geological, geochemical and geophysical investigations. Two belts of Precambrian supracrustal rocks occur in the area; one is Archaean, the other is early Proterozoic in age. The Archaean belt is dominated by greenstones whereas the younger belt is composed of low grade metamorphic sedimentary rocks which unconformably overlie the Archaean rocks. Both supracrustal belts contain mineralizations which have been investigated principally by the Kryolitselskabet Øresund A/S in the mid-1980s. Mineralization types are varied, ranging from banded iron formations to small copper and zinc-bearing massive sulphides, through disseminated gold-bearing sulphides in volcaniclastic rocks to epigenetic gold and copper-bearing quartz-carbonate vein-like structures. A review of these mineral occurrences is planned, and will provide an assessment of the mineralizations in relation to their stratigraphic setting and the processes of mineralization.

Ivisârtoq. Field work carried out in the Archaean Malene supracrustal rocks of the Godthåbsfjord area concentrated on detailed geological investigation and chip sampling of previously located extensive scheelite-bearing calc-silicate horizons.

Scheelite was discovered in the Godthåbsfjord area in 1982, both as grains in heavy minerals from stream sediments and as *in situ* mineralizations (Appel, 1989). During the following years, a stream sediment sampling programme was carried out in the Godthåbsfjord area and scheelite was found to occur in heavy minerals from stream sediments over an area of more than 35 000 km^2.

Further field work revealed that the scheelite is confined to the early Archaean Isua–Akilia supracrustal rocks and to the mid Archaean Malene supracrustal rocks; gneisses and the intrusive granites proved to be barren. The scheelite occurrences in the younger Malene supracrustals appear to be the most promising from an economic point of view. These occurrences are associated with gahnite-bearing sulphide-rich horizons as well as with tourmalinites.

Work with ultra-violet light in the Godthåbsfjord area demonstrates that a single scheelite-bearing horizon can be traced intermittently for well over 3.5 km. This zone was discovered in 1987 and was 'chip sampled' in 1989. During the 1989 field season further extensive scheelite-bearing horizons were discovered in the Ivisârtoq area.

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A gold mine in East Greenland?

Troels F. D. Nielsen

The search for gold in Greenland has hitherto been concentrated in geological terrains such as Precambrian volcanics that elsewhere on earth are traditionally regarded as gold-bearing. However, as it happens, the first exploitation of gold in Greenland could well be from a truly new type of gold mineralisation.

It was a major scientific surprise that the Skaergaard intrusion in southern East Greenland (fig. 1) was shown to host a stratiform gold and platinum group metals mineralisation (Nielsen, 1989; Nielsen & Schønwandt, 1990). The discovery was made in conjunction with a 1986 GGU programme focusing on the economic poten-

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Searching for gold in southern East Greenland. The Skaergaard intrusion often shows a characteristic banding due to the density-controlled accumulation of minerals during the solidification of the intrusion. Photo: C. K. Brooks.

tial of the Tertiary intrusions in the Kangerdlugssuaq area, 68°N. Logistic cooperation was established with Platinova Resources Ltd. (hereafter Platinova) who initiated prospecting for precious metals between 66° and 69°N. The primary objective was to investigate the possibility for platinum group metals in the Tertiary gabbro intrusions related to the Lower Tertiary continental break-up of the North Atlantic.

The gabbro intrusions in the Kangerdlugssuaq area had previously been compared to gabbroic bodies of the ocean floor and ophiolites, and several have been demonstrated to be multiple intrusions, possibly involving pulses of high MgO basaltic liquids (Brooks & Nielsen, 1982). The fundamental similarities between the gabbro complexes in East Greenland and gabbro complexes with precious metal mineralisation such as Bushveld (RSA) and Stillwater (USA) suggested that precious metal reefs could have formed in the gabbro intrusions in the Tertiary of East Greenland.

The Skaergaard intrusion

The Skaergaard intrusion is a large stubby sill-like intrusion with a present surface exposure of about 7 × 10 km. The well layered gabbros dip 10 to 15° to the south; a tectonic effect of the coast-parallel flexure formed during continental break up in the North Atlantic. The lowermost part of the intrusion is exposed to the north; to the south the intrusion is hidden below the roof of slightly older tholeiitic lavas (fig. 2).

Wager & Deer (1939) divided the Skaergaard intrusion into three major structural units: (1) the Marginal Border Group along the floor and the walls of the magma chamber, (2) the Upper Border Group along the roof of the magma chamber and (3) the Layered Series, the main body of well layered gabbro. On the basis of the distribution of cumulus olivine the Layered Series is divided into three major zones; a Lower Zone (LZ) of olivine gabbro, an olivine-free Middle Zone (MZ) of two-pyroxene gabbro and an Upper Zone (UZ) in which iron-rich olivine reappears as a cumulus phase. These zones are subdivided into a number of subzones on the basis of other cumulus phases.

Wager & Deer demonstrated, on the basis of the phase layering and chemical evolution of minerals and calculated liquids, the differentiation of a tholeiitic magma by crystal fractionation and the Skaergaard intrusion became the type example for all petrologists.

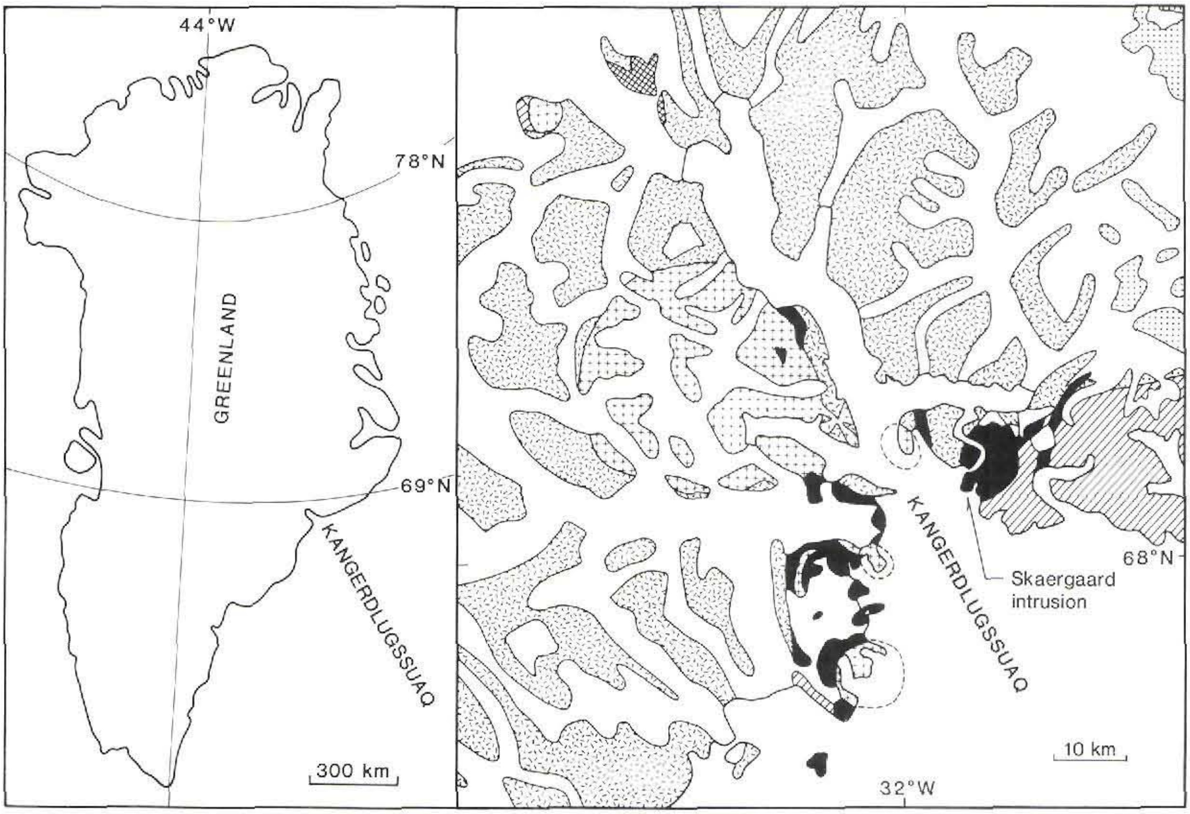

Fig. 1. Location of the Skaergaard intrusion between Ammassalik and Scoresby Sund in East Greenland. Skaergaard and other Tertiary mafic intrusions are shown in black; acidic intrusions shown by crosses. Hatched = Precambrian basement, dots = Cretaceous sediments, diagonal ruling = Tertiary lavas.

Although the intrusion has been extensively studied there are still doubts regarding the development of the complex – as evidenced by the recent discussions on the differentiation of the intrusion (see several papers in *Contributions to Petrology and Mineralogy,* vol. **104,** 1990).

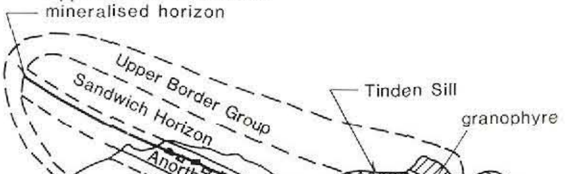

Fig. 2. Cross section of the Skaergaard intrusion showing the main divisions of the intrusive body and the location of the mineralised horizon.

The fact that the Skaergaard intrusion is regarded as formed from a single pulse of magma sets it apart from the other gabbro complexes with precious metal mineralisation. This type of mineralisation in gabbro intrusions is generally regarded as the result of interaction of contrasting magma pulses within the magma chamber followed by a redistribution of platinum group metals due to deuteric processes (e.g. Mcdonald, 1987).

The exploration work and the mineralisation

Heavy metal concentrates, stream sediment samples and grab samples have been collected by Platinova and GGU throughout the Kangerdlugssuaq area and some of the samples from the Skaergaard intrusion showed anomalous gold and platinum group metal values.

From 1987 onwards most of the exploration activity has been concentrated on the Skaergaard intrusion. The mineralised gabbro was localised in 1987 in a strata-bound horizon in the upper part of the Middle Zone of the intrusion (fig. 2).

The total area of the intrusion is close to 55 km^2 and the mineralisation is suspected to occur over an area of *c.* 40 km². Only a minor part of this area can be studied as the layers disappear below surface in the southern part of the intrusion (fig. 2).

Exploration throughout 1987 and 1988 concentrated on the exposed parts of the mineralised horizon. The first step was to collect lines of chip samples (5 and 10 m samples). Once located the mineralised horizon was re-sampled at 1/2 to 1 m intervals. The profiles showing the highest concentrations of gold and platinum group metals were also re-sampled from saw-cut channels and cores collected with hand-held drills.

The investigation of the horizon below sea level by diamond drilling (size BQ) of 9 deep holes began in 1989.

Some information has been made public by Platinova, and since 1989, by a joint venture of Platinova and Corona Corporation. At present average gold values of 2–3 g/t have been found in an upper 2–5 m thick layer of the mineralised horizon. Maximum gold contents are between 5 and 6 g/t. Both the thickness and the concentration of gold seem to increase toward the assumed centre of the intrusion, where the mineralised horizon is projected to occur at a depth of several hundred metres. The horizon also contains up to 3.5 g/t palladium and up the 1.5 g/t platinum. In general the ratio Pd/Pt is close to 10/1. A lower layer in the mineralised horizon is dominated by palladium but this appears at present to be less interesting from an economic point of view.

Even though average grades of gold are rather low compared to other underground mineralisations the deposit may have an economic future due to the large tonnage (probably more than 100 million tons) with possibly more than 150 tons of gold.

The future

Following reports in mining magazines the concessionaires intend to drill 12 000 m of core from the unexposed parts of the intrusion in 1990. Although there is still much exploration work to be carried out, a decision on the feasibility of a mining operation may not be more than a few years ahead. The establishment of such a mine would clearly have a major impact on the Greenland economy.

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Geochemistry in GGU

Feiko Kalsbeek

Chemical analyses are essential for many of GGU's activities, especially in the search and evaluation of mineral resources and in the study of rock units. GGU has a well-equipped laboratory for the analysis of rock material, and has a close cooperation with laboratories belonging to the Department of Geology of the University of Copenhagen and the Risø National Laboratory, Denmark. Special analyses that cannot be done in Copenhagen are carried out abroad under contract. Apart from the staff employed at the geochemical laboratory three geologists and one technician at GGU's Department of Geochemistry are engaged with geo-

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