

# **Microfaunal and nannofloral analysis of the Upper Cretaceous of the Bo-1 well**

- a contribution to the EFP-93 project:  
Lower and Upper Cretaceous  
stratigraphy in the Central Trough

David J. Jutson and Emma Sheldon



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**Enclosures: Fig. 1 and Summary Sheets 1-2**

**Appendix 1**

# 1. Introduction

As part of the EFP-93 Cretaceous Stratigraphy Project, microfaunal and nannofossil analyses of the cored intervals and intervening sections with only ditch cutting sample coverage from the Chalk Group of the Bo-1 well were undertaken. A stratigraphic subdivision has been produced and is presented in this report.

The chronostratigraphic subdivision of the Chalk Group that has been established from the Bo-1 material is based on both published and confidential proprietary schemes from the North Sea and adjacent areas.

## 1.1 Materials and methods

Core samples were collected using normal techniques appropriate to the discipline involved. In the case of nannofossils, this required stringent precautions to avoid contamination from sample to sample. Implements used to take samples were cleaned with mild acid before a new sample was taken.

Preparation techniques for microfaunas were as follows. The samples were cleaned in water and then crushed by use of a hammer. The resultant material was soaked in hydrogen peroxide for a period not less than 12 hours. They were then heated to just below boiling point and left to cool. The peroxide which had soaked into the sample material caused the sediment particles to disaggregate due to the release of oxygen in the form of small bubbles. The residues of this were separated through a 63 $\mu$  sieve and the remaining material was dried under infra-red lamp and bagged for future analysis.

The nannofossil samples were prepared by smear technique. That is, the samples were crushed and put into solution with distilled water in a test tube. This was physically agitated and left to stand for ten seconds to allow the larger fragments to fall out of suspension. A small amount of the dissolved material was removed from the top 1 cm of solution by use of a dropper pipette. The sediment solution was then spread on a cover slip and left to dry. When it had dried, the cover slip was set onto a standard thickness microscope slide with an epoxy resin (Norland Optical Adhesive) and set under ultra violet light. At all stages, precautions to avoid contamination were taken. Nannofossils are small enough to be

transported in the air around a room so a positive pressure environment would be desirable. Unfortunately, this was not available for this project.

Number of samples analysed:    Microfaunal: 32  
    Nannofossil: 32

A full sample list is given in Appendix 1. Preparations for this project are catalogued and stored in the GEUS laboratory.

## 2. Biostratigraphic summary

All depths quoted are in feet and inches and are measured depth from rotary table (MDRT). The stratigraphic distribution of micro and nannofossils are summarised in Summary Charts 1- 2.

### 2.1 Compiled biostratigraphy: Bo-1 well

INTERVAL AGE	MICROZONE	DEPTH	NANNOZONE	DEPTH	COMBINED ZONE
Intra Upper Maastrichtian (top not seen)	UCM3	6767.00'	NUC3	6767.00'	TB
	UCM4	6797.00'	NUC4	6797.00'	TC(II)
basal Upper Campanian to Lower Campanian	UCM9/10	6827.00'	NUC 9/10	6827.00'	HA(I)/HB
Santonian	UCM10/11	6842.00'	NUC 11/12	6842.00'	HC
Coniacian (undivided)	UCM11/12	6948.00'	NUC 13/14	6948.00'	HD(III)
6948' - 7156':	<i>No samples analysed</i>				
Lower Coniacian	UCM13/14	7216.00'	NUC14	7156.00'	HD(II)
Upper Turonian	UCM14(part)	7240.00'		7231.00'	HD(I)
Upper to Middle Cenomanian	<i>poor recovery</i>		NUC 16/17	7276.00'	HRA/B
Lower Cenomanian) (base not seen)	<i>poor recovery</i>		NUC18	7351.00'	HRC

Last sample examined at 7410.00'

## 2.2 Biostratigraphic description

### Bo-1 well: Microfauna

6767.00' (first sample examined) - 6827.00': Intra Upper Maastrichtian

The occurrence at 6767' of the calcareous benthic foraminifera *Bolivinooides draco draco*, *Stensioeina pommerana*, *Gavelinella bembix* and *Bolivinooides incrassata incrassata* together with the planktic species *Rugoglobigerina rugosa*, *Heterohelix globulosa* and *Globigerinelloides asper* indicate that the topmost sample in this interval is of Upper Maastrichtian age (Koch, 1977).

This age designation is supported by the occurrences of *Praebulimina laevis*, *Neoflabellina florealis* and *Conorbis supracretacea* at 6784'. The samples at 6797' and 6812' contained similar microfaunas to the sample at 6784'.

6827.00' - 6842.00': Basal Upper Campanian to Lower Campanian

The presence of *Stensioeina exsculpta gracilis* at 6827' is evidence that the basal part of the Upper Campanian has been reached (Koch, 1977). Faunal abundance in this interval is poor and declines downhole.

The range of *S. exsculpta gracilis* overlaps the ranges of *S. exsculpta exsculpta* and *S. granulata polonica* which, together with the poor faunal recovery requires that a wide interpretation of the age be used for this interval.

6842.00' - 6948.00': Santonian

At 6842', the incoming of *Stensioeina exsculpta exsculpta* and *Stensioeina granulata polonica* with a radiolarian influx suggest a Santonian age. At 6857', the occurrence of a microfauna with planktic foraminifera including *Marginotruncana marginata* and *Dicarinella asymetrica* indicates that the age of this interval is Santonian. This is supported by the top occurrence of *Stensioeina granulata polonica* at 6872' and in subsequent samples down-

hole. At 6901', a minor influx of small actinommid radiolaria may add support to this age determination.

*6948' (single sample): Coniacian (undivided)*

The occurrence of *Whiteinella archaeocretacea* at 6945' suggests that the age of the sample is Coniacian (Robaszynski et al., 1984). Microfaunal recovery from this sample was very poor.

*6948' - 7156': No samples analysed*

*7156' - 7216': Coniacian (undivided)*

The continued occurrence of species of the genus *Whiteinella* including *W. baltica* and *W. paradubia* suggest that the age of this interval is still Coniacian (Robaszynski & Caron, 1979). This is supported by the influx of actinommid radiolaria at 7171' which is a marker horizon recognised by industrial biostratigraphers but which has not been formally described.

*7216' - 7240': Lower Coniacian*

The top occurrence of *Dicarinella imbricata* is evidence that the Lower Coniacian has been reached.

*7240' - 7321': Upper Turonian*

The top of the consistent occurrence of *Hedbergella planispira* at 7240' is taken as the first indication of Upper Turonian age. Although not a formal stratigraphic indicator, it has been used to indicate this age in the absence of more conventional marker species.



7321' - 7410' (last sample examined): ?Middle to Lower Turonian

At 7321', the occurrence of abundant actinommid radiolaria in a glassy preservation suggests that the Middle Turonian has been penetrated. This age determination is supported at 7351' by the LO of *Globigerinelloides bentonensis* and at 7366' by the LO of *Stensioeina granulata humilis* (Koch, 1977). Microfaunal recovery was very poor in this interval.

## Bo-1 well: Calcareous Nannofossils

6767.00' (first sample examined) - 6827.00': *Intra Upper Maastrichtian*

Samples in this interval contained nannoflora assemblages dominated by very common *Prediscosphaera cretacea*, common *Lucianorhabdus cayeuxii*, *Micula decussata*, *Kamptneria magnificus* and *Arkhangelskiella cymbiformis* indicating intra Upper Maastrichtian age (Crux, 1978). The latter species, *A. cymbiformis*, had shield dimensions which are considered to be indicative of an age equivalent to the basal part of the Upper Maastrichtian (Varol 1989, Girgis 1989 and in-house unpublished data). A notable nannofossil occurrence supporting this age was that of *Nephrolithus frequens* at 6782'

6827.00' - 6842.00': *Lower Maastrichtian or older*

At 6827', the incoming of a nannofloral assemblage including *Calculites obscurus*, *Reinhardtites levis*, abundant *Lucianorhabdus cayeuxii* and *A. cymbiformis* with a reduced shield dimension indicates that the Lower Maastrichtian has been encountered.

6842.00' - 6887.00': *Lower Campanian or older*

The increase in the abundance of *Micula decussata* together with the LO of *Reinhardtites anthophorus* suggests Lower Campanian age for this depth (Mortimer 1987). This is supported by the first downhole occurrence of *Lithastrinus grillii* at 6857'. At 6870', the increase in abundance of *Prediscosphaera cretacea* would indicate that the age is basal Lower Campanian.

6887.00' - 7156.00': *Santonian to Coniacian*

From the sample at 6887' and downhole to the base of the interval, nannofloras decrease both in diversity and abundance. Accurate age determinations could be made based on the reduced nannofossil recovery in these samples and therefore a rather wide age determination has been given to this interval.

7156.00' - 7231.00': *Lower Coniacian*

At 7156', a change in nannofloral assemblage, typified by abundant *Watznaueria barnesae* together with *Helicolithus trabeculatus* and the absence of *Micula decussata* indicates that the age of the sample is Lower Coniacian (Crux 1982, Mortimer 1987).

7231' - 7276': *Upper Turonian*

An increase in the abundance of *Gartnerago obliquum* at 7231' indicates that the Upper Turonian has been reached. (Mortimer 1987). At 7261', the occurrence of *Crucibiscutum salebrosum* is evidence of reworking from the Lower Cretaceous.

7276' - 7351' : *Upper to Middle Cenomanian*

The LO of nannofloral assemblages dominated by *W. barnesae* and *Tranolithus orionatus* and including *Rhagodiscus asper*, *Axopodorhabdus albianus*, *Rhagodiscus angustus* and *Prediscosphaera columnata* indicate Upper Cenomanian age for this interval (Mortimer 1987). This is supported by the occurrence *Zygodiscus theta* at 7291' .

7351' - 7409': *Lower Cenomanian*

An influx (and LO) of *Gartnerago nanum* at 7351' together with the occurrence of *Braarudosphaera hockwaldensis* indicates Lower Cenomanian age for this interval.

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# Enclosures

Fig. 1 and Summary Sheets 1-2



# EFP 93

## MAASTRICHTIAN TO LATE APTIAN BIOSTRATIGRAPHIC ZONATION

FIG.1

AGE/LITHOSTR.			ZONATIONS			MICROFAUNAL EVENTS		NANNOFOSSIL EVENTS	
PAL.	LWR.	EKO.	MICROFAUNA NANNOFOSSIL COMBINED						
MAASTRICHTIAN	UPPER	TOR FM.	UCM1	NUC1	TA	(III)	☞ P. elegans, R. contusa, R. fructifera	☞ A. cymbiformis, N. frequens, K. magnificus M. decussata	
			UCM2			(II)	☞ S. beccariformis, G. volziana, R. szajnochae		
				NUC2	(I)		☞ comm. L. cayeuxi, R. levis(?rew.)		
			UCM3	NUC3	TB		☞ incr. in diversity comm. B. draco, G. nitidus	☞ comm. P. cretacea, dom. A. cymbiformis v1	
			UCM4	NUC4	TC	(II)	☞ abnt. S. beccariformis, comm/v. comm. Præbulimina spp., Citharinella spp.; comm/v. comm. ostracods	☞ dominant A. cymbiformis v2	
	UCM5	(I)	☞ abnt. Nuttallinella spp. comm. Lenticulina spp.			☞ dominant A. cymbiformis v3 ☞ comm. Biscutum spp.			
	LOWER			UCM6	NUC5	TD		☞ abnt. Inoceramus spp. prisms, comm. echinoid spines, V. ?art. reideli, B. draco miliaris	☞ decr. in diversity and abundance R. levis    ☞ N. frequens
				UCM7			NUC6	(II)	☞ comm. H. globulosa
					NUC7	(I)		☞ dominant A. cymbiformis v4 comm. W. barnesae	
	UPPER			UCM8	NUC8	HA	(II)	☞ R. szajnochae, T. dubia, C. supracretacea	☞ R. anthophorus, L. maleformis
UCM9				NUC9	(I)		☞ comm. Archæoglobigerina spp. E. concinna, S. exsculpta gracilis	☞ E. eximius, O. campanensis	
LOWER			UCM10	NUC10	HB		☞ Globotruncana/Marginotruncana spp.	☞ B. normis, Q. gartneri, L. grilli M. quaternarius	
								☞ S. gran. polonica    ☞ S. gran. incondita	☞ super abnt. W. barnesae
SANTONIAN	UPPER	HOD FM.	UCM11	NUC11	HC	(II)	☞ comm. -abnt. ?Whiteinella spp. comm. actinommid radiolaria ☞ S. exsculpta gracilis, S. granulata perfecta	☞ abnt. L. maleformis, H. trabeculatus	
			UCM12	NUC12		(I)	☞ S. gran. polonica    ☞ S. gran. incondita		
CONIACIAN	UPPER		UCM13	NUC13	HD	(III)	☞ comm. -abnt. grey/glassy Hedbergella spp. S. granulata granulata	☞ abnt. H. trabeculatus, E. floralis,	
			UCM14	NUC14		(II)	☞ comm. -abnt. M. marginata, M. pseudomarginata, comm. -abnt. actinommid radiolaria	☞ Eprolithus sp. 7 Eprolithus sp. 7, M. decussata	
TURON.	MID-UPPER		UCM15				(I)	☞ D. imbricata    ☞ S. gran. levis	
			UCM16	NUC15	HE		☞ S. granulata kelleri	☞ R. laffittei, R. asper	
CENOMANIAN	UPPER	HIDRA FM.	UCM17	NUC16	HRA		☞ S. granulata humilis    ☞ S. granulata humilis    ☞ keeled planktics	☞ E. planus M. chiastius Z. theta	
				NUC17	HRB		☞ G. baltica, G. cenomanica, L. ciryi inflata Rotalipora spp.	☞ comm. T. phacelosus, B. normis, G. nanum	
ALBIAN	MID-UPPER		UCM18	NUC18	HRC		☞ comm. H. planispira, H. delrioensis (chalky)	☞ P. anfractus, B. constans	
							☞ S. antiqua		
APT.	UPPER	SOLO	LCM1	NLC1	RA		☞ O. schloenbachi, consistent S. antiqua	☞ H. gorkae?	
			LCM2	NLC2	RB		☞ comm. -abnt. H. planispira, H. delrioensis (non-chalky)		
			NO SAMPLES COVERING THIS INTERVAL						
			LCM3	a	SL1		☞ comm. G. barreimiana, v. comm. ostracods	☞ abnt. R. asper	



# BIOSTRATIGRAPHIC SUMMARY SHEET

1

Well: *BO-1*  
 Operator: *MÆRSK OLIE OG GAS*  
 Country: *OFFSHORE DENMARK*  
 Analyst(s): *D. JUTSON*

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Date: *JULY 1996*

LITHOSTRAT.	AGE	ZONE/SUBZONE	LITH.	FEET	S	BIOSTRATIGRAPHIC EVENTS	
TOR FM.	INTRA UPPER MAASTRICHTIAN	UCM 3	[Green brick pattern]	6770	◇	B.draco draco, B.incrassata, R.rugosa, S.pommerana, G.bembix A.cymbiformis var3, comm. L.cayeuxii, comm. P.cretacea, E.gorkæ	
		UCM 4		NUC 3	6780	◇	S.beccariiiformis, P.lævis, comm. N.florealis N.frequens, A.cymbiformis var1
HOD FM.	SANTONIAN	UCM 11/12	[Blue brick pattern]	6800	◇	A.cymbiformis var2	
		UCM 13/14		NUC 4	6810	◇	G.bembix
		UCM 9/10		NUC 9/10	6820	◇	S.exsculpta gracilis: R.levis, C.ovalis, C.obscurus, abnt. L.cayeuxii
		UCM 11/12		NUC 11/12	6830	◇	S.exsculpta exsculpta, S.granulata perfecta, radiolarian influx abnt. W.barnesæ, R.anthophorus, T.pyramidatus
		UCM 13/14		NUC 13/14	6840	◇	G.contusa, M.marginata, T.capitosa, R.szajnochæ, G.asymmetrica L.grillii, comm. R.anthophorus
		UCM 11/12		NUC 11/12	6850	◇	incr.Prediscosphaera spp., B.enormis, B.parca
		UCM 11/12		NUC 11/12	6860	◇	incr. M.decussata
		UCM 11/12		NUC 11/12	6870	◇	actinommid/Dictyomitra spp. radiolaria influx: incr. B.enormis
		UCM 11/12		NUC 11/12	6880	◇	
		UCM 11/12		NUC 11/12	6890	◇	
HOD FM.	CONIACIAN	UCM 11/12	[Blue brick pattern]	6900	◇		
		UCM 11/12		NUC 11/12	6910	◇	
		UCM 11/12		NUC 11/12	6920	◇	
		UCM 11/12		NUC 11/12	6930	◇	
		UCM 11/12		NUC 11/12	6940	◇	
		UCM 11/12		NUC 11/12	6950	◇	W.archæocretacea
		UCM 11/12		NUC 11/12	6960	◇	
		UCM 11/12		NUC 11/12	6970	◇	
		UCM 11/12		NUC 11/12	6980	◇	
		UCM 11/12		NUC 11/12	6990	◇	
		HD		7000			
				7010			
				7020			
				7030			
				7040			
				7050			

NO SAMPLES FROM 6948-7156'



**BIOSTRATIGRAPHIC SUMMARY SHEET**

2

Well: BO-1  
 Operator: MÆRSK OLIE OG GAS  
 Country: OFFSHORE DENMARK  
 Analyst(s): D. JUTSON

**EFP  
93**

Date: JULY 1996

LITHOSTRAT.	AGE	ZONE/SUBZONE	LITH.	FEET	S	BIOSTRATIGRAPHIC EVENTS
HOD FM.	CONIACIAN (UNDIVIDED)	UCM 13/14	NUC 13/14	HD	7070-7150	NO SAMPLES FROM 6948'-7156'
HIDRA FM.	UPPER TURONIAN	UCM 14	NUC 14	HD (II)	7160-7280	
	LWR. CON.					
HIDRA FM.	MIDDLE TO UPPER CENOMANIAN	NO ZONATION - POOR RECOVERY	NUC 16/17	HRA/B	7280-7350	
	LOWER CENOMANIAN (BASE NOT SEEN)					
			NUC 18	HRC	7350-7410	



# Appendix 1

## Samples Analysed for Micro/nannopaleontology

### Bo-1

#### Microfossils & Nannofossils

6767.00'  
6782.00'  
6797.00'  
6812.00'  
6827.00'  
6842.00'  
6857.00'  
6872.00'  
6887.00'  
6902.00'  
6917.00'  
6932.00'  
6945.00'  
7156.00'  
7171.00'  
7180.00'  
7186.00'  
7207.00'  
7216.00'  
7231.00'  
7246.00'  
7261.00'  
7276.00'  
7291.00'  
7306.00'  
7321.00'  
7336.00'  
7351.00'  
7366.00'  
7381.00'  
7396.00'  
7410.00'

Total number of samples:	Microfaunas	32
	Nannofossils	32

N.B. all samples are conventional core samples