
# Systematic geological mapping in 1985 in central and western North Greenland.

## General introduction to the present collection of papers

*Niels Henriksen*

The fifth and final field season in GGU's North Greenland programme (1978–80, 1984–85) comprised geological mapping and general geological investigations in the region between J. P. Koch Fjord (40°W) and Washington Land (65°W), the same area as the 1984 investigations.

A working party of 40 participants, consisting of 12 geological two-man teams, a four-man drilling team and 12 supporting personnel, including aircraft crews, worked in the region for two months during the summer. The preliminary results of the geological work are presented in in this report.

*N. H., Grønlands Geologiske Undersøgelse, Øster Voldgade 10, DK-1350 Copenhagen K, Denmark.*

The final field season in the Survey's five-season North Greenland programme took place from mid-June to late August 1985. As in 1984, the work in 1985 was carried out in the region between Nansen Land/J. P. Koch Fjord and Petermann Gletscher, whereas the field work in the three first seasons from 1978–80 included the Peary Land and Kronprins Christian Land region of central and eastern North Greenland. A systematic field mapping programme was carried out during all five seasons with the aim of producing two 1:500 000 geological map sheets as well as a variety of regional geological studies. Reports from the first four field seasons have been published (GGU, 1979, 1980, 1981, 1984); the present report primarily deals with the results of the 1985 field work.

The expedition in 1985 numbered 40 participants (fig. 1), comprising 12 geological two-man parties, a four-man drilling team and 12 supporting personnel including aircraft crews. Transport to and from North Greenland of equipment, provisions and personnel was by air. Operations in the working area were supported by helicopters and a small fixed-wing STOL aircraft. Danish C–130 transport aircraft of the Royal Danish Air Force carried the expedition to and from Canadian Forces Station (C.F.S.) Alert in north-east Ellesmere Island which, as in 1984, supported the expedition with transit and back-up facilities during the season. The expedition's chartered Twin Otter transported participants and equipment from Alert to the working area in North Greenland and maintained frequent connections between C.F.S. Alert and the expedition group during the season.

The tent base camp in south-eastern Warming Land established in 1984 also served as an operation centre for the 1985 expedition. Two chartered Jet Ranger helicopters and the Twin

Fig. 1. Participants in the 1985 expedition in the tent base camp in Warming Land.

Otter were based here together with the support personnel, and regular radio communication was maintained between the base and all geological field parties and aircraft during the season.

The geological field work was organised along the same general lines as in 1984, and much of the 1985 programme represented a direct continuation of the activities of the previous year. Each of the two-man geological parties worked with specific subjects or areas of responsibility. Activities were spread over a region extending 500 km from east to west and 150–200 km from south to north.

The basis for the geological mapping was a set of topographic and photogeological maps at a scale of 1:100 000 with 50 m contours covering the entire region, prepared photogrammetrically at GGU on the basis of control points established by the Geodetic Institute (GI) (Henriksen, 1985). Aerial photographs at scales of 1:50 000 and 1:150 000, and orthophotos at 1:100 000, were also supplied by GI, Copenhagen. A new set of 1:100 000 GI orthophoto maps of North Greenland is in preparation, but only a few maps from the Nansen Land area were printed and available before the field season.

In North Greenland Proterozoic and Early Palaeozoic sedimentary rocks are developed to the north of the Precambrian crystalline Greenland shield; the latter outcrops only around the head of Victoria Fjord (fig. 2). In the eastern part of North Greenland, a thick, undeformed, Middle Proterozoic sequence of fluvio-lacustrine sandstones (Collinson, 1983) forms the oldest sediments above the crystalline basement, and these are overlain by an up to 1300 m thick Middle Proterozoic basalt succession (Kalsbeek & Jepsen, 1984). These are followed by Upper Proterozoic shallow marine sandstones and siltstones with some carbonate units (Clemmensen, 1979) and tillite-bearing diamictites (Bevins *et al.*, in press).

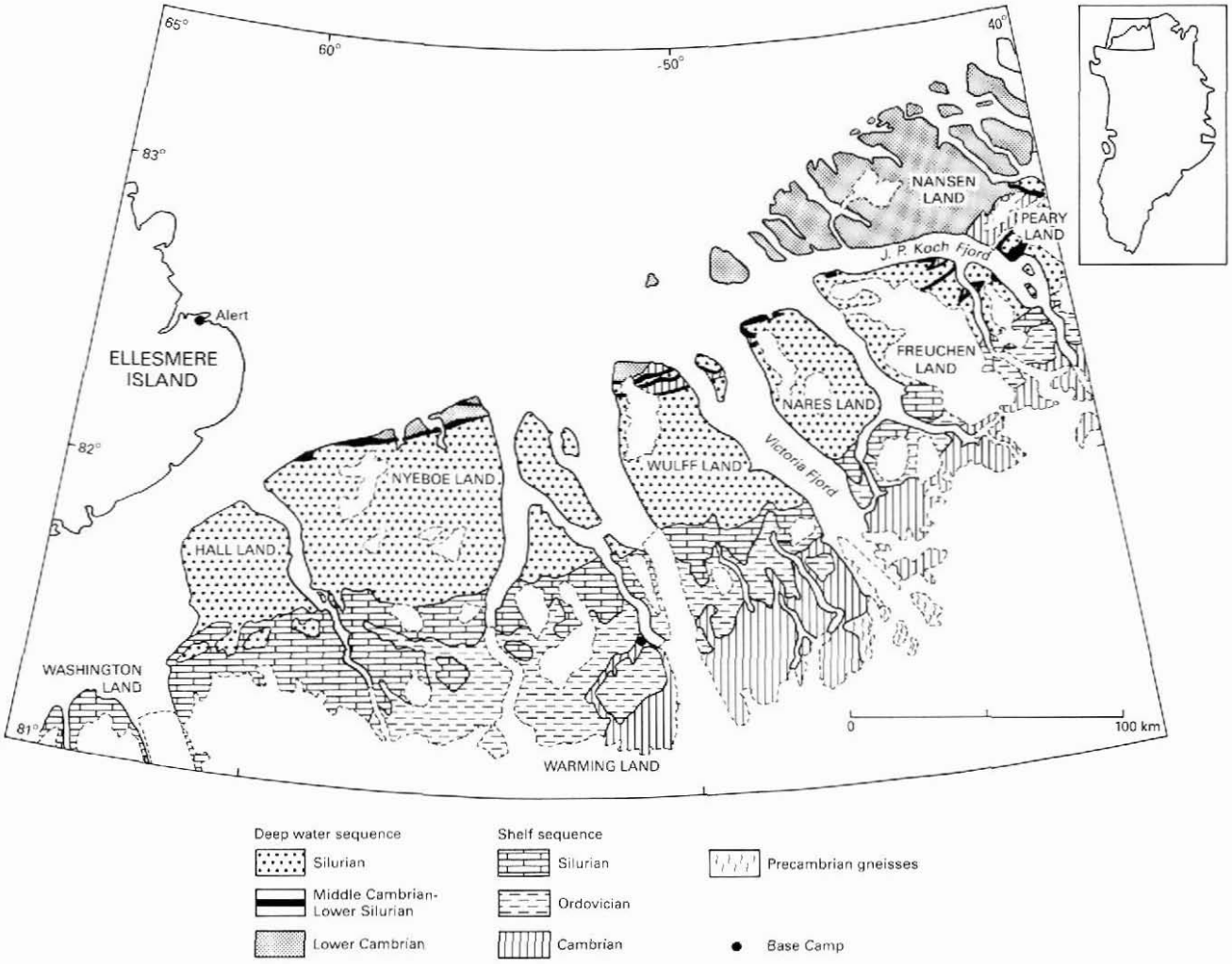


Fig. 2. Geological sketch map of central and western North Greenland.

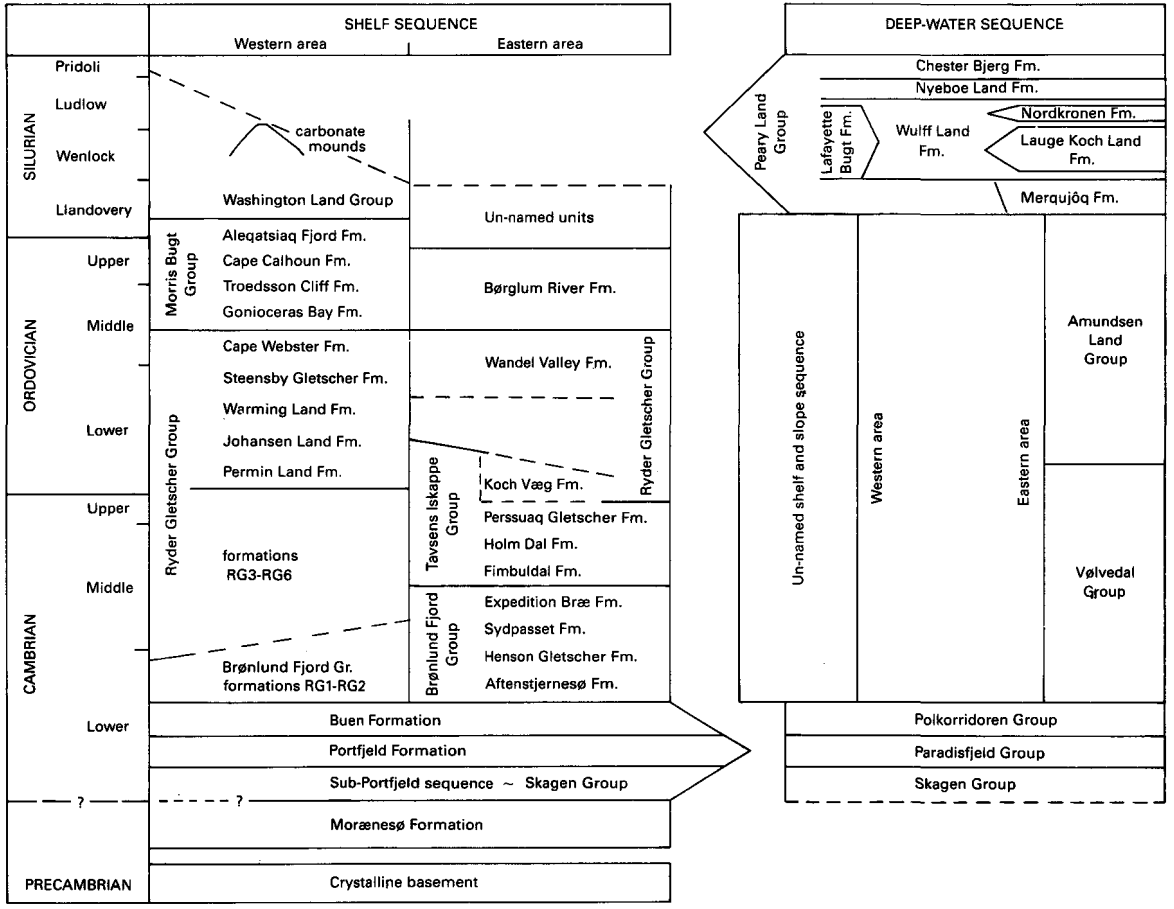


Fig. 3. Schematic summary of stratigraphic nomenclature used in this report. Due to changes in the position of the platform margin relative to the deep-water trough, the un-named shelf and slope sequence overlies formations of the Lower Cambrian shelf sequence. Likewise, expansion of the trough during the Silurian resulted in deposition of formations of the deep-water Peary Land Group above the carbonate shelf sequence.

The Early Palaeozoic Franklinian basin extended from Arctic Canada (Trettin, 1982) across North Greenland; it was initiated in the Early Cambrian and lasted probably into the lowest Devonian. The basin in North Greenland can be divided into a southern *c.* 150 km wide shallow shelf sea in which an up to 4 km thick sequence of Cambrian–Silurian mainly carbonate sediments accumulated (Peel, 1982), and a northern deep-water basin or trough in which accumulated an 8–10 km thick sequence of mainly clastic sediments. The elongated east–west trending deep-water basin had a width of at least 100 km. During Early Palaeozoic time the basin widened by movement of the shelf edge southwards to new positions, probably controlled by basin-parallel fault lines (Surlyk & Hurst, 1984).

Early Palaeozoic deposition in North Greenland was brought to a close by the Ellesmerian deformation (Devonian–Carboniferous). The intensity of folding increases from south to north. In general, the Cambrian–Silurian shelf sequence in the south is unfolded, and the deep-water trough sequence in the north is intensely deformed. There is a transition from unfolded platform via a zone with very weak deformation with kinks and box folds in the south, through a divergence zone with thin-skinned south-verging folds and thrusts, to a multiply deformed, north-verging orthotectonic zone in the north (Larsen & Escher, 1985; Soper & Higgins, 1985). The sediments in the fold belt are almost unmetamorphosed in the weakly deformed and divergence zone, although oil source rock studies show they have been sufficiently heated to be over-mature. Northwards through the orthotectonic zone prograde metamorphism increases, and reaches low amphibolite facies in the northernmost part of Peary Land (Higgins *et al.*, 1981). Several articles on both the geology and geophysics of North Greenland and adjacent Ellesmere Island are presented in a symposium volume discussing the possible drift along Nares Strait between Canada and Greenland (Dawes & Kerr, 1982).

The distribution and working objectives of the 1985 geological parties were as follows (Henriksen, 1986). One team supplemented the 1984 reconnaissance work in the Precambrian crystalline basement area at the head of Victoria Fjord, with a limited amount of extra sampling for age determinations and lithological investigations. The same party was responsible for the completion of the oblique aerial photography programme; this programme was undertaken from the Twin Otter and has resulted in an almost complete series of both black and white and colour photographs of all coast and valley sections in the working area. The main objective of the 1985 work in the southern shelf sequence was mapping and study of the Silurian carbonate succession, with supplementary investigations in the Cambro-Ordovician sequences to the east; three parties were responsible for this work. One party carried out a general basin analysis, mainly of the Cambro-Ordovician shelf and deep-water successions. A special survey aimed at compiling maps at a scale of 1:100 000 accompanied by constructed profiles, was continued in Wulff Land by one team. The Silurian deep-water turbidite sequence was mapped by one party, who were also continuing investigations begun in 1984. Stratigraphical and structural studies in the northern trough sequence and fold belt were carried out by two parties. A regional geochemical exploration programme with sampling of drainage sediments, and detailed studies of anomalies recorded in 1984 was undertaken by one team. Field work for a study of rock magnetism and palaeomagnetism was carried out by one party, who collected representative samples from a large part of the exposed sequences.

A special source rock project, 'Nordolie', mainly financed by the Danish Ministry of Energy (Christiansen *et al.*, 1986), was fully integrated into the general programme. It com-

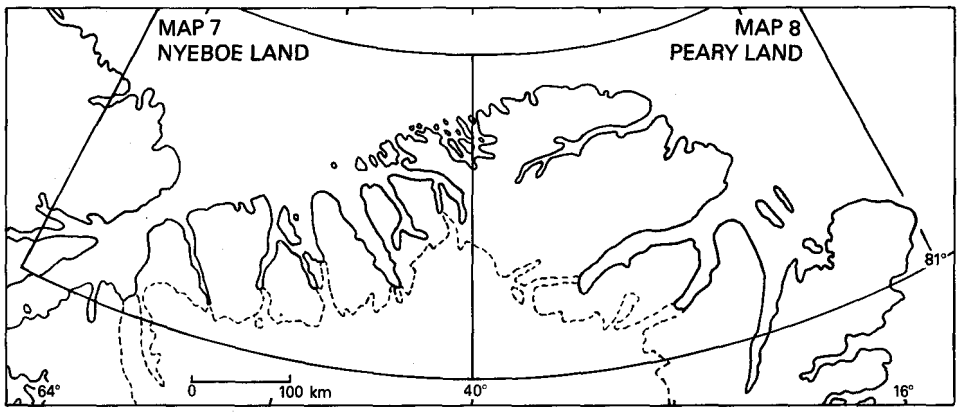


Fig. 4. Regional maps at a scale of 1:500 000 mapped during GGU's North Greenland programme (1978–80, 1984–85).

prised a geological two-man team and a four-man drilling team, who carried out a shallow core drilling programme. This project continued the systematic source rock investigations commenced in 1984.

The completion of field work in 1985 in the central and western parts of North Greenland brought to an end the second phase of GGU's North Greenland project. In the course of these five seasons' work (1978–80, 1984–85) the whole of North Greenland between Kronprins Christian Land in the east and eastern Washington Land in the west has been systematically mapped geologically, with the aim of publishing two coloured geological map sheets at a scale of 1:500 000 (fig. 4). The eastern sheet (No. 8, Peary Land) was printed in 1986, while the western sheet (No. 7, Nyeboe Land) awaits compilation. These two sheets are based on mapping in the field, generally at a scale of 1:100 000, and it is planned to publish six special maps at this larger scale as examples of the geology in two north–south traverses – one through Peary Land and one covering Wulff Land. The map accompanying this report (Map 1) at a scale of 1:1 million summarises the results of the geological mapping from the whole project.

Results from the first phase of the project (1978–80) covering the eastern part of North Greenland have been published in Survey Reports and Bulletins and in a variety of papers in international journals. The results from the second phase of the project (1984–85) are only available so far in a preliminary form (GGU 1985, this report). All investigations from this phase are ongoing, and will be reported over the next few years in Survey and international publications.

With the completion of field work in 1985 GGU has successfully concluded its most ambitious project to date. During the five years of field work in North Greenland more than 100 000 km$^2$ of ice-free land area have been geologically mapped, with approximately 40 participants in the field each season. In addition to the regional mapping, comprehensive general geological knowledge of two geological domains has been built up – the northern part of the Caledonian fold belt in East Greenland and its foreland, and the Lower Palaeozoic Franklinian sedimentary basin and east–west trending Ellesmerian fold belt in North Greenland. The development of the Franklinian basin in North Greenland is now well docu-

mented with the parallel development of the carbonate shelf sequence in the south and the deep-sea basin sequence deposits in the north. Structural analyses of the thin-skinned tectonic patterns in the North Greenland fold belt (Soper & Higgins, 1985) permit an evaluation of the minimum primary width of the sedimentary basin. The original dimensions of the now exposed parts of the Franklinian basin in North Greenland are more than 800 km from east to west and 200 km from north to south. The study of the basin development in this vast area is considered to be an important case story of a shelf and deep-sea basin development at the margin of a stable continent (Surlyk & Hurst, 1984).

The present report contains 14 contributions from the participating geologists, geophysicists and their collaborators.

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## References

Bevins, R. E., Clemmensen, L. B. & Collinson, J. D. in press: Diamictites and associated sediments in the late Precambrian of eastern North Greenland: tillite or mass flow. *Sedimentology.*

Christiansen, F. G., Nykjær, O. & Nøhr-Hansen, H. 1985: Source rock investigations and shallow core drilling in central and western North Greenland. *Rapp. Grønlands geol. Unders* **130,** 17–23.

Clemmensen, L. B. 1979: Notes on the palaeogeographical setting of the Eocambrian tillite-bearing sequence of southern Peary Land, North Greenland. *Rapp. Grønlands geol. Unders.* **88,** 15–22.

Collinson, J. D. 1983: Sedimentology of unconformities within a fluvio-lacustrine sequence; Middle Proterozoic of eastern North Greenland. *Sedim. Geol.* **34,** 145–166.

Dawes, P. R. in press: Topographical and geological maps of Hall Land, North Greenland (81°–82°N); description of Lower Palaeozoic and surficial geology. *Bull. Grønlands geol. Unders.* **155.**

Dawes, P. R. & Kerr, J. W. (edit.) 1982: Nares Strait and the drift of Greenland: a conflict in plate tectonics. *Meddr Grønland, Geosci.* **8,** 396 pp.

GGU, 1979: Report on the 1978 geological expedition to the Peary Land region, North Greenland. *Rapp. Grønlands geol. Unders.* **88,** 94 pp.

GGU, 1980: Report on the 1979 geological expedition to the Peary Land region, North Greenland. *Rapp. Grønlands geol. Unders.* **99,** 154 pp.

GGU, 1981: Report on the 1980 geological expedition to the Peary Land region, North Greenland. *Rapp. Grønlands geol. Unders.* **106,** 107 pp.

GGU, 1985: Report on the 1984 geological expedition to central and western North Greenland. *Rapp. Grønlands geol. Unders.* **126,** 128 pp.

Henriksen, N. 1985: Systematic geological mapping in 1984 in central and western North Greenland. *Rapp. Grønlands geol. Unders.* **126,** 5–10.

Henriksen, N. 1986: Completion of field work for the 1:500 000 mapping and regional geological studies in central and western North Greenland. *Rapp. Grønlands geol. Unders.* **130,** 9–17.

Higgins, A. K., Friderichsen, J. D. & Soper, N. J. 1981: The North Greenland fold belt between Johannes V. Jensen Land and eastern Nansen Land. *Rapp. Grønlands geol. Unders.* **106,** 35–45.

Jepsen, H. F., Henriksen, N., Hurst, J. M. & Peel, J. S. 1983: Geological map of Washington Land and Daugaard-Jensen Land. Copenhagen: Geol. Surv. Greenland.

Kalsbeek, F. & Jepsen, H. F. 1984: The late Proterozoic Zig-Zag Dal Basalt Formation of eastern North Greenland. *J. Petrol.* **25,** 644–664.

Larsen, P.-H. & Escher, J. C. 1985: The Silurian turbidite sequence of the Peary Land Group between Newman Bugt and Victoria Fjord, western North Greenland. *Rapp. Grønlands geol. Unders.* **126,** 47–67.

Peel, J. S. 1982: The lower Palaeozoic of Greenland. *Mem. Can. Soc. Petrol. Geol.* **8,** 309–330.

Soper, N. J. & Higgins, A. K. 1985: Thin-skinned structures at the basin–shelf transition in North Greenland. *Rapp. Grønlands geol. Unders.* **126,** 87–94.

Surlyk, F. & Hurst, J. M. 1984: The evolution of the early Paleozoic deep-water basin of North Greenland. *Bull. geol. Soc. Am.* **95,** 131–154.

Trettin, H. 1982: Innutian Orogen and Arctic Platform. *In* Palmers, A. R. (edit.) Perspectives in regional geological synthesis. *D-NAG Spec. Publ. geol. Soc. Am.* **1,** 49–55.