



Dinoflagellate cyst stratigraphy of the Barremian to Albian, Lower Cretaceous, North-East Greenland – a summary

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As part of studies of the onshore hydrocarbon potential in East Greenland undertaken by the Geological Survey of Greenland (GGU), a project was initiated with the purpose of describing the dinoflagellate cyst stratigraphy of the Lower Cretaceous succession in East Greenland (72°–76°N) and correlating the exposed sections throughout the region (Nøhr-Hansen, 1993).

Based on the rather sporadic occurrence of macrofossils the Lower Cretaceous sediments of East Greenland were previously dated as Aptian to Albian (Spath, 1946; Maync, 1949; Donovan, 1953, 1955, 1957). Maync (1949) reported the total exposed thickness of the 'Aptian–Albian series' to be more than 2000 m, whereas Surlyk (1990) noted that the Lower Cretaceous shale succession reached a cumulative thickness of 1000 m. Furthermore, Donovan (1972) reported that Hauterivian and Barremian sediments were unknown in East Greenland.

Dinoflagellate cysts recorded from 40 sections throughout the region have now dated the Lower Cretaceous sequence as Barremian to Albian, and correlation of sections yields a cumulative thickness of approximately 1500 m (Nøhr-Hansen, 1993) (Figs 1–3).

General stratigraphy

The Lower Cretaceous mudstone succession of East Greenland was apparently deposited in a storm-dominated muddy inner shelf environment (Stemmerik *et al.*, 1993).

The Barremian deposits are represented by approximately 140 m of poorly laminated, silty shales with abundant kidney-shaped calcareous concretions. These shales are *erosively overlain* by a thin calcareous sandstone of early Aptian age, followed by 80 m to 220 m of sandy shales of Aptian age. Following a presumed depositional break in the upper Aptian/lower Albian, depositional rates increased considerably and 1120 m of shales and fine-grained sandstones with several coarsening-upward cycles were deposited during the Albian. A hiatus between the lower and middle Albian and a second hiatus between the middle and upper Albian is suggested by the fact that several dinoflagellate cyst species have their last or first occurrences at these levels (Fig. 2).

The Barremian–Albian succession unconformably overlies sediments of Late Permian to Early Cretaceous age (Stemmerik *et al.*, 1993). During deposition of the shales an increase in subsidence rate took place, possibly as-

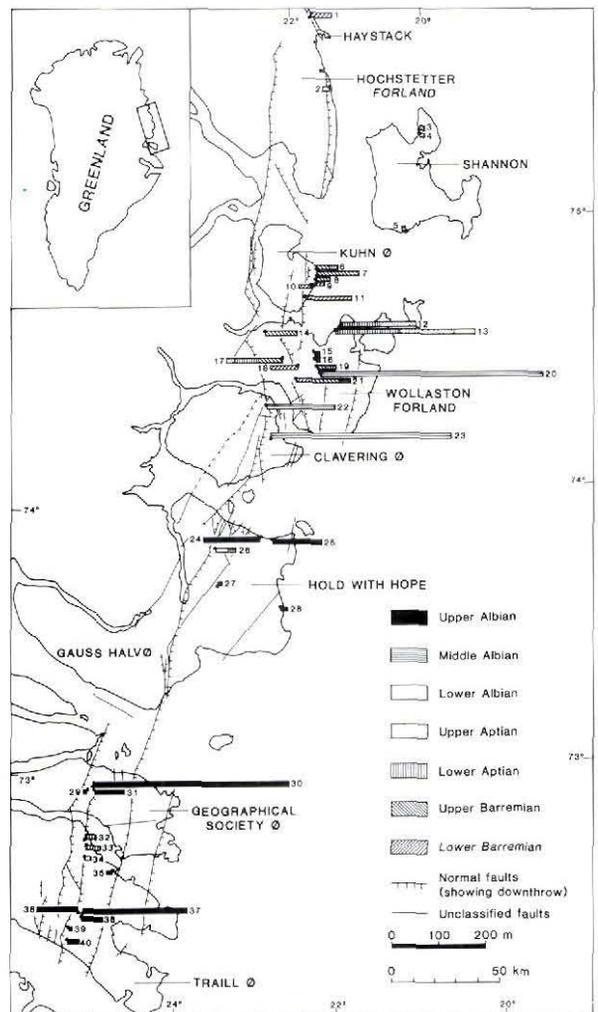


Fig. 1. Location of 40 examined Lower Cretaceous sections in East Greenland that yielded dinoflagellate cysts. The length of the bars represent the thicknesses of the sections and the hatching illustrates the stages represented in each section, as determined on the basis of the dinoflagellate cyst assemblages.

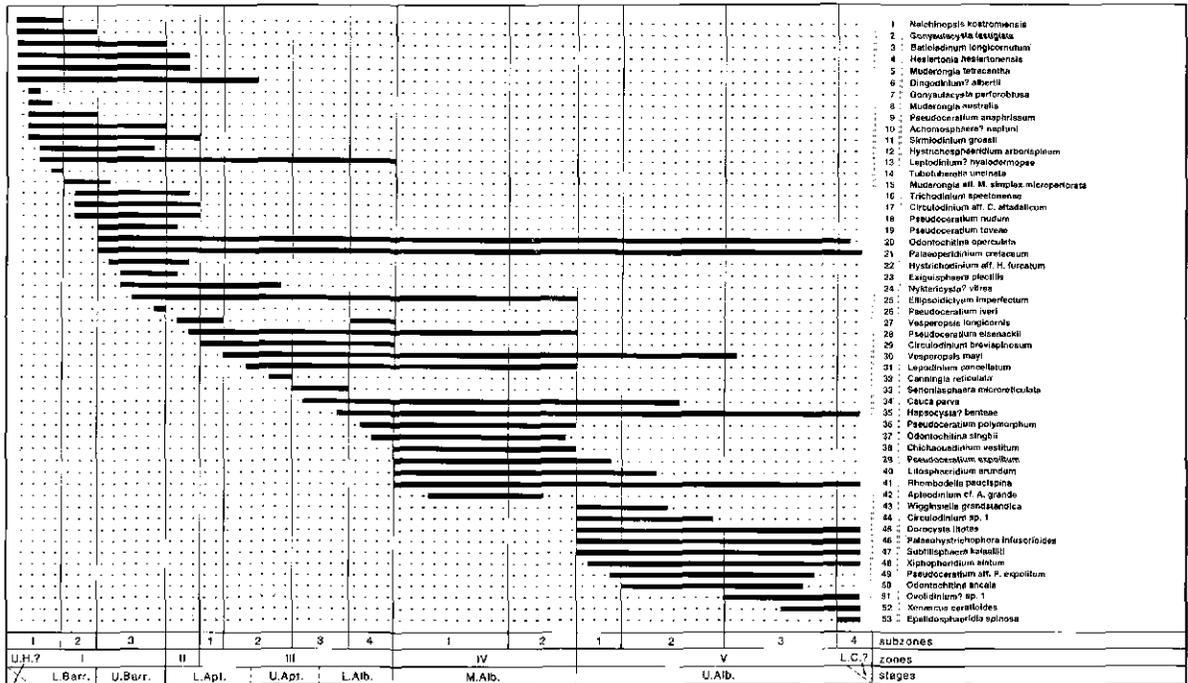


Fig. 2. Total stratigraphical range of 53 age diagnostic dinoflagellate cyst species selected from the 176 recorded species of the Lower Cretaceous succession of East Greenland.

sociated with an overall sea-level rise initiated during the latest Hauterivian? or early Barremian and culminating in the Albian (Nøhr-Hansen, 1993; Stemmerik *et al.*, 1993).

Composition of the organic material

Well preserved dinoflagellate cysts dominate the palynomorph assemblages throughout the succession; 176 dinoflagellate cyst species were recorded in the present study. Saccate pollen and other miospores occur throughout in low numbers, while acritarchs, other algae and miscellaneous palynomorphs are rare.

The organic material is dominated by palynomorphs and by brownish to black woody material; amorphous organic material constitutes a minor part. No clear stratigraphical or regional variation in composition of the organic material was observed.

The organic material is thermally immature to mature with respect to oil generation. The thermal alteration index (TAI) is -2 to $+3$. Chemical analyses of the organic matter yielded total organic carbon (TOC) values of 0.5 to 5.0 wt. %, whereas the S_2 values are too low (0.1 to 1.0 mg HC/g rock) to indicate potential as source-rocks for oil.

Diversity

The diversity of dinoflagellate cyst species, as measured by the number of recorded species per sample, varies from 9 to 46 (Nøhr-Hansen, 1993). The diversity is relatively high (18–30 species) in samples of earliest Barremian age. The highest diversity (more than 40 species) is recorded in samples of latest Barremian to earliest Aptian age, and this is followed by a low diversity interval (9–25 species) of late early Aptian to early Albian age. In the middle Albian the diversity again increases (30–40 species). Finally, in the upper part of the studied succession assigned a late Albian age the diversity is again relatively low and stratigraphically uniform (15–25 species).

Dominant and frequent species

References to the species mentioned below and listed in Figure 2 are described in Lentin & Williams (1989) and in Nøhr-Hansen (1993).

Oligosphaeridium? asterigerum is common in the lowermost Barremian sediments, whereas *Muderongia australis* dominates a thin zone in the same interval. *Pseudoceratium anaphrissum* and *Muderongia* aff. *M. simplex microperforata* are common to very abundant in the higher parts

		ZONES	SUBZONES	
ALBIAN	UPPER	Subtilisphaera kalaalliti (V)	Epelidosphaeridia spinosa (4)	
			Ovoidinium? sp. 1 (3)	
			Odontochitina ancala (2)	
			Wigginsella grandstandica (1)	
	MIDDLE	Rhombodella paucispina (IV)	Chichaouadinium vestitum (2)	
			Litosphaeridium arundum (1)	
APTIAN	LOWER	Circulodinium brevispinosum (III)	Leptodinium? hyalodermopse (4)	
			Senoniasphaera microreticulata (3)	
	UPPER		Vesperopsis mayi (2)	
			Vesperopsis longicornis (1)	
	LOWER		Pseudoceratium nudum (II)	
BARREMIAN	UPPER	Batioladinium longicornutum (I)	Pseudoceratium toveae (3)	
			Pseudoceratium anaphrissum (2)	
	LOWER		Nelchinopsis kostromiensis (1)	

Fig. 3. Dinoflagellate cyst zonation for the Barremian to Albanian in East Greenland (72°–76°N).

of the lower Barremian. *Pseudoceratium toveae* (Fig. 4g) and *Circulodinium* aff. *C. attadalicum* are common in the upper Barremian, whereas *Cribroperidinium mude-rogense* is very abundant in a restricted interval in the uppermost Barremian.

Circulodinium aff. *C. attadalicum* is very abundant in the lowermost Aptian whereas *Vesperopsis longicornis* and *Chlamydophorella trabeculosa* are common to very abundant in sediments considered to belong to a higher level of the lower Aptian. *Oligosphaeridium complex*

is very abundant in the higher parts of the lower Aptian to the lower parts of the upper Aptian. *Senoniasphaera microreticulata* is very common in the uppermost Aptian to the lowermost Albanian.

Circulodinium brevispinosum and *Vesperopsis longicornis* are common to abundant in the lower Albanian. *Circulodinium* sp. 1 is very abundant in the lowermost parts of the upper Albanian. *Rhombodella paucispina* and *Subtilisphaera kalaalliti* (Fig. 4j) dominate the assemblages in the middle and the uppermost Albanian; *Ovoidinium?* sp. 1 (Figs 4h & i) is quite common in the upper part of this interval.

Chlamydophorella trabeculosa, *Oligosphaeridium complex* and *Spiniferites* spp. are common to abundant throughout the major part of the studied sequences. *Odontochitina operculata*, *Palaeoperidinium cretaceum* and *Sentusidinium* sp. 1 are common to abundant in most of the samples tentatively considered to belong to the upper Barremian to upper Albanian.

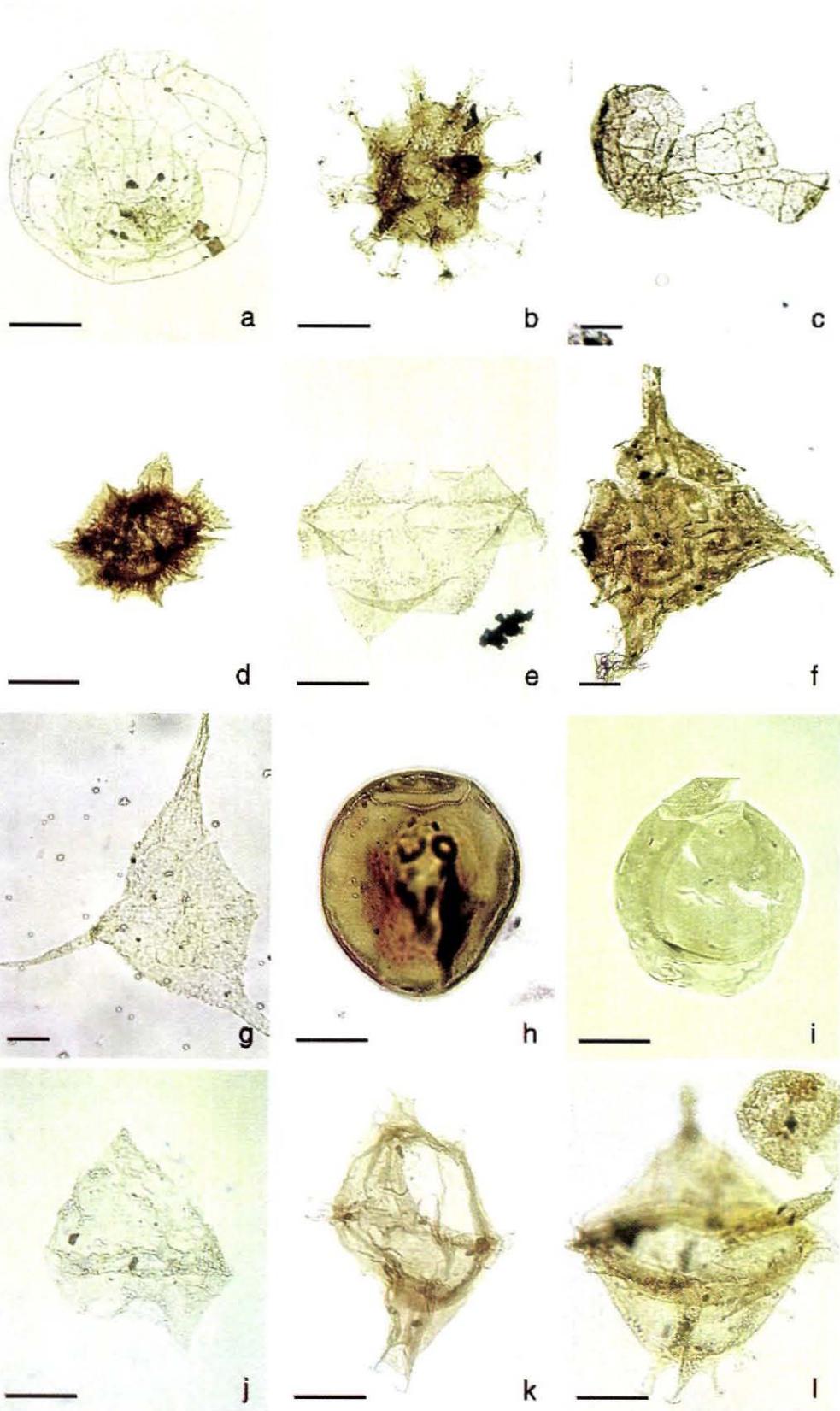
Provincialism

The dinoflagellate cyst assemblages from East Greenland seem to be almost identical to assemblages from offshore Norway and show similarities with assemblages previously described from north-west Europe and Canada. However, it is remarkable that some of the assemblage

Fig. 4. Examples of stratigraphically important dinoflagellate cysts from Lower Cretaceous of East Greenland.

- a. *Hapsocysta? benteeae* holotype, 500×, section 21; GGU 342240–4, 10.0–140.0; MGUH 21988
- b. *Hystrichosphaeridium arborispinum* 500×, section 7; GGU 342081–4, 17.4–157.1; MGUH 21807
- c. *Leptodinium cancellatum* 500×, section 20; GGU 342176–4, 11.3–150.2; MGUH 21825
- d. *Nelchinopsis kostromiensis* 500×, section 10; GGU 342092–4, 21.9–144.8; MGUH 21843
- e. *Nyktericysta? vitrea* 500×, section 17; GGU 342169–4, 17.1–153.2; MGUH 21850
- f. *Pseudoceratium iveri* holotype 500×, section 17; GGU 342166–5, 16.7–146.0; MGUH 21924
- g. *Pseudoceratium toveae* holotype 500×, section 1; GGU 360371–3, 15.3–132.0; MGUH 21948
- h. *Ovoidinium?* sp. 1 500×, section 30; GGU 324615–7, 19.0–127.8; MGUH 21970
- i. *Ovoidinium?* sp. 1 700×, section 24; GGU 346451–4, 5.6–143.0; MGUH 21972
- j. *Subtilisphaera kalaalliti* holotype 730×, section 30; GGU 324622–3, 23.0–138.4; MGUH 21992
- k. *Tubotuberella uncinata* 500×, section 9; GGU 342069–4, 5.6–147.8; MGUH 22011
- l. *Wigginsella grandstandica* 500×, section 29; GGU 324599–4, 3.5–124.9

All scale bars represent 20 μ.



characteristics from East Greenland are comparable with those from Australia and Papua New Guinea.

Pseudoceratium anaphrissum, which is an important stratigraphic marker for the lower Barremian black shale facies in north-west Europe, Norway and East Greenland, is apparently absent in Arctic Canada and probably also in Eastern Canada. *Batioladinium longicornutum* is common in Hauterivian to Barremian deposits in north-west Europe, Norway and East Greenland but is very rare in Arctic Canada and not reported from Eastern Canada. *Pseudoceratium nudum* (Barremian to lower Aptian), which is common in East Greenland, Norway and Arctic Canada, is very rare in north-west Europe and apparently absent in eastern Canada. The species *Pseudoceratium toveae* (Barremian, Fig. 4g), recorded from East Greenland, offshore Norway and Arctic Canada (unpublished data 1989) has not been reported from north-west Europe, except offshore Norway. However, the closely related species *Pseudoceratium weymouthense* occurs in the uppermost Late Jurassic and lowermost Early Cretaceous in Australia.

Senoniasphaera microreticulata (upper? Aptian to middle Albian) has not been reported from north-west Europe or from the southern hemisphere, whereas it seems to be a good stratigraphical marker in offshore Norway, Arctic Canada and East Greenland. *Pseudoceratium expositum* (middle to upper Albian) is also very rare in Europe except offshore Norway, Arctic and Eastern Canada and East Greenland where it is common and stratigraphically useful.

Chichaouadinium vestitum (middle to upper Albian) and *Wigginsella grandstandica* (lower part of upper Albian, Fig. 4l) have not been recorded from areas outside North America and East Greenland.

Ovoidinium? sp. 1 (Figs 4h & i) has only been recorded from offshore Norway and East Greenland. It is common to very abundant in the uppermost Albian to lowermost Cenomanian.

The combined dominance of *Rhombodella paucispinosa* and *Subtilisphaera kalaalliti* (Fig. 4j) in upper Albian sediments in East Greenland seems to be a local phenomenon.

According to palaeogeographic maps of the Early Cretaceous of the North Atlantic region, land barriers having an influence on the mixing of Arctic and Boreal dinoflagellate cyst assemblages apparently did not exist. The geographically restricted occurrence of some of the species may therefore have been controlled by differences in salinity, temperature or local current patterns.

Dinoflagellate cyst zonation in East Greenland

The zonation is based on the ranges and acmes of 53 stratigraphically important species (Fig. 2). Five zones

(I–V) are erected, and subdivided into 13 subzones (Fig. 3). One zone and three subzones are distinguished in the Barremian, two zones and four subzones for the Aptian to Lower Albian, and two zones and six subzones for the Middle and Upper Albian. Each zone and subzone is defined by two lowest or highest occurrences of taxa.

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