The Devonian basin project, North-East Greenland – a summary

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As part of the general studies of Phanerozoic basin development and onshore hydrocarbon potential in East Greenland undertaken by the Geological Survey of Greenland (GGU) in the years 1986–1990, integrated structural and sedimentological studies of the Devonian basin in North-East Greenland (Fig. 1) were carried out in order to gain an understanding of the early basin formation following the Caledonian orogeny (Marcussen *et al.*, 1987, 1988; Larsen *et al.*, 1989). The immediate relevance of the Devonian basin studies lies in the necessity of having first-hand knowledge of the structural style and sedimentary history of the exposed part

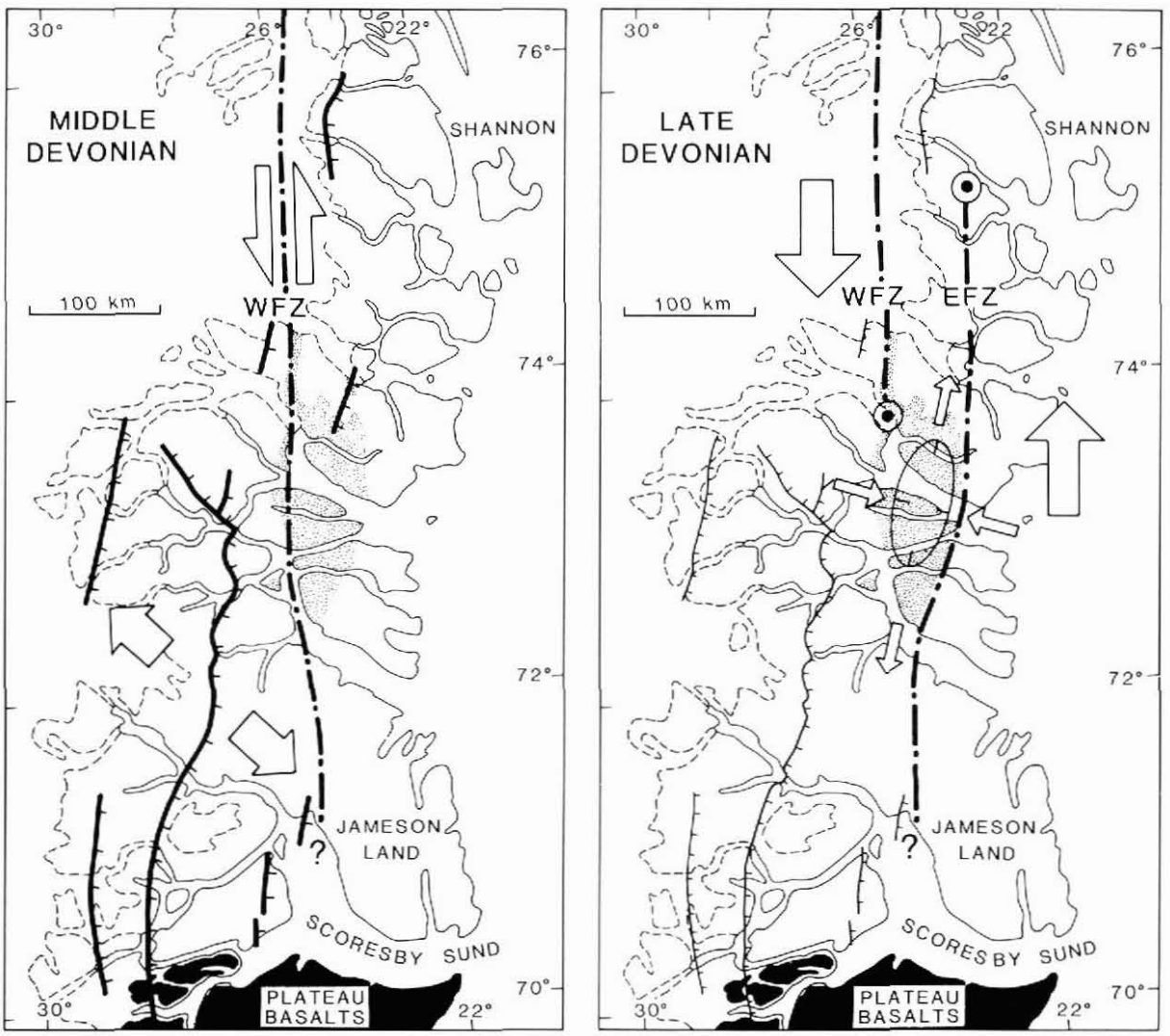

Fig. 1. Tectonic setting of the East Greenland Devonian basin in Middle and Late Devonian times. WFZ: Western fault zone. EFZ: Eastern fault zone. After Larsen (in review) and Larsen & Olsen (in review).

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of the basin, if the deeper seismic image and early history of the Jameson Land basin farther to the south are to be understood (H. C. Larsen *et al.*, 1989).

The continental Devonian basin has been studied with regard to sedimentology, stratigraphy, structural style and evolution. Field work in 1986–1988 was supplemented by stereoscopic studies of vertical aerial photographs (1:150 000), using the Kern PG2 stereo plotter installed at GGU's photogeological laboratory. At the time of writing a new geological map of the main part of the Devonian basin has been completed (Larsen, 1990a), a new formal lithostratigraphy for the sedimentary succession has been established (Olsen & Larsen, in review), and the palaeogeographic basin evolution has been essentially unravelled (Olsen, in review).

The project studies indicate that the basin was initiated by NW–SE extensional collapse of an overthickened Caledonian crustal welt. At about the same time left-lateral strike-slip deformation caused by continental plate motions commenced, and the two processes acting together resulted in a composite left-lateral transtensional regime (Larsen & Bengaard, 1991). After initiation and during the deposition of 8 km of basin fill, the basin underwent a series of deformations which continued into the Early Carboniferous (the Hudson Land and Ymer Ø phases of Bütler, 1935). These deformations were caused by left-lateral strike-slip movements along the eastern basin margin, and the basin during this period can be viewed as a subsiding graben undergoing transpressional deformation between overstepping strike-slip faults (Fig. 1.) (Larsen, in review). A complete analysis of the structural development of East Greenland during Late Palaeozoic time must await the results of the interpretation of deep seismic data from the Jameson Land basin to the south, where a thick Late Palaeozoic sequence appears to exist at depth (H. C. Larsen *et al.*, 1989).

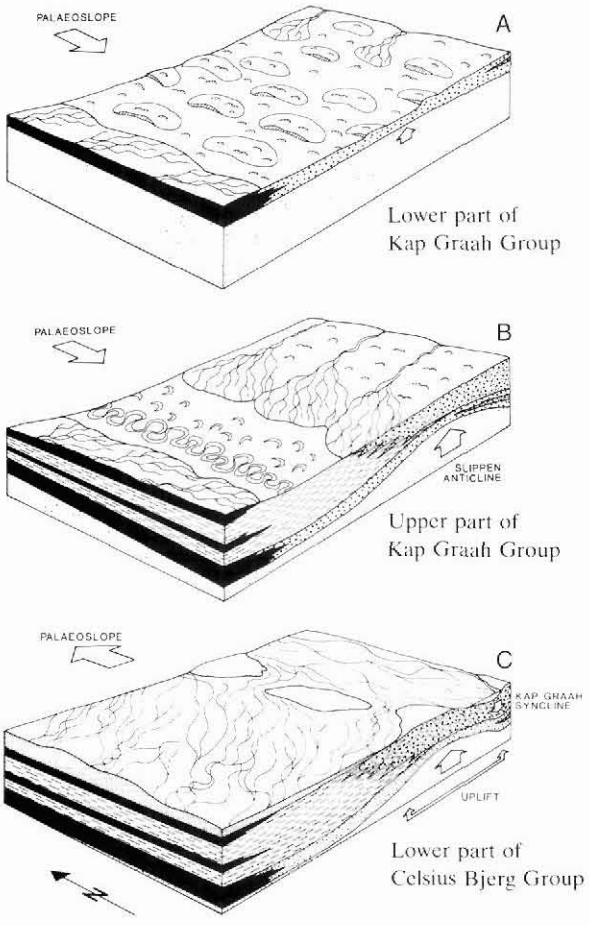
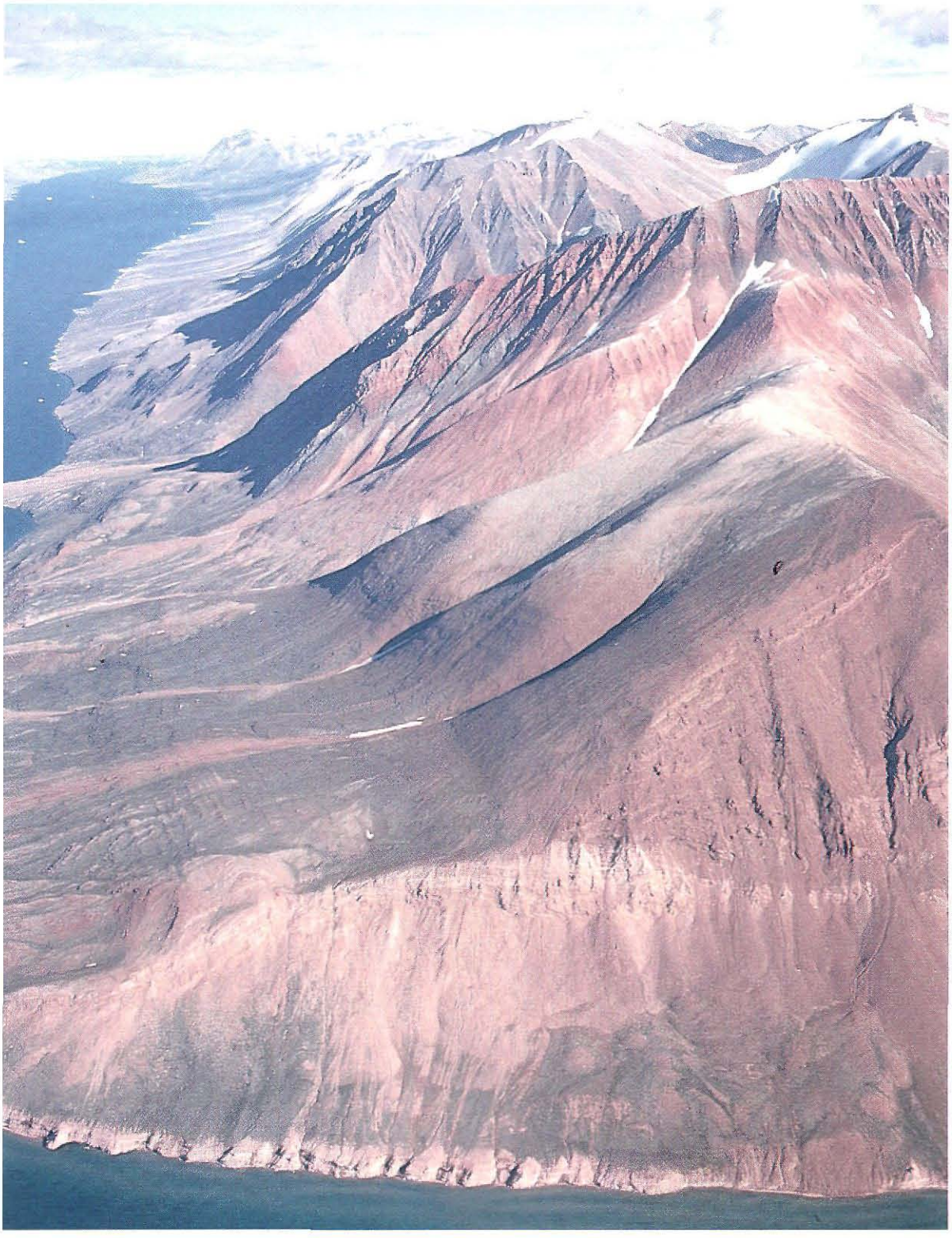


Fig. 2. Tectonic control of basin fill geometry and drainage patterns during deposition of the Famennian (Upper Devonian) Kap Graah and Celsius Bjerg Groups. The interpretation is based on integrated structural and sedimentological investigations. After Olsen & Larsen (in press).

Integrated studies of the structural and sedimentological evolution have demonstrated that the Hudson Land deformation phases and part of the Ymer Ø phase of Bütler (1935), accompanied by climatic changes, have controlled the basin fill geometry, sedimentological facies distribution and drainage systems (Larsen, 1990b, c, d; Larsen & Olsen, in review; Olsen & Larsen, in press). Isopach maps of the various formations and groups reflect very closely the shapes of the broad synclinal structures within the basin, indicating that folding was synsedimentary. Developing folds can also be shown to have progressively forced an axial-flowing meandering river system to narrow and to become constrained within the core of a syncline (Fig. 2). By combining a quantitative geometrical analysis of the basin evolution (Larsen, 1990a, b, c, d) with a detailed sedimentological study of the sedimentary succession (Olsen, in review), the problem of the relative roles of tectonic activity and climatic change in determining the major palaeogeographic reorganisations within the basin can be addressed. A main climatic change towards dry conditions followed by a gradual climatic change towards more humid conditions took place during Late Devonian times (Famennian). The dry conditions are indicated by aeolian sediments which formed a basin-wide sand sea and later by establishment of a playa lake complex (Olsen, in review). In addition short-term cyclic climatic changes are observed and interpreted as reflecting astronomical, Milankovitch-type control on precipitation in the source areas (Olsen, 1990).

Regarding the petroleum potential of the Devonian sequence, the most interesting feature is the occurrence



View eastwards of multicoloured Devonian sediments (Old Red Sandstone) exposed on the north coast of Geographical Society Ø, East Greenland. The mountain in the foreground is the 1600 m high Svedenborg Bjerg. The mountain Rudbeck Bjerg is seen in the far distance (50 km away) near the shore of Sofia Sund. Photo: P.-H.L.

of thin organic-rich lacustrine shales of excellent source rock quality (Christiansen *et al.*, 1990).

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