that they sometimes grade into carbonatites which is normal for ultramafic lamprophyres (Rock, 1987). The zoned internal structure indicates that the dykes were either injected by multiple intrusion or differentiated by secondary processes such as reaction with country rock or by metamorphic differentiation. The mineral assemblages are probably essentially metamorphic as is also suggested by their characteristic internal deformation.

The ultramafic lamprophyre dykes are possibly also widespread in other parts of the district where similar dykes have been observed in the yet sparsely mapped area west of Eqe. Dykes of lamprophyric affinity are known both from South-West Greenland (Hansen, 1980), from the Holsteinsborg area in central West Greenland (Larsen, 1980; Larsen *et al.*, 1983) and from the Umanak district (Larsen & Møller, 1968). While the lamprophyric dykes in South-West Greenland are of Mesozoic age, the dykes from central West Greenland range in ages from Eocambrian to Late Archaean. However, no dykes are reported to have ages around the *c.* 1635 Ma as deduced above.

In an economic-geological context it is interesting that the ultramafic lamprophyre dykes of the Eqe area follow the same general trends as gold-mineralized shear or breccia zones in the western part of the supracrustal rock sequence (Knudsen *et al.*, 1988). A similar feature occurs in the Norseman – Wiluna Belt of the Yilgarn Block in the Precambrian of Western Australia where there is a spatial and chronological coincidence between lamprophyre dykes and epigenetic gold mineralization (Rock & Groves, 1988).

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Reinvestigation of the Cretaceous boundary fault in Sarqaqdalen, Nûgssuaq, central West Greenland

T. Christopher R. Pulvertaft

A reinvestigation of the major fault in Sarqaqdalen was undertaken in 1988 in response to a renewed interest in the style and timing of the whole fault system that marks the easterly limit of Cretaceous sediments in central West Greenland. This interest stems in turn from the reinterpretation of seismic lines from the 1970s that has recently been initiated in GGU (Chalmers, 1988; 1989). Dating of seismic sequences is influenced greatly by what can be learnt from the nearest onshore outcrops, for example proven unconformities in onshore sequences, and demonstrable relationships between sedimentation and fault movements.

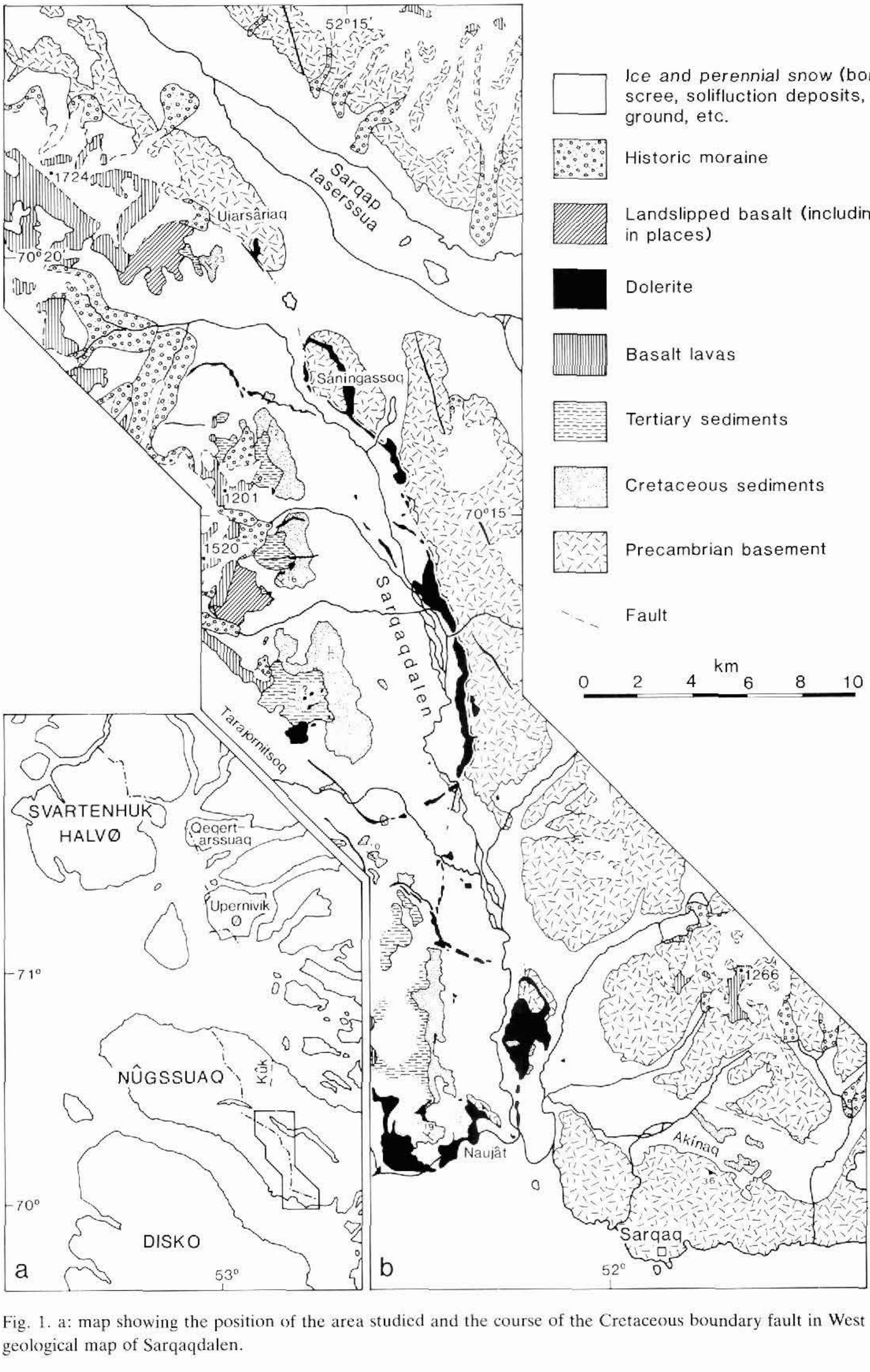

Fig. 1. a: map showing the position of the area studied and the course of the Cretaceous boundary fault in West Greenland; b: geological map of Sarqaqdalen.

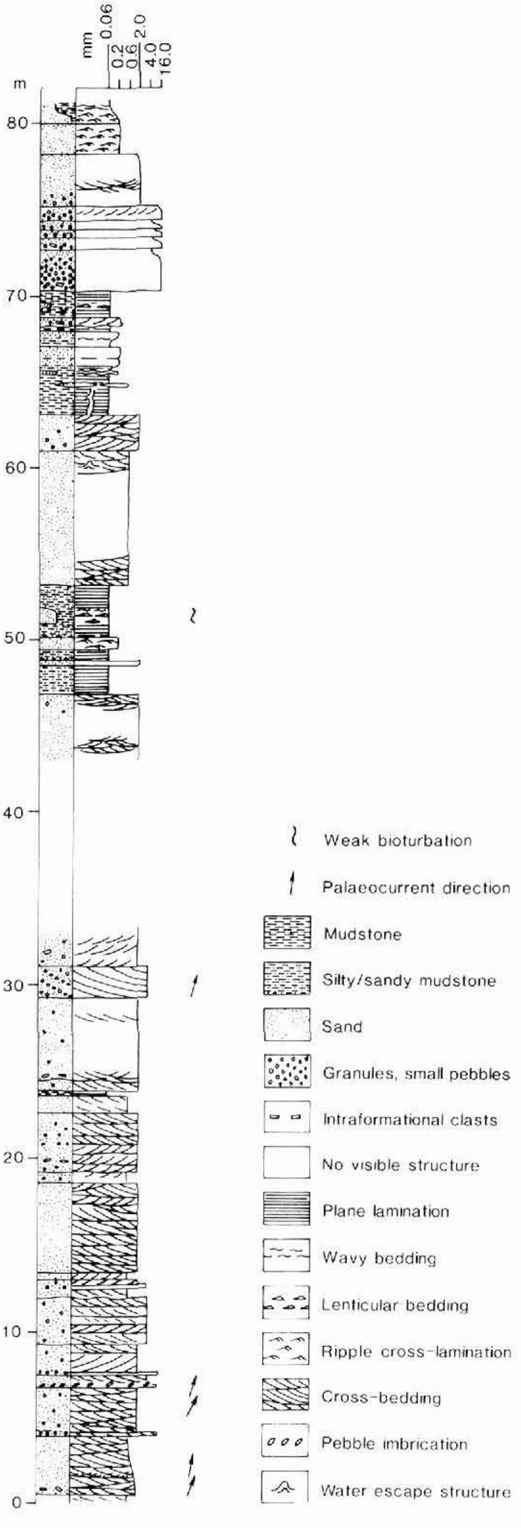

Fig. 2. Graphic log of Cretaceous sediments in an outcrop within 500 m of the boundary fault in central Sarqaqdalen.

In central West Greenland Cretaceous sediments are separated from the Precambrian basement to the east by a system of faults running from near Sarqaq in southern Nûgssuaq to Svartenhuk Halvø in the north (fig. 1a). Near this the Cretaceous strata have been tilted and dip towards the fault system, while Tertiary (Paleocene) strata are virtually horizontal and, in the eastern part of the basin, overlie the Cretaceous with angular unconformity.

Observations pertaining directly to the boundary fault system have been made in Svartenhuk Halvø (J. Grocott, personal communication), Qeqertarssuaq and Upernivik Ø (Rosenkrantz & Pulvertaft, 1969) and near Kûk (Pulvertaft, 1979). However, nothing has been published about the Sarqaqdalen segment of the fault system since the work of Munck (1945), whose observations date from the first Nûgssuaq expedition in 1938. The principal aim of the 1988 field work in the valley was therefore to supplement Munck's observations with new data on the geometry and timing of the faulting in this segment of the fault system, in particular to find out if the Cretaceous sediments contain any evidence of syn-sedimentary fault movements, as they do along the northern segments of the system.

One of the main features of Sarqaqdalen is a suite of major, largely interconnected, dolerite intrusions, which were described by Munck (1945; see fig. 1b). One of these intrusions is a thick dyke/sheet which coats the steep, eastern side of the valley for a distance of about 20 km (fig. 1b). Along its eastern contact this dolerite is bordered by gneiss which shows obvious effects of fault movement: fracturing and brecciation, chloritisation of dark minerals, and a general bleaching. The western contact and wall rock of this dolerite are nowhere exposed, but the outcrops nearest to the dolerite on its western side are all of Cretaceous sediments. There is no doubt that Munck (1945) was right in her conclusion that in this part of the valley dolerite was emplaced along the plane of a major fault separating the gneiss basement from Cretaceous sediments. The dip of the dolerite-crushed gneiss contact, which is taken to be the dip of the fault plane, is between 47° and 60° to the west or south-west. In places the fault plane dolerite sends major apophyses into the basement gneiss, for example at Sáningassoq. These apophyses have the shape of spoons tipped towards the fault plane.

The course of the Cretaceous boundary fault in Sarqaqdalen is shown on the map fig. 1b. As can be seen from this map, the fault system takes a number of turns, but there is no evidence for branching of the fault. Contrary to what is shown in many text figures in *Geology of Greenland* (Escher & Watt, 1976), no connection exists between the fault in Sarqaqdalen and that at Kûk on the north side of Nûgssuaq (nor was any such connection shown in A. Rosenkrantz's original sketch map of the fault). The Kûk fault block is a separate fault block and it need not have the same history as other blocks along the boundary fault system.

North-east of Sarqaq the boundary fault trends 110°. Here there is no dolerite along or near the fault plane. The faulted gneiss-sediment contact is exposed at a locality 6.5 km north-east of Sarqaq. The strike of the fault plane at this locality is 96°, which is slightly oblique to the overall trend of the fault along the Akínaq slope north of Sarqaq. The dip of the fault plane is 73°S. Approaching the fault the gneiss (a homogeneous medium- to fine-grained biotite gneiss) becomes fractured and its biotite chloritised. A few centimetres of soft brown crush material separates the fractured gneiss from a 5–10 m wide zone of intensely brecciated and crushed gneiss which in turn is bordered by strongly disturbed Cretaceous sand and pebble conglomerate. A few metres from the fault all signs of fault disturbance disappear in the sediments which now strike 75° and dip 16° towards the fault.

The southern margin of the sediments at Akínaq is not exposed. It is believed that the sediments overlie the gneiss here (a coarse biotite augen gneiss) without the intervention of a fault. However, no sign of Cretaceous weathering of the gneiss has been seen in this area.

Exposures in Sarqaqdalen are poor, and there are very few outcrops of Cretaceous sediments close enough to the boundary fault to be likely to show the influence of any fault scarp that might have existed at the time of sedimentation. All outcrops close to the fault show sand-dominated sequences with intercalations of dark silty mudstone with small amounts of coal (fig. 2). All the 1988 season's observations indicate that these sequences were deposited in the general braided river environment proposed for Cretaceous sedimentation in the east Disko and Sarqaqdalen area by Schiener (1975), Johannessen & Nielsen (1982) and Surlyk (1982). Although granules and small pebbles occur in the sands, actual layers of conglomerate are rare, and there is no general decrease in grain size of the sediments from east to west across Sarqaqdalen. Coarser sediments occur in the outcrops at Akínaq, but those bordering the fault are no coarser than those farther away. Palaeocurrent data from Sarqaqdalen (foreset dip and rare pebble imbrication), although sparse, consistently indicate a longitudinal, northward or NNW current direction for the fluvial system. No evidence was found for fluvial fans fed from the east (contrast with Pedersen & Jeppesen, 1988), nor were any west or north-west directed channels like those at Kûk seen (cf. Pulvertaft, 1979).

The conclusion drawn from the above is that no steep fault scarp existed along the east side of Sarqaqdalen at the time of deposition of the Cretaceous sediments exposed in this valley. This is not to say that faulting had not commenced at this time – *something* must have determined the general northerly course of the river sytem in Cretaceous time, and this 'something' was most likely faulting. What the evidence indicates is that if faulting had commenced at the time sedimentation was taking place (?Albian–Cenomanian – Ehman *et al.*, 1976; Croxton, 1978), movement on the fault(s) cannot have been rapid at first, so that sedimentation could keep pace with subsidence on the fault(s). This is not like the situation in west Upernivik Ø, Qeqertarssuaq and Svartenhuk Halvø where large boulders of gneiss and metasediment are found in the Cretaceous sediments close to the boundary fault, suggesting the proximity of a penecontemporaneous fault scarp (Rosenkrantz & Pulvertaft, 1969; J. Grocott, personal communication).

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Sedimentological studies in the Upper Cretaceous coal-bearing strata of southern Nûgssuaq, central West Greenland

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During the 1988 field season coal-bearing strata in the Upper Cretaceous Atane Formation on southern Nûgssuaq, West Greenland (fig. 1) were investigated in order to describe and interpret the sedimentological features. On the basis of this, it was hoped that a more refined synthesis of the regional geology could be made.

Previous work in the area has dealt mainly with the dating of the formation (earlier references in Rosenkrantz, 1970), its assemblage of plant fossils (Heer, 1883; Seward, 1926), marine macrofossils (Steenstrup, 1874; Ravn, 1918) and its coal potential and petrography (Shekhar *et al.*, 1982).

The general depositional environment was discussed by Schiener (1975) and Henderson *et al.* (1976). The GGU coal project (Shekhar *et al.*, 1982) adopted the models presented in these papers but despite impressive field work did not shed much new light on the origin of these sediments.

The topography at the localities investigated is impressive and typically glacial (fig. 3). Glacier-capped basalts up to a height of 2000 m overlook relict glacial valleys carved out in lower lying basalts, agglomerates and intercalated sediments of Tertiary age. At a height of 400 to 800 m a moderate to weak angular unconformity is found, below which the interbedded sand, shale and coal of the Atane Formation outcrop in a number of deeply dissected gullies.

Field work took place from 1st July to 26th August at three main localities: Pautût, Kingigtoq and Atanikerdluk (fig. 1). It was supported by boat and helicopter in connection with other GGU activities in the area (Kalsbeek, 1989). The present paper describes a typical section selected from Pautût (figs 1, 3), both vertically and laterally, and its sedimentological characters are discussed and a tentative depositional environment is presented.

General geological setting

The Atane Formation, which consists mainly of loose to weakly consolidated sediments, is found in the Nûgssuaq embayment of the West Greenland sedimentary basin which extends from Grønne Ejland and Disko in the south to Svartenhuk Halvø in the north. A thick sequence of marine and non-marine deposits was laid down (Rosenkrantz & Pulvertaft, 1969) between the Early Cretaceous and the Danian. In Danian times the area was influenced by volcanism and the sediments in

Fig. 1. Geological sketch map of Nûgssuaq and Disko indicating localities mentioned in the text. P: Pautût, K: Kingigtoq, A: Atanikerdluk.