however, rather to suggest that there must be a fault zone along the north coast of Kangiussap imâ, and that this fault zone has only arisen after the deposition of the sediments, possibly at the same time that the whole of the Itsako complex has been tilted towards the southwest. As mentioned by Rosenkrantz (p. 70), a fault zone between the southern and northern part of Svartenhuk is probable.



A. NOE-NYGAARD phot. 11/8 1939.

Fig. 16. South-east corner of the Svartenhuk peninsula – from Uvdlisaut to Kakilíssat – seen from the south. Basalt breccia with a pronounced south-westerly dip. (See p. 48 and p. 68).

THE MARINE, CRETACEOUS SEDIMENTS AT UMÎVIK

BY

ALFRED ROSENKRANTZ

The fragments of shales mentioned by STEENSTRUP 1883 (**33**, p. 53) from the base of Firefjæld at the head of the Umîvik bay undoubtedly belong to the marine series, which was discovered on the south coast of this bay by the Nûgssuaq Expedition in 1939. Along the southern margin of the delta of the Usuit kûat river DAN LAURSEN and the author of the present chapter succeeded, on the same occasion, in discovering an ammonite fauna, rich in individuals and belonging to the Coniacian; it was indigenous to a shale section, only a couple of metres high and situated about 1 m above the mean level of the sea. The shales were thinly laminated, bituminous and of a dark-grey colour, containing subordinate intercalations of yellowish, rather finely grained sandstone, which also appeared as thin lenses in the shales. Further, a few lime concretions were observed, lens-shaped and of the size of a fist, which sometimes enclosed ammonites, and a quantity of ammonites filled with calcite and pyrite and with a weathering crust consisting of limonite. The shales were pressed into the limonite crust in a peculiar manner (see plate 1, 2a), and as the result of the disintegration which has taken place, the sculpture of the ammonites is often somewhat obscured. The ammonite-carrying series of beds has a faintly south-western dip. The top of the shale complex was observed at an altitude of fully a hundred metres on the south-western corner of the Usuit kûat valley, overlain by the brown basalt breccia. Here no fossils were found.

Sediments belonging to the same series were observed by NOE-NYGAARD and SOLE MUNCK at a point somewhat to the south of the ammonite locality, but no fossils were found here. NOE-NYGAARD describes the occurence in the following manner: "When ascending the northern side of Umîviup qáqai we found at a height of 68 m above sea level a black, finely splitting, somewhat rustily weathering shale, containing a large quantity of well-cemented lenses of up to 3—4 dm in thickness and several metres in length; the lenses are of a strong rusty colour, sometimes with discoloured white coatings. The shales contain numerous concretions of the size of a nut. In a dry state the shales are greyish in colour. They occur along the river in a section about 100 m long and have a faintly south-western dip. The series of shales must be supposed to continue as far as to an altitude of about 135 m, but its upper parts are entirely obscured by screes from the overlying, brown basalt breccia."

As shown by the investigations of Gry, an entirely similar series of beds of a marine character makes part of the sediments on Itsako and has been described on p. 30. No fossils are found in this, any more than in the preceding locality.

While passing along the coast in a southern direction between the head of Umîvik and the headland Niaqornaq, where the coast turns in a north-southerly direction (see figs. 26 and 31), I was able to observe the marine series underlying the basalt breccia in several river beds. The superposition boundary is, at a rough estimate, rather constant at an altitude of fully 100 m. South of Niaqornaq the shales disappear, and the basalt breccia crops out along the coast.

The distribution of the marine-shales may be summed up in the following manner: A narrow zone extends from Niaqornaq along the south coast of the Umîvik bay, sends an offshoot in a western direction into the Usuit kûat valley where, however, the marine beds are largely covered by Quaternary deposits, and continue in a northern direction along the eastern side of Firefjæld. There is reason to suppose that these beds are more widely distributed in a northern direction through the valley, which from the northern point of Firefjæld is connected with the Simiútap kûa valley, debouching into the Umîarfik fjord (see plate 5). It was here that in 1879 Steenstrup, from the northern coast of the fjord, observed sediments in both sides of the valley; the nature of these sediments is, however, not known in details. Further, the series of marine shales undoubtedly enters into the composition of the peninsula of Itsako.

Faunal remarks.

The marine fauna found at Umîvik comprises forms of the genus *Scaphites*. The most commonly occurring form is a rather coarse-ribbed *Scaphites ventricosus* Meek and Hayden *var. stantoni* Reeside (**25**). With these must be classed the very incomplete ammonites (plate 1), which were presumably secured in the 18th century by unknown collectors. The new, abundant material comprises specimens in a much better state of preservation, which correspond with the forms figured by Reeside (**25**) from the lower part of the Cody shale of the Oregon

Basin, Wyoming. These forms will be described together with the remaining fauna in a separate treatise.

The *Scaphites ventricosus* group characterizes a faunal zone within the Niobrara formation of the central provinces of the United States and has also been found in southern Canada. This formation corresponds with the European Coniacian or Emscherian, and the find of this fauna on Svartenhuk thus forms a new link in the series of marine Cretaceous in West Greenland, only Senonian deposits having been known from this area before the Nûgssuaq expeditions of 1938 and 1939.

Besides members of the *ventricosus* group the Umîvik fauna also comprises a few representatives of other ammonite genera. Among these there are some specimens which seem to belong to the genus *Borissjakoceras* Arkhanguelski, formerly only known from Turonian rocks in Turkestan and from the Graneros shale and the Carlile formation of the Upper Cretaceous of Kansas (Morrow, **17**, p. 465), and a fragment belonging to a *Crioceras*-like ammonite. Further, a few lamellibranches referable to *Inoceramus* and *Pseudomonotis* have been found. The Umîvik fauna may thus be characterized as poor in species, but rich in individuals, members of the genus *Scaphites* predominating.

Palæogeographical remarks.

It appears from what has been said above that there has been, in Coniacian time, a marine connection between central North-America and West-Greenland. As forms of the *ventricosus* group are unknown in the Atlantic Cretaceous provinces, it must be supposed that the Coloradoan Sea (see Schuckert (**29**) plates 94 and 95) has extended as far as West Greenland, through the Arctic Ocean across the archipelago north of Baffin Land, and has possibly covered parts of northern Baffin Land. Teichert puts forward the hypothesis (**35**, p. 155, fig. 12) that such a marine connection existed in Senonian time, and he based this hypothesis upon the West Greenland Senonian fauna, which was described by de Loriol, Stanton and Ravn (**24**) and, according to these investigations, points to some connection with the Montana formation in the interior of the United States and adjoining regions of Canada. Ravn (**24**), however, maintains that certain forms show affinity with the European Senonian.

A large part of the fauna which de Loriol, Stanton and Ravn (**24**) referred to the Senonian, and which was collected by K. J. V. Steenstrup in loose-lying concretions and burned shales, were by means of our investigations in 1938 and 1939 proved to be considerably younger than the Senonian, being presumably of Paleocene age, and so they must be left out of consideration. A number of forms remain, of which the following must undoubtedly be of Senonian age:

1. *Hemiaster humphreysanus* MEEK & HAYDEN
2. *Oxytoma nebrascana* EVANS & SCHUMARD
3. *Inoceramus steenstrupi* DE LORIOL, RAVN
4. *Inoceramus patootensis* DE LORIOL, RAVN
5. *Solenomya subplicata* (MEEK & HAYDEN)
6. *Scaphites nicolleti* (MORTON)

In favour of the marine connection between West Greenland and the Coloradoan Sea in Senonian time is the presence of the species 1,2 and 5, in so far as the correctness of the determination can be maintained. The other species are in favour of a marine connection with European Senonian areas, where investigations of later years have proved the presence of both *Inoceramus* species, whereas they are not known from the central area of North America. As regards the occurrence of *Scaphites nicolleti* in West Greenland the following facts should be borne in mind:

In 1897 VICTOR MADSEN (**15**) referred these forms to *Scaphites romeeri* d'ORBIGNY (see SCHLÜTER (**28**)) from the North European Senonian, whereas RAVN (**24**) refers them to *Scaphites nicolleti* (MORTON) (see MEEK, **16**). Both MADSEN and RAVN are of the opinion that the said two species are identical, and RAVN therefore uses MORTON's name as being the oldest. In my opinion *Scaphites nicolleti* and *Sc. roemeri* are two quite distinct species. Among the characteristics distinguishing them I shall here content myself with calling attention to the following:

	Sc. roemeri	*Sc. nicolleti*
outline in lateral view	oblong, oval	subcircular
venter of the last volution	evenly rounded	flattened
tubercles	none or in exceptional cases a single row on the flanks, radially elongated	a single row on the outer volution, elongated longitudinally and placed along the sharp edge between the flanks and the flattened venter.

The great difference between the two forms is further emphasized by the fact that NOWAK (**22**) refers *Sc. roemeri* to *Acanthoscaphites* NOWAK, while *Sc. nicolleti* belongs to *Discoscaphites* MEEK.

The Greenland specimens agree closely with *Scaphites roemeri* and are mostly without tubercles.

Scaphites roemeri and *Scaphites nicolleti* are both to be found in the Upper Senonian, but belong to different levels, the Upper Campanian and the Mastrichtian, and to different seas, the North-European and the Coleradoan, respectively.

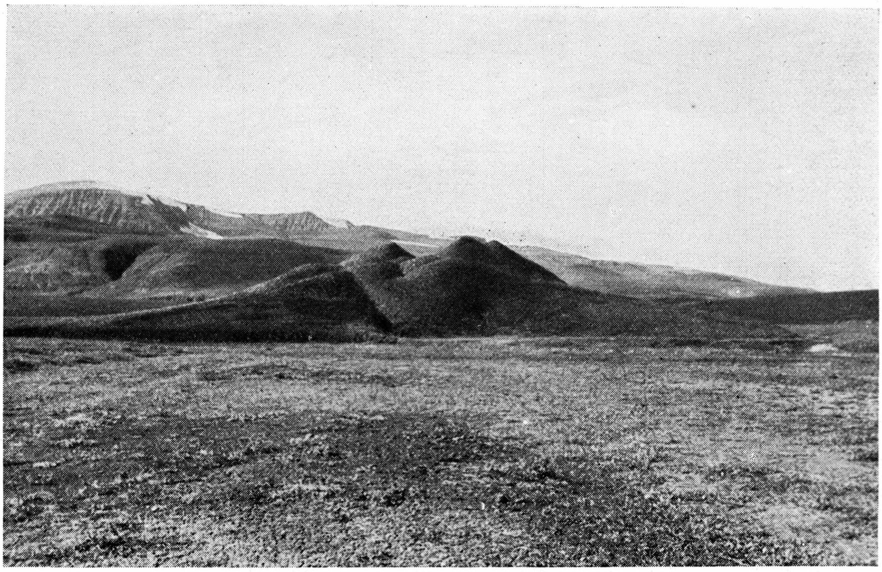
The above-mentioned Senonian fossils from West Greenland belong, as already pointed out by Freebold (**4**), to two different Senonian levels. The oldest of these is characterized by the two *Inoceramus* species, the European occurrence of which is restricted to the Uppermost Santonian and Lower Campanian. The forms 1—5 presumably belong to this zone; and there consequently seems to have been a connection as far as with the Coloradoan Sea, but at the same time the *Inoceramus* show that a new marine connection has been opened in a southern direction through Davis Strait to the North European Senonian Sea. The younger zone is characterized by *Scaphites roemeri* and has a purely European character; it must be placed in the Uppermost Campanian (*Bostrychoceras polyplocum* zone). The succeeding marine zones of the Cretaceous and Tertiary, which were discovered by the Nûgssuaq Expeditions (**27**), are Atlantic in character.

The marine connections with West Greenland in Cretaceous-Tertiary time are distributed in the following manner:

Connections towards north with the Coloradoan Sea	Connections towards south with Europe and the Atlantic provinces of the United States
÷	Lower Eocene
÷	Paleocene
÷	Danian
÷	Upper Senonian
Lower Senonian	Lower Senonian
Coniacian	÷

Appendix. A mud volcano connected with the marine shales.

In 1938 the author observed the presence of mud volcanos within the areas of marine, bituminous shales on the Nûgssuaq peninsula. Also on Svartenhuk, when we were walking towards Umîvik, I found a mud volcano placed in a similar manner (fig. 17). It is situated in the Usuit kûat valley, 6,3 km from the beginning of the river delta, that is, so close to Umîvik that there cannot be any doubt that the substratum of the river sediments must be the marine shales, which are visible in the river slopes where the delta beginns. The mud volcano has an extension in length (east-west) of 137 m and a breadth (north-south) of 70 m, its highest conical peak rising 13 m above the surrounding river plain. It is apparently composed of coarse gravel and stone material, but, as was also observed in the older parts of the mud volcanos on Nûgssuaq, the finer mud constituents had also here, in the course of time, been washed off from the surface beds. The extremely steep, conical peaks surrounding the crater are very characteristic, as it is possible to prove that the last eruption of the mud volcano dates some years



A. ROSENKRANTZ phot. 15/8 1939.

Fig. 17. Mud volcano in the Usuit kûat valley seen from the east. In the background mountains consisting of basalt breccia covered by plateau basalt.

back. From the bottom of the deepest crater we brought home the stem of a willow, 2.5—3.0 cm thick; according to the examination made by T. W. BØCHER Ph. D. the yearly rings show that this willow has struck root here at least twenty-eigth years ago.

There is hardly any reason to doubt that this mud volcano has arisen in the same manner as the mud volcano Marrait qapiortua = Qapiortoq kitdleq on Nûgssuaq, which in 1939 was observed in faint eruption by the Nûgssuaq Expedition. Mud, gravel and stones are here thrown up to the surface by groundwater, the pressure of which is due to a considerable constituent of gases, chiefly Metan, which makes the water foam (hence the name used by the Greenlanders: Qapiortoq = the foamer). There is undoubtedly a connection between the gases and the bituminous marine shales, which are to be found below the Quaternary covers on Nûgssuaq as well as on Svartenhuk. In this connection it may be mentioned that just as there are older reports of oil seepages originating from Greenlanders, who have traversed the Nûgssuaq peninsula, in the same manner there are native reports from Svartenhuk, but it has not been possible to localise the occurrences, and the expedition in 1939 made no observations of this kind.

In the valley connecting the heads of the Umîvik and Umiarfik fjords at the mouth of Simiútap kûa, the geological conditions suggest the possibility that other mud volcanos may occur.

THE BASALT BRECCIA

BY

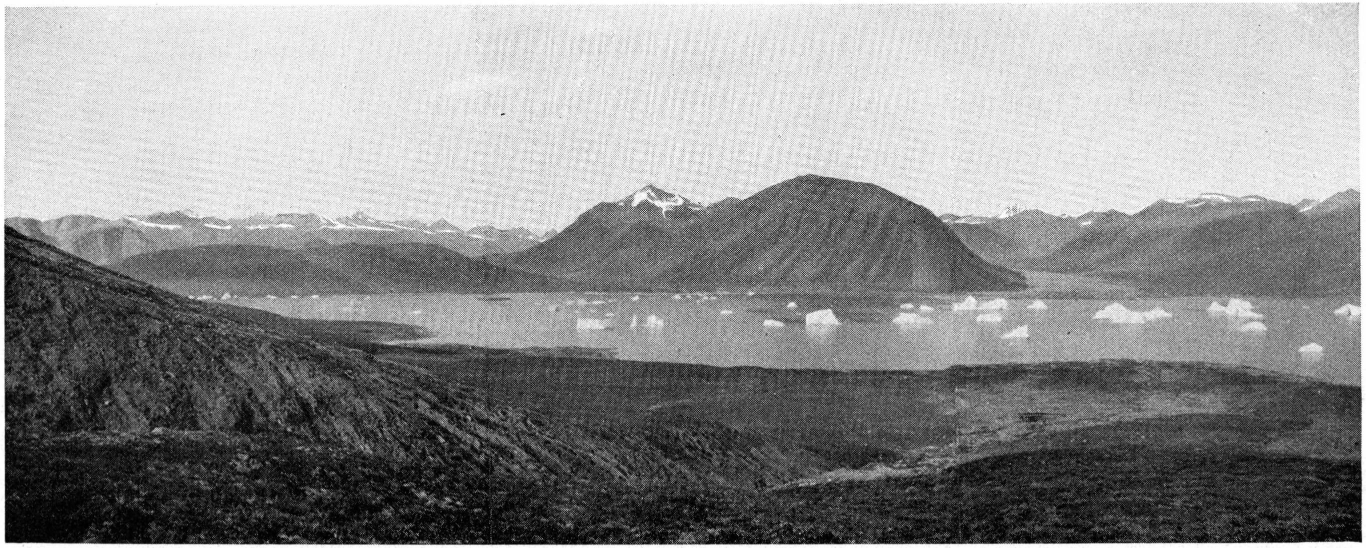
SOLE MUNCK

On Svartenhuk the breccia formation is found to be partly overlying Mesozoic and possibly still younger sediments, partly resting on the Pre-Cambrian phyllite series. It is overlain by the plateau basalt series, which attains an immense thickness. On Svartenhuk, as in the other West Greenland basalt areas investigated in 1938 and 1939 by the Nûgssuaq Expeditions, the breccia is genetically very closely associated with the plateau basalt. It is, however, convenient to consider the breccia as a separate formation, owing to its peculiar and characteristic appearance, which bears upon the conditions under which it has arisen (see p. 53 and also **27**, p. 659). The breccia, does not constitute the oldest member of the West Greenland basalt formation, layers of ashes from still older volcanic eruptions having been found in sediments underlying the breccia. (**27**, p. 658)

The breccia on Svartenhuk comprises two divisions, 1) a lower brown breccia with characteristic domical weathering forms and 2) an upper grey, more or less clearly bedded breccia, the latter, particularly in Firefjæld, attaining the greatest thickness.

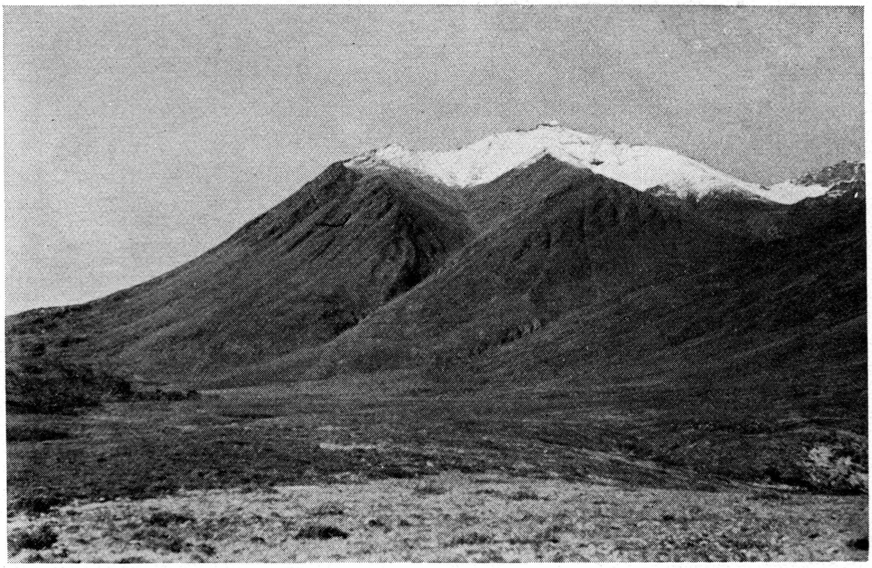
Distribution.

On the reconnaissance trip to Svartenhuk in 1939 we succeeded in proving the occurrence of breccia over much larger areas, than had been indicated by K. J. V. STEENSTRUP (cf. the maps fig. 5, p. 13 and fig. 9, p. 18). In the country north of Kangiussap imâ it was thus found overlying the steep beds of phyllite up to a considerable height (see fig. 18). On the mountain which on the map (p. 19) is marked 1313, its lower boundary was observed at a height of 1100 m and could be traced up to 1250 m, at which height it was overlain by thin basalt beds, which rarely exceeded 0,5 m and which consisted of amygdaloidal



HELGE GRY phot. 15/8 1939.

Fig. 18. The country north of Kangiussap imâ, photographed from the northern coast of Itsako (cf. the map p. 19). The peak in the centre of the photo is 1313 m high. The jagged mountain range to the left is the western side of the Kangiussap agfâ valley, with horizontal basalt on steep phyllite. In front of this is seen the flat phyllite tongue, Simiutaq. To the right of the 1313 m mountain the 932 m mountain, also consisting of phyllite.



SOLE MUNCK phot. 12/8 1939.

Fig. 19. The 1313 m mountain, photographed from the south. Above the phyllite beds, with a marked westerly dip, horizontal beds of breccia and plateau basalt, covered with snow.

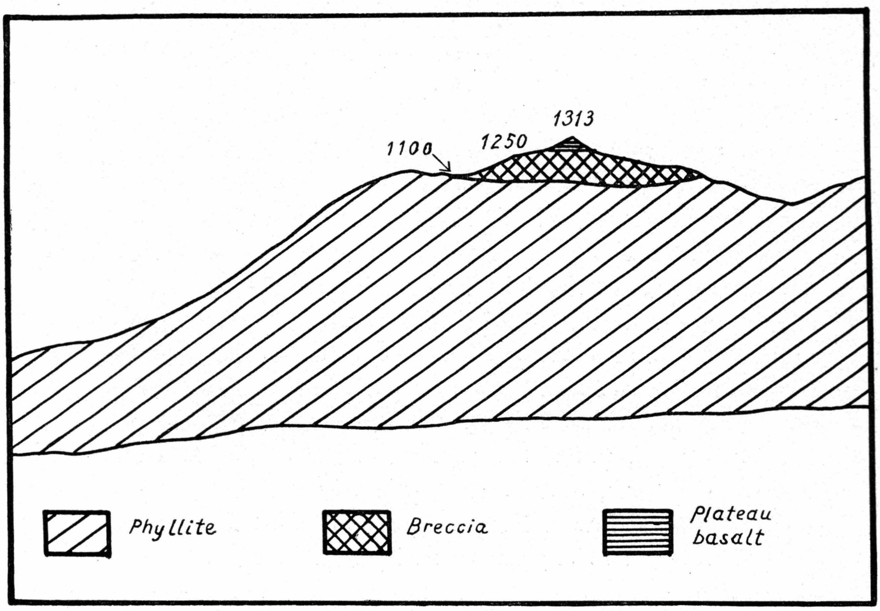


Fig. 20. Schematic section of the 1313 m mountain.

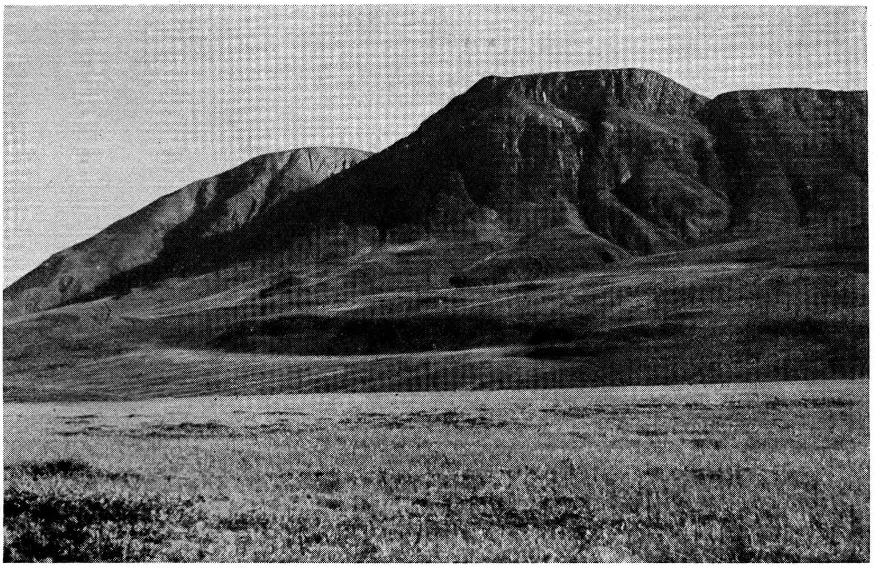
basalt with red intercalations (see figs. 19 and 20). From the 1313 mountain a steep wall was seen in the western side of Kangiussap agfâ, constituting the base of the basalt formation. In thickness and height above the sea it corresponded entirely with the breccia wall in 1313, and it extended in a northern direction, as far as one could see. Unfortunately the sun was in the west, and owing to the deep shadow in the narrow valley it was not possible to determine with certainty whether it was really breccia, for which reason the distribution on the map (fig. 9, p. 18) is given the signature "probable occurrences". South of the 1313 mountain the breccia was further found in a couple of small areas, the largest and most westerly of which lay at a strikingly low level, the upper boundary being only 778 m above sea level. The dislocated appearance of the breccia, with crushed and overturned structure, seemed to suggest that the present position is not original, but the result of subsequent disturbances of a tectonic nature.

Farthest east, at both sides of the valley Usuit kûat and over a distance of 13 km, the members of the expedition, who traversed Svartenhuk from Kugssineq to Umîvik, were able to identify the presence of breccia, which also here underlay the plateau basalt. The upper grey, here clearly stratified breccia (see fig. 21) was in the main conformable with the plateau basalt, the lower brown breccia standing out as easily distinguishable, rounded cliffs (see fig. 22). The surface of the breccia rose gradually towards east, and farthest out in the mountains on the northern side of the valley the plateau basalt had disappeared. Thus the upper part of Firefjæld consisted of grey breccia (fig. 23), and this is also confirmed by K. J. V. Steenstrup (**30**), who ascended the mountain and wrote that right below the top it consists of "basalt tuff with grains of palagonite". At the base of this mountain the brown breccia was seen to overlie sediments, which are presumably of the same character as the marine beds along the south coast of Umîvik. Through the valley west of Firefjæld the plateau basalt in mountain 1307 (see fig. 26, p. 53) was observed to overlie grey breccia. The number of basalt dykes intersecting the breccia increased towards the east.

In the north-eastern flank of Umîviup qáqai the breccia is fixed from about 140 m to 450 m above sea level, and in the southern flank of the mountain range above Igpik the upper boundary is about 400 m. Where the three river branches converge to the south-west of Igpiup qáqâ (see the map fig. 26, p. 53) the upper margin of the breccia is about 300 m above sea level, and in the most westerly branch of the river probably still a little lower. Here breccia was measured up to a height of 270 m, but owing to the great quantity of screes the upper boundary could not be determined with certainty (cf. the description **21** pp. 18—20).

A. ROSENKRANTZ phot. 15/8 1939.

Fig. 21. Southern side of Usuit kûat near the sea. Overlying brown breccia of small thickness the finely stratified grey breccia, traversed by dykes.



A. ROSENKRANTZ phot. 15/8 1939.

Fig. 22. Northern flank of Umîviup qâqai, photographed in a southern direction from the innermost part of the delta in the Usuit kûat valley. The brown breccia with characteristic rounded weathering forms here attains a thickness of more than 100 m. Overlying it grey breccia of no great thickness.

According to our observations in 1939 the upper boundary of the breccia towards the plateau basalt seems to have a strike, which almost coincides with the direction of the southern coast of the Umîvik fjord, and with a dip towards south-west. As to this Steenstrup (**30**) writes from his camp north of Igpik (translation): "The rock at the coast is trap-tuff, the mountains behind are trap, which seems to have a western dip." From the thickness of this breccia at Igpik and its height above sea level at the confluence of the Uvdlisaut river branches, it appears that it must probably exist at any rate as far as Manîserqut[1]).

At Uvdlisaut where we went ashore in order to take sand samples, the breccia was not found in situ, whereas it was seen in great quantities as loose blocks in the river bed as well as in an old delta (the locality is marked × on the map fig. 26).

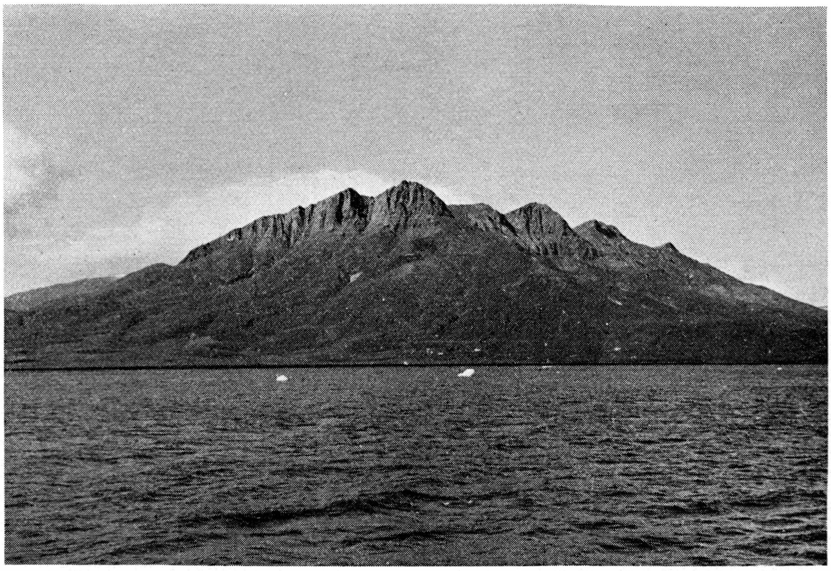
Along the shore to the south and north of Igpik, with a strong inclination of beds inland, huge landslips of breccia were seen, their origin being undoubtedly due to faults running parallel with the coast. The trigonometric station south of Igpik lies on the top of such a landslip.

On the maps the 1313 mountain is the northernmost occurrence of breccia which has been identified with certainty, but there is a very great probability that it occurs still farther north. Even though Steenstrup, on his geological map, does not indicate breccia round the Umîarfik fjord, he mentions in his diary from July 17th 1879 that he found basalt tuff (breccia) in a river bed close to the sea at Painivik; it is true that it does not appear with certainty, whether it is a case of loose blocks or a rock in situ, but at any rate it is the most northerly breccia occurrence, which has been identified up to the present day.

Appearance.

In the northern flank of Umîviup qâqai the following section was taken (see figs. 24 and 25): Up to a height of about 140 m sediments were found, viz. marine shales which are mentioned on p. 37. After a long stretch, completely covered with screes, the first fixed breccia bed was observed 200 m above sea level and transversed by a dyke. It was the lower brown breccia, consisting of small angular blocks of a fine-grained basalt in a greyish-brown matrix, rather poor in glass but rich in zeolites. Somewhat higher up in the section, 230 m above sea level there were, besides the small sharp-edged basalt blocks, a few large round pillows, one of them measuring 0.74 × 0.40 m in diameter, and rolled-out

[1]) From photographs taken by Søminemester Janus Sørensen, who kindly placed them at the disposal of the expedition, it appears clearly that there is really a breccia of a considerable thickness at Manîserqut. Judging by these photographs it seems to be the upper grey breccia series. (See also fig. 16, p. 36).



A. NOE-NYGAARD phot. 12/8 1939.

Fig. 23. Firefjeld viewed from south-east. The grey breccia forms nearly the upper half of the mountain, which is 857 m high. Underlying it brown breccia and sediments, rather obscured by screes.

basalt globes sometimes formed more or less continuous "basalt beds" similar to those which occur in the breccia at Godhavn on Disko. These "beds" and the large pillows were covered with a 0.75 cm thick coating of a black shining basaltic glass, and also here the matrix was very rich in glass, cemented together with an earthy brown mineral and zeolites.

At a height of 291 m this brown breccia ceased and was succeeded by the upper grey breccia, which is very rich in olivine. Between the two breccia-horizons there was a deposit of black sandy shale, at least 1.5 m thick. The overlying grey breccia was clearly bedded: 5—10 m thick layers of extremely coarse breccia interchanging with tuff layers of varying thickness, more frequently 1 m or less. In the tuff layers black grains of sideromelane were seen, a few mm in diameter, and in the thicker tuff beds a few scattered basalt blocks with a thick coating of glass. In the breccia beds the blocks were numerous and rather large, 15, 20, 30 cm in diameter. They were sharp-edged with a thick coating of glass, twice as thick as that of the blocks in the brown breccia. In many cases these coatings showed distinct flow phenomena, and the olivine contents seemed to increase with the sizes of the blocks. The matrix was extremely rich in glass.

At a height of 382 m above sea level a bed stood out in the grey breccia. It contained unbroken pillows, rather large with a radial arrangement of elongated pores, a thick glass coating and more phenocrystic olivine than the smaller, sharp-edged fragments and sectors which generally also were lacking in pores. The matrix was here very tuffoidal. The grey colour of the breccia is partly owing to a white coating on the surface, but it is possible that the zeolite constituent also plays a part.

At a height of 450 m the upper limit of the grey breccia was found, succeeded by the plateau basalt.

The breccia north of Kangiussap imâ in the 1313 mountain was greatly obscured by screes, but fixed outcrops showed its presence along the whole distance from 1100—1250 m above sea level. Many unbroken round pillows were visible with a 1 cm thick glass coating and with or without a radial arrangement of pores. A radial jointing often formed prismatic wedges. The matrix was rather rich in zeolites and very strongly weathering.

As it appears, the thickness of the breccia may vary considerably. From 150 m in the 1313 mountain the thickness increases greatly, to very nearly 700 m in Firefjeld, and then again decreases to about 300 m in Umîviup qaqai.

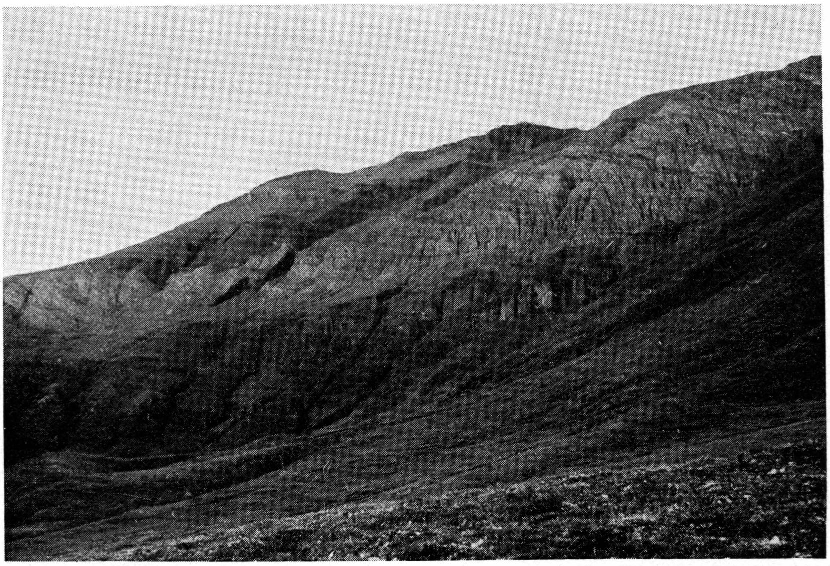
In the accompanying map-sketch (fig. 26) I have attempted to clear up the distribution of the two divisions of breccia, in so far as it was observed by the expedition in 1939.

Petrography.

The results of the microscopical investigations of the breccia formation on Svartenhuk will be dealt with in detail in a subsequent work, exclusively comprising the basalt breccia in West Greenland, and so the following is only to be regarded as a summary of the most necessary data.

A section through a pillow from the breccia on the 1313 mountain showed farthest out the 1 cm thick glass coating, consisting of a pale yellowish green, completely untransformed sideromelane with numerous small fluidally arranged laths of felspar (81 $^0/_0$ an, the average of six measurings) and large, fresh olivine phenocrysts with $2\,V\gamma = 89^\circ$ (the average of six measurings). Farther within the pillow the fresh sideromelane gradually passed into a dark-brownish, opaque or faintly doubly refracting groundmass, the phenocrysts remaining the same, viz. small plagioclase laths (78 $^0/_0$ an) and large, fresh olivine crystals ($2\,V\gamma = 88^\circ$) with small grains of ore (see plate 2, fig. 1 and 2).

In a block of dense, grey basalt from the brown breccia in Umîviup qáqai the groundmass consisted of small felspar laths, a yellowish green glass and a strongly pigmented, not doubly refracting material. Further,



A. NOE-NYGAARD phot. 14/8 1939.

Fig. 24. North-eastern flank of Umîviup qáqai, viewed from the north, from the locality marked 135 on the map, fig. 25. Lowest down brown breccia about 150 m in thickness; over it cross-bedded breccia, about 160 m thick and overlain by plateau basalt. A dyke traverses the whole series (almost in the centre of the photograph).

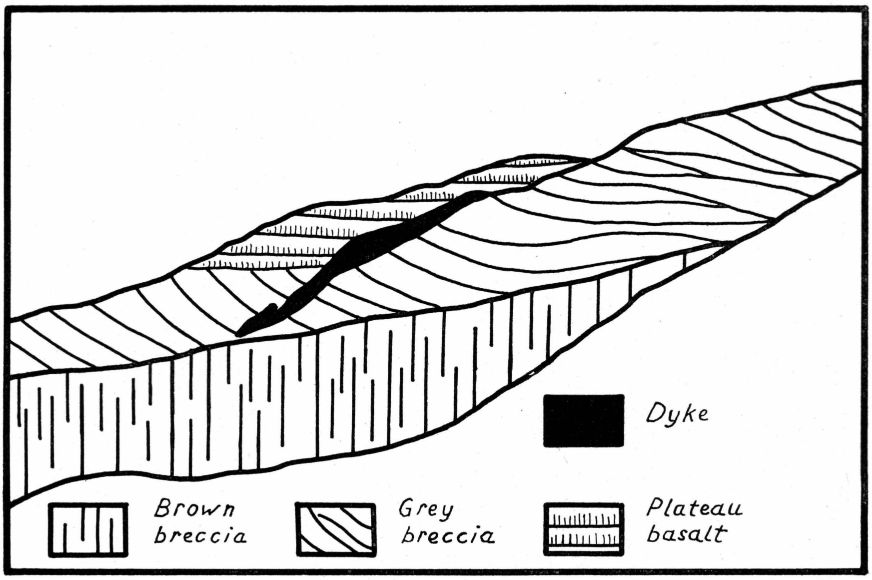


Fig. 25. Schematic section of fig. 24.

phenocrystic felspar (85 $^0/_0$ an) was seen and, in smaller quantities and sizes, olivine with $2\,V\gamma = 89°$ (the average of nine measurings).

A couple of sections through pillows from the grey Umîviup qáqai breccia, rich in olivine, showed a 0.5 cm thick glass coating which consisted of a strongly coloured, brownish yellowish green, completely isotropic glass, with phenocrysts of small plagioclase laths (78 $^0/_0$ an) and huge olivines containing grains of ore and traversed by fissures, along which the olivine is decomposed. Optic angles were measured at $2\,V\gamma = 89°$ (the average of five measurings in no. 80) and at $2\,V\gamma = 85°$ (the average of seven measurings in no. 2274). Farther within the pillow the groundmass becomes pigmented and non-translucent. The phenocrysts are the same as before, viz. plagioclase and olivine. Small cavities in the rock are filled out with secondary minerals, such as calcite and various zeolites, one of which is isotropic, others radiate and faintly doubly refracting.

One of the tuff beds in the upper grey Umîviup qáqai breccia consisted almost entirely of glass of which several kinds could be distinguished under the microscope. The sections showed that the tuff layer was built up of small angular glass fragments with curved boundaries, stowed closely together and cemented by zeolitic material (see plate 3, figs. 1 and 2). In some of the grains a core was observed of a colourless to pale yellow, completely isotropic glass, the refractive index of which was determined at 1.604. This refractive index indicates a rather basic composition of the glass according to the variation curves of W. O. GEORGE (**6**). It may be identified as sideromelane as described by PEACOCK in 1928 (**5** and **23**). The margins of the grains showed a more strongly coloured, greenish, faintly doubly refracting glass, evidently formed at the expense of the pale sideromelane. Its refractive index varies somewhat, but lies between 1.485 and 1.500 and agrees with the fibro-palagonite described by PEACOCK. A transition zone between the two kinds of glass described above shows a glass, almost isotropic and very much like the sideromelane in colour but rather pigmented, especially towards the irregular margin against the fibro-palagonite (see plate 4, figs. 1 and 2). The distinct, thin contraction-cracks in the sideromelane are obscured or have quite disappeared from this transitional zone. Around the borders of the palagonitized glass fragments are seen a fibrous mineral probably of zeolitic composition, with very low refractive indices, clearly doubly refracting and with a positive elongation. The usual phenocrysts are observed; however, plagioclase laths only occur sporadically, and a few broad, irregularly bounded plagioclase individuals have been observed. Olivine phenocrysts are of common occurrence, but are far smaller than those in the slides described above, and they often occur as small angular, irregularly bounded fragments with $2\,V\gamma = 88°$.

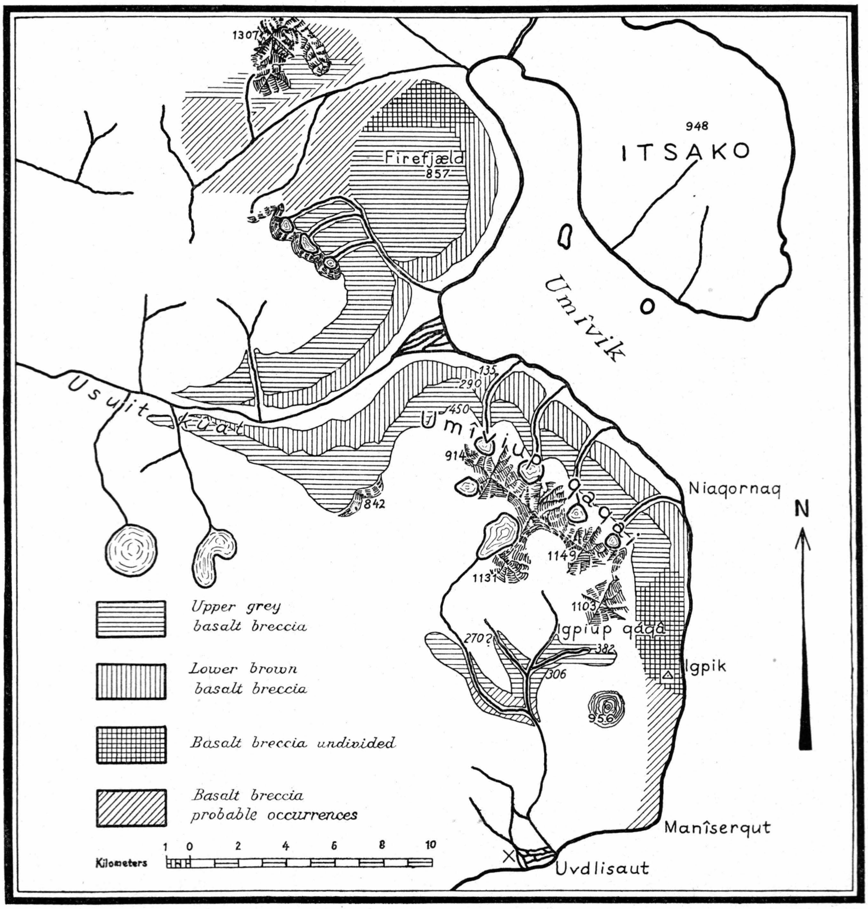


Fig. 26. Map sketch of the distribution of the two breccia horizons in the south-eastern part of Svartenhuk, based upon observations made by members of the Nûgssuaq Expedition in the course of the summer 1939. The italized figures mark the breccia boundaries measured by means of a barometer; the ordinary figures indicate the heights of mountains. West of Uvdlisaut loose blocks of brown breccia have been found (×).

According to what has been said above, the plagioclase both in the brown and the grey breccia is bytownite, the olivine is forsterite with 10 $^0/_0$ fayalite, in a single section (no. 2274) with 2 $^0/_0$ fayalite (**36**, fig. 1, p. 21). Analyses of the breccia on Svartenhuk will be published later, but the microscopical data alone clearly indicate a rather basic composition of this rock complex.

Origin.

As mentioned in a paper read in the Danish Geological Association (**27**, p. 659), there are various reasons for supposing that the breccia has a subaquatic, or rather—considering its wide distribution—a sub-marine origin. Here on Svartenhuk it is more particularly the intercalated beds of shales (291 m above sea level in Umîviup qaqai) and the marked bedding of the tuffoidal interstratifications, which makes the connection between breccia and marine sedimentation probable.

Schades Øer.

The small group of islands, Qeqartat or Schades Øer, are situated in Karrats Fjord between Svartenhuk and Ubekendt Ejland. K. J. V. Steenstrup writes about them in his diary from July 1878 (**30**, translation): "They consist of basalt tuff with kidney-shaped chalcedony, quartz and calcite." In August 1939 we had, on our way to Itsako, the opportunity of paying a short visit to the largest of these islands, Angineq. The south-western part of it consisted of ordinary basalt beds, but in the shore cliffs at the sealers' house we saw an exposure of pillow lava with fine pillows of various sizes; many had by weathering become entirely freed from the groundmass and lay loose in their cavities, so that it was possible, without any difficulty, to get them unbroken onboard the motor boat. Right across the island a low strike passing east-west had cut into this pillow lava bed, which in thickness was about 30 m. The unbroken pillows had a glass coating, whose thickness hardly exceeded 0.5 cm, and whose surface showed distinct flow phenomena. Besides unbroken pillows we also saw segments of pillows with a glass coating preserved on the original surface, and irregular small fragments, often scoriaceous or amygdaloidal and very angular. The matrix was brownish black, very disintegrated and weathering into sharp-edged grains. The breccia bed was under- and overlain by compact basalt beds, with surface flow phenomena and bulbous lobes. Below the surface the lava in these beds was very porous, with cavities filled with zeolites, all of it indicating a subaerial formation. We rowed along the coast in a northern direction, and here we were able to state that the basalt beds, in their turn, were overlain by breccia. The western side of the island thus consisted of interstratified breccia and compact lava. The breccia is here intra-plateau-basaltic and is an example of the "recurrence to breccia facies", which Noe-Nygaard mentioned in a paper read in the Geological Association (**27**, p. 660), and which was also observed by the Nûgssuaq Expedition over a larger area in northern Nûgssuaq. The strike of the beds agreed with the strike in south-eastern Svartenhuk and on the north side of Ubekendt Ejland (Ilimanaq-Îngia).

THE PLATEAU BASALTS

BY

ARNE NOE-NYGAARD

A more detailed work on the plateau basalt on Svartenhuk will be published at the same time as the present treatise, and therefore there will in the following only be given a short summary of the geology and petrography of this formation.

The investigations in the field comprise: 1) a reconnaissance from the bay at Pângnâgigsoq in the south-western corner of the peninsula through the valley of the Kugssineq river and along the western side of Søndre Aputitût to the Usuit kûat valley, which was followed as far as its debouch into Umîvik (ROSENKRANTZ and LAURSEN); 2) a trip by boat along the coast from Pângnâgigsoq eastwards via Savît, Uvdlisaut to the Itsako peninsula (MUNCK and the author); 3) a traversing of the Umîviup qáqai mountain complex (MUNCK and the author); 4) investigations of doleritic sills on the Itsako peninsula (GRY), and 5) investigations north of the Kangiussap imâ fjord (MUNCK and the author). Compare the map of routes (fig. 10).

Geological conditions.

The chronological succession of the basalts on Svartenhuk seem, in so far as we know them at the present day, to be the following: After the submarine basalt breccia formation had come into existence (cf. the preceding chapter), a sub-aerial basalt series has erupted, attaining about 10 km in thickness; roughly speaking, this series begins with melanocratic olivine basalts which in an upward direction pass into plagioclase-porphyric basalts with subordinate olivine, which in their turn, via olivine-free basalts, pass into andesitic basalt and end in anorthclase-trachyte.

The whole of the plateau basalt series dips between 15° and 45° towards west-southwest.

As it has been found that dykes are sparse towards the west, viz. in the uppermost beds of the plateau, and that they increase in frequency the further east we get, in other words, the nearer we get to the bottom of the basalt series, it is an obvious conclusion that there is a direct connection between the dykes and the lava beds in the plateau. This supposition is further confirmed by the agreement between the rocks in the lavas and the rocks in the dykes. In the author's opinion there can hardly be any doubt that in the dykes we find the remains of the feeders of the lava flows of the plateau series.

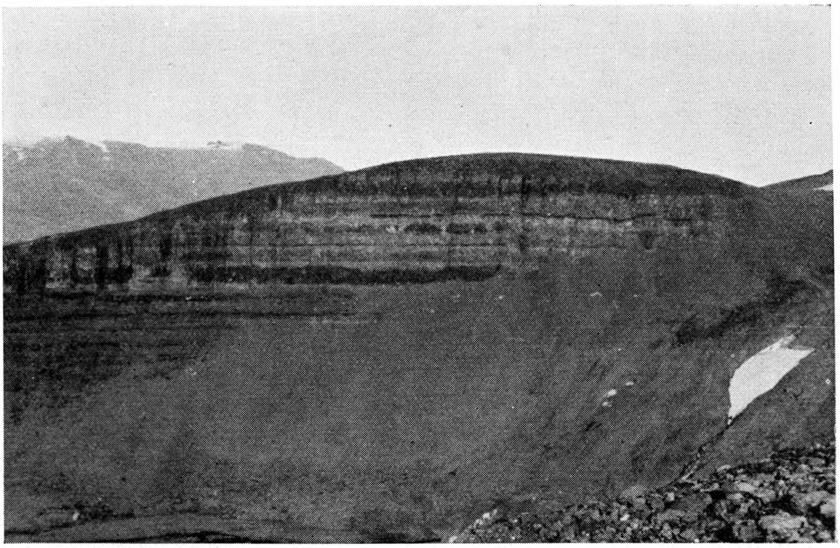
In the sills which have been investigated by H. Gry in the subbasaltic series of sediments on Itsako, only the dolerites with subordinate olivine are met with. In the course of our investigations no doleritic sills were found in the basalt plateau proper.

It is probable that during the strong lava production the whole area has been in a state of constant subsidence, so that for the greater part of the time the extrusion level has remained fairly constant a little above sea-level; this is borne out by the recurrence of subaquatic formations (basalt breccia) which the expedition observed farther up in the plateau proper on the Nûgssuaq peninsula and Schades Øer. The subaerial basalts are interstratified by thin beds of red tuff, of exactly the same type which is found in Tertiary Iceland and on the Faeroe Islands.

The basalt plateau on Svartenhuk has a considerable, though not a uniform dip towards the west-southwest (fig. 28). This must go to show that after the formation of the plateau basalts the substratum farthest west, where the weight may be supposed to have been greatest, has given way and subsided. It seems to me most probable that what has given way are the very underlying parts of the sial-sphere, which have been exposed to an almost geosynclinal amount of load. (For further details see **21**, p. 70).

Petrography.

Sills: The rocks which have been found in the Itsako sills, investigated by Gry, are olivine-carrying, pigeonite-dolerites, some of which have a microgranitic interstitial mass. As an example of the composition of these rocks may be given the following (No. 1255): Plagioclase (core 63 % an, border 53 % an) 52.1 %, pyroxene (En_{47} Fs_{28} Wo_{27}) 34.4 %, olivine (Fa_{28}) 3.0 % and pseudomorphs on olivine 0.5 %, ore 3.4 %, apatite 0.1 %, chlorite about 3.2 % and microgranite, about 3.3 % (potash felspar about two thirds, and quartz one).



A. ROSENKRANTZ phot. 13/8 1939.

Fig. 27. Plateau basalt, apparently horizontal owing to the rock face lying almost in the strike. Northern slope of Søndre Aputitût seen from an altitude of about 600 m.

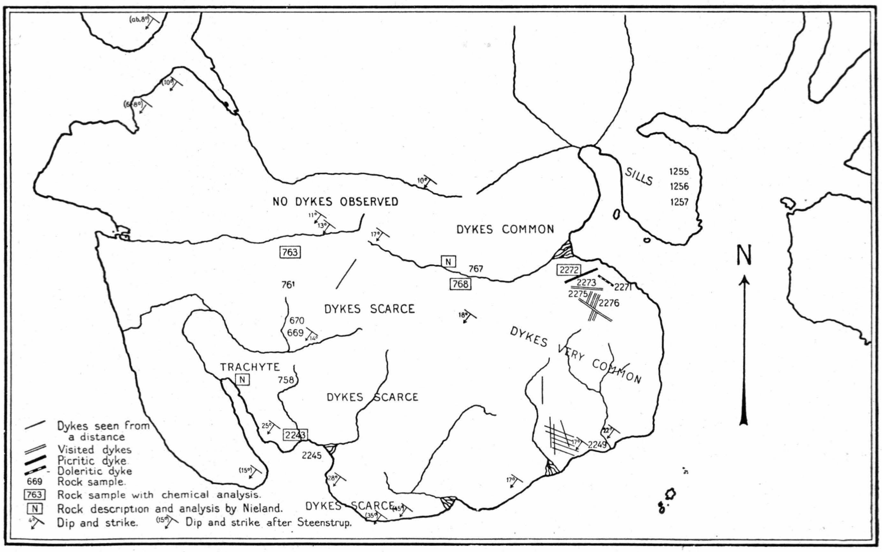


Fig. 28. Contour map of Svartenhuk showing the distribution of dykes recorded by the Nûgssuaq Expedition, and the dip of the basalt sheets. Some of the observations made by STEENSTRUP in 1878 have been added. The numbers of the samples described have been entered in the map.

Chemical analyses from Svartenhuk.

	1	2	3	4	5	6
	768	2272		763	2243	
SiO_2	40.09	42.08	44.42	46.42	48.75	63.32
TiO_2	1.72	2.25	1.92	3.82	2.99	0.75
Al_2O_3	6.21	8.15	13.61	14.50	13.31	16.80
Fe_2O_3	3.98	1.88	3.19	5.07	6.36	3.89
FeO	6.87	8.25	9.67	6.04	7.89	1.25
MnO	0.08	0.18	0.20	0.11	0.20	0.15
MgO	29.21	20.30	9.25	6.35	5.79	0.85
CaO	4.31	12.99	14.49	12.80	11.15	2.07
Na_2O	0.39	1.69	1.01	1.92	2.12	5.75
K_2O	0.47	0.94	0.65	0.83	0.67	4.64
P_2O_5	0.11	0.11	0.26	0.14	0.41	tr.
CO_2	0.25	—	—	0.48	0.05	—
BaO	—	—	—	—	—	0.05
NiO	—	—	0.03	—	—	—
Cr_2O_3	—	—	0.09	—	—	—
H_2O^+	4.67	0.74	1.14	1.17	0.17	0.44
H_2O^-	1.42	0.52	0.33	0.63	0.39	0.35
	99.78	100.08	100.35	100.28	100.25	100.31

Nos 3 and 6 carried out by H. Nieland (**20**), the remainder by Sven Palmquist.
No. 1: Schönfelsite, no. 2: Oceanite, no. 3: Olivine basalt with about 10 % Olivine, no. 4: Olivine-carrying, plagioclase-phenocrystic basalt, no. 5: Olivine-free basalt and no. 6: Anorthoclase-trachyte.

Plateau basalts proper and dykes: Besides the rocks taken in situ, the plateau basalts include the two picrite-basalts with an ophitic interphenocrystic mass, which will be mentioned first. The rocks fall into the following petrographic groups:

1. Picrite-basalts with ophitic groundmass.

Schönfelsite (no. 768) with the following mineral composition: Olivine (Fa_3) 54.0 %, pyroxene (En_{57} Fs_1 Wo_{42}) 15.9 %, ore 3.9 %, interstitial chlorite 2.0 % and plagioclase (65 % an) 24.2 %.

Massafuerite (no. 2249) of the following composition: Olivine (Fa_{14}) 43.3 %, pyroxene (En_{57} $Fs_{4.5}$ $Wo_{38.5}$) 24.5 %, chlorite 0.2 %, ore 5.3 %, plagioclase (varying from 78 to 59 % an) 20.9 %, glass 5.4 % and zeolites 0.4 %.

2. Picrite-basalts with doleritic groundmass.

Oceanite (no. 2272) of the following composition: Olivine (first generation Fa_{14} second Fa_{25}) and pseudomorphic substance in olivine 37.5 %, pyroxene (En_{59} Fs_3 Wo_{38}) 23.1 %, ore 3.8 %, plagioclase (74 % an) 33.2 % and glass 2.4 %.

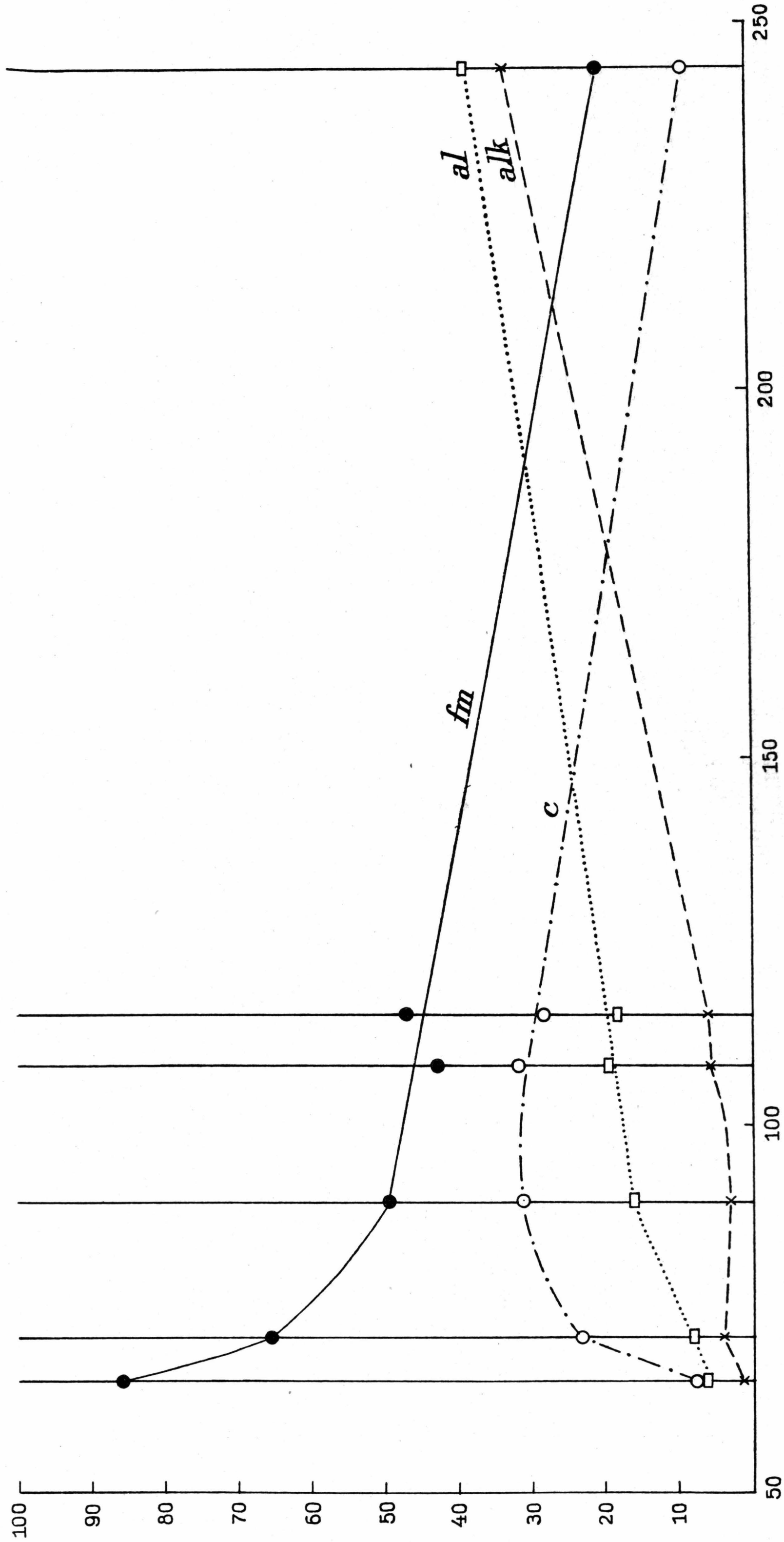


Fig. 29. Variation-diagram after NIGGLI of the rock series of Svartenhuk.

3. Olivine basalts.

Olivine basalts with picritic affinities (no. 767). The olivines are always phenocrystic and of a considerable size compared with the other constituents. The approximate composition is as follows: Olivine (Fa_6) 14.4 %, pyroxene (groundmass), about 52.0 %, plagioclase (groundmass), about 21.8 %, ore 7.6 %, residual glass 1.6 % and zeolites 2.6 %.

Olivine basalts with about 10 vol-% olivine (no. 2273). The following composition is recorded: Olivine (Fa_7) and pseudomorphs on olivine 12.1 %, pyroxene (En_{44} Fs_{23} Wo_{33}) 40.9 %, plagioclase (an-content varying from 73 to 66 %) 32.8 %, ore 9.5 %. chlorite (chiefly in amygdules) and interstitial mass (partly chloritic and partly matted with ironoxides) 4.7 %.

4. Olivine-carrying plagioclase-phenocrystic basalts.

As an example may be taken no. 2276, which has the following composition: Olivine (Fa_{10}) and pseudomorphs on olivine 1.9 %, pyroxene (En_{46} Fs_{20} Wo_{34}) 45.6 %, plagioclase (an-content varying from 78 % to 56 %) 37.5 %, ore 8.6 % and glass 6.4 %.

5. Olivine-free basalts.

Fine-grained rocks predominate, frequently with phenocrysts of plagioclase. A lamellated appearance is typical of some of the rocks. As an example may be taken no. 761 which has the following composition: Plagioclase (an-content varying from 76 to 55 %) 41.2 %, pyroxene (En_{43} Fs_{30} Wo_{27}) 43.3 %, ore 13.3 % and interstitial glass 2.2 %.

6. Andesitic basalt.

No. 758 is a light-grey, fine-grained, zeolite-carrying rock. No quantitative measurements could be made as to the mineral composition. The plagioclase has an an-content varying from 55 % to 48 %. Both the texture, which approaches the pilotaxitic, and the composition of the plagioclase show that this group is considerably more andesitic than the preceding rocks.

7. Anorthoclase-trachyte.

The mineral composition is: Phenocrysts of anorthoclase ($2V\alpha$ 52°—60°), groundmass also with anorthoclase ($2V\alpha$ 40°—50°). but close to soda-sanidine, pyroxene (En_{25} Fs_{39} Wo_{36}); further, small quantities of aegirite-augite and aegirite. Quartz occurs in the orthophyric parts of the rock; of the ore ti-carrying magnetite prevails, but ilmenite also occurs. Neglegible amounts of hornblende and some apatite.

Chemical considerations.

The present investigation was preceded by two analyses of rocks, carried out by H. NIELAND (**20**); besides four new analyses have now been carried out by S. PALMQUIST. The table on p. 58 shows all the analyses from Svartenhuk.

Fig. 29 represents a NIGGLI-diagram of the width of variation of the rock series. NIGGLI- and VON WOLFF-values are found in tables 9 and 10 in my paper on the plateau basalt (**21**), where also a more detailed treatment of the chemical aspects is to be found (p. 57).

THE QUATERNARY DEPOSITS

BY

DAN LAURSEN

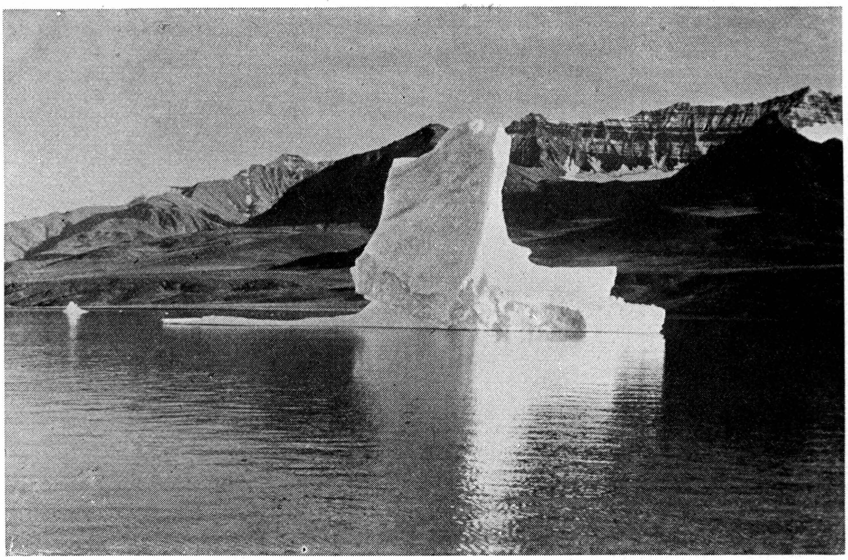
During the last Glacial period the Inlandice undoubtedly covered the whole of the Svartenhuk peninsula. Remains of this continuous cover of ice occurs in the form of Highland ice on the top of the highest mountain plateaux, especially in the northern part of the peninsula. In the central area there are a few valley glaciers and in the eastern part some typical Cwm-glaciers.

The ground moraine produced by the Indlandice occurs as a generally very thin cover over the country, and it seems as if it is entirely lacking within not inconsiderable areas. Boulders from this ground moraine are accumulated in the river valleys and comprise a number of types of rock species, which cannot originate from the peninsula proper, but must have been carried by the Inlandice from areas far towards the east. Some of these boulders have been mentioned by NOE-NYGAARD (p. 26). Mineralogical investigations of samples of sand from river beds, deltas and the coast, which investigations were undertaken by HELGE GRY, show that this material almost exclusively consists of minerals originating from the basalt, which goes to show that far-derived moraine material only plays an extremely small part on Svartenhuk. Over very large stretches the moraine cover is so thin or entirely lacking, that the basalt beds stand out very clearly, which has to a very large extent facililitated the geological mapping (fig. 30). The large valleys of the peninsula are all U-shaped, and thus bear the impression of being modelled by glaciers.

Marginal moraines belonging to the recent glaciers were observed on several occasions. The largest were connected with glaciers descending from the Søndre Aputitût complex; but also the somewhat smaller glaciers south of Usuit kûat had rather outstanding, marginal moraines, consisting of basalt material.

A. ROSENKRANTZ phot. 12/8 1939.

Fig. 30. Scenery north of the Narssaq river with heights of about 500 m. The basalt sheets are clearly visible owing to the thin moraine cover.



A. ROSENKRANTZ phot. 15/8 1939.

Fig. 31. Marine terraces along the southern shore of Umîvik bay, cut out in the marine, Cretaceous shales. The mountain consists of plateau basalt overlying basalt breccia.

The river valleys are covered by fluviatile deposits, overgrown with a vegetation which at times is rather luxuriant. Distinct river terraces are seen in the Kugssineq and Usuit kûat valley, and at the river mouths large deltas have arisen. The delta of Usuit kûat extends far into the Umîvik bay and is at highwater very largely covered by the sea.

Marine deposits. Along the coasts of Svartenhuk there are, in many places, narrow fringes of marine deposits, the upwards boundary of which is distinctly marked. Particularly well developed terraces are seen along the southern coast of the Umîvik bay, where they attain a height a little less than 100 m (see fig. 31). Further, the sea has on an earlier occasion sent a small, narrow fjord into the Kugssineq valley in the southwestern part of the peninsula, and a section through the marine layers, which in this place are fossiliferous, is seen in the coast cliff west of the mouth of Kugssineq. These beds and their contents of shells were observed by K. J. V. STEENSTRUP in 1879 (**31**, p. 235).

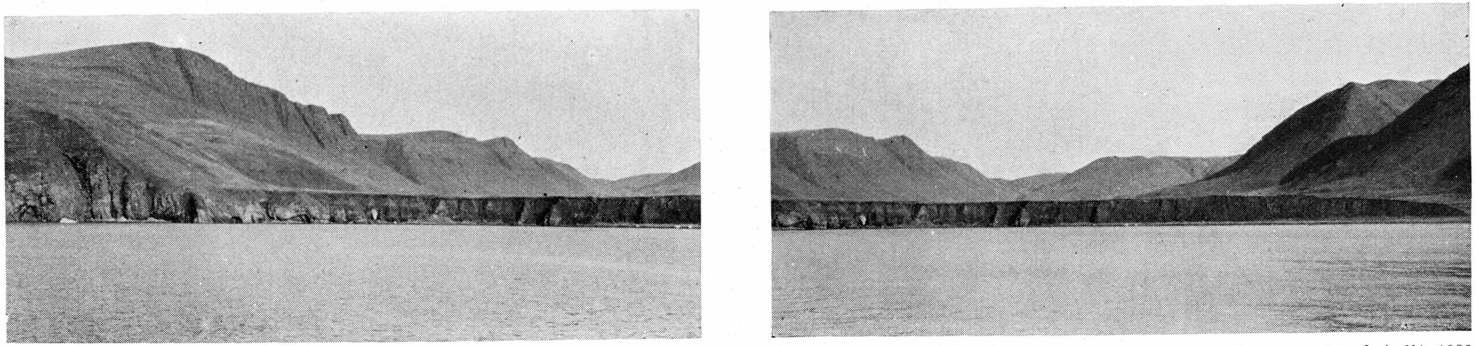
The coast cliff at Kugssineq fig. 32. The section exposed through the agency of the sea has a length of hardly 400 m and a maximal height of 18 m. It decreases in height towards the east, and where the river cuts through the cliff, it is 10 m high. The most easterly part of the cliff consists of very coarse material, viz. gravel and sand, the beds showing a dip towards Kugssineq. The only fossils found here are crushed shells. Further west towards Pângnâgigsoq clay, interspersed with accumulations of closely packed pebbles of the size of hens' eggs, is found in the lowermost part. Higher up the clay becomes free from stones and at last merges into beds of sand and gravel. In the clay scattered shells are found, and in the uppermost part of the sand bed there is a shell horizon with a fauna, very poor in species. The alluvial, marine beds towards the west are seen to overlie the basalt over a distance of about 200 m.

The Kugssineq valley. The marine deposits are seen in a terrace, which rises about 40 m above sea level. A similar river terrace was observed by GRY behind the delta at Uvdlisaut on the most easterly part of the south coast of Svartenhuk. In the Kugssineq valley, at a height of about 75 m, terraces were observed in both sides of the valley, which terraces presumably mark the maximum level of the sea. Shells were, however, not observed higher up than 40 m.

In the marine layers the following species have been found:

The coast section:

Uppermost shell horizon: *Mya truncata* (L.)
Mya truncata var. uddevallensis HANC.
Saxicava arctica (L.)



A. ROSENKRANTZ phot. 11/8 1939.

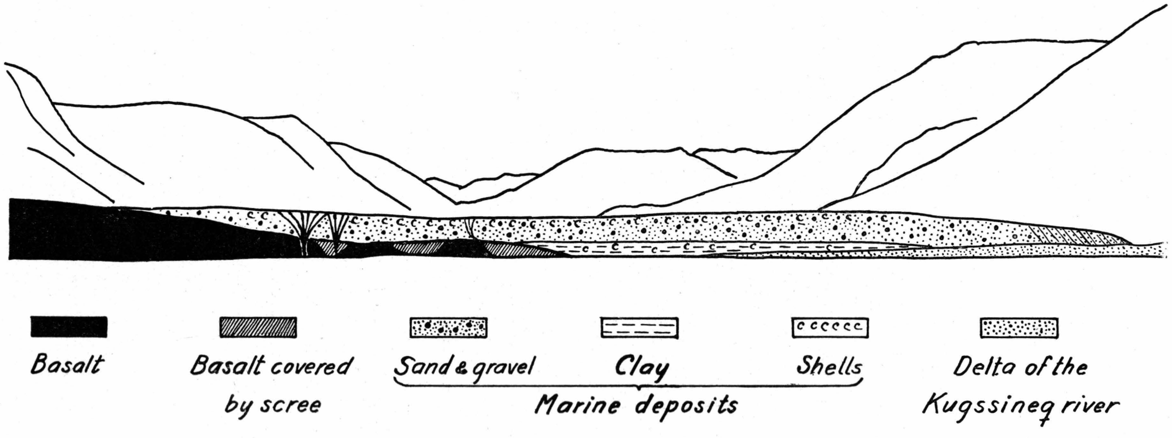


Fig. 32. The coast cliff at the mouth of the Kugssineq valley.

In the clay:	*Saxicava arctica* (L.)
	Portlandia arctica (Gray)
	Macoma calcarea (Chemn.)
	Astarte elliptica (Brown)
	Astarte montagui (Dill.)
	Astarte montagui var. striata Leach) Sars
	Astarte montagui var. warhami Hanc.
	Mya truncata (L.)
	Mya truncata var. uddevallensis Hanc.
The Kugssineq valley:	*Mya truncata* (L.)
	Astarte borealis (Chemn.) common
	Saxicava arctica (L.)

The presence of the *Portlandica arctica* in the clay beds of the coast cliff shows that they must have been deposited in a high-arctic sea. As to the climate during the deposition of the beds in the valley it can only be said that it has been arctic. *Astarte borealis*, which characterizes this bed, is thus arctic-circumpolar and in Europe does not extend farther south than the Lofoten, whereas at the coasts of America it extends as far as New England.

The present occurrence of the marine Quaternary beds in Svartenhuk presupposes a rise of the land, which in any case can be put at about 100 m. However, in West Greenland it has been possible to prove a renewed subsidence, which has been going on during the last centuries. Evidence of this subsidence in the Svartenhuk area may presumably be found in the circumstance that great parts of the river deltas in the Umîvik bay are now covered by the sea at high level.

As in the case of the Second Hessian Expedition we had the opportunity to study moving soil phenomena in many places, where the covering loose strata were particularly moist. Stone nets seem not to appear below an altitude of about 400 m.

REMARKS ON THE GEOLOGICAL MAP

BY

ALFRED ROSENKRANTZ

On the map plate 5 an attempt has been made to collect all available data regarding the geology of Svartenhuk south of 72° lat. N, the object being to provide a foundation of future investigations. The material constituting the base of this attempt is, apart from our own map (fig. 9), K. J. V. STEENSTRUP's map from 1883 (fig. 5), and I have tried to adapt it to the topographical map of those areas, which were not covered by the observations of the Nûgssuaq Expedition. A great help towards the elaboration of this map were also the photographs, which have been obligingly placed at our disposal by members of the mapping expedition to Svartenhuk, which took place in the years 1933—34 under the auspices of the Geodetical Institute. We consequently owe a great debt of gratitude to Stabsofficiant V. JENSEN AARIS, Søminemester JANUS SØRENSEN, Topograf A. GREVSEN and Topografassistent E. LAURSEN, seeing that by means of these photographs it has been possible to form an opinion on the geological conditions in areas which up to the present have not been visited by geologists. This first and foremost applies to the large valley, which connects the head of Umîvik with the Umîarfik fjord, in the following called the large sediment valley. In connection with the use of this material, the following remarks on the various geological formations may be added:

1. The phyllite formation. In agreement with K. J. V. STEENSTRUP's map the sides of the Uvkusigssat fjord were mapped as phyllite, and photographs taken by Mr. JANUS SØRENSEN show that within the frame of the map (plate 5), no other formations are to be seen in the immediate vicinity of the fjord. It is, however, possible that the phyllite is overlain by the basalt formation in the area between the Uvkusigssat fjord and the valley named Kangiussap agfâ, as is suggested by the topography. According to STEENSTRUP (see fig. 5) such a superposition takes place north of 72° lat. N. Judging by a colour photo taken by SOLE MUNCK the phyllite seems to appear as an original substratum

of now removed cretaceous sediments along the southern side of the bay of Kangiussap imâ near the head and on a small island in the bay.

2. The cretaceous sediments. According to K. J. V. Steenstrup sediments of the same kind as those on Itsako are found in the valley, which on the map of the Geodetical Institute is drained by the river Simiútap kûa, debouching into the Umîarfik fjord. Photographs taken by Mr. E. Laursen show that these sediments extend farther towards the southeast at both sides of the valley and continue, after the valley has changed its direction towards the south, a connection being obtained with the sediment area at Umîvik. Also on the south side of the Ingnerit peninsula there are corresponding sediments, as was proved by Steenstrup. Judging by the photographs of Mr. E. Laursen the sediment area seems to be much larger in extent than indicated by Steenstrup.

3. The basalt breccia. Particularly along the western side of the big sediment valley it seems, as appears from the photographs of Mr. E. Laursen, that the basalt breccia is very widely distributed. Above the cretaceous sediments the mountains here seem to be composed of dark, easily weathering rocks traversed by basalt dykes and, as contrasted with the plateau basalt, without any clearly marked stratification, this appearance being characteristic of the basalt breccia. These areas lie in direct continuation of the Firefjæld area, where the basalt breccia not only attains a considerable thickness, but also a very wide distribution. As mentioned in a previous chapter by Sole Munck (p. 48) the basalt breccia is also found on Ingnerit, which occurrence was first mentioned in Steenstrup's diary, its probable location appearing from plate 5. Photographs taken by Mr. Aaris from Qeqertarssuaq and short-range-photos taken by Mr. Janus Sørensen at Manîserqut show that basalt breccia without any doubt extends as far as the south-eastern corner of Svartenhuk.

4. The plateau basalts. The presumed basalt breccia in the large sediment valley is towards the west seen to be overlain by typical plateau basalts. Between the sediment valley and the Kangiussap agfâ valley there are very large areas of nearly horizontal plateau basalt, and the same is the case north of 72° lat. N. round the Uvkusigssat fjord.

The Structure of the Peninsula.

Before giving a concluding summary of the geological evolution of Svartenhuk, such as it appears from the material now at hand, two features which Lauge Koch (**13**, p. 300) considers of essential importance to the geology of the area will, as indicated on p. 14, be made subject to discussion.

"A Cretaceous coast line". In 1929 LAUGE KOCH, in accordance with ARNOLD HEIM (**11**, p. 184), set forth the hypothesis that the cretaceous sediments on the peninsula Nûgssuaq, the islands Upernivik and Qeqertarssuaq and the peninsulas Svartenhuk and Ingnerit had been deposited at the foot of "a coast cliff, 800 to 1000 m high", consisting of Pre-Cambrian rock. The position of this cliff appears from fig. 6, p. 15). In 1938 I had the opportunity to follow this line across the Nûgssuaq peninsula and was able to establish that it is here partly composed of a fault line of major importance extending from Sarqaq on the south coast of the peninsula to a point due west of Ikorfat on the north coast, partly of a fault of more secondary importance at Kûk on the north coast. The existence of the latter was already suggested by RAVN (**24**, p. 317). The character of the sediments near these fault lines shows that the faulting is younger than the sediments, as the sediments do not contain any trace whatsoever of the coarse material, which would indisputably have accumulated at the base of an about 1000 m steep cliff, but are of the same kind, whether they lie close to or are farther away from the "coast line". At Slibestensfjæld between Kûk and Ikorfat on the north coast of Nûgssuaq, another point in KOCH's "coast cliff", it was possible to prove that there was no cliff whatsoever, but that the sediments overlie a gneiss substratum rising evenly towards the south.

These occurrences along the north coast of Nûgssuaq were in 1939 investigated in detail by HELGE GRY, who was able to confirm the opinion set forth in the preceding. At Kangiussap imâ he had the opportunity to judge of KOCH's line, as far as Svartenhuk was concerned. Also here the natural explanation seems to be that the highly situated phyllite north of the bay is separated by faults from the sediments on Itsako (see p. 34). Further, photographs show that the Cretaceous sediments west of the valley Kangiussap agfâ adjoin a very high and steep phyllite escarpment, completely corresponding with the conditions at Kûk on Nûgssuaq.

"A fault line". In his work from 1929 LAUGE KOCH (**13**, p. 306) has indicated a fault line, which cuts off an area comprising south-western Svartenhuk, Ubekendt Ejland, north-western Nûgssuaq, Hareøen and the north-western part of Disko (see fig. 7, p. 15). West of this line strongly inclining beds of plateau basalt have been observed, whereas the corresponding beds are lying horizontally east of the line. In the case of Svartenhuk it has not been possible to prove the existence of this line in the place indicated by KOCH, and moreover the basalt beds on both sides of it dip towards the south-west.

The material observed seems to justify the following phases in the younger geological development of Svartenhuk.

Overlying a folded, crystalline Pre-Cambrian basement, chiefly consisting of phyllite, a series of sediments was deposited in Cretaceous and Early Tertiary time, at least 1 km thick and ranging from Kome beds (presumably Gault) to Upper Atanikerdluk beds (Danian or Early Tertiary) and including a marine series, in part Coniacian.

After the deposition of the sediments the south-western part of the area subsided by faulting, and by erosion the sediments were removed in the elevated northern part of the peninsula.

On an uneven surface, cut through sediments towards the south and phyllite towards the north, the basalt breccia was then deposited subaquatically, its greatly varying thickness contributing to the levelling of the former relief of the surface. Later on a several km thick series of plateau basalt was deposited over the basalt breccia.

After the basalt formation had been formed, the south-western part of Svartenhuk was tilted towards the south-west, along a line passing through Kangiussap imâ towards the west to the large sediment valley, the eastern side of which it follows in a northerly direction. To the east of this line the basalt formation rests horizontally on the phyllite substratum. Thus the tilting has followed a line, which seems to coincide with the older, pre-basaltic fault line mentioned above. Similar conditions are to be found in the Nûgssuaq peninsula (**27**, p. 660).

Up till now it has not been possible to prove whether this subsidence of the south-western area had commenced, while the forming of the basalt formation proper was in progress, seeing that unlike in north-western Nûgssuaq (Noe-Nygaard **21**, p. 72) no unconformity has yet been proved within the plateau basalts of Svartenhuk.

The problem whether the huge tilting over of the south-western area comprises one collected block or several blocks must also for the present be left unanswered. Variations in the dip, in connection with the fact that several fjords, such as Arfertuarssuk, Mitdlorfik and Amitsoq and a few valleys, have the same strike as the overturned plateau basalt suggest the presence of faults running northwest—southeast.

An exact estimate of the thickness of the basalt formation is for the same reason not possible at present, but it seems probable, as calculated by Noe-Nygaard, p. 55, that the thickness comprises several kilometers.

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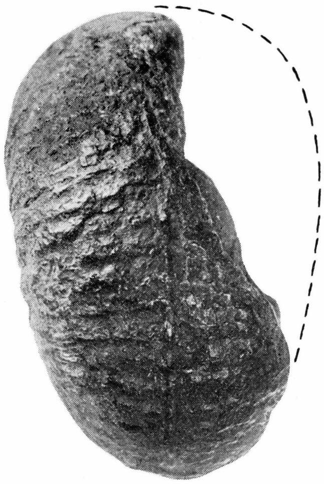
Færdig fra Trykkeriet den 31. Oktober 1942.

PLATES

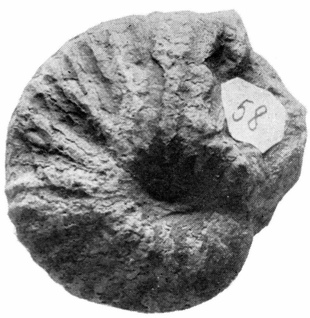
Plate 1.

Three badly preserved ammonites belonging to the *Scaphites ventricosus* group from the Coniacian. They were possibly collected by whalers in the 18th century or earlier and were later on incorporated in the Spengler collection, which in 1804 was purchased by the Royal Museum of Natural History at Copenhagen. Se p. 7.



1 a

1 b



2 a

2 b

3 b

3 a

CHR. HALKIER phot.

Plate 2.

Fig. 1. Pillow from the 1313 m mountain. See p. 50.

Transition from translucent marginal sideromelane (left) to compact, non-translucent interior basalt (right). The sideromelane is a little pigmented towards the boundary. Small, fluidally arranged felspar laths and large olivine phenocrysts with cubes of ore (magnetite?).

1 nic. 42 ×.

Fig. 2. Non-translucent, basaltic interior of a pillow from the 1313 m mountain with large, fresh olivine phenocrysts and fluidally arranged felspar laths. See p. 50.

1 nic. 42 ×.

Fig. 1.

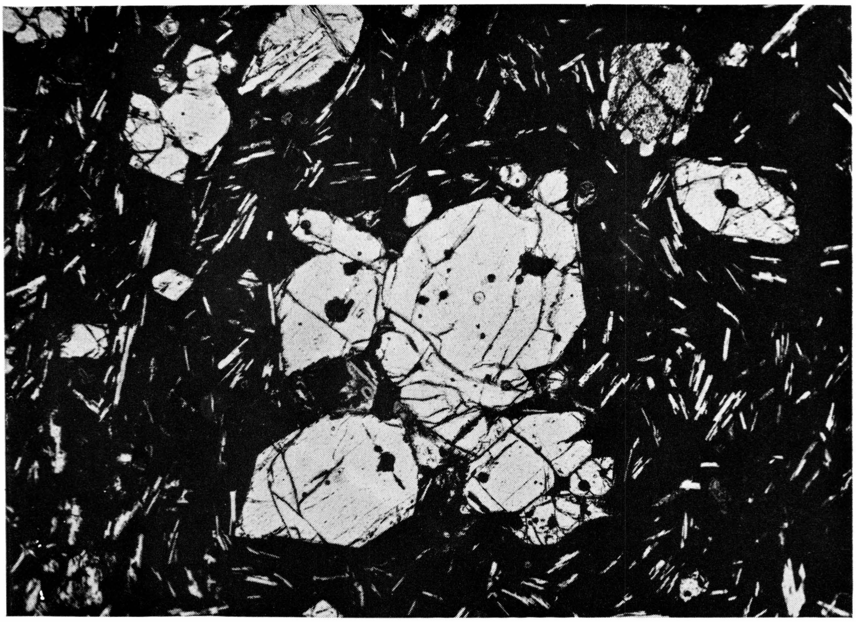


Fig. 2.

CHR. HALKIER phot.

Plate 3.

Fig. 1. Tuff bed in the basalt breccia, Umîviup qáqai, see p. 52. The sideromelane relicts are as a rule of no considerable size; in the lower left corner a single large grain; in this also large olivine and plagioclase phenocrysts. The chief constituents of the rock are palagonite and zeolites.

1 nic. 90 ×.

Fig. 2. Same. The sharp-curved boundaries of the original grains of ashes are seen more or less distinctly. The black areas are relicts of isotropic sideromelane, whereas the palagonite is distinctly doubly refracting.

1 nic. 90 ×.

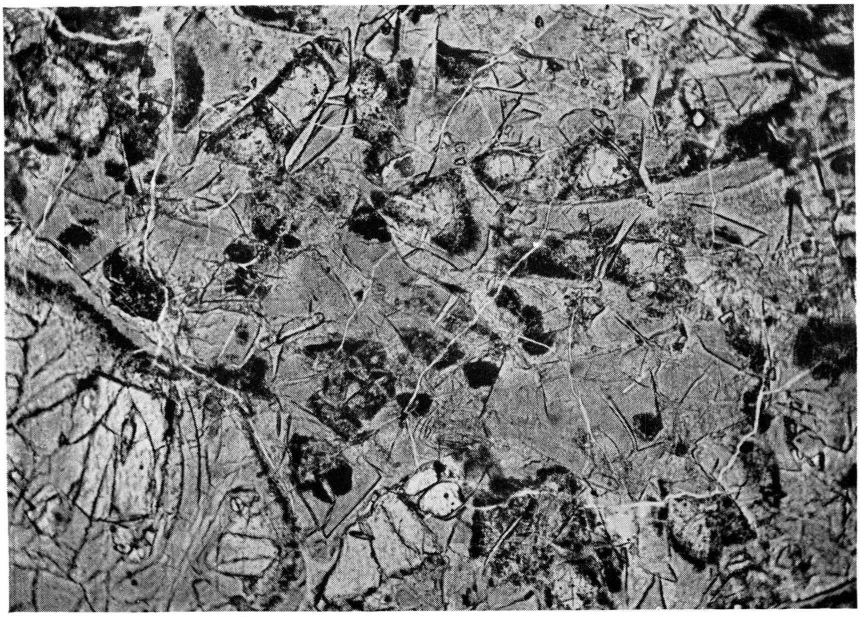


Fig. 1.

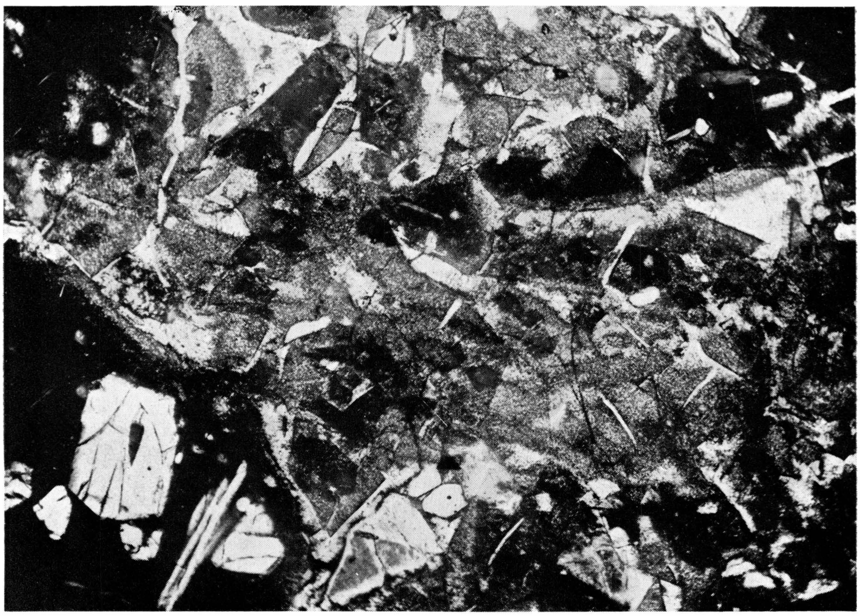


Fig. 2.

CHR. HALKIER phot.

Plate 4.

Fig. 1. Tuff bed in the basalt breccia, Umîviup qáqai (see p. 52). Section of larger, untransformed glass grain. In the centre is seen untransformed sideromelane with thin contraction-cracks and several small phenocrysts of olivine and plagioclase; then a pigmented transitional zone and farthest out the doubly refractory fibro-palagonite.

1 nic. 222 ×.

Fig. 2. Same. The fibrous border zone along the fibro-palagonite is distinctly birefringent.

+ nic. 222 ×.

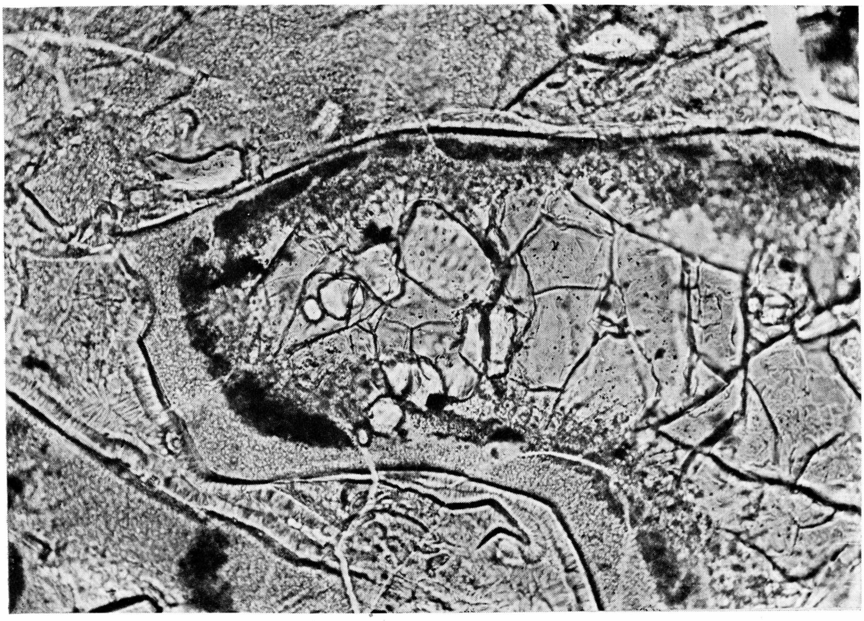


Fig. 1.

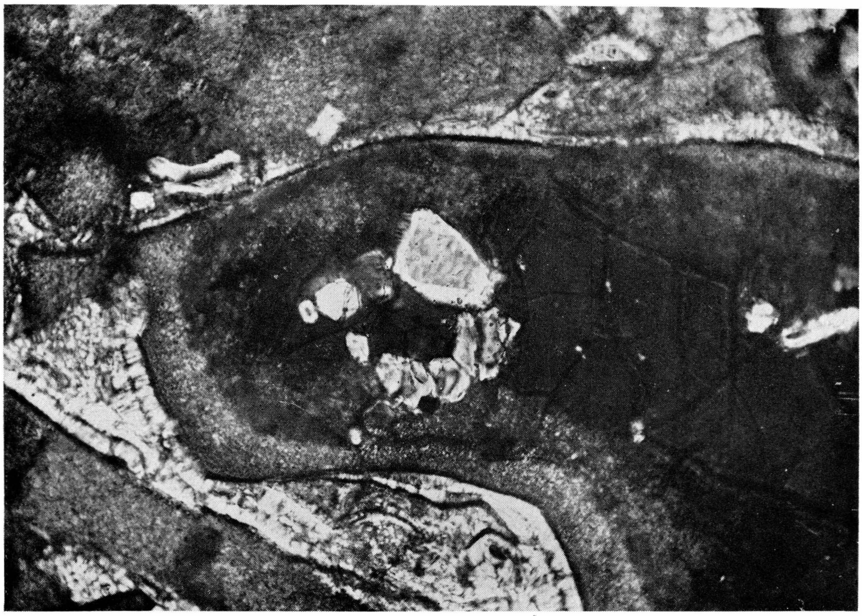


Fig. 2.

CHR. HALKIER phot.

Plate 5.

Geological map of the Svartenhuk peninsula, based upon the topographical map 71. V. 1. published by the Danish Geodetical Institute. The geological signatures are based upon the map of K. J. V. Steenstrup 1883 (fig. 5, p. 13) and the map compiled by the members of the Danish Nûgssuaq Expedition 1939 (fig. 9, p. 18). Moreover photographs taken by members of the mapping expedition of the Geodetical Institute 1933—34 have been used (see: p. 67).

Mud volcano

Plateau basalt

Plateau basalt probable occurrences

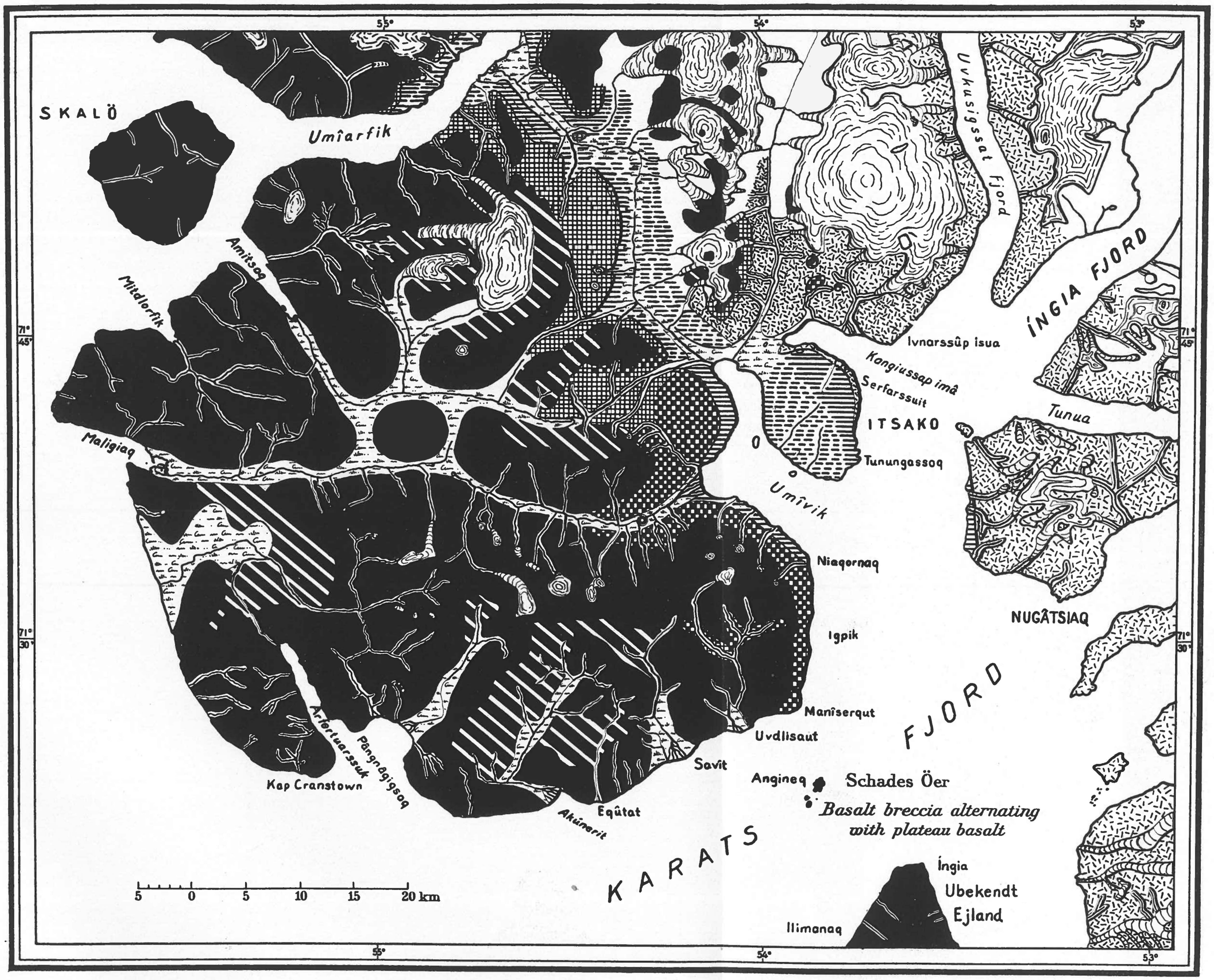
Basalt breccia

Basalt breccia probable occurrences

Sediments Cretaceous and Tertiary

Sediments Cretaceous and Tertiary probable occurrences

Precambrian in Svartenhuk phyllites


SKALÖ
Umîarfik
Amitsoq
Mitdlorfik
Maligiaq
Uvkusigssat fjord
ÍNGIA FJORD
Ivnarssûp isua
Kangiussap imâ
Serfarssuit
ITSAKO
Tunua
Tunungassoq
Umîvik
Niaqornaq
NUGÂTSIAQ
Igpik
Manîserqut
FJORD
Uvdlisaut
Savit
Angineq
Schades Öer
Basalt breccia alternating
with plateau basalt
Kap Cranstown
Pangnâgigsoq
Akúnerit
Equtat
KARATS
Íngia
Ubekendt
Ejland
Ilimanaq
5 0 5 10 15 20 km
55°
54°
53°
71° 45'
71° 30'