



Regional geology and 1:500 000 mapping in North-East Greenland

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A three-year field mapping programme was initiated in 1988 aiming at regional geological studies and geological mapping in North-East Greenland between latitudes 75° and 78°N. This region encompasses relatively little known parts of the Caledonian fold belt and the overlying post-Caledonian sequences, which lie north of the better known regions of central East Greenland (Henriksen, 1989). Major aims of the programme include compilation a 1:500 000 geological map, and an understanding of the general geology of the region.

North-East Greenland is geologically part of the East Greenland Caledonian fold belt, which incorporates

substantial amounts of reactivated Precambrian crystalline units and an up to 15 km thick sequence of Proterozoic to Ordovician sediments folded and metamorphosed during the Caledonian orogeny. Caledonian granites are widespread to the south of latitude 75°N. The western foreland to the Caledonian fold belt is sporadically exposed in the inner nunatak zone beneath westwards-directed Caledonian thrust units (fig. 1). Post-Caledonian sequences of Upper Palaeozoic to Mesozoic sediments and Tertiary basalts are found in the coastal regions preserved in block-faulted remnants of coast-parallel sedimentary basins.



Almost 400 drums of aviation fuel will be used by aircraft operating out of GGU base camps during the 3 years of the programme in North-East Greenland. The empty drums are cut to a manageable size prior to removal by aircraft to approved collecting points, in accordance with National Park legislation designed to protect the environment. Photo: J. Lautrup.

Geological activities in the 1989 season included: (1) mapping of the crystalline complexes around and west of Dove Bugt (between 76° and 77°N); (2) continued sedimentological investigations in the Late Precambrian Eleonore Bay Group sediments of central East Greenland; (3) investigations of Upper Palaeozoic–Mesozoic sediments in relation to an evaluation of the hydrocarbon potential; (4) studies of the Tertiary basaltic lavas. Sampling for geochemical reconnaissance exploration was carried out in the region between 76° and 77°N. Glaciological studies of the Inland Ice margin were carried out by a group from the Alfred Wegener Institute, Bremerhaven.

Logistic background

This second season of the three-year mapping programme in North-East Greenland between 75° and 78°N was organised as an integrated activity between three institutions: Grønlands Landsmuseum (GL), Godthåb/Nuuk; the Alfred Wegener Institute for Polar and Marine Studies (AWI), Bremerhaven, West Germany; and the Geological Survey of Greenland (GGU), Copenhagen. GGU was responsible for the logistical organisation of the field work on behalf of all groups. In addition to the three main co-operating institutions, support was also given to five smaller groups working in the region. Twenty-five of the 47 expedition members were from GGU, although some participants stayed for only part of the season. The field season extended from July 1st to August 31st.

A tent base camp was established near Hvalrosodden (76° 57'N, 20° 07'W) where a small landing strip adequate for STOL aircraft was prepared. Two small helicopters from Uni-Fly, Svendborg, and a Twin Otter aircraft from Flugfélag Norðurlands, Akureyri, were chartered through Greenlandair Charter for local transport. A C-130 Hercules transport aircraft from the Royal Danish Air Force flew the expedition to and from Greenland.

At the end of the season a depot of equipment was established at Hvalrosodden in preparation for the 1990 season.

Crystalline complexes

Investigations in the crystalline rocks of the Caledonian fold belt in 1988 (Henriksen *et al.*, 1989) and in 1989 reveal a very complex development. In the gneiss regions (fig. 1) there is evidence for the existence of early Precambrian rock units (*c.* 3000 million years old) and later Precambrian, middle to early Proterozoic, units (*c.* 2000 million years old) (F. Kalsbeek & P. N.

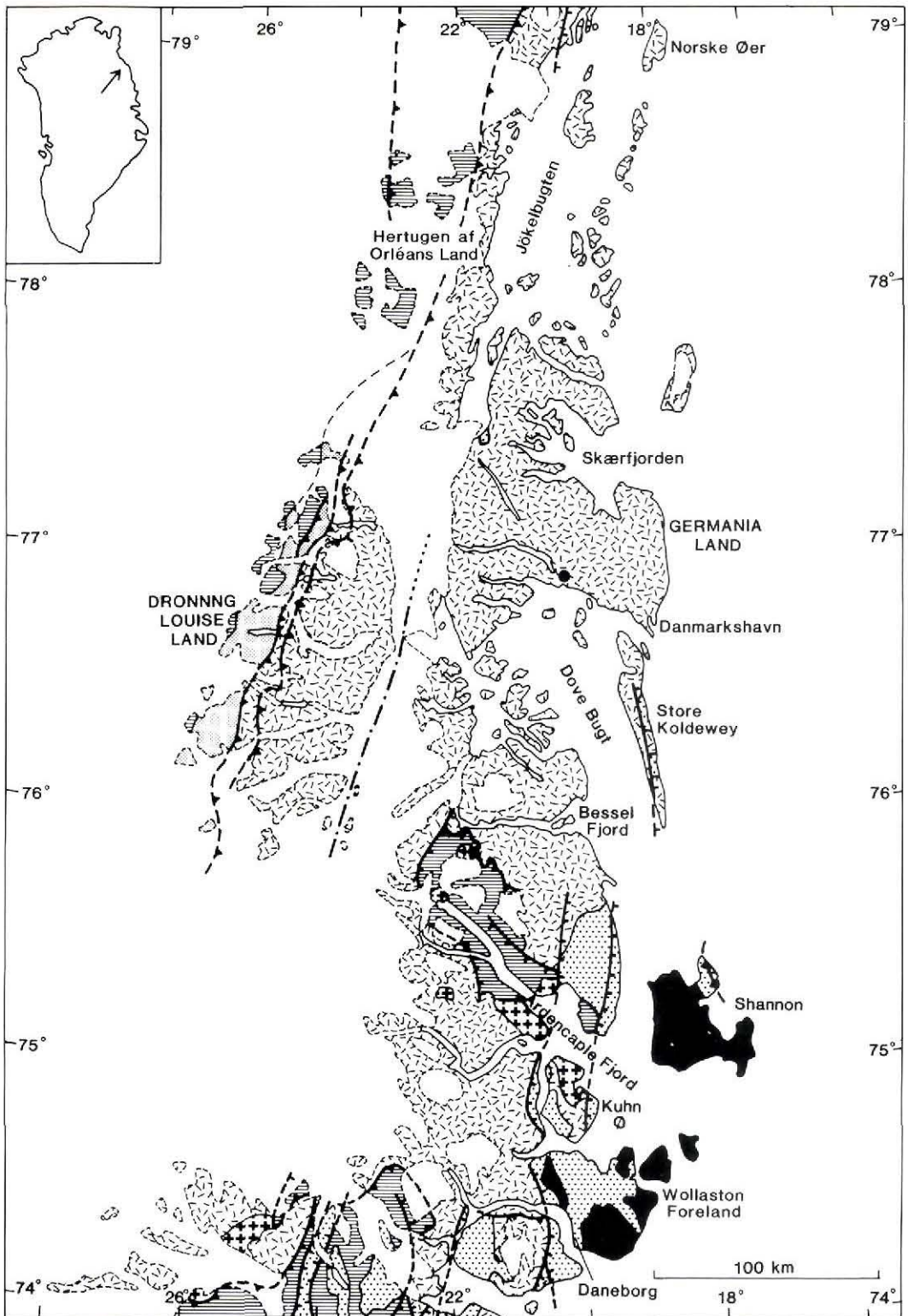
Taylor, personal communication, 1989). South of Bessel Fjord an extensive sequence of strongly folded and metamorphosed rusty schists (the Smallefjord sequence) occurs interfolded with the Precambrian gneisses, and is interpreted as a probable middle(?) Proterozoic (1200–1000 million years old?) sedimentary sequence.











The area studied in 1989 encompasses the region between Bessel Fjord (*c.* 76°N) and Germania Land (*c.* 77°N), including the large nunatak area of Dronning Louise Land. Geologically it comprises an outer western sector of the Caledonian fold belt and its foreland (in Dronning Louise Land), and a sector of the interior part of the fold belt dominated by crystalline rocks around Dove Bugt.

The Dronning Louise Land area was mapped by two teams (Friderichsen *et al.*, 1990). The area consists mainly of an old Precambrian gneiss complex (late Archaean – early Proterozoic), overlain by two Precambrian sedimentary cover sequences; the latter can be compared with two similar successions in North Greenland, which are respectively 1350 and 700–550? million years old (see Friderichsen *et al.*, 1990).

Structurally the Dronning Louise Land area has been divided into four tectonic zones: (1) a western foreland zone of gneisses overlain by two little-deformed cover sequences; (2) a Caledonian thrust zone of strongly deformed interleaved gneisses and sediments (imbricate zone); (3) an eastern 'hinterland' of gneisses with thin bands of infolded sediments, largely reworked during the Caledonian orogeny; (4) a NNE–SSW trending shear zone of strongly deformed gneisses, which structurally separates Dronning Louise Land from the crystalline areas around Dove Bugt. Stratigraphical evidence indicates that the general N–S structural pattern in Dronning Louise Land is of Caledonian age.

The Dove Bugt area between Bessel Fjord and Germania Land was mapped by two teams (Chadwick *et al.*, 1990). The region here is quantitatively dominated by granitic intrusive rocks, now quartzo-feldspathic orthogneisses. Narrow strips of metamorphosed sediments (now schists and marbles) and basic intrusive rocks (now amphibolites), which appear to be older than the surrounding gneisses, occur within the orthogneisses. Radiometric isotopic ages of the crystalline rocks in the region immediately south of Dove Bugt suggest emplacement and deformation in the period *c.* 3000–2000 million years ago, with an uncertain degree of reactivation during the Caledonian orogeny *c.* 450–400 million years ago. The area is intensely folded with fold patterns which are the consequence of several superimposed episodes of deformation.



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|------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------|
|  Tertiary basalts |  Caledonian granites |
|  Post-Caledonian sediments |  Schists & gneisses in Caledonian fold belt |
|  Proterozoic - Ordovician sediments |  Gneisses of Greenland shield |
|  Thrust |  Fault |
|  Shear zone |  Base Camp 1989 - 1990 |

Late Precambrian sediments in the Caledonian fold belt

Sedimentological studies of the late Precambrian Eleonore Bay Group were continued in 1989, with detailed investigation of a c. 1000 m thick sequence of mudstones and carbonates (the Multicoloured series) which forms the middle part of the up to 5 km thick Upper Eleonore Bay Group. The study was undertaken by a two-man party (Sønderholm & Tirsgaard, 1990) in the region between Strindberg Land (74°N) and Mesters Vig (72° 15'N), i.e. some distance to the south of the expedition's main working area. This work was partially financed by a grant from the Danish Natural Science Research Council (Statens Naturvidenskabelige Forskningsråd).

The Eleonore Bay Group was laid down on a broad marine stable shelf at the margin of the Greenland shield area, in an early precursor to the North Atlantic Ocean (the Iapetus Ocean). The sediments forming the Multicoloured series have a very uniform development which allows detailed lateral correlation over most of the studied area, about 200 km from north to south. Within the sequence a change in type of deposition can be demonstrated, from a lower part with erosional derived material to an upper part with chemically precipitated sediments. Samples were collected for a pilot study in chemical stratigraphy and with a view to isotopic dating of this non-fossiliferous sequence.

Post-Caledonian sediments

The continued investigations of the onshore hydrocarbon potential north of 73°N in East and North-East Greenland (Marcussen *et al.*, 1988) included in 1989 a survey by one team of the Mesozoic sediments around Dove Bugt. Previously recognised deposits on the east side of the island Store Koldewey were remapped and investigated (Stemmerik & Piasecki, 1990). The sequence was shown to include Middle Jurassic to Early Cretaceous sediments preserved in small fault block areas.

Supposed occurrences of post-Caledonian deposits indicated at seven localities between 76° and 78° 30'N on Haller's (1983) map were confirmed at only one of the indicated localities. At the remaining six localities only Quaternary sediments were found. This suggests that the Mesozoic sedimentary basin known from onshore East Greenland does not extend as far north as previously assumed. The northernmost known exposures are now those found in the Dove Bugt region.

Fig. 1. Geological sketch map of North-East Greenland.

Tertiary basalts

A more than 800 m thick succession of Tertiary basaltic lavas is exposed in the coastal region between Hold with Hope (73° 30'N) and the island Shannon, preserved in fault blocks divided by a series of NNE–SSW faults. The basalts were investigated by a party of three (W. S. Watt, M. Watt & P. Nordgerd) with the aim of establishing a regional basalt stratigraphy which could be compared with other parts of the East Greenland basalt succession. In addition an investigation of the magnetic characteristics of the basalts will be undertaken as a basis for interpretation of airborne magnetic data, especially from the shelf area. The magnetic programme is carried out in collaboration with the Geophysical Institute of Aarhus University, with support from the Danish Natural Science Research Council (Statens Naturvidenskabelige Forskningsråd).

Glaciology

A glaciological party (Niels Reeh, Hans Oerter and Anne Letrégilly) from the Alfred Wegener Institute for Polar and Marine Studies, Bremerhaven, West Germany (AWI), carried out a field programme aimed at studying the present dynamic and climatic conditions of the margin of the Inland Ice west of Germania Land (c. 77°N). Movement of the ice and the amount of melting/accumulation of ice and snow was studied along a 60–70 km long profile line extending WNW from the ice margin.

A major part of the glaciological programme was the collection of more than 2000 ice samples for oxygen isotope analyses. These samples were taken from the ice surface over a c. 1700 m long profile near the Inland Ice margin. The analyses of oxygen isotopes from these samples are expected to provide a record of climatic variations over the past 100 000 years.

Geochemical exploration reconnaissance

A geochemical exploration programme based on collection of stream and sediment samples was carried out for the whole area between 76° and 77°N. In total about 200 silt and sand samples and accompanying water samples were collected, corresponding to a sampling density of one sample to 30 km². The collections were made by all field parties working in the area. All samples will be analysed geochemically for about fifty elements. The resulting data will provide information on the general distribution pattern of chemical elements, and may reveal anomalies which could lead to mineral prospecting in the region.

Topographic mapping

Geological mapping in 1989 was concentrated in an area from which there were no recent detailed topographic maps. Thus, prior to the field season a new set of 1:100 000 maps with 100 m contour intervals was prepared by GGU's photogrammetric laboratory, based on aerial photographs and ground control points supplied by Kort- og Matrikelstyrelsen (KMS) in Denmark. According to an agreement between GGU and KMS the topographic maps will be used by KMS as a basis for their own production of 1:100 000 orthophotographic maps.

Status

The second season of the North-East Greenland programme mapped the whole of Dronning Louise Land and most of the Dove Bugt region. Only the area north of Dove Bugt, which will be covered in 1990, remains unmapped. General geological investigations in the late Precambrian sediments (Eleonore Bay Group), the Mesozoic sediments and the Tertiary basalts were all carried out as planned, and the glaciological field investigations by the AWI group were also successful in all respects.

It is planned that the present co-operation between GGU, Grønlands Landsmuseum and the Alfred Wegener Institute will continue in 1990 and preparations for this field season have already been initiated with establishment of depots of equipment, provisions and fuel.

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