PRECAMBRIAN ROCKS OF THE AMGMAGSSALIK AREA, EAST GREENLAND

D. Bridgwater and K. Gormsen

Introduction

The area between Angmagssalik fjord (ca. 66°N) and Køge Bugt (65°N) shown in fig. 3 was mapped by the writers during a two month field season in the summer of 1967.

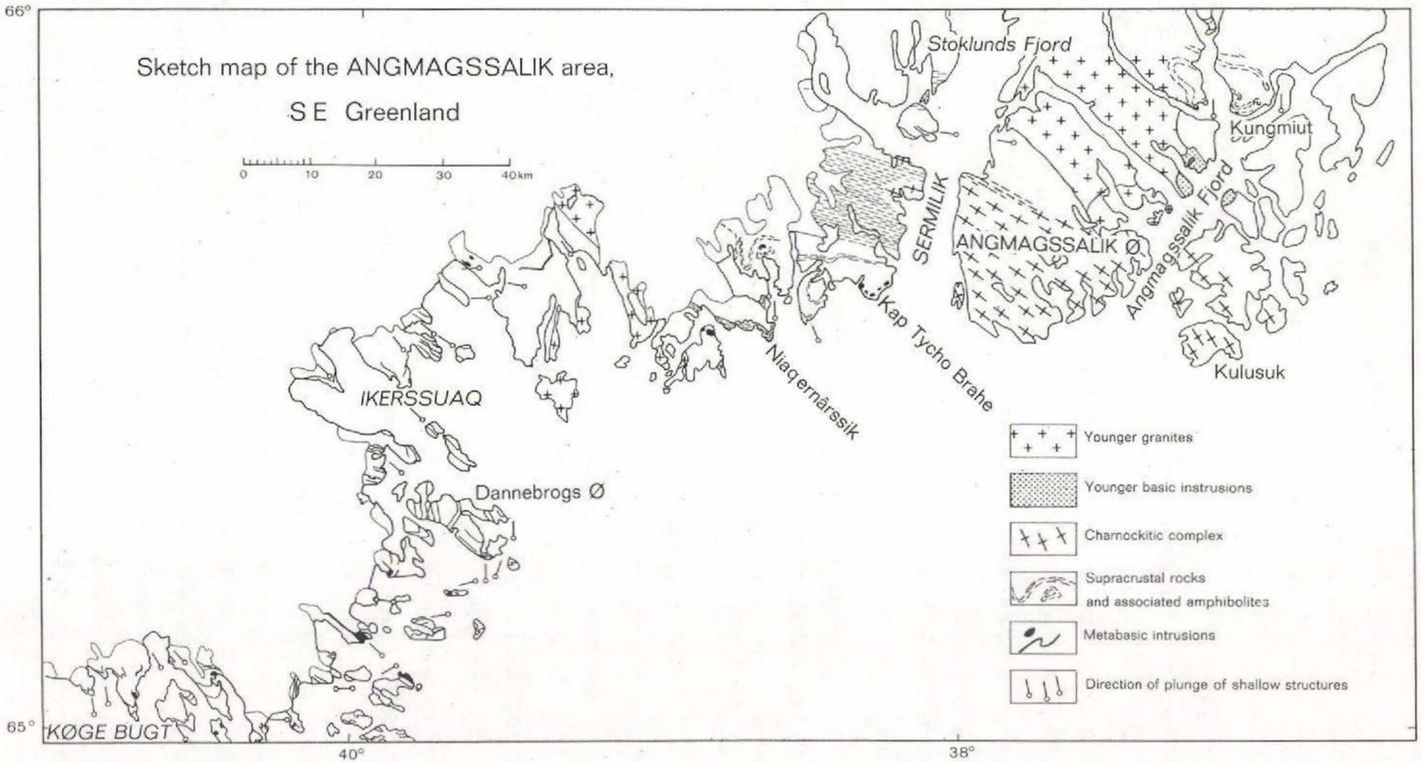
The Precambrian rocks of the area consist dominantly of biotite-hornblende or biotite-chlorite-epidote feldspathic gneisses (the grey gneisses of Wager, 1934). In these are intercalated pelitic, semipelitic and calcareous migmatitic gneisses with amphibolite facies mineral assemblages. The gneisses contain large numbers of concordant, semi-concordant and discordant bodies of metamorphosed basic and ultrabasic igneous rocks. Some of these are found inter-layered with the metasediments.

Both the gneisses and the metasediments were involved in local high-grade metamorphism with considerable anatexis and the emplacement of syntectonic hypersthene-bearing intrusives. These rocks are shown collectively on fig. 3 as the charnockite suite. They form a 25 km wide belt trending parallel to the prevailing structures on Angmagssalik Ø.

The youngest plutonic rocks in the area constitute a suite of late- to post-tectonic calc-alkaline norites, diorites and granites.

Preliminary Rb/Sr age determinations from the area between Angmagssalik and Kangerdlugssuaq (Wager and Hamilton, 1964) suggest that the last major plutonic event in this part of East Greenland took place between 1600 and 1800 m.y. age corresponding to the Ketilidian of South Greenland and the Nagssugtoqidian of central West Greenland. This plutonic episode is assumed to have affected all the Precambrian rocks described from the Angmagssalik district.

All these Precambrian rocks are cut by several generations of basic dykes, the most prominent of which show trends varying from 20-60° and are assumed to be Tertiary in age.



Sketch map of the ANGMAGSSALIK area,
S E Greenland
0 10 20 30 40km
66°
65°
40°
38°
Stoklunds Fjord
Kungmiut
SERMILIK
ANGMAGSSALIK Ø
Angmagssalik Fjord
Kulusuk
Kap Tycho Brahe
Niaqernârssik
IKERSSUAQ
Dannebrogs Ø
KØGE BUGT
Younger granites
Younger basic instrusions
Charnockitic complex
Supracrustal rocks
and associated amphibolites
Metabasic intrusions
Direction of plunge of shallow structures

Structure

a) E-W isoclinal folds

The overall structural pattern of the area is dominated by recumbent isoclinal folds and nappes with E-W to NW subhorizontal axes. These folds affected all the Precambrian rocks in the area except the post-tectonic calc-alkaline suite. The axial planes of the E-W folds (which are the main foliation planes measurable in the field) generally have a low dip towards the north in the area SW of Angmagssalik but are steeper in the northern part of the area. Locally there has been considerable overthrusting along the axial planes which has led to the destruction of many of the fold hinges. It is quite common to find one set (often northward-facing) of fold hinges preserved while the corresponding southward-facing hinges are absent. Tightly folded minor structures with their axes parallel to the major isoclines are common and many of the gneisses show a well-marked mineral lineation also parallel to the axes of the major structures. Locally the lineation becomes so strong that the foliation is lost and the main structural element seen in the gneisses is a strong rodding. The scale of the major structures is difficult to measure because of the lack of marker horizons. Metabasic intrusive sheets are frequently isoclinally folded so that their limbs may be separated by only a few metres (often less than the width of the dykes themselves); however larger folds are thought to be present with limbs separated by tens of kilometres.

There is considerable evidence to suggest that movement occurred several times along the E-W trending foliation planes. Two lineations separated by a small angle may be present in one outcrop and many of the gneiss outcrops show small scale interference patterns. The deformation associated with the youngest main phase of E-W folding varies considerably both regionally and locally. In general earlier major structures have been either destroyed or modified to such an extent that it has not proved possible to erect a regional chronology of events earlier than the last main E-W folding.

← Fig. 3

Major unconformities such as that once present between the meta-sediments and the intercalated gneisses have been completely destroyed. However enclaves of gneiss, sometimes several kilometres across, are found with earlier structures preserved and it is clear that the majority of gneisses in the area are formed from a reworked older metamorphic complex. On a local scale the variation in the deformation associated with the E-W folding can be seen in its effects on earlier structures in the gneisses and on the metabasic dykes. Some of the gneisses contain inclusions of anorthositic gabbro and hornblendic material (strongly reminiscent of those found in the reworked pre-Ketilidian rocks of West Greenland). In layers in the gneisses where they are comparatively little affected by younger deformation these inclusions are approximately equidimensional and show a non-directional metamorphic texture. However in adjacent gneiss layers similar inclusions are either flattened as ovoids or they may be pulled out as long cigars. The variation in the deformation of the metabasic intrusions in perhaps even more striking. Where these bodies are isoclinally folded it is quite common to find one limb of the isocline consisting of hypersthene gabbro with the original igneous texture preserved while the other limb consists of highly foliated garnet amphibolite and is a fraction of the width of the undeformed body.

b) Later structures

The E-W structural pattern is locally modified by at least one period of younger folding about N-S or NE trending axes with low plunges. Most of the folds produced during this phase are recumbent but they are rarely as tightly folded as the earlier E-W structures. The size of the younger folds varies from a few centimetres to a few kilometres from limb to limb; they are generally confined to relatively narrow belts of country and do not produce the same regional structures as the E-W folding. Typical interference patterns on both a major and minor scale resulting from the refolding of earlier E-W isoclines occur in the Niaqernârssik area, to the north of Kungmiut and on the eastern end of Dannebrogs Ø. Late shear movements along the regional E-W foliation planes have sliced off the crests of some of the smaller N-S folds and may be responsible for widespread retrograde metamorphism along the foliation planes in the gneisses.

Petrology of the gneisses

Most of the gneisses are leucocratic rocks with amphibolite facies mineral assemblages. Biotite, hornblende, diopside, garnet and sometimes kyanite are the commonest non-quartzo-feldspathic minerals. The anorthosite inclusions when undeformed consist of labradorite and hornblende. When strongly deformed these break down to less calcic plagioclase, epidote, chlorite, biotite and quartz. Most of the basic inclusions are zoned with actinolite-rich centres and biotite-chlorite rich margins. Locally some of the foliation planes within the gneisses contain considerable epidote, chlorite and biotite suggesting that the youngest movements along the E-W foliation planes were accompanied by retrograde metamorphism. Very occasionally the gneisses are purplish grey in colour and hypersthene has been found in two localities. The original extent of these high grade rocks is unknown; they appear to be isolated relics which escaped deformation during the E-W folding.

The metasediments and associated igneous rocks

The metasediments and associated basic igneous rocks are best preserved in a belt from Niaqernârssik to north of Kungmiut. They occur as conformable migmatised layers up to several kilometres wide within the quartzo-feldspathic gneisses and are regarded as an original supracrustal series overlying an older basement. These have been isoclinally folded together during at least two later major plutonic episodes. It is impossible to map a sharp boundary between basement and cover since any original unconformity has been destroyed during the isoclinal folding. However the majority of quartzo-feldspathic gneisses found between the folded metasedimentary horizons are regarded as reworked basement rocks since they contain large numbers of sub-concordant amphibolite sheets not found in the metasedimentary horizons and because they contain inclusions of older basic and anorthositic material though to have been derived from pre-metamorphic igneous rocks. Isolated relics of supracrustal material are found in belts within the quartzo-feldspathic gneisses south of Niaqernârssik; however it is impossible to show whether these belong to the same sequences as the main occurrences of these rocks to the north.

The metasediments north of Niaqernârssik are accompanied by layers of garnet amphibolite, some of which reach a kilometre wide and form prominent rust horizons in the gneisses. Several of these amphibolites are surrounded by a sheath of pelitic metasediments and are thought to represent old lava flows or basic sills injected into the sediments before metamorphism. However many of the sheets are found independent of supracrustal relics and may be slightly discordant to the local gneiss structure. These are regarded as basic dykes or sheets intruded into basement rocks at approximately the same time as the deposition of the sediments.

Associated with the supracrustal series there is a group of ultrabasic rocks which are commonly found as plugs in the migmatites a few hundred metres below the supracrustal rocks or as irregular layers within the sedimentary succession itself. When found in the supracrustal rocks they commonly form part of a characteristic succession of ultrabasics, calc-silicates and migmatised amphibolite horizons. Many of the ultrabasic bodies are zoned with tremolite-actinolite, talc and chlorite in the margins while the centres may contain enstatite and olivine relics set in a mixture of talc, chlorite and carbonate.

Petrology of the supracrustal rocks

The majority of the supracrustal rocks are pelites or semi-pelites heavily migmatised by quartzo-feldspathic veins. Apart from quartz and feldspar they contain biotite, garnet and kyanite as rock-forming minerals. Around Kungmiut sillimanite is found replacing kyanite and it appears that there may be a regional change in metamorphic facies northwards. The calc-silicate horizons consist dominantly of diopside, tremolite-actinolite and carbonate.

Metabasic intrusions

The gneisses contain innumerable sheets, dykes and irregular plugs of metabasic material. The largest concentration of these bodies is found south of Ikerssuaq where they may form 10% or more of the rock surface over areas of several tens of square kilometres. The original intrusion form of these bodies appears to have been highly irregular, many of the dykes are sinuous and give out a great number of apophyses. In gneisses comparatively little affected by later movements it is possible to show that there has been more than one period of basic intrusion separated by a period of deformation. However this distinction is lost over much of the area mapped and the only subdivision of the intrusions possible is based on degree of metamorphism and conformability to the local gneiss structures. This in turn appears more to be controlled by the relative competency of the intrusions and the surrounding gneisses than to reflect any differences in number of metamorphic episodes through which they have passed. It is quite common to find large unmetamorphosed masses of basic material cut by recrystallised metabasic intrusions which have acted as zones of weakness during later movements. The variable effects of the E-W deformation has made it very difficult to use the basic intrusions as reliable regional chronological markers. In any case some of the unmetamorphosed hypersthene-bearing dykes have features suggesting emplacement in deep-seated conditions and may not indicate major breaks in the plutonic evolution of the area.

Basic intrusions of similar aspect to those mapped south of Ikerssuaq are found between the mouth of Sermilik fjord and Kungmiut, an older group represented by the garnet amphibolites and a younger group cutting the garnet amphibolites and the folded metasediments. Which (if either) of these is correlatable with the main phase of basic intrusion south of Ikerssuaq is uncertain.

Petrology of the metabasic intrusions south of Ikerssuaq

Original igneous textures and minerals are preserved in many of the intrusions either in the centres of boudin-like pods where the bodies have been dislocated by younger movements or more occasionally where both intrusions and the local country rocks have escaped later deformation. Most of the intrusions are coarse grained, some of the contact rocks are spherulitic and contain crystallites of plagioclase set in an aphanitic ground mass. The coarse centres contain hypersthene, clinopyroxene and a little olivine. The plagioclases are typically clouded but the rims are clear. Quartz-feldspar intergrowths are common, especially in pegmatitic segregations, and it is thought that the suite has tholeiitic affinities. The metamorphic equivalents of the hypersthene gabbros show a large variety of textures and mineralogy, the most common rock type is a foliated and lineated amphibolite with black hornblendes and some garnet. Original plagioclase phenocrysts are frequently pulled out as rods parallel to the regional structures.

The charnockite complex

The charnockites and associated garnet gneisses are found as an E-W belt through Angmagssalik Ø parallel to the regional E-W isoclinal structures. The high-grade complex consists of both igneous and metamorphic rocks. Both contain hypersthene, garnet, biotite and the soapy brown feldspars typical of charnockites, and it is impossible to distinguish major mappable units within the complex, at least during a reconnaissance. The rocks within the complex are foliated parallel to the regional structures and the complex appears to have formed at the same time as some of the major E-W structures in the surrounding gneisses. The high-grade rocks show gradational contacts with amphibolite facies migmatites; approaching the high-grade rocks there is a gradual loss of clearly defined units, a loss in linear structural elements, an increase in grain size and the formation of a more equigranular texture, and a gradual increase in features suggesting anatexis and plastic deformation. Finally hypersthene, brown-coloured feldspars and milky quartz appear. Kyanite appears to be stable both in the amphibolite facies gneisses and the marginal rocks of the charnockite complex where kyanite and hypersthene are found in the same garnet-biotite gneiss. The most common rock type in the border zone of the charnockite complex is a pale coloured garnet gneiss (corresponding to the garnet granite of Wager, 1934). This rock was apparently formed by large scale anatexis of the pre-existing amphibolite facies gneisses and it is quite common to find sheets of the garnet gneisses interlayered with sheets of the original amphibolite facies gneisses. The border zones of the high grade complex are cut by dark coloured sheets and veins of intrusive basic charnockite. These are frequently choked with inclusions. Locally the garnet gneisses became mobile and disrupted the basic veins. In a few localities the garnet gneisses became thoroughly intrusive and breccias are found in which early formed garnet gneiss fragments are found surrounded by a slightly younger more mobile phase.

The rocks in the centre of the complex are dark coloured and contain hypersthene. They vary in composition from biotite two-pyroxene gabbroic rocks to pyroxene-garnet granites. Most of the rocks appear either to be magmatic in origin or at least to have passed through an extremely plastic stage during which earlier structures were obliterated. Inclusions or rootless sheets of gneiss are common and many of these show signs of recrystallisation near the contacts with equigranular marginal zones surrounding cores with a strong foliation and containing amphibole instead of ortho-pyroxene. At present we are unable to draw any sharp distinction between rocks crystallised from allochthonous magmas and those formed by the anatexis in situ.

At a late stage in the formation of the charnockites the complex was intruded by a series of extremely mafic biotite-pyroxenite sheets. These appear to have been emplaced while the rest of the complex was still mobile and are often back veined by quartzo-feldspathic material.

Locally the charnockites were affected by younger movements along the E-W foliation planes after the end of high-grade meta-morphism. This has resulted in downgrading especially near the contact of the complex and inclusions of dark-coloured high grade material are found in sheared garnet gneisses.

The last major plutonic event in the area was the intrusion of a late- and post-tectonic suite of noritic gabbros, diorites and granites. Some of these show considerable resemblances to the intrusive rocks of the charnockite complex. Two major occurrences of these late intrusive rocks have been noted: directly north of Angmagssalik Ø and on the north side of Ikerssuaq bay. Pegmatites apparently related to these late intrusions are found throughout the Angmagssalik area as far south as Dannebrogs Ø. The granites and associated rocks north of Angmagssalik Ø may be divided into two groups: an older suite of medium grained granites with semi-contemporaneous diorites and intermediate rocks and a slightly younger group of norites and porphyritic granites which outcrop on the NE corner of Angmagssalik Ø. These intrusions, particularly the younger group, resemble the calc-alkaline suite of South Greenland. They show several features such as granitic pipes and net-veined bodies which suggest that the basic and acid members of the suite were intruded at approximately the same time. The acid rocks generally remained mobile after the basic rocks had solidified. In contrast to the calk-alkaline suite in South Greenland, rapakivi texture is rare, the only cases noted are found where potash feldspar megacrysts have grown in earlier basic rocks.

The area shown as granite (fig. 3) on the north side of Ikerssuaq may be regarded as the roof zone of a granitic and dioritic complex. The rocks consist dominantly of blocks of gneiss set in a younger matrix of granitic rocks. The granitic rocks themselves show several intrusive phases, generally the younger rocks tend to be nearer true granites than the older more mafic varieties. Some of the gneiss blocks have been rotated within the granites and form gigantic disoriented agmatites. However, in general the gneiss blocks still show the flat-lying structures seen in the surrounding country rocks and it is impossible to draw a sharp distrinction between gneisses veined by younger granite veins and gneisses actually included in the roof zone of the main intrusion. The pegmatites associated with the granites belong to several different generations presumably linked to the different intrusive phases of the main granite body. Layered aplite-pegmatites are common. Amphibolite layers in the gneisses commonly show Cu mineralisation. It appears that some concentration of this element was associated with the emplacement of the granite.

The post-tectonic basic dykes which are found throughout the area have not been examined in detail. They all appear in the field to be doleritic in composition. Scattered examples of feldspar megacrysts with black (cloudy) centres and clear rims have been noted. These appear similar to the black megacrysts described from the Gardar province of South Greenland.

References

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