# Petroleum geology and thermal maturity of eastern North Greenland – a new energy research project

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Petroleum geological studies were initiated in eastern North Greenland in 1993 as part of a regional mapping programme carried out by the Geological Survey of Greenland (Henriksen, 1994, 1995; Stemmerik & Elvebakk, 1994). These activities continued in 1994, and a three-year research programme was initiated to generate data for basin modelling of the Phanerozoic sedimentary basins in the easternmost part of North Greenland. The basin modelling project is supported by the Danish Ministry of Environment and Energy and is a continuation of previous petroleum-related research programmes in the region (Christiansen, 1989; Håkansson & Stemmerik, this report). The aim of the project is to improve the understanding of the subsidence and uplift history of the adjacent shelf basins, and to evaluate the presence of pre-Carboniferous source rocks with adequate maturity in these areas.

The petroleum related studies mainly comprised detailed sedimentological and biostratigraphic investigations of the Carboniferous and Permian sediments of Holm Land and Amdrup Land during the 1994 field season (Fig. 1). In addition, samples for thermal maturity analyses and biostratigraphy were collected from the Lower Palaeozoic sediments of southern Peary Land and northern Valdemar Glückstadt Land, the Mesozoic of Kap Rigsdagen and the Tertiary of Prinsesse Thyra Ø (Fig. 1).

## Lower Carboniferous, Sortebakker Formation

The Sortebakker Formation comprises a thick succession of fluviatile sandstones and shales of Lower Carboniferous age (Stemmerik & Håkansson, 1989). The formation is restricted to the southernmost part of Holm Land where it crops out in the coastal cliffs around Sortebakker (Figs 1, 2). The base of the formation is not exposed and the fluviatile sediments are overlain unconformably by Moscovian marine carbonate and siliciclastic sediments (Fig. 2).

Correlation of more than 20 sedimentological profiles measured through various parts of the Sortebakker Formation suggests a thickness of approximately 1000 m for the formation, well in excess of previous estimates of *c.* 600 m (Stemmerik & Håkansson, 1989). The new sedimentological data allow the first detailed study of the depositional environments and evolution of the formation which is divided into two units by a low-angel disconformity. The lower unit is composed of 0.5–4 m thick shale dominated fluvial cycles. Each cycle begins with a sharp based, medium-grained sandstone and is overlain by laminated shales and siltstones. The upper unit is composed of 1.5–10 m thick sandstone dominated cycles with intervals of thick lacustrine shales with channelised sandstone bodies.

The formation is generally post-mature with respect to hydrocarbon generation. Dating of the formation is somewhat uncertain due to lack of well preserved sporomorphs. Material sampled during the 1994 field season from the uppermost part of the formation appears less thermally altered than the previously studied material, and suggests a Visean age.

## Mid-Carboniferous – Permian, Mallemuk Mountain Group

Investigations of the marine, mid-Carboniferous to Permian, Mallemuk Mountain Group was concentrated on Amdrup Land during the 1994 field season. The main aims included collection of fusulinids for dating of the succession, measurement of detailed sedimentological sections and collection of samples for maturity analyses. Sedimentation on Amdrup Land took place within two separate fault blocks (Fig. 1; Håkansson & Stemmerik, 1984), and field work indicates that the post-depositional tectonic history was very different in the two areas. In southern Amdrup Land, the Upper Palaeozoic succession dips gently towards the east and major tectonic disturbance is only seen along the NNW–SSE trending fault zone separating the two fault blocks. By contrast, the sediments in northern Amdrup Land are folded and disturbed along NNW–SSE trending faults.

*South Amdrup Land block.* Detailed sedimentological profiles were measured in south-western Amdrup Land in order to outline the lateral thickness and facies variations of the Upper Carboniferous part of the succession. The Upper Carboniferous succession thins from 500–600 m at Kap Jungersen to less than 100 m in the westernmost out-

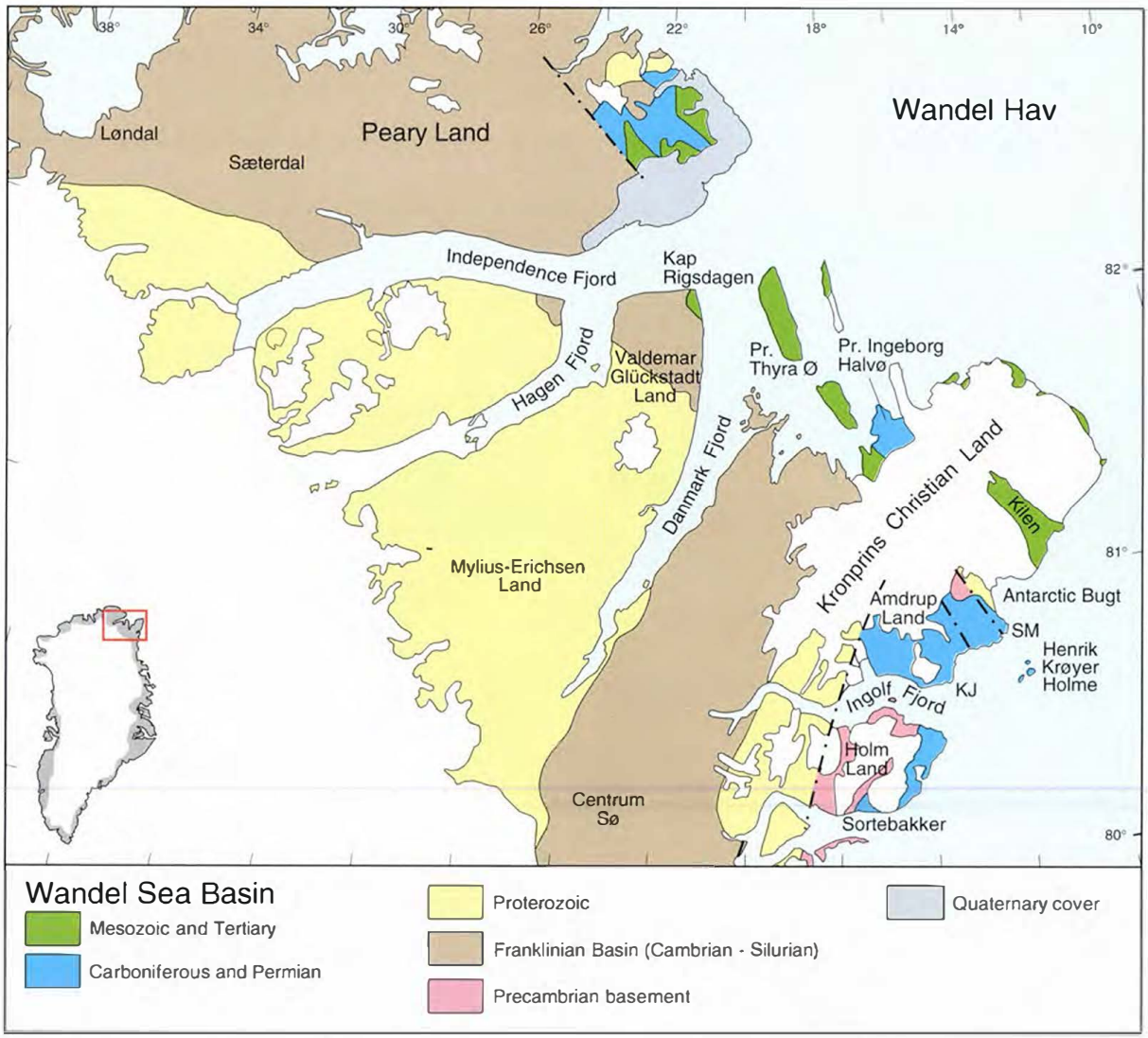


Fig. 1. Simplified geological map of eastern North Greenland with names mentioned in the text. KJ: Kap Jungersen, SM: Sophus Müller Næs.

crops, immediately east of the East Greenland fault zone (Fig. 1). This westwards thinning over a distance of 15–20 km is associated with marked changes in facies. The western succession is mainly composed of fluvial and alluvial sandstones and lagoonal gypsum in contrast to the open marine carbonate dominated succession at Kap Jungersen (Fig. 3).

In the northern part of the south Amdrup Land block, a new Upper Palaeozoic unit, more than 50 m thick, was found during field work in 1994. Stratigraphically, it overlies the ?late Artinskian – Kungurian Kim Fjelde Formation exposed in the coastal cliffs from Kap Jungersen and northwards. The succession forms one large shoaling upwards unit which in the lower part comprises bioturbated chert and chert-rich shales and limestones. The upper part is composed of interbedded chert-rich biogenic packstones and shales. The fauna is dominated by bryozoans, brachiopods and silicious sponges, and resembles that described from the Kim Fjelde and Midnatfjeld Formations of eastern Peary Land (Stemmerik & Håkansson, 1989).

*North Amdrup Land block*. The north Amdrup Land block is divided by a major NNW–SSE trending fault running parallel to the cliff along Antarctic Bugt (Fig. 1). More than 300 m of gently folded ?Moscovian carbonates occur in the southern part of the fault block. They overlie Caledonian deformed crystalline basement rocks with considerable pre-depositional relief. The succession is dominated by cyclic interbedded shallow shelf carbonates and includes

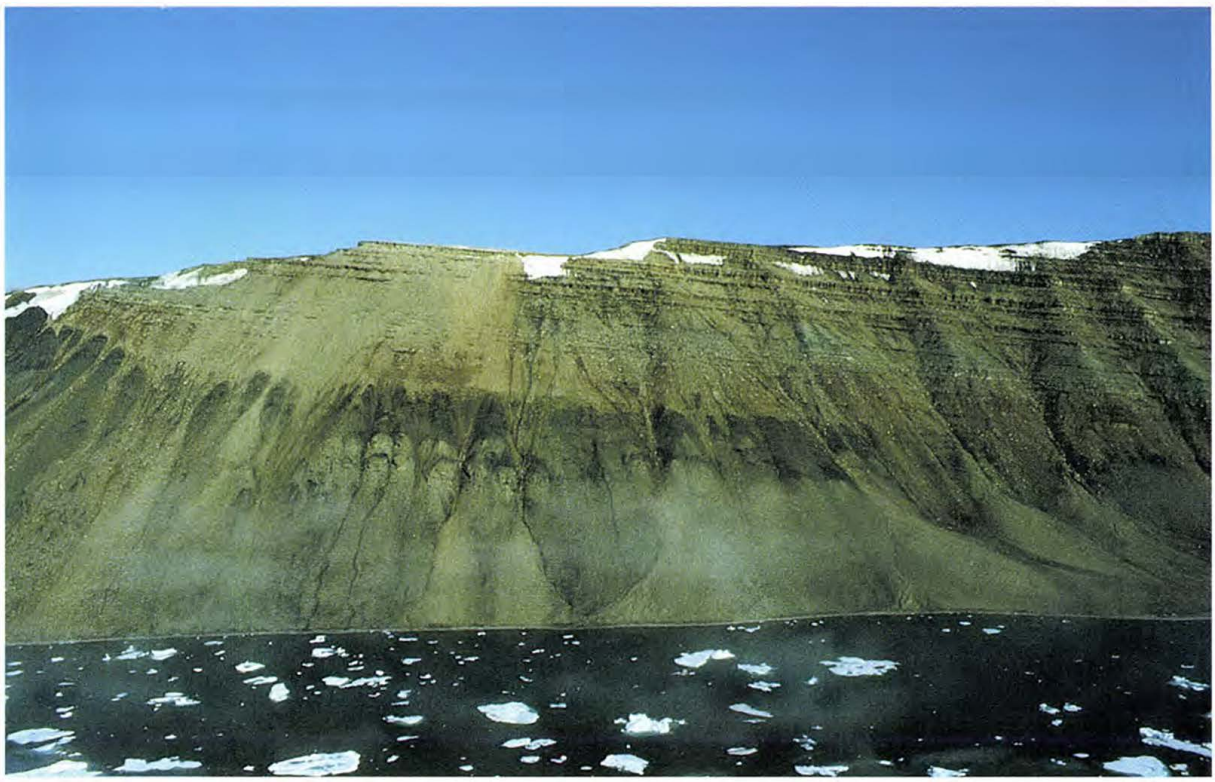

Fig. 2. Coastal cliffs of southern Holm Land showing the easternmost outcrops of the Sortebakker Formation and the unconformity with the overlying Kap Jungersen Formation. Cliff approximately 300 m high.

thick bryozoan build-ups in the basal part. North of the fault Moscovian sediments overlie sediments of presumed late Proterozoic age. The succession starts with a thin shale-rich unit with abundant resedimented carbonates. The overlying succession resembles that seen immediately to the south.

In the coastal plains around Sophus Müller Næs, the Moscovian succession is overlain by sediments belonging to the mid-Permian Kim Fjelde Formation, and approximately 10 m of ?Mesozoic sandstones were found in the core of a major synform.

## Future work

Field work will continue during 1995 with sedimentological and biostratigraphical studies of the Upper Palaeozoic succession on Holm Land, Amdrup Land and Prinsesse Ingeborg Halvø, and the Jurassic of Kilen. The 1994 field work has confirmed the suggested flood-plain origin of the Sortebakker Formation (Håkansson & Stemmerik, 1984; Stemmerik & Håkansson, 1989). Detailed sedimentological sections throughout the formation allow the first detailed facies and environmental analysis of this formation. More than 100 samples were collected from the Sortebakker Formation in order to study variations in thermal maturity and to provide material for a sporomorph-based dating of the formation.

Material collected from the mid-Carboniferous to Permian succession will form the basis for the first detailed biostratigraphic zonation of the succession with dating based mainly on fusulinids. The sporomorphs will be studied as part of an M.Sc. project at the University of Copenhagen. Future sedimentological studies will focus mainly on the Upper Carboniferous succession.

Basin modelling in the region will include construction of a series of pseudowells in collaboration with the basin modelling group at the Geological Survey of Denmark. The modelling will be based on available biostratigraphic data and various types of maturity data, including Leco/Rval, GC and GCMS, vitrinite reflectance, biomarker analyses and apatite fission track analyses. Eastern Peary Land, northern Valdemar Glückstadt Land and northern Amdrup Land have been selected as key areas for studies of maturity changes between the Lower Palaeozoic and the Upper Palaeozoic – Mesozoic succession. Maturity trends within the Upper Palaeozoic succession will be studied in southern Holm Land and southern Amdrup Land and maturity trends in the Lower Palaeozoic succession will be studied at several localities in eastern Peary Land and Kronprins Christian Land.

Fig. 3. Fluvial sandstones and siltstones from the westernmost Carboniferous outcrops of southern Amdrup Land.

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