GRØNLANDS GEOLOGISKE UNDERSØGELSE
BULLETIN No. 10.

STRUCTURAL STUDIES IN THE PRE-CAMBRIAN OF WESTERN GREENLAND

I

A SMALL BODY OF DIORITE, GODTHAAB DISTRICT

BY

ASGER BERTHELSEN

WITH 10 FIGURES IN THE TEXT AND 2 PLATES

Reprinted from
Meddelelser om Grønland Bd. 135, Nr. 6

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI A/S
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ABSTRACT

A structural analysis of a small body of diorite as well as reconnaissance work in the surrounding region tend to show that within this region a division can be made into two kinetic phases, each followed and succeeded by granitization and mutually separated by a period with intrusions of basic dykes.

INTRODUCTION

The work of the Geological Survey of Greenland on the pre-Cambrian has during the last years mainly been focused on the elaboration of a geological reconnaissance map of the hitherto little known gneiss areas of Western Greenland. This preliminary mapping has been combined with more detailed investigations of suitable key areas and of certain "problematic" rock suites to secure a deeper perspective visualizing the regional geological features (3, 6, 7, 8, 9, 10, 20, 21).

In this report, I describe a small well exposed locality which on close examination has revealed the complex history of these ancient rocks in an exceptionally clear way. It is the aim of the present work, to demonstrate this complexity and to establish a chronological sequence rather than to submit a mere description of certain peculiar rocks.

It is my hope that this paper may contribute to a better understanding of the structural evolution of the neighbouring areas.

The fieldwork was for the greater part carried out in the summer of 1953. Moreover, in 1954, I had occasion to pay a shorter visit to the locality to make some control observations. The outcrop was mapped to a scale of 1:200 by means of a ground grid laid out in NS and EW with 15 m between the individual lines. Only the more important structures, like pegmatites, joints, etc. are drawn on the map as even this scale was insufficient for a complete recording of all the minor structures observed.

The laboratory work has been carried out in the Geological Institute of the University of Copenhagen. I have paid special attention to the structural and chronological features, whereas the petrographic descriptions for the most part are held in general terms. The given An. $^0/_0$ have been determined by the combined methods of RITTMANN (13) and VAN DER KADEN (4).

A thorough petrological discussion of the obscure genesis of the diorite is left out, as the author wishes to discuss this interesting problem in another connection.

I am greatly indebted to Professor, A. NOE-NYGAARD, Dr. phil., member of the Board of the Geological Survey of Greenland and director of the Geological Institute, for permission to elaborate the material and for according me such pleasant conditions in the institute. I also wish to express my sincere thanks to Messrs. NIELS HENRIKSEN, ERLING BONDESEN and STIG BAK JENSEN, who have assisted me in the field.

Mrs. HARRIET OPPENHEJM has revised the English manuscript. The conservator, Mr. CHR. HALKIER prepared the micro photographs. The thin sections were skilfully prepared by Mr. C. A. JENSEN, both of the Geological Institute. To all, I render my best thanks.

The preparation of the map of fig. 1 has been made possible through the kindness of the Geodetic Institute of Copenhagen.

Copenhagen, the 9th of November, 1954.

LOCATION AND GENERAL GEOLOGY

The locality described in the present paper is situated on a small point on the south-eastern coast of the island Qilángârssuit which is the greatest island in the skærgård between the outpost Narssaq (South of Godthaab) and the fishing station Færingehavn (fig. 1).

The skærgård forms part of an almost submerged strandflat. The skerries and islands rarely reach higher altitudes than 100 m, whereas the mountains of the fjord-region rise to about 500—1000 m. The islands show round and ice-sculptured forms, and *roches moutonnées* are often met with. The development of these forms seems to have been facilitated by the presence of the locally well developed sheeting in the gneiss.

Geologically the skærgård between Narssaq and Færingehavn forms a southwestern continuation of the Godthaabsfjord area, which according to H. SØRENSEN (21, p. 68) "comprises a series of various gneissic rocks including thick layers of amphibolite and garnet-sillimanite-micaschists. The two last named may be intimately interbanded giving the impression of a highly metamorphosed sedimentary series. In addition, quartz-rich, in part sparagmitic, rocks are occasionally seen, but in subordinate amount. In one locality a rock, which may be interpreted as a highly deformed conglomerate, was found".

This description also covers the present area, it should only be added that the main rock is here a biotite- (or hornblende-) bearing gneiss of granodioritic affinity. Locally it may be developed as a flaser-gneiss. In some places smaller amphibolitized basic dykes and apophyses are met with, as for example to the north and the south of the Ameralik fjord (fig. 2) and on the southwestern headland of Qilángârssuit. Larger metagabbroic masses were furthermore observed north of the entrance of the Ameralik fjord and south of Narssaq. The possible significance of these metamorphosed basic intrusions will be treated below.

A short description of the gneiss from a road cut near Godthaab harbour is given by BOUCOT (1), who on the basis of a semi-quantitative spectro-chemical analysis of allanite estimates the age of the rock to be "somewhere between seven and eleven hundred million years".

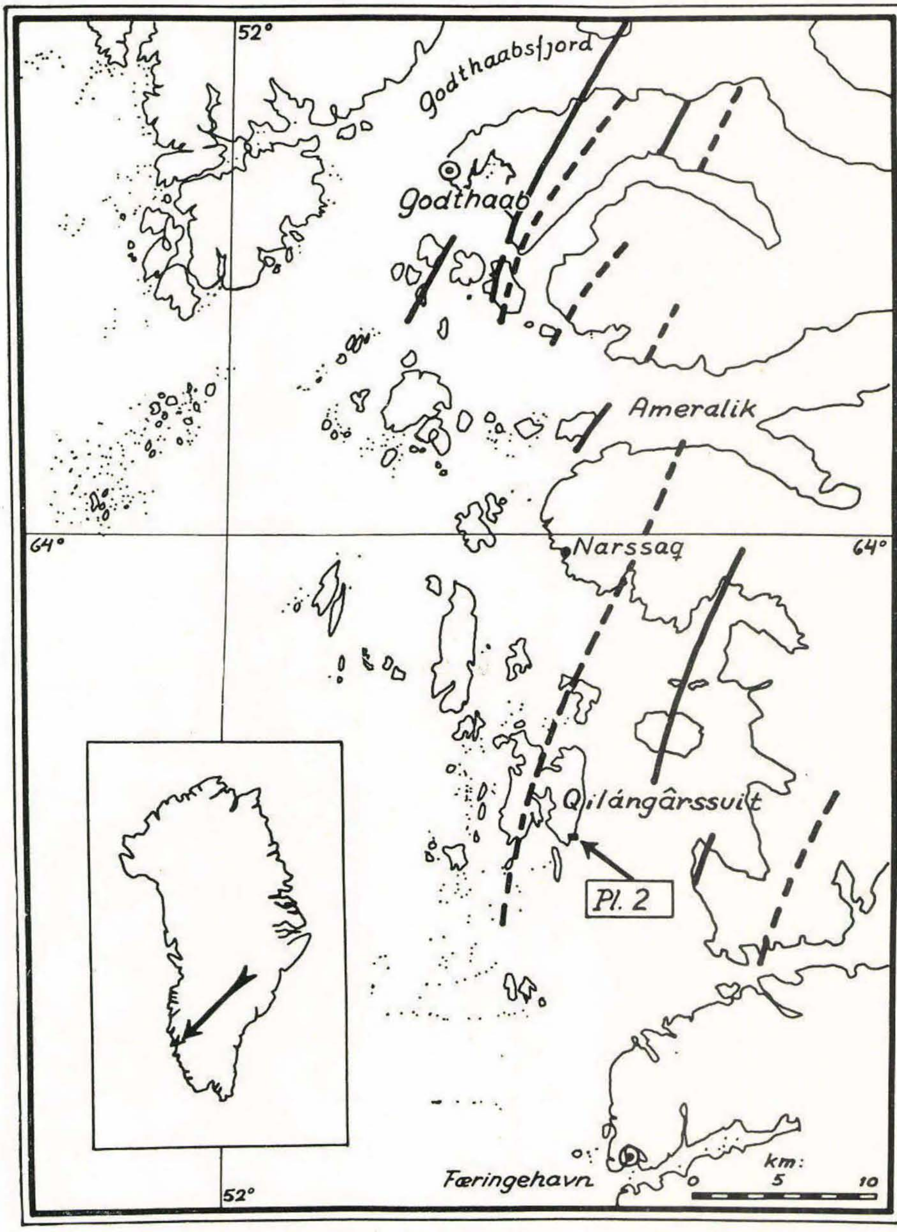

Fig. 1. Location of the island Qilángârssuit and the specially investigated area (Pl. 2). The thick unbroken lines indicate anticlinal structures, the broken lines synclinal structures.

In the skærgård region the fold axes strike NNE—SSW with a regional plunge towards SSW. Some of the major anticlines and synclines are shown in fig. 1. It will be seen that Qilángârssuit is situated in

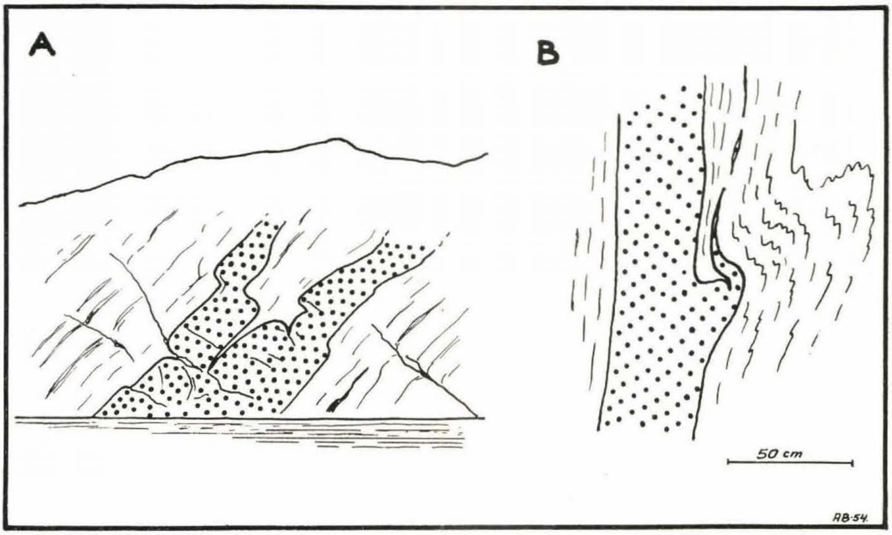

Fig. 2. Metabasaltic dykes. A: partly boudinée, bifurcated metabasaltic dyke. Small headland north of the entrance to the Ameralik-fjord (drawn from a photography). B: Metabasaltic dyke exhibiting a relic apophysis, which has been folded together with the present flaser-gneiss. South coast of the outer Ameralik-fjord, south of Simiutâ (drawn from a note book sketch).

the central part of a synclinal structure, the north-eastern continuation of which is found around Narssaq and the Ameralik fjord. The locality described in detail here is situated on the eastern flank of this structure.

The seemingly simple type of folding in this district most probably is superimposed on an older and more complicated style with horizontal movements, as emphasized by Wegmann (24, pp. 193—194).

BRIEF DESCRIPTION OF THE ROCKS SURROUNDING THE DIORITE

The south-eastern end of Qilángârssuit is mainly composed of a light biotite-bearing gneiss with amphibolitic *Schlieren* and bands. Thick cross-cutting pegmatites are fairly common. Conformably enclosed in this gneiss are two zones of gabbroic and ultrabasic rocks. The western occurrence consists of about 5 m thick lenses of a green gabbroic rock with hornblende, plagioclase and hypersthene. The hornblende and plagioclase form a medium-grained "groundmass" in which almost digested larger grains of hypersthene are found. The eastern zone comprises boudins 10 to 20 m thick. The central parts of these boudins are made up of serpentinite and possibly dunite or peridotite. Towards the periphery reaction zones of hypersthene-hornblende and hornblende-biotite are developed. The contact to the gneiss is usually replaced by pegmatitic material which also separates the ends of the different boudins. The gneiss in the immediate neighbourhood of these basic to ultrabasic rocks contains streaks and partly digested remnants of amphibolite; most probably it is formed by granitization *in situ* of an amphibolite layer. The gabbroic rocks of the western zone are obviously hybrid products which were formed through the metasomatic transformations accompanying the granitization of the amphibolite layer originally enclosing the ultrabasites. This mode of formation is clearly demonstrated in the eastern zone, where gradual transitions from ultrabasites into gabbroic rocks are observed in the southern and most granitized part. Similar relations have been described in detail by H. Sørensen (21) from the Sukkertoppen district.

East of the zone with ultrabasites is a light grey mylonitic gneiss with a few 10—20 cm broad amphibolitic bands. Under the microscope the gneiss (G. G. U. 19130) is seen to be a fine to medium-grained strongly foliated rock of a blastomylonitic texture. The minerals are, plagioclase (27—30 % An), quartz, microcline, biotite and epidote, zircon, apatite and ore. Myrmekite is seen locally. This gneiss borders on the diorite described in greater detail below.

The gneiss to the east of the diorite is a light grey, veined biotite-gneiss with small ($^1/_2$—1 m) conformable lenses of hornblendite. A sample of the gneiss (G. G. U. 35871) shows a fine-grained groundmass which much resembles the mylonitic gneiss described above. It moreover contains a light-coloured medium-to coarse-grained vein. The specimen shows a rather distinct transverse foliation indicated by the arrangement

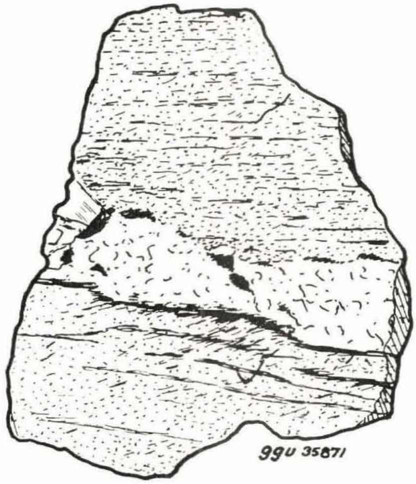

Fig. 3. Specimen of the veined gneiss, which underlies the diorite to the east. Note the transverse foliation indicated by the arrangement of the biotite flakes. The younger foliation is parallel to the light vein.

of the biotite flakes. The older foliation is seen to be cut by the younger foliation-structure which is parallel to the light vein (fig. 3).

Unfortunately the northernmost part of the diorite is covered by vegetation, and the relations to the surrounding gneiss cannot be mapped. Judging from the scattered outcrops, the northern end of the diorite seems partly replaced by large cross-cutting pegmatitic dykes. Further to the north a small-folded gneiss, rich in biotite, is found. A few boudins (2—5 m thick) of ultrabasite are seen in the gneiss which seems to bend and close around the diorite.

Erratum.

Page 12, line 3 from foot of page
" 13, " 11 " top " "
read shearfolds instead of dragfolds.

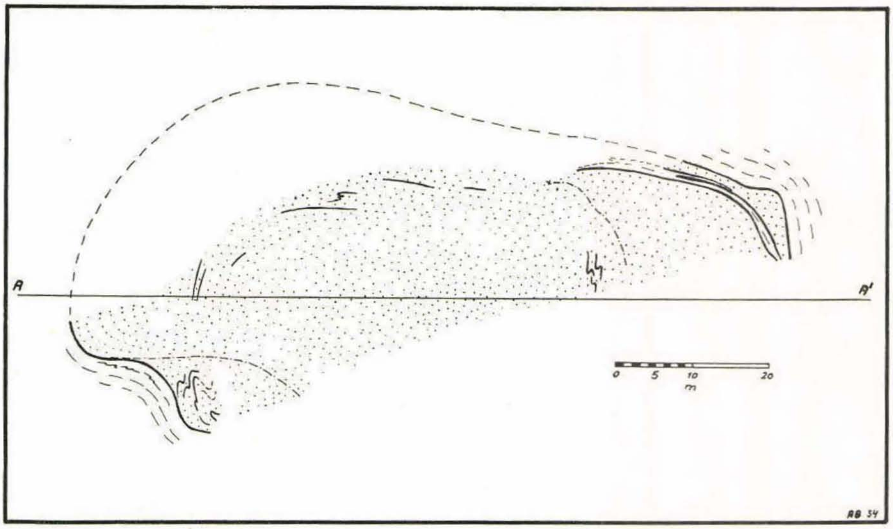

Fig. 4. Profile at right angle to the average of the meassured lineations and fold-axes. Diorite is finedotted. A—A¹ corresponds to the line on the map of pl. 2. For further explanation see the text.

SHAPE, STRUCTURE AND COMPOSITION OF THE DIORITE BODY

As mentioned above the northern part of the diorite is too much covered by vegetation to be mapped in detail. We only know that diorite is exposed locally for some 150 m to the north of the shore. Further to the north only gneisses are found.

The southern well-exposed part is shown on the map of pl. 2. The profile of fig. 4 is an attempt to reconstruct the shape of this better known part. The structures were projected on a plane at right angles to the average direction of the measured lineations and fold-axes within the diorite and the surrounding gneisses. Plotted on a hemisphere these axes are grouped within a limited area thus suggesting that there is a conformable relationship between the structure in the gneisses and the shape of the diorite.

The broken line in the top of the profile shows the inferred upper border of the diorite as it may be extrapolated from the foliation in the known part. The small-folding is seen to belong to a simple system of dragfolds which presumably are due to upwards movements of the diorite during the emplacement. The northern outcrops fall below the construction, as the axis of the body plunges to SSW. At a certain

Fig. 5. The central part of the diorite.

depth in the profile the diorite will terminate, surrounded by the biotite-rich gneisses.

The diorite body therefore seems to form a lenticular plate elongated along the fold axis. This shape indicates a tectonic emplacement.

The mylonites seen in the profile of fig. 4 seem to have been developed by a deformation younger than the emplacement and are presumably connected with the partial boudinage structure of the body. The flow folds in the veined gneiss below the diorite were most probably formed along with the development of the initial boudinage structure as they show a direction of movement contrary to that demonstrated by the dragfolds of the diorite (cf. p. 20 and fig. 9).

The central part of the diorite

is made up of a very homogeneous type (fig. 5) (G. G. U. 19123 A and B) of a dark, somewhat rusty, colour. It shows a more or less pronounced lineation (in this paper the term lineation is only used for a preferred orientation of the mineral grains) and sometimes a badly developed foliation. Besides, a remarkable, seemingly blastophitic, texture may be seen in the less lineated and foliated types. In thin section, however, this texture is difficult to distinguish, and the medium-grained rock seems here to have a crystalloblastic to almost cataclastic texture.

The minerals are plagioclase, hornblende, diopside and garnet as main constituents, besides a little quartz and biotite, magnetite and apatite.

The plagioclase shows zonal structure in the larger grains. The core contains c. 35 $^0/_0$ An, the outer part c. 29 $^0/_0$. Repeated measurements of smaller grains have given values from 26 $^0/_0$ to 29 $^0/_0$ An. In a few grains a weak antiperthitic texture is seen; myrmekite rarely occurs.

Fig. 6. Microdrawing of a thin section from the central part of the diorite (G. G. U. 19123 A). To the left a large plagioclase grain which is partly replaced by garnet. The latter contains inclusions of plagioclase with undisturbed twin lamellae. Hornblende is shaded, diopside dark shaded. Quartz is found as small grains in the hornblende.

The pleochroic green hornblende has a fairly small 2 V (hastingsitic). It occurs as individual grains filled with, and assosiated with, small rounded quartz grains. Further hornblende often forms a narrow reaction rim around the more or less uralitized diopside grains. Judging from the texture, the hastingsitic hornblende and the diopside seem, nevertheless, to be co-existing stable minerals. This paragenesis also includes the garnet. The latter which clearly replaces the plagioclase (fig. 6) often contains small inclusions of plagioclase, the twinning of which is in accordance with that of the surrounding larger plagioclase.

Fig. 7. Conformable and sharp contact between the diorite and the underlying eastern gneiss.

The presence of small quartz grains intimately associated with the hastingsitic hornblende (quartz is rarely found as larger aggregates) suggests that the present paragenesis came into being through the following reaction:

hypersthene + plagioclase → hornblende + garnet + quartz. (11, p. 36, (7)).

This also explains the zonal structure of the plagioclase since mainly the An-component was used in the said reaction during progressive recrystallisation.

The paragenesis, garnet, diopside and hornblende, classifies the rock as belonging to the almandine, diopside, hornblende subfacies of amphibolite facies.

The biotite is clearly younger than the hastingsitic hornblende and may together with the uralitisation be taken as evidence of a weak retrograde metamorphism. As the biotite is contorted the cataclasis is still younger.

In the homogeneous type a system of intersecting planes along which the diorite is more coarse-grained may be observed on the ice-polished rock surfaces. The feature strongly reminds of incipient formation of pegmatites in relation to a pre-existing joint pattern.

The peripheric parts of the diorite

is more distinctly foliated than the central part. Lineation is still present and is parallel to the axes of the small folds locally shown by the foliation. Conformable light bands and *Schlieren* give the diorite a gneissic appearance near the contact which, although conformable, is always sharp and distinct (fig. 7).

In the contact-near parts of the diorite the hornblende is almost completely biotitized, and as one approaches the contact the garnets finally disappear. No traces of a possible original fine-grained zone along the contact have been observed.

The western gneiss lamella

Along the western contact the diorite conformably encloses a long gneiss lamella which in the southern part splits up into a thin western slice and a thicker eastern band. The gneiss lamella consists of a fine-grained blastomylonitic rock with plagioclase (23—24 °/₀ An.), quartz, microcline, biotite, epidote and accessoric apatite, zircon and ore. Myrmekite occurs rarely. Petrographically this gneiss is simillar to the mylonitic gneiss bordering on the diorite to the west.

Inclusions

In uneven distribution a number of inclusions of different rock types occur in the diorite. They vary in size from 4 m to a few cm. All the elongated inclusions seem to be arranged with their longest axes parallel to the lineation of the enclosing diorite. The greatest inclusion near the eastern contact is intimately co-folded with the diorite.

The following three rock types have been found as inclusions,

a) ultrabasite
b) anorthosite
c) amphibolite

a) The ultrabasite comprises the two largest and several small inclusions. They are all composed of hornblendite which occasionally may be biotite-bearing.

One of the smaller inclusions (G. G. U. 19126) has been more closely investigated. It consists of a dark-green, medium- to coarse-grained hornblendite with small amounts of biotite and plagioclase. Towards the border of the inclusion the diorite becomes increasingly mafic, while the ultrabasite shows decreasing grain size towards the diorite. In the field this may give an impression of an igneous contact. In thin sections, however, the transition is seen to be gradual, and it is evident that a certain metamorphic reaction took place between the two rocks in relation to the recrystallisation of the diorite.

Along the border stretches a zone, rich in large hornblende grains. The hornblende is so full of small inclusions of quartz that it exhibits an almost sieve-like structure. Entering the ultrabasite is seen a decussate-textured rock, composed of amphiboles. The principal amphibole is a metamorphic green hornblende with ore-coating on the cleavage planes. The peripheries of these hornblende grains are transformed into a colourless cummingtonite, which is optically positive, has a large 2 V, and shows polysynthetic twinning. The cummingtonite is devoid of ore-coating. A few plagioclase grains are found in addition to the amphiboles.

This reaction zone strongly reminds of the border relations of some ultrabasic rocks from the Sukkertoppen district described and discussed by H. Sørensen (20, p. 236 and p. 240). In the latter occurrences the colourless hornblende, however, only seems to represent a transitional stage in the formation of anthophyllite from green hornblende secondary to hypersthene.

b) The anorthosite (G. G. U. 35869 and 35870) is a fine-grained grey rock with a granoblastic texture. One of the inclusions (G. G. U. 35869) exhibits a gneissic structure due to layers rich in dark minerals. The diorite becomes more mafic towards the border with the anorthosite, the latter is medium-grained along the contact. In addition to the plagioclase (45—27 $^0/_0$ An) the anorthosite contains smaller amounts of green hornblende, scapolite, biotite, garnet, and ore. The presence of scapolite suggests an originally higher An content, which evidently became reduced along with the recrystallisation of the enclosing rock.

c) The amphibolite (G. G. U. 35868) is a dark-grey, fine-grained rock with a granoblastic texture. The main components are hornblende and plagioclase. This inclusion also shows an increase in grain-size towards the enclosing diorite.

THE METABASALTIC DYKE

In the north-eastern section of the mapped part of the diorite occurs an amphibolitized basic, dyke-shaped intrusion. The maximum breadth (4 m) is obtained at the southern end of the dyke, where it ends abruptly. About 100 m to the north an outcrop is found where the metabasite reappears with a thickness of c. 1 m. Also in this place it is intrusive into diorite.

The intrusive relationship to the diorite is clearly demonstrated by the fact that the metabasalt in places cuts the foliation and small-folding of the diorite. Thus fig. 8 shows an apophysis intersecting the fold structures of the diorite. Moreover fine-grained contact zones with relic phenocrysts (blastophenocrysts) are preserved.

A sample from the central part of the dyke (G. G. U. 19107) shows a dark, greyish-green, fine-grained amphibolitic rock with a slight foliation and a distinct lineation. Under the microscope the distribution of the light and dark minerals is seen to indicate a blastophitic texture, which partly is effaced by the preferred orientation of the hornblende grains due to differential movements during the recrystallisation of the original basic intrusion (pl. 1).

The minerals are, hornblende, plagioclase, a little boitite and accessory ore. The pleochroic green hornblende occurs in more or less prismatic grains, whereas the plagioclase forms aggregates presumably indicating the position of former plagioclase laths. Measurements of the plagioclase have revealed a zonal structure. The core of some grains contain 70 to 60 % An, while the outer parts and smaller grains show values down to 39 %. Biotite occurs sparingly as small flakes parallel to the preferred orientation of the hornblende.

The blastoporphyritic texture

is best preserved along the western contact. The amphibolite (G. G. U. 19110) is here more fine-grained than the type described above from the central part of the dyke. The relic phenocrysts are about 1 cm long and of a dense white colour. Under the microscope these phenocrysts are seen to be composed of a central core of highly sericitized feldspar

Fig. 8. The metabasaltic dyke (to the left) cuts across the fold structures of the diorite and protrudes as an apophysis into the latter rock. The development of segregation pegmatites from cross-joints may be seen in the metabasalt. Note the "basic residual front" around the pegmatite.

surrounded by an aggregate of recrystallised clear plagioclase (c. 70 $^0/_0$ An) (pl. 1).

The relic phenocrysts observed along the eastern contact (G. G. U. 19108) are about half a centimetre long and of brownish tinge. They are composed of a fine aggregate of a light amphibole wherein relics of a highly altered mineral may be found. Due to the almost complete alteration a closer determination is impossible. The refractive indices are rather high, between crossed nicols a grey interference colour of first order is seen, and the angle of extinction is small. Habitually the mineral reminds of an altered hypersthene.

Segregation pegmatites in the metabasaltic dyke

The metabasalt contains several pegmatites which obviously are of segregational origin. Going from north to south, one observes a complete evolutionary series illustrating the formation of these pegmatites. In the northernmost and least transformed part of the metabasalt there occur north, northeast-dipping tensional cross-joints. Towards the south they become healed joints, which gradually pass into segregation pegmatites (fig. 8). In the southernmost end the pegmatites are arranged as

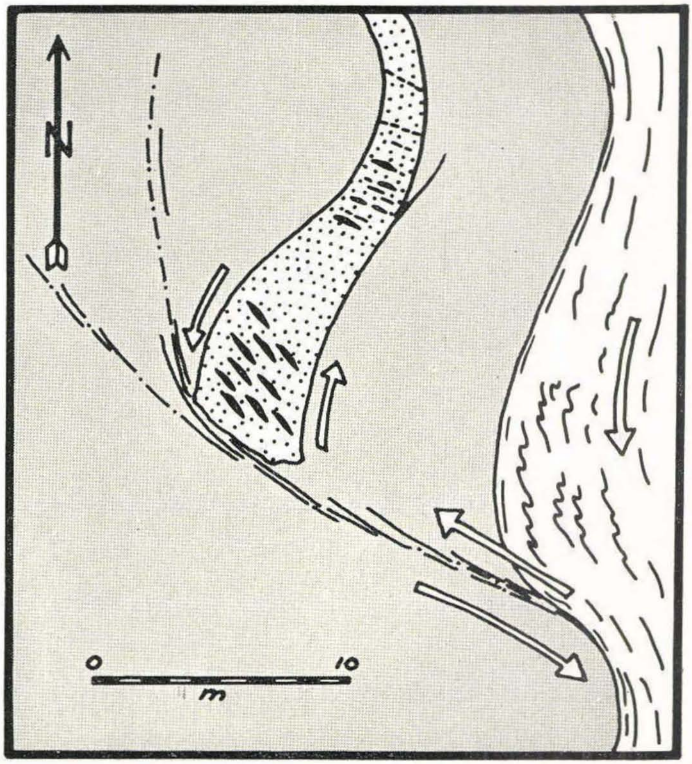

Fig. 9. Diagram of the supposed relative movements around the metabasaltic dyke during the last stages of its recrystallisation.

gash joints. The segregation pegmatites are all surrounded by "basic residual fronts", which represent the part of the wall-rock from which the light material now found in the pegmatite was derived.

The segregation pegmatites are exclusively composed of plagioclase with an An content of 38—39 %, (G. G. U. 19109). They thus seem to have been formed at a late phase of the recrystallisation of the original basic intrusive.

The orientation of the pegmatites in the southern part of the metabasalt indicates that this part of the intrusive was exposed to shearing movements during the last phases of its recrystallisation. As shown in fig. 9 the relative movements responsible for the opening and pegmatitization of the gash joints agree completely with those causing the initial boudinage structure of the diorite and the flow-folds of the underlying gneiss.

It therefore lies near to conclude that these movements took place during a single—more or less continuous—phase of deformation, which decidedly was younger than that producing the folds of the diorite, since these are cut off discordantly by the metabasalt.

PEGMATITES IN THE DIORITE

On surveying the diorite two generations of pegmatitic dykes and veins were found. The most prominent of these veins have been shown on the map of pl. 2.

The first generation

may be divided into longitudinal pegmatites parallel to the direction of the fold axes, and cross-pegmatites at almost right angles to this direction. They are synchronous as may be seen along the western contact where a cross-pegmatite sends two longitudinal branches to either side. They cut the contact with the gneiss, the gneiss lamella, the foliation and lineation of the diorite, and are thus clearly younger than the emplacement of the latter rock.

When occurring in the diorite the pegmatites are hornblende-bearing, while they become biotite-bearing when intersecting the gneiss lamella.

One of the hornblende-bearing pegmatites deserves a more detailed description. It is situated in the western part of the diorite which is here strongly lineated. It is about 15 cm thick, and consists of a medium-grained quartz-plagioclase rock with 2—3 cm long hornblende prisms, which are arranged parallel to the lineation of the surrounding diorite (G. G. U. 19120). The plagioclase contains 27—29 $^0/_0$ An. The hornblende often contains small quartz grains in the central part and sometimes small flakes of biotite (fig. 10).

The above mentioned features show clearly that the pegmatites are replacement veins formed by material from the immediate surroundings. Therefore, they reflect in their paragenesis the composition of the enclosing rock and in their fabric the texture of the wall rock (the diorite). This oldest generation may thus be classified as autochtonous replacement dykes just like the segregation pegmatites found in the metabasalt. This view is in complete conformity with those expressed by RAMBERG (12) in his modern text-book.

The composition of the plagioclase in the hornblende-bearing pegmatites agrees with that of the most sodic plagioclases found in the

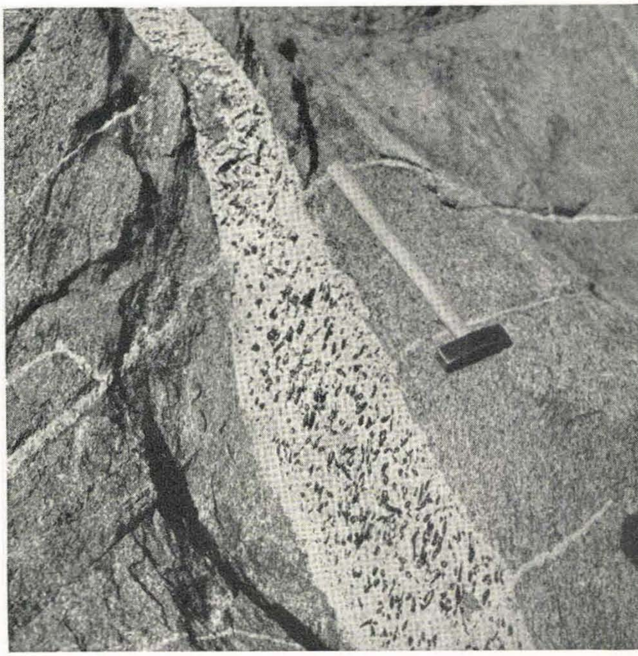

Fig. 10. Hornblende-bearing replacement pegmatite in diorite. A quartz-filled core may be seen in some of the larger hornblende prisms.

diorite. This fact together with the preservation of the linear structure inside the pegmatite suggest that the replacement took place during the final stages of the recrystallisation of the diorite when the deforming forces causing the lineation had not yet ceased to act.

A lenticular pegmatite between the gneiss lamella and the western contact contains in addition to the minerals already mentioned crystals about 3 cm long of a light green apatite.

This older generation of pegmatites often shows somewhat mylonitized contacts and are cut by NW-striking mylonites. These mylonites are themselves cut by the younger pegmatite generation.

The second generation

comprises a group of younger pegmatitic dykes and veins which carry biotite as the only mafic mineral whether they occur in the gneiss, diorite or the metabasalt. A sample (G. G. U. 19133) from a vein in the gneiss east of the diorite shows plagioclase (25—26 $^0/_0$ An), quartz, biotite, and zircon.

The course of the dykes is somewhat irregular, but they generally strike EW to ENE. They attain a thickness of 4 m in the mapped area, but to the north still thicker dykes occur. The dykes of this youngest generation intersect the segregation-pegmatites of the metabasalt. The thin veins crossing the diorite-gneiss border to the east have after their formation been shear-folded when occurring in the gneiss.

The younger pegmatite generation most probably comprises allochtonous replacement dykes. Positive evidence is not, however, available.

JOINTS

The joints measured in the diotite fall well within the regional pattern of longitudinal and cross joints. The healed joints, reminding of incipient formation of pegmatites, possibly represent an older joint system in the diorite.

CONCLUSIONS

On the basis of the above descriptions and the information contained in the map of pl. 2, we are now able to establish the following chronological sequence.

Table I.

Older:	Existence of a metamorphic rock suite comprising amphibolite, ultrabasite, and anorthosite, presumably formed under P. T. conditions corresponding to granulite-facies.	
	Tectonic emplacement of an originally hypersthene-carrying diorite which recrystallised under P. T. cond. corresp. to almandine-diopside-hornblende-subfacies.	
	Formation of hornbl.-bearing replacement pegmatites.	
	Mylonitization.	Intrusion of a basic dyke into the diorite.
	Deformation and amphibolitization of the basic intrusive.	
	Formation of the segregation pegmatites in the metabasalt.	
	Formation of the younger biotite-bearing pegmatites.	
Younger:	Slight deformation.	
	Still younger is the intrusion of diabase dykes within a greater area and kratogenic mylonitization *).	

*) These post-orogenitic events are not treated here, as a paper dealing with this subject may be expected from another quarter in the near future.

If we take the formation of pegmatites inside the structural as well as petrochemical, competent, and resistent diorite body as indications of granitization and metamorphism of the wall-rock, the gneiss, we arrive at two phases of deformation, each followed and succeeded by granitization and mutually separated by a hiatus marked by the intrusion of the basic dyke, the present metabasalt.

The objection may be raised that this chronology is based on too few data and on too small a locality. Against this may be argued that numerous indications of such a separation into two kinetic phases have been met with in the surrounding regions from Godthaab to Færingehavn. As mentioned on p. 7, metabasaltic dykes and metagabbroes in all probability synchronous with the metabasalt described in this paper occur at scattered localities within the skærgård and along the coast.

The present locality, however, affords the best opportunity to study the kinetic problems, as traces of older phases here are better preserved in the diorite and the metabasaltic dyke. An ordinary gneiss is not so resistent to deformation and metamorphic processes, and usually only shows the younger imprints.

The present work also shows that a classification into metamorphic facies becomes increasingly difficult to undertake the more detailed the investigations are. In the present case, the superimposition of two episodes of metamorphism of mutually different intensity have produced a very complex series of parageneses.

During the last cycle, the basic intrusion has been exposed to a retrograde metamorphism, but having been protected by the diorite, which exhibits a relic paragenesis developed during the first cycle, the metabasalt has not been completely adjusted to the younger facies conditions. These conditions are, however, revealed by the surrounding gneisses. The association found within these rocks of plagioclase with an An $^0/_0$ just below 30 and epidote suggests that P. T.-conditions corresponding to high epidote-amphibolite facies ruled during the last phase of metamorphism and granitization.

A classification carried out on the basis of metamorphic facies alone must therefore be considered of small value only. Gradual transitions from one facies into another offer no evidence of a synchronous development.

A division into two kinetic phases separated by basic intrusions is quite a common event in pre-Cambrian geology. Sederholm, the great pioneer, was the first to emphasize the importance of the metabasaltic dykes (14, 15, 16, 17). Wegmann followed up the same line of thought during his classical kinetic studies in the Finnish part of the Svecofenides (22, 25) and the Ketilides of Southern Greenland (23, 24). Recently Edelmann has continued the study in the Svecofenides (2).

Opinions differ as to the importance of the hiatus marked by the basic dykes. From his intensive investigations, Sederholm was led to the result that the metabasaltic dykes were the distinguishing mark of a period with volcanic intrusions and eruptions separating two different orogenetic cycles (Svecofenides and Bothnides). Both cycles were accompanied by granitic intrusions and migmatitization.

Later students of the same areas only regard the metabasaltic dykes as indications of a fairly quiet intra-orogenic period (2,5).

One author (18) even hardly pays any attention to the unquestionable evidence produced by SEDERHOLM in the metabasaltic dykes. When applying "magmatectonic" methods to migmatitic rocks, one may reach any classification desired.

The relations are clearer where old border-areas with an unfolded postkinematic dyke-system is found (10, 19). Where no such border-areas are observed, it seems a matter of traditional or personal conviction, which interpretation should be favoured by the investigator.

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Plate 1.

Fig. 1. The central part of the metabasaltic dyke (G. G. U. 19107). The blastophitic texture is almost effaced by the preferred orientation of the hornblende. 25 ×.

Fig. 2. Blastoporphyritic texture in the metabasalt from the western contact (G. G. U. 19110). The highly sericitized relic phenocryst is surrounded by an aggregate of recrystallised clear plagioclase. 25 ×.

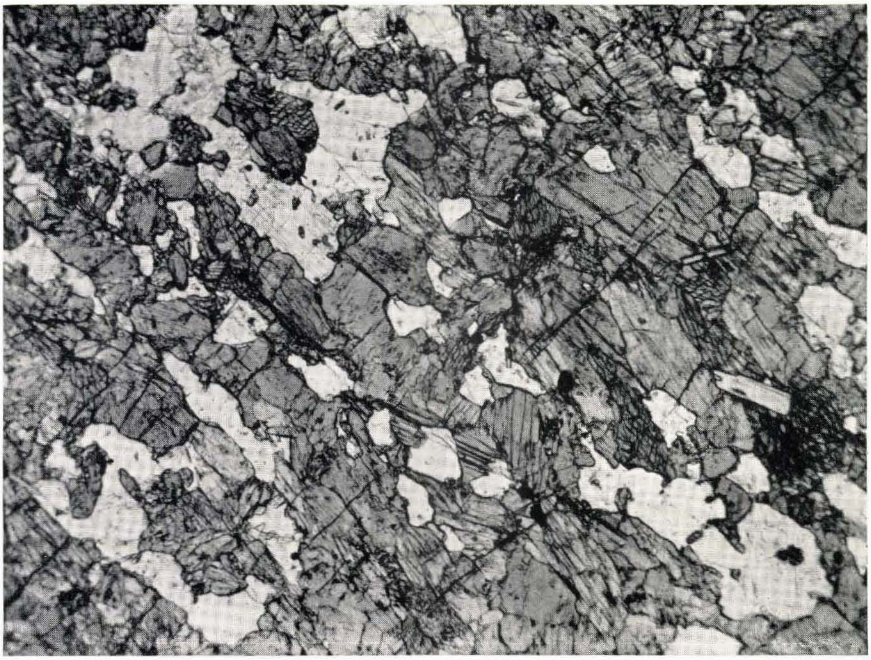


Fig. 1.

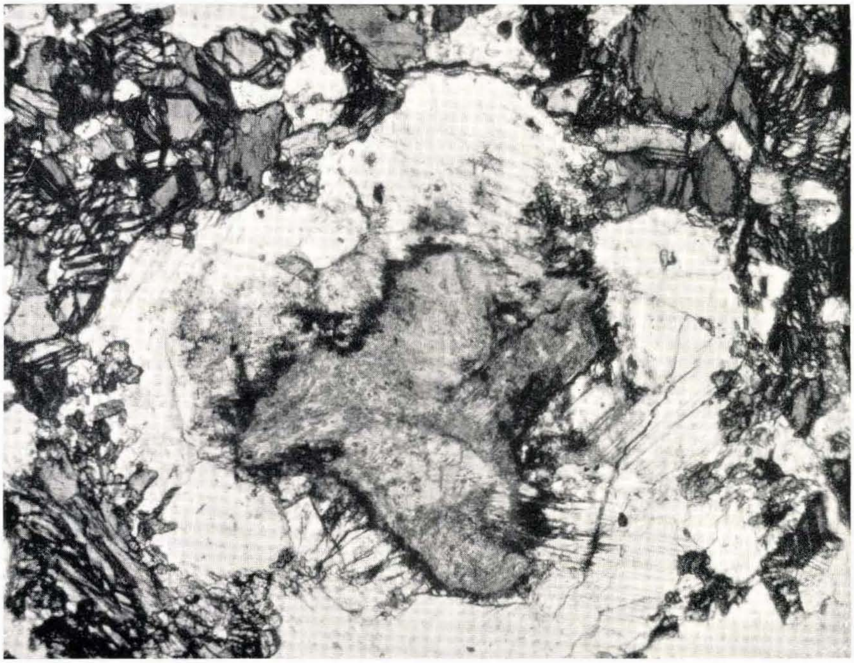
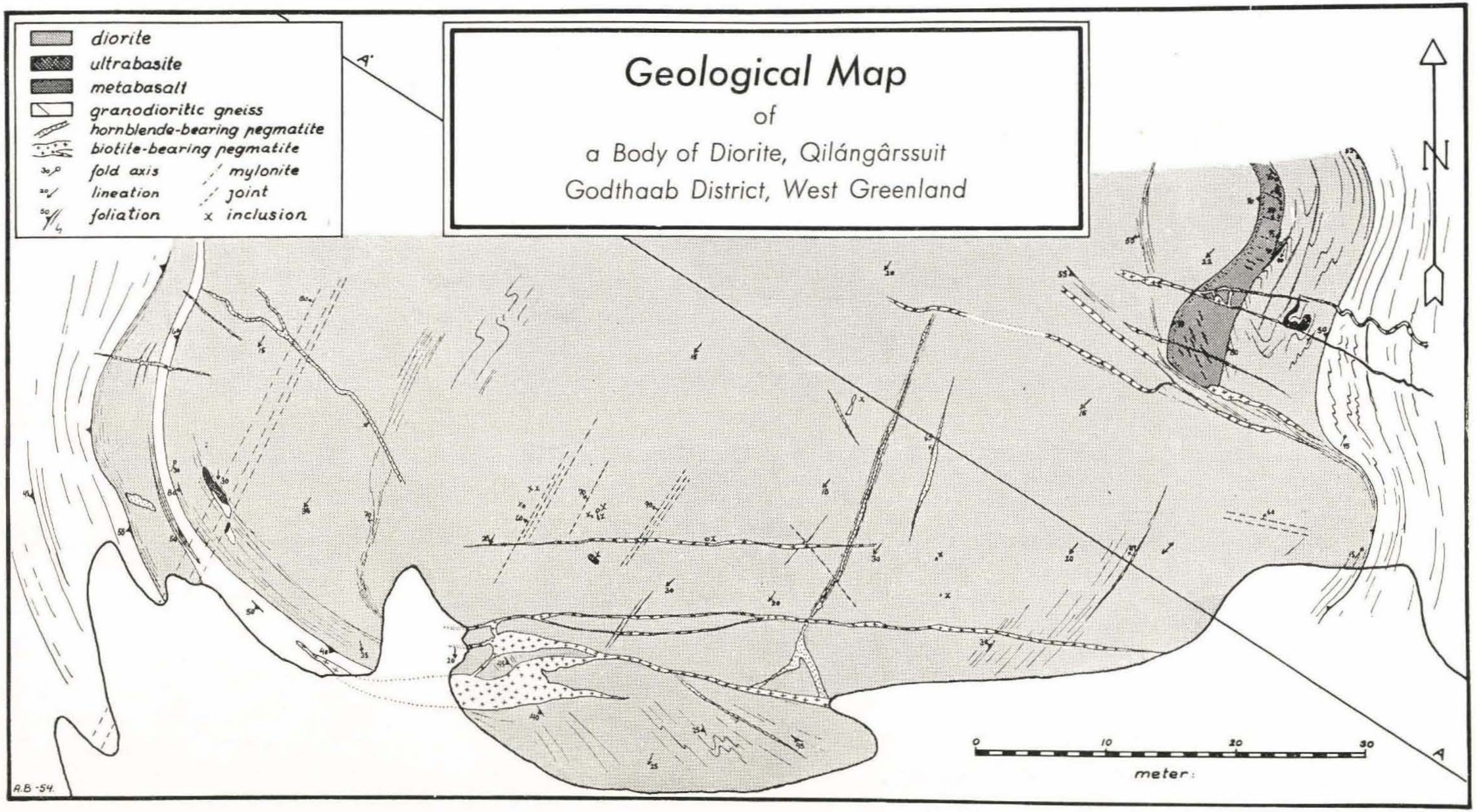


Fig. 2.


Geological Map
of
a Body of Diorite, Qilángârssuit
Godthaab District, West Greenland
diorite
ultrabasite
metabasalt
granodioritic gneiss
hornblende-bearing pegmatite
biotite-bearing pegmatite
fold axis
mylonite
lineation
joint
foliation
inclusion
A'
A
0
10
20
30
meter
A.B -54.