An occurrence of Tertiary shales from the Harder Fjord Fault, North Greenland fold belt, Peary Land

C. A. Croxton, P. R. Dawes, N. J. Soper and E. Thomsen

A shale outcrop from the Harder Fjord Fault zone in eastern Peary Land, North Greenland, is dated on palynological evidence as early Tertiary. The Harder Fjord Fault traverses the North Greenland fold belt and the shale occurrence extends the age range of strata known to be trapped in this important fault zone. The occurrence represents the most northerly record of Tertiary pollen.

C.A.C., Robertson Research International Ltd., Tyn-y-Coed, Llanrhos, Llandudno, Gwynedd, U.K.
P.R.D., Grønlands Geologiske Undersøgelse, Øster Voldgade 10, DK-1350 København K, Danmark.
N.J.S., Department of Geology, University of Sheffield, Mappin Street, Sheffield S1 3JD, U.K.
E.T., Laboratoriet for palæontologi og stratigrafi, Geologisk Institut, Aarhus Universitet, 8000 Århus C, Danmark.

Recent field work in Peary Land has focussed attention on the Harder Fjord Fault as an important dislocation zone of the North Greenland fold belt (Soper *et al.*, 1980). Sequences containing strata of Late Palaeozoic and Mesozoic ages, as well as a variety of extrusive and intrusive rocks of uncertain age, were identified in 1979 within the fault zone on the north side of Frederick E. Hyde Fjord. In addition, shales outcropping in the eastern section of the fault zone, south of Frederick E. Hyde Fjord, and sampled by two of us (NJS & PRD) during earlier field work, have now been identified as Tertiary on palynological evidence.

Description of the occurrence

The location of the Tertiary rocks is indicated on fig. 1. The locality was briefly visited in 1969 during a single traverse from the coast at Depotbugt (Dawes & Soper, 1979, fig. 2). A wide Quaternary-filled valley stretching south-eastwards from Depotbugt marks the site of the Harder Fjord Fault zone which, in this region, is composed of several fault planes.

The Tertiary outcrops occur in the poorly exposed southern part of the valley, south-east of a large lake. Several small, ill-defined outcrops of brittle, dark carbonaceous shales,

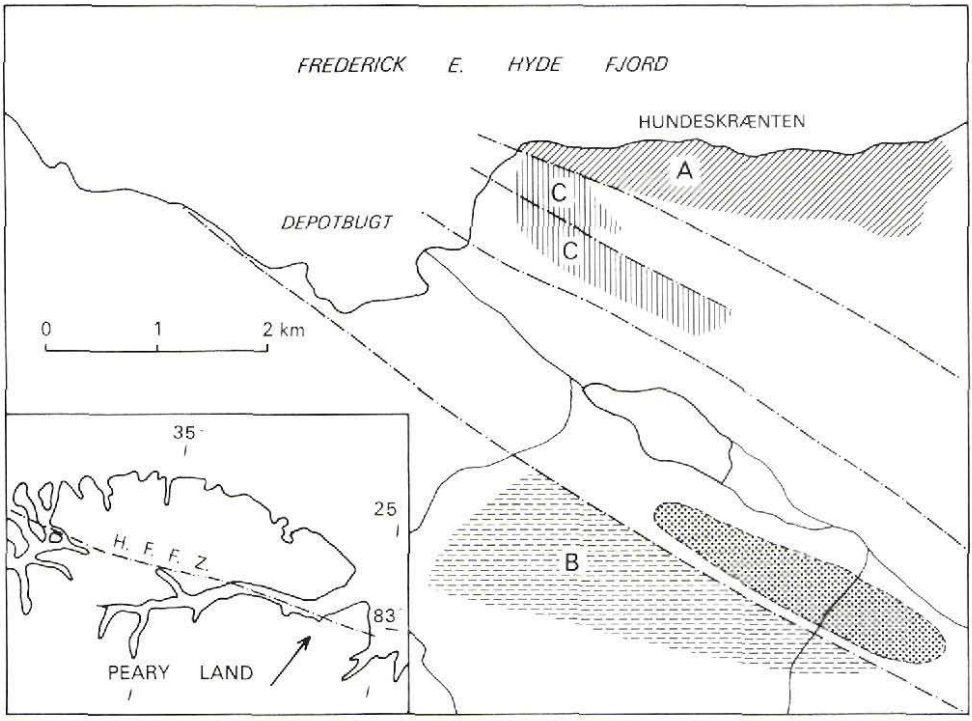

Fig. 1. Sketch map of the Depotbugt area indicating the major faults of the Harder Fjord Fault zone (H.F.F.Z.). A, B and C mark the different rock sequences mentioned in the text. The stippled ornament south-east of the large lake indicates the area in which Tertiary shales and sulphur-rich mounds were located.

commonly crushed and locally rusty, were located. The region was visited in early summer while there was appreciable snow-cover so that more extensive outcrops must be expected to occur. At least two of the outcrops visited are in the vicinity of conspicuous, mound-like, and brightly coloured, orange, red and yellow, gossan areas. These gossans, rich in sulphur and iron compounds, have been interpreted as the product of solfatara-type volcanic activity of the same type as described by Troelsen (1949) elsewhere from Peary Land (Dawes & Peel, in press). In the field, the low density nature of the shales was assumed to be due to a thermal effect of the solfatara activity, rather than due to the original carbonaceous composition of the shale. The rocks have been described elsewhere as thermally altered brittle shales and assumed to be part of the Franklinian (Lower Palaeozoic) rock succession (Dawes & Soper, 1979).

Geological setting of the shales

Three rock sequences (marked A to C on fig. 1) are known from the region east and south of Depotbugt in the general vicinity of the Tertiary outcrops. The fault zone separates a northern sequence of mainly carbonates (designated A on fig. 1), forming the steep coast at Hundeskrænten and correlated with the Paradisfjeld Group of probable Cambrian age, from

a southern sequence (marked B) of Proterozoic psammitic rocks with prominent basic intrusions (Dawes & Soper, 1979; Christie & Ineson, 1979; Soper *et al.*, 1980). The third sequence (marked C) outcrops immediately to the east of Depotbugt and it is in fault contact with the Hundeskrænten sequence to the north. The sequence contains quartzites, conglomerates, sandstones and shales with basic meta-igneous rocks. The stratigraphic relationship of this sequence to the Tertiary shales farther east within the fault zone is at present unknown. However, it is worth noting that Soper *et al.* (1980) report the presence of dark carbonaceous siltstones and shales within sequence C, although microscopic examination of this shale material has not produced diagnostic organic remains.

Fossil evidence

Sample GGU 53578 from 1969 is composed of dark carbonaceous shale, several megascopic dull dark wood fragments and homogeneous coal fragments. Microscopic examination of the wood and coal fragments (ET) and palynological investigation of a split of the shale material (CAC) have been carried out.

The wood is identified as a resin-rich, strongly deformed gymnosperm, representing a low range lignite. The homogeneous coal fragment is dominated by a densinitic groundmass often associated with resin-rich wood fragments, cork tissues and rootlets. The content of liptinite is high, mainly represented by cutinite and suberinite. In the humic groundmass, local occurrences of bituminite are found often associated with alginite. On visual examination the strongly gelified nature of this sample seems to indicate the onset of geochemical gelification corresponding to the boundary between dull brown coal and bright brown coal. This change is related to specific conditions of temperature and/or burial, but this aspect must be verified by quantitative means, e.g. huminite/vitrinite reflectance measurements, before values can be suggested.

The microscopic matter of the shale includes light-coloured fibrous grains and algal filaments, as well as pollen grains. The pollen recorded includes bisaccate and monosulcate types (gymnospermous) and tricolpate, triporate and polyporate types (angiospermous). The angiospermous group includes *Ulmus* and *Carya* types indicating a Tertiary age for the sample. No graminaceous pollen or pollen of Compositae have been observed and, therefore, an early Tertiary age is favoured. This is the most northerly record of early Tertiary pollen. The palaeolatitude of Peary Land in Palaeocene time was 65–70°N (Smith & Briden, 1977).

Discussion

The Harder Fjord Fault most probably has a long and complex tectonic history (Soper *et al.*, 1980) and its probable activation in response to the late Phanerozoic tectonic history of the Greenland Sea has already been remarked upon (Dawes & Peel, in press). The presence of Cenozoic strata within the fault zone is significant, not only for an analysis of the fault movements, but also for the assessment of the Tertiary tectonic history of the region as a whole. While it is clear that the Tertiary (Palaeocene) strata in the main outcrops of the Wandel Sea Basin in eastern Peary Land have been subjected to folding and faulting, the

effects of Tertiary deformation elsewhere, particularly in the North Greenland fold belt are more difficult to assess. These Tertiary cover rocks, even within a fault zone, provide an important possibility to distinguish the Tertiary deformation effects (considered to have been widespread in North Greenland) from those of the mid-Palaeozoic orogeny.

References

Christie, R. L. & Ineson, J. R. 1979: Precambrian–Silurian geology of the G.B. Schley Fjord region, eastern Peary Land, North Greenland. *Rapp. Grønlands geol. Unders.* **88,** 63–71.

Dawes, P. R. & Peel, J. S. in press: The northern margin of Greenland from Baffin Bay to the Greenland Sea. *In* Nairn, A. E. M., Churkin, M. & Stehli, F. G. (edit.) *The Ocean Basins and Margins,* **5,** New York: Plenum Publ.

Dawes, P. R. & Soper, N. J. 1979: Structural and stratigraphic framework of the North Greenland fold belt in Johannes V. Jensen Land, Peary Land. *Rapp. Grønlands geol. Unders.* **93,** 40 pp.

Smith, A. C. & Briden, J. C. 1977: *Mesozoic and Cenozoic palaeocontinental maps.* 63 pp. Cambridge U.P.

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.

Troelsen, J. C. 1949: Contributions to the geology of the area round Jørgen Brønlunds Fjord, Peary Land, North Greenland. *Meddr Grønland* **149**(2), 29 pp.