Systematic 1:500 000 mapping in the Peary Land region, North Greenland

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The third and last year of a systematic field mapping programme in eastern North Greenland was carried out from June to August 1980. The work concluded the field investigations for the 1:500 000 map sheet, while in addition reconnaissance investigations were carried out to the south of the planned map sheet boundary at 81°N latitude (fig. 3). As an integrated part of the mapping, general geological investigations were included in the research. As in the previous two years the logistic back-up for the expedition was arranged in co-operation with a surveying group from the Geodetic Institute, Copenhagen, who established ground control data for new topographical maps of North and North-East Greenland.

As in the two first years a tent base camp at the mouth of Jørgen Brønlund Fjord served as an operation centre for the expedition. Two small helicopters and a STOL aircraft were based here, and served the expedition groups with transport facilities throughout the season. Mobilisation and demobilisation of the expedition from Denmark was carried out with help from the Royal Danish Air Force, who airlifted the expedition to and from Station Nord. The GGU group numbered 35, comprising 12 geological two-man parties and 11 supporting personnel including aircraft crews.

The geological parties were divided into several working groups, each covering a specific area or topic. The major activity was concentrated in Kronprins Christian Land which had not been systematically investigated during the first two years. In north-western Peary Land mapping in the North Greenland fold belt was continued. After the three years' fieldwork in eastern North Greenland the planned systematic geological mapping and general investigations have been completed, and compilation of results is well under way.

A large amount of geological information has been obtained from a region not hitherto systematically studied. Preliminary results from the expeditions have been presented in two special reports ('Report on the 1978 geological expedition to the Peary Land region, North Greenland' and 'Report on the 1979 geological expedition to the Peary Land region, North Greenland': *Rapp. Grønlands geol. Unders.* no. 88, 1979 and no. 99, 1980). A similar report is planned for the 1980 work. The present report is based on an internal GGU report ('Express report, GGU Peary Land 1980') contributed to by all the participating geologists immediately after the end of the field season.

Geological investigations

The eastern part of North Greenland is composed of six major geological units: (1) a more than 8000 m thick succession of flat-lying Proterozoic – Silurian platform sediments with a *c.* 1000 m thick basalt sequence in the Proterozoic part; (2) the east–west trending Lower Palaeozoic North Greenland fold belt, which covers the region mainly north of Frederick E. Hyde Fjord; (3) the northernmost part of the East Greenland Caledonides, which outcrops in Kronprins Christian Land and has NNE structural trends; (4) scattered outcrops of

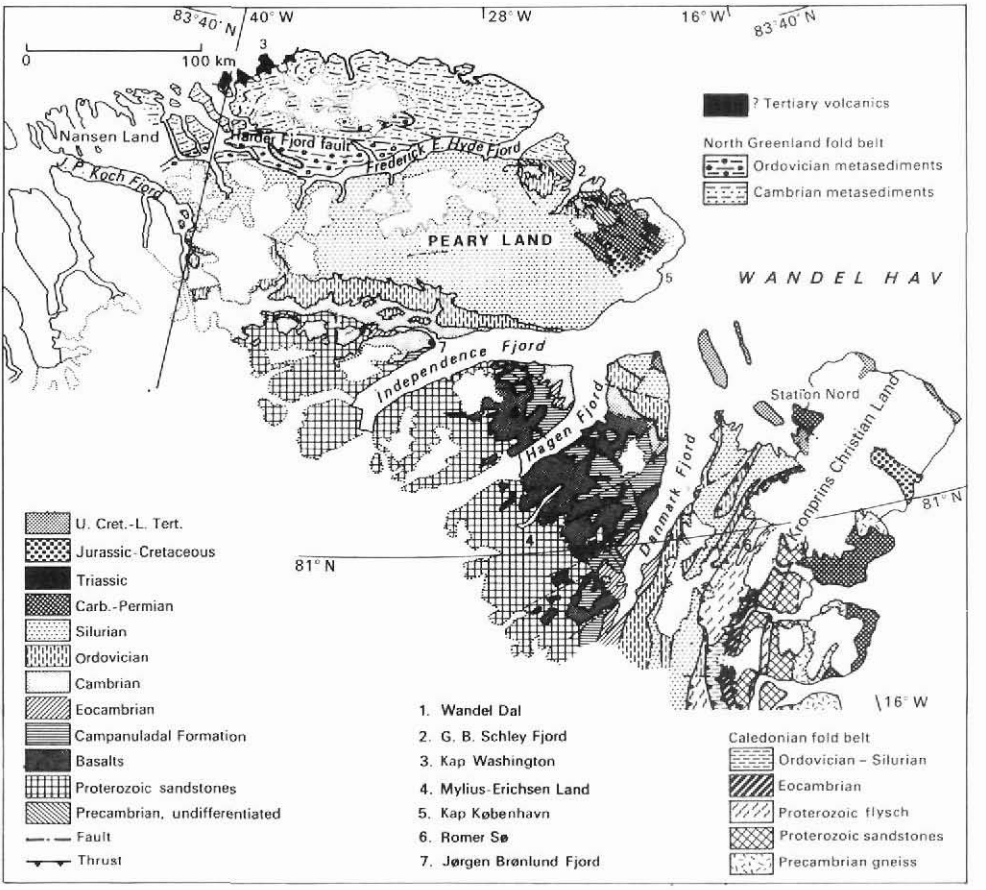

Fig. 3. Geological sketch map of the Peary Land region, eastern North Greenland, showing results of mapping in 1978–1980.

Precambrian crystalline basement rocks found below the Caledonian units in eastern Kronprins Christian Land; (5) an Upper Palaeozoic – Tertiary sedimentary sequence (3000 m thick) forming the Wandel Sea Basin, which outcrops mainly in the eastern coastal areas of the region; and (6) the Tertiary(?) volcanic Kap Washington Group (4–5 km thick) which is found in a small area at the rim of the Arctic Ocean in north Peary Land. The general geology of the area is described in the two reports from the 1978 and 1979 expeditions (*Rapp. Grønlands geol. Unders.* no. 88, 1979 and no. 99, 1980).

Investigations of the platform sequence were mainly carried out in the first two years, while this year's work included mainly the mapping of the Lower Palaeozoic sequence to the east of Danmark Fjord. Here the investigations were carried out by H. A. Armstrong, J. R. Ineson, P. D. Lane, (all Keele Univ.) and J. S. Peel (GGU). The identified sequence corresponds generally to the previously recognised units from the Peary Land area (for pre-1980 references see Peel, 1980), and it was possible to distinguish the same mapping

units in both areas. Of special interest is the widespread occurrence of Silurian carbonate mounds, comparable to those already known from Peary Land. The platform sequence to the east of Danmark Fjord occurs on a foreland immediately in front of the Caledonian fold belt. The rocks are therefore slightly affected by deformation, and small scale thrusts, and reverse faults trending parallel to the fold belt are common.

In addition to mapping in the Danmark Fjord area, the investigations of the Lower Palaeozoic rocks included detailed stratigraphical studies and collection of both macro- and microfossils from specific units. These special studies aim at establishing the stratigraphy and the sedimentological development of the Lower Palaeozoic platform sequence.

Investigations in the North Greenland fold belt continued this year when J. D. Friderichsen, A. K. Higgins (both GGU) and N. J. Soper (Sheffield Univ.) mapped the western part of the area as far west as eastern Nansen Land. They were able to trace the same major lithostratigraphical units distinguished last year (Soper *et al.*, 1980) and continue to use these as mapping units in the western part of the area. These units form a sequence of four groups of sediments which were deposited on the edge of the continental slope, and make up a thick series of Lower Palaeozoic turbiditic rocks. In the northernmost part of the fold belt these rocks are metamorphosed and the detailed stratigraphical division cannot always be maintained; in such cases it has only been possible to map lithological units. Three phases of deformation have been distinguished in the east–west trending fold belt. The intensity of deformation increases northwards and the folds have generally a northerly vergence. Axial plane cleavage and schistosity are developed in relation to the two first phases of deformation. The diastrophism of the fold belt is mainly of an Upper Palaeozoic age (Devonian?), but later important Tertiary(?) thrusting has brought Lower Palaeozoic folded sediments on top of Permian sediments and volcanics of the Kap Washington Group.

The northernmost part of the Caledonian fold belt in East Greenland outcrops in Kronprins Christian Land. Reconnaissance mapping in local areas has previously been carried out in connection with Lauge Koch's 'Danish Expeditions to East Greenland 1926–58', and regional compilations based on these observations and extensive photo-interpretation have been published by Haller (1970). Systematic investigations of the area north of 81°N latitude and reconnaissance mapping farther south were carried out in 1980 by two parties. H. F. Jepsen and F. Kalsbeek (both GGU) studied the Proterozoic sandstones and associated intrusives in the core zone of the fold belt, especially with respect to the age of this sector of the fold belt which was previously thought to reflect a pre-Caledonian orogeny – termed the Carolinidian orogeny (Haller, 1961). The investigations comprised both stratigraphical and structural studies and collection of material for radiometric age determinations. As a preliminary result it has been possible to correlate folded Proterozoic sandstones with the *c.* 1350 m.y. old unfolded Independence Fjord Group (Collinson, 1980) occurring in the foreland area north-west of Danmark Fjord. A gneissic and migmatitic complex found to the east of the folded Proterozoic sandstones in Kronprins Christian Land is probably a remnant of an older crystalline basement. The folded Proterozoic sandstones with their intrusive basic sills and dykes are conformably overlain by various younger sediments, and at some localities a basal conglomerate occurs. The basic intrusions do not extend into these younger sediments, but a major unconformity between the Proterozoic sandstones and the younger sediments has not been found. Structural investigations in both the folded Proterozoic sandstones and in the younger sediments have not revealed any differences in fold and lineament trends, and it has not been possible to find structural indications of differences in

tectonic style and trend between the older and the younger sedimentary sequence. Jepsen and Kalsbeek have not, therefore, found evidence to support arguments for a separate Carolinidian orogeny.

To the west of the folded Proterozoic sandstone sector occurs a belt of large westward directed thrusts. These are made up of a more than 2000 m thick series of Upper Proterozoic clastic sediments dominated by flysch in its lower parts. The stratigraphy and structure of this part of the fold belt were studied by J. M. Hurst (GGU) and W. S. McKerrow (Oxford Univ.) who mapped the zone for a distance of *c.* 150 km along its trend. They correlated the upper units of the sediments with Upper Proterozoic strata known from the foreland area (Campanuladal Formation, Fyns Sø Formation), and concluded, in agreement with previous investigations by Fränkl (1955), that the thick flysch succession in the thrust belt is of Proterozoic age. Structural studies indicate that the zone is composed of a series of large westwards directed thrusts, which have brought deep trough sediments in contact with the platform deposits on the foreland area.

Systematic mapping of the Upper Palaeozoic – Tertiary Wandel Sea Basin deposits was initiated in 1978 (Håkansson, 1979) and continued in 1980 by E. Håkansson, C. Heinberg and L. Stemmerik (all Copenhagen Univ.). The investigations were concentrated in the southern part of the basin area where the main exposures outcrop in the coastal areas east of Kronprins Christian Land and on the islands to the north. The Upper Palaeozoic sequence includes more than 1000 m of continental to marine sandstones and limestones, which in the upper part are very fossiliferous. In north-eastern Kronprins Christian Land a previously unknown Mesozoic sequence was discovered. The sequence includes fine-grained sandstones and shales of probable Upper Jurassic age, and similar sediments of Upper Cretaceous age. Isolated exposures of Wandel Sea Basin sediments outcropping in the Harder Fjord fault zone and below the Kap Washington Group volcanics were also visited this summer. A more than 900 m thick sequence of Carboniferous – Permian fossiliferous cherty limestones and shales, including 300 m of sills, was recorded below the volcanics.

The Kap Washington volcanics outcrop in a *c.* 50 km long zone along the north coast of Peary Land. They are exposed below thrusts which bring the Lower Palaeozoic fold belt units in contact with the volcanics. The volcanic sequence is probably of Tertiary age. Systematic investigations of the volcanic succession were carried out by P. E. Brown and I. Parsons (both Aberdeen Univ.). They recorded a succession of more than 4–5 km thickness, comprising andesites, agglomerates and breccias, and rhyolites. The volcanics outcrop on four isolated peninsulas and are separated from each other by thrust faults. At the base of the volcanics and interbedded with its lower part occurs a thin sequence of black shale and sandstones. Black shales have also been found interbedded with the volcanics at a higher level, and in the shales of both levels plant debris has been found.

A group of small volcanic centres cutting Lower Palaeozoic folded rocks was found in 1979 between the Harder Fjord fault and Frederick E. Hyde Fjord (Soper *et al.*, 1980; Pedersen, 1980). These intrusive centres were investigated in detail in 1980 by I. Parsons (Aberdeen Univ.) who found that all centres were discordant volcanic pipes filled with intensely brecciated rocks. The volcanic material is mainly gabbro, agglomerate and serpentinite. The centres post-date the main regional tectonism.

The palaeomagnetic programme started in 1979 (Abrahamsen & Marcussen, 1980) was continued this year by C. Marcussen (Århus Univ.), who completed the collection of orientated rock samples from a representative suite of rock types reflecting the Proterozoic

to Cainozoic development in North Greenland. This year 685 orientated samples were collected mainly representing the Upper Proterozoic to Lower Palaeozoic platform sequence, and the interglacial sediments found last year at Kap København in easternmost Peary Land (Funder & Hjort, 1980). Associated with the palaeomagnetic work, O. Bennike (Copenhagen Univ.) made Quaternary geological investigations, especially concentrating on the interglacial sediments at Kap København.

An initial evaluation of the hydrocarbon potential of the Peary Land region was undertaken by F. Rolle (GGU) who collected material for source rock analyses, and made detailed sedimentological studies of special rock units. Investigations were carried out in the Lower Palaeozoic platform succession, in some units in the fold belt, and in the Mesozoic Wandel Sea Basin. Middle and Upper Cambrian black carbonates are of interest, as some are bituminous and have source rock characteristics.

Ole Larsen (Copenhagen Univ.) collected samples for radiometric Rb-Sr dating. This programme was initiated in 1979 by N. Springer (Copenhagen Univ.), and this year's sampling was therefore aimed at supplementing the 1979 work. The main collections were for dating some of the key units in the Proterozoic sediments of the platform, and for further work on the Kap Washington volcanics. Additional samples from metamorphic schists and other rocks from the North Greenland fold belt were also collected. With the present collections from the Peary Land region it is hoped that dates from a representative sequence of Proterozoic to Tertiary events may be obtained. The first results from this programme are already published (Larsen & Graff-Petersen, 1980; Kalsbeek & Jepsen, 1980).

The regional geochemical survey, which has been carried out as an integrated part of the mapping project (Ghisler *et al.*, 1979; Henriksen, 1980), was continued this year with the collection of stream sediments. The purpose is to obtain an evaluation of the mineral potential and to collect general geochemical data from the region. This year about 350 samples were collected, mainly from areas which were not previously visited. Most samples were collected on a reconnaissance basis, but special, more detailed collections were also made from areas which were known from previous investigations to contain geochemical anomalies. Moss and soil samples were collected to evaluate their suitability as samples for plant geochemical investigations to be carried out by P. Mølgaard (Copenhagen Univ.).

The possibility of a geological comparison between North Greenland and Svalbard was preliminarily investigated by T. Winsnes (Norsk Polarinstitutt, Oslo) who participated as a guest in the field work and worked through a representative section of the Proterozoic – Mesozoic sequence.

With the termination of this year's field work the first phase of the Survey's North Greenland mapping project has been fully accomplished. The data obtained will be worked up in the coming years and published in due course. The 1:500 000 map covering the area from east of 40°W longitude and north of 81°N latitude will be compiled and published as a fully coloured map. Preliminary maps will be published in black and white together with the annual expedition reports. The second phase of the North Greenland mapping project will include the central part of North Greenland between J. P. Koch Fjord in the east and Hall Land in the west. The field work for this phase is planned for 1983 and 1984.

References

Abrahamsen, N. & Marcussen, C. 1980: Preliminary results of rock- and palaeomagnetic field work in Peary Land, North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 137–145.

Collinson, J. D. 1980: Stratigraphy of the Independence Fjord Group (Proterozoic) of eastern North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 7–23.

Fränkl, E. 1955: Weitere Beiträge zur Geologie von Kronprins Christians Land (NE-Grönland). *Meddr Grønland* **103** (7), 35 pp.

Funder, S. & Hjort, C. 1980: A reconnaissance of the Quaternary geology of eastern North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 99–105.

Ghisler, M., Henriksen, N., Steenfelt, A. & Stendal, H. 1979: A reconnaissance geochemical survey in the Proterozoic–Phanerozoic platform succession of the Peary Land region, North Greenland. *Rapp. Grønlands geol. Unders.* **88,** 85–91.

Haller, J. 1961: The Carolinides: an orogenic belt of late Precambrian age in Northeast Greenland. *In* Raasch, G. O. (edit.) *Geology of the Arctic* **1,** 155–159. Toronto U.P.

Haller, J. 1970: Tectonic map of East Greenland (1:500 000). *Meddr Grønland* **171** (5), 286 pp.

Henriksen, N. 1980: Collection of stream sediments for a reconnaissance geochemical survey from the Peary Land region, North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 119–120.

Håkansson, E. 1979: Carboniferous to Tertiary development of the Wandel Sea Basin, eastern North Greenland. *Rapp. Grønlands geol. Unders.* **88,** 73–83.

Kalsbeek, F. & Jepsen, H. F. 1980: Preliminary Rb-Sr isotope evidence on the age and metamorphic history of the North Greenland crystalline basement. *Rapp. Grønlands geol. Unders.* **99,** 107–110.

Larsen, O. & Graff-Petersen, P. 1980: Sr-isotopic studies and mineral composition of the Hagen Bræ Member in the Proterozoic clastic sediments at Hagen Bræ, eastern North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 111–118.

Pedersen, S. A. S. 1980: Regional geology and thrust fault tectonics in the southern part of the North Greenland fold belt, north Peary Land. *Rapp. Grønlands geol. Unders.* **99,** 79–87.

Peel, J. S. 1980: Geological reconnaissance in the Caledonian foreland of eastern North Greenland with comments on the Centrum Limestone. *Rapp. Grønlands geol. Unders.* **99,** 61–72.

Soper, N. J., Higgins, A. K. & Friderichsen, J. D. 1980: The North Greenland fold belt in eastern Johannes V. Jensen Land. *Rapp. Grønlands geol. Unders.* **99,** 89–98.

Comparative note on the Precambrian basement of southern Inglefield Land and eastern Ellesmere Island

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A one-week visit to southern Inglefield Land, by the GGU motor cutter *K. J. V. Steenstrup* in conjunction with P. R. Dawes's geological studies in North-West Greenland, provided an opportunity to examine the Precambrian crystalline basement between Sunrise Pynt and Kap Alexander (fig. 4). The basement exposures face those on eastern Ellesmere