

Nannofossil biostratigraphy of the Karlslunde-1 well, Danish Basin

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G E U S

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Introduction

Detailed nannofossil biostratigraphy of part of the cored upper Maastrichtian section of the Karlslunde-1 well was carried out as part of the PhD study 'Upper Maastrichtian – Danian nannofossils of the Danish Central Graben and the Danish Basin: a combined biostratigraphic – palaeoecological approach' (Sheldon 2006). The Karlslunde-1 well (DGU 207.3850, Figure 1) was drilled in 2003 for a hydrology/groundwater research project. The following report presents a biostratigraphic breakdown of selected core samples from the well, based on nannofossils.

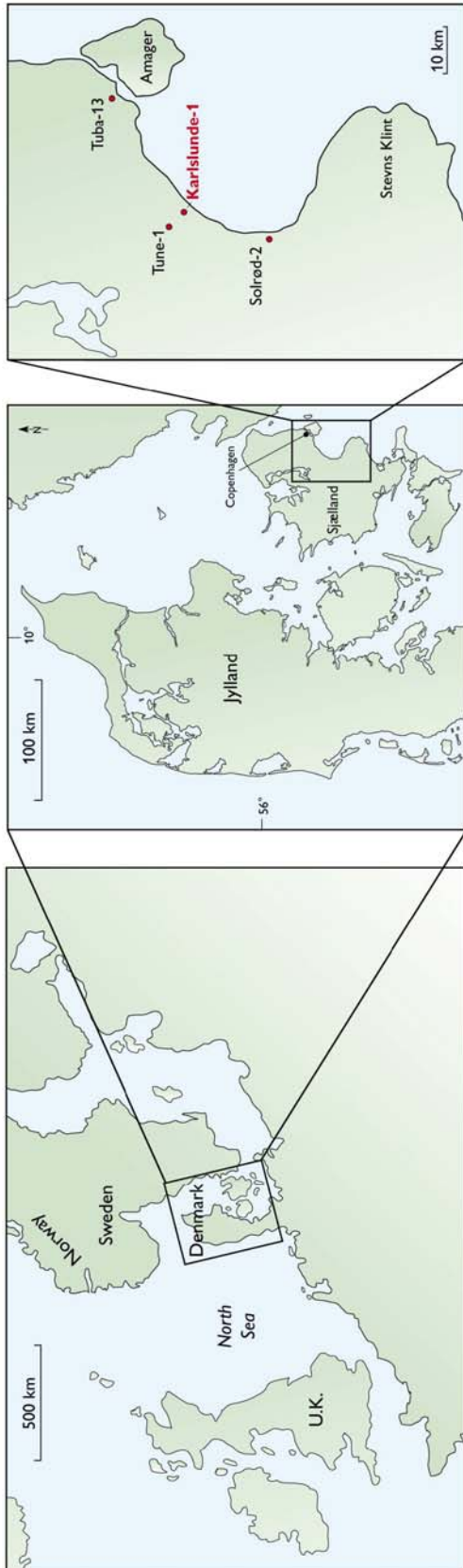


Figure 1. Location map, Danish Central Graben

Methods

28 samples were examined from the Karlslunde-1 well. Sampling was undertaken approximately every 10 m and at a slightly higher resolution where it was necessary to check a nannofossil zonal boundary. Samples were taken in clean, uniform chalk, away from clay partings and stylolitic horizons. In order to avoid zones of excessive diagenetic alteration (e.g. due to stylolitisation), care was taken where possible to sample in uniform pelagic chalk, away from solution horizons and mineralised fractures.

Nannofossil smear slides were prepared using the simple smear slide technique described in Bown & Young (1998). The prepared slides were examined using a Leitz Labrolux 8 light microscope under x1250 magnification. All slides are stored at GEUS.

Simple relative abundance counting (Bown & Young 1998) was utilised in this study, i.e. a minimum of 300 specimens, which at the 95% confidence level provides representation of taxa present at 1% or greater. At important stratigraphic levels (i.e. close to zonal boundaries) extra counting was undertaken when necessary to check for the presence of key zonal marker taxa. Samples which upon initial examination appeared to be barren of nannofossils were subsequently examined for 10 length-traverses to obtain a rough species abundance. The quantitative data was recorded as a biostratigraphic range chart (Enclosure 1).

Nannofossil biozonation

The UC^{BP} nannofossil zonation scheme of Burnett (1998) is used in this study and is applicable to the Cretaceous of the northern high latitudes and North Sea area. The scheme is modified using local observations from the Danish and Norwegian sectors of the North Sea (Fritsen 1999) (Figure 2). In this study, where cored intervals are assigned to a nannofossil zone or subzone, the 'Interval Zone' convention of Hedberg (1976) is followed. The time-scale of Gradstein *et al.* (1994) is used for the Maastrichtian.

Terminology

In this study the use of 'FO' (First evolutionary Occurrence) and 'LO' (Last evolutionary Occurrence) is used. The sections from the Danish Basin are measured in metric units (metres and centimetres), with M.U.T (Metres Under Terrain) commonly used. In this study, sample depths are referred to as M.D.f.b.R.L. (Measured Depth, feet below Reference Level).

Reworking and caving

As core material was used in this study, caving is not an issue. Although much of the chalk is thoroughly bioturbated, the scale of biogenic mixing is considered negligible with regard to the biozonation.

Figure 2. Upper Maastrichtian multidisciplinary biostratigraphic correlation

Stage	Substage	Nannofossils				Belemnites	Brachiopods	Foraminifera	Dinoflagellates		
		Sissingh (1977)	Europe Burnett (1998)	North Sea Fritsen et al. (1999)		Jeletzky (1951) Birkelund (1957)	Surlyk (1970, 1984)	King et al. (1989)	Schiøler & Wilson (1993)		
MAASTRICHTIAN	UPPER	CC 26	b	unreworked, non-survivor Cretaceous taxa	UC20 ii	Belemnella casimirovensis	10	FCS 23	Polymodinium grallator	Tpe	P. grallator T. pelagica
			a							dBP	
		CC 25	c	C. daniae	UC20 i	C. daniae	9		Hbo	H. borisii	
			b	cBP	A. maastrichtiana		8 (pars)		Pde	I. cooksoniae	
		aBP	L. quadratus	UC19 iii	N. frequens		Tut	T. utinensis			

* BP = 'Boreal Province'

Biostratigraphy

On the basis of nannofossil assemblage analysis, the cored upper Maastrichtian section of the Karlslunde-1 well is divided into biozones UC20b^{BP}-c and UC20d^{BP} (Figure 3, Enclosure 1, Table i).

	Base	Top	Thickness (metres)
UC20d ^{BP}	72.00 m	47.90 m	24.10 m (minimum)
UC20b ^{BP} -c ^{BP}	269.00 m	72.00 m	197.00 m (minimum)

Table i Nannofossil subzone thickness in Karlslunde-1

Lithostratigraphy

The cored section is referred lithologically to the Tor Formation equivalent (Figure 4).

Tor Formation equivalent

Subzones UC20b^{BP}-c^{BP}

269.00 m–72.00 m

Definition

The base of subzone UC20b^{BP} in the 'boreal' province is marked by the FO of *Nephrolithus frequens* and the top by the FO of *Arkhangelskiella maastrichtiana* (Burnett 1998). The base of the overlying subzone UC20c^{BP} is marked in the 'boreal' province by the FO of *A. maastrichtiana* and the top by the FO of *Cribrosphaerella daniae* (Burnett 1998).

Floral characteristics

This interval is characterised by a high abundance and diversity nannofossil assemblage dominated by *Prediscosphaera cretacea*, *Prediscosphaera stoveri*, *N. frequens*, *Kamptnerius magnificus*, *Placozygus* cf. *P. fibuliformis*, *Arkhangelskiella cymbiformis* and comprising fairly common *Cribrosphaerella ehrenbergii*, *Eiffelithus turriseiffelii*, and *Watznaueria barnesiae*. *C. daniae*, the marker for the overlying UC20d^{BP} subzone is absent. Reworking from the lower Maastrichtian and Campanian (or older) is indicated by rare occurrences of

Reinhardtites anthophorus, *Rerinhardtites levis*, *Eiffelithus eximius*, *Tranolithus orionatus*, and *Broinsonia parca constricta*.

Remarks

The absence of *C. daniae* and *N. frequens*, in addition to the absence of marker species from stratigraphically older levels from 269 m to 254 m, suggests the possible presence of subzone UC20a^{BP} at this level. In the 'boreal' province, the base of UC20a^{BP} is marked by the FO of *Lithraphidites quadratus*, and the top by the FO of *N. frequens* (Burnett 1998). As *L. quadratus* has only been identified sporadically in this study, referral to this subzone would be very tentative. Further up section, an equivalent thickness also appears to lack *N. frequens* (Enclosure 1). It is possible in both cases that the lack of this marker species is due to environmental or sedimentological factors (Sheldon 2006). The presence of *Isabelidium cooksoniae* (a dinoflagellate cyst) from the lower two samples (P. Schiøler, personal communication, 2006) indicates the presence of sediments younger than UC20a^{BP}. Subzones UC20b^{BP} and UC20c^{BP} are subdivided on the presence/absence of *A. maastrichtiana* (Burnett 1998). *A. maastrichtiana* is equivalent to the large to very large variety of *Arkhangelskiella* with a broad rim (Varol 1989). The morphometric study applied to the North Sea wells (Sheldon *et al.* 2012a, b, c and d) was also conducted in the Karlslunde-1 well, but a pattern indicating a size increase, of rim width or coccolith length, was not recognised and therefore the boundary between subzones UC20b^{BP} and c^{BP} is not recognised. Reworking from the Upper Campanian in this interval is represented by a rare occurrence of *Heteromarginatus bugensis* at 269 m. UC20b^{BP}–c^{BP} coincides with subzone UC20i (Fritsen 1999).

Subzone UC20d^{BP}

72.00 m–47.90 m (highest sample examined)

Definition

The base of subzone UC20d^{BP} of the 'boreal' province is defined by the FO of *C. daniae*, and the top by the LO of unworked, non-survivor taxa (Burnett 1998).

Floral characteristics

This interval comprises a diverse assemblage including common *P. cretacea*, *P. stoveri*, *N. frequens*, and *Placozygus* cf. *P. fibuliformis*, along with *Micula decussata*, *K. magnificus*, *E. turriseiffelii*, *Lucianorhabdus cayeuxii*, *Ahmuellerella octoradiata*, *Cretarhabdus conicus*, *W. barnesiae* and *C. ehrenbergii*, amongst others. Present in the lower sample is the marker

for this subzone, *C. daniae*, although this species has not been recognised in the overlying 3 samples. Reworking has not been recognised in this interval in this well.

Remarks

UC20d^{BP} coincides with subzone UC20ii (Fritsen, 1999). The Kjølbj Gaard Marl (Troelsen 1955), which acts as a good correlation horizon in some cases, was not encountered in this well.

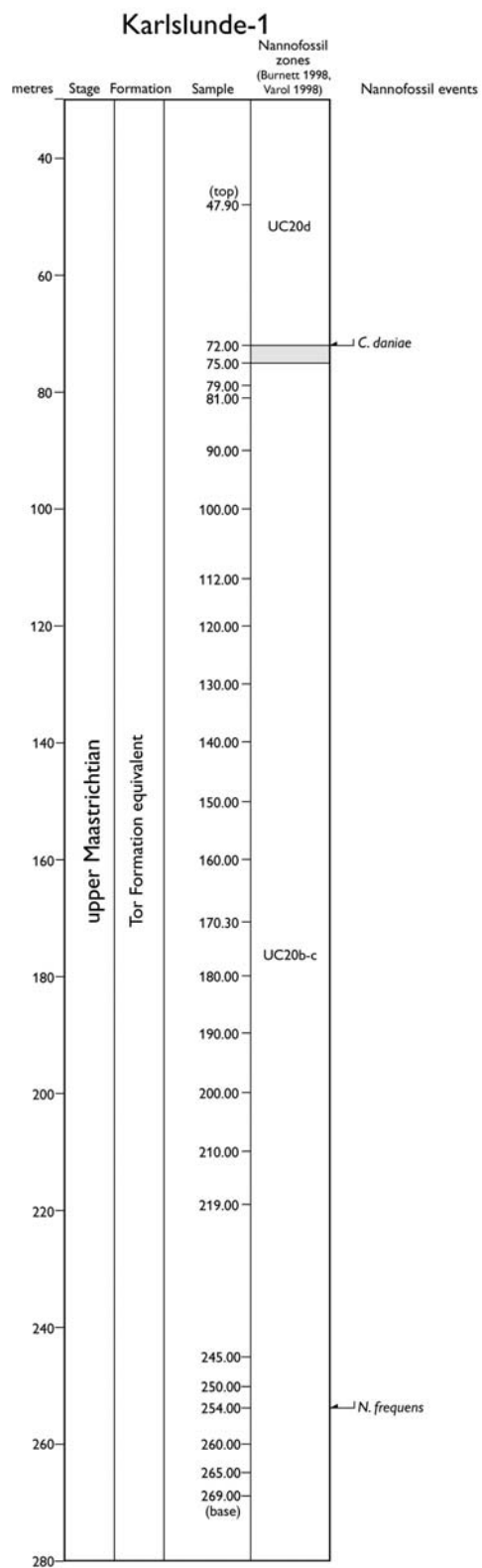


Figure 4. Karlslunde-1 nannofossil biostratigraphy

List of samples from Karlslunde-1 (in metres)

47.9	130	219
72	140	230
75	150	245
79	160	250
81	170.3	254
90	180	260
100	190	265
112	200	269
120	210	

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