Correlation

This is the first record of high-level structures to be reported from the Nagssugtoqidian mobile belt in West Greenland. From earlier reconnaissance work (J. Watterson pers. comm.) it appears that the Sarfartûp nunâ metavolcanic succession is the only occurrence of this type in the southern part of the Nagssugtoqidian on the west coast. The nature of the succession (basic, subaqueous, extrusive lavas and tuffs overlying ultrabasic rocks) is strongly reminiscent of similar occurrences of supracrustal rocks associated with highly deformed Archaean – Lower Proterozoic terrains elsewhere in the world, e.g. SW Greenland, S. Africa and NW Scotland. It is also similar to successions found in the lower parts of many Archaean greenstone belts.

Age

The age of formation of the metavolcanic rocks at Sarfartûp nunâ is still a matter for speculation. Whilst it is tempting to correlate with the generation of the Kangâmiut dyke magmas, the allochthonous nature of the outcrop makes direct field correlation difficult.

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FIELD MAPPING ON THE EARLY PRECAMBRIAN ROCKS OF THE GODTHÅBSFJORD REGION, SOUTHERN WEST GREENLAND

David Bridgwater and V. R. McGregor

Mapping of the Precambrian rocks in the Godthåbsfjord region was continued in 1973 by R. Macdonald (Makerere University, see this report) and the present authors. A special study on the type and degree of deformation in the gneisses was begun by R. Hollingworth (Univ. of Liverpool). In June and July D. B. and

V. R. M. helped parties from Oxford University (S. Moorbath and R. J. Pankhurst) and the California Institute of Technology (G. J. Wasserburg, A. L. Albee, R. Dymek and A. J. Gancarz) to collect material for detailed isotope studies. V. R. M. worked between Tovqussaq and southern Qilángârssuit as part of this programme.

Work on the 1:100 000 Godthåb map sheet (64 V 1) was continued on Bjørneøen (D. B.), Storeøen (V. R. M.) and Nordland south of 64°15′ (R. M.). Reconnaissance mapping was carried out between Qugssuk and Kapisigdlit (D. B.), on the east coast of Nordland (D. B., R. M.) and in the inner part of Ameralik fjord (V. R. M. accompanied by J. S. Myers). Bridgwater and McGregor also visited the supracrustal rocks at Isua (see Bridgwater & McGregor, this report).

Special thanks are due to skipper Orla Norsk, without whose help and willingness to alter sailing plans in order to meet sudden demands from other groups, this season's work would have been impossible to carry out. F. Ulff-Møller took much of the burden of practical arrangements in the field.

Results

No major changes have been made in the chronology of events and subdivision of lithological units put forward for the Godthåb district by McGregor (1973), and the same terminology is used in this report.

Amîtsoq gneisses

Amîtsoq gneisses have now been recognised within an area that extends from the area mapped by the Exeter University group south of 64°N (see Chadwick *et al.*, this report), at least as far north as the margin of the Inland Ice at Isua, and as far east as the head of Ameralik. No Amîtsoq gneisses have yet been recognised on the west side of Godthåbsfjord south of the mountain Ivnajaugtoq.

It now appears likely that the majority of the Amîtsoq gneisses are derived from streaky, syn-tectonic granitic rocks, in structure similar to the parents of many of the Nûk gneisses. Amîtsoq gneisses derived from more homogeneous parents have been recognised only south of Godthåb. They include gneisses derived from relatively fine-grained tonalite in the area around Præstefjord, and gneisses derived from big-feldspar granites and granodiorites south of the mouth of Ameralik and on the islands to the south-west.

Malene supracrustals

Basic rocks, commonly containing layers and lenses rich in calc-silicate minerals, dominate the Malene units in the northern and western parts of the region mapped. They include metagabbroic sills and are lithologically closely comparable to the amphibolites of the Ravns Storø group of Andersen & Friend (1973).

Metasedimentary units that contain garnet-sillimanite bearing pelites, quartzites with bright green mica and biotite-anthophyllite-garnet-cordierite gneisses are more common in the southern and eastern parts of the region. Several of the supracrustal sequences contain pale coloured intermediate or acidic gneiss units commonly with primary layering. These units locally contain fragments of other gneisses, some of which are apparently derived from units similar in petrology to the adjacent supracrustal rocks, while others are apparently derived from earlier quartzo-feldspathic gneisses. The matrix of these intermediate and acid gneiss units consists of quartz, feldspar, biotite and some pale diopside. There is frequently some sulphide mineralisation. Some of these pale units are interpreted as volcanogenic sediments, others could represent layered acidic intrusives within the successions possibly emplaced at a much later period.

While over most of the area the lithological features of the rocks mapped as Malene supracrustals are sufficiently distinct to recognise them as a suite of sediments, lavas and related shallow intrusives, identification of the origin of some of the more amphibole-rich layers in the gneiss complex becomes increasingly difficult in the area around Qugssuk and the east coast of Nordland. It seems possible that some units mapped initially as supracrustals are intrusive sheets not necessarily forming part of an original supracrustal pile.

Anorthositic rocks

Anorthosites and related more mafic igneous rocks are common, both as continuous units and as inclusions within distinct mappable units of Nûk gneisses in the central part of the region. An anorthosite-leucogabbro-gabbro association on the northern part of Storø has igneous layering preserved. The rocks become increasingly broken up by Nûk gneisses towards the north and east. The amphibolites separating the anorthositic rocks from the adjacent metasedimentary gneisses appear to be mainly or entirely derived from gabbroic parents.

The anorthositic rocks in some units are pure anorthosites, in others they are mainly derived from leucogabbros or gabbros. If these rocks were derived from one or more composite, layered complexes of the Fiskenæsset type (Windley *et al.*, 1973; Myers, 1973), then it would appear that the complex was dismembered by low-angle thrusting and intercalated with Amîtsoq gneisses and Malene supracrustals before it was intruded and migmatised by the granitic parents of the Nûk gneisses.

Nûk gneisses

The informal rock-stratigraphic term *Nûk gneisses* is applied to all the quartzo-feldspathic gneisses in the Godthåbsfjord region that do not contain Ameralik dykes and that have intrusive relations to the Malene supracrustals, the anorthositic rocks and the Amîtsoq gneisses.

There is abundant evidence that there was considerable deformation during the emplacement of many phases of the Nûk gneisses, especially the earlier phases. Many of them are of the type commonly referred to in Greenland geological literature as *streaky gneisses:* composite gneisses that are made up of streaked-out bodies of slightly different lithologies and that commonly contain much deformed pegmatite. It appears that the streaky nature of these gneisses is to a considerable extent primary and is the result of emplacement and *in situ* differentiation under stress conditions.

In many places earlier Nûk phases, often containing broken-up and migmatised inclusions, have been strongly deformed before being intruded by later phases of diorite, tonalite, granodiorite and granite. It is not known to what extent all the rocks grouped as Nûk gneisses belong to a single, broadly co-genetic suite, and to what extent they were intruded during periods of unrelated granitic activity separated by major time intervals. Intrusion of granitic material and deformation may, however, have gone on intermittently in the Godthåbsfjord region for some time before 3100 m.y. ago up to about 2600 m.y. ago when the Qôrqut granite is thought to have been emplaced (Pankhurst *et al.,* 1973). Earlier phases of the Qôrqut granite are deformed although not as strongly as the majority of the Nûk gneisses, and in places there is evidence of deformation during intrusion.

In the Qugssuk area the Nûk gneiss suite was found to contain local ultrabasic and basic units some of which show original igneous layering. Hornblende-pyroxene bearing diorites resembling the appinitic suite described from the Julianehåb area (Allaart, 1967) form distinctive members of the suite.

A large, deformed, diorite-gabbro complex in the middle of Ameralik may well be an early member of the Nûk gneiss suite, rather than part of the anorthosite-leucogabbro suite as was previously suggested (McGregor & Bridgwater, 1973). Excellent igneous layering, with clear tops and bottoms, is preserved in parts of this complex.

Granulite facies rocks

The transition between granulite facies and amphibolite facies areas was examined in Qugssuk and along the east coast of Nordland (in collaboration with R. Macdonald). On a regional scale the boundary is prograde with high-grade minerals forming in Nûk gneisses and Malene supracrustals which had previously been strongly deformed to give a strong planar fabric trending approximately 020° vertical along the east coast of Nordland (corresponding in place but not in time to the post-granulite straight belt of Windley, 1969). The recrystallisation of the heavily deformed gneisses under granulite facies conditions was preceded and possibly accompanied by the formation of granites as sheets and some massive bodies apparently by the syn- to late-tectonic recrystallisation of earlier highly deformed Nûk gneisses.

In detail the transition between amphibolite and granulite facies areas is complex. Amphibolite facies gneisses on the east side of Qugssuk up to 10 km east of the massive granulite facies rocks locally contain hypersthene. The mineral is particularly noticeable in leucocratic patches separating boudins of amphibolitic material, suggesting that these late sweats solidified under conditions approaching granulite facies.

As the boundary of the massive granulites is approached layers of gneiss with a slight overall pink cast and locally containing some hypersthene alternate with white gneisses lacking hypersthene. The structures within the hypersthene-bearing layers are commonly more nebulous than those in the surrounding rocks, and in general it was noted that structures in the granulite facies rocks are more blurred than in corresponding amphibolite facies rocks. A similar blurring effect was noted in areas that appear to have been retrogressed from granulite facies e.g. in the Tovqussaq area and on the south coast of the central part of Ameralik.

The Qôrqut granite

This body extends much further north than previously reported. It is now known to occur at least 100 km from the coast near Buksefjorden (mapped by the University of Exeter group), north-east to Kanguissaq nunâ.

Basic dykes

One of the problems of correlating events in the Godthåbsfjord region with other parts of the Archaean block has been the lack of regional information on basic dykes. In the Godthåbsfjord region the major dyke swarms cut the Qôrqut granite and are thus later than 2600 m.y. Further north the Kangâmiut dykes are regarded as emplaced around 2600–2700 m.y. ago. It seems possible therefore that there may be at least two major groups of dykes in the Archaean of West Greenland – the early group represented by the Kangâmiut dykes and the two earliest dyke suites described by Berthelsen & Bridgwater (1960), and the later group represented by three generations in the Sukkertoppen district and presumably by the majority of dolerites in the Godthåbsfjord–Frederikshaab area. Whether any of the earlier dyke generations in Godthåbsfjord and further south correspond to the Kangâmiut dykes is not known. However, a small number of thin metadolerite dykes cutting gneisses in Kangiussaq and near Godthåb appear to have been affected by a metamorphic event not seen in the majority of basic dykes in the area and may represent a post-granulite – pre-Qôrqut granite generation of dolerites.

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INVESTIGATIONS ON THE GRANULITES OF SOUTHERN NORDLAND, GODTHÅBSFJORD, CENTRAL WEST GREENLAND

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The rocks of the Nordland (Akia) peninsula lying west of Godthåbsfjord (the Nordland Complex of Noe-Nygaard & Ramberg, 1961) are regarded as part of the Greenland Archaean Craton (Bridgwater *et al.*, 1973). Reconnaissance surveys prior to 1973 by B. F. Windley of GGU amplified Noe-Nygaard and Ramberg's statement that the complex is made up principally of intensely metamorphosed and migmatised rocks generally at the granulite facies grade which show diapthoresis in places. A minor part of the complex has also been regarded as supracrustal and anorthosites are present.

Systematic mapping was begun in 1973 by the present author in the extreme southern part of Nordland with a view particularly to working out metamorphic grade, structural relationships and a basis for correlation with the increasingly well-known Nûk, Amîtsoq and other units on the eastern side of Godthåbsfjord (see McGregor, 1973; Bridgwater & McGregor, this report).