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5. Data Report: Stable Isotopes from Sites 1147 and 1148[1]

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INTRODUCTION

Sites 1147 (18°50.11′N, 116°33.28′E; water depth = 3246 m) and 1148 (18°50.17′N, 116°33.94′E; water depth = 3294 m) are located on the lowermost continental slope off southern China near the continent/ocean crust boundary of the South China Sea Basin. Site 1147 is located upslope ~0.45 nmi west of Site 1148. Three advanced piston corer holes at Site 1147 and two extended core barrel holes at Site 1148 were cored and combined into a composite (spliced) stratigraphic section, which provided a relatively continuous profile for the lower Oligocene to Holocene (Wang, Prell, Blum, et al., 2000; Jian, et al., 2001) for studying stratigraphy and paleoceanography. A total of 1047 planktonic foraminifers stable isotope measurements were performed on 975 samples covering the upper 409.58 meters composite depth (mcd) at ~42-cm intervals (Tables T1, T2), and a total of 1864 benthic foraminifers measurements were performed on 1650 samples in the upper 837.11 mcd at ~51-cm intervals (Tables T3, T4). We significantly improved the time resolution of the benthic stable isotope record in the upper 476.68 mcd by reducing the average sample spacing to ~29 cm. This translates into an average sampling resolution of ~16 k.y. for the Miocene sequence and ~8 k.y. for the Pliocene–Holocene interval, assuming a change in sedimentation rates from ~1.8 to ~3.5 cm/k.y., as suggested by shipboard stratigraphy. These data sets provide the basis for upcoming studies to establish an oxygen isotope stratigraphy and examine the Neogene evolution of deep and surface water signatures (temperature, salinity, and nutrients) in the South China Sea.

[1]Cheng, X., Zhao, Q., Wang, J., Jian, Z., Xia, P., Huang, B., Fang, D., Xu, J., Zhou, Z., and Wang, P., 2004. Data report: Stable Isotopes from Sites 1147 and 1148. *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/223.PDF>. [Cited YYYY-MM-DD]

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METHODS

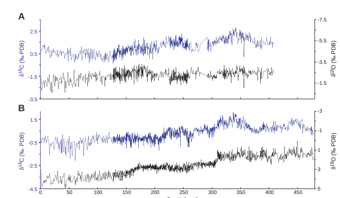
Samples were oven-dried at 60°C and washed through a 63-µm sieve. Well-preserved specimens were chosen from the coarse-fraction residues and cleaned with analytical grade ethanol (≥99.7%) in an ultrasonic bath. They were dried again in an oven at 60°C and reacted with orthophosphoric acid in an automatic carbonate device (Kiel III) at 70°C to generate CO_2. The escaping CO_2 was then transferred to a Finnigan MAT252 mass spectrometer for measurement of stable isotopes at the Laboratory of Marine Geology in Tongji University, People's Republic of China. The epibenthic species *Cibicidoides wuellerstorfi* was preferred for isotope analysis because various studies have demonstrated that the $\delta^{13}C$ value of this species is approximately equal to bottom water $\delta^{13}C$ and is therefore a good proxy for reconstructions of deepwater ventilation (McCorkle and Keigwin, 1994). In intervals where *C. wuellerstorfi* was absent in the sediments, other benthic foraminifers were analyzed (Table T5) to obtain a complete oxygen isotope record. *Globigerinoides ruber* was mainly used for the upper 165 mcd, and *Globigerinoides sacculifer* was used for the lower part. Because of isotopic differences between species, adjustments were made to account for taxon-dependent deviations from seawater isotopic equilibrium using the adjustment factors given in Table T5, according to Shackleton et al. (1995), Shackleton and Hall (1983, 1990), and Z. Jian et al. (2003, unpubl. data). When several measurements were made on different planktonic or benthic foraminifers from the same sample, the adjusted average value was used (Tables T1, T2, T3, T4). Precision was regularly checked with the Chinese national carbonate standard GBW04405. Conversion to the international Peedee belemnite (PDB) scale was performed using NBS19 and NBS18 standards: $\delta^{13}C$ = 0.57‰, $\delta^{18}O$ = –8.49‰); the standard deviation was 0.07‰ for $\delta^{18}O$ and 0.04‰ for $\delta^{13}C$ for measurements carried out during the years 1999–2000.

T5. Adjustment factors for oxygen and carbon isotopes, p. 12.

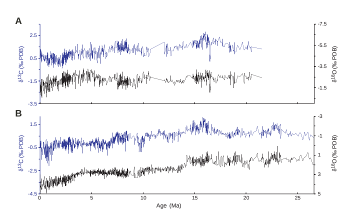
RESULTS

The chronological framework of the upper 837.11-m composite section (~32.7 Ma to present) at Sites 1147 and 1148 is based on biostratigraphy and magnetostratigraphy (Wang, Prell, Blum, et al., 2000; Z. Jian et al., unpubl. data). The isotope records below 476.68 mcd (~26.5–32.7 Ma) cannot be used as a paleoclimatic indicator because all the calcareous microfossils were heavily mineralized (Zhao et al., 2001a) as a result of diagenesis. However, oxygen and carbon isotope measurements from the upper 476.68 mcd (Fig. F1) are considered to reflect paleoceanographic changes in the northern South China Sea since ~26.5 Ma (Fig. F2). The oxygen isotope record of benthic foraminifers can be divided into three major intervals: 0–3.2, 3.2–13.6, and 13.6–26.5 Ma (Fig. F2). Its steplike variation indicates a general cooling trend for the past 26.5 m.y., which is most obvious since 3.2 Ma (Figs. F2, F3). The steplike cooling may be equivalent to major ice sheet expansions, as mentioned by Lear et al. (2000). Both benthic and planktonic $\delta^{13}C$ display a generally decreasing trend (Zhao et al., 2001b) with obvious increases in $\delta^{13}C$ at 24.4–22.7 and 17.9–16.0 Ma, the latter case marking the "Monterey carbon positive excursion." The planktonic foraminifer $\delta^{18}O$ record significantly differs from the benthic record, possibly indicating regional changes in sea-surface temperature and/or salinity during the Neogene.

F1. Stable isotope record vs. meters composite depth, p. 5.



F2. Stable isotope record vs. age, p. 6.



F3. Stable isotope record during the last 5 m.y., p. 7.

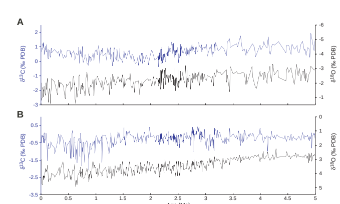


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Figure F1. Stable isotope record from ODP Sites 1147 and 1148 vs. meters composite depth (mcd). PDB = Peedee belemnite scale. **A.** Planktonic δ¹⁸O and δ¹³C. **B.** Benthic δ¹⁸O and δ¹³C.

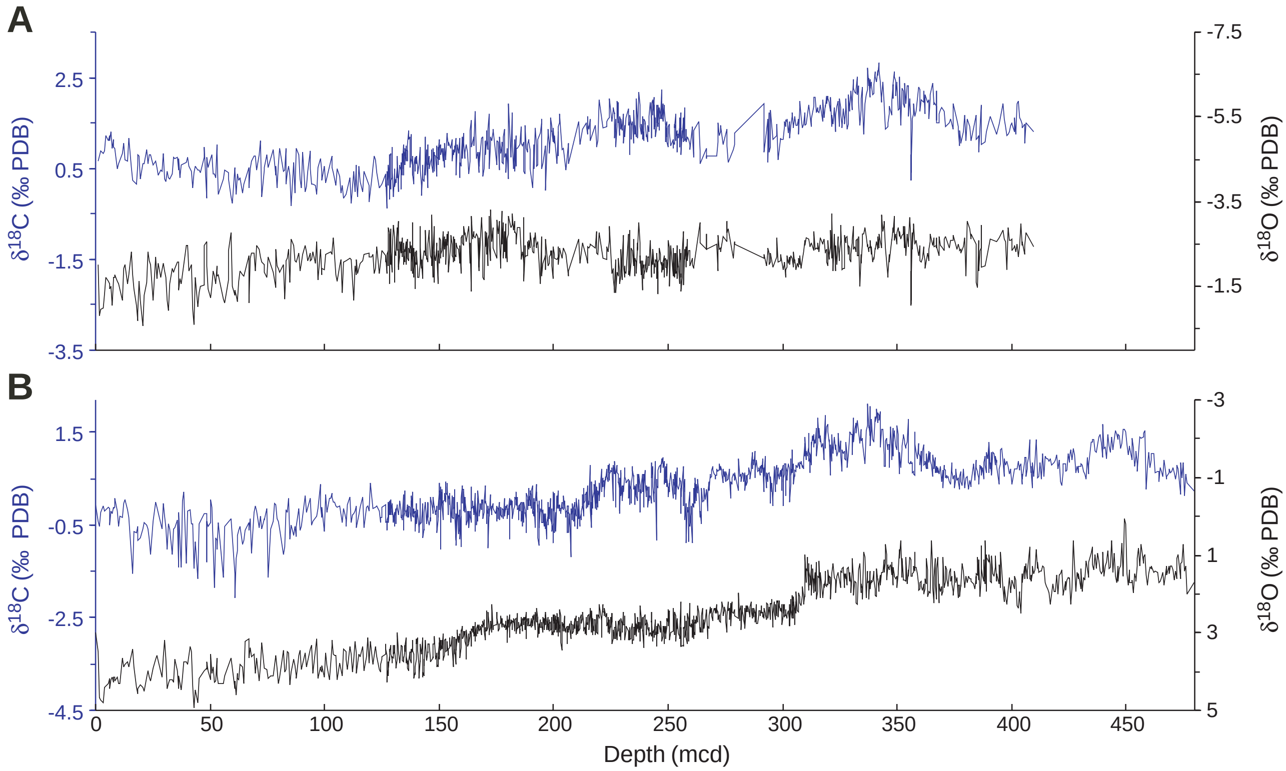

Figure F2. Stable isotope record from ODP Sites 1147 and 1148 vs. age. PDB = Peedee belemnite scale. **A.** Planktonic $\delta^{18}O$ and $\delta^{13}C$. **B.** Benthic $\delta^{18}O$ and $\delta^{13}C$.

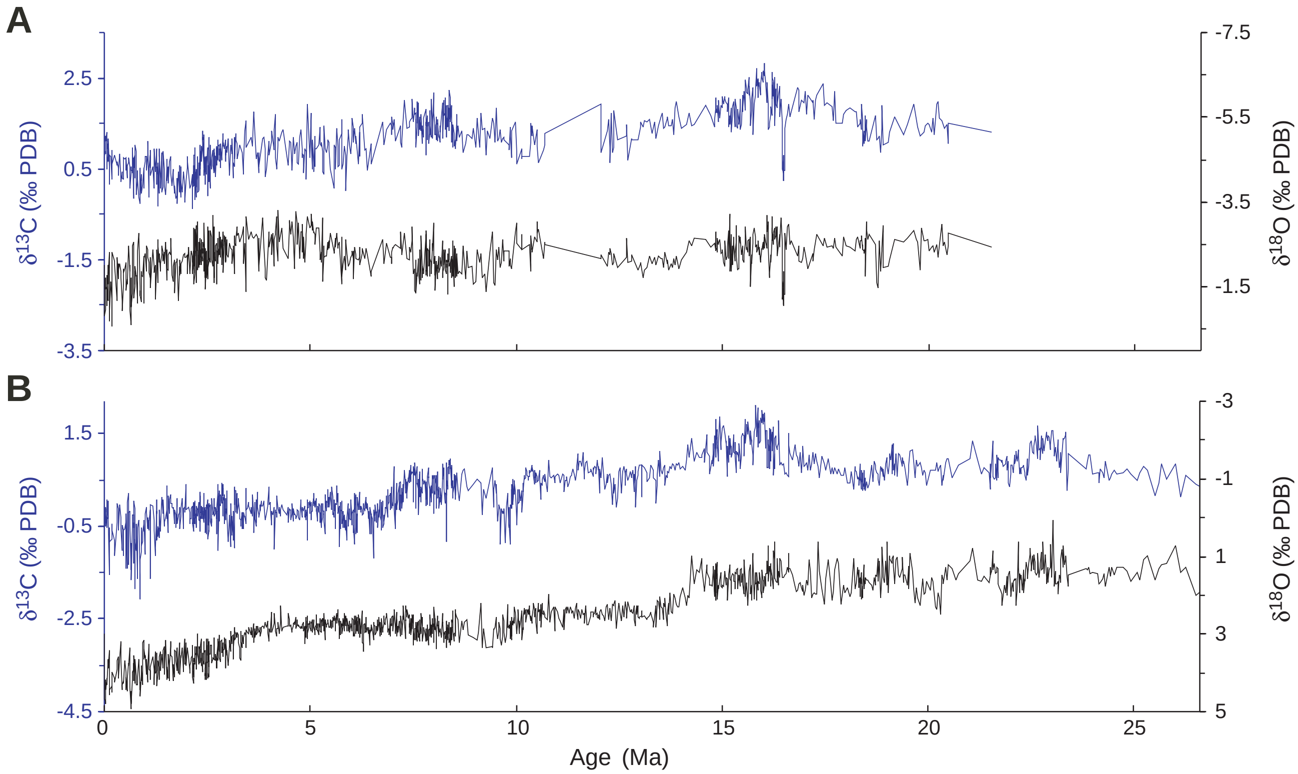

Figure F3. Stable isotope record during the last 5 m.y. at ODP Sites 1147 and 1148. PDB = Peedee belemnite scale. **A.** Planktonic $\delta^{18}O$ and $\delta^{13}C$. **B.** Benthic $\delta^{18}O$ and $\delta^{13}C$.

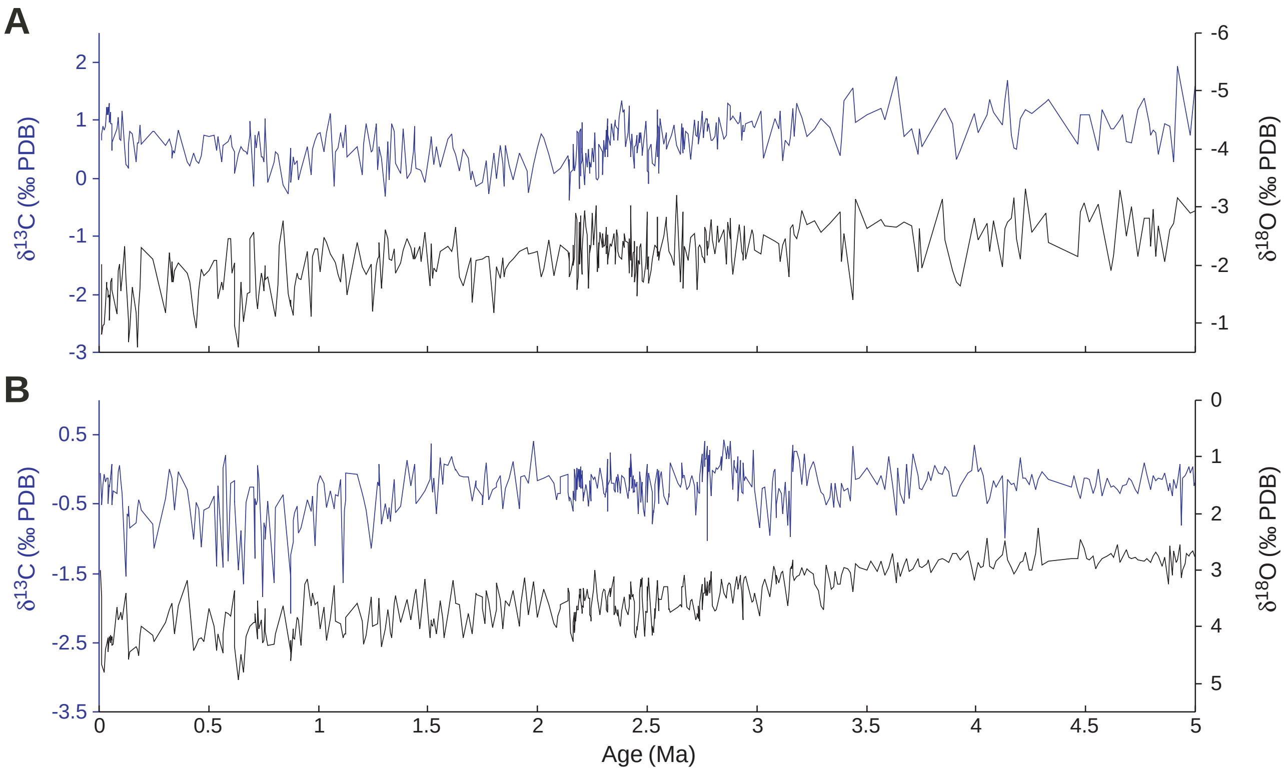

Table T1. Planktonic foraminifer oxygen and carbon isotope data, Sites 1147 and 1148.

Core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	Species	$\delta^{13}C$ (‰) (raw)	$\delta^{18}O$ (‰) (raw)	$\delta^{13}C$ (‰) (adjust)	$\delta^{18}O$ (‰) (adjust)
184-1147A-							
3H-2, 10–12	16.51	18.26	*G. ruber*	0.581	–0.682	0.581	–0.682
3H-2, 90–92	17.31	19.06	*G. ruber*	0.767	–1.612	0.767	–1.612
3H-3, 10–12	18.01	19.76	*G. ruber*	0.276	–1.180	0.276	–1.180
3H-3, 90–92	18.81	20.56	*G. ruber*	0.610	–0.587	0.610	–0.587
3H-4, 10–12	19.51	21.26	*G. ruber*	0.611	–1.303	0.611	–1.303
3H-4, 90–92	20.31	22.06	*G. ruber*	0.917	–1.595	0.917	–1.595
3H-5, 10–12	21.01	22.76	*G. ruber*	0.594	–2.307	0.594	–2.307
3H-5, 90–92	21.81	23.56	*G. ruber*	0.804	–2.104	0.804	–2.104
3H-6, 10–12	22.51	24.26	*G. ruber*	0.803	–2.013	0.803	–2.013
3H-6, 90–92	23.31	25.06	*G. ruber*	0.565	–1.177	0.565	–1.177
184-1147B-							
1H-1, 90–92	0.91	0.91	*G. ruber*	0.508	–1.731	0.508	–1.731
1H-1, 90–92	0.91	0.91	*G. sacculifer*	1.159	–2.007	0.809	–2.327
1H-2, 10–12	1.61	1.61	*G. ruber*	0.755	–0.892	0.755	–0.892
1H-2, 10–12	1.61	1.61	*G. sacculifer*	1.129	–0.398	0.779	–0.718
1H-2, 90–92	2.41	2.41	*G. ruber*	0.927	–1.033	0.927	–1.033
1H-2, 90–92	2.41	2.41	*G. sacculifer*	1.197	–0.571	0.847	–0.891
1H-3, 10–12	3.11	3.11	*G. ruber*	0.833	–0.988	0.833	–0.988
1H-3, 90–92	3.91	3.91	*G. ruber*	0.899	–1.311	0.899	–1.311
1H-4, 10–12	4.61	4.61	*G. ruber*	1.234	–1.707	1.234	–1.707
1H-4, 90–92	5.41	5.41	*G. ruber*	1.103	–1.632	1.103	–1.632
1H-5, 10–12	6.11	6.11	*G. ruber*	1.228	–1.553	1.228	–1.553
1H-5, 90–92	6.91	6.91	*G. ruber*	1.296	–1.495	1.296	–1.495
1H-6, 10–12	7.61	7.61	*G. ruber*	1.137	–1.665	1.137	–1.665
1H-6, 90–92	8.41	8.41	*G. ruber*	0.624	–2.093	0.624	–2.093
1H-6, 90–92	8.41	8.41	*G. sacculifer*	1.600	–1.001	1.250	–1.321
2H-2, 90–92	11.91	12.41	*G. ruber*	1.048	–1.915	1.048	–1.915
2H-3, 10–12	12.61	13.11	*G. ruber*	0.676	–2.029	0.676	–2.029
2H-3, 90–92	13.41	13.91	*G. ruber*	0.649	–1.557	0.649	–1.557
2H-4, 10–12	14.11	14.61	*G. ruber*	1.159	–1.780	1.159	–1.780
2H-4, 90–92	14.91	15.41	*G. ruber*	0.527	–2.317	0.527	–2.317
2H-5, 10–12	15.61	16.11	*G. ruber*	0.239	–1.785	0.239	–1.785
2H-5, 90–92	16.41	16.91	*G. ruber*	0.223	–1.434	0.223	–1.434
2H-6, 10–12	17.11	17.61	*G. ruber*	0.168	–1.040	0.168	–1.040
2H-6, 90–92	17.91	18.41	*G. ruber*	0.801	–0.894	0.801	–0.894
4H-1, 10–12	28.61	30.31	*G. ruber*	0.275	–1.875	0.275	–1.875
4H-1, 90–92	29.41	31.11	*G. ruber*	0.425	–1.170	0.425	–1.170
4H-2, 10–12	30.11	31.81	*G. ruber*	0.293	–0.921	0.293	–0.921
4H-2, 90–92	30.91	32.61	*G. ruber*	0.258	–1.581	0.258	–1.581
4H-3, 10–12	31.61	33.31	*G. ruber*	0.391	–1.940	0.391	–1.940
4H-3, 90–92	32.41	34.11	*G. ruber*	0.734	–1.823	0.734	–1.823
4H-4, 10–12	33.11	34.81	*G. ruber*	0.709	–1.918	0.709	–1.918
4H-4, 90–92	33.91	35.61	*G. ruber*	0.739	–2.088	0.739	–2.088
4H-5, 10–12	34.61	36.31	*G. ruber*	0.474	–2.093	0.474	–2.093
4H-5, 90–92	35.41	37.11	*G. ruber*	0.285	–1.701	0.285	–1.701
5H-2, 90–92	40.41	42.31	*G. ruber*	0.070	–0.965	0.070	–0.965
5H-3, 10–12	41.11	43.01	*G. ruber*	0.400	–0.591	0.400	–0.591
5H-3, 90–92	41.91	43.81	*G. ruber*	0.543	–1.718	0.543	–1.718
5H-4, 10–12	42.61	44.51	*G. ruber*	0.477	–1.033	0.477	–1.033
5H-4, 90–92	43.41	45.31	*G. ruber*	0.451	–1.342	0.451	–1.342
5H-5, 10–12	44.11	46.01	*G. ruber*	0.310	–1.421	0.310	–1.421
5H-5, 10–12	44.11	46.01	*G. ruber*	0.491	–1.611	0.491	–1.611
5H-6, 10–12	45.61	47.51	*G. ruber*	0.738	–1.545	0.738	–1.545
5H-6, 90–92	46.41	48.31	*G. ruber*	-0.145	–2.560	-0.145	–2.560
184-1147C-							
2H-3, 10–12	5.71	6.31	*G. ruber*	1.101	–1.457	1.101	–1.457
2H-3, 90–92	6.51	7.11	*G. ruber*	0.952	–1.059	0.952	–1.059
2H-4, 10–12	7.21	7.81	*G. ruber*	0.976	–1.703	0.976	–1.703
2H-4, 90–92	8.01	8.61	*G. ruber*	0.947	–1.773	0.947	–1.773
2H-5, 10–12	8.71	9.31	*G. ruber*	0.483	–1.631	0.483	–1.631

Notes: *G. ruber* = *Globigerinoides ruber*, *G. sacculifer* = *Globigerinoides sacculifer*. * = adjustment factors after Shackleton et al. (1995). Oxygen isotope data are given in reference to Peedee belemnite standard. Only a portion of this table appears here. The complete table is available in **ASCII**.

Table T2. Planktonic foraminifer stable isotope data for the spliced section (0–410 mcd).

Depth (mcd)	Age (Ma)	$\delta^{13}C$ (‰) (final)*	$\delta^{18}O$ (‰) (final)*
0.91	0.010	0.659	–2.029
1.61	0.014	0.767	–0.805
2.41	0.019	0.887	–0.962
3.11	0.022	0.833	–0.988
3.91	0.028	0.899	–1.311
4.61	0.032	1.234	–1.707
5.41	0.038	1.103	–1.632
6.11	0.042	1.228	–1.553
6.31	0.043	1.101	–1.457
6.91	0.047	1.296	–1.495
7.11	0.049	0.952	–1.059
7.61	0.052	1.137	–1.665
7.81	0.053	0.976	–1.703
8.41	0.055	0.937	–1.707
8.61	0.056	0.947	–1.773
9.31	0.058	0.483	–1.631
10.11	0.061	0.602	–1.570
11.61	0.080	0.843	–1.170
12.41	0.087	1.048	–1.915
13.11	0.092	0.676	–2.029
13.91	0.099	0.649	–1.557
14.61	0.106	1.159	–1.780
15.41	0.115	0.527	–2.317
16.11	0.122	0.239	–1.785
16.91	0.128	0.223	–1.434
17.61	0.132	0.168	–1.040
18.26	0.135	0.581	–0.682
18.41	0.139	0.801	–0.894
19.06	0.154	0.767	–1.612
19.76	0.171	0.276	–1.180
20.56	0.177	0.610	–0.587
21.26	0.183	0.611	–1.303
22.06	0.189	0.917	–1.595
22.76	0.194	0.594	–2.307
23.56	0.245	0.804	–2.104
24.26	0.249	0.803	–2.013
25.06	0.303	0.565	–1.177
26.06	0.319	0.668	–2.209
26.76	0.331	0.511	–1.701
27.56	0.334	0.352	–2.053
28.26	0.338	0.473	–1.716
29.06	0.341	0.422	–1.898
29.76	0.362	0.827	–2.036
30.31	0.405	0.275	–1.875
30.56	0.414	0.218	–1.714
31.11	0.434	0.425	–1.170
31.81	0.444	0.293	–0.921
32.61	0.456	0.258	–1.581
33.31	0.467	0.391	–1.940
34.11	0.480	0.734	–1.823
34.81	0.502	0.709	–1.918
35.61	0.524	0.739	–2.088
36.31	0.538	0.474	–2.093
36.41	0.541	0.709	–1.418
37.11	0.560	0.285	–1.701
37.21	0.563	0.567	–1.576
39.41	0.587	0.629	–2.469
40.21	0.598	0.739	–2.469
40.91	0.608	0.553	–1.869
41.71	0.618	0.449	–2.030
42.31	0.620	0.070	–0.965
43.01	0.638	0.400	–0.591
43.81	0.649	0.543	–1.718
44.51	0.659	0.477	–1.033
45.31	0.673	0.451	–1.342
46.01	0.678	0.401	–1.516
47.51	0.689	0.738	–1.545
47.71	0.690	0.981	–2.460
48.31	0.704	–0.145	–2.560
48.51	0.709	0.748	–1.990
49.21	0.715	0.512	–1.438
50.01	0.722	0.714	–1.245
50.71	0.731	0.813	–1.495
51.51	0.741	0.373	–1.872
52.06	0.748	0.369	–1.746
52.21	0.750	0.289	–1.566
52.86	0.758	1.023	–2.001
53.01	0.760	0.897	–1.745
53.56	0.767	–0.075	–1.788
55.86	0.798	0.280	–1.219
56.56	0.802	0.456	–1.116
58.06	0.814	0.415	–1.664
58.31	0.819	0.273	–2.354
59.11	0.837	–0.12	–2.762
59.81	0.865	–0.271	–1.502
60.61	0.872	0.528	–1.302
61.01	0.875	0.459	–1.404
61.31	0.877	–0.081	–1.306
61.81	0.884	0.377	–1.140
62.11	0.888	0.376	–1.180
62.51	0.894	0.225	–1.623
63.31	0.905	0.299	–1.866
64.01	0.910	–0.039	–1.787
64.81	0.918	0.154	–1.760
66.78	0.948	0.534	–2.231
67.01	0.965	0.069	–1.116
67.81	0.974	0.498	–2.158
68.28	0.983	0.662	–2.280
69.08	0.997	0.763	–2.281
69.78	1.008	0.778	–1.882
70.58	1.026	0.459	–2.479
71.28	1.040	0.789	–2.392
72.08	1.053	1.104	–2.187
72.78	1.070	–0.138	–2.092
73.58	1.081	0.451	–2.032
73.93	1.087	0.512	–1.852
74.73	1.101	0.789	–1.712
75.43	1.115	0.530	–2.198
77.73	1.126	0.908	–1.844
78.43	1.129	0.359	–1.482
78.88	1.177	0.541	–2.393
79.23	1.199	0.058	–1.978
79.58	1.207	0.588	–1.923
80.38	1.215	0.928	–1.842
81.88	1.242	0.449	–2.010
82.38	1.249	0.475	–1.197
83.18	1.267	0.933	–1.996
83.28	1.268	0.154	–2.104
83.88	1.276	0.406	–2.157
84.08	1.279	0.551	–2.383
84.78	1.286	0.354	–1.599
85.58	1.304	–0.313	–2.619
86.28	1.316	0.640	–2.459
87.08	1.322	–0.035	–2.108
87.78	1.334	0.933	–2.087
88.58	1.347	0.801	–2.283
89.08	1.351	0.255	–1.867
89.88	1.376	0.082	–2.041
90.58	1.386	0.854	–2.256
91.38	1.404	–0.001	–2.466
92.08	1.422	0.095	–2.306
92.88	1.435	0.447	–2.107
93.53	1.440	0.895	–2.296
93.58	1.440	0.499	–2.105
94.33	1.445	0.160	–2.147
95.03	1.460	0.145	–2.316
95.83	1.469	0.121	–2.054
96.53	1.484	–0.081	–2.560
97.33	1.509	0.518	–1.648
98.03	1.516	0.716	–2.378
98.81	1.524	0.435	–1.782
98.93	1.525	0.239	–1.942
99.63	1.537	0.550	–1.892
100.43	1.554	0.194	–2.246
102.53	1.589	0.665	–2.328
103.33	1.611	0.764	–2.244
103.40	1.613	0.526	–2.322
104.03	1.625	0.421	–2.661
104.83	1.641	0.125	–1.792
105.53	1.660	0.502	–1.638
106.33	1.682	0.334	–1.975
107.03	1.694	–0.038	–2.136
107.83	1.702	0.121	–1.364
108.53	1.720	–0.147	–2.090
109.53	1.750	–0.075	–2.104
110.88	1.765	0.297	–2.160
111.59	1.777	–0.267	–2.143
112.59	1.802	0.427	–1.184
113.11	1.815	–0.014	–1.975
113.59	1.832	0.570	–1.777
113.91	1.841	0.263	–2.135
114.29	1.846	–0.1405	–1.806
115.09	1.855	0.562	–1.924
115.79	1.868	0.216	–2.035
116.59	1.890	–0.027	–2.099
117.29	1.916	0.424	–2.245
119.29	1.954	0.131	–2.302
119.51	1.957	0.243	–2.188
120.31	1.983	0.243	–2.212
121.01	1.999	0.519	–2.246
121.81	2.019	0.760	–1.799
122.26	2.027	0.686	–1.931
123.06	2.051	0.421	–2.433
123.76	2.072	0.070	–1.818
125.26	2.104	0.163	–2.353
126.71	2.141	0.390	–2.242
126.81	2.142	0.097	–2.085
126.96	2.144	0.322	–2.214
127.11	2.146	–0.371	–1.800
127.26	2.152	0.104	–1.865
127.41	2.162	0.136	–2.088
127.46	2.163	0.436	–2.249
127.56	2.164	0.178	–2.338
127.61	2.164	0.577	–1.997
127.71	2.165	0.133	–2.136
128.06	2.175	0.229	–2.906
128.16	2.181	0.576	–2.786
128.21	2.182	0.815	–1.580
128.36	2.186	0.793	–1.796
128.46	2.189	–0.186	–2.748
128.51	2.190	0.122	–2.695
128.61	2.193	0.809	–2.320
128.66	2.194	0.796	–2.023
128.79	2.195	0.840	–2.659
128.91	2.197	0.039	–2.857
129.06	2.198	0.245	–2.316
129.21	2.200	0.295	–1.848
129.34	2.202	0.956	–1.944
129.51	2.204	0.434	–1.978
129.66	2.205	0.511	–2.258
130.26	2.216	–0.122	–2.938
130.41	2.222	0.430	–2.662
130.56	2.227	0.189	–2.530

Notes: * = after adjustment. Only a portion of this table appears here. The complete table is available in **ASCII**.

Table T3. Benthic foraminifer oxygen and carbon isotope data, Sites 1147 and 1148.

Core, section, interval (cm)	Depth (mbsf)	Depth (mcd)	Species	$\delta^{13}C$ (‰) (raw)	$\delta^{18}O$ (‰) (raw)	$\delta^{13}C$ (‰) (adjusted)	$\delta^{18}O$ (‰) (adjusted)
184-1147A-							
3H-2, 10–12	16.51	18.26	*C. wuellerstorfi*	–0.527	3.932	–0.527	4.572
3H-3, 10–12	18.01	19.76	*Cibicidoides* spp.	–0.779	3.847	–0.779	4.347
3H-3, 90–92	18.81	20.56	*Cibicidoides* spp.	–0.572	3.900	–0.572	4.400
3H-4, 10–12	19.51	21.26	*C. wuellerstorfi*	–0.435	3.876	–0.435	4.516
3H-4, 90–92	20.31	22.06	*Cibicidoides* spp.	–0.493	3.655	–0.493	4.155
3H-5, 10–12	21.01	22.76	*C. wuellerstorfi*	–0.588	3.340	–0.588	3.980
3H-5, 90–92	21.81	23.56	*Cibicidoides* spp.	–0.798	3.646	–0.798	4.146
3H-6, 10–12	22.51	24.26	*Cibicidoides* spp.	–1.141	3.757	–1.141	4.257
3H-6, 90–92	23.31	25.06	*Cibicidoides* spp.	–0.429	3.425	–0.429	3.925
184-1147B-							
1H-1, 10–12	0.11	0.11	*Oridorsalis* spp.	–1.059	2.998	–0.059	2.998
1H-1, 90–92	0.91	0.91	*Cibicidoides* spp.	–0.432	2.981	–0.432	3.481
1H-2, 10–12	1.61	1.61	*Cibicidoides* spp.	–0.519	4.168	–0.519	4.668
1H-2, 90–92	2.41	2.41	*C. wuellerstorfi*	–0.213	4.086	–0.213	4.726
1H-3, 10–12	3.11	3.11	*Uvigerina* sp.	–0.978	4.810	–0.078	4.810
1H-3, 90–92	3.91	3.91	*C. wuellerstorfi*	–0.185	3.762	–0.185	4.402
1H-4, 90–92	5.41	5.41	*C. wuellerstorfi*	–0.117	3.655	–0.117	4.295
1H-5, 10–12	6.11	6.11	*C. wuellerstorfi*	–0.132	3.544	–0.132	4.184
1H-5, 90–92	6.91	6.91	*C. wuellerstorfi*	–0.212	3.559	–0.212	4.199
1H-6, 10–12	7.61	7.61	*C. wuellerstorfi*	–0.125	3.646	–0.125	4.286
1H-6, 90–92	8.41	8.41	*C. wuellerstorfi*	–0.114	3.514	–0.114	4.154
2H-2, 10–12	11.11	11.61	*Cibicidoides* spp.	–0.348	3.153	–0.348	3.653
2H-2, 90–92	11.91	12.41	*C. wuellerstorfi*	–0.041	3.244	–0.041	3.884
2H-3, 10–12	12.61	13.11	*Uvigerina* sp.	–0.849	3.825	0.051	3.825
2H-3, 90–92	13.41	13.91	*C. wuellerstorfi*	–0.163	3.102	–0.163	3.742
2H-4, 10–12	14.11	14.61	*Cibicidoides* spp.	–0.349	3.375	–0.349	3.875
2H-5, 10–12	15.61	16.11	*Cibicidoides* spp.	–1.540	2.908	–1.540	3.408
2H-5, 90–92	16.41	16.91	*Cibicidoides* spp.	–0.633	3.381	–0.633	3.881
2H-6, 10–12	17.11	17.61	*Cibicidoides* spp.	–0.680	3.919	–0.680	4.419
2H-6, 90–92	17.91	18.41	*Cibicidoides* spp.	–0.838	3.930	–0.838	4.430
4H-1, 10–12	28.61	30.31	*C. wuellerstorfi*	–0.296	2.546	–0.296	3.186
4H-1, 90–92	29.41	31.11	*Cibicidoides* spp.	–1.015	3.928	–1.015	4.428
4H-2, 10–12	30.11	31.81	*C. wuellerstorfi*	–0.469	3.677	–0.469	4.317
4H-2, 90–92	30.91	32.61	*C. wuellerstorfi*	–0.576	3.568	–0.576	4.208
4H-3, 10–12	31.61	33.31	*Cibicidoides* spp.	–1.129	3.701	–1.129	4.201
4H-3, 90–92	32.41	34.11	*Uvigerina* sp.	–1.477	4.269	–0.577	4.269
4H-4, 10–12	33.11	34.81	*Cibicidoides* spp.	–0.546	3.177	–0.546	3.677
4H-4, 90–92	33.91	35.61	*C. wuellerstorfi*	–0.392	3.355	–0.392	3.995
4H-5, 10–12	34.61	36.31	*Cibicidoides* spp.	–1.405	3.928	–1.405	4.428
5H-2, 10–12	39.61	41.51	*Cibicidoides* spp.	–0.169	2.855	–0.169	3.355
5H-2, 90–92	40.41	42.31	*C. wuellerstorfi*	–0.464	3.719	–0.464	4.359
5H-3, 10–12	41.11	43.01	*Cibicidoides* spp.	–1.452	4.446	–1.452	4.946
5H-3, 90–92	41.91	43.81	*Cibicidoides* spp.	–0.873	3.983	–0.873	4.483
5H-4, 10–12	42.61	44.51	*Cibicidoides* spp.	–1.662	4.295	–1.662	4.795
5H-4, 90–92	43.41	45.31	*Cibicidoides* spp.	–0.471	3.680	–0.471	4.180
5H-6, 90–92	46.41	48.31	*C. wuellerstorfi*	–0.248	3.281	–0.248	3.921
184-1147C-							
2H-3, 10–12	5.71	6.31	*Cibicidoides* spp.	–0.495	3.935	–0.495	4.435
2H-3, 90–92	6.51	7.11	*C. wuellerstorfi*	–0.254	3.520	–0.254	4.160
2H-4, 10–12	7.21	7.81	*C. wuellerstorfi*	–0.136	3.520	–0.136	4.160
2H-4, 90–92	8.01	8.61	*C. wuellerstorfi*	0.087	3.599	0.087	4.239
2H-5, 10–12	8.71	9.31	*C. wuellerstorfi*	–0.187	3.519	–0.187	4.159
2H-5, 90–92	9.51	10.11	*C. wuellerstorfi*	–0.518	3.684	–0.518	4.324
2H-6, 10–12	10.21	10.81	*C. wuellerstorfi*	–0.306	3.659	–0.306	4.299
4H-2, 90–92	24.01	26.06	*C. wuellerstorfi*	0.002	3.056	0.002	3.696
4H-3, 10–12	24.71	26.76	*C. wuellerstorfi*	–0.126	2.946	–0.126	3.586
4H-4, 90–92	27.01	29.06	*Cibicidoides* spp.	–0.582	3.634	–0.582	4.134
4H-5, 10–12	27.71	29.76	*C. wuellerstorfi*	–0.027	2.978	–0.027	3.618
4H-5, 90–92	28.51	30.56	*Cibicidoides* spp.	–0.545	3.175	–0.545	3.675
5H-3, 10–12	34.23	36.41	*C. wuellerstorfi*	–0.234	3.485	–0.234	4.125

Notes: *C. wuellerstorfi* = *Cibicidoides wuellerstorfi*, *C. kullenbergi* = *Cibicidoides kullenbergi*. * = adjustment factors after Shackleton et al. (1995). Oxygen isotope data are given in reference to Peedee belemnite standard. Only a portion of this table appears here. The complete table is available in **ASCII**.

Table T4. Benthic foraminifer stable isotope data for spliced section (0–837 mcd).

Depth (mcd)	Age (Ma)	$\delta^{13}C$ (‰) (final)*	$\delta^{18}O$ (‰) (final)*
0.11	0.006	–0.059	2.998
0.91	0.010	–0.432	3.481
1.61	0.014	–0.519	4.668
2.41	0.019	–0.213	4.726
3.11	0.022	–0.078	4.810
3.91	0.028	–0.185	4.402
5.41	0.038	–0.117	4.295
6.11	0.042	–0.132	4.184
6.31	0.043	–0.495	4.435
6.91	0.047	–0.212	4.199
7.11	0.049	–0.254	4.160
7.61	0.052	–0.125	4.286
7.81	0.053	–0.136	4.160
8.41	0.055	–0.114	4.154
8.61	0.056	0.087	4.239
9.31	0.058	–0.187	4.159
10.11	0.061	–0.518	4.324
10.81	0.065	–0.306	4.299
11.61	0.080	–0.348	3.653
12.41	0.087	–0.041	3.884
13.11	0.092	0.051	3.825
13.91	0.099	–0.163	3.742
14.61	0.106	–0.349	3.875
16.11	0.122	–1.540	3.408
16.91	0.128	–0.633	3.881
17.61	0.132	–0.680	4.419
18.26	0.135	–0.527	4.572
18.41	0.139	–0.838	4.430
19.76	0.171	–0.779	4.347
20.56	0.177	–0.572	4.400
21.26	0.183	–0.435	4.516
22.06	0.189	–0.493	4.155
22.76	0.194	–0.588	3.980
23.56	0.245	–0.798	4.146
24.26	0.249	–1.141	4.257
25.06	0.303	–0.429	3.925
26.06	0.319	0.002	3.696
26.76	0.331	–0.126	3.586
29.06	0.341	–0.582	4.134
29.76	0.362	–0.027	3.618
30.31	0.405	–0.296	3.186
30.56	0.414	–0.545	3.675
31.11	0.434	–1.015	4.428
31.81	0.444	–0.469	4.317
32.61	0.456	–0.576	4.208
33.31	0.467	–1.129	4.201
34.11	0.480	–0.577	4.269
34.81	0.502	–0.546	3.677
35.61	0.524	–0.392	3.995
36.31	0.538	–1.405	4.428
36.41	0.541	–0.234	4.125
37.21	0.563	–1.423	4.474
37.91	0.565	0.031	4.128
38.71	0.577	0.207	3.737
39.41	0.587	–1.326	3.763
40.21	0.598	–0.194	3.808
41.51	0.617	–0.169	3.355
41.71	0.618	–0.468	3.470
42.31	0.620	–0.464	4.359
43.01	0.638	–1.452	4.946
43.81	0.649	–0.873	4.483
44.51	0.659	–1.662	4.795
45.31	0.673	–0.471	4.180
47.71	0.690	–0.260	3.980
48.31	0.704	–0.248	3.921
48.51	0.709	–1.293	3.933
48.52	0.709	–0.420	3.759
49.21	0.715	–0.519	3.985
50.01	0.722	–0.442	4.225
50.02	0.722	0.055	3.545
50.71	0.731	–0.128	4.032
51.51	0.741	–0.931	3.876
52.06	0.748	–1.843	4.274
52.21	0.750	–0.773	4.239
52.86	0.758	–0.836	3.664
53.01	0.760	–1.019	4.089
53.56	0.767	–0.453	4.318
55.86	0.798	–1.633	4.295
56.56	0.802	–0.543	4.120
59.11	0.837	–0.356	3.636
60.61	0.872	–1.556	4.445
61.01	0.875	–2.083	4.241
61.31	0.877	–1.225	4.606
61.81	0.884	–1.052	4.033
62.11	0.888	–0.736	4.183
62.51	0.894	–0.624	4.204
63.31	0.905	–0.522	3.830
64.01	0.910	–0.911	3.866
64.81	0.918	–0.836	4.317
65.51	0.936	–0.600	3.235
66.78	0.948	–0.434	3.150
67.01	0.965	–0.605	3.640
67.81	0.974	–0.374	3.394
68.28	0.983	–1.107	3.607
69.08	0.997	–0.217	3.557
69.78	1.008	–0.081	4.045
70.58	1.026	–0.191	3.648
71.28	1.040	–0.557	4.238
72.08	1.053	–0.309	3.845
72.78	1.070	–0.572	3.262
73.58	1.081	–0.360	3.900
73.93	1.087	–0.385	3.929
74.73	1.101	–0.147	3.947
75.43	1.115	–1.631	4.190
76.23	1.119	–0.583	4.114
77.73	1.126	–0.433	4.126
78.08	1.127	–0.043	3.837
78.88	1.177	–0.062	3.586
79.23	1.199	–0.355	3.902
79.58	1.207	–0.417	4.308
80.38	1.215	–0.584	4.139
81.88	1.242	–1.148	3.462
82.38	1.249	–0.977	3.999
83.28	1.268	–0.173	3.936
83.88	1.276	–0.238	3.485
84.08	1.279	0.079	3.517
84.78	1.286	–0.795	4.355
85.58	1.304	–0.496	4.029
86.28	1.316	–0.715	3.698
87.08	1.322	–0.541	3.855
87.58	1.331	–0.744	4.104
87.78	1.334	–0.517	4.186
88.58	1.347	–0.143	3.588
89.08	1.351	–0.616	3.449
89.88	1.376	–0.524	3.933
91.38	1.404	0.131	3.521
92.08	1.422	–0.235	3.878
93.58	1.440	0.077	3.430
94.33	1.445	–0.494	3.334
95.03	1.460	–0.417	4.029
96.53	1.484	–0.310	3.158
97.33	1.509	–0.142	4.185
98.03	1.516	0.376	3.877
98.13	1.517	–0.079	3.951
98.81	1.524	–0.332	4.001
98.93	1.525	–0.123	3.848
99.63	1.537	–0.646	4.130
100.43	1.554	0.165	3.532
101.13	1.569	–0.217	3.854
101.93	1.572	0.079	4.203
102.53	1.589	0.066	3.790
103.33	1.611	0.190	3.329
103.40	1.613	0.102	3.182
104.03	1.625	–0.019	3.538
104.20	1.629	0.001	3.581
104.83	1.641	–0.096	3.599
105.53	1.660	–0.110	4.197
106.33	1.682	–0.099	3.766
107.83	1.702	–0.458	4.128
108.53	1.720	–0.155	3.407
108.58	1.722	–0.258	3.437
109.33	1.746	–0.390	3.480
109.38	1.748	–0.517	3.680
110.08	1.757	–0.057	3.934
110.88	1.765	0.091	3.359
111.59	1.777	–0.441	3.564
112.39	1.795	–0.285	4.004
112.79	1.810	–0.262	3.693
113.11	1.815	–0.207	3.233
113.59	1.832	–0.092	3.519
113.91	1.841	–0.561	4.043
115.09	1.855	–0.274	3.543
115.79	1.868	–0.123	3.619
116.59	1.890	0.110	3.348
117.29	1.916	–0.563	3.979
118.09	1.924	–0.114	3.611
118.79	1.939	–0.090	3.139
119.51	1.957	–0.201	3.786
120.21	1.982	0.414	3.210
121.01	1.999	–0.155	3.821
122.26	2.027	–0.116	3.347
123.06	2.051	–0.095	3.614
123.76	2.072	–0.193	3.955
124.41	2.086	–0.443	4.021
124.56	2.090	–0.339	3.807
125.21	2.103	–0.347	3.680
125.26	2.104	–0.115	3.606
126.51	2.136	–0.067	3.535
126.66	2.140	–0.329	3.304
126.96	2.144	–0.454	3.414
127.11	2.146	–0.408	3.571
127.26	2.152	–0.414	4.101
127.41	2.162	–0.604	4.269
127.46	2.163	–0.394	4.133
127.56	2.164	–0.309	3.924
127.71	2.165	–0.435	3.742
127.76	2.166	–0.286	4.061
127.84	2.166	–0.065	3.959
127.91	2.167	0.005	4.108
128.01	2.173	–0.139	3.746
128.06	2.175	–0.455	3.898
128.16	2.181	0.022	3.621
128.21	2.182	–0.283	3.703
128.31	2.185	0.008	3.690
128.36	2.186	–0.023	3.621
128.46	2.189	–0.252	3.438
128.51	2.190	0.004	3.436
128.61	2.193	–0.064	3.486
128.66	2.194	–0.008	3.332
128.76	2.195	–0.222	3.345
128.79	2.195	0.045	3.372

Notes: * = after adjustment. Only a portion of this table appears here. The complete table is available in ASCII.

Table T5. Adjustment factors for oxygen and carbon isotopes.

Species	$\delta^{13}C$	$\delta^{18}O$
Cibicidoides wuellerstorfi	0.00	0.64
Cibicidoides kullenbergi	0.00	0.64
C. wuellerstorfi + *C. kullenbergi*	0.00	0.64
Uvigerina sp.	0.90	0.00
Cibicidoides spp.	0.00	0.50
Oridorsalis sp.	1.00	0.00
Cibicidoides + *Oridorsalis*	0.50	0.32
Globigerinoides ruber	0.00	0.00
Globigerinoides sacculifer	–0.35	–0.32

Notes: Benthic foraminifer standards: $\delta^{13}C$ = *C. wuellerstorfi*, $\delta^{18}O$ = *U. peregrina*. Planktonic foraminifer standard: *G. ruber.* Adjustment factors after Shackleton et al. (1995), Shackleton and Hall (1983, 1990), and Z. Jian et al. (2003, unpub. data).