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MAPPING OF THE PRECAMBRIAN BASEMENT IN THE BUKSEFJORDEN REGION, SOUTHERN WEST GREENLAND

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The summer of 1973, the second of a six-year series of field studies by teams from the University of Exeter, saw the completion of 1:20 000 mapping of the coast region from Ameralik (Narssaq-Præstefjord) south to Sermilik, i.e. approximately between latitudes 64°N to 63°30′N. The area mapped in detail, which excludes the Qilángârssuit island complex, extends inland for about 10 km. A. D. G. Mapped the ground between Ameralik and Buksefjorden, M. R. S. mapped from south of Buksefjorden to, and including, the Tre Brødre anorthosite complex, B.C. covered most of the ground between Tre Brødre and Amitsuarssugssuaq, including Sanerâta timâ, and P. R. A. W. began work in the area between Alángordlia and Sermilik. B. C. also spent a week at the end of the season making a reconnaissance of Qilángârssuit.

The field work was again supported by the GGU cutter *N. V. Ussing* and we gratefully acknowledge the contribution made by skipper Flemming Nielsen to the success of the summer's work. We are also grateful to Feiko Kalsbeek for arranging helicopter support from the Midgård base.

Previous work in the region has already been outlined by Chadwick & Coe (1973) and we wish to repeat that the terminology set up by McGregor (1973) in the Godthåbsfjord region has been applied with somereservation, particularly with regard to the Nûk gneiss, which we can now show to have been derived by in-

jection and by remobilisation of older gneisses. The location of topographic features referred to in the text may be found by reference to 1:250 000 maps 64 V.1 Godthåb and 63 V.1 Færingehavn. Only the bare details and significant implications of essentially new field evidence are presented in this account.

Amîtsoq gneiss

A large mass of augen granite gneiss on the coast north-west of Narssaq (McGregor, 1973, figs 7 and 8) has intrusive contacts with banded Amîtsoq gneiss containing two sets of pre-existing small-scale isoclines. The augen gneiss is by definition Amîtsoq because it is cut by Ameralik dykes but it is clearly younger than its banded host. Both gneiss types have been intensely deformed and recrystallised under high amphibolite facies conditions after the formation of Nûk gneisses, yet they lie on the same Rb/Sr isochron of 3750 ± 90 m.y. (Moorbath *et al.*, 1972). Similar augen gneisses occur within banded Amîtsoq gneiss on Qilángârssuit and Akilia. A garnetiferous augen gneiss of presumed Amîtsoq affinity outcrops on the north coast of Sermilik (in granulite facies terrain it is charnockitic), but its relation to banded Amîtsoq gneiss is not clear.

In addition to those known already around Narssaq and on Qilángârssuit, large areas of Amîtsoq gneisses, identified by the presence of Ameralik dykes variably preserved as discordant amphibolite sheets or small pods and strips, have been found north-west of Amitsuarssugssuaq, at the entrance to Alángordlia, on the north coast of Sermilik and north of Ikerasagssuaq. The gneisses are granodioritic, streaky or banded and heavily migmatised.

Ameralik dykes

More outcrops of Ameralik dykes have been found in Amitsuarssugssuaq, and it seems likely that many of the thin dark amphibolites in the gneisses around Ikerasagssuaq are relics of the same suite.

A potential way-up criterion, which has important ramifications in understanding the regional structure, has been recognised in the Ameralik dykes on Qilángârssuit. It is based on the assumption that concentrations of plagioclase phenocrysts in a differentiated Ameralik 'dyke', which cuts the metadiorite in southeast Qilángârssuit (Berthelsen, 1955), represent the top of an originally gently inclined sheet. Similar plagioclase phenocrysts in about ten Ameralik dykes on the east and west limbs of the synform on south-west Qilángârssuit have a systematic asymmetric distribution which suggests the structure in this part is a synformal anticline. It is hoped that the criterion will be tested rigorously in 1974.

Malene supracrustal rocks

Thick units of quartz-sillimanite gneisses and variably garnetiferous or cordierite-bearing biotite schists with subordinate amphibolites are common around

the anorthosite complex which extends from Buksefjorden to Ameralik. Similar gneisses, though subordinate to amphibolites, are also common on Qilángârssuit. Such gneisses are, however, rare or absent between Tre Brødre and Amitsuarssugssuaq where the supracrustal formations are largely homogeneous or metagabbroic amphibolites. Variably agmatised amphibolites on the north coast of Sermilik are associated with thick units of quartz-garnet-cordierite-sillimanite-biotite gneisses.

Primary features include possible meta-conglomeratic gneiss, thin quartzites and meta-ironstones in the Færingehavn – Tre Brødre tract and agglomeratic breccias north of Ikerasagssuaq and on north-west Qilángârssuit. Green fuchsitic quartzite, 1–2 m thick, is common at boundaries between amphibolite and Amîtsoq gneiss on Qilángârssuit. Thin discordant amphibolites, some closely similar to Ameralik dykes in adjacent outcrops of Amîtsoq gneiss, were found in sillimanite gneisses on Tre Brødre, Qilángârssuit and a small island off southwest Qilángârssuit. Less discordant amphibolites were found in amphibolite formations north of Ikerasagssuaq and in north Qilángârssuit.

Thick units of amphibolite, very similar to those in the Malene supracrustal sequence but cut by Ameralik dykes, are common in the Amîtsoq gneiss on Qilángârssuit. 'Gingerbread' ultramafic rocks, also known in the Malene formations, occur as large isolated enclaves or strips in the Amîtsoq gneiss around Narssaq and on Qilángârssuit. Evidence is accumulating to provide a case for regarding the Ameralik dykes as feeders to the basaltic parents of amphibolites in the Malene supracrustals. Such a relation would suggest that what might otherwise be regarded as pre-Amîtsoq rocks (McGregor & Bridgwater, 1973) on Qilángârssuit may in fact be of Malene supracrustal age. It would also indicate that the Malene supracrustal rocks were deposited on a continental basement.

Anorthosites

The anorthosite complexes north of the entrance to Buksefjorden and on the south coast of Ameralik between Præstefjord and Qasigiánguit are linked with continuous outcrops of variably agmatised, banded leucogabbro and anorthosite. Structural analysis has shown that this large mass comprises only one sheet. The Tre Brødre anorthosite on the other hand is made up of two distinct sheets separated by supracrustal rocks and intrusive gneisses. The southern unit of the Tre Brødre complex links with the Færingehavn body and includes banded anorthosites and leucogabbros with minor ultramafic components. The northern unit in Tre Brødre contains abundant relict cumulus-textured leucogabbro and anorthosite with local garnet anorthosite and garnetite. Xenolithic inclusions of corundum-bearing supracrustal gneisses in the Tre Brødre – Færingehavn and Buksefjorden – Ameralik anorthosites are taken to indicate that the anorthosites

were injected into the associated supracrustal formations, although no igneous contacts have survived.

The presence of anorthosite north of Ikerasagssuaq, suggested by Windley (1972, map 1), has been confirmed. The anorthosite is homogeneous, leucocratic and variably agmatised. Local metagabbro with thin discordant amphibolite horizons occurs at the margins. A large differentiated metadiorite body with associated ultramafic rocks south-east of Færingehavn fjord may be comparable in age to the anorthosite complexes. All of the anorthosites in the Buksefjorden region are cut by Nûk gneisses.

Nûk gneiss

Our proposal that much of the Nûk gneiss was formed by remobilisation of Amîtsoq gneiss (Chadwick & Coe, 1973) has been confirmed by particularly clear evidence in north-east Amitsuarssugssuaq. The coast outcrops show a progressive break-up of discordant Ameralik dykes in the Amîtsoq gneisses until at the boundaries of the older gneiss blocks the dykes become strongly attenuated wisps in a nebulitic pale gneiss. The amphibolite wisps have locally recrystallised to coarse hornblendes and ultimately become absorbed in the younger gneiss. The old gneiss host is similarly reduced to xenolithic wisps which ultimately merge completely into the new gneiss. Elsewhere the older gneiss remnants form linear strips within the new which suggests they have peeled off the large areas and are in an interrupted stage of incorporation into newer gneiss. Similar evidence of incorporation of Amîtsoq gneiss in younger gneiss occurs around the coast of Ikerasagssuaq.

Injected Nûk gneiss also occurs throughout the Buksefjorden region. Original igneous textures survive only rarely: a hornblende granodiorite, injected along an Amîtsoq gneiss – Malene amphibolite boundary in east Amitsuarssugssuaq, retains igneous textures in the north and becomes gneissose with acid ptygma in the south. Most of the Nûk gneiss between Tre Brødre and Buksefjorden and east of the Buksefjorden anorthosite contains enclaves of Amîtsoq gneiss in various states of preservation. The field evidence in the Buksefjorden region shows irrefutably that Nûk gneiss has been derived not only from injected material, but also by remobilisation of Amîtsoq gneiss. Our evidence is thus at variance with the conclusion drawn from isotope studies in the Godthåbsfjord region by Pankhurst *et al.* (1973) that the Nûk gneisses "cannot have been derived by partial or complete melting of older rocks similar to the Amîtsoq gneisses."

Two other groups of younger gneisses have also been recognised. One has been derived by remobilisation of both Nûk and Amîtsoq gneiss on the north and south of Buksefjorden. Remobilisation and injection took place synkinematically with the generation of the regional asymmetric folds described below. The

other variety includes banded gneisses which formed in straight belts by strong flattening of Nûk gneisses with Amîtsoq enclaves. Outcrops showing the transition into this variety occur west and east of the entrance to Amitsuarssugssuaq.

Structure

The regional structure is essentially a group of elongate domes and rarer basins separated by straight belts; the structural grain trends north or north-east. The Buksefjorden – Ameralik anorthosite structure provides a convenient key to the regional chronology. This structure, an elongate dome 35 km long by 5 km wide, is the result of the superimposition of large-scale asymmetric folds on regional isoclines which deform Amîtsoq, Nûk and Malene units in addition to the anorthosite. A straight belt, produced by extreme flattening and attenuation of more ductile gneiss and amphibolite units, formed at the same time as the asymmetric folds. An intense mineral lineation coaxial with asymmetric folds of all scales is ubiquitous, although in the south it is more intense in the straight belts. Deformed inclusions and augen show that powerful extensions took place parallel to the lineation. The lineation generally has a southerly plunge.

Straight belts, so-called because the outcrop of the vertical foliation gives rise to a regular linear pattern, occur on various scales. The largest, up to 6 km wide, extends from Buksefjorden south to Færingehavn. It is overlain in the north-west by a thrust mass of Qôrqut granite which forms Skinderhvalen, 244 m, and in the south-west beyond Færingehavn fjord it appears to bifurcate around the Tre Brødre anorthosite structure, itself a large-scale interference pattern similar to that in Buksefjorden. Further east the straight belt is replaced by domes and basins of amphibolite.

The structure of Qilángârssuit is formed by part of a group of domes and basins with an extreme conical shape. The axes plunge gently south of south-west parallel to the regional mineral lineation which is found in all the rocks on the island except the Qôrqut pegmatites. A sandwich of Malene amphibolite and gneiss formations symmetrically disposed about a core of Amîtsoq gneiss suggests the presence of a pre-dome isocline with nappe dimensions.

A straight belt outcrops along the length of Amitsuarssugssuaq and separates a group of domes and basins around Ikerasassuaq to the west from a large half-dome to the east. The northern half of this structure is presumed to occur north of Alángordlia. It closes to the south on the coast of Sermilik where it refolds a major isocline of Malene amphibolite and sillimanite-garnet gneiss.

There appears to be a regional fanning of the superimposed asymmetric structures which relates to the fanning further north in the Godthåbsfjord region. The domes and straight belts might be explained as regional lobe and cusp phenomena produced by contrasting ductilities of rocks at different levels in the rock pile.

Metamorphism

Sillimanite and hornblende parallel to the regional mineral lineation show that the asymmetric fold phase took place in conditions of upper amphibolite facies. Likewise, lineated hypersthene shows that granulite facies conditions were attained during this phase in Sermilik and north-west Amitsuarssugssuaq. Field relations and hornblende rims to hypersthene in the patchy development of granulite facies east of Amitsuarssugssuaq, north of Ikerasagssuaq and north and south of the entrance of Buksefjorden suggests that these areas are not relicts surrounded by retrogressed host but instead represent local zones where either temperatures just exceeded upper amphibolite facies conditions or there was a slow build up of water pressures. Textural evidence in Sermilik suggests granulite facies conditions there outlasted the asymmetric fold phase. Outcrops in this part also contain evidence of pre-Nûk gneiss granulite facies metamorphism similar to that noted in Alángordlia by Chadwick & Coe (1973).

Basic dyke swarms

Black doleritic dykes are common in the south of the Buksefjorden region. Evidence of control of intrusion by faults and splay phenomena is particularly common around Amitsuarssugssuaq. Of special interest is a 50–60 m hornblende-plagioclase dyke, dyke 1, 10, described by Jensen (1962, fig. 1), which has now been mapped for 30 km from the coast north of Tre Brødre into the mountains north of Sermilik. Chilled intersections east of Amitsuarssugssuaq show that the dyke is younger than the normal dolerite dykes. The dyke contains good igneous grading which is cut by a strong planar fabric parallel to the dyke contacts.

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