Nagssugtoqidian mobile belt in East Greenland

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Fig. 92. Almost undeformed garnet-bearing amphibolite dykes on Zebrafjeld, Nansens Bugt near Umîvik.

Introduction

The Nagssugtoqidian mobile belt in East Greenland outcrops from Gyldenløves Fjord northwards to the Angmagssalik region (fig. 93) and possibly further north towards Kangerdlugssuaq (fig. 70). Compared to the Nagssugtoqidian mobile belt of the west coast little work has been done in this region. Wager (1934) gives a brief description of the gneiss complex from Angmagssalik to Kangerdlugssuaq where the Precambrian rocks are overlain by Tertiary basalts. Bridgwater & Gormsen (1968, 1969), Andrews *et al.* (1973) and Bridgwater *et al.* (1973b, c) give the main features of the rocks exposed between the southern border and Angmagssalik. A more detailed description of the area surrounding Angmagssalik is given by Wright *et al.* (1973) (fig. 94).

Isotopic age determinations are limited to K-Ar and Rb-Sr mineral determinations (Wager & Hamilton, 1964; Turner, 1970) and a single U-Pb zircon concordia determination on zircons from an anorthosite inclusion in the gneisses west of Angmagssalik (Nunes *et al.,* 1974). These determinations show that the area was affected by a thermal event at about 2000–1600 m.y. ago which overprinted a major event about 2800–2700 m.y. ago. The effect of the 2000–1600 m.y. event appears to have varied from place to place within the Nagssugtoqidian mobile belt. In the north of the region around Kangerdlugssuaq there is a marked discrepancy between Rb-Sr mineral ages at 1800–1600 m.y. and K-Ar mineral ages at 2800–2700 m.y. suggesting that this part of the mobile belt was remarkably little affected by Proterozoic metamorphism.

The Nagssugtoqidian mobile belt in East Greenland consists largely of Archaean rocks comparable

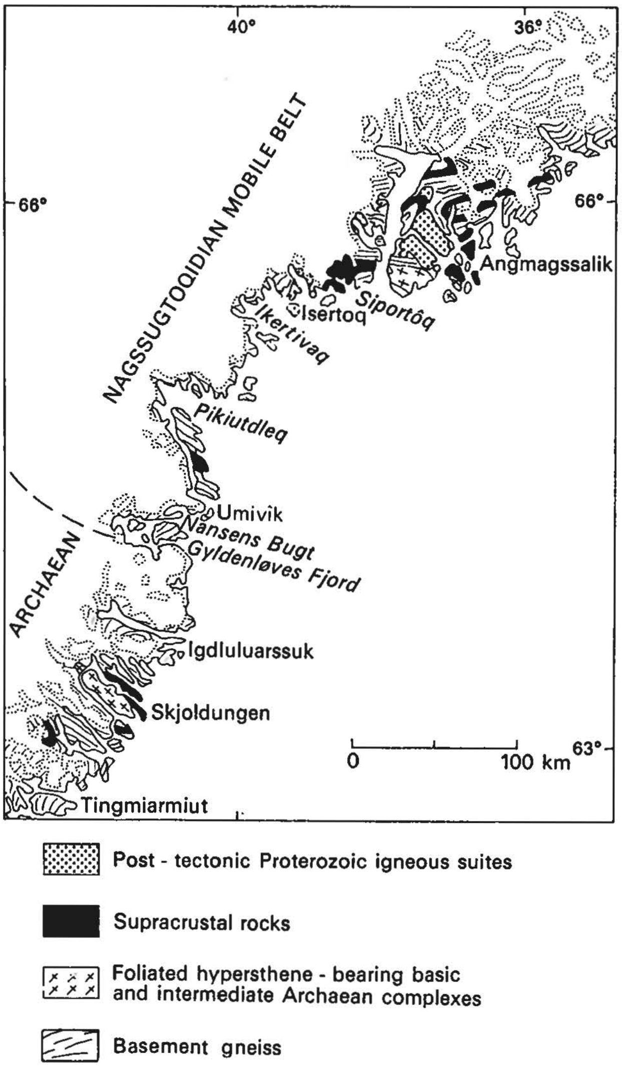


Fig. 93. Geological sketch map of the Nagssugtoqidian boundary zone in East Greenland.

to those of the gneiss complex to the south (see Bridgwater *et al.*, this volume). They have been partially reworked by belts of intense deformation during the early Proterozoic. Before and during this deformation the rocks were intruded by major swarms of basic dykes. A variety of syn-tectonic to post-tectonic igneous bodies are found ranging from the leuconorite-charnockite complex of Angmagssalik Ø to a variety of calc-alkaline diorites, granodiorites and adamellites.

Subsequently this Precambrian complex was intruded by basic dyke swarms which have yielded K-Ar ages of about 1300 m.y., and by the southern continuation of the coast parallel Tertiary dyke swarm (Wager, 1934).

Major Nagssugtoqidian structures

The dominant structural features of the area are the belts of shearing which affect the earlier Archaean gneisses. The distribution and character of the shear belts changes from place to place within the mobile belt. In the south of the region most of the shear belts are sharply defined zones ranging from a few metres to a kilometre or more across, in which deformation is extremely intense. Between the shear belts the Archaean gneisses and the basic dykes cutting them are undeformed. Regionally the shear belts join so that the areas of non-sheared Archaean gneiss are preserved as elongate pods of varying size (from single blocks of competent rock such as gabbro anorthosite to major areas a few kilometres wide and many kilometres long) (fig. 95).

The boundary between deformed and undeformed rocks is commonly extremely sharp. Further away from the boundary the shear belts tend to be more diffuse and have been partly modified by higher grade metamorphism and the intrusion of younger granites. In the Angmagssalik area shear belts are themselves pierced by late to post-tectonic granites which have yielded mineral ages between 2000 and 1600 m.y.

There are several different generations of Nagssugtoqidian shear belts in East Greenland. This is shown by the complex relations between the shear belts and the major swarms of basic dykes in the area (Bridgwater *et al.*, 1973 c). The earliest shear belts were dominantly steeply dipping approximately E–W structures which appear partly to have guided the injection of some of the basic dykes and partly to have moved at the same time as the dykes were emplaced. These correspond in type and interrelationship with the dykes and the early Nagssugtoqidian movements on the west coast (Bridgwater *et al.*, 1973a; Watterson, 1974). The late belts of deformation dip at low angles to the north and deform most of the dykes and the earlier structures. There is probably more than one generation of low-dipping shear structures with slight changes in movement direction. Linear structures in the low-dipping shear zones (parallel to the supposed major direction of transport) are concentrated in either WNW or N–S directions plunging 10°-25° to the north or west-north-west.

North of Angmagssalik the belts of deformation have not been mapped regionally. Observations by Wallis (1966) record the presence of alternating amphibolite facies and granulite facies gneiss units trending approximately E–W in the mountainous area north of 66°N, suggesting that the pattern of belts

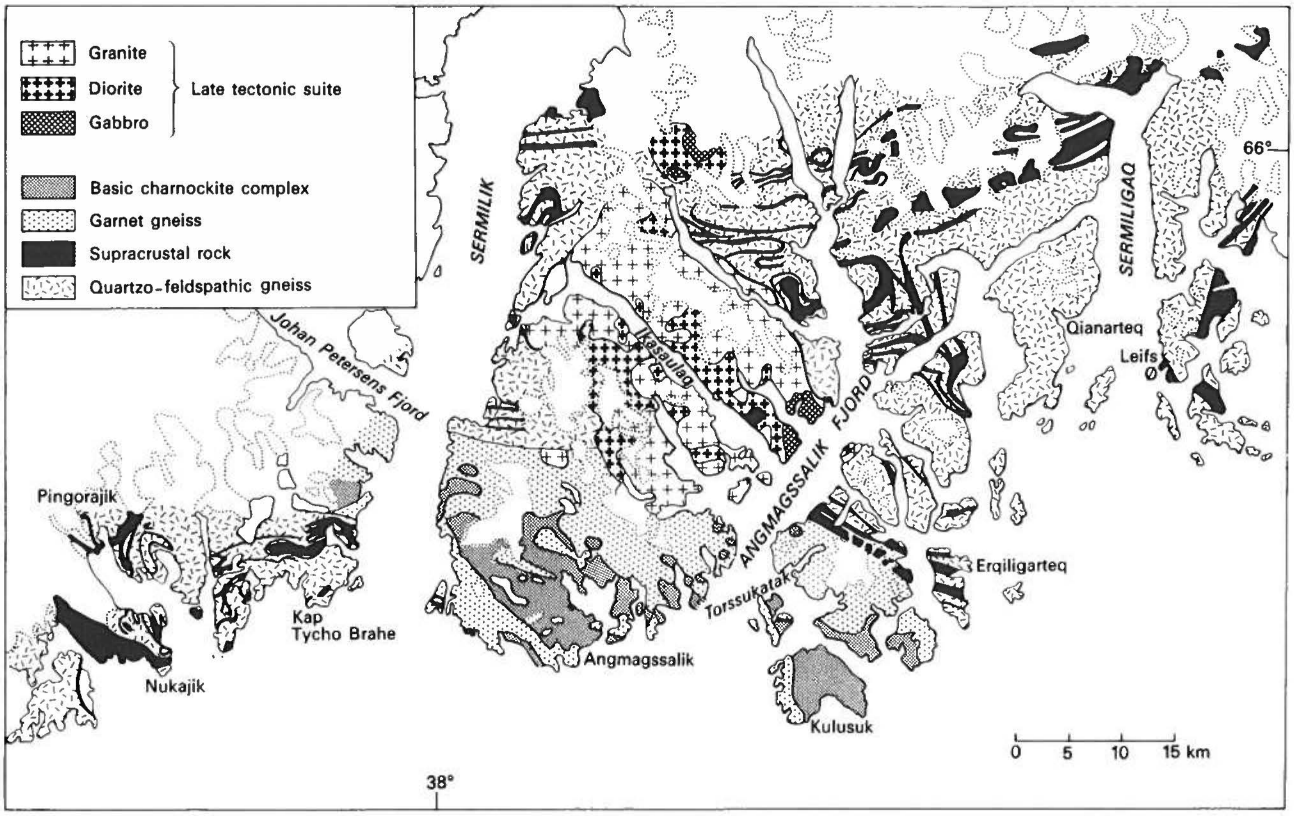


Fig. 94. Geological sketch map of the Angmagssalik area. (After Wright *et al.*, 1973).

of intense shear alternating with less deformed rocks may extend farther north.

Archaean gneisses

Where the Archaean gneisses are unaffected by the Nagssugtoqidian shear belts they are clearly a continuation of the Archaean complex to the south. They consist of a layered sequence of quartzo-feldspathic rocks interleaved with supracrustal sequences and occasional highly broken up gabbro-anorthosite layers, comparable to those described from the Fiskenæsset complex in West Greenland. The interleaving between supracrustal rocks, anorthosites and quartzo-feldspathic gneiss occurred at an early stage in the tectonic history of the area (Andrews *et al.*, 1973; Wright *et al.*, 1973); it is interpreted as partly due to the repeated thrusting together of older gneisses and supracrustal sequences and partly to the emplacement of concordant or sub-concordant granitic bodies some of which clearly break up earlier layered rocks. Most of the Archaean rocks which have not been strongly affected by Nagssugtoqidian tectonism and metamorphism are in amphibolite facies; it is not known how much of the area was affected by the high grade metamorphism about 2800 m.y. ago although this is one of the dominant features of Archaean geology on the west coast of Greenland.

The quartzo-feldspathic gneisses are dominated by granodiorite or tonalite gneisses commonly containing enclaves and inclusions of basic, ultrabasic and

Fig. 95. Enclave of undeformed Archaean gneiss surrounded by sheared rocks. Between Gyldenløves Fjord and Pikiutdleq.

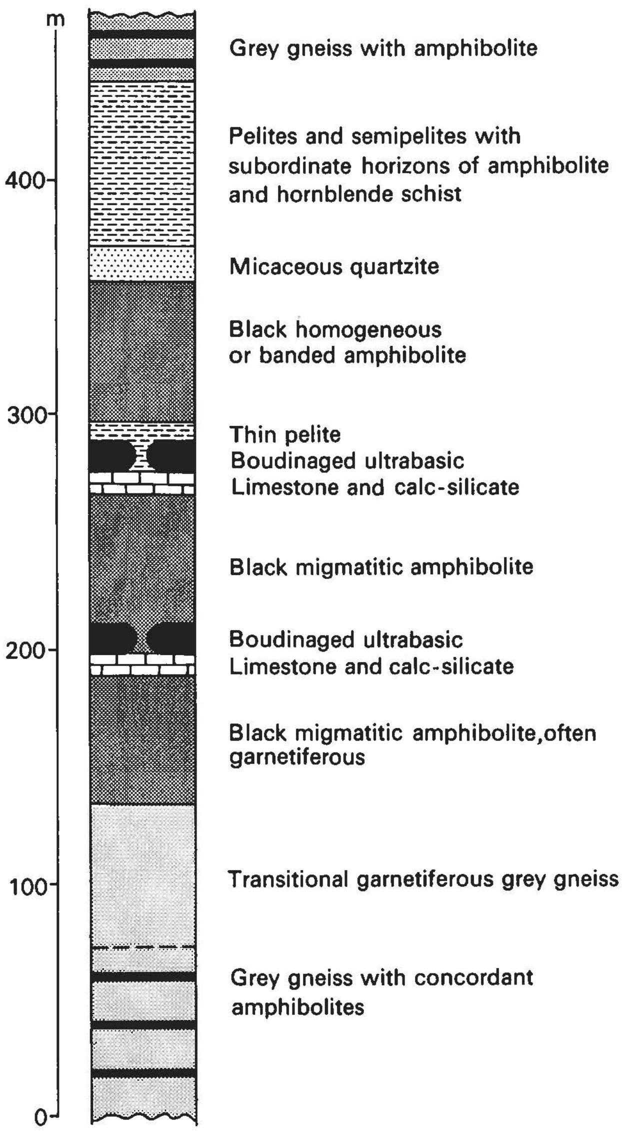


Fig. 96. Schematic succession in the supracrustal gneisses and schists in the Pingorajik region. (After Wright *et al.*, 1973).

diopside-rich material. Some potash megacryst granites occur locally.

The supracrustal rocks

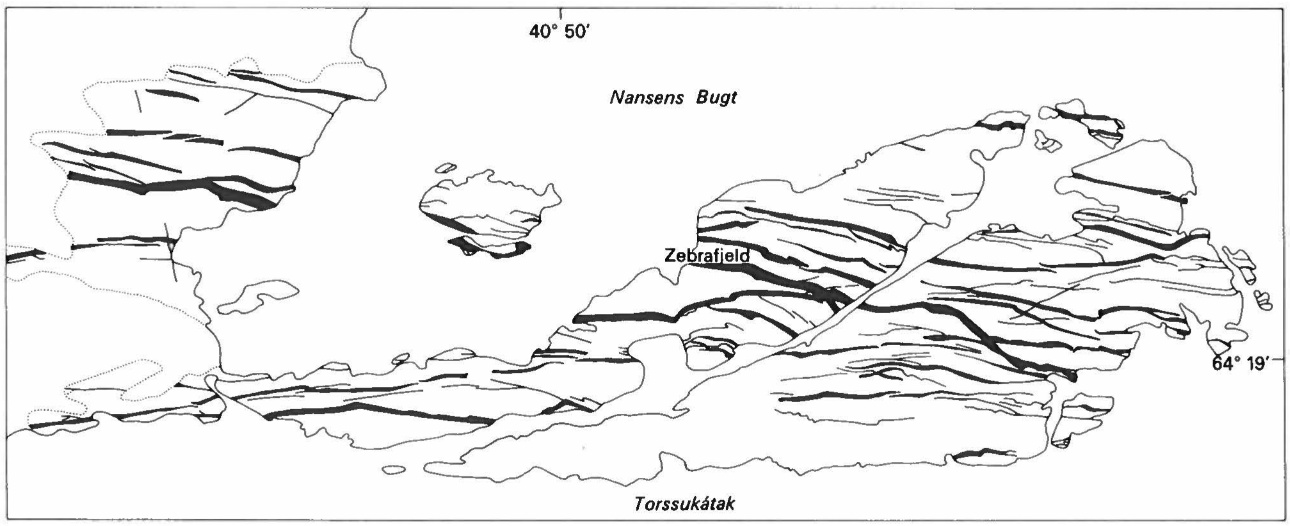
The supracrustal sequences interleaved with the gneisses all appear to be Archaean in age, and many of them have been reworked by the Nagssugtoqidian shear deformation. The main supracrustal sequences are found in the Angmagssalik region (figs 93, 94). In the Pingorajik and Sermilik fjord areas about 50 per cent of the supracrustals are metasediments, part of which may be volcanogenic; this is a higher metasedimentary proportion than in most other Archaean supracrustal sequences in Greenland. A generalised sequence is shown in fig. 96.

In contrast to the pelitic and semipelitic rocks in the unreworked Archaean areas kyanite is the dominant aluminosilicate found in the supracrustal sequences affected by Nagssugtoqidian metamorphism. Some kyanite needles are aligned parallel to the main north and west-north-west trending Nagssugtoqidian linear structures. In the north of the area kyanite is commonly overgrown by sillimanite needles.

Quartzites or muscovite quartzites are recorded by Wright *et al.* (1973) in the supracrustal rocks around Pingorajik and Siportôq. Further north in the Kangerdlugssuaq area quartzites form major units in the succession (K. Brooks, personal communication, 1971).

Calcareous and calc-silicate rich rocks are rela-

Fig. 97. Map of basic dykes in the Nansens Bugt region, near Umîvik. After an interpretation of aerial photographs by S. Jack, Liverpool University. Approximate scale 1:100 000.



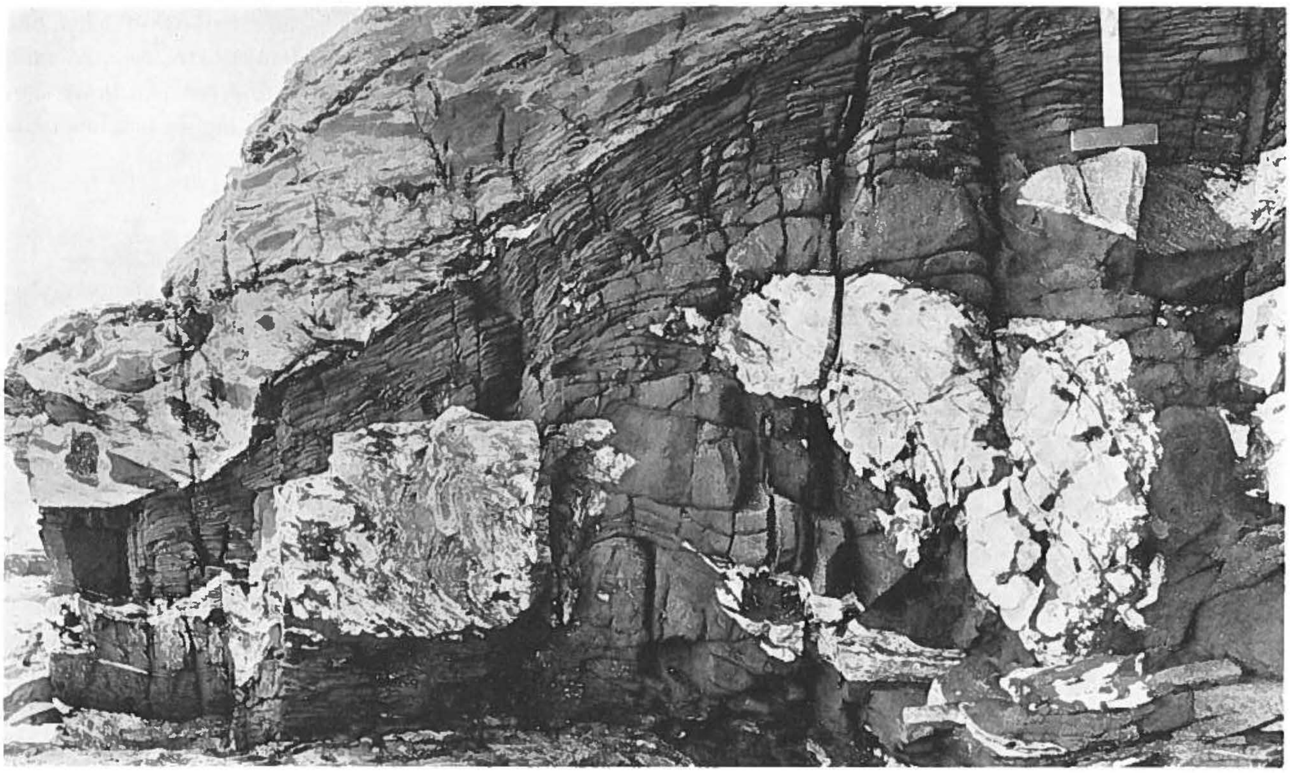


Fig. 98. Discordant metadolerite partly sheared by late Nagssugtoqidian movements. Note the original irregular form suggesting synkinematic emplacement and the way in which the dyke has partly protected earlier Archaean structures. Near Isertoq.

tively abundant and commonly show complex fold patterns (fig. 32).

Basic dykes

The basic dykes cutting the Archaean gneisses and which are reworked by the youngest Nagssugtoqidian movements, show considerable range in petrology and original intrusion form. They appear to have been emplaced during regional stress conditions possibly while the country rocks were at moderately high temperatures (Bridgwater *et al.*, 1973c).

On the southern border of the mobile belt most of the undeformed dykes were emplaced as rectilinear intrusions with comparatively few apophyses (figs 92, 97). The majority are now amphibolites or garnet amphibolites. This may represent an original igneous assemblage corresponding to the primary garnet amphibolites of the west coast (Kangâmiut dyke swarm, see Bridgwater *et al.*, this volume). Further north many of the dykes are highly irregular in form, ranging from strings of basic pods to irregular sinuous bodies with many apophyses (figs 98, 99).

Where unaffected by strong later deformation the dykes commonly contain primary igneous assemblages. Many are mafic-rich and the suite is remarkably similar petrologically to the dykes described by Berthelsen & Bridgwater (1960) from the Fiskefjord region of West Greenland. Orthopyroxene-rich rocks are common, and many of the dykes contain dusty black feldspar. Some dykes show a clear zonation with dark amphibole-bearing margins and leucocratic garnet-bearing centres. Chemically the garnet-bearing rocks appear to contain markedly more iron than the amphibolitic margins or the other basic dykes in the area (S. Jack, personal communication, 1974) and it is thought that the garnet-rich centres may represent primary igneous assemblages.

Leuconorite – basic charnockite, garnet granite complexes

A major basic charnockite complex dominated by andesine-rich basic igneous rocks extends from the west coast of Sermilik fjord through the southern part of Angmagssalik Ø through to Kulusuk island

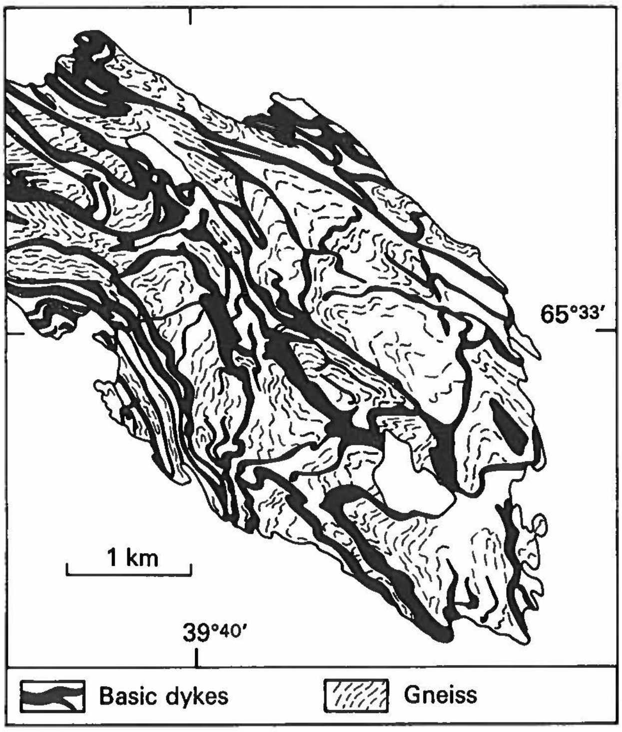


Fig. 99. Map of basic dykes in the Ikertivaq region. The irregular pattern in the centre of the peninsula is interpreted as due to the synkinematic emplacement of these bodies. The original form of the dykes has been modified by shearing along shallow north-east dipping planes parallel to the north-east and south-west shorelines of the peninsula.

(fig. 94). The complex is concordant to the major structures in the surrounding gneisses. Most parts of the complex are foliated parallel to the regional strike although a few late fractions are unfoliated and locally discordant to the main structures. Concordant sheets of norite occur within the country gneisses for a kilometre or more outside the main mass. The complex itself appears to be made up of a series of sheets separated by pendants of country rock. The country rocks on both margins of the body contain appreciable amounts of garnet and were termed garnet granite gneisses by Wager (1934). As the contact of the igneous body is approached the garnet gneisses gradually loose structural coherence and locally become mobilised so that they show intrusive relations with both the main igneous complex and less mobilised parts of the gneiss complex.

Petrologically the charnockite complex is dominated by hypersthene-bearing rocks of intermediate basic composition. Quartz monzonites and minor hypersthene adamellitic bodies occur on Kulusuk island.

The age of this complex is unknown. It is younger than the main tectonic interleaving of the supracrustal rocks and Archaean quartzo-feldspathic gneisses. None of the Proterozoic basic dykes have been found cutting the complex. It is affected by at least one major phase of Nagssugtoqidian deformation. It could therefore either represent a late Archaean body subjected to Nagssugtoqidian reworking, or a syntectonic Proterozoic intrusion.

Late to post-tectonic calc-alkaline suite

The Nagssugtoqidian rocks of South-East Greenland were intruded by a major suite of granites, granodiorites, diorites and minor gabbros and ultrabasic bodies during and following the youngest movements along the Nagssugtoqidian shear zones. These intrusions form major masses on the northern coast of Angmagssalik Ø and west of Sermilik. The intrusions form well-defined bodies with considerable evidence for emplacement by stoping. Large inclusions of country rocks or earlier members of the suite are abundant. Minor intrusions showing an intimate mixture of acid and basic rocks (net veining) and strong foliation due to intrusion in shear zones, are abundant.

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