Prell, W.L., Wang, P., Blum, P., Rea, D.K., and Clemens, S.C. (Eds.)
Proceedings of the Ocean Drilling Program, Scientific Results Volume 184

21. Data Report: Late Miocene–Quaternary Biogenic Opal Accumulation at ODP Site 1143, Southern South China Sea[1]

Rujian Wang,[2] Jianru Li,[2] and Baohua Li[3]

INTRODUCTION

Since the 1970s, Ocean Drilling Program (ODP) and Deep Sea Drilling Program (DSDP) studies have documented high accumulations of biogenic silica and carbonate in the late Miocene–early Pliocene Indian-Pacific Ocean. This high biogenic productivity event, or the "Biogenic Bloom Event," has been dated from 9.0 to 3.5 Ma (Leinen, 1979; Theyer et al., 1985; Farrell et al., 1995; Dickens and Owen, 1996, 1999; Dickens and Barron, 1997; Berger et al., 1993). It is unknown, however, whether the Biogenic Bloom Event existed in the South China Sea (SCS). High-quality Cenozoic sediment cores taken from the SCS during ODP Leg 184 provide an opportunity to investigate this question. The purpose of this study is to trace and illustrate the change in biogenic productivity in the southern SCS since the late Miocene and the Biogenic Bloom Event in terms of the content and accumulation rate of opal and carbonate at Site 1143.

MATERIALS AND METHODS

A total of 463 sediment samples were taken from three cores from Site 1143 (9°21.72′N, 113°17.11′E; water depth = 2722 m; penetration = 516 meters composite depth [mcd]) (Wang, Prell, Blum, et al., 2000) for opal analysis. Samples were taken at intervals from 0.6 to 1.5 m with an average time resolution of ~20 k.y. (Table T1).

T1. Sample information, p. 8.

[1] Wang, R., Li, J., and Li, B., 2004. Data report: Late Miocene–Quaternary biogenic opal accumulation at ODP Site 1143, southern South China Sea. *In* Prell, W.L., Wang, P., Blum, P., Rea, D.K., and Clemens, S.C. (Eds.), *Proc. ODP, Sci. Results,* 184, 1–12 [Online]. Available from World Wide Web: <http://www-odp.tamu.edu/publications/184_SR/VOLUME/CHAPTERS/217.PDF>. [Cited YYYY-MM-DD]
[2] Laboratory of Marine Geology, Ministry of Education, Tongji University, Shanghai 200092, People's Republic of China. Correspondence author: rjwangk@online.sh.cn
[3] Nanjing Institute of Geology and Paleontology, Chinese Academy of Sciences, Nanjing 210008, People's Republic of China.

Initial receipt: 16 January 2002
Acceptance: 5 January 2004
Web publication: 16 March 2004
Ms 184SR-217

The opal analysis was performed in the Laboratory of Marine Geology of the Ministry of Education, Tongji University, People's Republic of China, following the methods proposed by Mortlock and Froelich (1989). Opal concentration values in the 463 samples range from 0.33 to 23.35 wt%, with an average value of 2.16 wt%. Precision and reproducibility of this method were estimated from the duplicate analyses of 47 random samples. The discrepancy between the two values of the same samples ranges from –1.68% to 14.76%, with an average of ±4.75%. The replicated measurements of 47 samples indicate that the average discrepancy of duplicate analyses is relatively low and document high accuracy and reproducibility. Therefore, we believe that this method may be used for values <5%, although the low opal values (<5%) should be regarded with suspicion (Mortlock and Froelich, 1989).

Mass accumulation rates (MARs) of opal and carbonate are calculated according to the following equation:

$$\text{MAR (g/cm}^2\text{/k.y.)} = \text{Wc} \times \text{LSR} \times \text{DBD}$$

where

Wc = opal and carbonate contents (wt%),
LSR = the linear sedimentation rate (cm/k.y.), and
DBD = the dry bulk density (g/cm^3).

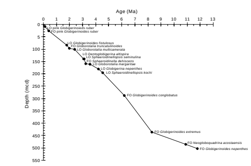
The latter is calculated by interposition of the DBD data at this site (Wang, Prell, Blum, et al., 2000). The data for carbonate and total mass accumulation rates used in the present study are from Wang, Prell, Blum, et al. (2000).

AGE MODEL

Fifteen planktonic foraminiferal stratigraphic events were used to provide an age model for Site 1143 (Table T2; Fig. F1) (Li and Jian, 2001). The Brunhes/Matuyama boundary is present at 42.54 mcd, corresponding to an age of 0.78 Ma (Wang, Prell, Blum, et al., 2000). Microtektites are found at 42.81 mcd, with an age of ~0.8 Ma (Wang et al., 2000). Figure F1 shows the age-depth model of sedimentation rates between stratigraphic control points that are assumed to be constant. Based on the sedimentation rate, the age of the bottom sediments is assigned to be ~12.3 Ma. No obvious hiatuses are found at Site 1143 over the past 12.3 m.y., although slumped sediments have been reported over two short intervals (7.5–7.4 and 6.9–6.8 Ma) (Wang, Prell, Blum, et al., 2000).

T2. Planktonic foraminiferal biostratigraphic datum levels, p. 9.

F1. Age-depth model, p. 6.

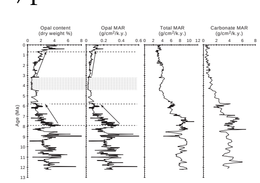


RESULTS

The results of opal analysis at Site 1143 indicate the following variabilities (Fig. F2):

1. 12.3–7.9 Ma: opal content and MAR were relatively high and obviously variable (average opal = ~2.9 wt%; average opal MAR = 0.24 g/cm^2/k.y.).
2. 7.90–5.8 Ma: opal content and MAR dropped sharply (average opal = 2.0 wt%; average opal MAR = 0.16 g/cm^2/k.y.).

F2. Changes of opal content and MARs, p. 7.



3. 5.8–4.4 Ma: opal content and MAR were stable (average opal = 1.2 wt%; average opal MAR = 0.06 g/cm²/k.y.).
4. 4.4 –3.2 Ma: opal content and MAR were at their lowest (average opal = 0.63 wt%; average opal MAR = 0.02 g/cm²/k.y.).

Both opal content and MAR increased from ~3.2 Ma and then showed a rapid increase at ~0.7 Ma (Table T3). The increase from low values (4.4–3.2 Ma) could be important in understanding the response of the SCS to large-scale Northern Hemisphere glaciation.

T3. Opal content and MARs, p. 10.

Changes in opal content and MAR directly reflect changes in sea-surface productivity: higher opal MAR indicates higher surface productivity, and lower opal MAR indicates lower surface productivity. Thus, the variations of surface productivity for the past 12.3 m.y. in the southern SCS can be reconstructed in terms of opal content and MAR data at Site 1143. The surface productivity was enhanced and varied during the period from 12.3 to 7.9 Ma, reduced sharply during the period from 7.9 to 5.8 Ma, and was relatively stable during the period from 5.8 to 4.4 Ma. The lowest levels during the period occurred from 4.4 to 3.2 Ma and then increased from ~3.2 Ma and showed a rapid increase at ~0.7 Ma.

The extremely high biogenic silica accumulation rates were first found in the central equatorial Pacific from the late Miocene to the early Pliocene (Leinen, 1979). This was confirmed and designated as the "Biogenic Bloom Event" during DSDP Leg 85 (Theyer et al., 1985). According to a study during ODP Leg 138, biogenic accumulation rates evidently increased in the eastern equatorial Pacific from the late Miocene to the early Pliocene, with high peaks of carbonate MAR between 6.5 and 3.5 Ma. High opal MAR was contemporaneous with high carbonate MAR, indicating a biogenic bloom (Farrell et al., 1995). Dickens and others documented that the Biogenic Bloom Event occurred commonly in the Indian-Pacific Ocean from the late Miocene to the early Pliocene, when the surface productivity increased conspicuously in the upwelling areas of the Indian and Pacific Oceans. Based on data from 12 ODP sites, they concluded that the age of the Biogenic Bloom Event was 9.0–3.5 Ma (Dickens and Owen, 1996, 1999; Dickens and Barron, 1997). The Biogenic Bloom Event was also reported at the Ontong Java Plateau during ODP Leg 130. Both high biogenic sedimentation and accumulation rates occurred during the period from 9.4 to 4.1 Ma, indicating high biogenic productivity (Berger et al., 1993).

As shown in Figure F2, high biogenic productivity is clearly indicated by high values in opal, carbonate, and total MAR as well as opal content from 12.3 to 5.8 Ma at Site 1143, which corresponds to the late Miocene–early Pliocene Biogenic Bloom Event reported from the eastern equatorial Pacific, Indian Ocean, and Ontong Java Plateau. Thus, the conclusion can be drawn that the late Miocene Biogenic Bloom Event occurred in the southern SCS.

ACKNOWLEDGMENTS

We are grateful to Prof. Pinxian Wang for his suggestions and revision of the manuscript. We especially thank Prof. Warren Prell of Brown University and Dr. Robert Owen of the University of Michigan for helpfully reviewing the manuscript; their comments and constructive criticisms greatly improved our presentation. This research used samples and data provided by the Ocean Drilling Program (ODP). ODP is sponsored by the U.S. National Science Foundation (NSF) and participating countries under management of Joint Oceanographic Institutions (JOI), Inc. This project was supported by the NKBRSF (grant number G2000078500), and the National Natural Science Foundation of China (grant number 49946011 and 49999560), the National Foundation for the Authors of Excellent Doctoral Dissertations of the People's Republic of China (project number 200126), and the Foundation for University Key Teachers, Ministry of Education, China.

REFERENCES

Berger, W.H., Leckie, R.M., Janecek, T.R., Stax, R., and Takayama, T., 1993. Neogene carbonate sedimentation on Ontong Java Plateau: highlights and open questions. *In* Berger, W.H., Kroenke, L.W., Mayer, L.A., et al., *Proc. ODP, Sci. Results,* 130: College Station, TX (Ocean Drilling Program), 711–744.

Dickens, G.R., and Barron, J.A., 1997. A rapidly deposited pennate diatom ooze in upper Miocene–lower Pliocene sediment beneath the North Pacific Polar Front. *Mar. Micropaleontol.,* 31:177–182.

Dickens, G.R., and Owen, R.M., 1996. Sediment geochemical evidence for an early–middle Gilbert (early Pliocene) productivity peak in the North Pacific Red Clay Province. *Mar. Micropaleontol.,* 27:107–120.

————, 1999. The latest Miocene–Early Pliocene biogenic bloom: a revised Indian Ocean perspective. *Mar. Geol.,* 161:75–91.

Farrell, J.W., Raffi, I., Janecek, T.C., Murray, D.W., Levitan, M., Dadey, K.A., Emeis, K.C., Lyle, M., Flores, J.-A., and Hovan, S., 1995. Late Neogene sedimentation patterns in the eastern equatorial Pacific Ocean. *In* Pisias, N.G., Mayer, L.A., Janecek, T.R., Palmer-Julson, A., and van Andel, T.H. (Eds.), *Proc. ODP, Sci. Results,* 138: College Station, TX (Ocean Drilling Program), 717–756.

Leinen, M., 1979. Biogenic silica accumulation in the central equatorial Pacific and its implications for Cenozoic paleoceanography. *Geol. Soc. Am. Bull.,* 90: (Pt.1) 801–803; (Pt. 2) 1310–1376.

Li, B., and Jian, Z., 2001. Evolution of planktonic foraminifera and thermocline in the southern South China Sea since 12 Ma (ODP-184, Site 1143). *Sci. China, Ser. D: Earth Sci.,* 44:889–896.

Mortlock, R.A., and Froelich, P.N., 1989. A simple method for the rapid determination of biogenic opal in pelagic marine sediments. *Deep-Sea Res., Part A,* 36:1415–1426.

Theyer, F., Mayer, L.A., Barron, J.A., and Thomas, E., 1985. The equatorial Pacific high-productivity belt: elements for a synthesis of Deep Sea Drilling Project Leg 85 results. *In* Mayer, L., Theyer, F., Thomas, E., et al., *Init. Repts. DSDP,* 85: Washington (U.S. Govt. Printing Office), 971–985.

Wang, P., Prell, W.L., Blum, P., et al., 2000. *Proc. ODP, Init. Repts.,* 184 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.

Wang, J., Zhao, Q., Cheng, X., Wang, R., and Wang, P., 2000. Age estimation of the mid-Pleistocene microtektite event in the South China Sea: a case showing the complexity of the sea-land correlation. *Chin. Sci. Bull.,* 45: 2277–2280.

Figure F1. Age-depth model for Site 1143, based on planktonic stratigraphic datum levels given in Table T2, p. 9. FO = first occurrence, LO = last occurrence.

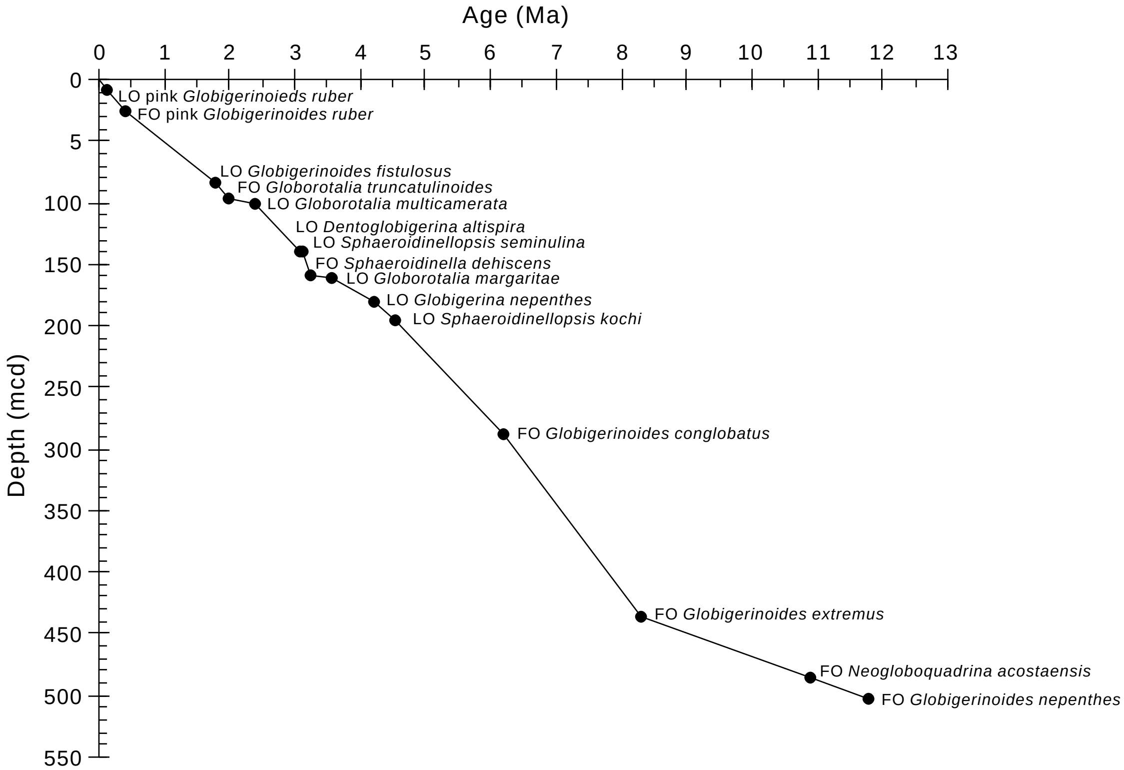


Figure F2. Changes of opal content and mass accumulation rate (MAR) and total and carbonate MARs at Site 1143, southern South China Sea. Hatched area = lowest interval of opal content and MAR. Dashed lines = the change boundaries of opal content and MAR.

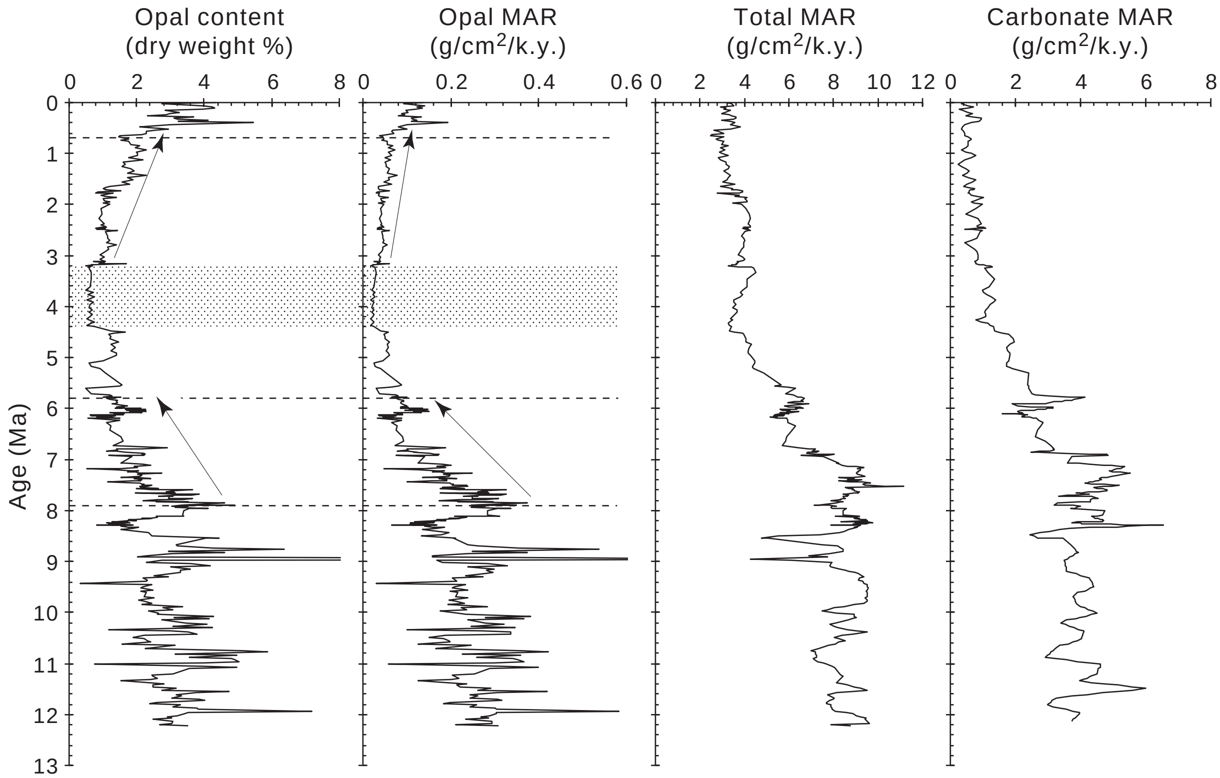


Table T1. Sample information, Site 1143.

Depth (mcd)	Sample interval (m)	Sample number
0–186.7	1.5	126
188.2–413.8	1.2	180
414.0–511.8	0.6	157

Table T2. Planktonic foraminiferal biostratigraphic datum levels, Site 1143.

Stratigraphic datum	Depth (mcd)	Age (Ma)
LO pink *Globigerinoides ruber*	8.07	0.12
FO pink *Globigerinoieds ruber*	25.03	0.4
LO *Globigerinoides fistulosus*	83.4	1.8
FO *Globorotalia truncatulinoides*	96.09	2.0
LO *Globorotalia multicamerata*	101.77	2.4
LO *Dentoglobigerina altispira*	138.98	3.09
LO *Sphaeroidinellopsis seminulina (*Ss. spp.)	138.98	3.12
FO *Sphaeroidinella dehiscens*	158.08	3.25
LO *Globorotalia margaritae*	161.58	3.58
LO *Globigerina nepenthes*	180.67	4.2
LO *Sphaeroidinellopsis kochi*	196.22	4.53
FO *Globigerinoides conglobatus*	288.39	6.2
FO *Globigerinoides extremus*	435.4	8.3
FO *Neogloboquadrina acostaensis*	484.5	10.9
FO *Globigerinoides nepenthes*	502.99	11.8

Notes: FO = first occurrence, LO = last occurrence. Adopted from Li and Jian, 2001.

Table T3. Data of opal content and MAR, Site 1143. (See table note. Continued on the next two pages.)

Depth (mcd)	Age (Ma)	Opal (wt%)	Opal MAR (g/cm²/ k.y.)
0.470	0.007	4.343	0.139
1.970	0.029	2.729	0.093
3.770	0.056	3.983	0.140
5.270	0.078	4.232	0.123
6.770	0.101	4.296	0.135
8.270	0.126	3.938	0.122
9.770	0.155	2.850	0.097
11.270	0.186	3.269	0.102
12.770	0.216	2.978	0.089
13.950	0.240	2.873	0.096
15.450	0.267	2.319	0.079
16.950	0.288	3.684	0.133
18.450	0.309	3.097	0.112
19.950	0.330	3.195	0.112
21.450	0.351	4.128	0.123
22.950	0.371	3.230	0.109
24.490	0.396	5.452	0.195
25.990	0.442	3.017	0.102
27.490	0.480	2.083	0.079
28.990	0.513	2.937	0.099
30.490	0.542	2.553	0.067
31.990	0.571	2.290	0.065
33.490	0.600	2.271	0.070
34.390	0.617	2.171	0.055
35.890	0.646	1.489	0.037
37.390	0.675	1.460	0.045
38.890	0.704	1.772	0.049
40.390	0.733	1.543	0.044
41.890	0.762	1.770	0.054
44.110	0.813	1.835	0.055
45.610	0.851	2.080	0.068
47.110	0.889	1.969	0.058
48.610	0.926	2.284	0.072
50.110	0.964	1.982	0.057
51.610	1.002	2.020	0.060
53.110	1.043	2.009	0.066
54.270	1.079	1.779	0.050
55.770	1.124	2.184	0.064
57.270	1.170	1.609	0.051
58.770	1.215	1.664	0.053
60.270	1.260	1.558	0.052
61.770	1.305	1.825	0.059
63.270	1.351	1.916	0.059
64.050	1.374	1.739	0.056
65.550	1.420	2.294	0.077
67.050	1.465	1.746	0.057
68.550	1.510	1.893	0.061
70.050	1.555	1.573	0.048
71.550	1.601	1.809	0.064
73.050	1.646	1.205	0.035
73.950	1.671	1.091	0.035
75.450	1.687	1.027	0.035
76.950	1.703	1.101	0.038
78.450	1.718	1.089	0.040
79.950	1.734	1.549	0.060
81.450	1.750	0.842	0.033
82.950	1.767	0.790	0.030
83.990	1.781	1.307	0.036
85.490	1.808	0.946	0.036
86.990	1.835	1.063	0.038
88.490	1.862	1.410	0.058
89.990	1.889	1.011	0.041
91.490	1.917	1.052	0.043
92.990	1.944	1.209	0.050
94.090	1.964	1.008	0.035
95.590	1.993	1.213	0.047
97.090	2.070	0.962	0.039
98.590	2.176	0.990	0.042
100.090	2.282	0.892	0.038
101.590	2.387	1.030	0.043
103.530	2.410	0.937	0.039
105.030	2.419	1.045	0.045
106.530	2.427	1.030	0.044
108.030	2.436	1.094	0.047
109.530	2.445	1.111	0.046
111.030	2.454	0.965	0.038
112.530	2.464	0.780	0.032
113.490	2.471	1.063	0.042
114.990	2.482	0.828	0.034
116.490	2.492	1.020	0.043
117.990	2.503	1.247	0.053
119.490	2.513	1.450	0.060
120.990	2.537	1.077	0.043
123.370	2.610	1.154	0.045
124.870	2.656	1.150	0.045
126.370	2.702	1.206	0.049
127.870	2.748	1.110	0.044
129.370	2.794	1.409	0.056
130.870	2.841	1.157	0.046
132.370	2.887	1.168	0.045
133.730	2.929	1.091	0.041
135.230	2.975	0.923	0.034
136.730	3.021	1.035	0.041
138.230	3.067	0.917	0.037
139.730	3.096	0.970	0.038
141.230	3.109	1.063	0.040
142.910	3.123	0.722	0.026
144.410	3.136	1.043	0.039
145.910	3.148	0.877	0.032
147.410	3.161	1.682	0.061
148.910	3.173	0.650	0.024
150.410	3.186	0.731	0.025
151.910	3.198	0.491	0.017
152.830	3.206	0.697	0.023
154.330	3.219	0.582	0.022
155.830	3.231	0.623	0.027
157.330	3.244	0.601	0.026
158.830	3.321	0.656	0.029
160.330	3.462	0.643	0.026
162.870	3.622	0.608	0.025
164.370	3.671	0.504	0.020
165.870	3.719	0.727	0.028
167.370	3.768	0.569	0.022
168.870	3.817	0.751	0.029
170.370	3.866	0.514	0.018
172.020	3.919	0.709	0.025
173.520	3.968	0.617	0.022
175.020	4.017	0.577	0.020
176.520	4.065	0.696	0.026
178.020	4.114	0.578	0.021
179.520	4.163	0.697	0.025
181.020	4.206	0.629	0.022
182.200	4.233	0.535	0.018
183.700	4.264	0.573	0.020
185.200	4.296	0.755	0.025
186.700	4.328	0.655	0.021
188.200	4.360	0.514	0.017
189.700	4.392	0.765	0.026
193.540	4.473	1.243	0.041
194.440	4.492	1.660	0.058
195.340	4.511	1.355	0.053
196.240	4.544	1.170	0.046
197.140	4.582	1.255	0.050
198.040	4.632	1.205	0.049
198.940	4.683	1.465	0.060
199.840	4.734	1.256	0.054
201.120	4.806	1.366	0.058
202.020	4.856	1.247	0.052
202.920	4.907	1.414	0.059
203.820	4.958	1.400	0.060
205.620	5.059	1.010	0.045
206.520	5.110	0.580	0.026
207.420	5.160	0.647	0.028
207.840	5.184	0.776	0.034
208.520	5.222	0.930	0.041
209.720	5.290	1.065	0.052
220.940	5.545	1.553	0.088
221.840	5.560	1.503	0.081
223.040	5.580	1.037	0.062
223.790	5.592	0.490	0.031
231.380	5.717	0.661	0.039
232.580	5.737	1.220	0.076
233.480	5.752	1.259	0.079
234.380	5.766	1.010	0.065
235.580	5.786	1.520	0.100
236.480	5.801	1.122	0.075
237.380	5.816	1.222	0.081
238.580	5.835	1.430	0.093
238.880	5.840	1.420	0.094
240.080	5.860	1.405	0.093
240.600	5.869	1.413	0.088
241.800	5.888	1.434	0.086
242.700	5.901	1.329	0.088
243.700	5.908	1.274	0.088
250.740	5.954	1.736	0.101
251.940	5.962	1.411	0.085
252.840	5.968	1.617	0.103
253.740	5.974	1.484	0.097
254.940	5.981	1.563	0.104
255.840	5.987	1.371	0.086
256.740	5.993	2.138	0.136
257.940	6.001	1.822	0.117
258.840	6.007	1.681	0.106
259.440	6.011	1.847	0.111
260.640	6.019	2.633	0.147
261.540	6.025	1.689	0.096
262.440	6.030	1.934	0.114
263.640	6.038	1.720	0.104
264.540	6.044	2.413	0.144
265.440	6.050	2.557	0.151
266.640	6.058	1.963	0.119
267.540	6.064	1.795	0.116
268.440	6.070	2.164	0.132
270.180	6.081	1.364	0.077
271.060	6.087	1.221	0.071
272.250	6.095	1.481	0.089
273.150	6.100	1.334	0.078
274.060	6.106	1.638	0.091
275.260	6.114	1.332	0.071
276.160	6.120	1.591	0.089
277.060	6.126	0.618	0.036
278.270	6.134	0.638	0.037
278.900	6.138	0.983	0.055
279.940	6.145	1.196	0.064
280.850	6.151	1.377	0.076
282.040	6.159	0.820	0.045
282.940	6.164	1.043	0.054
283.840	6.170	1.193	0.062
285.040	6.178	1.379	0.075
285.940	6.184	1.517	0.087
286.850	6.190	0.552	0.032
288.040	6.236	1.497	0.089
288.610	6.268	1.107	0.066
289.860	6.346	1.239	0.078
290.760	6.435	1.215	0.075
291.950	6.553	1.524	0.090
292.860	6.642	1.594	0.093

Table T3 (continued).

Depth (mcd)	Age (Ma)	Opal (wt%)	Opal MAR (g/cm²/ k.y.)
293.760	6.724	1.291	0.074
294.980	6.772	2.910	0.188
295.860	6.784	2.117	0.146
296.760	6.795	1.413	0.102
297.960	6.811	1.433	0.102
299.220	6.827	1.106	0.078
300.380	6.842	1.404	0.103
301.270	6.854	1.680	0.122
302.180	6.866	1.676	0.115
303.380	6.881	2.231	0.152
304.250	6.893	2.239	0.162
305.180	6.905	2.139	0.172
306.380	6.920	2.206	0.171
307.270	6.932	1.160	0.076
308.180	6.944	1.853	0.140
317.760	7.068	1.542	0.127
318.960	7.084	1.664	0.135
319.860	7.095	2.193	0.182
320.760	7.107	2.407	0.202
321.960	7.123	2.374	0.199
322.860	7.134	1.937	0.167
323.760	7.146	1.958	0.177
324.960	7.162	2.012	0.188
325.860	7.173	1.533	0.139
326.760	7.185	0.513	0.047
327.980	7.201	1.361	0.126
329.180	7.216	1.833	0.168
330.080	7.228	2.042	0.186
330.980	7.240	1.739	0.159
332.180	7.255	1.950	0.177
333.080	7.267	2.082	0.188
333.980	7.279	2.736	0.247
335.180	7.294	2.026	0.184
336.580	7.312	2.139	0.199
337.840	7.329	2.079	0.196
339.040	7.344	1.533	0.136
339.940	7.356	2.014	0.166
340.840	7.368	2.430	0.213
342.040	7.383	1.933	0.172
342.940	7.395	2.171	0.187
343.840	7.404	2.050	0.190
345.040	7.417	2.116	0.191
345.940	7.427	1.908	0.157
346.840	7.436	1.142	0.099
348.000	7.449	1.157	0.108
349.200	7.462	1.996	0.193
350.100	7.472	2.085	0.199
351.000	7.481	2.142	0.200
352.200	7.494	2.211	0.207
353.100	7.504	2.148	0.202
354.000	7.514	2.452	0.235
355.200	7.527	2.313	0.239
356.100	7.537	2.074	0.231
357.060	7.547	2.131	0.182
358.300	7.561	2.646	0.230
359.200	7.570	1.987	0.177
360.400	7.583	2.464	0.218
361.300	7.593	2.837	0.254
362.200	7.603	3.669	0.327
363.400	7.616	3.081	0.274
364.300	7.626	2.859	0.260
365.200	7.635	3.091	0.284
366.340	7.648	3.069	0.279
367.040	7.655	3.128	0.286
367.640	7.662	1.956	0.175
368.540	7.671	3.200	0.274
369.740	7.685	3.863	0.325
370.640	7.694	3.613	0.314
372.140	7.711	3.128	0.268
372.740	7.717	2.637	0.227
373.640	7.727	3.067	0.262
374.140	7.732	2.956	0.249
376.500	7.758	2.939	0.249
377.100	7.764	3.184	0.272
378.000	7.774	3.661	0.309
379.200	7.787	3.365	0.279
380.100	7.797	2.655	0.221
381.000	7.807	2.202	0.174
382.200	7.820	3.395	0.286
383.100	7.829	3.528	0.296
384.000	7.839	2.576	0.215
384.970	7.850	4.595	0.375
388.560	7.888	3.368	0.247
389.160	7.895	4.898	0.350
390.060	7.905	3.322	0.259
391.260	7.918	3.050	0.248
392.160	7.927	3.517	0.278
393.060	7.937	3.141	0.247
394.260	7.953	3.975	0.315
395.160	7.957	4.104	0.337
395.870	7.967	3.564	0.305
398.260	7.994	3.381	0.284
406.980	8.088	3.365	0.285
408.180	8.101	3.401	0.312
409.080	8.111	3.307	0.294
409.980	8.121	2.580	0.208
411.180	8.134	2.596	0.236
412.480	8.148	2.385	0.216
413.080	8.154	2.399	0.220
413.420	8.158	2.168	0.195
414.020	8.164	2.439	0.218
414.620	8.171	1.967	0.181
415.520	8.181	1.762	0.167
416.420	8.190	1.879	0.177
417.020	8.196	1.977	0.189
417.920	8.203	1.739	0.164
418.520	8.207	1.753	0.167
419.420	8.212	1.413	0.118
420.020	8.215	1.384	0.129
420.920	8.220	1.272	0.119
421.520	8.223	1.711	0.161
422.170	8.227	1.724	0.164
423.120	8.232	1.614	0.158
423.720	8.235	1.593	0.156
424.320	8.239	1.689	0.162
424.920	8.242	1.624	0.147
425.520	8.245	1.784	0.160
426.120	8.249	1.196	0.111
426.720	8.252	1.113	0.107
427.320	8.255	1.421	0.134
427.920	8.259	1.166	0.108
428.520	8.262	1.558	0.142
429.120	8.265	1.267	0.114
429.720	8.269	1.552	0.138
430.320	8.272	1.559	0.139
430.920	8.275	1.844	0.165
431.520	8.279	1.281	0.114
432.120	8.282	1.382	0.118
432.770	8.286	1.882	0.155
433.320	8.289	0.811	0.064
433.920	8.292	1.840	0.167
434.520	8.295	1.757	0.162
434.820	8.301	1.539	0.141
435.420	8.318	1.777	0.159
435.720	8.327	2.042	0.185
436.320	8.349	1.885	0.167
436.920	8.381	1.546	0.134
437.520	8.412	2.042	0.173
438.120	8.444	2.361	0.195
438.720	8.476	2.430	0.179
439.320	8.508	2.441	0.134
439.840	8.535	4.436	0.211
440.140	8.551	4.035	0.205
442.320	8.666	3.160	0.237
442.920	8.698	3.206	0.262
443.520	8.730	4.260	0.354
444.120	8.762	6.362	0.536
444.720	8.794	2.955	0.249
445.320	8.825	4.600	0.373
445.920	8.857	3.042	0.238
446.520	8.889	2.297	0.158
447.120	8.921	2.036	0.157
447.720	8.952	23.348	0.991
448.320	8.984	2.759	0.169
448.920	9.016	2.287	0.182
449.520	9.048	3.601	0.285
450.120	9.080	4.191	0.329
450.720	9.111	3.006	0.238
451.320	9.143	3.606	0.298
451.760	9.166	3.303	0.282
452.060	9.182	3.301	0.287
452.520	9.207	3.297	0.296
453.120	9.238	3.038	0.277
453.720	9.270	2.503	0.233
454.320	9.302	2.940	0.275
454.920	9.334	2.204	0.202
455.520	9.365	2.324	0.212
456.120	9.397	2.285	0.213
456.720	9.429	0.332	0.031
457.320	9.461	2.456	0.234
457.920	9.493	2.190	0.209
458.520	9.524	2.129	0.203
459.120	9.556	2.498	0.238
459.680	9.586	2.106	0.200
460.210	9.614	2.274	0.217
461.620	9.688	2.208	0.210
462.220	9.720	2.528	0.238
462.820	9.752	2.067	0.197
463.420	9.784	2.220	0.211
464.020	9.816	2.459	0.230
464.620	9.847	2.170	0.194
465.220	9.879	3.356	0.284
465.820	9.911	2.779	0.223
466.420	9.943	3.064	0.237
467.020	9.974	2.352	0.176
467.620	10.006	2.650	0.215
468.220	10.038	2.605	0.233
468.820	10.070	4.287	0.382
469.420	10.102	3.086	0.279
470.020	10.133	4.151	0.366
470.420	10.154	2.755	0.239
471.320	10.202	3.451	0.279
471.920	10.234	4.086	0.320
472.520	10.266	3.062	0.246
473.120	10.297	4.234	0.346
473.720	10.329	1.172	0.101
474.320	10.361	2.992	0.270
474.920	10.393	3.520	0.336
475.520	10.425	3.776	0.336
476.120	10.456	2.232	0.187
476.720	10.488	1.878	0.151
477.320	10.520	2.226	0.183
477.920	10.552	2.309	0.196
478.520	10.583	2.420	0.199
479.120	10.615	1.557	0.126
479.750	10.649	3.143	0.245
480.920	10.710	2.256	0.166

Table T3 (continued).

Depth (mcd)	Age (Ma)	Opal (wt%)	Opal MAR (g/cm^2/ k.y.)
481.520	10.742	5.149	0.361
482.120	10.774	5.871	0.421
482.720	10.806	3.126	0.225
483.320	10.838	4.952	0.360
483.920	10.870	3.551	0.258
484.520	10.901	4.800	0.342
485.120	10.930	4.904	0.351
485.720	10.959	5.037	0.367
486.320	10.989	3.977	0.300
486.920	11.018	0.748	0.058
487.520	11.047	3.915	0.310
488.120	11.076	4.969	0.400
488.660	11.103	3.570	0.288
490.620	11.198	3.074	0.254
491.220	11.227	2.439	0.204
491.820	11.256	2.481	0.209
492.420	11.286	2.615	0.218
493.020	11.315	2.407	0.200
493.620	11.344	1.543	0.127
494.220	11.373	2.406	0.195
494.820	11.402	2.801	0.235
495.420	11.432	2.486	0.214
496.020	11.461	2.470	0.221
496.620	11.490	3.153	0.291
497.220	11.519	2.740	0.262
497.820	11.548	4.727	0.420
498.420	11.578	3.762	0.307
499.020	11.607	3.152	0.245
499.650	11.637	3.320	0.260
500.320	11.670	3.051	0.245
500.920	11.699	3.845	0.307
501.520	11.728	4.019	0.315
502.120	11.758	2.589	0.200
502.720	11.787	2.385	0.183
503.320	11.816	3.286	0.258
503.920	11.845	3.077	0.243
504.520	11.875	3.795	0.300
505.120	11.904	3.827	0.303
505.720	11.933	7.172	0.581
506.320	11.962	3.535	0.303
506.920	11.991	3.434	0.304
507.520	12.021	3.193	0.289
508.120	12.050	2.912	0.268
508.720	12.079	3.039	0.287
509.180	12.101	2.486	0.234
510.020	12.142	3.080	0.293
510.620	12.171	3.050	0.293
511.220	12.201	2.674	0.211
511.820	12.230	3.514	0.309

Note: MAR = mass accumulation rate.