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17. BENTHIC FORAMINIFER STABLE ISOTOPE RECORD FROM SITE 849 (0–5 MA): LOCAL AND GLOBAL CLIMATE CHANGES[1]

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ABSTRACT

Benthic foraminifer and $\delta^{13}C$ data from Site 849, on the west flank of the East Pacific Rise (0°11′N, 110°31′W; 3851 m), give relatively continuous records of deep Pacific Ocean stable isotope variations between 0 and 5 Ma. The mean sample spacing is 4 k.y. Most analyses are from *Cibicides wuellerstorfi,* but isotopic offsets relative to *Uvigerina peregrina* appear roughly constant. Because of its location west of the East Pacific Rise, Site 849 yields a suitable record of mean Pacific Ocean $\delta^{13}C$, which approximates a global oceanic signal. The ~100-k.y.-period climate cycle, which is prevalent in $\delta^{18}O$ does not dominate the long-term $\delta^{13}C$ record. For $\delta^{13}C$, variations in the ~400- and 41-k.y. periods are more important. Phase lags of $\delta^{13}C$ relative to ice volume in the 41- and 23-k.y. bands are consistent with $\delta^{13}C$ as a measure of organic biomass. A model-calculated exponential response time of 1–2 k.y. is appropriate for carbon stored in soils and shallow sediments responding to glacial-interglacial climate change. Oceanic $\delta^{13}C$ leads ice volume slightly in the 100-k.y. band, and this suggests another process such as changes in continental weathering to modulate mean river $\delta^{13}C$ at long periods.

The $\delta^{13}C$ record from Site 849 diverges from that of Site 677 in the Panama Basin mostly because of decay of ^{13}C-depleted organic carbon in the relatively isolated Panama Basin. North Atlantic to Pacific $\delta^{13}C$ differences calculated using published data from Sites 607 and 849 reveal variations in Pliocene deep water within the range of those of the late Quaternary. Maximum $\delta^{13}C$ contrast between these sites, which presumably reflects maximum influx of high-$\delta^{13}C$ northern source water into the deep North Atlantic Ocean, occurred between 1.3 and 2.1 Ma, well after the initiation of Northern Hemisphere glaciation. Export of high-$\delta^{13}C$ North Atlantic Deep Water from the Atlantic to the circumpolar Antarctic, as recorded by published $\delta^{13}C$ data from Subantarctic Site 704, appears unrelated to the North Atlantic–Pacific $\delta^{13}C$ contrast. To account for this observation, we suggest that deep-water formation in the North Atlantic reflects northern source characteristics, whereas export of this water into the circumpolar Antarctic reflects Southern Hemisphere wind forcing. Neither process appears directly linked to ice-volume variations.

INTRODUCTION

Our primary goal is to develop a standard deep Pacific stable isotopic record over the last 5 m.y. As the largest of the ocean basins, the deep Pacific Ocean is the most important to the global budget of carbon and oxygen isotopes. We analyze $\delta^{18}O$ and $\delta^{13}C$ in benthic foraminifers at an average time spacing of ~4 k.y. in Site 849 (0°11′N, 110°31′W, 3851 m water depth; Fig. 1). We compare this record to the only other long, high-resolution record available from the area: Site 677 from the Panama Basin (1°12′N, 83°44′W, 3461 m water depth), which was analyzed by Shackleton et al. (1990). To evaluate the global implications of this new Pacific Ocean data set, we also compare the isotope record from Site 849 to that of Site 607 from the North Atlantic Ocean (41°00′N, 32°37′W, 3427 m water depth), which was assembled by Raymo et al. (1990), as well as to subantarctic Site 704 (46°53′S, 7°25′E, 2532 m water depth), which was reported by Hodell (1993) and Hodell and Venz (1992).

Until now, the closest approximation to a standard deep Pacific Ocean reference section for stable isotopes has been the high-resolution record of the last ~2.5 Ma. from Site 677 in the Panama Basin (Shackleton et al., 1990). The $\delta^{13}C$ record from this site was used by others (e.g., Raymo et al., 1990, 1992; Hodell and Venz, 1992) for comparison with Atlantic and Southern Ocean records, to assess long-term variations in deep-ocean circulation. For $\delta^{13}C$, however, Site 677 may not be an ideal Pacific Ocean isotopic reference section. Modern $\delta^{13}C$ values of $\sum CO_2$ in Panama Basin bottom water are lower than values in the open Pacific. This results from the combined effects of local bathymetric isolation, mixing of source waters from the southeastern and central Pacific Ocean, and in-situ oxidation of ^{13}C-depleted organic matter (Kroopnick, 1974; Lonsdale, 1977). Because the Panama Basin is relatively small and is located under one of the highest productivity open-ocean areas in the world (Chavez and Barber, 1987), it is very sensitive to the organic influx effect (Fig. 2). Any variation in this local effect on $\delta^{13}C$ in the Panama Basin would be superimposed on global or regional signals.

The ideal place to monitor central Pacific Ocean waters is the west flank of the East Pacific Rise. Site 849 is located about 860 km west of the East Pacific Rise on oceanic crust generated about 11–12 Ma. Recovered from 3851 m water depth, the site has been above the carbonate compensation depth (CCD) throughout its history. Thermal subsidence of the site is negligible over the interval we have studied here. The water mass bathing this site is characteristic of average deep Pacific Ocean water, with potential temperature of 1.2°C and salinity of 34.68‰ (Lonsdale, 1976). This is identical to that of the most abundant water-mass class in the world ocean, often referred to as "Common Water" (Worthington, 1981). Concentration of oxygen at the site is about 155 µmole/kg (Lonsdale, 1976), which is about average for the deep Pacific Ocean (Levitus, 1982). Sedimentation rates at Site 849 are high enough (on average, 25–30 m/m.y.) that bioturbation does not severely attenuate the glacial/interglacial amplitudes, because a 20-k.y. or longer cycle would comprise >50 cm depth, much longer than a typical bioturbation smoothing depth of 5–10 cm. Total sediment thickness at the site is about 340 m, but the results here present data from the top ~140 m of the sediment column.

RESULTS

All isotope data from Site 849 reported here were analyzed at the College of Oceanic and Atmospheric Sciences Stable Isotope Laboratory at Oregon State University (OSU) between December 1991 and August 1993, using a Finnigan/MAT 251 mass spectrometer equipped with an Autoprep Systems automated carbonate device. Foraminifera were hand picked from the >150-µm size fraction, and

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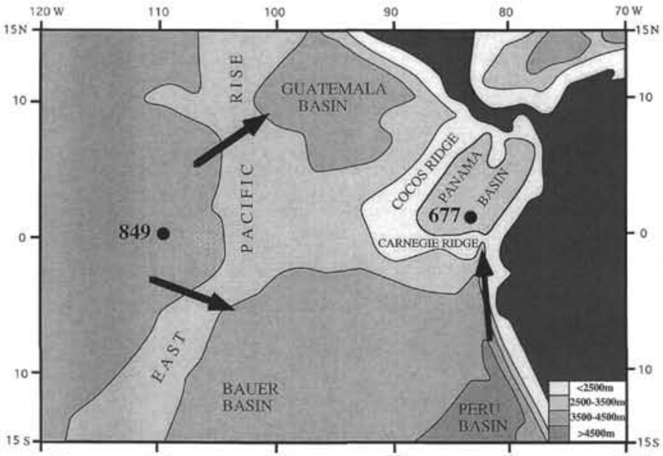


Figure 1. Site 849, at 0°11′N, 110°31′W, at a water depth of 3851 m, is located about 860 km west of the East Pacific Rise on oceanic crust generated about 11–12 Ma. Site 849 is presently bathed by Pacific "Common Water," with potential temperature = 1.2°C and salinity = 34.68‰. For comparison, Site 677, at 1°12′N, 83°44′W, at a water depth of 3461 m, is in the relatively isolated Panama Basin. Arrows indicate the deep-water flow paths inferred by Lonsdale (1977).

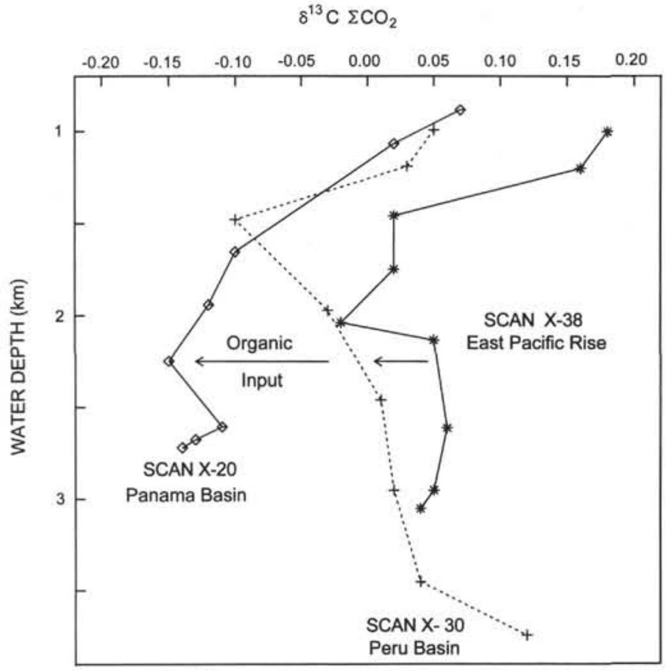


Figure 2. The $\delta^{13}C$ value of ΣCO_2 in the deep waters of the Panama Basin (SCAN X-20) is about 0.2‰ lower than values of the open Pacific (SCAN X-38), mostly because of the decomposition of ^{13}C-depleted organic matter in the basin. Sites in the Peru Basin (SCAN X-30) are intermediate between the two others. All water column data are from Kroopnick (1974).

were ultrasonically cleaned in alcohol and roasted for 1 hr at 400°C under high vacuum to remove organic contaminants. Reactions of carbonates occurred at 90°C, in ~100% phosphoric acid. Precision of the OSU local carbonate standard (WILEY) over the period of analysis was ±0.06‰ for $\delta^{18}O$ and ±0.03‰ for $\delta^{13}C$ ($\pm 1\ \sigma$, $N = 567$). Primary calibration to the PDB standard was through NBS-20, supplied by the U.S. National Institute for Standards and Technology, assuming $\delta^{18}O = -4.14$‰ and $\delta^{13}C = -1.06$‰. Precision on this standard over the same period as the foraminiferal analyses was ±0.08‰ for $\delta^{18}O$ and ±0.05‰ for $\delta^{13}C$ ($\pm 1\ \sigma$, $N = 55$).

Benthic foraminifers were analyzed in 1241 samples from Site 849, at a typical depth spacing of 10 cm. We made 1219 analyses of the species *Cibicides wuellerstorfi* and 200 analyses of the species *Uvigerina peregrina.* Both species were analyzed in 140 samples. Oxygen and carbon isotopic differences between species within the same samples are illustrated in Figure 3. The mean isotopic differences (*Cibicides – Uvigerina*) are −0.60‰ ± 0.18‰ for $\delta^{18}O$ (Fig. 3A) and +0.91‰ ± 0.16‰ for $\delta^{13}C$ (Fig. 3B). Most of the scatter in these offsets is the result of analytical error (about ±0.15‰ for the difference between species, using a conservative estimate of ±0.1‰ random error on any individual foraminiferal analysis; Mix et al., 1991). Any additional error results from the combination of true variability (either random or systematic) in the isotopic offset between different species of foraminifers, plus the possible effects of bioturbation having mixed together specimens from different times.

We found no evidence for systematic relationships of oxygen and carbon isotopic offsets between species (Fig. 3C) and no systematic changes in the species offsets as a function of age or ice volume (as recorded by $\delta^{18}O$). Thus, we consider the variations in the species offsets for both $\delta^{18}O$ and $\delta^{13}C$ in this data set to be random. Although the variability is larger than the precision of the mass spectrometer, it is not significantly different from the analytical noise of typical foraminiferal measurements, and we assume that the true offsets are constant. The bioturbation effect appears to be negligible.

In the combined record, we added the constant 0.64‰ to $\delta^{18}O$ values from *Cibicides wuellerstorfi* to approximate values from *Uvigerina peregrina* (Shackleton, 1974). This value is consistent with our measured offset and is used by most analysts. For the $\delta^{13}C$ values from *U. peregrina,* we used with the standard adjustment of 0.90‰ (Duplessy et al., 1984), which is statistically identical to the offset of 0.91‰ ± 0.16‰ found here. The final composite records of both $\delta^{18}O$ and $\delta^{13}C$ in Site 849 contains 1415 analyses, of which 174 replicate analyses of the same sample. All analyses are listed in Appendix A.

Before plotting the isotope data as a function of sediment depth, we must develop a composite depth model to assemble data from adjacent holes drilled a few tens of meters away from each other. This is because cores obtained by the Ocean Drilling Program (ODP) are recovered in discrete intervals of about 9.5 m, with small gaps or overlaps between them. Depths assigned during drilling, referred to as meters below sea floor (mbsf), are not precise enough for correlation between holes. The initial composite section for Site 849 was developed at sea during Leg 138 using high-resolution (1- to 4-cm intervals) measurements of gamma-ray attenuation porosity evaluator (GRAPE) density, magnetic susceptibility, and light reflectance in triple-cored sites. The shipboard composite depth model moved each core up or down relative to overlapping intervals of adjacent holes, so as to maximize the correlation among holes in these intervals. This process defined linear offsets to the mbsf depths assigned for each core as it was drilled. The offsets tend to increase at greater subbottom depths. Thus, the process created a new depth scale, referred to as meters composite depth (mcd), reported by Hagelberg et al. (1992). A reference section, referred to as the "shipboard splice," assembled representative intervals from all the holes at a site (jumping between holes at a point of excellent match of a distinctive feature) to define a single reference record on the mcd scale.

The mcd scale used to determine the shipboard splice, therefore, was derived from the linear adjustment of whole cores. It does not take into account distortions within individual cores; as a result, some features found in corresponding cores from different holes may not match precisely. To maintain a good correlation among all the holes sampled, the depth in each core must be adjusted to correct for distortion relative to the shipboard splice. Final depth corrections were done by adjusting the depth scale in each core continuously, using the technique of Martinson et al. (1982) to maximize the fit of high-resolution GRAPE data in each core to the corresponding interval of the shipboard splice. This adjustment defines a third depth scale, referred to as revised meters composite depth (rmcd). It is docu-

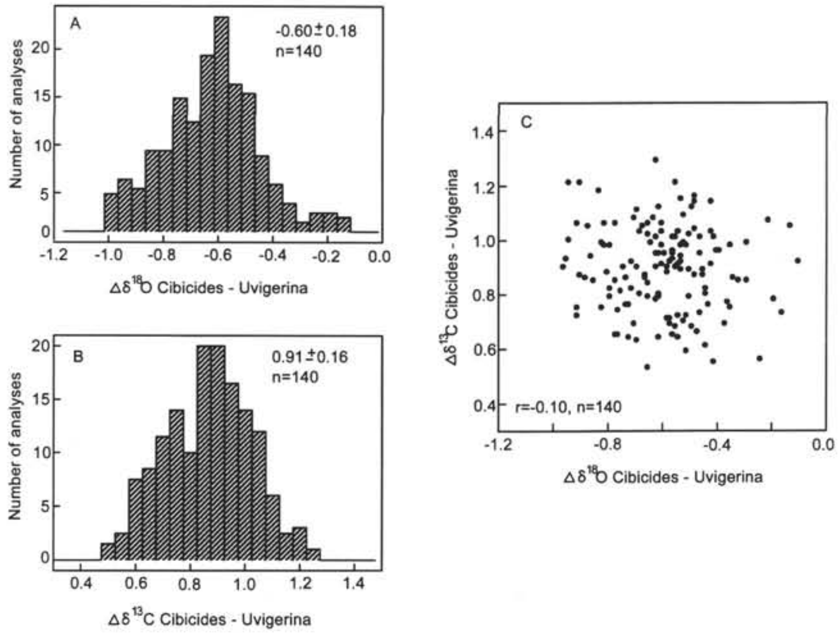


Figure 3. Isotopic offsets between paired analyses of *Cibicides wuellerstorfi* and *Uvigerina peregrina* at Site 849. **A.** Histogram of $\Delta\delta^{18}O$ *Cibicides – Uvigerina* (mean = –0.60‰ ± 0.18‰). **B.** Histogram of $\Delta\delta^{13}C$ *Cibicides – Uvigerina* (mean = 0.91‰ ± 0.16‰). **C.** Scatter plot of individual paired analyses of $\Delta\delta^{13}C$ *Cibicides – Uvigerina* vs. $\Delta\delta^{13}C$ *Cibicides – Uvigerina*, showing that variations in the carbon and oxygen isotopic offsets between species are not related to each other.

mented for all cores by Hagelberg et al. (this volume). The adjustment from mcd to rmcd is small, typically on the order of decimeters. By definition, the adjustment is 0 cm in all intervals that defined the shipboard splice. All three depth scales for our samples in Site 849 are given in Appendix A, but we use the rmcd depth scale.

Figure 4 illustrates the combined isotope data from Site 849 plotted vs. rmcd. Different symbols represent the different holes. The stable isotope data, an independent check of the matches among holes in the rmcd scale, yielded no evidence for gaps or the duplication of intervals in the Site 849 composite. The composite isotope record from 0 to 155 rmcd is shown in detail in 30-m intervals (Figs. 5A–5J). The holes, cores, and sections analyzed are noted here, and different species are illustrated by symbol size. Note that advanced hydraulic piston corer (APC) cores extend to 123 rmcd. Below this depth, the isotope records are based on extended core barrel (XCB) cores from Hole 849D only, and the record is therefore discontinuous. Where sampled intervals in different holes overlap, the match of the isotope data is generally excellent. The only exception appears to be the match between Core 138-849D-12X and -13X at ~133 rmcd. The composite depths for XCB cores, such as these, are less reliable than are depths for APC cores shallower in the sediment column.

AGE MODEL

The age model developed here for Site 849 is defined relative to rmcd depths. It should be equally applicable to the intervals that define the "shipboard splice" on the mcd depth scale, assuming all cores analyzed here were correlated accurately by means of GRAPE, magnetic susceptibility, and reflectance to the shipboard spliced records (Hagelberg et al., this volume). The age model developed here is not applicable to the mbsf depth scale.

The shipboard paleomagnetic reversal record at Site 849 was not useful (Mayer, Pisias, Janecek, et al., 1992). Thus, development of the Site 849 age model started with shipboard biostratigraphic data (which was excellent for all fossil groups) and GRAPE density stratigraphy linked to the magnetic reversal sequence in other Leg 138 sites (Shackleton et al., 1992). This first step was followed by correlation of the $\delta^{18}O$ record from Site 849 directly to the $\delta^{18}O$ record from Site 677, using the SPECMAP time scale (Imbrie et al., 1984) at ages < 0.6 Ma, and the age model of Shackleton et al. (1990) from 0.6 to 2.5 Ma. At ages > 2.5 Ma, Site 677 is discontinuously cored and sampled, and the correlations between Sites 849 and 677 are not obvious. For this interval, we used the tuned GRAPE age model for Site 849 from Shackleton et al. (this volume).

We refer here to the result as the Site 849 oxygen isotope age model. When comparing Site 849 with other sites, we correlate them directly to the $\delta^{18}O$ record from Site 849. The Site 849 age model makes many events older than other isotopic age models in use by about 6% (Ruddiman et al., 1989; Raymo et al., 1990, 1992; Hodell and Venz, 1992). For example, the "2.4 Ma glacial event" (Sykes et al., 1991), thought by some workers to represent the earliest stage of major Northern Hemisphere glaciation (Stage 100 of Raymo et al., 1990), occurs at 2.54 Ma in this time scale. It predicts older ages for paleomagnetic reversals than previously thought (Berggren et al., 1985), but these older dates for the paleomagnetic record have since been accepted by Cande and Kent (1992).

To accomplish the correlation of Site 849 with Site 677 at ages < 2.5 Ma, secondary selection of ages in Site 849 were made by visually comparing its $\delta^{18}O$ record with that of Site 677. Our final age model (tabulated in Appendix B) used the inverse correlation method of Martinson et al. (1982), which mapped $\delta^{18}O$ variations in the Site 849 record to those of the Site 677 reference. This method adjusts ages continuously down the core with a Fourier mapping function, which is modified iteratively to maximize the correlation coefficient between $\delta^{18}O$ records. To avoid artificially correlating high-frequency noise with this method, we first smoothed the Site 677 $\delta^{18}O$ record as a function of time, with a time step of 4 k.y. and a Gaussian smoothing window of 19-k.y width at the $\pm3\sigma$ points. This smoothing effectively removed variations with wavelength less than 10 k.y., but preserved all the variance in the primary orbital bands of 19 k.y. and longer. For correlation purposes only, we smoothed the raw data from Site 849 in the depth domain with a sample interval of 10 cm and a Gaussian

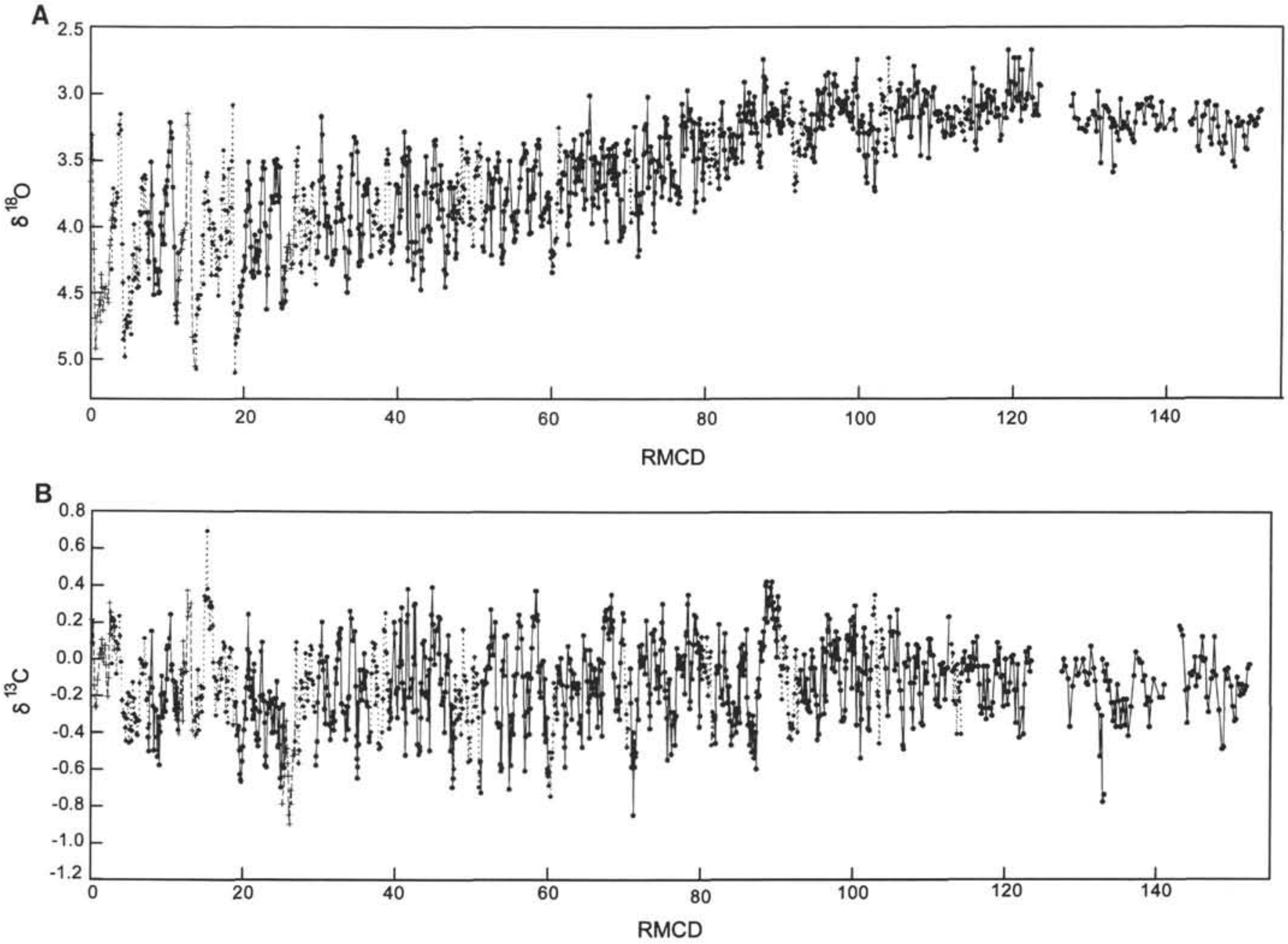


Figure 4. Benthic foraminifer isotope analyses from Site 849 vs. depth (rmcd). Replicate analyses are averaged. Dashed lines = Hole 849B, dotted lines = Hole 849C, and solid lines = Hole 849D. **A.** $\delta^{18}O$. **B.** $\delta^{13}C$. The time span covered is ~5 Ma.

smoothing window of 50 cm. This is roughly equivalent to the time-domain smoothing of Site 677, given an average sedimentation rate of 2.8 cm/k.y. in Site 849. Before final data analysis, the age model was applied to the raw (unsmoothed) data, and a 19-k.y. Gaussian smoothing function was applied in the time domain.

For the interval from 0 to 2.5 Ma, the Site 849 oxygen isotope age model developed here and the Leg 138 tuned GRAPE age model developed by Shackleton et al. (this volume) are similar, but not identical. Both age models are shown in Figures 6A (0–80 rmcd) and 6C (80–160 rmcd). The differences between the age models, generally less than ±20 k.y, are documented in Figures 6B (0–80 rmcd) and 6D (80–160 rmcd). Because of their similarities, either time scale is equally suitable for analyzing climatic variability at periods ≥100 k.y. For analysis of shorter periods of variability and for detailed comparisons to other sites with stable isotope records, the isotopic time scale used here is more appropriate.

The stable isotope records from Sites 849 and 677 are shown as a function of age, after interpolation and smoothing as noted above, in Figure 7. The match between the $\delta^{18}O$ records is exceptionally good above 2.5 Ma. All the isotopic events detected and named by Shackleton et al. (1990) and Raymo et al. (1990) are present and easily identified in the Site 849 record. One additional small interglacial event may be present in Site 849, at 1.74 Ma (48.3 rmcd). This appears to be a part of $\delta^{18}O$ stage 61, which is adjacent to a core break in Site 677, but this event clearly is present in Atlantic Ocean Site 607 (Ruddiman et al., 1989).

DISCUSSION

$\delta^{18}O$ and $\delta^{13}C$

Over the past 2.5 Ma, Site 849 benthic foraminifers have $\delta^{18}O$ values 0.17‰ ± 0.15‰ less than Site 677. This would suggest bottom water slightly colder, saltier, or otherwise enriched in $\delta^{18}O$ at Site 677 relative to that at Site 849. Modern bottom-water temperatures in the Panama Basin, however, are about 0.6°C warmer than those at Site 849 (Lonsdale, 1976, 1977). There may be a slight difference in mass spectrometer calibration because the OSU mass spectrometer is presently calibrated for $\delta^{18}O$ primarily through NBS-20, and the University of Cambridge instrument is calibrated primarily through NBS-19 (N.J. Shackleton, pers. comm., 1992). However, other comparisons of isotopic results from OSU and Cambridge suggest no significant calibration offsets for either $\delta^{18}O$ or $\delta^{13}C$ (Zahn and Mix, 1991; Mix, Le, et al., this volume; Shackleton, this volume).

Relationships among the isotope records of Sites 677 and 849 are explored in more detail using spectra and cross spectra. Details of methods are given by Imbrie et al. (1989). For consistency of phase calculations with SPECMAP conventions (Imbrie et al., 1989), all $\delta^{18}O$ records are multiplied by –1, so that larger values indicate interglacial conditions. Positive phase indicates a lag of variable 2 relative to variable 1. If variable 1 is $-\delta^{18}O$, this indicates a lag of variable 2 relative to interglacial conditions. In the spectral calculations, unless otherwise noted, the bandwidth is 0.0017 k.y.$^{-1}$, and spectra were calculated from 601 points with 4-k.y. spacing, using 200 lags in the cross-covariance calculation.

The δ^{18}O records from Sites 849 and 677 contain essentially identical distributions of variance as a function of frequency, with the strongest concentrations of variance at the orbital periods of 100, 41, 23, and 19 k.y. (Fig. 8A). The two δ^{18}O records are highly coherent with each other and in phase in all dominant bands with wavelengths $\geq$19 k.y. (Fig. 8B–C). We conclude that the δ^{18}O records are sufficiently well correlated that we can consider differences between their δ^{13}C records at periods $\geq$19 k.y.

The carbon isotope records at the two sites share many similarities, but they are not identical (Fig. 7B). Over most of the record, the δ^{13}C values from Site 677 are significantly lower than those from Site 849, consistent with the modern water column difference (Fig. 2), which is driven mostly by organic carbon influx to the Panama Basin. This difference is especially obvious in the intervals from 1.2 to 1.6 Ma and from 2.1 to 2.4 Ma, where the δ^{13}C values from Site 677 are typically 0.5‰ lower than those from Site 849. Site 677 contains a long-term trend toward lower δ^{13}C values in older intervals. This trend was interpreted by Raymo et al. (1990) as reflecting higher global-average nutrient contents in the Pliocene ocean. Site 849 has no trend. This lack of a long-term trend in δ^{13}C is confirmed for the past 1.8 Ma in the benthic δ^{13}C record from Site 846 (Mix et al., this volume). Therefore, we think that the δ^{13}C trend in Site 677 is a local signal associated with the unique setting of the Panama Basin. This new view of stable long-term average δ^{13}C in Site 849 will force a reexamination of inferences about long-term ocean history that have depended on the Site 677 record.

After removing the long-term trend in Site 677, the δ^{13}C records from Sites 849 and 677 are highly coherent and nearly in phase with each other over the last 2.4 Ma, at almost all periods (1/frequency) longer than 40 k.y. (Fig. 8E–F). With the narrow bandwidth of this analysis relative to those commonly used for shorter paleoceanographic records, we can clearly distinguish some of the lower frequency bands that often have been lumped into the 100-k.y. cycle. On this time frame, the Pacific Ocean δ^{13}C record does not have as strong a concentration of variance at the 100-k.y. climate cycle as does δ^{18}O. Instead, the dominant long-period variations in δ^{13}C are at a longer period (near 400 k.y.) and about equally at three periods of 80, 100, and 133 k.y. (Fig. 8D). The strong 41-k.y. period in δ^{13}C is similar to that of orbital obliquity. The variations in δ^{13}C near the precessional periods of 23 and 19 k.y. are not well defined at Site 677 and are not strongly coherent in these two δ^{13}C records, even though they were strong in δ^{18}O measured on the same samples in both cores.

The presence of similar rhythmic signals in deep Pacific Ocean δ^{13}C (Fig. 8D) and δ^{18}O (Fig. 8A) is expected for periods much shorter than the 200- to 300-k.y. residence time of carbon in the oceans (Broecker and Peng, 1982). On these time frames, variations in the mass of organic matter stored in forests, soils, and shallow-marine sediments, presumably related to glacial-interglacial climate change, are thought to dominate the δ^{13}C record (Shackleton, 1977). At periods longer than a few 100 k.y., however, the isotopic balance of long-term erosion and deposition of carbon must play a more important role in driving oceanic δ^{13}C. At these long periods, the ocean is flushed by an influx of carbon from rivers and by burial of carbon to balance the river flux. Transient effects such as biomass change are not expressed in this long-term balance. Long-term changes in oceanic δ^{13}C could reflect either the δ^{13}C of the mean river flux, the δ^{13}C of buried carbonate and organic carbon, or the fraction of carbon buried as organic matter. It is not clear which mechanisms dominate the spectrum in the range of periods from 100 to 300 k.y.

To examine the significance of relationships between δ^{13}C and δ^{18}O, we plot spectra and cross spectra between $-\delta^{18}$O and δ^{13}C at each site (Fig. 9). At Site 849, δ^{13}C is coherent with $-\delta^{18}$O in all the major orbital bands except the 19-k.y. precessional period (Figs. 9A–9B). Information on phase of δ^{13}C relative to $-\delta^{18}$O (Fig. 9C) is meaningful where there is significant shared variance (peaks in Fig. 9A) and where these peaks are coherent (Fig. 9B). In these coherent bands, the phases of δ^{13}C relative to $-\delta^{18}$O are not constant. Variations in δ^{13}C lead those of $-\delta^{18}$O at longer periods such as 100 k.y. (phase = $-12° \pm 12°$), and lag behind $-\delta^{18}$O at shorter periods such as 41 k.y. (phase = $+15° \pm 8°$) and 23 k.y. (phase = $+22° \pm 15°$).

A similar analysis of the relationships between the δ^{13}C and $-\delta^{18}$O records in the interval 0–2.4 Ma in Site 677 agrees in most features with Site 849, but does not reveal any significant bands of concentrated variance common to δ^{13}C and $-\delta^{18}$O at periods shorter than 41 k.y., and has lower integrated coherency (Figs. 9D–9F). Site 846, analyzed over the interval 0–1.8 m.y. by Mix et al. (this volume), yields relationships between the δ^{13}C and $-\delta^{18}$O records that are essentially identical to those of Site 849.

In the interval 2.4–4.42 Ma in Site 849, the distribution of variance is somewhat different in δ^{13}C and $-\delta^{18}$O than in the younger record (Fig. 9G). The total variance is less, and $-\delta^{18}$O contains variance at long periods (>400 k.y.) as well as at the primary orbital bands of 100, 41, and 23 k.y. The δ^{13}C record contains significant variance in the 41-k.y. band that is coherent with that of $-\delta^{18}$O (Fig. 9H). The phase spectrum, however, is nearly identical to that from 0–2.4 Ma, with δ^{13}C leading $-\delta^{18}$O at the 100-k.y. period, and lagging in the shorter periods (Fig. 9I). This feature of the phase spectrum appears to be robust and not sensitive to the radically different global climate regimes of the Pliocene and Pleistocene. This has not been noticed before, because most records from late Pleistocene time are too short to allow calculation of phase with sufficient precision to detect such small phase shifts.

Assuming that Site 849 represents the global average record, the observation that δ^{13}C lags $-\delta^{18}$O at shorter periods is consistent with the biosphere behaving as a simple exponential system responding with a single time constant. Following modeling concepts in Imbrie (1985) and Pisias et al. (1990), the phase of biomass relative to presumed forcing in such a system would be described by $\phi = \arctan(2\pi f\tau_b)$, where ϕ is the phase angle at a given frequency, f is frequency (= 1/period), and τ_b is the time constant for changing biomass. A model such as this produces a phase shift, with greater lags of the response behind the forcing at shorter periods. If we assume that the climatic forcing of biomass is glaciation, as recorded by δ^{18}O, the phase of δ^{13}C relative to $-\delta^{18}$O can be simulated with $\tau_b = 1–2$ k.y. This time constant is too long for living forest biomass, which should respond by factor of 10 times faster (Sundquist, 1993). If τ_b is indeed > 1 k.y., then changes in the mass of carbon in soils and shallow sediments must be involved, as these would take longer to respond than living forests.

This model cannot simulate the lead of δ^{13}C relative to $-\delta^{18}$O at the 100-k.y. period. A lead of δ^{13}C would require either some unknown climatic forcing of biomass unique to this band, which leads $-\delta^{18}$O by 10° to 20°, or the addition of another process such as changes in mean river δ^{13}C that could occur on climatic transitions (perhaps related to rise and fall of sea level). This latter process seems more plausible, as it could reflect changes in chemical weathering that would only be expressed significantly by δ^{13}C at longer time scales because of the long residence time of carbon in the ocean. It is consistent with recent evidence for changes in the ^{87}Sr/^{86}Sr value of seawater with a 100-k.y. rhythm (Clemens et al, 1993), which if true would require massive changes in chemical weathering on the continents leading ice-volume change.

The roughly equal strength of δ^{13}C variations over a range of periods from ~80 to ~133 k.y. (Figs. 9A and 9D) may reflect nonlinear processes related to orbital eccentricity controlling δ^{13}C in these bands, as these periods match those of sum and difference interactions of the primary orbital eccentricity bands of ~100 and ~400 k.y. (i.e., $1/80 = 1/100 + 1/400$, and $1/133 = 1/100 - 1/400$). The existence of these bands, however, is not sufficient to establish clear nonlinear linkage. These possibilities will need to be examined with higher order spectral techniques (Hagelberg et al., 1991) to confirm a rela-

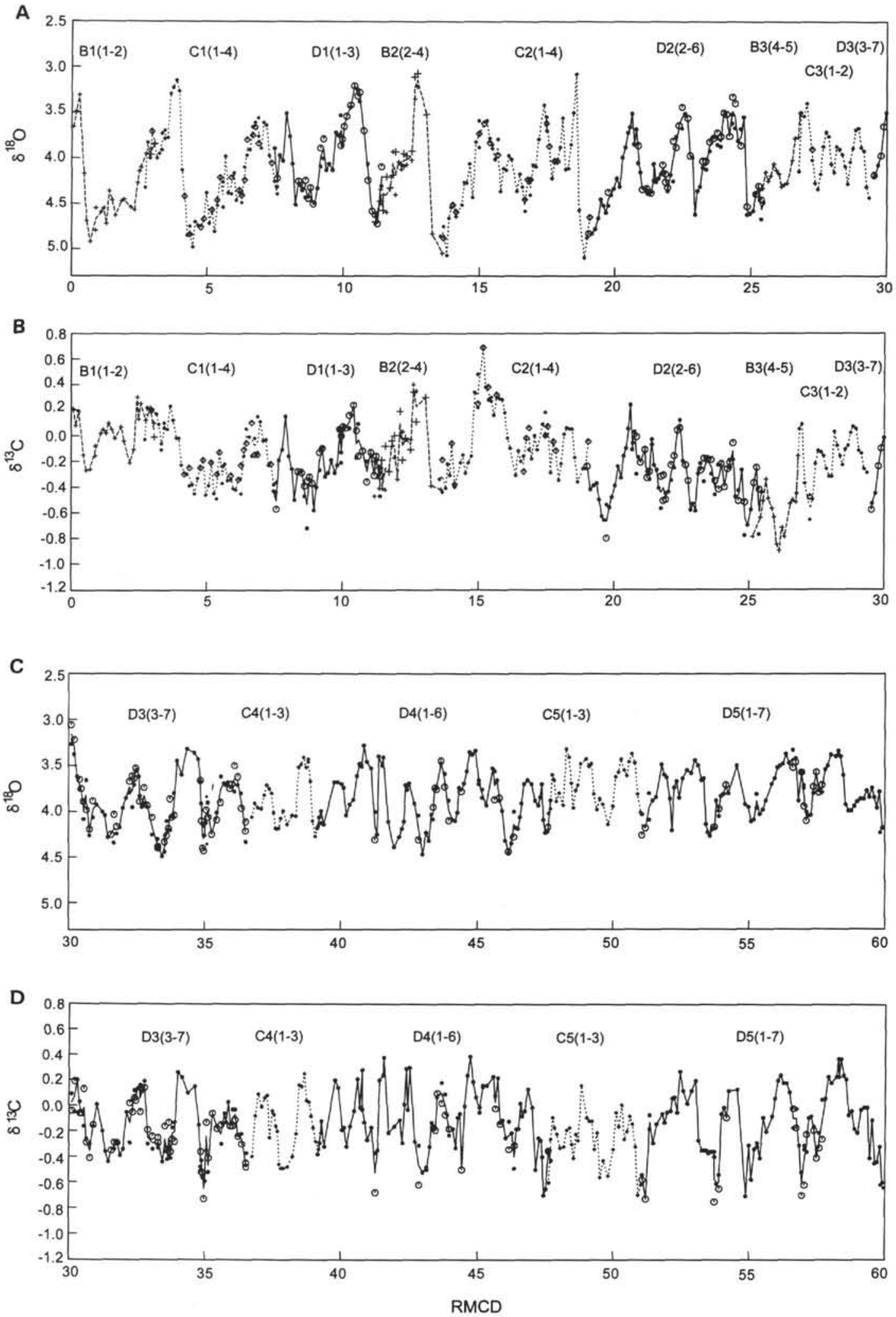


Figure 5. Data as in Figure 4, but shown at a larger scale to illustrate the cores and sections measured, and the matches of the composite depth section between holes. Replicate analyses are averaged for the lines, but all individual analyses are shown without averaging as discrete points. Small symbols are from *Cibicides wuellerstorfi,* and large symbols are from *Uvigerina peregrina.* Hole 849B has dashed lines and plus symbols. Hole 849C has dotted lines and diamond symbols. Hole 849D has solid lines and circle symbols. **A.** $\delta^{18}O$ (0–30 rmcd). **B.** $\delta^{13}C$ (0–30 rmcd). **C.** $\delta^{18}O$ (30–60 rmcd). **D.** $\delta^{13}C$ (30–60 rmcd). **E.** $\delta^{18}O$ (60–90 rmcd). **F.** $\delta^{13}C$ (60–90 rmcd). **G.** $\delta^{18}O$ (90–120 rmcd). **H.** $\delta^{13}C$ (90–120 rmcd). **I.** $\delta^{18}O$ (120–155 rmcd). **J.** $\delta^{13}C$ (120–155 rmcd). All cores were cored with the APC, except in Figures 5I and 5J, where Cores 138-849D-12X, -13X, and -14X were taken with the XCB.

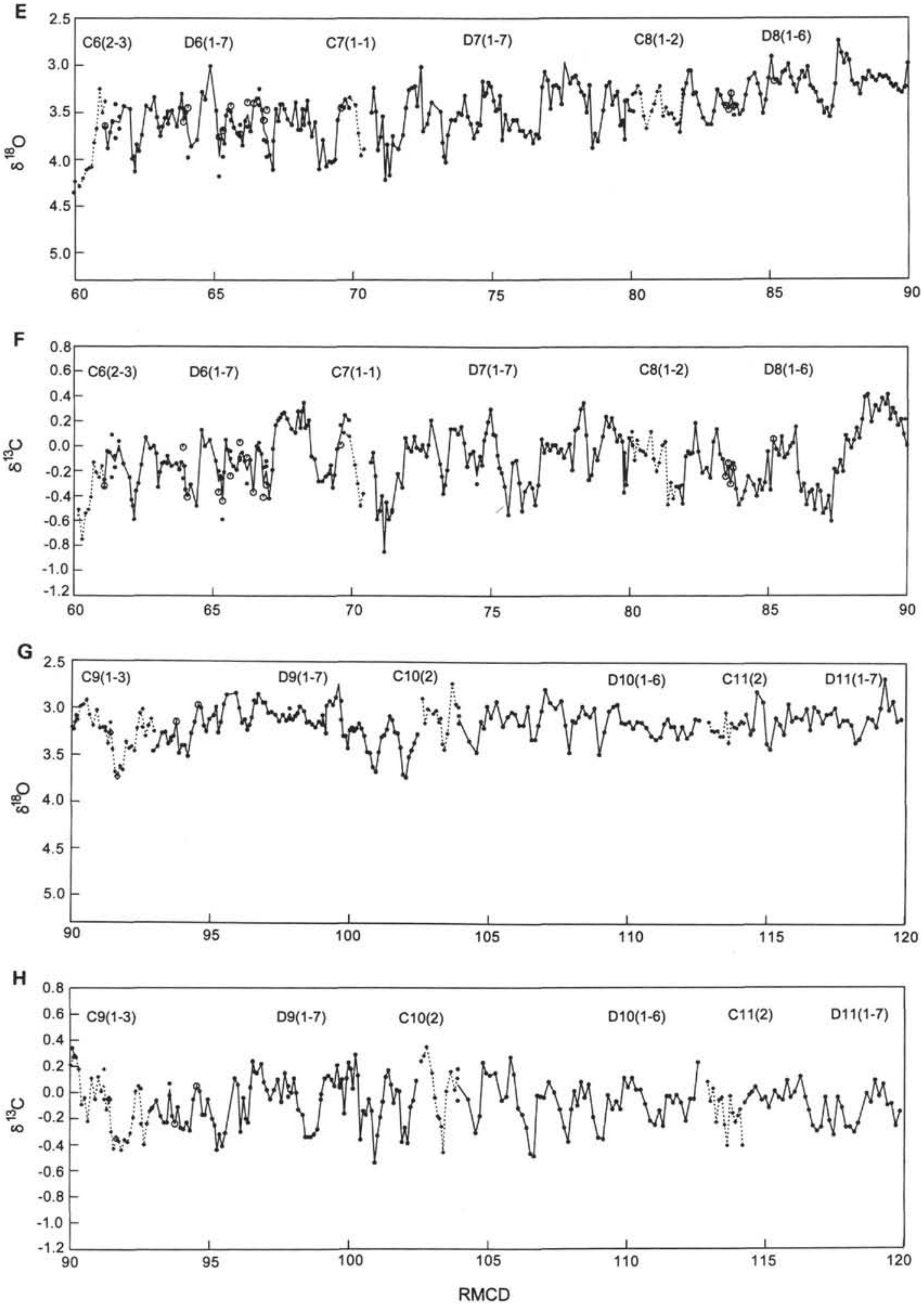
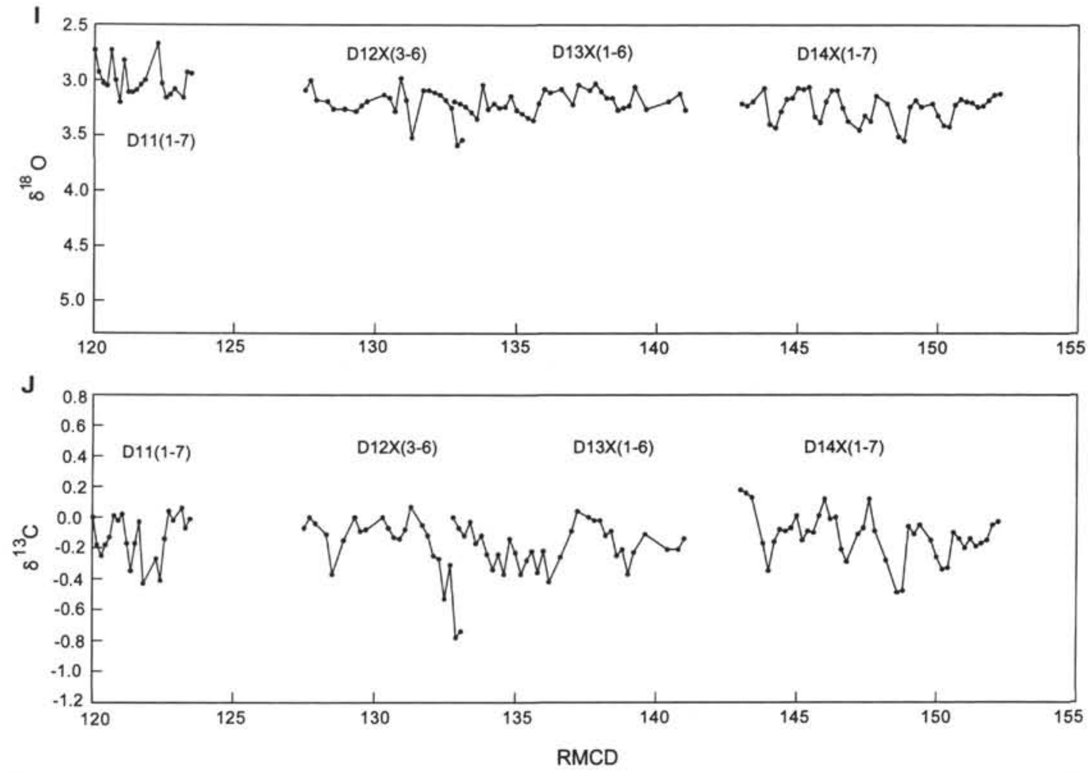


Figure 5 (continued).

tionship. The relatively strong and consistent 41-k.y. rhythm in $\delta^{13}C$ suggests that variations in high-latitude organic carbon mass may be a critical contributor to the signal. In contrast, tropical climates (especially in the tropical Atlantic and Amazon region) appear to vary more strongly with the 23-k.y. precessional rhythm, which dominates seasonal insolation at low latitudes (Imbrie et al., 1989).

$\delta^{13}C$ Gradients: Panama Basin–Pacific

Based on modern water column information in Figure 2, it is likely that some local carbon isotope signals are present in the deep Panama Basin record from Site 677, which have been superimposed on global variations. To examine this possibility in more detail, we calculate the



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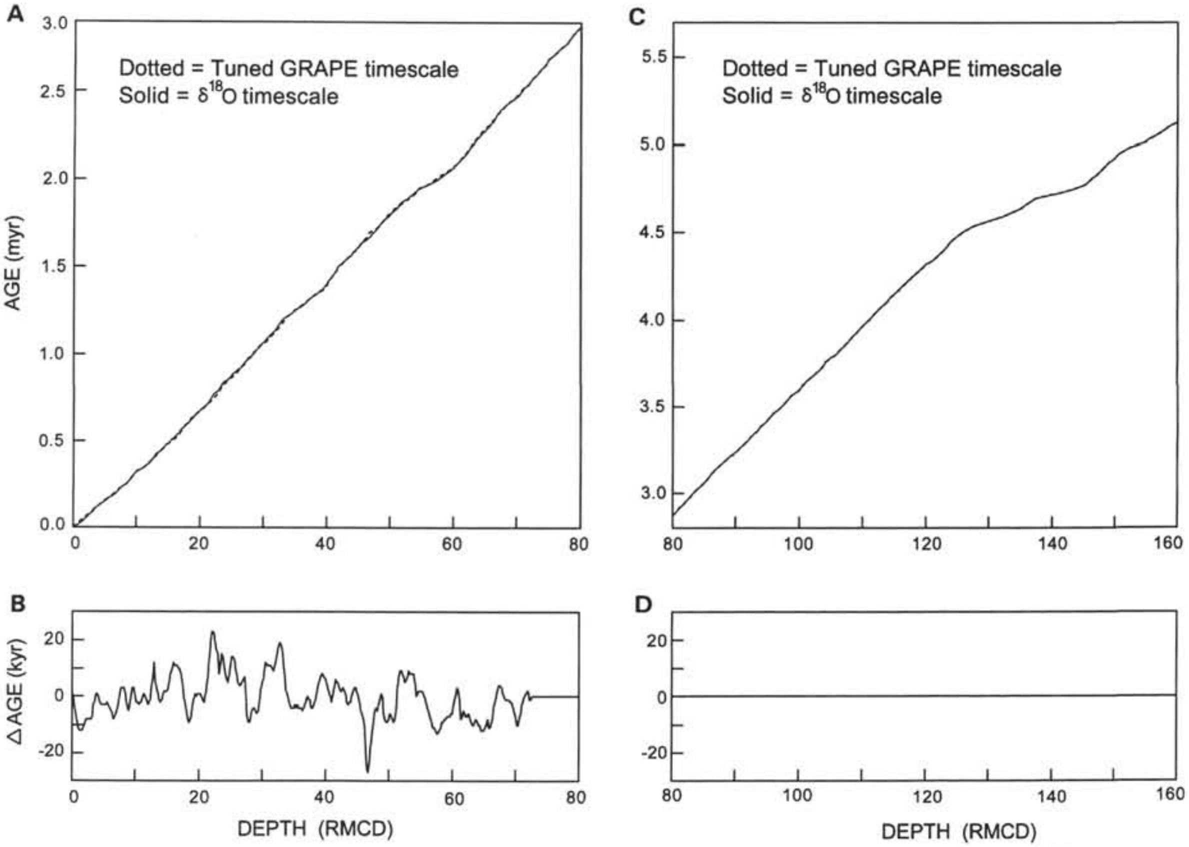

Figure 6. Age models for Site 849. **A.** Depth vs. age (0–80 rmcd). The solid line is the $\delta^{18}O$ age model developed here, and the dotted line is the tuned GRAPE age model of Shackleton et al (this volume). **B.** Difference between the two age models in Figure 6A. Positive values indicate that the isotope age model is older than the tuned GRAPE age model. Differences are generally within ±20 k.y. **C.** Depth vs. age (80–160 rmcd). **D.** Difference between the two age models in Figure 6C. Note that below ~70 rmcd, independent age models were not generated, so the difference between the two models is 0.0. Over the interval we analyzed here, mean sedimentation rates are 28 m/m.y.

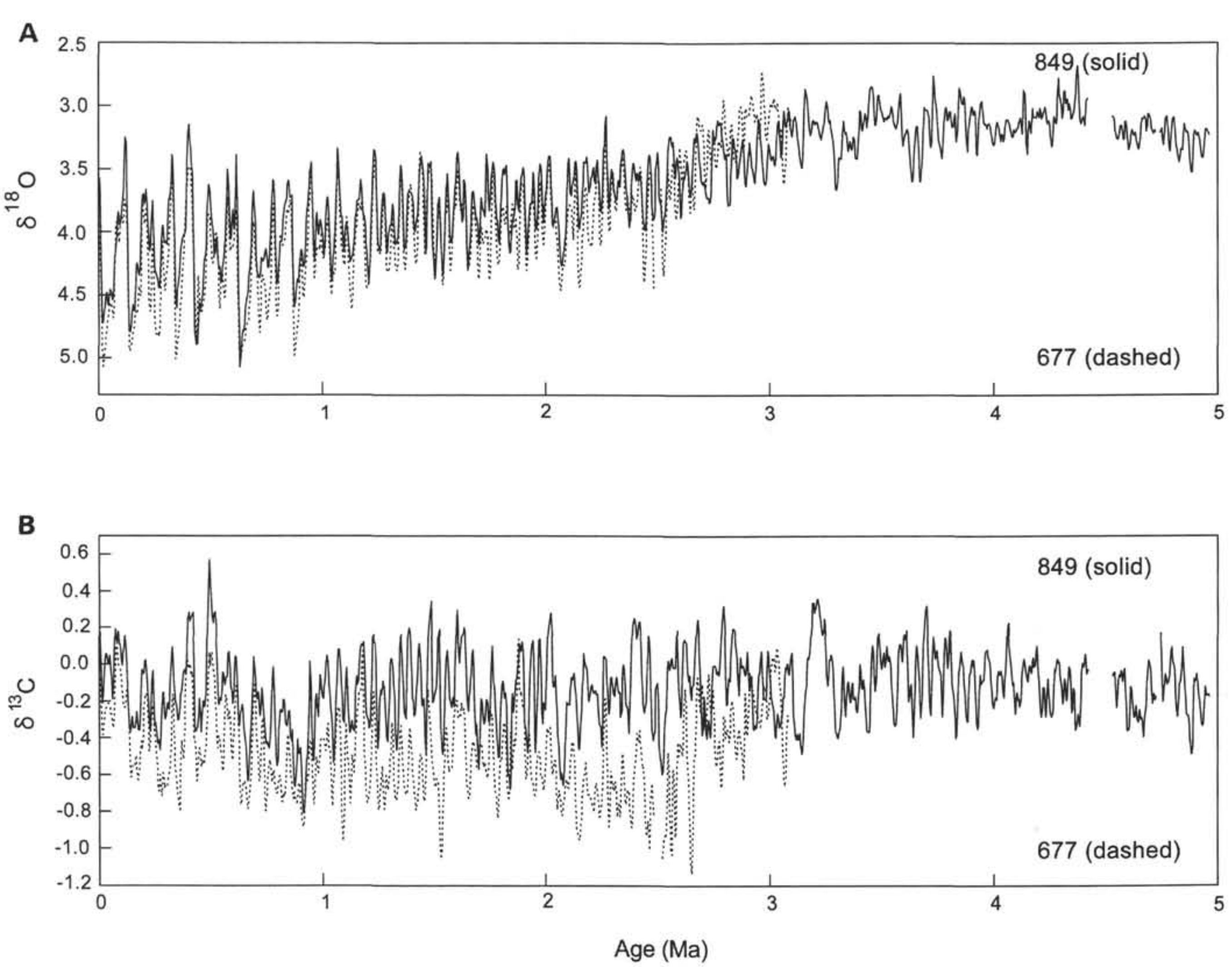

Figure 7. Isotope records from Sites 849 and 677 vs. age, after interpolation to 4-k.y. intervals and smoothing with a 19-k.y. Gaussian filter. **A.** $\delta^{18}O$ vs. age. **B.** $\delta^{13}C$ vs. age. No attempts were made to force correlations below 2.48 Ma, because Site 677 is discontinuous here. The record from Site 849 is essentially continuous over the full transition from mid-Pliocene warmth (3.4–4.4 Ma) to the late Pleistocene glacial extremes.

$\delta^{13}C$ difference between Panama Basin Site 677 and Pacific Ocean Site 849 (Fig. 10), $\Delta\delta^{13}C_{(PB\text{-}P)}$. When making this difference calculation, we first interpolated both records to constant sampling intervals of 4 k.y., using a Gaussian smoothing window 19 k.y. wide. The interpolated, smoothed records are shown in Figure 10A. Where less than two data points exist within a smoothing window, the record has been left blank and the isotopic difference was not calculated.

The variance in $\Delta\delta^{13}C_{(PB\text{-}P)}$ (0.037‰^{2}) is large, nearly the same as the variance in either the $\delta^{13}C$ record from either Site 677 (0.049‰^{2}) or Site 849 (0.047‰^{2}). It is significantly greater than the variance expected from conservative estimates of random analytical noise that exists in any difference between records (0.020‰^{2}). Clearly the local signals in the Panama Basin are great enough to preclude the use of the Site 677 record as a proxy for global $\delta^{13}C$. The $\delta^{13}C$ difference between sites is almost always negative, reflecting lower $\delta^{13}C$ values in the Panama Basin than in the open Pacific because of degradation of low-$\delta^{13}C$ organic matter in the Panama Basin. A significant long-term trend can be seen in the $\delta^{13}C$ difference record (Fig. 10B). Over the last 300 k.y., the average $\delta^{13}C$ difference between Sites 849 and 677 is –0.2‰ (about the same as the modern value), whereas for the period from 2.2 to 2.5 Ma, the average is –0.6‰. In some parts of the record, such as near 1.5 and 2.4 Ma, the $\delta^{13}C$ gradients between the Panama Basin and the deep Pacific Ocean reached –1.0‰. Using modern relationships of oxygen and $\delta^{13}C$ in the eastern Pacific (Kroopnick, 1974), this $\delta^{13}C$ contrast suggests that Panama Basin bottom waters approached anoxia at these times. It is difficult, however, to constrain the oxygen level with certainty, because the point of anoxia recorded by $\delta^{13}C$ within the basin depends on both the concentration of oxygen in source waters outside the basin, and the $\delta^{13}C$ of organic matter decaying in the basin, and these values only partially known in the past.

To explore what processes may drive such large differences in $\delta^{13}C$ between the Panama Basin and the Pacific, we consider a simple one-box model that calculates the $\delta^{13}C$ gradient between the deep Panama Basin and the open Pacific Ocean at equivalent depths ($\Delta\delta^{13}C_{(PB\text{-}P)}$), for variations in water residence times and upper ocean export productivity. Figure 11 shows this box model structure.

The volume of the Panama Basin deeper than 1.9 km is 4.4×10^5 km^3. Depths of the basin are typically 3100–4000 m, whereas ridges around the basin average depths of 1000–1500 m (Van Andel et al., 1971). Primary ventilation of water is through the Peru Trench, with a sill depth of about 2900 m (Laird, 1971; Lonsdale, 1977), but the entire basin is relatively isolated from the open Pacific below 2 km depth. The water residence time in the basin is relatively short, about

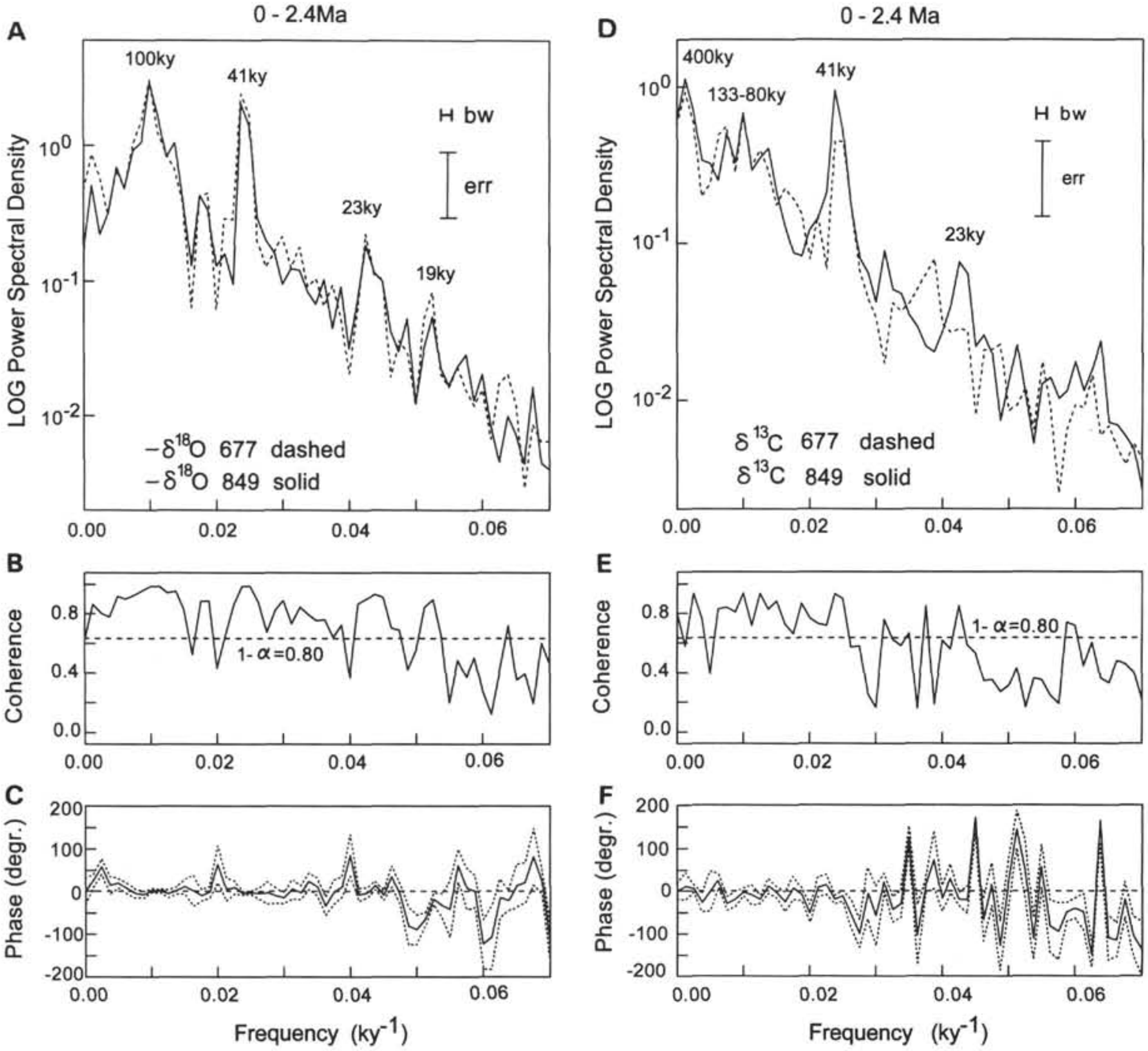

Figure 8. Spectra and cross spectra comparing the $\delta^{18}O$ and $\delta^{13}C$ records between Sites 849 and 677 from 0 to 2.4 Ma. The bandwidth (bw) is 0.0017 k.y.^{1}. **A.** Power spectra. **B.** Coherency spectrum, between $\delta^{18}O$ in Sites 849 and 677. Values higher than the dashed line are significant at the 80% confidence level. **C.** Phase spectrum, $\delta^{18}O$ in Sites 849 and 677. Dashed lines outline 80% confidence envelope. Positive phase indicates Site 849 lags Site 677. All coherent bands are essentially in phase. **D.** Power spectra. **E.** Coherency spectrum, $\delta^{13}C$ in Sites 849 and 677. **F.** Phase spectrum, $\delta^{13}C$ in Sites 849 and 677.

40–50 yr (Lonsdale, 1977). This rapid flushing is driven by the intense hydrothermal heat flow into the basin (Detrick et al., 1974), which raises the temperature and thus lowers the density of deep water in the Panama Basin relative to that at equivalent depths just outside the basin.

In the box model, water outside the basin (which is the source water for ventilation) has a $\delta^{13}C$ value fixed at 0.0‰, and a $\sum CO_2$ value of 2300 μm kg^{-1}. We set advection so that the modern water residence time in the basin τ_0 = 42 yr (Lonsdale, 1977). Vertical diffusion is also included for exchange with overlying waters, with diffusivity of 0.3 cm^2 s^{-1} between depths of 1.9 and 3.1 km, but this term is small relative to the advection and may be ignored. The modern influx and oxidation of low-$\delta^{13}C$ organic matter, J_0 is ~3.3 gC/m^2/yr, based on sediment trap data at the 2400-m depth (Honjo et al., 1992). The organic matter decaying in the deep Panama Basin has a $\delta^{13}C$ value of −21‰ (Pedersen et al., 1991), and for the purpose of this model we assume it stays constant through time. We ignore the contributions of carbon from hydrothermal venting in the Panama Basin (with a mantle $\delta^{13}C$ of −6‰; Des Marais, 1985). We justify this by estimating volcanic carbon flux from heat-flow data, knowing the total heat flow is 1.5×10^{18} cal/yr (Detrick et al., 1974), the enthalpy/^{3}He ratio is 7.6×10^{-8} cal/atom (Craig and Lupton, 1981), and the C/^{3}He ratio is 1.4×10^9 in the Galapagos region (Des Marais, 1985). This yields an estimate for the volcanic carbon flux of 5×10^{10} gC/yr in the Panama Basin, nearly 2 orders of magnitude less than the degradation of organic carbon in the deep basin (2×10^{12} gC/yr). In spite of the rapid flushing of water in the basin, this organic carbon flux is sufficient to lower the $\delta^{13}C$ value of $\sum CO_2$ in the model by 0.15‰ relative to values outside the basin, roughly consistent with water column data (Fig. 2).

To examine the sensitivity of the model to changing circulation and productivity, we solve the model for $\Delta\delta^{13}C_{(PB-P)}$ over a range of water residence times and organic carbon fluxes relative to modern values (Fig. 12). With a tripling of either J or τ, the $\delta^{13}C$ gradient would also roughly triple, to a value of −0.45‰. Tripling both J and τ would increase the $\delta^{13}C$ gradient by a factor of about 9, to −1.35‰.

Thus, to explain the long-term variations in $\Delta\delta^{13}C_{(PB-P)}$ observed in Figure 10, either the Panama Basin was more isolated and water residence times longer in the earlier period, or average productivity over the basin was much higher in this older interval than in the late

Pleistocene interval. Major changes in the volume or ventilation of Panama Basin associated with sequential closing of the Panamanian Isthmus (completed between 3 and 4 m.y. ago; Keigwin, 1982), might induce local $\delta^{13}C$ signals in the basin by changing deep-water residence times or productivity of overlying surface waters. Christie et al. (1992) inferred surprisingly rapid tectonic subsidence of parts of the Carnegie Ridge in the last few million years. Holding other variables (such as geothermal heating) constant, this would increase ventilation of the deep Panama Basin through time and thus drive local $\delta^{13}C$ toward that of the open Pacific, as observed. It is likely that long-term tectonic control of the shape and size of the Panama Basin or its bounding ridges would induce only gradual change in $\Delta\delta^{13}C_{(PB-P)}$.

Shorter period variations cannot be explained by tectonics. Were the benthic foraminifer $\delta^{13}C$ gradient between the Panama Basin and the deep Pacific to covary with surface-ocean signals or ice-age rhythms, then the most likely cause of local $\delta^{13}C$ change in the basin would be changing productivity of near-surface waters. Independent evidence exists for changing productivity over the Panama Basin, with glacial productivity perhaps several-fold higher than modern values (Pedersen, 1983). Variations in water residence time most likely would respond to changes in hydrothermal heating in the basin, which is probably random and unrelated to ice-age rhythms. To distinguish between the productivity and hydrothermal hypotheses, we ask whether the shorter term variations in $\Delta\delta^{13}C_{(PB-P)}$ are random or related systematically to rhythmic climate changes of the ice ages. Spectra and cross spectra between $\Delta\delta^{13}C_{(PB-P)}$ and $-\delta^{18}O$ (Pacific) over the last 2.4 Ma reveal no concentrations of variance in $\Delta\delta^{13}C_{(PB-P)}$ that stand out as spectral peaks greater than the error of estimate (Fig. 13A), and no significant coherence with the dominant spectral bands of $\delta^{18}O$ (Fig. 13B). The spectrum of $\Delta\delta^{13}C_{(PB-P)}$ is to first approximation "red" noise. This is also the case when the spectrum of $\Delta\delta^{13}C_{(PB-P)}$ is calculated only within the late Quaternary interval. This suggests either that much of the variation in the Panama Basin to Pacific $\delta^{13}C$ gradient is driven by changes in the rate of basin flushing, with no obvious link to global climate or orbital variation, or that our assumption that productivity changes are systematically related to climate change was wrong.

$\delta^{13}C$ Gradients: Atlantic–Pacific

If the Site 849 $\delta^{13}C$ record is taken as the most representative measure of Pacific deep-water $\delta^{13}C$, how does this change our view of the history of global deep-ocean circulation? To address this question, we first compare the isotope record from Site 849 with the North Atlantic Ocean record from Site 607 (Raymo et al., 1990, with additions by Raymo et al., 1992). The record from Site 607 contains analyses from the genus *Uvigerina* in the upper ~300 k.y. (from nearby piston Core V30-97 analyzed by Mix and Fairbanks, 1985), and we have not attempted to remove those analyses from the record. To make this comparison, we placed the Site 607 record on the same time scale as the Site 849 and 677 records, using the inverse correlation methods discussed above (the revised time scale for Site 607 is tabulated in Appendix E).

Figure 14 illustrates the $\delta^{18}O$ and $\delta^{13}C$ isotope records from Atlantic Site 607 and Pacific Site 849 on the Site 849 time scale. The two $\delta^{18}O$ records (Fig. 14A) are exceptionally coherent with each other. The two $\delta^{13}C$ records are significantly different from each other. The Pacific site almost always has $\delta^{13}C$ values lower than the Atlantic site, consistent with earlier studies.

To examine the interocean $\delta^{13}C$ contrast, we calculated the Atlantic-Pacific differences $\Delta\delta^{13}C_{(A-P)}$ with the same smoothing and interpolation used for the Panama Basin–Pacific comparisons. Smoothed versions of the Site 849 and 607 $\delta^{13}C$ records are shown in Figure 15A. We calculated the interocean differences in two ways: first, the $\delta^{13}C$ differences between Atlantic Site 607 and Panama Basin Site 677 are shown as a dashed line in Figure 15B; second, we made a similar calculation of the $\delta^{13}C$ differences between Atlantic Site 607 and Pacific Site 849, which is shown as a solid line in Figure 15B.

We did not make the "%ATL/PAC" calculation of Raymo et al. (1990), which involves the relative position of $\delta^{13}C$ in Site 607 between the data from a Pacific site and a shallower Atlantic site (DSDP Site 552, 56°N, 23°W, 2301 m depth). This calculation would attempt to remove the effect of changing pre-formed $\delta^{13}C$ in the NADW source water. Although we agree in principle that this calculation is a useful way to look at the data, we avoided it here for three reasons. First, this double-difference calculation tends to amplify analytical noise, which makes all but the largest amplitude signals impossible to interpret. Second, it is not clear that Site 552 always monitors pure northern Atlantic source waters (deMenocal et al., 1992). Third, the data from Site 552 are not sufficiently complete to construct a long, continuous time series of isotope differences. Raymo et al. (1990) were left with some large gaps in their %ATL/PAC calculation, and we sought to avoid these gaps as much as possible.

The largest amplitude variations in the $\delta^{13}C$ contrast between the oceans occur between ~0.4 and 0.9 Ma (Fig. 15B). Most likely, this results from large variations in the influence of low-nutrient, high-$\delta^{13}C$ northern Atlantic waters in the deep Atlantic Ocean. These findings are completely consistent with the inferences of Raymo et al. (1990). Furthermore, for these results, it does not matter whether Site 849 or Site 677 is used to represent the Pacific Ocean in the calculation. With the new data from Site 849, however, $\Delta\delta^{13}C_{(A-P)}$ values as low as the last glacial maximum occur back to ~1.5 Ma. Thus, variations in Atlantic water masses as large as those of the latest Pleistocene must have been common before the expanded glacial cycles of the last million years.

The interval from about 1.3 to 2.1 Ma stands out as having mean Atlantic-Pacific $\delta^{13}C$ contrast values larger than those typical for late Pleistocene interglacial events (Fig. 15B). This feature implies either (1) greater nutrient contrast between the ocean basins at that time, (2) greater pre-formed $\delta^{13}C$ in NADW source waters relative to nutrients, or (3) lower pre-formed $\delta^{13}C$ in waters feeding the deep Pacific. The nutrient-contrast scenario might reflect a greater role for import of nutrient-poor upper ocean waters relative to nutrient-rich bottom waters into the Atlantic, which combine to balance the export of deep water in the modern ocean. Were the total nutrient content of the global oceans higher at that time, this would increase the net nutrient and $\delta^{13}C$ gradient between oceans without requiring changes in circulation (Boyle, 1986). The pre-formed $\delta^{13}C$ scenario comes from the role of partial gas exchange in setting the $\delta^{13}C$ value of source waters leaving the sea surface. Broecker and Maier-Reimer (1992) argued that, today, southern source waters to the deep Pacific (actually a mixture of Weddell Sea Bottom Water and NADW) have a pre-formed $\delta^{13}C$ value about 0.5‰ higher than that in the North Atlantic. Were this contrast in pre-formed $\delta^{13}C$ lower, a greater Atlantic-Pacific $\delta^{13}C$ gradient would result.

Before 2.1 Ma, the mean Atlantic-Pacific $\delta^{13}C$ difference calculated using Site 849 to represent the Pacific is similar to that of late Pleistocene interglacial extremes, but lower than the mean difference between 1.3 and 2.1 Ma. The values of $\Delta\delta^{13}C_{(A-P)}$ between 2.1 and 3.2 Ma often are within the range of the glacial and interglacial events of the last 120 k.y. (marked by horizontal dashed lines in Fig. 15B). This suggests that variations in deep circulation in the Atlantic were nearly as large during some intervals of the late Pliocene as they have been during the last glacial cycle.

The simplest scenario to explain the long-period variations in $\Delta\delta^{13}C_{(A-P)}$ is (1) that influx of northern-source water to the deep North Atlantic (analogous to modern NADW) was stronger than today on average between 1.3 and 2.1 Ma, and (2) that the earlier portions of the glacial ages (from 2.1 to 3.2 Ma) had a lower influx of northern source waters (but not as low as that during the late Pleistocene glacial extremes). This view contrasts with that of Raymo et al. (1992), who argued that progressive (though perhaps nonlinear) decreases in NADW formation were associated with increasing intensity of Northern Hemisphere glaciation over this interval. It also conflicts with the opposing view of Sykes et al. (1991), who inferred influx of north-

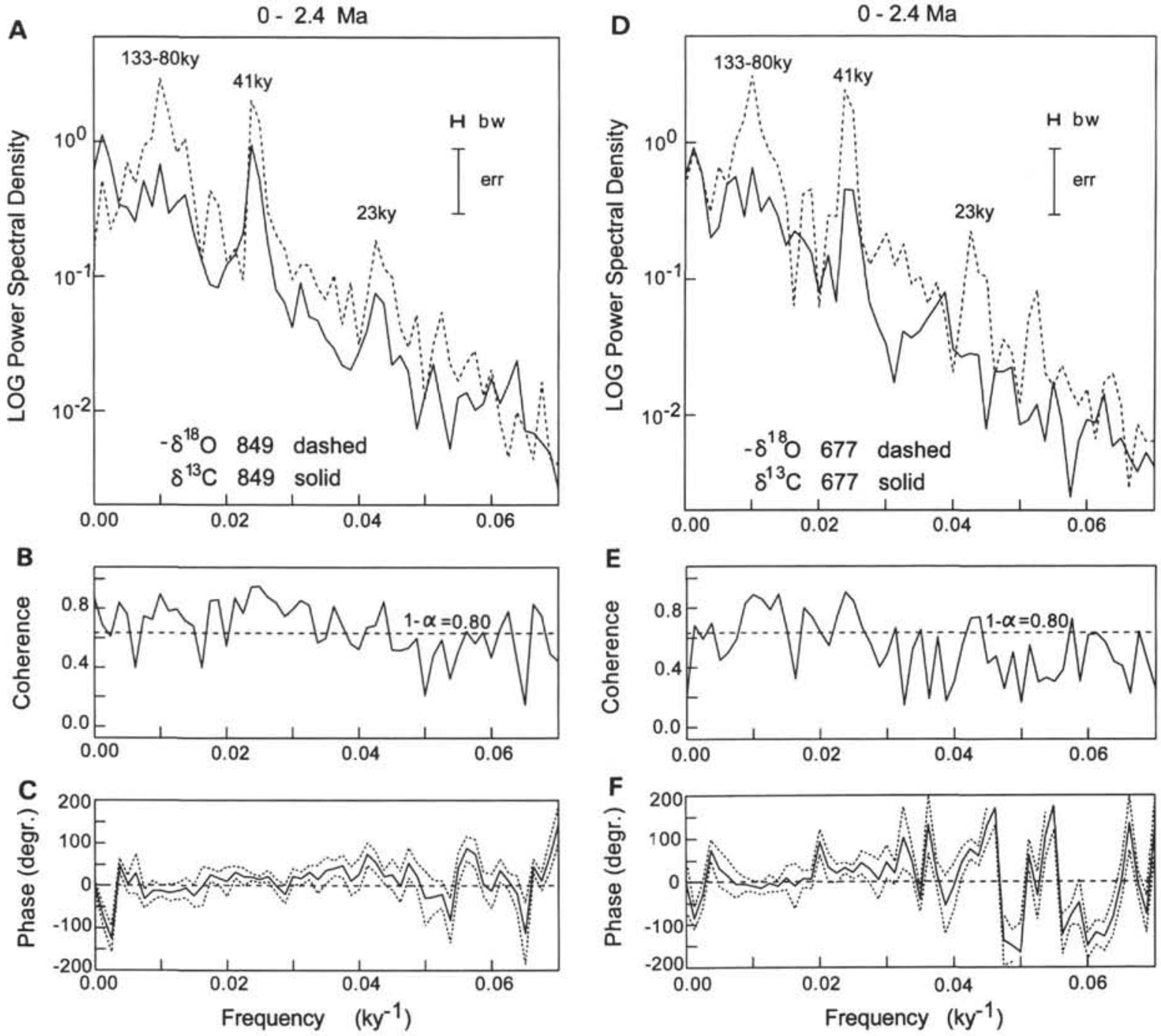

Figure 9. Spectra and cross spectra comparing the $\delta^{18}O$ and $\delta^{13}C$ records within Sites 849 and 677. For the interval from 0 to 2.4 Ma, bandwidth (bw) is 0.0017 $k.y.^{-1}$; for the interval from 2.4 to 4.42 Ma, bandwidth is 0.0025 $k.y.^{-1}$. **A.** Power spectra, 0–2.4 Ma. **B.** Coherency spectrum, $\delta^{18}O$ vs. $\delta^{13}C$ in Site 849, 0–2.4 Ma. Values higher than the dashed lines indicate >80% confidence level for significant coherency. **C.** Phase spectrum, $\delta^{13}C$ vs. $-\delta^{18}O$ in Site 849, 0–2.4 Ma. Dashed lines outline 80% confidence envelope. Positive phase angle (in degrees) indicates that $\delta^{13}C$ lags $-\delta^{18}O$. **D.** Power spectra, 0–2.4 Ma. **E.** Coherency spectrum, $\delta^{13}C$ vs. $-\delta^{18}O$ in Site 677, 0–2.4 Ma. **F.** Phase spectrum, $\delta^{13}C$ vs. $-\delta^{18}O$ in Site 677, 0–2.4 Ma. **G.** Power spectra, 2.4–4.42 Ma. **H.** Coherency spectrum, $\delta^{13}C$ vs. $-\delta^{18}O$ in Site 849, 2.4–4.42 Ma. **I.** Phase spectrum, $\delta^{13}C$ vs. $-\delta^{18}O$ in Site 849, 2.4–4.42 Ma.

ern-source relative to southern-source waters lower than at present at most times during the Pliocene.

Relationships among the variations in Atlantic-Pacific $\delta^{13}C$ differences and $-\delta^{18}O$ are explored in Figure 16. Because the character of $\Delta\delta^{13}C_{(A-P)}$ clearly evolved through time, we have divided the record into thirds before calculating spectra. Over the last 1.1 Ma (Fig. 16A–C), $\Delta\delta^{13}C_{(A-P)}$ contained concentrations of variance at periods of ≥100 k.y., and significant coherency with $-\delta^{18}O$ in the 100-k.y. band. We did not detect a significant concentration of variance in $\Delta\delta^{13}C_{(A-P)}$ in the 41- or 23-k.y. bands over the last 1.1 Ma. A phase estimate of 24° ± 13° in the 100-k.y. band indicates that maximal interocean $\delta^{13}C$ differences on average follow 3–10 k.y. after interglacial maxima (and minimal differences follow 3–10 k.y. after extreme glacial events in this band). This is slightly different from the conventional wisdom that formation rates of NADW were reduced relative to those of Antarctic Bottom Water (AABW) in the deep Atlantic Ocean coincident with glacial maxima (e.g., Broecker and Denton, 1989; Raymo et al., 1990).

In the interval 1.1–2.2 Ma, the relationships between $\Delta\delta^{13}C_{(A-P)}$ and $\delta^{18}O$ changed (Figs. 16D–16F). Here, the dominant variations in $\Delta\delta^{13}CMV_{(A-P)}$ were at very long periods (>200-k.y. period), unlike those of $\delta^{18}O$. The only band where coherent relationships between these variables were detected is the 41-k.y. period; and even in this band, the relationship is weak. The phase in this band (–43° ± 16°) indicates that maximum Atlantic-Pacific $\delta^{13}C$ gradients in this interval occurred during deglacial episodes. This pattern suggests that the modulation of NADW was not always a direct, in-phase response to Northern Hemisphere ice volume. Perhaps with the smaller variations in ice volume of the early Pleistocene and late Pliocene, the direct role of insolation is more important than the role of ice-sheet modulation of winds for driving changes in large-scale ocean circulation and thus interocean $\delta^{13}C$ contrast. In this case, times of relatively high seasonal contrast in insolation in the high latitudes (i.e., colder winters) would be associated with higher NADW formation. This speculation requires confirmation in further detailed study at a range of water depths in the North Atlantic.

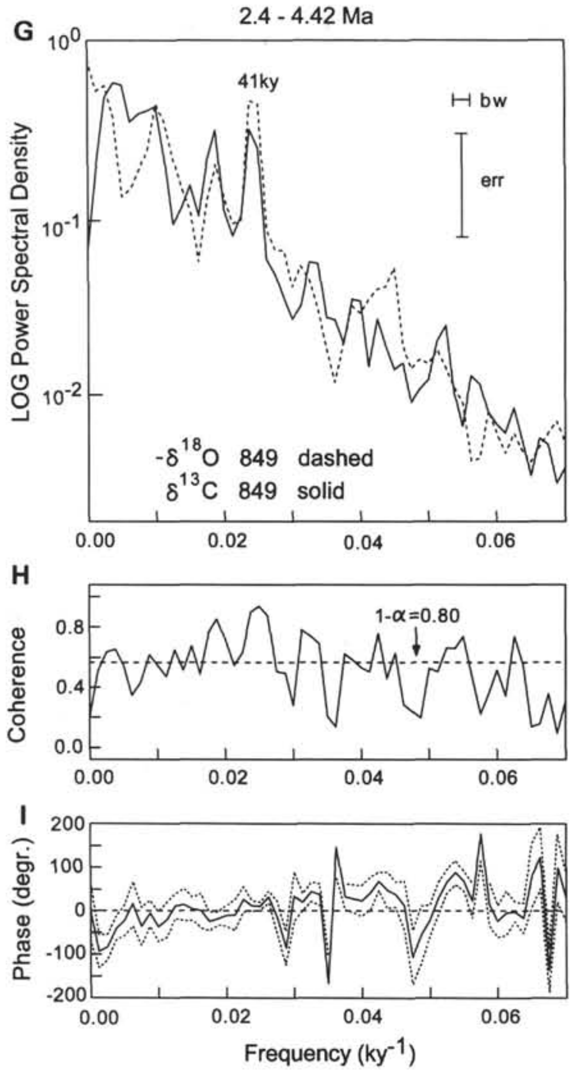

Figure 9 (continued).

In the interval older than 2.2 Ma, the variance in $\Delta\delta^{13}C_{(A-P)}$ was low enough ($0.029‰^2$) that it approached conservative estimates of analytical noise in the difference between two records ($0.020‰^2$). With this low signal/noise ratio, we did not attempt to analyze the variability in the frequency domain. Some of the variations here may be real, however. For example, during the relatively large glacial event at 2.54 Ma (stage 100, thought to reflect the first major glaciation in the Northern Hemisphere), $\Delta\delta^{13}C_{(A-P)}$ has attained a value more than half way between those of the Holocene and the last glacial maximum. Clearly, some of the early glacial events were associated with reduced influence of nutrient-depleted deep waters in the North Atlantic. Looking at the entire record, however, one cannot see any major change in the character of the $\Delta\delta^{13}C_{(A-P)}$ variations near 2.5 Ma, which argues against a unique link between Northern Hemisphere glaciation and deep-water formation.

$\delta^{13}C$ Gradients: Subantarctic–Pacific

A further constraint on past variability of deep-ocean circulation comes from comparing the Pacific $\delta^{13}C$ record from Site 849 with a record from the subantarctic portion of the Atlantic Ocean. At Site 704, a high-resolution isotope record of *Cibicides wuellerstorfi* is available for the interval older than ~1 Ma (Hodell and Venz, 1992), and a partial record is available at this site over the past 0.7 Ma (Hodell, 1993). Site 704 lies in the mixing zone between modern NADW and Circumpolar Deep Water (CPDW) and is thus well placed to monitor variations in export of deep water from the Atlantic in the past.

Consistent with the treatment of other data here, we added 0.64‰ to the published $\delta^{18}O$ data from *C. wuellerstorfi* in Site 704. We modified the published time scale in Site 704 to make it consistent with that of Pacific Site 849. To do this, we first increased the published ages of Site 704 by 6%, as recommended by Hodell and Venz (1992) and Raymo et al. (1992). We then made minor adjustments to the age assignments at Site 704 to improve the fit between the $\delta^{18}O$ record at this site with those of Site 849 between 1.1 and 2.4 Ma. The resulting isotope records are illustrated in Figure 17. In most cases, the match of $\delta^{18}O$ records between Site 704 and Site 849 is good. Hodell and Venz (1992) suggest, based on diatom biostratigraphy, that a hiatus is present at Site 704 at about 166 mbsf, which on our time scale is from ~2.44 to ~2.77 Ma. Below this point, the Site 704 $\delta^{18}O$ values are higher than those of Site 849 by an average of 0.6‰. This isotopic offset, if real, would suggest that deep Pacific water at a depth of ~3850 m was 2°–3°C warmer, or considerably fresher, than deep waters of the subantarctic at a depth of ~2500 m during that time interval. The similarity of $\delta^{18}O$ values from North Atlantic Site 607 with those of Pacific Site 849 at this time (Fig. 15A), however, make the anomalously high $\delta^{18}O$ values at Site 704 difficult to explain. It would require that both the deep North Atlantic and the deep Pacific oceans were warmer and/or fresher (and thus less dense) than shallower locations of the deep subantarctic ocean. This is physically implausible. A possible explanation is that the duration of the hiatus in Site 704 was overestimated; however, in the absence of other supporting data, we use the stratigraphy as given by Hodell and Venz (1992) and do not attempt to force isotopic correlations below the suspected hiatus.

The $\delta^{13}C$ values from Site 704 are shown along with those of North Atlantic Site 607 and Pacific Site 849, after all records have been interpolated to 4-k.y. intervals and smoothed with a 19-k.y. Gaussian filter, as discussed above (Fig. 18A). Carbon isotopic differences between subantarctic and Pacific $\Delta\delta^{13}C_{(S-P)}$ and North Atlantic and Pacific $\Delta\delta^{13}C_{(A-P)}$ are shown together in Figure 18B. On average, subantarctic $\delta^{13}C$ values are lower than Pacific values from ~1.1 to 1.7 Ma. They are roughly similar to Pacific values from 1.7 to 2.9 Ma (but, of course, they are not constrained in the hiatus from ~2.44 to ~2.77 Ma in Site 704). Subantarctic $\delta^{13}C$ values are much higher than Pacific values (but similar to Atlantic values) below 2.9 Ma. Significant variability exists around these general trends.

The younger portion of the $\Delta\delta^{13}C_{(S-P)}$ record is reminiscent of the late Pleistocene glacial intervals, in which Antarctic $\delta^{13}C$ values are lower than deep Pacific values (Curry et al., 1988). This pattern appears to hold back to at least 1.7 Ma and occurs at times throughout the record (Fig. 18B). For much of the time considered here, $\Delta\delta^{13}C_{(S-P)}$ was much lower than the Holocene gradient (marked by the solid horizontal line in Fig. 18B), suggesting less influence of high-$\delta^{13}C$ northern source waters at Site 704 than at present. There must have been little or no export of high-$\delta^{13}C$ NADW into the circumpolar Antarctic at Site 704 during times of extremely low $\Delta\delta^{13}C_{(S-P)}$. To achieve lower $\delta^{13}C$ in the Antarctic than in the Pacific at these times, either a different source of low-nutrient and/or high pre-formed $\delta^{13}C$ Pacific deep water must have existed (perhaps in the North Pacific), or the circumpolar waters must have been sufficiently isolated from Pacific waters that they acted as a local nutrient trap (Imbrie et al., 1992). Obtaining high-resolution benthic foraminifer isotope data from the North Pacific, as well as a transect of isotope data across the circumpolar Antarctic, should help to constrain these options.

In the interval older than ~2.9 Ma (noting the age uncertainty caused by poor correlation of the $\delta^{18}O$ records here), the $\delta^{13}C$ values from the deep North Atlantic and the subantarctic are similar, and the $\delta^{13}C$ gradient from both areas to the central Pacific is about 1‰. This suggests strong export of NADW-like water to the Antarctic much of the time before 2.9 Ma, which is consistent with the inferences of Hodell and Venz (1992) and Raymo et al. (1992).

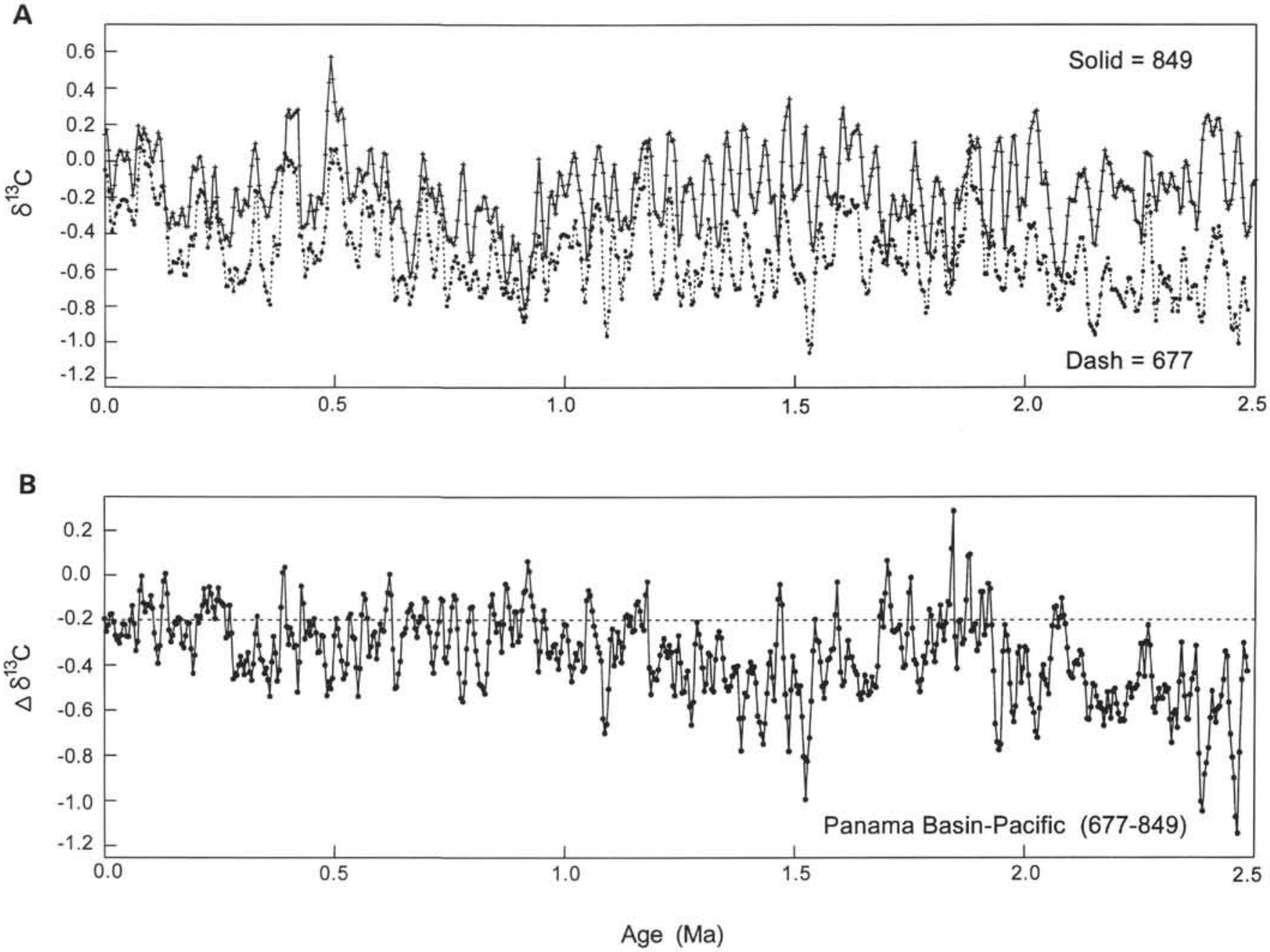

Figure 10. **A.** $\delta^{13}C$ in Sites 849 and 677, after interpolation to 4-k.y. intervals and smoothing with a 19-k.y. Gaussian filter. **B.** Isotopic difference between the deep Pacific Ocean west of the East Pacific Rise and the Panama Basin ($\Delta\delta^{13}C_{(PB-P)}$). Horizontal dashed line is the modern (core top) difference between the sites.

The change from high to low export of NADW-like Atlantic deep water, which appears to occur near 2.9 Ma (and perhaps again near 2.0 Ma) was not accompanied by any change in the Atlantic-Pacific $\delta^{13}C$ gradient (Fig. 18B). Curiously, the interval of highest average $\Delta\delta^{13}C_{(A-P)}$, from ~1.3 to ~2.1 Ma, which most likely reflects dominance of low-nutrient northern source waters within the North Atlantic, was associated with low, or even negative, Antarctic-Pacific gradients. This suggests little or no NADW export to the CPDW. Hodell and Venz (1992) and Raymo et al. (1992) examined the subantarctic data and favored the view that the record was driven primarily from the Northern Hemisphere, by decreasing rates of NADW formation after 2.7 Ma (the same as 2.9 Ma on our time scale). They argued that Site 704 was especially sensitive to mixing between NADW and CPDW, and that this might account for larger amplitude signals here than in the deep North Atlantic. We would accept this inference were the patterns of $\delta^{13}C$ change similar in the two locations relative to the Pacific. But our finding here that $\Delta\delta^{13}C_{(S-P)}$ and $\Delta\delta^{13}C_{(A-P)}$ do not covary at all, presents a problem for an interpretation that drives both signals from the North Atlantic.

We think a second mechanism must exist, operating independently from the Northern Hemisphere ice sheets to allow the Southern Ocean to evolve so differently from the deep North Atlantic. One possible mechanism was proposed in the modeling study of Toggweiler and Samuels (1993). They argued that modern export of Atlantic deep waters into the circumpolar Antarctic is presently driven from the south, by westerly wind stress at the latitude of the southern tip of South America (Trenberth et al., 1990). Today, the axis of maximum westerly winds is a few degrees north of the Drake Passage. Were this axis a few degrees farther south during warmer climatic episodes near 3 Ma, it would tend to draw more high-$\delta^{13}C$ NADW southward to Site 704. As the wind axis migrated north, the Atlantic outflow would diminish and, along with it, $\Delta\delta^{13}C_{(S-P)}$ would decrease.

Formation of deep water in the North Atlantic may have increased as the Northern Hemisphere cooled in the early stages of glaciation as envisioned by Raymo et al. (1992). However, if Toggweiler and Samuels (1993) are correct, these waters would not have reached subantarctic Site 704 unless Southern Hemisphere winds were favorable. With weaker wind forcing in the south, we speculate that Atlantic deep waters would either leak into the Indian Ocean along the South African margin, or recirculate within the Atlantic, with relatively little export into the circumantarctic circulation. If so, the apparent lack of covariation of the $\Delta\delta^{13}C_{(S-P)}$ and $\Delta\delta^{13}C_{(A-P)}$ records would make sense. This leaves us with several unanswered questions, however, that beg for more data acquisition and modeling of the linkage of global circulation in the Antarctic:

1. Can circumantarctic circulation be isolated from the Atlantic and Pacific sufficiently to maintain large $\delta^{13}C$ (and presumably nutrient) gradients?
2. Did Southern Hemisphere westerly winds vary significantly in intensity or position, and if so, why?

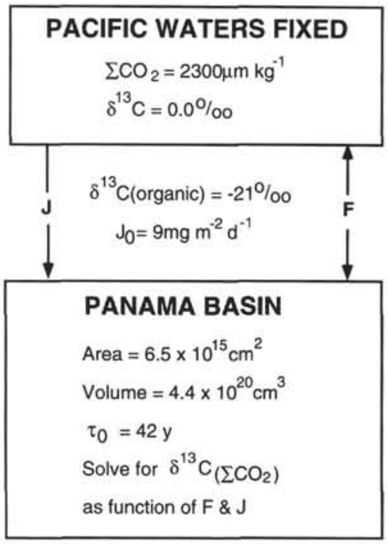

Figure 11. Box model designed to assess the sensitivity of the deep Panama Basin to influxes and oxidation of organic matter (J), and flushing of water in the basin (F). Volume (V) of the Panama Basin below 1.9 km is 4.4×10^5 km^3, and the modern residence time of water in the basin, $\tau = V/F$, is 42 yr (Lonsdale, 1977). At present, organic carbon degradation in the basin is $\sim 1.8 \times 10^{11}$ moles/yr (Honjo et al., 1992).

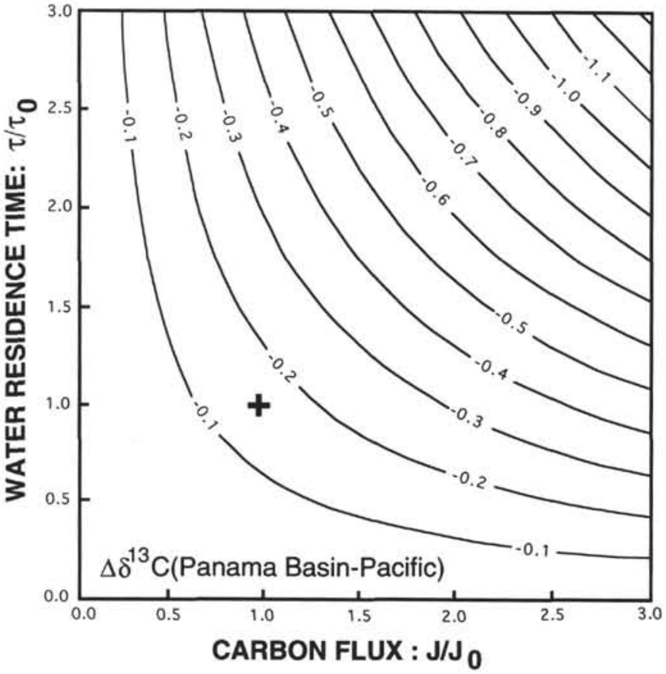

Figure 12. The $\delta^{13}C$ gradient between the Panama Basin and the deep Pacific Ocean ($\Delta\delta^{13}C_{(PB-P)}$) is contoured, as a function of water residence time relative to modern values (τ/τ_0) and organic carbon influxes relative to modern values (J/J_0). The value of $\Delta\delta^{13}C_{(PB-P)}$ for the modern carbon flux and water residence time is –0.15‰ in this model, approximately consistent with the water column data in Figure 2.

3. Is there a plausible mechanism for upwelling and recirculation of deep water within a relatively isolated Atlantic?

4. Can small amounts of deep water be transported out of the Atlantic around Africa without influencing Site 704?

5. What would this circulation imply for heat, salt, and other property distributions within the ocean?

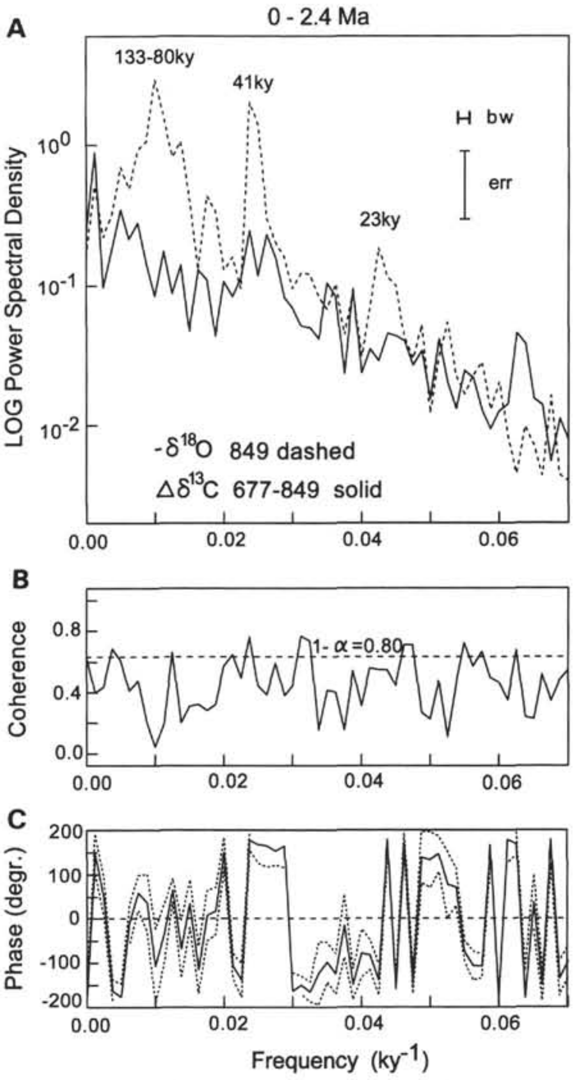

Figure 13. Spectra and cross spectra comparing $\delta^{18}O$ (ice volume) and $\Delta\delta^{13}C_{(PB-P)}$. Bandwidth (bw) is 0.0017 k.y.$^{-1}$. **A.** Power spectra. **B.** Coherency spectrum, $-\delta^{18}O$ vs. $\Delta\delta^{13}C_{(PB-P)}$. Values higher than the dashed line are significant at the 80% confidence level. **C.** Phase spectrum, $-\delta^{18}O$ vs. $\Delta\delta^{13}C_{(PB-P)}$. Dashed lines outline 80% confidence envelope. Positive phase indicates $\Delta\delta^{13}C_{(PB-P)}$ lags $-\delta^{18}O$. The lack of discrete spectral peaks in Figure 13A and the low coherency in Figure 13B argue that $\Delta\delta^{13}C_{(PB-P)}$ is essentially "red" noise, unrelated to systematic changes in global climate.

We cannot answer these questions adequately at present but pose them to stimulate further research.

CONCLUSIONS

Here we present a high-resolution time series of benthic foraminifer stable isotopes from Site 849. The record extends to 5 Ma and is essentially complete over the last 4.4 Ma, with an average interval of 4 k.y. Because this site lies in the open Pacific Ocean, on the western flank of the East Pacific Rise at a water depth of 3851 m, it is well suited as a proxy for the mean deep Pacific Ocean. Of the 1415 analyses reported here, 86% were from the preferred species *Cibicides wuellerstorfi,* although we detect no systematic variations in isotopic offsets between this species and *Uvigerina peregrina,* and combine data from the two species in a composite record.

The $\delta^{18}O$ record from Site 849 compares well with other long $\delta^{18}O$ data sets, including the other available long, continuous, high-resolution benthic records from Atlantic Ocean Site 607 (Raymo et

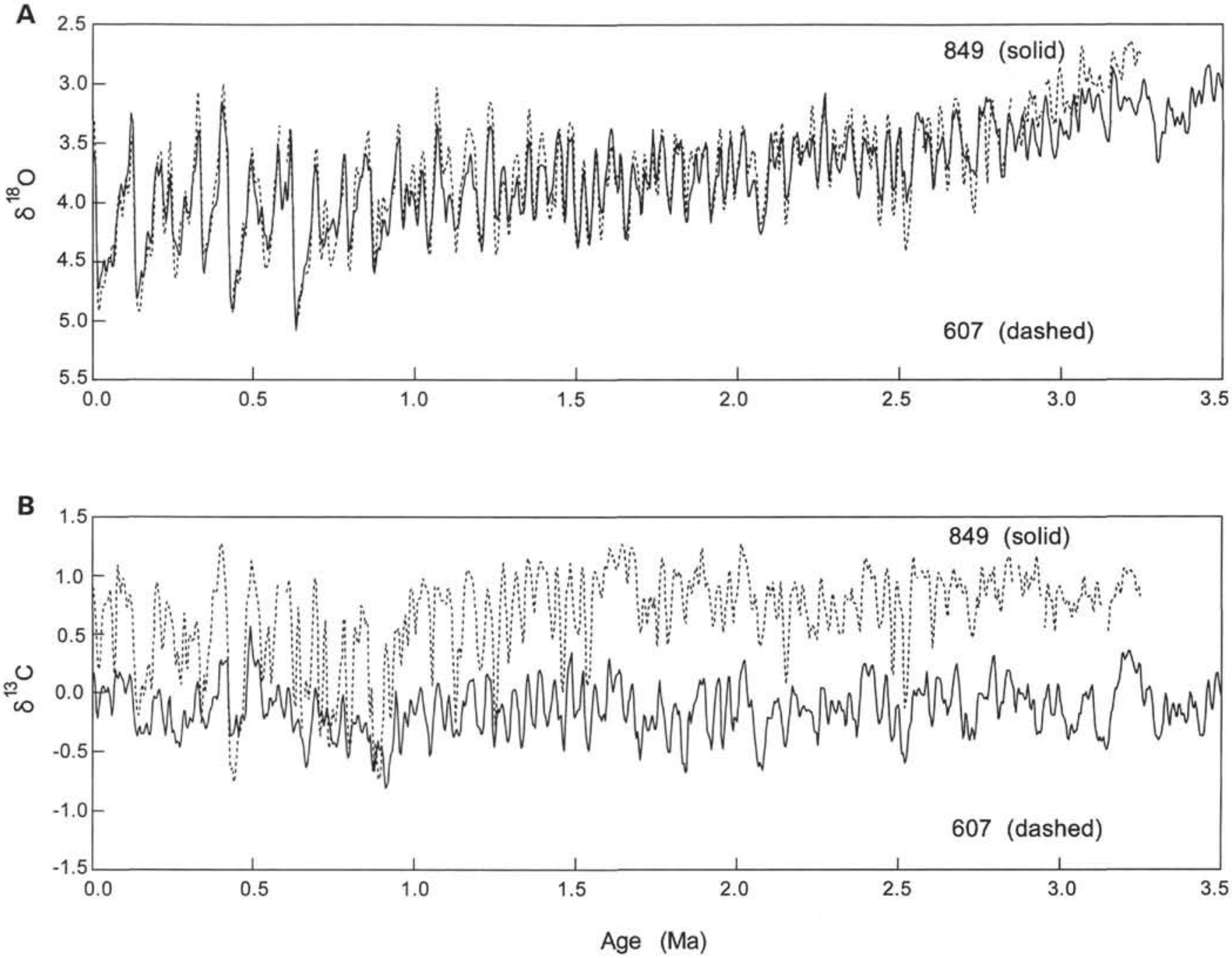

Figure 14. Stable isotope records from Pacific Site 849 and North Atlantic Site 607, smoothed with 19-k.y. Gaussian filter and interpolated to 4-k.y. sample spacing. **A.** $\delta^{18}O$ vs. age. **B.** $\delta^{13}C$ vs. age.

al., 1990, 1992) and Panama Basin Site 677 (Shackleton et al., 1990). The Site 849 $\delta^{18}O$ record confirms the major features of evolving glacial climate during the past 2.5 m.y., and adds a new time scale and new high-resolution data back to 5 Ma, covering the full range of conditions from mid-Pliocene global warmth to the late Pleistocene glacial events.

The $\delta^{13}C$ records are different in the Pacific Ocean and Panama Basin sites. This reflects local variations in low-$\delta^{13}C$ organic matter contributing to ΣCO_2 in the relatively isolated Panama Basin. Variations in the Panama Basin to Pacific $\delta^{13}C$ differences may reflect either changes in biological productivity over the basin, or variations in the basin's ventilation rate. Much of the variance in the Panama Basin to Pacific $\delta^{13}C$ gradient appears to be random, with a "red" spectrum, as would be expected were changing rates of basin flushing associated with random variations in hydrothermal heat fluxes.

Using the record from Site 849 as a new standard for deep Pacific $\delta^{13}C$ history over this time frame, we gained new insight into changing global chemical budgets of the ocean and biosphere. Over the last 2.4 m.y., the ~100-k.y. climate cycle, which is prevalent in the record of ice volume, is a less significant factor in the $\delta^{13}C$ budget. Variations with a longer period (near 400 k.y.) and a strong 41-k.y. cycle are more prevalent in $\delta^{13}C$. Changing continental biomass is a likely cause of variations at shorter periods, and the strength of the 41-k.y. period relative to that of precession points toward high-latitude biospheric processes. The weakness of the 100-k.y. cycle in $\delta^{13}C$ relative to that in $\delta^{18}O$, however, suggests that sea level and the boreal forests of North America may not be the source of the biomass signal. The strength of several periodic signals in $\delta^{13}C$ from 133 to 80 ka may imply nonlinear responses of $\delta^{13}C$ to orbital eccentricity or some intermediate process. Phase of $\delta^{13}C$ relative to $-\delta^{18}O$ over the 41- to 23-k.y. period bands is consistent with a biospheric response time of 1–2 k.y. This is too long to reflect changes in the mass of living forests, but it is appropriate for carbon in soils and shallow sediments. The $\delta^{13}C$ variations at longer periods, perhaps including signals in the ~100-k.y. bands, most likely reflect the isotopic balance of erosion and deposition.

With a new Pacific stable isotope record, we also gained new insight into the history of global deep-water circulation. Significant events of reduced Atlantic-Pacific $\delta^{13}C$ contrast occurred back to at least 1.5 Ma. The interval from ~1.3 to 2.1 Ma stands out as a time of greater than average Atlantic-Pacific $\delta^{13}C$ contrast to those of the late Pleistocene interglacial events, or earlier Pliocene events. Before ~2.1 Ma, the Atlantic-Pacific contrast is mostly within the range of variations of the late Pleistocene, although variability is lower and the mean is similar to the past few interglacial events.

The $\delta^{13}C$ contrast between the deep subantarctic (Site 704) and deep Pacific (Site 849) oceans evolves differently from the contrast between the deep North Atlantic and deep Pacific oceans. Before ~2.9 Ma (with some uncertainty about exact timing), high $\delta^{13}C$ in the

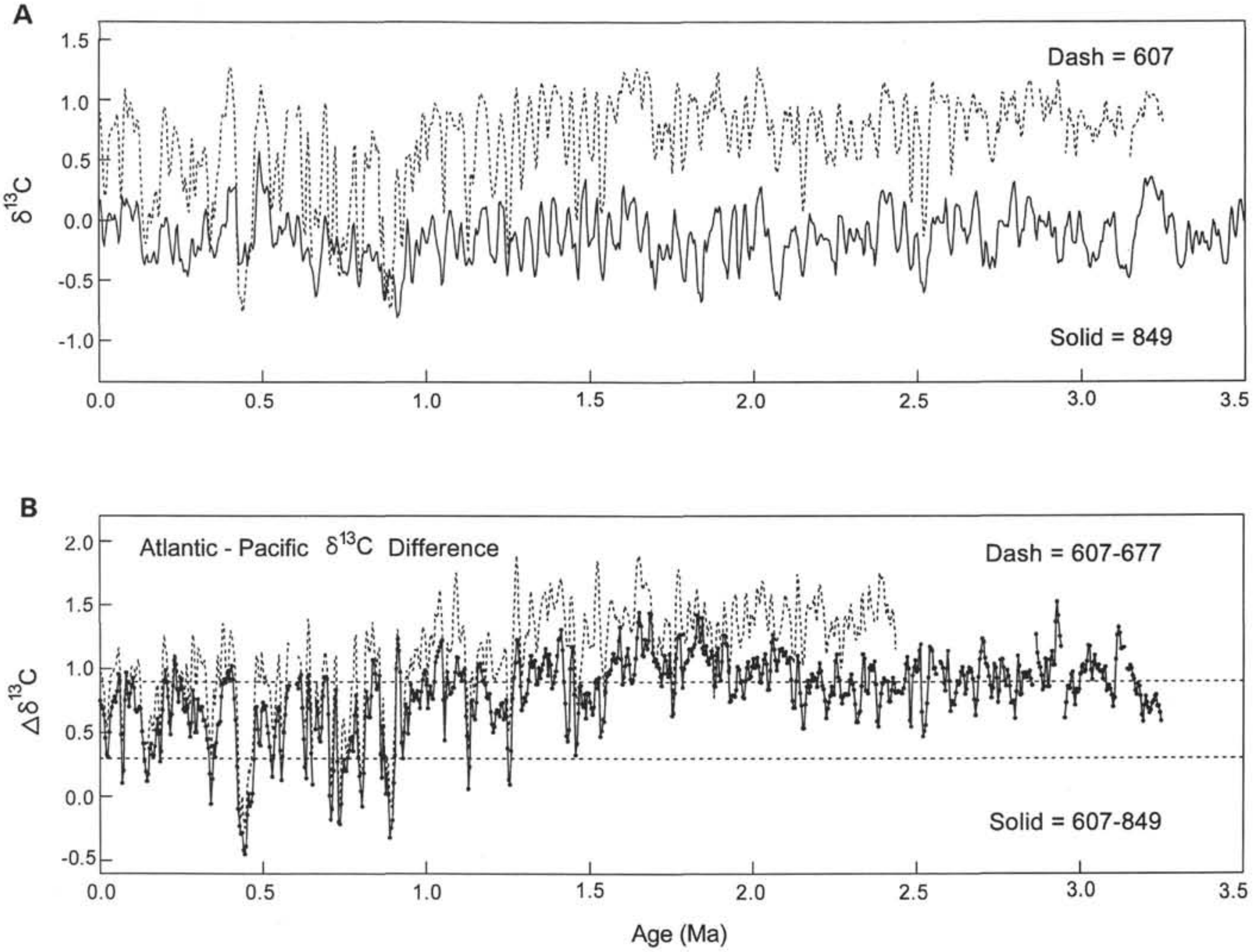

Figure 15. **A.** $\delta^{13}C$ in Pacific Site 849 and North Atlantic Site 607, after interpolation to 4-k.y. intervals and smoothing with a 19-k.y. Gaussian filter. **B.** Carbon isotopic difference between deep North Atlantic and Pacific ($\Delta\delta^{13}C_{(A-P)}$). The dotted line here is the Atlantic-Pacific difference calculated using Panama Basin Site 677 as the Pacific reference, and the solid line is the Atlantic-Pacific difference calculated using Site 849 as the Pacific reference. Horizontal dashed lines mark the range of variation in $\Delta\delta^{13}C_{(PB-P)}$ over the last glacial cycle of 0–120 k.y.

deep Antarctic suggests rapid export of Atlantic deep waters into the CPDW. The $\delta^{13}C$ values in the deep subantarctic between ~1.7 and ~1.1 Ma are almost always lower than values in the deep central Pacific, and similar features occurred back to at least 2.8 Ma. This suggests either the presence of a high-$\delta^{13}C$ North Pacific deep-water source, or isolation of the circumantarctic as a nutrient trap.

To explain the apparently independent evolution in subantarctic to Pacific and North Atlantic to Pacific $\delta^{13}C$ gradients, we hypothesize that at least two mechanisms must have contributed to these inter-ocean $\delta^{13}C$ gradients. Variation in the formation of deep waters in the North Atlantic may have been driven by changing Northern Hemisphere glacial climates. Variations in the export of deep water from the Atlantic may have been a function of wind stress at the southern tip of South America (Toggweiler and Samuels, 1993). We speculate that these two effects combined to make the deep North Atlantic and the subantarctic evolve in different ways relative to the mean ocean.

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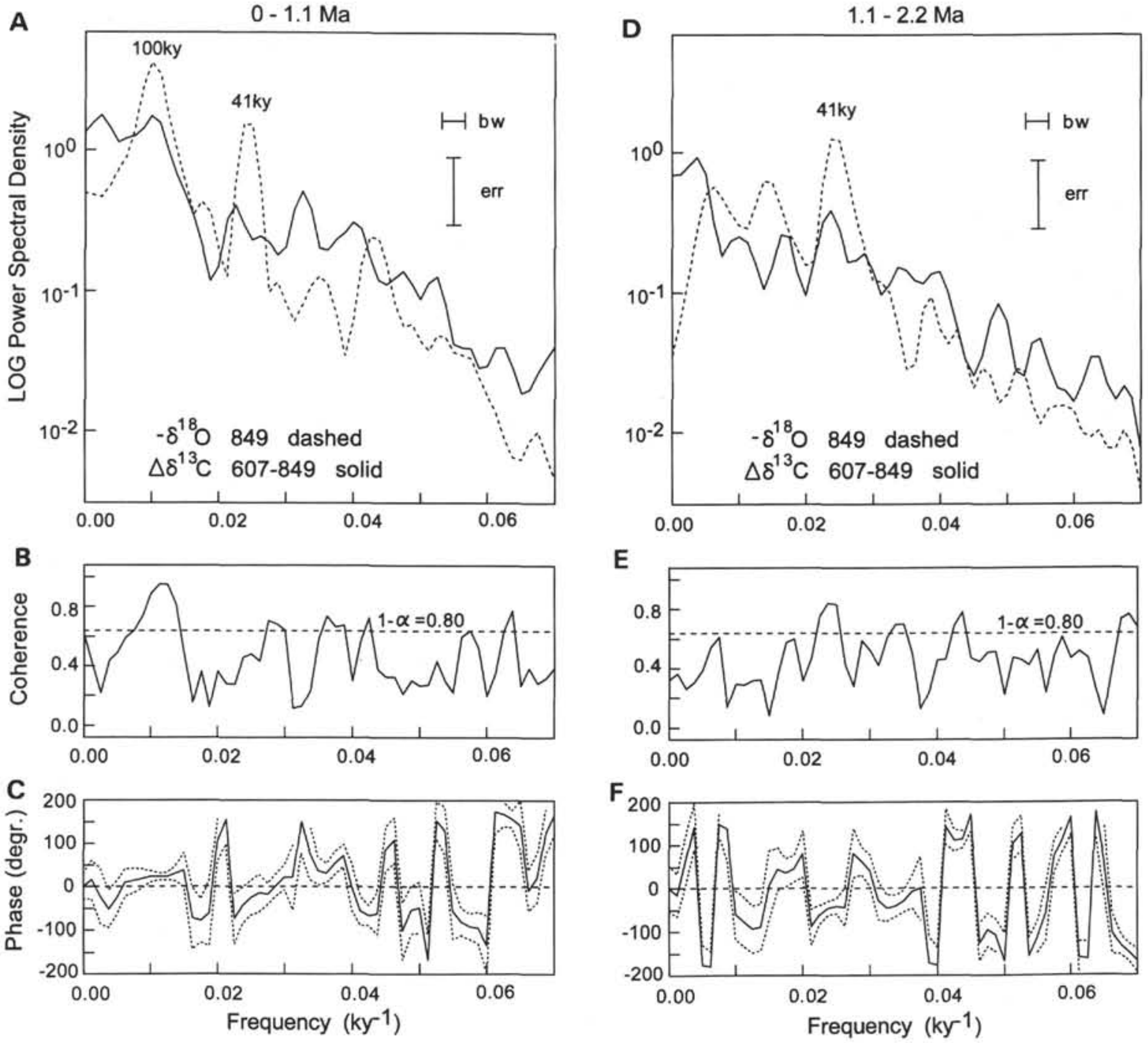

Figure 16. Spectra and cross spectra comparing the $\delta^{18}O$ (approximate ice volume) and $\Delta\delta^{13}C_{(A-P)}$ (Site 607 – Site 849). **A.** Power spectra, 0–1.1 Ma. **B.** Coherency spectrum, 0–1.1 Ma, $\delta^{18}O$ vs. $\Delta\delta^{13}C_{(A-P)}$. **C.** Phase spectrum, 0–1.1 Ma, $-\delta^{18}O$ vs. $\Delta\delta^{13}C_{(A-P)}$. **D.** Power spectra, 1.1–2.2 Ma. **E.** Coherency spectrum, 1.1–2.2 Ma, $\delta^{18}O$ vs. $\Delta\delta^{13}C_{(A-P)}$. **F.** Phase spectrum, 1.1–2.2 Ma, $-\delta^{18}O$ vs. $\Delta\delta^{13}C_{(A-P)}$.

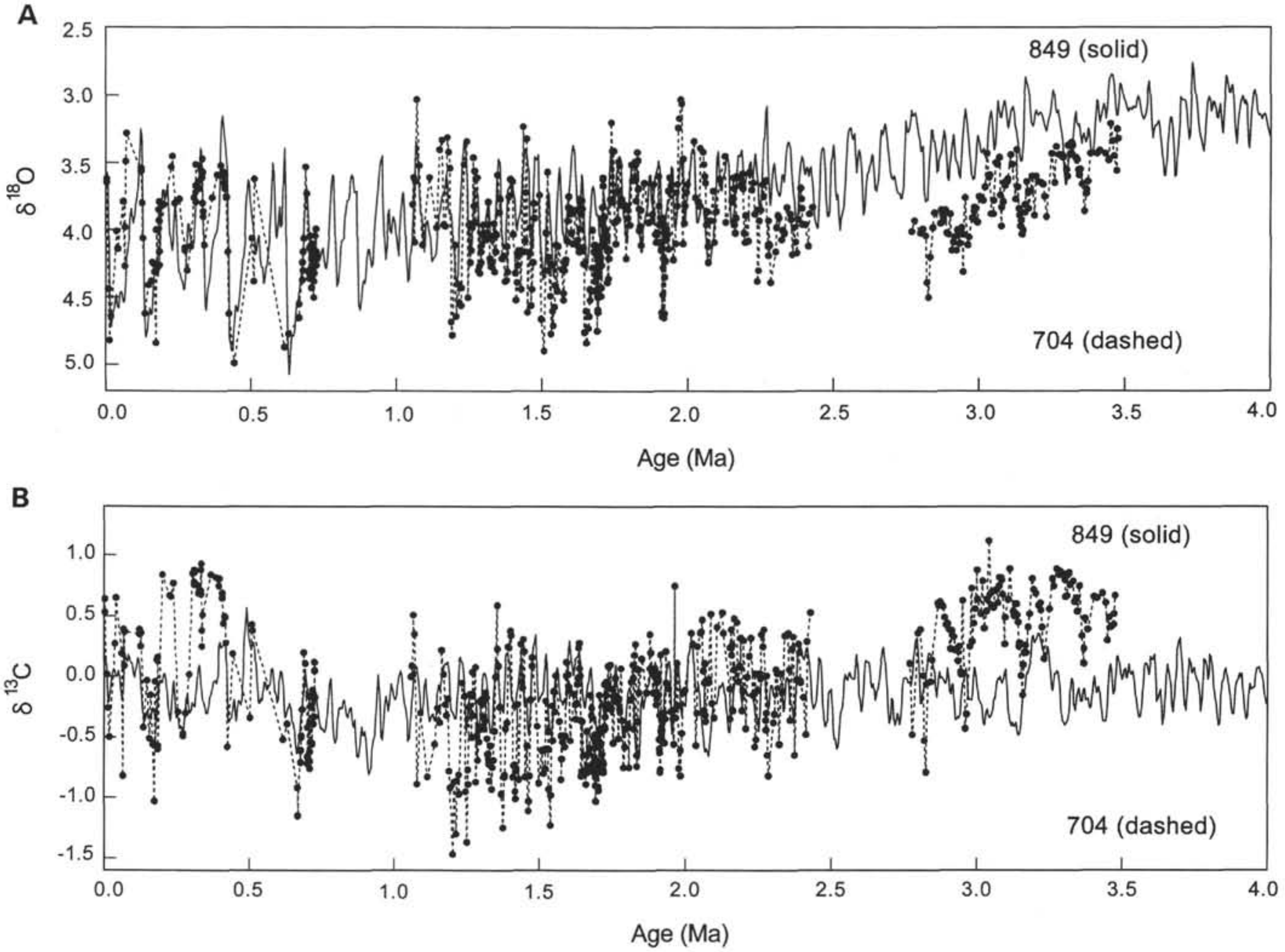

Figure 17. Isotope records from Pacific Site 849 and subantarctic Site 704 (Hodell, 1993; Hodell and Venz, 1992; data from *Cibicides wuellerstorfi* only with no smoothing or interpolation). **A.** $\delta^{18}O$ vs. age. **B.** $\delta^{13}C$ vs. age.

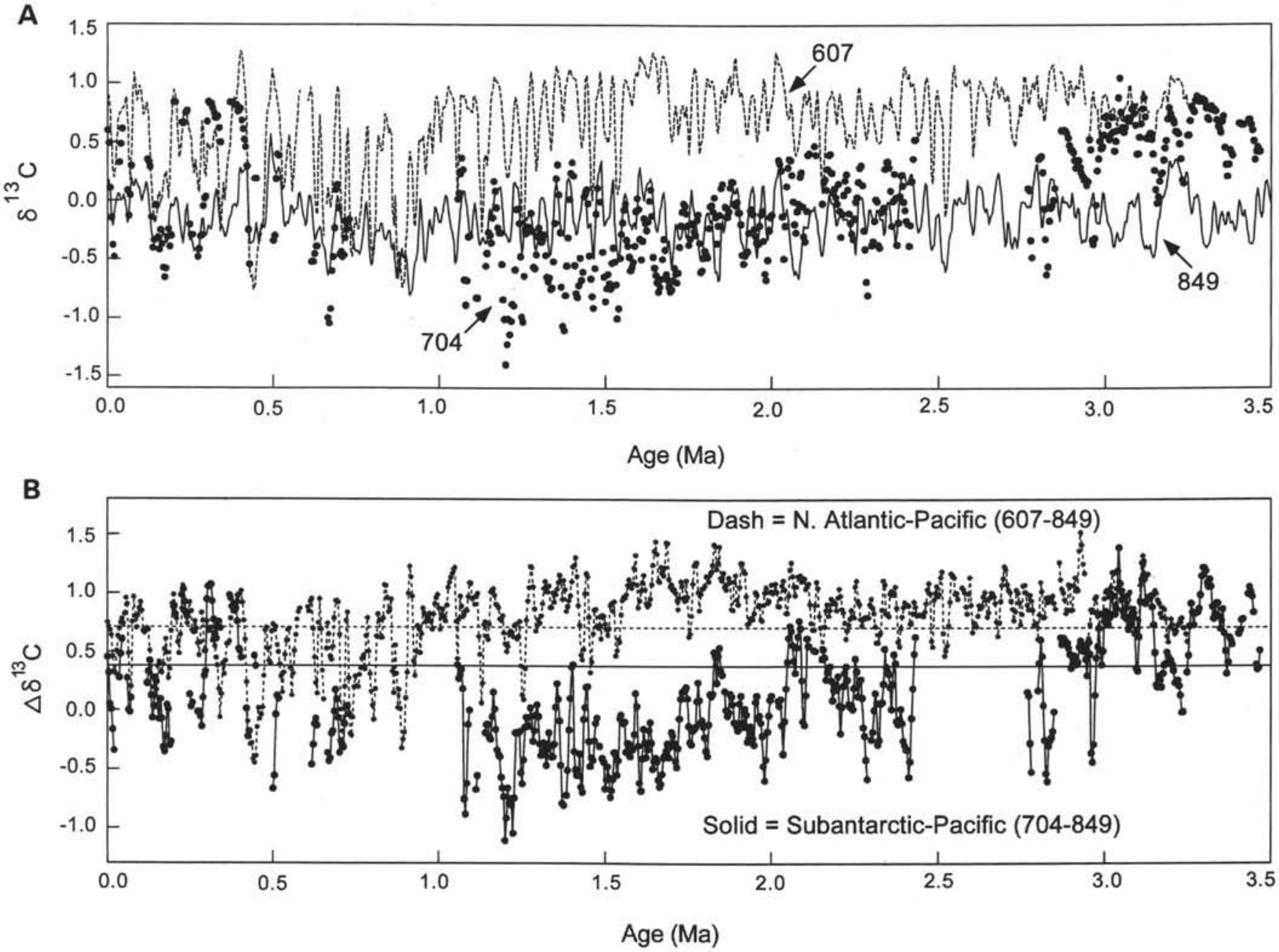

Figure 18. **A.** $\delta^{13}C$ in Pacific Site 849, North Atlantic Site 607, and subantarctic Site 704, after interpolation to 4-k.y. intervals and smoothing with a 19-k.y. Gaussian filter. **B.** Carbon isotopic difference between deep North Atlantic Site 607 and Pacific Site 849 and between subantarctic Site 704 and Pacific Site 849. The horizontal dashed line marks the level of the modern $\delta^{13}C$ gradient between Sites 607 and 849. The horizontal solid line marks the modern $\delta^{13}C$ gradient between Sites 704 and 849. Note the change from large positive values of $\Delta\delta^{13}C_{(S-P)}$ below 2.9 Ma to negative values of $\Delta\delta^{13}C_{(S-P)}$ in the younger intervals (especially from 1 to 2 Ma), and the lack of covariance between $\Delta\delta^{13}C_{(S-P)}$ and $\Delta\delta^{13}C_{(A-P)}$.

APPENDIX A

Oxygen and Carbon Isotope Data for Site 849 With Three Depth Scales

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849B-1H-1	*C. wuellerstorfi*	7	0.07	0.07	0.07	3.66	0.21
849B-1H-1	*C. wuellerstorfi*	17	0.17	0.17	0.17	3.49	0.08
849B-1H-1	*C. wuellerstorfi*	28	0.28	0.28	0.28	3.31	0.19
849B-1H-1	*C. wuellerstorfi*	44	0.44	0.44	0.45	4.17	–0.15
849B-1H-1	*C. wuellerstorfi*	54	0.54	0.54	0.55	4.69	–0.27
849B-1H-1	*C. wuellerstorfi*	69	0.69	0.69	0.69	4.92	–0.26
849B-1H-1	*C. wuellerstorfi*	89	0.89	0.89	0.89	4.55	–0.08
849B-1H-1	*C. wuellerstorfi*	89	0.89	0.89	0.89	4.80	–0.16
849B-1H-1	*C. wuellerstorfi*	109	1.09	1.09	1.09	4.59	0.02
849B-1H-1	*C. wuellerstorfi*	118	1.18	1.18	1.18	4.55	0.05
849B-1H-1	*C. wuellerstorfi*	128	1.28	1.28	1.28	4.72	0.02
849B-1H-1	*C. wuellerstorfi*	138	1.38	1.38	1.39	4.36	0.10
849B-1H-1	*C. wuellerstorfi*	148	1.48	1.48	1.50	4.46	0.05
849B-1H-2	*C. wuellerstorfi*	11	1.61	1.61	1.61	4.63	–0.02
849B-1H-2	*C. wuellerstorfi*	38	1.88	1.88	1.85	4.47	0.07
849B-1H-2	*C. wuellerstorfi*	48	1.98	1.98	1.94	4.45	–0.04
849B-1H-2	*C. wuellerstorfi*	68	2.18	2.18	2.17	4.54	–0.21
849B-1H-2	*C. wuellerstorfi*	78	2.28	2.28	2.31	4.57	–0.11
849B-1H-2	*C. wuellerstorfi*	92	2.42	2.42	2.43	4.27	0.30
849B-1H-2	*C. wuellerstorfi*	101	2.51	2.51	2.49	4.14	0.13
849B-1H-2	*C. wuellerstorfi*	111	2.61	2.61	2.56	4.10	0.25
849C-1H-1	*C. wuellerstorfi*	87	1.87	2.62	2.71	4.32	–0.03
849B-1H-2	*C. wuellerstorfi*	123	2.73	2.73	2.75	3.95	0.12
849C-1H-1	*C. wuellerstorfi*	97	1.97	2.72	2.80	3.83	0.22
849C-1H-1	*C. wuellerstorfi*	107	2.07	2.82	2.89	4.00	0.21
849B-1H-2	*C. wuellerstorfi*	133	2.83	2.83	2.92	3.90	0.21
849B-1H-2	*U. peregrina*	133	2.83	2.83	2.92	3.96	0.21
849C-1H-1	*U. peregrina*	117	2.17	2.92	2.96	3.71	0.20
849B-1H-2	*C. wuellerstorfi*	146	2.96	2.96	3.06	3.85	0.10
849B-1H-2	*U. peregrina*	146	2.96	2.96	3.06	3.84	–0.01
849C-1H-2	*C. wuellerstorfi*	7	2.43	3.18	3.15	4.00	0.17
849C-1H-2	*C. wuellerstorfi*	17	2.53	3.28	3.24	3.95	0.09
849C-1H-2	*C. wuellerstorfi*	27	2.63	3.38	3.33	3.91	–0.06
849C-1H-2	*C. wuellerstorfi*	27	2.63	3.38	3.33	3.73	–0.11
849C-1H-2	*C. wuellerstorfi*	37	2.73	3.48	3.44	3.70	0.06
849C-1H-2	*C. wuellerstorfi*	37	2.73	3.48	3.44	3.79	0.10
849C-1H-2	*C. wuellerstorfi*	47	2.83	3.58	3.55	3.78	0.05
849C-1H-2	*C. wuellerstorfi*	57	2.93	3.68	3.66	3.30	0.23
849C-1H-2	*C. wuellerstorfi*	67	3.03	3.78	3.77	3.23	0.12
849C-1H-2	*C. wuellerstorfi*	77	3.13	3.88	3.88	3.15	–0.02
849C-1H-2	*C. wuellerstorfi*	87	3.23	3.98	3.98	3.27	–0.02
849C-1H-2	*C. wuellerstorfi*	97	3.33	4.08	4.08	4.13	–0.23
849C-1H-2	*U. peregrina*	107	3.43	4.18	4.18	4.42	–0.30
849C-1H-2	*C. wuellerstorfi*	117	3.53	4.28	4.28	4.85	–0.30
849C-1H-2	*C. wuellerstorfi*	127	3.63	4.38	4.37	4.75	–0.39
849C-1H-2	*U. peregrina*	127	3.63	4.38	4.37	4.84	–0.25
849C-1H-2	*C. wuellerstorfi*	137	3.73	4.48	4.47	4.98	–0.38
849C-1H-2	*C. wuellerstorfi*	147	3.83	4.58	4.56	4.70	–0.45
849C-1H-3	*C. wuellerstorfi*	7	3.93	4.68	4.67	4.74	–0.33
849C-1H-3	*U. peregrina*	17	4.03	4.78	4.77	4.76	–0.25
849C-1H-3	*U. peregrina*	27	4.13	4.88	4.88	4.67	–0.19
849C-1H-3	*C. wuellerstorfi*	37	4.23	4.98	4.98	4.38	–0.46
849C-1H-3	*C. wuellerstorfi*	47	4.33	5.08	5.08	4.72	–0.39
849C-1H-3	*U. peregrina*	57	4.43	5.18	5.18	4.57	–0.21
849C-1H-3	*C. wuellerstorfi*	67	4.53	5.28	5.28	4.81	–0.45
849C-1H-3	*C. wuellerstorfi*	77	4.63	5.38	5.38	4.52	–0.49
849C-1H-3	*U. peregrina*	77	4.63	5.38	5.38	4.46	–0.30
849C-1H-3	*U. peregrina*	87	4.73	5.48	5.48	4.21	–0.13
849C-1H-3	*C. wuellerstorfi*	97	4.83	5.58	5.58	4.26	–0.37
849C-1H-3	*C. wuellerstorfi*	97	4.83	5.58	5.58	4.54	–0.24
849C-1H-3	*C. wuellerstorfi*	107	4.93	5.68	5.68	3.98	–0.22
849C-1H-3	*C. wuellerstorfi*	117	5.03	5.78	5.78	4.38	–0.35
849C-1H-3	*C. wuellerstorfi*	127	5.13	5.88	5.89	4.39	–0.34
849C-1H-3	*U. peregrina*	127	5.13	5.88	5.89	4.21	–0.31
849C-1H-3	*C. wuellerstorfi*	137	5.23	5.98	5.99	4.16	–0.41
849C-1H-3	*C. wuellerstorfi*	147	5.33	6.08	6.08	4.46	–0.42
849C-1H-4	*U. peregrina*	7	5.43	6.18	6.18	4.35	–0.34
849C-1H-4	*C. wuellerstorfi*	17	5.53	6.28	6.28	4.49	–0.45
849C-1H-4	*U. peregrina*	17	5.53	6.28	6.28	4.41	–0.23
849C-1H-4	*C. wuellerstorfi*	27	5.63	6.38	6.38	4.10	–0.16
849C-1H-4	*U. peregrina*	27	5.63	6.38	6.38	4.24	–0.11
849C-1H-4	*C. wuellerstorfi*	37	5.73	6.48	6.47	3.97	0.05
849C-1H-4	*U. peregrina*	37	5.73	6.48	6.47	3.80	–0.06
849C-1H-4	*C. wuellerstorfi*	47	5.83	6.58	6.57	3.91	–0.01
849C-1H-4	*C. wuellerstorfi*	57	5.93	6.68	6.67	3.66	–0.16
849C-1H-4	*U. peregrina*	57	5.93	6.68	6.67	3.75	0.10
849C-1H-4	*C. wuellerstorfi*	67	6.03	6.78	6.77	3.61	–0.02
849C-1H-4	*U. peregrina*	67	6.03	6.78	6.77	3.66	–0.15
849C-1H-4	*C. wuellerstorfi*	77	6.13	6.88	6.88	3.76	–0.13
849C-1H-4	*C. wuellerstorfi*	77	6.13	6.88	6.88	3.56	0.15
849C-1H-4	*U. peregrina*	77	6.13	6.88	6.88	3.84	–0.15
849C-1H-4	*C. wuellerstorfi*	87	6.23	6.98	6.98	3.89	0.11
849C-1H-4	*C. wuellerstorfi*	97	6.33	7.08	7.08	3.61	–0.04
849C-1H-4	*C. wuellerstorfi*	107	6.43	7.18	7.18	3.64	–0.03
849C-1H-4	*C. wuellerstorfi*	117	6.53	7.28	7.28	3.97	–0.23
849C-1H-4	*U. peregrina*	127	6.63	7.38	7.37	4.05	–0.22
849C-1H-4	*C. wuellerstorfi*	137	6.73	7.48	7.47	4.25	–0.38
849D-1H-1	*C. wuellerstorfi*	21	4.21	7.51	7.47	3.89	–0.43
849D-1H-1	*C. wuellerstorfi*	31	4.31	7.61	7.56	4.31	–0.44
849D-1H-1	*U. peregrina*	31	4.31	7.61	7.56	4.22	–0.57
849C-1H-4	*C. wuellerstorfi*	147	6.83	7.58	7.57	4.39	–0.36
849D-1H-1	*C. wuellerstorfi*	41	4.41	7.71	7.66	3.97	–0.19
849D-1H-1	*C. wuellerstorfi*	51	4.51	7.81	7.78	4.03	–0.11
849D-1H-1	*C. wuellerstorfi*	61	4.61	7.91	7.91	3.51	0.15
849D-1H-1	*C. wuellerstorfi*	71	4.71	8.01	8.03	3.76	–0.16
849D-1H-1	*C. wuellerstorfi*	81	4.81	8.11	8.13	4.06	–0.26
849D-1H-1	*C. wuellerstorfi*	91	4.91	8.21	8.24	4.51	–0.50
849D-1H-1	*U. peregrina*	101	5.01	8.31	8.35	4.25	–0.28
849D-1H-1	*C. wuellerstorfi*	111	5.11	8.41	8.49	4.35	–0.27
849D-1H-1	*U. peregrina*	111	5.11	8.41	8.49	4.29	–0.29
849D-1H-1	*C. wuellerstorfi*	121	5.21	8.51	8.61	4.43	–0.47
849D-1H-1	*U. peregrina*	121	5.21	8.51	8.61	4.24	–0.39
849D-1H-1	*C. wuellerstorfi*	131	5.31	8.61	8.71	4.42	–0.72
849D-1H-1	*U. peregrina*	131	5.31	8.61	8.71	4.44	–0.35
849D-1H-1	*U. peregrina*	141	5.41	8.71	8.79	4.32	–0.32
849D-1H-2	*U. peregrina*	4	5.54	8.84	8.89	4.50	–0.37
849D-1H-2	*C. wuellerstorfi*	11	5.61	8.91	8.95	4.49	–0.58
849D-1H-2	*C. wuellerstorfi*	21	5.71	9.01	9.05	4.33	–0.40
849D-1H-2	*C. wuellerstorfi*	31	5.81	9.11	9.16	4.09	–0.27
849D-1H-2	*U. peregrina*	31	5.81	9.11	9.16	3.89	–0.13
849D-1H-2	*C. wuellerstorfi*	41	5.91	9.21	9.27	4.00	–0.09
849D-1H-2	*U. peregrina*	41	5.91	9.21	9.27	3.79	–0.10
849D-1H-2	*C. wuellerstorfi*	51	6.01	9.31	9.37	4.13	–0.32
849D-1H-2	*C. wuellerstorfi*	61	6.11	9.41	9.48	4.06	–0.29
849D-1H-2	*C. wuellerstorfi*	71	6.21	9.51	9.60	4.13	–0.19
849D-1H-2	*C. wuellerstorfi*	81	6.31	9.61	9.72	3.72	–0.29
849D-1H-2	*C. wuellerstorfi*	91	6.41	9.71	9.82	3.75	–0.23
849D-1H-2	*C. wuellerstorfi*	101	6.51	9.81	9.90	3.53	0.05
849D-1H-2	*U. peregrina*	101	6.51	9.81	9.90	3.86	0.05
849D-1H-2	*C. wuellerstorfi*	111	6.61	9.91	9.96	3.85	–0.21
849D-1H-2	*C. wuellerstorfi*	111	6.61	9.91	9.96	3.86	–0.13
849D-1H-2	*U. peregrina*	111	6.61	9.91	9.96	3.79	0.00
849D-1H-2	*U. peregrina*	121	6.71	10.01	10.03	3.65	0.07
849D-1H-3	*U. peregrina*	1	6.80	10.10	10.12	3.54	0.06
849D-1H-3	*C. wuellerstorfi*	11	6.90	10.20	10.26	3.44	0.06
849D-1H-3	*U. peregrina*	11	6.90	10.20	10.26	3.42	0.16
849D-1H-3	*U. peregrina*	21	7.00	10.30	10.41	3.21	0.24
849D-1H-3	*C. wuellerstorfi*	31	7.10	10.40	10.52	3.25	–0.17
849D-1H-3	*U. peregrina*	31	7.10	10.40	10.52	3.32	0.04
849D-1H-3	*C. wuellerstorfi*	41	7.20	10.50	10.59	3.38	0.09
849D-1H-3	*U. peregrina*	41	7.20	10.50	10.59	3.28	–0.16
849D-1H-3	*U. peregrina*	61	7.40	10.70	10.75	3.70	–0.12
849D-1H-3	*C. wuellerstorfi*	71	7.50	10.80	10.90	4.06	–0.20
849D-1H-3	*U. peregrina*	71	7.50	10.80	10.90	4.24	–0.36
849D-1H-3	*U. peregrina*	81	7.60	10.90	11.05	4.58	–0.13
849D-1H-3	*U. peregrina*	91	7.70	11.00	11.17	4.62	–0.31
849B-2H-2	*C. wuellerstorfi*	104	9.24	11.19	11.19	4.64	–0.47
849B-2H-2	*U. peregrina*	104	9.24	11.19	11.19	4.70	–0.20
849D-1H-3	*U. peregrina*	101	7.80	11.10	11.25	4.72	–0.16
849B-2H-2	*C. wuellerstorfi*	122	9.42	11.37	11.37	4.34	–0.41
849B-2H-2	*U. peregrina*	122	9.42	11.37	11.37	4.47	–0.25
849D-1H-3	*C. wuellerstorfi*	121	8.00	11.30	11.40	4.30	–0.47
849D-1H-3	*U. peregrina*	121	8.00	11.30	11.40	4.09	–0.31
849B-2H-2	*U. peregrina*	131	9.51	11.46	11.46	4.57	–0.19
849B-2H-2	*C. wuellerstorfi*	132	9.52	11.47	11.47	4.40	–0.41
849B-2H-2	*C. wuellerstorfi*	143	9.63	11.58	11.58	4.59	–0.42
849B-2H-2	*U. peregrina*	143	9.63	11.58	11.58	4.20	–0.08
849B-2H-3	*C. wuellerstorfi*	7	9.77	11.72	11.72	4.33	–0.28
849B-2H-3	*U. peregrina*	7	9.77	11.72	11.72	4.32	–0.28
849B-2H-3	*C. wuellerstorfi*	17	9.87	11.82	11.82	3.93	–0.08
849B-2H-3	*U. peregrina*	17	9.87	11.82	11.82	4.18	–0.04
849B-2H-3	*C. wuellerstorfi*	27	9.97	11.92	11.92	4.40	–0.17
849B-2H-3	*U. peregrina*	27	9.97	11.92	11.92	3.93	0.00
849B-2H-3	*C. wuellerstorfi*	38	10.08	12.03	12.03	4.04	–0.34
849B-2H-3	*C. wuellerstorfi*	47	10.17	12.12	12.12	4.12	0.00
849B-2H-3	*U. peregrina*	47	10.17	12.12	12.12	4.07	0.19
849B-2H-3	*C. wuellerstorfi*	57	10.27	12.22	12.22	4.09	0.03
849B-2H-3	*U. peregrina*	57	10.27	12.22	12.22	3.95	–0.19
849B-2H-3	*C. wuellerstorfi*	67	10.37	12.32	12.32	4.07	–0.03
849B-2H-3	*U. peregrina*	67	10.37	12.32	12.32	3.97	–0.02
849B-2H-3	*C. wuellerstorfi*	87	10.57	12.52	12.52	4.02	–0.03
849B-2H-3	*U. peregrina*	87	10.57	12.52	12.52	3.92	–0.11
849B-2H-3	*C. wuellerstorfi*	97	10.67	12.62	12.62	3.35	0.40
849B-2H-3	*U. peregrina*	97	10.67	12.62	12.62	3.11	0.34
849B-2H-3	*C. wuellerstorfi*	107	10.77	12.72	12.72	3.22	0.35
849B-2H-3	*U. peregrina*	107	10.77	12.72	12.72	3.07	0.11
849B-2H-3	*U. peregrina*	141	11.11	13.06	13.06	3.52	0.30
849B-2H-4	*C. wuellerstorfi*	13	11.33	13.28	13.28	4.83	–0.39

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	$\delta^{18}O$	$\delta^{13}C$
849C-2H-1	*C. wuellerstorfi*	7	10.57	13.57	13.58	4.86	–0.34
849B-2H-4	*C. wuellerstorfi*	49	11.69	13.64	13.64	5.05	–0.42
849C-2H-1	*C. wuellerstorfi*	17	10.67	13.67	13.69	4.75	–0.44
849C-2H-1	*U. peregrina*	17	10.67	13.67	13.69	4.88	–0.19
849C-2H-1	*C. wuellerstorfi*	27	10.77	13.77	13.81	5.07	–0.41
849C-2H-1	*C. wuellerstorfi*	37	10.87	13.87	13.88	4.66	–0.22
849C-2H-1	*C. wuellerstorfi*	47	10.97	13.97	13.95	4.54	–0.31
849C-2H-1	*U. peregrina*	57	11.07	14.07	14.03	4.51	–0.06
849C-2H-1	*C. wuellerstorfi*	67	11.17	14.17	14.14	4.64	–0.40
849C-2H-1	*U. peregrina*	67	11.17	14.17	14.14	4.59	–0.38
849C-2H-1	*C. wuellerstorfi*	87	11.37	14.37	14.36	4.51	–0.21
849C-2H-1	*C. wuellerstorfi*	97	11.47	14.47	14.44	4.26	–0.15
849C-2H-1	*C. wuellerstorfi*	107	11.57	14.57	14.53	4.27	–0.29
849C-2H-1	*C. wuellerstorfi*	117	11.67	14.67	14.64	4.06	–0.21
849C-2H-1	*C. wuellerstorfi*	127	11.77	14.77	14.75	4.43	–0.16
849C-2H-1	*C. wuellerstorfi*	137	11.87	14.87	14.87	3.82	0.34
849C-2H-1	*C. wuellerstorfi*	147	11.97	14.97	14.98	3.59	0.48
849C-2H-1	*C. wuellerstorfi*	147	11.97	14.97	14.98	3.88	0.22
849C-2H-1	*U. peregrina*	147	11.97	14.97	14.98	3.73	0.25
849C-2H-2	*U. peregrina*	17	12.17	15.17	15.18	3.62	0.69
849C-2H-2	*C. wuellerstorfi*	27	12.27	15.27	15.27	3.59	0.38
849C-2H-2	*C. wuellerstorfi*	37	12.37	15.37	15.37	3.78	0.28
849C-2H-2	*U. peregrina*	37	12.37	15.37	15.37	3.83	0.38
849C-2H-2	*C. wuellerstorfi*	47	12.47	15.47	15.47	3.85	0.30
849C-2H-2	*C. wuellerstorfi*	47	12.47	15.47	15.47	3.89	0.27
849C-2H-2	*C. wuellerstorfi*	57	12.57	15.57	15.57	4.01	0.16
849C-2H-2	*C. wuellerstorfi*	67	12.67	15.67	15.67	3.79	0.30
849C-2H-2	*U. peregrina*	67	12.67	15.67	15.67	3.96	0.32
849C-2H-2	*C. wuellerstorfi*	77	12.77	15.77	15.77	4.36	0.29
849C-2H-2	*C. wuellerstorfi*	87	12.87	15.87	15.87	4.11	0.28
849C-2H-2	*C. wuellerstorfi*	97	12.97	15.97	15.97	4.13	0.18
849C-2H-2	*C. wuellerstorfi*	107	13.07	16.07	16.07	3.97	–0.02
849C-2H-2	*C. wuellerstorfi*	117	13.17	16.17	16.17	4.01	–0.10
849C-2H-2	*C. wuellerstorfi*	137	13.37	16.37	16.37	4.36	–0.31
849C-2H-2	*C. wuellerstorfi*	147	13.47	16.47	16.47	4.17	–0.12
849C-2H-3	*C. wuellerstorfi*	7	13.57	16.57	16.57	4.31	–0.20
849C-2H-3	*C. wuellerstorfi*	17	13.67	16.67	16.67	4.58	–0.16
849C-2H-3	*U. peregrina*	17	13.67	16.67	16.67	4.45	–0.28
849C-2H-3	*U. peregrina*	27	13.77	16.77	16.77	4.23	–0.02
849C-2H-3	*C. wuellerstorfi*	37	13.87	16.87	16.87	4.40	–0.11
849C-2H-3	*U. peregrina*	37	13.87	16.87	16.87	4.23	0.06
849C-2H-3	*C. wuellerstorfi*	47	13.97	16.97	16.97	4.07	–0.18
849C-2H-3	*C. wuellerstorfi*	57	14.07	17.07	17.07	4.09	0.00
849C-2H-3	*C. wuellerstorfi*	67	14.17	17.17	17.17	3.79	–0.11
849C-2H-3	*C. wuellerstorfi*	87	14.37	17.37	17.37	3.42	0.09
849C-2H-3	*C. wuellerstorfi*	97	14.47	17.47	17.47	3.55	0.18
849C-2H-3	*C. wuellerstorfi*	97	14.47	17.47	17.47	3.70	–0.01
849C-2H-3	*U. peregrina*	97	14.47	17.47	17.47	3.62	0.00
849C-2H-3	*U. peregrina*	107	14.57	17.57	17.57	3.87	0.07
849C-2H-3	*C. wuellerstorfi*	117	14.67	17.67	17.67	4.22	–0.29
849C-2H-3	*U. peregrina*	127	14.77	17.77	17.77	4.03	–0.05
849C-2H-3	*U. peregrina*	137	14.87	17.87	17.87	4.03	–0.12
849C-2H-3	*C. wuellerstorfi*	147	14.97	17.97	17.97	3.88	–0.35
849C-2H-4	*C. wuellerstorfi*	7	15.07	18.07	18.07	3.56	–0.22
849C-2H-4	*C. wuellerstorfi*	17	15.17	18.17	18.17	4.12	0.01
849C-2H-4	*C. wuellerstorfi*	27	15.27	18.27	18.27	4.11	0.06
849C-2H-4	*C. wuellerstorfi*	37	15.37	18.37	18.37	3.85	0.05
849C-2H-4	*C. wuellerstorfi*	47	15.47	18.47	18.47	3.50	0.05
849C-2H-4	*C. wuellerstorfi*	57	15.57	18.57	18.57	3.08	–0.17
849C-2H-4	*C. wuellerstorfi*	67	15.67	18.67	18.67	4.57	–0.36
849C-2H-4	*C. wuellerstorfi*	87	15.87	18.87	18.87	5.10	–0.26
849C-2H-4	*C. wuellerstorfi*	97	15.97	18.97	18.97	4.88	–0.26
849D-2H-2	*U. peregrina*	6	15.06	18.96	19.03	4.83	–0.24
849C-2H-4	*U. peregrina*	107	16.07	19.07	19.07	4.65	–0.05
849D-2H-2	*C. wuellerstorfi*	16	15.16	19.06	19.15	4.83	–0.42
849D-2H-2	*C. wuellerstorfi*	26	15.26	19.16	19.27	4.78	–0.39
849D-2H-2	*C. wuellerstorfi*	36	15.36	19.26	19.38	4.66	–0.37
849D-2H-2	*C. wuellerstorfi*	46	15.46	19.36	19.48	4.45	–0.50
849D-2H-2	*C. wuellerstorfi*	56	15.56	19.46	19.57	4.52	–0.63
849D-2H-2	*C. wuellerstorfi*	66	15.66	19.56	19.66	4.60	–0.66
849D-2H-2	*C. wuellerstorfi*	76	15.76	19.66	19.75	4.52	–0.54
849D-2H-2	*U. peregrina*	76	15.76	19.66	19.75	4.37	–0.80
849D-2H-2	*C. wuellerstorfi*	86	15.86	19.76	19.85	4.40	–0.56
849D-2H-2	*C. wuellerstorfi*	96	15.96	19.86	19.95	4.33	–0.48
849D-2H-2	*C. wuellerstorfi*	106	16.06	19.96	20.06	4.22	–0.39
849D-2H-2	*C. wuellerstorfi*	116	16.16	20.06	20.17	4.31	–0.24
849D-2H-2	*C. wuellerstorfi*	126	16.26	20.16	20.28	3.99	–0.33
849D-2H-2	*C. wuellerstorfi*	136	16.36	20.26	20.38	3.88	–0.16
849D-2H-2	*C. wuellerstorfi*	146	16.46	20.36	20.47	3.72	–0.10
849D-2H-3	*C. wuellerstorfi*	6	16.56	20.46	20.55	3.66	0.05
849D-2H-3	*C. wuellerstorfi*	16	16.66	20.56	20.63	3.51	0.24
849D-2H-3	*C. wuellerstorfi*	26	16.76	20.66	20.70	3.84	–0.11
849D-2H-3	*C. wuellerstorfi*	26	16.76	20.66	20.71	3.85	–0.06
849D-2H-3	*C. wuellerstorfi*	36	16.86	20.76	20.78	3.68	0.03
849D-2H-3	*C. wuellerstorfi*	46	16.96	20.86	20.85	4.05	–0.30
849D-2H-3	*U. peregrina*	46	16.96	20.86	20.85	3.86	–0.01
849D-2H-3	*C. wuellerstorfi*	56	17.06	20.96	20.92	4.15	–0.17
849D-2H-3	*U. peregrina*	66	17.16	21.06	21.00	4.34	–0.21
849D-2H-3	*U. peregrina*	86	17.36	21.26	21.16	4.33	–0.11
849D-2H-3	*U. peregrina*	95	17.45	21.35	21.23	4.37	–0.33
849D-2H-3	*C. wuellerstorfi*	96	17.46	21.36	21.24	4.38	–0.28
849D-2H-3	*C. wuellerstorfi*	106	17.56	21.46	21.33	4.36	–0.34
849D-2H-3	*U. peregrina*	106	17.56	21.46	21.33	4.38	–0.28
849D-2H-3	*C. wuellerstorfi*	116	17.66	21.56	21.41	4.24	–0.03
849D-2H-3	*C. wuellerstorfi*	116	17.66	21.56	21.42	4.06	–0.07
849D-2H-3	*C. wuellerstorfi*	126	17.76	21.66	21.50	4.26	–0.23
849D-2H-3	*C. wuellerstorfi*	136	17.86	21.76	21.59	4.22	–0.27
849D-2H-3	*C. wuellerstorfi*	146	17.96	21.86	21.67	4.17	–0.41
849D-2H-4	*C. wuellerstorfi*	6	18.06	21.96	21.75	4.14	–0.57
849D-2H-4	*U. peregrina*	6	18.06	21.96	21.75	4.07	–0.32
849D-2H-4	*U. peregrina*	16	18.16	22.06	21.84	4.17	–0.51
849D-2H-4	*U. peregrina*	16	18.16	22.06	21.84	4.26	–0.31
849D-2H-4	*C. wuellerstorfi*	26	18.26	22.16	21.93	4.36	–0.45
849D-2H-4	*U. peregrina*	26	18.26	22.16	21.93	4.32	–0.50
849D-2H-4	*C. wuellerstorfi*	36	18.36	22.26	22.03	4.18	–0.44
849D-2H-4	*C. wuellerstorfi*	46	18.46	22.36	22.13	4.25	–0.35
849D-2H-4	*U. peregrina*	46	18.46	22.36	22.13	3.81	–0.23
849D-2H-4	*C. wuellerstorfi*	56	18.56	22.46	22.24	3.76	–0.25
849D-2H-4	*U. peregrina*	56	18.56	22.46	22.24	3.88	–0.16
849D-2H-4	*U. peregrina*	66	18.66	22.56	22.35	3.64	0.04
849D-2H-4	*C. wuellerstorfi*	76	18.76	22.66	22.46	3.67	0.12
849D-2H-4	*U. peregrina*	76	18.76	22.66	22.46	3.44	0.06
849D-2H-4	*C. wuellerstorfi*	86	18.86	22.76	22.57	3.51	–0.20
849D-2H-4	*U. peregrina*	96	18.96	22.86	22.67	3.56	–0.23
849D-2H-4	*U. peregrina*	106	19.06	22.96	22.76	3.97	–0.35
849D-2H-4	*C. wuellerstorfi*	116	19.16	23.06	22.85	3.99	–0.58
849D-2H-4	*C. wuellerstorfi*	126	19.26	23.16	22.94	4.62	–0.53
849D-2H-4	*C. wuellerstorfi*	136	19.36	23.26	23.03	4.36	–0.59
849D-2H-4	*C. wuellerstorfi*	146	19.46	23.36	23.12	4.31	–0.30
849D-2H-5	*C. wuellerstorfi*	6	19.56	23.46	23.22	4.10	–0.22
849D-2H-5	*U. peregrina*	6	19.56	23.46	23.22	4.03	–0.27
849D-2H-5	*C. wuellerstorfi*	16	19.66	23.56	23.34	4.12	–0.36
849D-2H-5	*U. peregrina*	16	19.66	23.56	23.34	4.03	–0.18
849D-2H-5	*C. wuellerstorfi*	26	19.76	23.66	23.47	3.92	–0.17
849D-2H-5	*U. peregrina*	26	19.76	23.66	23.47	3.82	–0.19
849D-2H-5	*C. wuellerstorfi*	36	19.86	23.76	23.61	3.76	–0.30
849D-2H-5	*U. peregrina*	36	19.86	23.76	23.61	3.78	–0.19
849D-2H-5	*C. wuellerstorfi*	46	19.96	23.86	23.75	3.85	–0.46
849D-2H-5	*U. peregrina*	46	19.96	23.86	23.75	3.72	–0.35
849D-2H-5	*C. wuellerstorfi*	56	20.06	23.96	23.88	3.87	–0.23
849D-2H-5	*U. peregrina*	56	20.06	23.96	23.88	3.76	–0.42
849D-2H-5	*U. peregrina*	66	20.16	24.06	23.99	3.50	–0.22
849D-2H-5	*U. peregrina*	76	20.26	24.16	24.10	3.52	–0.40
849D-2H-5	*U. peregrina*	86	20.36	24.26	24.20	3.76	–0.26
849D-2H-5	*C. wuellerstorfi*	96	20.46	24.36	24.30	3.52	–0.19
849D-2H-5	*C. wuellerstorfi*	96	20.46	24.36	24.30	3.62	–0.25
849D-2H-5	*U. peregrina*	96	20.46	24.36	24.30	3.33	–0.21
849D-2H-5	*C. wuellerstorfi*	106	20.56	24.46	24.40	3.67	–0.19
849D-2H-5	*U. peregrina*	106	20.56	24.46	24.40	3.40	–0.06
849D-2H-5	*C. wuellerstorfi*	116	20.66	24.56	24.50	3.81	–0.48
849D-2H-5	*C. wuellerstorfi*	126	20.76	24.66	24.61	3.68	–0.43
849D-2H-5	*U. peregrina*	126	20.76	24.66	24.61	3.86	–0.51
849D-2H-5	*C. wuellerstorfi*	136	20.86	24.76	24.72	3.55	–0.27
849D-2H-5	*C. wuellerstorfi*	146	20.96	24.86	24.84	4.62	–0.78
849D-2H-5	*U. peregrina*	146	20.96	24.86	24.84	4.53	–0.52
849D-2H-6	*C. wuellerstorfi*	6	21.06	24.96	24.95	4.61	–0.70
849D-2H-6	*C. wuellerstorfi*	16	21.16	25.06	25.06	4.58	–0.58
849B-3H-4	*C. wuellerstorfi*	42	21.12	25.17	25.14	4.39	–0.79
849D-2H-6	*U. peregrina*	26	21.26	25.16	25.17	4.39	–0.37
849D-2H-6	*U. peregrina*	36	21.36	25.26	25.27	4.30	–0.25
849D-2H-6	*C. wuellerstorfi*	46	21.46	25.36	25.37	4.67	–0.77
849D-2H-6	*U. peregrina*	46	21.46	25.36	25.37	4.45	–0.42
849B-3H-4	*C. wuellerstorfi*	65	21.35	25.40	25.42	4.33	–0.64
849D-2H-6	*C. wuellerstorfi*	56	21.56	25.46	25.46	4.48	–0.44
849B-3H-4	*C. wuellerstorfi*	75	21.45	25.50	25.52	4.15	–0.51
849B-3H-4	*C. wuellerstorfi*	87	21.57	25.62	25.62	4.25	–0.34
849B-3H-4	*C. wuellerstorfi*	97	21.67	25.72	25.71	4.19	–0.49
849B-3H-4	*C. wuellerstorfi*	107	21.77	25.82	25.83	4.06	–0.57
849B-3H-4	*C. wuellerstorfi*	117	21.87	25.92	25.92	4.13	–0.64
849B-3H-4	*C. wuellerstorfi*	127	21.97	26.02	26.02	4.17	–0.85
849B-3H-4	*C. wuellerstorfi*	137	22.07	26.12	26.12	4.31	–0.90
849B-3H-4	*C. wuellerstorfi*	147	22.17	26.22	26.22	4.28	–0.72
849B-3H-5	*C. wuellerstorfi*	7	22.27	26.32	26.32	4.27	–0.79
849B-3H-5	*C. wuellerstorfi*	27	22.47	26.52	26.52	4.02	–0.53
849B-3H-5	*C. wuellerstorfi*	37	22.57	26.62	26.62	3.78	–0.50
849B-3H-5	*C. wuellerstorfi*	49	22.69	26.74	26.74	3.77	–0.52
849C-3H-1	*C. wuellerstorfi*	36	20.36	26.76	26.76	4.14	–0.45
849B-3H-5	*C. wuellerstorfi*	56	22.76	26.81	26.81	3.50	–0.16
849C-3H-1	*C. wuellerstorfi*	46	20.46	26.86	26.86	3.50	0.05
849C-3H-1	*C. wuellerstorfi*	56	20.56	26.96	26.96	3.54	0.09
849C-3H-1	*C. wuellerstorfi*	66	20.66	27.06	27.06	3.40	–0.37
849C-3H-1	*C. wuellerstorfi*	86	20.86	27.26	27.26	4.02	–0.66

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849C-3H-1	*U. peregrina*	86	20.86	27.26	27.26	3.90	–0.48
849C-3H-1	*C. wuellerstorfi*	96	20.96	27.36	27.36	4.27	–0.50
849C-3H-1	*C. wuellerstorfi*	106	21.06	27.46	27.46	4.34	–0.22
849C-3H-1	*C. wuellerstorfi*	116	21.16	27.56	27.56	4.17	–0.12
849C-3H-1	*C. wuellerstorfi*	126	21.26	27.66	27.66	3.87	–0.13
849C-3H-1	*C. wuellerstorfi*	136	21.36	27.76	27.76	3.71	–0.16
849C-3H-1	*C. wuellerstorfi*	146	21.46	27.86	27.86	3.76	–0.26
849C-3H-2	*C. wuellerstorfi*	6	21.56	27.96	27.96	4.06	–0.32
849C-3H-2	*C. wuellerstorfi*	16	21.66	28.06	28.06	4.15	–0.32
849C-3H-2	*C. wuellerstorfi*	26	21.76	28.16	28.15	3.87	0.03
849C-3H-2	*C. wuellerstorfi*	36	21.86	28.26	28.26	3.90	–0.08
849C-3H-2	*C. wuellerstorfi*	46	21.96	28.36	28.37	3.96	–0.16
849C-3H-2	*C. wuellerstorfi*	56	22.06	28.46	28.47	4.09	–0.23
849C-3H-2	*C. wuellerstorfi*	66	22.16	28.56	28.56	4.28	–0.11
849C-3H-2	*C. wuellerstorfi*	76	22.26	28.66	28.66	4.04	–0.08
849C-3H-2	*C. wuellerstorfi*	86	22.36	28.76	28.75	3.89	0.02
849C-3H-2	*C. wuellerstorfi*	96	22.46	28.86	28.85	3.69	0.07
849C-3H-2	*C. wuellerstorfi*	106	22.56	28.96	28.96	3.67	0.05
849C-3H-2	*C. wuellerstorfi*	116	22.66	29.06	29.06	3.88	–0.12
849C-3H-2	*C. wuellerstorfi*	126	22.76	29.16	29.16	3.92	–0.14
849C-3H-2	*C. wuellerstorfi*	136	22.86	29.26	29.25	4.31	–0.26
849C-3H-2	*C. wuellerstorfi*	146	22.96	29.36	29.36	4.43	–0.29
849D-3H-3	*U. peregrina*	6	25.80	29.65	29.53	4.18	–0.58
849D-3H-3	*C. wuellerstorfi*	6	25.80	29.65	29.56	4.19	–0.53
849D-3H-3	*C. wuellerstorfi*	16	25.90	29.75	29.68	4.07	–0.45
849D-3H-3	*U. peregrina*	26	26.00	29.85	29.79	3.97	–0.24
849D-3H-3	*U. peregrina*	36	26.10	29.95	29.89	3.65	–0.10
849D-3H-3	*C. wuellerstorfi*	46	26.20	30.05	29.99	3.50	–0.02
849D-3H-3	*C. wuellerstorfi*	56	26.30	30.15	30.10	3.27	0.09
849D-3H-3	*U. peregrina*	56	26.30	30.15	30.10	3.06	–0.04
849D-3H-3	*C. wuellerstorfi*	66	26.40	30.25	30.21	3.38	–0.05
849D-3H-3	*U. peregrina*	66	26.40	30.25	30.21	3.22	0.19
849D-3H-3	*C. wuellerstorfi*	76	26.50	30.35	30.31	3.62	0.20
849D-3H-3	*C. wuellerstorfi*	86	26.60	30.45	30.40	3.76	0.03
849D-3H-3	*U. peregrina*	86	26.60	30.45	30.40	3.65	–0.06
849D-3H-3	*U. peregrina*	96	26.70	30.55	30.47	3.75	–0.06
849D-3H-3	*C. wuellerstorfi*	106	26.80	30.65	30.55	4.08	–0.16
849D-3H-3	*U. peregrina*	106	26.80	30.65	30.55	3.89	0.13
849D-3H-3	*C. wuellerstorfi*	116	26.90	30.75	30.65	3.66	–0.26
849D-3H-3	*U. peregrina*	116	26.90	30.75	30.65	3.98	–0.29
849D-3H-3	*C. wuellerstorfi*	126	27.00	30.85	30.77	4.26	–0.30
849D-3H-3	*U. peregrina*	126	27.00	30.85	30.77	4.19	–0.41
849D-3H-3	*C. wuellerstorfi*	136	27.10	30.95	30.90	4.06	–0.16
849D-3H-3	*U. peregrina*	136	27.10	30.95	30.90	3.88	–0.15
849D-3H-3	*C. wuellerstorfi*	146	27.20	31.05	31.03	3.92	0.01
849D-3H-4	*C. wuellerstorfi*	16	27.40	31.25	31.24	4.00	–0.20
849D-3H-4	*C. wuellerstorfi*	26	27.50	31.35	31.34	4.04	–0.36
849D-3H-4	*C. wuellerstorfi*	36	27.60	31.45	31.45	4.28	–0.44
849D-3H-4	*U. peregrina*	46	27.70	31.55	31.56	4.25	–0.35
849D-3H-4	*C. wuellerstorfi*	56	27.80	31.65	31.67	4.34	–0.34
849D-3H-4	*U. peregrina*	56	27.80	31.65	31.67	4.03	–0.29
849D-3H-4	*C. wuellerstorfi*	66	27.90	31.75	31.77	4.24	–0.29
849D-3H-4	*U. peregrina*	66	27.90	31.75	31.77	4.16	–0.29
849D-3H-4	*C. wuellerstorfi*	76	28.00	31.85	31.88	4.17	–0.39
849D-3H-4	*C. wuellerstorfi*	86	28.10	31.95	31.99	3.96	–0.34
849D-3H-4	*C. wuellerstorfi*	96	28.20	32.05	32.12	3.85	–0.05
849D-3H-4	*C. wuellerstorfi*	106	28.30	32.15	32.24	3.79	–0.29
849D-3H-4	*U. peregrina*	106	28.30	32.15	32.24	3.67	0.02
849D-3H-4	*C. wuellerstorfi*	116	28.40	32.25	32.34	3.95	0.04
849D-3H-4	*U. peregrina*	116	28.40	32.25	32.34	3.61	–0.05
849D-3H-4	*C. wuellerstorfi*	126	28.50	32.35	32.41	3.71	0.12
849D-3H-4	*U. peregrina*	126	28.50	32.35	32.41	3.64	0.06
849D-3H-4	*C. wuellerstorfi*	136	28.60	32.45	32.47	3.56	0.12
849D-3H-4	*U. peregrina*	136	28.60	32.45	32.47	3.53	0.04
849D-3H-4	*C. wuellerstorfi*	146	28.70	32.55	32.52	3.55	0.13
849D-3H-5	*C. wuellerstorfi*	6	28.80	32.65	32.58	3.62	0.14
849D-3H-5	*C. wuellerstorfi*	16	28.90	32.75	32.62	3.83	0.16
849D-3H-5	*U. peregrina*	16	28.90	32.75	32.62	3.89	–0.05
849D-3H-5	*C. wuellerstorfi*	26	29.00	32.85	32.69	3.95	0.11
849D-3H-5	*C. wuellerstorfi*	36	29.10	32.95	32.78	3.91	0.19
849D-3H-5	*U. peregrina*	36	29.10	32.95	32.78	3.74	0.14
849D-3H-5	*C. wuellerstorfi*	46	29.20	33.05	32.90	3.95	–0.30
849D-3H-5	*U. peregrina*	46	29.20	33.05	32.90	3.93	–0.19
849D-3H-5	*C. wuellerstorfi*	56	29.30	33.15	33.07	4.25	–0.34
849D-3H-5	*U. peregrina*	56	29.30	33.15	33.07	4.06	–0.24
849D-3H-5	*C. wuellerstorfi*	66	29.40	33.25	33.28	4.30	–0.33
849D-3H-5	*C. wuellerstorfi*	66	29.40	33.25	33.28	4.40	–0.31
849D-3H-5	*U. peregrina*	66	29.40	33.25	33.28	4.38	–0.25
849D-3H-5	*U. peregrina*	66	29.40	33.25	33.28	4.40	–0.29
849D-3H-5	*C. wuellerstorfi*	76	29.50	33.35	33.44	4.49	–0.44
849D-3H-5	*C. wuellerstorfi*	86	29.60	33.45	33.53	4.44	–0.36
849D-3H-5	*U. peregrina*	86	29.60	33.45	33.53	4.33	–0.16
849D-3H-5	*C. wuellerstorfi*	96	29.70	33.55	33.61	4.10	–0.42
849D-3H-5	*U. peregrina*	96	29.70	33.55	33.61	4.26	–0.34
849D-3H-5	*C. wuellerstorfi*	106	29.80	33.65	33.67	4.20	–0.39
849D-3H-5	*U. peregrina*	106	29.80	33.65	33.67	4.18	–0.13
849D-3H-5	*C. wuellerstorfi*	116	29.90	33.75	33.73	4.20	–0.41
849D-3H-5	*U. peregrina*	116	29.90	33.75	33.73	3.86	–0.36
849D-3H-5	*C. wuellerstorfi*	126	30.00	33.85	33.80	4.05	–0.17
849D-3H-5	*U. peregrina*	126	30.00	33.85	33.80	4.06	–0.26
849D-3H-5	*C. wuellerstorfi*	136	30.10	33.95	33.88	3.80	–0.13
849D-3H-5	*U. peregrina*	136	30.10	33.95	33.88	4.04	–0.28
849D-3H-5	*C. wuellerstorfi*	146	30.20	34.05	33.99	3.45	0.26
849D-3H-6	*C. wuellerstorfi*	6	30.30	34.15	34.15	3.60	0.22
849D-3H-6	*C. wuellerstorfi*	16	30.40	34.25	34.37	3.32	0.10
849D-3H-6	*C. wuellerstorfi*	26	30.50	34.35	34.63	3.36	0.15
849D-3H-6	*C. wuellerstorfi*	36	30.60	34.45	34.78	3.43	–0.15
849D-3H-6	*C. wuellerstorfi*	46	30.70	34.55	34.85	3.67	–0.48
849D-3H-6	*U. peregrina*	46	30.70	34.55	34.85	3.66	–0.36
849D-3H-6	*C. wuellerstorfi*	56	30.80	34.65	34.89	3.91	–0.43
849D-3H-6	*U. peregrina*	56	30.80	34.65	34.89	4.10	–0.52
849D-3H-6	*C. wuellerstorfi*	66	30.90	34.75	34.93	4.13	–0.56
849D-3H-6	*U. peregrina*	66	30.90	34.75	34.93	4.40	–0.53
849D-3H-6	*C. wuellerstorfi*	76	31.00	34.85	34.97	4.15	–0.57
849D-3H-6	*U. peregrina*	76	31.00	34.85	34.97	4.43	–0.73
849D-3H-6	*C. wuellerstorfi*	86	31.10	34.95	35.01	4.26	–0.59
849D-3H-6	*C. wuellerstorfi*	96	31.20	35.05	35.06	4.12	–0.35
849D-3H-6	*U. peregrina*	96	31.20	35.05	35.06	3.98	–0.13
849D-3H-6	*C. wuellerstorfi*	106	31.30	35.15	35.13	3.90	–0.52
849D-3H-6	*U. peregrina*	106	31.30	35.15	35.13	4.06	–0.41
849D-3H-6	*U. peregrina*	116	31.40	35.25	35.27	4.25	–0.06
849D-3H-6	*C. wuellerstorfi*	126	31.50	35.35	35.45	4.01	–0.16
849D-3H-6	*U. peregrina*	126	31.50	35.35	35.45	4.09	–0.18
849D-3H-6	*C. wuellerstorfi*	136	31.60	35.45	35.60	3.62	–0.30
849D-3H-6	*U. peregrina*	136	31.60	35.45	35.60	3.90	–0.15
849D-3H-6	*C. wuellerstorfi*	146	31.70	35.55	35.71	3.69	–0.06
849D-3H-7	*C. wuellerstorfi*	6	31.80	35.65	35.78	3.71	–0.13
849D-3H-7	*C. wuellerstorfi*	16	31.90	35.75	35.86	3.68	0.03
849D-3H-7	*U. peregrina*	26	32.00	35.85	35.93	3.75	–0.16
849D-3H-7	*C. wuellerstorfi*	36	32.10	35.95	36.01	3.73	–0.03
849D-3H-7	*U. peregrina*	36	32.10	35.95	36.01	3.70	–0.16
849D-3H-7	*C. wuellerstorfi*	46	32.20	36.05	36.11	3.78	–0.03
849D-3H-7	*U. peregrina*	46	32.20	36.05	36.11	3.50	–0.11
849D-3H-7	*C. wuellerstorfi*	56	32.30	36.15	36.22	3.71	–0.23
849D-3H-7	*U. peregrina*	56	32.30	36.15	36.22	3.62	–0.24
849D-3H-7	*C. wuellerstorfi*	66	32.40	36.25	36.35	3.80	–0.22
849D-3H-7	*U. peregrina*	66	32.40	36.25	36.35	3.96	–0.30
849D-3H-7	*U. peregrina*	76	32.50	36.35	36.51	4.21	–0.45
849D-3H-7	*C. wuellerstorfi*	76	32.50	36.35	36.52	4.33	–0.37
849D-3H-7	*U. peregrina*	76	32.50	36.35	36.52	4.11	–0.48
849C-4H-1	*C. wuellerstorfi*	6	29.56	36.66	36.74	4.06	–0.40
849C-4H-1	*C. wuellerstorfi*	16	29.66	36.76	36.85	3.91	–0.08
849C-4H-1	*C. wuellerstorfi*	26	29.76	36.86	36.96	3.96	0.09
849C-4H-1	*C. wuellerstorfi*	36	29.86	36.96	37.08	3.97	–0.01
849C-4H-1	*C. wuellerstorfi*	46	29.96	37.06	37.20	3.82	0.06
849C-4H-1	*C. wuellerstorfi*	56	30.06	37.16	37.29	3.71	0.08
849C-4H-1	*C. wuellerstorfi*	66	30.16	37.26	37.38	3.75	–0.25
849C-4H-2	*C. wuellerstorfi*	6	30.28	37.38	37.47	3.80	–0.04
849C-4H-2	*C. wuellerstorfi*	16	30.38	37.48	37.54	4.01	–0.07
849C-4H-2	*C. wuellerstorfi*	26	30.48	37.58	37.61	4.18	–0.16
849C-4H-2	*C. wuellerstorfi*	36	30.58	37.68	37.67	4.19	–0.20
849C-4H-2	*C. wuellerstorfi*	46	30.68	37.78	37.73	4.18	–0.46
849C-4H-2	*C. wuellerstorfi*	56	30.78	37.88	37.80	4.07	–0.49
849C-4H-2	*C. wuellerstorfi*	66	30.88	37.98	37.89	3.99	–0.49
849C-4H-2	*C. wuellerstorfi*	76	30.98	38.08	38.04	4.14	–0.48
849C-4H-2	*C. wuellerstorfi*	86	31.08	38.18	38.22	4.04	–0.40
849C-4H-2	*C. wuellerstorfi*	96	31.18	38.28	38.36	4.05	–0.22
849C-4H-2	*C. wuellerstorfi*	106	31.28	38.38	38.46	3.52	0.16
849C-4H-2	*C. wuellerstorfi*	116	31.38	38.48	38.56	3.49	0.15
849C-4H-2	*C. wuellerstorfi*	126	31.48	38.58	38.65	3.41	0.25
849C-4H-2	*C. wuellerstorfi*	136	31.58	38.68	38.74	3.52	0.04
849C-4H-2	*C. wuellerstorfi*	146	31.68	38.78	38.82	3.43	0.03
849C-4H-2	*C. wuellerstorfi*	146	31.68	38.78	38.82	3.46	0.03
849C-4H-3	*C. wuellerstorfi*	6	31.78	38.88	38.90	3.67	–0.08
849C-4H-3	*C. wuellerstorfi*	16	31.88	38.98	38.98	4.10	–0.17
849C-4H-3	*C. wuellerstorfi*	26	31.98	39.08	39.08	4.27	–0.28
849D-4H-1	*C. wuellerstorfi*	16	32.66	39.21	39.15	4.18	–0.38
849C-4H-3	*C. wuellerstorfi*	36	32.08	39.18	39.18	4.16	–0.34
849D-4H-1	*C. wuellerstorfi*	26	32.76	39.31	39.22	4.06	–0.29
849C-4H-3	*C. wuellerstorfi*	46	32.18	39.28	39.28	4.12	–0.21
849D-4H-1	*C. wuellerstorfi*	36	32.86	39.41	39.29	3.99	–0.12
849D-4H-1	*C. wuellerstorfi*	46	32.96	39.51	39.39	4.14	–0.32
849D-4H-1	*C. wuellerstorfi*	66	33.16	39.71	39.78	3.68	0.20
849D-4H-1	*C. wuellerstorfi*	76	33.26	39.81	39.90	3.68	0.14
849D-4H-1	*C. wuellerstorfi*	96	33.46	40.01	40.05	3.70	–0.19
849D-4H-1	*C. wuellerstorfi*	106	33.56	40.11	40.12	3.74	–0.17
849D-4H-1	*C. wuellerstorfi*	116	33.66	40.21	40.21	4.04	–0.32
849D-4H-1	*C. wuellerstorfi*	126	33.76	40.31	40.34	3.92	–0.16
849D-4H-1	*C. wuellerstorfi*	136	33.86	40.41	40.48	3.87	–0.04
849D-4H-1	*C. wuellerstorfi*	146	33.96	40.51	40.60	3.61	0.21

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849D-4H-2	*C. wuellerstorfi*	6	34.06	40.61	40.69	3.48	–0.01
849D-4H-2	*C. wuellerstorfi*	16	34.16	40.71	40.77	3.51	0.28
849D-4H-2	*C. wuellerstorfi*	16	34.16	40.71	40.78	3.50	–0.03
849D-4H-2	*C. wuellerstorfi*	26	34.26	40.81	40.86	3.28	–0.13
849D-4H-2	*C. wuellerstorfi*	36	34.36	40.91	40.97	3.46	–0.27
849D-4H-2	*C. wuellerstorfi*	46	34.46	41.01	41.12	3.53	–0.17
849D-4H-2	*C. wuellerstorfi*	56	34.56	41.11	41.26	4.00	–0.37
849D-4H-2	*U. peregrina*	56	34.56	41.11	41.26	4.31	–0.68
849D-4H-2	*C. wuellerstorfi*	66	34.66	41.21	41.34	4.25	–0.35
849D-4H-2	*C. wuellerstorfi*	76	34.76	41.31	41.40	3.40	0.20
849D-4H-2	*C. wuellerstorfi*	106	35.06	41.61	41.53	3.50	0.24
849D-4H-2	*C. wuellerstorfi*	116	35.16	41.71	41.57	3.41	0.38
849D-4H-2	*C. wuellerstorfi*	136	35.36	41.91	41.75	4.11	–0.21
849D-4H-2	*C. wuellerstorfi*	146	35.46	42.01	41.95	4.39	–0.16
849D-4H-3	*C. wuellerstorfi*	6	35.56	42.11	42.15	4.28	–0.11
849D-4H-3	*C. wuellerstorfi*	16	35.66	42.21	42.25	4.19	–0.29
849D-4H-3	*C. wuellerstorfi*	26	35.76	42.31	42.32	4.11	0.01
849D-4H-3	*C. wuellerstorfi*	36	35.86	42.41	42.38	3.71	0.29
849D-4H-3	*C. wuellerstorfi*	46	35.96	42.51	42.44	3.76	–0.03
849D-4H-3	*C. wuellerstorfi*	56	36.06	42.61	42.51	3.69	0.30
849D-4H-3	*C. wuellerstorfi*	76	36.26	42.81	42.71	3.91	–0.28
849D-4H-3	*C. wuellerstorfi*	86	36.36	42.91	42.85	4.04	–0.31
849D-4H-3	*U. peregrina*	86	36.36	42.91	42.85	4.31	–0.62
849D-4H-3	*C. wuellerstorfi*	96	36.46	43.01	43.00	4.47	–0.52
849D-4H-3	*C. wuellerstorfi*	106	36.56	43.11	43.13	4.23	–0.48
849D-4H-3	*C. wuellerstorfi*	106	36.56	43.11	43.14	4.23	–0.50
849D-4H-3	*C. wuellerstorfi*	116	36.66	43.21	43.24	4.32	–0.32
849D-4H-3	*C. wuellerstorfi*	126	36.76	43.31	43.32	4.03	–0.13
849D-4H-3	*C. wuellerstorfi*	136	36.86	43.41	43.39	4.08	–0.18
849D-4H-3	*U. peregrina*	136	36.86	43.41	43.39	3.95	–0.17
849D-4H-3	*U. peregrina*	146	36.96	43.51	43.46	3.74	–0.19
849D-4H-4	*C. wuellerstorfi*	6	37.06	43.61	43.52	3.73	0.07
849D-4H-4	*U. peregrina*	6	37.06	43.61	43.52	3.76	0.10
849D-4H-4	*C. wuellerstorfi*	26	37.26	43.81	43.69	3.48	0.18
849D-4H-4	*U. peregrina*	26	37.26	43.81	43.69	3.45	0.02
849D-4H-4	*C. wuellerstorfi*	36	37.36	43.91	43.82	3.59	0.09
849D-4H-4	*U. peregrina*	36	37.36	43.91	43.82	3.73	–0.07
849D-4H-4	*C. wuellerstorfi*	46	37.46	44.01	43.97	3.88	–0.23
849D-4H-4	*U. peregrina*	46	37.46	44.01	43.97	4.10	–0.18
849D-4H-4	*C. wuellerstorfi*	56	37.56	44.11	44.10	4.09	–0.18
849D-4H-4	*C. wuellerstorfi*	66	37.66	44.21	44.20	4.10	–0.33
849D-4H-4	*C. wuellerstorfi*	76	37.76	44.31	44.28	4.01	–0.09
849D-4H-4	*C. wuellerstorfi*	86	37.86	44.41	44.35	3.74	–0.06
849D-4H-4	*U. peregrina*	96	37.96	44.51	44.43	3.78	–0.50
849D-4H-4	*C. wuellerstorfi*	106	38.06	44.61	44.52	3.69	0.00
849D-4H-4	*C. wuellerstorfi*	116	38.16	44.71	44.62	3.56	0.24
849D-4H-4	*C. wuellerstorfi*	126	38.26	44.81	44.73	3.35	0.39
849D-4H-4	*C. wuellerstorfi*	136	38.36	44.91	44.83	3.38	0.19
849D-4H-4	*C. wuellerstorfi*	146	38.46	45.01	44.94	3.34	0.07
849D-4H-5	*C. wuellerstorfi*	6	38.56	45.11	45.06	3.70	–0.01
849D-4H-5	*C. wuellerstorfi*	6	38.56	45.11	45.06	3.66	–0.05
849D-4H-5	*C. wuellerstorfi*	16	38.66	45.21	45.19	3.85	0.16
849D-4H-5	*C. wuellerstorfi*	16	38.66	45.21	45.19	3.76	0.15
849D-4H-5	*C. wuellerstorfi*	26	38.76	45.31	45.34	3.93	0.16
849D-4H-5	*C. wuellerstorfi*	46	38.96	45.51	45.57	3.53	0.23
849D-4H-5	*C. wuellerstorfi*	56	39.06	45.61	45.65	3.56	0.08
849D-4H-5	*U. peregrina*	56	39.06	45.61	45.65	3.87	–0.02
849D-4H-5	*C. wuellerstorfi*	66	39.16	45.71	45.74	3.66	0.22
849D-4H-5	*C. wuellerstorfi*	76	39.26	45.81	45.83	3.88	–0.13
849D-4H-5	*U. peregrina*	76	39.26	45.81	45.83	3.85	–0.14
849D-4H-5	*C. wuellerstorfi*	86	39.36	45.91	45.92	3.99	–0.11
849D-4H-5	*C. wuellerstorfi*	96	39.46	46.01	46.04	4.32	–0.25
849D-4H-5	*C. wuellerstorfi*	106	39.56	46.11	46.15	4.46	–0.12
849D-4H-5	*U. peregrina*	106	39.56	46.11	46.15	4.44	–0.34
849D-4H-5	*C. wuellerstorfi*	116	39.66	46.21	46.26	4.35	–0.21
849D-4H-5	*C. wuellerstorfi*	126	39.76	46.31	46.35	4.00	–0.49
849D-4H-5	*U. peregrina*	126	39.76	46.31	46.35	4.28	–0.31
849D-4H-5	*C. wuellerstorfi*	136	39.86	46.41	46.43	4.18	–0.18
849D-4H-5	*C. wuellerstorfi*	146	39.96	46.51	46.50	4.19	–0.18
849D-4H-6	*C. wuellerstorfi*	6	40.06	46.61	46.57	4.06	0.02
849D-4H-6	*C. wuellerstorfi*	16	40.16	46.71	46.64	3.91	–0.08
849D-4H-6	*C. wuellerstorfi*	26	40.26	46.81	46.73	3.70	–0.04
849D-4H-6	*C. wuellerstorfi*	36	40.36	46.91	46.85	3.66	0.13
849D-4H-6	*C. wuellerstorfi*	46	40.46	47.01	47.00	3.70	–0.01
849D-4H-6	*C. wuellerstorfi*	56	40.56	47.11	47.14	3.88	–0.50
849D-4H-6	*C. wuellerstorfi*	66	40.66	47.21	47.25	3.93	–0.25
849D-4H-6	*C. wuellerstorfi*	76	40.76	47.31	47.33	3.84	–0.27
849D-4H-6	*C. wuellerstorfi*	86	40.86	47.41	47.38	3.70	–0.40
849D-4H-6	*C. wuellerstorfi*	96	40.96	47.51	47.43	4.09	–0.70
849D-4H-6	*C. wuellerstorfi*	106	41.06	47.61	47.51	4.23	–0.65
849D-4H-6	*C. wuellerstorfi*	116	41.16	47.71	47.60	4.22	–0.35
849D-4H-6	*U. peregrina*	116	41.16	47.71	47.60	4.17	–0.35
849C-5H-1	*C. wuellerstorfi*	36	39.36	47.51	47.62	4.02	–0.60
849C-5H-1	*C. wuellerstorfi*	46	39.46	47.61	47.69	3.97	–0.26
849D-4H-6	*C. wuellerstorfi*	126	41.26	47.81	47.70	3.88	–0.43
849C-5H-1	*C. wuellerstorfi*	56	39.56	47.71	47.76	3.60	–0.09
849C-5H-1	*C. wuellerstorfi*	66	39.66	47.81	47.83	3.66	–0.17
849C-5H-1	*C. wuellerstorfi*	76	39.76	47.91	47.92	3.89	–0.22
849C-5H-1	*C. wuellerstorfi*	86	39.86	48.01	48.03	3.80	–0.33
849C-5H-1	*C. wuellerstorfi*	96	39.96	48.11	48.17	3.93	–0.32
849C-5H-1	*C. wuellerstorfi*	106	40.06	48.21	48.29	3.32	–0.19
849C-5H-1	*C. wuellerstorfi*	116	40.16	48.31	48.39	3.41	–0.17
849C-5H-1	*C. wuellerstorfi*	126	40.26	48.41	48.47	3.69	–0.30
849C-5H-1	*C. wuellerstorfi*	136	40.36	48.51	48.54	3.96	–0.41
849C-5H-1	*C. wuellerstorfi*	146	40.46	48.61	48.63	3.77	–0.22
849C-5H-2	*C. wuellerstorfi*	6	40.56	48.71	48.71	3.71	–0.27
849C-5H-2	*C. wuellerstorfi*	16	40.66	48.81	48.82	3.48	0.16
849C-5H-2	*C. wuellerstorfi*	36	40.86	49.01	49.02	3.43	–0.09
849C-5H-2	*C. wuellerstorfi*	46	40.96	49.11	49.12	3.51	–0.12
849C-5H-2	*C. wuellerstorfi*	56	41.06	49.21	49.21	3.48	–0.12
849C-5H-2	*C. wuellerstorfi*	66	41.16	49.31	49.30	3.81	–0.34
849C-5H-2	*C. wuellerstorfi*	76	41.26	49.41	49.41	3.98	–0.21
849C-5H-2	*C. wuellerstorfi*	86	41.36	49.51	49.52	3.86	–0.56
849C-5H-2	*C. wuellerstorfi*	96	41.46	49.61	49.63	3.92	–0.43
849C-5H-2	*C. wuellerstorfi*	116	41.66	49.81	49.82	4.14	–0.55
849C-5H-2	*C. wuellerstorfi*	136	41.86	50.01	50.00	3.94	–0.34
849C-5H-2	*C. wuellerstorfi*	146	41.96	50.11	50.10	3.62	–0.05
849C-5H-3	*C. wuellerstorfi*	6	42.06	50.21	50.20	3.57	–0.16
849C-5H-3	*C. wuellerstorfi*	16	42.16	50.31	50.31	3.43	0.01
849C-5H-3	*C. wuellerstorfi*	26	42.26	50.41	50.41	3.55	–0.26
849C-5H-3	*C. wuellerstorfi*	36	42.36	50.51	50.51	3.61	–0.20
849C-5H-3	*C. wuellerstorfi*	46	42.46	50.61	50.60	3.46	–0.08
849C-5H-3	*C. wuellerstorfi*	56	42.56	50.71	50.70	3.37	–0.14
849C-5H-3	*C. wuellerstorfi*	66	42.66	50.81	50.81	3.47	–0.32
849C-5H-3	*C. wuellerstorfi*	76	42.76	50.91	50.91	3.81	–0.70
849C-5H-3	*C. wuellerstorfi*	86	42.86	51.01	51.02	4.01	–0.62
849D-5H-1	*C. wuellerstorfi*	76	42.76	51.21	51.07	4.03	–0.54
849D-5H-1	*U. peregrina*	76	42.76	51.21	51.07	4.26	–0.58
849D-5H-1	*U. peregrina*	86	42.86	51.31	51.20	4.18	–0.73
849D-5H-1	*C. wuellerstorfi*	96	42.96	51.41	51.33	4.09	–0.07
849D-5H-1	*C. wuellerstorfi*	96	42.96	51.41	51.33	3.80	–0.18
849D-5H-1	*C. wuellerstorfi*	106	43.06	51.51	51.46	3.88	–0.29
849D-5H-1	*C. wuellerstorfi*	116	43.16	51.61	51.59	3.84	–0.14
849D-5H-1	*C. wuellerstorfi*	136	43.36	51.81	51.80	3.49	–0.06
849D-5H-1	*C. wuellerstorfi*	145	43.45	51.90	51.88	3.60	–0.13
849D-5H-2	*C. wuellerstorfi*	6	43.56	52.01	51.97	3.63	–0.05
849D-5H-2	*C. wuellerstorfi*	26	43.76	52.21	52.10	3.86	–0.04
849D-5H-2	*C. wuellerstorfi*	36	43.86	52.31	52.17	4.21	0.06
849D-5H-2	*C. wuellerstorfi*	46	43.96	52.41	52.25	3.74	0.07
849D-5H-2	*C. wuellerstorfi*	56	44.06	52.51	52.34	3.67	–0.05
849D-5H-2	*C. wuellerstorfi*	66	44.16	52.61	52.44	3.85	0.27
849D-5H-2	*C. wuellerstorfi*	76	44.26	52.71	52.56	3.64	0.12
849D-5H-2	*C. wuellerstorfi*	86	44.36	52.81	52.72	3.55	0.02
849D-5H-2	*C. wuellerstorfi*	96	44.46	52.91	52.88	3.58	0.12
849D-5H-2	*C. wuellerstorfi*	106	44.56	53.01	53.03	3.44	0.20
849D-5H-2	*C. wuellerstorfi*	116	44.66	53.11	53.15	3.50	–0.27
849D-5H-2	*C. wuellerstorfi*	126	44.76	53.21	53.26	3.66	–0.35
849D-5H-2	*C. wuellerstorfi*	136	44.86	53.31	53.35	3.64	–0.35
849D-5H-2	*C. wuellerstorfi*	146	44.96	53.41	53.43	4.14	–0.35
849D-5H-3	*C. wuellerstorfi*	6	45.06	53.51	53.50	4.23	–0.37
849D-5H-3	*C. wuellerstorfi*	16	45.16	53.61	53.58	4.27	–0.36
849D-5H-3	*C. wuellerstorfi*	26	45.26	53.71	53.65	4.20	–0.36
849D-5H-3	*C. wuellerstorfi*	36	45.36	53.81	53.72	4.18	–0.36
849D-5H-3	*C. wuellerstorfi*	36	45.36	53.81	53.73	4.19	–0.40
849D-5H-3	*U. peregrina*	36	45.36	53.81	53.73	4.17	–0.75
849D-5H-3	*C. wuellerstorfi*	46	45.46	53.91	53.80	3.88	–0.61
849D-5H-3	*C. wuellerstorfi*	56	45.56	54.01	53.89	4.05	–0.54
849D-5H-3	*U. peregrina*	56	45.56	54.01	53.89	3.97	–0.65
849D-5H-3	*C. wuellerstorfi*	66	45.66	54.11	53.97	3.83	–0.06
849D-5H-3	*C. wuellerstorfi*	76	45.76	54.21	54.06	3.81	–0.01
849D-5H-3	*U. peregrina*	86	45.86	54.31	54.15	3.71	–0.09
849D-5H-3	*C. wuellerstorfi*	96	45.96	54.41	54.24	3.80	0.12
849D-5H-3	*C. wuellerstorfi*	126	46.26	54.71	54.55	3.50	0.13
849D-5H-4	*C. wuellerstorfi*	6	46.56	55.01	54.87	3.92	–0.71
849D-5H-4	*C. wuellerstorfi*	16	46.66	55.11	54.98	3.95	–0.31
849D-5H-4	*C. wuellerstorfi*	26	46.76	55.21	55.08	4.11	–0.58
849D-5H-4	*C. wuellerstorfi*	36	46.86	55.31	55.18	4.09	–0.34
849D-5H-4	*C. wuellerstorfi*	46	46.96	55.41	55.29	3.96	–0.29
849D-5H-4	*C. wuellerstorfi*	46	46.96	55.41	55.29	3.81	–0.32
849D-5H-4	*C. wuellerstorfi*	56	47.06	55.51	55.40	4.03	–0.41
849D-5H-4	*C. wuellerstorfi*	66	47.16	55.61	55.51	3.98	–0.09
849D-5H-4	*C. wuellerstorfi*	76	47.26	55.71	55.63	3.88	–0.20
849D-5H-4	*C. wuellerstorfi*	96	47.46	55.91	55.84	3.70	–0.08
849D-5H-4	*C. wuellerstorfi*	106	47.56	56.01	55.95	3.64	0.06
849D-5H-4	*C. wuellerstorfi*	116	47.66	56.11	56.05	3.52	0.20
849D-5H-4	*C. wuellerstorfi*	126	47.76	56.21	56.15	3.50	0.24
849D-5H-4	*C. wuellerstorfi*	136	47.86	56.31	56.26	3.48	0.18
849D-5H-4	*C. wuellerstorfi*	146	47.96	56.41	56.37	3.37	0.18
849D-5H-5	*C. wuellerstorfi*	6	48.06	56.51	56.49	3.47	0.11
849D-5H-5	*C. wuellerstorfi*	16	48.16	56.61	56.62	3.33	–0.17
849D-5H-5	*U. peregrina*	16	48.16	56.61	56.62	3.52	–0.02
849D-5H-5	*C. wuellerstorfi*	26	48.26	56.71	56.73	3.42	–0.02
849D-5H-5	*U. peregrina*	26	48.26	56.71	56.73	3.46	–0.17
849D-5H-5	*C. wuellerstorfi*	36	48.36	56.81	56.84	3.88	–0.31

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849D-5H-5	*C. wuellerstorfi*	46	48.46	56.91	56.94	3.57	–0.52
849D-5H-5	*U. peregrina*	46	48.46	56.91	56.94	3.57	–0.70
849D-5H-5	*C. wuellerstorfi*	56	48.56	57.01	57.03	3.74	–0.34
849D-5H-5	*C. wuellerstorfi*	56	48.56	57.01	57.03	3.71	–0.31
849D-5H-5	*U. peregrina*	56	48.56	57.01	57.03	3.94	–0.62
849D-5H-5	*C. wuellerstorfi*	66	48.66	57.11	57.12	4.00	–0.36
849D-5H-5	*U. peregrina*	66	48.66	57.11	57.12	4.10	–0.22
849D-5H-5	*C. wuellerstorfi*	76	48.76	57.21	57.20	4.04	–0.09
849D-5H-5	*C. wuellerstorfi*	86	48.86	57.31	57.29	4.04	–0.08
849D-5H-5	*C. wuellerstorfi*	96	48.96	57.41	57.39	3.80	–0.16
849D-5H-5	*U. peregrina*	96	48.96	57.41	57.39	3.73	–0.19
849D-5H-5	*U. peregrina*	106	49.06	57.51	57.49	3.57	–0.41
849D-5H-5	*C. wuellerstorfi*	116	49.16	57.61	57.59	3.77	–0.21
849D-5H-5	*U. peregrina*	116	49.16	57.61	57.59	3.79	–0.33
849D-5H-5	*C. wuellerstorfi*	126	49.26	57.71	57.70	3.79	0.05
849D-5H-5	*U. peregrina*	126	49.26	57.71	57.70	3.71	–0.26
849D-5H-5	*C. wuellerstorfi*	136	49.36	57.81	57.82	3.54	0.06
849D-5H-5	*C. wuellerstorfi*	146	49.46	57.91	57.92	3.50	0.23
849D-5H-6	*C. wuellerstorfi*	6	49.56	58.01	58.03	3.38	0.18
849D-5H-6	*C. wuellerstorfi*	26	49.76	58.21	58.22	3.40	0.23
849D-5H-6	*C. wuellerstorfi*	36	49.86	58.31	58.30	3.38	0.37
849D-5H-6	*C. wuellerstorfi*	36	49.86	58.31	58.31	3.34	0.23
849D-5H-6	*C. wuellerstorfi*	46	49.96	58.41	58.39	3.40	0.37
849D-5H-6	*C. wuellerstorfi*	56	50.06	58.51	58.48	3.60	0.24
849D-5H-6	*C. wuellerstorfi*	66	50.16	58.61	58.57	3.92	0.21
849D-5H-6	*C. wuellerstorfi*	76	50.26	58.71	58.67	3.99	–0.07
849D-5H-6	*C. wuellerstorfi*	86	50.36	58.81	58.77	3.99	–0.04
849D-5H-6	*C. wuellerstorfi*	96	50.46	58.91	58.88	3.94	–0.18
849D-5H-6	*C. wuellerstorfi*	106	50.56	59.01	59.00	3.89	–0.21
849D-5H-6	*C. wuellerstorfi*	116	50.66	59.11	59.12	3.86	–0.03
849D-5H-6	*C. wuellerstorfi*	126	50.76	59.21	59.23	3.86	–0.01
849D-5H-6	*C. wuellerstorfi*	136	50.86	59.31	59.34	3.77	–0.01
849D-5H-6	*C. wuellerstorfi*	146	50.96	59.41	59.44	3.84	–0.41
849D-5H-7	*C. wuellerstorfi*	6	51.06	59.51	59.53	3.74	–0.11
849D-5H-7	*C. wuellerstorfi*	16	51.16	59.61	59.62	3.84	–0.45
849D-5H-7	*C. wuellerstorfi*	26	51.26	59.71	59.71	3.96	–0.44
849D-5H-7	*C. wuellerstorfi*	36	51.36	59.81	59.81	3.78	–0.32
849C-6H-2	*C. wuellerstorfi*	56	50.30	59.90	59.84	4.23	–0.62
849D-5H-7	*C. wuellerstorfi*	46	51.46	59.91	59.91	4.18	–0.60
849C-6H-2	*C. wuellerstorfi*	66	50.40	60.00	59.95	4.17	–0.64
849D-5H-7	*C. wuellerstorfi*	56	51.56	60.01	60.02	4.34	–0.62
849C-6H-2	*C. wuellerstorfi*	76	50.50	60.10	60.06	4.22	–0.69
849C-6H-2	*C. wuellerstorfi*	86	50.60	60.20	60.17	4.29	–0.51
849C-6H-2	*C. wuellerstorfi*	96	50.70	60.30	60.30	4.20	–0.75
849C-6H-2	*C. wuellerstorfi*	106	50.80	60.40	60.42	4.11	–0.54
849C-6H-2	*C. wuellerstorfi*	116	50.90	60.50	60.52	4.09	–0.51
849C-6H-2	*C. wuellerstorfi*	126	51.00	60.60	60.61	4.08	–0.41
849C-6H-2	*C. wuellerstorfi*	136	51.10	60.70	60.70	3.82	–0.13
849C-6H-2	*C. wuellerstorfi*	146	51.20	60.80	60.79	3.67	–0.21
849C-6H-3	*C. wuellerstorfi*	6	51.30	60.90	60.90	3.25	–0.25
849C-6H-3	*C. wuellerstorfi*	16	51.40	61.00	61.00	3.50	–0.16
849D-6H-1	*C. wuellerstorfi*	26	51.76	61.01	61.09	3.66	–0.27
849D-6H-1	*U. peregrina*	26	51.76	61.01	61.09	3.64	–0.32
849C-6H-3	*C. wuellerstorfi*	26	51.50	61.10	61.10	3.38	–0.33
849D-6H-1	*C. wuellerstorfi*	36	51.86	61.11	61.19	3.88	–0.04
849D-6H-1	*C. wuellerstorfi*	46	51.96	61.21	61.27	3.71	–0.05
849D-6H-1	*C. wuellerstorfi*	56	52.06	61.31	61.36	3.59	0.09
849D-6H-1	*C. wuellerstorfi*	56	52.06	61.31	61.36	3.60	–0.25
849D-6H-1	*C. wuellerstorfi*	66	52.16	61.41	61.47	3.41	–0.17
849D-6H-1	*C. wuellerstorfi*	66	52.16	61.41	61.47	3.77	–0.08
849D-6H-1	*C. wuellerstorfi*	76	52.26	61.51	61.61	3.67	–0.03
849D-6H-1	*C. wuellerstorfi*	76	52.26	61.51	61.61	3.54	0.04
849D-6H-1	*C. wuellerstorfi*	86	52.36	61.61	61.77	3.43	–0.14
849D-6H-1	*C. wuellerstorfi*	106	52.56	61.81	62.00	3.46	–0.25
849D-6H-1	*C. wuellerstorfi*	116	52.66	61.91	62.07	3.99	–0.43
849D-6H-1	*C. wuellerstorfi*	126	52.76	62.01	62.12	3.97	–0.48
849D-6H-1	*C. wuellerstorfi*	136	52.86	62.11	62.17	4.13	–0.59
849D-6H-1	*C. wuellerstorfi*	146	52.96	62.21	62.23	3.84	–0.36
849D-6H-2	*C. wuellerstorfi*	6	53.06	62.31	62.31	3.91	–0.30
849D-6H-2	*C. wuellerstorfi*	16	53.16	62.41	62.42	3.74	–0.15
849D-6H-2	*C. wuellerstorfi*	26	53.26	62.51	62.57	3.43	0.07
849D-6H-2	*C. wuellerstorfi*	36	53.36	62.61	62.73	3.47	–0.02
849D-6H-2	*C. wuellerstorfi*	46	53.46	62.71	62.86	3.34	0.00
849D-6H-2	*C. wuellerstorfi*	56	53.56	62.81	62.95	3.55	–0.06
849D-6H-2	*C. wuellerstorfi*	66	53.66	62.91	63.02	3.66	–0.33
849D-6H-2	*C. wuellerstorfi*	76	53.76	63.01	63.08	3.75	–0.21
849D-6H-2	*C. wuellerstorfi*	86	53.86	63.11	63.16	3.65	–0.14
849D-6H-2	*C. wuellerstorfi*	96	53.96	63.21	63.24	3.56	–0.13
849D-6H-2	*C. wuellerstorfi*	106	54.06	63.31	63.34	3.49	–0.14
849D-6H-2	*C. wuellerstorfi*	106	54.06	63.31	63.35	3.62	–0.08
849D-6H-2	*C. wuellerstorfi*	116	54.16	63.41	63.49	3.48	–0.16
849D-6H-2	*C. wuellerstorfi*	126	54.26	63.51	63.67	3.65	–0.14
849D-6H-2	*C. wuellerstorfi*	136	54.36	63.61	63.78	3.45	–0.19
849D-6H-2	*C. wuellerstorfi*	146	54.46	63.71	63.85	3.30	–0.13
849D-6H-3	*C. wuellerstorfi*	6	54.56	63.81	63.91	3.46	–0.26
849D-6H-3	*U. peregrina*	6	54.56	63.81	63.91	3.60	–0.01
849D-6H-3	*C. wuellerstorfi*	16	54.66	63.91	63.96	3.55	–0.16
849D-6H-3	*C. wuellerstorfi*	26	54.76	64.01	64.00	3.50	–0.35
849D-6H-3	*C. wuellerstorfi*	36	54.86	64.11	64.07	3.98	–0.39
849D-6H-3	*U. peregrina*	36	54.86	64.11	64.07	3.45	–0.41
849D-6H-3	*C. wuellerstorfi*	46	54.96	64.21	64.19	3.86	–0.31
849D-6H-3	*C. wuellerstorfi*	56	55.06	64.31	64.40	3.79	–0.48
849D-6H-3	*C. wuellerstorfi*	66	55.16	64.41	64.58	3.28	0.13
849D-6H-3	*C. wuellerstorfi*	76	55.26	64.51	64.69	3.36	0.00
849D-6H-3	*C. wuellerstorfi*	96	55.46	64.71	64.87	3.01	0.05
849D-6H-3	*C. wuellerstorfi*	116	55.66	64.91	65.09	3.48	–0.12
849D-6H-3	*C. wuellerstorfi*	126	55.76	65.01	65.19	4.18	–0.20
849D-6H-3	*U. peregrina*	126	55.76	65.01	65.19	3.76	–0.37
849D-6H-3	*C. wuellerstorfi*	136	55.86	65.11	65.27	3.78	–0.24
849D-6H-3	*C. wuellerstorfi*	146	55.96	65.21	65.34	3.68	–0.26
849D-6H-3	*C. wuellerstorfi*	146	55.96	65.21	65.34	3.97	–0.59
849D-6H-3	*U. peregrina*	146	55.96	65.21	65.34	3.69	–0.44
849D-6H-4	*C. wuellerstorfi*	6	56.06	65.31	65.39	3.83	–0.21
849D-6H-4	*C. wuellerstorfi*	16	56.16	65.41	65.45	3.53	0.05
849D-6H-4	*C. wuellerstorfi*	26	56.26	65.51	65.52	3.47	–0.03
849D-6H-4	*C. wuellerstorfi*	36	56.36	65.61	65.62	3.58	–0.10
849D-6H-4	*C. wuellerstorfi*	36	56.36	65.61	65.62	3.49	–0.04
849D-6H-4	*U. peregrina*	36	56.36	65.61	65.62	3.43	–0.24
849D-6H-4	*C. wuellerstorfi*	46	56.46	65.71	65.73	3.66	–0.16
849D-6H-4	*C. wuellerstorfi*	56	56.56	65.81	65.85	3.72	–0.19
849D-6H-4	*C. wuellerstorfi*	66	56.66	65.91	65.96	3.75	–0.09
849D-6H-4	*C. wuellerstorfi*	66	56.66	65.91	65.96	3.63	–0.11
849D-6H-4	*U. peregrina*	66	56.66	65.91	65.96	3.73	0.03
849D-6H-4	*C. wuellerstorfi*	76	56.76	66.01	66.04	3.85	–0.05
849D-6H-4	*C. wuellerstorfi*	86	56.86	66.11	66.13	3.59	–0.12
849D-6H-4	*C. wuellerstorfi*	96	56.96	66.21	66.22	3.65	–0.30
849D-6H-4	*U. peregrina*	96	56.96	66.21	66.22	3.39	–0.09
849D-6H-4	*C. wuellerstorfi*	106	57.06	66.31	66.33	3.70	–0.11
849D-6H-4	*U. peregrina*	116	57.16	66.41	66.45	3.40	–0.37
849D-6H-4	*C. wuellerstorfi*	126	57.26	66.51	66.56	3.35	0.00
849D-6H-4	*C. wuellerstorfi*	136	57.36	66.61	66.65	3.42	–0.03
849D-6H-4	*C. wuellerstorfi*	136	57.36	66.61	66.65	3.25	0.03
849D-6H-4	*C. wuellerstorfi*	146	57.46	66.71	66.74	3.47	–0.06
849D-6H-5	*C. wuellerstorfi*	6	57.56	66.81	66.81	3.79	–0.17
849D-6H-5	*U. peregrina*	6	57.56	66.81	66.81	3.58	–0.41
849D-6H-5	*C. wuellerstorfi*	16	57.66	66.91	66.91	3.81	–0.12
849D-6H-5	*C. wuellerstorfi*	16	57.66	66.91	66.91	3.97	–0.16
849D-6H-5	*U. peregrina*	16	57.66	66.91	66.91	3.47	–0.31
849D-6H-5	*C. wuellerstorfi*	26	57.76	67.01	67.02	3.95	–0.42
849D-6H-5	*C. wuellerstorfi*	36	57.86	67.11	67.14	4.11	–0.19
849D-6H-5	*C. wuellerstorfi*	36	57.86	67.11	67.15	3.80	–0.02
849D-6H-5	*C. wuellerstorfi*	46	57.96	67.21	67.25	3.46	0.17
849D-6H-5	*C. wuellerstorfi*	56	58.06	67.31	67.34	3.59	0.21
849D-6H-5	*C. wuellerstorfi*	66	58.16	67.41	67.41	3.41	0.23
849D-6H-5	*C. wuellerstorfi*	76	58.26	67.51	67.48	3.41	0.26
849D-6H-5	*C. wuellerstorfi*	86	58.36	67.61	67.56	3.46	0.27
849D-6H-5	*C. wuellerstorfi*	96	58.46	67.71	67.67	3.57	0.22
849D-6H-5	*C. wuellerstorfi*	106	58.56	67.81	67.82	3.63	0.14
849D-6H-5	*C. wuellerstorfi*	116	58.66	67.91	67.96	3.39	0.11
849D-6H-5	*C. wuellerstorfi*	126	58.76	68.01	68.06	3.68	0.28
849D-6H-5	*C. wuellerstorfi*	136	58.86	68.11	68.15	3.68	0.15
849D-6H-5	*C. wuellerstorfi*	146	58.96	68.21	68.20	3.46	0.28
849D-6H-6	*C. wuellerstorfi*	6	59.06	68.31	68.26	3.63	0.35
849D-6H-6	*C. wuellerstorfi*	16	59.16	68.41	68.32	3.47	0.15
849D-6H-6	*C. wuellerstorfi*	26	59.26	68.51	68.38	3.37	0.17
849D-6H-6	*C. wuellerstorfi*	36	59.36	68.61	68.45	3.61	0.21
849D-6H-6	*C. wuellerstorfi*	46	59.46	68.71	68.54	3.75	–0.08
849D-6H-6	*C. wuellerstorfi*	56	59.56	68.81	68.66	3.60	–0.10
849D-6H-6	*C. wuellerstorfi*	66	59.66	68.91	68.80	4.10	–0.28
849D-6H-6	*C. wuellerstorfi*	76	59.76	69.01	68.94	3.79	–0.28
849D-6H-6	*C. wuellerstorfi*	86	59.86	69.11	69.06	4.07	–0.24
849D-6H-6	*C. wuellerstorfi*	96	59.96	69.21	69.16	4.02	–0.22
849D-6H-6	*C. wuellerstorfi*	106	60.06	69.31	69.24	4.03	–0.15
849D-6H-6	*C. wuellerstorfi*	116	60.16	69.41	69.31	4.02	–0.33
849D-6H-6	*C. wuellerstorfi*	126	60.26	69.51	69.38	4.00	–0.23
849D-6H-6	*C. wuellerstorfi*	136	60.36	69.61	69.47	3.58	–0.02
849D-6H-6	*C. wuellerstorfi*	146	60.46	69.71	69.59	3.43	0.17
849D-6H-6	*U. peregrina*	146	60.46	69.71	69.59	3.45	0.01
849C-7H-1	*C. wuellerstorfi*	76	58.76	69.71	69.70	3.45	0.11
849D-6H-7	*C. wuellerstorfi*	6	60.56	69.81	69.74	3.36	0.25
849D-6H-7	*C. wuellerstorfi*	16	60.66	69.91	69.88	3.45	0.21
849C-7H-1	*C. wuellerstorfi*	96	58.96	69.91	69.90	3.34	0.08
849C-7H-1	*C. wuellerstorfi*	116	59.16	70.11	70.11	3.42	–0.15
849C-7H-1	*C. wuellerstorfi*	126	59.26	70.21	70.21	3.72	–0.30
849C-7H-1	*C. wuellerstorfi*	136	59.36	70.31	70.31	3.96	–0.48
849C-7H-1	*C. wuellerstorfi*	146	59.46	70.41	70.41	3.89	–0.38
849D-7H-1	*C. wuellerstorfi*	7	61.07	70.52	70.68	3.50	–0.13
849D-7H-1	*C. wuellerstorfi*	17	61.17	70.62	70.76	3.24	–0.05
849D-7H-1	*C. wuellerstorfi*	27	61.27	70.72	70.84	3.49	–0.24
849D-7H-1	*C. wuellerstorfi*	36	61.36	70.81	70.91	3.90	–0.59
849D-7H-1	*C. wuellerstorfi*	46	61.46	70.91	71.00	3.76	–0.52
849D-7H-1	*C. wuellerstorfi*	56	61.56	71.01	71.08	3.54	–0.40

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849D-7H-1	*C. wuellerstorfi*	67	61.67	71.12	71.17	4.22	–0.85
849D-7H-1	*C. wuellerstorfi*	76	61.76	71.21	71.24	3.84	–0.45
849D-7H-1	*C. wuellerstorfi*	86	61.86	71.31	71.33	4.17	–0.59
849D-7H-1	*C. wuellerstorfi*	96	61.96	71.41	71.44	3.75	–0.53
849D-7H-1	*C. wuellerstorfi*	96	61.96	71.41	71.45	3.84	–0.51
849D-7H-1	*C. wuellerstorfi*	107	62.07	71.52	71.64	3.89	–0.22
849D-7H-1	*C. wuellerstorfi*	117	62.17	71.62	71.80	3.74	–0.33
849D-7H-1	*C. wuellerstorfi*	127	62.27	71.72	71.91	3.45	0.07
849D-7H-1	*C. wuellerstorfi*	136	62.36	71.81	72.01	3.26	–0.01
849D-7H-1	*C. wuellerstorfi*	146	62.46	71.91	72.12	3.24	–0.04
849D-7H-2	*C. wuellerstorfi*	6	62.56	72.01	72.23	3.22	0.08
849D-7H-2	*C. wuellerstorfi*	16	62.66	72.11	72.31	3.43	–0.01
849D-7H-2	*C. wuellerstorfi*	36	62.86	72.31	72.45	3.02	–0.03
849D-7H-2	*C. wuellerstorfi*	46	62.96	72.41	72.52	3.70	0.01
849D-7H-2	*C. wuellerstorfi*	66	63.16	72.61	72.67	3.62	–0.08
849D-7H-2	*C. wuellerstorfi*	76	63.26	72.71	72.74	3.51	0.01
849D-7H-2	*C. wuellerstorfi*	86	63.36	72.81	72.83	3.39	0.21
849D-7H-2	*C. wuellerstorfi*	116	63.66	73.11	73.16	3.49	–0.14
849D-7H-2	*C. wuellerstorfi*	126	63.76	73.21	73.23	3.82	–0.24
849D-7H-2	*C. wuellerstorfi*	136	63.86	73.31	73.28	3.97	–0.38
849D-7H-2	*C. wuellerstorfi*	146	63.96	73.41	73.34	4.03	–0.31
849D-7H-3	*C. wuellerstorfi*	6	64.06	73.51	73.41	3.74	–0.19
849D-7H-3	*C. wuellerstorfi*	16	64.16	73.61	73.53	3.58	0.14
849D-7H-3	*C. wuellerstorfi*	26	64.26	73.71	73.68	3.58	0.14
849D-7H-3	*C. wuellerstorfi*	36	64.36	73.81	73.80	3.50	0.10
849D-7H-3	*C. wuellerstorfi*	46	64.46	73.91	73.91	3.52	0.16
849D-7H-3	*C. wuellerstorfi*	56	64.56	74.01	74.02	3.32	0.03
849D-7H-3	*C. wuellerstorfi*	66	64.66	74.11	74.13	3.54	–0.16
849D-7H-3	*C. wuellerstorfi*	76	64.76	74.21	74.24	3.62	–0.06
849D-7H-3	*C. wuellerstorfi*	86	64.86	74.31	74.35	3.77	–0.04
849D-7H-3	*C. wuellerstorfi*	96	64.96	74.41	74.48	3.70	–0.17
849D-7H-3	*C. wuellerstorfi*	96	64.96	74.41	74.48	3.61	–0.30
849D-7H-3	*C. wuellerstorfi*	106	65.06	74.51	74.59	3.63	–0.08
849D-7H-3	*C. wuellerstorfi*	116	65.16	74.61	74.67	3.17	–0.15
849D-7H-3	*C. wuellerstorfi*	126	65.26	74.71	74.74	3.32	0.05
849D-7H-3	*C. wuellerstorfi*	136	65.36	74.81	74.81	3.29	0.11
849D-7H-3	*C. wuellerstorfi*	146	65.46	74.91	74.88	3.18	0.20
849D-7H-4	*C. wuellerstorfi*	6	65.56	75.01	74.97	3.22	0.30
849D-7H-4	*C. wuellerstorfi*	16	65.66	75.11	75.07	3.37	0.10
849D-7H-4	*C. wuellerstorfi*	26	65.76	75.21	75.15	3.48	0.09
849D-7H-4	*C. wuellerstorfi*	36	65.86	75.31	75.23	3.46	–0.07
849D-7H-4	*C. wuellerstorfi*	46	65.96	75.41	75.30	3.32	–0.17
849D-7H-4	*C. wuellerstorfi*	56	66.06	75.51	75.38	3.79	–0.21
849D-7H-4	*C. wuellerstorfi*	66	66.16	75.61	75.49	3.52	–0.32
849D-7H-4	*C. wuellerstorfi*	76	66.26	75.71	75.63	3.68	–0.55
849D-7H-4	*C. wuellerstorfi*	86	66.36	75.81	75.77	3.58	–0.13
849D-7H-4	*C. wuellerstorfi*	96	66.46	75.91	75.90	3.58	–0.11
849D-7H-4	*C. wuellerstorfi*	106	66.56	76.01	76.02	3.69	–0.29
849D-7H-4	*C. wuellerstorfi*	116	66.66	76.11	76.12	3.69	–0.52
849D-7H-4	*C. wuellerstorfi*	126	66.76	76.21	76.21	3.75	–0.36
849D-7H-4	*C. wuellerstorfi*	146	66.96	76.41	76.39	3.70	–0.29
849D-7H-5	*C. wuellerstorfi*	6	67.06	76.51	76.49	3.82	–0.33
849D-7H-5	*C. wuellerstorfi*	16	67.16	76.61	76.59	3.73	–0.47
849D-7H-5	*C. wuellerstorfi*	26	67.26	76.71	76.70	3.77	–0.31
849D-7H-5	*C. wuellerstorfi*	36	67.36	76.81	76.81	3.23	0.06
849D-7H-5	*C. wuellerstorfi*	46	67.46	76.91	76.91	3.07	–0.05
849D-7H-5	*C. wuellerstorfi*	56	67.56	77.01	77.01	3.16	0.02
849D-7H-5	*C. wuellerstorfi*	66	67.66	77.11	77.11	3.46	–0.03
849D-7H-5	*C. wuellerstorfi*	76	67.76	77.21	77.21	3.22	0.01
849D-7H-5	*C. wuellerstorfi*	86	67.86	77.31	77.31	3.21	0.01
849D-7H-5	*C. wuellerstorfi*	96	67.96	77.41	77.41	3.24	–0.05
849D-7H-5	*C. wuellerstorfi*	106	68.06	77.51	77.51	3.41	–0.02
849D-7H-5	*C. wuellerstorfi*	116	68.16	77.61	77.61	2.97	–0.09
849D-7H-5	*C. wuellerstorfi*	136	68.36	77.81	77.81	3.19	0.02
849D-7H-5	*C. wuellerstorfi*	146	68.46	77.91	77.91	3.13	–0.19
849D-7H-6	*C. wuellerstorfi*	6	68.56	78.01	78.01	3.11	0.13
849D-7H-6	*C. wuellerstorfi*	16	68.66	78.11	78.11	3.19	0.15
849D-7H-6	*C. wuellerstorfi*	26	68.76	78.21	78.21	3.28	0.30
849D-7H-6	*C. wuellerstorfi*	36	68.86	78.31	78.31	3.32	0.35
849D-7H-6	*C. wuellerstorfi*	46	68.96	78.41	78.41	3.50	0.09
849D-7H-6	*C. wuellerstorfi*	56	69.06	78.51	78.51	3.21	–0.27
849D-7H-6	*C. wuellerstorfi*	66	69.16	78.61	78.61	3.88	–0.23
849D-7H-6	*C. wuellerstorfi*	76	69.26	78.71	78.71	3.73	–0.02
849D-7H-6	*C. wuellerstorfi*	86	69.36	78.81	78.81	3.81	–0.11
849D-7H-6	*C. wuellerstorfi*	106	69.56	79.01	79.01	3.48	0.08
849D-7H-6	*C. wuellerstorfi*	116	69.66	79.11	79.12	3.22	0.24
849D-7H-6	*C. wuellerstorfi*	126	69.76	79.21	79.23	3.18	0.16
849D-7H-6	*C. wuellerstorfi*	136	69.86	79.31	79.33	3.42	0.23
849D-7H-6	*C. wuellerstorfi*	146	69.96	79.41	79.42	3.33	0.14
849D-7H-7	*C. wuellerstorfi*	6	70.06	79.51	79.52	3.28	0.04
849D-7H-7	*C. wuellerstorfi*	16	70.16	79.61	79.62	3.64	0.09
849D-7H-7	*C. wuellerstorfi*	26	70.26	79.71	79.71	3.59	0.04
849D-7H-7	*C. wuellerstorfi*	36	70.36	79.81	79.78	3.79	–0.37
849D-7H-7	*C. wuellerstorfi*	36	70.36	79.81	79.79	3.38	–0.05
849D-7H-7	*C. wuellerstorfi*	46	70.46	79.91	79.86	3.37	–0.31
849D-7H-7	*C. wuellerstorfi*	56	70.56	80.01	79.96	3.48	0.07
849C-8H-1	*C. wuellerstorfi*	76	68.26	80.06	80.06	3.31	0.12
849D-7H-7	*C. wuellerstorfi*	66	70.66	80.11	80.09	3.49	0.01
849C-8H-1	*C. wuellerstorfi*	86	68.36	80.16	80.16	3.29	–0.11
849C-8H-1	*C. wuellerstorfi*	96	68.46	80.26	80.25	3.22	0.05
849C-8H-1	*C. wuellerstorfi*	106	68.56	80.36	80.35	3.30	–0.03
849C-8H-1	*C. wuellerstorfi*	116	68.66	80.46	80.46	3.54	–0.04
849C-8H-1	*C. wuellerstorfi*	126	68.76	80.56	80.56	3.67	–0.07
849C-8H-1	*C. wuellerstorfi*	146	68.96	80.76	80.75	3.49	0.12
849C-8H-2	*C. wuellerstorfi*	6	69.06	80.86	80.85	3.41	–0.10
849C-8H-2	*C. wuellerstorfi*	16	69.16	80.96	80.95	3.28	–0.20
849C-8H-2	*C. wuellerstorfi*	26	69.26	81.06	81.05	3.22	–0.13
849C-8H-2	*C. wuellerstorfi*	36	69.36	81.16	81.16	3.54	0.01
849C-8H-2	*C. wuellerstorfi*	46	69.46	81.26	81.26	3.45	0.04
849C-8H-2	*C. wuellerstorfi*	56	69.56	81.36	81.36	3.52	–0.47
849C-8H-2	*C. wuellerstorfi*	66	69.66	81.46	81.46	3.51	–0.29
849C-8H-2	*C. wuellerstorfi*	76	69.76	81.56	81.55	3.57	–0.42
849C-8H-2	*C. wuellerstorfi*	86	69.86	81.66	81.65	3.63	–0.32
849D-8H-1	*C. wuellerstorfi*	36	70.86	81.96	81.76	3.71	–0.33
849C-8H-2	*C. wuellerstorfi*	96	69.96	81.76	81.76	3.61	–0.32
849C-8H-2	*C. wuellerstorfi*	106	70.06	81.86	81.86	3.26	–0.31
849D-8H-1	*C. wuellerstorfi*	46	70.96	82.06	81.89	3.31	–0.46
849D-8H-1	*C. wuellerstorfi*	56	71.06	82.16	81.99	3.19	–0.08
849D-8H-1	*C. wuellerstorfi*	66	71.16	82.26	82.08	3.06	–0.04
849D-8H-1	*C. wuellerstorfi*	76	71.26	82.36	82.16	3.06	–0.06
849D-8H-1	*C. wuellerstorfi*	86	71.36	82.46	82.24	3.31	–0.05
849D-8H-1	*C. wuellerstorfi*	96	71.46	82.56	82.34	3.29	0.19
849D-8H-1	*C. wuellerstorfi*	106	71.56	82.66	82.45	3.42	–0.04
849D-8H-1	*C. wuellerstorfi*	116	71.66	82.76	82.60	3.56	–0.21
849D-8H-1	*C. wuellerstorfi*	126	71.76	82.86	82.75	3.63	–0.17
849D-8H-1	*C. wuellerstorfi*	136	71.86	82.96	82.89	3.63	–0.25
849D-8H-1	*C. wuellerstorfi*	146	71.96	83.06	83.00	3.49	0.04
849D-8H-2	*C. wuellerstorfi*	6	72.06	83.16	83.12	3.26	0.14
849D-8H-2	*C. wuellerstorfi*	16	72.16	83.26	83.23	3.32	–0.06
849D-8H-2	*C. wuellerstorfi*	26	72.26	83.36	83.34	3.41	–0.10
849D-8H-2	*U. peregrina*	36	72.36	83.46	83.44	3.43	–0.24
849D-8H-2	*C. wuellerstorfi*	46	72.46	83.56	83.53	3.44	–0.17
849D-8H-2	*U. peregrina*	46	72.46	83.56	83.53	3.47	–0.13
849D-8H-2	*U. peregrina*	56	72.56	83.66	83.62	3.30	–0.30
849D-8H-2	*C. wuellerstorfi*	66	72.66	83.76	83.72	3.53	–0.13
849D-8H-2	*U. peregrina*	66	72.66	83.76	83.72	3.43	–0.17
849D-8H-2	*C. wuellerstorfi*	76	72.76	83.86	83.82	3.42	–0.34
849D-8H-2	*C. wuellerstorfi*	86	72.86	83.96	83.93	3.52	–0.47
849D-8H-2	*C. wuellerstorfi*	96	72.96	84.06	84.04	3.48	–0.42
849D-8H-2	*C. wuellerstorfi*	105	73.05	84.15	84.14	3.32	–0.36
849D-8H-2	*C. wuellerstorfi*	116	73.16	84.26	84.26	3.15	–0.24
849D-8H-2	*C. wuellerstorfi*	136	73.36	84.46	84.46	3.09	–0.31
849D-8H-2	*C. wuellerstorfi*	146	73.46	84.56	84.57	3.20	–0.40
849D-8H-3	*C. wuellerstorfi*	6	73.56	84.66	84.67	3.31	–0.27
849D-8H-3	*C. wuellerstorfi*	16	73.66	84.76	84.76	3.51	–0.35
849D-8H-3	*C. wuellerstorfi*	26	73.76	84.86	84.86	3.37	–0.29
849D-8H-3	*C. wuellerstorfi*	36	73.86	84.96	84.96	3.14	–0.04
849D-8H-3	*C. wuellerstorfi*	46	73.96	85.06	85.06	2.91	–0.35
849D-8H-3	*U. peregrina*	56	74.06	85.16	85.16	3.17	0.06
849D-8H-3	*C. wuellerstorfi*	66	74.16	85.26	85.26	3.16	–0.02
849D-8H-3	*C. wuellerstorfi*	76	74.26	85.36	85.36	3.20	–0.07
849D-8H-3	*C. wuellerstorfi*	86	74.36	85.46	85.46	3.08	0.08
849D-8H-3	*C. wuellerstorfi*	96	74.46	85.56	85.56	3.06	–0.09
849D-8H-3	*C. wuellerstorfi*	106	74.56	85.66	85.66	2.99	–0.06
849D-8H-3	*C. wuellerstorfi*	116	74.66	85.76	85.76	3.13	0.00
849D-8H-3	*C. wuellerstorfi*	126	74.76	85.86	85.86	3.21	0.03
849D-8H-3	*C. wuellerstorfi*	136	74.86	85.96	85.96	3.29	0.16
849D-8H-3	*C. wuellerstorfi*	146	74.96	86.06	86.06	3.15	–0.21
849D-8H-4	*C. wuellerstorfi*	6	75.06	86.16	86.16	3.07	–0.36
849D-8H-4	*C. wuellerstorfi*	16	75.16	86.26	86.26	3.13	–0.30
849D-8H-4	*C. wuellerstorfi*	26	75.26	86.36	86.36	3.02	–0.47
849D-8H-4	*C. wuellerstorfi*	36	75.36	86.46	86.46	3.22	–0.37
849D-8H-4	*C. wuellerstorfi*	46	75.46	86.56	86.56	3.25	–0.35
849D-8H-4	*C. wuellerstorfi*	56	75.56	86.66	86.66	3.29	–0.51
849D-8H-4	*C. wuellerstorfi*	66	75.66	86.76	86.76	3.39	–0.31
849D-8H-4	*C. wuellerstorfi*	76	75.76	86.86	86.86	3.38	–0.36
849D-8H-4	*C. wuellerstorfi*	86	75.86	86.96	86.96	3.51	–0.54
849D-8H-4	*C. wuellerstorfi*	96	75.96	87.06	87.06	3.46	–0.50
849D-8H-4	*C. wuellerstorfi*	106	76.06	87.16	87.16	3.55	–0.40
849D-8H-4	*C. wuellerstorfi*	116	76.16	87.26	87.26	3.44	–0.60
849D-8H-4	*C. wuellerstorfi*	126	76.26	87.36	87.36	3.20	–0.18
849D-8H-4	*C. wuellerstorfi*	136	76.36	87.46	87.46	2.74	–0.21
849D-8H-4	*C. wuellerstorfi*	146	76.46	87.56	87.57	2.87	–0.11
849D-8H-5	*C. wuellerstorfi*	6	76.56	87.66	87.67	2.98	–0.20
849D-8H-5	*C. wuellerstorfi*	16	76.66	87.76	87.76	2.89	0.09
849D-8H-5	*C. wuellerstorfi*	26	76.76	87.86	87.86	2.95	0.05
849D-8H-5	*C. wuellerstorfi*	36	76.86	87.96	87.96	3.17	–0.01
849D-8H-5	*C. wuellerstorfi*	46	76.96	88.06	88.06	3.21	0.05
849D-8H-5	*C. wuellerstorfi*	56	77.06	88.16	88.16	3.20	0.15
849D-8H-5	*C. wuellerstorfi*	66	77.16	88.26	88.26	3.31	0.07

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	$\delta^{18}O$	$\delta^{13}C$
849D-8H-5	*C. wuellerstorfi*	76	77.26	88.36	88.36	3.14	0.22
849D-8H-5	*C. wuellerstorfi*	86	77.36	88.46	88.46	3.16	0.40
849D-8H-5	*C. wuellerstorfi*	96	77.46	88.56	88.57	3.07	0.42
849D-8H-5	*C. wuellerstorfi*	106	77.56	88.66	88.69	3.13	0.20
849D-8H-5	*C. wuellerstorfi*	116	77.66	88.76	88.83	3.17	0.33
849D-8H-5	*C. wuellerstorfi*	126	77.76	88.86	88.97	3.11	0.29
849D-8H-5	*C. wuellerstorfi*	136	77.86	88.96	89.09	3.13	0.39
849D-8H-5	*C. wuellerstorfi*	146	77.96	89.06	89.20	3.12	0.34
849D-8H-6	*C. wuellerstorfi*	6	78.06	89.16	89.29	3.15	0.42
849D-8H-6	*C. wuellerstorfi*	16	78.16	89.26	89.37	3.20	0.22
849D-8H-6	*C. wuellerstorfi*	26	78.26	89.36	89.46	3.23	0.31
849D-8H-6	*C. wuellerstorfi*	36	78.36	89.46	89.55	3.21	0.27
849D-8H-6	*C. wuellerstorfi*	46	78.46	89.56	89.65	3.27	0.17
849D-8H-6	*C. wuellerstorfi*	56	78.56	89.66	89.76	3.29	0.22
849D-8H-6	*C. wuellerstorfi*	66	78.66	89.76	89.87	3.24	0.10
849C-9H-1	*C. wuellerstorfi*	36	77.36	89.96	89.91	3.23	0.22
849D-8H-6	*C. wuellerstorfi*	76	78.76	89.86	89.98	2.98	0.01
849C-9H-1	*C. wuellerstorfi*	46	77.46	90.06	90.02	3.21	0.21
849D-8H-6	*C. wuellerstorfi*	86	78.86	89.96	90.08	3.23	0.34
849C-9H-1	*C. wuellerstorfi*	56	77.56	90.16	90.12	3.16	0.27
849D-8H-6	*C. wuellerstorfi*	96	78.96	90.06	90.17	3.09	0.28
849C-9H-1	*C. wuellerstorfi*	66	77.66	90.26	90.22	3.13	0.27
849C-9H-1	*C. wuellerstorfi*	76	77.76	90.36	90.32	2.99	0.18
849C-9H-1	*C. wuellerstorfi*	86	77.86	90.46	90.42	2.97	–0.09
849C-9H-1	*C. wuellerstorfi*	96	77.96	90.56	90.53	2.92	–0.04
849C-9H-1	*C. wuellerstorfi*	106	78.06	90.66	90.64	3.08	–0.22
849C-9H-1	*C. wuellerstorfi*	116	78.16	90.76	90.77	3.19	0.11
849C-9H-1	*C. wuellerstorfi*	126	78.26	90.86	90.90	3.03	–0.05
849C-9H-1	*C. wuellerstorfi*	136	78.36	90.96	91.01	3.22	0.12
849C-9H-1	*C. wuellerstorfi*	146	78.46	91.06	91.12	3.21	0.01
849C-9H-2	*C. wuellerstorfi*	6	78.56	91.16	91.22	3.21	–0.05
849C-9H-2	*C. wuellerstorfi*	6	78.56	91.16	91.22	3.25	0.18
849C-9H-2	*C. wuellerstorfi*	16	78.66	91.26	91.31	3.38	–0.13
849C-9H-2	*C. wuellerstorfi*	26	78.76	91.36	91.40	3.16	–0.05
849C-9H-2	*U. peregrina*	26	78.76	91.36	91.40	3.27	–0.05
849C-9H-2	*C. wuellerstorfi*	36	78.86	91.46	91.48	3.44	–0.30
849C-9H-2	*C. wuellerstorfi*	46	78.96	91.56	91.57	3.68	–0.43
849C-9H-2	*U. peregrina*	56	79.06	91.66	91.66	3.73	–0.35
849C-9H-2	*C. wuellerstorfi*	66	79.16	91.76	91.76	3.62	–0.37
849C-9H-2	*C. wuellerstorfi*	76	79.26	91.86	91.85	3.66	–0.44
849C-9H-2	*C. wuellerstorfi*	86	79.36	91.96	91.96	3.36	–0.36
849C-9H-2	*C. wuellerstorfi*	96	79.46	92.06	92.07	3.43	–0.38
849C-9H-2	*C. wuellerstorfi*	106	79.56	92.16	92.17	3.41	–0.31
849C-9H-2	*C. wuellerstorfi*	116	79.66	92.26	92.27	3.46	–0.19
849C-9H-2	*C. wuellerstorfi*	126	79.76	92.36	92.36	3.22	0.01
849C-9H-2	*C. wuellerstorfi*	136	79.86	92.46	92.46	3.06	0.05
849C-9H-2	*C. wuellerstorfi*	146	79.96	92.56	92.55	3.21	0.03
849C-9H-2	*C. wuellerstorfi*	146	79.96	92.56	92.55	3.02	–0.24
849C-9H-3	*C. wuellerstorfi*	6	80.06	92.66	92.66	3.30	–0.40
849C-9H-3	*C. wuellerstorfi*	16	80.16	92.76	92.76	3.19	–0.24
849C-9H-3	*C. wuellerstorfi*	26	80.26	92.86	92.86	3.12	–0.14
849D-9H-1	*C. wuellerstorfi*	16	80.16	93.06	92.94	3.46	–0.12
849C-9H-3	*C. wuellerstorfi*	36	80.36	92.96	92.97	3.25	–0.11
849D-9H-1	*C. wuellerstorfi*	26	80.26	93.16	93.10	3.41	–0.06
849D-9H-1	*C. wuellerstorfi*	36	80.36	93.26	93.25	3.27	–0.18
849D-9H-1	*C. wuellerstorfi*	46	80.46	93.36	93.37	3.26	–0.23
849D-9H-1	*C. wuellerstorfi*	56	80.56	93.46	93.48	3.38	–0.23
849D-9H-1	*C. wuellerstorfi*	66	80.66	93.56	93.58	3.32	–0.02
849D-9H-1	*C. wuellerstorfi*	66	80.66	93.56	93.58	3.35	0.07
849D-9H-1	*C. wuellerstorfi*	76	80.76	93.66	93.67	3.30	–0.18
849D-9H-1	*U. peregrina*	86	80.86	93.76	93.77	3.15	–0.24
849D-9H-1	*C. wuellerstorfi*	96	80.96	93.86	93.87	3.48	–0.11
849D-9H-1	*C. wuellerstorfi*	106	81.06	93.96	93.97	3.40	–0.27
849D-9H-1	*C. wuellerstorfi*	116	81.16	94.06	94.08	3.40	–0.28
849D-9H-1	*C. wuellerstorfi*	126	81.26	94.16	94.19	3.51	–0.23
849D-9H-1	*C. wuellerstorfi*	136	81.36	94.26	94.31	3.27	–0.29
849D-9H-1	*C. wuellerstorfi*	146	81.46	94.36	94.43	3.15	–0.05
849D-9H-2	*U. peregrina*	6	81.56	94.46	94.55	2.97	0.05
849D-9H-2	*C. wuellerstorfi*	16	81.66	94.56	94.66	3.00	0.01
849D-9H-2	*C. wuellerstorfi*	26	81.76	94.66	94.76	3.19	–0.17
849D-9H-2	*C. wuellerstorfi*	36	81.86	94.76	94.85	3.25	–0.17
849D-9H-2	*C. wuellerstorfi*	46	81.96	94.86	94.95	3.12	–0.05
849D-9H-2	*C. wuellerstorfi*	66	82.16	95.06	95.11	3.08	–0.20
849D-9H-2	*C. wuellerstorfi*	76	82.26	95.16	95.20	2.99	–0.25
849D-9H-2	*C. wuellerstorfi*	86	82.36	95.26	95.28	3.26	–0.44
849D-9H-2	*C. wuellerstorfi*	96	82.46	95.36	95.37	3.15	–0.32
849D-9H-2	*C. wuellerstorfi*	106	82.56	95.46	95.47	2.96	–0.41
849D-9H-2	*C. wuellerstorfi*	116	82.66	95.56	95.58	2.86	–0.31
849D-9H-2	*C. wuellerstorfi*	146	82.96	95.86	95.92	2.84	0.11
849D-9H-3	*C. wuellerstorfi*	6	83.06	95.96	96.04	3.00	0.06
849D-9H-3	*C. wuellerstorfi*	16	83.16	96.06	96.14	3.16	–0.30
849D-9H-3	*C. wuellerstorfi*	26	83.26	96.16	96.24	3.12	–0.04
849D-9H-3	*C. wuellerstorfi*	36	83.36	96.26	96.33	3.23	–0.20
849D-9H-3	*C. wuellerstorfi*	46	83.46	96.36	96.41	3.18	–0.23
849D-9H-3	*C. wuellerstorfi*	56	83.56	96.46	96.49	3.10	0.04
849D-9H-3	*C. wuellerstorfi*	66	83.66	96.56	96.57	2.92	0.24
849D-9H-3	*C. wuellerstorfi*	76	83.76	96.66	96.64	2.94	0.16
849D-9H-3	*C. wuellerstorfi*	86	83.86	96.76	96.72	2.85	0.15
849D-9H-3	*C. wuellerstorfi*	106	84.06	96.96	96.88	2.94	0.22
849D-9H-3	*C. wuellerstorfi*	116	84.16	97.06	96.97	2.94	0.08
849D-9H-3	*C. wuellerstorfi*	126	84.26	97.16	97.08	3.05	0.02
849D-9H-3	*C. wuellerstorfi*	136	84.36	97.26	97.20	3.04	–0.05
849D-9H-3	*C. wuellerstorfi*	146	84.46	97.36	97.34	3.07	0.02
849D-9H-4	*C. wuellerstorfi*	6	84.56	97.46	97.47	3.14	0.10
849D-9H-4	*C. wuellerstorfi*	16	84.66	97.56	97.60	3.07	–0.07
849D-9H-4	*C. wuellerstorfi*	26	84.76	97.66	97.73	3.13	0.15
849D-9H-4	*C. wuellerstorfi*	36	84.86	97.76	97.85	3.00	0.05
849D-9H-4	*C. wuellerstorfi*	36	84.86	97.76	97.85	3.11	–0.03
849D-9H-4	*C. wuellerstorfi*	46	84.96	97.86	97.96	3.12	0.00
849D-9H-4	*C. wuellerstorfi*	56	85.06	97.96	98.05	3.08	0.11
849D-9H-4	*C. wuellerstorfi*	66	85.16	98.06	98.13	3.05	0.00
849D-9H-4	*C. wuellerstorfi*	76	85.26	98.16	98.21	2.98	–0.13
849D-9H-4	*C. wuellerstorfi*	96	85.46	98.36	98.37	3.03	–0.17
849D-9H-4	*C. wuellerstorfi*	106	85.56	98.46	98.46	3.15	–0.34
849D-9H-4	*C. wuellerstorfi*	116	85.66	98.56	98.55	3.14	–0.34
849D-9H-4	*C. wuellerstorfi*	126	85.76	98.66	98.66	3.17	–0.34
849D-9H-4	*C. wuellerstorfi*	136	85.86	98.76	98.77	3.20	–0.32
849D-9H-4	*C. wuellerstorfi*	146	85.96	98.86	98.90	3.14	–0.28
849D-9H-5	*C. wuellerstorfi*	6	86.06	98.96	99.02	3.17	–0.05
849D-9H-5	*C. wuellerstorfi*	6	86.06	98.96	99.03	3.07	–0.01
849D-9H-5	*C. wuellerstorfi*	16	86.16	99.06	99.15	3.26	0.11
849D-9H-5	*C. wuellerstorfi*	16	86.16	99.06	99.16	2.97	0.11
849D-9H-5	*C. wuellerstorfi*	26	86.26	99.16	99.28	2.92	0.13
849D-9H-5	*C. wuellerstorfi*	36	86.36	99.26	99.40	2.96	0.10
849D-9H-5	*C. wuellerstorfi*	46	86.46	99.36	99.50	2.88	0.05
849D-9H-5	*C. wuellerstorfi*	56	86.56	99.46	99.60	2.74	0.21
849D-9H-5	*C. wuellerstorfi*	66	86.66	99.56	99.69	2.92	0.04
849D-9H-5	*C. wuellerstorfi*	66	86.66	99.56	99.69	3.12	0.06
849D-9H-5	*C. wuellerstorfi*	76	86.76	99.66	99.77	3.29	0.10
849D-9H-5	*C. wuellerstorfi*	86	86.86	99.76	99.85	3.29	–0.16
849D-9H-5	*C. wuellerstorfi*	96	86.96	99.86	99.93	3.42	0.11
849D-9H-5	*C. wuellerstorfi*	106	87.06	99.96	100.00	3.23	0.23
849D-9H-5	*C. wuellerstorfi*	116	87.16	100.06	100.08	3.20	0.18
849D-9H-5	*C. wuellerstorfi*	126	87.26	100.16	100.16	3.24	0.03
849D-9H-5	*C. wuellerstorfi*	136	87.36	100.26	100.25	3.21	0.29
849D-9H-5	*C. wuellerstorfi*	146	87.46	100.36	100.34	3.16	0.13
849D-9H-6	*C. wuellerstorfi*	6	87.56	100.46	100.43	3.21	–0.36
849D-9H-6	*C. wuellerstorfi*	16	87.66	100.56	100.53	3.29	–0.14
849D-9H-6	*C. wuellerstorfi*	26	87.76	100.66	100.63	3.46	–0.17
849D-9H-6	*C. wuellerstorfi*	36	87.86	100.76	100.74	3.47	–0.05
849D-9H-6	*C. wuellerstorfi*	46	87.96	100.86	100.84	3.62	–0.14
849D-9H-6	*C. wuellerstorfi*	56	88.06	100.96	100.95	3.67	–0.54
849D-9H-6	*C. wuellerstorfi*	66	88.16	101.06	101.05	3.46	–0.33
849D-9H-6	*C. wuellerstorfi*	76	88.26	101.16	101.15	3.30	–0.19
849D-9H-6	*C. wuellerstorfi*	86	88.36	101.26	101.24	3.28	–0.07
849D-9H-6	*C. wuellerstorfi*	96	88.46	101.36	101.34	3.22	0.12
849D-9H-6	*C. wuellerstorfi*	106	88.56	101.46	101.44	3.08	0.17
849D-9H-6	*C. wuellerstorfi*	116	88.66	101.56	101.53	3.12	0.06
849D-9H-6	*C. wuellerstorfi*	126	88.76	101.66	101.63	3.25	–0.08
849D-9H-6	*C. wuellerstorfi*	136	88.86	101.76	101.73	3.26	0.02
849D-9H-6	*C. wuellerstorfi*	146	88.96	101.86	101.83	3.41	0.01
849D-9H-7	*C. wuellerstorfi*	6	89.06	101.96	101.93	3.70	–0.38
849D-9H-7	*C. wuellerstorfi*	16	89.16	102.06	102.03	3.73	–0.27
849D-9H-7	*C. wuellerstorfi*	26	89.26	102.16	102.13	3.51	–0.39
849D-9H-7	*C. wuellerstorfi*	36	89.36	102.26	102.23	3.44	–0.11
849D-9H-7	*C. wuellerstorfi*	46	89.46	102.36	102.33	3.36	–0.06
849D-9H-7	*C. wuellerstorfi*	56	89.56	102.46	102.44	3.27	0.09
849C-10H-2	*C. wuellerstorfi*	16	88.16	102.61	102.61	2.89	0.24
849C-10H-2	*C. wuellerstorfi*	26	88.26	102.71	102.71	3.15	0.28
849C-10H-2	*C. wuellerstorfi*	36	88.36	102.81	102.81	3.00	0.35
849C-10H-2	*C. wuellerstorfi*	56	88.56	103.01	103.01	3.05	0.15
849C-10H-2	*C. wuellerstorfi*	66	88.66	103.11	103.11	3.02	–0.04
849C-10H-2	*C. wuellerstorfi*	76	88.76	103.21	103.21	3.14	–0.18
849C-10H-2	*C. wuellerstorfi*	86	88.86	103.31	103.28	3.10	–0.20
849C-10H-2	*C. wuellerstorfi*	96	88.96	103.41	103.35	3.37	–0.26
849C-10H-2	*C. wuellerstorfi*	106	89.06	103.51	103.41	3.43	–0.46
849C-10H-2	*C. wuellerstorfi*	116	89.16	103.61	103.52	3.26	0.01
849C-10H-2	*C. wuellerstorfi*	126	89.26	103.71	103.68	2.73	0.16
849C-10H-2	*C. wuellerstorfi*	136	89.36	103.81	103.82	2.95	0.02
849C-10H-2	*C. wuellerstorfi*	146	89.46	103.91	103.92	2.98	0.11
849D-10H-1	*C. wuellerstorfi*	46	89.96	104.21	103.93	3.07	0.18
849D-10H-1	*C. wuellerstorfi*	46	89.96	104.21	103.93	3.15	–0.06
849D-10H-1	*C. wuellerstorfi*	61	90.11	104.36	104.30	3.34	–0.05
849D-10H-1	*C. wuellerstorfi*	76	90.26	104.51	104.57	3.46	–0.31
849D-10H-1	*C. wuellerstorfi*	91	90.41	104.66	104.72	3.13	–0.18
849D-10H-1	*C. wuellerstorfi*	106	90.56	104.81	104.83	3.20	0.23
849D-10H-1	*C. wuellerstorfi*	121	90.71	104.96	104.94	2.97	0.15
849D-10H-1	*C. wuellerstorfi*	136	90.86	105.11	105.08	3.09	0.13
849D-10H-2	*C. wuellerstorfi*	1	91.01	105.26	105.28	2.92	0.15
849D-10H-2	*C. wuellerstorfi*	16	91.16	105.41	105.51	3.18	–0.06
849D-10H-2	*C. wuellerstorfi*	31	91.31	105.56	105.68	3.08	–0.03
849D-10H-2	*C. wuellerstorfi*	46	91.46	105.71	105.82	3.03	0.27
849D-10H-2	*C. wuellerstorfi*	61	91.61	105.86	105.95	3.05	0.14
849D-10H-2	*C. wuellerstorfi*	76	91.76	106.01	106.09	3.17	–0.12

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	δ18O	δ13C
849D-10H-2	*C. wuellerstorfi*	91	91.91	106.16	106.25	3.17	–0.17
849D-10H-2	*C. wuellerstorfi*	106	92.06	106.31	106.40	2.97	–0.27
849D-10H-2	*C. wuellerstorfi*	121	92.21	106.46	106.54	3.32	–0.47
849D-10H-2	*C. wuellerstorfi*	136	92.36	106.61	106.67	3.32	–0.49
849D-10H-3	*C. wuellerstorfi*	1	92.51	106.76	106.78	3.17	–0.02
849D-10H-3	*C. wuellerstorfi*	16	92.66	106.91	106.89	3.02	–0.03
849D-10H-3	*C. wuellerstorfi*	31	92.81	107.06	107.02	2.79	–0.04
849D-10H-3	*C. wuellerstorfi*	46	92.96	107.21	107.19	2.93	0.08
849D-10H-3	*C. wuellerstorfi*	61	93.11	107.36	107.39	2.99	0.00
849D-10H-3	*C. wuellerstorfi*	76	93.26	107.51	107.59	2.91	–0.13
849D-10H-3	*C. wuellerstorfi*	91	93.41	107.66	107.75	3.17	–0.27
849D-10H-3	*C. wuellerstorfi*	106	93.56	107.81	107.89	3.46	–0.38
849D-10H-3	*C. wuellerstorfi*	121	93.71	107.96	108.00	3.12	–0.13
849D-10H-3	*C. wuellerstorfi*	136	93.86	108.11	108.11	3.14	0.01
849D-10H-4	*C. wuellerstorfi*	1	94.01	108.26	108.22	3.08	–0.10
849D-10H-4	*C. wuellerstorfi*	16	94.16	108.41	108.35	2.97	0.08
849D-10H-4	*C. wuellerstorfi*	31	94.31	108.56	108.48	3.05	–0.04
849D-10H-4	*C. wuellerstorfi*	46	94.46	108.71	108.63	3.08	0.06
849D-10H-4	*C. wuellerstorfi*	61	94.61	108.86	108.79	2.99	–0.19
849D-10H-4	*C. wuellerstorfi*	76	94.76	109.01	108.97	3.48	–0.35
849D-10H-4	*C. wuellerstorfi*	91	94.91	109.16	109.15	3.24	–0.36
849D-10H-4	*C. wuellerstorfi*	106	95.06	109.31	109.32	3.02	–0.02
849D-10H-4	*C. wuellerstorfi*	121	95.21	109.46	109.48	2.97	–0.13
849D-10H-4	*C. wuellerstorfi*	136	95.36	109.61	109.62	2.95	–0.07
849D-10H-5	*C. wuellerstorfi*	1	95.51	109.76	109.77	3.14	–0.13
849D-10H-5	*C. wuellerstorfi*	16	95.66	109.91	109.91	3.15	0.11
849D-10H-5	*C. wuellerstorfi*	31	95.81	110.06	110.05	3.13	0.04
849D-10H-5	*C. wuellerstorfi*	46	95.96	110.21	110.19	3.20	0.11
849D-10H-5	*C. wuellerstorfi*	61	96.11	110.36	110.34	3.13	0.02
849D-10H-5	*C. wuellerstorfi*	76	96.26	110.51	110.50	3.14	0.02
849D-10H-5	*C. wuellerstorfi*	91	96.41	110.66	110.67	3.19	–0.09
849D-10H-5	*C. wuellerstorfi*	106	96.56	110.81	110.85	3.28	–0.22
849D-10H-5	*C. wuellerstorfi*	121	96.71	110.96	111.02	3.32	–0.25
849D-10H-5	*C. wuellerstorfi*	136	96.86	111.11	111.18	3.29	–0.14
849D-10H-6	*C. wuellerstorfi*	1	97.01	111.26	111.31	3.15	–0.26
849D-10H-6	*C. wuellerstorfi*	16	97.16	111.41	111.44	3.10	–0.03
849D-10H-6	*C. wuellerstorfi*	31	97.31	111.56	111.55	3.18	–0.03
849D-10H-6	*C. wuellerstorfi*	46	97.46	111.71	111.67	3.18	–0.08
849D-10H-6	*C. wuellerstorfi*	61	97.61	111.86	111.80	3.31	–0.02
849D-10H-6	*C. wuellerstorfi*	76	97.76	112.01	111.96	3.18	–0.08
849D-10H-6	*C. wuellerstorfi*	91	97.91	112.16	112.13	3.30	–0.22
849D-10H-6	*C. wuellerstorfi*	106	98.06	112.31	112.29	3.25	–0.05
849D-10H-6	*C. wuellerstorfi*	121	98.21	112.46	112.43	3.10	–0.05
849D-10H-6	*C. wuellerstorfi*	136	98.36	112.61	112.57	3.11	0.23
849C-11H-2	*C. wuellerstorfi*	16	97.66	112.86	112.92	3.13	0.08
849C-11H-2	*C. wuellerstorfi*	26	97.76	112.96	113.02	3.22	–0.07
849C-11H-2	*C. wuellerstorfi*	36	97.86	113.06	113.12	3.23	0.03
849C-11H-2	*C. wuellerstorfi*	46	97.96	113.16	113.23	3.22	–0.23
849C-11H-2	*C. wuellerstorfi*	56	98.06	113.26	113.33	3.28	–0.06
849C-11H-2	*C. wuellerstorfi*	66	98.16	113.36	113.43	3.28	–0.04
849C-11H-2	*C. wuellerstorfi*	76	98.26	113.46	113.53	3.03	–0.25
849C-11H-2	*C. wuellerstorfi*	86	98.36	113.56	113.63	3.35	–0.41
849C-11H-2	*C. wuellerstorfi*	96	98.46	113.66	113.73	3.14	–0.03
849C-11H-2	*C. wuellerstorfi*	106	98.56	113.76	113.82	3.18	–0.16
849C-11H-2	*C. wuellerstorfi*	116	98.66	113.86	113.92	3.19	–0.23
849C-11H-2	*C. wuellerstorfi*	126	98.76	113.96	114.01	3.15	–0.18
849C-11H-2	*C. wuellerstorfi*	136	98.86	114.06	114.09	3.12	–0.13
849C-11H-2	*C. wuellerstorfi*	146	98.96	114.16	114.18	3.14	–0.41
849D-11H-1	*C. wuellerstorfi*	46	99.46	114.31	114.26	3.05	–0.08
849D-11H-1	*C. wuellerstorfi*	61	99.61	114.46	114.42	3.26	–0.02
849D-11H-1	*C. wuellerstorfi*	76	99.76	114.61	114.51	3.21	0.00
849D-11H-1	*C. wuellerstorfi*	91	99.91	114.76	114.64	2.81	0.04
849D-11H-1	*C. wuellerstorfi*	106	100.06	114.91	114.87	2.92	–0.06
849D-11H-1	*C. wuellerstorfi*	121	100.21	115.06	115.00	3.36	–0.04
849D-11H-1	*C. wuellerstorfi*	136	100.36	115.21	115.13	3.42	–0.12
849D-11H-2	*C. wuellerstorfi*	1	100.51	115.36	115.33	3.09	0.01
849D-11H-2	*C. wuellerstorfi*	16	100.66	115.51	115.48	3.16	–0.04
849D-11H-2	*C. wuellerstorfi*	31	100.81	115.66	115.62	3.26	–0.06
849D-11H-2	*C. wuellerstorfi*	46	100.96	115.81	115.78	2.94	0.09
849D-11H-2	*C. wuellerstorfi*	61	101.11	115.96	115.91	3.12	–0.04
849D-11H-2	*C. wuellerstorfi*	76	101.26	116.11	116.06	3.08	0.00
849D-11H-2	*C. wuellerstorfi*	91	101.41	116.26	116.26	3.10	0.12
849D-11H-2	*C. wuellerstorfi*	106	101.56	116.41	116.44	2.99	–0.04
849D-11H-2	*C. wuellerstorfi*	121	101.71	116.56	116.57	3.21	–0.14
849D-11H-2	*C. wuellerstorfi*	136	101.86	116.71	116.70	2.97	–0.26
849D-11H-3	*C. wuellerstorfi*	1	102.01	116.86	116.86	3.02	–0.30
849D-11H-3	*C. wuellerstorfi*	16	102.16	117.01	117.01	3.14	–0.27
849D-11H-3	*C. wuellerstorfi*	31	102.31	117.16	117.16	3.05	–0.04
849D-11H-3	*C. wuellerstorfi*	46	102.46	117.31	117.31	3.04	–0.22
849D-11H-3	*C. wuellerstorfi*	61	102.61	117.46	117.46	2.98	–0.33
849D-11H-3	*C. wuellerstorfi*	76	102.76	117.61	117.61	3.17	–0.04
849D-11H-3	*C. wuellerstorfi*	91	102.91	117.76	117.76	3.11	–0.12
849D-11H-3	*C. wuellerstorfi*	106	103.06	117.91	117.91	3.11	–0.27
849D-11H-3	*C. wuellerstorfi*	121	103.21	118.06	118.06	3.16	–0.27
849D-11H-3	*C. wuellerstorfi*	136	103.36	118.21	118.21	3.35	–0.31
849D-11H-4	*C. wuellerstorfi*	1	103.51	118.36	118.35	3.31	–0.24
849D-11H-4	*C. wuellerstorfi*	31	103.81	118.66	118.66	3.08	–0.01
849D-11H-4	*C. wuellerstorfi*	46	103.96	118.81	118.81	3.10	–0.08
849D-11H-4	*C. wuellerstorfi*	61	104.11	118.96	118.96	3.18	0.09
849D-11H-4	*C. wuellerstorfi*	76	104.26	119.11	119.11	2.98	–0.03
849D-11H-4	*C. wuellerstorfi*	91	104.41	119.26	119.26	2.67	0.06
849D-11H-4	*C. wuellerstorfi*	106	104.56	119.41	119.41	3.00	–0.10
849D-11H-4	*C. wuellerstorfi*	121	104.71	119.56	119.56	2.91	–0.09
849D-11H-4	*C. wuellerstorfi*	136	104.86	119.71	119.71	3.12	–0.26
849D-11H-5	*C. wuellerstorfi*	1	105.01	119.86	119.86	3.10	–0.15
849D-11H-5	*C. wuellerstorfi*	16	105.16	120.01	120.01	2.73	0.00
849D-11H-5	*C. wuellerstorfi*	31	105.31	120.16	120.16	2.93	–0.18
849D-11H-5	*C. wuellerstorfi*	46	105.46	120.31	120.32	3.03	–0.25
849D-11H-5	*C. wuellerstorfi*	61	105.61	120.46	120.46	3.05	–0.18
849D-11H-5	*C. wuellerstorfi*	76	105.76	120.61	120.61	2.73	–0.13
849D-11H-5	*C. wuellerstorfi*	91	105.91	120.76	120.76	3.00	0.01
849D-11H-5	*C. wuellerstorfi*	106	106.06	120.91	120.91	3.20	–0.02
849D-11H-5	*C. wuellerstorfi*	121	106.21	121.06	121.06	2.82	0.02
849D-11H-5	*C. wuellerstorfi*	136	106.36	121.21	121.22	3.11	–0.17
849D-11H-6	*C. wuellerstorfi*	1	106.51	121.36	121.36	3.11	–0.35
849D-11H-6	*C. wuellerstorfi*	16	106.66	121.51	121.51	3.09	–0.17
849D-11H-6	*C. wuellerstorfi*	31	106.81	121.66	121.66	3.04	–0.03
849D-11H-6	*C. wuellerstorfi*	46	106.96	121.81	121.81	3.00	–0.43
849D-11H-6	*C. wuellerstorfi*	91	107.41	122.26	122.26	2.67	–0.27
849D-11H-6	*C. wuellerstorfi*	106	107.56	122.41	122.41	3.03	–0.41
849D-11H-6	*C. wuellerstorfi*	121	107.71	122.56	122.56	3.16	–0.14
849D-11H-6	*C. wuellerstorfi*	136	107.86	122.71	122.71	3.13	0.04
849D-11H-7	*C. wuellerstorfi*	1	108.01	122.86	122.86	3.08	–0.02
849D-11H-7	*C. wuellerstorfi*	31	108.31	123.16	123.17	3.16	0.06
849D-11H-7	*C. wuellerstorfi*	46	108.46	123.31	123.30	2.93	–0.07
849D-11H-7	*C. wuellerstorfi*	61	108.61	123.46	123.46	2.94	–0.01
849D-12X-3	*C. wuellerstorfi*	11	111.61	127.51	127.51	3.09	–0.07
849D-12X-3	*C. wuellerstorfi*	31	111.81	127.71	127.71	3.00	0.00
849D-12X-3	*C. wuellerstorfi*	51	112.01	127.91	127.91	3.18	–0.04
849D-12X-3	*C. wuellerstorfi*	91	112.41	128.31	128.31	3.19	–0.11
849D-12X-3	*C. wuellerstorfi*	111	112.61	128.51	128.51	3.26	–0.37
849D-12X-4	*C. wuellerstorfi*	1	113.01	128.91	128.91	3.26	–0.15
849D-12X-4	*C. wuellerstorfi*	41	113.41	129.31	129.31	3.28	0.00
849D-12X-4	*C. wuellerstorfi*	61	113.61	129.51	129.51	3.23	–0.09
849D-12X-4	*C. wuellerstorfi*	81	113.81	129.71	129.71	3.19	–0.08
849D-12X-4	*C. wuellerstorfi*	141	114.41	130.31	130.31	3.13	0.00
849D-12X-5	*C. wuellerstorfi*	11	114.61	130.51	130.51	3.16	–0.07
849D-12X-5	*C. wuellerstorfi*	31	114.81	130.71	130.71	3.28	–0.13
849D-12X-5	*C. wuellerstorfi*	51	115.01	130.91	130.91	2.98	–0.14
849D-12X-5	*C. wuellerstorfi*	71	115.21	131.11	131.11	3.18	–0.08
849D-12X-5	*C. wuellerstorfi*	91	115.41	131.31	131.31	3.52	0.07
849D-12X-5	*C. wuellerstorfi*	131	115.81	131.71	131.71	3.09	–0.05
849D-12X-6	*C. wuellerstorfi*	1	116.01	131.91	131.91	3.09	–0.12
849D-12X-6	*C. wuellerstorfi*	21	116.21	132.11	132.11	3.11	–0.25
849D-12X-6	*C. wuellerstorfi*	41	116.41	132.31	132.31	3.13	–0.27
849D-12X-6	*C. wuellerstorfi*	61	116.61	132.51	132.51	3.18	–0.53
849D-12X-6	*C. wuellerstorfi*	81	116.81	132.71	132.71	3.25	–0.31
849D-13X-1	*C. wuellerstorfi*	11	115.61	132.81	132.81	3.19	0.00
849D-12X-6	*C. wuellerstorfi*	101	117.01	132.91	132.91	3.59	–0.78
849D-13X-1	*C. wuellerstorfi*	31	115.81	133.01	133.01	3.21	–0.07
849D-12X-6	*C. wuellerstorfi*	119	117.19	133.09	133.09	3.54	–0.74
849D-13X-1	*C. wuellerstorfi*	51	116.01	133.21	133.21	3.24	–0.12
849D-13X-1	*C. wuellerstorfi*	71	116.21	133.41	133.41	3.29	–0.03
849D-13X-1	*C. wuellerstorfi*	91	116.41	133.61	133.61	3.35	–0.17
849D-13X-1	*C. wuellerstorfi*	111	116.61	133.81	133.81	3.04	–0.12
849D-13X-1	*C. wuellerstorfi*	131	116.81	134.01	134.01	3.26	–0.24
849D-13X-2	*C. wuellerstorfi*	1	117.01	134.21	134.21	3.21	–0.34
849D-13X-2	*C. wuellerstorfi*	21	117.21	134.41	134.41	3.25	–0.24
849D-13X-2	*C. wuellerstorfi*	41	117.41	134.61	134.61	3.24	–0.37
849D-13X-2	*C. wuellerstorfi*	61	117.61	134.81	134.81	3.14	–0.14
849D-13X-2	*C. wuellerstorfi*	81	117.81	135.01	135.01	3.27	–0.23
849D-13X-2	*C. wuellerstorfi*	101	118.01	135.21	135.21	3.30	–0.37
849D-13X-2	*C. wuellerstorfi*	121	118.21	135.41	135.41	3.34	–0.28
849D-13X-2	*C. wuellerstorfi*	141	118.41	135.61	135.61	3.36	–0.22
849D-13X-3	*C. wuellerstorfi*	11	118.61	135.81	135.81	3.21	–0.36
849D-13X-3	*C. wuellerstorfi*	31	118.81	136.01	136.01	3.08	–0.22
849D-13X-3	*C. wuellerstorfi*	51	119.01	136.21	136.21	3.11	–0.42
849D-13X-3	*C. wuellerstorfi*	91	119.41	136.61	136.61	3.08	–0.26
849D-13X-3	*C. wuellerstorfi*	131	119.81	137.01	137.01	3.22	–0.09
849D-13X-4	*C. wuellerstorfi*	1	120.01	137.21	137.21	3.04	0.04
849D-13X-4	*C. wuellerstorfi*	41	120.41	137.61	137.61	3.09	0.00
849D-13X-4	*C. wuellerstorfi*	61	120.61	137.81	137.81	3.03	–0.02
849D-13X-4	*C. wuellerstorfi*	81	120.81	138.01	138.01	3.10	–0.02
849D-13X-4	*C. wuellerstorfi*	101	121.01	138.21	138.21	3.16	–0.12
849D-13X-4	*C. wuellerstorfi*	121	121.21	138.41	138.41	3.16	–0.09
849D-13X-4	*C. wuellerstorfi*	141	121.41	138.61	138.61	3.27	–0.25
849D-13X-5	*C. wuellerstorfi*	11	121.61	138.81	138.81	3.25	–0.21
849D-13X-5	*C. wuellerstorfi*	31	121.81	139.01	139.01	3.23	–0.37
849D-13X-5	*C. wuellerstorfi*	51	122.01	139.21	139.21	3.06	–0.23
849D-13X-5	*C. wuellerstorfi*	91	122.41	139.61	139.61	3.26	–0.11
849D-13X-6	*C. wuellerstorfi*	21	123.21	140.41	140.41	3.19	–0.21
849D-13X-6	*C. wuellerstorfi*	61	123.61	140.81	140.81	3.12	–0.21
849D-13X-6	*C. wuellerstorfi*	81	123.81	141.01	141.01	3.27	–0.14
849D-14X-1	*C. wuellerstorfi*	1	125.11	143.01	143.01	3.21	0.18

APPENDIX A (continued).

Section	Species	Depth (cm)	Depth (mbsf)	Depth (mcd)	Depth (rmcd)	$\delta^{18}O$	$\delta^{13}C$
849D-14X-1	*C. wuellerstorfi*	21	125.31	143.21	143.21	3.23	0.16
849D-14X-1	*C. wuellerstorfi*	41	125.51	143.41	143.41	3.19	0.13
849D-14X-1	*C. wuellerstorfi*	81	125.91	143.81	143.81	3.07	–0.17
849D-14X-1	*C. wuellerstorfi*	101	126.11	144.01	144.01	3.40	–0.35
849D-14X-1	*C. wuellerstorfi*	121	126.31	144.21	144.21	3.43	–0.16
849D-14X-1	*C. wuellerstorfi*	141	126.51	144.41	144.41	3.28	–0.08
849D-14X-2	*C. wuellerstorfi*	11	126.71	144.61	144.61	3.17	–0.09
849D-14X-2	*C. wuellerstorfi*	31	126.91	144.81	144.81	3.16	–0.07
849D-14X-2	*C. wuellerstorfi*	51	127.11	145.01	145.01	3.07	0.01
849D-14X-2	*C. wuellerstorfi*	71	127.31	145.21	145.21	3.08	–0.15
849D-14X-2	*C. wuellerstorfi*	91	127.51	145.41	145.41	3.06	–0.09
849D-14X-2	*C. wuellerstorfi*	111	127.71	145.61	145.61	3.33	–0.10
849D-14X-2	*C. wuellerstorfi*	131	127.91	145.81	145.81	3.38	0.01
849D-14X-3	*C. wuellerstorfi*	1	128.11	146.01	146.01	3.19	0.12
849D-14X-3	*C. wuellerstorfi*	21	128.31	146.21	146.21	3.09	–0.01
849D-14X-3	*C. wuellerstorfi*	41	128.51	146.41	146.41	3.09	0.00
849D-14X-3	*C. wuellerstorfi*	61	128.71	146.61	146.61	3.25	–0.21
849D-14X-3	*C. wuellerstorfi*	80	128.90	146.80	146.80	3.37	–0.29
849D-14X-3	*C. wuellerstorfi*	121	129.31	147.21	147.21	3.45	–0.11
849D-14X-3	*C. wuellerstorfi*	141	129.51	147.41	147.41	3.32	–0.07
849D-14X-4	*C. wuellerstorfi*	11	129.71	147.61	147.61	3.37	0.12
849D-14X-4	*C. wuellerstorfi*	31	129.91	147.81	147.81	3.14	–0.09
849D-14X-4	*C. wuellerstorfi*	71	130.31	148.21	148.21	3.21	–0.28
849D-14X-4	*C. wuellerstorfi*	111	130.71	148.61	148.61	3.51	–0.49
849D-14X-4	*C. wuellerstorfi*	131	130.91	148.81	148.81	3.55	–0.48
849D-14X-5	*C. wuellerstorfi*	1	131.11	149.01	149.01	3.24	–0.06
849D-14X-5	*C. wuellerstorfi*	21	131.31	149.21	149.21	3.18	–0.11
849D-14X-5	*C. wuellerstorfi*	41	131.51	149.41	149.41	3.24	–0.05
849D-14X-5	*C. wuellerstorfi*	81	131.91	149.81	149.81	3.21	–0.15
849D-14X-5	*C. wuellerstorfi*	101	132.11	150.01	150.01	3.32	–0.26
849D-14X-5	*C. wuellerstorfi*	121	132.31	150.21	150.21	3.41	–0.34
849D-14X-5	*C. wuellerstorfi*	141	132.51	150.41	150.41	3.42	–0.33
849D-14X-6	*C. wuellerstorfi*	11	132.71	150.61	150.61	3.22	–0.10
849D-14X-6	*C. wuellerstorfi*	31	132.91	150.81	150.81	3.17	–0.14
849D-14X-6	*C. wuellerstorfi*	51	133.11	151.01	151.01	3.19	–0.20
849D-14X-6	*C. wuellerstorfi*	71	133.31	151.21	151.21	3.20	–0.14
849D-14X-6	*C. wuellerstorfi*	91	133.51	151.41	151.41	3.24	–0.19
849D-14X-6	*C. wuellerstorfi*	111	133.71	151.61	151.61	3.23	–0.17
849D-14X-6	*C. wuellerstorfi*	131	133.91	151.81	151.81	3.18	–0.15
849D-14X-7	*C. wuellerstorfi*	1	134.11	152.01	152.01	3.13	–0.05
849D-14X-7	*C. wuellerstorfi*	21	134.31	152.21	152.21	3.12	–0.03

APPENDIX B

Age Model for Site 849

Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)
0.0	0.0025	16.8	0.5526	33.6	1.2137	50.4	1.8142	67.2	2.3822	84.0	3.0265	100.8	3.6338
0.2	0.0056	17.0	0.5627	33.8	1.2183	50.6	1.8207	67.4	2.3904	84.2	3.0323	101.0	3.6415
0.4	0.0101	17.2	0.5713	34.0	1.2226	50.8	1.8262	67.6	2.3977	84.4	3.0391	101.2	3.6490
0.6	0.0142	17.4	0.5787	34.2	1.2269	51.0	1.8325	67.8	2.4046	84.6	3.0466	101.4	3.6559
0.8	0.0183	17.6	0.5853	34.4	1.2317	51.2	1.8424	68.0	2.4114	84.8	3.0544	101.6	3.6620
1.0	0.0229	17.8	0.5918	34.6	1.2373	51.4	1.8543	68.2	2.4181	85.0	3.0622	101.8	3.6679
1.2	0.0281	18.0	0.5981	34.8	1.2432	51.6	1.8633	68.4	2.4247	85.2	3.0701	102.0	3.6737
1.4	0.0338	18.2	0.6044	35.0	1.2494	51.8	1.8699	68.6	2.4309	85.4	3.0780	102.2	3.6795
1.6	0.0403	18.4	0.6113	35.2	1.2555	52.0	1.8751	68.8	2.4368	85.6	3.0861	102.4	3.6855
1.8	0.0478	18.6	0.6197	35.4	1.2611	52.2	1.8794	69.0	2.4424	85.8	3.0944	102.6	3.6921
2.0	0.0552	18.8	0.6299	35.6	1.2659	52.4	1.8828	69.2	2.4472	86.0	3.1028	102.8	3.6993
2.2	0.0625	19.0	0.6399	35.8	1.2701	52.6	1.8865	69.4	2.4519	86.2	3.1113	103.0	3.7066
2.4	0.0690	19.2	0.6483	36.0	1.2742	52.8	1.8925	69.6	2.4563	86.4	3.1197	103.2	3.7134
2.6	0.0750	19.4	0.6555	36.2	1.2788	53.0	1.8994	69.8	2.4617	86.6	3.1280	103.4	3.7200
2.8	0.0812	19.6	0.6622	36.4	1.2844	53.2	1.9056	70.0	2.4677	86.8	3.1357	103.6	3.7280
3.0	0.0881	19.8	0.6687	36.6	1.2914	53.4	1.9110	70.2	2.4743	87.0	3.1425	103.8	3.7393
3.2	0.0963	20.0	0.6750	36.8	1.2991	53.6	1.9160	70.4	2.4821	87.2	3.1491	104.0	3.7513
3.4	0.1055	20.2	0.6808	37.0	1.3067	53.8	1.9214	70.6	2.4921	87.4	3.1558	104.2	3.7602
3.6	0.1144	20.4	0.6864	37.2	1.3136	54.0	1.9278	70.8	2.5033	87.6	3.1631	104.4	3.7672
3.8	0.1217	20.6	0.6921	37.4	1.3195	54.2	1.9352	71.0	2.5139	87.8	3.1706	104.6	3.7738
4.0	0.1273	20.8	0.6985	37.6	1.3246	54.4	1.9431	71.2	2.5218	88.0	3.1777	104.8	3.7797
4.2	0.1319	21.0	0.7064	37.8	1.3293	54.6	1.9491	71.4	2.5273	88.2	3.1841	105.0	3.7846
4.4	0.1365	21.2	0.7160	38.0	1.3340	54.8	1.9529	71.6	2.5324	88.4	3.1902	105.2	3.7888
4.6	0.1413	21.4	0.7268	38.2	1.3390	55.0	1.9553	71.8	2.5396	88.6	3.1963	105.4	3.7929
4.8	0.1465	21.6	0.7385	38.4	1.3447	55.2	1.9576	72.0	2.5497	88.8	3.2025	105.6	3.7972
5.0	0.1522	21.8	0.7508	38.6	1.3511	55.4	1.9602	72.2	2.5611	89.0	3.2088	105.8	3.8030
5.2	0.1579	22.0	0.7626	38.8	1.3579	55.6	1.9633	72.4	2.5708	89.2	3.2152	106.0	3.8112
5.4	0.1635	22.2	0.7721	39.0	1.3644	55.8	1.9669	72.6	2.5782	89.4	3.2215	106.2	3.8205
5.6	0.1685	22.4	0.7791	39.2	1.3697	56.0	1.9704	72.8	2.5847	89.6	3.2279	106.4	3.8283
5.8	0.1731	22.6	0.7843	39.4	1.3749	56.2	1.9738	73.0	2.5918	89.8	3.2342	106.6	3.8347
6.0	0.1774	22.8	0.7896	39.6	1.3823	56.4	1.9771	73.2	2.6000	90.0	3.2406	106.8	3.8408
6.2	0.1818	23.0	0.7976	39.8	1.3908	56.6	1.9804	73.4	2.6090	90.2	3.2470	107.0	3.8474
6.4	0.1866	23.2	0.8093	40.0	1.4006	56.8	1.9838	73.6	2.6177	90.4	3.2537	107.2	3.8548
6.6	0.1922	23.4	0.8223	40.2	1.4125	57.0	1.9873	73.8	2.6258	90.6	3.2608	107.4	3.8628
6.8	0.1989	23.6	0.8325	40.4	1.4244	57.2	1.9913	74.0	2.6334	90.8	3.2680	107.6	3.8710
7.0	0.2067	23.8	0.8391	40.6	1.4342	57.4	1.9957	74.2	2.6402	91.0	3.2752	107.8	3.8796
7.2	0.2152	24.0	0.8436	40.8	1.4417	57.6	2.0009	74.4	2.6474	91.2	3.2822	108.0	3.8883
7.4	0.2233	24.2	0.8476	41.0	1.4490	57.8	2.0065	74.6	2.6576	91.4	3.2887	108.2	3.8966
7.6	0.2306	24.4	0.8525	41.2	1.4591	58.0	2.0123	74.8	2.6705	91.6	3.2952	108.4	3.9045
7.8	0.2368	24.6	0.8592	41.4	1.4733	58.2	2.0183	75.0	2.6820	91.8	3.3026	108.6	3.9121
8.0	0.2420	24.8	0.8680	41.6	1.4884	58.4	2.0240	75.2	2.6899	92.0	3.3112	108.8	3.9195
8.2	0.2468	25.0	0.8774	41.8	1.4993	58.6	2.0294	75.4	2.6958	92.2	3.3198	109.0	3.9266
8.4	0.2520	25.2	0.8858	42.0	1.5062	58.8	2.0345	75.6	2.7015	92.4	3.3279	109.2	3.9338
8.6	0.2581	25.4	0.8927	42.2	1.5119	59.0	2.0394	75.8	2.7075	92.6	3.3356	109.4	3.9412
8.8	0.2651	25.6	0.8987	42.4	1.5184	59.2	2.0442	76.0	2.7140	92.8	3.3430	109.6	3.9490
9.0	0.2735	25.8	0.9042	42.6	1.5262	59.4	2.0492	76.2	2.7210	93.0	3.3496	109.8	3.9569
9.2	0.2833	26.0	0.9096	42.8	1.5339	59.6	2.0547	76.4	2.7288	93.2	3.3556	110.0	3.9644
9.4	0.2942	26.2	0.9153	43.0	1.5402	59.8	2.0608	76.6	2.7372	93.4	3.3622	110.2	3.9716
9.6	0.3052	26.4	0.9218	43.2	1.5455	60.0	2.0676	76.8	2.7447	93.6	3.3705	110.4	3.9787
9.8	0.3145	26.6	0.9298	43.4	1.5505	60.2	2.0749	77.0	2.7506	93.8	3.3801	110.6	3.9858
10.0	0.3214	26.8	0.9388	43.6	1.5564	60.4	2.0826	77.2	2.7560	94.0	3.3887	110.8	3.9929
10.2	0.3261	27.0	0.9483	43.8	1.5636	60.6	2.0901	77.4	2.7612	94.2	3.3947	111.0	4.0001
10.4	0.3296	27.2	0.9571	44.0	1.5724	60.8	2.0977	77.6	2.7664	94.4	3.3995	111.2	4.0073
10.6	0.3329	27.4	0.9640	44.2	1.5817	61.0	2.1056	77.8	2.7721	94.6	3.4056	111.4	4.0150
10.8	0.3366	27.6	0.9696	44.4	1.5906	61.2	2.1134	78.0	2.7799	94.8	3.4134	111.6	4.0234
11.0	0.3411	27.8	0.9746	44.6	1.5986	61.4	2.1205	78.2	2.7903	95.0	3.4221	111.8	4.0317
11.2	0.3465	28.0	0.9806	44.8	1.6061	61.6	2.1268	78.4	2.8017	95.2	3.4311	112.0	4.0393
11.4	0.3528	28.2	0.9890	45.0	1.6140	61.8	2.1337	78.6	2.8124	95.4	3.4402	112.2	4.0461
11.6	0.3590	28.4	0.9996	45.2	1.6226	62.0	2.1428	78.8	2.8220	95.6	3.4490	112.4	4.0531
11.8	0.3647	28.6	1.0099	45.4	1.6315	62.2	2.1528	79.0	2.8305	95.8	3.4574	112.6	4.0609
12.0	0.3701	28.8	1.0184	45.6	1.6395	62.4	2.1634	79.2	2.8384	96.0	3.4648	112.8	4.0689
12.2	0.3765	29.0	1.0259	45.8	1.6449	62.6	2.1736	79.4	2.8461	96.2	3.4709	113.0	4.0760
12.4	0.3853	29.2	1.0340	46.0	1.6489	62.8	2.1828	79.6	2.8539	96.4	3.4765	113.2	4.0822
12.6	0.3957	29.4	1.0432	46.2	1.6529	63.0	2.1916	79.8	2.8618	96.6	3.4819	113.4	4.0885
12.8	0.4066	29.6	1.0521	46.4	1.6581	63.2	2.2007	80.0	2.8698	96.8	3.4874	113.6	4.0954
13.0	0.4182	29.8	1.0594	46.6	1.6646	63.4	2.2103	80.2	2.8781	97.0	3.4933	113.8	4.1029
13.2	0.4258	30.0	1.0656	46.8	1.6723	63.6	2.2204	80.4	2.8869	97.2	3.5003	114.0	4.1106
13.4	0.4309	30.2	1.0715	47.0	1.6805	63.8	2.2299	80.6	2.8958	97.4	3.5086	114.2	4.1187
13.6	0.4356	30.4	1.0783	47.2	1.6887	64.0	2.2383	80.8	2.9042	97.6	3.5174	114.4	4.1267
13.8	0.4408	30.6	1.0869	47.4	1.6966	64.2	2.2460	81.0	2.9120	97.8	3.5263	114.6	4.1341
14.0	0.4477	30.8	1.0969	47.6	1.7040	64.4	2.2537	81.2	2.9192	98.0	3.5350	114.8	4.1408
14.2	0.4568	31.0	1.1060	47.8	1.7115	64.6	2.2610	81.4	2.9257	98.2	3.5436	115.0	4.1473
14.4	0.4664	31.2	1.1135	48.0	1.7202	64.8	2.2679	81.6	2.9317	98.4	3.5519	115.2	4.1539
14.6	0.4741	31.4	1.1196	48.2	1.7301	65.0	2.2749	81.8	2.9391	98.6	3.5599	115.4	4.1609
14.8	0.4804	31.6	1.1261	48.4	1.7400	65.2	2.2818	82.0	2.9485	98.8	3.5667	115.6	4.1681
15.0	0.4863	31.8	1.1341	48.6	1.7492	65.4	2.2893	82.2	2.9575	99.0	3.5721	115.8	4.1753
15.2	0.4929	32.0	1.1441	48.8	1.7578	65.6	2.2978	82.4	2.9654	99.2	3.5768	116.0	4.1825
15.4	0.5004	32.2	1.1555	49.0	1.7662	65.8	2.3074	82.6	2.9732	99.4	3.5812	116.2	4.1898
15.6	0.5089	32.4	1.1671	49.2	1.7732	66.0	2.3168	82.8	2.9811	99.6	3.5859	116.4	4.1969
15.8	0.5171	32.6	1.1781	49.4	1.7791	66.2	2.3256	83.0	2.9893	99.8	3.5915	116.6	4.2036
16.0	0.5238	32.8	1.1879	49.6	1.7842	66.4	2.3350	83.2	2.9978	100.0	3.5992	116.8	4.2097
16.2	0.5293	33.0	1.1960	49.8	1.7899	66.6	2.3466	83.4	3.0064	100.2	3.6086	117.0	4.2160
16.4	0.5352	33.2	1.2027	50.0	1.7973	66.8	2.3596	83.6	3.0145	100.4	3.6179	117.2	4.2230
16.6	0.5428	33.4	1.2086	50.2	1.8061	67.0	2.3720	83.8	3.0211	100.6	3.6261	117.4	4.2304

APPENDIX B (continued)

Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)	Depth (rmcd)	Age (Ma)
117.6	4.2379	129.8	4.5641	142.0	4.7347
117.8	4.2450	130.0	4.5664	142.2	4.7365
118.0	4.2515	130.2	4.5688	142.4	4.7383
118.2	4.2577	130.4	4.5712	142.6	4.7401
118.4	4.2638	130.6	4.5735	142.8	4.7420
118.6	4.2699	130.8	4.5759	143.0	4.7440
118.8	4.2763	131.0	4.5782	143.2	4.7462
119.0	4.2829	131.2	4.5806	143.4	4.7487
119.2	4.2896	131.4	4.5830	143.6	4.7511
119.4	4.2965	131.6	4.5853	143.8	4.7536
119.6	4.3035	131.8	4.5877	144.0	4.7561
119.8	4.3105	132.0	4.5900	144.2	4.7586
120.0	4.3168	132.2	4.5924	144.4	4.7611
120.2	4.3220	132.4	4.5950	144.6	4.7635
120.4	4.3262	132.6	4.5980	144.8	4.7660
120.6	4.3301	132.8	4.6012	145.0	4.7689
120.8	4.3342	133.0	4.6045	145.2	4.7726
121.0	4.3387	133.2	4.6078	145.4	4.7772
121.2	4.3442	133.4	4.6111	145.6	4.7824
121.4	4.3506	133.6	4.6143	145.8	4.7880
121.6	4.3572	133.8	4.6176	146.0	4.7942
121.8	4.3638	134.0	4.6209	146.2	4.8009
122.0	4.3704	134.2	4.6242	146.4	4.8075
122.2	4.3771	134.4	4.6275	146.6	4.8133
122.4	4.3837	134.6	4.6308	146.8	4.8185
122.6	4.3903	134.8	4.6341	147.0	4.8240
122.8	4.3970	135.0	4.6375	147.2	4.8301
123.0	4.4037	135.2	4.6415	147.4	4.8365
123.2	4.4112	135.4	4.6465	147.6	4.8432
123.4	4.4199	135.6	4.6520	147.8	4.8502
123.6	4.4296	135.8	4.6571	148.0	4.8576
123.8	4.4395	136.0	4.6620	148.2	4.8651
124.0	4.4484	136.2	4.6667	148.4	4.8727
124.2	4.4557	136.4	4.6714	148.6	4.8802
124.4	4.4617	136.6	4.6762	148.8	4.8875
124.6	4.4675	136.8	4.6809	149.0	4.8944
124.8	4.4732	137.0	4.6857	149.2	4.9003
125.0	4.4789	137.2	4.6904	149.4	4.9056
125.2	4.4846	137.4	4.6947	149.6	4.9108
125.4	4.4901	137.6	4.6979	149.8	4.9163
125.6	4.4953	137.8	4.7001	150.0	4.9227
125.8	4.5002	138.0	4.7017	150.2	4.9300
126.0	4.5051	138.2	4.7033	150.4	4.9371
126.2	4.5098	138.4	4.7048	150.6	4.9431
126.4	4.5142	138.6	4.7064	150.8	4.9481
126.6	4.5181	138.8	4.7079	151.0	4.9527
126.8	4.5218	139.0	4.7095	151.2	4.9573
127.0	4.5255	139.2	4.7110	151.4	4.9618
127.2	4.5292	139.4	4.7126	151.6	4.9660
127.4	4.5328	139.6	4.7141	151.8	4.9700
127.6	4.5362	139.8	4.7157	152.0	4.9740
127.8	4.5391	140.0	4.7172	152.2	4.9780
128.0	4.5417	140.2	4.7187	152.4	4.9817
128.2	4.5442	140.4	4.7203	152.6	4.9849
128.4	4.5467	140.6	4.7219	152.8	4.9875
128.6	4.5492	140.8	4.7237	153.0	4.9899
128.8	4.5517	141.0	4.7255	153.2	4.9922
129.0	4.5542	141.2	4.7273	153.4	4.9946
129.2	4.5567	141.4	4.7292	153.6	4.9969
129.4	4.5592	141.6	4.7310	153.8	4.9993
129.6	4.5616	141.8	4.7328		

APPENDIX C

Smoothed, Interpolated Benthic Foraminifer Isotope Record for Site 849

Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C
0.000	3.580	0.145	0.336	3.771	–0.134	0.672	4.356	–0.517	1.008	4.191	–0.125
0.004	3.576	0.170	0.340	4.243	–0.202	0.676	4.277	–0.402	1.012	4.065	–0.067
0.008	3.713	0.058	0.344	4.561	–0.216	0.680	4.182	–0.303	1.016	3.894	0.001
0.012	4.341	–0.154	0.348	4.597	–0.250	0.684	3.976	–0.225	1.020	3.746	0.048
0.016	4.722	–0.215	0.352	4.450	–0.306	0.688	3.771	–0.082	1.024	3.724	0.019
0.020	4.715	–0.136	0.356	4.398	–0.302	0.692	3.676	0.040	1.028	3.832	–0.076
0.024	4.622	–0.023	0.360	4.340	–0.252	0.696	3.746	0.004	1.032	3.993	–0.158
0.028	4.594	0.033	0.364	4.210	–0.175	0.700	3.927	–0.097	1.036	4.214	–0.229
0.032	4.525	0.058	0.368	4.119	–0.144	0.704	4.181	–0.176	1.040	4.385	–0.281
0.036	4.481	0.050	0.372	4.077	–0.117	0.708	4.304	–0.190	1.044	4.362	–0.363
0.040	4.573	0.004	0.376	4.048	–0.048	0.712	4.336	–0.150	1.048	4.197	–0.537
0.044	4.581	0.005	0.380	4.025	–0.037	0.716	4.352	–0.202	1.052	4.138	–0.508
0.048	4.476	0.047	0.384	4.017	–0.031	0.720	4.365	–0.281	1.056	4.025	–0.375
0.052	4.459	0.005	0.388	3.971	–0.056	0.724	4.298	–0.220	1.060	3.835	–0.206
0.056	4.475	–0.075	0.392	3.838	0.009	0.728	4.205	–0.129	1.064	3.564	–0.071
0.060	4.537	–0.190	0.396	3.410	0.248	0.732	4.224	–0.188	1.068	3.339	0.015
0.064	4.532	–0.133	0.400	3.188	0.282	0.736	4.230	–0.258	1.072	3.378	0.082
0.068	4.392	0.062	0.404	3.148	0.236	0.740	4.198	–0.331	1.076	3.593	0.081
0.072	4.202	0.193	0.408	3.249	0.248	0.744	4.153	–0.410	1.080	3.753	–0.004
0.076	4.141	0.142	0.412	3.350	0.260	0.748	4.134	–0.434	1.084	3.873	–0.060
0.080	4.046	0.121	0.416	3.451	0.271	0.752	4.193	–0.424	1.088	3.881	–0.188
0.084	3.903	0.179	0.420	3.552	0.283	0.756	4.276	–0.444	1.092	4.009	–0.302
0.088	3.844	0.147	0.424	4.133	–0.023	0.760	4.282	–0.459	1.096	4.159	–0.319
0.092	3.903	0.113	0.428	4.787	–0.364	0.764	4.172	–0.415	1.100	4.033	–0.199
0.096	3.950	0.107	0.432	4.860	–0.366	0.768	4.048	–0.323	1.104	3.950	–0.081
0.100	3.890	0.019	0.436	4.896	–0.353	0.772	3.881	–0.211	1.108	3.929	–0.017
0.104	3.803	–0.005	0.440	4.886	–0.343	0.776	3.711	–0.066	1.112	3.981	–0.154
0.108	3.758	0.055	0.444	4.714	–0.276	0.780	3.590	–0.015	1.116	4.042	–0.275
0.112	3.679	0.090	0.448	4.562	–0.188	0.784	3.603	–0.159	1.120	4.166	–0.373
0.116	3.431	0.155	0.452	4.577	–0.276	0.788	3.816	–0.345	1.124	4.235	–0.372
0.120	3.251	0.121	0.456	4.607	–0.369	0.792	4.155	–0.498	1.128	4.211	–0.326
0.124	3.303	0.001	0.460	4.537	–0.266	0.796	4.414	–0.553	1.132	4.194	–0.308
0.128	3.776	–0.139	0.464	4.458	–0.200	0.800	4.386	–0.514	1.136	4.176	–0.348
0.132	4.433	–0.267	0.468	4.335	–0.205	0.804	4.306	–0.358	1.140	4.091	–0.367
0.136	4.774	–0.340	0.472	4.222	–0.234	0.808	4.167	–0.271	1.144	3.976	–0.328
0.140	4.795	–0.371	0.476	4.197	–0.178	0.812	4.075	–0.249	1.148	3.888	–0.150
0.144	4.738	–0.313	0.480	4.110	0.035	0.816	4.073	–0.265	1.152	3.837	–0.065
0.148	4.650	–0.286	0.484	3.842	0.275	0.820	4.049	–0.258	1.156	3.758	–0.112
0.152	4.578	–0.348	0.488	3.709	0.431	0.824	3.902	–0.195	1.160	3.746	–0.087
0.156	4.628	–0.344	0.492	3.628	0.571	0.828	3.846	–0.196	1.164	3.742	0.010
0.160	4.620	–0.348	0.496	3.665	0.448	0.832	3.783	–0.259	1.168	3.656	0.070
0.164	4.432	–0.300	0.500	3.790	0.327	0.836	3.777	–0.326	1.172	3.587	0.103
0.168	4.271	–0.260	0.504	3.896	0.259	0.840	3.731	–0.337	1.176	3.661	0.110
0.172	4.246	–0.303	0.508	3.954	0.225	0.844	3.627	–0.300	1.180	3.823	0.102
0.176	4.293	–0.360	0.512	4.022	0.273	0.848	3.591	–0.260	1.184	3.882	0.121
0.180	4.345	–0.360	0.516	4.181	0.286	0.852	3.610	–0.256	1.188	3.875	0.029
0.184	4.275	–0.251	0.520	4.154	0.232	0.856	3.724	–0.389	1.192	3.939	–0.181
0.188	4.040	–0.093	0.524	4.060	0.087	0.860	3.722	–0.418	1.196	4.084	–0.273
0.192	3.840	–0.030	0.528	4.040	–0.063	0.864	3.712	–0.358	1.200	4.195	–0.290
0.196	3.708	–0.050	0.532	4.203	–0.204	0.868	4.197	–0.513	1.204	4.350	–0.308
0.200	3.701	–0.045	0.536	4.273	–0.221	0.872	4.561	–0.659	1.208	4.406	–0.348
0.204	3.778	0.019	0.540	4.278	–0.182	0.876	4.594	–0.666	1.212	4.326	–0.345
0.208	3.739	0.024	0.544	4.396	–0.197	0.880	4.527	–0.610	1.216	4.108	–0.274
0.212	3.666	–0.035	0.548	4.386	–0.137	0.884	4.419	–0.515	1.220	3.828	–0.073
0.216	3.790	–0.119	0.552	4.283	–0.043	0.888	4.377	–0.410	1.224	3.603	0.151
0.220	3.976	–0.221	0.556	4.260	–0.049	0.892	4.396	–0.486	1.228	3.457	0.161
0.224	4.078	–0.315	0.560	4.149	–0.112	0.896	4.304	–0.486	1.232	3.348	0.116
0.228	4.153	–0.366	0.564	4.061	–0.083	0.900	4.207	–0.454	1.236	3.355	0.119
0.232	4.089	–0.257	0.568	3.920	–0.070	0.904	4.140	–0.548	1.240	3.428	0.003
0.236	3.907	–0.088	0.572	3.748	–0.066	0.908	4.149	–0.700	1.244	3.706	–0.297
0.240	3.755	–0.033	0.576	3.503	0.058	0.912	4.234	–0.809	1.248	4.031	–0.459
0.244	3.957	–0.200	0.580	3.576	0.068	0.916	4.276	–0.791	1.252	4.098	–0.405
0.248	4.254	–0.338	0.584	3.859	–0.015	0.920	4.253	–0.760	1.256	4.142	–0.221
0.252	4.312	–0.321	0.588	4.059	–0.124	0.924	4.077	–0.601	1.260	4.112	–0.139
0.256	4.327	–0.353	0.592	4.036	–0.142	0.928	3.928	–0.521	1.264	3.916	–0.165
0.260	4.363	–0.431	0.596	3.902	–0.214	0.932	3.826	–0.497	1.268	3.751	–0.128
0.264	4.384	–0.412	0.600	3.827	–0.184	0.936	3.776	–0.397	1.272	3.705	–0.092
0.268	4.443	–0.421	0.604	3.979	–0.032	0.940	3.630	–0.169	1.276	3.688	–0.124
0.272	4.439	–0.466	0.608	3.966	0.044	0.944	3.528	0.015	1.280	3.747	–0.208
0.276	4.307	–0.397	0.612	3.691	0.037	0.948	3.476	–0.115	1.284	3.934	–0.301
0.280	4.085	–0.255	0.616	3.388	–0.058	0.952	3.448	–0.325	1.288	4.159	–0.406
0.284	3.953	–0.156	0.620	3.731	–0.228	0.956	3.804	–0.503	1.292	4.159	–0.419
0.288	3.956	–0.155	0.624	4.409	–0.338	0.960	4.064	–0.524	1.296	4.043	–0.349
0.292	4.079	–0.274	0.628	4.786	–0.319	0.964	4.220	–0.366	1.300	3.974	–0.179
0.296	4.088	–0.300	0.632	5.076	–0.262	0.968	4.131	–0.194	1.304	3.947	0.004
0.300	4.076	–0.272	0.636	4.989	–0.253	0.972	3.891	–0.164	1.308	3.948	0.031
0.304	4.095	–0.213	0.640	4.829	–0.221	0.976	3.848	–0.235	1.312	3.867	0.027
0.308	3.941	–0.235	0.644	4.779	–0.262	0.980	4.003	–0.287	1.316	3.779	–0.011
0.312	3.751	–0.248	0.648	4.787	–0.368	0.984	4.023	–0.186	1.320	3.838	–0.100
0.316	3.736	–0.140	0.652	4.725	–0.393	0.988	3.922	–0.057	1.324	4.022	–0.182
0.320	3.701	–0.025	0.656	4.595	–0.443	0.992	3.903	–0.072	1.328	4.096	–0.359
0.324	3.563	0.059	0.660	4.525	–0.560	0.996	3.943	–0.133	1.332	4.078	–0.466
0.328	3.390	0.096	0.664	4.520	–0.636	1.000	4.015	–0.184	1.336	4.087	–0.452
0.332	3.411	0.011	0.668	4.449	–0.613	1.004	4.132	–0.187	1.340	4.035	–0.344

APPENDIX C (continued).

Age (Ma)	$\delta^{18}O$	$\delta^{13}C$	Age (Ma)	$\delta^{18}O$	$\delta^{13}C$	Age (Ma)	$\delta^{18}O$	$\delta^{13}C$	Age (Ma)	$\delta^{18}O$	$\delta^{13}C$
1.344	3.857	–0.123	1.688	3.887	–0.386	2.032	3.942	–0.007	2.376	3.961	–0.281
1.348	3.589	0.098	1.692	3.885	–0.329	2.036	3.943	–0.122	2.380	3.859	–0.065
1.352	3.471	0.161	1.696	3.938	–0.462	2.040	3.892	–0.122	2.384	3.596	0.117
1.356	3.496	0.080	1.700	4.098	–0.570	2.044	3.849	–0.062	2.388	3.502	0.206
1.360	3.669	–0.044	1.704	4.073	–0.468	2.048	3.812	–0.129	2.392	3.454	0.241
1.364	3.991	–0.179	1.708	3.856	–0.293	2.052	3.807	–0.261	2.396	3.472	0.251
1.368	4.138	–0.268	1.712	3.728	–0.189	2.056	3.866	–0.372	2.400	3.548	0.221
1.372	4.115	–0.275	1.716	3.803	–0.213	2.060	3.973	–0.458	2.404	3.590	0.163
1.376	4.124	–0.297	1.720	3.826	–0.290	2.064	4.120	–0.560	2.408	3.532	0.142
1.380	3.915	–0.063	1.724	3.842	–0.323	2.068	4.231	–0.625	2.412	3.544	0.186
1.384	3.706	0.170	1.728	3.876	–0.312	2.072	4.266	–0.592	2.416	3.601	0.230
1.388	3.680	0.198	1.732	3.597	–0.248	2.076	4.243	–0.625	2.420	3.546	0.234
1.392	3.680	0.179	1.736	3.379	–0.192	2.080	4.176	–0.658	2.424	3.532	0.171
1.396	3.681	0.134	1.740	3.500	–0.219	2.084	4.116	–0.556	2.428	3.631	0.038
1.400	3.692	–0.043	1.744	3.728	–0.306	2.088	4.070	–0.456	2.432	3.721	–0.103
1.404	3.712	–0.179	1.748	3.830	–0.314	2.092	3.941	–0.302	2.436	3.894	–0.220
1.408	3.781	–0.200	1.752	3.747	–0.240	2.096	3.719	–0.207	2.440	3.940	–0.265
1.412	3.965	–0.282	1.756	3.601	–0.050	2.100	3.466	–0.219	2.444	3.980	–0.242
1.416	3.998	–0.269	1.760	3.497	0.102	2.104	3.412	–0.217	2.448	3.986	–0.213
1.420	3.926	–0.168	1.764	3.449	–0.029	2.108	3.539	–0.220	2.452	3.796	–0.123
1.424	3.902	–0.116	1.768	3.460	–0.101	2.112	3.689	–0.146	2.456	3.529	0.052
1.428	3.850	–0.024	1.772	3.547	–0.152	2.116	3.708	–0.072	2.460	3.415	0.155
1.432	3.703	0.088	1.776	3.734	–0.245	2.120	3.622	–0.087	2.464	3.387	0.137
1.436	3.554	0.114	1.780	3.886	–0.357	2.124	3.596	–0.069	2.468	3.414	–0.014
1.440	3.460	0.036	1.784	3.921	–0.447	2.128	3.563	–0.045	2.472	3.538	–0.203
1.444	3.395	–0.102	1.788	4.040	–0.505	2.132	3.462	–0.114	2.476	3.762	–0.343
1.448	3.430	–0.227	1.792	4.092	–0.505	2.136	3.436	–0.152	2.480	3.900	–0.413
1.452	3.502	–0.205	1.796	3.939	–0.344	2.140	3.501	–0.256	2.484	3.898	–0.392
1.456	3.557	–0.188	1.800	3.766	–0.194	2.144	3.659	–0.325	2.488	3.861	–0.362
1.460	3.959	–0.411	1.804	3.602	–0.111	2.148	3.939	–0.452	2.492	3.507	–0.136
1.464	4.162	–0.490	1.808	3.517	–0.091	2.152	3.977	–0.463	2.496	3.463	–0.119
1.468	4.110	–0.315	1.812	3.497	–0.113	2.156	3.907	–0.361	2.500	3.367	–0.103
1.472	3.710	–0.002	1.816	3.542	–0.184	2.160	3.858	–0.267	2.504	3.453	–0.214
1.476	3.454	0.174	1.820	3.496	–0.157	2.164	3.759	–0.168	2.508	3.708	–0.432
1.480	3.478	0.248	1.824	3.472	–0.234	2.168	3.604	–0.054	2.512	3.774	–0.519
1.484	3.462	0.300	1.828	3.645	–0.469	2.172	3.442	0.059	2.516	3.738	–0.515
1.488	3.439	0.345	1.832	3.924	–0.604	2.176	3.451	0.022	2.520	3.916	–0.599
1.492	3.890	–0.025	1.836	4.087	–0.598	2.180	3.451	–0.015	2.524	3.999	–0.585
1.496	4.114	–0.209	1.840	4.163	–0.679	2.184	3.403	–0.015	2.528	3.914	–0.506
1.500	4.216	–0.191	1.844	4.152	–0.656	2.188	3.475	–0.072	2.532	3.872	–0.332
1.504	4.370	–0.158	1.848	3.985	–0.232	2.192	3.630	–0.192	2.536	3.828	–0.270
1.508	4.319	–0.145	1.852	3.931	–0.160	2.196	3.683	–0.202	2.540	3.704	–0.251
1.512	4.202	–0.129	1.856	3.886	–0.261	2.200	3.625	–0.148	2.544	3.513	–0.044
1.516	3.993	–0.008	1.860	3.860	–0.213	2.204	3.570	–0.125	2.548	3.348	0.021
1.520	3.776	0.151	1.864	3.802	–0.139	2.208	3.561	–0.111	2.552	3.264	–0.014
1.524	3.726	0.190	1.868	3.596	–0.088	2.212	3.513	–0.139	2.556	3.241	–0.028
1.528	3.871	–0.163	1.872	3.590	–0.072	2.216	3.488	–0.158	2.560	3.242	0.021
1.532	3.997	–0.336	1.876	3.768	–0.030	2.220	3.592	–0.147	2.564	3.311	0.036
1.536	4.205	–0.453	1.880	3.831	0.046	2.224	3.616	–0.147	2.568	3.324	–0.002
1.540	4.345	–0.491	1.884	3.733	0.110	2.228	3.484	–0.164	2.572	3.284	–0.016
1.544	4.282	–0.418	1.888	3.617	0.079	2.232	3.429	–0.162	2.576	3.463	–0.018
1.548	4.100	–0.247	1.892	3.568	0.070	2.236	3.514	–0.220	2.580	3.575	–0.018
1.552	3.865	–0.085	1.896	3.544	0.123	2.240	3.640	–0.326	2.584	3.476	0.090
1.556	3.658	0.037	1.900	3.487	0.075	2.244	3.795	–0.335	2.588	3.407	0.184
1.560	3.536	0.074	1.904	3.535	–0.158	2.248	3.840	–0.345	2.592	3.441	0.041
1.564	3.628	0.022	1.908	3.718	–0.325	2.252	3.788	–0.451	2.596	3.531	–0.154
1.568	3.840	–0.107	1.912	4.011	–0.357	2.256	3.643	–0.304	2.600	3.673	–0.209
1.572	3.998	–0.193	1.916	4.166	–0.395	2.260	3.345	0.043	2.604	3.886	–0.288
1.576	4.069	–0.201	1.920	4.077	–0.480	2.264	3.309	0.043	2.608	3.854	–0.235
1.580	4.082	–0.236	1.924	3.947	–0.411	2.268	3.124	0.036	2.612	3.679	–0.027
1.584	4.003	–0.191	1.928	3.846	–0.162	2.272	3.078	0.027	2.616	3.591	0.118
1.588	3.847	–0.179	1.932	3.775	–0.033	2.276	3.451	–0.108	2.620	3.572	0.136
1.592	3.750	–0.233	1.936	3.777	0.055	2.280	3.685	–0.196	2.624	3.537	0.123
1.596	3.660	–0.012	1.940	3.772	0.106	2.284	3.814	–0.270	2.628	3.498	0.122
1.600	3.520	0.233	1.944	3.530	0.129	2.288	3.738	–0.218	2.632	3.439	0.075
1.604	3.397	0.294	1.948	3.544	0.051	2.292	3.583	–0.074	2.636	3.455	–0.046
1.608	3.367	0.188	1.952	3.814	–0.374	2.296	3.502	–0.068	2.640	3.580	–0.089
1.612	3.424	0.071	1.956	3.973	–0.479	2.300	3.545	–0.126	2.644	3.696	–0.061
1.616	3.610	0.011	1.960	3.970	–0.303	2.304	3.640	–0.158	2.648	3.711	–0.124
1.620	3.755	0.086	1.964	3.867	–0.167	2.308	3.698	–0.173	2.652	3.660	–0.192
1.624	3.832	0.150	1.968	3.687	–0.010	2.312	3.719	–0.133	2.656	3.597	–0.126
1.628	3.916	0.159	1.972	3.544	0.133	2.316	3.749	–0.068	2.660	3.388	–0.109
1.632	3.869	0.170	1.976	3.460	0.139	2.320	3.715	–0.085	2.664	3.256	–0.056
1.636	3.587	0.199	1.980	3.482	–0.022	2.324	3.592	–0.143	2.668	3.291	0.057
1.640	3.625	0.150	1.984	3.633	–0.254	2.328	3.592	–0.156	2.672	3.254	0.137
1.644	3.803	0.022	1.988	3.831	–0.324	2.332	3.642	–0.151	2.676	3.210	0.209
1.648	4.090	–0.136	1.992	3.925	–0.208	2.336	3.490	–0.285	2.680	3.241	0.245
1.652	4.300	–0.229	1.996	3.796	–0.229	2.340	3.389	–0.251	2.684	3.345	0.154
1.656	4.256	–0.256	2.000	3.717	–0.246	2.344	3.353	–0.038	2.688	3.432	0.034
1.660	4.156	–0.184	2.004	3.675	–0.091	2.348	3.344	–0.002	2.692	3.494	–0.108
1.664	4.020	–0.082	2.008	3.547	0.095	2.352	3.388	–0.025	2.696	3.581	–0.246
1.668	3.825	–0.039	2.012	3.440	0.182	2.356	3.513	–0.113	2.700	3.613	–0.385
1.672	3.696	0.047	2.016	3.396	0.216	2.360	3.637	–0.226	2.704	3.622	–0.345
1.676	3.674	0.079	2.020	3.399	0.269	2.364	3.725	–0.230	2.708	3.596	–0.177
1.680	3.710	–0.033	2.024	3.508	0.279	2.368	3.790	–0.246	2.712	3.624	–0.198
1.684	3.807	–0.281	2.028	3.770	0.167	2.372	3.924	–0.375	2.716	3.682	–0.349

APPENDIX C (continued).

Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C
2.720	3.722	–0.404	3.064	3.039	–0.182	3.408	3.046	–0.028	3.752	3.168	0.028
2.724	3.729	–0.353	3.068	3.094	–0.075	3.412	3.160	–0.125	3.756	3.276	–0.020
2.728	3.727	–0.304	3.072	3.163	–0.015	3.416	3.198	–0.134	3.760	3.308	–0.037
2.732	3.766	–0.339	3.076	3.164	–0.025	3.420	3.145	–0.083	3.764	3.341	–0.053
2.736	3.760	–0.396	3.080	3.109	0.004	3.424	3.095	–0.141	3.768	3.389	–0.160
2.740	3.679	–0.311	3.084	3.056	–0.037	3.428	3.062	–0.220	3.772	3.416	–0.285
2.744	3.395	–0.100	3.088	3.037	–0.054	3.432	3.100	–0.307	3.776	3.270	–0.170
2.748	3.189	–0.010	3.092	3.101	–0.014	3.436	3.169	–0.366	3.780	3.128	0.052
2.752	3.246	–0.007	3.096	3.191	0.036	3.440	3.093	–0.366	3.784	3.061	0.145
2.756	3.274	–0.005	3.100	3.241	0.065	3.444	2.961	–0.370	3.788	3.009	0.137
2.760	3.251	–0.018	3.104	3.194	–0.085	3.448	2.879	–0.328	3.792	3.030	0.071
2.764	3.194	–0.048	3.108	3.116	–0.275	3.452	2.861	–0.148	3.796	3.116	–0.019
2.768	3.110	–0.051	3.112	3.098	–0.333	3.456	2.844	0.032	3.800	3.084	0.051
2.772	3.150	–0.037	3.116	3.084	–0.383	3.460	2.855	0.104	3.804	3.045	0.184
2.776	3.144	–0.057	3.120	3.126	–0.408	3.464	2.930	0.051	3.808	3.049	0.163
2.780	3.127	0.044	3.124	3.219	–0.379	3.468	3.073	–0.091	3.812	3.105	0.022
2.784	3.167	0.143	3.128	3.272	–0.410	3.472	3.150	–0.147	3.816	3.163	–0.109
2.788	3.230	0.220	3.132	3.332	–0.406	3.476	3.145	–0.104	3.820	3.167	–0.156
2.792	3.283	0.301	3.136	3.390	–0.376	3.480	3.027	0.058	3.824	3.120	–0.197
2.796	3.328	0.319	3.140	3.448	–0.450	3.484	2.919	0.157	3.828	3.062	–0.292
2.800	3.417	0.188	3.144	3.488	–0.486	3.488	2.914	0.169	3.832	3.202	–0.402
2.804	3.393	–0.034	3.148	3.482	–0.470	3.492	2.961	0.117	3.836	3.280	–0.386
2.808	3.376	–0.221	3.152	3.332	–0.400	3.496	3.019	0.027	3.840	3.176	–0.169
2.812	3.693	–0.217	3.156	3.031	–0.244	3.500	3.043	–0.024	3.844	3.003	–0.043
2.816	3.788	–0.111	3.160	2.863	–0.167	3.504	3.061	–0.002	3.848	2.856	–0.029
2.820	3.777	–0.075	3.164	2.905	–0.128	3.508	3.095	0.047	3.852	2.883	0.037
2.824	3.780	–0.089	3.168	2.931	–0.034	3.512	3.122	0.066	3.856	2.932	0.069
2.828	3.546	0.043	3.172	2.977	0.036	3.516	3.092	–0.014	3.860	2.979	0.015
2.832	3.398	0.128	3.176	3.109	0.029	3.520	3.097	0.030	3.864	2.983	–0.010
2.836	3.254	0.193	3.180	3.198	0.066	3.524	3.108	0.102	3.868	2.925	–0.105
2.840	3.257	0.192	3.184	3.230	0.116	3.528	3.079	0.037	3.872	2.948	–0.150
2.844	3.339	0.181	3.188	3.203	0.200	3.532	3.092	0.018	3.876	3.131	–0.248
2.848	3.341	0.119	3.192	3.141	0.332	3.536	3.089	0.046	3.880	3.274	–0.308
2.852	3.427	0.070	3.196	3.111	0.338	3.540	3.045	0.002	3.884	3.358	–0.312
2.856	3.570	0.031	3.200	3.133	0.280	3.544	3.005	–0.091	3.888	3.205	–0.166
2.860	3.554	–0.107	3.204	3.147	0.301	3.548	3.021	–0.163	3.892	3.130	–0.051
2.864	3.465	–0.167	3.208	3.127	0.323	3.552	3.077	–0.238	3.896	3.097	–0.050
2.868	3.434	–0.021	3.212	3.125	0.356	3.556	3.133	–0.319	3.900	3.030	–0.010
2.872	3.391	0.038	3.216	3.142	0.356	3.560	3.158	–0.337	3.904	3.005	0.027
2.876	3.322	–0.013	3.220	3.182	0.313	3.564	3.177	–0.324	3.908	3.043	–0.007
2.880	3.262	–0.004	3.224	3.217	0.274	3.568	3.163	–0.260	3.912	3.068	0.023
2.884	3.307	–0.011	3.228	3.246	0.228	3.572	3.125	–0.095	3.916	3.037	–0.059
2.888	3.459	–0.037	3.232	3.266	0.193	3.576	3.054	0.062	3.920	3.065	–0.197
2.892	3.607	–0.057	3.236	3.225	0.161	3.580	2.951	0.105	3.924	3.361	–0.313
2.896	3.636	–0.042	3.240	3.165	0.173	3.584	2.897	0.110	3.928	3.393	–0.352
2.900	3.510	0.072	3.244	3.145	0.246	3.588	3.015	0.086	3.932	3.242	–0.331
2.904	3.446	0.017	3.248	3.088	0.231	3.592	3.230	0.016	3.936	3.099	–0.145
2.908	3.348	–0.123	3.252	3.003	0.090	3.596	3.314	0.068	3.940	3.011	–0.058
2.912	3.290	–0.142	3.256	2.962	–0.041	3.600	3.262	0.164	3.944	2.975	–0.109
2.916	3.384	–0.062	3.260	3.004	–0.114	3.604	3.222	0.137	3.948	2.962	–0.094
2.920	3.479	–0.066	3.264	3.105	–0.068	3.608	3.221	0.145	3.952	3.021	–0.093
2.924	3.502	–0.257	3.268	3.132	0.028	3.612	3.198	0.184	3.956	3.124	–0.082
2.928	3.539	–0.357	3.272	3.111	0.023	3.616	3.187	–0.005	3.960	3.146	0.038
2.932	3.595	–0.352	3.276	3.178	0.053	3.620	3.233	–0.204	3.964	3.141	0.071
2.936	3.611	–0.331	3.280	3.228	0.035	3.624	3.332	–0.181	3.968	3.158	0.070
2.940	3.454	–0.346	3.284	3.277	–0.026	3.628	3.436	–0.132	3.972	3.177	0.082
2.944	3.285	–0.307	3.288	3.336	–0.132	3.632	3.514	–0.108	3.976	3.146	0.040
2.948	3.179	–0.135	3.292	3.491	–0.282	3.636	3.599	–0.234	3.980	3.137	0.019
2.952	3.102	–0.058	3.296	3.653	–0.367	3.640	3.591	–0.396	3.984	3.154	–0.011
2.956	3.142	–0.044	3.300	3.664	–0.380	3.644	3.450	–0.318	3.988	3.189	–0.083
2.960	3.258	0.028	3.304	3.614	–0.404	3.648	3.317	–0.153	3.992	3.242	–0.165
2.964	3.339	0.070	3.308	3.474	–0.388	3.652	3.240	0.007	3.996	3.286	–0.222
2.968	3.423	–0.033	3.312	3.405	–0.369	3.656	3.159	0.103	4.000	3.311	–0.238
2.972	3.530	–0.167	3.316	3.419	–0.342	3.660	3.159	0.054	4.004	3.301	–0.196
2.976	3.591	–0.190	3.320	3.418	–0.256	3.664	3.253	–0.012	4.008	3.244	–0.183
2.980	3.626	–0.188	3.324	3.341	–0.116	3.668	3.414	–0.082	4.012	3.160	–0.196
2.984	3.611	–0.193	3.328	3.182	–0.011	3.672	3.600	–0.240	4.016	3.124	–0.089
2.988	3.530	–0.066	3.332	3.120	–0.058	3.676	3.595	–0.292	4.020	3.150	–0.036
2.992	3.377	0.074	3.336	3.196	–0.230	3.680	3.461	–0.182	4.024	3.180	–0.055
2.996	3.298	0.055	3.340	3.225	–0.282	3.684	3.344	–0.025	4.028	3.225	–0.056
3.000	3.340	–0.050	3.344	3.212	–0.185	3.688	3.196	0.101	4.032	3.278	–0.035
3.004	3.399	–0.125	3.348	3.292	–0.117	3.692	3.010	0.225	4.036	3.223	–0.065
3.008	3.427	–0.186	3.352	3.357	–0.094	3.696	3.033	0.287	4.040	3.227	–0.130
3.012	3.410	–0.209	3.356	3.314	–0.146	3.700	3.033	0.321	4.044	3.281	–0.181
3.016	3.395	–0.231	3.360	3.281	–0.206	3.704	3.032	0.210	4.048	3.254	–0.100
3.020	3.440	–0.281	3.364	3.326	–0.202	3.708	3.046	0.070	4.052	3.173	–0.047
3.024	3.469	–0.387	3.368	3.347	–0.108	3.712	3.087	–0.088	4.056	3.112	0.047
3.028	3.418	–0.398	3.372	3.311	–0.102	3.716	3.209	–0.229	4.060	3.109	0.198
3.032	3.263	–0.313	3.376	3.245	–0.189	3.720	3.327	–0.280	4.064	3.111	0.226
3.036	3.161	–0.269	3.380	3.281	–0.191	3.724	3.292	–0.102	4.068	3.130	0.093
3.040	3.115	–0.311	3.384	3.409	–0.178	3.728	3.071	0.051	4.072	3.144	0.058
3.044	3.162	–0.344	3.388	3.418	–0.243	3.732	2.758	0.151	4.076	3.186	0.006
3.048	3.288	–0.332	3.392	3.419	–0.262	3.736	2.811	0.108	4.080	3.224	–0.062
3.052	3.403	–0.315	3.396	3.349	–0.226	3.740	2.945	0.031	4.084	3.244	–0.113
3.056	3.365	–0.265	3.400	3.175	–0.110	3.744	3.003	0.058	4.088	3.242	–0.100
3.060	3.180	–0.177	3.404	3.035	0.000	3.748	3.060	0.076	4.092	3.185	–0.189

APPENDIX C (continued).

Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C	Age (Ma)	δ^{18}O	δ^{13}C
4.096	3.212	–0.270	4.392	3.139	–0.046	4.688	3.138	–0.030
4.100	3.201	–0.172	4.396	3.109	0.006	4.692	3.062	0.023
4.104	3.177	–0.154	4.400	3.085	–0.015	4.696	3.074	0.003
4.108	3.173	–0.194	4.404	3.106	0.006	4.700	3.094	–0.031
4.112	3.146	–0.188	4.408	3.152	0.055	4.704	3.156	–0.119
4.116	3.123	–0.231	4.412	3.078	0.014	4.708	3.193	–0.214
4.120	3.093	–0.195	4.416	2.955	–0.052	4.712	3.199	–0.193
4.124	3.147	–0.080	4.420	2.937	–0.030	4.716	3.217	–0.159
4.128	3.221	–0.015	4.424	-9999.000	-9999.000	4.720	3.192	–0.193
4.132	3.077	0.011	4.428	-9999.000	-9999.000	4.724	3.207	–0.178
4.136	2.875	0.029	4.432	-9999.000	-9999.000	4.728	-9999.000	-9999.000
4.140	2.898	–0.023	4.436	-9999.000	-9999.000	4.732	-9999.000	-9999.000
4.144	3.057	–0.054	4.440	-9999.000	-9999.000	4.736	-9999.000	-9999.000
4.148	3.307	–0.069	4.444	-9999.000	-9999.000	4.740	-9999.000	-9999.000
4.152	3.380	–0.094	4.448	-9999.000	-9999.000	4.744	3.211	0.170
4.156	3.199	–0.033	4.452	-9999.000	-9999.000	4.748	3.196	0.119
4.160	3.118	–0.008	4.456	-9999.000	-9999.000	4.752	3.178	–0.076
4.164	3.170	–0.037	4.460	-9999.000	-9999.000	4.756	3.268	–0.204
4.168	3.213	–0.045	4.464	-9999.000	-9999.000	4.760	3.306	–0.150
4.172	3.092	0.017	4.468	-9999.000	-9999.000	4.764	3.202	–0.080
4.176	3.019	0.036	4.472	-9999.000	-9999.000	4.768	3.117	–0.055
4.180	3.087	–0.014	4.476	-9999.000	-9999.000	4.772	3.081	–0.092
4.184	3.088	–0.005	4.480	-9999.000	-9999.000	4.776	3.082	–0.107
4.188	3.089	0.052	4.484	-9999.000	-9999.000	4.780	3.196	–0.096
4.192	3.090	0.101	4.488	-9999.000	-9999.000	4.784	3.326	–0.068
4.196	3.043	0.013	4.492	-9999.000	-9999.000	4.788	3.359	0.000
4.200	3.072	–0.083	4.496	-9999.000	-9999.000	4.792	3.265	0.075
4.204	3.089	–0.181	4.500	-9999.000	-9999.000	4.796	3.177	0.093
4.208	3.019	–0.258	4.504	-9999.000	-9999.000	4.800	3.107	0.012
4.212	3.042	–0.287	4.508	-9999.000	-9999.000	4.804	3.091	–0.005
4.216	3.099	–0.250	4.512	-9999.000	-9999.000	4.808	3.112	–0.029
4.220	3.080	–0.129	4.516	-9999.000	-9999.000	4.812	3.209	–0.151
4.224	3.047	–0.128	4.520	-9999.000	-9999.000	4.816	3.309	–0.248
4.228	3.027	–0.231	4.524	-9999.000	-9999.000	4.820	3.362	–0.285
4.232	3.008	–0.284	4.528	-9999.000	-9999.000	4.824	3.397	–0.228
4.236	3.087	–0.166	4.532	3.082	–0.063	4.828	3.448	–0.111
4.240	3.142	–0.080	4.536	3.079	–0.046	4.832	3.423	–0.102
4.244	3.117	–0.144	4.540	3.119	–0.042	4.836	3.341	–0.070
4.248	3.117	–0.232	4.544	3.191	–0.139	4.840	3.343	0.016
4.252	3.157	–0.272	4.548	3.233	–0.235	4.844	3.351	0.095
4.256	3.257	–0.287	4.552	3.258	–0.188	4.848	3.212	–0.024
4.260	3.320	–0.272	4.556	3.262	–0.086	4.852	3.143	–0.087
4.264	3.306	–0.239	4.560	3.236	–0.057	4.856	3.175	–0.180
4.268	3.145	–0.076	4.564	3.198	–0.068	4.860	3.207	–0.272
4.272	3.084	–0.023	4.568	3.154	–0.034	4.864	3.210	–0.280
4.276	3.103	–0.041	4.572	3.156	–0.054	4.868	3.210	–0.280
4.280	3.138	0.019	4.576	3.168	–0.094	4.872	3.256	–0.312
4.284	3.075	0.029	4.580	3.268	–0.039	4.876	3.384	–0.401
4.288	2.893	0.007	4.584	3.265	–0.021	4.880	3.511	–0.490
4.292	2.779	0.016	4.588	3.127	–0.112	4.884	3.528	–0.486
4.296	2.905	–0.056	4.592	3.121	–0.247	4.888	3.528	–0.453
4.300	2.951	–0.098	4.596	3.174	–0.361	4.892	3.354	–0.217
4.304	2.996	–0.156	4.600	3.269	–0.358	4.896	3.232	–0.080
4.308	3.092	–0.215	4.604	3.347	–0.355	4.900	3.196	–0.096
4.312	3.048	–0.152	4.608	3.326	–0.240	4.904	3.218	–0.072
4.316	2.885	–0.079	4.612	3.290	–0.121	4.908	3.237	–0.054
4.320	2.879	–0.125	4.616	3.219	–0.142	4.912	3.219	–0.120
4.324	2.978	–0.198	4.620	3.188	–0.209	4.916	3.215	–0.155
4.328	2.947	–0.163	4.624	3.223	–0.278	4.920	3.268	–0.208
4.332	2.945	–0.070	4.628	3.233	–0.291	4.924	3.324	–0.263
4.336	3.031	–0.014	4.632	3.211	–0.260	4.928	3.388	–0.320
4.340	2.978	–0.025	4.636	3.221	–0.226	4.932	3.411	–0.338
4.344	3.031	–0.137	4.640	3.277	–0.294	4.936	3.411	–0.323
4.348	3.102	–0.264	4.644	3.317	–0.318	4.940	3.336	–0.235
4.352	3.098	–0.242	4.648	3.342	–0.271	4.944	3.220	–0.125
4.356	3.071	–0.130	4.652	3.335	–0.250	4.948	3.184	–0.142
4.360	3.034	–0.155	4.656	3.252	–0.302	4.952	3.185	–0.173
4.364	3.007	–0.359	4.660	3.147	–0.292	4.956	3.199	–0.167
4.368	2.898	–0.344	4.664	3.100	–0.316	4.960	3.220	–0.167
4.372	2.789	–0.328	4.668	3.106	–0.396	4.964	3.229	–0.176
4.376	2.678	–0.273	4.672	3.093	–0.328			
4.380	2.762	–0.304	4.676	3.080	–0.261			
4.384	2.984	–0.338	4.680	3.110	–0.223			
4.388	3.115	–0.206	4.684	3.201	–0.090			

Note:–9999.00 = data gap.

APPENDIX D
Age Model for Site 677

Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)
0.0	0.0007	17.0	0.4174	28.9	0.7349	37.6	0.9431	46.1	1.1494	55.0	1.3501	63.5	1.5411
0.2	0.0032	17.2	0.4276	29.2	0.7431	37.7	0.9467	46.2	1.1510	55.1	1.3522	63.6	1.5438
0.4	0.0066	17.4	0.4371	29.3	0.7448	37.8	0.9493	46.3	1.1525	55.2	1.3549	63.7	1.5467
0.6	0.0101	17.6	0.4444	29.4	0.7470	37.9	0.9523	46.4	1.1539	55.3	1.3570	63.8	1.5480
0.8	0.0137	17.8	0.4502	29.5	0.7493	38.0	0.9555	46.5	1.1554	55.4	1.3588	63.9	1.5516
1.0	0.0176	18.0	0.4557	29.6	0.7512	38.1	0.9578	46.6	1.1570	55.5	1.3610	64.0	1.5532
1.2	0.0216	18.2	0.4608	29.7	0.7541	38.2	0.9600	46.7	1.1585	55.6	1.3632	64.1	1.5559
1.4	0.0255	18.4	0.4652	29.8	0.7560	38.3	0.9618	46.8	1.1600	55.7	1.3652	64.2	1.5581
1.6	0.0296	18.6	0.4695	29.9	0.7589	38.4	0.9635	46.9	1.1614	55.8	1.3670	64.3	1.5609
1.8	0.0336	18.8	0.4740	30.0	0.7609	38.5	0.9654	47.0	1.1627	55.9	1.3691	64.4	1.5631
2.0	0.0378	19.0	0.4785	30.1	0.7630	38.6	0.9671	47.1	1.1644	56.0	1.3708	64.5	1.5659
2.2	0.0415	19.2	0.4826	30.2	0.7651	38.7	0.9691	47.2	1.1656	56.1	1.3730	64.6	1.5681
2.4	0.0452	19.4	0.4854	30.3	0.7680	38.8	0.9714	47.3	1.1677	56.2	1.3752	64.7	1.5711
2.6	0.0486	19.6	0.4884	30.4	0.7700	38.9	0.9742	47.4	1.1703	56.3	1.3770	64.8	1.5749
2.8	0.0521	19.8	0.4906	30.5	0.7721	39.0	0.9762	47.5	1.1729	56.4	1.3790	64.9	1.5780
3.0	0.0556	20.0	0.4943	30.6	0.7750	39.1	0.9791	47.6	1.1750	56.5	1.3810	65.0	1.5810
3.2	0.0588	20.2	0.4976	30.7	0.7771	39.2	0.9819	47.7	1.1774	56.6	1.3830	65.1	1.5840
3.4	0.0619	20.4	0.5019	30.8	0.7787	39.3	0.9840	47.8	1.1798	56.7	1.3850	65.2	1.5873
3.6	0.0648	20.6	0.5071	30.9	0.7812	39.4	0.9878	47.9	1.1825	56.8	1.3870	65.3	1.5902
3.8	0.0679	20.8	0.5129	31.0	0.7841	39.5	0.9900	48.0	1.1852	56.9	1.3890	65.4	1.5941
4.0	0.0711	21.0	0.5193	31.1	0.7861	39.6	0.9930	48.1	1.1879	57.0	1.3910	65.5	1.5970
4.2	0.0746	21.2	0.5260	31.2	0.7880	39.7	0.9958	48.2	1.1901	57.1	1.3928	65.6	1.6001
4.4	0.0788	21.4	0.5344	31.3	0.7901	39.8	0.9985	48.3	1.1930	57.2	1.3950	65.7	1.6039
4.6	0.0837	21.6	0.5454	31.4	0.7920	39.9	1.0012	48.4	1.1958	57.3	1.3971	65.8	1.6070
4.8	0.0894	21.8	0.5556	31.5	0.7940	40.0	1.0047	48.5	1.1985	57.4	1.3990	65.9	1.6100
5.0	0.0959	22.0	0.5616	31.6	0.7960	40.1	1.0078	48.6	1.2011	57.5	1.4010	66.0	1.6129
5.2	0.1028	22.2	0.5661	31.7	0.7980	40.2	1.0107	48.7	1.2031	57.6	1.4030	66.1	1.6151
5.4	0.1093	22.4	0.5702	31.8	0.8000	40.3	1.0141	48.8	1.2059	57.7	1.4052	66.2	1.6181
5.6	0.1153	22.6	0.5744	31.9	0.8021	40.4	1.0167	48.9	1.2081	57.8	1.4070	66.3	1.6204
5.8	0.1210	22.8	0.5792	32.0	0.8035	40.5	1.0195	49.0	1.2109	57.9	1.4091	66.4	1.6233
6.0	0.1262	23.0	0.5841	32.1	0.8053	40.6	1.0241	49.1	1.2131	58.0	1.4110	66.5	1.6270
6.2	0.1305	23.2	0.5887	32.2	0.8072	40.7	1.0270	49.2	1.2160	58.1	1.4130	66.6	1.6291
6.4	0.1341	23.4	0.5940	32.3	0.8093	40.8	1.0299	49.3	1.2189	58.2	1.4148	66.7	1.6320
6.6	0.1374	23.6	0.5996	32.4	0.8113	40.9	1.0320	49.4	1.2210	58.3	1.4170	66.8	1.6348
6.8	0.1405	23.8	0.6060	32.5	0.8142	41.0	1.0341	49.5	1.2239	58.4	1.4191	66.9	1.6375
7.0	0.1436	23.9	0.6090	32.6	0.8170	41.1	1.0369	49.6	1.2260	58.5	1.4210	67.0	1.6402
7.2	0.1467	24.0	0.6120	32.7	0.8191	41.2	1.0382	49.7	1.2289	58.6	1.4230	67.1	1.6430
7.4	0.1501	24.1	0.6152	32.8	0.8220	41.3	1.0411	49.8	1.2311	58.7	1.4250	67.2	1.6459
7.6	0.1536	24.2	0.6173	32.9	0.8249	41.4	1.0431	49.9	1.2339	58.8	1.4271	67.3	1.6480
7.8	0.1578	24.3	0.6212	33.0	0.8268	41.5	1.0460	50.0	1.2360	58.9	1.4299	67.4	1.6491
8.0	0.1635	24.4	0.6240	33.1	0.8300	41.6	1.0473	50.1	1.2389	59.0	1.4319	67.5	1.6509
8.2	0.1714	24.5	0.6254	33.2	0.8331	41.7	1.0501	50.2	1.2410	59.1	1.4340	67.6	1.6530
8.4	0.1804	24.6	0.6293	33.3	0.8351	41.8	1.0522	50.3	1.2438	59.2	1.4363	67.7	1.6551
8.6	0.1888	24.7	0.6306	33.4	0.8379	41.9	1.0544	50.4	1.2451	59.3	1.4380	67.8	1.6571
8.8	0.1966	24.8	0.6341	33.5	0.8401	42.0	1.0563	50.5	1.2469	59.4	1.4401	67.9	1.6599
9.0	0.2040	24.9	0.6361	33.6	0.8430	42.1	1.0592	50.6	1.2479	59.5	1.4420	68.0	1.6620
9.2	0.2107	25.0	0.6389	33.7	0.8460	42.2	1.0619	51.1	1.2552	59.6	1.4441	68.1	1.6640
9.4	0.2161	25.1	0.6411	33.8	0.8484	42.3	1.0640	51.2	1.2580	59.7	1.4469	68.2	1.6661
9.6	0.2211	25.2	0.6439	33.9	0.8511	42.4	1.0660	51.3	1.2613	59.8	1.4490	68.3	1.6689
9.8	0.2256	25.3	0.6461	34.0	0.8541	42.5	1.0681	51.4	1.2642	59.9	1.4510	68.4	1.6710
10.0	0.2302	25.4	0.6489	34.1	0.8569	42.6	1.0709	51.5	1.2669	60.0	1.4530	68.5	1.6730
10.2	0.2344	25.5	0.6511	34.2	0.8591	42.7	1.0730	51.6	1.2712	60.1	1.4549	68.6	1.6751
10.4	0.2387	25.6	0.6542	34.3	0.8620	42.8	1.0750	51.7	1.2735	60.2	1.4561	68.7	1.6779
10.6	0.2430	25.7	0.6562	34.4	0.8650	42.9	1.0771	51.8	1.2773	60.3	1.4579	68.8	1.6800
10.8	0.2478	25.8	0.6592	34.5	0.8679	43.0	1.0800	51.9	1.2817	60.4	1.4591	68.9	1.6820
11.0	0.2526	25.9	0.6614	34.6	0.8701	43.1	1.0813	52.0	1.2842	60.5	1.4609	69.0	1.6841
11.2	0.2575	26.0	0.6641	34.7	0.8729	43.2	1.0841	52.1	1.2871	60.6	1.4621	69.1	1.6869
11.4	0.2627	26.1	0.6663	34.8	0.8751	43.3	1.0862	52.2	1.2890	60.7	1.4640	69.2	1.6890
11.6	0.2675	26.2	0.6692	34.9	0.8780	43.4	1.0884	52.3	1.2910	60.8	1.4661	69.3	1.6910
11.8	0.2718	26.3	0.6721	35.0	0.8809	43.5	1.0903	52.4	1.2930	60.9	1.4689	69.4	1.6931
12.0	0.2755	26.4	0.6742	35.1	0.8839	43.6	1.0932	52.5	1.2959	61.0	1.4711	69.5	1.6959
12.2	0.2800	26.5	0.6770	35.2	0.8858	43.7	1.0960	52.6	1.2979	61.1	1.4739	69.6	1.6979
12.4	0.2852	26.6	0.6791	35.3	0.8882	43.8	1.0989	52.7	1.3000	61.2	1.4760	69.7	1.6991
12.6	0.2918	26.7	0.6818	35.4	0.8901	43.9	1.1011	52.8	1.3020	61.3	1.4781	69.8	1.7009
12.8	0.2987	26.8	0.6838	35.5	0.8931	44.0	1.1040	52.9	1.3040	61.4	1.4809	69.9	1.7021
13.0	0.3050	26.9	0.6852	35.6	0.8959	44.1	1.1070	53.0	1.3060	61.5	1.4832	70.0	1.7038
13.2	0.3106	27.0	0.6871	35.7	0.8980	44.2	1.1100	53.1	1.3081	61.6	1.4881	70.1	1.7051
13.4	0.3163	27.1	0.6891	35.8	0.9000	44.3	1.1130	53.2	1.3109	61.7	1.4937	70.2	1.7061
13.6	0.3221	27.2	0.6910	35.9	0.9021	44.4	1.1159	53.3	1.3130	61.8	1.4969	70.3	1.7082
13.8	0.3279	27.3	0.6931	36.0	0.9049	44.5	1.1184	53.4	1.3149	61.9	1.4991	70.4	1.7110
14.0	0.3335	27.4	0.6961	36.1	0.9070	44.6	1.1202	53.5	1.3170	62.0	1.5020	70.5	1.7140
14.2	0.3388	27.5	0.6999	36.2	0.9090	44.7	1.1232	53.6	1.3192	62.1	1.5049	70.6	1.7170
14.4	0.3438	27.6	0.7030	36.3	0.9109	44.8	1.1261	53.7	1.3219	62.2	1.5073	70.7	1.7199
14.6	0.3482	27.7	0.7061	36.4	0.9130	44.9	1.1284	53.8	1.3240	62.3	1.5101	70.8	1.7229
14.8	0.3523	27.8	0.7099	36.5	0.9152	45.0	1.1303	53.9	1.3258	62.4	1.5131	70.9	1.7259
15.0	0.3564	27.9	0.7129	36.6	0.9171	45.1	1.1329	54.0	1.3280	62.5	1.5159	71.0	1.7290
15.2	0.3606	28.0	0.7151	36.7	0.9199	45.2	1.1350	54.1	1.3302	62.6	1.5181	71.1	1.7319
15.4	0.3646	28.1	0.7179	36.8	0.9220	45.3	1.1370	54.2	1.3329	62.7	1.5210	71.2	1.7341
15.6	0.3687	28.2	0.7200	36.9	0.9232	45.4	1.1385	54.3	1.3350	62.8	1.5239	71.3	1.7370
15.8	0.3732	28.3	0.7220	37.0	0.9261	45.5	1.1401	54.4	1.3370	62.9	1.5261	71.4	1.7398
16.0	0.3782	28.4	0.7241	37.1	0.9290	45.6	1.1419	54.5	1.3390	63.0	1.5289	71.5	1.7424
16.2	0.3840	28.5	0.7269	37.2	0.9320	45.7	1.1433	54.6	1.3411	63.1	1.5311	71.6	1.7454
16.4	0.3904	28.6	0.7290	37.3	0.9352	45.8	1.1453	54.7	1.3439	63.2	1.5339	71.7	1.7481
16.6	0.3984	28.7	0.7311	37.4	0.9378	45.9	1.1464	54.8	1.3460	63.3	1.5361	71.8	1.7510
16.8	0.4080	28.8	0.7335	37.5	0.9405	46.0	1.1477	54.9	1.3483	63.4	1.5389	71.9	1.7519

APPENDIX D (continued).

Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)
72.0	1.7545	80.6	1.9731	89.5	2.0669	98.1	2.2561	106.7	2.4581	116.8	2.6239	126.2	2.7389
72.1	1.7550	80.7	1.9750	89.6	2.0681	98.2	2.2589	106.8	2.4591	116.9	2.6250	126.3	2.7397
72.2	1.7571	80.8	1.9761	89.7	2.0700	98.3	2.2611	106.9	2.4609	117.0	2.6261	126.4	2.7411
72.3	1.7577	80.9	1.9780	89.8	2.0720	98.4	2.2639	107.0	2.4620	117.1	2.6278	126.5	2.7420
72.4	1.7597	81.0	1.9800	89.9	2.0741	98.5	2.2661	107.1	2.4639	117.2	2.6295	126.6	2.7431
72.5	1.7604	81.1	1.9819	90.0	2.0760	98.6	2.2689	107.2	2.4649	117.3	2.6302	126.7	2.7449
72.6	1.7630	81.2	1.9831	90.1	2.0781	98.7	2.2708	107.3	2.4661	117.4	2.6320	126.8	2.7460
72.7	1.7664	81.3	1.9850	90.2	2.0800	98.8	2.2744	107.4	2.4671	117.5	2.6329	126.9	2.7470
72.8	1.7674	81.4	1.9870	90.3	2.0821	98.9	2.2758	107.5	2.4690	117.6	2.6347	127.0	2.7480
72.9	1.7701	81.5	1.9889	90.4	2.0840	99.0	2.2781	107.6	2.4701	117.7	2.6358	127.1	2.7490
73.0	1.7720	81.6	1.9901	90.5	2.0861	99.1	2.2809	107.7	2.4719	117.8	2.6379	127.2	2.7500
73.1	1.7742	81.7	1.9911	90.6	2.0880	99.2	2.2831	107.8	2.4729	117.9	2.6390	127.3	2.7511
73.2	1.7761	81.8	1.9931	90.7	2.0900	99.3	2.2859	107.9	2.4744	118.0	2.6400	127.4	2.7529
73.3	1.7791	81.9	1.9950	90.8	2.0911	99.4	2.2881	108.0	2.4761	118.1	2.6411	127.5	2.7540
73.4	1.7810	82.0	1.9969	90.9	2.0932	99.5	2.2909	108.1	2.4771	118.2	2.6429	127.6	2.7549
73.5	1.7831	82.1	1.9981	91.0	2.0949	99.6	2.2931	108.2	2.4789	118.3	2.6440	127.7	2.7561
73.6	1.7859	82.2	1.9998	91.1	2.0974	99.7	2.2959	108.3	2.4801	118.4	2.6450	127.8	2.7571
73.7	1.7880	82.6	2.0061	91.2	2.0991	99.8	2.2982	108.4	2.4819	118.5	2.6461	127.9	2.7591
73.8	1.7900	82.7	2.0080	91.3	2.1010	99.9	2.3001	108.5	2.4829	118.6	2.6478	128.0	2.7610
73.9	1.7921	82.8	2.0091	91.4	2.1031	100.0	2.3031	109.2	2.5171	119.3	2.6561	128.1	2.7629
74.0	1.7949	82.9	2.0110	91.5	2.1050	100.1	2.3059	109.3	2.5180	119.4	2.6574	128.2	2.7640
74.1	1.7970	83.0	2.0121	91.6	2.1071	100.2	2.3081	109.4	2.5199	119.5	2.6589	128.3	2.7659
74.2	1.7991	83.1	2.0140	91.7	2.1090	100.3	2.3109	109.5	2.5210	119.6	2.6599	128.4	2.7670
74.3	1.8021	83.2	2.0151	91.8	2.1108	100.4	2.3130	109.6	2.5221	119.7	2.6611	128.5	2.7690
74.4	1.8059	83.3	2.0171	91.9	2.1129	100.5	2.3151	109.7	2.5239	119.8	2.6621	128.6	2.7709
74.5	1.8090	83.4	2.0189	92.0	2.1151	100.6	2.3179	109.8	2.5250	119.9	2.6639	128.7	2.7721
74.6	1.8122	83.5	2.0202	92.1	2.1169	100.7	2.3198	109.9	2.5268	120.0	2.6650	128.8	2.7738
74.7	1.8152	83.6	2.0219	92.2	2.1183	100.8	2.3224	110.0	2.5280	120.1	2.6660	129.6	2.7871
74.8	1.8191	83.7	2.0231	92.3	2.1200	100.9	2.3250	110.1	2.5291	120.2	2.6671	129.7	2.7889
74.9	1.8219	83.8	2.0249	92.4	2.1221	101.0	2.3272	110.2	2.5310	120.3	2.6681	129.8	2.7901
75.0	1.8241	83.9	2.0259	92.5	2.1240	101.1	2.3311	110.3	2.5321	120.4	2.6700	129.9	2.7919
75.1	1.8269	84.0	2.0261	92.6	2.1258	101.2	2.3329	110.4	2.5339	120.5	2.6710	130.0	2.7931
75.2	1.8290	84.1	2.0269	92.7	2.1279	101.3	2.3348	110.5	2.5351	120.6	2.6720	130.1	2.7950
75.3	1.8311	84.2	2.0275	92.8	2.1301	101.4	2.3374	110.6	2.5369	120.7	2.6731	130.2	2.7969
75.4	1.8339	84.3	2.0281	92.9	2.1321	101.5	2.3402	110.7	2.5379	120.8	2.6749	130.3	2.7981
75.5	1.8360	84.4	2.0289	93.0	2.1341	101.6	2.3429	110.8	2.5394	120.9	2.6760	130.4	2.8000
75.6	1.8381	84.5	2.0291	93.1	2.1370	101.7	2.3451	110.9	2.5411	121.0	2.6770	130.5	2.8011
75.7	1.8409	84.6	2.0299	93.2	2.1391	101.8	2.3479	111.0	2.5421	121.1	2.6781	130.6	2.8030
75.8	1.8431	84.7	2.0301	93.3	2.1420	101.9	2.3501	111.1	2.5439	121.2	2.6798	130.7	2.8041
75.9	1.8459	84.8	2.0309	93.4	2.1441	102.0	2.3529	111.2	2.5451	121.3	2.6809	130.8	2.8059
76.0	1.8480	84.9	2.0310	93.5	2.1462	102.1	2.3551	111.3	2.5461	121.4	2.6821	130.9	2.8071
76.1	1.8502	85.0	2.0318	93.6	2.1490	102.2	2.3580	111.4	2.5480	121.5	2.6838	131.0	2.8089
76.2	1.8521	85.1	2.0322	93.7	2.1512	102.3	2.3609	111.5	2.5491	121.6	2.6847	131.1	2.8101
76.3	1.8552	85.2	2.0331	93.8	2.1530	102.4	2.3631	111.6	2.5501	121.7	2.6857	131.2	2.8119
76.4	1.8590	85.3	2.0339	93.9	2.1552	102.5	2.3659	111.7	2.5520	121.8	2.6870	131.3	2.8131
76.5	1.8634	85.4	2.0341	94.0	2.1579	102.6	2.3689	111.8	2.5531	122.1	2.6911	131.4	2.8149
76.6	1.8667	85.5	2.0349	94.1	2.1598	102.7	2.3710	111.9	2.5549	122.2	2.6920	131.5	2.8161
76.7	1.8719	85.6	2.0359	94.2	2.1624	102.8	2.3741	112.0	2.5561	122.3	2.6930	131.6	2.8179
76.8	1.8760	85.7	2.0361	94.3	2.1651	102.9	2.3761	112.1	2.5579	122.4	2.6941	131.7	2.8191
76.9	1.8800	85.8	2.0370	94.4	2.1671	103.0	2.3791	112.2	2.5589	122.5	2.6959	131.8	2.8209
77.0	1.8839	85.9	2.0371	94.5	2.1691	103.1	2.3820	112.9	2.5691	122.6	2.6970	131.9	2.8221
77.1	1.8888	86.0	2.0379	94.6	2.1720	103.2	2.3849	113.0	2.5701	122.7	2.6980	132.0	2.8231
77.2	1.8920	86.1	2.0381	94.7	2.1740	103.3	2.3871	113.1	2.5711	122.8	2.6991	132.1	2.8251
77.3	1.8969	86.2	2.0390	94.8	2.1762	103.4	2.3900	113.2	2.5730	122.9	2.7009	132.2	2.8268
77.4	1.9010	86.3	2.0399	94.9	2.1789	103.5	2.3929	113.3	2.5741	123.0	2.7019	132.5	2.8311
77.5	1.9049	86.4	2.0401	95.0	2.1811	103.6	2.3951	113.4	2.5759	123.1	2.7026	132.6	2.8319
77.6	1.9079	86.5	2.0409	95.1	2.1839	103.7	2.3980	113.5	2.5771	123.2	2.7041	132.7	2.8334
77.7	1.9101	86.6	2.0411	95.2	2.1862	103.8	2.4009	113.6	2.5789	123.3	2.7051	132.8	2.8351
77.8	1.9129	86.7	2.0420	95.3	2.1881	103.9	2.4031	113.7	2.5800	123.4	2.7070	132.9	2.8368
77.9	1.9148	86.8	2.0429	95.4	2.1911	104.0	2.4059	113.8	2.5811	123.5	2.7080	133.0	2.8384
78.0	1.9174	86.9	2.0431	95.5	2.1931	104.1	2.4089	113.9	2.5829	123.6	2.7090	133.1	2.8400
78.1	1.9202	87.0	2.0439	95.6	2.1959	104.2	2.4110	114.0	2.5841	123.7	2.7099	133.2	2.8414
78.2	1.9230	87.1	2.0441	95.7	2.1980	104.3	2.4138	114.1	2.5858	123.8	2.7114	133.3	2.8431
78.3	1.9251	87.2	2.0450	95.8	2.2001	104.4	2.4159	114.2	2.5875	123.9	2.7130	133.4	2.8439
78.4	1.9280	87.3	2.0459	95.9	2.2030	104.5	2.4181	114.3	2.5882	124.0	2.7139	133.5	2.8454
78.5	1.9301	87.4	2.0461	96.0	2.2051	104.6	2.4191	114.4	2.5900	124.1	2.7151	133.6	2.8470
78.6	1.9331	87.5	2.0469	96.1	2.2080	104.7	2.4210	114.5	2.5911	124.2	2.7160	133.7	2.8484
78.7	1.9351	87.6	2.0471	96.2	2.2101	104.8	2.4230	114.6	2.5922	124.3	2.7170	133.8	2.8501
78.8	1.9381	87.7	2.0480	96.3	2.2130	104.9	2.4250	114.7	2.5939	124.4	2.7180	133.9	2.8519
78.9	1.9402	87.8	2.0489	96.4	2.2150	105.0	2.4270	115.1	2.6001	124.5	2.7199	134.0	2.8531
79.0	1.9432	87.9	2.0491	96.5	2.2171	105.1	2.4290	115.2	2.6010	124.6	2.7210	134.1	2.8549
79.1	1.9453	88.0	2.0499	96.6	2.2199	105.2	2.4309	115.3	2.6021	124.7	2.7220	134.2	2.8559
79.2	1.9482	88.1	2.0501	96.7	2.2223	105.3	2.4321	115.4	2.6039	124.8	2.7230	134.3	2.8577
79.3	1.9501	88.2	2.0509	96.8	2.2242	105.4	2.4340	115.5	2.6051	124.9	2.7240	134.4	2.8580
79.4	1.9519	88.3	2.0511	96.9	2.2271	105.5	2.4359	115.6	2.6069	125.0	2.7250	134.5	2.8617
79.5	1.9535	88.4	2.0520	97.0	2.2291	105.6	2.4380	115.7	2.6081	125.1	2.7263	134.6	2.8620
79.6	1.9552	88.5	2.0529	97.1	2.2319	105.7	2.4398	115.8	2.6091	125.2	2.7271	134.7	2.8634
79.7	1.9571	88.6	2.0531	97.2	2.2341	105.8	2.4420	115.9	2.6110	125.3	2.7290	134.8	2.8650
79.8	1.9584	88.7	2.0539	97.3	2.2368	105.9	2.4431	116.0	2.6121	125.4	2.7297	134.9	2.8677
79.9	1.9602	88.8	2.0540	97.4	2.2393	106.0	2.4451	116.1	2.6131	125.5	2.7311	135.0	2.8693
80.0	1.9622	88.9	2.0554	97.5	2.2412	106.1	2.4470	116.2	2.6151	125.6	2.7320	135.1	2.8721
80.1	1.9641	89.0	2.0571	97.6	2.2440	106.2	2.4490	116.3	2.6169	125.7	2.7330	135.2	2.8749
80.2	1.9652	89.1	2.0590	97.7	2.2462	106.3	2.4510	116.4	2.6180	125.8	2.7340	135.3	2.8768
80.3	1.9672	89.2	2.0610	97.8	2.2489	106.4	2.4529	116.5	2.6191	125.9	2.7350	135.6	2.8851
80.4	1.9691	89.3	2.0622	97.9	2.2511	106.5	2.4539	116.6	2.6209	126.0	2.7369	135.7	2.8868
80.5	1.9712	89.4	2.0650	98.0	2.2539	106.6	2.4559	116.7	2.6221	126.1	2.7379	135.8	2.8894

APPENDIX D (continued).

Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)
135.9	2.8920	145.1	3.0485	154.0	3.1750
136.0	2.8944	145.2	3.0501	154.1	3.1765
136.1	2.8971	145.3	3.0509	154.2	3.1780
136.2	2.8999	145.7	3.0572	154.3	3.1795
136.3	2.9020	145.8	3.0589	154.4	3.1805
136.4	2.9051	145.9	3.0600	154.5	3.1820
136.5	2.9071	146.0	3.0611	154.6	3.1836
136.6	2.9101	146.1	3.0629	154.7	3.1852
136.7	2.9121	146.2	3.0641	154.8	3.1863
136.8	2.9149	146.3	3.0659	155.6	3.1981
136.9	2.9171	146.4	3.0670	155.7	3.1990
137.0	2.9199	146.5	3.0678	155.8	3.2007
137.1	2.9221	146.6	3.0704	155.9	3.2018
137.2	2.9249	146.7	3.0712	156.0	3.2035
137.3	2.9270	146.8	3.0730	156.1	3.2049
137.4	2.9290	146.9	3.0741	156.2	3.2060
137.5	2.9310	147.0	3.0759	156.3	3.2079
137.6	2.9328	147.1	3.0770	156.4	3.2091
137.7	2.9349	147.2	3.0779	156.5	3.2108
137.8	2.9372	147.5	3.0831	156.6	3.2112
137.9	2.9399	147.6	3.0840	156.7	3.2131
138.0	2.9412	147.7	3.0851	156.8	3.2149
138.1	2.9440	147.8	3.0869	156.9	3.2161
138.2	2.9460	147.9	3.0889	157.0	3.2179
138.3	2.9480	148.0	3.0899	157.1	3.2190
138.4	2.9499	148.1	3.0911	157.2	3.2201
138.5	2.9510	148.2	3.0919	157.3	3.2219
138.6	2.9520	148.3	3.0942	157.4	3.2231
138.7	2.9530	148.4	3.0951	157.5	3.2249
138.8	2.9541	148.5	3.0969	157.6	3.2261
138.9	2.9559	148.6	3.0981	157.7	3.2279
139.0	2.9569	148.7	3.0999	157.8	3.2290
140.0	2.9681	148.8	3.1011	157.9	3.2301
140.1	2.9689	148.9	3.1029	158.0	3.2319
140.2	2.9700	149.0	3.1040	158.1	3.2335
140.3	2.9711	149.1	3.1051	158.2	3.2351
140.4	2.9738	149.2	3.1069	158.3	3.2360
140.5	2.9758	149.3	3.1083	158.4	3.2371
140.6	2.9782	149.4	3.1089	158.5	3.2389
140.7	2.9800	150.0	3.1181	158.6	3.2401
140.8	2.9819	150.1	3.1199	158.7	3.2419
141.1	2.9891	150.2	3.1211	158.8	3.2431
141.2	2.9909	150.3	3.1219	158.9	3.2449
141.5	2.9971	150.4	3.1244	159.0	3.2460
141.6	2.9989	150.5	3.1252	159.1	3.2469
141.7	3.0001	150.6	3.1269	159.8	3.2572
141.8	3.0019	150.7	3.1282	159.9	3.2588
141.9	3.0035	150.8	3.1294	160.0	3.2605
142.0	3.0051	150.9	3.1311	160.1	3.2621
142.1	3.0061	151.0	3.1322	160.2	3.2630
142.2	3.0071	151.1	3.1335	160.3	3.2641
142.3	3.0089	151.2	3.1350	160.4	3.2659
142.6	3.0131	151.3	3.1369	160.5	3.2671
142.7	3.0141	151.4	3.1373	160.6	3.2689
142.8	3.0159	151.5	3.1400	160.7	3.2705
142.9	3.0169	151.6	3.1410	160.8	3.2721
143.0	3.0185	151.7	3.1421	160.9	3.2730
143.1	3.0202	151.8	3.1433	161.0	3.2743
143.2	3.0219	151.9	3.1451	161.1	3.2759
143.3	3.0229	152.0	3.1460	161.2	3.2770
143.4	3.0245	152.1	3.1487	161.3	3.2785
143.5	3.0261	152.2	3.1495	161.4	3.2800
143.6	3.0271	152.3	3.1510	161.5	3.2812
143.7	3.0281	152.4	3.1525	161.6	3.2831
143.8	3.0301	152.5	3.1535	161.7	3.2841
143.9	3.0319	152.6	3.1550	161.8	3.2859
144.0	3.0330	152.7	3.1565	161.9	3.2871
144.1	3.0339	152.8	3.1580	162.0	3.2889
144.2	3.0355	152.9	3.1595	162.1	3.2900
144.3	3.0372	153.0	3.1600	162.2	3.2911
144.4	3.0389	153.1	3.1630	162.3	3.2929
144.5	3.0400	153.2	3.1633	162.4	3.2946
144.6	3.0412	153.3	3.1650	162.5	3.2962
144.7	3.0429	153.4	3.1667	162.6	3.2972
144.8	3.0440	153.7	3.1710		
144.9	3.0459	153.8	3.1720		
145.0	3.0468	153.9	3.1735		

Appendix E

Age Model for Site 607

Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)
0.190	0.0029	9.727	0.2615	20.630	0.5301	32.534	0.8019	43.220	1.0549	53.046	1.3092	64.155	1.5659
0.380	0.0058	10.000	0.2649	20.690	0.5334	32.680	0.8052	43.375	1.0574	53.101	1.3124	64.300	1.5687
0.570	0.0088	10.273	0.2683	20.747	0.5367	32.880	0.8083	43.540	1.0598	53.173	1.3156	64.487	1.5714
0.780	0.0118	10.427	0.2716	20.803	0.5399	33.070	0.8113	43.668	1.0621	53.280	1.3188	64.626	1.5740
1.000	0.0148	10.665	0.2749	20.861	0.5431	33.240	0.8143	43.790	1.0644	53.443	1.3220	64.704	1.5767
1.230	0.0180	10.880	0.2782	20.926	0.5463	33.353	0.8171	43.957	1.0667	53.740	1.3252	64.805	1.5793
1.410	0.0212	11.080	0.2815	20.990	0.5493	33.433	0.8199	44.070	1.0690	53.965	1.3284	64.923	1.5819
1.590	0.0245	11.255	0.2847	21.065	0.5523	33.498	0.8226	44.145	1.0713	54.340	1.3315	65.053	1.5845
1.770	0.0278	11.405	0.2878	21.140	0.5552	33.563	0.8253	44.220	1.0736	54.540	1.3345	65.180	1.5871
1.963	0.0314	11.530	0.2910	21.215	0.5580	33.628	0.8279	44.333	1.0759	54.670	1.3375	65.270	1.5898
2.143	0.0350	11.680	0.2940	21.290	0.5607	33.688	0.8305	44.437	1.0783	54.753	1.3405	65.368	1.5925
2.285	0.0387	11.853	0.2970	21.380	0.5633	33.744	0.8332	44.537	1.0807	54.833	1.3434	65.480	1.5951
2.447	0.0425	12.040	0.3000	21.490	0.5659	33.801	0.8358	44.637	1.0832	54.927	1.3462	65.592	1.5979
2.657	0.0465	12.137	0.3029	21.640	0.5684	33.863	0.8384	44.730	1.0858	55.003	1.3489	65.762	1.6006
2.830	0.0504	12.222	0.3058	21.890	0.5707	33.927	0.8410	44.820	1.0885	55.067	1.3517	65.950	1.6035
2.965	0.0544	12.337	0.3086	22.210	0.5731	33.991	0.8437	44.928	1.0912	55.143	1.3543	66.080	1.6064
3.150	0.0584	12.417	0.3113	22.630	0.5754	34.056	0.8464	45.012	1.0942	55.240	1.3570	66.210	1.6093
3.370	0.0624	12.474	0.3140	22.930	0.5776	34.120	0.8491	45.093	1.0972	55.390	1.3596	66.337	1.6123
3.560	0.0662	12.530	0.3167	23.230	0.5798	34.195	0.8519	45.188	1.1004	55.690	1.3622	66.445	1.6154
3.730	0.0700	12.620	0.3193	23.667	0.6039	34.270	0.8547	45.290	1.1038	55.915	1.3648	66.553	1.6185
3.860	0.0737	12.705	0.3219	23.713	0.6063	34.353	0.8576	45.400	1.1074	56.154	1.3674	66.680	1.6216
4.010	0.0772	12.780	0.3244	23.763	0.6088	34.435	0.8605	45.528	1.1111	56.257	1.3700	66.830	1.6248
4.120	0.0806	12.867	0.3270	23.813	0.6114	34.530	0.8634	45.645	1.1150	56.360	1.3726	66.980	1.6280
4.270	0.0838	12.980	0.3295	23.940	0.6141	34.655	0.8665	45.757	1.1190	56.497	1.3752	67.092	1.6312
4.380	0.0870	13.093	0.3320	24.090	0.6168	34.766	0.8695	45.870	1.1232	56.610	1.3779	67.250	1.6344
4.483	0.0900	13.230	0.3345	24.243	0.6197	34.844	0.8727	45.983	1.1274	56.740	1.3806	67.430	1.6376
4.630	0.0928	13.368	0.3370	24.430	0.6228	34.945	0.8759	46.090	1.1316	56.853	1.3834	67.600	1.6408
4.702	0.0956	13.500	0.3395	24.655	0.6259	35.057	0.8791	46.202	1.1358	56.990	1.3862	67.730	1.6440
4.780	0.0983	13.750	0.3420	24.880	0.6292	35.170	0.8824	46.325	1.1399	57.083	1.3892	67.880	1.6471
4.870	0.1009	13.930	0.3446	25.003	0.6326	35.260	0.8857	46.448	1.1438	57.147	1.3922	68.030	1.6502
5.000	0.1034	14.080	0.3472	25.125	0.6361	35.350	0.8891	46.563	1.1477	57.211	1.3953	68.217	1.6532
5.090	0.1058	14.255	0.3498	25.248	0.6397	35.440	0.8924	46.690	1.1514	57.276	1.3985	68.330	1.6563
5.180	0.1082	14.430	0.3525	25.403	0.6433	35.537	0.8958	46.833	1.1549	57.340	1.4018	68.443	1.6592
5.294	0.1106	14.590	0.3552	25.590	0.6469	35.637	0.8991	46.955	1.1583	57.385	1.4052	68.630	1.6622
5.392	0.1129	14.780	0.3580	25.743	0.6505	35.737	0.9024	47.058	1.1615	57.430	1.4086	68.724	1.6651
5.458	0.1152	14.930	0.3608	25.904	0.6540	35.870	0.9057	47.162	1.1646	57.475	1.4122	68.819	1.6680
5.524	0.1175	15.080	0.3638	26.061	0.6575	36.020	0.9089	47.265	1.1676	57.558	1.4158	68.916	1.6708
5.590	0.1198	15.182	0.3669	26.217	0.6608	36.198	0.9121	47.388	1.1704	57.660	1.4195	69.014	1.6737
5.680	0.1221	15.315	0.3700	26.374	0.6640	36.390	0.9152	47.520	1.1732	57.747	1.4231	69.155	1.6765
5.747	0.1243	15.480	0.3733	26.530	0.6670	36.520	0.9183	47.632	1.1758	57.833	1.4268	69.305	1.6793
5.850	0.1267	15.590	0.3768	26.680	0.6699	36.707	0.9213	47.735	1.1785	57.920	1.4304	69.430	1.6821
5.930	0.1290	15.680	0.3803	26.793	0.6727	36.820	0.9242	47.855	1.1810	58.044	1.4339	69.555	1.6849
6.010	0.1314	15.830	0.3841	26.977	0.6753	37.020	0.9271	48.040	1.1835	58.118	1.4374	69.630	1.6878
6.095	0.1338	15.980	0.3879	27.130	0.6778	37.190	0.9299	48.205	1.1860	58.191	1.4408	69.717	1.6907
6.179	0.1362	16.092	0.3920	27.300	0.6801	37.383	0.9326	48.355	1.1885	58.278	1.4440	69.830	1.6935
6.264	0.1388	16.200	0.3961	27.397	0.6824	37.565	0.9353	48.460	1.1910	58.390	1.4472	69.942	1.6965
6.348	0.1413	16.324	0.4004	27.580	0.6846	37.740	0.9379	48.613	1.1935	58.615	1.4502	70.110	1.6994
6.433	0.1439	16.456	0.4048	27.730	0.6867	37.908	0.9405	48.770	1.1959	58.776	1.4532	70.222	1.7024
6.505	0.1466	16.580	0.4093	27.917	0.6887	38.095	0.9430	48.945	1.1985	58.904	1.4561	70.318	1.7054
6.550	0.1494	16.880	0.4139	28.030	0.6906	38.270	0.9455	49.090	1.2010	59.037	1.4588	70.430	1.7085
6.670	0.1522	17.180	0.4184	28.230	0.6926	38.490	0.9480	49.170	1.2036	59.200	1.4615	70.558	1.7116
6.730	0.1551	17.330	0.4229	28.361	0.6945	38.568	0.9505	49.282	1.2062	59.400	1.4642	70.655	1.7147
6.786	0.1580	17.630	0.4274	28.456	0.6963	38.646	0.9529	49.390	1.2089	59.610	1.4668	70.744	1.7179
6.840	0.1610	17.810	0.4318	28.550	0.6981	38.724	0.9554	49.480	1.2116	59.820	1.4694	70.846	1.7210
6.915	0.1640	17.900	0.4361	28.658	0.6999	38.790	0.9579	49.580	1.2144	59.976	1.4719	70.955	1.7242
7.007	0.1671	17.990	0.4402	28.743	0.7018	38.870	0.9604	49.688	1.2173	60.104	1.4744	71.080	1.7274
7.085	0.1702	18.080	0.4441	28.843	0.7036	38.990	0.9629	49.790	1.2201	60.215	1.4769	71.218	1.7306
7.160	0.1734	18.250	0.4479	28.967	0.7055	39.155	0.9655	49.887	1.2231	60.290	1.4794	71.332	1.7338
7.260	0.1765	18.380	0.4515	29.080	0.7074	39.305	0.9681	49.995	1.2261	60.365	1.4820	71.455	1.7370
7.420	0.1797	18.530	0.4550	29.170	0.7093	39.445	0.9708	50.100	1.2291	60.440	1.4845	71.620	1.7402
7.570	0.1829	18.755	0.4583	29.267	0.7113	39.585	0.9736	50.190	1.2322	60.528	1.4871	71.850	1.7434
7.770	0.1860	18.930	0.4615	29.380	0.7134	39.718	0.9764	50.320	1.2353	60.640	1.4898	72.070	1.7465
7.908	0.1891	19.080	0.4645	29.530	0.7156	39.820	0.9793	50.430	1.2384	60.706	1.4925	72.247	1.7496
8.077	0.1923	19.210	0.4674	29.643	0.7179	39.933	0.9824	50.520	1.2415	60.772	1.4952	72.393	1.7527
8.290	0.1954	19.390	0.4702	29.780	0.7203	40.070	0.9855	50.649	1.2447	60.838	1.4981	72.540	1.7557
8.365	0.1984	19.523	0.4730	29.918	0.7228	40.220	0.9888	50.777	1.2478	60.940	1.5010	72.700	1.7587
8.440	0.2015	19.620	0.4756	30.050	0.7255	40.362	0.9921	50.890	1.2509	61.013	1.5041	72.790	1.7617
8.515	0.2046	19.683	0.4783	30.243	0.7284	40.490	0.9956	51.040	1.2540	61.086	1.5072	72.880	1.7646
8.587	0.2076	19.747	0.4809	30.387	0.7315	40.612	0.9991	51.165	1.2571	61.197	1.5104	72.970	1.7676
8.642	0.2106	19.811	0.4835	30.530	0.7349	40.740	1.0028	51.290	1.2601	61.390	1.5137	73.088	1.7705
8.690	0.2137	19.876	0.4860	30.680	0.7384	40.885	1.0065	51.410	1.2631	61.615	1.5170	73.220	1.7734
8.735	0.2167	19.940	0.4886	30.780	0.7423	41.020	1.0102	51.530	1.2661	61.840	1.5205	73.413	1.7763
8.800	0.2197	19.996	0.4912	30.855	0.7464	41.170	1.0139	51.657	1.2692	61.990	1.5239	73.563	1.7792
8.850	0.2228	20.052	0.4939	30.955	0.7507	41.357	1.0176	51.785	1.2722	62.156	1.5275	73.703	1.7820
8.887	0.2259	20.105	0.4965	31.080	0.7552	41.470	1.0213	51.920	1.2751	62.284	1.5310	73.870	1.7849
8.933	0.2289	20.150	0.4993	31.207	0.7599	41.670	1.0249	52.066	1.2781	62.417	1.5345	74.050	1.7878
8.970	0.2321	20.195	0.5021	31.303	0.7646	41.783	1.0284	52.204	1.2812	62.559	1.5379	74.162	1.7907
9.000	0.2352	20.240	0.5049	31.431	0.7693	41.960	1.0318	52.343	1.2842	62.700	1.5413	74.275	1.7936
9.050	0.2384	20.295	0.5078	31.560	0.7740	42.185	1.0351	52.490	1.2872	62.892	1.5447	74.388	1.7966
9.088	0.2416	20.350	0.5108	31.640	0.7785	42.370	1.0383	52.613	1.2903	63.017	1.5479	74.500	1.7995
9.133	0.2449	20.405	0.5139	31.720	0.7829	42.560	1.0413	52.690	1.2933	63.155	1.5511	74.594	1.8025
9.218	0.2482	20.460	0.5170	31.900	0.7871	42.673	1.0443	52.765	1.2965	63.423	1.5542	74.689	1.8055
9.320	0.2515	20.508	0.5202	32.090	0.7911	42.785	1.0471	52.840	1.2996	63.610	1.5573	74.800	1.8085
9.480	0.2548	20.552	0.5235	32.267	0.7948	42.912	1.0498	52.915	1.3028	63.737	1.5602	74.928	1.8115
9.585	0.2582	20.587	0.5268	32.406	0.7985	43.067	1.0524	52.990	1.3060	63.980	1.5631	75.035	1.8145

APPENDIX E (continued).

Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)	Depth (mcd)	Age (Ma)
75.137	1.8176	86.185	2.0476	96.188	2.2816	107.390	2.5098	117.292	2.7523	125.500	2.9953
75.250	1.8206	86.262	2.0509	96.320	2.2845	107.528	2.5153	117.410	2.7546	125.675	2.9981
75.340	1.8237	86.338	2.0543	96.495	2.2875	107.667	2.5208	117.523	2.7569	125.900	3.0009
75.430	1.8267	86.415	2.0578	96.713	2.2905	107.790	2.5236	117.633	2.7593	126.100	3.0038
75.520	1.8297	86.490	2.0614	96.928	2.2935	107.905	2.5265	117.743	2.7617	126.265	3.0067
75.625	1.8328	86.565	2.0651	97.075	2.2965	108.030	2.5294	117.855	2.7643	126.490	3.0096
75.730	1.8358	86.740	2.0688	97.225	2.2996	108.210	2.5324	117.960	2.7668	126.740	3.0125
75.820	1.8388	86.932	2.0726	97.525	2.3027	108.347	2.5354	118.050	2.7694	127.025	3.0154
75.925	1.8418	87.060	2.0765	97.820	2.3058	108.515	2.5386	118.150	2.7721	127.250	3.0184
76.055	1.8448	87.228	2.0804	98.100	2.3090	108.683	2.5419	118.255	2.7748	127.485	3.0214
76.220	1.8477	87.340	2.0843	98.300	2.3122	108.815	2.5453	118.360	2.7776	127.700	3.0244
76.385	1.8506	87.472	2.0881	98.405	2.3155	108.927	2.5488	118.441	2.7803	127.997	3.0275
76.502	1.8536	87.620	2.0919	98.486	2.3188	109.040	2.5524	118.523	2.7831	128.207	3.0305
76.600	1.8565	87.763	2.0956	98.568	2.3221	109.153	2.5561	118.615	2.7859	128.430	3.0336
76.784	1.8594	87.920	2.0992	98.650	2.3255	109.264	2.5598	118.705	2.7886	128.600	3.0368
76.886	1.8623	88.048	2.1027	98.740	2.3289	109.376	2.5636	118.780	2.7914	128.900	3.0400
77.007	1.8652	88.260	2.1060	98.830	2.3322	109.487	2.5674	118.855	2.7941	129.100	3.0432
77.118	1.8681	88.432	2.1093	98.920	2.3356	109.599	2.5711	118.930	2.7968	129.250	3.0465
77.220	1.8710	88.560	2.1124	99.007	2.3391	109.710	2.5748	119.005	2.7994	129.460	3.0498
77.285	1.8740	88.728	2.1153	99.092	2.3425	109.847	2.5783	119.080	2.8019	129.650	3.0531
77.350	1.8769	88.842	2.1182	99.178	2.3459	110.003	2.5818	119.155	2.8045	129.822	3.0565
77.500	1.8798	88.970	2.1209	99.263	2.3492	110.165	2.5851	119.230	2.8069	129.961	3.0599
77.594	1.8827	89.140	2.1235	99.340	2.3526	110.360	2.5882	119.305	2.8094	130.100	3.0633
77.689	1.8857	89.268	2.1261	99.400	2.3559	110.540	2.5912	119.380	2.8117	130.230	3.0668
77.800	1.8887	89.375	2.1285	99.502	2.3591	110.690	2.5941	119.455	2.8141	130.332	3.0702
77.900	1.8917	89.478	2.1309	99.602	2.3623	110.840	2.5968	119.530	2.8164	130.433	3.0737
78.000	1.8947	89.590	2.1333	99.700	2.3654	110.990	2.5994	119.607	2.8187	130.533	3.0772
78.100	1.8978	89.702	2.1355	99.790	2.3685	111.155	2.6019	119.690	2.8210	130.633	3.0806
78.287	1.9008	89.815	2.1378	99.888	2.3715	111.290	2.6043	119.773	2.8233	130.732	3.0841
78.400	1.9039	89.940	2.1400	100.000	2.3744	111.375	2.6067	119.840	2.8255	130.830	3.0875
78.550	1.9071	90.190	2.1422	100.112	2.3773	111.460	2.6089	119.908	2.8278	130.950	3.0908
78.800	1.9102	90.375	2.1444	100.225	2.3801	111.640	2.6112	119.993	2.8301	131.070	3.0941
78.925	1.9134	90.560	2.1465	100.338	2.3828	111.777	2.6133	120.076	2.8324	131.185	3.0974
79.073	1.9166	90.695	2.1487	100.450	2.3855	111.890	2.6155	120.154	2.8348	131.290	3.1006
79.260	1.9198	90.808	2.1509	100.514	2.3881	112.040	2.6177	120.235	2.8372	131.395	3.1038
79.470	1.9231	90.920	2.1531	100.579	2.3907	112.119	2.6198	120.316	2.8397	131.506	3.1069
79.680	1.9263	91.020	2.1554	100.688	2.3932	112.198	2.6220	120.398	2.8423	131.620	3.1099
79.900	1.9295	91.120	2.1577	100.820	2.3956	112.285	2.6243	120.480	2.8449	131.750	3.1129
80.050	1.9328	91.220	2.1600	100.928	2.3981	112.390	2.6266	120.570	2.8477	131.823	3.1158
80.350	1.9360	91.305	2.1624	101.013	2.4005	112.486	2.6289	120.659	2.8507	131.896	3.1187
80.600	1.9393	91.390	2.1649	101.113	2.4028	112.578	2.6314	120.831	2.8570	131.980	3.1216
80.800	1.9425	91.517	2.1674	101.250	2.4052	112.662	2.6340	121.003	2.8642	132.070	3.1244
80.970	1.9457	91.625	2.1700	101.425	2.4076	112.754	2.6367	121.087	2.8681	132.148	3.1271
81.108	1.9489	91.717	2.1727	101.650	2.4099	112.850	2.6396	121.167	2.8722	132.232	3.1299
81.193	1.9522	91.800	2.1755	101.849	2.4123	112.955	2.6428	121.247	2.8765	132.705	3.1436
81.287	1.9553	91.870	2.1784	102.048	2.4146	113.054	2.6461	121.327	2.8809	132.800	3.1463
81.400	1.9585	91.940	2.1814	102.247	2.4170	113.150	2.6498	121.404	2.8855	132.913	3.1491
81.550	1.9616	92.100	2.1845	102.480	2.4195	113.330	2.6538	121.477	2.8901	133.010	3.1519
81.800	1.9647	92.293	2.1877	102.690	2.4219	113.485	2.6581	121.550	2.8947	133.100	3.1548
81.950	1.9678	92.447	2.1911	102.930	2.4244	113.590	2.6627	121.615	2.8991	133.265	3.1577
82.100	1.9708	92.620	2.1944	103.123	2.4270	113.710	2.6676	121.680	2.9035	133.391	3.1607
82.250	1.9738	92.770	2.1979	103.285	2.4296	113.858	2.6727	121.770	2.9077	133.499	3.1637
82.400	1.9768	92.877	2.2015	103.490	2.4323	114.019	2.6779	121.851	2.9118	133.613	3.1668
82.600	1.9797	93.000	2.2051	103.710	2.4351	114.180	2.6830	121.916	2.9156	133.750	3.1700
82.743	1.9826	93.144	2.2087	103.875	2.4379	114.330	2.6881	121.980	2.9192	133.900	3.1732
82.901	1.9855	93.276	2.2123	104.003	2.4409	114.459	2.6928	122.049	2.9227	134.050	3.1765
83.060	1.9883	93.400	2.2159	104.165	2.4439	114.587	2.6972	122.117	2.9260	134.200	3.1799
83.197	1.9912	93.528	2.2195	104.390	2.4470	114.780	2.7014	122.207	2.9292	134.350	3.1834
83.375	1.9939	93.700	2.2231	104.540	2.4502	114.960	2.7052	122.307	2.9323	134.500	3.1869
83.515	1.9967	93.829	2.2266	104.765	2.4534	115.135	2.7088	122.407	2.9352	134.655	3.1906
83.632	1.9995	93.957	2.2300	104.933	2.4567	115.300	2.7120	122.510	2.9380	134.820	3.1943
83.760	2.0022	94.060	2.2334	105.071	2.4601	115.450	2.7151	123.059	2.9538	134.918	3.1980
83.857	2.0049	94.150	2.2367	105.210	2.4634	115.593	2.7180	123.163	2.9563	135.032	3.2018
84.040	2.0076	94.240	2.2400	105.419	2.4669	115.710	2.7207	123.300	2.9588	135.180	3.2056
84.190	2.0103	94.330	2.2432	105.611	2.4702	115.800	2.7233	123.438	2.9613	135.308	3.2095
84.302	2.0130	94.420	2.2463	105.790	2.4736	115.905	2.7258	123.570	2.9638	135.437	3.2133
84.433	2.0157	94.550	2.2494	105.940	2.4770	116.017	2.7281	123.692	2.9663	135.593	3.2171
84.573	2.0184	94.710	2.2524	106.115	2.4803	116.130	2.7304	123.820	2.9688	135.725	3.2210
84.740	2.0212	94.900	2.2554	106.290	2.4835	116.243	2.7327	123.876	2.9714	135.860	3.2249
84.920	2.0239	95.028	2.2584	106.440	2.4867	116.355	2.7348	123.931	2.9739	136.040	3.2287
85.090	2.0267	95.157	2.2613	106.600	2.4898	116.467	2.7370	124.150	2.9765	136.173	3.2326
85.277	2.0295	95.313	2.2642	106.790	2.4928	116.580	2.7392	124.400	2.9791	136.283	3.2364
85.447	2.0324	95.481	2.2671	106.958	2.4957	116.709	2.7413	124.600	2.9818	136.393	3.2403
85.592	2.0353	95.650	2.2700	107.094	2.4986	116.837	2.7435	124.753	2.9844	136.523	3.2441
85.690	2.0382	95.762	2.2729	107.167	2.5015	116.948	2.7456	124.911	2.9871	136.657	3.2480
85.895	2.0413	95.950	2.2758	107.240	2.5043	117.050	2.7478	125.070	2.9898		
86.060	2.0444	96.062	2.2787	107.315	2.5071	117.180	2.7500	125.320	2.9925		

APPENDIX F

Age Model for Site 704

Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)	Depth (mbsf)	Age (Ma)
0.07	0.0030	22.02	0.7090	64.61	1.3700	90.35	1.6780	112.01	1.8350	144.06	2.1780	163.53	2.9860
0.23	0.0090	22.02	0.7090	64.90	1.3750	90.64	1.6800	112.29	1.8380	144.39	2.1820	163.71	2.9910
0.41	0.0140	22.12	0.7090	65.24	1.3800	91.14	1.6830	112.62	1.8400	144.68	2.1850	163.82	2.9960
0.65	0.0180	22.12	0.7090	65.31	1.3810	91.25	1.6830	112.65	1.8410	144.95	2.1880	163.98	3.0020
1.25	0.0380	22.36	0.7100	65.50	1.3840	91.54	1.6850	113.00	1.8520	145.26	2.1910	164.01	3.0040
1.32	0.0410	22.98	0.7140	65.80	1.3890	91.85	1.6870	113.56	1.8670	145.55	2.1940	164.28	3.0150
1.75	0.0610	23.52	0.7170	66.11	1.3930	92.17	1.6880	114.12	1.8790	145.87	2.1970	164.45	3.0210
1.88	0.0650	23.52	0.7170	66.40	1.3960	92.46	1.6900	114.16	1.8800	146.18	2.2000	164.61	3.0270
2.06	0.0670	23.74	0.7180	66.81	1.4010	92.65	1.6900	114.31	1.8830	146.75	2.2080	164.84	3.0350
2.13	0.0690	24.48	0.7220	67.00	1.4030	92.75	1.6910	114.75	1.8900	147.05	2.2120	164.91	3.0370
2.28	0.0710	24.48	0.7220	67.61	1.4100	93.05	1.6910	114.91	1.8920	147.69	2.2210	165.08	3.0430
2.36	0.1220	25.02	0.7250	67.90	1.4130	93.34	1.6920	115.15	1.8950	147.95	2.2260	165.28	3.0500
2.36	0.1220	25.02	0.7250	68.24	1.4160	93.64	1.6920	115.21	1.8960	148.19	2.2310	165.32	3.0510
2.60	0.1260	25.12	0.7250	68.31	1.4170	93.95	1.6930	115.51	1.9010	148.54	2.2390	165.51	3.0580
2.72	0.1280	25.36	0.7270	68.50	1.4190	94.14	1.6930	115.62	1.9020	148.57	2.2390	165.64	3.0630
2.87	0.1350	48.33	1.0550	68.71	1.4210	94.25	1.6930	115.65	1.9020	148.72	2.2430	165.84	3.0700
3.15	0.1470	48.35	1.0570	69.11	1.4240	94.50	1.6940	115.96	1.9050	148.87	2.2470	165.96	3.0740
3.36	0.1560	48.65	1.0600	69.74	1.4300	94.80	1.6940	116.11	1.9060	149.10	2.2530	166.11	3.0780
3.44	0.1600	48.86	1.0630	70.50	1.4370	95.45	1.6960	116.75	1.9090	149.32	2.2580	166.14	3.0790
3.63	0.1680	49.12	1.0660	70.69	1.4390	95.62	1.6970	117.05	1.9110	149.55	2.2620	166.30	3.0840
3.78	0.1740	49.21	1.0700	70.88	1.4420	95.75	1.6970	117.35	1.9120	149.85	2.2670	166.41	3.0870
3.84	0.1750	49.35	1.0790	71.14	1.4460	96.00	1.6980	117.51	1.9130	150.07	2.2700	166.53	3.0900
3.98	0.1780	49.50	1.0900	71.31	1.4490	96.35	1.6990	117.63	1.9130	150.97	2.2760	166.82	3.0980
4.10	0.1830	49.85	1.1150	71.44	1.4520	96.65	1.7000	117.98	1.9150	151.12	2.2770	166.86	3.0990
4.21	0.1840	50.21	1.1400	71.77	1.4580	97.05	1.7020	118.11	1.9160	151.27	2.2780	167.18	3.1090
4.32	0.1850	50.36	1.1490	72.00	1.4620	97.25	1.7030	118.25	1.9170	151.42	2.2790	167.37	3.1140
4.41	0.1850	50.50	1.1570	72.12	1.4640	97.46	1.7040	118.41	1.9170	151.57	2.2820	167.76	3.1260
4.41	0.1850	50.62	1.1640	72.36	1.4670	97.77	1.7050	118.56	1.9180	151.72	2.2860	167.91	3.1300
4.64	0.2010	50.71	1.1700	72.56	1.4700	98.01	1.7060	118.86	1.9200	152.22	2.3030	168.03	3.1330
4.87	0.2260	50.85	1.1760	72.81	1.4740	98.35	1.7060	119.13	1.9220	152.32	2.3060	168.21	3.1380
4.91	0.2300	51.00	1.1800	72.95	1.4760	98.69	1.7070	119.17	1.9220	152.47	2.3110	168.32	3.1410
4.99	0.2390	51.35	1.1850	73.68	1.4930	99.00	1.7080	119.49	1.9250	152.62	2.3150	168.43	3.1440
5.13	0.2540	51.65	1.1900	73.87	1.4990	99.25	1.7090	119.75	1.9270	152.92	2.3230	168.51	3.1460
5.28	0.2720	51.86	1.1930	74.14	1.5090	99.57	1.7090	120.05	1.9290	153.07	2.3280	168.61	3.1490
5.28	0.2720	52.50	1.2020	74.31	1.5150	99.84	1.7100	120.35	1.9320	153.22	2.3340	168.78	3.1530
5.36	0.2810	52.85	1.2070	74.45	1.5200	100.10	1.7110	120.64	1.9350	153.37	2.3420	169.00	3.1580
5.46	0.2930	53.15	1.2130	74.60	1.5210	100.46	1.7130	120.67	1.9350	153.67	2.3540	169.11	3.1600
5.61	0.3050	53.36	1.2170	74.77	1.5220	100.75	1.7140	120.98	1.9390	153.72	2.3560	169.25	3.1640
5.75	0.3100	53.62	1.2230	75.71	1.5300	101.06	1.7150	121.25	1.9430	153.82	2.3600	169.43	3.1690
5.75	0.3100	53.71	1.2240	75.81	1.5310	101.35	1.7170	121.55	1.9510	154.12	2.3670	169.53	3.1720
5.75	0.3100	54.00	1.2330	75.95	1.5330	101.66	1.7180	121.85	1.9580	154.27	2.3710	169.71	3.1780
5.81	0.3120	54.35	1.2420	76.27	1.5380	101.96	1.7190	122.01	1.9620	154.42	2.3760	169.86	3.1830
5.81	0.3120	54.65	1.2470	76.37	1.5400	102.25	1.7200	122.15	1.9650	154.57	2.3810	170.11	3.1920
6.03	0.3190	54.86	1.2510	76.86	1.5440	102.55	1.7210	122.17	1.9650	154.87	2.3890	170.26	3.1970
6.21	0.3250	55.12	1.2540	77.11	1.5460	102.86	1.7220	122.31	1.9680	155.02	2.3920	170.45	3.2040
6.33	0.3280	55.21	1.2550	77.43	1.5490	103.20	1.7230	122.61	1.9720	155.17	2.3940	170.75	3.2140
6.57	0.3340	55.50	1.2580	77.86	1.5530	103.44	1.7240	122.91	1.9760	155.32	2.3960	170.91	3.2200
6.57	0.3340	55.85	1.2620	78.11	1.5560	103.75	1.7250	123.21	1.9790	155.92	2.4060	170.95	3.2220
6.62	0.3350	56.15	1.2650	78.92	1.5690	104.05	1.7260	123.67	1.9840	156.37	2.4150	171.05	3.2260
6.62	0.3350	56.38	1.2670	79.30	1.5750	104.69	1.7280	123.81	1.9850	156.52	2.4190	171.20	3.2330
6.78	0.3380	56.62	1.2700	79.31	1.5750	104.96	1.7290	124.25	1.9890	156.87	2.4300	171.54	3.2510
6.78	0.3380	56.71	1.2710	79.46	1.5770	105.02	1.7300	124.55	1.9920	157.35	2.7600	171.71	3.2610
6.95	0.3400	57.35	1.2790	79.68	1.5800	105.14	1.7300	124.85	1.9950	157.37	2.7700	171.79	3.2660
7.24	0.3690	57.51	1.2820	79.86	1.5820	105.25	1.7320	125.17	1.9990	157.47	2.7800	171.97	3.2760
7.44	0.3850	57.71	1.2850	80.41	1.5870	105.55	1.7360	126.84	2.0220	158.07	2.8000	172.14	3.2860
7.58	0.3960	57.91	1.2880	80.65	1.5890	105.71	1.7380	127.16	2.0270	158.37	2.8080	172.20	3.2890
7.61	0.3980	58.11	1.2910	80.82	1.5910	106.01	1.7420	127.77	2.0370	158.67	2.8170	172.46	3.3020
7.78	0.4080	58.21	1.2920	80.98	1.5930	106.07	1.7430	128.05	2.0400	158.82	2.8210	172.54	3.3050
7.78	0.4080	58.31	1.2940	81.57	1.5990	106.31	1.7460	128.34	2.0430	158.97	2.8270	172.61	3.3070
7.82	0.4090	58.51	1.2960	81.75	1.6010	106.48	1.7490	129.55	2.0530	159.12	2.8320	172.75	3.3120
7.92	0.4120	58.79	1.2990	81.86	1.6020	106.75	1.7530	129.85	2.0550	159.42	2.8430	172.91	3.3180
8.02	0.4160	59.01	1.3020	82.17	1.6060	107.08	1.7580	130.44	2.0590	159.57	2.8480	172.95	3.3190
8.09	0.4180	59.21	1.3040	83.31	1.6180	107.25	1.7600	130.75	2.0610	160.16	2.8690	173.05	3.3220
8.18	0.4210	59.40	1.3060	83.72	1.6230	107.25	1.7600	131.75	2.0650	160.21	2.8710	173.35	3.3330
8.52	0.4260	59.60	1.3080	83.96	1.6250	107.49	1.7630	131.85	2.0650	160.32	2.8750	173.47	3.3370
9.41	0.4450	59.79	1.3100	84.14	1.6280	107.85	1.7670	132.20	2.0670	160.47	2.8800	173.65	3.3430
12.31	0.5030	60.01	1.3130	84.34	1.6300	108.12	1.7710	132.61	2.0690	160.62	2.8860	173.70	3.3450
12.49	0.5110	60.16	1.3150	84.54	1.6320	108.16	1.7710	132.80	2.0700	160.77	2.8910	173.81	3.3480
12.52	0.5130	60.30	1.3170	84.76	1.6350	108.46	1.7750	133.80	2.0780	160.92	2.8960	174.00	3.3550
15.11	0.6170	60.52	1.3200	84.88	1.6370	108.75	1.7790	133.95	2.0800	161.07	2.9020	174.25	3.3630
15.32	0.6310	60.71	1.3220	84.98	1.6380	109.05	1.7840	134.25	2.0880	161.22	2.9070	174.41	3.3690
16.98	0.6670	60.92	1.3250	85.16	1.6400	109.35	1.7890	134.35	2.0910	161.37	2.9120	174.45	3.3710
16.98	0.6670	61.11	1.3260	85.41	1.6420	109.51	1.7930	134.55	2.0990	161.52	2.9170	174.55	3.3740
17.52	0.6780	61.30	1.3280	85.67	1.6440	109.62	1.7950	134.87	2.1100	161.67	2.9230	174.85	3.3840
17.52	0.6780	61.61	1.3300	85.86	1.6460	109.96	1.8040	136.36	2.1280	161.80	2.9270	175.46	3.4050
17.62	0.6800	61.90	1.3330	86.00	1.6470	110.11	1.8080	136.70	2.1310	161.97	2.9330	175.73	3.4150
17.62	0.6800	62.31	1.3370	86.56	1.6520	110.25	1.8110	140.78	2.1520	162.08	2.9370	176.30	3.4340
17.86	0.6830	62.50	1.3390	86.85	1.6540	110.56	1.8140	141.05	2.1530	162.21	2.9420	176.64	3.4460
18.48	0.6890	62.80	1.3420	87.75	1.6610	111.07	1.8200	141.35	2.1540	162.32	2.9460	176.81	3.4520
19.07	0.6930	63.11	1.3460	88.25	1.6630	111.12	1.8210	142.25	2.1580	162.35	2.9470	176.97	3.4580
20.52	0.7010	63.40	1.3490	88.54	1.6650	111.31	1.8240	142.71	2.1600	162.51	2.9530	177.15	3.4640
20.52	0.7010	63.74	1.3550	88.84	1.6660	111.46	1.8270	142.87	2.1620	162.76	2.9620	177.41	3.4730
20.62	0.7010	63.81	1.3560	89.54	1.6700	111.61	1.8300	143.11	2.1640	162.89	2.9660	177.44	3.4740
20.73	0.7020	64.00	1.3590	89.75	1.6720	111.75	1.8320	143.31	2.1670	163.26	2.9780	177.55	3.4780
21.48	0.7060	64.30	1.3640	90.05	1.6750	111.91	1.8340	143.45	2.1680	163.45	2.9840		