74. CALCAREOUS NANNOFOSSILS — LEG 37, DEEP SEA DRILLING PROJECT

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The calcareous nannofossils recovered from sediments on Leg 37 are not only remarkably well preserved, but in most samples constitute more than 90% of the sediment. The only poorly preserved specimens come from baked chalk interbedded with the basement basalts, and the state of preservation correlates with the degree of metamorphism. Nannofossils are unrecognizable from the most intensely heated calcareous sediments although they likely formed the bulk of these deposits.

Within and just above acoustic basement, Holes 332A and 332B show a similar nannofossil succession (Tables 1 and 2). Nannofossil assemblages below Section 5, Core 5, Hole 332A closely resemble the Section 2, Core 6, Hole 332B flora with rare large *Reticulofenestra pseudoumbilica.* This species is smaller and more common in assemblages from Section 5, Core 5, Hole 332A and Section 5, Core 1, Hole 332B and higher until its absence above Section 4, Core 3, Hole 332A and Section 2, Core 1, Hole 332B. These results indicate that the sediment immediately above basement in Hole 332B is slightly younger than that in Hole 332A but an age near the early Pliocene-late Pliocene boundary is indicated in both cases.

Hole 333 samples have nannofossils indicating a slightly older age (late early Pliocene) for sediments immediately above basement (Table 3). Nannofossil assemblages below Section 4, Core 3 resemble those from samples below Section 5, Core 5, Hole 332A. Additional evidence for an older age is the sporadic occurrence of *Sphenolithus abies* below Section 2, Core 6, Hole 333.

Figure 1 shows the results of age determinations based on previous nannofossil zonations (Martini, 1971; Bukry, 1971, 1973). The NN15-NN16 zonal contact does not coincide with the *Discoaster asymmetricus-D. tamalis* Subzone boundary of Bukry. The NN15-NN16 contact was picked on the last occurrence of small *Reticulofenestra pseudoumbilica.* Unlike the large specimens of *R. pseudoumbilica* mentioned previously, these small specimens have fewer than 60 shield segments. The *D. asymmetricus-D. tamalis* contact was based on the last occurrence of rare large specimens of *R. pseudoumbilica* with additional support from sporadic occurrences of *Sphenolithus abies.*

Nanno assemblages from Sites 334 and 335 (Tables 4 and 5) were easily dated. A sample from Site 334 taken just above basement appears to be early late Miocene in age (Zone NN10). Minor difficulties such as the rarity of *Discoaster neohamatus* and the absence of *D. calcaris*, two species which are expected in NN10, posed problems for age determination. Leg 37 specimens assigned to *D. neohamatus* had more slender rays than do the type specimens of that species. Also surprising was the occurrence of *Discoaster loeblichii* in the *D. berggrenii* Subzone of Bukry and the complete absence of *D. neorectus* from the subzone bearing its name. Core 1, Site 335 produced samples that appeared to range in age from NN16 to NN18. A sample from just above basement in Core 5, Site 335 is considered possibly middle Miocene (NN7) on the basis of the occurrence of *D.* cf. *D. kugleri.*

One significant conclusion that can be made is that the sediments immediately above acoustic basement get progressively older away from the crest of the Mid-Atlantic Ridge. Of equal importance is the additional conclusion based on samples from Holes 332A, 332B, and 334 that the basement sediments interlayered with the basalts are only slightly older than those at the upper basement contact. The oldest dated sediment from Hole 332A is from Section 1, Core 25 and it is placed in Zone NN15. Likewise, the oldest dated sediment from Hole 332B is placed in Zone NN15. The oldest dated chalk from Site 334 is from Section 2, Core 20 and it is placed tentatively in Zone NN10. These results support the theory of rapid formation of Layer 2 basaltic crust.

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TABLE 1
Nannofossils, Hole 332A

Species	Sample (Interval in cm)																												
	1-1, 99	1 CC	2-2, 56	2-3, 60	2-4, 58	2-5, 54	2, CC	3-2, 75	3-3, 80	3-4, 58	3, CC	4-3, 110	4-4, 54	4-5, 23	4, CC	5-2, 60	5-3, 138	5-4, 30	5-5, 130	5-6, 129	5, CC	6-1, 75	6-2, 55	13-1, 120	22-1, 24	25-1, 109
Ceratolithus cristatus	R																												
C. rugosus				R	R	R			R		R	R		R		R	R		R				R	R		R
Crassapontosphaera jonesi						R			R		R	R		R		R	R		R	R	R		R	R		R
Crenalithus doronicoides			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Coccolithus pelagicus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Cyclococcolithina leptopora	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discoaster asymmetricus			R	R	R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R
D. braarudii			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D. brouweri			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D. pentaradiatus			R	R	✓	✓	✓	✓	✓	✓	✓	✓	R	R	R	R		R		R	R	R	R	R		
D. stellulus			R	R	R	R	R		R	R	R	✓	✓	✓	✓	✓	R	✓	✓	✓	✓	✓	✓	✓	R	✓
D. surculus			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
D. tamalis						✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R	R
D. variabilis																					R			R		R
D. japonica		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gephyrocapsa caribbeanica	R	R																								
G. oceanica	✓	✓																								
Helicopontosphaera kamptneri	✓	✓	R	R	✓	✓	✓	✓	R	R	R	✓	R	✓	✓	✓	✓	R	R	R	✓	R	R	✓	✓	
H. sellii	✓	✓	✓	✓	R	R	R	R	R	R	R	R	R	✓	R	✓	R	R	R	R						
Pseudoemiliania lacunosa		R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R	R	R	R			
Reticulofenestra pseudoumbilica										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R	R	R	R	✓	R	R
Rhabdosphaera clavigera	✓	R																								
R. procera			R			R	R		R	R					R		R	R	R		R	R		R		R
Scyphosphera amphora			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S. apsteini		✓	R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
S. intermedia						R					R	R		R		R	R			R			R	R	R	R
S. pulcherrima			R			R					R		R					R		R		R				
S. recurvata	✓		R		R		R		R	R	R	R			R	R		R	R	R	R		R	R	R	R
Thoracosphaera heimi	R																									
Bukry Subzone	a		b			*D. tamalis*				*D. asymmetricus?*										*D. asymmetricus*						
Martini and Worsley Zone	NN 20	NN 19	NN 16							NN 15?										NN 15						

[a] *G. oceanica*

[b] *D. pentaradiatus*

TABLE 2
Nannofossils, Hole 332B

Species	Sample (Interval in cm)						
	1-1, 65	1-2, 30	1-3, 30	1-4, 30	1-5, 4	1-5, 43	6-2, 64
Ceratolithus rugosus						R	R
Crassapontosphaera jonesi		R	R	R		R	R
Crenalithus doronicoides	✓	✓	✓	✓	✓	✓	✓
Coccolithus pelagicus	✓	✓	✓	✓	✓	✓	✓
Cyclococcolithina leptopora	✓	✓	✓	✓	✓	✓	✓
Discoaster asymmetricus	✓	✓	✓	✓	✓	✓	✓
D. braarudii	✓	✓	✓	✓	✓	✓	✓
D. brouweri	✓	✓	✓	✓	✓	✓	✓
D. decorus		R					
D. pentaradiatus		✓	✓	✓	R	R	R
D. stellulus	✓	R	✓	✓	✓	✓	✓
D. surculus	✓	✓	✓	✓	✓	✓	✓
D. tamalis		✓	✓	✓	✓	✓	✓
D. variabilis							R
D. japonica	✓	✓	✓	✓	✓	✓	✓
Helicopontosphaera kamptneri	R	R	R	R	R	R	R
H. sellii	✓	R	R	R	R	R	
Pseudoemiliania lacunosa	✓	✓	✓	✓			
Reticulofenestra pseudoumbilica		✓	✓	✓	✓	✓	R
Rhabdosphaera procera	R	R			R	R	
Scyphosphaera amphora	✓	✓	✓	✓	✓	✓	✓
S. apsteini	✓	✓	✓	✓	✓	✓	✓
S. intermedia	✓	✓	✓		R	R	
S. recurvata					R		R
Sphenolithus abies							R
Bukry Subzone	a	*D. asym-metricus?*					*D. asym-metricus*
Martini and Worsley Zone	NN 16	NN 15?					NN 15

[a] *D. tamalis*

TABLE 3
Nannofossils, Hole 333

Species	Sample (Interval in cm)																																				
	1-1, 140	1-2, 35	1, CC	2-1, 40	2-2, 40	2-3, 40	2-4, 40	2-5, 40	2-6, 40	2, CC	3-1, 40	3-2, 40	3-3, 40	3-4, 40	3-5, 40	3-6, 40	3, CC	4-1, 40	4-2, 40	4-3, 40	4-4, 40	4-5, 40	4, CC	5-1, 15	5-2, 60	5-3, 100	5-4, 62	5-5, 100	5, CC	6-1, 100	6-2, 40	6, CC	7-1, 137	7-2, 40	7, CC	1-1, 100[a]	1-2, 40[a]
Ceratolithus cristatus		√																																			
C. rugosus									R		R						R				R		R	R			R	R				R			R	R	
Crassapontosphaera jonesi				R	R		R	R	R	R		R	R		R	R	R		R	R	R	R	R		R	R	R		R	R	R	R	R	R		R	R
Crenalithus doronicoides				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Coccolithus pelagicus	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Cyclococcolithina leptopora	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Discoaster asymmetricus				R	√	√	R	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. braarudii				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. brouweri				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. decorus																							R														
D. pentaradiatus				√	√	√	√	√	√	√	√	R	√	√	√	R	R	√	R	√	√	R	R	R	R	R	R	R	R	√	R	R	R	R	R	R	R
D. stellulus				R	√	√	√	√	R	√	√	√	√	R	R	R	R		R	R	R	R	R		R	R	R	√	R	R	R	R	R	R	R	√	R
D. surculus				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. tamalis				R							R	√	√	√	√		√	√					√	√			√	√	√	√	√	√	√	√	R	√	√
D. variabilis							R		R																							R		R	R		R
D. japonica				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Emiliania huxleyi	√	√	√																																		
Gephyrocapsa caribbeanica	R	R	R																																		
G. oceanica	√	√	√																																		
Helicopontosphaera kamptneri	√	√	√	√	√	√	√	√	√	√	√	R	√	R	R	R	R	R	R	R	√	R	R	R	√	R	R	R	R	R	√	R	R	R	R	R	R
H. sellii	√	√	√	√	R	√	√	√	R	√	√	√	√	√	√	√	R	R	R	R	√	√	√	√	√	√	√	√	R	R	R	R	R	R	R	R	R
Pseudoemiliania lacunosa				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	R	√	R	R	R	R	R
Reticulofenestra pseudoumbilica									R	R	R	R	√	√	R		R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Rhabdosphaera clavigera		R																																			
R. procera						R				R				R						R		R	R					R									
Scyphospheara amphora				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
S. apsteini				√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
S. intermedia											R						R												R						R		R
S. pulcherrima					R	R		R							R														R			R				R	
S. recurvata	√	√	√	R		R	R		R	√	R	√	R	R	R		R			R	R		R		R				R			R			R	R	
Sphenolithus abies																																R		R			
Bukry Subzone	*E. huxleyi*			*D. tamalis*					*D. asymmetricus*?						*D. asymmetricus*																						
Martini and Worsley Zone	NN 21			NN 16					NN 15?						NN 15																						

[a]Hole 333A

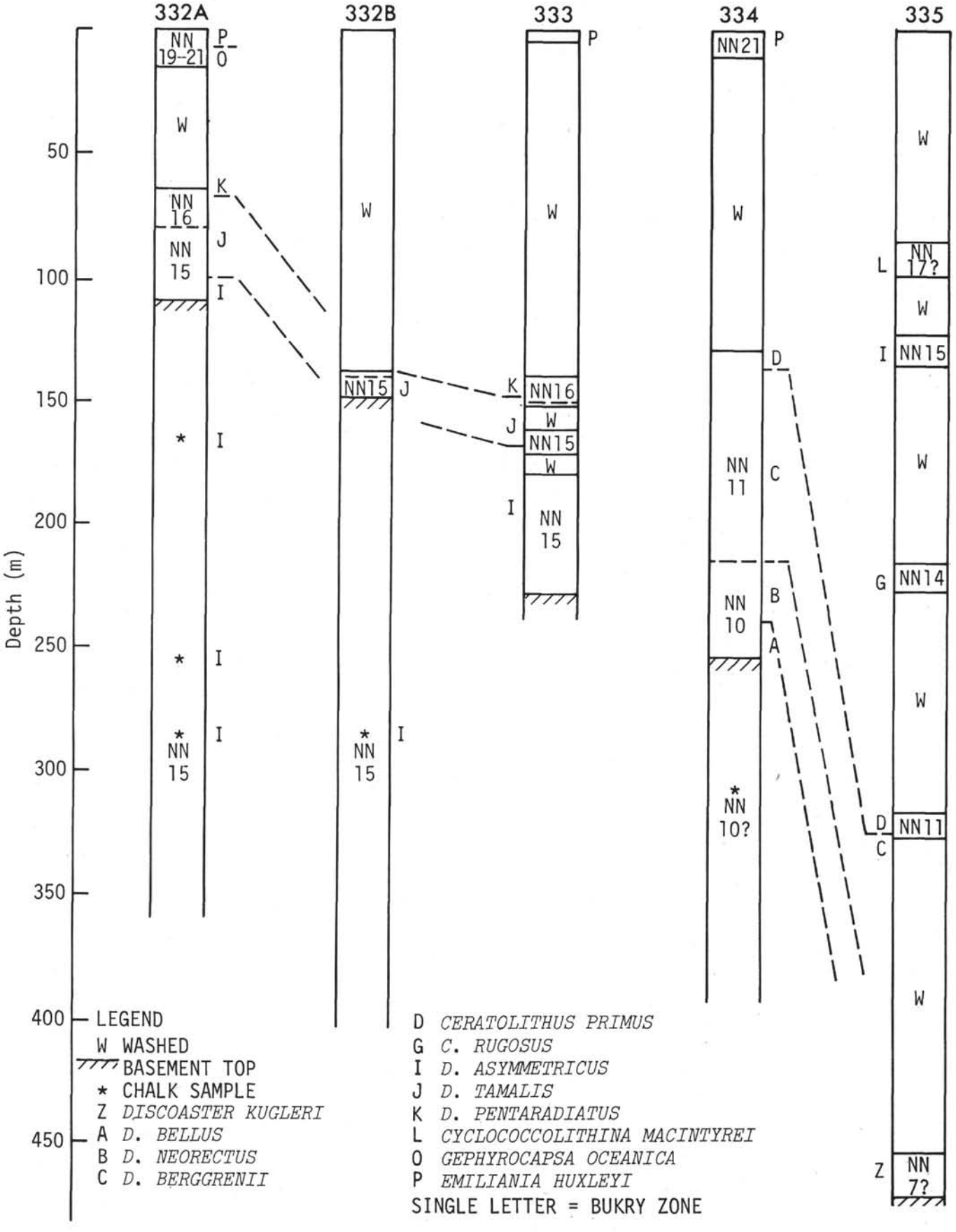

Figure 1. *Nanno zones, Leg 37.*

TABLE 4
Nannofossils, Site 334

Species	Sample (Interval in cm)																														
	2-1, 40	2-2, 40	2-3, 40	2-4, 40	2-5, 40	2-6, 40	2, CC	3-1, 113	3-2, 40	3, CC	4-1, 40	4, CC	5-1, 94	5-2, 99	5-3, 100	5-4, 40	5, CC	6-1, 40	6-2, 100	6, CC	7-1, 40	7-2, 40	7-3, 39	7-4, 100	7-5, 40	7-6, 40	7, CC	8-1, 40	8-2, 40	8, CC
Catinaster calyculus																															
Ceratolithus amplificus		R				R																									
C. dentatus			R			R																									
C. primus	√	√	√	√	√	√																									
Coccolithus pelagicus	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Cyclococcolithina leptopora	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
Discoaster bellus																															
D. berggrenii	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	R	R	R	
D. bollii																															
D. braarudii	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. brouweri	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
D. challengeri		R		R	R		R	R	R	R		R		√	√	√	√	√	√	√		R			R		R			R	
D. icarus																	R		R			R	R		R		R	R		R	
D. intercalaris		R	R	R		R			R	R	R		R	R	R	R		R	R	R		R	R	R		R		R	R	R	
D. loeblichii																	cf.		√	√	√	√	√	R	√	√	√	√	√	√	
D. neohamatus																															
D. pansus	R	R	R	R		R	R	√	R	√	√	R	R	√	√	√	√	√	R	√	√	√	√	√	√	√	√	√	√	√	√
D. pentaradiatus	R	R	R	R	R	R	√	√	R	√	R	R	R	R	R	R	R	√	R	R	R	R	R	√	R	R	R	R	R	R	
D. prepentaradiatus																															
D. quinqueramus				R				R		R	R	R		R		R	R	R	R	R		R	R	R	R	R	R	R	R	R	
D. stellulus	R	R	R	R		R	R	R	R	R	R	R	R	R	R	R		R		R		R	R	R	R	R	R	R		R	
D. surculus		R		R	R		R	R	R	R															cf.		cf.	cf.		cf.	
D. variabilis	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Discolithina callosa																			cf.	cf.		cf.	cf.	cf.		cf.	cf.	cf.	cf.	cf.	
D. japonica		R	R	R	R	R	R		R	R	R	R	R	R	R		R	R	R	R	R	R		R	R		R	R	R	R	
Helicopontosphaera kamptneri	R	R	R	R	R	R	R	R	R	R	√	R	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Reticulofenestra pseudoumbilica	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	R	R	R	R	R	R	R	R	R	R	R	R	
Rhabdosphaera procera		R		R	R		R		R		R	R		R	R		R	R								R		R	R	R	
Scyphosphaera apsteini	R	R		R			R	R	R	R	R		R				R		R	R			R					R		R	
S. intermedia		R	R	R			R	R		R	R																				
S. pulcherrima	√	√	√	√	√	√	R	√	√	R	R	√	√	√	√	√	√	√	√	√	R	R	√	√	√	√	√	√	R	√	
S. recurvata	√	√	√	√	R	√	√	√	R	R	R	R	R	R		R	R				R		R	R		R	R				
Sphenolithus abies	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Triquetrorhabdulus rugosus		R		R	R			R	R	R	R	R			R	R			R	R		R	R	R	R	R	R	R		R	
Bukry Subzone	*C. primus*							*D. berggrenii*																							
Martini and Worsley Zone	NN 11																														

TABLE 4 – *Continued*

Species	Sample (Interval in cm)																															
	9-2, 100	9-3, 39	9-4, 40	9, CC	10-2, 121	10-3, 100	10-4, 39	10, CC	11-1, 109	11-2, 39	11-3, 40	11-4, 40	11, CC	12-1, 100	12-2, 40	12-3, 40	12-4, 39	12, CC	13-1, 138	13-2, 39	13-3, 40	13-4, 40	13-5, 41	13-6, 40	13, CC	14-1, 100	14, CC	15-1, 70	20-2, 108
Catinaster calyculus																											R	R		
Ceratolithus amplificus																														
C. dentatus																														
C. primus																														
Coccolithus pelagicus	√	√	√	√	√	√	√	√	R	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	R	R	R	
Cyclococcolithina leptopora	√	√	√	√	√	√	√	√	√	√	√	√	R	√	√	R	√	√	√	√	R	√	√	R	√	√	√	√	√	
Discoaster bellus															R			R		R	R		R	√	√	√	√	√	R	
D. berggrenii	R	R	R	R	R	R																								
D. bollii																									R	√	√		R	
D. braarudii	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
D. brouweri	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
D. challengeri					R						R				R					R			R	R	R	R	R	R	R	
D. icarus	R	R		√	√	√	√	√		√	√	√	√	√		R		R												
D. intercalaris	R		R		R	R	R		R	R	R		R	R		R	R	R		R	R	R	R		R					
D. loeblichii	R	√	√	√	√	R	R	√	√	√	√	R	√	√	√	R	R	√												
D. neohamatus																		cf.		cf.	cf.		cf.		cf.	cf.	cf.	cf.		
D. pansus	R	√	R	R	R		R	R																						
D. pentaradiatus		R	R	R	R																									
D. prepentaradiatus																R	R	R		R		R								
D. quinqueramus	R	R		R	R								cf.																	
D. stellulus	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	R	R	√	√	√	√	√	R	√	√	√	R	R	
D. surculus																														
D. variabilis	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Discolithina callosa		cf.	cf.	cf.	cf.													cf.		cf.				cf.			cf.			
D. japonica	R	R		R	R	R	R	R	R	R	R	R		R	R	R	R	R	R		R	R	R	R	R	R	R			
Helicopontosphaera kamptneri	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Reticulofenestra pseudoumbilica	R	R	√	√	√	√	R	R	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Rhabdosphaera procera		R	R	R	R																									
Scyphosphaera apsteini	R	R		R	R	R	R	R	R		R	R	R	R		R		R												
S. intermedia										R		R	R	R	R	R		R		R	R									
S. pulcherrima	R	R	R	R	R	R	R	√	R	R	R		R	R	R	R	R	R		R				R		R	R	R		
S. recurvata	R					R				R		R	R																	
Sphenolithus abies	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	
Triquetrorhabdulus rugosus	R	R	R	R		R	R	R	R		R	R	R	R		R	R	R	R	R	R	R	R	R	R	R	R	R		
Bukry Subzone	*D. berggrenii*							*D. neorectus*																			*D. bellus*			
Martini and Worsley Zone	NN 11							NN 10																						

TABLE 5
Nannofossils, Site 335

Species	Sample (Interval in cm)																			
	1-1, 99	1-2, 40	1-3, 55	1-4, 40	1, CC	2-1, 132	2-2, 40	2-3, 40	2-4, 40	2-5, 40	2, CC	3-1, 40	3, CC	4-1, 128	4-2, 39	4-3, 40	4, CC	5-1, 78	5-1, 147
Ceratolithus cristatus	R	R		R															
C. pumus											R	R	R		✓	✓			
C. rugosus								R	R		R	R	R						
Coccolithus pelagicus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
C. miopelagicus																		✓	✓
Cyclococcolithina leptopora	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Discoaster asymmetricus	R	R	R	R	R	✓	✓	✓	✓	✓	✓	R							
D. berggrenii														R	R		R		
D. braarudii			R		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
D. brouweri			R	R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	R	
D. challengeri								R	R		R	R	R	✓	R	R	R	✓	✓
D. decorus									R		R								
D. exilis																			✓
D. icarus														R	R	R	R		
D. intercalaris							R	R		R	R							R	
D. kugleri																			cf.
D. pansus														R	R	R	R		
D. pentaradiatus			R	R	R	R	R	R	R	R	R	✓	✓	R			R		
D. quinqueramus														✓	✓	✓	✓	✓	✓
D. stellulus			✓	✓	✓	✓	R	✓	R	R	R	✓	✓	✓	✓				
D. surculus			R			✓	✓	✓	✓	✓	✓	R	R						
D. tamalis					R	✓	✓	✓	✓	✓	✓	R		✓	✓	✓	✓	✓	✓
D. variabilis												✓	✓						
Discolithina japonica	✓	✓	✓	✓	✓	R	✓	R	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Helicopontosphaera kamptneri	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
H. sellii	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓								
Pseudoemiliania lacunosa	✓	✓	R	✓	R	R		R	R	R				✓	✓	✓	✓	✓	✓
Scyphosphaera amphora						✓	✓	✓	✓	✓	✓	✓	✓						
S. apsteini	R	R	R	R	R									R	R	R	R		
S. globulata	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓						
S. intermedia								R	R		R		R						
S. pulcherrima	R	R	R		R		R		R	R	R	R	R	R	R	R	R		
S. recurvata	R	R	R	R	R	R		R	R	R	R	R	R						
S. turris		R	R		R								R						
Sphenolithus abies	R			R	R									✓	✓	✓	✓	✓	✓
Triquetrorhabdulus rugosus						✓	✓	✓	✓	✓	✓	✓	✓	R	R	R	R	R	R
Bukry Subzone	a		*D. penta-radiatus?*			*D. asymmetricus*						b							
Martini and Worsley Zone	NN 18?		NN 17?			NN 15						NN 14							

[a] *C. macintyrei*

[b] *C. rugosus*