Wilson, P.A., Lyle, M., and Firth, J.V. (Eds.)
Proceedings of the Ocean Drilling Program, Scientific Results Volume 199

18. Data Report: High-Resolution Stable Isotope Records across the Paleocene/Eocene Boundary, ODP Sites 1220 and 1221[1]

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ABSTRACT

High-resolution carbon and oxygen isotope records were produced from 240 analyses of two species of benthic foraminifers and bulk carbonate in sediments from across the Paleocene/Eocene (P/E) boundary in Ocean Drilling Program (ODP) Holes 1220B and 1221C. Although part of the carbon isotope excursion is not recorded in either Hole 1220B or Hole 1221C because of carbonate dissolution, both sites do record a significant part of the main geochemical excursion. The benthic foraminifers from Hole 1220B are believed to provide reliable geochemical records of the magnitude of the P/E excursion as judged by the quality of foraminifer preservation and similarity of the carbon isotope record to that seen at other deep-sea sites. However, anomalously positive values in the benthic $\delta^{18}O$ record in sediments from Hole 1221C and bulk carbonate in sediments from Hole 1220B indicate that diagenesis masks the primary isotopic signature in this part of the records. The Paleocene–Eocene Thermal Maximum is only observed in the Hole 1220B benthic foraminifer records, with a $\delta^{18}O$ excursion of –0.65‰ to –0.85‰. The magnitude of the carbon isotope excursion is as much as 0.96‰ in Hole 1221C and 2.01‰ in Hole 1220B. Although smaller than at Southern Ocean Site 690 (2.6‰), the carbon isotope excursion in Hole 1220B is of similar magnitude to that observed in Deep Sea Drilling Project and ODP Sites 527, 738, and 1051 and the Alamedilla Section in Spain (–2.1‰, –1.6‰, –1.9‰, and –1.7‰, respectively).

[1] Nunes, F., and Norris, R.D., 2005. Data report: High-resolution stable isotope records across the Paleocene/Eocene boundary, ODP Sites 1220 and 1221. *In* Wilson, P.A., Lyle, M., and Firth, J.V. (Eds.), *Proc. ODP, Sci. Results,* 199, 1–12 [CD-ROM]. Available from: Ocean Drilling Program, Texas A&M University, College Station TX 77845-9547, USA.
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Initial receipt: 30 March 2004
Acceptance: 31 January 2005
Web publication: 15 December 2005
Ms 199SR-206

INTRODUCTION

One of the goals of Ocean Drilling Program (ODP) Leg 199 was to study the changes in ocean circulation in the Pacific Basin during the Paleogene. Stable isotopes are useful proxies for this purpose because the temperature of water masses can be deduced from $\delta^{18}O$ records, whereas $\delta^{13}C$ can be used as a nutrient tracer for ocean circulation. We present oxygen and carbon isotope values from bulk carbonate and benthic foraminifers across the Paleocene/Eocene (P/E) boundary in Holes 1220B and 1221C in the equatorial Pacific Ocean. The P/E boundary is characterized by an abrupt negative excursion in both oxygen and carbon isotopes, which is an indication of transient changes in temperature and the global carbon cycle at this time. Here, high-resolution sampling (3–5 k.y. in the core of the carbon isotope excursion) focused on the P/E transition to capture a detailed record of the carbon and oxygen isotope excursions in the deep equatorial Pacific.

Both sites are assumed to have had a paleodepth of ~2500–2600 m at the time of the P/E boundary. It is important to recognize that there may be significant uncertainty in the actual paleodepth for both sites, which is estimated by assuming that both sites were deposited near the crest of the newly formed oceanic ridge. Both sites were drilled on 56-Ma crust (considered to have formed near 2500 m water depth) but then had perhaps 500,000 to 1 million years to subside before deposition of the P/E sequence. Hence, it is possible that the sites actually reached depths of ~2580–2660 m prior to deposition of the P/E section, depending upon what age is assumed for the P/E boundary and assuming constant thermotectonic subsidence of the ocean crust. In addition, bottom roughness around the sites could account for perhaps up to an additional ±100 m of depth uncertainty. We assume an age for the P/E boundary of ~55.2 Ma, suggesting that the sites may both have reached depths of as much as ~2660–2760 m by the time the carbonate sequence began to accumulate.

METHODS AND MATERIALS

Bulk Carbonate

Sediment samples from Holes 1220B and 1221C were taken at 5-cm intervals and were allowed to dry overnight in a Memmert Wisconsin oven at 50°C. The samples were homogenized by grinding with a mortar and pestle and were weighed on a Mettler Toledo MX5 microbalance with a precision of ~1 µg. Sample size varied depending on the carbonate content of the interval, published in the Leg 199 *Initial Reports* volume (Lyle, Wilson, Janecek, et al., 2002). About 500 µg of sediment was analyzed in samples with high carbonate content, whereas ~1000 µg of sediment was analyzed in samples with low $CaCO_3$ content. Carbon and oxygen isotopic composition of these sediments were measured at Scripps Institution of Oceanography (SIO; USA) using an automated common acid bath carbonate preparation device (Fairbanks device) attached to a Finnigan MAT252 mass spectrometer. NBS-19 was used as a standard, with 7 standard analyses per run of 40 unknowns. The average instrument error is <0.1‰ for both $\delta^{13}C$ and $\delta^{18}O$.

Benthic Foraminifers

Sediment samples with volumes of ~10 cm^3 were taken at 5-cm intervals in Hole 1220B through the Paleocene/Eocene Thermal Maximum (PETM) interval. These samples were allowed to dry overnight at 50°C before being washed with deionized water through a 38-µm sieve. Samples from Hole 1221C were those used for a study of phosphorous chemistry and were processed using similar methods to ours at University of California, Santa Cruz (USA), by Christina Faul. Her sample set consisted of 20-cm^3 core pieces taken at 2-cm spacing through the core of the PETM and at 5-cm intervals above and below the excursion interval. In both Holes 1220B and 1221C, the benthic foraminifers *Nuttalides truempyi* and *Cibicidoides* spp. were picked from the >250-µm fraction for isotopic analyses. Approximately 10–15 individuals of each genus or species were selected so that an average signature for the interval was obtained. Carbon and oxygen isotopic composition of these benthic foraminifers were measured at SIO with the same methodology reported for bulk carbonate.

Preservation of Materials

The P/E boundary interval in both Holes 1220B and 1221C consists of a series of colorful beds in what is otherwise a foraminifer-nannofossil ooze. The boundary is identified partly by the last appearance of Paleocene benthic foraminifers at 199.68 meters below seafloor (mbsf) in Hole 1220B and at 154.31 mbsf in Hole 1221C. In addition, the P/E boundary in Hole 1220B is marked by the occurrence of the "excursion fauna" of planktonic foraminifers (Lyle, Wilson, Janecek, et al., 2002). In both holes, the boundary beds change upsection from yellow dolomite-rich sediments to rose-pink, black, dark brown, and, eventually, tan calcareous ooze in the interval spanned by the most negative benthic foraminifer $\delta^{13}C$ ratios. These multicolored beds, representing the core of the P/E boundary interval, have low carbonate content.

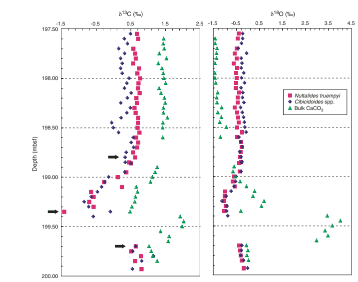
The coarse (>38 µm) fraction in samples from Holes 1220B and 1221C are dominated by benthic foraminifers because of the dissolution of most planktonic forms. Planktonic foraminifers are sparse but occur throughout most of the section in Hole 1220B, whereas Hole 1221C is nearly devoid of them. Benthic foraminifers are abundant at both sites except within a carbonate dissolution horizon occurring between 199.40 and 199.70 mbsf in Hole 1220B and between 154.10 and 154.30 mbsf in Hole 1221C. Foraminifers are generally well preserved in Hole 1220B, particularly within and above the PETM, but typically display a coarse, sugary coating in Hole 1221C. Below the carbonate dissolution horizon, benthic foraminifers in both holes commonly have a sugary surface texture, and both planktonic and benthic foraminifers in Hole 1220B are occasionally overgrown by glassy, yellow dolomite rhombs. In some intervals of both sites, particularly below the P/E boundary, dolomite rhombs compose a significant portion of the fine fraction. Benthic foraminifers containing dolomite rhombs on their surface were not selected for isotope analysis.

Carbonate preservation is distinctly worse in Hole 1221C than it is in Hole 1220B. The different quality of preservation between the sites may reflect a slightly deeper paleodepth for Hole 1221C than Hole 1220B because we expect that differences in the actual age of the seafloor beneath these sites and bottom roughness might account for differences as great as several hundred meters in their actual paleodepths. The two sites also differ in paleolatitude, with the area around Hole 1220 having crossed the equator about the time of the P/E boundary, whereas Hole 1221C was nearly 200 km to the north (Lyle, Wilson, Janecek, et al., 2002). Hence, Hole 1221C may have been farther from the belt of equatorial carbonate accumulation at the P/E boundary and in an area with a shallower carbonate compensation depth than Hole 1220B.

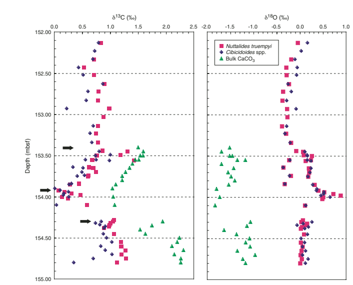
PROVISIONAL TIMESCALE

A provisional timescale based on the astrochronology of the P/E boundary at ODP Hole 690 (Röhl et al., 2000) was developed for sediments from Holes 1220B and 1221C. Three common points, recognizable on the $\delta^{13}C$ curves from Site 690, and Holes 1220B and 1221C were chosen for correlation. These points are the onset of the excursion at 55.234 Ma, the minimum $\delta^{13}C$ value at 55.1815 Ma, and the inflection point where carbon isotope ratios recover from the excursion at 55.0011 Ma. The locations of the datum points are indicated on Figures F1 and F2. A timescale for Holes 1220B and 1221C was created by interpolation between these three datum points and can be found in Table T1 and in Figure F3. Sedimentation rates were assumed to be constant above the highest datum point and below the lowest datum point.

F1. Carbon and oxygen isotope data, Hole 1220B, p. 8.

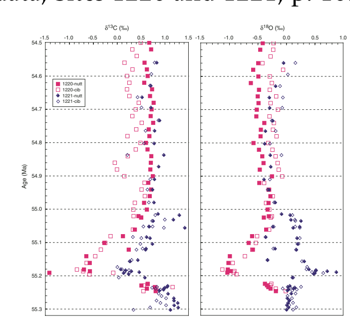


F2. Carbon and oxygen isotope data, Hole 1221C, p. 9.



T1. Stable isotope data, Sites 1220 and 1221, p. 11

F3. Carbon and oxygen isotope data, Sites 1220 and 1221, p. 10.



The accuracy of this timescale depends on appropriate selection of datum points. Gaps in the isotope record of ~30 cm in Hole 1220B and of ~20 cm in Hole 1221C restrict our ability to identify the exact onset of the carbon isotope excursion. The start of the carbon isotope excursion is unlikely to have been incorrectly located by more than the duration of these gaps. We have assumed that carbonate burndown during the PETM is minimal because errors as large as these would require extensive dissolution of seafloor sediments deposited before the start of the carbon isotope excursion. Nonetheless, it is possible that the isotope record from Sites 1220 and 1221 does not capture the most negative value of the $\delta^{13}C$ excursion either due to dissolution or a hiatus. Despite this potential source of error, we believe the minimum $\delta^{13}C$ value is a reasonable datum point because it is more readily identified in each of the records, whereas attempting to correlate a different point in the isotope curve, particularly a point where the curve changes rapidly, is likely to be more ambiguous. Although the use of biostratigraphic datums would strengthen the accuracy of this timescale, there are intervals in the sedimentary record where this information is not available because the calcareous material is absent. At the moment, there is no well-defined set of biostratigraphic events that can be used to subdivide the interval within the P/E carbon isotope excursion, and cyclostratigraphies have been constructed for only a few sites. For this reason we believe the approach used here provides a good chronological estimate for these two sites. At the very least, we think that our chronology allows us to accurately compare parts of the isotope record that fall before, during, and after the PETM.

RESULTS

The $\delta^{13}C$ and $\delta^{18}O$ data from Holes 1220B and 1221C obtained from bulk carbonate and benthic foraminifers are shown in Table T1 and in Figures F1 and F2.

The carbon isotope excursion is present at both sites and appears on all $\delta^{13}C$ records. The magnitude of the excursion in Hole 1220B is 2.01‰ in the *N. truempyi* record, 1.35‰ in the *Cibicidoides* spp. record, and 1.44‰ in the bulk carbonate record. In Hole 1221C, the magnitude of the carbon isotope excursion is 0.96‰, 0.83‰, and 0.82‰ for *N. truempyi, Cibicidoides* spp., and bulk carbonate, respectively. The $\delta^{13}C$ records from Hole 1220B are larger in magnitude than those produced from Hole 1221C.

The $\delta^{13}C$ values from Leg 199 sites are lower than the magnitude observed at higher latitudes, such as the 2.6‰ excursion seen in *N. truempyi* at Site 690 in the Weddell Sea (Kennett and Stott, 1991) but is of similar magnitude to those observed in Deep Sea Drilling Project and ODP Sites 527, 738, and 1051 and the Alamedilla Section in Spain (–2.1‰, –1.6‰, –1.9‰, and –1.7‰, respectively) (Katz et al., 1999; Lu et al., 1998; Lu and Keller, 1993; Thomas and Shackleton, 1996). All of these sites (including ODP 690) contain small gaps in the $\delta^{13}C$ record like the Leg 199 sites because of some combination of carbonate dissolution or absence of appropriate foraminifers for isotopic analysis.

There appears to be a systematic offset between the $\delta^{13}C$ records of bulk carbonate, *N. truempyi,* and *Cibicidoides* spp. in both Holes 1220B and 1221C. The *Cibicidoides* spp. record consistently has the lightest values of $\delta^{13}C$, whereas the bulk carbonate record consistently has the heaviest $\delta^{13}C$ values of both sites. The average offset between *Cibicidoides* spp. and *N. truempyi* is 0.21 ± 0.29‰ (N = 86); between *Cibicidoides* spp. and the bulk carbonate record, the offset is 1.10 ± 0.38‰ (N = 56); and the offset between the *N. truempyi* record and the bulk carbonate record is 0.86 ± 0.31‰ (N = 52). Our results differ from those of Katz et al. (2003), who report that $\delta^{13}C$ of *Cibicidoides* spp. is typically more positive than that of *N. truempyi.* We can only note that the interspecies offset in our results is internally consistent and is based upon well-preserved foraminifers in Hole 1220B that are selected with a narrowly defined species concept even if we have not identified the species of *Cibicidoides* used in our analysis. Unfortunately, *Cibicidoides* spp. is known to contain a large number of species that are likely to have distinctly different isotope fractionation effects, and these may account for the contrast between our results and those of Katz et al. (2003).

The PETM is recognized only in the benthic foraminiferal $\delta^{18}O$ records from Hole 1220B, where an excursion of –0.65‰ is observed in the *N. truempyi* record and –0.86‰ is observed in the *Cibicidoides* spp. record. In contrast, the bulk carbonate $\delta^{18}O$ values at this site actually increase across the P/E boundary to unusually heavy values of $\delta^{18}O$, reaching up to +4.0‰. It is unlikely that these ratios represent actual deep-sea $\delta^{18}O$ values in a time when the world's oceans experienced a ubiquitous increase in temperature. These anomalous values are coincident with the carbonate dissolution horizon, where dolomite crystals are abundant. It is likely that the $\delta^{18}O$ values in this part of the bulk carbonate record are of diagenetic origin, rather than a primary signal. Bulk carbonate $\delta^{13}C$ in Hole 1220B also yields unusually positive ratios, suggesting that carbon isotopes have also been affected by diagenesis.

In Hole 1221C, neither the bulk carbonate record of $\delta^{18}O$ nor the benthic foraminiferal $\delta^{18}O$ records have a negative excursion related to the PETM. The data from the bulk carbonate record have much scatter and do not show a clear pattern, whereas the benthic foraminifer records show an inverse pattern from that expected: $\delta^{18}O$ values increase across the P/E boundary. We also attribute this unusual result to diagenesis.

SUMMARY

Stable isotope records based on analyses of the benthic foraminifers *N. truempyi* and *Cibicidoides* spp., as well as bulk carbonate records spanning the P/E boundary, have been produced at a high-resolution interval. The magnitude of the $\delta^{13}C$ excursion is much smaller in Hole 1221C when compared to Hole 1220B, a difference we attribute to a pervasive diagenetic overprint in Hole 1221C. However, the visually good preservation of foraminifers in Hole 1220B and the consistency of the benthic foraminifer isotope results for species of both *N. truempyi* and *Cibicidoides* spp. suggest that these data record seafloor chemistry through the P/E boundary interval. Furthermore, the overall similarity of our benthic foraminiferal isotopic results for Hole 1220B and those of previously published records suggest that the new Pacific record captures at least part of the core of the P/E carbon isotope excursion. The PETM is only recorded in benthic foraminifers from Hole 1220B, an indication that $\delta^{18}O$ from Hole 1221C may be overprinted by a secondary signal.

ACKNOWLEDGMENTS

This research used samples and/or 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. Funding for this research was provided by a Leg 199 postcruise grant from JOI/U.S. Science Support Program and NSF OCE02-44264.

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Figure F1. Hole 1220B carbon and oxygen isotope records from benthic foraminifers. Arrows indicate datum points selected for developing a timescale.

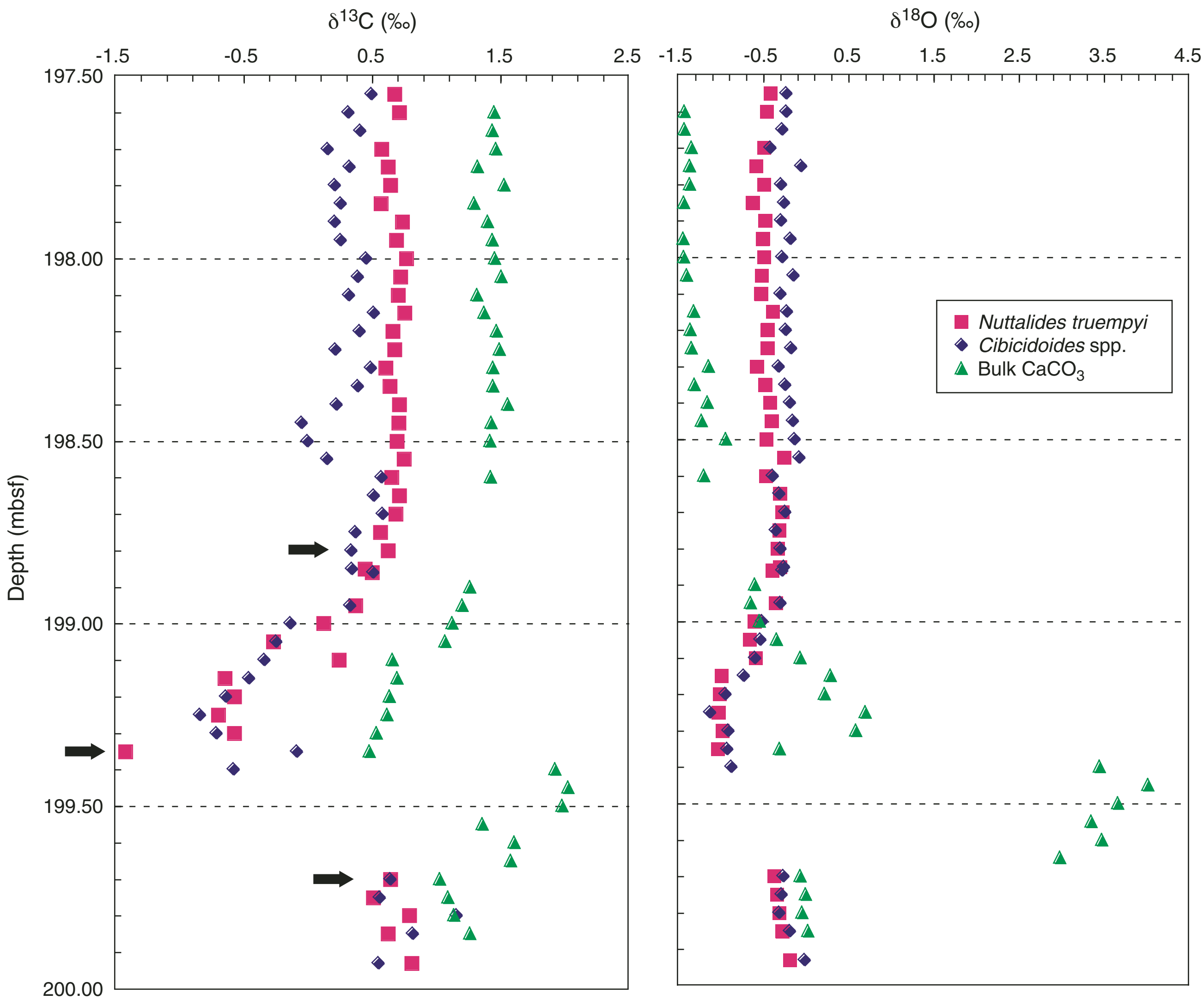

Figure F2. Hole 1221C carbon and oxygen isotope records from benthic foraminifers. Arrows indicate datum points selected for developing a timescale.

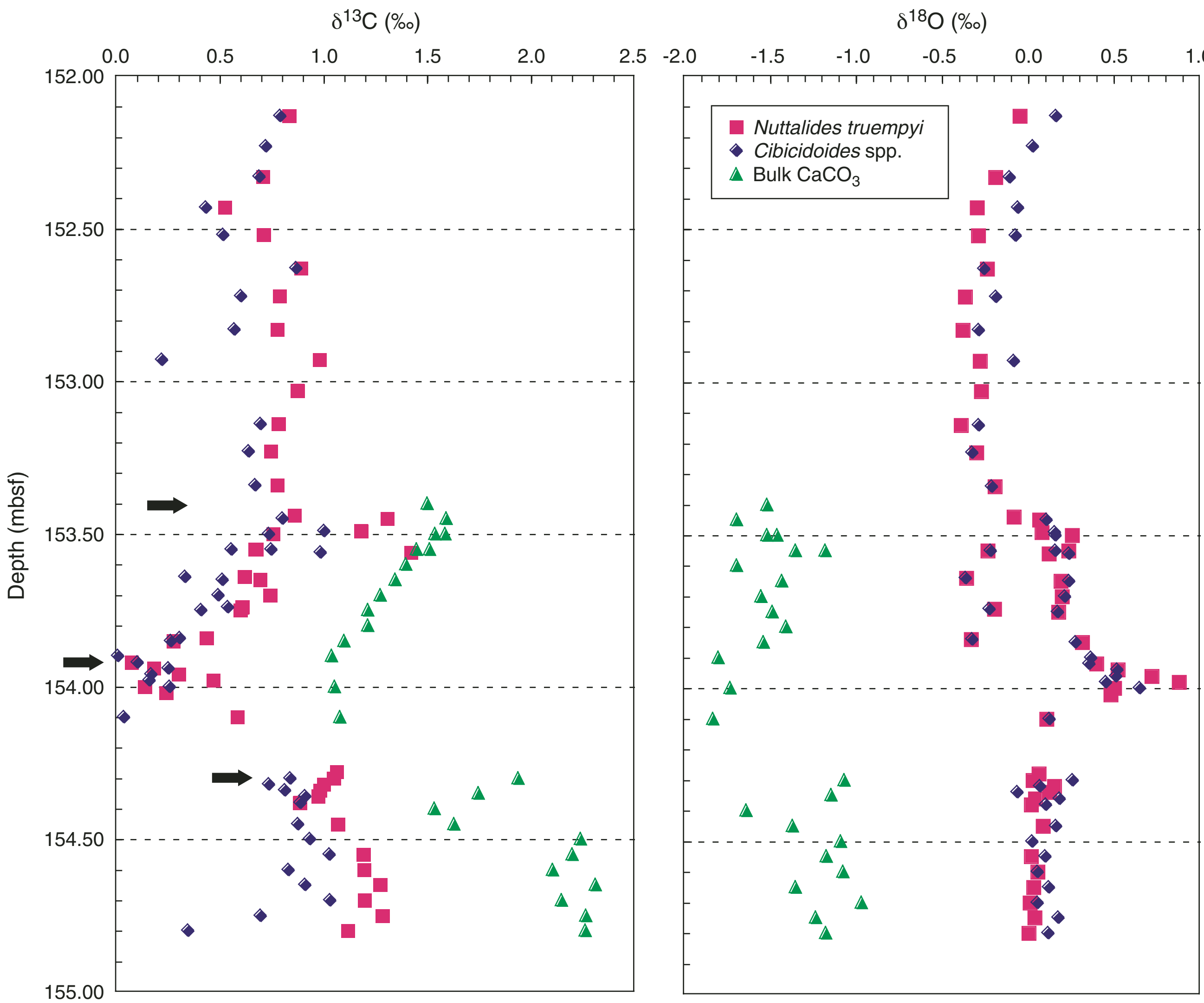

Figure F3. Carbon and oxygen isotope from Sites 1220 and 1221 plotted on a common timescale. Nutt = data from benthic foraminifer *Nuttalides truempyi*, cib = data from benthic foraminifer *Cibicidoides* spp.

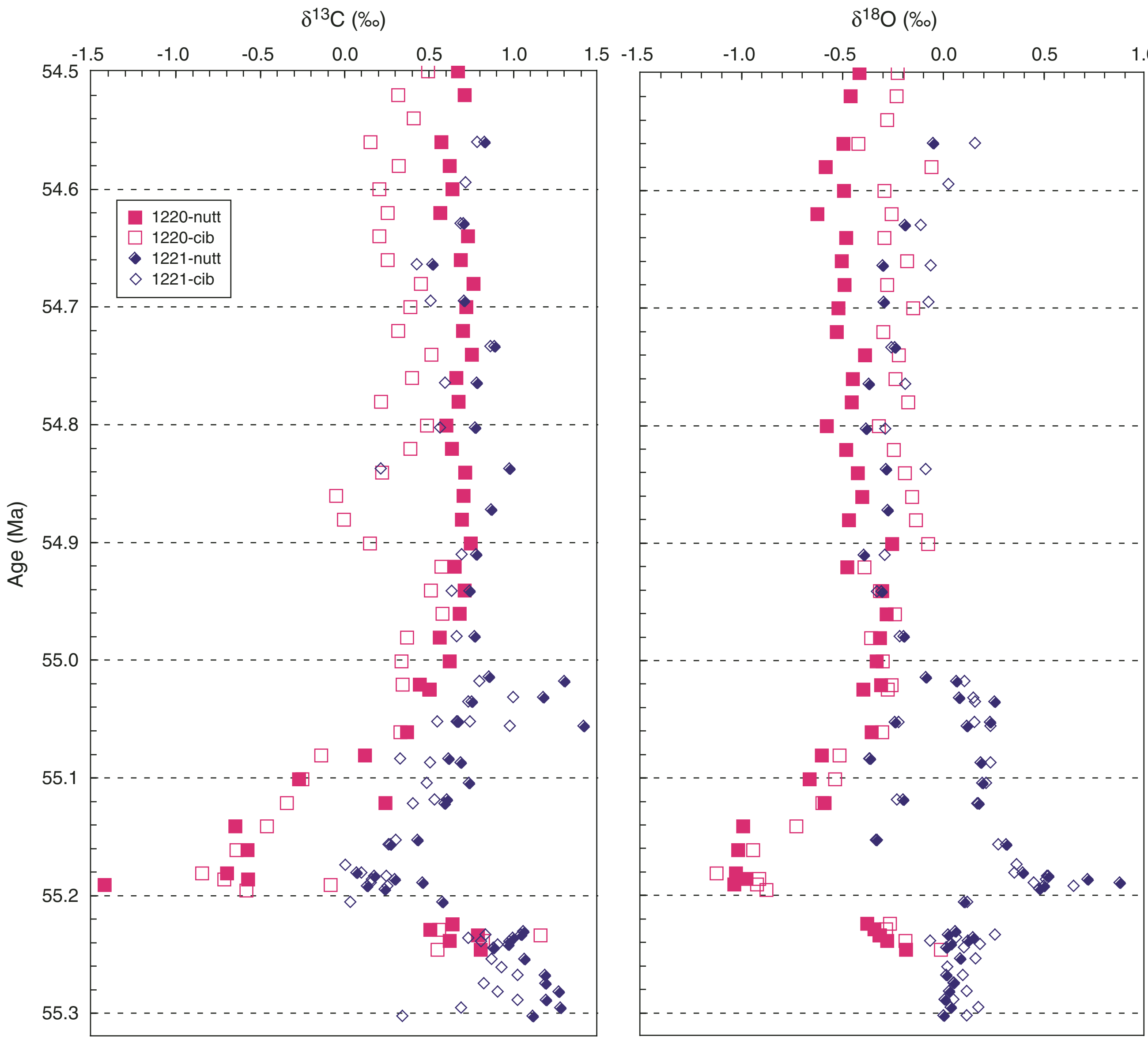

Table T1. Stable isotope data from benthic foraminifers, Sites 1220 and 1221. (Continued on next page.)

Core, section, interval (cm)	Depth (mbsf)	Age (Ma)	*Nuttalides truempyi* (‰)		*Cibicidoides* spp. (‰)		Bulk $CaCO_3$ (‰)	
			δ13C	δ18O	δ13C	δ18O	δ13C	δ18O
199-1220B-								
20X-1, 15–17	197.55	54.5000	0.67	–0.42	0.50	–0.23		
20X-1, 20–22	197.60	54.5200	0.71	–0.46	0.32	–0.23	1.46	–1.43
20X-1, 25–27	197.65	54.5401			0.41	–0.28	1.44	–1.43
20X-1, 30–32	197.70	54.5601	0.57	–0.50	0.15	–0.42	1.47	–1.34
20X-1, 35–37	197.75	54.5802	0.62	–0.58	0.32	–0.06	1.33	–1.36
20X-1, 40–42	197.80	54.6002	0.64	–0.49	0.21	–0.29	1.53	–1.36
20X-1, 45–47	197.85	54.6203	0.57	–0.62	0.26	–0.26	1.30	–1.43
20X-1, 50–52	197.90	54.6403	0.73	–0.48	0.21	–0.29	1.40	–1.55
20X-1, 55–57	197.95	54.6603	0.69	–0.50	0.26	–0.18	1.44	–1.44
20X-1, 60–62	198.00	54.6804	0.77	–0.49	0.45	–0.28	1.46	–1.43
20X-1, 65–67	198.05	54.7004	0.72	–0.52	0.39	–0.15	1.51	–1.40
20X-1, 70–72	198.10	54.7205	0.70	–0.53	0.32	–0.30	1.32	–1.57
20X-1, 75–77	198.15	54.7405	0.76	–0.39	0.52	–0.22	1.38	–1.31
20X-1, 80–82	198.20	54.7606	0.66	–0.45	0.40	–0.24	1.47	–1.35
20X-1, 85–87	198.25	54.7806	0.68	–0.45	0.22	–0.17	1.50	–1.34
20X-1, 90–92	198.30	54.8007	0.60	–0.58	0.49	–0.32	1.45	–1.14
20X-1, 95–97	198.35	54.8207	0.64	–0.48	0.39	–0.25	1.44	–1.30
20X-1, 100–102	198.40	54.8407	0.71	–0.42	0.22	–0.19	1.56	–1.15
20X-1, 105–107	198.45	54.8608	0.71	–0.40	-0.05	–0.16	1.43	–1.22
20X-1, 110–112	198.50	54.8808	0.70	–0.47	0.00	–0.13	1.42	–0.94
20X-1, 115–117	198.55	54.9009	0.75	–0.25	0.15	–0.07		
20X-1, 120–122	198.60	54.9209	0.65	–0.48	0.58	–0.39	1.43	–1.20
20X-1, 125–127	198.65	54.9410	0.71	–0.30	0.51	–0.31		
20X-1, 130–132	198.70	54.9610	0.68	–0.28	0.58	–0.24		
20X-1, 135–137	198.75	54.9811	0.56	–0.31	0.37	–0.36		
20X-1, 140–142	198.80	55.0011	0.62	–0.33	0.34	–0.30		
20X-1, 145–147	198.85	55.0211	0.45	–0.31	0.34	–0.26		
20X-1, 146–148	198.86	55.0252	0.50	–0.40	0.51	–0.28		
20X-2, 0–1	198.90	55.0412					1.26	–0.60
20X-2, 5–7	198.95	55.0612	0.37	–0.35	0.33	–0.30	1.21	–0.65
20X-2, 10–12	199.00	55.0813	0.12	–0.60	-0.14	–0.51	1.13	–0.54
20X-2, 15–17	199.05	55.1013	-0.27	–0.66	-0.25	–0.54	1.07	–0.34
20X-2, 20–22	199.10	55.1214	0.24	–0.59	-0.34	–0.60	0.66	–0.06
20X-2, 25–27	199.15	55.1414	-0.65	–0.99	-0.46	–0.73	0.70	0.29
20X-2, 30–32	199.20	55.1615	-0.58	–1.02	-0.64	–0.94	0.64	0.22
20X-2, 35–37	199.25	55.1815	-0.70	–1.03	-0.84	–1.12	0.62	0.70
20X-2, 40–42	199.30	55.1863	-0.57	–0.98	-0.71	–0.91	0.54	0.59
20X-2, 45–47	199.35	55.1910	-1.42	–1.04	-0.08	–0.92	0.48	–0.30
20X-2, 50–52	199.40	55.1958			-0.58	–0.88	1.93	3.45
20X-2, 55–52	199.45	55.2006					2.03	4.02
20X-2, 60–62	199.50	55.2054					1.98	3.67
20X-2, 65–67	199.55	55.2101					1.36	3.35
20X-2, 70–72	199.60	55.2149					1.61	3.48
20X-2, 75–77	199.65	55.2197					1.58	2.99
20X-2, 80–82	199.70	55.2245	0.64	–0.38	0.64	–0.26	1.03	–0.06
20X-2, 85–87	199.75	55.2292	0.51	–0.34	0.56	–0.28	1.09	0.00
20X-2, 90–92	199.80	55.2340	0.79	–0.32	1.16	–0.31	1.14	–0.04
20X-2, 95–97	199.85	55.2388					1.27	0.03
20X-CC, 0–2	199.85	55.2388	0.62	–0.28	0.82	–0.19		
20X-CC, 8–10	199.93	55.2464	0.81	–0.19	0.55	–0.01		
199-1221C-								
11X-2, 3–5	151.93	54.4911	0.81	–0.14	0.81	–0.11		
11X-2, 23–25	152.13	54.5605	0.83	–0.05	0.79	0.16		
11X-2, 33–35	152.23	54.5952			0.72	0.03		
11X-2, 43–45	152.33	54.6299	0.71	–0.19	0.69	–0.11		
11X-2, 53–55	152.43	54.6646	0.53	–0.30	0.43	–0.06		
11X-2, 62–64	152.52	54.6958	0.71	–0.29	0.52	–0.07		
11X-2, 73–75	152.63	54.7340	0.89	–0.24	0.87	–0.25		
11X-2, 83–85	152.72	54.7652	0.79	–0.37	0.60	–0.18		
11X-2, 93–95	152.83	54.8034	0.78	–0.38	0.57	–0.28		
11X-2, 103–105	152.93	54.8380	0.98	–0.28	0.22	–0.08		
11X-2, 113–115	153.03	54.8727	0.87	–0.27				
11X-2, 124–126	153.14	54.9109	0.78	–0.39	0.70	–0.29		
11X-2, 133–135	153.23	54.9421	0.75	–0.30	0.64	–0.32		
11X-2, 144–146	153.34	54.9803	0.78	–0.19	0.67	–0.21		
11X-3, 0–3	153.40	55.0011					1.50	–1.52

Table T1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Age (Ma)	*Nuttalides truempyi* (‰)		*Cibicidoides* spp. (‰)		Bulk $CaCO_3$ (‰)	
			$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$	$\delta^{18}O$	$\delta^{13}C$	$\delta^{18}O$
11X-3, 4–6	153.44	55.0150	0.86	–0.08				
11X-3, 5–8	153.45	55.0184	1.31	0.07	0.80	0.11	1.59	–1.69
11X-3, 9–12	153.49	55.0323	1.18	0.08	1.00	0.16		
11X-3, 10–13	153.50	55.0358	0.76	0.26	0.74	0.16	1.59	–1.46
11X-3, 10–12	153.50	55.0358					1.54	–1.52
11X-3, 15–18	153.55	55.0531	0.68	0.24	0.56	0.16	1.51	–1.35
11X-3, 15–17	153.55	55.0531	0.67	–0.24	0.75	–0.22	1.45	–1.18
11X-3, 16–19	153.56	55.0566	1.42	0.12	0.99	0.24		
11X-3, 20–22	153.60	55.0705					1.40	–1.69
11X-3, 24–26	153.64	55.0844	0.62	–0.36	0.33	–0.36		
11X-3, 25–28	153.65	55.0878	0.69	0.19	0.51	0.24	1.35	–1.43
11X-3, 30–33	153.70	55.1052	0.74	0.20	0.49	0.22	1.28	–1.55
11X-3, 34–36	153.74	55.1191	0.61	–0.20	0.54	–0.23		
11X-3, 35–38	153.75	55.1225	0.60	0.18	0.41	0.17	1.22	–1.49
11X-3, 40–42	153.80	55.1399					1.22	–1.41
11X-3, 44–46	153.84	55.1537	0.44	–0.33	0.31	–0.33		
11X-3, 45–48	153.85	55.1572	0.28	0.32	0.27	0.28	1.10	–1.54
11X-3, 50–52	153.90	55.1746			0.01	0.37	1.04	–1.80
11X-3, 52–54	153.92	55.1815	0.07	0.40	0.10	0.36		
11X-3, 54–56	153.94	55.1843	0.18	0.52	0.25	0.52		
11X-3, 56–58	153.96	55.1870	0.30	0.72	0.17	0.51		
11X-3, 58–60	153.98	55.1898	0.47	0.88	0.16	0.45		
11X-3, 60–62	154.00	55.1926	0.14	0.50	0.26	0.65	1.06	–1.73
11X-3, 62–64	154.02	55.1953	0.24	0.48				
11X-3, 70–72	154.10	55.2064	0.58	0.11	0.04	0.12	1.08	–1.83
11X-3, 88–90	154.28	55.2312	1.06	0.06				
11X-3, 90–92	154.30	55.2340	1.05	0.03	0.84	0.26	1.94	–1.07
11X-3, 92–94	154.32	55.2368	1.00	0.15	0.74	0.07		
11X-3, 94–96	154.34	55.2395	0.98	0.13	0.81	–0.06		
11X-3, 90–92	154.35	55.2409					1.75	–1.14
11X-3, 96–98	154.36	55.2423	0.98	0.04	0.91	0.19		
11X-3, 98–100	154.38	55.2451	0.89	0.02	0.89	0.11		
11X-3, 100–102	154.40	55.2478					1.54	–1.64
11X-3, 105–108	154.45	55.2547	1.07	0.09	0.88	0.17	1.63	–1.37
11X-3, 110–113	154.50	55.2616			0.94	0.03	2.24	–1.09
11X-3, 115–118	154.55	55.2685	1.19	0.02	1.03	0.10	2.20	–1.17
11X-3, 120–123	154.60	55.2754	1.20	0.06	0.83	0.06	2.11	–1.07
11X-3, 125–128	154.65	55.2824	1.27	0.03	0.91	0.12	2.32	–1.35
11X-3, 130–133	154.70	55.2893	1.20	0.01	1.03	0.06	2.15	–0.97
11X-3, 135–138	154.75	55.2962	1.28	0.04	0.70	0.18	2.27	–1.23
11X-3, 140–142	154.80	55.3031	1.12	0.01	0.35	0.12	2.27	–1.17