RECONNAISSANCE MAPPING OF SOUTH-EAST GREENLAND BETWEEN 62°30′ N AND 60°30′ N

J. R. Andrews, D. Bridgwater, B. Gulson and J. Watterson

The 220 km coastline from Tingmiarmiut Fjord to Nanûseq Fjord (fig. 6) was sailed during August and the first week in September, 1970, with the object of completing the 1:500 000 map sheet of South Greenland. Ice conditions prevented access to the coastline between Kap Steen Bille and Puisortoq and between Napassorssuaq Fjord and Anoritûp kangerdlua, in addition to inner parts of fjords north of Kap Herluf Trolle. From this point south sea conditions prevented landings on the seaward capes.

A major geological boundary occurs immediately south of Mogens Heinesen Fjord (62°15′ N). To the north of this boundary early Archaean amphibolite-facies gneisses, with small areas of granulite facies, have a complex structural pattern in which amphibolite layers with ultrabasic remnants, interlayered with smaller amounts of semipelitic, calc-silicate and possible dacitic volcanic rocks, form distinctive mappable units. Compositional layering within the amphibolites is thought to be a relict original supracrustal feature. These recognisably supracrustal units have been regarded as having been deposited on an earlier basement thought by Bridgwater & Gormsen (1968) to form a major component of the gneisses immediately to the north of the area investigated. A significant proportion of the gneisses represent deformed sheets of granite and granodiorite several hundred metres thick which have intrusive relationships with the amphibolite units. In structural style and general lithology the Archaean gneiss in this area shows many resemblances to the gneisses of the Frederikshåb district of South-West Greenland. Our present views on the components present in the early Archaean gneiss are close to those suggested by McGregor (1969) for the Godthåbsfjord area.

The early Archaean gneiss complex with its amphibolite layers forms the basement to younger rocks which occur southwards from 62°15′ N. The younger rocks comprise quartzo-feldspathic gneisses with a less complex structural pattern than the basement rocks to the north. The mapped geological division of the area coincides closely with a change in the K/Ar ages from the rocks. North of Mogens Heinesen Fjord the gneisses yield K/Ar ages older than 2200 m.y. (Bridgwater, 1970). South of Mogens Heinesen Fjord the gneisses yield ages younger than 1800 m.y. (Bridgwater, this report).

The younger gneisses to the south of Mogens Heinesen Fjord contain layers of indubitable metamorphosed acid volcanics with primary phenocrysts and banding preserved. Interlayered with these are homogeneous grey granodioritic gneisses.

Where the interlayering between the granodioritic gneisses and the acid volcanics is present on a small scale (for example on Ikermît island) the gneisses can be seen to have formed as a result of relatively weak deformation and recrystallisation of a homogeneous variety of the acid volcanic succession. Recognition of granodioritic gneisses indistinguishable from the gneissose part of the Ikermît succession as one of the major rock units from Ikermît to Kap Herluf Trolle has considerably influenced our interpretation of the regional geology. We regard the feldspathic gneiss complex as derived mainly from a supracrustal pile dominated by acid volcanics. Only a limited thickness of the original succession is exposed in the 70 km south of Ikermît since in this area the gneisses are flat-lying. A somewhat greater variety of rock types is exposed in Napassorssuaq Fjord where the gneisses locally form an ENE belt of steeply dipping rocks. In this area intermediate and basic volcanic rocks, including porphyritic lavas closely resembling those described by Watterson (1965) from Kobberminebugt, are found within the otherwise more acid rocks.

In most cliff sections the supracrustal sequences can be shown to have been intruded by concordant sheets of dioritic or granodioritic material. These show the same regional structures and foliation as the surrounding host rocks. In areas of moderate to heavy deformation the proportions of gneiss derived from supracrustal material and gneiss derived from intrusive material could not readily be determined during reconnaissance mapping. However, the presence of recognisable acid volcanic units within all the major areas of gneiss visited gives us confidence in interpreting the gneiss sequence as essentially supracrustal in origin.

From Kap Herluf Trolle for 50 km south to Kap Ivar Huitfeldt a series of large gently plunging, ENE-trending overturned folds produces a well defined structural grain to the gneisses in addition to exposing greater thicknesses and a greater variety of rock types in the supracrustal sequences. South of Kap Ivar Huitfeldt the structure becomes again flat-lying (Sutton & Watterson, 1968). The 50 km wide belt of ENE structures is thought to extend to SW Greenland and is believed to post-date the development of the flat-lying structures and the major period of migmatisation seen in the gneisses to the north and south.

In each of the fjords Igutsait, Kangerdluluk, Danells, Pâtussoq and Kutseq, migmatitic grey gneisses can be seen to be stratigraphically conformable with well-preserved supracrustal rocks. Basic and intermediate volcanics including porphyritic andesite flows and a variety of basic and intermediate tuffs occur from Kangerdluluk to the south. Cordierite-sillimanite-bearing pelites and semipelites, and a variety of basic and intermediate tuffs occur in Kangerdluluk and southwards. From approximately 61° southwards the successions contain major units of grey psammitic gneiss commonly with intercalated thin calc-silicate bands. Current bedding is locally preserved. These impure psammitic units are regarded as the continuation

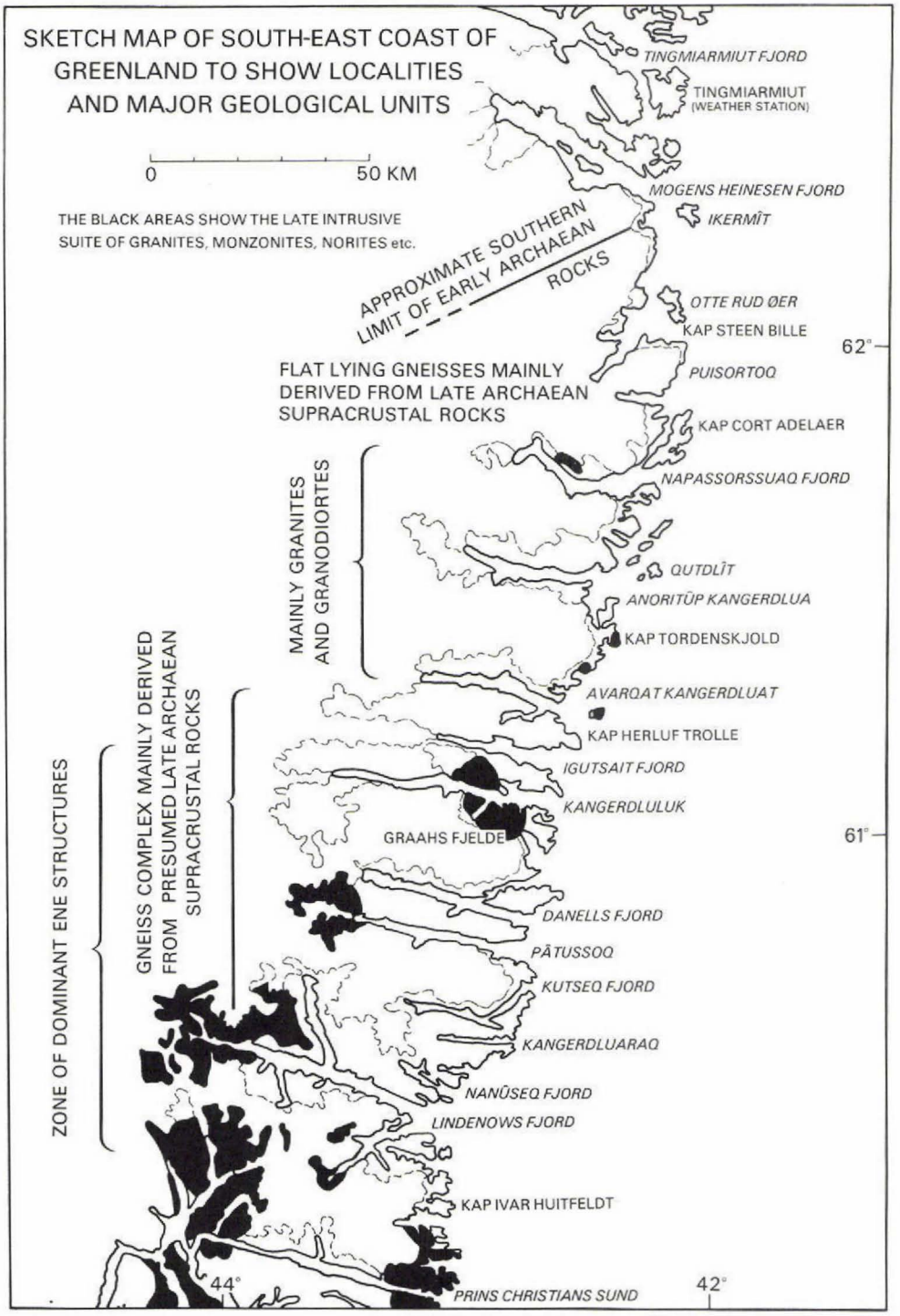

Fig. 6. Sketch map of south-east coast of Greenland to show localities and major geological units.

of the upper psammitic unit of the flat-lying succession mapped northwards from Kap Farvel (Sutton & Watterson, 1968). They are thought to represent arenaceous sediments with a variable component of potassic, sodic and calcareous material possibly derived from volcanic activity taking place at the same time as the formation of the sediments.

The degree to which migmatisation and gneissification have proceeded is determined partly by the original characters of the rocks and partly by the structural position within the large-scale folds, some of which have amplitudes of several kilometres. The envelopes of the folds are of well preserved supracrustals in which original sedimentary structures may be seen, while the cores show a much higher degree of migmatisation. In places the fold cores are occupied by a melange of agmatitic granodioritic material which, although retaining clear evidence of its supracrustal origin, has become mobilised and partly intruded the fold envelope. Even in the most migmatised parts of the succession agglomeratic horizons can be locally identified. No evidence for the presence of an older basement was found in the area south of 62°15′.

The rocks between Napassorssuaq Fjord and Avarqat kangerdluat are dominated by intrusive granites, granodiorites and lesser amounts of diorite, appinite and minor basic intrusions to the almost total exclusion of gneiss. This igneous suite is regarded as the ENE continuation of the Julianehåb granite and contains many features in common with the type area in SW Greenland. In any particular area the intrusive rocks show a complex chronology with earlier deformed granites, diorites, net-veined bodies and pegmatites cut by later undeformed or less deformed members. In general the major trend of structures within the deformed parts of the granitic complex is approximately ENE. Outside the main area of igneous activity the gneisses are cut by granitic and granodioritic intrusions which commonly show marked deformation near the margins but which are less affected near the centres. Some of these intrusions (for example the granodioritic mass at the head of Kangerdluluk fjord) reach a considerable size and resemble the igneous bodies found to the south of the main Julianehåb granite (e.g. the Isortoq granodiorite, Persoz, 1969). Minor basic intrusions emplaced under regional plutonic conditions, for example net-veined bodies and synkinematic dykes, are found both on a regional scale and associated with individual granitic intrusions. Granodioritic, dioritic and appinitic bodies thought to belong to the same general suite of igneous rocks are found as cross-cutting plugs and sheets which extend to the northern limit of the area mapped. From Otte Rud Øer north these show little sign of impressed regional deformation. To the north of Mogens Heinesen Fjord the appinites are closely associated spatially with a group of small carbonatites ranging from dykes and sills a few metres in width to carbonate-cemented diatremes up to 200 m across. Most of the bodies are clearly intrusive and transgress the country rocks. Some of the bodies, in particular those found near Tingmiarmiut weather station, were apparently formed by carbonatisation of the gneisses in situ. A K/Ar hornblende age determination (Bridg-

water, this report) gives an apparent age of 1880±56 m.y. on an appinitic sill belonging to this group of rocks.

The early Archaean gneisses to the north of Mogens Heinesen Fjord are cut by several series of basic dykes, two main directions being particularly notable: 1) an older group of fresh hypersthene-bearing rocks with clouded poikilitic plagioclase crystals, which show a persistent SSE to N-S trend; 2) a younger set of greenish-brown doleritic dykes with a rather altered appearance. Both sets are cut by the appinitic intrusions described above. These dykes are regarded as occupying a similar position in the Precambrian of southern Greenland as the MD dykes of the Frederikshåb district (Jensen, 1968), that is to say they were probably intruded at some time between 2000 and 2600 m.y. ago. South of Mogens Heinesen Fjord the metamorphosed acid volcanic succession and concordant granite sheets within it are cut by metamorphosed and slightly deformed continuations of these dyke swarms as far as Otte Rud Øer. Farther south, at the mouth of Napassorssuaq Fjord, basic metavolcanic members of the supracrustal succession and foliated porphyritic granite representing the northern part of the main granite mass are both cut by metadolerites. South of Napassorssuaq Fjord metadolerites have not been identified with certainty. However the gneisses as far south as Nanûseq Fjord contain a variety of intrusive basic sheets which cross-cut the gneissic structures but which have themselves been severely deformed, suggesting that the original crustal pile has a complex history. On this basis the supracrustal succession south of Mogens Heinesen Fjord is of pre-Ketilidian age (i.e. probably late Archaean) and broadly comparable in age with the Tartoq Group on the west coast (Higgins, 1968). We have found no evidence of a stratigraphic break between these supracrustal rocks and the successions seen from Kap Herluf Trolle to Kap Farvel. From this we would suggest that the majority of supracrustal units now preserved within the area affected by Ketilidian metamorphism are probably late Archaean, the main exception to this being the Grænseland succession of the west coast. The coincidence between the marked change in lithology just south of Mogens Heinesen Fjord with a regional change in K/Ar ages suggest that the thermal effects of the Ketilidian activity may have been partially controlled by earlier structures.

The age of the Julianehåb granite and its extension on the east coast remains uncertain; however, if the supracrustal rocks are regarded as Archaean then there is no reason why at least some of the phases of the granite should not be Archaean.

A late igneous suite post-dating all regional deformation comprises several intrusions of biotite and hornblende granite, quartz syenites and subordinate monzonites and hypersthene granites. The largest of these are at Graahs Fjelde (17 × 15 km), Pâtussoq (at least as large as Graahs Fjelde), Napassorssuaq Fjord (5 km^2), and three incompletely exposed coastal intrusions of at least a few square kilometres each in the vicinity of Kap Tordenskjold. These intrusions are thought to be related to the rapakivi granite suite of the Kap Farvel area.

Post-tectonic dolerite dykes trending approximately N-S and post-dating the

late intrusive suite of granites occur throughout the area and form members of the regional N-S swarms of Proterozoic dykes now known from Angmagssalik to Kap Farvel. To the north of the area described dykes belonging to this general period of basic intrusion have given K/Ar ages between 1450 and 1700 m.y. (GGU 99499 and 99362; Bridgwater, this report) From Tingmiarmît island southwards they are cut by E-W dolerites known to be the continuation of the Gardar province of SW Greenland. South of Mogens Heinesen Fjord some members of the swarm contain clouded feldspar thought to indicate that these dykes were emplaced during the last stages of the Ketilidian metamorphic activity around 1500 m.y. ago.

The E-W Gardar dykes occur throughout the area mapped. They are locally concentrated into distinct swarms, particularly in the area to the north of Kap Herluf Trolle. Several of the dykes contain aggregates of plagioclase xenocrysts and plagioclase megacrysts up to 20 cm long. Preliminary petrographic work shows that many have strong alkali tendencies with interstitial alkali feldspar and considerable biotite. The syenite dyke recorded in field diaries by R. Bøgvad from the coast directly north of Avarqat kangerdluat could not be reached due to ice. Loose boulders of microsyenite were collected from Igutsait Fjord. The distribution of these alkali rocks suggests that the main belt of Gardar alkali magmatism trends approximately E-W parallel to the main transcurrent fault direction recorded from the west coast.

Phanerozoic dolerites (TDs) were not identified in the area with certainty. A swarm of 20-30 1 m pyroxene-mica lamphrophyres, trending 60° and cut by a single dolerite dyke in the inner parts of Danells Fjord and Pâtussoq, might be Phanerozoic.

Sinistral faults with post-Gardar displacements of several km were proved along several of the E-W trending fjords and are clearly extensions of the major Gardar faults of SW Greenland.

The economic potential of the area is reduced by the difficulty of access and the lack of established settlements. However, it is worth noting that the considerable thicknesses of gneisses derived from acid volcanic successions are favourable hosts for sulphides and that geologically the area mapped is more likely to yield ore minerals than most of the gneissose terrains so far described from Greenland. Disseminated sulphides are reasonably abundant in the semipelitic and calcareous metasediments of Danells Fjord and Pâtussoq.

References

Bridgwater, D. 1970: A compilation of K/Ar age determinations on rocks from Greenland carried out in 1969. *Rapp. Grønlands geol. Unders.* **28**, 47-55.

Bridgwater, D. & Gormsen, K. 1969: Geological reconnaissance of the Precambrian rocks of South-East Greenland. *Rapp. Grønlands geol. Unders.* **19**, 43-50.

Higgins, A. K. 1968: The Tartoq Group on Nuna qaqortoq and in the Iterdlak area. South-West Greenland. *Rapp. Grønlands geol. Unders.* **17**, 17 pp.

Jensen, S. B. 1968: Field work in the Frederikshåb area. *Rapp. Grønlands geol. Unders.* **15**, 40-44.

McGregor, V. R. 1969: Early Precambrian geology of the Godthåb area. *Rapp. Grønlands geol. Unders.* **19**, 28-30.

Persoz, F. 1969: Evolution plutonique et structurale de la presqu' île d'Akuliaruseq, Groenland méridional. *Bull. Grønlands geol. Unders.* **72** (also *Meddr Grønland* **175**, 3) 202 pp.

Sutton, J. & Watterson, J. 1968: The flat-lying metamorphic complex and related igneous rocks of the Kap Farvel area. *Rapp. Grønlands geol. Unders.* **15**, 58-60.

Watterson, J. 1965: Plutonic development of the Ilordleq area, South Greenland. *Bull. Grønlands geol. Unders.* **51** (also *Meddr Grønland* **172**, 7) 147 pp.

FIELD MAPPING IN THE SCORESBY SUND REGION, EAST GREENLAND

Niels Henriksen

The third season, 1970, of the five year mapping programme in the Scoresby Sund area lasted slightly more than two months. As in the previous years the expedition was based on a special polar vessel which carried two Bell helicopters. The ship used was the 2675 ton "Perla Dan", which with a crew of 25 supported 3 smaller boats. The expedition members numbered 43, comprising 16 geological two- or three-man teams, and supporting personnel. The geological teams were divided into several working groups. Eight two-man parties worked in the crystalline complex in the inner fjord region around Rødefjord and on Milne Land. One party mapped the upper Palaeozoic sediments at Rødefjord. Five parties mapped the Mesozoic rocks on Milne Land and on south-eastern Jameson Land (see Birkelund, this report); three of these parties, in addition to mapping, undertook special palaeontological investigations along the west coast of Hurry Inlet and were financially supported by the Carlsberg Foundation. One party worked in the Tertiary basalt on south-eastern Milne Land and north-west Gåseland, and one party undertook a Quaternary geological investigation in the central part of the inner fjord zone.

During the season logistic co-operation between prospecting groups from "Nordisk Mineselskab" and the GGU expedition benefited both groups.

Approximately 6000 km^2 were mapped in the crystalline complex and about 1200 km^2 in the Mesozoic sediments at a scale of 1:50 000. After three seasons' mapping the field work between 70°40′ and 72°00′ N in the inner fjord zone is almost completed.

The crystalline complex

In the part of the inner Scoresby Sund region hitherto mapped by GGU it has been possible to distinguish the following main units among the crystalline rocks: 1) a pre-Caledonian basement more or less reworked by the Caledonian events; 2) two supracrustal sequences – the Charcot Land sequence and the Krummedal