DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 1997/105

Palynological analysis of the Upper Cretaceous of the Adda-3 and Bo-1 wells

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

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1. INTRODUCTION

As part of the EFP-93 Cretaceous Stratigraphy Project, palynological analysis of samples from the Adda-3 and Bo-1 wells were undertaken to produce a chronostratigraphic breakdown of the Chalk Group (Cenomanian-Danian).

The chronostratigraphic subdivision of the Chalk Group that has been produced as a result of these analyses is presented below. It builds on correlation of the assemblages with north-west European and North American literature on the dinoflagellate distribution in a number of well-dated sections.

1.1 MATERIALS AND METHODS

All samples studied from both Adda-3 and Bo-1 wells are core samples. The samples were prepared using conventional palynological preparation techniques (cf. Wilson, 1971) as well as modified techniques (Nørgaard *et al*, 1991). The residues were filtered on 20 µm (Adda-3) and 18 µm (Bo-1) meshes. The samples were analysed quantitatively and qualitatively.

Gaps between cores were not analysed. Certain intervals in both wells had a very low recovery of palynomorphs, and some samples were barren. As a result of this, these intervals have limited data (see biostratigraphic distribution chart, Enclosures 1, 2).

Number of samples analysed:	Adda-3:	35
	Bo-1:	39

A full sample list is given in Appendix 3.2. Microscope slides are stored in the palynological slide collection at GEUS.

2. BIOSTRATIGRAPHIC SUMMARY

All depths are given in feet and inches. The stratigraphic distribution of dinoflagellates in the two wells are shown in Appendix 3.4.

2.1 ADDA-3 WELL

Dinoflagellate biostratigraphy of the interval 6931´ - 7684´4´´

6931´-6946´: Danian

Age assessement on the presence of *Spiniferites cryptovesiculata* in the sample at 6931´ (Hansen, 1977; Powell, 1992). The age determination is further supported by the presence of *Thalassiphora pelagica* which only occurs frequently in Paleogene strata. The sample at 6946´ contains no age-diagnostic species, but the lack of typical Maastrichtian taxa is taken as an indication of a Danian age for this sample also.

7220´-7262´: upper Campanian

Cassiculosphaeridia intermedia occurs in all four samples. This species has been reported from Maastrichtian-upper Campanian strata only (Wilson, 1974; Schiøler & Jutson, 1993; Schiøler & Wilson, 1993; Slimani, 1994). The presence of *Xenascus ceratioides* in the uppermost sample (at 7220´) indicates a Campanian or older age (Schiøler & Wilson, in prep.). *Chatangiella ditissima* occurs in the sample at 7252´. This species was noted to have its last occurrence (LO) in the lower part of the upper Campanian in the North Sea by Schiøler & Jutson (1993), but ranges through the upper Campanian according to Costa & Davey (1992). Although the excact age of LO *C. ditissima* is not known, the event seems to occur in the upper Campanian.

7275´-7439´2´´: upper Campanian-Coniacian

Four of the twelve samples from the interval are barren; and most samples contain only scarce dinoflagellate assemblages. The lowermost sample from this interval (at 7439´2´´) has a reasonably rich assemblage that indicates a general pre-Maastrichtian Upper Cretaceous age. As the interval is overlain by upper Campanian strata and underlain by strata of Coniacian age, it may be assigned a general upper Campanian-Coniacian age.

7452´8´´-7548´: Coniacian-middle Turonian

The presence of *Florentinia deanei* at 7452´8´´ indicates a Coniacian or older age (Foucher, 1979; Costa & Davey, 1992, Schiøler & Jutson, 1993). The interval is

characterised by the assemblage of *Achomosphaera sagena, Atopodinium chleuh, Cyclonephelium membraniphorum, Chatangiella spp., Palaeohystrichophora infusorioides, Raetiadinium truncigerum, Senoniasphaera microperforata, Stephodinium coronatum* and *Xiphophoridium alatum*. This assemblage also characterises the Coniacian of Bornholm (Schiøler, 1992). The presence of *Senoniasphaera rotundata* at 7548´ indicates an age not older than mid Turonian (Foucher, 1981).

7556´5´´-7643´: lower Turonian

The age assignment is based on the absence of the middle Turonian marker species *S. rotundata* from the relatively rich assemblages in the interval (Foucher, 1981) and the absence of *Litosphaeridium siphoniphorum siphoniphorum,* which has its LO in the lowermost Turonian. The interval is characterised by the typical Turonian assemblage of *Callaiosphaeridium asymmetricum, Cyclonephelium membraniphorum, Elipsodinium rugulosum, Endoscrinium campanula, Florentinia deanei, Kleithriasphaeridium readei, Leberidocysta clamydata, Psaligonyaulax deflandrei, Senoniasphaera microperforata* and *Xiphophoridium alatum*.

7657´-7682´2´´: barren interval

7682´9´´-7684´4´´: lowermost Turonian-upper Cenomanian

Based on the presence of *L. s. siphoniphorum* that has its LO in the lowermost Turonian (Foucher, 1979; Lucas-Clark, 1984; Williams et al., 1993; Herngreen et al., 1997) and the absence of the middle Cenomanian marker species *Epelidosphaeridia spinosa*, which occurs consistently in middle Cenomanian and older strata in the North Sea area (Costa & Davey, 1992; Herngreen *et al*, 1996).

2.2 BO-1 WELL

Dinoflagellate biostratigraphy of the interval 6768´ - 7411´

6768´: Barren sample

6782´: Uppermost Maastrichtian

Palynodinium grallator occurs in the sample at 6782´; this species is the index-species for the *P. grallator* Zone of Hansen (1977). This zone largely corresponds to the uppermost Maastrichtian *Belemnella casimirovensis* belemnite zone of Jeletzky (1955) & Birkelund (1959), according to Schiøler & Wilson (1993).

6797´: Upper Maastrichtian.

On the basis of the presence of ?*Cassiculosphaeridia tocherii*, which has only been reported from upper Maastrichtian strata (Schiøler, 1993) and the absence of *P. grallator*.

6810´-6825´: Maastrichtian-uppermost Campanian

Although the dinoflagellate assemblages in this interval are sparse, it may be assigned a general Maastrichtian age based on the presence of *Cassiculosphaeridia intermedia*, *Cerodinium diebelii*, *Hystrichosphaeropsis irisae* and "*Neonorthidium perforatum*" (Marheinecke, 1992; Schiøler & Wilson, 1993). *Cerodinium diebelii* is present in the lowermost sample in the interval (at 6825´); this species has its FO close to the stratigraphic interval recently proposed to host the type of the Maastrichtian-Campanian boundary at the boundary type section (Wilson & Schiøler, in prep.).

6840´-6873´: barren interval

6888´-7166´: lower Santonian-Turonian

Four out of six samples from this interval are barren. The uppermost productive sample contains *Ovoidinium verrucosum* which has its LO in the lower Santonian according to Herngreen *et al* (1996). As the interval is underlain by strata of Turonian age, it is tentatively assigned a general lower Santonian-Turonian age.

7182´-7226´: barren interval

7241´-7280´: lower Turonian

Eurydinium saxoniense has its LO in the sample at 7241´. This species has been reported from the Turonian-Cenomanian transition only (Marshall and Batten, 1988), thus the interval is assigned an age no younger than early Turonian.

7283´-7409´: upper-middle Cenomanian

The LO of *Litosphaeridium siphoniphorum glabrum* at 7283´ indicates a Cenomanian age or older for that sample (Lucas-Clarke, 1984). The LO of *Pterodinium cingulatum granulatum* in the samples at 7325´ and 7343´ indicates the vicinity of the upper/middle Cenomanian boundary (Herngreen et al., 1997). The lowermost sample in the interval could be as old as middle Cenomanian based on the absence of *Epelidosphaeridia spinosa* which occurs consistently up into the middle Cenomanian elsewhere in the North Sea (Costa & Davey, 1992; Herngreen *et al*, 1996).

7411´(LSE): barren sample

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4. APPENDICES

4.1 LIST OF SAMPLES ANALYSED FOR PALYNOLOGY

Adda-3

Core #	box	depth	lithology
1	2	6931´	white chalk (rubble)
1	7	6946´	white chalk (rubble)
2	1	7220´	white chalk, stylolites
2	7	7237´	greyish chalk, bioturb, few stylolites
2	12	7252´	greyish chalk, bioturb, many stylolites
2	16	7262´	greyish chalk, clay rich
2	21	7275´	white chalk
3	1	7282´	greyish chalk, bioturb, stylolites
3	7	7290´	white chalk (rubble)
4	1	7311´	white chalk, few stylolites
4	6	7324´5´´	white chalk, few stylolites
4	6	7324´9´´	clay from thick stylolite
4	13	7342´4´´	white chalk, stylolites, heavy diagenesis
5	4	7359´	white chalk, stylolites
5	14	7377´8´´	mottled, whitish chalk
5	23	7401´	mottled, whitish chalk, few stylolites
6	5	7416´3´´	white chalk
7	3	7439´2´´	white chalk
8	3	7452´8´´	white chalk, clay-streaked
9	2	7481´	white chalk, stylolites
11	3	7516´	white chalk, many stylolites
13	1	7532´5´´	white chalk, many stylolites
13	7	7548´	white chalk, many stylolites
13	11	7556´5´´	white chalk, many stylolites, clay lamin.
14	7	7577´	white chalk (rubble)
15	1	7588´7´´	white chalk, stylolites
15	1	7589´	black shale bed (1 cm thick)
15	6	7598´6´´	white chalk, many stylolites
16	2	7617´5´´	white chalk, many stylolites
17	1	7643´	white chalk
17	6	7657´	white chalk
18	1	7672´5´´	greenish streaked, mottled chalk
18	5	7682´2´´	light green chalk (rubble)
18	5	7682´9´´	black shale
18	6	7684´4´´	light green marl

Total number of samples: 35

Bo-1

Core #	box	depth	lithology
1	1	6768´	white chalk
1	6	6782´	white chalk
1	11	6797´	white chalk
1	16	6810´	white chalk
2	1	6825´	white chalk
2	6	6840´	white chalk
2	16	6870´	white chalk, clay streaks
2	17	6873´	white chalk
3	2	6888´	white chalk, clay streaks
3	8	6907´	white chalk
3	18	6939´	white chalk, clay streaks
3	21	6946´	white chalk
4	1	7156´	white chalk
4	4	7166´	white chalk
5	4	7182´	white chalk
5	7	7191´	white chalk
5	13	7210´	white chalk
5	19	7226´	white chalk
6	4	7241´	white chalk
6	9	7256´	light grey chalk
6	11	7265´	white chalk
6	13	7268´	black shale (top of shale bed)
6	14	7271´	black shale (middle part of shale bed)
6	15	7274´	white chalk (just below shale bed)
6	17	7280´	white chalk
6	18	7283´	marl
6	19	7287´	white chalk
7	5	7303´	white chalk
7	9	7316´	white chalk
7	12	7325´	white chalk, clay streaks
7	18	7343´	white chalk, clay streaks
8	1	7352´	white chalk, clay streaks
8	3	7359´	white chalk
8	7	7370´	white chalk, clay streaks
8	14	7390´	white chalk
8	15	7396´	white chalk
8	18	7404´	white chalk, clay streaks
8	20	7409´	white chalk, clay streaks
8	20	7411´	white chalk

Total number of samples: 39

4.2 SPECIES LIST

Dinoflagellates and acritarchs from Adda-3 (A) and Bo-1 (B) wells. Most of the dinoflagellate species are fully referenced in Lentin & Williams (1993); others are referenced herein.

Acanthaulax wilsonii	A
Achomosphaera cf. *neptunii*	B
Achomosphaera ramulifera	AB
Achomosphaera sagena	AB
Achomosphaera sp. 1	B
Alisocysta reticulata	A
Alterbidinium acutul	A
Alterbidinium minor	AB
Alterbidinium varia	A
Areoligera coronat	B
Areoligera ssp.	A
Atopodinium chleu	A
Atopodinium haromense	A
Batiacasphaera cf. *ovata*	B
Batiacasphaera sp. 1	AB
Batiacasphaera sp. 4	B
Callaiosphaeridium asymmetricum	A
Canningia sp. A of Marshall & Batten, 1988	B
Cassiculosphaeridia aff. magna	AB
Cassiculosphaeridia reticulata	A
Cassiculosphaeridia sp. 1	A
Cassiculosphaeridia? tocherii	AB
Cassiculusphaeridia intermedia	AB
Cerodinium diebelii	B
Chatangiella ditissima	A
Chatangiella sp. 1 of GEUS	A
Chatangiella spp. (pars)	A
Chatangiella victoriensis	A
Chlamydophorella ambigua	AB
Chlamydophorella discreta	A
Chlamydophorella spp. (pars)	AB
Circulodinium brevispinosum	A
Circulodinium distinctum distinctum	AB
Cleistosphaeridium aciculare	B
Cleistosphaeridium armatum	AB
Cleistosphaeridium clavulum	B
Cleistosphaeridium spp. (pars)	AB
Codoniella campanulata	A
Cometodinium spp.	AB
Cordosphaeridium varians	A
Coronifera oceanica	A
Coronifera striolata	AB

Cribroperidinium cf. *edwardsii*	A
Cribroperidinium cf. *wetzelii*	B
Cribroperidinium exilicristatum	AB
Cribroperidinium spp. (pars)	A
Cyclonephelium aff. *distinctum* of Schiøler & Wilson, 1993	B
Cyclonephelium cf. *expansum*	A
Cyclonephelium compactum	AB
Cyclonephelium membraniphorum	AB
Cyst form A of Marshall & Batten, 1988	B
Dapsilidinium sp. 1 of Schiøler & Wilson, in press	A
Dapsilidinium spp.	AB
Dapsilidinium warrenii	A
Diconodinium sp. 1	A
Dinopterygium cladoides	B
Dorocysta litotes	B
Elipsodinium rugulosum	AB
Endoscrinium campanula	AB
Eurydinium saxoniense	B
Exochosphaeridium bifidum	AB
Exochosphaeridium phragmites	AB
Florentinia buspina	A
Florentinia cf. *buspina*	B
Florentinia cf. *tenera*	B
Florentinia deanei	AB
Florentinia ferox	A
Florentinia laciniata	B
Florentinia mantellii	AB
Florentinia radiculata	B
Florentinia sp. 1	B
Gen. sp. 6	AB
Gen. sp. 7	A
Gen. sp. 8	A
Gen. sp. 9	A
Hapsocysta dictyota	AB
Hapsocysta peridictya	A
Heslertonia spp.	B
Heterosphaeridium heteracanthum	AB
Histiocysta palla	A
Hystrichodinium pulchrum	AB
Hystrichodinium ramoides	A
Hystrichosphaeridium difficili	A
Hystrichosphaeridium recurvatum	AB
Hystrichosphaeridium tubiferum	AB
Hystrichosphaeropsis irisae	B
Hystrichostrogylon borisii	AB
Hystrichostrogylon coninckii	AB
Hystrichostrogylon membraniphorum	AB

Isabelidinium cf. *belfastense*	A
Isabelidinium cf. *cretaceum*	A
Isabelidinium cf. *glabrum*	A
Isabelidinium glabrum	A
Isabelidinium spp.	AB
Kallosphaeridium sp. A of Tocher and Jarvis, 1987	B
Kleithriasphaeridium loffrense	A
Kleithriasphaeridium readei	A
Leberidocysta chlamydata	AB
Litosphaeridium siphoniphorum glabrum	B
Litosphaeridium siphoniphorum siphoniphorum	AB
Manumiella sp. 1	AB
Membranilarnacia polycladiata	A
Microdinium group	AB
Microdinium setosum	A
Montanarocysta aemilliana	A
Nematosphaeropsis philippotii	A
Nematosphaeropsis sp. 1	A
"Neonorthidium perforatum" of Marheinecke, 1992	B
Odontochitina costata/operculata	AB
Oligosphaeridium cf. *albertense*	A
Oligosphaeridium complex brevispinum	A
Oligosphaeridium complex complex	AB
Ovoidinium spp. (pars)	A
Ovoidinium verrucosum	B
Palaeocystodinium golzowense	B
Palaeohystrichophora infusorioides	AB
Palaeoperidinium pyrophorum	B
Palambage spp.	B
Palynodinium grallator	B
Paralecaniella spp.	A
Pervosphaeridium cf. *truncatum*	AB
Pervosphaeridium intervelum	B
Pervosphaeridium monasteriense	A
Pervosphaeridium pseudhystrichodinium	AB
Pervosphaeridium spp. (pars)	A
Prolixosphaeridium parvispinum	B
Psaligonyaulax deflandrei	AB
Pterodinium sp. B of Schiøler & Wilson, 1993	AB
Pterodinium aliferum	A
Pterodinium cingulatum granulatum	AB
Pterodinium sp. 1	A
Pterodinium spp.	AB
Pterospermella spp.	A
Rhiptocorys veligera	B
Senoniasphaera microperforata	B
Sentusidinium spp.	B

Spinidinium balmei	A
Spinidinium echinoideum	A
Spiniferites cornutus	A
Spiniferites cryptovesiculata	A
Spiniferites pseudofurcatus	AB
Spiniferites ramosus meandriformis	A
Spiniferites ramosus ramosus	AB
Spiniferites ramosus reticulatus	AB
Spiniferites sp. 1 of Schiøler & Wilson, in press	A
Stephodinium coronatum	AB
Subtilisphaera cf. *pontis-mariae*	B
Subtilisphaera sp. 2	A
Subtilisphaera spp. (pars)	A
Tanyosphaeridium spp.	A
Tasmanites spp.	A
Tectatodinium cf. *pellitum*	B
Thalassiphora cf. *succincta*	A
Thalassiphora pelagica	A
Thalassiphora sp. 1	A
Thalassiphora spp. (pars)	A
Trichodinium cf. *castanea*	AB
Trithyrodinium fragile	B
Trithyrodinium suspectum	A
Valensiella spp.	A
Wallodinium spp.	A
Xenascus ceratioides	AB
Xenascus plotei	A
Xenascus sp. A of Schiøler, 1992	A
Xenascus wetzelii of Slimani, 1996	A
Xiphophoridium alatum	AB

5. ENCLOSURES

1. PALAEONTOLOGICAL DISTRIBUTION CHART; ADDA-3 WELL

Grey shading of columns indicates barren samples. Grey shading of rows indicates biostratigraphic important taxa. Yellow colour indicates occurrence-interval of important taxa.

2. PALAEONTOLOGICAL DISTRIBUTION CHART; BO-1 WELL

Grey shading of columns indicates barren samples. Grey shading of rows indicates biostratigraphic important taxa. Yellow colour indicates occurrence-interval of important taxa

Adda-3 Palynological distribution chart

	Danian		upper Campanian				upper Campanian - Coniacian												Coniacian-middle Turonian						lower Turonian										lowermost Turonian- u. Cenomanian	
Depths	6931'	6946'	7220'	7237'	7252'	7262'	7275'	7282'	7290'	7311'	7324'5"	7324'9"	7342'4"	7359'	7377'8"	7401'	7416'3"	7439'2"	7452'8"	7481'	7516'	7532'5"	7548'	7556'5"	7577'	7588'7"	7589'	7598'6"	7617'5"	7643	7657	7672'5"	7682'2"	7682'9"	7684'4"
Acanthaulax wilsonii																												x								
Achomosphaera ramulifera						3												1	2						1	2		x					x			
Achomosphaera sagena																		1			x				x		1	1	x					1		
Alisocysta reticulata	1																																			
Alterbidinium acutulum																					1															
Alterbidinium minor						x																														
Alterbidinium varians																					3															
Areoligera spp.	1																																			
Atopodinium chleuh																					x						x		x				x			
Atopodinium haromense																								x												
Batacasphaera sp. 1						1																														
Callaiosphaeridium asymmetricum																										5	2	3.5	x						1	
Cassiculosphaeridia aff. magna																									0.5	1	2	1							1	
Cassiculosphaeridia intermedia			1	1.5	1	1																														
Cassiculosphaeridia reticulata																												x							1	
Cassiculosphaeridia sp.1																								2	1	0.5										
Cassiculosphaeridia tocherii	1																																			
Chatangiella ditissima					0.5																															
Chatangiella sp. 1 (DGU)						1	1																													
Chatangiella spp. (pars)			1			0.5															2															
Chatangiella victoriensis																					2															
Chlamydophorella ambigua																																		8	6	
Chlamydophorella discreta																					7															
Chlamydophorella spp. (pars)						1																													1	
Circulodinium brevispinosum																								x		x	x									
Cleistosphaeridium armatum				2																	4		2	1										1		
Cleistosphaeridium spp. (pars)																		1	1																3	
Codoniella campanulata																													x							
Cometodinium spp.																												5						1	1	
Coronifera oceanica						1																														
Coronifera striolata																										x	x	x								
Cribroperidinium cf. edwardsii						1																														
Cribroperidinium exilicristatum																																		x		
Cribroperidinium spp. (pars)					1	1													x															2	x	
Cyclonephelium cf. expansum						2																														
Cyclonephelium compactum					4.5																															
Cyclonephelium d. distinctum						1												3	2	0.5	3.5		2.5	2	3	1		6	x	x					x		
Cyclonephelium membraniphorum																							1		x	1		x	1							x	
Dapsilidinium sp. 1 of S.&W., in press																		1	1																		
Dapsilidinium warrenii																																			1	
Diconodinium sp. 1						2																														
Elipsodinium rugulosum																								3	9	x	x	1	x						1	
Endoscrinium campanula																												4	x					cf.		
Exochosphaeridium bifidum			1		12																															
Exochosphaeridium phragmites																											1	x						x		
Fibrocysta varians						1																														
Florentinia buspina																																		x		
Florentinia cf. mantellii																					2															
Florentinia deanei																			3				0.5		1.5	1									1	
Florentinia ferox						1																				1		x								
Gen. sp. 6																																		1		
Gen. sp. 7																																		2	2	
Gen. sp. 8																																		x		
Gen. sp. 9																																		1		
Hapsocysta dictyota																										1		4	x					1	1	
Hapsocysta peridictya																																			x	
Heterosphaeridium heteracanthum																	1	3.5	1	1.5	2			3	x	3	5									
Histiocysta palla																																			1	
Hystrichodinium pulchrum																					x		0.5					x	13					5	1	
Hystrichodinium ramoides																								1												
Hystrichosphaeridium difficile																													1							
Hystrichosphaeridium recurvatum																			2		x		3	x	1			x	x							
Hystrichosphaeridium tubiferum						2																			3	3	1							x		
Hystrichostrogylon borisii																			1																	
Hystrichostrogylon coninckii						x																	18				7	3	5						1	
Hystrichostrogylon membraniphorum																					0.5															
Isabelidinium cf. belfastense						13																	1													
Isabelidinium cf. cretaceum																					10															
Isabelidinium cf. glabrum																							3													
Isabelidinium glabrum																																				
Kleithriasphaeridium loffrense						x																												x		
Kleithriasphaeridium readei																			1									1	x							
Leberidocysta chlamydata																					2		1	x		1	2	2	3	x						
Litosphaeridium s. siphoniphorum																																		2	2	
Manumiella sp. 1																					4															
Membranilarnacia polycladiata																		3	23							1			2	x						
Microdinium setosum																																			1	
Montanarocysta aemiliana																																			1	
Nematosphaeropsis philippotii																												x								
Nematosphaeropsis sp. 1																																			x	
Odontochitina costata/operculata													1					82.5	30		27.5		2	45.5	29	9.5	13	49.5	11	x				2	3	
Oligosphaeridium c. brevispinum																								1												
Oligosphaeridium cf. albertense																					x								x						x	
Oligosphaeridium complex																		4.5	23	0.5	30.5		29.5	59.5	1.5	3		x	1					1	1	
Ovoidinium spp.																																		2	2	
Palaeohystrichophora infusorioides																			1	1	4								4	x					2	
Paralecanella spp.	122	4							1												x															
Pervosphaeridium cf. truncatum																													x					x	3	
Pervosphaeridium monasteriense																												2.5								
Pervosphaeridium pseudhystrichodinium																												1						x		
Pervosphaeridium spp. (pars)																																				
Psaligonyaulax deflandrei																													x	x						
Pterodinium aliferum																			1					1										1		
Pterodinium sp. 1																										13	3									
Pterodinium sp. B (S&W, 1993)																																			1	
Pterodinium spp. (pars)						x												3	5		3	1	2	1	6	6	17	1	33.5	x				3	4	
Pterospermella spp.									1																											
Raetiadinium evittigrata						x																														
Raetiadinium truncigerum																			1																	
Rhiptocorys veligera																					2															
Senoniasphaera microperforata																			1										4	x						
Senoniasphaera rotundata																							0.5													
Senoniasphaera spp. (pars)						1																														
Senoniasphaera? sp. A of Schiøler, 1992																												1								
Spinidinium balmei						1																														
Spinidinium echinoideum																																		30	1	
Spiniferites cornutus																1																				
Spiniferites cryptovesiculata	15																																			
Spiniferites pseudofurcatus						x																														
Spiniferites r. meandriformis			1		1																															
Spiniferites r. ramosus		4	1			15						1						12	28	1	12	0.5	3	7	3	37	30	32	88					8	9	
Spiniferites r. reticulatus					2	1			1								0.5	5	1		5			5	1		5	5	1							
Spiniferites sp. 1 of S.&W., in press																		2	6				1			3										
Stephodinium coronatum																			1										2	x				1	2	
Subtilisphaera sp. 2																																				
Subtilisphaera spp.																					1					62	6	1							1	
Tanyosphaeridium sp.																			3							x		1	x							
Tasmanites spp.									1																											
Thalassiphora cf. succincta																													x							
Thalassiphora pelagica	1																																			
Thalassiphora sp. 1																													x							
Thalassiphora spp. (pars)																																		1		
Trichodinium cf. castanea						1																						1								
Trithyrodinium suspectum																					1															
Valensiella spp.																					6	1														
Wallodinium spp.																																		1		
Xenascus ceratioides			1																1		1			1.5		1.5				x						
Xenascus plotei																							1													
Xenascus sp. A of Schiøler, 1992																											x		x							
Xenascus wetzelii						4																				x	1.5									
Xiphophoridium alatum																			1		1						1		7.5						1	

Enclosure 1

BO-1 Palynological distribution chart

	lowermost Danian- uppermost Maastricht.		upper Maastrichtia	Maastricht. -uppermost Campanian		lower Santonian - Turonian						lower Turonian							upper-middle Cenomanian														
Depths	6768'	6782'	6797'	6810'	6825'	6840'	6870'	6873'	6888'	6907'	6939'	6946'	7156'	7166'	7182'	7191'	7210'	7226'	7241'	7256'	7265'	7268'	7271'	7274'	7280'	7283'	7287'	7303'	7316'	7325'	7343'	7352'	7359'	7370'	7390'	7396'	7404'	7409'	7411'
Achomosphaera cf. neptunii																																						
Achomosphaera ramulifera			1																										3	14.5								
Achomosphaera sagena																										x												
Achomosphaera sp. 1																														6.5								
Alterbidinium minor			2																																			
Areoligera coronata			x																							x												
Batiacasphaera cf. ovata																						2	4			1												
Batiacasphaera sp. 1									1																													
Batiacasphaera sp. 4																						1																
Canningia sp. A (Marshall & Batten, 1988)																													2	1	13.5	1	1	6		2	1	
Cassiculosphaeridia aff. magna			1.5	0.5																						5												
Cassiculosphaeridia intermedia			1																										1	3								
Cassiculosphaeridia tocherii		1			1																																	
Cerodinium diebelii																						1	7															
Chlamydophorella ambigua																							3			2			6	3	x						2	
Chlamydophorella spp. (pars)																											1				3							
Circulodinium d. distinctum																													1									
Cleistosphaeridium aciculare																										2				3		9	1	5	9		3	5
Cleistosphaeridium armatum																														1	3							
Cleistosphaeridium clavulum																										1												
Cleistosphaeridium spp. (pars)																														3								
Cometodinium spp.			2																							2				1	3							
Coronifera striolata		1	1.5																							1												
Cribroperidinium cf. wetzelii																																						
Cribroperidinium exilicristatum									1																	1				3	4				1			
Cyclonephelium aff. distinctum (S&W, 1993)																								2	1													
Cyclonephelium compactum																						2	3	5														
Cyclonephelium membraniphorum																						1				10												
Cyst form A (Marshall & Batten)																														1								
Dapsilidinium spp.																							1															
Dinopterygium cladoides																										x												
Dorocysta litotes																									1	1				1	1			1		4		
Elipsodinium rugulosum																														1	2							
Endoscrinium campanula																			3	1		9				57												
Eurydinium saxoniense														1												1												
Exochosphaeridium bifidum				1					1																	1												
Exochosphaeridium phragmites																										1												
Florentinia cf. buspina																										2												
Florentinia cf. tenera																										1												
Florentinia deanei																										1												
Florentinia laciniata																														1								
Florentinia mantellii																														1								
Florentinia radiculata																										2												
Florentinia sp. 1																										2				1	5							
Gen. sp. 6																														1								
Hapsocysta dictyota																						6				1				1	1							
Heslertonia spp.			3																							2			1									
Heterosphaeridium heteracanthum																																						
Hystrichodinium pulchrum			1																							1				x								
Hystrichosphaeridium recurvatum			17	0.5																																		
Hystrichosphaeridium tubiferum			1																																			
Hystrichosphaeropsis irisae			2																																			
Hystrichostrogylon borisii									1																													
Hystrichostrogylon coninckii																										1												
Hystrichostrogylon membraniphorum			1																																			
Isabelidinium spp.																										x												
Kallosphaeridium sp. A (T&J, 1987)				1																						1												
Leberidocysta chlamydata																										3												
Litosphaeridium s. glabrum					1																					x												
Litosphaeridium s. siphoniphorum				1																		2				1												
Manumiella spp.																																						
Microdinium group			15.5	4					1													4				1			3	8.5	1		0.5	1.5		2.5	67	
Neonorthidium perforatum									1																				5	7	10	14		1			5	
Odontochitina costata/operculata																																						
Oligosphaeridium complex																														1								
Ovoidinium verrucosum																																						
Palaeocystodinium golzowense	1	1																																				
Palaeohystrichophora infusorioides																																						
Palaeoperidinium pyrophorum	2																																					
Palambage spp.																																						
Palynodinium grallator	1																																					
Pervosphaeridium cf. truncatum																																						
Pervosphaeridium intervelum																																						
Pervosphaeridium pseudhystrichodinium			5																																			
Prolixosphaeridium parvispinum																																						
Psaligonyaulax deflandrei																																						
Pterodinium c. granulatum																																						
Pterodinium sp. B (S&W, 1993)																																						
Pterodinium spp. (pars)			4						1																													
Rhiptocorys veligera																																						
Senoniasphaera microperforata																																						
Sentusidinium spp.																																						
Spiniferites pseudofurcatus			1.5																																			
Spiniferites r. ramosus			3.5						1																													
Spiniferites r. reticulatus			x																																		
Stephodinium coronatum																																						
Subtilisphaera cf. pontis-mariae																																						
Tectatodinium cf. pellitum									1					1																								
Trichodinium cf. castanea																																						
Trithyrodinium fragile	1																																					
Xenascus ceratioides																																						
Xiphophoridium alatum																																						

Enclosure 2