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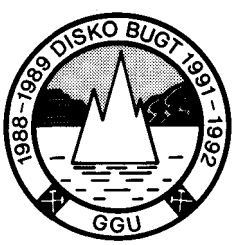

A new anorthosite/gabbro complex at Nûgssuaq, central West Greenland

A. A. Garde and A. Steenfelt

As part of the GGU activity in the Disko Bugt region, central West Greenland (Kalsbeek, 1989), the authors carried out helicopter-supported geological reconnaissance mapping and stream sediment sampling for geochemical mapping in the area between Jakobshavn Isfjord and Qarajaq Isfjord (fig. 1). A considerable part of the season was spent in the eastern part of the Nûgssuaq peninsula, partly to complete the stream sediment sampling initiated in 1986 (see Steenfelt, 1988) and also because previous geological field work in eastern Nûgssuaq was very limited. The existing geological map at a scale of 1:500 000 covering Nûgssuaq is almost entirely based on interpretation of aerial photographs.

During the field work large occurrences of hitherto unknown anorthosite/gabbro rocks and supracrustal sequences were discovered in the gneiss terrain. Both the anorthosite/gabbro and supracrustal units appear to be tectonically interleaved with strongly foliated, flat-lying or shallowly south-dipping orthogneisses, which themselves contain numerous shear zones suggesting substantial subhorizontal movements.

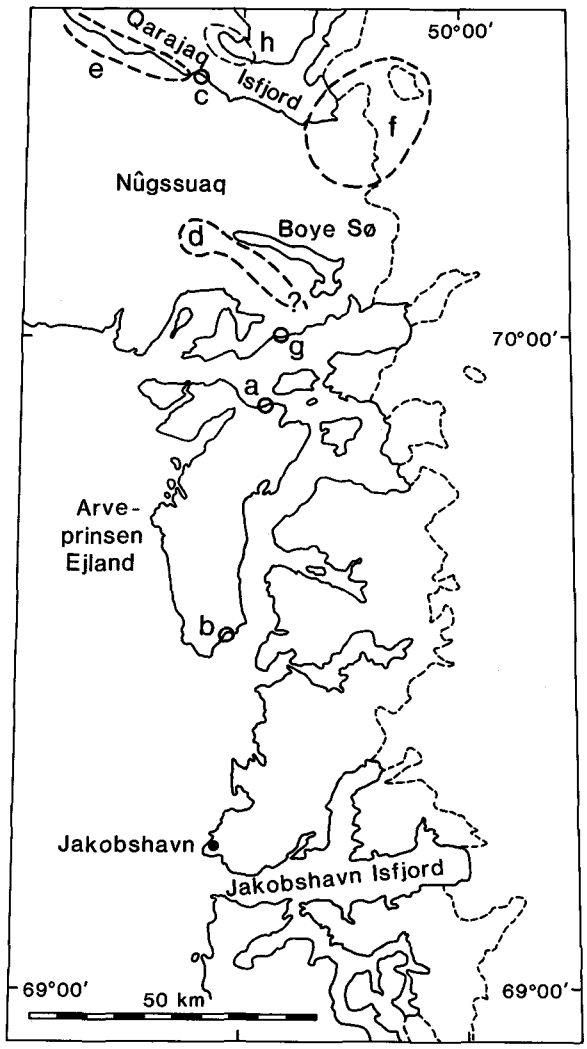

Fig. 1. Index map of the area between Jakobshavn and Qarajaq Isfjord. Letters a to f denote anorthosite/leucogabbro localities referred to in the text.

Occurrences of anorthosite, leucogabbro and gabbro in the Disko Bugt region

On Arveprinsen Ejland two occurrences of anorthosite/leucogabbro are now known. In the north-east (a, fig. 1) a sheet of greenish, epidotised coarse-grained leucogabbro occurs within the supracrustal rocks (Knudsen *et al.*, 1988). Anorthosite was also found by the present authors in 1988 on the south coast of Arveprinsen Ejland (b, fig. 1), where a *c.* 100 m thick zone of closely packed, metre-sized lenses of snowball-textured leucogabbro and almost pure anorthosite occurs in quartzofeldspathic orthogneiss. It is not known how far this anorthosite zone extends into the interior of the island.

On Nûgssuaq thin sheets of anorthosite occur in gneisses at the north coast (c, fig. 1) (Andersen & Pulvertaft, 1986). Massive anorthosite and associated leucogabbroic, gabbroic and ultrabasic rocks were discovered in 1988 in several areas (fig. 1), viz. west and south-west of Boye Sø (d), in cliff faces along the north coast of Nûgssuaq (e), in the north-eastern part of Nûgssuaq (f) and near the south coast of Nûgssuaq (g).

The easternmost part of Nûgssuaq was covered by low density stream sediment sampling in 1986 (Steenfelt, 1988). The regional distribution pattern for MgO indicates the presence of mafic rocks in the north-eastern corner of Nûgssuaq (area f, fig. 1) as noted by Steenfelt (1988). Also the Ni and Cr distribution patterns from the 1986 sampling (fig. 2) reflect the existence of what is now known to be anorthosite/gabbro and ultrabasic bodies and enclaves in the gneisses. With the supplementary sampling carried out in 1988, the eastern half of Nûgssuaq (underlain by Precambrian rocks) is now fully covered by low density stream sediment sampling, and it is believed that the complete data will provide a good measure of the total extent of the anorthosite/gabbro occurrences in Nûgssuaq.

The Boye Sø anorthosite complex

The largest occurrence (*c.* 25 km^2 in area) on Nûgssuaq consists of massive snowball-type anorthosite/leucogabbro with associated medium-grained anorthosite, leucogabbro, hornblende gabbro and ultrabasic rocks, and is well exposed on the steep sides of an ice-capped mountain *c.* 7 km west of Boye Sø (a, fig. 1; fig. 3). We propose the name Boye Sø anorthosite complex for this occurrence. From the central outcrop, sheets of deformed gabbro and leucogabbro extend both southwards and south-eastwards towards the south coast of Nûgssuaq.

The central part of the Boye Sø anorthosite complex appears to consist of one or several tectonically repeated igneous sequences of ultrabasic rocks, gabbro, leucogabbro and anorthosite, forming a south-west to west dipping sheet in the gneisses with an estimated total thickness of about one kilometre. The succession is locally folded together with the underlying gneiss. Gabbro and associated ultrabasic rocks occur as sheets within the main leucogabbro/anorthosite body as well as at its outer contacts. The deformation is generally low and magmatic textures can be easily recognised within the central leucogabbro/anorthosite body. However, there are many thin shear zones cutting the body and dividing it into little deformed sheets up to tens of metres thick.

The predominant rock is snowball-textured leuco-

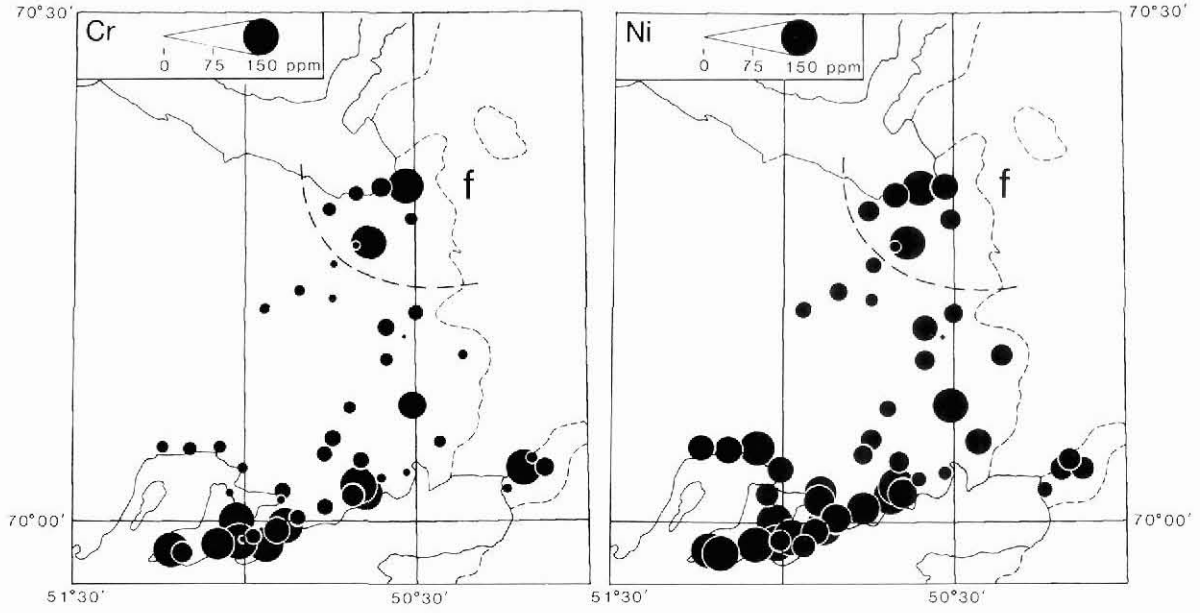

Fig. 2. Cr and Ni in stream sediments (<0.1 mm fractions, preliminary analyses) in eastern Nûgssuaq. High Cr and Ni values indicate mafic and ultramafic rocks. Note the high values in area f caused by metagabbros associated with anorthosite (compare fig. 1).

gabbro, composed of partially recrystallised, round to somewhat deformed, ellipsoid aggregates of calcic plagioclase (*c.* 4–8 cm in size) in a matrix of medium-grained hornblende (fig. 4). The amount of matrix hornblende varies considerably, and the leucogabbro grades into almost pure anorthosite.

In the north-eastern part of the complex a magmatic sequence more than 200 m thick was recognised above a tectonic (or tectonised) contact with homogeneous medium-grained anorthosite. The lower part of this north-west – south-east striking sequence consists of a hornblende gabbro *c.* 125 m thick with local rythmic and graded magmatic layering at a scale of 5–10 cm (fig. 5). The layering suggests right way up to the north-east. At the base of the gabbro there are two *c.* 5 m thick, rusty, serpentinised ultrabasic layers or flat lenses separated by *c.* 10 m gabbro. Near the base of the upper of these ultrabasic units there is a *c.* 10 cm thick layer with numerous magnetite (possibly recrystallised chromite) crystals up to *c.* 1 cm in size, as well as small amounts of disseminated sulphides. Both of the ultrabasic units

Fig. 3. The Boye Sø anorthosite complex viewed from the south-west. The cliffs are *c.* 500 m high.

Fig. 4. Anorthosite and leucogabbro, Boye Sø anorthosite complex.

Fig. 5. Magmatic layering in gabbro and leucogabbro, Boye Sø anorthosite complex.

have sharp lower contacts and gradational upper contacts with the gabbro. The gabbro locally contains leucogabbro/anorthosite xenoliths and plagioclase xenocrysts, and intrudes the overlying layer of leucogabbro/anorthosite, which is more than 100 m thick.

At two localities within the gabbro fine- to medium-grained, grey amphibolite dykes *c.* 1 m thick were observed; it is uncertain whether they are genetically related to the complex. Sporadic grey quartzofeldspathic dykes, a few metres thick, also occur.

Deformed leucogabbro, gabbro and ultrabasic rocks belonging to the Boye Sø anorthosite complex extend to the south-east, perhaps all the way to the south coast of Nûgssuaq. The area east of g in fig. 1 predominantly consists of hornblende-biotite diorite with intrusive relations to various fine- to coarse-grained homogeneous hornblenditic and amphibolitic rocks which form 20–40% of the area. Both the diorites and metabasic rocks are mineralised with iron (-copper-nickel) sulphides. During our reconnaissance in 1988 it was not possible to establish the genetic relations between rocks which definitely belong to the Boye Sø anorthosite complex and the diorites and metabasic rocks near the south coast of Nûgssuaq.

Other occurrences of anorthosite/gabbro on Nûgssuaq

At the north coast of Nûgssuaq there are flat-lying continuous layers of anorthosite, leucogabbro and gabbro, which are tens of metres to a few hundred metres thick. The rocks were observed from the helicopter on vertical cliff faces along Qarajaq Isfjord (c, fig. 1), and their nature confirmed by examination of loose blocks of local origin at sea level. The rocks are strongly deformed, tectonically banded, and some of the gabbroic units are boudinaged.

Anorthosite, leucogabbro and gabbro form a substantial part of area f, fig. 1. Massive medium-grained anorthosites and local leucogabbros with snowball-textures form continuous layers with thicknesses of about 100–300 m both on the nunatak and due east of Qarajaq Isfjord. These layers outline complex refolded folds at a scale of kilometres. In the south-western part of area f, gabbro outcrops up to *c.* 1 km^2 in area are common and are locally associated with minor leucogabbro and anorthosite. The host gneisses are characterised by frequent centimetre- to metre-thick bands of both granular medium-grained grey leucogabbro and metagabbro with a characteristic 'salt and pepper' texture, together with less frequent bands and lenses of massive and snowball-textured anorthosite.

A *c.* 100 m thick and 2 km long slice of snowball-textured anorthosite/leucogabbro was found intercalated with supracrustal amphibolites and muscovite-biotite-garnet-staurolite bearing metasediments close to the south coast of Nûgssuaq (g, fig. 1). Lithologically this isolated outcrop of anorthosite strongly resembles those in the central part of the Boye Sø anorthosite complex and we assume that it is related to this complex and was emplaced into its present position by large-scale horizontal thrusting.

Discussion and regional implications

Anorthosite/leucogabbro occurrences on Drygalski Halvø north of Qajaraq Isfjord (h, fig. 1) have been mapped and described by Andersen (1981) and Andersen & Pulvertaft (1986). In this area there are three large exposures which are all part of a single flat-lying sheet. The outcrops consist of jumbled, closely packed leucogabbro/anorthosite lumps (1–3 cm across) in a granitic matrix. Andersen (1981) concluded that this anorthosite/leucogabbro occurrence belongs to the Archaean high-calcium type of anorthosites in layered intrusions. He suggests that the anorthositic/leucogabbroic parts were disrupted from cogenetic mafic and ultrabasic rocks at depth and carried upwards in a granitic melt as a diapiric intrusion into tonalitic orthogneisses.

We consider that all the anorthosite/leucogabbro occurrences and associated gabbroic and ultrabasic rocks at Nûgssuaq, as well as the anorthosite/leucogabbro occurrence at Drygalski Halvø, may represent disrupted parts of a large Archaean layered intrusion comparable to the Fiskenæsset Complex of southern West Greenland (Myers, 1985). The distribution of these rocks, as known at present, suggests that the Archaean basement as well as the Proterozoic flat-lying structural regime at the southern margin of the Rinkian belt in the Umanak

district (Pulvertaft, 1986) continues southwards into Nûgssuaq.

The large layered basic intrusions in Nûgssuaq are considered to have a potential for mineral deposits containing chromium and the platinum group elements. The samples from the low density stream sediment survey are being analysed for chromium, and the data may provide indications of chromite occurrences. Analyses for the platinum group elements are not made on a routine basis. However, in addition to the regional survey a number of sediment samples were collected in the small streams draining the Boye Sø anorthosite complex, and these will be analysed for the platinum group elements.

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Gravity and magnetic susceptibility survey over the northern part of the supracrustal rocks in the Disko Bugt area, central West Greenland

Leif Thorning

As part of the Disko Bugt project (Kalsbeek, 1989) a survey of gravity and magnetic susceptibility was carried out over parts of the supracrustal rocks and the Atâ granite/tonalite (fig. 1). The objective of the survey was to acquire new geophysical data that, together with the existing regional aeromagnetic survey in the area (Thorning, 1988), can be used to study the deeper structures related to the granite and the supracrustal belts in the area.

Field work

The measurements were carried out by the author and E. Hansen, GGU. A LaCoste-Romberg gravimeter (accuracy around 0.02 mgal) on loan from the Danish Geodetic Institute, and two Scintrex SM–5 susceptibility meters were used. The work was supported by the GGU base camp at Atâ, and boat (GGU's cutter *J. F. Johnstrup*) as well as helicopter were employed. In a 10-day period at the end of July and beginning of August gravity stations were occupied along the coast at sea level. A rubber dingy from *J. F. Johnstrup* was used for transport between nearby stations, and the measurements were placed at the sea-weed mark (accepted as altitude 0 m) or as close as possible. Later, inland stations were reached by helicopter from Atâ, and at these the altitude was measured with a high-precision altimeter ('Baromec') with a proven accuracy of 0.1 mbar (approximately 80 cm in height). Stations were measured in loops returning to the base station at Atâ or to points of known height so that the pressure readings could be corrected for drift and variations due to changes in weather. At all coastal stations 8–10 measurements of magnetic susceptibility of typical rock types were taken in the immediate surroundings.

Although operating conditions were difficult, extreme care was taken during use and transport of the gravity meter in order to avoid jumps in the bias of the instrument readings. The gravity meter was kept under power and at operating temperature for the entire field