DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2012/43

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GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
DANISH MINISTRY OF CLIMATE, ENERGY AND BUILDING

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Contents

Introduction

Detailed nannofossil biostratigraphy of the cored upper Maastrichtian – Danian section of the Tune-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 Tune-1 well (DGU 207.3841, 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.

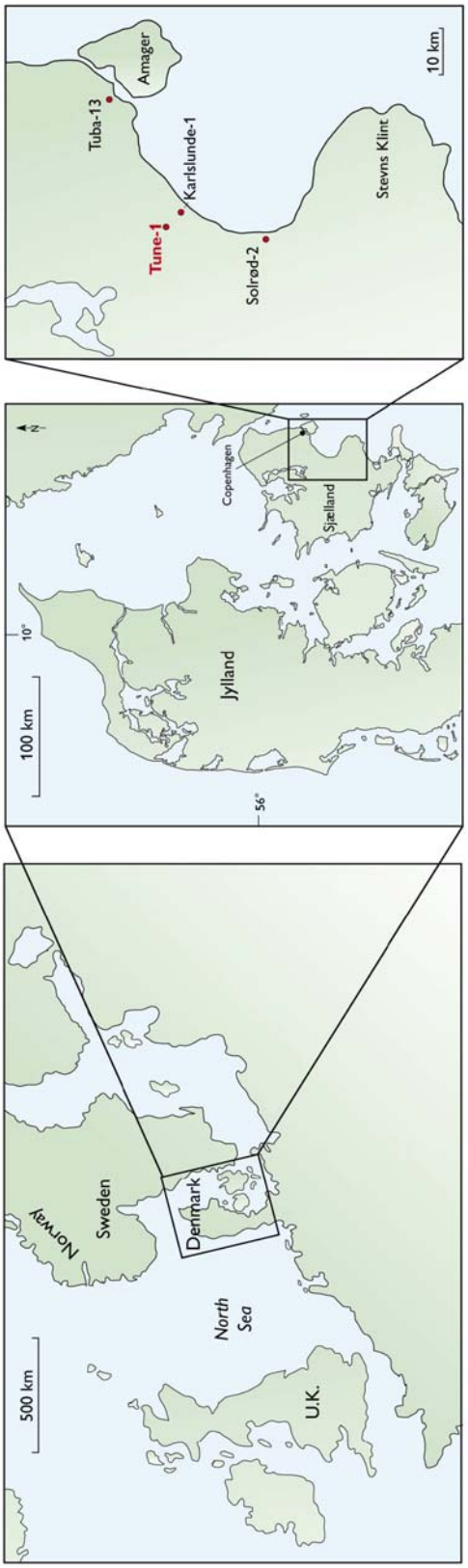

Figure 1. Location map, Danish Central Graben

Methods

19 samples were examined from the Tune-1 well. Sampling was undertaken approximately every 1 m where recovery allowed, and at a higher resolution where it was necessary to check a nannofossil zonal boundary, and over the K/T (Cretaceous- Tertiary) 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 nannofossil zonation schemes used in this study are applicable to the northern high latitudes and North Sea area. The UC^{BP}scheme of Burnett (1998) is used for the Cretaceous, and the scheme of Varol (1998) is used for the Paleocene. Both schemes are modified using local observations from the Danish and Norwegian sectors of the North Sea (Fritsen 1999) (Figures 2 & 3). In this study, where cored intervals are assigned to a nannofossil zone or subzone, the 'Interval Zone' convention of Hedberg (1976) is followed. The timescale of Gradstein *et al.* (1994) is used for the Maastrichtian, and those of Berggren *et al.* (1995) and Haq *et al.* (1987) are used for the Danian.

Terminology

In this study the use of 'FO' (First evolutionary Occurrence) and 'LO' (Last evolutionary Occurrence) is used. The Cretaceous/Tertiary boundary is referred to herafter as the K/T boundary.

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.

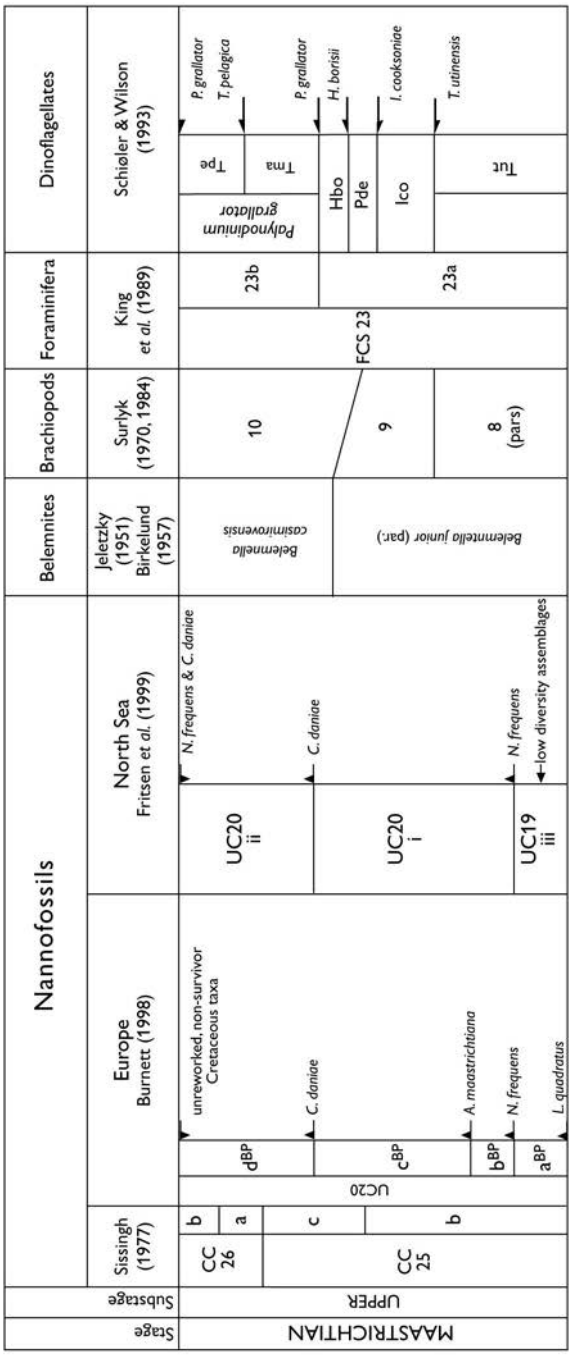

Figure 2. Upper Maastrichtian multidisciplinary biostratigraphic correlation

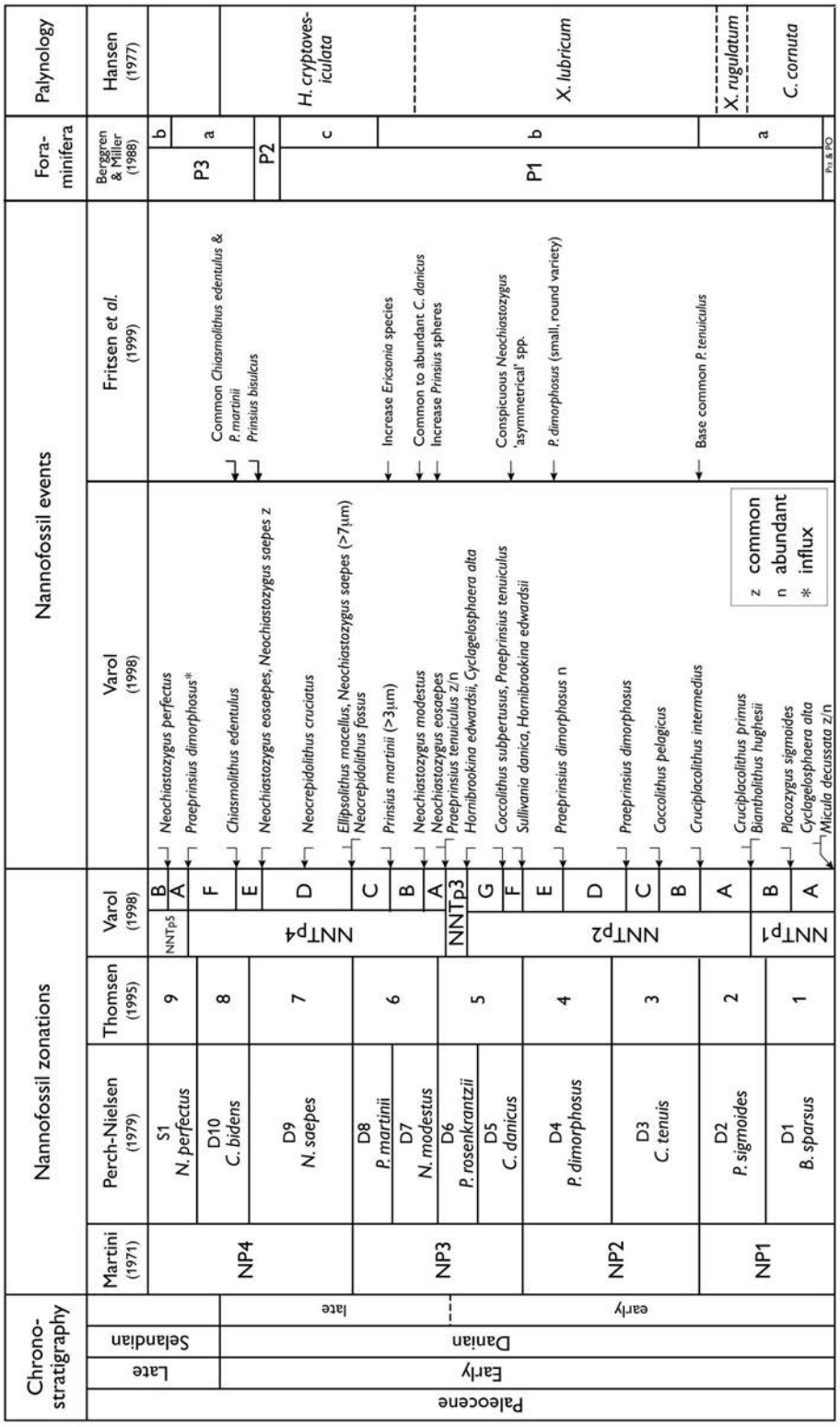

Figure 3. Danian multidisciplinary biostratigraphic correlation

Biostratigraphy

On the basis of nannofossil assemblage analysis, the cored upper Maastrichtian – Danian section of the Tune-1 well is divided into upper Maastrichtian nannofossil subzone UC20d^{BP} and Danian NNTp1A and NNTp1B subzones (Figure 4, Enclosure 1, Table i).

	Base	Top	Thickness
NNTp1B	84.05 m	84.05 m	
NNTp1A	85.06 m	84.05 m	1.01 m
UC20d^{BP}	94.25 m	85.06 m	9.19 m (minimum)

Table i *Nannofossil subzone thickness in Tune-1*

Lithostratigraphy

The cored section is referred lithologically to the Tor Formation equivalent (Maastrichtian) and the Rødvig Formation (Danian), Figure 5. The following biostratigraphic breakdown is subdivided according to these broad lithological boundaries.

Tor Formation Equivalent

Subzone UC20d^{BP}

94.25 m (lowest sample examined) – 85.06 m

Definition

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

Floral characteristics

This subzone is characterised by an assemblage rich in nannofossils, including common *Nephrolithus frequens*, *Watznaueria barnesiae*, *Prediscosphaera stoveri*, *Prediscosphaera cretacea*, *Micula decussata*, *Eiffelithus turriseiffelii*, *Cribrosphaerella ehrenbergii*, *Chiastozygus amphipons* and *Arkhangelskiella cymbiformis*. The marker species for this subzone, *C. daniae* is present throughout. Fairly common reworking from the Campanian (or older) and lower in the Maastrichtian is represented by *Eiffelithus eximius*, *Broinsonia parca*

parca, *Gartnerego obliquum*, *Reinhardtites levis*, *Zeugrhabdotus bicrescenticus*, *Tranolithus orionatus* and *Calculites obscurus*.

Remarks

UC20d^{BP} coincides with subzone UC20ii (Fritsen 1999). The important upper Maastrichtian marker bed, the Kjølby Gaard Marl (Troelsen 1955), is found from 93.50 m – 94.00 m (Sheldon 2006).

Rødvig Formation

Subzone NNTp1A

85.06 m–84.05 m

Definition

The base of this subzone is marked by the LO of common *A. cymbiformis* with common *M. decussata* and/or the FO of *Biantholithus sparsus* (Romein 1979) and/or the FO of *Cyclagelosphaera alta* (Varol 1989). The top is marked by the FO of *Zeugrhabdotus sigmoides* (Varol 1998).

Floral characteristics

Common *Biscutum harrisonii*, *Neocrepidolithus dirimosus*, *Cyclagelosphaera reinhardtii* and *Thoracosphaera* spp. in addition to *Cyclagelosphaera* cf. *C. alta* characterise this subzone in this well. Also notable is the presence of *Biantholithus hughesii* and *B. sparsus*. *Z. sigmoides, Neocrepidolithus neoscrassus* and *Octolithus multiplus* are present in very low numbers in this interval. In addition to fairly common reworking from the upper Maastrichtian in this interval (*W. barnesiae*, *N. frequens*, *Kamptnerius magnificus*, *Placozygus* cf. *P. fibuliformis*, *C. amphipons*, *P. stoveri*, *P. cretacea*, *Ahmuellerella octoradiata*, *A. cymbiformis*, *C. ehrenbergii* and *E. turriseiffelii*), rare reworked specimens are found from the Lower and mid-Maastrichtian (*R. levis*, *C. obscurus* and *T. orionatus*). *M. decussata* remains fairly common in the lower sample but decreases thereafter.

Remarks

The samples from this interval are placed lithologically as follows: sample 85.06 m is from within the earliest Danian Fiskeler Member (Surlyk *et al.* 2006), previously known as the Fish Clay; sample 84.87 m from above the Fiskeler Member, sample 84.30 m from a burrow fill in the Cerithium Limestone Member, and 84.20 m from porcellaneous material within the Cerithium Limestone Member. The samples at 84.30 m and 84.20 m contain very

sparse nannofossils, therefore 10 length traverses were examined instead of the usual 300 specimens. Perch-Nielsen (1979) found *Z. sigmoides* to be absent or very rare in the DI interval (equivalent to NNTp1A) while Varol (1989) questioned the occurrence of this species in the NNTp1A interval. According to Varol (1998), after Perch-Nielsen (1979), the FO of *Z. sigmoides* characterises the top of subzone NNTp1A. However Varol (1998) notes that 'typical' specimens of this species are not found below subzone NNTp1B. Common *Thoracosphaera* spp. and rare *Z. sigmoides* are considered in this well to be indicative of subzone NNTp1A. Varol (1989) noted common to abundant reworking from the Maastrichtian and Campanian in Zone NNTp1; in this well, reworking from the upper Maastrichtian is present, although no evidence of Campanian nannofossils has been found. The earliest Danian subzone NNTp1A is also reported from the Tuba-13 and Solrød-2 boreholes (Sheldon *et al.* 2012a and b).

Subzone NNTp1B

84.05 m (highest sample examined)

Definition

The base of NNTp1B is characterised by the FO *Z. sigmoides*, while the top is characterised by the LO of *B. hughesii* and/or the FO of *Cruciplacolithus primus* (Varol 1998).

Floral characteristics

Low diversity assemblages in this subzone (represented by 1 sample) are characterised by common *B. harrisonii*, *N. dirimosus*, *Thoracosphaera* spp. and *Z. sigmoides*. Also present are *Markalius inversus*, *C. reinhardtii, B. hughesi, Braarudosphaera bigeloweiii* and *O. multiplus*. Specimens of *Cruciplacolithus* and *Coccolithus*, indicative of younger subzones, are not found in the sampled interval of this well. It should be noted, however, that the upper 49.85 m of cored section was not sampled in this study. Fairly common reworking from the upper Maastrichtian is indicated by *A. cymbiformis*, *W. barnesiae*, *Prediscosphaera spinosa*, *P. cretacea*, *N. frequens*, *E. turriseiffelii*, *C. ehrenbergii*, *C. amphipons* and *A. octoradiata*.

Remarks

The parameters characterising the boundary between this, and the underlying subzone are discussed above. The highest sample investigated in this well contains common *Z. sigmoides* for the first time in addition to the presence of *O. multiplus*, *C. reinhardtii*, *Neocrepidolithus* spp. and *Biscutum* spp., indicative of the base of Zone D2 (Perch-Nielsen 1979),

equivalent to the base of NNTp1B. Specimens of *Neochiastozygus* noted by Varol (1998) in this interval have not been recognised in this study.

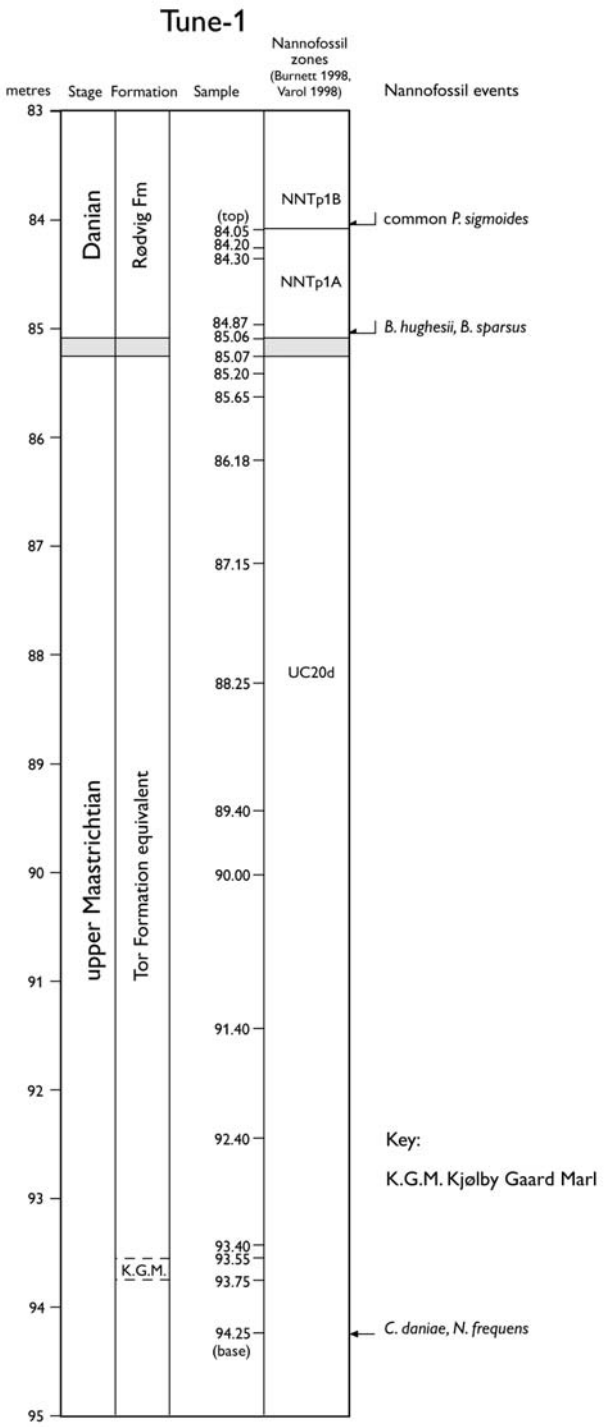

Figure 4. Tune-1 nannofossil biostratigraphy

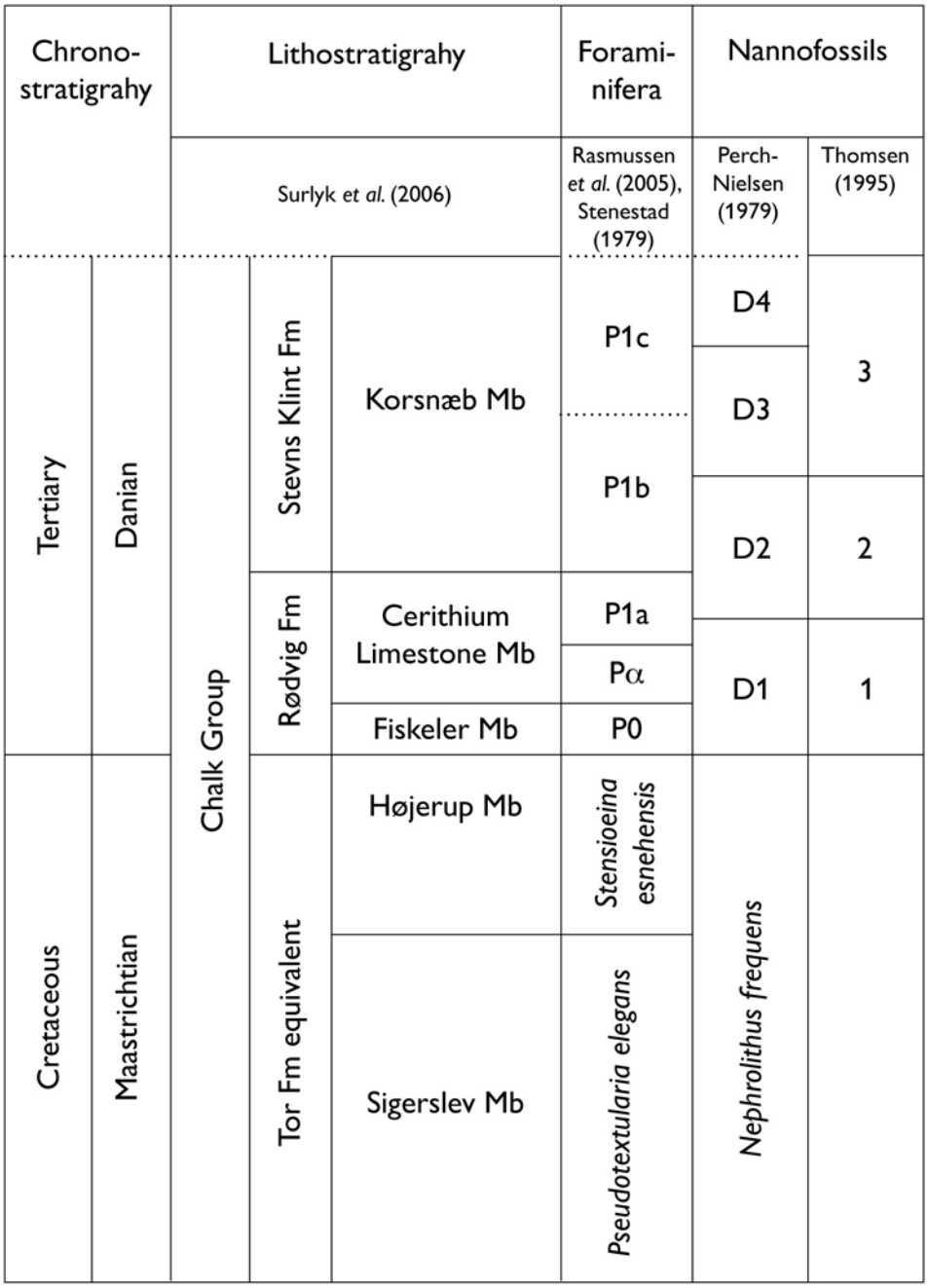

Figure 5. Maastrichtian-Danian stratigraphy (after Surlyk *et al.* 2006)

List of samples from Tune-1 (in metres)

84.05	85.20	90.0
84.20	85.65	91.40
84.30	86.18	92.40
84.87	87.15	93.40
85.06	88.25	94.25
85.07	89.40	

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