Berger, W.H., Kroenke, L.W., Mayer, L.A., et al., 1993
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 130

17. OXYGEN AND CARBON ISOTOPE STRATIGRAPHY OF THE MIDDLE MIOCENE, HOLES 805B AND 806B[1]

Richard M. Corfield[2] and Julie E. Cartlidge[2]

ABSTRACT

Bulk carbon isotope records are an effective chemostratigraphic tool for the middle Miocene because of the large and systematic variation in first-order $\delta^{13}C$ signals. Bulk $\delta^{13}C$ measurements support the presence of a hiatus at 305 mbsf in Hole 805B (latest middle Miocene), provisionally located while on board ship using biostratigraphic and magnetostratigraphic events. Records at Holes 805B and 806B show the middle Miocene Monterey carbon isotope excursion although the record at Hole 806B is apparently more stratigraphically continuous. Detailed analysis of multispecies foraminiferal carbon isotope records during the middle Miocene ("Monterey excursion") segment at Hole 806B support the assertion that this carbon isotope excursion comprises mainly between-reservoir effects. The benthic $\delta^{18}O$ data increase after 15.3 Ma, which we suggest corresponds to the mid-Miocene cooling step/ice volume increase of other authors. Planktonic foraminiferal $\delta^{18}O$ evidence exists for steepening of the thermocline at 17.4 Ma. A second-order $\delta^{13}C$ excursion superimposed at 13.8 Ma on the first-order Monterey excursion is associated with a second-order negative $\delta^{18}O$ excursion.

INTRODUCTION

One of the most important achievements of Ocean Drilling Program (ODP) Leg 130 was the recovery of thick middle Miocene carbonate oozes and chalks drilled using the advanced hydraulic piston corer (APC), especially at Holes 805B and 806B (Fig. 1). Sedimentation rates at these sites were relatively high (12–13 m/m.y. at Hole 805B and between 20 and 30 m/m.y. at Hole 806B, as documented by the Shipboard Scientific Party), and this permits the generation of high-resolution $\delta^{18}O$ and $\delta^{13}C$ records from the western equatorial Pacific through the middle Miocene. From the perspective of $\delta^{18}O$ reconstruction of marine paleoclimates, this is an important region because the thermal stability of the surface waters (Matthews and Poore, 1980; Prentice and Matthews, 1988; Ravelo et al., 1990) may permit further constraints on the relative contribution of ice-volume and temperature change to the marine carbonate $\delta^{18}O$ signal (Miller et al., 1991).

Several previous studies have focused on this important interval at other sites. Shackleton and Kennett (1975) and Savin et al. (1975) were the first to identify the profound $\delta^{18}O$ increase in benthic foraminifers that has been associated with the onset of Antarctic glaciation (Shackleton and Kennett, 1975; Savin et al., 1975, 1981; Woodruff et al., 1981), although the significance of this change in terms of ice-volume vs. temperature contribution to the $\delta^{18}O$ signal remains obscure (Matthews and Poore, 1980; see discussion in Miller et al., 1991). Woodruff et al. (1981) analyzed the benthic $\delta^{18}O$ record in detail at Deep Sea Drilling Project (DSDP) Site 289 (close to Hole 806B; Fig. 1) and concluded that the onset of major Antarctic glaciation occurred between 14.8 and 14.0 Ma. Shackleton (1982) examined the planktonic record at Site 289 and concluded that the middle Miocene stable isotope record offered the potential to examine climatic variability on time scales similar to that at present possible in the Pleistocene.

In a more recent series of studies, several authors (Savin et al., 1985; Barrera et al., 1985; Vincent et al., 1985; Miller et al., 1989, 1991; Wright et al., 1992) have identified this mid-Miocene ^{18}O enrichment in deep waters at a number of sites in the Atlantic, Indian, and Pacific oceans. However, estimates of the precise timing of this cooling episode vary. Woodruff and Savin (1989) developed a model that identifies a profound change in the nature of deep-water circulation during this interval. They hypothesize that the early Miocene was a time when deep-water circulation was dominated by Tethyan outflow but that following the mid-Miocene ^{18}O enrichment the emphasis shifted to the production of cool, dense waters in the Antarctic region. Wright et al. (1992) used $\delta^{13}C$ variations in benthic foraminifers to monitor deep-water movements during the early and middle Miocene and concluded that two modes of deep-water formation were present during this interval. Between 24–20 Ma and 16–12.5 Ma, the deep oceans were ventilated by Southern Component Water (SCW), which is analogous to Antarctic Bottom Water (AABW); however, during other intervals, deep-water formation was from multiple sources with relatively warm Northern Component Water (NCW; analogous to North Atlantic Deep Water [NADW]) and Tethyan water masses (as suggested by Woodruff and Savin, 1989), supplementing SCW production between 20 and 16 Ma and NCW and SCW production dominating between 12.5 and 10 Ma. The combination of NCW and Tethyan water mass production between 20 and 16 Ma warmed the deep ocean by 3°–4°; after 16 Ma, deep-water temperatures cooled and have remained relatively cold ever since.

Stratigraphic reference sections for the middle Miocene interval based on stable isotopic changes in foraminifers have also been established. Loutit et al. (1983) subdivided the middle Miocene on the basis of $\delta^{13}C$ inflections and claimed that this improved the precision of stratigraphic correlation of events to ±105 yr. Miller et al. (1991) and Wright and Miller (1992) defined eight oxygen isotope zones (their "Mi" zones), based on $\delta^{18}O$ inflections in benthic foraminifers that they assert correlate with glacioeustatic sea-level changes.

Because ice-volume fluctuations, temperature effects, and salinity-correlated effects influence oxygen isotope fractionation, $\delta^{18}O$ records from foraminifers cannot be uniquely interpreted in terms of a single variable (see discussion in Miller et al., 1991). As a consequence of this, a considerable body of work has focused on quantifying the different contributions of these three variables to Cenozoic (particularly Pleistocene) $\delta^{18}O$ records. The usual approach to estimate the ice volume/temperature effect contribution is to compare planktonic foraminiferal records from tropical or subtropical regions and benthic foraminiferal $\delta^{18}O$ records. This strategy is based on the assumption that ice-volume growth or decay will affect both benthic

[1] Berger, W.H., Kroenke, L.W., Mayer, L.A., et al., 1993. *Proc. ODP, Sci. Results,* 130: College Station, TX (Ocean Drilling Program).
[2] Department of Earth Sciences, University of Oxford, Park's Road, Oxford OX1 3PR, United Kingdom.

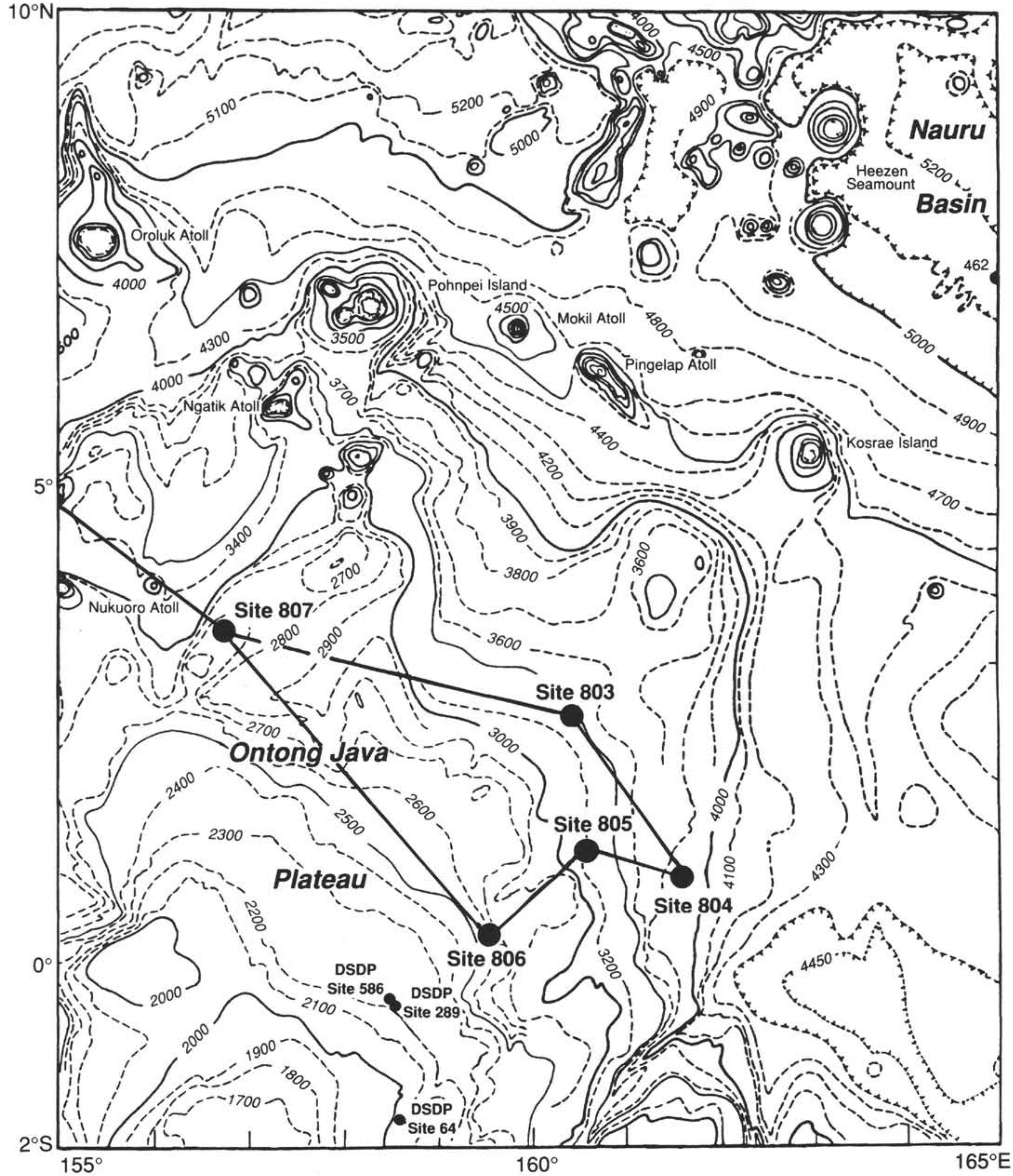

Figure 1. Location map of Leg 130 sites, including Holes 805B and 806B.

and planktonic records whereas temperature change will register only in planktonic records (e.g., Shackleton, 1967; Shackleton and Opdyke, 1973, 1976; Fairbanks and Matthews, 1978). Miller et al. (1991) advocate a similar approach further back in the Cenozoic, but they point out that the western equatorial regions offer the opportunity to obtain $\delta^{18}O$ records from planktonic foraminifers that are less likely to be affected by temperature variations than other regions because of their thermal stability (Ravelo et al., 1990).

Vincent and Berger (1985) developed a significant model that linked the middle Miocene ^{18}O enrichment in benthic $\delta^{18}O$ records to the isotopically positive ^{13}C values that typify middle Miocene foraminifers. They named this positive $\delta^{13}C$ interval the "Monterey excursion."

Our aim in this contribution is to develop an oxygen and carbon isotope stratigraphy for Holes 805B and 806B in the interval between 12 and 20 Ma. We wish to investigate the isotopically positive $\delta^{13}C$ values that characterize the early to middle Miocene interval and also to investigate their possible climatic consequences in the western equatorial Pacific. In conducting this preliminary contribution, our data were collected at a sampling resolution of one per core section (Appendixes A and B). This work continues at a higher sampling resolution.

METHODS

The $\delta^{13}C$ and $\delta^{18}O$ stratigraphies generated by the analysis of bulk samples were used to identify discontinuities that might be caused by the presence of hiatuses. In addition, we picked up to five species of planktonic foraminifers and four species of benthic foraminifers for study. However, because our focus is on the changing vertical gradients of $\delta^{18}O$ and $\delta^{13}C$ across this time interval, we restrict the present discussion to data derived from a surface-water-dwelling planktonic foraminiferal species (*Dentoglobigerina altispira*), a deeper dwelling planktonic foraminiferal species (*Globoquadrina venezuelana*), and benthic foraminifers (usually *Cibicidoides* spp. and *Planulina wuellerstorfi*). The benthic foraminifer data were corrected for isotopic disequilibrium effects using the correction factors of Shackleton et al. (1984).

Foraminiferal samples were disaggregated in distilled water. Between 5 and 15 planktonic specimens were picked from the 300–355-µm size fraction to minimize ontogenetic effects. The number of benthic specimens picked from this size fraction was generally lower as a result of their scarcity within the samples. Samples were cleaned using H_2O_2 and $(CH_3)_2CO$ and then dried for 30 min at 60°C. Samples were analyzed isotopically using a VG Isotech PRISM mass spectrometer in the Oxford Laboratory calibrated to NBS 19 and Cambridge Carrara marble.

The lower portion of the interval studied at Hole 806B in particular was relatively deeply buried (300–600 mbsf). The interval studied at Hole 805B was shallower (290–390 mbsf). In sections more deeply buried than about 400 m, diagenetic alteration of stable isotope ratios becomes an important consideration (Miller and Curry, 1982; Barrera et al., 1987; Wright et al., 1992). Clearly, therefore, the possibility of diagenetic overprinting must be investigated in the deeper portions of Hole 806B. This is especially important because the adjacent DSDP Site 289 has a similar burial depth and has been used as a reference section for this interval in the western equatorial Pacific (Shackleton, 1982; Wright et al., 1991, 1992). Other authors have suggested that the $\delta^{18}O$ signal may be degraded because of diagenetic overprinting (Elderfield et al., 1982; Miller et al., 1991). We have followed the approach used by Wright et al. (1992) and adopted two criteria for the identification of diagenesis: (1) optical examination for calcite overgrowths and (2) similarity to other, shallower records. With respect to the first criterion, sediments disaggregated easily, suggesting only minimal cementation and significant calcite overgrowth was not observed. Comparison of the $\delta^{18}O$ record from Hole 806B with other records is discussed below. In general, however, the major features of middle Miocene $\delta^{13}C$ and $\delta^{18}O$ history are well represented in Holes 805B and 806B, and we conclude therefore that diagenetic overprinting is not a major problem.

RESULTS AND DISCUSSION

Bulk Isotope Stratigraphy

Figures 2 and 3 illustrate the middle Miocene bulk isotope stratigraphy at Holes 805B and 806B. Both Figures 2 and 3 exhibit $\delta^{13}C$ values that reach broad maxima in the middle of the sections studied. At Hole 805B, these values are most positive between Cores 130-805B-35X (325 mbsf) and -38X (352 mbsf). At Hole 806B, a particularly positive second-order $\delta^{13}C$ excursion (marked "A" on Fig. 3) is discernible between Cores 130-806B-50X (452 mbsf) and -52X (470 mbsf), whereas values in general remain high between Cores 130-806B-53X (490 mbsf) and -55X (530 mbsf). We interpret this positive first-order feature to be the local expression of the middle Miocene $\delta^{13}C$ excursion documented by Vincent and Berger (1985). The second-order excursion may correlate with one of the benthic $\delta^{13}C$ events of Loutit et al. (1983). Pending further examination, we have tentatively identified this as the "Zone N11 subevent."

Detailed analysis of Hole 805B suggests that the middle Miocene portion of Hole 805B is less continuous than the equivalent section at Hole 806B. In particular, we note steps in the $\delta^{13}C$ signal within Core 130-805B-33X (between Samples 130-805B-33X-3, 139–141 cm, and -33X-4, 9–11 cm; marked "A" on Fig. 2) that correspond to a hiatus as identified by the shipboard biostratigraphers. Breaks in sedimentation may exist between Samples 130-805B-35X-3, 99–101 cm, and -35X-4, 9–11 cm (marked "B" on Fig. 2) and between Samples 130-805B-37X-4, 69–71 cm, and -38X-1, 59–61 cm (marked "C" on Fig. 2). Judging from the positive $\delta^{13}C$ values immediately above our suggested stratigraphic break at point "B," we suggest that the second-order $\delta^{13}C$ excursion, which we have termed the "Zone N11 subevent" (marked "A" on Fig. 3), is probably partially missing in Hole 805B.

It is clear that the bulk carbonate records of the first-order mid-Miocene $\delta^{13}C$ excursion provide a sufficiently systematic signal of high signal-to-noise ratio to serve as a high-resolution stratigraphic tool. In this it is comparable to the large amplitude of the $\delta^{13}C$ signal in the Paleocene, which similarly provides high-resolution chemostratigraphic control as discussed by Shackleton et al. (1985).

In contrast, the bulk $\delta^{18}O$ records at Holes 805B and 806B do not show systematic change over the whole of the middle Miocene interval. However, systematic changes on shorter time scales are visible. Hole 805B shows a trend toward positive $\delta^{18}O$ values between Cores 130-805B-34X and -33X (marked "D" on Fig. 2), and Hole 806B shows the same trend between Core 130-805B-48X and -45X (marked "B" on Fig. 3). This probably corresponds to the ^{18}O enrichment associated with the cooling/ice-volume increase effect discussed in the introduction and well known from the benthic records at several sites (e.g., Miller et al., 1991). In general, however, the greater amplitude of the high-frequency variation in the bulk carbonate $\delta^{18}O$ signal in the middle Miocene sequence at Holes 805B and 806B probably precludes the same stratigraphic usefulness as the $\delta^{13}C$ signal.

A possible exception to this is the pronounced positive excursion between Cores 130-806B-50X (452 mbsf) and -52X (470 mbsf) (marked "C" in Fig. 3), which is contemporaneous with the maximum noted in the d13C record. These positive $\delta^{18}O$ values are missing from Hole 805B, which supports our assertion that this portion of the succession is missing in Hole 805B.

Based on our assessment of the stratigraphic continuity of Holes 805B and 806B, we have concentrated this initial investigation on the apparently more complete record of Hole 806B. We intend to combine records from Holes 805B and 806B as our contribution to the high-resolution Neogene stratigraphy project of the Leg 130 Shipboard Scientific Party.

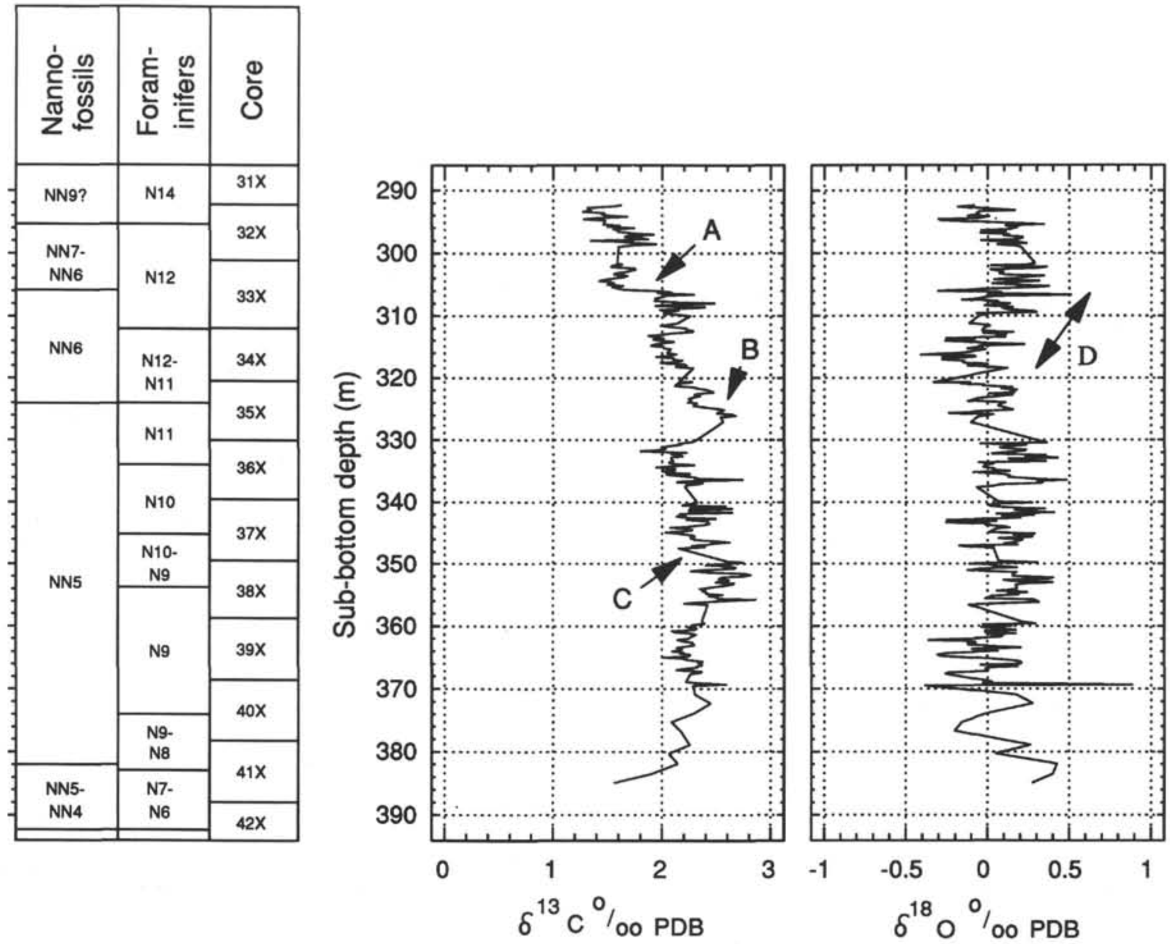

Figure 2. Bulk sample oxygen and carbon isotope stratigraphy, Hole 805B. A = probable hiatus in succession also noted by shipboard bio- and magnetostratigraphers, B and C = possible hiatuses within Monterey carbon isotope excursion, D = positive $\delta^{18}O$ excursion.

Foraminiferal Isotope Stratigraphy

Figure 4 illustrates the data set for Hole 806B. The Monterey $\delta^{13}C$ excursion is clearly expressed in all three groups of foraminifers. In particular, the second-order positive excursion between Cores 130-806B-50X (452 mbsf) and -52X is clearly depicted in *D. altispira, G. venezuelana*, and the benthic foraminifers. Examination of the $\delta^{18}O$ data shows that this second-order event is contemporaneous with a marked positive excursion in both sub-surface dwellers (*G. venezuelana*) and benthic foraminifers.

The $\delta^{18}O$ data for all three groups of foraminifers trend toward negative values between 600 and 550 mbsf, which we interpret as the early Miocene warming trend noted by Vincent and Berger (1985). Within Core 130-806B-58X (550 mbsf), separation of the *D. altispira* and *G. venezuelana* $\delta^{18}O$ signals occurs. The $\delta^{13}C$ signals for the same species separate at about the same level, and we interpret this as the steepening of the thermocline and probably the sub-surface oxygen minimum as suggested by Vincent and Berger (1985). Within Core 130-806B-54X, benthic $\delta^{18}O$ values start to trend toward more positive values, which we interpret as the cooling/ice-volume increase associated with the buildup of Antarctic ice.

We developed a chronology for our samples from Hole 806B using the biostratigraphic datums identified by Takayama (this volume). We used the time scale of Berggren et al. (1985) and calculated sample ages by linear interpolation between age control points. To reduce scatter in the data over this relatively long interval, we stacked the data into 0.1-m.y. increments of modeled time. Figure 5 shows the bulk data when processed by this method, and Figure 6 illustrates the foraminiferal data. A problem with Hole 806B is the lack of detailed magnetostratigraphy. Hence, our chronology, which is based solely at present on the nannofossil zonation of Takayama (this volume), must be regarded as preliminary.

Figure 5 shows clearly the start of the Monterey excursion at 18.75 Ma. Values increase to 16.8 Ma and then stabilize at about 2.3‰ before declining again at 14.6 Ma. Subsequently, $\delta^{13}C$ values peak to values of 2.7‰ at 13.8 Ma. This is the expression in the bulk sediment of our foraminiferal "Zone N11 subevent." The $\delta^{18}O$ values remain rather constant throughout the succession with the exception of a positive inflection between 14.3 and 13.4 Ma, which is contemporaneous with the "Zone N11 subevent."

Figure 6 illustrates the foraminiferal data chronologically. The possible steepening of the thermocline discussed previously occurs at 17.4 Ma. Our data suggest that the onset of the increasing $\delta^{13}C$ values characteristic of the Monterey excursion occur in planktonic foraminifers at about 18.8 Ma. This is effectively contemporaneous with the onset of the increase in bulk sediment $\delta^{13}C$ values. However, our benthic $\delta^{13}C$ data do not start to increase until about 17.9 Ma; this lag is likely to be an artifact our low benthic sampling density.

Vincent and Berger (1985) inferred on the basis of covarying foraminiferal $\delta^{13}C$ data from DSDP Site 216 that the middle Miocene carbon isotope maximum was composed largely of between-reservoir carbon isotope fractionation effects. In contrast, Corfield and Cartlidge (1992) noted that the Paleocene carbon isotope maximum was comprised of both between-reservoir (burial of organic carbon) and within-reservoir (surface-water productivity) change. We have assessed the intensity of the vertical carbon isotope gradient during the

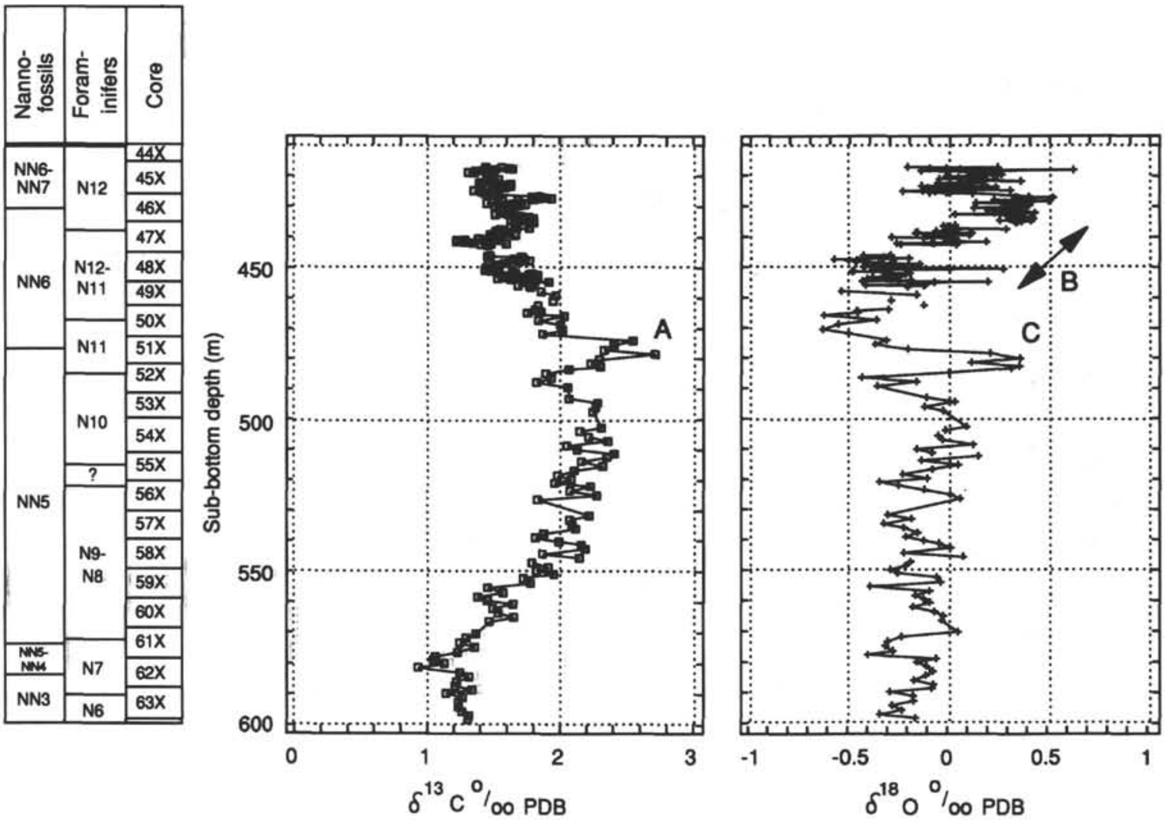

Figure 3. Bulk sample oxygen and carbon isotope stratigraphy, Hole 806B. A = "Zone N11 $\delta^{13}C$ subevent" discussed in the text, B = positive $\delta^{18}O$ excursion, C = "Zone N11 $\delta^{18}O$ subevent" discussed in the text.

middle Miocene interval at Hole 806B ($\Delta\delta^{13}C$) by subtracting benthic $\delta^{13}C$ values from *D. altispira* values ($\delta^{13}C_{alt\text{-}ben}$) as well as subtracting *G. venezuelana* values from *D. altispira* ($\delta^{13}C_{alt\text{-}ven}$) values. The results are plotted as a function of bulk $\delta^{13}C$ (Fig. 7). This plot suggests a weak increase in $\Delta\delta^{13}C_{alt\text{-}ven}$, whereas no relationship exists between bulk $\delta^{13}C$ values and $\Delta\delta^{13}C_{alt\text{-}ben}$. This suggests that a minor increase in surface-water productivity may have been associated with the Monterey excursion but that the bulk of the increase in $\delta^{13}C$ values was caused by the lithospheric sequestration of isotopically light carbon. This finding is consistent with the hypothesis of Vincent and Berger (1985) that the Monterey carbon isotope excursion was caused by an increase in the rate of burial of organic carbon.

Vincent and Berger (1985) and Berger and Vincent (1986) related the middle Miocene increase in benthic $\delta^{18}O$ values found globally to the increase in $\delta^{13}C$ values in surface, deeper water, and benthic foraminifers. The mechanism they propose is that an increase in the rate of burial of organic carbon in the sediments rimming the Pacific Basin (the Monterey Shale and time-equivalent organic-rich strata) cause re-equilibration of CO_2 between the ocean and the atmosphere, with the result that atmospheric pCO_2 decreased and triggered polar cooling. Our data broadly support their speculation although we note that explicitly quantitative modeling experiments are required to verify their hypothesis. Our estimates of the chronology (subject to the reservations outlined above) of these events are as follows:

1. The $\delta^{13}C$ values in bulk sediment, as well as surface and deeper dwelling planktonic foraminifers, begin to increase at 18.8 Ma. The $\delta^{13}C$ increase in benthic foraminifers begins at 17.9 Ma; however, this lag may be a function of our low benthic sampling density. The increase in $\delta^{13}C$ in these three groups of foraminifers may indicate the onset of organic carbon burial in Pacific Basin sediments.
2. The $\delta^{18}O$ records of surface and deeper dwelling planktonic foraminifers begin to diverge at 17.4 Ma, suggesting a steepening in the thermocline.
3. The benthic $\delta^{18}O$ record begins to increase at 15.3 Ma.
4. By the early/middle Miocene boundary (16.4 Ma), the thermocline is at its steepest in our record and the broad maximum of the Monterey carbon excursion has been reached.
5. The "Zone N11 subevent" occurs between 14.1 and 13.2 Ma. The $\delta^{13}C$ values peak to their most positive Miocene values in all three foraminiferal groups. Contemporaneous deeper dwelling planktonic and benthic $\delta^{18}O$ values increase and then recover. This positive $\delta^{18}O$ inflection in the benthic curve may be the expression in the record from Hole 806B of oxygen isotope Zone Mi3 of Miller et al. (1991). The $\delta^{13}C$ excursion with which it is apparently associated has been identified in other sites from benthic $\delta^{13}C$ data (e.g., DSDP Sites 289 and 563; see fig. 14 in Wright et al., 1992), although this $\delta^{13}C$ event has apparently not been explicitly named. Our data from Hole 806B suggests that our "Zone N11 subevent" affects all foraminiferal groups examined in this study and therefore all levels in the water column. If, as Miller et al. (1991) assert, oxygen isotope Zone Mi3 is associated with glacioeustatic lowering, this is not surprising. However, the reasons behind the apparently synchronous $\delta^{18}O$ and $\delta^{13}C$ change during this event need further examination.

Finally, our planktonic and benthic foraminiferal data from this western equatorial site may contribute some additional constraints to the discussion concerning the relative contributions of ice-volume

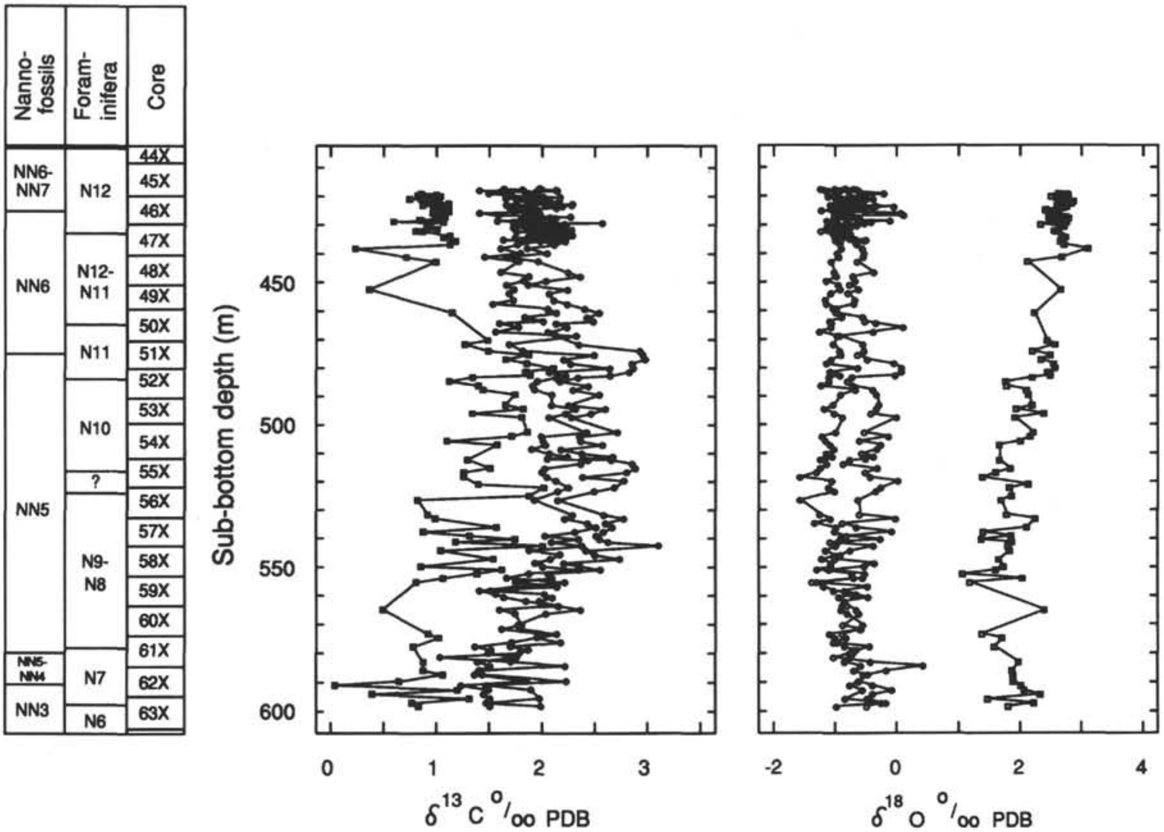

Figure 4. Foraminiferal $\delta^{13}C$ and $\delta^{18}O$ stratigraphy, Hole 806B. The Monterey carbon isotope excursion is clearly expressed. Note also the steepening of the thermocline indicated by both $\delta^{13}C$ and $\delta^{18}O$ data near 550 mbsf. The benthic $\delta^{18}O$ signal begins to decline after about 510 mbsf. The "Zone N11 subevent" is clearly shown in all $\delta^{13}C$ water mass monitors and is well expressed in both the deeper dwelling planktonic and benthic $\delta^{18}O$ record. Solid circles = *Dentoglobigerina altispira*, open circles = *Globoquadrina venezuelana*, and squares = benthic data.

increase and temperature decrease to the middle Miocene ^{18}O enrichment. As Figure 6 shows, over the interval between 15.3 Ma (our estimate of the onset of the middle Miocene ^{18}O enrichment) and the top of the measured section at 12.4 Ma, mean benthic $\delta^{18}O$ data increase by 0.8‰ whereas surface planktonic foraminiferal data increase by 0.4‰. Miller et al. (in press) have compared data from Holes 563 (North Atlantic) and 707 (western equatorial Indian Ocean) and also noted that the planktonic $\delta^{18}O$ change is smaller than the benthic $\delta^{18}O$ change. Their estimates are that benthic $\delta^{18}O$ increased by 0.7‰ and planktonic $\delta^{18}O$ increased by 0.4‰ over the middle Miocene ^{18}O "shift." Their estimates, therefore, are similar to ours, although ours are made from the same site in a western equatorial location and thus avoid problems of comparing distant records.

Miller et al. (in press) point out that this well-known difference in amplitude has been attributed either (1) to warming of equatorial surface waters during the growth of the Antarctic Ice Sheet (Shackleton and Kennett, 1975; Savin et al., 1975, 1985) or (2) to cooling of deep waters (Matthews and Poore, 1980; Prentice and Matthews, 1988) in addition to the ^{18}O enrichment from the growth of the Antarctic Ice Sheet.

Miller et al. (in press) suggest that the surface-water warming hypothesis is unreasonable because of planktonic and benthic foraminiferal covariance subsequent to 12.5 Ma that implies larger ice volumes on Antarctica than the scarcity of glaciomarine sediments supports (Miller et al., 1991). They therefore conclude that the change in benthic foraminiferal values is attributable to a combination of ice-volume increase and a cooling of deep waters by 1°–4°C. Our data from Hole 806B do not contradict this suggestion.

ACKNOWLEDGMENTS

RMC warmly thanks shipboard colleagues for their support and friendship during our 63-day sojourn on board the *JOIDES Resolution* during Leg 130. In particular, thanks go to Dave Mosher, Mike Prentice, Mark Leckie, Carina Lange, Johanna Resig, and Mike Storey for psychic sustenance. Our thanks to Norman Charnley for writing the stacker software used for the generation of Figures 5 and 6.

REFERENCES*

Barrera, E.B., Huber, B.T., Savin, S.M., and Webb, P.-N., 1987. Antarctic marine temperatures: late Campanian through early Paleocene. *Paleoceanography,* 2:21–47.

Barrera, E.B., Keller, G., and Savin, S.M., 1985. Evolution of the Miocene Ocean in the eastern North Pacific as inferred from oxygen and carbon isotopic ratios of foraminifera. *In* Kennett, J.P. (Ed.), *The Miocene Ocean: Paleoceanography and Biogeography.* Mem. Geol. Soc. Am., 163:83–102.

Berger, W.H., and Vincent, E., 1986. Deep-sea carbonates: reading the carbon isotope signal. *Geol. Rundsch.,* 75:249–269.

Berggren, W.A., Kent, D.V., and Van Couvering, J.A., 1985. The Neogene: Part 2. Neogene geochronology and chronostratigraphy. *In* Snelling, N.J. (Ed.), *The Chronology of the Geological Record.* Geol. Soc. London Mem., 10:211–260.

Corfield, R.M., and Cartlidge, J.E., 1992. Oceanographic and climatic implications of the Palaeocene carbon isotope maximum. *Terra Nova,* 4:443–455.

* Abbreviations for names of organizations and publication titles in ODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

Elderfield, H., Gieskes, J.M., Baker, P.A., Oldfield, R.K., Hawkesworth, C.J., and Miller, R., 1982. $^{87}Sr/^{86}Sr$ and $^{18}O/^{16}O$ ratios, interstitial water chemistry and diagenesis in deep-sea carbonate sediments of the Ontong-Java Plateau. *Geochim. Cosmochim. Acta,* 46:2259–2268.

Fairbanks, R.G., and Matthews, R.K., 1978. The marine oxygen isotopic record in Pleistocene coral, Barbados, West Indies. *Quat. Res.,* 10:181–196.

Loutit, T.S., Pisias, N.G., and Kennett, J.P., 1983. Pacific Miocene carbon isotope stratigraphy using benthic foraminifera. *Earth Planet. Sci. Lett.,* 66:48–62

Matthews, R.K., and Poore, R.Z., 1980. Tertiary ^{18}O record and glacio-eustatic sea-level fluctuations. *Geology,* 8:501–504.

Miller, K.G., and Curry, W.B., 1982. Eocene to Oligocene benthic foraminiferal isotope record in the Bay of Biscay. *Nature,* 296:347–350.

Miller, K.G., Wright, J.D., and Brower, A.N., 1989. Oligocene to Miocene stable isotope stratigraphy and planktonic foraminifer biostratigraphy of the Sierra Leone Rise (DSDP Site 366 and ODP Site 667). *In* Ruddiman, W., Sarnthein, M., et al., *Proc. ODP, Sci. Results,* 108, Pt. 2: College Station, TX (Ocean Drilling Program), 279–294.

Miller, K.G., Wright, J.D., and Fairbanks, R.G., 1991. Unlocking the Ice-House: Oligocene-Miocene oxygen isotopes, eustasy, and margin erosion. *J. Geophys. Res.,* 96:6829–6848.

Miller, K.G., Wright, J.D., Peterson, L.C., Swart, P.K., in press. Early to middle Miocene $\delta^{18}O$: global sea level or temperature? *Nature.*

Prentice, M.L., and Matthews, R.K., 1988. Cenozoic ice volume history: development of a composite oxygen isotope record. *Geology,* 17:963–966.

Ravelo, C.A., Fairbanks, R.G., and Philander, R., 1990. Reconstructing tropical hydrography using planktonic foraminifera and an ocean model. *Paleoceanography,* 5:409–431.

Savin, S.M., Abel, L., Barrera, E., Hodell, D., Keller, G., Kennett, J.P., Killingley, J., Murphy, M., and Vincent, E., 1985. The evolution of Miocene surface and near-surface marine temperatures: oxygen isotopic evidence. *In* Kennett, J.P. (Ed.), *The Miocene Ocean: Paleoceanography and Biogeography.* Mem. Geol. Soc. Am., 163:49–82.

Savin, S.M., Douglas, R.G., and Stehli, F.G., 1975. Tertiary marine paleotemperatures. *Geol. Soc. Am. Bull.,* 86:1499–1510.

Savin, S.M., Keller, G., Douglas, R.G., Killingley, J.S., Shaughnessy, L., Sommer, M.A., Vincent, E., and Woodruff, F., 1981. Miocene benthic foraminiferal isotope records: a synthesis. *Mar. Micropaleontol.,* 6:423–450.

Shackleton, N.J., 1967. Oxygen isotope analyses and Pleistocene temperatures re-assessed. *Nature,* 215:15–17.

————, 1982. The deep-sea sediment record of climate variability. *Progr. Oceanogr.,* 11:199–218.

Shackleton, N.J., Hall, M.A., and Bleil, U., 1985. Carbon isotope stratigraphy, Site 577. *In* Heath, G.R., Burckle, L.H., et al., *Init. Repts. DSDP,* 86: Washington (U.S. Govt. Printing Office), 503–512.

Shackleton, N.J., Hall, M.A., and Boersma, A., 1984. Oxygen and carbon isotope data from Leg 74 foraminifers. *In* Moore, T.C., Jr., Rabinowitz, P.D., et al., *Init. Repts. DSDP,* 74: Washington (U.S. Govt. Printing Office), 599–612.

Shackleton, N.J., and Kennett, J.P., 1975. Paleotemperature history of the Cenozoic and the initiation of Antarctic glaciation: oxygen and carbon isotope analyses in DSDP Sites 277, 279, and 281. *In* Kennett, J.P., Houtz, R.E., et al., *Init. Repts. DSDP,* 29: Washington (U.S. Govt. Printing Office), 743–755.

Shackleton, N.J., and Opdyke, N.D., 1973. Oxygen isotope and paleomagnetic stratigraphy of equatorial Pacific Core V28-238: oxygen isotope temperatures and ice volumes on a 10^5 year and 10^6 year scale. *Quat. Res.,* 3:39–55.

————, 1976. Oxygen isotope and paleomagnetic stratigraphy of Pacific Core V28-239, late Pliocene to Pleistocene. *Geol. Soc. Am. Bull.,* 145:449–464.

Vincent, E., and Berger, W.H., 1985. Carbon dioxide and polar cooling in the Miocene: the Monterey hypothesis. *In* Sundquist, E.T., and Broecker, W.S. (Eds.), *The Carbon Cycle and Atmospheric CO_2: Natural Variations Archean to Present.* Am. Geophys. Union Monogr., 32:455–468.

Vincent, E., Killingley, J.S., and Berger, W.H., 1985. Miocene oxygen and carbon isotope stratigraphy of the tropical Indian Ocean. *In* Kennett, J.P. (Ed.) *The Miocene Ocean: Paleoceanography and Biogeography.* Mem. Geol. Soc. Am., 163:103–130.

Woodruff, F., and Savin, S.M., 1989. Miocene deep-water oceanography. *Paleoceanography,* 4:87–140.

Woodruff, F., Savin, S.M., and Douglas, R.G., 1981. Miocene stable isotope record: a detailed deep Pacific ocean study and its paleoclimatic implications. *Science,* 212:665–668.

Wright, J.D., and Miller, K.G., 1992. Miocene stable isotope stratigraphy, Site 747, Kerguelen Plateau. *In* Wise, S.W., Jr., Schlich, R., et al., *Proc. ODP, Sci. Results,* 120, Pt. 2: College Station, TX (Ocean Drilling Program), 855–866.

Wright, J.D., Miller, K.G., and Fairbanks, R.G., 1991. Evolution of modern deep-water circulation: evidence from the late Miocene southern ocean. *Paleoceanography,* 6:275–290.

————, 1992. Early and middle Miocene stable isotopes: implications for deep-water circulation and climate. *Paleoceanography,* 7:357–389.

Date of initial receipt: 30 August 1991
Date of acceptance: 3 September 1992
Ms 130B-026

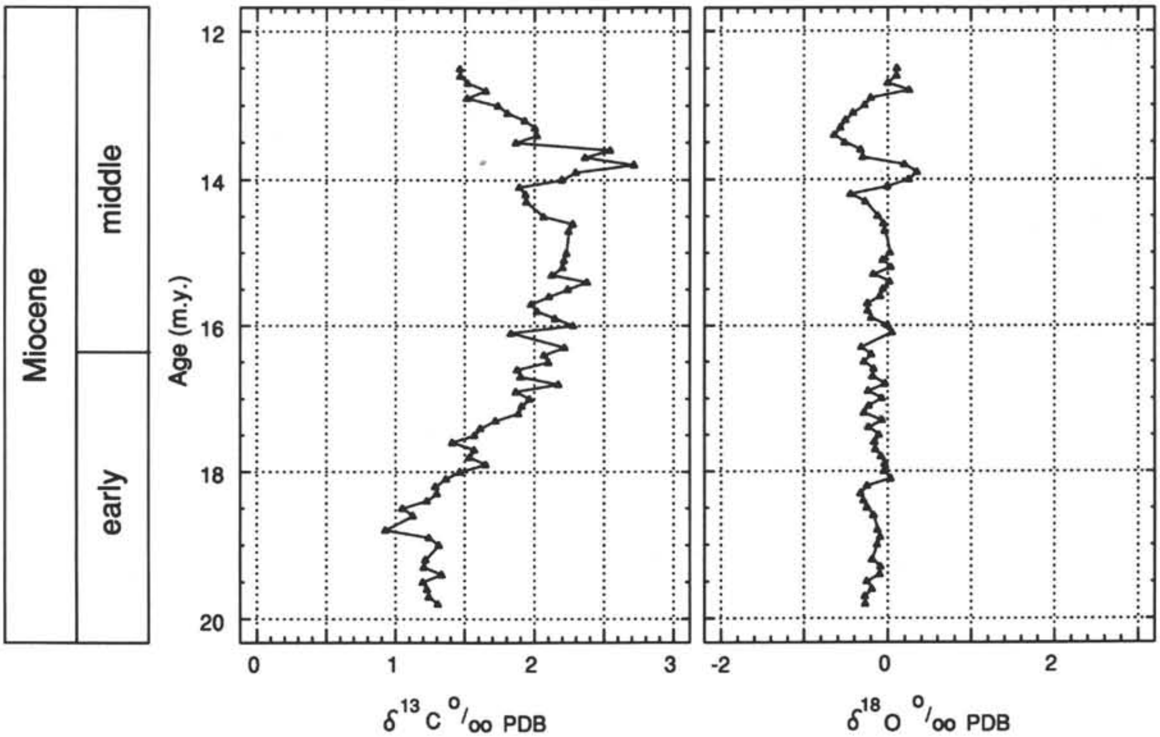

Figure 5. Chronostratigraphy of bulk sample $\delta^{13}C$ and $\delta^{18}O$ measurements, Hole 806B. These $\delta^{13}C$ data show the onset of the middle Miocene Monterey excursion at 18.8 Ma and its decline following the "Zone N11 subevent" at 14.5 Ma. The $\delta^{18}O$ data are more monotonous except for the increase in $\delta^{18}O$ values during the "Zone N11 subevent."

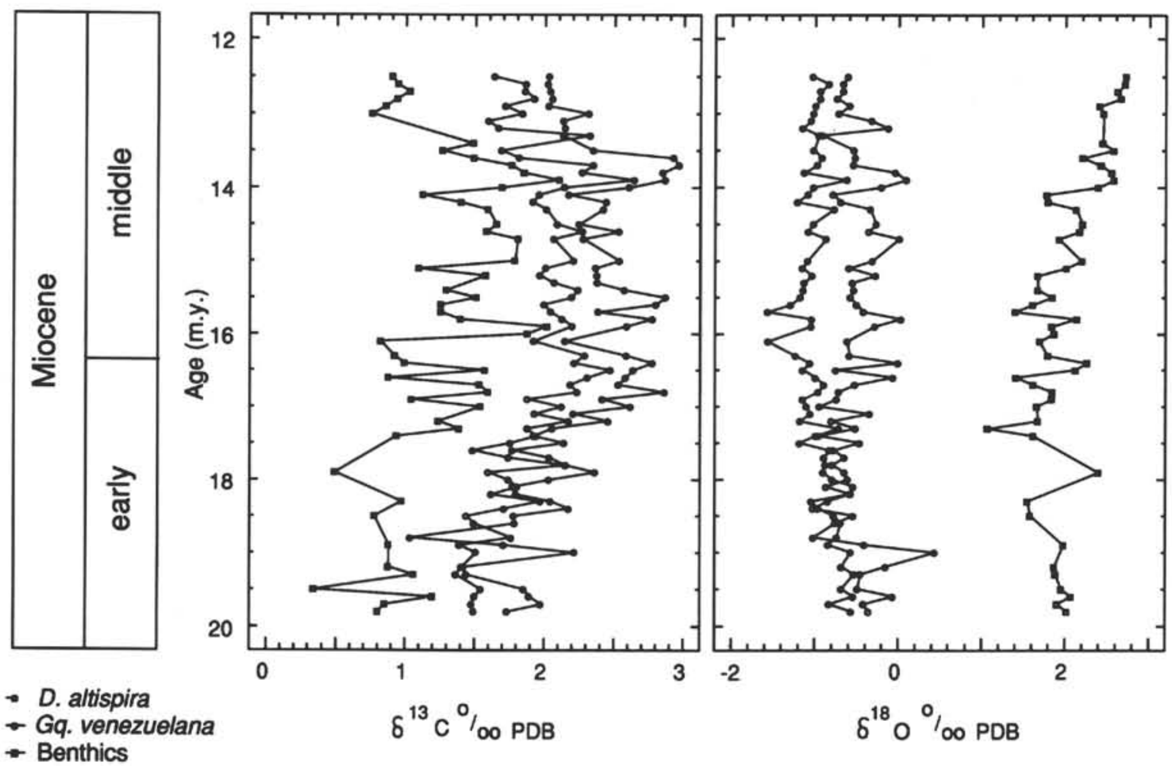

Figure 6. Chronostratigraphy of foraminiferal $\delta^{13}C$ and $\delta^{18}O$ measurements, Hole 806B. The chronology of events is discussed in the text. Note the increase in $\delta^{18}O$ values starting at 15.3 Ma. With the exception of the data set discussed by Shackleton et al. (1984), our estimate of the onset of the $\delta^{18}O$ increase is 1–2 m.y. older than other published estimates (e.g., Barrera et al., 1985), although our estimates are provisional (as discussed in the text) because they are based solely on nannofossil age control points. Symbols as for Figure 4.

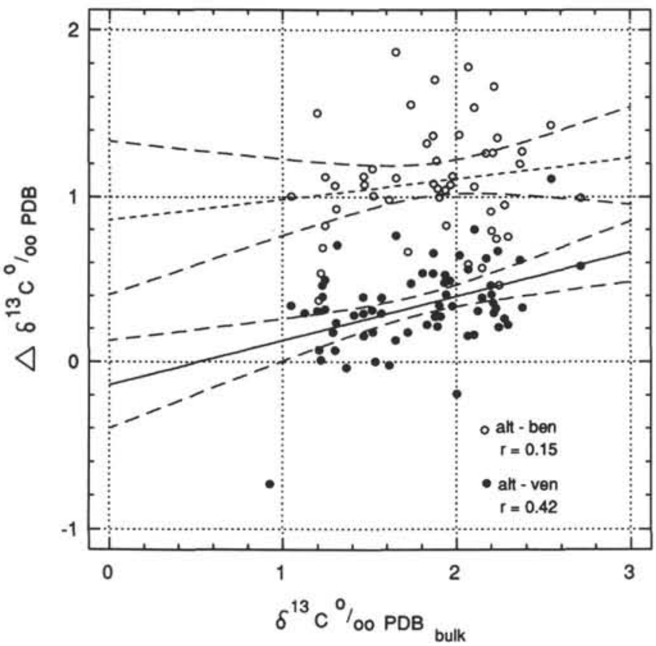

Figure 7. Two estimates of the vertical carbon isotope gradient in the middle Miocene Pacific Ocean. The increase in $\Delta\delta^{13}C_{alt\text{-}ven}$ suggests a minor contribution from surface-water productivity to the structure of the Monterey carbon isotope excursion. However, $\Delta\delta^{13}C_{alt\text{-}ben}$ are not even weakly correlated, suggesting that the major component of the Monterey carbon isotope excursion is caused by between-reservoir fractionation of carbon isotopes.

APPENDIX A

Bulk-rock $\delta^{13}C$ and $\delta^{18}O$ Data from Hole 805B

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
292.39	11.53	A90/4012	32R-1, 19	Bulk	1.62	–0.08
292.59	11.55	A90/4013	32R-1, 39	Bulk	1.53	–0.19
292.79	11.56	A90/3717	32R-1, 59	Bulk	1.32	–0.11
292.99	11.58	A90/4014	32R-1, 79	Bulk	1.32	0.02
293.19	11.59	A90/4015	32R-1, 99	Bulk	1.35	0.17
293.39	11.60	A90/4016	32R-1, 119	Bulk	1.27	–0.05
293.59	11.62	A90/4017	32R-1, 139	Bulk	1.47	–0.07
293.79	11.63	A90/4018	32R-2, 9	Bulk	1.44	–0.05
293.99	11.65	A90/4019	32R-2, 29	Bulk	1.49	–0.12
294.19	11.66	A90/4020	32R-2, 49	Bulk	1.68	0.01
294.39	11.68	A90/3718	32R-2, 69	Bulk	1.40	–0.05
294.57	11.69	A90/4021	32R-2, 87	Bulk	1.28	–0.30
294.79	11.71	A90/4022	32R-2, 109	Bulk	1.48	–0.29
295.39	11.75	A90/4023	32R-3, 19	Bulk	1.46	0.35
295.59	11.77	A90/4024	32R-3, 39	Bulk	1.62	0.11
295.79	11.78	A90/3719	32R-3, 59	Bulk	1.50	0.19
295.99	11.79	A90/4025	32R-3, 79	Bulk	1.75	0.16
296.19	11.81	A90/4026	32R-3, 99	Bulk	1.55	0.14
296.39	11.82	A90/4027	32R-3, 119	Bulk	1.59	–0.04
296.59	11.84	A90/4028	32R-3, 139	Bulk	1.60	0.11
296.79	11.85	A90/4029	32R-4, 9	Bulk	1.74	–0.05
296.99	11.87	A90/4030	32R-4, 29	Bulk	1.92	0.13
297.19	11.88	A90/4031	32R-4, 49	Bulk	1.69	0.10
297.39	11.90	A90/3720	32R-4, 69	Bulk	1.65	0.21
297.59	11.91	A90/4032	32R-4, 89	Bulk	1.81	0.21
297.79	11.93	A90/4033	32R-4, 109	Bulk	1.87	0.18
297.99	11.94	A90/4034	32R-4, 129	Bulk	1.34	–0.04
298.18	11.95	A90/4035	32R-4, 148	Bulk	1.59	0.15
298.39	11.97	A90/4036	32R-5, 19	Bulk	1.77	0.24
298.59	11.98	A90/4037	32R-5, 39	Bulk	1.94	0.06
298.79	12.00	A90/3721	32R-5, 59	Bulk	1.71	0.17
298.99	12.01	A90/4038	32R-5, 79	Bulk	1.60	0.20
301.59	12.20	A90/4039	33R-1, 19	Bulk	1.58	0.29
301.79	12.22	A90/4040	33R-1, 39	Bulk	1.64	0.23
301.99	12.23	A90/3722	33R-1, 59	Bulk	1.54	0.02
302.19	12.25	A90/4041	33R-1, 79	Bulk	1.53	0.36
302.39	12.26	A90/4042	33R-1, 99	Bulk	1.75	0.28
302.59	12.28	A90/4043	33R-1, 119	Bulk	1.76	0.02
302.99	12.31	A90/4115	33R-2, 9	Bulk	1.65	0.09
303.19	12.32	A90/4116	33R-2, 29	Bulk	1.57	0.07
303.39	12.34	A90/4117	33R-2, 49	Bulk	1.55	0.11
303.59	12.35	A90/3723	33R-2, 69	Bulk	1.68	0.35
303.79	12.36	A90/4118	33R-2, 89	Bulk	1.64	0.24
304.21	12.40	A90/4119	33R-2, 131	Bulk	1.47	0.04
304.38	12.41	A90/4120	33R-2, 148	Bulk	1.42	0.32
304.59	12.42	A90/4121	33R-3, 19	Bulk	1.51	0.15
304.79	12.44	A90/4122	33R-3, 39	Bulk	1.56	0.03
304.99	12.45	A90/3724	33R-3, 59	Bulk	1.49	0.12
305.19	12.47	A90/4123	33R-3, 79	Bulk	1.64	0.38
305.39	12.48	A90/4124	33R-3, 99	Bulk	1.54	0.27
305.79	12.51	A90/4127	33R-3, 139	Bulk	1.65	–0.11
305.99	12.53	A90/4128	33R-4, 9	Bulk	1.97	–0.31
306.19	12.54	A90/4129	33R-4, 29	Bulk	2.08	0.08
306.39	12.55	A90/4130	33R-4, 49	Bulk	1.95	0.00
306.59	12.57	A90/3725	33R-4, 69	Bulk	2.29	0.51
306.79	12.58	A90/4131	33R-4, 89	Bulk	2.01	0.06
306.99	12.60	A90/4132	33R-4, 109	Bulk	2.01	–0.01
307.22	12.62	A90/4133	33R-4, 132	Bulk	1.93	–0.05
307.38	12.63	A90/4134	33R-4, 148	Bulk	1.96	–0.16
307.59	12.64	A90/4135	33R-5, 19	Bulk	1.93	0.06
307.79	12.66	A90/4136	33R-5, 39	Bulk	2.10	0.00
307.99	12.67	A90/3726	33R-5, 59	Bulk	2.48	0.14
308.19	12.69	A90/4137	33R-5, 79	Bulk	2.10	0.08
308.39	12.70	A90/4138	33R-5, 99	Bulk	1.93	–0.02
308.59	12.72	A90/4139	33R-5, 119	Bulk	2.39	0.16
308.79	12.73	A90/4140	33R-5, 139	Bulk	2.20	0.09
308.99	12.74	A90/4153	33R-6, 9	Bulk	1.97	0.13
309.19	12.76	A90/4154	33R-6, 29	Bulk	2.15	0.28
309.40	12.77	A90/4155	33R-6, 50	Bulk	2.02	0.30
309.59	12.79	A90/3727	33R-6, 69	Bulk	2.01	–0.07
309.79	12.80	A90/4156	33R-6, 89	Bulk	2.12	0.00
309.99	12.81	A90/4157	33R-6, 109	Bulk	2.25	–0.05
311.19	12.86	A90/4158	34R-1, 19	Bulk	2.14	–0.12
311.59	12.88	A90/3728	34R-1, 59	Bulk	1.98	0.02
311.99	12.90	A90/4161	34R-1, 99	Bulk	2.22	–0.03
312.19	12.91	A90/4162	34R-1, 119	Bulk	2.22	–0.03
312.39	12.92	A90/4163	34R-1, 139	Bulk	2.29	–0.04
312.59	12.93	A90/4164	34R-2, 9	Bulk	2.28	0.16
312.79	12.94	A90/4565	34R-2, 29	Bulk	2.10	–0.03
312.99	12.94	A90/4566	34R-2, 49	Bulk	2.01	0.12
313.19	12.95	A90/3729	34R-2, 69	Bulk	1.87	0.05
313.39	12.96	A90/4567	34R-2, 89	Bulk	1.93	0.11
313.59	12.97	A90/4568	34R-2, 109	Bulk	2.01	–0.26
313.79	12.98	A90/4569	34R-2, 129	Bulk	1.91	–0.08
313.99	12.99	A90/4570	34R-2, 149	Bulk	1.97	–0.26
314.19	13.00	A90/4571	34R-3, 19	Bulk	2.11	–0.13
314.39	13.01	A90/4572	34R-3, 39	Bulk	2.01	–0.03
314.59	13.02	A90/3730	34R-3, 59	Bulk	1.93	0.22
314.79	13.02	A90/4573	34R-3, 79	Bulk	1.89	–0.05
314.99	13.03	A90/4574	34R-2, 99	Bulk	2.01	–0.03
315.19	13.04	A90/4575	34R-3, 119	Bulk	2.02	–0.13
315.39	13.05	A90/4576	34R-3, 139	Bulk	2.08	–0.01
315.59	13.06	A90/4577	34R-4, 9	Bulk	2.07	–0.05
315.79	13.07	A90/4578	34R-4, 29	Bulk	2.05	–0.13
315.99	13.08	A90/4579	34R-4, 49	Bulk	2.05	–0.18
316.19	13.09	A90/3731	34R-4, 69	Bulk	2.13	–0.41
316.39	13.10	A90/4580	34R-4, 89	Bulk	2.06	–0.09
316.59	13.11	A90/4581	34R-4, 109	Bulk	1.94	–0.07
316.79	13.12	A90/4582	34R-4, 129	Bulk	2.11	–0.28
316.99	13.13	A90/4583	34R-4, 149	Bulk	2.10	–0.28
317.19	13.14	A90/4584	34R-5, 19	Bulk	2.19	–0.15
317.39	13.15	A90/4585	34R-5, 39	Bulk	2.13	–0.16
317.59	13.16	A90/3732	34R-5, 59	Bulk	1.98	–0.14
317.79	13.17	A90/4586	34R-5, 79	Bulk	2.21	0.00
317.99	13.18	A90/4587	34R-5, 99	Bulk	2.23	–0.12
318.19	13.19	A90/4588	34R-5, 119	Bulk	2.12	–0.02
318.39	13.20	A90/4589	34R-5, 139	Bulk	2.28	0.12
320.69	13.32	A90/4590	35R-1, 19	Bulk	2.28	–0.11
320.69	13.32	A90/4639	35R-1, 19	Bulk	2.15	–0.34
320.89	13.33	A90/4640	35R-1, 39	Bulk	2.13	–0.17
321.09	13.34	A90/3733	35R-1, 59	Bulk	2.13	–0.02
321.29	13.35	A90/4641	35R-1, 79	Bulk	2.11	–0.03
321.49	13.36	A90/4642	35R-1, 99	Bulk	2.28	0.15
321.69	13.37	A90/4643	35R-1, 119	Bulk	2.33	0.08
321.89	13.38	A90/4644	35R-1, 139	Bulk	2.41	0.18
322.09	13.40	A90/4645	35R-2, 9	Bulk	2.45	0.14
322.29	13.41	A90/4646	35R-2, 29	Bulk	2.47	0.17
322.49	13.42	A90/4647	35R-2, 49	Bulk	2.32	0.01
322.69	13.43	A90/3734	35R-2, 69	Bulk	2.29	0.15
322.89	13.44	A90/4648	35R-2, 89	Bulk	2.35	0.10
323.29	13.46	A90/4650	35R-2, 129	Bulk	2.24	–0.06
323.69	13.48	A90/4652	35R-3, 19	Bulk	2.27	–0.12
323.89	13.49	A90/4653	35R-3, 39	Bulk	2.23	0.11
324.09	13.50	A90/3774	35R-3, 59	Bulk	2.32	0.08
324.49	13.52	A90/4655	35R-3, 99	Bulk	2.29	0.06
325.09	13.55	A90/4656	35R-4, 9	Bulk	2.57	0.16
325.69	13.58	A90/3775	35R-4, 69	Bulk	2.50	–0.24
325.89	13.60	A90/4659	35R-4, 89	Bulk	2.65	0.04
326.09	13.61	A90/4660	35R-4, 109	Bulk	2.68	–0.03
326.29	13.63	A90/4661	35R-4, 129	Bulk	2.54	–0.07
327.09	13.69	A90/3776	35R-5, 59	Bulk	2.56	–0.10
330.19	13.94	A91/3221	36R-1, 19	Bulk	2.30	0.33
330.39	13.96	A91/3222	36R-1, 39	Bulk	2.24	0.37
330.59	13.98	A90/3777	36R-1, 59	Bulk	2.15	–0.05
330.79	13.99	A91/3223	36R-1, 79	Bulk	2.18	0.24
330.99	14.01	A91/3224	36R-1, 99	Bulk	2.03	0.14
331.19	14.03	A91/3225	36R-1, 119	Bulk	1.99	0.07
331.39	14.04	A91/3226	36R-1, 139	Bulk	2.04	0.12
331.59	14.06	A91/3227	36R-2, 9	Bulk	1.97	0.23
331.79	14.08	A91/3228	36R-2, 29	Bulk	1.80	0.22
331.99	14.09	A91/3229	36R-2, 49	Bulk	2.23	0.09
332.19	14.11	A90/3778	36R-2, 69	Bulk	2.08	0.02
332.39	14.13	A91/3230	36R-2, 89	Bulk	2.14	0.36
332.59	14.14	A91/3231	36R-2, 109	Bulk	2.19	0.23
332.79	14.16	A91/3286	36R-2, 129	Bulk	2.08	0.43
332.98	14.17	A91/3287	36R-2, 148	Bulk	2.07	0.13
333.19	14.19	A91/3288	36R-3, 19	Bulk	2.08	0.16
333.39	14.21	A91/3289	36R-3, 39	Bulk	2.10	0.36

Appendix A (continued).

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
333.59	14.22	A90/3779	36R-3, 59	Bulk	2.06	–0.06
333.79	14.24	A91/3290	36R-3, 79	Bulk	2.10	0.03
333.99	14.26	A91/3291	36R-3, 99	Bulk	2.29	0.00
334.19	14.27	A91/3292	36R-3, 119	Bulk	2.12	–0.02
334.39	14.29	A91/3293	36R-3, 139	Bulk	1.94	–0.03
334.59	14.31	A91/3294	36R-4, 9	Bulk	2.11	0.04
334.79	14.32	A91/3295	36R-4, 29	Bulk	2.12	0.03
334.99	14.34	A91/3296	36R-4, 49	Bulk	2.00	0.14
335.19	14.35	A90/3780	36R-4, 69	Bulk	2.05	–0.09
335.39	14.37	A91/3297	36R-4, 89	Bulk	2.25	0.04
335.59	14.39	A91/3298	36R-4, 109	Bulk	2.03	0.10
335.79	14.40	A91/3299	36R-4, 129	Bulk	2.12	0.14
335.98	14.42	A91/3300	36R-4, 148	Bulk	2.30	0.13
336.19	14.44	A91/3301	36R-5, 19	Bulk	2.30	0.28
336.39	14.45	A91/3302	36R-5, 39	Bulk	2.74	0.48
36.59	14.47	A90/3781	36R-5, 59	Bulk	2.22	0.30
336.79	14.49	A91/3303	36R-5, 79	Bulk	2.13	0.34
336.99	14.50	A91/3304	36R-5, 99	Bulk	2.37	0.33
337.19	14.52	A91/3305	36R-5, 119	Bulk	2.30	0.08
337.39	14.53	A91/3306	36R-5, 139	Bulk	2.21	0.03
337.59	14.55	A90/3782	36R-6, 9	Bulk	2.21	–0.07
339.89	14.74	A91/3307	37R-1, 19	Bulk	2.31	0.07
340.09	14.76	A91/3308	37R-1, 39	Bulk	2.32	0.28
340.29	14.77	A90/3783	37R-1, 59	Bulk	2.24	0.06
340.49	14.79	A91/3309	37R-1, 79	Bulk	2.18	0.00
340.69	14.81	A91/3310	37R-1, 99	Bulk	2.58	0.02
340.89	14.82	A91/3311	37R-1, 119	Bulk	2.25	0.10
341.09	14.84	A91/3312	37R-1, 139	Bulk	2.65	0.35
341.29	14.85	A91/3313	37R-2, 9	Bulk	2.24	0.16
341.49	14.87	A91/3314	37R-2, 29	Bulk	2.24	0.22
341.69	14.89	A91/3315	37R-2, 49	Bulk	2.65	0.41
341.89	14.90	A90/3784	37R-2, 69	Bulk	2.16	0.05
342.09	14.92	A91/3316	37R-2, 89	Bulk	2.21	0.29
342.29	14.94	A91/3317	37R-2, 109	Bulk	2.13	0.09
342.49	14.95	A91/3318	37R-2, 129	Bulk	2.22	0.20
342.68	14.97	A91/3319	37R-2, 148	Bulk	2.49	0.12
342.89	14.99	A91/3320	37R-3, 19	Bulk	2.22	–0.25
343.09	15.00	A91/3321	37R-3, 39	Bulk	2.42	0.06
343.29	15.02	A90/3785	37R-3, 59	Bulk	2.42	–0.26
343.49	15.03	A91/3325	37R-3, 79	Bulk	2.43	0.01
343.69	15.05	A91/3326	37R-3, 99	Bulk	2.37	–0.02
343.89	15.07	A91/3327	37R-3, 119	Bulk	2.25	0.08
344.09	15.08	A91/3328	37R-3, 139	Bulk	2.07	0.14
344.29	15.10	A91/3329	37R-4, 9	Bulk	2.21	0.06
344.49	15.12	A91/3330	37R-4, 29	Bulk	2.28	0.03
344.69	15.13	A91/3331	37R-4, 49	Bulk	2.21	0.03
344.89	15.15	A90/3786	37R-4, 69	Bulk	2.03	0.01
345.09	15.17	A91/3332	37R-4, 89	Bulk	2.15	0.29
345.29	15.18	A91/3333	37R-4, 109	Bulk	2.26	0.16
345.49	15.20	A91/3334	37R-4, 129	Bulk	2.30	0.28
345.68	15.21	A91/3335	37R-4, 148	Bulk	2.25	0.27
345.89	15.23	A91/3336	37R-5, 19	Bulk	2.27	0.07
346.09	15.25	A91/3337	37R-5, 39	Bulk	2.30	0.22
346.49	15.28	A91/3338	37R-5, 79	Bulk	2.63	0.17
346.69	15.30	A91/3398	37R-5, 99	Bulk	2.46	0.10
346.89	15.31	A91/3340	37R-5, 119	Bulk	2.40	0.19
347.09	15.33	A91/3342	37R-5, 139	Bulk	2.27	–0.18
347.29	15.35	A91/3343	37R-6, 9	Bulk	2.39	–0.10
347.49	15.36	A91/3344	37R-6, 29	Bulk	2.15	0.04
349.59	15.53	A91/3345	38R-1, 19	Bulk	2.59	0.07
349.79	15.55	A91/3346	38R-1, 39	Bulk	2.75	0.31
349.99	15.57	A90/3789	38R-1, 59	Bulk	2.59	–0.12
350.19	15.58	A91/3347	38R-1, 79	Bulk	2.40	0.03
350.39	15.60	A91/3348	38R-1, 99	Bulk	2.63	0.06
350.59	15.62	A91/3349	38R-1, 119	Bulk	2.68	0.18
350.77	15.63	A91/3350	38R-1, 137	Bulk	2.66	0.03
350.99	15.65	A91/3351	38R-2, 9	Bulk	2.41	–0.13
351.19	15.67	A91/3352	38R-2, 29	Bulk	2.26	0.00
351.39	15.68	A91/3353	38R-2, 49	Bulk	2.43	0.18
351.59	15.70	A90/3790	38R-2, 69	Bulk	2.75	0.15
351.79	15.71	A91/3354	38R-2, 89	Bulk	2.82	0.16
351.99	15.73	A91/3355	38R-2, 109	Bulk	2.74	0.15
352.19	15.75	A91/3356	38R-2, 129	Bulk	2.56	0.41
352.38	15.76	A91/3357	38R-2, 148	Bulk	2.52	0.37
352.59	15.78	A91/3358	38R-3, 19	Bulk	2.61	0.09
352.79	15.80	A91/3359	38R-3, 39	Bulk	2.53	0.17
352.99	15.81	A90/3791	38R-3, 59	Bulk	2.49	0.40
353.19	15.83	A91/3360	38R-3, 79	Bulk	2.67	0.23
353.39	15.85	A91/3361	38R-3, 99	Bulk	2.63	0.17
353.99	15.90	A91/3362	38R-4, 9	Bulk	2.34	0.18
354.19	15.91	A91/3363	38R-4, 29	Bulk	2.39	0.13
354.39	15.93	A91/3364	38R-4, 49	Bulk	2.37	0.06
354.59	15.94	A90/3792	38R-4, 69	Bulk	2.40	0.24
354.79	15.96	A91/3365	38R-4, 89	Bulk	2.40	0.12
354.99	15.98	A91/3366	38R-4, 109	Bulk	2.56	0.19
355.19	15.99	A91/3367	38R-4, 129	Bulk	2.43	0.02
355.38	16.01	A91/3368	38R-4, 148	Bulk	2.50	0.01
355.59	16.03	A91/3369	38R-5, 19	Bulk	2.52	–0.02
355.79	16.04	A91/3370	38R-5, 39	Bulk	2.86	0.28
355.99	16.06	A90/3793	38R-5, 59	Bulk	2.56	0.30
356.19	16.08	A91/3371	38R-5, 79	Bulk	2.33	0.32
356.39	16.09	A91/3372	38R-5, 99	Bulk	2.20	0.09
356.59	16.11	A91/3373	38R-5, 119	Bulk	2.42	–0.12
359.19	16.32	A91/3374	39R-1, 19	Bulk	2.36	0.20
359.39	16.34	A91/3375	39R-1, 39	Bulk	2.37	0.23
359.61	16.36	A90/3794	39R-1, 61	Bulk	2.39	0.30
359.79	16.37	A91/3376	39R-1, 79	Bulk	2.27	–0.03
360.04	16.39	A91/3377	39R-1, 104	Bulk	2.30	0.15
360.19	16.40	A91/3378	39R-1, 119	Bulk	2.24	–0.04
360.39	16.42	A91/3379	39R-1, 139	Bulk	2.32	0.07
360.59	16.44	A91/3380	39R-2, 9	Bulk	2.30	0.18
360.79	16.45	A91/3381	39R-2, 29	Bulk	2.09	–0.02
361.00	16.47	A91/3382	39R-2, 50	Bulk	2.13	–0.02
361.19	16.49	A90/3795	39R-2, 69	Bulk	2.28	0.18
361.39	16.50	A91/3383	39R-2, 89	Bulk	2.31	0.01
361.57	16.52	A91/3384	39R-2, 107	Bulk	2.28	0.10
361.79	16.53	A91/3385	39R-2, 129	Bulk	2.26	0.08
361.98	16.55	A91/3386	39R-2, 148	Bulk	2.24	–0.06
362.19	16.57	A91/3387	39R-3, 19	Bulk	2.14	–0.37
362.39	16.58	A91/3388	39R-3, 39	Bulk	2.19	–0.12
362.59	16.60	A90/3997	39R-3, 59	Bulk	2.28	–0.07
362.79	16.62	A91/3389	39R-3, 79	Bulk	2.28	–0.12
362.99	16.63	A91/3390	39R-3, 99	Bulk	2.30	–0.12
363.19	16.65	A91/3391	39R-3, 119	Bulk	2.23	0.04
363.39	16.67	A91/3392	39R-3, 139	Bulk	2.13	0.21
363.59	16.68	A91/3393	39R-4, 9	Bulk	2.18	–0.10
363.79	16.70	A91/3394	39R-4, 29	Bulk	2.18	0.01
363.99	16.71	A91/3395	39R-4, 49	Bulk	2.09	0.07
364.19	16.73	A90/3998	39R-4, 69	Bulk	2.20	–0.15
364.33	16.74	A91/3396	39R-4, 83	Bulk	2.16	–0.25
364.57	16.76	A91/3397	39R-4, 107	Bulk	2.26	–0.31
364.81	16.78	A91/3398	39R-4, 131	Bulk	2.24	–0.28
364.98	16.80	A91/3399	39R-4, 148	Bulk	2.01	–0.15
365.19	16.81	A91/3400	39R-5, 19	Bulk	2.21	0.00
365.39	16.83	A91/3401	39R-5, 39	Bulk	2.23	0.13
365.59	16.85	A90/3999	39R-5, 59	Bulk	2.37	0.19
365.79	16.86	A91/3402	39R-5, 79	Bulk	2.33	0.21
365.99	16.88	A91/3403	39R-5, 99	Bulk	2.37	0.20
366.19	16.89	A91/3404	39R-5, 119	Bulk	2.37	–0.04
366.39	16.91	A91/3405	39R-5, 139	Bulk	2.31	0.19
366.59	16.93	A91/3406	39R-6, 9	Bulk	2.31	0.03
366.79	16.94	A91/3407	39R-6, 29	Bulk	2.19	–0.02
366.99	16.96	A91/3408	39R-6, 49	Bulk	2.13	0.01
367.19	16.98	A90/4000	39R-6, 69	Bulk	2.36	–0.01
367.39	16.99	A91/3409	39R-6, 89	Bulk	2.35	–0.24
367.59	17.01	A91/3410	39R-6, 109	Bulk	2.26	–0.26
368.89	17.12	A91/3411	40X-1, 19	Bulk	2.21	0.03
369.09	17.13	A91/3412	40X-1, 39	Bulk	2.35	–0.03
369.49	17.17	A91/3413	40X-1, 79	Bulk	2.28	–0.39
370.89	17.28	A90/4002	40X-2, 69	Bulk	2.30	0.17
372.29	17.39	A90/4003	40X-3, 59	Bulk	2.44	0.28
373.90	17.53	A90/4004	40X-4, 70	Bulk	2.29	0.00
375.29	17.64	A90/4005	40X-5, 59	Bulk	2.08	–0.16
376.69	17.76	A90/4006	40X-6, 49	Bulk	2.17	–0.21
378.88	17.93	A90/4007	41R-1, 58	Bulk	2.25	0.26
380.31	18.05	A90/4008	41R-2, 51	Bulk	2.06	0.05
381.89	18.18	A90/4009	41R-3, 59	Bulk	2.14	0.43
383.48	18.31	A90/4010	41R-4, 68	Bulk	1.90	0.40
384.89	18.43	A90/4011	41R-5, 59	Bulk	1.56	0.28

APPENDIX B

Bulk-rock and Foraminiferal Isotope Data from Hole 806B

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
416.99	12.51	A90/2941	45X-1, 9	Bulk	1.44	–0.21
417.19	12.52	A91/682	45X-1, 29	*D. alt.*	1.97	–0.82
417.19	12.52	A90/2942	45X-1, 29	Bulk	1.56	0.24
417.39	12.53	A91/681	45X-1, 49	*G. venez.*	1.64	–0.69
417.39	12.53	A90/2943	45X-1, 49	Bulk	1.62	–0.02
417.39	12.53	A91/680	45X-1, 49	*D. alt.*	1.99	–0.99
417.59	12.53	A91/1763	45X-1, 69	*D. alt.*	2.13	–1.23
417.59	12.53	A91/2405	45X-1, 69	*G. venez.*	1.81	–0.64
417.59	12.53	A90/2944	45X-1, 69	Bulk	1.64	–0.10
417.79	12.54	A90/2945	45X-1, 89	Bulk	1.51	0.05
417.79	12.54	A91/674	45X-1, 89	*D. alt.*	2.14	–1.15
417.79	12.54	A91/675	45X-1, 89	*G. venez.*	1.63	–0.77
417.99	12.55	A90/2946	45X-1, 109	Bulk	1.43	0.62
417.99	12.55	A91/673	45X-1, 109	*G. venez.*	1.41	–0.61
417.99	12.55	A91/672	45X-1, 109	*D. alt.*	2.14	–0.91
418.19	12.55	A90/2947	45X-1, 129	Bulk	1.36	–0.14
418.19	12.55	A91/670	45X-1, 129	*D. alt.*	1.94	–1.14
418.19	12.55	A91/671	45X-1, 129	*G. venez.*	1.83	–0.77
418.59	12.57	A90/2949	45X-2, 19	Bulk	1.31	0.20
418.79	12.57	A90/2950	45X-2, 39	Bulk	1.35	0.14
418.99	12.58	A91/1761	45X-2, 59	*D. alt.*	1.88	–0.96
418.99	12.58	A90/2951	45X-2, 59	Bulk	1.45	0.21
418.99	12.58	A91/1427	45X-2, 59	*Cib.* spp.	0.85	2.13
418.99	12.58	A91/1426	45X-2, 59	*P. wuell.*	0.97	1.99
418.99	12.58	A91/1762	45X-2, 59	*G. venez.*	1.49	–0.20
419.19	12.59	A91/1428	45X-2, 79	IB	0.86	2.26
419.19	12.59	A90/2952	45X-2, 79	Bulk	1.45	0.10
419.39	12.59	A91/1429	45X-2, 99	*Cib.* spp.	1.00	2.28
419.39	12.59	A90/2953	45X-2, 99	Bulk	1.47	0.26
419.59	12.60	A91/1431	45X-2, 119	*Cib.* spp.	0.82	2.24
419.59	12.60	A90/2954	45X-2, 119	Bulk	1.48	0.22
419.59	12.60	A91/1430	45X-2, 119	*P. wuell.*	1.08	2.18
419.79	12.61	A91/1432	45X-2, 139	*P. wuell.*	1.00	2.13
419.79	12.61	A91/1433	45X-2, 139	*Cib.* spp.	0.92	2.11
419.79	12.61	A91/575	45X-2, 139	*G. venez.*	1.71	–0.51
419.79	12.61	A90/2948	45X-2, 139	Bulk	1.47	0.24
419.99	12.61	A90/2955	45X-3, 9	Bulk	1.49	–0.02
419.99	12.61	A91/569	45X-3, 9	*D. alt.*	2.01	–1.10
419.99	12.61	A91/1434	45X-3, 9	*P. wuell.*	1.07	1.98
419.99	12.61	A91/1435	45X-3, 9	*Cib.* spp.	1.03	2.01
419.99	12.61	A91/570	45X-3, 9	*G. venez.*	1.97	–0.74
420.19	12.62	A90/2956	45X-3, 29	Bulk	1.46	–0.01
420.19	12.62	A91/460	45X-3, 29	*D. alt.*	2.17	–0.97
420.39	12.63	A91/1437	45X-3, 49	*Cib.* spp.	0.98	2.08
420.39	12.63	A91/455	45X-3, 49	*D. alt.*	1.90	–0.59
420.39	12.63	A91/456	45X-3, 49	*G. venez.*	1.95	–0.77
420.39	12.63	A90/2957	45X-3, 49	Bulk	1.46	0.04
420.39	12.63	A91/1436	45X-3, 49	*P. wuell.*	1.06	2.17
420.59	12.63	A91/1438	45X-3, 69	*P. wuell.*	0.91	2.09
420.59	12.63	A91/1439	45X-3, 69	*Cib.* spp.	0.96	2.17
420.59	12.63	A91/1759	45X-3, 69	*D. alt.*	1.95	–0.99
420.59	12.63	A90/2958	45X-3, 69	Bulk	1.47	0.17
420.59	12.63	A91/1760	45X-3, 69	*G. venez.*	1.79	–0.71
420.79	12.64	A91/1440	45X-3, 89	*P. wuell.*	1.08	2.21
420.79	12.64	A91/1441	45X-3, 89	*Cib.* spp.	0.74	2.27
420.79	12.64	A90/2959	45X-3, 89	Bulk	1.49	–0.05
420.79	12.64	A91/446	45X-3, 89	*G. venez.*	1.65	–0.48
420.79	12.64	A91/445	45X-3, 89	*D. alt.*	2.06	–0.77
420.99	12.65	A91/440	45X-3, 109	*D. alt.*	2.00	–0.86
420.99	12.65	A90/2960	45X-3, 109	Bulk	1.54	0.17
420.99	12.65	A91/1442	45X-3, 109	*Cib.* spp.	0.85	2.13
420.99	12.65	A91/441	45X-3, 109	*G. venez.*	1.89	–0.37
421.59	12.67	A91/436	45X-4, 19	*G. venez.*	2.16	–0.93
421.59	12.67	A91/1443	45X-4, 19	*Cib.* spp.	0.90	2.38
421.59	12.67	A91/435	45X-4, 19	*D. alt.*	2.07	–0.65
421.59	12.67	A90/2961	45X-4, 19	Bulk	1.46	0.36
421.79	12.68	A91/1444	45X-4, 39	*P. wuell.*	0.99	2.27
421.79	12.68	A91/431	45X-4, 39	*G. venez.*	1.76	–0.81
421.79	12.68	A90/2962	45X-4, 39	Bulk	1.48	0.12
421.79	12.68	A91/430	45X-4, 39	*D. alt.*	2.05	–0.69
421.79	12.68	A91/1445	45X-4, 39	*Cib.* spp.	0.97	2.36
421.99	12.68	A90/2963	45X-4, 59	Bulk	1.41	0.06
421.99	12.68	A91/1447	45X-4, 59	*Cib.* spp.	1.02	2.22
421.99	12.68	A91/426	45X-4, 59	*G. venez.*	1.91	–0.54
421.99	12.68	A91/1757	45X-4, 59	*D. alt.*	1.87	–0.85
421.99	12.68	A91/1446	45X-4, 59	*P. wuell.*	1.04	2.30
422.19	12.69	A91/1448	45X-4, 79	*P. wuell.*	1.12	2.05
422.19	12.69	A90/2964	45X-4, 79	Bulk	1.39	–0.06
422.19	12.69	A91/1449	45X-4, 79	*Cib.* spp.	1.01	2.23
422.39	12.70	A91/416	45X-4, 99	*G. venez.*	1.88	–0.82
422.39	12.70	A91/1450	45X-4, 99	*Cib.* spp.	1.11	2.34
422.39	12.70	A90/2965	45X-4, 99	Bulk	1.52	0.16
422.39	12.70	A91/415	45X-4, 99	*D. alt.*	2.14	–0.88
422.59	12.70	A91/1451	45X-4, 119	*P. wuell.*	1.06	1.96
422.59	12.70	A90/2966	45X-4, 119	Bulk	1.63	0.09
422.59	12.70	A91/411	45X-4, 119	*G. venez.*	2.29	–0.96
422.59	12.70	A91/410	45X-4, 119	*D. alt.*	2.05	–0.97
422.59	12.70	A91/1452	45X-4, 119	*Cib.* spp.	1.12	2.22
422.79	12.71	A90/2967	45X-4, 129	Bulk	1.57	0.04
422.79	12.71	A91/1453	45X-4, 139	*Cib.* spp.	1.03	2.16
422.79	12.71	A91/405	45X-4, 139	*D. alt.*	2.08	–0.87
422.79	12.71	A91/406	45X-4, 139	*G. venez.*	2.03	–0.86
422.99	12.72	A91/1454	45X-5, 9	*Cib.* spp.	1.00	2.14
422.99	12.72	A90/2968	45X-5, 9	Bulk	1.56	0.06
422.99	12.72	A91/401	45X-5, 9	*G. venez.*	1.66	–0.72
422.99	12.72	A91/400	45X-5, 9	*D. alt.*	2.28	–1.07
423.19	12.72	A91/254	45X-5, 29	*D. alt.*	2.15	–0.88
423.19	12.72	A91/1457	45X-5, 29	*Cib.* spp.	0.87	2.11
423.19	12.72	A90/2969	45X-5, 29	Bulk	1.59	–0.14
423.19	12.72	A91/255	45X-5, 29	*G. venez.*	1.92	–0.62
423.39	12.73	A91/1456	45X-5, 49	*Cib.* spp.	1.03	2.26
423.39	12.73	A91/259	45X-5, 49	*D. alt.*	2.19	–0.61
423.39	12.73	A90/2970	45X-5, 49	Bulk	1.63	–0.02
423.39	12.73	A91/260	45X-5, 49	*G. venez.*	1.71	–0.32
423.39	12.73	A91/1455	45X-5, 49	*P. wuell.*	1.02	2.24
423.59	12.74	A91/1756	45X-5, 69	*G. venez.*	1.75	–0.04
423.59	12.74	A90/2971	45X-5, 69	Bulk	1.50	0.23
423.59	12.74	A91/1458	45X-5, 69	*Cib.* spp.	1.11	2.27
423.59	12.74	A91/1755	45X-5, 69	*D. alt.*	2.13	–1.00
423.79	12.74	A91/245	45X-5, 89	*G. venez.*	1.79	–0.38
423.79	12.74	A91/1459	45X-5, 89	*Cib.* spp.	1.06	2.18
423.79	12.74	A91/244	45X-5, 89	*D. alt.*	2.13	–1.01
423.79	12.74	A90/2972	45X-5, 89	Bulk	1.59	0.19
423.99	12.75	A90/2973	45X-5, 109	Bulk	1.52	–0.11
423.99	12.75	A91/1460	45X-5, 109	*P. wuell.*	1.08	2.12
423.99	12.75	A91/239	45X-5, 109	*D. alt.*	2.14	–0.92
423.99	12.75	A91/240	45X-5, 109	*G. venez.*	1.88	–0.76
423.99	12.75	A91/1461	45X-5, 109	*Cib.* spp.	1.00	2.21
424.19	12.76	A91/1463	45X-5, 129	*Cib.* spp.	1.06	2.15
424.19	12.76	A90/2974	45X-5, 129	Bulk	1.45	–0.08
424.19	12.76	A91/235	45X-5, 129	*G. venez.*	1.70	–0.90
424.19	12.76	A91/234	45X-5, 129	*D. alt.*	1.91	–0.95
424.19	12.76	A91/1462	45X-5, 129	*P. wuell.*	1.10	2.28
424.59	12.77	A91/230	45X-6, 19	*G. venez.*	1.81	–0.82
424.59	12.77	A90/2975	45X-6, 19	Bulk	1.53	0.30
424.59	12.77	A91/229	45X-6, 19	*D. alt.*	1.87	–1.06
424.59	12.77	A91/1464	46X-6, 19	*Cib.* spp.	0.96	1.92
424.79	12.78	A90/2976	45X-6, 39	Bulk	1.35	–0.14
424.79	12.78	A91/186	45X-6, 39	*D. alt.*	1.96	–0.93
424.79	12.78	A91/1465	45X-6, 39	*Cib.* spp.	0.98	1.91
424.79	12.78	A91/187	45X-6, 39	*G. venez.*	1.92	–0.77
424.99	12.78	A91/1466	45X-6, 59	*P. wuell.*	1.02	2.25
424.99	12.78	A91/182	45X-6, 59	*G. venez.*	1.74	–0.49
424.99	12.78	A91/1467	45X-6, 59	*Cib.* spp.	1.07	2.09
424.99	12.78	A91/1753	45X-6, 59	*D. alt.*	1.83	–1.22
424.99	12.78	A90/2977	45X-6, 59	Bulk	1.41	–0.24
425.19	12.79	A90/2978	45X-6, 79	Bulk	1.47	–0.07
425.19	12.79	A91/177	45X-6, 79	*G. venez.*	1.92	–0.76
425.19	12.79	A91/176	45X-6, 79	*D. alt.*	1.87	–0.74
425.19	12.79	A91/1468	45X-6, 79	*Cib.* spp.	0.97	2.06
425.39	12.80	A91/1469	45X-6, 99	*P. wuell.*	1.11	2.02
425.39	12.80	A90/2979	45X-6, 99	Bulk	1.53	–0.10
425.39	12.80	A91/1470	45X-6, 99	*Cib.* spp.	1.12	2.06
425.39	12.80	A91/172	45X-6, 99	*G. venez.*	1.92	–0.90
425.39	12.80	A91/171	45X-6, 99	*D. alt.*	1.95	–0.89
425.59	12.80	A90/2980	45X-6, 119	Bulk	1.43	–0.02
425.79	12.80	A91/676	45X-6, 139	*D. alt.*	1.98	–0.99
425.79	12.80	A91/1471	45X-6, 139	*Cib.* spp.	0.96	2.12
425.79	12.80	A91/677	45X-6, 139	*G. venez.*	1.41	0.08
425.79	12.80	A90/2981	45X-6, 139	Bulk	1.46	0.11
426.59	12.81	A91/162	46X-1, 9	*G. venez.*	1.59	0.12
426.59	12.81	A91/161	46X-1, 9	*D. alt.*	1.94	–0.71
426.59	12.81	A90/2982	46X-1, 9	Bulk	1.85	0.39
426.79	12.81	A90/2983	46X-1, 29	Bulk	1.79	0.33
426.79	12.81	A91/156	46X-1, 29	*D. alt.*	1.87	–0.86
426.79	12.81	A91/157	46X-1, 29	*G. venez.*	1.87	–1.00

Appendix B (continued).

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
426.99	12.81	A91/152	46X-1, 49	*G. venez.*	2.27	–1.01
426.99	12.81	A91/1473	46X-1, 49	*P. wuell.*	1.06	2.10
426.99	12.81	A90/2984	46X-1, 49	Bulk	1.88	0.52
426.99	12.81	A91/151	46X-1, 49	*D. alt.*	1.88	–0.89
427.19	12.81	A91/1752	46X-1, 69	*G. venez.*	1.95	–0.84
427.19	12.81	A91/1474	46X-1, 69	*Cib.* spp.	1.08	1.97
427.19	12.81	A91/1751	46X-1, 69	*D. alt.*	2.07	–0.67
427.19	12.81	A90/2985	46X-1, 69	Bulk	1.94	0.34
427.39	12.82	A90/2986	46X-1, 89	Bulk	1.84	0.33
427.39	12.82	A90/4922	46X-1, 89	*D. alt.*	2.13	–0.98
427.39	12.82	A91/1475	46X-1, 89	*P. wuell.*	1.17	2.12
427.39	12.82	A91/1476	46X-1, 89	*Cib.* spp.	1.05	2.07
427.39	12.82	A90/4923	46X-1, 89	*G. venez.*	1.87	–0.60
427.59	12.82	A90/4918	46X-1, 109	*G. venez.*	2.11	–0.95
427.59	12.82	A91/1477	46X-1, 109	*P. wuell.*	1.02	2.15
427.59	12.82	A90/4917	46X-1, 109	*D. alt.*	1.98	–0.95
427.59	12.82	A90/2987	46X-1, 109	Bulk	1.80	0.37
427.79	12.82	A91/1478	46X-1, 129	*Cib.* spp.	0.98	2.20
427.79	12.82	A90/4913	46X-1, 129	*G. venez.*	1.87	–0.60
427.79	12.82	A90/2988	46X-1, 129	Bulk	1.69	0.22
427.79	12.82	A90/4912	46X-1, 129	*D. alt.*	1.80	–0.76
428.19	12.82	A90/4907	46X-2, 19	*G. venez.*	1.89	–0.80
428.19	12.82	A90/4906	46X-2, 19	*D. alt.*	1.80	–1.00
428.19	12.82	A91/1479	46X-2, 19	*Cib.* spp.	0.84	1.97
428.19	12.82	A90/2989	46X-2, 19	Bulk	1.57	0.50
428.39	12.82	A90/2990	46X-2, 39	Bulk	1.49	0.41
428.39	12.82	A91/1480	46X-2, 59	*Cib.* spp.	0.86	2.17
428.59	12.82	A91/1749	46X-2, 59	*D. alt.*	1.85	–1.12
428.59	12.82	A90/2991	46X-2, 59	Bulk	1.53	0.27
428.59	12.82	A91/1750	46X-2, 59	*G. venez.*	1.58	–0.10
428.79	12.83	A90/4893	46X-2, 79	*G. venez.*	1.77	–0.62
428.79	12.83	A91/1281	46X-2, 79	*Cib.*	0.59	2.18
428.79	12.83	A90/2992	46X-2, 79	Bulk	1.45	0.13
428.79	12.83	A90/4892	46X-2, 79	*D. alt.*	2.09	–0.98
428.99	12.83	A90/4886	46X-2, 99	*G. venez.*	1.73	–0.40
428.99	12.83	A90/2993	46X-2, 99	Bulk	1.65	0.27
428.99	12.83	A91/1285	46X-2, 99	*Cib. mun.*	1.06	2.26
428.99	12.83	A90/4885	46X-2, 99	*D. alt.*	1.99	–1.03
429.19	12.83	A90/4880	46X-2, 119	*G. venez.*	1.73	–0.61
429.19	12.83	A90/2994	46X-2, 119	Bulk	1.74	0.33
429.19	12.83	A91/683	46X-2, 119	*D. alt.*	2.57	–1.02
429.39	12.83	A90/4838	46X-2, 139	*G. venez.*	1.97	–0.52
429.39	12.83	A90/2995	46X-2, 139	Bulk	1.71	0.37
429.59	12.83	A90/2996	46X-3, 9	Bulk	1.68	0.40
429.59	12.83	A90/4833	46X-3, 9	*G. venez.*	2.21	–0.96
429.59	12.83	A90/4832	46X-3, 9	*D. alt.*	2.03	–1.10
429.79	12.83	A90/4828	46X-3, 29	*G. venez.*	1.89	–0.81
429.79	12.83	A91/1282	46X-3, 29	*Cib. mun.*	0.90	1.84
429.79	12.83	A90/4827	46X-3, 29	*D. alt.*	2.00	–0.98
429.79	12.83	A90/2997	46X-3, 29	Bulk	1.51	0.36
429.99	12.84	A90/4726	46X-3, 49	*G. venez.*	2.23	–0.99
429.99	12.84	A90/2998	46X-3, 49	Bulk	1.58	0.29
429.99	12.84	A90/4725	46X-3, 49	*D. alt.*	2.15	–0.97
430.19	12.84	A91/1747	46X-3, 69	*D. alt.*	2.09	–1.11
430.19	12.84	A91/1748	46X-3, 69	*G. venez.*	1.99	–0.63
430.19	12.84	A90/2999	46X-3, 69	Bulk	1.62	0.27
430.39	12.84	A90/4716	46X-3, 89	*G. venez.*	1.76	–0.83
430.39	12.84	A90/3000	46X-3, 89	Bulk	1.51	0.12
430.39	12.84	A90/4715	46X-3, 89	*D. alt.*	2.07	–0.97
430.59	12.84	A91/1289	46X-3, 109	*Cib. mun.*	0.94	2.22
430.59	12.84	A90/4710	46X-3, 109	*D. alt.*	1.89	–0.88
430.59	12.84	A90/4711	46X-3, 109	*G. venez.*	1.93	–0.72
430.59	12.84	A90/3001	46X-3, 109	Bulk	1.61	0.35
430.79	12.84	A90/3002	46X-3, 129	Bulk	1.63	0.31
430.79	12.84	A90/4705	46X-3, 129	*D. alt.*	2.00	–0.91
430.79	12.84	A90/4706	46X-3, 129	*G. venez.*	1.73	–0.84
431.19	12.84	A90/4700	46X-4, 19	*D. alt.*	2.06	–0.95
431.19	12.84	A90/4701	46X-4, 19	*G. venez.*	1.85	–1.12
431.19	12.84	A91/3176	46X-4, 19	Bulk	1.60	0.19
431.39	12.85	A90/4696	46X-4, 39	*G. venez.*	1.88	–1.12
431.39	12.85	A91/1286	46X-4, 39	*Cib. mun.*	1.01	2.14
431.39	12.85	A91/3177	46X-4, 36	Bulk	1.61	0.32
431.59	12.85	A91/3178	46X-4, 59	Bulk	1.61	0.38
431.59	12.85	A91/1745	46X-4, 59	*D. alt.*	2.29	–0.97
431.59	12.85	A91/1746	46X-4, 59	*G. venez.*	2.01	–0.90
431.79	12.85	A90/4685	46X-4, 79	*D. alt.*	2.21	–1.10
431.79	12.85	A91/3179	46X-4, 79	Bulk	1.55	0.24
431.79	12.85	A90/4686	46X-4, 79	*G. venez.*	2.00	–1.06
431.99	12.85	A90/4681	46X-4, 99	*G. venez.*	2.04	–0.89
431.99	12.85	A91/1288	46X-4, 99	*Cib. mun.*	0.80	2.07
431.99	12.85	A90/4680	46X-4, 99	*D. alt.*	1.97	–1.03
431.99	12.85	A91/3180	46X-4, 99	Bulk	1.58	0.42
432.19	12.85	A91/3181	46X-4, 119	Bulk	1.61	0.23
432.19	12.85	A90/4675	46X-4, 119	*D. alt.*	1.90	–0.99
432.19	12.85	A91/1292	46X-4, 119	*Cib. mun.*	0.87	2.09
432.19	12.85	A90/4676	46X-4, 119	*G. venez.*	2.03	–1.21
432.23	12.85	A91/3182	46X-4, 123	Bulk	1.58	0.35
432.39	12.85	A90/4670	46X-4, 139	*D. alt.*	2.05	–0.92
432.39	12.85	A91/3183	46X-4, 139	Bulk	1.61	0.29
432.39	12.85	A90/4671	46X-4, 139	*G. venez.*	1.76	–0.77
432.59	12.86	A90/4637	46X-5, 9	*G. venez.*	1.93	–0.83
432.59	12.86	A91/3184	46X-5, 9	Bulk	1.51	0.02
432.59	12.86	A90/4636	46X-5, 9	*D. alt.*	2.05	–0.96
432.79	12.86	A90/4632	46X-5, 29	*G. venez.*	2.01	–0.95
432.79	12.86	A91/3185	46X-5, 29	Bulk	1.65	0.28
432.79	12.86	A90/4631	46X-5, 29	*D. alt.*	2.15	–0.97
432.99	12.86	A91/3189	46X-5, 49	Bulk	1.70	0.35
432.99	12.86	A90/4627	46X-5, 49	*G. venez.*	2.21	–0.77
432.99	12.86	A90/4626	46X-5, 49	*D. alt.*	2.22	–0.80
433.19	12.86	A91/3190	46X-5, 69	Bulk	1.72	0.37
433.19	12.86	A91/1744	46X-5, 69	*G. venez.*	2.06	–0.73
433.19	12.86	A91/1743	46X-5, 69	*D. alt.*	2.27	–1.01
433.39	12.86	A90/4616	46X-5, 89	*D. alt.*	2.27	–0.96
433.39	12.86	A91/3186	46X-5, 89	Bulk	1.77	0.29
433.39	12.86	A90/4617	46X-5, 89	*G. venez.*	2.23	–0.83
433.59	12.86	A91/3187	46X-5, 109	Bulk	1.74	0.40
433.59	12.86	A90/4612	46X-5, 109	*G. venez.*	2.26	–0.83
433.59	12.86	A90/4611	46X-5, 109	*D. alt.*	2.29	–0.86
433.79	12.87	A91/3188	46X-5, 129	Bulk	1.80	0.42
433.79	12.87	A90/4606	46X-5, 129	*D. alt.*	2.07	–0.87
433.79	12.87	A91/1290	46X-5, 129	*Cib. mun.*	1.13	2.19
433.79	12.87	A90/4607	46X-5, 129	*G. venez.*	2.10	–0.84
434.19	12.87	A91/3191	46X-6, 19	Bulk	1.75	0.30
434.19	12.87	A90/4601	46X-6, 19	*D. alt.*	2.11	–0.98
434.19	12.87	A90/4602	46X-6, 19	*G. venez.*	1.87	–0.86
434.19	12.87	A91/1291	46X-6, 19	*Cib. mun.*	1.07	2.25
434.39	12.87	A91/3192	46X-6, 39	Bulk	1.68	0.35
434.39	12.87	A90/4546	46X-6, 39	*G. venez.*	2.23	–0.91
434.39	12.87	A90/4545	46X-6, 39	*D. alt.*	1.75	–0.87
434.59	12.87	A91/3193	46X-6, 59	Bulk	1.63	0.25
434.59	12.87	A91/1741	46X-6, 59	*D. alt.*	1.97	–0.90
434.59	12.87	A91/1742	46X-6, 59	*G. venez.*	1.90	–0.74
434.79	12.87	A91/3194	46X-6, 79	Bulk	1.70	0.41
434.79	12.87	A90/4535	46X-6, 79	*D. alt.*	1.97	–0.75
434.79	12.87	A90/4536	46X-6, 79	*G. venez.*	2.09	–0.95
434.99	12.87	A90/4532	46X-6, 99	*G. venez.*	2.03	–0.65
434.99	12.87	A91/3195	46X-6, 99	Bulk	1.79	0.36
434.99	12.87	A90/4531	46X-6, 99	*D. alt.*	2.12	–0.92
435.19	12.88	A90/4528	46X-6, 119	*G. venez.*	1.64	–0.48
435.19	12.88	A91/3196	46X-6, 119	Bulk	1.80	0.33
435.19	12.88	A90/4527	46X-6, 119	*D. alt.*	2.22	–0.96
435.39	12.88	A91/1046	46X-6, 139	*D. alt.*	2.07	–0.98
435.39	12.88	A91/1047	46X-6, 139	*G. venez.*	1.82	–0.52
435.39	12.88	A91/3197	46X-6, 139	Bulk	1.77	0.34
435.59	12.88	A91/1738	46X-7, 9	*G. venez.*	1.98	–0.66
435.59	12.88	A91/1737	46X-7, 9	*D. alt.*	2.23	–0.89
435.59	12.88	A91/1424	46X-7, 9	*Cib.* spp.	1.18	2.16
436.18	12.88	A90/3018	47X-1, 8	Bulk	1.66	0.02
436.39	12.89	A90/3019	47X-1, 29	Bulk	1.63	–0.04
436.59	12.89	A90/3020	47X-1, 49	Bulk	1.68	–0.01
436.79	12.89	A91/1423	47X-1, 69	*Cib.* spp.	1.13	2.22
436.79	12.89	A91/1422	47X-1, 69	*P. wuell.*	1.18	2.08
436.79	12.89	A91/1740	47X-1, 69	*G. venez.*	1.77	–0.64
436.79	12.89	A91/2430	47X-1, 69	*D. alt.*	2.12	–0.90
436.99	12.89	A90/3021	47X-1, 89	Bulk	1.77	0.02
437.19	12.89	A90/3022	47X-1, 109	Bulk	1.67	0.04
437.39	12.89	A90/3023	47X-1, 129	Bulk	1.55	0.28
437.58	12.89	A90/3024	47X-1, 148	Bulk	1.58	–0.02
437.79	12.90	A90/3025	47X-2, 19	Bulk	1.52	–0.01
437.99	12.90	A90/3026	47X-2, 39	Bulk	1.59	–0.07
438.19	12.90	A91/1420	47X-2, 59	*P. wuell.*	0.89	2.13
438.19	12.90	A91/1733	47X-2, 59	*D. alt.*	1.86	–0.88
438.19	12.90	A91/1421	47X-2, 59	*Cib.* spp.	0.23	2.62
438.19	12.90	A91/1734	47X-2, 59	*G. venez.*	1.61	–0.55
438.39	12.90	A90/3027	47X-2, 79	Bulk	1.51	–0.16
438.59	12.90	A90/3028	47X-2, 99	Bulk	1.60	–0.17

Appendix B (continued).

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$	Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
438.79	12.90	A90/3029	47X-2, 119	Bulk	1.59	0.11	454.49	13.03	A90/3082	48X-6, 119	Bulk	1.92	–0.44
438.99	12.91	A90/3030	47X-2, 139	Bulk	1.47	–0.09	454.69	13.03	A90/3083	48X-6, 139	Bulk	1.72	0.19
439.19	12.91	A90/3031	47X-3, 9	Bulk	1.54	–0.07	454.89	13.03	A90/3084	48X-7, 9	Bulk	1.80	–0.08
439.39	12.91	A90/3032	47X-3, 29	Bulk	1.66	0.10	455.59	13.04	A90/3085	49X-1, 9	Bulk	1.79	–0.12
439.59	12.91	A90/3033	47X-3, 49	Bulk	1.48	–0.12	455.79	13.04	A90/3086	49X-1, 29	Bulk	1.69	–0.42
439.79	12.91	A91/1735	47X-3, 69	*D. alt.*	2.05	–0.95	455.99	13.04	A90/3087	49X-1, 49	Bulk	1.77	–0.13
439.79	12.91	A91/1736	47X-3, 69	*G. venez.*	1.80	–0.51	456.19	13.04	A91/948	49X-1, 69	*D. alt.*	2.11	–1.14
439.99	12.91	A90/3034	47X-3, 89	Bulk	1.55	–0.29	456.19	13.04	A91/949	49X-1, 69	*G. venez.*	1.73	–0.67
440.19	12.92	A90/3035	47X-3, 109	Bulk	1.47	–0.13	456.19	13.04	A91/1306	49X-1, 69	*Cib.* spp.	1.76	–1.10
440.39	12.92	A90/3036	47X-3, 129	Bulk	1.38	–0.03	456.39	13.04	A90/3088	49X-1, 89	Bulk	1.78	–0.21
440.58	12.92	A90/3037	47X-3, 148	Bulk	1.42	0.02	457.59	13.05	A91/947	49X-2, 59	*G. venez.*	1.54	–0.68
440.79	12.92	A90/3038	47X-4, 19	Bulk	1.28	–0.01	457.59	13.05	A91/946	49X-2, 59	*D. alt.*	2.24	–1.14
440.99	12.92	A90/3039	47X-4, 39	Bulk	1.22	0.02	457.79	13.05	A90/3089	49X-2, 79	Bulk	1.86	–0.55
441.19	12.92	A91/1313	47X-4, 59	*P. wuell.*	0.71	2.05	458.99	13.06	A90/3090	49X-3, 49	Bulk	1.97	–0.17
441.19	12.92	A91/1730	47X-4, 59	*G. venez.*	1.46	–0.53	459.19	13.06	A91/944	49X-3, 69	*D. alt.*	2.41	–0.97
441.19	12.92	A91/1729	47X-4, 59	*D. alt.*	1.66	–0.92	459.19	13.06	A91/945	49X-3, 69	*G. venez.*	2.06	–1.02
441.39	12.92	A90/3040	47X-4, 79	Bulk	1.22	0.04	460.59	13.08	A91/943	49X-4, 59	*G. venez.*	2.14	–0.98
441.59	12.93	A90/3041	47X-4, 99	Bulk	1.28	0.18	460.59	13.08	A91/1294	49X-4, 59	*Cib. mun.*	1.15	1.74
441.79	12.93	A90/3042	47X-4, 119	Bulk	1.34	–0.09	460.59	13.08	A91/942	49X-4, 59	*D. alt.*	2.55	–0.97
441.99	12.93	A90/3043	47X-4, 139	Bulk	1.59	–0.27	460.59	13.08	A91/1295	49X-4, 59	*P. wuell.*	1.24	1.58
442.19	12.93	A90/3044	47X-5, 9	Bulk	1.48	–0.08	460.79	13.08	A90/3091	49X-4, 79	Bulk	1.95	–0.30
442.39	12.93	A90/3045	47X-5, 29	Bulk	1.40	–0.25	462.19	13.09	A91/940	49X-5, 69	*D. alt.*	2.43	–0.88
442.59	12.93	A90/3046	47X-5, 49	Bulk	1.45	0.03	462.19	13.09	A91/941	49X-5, 69	*G. venez.*	1.84	–0.54
442.79	12.94	A91/1731	47X-5, 69	*D. alt.*	1.97	–1.05	462.39	13.09	A90/3092	49X-5, 89	Bulk	1.84	–0.13
442.79	12.94	A91/1311	47X-5, 69	*P. wuell.*	1.06	2.03	463.59	13.10	A91/938	49X-6, 59	*D. alt.*	2.49	–1.08
442.79	12.94	A91/1312	47X-5, 69	*Cib.* spp.	0.99	1.63	463.59	13.10	A91/939	49X-6, 59	*G. venez.*	2.01	–0.51
442.79	12.94	A91/1732	47X-5, 69	*G. venez.*	1.78	–0.63	463.79	13.10	A90/3093	49X-6, 79	Bulk	1.81	–0.31
445.89	12.96	A90/3047	48X-1, 9	Bulk	1.47	–0.30	464.29	13.13	A90/3095	50X-1, 69	Bulk	1.86	–0.47
446.09	12.96	A90/3048	48X-1, 29	Bulk	1.45	–0.44	464.29	13.13	A91/936	50X-1, 69	*D. alt.*	2.13	–1.05
446.29	12.96	A90/3049	48X-1, 49	Bulk	1.71	–0.31	464.29	13.13	A91/937	50X-1, 69	*G. venez.*	1.60	–0.33
446.49	12.96	A91/1032	48X-1, 69	*D. alt.*	2.25	–1.00	464.79	13.16	A90/3094	49X-7, 29	Bulk	1.75	–0.46
446.49	12.96	A91/1033	48X-1, 69	*G. venez.*	1.61	–0.36	465.69	13.21	A91/935	50X-2, 59	*G. venez.*	1.78	0.12
446.69	12.97	A90/3050	48X-1, 89	Bulk	1.72	–0.34	465.69	13.21	A91/934	50X-2, 59	*D. alt.*	2.24	–1.06
446.89	12.97	A90/3051	48X-1, 109	Bulk	1.65	–0.21	465.69	13.21	A90/3096	50X-2, 59	Bulk	2.03	–0.63
447.09	12.97	A90/3052	48X-1, 129	Bulk	1.72	–0.43	467.29	13.30	A90/3097	50X-3, 69	Bulk	1.84	–0.37
447.28	12.97	A90/3053	48X-1, 148	Bulk	1.71	–0.58	467.29	13.30	A91/811	50X-3, 69	*G. venez.*	1.56	–0.37
447.49	12.97	A90/3054	48X-2, 19	Bulk	1.74	–0.47	467.29	13.30	A91/810	50X-3, 69	*D. alt.*	2.06	–1.25
447.69	12.97	A90/3055	48X-2, 39	Bulk	1.77	–0.51	468.69	13.37	A91/808	50X-4, 59	*D. alt.*	2.13	–0.96
447.89	12.98	A91/1031	48X-2, 59	*G. venez.*	1.88	–0.70	468.69	13.37	A90/3098	50X-4, 59	Bulk	2.00	–0.56
447.89	12.98	A91/1030	48X-2, 59	*D. alt.*	2.37	–0.97	468.69	13.37	A91/809	50X-4, 59	*G. venez.*	2.33	–0.92
448.09	12.98	A90/3056	48X-2, 79	Bulk	1.69	–0.47	470.29	13.46	A90/3099	50X-5, 69	Bulk	2.02	–0.64
448.29	12.98	A90/3057	48X-2, 99	Bulk	1.61	–0.36	470.29	13.46	A91/1343	50X-5, 69	*P. wuell.*	1.49	1.81
448.49	12.98	A90/3058	48X-2, 119	Bulk	1.57	–0.29	471.69	13.54	A91/804	50X-6, 59	*D. alt.*	2.35	–1.02
448.69	12.98	A90/3059	48X-2, 139	Bulk	1.47	–0.28	471.69	13.54	A91/805	50X-6, 59	*G. venez.*	1.69	–0.54
448.89	12.98	A90/3060	48X-3, 9	Bulk	1.51	–0.15	471.69	13.54	A91/1340	50X-6, 59	*P. wuell.*	1.27	1.94
449.09	12.99	A90/3061	48X-3, 39	Bulk	1.53	–0.30	471.69	13.54	A90/3100	50X-6, 59	Bulk	1.87	–0.51
449.29	12.99	A90/3062	48X-3, 49	Bulk	1.54	–0.42	473.99	13.66	A91/1342	51X-1, 69	*Cib.* spp.	1.49	1.71
449.49	12.99	A91/1028	48X-3, 69	*D. alt.*	2.04	–1.13	473.99	13.66	A91/803	51X-1, 69	*G. venez.*	1.82	–0.53
449.49	12.99	A91/1029	48X-3, 69	*G. venez.*	1.82	–0.66	473.99	13.66	A91/1341	51X-1, 69	*P. wuell.*	1.97	1.99
449.69	12.99	A90/3063	48X-3, 89	Bulk	1.50	–0.43	473.99	13.66	A90/3154	51X-1, 69	Bulk	2.55	–0.32
449.89	12.99	A90/3064	48X-3, 109	Bulk	1.44	–0.35	473.99	13.66	A91/802	51X-1, 69	*D. alt.*	2.93	–0.92
450.49	13.00	A90/3065	48X-4, 19	Bulk	1.54	0.27	475.39	13.72	A91/1339	51X-2, 59	*P. wuell.*	1.87	1.86
450.69	13.00	A90/3066	48X-4, 39	Bulk	1.44	–0.39	475.39	13.72	A90/3155	51X-2, 59	Bulk	2.40	–0.38
450.89	13.00	A91/1026	48X-4, 59	*D. alt.*	1.87	–0.94	475.39	13.72	A91/800	51X-2, 59	*D. alt.*	2.96	–0.89
450.89	13.00	A91/1027	48X-4, 59	*G. venez.*	1.66	–0.75	475.39	13.72	A91/801	51X-2, 59	*G. venez.*	2.50	–0.62
451.09	13.00	A90/3067	48X-4, 79	Bulk	1.48	–0.48	476.99	13.80	A91/1337	51X-3, 69	*P. wuell.*	1.71	1.87
451.29	13.00	A90/3068	48X-4, 99	Bulk	1.64	–0.49	476.99	13.80	A91/799	51X-3, 69	*G. venez.*	2.20	–0.47
451.49	13.00	A90/3069	48X-4, 119	Bulk	1.54	–0.33	476.99	13.80	A91/1338	51X-3, 69	*Cib.* spp.	1.65	1.85
451.69	13.01	A90/3070	48X-4, 139	Bulk	1.67	–0.31	476.99	13.80	A91/798	51X-3, 69	*D. alt.*	2.98	–1.06
451.89	13.01	A90/3071	48X-5, 9	Bulk	1.79	–0.20	476.99	13.80	A90/3156	51X-3, 69	Bulk	2.33	–0.21
452.09	13.01	A90/3072	48X-5, 29	Bulk	1.77	–0.30	478.39	13.86	A91/1336	51X-4, 59	*P. wuell.*	1.85	1.91
452.29	13.01	A90/3073	48X-5, 49	Bulk	1.83	–0.22	478.39	13.86	A91/795	51X-4, 59	*G. venez.*	2.27	–0.04
452.49	13.01	A91/1309	48X-5, 69	*P. wuell.*	1.14	1.89	478.39	13.86	A90/3157	51X-4, 59	Bulk	2.72	0.20
452.49	13.01	A91/1310	48X-5, 69	*Cib.* spp.	0.36	2.17	478.39	13.86	A91/794	51X-4, 59	*D. alt.*	2.85	–1.13
452.49	13.01	A91/1025	48X-5, 69	*G. venez.*	1.74	–0.60	479.99	13.94	A91/793	51X-5, 69	*G. venez.*	2.65	0.09
452.49	13.01	A91/1024	48X-5, 69	*D. alt.*	2.24	–0.91	479.99	13.94	A90/3158	51X-5, 69	Bulk	2.30	0.35
452.69	13.01	A90/3074	48X-5, 89	Bulk	1.83	–0.33	479.99	13.94	A91/1335	51X-5, 69	*P. wuell.*	2.11	1.94
452.89	13.02	A90/3075	48X-5, 109	Bulk	1.63	–0.25	479.99	13.94	A91/792	51X-5, 69	*D. alt.*	2.87	–0.62
453.09	13.02	A90/3076	48X-5, 129	Bulk	1.70	–0.32	481.39	14.00	A91/782	51X-6, 59	*D. alt.*	2.83	–1.07
453.28	13.02	A90/3077	48X-5, 148	Bulk	1.57	–0.39	481.39	14.00	A91/1305	51X-6, 59	*P. wuell.*	1.85	1.82
453.49	13.02	A90/3078	48X-6, 19	Bulk	1.53	–0.27	481.39	14.00	A90/3713	51X-6, 59	Bulk	2.23	0.11
453.69	13.02	A90/3079	48X-6, 39	Bulk	1.63	–0.41	481.39	14.00	A91/783	51X-6, 59	*G. venez.*	2.07	0.09
453.89	13.02	A91/1022	48X-6, 59	*D. alt.*	2.07	–1.05	482.59	14.06	A91/933	51X-7, 29	*G. venez.*	2.23	–0.01
453.89	13.02	A91/1308	48X-6, 59	*Cib.* spp.	1.69	–1.18	482.59	14.06	A91/932	51X-7, 29	*D. alt.*	2.65	–0.90
453.89	13.02	A91/1023	48X-6, 59	*G. venez.*	1.69	–0.78	482.59	14.06	A91/1304	51X-7, 29	*P. wuell.*	1.89	1.87
453.89	13.02	A91/1307	48X-6, 59	*P. wuell.*	1.03	2.26	482.59	14.06	A90/3714	51X-7, 29	Bulk	2.30	0.35
454.09	13.02	A90/3080	48X-6, 79	Bulk	1.73	–0.20	483.29	14.09	A90/3715	52X-1, 69	Bulk	2.07	0.31
454.29	13.03	A90/3081	48X-6, 99	Bulk	1.82	–0.25	483.29	14.09	A91/931	52X-1, 69	*G. venez.*	2.14	–0.71

Appendix B (continued).

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
483.29	14.09	A91/1300	52X-1, 69	*P. wuell.*	1.34	1.57
483.29	14.09	A91/930	52X-1, 69	*D. alt.*	2.35	−1.08
484.69	14.16	A91/1299	52X-2, 59	*Cib.* spp.	1.12	1.28
484.69	14.16	A91/928	52X-2, 59	*D. alt.*	2.17	−1.09
484.69	14.16	A90/3716	52X-2, 59	Bulk	1.89	−0.01
484.69	14.16	A91/929	52X-2, 59	*G. venez.*	1.96	−0.79
484.69	14.16	A91/1298	52X-2, 59	*P. wuell.*	1.25	1.09
486.29	14.23	A91/1334	52X-3, 69	*Cib.* spp.	1.40	1.29
486.29	14.23	A91/926	52X-3, 69	*D. alt.*	2.44	−1.21
486.29	14.23	A91/1333	52X-3, 69	*P. wuell.*	1.45	1.24
486.29	14.23	A91/927	52X-3, 69	*G. venez.*	1.92	−0.70
486.29	14.23	A90/3735	52X-3, 69	Bulk	1.94	−0.44
487.69	14.30	A90/3736	52X-4, 59	Bulk	1.83	−0.17
487.69	14.30	A91/924	52X-4, 59	*D. alt.*	2.30	−0.65
487.69	14.30	A91/925	52X-4, 59	*G. venez.*	1.93	−0.37
487.69	14.30	A91/1332	52X-4, 59	*P. wuell.*	1.44	1.48
489.29	14.38	A91/922	52X-5, 69	*D. alt.*	2.55	−0.90
489.29	14.38	A90/3737	52X-5, 69	Bulk	2.06	−0.36
489.29	14.38	A91/923	52X-5, 69	*G. venez.*	2.10	−0.31
489.29	14.38	A91/1331	52X-5, 69	*Cib.* spp.	1.74	1.65
489.29	14.38	A91/1330	52X-5, 69	*P. wuell.*	1.67	1.39
492.99	14.55	A91/1329	53X-1, 69	*P. wuell.*	1.66	1.57
492.99	14.55	A90/3738	53X-1, 69	Bulk	2.07	−0.12
492.99	14.55	A91/920	53X-1, 69	*D. alt.*	2.25	−1.02
492.99	14.55	A91/921	53X-1, 69	*G. venez.*	2.09	−0.27
494.39	14.62	A91/919	53X-2, 59	*G. venez.*	2.32	−0.32
494.39	14.62	A91/918	53X-2, 59	*D. alt.*	2.60	−1.17
494.39	14.62	A91/1327	53X-2, 59	*P. wuell.*	2.01	1.34
494.39	14.62	A91/1328	53X-2, 59	*Cib.* spp.	1.82	1.45
494.39	14.62	A90/3739	53X-2, 59	Bulk	2.29	0.03
495.99	14.69	A91/1325	53X-3, 69	*P. wuell.*	1.84	1.25
495.99	14.69	A91/1326	53X-3, 69	*Cib.* spp.	1.34	1.90
495.99	14.69	A90/3740	53X-3, 69	Bulk	2.27	−0.13
495.99	14.69	A91/916	53X-3, 69	*D. alt.*	2.47	−1.00
495.99	14.69	A91/917	53X-3, 69	*G. venez.*	2.23	−0.40
497.39	14.76	A91/915	53X-4, 59	*G. venez.*	2.07	0.01
497.39	14.76	A91/1316	53X-4, 59	*Cib.* spp.	1.81	1.43
497.39	14.76	A91/914	53X-4, 59	*D. alt.*	2.28	−0.87
497.39	14.76	A90/3741	53X-4, 59	Bulk	2.25	−0.03
502.59	15.00	A91/1324	54X-1, 69	*P. wuell.*	1.86	1.59
502.59	15.00	A91/841	54X-1, 69	*G. venez.*	2.43	−0.51
502.59	15.00	A90/3742	54X-1, 69	Bulk	2.31	0.08
502.59	15.00	A91/840	54X-1, 69	*D. alt.*	2.72	−0.98
503.79	15.06	A90/3743	54X-2, 59	Bulk	2.15	−0.02
503.99	15.07	A91/839	54X-2, 59	*G. venez.*	2.00	−0.12
503.99	15.07	A91/838	54X-2, 59	*D. alt.*	2.36	−1.20
503.99	15.07	A91/1323	54X-2, 59	*P. wuell.*	1.71	1.53
505.59	15.14	A91/836	54X-3, 69	*D. alt.*	2.37	−1.15
505.59	15.14	A91/837	54X-3, 69	*G. venez.*	2.01	−0.59
505.59	15.14	A91/1322	54X-3, 69	*P. wuell.*	1.10	1.37
505.59	15.14	A90/3744	54X-3, 69	Bulk	2.21	−0.06
506.99	15.21	A91/835	54X-4, 59	*G. venez.*	2.03	−0.25
506.99	15.21	A90/3745	54X-4, 59	Bulk	2.36	−0.04
506.99	15.21	A91/834	54X-4, 59	*D. alt.*	2.57	−1.07
506.99	15.21	A91/1320	54X-4, 59	*P. wuell.*	1.58	1.03
508.59	15.28	A91/833	54X-5, 69	*G. venez.*	1.90	−0.31
508.59	15.28	A91/832	54X-5, 69	*D. alt.*	2.18	−1.01
508.59	15.28	A90/3746	54X-5, 69	Bulk	2.05	0.12
509.99	15.35	A91/1317	54X-6, 59	*P. wuell.*	1.65	1.16
509.99	15.35	A91/1318	54X-6, 59	*Cib.* spp.	1.80	0.25
509.99	15.35	A91/831	54X-6, 59	*G. venez.*	2.07	−0.56
509.99	15.35	A90/3747	54X-6, 59	Bulk	2.13	−0.17
509.99	15.35	A91/830	54X-6, 59	*D. alt.*	2.38	−1.13
511.19	15.41	A90/3748	54X-7, 29	Bulk	2.41	−0.09
511.19	15.41	A91/829	54X-7, 29	*G. venez.*	2.24	−0.37
511.19	15.41	A91/828	54X-7, 29	*D. alt.*	2.67	−1.03
511.89	15.44	A91/699	55X-1, 29	*G. venez.*	2.05	−0.50
511.89	15.44	A91/698	55X-1, 29	*D. alt.*	2.39	−1.16
512.29	15.46	A91/1302	55X-1, 69	*P. wuell.*	1.75	1.01
512.29	15.46	A91/827	55X-1, 69	*G. venez.*	2.44	−0.75
512.29	15.46	A91/826	55X-1, 69	*D. alt.*	2.66	−1.23
512.29	15.46	A90/3749	55X-1, 69	Bulk	2.35	0.14
512.29	15.46	A91/1301	55X-1, 69	*Cib.* spp.	1.29	1.17
513.69	15.52	A91/824	55X-2, 59	*D. alt.*	2.85	−1.12
513.69	15.52	A90/3750	55X-2, 59	Bulk	2.16	−0.15
513.69	15.52	A91/825	55X-2, 59	*G. venez.*	2.37	−0.86
515.29	15.60	A91/693	55X-3, 69	*G. venez.*	2.03	−0.30
515.29	15.60	A90/3751	55X-3, 69	Bulk	2.32	0.04
515.29	15.60	A91/796	55X-3, 69	*D. alt.*	2.89	−1.23
515.29	15.60	A91/1293	55X-3, 69	*P. wuell.*	1.51	1.21
516.69	15.66	A91/788	55X-4, 59	*D. alt.*	2.80	−1.29
516.69	15.66	A91/1297	55X-4, 59	*Cib. mun.*	1.26	1.11
516.69	15.66	A90/3752	55X-4, 59	Bulk	2.11	−0.09
516.69	15.66	A91/789	55X-4, 59	*G. venez.*	2.00	−0.50
516.69	15.66	A91/1296	55X-4, 59	*P. wuell.*	1.52	1.16
518.29	15.74	A91/786	55X-5, 69	*D. alt.*	2.39	−1.57
518.29	15.74	A91/1283	55X-5, 69	*Cib. mun.*	1.26	0.90
518.29	15.74	A90/3753	55X-5, 69	Bulk	1.98	−0.24
518.29	15.74	A91/807	55X-5, 69	*G. venez.*	2.05	−0.42
519.69	15.81	A90/3754	55X-6, 59	Bulk	2.08	−0.12
519.69	15.81	A91/3198	55X-6, 59	*Cib.* spp.	2.21	0.01
519.69	15.81	A91/784	55X-6, 59	*D. alt.*	2.78	−1.04
519.69	15.81	A91/785	55X-6, 59	*G. venez.*	2.13	0.03
520.89	15.86	A90/3755	55X-7, 29	Bulk	1.96	−0.36
520.89	15.86	A91/3199	55X-7, 29	*Cib.* spp.	1.40	1.64
521.99	15.91	A91/697	56X-1, 69	*G. venez.*	2.25	−0.25
521.99	15.91	A90/3756	56X-1, 69	Bulk	2.23	−0.26
521.99	15.91	A91/3200	56X-1, 69	*Cib.* spp.	2.02	1.34
521.99	15.91	A91/696	56X-1, 69	*D. alt.*	2.69	−1.10
523.39	15.98	A90/3757	56X-2, 59	Bulk	2.07	−0.13
523.39	15.98	A91/695	56X-2, 59	*G. venez.*	2.15	−0.33
523.39	15.98	A91/694	56X-2, 59	*D. alt.*	2.50	−1.00
523.39	15.98	A91/3201	56X-2, 59	*Cib.* spp.	2.11	−0.58
524.99	16.06	A90/3758	56X-3, 69	Bulk	2.28	0.00
524.99	16.06	A91/3202	56X-3, 69	*G-cass.* spp.	1.38	1.97
526.39	16.12	A91/690	56X-4, 59	*D. alt.*	2.15	−1.56
526.39	16.12	A91/3204	56X-4, 59	*Cib.* spp.	0.82	1.20
526.39	16.12	A91/691	56X-4, 59	*G. venez.*	1.92	−0.62
526.39	16.12	A90/3759	56X-4, 59	Bulk	1.83	0.05
531.59	16.37	A90/3760	57X-1, 69	Bulk	2.22	−0.31
531.59	16.37	A91/689	57X-1, 69	*G. venez.*	2.29	−0.59
531.59	16.37	A91/688	57X-1, 69	*D. alt.*	2.59	−1.23
531.59	16.37	A91/3205	57X-1, 69	*Cib.* spp.	0.92	1.44
532.99	16.43	A91/685	57X-2, 59	*D. alt.*	2.78	−1.06
532.99	16.43	A91/3207	57X-2, 59	*Cib.* spp.	0.99	1.91
532.99	16.43	A90/3761	57X-2, 59	Bulk	2.07	−0.19
532.99	16.43	A91/686	57X-2, 59	*G. venez.*	2.22	0.00
534.59	16.51	A91/822	57X-3, 69	*D. alt.*	2.61	−1.32
534.59	16.51	A91/823	57X-3, 69	*G. venez.*	2.44	−0.87
534.59	16.51	A90/3762	57X-3, 69	Bulk	2.09	−0.33
535.99	16.57	A91/821	57X-4, 59	*G. venez.*	2.51	−0.64
535.99	16.57	A90/3763	57X-4, 59	Bulk	2.12	−0.23
535.99	16.57	A91/820	57X-4, 59	*D. alt.*	2.67	−0.97
535.99	16.57	A91/3208	57X-4, 59	*Cib.* spp.	1.57	1.62
537.59	16.65	A91/818	57X-5, 69	*D. alt.*	2.58	−0.99
537.59	16.65	A91/819	57X-5, 69	*G. venez.*	2.31	−0.06
537.59	16.65	A90/3764	57X-5, 69	Bulk	1.88	−0.16
537.59	16.65	A91/3209	57X-5, 69	*Cib.* spp.	0.88	0.91
538.99	16.71	A90/3765	57X-6, 59	Bulk	1.82	−0.22
538.99	16.71	A91/3210	57X-6, 59	*Cib.* spp.	1.32	1.36
538.99	16.71	A91/817	57X-6, 59	*G. venez.*	2.03	−0.80
538.99	16.71	A91/816	57X-6, 59	*D. alt.*	2.51	−0.88
540.19	16.77	A91/3212	57X-7, 29	*Cib.* spp.	1.75	0.88
540.19	16.77	A91/815	57X-7, 29	*G. venez.*	2.35	−0.25
540.19	16.77	A91/814	57X-7, 29	*D. alt.*	2.55	−0.90
540.19	16.77	A90/3766	57X-7, 29	Bulk	1.99	−0.13
541.19	16.82	A90/3767	58X-1, 69	Bulk	2.16	−0.06
541.19	16.82	A91/813	58X-1, 69	*G. venez.*	2.09	−1.07
541.19	16.82	A91/3213	58X-1, 69	*Cib.* spp.	1.18	1.38
541.19	16.82	A91/812	58X-1, 69	*D. alt.*	2.63	−0.94
542.59	16.88	A91/3214	58X-2, 59	*Cib.* spp.	2.01	1.32
542.59	16.88	A91/791	58X-2, 59	*G. venez.*	2.38	−0.36
542.59	16.88	A90/3768	58X-2, 59	Bulk	2.19	0.00
542.59	16.88	A91/790	58X-2, 59	*D. alt.*	3.11	−0.98
544.19	16.96	A91/781	58X-3, 69	*G. venez.*	1.88	−0.74
544.19	16.96	A91/3216	58X-3, 69	*Cib.* spp.	1.04	1.49
544.19	16.96	A90/3769	58X-3, 69	Bulk	1.87	−0.23
544.19	16.96	A91/780	58X-3, 69	*D. alt.*	2.42	−1.14
545.59	17.03	A91/779	58X-4, 59	*G. venez.*	2.17	−0.90
545.59	17.03	A90/3709	58X-4, 59	Bulk	2.14	0.07
545.79	17.03	A91/778	58X-4, 59	*D. alt.*	2.50	−0.99
547.19	17.10	A91/777	58X-5, 69	*G. venez.*	2.08	−0.99
547.19	17.10	A91/3218	58X-5, 69	*Cib.* spp.	1.54	1.16
547.19	17.10	A91/776	58X-5, 69	*D. alt.*	2.74	−1.21
547.19	17.10	A90/3710	58X-5, 69	Bulk	1.79	−0.20
548.59	17.17	A91/775	58X-6, 59	*G. venez.*	1.93	−0.35

Appendix B (continued).

Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$	Depth (mbsf)	Age (Ma)	Lab no.	Core, section, interval (cm)	Species	$\delta^{13}C$	$\delta^{18}O$
548.59	17.17	A91/774	58X-6, 59	*D. alt.*	2.21	−1.06	576.29	18.47	A90/3117	61X-5, 69	Bulk	1.23	−0.29
548.59	17.17	A90/3772	58X-6, 59	Bulk	1.91	−0.23	576.29	18.47	A91/2790	61X-5, 69	*D. alt.*	2.18	−0.96
549.79	17.22	A90/3773	58X-7, 29	Bulk	1.82	−0.30	576.29	18.47	A91/2791	61X-5, 69	*G. venez.*	1.71	−1.02
549.79	17.22	A91/772	58X-7, 29	*D. alt.*	2.36	−1.07	577.69	18.53	A90/3118	61X-6, 59	Bulk	1.06	−0.41
549.79	17.22	A91/773	58X-7, 29	*G. venez.*	2.01	−0.52	577.69	18.53	A91/2792	61X-6, 59	*D. alt.*	1.70	−0.84
549.79	17.22	A91/3219	58X-7, 29	*Cib.* spp.	0.85	1.24	577.69	18.53	A91/3023	61X-6, 59	*Cib.* spp.	0.78	1.09
550.89	17.27	A91/2836	59X-1, 69	*Cib.* spp.	1.62	1.12	577.69	18.53	A91/2793	61X-6, 59	*G. venez.*	1.36	−0.43
550.89	17.27	A91/2651	59X-1, 69	*G. venez.*	2.35	−1.09	578.89	18.59	A90/3119	61X-7, 29	Bulk	1.04	−0.07
550.89	17.27	A91/2650	59X-1, 69	*D. alt.*	2.56	−1.29	578.89	18.59	A91/2795	61X-7, 29	*G. venez.*	1.52	−0.65
550.89	17.27	A90/3101	59X-1, 69	Bulk	1.95	−0.26	578.89	18.59	A91/2794	61X-7, 29	*D. alt.*	1.87	−0.71
552.29	17.34	A91/2653	59X-2, 59	*G. venez.*	1.88	−0.51	579.99	18.68	A91/2796	62R-1, 69	*D. alt.*	1.79	−0.69
552.29	17.34	A90/3102	59X-2, 59	Bulk	1.72	−0.07	579.99	18.68	A91/2797	62R-1, 69	*G. venez.*	1.49	−0.76
552.29	17.34	A91/2652	59X-2, 59	*D. alt.*	2.06	−0.72	579.99	18.68	A90/3120	62R-1, 69	Bulk	1.13	−0.17
552.29	17.34	A91/2838	59X-2, 59	*Cib.* spp.	1.39	0.72	581.39	18.81	A90/3121	62R-2, 59	Bulk	0.93	−0.12
553.89	17.41	A91/2840	59X-3, 69	*Cib.* spp.	1.06	1.54	581.39	18.81	A91/3025	62R-2, 59	*Cass.* spp.	0.08	0.60
553.89	17.41	A91/2654	59X-3, 69	*D. alt.*	2.10	−0.69	581.39	18.81	A91/2799	62R-2, 59	*G. venez.*	1.77	−1.02
553.89	17.41	A91/2655	59X-3, 69	*G. venez.*	1.67	−0.54	581.39	18.81	A91/2798	62R-2, 59	*D. alt.*	1.04	−0.74
553.89	17.41	A90/3103	59X-3, 69	Bulk	1.78	−0.05	582.99	18.96	A91/2801	62R-3, 69	*G. venez.*	1.39	−0.41
555.29	17.48	A91/2656	59X-4, 59	*D. alt.*	1.75	−1.29	582.99	18.96	A91/3026	62R-3, 69	*Cib.* spp.	0.88	1.48
555.29	17.48	A91/2657	59X-4, 59	*G. venez.*	2.22	−1.37	582.99	18.96	A91/2800	62R-3, 69	*D. alt.*	1.71	−0.84
555.29	17.48	A91/2843	59X-4, 59	*Cib.* spp.	0.81	0.70	582.99	18.96	A90/3122	62R-3, 69	Bulk	1.24	−0.09
555.29	17.48	A90/3104	59X-4, 59	Bulk	1.45	−0.40	584.39	19.09	A90/3123	62R-4, 59	Bulk	1.32	−0.12
556.89	17.56	A91/2658	59X-5, 69	*D. alt.*	2.15	−1.18	584.39	19.09	A91/2802	62R-4, 59	*D. alt.*	2.22	−0.57
556.89	17.56	A90/3105	59X-5, 69	Bulk	1.57	−0.10	584.39	19.09	A91/2803	62R-4, 59	*G. venez.*	1.51	0.44
556.89	17.56	A91/2659	59X-5, 69	*G. venez.*	1.75	−0.46	585.99	19.24	A91/2805	62R-5, 69	*G. venez.*	1.41	−0.15
558.29	17.62	A91/2661	59X-6, 59	*G. venez.*	1.41	−0.84	585.99	19.24	A91/3027	62R-5, 69	*Cib.* spp.	0.88	1.37
558.29	17.62	A91/2660	59X-6, 59	*D. alt.*	1.52	−1.01	585.99	19.24	A90/3124	62R-5, 69	Bulk	1.22	−0.18
558.29	17.62	A90/3106	59X-6, 59	Bulk	1.38	−0.18	585.99	19.24	A91/2804	62R-5, 69	*D. alt.*	1.42	−0.68
559.49	17.68	A91/2770	59X-7, 29	*D. alt.*	2.02	−0.65	587.39	19.37	A91/2809	62R-6, 59	*G. venez.*	1.37	−0.45
559.49	17.68	A91/2771	59X-7, 29	*G. venez.*	1.56	−0.71	587.39	19.37	A91/2808	62R-6, 59	*D. alt.*	1.44	−0.53
559.49	17.68	A90/3107	59X-7, 29	Bulk	1.45	−0.13	587.39	19.37	A91/2810	62R-6, 59	*Cib.* spp.	1.06	1.39
560.59	17.73	A91/2773	60X-1, 69	*G. venez.*	1.64	−0.45	587.39	19.37	A90/3125	62R-6, 59	Bulk	1.21	−0.09
560.59	17.73	A91/2772	60X-1, 69	*D. alt.*	2.10	−0.93	588.59	19.48	A90/3126	62R-7, 29	Bulk	1.34	−0.09
560.59	17.73	A90/3108	60X-1, 69	Bulk	1.65	−0.10	589.69	19.54	A90/3147	63R-1, 69	Bulk	1.14	−0.31
561.99	17.80	A90/3109	60X-2, 59	Bulk	1.49	−0.19	589.69	19.54	A91/2813	63R-1, 69	*Cib.* spp.	0.65	1.40
561.99	17.80	A91/2774	60X-2, 59	*D. alt.*	1.97	−0.84	589.69	19.54	A91/2812	63R-1, 69	*G. venez.*	1.85	−0.60
561.99	17.80	A91/2775	60X-2, 59	*G. venez.*	1.85	−0.84	589.69	19.54	A91/2811	63R-1, 69	*D. alt.*	2.23	−0.61
563.59	17.87	A91/2776	60X-3, 69	*D. alt.*	2.16	−0.88	591.09	19.59	A91/2814	63R-2, 59	*D. alt.*	1.47	−0.75
563.59	17.87	A91/2777	60X-3, 69	*G. venez.*	2.15	−0.79	591.09	19.59	A90/3148	63R-2, 59	Bulk	1.26	−0.19
563.59	17.87	A90/3110	60X-3, 69	Bulk	1.54	−0.08	591.09	19.59	A91/2816	63R-2, 59	*Cib.* spp.	0.04	1.52
564.99	17.94	A91/2779	60X-4, 59	*G. venez.*	1.60	−0.65	591.09	19.59	A91/2815	63R-2, 59	*G. venez.*	1.24	−0.38
564.99	17.94	A91/2778	60X-4, 59	*D. alt.*	2.37	−0.90	592.69	19.66	A91/2819	63R-3, 69	*Cib.* spp.	1.20	1.57
564.99	17.94	A91/3020	60X-4, 59	*Cib.* spp.	0.49	2.05	592.69	19.66	A91/2817	63R-3, 69	*D. alt.*	1.90	−0.54
564.99	17.94	A90/3111	60X-4, 59	Bulk	1.65	−0.04	592.69	19.66	A91/2818	63R-3, 69	*G. venez.*	1.50	−0.06
566.39	18.00	A90/3112	60X-5, 49	Bulk	1.47	−0.04	592.69	19.66	A90/3149	63R-3, 69	Bulk	1.23	−0.19
566.39	18.00	A91/2780	60X-5, 49	*D. alt.*	2.04	−0.79	594.09	19.72	A91/2822	63R-4, 59	*Cib.* spp.	0.39	1.84
566.39	18.00	A91/2781	60X-5, 49	*G. venez.*	1.74	−0.61	594.09	19.72	A90/3150	63R-4, 59	Bulk	1.23	−0.29
570.29	18.19	A91/2783	61X-1, 69	*G. venez.*	1.81	−0.87	594.09	19.72	A91/2821	63R-4, 59	*G. venez.*	1.45	−0.38
570.29	18.19	A90/3113	61X-1, 69	Bulk	1.69	0.66	595.69	19.78	A91/2823	63R-5, 69	*D. alt.*	1.98	−0.83
570.29	18.19	A91/2782	61X-1, 69	*D. alt.*	1.77	−0.54	595.69	19.78	A91/2824	63R-5, 69	*G. venez.*	1.51	−0.46
571.69	18.25	A91/2785	61X-2, 59	*G. venez.*	1.62	−0.58	595.69	19.78	A90/3151	63R-5, 69	Bulk	1.26	−0.25
571.69	18.25	A91/2784	61X-2, 59	*D. alt.*	1.80	−0.57	595.69	19.78	A91/2825	63R-5, 69	*G-cass.* spp.	0.81	1.58
571.69	18.25	A90/3114	61X-2, 59	Bulk	1.29	−0.24	597.09	19.84	A90/3152	63R-6, 59	Bulk	1.31	−0.36
573.29	18.33	A90/3115	61X-3, 69	Bulk	1.25	−0.32	597.09	19.84	A91/2828	63R-6, 59	*D. alt.*	1.48	−0.16
573.29	18.33	A91/3021	61X-3, 69	*Cass.* spp.	0.42	1.49	597.09	19.84	A91/2829	63R-6, 59	*G. venez.*	1.48	−0.24
573.29	18.33	A91/2786	61X-3, 69	*D. alt.*	2.14	−1.08	597.09	19.84	A91/2830	63R-6, 59	*Cib.* spp.	0.77	1.73
573.29	18.33	A91/2787	61X-3, 69	*G. venez.*	2.00	−0.88	598.29	19.89	A91/2832	63R-7, 29	*D. alt.*	1.99	−0.97
574.69	18.39	A91/2789	61X-4, 59	*G. venez.*	1.95	−0.82	598.29	19.89	A91/2833	63R-7, 29	*G. venez.*	1.51	−0.48
574.69	18.39	A91/3022	61X-4, 59	*Cib.* spp.	1.02	1.21	598.29	19.89	A91/2834	63R-7, 29	*Cib.* spp.	0.83	1.32
574.69	18.39	A91/2788	61X-4, 59	*D. alt.*	1.95	−1.00	598.29	19.89	A90/3153	63R-7, 29	Bulk	1.31	−0.18
574.69	18.39	A90/3116	61X-4, 59	Bulk	1.36	−0.33							

Notes: *D. alt.* = *Dentoglobigerina altispira*, *G. ven.* = *Globoquadrina venezuelana*, *Cib.* spp. = *Cibicidoides* spp., *Cib. mun.* = *Cibicidoides mundulus*, *P. wuell.* = *Planulina wuellerstorfi*, *Cass.* spp. = *Cassidulina* spp., and *G-cass.* spp. = *Globocassidulina* spp.