Project SUPRASYD 1993 – granitic rocks and shear zones with possible gold potential, Julianehåb batholith, South Greenland

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In 1992 the Geological Survey of Greenland (GGU) initiated the project SUPRASYD in order to carry out an economic assessment of the Ketilidian orogen in South Greenland, especially the supracrustal rocks in the southern and eastern parts of the orogen (see Dawes & Schønwandt, 1992). Geological investigations in the area east of Nanortalik and along the east coast of South Greenland as far as 62°N had previously indicated that acid metavolcanic rocks were an important constituent of the supracrustal rocks, and it was therefore expected that the region might have a significant potential for sulphide deposits.

A reappraisal of supracrustal rocks along the east coast of South Greenland was carried out in 1992, mainly by helicopter reconnaissance (see Dawes & Schønwandt, 1992; Nielsen *et al.,* 1993). The field work revealed that the geology in this region as shown on the 1:500 000 map sheet (Sheet 1, Sydgrønland; Allaart, 1975) was in need of revision, and that the supracrustal rocks contrary to earlier belief only appeared to contain a small proportion of acid and intermediate metavolcanic rocks. It was also discovered in 1992 that the previous interpretation of certain geological units north-east of Qaqortoq/Julianehåb as supracrustal rocks was likewise in need of renewed study.

This report presents a brief outline of the second field season of project SUPRASYD, which was carried out by seven geologists working in three teams from the beginning of July to the middle of August, 1993. The area studied is located around the fjord Søndre Sermilik north of Nanortalik, South Greenland, in the southern part of the early Proterozoic Julianehåb batholith of the Ketilidian orogen (Fig. 1). A detailed geological account of the field work in 1993 can be found in Chadwick *et al.* (in press). Much of the study area is difficult of access because of its alpine relief, large boulder fields and many local glaciers. However, the least accessible parts are commonly well exposed, and it was possible to obtain a general impression of the geology in such areas from the air, supplemented by short helicopter landings.

The 1993 field work was focused on three problems in the central part of the orogen on the west coast of South Greenland. The first aim was to investigate an area of supposed supracrustal rocks in the central part of the area of the 1:100 000 scale map sheet 60 V.3 N (Søndre Sermilik), the presence of which could not be confirmed during GGU's reconnaissance in 1992. The second aim was a detailed study of shear zones and mylonites, particularly the Sardloq shear zone in the north-western part of the traverse area, which was visited briefly in 1992. It is known from other parts of the world that gold deposits may be closely related to large shear zone systems; the best known are hosted in Archaean greenstone belts (see e.g. Eisenlohr *et al.,* 1989). The third objective was an investigation of mineralising processes with the aim of explaining stream sediment gold anomalies of the area and placing these processes in a regional geological framework. In order to solve these problems, geological mapping was undertaken along a NW–SE trending corridor within the area of the map sheet. This map sheet was not compiled when GGU published its series of 1:100 000 scale maps of South Greenland (see Kalsbeek *et al.,* 1990, fig. 1), although geological mapping in the area had been carried out in the early 1960s.

Good weather in July and adequate logistic support made it possible to extend the 1993 field work to locations within most of the map sheet area, and about 300 samples of hydrothermally affected rocks were collected for chemical analysis. The geological field maps from the early 1960s were useful and mostly of high quality, once the lithologies had been 'translated' from the original descriptions based on granitisation theory. However, these field maps generally contained little structural information, and closely related rocks with different states of deformation had often been placed into groups of supposedly different age and origin.

Outline of the geology in the Søndre Sermilik area

The Søndre Sermilik area comprises three different Ketilidian rock associations. Most of the area consists of felsic to intermediate granitoid rocks and smaller related dioritic bodies. Most of this association was previously referred to as the Julianehåb granite and related granitoids; Windley (1991) introduced the term Julianehåb batholith in a recent plate-tectonic model for the Ketilidian orogen (based on earlier data). We have adopted this term, al-

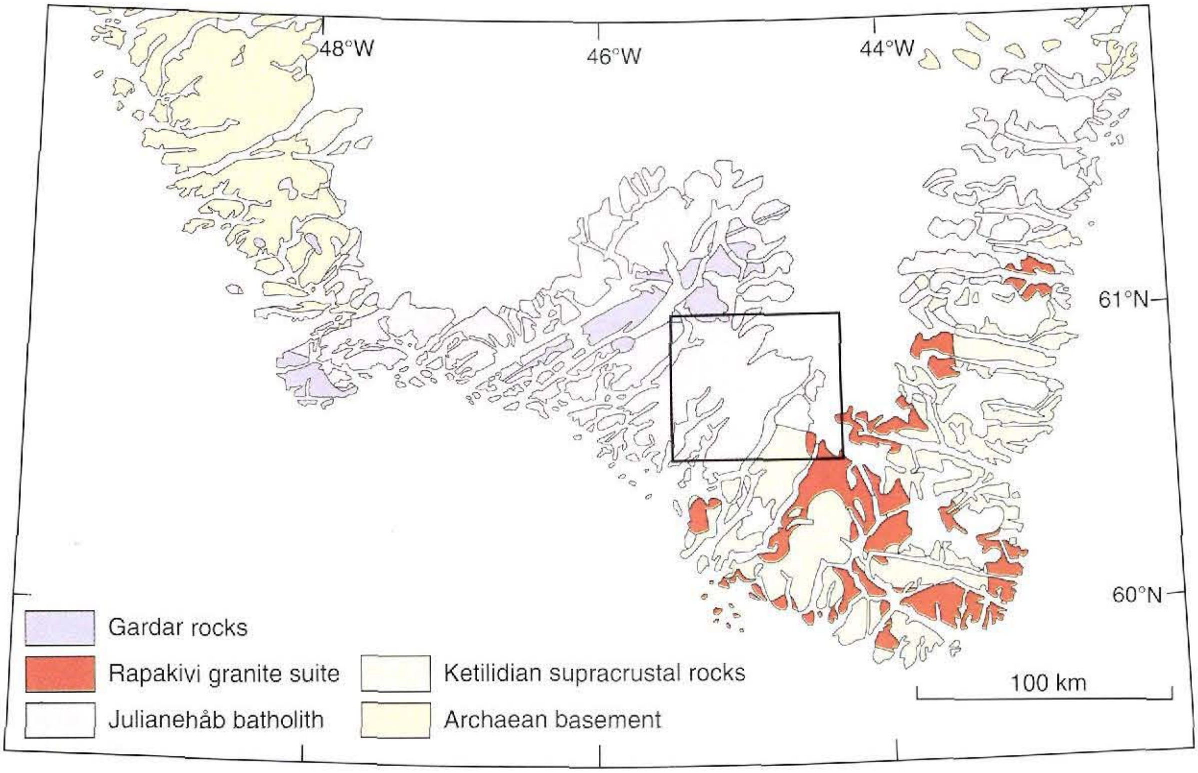

Fig. 1. Geological sketch map of South Greenland with the position of the 1:100 000 map sheet area (60 V.3 N, Søndre Sermilik) studied in 1993.

though the results obtained so far under the SUPRASYD project are incompatible with many aspects of Windley's model (see Chadwick *et al.*, in press). The south-eastern corner of the map sheet area contains a metamorphosed supracrustal association of clastic and volcanic rocks. The third association comprises late intrusions of the rapakivi granites of South Greenland. The latter were not visited in 1993.

The Julianehåb batholith and related transcurrent shear zones

During the field work in 1993 it was quickly realised that almost the entire study area is underlain by biotite- and hornblende-bearing granitoid rocks, which (based on field aspects alone) probably range in composition from granite *sensu stricto* through granodiorite and tonalite to quartz diorite, diorite and rarely gabbro. The most voluminous rocks are granodiorites and tonalites. Previously published and unpublished maps of the area also indicate substantial areas of older gneisses and massive intermediate to basic rocks of supposed volcanogenic origin, but these were found to be more strongly deformed varieties of the main granitoid rocks as well as cogenetic dioritic intrusives. Local bands of aplites and quartzitic metasediments indicated on some of the old maps are in fact strongly deformed, more or less silicified granites *sensu lato* and mylonites in several regional shear zones (see below). The batholith also contains numerous appinitic, dioritic and amphibolitic dykes which have been described previously as distinct dyke swarms, but which we consider to be cogenetic with the batholith itself and injected more or less continuously throughout its emplacement.

An important outcome of this summer's field work is the confirmation that the batholith contains not just one but several major shear zones with thicknesses in the order of several hundred metres and strike lengths of tens of kilometres. The shear zones are vertical and trend approximately NE–SW. Their central parts typically contain one or several zones of mylonites or ultramylonites up to about 10 m wide, and they commonly possess strong linear fabrics with subhorizontal or shallow north-easterly plunge. Along the margins of the shear zones one can consistently find small-scale evidence of sinistral transcurrent displacement (Fig. 2). The most prominent shear zone, the Sardloq shear zone, can be followed for at least 50 km along strike from the Inland Ice in the north-east towards the south-west, and it probably links up with a previously known shear zone near the abandoned settlement Saarloq (formerly Sardloq) at the outer coast. Its possible continu-

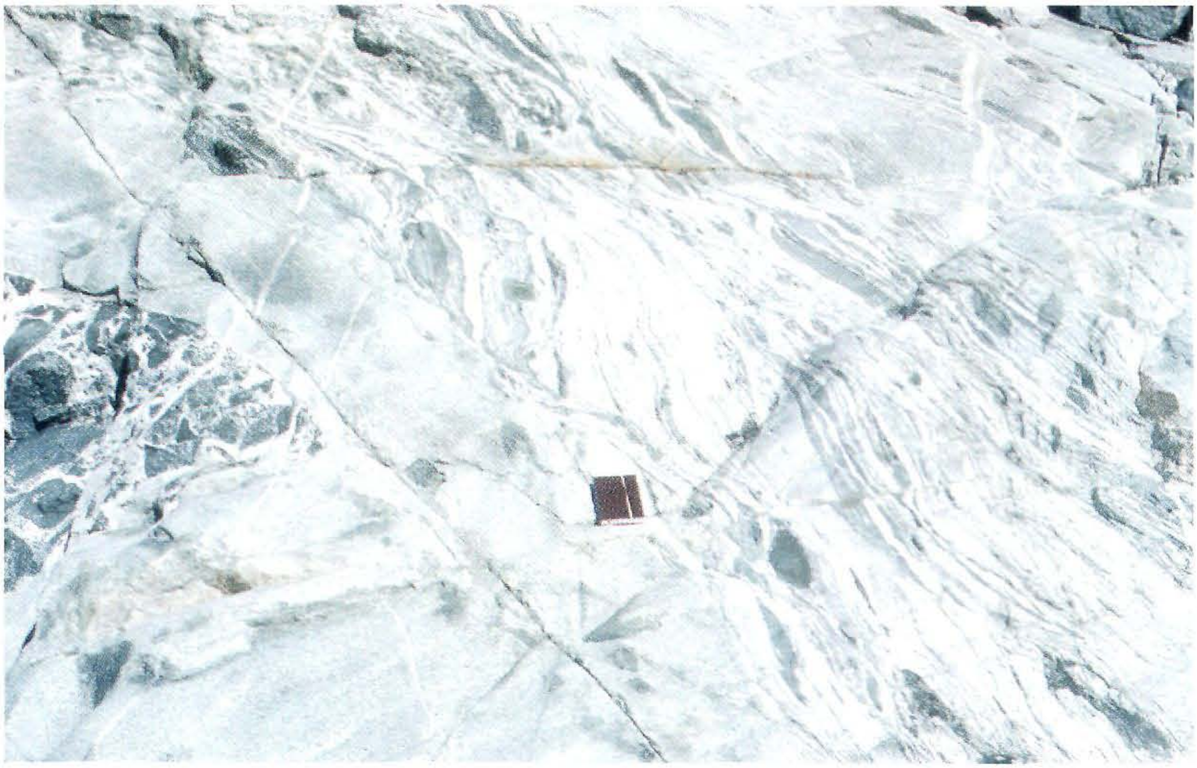

Fig. 2. Deformed granite with sigmoidal rafts of syntectonic amphibolite dykes and other lithologies, indicating sinistral transcurrent movement. The outcrop is located at the margin of a major, north-east trending shear zone in the southern part of the Julianehåb batholith.

ation on the east coast of South Greenland has not been located. Other major shear zones are situated in, or along, the margins of the fjords Unartoq and Søndre Sermilik, and in the eastern part of the peninsula Niaqornarsuk. Numerous smaller shear zones occur between the large ones, mostly trending between 40°–80°, also with indications of sinistral displacement. A conjugate set with dextral displacements trends *c.* 100°–120° but is less well developed.

Most of the rocks within the Julianehåb batholith have a weak to distinct vertical foliation. This mostly trends NE–SW and is intensified close to the major shear zones. The numerous amphibolite dykes which are found within the batholith commonly cut across the foliation in their host rock, but they are themselves frequently sheared and curve into shear zones. Apparently, the dykes intruded host rocks which mostly failed in a brittle condition, but locally yielded with plastic flow in the contemporaneous shear zones.

Chadwick *et al.* (in press) suggest that the shear zones were active during the emplacement of the Julianehåb batholith and dyke intrusion, and formed in response to sinistral transpression that was the result of oblique subduction of an oceanic plate from the south under the stable craton to the north-west.

Hydrothermal activity associated with deformation of the batholith and its possible significance for gold mineralisation

Regional stream sediment sampling programmes carried out in South Greenland by GGU and Nunaoil A/S have revealed that South Greenland in general, and the Nanortalik region in particular, have anomalous abundances of gold (see Steenfelt & Tukiainen, 1991). In 1992 Nunaoil A/S succeeded in locating a high-grade lode gold occurrence in mafic metavolcanic rocks just south of the area described here (Gowen *et al.*, 1993). This occurrence was drilled in 1993 by the joint venture Cyprus Greenland Corporation and Nunaoil A/S. Several mining companies also carried out follow-up prospecting on gold anomalies inside the Julianehåb batholith, mainly by narrowing the source areas of stream sediment gold anomalies with further sampling.

One of the objectives of the SUPRASYD project in 1993 was to identify possible gold mineralised localities and relate their setting to the regional geology. No visible gold was found during the field work. However, widespread hydrothermal activity has occurred which was associated with the shear zones of the batholith. The hydrothermal activity resulted in formation of quartz vein systems, silicification, chloritisation and minor carbonate alteration as well as dissemination of pyrite in the pluton, notably along the margins of sheared amphibolite dykes.

It may be speculated that the regional Proterozoic shear zones formed a plumbing system for auriferous fluids tapping either the deforming batholith itself or a deeper source, and that the host rocks in and adjacent to the shear zones, especially the sheared margins of amphibolite dykes, may have acted as traps for the mineralised fluids. Analysis of rock and chip samples collected this summer will test this hypothesis, and hopefully the results will establish the pattern of gold mineralisation in the Julianehåb batholith.

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