SEDIMENTOLOGICAL STUDIES IN SOUTHERN JAMESON LAND, EAST GREENLAND

I. Fluviatile sequences in the Kap Stewart Formation (Rhaetic – Hettangian)

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The lower part of the Kap Stewart Formation, formed by the dominantly conglomeratic 'barren sandstone', represents alluvial fan deposits. Upwards there is a marked change to the well developed fining upwards sequences of the 'plant-bearing series' which comprise three facies: 1. Coarse arkosic sandstones and conglomerates; 2. Fine rippled bioturbated green sandstones; 3.Variegated siltstones with plant remains and occasional rootlet beds and coal seams. Trough shaped channels, unidirectional palaeocurrents and a lack of epsilon cross-beds all indicate a low sinuosity non braided river environment in close proximity to a SSE source area. In the basal Jurassic a humid climate coal belt in Northern Europe and East Greenland contrasts with an arid climate evaporite belt in Morocco and on the Nova Scotian shelf.

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Geological knowledge of the 50,000 square kilometre Jameson Land Mesozoic basin has been accumulating steadily since the visit of Scoresby 150 years ago. Early work has been summarised by Donovan (1957), though only recently has the systematic mapping been completed (Surlyk & Birkelund, 1972; Surlyk, Callomon, Bromley & Birkelund, 1973). In consequence the stratigraphy and broad facies relations are now well known but little detailed sedimentology has been done. It is hoped that this and the immediately following paper will help to rectify this situation for rocks of Rhaetic and Lower Jurassic age in southern Jameson Land.

Table 1. Stratigraphy of the Triassic-Middle Jurassic rocks of southern Jameson Land (after Rosenkrantz, 1929; Harris, 1937; Perch-Nielsen, Bromley, Birkenmajer & Aellen, 1972; Surlyk et al., 1973). Wavy line indicates an unconformity.

FORMATION	MEMBER	STAGE	ZONE
VARDEKLØFT	Sortehat	?Upper Bajocian	
	Ostreaelv (85 m)	Toarcian	*G. thouarsense* *H. variabilis* *H. bifrons*
NEILL KLINTER (215 m)	Gule Horn (125 m)		
	Rævekløft (0–20 m)	Pliensbachian	*P. davoei* *U. jamesoni*
KAP STEWART (175 m)	'Plant-bearing Series' (90 m)	Hettangian	*Thaumopteris*
	'Barren sandstone' (85 m)	Rhaetian	*Lepidopteris* ?
FLEMING FJORD	Ørsted Dal	Norian	

Stratigraphy

The stratigraphic nomenclature has now been formalised by Surlyk et al. (1973) and their usage will, for the most part, be followed (see Table 1). The base of the Kap Stewart Formation is marked by a change from red mudstones of the underlying Fleming Fjord Formation (Perch-Nielsen, Bromley, Birkenmajer & Aellen, 1972, pp. 55–56) to coarse arkoses and conglomerates. Harris (1937, p. 70) divided the unit into a lower "barren sandstone" (85 m) followed by the 90 m thick "plant-bearing series". Although these units have not been adopted as members in the recent stratigraphic revision (Surlyk et al., 1973, p. 10), they do separate a dominantly conglomeratic unit below from well developed fining upwards sequences above. Thus these terms are retained in this paper.

Plants and logs are abundant but the fauna is very sparse. After intensive collecting Harris (1937, pp. 74–75) found only a single fish spine, a freshwater bivalve, an ostracod and insect remains. The flora indicates that

the "barren sandstone" and the lowest 50 m of the "plant-bearing series" belong to the *Lepidopteris* Zone (Rhaetic). After a 5 m transition the remaining 30 m of the "plant-bearing series" belong to the Hettangian *Thaumopteris* Zone (Harris, 1937, pp. 74–75; Surlyk, Bromley, Asgaard & Pedersen, 1971, p. 26). Thus the thickness of Rhaetic deposits it greater than 140 m, for ostracods seem to indicate a Lower Rhaetic age for the topmost beds of the Fleming Fjord Formation (Defretin-Lefranc, Grasmück & Trumpy, 1969; Perch-Nielsen, Birkenmajer, Birkelund & Aellen, 1974, p. 44).

"Plant-bearing series": Facies description

This unit is poorly exposed at the bottom of ravines penetrating Neill Klinter and good sections were only seen at Astartekløft and in the lower reaches of the Hareelv (fig. 1). At Astartekløft there is 100 m of continuous section which shows well developed fining upwards sequences 2.5–24.4 m thick in which three major facies can be distinguished:

Facies 1. Coarse arkoses and conglomerates. The base of each major sequence is erosive and downcutting and is overlain by a massive conglomerate up to 1 m thick. Quartz and metamorphic rock clasts up to 8 cm diameter are dominant, accompanied by large logs and mudstone clasts. Grain size decreases upwards to a massive pebbly coarse arkose often with accumulations of large logs immediately above the conglomerate. With further grain size reduction well developed trough cross-bedding appears, locally with mud laminae on the foresets. Finally, at the very top, parallel or ripple cross-lamination is occasionally seen. Parallel lamination is also developed above the erosive base of some small channels. Individual facies 1 units are up to 5 m thick, but several sandstones may be superposed on each other to give a maximum thickness of 14 m.

Facies 2. Fine rippled sandstones. Upwards there is a gradational passage into fine-grained green quartz sandstones. This facies is usually only about 50 cm thick and is characterised by ripple and low-angle cross-lamination. Rather indefinite white sand burrow fills are often present.

Facies 3. Variegated siltstones with plant remains. Variegated siltstones at the top of each sequence are up to 4.5 m thick. They are either green, red or purple in colour and near the base may alternate with facies 2, though higher up more nodular sandstones are developed. Well preserved plant remains are abundant at certain levels – often in the topmost 20 cm. Also within this facies a rootlet bed, ganister and coal seam were observed at Dinosauruskløft (R. G. Bromley, personal communication, 1973).

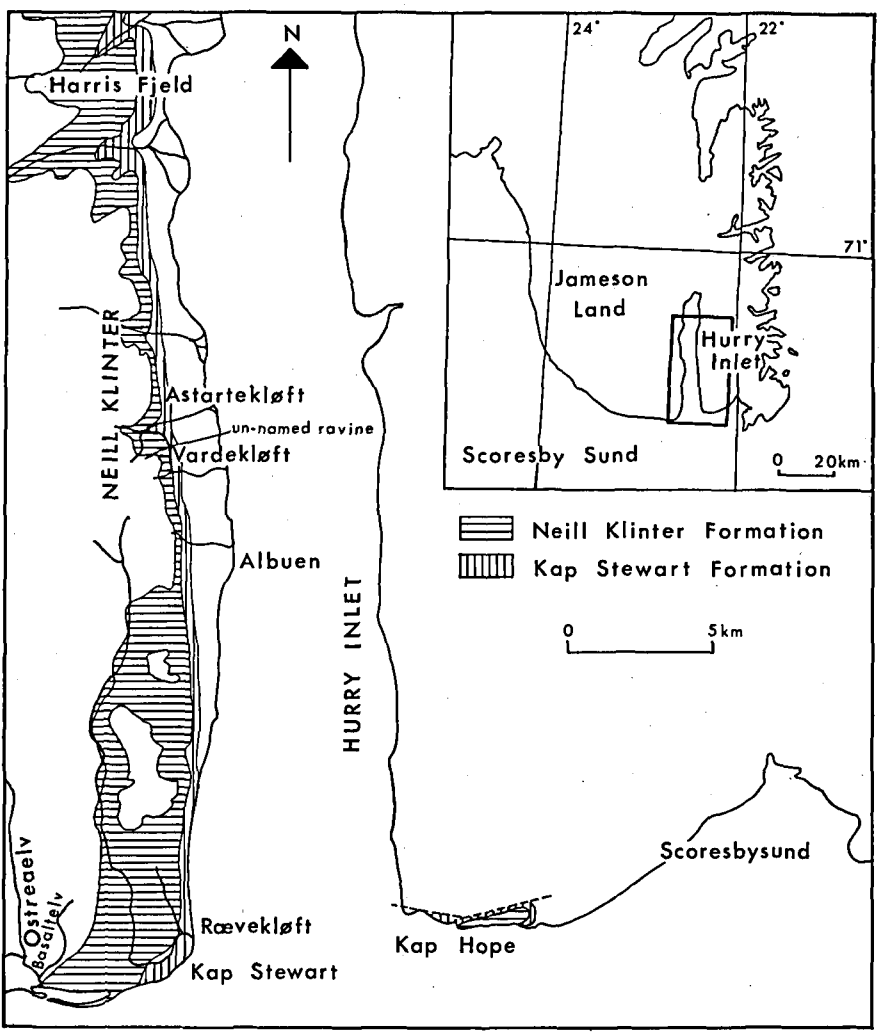

Fig. 1. Map of southern Jameson Land showing outcrops of the Kap Stewart and Neill Klinter Formations, with the localities mentioned in the text (modified from Surlyk & Birkelund, 1972).

The detailed section at Astartekløft is illustrated in fig. 2, whilst fig. 3 shows a generalised fining upwards sequence.

Facies relations. Facies 1 forms lenticular channel bodies 50–200 m wide in contrast with facies 2 which is laterally more persistant and overlaps the channel sides to alternate with the siltstones of facies 3. These relations are illustrated in the upper part of fig. 3.

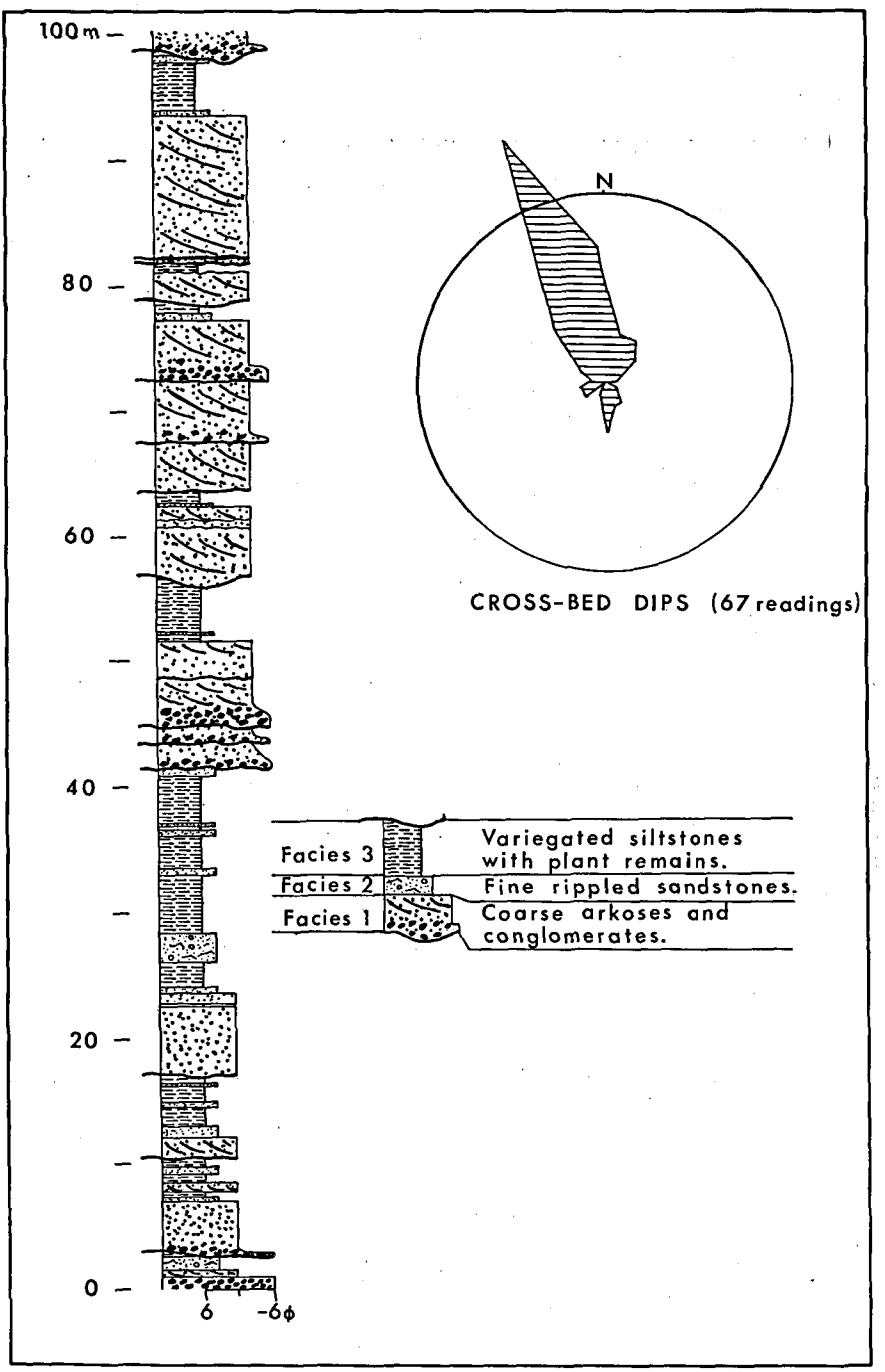

Fig. 2. Detailed section through the "plant-bearing series" at Astartekløft. The section terminates about 10 m below the top of the Kap Stewart Formation. Radius of the palaeocurrent circle indicates 15 measurements. Ø is a logarithmic grain size scale in which silt $>$ 4 Ø, sand 4 to –1 Ø and conglomerate $<$ –1 Ø.

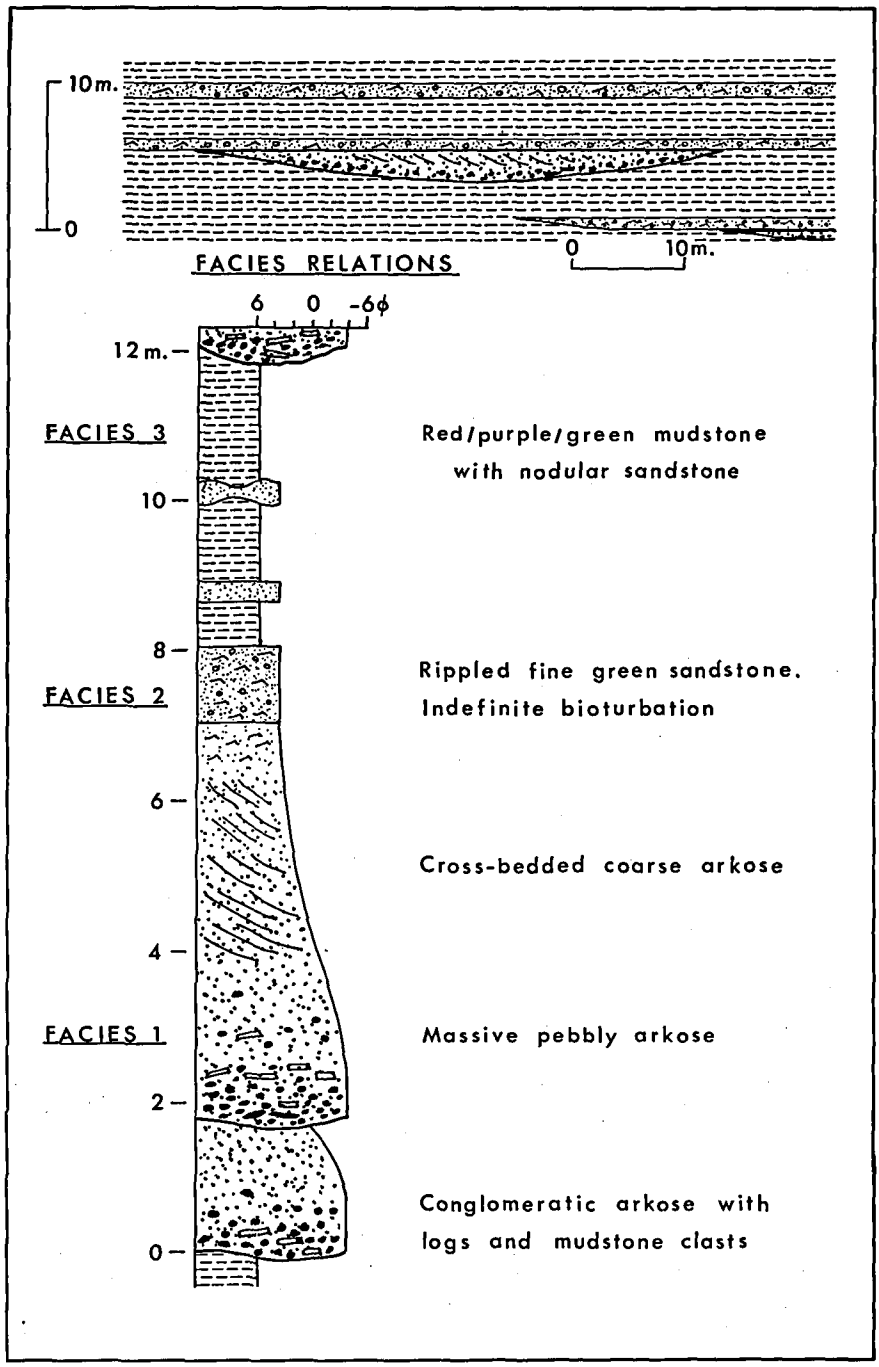

Fig. 3. Generalised fining upwards sequence in the "plant-bearing series". Lateral facies relations are shown diagramatically above.

"Barren sandstone": Facies description

The only good exposures of this unit are at Kap Stewart itself where, contrary to Donovan (1957, p. 23), it is faulted against the Neill Klinter Formation. The same three facies of the "plant-bearing series" can be recognised, but facies 1 arkoses and conglomerates are dominant, often with vast logs up to 10 m long, and only two thin examples of facies 3 siltstones were observed. Unfortunately the steep cliffs and rarity of bedding planes made measurement of a section impossible.

Interpretation

In the "plant-bearing series" the lack of marine fauna together with well defined fining upwards sequences indicate a fluviatile environment. The conglomerates of facies 1 represent channel lag deposits above a scoured floor. The sandstones are dominantly cross-bedded (93.7 %) indicating high-powered streams (Allen, 1970, p. 320), whilst the unidirectional cross-bed orientation (fig. 2) suggests that there was only limited lateral migration. In this case the cross-beds were formed by dunes migrating down low sinuosity streams (Kelling, 1968, p. 2382). As the channel was filled and current velocities waned, rippled bedforms developed in finer-grained sandstones (facies 2) which extended laterally outside the channel as levee deposits. The reduced rate of sedimentation and lower energy conditions allowed limited bioturbation typical of this facies (Allen, 1963, fig. 5; Kelling, 1968, p. 2377). Finally, overbank silts accumulated with occasional vegetation growth.

The dominance of coarse detritus in the "barren sandstone" indicates deposition nearer the source area, probably under low sinuosity braided river conditions at the distal end of an alluvial fan.

Although difficult to prove, the "barren sandsone" seems to thin towards the north. Also the "plant-bearing series" is much sandier at Rævekløft (Lacoste, 1928. fig. 9) than the Astartekløft section. These suggestions of a southerly source area are confirmed by the palaeocurrent data (fig. 2). This source, which controlled the distribution of floodplain facies, retreated in time showing a change from braided to low sinuosity meandering river deposition.

Rosenkrantz (1942, pp. 16–21) recorded similar arkose, silts and coals from the Kap Hope area. However, 110 km to the north west in Schuchert Flod alternating thin beds of coarse arkose and black shales together with flaser bedding and a better developed trace fossil assemblage possibly indicates a marginal marine environment (Surlyk et al., 1973, fig. 6, p. 12 and Surlyk, personal communication, 1973). Even further north in Scoresby

Land the top of the unit is less clearly defined for intercalations of ?marine quartz sandstones of the Neil Klinter Formation are developed (Perch-Nielsen et al., 1972, p. 56).

Discussion

Modern alluvial deposits accumulate in either meandering or braided stretches of rivers (Allen, 1965). However Moody-Stuart (1966, p. 1104) considered that the sinuosity of a river was both more fundamental and easier to recognise in ancient fluviatile sequences. In addition to braided low sinuosity and meandering high sinuosity rivers he proposed an intermediate type of low sinuosity non braided river. In the Kap Stewart Formation the unidirectional palaeocurrents, trough shaped channels and lack of sigmoidal epsilon cross-beds all agree with low sinuosity sequences described from the Devonian of Spitsbergen (Moody-Stuart, 1966, pp. 1109–1113). They have formed on a high gradient upper floodplain in close proximity to the SSE source area.

Very similar fluviatile sequences with coals have been described by Kelling (1968) from the Pennant Measures (Upper Carboniferous) of South Wales. Both successions were controlled by a humid climate and contrast strongly with the classical redbed fluviatile sequences of the Old Red Sandstone (Allen, 1963; Leeder, 1973). The latter usually show development of mudcracks and calcretes in the topstratum deposits indicating an arid climate. Thus it should be emphasised that climate is a fundamental factor controlling the nature of fluviatile sequences, which may be termed either "humid climate" or "arid climate" sequences.

Jameson Land is part of a Rhaetic-Hettangian coal-bearing province which includes Bornholm (Sellwood, 1972), Scania (Troedsson, 1951), and NW Germany. This "coal belt" contrasts strongly with areas of redbed and evaporite deposition in the basal Jurassic of Morocco and the Nova Scotian shelf (McIver, 1972, p. 57; L. F. Jansa, personal communication, 1973). This indicates well defined climatic belts in contrast to the generally accepted ideas of a world-wide "equable" climate during the Lower Jurassic (Hallam, 1969, p. 4).

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Dansk sammendrag

Den nedre del af Kap Stewart Formationen, der for største delen består af den konglomeratagtige "fossilfri sandsten", repræsenterer alluviale aflejringskegler. I den øvre del af formationen er der et tydeligt skift til veludviklede, gradvis mere finkornede lagfølger, den "planteførende serie", der omfatter tre facies. 1: Grove arkosiske sandsten og konglomerater; 2: Finriblede, bioturberede grønne sandsten; 3: Brogede siltsten med planterester samt undertiden rodhorisonter og kullag. Trugformede kanaler, strømme i én retning og mangel på epsilon krydslejring tyder på at sedimentationen er foregået i et miljø med svagt bugtede, ikke opsplittede, flodløb nær ved det mod SSØ beliggende område, der har leveret sedimenterne.

I nedre jura findes et humidt kulbælte i Nordeuropa og Østgrønland som kontrast til et aridt evaporitbælte i Marocco og på shelfen ved Nova Scotia.

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