CHEMICAL RELATIONS BETWEEN METABASALTIC LAVAS AND METADOLERITES IN THE IVIGTUT AREA, SOUTH-WEST GREENLAND

By

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Abstract

Chemical analyses of representative samples from a swarm of metadolerite dykes which penetrates the pre-Ketilidian basement in the Ivigtut area indicates that the earlier and main part of the intrusives have tholeiitic compositions and that the latest dyke intrusions are more alkaline. Analyses of rocks representing different metamorphic facies conditions produced in one and the same dyke indicates that the Ketilidian metamorphic reactivation of the basement took place under isochemical conditions in the northern part of the Ivigtut area. Comparison between the chemical composition of the metadolerites and the Ketilidian metavolcanics shows that they are slightly different, and it is concluded that the metadolerites and the metavolcanics cannot have been derived at the same time from the same source. The dykes are ascribed to a pre-Ketilidian age.

INTRODUCTION

The geological mapping in the Ivigtut area between approximately 61°00′ and 61°45′ N by the Geological Survey of Greenland (GGU) has revealed a boundary between a younger Precambrian fold belt and its basement. The basement, the pre-Ketilidian, is a crustal segment in which the majority of the K/Ar age determinations give values of 2500–2700 m.y. while the younger unit, the Ketilidian, gives values mainly between 1580 and 1640 m.y. which correspond to late-plutonic thermal events (ALLAART, BRIDGWATER and HENRIKSEN, in press; HENRIKSEN, in press).

After the formation of the pre-Ketilidian metamorphic complex the area passed through a cratogenic episode and thereafter Ketilidian supracrustal rocks were deposited with a major unconformity on the pre-Ketilidian basement (HIGGINS & BONDESEN, 1966). The Ketilidian supracrustals consist of metasediments and metavolcanics which form a sequence probably considerably over 6000 m in thickness. The lowest part of the succession in which the supracrustal rocks occur is preserved in the north-eastern part of the belt. The metamorphic grade here varies between very low greenschist facies and epidote-amphibolite facies. The Ketilidian supracrustals in the northern part of the Ivigtut area have been divided into a lower metasedimentary Vallen Group and an upper metavolcanic Sortis Group. These supracrustal rocks have been described in detail by BONDESEN (in press) and HIGGINS (in press).

In the pre-Ketilidian basement in the Ivigtut area a major swarm of metadoleritic dykes occurs which was emplaced during a tensional period after the last pre-Ketilidian folding and migmatisation. The dykes may be divided into four main sets each with a characteristic general trend. As the dykes are followed south and east they become increasingly affected by the metamorphism and deformation associated with the Ketilidian fold belt (BONDESEN and HENRIKSEN, 1965). The metadolerites do not occur in the Ketilidian supracrustal rocks. On the other hand the dykes have not been found cut by the basal Ketilidian unconformity and thus their exact relationship to the Ketilidian supracrustals is uncertain. The dykes could therefore be intruded during the cratogenic period prior to the initial development of the Ketilidian orogenic period (HENRIKSEN, in press), or they could be regarded as hypabyssal equivalents of the Ketilidian volcanic Sortis Group as suggested by BONDESEN (in press). Anyway, the dykes are folded by the Ketilidian deformations and they are thus either very early Ketilidian or pre-Ketilidian.

This paper deals with the possible chemical correlation between the metadolerites and the Sortis Group rocks. Chemical analyses from the metadolerites and a few metavolcanic rocks are published here for the first time whereas most of the analyses of the Sortis Group rocks are taken from the detailed description of the supracrustal rocks by BONDESEN (in press) and HIGGINS (in press).

ANALYSED MATERIAL

The rocks analysed represent the Ketilidian metavolcanic Sortis Group and the metadolerites which are found in the pre-Ketilidian basement in the Ivigtut area.

The Sortis Group

According to BONDESEN and HIGGINS this group is composed of basaltic pillow lavas with sills overlain by pyroclastics and sediments with thick intrusive sills and an upper thick pillow lava unit. The total thickness of the Group is of the order of 5000 m on Midternæs.

The metadolerites

These can, as mentioned, be divided into four sets in the part of the region where they are only slightly deformed. From youngest to oldest these sets trend WNW-EW, NNE-NE, NNW, and EW-WNW. Within each set there may be more than one generation. In the north-western part of the area the dykes have retained many of their original features. They are here nearly always clearly dyke-shaped and often show preserved intrusive features such as apophyses and en échelon structures. The dykes vary in thickness from a few metres to more than 150 m, but most are between 5 and 20 m thick.

The four sets of metadoleritic dykes have the following main characteristics, mentioned from youngest to oldest:

Dyke set 4. WNW – EW trends. Dykes belonging to this set occur most commonly around Kuánit fjord, where there is a narrow swarm of often relatively thick dykes from 20–150 m wide. Dykes belonging to this swarm can be traced from Arsuk Fjord to the western part of Tôrnârssuk. The dykes are very persistent and their trends are often somewhat irregular. Very characteristic of some of these dykes is their irregular content of feldspar megacrysts which can occur with a very high density (BONDESEN and HENRIKSEN, 1965). Some of the megacrysts can be up to 10 cm in size and their shapes vary from the perfect rectangular form of euhedral feldspar phenocrysts to completely irregular xenolithic forms.

Dyke set 3. NNE – NE trends. The majority of the known metadolerites in the area belong to this set. They often occur in swarms and their density within the gneisses therefore varies to some extent. The dykes vary from approximately 1–50 m in width and occasionally reach nearly 100 m although their average is between 5 and 20 m. Dykes belonging to this set have often a somewhat irregular trend and also the width of the individual dykes often changes along its length.

From intersections between dykes belonging to this set it can be shown that there must be at least three generations within this group.

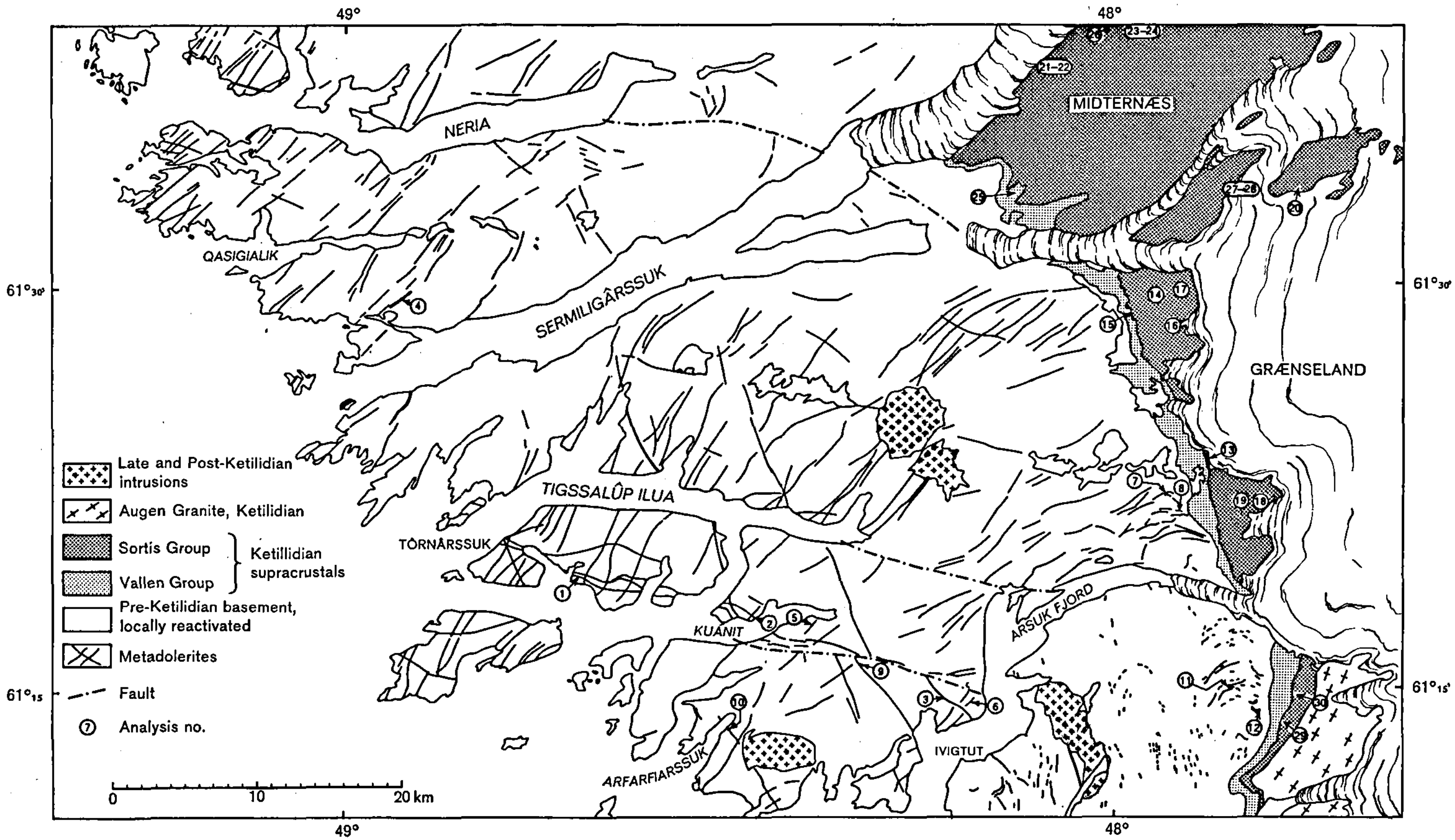
Dyke set 2. NNW trends. Quite thick (20–150 m) persistent dykes which form an open swarm parallel to the general coastline. The dykes have very regular trends and unlike the dykes belonging to the other sets they are normally without small intrusive irregularities.

Dyke set 1. EW – WNW trends. Single vertical dykes often rather thick (10–50 m). They have a fairly widespread distribution over the area on both sides of Tigssalûp ilua. No representative from this set has been analysed.

THE RELATIONSHIP BETWEEN THE METADOLERITES AND THE KETILIDIAN SUPRACRUSTAL ROCKS

The relationship between the dykes and Ketilidian supracrustals has already been described and discussed at some length earlier (WINDLEY et al. 1966). It is therefore sufficient here to sum up the main points. In the northern part of the region there exists a number of unfolded metadolerites in the pre-Ketilidian basement, but they cannot be traced up to the unconformity between the supracrustals and the basement and therefore no age relation between the two rock types is indicated here.

In the central and southern part of the area the metadolerites are very common in the basement gneisses but as they are traced towards the border of the supracrustals they become deflected. They are all deflected towards the south in a broad zone near the supracrustal border, the deflection being due to Ketilidian deformation. The dykes neither transect the border between supracrustals and the basement, nor are they ever found within the supracrustals.



49°
48°
61°30'
61°15'
MIDTERNÆS
GRÆNSELAND
NERIA
QASIGIALIK
SERMILIGÂRSSUK
TIGSSALÛP ILUA
TÔRNÂRSSUK
KUÁNIT
ARFARFIARSSUK
IVIGTUT
ARSUK FJORD
21–22
23–24
27–28
Late and Post-Ketilidian intrusions
Augen Granite, Ketilidian
Sortis Group
Vallen Group
Ketilidian supracrustals
Pre-Ketilidian basement, locally reactivated
Metadolerites
Fault
Analysis no.
0
10
20 km

DESCRIPTION OF THE ANALYSED ROCKS

Metadolerites

The following samples of metadolerites have been analysed and are described from the youngest to oldest set: (The localities are shown on the sketch map and the five figure numbers refer to GGU sample numbers).

Dyke set no. 4 (youngest set).

All the analysed rocks belonging to this set have earlier been described in detail by BONDESEN & HENRIKSEN, 1965, therefore only a short description is given here. The samples all come from the same dyke, but they are taken at equal intervals over a distance of approx. 25 km along the dyke and they represent different degress of recrystallisation. The rocks often contain big feldspar megacrysts but these have been avoided in the chemically analysed material i. e. the analyses represent the matrix rocks.

Locality no. 1, sample no. 32002. The rock is recrystallised with the preservation of the original ophitic texture, primary plagioclase and uralitic hornblende. Plagioclase is the most abundant mineral with compositions varying between 37 and 60% An. Amphibole is next in abundance to plagioclase, and chlorite, biotite, ore, leucoxene and quartz are found in smaller amounts. Biotite and ore clusters occur in such a way that they could be interpreted as evidence of olivine in the primary rock.

Locality no. 2, sample no. 19715. A nearly completely recrystallised, homogeneous rock with traces of relic ophitic texture. The rock is composed of approx. 53% hornblende, 40% plagioclase, 4% biotite, 2% ore and 1% quartz. The sample contains relic primary plagioclase individuals, but the main part of the plagioclase has recrystallised.

Locality no. 3, sample no. 19785. A completely recrystallised rock with approx. 50% hornblende, 40% plagioclase, 5% biotite, 2% ore and 3% quartz. The texture is nematoblastic.

Dyke set no. 3.

Locality no. 4, sample no. 69229. A slightly recrystallised, medium-grained, homogeneous rock with ophitic texture. The sample represents the inner part of a 100 m wide metadolerite which can be traced for more than 10 km. The rock contains approximately 55–60% plagioclase, 25% augite, 5% ore, 5% uralite, 1–2% olivine, 5% ore-serpentine aggregates after olivine and some chlorite, zoicite and sericite. The plagioclase is a zoned andesine- labradorite and nearly all plagioclase laths are completely fresh. The augite has often uralitic rims and the olivine is nearly entirely altered into an aggregate of secondary minerals.

Locality no. 5, sample no. 19479. An almost completely recrystallised, homogeneous, medium-grained rock from a 3 m wide dyke. The rock is composed of more than 50% hornblende, and granular plagiolase in two generations forms more than 40% of the total. The relic, primary, plagioclase grains have a composition corresponding to medium andesine whereas the recrystallised plagioclase is low andesine to oligoclase. Biotite, ore and leucoxene are found in small amounts.

Locality no. 6, sample no. 19755. A completely recrystallised, well-foliated, medium-grained rock from an approx. 25 m wide dyke which can be traced for some kilometres. The rock contains approx. 60% hornblende, 30% plagioclase (andesine), 5% quartz, 3% ore and a little chlorite and leucoxene.

Locality no. 7, sample no. 93110. A completely recrystallised, approx. 10 m wide, folded dyke that is deflected near to the border of the Ketilidian supra-

Fig. 1. Sketch map of the central and northern part of the Ivigtut area showing distribution of metadolerites and Ketilidian metavolcanics.

crustals. The analysed rock is slightly foliated and composed mainly of plagioclase, biotite, epidote and ore with some quartz.

Locality no. 8, sample no. 93115. This sample represents a 20 m wide, folded dyke which is completely recrystallised and has been deflected near to the border of the Ketilidian supracrustals. The analysed sample is a homogeneous, fine-grained rock composed of hornblende and epidote forming the dominant part with plagioclase, ore, quartz and some leucoxene forming the remaining part of the main components. Chlorite, biotite and apatite are found in small amounts.

Dyke set no. 2.

Locality no. 9, sample no. 39239 represents a 20–30 m wide, almost completely recrystallised dyke which can be followed approx. 6 km. The analysed sample is a fine-grained, homogeneous rock which is mainly composed of approx. 55–60% hornblende, 30–35% plagioclase, 5% quartz and a few percent ore and leucoxene. The plagioclase is found as both primary lath-formed and twinned grains and as secondary recrystallised, anhedral grains. The hornblende forms poikilitic aggregates of needle-shaped non-oriented grains.

Locality no. 10, sample no. 39272 represents a 40–50 m wide, partly recrystallised dyke which can be followed 8–10 km. The dyke can be traced towards Sortis Group rocks on Arsuk Ø (immediately south of the sketch map), but the dyke has not been found on Arsuk Ø. The analysed sample comes from a medium-grained, homogeneous rock with a relic ophitic texture. The rock is mainly composed of zoned, primary plagioclase (andesine- labradorite) surrounded by a fibrous uralitic amphibole containing a little biotite. The plagioclase is only slightly altered.

Dykes set no. 1 (oldest set).

No rocks from this set were analysed.

Dykes not referable to any special set.

These are strongly folded dykes south of Arsuk Fjord which, because of the deformation, have lost their original trend directions.

Locality no. 11, sample no. 39154. A thin dyke which is medium-grained, completely recrystallised and has a somewhat foliated appearance. The rock is mainly composed of hornblende and granular plagioclase. Biotite, sphene, ore and quartz are found in small amounts.

Locality no. 12, sample no. 39104. A completely recrystallised, medium-grained rock from the inner part of an approximately 100 m wide dyke. The rock is somewhat foliated and is mainly composed of hornblende and plagioclase with small amounts of quartz, sphene, leucoxene, ore and apatite.

Sortis Group rocks

The analysed rocks representing the Sortis Group have been treated by BONDESEN (in press) and HIGGINS (in press) to whose work reference is made for a more detailed description of these rocks. There are however two rocks from the Sortis Group south of Arsuk Fjord which are not described elsewhere and they will therefore be dealt with here.

Locality no. 29, sample no. 39113. A fine-grained, homogeneous, non-foliated amphibolite which contains some microscopic schlieren with plagioclase and a little quartz. The rock is mainly composed of hornblende and granular plagioclase. Ore occurs in small clusters all over the rock; quartz is only seen occasionally.

Locality no. 30, sample no. 39125. A fine-grained amphibolitic greenschist with a foliated texture. The rock is mainly composed of tremolitic hornblende and plagioclase, but there are also considerable amounts of biotite, secundary chlorite, ore and quartz. The quartz is mainly concentrated in microscopic schlieren of leucocratic material. Apatite and calcite are occasionally found.

CHEMICAL DATA ON METADOLERITES AND METAVOLCANIC ROCKS

The dykes selected for chemical analyses have been chosen in such a way that the samples represent not only different sets of dykes, but also a varying degree of metamorphism. In this way it is hoped that any major differences between the sets, or changes caused by the alterations, could be detected and taken into consideration.

After the rocks had been analysed CIPW norms, Niggli values, AMF values and a number of other parameters were calculated on an electronic computer. The results have been plotted on a number of diagrams so that the two rock groups (metadolerites and metavolcanics) can be compared.

The analysed metadolerites are listed above and the results are seen in Tables I and II. Tables III and IV give the results of the norm calculations, the AMF and the Niggli values for the metadolerites analysed. Table V shows the results of the chemical analyses of the Sortis Group rocks from Grænseland as given by Bondesen (in press), and Table VI the corresponding norms, AMF and Niggli values. The chemical analyses from the Sortis Group rocks from the Midternæs area (Higgins, in press) are given in Table VII. Tables VIII and IX give the norms, AMF and Niggli values from the Midternæs samples. Among the analysed Sortis Group rocks described by Higgins are two which do not represent the normal rock types of this Group, since they have rather extreme compositions. These two analyses are not included in the comparative presentation given here. Two volcanic rocks representing the Sortis Group from the area south of Arsuk Fjord have also been analysed and the results given in Table X. The rocks from this area are more strongly metamorphosed than the corresponding rocks from Grænseland and Midternæs. To the south of Arsuk Fjord the supracrustal rocks are recrystallised under high epidote-amphibolite to low amphibolite facies and the Sortis Group volcanics are amphibolitic in this area.

EVALUATION OF THE RESULTS OF THE CHEMICAL ANALYSES

Metadolerites

Analyses of the metadolerites show that most of the rocks fall within the tholeiitic field when compared with the Hawaiian basalts (MacDonald and Katsura, 1964). There are however, three analyses with plots in the alkalic field (Fig. 2) all of which come from the three samples representing dyke set no. 4 – the youngest set of dykes. Although the statistical value of these few results is debatable, they could indicate that the last set of dykes is more alkaline and perhaps also more basic than the earlier sets.

The analysed rocks representing the third set of dykes have normative quartz in four of the five analyses. Three of the analyses represent unfolded

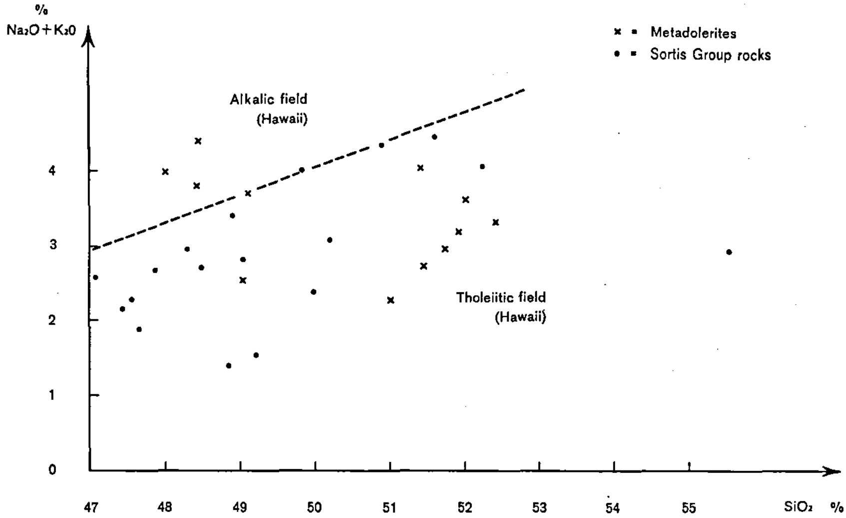


Fig. 2. Variation diagram illustrating the relation between alkalies and silica given as weight percentages. Boundary line after MACDONALD and KATSURA (1964).

dykes but the remaining two come from the folded dykes west of Grænseland which further to the west have kept their original NE trend+. This dyke set thus seems generally to be characterised by the occurrence of normative quartz.

Set no. 2 is represented by only two analyses, both of which are tholeiitic but without normative quartz.

The analyses from the metadolerites south of Arsuk Fjord which could not be referred to any special set of dykes, because they had lost their normal trend directions, both contain normative quartz. It is therefore likely that they belong to set no. 3 and had an original NE trend. The general outcrop pattern of the dykes south-east of Arsuk Fjord also indicates that the majority of the dykes were originally NE-trending dykes, which are deflected near the boundary of the Ketilidian supracrustals.

The scheme below shows the generalised results of the composition of the different sets of metadolerites:

+) see also Fig. 7, WINDLEY et al., 1966.

youngest:

Set No.	Trend	No. of analyses	Composition	Number of analyses with Norm. Oliv.	Norm. Hyp.	Norm. Qts.
4	WNW – E-W	3*	alkaline	3	3	
3	NNE – NE	5–(7)	tholeiitic	1	5–(7)	4–(6)
2	NNW	2	tholeiitic	2	2	
1	E-W – WNW	0		No information		

oldest:

*) all from the same dyke.

Relation between the chemical composition of the dykes and the metamorphic recrystallisation

The chemical alterations which could have arisen in connection with the metamorphic alterations have been investigated by analysing three metamorphically different samples from one dyke. These samples correspond to rocks taken from a dyke belonging to set no. 4 which can be traced for ca. 40 km. The metamorphic grade changes along the dyke from greenschist to amphibolite facies and a detailed description of this, including the analysed samples, has been given by BONDESEN and HENRIKSEN (1965). The least altered sample (32002) is a metadolerite with preserved primary plagioclase and uralitic hornblende. Chlorite is present and the texture is ophitic. The next sample (19715) was taken ca. 12 km farther east and is characterised by recrystallisation of plagioclase and by uralitic hornblende; there are now only traces of ophitic texture. The most altered sample (19785) comes from ca. 12 km farther east again and this rock is a completely recrystallised amphibolite with a nematoblastic texture.

The results of the chemical analyses and the petrochemical calculations of these rocks are astonishingly similar and there is no doubt that all the small differences can be explained as primary. There is therefore no evidence of any metasomatic alterations in connection with the recrystallisation of this dyke and the metamorphic alterations should be regarded as isochemical. Based on this assumption it seems justifiable to compare the analyses of dykes of varying metamorphic grade with the Sortis Group rocks without considering the degree of metamorphic alteration and assuming that the chemical analyses of all the analysed dykes sufficiently reflect their original composition.

Sortis Group metavolcanics

The chemical composition of the Sortis Group rocks, which all plot in the tholeiitic field on Fig. 2, can be summarised as follows:

	No. of anal.	*Number of analyses with* Norm. Oliv.	Norm. Hyp.	Norm. Qts.
Lavas and tuffs	7	5	7	2
Intrusives (sills)	9	6	8	3
"Greenschists"	2	1	2	1

According to the nomenclature given by WILKINSON (1967) the main part of the lavas consists of undersaturated olivine tholeiites and only a few are oversaturated tholeiites. The intrusive sills show the same distribution pattern. HIGGINS (in press) points out that the average Midternæs sill and lava show strong similarities and he concludes that both intrusives and extrusives were probably derived from the same magma chamber. The equivalent analyses from Grænseland (BONDESEN, in press) show the same characteristics.

The Sortis Group rocks are generally low or very low in K and in this differ distinctly from the metadolerites. The low K_2O content and the approximately normal Na_2O content in the Sortis Group rocks give a K/Na ratio near to that found in spilitic associations. The rocks must not, however, be regarded as spilitic solely on the basis of a low K_2O value. According to TURNER and VERHOOGEN (1960) the relationship $CaO/Na_2O \leq 1.5$ is characteristic of spilitic compositions, whereas a high CaO/Na_2O ratio is normal for common basalts of both tholeiitic and alkaline types. The Sortis Group rocks all belong to the catagory with high CaO/Na_2O ratios. Other non-spilitic chemical features are the CaO and MgO contents which are both close to those found in normal basaltic rocks and somewhat higher than in the average spilitic rock. The relatively low TiO_2 content in the Sortis Group rocks indicates normal basaltic compositions as in spilitic rocks it generally varies between 2.5% and 3.5%, whereas in the metavolcanics in the Ivigtut area it is usually below 1% and rarely above 1.5%.

COMPARISON BETWEEN THE METADOLERITES AND THE SORTIS GROUP ROCKS

The petrochemical similarities and differences between the metavolcanic rocks and the metadolerites are best shown by a number of diagrams.

In Fig. 2 $Na_2O + K_2O$ is plotted against SiO_2 and compared with the Hawaiian lavas belonging to the alkaline and tholeiitic suites. It is thus seen that all except three analyses plot in the tholeiitic field. There is no significant difference in the distribution of the plots of the metavolcanics and the metadykes, although there is a vague indication that the metadykes are generally slightly more SiO_2-rich than the metavolcanics. The three analyses which plot in the alkaline field all belong to the last dyke set (see p. 35).

Fig. 3 is a triangular diagram of the type used ny NOCHOLDS and ALLEN (1953). Here the alkalies $Na_2O + K_2O$, the total iron as FeO, and MgO (AMF values) are plotted at the three corners.

From this diagram it is also evident that most of the analysed rocks belong to the tholeiitic type and it is only at the MgO-rich end of the trend lines, where they are close together, that some plots are nearer to the alkaline trend line. The differences between metavolcanics and metadykes are not evident in this diagram.

The plots of the normative feldspar composition and those of the Niggli values do, however, show clearly the chemical differences between the metadolerites and metavolcanics. Fig. 4 is a triangular diagram with Ab, An and Or at the three corners, and here the low K_2O content in the metavolcanics is seen, thus distinguishing them from the metadykes. The same difference can easily by seen by plotting the Niggli k values against the Niggli si values. This has been done in Fig. 5 together with the Niggli values alk, fm, al and c – all against the si values. Although there is some scatter among the plotted points it seems evident that here there is a difference between the two rock groups in the distribution of their fm and al values. The c and alk values do not, however, plot in such a way that any differences between them are apparent.

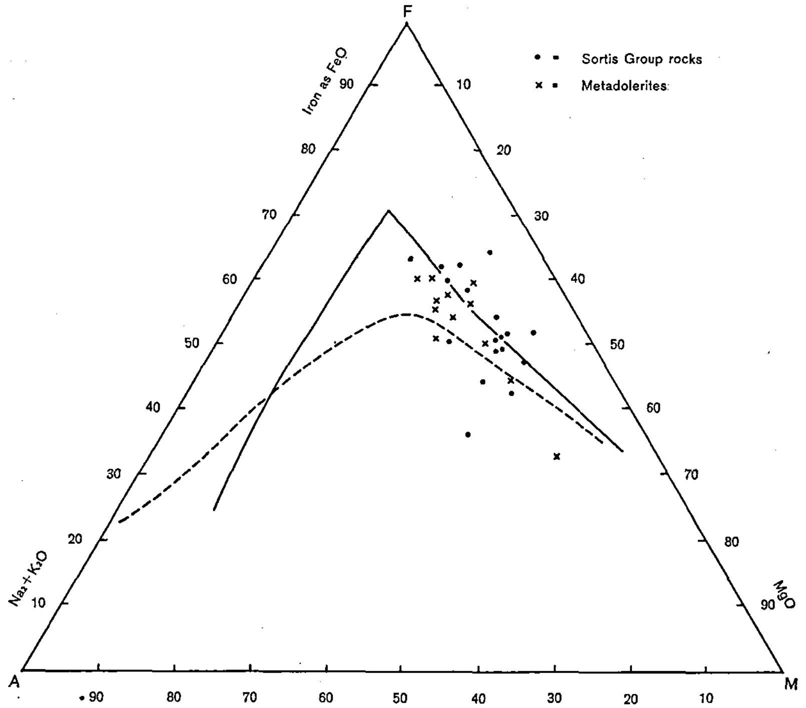


Fig. 3. Variation diagram of analysed metadolerites and metavolcanics. Solid line: Trend of Hawaiian tholeiitic suite and dashed line: Trend of Hawaiian akalic suite; after MACDONALD and KATSURA (1964).

These results show that both rock groups*) belong to the tholeiitic suite and that therefore generally speaking they are close to each other in chemical composition. The existing differences, which are best shown by plotting the Niggli values, do however make it apparent that the source material for the two rock types was not identical. This is seen from the fact that the two types plot differently for the same parameters and that they do not lie on the same differentiation trend. The implication of this is that the metadolerites cannot be regarded as being feeders of the metavolcanic Sortis Group rocks. Not even the last set of dykes, which was the one with the alkaline composition, could with any right be considered as being related to the Ketilidian metavolcanics, although it could of course be argued that dykes and corresponding metavolcanics need not necessarily be identical chemically. The proposition is, however, unlikely especially as the Sortis Group rocks contain both lavas and sills which are almost identical. Evidence from other regions also shows that lavas and corresponding dykes are often chemically very closely related, as is the case for instance with the Karroo dolerites and the corresponding Storm-

*) Except the WNW-EW youngest set of dykes.

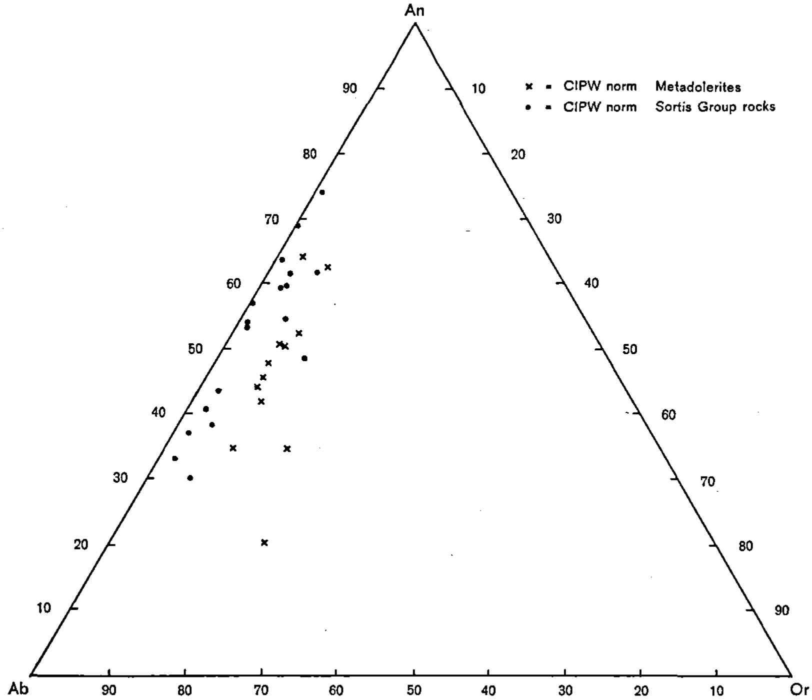


Fig. 4. Variation diagram of analysed metadolerites and metavolcanics. The Ab – An – Or apices calculated from the CIPW weight norm.

berg lavas (WALKER and POLDERVAART, 1949). Both these belong to the tholeiitic suite and are therefore comparable with the rocks discussed here. The variation, for instance, in the K_2O and Na_2O ratio is only small in the South African example and not comparable with the differences found in dykes and volcanics in the Ivigtut area.

The main conclusion to be drawn from this is that the dykes and the Ketilidian metavolcanics were originally different petrologically and therefore are probably not of the same age. As the dykes can be shown to be older than the Ketilidian deformation, they could either be early or pre-Ketilidian, i. e. contemporaneous with or older than the initial volcanism in the Ketilidian geosyncline. The chemical considerations favour the latter possibility.

A K/Ar age determination on the rheomorphosed contact gneiss beside a fresh NE-trending metadolerite, which in age corresponds to the NE-trending metadolerites treated here, has been undertaken from the northernmost part of the Ivigtut area (JØRGENSEN, 1967). The results of this gave 1750 ± 45 my as a probable intrusive age of the dyke. This shows that even if a certain amount of up-dating is taken into consideration, at

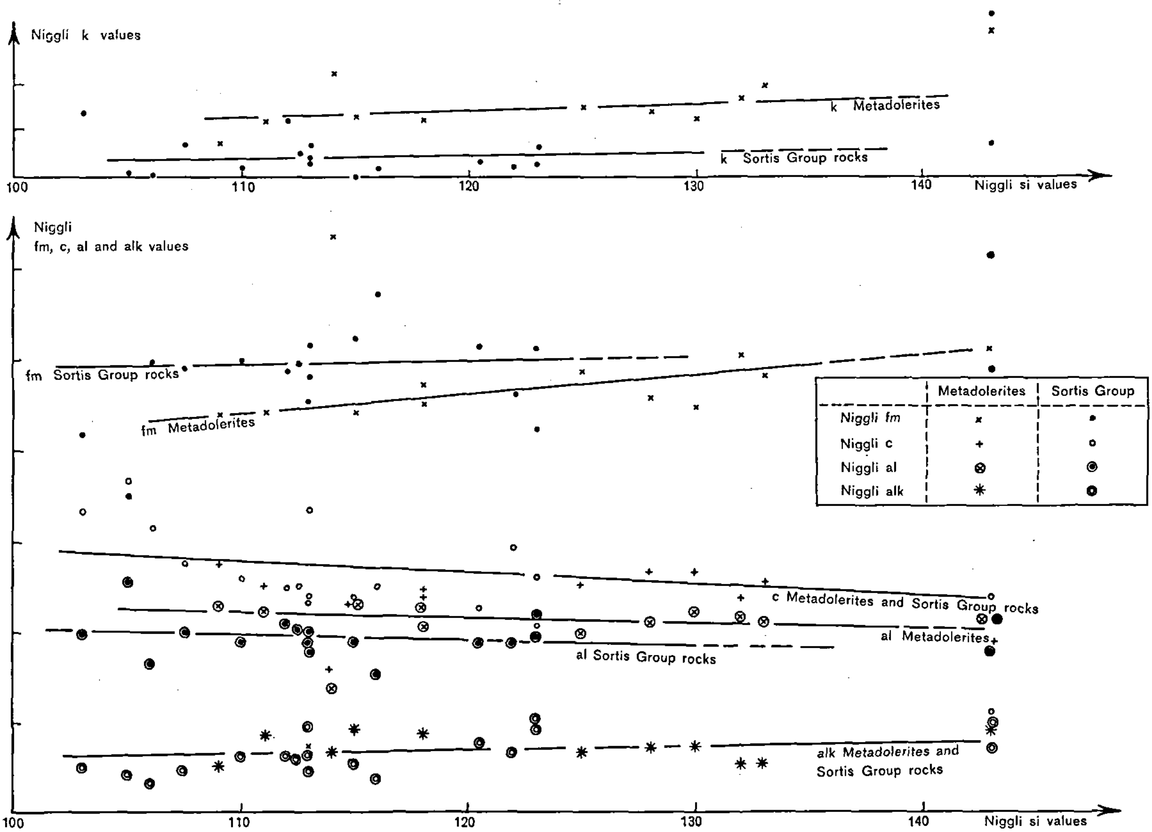


Fig. 5. Variation diagram comparing Niggli values of metadolerites and metavolcanics.

least the youngest of the dykes must have been emplaced shortly before the beginning of the Ketilidian episode.

The number of analyses on which these conclusions have been based are relatively small in relation to the number of dykes mapped. The possibility that there are some undated dykes in the basement which could correspond to the Sortis Group rocks cannot therefore be completely ruled out. The existence of two thin metadolerites cutting into the Ketilidian supracrustals in Grænseland (WINDLEY et al., 1966) indicates that a few basic dykes were emplaced in the central Ivigtut area in the Ketilidian period.

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DANSK RESUMÉ

Den geologiske kortlægning af Ivigtut området i sydvest Grønland har vist, at der i dette område findes en grænse mellem to prækambriske foldekomplekser. Det ældste af disse – kaldet det præketilidiske – findes bevaret imod nord og herfra giver de fleste K/Ar aldersbestemmelser værdier på 2500–2700 millioner år. Den yngre ketilidiske foldekæde findes imod syd og K/Ar aldersbestemmelser på sen-orogene bjergarter herfra giver 1580–1640 millioner år.

De orogene perioder, hvorunder de to foldekomplekser blev dannet, adskilles af en mellemliggende kratogen periode, der er karakteriseret af relative stabile og rolige jordskorpeforhold. I denne periode bliver de ældre bjergarter yderligere konsoliderede, og det tidligere dannede foldekompleks eroderes.

En geosynklinaldannelse indleder udviklingen af den yngre foldekæde mod syd. I denne geosynklinal aflejres først en tyk serie sedimenter (Vallen Gruppen) og herefter følger en mægtig vulkansk serie (Sortis Gruppen), der hovedsagelig består af basaltiske bjergarter. Tilsammen overstiger geosynklinalaflejringernes mægtighed adskilligt over 6000 m. Ved den efterfølgende ketilidiske bjergkædefoldning bliver de geosynklinikale aflejringer samt de tidligere dannede bjergarter i det tilgrænsende geosynklinalforland foldede og metamorfoserede. Omdannelsesgraden og foldeintensiteten stiger fra nordvest mod sydøst.

I det præketilidiske forlandsområde findes en stor sværm af basiske gange, der er intruderet efter dannelsen af de præketilidiske foldekædebjergarter på et tidspunkt, hvor der herskede tensionsbetingelser i jordskorpen. Gangene kan spores næsten op til grænsen mellem de gamle forlandsbjergarter (hovedsageligt udviklet som gnejser) og de ketilidiske geosynklinalbjergarter, men gangene findes ikke i geosynklinalaflejringer, og deres relation til geosynklinalaflejringernes pålejringsdiskordans er ukendt. Gangene påvirkes ligesom deres omgivelser af den ketilidiske foldning og metamorfose og diabaserne omdannes herved gradvis til amfibolitiske gange, der længst mod sydøst er stærkt deformerede. De basiske gange må derfor enten være dannet i den ketilidiske evolusionsfase eller være af en præketilidisk alder. I første tilfælde kunne de svare til vulkaniterne i den ketilidiske geosynklinal, (Sortis Gruppen). Afhandlingen søger at belyse gangenes aldersforhold ved at sammenligne gangenes og vulkaniternes kemiske sammensætning.

Sortis Gruppens bjergarter er blevet detailleret beskrevet af ERLING BONDESEN (in press) fra Grænseland og af A. K. HIGGINS (in press) fra Midternæs. Kemiske analyser af disse bjergarter er refereret fra de to ovennævnte arbejder i tabellerne V og VII. Endvidere er 2 andre Sortis Gruppe bjergarter blevet analyseret og resultatet heraf vises i tabel X.

Kemiske analyser af de basiske gange er anført i tabellerne I og II. Gangene kan generelt opdeles i 4 forskellige sæt, med forskellige hovedintrusionsretninger. Disse sæt er benævnt: Sæt 4 – 3 – 2 – 1 fra yngst til ældst. Sæt-betegnelserne står anført ved de enkelte analyser.

Alle analyserede prøver er lokalitetsangivet på skitsekortet (fig. 1) ved hjælp af løbenumre, der samtidig findes angivet ved analyserne i tabellerne.
På grundlag af analyseresultaterne er der gennemført en elektronisk udregning af en række petrokemiske parametre, der benyttes til sammenligning af de to bjergartsgrupper. Disse parametre (CIPW-normer, AMF-værdier og Niggli-værdier) angives i en række tabeller, der hver for sig er anbragt lige efter tabellerne med de tilsvarende analyseresultater. Udvalgte petrokemiske parametre er dernæst plottet i variationsdiagrammer (fig. 3, 4 og 5), hvorved der fås et overblik over ligheder og forskelle mellem de to bjergartsgrupper. Således ses f. eks. den teoretiske sammensætning af bjergartsgruppernes feldspat angivet i fig. 4 – der tydeligt viser en forskel mellem vulkaniternes og gangenes beregnede feldspatsammensætning.
På grundlag af undersøgelsen og vurderingen af det ovennævnte analysemateriale nås følgende hovedkonklusioner:

1) 2 af de tidligste 3 sæt gange, der udgør hovedparten af de metamorfoserede diabaser, havde tholeiitisk primærsammensætning, medens gange fra det sidste sæt er mere alkaline.

2) Den ketilidiske metamorfose i den nordlige del af Ivigtutområdet har ikke medført større stof-migrationer (er foregået under isokemiske betingelser).

3) Den kemiske sammensætning af de metamorfoserede diabaser og de ketilidiske vulkaniter viser, at de er en smule forskellige, trods deres generelle lighed. De anses derfor ikke for at kunne være dannet på samme tid fra den samme udgangsbjergart og gangene må derfor regnes for præketilidiske af alder d.v.s. dannet før vulkaniterne i den ketilidiske geosynklinal.

REFERENCES

ALLART, J. H., BRIDGWATER, D. and HENRIKSEN, N. (in press). The pre-Quaternary geology of South-West Greenland and its bearing on problems of correlation in the North Atlantic. – *Bull. Am. Ass. Petrol. Geol.*

BONDESEN, E. (in press). The stratigraphy and deformation of the Precambrian rocks of the Grænseland area, South-West Greenland. – *Bull. Grønlands geol. Unders., (also* Meddr Grønland, Bd. 181, Nr. 1.)

BONDESEN, E. and HENRIKSEN, N., 1965. On some Precambrian metadolerites from the central Ivigtut region, S.W. Greenland. – *Bull. Grønlands geol. Unders.,* No. 52 *(also* Meddr Grønland, Bd. 179, Nr. 2.)

HENRIKSEN, N. (in press). Boundary relations between Precambrian fold belts in the Ivigtut area, South-West Greenland. – *Proc. Geol. Ass. Canada,* centennial volume.

HIGGINS, A. K. (in press). The stratigraphy and structures of the Ketilidian rocks of Midternæs, South-West Greenland. – *Bull. Grønlands geol. Unders.*

HIGGINS, A. K. and BONDESEN, E., 1966. Supracrustals of pre-Ketilidian age (the Tartoq Group) and their relationships with Ketilidian supracrustals in the Ivigtut region, South-West Greenland. – *Rapp. Grønlands geol. Unders.,* Nr. 8.

JØRGENSEN, O., 1967. K/Ar age determinations from western Greenland II. The Ivigtut region. – *Rapp. Grønlands geol. Unders.,* Nr. 15, p. 87–91.

MACDONALD, G. A. and KATSURA, T., 1964. Chemical composition of Hawaiian lavas. *J. Petrology,* Vol. 5, p. 82–133.

NOCHOLDS, S. R. and ALLEN, R. S., 1953. The geochemistry of some igneous rock series. Part I. – *Geochim. et Cosmochim. Acta,* Vol. 4, p. 105–142.

TURNER, F. J. and VERHOOGEN, J., 1960. Igneous and metamorphic petrology. (2nd edit). McGraw-Hill, New York.

WALKER, F. and POLDERVAART, A., 1949. The Karroo dolerites of the Union of South Africa. – *Bull. Geol. Soc. America,* Vol. 60, p. 591–706.

WILKINSON, J. F. G., 1967. The petrology of basaltic rocks. – *In* HESS, H. H. and POLDERVAART, A. (Ed.) Basalts. Vol. 1, 163–214. Interscience Publishers.

WINDLEY, B. F., HENRIKSEN, N., HIGGINS, A. K., BONDESEN, E. and JENSEN, S. B., 1966. Some border relations between supracrustals and infracrustals in South-West Greenland. – *Rapp. Grønlands geol. Unders.,* Nr. 9.

TABLE I

Chemical analyses of metadolerites (analyst: Ib Sørensen)

Dyke set. no.	4	4	4	3	3	3
Locality no.	1	2	3	4	5	6
GGU no.	32002	19715	19785	69229	19479	19755
SiO_2	48.45	47.99	48.41	49.05	51.92	51.74
TiO_2	1.51	1.83	2.04	0.66	1.19	1.06
Al_2O_3	16.45	15.93	16.08	17.93	14.35	13.97
Fe_2O_3	1.95	2.52	2.63	2.03	2.47	2.65
FeO	9.34	9.55	9.88	6.86	9.77	8.11
MnO	0.27	0.17	0.13	0.24	0.20	0.25
MgO	6.30	5.65	5.64	8.20	5.62	7.43
CaO	8.88	9.79	9.10	11.44	9.99	9.70
Na_2O	3.60	3.25	3.12	2.25	2.53	2.27
K_2O	0.83	0.74	0.68	0.30	0.66	0.68
P_2O_5	0.39	0.33	0.31	0.22	0.21	0.22
CO_2	–	–	–	–	–	–
H_2O	1.41	1.31	1.13	1.00	0.93	1.33
	99.38	99.06	98.97	100.18	99.84	99.41

TABLE II

Chemical analyses of metadolerites (analyst: Ib Sørensen)

Dyke set no.	3	3	2	2	?	?
Locality no.	7	8	9	10	11	12
GGU no.	93110	93115	39239	39272	39154	39104
SiO_2	51.40	51.03	49.12	52.03	52.40	51.49
TiO_2	2.77	1.39	1.83	0.54	0.99	1.17
Al_2O_3	12.68	14.13	14.35	10.61	14.98	14.23
Fe_2O_3	5.40	5.62	2.79	1.28	2.19	3.44
FeO	8.54	7.28	11.10	7.71	8.98	8.75
MnO	0.14	0.11	0.20	0.17	0.00	0.00
MgO	4.83	6.15	5.36	14.47	5.85	6.36
CaO	6.22	8.22	9.52	6.56	9.74	9.35
Na_2O	2.34	1.68	3.05	2.45	2.65	1.98
K_2O	1.70	0.58	0.65	1.15	0.63	0.75
P_2O_5	0.36	0.19	0.12	0.27	0.15	0.00
CO_2	–	–	–	–	–	–
H_2O	2.16	2.68	1.40	1.81	1.00	1.40
	98.54	99.06	99.49	99.38	99.56	98.92

TABLE III

Metadolerites

CIPW norms; AMF values; Niggli values

Dyke set no.	4	4	4	3	3	3
Locality no.	1	2	3	4	5	6
GGU no.	32002	19715	19785	69229	19479	19755
Norms						
q	0.00	0.00	0.00	0.00	3.74	3.90
or	4.90	4.37	4.01	1.77	3.90	4.01
ab	30.43	27.47	26.37	19.02	21.38	19.19
an	26.46	26.68	27.85	37.91	25.83	25.90
ne	0.00	0.00	0.00	0.00	0.00	0.00
di	12.51	16.23	12.57	14.04	18.46	16.88
hy	0.91	4.51	13.83	15.60	19.22	21.78
ol	16.31	10.55	4.75	6.08	0.00	0.00
mt	2.83	3.66	3.82	2.95	3.59	3.85
il	2.87	3.48	3.88	1.25	2.26	2.01
ap	0.92	0.78	0.73	0.52	0.50	0.52
Feldspar						
or	8.0	7.5	6.9	3.1	7.6	8.2
ab	49.4	47.0	45.2	32.4	42.1	39.1
an	42.6	45.5	47.9	64.5	50.3	52.7
AMF						
A	20.30	18.60	17.67	13.12	15.33	14.13
M	28.87	26.33	25.39	42.19	27.02	35.59
F	50.83	55.07	56.94	44.69	57.65	50.27
Niggli						
al	23.01	22.38	23.01	23.54	20.82	19.92
fm	44.86	43.98	44.91	43.87	45.74	48.55
c	22.59	25.01	23.68	27.31	26.36	25.15
alk	9.54	8.64	8.40	5.29	7.08	6.38
k	0.131	0.130	0.125	0.082	0.146	0.166
si	115	111	118	109	128	125

TABLE IV

Metadolerites

CIPW norms; AMF values; Niggli values

Dyke set no.	3	3	2	2	?	?
Locality no.	7	8	9	10	11	12
GGU no.	93110	93115	39239	39272	39154	39104
Norms						
q	10.68	11.92	0.00	0.00	3.77	6.47
or	10.06	3.42	3.84	6.79	3.72	4.44
ab	19.78	14.20	25.78	20.71	22.40	16.73
an	19.04	29.28	23.51	14.55	27.10	27.69
ne	0.00	0.00	0.00	0.00	0.00	0.00
di	7.70	8.24	19.07	12.98	16.63	15.30
hy	15.22	18.05	14.62	28.84	19.47	19.68
ol	0.00	0.00	3.47	9.81	0.00	0.00
mt	7.83	8.16	4.05	1.86	3.18	4.99
il	5.26	2.64	3.48	1.03	1.88	2.22
ap	0.85	0.45	0.28	0.64	0.35	0.00
Feldspar						
or	20.6	7.3	48.5	16.1	7.0	9.1
ab	40.5	30.3	44.3	49.2	42.1	34.2
an	38.9	62.4	7.2	34.7	50.9	56.7
AMF						
A	18.14	10.89	16.32	13.37	16.33	13.04
M	21.69	29.64	23.64	53.73	29.13	30.38
F	60.17	59.46	60.04	32.90	54.53	56.58
Niggli						
al	20.75	21.51	20.34	13.74	22.01	20.87
fm	51.44	50.57	47.01	63.99	44.57	48.24
c	18.51	22.75	24.54	15.44	26.02	24.93
alk	9.31	5.16	8.11	6.83	7.41	5.97
k	0.324	0.185	0.124	0.236	0.135	0.200
si	143	132	118	114	130	133

TABLE V

Chemical analyses of volcanic rocks from the Sortis Group, Grænseland by E. BONDESEN (in press) (analyst: IB SØRENSEN)

Locality no. GGU no.	13 20862	14 53058	15 53047	16 52958	17 53079	18 53111	19 53108
SiO_2	48.85	49.98	48.48	48.30	50.21	49.20	47.64
TiO_2	0.76	0.80	0.87	0.87	1.48	1.25	0.43
Al_2O_3	12.21	13.70	14.08	14.95	12.72	10.68	19.54
Fe_2O_3	2.65	1.85	2.02	1.99	2.64	2.30	1.45
FeO	8.56	8.90	9.58	8.78	10.90	13.90	4.31
MnO	0.16	0.18	0.17	0.17	0.21	0.24	0.11
MgO	8.55	9.22	8.26	7.98	5.21	7.14	7.17
CaO	13.00	9.60	10.62	9.90	11.19	9.75	15.35
Na_2O	1.40	2.38	2.62	2.43	2.18	1.47	1.82
K_2O	0.00	0.00	0.09	0.52	0.88	0.04	0.04
P_2O_5	0.08	0.08	0.09	0.08	0.19	0.12	0.06
CO_2	0.09	n.d.	0.00	n.d.	0.00	0.2	0.00
H_2O	3.37	3.40	2.64	3.75	2.16	3.62	2.34
	99.68	100.09	99.52	99.72	99.97	99.91	100.26

20862 Pillow lava
53058 Tuffite
53047 Basic sill
52958 Basic sheet-like body
53079 Mesocratic basic intrusive
53111 Melanocratic basic intrusive
53108 Leucocratic basic intrusive

TABLE VI

Volcanic rocks from the Sortis Group, Grænseland

CIPW norms; AMF values; Niggli values

Locality no.	13	14	15	16	17	18	19
GGU no.	20862	53058	53047	52958	53079	53111	53108
Norms							
q	2.49	0.06	0.00	0.00	2.61	4.64	0.00
or	0.00	0.00	0.53	3.07	5.19	0.24	0.24
ab	11.83	20.11	22.14	20.54	18.42	12.42	15.38
an	27.01	26.68	26.38	28.33	22.31	22.41	45.00
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00
di	29.99	16.57	20.99	16.50	26.56	20.93	24.59
hy	19.37	28.82	13.34	16.02	15.57	29.43	2.50
ol	0.00	0.00	8.65	6.73	0.00	0.00	7.09
mt	3.85	2.69	2.93	2.89	3.84	3.34	2.11
il	1.44	1.52	1.65	1.65	2.81	2.38	0.82
ap	0.19	0.19	0.21	0.19	0.45	0.28	0.14
Feldspar							
or	0.0	0.0	1.1	5.9	11.3	0.7	0.4
ab	30.6	42.9	45.1	39.6	40.2	35.3	25.4
an	69.4	57.1	53.8	54.5	48.5	64.0	74.2
AMF							
A	6.71	10.74	12.12	13.72	14.20	6.13	12.70
M	40.97	41.60	36.93	37.12	24.18	29.00	48.96
F	52.32	47.66	50.96	49.16	61.62	64.86	38.34
Niggli							
al	16.16	18.60	18.75	20.50	18.19	14.85	25.46
fm	49.50	52.38	49.68	48.57	46.22	57.09	34.22
c	31.29	23.70	25.71	24.68	29.10	24.64	36.36
alk	3.05	5.32	5.87	6.25	6.49	3.42	3.96
k	0.00	0.00	0.02	0.123	0.21	0.017	0.015
si	106	115	110	112	122	116	105

TABLE VII

Chemical analyses of volcanic rocks from the Sortis Group, Midternæs by A. K. HIGGINS (in press) (analyst: Ib Sørensen)

Locality no.	20	21	22	23	24	25	26	27	28
GGU no.	25781	71463	71464	24358	24357	71238	24386	33901	33907
SiO_2	48.89	50.89	47.43	47.14	47.56	52.26	47.84	51.62	49.83
TiO_2	1.57	0.75	0.84	0.79	0.83	1.79	0.57	0.52	0.75
Al_2O_3	12.76	13.43	12.92	15.23	14.25	11.57	15.62	15.28	13.84
Fe_2O_3	2.64	1.29	1.12	1.42	1.65	2.20	2.23	2.16	0.92
FeO	11.70	10.42	9.93	9.84	9.72	12.47	5.96	5.04	9.14
MnO	0.21	0.05	0.21	0.27	0.20	0.17	0.81	0.16	0.17
MgO	5.96	7.01	6.92	8.11	8.14	4.31	8.05	7.87	8.60
CaO	8.45	9.20	13.77	10.30	11.36	8.36	14.31	10.13	7.99
Na_2O	3.22	4.13	1.90	2.30	2.01	3.58	2.10	4.26	3.60
K_2O	0.19	0.19	0.25	0.25	0.24	0.45	0.57	0.20	0.40
P_2O_5	0.22	0.19	0.00	0.23	0.13	0.15	0.08	0.06	0.10
CO_2	tr	n.d.	1.00	n.d.	n.d.	n.d.	n.d.	n.d.	1.05
H_2O	3.29	2.78	3.73	4.35	3.41	2.40	2.16	2.80	3.80
	99.10	100.33	100.02	100.23	99.50	99.71	100.30	100.10	100.19

25781 Massive lava
71463 Pillow lava
71464 Pillov lava
24358 Pillow lava
24357 Pillow lava
71238 Hornblende gabbro sill
24386 Basic sill
33901 Basic sill
33907 Basic sill

Two special volcanic rock types listed by Higgins have not been included here.

TABLE VIII

Volcanic rocks from the Sortis Group, Midternæs

CIPW norms; AMF values; Niggli values

Locality no.	20	21	22	23	24	25	26
GGU no.	25781	71463	71464	24358	24357	71238	24386
Norms							
q	0.00	0.00	0.00	0.00	0.00	3.05	0.00
or	1.12	1.12	1.48	1.48	1.42	2.66	3.36
ab	27.21	34.91	16.06	19.44	16.99	30.26	15.51
an	19.79	17.54	25.97	30.47	29.13	14.17	31.49
ne	0.00	0.00	0.00	0.00	0.00	0.00	1.21
di	17.16	22.15	29.68	15.65	21.57	22.14	31.44
hy	22.25	2.85	13.69	13.79	15.57	18.06	0.00
ol	0.90	15.19	3.87	10.91	7.09	0.00	10.56
mt	3.84	1.87	1.63	2.06	2.40	3.20	3.24
il	2.98	1.42	1.60	1.50	1.58	3.40	1.08
ap	0.52	0.45	0.00	0.54	0.31	0.35	0.19
Feldspar							
or	2.3	2.1	3.4	2.9	3.0	5.7	6.7
ab	56.8	65.1	36.9	37.8	35.6	64.3	30.8
an	40.9	32.8	59.7	59.3	61.4	30.0	62.5
AMF							
A	14.54	18.86	10.75	11.71	10.42	17.68	14.29
M	25.42	30.60	34.59	37.24	37.69	18.91	43.08
F	60.03	50.55	54.67	51.05	51.89	63.40	42.63
Niggli							
al	18.50	18.81	17.30	20.39	18.94	17.86	19.89
fm	51.25	47.96	44.63	49.11	48.87	48.85	41.80
c	22.27	23.43	33.52	25.07	27.45	23.46	33.13
alk	7.98	9.80	4.55	5.43	4.74	9.84	5.18
k	0.038	0.029	0.079	0.067	0.074	0.076	0.148
si	120.5	113	113	112.5	107.5	143	103

TABLE IX

Volcanic rocks from the Sortis Group, Midternæs

CIPW norms; AMF values; Niggli values

Locality no.	27	28
GGU no.	33901	33907
Norms		
q	0.00	0.00
or	1.18	2.36
ab	36.00	30.43
an	21.97	20.41
ne	0.00	0.00
di	22.32	9.73
hy	0.27	17.71
ol	11.23	10.32
mt	3.14	1.34
il	0.99	1.42
ap	0.14	0.24
Feldspar		
or	2.0	4.4
ab	60.9	57.2
an	37.1	38.4
AMF		
A	23.09	17.72
M	40.75	38.11
F	36.16	44.17
Niggli		
al	21.53	19.53
fm	42.34	51.00
c	25.95	20.50
alk	10.18	8.97
k	0.030	0.069
si	123	123

TABLE X

Volcanic rocks from the Sortis Group, south of Arsuk Fjord.

Chemical analyses (analyst: IB SØRENSEN);

CIPW norms; AMF values; Niggli values

Locality no.	29	30
GGU no.	39113	39125
SiO_2	49.03	55.55
TiO_2	1.61	1.36
Al_2O_3	14.35	12.44
Fe_2O_3	2.05	0.50
FeO	13.06	13.27
MnO	0.22	0.00
MgO	6.26	6.84
CaO	9.05	3.69
Na_2O	2.66	1.60
K_2O	0.13	1.35
P_2O_5	0.16	0.27
CO_2	n.d.	n.d.
H_2O	1.49	2.20
	100.07	99.07

Locality no.	29	30
GGU no.	39113	39125
Norms		
q	0.00	13.78
c	0.00	2.29
or	0.77	7.97
ab	22.48	13.52
an	26.82	16.53
ne	0.00	0.00
di	14.18	0.00
hy	25.82	38.82
ol	2.08	0.00
mt	2.98	0.73
il	3.06	2.58
ap	0.38	0.64
Feldspar		
or	1.5	20.9
ab	44.9	35.5
an	53.6	43.6
AMF		
A	11.65	12.55
M	26.13	29.09
F	62.22	58.36
Niggli		
al	19.76	20.73
fm	51.36	61.27
c	22.66	11.18
alk	6.22	6.82
k	0.031	0.360
si	113	143

39113 Homogeneous amphibolite
39125 Amphibolitic greenschist