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Mapping in the Umanak district, central West Greenland

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Geological mapping in the Umanak district aimed at the production of the 1:100 000 sheet 70 V.2 Nord – Agpat continued in 1979. The background for this work was outlined by Pulvertaft (1979a). The four geologists who were in the field in 1978 were joined in 1979 by Lasse Schiøtte who mapped area III (Pulvertaft, 1979a, p. 27, fig. 9). In response to a request from Umanak Kommune, one of us (T.C.R.P.) visited the village of Niaqornat to investigate the rock falls that have damaged buildings in the village, and to assess the risk of further falls. Copies of a report on this investigation have been submitted to Umanak Kommune and GGU.

Rock types in the Umanak area

Apart from a small area of Cretaceous sediments (Pulvertaft, 1979b) overlain by Tertiary basalts which overlap onto the surrounding basement, the Umanak area is made up of Precambrian metamorphic and igneous rocks that are cut by a number of dolerite dykes of uncertain age. The Precambrian rocks are predominantly of Archaean age, the only proven Proterozoic cover rocks being the isolated occurrences of marbles and associated metasediments belonging to the Marmorilik Formation. Gneisses dominate the area. Within these there are horizons of amphibolite-dominated supracrustal rocks, paragneiss, and gneiss packed with anorthosite or leucogabbro inclusions. These were described briefly in last year's report, and the only important additional discoveries from 1979 are as follows:

(1) Good examples of relic spinifex textures are preserved in some of the larger ultrabasic bodies that occur within the amphibolite-dominated supracrustal horizons; these are described in the following article.

(2) The Akugdleq supracrustal unit, which is conspicuous for its rusty-ochre-weathering pyrrhotite-rich rocks and which was thought to be an exclusively metasedimentary unit, also contains amphibolitic rocks which are tightly folded into the metasediments.

(3) Some of the basic horizons noted simply as 'amphibolite' on the 1:500 000 sheet Søndre Strømfjord – Nûgssuaq contain not only the rich variety of less usual rocks noted by one of us (J.C.K.) in 1978, but also in places a considerable amount of metadiorite rather similar to the dioritic rocks associated with amphibolite horizons in the Bjørnesund area far to the south (Kalsbeek & Myers, 1973, p. 14).

The gneisses superficially appear to embrace a wide variety of rock types, but in reality more than 75 per cent of these rocks belong to a single lithological type – a light grey biotitic orthogneiss. The many manifestations of this type are expressions of variations in the nature and abundance of inclusions in the gneiss and in the amount of leucocratic veining, and above all in the style and intensity of deformation that has affected the rocks.

Inclusions of hornblendic gneiss and of finer-grained gneiss slightly richer in biotite appear as lenses, streaks and thin layers respectively as the degree of deformation increases.

Amphibolite is a common type of inclusion, both as an anonymous medium-grained amphibolite and as layered amphibolite. Amphibolite inclusions often occur as lenses scattered along zones parallel to the general structure. In these zones, and particularly in the vicinity of the amphibolite lenses, the gneiss usually carries a small amount of hornblende.

Light pink microcline-quartz veins with a very small amount of biotite are ubiquitous in the biotite gneiss, but their frequency and thickness varies so that anything between 2–3 per cent and 50 per cent of an outcrop can be made up of light pink veins from a few millimetres to more than a metre thick. Grain size in the veins varies from very coarse to medium-grained. This variation is partly, but not entirely, due to deformation. Deformation is however the deciding factor in determining the form of the veins. In less deformed areas the veins form a stretched criss-cross network in which some veins may show ptygmatic folding. In strongly deformed areas the veins occur as thin parallel *lit-par-lit* layers, or if breakdown of the large microclines is incomplete, as rows of isolated pink microcline augen.

Outcrops of biotite gneiss identical to much of the gneiss in the Umanak area have been observed as far afield as at Jakobshavn, 150 km to the south.

The other quantitatively significant gneiss types that have been recorded are (1) rather variegated hornblende-biotite gneisses that occur for example around the town of Umanak (a visitor to the town must climb to 300 m if he is to see the main biotite gneiss type); (2) slightly finer-grained, darker gneiss relatively rich in biotite but with only a little hornblende; (3) pink homogeneous granitoid gneiss, easily seen for example in the higher parts of the east end of Agpat island; (4) biotite-hornblende augen gneiss. Horizons of augen gneiss have proved immensely valuable as marker horizons, being less prone to lensing out and boudinage than the amphibolite horizons. The augen gneiss horizons have been derived by deformation of megacryst granite. Extreme deformation has often almost destroyed the augen character of the rock, which appears as a leucocratic layered or schlieren gneiss distinguishable from its surroundings mainly by its higher content of dark minerals.

Our observations on the gneisses of the Umanak area are in complete agreement with the conclusions reached by Myers (1978), who has emphasised the role of deformation in the production of banded gneisses. In the Umanak area zones 1–2 m thick of well-banded, very high strain gneiss within more massive gneiss showing only medium strain often give rise to step features in the topography (with the banded high strain gneiss at the foot of the step). Most trend lines drawn from photogeological interpretation are in fact traces of zones of very high strain in the gneisses. That these trend lines reveal the trend of lithological boundaries is an expression of, or result of, the strong deformation to which the area as a whole has been subjected, which has led to widespread parallelism of all lithological and structural features.

Metabasite bodies

The existence and possible significance of metabasite bodies in the Umanak gneisses was mentioned by Escher & Pulvertaft (1976, p. 114–116). We are now in a position to enlarge on previous descriptions, although the compilation and interpretation of our data is not yet complete.

Lithologically the bodies vary from scarcely altered dolerite with ophitic texture which grades into mafic or even ultramafic rock types, to foliated or lineated amphibolite. The complete spread of rock types may occur in a single body, the most altered rocks being at the margin.

Structurally three types can be distinguished: (1) Blocks with angular or rectangular profiles from a few metres to several tens of metres in length; the long axis is usually parallel to the general structure in the enclosing gneiss, but a narrow angular discordance between the long edge and the foliation in the adjacent gneiss has sometimes been observed. These bodies have basic to ultrabasic compositions. There is no doubt that these bodies are disrupted portions of originally larger sheets. Along long edges there is a relic chilled margin, while the rock retains its normal grain size right up to the blunt ends at which the bodies are often in contact with pegmatite.

(2) Pods up to 300 m long, also of metadoleritic to ultrabasic composition. The contacts of these pods often show no discordance with the layering and foliation in the surrounding gneiss which has adapted itself – or been adapted – to the form of the bodies. In detail three types of contact exist: (a) a highly deformed contact zone comprising the outer 25–50 cm of the amphibolite which is strongly foliated and/or lineated, and about a metre of the adjacent gneiss which is almost mylonitic; (b) a contact showing no sign of deformation, where the metabasite is bordered by quartzo-feldspathic pegmatite; (c) a contact where slightly finer-grained amphibolite borders on ordinary gneiss without noteworthy deformation of either rock. Even though discordance is only rarely observed at the contacts of individual pods, zones of pods often show distinct discordance to the general structure and to lithological boundaries in the surrounding gneiss complex.

(3) Relatively narrow sheets consisting of amphibolite. These have been seen cutting sharply across layering and veining in the surrounding gneiss, and at the same time showing typical fold shapes. Often there is no sign of the surrounding gneiss being correspondingly folded, even when the amphibolite sheet shows lineation and other signs of deformation. Some of the fold shapes must be primary intrusion forms, while in other cases the sheets have been preferentially affected by a deformation that has not had any particularly marked effect on the surrounding gneisses.

Structure

Tight to isoclinal folds with low-dipping axial planes are the characteristic structures of the Umanak area. Analysis of these folds is hampered by the very condition that has allowed them to be recognised at all – their occurrence in steep cliffs that surround widely separated islands and peninsulas. Furthermore some of these folds are rootless, and are best described as giant intrafolial folds. Two axial directions appear to dominate – N–S roughly horizontal, and ESE with low plunge. The folds with N–S axes are generally overturned towards west, while the ESE folds are overturned towards both north and south. The age relationships between these folds are still uncertain; there are indications that the axial direction may change the level.

Whatever the age relationships between the various folds, it is now evident that the Proterozoic, post-Marmorilik Formation, tectonics of the area are very complicated. A distinctive sequence of amphibolite, augen gneiss, biotite gneiss and augen biotite schist has been traced over about 1250 km² in the north-east part of the area. This sequence overlies an infolded remnant of the Marmorilik Formation, a situation which requires at least 30 km of lateral transport of the marker sequence. Both the Marmorilik Formation and the marker sequence have been subsequently involved in tight folds with N–S axes and overturned to the west. One of us (M.C.A.) has collected material for a study of what effect this Proterozoic deformation has had on the Rb-Sr isotopic system.

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Archaean ultramafic rocks with relict spinifex textures in the Umanak area, central West Greenland

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Conspicuous olivine and serpentine textures were found in a number of ultramafic bodies in the Umanak area while it was being mapped on a scale of 1:20 000. The rocks in the area mapped by the writer are mainly a suite of quartzo-feldspathic gneisses (Pulvertaft *et al.,* this report) in which there are distinct amphibolite-dominated supracrustal horizons which enable the major structures of the area to be recognised. The structure which dominates the area is a large recumbent/reclined fold plunging ESE at a low angle and closing to the NNE.