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UNDER LEDELSE AF ALFRED ROSENKRANTZ

ON THE GEOLOGY AND PETROGRAPHY OF THE WEST GREENLAND BASALT PROVINCE

PART III
THE PLATEAUBASALTS OF SVARTENHUK PENINSULA

BY

ARNE NOE-NYGAARD

WITH 25 FIGURES IN THE TEXT AND 10 PLATES

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C. A. REITZELS FORLAG
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PREFACE

In the first place I wish to express my sincere thanks to Docent ALFRED ROSENKRANTZ, the leader of "the Danish Nûgssuaq Expedition 1939", for the opportunity to visit the remote Svartenhuk district in West Greenland described in the present work, and for inspiring geological discussions during the journey and after our return.

I also wish to thank my fellow members of the expedition for good comradeship, in particular our skipper JENS OLSEN for his assistance and his understanding of geological needs, and Miss SOLE MUNCK, M. Sc. for valuable collaboration in field and laboratory.

In working out the material it has been a great help that Professor Ph. D. ASSAR HADDING of Lund kindly has let the laboratory of his institution prepare the thin-sections, and that Dr. SVEN PALMQUIST, also of Lund, has been able to carry out the new chemical analyses in spite of the difficulties created by the war situation.

The chemical analyses first published in this paper were carried out at the expense of the CARLSBERG FOUNDATION.

The microphotographs have been carefully executed by Mr. CHR. HALKIER of the Mineralogical Museum, and Mrs. AASE HOLST has undertaken the translation into English.

In conclusion, I wish to acknowledge my indebtedness to Professor O. B. BØGGILD, the director of the Mineralogical Museum of Copenhagen, for giving me working room in the museum and allowing me to make use of the collections and instruments of the institute for my work on the present paper.

ARNE NOE-NYGAARD.

1. Introduction.

The present work deals with some results of a reconnaissance trip from August 11th—15th incl. to the peninsula of Svartenhuk—so far the least known part of the West Greenland basalt area. The trip which was part of the itinerary of "The Danish Nûgssuaq Expedition 1939" was undertaken by the following members of the expedition, H. Gry, D. Laursen, S. Munck, A. Rosenkrantz and the author.

Of course, a short visit like that, does not enable us to give an exhaustive account of the conditions, but as we made a number of new geological observations, we have given a short description of the Svartenhuk geology together with a map of survey (36).

Some of the different geological observations, for example the prebasaltic, limnic and marine sediments, the basalt breccia formation, etc., will be treated more extensively, and published later.

I am, however, dealing with the basalt formation now, both because little is known of the petrography of Svartenhuk, and also because the territory forms a complete and geographically well defined whole. As the geology of Ubekendt Ejland, which lies between Svartenhuk and Nûgssuaq, will be described by members of the expedition led by H. Drever, the following pages may also be of some importance to their work.

Examinations have been made of 25 thin-sections, and 4 new analyses were carried out, the total number of chemical analyses from Svartenhuk thereby having been increased to 6. In this way we now possess a picture of the succession and variation of the rocks, which we have not had before, as well as investigations of the structure of the basalt plateau. With regard to earlier geological works dealing with Svartenhuk reference is made to the grouping in our aforementioned publication (36); of petrographic literature proper there is only one paper by H. Nieland (30).

No comparison is made between the districts to the south, i. e. Ubekendt Ejland, Nûgssuaq and Disko, as the large work on material collected by the Nûgssuaq expeditions from the two latter places has not yet been completed, and the existing accounts of these districts vary greatly as to nature and value.

As reference-map to the present paper the topographical map-sheet: 71. V. 1 Svartenhuk, published by the Geodetic Institute of Copenhagen may be recommended; the scale of the map is 1:250 000, and all place-names mentioned in the text can be found in it. The map of the travelling routes of the expedition contains the greater part of the place-names of interest (fig. 2).

2. Brief Outline of the Geology of Svartenhuk.

A brief survey of the geology of the Svartenhuk peninsula will be published at the same time as the present paper. The map accompanying this paper is reproduced here as fig. 1; it shows the main features of the geology, and only a few points will therefore be discussed here.

The oldest part within the area is a pre-Cambrian substratum, which about and north of Kangiussap imâ has developed chiefly as phyllite, as already stated by K. I. V. STEENSTRUP (38); the relation of the phyllite to the "Agpat Formation" south of it, which has been described by KRUEGER (27), is briefly dealt with in our preliminary report (15).

Resting on the phyllite there is on Itsako a series of sediments investigated by H. GRY, and along the base of Umîviup qaqai and Firefjeld at the head of Umîvik a series of marine sediments were found, a more detailed investigation of which has been carried out by A. ROSENKRANTZ; the fossils in the marine sediments determine their age to be Coniacian (comp. 15 and 36)

The so-called "basalt breccia formation" rests on a substratum of pre-Cambrian rocks and Cretaceous formations, and is succeeded by the plateau basalt series.

3. The Basalt Breccia Formation.

This section of the West Greenland basalt field has especially been investigated by SOLE MUNCK. The following brief survey of this characteristic formation is based on her description in the above account of the Svartenhuk geology. It is included in a little more detailed form in this paper, because the basalt breccia formation is so closely related to the plateau basalts which form the chief subject of this publication.

MUNCK believes the glass-rich breccia formation, chiefly composed of glassy, basaltic materials, tuffs and glass-coated pillows, to be a sub-aquatic formation. Intercalated layers of shale were found in the Svartenhuk breccia—in the Umîviup qaqai at a height of 291 m above sea-level, and the finegrained pyroclastic beds so often found in the breccia, are markedly stratified. Because of the extensive distribution of the breccia—from Disko Island to Svartenhuk Peninsula—it is highly probable that subaquatic here means submarine.

The areas covered by the breccia in Svartenhuk are shown on the geological map (fig. 1). The thickness of the formation in Umîviup qaqai is about 300 metres, in Firefjeld considerably greater (36).

Field Relations:

In Svartenhuk the breccia is divided in two parts, a lower, brown, and an upper, grey division; the latter being considerably thicker than the former.

The lower, brown breccia in Umîviup qaqai is very similar to the breccia formation developed at Godhavn on Disko.

On the top of the brown breccia there is a layer of black, sandy shale at least 1.5 m thick; this is overlain by the grey breccia.

The grey breccia is clearly bedded, beds of coarse breccia with a thickness of 5—10 metres alternating with layers of tuffs of varying thickness, often only one meter or less. The grey breccia carries a good deal of macroscopically visible olivine, and the matrix is rich in glass.

Petrography:

In a sample of a dense, greyish basalt from the brown breccia in Umîviup qaqai the groundmass consists of small plagioclase laths, a yellowish-green glass and a dark, pigmented, not birefringent substance, in which phenocrysts of bytownite (85 % an) and olivine rich in magnesia ($2\ V_\gamma = 89°$) occur; the latter are fewer in number and of smaller size than the former.

A section through a pillow from the grey breccia in Umîviup qaqai reveals an outside coating of glass of about 0.5 cm; the glass goes from brownish to yellowish-green and is quite isotropic. It contains laths of plagioclase (78 % an) and large olivines ($2\ V_\gamma = 89°$, $2\ V_\alpha = 85°$ averages in two slides) containing small individuals of black ore, and penetrated by cracks along which the olivine is decomposed. Inside the glass-coating the groundmass of the rock is pigmented and intranslucent; the phenocrysts remain the same, but in small cavities calcite and zeolites occur as later infillings.

A section through a pillow from the breccia in the mountain north of Kangiussap imâ, marked 1313 m on the map, where the breccia rests

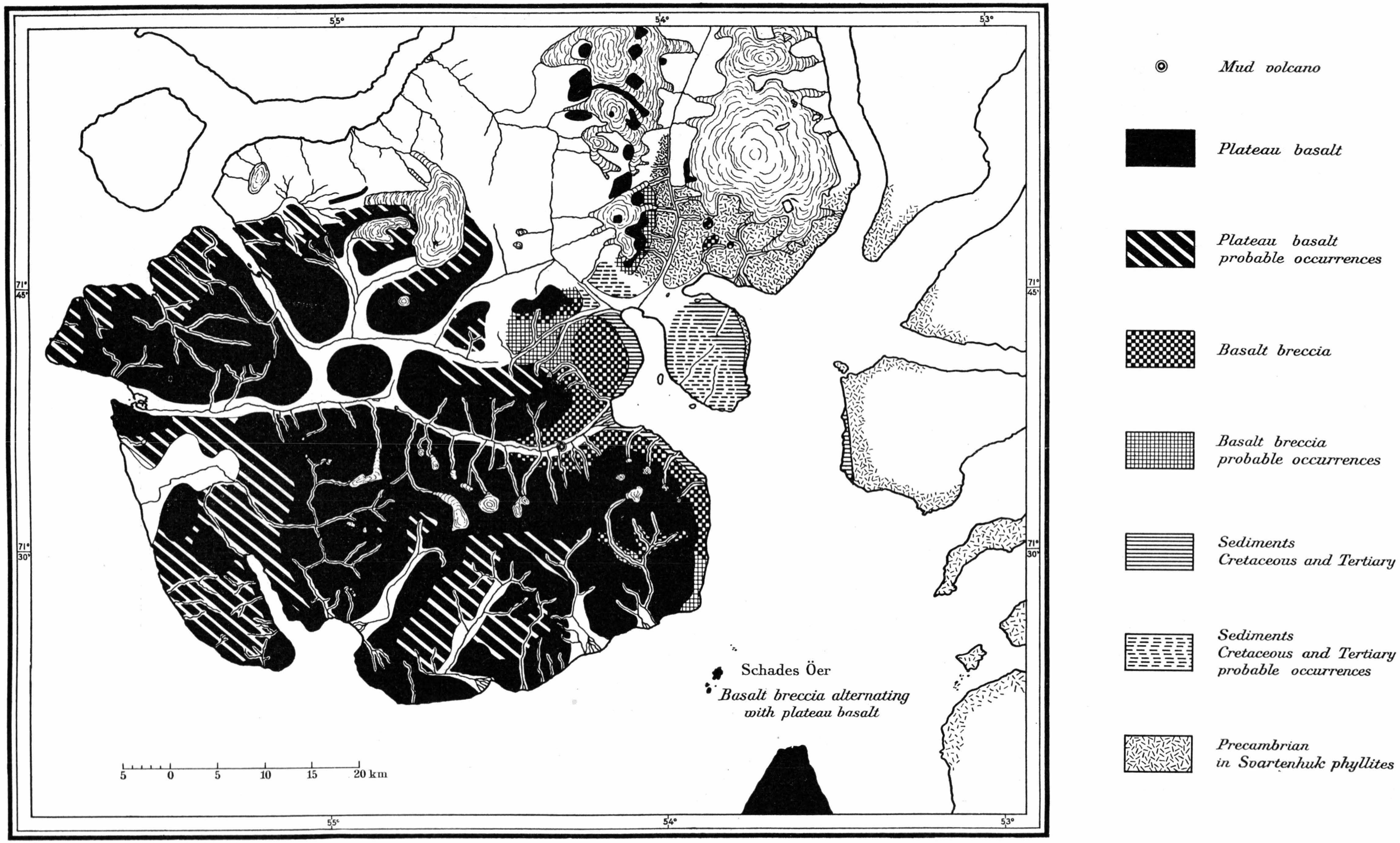

55°
54°
53°
71° 45'
71° 30'
Schades Öer
Basalt breccia alternating with plateau basalt
5 0 5 10 15 20 km
Mud volcano
Plateau basalt
Plateau basalt probable occurrences
Basalt breccia
Basalt breccia probable occurrences
Sediments Cretaceous and Tertiary
Sediments Cretaceous and Tertiary probable occurrences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

Fig. 1.

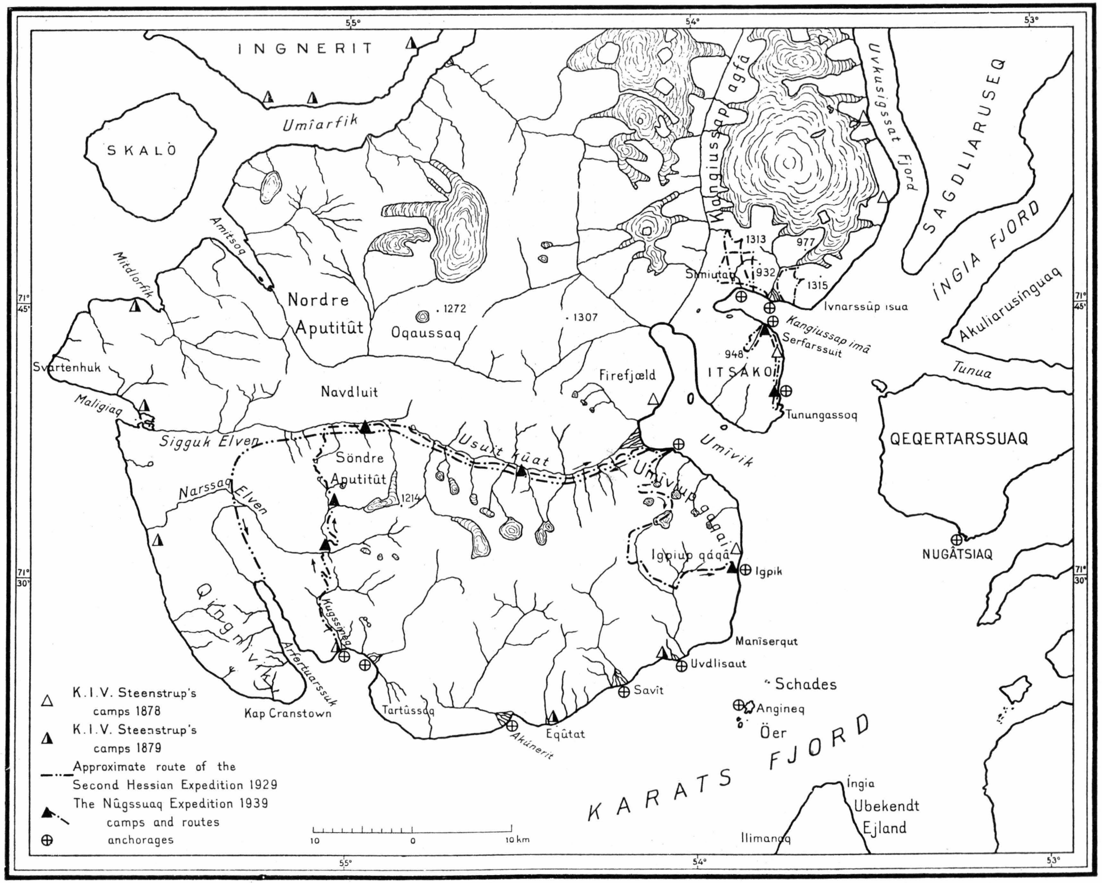


Fig. 2.

Fig. 1. Geologic map of Southern Svartenhuk, compiled by the members of the Nûgssuaq Expedition 1939 (36), drawn by A. ROSEN-KRANTZ.

Fig. 2. Map showing the travelling routes, camps and anchorages of the Nûgssuaq Expedition 1939.

on the pre-Cambrian phyllite formation, reveals an outer cover of glass about 1 cm thick. It consists of a pale, yellowish-green, quite fresh sideromelane with phenocrysts of plagioclase (81 % an) and olivine ($2\,V_\gamma = 89°$). Conditions in the inner part of the pillow are analogous with the pillow from Umîviup qaqai.

From the brief summary of the Svartenhuk breccia it must be concluded that volcanic activity started with the formation of a submarine accumulation in a shelf-area. The breccia filled out the lower parts of the surface. When sea-level was reached, the volcanic activity altered its character to the production of the subaerial lavas, which form the chief subject of the present treatise on the plateau basalt series of Svartenhuk.

The beginning of the subaerial volcanism seems to differ as to time in the various parts of the West Greenland basalt-province; but this question and a number of other problems in connection with the breccia formation will be dealt with later by S. MUNCK.

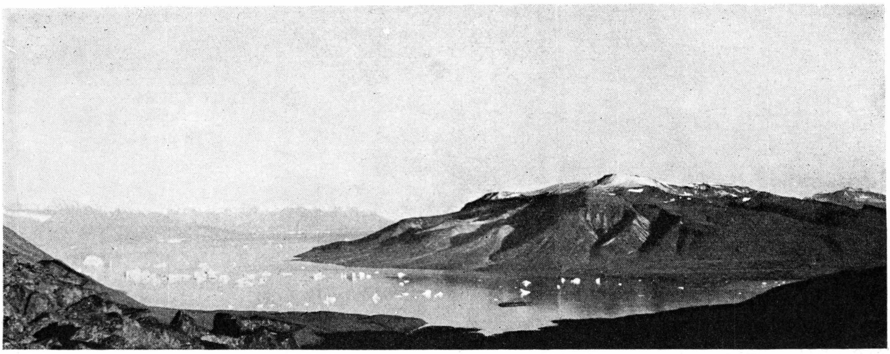
No chemical analyses of the Svartenhuk breccia have as yet been made; the existing optical data for plagioclases and olivines, however, enable us to form an opinion on the composition of the rapidly chilled basaltic magma of the breccia formation.

4. The Plateaubasalts; Investigations in the Field.

A. Doleritic sills in the sub-basaltic sediments.

The young Mesozoic-Tertiary sediments on the Itsako peninsula were examined by H. GRY. These sediments and possibly similar formations in a small area of Qeqertarssuaq farther east are traversed by somewhat irregular sills. From Itsako GRY collected three samples of intrusives, no. 1255 from 300 metres above sea-level over Tunungassoq, and no.s 1256 and 1257 from almost the same locality, but from a lower level, presumably a different sill; GRY believes that the two latter samples belong to the same sill.

In a sketch of the east side of Itsako drawn by GRY basalt is indicated on three different levels, but as the cliff wall is full of screes, he has not been able to trace the basalt continuously for the whole stretch; the individual exposures, however, within each system are in so close continuation to each other that they must be looked upon as of one set. The matter is further complicated by the fact that irregular dykes are evidently present, the boundaries of which are difficult to determine on account of a thick covering of talus. In ravines GRY has ascertained



Author phot. 12/8-39.

Fig. 3. Itsako Peninsula seen from the North across Kangiussap imâ; at sea-level to the east, at Serfarssuit, the crystalline basement crops out, it is overlain by Cretaceous sediments penetrated by doleritic sills.

that one of the sheets of basalt appearing as a sill in the wall had a considerable dip into the host rock in a westerly direction; this is possibly the remains of a cone-sheet.

The samples from Itsako are dolerites with subordinate olivine; the most coarse-grained of them—No. 1255—has a micro-granitic interstitial mass.

When seen from the north coast of Kangiussap imâ there is on the north side of Itsako an almost horizontal sill in the middle of the wall, in the upper part of the cliff there are still parts of one or two more, and a little above sea-level some basalt is seen here and there far east; but from a distance it was impossible to determine, whether this is part of a sill or irregular dykes, see fig. 3.

In Umîviup qaqai, south of Itsako, intrusive in the grey breccia there was a dyke containing a rock strongly resembling the Itsako dolerites; the texture is doleritic, the rock contains more olivine. In the petrographic part of this work it is described together with the Itsako dolerites.

B. The Plateaubasalts proper.

Our investigations in the largest district of Svartenhuk—the plateaubasalt area—were made by four routes. (Comp. map fig. 2).

1. A reconnaissance trip from the bay at Pangnagigsok near the mouth of Arfertuarssuk Fjord in the south-west corner of the peninsula along the river Kugssineq continuing along the Søndre Aputitût mountain to the large Usuit kûat valley, which intersects the peninsula from west to east. This route was followed by D. Laursen and

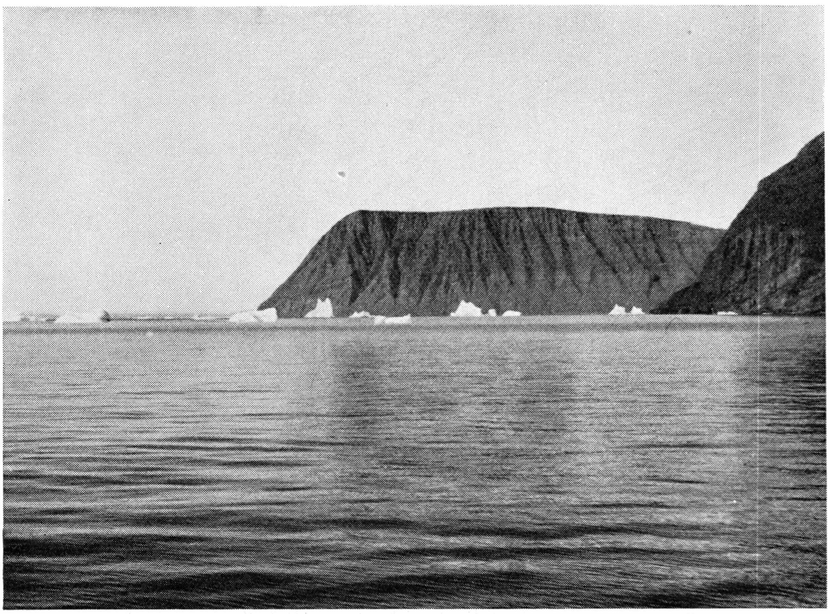
A. ROSENKRANTZ and joins the one below. In the following it will be called"the North-South Section" and forms an acute angle with the strike of the strata.

2. A continuation of route no. 1 eastwards from the Navdluit mountain through the Usuit kûat valley to the head of Umîvik Fjord, "the East-West section". The investigations along this route were also made by D. LAURSEN and A. ROSENKRANTZ.

3. Moving by motorboat along the coast eastwards from Pangnagigsok via Eqûtat, Savît, Uvdlisaut, Manîserqut, Niaqornaq to Itsako, a detour was made to Schades Øer. Observations from this coastal route were made by S. MUNCK and the author.

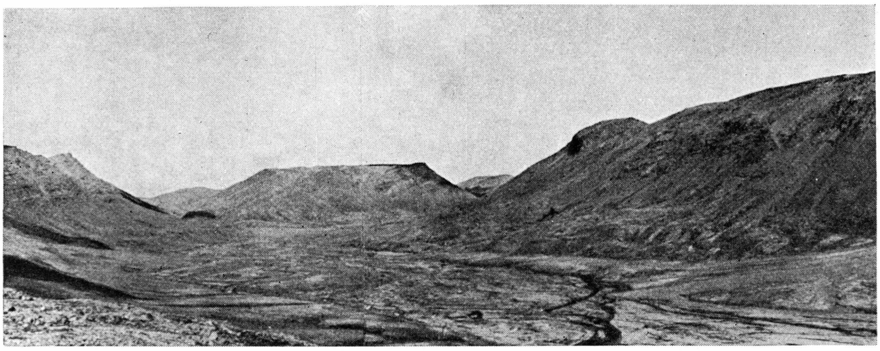
4. Traversing the Umîviup qaqai mountain complex from the head of the Umîvik fjord across the ridge, through the hinterland to Igpik on the east side of the peninsula. The route was travelled by S. MUNCK and myself.

In addition to these principal tours investigations were made by S. MUNCK and the writer north of the Kangiussap imâ fjord, chiefly in connection with the pre-Cambrian phyllite series and the basaltic breccia



A. ROSENKRANTZ phot. 11/8-39.

Fig. 4. Kap Cranstown, at the entrance to the fjord Arfertuarssuk, South-west Svartenhuk. Plateaubasalt dipping towards the Southwest (This dip is in accordance with STEENSTRUP's diary, but not with the map published by the same author in 1883 (38)).



S. MUNCK phot. 11/8-39.

Fig. 5. Kugssineq valley, South-west Svartenhuk, seen from the slopes of Pangnagigsoq towards the Northwest. Plateaubasalts dipping towards the Southwest.

formation—and, as said before intrusive sills on the Itsako peninsula were dealt with by H. GRY.

As the Nûgssuaq expedition did not have time to visit the inner part of the Arfertuarssuk Fjord we must in this connection draw attention to NIELAND's investigations in 1931. These will be discussed later (p. 41 and p. 51).

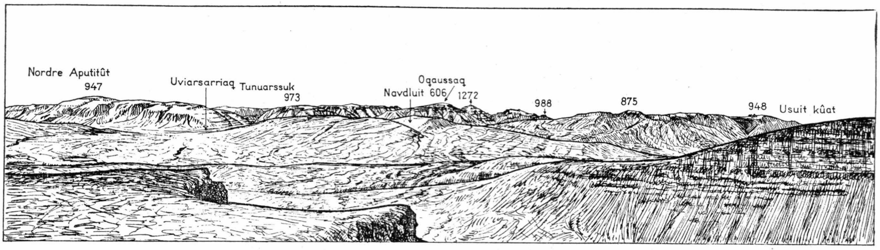
1. The North—South Section.

The author visited the Pangnagigsok mountain for a couple of hours. The dip is here 25°—30° south-west and seems to be constant in the outer parts of the Kugssineq valley.

The rocks are mostly finely grained or solid homogeneous plateaubasalts, occasionally of a lamellated appearance (sample no. 2243). Between the actual basalt sheets agglomeratic layers are found, which on account of their brownish weathering colours stand out in the walls as distinct bands (sample no. 2246).

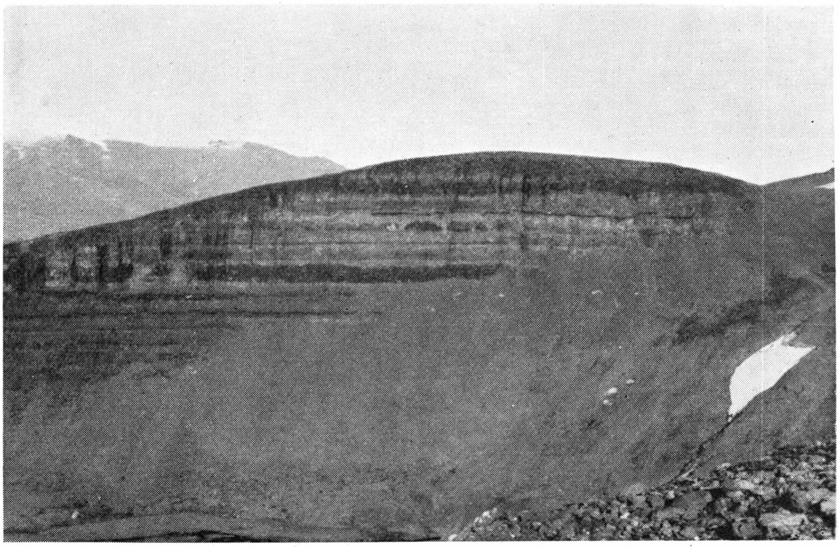
From the delta of the Kugssineq river specimens of various rocks of different nature were collected (samples 2245a, 2245b and 2245c). In this place a great deal of material belonging to the metamorphic complex was also seen, presumable coming from washed out moraine material (marble, phyllite, quartzite, etc.).

ROSENKRANTZ states the dip to be about the same on the whole north—south route (comp. map, fig. 13). From south to north the following samples were taken: About 8 kilometres from the mouth of the Kugssineq river at a height of 130 m above sea-level no. 758; 16 kilometres from the mouth of the same river no. 670, and from the west side of the Söndre Aputitût mountain at a height of 660 m above sea-level no. 761.



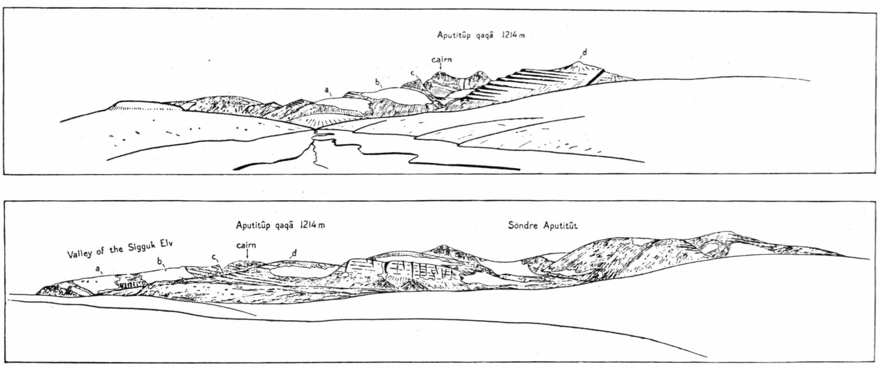
After a sketch by A. ROSENKRANTZ 13/8-39.

Fig. 6. Central part of Svartenhuk seen from the northern slope of Søndre Aputitût from an altitude of about 600 m.



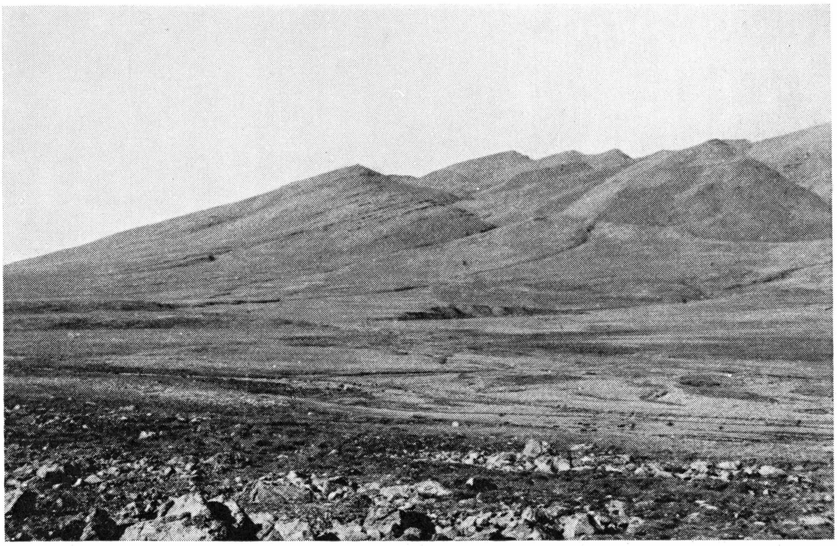
A. ROSENKRANTZ phot. 14/8-39.

Fig. 7. Plateaubasalt, apparently horizontal owing to the rock face lying almost in the strike. Detail of fig. 6. (Right side).



Sketches by A. ROSENKRANTZ 14/8-39.

Fig. 8. Søndre Aputitût and Aputitûp qaqâ seen from the North. The lower sketch taken from the big valley drained by the Sigguk river opposite Navdluit; the upper one from the small lake at the foot of Navdluit. (To the right of "d" a basalt dyke).



A. ROSENKRANTZ phot. 14/8-39.

Fig. 9. North side of the Usuit kuât valley due east of Navdluit showing the general southwesterly dip of the plateau basalts.

A. ROSENKRANTZ phot. 14/8-39.

Fig. 10. Navdluit seen from the East. The mountain, which is not as regular as shown in the topographic map, consists of plateau basalts dipping Southwest.

2. The West—East Section.

ROSENKRANTZ states that the strike is practically the same through the whole series passed in the Usuit kûat valley, the dip perhaps becomming slightly less steep in an easterly direction. From this route are the samples: no. 763, collected at an altitude of 440 m on the north side of the Søndre Aputitût mountain opposite Navdluit; no. 767 taken 13 kilometres from the eastermost end of the valley at 105 m above the sea, both taken in situ, and no. 768 from almost the same locality, but collected as a loose block in a river bed filled with numerous pebbles of the same kind at a height of 95 m above sea-level.

ROSENKRANTZ also investigated the areal extent of the breccia into the Usuit kûat and adjacent valleys and the distribution of dykes.

3. The Coastal Route.

As far as we could see from the boat, the strike along the route travelled is the same. As said before the dip was 25° at Pangnagigsok; between Equtat and Savît it measured 17°, and at Uvdlisaut 22° (the last two observations were made from the boat in passing).

We had only time to go ashore in one place, Uvdlisaut, where we collected a loose block of picrite-basalt, no. 2249.

4. Crossing the Umîviup qaqai complex.

S. MUNCK and the writer, who undertook the ascent, started on the route from the innermost of the four streams each of which drain a small glacier on the south side of the Umîvik fjord. We followed the stream to a height of 400 m above the sea, and then kept a south-westerly course across the western corner of the complex in order to make a curved ascent to the top, which on the topographical map is marked 914 m. We then followed the ridge itself in a south-easterly direction almost to a top marked 1149 m, and continued downwards to the south-west across a glacier which drains into the Uvdlisaut river. After a westward curve we reached almost due east of the 853 m mountain a canyon made by the aforementioned glacier stream; we followed the river until we came to a tributary coming from the north, and continued along the latter until arriving in a valley south of the Igpiup qáqâ mountain. We passed this valley and, by crossing a pass, reached the coast at Igpik.

On the north side of Umîviup qaqai after having passed a series of marine beds and the submarine basalt breccia formation we found the real plateau basalt series at 450m above sea-level. The plateaubasalt occupies the whole upper part of the mountain as shown in fig. 12. We traced it to a height of 1204 m above the sea. Taking the dip into consideration the thickness is here about 700 m.

Descending the south side of the same complex we found the breccia in the canyon to be solid at 270 m. The upper limit of the breccia

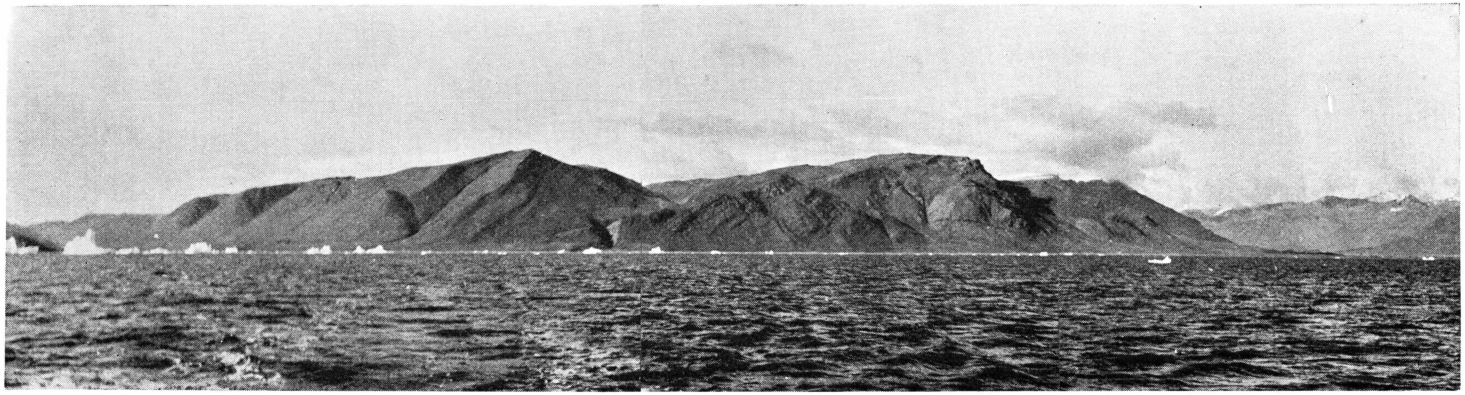


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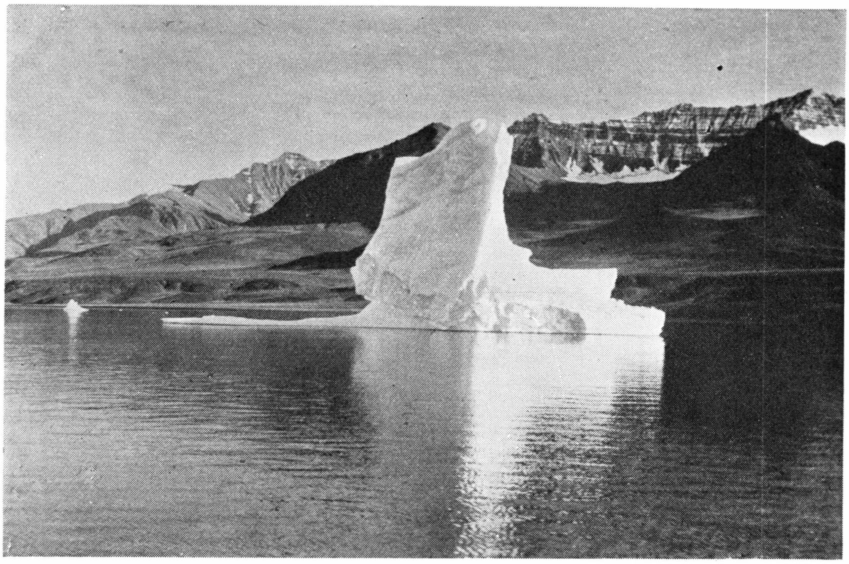
Fig. 11. Southeast corner of Svartenhuk—from Uvdlisaut to Kakilíssat—seen from the South. Basalt breccia with strong south-westerly dip.



A. ROSENKRANTZ phot. 15/8 39.

Fig. 12. Eastern part of Umîviup qaqai seen from the Umîvik fjord. The mountain consists of plateau basalts overlying basalt breccia. The low foreland consists of marine Cretaceous shales.

probably rises still higher; but this we were unable to ascertain on account of a cover of loose material in the valley. From where the streams meet and enter the main river, which drains into the Uvdlisaut river, the breccia can again be traced in a northerly direction under the Umîviup qaqai mountain. At the point south of Igpiup qáqâ where we turned eastwards, the boundary between the breccia and plateaubasalt was 306 m above sea-level.

In the south flank of Igpiup qáqâ the surface of the breccia almost reached the pass down to Igpik; the uppermost certain exposure of solid breccia with large pillows was 382 m above the sea.

The investigations may be summarized as follows: the upper contact of the breccia formation, i. e. the lower contact of the plateau basalt, has a strike which almost corresponds to the coast line of the south side of the Umîvik fjord. The height of the breccia above the sea is in the west side of Umîviup qaqai about 450 m and over Igpik 400 m, in the aforementioned river running north—south about 300 m. The strike of the basalt formation seems almost to coincide with the substratum of marine shales.

On account of the length of the excursion and the difficult territory, we only collected samples from the breccia formation and a large number of dykes (comp. following chapter).

C. Dykes.

On the south-west side of Svartenhuk in the cliff marked 567 m on the map, east of the river Kugssineq, we noticed three dykes running irregularly with a strike almost due north—south.

On routes 1 and 2 Rosenkrantz only observed one dyke in the western and central part of the peninsula, namely in the Søndre Aputitût complex, with a north-east south-west strike. At the eastern end of the Usuit kûat valley dykes become more frequent and reach their maximum number near the bottom of the basalt and in the underlying breccia.

On the coastal route from Igdlerussat to Eqûtat no dykes were observed possibly on account of very bad visibility (fog). Between Eqûtat and Savît, nearest to Savît, dykes are seen, either intersecting the coast at acute angles or running almost parallel with it. In the valley near Savît and in the coast cliff there are numerous dykes, mostly with a W.N.W.—E.S.E. strike. Two other cross-cutting directions are represented by the smaller number of three, two strike almost north—south and a single one N.N.W.—S.S.E. The majority of the dykes belonging to the first system observed in the valley of Savît intersect the coast before Uvdlisaut; as we made a detour from this point to Schades' Øer and did not reach the coast again until Igpik, we have no data from the intermediate stretch.

As the distance from the coast and the visibility varied a good deal, the above observations should be accepted with some reservation. All the same, I record them here, because they supply us with certain data. The directions of the dykes have been measured from a distance, and no samples were collected.

From the investigation of the Umîviup qaqai complex nine dykes were measured and more closely examined.

The first strikes almost parallel with the south side of the Umîvik-fjord; it is 3 m thick, and its course irregular. The sample, a dolerite, was collected at an altitude of 336 m above sea-level (no. 2271).

The second dyke striking E.N.E.—W.S.W. is vertical and has a thickness of 2 m. The rock, a picrite-basalt (no. 2272), was collected 448 m above the sea.

The third striking almost due E.—W. is about 10 m thick and dips steeply, about 80°, southwards. The rock is an olivine-basalt, the sample (no. 2273) being taken 474 m above sea-level.

The ridge itself, which was followed from the 914 m top to the 1140 m top, has a N.W.—S.E. strike, and consists of an olivine-basaltic dyke of varying thickness. The dyke is vertical, and the rock type harmonizes macroscopically with the one described above.

On the north side there are three, on the south side two dykes

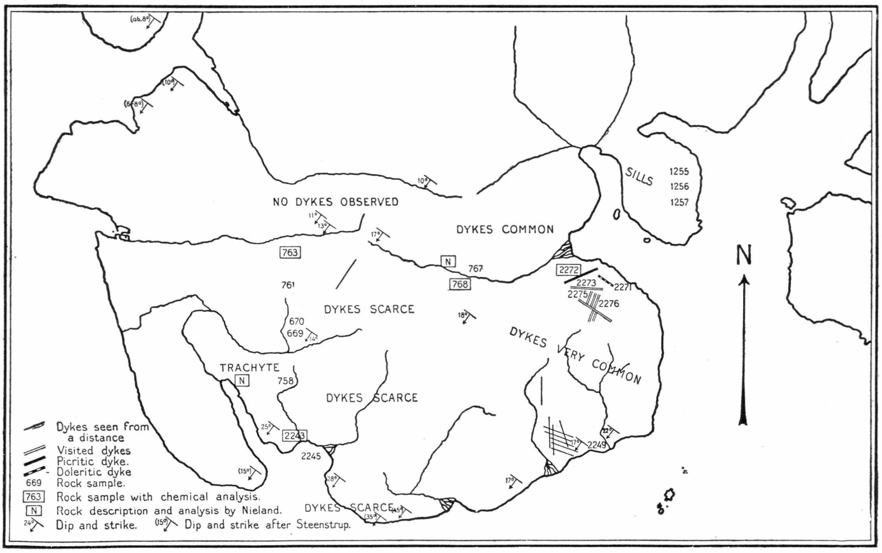


Fig. 13. Contour map of Svartenhuk showing the distribution of dykes recorded by the expedition, and the dip of the lavas; some of the observations made by STEENSTRUP in 1879 have been added. The numbers of the samples described in the present paper have been entered on the map.

cross-cutting the mountain in a N.N.E.—S.S.W. direction. They are all plagioclase-porphyric basalts, and the samples, nos. 2275 and 2276, are taken from the first and the third dyke in the north side of the ridge respectively. The thickness of the dykes in this system varies from 2 m to 6—8 m.

The investigations of dykes have been recorded on the sketch. They are too few and scattered to make a complete picture of the conditions; but there seems to be two main systems, one almost parallel with the strike of the plateaubasalt series, and one at right angles to it. The former is represented by the dyke swarm at Savît, the dyke (olivine-basalt) along the Umîviup qaqai ridge, and the doleritic dyke in the same locality. The second system appears as five parallel dykes in Umîviup qaqai (felspar-porphyric basalts). Different are the two dykes, nos. 2272 and 2273, in Umîviup qaqai, and quite crossing are the dykes observed from the sea in the valley near Savît, they strike north—south.

5. The Plateau Basalts; Petrography.

The optical determinations are almost exclusively carried out on the universal-stage (system LEITZ).

In pigeonites and olivines 2 V were determined by orienting β // K, taking into consideration the difference in refringence between mineral and glashemisphere; in most cases a number of individuals of each mineral were measured in each slide. The angle of extinction in the pyroxene was also determined on the universal-stage, mainly by adjustment of the optical normal and corresponding measuring of the extinction on both sides of the composition plane in a twinned individual. In single cases $c \wedge \gamma$ were obtained through construction (BURRI).

The plagioclase-determinations were carried out ad modus REINHARD both as regards the determination of the anorthite-contents and the twin-laws.

The quantitative mineral-composition was measured, whenever possible, on an integration-table (system LEITZ). Indicatrix-lengths of 30—35 cm were used.

A. Dolerites.

In this chapter three samples from the dolerite sills of Itsako, investigated by GRY, are dealt with, as well as a single sample of the doleritic dyke in the north side of Umîviup qaqai.

1. Olivine-carrying pigeonite-dolerite with micrographic interstitial mass (no. 1255). (Cf. pl. 1.)

Sill near Tunungassoq. The rock is fairly coarse-grained, the texture doleritic (KROKSTRÖM, 24).

The fresh plagioclase contains simple as well as multiple twins; only a few of the larger individuals show zoning. In a larger individual the anorthite-contents measured

Core .... 63 % an
Outer zone .... 53 % an.

The biggest laths have a length of 2 mm and a width of 0.7 mm. The average size, however, is a good deal smaller.

The pyroxene is fresh, slightly ash-coloured and shows no pleochroism. The grains of pyroxene occur partly in groups of 20—30 individuals, where the single individuals do not have an independant crystal form, partly as automorphic or sub-automorphic individuals evenly distributed. Both simple and multiple twins occur, chiefly in the isolated individuals; the twin-plane is (100). In the basal section the angle between the directions of cleavage was measured to be near to 87°. A few larger individuals reach a length of more than 1 mm The following optic values were determined:

1.	$2\,V\gamma = 44°$,	$c \wedge \gamma = 44°$	$En_{45}Fs_{29}Wo_{26}$
2.	— ,	$c \wedge \gamma = 43°$	
3.	$2\,V = 49°$ (core)	—	
	$2\,V = 44°$ (outer zone)	—	
Average:	$2\,V\gamma = 46°$,	$c \wedge \gamma = 43°5$	$En_{47}Fs_{26}Wo_{27}$

Sometimes slight zoning is found, and attempts at hour-glass structures occur.

A few grains of phenocrystic olivine with rounded contours occur —fairly evenly distributed in the rock, many of them surrounded by later pyroxene.

Besides ore the olivine also contains a few laths of plagioclase, the crystallisation of which must thus have commenced before the expiration of the period of the olivine formation. A single olivine phenocryst reached the remarkable size of 1.8 mm in length, most of them have a diameter of just over or under 0.5 mm. A few of the olivine phenocrysts contain no decomposition products whatever; but most of them contain larger or smaller quantities of chloritic material varying from colourless to greenish, and most often part of another pseudomorphic substance of a reddish-brown colour and conspicuous birefringence (iddingsite?). At times all the primary material has been replaced by alteration products, and only the contour and the original irregular cracks in the mineral show that it is pseudomorphic on olivine. In two fresh individuals the following values of the angle of optic axes were determined:

1.	$2\,V\alpha = 84°$	Fa_{25}
2.	$2\,V\alpha = 82°$	Fa_{30}
Average:	$2\,V\alpha = 83°$	Fa_{28}.

The ore occurs partly as larger individuals, the borders of which to the plagioclase often are determined by the latter, partly as irregular, elongated, interstial individuals; it seems that some of the ore is a relatively late product. Besides the aforementioned ore, smaller, equidimensional grains with automorphic borders are fairly evenly distributed in the rock. Finally, there are small, rounded grains in pseudomorphic olivine and in the interstitial mass. Small individuals of pyroxene, and in a single case a small lath of plagioclase occur sporadically in the ore.

A few prisms and small hexagonal sections of apatite are evenly distributed in the rock.

Even if the rock is olivine-carrying, there is a microgranitic interstitial mass, which is very conspicuous on account of the brownish transformation products of the potash felspar, and the transparent quartz grains.

The mineral composition as measured on the integration table is as follows:

	Vol-%	Weight-%
Plagioclase	52.1	46.4
Pyroxene	34.4	39.3
Olivine (+ a small quantity of pseudomorphic substance)	3.0	4.0
Pseudomorphs on Olivine	0.5	
Ore	3.4	4.5
Apatite	0.1	0.1
Interstitial mass ... 6.5		
of this Chlorite ... about	3.2	2.9
Microgranite ... about 3.3		
of this Potash Felspar about	2.2	1.8
Quartz ... about	1.1	1.0

2. Olivine-carrying pigeonite-dolerite (no. 1256).

The sample was taken from an exposure—presumably a sill—near Tunungassoq. The rock is almost of the same character as No. 1255, but more fine-grained; it contains more chloritic substance, but no microgranite as interstitial mass. The texture is doleritic (Krokström, 24).

The plagioclase comes up to 1.6 mm in length; the maximum breadth is 0.7 mm, but most individuals are smaller. The following anorthite contents was determined:

Core ... 59 % an.

Zoning is seen, although not very pronounced.

The pyroxene is faintly smoke-coloured. Twins are seen, but are less numerous than in the coarse grained no. 1255. The largest size measured was 1.2 by 0.9 mm, most individuals being equidimensional with a diameter of about 0.6 mm. The following optic values were determined:

$2\,V\gamma = 49°, \quad c \wedge \gamma = 42°.5$ ... $En_{47}Fs_{21}Wo_{32}$.

The olivine is on the whole quite fresh, although some scattered chloritic transformation products are found. A few individuals are more than 1 mm, the majority have a size of about 0.7 by 0.7, and very few are under 0.5 mm. The angle of optic axes was

$$2\,V\alpha = 84^\circ \ldots\ldots\ldots\ldots\ldots\ldots \mathrm{Fa}_{25}$$

Ore is found in irregular individuals which come up to more than 1 mm in length, and numerous isolated small grains occur, which measure 0.2—0.3 mm in both directions.

Apatite is fairly evenly distributed in the rock and is seen in the thin sections as long, slender prisms or small, hexagonal sections.

3. Olivine-carrying pigeonite-dolerite (no. 1257).

As was the case with the foregoing samples, the present one comes from the east side of Itsako.

The composition of the rock is almost the same, and, as in no. 1255, this sample too contains a little micrographic interstitial mass. The texture is sub-doleritic (KROKSTRÖM, 24).

The rock contains only insignificant remains of olivine, but a certain amount of chloritic substance. Only few plagioclase laths have a length of 1 mm; the rest of the plagioclases and the other components are much smaller. There is a fairly continuous diminuation of the size of the grains from 1255 via 1256 to 1257.

The following optical determinations were made:

Plagioclase:	Large individual	(core)	67 % an
	Small lath	(core)	52 % an.

Pyroxene:	1.	$2\,V\gamma = 50^\circ$,	—	
	2.	—	$c \wedge \gamma = 44^\circ$	
	Average:	$2\,V\gamma = 50^\circ$,	$c \wedge \gamma = 44^\circ$	...... $\mathrm{En}_{40.5}\mathrm{Fs}_{29}\mathrm{Wo}_{30.5}$

The pyroxene contains the same characteristical multiple twins as the two preceding sections.

4. Olivine-pigeonite-dolerite (no. 2271).

A single dyke through the grey breccia in the north side of Umîviup qaqai should also be included in the doleritic group; the sample examined was collected by the author at an altitude of 336 m.

If this dyke belongs to the same epoch as the doleritic sills described above, as is likely from the petrographic conditions, we get certain data with regard to the age of the dolerites in relation to the extrusive basalt series; they must be younger than the beginning of the extensive volcanic activity, as they show intrusive contact against the youngest part of the submarine basalt breccia.

The rock from Umîviup qaqai contains more olivine than the doleritic sills from Itsako and also some brown glass substance which is wholly or nearly absent from the Itsako rocks.

Olivine and to a certain extent pyroxene have given rise to a good deal of chloritic material, which is found both as large areas and as an infilling in thin cracks in the other minerals. The rock is rather coarse-grained, as all the three chief components come up to a length of 1 mm, the plagioclase even to 1.5 mm.

The plagioclase is highly zoned, but with a continuous variation of the extinction from centre to margin. The pyroxene is often twinned on (100).

The following optical determinations were made:

Plagioclase:	Core		70 %
	Outer zone		40 %
Pyroxene:	1. $2V\gamma = 50°$,	—	
	2. $2V\gamma = 48°$,	—	
	3. — ,	$c \wedge \gamma = 43°.5$	
Average:	$2V\gamma = 49°$,	$c \wedge \gamma = 43°.5$	$En_{43}Fs_{26.5}Wo_{30.5}$
Olivine:	$2V\alpha = 88°$		Fa_{16}

Besides the main components a certain amount of ore and a small quantity of zeolitic material are found.

B. Plateaubasalts proper and dykes.

The examination of the material shows that petrographically the rocks of the lava sheets in the plateau and the rocks of the dykes cutting through it agree so well that it is impossible to separate them, and they will be treated together. This agreement as regards rocks will be discussed later in chapter 8.

Broadly speaking, the petrographic succession seems to coincide with the chronological succession.

First some ultra-basic rocks, here classified as picrite-basalts, will be dealt with. The most basic of them should perhaps be included under picrites; but as they contain 20 per cent plagioclase, and by continuous transition are connected with the ones immediately following, the present grouping seems to be justified. It is remarkable that the plagioclase in the most basic representatives is labradorite; but this must be due to the circumstance that together with the labradorite there is a diopsidic pyroxene, whereby a certain amount of Ca, which otherwise might have entered into the plagioclase, has been retained in the pyroxene.

In their description of the "marginal border group" in the Skaergaard complex of S.E. Greenland WAGER and DEER (14, p.159—164) mention a rock which they call gabbro-picrite, and which seems to be related to the picrite-basalts nos. 768 and 2249 from Svartenhuk. The gabbro-picrite from the Skaergaard massif has the following modal composition:

	vol-%
Olivine (Fa_{20})	65.0
Clinopyroxene ($En_{48}Fs_5Wo_{47}$)	13.8
Hypersthene (Ab. 20 % Fe SiO_3)	4.7
Plagioclase (zoned from An_{65} to An_{45})	15.8
Ore (primary)	0.7

WAGER & DEER do not think it possible to describe the rock as a peridotite, as the plagioclase is labradorite and not bytownite; on the other hand, the rock is too extremely olivine-rich to be called olivine gabbro, so for want of a better name they call it gabbro-picrite. In analogy herewith I have used the collective term: picrite-basalt, which in the following discussion comprises ultra-basic rocks with from 34 to 54 vol-% of olivine.

On account of their different texture they are divided into two groups, first the one richest in olivine with ophitic interphenocrystic mass (I), and then a rock less rich in olivine with doleritic groundmass (II). Using the olivine-pyroxene proportion as the basis of classification, as TRÖGER did (40), I have described the individual rocks by special names.

BOWEN (6) has made it sufficiently clear that picrite-peridotite magmas proper do not occur. Special names for rocks to which has been added more or less, early crystallised olivine can therefore not be regarded as very significant. The domination of the size of the olivine-phenocrysts over the other components, as well as the pronounced automorphy of the olivines is characteristic of the ultra-basic rocks from Svartenhuk (cf. BOWEN, 6).

The other rocks belonging to the plateaubasalt series have been divided into the following main groups:

III. Olivine-basalts.
 Olivine-basalts with picritic affinities.
 Olivine-basalts with about 10 vol-% olivine.

IV. Olivine-carrying, plagioclase-phenocrystic basalts.

V. Olivine-free basalts.
Agglomeratic basalts.

VI. Andesitic basalt.

VII. Anorthoclase-trachyte.

I. Picrite-basalts with ophitic groundmass.

In this chapter two, presumably hypabyssal, members of the tilaitic magma group are described. Unfortunately neither of them have been taken in situ, but were collected as loose blocks in the eastern part of Svartenhuk, one (no. 768) by A. Rosenkrantz about 13 kilometers from the east end of the Usuit kûat valley, and the other by the author at sea-level near Uvdlisaut in the S.E. corner of the peninsula (no. 2249). Both localities are near the base of the actual plateaubasalt series, that is, near the transition from the submarine breccia formation to the subaerial lava sequences.

As an oceanitic olivine basalt, no. 2272, was taken—in situ—in a dyke in Umîviup qaqai (comp. next chapter) it is possible that the rocks described in this part originate from dykes too; the possibility also exists of their belonging to sill-like intrusions, such as peridotite sills known from the Nûgssuaq peninsula to the south (A. Heim, 19, and Drescher & Krueger, 16), and finally they may belong to the extrusive series (Quensel, 33).

Both rocks are extremely rich in olivine, and their olivine-pyroxene proportion is 3:1 and 2:1 respectively (nos. 768 and 2249). Both are porphyric and macroscopically dominated by the large olivine phenocrysts, which often have a size of some millimeters.

Rock no. 768 will in the following be called "Schönfelsite". (Tröger/Uhlemann, 40, 43), the original rock of this name has a similar modal composition, but has developed into greenstone-facies, while the Svartenhuk rock is quite fresh and not transformed.

For rock no. 2249 the name "Massafuerite" (Johannsen/Quensel, 20, 33) has been used, and the term picrite-basalt as a collective name for the groups 409, 410 and 411 in Tröger's work (40, p. 177). The reasons for this mode of description are stated above.

1. Schönfelsite (no. 768), (cf. pl. II and pl. III, fig. 1).

The olivine occurs as large or small phenocrysts, ranging in size from 3×3 mm to 0.5×0.5 mm; the great majority are automorphic, but there is a more or less pronounced rounding of edges and corners as well as a few bends due to corrosion. The most frequently developed faces are (010), (110) and (021). Parting on (010) is well developed. A small quantity of reddish-brown iddingsite occurs along irregular, curved cracks or as irregular areas in the olivine; a few cracks contain a little pale green chloritic material, but otherwise the mineral is quite fresh with the exception of a few opaque individuals, the opacity of which is due to small grains of ore, which apparently have been separated later and which almost obscure the original mineral. The angle of optic axes was determined in two individuals on the FEDOROW-table and was:

1.	$2\,V\gamma = 84°$	Fa_0
2.	$2\,V\gamma = 86°$	Fa_5
Average:	$2\,V\gamma = 85°$	Fa_3

The mineral is apparently almost pure forsterite (BOWEN & SCHAIRER, 7, WAGER & DEER, 12).

The olivine contains grains of ore, mostly in the form of equidimensional, rounded individuals.

The clinopyroxene is somewhat smaller than the olivine and occurs in the form of irregular individuals interwoven with automorphic plagioclase laths; the mineral is colourless and without pleochroism. Lamellated twins on (100) are often seen. When the pyroxene touches the olivine, it is often curved round the corners and edges of the latter. The following optical determinations were made on the FEDOROW-table:

1.	$2\,V\gamma = 52°$,	—	
2.	$2\,V\gamma = 50°$,	—	
3.	— ,	$c \wedge \gamma = 35°$	
4.	$2\,V\gamma = 52°$,	$c \wedge \gamma = 38°$	$En_{55}Fs_4Wo_{41}$
5.	$2\,V\gamma = 55°$		
Average:	$2\,V\gamma = 52°$,	$c \wedge \gamma = 36°.5$	$En_{57}Fs_1Wo_{42}$.

The plagioclase, which compared with the mafic components is subordinate in the rock composition, occurs as laths in ophitic relation to the pyroxene, or as longer, more uniformly homogenous streaks as infilling between the dark-coloured components. The mineral is fairly homogenous with a labradoritic composition:

1.	68 % an	
2.	65 % an	
3.	62 % an	Average: 65 % an.

The longest plagioclases attain a length of 0.8 mm. Automorphic laths are sometimes entirely surrounded by pyroxene; and the plagioclase laths which protrude into the pyroxene often show distinct tapering. This seems to indicate that the plagioclase began to crystallize earlier than the pyroxene and finished later. Alongside the large olivine phenocrysts we often find a coating of parallel laths of plagioclase surrounding the mineral first crystallized. (Compare the oceanite fig. 1, pl. VII.)

The black, equidimensional grains of ore are fairly evenly distributed in the slide.

A small quantity of zeolitic matter and secondary calcite, both interstitial, is found locally.

The course of crystallization is: (ore), olivine, simultaneous crystallization of plagioclase and pyroxene, and crystallization of the rest of the plagioclase material.

The mineral composition was measured on the LEITZ integration-table with the following result:

	Vol-%	Weight-%
Olivine	54.0	57.1
Pyroxene	15.9	16.8
Ore	3.9	4.7
Chlorite (interstitial)	2.0	1.7
Plagioclase	24.2	19.7

Sp. gr. {Calculated ... 3.31; Measured 3.15

By calculation of the Weight-% the following round figures were used:

Olivine 3.5; pyroxene 3.5; plagioclase 2.7; ore 4.0; chlorite 2.8; glass 2.4, and zeolites 2.2 (the last-named values are brought into use below).

There are only few extrusive or dyke rocks with a so extreme content of olivine; closest comes the "Schönfelsite" established by UHLEMANN in 1909 (43). It is a glass-carrying picrite-basalt in greenstone facies. The Svartenhuk rock contains no glass; but perhaps some of the interstitial chloritic substance originates from residual glass.

Contrary to the olivine of the Svartenhuk rock the olivine of the Schönfelsite has been completely transformed into serpentine. TRÖGER (40) measured the following volumetric composition of the original rock:

	Vol-%
Olivine phenocrysts	53
Pyroxene (partly phenocrysts)	16
Ore and Apatite	3
Plagioclase + globular devitrified glass bases	28

By comparison the two results of integration show a very close correspondence, and the obvious conclusion will be to describe the extremely olivine-carrying picrite-basalt from Svartenhuk as Schönfelsite. In this manner we get an interesting kaenozoic analogue to the palaeozoic original rock.

Table I.

			NIGGLI-values		v. WOLFF-values	
SiO_2	40.09	668				
TiO_2	1.72	21	si	65.2	L	17.0
Al_2O_3	6.21	61	ti	2.05	M	100.9
Fe_2O_3	3.98	25	p	0.10	Q	—17.9
FeO	6.87	95	qz	—39.2		
MnO	0.08	1			A	0.65
MgO	29.21	730	al	6.0	C	2.96
CaO	4.31	77	fm	85.4	K_2O	0.29
Na_2O	0.39	6	c	7.5	MgO	43.20
K_2O	0.47	5	alk	1.1	C′	1.54
P_2O_5	0.11	1			Fe″	4.20
CO_2	0.25	6	k	0.45	Mt	2.96
H_2O^+	4.67	—	mg	0.83		
H_2O^-	1.42	—	c/fm	0.88	Analyst	
			Sect. V		SVEN PALMQUIST	
Sum...	99.78		Schönfelsite (No. 768)			

2. Massafuerite (no. 2249), (cf. Pl. III fig. 2 and pl. IV).

The rock closely resembles the one described above, but is clearly less rich in olivine. The large grains of olivine are more rounded than in the Schönfelsite; the largest attains a length of 2.7 mm, but the great majority a little less than half of that.

Enclosures of rounded, equidimensional grains of ore occur. The mineral is quite fresh, and the angle of optic axes in two individuals was

1. 2 V = 90° .... Fa_{14}
2. 2 V = 90° .... Fa_{14}.

The texture between the large olivines is ophitic with local transitions to sub-ophitic (KROKSTRÖM, 24). The pyroxene, which fills up more areas than in the Schönfelsite, harmonizes with the latter. The largest individuals measure 1.3 mm in length, and are half as broad. The following optic determinations were made on the FEDOROW-table:

1. $2V\gamma = 48°$, $c \wedge \gamma = 39°$ (constr.) .... $En_{58}Fs_7\,Wo_{35}$
2. $2V\gamma = 50°$, —
3. $2V\gamma = 54°$, —
4. — , $c \wedge \gamma = 37°$

Average: $2V\gamma = 51°$, $c \wedge \gamma = 38°$ .... $En_{57}Fs_{4.5}Wo_{38.5}$.

Plagioclase appears in almost the same quantity as above. There are automorphic laths surrounded by pyroxene and a pronounced tapering of the plagioclase laths protruding into the pyroxene. The crystallization of the plagioclase thus began a little before the pyroxene crystallization and finished later.

A large, apparently early crystallized individual has an anorthite content of 78 % (bytownite); in the dominating laths the anorthite is labradoritic, determined by the values of two different individuals:

1. 65 % an
2. 62 % an.

Finally, the anorthite content of a thin lath of the youngest generation was 59 %.

As in Schönfelsite the course of crystallization was:

(Ore), olivine, simultaneous crystallization of plagioclase and pyroxene (and perhaps a younger generation of ore) and, finally, the rest of the plagioclase. About 5 % has solidified as glass.

Measured on the integration table the mineral composition was as follows:

	Vol-%	Weight-%
Olivine	43.3	46.0
Pyroxene	24.5	26.2
Chlorite	0.2	0.2
Ore	5.3	6.4
Plagioclase	20.9	17.1
Glass	5.4	3.9
Zeolites	0.4	0.2

Sp. gr. { Calculated 3.29
Measured 3.08

This mineral composition agrees with the weight-percentage composition of the very olivine-rich melabasalt from the Juan Fernandez Islands, which Johannsen (20) calls "Massafuerite" and which was calculated by Tröger (40) on basis of Quensel's (33) records with the following result:

	Weight-%
Olivine	45
Pyroxene	27
Ore + Apatite	5
Plagioclase	23
Glass basis	±

The Massafuerite comes from dykes on the Massafuera Island. Quensel, however, states (33, p. 286) that a similar rock occurs as "Deckenbasalt" on the neighbouring island of Masatierra, and that the analysis (33, p. 287) will be perfectly valid for the rocks in this place. The microphotograph fig. 17 (33, p. 286) closely resembles the Svartenhuk rock, but the pyroxene is limited to the groundmass. Another difference is that the ti-content of the original rock was considerable and that the pyroxene is a pink ti-augite.

Prof. P. D. QUENSEL, Stockholm, has kindly given me the opportunity of going through his material from the Juan Fernandez Islands, and examining the picrite-basalt from Massafuera.

With the knowledge thus gained I can add to the above that the groundmass between the large, automorphic olivines is rather similar to the groundmass of the picrite-basalt from Svartenhuk dealt with in the next chapter (Oceanite), but that the total amount of olivine is larger, in the main consistent with no. 2249.

II. Picrite-basalts with doleritic groundmass.

In the following is given a description of two rocks, one of which (no. 2272) is fresh and originates from a dyke in Umîviup qaqai, the other (no. 2278) has been thoroughly converted and was collected as a loose block on top of the breccia formation off the westernmost botn in the same mountain. The rocks show a clear relation to those described in the previous chapter, but they are dealt with separately here, partly on account of the larger content of plagioclase, and partly on account of the texture of their groundmass; for the purpose of classification they should presumably be called oceanites.

The fresh rock will be dealt with first. Macroscopically, it is dominated by the large, transparent olivine-phenocrysts, the groundmass being greyish. The weathering-crust is about 2 mm thick and reddish-brown in colour. The converted rock is light greyish, and the olivine completely transformed.

Oceanite (no. 2272), (cf. pl. V, fig. 2 and pl. VI).

The largest olivines may be more than 3 mm long, but the majority of the phenocrysts are about 1.5 × 1.5 mm. The smaller grains of 0.3 mm in both directions are rounded.

It is characteristic that the olivine-formation has covered a longer period than in the case of the rocks of the preceding chapter, as small grains of olivine (0.1 × 0.1 mm) are contained in the groundmass distributed over certain areas.

Small automorphic or slightly rounded grains of ore are found in the olivine. Even if the automorphy of the olivine-phenocrysts is unmistakable, the rounding is much more pronounced than in Schönfelsite and Massafuerite. Considerably corroded individuals frequently occur, similar in appearance to the corroded pseudomorphs of no. 2278. The formation of plagioclase must have commenced a little earlier than the last crystallization of olivine, as small points of plagioclase are often seen protruding into the outer parts of larger grains of olivine, outside which their thickness rapidly increases. Apart from an incipient conversion along fissures into a light brown, granular substance the mineral is fresh.

The angle of optic axes in a large olivine-phenocryst was determined as

1. $2V = 90°$ .... Fa_{14}.

In a small groundmass individual the angle was

2. $2V\alpha = 84°$ .... Fa_{25}.

The pyroxene is colourless, non-pleocroic and most frequently occurs as an infilling of the angular cavities between the laths of plagioclase, a few, however, being automorphic. Both simple and lamellated twins on (100) are frequent occurrences. The largest individuals come up to about 0.3 × 0.3 mm. Accretions of plagioclase and pyroxene are usual. The optical characters were

1.	$2V\gamma = 50°$,	—	
2.	— ,	$c \wedge \gamma = 37°$	
Average:	$2V\gamma = 50°$,	$c \wedge \gamma = 37°$	$En_{59}Fs_{3}Wo_{38}$

The plagioclase is almost entirely developed in the form of thin laths, the maximum lenght of which is 0.7 mm. The great majority are smaller, their dimensions being about 0.5 by 0.05. The plagioclase has dominated the shape of the pyroxenes, although automorphic individuals are frequent, in other words, the texture is a transitional stage between doleritic and sub-doleritic (Krokström, 24). The anorthite-content—measured on a number of large laths—was

1. 70 % an
2. 74 % an
3. 75 % an
4. 78 % an .... bytownite.

A small lath from an area where plagioclase prevailed showed a lower anorthite-content, viz. 67 % an (labradorite). Alongside the large olivine-phenocrysts we often find a coating of parallel laths of plagioclase (fig. 1, pl. VII).

A little residual glass is found here and there, most often in the interstices that are not quite filled with pyroxene; the texture here must locally be described as intersertal.

The course of crystallization is: (Ore), olivine, plagioclase, pyroxene + plagioclase (glass). Thus, there is a difference between the present rock and the two fresh rocks of the foregoing group (no.s 768 and 2249). Here there is a larger period of olivine crystallization, as the olivine is included in the groundmass, and the crystallization of the plagioclase begins before the olivine material is used. As regards the converted rock, no. 2278, the conditions cannot be ascertained, as the primary components have been so thoroughly altered that the textural conditions cannot be clearly judged.

The mineral composition was as follows:

		Vol. %	
Olivine	35.0	37.5	
Conversion matter in olivine	2.5		
Pyroxene		23.1	
Ore		3.8	
Plagioclase		33.2	
Glass		2.4	Sp. gr.: 3.02

Table 2.

			NIGGLI-values		v. WOLFF-values	
SiO_2	42.08	707				
TiO_2	2.25	28	si	71.1	L	27.0
Al_2O_3	8.15	79	ti	2.81	M	94.6
Fe_2O_3	1.88	12	p	0.10	Q	−21.6
FeO	8.25	114	qz	−43.7		
MnO	0.18	2			A	2.15
MgO	20.30	508	al	7.9	C	2.45
CaO	12.99	231	fm	65.1	K_2O	0.58
Na_2O	1.69	27	c	23.3	MgO	29.55
K_2O	0.94	10	alk	3.7	C′	10.99
P_2O_5	0.11	1	k	0.27	Fe″	6.05
H_2O^+	0.74	—	mg	0.78	Mt	1.40
H_2O^-	0.52	—	c/fm	0.88	Analyst	
			Sect. V		SVEN PALMQUIST	
Sum...	100.08		Oceanite (no. 2272)			

Oceanite (no. 2278), (cf. pl. V, fig. 1).

In contradistinction to the rock described overleaf the present has been so completely transformed that nothing is left of the original olivine and pyroxene, and only part of the ore.

The rock is porphyric, and the large pseudomorphs on olivine attain a length of 1.8 mm; they show signs of strong corrosion before the inversion and often contain small, automorphic, unconverted grains of ore. The pseudomorphy is complete, and nothing remains of the original mineral. The pseudomorphic matter is evidently carbonatic, and there is a fine limonitic dusting.

The original pyroxene has also been completely converted and is now a brownish, matted mass, wherein lie the unaltered laths of plagioclase. In the planimetric analysis below all felty interstitial mass between the pseudomorphs on olivine and the laths of plagioclase have been treated as original pyroxene, which heading perhaps also includes a certain quantity of converted ore and some original glass material.

The anorthite content, in the plagioclase determined in some large individuals (core), was 75 % and 78 % respectively (bytownite).

A small individual had a lower anorthite content of 60 % (labradorite).

The weight percentage of the mineral composition in the below table refers to minerals originally present:

		Vol-%	Weight-%
(Pseudomorphs on) olivine		33.7	35.8
Pyroxene		ab. 39.7	42.1
Ore		0.9 +	1.1
Plagioclase	(phenocrysts) 6.9 / (groundmass) 18.8	25.7	21.0

Considering that the ore originally present in the Svartenhuk rock most certainly has been decimated by later inversions there is good agreement between the above figures and the weight-% of the olivine-rich, melanocratic olivine basalt from Réunion, which was calculated by Tröger according to Lacroix's (29) records, and which he gave the name of "Oceanite".

The original rock from Réunion has the following mineral composition:

	Weight-%
Olivine	34
Pyroxene (titaniferous augite)	40
Ore + Apatite	6
Plagioclase	20

Table 3 offers an opportunity of a comparison of the volumetric mineral composition of the four picrite-basalts described above.

Taken in one, the olivine from no. 768 to no. 2278 drops from 54 vol-% to 34 vol-%, while at the same time the pyroxene rises from 16 vol-% to 40 vol-%. The plagioclase has a more uneven variation, the high plagioclase content of no. 2272 being particularly noticeable.

Table 3.

	Schönfelsite	Massafuerite	Oceanite	Oceanite
	no. 768	no. 2249	no. 2272	no. 2278
Olivine	54.0	43.3	37.5	33.7
Pyroxene	15.9	24.5	23.1	ab. 39.7
Plagioclase	24.2	20.9	32.2	25.7
Ore	3.9	5.3	3.8	0.9 +
Chlorite	2.0	0.2	—	—
Glass	—	5.4	2.4	—
Zeolites	+	0.4	—	—

Volcanic or hypabyssal representatives of the present magma group are not very numerous, but the author considers that conditions on Svartenhuk justify the present "actualization" of the two designations: Schönfelsite and Massafuerite for the purpose of distinguishing the picrites proper from the felspar-carrying picrite-basalts, and bridge the interval.

As regards the name Oceanite, it seems to be more comprehensive than the others (comp. TYRRELL, 42).

On TRÖGER's suggestion (TRÖGER, 40) the name Oceanite is used to describe a rock with a olivine/pyroxene proportion of about $^1/_1$ within a fairly wide limit. This results in the two rocks with almost the same olivine-content—nos. 2272 and 2278—being grouped together, although they have an almost opposite content of pyroxene/plagioclase.

With the material available it has not been possible to come closer to the matter, all the more so, as the one of the rocks is greatly altered.

III. Olivine Basalts.

The basalts under this heading contain from 8 to 14 vol-$^0/_0$ olivine, and those richest in olivine are systematically a transition between olivine-basalts proper and picritic basalts. The relation to the afore-mentioned picrite-basalts with doleritic groundmass is evident.

In this work the olivine basalts have been divided into two groups, one with about 14 vol-$^0/_0$ olivine and the other with about 10 vol-$^0/_0$ olivine. The reason for this grouping is not so much the difference in the olivine-content as the difference in texture. In the first group, which comprises the nos. 767 and 2245b, the olivine only occurs as phenocrysts, which far exceed the other components in size. The groundmass is more fine-grained. In the other group the difference between olivine and the other components is less conspicuous, and, according to NIE-

LAND, disappears in the rock described by him (comp. below); the groundmass is of a coarser type.

1. Olivine basalts with picritic affinities. (Cf. pl. VII, fig. 2.)

Rock sample no. 767 was collected by ROSENKRANTZ about 13 kilometres from the east end of the Usuit kûat valley, about 105 m above sea-level: Solid plateaubasalt. The author collected sample no. 2245b in the delta of the Kugssineq river in the south-west corner of Svartenhuk: loose block.

No. 767 is a distinctly olivine-porphyric rock with an exceedingly fine-grained groundmass. It has not been possible to measure the optical data of other components than the olivine occurring in phenocrystic form. The olivine-individuals reach a length of over 3 mm, but the majority are smaller; all are surrounded by an opaque border, and opaque zones of varying thickness follow the curved cracks in the mineral. The olivine contains larger or smaller, slightly rounded, automorphic grains of ore. Twinning on (110) occurred in a single instance. The composition of the olivine is as follows:

1.	$2\,V\gamma = 84°$	Fa_0
2.	$2\,V\gamma = 88°$	Fa_{12}
Average:	$2\,V\gamma = 86°$	Fa_6

The fine-grained groundmass consists mostly of clinopyroxene, the groundmass plagioclases are lath-shaped; furthermore there is a certain amount of ore, often as irregular, lobed grains surrounded by a thin zone of rust. The residual glass present is olive-coloured.

The approximate mineral composition is	Vol-%	Weight-%
Olivine (pseudomorphs)	14.4	15.2
Pyroxene (groundmass)	ab. 52.0	ab. 55.0
Plagioclase (groundmass)	ab. 21.8	ab. 17.8
Ore	7.6	9.2
Residual glass	1.6	1.1
Zeolites	2.6	1.7

The loose block from the Kugssineq delta is of similar character; the olivine content of both samples is the same, but the rock from Kugssineq also contains a few phenocrysts of plagioclase and clinopyroxene. Contrary to no. 767 the olivine of no. 2245b does not possess the thick opaque borders, but contains a small quantity of chloritic matter along the curved cracks in the mineral. The latter is almost quite fresh, but a number of individuals are somewhat corroded. A single case of twinning on (110) was found, as in the rock previously described. The plagioclase contains some alteration substance, mainly sericite. The rock itself carries zeolite-filled cavities, and there is quite a considerable infiltration of zeolitic material locally in the groundmass. The following optical determinations were made:

Olivine:	1.	$2\,V\gamma = 87°$	Fa_8
	2.	$2\,V\gamma = 87°$	
Pyroxene:		$2\,V\gamma = 54°$	
Plagioclase:	1.	80 % an (phenocryst)	
	2.	79 % an (phenocryst).	

The mineral-composition is:

	Vol-%	Weight-%
Olivine { phenocrysts 13.2, groundmass 0.6 }	13.8	16.7
Pyroxene (phenocrysts)	2.9	2.7
Ore	5.5	7.6
Remaining groundmass (pyroxene strongly dominating over plagioclase)	68.1	(ab. 65.4)
Zeolites	9.1	ab. 6.9

2. Olivine basalts with about 10 vol-% olivine. (Cf. pl. VIII, fig. 1.)

As already stated the olivine content of this group is not much smaller than in the previous one; but the occurrence of the mineral varies. There seems to be a smooth transition from no. 2273, in which the olivine is still a distinctly phenocrystic mineral, via no. 2245c, where the olivine is considerably smaller, to the dyke-rock described by NIELAND (30), in which none of the components of the rock differ in size from the others.

The three rocks have been collected from three different areas of Svartenhuk, viz. no. 2273 from a dyke in Umîviup qaqai, NIELAND's sample from a dyke in the Usuit kûat valley and the loose block no. 2245c, from the delta of the Kugssineq river in the south-west corner of the peninsula. The two samples from the journey of 1939 were collected by the author.

No. 2273. Dyke, Umîviup qaqai, 474 m above sea-level. The rock contains phenocrysts of olivine, the great majority of which are greatly converted in antigoritic direction, the largest pseudomorphs, in which there often is very little original material left, attain lengths of up to 2 mm. The plagioclases of the groundmass are considerably smaller, but occasionally become about 1 mm long, whereas pyroxenes are only 0.3 mm in both directions. The rock contains a certain amount of ore, appearing in small clusters of mostly automorphic grains. There are some pores filled with chlorite, they may be up to 0.4 mm in diameter.

The texture varies; in certain areas the form of the pyroxene is determined by the feldspar; this texture approaches the sub-doleritic (Krokström, 24). Other parts of the slide show large pyroxenes interwoven with plagioclase laths, so that the pyroxene of neighbouring interstices gets the same orientation. The latter form is close to subophitic texture (Krokström, 24) and in still other parts of the slide we find an almost even grained texture.

Olivine:	1.	$2V\gamma = 85°$		Fa_4
	2.	$2V\gamma = 88°$		Fa_{10}
	Average:	$2V\gamma = 86°.5$		Fa_7
Pyroxene:	1.	$2V\gamma = 52°$,	$c \wedge \gamma = 41°$	$En_{48}Fs_{14}Wo_{38}$
	2.	$2V\gamma = 48°$		
	3.	$2V\gamma = 49°$,	$c \wedge \gamma = 45°$ (constr.)	$En_{33}Fs_{39}Wo_{28}$
	4.	$2V\gamma = 52°$		
	5.	$2V\gamma = 51°$		
	Average:	$2V\gamma = 50°$,	$c \wedge \gamma = 43°$	$En_{44}Fs_{23}Wo_{33}$
Plagioclase:	1.	73 % an	(large phenocrystic individuals)	
	2.	70 % an	(large phenocrystic individuals)	
	3.	69 % an	(smaller laths from groundmass)	
	4.	68 % an	(smaller laths from groundmass)	
	5.	66 % an	(smaller laths from groundmass)	

The following mineral composition was determined:

	Vol-%	Weight-%
Olivine { not converted 4.7, pseudomorphs 7.4 }	12.1	13.1
Pyroxene	40.9	44.2
Plagioclase	32.8	27.3
Ore	9.5	11.7
Chlorite (chiefly in amygdules) + Interstitial mass (partly chloritic and partly matted with ironoxides).	4.7	ab. 3.7

In this group is also included a dyke-rock described by Nieland (30, p. 599—601):

"Das Gestein stammt von einem herausgewitterten Gang, etwa eine Tagesreise westlich vom inneren Ende des Umîvik-Fjords", in other words nearly the same place from where ROSENKRANTZ collected the solid, olivine-rich plateaubasalt (no. 767) described above.

"Der sehr frische dunkelgrau, im Anschliff tiefschwarze, körnige Basalt lässt keine Einsprenglinge erkennen, Feldspatleisten sind jedoch bereits mit blottem Auge wahrnehmbar. U. d. M. zeigt sich diabaskörnige Struktur."

NIELAND gives the following optical data of the minerals of the rock:

Olivine:	$2V = 90°$	
	$N\gamma = 1.700$, $N\alpha = 1.662$	
	$N\gamma - N\alpha = 0.038$	Fa_{14}[1])
Pyroxene:	$2V\gamma = 56°—58°$	
	$c \wedge \gamma = 45°$	
	$N\gamma = 1.722$, $N\alpha = 1.694$	
	$N\gamma - N\alpha = 0.028$	$En_{23}Fs_{34}Wo_{43}$[1])
Plagioclase:	84 % an (core)	
	55 % an (outer zone).	

The modal mineral composition stated by NIELAND is:

	Vol-%	Weight-%[2])
Olivine	10.5	11.4
Augite	47.0	50.7
Plagioclase	26.0	21.6
Ore	8.0	9.9
Apatite	0.5	0.5
Glass	8.0	5.9

Table 4 shows the chemical analysis carried out by NIELAND.

No. 2245c. Loose block, the delta of the Kugssineq river. This rock, the field relations of which are not known, belongs to the present group of rocks. The olivine, which is greatly converted, is of the same size as the pyroxene, about 0.5 mm in both directions. The pyroxene is colourless and occupies considerable parts of the rock—twinning is frequent. Plagioclase is present, partly as somewhat larger individuals of up to 1 mm in length, and partly as laths which are important components of the rock. Laths of plagioclase pervade the pyroxenes every-

[1]) The contents stated of Fa and of En, Fs and Wo have been calculated by the writer in order to bring a certain uniformity to the material and make it easily comparable with that examined by the writer himself.

[2]) The weight-percentages have been computed by the author.

Table 4.

			NIGGLI-values		v. WOLFF-values	
SiO_2	44.42	740				
TiO_2	1.92	24				
Al_2O_3	13.61	134	si	89.7	L	40.4
Fe_2O_3	3.19	20	ti	2.90	M	65.8
FeO	9.67	134	p	0.48	Q	—6.2
MnO	0.20	3	qz	—22.3	A	1.58
MgO	9.25	231	al	16.2	C	6.93
CaO	14.49	259	fm	49.4	K_2O	0.44
Na_2O	1.01	16	c	31.4	MgO	14.67
K_2O	0.65	7	alk	3.0	C′	9.51
P_2O_5	0.26	4			Fe″	7.37
Cr_2O_3	0.09	1	k	0.28	Mt	2.66
NiO	0.03	—	mg	0.57		
H_2O—	1.14	—	c/fm	0.64	Analyst	
H_2O^-	0.33	—	Sect. IV		H. NIELAND	
Sum...	100.35		Olivine basalt			

where, and tapered individuals protuding into the pyroxene are common. The ore is automorphic.

It is difficult to give an exact classification of the texture, but it resembles the sub-ophitic texture (KROKSTRÖM, 24).

Optical determinations:

Olivine: 1. $2\,V\alpha = 82°$ .... Fa_{30}
2. $2\,V\alpha = 86°$ .... Fa_{20}

Average: $2\,V\alpha = 84°$ .... Fa_{25}

Pyroxene: 1. $2\,V\gamma = 56°$, —
2. $2\,V\gamma = 53°$, —
3. — , $c \wedge \gamma = 42°$

Average: $2\,V\gamma = 54.5°$, $c \wedge \gamma = 42°$ .... $En_{44}Fs_{18}Wo_{38}$

Plagioclase: 1. 70 % an (larger individual)
2. 59 % an (groundmass-lath).

The mineral composition was found to be:

	Vol-%	Weight-%
Olivine { fresh .... 4.1; pseudomorphic 3.9 }	8.0	9.0
Pyroxene	36.9	41.4
Plagioclase	47.5	41.1
Ore	5.2	6.7
Chlorite (outside olivine pseud.) + a little opaque interstitial mass	2.4	1.8
Zeolites	+	

IV. Olivine-carrying Plagioclase-phenocrystic Basalts.

(Cf. pl. VIII, fig. 2 and pl. IX).

Among the numerous dykes found in the Umîviup qaqai mountain (comp. map, fig. 13); two, nos. 2275 and 2276 agree so well that they will be dealt with together.

The first was found above the innermost glacier in the ridge towards Umîvik at an altitude of about 1050 m, the second cuts through the second innermost top of the same mountain about 1200 m above sea-level.

The rocks contain large glomerophyric accumulations of plagioclase, the largest individual grains going up to 1.5 mm in length (2275) and 1.0 mm (2276). In addition, pseudomorphs on olivine up to 1.0 mm are found together with remains of the original mineral in no. 2275. In no. 2276 more of the olivine is preserved, but, on the other hand, the grains are only half as large. Both groundmasses consist of clinopyroxene, plagioclase and ore, and contain a certain quantity of residual glass. The groundmass of no. 2275 is somewhat more fine-grained than in no. 2276, and both rocks contain very small quantities of light green chlorite matter.

Optical determinations (no. 2275):

Olivine:	1.	$2\,V\alpha = 82°$	Fa_{30}
Pyroxene:	1.	$2\,V\gamma = 58°$	
Plagioclase:	1.	70 % an (isolated phenocryst)	
	2.	69 % an (clustered phenocryst)	
	3.	70 % an (small lath-shaped individual).	

Optical determinations (no. 2276):

Olivine:	1.	$2\,V = 90°$	....	Fa_{14}
	2.	$2\,V\gamma = 86°$	....	Fa_5
	Average:	$2\,V\gamma = 88°$	....	Fa_{10}
Pyroxene:	1.	$2\,V\gamma = 60°$,	$c \wedge \gamma = 42°$	$En_{33}Fs_{16}Wo_{51}$
	2.	$2\,V\gamma = 47°$,	$c \wedge \gamma = 42°$	$En_{52}Fs_{22}Wo_{26}$
	Average:	$2\,V\gamma = 54°$,	$c \wedge \gamma = 42°$	$En_{46}Fs_{20}Wo_{34}$
Plagioclase:	1.	78 % an (core in big phenocryst)		
	1a.	62 % an (narrow border in same individual)		
	2.	64 % an (smaller phenocrysts)		
	3.	56 % an (groundmass individual).		

The mineral composition is shown by the integrations below:

No. 2275:

		Vol-%
Olivine	pseudomorphs 2.5; fresh ...... > 0.002	2.5
Pyroxene (phenocrysts)		> 0.1
Plagioclase (phenocrysts)		10.8
Ore		10.1
Chlorite		> 0.1
Glass		6.3
Remaining groundmass (pyroxene/plagioclase in proportion about $^2/_1$)		70.3

No. 2276:

			Vol-%	Weight%
Olivine	pseudomorphs	0.6	1.9	2.1
	fresh	1.3		
Pyroxene	phenocrysts	0.4	45.6	50.6
	groundmass	45.2		
Plagioclase	phenocrysts	3.7	37.5	31.8
	groundmass	33.8		
Ore			8.6	10.7
Glass			6.4	4.8

It will be seen from the mineral compositions that it is impossible to make an immediate comparison, as the fine-grained nature of no. 2275 prevented complete integration of the groundmass. Common to both rocks is an original olivine-content of about 2 vol-%, agreement between the ore values and the high content of residual glass is good. No. 2275 contains more than 10 % plagioclase phenocrysts, while no. 2276 has less than 4 %.

Sample no. 763 belongs to the same rock group. It comes from the plateaubasalt series, and was collected by Rosenkrantz near the middle of the peninsula from the inner part of the Usuit kûat valley on the northern slope of the Søndre Aputitût mountain 440 m above sea-level.

The rock contains a quantity of secondary material consisting of calcite and zeolites, both as areal infiltrations and infilling of cavities, in the latter case thin outer borders of light green chlorite are often seen. Of olivine only the remains of one individual were found, but the numerous inversion-products have come into existence at the sacrifice of the original olivine; traces of original automorphy, of certain areas of the secondary minerals point in this direction.

Compared with the two rocks, previously described, no. 763 has a higher content of pyroxene phenocrysts.

The rock is a plagioclase-porphyric, fine-grained basalt. The phenocrysts occur as glomerophyric accumulations, the individual laths of plagioclase attain lengths of up to 1.3 mm, and isolated phenocrysts are also seen. The anorthite contents was determined to be:

1. 71 % an ($2\,V\alpha = 87° = 70$ % an)
2. 64 % an.

The pyroxene is found together with the plagioclase in the glomerophyric accumulations, but is not larger than 0.7 mm, the majority being considerably smaller. Some pyroxene is found together with the above mentioned replacement material, which probably comes from original olivine. The following optical values were measured:

1.	$2\,V\gamma = 54°$,	—	
2.	$2\,V\gamma = 58°$,	—	
3.	— ,	$c \wedge \gamma = 42°.5$	
4.	— ,	$c \wedge \gamma = 45°$	
5.	$2\,V\gamma = 54°$,	—	
6.	$2\,V\gamma = 50°$,	—	
Average:	$2\,V\gamma = 54°$,	$c \wedge \gamma = 44°$	$En_{35}Fs_{27}Wo_{38}$

The mineral composition is seen from the following measuring on the integration table:

	Vol-%		
Olivine	+		
Pyroxene (phenocrysts)	2.4	phenocrysts	14.1
Plagioclase (phenocrysts)	11.7		
Groundmass (pyroxene predominates over plagioclase)	79.4	groundmass	79.4
Calcite and Zeolites (amygdules and patches)	3.6	secondary materials	6.5
Chlorite (patches and borders of amygdules)	2.9		

If the mineral composition of the present rock is compared with the composition of no. 2275, then will be good conformity, apart from a higher content of porphyric pyroxene and lower content of plainly recognizable olivine. The groundmass of no. 763 is still more fine-grained than no. 2275.

On the whole there seems to be no reason why the dykes of the type, 2275 and 2276, should not have been feeding channels to the extrusive rocks of the type 763.

The result of the chemical analysis of rock no. 763 is seen from table 5:

Table 5.

			NIGGLI-values		v. WOLFF-values	
SiO_2	46.42	774	si	108	L	48.8
TiO_2	3.82	47	ti	6.54	M	50.0
Al_2O_3	14.50	142	p	0.07	Q	+ 1.2
Fe_2O_3	5.07	32	qz	— 14.4	A	2.69
FeO	6.04	84	al	19.7	C	6.86
MnO	0.11	1	fm	42.8	K_2O	0.60
MgO	6.35	159	c	31.9	MgO	10.62
CaO	12.80	229	alk	5.6	C′	8.52
Na_2O	1.92	31	k	0.23	Fe″	3.57
K_2O	0.83	9	mg	0.52	Mt	4.28
P_2O_5	0.14	1	c/fm	0.74	Analyst	
CO_2	0.48	10	Sect. V		SVEN PALMQUIST	
H_2O^+	1.17	—				
H_2O^-	0.63	—				
Sum...	100.28		Plagioclase-porphyric, olivine-carrying basalt (no. 763)			

V. Olivine-free Basalts.

(Cf. pl. X, fig. 1).

This rock group, representing a section high up in the Svartenhuk plateau, comprises the number of samples collected by ROSENKRANTZ along a line going north—south from the inner part of the Usuit kûat valley, along the west side of the Søndre Aputitût mountain and ending in the south near the outfall of the Kugssineq river. From the Pangnagigsok mountain just west of the mouth of the same river the author collected one sample. Going from north to south the description includes the following numbers: 761, 670, 669 and 2243[1]).

To the same group belong two agglomeratic rocks, one of which was taken in situ at Pangnagigsok (2246), and the other was found as a loose block in the river at Kugssineq (2245a).

The rocks in this section are mostly fine-grained basalts often with phenocrysts of plagioclase. Phenocrysts of pyroxene also occur but only visible to the naked eye in exceptional cases. Some scattered zeolites are to be found. A lamellated appearance is typical of some of the rocks, as brownish streaks a few millimeters thick, which in a somewhat arcuated course penetrate the plain grey or greyish-black rock, are

1) The section is given here with the numbers in reversed order as compared with the description on page 15, in order to illustrate the chronological succession from lower strata upwards.

present. The brownish colour is presumably due to the weathering of the ore, the distribution of which is irregular, often in streaks.

1. Slightly porphyric basalt (no. 761).

West side of the Søndre Aputitût mountain; tributary to the Sigguk river draining to the west (fig. 7). 660 m abov sea-level.

The rock contains phenocrysts of plagioclase and pyroxene. The groundmass is fairly fine-grained.

The pyroxene often has a fan-shaped extinction and a tendency to hour-glass structure. Twinning on (100) is common. The plagioclase laths projecting into the pyroxene grains are distinctly tapered. The following optical values were measured:

1. $2\,V\gamma = 47°$, $c \wedge \gamma = 44°$ (constr.) ..... $En_{42.5}Fs_{29.5}Wo_{28}$
2. $2\,V\gamma = 47°$ and $45°$ (in different parts of the same individual)

Average: $2\,V\gamma = 46°$, $c \wedge \gamma = 44°$ .... $En_{43}Fs_{30}Wo_{27}$

The plagioclase forms phenocrysts of double the size of the pyroxene, and glomerophyric accumulations frequently occur. The largest phenocrysts often contain small grains of pyroxene of irregular contours. The longest plagioclases are about 2 mm long. The albite lamellation is very fine. The anortite content was measured at the following values:

1. 76 % an (large phenocryst)
2. 74 % an (large phenocryst, core)
   70 % an (large phenocryst, outer zone)
3. 67 % an (equidimensional, smaller grain)
4. 55 % an (lath from the groundmass).

The ore is essentially automorphic, but irregular, lobed individuals are frequently seen—sometimes the laths of plagioclase protrude into the grains of ore, which also may contain a few small grains of pyroxene.

A small quantity of interstitial, light brown glass is found but no microgranitic interstitial mass.

On the integration table the measuring of the mineral composition gave the following values:

			Vol-%	Weight-%
Plagioclase	phenocrysts	4.0	41.2	34.6
	groundmass	37.2		
Pyroxene	phenocrysts	2.6	43.3	47.2
	groundmass	40.7		
Ore			13.3	16.6
Interstitial glass			2.2	1.6

The groundmass texture goes in a sub-doleritic direction (Krokström, 24), as the chiefly lathed plagioclase of the groundmass is only slightly affected by the pyroxene; on the other hand, the pyroxene of the groundmass only occurs as small, irregular grains without automorphic development.

Apart from the phenocrysts the course of crystallization appears to be: plagioclase, pyroxene, ore.

2. Porphyric "lamellated" basalt (no. 670).

About 16 kilometres north of the mouth of the Kugssineq river, 490 m above the sea.

The rock is considerably more fine-grained than the one previously described and is of a distinctly "lamellated" appearance, which under the microscope is seen as alternating streaks with infiltrations of iron oxides and "pure" streaks. The rock contains long thin laths of plagioclase in the form of phenocrysts with a length of 0.5 to 1.0 mm, and a few considerably smaller individuals of pyroxene ($c \wedge \gamma = 44°$). Glass of a dirty-brown colour is found in the groundmass.

Optic determinations, plagioclase:

1. Phenocryst .... 70 % an
2. Lath (in groundmass) .... 62 % an.

3. Porphyric "lamellated" basalt (no. 669).

About 13 kilometres north of the mouth of the Kugssineq river, 300 m above sea-level.

The nature of the rock is very similar to the one above, although in the present case the distribution in streaks of the ore grains is more pronounced. Only plagioclase phenocrysts occur, partly as isolated phenocrysts and partly as glomerophyric clusters. The plagioclase is more tabular than in no. 670, and the largest individuals attain a length of 2 mm. The ore is markedly automorphic. The residual glass is light brown, and a small quantity of greenish brown chlorite matter is seen as infilling in pores and as discoloured parts of infiltration.

Optical determinations, plagioclase:

1. 79 % an (phenocryst)
2. 76 % an (phenocryst).

4. Light grey "lamellated" porphyric basalt (no. 2243).

Lower part of the east side of the Pangnagigsoq mountain west of the mouth of the Kugssineq river, 105 m above sea-level.

The fine-grained rock contains phenocrysts of plagioclase, sometimes more than 1 mm long, but mostly smaller. They are often found in small clusters, which give the impression of the phenocrysts being larger than they really are.

The groundmass harmonizes with nos. 2 and 3 in this chapter. The ore can be both automorphic and irregularly lobed; it carries inclusions of small grains of pyroxene and thin laths of plagioclase. A small quantity of brownish residual glass is present.

Optical determinations:

Pyroxene: 1. $2\,V\gamma = 55°$
2. $2\,V\gamma = 50°$

Plagioclase: 1. 72 % an (phenocryst, core)
2. 78 % an (phenocryst, core)
68 % an (same, outerzone).

Table 6.

			NIGGLI-values		v. WOLFF-values	
SiO_2	48.75	812	si	115	L	45.2
TiO_2	2.99	38	ti	5.38	M	48.2
Al_2O_3	13.31	130	p	0.42	Q	+ 6.6
Fe_2O_3	6.36	40	qz	— 8.2	A	2.70
FeO	7.89	109	al	18.4	C	5.86
MnO	0.20	3	fm	47.4	K_2O	0.44
MgO	5.79	144	c	28.4	MgO	9.48
CaO	11.15	199	alk	5.8	C′	7.24
Na_2O	2.12	34	k	0.17	Fe″	4.74
K_2O	0.67	7	mg	0.43	Mt	5.26
P_2O_5	0.41	3	c/fm	0.60	Analyst	
CO_2	0.05	1	Sect. IV		SVEN PALMQUIST	
H_2O^+	0.17	—				
H_2O^-	0.39	—				
Sum...	100.25		Basalt (no. 2243)			

Agglomeratic Basalt.

To the olivine-free group of rocks belongs the agglomeratic basalt, no. 2246 from Pangnagigsoq, and no. 2245a, which was found as a loose block in the Kugssineq river.

No. 2246 is a highly porous, basaltic rock, in which all the porous areas are coated with a more ar less thick layer of light brown glass; the pore itself is in any case filled with calcite, and may come up to a length of 0.5 cm. The rock itself is semi-opaque and shows laths of plagioclase often in a stellar-like arrangement; small, as a rule automorphic, twinned pyroxene phenocrysts are also seen. The pyroxenes are frequently penetrated by laths of plagioclase.

No. 2245 is a heterogenous, very fine-grained rock, which does not contain calcite, but much zeolitic material. A small quantity of light brown glass occurs in pores. Besides plagioclase phenocrysts a number of pseudomorphs are found; they are now quite filled with a bright green chloritic mineral.

Both rocks undoubtedly belong to the porous, intermediate strata in the upper part of the plateau.

VI. Andesitic Basalt.

(Cf. pl. X, Fig. 2).

The name is given to a light grey, fine-grained, zeolite-carrying basalt, no. 758, which was collected by Rosenkrantz 8 kilometres north of the mouth of the Kugssineq river, about 130 m above sea-level.

The rock is exceedingly fine-grained and highly homogenous. The 0.15 mm long laths of plagioclase in the groundmass are fluidal, and the texture approaches the pilotaxitic. Later infiltrations of calcite makes a closer study of part of the groundmass very difficult. On account of the fine-grained nature integration was impossible, but it is safe to say that plagioclase dominates over pyroxene.

A number of larger amygdules are to be seen; they have a diameter of up to 2 mm and are now filled with calcite and zeolites; a small quantity of light green chlorite substance is also present. Only a few phenocrysts occur; they are plagioclase with a size of 0.5 mm; most of them are lath-shaped, but a simple tabular individual is shown in fig. 2, table X.

Optical determinations:

Plagioclase: 1. 55 % an (core of larger individual)
47 % an (outer zone of same)
2. 48 % an.

The texture of the rock and the composition of the plagioclase both show that we are dealing with a basalt considerably more andesitic than the rocks described in the preceding chapter.

VII. Anorthoclase-trachyte.

The inner N.E.side of Arfertuarssuk fjord in the south-western part of Svartenhuk (Nieland, 30, p. 592—599).

"Es handelt sich um eine Trachytkuppe von etwa 40—50 m Höhe. Ihr in etwa NS-Richtung verlaufenden Steilabfall in den Fjord hat eine Ausdehnung von rund 500 m. Der Kontakt gegen den Basalt ist durch Geröll und Schutt verdeckt. — In östlicher Richtung landeinwärts erheben sich zwei weitere Kuppen, die nicht untersucht werden konnten" (op. cit. p. 592).

On account of the numerous, more than one centimeter long phenocrysts of felspar the light grey rock with its reddish weathering colours appears to be coarse-grained. In addition to felspar a few phenocrysts of ore and pyroxene are seen. The groundmass is sometimes rather coarse, orthophyric, sometimes fine and more trachytic.

The mineral composition is: Phenocrysts of anorthoclase ($2\,V\alpha$ 52°—60°), the groundmass felspar is also anorthoclase ($2\,V\alpha$ 40°—50°) but lies close to soda-sanidine.

The following data were determined for:

Pyroxene:

$$\left.\begin{array}{rl} 2\,V\gamma &= 57°.5 \text{ (in the periferal zone } 2\,V\gamma = 50°) \\ c \wedge \gamma &= 45°—46° \\ N\gamma — N\alpha &= 0.024 \end{array}\right\} En_{25}\,Fs_{39}\,Wo_{36}$$ [1])

Small quantities of aegirite augite and aegerite were found. Quartz occurred only in the orthophyric parts of the rock. Ore reaches a size of 0.06 mm in diameter and is unevenly distributed. Magnetite containing Ti prevails, but ilmenite is also found. Furthermore, there are quite neglegible amounts of hornblende and some apatite.

Table 7 shows the analysis carried out by NIELAND and the NIGGLI and VON WOLFF-values (30, p. 598).

Table 7.

			NIGGLI-values		v. WOLFF-values	
SiO_2	63.32	1055	si	244	L	83.2
TiO_2	0.75	9	ti	2.08	M	7.7
Al_2O_3	16.80	165	p	—	Q	9.1
Fe_2O_3	3.89	24	qz	+12.8	A	9.64
FeO	1.25	17	al	38.1	C	1.56
MnO	0.15	2	fm	20.3	K_2O	0.32
MgO	0.85	21	c	8.8	MgO	1.43
CaO	2.07	38 (CaO + BaO)	alk	32.8	C′	1.02
BaO	0.05		k	0.35	Fe″	0
Na_2O	5.75	93	mg	0.24	Mt	2.58
K_2O	4.64	49	c/fm	0.43	Analyst H. NIELAND	
P_2O_5	tr.		Sect. III/IV			
H_2O^+	0.44					
H_2O^-	0.35					
Sum...	100.31		Anorthoclase-trachyte			

[1]) Calculated by the author on the basis of the values:

$$2\,V\alpha = 54° \text{ (average) and}$$
$$c \wedge \gamma = 45°.5.$$

During our reconnaissance expedition to Svartenhuk in 1939 no visit was paid to the Arfertuarssuk fjord, so I am unable to give more detailed information about this area; nor did we succeed in finding any new occurrences in other districts of Svartenhuk, for example on the long traverse undertaken by LAURSEN and ROSENKRANTZ. Apparently the anorthoclase-trachyte occurs only in the extreme west, that is very high up in that part of the plateau basalt series which is accessible to-day. Even if we, as NIELAND believes, may expect to find new occurrences, there is hardly reason to suppose that they will be of greater areal importance.

General Remarks on the Minerals of the Rocks of Svartenhuk.

The three principal non-opaque minerals are plagioclase, clino-pyroxene and olivine. They are present in varying quantities in the different rocks, but each of them varies relatively little from one rock to another.

Fig. 14 shows a triangle diagram in which the three principal minerals are the corner points. The thirteen rocks from Svartenhuk, which permitted a volumetric determination of the components are entered in the diagram.

Nearest the olivine point are the two picrite-basalts with ophitic groundmass; near the middle of the diagram are the two picrite-basalts with doleritic groundmass. The olivine-basalts occupy a longish area parallel with the pyroxene-plagioclase side of the triangle. They include pyroxene-rich, melanocratic and plagioclase-rich types, the olivine content being fairly constant. With a downward tendency of the olivine-content we reach the two olivine-carrying, plagioclase-porphyric basalts and the doleritic sill (no. 1255), which shows a higher content of plagioclase than the other rocks, that have been volumetrically measured; finally, with the absence of olivine we arrive at the pyroxene-plagioclase line at about 50 $^0/_0$ of each mineral (no. 761).

It has not been possible to ascertain a further movement along the pyroxene-plagioclase line in the rest of the olivine-free basalts and the andesitic basalt, as the rocks in question were too fine-grained for integration.

Plagioclase.

In the cases examined twinning in the plagioclase is limited to the laws: Albite, Karlsbad, Albite-Karlsbad complex and Pericline. Pericline lamellae, however, are rare, whereas both Karlsbad and Albite-Karlsbad complex are frequently seen.

With regard to inclusions in the mineral reference is made to previous descriptions in the various sections.

The most constant composition and the comparatively lowest anorthite content of the plagioclase is found in the picrite-basalts (picrites) nos. 768 and 2249, where it varies from 62—68 % an (labra-

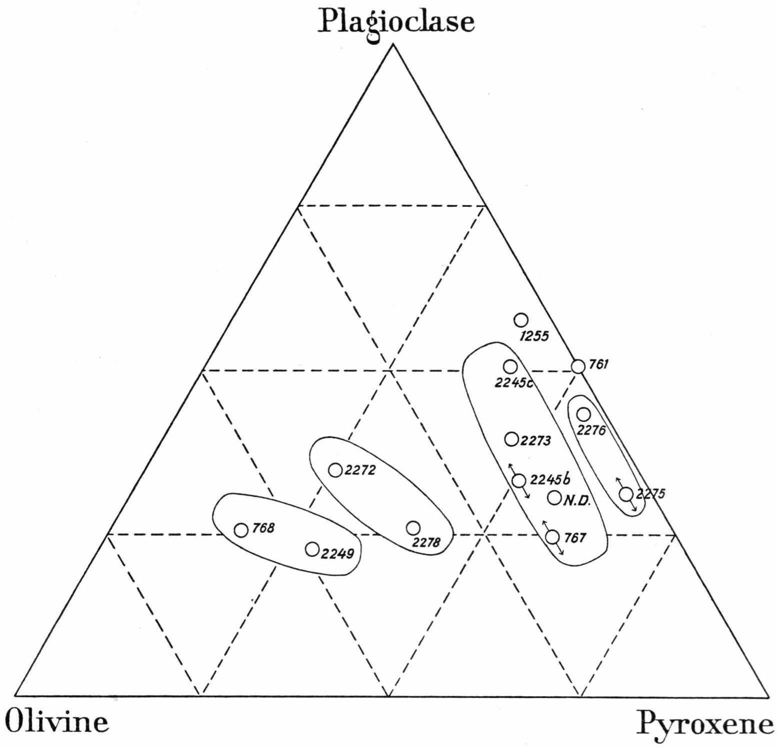


Fig. 14. The quantitative proportions of the three main-minerals in the Svartenhuk rocks (vol-%).

dorite) in six determinations. The low an-content is presumably due to the fact that a considerable part of the CaO present is contained in the pyroxene, which in this case is diopsidic (compare fig. 15), while in basalts proper the pyroxene is more pigeonitic.

The anorthite content of the picrite-basalts, nos. 2272 and 2278, is nearly the same as in the subsequent group of olivine-basalts, but the spread of the former is not so great, namely 60—78 % an against 55—84 % an.

In the plagioclase-porphyric basalts with subordinate olivine the anorthite-content varies from 56—78 % an. Even within the olivine-free basalts some rather melanocratic rocks are found, and in the phenocryst generation contained in these rocks basic plagioclases occur; the variation margin is 55—78 % an.

The andesitic basalt has an-values, which are on the whole lower, at a figure of 46—55 % an.

In the dolerites the plagioclases show zoning; core values of 63—70 % were determined, the outer zone being represented by the values 53 % an and 40 % an.

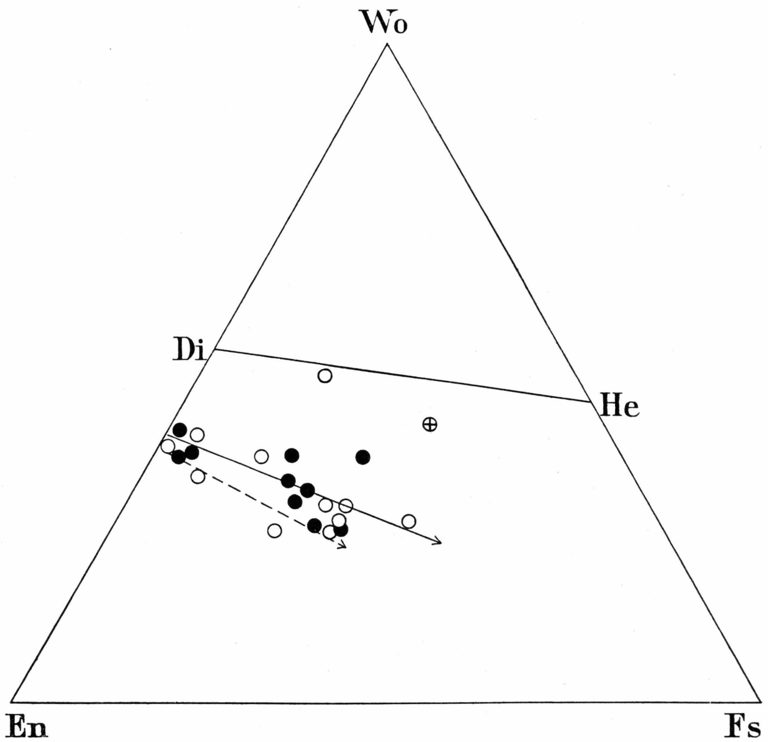


Fig. 15. Diagram showing the composition of the pyroxenes in the Svartenhuk rocks (comp. text p. 55). The six circles to the left = picrite-basalts, the rest = basalts proper and circle with cross = NIELAND's dyke.

Clino-pyroxene.

Like the plagioclase the clino-pyroxene is represented in all the slides examined. In all cases the mineral is almost colourless and shows no pleocroism. Twinning on (100) is frequent, generally as simple twins, although multiple lamellae are seen as well. In sections intersecting the composition plane at an oblique angle—obviously the most frequent—this plane reveals a very characteristic interference band (see fig. 1, pl. 1 and fig. 2, pl. 3).

Fig. 15 shows a diagram where the pyroxene individuals, in which it has been possible to measure both $c \wedge \gamma$ and $2\,V\gamma$, are marked as open circles, and where the average of the same values in the individual slides have been entered as filled circles. The points are shown in the diagram by TOMITA (39). Notwithstanding a certain spreading of the position of the points there is a clear tendency to variation from Di to Fs in the diagram, in other words from diopsidic to pigeonitic. This is in complete conformity with the statements of TOM. BARTH (cf. also 3, p. 327). In fig. 15 the fulldrawn arrow indicates the compositional variation in the pyroxenes from Svartenhuk, which have been examined; the dotted arrow shows the variation in pyroxenes of the Tertiary basalts from NE.-Greenland, drawn in the diagram on the basis of BACKLUND and MALMQUIST's data (1); here the same tendency is plainly seen.

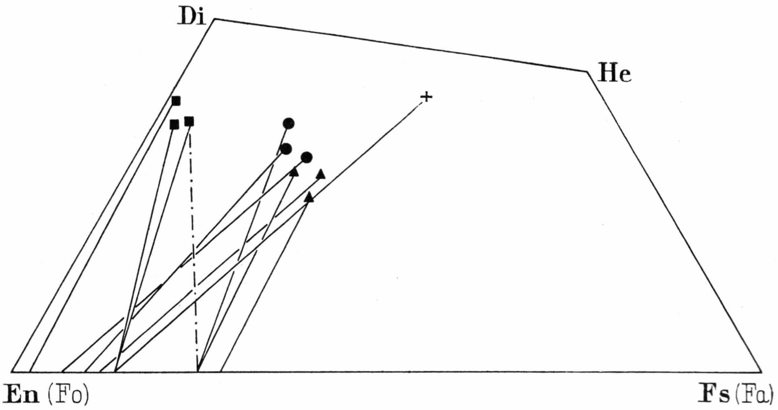


Fig. 16. Diagram showing relation between olivines and pyroxenes in the Svartenhuk rocks (comp. text p. 57).

In the foregoing description of the rocks the En, Fs, Wo-relations are traced on TOMITA's aforementioned diagram, in all probability the determinations should be taken with some reservation, for comparison see WAGER & DEER (11), but all the same they supply us with certain facts to go by.

Olivine.

In all thin-sections the olivine is colourless. The most frequently developed faces are found in the automorphic individuals (010), (110) and (021); cleavages on (110) are well developed; two instances of twinning were found (110).

The fayalite-content varies from about 0 % to about 30 %. (BOWEN & SCHAIRER, 7, WAGER & DEER, 12) and is distributed in 22 determined individuals in the following manner:

$Fa_{0\text{-}5\,\%}$	4
$Fa_{5\text{-}10\,\%}$	4
$Fa_{10\text{-}15\,\%}$	6
$F_{15\text{-}20\,\%}$	2
$Fa_{20\text{-}25\,\%}$	1
$Fa_{25\text{-}30\,\%}$	5

Fig. 16 shows the slides in which it was possible to make optical determinations of both pyroxene and olivine. The pyroxene points are part of the same as shown in the diagram above (fig. 15). The basal line is also used as the olivine-line, Fo and Fa being placed in En and Fs respectively. Even if the points are few, it can be seen that the diopsidic pyroxenes of the picrite-basalts (squares) are found together with the olivines richest in mg, and also overlap the pyroxene-olivine-region of the olivine-basalts (circles). The dotted line shows that the olivine in the groundmass of the rock in question (no. 2272) is richer in iron than the olivine of the phenocrysts of the same rock. The dolerites are shown by triangles. The cross indicates the values found by NIELAND (30).

It should be noted that in addition to the ore a small quantity of apatite is found as accessory component. Furthermore, in interstices fine needles, probably natrolite, occur. The chloritic material has not been examined in detail.

6. Chemical Variation and Differentiation of the Rocks.

In order to get a clear view of the chemical variations within the rocks of the area in question, and to form a conception of the nature of the differentiation, a number of diagrams (figs. 17—22) have been constructed. In table 8 the available material of analyses from Svarten-

Table 8.

	1. 768	2. 2272	3. NIELAND	4. 763	5. 2243	6. NIELAND
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
N_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

Table 9.

	1.	2.	3.	4.	5.	6.
si	65.2	71.1	89.7	108	115	244
ti	2.05	2.81	2.90	6.54	5.38	2.08
p	0.10	0.10	0.48	0.07	0.42	—
qz	—39.2	—43.7	—22.3	—14.4	—8.2	+12.8
al	6.0	7.9	16.2	19.7	18.4	38.1
fm	85.4	65.1	49.4	42.8	47.4	20.3
c	7.5	23.3	31.4	31.9	28.4	8.8
alk	1.1	3.7	3.0	5.6	5.8	32.8
k	0.45	0.27	0.28	0.23	0.17	0.35
mg	0.83	0.78	0.57	0.52	0.43	0.24
c/fm	0.88	0.36	0.64	0.74	0.60	0.43
Section	V	V	IV	V	IV	III/IV

huk is presented; two of these—nos. 3 and 6 resp.—were made by H. NIELAND (30), the remaining four were carried out by Dr. S. PALMQUIST for the present paper. Tables 9 and 10 shows the corresponding NIGGLI[1]) & VON WOLFF-values.

The NIGGLI-diagram, fig. 17 shows the variation of the Svartenhuk-rocks. Characteristic is the antagonistic course of the c and fm curves in the basic end of the diagram; otherwise the diagram is very regular. Representatives of the si-values between 115 and 224 have not yet been obtained.

The diagram in fig. 18 shows the k—mg relation according to NIGGLI. The figures in the brackets are the si-values. At the top of this diagram are the two picrite basalts with their large contents of Mg; the basalts proper lie at 0.5 Mg, and, separately, the anorthoclase-trachyte.

Table 10.

	L	M	Q	A	C	K_2O	MgO	C′	Fe″	Mt
1.	17.0	100.9	—17.9	0.65	2.96	0.29	43.20	1.54	4.20	2.96
2.	27.0	94.6	—21.6	2.15	2.45	0.58	29.55	10.99	6.05	1.40
3.	40.4	65.8	— 6.2	1.58	6.93	0.44	14.67	9.51	7.37	2.66
4.	48.8	50.0	+ 1.2	2.69	6.86	0.60	10.62	8.52	3.57	4.28
5.	45.2	48.2	+ 6.6	2.70	5.86	0.44	9.48	7.24	4.74	5.26
6.	83.2	7.7	+ 9.1	9.64	1.56	0.32	1.43	1.02	0	2.58

[1]) For uniformity the NIGGLI-values of the two analyses by NIELAND were recalculated by me.

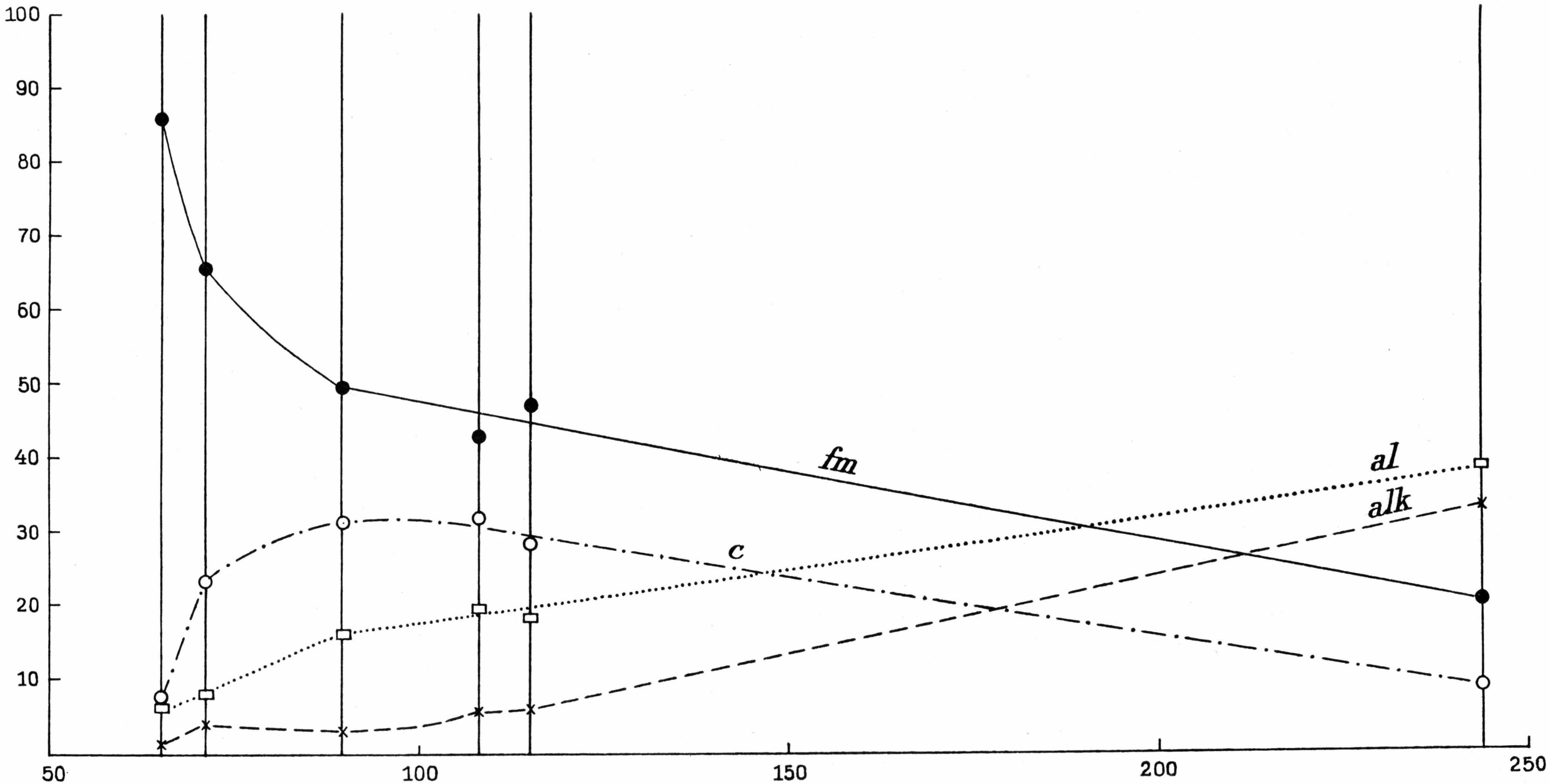


Fig. 17. Variation-diagram after Niggli of the rock series of Svartenhuk (comp. table 9).

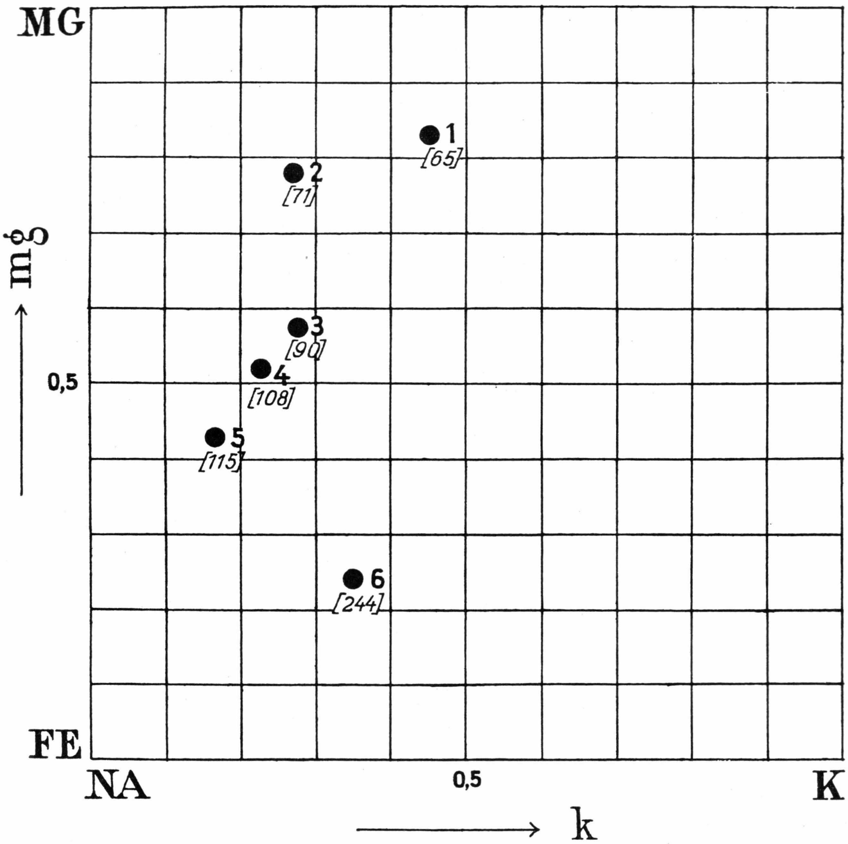


Fig. 18. K-Mg relationships after NIGGLI of the Svartenhuk rocks (comp. table 9).

As already stated it is clear from the NIGGLI-diagram, fig. 17 that the curves c and fm are antagonistic in the basic end; the diagram fig. 19, where the ordinate is weight-per cent oxides and the abscissa weight-per cent SiO_2 shows that it is chiefly MgO and CaO which are antagonistic while iron is almost constant at the low SiO_2 figures, but reaches a slight culmination, which falls on a higher SiO_2-value than that of the maximum of CaO.

The diagram, fig. 20, shows the relations between MgO, CaO and Na_2O, K_2O, and the diagram, fig. 21, gives the position of the VON WOLFF-values; for comparison the same values have been entered for the Qaersut peridotite from Nûgssuaq—the stippled line (see following chapter).

The calc-alkali index of the Svartenhuk series is 56 and thus on the border line between alkali-calc and calc-alkali. Compared with this the rocks of the Qaersut sill are more alkaline with a calc-alkali index of 51.

In the diagram, fig. 22, MgO, the significant constituent of the more refractory minerals is at one corner, while FeO, the significant constituent of the medium refractory minerals at the second corner, and total alkalies, the significant constituent of the less refractory minerals at the third corner. The full-drawn, almost straight line—with oblique crosses—is obtained from DALY's averages of basalt-andesite-

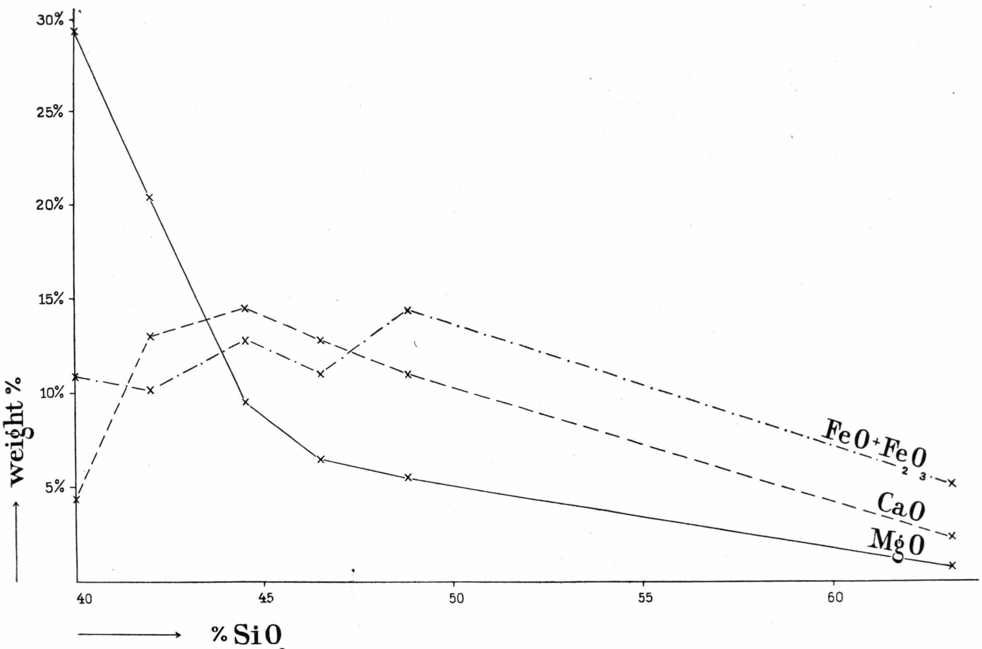


Fig. 19. Diagram where the ordinate is weight-per cent oxides of $FeO + Fe_2O_3$, MgO and CaO, and the abscisse weight-per cent SiO_2.

dacite-rhyolite and is here considered as defining the trend of the normal calc-alkaline series (9). The dash-line with open circles shows the trend of strong fractionation of a basaltic magma as described from the Skaergaard-intrusion in Southeast Greenland by WAGER and DEER (14), figs. 62 and 63. The curved area with filled circles—horizontally shaded—represents the fractionation of the Breven and Hällefors dolerite dykes in Sweden described by T. KROKSTRÖM (25, 26). Finally, the area with vertical shading represents the rock series, of Svartenhuk, triangles. As stated by WAGER and DEER the trend of the Skaergaard-liquid is very similar to conditions at Hällefors and Breven. As we have no analyses from Svartenhuk of the links between basalt and anorthoclase-trachyte, it is at present impossible to determine if one or more magma sources lying under Svartenhuk in the Tertiary period had a trend of development similar to the Skaergaard massif. In the meantime the known

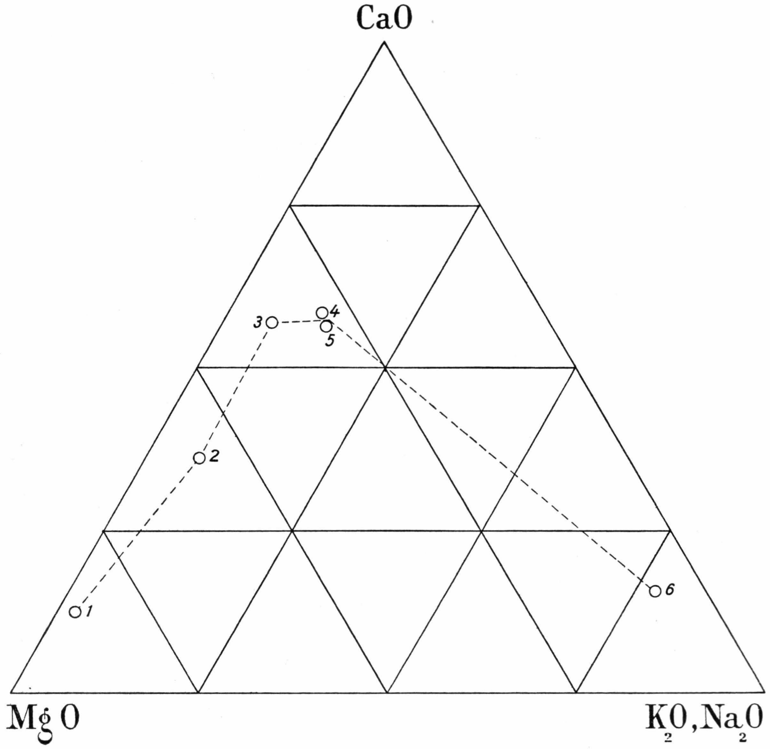


Fig. 20. MgO-CaO-K_2O, Na_2O-triangle showing the trend of variation from the ultra-basic schönfelsite (1), via oceanite (2) and basalts proper (3, 4, 5) to anorthoclase trachyte (6).

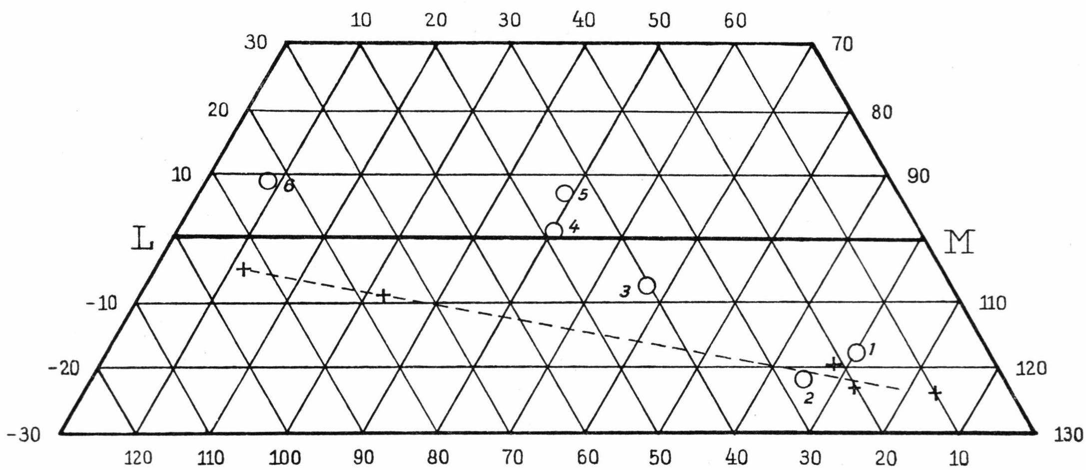


Fig. 21. von Wolff-diagram. Open circles = the Svartenhuk rocks, crosses on dash-line = rocks from the Qaersut-sill (comp. p. 65).

points have been connected by dotted lines, so that the four analyses almost follow DALY's average curve. From the right side of the diagram, the place of the three basalts, the area of the Svartenhuk series curves downwards—the two rocks exceedingly rich in olivine—which in the diagram gives us an elongation of the Skaergaard line and the right

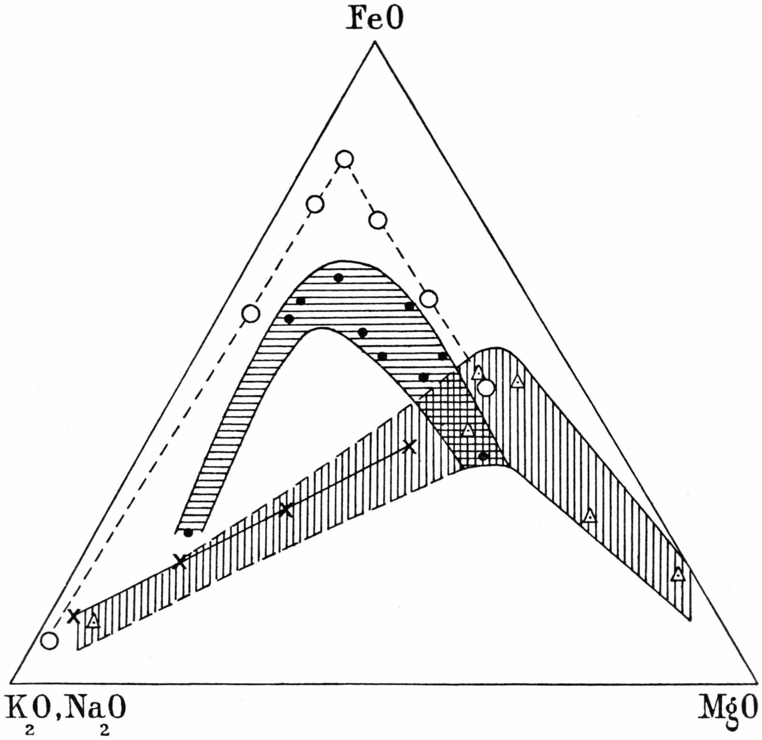


Fig. 22. K_2O, Na_2O-FeO-MgO triangle illustrating the fractionation of some basaltic magmas (Further explanation in text p. 61).

side of the Breven-Hällefors line which completes the picture of a fractionation almost parallel with the MgO-FeO and FeO-Na_2O K_2O lines (see WAGER and DEER, 14, p. 314).

Most likely the composition of the original Svartenhuk magma has been relatively near to the three basalts lying close to each other, and it may be supposed that the members extremely rich in olivine have been derived from a magma of almost this composition by gravitative separation of early crystallized olivine. According to the circumstances of finding—the position far down in the plateau—this may be a fairly early period of the volcanic development. The rock succession described in the petrographic chapter shows the later stages of differentiation from olivine-basalt through olivine-free basalt (and andesitic basalt) to anorthoclase-trachyte. This rock series cannot, however, be explained exclusively by supposing that its various parts are derivations by crystallization of an olivine-basalt of a mild alkaline nature (Bowen, 6, Barth, 3, 4). No doubt a certain contamination with sialic material has taken place; the calc-akali index is 56, and the f (norm) values of no. 4 (763) and no. 5 (2243) lie about 110. As there is every reason to suppose the prescense of a sialic substratum under Svartenhuk this cannot surprise.

7. Comparison between the Differentiated Peridotite-Sill at Qaersut, Nûgssuaq and the Rock-Series of Svartenhuk.

Without discussing in detail the ultra-basic rocks of the Nûgssuaq peninsula, which were investigated in various places by the Nûgssuaq expeditions of 1938 and 1939, I shall in the present chapter give a short account of the conditions in the differentiated sill at Qaersut which has been dealt with more extensively by Phalen (32), Heim (19) and Drescher & Krueger (16).

Heim describes three occurrences of peridotitic rocks from Nûgssuaq, viz.: 1) the north side of the Østerfjeld at Qaersut, 2) the Slibestensfjeld, and 3) the shore cliffs at Qarsuarssuk. The first two are sills, the third an irregular, almost vertical dyke. It is evident from the contacts that "es sich nicht um Ergussgesteine, sondern um intrusive Tiefengesteine handelt, die zur Zeit ihre Bildung wohl nie mit der Oberfläche in Verbindung gestanden sind" (19, p. 203).

The peridotite sill in the north side of the Østerfjeld—at Qaersut —is between 55 and 60 m thick. The rock consists chiefly of olivine and augite with accessory brown hornblende, green serpentine and ore. "Die untersuchten Schliffe sind völlig frei von Feldspat" (p. 204). Phalen, however, has also examined rock samples from this locality and gives an analysis of the principal rock. He states that the rock contains plagioclase with the composition Ab_1An_1 (32).

Heim determines the dyke in the coastal section at Qarsuarssuk to be picrite or picrite-peridotite and states the mineral composition to be: Olivine ($^4/_9$), augite ($^4/_9$) and bytownite ($^1/_9$) + hornblende.

From the Slibestensfjeld no microscopic data are yet available. The picritic rock from Niaqornat probably belongs to a different series of development. Both localities will be dealt with in future publications.

There is every reason to believe that the ultra-basic rocks on Nûgssuaq belong to the Tertiary basalt formation and can be compared with the ultra-basic links of Svartenhuk. Besides Phalen's analysis the basis of comparison is four more recent analyses from Drescher &

KRUEGER's paper, namely of the normal peridotite, "Augitzüge", "Pegmatite" and "Aplite" respectively. All the rocks analysed were taken from the same sill.

Tabel 11.

	1.	2.	3.	4.	5.
SiO_2	42.63	38.48	41.11	48.50	59.77
TiO_2	—	1.20	0.61	3.05	0.81
Al_2O_3	6.88	4.36	8.34	19.41	18.14
Fe_2O_3	3.33	4.69	2.99	1.07	1.04
FeO	7.27	10.12	7.19	4.67	1.90
MnO	0.63	trace	trace	0.11	0.05
MgO	29.36	29.54	29.32	4.26	1.76
CaO	5.90	5.94	4.96	8.93	1.67
N_2O	1.26	0.74	0.70	4.39	5.68
K_2O	0.14	0.13	0.12	2.15	6.33
P_2O_5	—	—	0.70	0.33	0.20
CO_2	—	0.46	1.00	0.37	0.35
H_2O	—	4.01	3.55	2.33[2]	2.12[3]
	97.40[1]	99.67	100.59	99.57	99.82

1. Peridotite. Anal. PHALEN (32).
2. "Augitzüge" in peridotite. Anal. SCHÄFFER.
3. Peridotite, common type, felspar-carrying. Anal. SCHÄFFER.
4. Pegmatitic veins in peridotite. Anal. SCHÄFFER.
5. "Aplitische Mittelfüllung" in pegmatitic veins. Anal. SCHÄFFER.

(2.–5.: DRESCHER & KRUEGER (16).)

For the purpose of comparison with the rock series from Svartenhuk the course of differentiation within this isolated intrusive body has been indicated in the VON WOLFF diagram fig. 21, where the analyses are on line (crosses).

For further comparison fig. 24 shows c-fm-alk diagram, where the rocks from Qaersut, Nûgssuaq are indicated by crosses, the Svartenhuk rocks by open circles; the enclosed area contains all the eleven analyses. The diagram is naturally rather similar to the MgO, CaO, Na_2O K_2O diagram, fig. 20.

DRESCHER & KRUEGER (16) use a triangular diagram as seen in fig. 23 to show the differentiation in the peridotite sill from Qaersut[4])

[1]) Including $NiO_2 = 0.27$ and $Cr_2O_3 = 0.05$.

[2]) $H_2O^{+105°} = 2.01$, $H_2O^{-105°} = 0.32$.

[3]) $H_2O^{+105°} = 1.82$, $H_2O^{-105°} = 0.30$.

[4]) The doleritic sill occurring in the Qaersut peridotite and which, according to DRESCHER & KRUEGER, belong to the same period of intrusion has been marked with an isolated cross in the diagram.

-stippled signature; the rocks of the Svartenhuk series are indicated by an unbroken line.

The aim of this brief comparison and the graphic descriptions accompanying it has been to point out the common features of the ultrabasic rocks from Nûgssuaq and Svartenhuk, and to draw

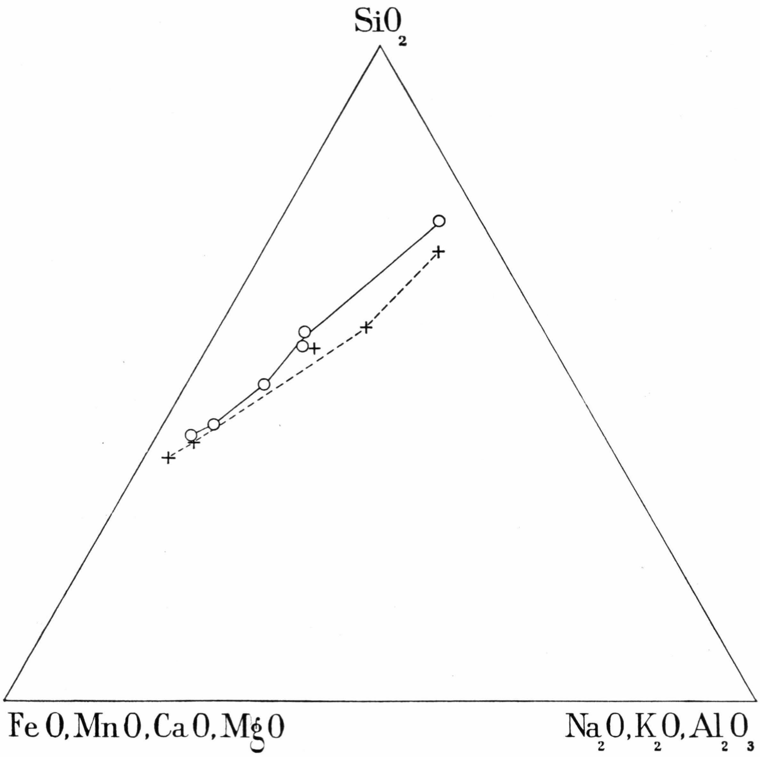


Fig. 23. Comparison between the Svartenhuk rock-series (full line and open circles) and the rock-series of the Qaersut-sill (dash-line and crosses) in a FeO, MnO, CaO, MgO-SiO_2-Na_2O, K_2O, Al_2O_3-triangle.

attention to parallels between the differentiation in the isolated intrusion at Qaersut and the whole differentiation process of the Svartenhuk rock series.

8. On the Formation of the Basalt-Plateau in Svartenhuk.

As mentioned in the introduction the present report is a result of a reconnaissance trip of a few days' duration. Therefore it must not be expected that the petrology of Svartenhuk has been exhaustively dealt with. But as far as the rocks are concerned certain new and hitherto unknown elements have been described and analysed, which should help to form a picture of the petrographic conditions, and as for the geology, a number of observations have been made, a few features of which should be of special interest.

The chronological succession of the volcanic activity of Svartenhuk

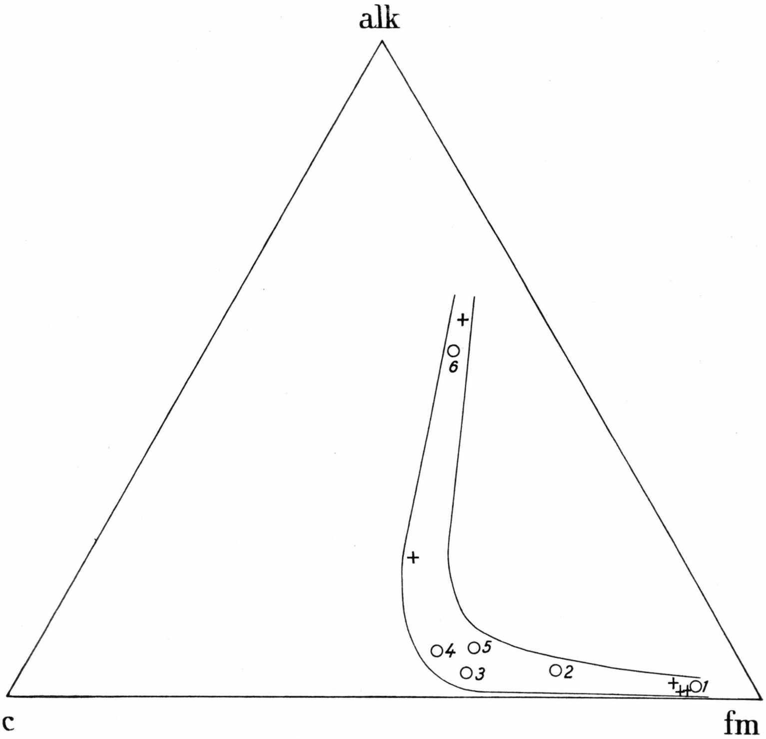


Fig. 24. Comparison between the Svartenhuk rock-series (open circles) and the rock-series of the Qaersut-sill (crosses) in a c-alk-fm triangle.

seems to be that after the formation of the submarine breccia a subaerial series of basalt has been produced, beginning with melanocratic olivine basalts, succeeded by plagioclase-porphyric basalts with subordinate olivine, and ending with olivine-free basalts and andesitic basalt. Youngest is the acid anorthoclase-trahyte appearing as a dome far west, at the top of the plateau. It is, however, likely that less regularity and perhaps recurrence of either type of rock will be found by closer investigations and more samples, as I have experienced in the Faeroe Islands.

No faults in the plateau basalt series of either the north—south or the east—west section have been recorded by ROSENKRANTZ. On the other hand faults may exist in the deep valleys, and no definite decision on this question can be made until a detailed field survey has been undertaken. That at least smaller faults or lines of tension should be present is highly probable, since variation in the dip-angles seems to suggest a stepwise grouping of the dip values (cf. map fig. 13). S. MUNCK or the author did not observe any faults during their boat trip along the south coast of the whole peninsula; but as part of the journey was made in foggy weather, this is no guarantee that faults do not exist.

Assuming that the plateau is practically undisturbed, and using an average southwesterly dip of 15°—20°, we have a thickness of over 10 kilometres of the plateaubasalt series of Svartenhuk.

Considering the very short period—geologically speaking—used for the formation of the basalt plateau this is an impressive thickness.

From the East coast of Greenland, north of Angmassalik, WAGER (13) reports the total thickness of the plateaubasalts to be about 7 kilometres. In the Faeroe Islands WALKER & DAVIDSON (10) estimate the thickness of the basalt to be 5 kilometres. As for Tertiary Iceland, HAWKES (18) records a thickness of 3.5 kilometres.

In NE.-Greenland we have only rather small remains of real plateaubasalt, the greater part of the NE.-Greenland rocks described (H. G. BACKLUND and D. MALMQUIST, 1, 2, A. RITTMANN, 34) originates from dykes, sills and cone-sheets, intrusive in the pre-basaltic sediments. On reaching the nearly 2 kilometres high cliff wall of the south side of the Scoresbysund fjord, which is built up entirely of plateaubasalt, we enter the field studied by WAGER (13, 14, 44).

With the exception of the district in SE.-Greenland I have personally visited the other areas, and the following observations on the general formation of the Svartenhuk plateau also apply to any of the others.

As recorded above there are few dykes in the western part of Svartenhuk, i. e. in the upper part of the plateau. The more we move eastwards, nearer to the bottom of the plateau series, the more numerous are the dykes. Similar, although far more complicated, conditions are found on Nûgssuaq. This question will be dealt with in a future publication.

In the dykes we find exactly the same rocks as in the plateau, picrite-basalt (oceanite), olivine-basalt, felspar-porphyric basalt with subordinate olivine, and olivine-free basalt[1]).

As no lava-producing volcanism of central type has been found in the plateau either on Svartenhuk, in Tertiary Iceland or in the Faeroe Islands, while in all these areas numerous dykes are met with — in the Faeroe Islands, on Kalsø and Kunø alone 75 (NOE-NYGAARD, 31)—

[1]) So far only material from the eastern part of the peninsula has been examined.

and as the rocks of the dykes are analogous with the rocks of the lava sheets in the plateau, it may be assumed that the two are causally connected. In other words, the dykes should be explained as remains of the fissure-formed feeding channels, through which the lava poured forth in ancient times. This view is not at all new, and already clearly formed by GEIKE (17, p. 264). In the Faeroe Islands WALKER & DAVIDSON (10, p. 874—75) succeeded in demonstrating how a dyke opens out directly into a lava sheet. For my own part, I have more than once observed the same dyke at sea-level on both sides of a narrow island, and not in the interjacent high mountain ridge. There is no doubt that such dykes are feeding channels leading to certain sheets in the plateau at a certain height above the sea, sheets in which the rocks are analogous with the rock of the dykes. For this reason the dykes come to an end when reaching a certain height above sea-level and do not continue above the flows of lava they have formed.

On Svartenhuk a parallel can be found in the decreasing number of dykes met with when moving upwards in the plateau from the basalt breccia.

A fact which beforehand might be expected to play an important part with regard to the thickness of the basalt plateau is the presence of sills. As far as I can see these are actually comparatively rare. On Svartenhuk we found none in the plateau basalt, in the Faeroe Islands a few systems are to be found on Strømø, Østerø and Svinø; in these places they often change level, and as they are generally columnar from top to bottom, they are easily distinguished even at a distance, so the possibility of the existence of more than the ones already known can be practically disregarded. Irregular sills have been met with in the sub-basaltic sediments at Itsako in the eastern part of Svartenhuk. The rocks examined all proved to be dolerites.

If we sum up the data of the Svartenhuk results which go to show that the dykes are the feeding channels of the extrusive lavas, they are as follows:

1) Agreement between the rocks of the extrusive basalts and the dykes.
2) The more frequent occurrence of dykes towards the bottom of the series.
3) No trace of volcanism of central type found.

To this must be added analogical conclusions from other areas, where very large eruptions of lava with low viscosity have occurred (for comparison see G. W. TYRRELL, 41, STEARNS and CLARKE's investigations at Hawaii (8), and the well-known post-glacial fissure eruptions in Iceland: Eldgjá and Laki). Consequently, I have also come to the conclusion that Svartenhuk and the other districts of similar nature, which I know, were built up by successive, subaerial fissure eruptions.

When sailing in a fjord or passing through a valley in a plateau-basaltic area one gets the impression that a wall in the basalt series consists entirely of plane-parallel strata, which can be traced kilometre after kilometre. In the Faeroe Islands, however, where I have been able to go more into details, I have often in the clean steep walls of

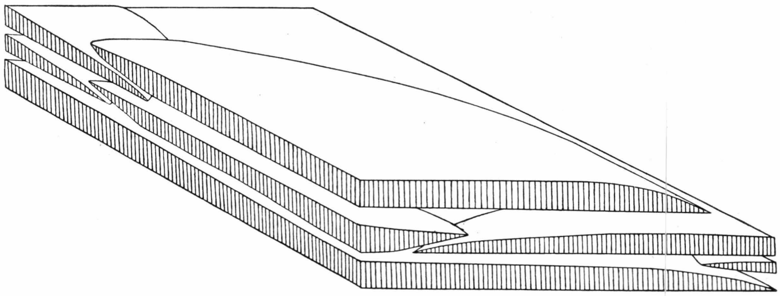


Fig. 25. Diagram of the structure of a typical area of plateau basalt.

the fjords found the individual sheets thinning out. The diagram (fig. 25) gives an idea of the building-up of a typical area of the plateau basaltic formation of the Faeroes and West Greenland. The height of the lenticular form of the individual sheets is somewhat exaggerated in the diagram.

The nature of the plateau may be explained by comparing the flows of lava to an irregular heap of pancakes on a table. If we let the pancakes cover a sufficiently large area, they will overlap in an irregular manner; but if we make a cut through the heap with a sharp knife—in nature a valley or a fjord—the section, i. e. the wall of the fjord, will show almost parallel boundary planes between the individual pancakes—or lava sheets.

9. Considerations on the Geophysical Conditions.

Previous investigations seem to have shown that the substratum of the Cretaceous sediments in the outer parts of the Umanak Fjord region has a surface developed as a rather even plain with several small round granite hills, perhaps with the original character of a Skaergaard. It is possible that the small flat or rounded outcrops of pre-Cambrian rocks which are found below the plateaubasalts in the fjords and valleys in the western part of Disko are remains of this socle or flat.

After the deposition of the Cretaceous-Tertiary sediments the volcanic activity set in. At the beginning of the volcanic period the greater part of the territory was submerged, as the first volcanic formations—apart from a few preceding falls of ashes in the sediments, the oldest of Danian age (Rosenkrantz(15))—have the character of pillow-lavas and pillow-lava breccias (S. Munck(15)). When the volcanic accumulations reached sea-level, the volcanic activity was continued with subaerially formed basalts. This is proved by the slaggy surfaces and the beautiful flow phenomena observed in the surface of the individual sheets; between the subaerial basalts are beds of red tuffs of the type found in Tertiary Iceland and the Faeroe Islands.

During the great production of lava the whole district has most likely been steadily sinking, so that the level of extrusion most of the time has kept almost constantly a little above sea-level, and that this is probably so, is also indicated by the recurrence of subaquatic volcanic formations in the plateaubasalt itself, as observed on Nûgssuaq and Schades Øer (15).

With the reservations pointed out above (p. 67) is seems probable that when the volcanic activity had ceased the total thickness of strata in Svartenhuk had reached a magnitude of about 10 kilometers. It is evident that the weight of the gradually increasing layer of plateau basalts on the part of the sial-sphere under it becomes very high. The weight of 10 kilometres of basalt with a specific gravity considerably higher than that of the usual sediments is of a magnitude which, as far as pressure goes, may well be compared with geosynclinal conditions.

When volcanic activity ceased, the reason for this may inter alia be sought in the circumstance that towards the end the eruptive energy was not able to overcome the weight of the overlying basaltic strata except through a few cracks, where the youngest dykes were formed.

When the volcanic energy eventually was exhausted, it must be imagined that the periferic magma-chambers were gradually chilled to such an extent that the magma still present solidified, thereby reducing its volume, and that the covering layers subsided a little. I assume that the semi-circular dip of the strata in the Faeroe Islands may be due to this process. As stated above, the lowest strata of the basalt formation have not been found in the Faeroe Islands, nor remains of a sub-basaltic substratum; but on Svartenhuk, on the other hand, there is reason to suppose that the sub-basaltic formations: pre-Cambrian and more or less large series of young-Mesozoic and old-Tertiary age continue westwards under the basalt-formation. When, therefore, the plateaubasalt series of Svartenhuk now has a considerable dip in a southwesterly direction, the whole of it having been moved from the horizontal position to a dip varying from ab. 10° to ab. 45°, this must be due to the fact that the substratum furthest to the southwest, where, presumably, the pressure has been the highest, has given way to the weight and subsided. We have not observed any nonconformity within the basalt plateau itself indicating that the subsidence has taken place in more than one period. In the westernmost part of the Nûgssuaq peninsula, i. e. west of the southern end of Itivdleq valley, a marked angular disconformity is observed within the plateau itself; here a lower series with a considerably westerly dip is overlain by a series with a marked, but much slighter inclination in the same direction. In this place a subsidence in the west must have occurred during the volcanic period while a later and less pronounced subsidence has taken place in the same place after the formation of the last plateaubasalts.

In Svartenhuk conditions most likely have developed in the following manner: During the *mise-en-place* of the basalts a general continuous lowering of the whole area seems to have taken place as indicated by the recurrent subaquatic breccias with pillow-lavas mentioned above. After the formation of the lavas a subsidence of the whole plateau in the extreme southwest took place. Processes like the one briefly described above in connection with the Faeroe Islands may have contributed to this change, but movements of quite a different size have here been the deciding factor. I consider it most likely that the "geosynclinal" weight has become so great that the sialic substratum has caved in, and in doing so caused the considerable subsidence in the southwest.

From southeast Greenland WAGER & DEER (13, p. 43) describe a Tertiary dyke-swarm which they consider associated with a flexuring of the sialic substratum, "which has controlled the direction and position of the swarm, and, indeed, has probably been the immediate cause of it." It is made clear from observations of the dips of the lavas and the underlying Tertiary sediments, "that this part of East Greenland has undergone a powerful flexuring movement, which has produced the Denmark Strait on the downthrow side and the highest mountain country in Greenland on the other. Apparently the flexure or monocline took place during the later stages of the East Greenland Tertiary igneous activity . . ." (comp. 13, textfig. 3).

If we imagine that in Svartenhuk the substratum of the plateau basalt series has subsided as a consequence of the weight, the present southwest dip is produced. In this respect conditions may remind us of conditions found by Wager & Deer (13) in East Greenland; as to the dyke-swarm recorded by the said authors no parallel has been met with in Svartenhuk, perhaps because our present knowledge of the Svartenhuk dykes is too slender, or because analogous conditions do not exist.

With the subsidence of the basalts, the underlying parts of the sial-sphere—at least the lower part of it—must be assumed to have reached so low a level that it required a certain plasticity, and in order that the area might again obtain an isostatic balance this plastic state had allowed a certain giving off of some of the lighter materials, which by migration eastwards reach a new position somewhere underneath the substratum of the basalt series, that to a great extent is the folded crystalline basement to the east, the present height of which gives the Umanaq country its beauty and grandeur.

The supposition that such a sialic substance migration in an easterly direction has taken place in the whole basalt field of West Greenland gives us an explanation of why we for example on Nûgssuaq now come across marine young-Mesozoic sediments and submarine volcanic deposits as high as one kilometer above sea-level. It also explains why the topography of the territories east of Svartenhuk and Ubekendt Ejland differs from the conditions to the north and south of it, a circumstance already known to K. I. V. Steenstrup. This stretch of country completely lacks the Skaergaard zone, which otherwise is found along the whole west coast of Greenland.

The absence of the Skaergaard zone in central West Greenland is in all probability due to a combination of three factors, i. e.: 1) the pre-basaltic faulting (Rosenkrantz (15)), 2) the isostatic processes of equalisation in the sial-sphere resulting in migration of sialic substances from the west towards the east in the way described above, and 3) the difference between the basaltic and the pre-Cambrian rocks as to nature and behaviour towards ice- and sea-action.

Most likely the youngest tectonic manifestations on Nûgssuaq are causally connected with the presumed movements within the sial-sphere.

Rather than an oblong trough the west subsidence seems to have been shaped like a semi-circular cauldron; the "fault line" without being correct in details shown on fig. 59 (21) by L. Koch gives an idea of this. The subsided area comprises Nûgssuaq peninsula west of the Itivdleq valley, Ubekendt Ejland and at least the southwestern half of Svartenhuk peninsula. The centre has presumably been west of the extreme part of the present coast line, almost due west of Ubekendt Ejland.

As mentioned in our preliminary report on the results of the expedition (15) we were able to follow the rock types belonging to the pre-Cambrian folded series of the Umanaq district as far to the south-southeast as the country east of Jacobshavn in Disko bay. The country here is considerably lower than that of the Umanaq district, and so is the easternmost parts of Nûgssuaq peninsula; it is thinkable that the sialic equalisation processes discussed above have not affected the country as far south and east.

It will therefore be understood that for a future investigation of the pre-Cambrian formations the Umanaq Fjord, where the assumed upheaval has been the greatest, offers particularly good opportunity for a study of these formations because of the accentuated relief and the considerable height of the mountains.

Another geologically interesting point is the age of the West Greenland Skaergaard zone, the "strand flat" (22, 23, 46).

At Godhavn and west of this place as well as in Disko Fjord and Storedal (M. P. PORSILD) all on Disko Island, small, generally flat areas and not very high rounded domes of the pre-Cambrian substratum are to be found, which have now been exposed in the cliff walls of valleys and fjords by the young-glacial erosion. They are in these places quite covered with basalt-breccia or plateaubasalt, which in all probability means that the pre-basaltic sediments of Mesozoic and Tertiary age heve been removed before the volcanic activity began. Apparently we have here as part of the pre-volcanic erosion surface remnants of the low socle, referred to at the beginning of this chapter, and which is older than the deposition of the Cretaceous and Tertiary sediments of West Greenland.

If we connect the westernmost visible remains of this surface, we get an almost straight line running north—south and uniting the Skaergaard zones of Egedesminde and Upernivik. It thus seems, as far as Disko is concerned, that covered by the volcanic accumulations and farther east of the Cretaceous sediments there is a continuation of the Skaergaard zone from the West Greenland coast to the south to the northern continuation, which seems to extent as far as Melville Bay.

As to Svartenhuk we must assume that the Cretaceous and Tertiary sediments have been deposited on a similar surface, which, however, is only to be seen where it dives under these sediments far east on Itsako. The age of the erosion surface is here at any rate older than Coniacian (ROSENKRANTZ (15)) and the Kome strata, GRY (15).

If the remains of the buried surfaces of Svartenhuk and Disko corresponds, and if they actually belong to the strand-flat north and south of central West Greenland, the latter may be of quite considerable age. That no new strand-flat has been formed in and east of the West Greenland basalt areas seems to indicate two things, i. e. 1) that the basalt areas are made of materials which are unwilling to accept that special erosional form and 2) that the modelling of such a flat needs a considerable time.

Whether remains of an original strandflat which has now been raised to a level of 1000 m or more are to be found in the plateau surface of Storøen and—less pronounced—elsewhere in the Umanaq Fjord I am not able to decide.

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Færdig fra Trykkeriet den 27. Juni 1942.

PLATES

Plate 1.

Fig. 1. Olivine-carrying pigeonite-dolerite (no. 1255) Itsako. + nic. 60 × magn. Coarse doleritic texture; note the twinned pyroxenes.

Fig. 2. Olivine-carrying pigeonite-dolerite (no. 1255) Itsako. + nic. 60 × magn. Big, somewhat corroded olivine left and twinned pigeonite in the centre.

Fig. 1.

Fig. 2.

CHR. HALKIER phot.

Plate 2.

Fig. 1. Picritebasalt (Schönfelsite), (no. 768) Usuit kûat. + nic. 60 × magn. Olivine dominates; in the right upper corner a single pyroxene.

Fig. 2. Picritebasalt (Schönfelsite), (no. 768) Usuit kûat. + nic. 60 × magn. Big individuals of olivine between which are laths of plagioclase.

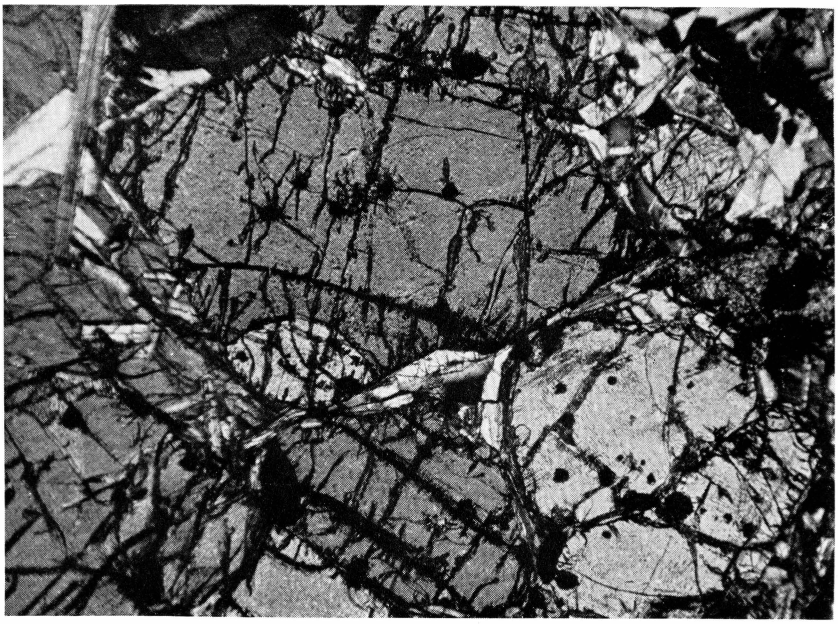

Fig. 1.

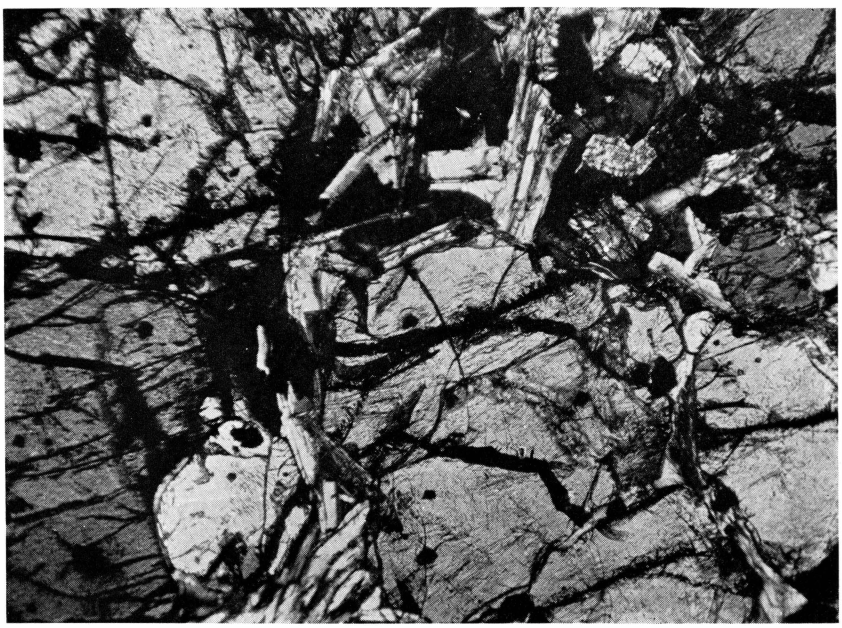

Fig. 2.

CHR. HALKIER phot.

Plate 3.

Fig. 1. Picritebasalt (Schönfelsite), (no. 768) Usuit kûat. + nic. 60 × magn. Big pyroxene with laths of plagioclase; at the right and left edge olivine.

Fig. 2. Picritebasalt (Massafuerite), (no. 2249) Usuit kûat. + nic. 35 × magn. Pyroxene-plagioclase mesostasis between somewhat rounded olivines. (Note twin in pyroxene in the centre).

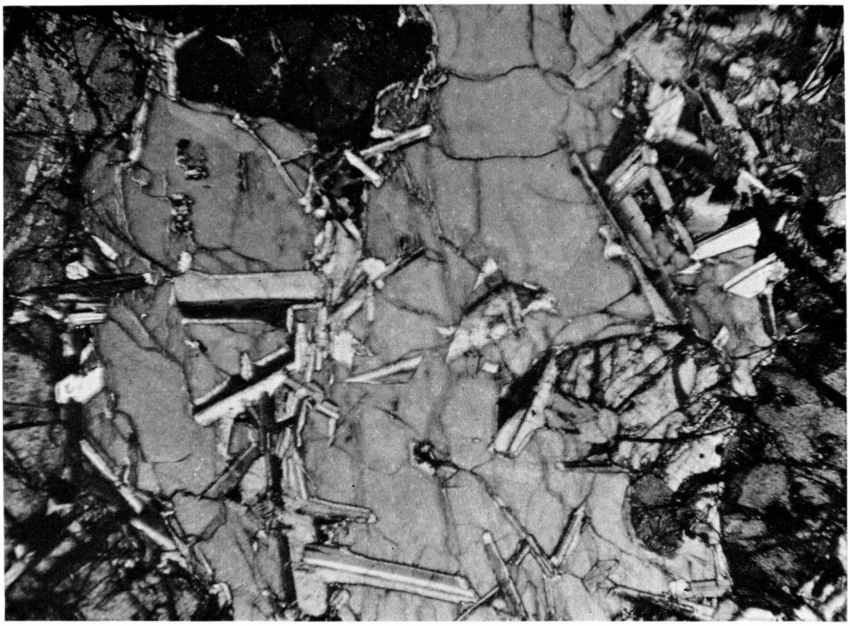

Fig. 1.

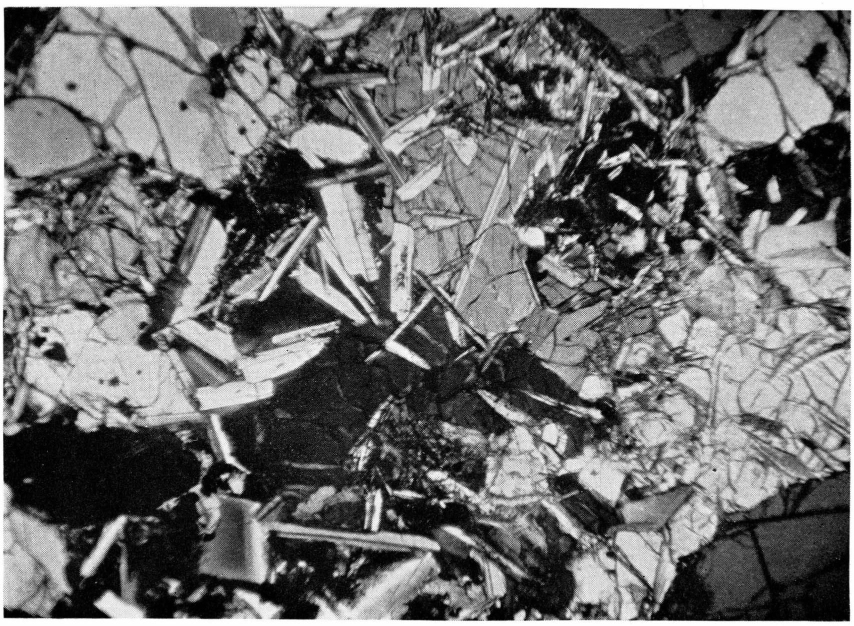

Fig. 2.

CHR. HALKIER phot.

Plate 4.

Fig. 1. Picritebasalt (Massafuerite), (no. 2249) Uvdlisaut. + nic. 60 × magn. Rounded olivines with plagioclase-mesostasis above and pyroxene penetrated by plagioclase laths below.

Fig. 2. Picritebasalt (Massafuerite), (no. 2249) Uvdlisaut. + nic. 60 × magn. Big, automorphic olivine above, mesostasis of plagioclase in the middle, and smaller olivines below.

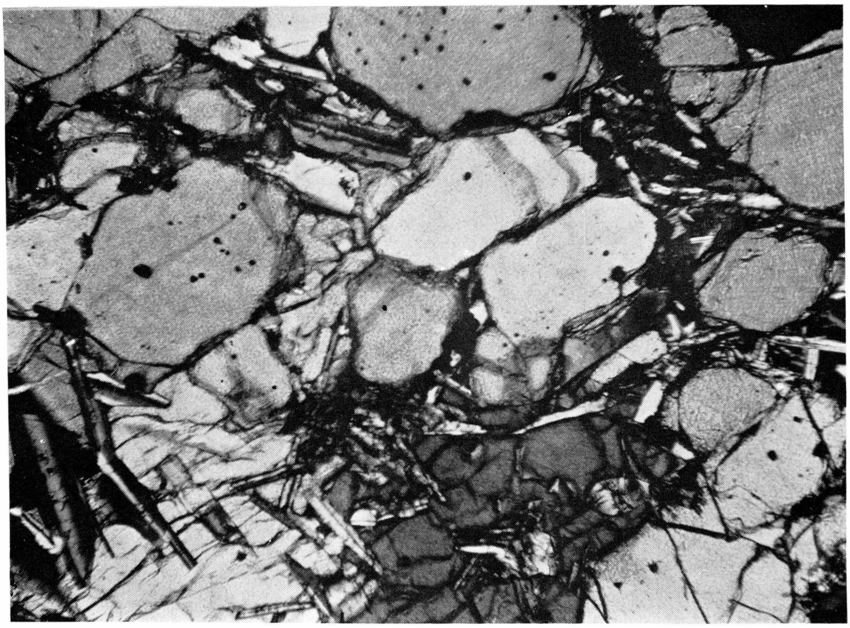

Fig. 1.

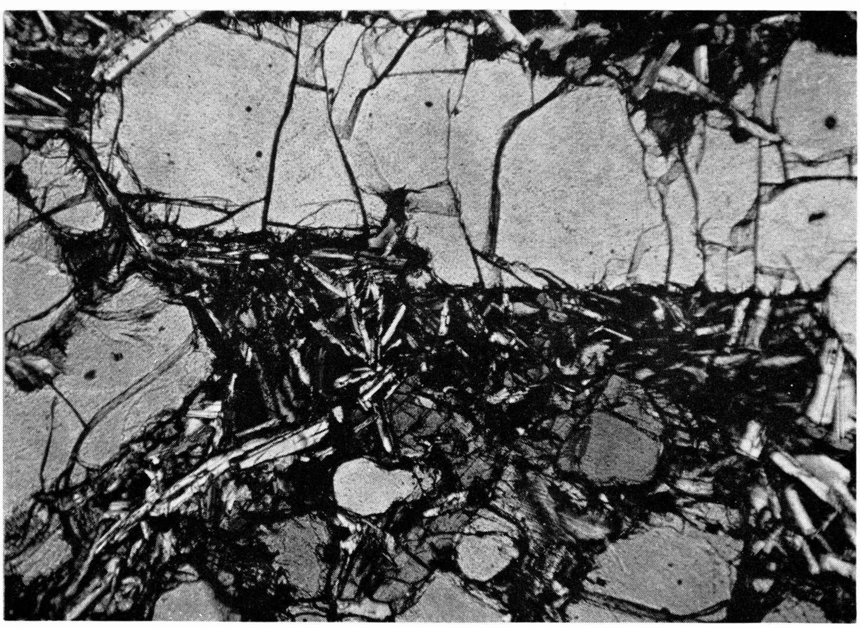

Fig. 2.

CHR. HALKIER phot.

Plate 5.

Fig. 1. Picritebasalt (cf. Oceanite), (no. 2278) Umîviup qaqai. + nic. 60 × magn. Somewhat corroded pseudomorph on olivine, fresh plagioclase in the groundmass.

Fig. 2. Picritebasalt (Oceanite), (no. 2272) Umîviup qaqai. + nic. 60 × magn. Corroded phenocryst of olivine in a groundmass mainly consisting of plagioclase laths.

Fig. 1.

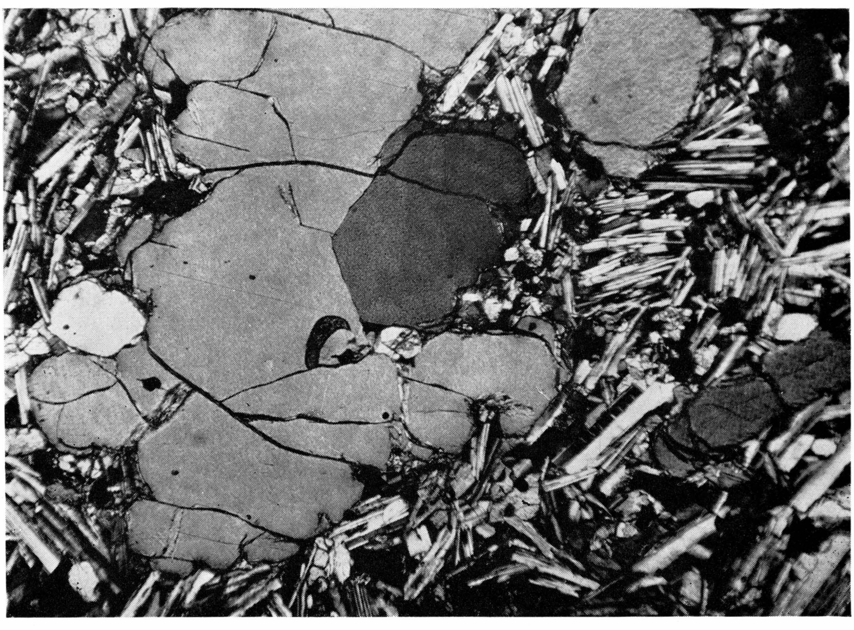

Fig. 2.

CHR. HALKIER phot.

Plate 6.

Fig. 1. Picritebasalt (Oceanite), (no. 2272) Umîviup qaqai. + nic. 35 × magn. Olivine phenocrysts in a groundmass of lath-shaped plagioclase and small equidimensional pyroxenes.

Fig. 2. Picritebasalt (Oceanite), (no. 2272) Umîviup qaqai. + nic. 60 × magn. Phenocrysts of olivine, partly automorphic partly rounded, in a groundmass of plagioclase laths and smaller pyroxenes.

Fig. 1.

Fig. 2.

CHR. HALKIER phot.

Plate 7.

Fig. 1. Picritebasalt (Oceanite), (no. 2272) Umîviup qaqai. + nic. 104 × magn. Parallel arrangement of plagioclase laths along phenocrysts of automorphio olivine.

Fig. 2. Olivinebasalt, (no. 767) Usuit kûat. + nic. 60 × magn. Big phenocrysts of olivine in a fine-grained groundmass.

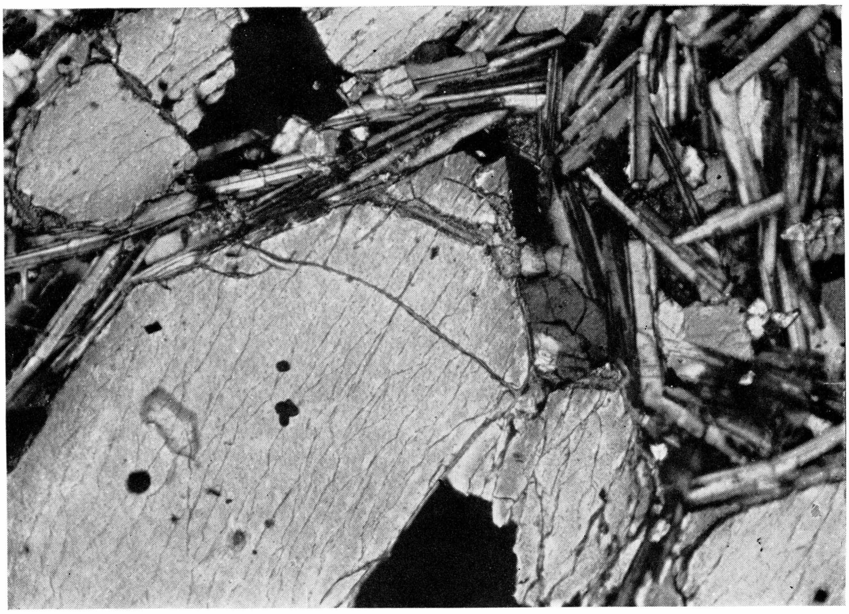

Fig. 1.

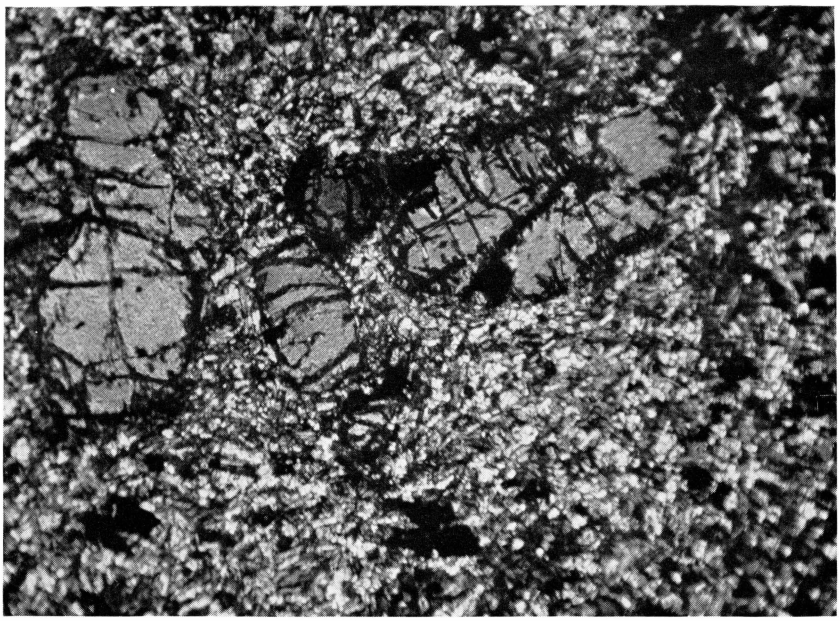

Fig. 2.

CHR. HALKIER phot.

Plate 8.

Fig. 1. Olivinebasalt (no. 2273) Umîviup qaqai. + nic. 60 × magn. Big almost altered olivine phenocryst in right, lower corner, smaller fresh individual just to the left.

Fig. 2. Olivine-carrying basalt with plagioclase phenocrysts (no. 2275) Umîviup qaqai. + nic. 60 × magn. Clusters of plagioclase phenocrysts, to the right pseudomorph on olivine.

Fig. 1.

Fig. 2.

CHR. HALKIER phot.

Plate 9.

Fig. 1. Olivine-carrying basalt with plagioclase phenocrysts (no. 2276) Umîviup qaqai. + nic. 60 × magn. Cluster of plagioclase individuals and a single somewhat altered olivine.

Fig. 2. Basalt with plagioclase phenocrysts (no. 763) North slope of Søndre Aputitût. + nic. 60 × magn. Clusters of plagioclase phenocrysts; groundmass extremely fine-grained.

Fig. 1.

Fig. 2.

CHR. HALKIER phot.

Plate 10.

Fig. 1. Olivinefree basalt (no. 761) Southwest side of Søndre Aputitût. + nic. 60 × magn. Big phenocrysts of plagioclase (zoned) and smaller phenocrysts of pyroxene in a rather fine-grained groundmass.

Fig. 2. Andesitic basalt (no. 758) Kugssineq. + nic. 35 × magn. Tabular phenocryst of plagioclase in a fine-grained groundmass. To the right a big, calcite-filled pore from which an impregnation of the groundmass with calcite can be traced (above the phenocryst of plagioclase).

Fig. 1.

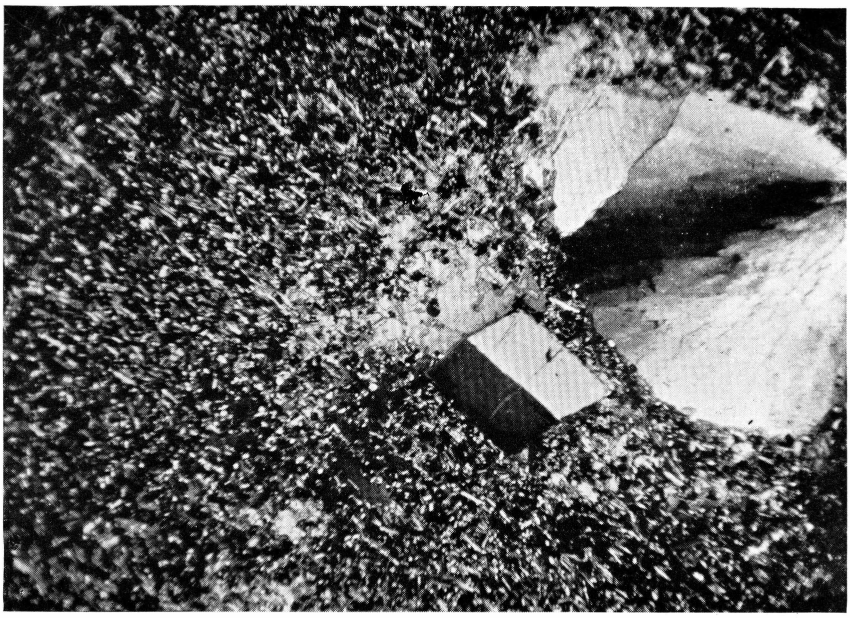

Fig. 2.

CHR. HALKIER phot.