DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 1997/104

Microfaunal and nannofloral analysis of the Lower 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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MINISTRY OF ENVIRONMENT AND ENERGY

GEUS

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

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G E U S

Contents

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 63µ 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 dröpper 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':	*No samples analysed*				
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	*poor recovery*		NUC 16/17	7276.00'	HRA/B
Lower Cenomanian) (base not seen)	*poor recovery*		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 *Bolivinoides draco draco, Stensioeina pommerana, Gavelinella bembix* and *Bolivinoides 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 granulate 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 if *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.

3. References

Bettenstaedt, F., Fahrion, H., Hiltermann, H & Wick, W.,1962: Tertiar Deutschland. *In* Bartenstein, H. (ed.) "*Leitfossilien der Micropalaontologie*" Gebruder Bontrager, 431pp.

Caron, M., 1986: Cretaceous planktic foraminiferainifera. *In* Bolli, H.M., Saunders, J.B & Perch-Nielsen, K. (ed.),*Plankton stratigraphy*. Cambridge Univ. Press, 17-86.

Hart, M. & Bailey, H.W., 1979: The distribution of planktic foraminiferida in the mid Cretaceous of NW Europe. *Aspekte der Kreide Europas. IUGS Series A*. **6**, 527-542.

Hart, M.B., Bailey, H.W., Crittenden, S., Fletcher, B.N., Price, R.J. & Swiecicki, A.,1989: Cretaceous. *In* Jenkins, D.G. & Murray, J.W. (ed.) *Stratigraphical Atlas of Fossil Foraminifera*. British Micropaleontological Society series. Ellis Horwood Ltd.,Chichester, U.K.

Hofker, J.: 1966: Maastrichtian, Danian and Paleocene Foraminifera. *Palaeontographica* Suppl. 10

King, C., Bailey, H.W., Burton, C.A. & King, D., 1989: Cretaceous of the North Sea. *In* Jenkins, D.G. & Murray, J.W. (ed.) *Stratigraphical Atlas of Fossil Foraminifera*, 2nd ed. BMS Series, Ellis Horwood, Chichester, 372-417.

Koch, W.,1977: Biostratigraphie in der Oberkreide und Taxonomie von Foraminiferen. *Geologisches Jahrbuch*, Reihe A **38**, 3-123.

Mortimer, C., 1987: Upper Cretaceous calcareous nannofossil biostratigraphy of the southern Norwegian and Danish North Sea area. *Abhandlung der Geologischen Bundesanstalt -A* **39**, 143-176.

Perch-Nielsen, K., 1979: Calcareous nannofossils from the Cretaceous between the North Sea and the Mediterranean: *Aspekte der Kreide Europas*, *IUGS, A*, 223-272.

Perch-Nielsen, K., 1985: Mesozoic calcareous nannofossils: *In* Bolli, H.M., Saunders, J.B. and Perch-Nielsen, K.,(ed.) *Plankton Stratigraphy*: Cambridge University Press, New York, 329-426

Robaszynski, F & Caron, M.,1979: Atlas de foraminifères planctoniques du Crétacé moyen (Mer Boréale et Téthys*). Cahiers de Micropaléontologie* 1979:1 & 2, 185 &181.

Robaszynski, F., Caron, M., Gonzalez Donoso, J.M., Wonders, A. H., 1984: Atlas of Late Cretaceous Globotruncanids. *Revue de Micropaléontologie* **26**(3-4), 145-305

Sissingh, W., 1977: Biostratigraphy of Cretaceous calcareous nannoplankton. *Geologie en Mijnbouw* **56**, 37-65

Sliter, W., 1980: Mesozoic Foraminifers and deep-sea benthic environments from Deep Sea Drilling Project Sites 415 and 426, Eastern North Atlantic. *In* Lancelot, Y. *et al. Initial Reports of the Deep Sea Drilling .Project* **50**, 353-427.

Swiecicki, A., 1980: A foraminiferal biostratigraphy of the Campanian and Maastrichtian chalks of the United Kingdom. Unpublished thesis, C.N.A.A., Vols. 1 & 2.

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
				MICROFAUNA	NANNOFOSSIL	COMBINED			
PAL.	LWR.	EKO.							
MAASTRICHTIAN	UPPER	TOR FM.		UCM1	NUC1	TA	(III)	P.elegans, R.contusa, R.fructicosa	A.cymbiformis, N.frequens, K.magnificus M.decussata
				UCM2			(II)	S.beccariiformis, G.volziana, R.szajnochæ	
					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.beccariiformis, comm/v.comm. Præbulimina spp., Citharinella spp.; comm/v.comm. ostracods	dominant A. cymbiformis v2
									dominant A.cymbiformis v3
									comm. Biscutum spp.
				UCM5			(I)	abnt. Nuttallinella spp. comm. Lenticulina spp.	
	LOWER			UCM6	NUC5	TD		abnt Inoceramus spp. prisms, comm. echinoid spines, V.?aff.reideli, B. draco millaris	decr. in diversity and abundance R.levis ◀┘I.frequens
									P.obscurus
				UCM7	NUC6	TE	(II)	comm. H. globulosa	A.cymbiformis v4
					NUC7		(I)		dominant A.cymbiformis v4 comm. W.barnesæ
CAMPANIAN	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. ◀┘S.pommerana S.exsculpta exsculpta	B.enormis, Q.gartneri, L.grillli M.quaternarius
								S.granulata perfecta, S.granulata incondita	
SANTONIAN	UPR.	HOD FM.		UCM11	NUC11	HC	(II)	comm.-abnt. ?Whiteinella spp. comm. actinommid radiolaria ◀┘S.exsculpta gracilis, S.granulata perfecta	abnt. L.maleformis, H.trabeculatus
	LWR.			UCM12	NUC12		(I)	S.gran. polonica ◀┘S.gran. incondita	super abnt. W.barnesæ
CONIACIAN	UPR.			UCM13	NUC13	HD	(III)	comm.-abnt. grey/glassy Hedbergella spp. S.granulata granulata	abnt H.trabeculatus, E.floralis,
	LOWER			UCM14	NUC14		(II)	comm.-abnt. M.marginata, M.pseudolinneana, comm.-abnt. actinommid radiolaria	Eprolithus sp.7 ◀┘Eprolithus sp.7, M.decussata
								D.imbricata ◀┘S.gran. levis	
TURON.	MID.-UPR.			UCM15			(I)	S.granulata kelleri	
	L.			UCM16	NUC15	HE		S.granulata humilis ◀┘S.granulata humilis ◀┘ keeled planktics	R.laffittei, R asper
CENOMANIAN	UPPR.	HIDRA FM.		UCM17	NUC16	HRA		G.baltica, G.cenomanica, L.ciryi inflata Rotalipora spp.	E.planus M.chiastius Z.theta
	LWR.-MID.				NUC17	HRB			comm. T.phacelosus, B.enormis, G.nanum
				UCM18	NUC18	HRC		comm. H.planispira, H.delrioensis (chalky) S.antiqua	P.anfractus, B.constans
ALBIAN	M.-U.	RØDBY		LCM1	NLC1	RA		O.schloenbachi, consistent S.antiqua	
				LCM2	NLC2	RB		comm.-abnt. H.planispira, H.delrioensis (non-chalky)	H.gorkæ?
	L.	SOLA		NO SAMPLES COVERING THIS INTERVAL					
APT.	UPR.			LCM3	a	SL1		comm. G.barremiana, v.comm. ostracods	abnt R.asper

BIOSTRATIGRAPHIC SUMMARY SHEET

1

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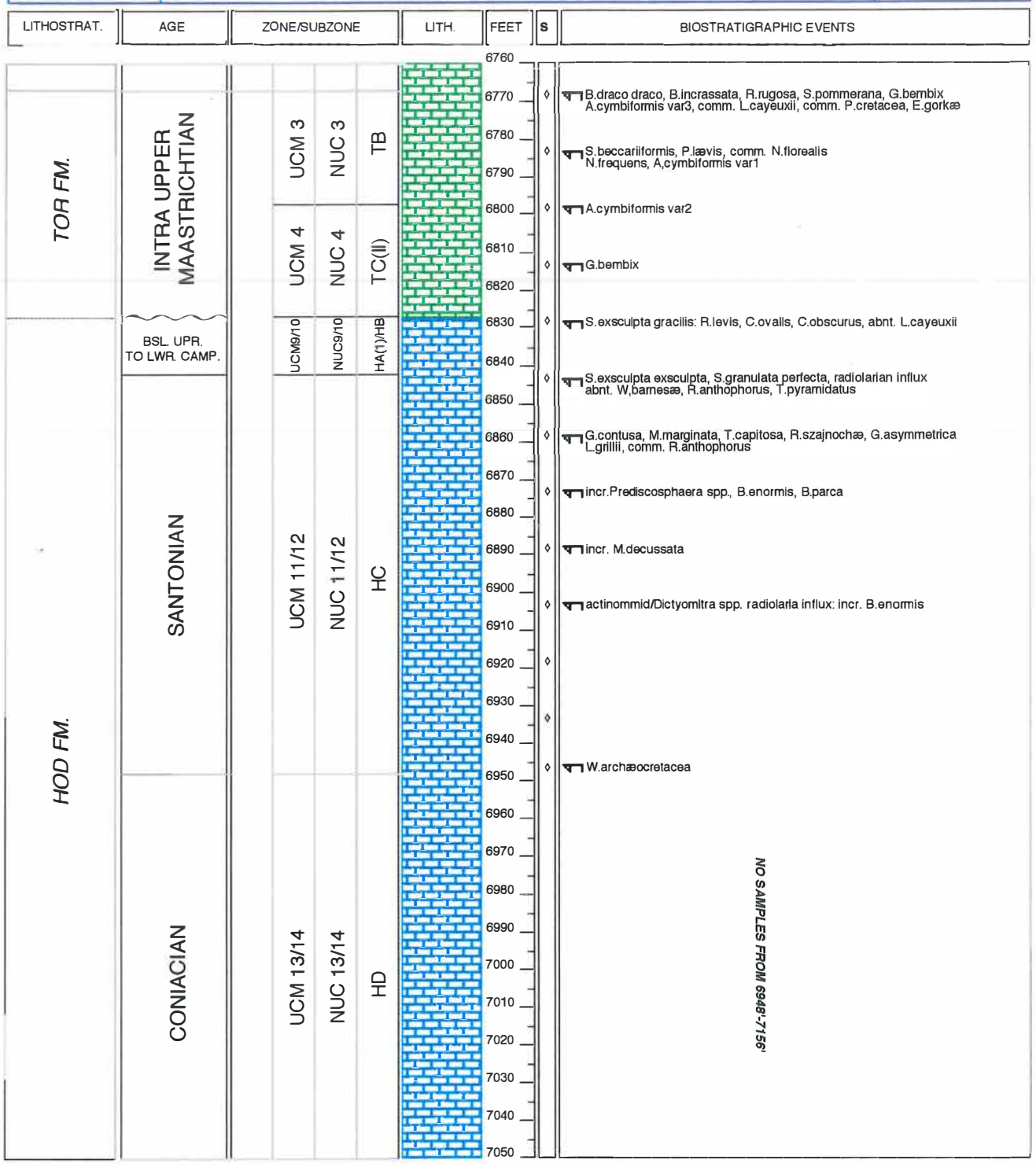
Well: *BO-1*
Operator: *MÆRSK OLIE OG GAS*
Country: *OFFSHORE DENMARK*
Analyst(s): *D. JUTSON* **Date:** *JULY 1996*



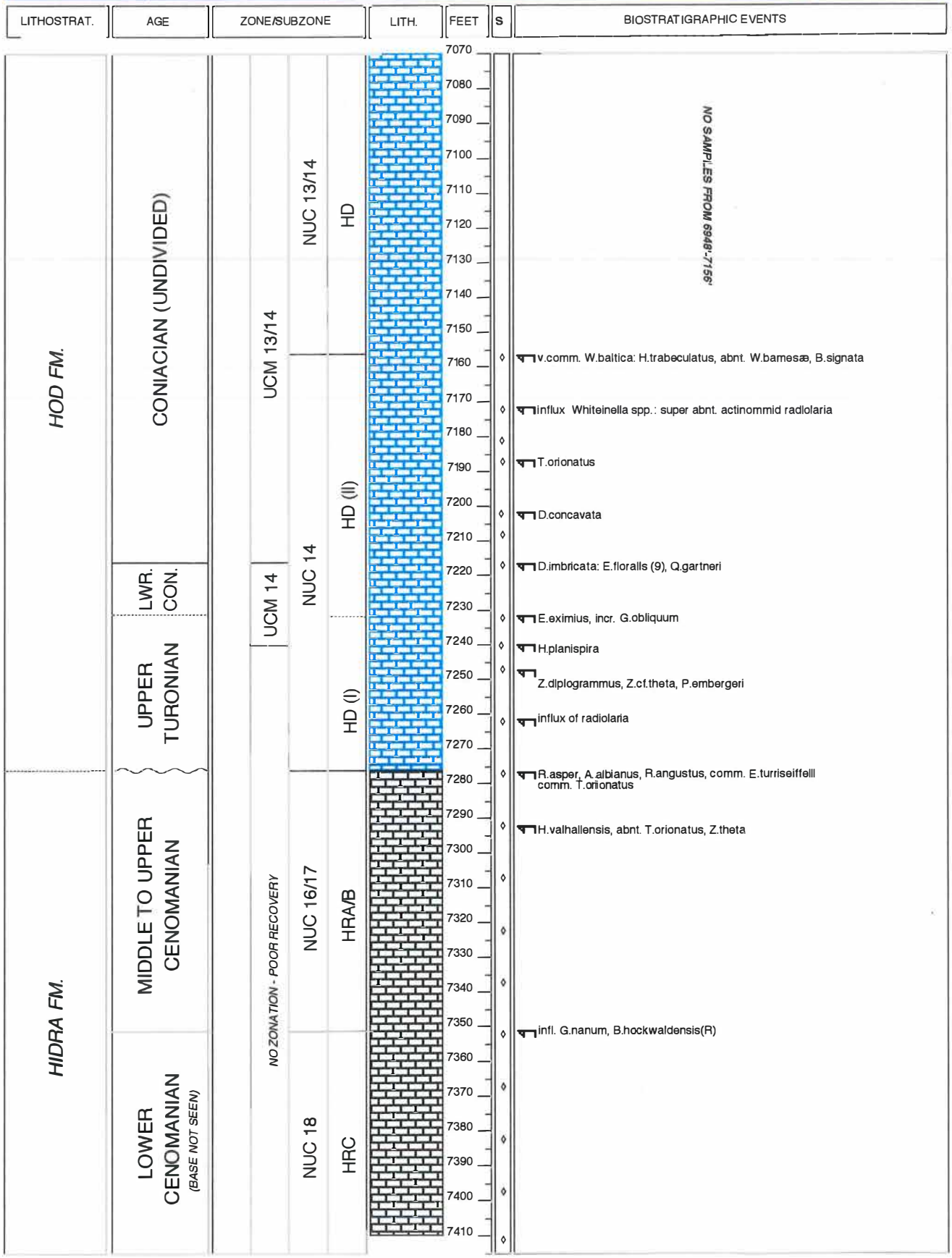
BIOSTRATIGRAPHIC SUMMARY SHEET

2

GEUS

Well: BO-1
Operator: MÆRSK OLIE OG GAS
Country: OFFSHORE DENMARK
Analyst(s): D. JUTSON **Date:** JULY 1996

EFP 93



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