15. OXYGEN AND CARBON ISOTOPE DATA FROM LEG 74 FORAMINIFERS[1]

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ABSTRACT

Oxygen and carbon isotope measurements have been made in picked planktonic and benthonic foraminifers from the five sites drilled on Leg 74, covering the whole Cenozoic. For the Neogene, the coverage gives good information on the development of the vertical temperature structure of Atlantic deep water. For the Paleogene, vertical gradients were weak and it is possible to combine data from different sites to obtain a very detailed record of both the temperature and carbon isotope history of Atlantic deep waters.

INTRODUCTION

One of the purposes of the Leg 74 drilling was to provide a suite of sites in which deep-water ^{18}O paleotemperature measurements could be made over a range of paleodepths. Ultimately this will enable a better description of variations in the vertical temperature structure of the ocean through time. It is not possible to complete such an analysis in the time available for the preparation of the *Initial Reports*, but a start has been made in obtaining the data. This chapter summarizes results that have been obtained to date and will give a good indication of the potential of different parts of the section for isotopic work.

METHODS AND RESULTS

Oxygen and carbon isotope measurements were made using a VG Isogas 903 triple collector mass spectrometer to analyze carbon dioxide released from picked foraminifers. The standard method of reaction on line at 50°C using 100% orthophosphoric acid was employed; the reaction line in use is shown in Figure 1.

To obtain seafloor records, benthic foraminifers were selected for analysis. Where possible, monospecific or monogeneric assemblages were picked. Where this proved impractical, species which have similar deviations from isotopic equilibrium were grouped together. In a number of levels it was possible to analyze more than one picking and so provide further data on species-dependent departures from isotopic equilibrium. Appendix A shows the adjustment factors which have been applied to the species analyzed in this chapter in order to obtain as good an approximation as possible to seafloor equilibrium values for ^{13}C and ^{18}O values. These adjustments must be made to take account of genetically controlled departures from isotopic equilibrium (Duplessy et al., 1970; Shackleton, 1974; Vincent et al., 1979; Graham et al., 1981). Appendix B gives the raw values and Appendix C the values adjusted on the basis of Appendix A, averaged where more than one measurement was obtained, and with the age estimate used for plotting (based on the timescales developed in Shackleton et al., this volume). Appendix A includes a number of mixtures; we recognize that there is additional uncertainty involved in these cases since the relative contributions are not known, but we consider that measurements based on specified mixtures are at least better than analyses of unspecified mixed species. A small number of measurements in Appendix B that were neither used in Appendix C nor plotted in the figures are marked with asterisks. These values include bad analyses, out-of-place samples, and some values for which correction factors are unknown or unreliable. For example, *Oridorsalis* appears to be close to isotopic equilibrium for ^{18}O, but to be erratic in its ^{13}C composition. It is possible that this reflects the presence of more than one species, or a significant effect of size on isotopic composition. It is interesting to note that Savin et al. (1981) found a perplexing variation in the difference in ^{13}C content between *Oridorsalis* and other species.

Figure 2 shows the oxygen and carbon isotope records for benthic and planktonic foraminifers from Sites 525–529. Oxygen isotope values are adjusted for departures from isotopic equilibrium (Shackleton, 1974), and carbon isotope values are adjusted so as to provide an estimate of the ^{13}C content of ocean deep water; members of the *Cibicides* genus are thought to provide a good estimate of this quantity in the modern ocean (Graham et al., 1981; Duplessy et al., pers. comm. 1982; Vincent et al., 1981) so that adjustments are made to *Cibicides* for ^{13}C and to *Uvigerina* for ^{18}O. Because Site 526 is significantly shallower and at present the seafloor is bathed by a different water mass, values from this site cannot be plotted with those from the deeper sites.

For planktonic species, we still do not know the order of depth stratification sufficiently well to confidently pick the best surface indicator in every sample. Additionally, it is sometimes useful to obtain a record from deep-dwelling species as well as from surface species (Boersma and Shackleton, 1978; Biolzi, pers. comm., 1982). Thus Table 4 contains data from several different species in some samples.

In the discussion below, oxygen isotope values are discussed in terms of temperature (°C) using the relationship between oxygen isotopic fractionation and temperature established by O'Neil et al. (1969) and discussed by Shackleton (1974). It is assumed that in the absence of an Antarctic ice sheet, the ocean had an oxygen isotopic composition of −1.2‰ on the PDB scale (Shackleton and Kennett, 1975).

DISCUSSION

Maestrichtian

Analyses of a number of samples in the uppermost part of the Maestrichtian show that there is a significant deep-water temperature variability, with deep-water temperatures varying between about 10° and 6.5°C (Fig. 2). No values as cold as this were encountered again through the Paleocene or lower Eocene. No significant deep-water temperature difference was observed in the immediate vicinity of the Cretaceous/Tertiary boundary, at which time the deep-water temperature was about 10°C.

Abathomphalus mayeroensis and *Planoglobulina glabrata* were analyzed in several Maestrichtian samples. Both ^{13}C and ^{18}O data indicate that of these two, the lat-

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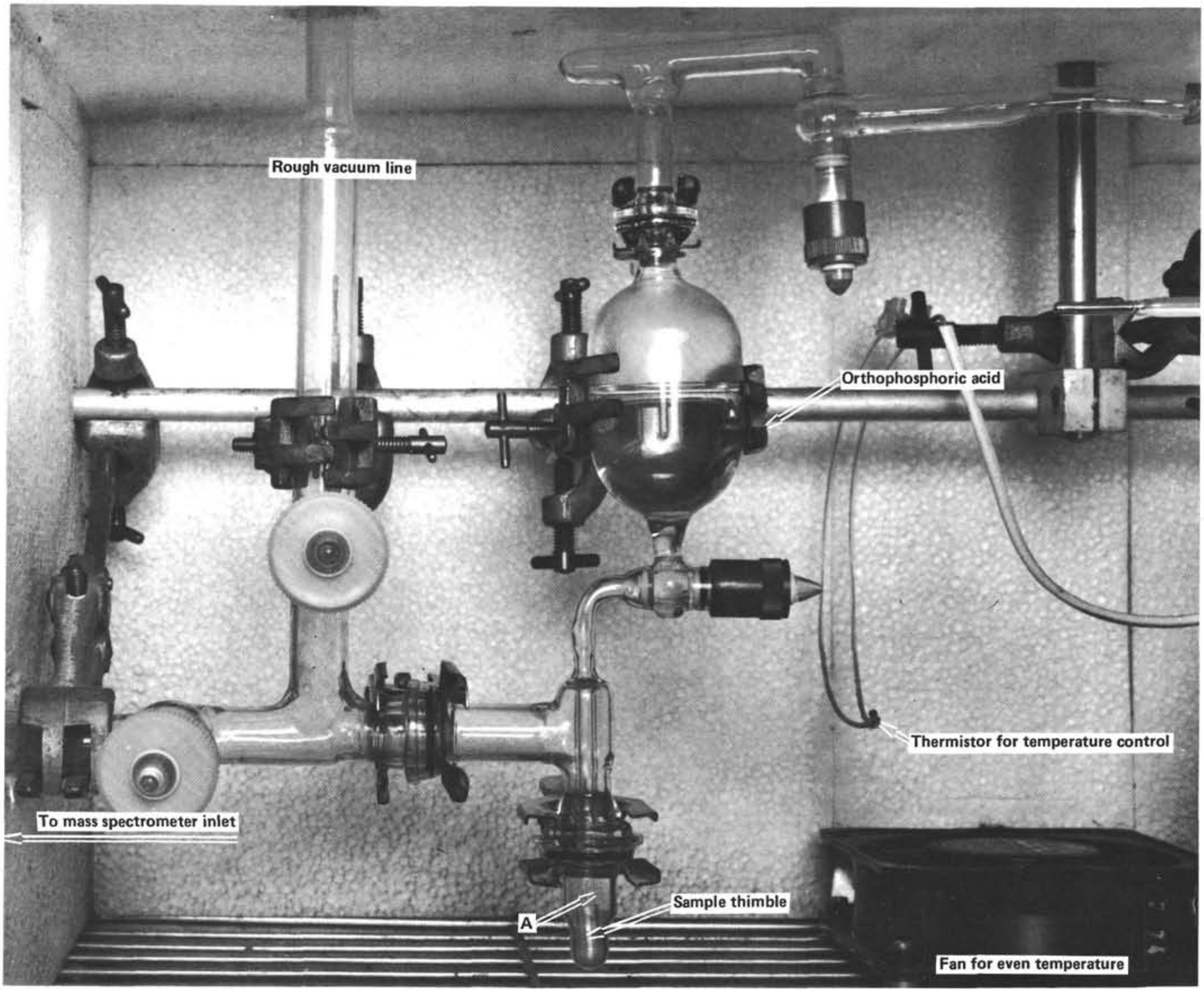

Figure 1. Reaction system used to generate CO_2 from foraminifers for isotopic analysis. The whole region illustrated is kept at 50°C. Orthophosphoric acid is dropped onto the foraminifers, which have previously been cleaned and vacuum-roasted in the thimble visible within container A. The acid is replenished monthly and is kept pumped so that it does not take up moisture.

ter calcified closer to the sea surface; on the basis of its isotopic composition surface temperatures between 13° and 16°C may be calculated. Mixed, very small (63–75 μm) species from a sample in Hole 527 at 280.10 m (10 cm below top of Maestrichtian) yield ^{18}O and ^{13}C values closer to those given by *A. mayeroensis*, implying that they are not good indicators of surface conditions.

Paleocene–Eocene

No remarkable changes in deep-water temperature occurred during the Paleocene, although there was apparently less variability and a somewhat higher mean temperature than during the late Maestrichtian. In the early Eocene a significant rise in deep-water temperature is observed, culminating in temperatures of about 12°C. After a few million years a considerable decline in temperature occurred relatively rapidly at about 50 Ma. The dating of this event is well controlled to within the interval of Magnetic Anomaly 21 on the basis of the measurements in Core 527-17. Only a small amount of late Eocene data was obtained; however, the values are consistent with those observed elsewhere, implying a deep-water temperature of about 7°C. The temperature decline within Magnetic Anomaly 21 was not unidirectional but was accompanied by considerable variability that would warrant detailed investigation in a site with a higher accumulation rate over this interval.

Surface temperature appears to have been low in the first 2 m.y. of the Paleocene, but this is probably an artifact of our inability to analyze species which truly reflect surface conditions. Mixed, very small (63–75 μm) planktonic foraminifers dominated by *Woodringina* and carefully cleaned of obvious Cretaceous specimens were analyzed from 279.91 m in Hole 527 and yielded an ^{18}O value similar to that of the sample analyzed at the top of the Maestrichtian. Because, as already mentioned, this Maestrichtian measurement was not regarded as a good estimate of surface temperature, we have no reason to suppose that the Danian measurement enables us to estimate lowermost Danian surface temperature. On the other hand, these very small foraminifers do register essentially the same change in ^{13}C values that is registered by bulk sediment (Shackleton and Hall, this volume). Thus it seems likely that these specimens were calcifying relatively close to the sea surface (certainly well above the oxygen minimum). If the oxygen isotopic composition of these very small specimens is not significantly affected by post-depositional processes (which cannot be definitely established), then we may reasonably argue that the similarity in ^{18}O values between the very small specimens analyzed on either side of the Cretaceous/Tertiary boundary constitutes evidence that there was not a significant change in surface temperature at that boundary. However, this is a difficult point to establish conclusively.

Later in the Paleocene and in the early Eocene, surface temperatures were apparently higher than during the Maestrichtian or, indeed, than during any other part of the Cenozoic. Surface temperatures dropped during the middle Eocene just as deep-water temperatures did. It is interesting to note that this more or less parallel trend in surface and deep-water temperatures during the Eocene shows that there was no thermal isolation between mid-latitude and high-latitude water masses.

Preliminary examination of the benthic data suggests that the vertical temperature and ^{13}C gradients between Sites 525 and 527 were too small during the Paleocene to be measured without considerably more data. The two sites then occupied approximately the same positions in the water column as Sites 526 and 525 occupy today; thus there would have been measurable isotopic differences between them, given oceanographic gradients similar to those now prevailing.

Oligocene

At Site 529 detailed measurements were made at the Eocene/Oligocene boundary, where a very sharp transition was observed. The data should be regarded with caution, however, since the nannofossil *I. recurvus* is not present in the uppermost Eocene sediments, implying that the latest Eocene may be missing at this site (Manivit, this volume). It is interesting to note that the oxygen isotope values obtained in benthic foraminifers just above the boundary (or hiatus) are the most positive observed in the Oligocene. The values, about +2.5‰ (adjusted to isotopic equilibrium), are in fact similar to the *lightest* values observed in the late Miocene. This value may be regarded as favoring the presence of an ice sheet in Antarctica for a brief interval in the early Oligocene; in the absence of any significant quantity of ice, a value of +2.5‰ would indicate a temperature of 2°C at a paleodepth of around 3000 m. This would certainly imply at least freezing winters at sea level around Antarctica, which itself would be consistent with substantial glaciation. It seems perhaps more likely that deep water was not so cold as 2°, and that there *was* a significant amount of ice on Antarctica for this short interval early in the Oligocene. (An isolated measurement from 225.67 m at Site 528 gave an even more positive ^{18}O value, but this may have been the result of mixing with one or more Neogene specimens, since the sample proved to contain some drillpipe rust indicative of downhole contamination).

Although we conclude that there may have been some accumulation of ice on Antarctica during the early Oligocene, as claimed by Matthews and Poore (1980), we have reached this conclusion by accumulating more benthic foraminiferal data and extending the argument used by Shackleton and Kennett (1975). We do not agree with the approach taken by Matthews and Poore (1980), who have argued that global ice volume in the Cenozoic may be estimated by assuming that the surface temperature in the tropics is more or less invariant. Indeed, were one to apply this argument to the data set discussed by Shackleton and Boersma (1981), one would conclude that during the early Eocene ocean surface temperature ranged between 28°C at the equator and 18°C at high latitudes, while somewhere on the continents sufficient ice was stored to render the oceans even more isotopically positive than today. For the early Oligocene, Poore and Matthews (in press) have obtained a data set considerably more detailed than ours; it documents isotopically positive values similar to those that we have obtained, but their interpretation is again based on the model of Matthews and Poore (1980), with which we disagree.

The total range in ^{18}O values in benthic samples from the Oligocene at Sites 528 and 529 is of the order 0.7‰ (from 1.8 to 2.5‰), but this is among a relatively small number of analyses and must underestimate the total range of variation.

Site 526, where the paleodepth was significantly shallower during the Oligocene than the present 1000 m, shows a rather different benthic temperature record. The values are isotopically lighter by the equivalent of 2–3°, and show a greater variability of about 1‰, or more than 3°. Unfortunately, the isotopic results from Site 526 sediments are somewhat unsatisfactory. Differences between species are not as one expects on the basis of present-day calibrations or of between-species comparisons at other sites. Matthews et al. (1980) have suggested that, in very shallow sites, aragonite that was preserved during initial sedimentation may very readily go into solution in the pore waters and reprecipitate on the foraminifers. If this is indeed the case, the values obtained may actually be closer to deep-water isotopic equilibrium than the original calcite was; this would explain the fact that between-species differences are very small in these sediments.

Early–Middle Miocene

Unfortunately the middle Miocene was not well recovered at any Leg 74 site. However, the fragmentary recovery is sufficient to reveal the deep-water temperature maximum of the middle Miocene and the associated positive extreme in ^{13}C values first observed by Shackleton and Kennett (1975) and to give hints of the important high-frequency variation in both isotope ratios that was revealed for the first time by the detailed work of Woodruff et al. (1981) from DSDP Site 289. Comparison of the planktonic and benthic records (Fig. 2A)

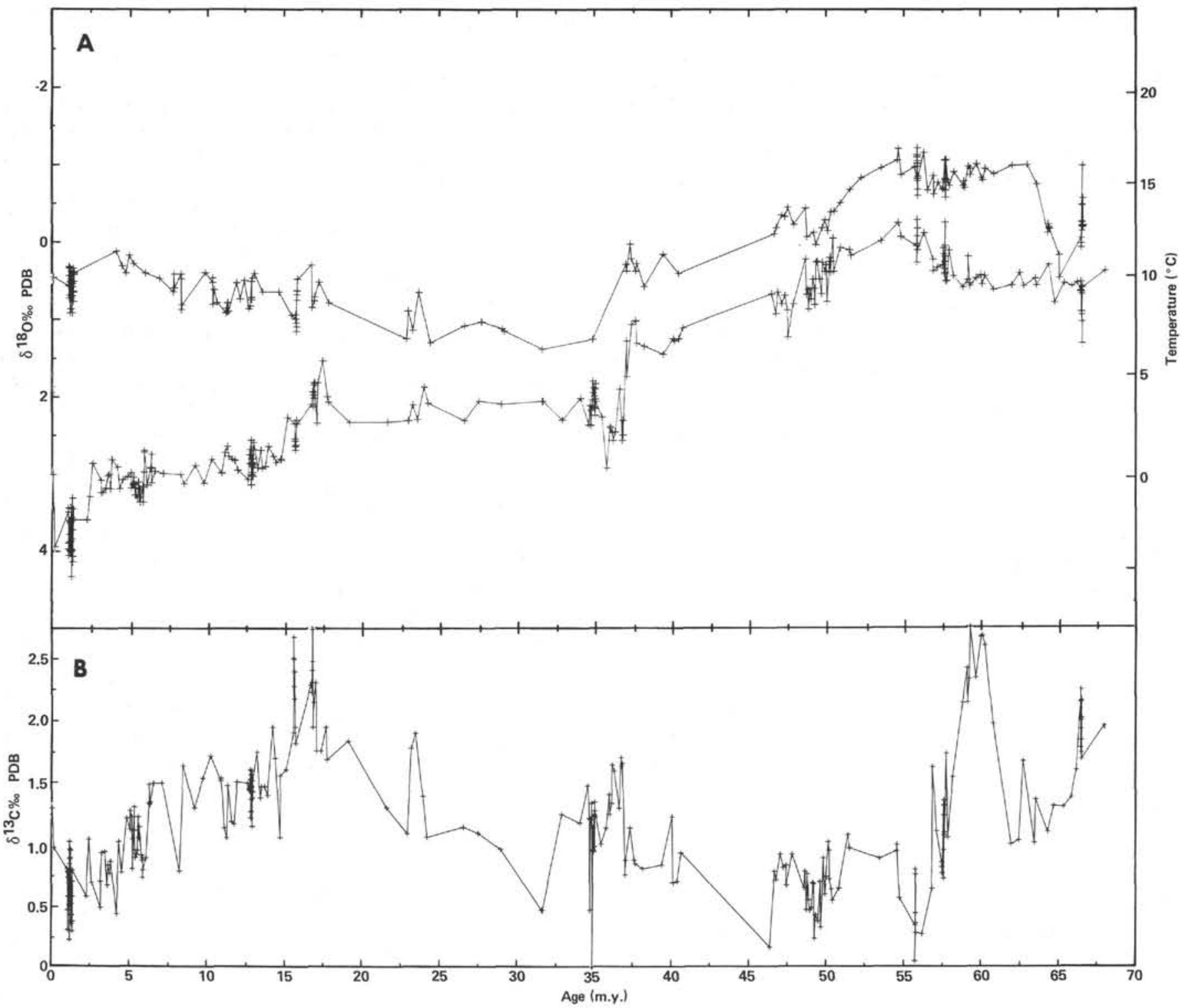

Figure 2. A. Oxygen isotope record in benthic and planktonic foraminifers from Sites 525-529, Maestrichtian to Recent. For planktonic species, data are selected to represent as well as possible those species that apparently calcify near the ocean surface. The temperature scale is calculated for a time without an Antarctic ice sheet. B. Carbon isotope record in benthic foraminifers from Sites 525-529, Maestrichtian to Recent. All data in Figure 2A-B are plotted on a common timescale (from Appendix C). C. Carbon isotope record in planktonic foraminifers from Sites 525-529, Maestrichtian to Recent. All data are plotted on a common timescale (from Appendix D). In samples from which more than one species was analyzed, the isotopically heaviest value is plotted, and analyses of species which are known to deposit their carbonate at depth are not plotted.

shows that the temperature gradient between surface and deep water was approximately the same from the late Eocene to the middle Miocene.

Late Miocene and Pliocene: Changing Vertical Gradients

The drilling of Site 526 provided the unusual opportunity of examining the vertical temperature and ^{13}C gradients within the ocean interior and the evolution of these gradients through the late Miocene. Table 1 shows mean ^{18}O and ^{13}C values over 1 m.y. increments (from Appendix C) in Sites 526 and 525.

It is striking that the vertical temperature gradient between the two sites was approximately 1° throughout this interval, with only rather subtle variations, whereas the carbon isotopic gradient actually reversed in the lower Pliocene. Today, Site 526 is bathed by Antarctic Intermediate Water (AIW) with a lower ^{13}C content than the North Atlantic Deep Water (NADW) that is found at the depth of the seafloor at Site 525 (~2500 m); the ^{13}C difference is about 0.2‰ (Kroopnick, 1981, from Station 103). In parts of the lower Pliocene, benthic foraminifers from Site 526 were isotopically more positive than at Site 525. Table 2 shows values from the deep Pacific; during the early Pliocene there was clearly an isotopic gradient between the South Atlantic and the deep Pacific just as strong as there is today, and it seems likely that NADW extended up to the depth of Site 526, perhaps with a reduction in the formation of AIW. These data show that the conclusion reached by Keigwin

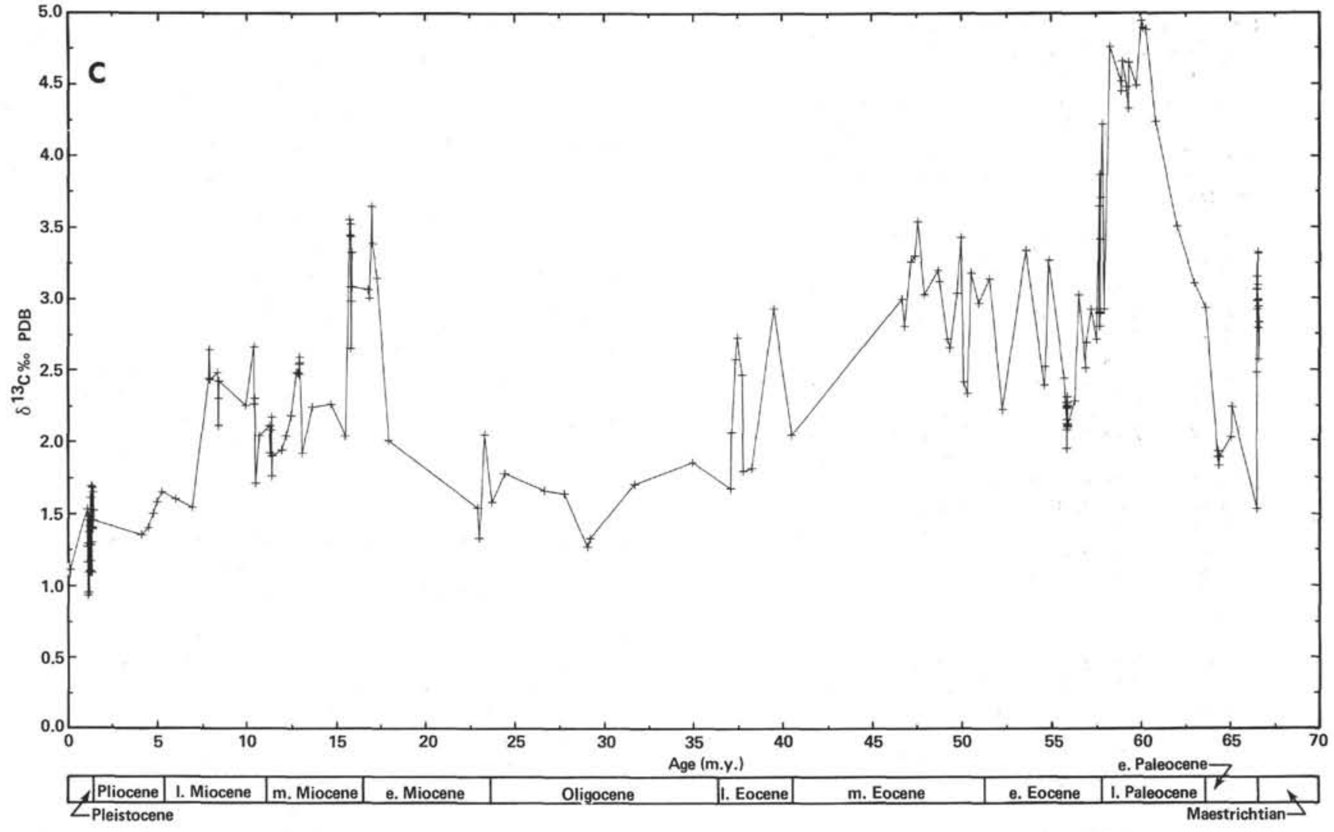

Figure 2. (Continued).

(1982), that the production of NADW was significantly less before the Panama Isthmus closed about 3 Ma, is not correct. Our data show an early Pliocene ^{13}C difference between South Atlantic NADW and deep Pacific water of more than 1‰ well prior to that event. It may be that the early Pliocene Caribbean is not an appropriate position from which to monitor the ^{13}C content of NADW.

The so-called "carbon shift" at about 6.4 Ma (Haq et al., 1980), when ocean-dissolved CO_2 became isotopically lighter for ^{13}C, is reasonably clearly expressed and indeed has been used as a guide to correlating Holes 525B and 526. Occurring just above the appearance of *Amaurolithus primus* at Hole 525B, it provides a useful datum, because this first appearance was not readily determined under the conditions of more extensive overgrowth observed in the late Miocene nannofossils of Site 526. However, it is certainly not such a striking effect as is observed in the Pacific, and indeed there is a clear overlap between pre-"carbon shift" values and those observed in the lower Pliocene (Fig. 2B).

The deep-water ^{18}O record of the late Miocene is thought to reflect the history of Antarctic glaciation, and the isotopic difference between the mean value for 16–17 Ma and today's equilibrium value is about 1.2‰. This means that if ocean isotopic composition changed by about 0.9‰ (Shackleton and Kennett, 1975), there was a deep-water temperature drop of only a little over a degree. By contrast, surface temperatures changed considerably; the temperature difference between the surface and the deep water bathing the shallowest site (526) has increased by about 6°C since the middle Miocene. This dramatic increase in temperature gradients during the last 15 Ma is a fascinating aspect of global paleoclimatology. It must be emphasized again that its interpretation is not affected by current uncertainty (Matthews and Poore, 1980) regarding the history of global oceanic isotopic composition, which affects the absolute temperatures estimated, but not temperature gradients.

Pleistocene

A lower Pleistocene section was analyzed from Hole 528A, where Cores 4–6 were sampled at close intervals. Benthic foraminifers were analyzed in part of the section, chiefly as a check on the reliability of the data obtained. Evidently early Pleistocene climatic variability is easily detectable. With only a single penetration of the site it would not be possible to obtain a long record suitable for spectral analysis. However, the material is suitable for paleoclimatic work; both faunal change and dissolution variability could be examined in relation to the ^{18}O record in this material.

CONCLUSIONS

The ^{18}O analyses in benthic foraminifers record the largely well-established temperature and ice-volume history of the Cenozoic. The temperature maximum in the early Eocene, the cooling early in the middle Eocene, and the very rapid cooling at the Eocene/Oligocene boundary are all well displayed. The accumulation of

Table 1. Oxygen and carbon isotope data averaged in million-year increments for Sites 525 and 526, Pliocene to middle Miocene.

Increment	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	No. of analyses
Site 525			
3–4	3.17 ± 0.10	0.79 ± 0.17	6
4–5	3.06 ± 0.12	0.87 ± 0.33	4
5–6	3.14 ± 0.19	1.02 ± 0.17	19
6–7	2.97 ± 0.15	1.32 ± 0.22	6
7–8	3.00	1.50	1
8–9	3.13	1.64	1
9–10	3.01 ± 0.16	1.42 ± 0.17	2
10–11	2.93 ± 0.11	1.59 ± 0.11	3
11–12	2.79 ± 0.10	1.29 ± 0.19	6
12–13	2.85 ± 0.15	1.44 ± 0.12	20
13–14	2.82 ± 0.14	1.49 ± 0.15	5
14–15	2.81 ± 0.03	1.57 ± 0.37	4
15–16	2.49 ± 0.16	2.18 ± 0.35	10
16–17	1.96 ± 0.12	2.32 ± 0.23	8
17–24	2.09 ± 0.25	1.65 ± 0.37	12
Site 526			
3–4	2.78 ± 0.12	1.11 ± 0.27	11
4–5	2.96 ± 0.10	0.94 ± 0.18	26
5–6	2.91 ± 0.12	0.91 ± 0.16	25
6–7	2.76 ± 0.10	1.07 ± 0.23	24
7–8	2.79 ± 0.09	1.47 ± 0.22	11
8–9	2.89 ± 0.07	1.51 ± 0.09	6
9–10	2.87 ± 0.16	1.44 ± 0.14	10
10–11	2.92 ± 0.11	1.42 ± 0.10	11
11–12	2.67 ± 0.14	1.22 ± 0.17	8
12–13	2.63 ± 0.17	1.36 ± 0.15	14
13–14	2.51 ± 0.14	1.54 ± 0.14	19
14–15	2.33 ± 0.09	1.64 ± 0.36	2
16–16	No data		
16–17	2.05 ± 0.23	2.24 ± 0.36	4
17–24	1.73 ± 0.20	1.59 ± 0.22	7

Table 2. Oxygen and carbon isotope data averaged in million-year increments for deep equatorial Pacific cores V28-179, V28-185, and RC12-66.

Increment	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)	No. of analyses
3–4	3.31 ± 0.23	−0.22 ± 0.23	49
4–5	3.06 ± 0.17	−0.30 ± 0.25	39
5–6	3.22 ± 0.13	−0.22 ± 0.20	26
6–7	3.09 ± 0.17	−0.10 ± 0.29	23

Note: Sources are: Shackleton and Opdyke, 1977; Keigwin and Shackleton, 1980; Shackleton, 1982; and Shackleton, unpublished data). Note that the data in the increment 6–7 m.y. are virtually all from between 6 and 6.5 Ma, after the late Miocene ^{13}C change.

Antarctic ice in the middle Miocene is clearly recorded although sediment recovery was poor in this part of the section and details of the transition are not well resolved. A good late Miocene record at Site 525 will clarify events during that time. A fairly good early Oligocene record is also available from Site 529. Although frequent slumps would preclude use of this section for detailed time-series analysis, it provides important evidence supporting the existence of limited Antarctic glaciation during the earliest Oligocene. The details of the Paleogene section permit the climatic events to be better dated than before. High deep-water temperatures were attained close to the Paleocene/Eocene boundary at about 56 Ma, and a temperature decline occurred over a period of about a million years early in the middle Eocene (~50–49 Ma).

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APPENDIX A
Isotopic Analyses of Benthic and Planktonic Foraminifers

Adjustment factors applied to the isotopic analyses of benthic foraminiferal species in order to obtain the best estimates of oxygen isotopic equilibrium and carbon isotopic composition of ocean deep-water dissolved CO_2.

Genus or Species	Computer Abbreviation	Adjustment	
		^{18}O	^{13}C
Uvigerina	UVIG	0.0	0.9
Hoeglundina	HELEGANS	−0.40	−1.3
Cibicidoides	CIB	0.5	0.0
C. kullenbergi	CIBKULL	0.5	0.0
C. wuellerstorffi	PWUELL	0.64	0.0
C. havanensis	CIBHAV	0.5	0.0
Melonis	MELONIS	0.3	0.8
M. pompilliodes	MELPOMP	0.3	0.6
M. barleearnum	MELBARL	0.4	1.0
Bulimina	BULIMINA	0.0	0.0
B. jarvisi	BJARV	0.0	0.0
Globocassidulina	GLOBOCAS	−0.1	0.5
Nuttalides	NUTT	0.35	0.0
Gavelinella	GAVELIN	0.3	0.0
Gyroidina	GYROID	0.0	0.0
Oridorsalis	ORID	0.0	1.0
Stilostomella	STABYSS	−0.15	1.0
Sphaeroidina	SBULL	−0.1	−0.1
Favocassidulina	FAVOCASS	−0.1	0.5
Planulina renzi	PRENZI	0.6	0.0
Pullenia bulloides	PULBUL	0.0	0.3
Rectuvigerina	RECTUVIG	0.0	0.9
Anomalinoides	ANOMALIN	0.3	0.3
Gavelinella	GAVELIN	0.3	0.0
Nodosaria	NOD	0.0	0.0
Osangularia	OSANG	0.0	0.0
NUTT + CIB	NUTTCIB	0.4	0.0
UVIG + GLOBOCAS	UVIGGLOB	−0.05	0.7
PWUELL + CIBKULL	WUELKULL	0.5	0.0
GLOBOCAS + BJARV	GLOBOJAR	0.0	0.25
ORID etc.	ORIDMIX	0.0	0.5
ORID + BUL	ORIDBUL	0.0	0.5
NUTT + ALAB	NUTTALAB	0.4	0.0
CIB + GAV	CIBGAV	0.5	0.0
BUL + CIB	BULCIB	0.15	0.0
UVIG + STABYSS	UVIGSTIL	0.0	1.0
GLOBOCAS + ORID	GLOBORID	0.0	0.75
UVIG + GLOBOCAS	UVIGGLOB	0.0	0.7
ORID + GYROID	ORIDGYR	0.0	0.5
STABYSS + BJARV	STILJARV	0.0	0.5
GLOBOCAS + STABYSS	GLOBSTIL	0.0	0.7
UVIG + BUL	UVIGBUL	0.0	0.45
NUTT + CIB	NUTTCIB	0.4	0.0
NUTT + GAV	NUTTGAV	0.35	0.0

Note: These figures are derived from our assessment of all the data available to us. Although a slightly different set of adjustments might be derived on the basis of data from Leg 74 alone, we consider that this would impede comparison with other sites.

APPENDIX B
Isotopic Analyses of Benthic Foraminifers from Sites 525–529

Sub-bottom Depth (m)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 525B			
0.80	UVIG	3.95	0.08
11.66	FAVOCASS	3.69	−0.03
11.66	PWUELL	2.96	0.70
13.05	GLOBOCAS	3.40	0.50
13.05	PWUELL	2.66	1.10
19.01	PWUELL	2.45	0.50
19.34	PWUELL	2.61	0.71
22.10	GLOBOCAS	3.41	0.51
22.20	CIBKULL	2.64	0.87
22.20	NUTT	3.21	0.27
22.20	GLOBOCAS	3.32	0.57
22.20	PWUELL	2.76	0.86
22.40	CIBKULL	2.89	0.74
22.40	GLOBOCAS	3.73	0.49
22.40	PWUELL	2.90	0.74
23.61	GLOBOCAS	3.28	0.36
27.78	GLOBOCAS	3.29	0.45
33.35	GLOBOCAS	3.11	0.34
35.10	GLOBOCAS	3.30	0.27
42.26	PWUELL	2.28	0.45
44.88	GLOBOCAS	3.30	0.53
48.05	GLOBOCAS	3.18	0.28
54.08	GLOBOCAS	3.14	0.72
55.58	GLOBOCAS	3.14	0.96
58.81	GLOBOCAS	3.09	0.63
59.11	GLOBOCAS	3.29	0.78
60.31	GLOBOCAS	3.37	0.83
61.71	CIB	2.57	1.14
61.71	GLOBOCAS	3.32	0.81
62.01	GLOBOCAS	3.44	0.79
62.91	GLOBOCAS	3.17	0.26
62.91	STABYSS	3.17	0.08
62.91	UVIG	3.09	0.41
63.21	GLOBOCAS	3.23	0.31
66.81	GLOBOCAS	3.58	0.81
66.81	ORID	3.07	−0.30*
66.81	UVIG	3.31	0.42
66.91	GLOBOCAS	3.24	0.62
67.41	GLOBOCAS	3.29	0.46
67.91	CIB	2.70	0.86
67.91	GLOBOCAS	3.45	0.43
70.61	CIBKULL	2.88	0.70
70.61	GLOBOCAS	3.38	0.76
70.61	PRENZI	2.67	0.82
70.68	PWUELL	2.70	0.83
72.11	GLOBOCAS	3.04	0.56
72.11	PRENZI	2.67	0.85
72.18	PWUELL	2.51	0.95
73.61	PWUELL	2.67	1.23
75.14	GLOBOCAS	3.30	0.56
75.81	GLOBOCAS	3.64	0.78
75.81	PRENZI	2.60	1.02
79.06	GLOBOCAS	3.29	0.64
79.06	PWUELL	2.51	0.73
79.71	CIBKULL	2.79	0.76
79.71	GLOBOCAS	3.24	0.56
79.71	PRENZI	2.49	0.95
81.01	PRENZI	2.77	0.88
82.06	GLOBOCAS	3.08	0.40
82.31	GLOBOCAS	2.88	0.30
82.31	PRENZI	2.05	0.68
82.49	GLOBOCAS	2.84	0.00
82.49	PWUELL	2.20	0.79
82.49	UVIG	2.52	0.22
82.93	GLOBOCAS	3.11	0.47
82.93	PWUELL	2.49	0.98
88.01	PRENZI	2.55	0.90
94.31	GLOBOCAS	3.01	0.90
94.31	PRENZI	2.35	1.27
95.04	GLOBOCAS	2.97	1.00
95.04	PRENZI	2.37	1.48
95.69	GLOBOCAS	2.85	0.83
96.21	GLOBOCAS	3.22	0.85
97.71	GLOBOCAS	3.07	1.00
99.37	CIBKULL	2.64	1.40
99.37	GLOBOCAS	3.13	1.10
103.54	GLOBOCAS	3.22	1.12
103.54	PRENZI	2.53	1.65
109.11	PWUELL	2.25	1.30
113.47	GLOBOCAS	3.36	1.04
113.47	PWUELL	2.34	1.54
117.25	GLOBOCAS	2.84	1.30
117.25	PWUELL	2.23	1.64
123.91	CIB	2.49	1.52
124.11	GLOBOCAS	3.01	1.09
124.11	PRENZI	2.44	1.49
126.59	PWUELL	2.08	1.14
128.51	CIB	2.14	1.06
129.56	CIB	2.27	1.48
132.71	CIBKULL	2.38	1.19
132.71	UVIGSTIL	2.74	0.55*
134.64	CIB	2.32	1.17
137.20	GLOBORID	3.00	0.98*
137.20	PRENZI	2.30	1.51
Hole 525B (cont.)			
139.18	PWUELL	2.52	1.50
139.18	UVIGGLOB	2.97	0.95*
139.41	GLOBOCAS	2.86	1.00
139.41	PWUELL	2.09	1.39
139.46	GLOBOCAS	2.78	0.94
139.61	GLOBOCAS	3.09	1.19
139.61	PWUELL	1.87	1.30
139.81	PWUELL	2.13	1.46
139.81	MIXED	2.96	0.86*
140.01	PWUELL	2.22	1.53
140.21	GLOBOCAS	2.58	1.12
140.21	PWUELL	2.00	1.59
140.41	PWUELL	2.43	1.63
140.41	SBULL	2.77	0.90
140.71	PWUELL	2.50	1.37
140.91	UVIGGLOB	2.86	0.97
141.11	PWUELL	2.16	1.48
141.31	PWUELL	2.37	1.44
141.51	PWUELL	2.26	1.46
141.71	CIB	2.30	1.57
142.21	PWUELL	2.24	1.47
142.41	PWUELL	2.19	1.46
142.41	SBULL	2.96	0.93
142.61	PWUELL	2.19	1.40
142.61	STABYSS	2.68	0.80
142.81	PWUELL	2.39	1.38
143.01	PWUELL	2.34	1.43
143.41	CIB	2.09	1.52
149.57	PWUELL	2.28	1.75
153.47	PWUELL	2.05	1.38
155.65	GLOBOCAS	3.01	1.21
155.65	PWUELL	2.18	1.30
155.65	PWUELL	2.43	1.40
157.91	PWUELL	2.26	1.47
159.41	PWUELL	2.00	1.40
162.31	GLOBOCAS	2.87	1.45
163.81	GLOBOCAS	2.95	1.20
166.45	GLOBOCAS	2.90	0.56
166.61	GLOBOCAS	2.94	1.11
166.61	PRENZI	2.20	1.50
169.90	GLOBOCAS	2.37	1.11
174.61	GLOBOCAS	2.64	2.01
174.71	GLOBOCAS	2.67	2.18
174.91	GLOBOCAS	2.68	1.86
174.91	PWUELL	2.06	2.20
175.02	GLOBOCAS	2.67	2.00
175.31	CIBKULL	2.12	1.83
175.31	GLOBOCAS	2.85	2.03
175.51	GLOBOCAS	2.71	1.89
175.51	GLOBOCAS	2.72	1.90
176.01	GLOBOCAS	2.40	1.45
176.41	CIBHAV	1.84	1.69
176.41	GLOBOCAS	2.45	1.45
188.71	BULIMINA	1.39*	1.25*
189.51	GLOBOCAS	2.20	1.79
190.31	ORIDGYR	1.94	1.81
190.61	CIB	1.48	2.23
191.01	GLOBOCAS	1.86	1.94
191.01	STILJARV	1.94	1.88
191.21	ORIDGYR	2.13	1.98
191.41	ORID	2.02	1.74
191.61	CIBKULL	1.32	1.95
192.20	GLOBOCAS	1.92	1.51
192.20	GLOBOCAS	1.93	1.78
194.21	CIBKULL	1.32	1.76
195.91	GLOBOCAS	1.64	1.26
201.05	GLOBOCAS	2.10	1.45
Hole 525A			
174.60	GLOBOCAS	2.45	1.41
193.60	GLOBOCAS	2.44	1.81
203.10	GLOBOCAS	2.17	1.19
212.60	GLOBOCAS	2.43	1.34
222.10	CIB	1.98	1.14
222.10	GLOBOCAS	2.26	0.95
231.91	GLOBOJAR	2.30	0.84
241.40	PRENZI	1.61	1.75
241.40	STABYSS	2.13	0.80
250.86	GLOBOCAS	2.31	1.46
250.86	GYROID	2.33	1.18
250.86	PRENZI	1.93	1.81
250.86	STABYSS	2.23	0.93
260.37	CIB	1.16	1.19
260.37	GLOBOCAS	2.17	1.09
263.91	BJARV	1.99	0.80
263.91	GLOBOCAS	2.07	1.03
263.91	GLOBOCAS	2.37	0.31
279.63	NUTTCIB	0.52	0.78
281.10	CIB	0.39	1.11
281.10	NUTT	0.33	0.73
282.60	NUTTCIB	0.47	0.83
284.10	NUTTCIB	0.41	0.92
284.10	ORID	0.77	0.39*
Hole 525A (cont.)			
287.10	NUTT	0.34	0.78
287.10	ORID	0.65	0.31*
289.01	BULIMINA	0.93	0.79
289.01	NUTT	0.33	0.68
290.51	NUTTCIB	0.28	0.70
290.51	ORIDMIX	0.64	0.40*
292.01	BULIMINA	0.81	0.92
292.01	NUTT	0.42	0.74
292.01	ORID	0.69	0.31
293.50	ORID	0.38	−0.05
295.01	CIB	0.01	0.76
295.01	NUTT	−0.13	0.33
298.00	NUTT	−0.29	0.65
302.29	NUTTCIB	−0.37	1.08
302.39	ORIDBUL	0.15	0.83*
322.79	NUTTALAB	−0.43	0.89
337.85	CIBGAV	−0.59	1.16
337.85	NUTT	−0.78	0.83
358.19	BULCIB	−0.21	0.35
358.29	CIB	−0.42	0.69
358.29	GAVELIN	−0.31	0.82
358.39	MIXED	−0.59	0.80
358.49	MIXED	−0.25	0.45
358.59	CIB	−0.38	0.66
358.59	ORID	−0.49	−0.14
358.69	CIBGAV	−0.80	0.06
358.99	NUTT	−0.10	0.47
359.09	BULIMINA	0.07	0.32
359.09	NUTT	−0.34	0.37
359.19	BULIMINA	0.19	0.31
359.19	NUTT	−0.10	0.53
359.29	NUTT	−0.36	0.21
359.39	NUTT	−0.20	0.44
359.49	NUTT	−0.21	0.37
359.59	NUTT	−0.26	0.29
371.57	NUTT	−0.48	0.28
379.21	NUTT	0.01	1.63
382.21	NUTT	−0.04	1.11
385.81	NUTT	−0.07	0.86
387.31	NUTT	−0.32	0.96
390.09	NUTT	−0.26	1.06
393.36	NUTT	0.07	1.55
403.35	CIB	−0.03	2.43
403.40	NUTT	−0.18	2.15
404.59	CIB	0.06	2.49
404.59	NUTT	0.13	2.18
404.65	NUTTCIB	0.15	2.76
408.91	NUTT	0.10	2.35
411.91	NUTT	0.06	2.68
412.81	CIB	0.12	2.80
412.81	NUTT	0.09	2.57
415.35	NUTT	0.07	2.61
422.01	NUTT	0.25	1.98
433.72	NUTT	0.19	1.01
436.05	NUTT	0.03	1.04
442.50	NUTT	−0.01	1.28
442.50	ORID	0.59	1.01*
442.70	NUTT	−0.11	1.34
442.90	NUTT	0.11	1.31
442.90	ORID	0.42	1.07*
444.00	GAVELIN	−0.18	1.20
444.00	NUTT	0.05	1.41
444.20	NUTT	0.20	1.18
470.91	GAVELIN	−0.06	1.62
470.91	NUTT	0.12	1.69
470.91	ORID	0.34	1.61
Hole 526B			
6.71	GLOBOCAS	3.92	0.42
6.71	PWUELL	3.42	1.19
15.51	GLOBOCAS	3.68	0.57
16.31	PWUELL	2.66	0.87
17.11	PWUELL	2.56	1.05
17.31	PWUELL	2.64	0.99
17.51	PWUELL	2.61	1.08
17.71	PWUELL	2.75	0.67
18.31	PWUELL	2.42	0.52
22.11	GLOBOCAS	3.16	0.09
25.51	PWUELL	2.30	1.04
26.71	CIB	2.72	0.07
26.71	PWUELL	2.16	0.87
Hole 526A			
28.91	PWUELL	2.00	0.85
28.91	UVIG	2.73	0.51
29.01	UVIG	2.62	0.37
29.20	UVIG	2.57	0.36
29.60	UVIG	2.82	0.74
29.79	UVIG	2.73	0.41
29.90	UVIG	2.76	0.44
30.10	GLOBOCAS	2.65	0.45
30.10	PWUELL	2.35	0.84
30.10	UVIG	2.85	0.52

Appendix B. (Continued).

Sub-bottom Depth (m)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 526A (cont.)			
30.20	PWUELL	2.39	0.92
30.20	UVIG	2.77	0.73
30.52	PWUELL	2.38	0.80
30.52	UVIG	2.77	0.46
30.72	UVIG	2.83	0.68
31.11	PWUELL	2.33	0.93
31.11	UVIG	2.75	0.39
31.30	PWUELL	2.19	0.83
31.41	PWUELL	2.35	0.88
31.41	UVIG	2.73	0.41
31.60	PWUELL	2.43	0.90
31.71	PWUELL	2.47	0.79
32.01	PWUELL	2.25	0.72
32.20	PWUELL	2.33	1.00
33.05	PWUELL	2.39	0.96
34.55	PWUELL	2.36	1.06
36.05	PWUELL	2.37	0.98
36.59	PWUELL	2.24	0.87
38.02	PWUELL	2.32	0.87
39.52	GLOBOCAS	3.03	0.26
39.52	PWUELL	2.31	1.00
41.02	PWUELL	2.45	0.71
41.28	GLOBOCAS	2.68	0.17
41.28	PWUELL	2.19	0.83
41.42	PWUELL	2.17	1.08
44.42	PWUELL	2.22	1.09
45.80	GLOBOCAS	3.21	0.42
45.80	PWUELL	2.28	1.00
46.41	PWUELL	2.32	0.90
46.51	PWUELL	2.43	0.89
46.61	PWUELL	2.47	0.80
46.71	PWUELL	2.42	1.05
46.91	PWUELL	2.30	1.10
47.07	PWUELL	2.34	1.08
47.14	PWUELL	2.45	1.07
47.31	PWUELL	2.56	1.25
47.52	PWUELL	2.30	1.06
47.71	PWUELL	2.41	0.91
47.91	PWUELL	2.40	1.05
48.11	PWUELL	2.36	1.04
48.31	PWUELL	2.43	0.96
48.41	GLOBOCAS	2.82	0.23
48.41	PWUELL	2.36	1.22
48.64	PWUELL	2.38	1.02
48.81	PWUELL	2.22	0.88
49.01	GLOBOCAS	2.86	0.29
49.22	GLOBOCAS	3.00	0.45
49.22	PWUELL	2.41	1.10
49.41	PWUELL	2.30	1.03
49.61	GLOBOCAS	2.98	0.30
49.99	PWUELL	2.25	0.84
49.99	GLOBOCAS	2.93	0.47
50.20	GLOBOCAS	2.91	0.59
51.21	GLOBOCAS	2.93	0.25
51.21	PWUELL	2.26	0.82
51.61	GLOBOCAS	2.75	0.19
51.61	PWUELL	2.19	0.78
51.81	GLOBOCAS	2.82	0.22
51.81	PWUELL	2.24	0.63
52.01	BULIMINA	2.72	0.07*
52.01	GLOBOCAS	2.77	0.11
52.01	PWUELL	2.29	0.51
52.21	PWUELL	2.24	0.73
52.41	PWUELL	2.40	0.82
52.61	PWUELL	2.14	0.86
52.71	PWUELL	2.21	0.81
52.81	PWUELL	2.20	1.01
52.81	UVIGGLOB	2.81	0.24
53.11	PWUELL	2.39	1.06
53.31	CIBKULL	2.21	0.43
53.31	GLOBOCAS	2.97	0.55
53.31	PWUELL	2.29	0.81
53.51	GLOBOCAS	3.05	0.27
53.51	PWUELL	2.05	0.70
53.51	STABYSS	2.72	−0.29
53.71	PWUELL	2.39	1.17
53.91	CIBKULL	2.05	0.46
53.91	PWUELL	2.16	0.82
54.11	CIBKULL	2.04	0.62
54.11	GLOBOCAS	2.97	0.11
54.21	GLOBOCAS	2.73	0.20
54.31	GLOBOCAS	2.91	0.62
54.31	PWUELL	2.10	1.10
54.50	GLOBOCAS	2.85	0.27
55.64	PWUELL	2.10	1.20
56.04	GLOBOCAS	2.86	0.40
56.04	PWUELL	2.24	1.13
56.21	PWUELL	2.25	1.27
56.61	GYROID	2.54	0.41*
56.61	PWUELL	2.11	1.29
56.81	GYROID	2.91	0.11*
56.81	PWUELL	2.13	1.07
57.01	PWUELL	2.26	1.25
57.27	GYROID	2.69	0.44*
57.27	RECTUVIG	2.64	0.55
57.27	PWUELL	2.16	1.07
57.54	CIBKULL	2.23	1.00
Hole 526A (cont.)			
57.54	PWUELL	2.34	1.27
57.71	PWUELL	2.06	1.24
57.91	PWUELL	2.03	1.18
58.11	PWUELL	2.05	1.25
58.31	PWUELL	2.06	1.27
58.51	ORID	2.67	0.65*
58.51	PWUELL	2.09	1.28
58.64	PWUELL	2.01	1.24
58.71	PWUELL	1.81	1.01
58.71	STABYSS	2.84	0.37
58.71	UVIG	2.96	0.28
58.86	PWUELL	2.11	1.16
60.16	PWUELL	1.98	1.47
60.40	GLOBOCAS	2.80	0.83
60.40	PWUELL	1.99	1.28
60.60	GLOBOCAS	2.86	1.25
60.89	GLOBOCAS	3.12	1.17
60.89	PWUELL	2.24	1.72
61.09	GLOBOCAS	2.90	1.17
61.09	PWUELL	2.10	1.55
61.29	GLOBOCAS	2.87	1.03
61.29	PWUELL	2.15	1.62
61.49	GLOBOCAS	2.87	1.09
61.49	PWUELL	2.32	1.57
61.66	PWUELL	2.25	1.60
63.41	GLOBOCAS	2.89	0.77
63.51	GLOBOCAS	2.79	0.52
63.81	GLOBOCAS	2.93	0.77
65.41	PWUELL	2.32	1.42
65.41	GLOBOCAS	2.91	1.03
66.16	CIBKULL	2.31	1.41
66.16	GLOBOCAS	3.03	1.08
66.16	GLOBOCAS	3.07	1.09
66.16	ORID	2.90	0.73
66.31	GLOBOCAS	2.97	0.92
66.31	GLOBOCAS	3.17	1.16
66.51	CIB	2.29	1.40
66.51	GLOBOCAS	2.86	0.78
66.51	GLOBOCAS	3.05	1.07
66.71	GLOBOCAS	3.07	0.92
70.47	GLOBOCAS	2.89	1.15
72.51	GLOBOCAS	2.62	1.10
74.38	PWUELL	2.51	1.34
74.38	GLOBOCAS	2.98	0.75
74.51	GLOBOCAS	3.18	1.00
74.71	GLOBOCAS	2.97	1.03
75.11	GLOBOCAS	3.16	0.81
75.29	GLOBOCAS	2.87	0.95
75.48	GLOBOCAS	2.91	1.00
75.51	GLOBOCAS	2.95	0.85
75.68	GLOBOCAS	2.94	0.74
75.90	GLOBOCAS	2.97	1.14
78.01	GLOBOCAS	2.99	0.96
78.21	CIBKULL	2.45	1.19
78.21	GLOBOCAS	2.98	0.93
78.21	PULBUL	2.83	0.66
78.41	PWUELL	2.28	1.46
78.41	GLOBOCAS	2.33	0.68*
78.61	GLOBOCAS	2.94	0.87
78.81	GLOBOCAS	3.13	0.88
79.01	GLOBOCAS	2.99	1.01
79.21	GLOBOCAS	3.05	0.71
79.41	GLOBOCAS	2.83	1.08
79.61	GLOBOCAS	3.12	0.88
79.81	GLOBOCAS	3.18	0.89
80.01	GLOBOCAS	2.99	0.97
80.01	GLOBOCAS	3.29	0.89
80.50	GLOBOCAS	2.87	0.81
83.81	GLOBOCAS	2.87	0.83
84.01	GLOBOCAS	2.62	0.44
84.21	GLOBOCAS	2.97	0.62
84.41	GLOBOCAS	2.62	0.75
85.57	GLOBOCAS	2.81	0.82
87.07	GLOBOCAS	2.75	0.72
87.07	GLOBOCAS	2.81	0.67
88.31	GLOBOCAS	2.59	0.59
88.57	GLOBOCAS	2.88	0.98
90.01	GLOBOCAS	2.72	0.74
90.21	GLOBOCAS	2.90	0.82
91.40	GLOBOCAS	2.61	0.77
91.61	GLOBOCAS	2.81	1.00
93.21	GLOBOCAS	2.94	1.21
95.31	BULIMINA	2.60	1.02*
95.31	GLOBOCAS	2.90	0.88
95.61	GLOBOCAS	2.60	0.87
95.81	GLOBOCAS	3.09	0.62
96.01	GLOBOCAS	2.73	0.89
96.21	GLOBOCAS	2.67	0.90
96.41	GLOBOCAS	2.72	1.03
96.61	GLOBOCAS	2.76	0.78
96.81	GLOBOCAS	2.51	0.80
97.11	GLOBOCAS	2.42	0.69
98.51	GLOBOCAS	2.57	0.98
98.80	GLOBOCAS	2.59	0.83
98.91	GLOBOCAS	2.52	1.05
99.11	GLOBOCAS	2.67	1.00
99.31	GLOBOCAS	2.46	0.85
Hole 5256A (cont.)			
99.51	GLOBOCAS	2.44	1.16
99.81	GLOBOCAS	2.68	1.16
103.00	GLOBOCAS	2.39	1.19
103.21	GLOBOCAS	2.68	1.18
103.21	GYROID	3.10	0.39*
103.61	GLOBOCAS	2.47	1.07
103.61	UVIG	2.79	0.54
104.51	PWUELL	2.03	1.74
104.51	PWUELL	2.17	1.76
104.71	GLOBOCAS	2.68	1.17
105.11	GLOBOCAS	2.79	1.18
105.11	CIB	2.29	1.77
105.31	GLOBOCAS	2.71	0.63
105.51	PWUELL	2.05	1.59
106.01	GLOBOCAS	2.82	1.19
106.01	GYROID	2.50	0.97
106.01	PWUELL	2.01	1.53
106.21	CIB	1.96	1.40
106.41	GLOBOCAS	2.54	1.01
106.41	GLOBOCAS	2.57	1.03
106.85	CIBKULL	1.94	1.45
107.09	GLOBOCAS	2.26	0.70
107.09	PWUELL	1.78	1.67
110.81	CIBKULL	1.89	1.50
110.81	GYROID	2.45	1.32
110.81	PWUELL	1.73	1.62
111.80	PWUELL	1.62	1.79
116.27	PWUELL	1.69	2.34
116.27	GLOBOCAS	2.14	1.74
116.41	GYROID	2.15	1.89
116.41	GLOBOCAS	2.16	1.85
116.41	GLOBOCAS	2.22	2.10
116.51	CIBKULL	1.23	1.72
116.57	GLOBOCAS	2.14	2.02
119.51	ANOMAL	1.44	1.44
120.76	CIB	1.32	1.75
124.92	GLOBOCAS	1.89	1.35
129.80	BJARV	1.45*	0.90*
129.80	HELEGANS	3.30*	2.96*
133.74	CIB	1.57	1.65
157.53	CIB	1.16	1.54
157.53	GLOBSTIL	1.21	0.86
159.45	CIB	1.13	1.43
159.45	CIBKULL	1.17	1.35
159.45	GLOBOCAS	1.39	1.11
159.45	GYROID	1.62	1.11
160.85	CIB	1.45	1.26
160.85	GLOBSTIL	1.45	0.38
164.87	SBULL	1.64	1.04
164.87	STABYSS	1.54	0.29
164.87	UVIGBUL	1.54	0.58
168.15	CIB	1.37	1.23
168.15	CIB	1.52	1.12
169.50	CIB	1.65	1.35
170.47	CIB	1.41	1.24
170.47	UVIG	1.78	0.76
172.18	CIB	1.48	0.80
174.54	CIB	1.73	1.32
175.70	CIB	1.55	1.25
175.90	CIB	1.33	0.88
176.10	UVIG	1.34	0.69
176.40	CIB	1.29	1.53
176.79	CIB	1.39	1.34
176.79	UVIGCIB	1.45	0.58
177.34	CIB	1.49	1.04
177.34	UVIG	1.40	0.77
177.71	CIB	1.48	1.23
179.82	CIB	1.56	1.40
181.32	STABYSS	1.80	0.78
181.60	CIB	1.57	1.39
185.11	UVIG	1.51	0.78
186.60	STABYSS	1.31	0.58
187.46	CIB	1.36	1.26
188.61	UVIG	1.39	0.58
190.11	BULIMINA	1.40	0.43*
190.11	CIB	1.32	1.03
190.11	UVIG	1.57	0.58
193.64	CIB	1.16	1.24
196.00	UVIG	1.51	0.78
201.90	UVIG	1.31	0.73
203.40	UVIG	1.30	1.01
205.95	BULIMINA	1.36	0.47*
205.95	CIB	1.05	1.41
205.95	UVIG	1.43	0.80
208.32	BULIMINA	1.58	0.72
217.53	BULIMINA	0.55	0.78
217.53	GYROID	0.90	1.16
Hole 527			
40.94	PWUELL	2.18	0.87
101.10	PWUELL	2.37	0.79
134.71	NUTT	1.08	0.96
137.51	NUTT	0.67	0.66
138.61	NUTT	0.44	1.02
138.81	NUTTCIB	0.17	0.86
139.01	NUTT	0.48	0.56
139.41	NUTT	0.41	0.77

Appendix B. (Continued).

Sub-bottom Depth (m)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 527 (cont.)			
143.29	NUTT	0.02	0.66
143.11	NUTTCIB	0.33	0.60
142.88	NUTT	0.19	0.48
142.71	MIXED	0.37	0.45
142.71	NUTT	0.29	0.78
142.31	NUTT	0.17	0.57
142.48	NUTTCIB	0.38	0.84
143.61	NUTTCIB	0.21	0.47
143.75	NUTTCIB	0.46	0.76
143.98	NUTTCIB	0.19	0.55
144.21	NUTTCIB	0.33	0.47
144.52	NUTTCIB	0.07	0.49
144.79	CIB	0.09	0.69
145.11	NUTT	−0.10	0.24
145.31	NUTT	−0.11	0.43
145.76	NUTTCIB	0.07	0.38
146.28	NUTTCIB	−0.15	0.33
146.77	NUTTCIB	−0.03	0.89
147.02	NUTTCIB	−0.12	0.60
147.68	NUTTCIB	−0.21	1.02
147.93	NUTT	−0.11	0.72
148.24	NUTT	−0.41	0.64
152.28	NUTT	−0.19	0.97
164.69	NUTT	−0.43	0.57
199.91	NUTT	−0.21	0.77
199.51	NUTT	−0.29	0.82
202.11	CIB	0.22	1.25
202.11	NUTT	−0.10	0.95
218.34	ORID	0.53	1.70
218.34	CIB	0.33	2.42
218.34	NUTT	0.12	2.02
218.34	GAVELIN	0.17	2.01
256.30	ORID	0.55	0.68
258.10	NUTTGAV	0.20	1.02
261.10	NUTT	0.19	1.37
260.62	GAVELIN	0.15	1.02
267.31	NUTT	0.65	1.41
267.51	ORID	0.26	0.65
267.72	GAVELIN	−0.16	1.13
267.72	NUTT	0.50	1.29
267.79	NUTTGAV	−0.14	1.11
267.79	ORID	0.32	0.65*
267.92	GAVELIN	0.58	1.12
267.92	NUTT	−0.02	1.32
267.92	ORID	0.42	0.57*
268.11	GAVELIN	−0.02	1.19
270.11	ORID	0.59	1.01*
270.11	NUTT	0.42	1.28
270.11	NUTT	0.58	1.36
271.71	NUTTGAV	0.33	1.30
271.71	ORID	0.61	1.09*
271.92	NUTT	0.18	1.30
271.92	ORID	0.56	0.94*
273.25	ORID	0.32	1.06*
273.25	NUTT	0.35	1.31
276.21	NUTTCIB	0.15	1.39
278.33	NUTTCIB	0.10	1.61
279.71	NUTTGAV	0.26	2.16
279.91	NUTTGAV	0.14	2.03
280.10	NUTTGAV	0.27	2.01
280.28	NUTT	0.53	2.01
280.49	NUTTGAV	0.27	1.79
280.68	NUTT	0.66	2.26
280.85	NUTTGAV	0.57	1.94
281.19	NUTTGAV	0.30	1.75
281.40	NUTT	0.94	2.17
281.40	NUTT	0.94	2.17
281.59	NUTT	−0.27	1.70*
281.59	NUTT	0.53	1.85
281.59	NUTT	−0.27	1.70
281.59	NUTT	0.53	1.85
282.00	NUTTGAV	0.20	2.03
282.20	NUTT	0.22	1.70
Hole 528A			
8.87	UVIG	3.50	−0.09
8.95	CIBKULL	2.85	0.77
8.95	ORID	3.49	−0.41
Hole 528A (cont.)			
8.95	UVIG	3.52	−0.05
9.05	CIBKULL	3.48	0.48
9.15	GLOBOCAS	4.27	−0.52
9.15	UVIG	3.94	−0.26
9.35	ORID	4.04	−0.54
9.35	UVIG	3.92	−0.18
9.45	GLOBOCAS	3.99	0.03
9.45	UVIG	3.90	0.13
9.55	PWUELL	3.05	0.66
9.55	UVIG	3.52	0.02
9.75	GLOBOCAS	3.65	0.13
9.75	UVIG	4.03	−0.50
9.95	GLOBOCAS	3.62	0.04
9.95	UVIG	3.76	0.04
10.05	CIBKULL	3.53	0.70
10.05	UVIG	3.96	−0.05
10.15	GLOBOCAS	4.00	−0.51
10.15	PWUELL	3.23	0.20
10.15	UVIG	3.88	−0.37
10.25	GLOBOCAS	4.00	−0.08
10.25	UVIG	4.05	−0.02
10.35	CIBKULL	3.24	0.96
10.35	UVIG	3.49	0.20
10.45	CIBKULL	2.94	0.85
10.55	CIBKULL	3.71	0.86
10.55	PWUELL	3.30	0.86
10.55	UVIG	3.89	0.05
10.62	GLOBOCAS	3.90	0.07
10.62	ORID	4.09	−0.59
10.62	PWUELL	3.54	0.25
10.62	UVIG	3.86	−0.02
10.75	CIBKULL	3.35	0.97
10.87	CIBKULL	2.99	0.93
10.87	UVIG	3.65	−0.04
10.95	UVIG	4.33	0.06
11.03	GLOBOCAS	4.19	−0.35
11.03	UVIG	3.89	−0.32
11.15	UVIG	4.14	−0.37
11.25	GLOBOCAS	3.83	−0.06
11.35	CIBKULL	2.68	0.62
11.35	UVIG	3.46	−0.35
11.55	CIB	3.57	0.31
11.64	GLOBOCAS	4.48	−0.39
11.64	ORID	4.10	−0.78
11.64	PWUELL	3.06	0.59
11.64	UVIG	4.36	−0.28
11.75	UVIG	3.46	−0.19
11.85	UVIG	3.60	−0.10
24.25	GLOBOCAS	2.93	0.01
24.25	GLOBOCAS	3.01	0.39
44.35	CIB	2.61	0.49
45.15	CIB	2.50	0.61
45.15	UVIGGLOB	3.05	0.29
Hole 528			
225.67	NUTTCIB	2.51	1.13
227.54	NUTTCIB	0.87	0.75
237.98	CIB	1.08	1.19
237.98	NUTT	0.92	0.69
246.40	NUTTCIB	0.72	0.90
249.40	NUTT	0.31	0.17
250.60	NUTTCIB	0.29	0.71
250.60	ORIDBUL	0.58	0.23*
252.00	NUTT	0.33	0.81
256.61	NUTTCIB	−0.19	0.65
257.47	NUTTCIB	0.07	1.01
263.01	NUTTCIB	−0.52	1.03
312.07	NUTT	−0.14	0.65
313.53	NUTT	0.05	1.32
313.56	NUTT	−0.02	1.36
313.82	NUTT	−0.11	1.24
314.21	CIB	−0.12	1.08
314.21	NUTT	−0.18	1.32
315.99	NUTT	0.13	1.74
Hole 529			
0.11	HELEGANS	3.61	2.89
0.11	PWUELL	2.19	1.01
Hole 529 (cont.)			
131.49	GLOBOCAS	2.20	0.64
131.49	GYROID	2.50	0.65*
135.71	GLOBORID	2.05	0.34
141.46	BULIMINA	1.99	0.66
141.46	GLOBOCAS	2.29	0.76
151.55	BULIMINA	2.05	0.47
156.21	CIB	1.79	1.24
160.75	GLOBOCAS	1.93	0.90
160.75	GYROID	2.19	0.94
163.91	BJARV	2.35	1.47
168.89	CIB	1.75	1.33
168.89	GLOBOCAS	2.05	0.58
168.89	GLOBOCAS	2.10	0.88
170.73	CIB	1.94	0.74
170.73	GYROID	2.60	0.66
170.73	STABYSS	2.20	0.41*
172.23	CIB	1.66	1.20
175.23	CIB	1.62	1.20
175.41	GLOBOCAS	2.13	0.83
176.73	CIBGLOB	1.54	1.15
178.23	CIB	1.44	0.01
179.62	ORID	1.87	0.13
181.50	CIB	1.49	0.95
181.50	ORID	1.97	0.10*
182.15	CIB	1.77	0.86
182.15	BULSTIL	1.96	0.51
183.41	BJARV	2.22	1.08
183.41	GLOBOCAS	2.34	0.88
183.41	ORID	2.04	0.60*
183.63	CIB	1.54	1.12
183.63	ORID	1.74	0.35*
184.87	CIB	1.52	1.22
184.87	UVIGORID	1.75	0.60
184.87	GYROID	2.07	0.98
184.87	GLOBORID	1.80	0.65
184.87	STABYSS	1.82	0.55
185.13	CIB	1.84	0.98
185.13	NOD	1.94	0.65*
185.57	CIB	1.55	1.27
189.01	MIXED	2.05	0.70
192.98	BJARV	2.37	1.40
193.21	BULIMINA	2.44	1.00
193.21	GLOBORID	2.34	0.73
194.18	BJARV	2.45	1.33
194.55	BJARV	2.55	1.64
195.57	BJARV	2.44	1.59
197.90	GYROID	1.95	1.01
197.90	UVIG	1.82	0.66
199.00	BJARV	2.38	1.58
199.00	CIB	2.22	1.81
199.20	BJARV	2.28	1.43
199.20	ORID	2.30	0.83
199.50	BJARV	2.48	1.65
200.04	BJARV	1.32	0.77
200.04	NUTT	0.60	0.76
200.04	STABYSS	1.06	0.80
200.13	BJARV	1.47	0.95
200.13	NUTT	0.91	0.88
200.20	BULIMINA	1.73	0.87
200.78	BJARV	1.18	1.12
200.78	NUTT	0.58	1.14
201.39	BJARV	1.19	0.97
201.39	NUTT	0.47	0.77
201.53	NOD	1.30	0.84
202.58	BJARV	1.44	0.83
202.58	NUTT	0.89	0.76
205.20	BJARV	1.44	0.83
206.60	BULIMINA	1.24	1.22
207.35	BJARV	1.37	0.79
207.35	NUTT	0.77	0.57
207.35	NUTT	0.88	0.74
207.88	ANOMAL	0.34	0.67
207.88	CIB	0.47	0.73
207.88	BULIMINA	1.26	0.82
207.88	ORID	1.10	0.32
207.88	OSANGUL	1.06	0.83
222.50	BJARV	1.34	0.74
222.50	NUTT	0.75	0.60
268.84	MIXED	−0.27	0.73

Note: Asterisks denote values that have not been used in Appendix C or in the figures. In the majority of cases these are ^{13}C values for species whose departure from isotopic equilibrium is poorly defined or very variable; in a small number of cases it is suspected either that the sample was displaced or that the analysis was suspect. For explanations of computer abbreviations, see Appendix A.

APPENDIX C
Isotopic Analyses of Benthic Foraminifers from Sites 525–529, Adjusted on the Basis of Appendix A

Sub-bottom Depth (m)	Age (m.y.)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 525B				
0.80	0.163	UVIG	3.95	0.98
11.66	2.216	MEAN	3.60	0.59
13.05	2.402	MEAN	3.30	1.05
19.01	3.126	PWUELL	3.09	0.50
19.34	3.138	PWUELL	3.25	0.71
22.10	3.234	MEAN	3.25	0.94
22.20	3.237	MEAN	3.32	0.93
22.40	3.244	MEAN	3.52	0.82
23.61	3.287	GLOBOCAS	3.18	0.86
27.78	3.432	GLOBOCAS	3.19	0.95
33.35	3.644	GLOBOCAS	3.01	0.84
35.10	3.748	GLOBOCAS	3.20	0.77
42.26	4.171	PWUELL	2.92	0.45
44.88	4.326	GLOBOCAS	3.20	1.03
48.05	4.513	GLOBOCAS	3.08	0.78
54.08	4.841	GLOBOCAS	3.04	1.22
55.58	4.923	GLOBOCAS	3.04	1.46
58.81	5.063	GLOBOCAS	2.99	1.13
59.11	5.074	GLOBOCAS	3.19	1.28
60.31	5.116	GLOBOCAS	3.27	1.33
61.71	5.164	MEAN	3.15	1.23
62.01	5.175	GLOBOCAS	3.34	1.29
62.91	5.206	MEAN	3.05	1.05
63.21	5.217	GLOBOCAS	3.13	0.81
66.81	5.342	MEAN	3.28	1.31
66.91	5.346	GLOBOCAS	3.14	1.12
67.41	5.363	GLOBOCAS	3.19	0.96
67.91	5.381	MEAN	3.28	0.90
70.61	5.475	MEAN	3.31	0.93
70.68	5.478	PWUELL	3.34	0.83
72.11	5.528	MEAN	3.11	0.96
72.18	5.530	PWUELL	3.15	0.95
73.61	5.580	PWUELL	3.31	1.23
75.14	5.633	GLOBOCAS	3.20	1.06
75.81	5.657	MEAN	3.37	1.15
79.06	5.770	MEAN	3.17	0.94
79.71	5.793	MEAN	3.17	0.92
81.01	5.838	PRENZI	3.37	0.88
82.06	5.875	GLOBOCAS	2.98	0.90
82.31	5.884	MEAN	2.72	0.74
82.49	5.890	MEAN	2.70	0.80
82.93	5.905	MEAN	3.07	0.98
88.01	6.083	PRENZI	3.15	0.90
94.31	6.303	MEAN	2.93	1.34
95.04	6.328	MEAN	2.92	1.49
95.69	6.351	GLOBOCAS	2.75	1.33
96.21	6.369	GLOBOCAS	3.12	1.35
97.71	6.600	GLOBOCAS	2.97	1.50
99.37	7.145	MEAN	3.00	1.50
103.54	8.505	MEAN	3.13	1.64
109.11	9.228	PWUELL	2.89	1.30
113.47	9.794	MEAN	3.12	1.54
117.25	10.285	MEAN	2.81	1.72
123.91	10.932	CIB	2.99	1.52
124.11	10.948	MEAN	2.98	1.54
126.59	11.142	PWUELL	2.72	1.14
128.51	11.293	CIB	2.64	1.06
129.56	11.375	CIB	2.77	1.48
132.71	11.623	MEAN	2.81	1.19
134.64	11.774	CIB	2.82	1.17
137.20	11.975	MEAN	2.95	1.51
139.18	12.645	MEAN	3.07	1.50
139.41	12.734	MEAN	2.75	1.45
139.46	12.753	GLOBOCAS	2.68	1.44
139.61	12.801	MEAN	2.75	1.50
139.81	12.811	MEAN	2.87	1.46
140.01	12.820	PWUELL	2.86	1.53
140.21	12.830	MEAN	2.56	1.61
140.41	12.839	MEAN	2.87	1.22
140.71	12.853	PWUELL	3.14	1.37
140.91	12.863	UVIGGLOB	2.86	1.27
141.11	12.872	PWUELL	2.80	1.48
141.31	12.881	PWUELL	3.01	1.44
141.51	12.891	PWUELL	2.90	1.46
141.71	12.900	CIB	2.80	1.57
142.21	12.924	PWUELL	2.88	1.47
142.41	12.933	MEAN	2.85	1.15
142.61	12.942	MEAN	2.68	1.60
142.81	12.952	PWUELL	3.03	1.38
143.01	12.961	PWUELL	2.98	1.43
143.41	12.980	CIB	2.59	1.52
149.57	13.270	PWUELL	2.92	1.75
153.47	13.453	PWUELL	2.69	1.38
155.65	13.555	MEAN	2.93	1.47
157.91	13.753	PWUELL	2.90	1.47
159.41	13.928	PWUELL	2.64	1.40
162.31	14.266	GLOBOCAS	2.77	1.95
163.81	14.441	GLOBOCAS	2.85	1.70
166.45	14.750	GLOBOCAS	2.80	1.06
166.61	14.768	MEAN	2.82	1.56
169.90	15.152	GLOBOCAS	2.27	1.61
174.60	15.627	GLOBOCAS	2.35	1.91
174.61	15.628	GLOBOCAS	2.54	2.51
174.71	15.635	GLOBOCAS	2.57	2.68
Hole 525B (cont.)				
174.91	15.650	MEAN	2.64	2.28
175.02	15.658	GLOBOCAS	2.57	2.50
175.31	15.680	MEAN	2.69	2.18
175.51	15.695	MEAN	2.62	2.40
176.01	15.732	GLOBOCAS	2.30	1.95
176.41	15.761	MEAN	2.35	1.82
189.51	16.731	GLOBOCAS	2.10	2.29
190.31	16.790	ORIDGYR	1.94	2.31
190.61	16.812	CIB	1.98	2.23
190.65	16.815	CIB	1.98	2.23
191.01	16.842	MEAN	1.85	2.41
191.05	16.845	MEAN	1.85	2.41
191.21	16.856	GYRORID	2.13	2.48
191.25	16.859	GYRORID	2.13	2.48
191.41	16.871	ORID	2.02	2.74
191.45	16.874	ORID	2.02	2.74
191.61	16.886	CIBKULL	1.82	1.95
191.65	16.889	CIBKULL	1.82	1.95
192.20	16.930	MEAN	1.83	2.15
193.60	17.070	GLOBOCAS	2.34	2.31
194.01	17.134	CIBKULL	1.82	1.76
194.21	17.165	CIBKULL	1.82	1.76
195.91	17.430	GLOBOCAS	1.54	1.76
201.05	17.748	GLOBOCAS	2.00	1.95
Hole 525A				
203.10	17.823	GLOBOCAS	2.07	1.69
212.60	19.187	GLOBOCAS	2.33	1.84
222.10	21.613	MEAN	2.32	1.30
231.91	22.955	GLOBOJAR	2.30	1.09
241.40	23.241	MEAN	2.10	1.78
250.86	23.526	MEAN	2.29	1.90
260.37	23.971	MEAN	1.87	1.39
263.91	24.229	MEAN	2.08	1.06
279.63	46.733	NUTTCIB	0.92	0.78
281.10	47.101	MEAN	0.79	0.92
282.60	47.477	NUTTCIB	0.87	0.83
284.10	47.860	MEAN	0.79	0.92
287.10	47.710	MEAN	0.67	0.78
289.01	49.252	MEAN	0.80	0.68
290.51	49.677	MEAN	0.66	0.70
292.01	50.050	MEAN	0.76	0.74
293.50	50.255	ORID	0.38	0.95
295.01	50.462	MEAN	0.37	0.55
298.00	50.874	NUTT	0.06	0.65
302.29	51.464	MEAN	0.09	1.08
302.39	51.477	ORIDBUL	0.15	1.33
322.79	53.502	ALABNUTT	−0.08	0.89
337.85	54.604	MEAN	−0.26	0.95
338.01	54.617	MEAN	−0.26	1.00
358.19	55.808	CIBBUL	0.04	0.35
358.29	55.811	MEAN	0.04	0.76
358.39	55.814	BENTHICS	−0.09	0.80
358.49	55.818	BENTHICS	0.25	0.45
358.59	55.821	MEAN	−0.19	0.76
358.69	55.824	CIBGAV	−0.30	0.06
358.99	55.834	NUTT	0.25	0.47
359.09	55.838	MEAN	0.04	0.35
359.19	55.841	MEAN	0.22	0.42
359.29	55.844	NUTT	−0.01	0.21
359.39	55.848	NUTT	0.15	0.44
359.49	55.851	NUTT	0.14	0.37
359.59	55.854	NUTT	0.09	0.29
371.57	56.255	NUTT	−0.13	0.28
379.21	56.888	NUTT	0.36	1.63
382.21	57.167	NUTT	0.31	1.11
385.81	57.503	NUTT	0.28	0.86
387.31	57.643	NUTT	0.03	0.96
390.09	57.902	NUTT	0.09	1.06
393.36	58.206	NUTT	0.42	1.55
403.35	59.144	CIB	0.47	2.43
403.40	59.149	NUTT	0.17	2.15
404.59	59.265	MEAN	0.52	2.34
404.65	59.271	NUTTCIB	0.55	2.76
408.91	59.687	NUTT	0.45	2.35
411.91	59.981	NUTT	0.41	2.68
412.81	60.069	MEAN	0.53	2.69
415.35	60.237	NUTT	0.42	2.61
422.01	60.800	NUTT	0.60	1.98
433.72	61.984	NUTT	0.54	1.01
436.05	62.488	NUTT	0.38	1.04
442.50	63.986	MEAN	0.47	1.28
442.70	64.032	NUTT	0.24	1.34
442.90	64.079	MEAN	0.44	1.31
444.00	64.339	MEAN	0.26	1.31
444.20	64.390	NUTT	0.55	1.18
470.91	68.034	MEAN	0.35	1.97
Hole 526B				
6.71	0.839	MEAN	3.94	1.05
15.51	1.823	GLOBOCAS	3.58	1.07
16.31	1.914	PWUELL	3.30	0.87
17.11	2.016	PWUELL	3.20	1.05
Hole 526B (cont.)				
17.31	2.042	PWUELL	3.28	0.99
17.51	2.067	PWUELL	3.25	1.08
17.71	2.093	PWUELL	3.39	0.67
18.31	2.170	PWUELL	3.06	0.52
22.11	2.655	GLOBOCAS	3.06	0.59
25.51	3.090	PWUELL	2.94	1.04
26.71	3.243	PWUELL	2.80	0.87
Hole 526A				
28.91	3.525	MEAN	2.69	1.13
29.01	3.537	UVIG	2.62	1.27
29.20	3.562	UVIG	2.57	1.26
29.60	3.633	UVIG	2.82	1.64
29.79	3.697	UVIG	2.73	1.31
29.90	3.733	UVIG	2.76	1.34
30.10	3.800	MEAN	2.80	1.07
30.20	3.833	MEAN	2.90	1.28
30.52	3.940	MEAN	2.90	1.08
30.72	4.007	UVIG	2.83	1.58
31.11	4.110	MEAN	2.86	1.11
31.30	4.127	PWUELL	2.83	0.83
31.41	4.137	MEAN	2.86	1.10
31.60	4.154	PWUELL	3.07	0.90
31.71	4.164	PWUELL	3.11	0.79
32.01	4.191	PWUELL	2.89	0.72
32.20	4.208	PWUELL	2.97	1.00
33.05	4.284	PWUELL	3.03	0.96
34.55	4.419	PWUELL	3.00	1.06
36.05	4.526	PWUELL	3.01	0.98
36.59	4.549	PWUELL	2.88	0.87
38.02	4.609	PWUELL	2.96	0.87
39.52	4.673	MEAN	2.94	0.88
41.02	4.737	PWUELL	3.09	0.71
41.28	4.748	MEAN	2.71	0.75
41.42	4.754	PWUELL	2.81	1.08
44.42	4.882	PWUELL	2.86	1.09
45.80	4.940	MEAN	3.02	0.96
46.41	4.966	PWUELL	2.96	0.90
46.51	4.971	PWUELL	3.07	0.89
46.61	4.975	PWUELL	3.11	0.80
46.71	4.979	PWUELL	3.06	1.05
46.91	4.988	PWUELL	2.94	1.10
47.07	4.994	PWUELL	2.98	1.08
47.14	4.997	PWUELL	3.09	1.07
47.31	5.019	PWUELL	3.20	1.25
47.52	5.054	PWUELL	2.94	1.06
47.71	5.086	PWUELL	3.05	0.91
47.91	5.120	PWUELL	3.04	1.05
48.11	5.154	PWUELL	3.00	1.04
48.31	5.188	PWUELL	3.07	0.96
48.41	5.205	MEAN	2.86	0.98
48.64	5.244	PWUELL	3.02	1.02
48.81	5.273	PWUELL	2.86	0.88
49.01	5.306	GLOBOCAS	2.76	0.79
49.22	5.342	MEAN	2.98	1.03
49.41	5.374	PWUELL	2.94	1.03
49.61	5.408	GLOBOCAS	2.88	0.80
49.99	5.472	MEAN	2.86	0.91
50.20	5.508	GLOBOCAS	2.81	1.09
51.21	5.679	MEAN	2.87	0.79
51.61	5.747	MEAN	2.74	0.74
51.81	5.781	MEAN	2.80	0.68
52.01	5.814	MEAN	2.77	0.56
52.21	5.848	PWUELL	2.88	0.73
52.41	5.882	PWUELL	3.04	0.82
52.61	5.916	PWUELL	2.78	0.86
52.71	5.933	PWUELL	2.85	0.81
52.81	5.950	MEAN	2.80	0.98
53.11	6.001	PWUELL	3.03	1.06
53.31	6.035	MEAN	2.84	0.76
53.51	6.068	MEAN	2.74	0.73
53.71	6.102	PWUELL	3.03	1.17
53.91	6.136	MEAN	2.68	0.64
54.11	6.170	MEAN	2.71	0.62
54.21	6.187	GLOBOCAS	2.63	0.70
54.31	6.204	MEAN	2.78	1.11
54.50	6.236	GLOBOCAS	2.75	0.77
55.64	6.429	PWUELL	2.74	1.20
56.04	6.497	MEAN	2.82	1.02
56.21	6.526	PWUELL	2.89	1.27
56.61	6.593	MEAN	2.65	1.29
56.81	6.627	MEAN	2.84	1.07
57.01	6.661	PWUELL	2.90	1.25
57.27	6.705	MEAN	2.71	1.16
57.54	6.751	MEAN	2.86	1.14
57.71	6.780	PWUELL	2.70	1.24
57.91	6.814	PWUELL	2.67	1.18
58.11	6.847	PWUELL	2.69	1.25
58.31	6.881	PWUELL	2.70	1.27
58.51	6.915	MEAN	2.70	1.28
58.64	6.937	PWUELL	2.65	1.24
58.71	6.949	MEAN	2.70	1.19
58.86	6.974	PWUELL	2.75	1.16

Appendix C. (Continued).

Sub-bottom Depth (m)	Age (m.y.)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 526A (cont.)				
60.16	7.194	PWUELL	2.62	1.47
60.40	7.235	MEAN	2.77	1.31
60.60	7.269	GLOBOCAS	2.76	1.75
60.89	7.318	MEAN	2.95	1.70
61.09	7.352	MEAN	2.77	1.61
61.29	7.386	MEAN	2.78	1.58
61.49	7.420	MEAN	2.87	1.58
61.66	7.448	PWUELL	2.89	1.60
63.41	7.745	GLOBOCAS	2.79	1.27
63.51	7.762	GLOBOCAS	2.69	1.02
63.81	7.813	GLOBOCAS	2.83	1.27
65.41	8.083	MEAN	2.89	1.47
66.16	8.210	MEAN	2.90	1.58
66.31	8.236	MEAN	2.97	1.54
66.51	8.270	MEAN	2.83	1.42
66.71	8.304	GLOBOCAS	2.97	1.42
70.47	8.947	GLOBOCAS	2.79	1.65
72.51	9.298	GLOBOCAS	2.52	1.60
74.38	9.620	MEAN	3.02	1.30
74.51	9.642	GLOBOCAS	3.08	1.50
74.71	9.676	GLOBOCAS	2.87	1.53
75.11	9.745	GLOBOCAS	3.06	1.31
75.29	9.776	GLOBOCAS	2.77	1.45
75.48	9.809	GLOBOCAS	2.81	1.50
75.51	9.814	GLOBOCAS	2.85	1.35
75.68	9.843	GLOBOCAS	2.84	1.24
75.90	9.881	GLOBOCAS	2.87	1.64
78.01	10.244	GLOBOCAS	2.89	1.46
78.21	10.278	MEAN	2.89	1.53
78.41	10.313	MEAN	2.92	1.46
78.61	10.347	GLOBOCAS	2.84	1.37
78.81	10.382	GLOBOCAS	3.03	1.38
79.01	10.416	GLOBOCAS	2.89	1.51
79.21	10.450	GLOBOCAS	2.95	1.21
79.41	10.485	GLOBOCAS	2.73	1.58
79.61	10.519	GLOBOCAS	3.02	1.38
79.81	10.554	GLOBOCAS	3.08	1.39
80.01	10.588	MEAN	3.04	1.43
80.50	10.661	GLOBOCAS	2.77	1.31
83.81	11.141	GLOBOCAS	2.77	1.33
84.01	11.170	GLOBOCAS	2.52	0.94
84.21	11.199	GLOBOCAS	2.87	1.12
84.41	11.228	GLOBOCAS	2.52	1.25
85.57	11.396	GLOBOCAS	2.71	1.32
87.07	11.614	MEAN	2.68	1.20
88.31	11.794	GLOBOCAS	2.49	1.09
88.57	11.832	GLOBOCAS	2.78	1.48
90.01	12.050	GLOBOCAS	2.62	1.24
90.21	12.086	GLOBOCAS	2.80	1.32
91.40	12.298	GLOBOCAS	2.51	1.27
91.61	12.336	GLOBOCAS	2.71	1.50
93.21	12.621	GLOBOCAS	2.84	1.71
95.31	12.870	MEAN	2.70	1.38
95.61	12.889	GLOBOCAS	2.50	1.37
95.81	12.902	GLOBOCAS	2.99	1.12
96.01	12.915	GLOBOCAS	2.63	1.39
96.21	12.928	GLOBOCAS	2.57	1.40
96.41	12.940	GLOBOCAS	2.62	1.53
96.61	12.953	GLOBOCAS	2.66	1.28
96.81	12.966	GLOBOCAS	2.41	1.30
97.11	12.985	GLOBOCAS	2.32	1.19
98.51	13.074	GLOBOCAS	2.47	1.48
98.80	13.093	GLOBOCAS	2.49	1.33
98.91	13.100	GLOBOCAS	2.42	1.55
99.11	13.113	GLOBOCAS	2.57	1.50
99.31	13.125	GLOBOCAS	2.36	1.35
99.81	13.157	GLOBOCAS	2.58	1.66
99.51	13.138	GLOBOCAS	2.34	1.65
103.00	13.361	GLOBOCAS	2.29	1.69
103.21	13.374	GLOBOCAS	2.58	1.68
103.61	13.400	MEAN	2.58	1.50
104.51	13.457	MEAN	2.74	1.75
104.71	13.470	GLOBOCAS	2.58	1.67
105.11	13.495	MEAN	2.74	1.73
105.51	13.521	MEAN	2.65	1.36
106.01	13.553	MEAN	2.62	1.52
106.21	13.566	CIB	2.46	1.40
106.41	13.578	MEAN	2.46	1.52
106.85	13.624	CIBKULL	2.44	1.45
107.09	13.682	MEAN	2.29	1.44
110.81	14.579	MEAN	2.40	1.48
111.80	14.818	PWUELL	2.26	1.79
116.27	16.718	MEAN	2.19	2.29
116.41	16.822	MEAN	2.24	2.44
116.51	16.896	CIBKULL	1.73	1.72
116.52	16.941	GLOBOCAS	2.04	2.52
119.51	17.827	ANOMAL	1.74	1.74
120.76	17.965	CIB	1.82	1.75
124.92	22.861	GLOBOCAS	1.79	1.85
133.74	23.047	CIB	2.07	1.65
157.53	23.546	MEAN	1.44	1.55
159.45	23.587	MEAN	1.55	1.38
160.85	23.938	MEAN	1.70	1.17
164.87	25.728	MEAN	1.49	1.09
166.25	26.342	STILOS	1.39	1.32
167.75	27.009	STIL	1.53	1.27
Hole 526A (cont.)				
168.15	27.188	MEAN	1.95	1.18
169.50	27.788	CIB	2.15	1.35
170.47	28.143	MEAN	1.85	1.45
172.18	28.413	CIB	1.98	0.80
174.54	28.787	CIB	2.23	1.32
175.70	28.971	CIB	2.05	1.25
175.90	29.002	CIB	1.83	0.88
176.10	29.034	UVIG	1.34	1.59
176.40	29.081	CIB	1.79	1.53
176.79	29.143	MEAN	1.80	1.19
177.34	29.230	MEAN	1.70	1.36
177.71	29.289	CIB	1.98	1.23
179.82	29.623	CIB	2.06	1.40
181.32	29.860	STABYSS	1.65	1.78
181.60	29.904	CIB	2.07	1.39
183.95	30.276	STIL	1.40	1.69
185.11	30.480	UVIG	1.51	1.68
186.60	30.745	STABYSS	1.16	1.58
187.46	30.899	CIB	1.86	1.26
188.61	31.103	UVIG	1.39	1.48
190.11	31.371	MEAN	1.60	1.26
193.64	32.000	CIB	1.66	1.24
196.00	32.420	UVIG	1.51	1.68
201.90	33.471	UVIG	1.31	1.63
203.40	33.738	UVIG	1.30	1.91
205.95	34.193	MEAN	1.45	1.56
208.32	34.615	BULIMINA	1.58	0.72
217.53	36.255	MEAN	0.73	0.97
Hole 527				
40.94	3.808	PWUELL	2.82	0.87
101.10	8.265	PWUELL	3.01	0.79
134.70	41.847	NUTT	1.43	0.96
137.50	45.012	NUTT	1.02	0.66
138.61	47.140	NUTT	0.79	1.02
138.81	47.523	NUTTCIB	0.57	0.86
139.01	47.617	NUTT	0.83	0.56
139.41	47.658	NUTT	0.76	0.77
142.31	48.346	NUTT	0.52	0.57
142.48	48.406	NUTTCIB	0.78	0.84
142.71	48.488	MEAN	0.51	0.62
142.88	48.548	NUTT	0.54	0.48
143.11	48.629	NUTTCIB	0.73	0.60
143.29	48.693	NUTT	0.37	0.66
143.61	48.805	NUTTCIB	0.61	0.47
143.75	48.853	NUTTCIB	0.86	0.76
143.98	48.932	NUTTCIB	0.59	0.55
144.21	49.010	NUTTCIB	0.73	0.47
144.52	49.117	NUTTCIB	0.47	0.49
144.79	49.209	CIB	0.59	0.69
145.11	49.319	NUTT	0.25	0.24
145.31	49.387	NUTT	0.24	0.43
145.76	49.542	NUTTCIB	0.47	0.38
146.28	49.720	NUTTCIB	0.25	0.33
146.77	49.888	NUTTCIB	0.37	0.89
147.02	49.973	NUTTCIB	0.28	0.60
147.68	50.199	NUTTCIB	0.19	1.02
147.93	50.285	NUTT	0.24	0.72
148.24	50.384	NUTT	−0.06	0.64
152.28	51.567	NUTT	0.16	0.97
164.69	54.786	NUTT	−0.08	0.57
199.51	57.517	NUTT	0.06	0.82
199.91	57.545	NUTT	0.14	0.77
202.11	57.699	MEAN	0.49	1.10
218.34	58.833	MEAN	0.57	2.15
256.30	62.762	ORID	0.55	1.68
258.10	62.959	NUTTGAV	0.55	1.02
260.62	63.502	GAVELIN	0.45	1.02
261.10	63.577	NUTT	0.54	1.37
267.31	64.279	NUTT	1.00	1.41
267.51	64.307	ORID	0.26	1.65
267.72	64.343	MEAN	0.50	1.21
267.79	64.356	MEAN	0.27	1.11
267.92	64.378	MEAN	0.54	1.22
268.11	64.411	GAVELIN	0.28	1.19
270.11	64.756	MEAN	0.76	1.32
271.71	65.032	MEAN	0.65	1.30
271.92	65.068	MEAN	0.55	1.30
273.25	65.381	MEAN	0.51	1.31
276.21	65.888	NUTTCIB	0.55	1.39
278.33	66.215	NUTTCIB	0.50	1.61
279.71	66.418	NUTTGAV	0.61	2.16
279.91	66.447	NUTTGAV	0.49	2.03
280.10	66.464	NUTTGAV	0.62	2.01
280.28	66.472	NUTT	0.88	2.01
280.49	66.481	NUTTGAV	0.62	1.79
280.68	66.489	NUTT	1.01	2.26
280.85	66.496	NUTTGAV	0.92	1.94
281.19	66.510	NUTTGAV	0.65	1.75
281.40	66.519	NUTT	1.29	2.17
281.59	66.527	MEAN	0.88	1.85
282.00	66.545	NUTTGAV	0.55	2.03
282.20	66.553	NUTT	0.57	1.70
Hole 528A				
8.87	1.002	UVIG	3.50	0.81
8.95	1.011	MEAN	3.45	0.74
9.05	1.022	CIBKULL	3.98	0.48
9.15	1.033	MEAN	4.06	0.32
9.35	1.056	MEAN	3.98	0.59
9.45	1.067	MEAN	3.90	0.78
9.55	1.078	MEAN	3.61	0.79
9.75	1.101	MEAN	3.79	0.52
9.95	1.124	MEAN	3.64	0.74
10.05	1.135	MEAN	4.00	0.78
10.15	1.146	MEAN	3.88	0.24
10.25	1.158	MEAN	3.98	0.65
10.35	1.169	MEAN	3.62	1.03
10.45	1.180	CIBKULL	3.44	0.85
10.55	1.191	MEAN	4.01	0.89
10.62	1.199	MEAN	3.98	0.53
10.75	1.214	CIBKULL	3.85	0.97
10.87	1.228	MEAN	3.57	0.90
10.95	1.237	UVIG	4.33	0.96
11.03	1.246	MEAN	3.99	0.37
11.15	1.259	UVIG	4.14	0.53
11.25	1.270	GLOBOCAS	3.73	0.44
11.35	1.282	MEAN	3.32	0.59
11.55	1.304	CIB	4.07	0.31
11.64	1.314	MEAN	4.14	0.39
11.75	1.327	UVIG	3.46	0.71
11.85	1.338	UVIG	3.60	0.80
24.25	2.570	MEAN	2.87	0.70
44.35	3.547	CIB	3.11	0.49
45.15	3.569	MEAN	3.03	0.68
Hole 528				
225.67	35.820	NUTTCIB	2.91	1.13
227.54	37.063	NUTTCIB	1.27	0.75
237.98	40.156	MEAN	1.43	0.94
246.40	44.920	NUTTCIB	1.12	0.90
249.40	46.439	NUTT	0.66	0.17
250.60	46.837	MEAN	0.64	0.71
252.00	47.302	NUTT	0.68	0.81
256.61	48.632	NUTTCIB	0.21	0.65
257.40	49.217	NUTTCIB	0.47	1.01
263.01	52.630	NUTTCIB	−0.12	1.03
312.07	56.869	NUTT	0.21	0.65
313.53	57.622	NUTT	0.40	1.32
313.56	57.623	NUTT	0.33	1.36
313.82	57.640	NUTT	0.24	1.24
314.21	57.666	MEAN	0.28	1.20
315.99	57.782	NUTT	0.48	1.74
Hole 529				
0.11	0.029	MEAN	3.02	1.30
131.49	26.571	MEAN	2.30	1.14
135.71	27.540	SUBGORID	2.05	1.09
141.46	28.982	MEAN	2.09	0.96
151.33	31.611	BULIMINA	2.05	0.47
151.55	31.670	BULIMINA	2.05	0.47
156.21	32.911	CIB	2.29	1.24
160.75	34.120	MEAN	2.01	1.17
163.91	34.629	BJARV	2.35	1.47
168.89	34.735	MEAN	2.10	1.21
170.73	34.774	MEAN	2.36	0.47
172.23	34.806	CIB	2.16	1.20
175.23	34.870	CIB	2.12	1.20
175.41	34.873	GLOBOCAS	2.03	1.33
176.73	34.901	CIBGLOB	1.79	1.15
178.23	34.933	CIB	1.94	0.01
179.62	34.963	ORID	1.87	1.13
181.50	35.003	MEAN	1.98	0.95
182.15	35.017	MEAN	2.12	0.94
183.41	35.043	MEAN	2.23	1.23
183.63	35.048	MEAN	1.89	1.24
184.87	35.074	MEAN	1.82	1.34
185.13	35.080	MEAN	2.14	0.98
185.57	35.089	CIB	2.05	1.27
189.01	35.486	BENTHICS	2.25	1.00
192.98	36.007	BJARV	2.37	1.40
193.21	36.037	MEAN	2.39	1.24
194.18	36.164	BJARV	2.45	1.33
194.55	36.213	BJARV	2.55	1.64
195.57	36.346	BJARV	2.44	1.59
197.90	36.652	MEAN	1.89	1.29
199.00	36.796	MEAN	2.55	1.70
199.20	36.823	MEAN	2.29	1.63
199.50	36.862	BJARV	2.48	1.65
200.13	37.059	MEAN	1.37	0.92
200.20	37.091	BULIMINA	1.73	0.87
200.78	37.362	MEAN	1.06	1.13
201.39	37.647	MEAN	1.01	0.87
201.53	37.712	NOD	1.30	0.84
202.58	38.202	MEAN	1.34	0.80
205.20	39.424	BJARV	1.44	0.83
206.60	40.078	BULIMINA	1.24	1.22
207.35	40.428	MEAN	1.24	0.70
207.88	40.675	MEAN	1.10	0.93
222.50	47.497	MEAN	1.22	0.67
268.84	57.639	BENTHICS	−0.27	0.73

Note: If more than one analysis was made, a mean was taken. Ages are estimated as described in Shackleton et al. (this volume).

APPENDIX D
Isotopic Analyses of Planktonic Foraminifers from Sites 525–529

Sub-bottom Depth (m)	Age (m.y.)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 525B				
99.37	7.145	*Globigerina bulloides*	3.10	0.94
117.25	10.285	*Globigerinoides sacculifer*	0.53	2.66
117.25	10.285	*Globigerina nepenthes*	0.47	2.26
117.25	10.285	*Globorotalia conoidea*	1.07	2.08
139.18	12.645	*Globoquadrina dehiscens*	1.07	1.90
139.18	12.645	*Globogerina nepenthes*	0.87	2.48
139.41	12.734	*G. nepenthes*	0.83	2.48
139.41	12.734	*Globoquadrina dehiscens*	0.85	1.81
139.61	12.801	*G. dehiscens*	0.94	1.84
139.61	12.801	*Globigerina nepenthes*	0.51	2.47
139.81	12.811	*G. nepenthes*	0.72	2.54
139.81	12.811	*Globoquadrina dehiscens*	0.74	1.83
140.01	12.820	*Globigerina nepenthes*	0.75	2.59
140.01	12.820	*Globoquadrina dehiscens*	0.91	1.84
140.21	12.830	*Globigerina nepenthes*	0.47	2.55
140.21	12.830	*Globoquadrina dehiscens*	0.50	1.90
141.71	12.900	*G. dehiscens*	0.71	2.19
141.71	12.900	*G. dehiscens*	0.78	1.65
174.61	15.628	*Globigerinoides sacculifer*	1.00	3.55
174.71	15.635	*Globoquadrina dehiscens*	1.38	3.02
174.91	15.650	*Globigerinoides sacculifer*	0.94	3.44
175.31	15.680	*G. sacculifer*	1.05	3.52
175.51	15.695	*Globoquadrina dehiscens*	1.16	2.65
175.51	15.695	*Globigerinoides sacculifer*	1.10	3.43
175.81	15.717	*G. sacculifer*	0.75	2.98
176.01	15.732	*G. sacculifer*	0.68	3.08
176.21	15.746	*G. sacculifer*	0.63	3.32
176.41	15.761	*G. sacculifer*	0.48	3.08
176.41	15.761	*Globoquadrina altispira*	0.77	2.48
188.71	16.671	*Globigerinoides sacculifer*	0.30	3.06
189.51	16.731	*Globigerinoides* spp.	0.85	3.00
191.41	16.871	*G.* spp.	0.76	3.64
191.61	16.886	*G.* spp.	0.71	3.38
194.21	17.165	*G.* spp.	0.52	3.14
Hole 525A				
279.10	46.600	*Morozovella* spp.	−0.11	3.00
279.63	46.733	*M. aragonensis*	−0.19	2.81
281.10	47.101	*M. aragonensis*	−0.35	3.26
282.60	47.477	*M. aragonensis*	−0.45	3.54
284.10	47.860	*M. aragonensis*	−0.23	3.03
287.10	48.710	*M. aragonensis*	−0.07	3.12
288.60	49.135	*M. subbotinae*	0.31	1.75
288.60	49.135	*M. lensiformis*	−0.13	2.72
289.10	49.277	*M. aragonensis*	0.03	2.66
290.51	49.677	*M. aragonensis*	−0.19	3.04
292.01	50.050	*M.* spp.	−0.15	2.42
293.51	50.256	*M.* spp.	−0.39	2.34
295.01	50.462	*M.* spp.	−0.40	3.18
298.01	50.875	*M. aragonensis*	−0.51	2.97
302.39	51.477	*M.* spp.	−0.68	3.14
322.79	53.502	*M.* spp.	−0.96	3.34
337.85	54.604	*M. aragonensis*	−1.21	2.53
358.19	55.808	*M. acuta*	−0.79	2.09
358.19	55.808	*Subbotina triloculāris*	−0.65	1.24
358.29	55.811	*Morozovella acuta*	−1.02	2.28
358.29	55.811	*Subbotina triloculāris*	−0.82	1.10
358.39	55.814	*Morozovella acuta*	−0.98	2.24
358.49	55.818	*M. acuta*	−1.13	2.16
358.49	55.818	*Subbotina triloculāris*	−0.69	1.08
358.59	55.821	*Morozovella acuta*	−1.22	2.13
358.59	55.821	*Subbotina triloculāris*	−0.53	0.94
358.69	55.824	*Chiloguembelina wilcoxensis*	−0.80	0.24
358.69	55.824	*Morozovella acuta*	−1.10	1.96
358.69	55.824	*Subbotina triloculāris*	−0.63	0.70
358.89	55.831	*Morozovella acuta*	−0.42	2.13
358.89	55.831	*Chiloguembelina wilcoxensis*	−0.54	1.00
358.89	55.831	*Morozovella subbotinae*	−1.13	2.28
358.99	55.834	*Chiloguembelina wilcoxensis*	−0.47	1.03
358.99	55.834	*Morozovella subbotinae*	−1.05	2.32
358.99	55.834	*M. acuta*	−0.45	2.07
358.99	55.834	*M. acuta*	−0.66	2.01
359.09	55.838	*Chiloguembelina wilcoxensis*	−0.36	0.91
359.09	55.838	*Morozovella subbotinae*	−0.60	2.25
359.19	55.841	*M. subbotinae*	−0.73	2.25
359.19	55.841	*Chiloguembelina wilcoxensis*	−0.40	0.79
359.19	55.841	*Morozovella subbotinae*	−0.82	2.13
359.29	55.844	*Chiloguembelina wilcoxensis*	−0.38	0.84
359.39	55.848	*Morozovella subbotinae*	−0.68	2.26
359.39	55.848	*Chiloguembelina wilcoxensis*	−0.26	0.93
359.49	55.851	*Morozovella subbotinae*	−0.85	2.11
359.49	55.851	*Chiloguembelina wilcoxensis*	−0.27	0.75
359.59	55.854	*Morozovella subbotinae*	−0.82	2.12
359.59	55.854	*Chiloguembelina wilcoxensis*	−0.48	0.82
371.57	56.255	*Morozovella marginodentata*	−1.16	2.29
379.21	56.888	*M. subbotinae*	−0.62	2.70
379.21	56.888	*Subbotina patagonica*	−0.28	1.74
382.21	57.167	*Morozovella marginodentata*	−0.77	2.93
382.21	57.167	*Subbotina patagonica*	−0.39	1.78
385.81	57.503	*Morozovella marginodentata*	−0.70	2.93
385.81	57.503	*Subbotina patagonica*	−0.43	1.68
387.31	57.643	*Morozovella marginodentata*	−0.67	2.90
Hole 525A (cont.)				
387.31	57.643	*Subbotina patagonica*	−0.40	1.76
390.09	57.902	*S. patagonica*	−0.41	1.78
390.09	57.902	*Morozovella marginodentata*	−0.73	2.93
404.65	59.271	*Subbotina patagonica*	−0.42	3.49
393.36	58.206	*Morozovella velascoensis*	−0.91	4.76
393.36	58.206	*Subbotina patagonica*	−0.27	2.41
403.35	59.144	*Morozovella velascoensis*	−0.98	4.48
403.35	59.144	*Subbotina patagonica*	−0.56	3.24
404.59	59.265	*S. patagonica*	−0.64	3.08
404.59	59.265	*Morozovella velascoensis*	−0.95	4.33
404.65	59.271	*M. pseudomenardii*	−0.40	3.23
404.65	59.271	*M. velascoensis*	−0.87	4.65
408.91	59.687	*M. velascoensis*	−1.01	4.49
408.91	59.687	*Subbotina patagonica*	−0.66	3.12
411.91	59.981	*S. patagonica*	−0.49	3.63
411.91	59.981	*Morozovella velascoensis*	−0.83	4.94
412.81	60.069	*Subbotina patagonica*	−0.42	3.50
412.81	60.069	*Morozovella velascoensis*	−0.80	4.89
415.35	60.237	*Subbotina patagonica*	−0.44	3.51
415.35	60.237	*Morozovella velascoensis*	−0.95	4.88
422.01	60.800	*M. marginodentata*	−0.88	4.24
422.01	60.800	*Subbotina patagonica*	−0.56	3.18
422.01	60.800	*Acarinina nitida*	−0.63	3.90
433.72	61.984	*Morozovella* spp.	−0.99	3.51
Hole 526A				
30.80	4.033	*Globigerinoides ruber*	0.13	1.35
34.55	4.419	*G. ruber*	0.32	1.40
39.52	4.673	*Globigerina nepenthes*	0.41	1.50
44.42	4.882	*G. nepenthes*	0.18	1.58
48.11	5.154	*G. nepenthes*	0.29	1.65
52.61	5.916	*G. nepenthes*	0.41	1.60
58.11	6.847	*Globigerinoides mitra*	0.48	1.54
63.41	7.745	*Globigerina nepenthes*	0.87	2.04
63.41	7.745	*Globigerinoides sacculifer*	0.65	2.44
63.61	7.779	*Globigerina nepenthes*	0.85	2.18
63.61	7.779	*Globigerinoides sacculifer*	0.42	2.64
63.81	7.813	*G. sacculifer*	0.60	2.43
63.81	7.813	*G. seiglei*	0.86	1.24
63.81	7.813	*Globigerina nepenthes*	1.12	2.16
64.01	7.846	*G. nepenthes*	1.16	2.20
64.21	7.880	*G. nepenthes*	1.06	2.23
66.31	8.236	*Globigerinoides sacculifer*	0.42	2.48
66.51	8.270	*G. sacculifer*	0.71	2.68
66.51	8.270	*G. ruber*	0.88	2.30
66.51	8.270	*G. sacculifer*	0.48	2.11
66.51	8.270	*Globigerina nepenthes*	0.73	2.02
66.71	8.304	*Globigerinoides sacculifer*	0.82	2.42
75.51	9.814	*G. sacculifer*	0.40	2.25
75.51	9.814	*Globigerina nepenthes*	0.55	1.91
78.41	10.313	*G. obesa*	1.23	1.65
78.41	10.313	*G. nepenthes*	0.81	2.30
78.81	10.382	*G. nepenthes*	0.62	1.71
80.01	10.588	*G. obesa*	1.55	1.63
80.01	10.588	*G. nepenthes*	0.79	2.04
83.81	11.141	*G. nepenthes*	0.92	2.11
83.81	11.141	*Globorotalia conoidea*	1.27	1.78
83.81	11.141	*G. miozea*	1.10	1.59
84.21	11.199	*Globigerina nepenthes*	0.86	1.92
84.41	11.228	*G. nepenthes*	0.92	2.08
84.61	11.257	*G. nepenthes*	0.79	2.17
84.81	11.286	*G. nepenthes*	0.79	1.76
85.01	11.315	*G. nepenthes*	0.90	1.90
88.57	11.832	*G. nepenthes*	0.53	1.94
91.61	12.336	*G. nepenthes*	0.50	2.18
97.11	12.985	*G. nepenthes*	0.41	1.92
105.51	13.521	*Globoquadrina dehiscens*	1.05	1.76
105.51	13.521	*Globigerina nepenthes*	0.65	2.24
110.81	14.579	*Globigerinoides sacculifer*	0.79	2.49
110.81	14.579	*G. subquadratus*	0.65	2.26
110.81	14.579	*Globigerina nepenthes*	0.94	2.29
110.81	14.579	*Globoquadrina dehiscens*	0.93	1.70
114.21	15.399	*G. dehiscens*	0.95	2.04
114.21	15.399	*G. altispira*	0.96	2.03
119.51	17.827	*G. dehiscens*	0.97	1.51
119.51	17.827	*Globorotalia peripheroronda*	1.21	1.64
128.26	22.931	*Globoquadrina dehiscens*	0.89	1.33
141.56	23.211	*G. dehiscens*	1.14	2.05
157.53	23.546	*G. transdehiscens*	1.05	1.97
157.53	23.546	*Catapsydrax* sp.	0.88	1.52
160.11	23.609	*C.* sp.	1.09	1.48
160.11	23.609	*Globigerina barbemoensis*	1.01	1.26
160.11	23.609	*G. angulisuturalis*	0.65	1.58
160.11	23.609	*Globigerina tripartita*	0.95	1.39
160.11	23.609	*G. globularis*	1.13	1.32
163.85	25.274	*G. bulloides*	1.49	1.09
175.90	29.002	*Globorotalia opima*	1.12	1.27
176.79	29.143	*G. opima nana*	1.17	1.07
176.79	29.143	*Globigerina ampliapertura*	1.15	1.33
213.21	35.486	*Globigerinatheka index*	0.14	2.92
213.21	35.486	*Catapsydrax* sp.	0.55	1.79
214.71	35.753	*Globorotalia cerroazulensis*	0.39	1.94
Hole 526A (cont.)				
214.71	35.753	*Globigerinatheka index*	0.24	2.80
214.71	35.753	*Catapsydrax* sp.	0.19	2.72
122.81	22.817	*Globoquadrina dehiscens*	1.25	1.54
119.51	17.827	*Globigerina apertura*	0.79	2.01
Hole 527				
146.77	49.888	*Morozovella* spp.	−0.29	3.43
164.69	54.786	*M. aragonensis*	−0.87	3.27
172.89	55.656	*Subbotina patagonica*	−0.51	1.27
172.89	55.656	*Globigerina reissii*	−0.56	1.23
172.89	55.656	*G. soldadoensis*	−0.69	2.22
172.89	55.656	*Morozovella formosa*	−0.78	2.56
172.89	55.656	*M. lehneri*	−0.97	2.45
172.89	55.656	*Chiloguembelina wilcoxensis*	−0.59	0.92
184.71	56.483	*Morozovella* spp.	−0.67	3.03
201.61	57.664	*M. marginodentata*	−0.58	2.91
201.61	57.664	*Subbotina patagonica*	−0.04	1.83
202.11	57.699	*S. patagonica*	−0.40	2.08
202.11	57.699	*Morozovella velascoensis*	−1.07	3.71
281.14	58.819	*M.* spp.	−0.73	4.52
218.34	58.833	*M.* spp.	−0.27	5.07
218.63	58.853	*M.* spp.	−0.79	4.45
219.38	58.906	*M.* spp.	−0.70	4.66
258.10	62.959	*Planorotalites ehrenbergi*	−0.15	1.74
258.10	62.959	*Morozovella angulata*	−1.00	3.11
258.10	62.959	*Planorotalites compressa*	−0.14	1.81
258.10	62.959	*Morozovella conicotruncata*	−0.91	2.73
261.10	63.577	*M. uncinata*	−0.75	2.94
267.31	64.279	*Planorotalites compressa*	−0.13	1.90
267.51	64.307	*P. compressa*	−0.24	1.94
267.72	64.343	*P. compressa*	−0.20	1.84
267.92	64.378	*P. compressa*	−0.18	1.90
271.92	65.068	*P. compressa*	0.45	2.25
271.71	65.032	*P. compresa*	0.16	2.04
279.91	66.447	Mixed planktonics, 63–75 µm	−0.06	1.54
280.10	66.464	*Planoglobulina* spp.	−0.22	2.99
280.10	66.464	*Abathomphalus mayeroensis*	−0.41	2.36
280.10	66.464	Mixed planktonics, 63–75 µm	0.06	2.49
280.28	66.472	*Planoglobulina* spp.	0.01	3.07
280.49	66.481	*Abathomphalus mayeroensis*	−0.53	2.07
280.49	66.481	*Planoglobulina* spp.	−0.49	3.16
280.68	66.489	*Abathomphalus mayeroensis*	−0.26	2.12
280.68	66.489	*Planoglobulina* spp.	−0.27	2.93
280.85	66.496	*Abathomphalus mayeroensis*	−0.14	2.14
280.85	66.496	*Planoglobulina spp.*	−0.15	3.33
281.19	66.510	*P.* spp.	−0.21	3.32
281.19	66.510	*Abathomphalus mayeroensis*	−0.09	2.11
281.40	66.519	*Planoglobulina* spp.	−0.48	2.99
281.40	66.519	*P.* spp.	−0.99	3.10
281.40	66.519	*Abathomphalus mayeroensis*	−0.17	2.08
281.59	66.527	*Planoglobulina* spp.	−0.26	2.80
282.00	66.545	*P.* spp.	−0.20	3.00
282.20	66.553	*Abathomphalus mayeroensis*	−0.46	1.70
282.40	66.562	*Planoglobulina* spp.	−0.57	2.95
282.70	66.574	*P.* spp.	−0.57	2.58
282.70	66.574	*Abathomphalus mayeroensis*	−0.58	2.06
283.14	66.593	*Planoglobulina* spp.	−0.22	2.84
Hole 528A				
8.87	1.002	*Globigerinoides ruber*	0.58	1.53
8.95	1.011	*G. ruber*	0.33	1.16
9.05	1.022	*Globorotalia inflata*	1.74	1.06
9.05	1.022	*Globigerinoides ruber*	0.45	1.27
9.05	1.022	*G. ruber*	0.35	0.95
9.15	1.033	*G. ruber*	0.70	0.93
9.35	1.056	*G. ruber*	0.74	1.09
9.45	1.067	*G. ruber*	0.57	1.48
9.55	1.078	*G. ruber*	0.35	1.29
9.75	1.101	*G. ruber*	0.93	0.95
9.95	1.124	*G. ruber*	0.53	1.37
10.05	1.135	*G. ruber*	0.49	1.10
10.15	1.146	*G. ruber*	0.88	1.41
10.25	1.158	*G. ruber*	0.53	1.45
10.35	1.169	*G. ruber*	0.39	1.61
10.45	1.180	*G. ruber*	0.59	1.10
10.55	1.191	*G. ruber*	0.52	1.09
10.62	1.199	*G. ruber*	0.74	1.17
10.75	1.214	*G. ruber*	0.55	1.28
10.83	1.223	*G. ruber*	0.55	1.69
10.95	1.237	*G. ruber*	0.71	1.69
11.03	1.246	*G. ruber*	0.93	1.09
11.25	1.270	*G. ruber*	0.59	1.30
11.35	1.282	*G. ruber*	0.35	1.68
11.55	1.304	*G. ruber*	0.65	1.40
11.64	1.314	*G. ruber*	0.78	1.39
11.64	1.314	*Globorotalia truncatulinoides*	1.83	1.20
11.64	1.314	*Globigerinoides ruber*	0.66	1.40
11.64	1.314	*Globorotalia inflata*	1.90	1.23
11.75	1.327	*Globigerinoides ruber*	0.52	1.65
11.85	1.338	*G. ruber*	0.41	1.45
11.85	1.338	*Globorotalia inflata*	1.54	1.51
11.85	1.338	*Globigerinoides ruber*	0.43	1.52

Appendix D. (Continued).

Sub-bottom Depth (m)	Age (m.y.)	Species	$\delta^{18}O$ (‰)	$\delta^{13}C$ (‰)
Hole 528				
228.29	37.285	*Globigerinatheka* spp.	0.02	2.58
252.00	47.302	*Morozovella aragonensis*	−0.33	3.30
256.61	48.632	*M.* spp.	−0.44	3.20
312.07	56.869	*M. subbotinae*	−0.86	2.52
312.07	56.869	*Subbotina patagonica*	−0.45	1.56
312.99	57.464	*S. patagonica*	−0.13	1.66
312.99	57.464	*Morozovella rex*	−0.68	2.72
313.56	57.623	*M. velascoensis*	−1.06	3.65
313.56	57.623	*Subbotina patagonica*	−0.26	2.21
313.82	57.640	*Morozovella acuta*	−0.82	3.87
313.82	57.640	*Subbotina patagonica*	−0.32	2.22
314.21	57.666	*Morozovella subbotinae*	−0.77	3.42
314.21	57.666	*Subbotina patagonica*	−0.24	2.17
315.99	57.782	*S. patagonica*	−0.38	2.92
315.99	57.782	*Morozovella rex*	−0.80	4.22
Hole 529				
0.11	0.029	*Globigerinoides ruber*	0.47	1.11
37.77	12.079	*Globigerina nepenthes*	0.74	2.04
121.81	24.348	*G. tripartita*	1.30	1.78
121.81	24.348	*Globoquadrina praedehiscens*	1.43	1.83
121.81	24.348	*Catapsydrax* sp.	1.40	1.41
121.81	24.348	*Globoquadrina* spp.	1.39	1.54
121.81	24.348	*Globigerina ouachitensis*	1.40	1.72
121.81	24.348	*G. sellii*	1.47	1.83
121.81	24.348	*Globoquadrina transdehiscens*	1.49	1.83
131.49	26.571	*Globigerina angulisuturalis*	1.08	1.66
131.49	26.571	*Catapsydrax* sp.	1.48	1.46
136.31	27.678	*Globigerina tripartita*	1.44	1.77
136.31	27.678	*G. globularis*	1.23	1.46
136.31	27.678	*G. angulisuturalis*	1.03	1.64
136.31	27.678	*Catapsydrax unicavus*	1.16	1.38
136.31	27.678	*Globigerina gortanii*	1.21	1.47
Hole 529 (cont.)				
141.46	28.982	*Catapsydrax* sp.	1.69	1.64
151.33	31.611	*C.* sp.	1.64	1.51
151.33	31.611	*Turborotalia* spp.	1.38	1.71
156.21	32.911	*Catapsydrax* sp.	1.33	1.86
156.21	32.911	*Globorotalia siakensis*	1.34	1.86
168.89	34.735	*Globigerina pseudoampliapertura*	1.35	1.96
168.89	34.735	*Catapsydrax* sp.	1.13	1.91
175.41	34.873	*Globigerina pseudoampliapertura*	1.25	1.86
175.41	34.873	*Turborotalia* spp.	1.41	1.80
175.41	34.873	*Globigerina euaperta*	1.34	2.12
175.41	34.873	*Catapsydrax* sp.	1.26	1.80
176.73	34.901	*C.* sp.	1.00	1.60
183.41	35.043	*Globigerina cerroazulensis*	1.41	1.90
183.41	35.043	*Catapsydrax* sp.	1.19	1.63
183.63	35.048	*C. unicavus*	1.30	1.76
193.21	36.037	*C.* sp.	1.15	1.92
198.95	36.790	*C.* sp.	1.33	2.08
199.20	36.823	*Globigerina pseudoeocaena*	1.17	2.25
199.20	36.823	*Catapsydrax* sp.	1.21	2.10
200.04	37.017	*Globigerina cerroazulensis*	0.28	1.68
200.13	37.059	*G. cerroazulensis*	0.46	1.87
200.13	37.059	*Turborotalia increbescens*	0.37	2.07
200.13	37.059	*Globigerinatheka index*	0.52	2.75
200.13	37.059	*Globigerina winkleri*	0.66	2.09
200.13	37.059	*Catapsydrax* sp.	0.52	1.84
200.78	37.362	*Hantkenina* spp.	0.30	2.22
200.78	37.362	*Globigerinatheka index*	0.21	2.73
200.78	37.362	*Catapsydrax* sp.	0.59	1.95
200.78	37.362	*Globigerina cerroazulensis*	0.37	2.17
201.39	37.647	*Catapsydrax* sp.	0.62	1.90
201.39	37.647	*Globigerinatheka index*	0.37	2.47
201.39	37.647	*Catapsydrax unicavus*	0.72	1.70
201.53	37.712	*Globigerina gortanii*	0.97	2.07
Hole 529 (cont.)				
201.53	37.712	*G. cerroazulensis*	0.27	1.80
201.53	37.712	*Catapsydrax* sp.	0.41	1.78
202.58	38.202	*Globigerina cerroazulensis*	0.57	1.82
202.58	38.202	*Catapsydrax* sp.	0.77	1.68
205.20	39.424	*Globigerinatheka index*	0.59	2.26
205.20	39.424	*Globigerina cerroazulensis*	0.60	1.91
205.20	39.424	*Catapsydrax echinatus*	0.15	2.93
205.20	39.424	*C.* sp.	0.60	1.89
205.20	39.424	*Turborotalia increbescens*	0.54	2.14
205.20	39.424	*Globigerina winkleri*	0.64	2.04
207.35	40.428	*Globigerinatheka index*	0.60	2.06
207.35	40.428	*Globigerina cerroazulensis*	0.54	1.85
207.35	40.428	*G. corpulenta*	0.65	1.86
207.35	40.428	*Catapsydrax* sp.	0.71	1.57
207.35	40.428	*Globigerinatheka subconglobata*	0.40	2.05
207.35	40.428	*Globigerina winkleri*	0.57	2.01
220.59	46.605	*Acarinina* sp.	0.62	2.86
220.59	46.605	*Globigerina cerroazulensis*	0.57	1.96
222.50	47.497	*Catapsydrax unicavus*	0.94	1.60
222.50	47.497	*Globigerina cerroazulensis*	0.46	1.82
222.50	47.497	*Globigerinatheka mexicana*	0.40	2.37
222.50	47.497	*Globigerina winkleri*	0.65	2.11
222.50	47.497	*Globigerinatheka subconglobata*	0.46	2.29
222.50	47.497	*Catapsydrax* sp.	0.90	1.50
238.11	52.201	*Globorotalia bullbrooki*	−0.63	1.34
238.11	52.201	*G. pseudotopilensis*	−0.57	1.62
238.11	52.201	*Morozovella aragonensis*	−0.83	2.23
238.11	52.201	*Chiloguembelina wilcoxensis*	−0.63	0.70
238.11	52.201	*Morozovella soldadoensis*	−0.83	1.62
238.11	52.201	*M. subbotinae*	−0.24	1.04
245.68	54.545	*M.* spp.	−1.06	2.40
268.84	57.639	*M.* spp.	−0.80	2.81

Note: Ages are estimated as described in Shackleton et al. (this volume).