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8. Data Report: Paleogene Calcareous Nannofossil Biostratigraphy of ODP Leg 189 (Australia-Antarctica Gateway)[1]

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INTRODUCTION

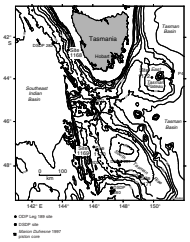
A major objective of Leg 189 was to date the opening of the Australia-Antarctic Gateway to shallow-water circulation and subsequently to deepwater circulation in the Paleogene. Calcareous nannofossils are the most consistently present, although not necessarily the most abundant fossil group in Paleogene sections, and the shipboard study (Exon, Kennett, Malone, et al., 2001) showed that they often provided critically needed age information. This report presents documentation of the stratigraphic distribution of nannofossils in the Paleogene and summarizes useful nannofossil datums, which should facilitate construction of age-depth curves and contribute to an integrated chronology for Leg 189 sediments. Previous Paleogene nannofossil study in this area is that of Edwards and Perch-Nielsen (1975).

MATERIALS AND METHODS

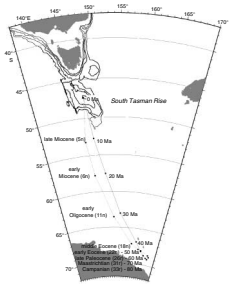
Five sites were drilled during Leg 189 (Fig. F1), and at four sites (1168 and 1170–1172) Paleogene sediments were recovered. All sites were located at high latitudes in the Paleogene (see Fig. F2 for backtrack); thus, the nannofossil assemblages are similar to those of the southern high latitudes (e.g., Wei and Wise, 1990; Wei and Thierstein, 1991, Wei et al., 1992).

Smear slides were made from unprocessed sediments and examined with a light microscope at a magnification of 1000×. The abundance of

F1. Locations of ODP Leg 189 sites, p. 4.



F2. Backtrack of site locations through time, p. 5.



[1]Wei, W., McGonigal, K.L., and Zhong, S., 2003. Data report: Paleogene calcareous nannofossil biostratigraphy of ODP Leg 189 (Australia-Antarctica Gateway). *In* Exon, N.F., Kennett, J.P., and Malone, M.J. (Eds.), *Proc. ODP, Sci. Results,* 189, 1–14 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/189_SR/VOLUME/CHAPTERS/103.PDF>. [Cited YYYY-MM-DD]
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selected nannofossil taxa on each slide was estimated using the following criteria:

V = very abundant, >10 specimens per field of view.
A = abundant, 1–10 specimens per field of view.
C = common, 1 specimen per 2–10 fields of view.
F = few, 1 specimen per 11–50 fields of view.
R = rare, 1 specimen per 51–200 fields of view.

For preservation of nannofossil assemblages

G = good, little evidence of etching or overgrowth.
M = moderate, etching and/or overgrowth is apparent.
P = poor, strong etching and/or overgrowth.

The bibliographic references of the species used in this study can be found in Perch-Nielsen (1985). Numerical ages discussed in this paper refer to the timescale of Berggren et al. (1995).

RESULTS AND SUMMARY

Nannofossil range charts are presented in Tables **T1, T2, T3,** and **T4,** and nannofossil age-depth control points are summarized in Table **T5.** Age control for the lower part of Hole 1171D is very poor because Cores 189-1171D-58R through 75R are largely barren of nannofossils (Table **T3**). However, rare occurrences of the genera *Toweius* and *Prinsius* in a number of samples, with the lowermost occurrence in Sample 189-1171D-74R-CC, suggest that the interval is of Paleocene–earliest Eocene age. Similarly, Cores 189-1172D-10R through 24R are virtually barren of nannofossils, but the occurrences of *Coccolithus pelagicus* and *Reticulofenestra* sp. in Core 189-1172D-24R suggest that this core is of Paleocene–Eocene age. Samples from the next core (189-1172D-25R) and downhole are clearly of late Maastrichtian age, as they contain typical late Maastrichtian nannofossils, including *Arkhangelskiella cymbiformis, Cribosphaerella daniae, Eiffelithus turriseiffelii,* and *Nephrolithus frequens* (see Exon, Kennett, Malone, et al., 2001).

The nannofossil biostratigraphic results presented here appear to be significantly different from those of the shipboard results and the preliminary shore-based studies of other fossil groups for the critical Eocene–Oligocene transition, and the paleoceanographic implications appear to be quite significant. Thus, we prefer to defer detailed discussion of the nannofossil biostratigraphy and its implications until more thorough evaluation of the data together with those of other stratigraphic data sets.

T1. Distribution of calcareous nannofossils, Site 1168, p. 6.

T2. Distribution of calcareous nannofossils, Site 1170, p. 8.

T3. Distribution of calcareous nannofossils, Site 1171, p. 10.

T4. Distribution of calcareous nannofossils, Site 1172, p. 12.

T5. Summary of calcareous nannofossil datums, p. 14.

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Figure F1. Locations of ODP Leg 189 sites. Other relevant core sites are also shown. Modified from Exon, Kennett, Malone, et al. (2001).

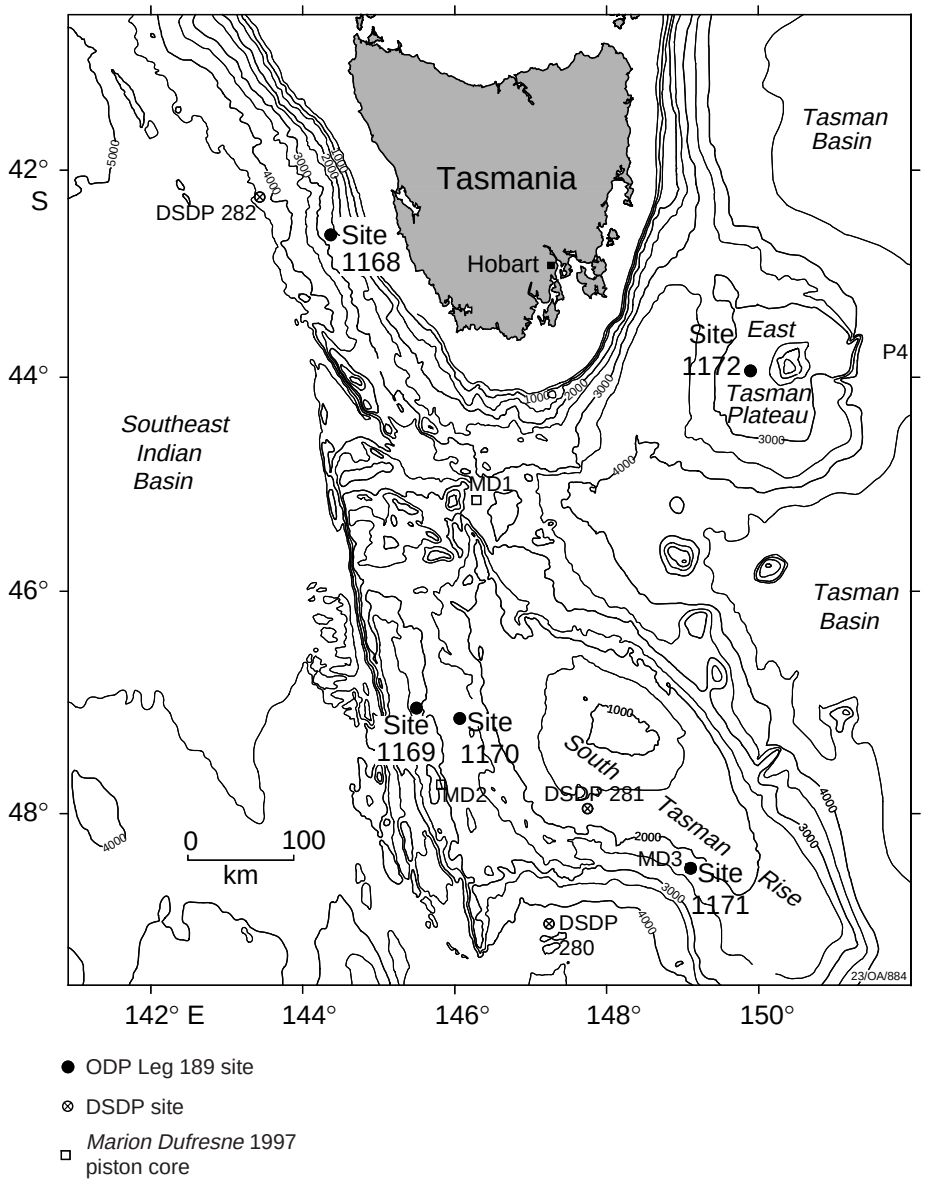

Figure F2. Backtrack of site locations through time. Taken from Exon, Kennett, Malone, et al. (2001).

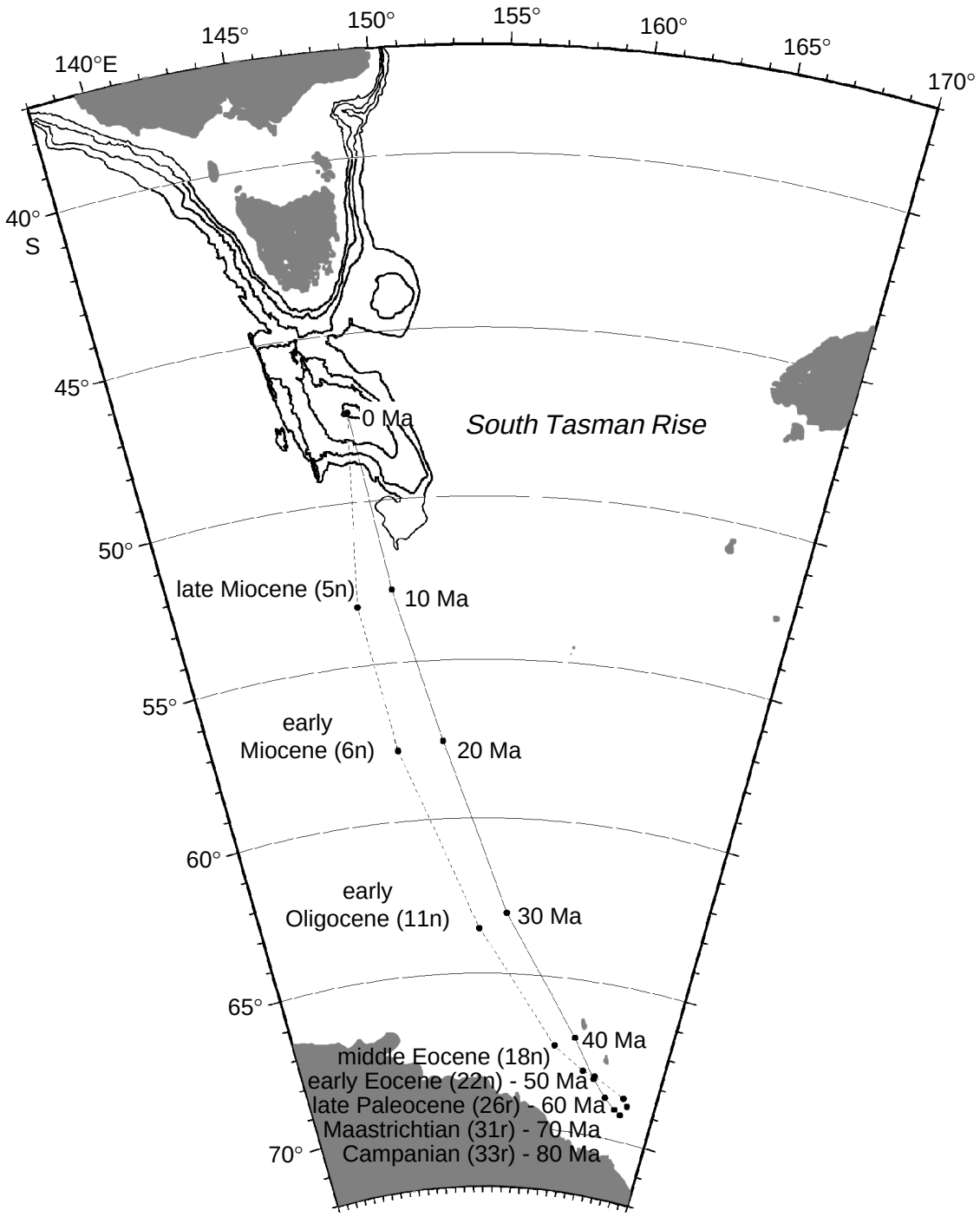

Table T1. Distribution of calcareous nannofossils, Site 1168. (**See table notes.** Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Braarudosphaera bigelowii*	*Chiasmolithus altus*	*Chiasmolithus oamaruensis*	*Coccolithus formosus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster deflandrei*	*Discoaster saipanensis*	*Isthmolithus recurvus*	*Reticulofenestra bisecta*	*Reticulofenestra davisii*	*Reticulofenestra reticulata*	*Reticulofenestra umbilicus*	*Sphenolithus moriformis*	*Sphenolithus predistentus*	*Zygrhablithus bijugatus*
189-1168A-																			
47X-1, 125	436.15	A	M					C	A										
47X-2, 125	437.65	A	M					C	A										
47X-3, 125	439.15	A	M					C	A	F			R				F		
47X-5, 125	442.15	A	M					C	A				R						
47X-CC	444.27	A	M	R				C	A				R	R					
48X-CC	454.24	A	M					F	A				F	R					
49X-CC	463.74	A	M					F	A				F						
50X-CC	472.75	A	M					F	A				F						R
51X-CC	482.90	A	M					F	A				C						F
52X-CC	501.51	A	M					F	A				C	C					R
54X-CC	511.70	A	M					C	A	C			C				F		R
55X-3, 125	496.75	A	M					C	A	R			C				F		R
55X-5, 125	499.75	A	M					C	A				C				F		R
55X-CC	521.20	A	M		C			F	C	F			C				F		F
56X-CC	529.60	A	M		C			F	C				C				C		F
57X-CC	540.56	A	M		C			F	C				C				C		F
58X-CC	550.40	A	M		C			F	A				C				C		F
59X-CC	560.37	A	M		C			F	A				C				C		F
60X-CC	569.19	A	M		F			C	A				C						F
61X-CC	578.36	A	M		C			C	A				C	C					F
62X-CC	587.27	A	M		C			C	A				C	C					F
63X-CC	597.35	A	M		A			C	A				C	C					F
64X-CC	608.00	A	M		A			C	A				A	A					F
65X-CC	616.58	A	M		A			F	C				A	C					C
66X-CC	625.54	A	M		A			A	C				C						F
67X-CC	634.16	A	M		A			C	F				C						F
68X-CC	645.99	A	M		C			C	C				C						F
69X-CC	654.99	A	M		C			C	C				C						F
70X-CC	661.55	A	M		C			F	A				C						F
71X-CC	673.98	A	M		C			F	C				C					R	C
72X-CC	682.01	A	M		C			F	A	R			C						C
73X-CC	691.67	A	M		C			F	A				C					R	F
74X-CC	702.39	A	M		C			F	C				C						F
75X-4, 125	710.15	C	M		C			R	C				C						F
75X-5, 125	711.55	C	M		C				C				C						F
75X-6, 125	713.05	C	M		C				C				C						F
76X-2, 125	716.65	C	M		C				C				C						F
76X-CC	722.89	A	G		A				A				A	C					C
77X-2, 125	726.35	A	G		A				A				A	C					C
77X-4, 125	729.35	C	M		C				C				C						F
77X-6, 125	732.35	A	M		A				A				A	C					C
77X-CC	733.20	A	M		A				A				C	A					F
78X-1, 38	732.58	A	M		A							R	C			C			
78X-2, 10	734.80	A	G		A							R	C			F			
78X-3, 50	735.65	A	M		C							F	C			C			
78X-6, 149	741.25	A	M		C							F	C			C			
78X-CC	742.80	A	M		A		F					R	C			C			
79X-1, 33	743.13	A	M		C							F	C			C			
79X-2, 30	744.60	A	M		C							F	C			C			
79X-3, 11	745.91	A	M		C							F	C			C			
79X-4, 110	747.40	A	P		C							F	C			C			A
79X-4, 146	747.76	A	M		C		C					F	C			C			
79X-5, 28	749.08	A	M		C							F	C			C			
79X-5, 144	750.32	A	M		C		C					F	C			C			
79X-6, 121	751.51	A	M		C		F					F	C			C			
79X-CC	752.40	A	M		C							C	C			C			
80X-2, 21	754.11	A	M		C						R	R	A			C			
80X-3, 21	755.61	A	M		C							R	C			C			
80X-CC	762.00	A	M		C						R	R	C			C			

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Braarudosphaera bigelowii*	*Chiasmolithus altus*	*Chiasmolithus oamaruensis*	*Coccolithus formosus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster deflandrei*	*Discoaster saipanensis*	*Isthmolithus recurvus*	*Reticulofenestra bisecta*	*Reticulofenestra davisii*	*Reticulofenestra reticulata*	*Reticulofenestra umbilicus*	*Sphenolithus moriformis*	*Sphenolithus predistentus*	*Zygrhablithus bijugatus*
81X-CC	771.60	R	P										R						
82X-1, 25	771.85	B																	
82X-3, 124	775.84	B																	
82X-5, 125	778.85	C	M		F							R	C			F			
82X-CC	781.05	A	M		C	R						R	C			C			F
83X-1, 125	782.35	C	M		R						R	R	F			F			F
84X-1, 125	792.05	B																	
84X-3, 125	795.05	B																	
84X-5, 125	798.05	C	M		R						R	R	F			F			
84X-CC	799.57	A	M		R	R						F	C			C			
85X-1, 123	801.63	C	M		R							R	C			C			R
85X-5, 121	807.61	C	M		R							R	C			F			
85X-CC	809.11	C	M		R							R	C			F			
86X-1, 125	811.15	F	M										R			R			
86X-2, 125	812.65	C	M		F						F	R	C			C			
86X-3, 125	814.15	F	M		R								F			F			
86X-4, 125	815.65	C	M		R							R	C			F			
86X-5, 125	817.15	B																	
86X-CC	818.38	A	G		F		R					R	C		R	C			R
87X-CC	828.41	C	P		R							R	F		R	F			
88X-CC	837.75	C	P		R							R	C		F	F			
89X-CC	847.81	B																	
90X-CC	850.33	B																	
91X-CC	861.40	B																	
92X-CC	867.50	B																	
93X-CC	876.05	B																	
94X-1, 125	874.75	B																	
94X-2, 125	876.25	B																	
94X-3, 52	877.02	A	M		C		R					F	C		R	C			
94X-3, 125	877.75	A	M		C		R					F	C		R	C			
94X-3,137	877.87	A	M		C		R					F	C		R	C			
94X-CC	878.20	B																	
95X-CC	880.45	B																	

Notes: Abundance: A = abundant, C = common, F = few, R = rare, B = barren. Preservation: M = moderate, G = good, P = poor.

Table T2. Distribution of calcareous nannofossils, Site 1170. (**See table notes.** Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Braarudosphaera bigelowii*	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus modestus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Chiasmolithus titus*	*Coccolithus pelagicus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Isthmolithus recurvus*	*Markalius inversus*	*Neococcolithus dubius*	*Pontosphaera pectinata*	*Reticulofenestra bisecta*	*Reticulofenestra reticulata*	*Reticulofenestra samodurovii*	*Reticulofenestra umbilicus*	*Reticulofenestra* small	*Rhabdosphaera tenuis*	*Sphenolithus moriformis*	*Zygrhablithus bijugatus*
189-1170A-																									
42X-3, 10–11	380.50	A	M								C	C	A												
42X-4, 10–11	382.00	A	M								F	C	A												
42X-5, 10–11	383.50	A	M								C	F	A					F							
42X-CC, 29–34	387.17	A	M								F	F	A					F							
43X-CC, 14–19	396.63	A	M								F	F	A					C						R	
44X-1, 10–11	396.70	A	M								F	F	C					C						R	
44X-2, 10–11	398.20	A	M		R						F	F	C					C							
44X-3, 10	399.70	A	M		R						F	F	C					C						R	
44X-5, 10–11	402.70	A	M		A						F	F	C					C							
44X-CC, 31–36	405.83	A	M		A						F	F	C					C							
45X-CC, 30–35	410.05	A	M		A						F	F	C					C							
46X-CC, 20–25	421.82	A	M		A						C	F	C					C							
47X-CC, 10–15	430.95	A	M		A						F	F	C					C							
189-1170D-																									
1R-2, 10–11	426.60	A	M		A						R	F	C					C				A		F	R
2R-2, 10–11	435.10	A	M		A						A	C	C					C				A		F	
3R-2, 10–11	444.40	A	M		A						A	C	C					C				A			
4R-2, 10–11	454.30	A	M		C						C	C	C					C				C		R	
5R-1, 6–7	462.36	C	P		R						F	R	R					F				F			R
5R-2, 7–8	463.57	A	P		A						C	F	C					A				C		R	
6R-1, 32–33	472.22	A	P		F						F	R	C					C							
6R-1, 44	472.34	C	P		F						R	R	F					F							
6R-CC	472.72	C	P		C						F	F	F					F							
7R-1, 6	476.52	F	P		F						F	R	F					R							
7R-1, 90	477.40	R	M		R							R	R					R							
7R-2, 10–11	478.20	B																							
7R-2, 72	478.82	B																							
7R-3, 10	479.20	B																							
7R-CC	479.85	B																							
8R-1, 10	481.60	B																							
8R-1, 45	481.95	B																							
8R-2, 10–11	483.10	B																							
8R-3, 10	484.60	B																							
8R-3, 130	485.80	B																							
8R-4, 10–11	486.10	B																							
8X-5, 10–11	487.60	F	P		R						F		R	R				F	R	F	F				
8R-5, 50	488.00	F	P		R						R		R	R				F	R	F	R				
9R-2, 10–11	492.70	F	P		R			R			F		R					C	F	R	F	C		R	
9R-4, 10–11	495.70	C	M		R			R			F		R					C	C	F	R	C		R	
9R-CC	497.66	C	M		R			R			F							F	C	F	C				
10R-3, 10–11	503.80	C	M					R			R				R			F	F	R	F			R	
11R-3, 10–11	513.40	C	M					R			C		R					R	C	R	R	F		R	
11R-4, 10–11	514.90	C	M				R	C			C		F			R	R	R	F	R		C		R	R
12R-3, 10–11	522.90	C	M				C				C		C			R	R	R	F	F	C	F	R	R	
12R-CC	524.59	F	P						R		F							R	F	F	F				
13R-1, 10–11	529.50	F	P						R									R			R				
13R-3, 10–11	532.50	B																							
14R-3, 10–11	542.20	B																							
14R-4, 10–11	543.70	C									F							R		F	R	F			
15R-4, 10–11	553.30	C				R			F		F					R	R	R		F	F	F			R
16R-4, 10–11	562.89	F							R		R							R		R	R				
17R-4, 10–11	572.50	F				R			F		F		R			R	R	R		F	R		R		R
18R-4, 10–11	582.10	F							R		R							R		R	R				
19R-4, 10–11	590.62	F							R		R					R		R		R	R				
20R-4, 10–11	601.33	B																							
21R-4, 10–11	610.90	B																							
22R-4, 10–11	619.35	B																							
23R-4, 10–11	630.20	B																							
24R-4, 10–11	639.90	F	P						R		R					R	R			R					

Table T2 (continued).

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Braarudosphaera bigelowii*	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus modestus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Chiasmolithus titus*	*Coccolithus pelagicus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Isthmolithus recurvus*	*Markalius inversus*	*Neococcolithus dubius*	*Pontosphaera pectinata*	*Reticulofenestra bisecta*	*Reticulofenestra reticulata*	*Reticulofenestra samodurovii*	*Reticulofenestra umbilicus*	*Reticulofenestra* small	*Rhabdosphaera tenuis*	*Sphenolithus moriformis*	*Zygrhablithus bijugatus*
25R-4, 10–11	649.40	R	P						R				R												
26R-4, 10–11	659.20	R	P								R				R					R		R			
27R-3, 10–11	667.30	C	M						C	R	C									C		A		R	R
28R-4, 10–11	677.89	C	M						F	R	R									R		F			
29R-4, 10–11	687.96	F	M							R	R				R	R				R		F			R
30R-4, 10–11	697.65	F	P						R													F			
31R-4, 10–11	707.40	B																							
32R-4, 10–11	717.00	B																							
33R-4, 10–11	726.60	C							F	R	F					R	R			F		F			
34R-4, 10–11	736.20	B																							
34R-6, 10–11	739.20	C	M		R				F							R				F	R				
34R-7, 10–11	740.70	F	M		R				F											F	R				
34R-CC	741.48	C	M						F							R				R	R				
35R-4, 10–11	745.80	B																							
35R-5, 10–11	741.30	C	M			R			F											R		C			
35R-CC	749.55	F	P			R			F											R					
36R-4, 10–11	755.40	B																							
37R-4, 10–11	765.10	B																							
37R-CC	768.73	C	M			R			F							R				F					
38R-4, 10–11	774.68	F	M	R					R		R					R				R		F		R	

Notes: Abundance: A = abundant, C = common, F = few, R = rare, B = barren. Preservation: M = moderate, P = poor.

Table T3. Distribution of calcareous nannofossils, Site 1171. (**See table notes.** Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster kupperi*	*Discoaster lodoensis*	*Isthmolithus recurvus*	*Neococcolithus dubius*	*Prinsius bisulcus*	*Reticulofenestra bisecta*	*Reticulofenestra oamaruensis*	*Reticulofenestra reticulata*	*Reticulofenestra umbilicus*	*Toweius callosus*	*Toweius craticulus*	*Zygrhablithus bijugatus*
189-1171C-																					
28X-1, 59	249.49	A	M					F	A												
28X-2, 59	250.99	A	M					F	A												
28X-3, 59	252.49	A	M					F	A												
28X-CC	253.79	A	M					C	A						R						
29X-1, 59	259.09	A	M					F	A						F						
29X-2, 59	260.59	A	M					F	A						F						
29X-3, 59	262.09	A	M					F	A						C						
29X-4, 59	263.59	A	M					F	A						F						
189-1171D-																					
2R-CC	260.68	A	M					F	A						C						
3R-1, 59	267.19	A	M					R	A						C						
3R-2, 3	268.13	A	M					F	A						C						
3R-2, 59	268.69	A	M					R	A						C						
3R-2, 127	269.27	A	M					F	A						C						
3R-3, 2	269.62	A	M					F	A						C						
3R-3, 20	269.80	A	M	C				F	A						C						
3R-3, 60	270.20	B																			
3R-3, 86	270.46	B																			
3R-CC, 12	271.32	C	M	F					F			R			C	R		R			
3R-CC, 22	271.42	C	M	F								F			C	F		R			
4R-1, 59	276.72	C	M	F								F			C	F		F			
4R-2, 59	278.29	C	M	F		R						F			C	F		F			
4R-3, 59	279.79	C	M	R		F						F			C	F		F			
4R-CC	280.59	C	M	R		R						F			C	F		C			
5R-CC	287.53	F	P	R											F		F	F			
6R-CC	295.26	R	P	R											R		R	R			
7R-1, 25	295.65	A	G		F		C								C			F			
7R-CC	302.30	A	G		C		C								C			F			
8R-CC	307.84	A	G		C		C								C			F			
9R-CC	318.77	B																			
10R-4, 59	329.39	R	P				R								R			R			
10R-CC	330.78	B																			
11R-CC	334.02	R	P				R														
12R-CC	343.61	C	P				F											F			
13R-CC	353.28	C	P				F											F			
14R-CC	363.28	C	P		R		C											R			
15R-CC	374.35	C	P		R		C											R			
16R-CC	385.18	C	P		F		F											R			
17R-CC	398.40	C	P		F		F											F			
18R-CC	401.20	C	P		F		F											R			
19R-1, 59	411.39	A	M		F		F											R			
19R-3, 59	414.39	A	P		F		F														
19R-5, 59	417.30	R	P				R														
19R-CC	417.63	C	P				C														
20R-CC	428.65	R	P				R														
21R-CC	430.32	B																			
22R-CC	448.84	A	M		R		A											R			
23R-CC	453.57	R	P				R														
24R-CC	464.32	B																			
25R-CC	476.81	B																			
26R-CC	487.98	F	M		R		F														
27R-CC	497.45	A	M		R		F														C
28R-CC	505.73	A	M		R		F														C
29R-CC	516.79	A	M		F		F														C
30R-CC	524.58	A	M		F		A														C
31R-CC	533.73	A	M		F		A														C
32R-CC	543.96	A	M		F		A														C
33R-CC	555.02	A	M		F		A														C

Table T3 (continued).

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster kupperi*	*Discoaster lodoensis*	*Isthmolithus recurvus*	*Neococcolithus dubius*	*Prinsius bisulcus*	*Reticulofenestra bisecta*	*Reticulofenestra oamaruensis*	*Reticulofenestra reticulata*	*Reticulofenestra umbilicus*	*Toweius callosus*	*Toweius craticulus*	*Zygrhablithus bijugatus*
34R-CC	564.79	A	M		F		A														A
35R-CC	573.86	A	M		F		A														C
36R-CC	584.10	A	M		F		A														F
37R-CC	593.56	A	M		F		A														F
38R-CC	603.22	A	M		F		A														F
189-1168A-																					
39R-CC	611.85	A	M		F		A														F
40R-CC	622.70	C	M				C														F
41R-CC	631.14	F	M				F														F
42R-CC	641.81	A	M				C														F
43R-CC	651.01	A	M				C														F
44R-CC	660.71	A	M				C														F
45R-CC	665.86	A	M				C			R											C
46R-CC	677.79	A	M				C			R											C
47R-CC	690.24	A	M				C			F	R										C
48R-CC	699.50	R	P				R						R								
49R-CC	709.35	R	P				R														
50R-CC	718.48	R	M				R														
51R-CC	726.94	F	M				R			R			R							R	
52R-CC	738.11	R	M				F														
53R-CC	745.80	C	M				R			R											
54R-CC	757.26	C	M				F			R									R		
55R-CC	766.95	F	M				R			R									R		
56R-CC	771.40	R	M				R			R											
57R-CC	781.73	R	M				R			R			R								
58R-CC	795.49	B																			
59R-CC	805.32	B																			
60R-CC	814.60	B																			
61R-CC	822.60	B																			
62R-CC	834.15	B																			
63R-CC	843.81	B																			
64R-CC	852.01	R	M																	R	
65R-CC	863.00	R	P																	R	
66R-1, 60	863.29	R	P																R		
66R-CC	870.81	R	P											R					R		
67R-CC	882.22	R	P											R					R		
68R-CC	889.42	B																			
69R-CC	901.08	B																			
70R-CC	908.07	B																			
71R-CC	919.12	B																			
72R-CC	929.29	B																			
73R-CC	939.51	B																			
74R-CC	949.50	R	P																	R	
75R-CC	954.54	B																			

Notes: Abundance: A = abundant, C = common, F = few, R = rare, B = barren. Preservation: M = moderate, G = good, P = poor.

Table T4. Distribution of calcareous nannofossils, Site 1172. (See table notes. Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus grandis*	*Chiasmolithus modestus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Coccolithus formosus*	*Coccolithus pelagicus*	*Coronocyclus nitescens*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster deflandrei*	*Discoaster kupperi*	*Discoaster lodoensis*	*Discoaster nodifer*	*Discoaster tanii*	*Neococcolithus dubius*	*Pontosphaera multiporus*	*Pontosphaera pectinata*	*Reticulofenestra bisecta*	*Reticulofenestra reticulata*	*Reticulofenestra samodurovii*	*Reticulofenestra* spp. (small)	*Reticulofenestra umbilicus*	*Sphenolithus moriformis*	*Transversopontis pulcher*	*Zygrhablithus bijugatus*
189-1172A-																													
37X-1, 59	335.89	A	M								A		F	C	R												R		
37X-2, 59	337.39	A	M								A		F	C	F												R		
37X-3, 59	338.89	A	M								A		C	F	R												F		
37X-4, 59	340.39	A	M								A		C	C	R												F		
37X-5, 59	341.88	A	M								A		C	C	R												F		
37X-6, 59	343.39	A	M								A		C	A	R												R		
37X-7, 59	344.6	A	M								F	R	C	A	F								F				C		
38X-1, 59	345.44	A	M								C	R	C	A	R								F				C		
38X-2, 59	346.94	A	M								C	R	C	A	R								C				C		
38X-3, 59	348.52	A	M								F		F	C	R								C				R		
38X-4, 59	349.94	A	M	A							C		F	A	R								C				R		
38X-5, 59	351.48	A	M	A							F		F	C	R								F				R		
38X-6, 59	352.99	A	M	C							F		F	C	R								C				R		
39X-2, 2	356.12	A	M	A							F		F	C									C						
39X-2, 4	356.14	A	M	A							F		R	A									C						
39X-2, 13	356.23	A	M	A							F		R	A									C						
39X-2, 18	356.28	A	M	A							F		R	A									C						
39X-2, 135	357.35	A	M	C							F			C									C						
39X-2, 143	357.43	A	M	C							F			C									C						
39X-3, 8	358.19	R	P	R										R									R						
39X-3, 35	357.95	R	P											R									R						
39X-3, 48	358.08	R	P											R									R						
39X-3, 67	358.77	B																											
39X-3, 143	359.03	B																											
39X-4, 132	360.42	B																											
39X-4, 139	360.49	B																											
39X-5, 14	360.74	B																											
39X-5, 63	361.23	C	P	F							F												F	C		C			
39X-6, 140	363.5	C	P	F							F												F	C		C			
39X-CC	364.34	A	M	F				F			F												F	C		C			
40X-1, 59	364.79	A	M				F	F			F												F	C	A	C	R	R	
40X-2, 59	366.29	A	M				F	F			F												R	C	C	F		R	
40X-3, 59	367.79	A	M				F	F			C												R	C	C	F			
40X-4, 59	369.29	A	M				F	F			C										R		R	C	C	F	R		
40X-5, 59	370.79	A	M				F	F			F												R	C	C	R	R		
40X-6, 59	372.29	A	M				F	R			R										R		R	C	C	R	R	R	
41X-1, 59	374.38	A	M		F		F	F			F				R			R	R	R		R	F	C	C	F	R		
41X-2, 59	375.89	A	M				F	R			F							R	R	R			R	C	C	R	R		R
41X-3, 59	377.39	A	M				F	F			F							R	R	R			R	C	C	F	R		
41X-4, 59	378.72	A	M				F	F			F							R		R			R	C	C	F	R		R
41X-5, 59	380.24	A	M				F	R			F								R	R		R	R	C	C	F	R		
41X-6, 59	381.74	A	M		F		F	R			F				R			R		R	R	R	R	C	C	F	R		
42X-1, 59	383.99	A	M		R		F	F			F											R	F	C	C	F	R	R	
42X-2, 59	385.49	A	M		F		F	F			C							R		R		F	F	C	C	F			
42X-3, 59	386.99	A	M		F		R	F			F										R	R	R	C	C	F		F	
42X-4, 59	388.49	A	M				C				R											F		C	C	F	R	F	
42X-5, 59	389.99	A	M				C				F													C	C	F		F	
42X-6, 59	391.49	A	M				C		F		F									F	R		R	C	C	F		F	
42X-7, 59	392.62	A	M				F		F		C									R	R		R	C	C	F	R	F	
42X-CC	393.18	A	M						R		F													C		C			
43X-CC	402.83	A	M						R											R				C		C			
44X-3, 59	406.19	A	M						R															C		C			
44R-5, 59	409.19	A	M						R															R		F			
44R-CC	412.47	F	P							R														R		R			
45R-2, 59	414.29	F	P						R															R		R			
45R-3, 59	415.79	B																											
45R-4, 59	417.29	F	P						R																	R			
45R-5, 59	418.79	R	P						R																	R			
45R-CC	422.11	C	P						F																	C			

Table T4 (continued).

Core, section, interval (cm)	Depth (mbsf)	Abundance	Preservation	*Chiasmolithus altus*	*Chiasmolithus expansus*	*Chiasmolithus grandis*	*Chiasmolithus modestus*	*Chiasmolithus oamaruensis*	*Chiasmolithus solitus*	*Coccolithus formosus*	*Coccolithus pelagicus*	*Coronocyclus nitescens*	*Cyclicargolithus abisectus*	*Cyclicargolithus floridanus*	*Discoaster deflandrei*	*Discoaster kupperi*	*Discoaster lodoensis*	*Discoaster nodifer*	*Discoaster tanii*	*Neococcolithus dubius*	*Pontosphaera multiporus*	*Pontosphaera pectinata*	*Reticulofenestra bisecta*	*Reticulofenestra reticulata*	*Reticulofenestra samodurovii*	*Reticulofenestra* spp. (small)	*Reticulofenestra umbilicus*	*Sphenolithus moriformis*	*Transversopontis pulcher*	*Zygrhablithus bijugatus*
46R-3, 59	425.39	C	M						F																		F			
46R-CC	431.66	B																												
47R-3, 59	434.99	B																												
47R-CC	441.29	B																												
48R-3, 59	444.59	B																												
48R-CC	450.85	B																												
49R-3, 59	454.19	B																												
49R-CC	460.45	B																												
50R-CC	470.2	B																												
51R-1, 59	470.39	B																												
51X-3, 53	473.39	B																												
51X-CC	476.15	B																												
52X-3, 59	482.99	B																												
52X-CC	488.65	R	P						R																					
53X-2, 59	491.09	B																												
53X-5, 59	495.59	B																												
53X-CC	498.8	A	M						C																					
54X-CC	504.44	A	P						C																					
55X-CC	509.07	A	P						C																					
56X-CC	518.23	A	P						C																					
189-1172D-																														
4R-CC	505.38	R	P						R																					
5R-CC	512.97	F	P						F																					
6R-CC	522.66	F	P						F																					
7R-CC	535.25	F	P						F																					
8R-CC	543.99	F	P						F																					
9R-CC	555.26	C	P						C							R	R													
10R-1, 59	555.69	C	M			R			C							R	F													
10R-4, 59	560.19	C	P						F							R	R													
10R-5, 59	561.69	C	P						F							R	R													
10R-6, 59	563.19	R	P						R							R														
10R-CC	564.3	B																												
11R-CC	573.54	B																												
13R-CC	593.63	B																												
14R-CC	601.86	B																												
15R-CC	612.95	B																												
16R-CC	619.02	B																												
17R-CC	632.21	B																												
18R-CC	639.53	B																												
19R-CC	645.91	B																												
20R-CC	660.85	B																												
21R-CC	667.2	B																												
22R-CC	673.03	B																												
23R-CC	682.06	B																												
24R-5, 13	695.83	B																												
24R-5, 31	696.01	B																												
24R-5, 78	696.48	R	P																							R				
24R-5, 116	686.86	B																												
24R-CC	699.02	R	P								R															R				

Notes: Abundance: A = abundant, C = common, F = few, R = rare, B = barren. Preservation: M = moderate, P = poor.

Table T5. Summary of calcareous nannofossil datums.

Datum	Age (Ma)	Core, section, interval (cm)	Depth interval (mbsf)
		189-1168A-	
LO *Reticulofenestra bisecta*	23.9	47X-2, 125/47X-3, 125	437.65/439.15
LO *Chiasmolithus altus*	26.1	55X-5, 125/55X-CC	518.95/521.15
FO *Cyclicargolithus abisectus*	31.1	75X-4, 125/75X-5, 125	710.05/711.55
LO *Reticulofenestra umbilicus*	31.3	77X-CC/78X-1, 38	733.41/733.68
LO *Isthmolithus recurvus*	32.3	77X-CC/78X-1, 38	733.41/733.68
LO *Reticulofenestra reticulata*	35.9	86X-4, 125/86X-CC	815.65/818.33
		189-1170A-	
LO *Reticulofenestra bisecta*	23.9	42X-4, 10/42X-5, 10	382.0/383.5
LO *Chiasmolithus altus*	26.1	44X-1, 10/44X-2, 10	396.7/398.2
		189-1170D-	
FO *Cyclicargolithus abisectus*	31.1	7R-1, 90/8R-5, 10	476.73/487.6
LO *Reticulofenestra umbilicus*	31.3	7R-1, 90/8R-5, 10	476.73/487.6
LO *Isthmolithus recurvus*	32.3	7R-1, 90/8R-5, 10	476.73/487.6
LO *Reticulofenestra reticulata*	35.9	7R-1, 90/8R-5, 10	476.73/487.6
FO *Isthmolithus recurvus*	36.0	8R-5, 50/9R-2, 10	488.0/492.70
LO *Chiasmolithus solitus*	38.2	12R-3, 10/12R-CC	522.90/524.59
FO *Reticulofenestra reticulata*	41.2	12R-CC/13R-1, 40	524.59/529.5
FO *Reticulofenestra umbilicus*	42.0	34R-CC/35R-5, 10	741.48/747.3
		189-1171C-	
LO *Reticulofenestra bisecta*	23.9	28X-3, 59/28X-CC	252.49/253.79
		189-1171D-	
LO *Chiasmolithus altus*	26.1	3R-3, 2/3R-3, 20	269.62/269.80
FO *Cyclicargolithus abisectus*	31.1	3R-3, 20/3R-CC, 12	269.79/271.32
LO *Reticulofenestra umbilicus*	31.3	3R-3, 20/3R-CC, 12	269.79/271.32
LO *Reticulofenestra oamaruensis*	33.7	3R-3, 20/3R-CC, 12	269.79/271.32
FO *Reticulofenestra oamaruensis*	35.8	4R-CC/5R-CC	280.59/287.53
LO *Reticulofenestra reticulata*	35.9	4R-CC/5R-CC	280.59/287.53
FO *Isthmolithus recurvus*	36.0	4R-CC/5R-CC	280.59/287.53
LO *Chiasmolithus solitus*	38.2	6R-CC/7R-1, 25	295.26/296.25
FO *Reticulofenestra reticulata*	41.2	6R-CC/7R-1, 25	295.26/296.25
FO *Reticulofenestra umbilicus*	42.0	19R-1, 59/19R-3, 59	411.39/414.39
LO *Discoaster kupperi*	48.4	44R-CC/45R-CC	660.71/665.86
		189-1172A-	
LO *Reticulofenestra bisecta*	23.9	37X-6, 59/37X-7, 59	343.39/344.6
LO *Chiasmolithus altus*	26.1	38X-3, 62/38X-4, 54	348.52/349.96
FO *Cyclicargolithus abisectus*	31.1	39X-2, 18/39X-2, 135	356.28/357.45
LO *Reticulofenestra umbilicus*	31.3	39X-2, 143/39X-5, 63	357.43/361.23
LO *Reticulofenestra reticulata*	35.9	39X-2, 143/39X-5, 63	357.53/361.23
LO *Chiasmolithus solitus*	38.2	42X-5, 59/42X-6, 59	389.99/391.49
FO *Reticulofenestra reticulata*	41.2	44X-CC/45X-4, 59	412.47/417.29
FO *Reticulofenestra umbilicus*	42.0	46X-3, 59/53X-CC	425.39/498.0
		189-1172D-	
LO *Discoaster kupperi*	48.4	8R-CC/9R-CC	543.99/555.26

Notes: LO = last occurrence; FO = first occurrence. Timescale from Berggren et al. (1995).