DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2012/42

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Emma Sheldon, Jon R. Ineson & Paul Bown

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 Solrød-2 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 Solrød-2 well (DGU 207.3358) was drilled in 1996 as a water works borehole (Figure 1). The following report presents a biostratigraphic breakdown of selected core samples from the well, based on nannofossils.

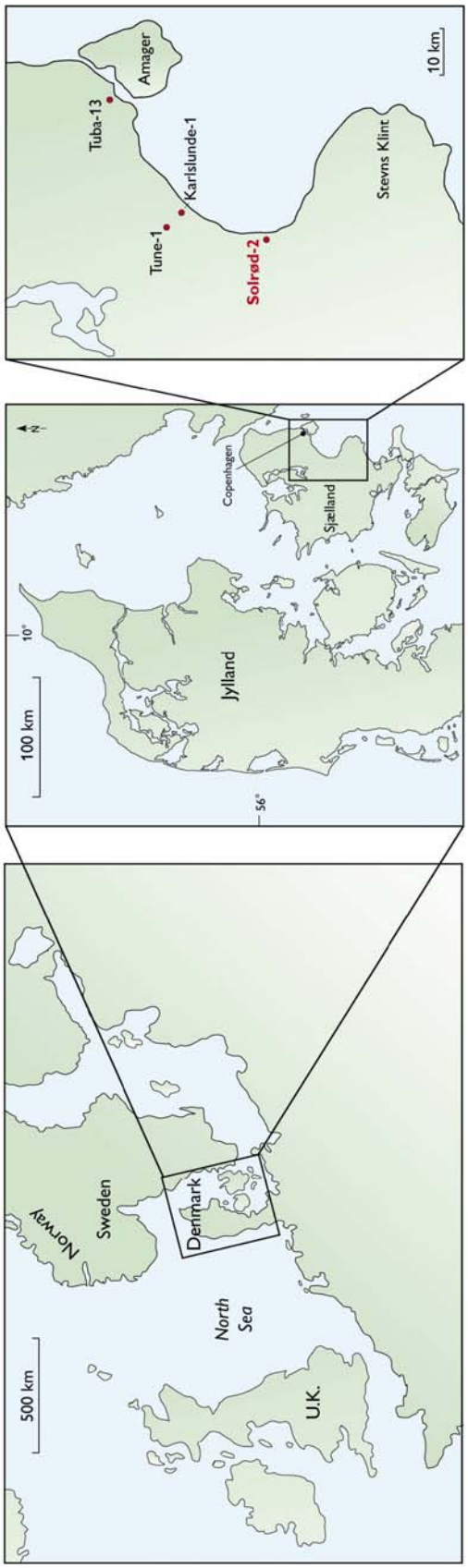

Figure 1. Location map, Danish Central Graben

Methods

18 samples were examined from the Solrød-2 well. Sampling was undertaken approximately every 1 m. 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.

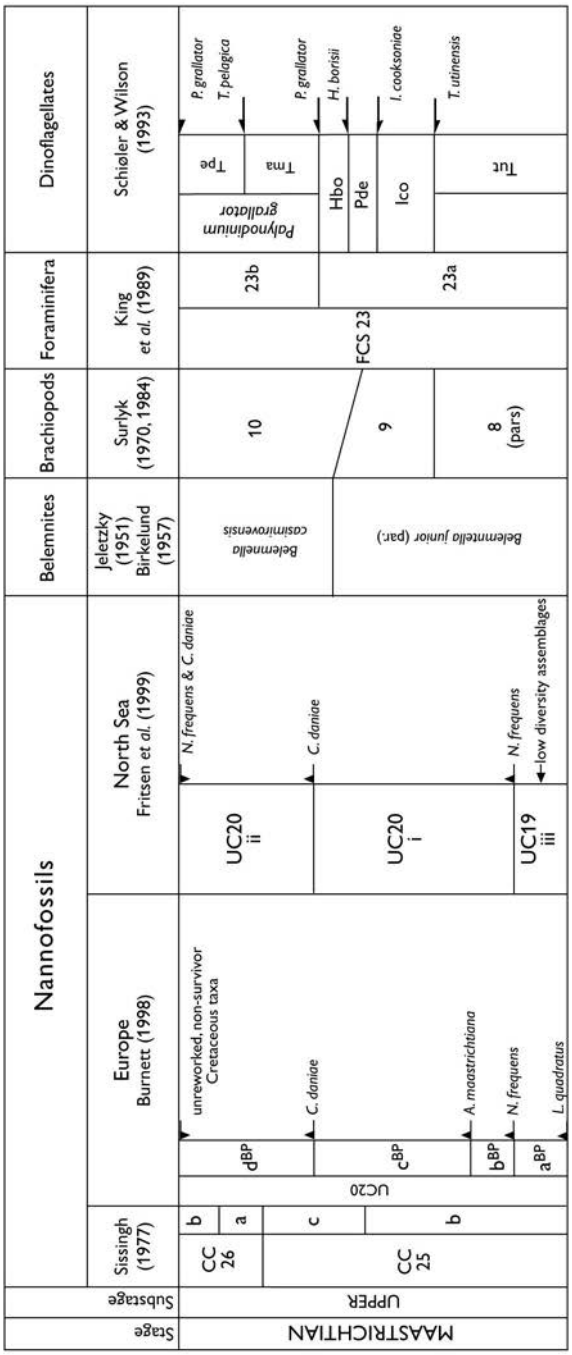

Figure 2. Upper Maastrichtian multidisciplinary biostratigraphic correlation

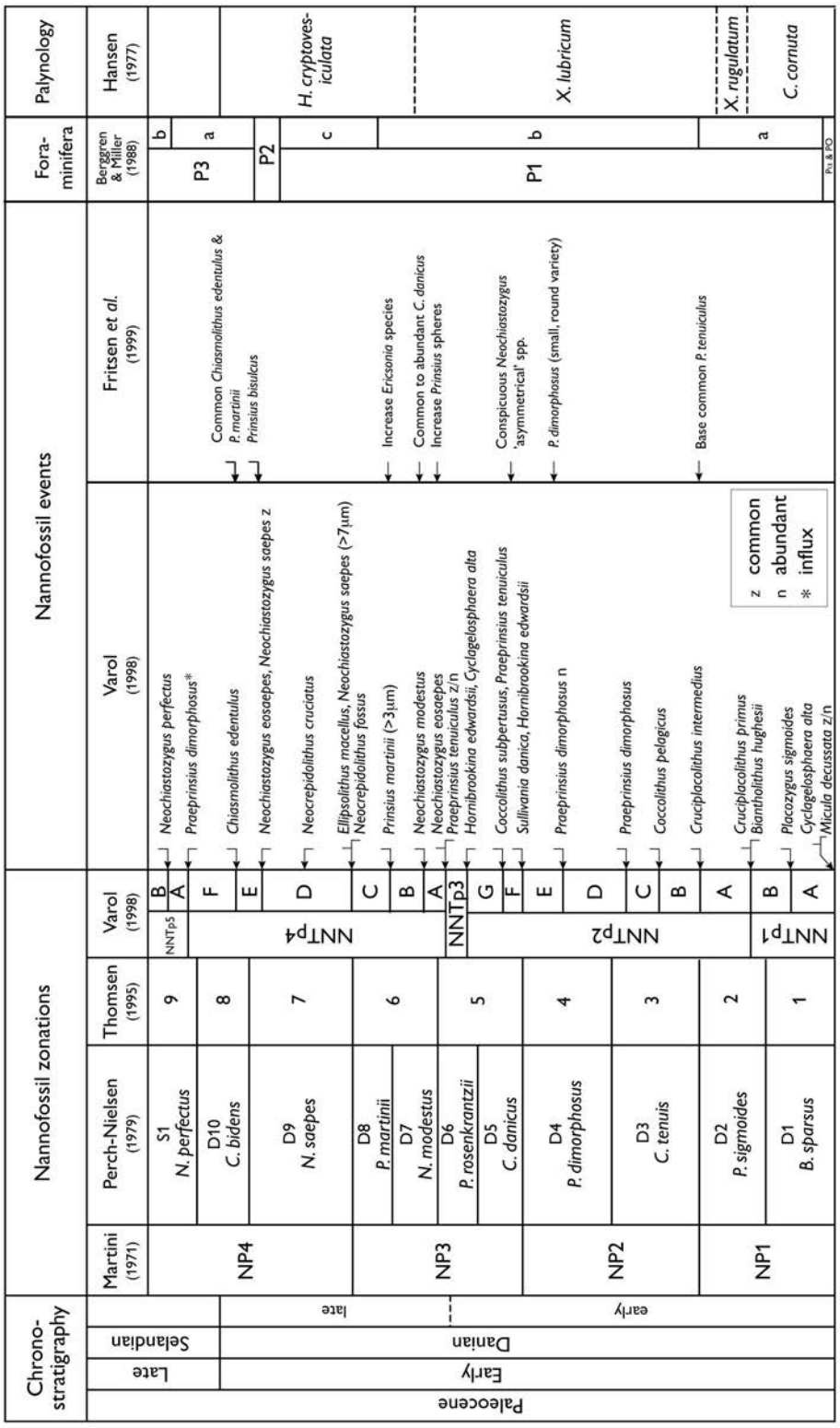

Figure 3. Danian multidisciplinary biostratigraphic correlation

Biostratigraphy

On the basis of nannofossil assemblage analysis, the cored upper Maastrichtian – Danian section of the Solrød-2 well is divided into upper Maastrichtian nannofossil subzone UC20d^{BP} and Danian subzone NNTp1A (Figure 4, Enclosure 1, Table i).

	Base	Top	Thickness
NNTp1A	29.95 m	28.55 m	1.40 m (minimum)
UC20d^{BP}	44.55 m	29.95 m	14.60 m (minimum)

Table i *Nannofossil subzone thickness in Solrød-2*

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}

44.55 m (lowest sample examined) – 29.95 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 interval is characterised by a diverse and abundant nannofossil assemblage comprising common *Prediscosphaera cretacea*, *Micula decussata*, *Watznaueria barnesiae*, *Nephrolithus frequens*, *Lucianorhabdus cayeuxii* and *Prediscosphaera stoveri*. Also present in lower numbers are *Chiastozygus amphipons*, *Ahmuellerella octoradiata*, *Kamptnerius magnificus*, *Placozygus* cf. *P. fibuliformis* and *Cribrosphaerella ehrenbergii*. The co-occurrence throughout of *C. daniae* and *N. frequens* assigns this interval to subzone UC20d^{BP}. Rare reworking from the lower Maastrichtian is indicated by *Reinhardtites levis* and from the mid-Maastrichtian by *Calculites obscurus*.

Remarks

UC20d^{BP} coincides with subzone UC20ii (Fritsen 1999). The important upper Maastrichtian marker bed, the Kjølby Gaard Marl (Troelsen 1955, Sheldon 2006), is represented by one sample at 39.25 m. Rasmussen (1999) reported common planktonic foraminifera *Heterohelix globulosa* and *Guembelitria cretacea* in the marl, in addition to a rich upper Maastrichtian benthic fauna.

Rødvig Formation

Subzone NNTp1A

29.95 m–28.55m (highest sample examined)

Definition

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

Floral characteristics

The low abundance and diversity assemblage comprises *Neocrepidolithus neocrassus*, *Neocrepidolithus dirimosus*, *C. alta*, *Z. sigmoides*, *B. hughesii*, *Markalius inversus* and *Thoracosphaera* spp. in low numbers and more common *Biscutum harrisonii*. Reworking from the Maastrichtian includes rare *A. cymbiformis*, *C. amphipons*, *P. cretacea* and *A. octoradiata*. Specimens of *Prinsius* spp., *Cruciplacoltihus* spp. and *Coccolithus* spp., indicative of younger zones, are absent.

Remarks

Perch-Nielsen (1979) found *Z. sigmoides* to be absent or very rare in the Danish 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. In the Solrød-2 well, the occurrence of rare *Z. sigmoides* in the presence of *Biscutum* spp., *Neocrepidolithus* spp. and *Cyclagelosphaera* spp. defines this interval as earliest Danian NNTp1A. *Thoracosphaera* spp. is rare. The foraminiferal assemblage comprises a mixed Maastrichtian and Danian benthic fauna. Assignment of this interval to the Danian rather than the

Maastrichtian is based upon lack of Maastrichtian planktonic foraminifera (J. Rasmussen, personal communication, 2005). The earliest Danian subzone NNTp1A is also reported from the Tuba-13 and Tune-1 boreholes (Sheldon *et al.* 2012a and b).

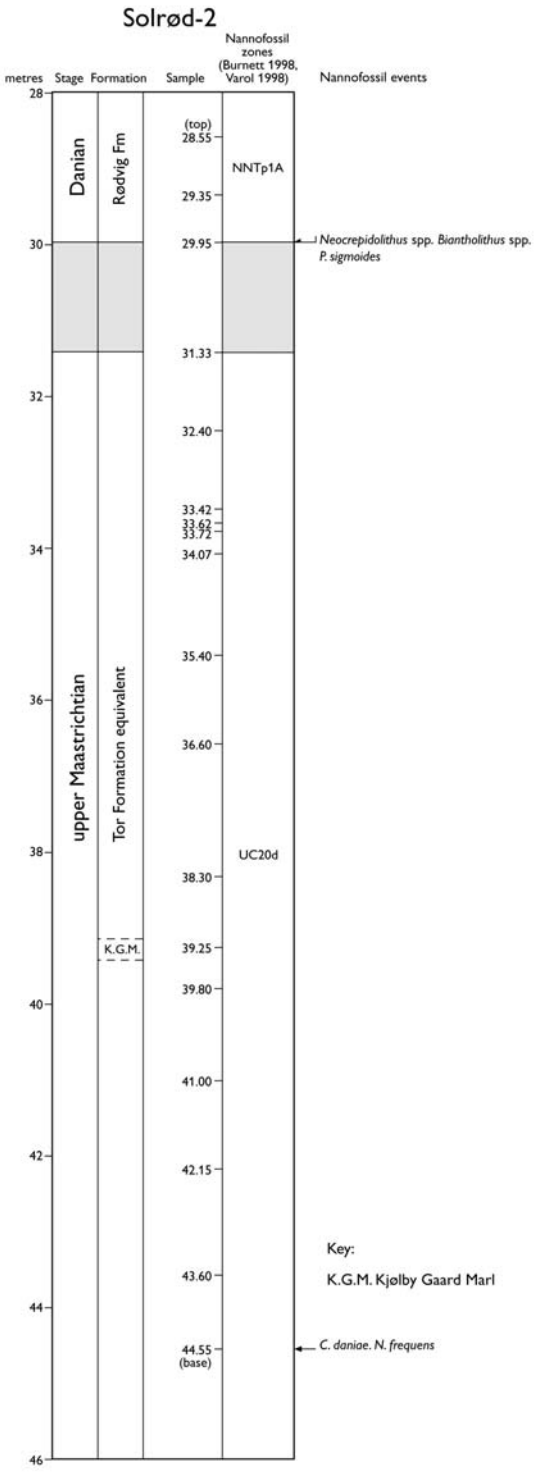

Figure 4. Solrød-2 nannofossil biostratigraphy

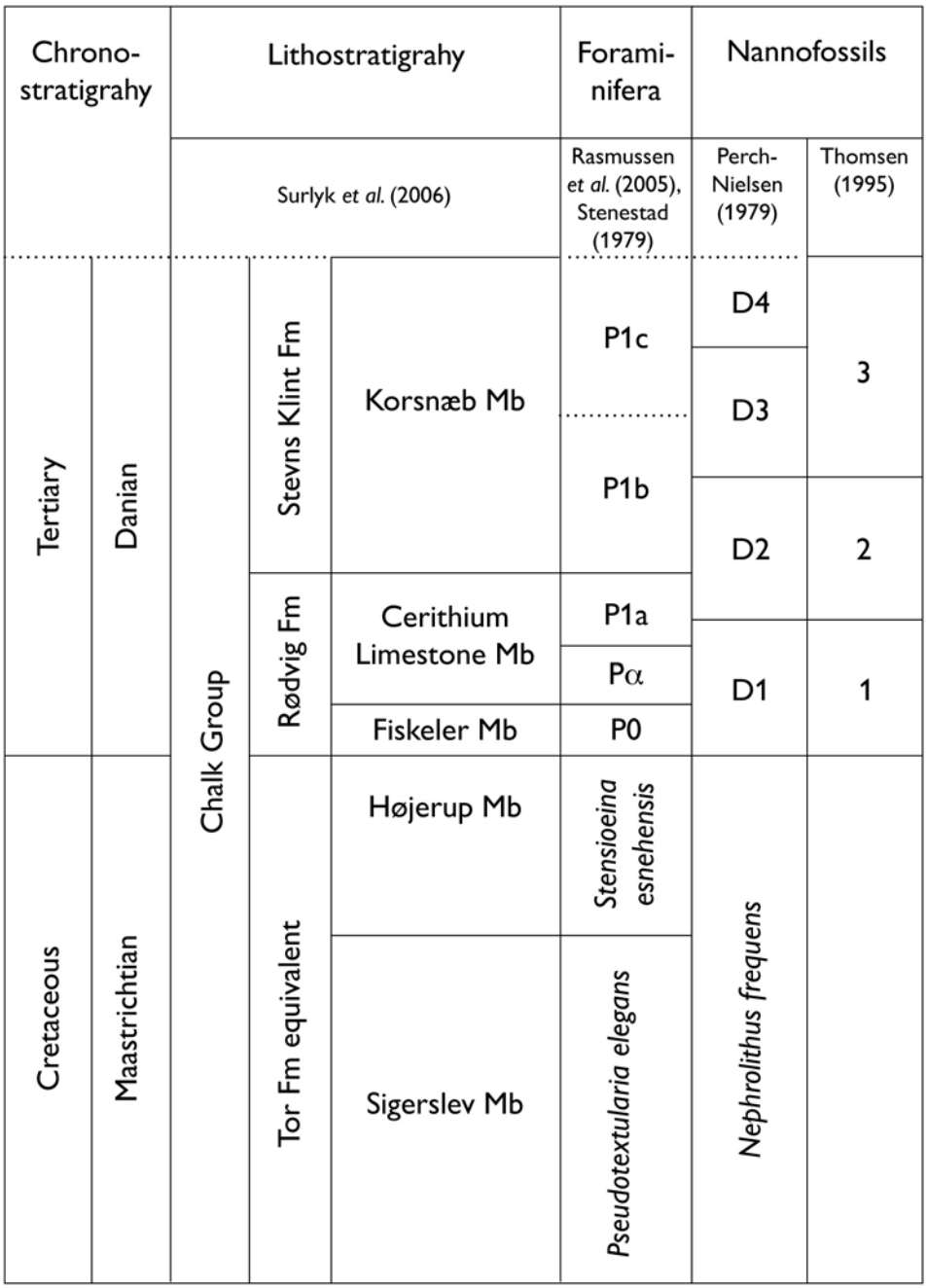

Figure 5. Maastrichtian-Danian stratigraphy (after Surlyk *et al.* 2006)

List of samples from Solrød-2 (in metres)

28.55	33.62	39.25
29.35	33.72	39.80
29.95	34.07	41.00
31.33	35.40	42.15
32.40	36.60	43.60
33.42	38.30	44.55

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