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**Late Pleistocene biogenic flux in the tropical Atlantic, a
response to climate change**

Verardo, David Joseph, Ph.D.

City University of New York, 1992

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LATE PLEISTOCENE BIOGENIC FLUX IN THE TROPICAL ATLANTIC,
A RESPONSE TO CLIMATE CHANGE

David Joseph Verardo

A dissertation submitted to the Graduate Faculty in Earth and Environmental
Sciences in partial fulfillment of the requirements for the degree of Doctor of
Philosophy, The City University of New York.

1992

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This manuscript has been read and accepted for the Graduate Faculty in Earth and Environmental Sciences in satisfaction of the dissertation requirements for the degree of Doctor of Philosophy.

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CHAPTER 1

PRODUCTION AND DESTRUCTION CONTROL BIOGENIC FLUXES IN THE
TROPICAL ATLANTIC 0-300,000 YEARS B.P.

Abstract. Cyclic changes in the flux of the biogenic components; organic carbon, nitrogen, calcium carbonate, and opal, to the seafloor are documented in cores from a zonal/meridional/depth transect in the Equatorial Atlantic Ocean. The largest concentrations of organic carbon, nitrogen, and opal occur in glacial stages of the Late Pleistocene, 0-300 Ka B.P. These changes in biogenic flux are a function of orbitally paced variations in primary production modified by fluctuations in oxygen and carbonate ion concentration at depth which enhance/diminish organic carbon preservation and calcium carbonate dissolution. Variations in sedimentary flux in the equatorial region of divergence is a function of orbital forced variation in trade wind zonality which modulates divergence. When perihelion is aligned with boreal winter, trade wind stress and upwelling are at maximum and surface productivity is increased. This imprints a pure orbital signal centered on precessional periods (19 & 23 Kyrs). The other major control is due to variation in the corrosive character of advected intermediate and deep water from high latitudes - a function of orbitally paced high latitude ice. The relative proportion of signal variance within the precessional band decreases while those of obliquity (41 Kyrs) and eccentricity (100 Kyrs) increase with depth. The signal of destruction dominates that of production.

INTRODUCTION

The modern Tropical Ocean responds rapidly to variation in wind stress on the sea surface (Weisberg and Tang, 1990). Katz *et al.* (1977) showed that the zonal pressure gradient of the lower atmosphere in the west and central Equatorial Atlantic varies, in phase, with annual perturbations in local wind stress. Consequently, increased trade wind velocity increases the rate of divergence in equatorial waters (Houghton, 1983; Weisberg and Tang, 1990). The region encompassing 0-4°S and centered on 10°W is the region of maximum vertical displacement of ocean water responding to seasonal wind forcing as characterized by maxima in measured heat flux from atmosphere to ocean (Hastenrath and Lamb, 1978; Houghton, 1983; Reverden, 1985). Nutrients enter the Turbulent Boundary Layer (TBL) - the upper layer of the ocean wherein heat and mass exchange occurs between oceanic and atmospheric reservoirs (Muller and Henderson, 1987) - via the underlying Equatorial Undercurrent (EUC) and subpycnocline waters rather than from coastally upwelled water along the west coast of Africa (Voituriez, 1981). Transient equatorial upwelling in the Gulf of Guinea contributes ~10% of the total heat budget of the Tropical Atlantic, bounded by an isotherm of 25°C (Reverden, 1985).

In Boreal summer (June-September) at 10°W, the Southern Hemisphere Trade Winds are at their maximum strength. Thus, speed of the South Equatorial Current (SEC), intensity of equatorial divergence, and primary productivity of the surface waters are all at maximum. Consequently, Sea Surface Temperature (SST) is low in the east and both the nutricline and thermocline lie within the euphotic zone (Weisberg and Tang, 1987). In summary, vertical and horizontal advection of energy, at the equator, is controlled by the surface winds forced by annual insolation.

A suite of cores in a meridional/zonal/depth transect in the Equatorial Atlantic (Fig. 1, Table 1) were examined to gain insight as to the paleoceanographic-paleoclimatologic character of this region over the interval ~0-300 Ka. These cores are distributed within an extremely dynamic region. In the west, the Equatorial Atlantic is characterized by minimal

SST variation and maximum heat storage (Merle, 1980). To the east, the region of maximum equatorial upwelling occurs between 0-4°S, centered on 10°W (Fig. 2) so that RC24-01, RC24-07, and RC24-12 lie within, while RC24-16 lies at the edge of, this highly productive region. Furthermore, RC24-01 is situated on the southern edge of the eastward flowing EUC whereas RC24-07, RC24-12, and RC24-16 are sited beneath the westward flowing SEC (Richardson and Walsh, 1986).

The goal of this research is to understand the response of part of the ocean carbon system to orbital forcing by insolation as evidenced by variations in the flux of biogenic sediments in the Equatorial Atlantic over the past 300 Ky. There are two specific objectives; i) to determine whether primary productivity and sediment deposition is influenced by climate change centered on orbital time scales and ii) to ascertain if signals show depth-dependent structure produced by destruction (i.e. dissolution) processes. The Tropical Atlantic has been targeted for this work because it is an area of high energy flux, CO₂ flux, and biological productivity. Additionally, good sediment records are available (i.e. calcium carbonate rich sequences which lend themselves to detailed chronostratigraphic study). Thus, to document the Turbulent Boundary Layer history of the Late Quaternary, organic carbon, nitrogen, calcium carbonate, and opaline silica were measured at ~1.0 Ky intervals in marine sediments recovered from the zone of equatorial divergence.

ANALYTICAL METHODS

Organic carbon and nitrogen determinations use the method of Verardo *et al.* (1990) wherein differentiation of organic from inorganic carbon is by sample acidification with sulfurous acid prior to analysis by gas chromatography. Analytical precision is $\pm 0.3\%$ of the measured value for organic carbon and $\pm 1.6\%$ for nitrogen.

Opal analyses use the method of Mortlock and Froelich (1989) which extracts biogenic silica from a sample by an alkaline solution of sodium carbonate. Measurement of

the dissolved silica concentration of the extract is by molybdate-blue spectrophotometry. Analytical precision is $\pm 4.0\%$ of the measured value for opal.

Calcium carbonate in cores RC24-01, RC24-07, RC24-16 and V25-56 is analyzed using the vacuum-gasometric technique of Jones and Kaiteris (1983) in which sediment is reacted with phosphoric acid in a vacuum reaction chamber. The pressure of the CO_2 gas evolved during the reaction is equivalent to the amount of CaCO_3 in the sample. Analytical precision is $\pm 1.0\%$ for calcium carbonate. Calcium carbonate in cores RC24-12 and RC16-66 is analyzed using coulometric titrimetry (ASTM, 1982) with operating parameters specific to our geologic samples (Table 2), yielding a precision of $\pm 0.1\%$ (Table 3).

The analysis of sediment, for all of the above components, does not sum to 100%. Therefore the residual is termed "other" and is the arithmetic difference between the sum of all measured sedimentary component concentrations (i.e. organic carbon, nitrogen, opal, calcium carbonate) and 100. No attempt has been made to analyze this material directly so it is offered without comment at this time.

Mass Accumulation Rates (MAR) for sedimentary fluxes are calculated according to the relationship:

$$\text{MAR (g/cm}^2\text{/1000 yrs)} = \rho_{\text{dry}} \text{ (g/cm}^3\text{)} \cdot \text{concentration (wt\%)} \cdot \text{sedimentation rate (cm/1000 yrs)} + 100$$

where ρ_{dry} is the dry bulk density and concentration refers to the sedimentary component of interest. Dry bulk density, for this study, is calculated from the algorithm:

$$\rho_{\text{dry}} \text{ (g/cm}^3\text{)} = 0.0074 \text{ (wt\% CaCO}_3\text{)} + 0.12 \pm 0.01 \text{ g/cm}^3 \quad [r=0.92, n=57]$$

This algorithm is a predictive equation calculated from a least-squares regression of calcium carbonate (the principle sediment component) concentration versus measured dry bulk density on samples from Equatorial Atlantic Ocean cores RC24-16 and RC24-30 (see Chapter 2 for details).

The analytical error of our chemical measurements versus the amplitude of the sedimentary component signal is small, thus analytical error is not a significant component of our signals.

STRATIGRAPHY AND CHRONOLOGY

Intercore stratigraphic correlation was established by stable oxygen isotope records of the planktonic foraminifera *Neogloboquadrina dutertrei* (Appendix A). Age models for each core were produced by, first, identifying isotopic events in each $\delta^{18}\text{O}$ isotopic record according to the criteria of Pisias *et al.* (1984). The resulting record was correlated to the SPECMAP oxygen isotope stacked record of Imbrie *et al.* (1984), using the chronology established by Martinson *et al.* (1987), to generate linear sedimentation rate age models (Table 4). Isotope records (Fig. 3) are highly coherent with the SPECMAP stack (Fig. 4) over Milankovitch periods (Table 5) and depth-age plots (Fig. 5) reveal continuous sedimentation over the time intervals studied. Calcium carbonate stratigraphy was used to supplement the chronology, derived from isotopes, in RC24-12 below 135 Ka. The strong correlation between calcium carbonate concentration signals in RC24-12 and RC24-16 provides a useful tool for stratigraphic correlation, pending additional isotopic measurements. We delineate glacials and interglacials by isotopic stage with their boundaries defined as follows; Stage 1 (interglacial), 0-12.0 Ka; Stages 2, 3, and 4 (glacial), 12.0-73.9 Ka; Stage 5 (interglacial), 73.9- 129.8 Ka; Stage 6 (glacial), 129.8-189.6 Ka; Stage 7 (interglacial), 189.6-244.1 Ka.

RESULTS

Time Series

All cores are of similar sedimentary character, primarily composed of foraminiferal nannofossil ooze. The sedimentary sequence is homogenous with respect to mineralogical composition and sedimentary structures with ubiquitous bioturbation and no evidence of

slumping or turbidite deposition. The cores lie above the modern lysocline as defined by Takahashi *et al.* (1980) and have been sampled at 5.0 cm intervals to provide ~1.0 Ky resolution. Tables of sedimentary component concentration and Mass Accumulation Rates can be found in Appendices B and C, respectively.

Calcium carbonate: Concentration of calcium carbonate shows distinct glacial-interglacial cyclicity through oxygen isotope Stage 7 (Fig. 6), with the typical Atlantic signature of higher concentrations occurring in interglacial intervals (Broecker, 1971; Crowley, 1983; Curry and Lohmann, 1986). Sediments from eastern cores are richer, overall, in calcium carbonate than western cores. Calcium carbonate concentration decreases from a mean value of ~86% in relatively shallow cores (RC24-12 & RC24-16) to ~71% in deeper cores (RC24-01 and RC24-07) while the range in the data increases with depth (Table 6). Western core V25-56 yields a mean calcium carbonate concentrations of ~41% from its relatively shallow setting while the mean calcium carbonate concentration in deeper core RC16-66 is ~38%. Amplitude of variation from the mean value of calcium carbonate concentration in each core increases with depth. Minima in carbonate concentration occur in Stage 2, Stage 4, and Stage 6 (although not as pronounced in the west) which are all documented times of calcium carbonate dissolution (Crowley, 1983, 1985).

Organic carbon: Distinct glacial-interglacial cycles in organic carbon concentration are evident in all of the eastern cores (i.e. RC24-01, RC24-07, RC24-12, RC24-16) regardless of depth below sea-level (Fig. 6). Greatest concentrations of organic carbon occur in glacial age sediments of Stage 2, Stage 4, and Stage 6. Sediments from cores RC24-01, RC24-07, and RC24-12 show organic carbon concentrations of approximately 1-2% (Table 6) during glacial Stage 2. Sediments from RC24-16, a relatively shallow core at the edge of the primary divergence in the east, exhibit glacial age concentrations of organic carbon in the range 0.3-0.5%, by weight. There is a four-fold increase in organic carbon

concentration from the edge to the center of equatorial divergence during this interval. Whereas the calcium carbonate concentration record is punctuated by short-lived discrete events, the organic carbon (percent) signals reveal concentration maxima superimposed on a broad oscillation of long period (~100 Ky duration). Although organic carbon records in the east are very similar in overall character, RC24-12 exhibits maxima at Stage 2 and Stage 4 which have greater affinity to deep cores (RC24-01 & RC24-07) than its relatively shallow equivalent, RC24-16. This similarity is due to the geographic position of RC24-12 within the center of maximum divergence as with RC24-01 and RC24-07.

Total nitrogen: Total nitrogen concentrations, both east and west, follow organic carbon concentration profiles closely so that highest concentrations occur in sediments assigned to glacial stages (Fig. 6).

Opal: Greater concentrations of opal occur in glacial age versus interglacial age sediments from both sides of the equatorial basin (Fig. 6). Eastern cores within the maximum upwelling zone, RC24-01, RC24-07, and RC24-12 show an approximate 2-4 fold increase in opal concentration from sediments lying at the edge of this area (RC24-16). To the west, V25-56 and RC16-66 possess comparatively lower concentrations of opal. Opal signals are different in character than either calcium carbonate or organic carbon. Opal maxima occur in Stage 2, Stage 4, and Stage 6 but, unlike organic carbon, its largest increase is synchronous across the equatorial basin and occurs in Stage 4. In the cores within the center of upwelling, Stage 6 is represented by a broad maxima in opal concentration. The opal record in RC16-66 is different than its shallow companion, V25-56, in that the peaks between ~40-200 Ka are broader in character and the record, overall, is less spiked.

Concentration of organic carbon and nitrogen are positively correlated in the sediments, as documented by the intracore statistics (Table 7). This relationship results from their mutual link in the metabolic processes of organisms as carbohydrate and protein fractions, respectively. Opal concentration is positively correlated to organic carbon and nitrogen in those cores richest in these components (RC24-01, RC24-07, RC24-12). Calcium carbonate concentration is negatively correlated with all the measured biogenous sediment components. When viewed in a regional context, the biogenous component concentration signals from the eastern basin exhibit similar character as evidenced by their intercore correlation coefficients (Table 8). The cores within the central mass of upwelled water however, show higher correlation due to their location within this oceanographic site.

Peaks in some sedimentary component concentrations occur as the antithesis of lows in other sedimentary components. For example, a decrease in calcium carbonate concentration in oxygen isotope Stage 4, a time of intense calcium carbonate dissolution in the Atlantic Ocean (Crowley, 1983), is opposed by an increase in opal concentration. Mass Accumulation Rates (MAR) are calculated to remove dilution artifacts of sedimentary components. Inspection of MAR signals (Fig. 7) for all cores reveals a consistent regional cyclic pattern of greater accumulation in glacial periods with one important caveat - the MAR signals are naturally biased because of their dependence on sedimentation rates. This idea will be refined in ensuing text.

Spectra

Concentration signals show a clear response for sedimentary components in the Equatorial Atlantic at broad band periods centered on 100 Ky and 23 Ky which we will prove are related to eccentricity and precessional orbital forcing. All spectra used in this study, unless otherwise specified, are linear variance density plots of time series with a variable number of data points (N), a variable Tukey-Hanning lag window ($M = N \div 3$), and a fixed time interval (T) of 1.0 Ky. The variance spectrum are calculated using

standard time series procedures (Jenkins and Watts, 1968) at the 95% confidence interval, with no pre-whitening, using linear detrend, and an autocovariance function.

All biogenous sediment records show a strong low frequency spectral response centered on ~100 Ky (Fig. 8). This observation is typical of climate proxy records of the Late Pleistocene, 0-400 Ka (Pisias and Moore, 1981; Start and Prell, 1984; Ruddiman *et al.*, 1989). Western Atlantic core V25-56 shows a broad band of power centered on 23 Ky which accounts for 32% of the total variance in calcium carbonate, 34% in organic carbon, and 28% in nitrogen. In opal concentration, higher frequency response manifests itself as power at 28 Ky representing 18% of total variance. The deeper western core, RC16-66, reveals an analogous but subdued spectral response in that 23 Ky power accounts for 12% of the total variance in calcium carbonate, 14% in organic carbon, and 10% in opal. Nitrogen shows no distinct peak in power at 23 Ky but possesses power at ~40 Ky which accounts for 25% of total variance.

Relatively shallow records contain strong 100 Ky and 23 Ky power while deeper cores show the predominance of 100 Ky power in all components at the expense of power at shorter periods. In RC24-16, 23 Ky period accounts for 38% of total variance in calcium carbonate concentration, 22% in organic carbon, 21% in total nitrogen, and 34% in opal. In RC24-12, the 23 Ky period accounts for 47% of total variance in calcium carbonate concentration, 15% in organic carbon, 19% in total nitrogen, and 14% in opal. Also, 40 Ky power is evident in records of organic carbon and nitrogen, accounting for 16 and 15% of total variance, respectively.

Even though concentration spectra from the deeper cores RC24-01, RC24-07, and RC16-66 exhibit 100 Ky dominated power, close examination of their concentration signals shows cyclicity present at shorter periods. Therefore, computation of prewhitened spectra for sedimentary component concentration should expose the spectral character of the shorter period variability within the data. Examination of power spectra estimated from prewhitened data in RC24-01 (representative of all deep cores) reveals 23 Ky power as

contributing to short-term variability in sedimentary component concentration (Fig. 9). Periodicity at 23 Ky is modulated by the low frequency power envelope.

In summary, these results point to the regional importance of 23 Ky power in the variability in biogenous sediments so that the picture which emerges from the Equatorial Atlantic is of a primary response of sedimentary components to variations at 100 Ky and 23 Ky. However, precessional frequencies are muted within the deeper records of the equatorial basin (Fig. 10).

Spectral Analysis of Mass Accumulation Rates

There are two popular means of viewing the composition of sediments. The concentration method relates the weight of a particular sedimentary component to the total weight of the sediment sample from which it is drawn. This method yields information regarding the chemical composition of a sample as well as the relative importance (numerically) of one component as compared to another. Concentration data must then be interpreted in relation to the relative rates of production, dissolution, and dilution that produced the measured value. Alternately, Mass Accumulation Rates (MAR) are calculated to quantify the accumulation of each sedimentary component. Due to the strong mathematical influence of sedimentation rates on Mass Accumulation Rate calculations, sedimentation and accumulation are inextricably linked. Accumulation is a result of the processes of production and destruction yet either may dominate in space and time.

The power spectra of Mass Accumulation Rate (MAR) signals illustrate a somewhat incongruous response when compared to concentration spectra (Fig. 11). A case in point is provided by examination of calcium carbonate concentration, MAR, and sedimentation rates versus age in sediments from RC24-16, along with their attendant power spectra (Fig. 12). Calcium carbonate concentration shows significant power at 23 Ky whereas calcium carbonate MAR does not. Calcium carbonate MAR parallels sedimentation rate (inter-signal correlation, r , is 0.97) so it is not surprising that their power spectra are similar.

In the Equatorial Atlantic, MAR are primarily controlled by sedimentation rates. Sedimentation rates are linearly interpolated between chronostratigraphic picks. This yields an average rate of sedimentation within a given interval. The sedimentation rates thus calculated represent deposition *over* an interval of time not *at* an instant in time. Sedimentation rates are determined at a coarser sampling interval than concentration data. If sedimentation rates could be measured at the same discrete and regular sampling interval as the concentration data, then Mass Accumulation Rates would show accumulation at an instant in time. Practically speaking, dating each sediment sample as suggested is impossible given the current limitations of absolute age dating methods. Therefore, MAR are calculated over intervals in which sedimentation is assumed to proceed at a constant rate even though sedimentation rates may actually vary within an interval in which they are modeled as constant.

In summary, Mass Accumulation Rates are stepped series of single values of accumulation which produce time series of square-wave character. Consequently, MAR are highly susceptible to artifacts of age modeling so their spectra cannot be compared to spectra generated from concentration data.

DISCUSSION

The processes of non-marine dilution, redistribution, productivity, and preservation-dissolution must be evaluated as to their relative importance in contributing to the extant variations in the concentration and accumulation of biogenous sediments.

Non-marine Dilution

Dilution by non-marine sediments is minimal in our cores due to i) distance of our sites from continental margins and ii) C/N ratio of organic matter is the marine not continental value. Although western cores are nearer the continental margin than their eastern counterparts, the North Brazil Current distributes sediments from Amazon River

discharge to the northwest, bypassing the sites of V25-56 and RC16-66 (Milliman *et al.*, 1975; Flagg *et al.*, 1986; Richardson and Reverdin, 1987; Muller-Karger *et al.*, 1988).

In contrast to the variability in concentration of organic matter within the sediments of this study, the ratio of organic carbon/nitrogen changes little throughout the sedimentary sequence. This trend indicates that the provenance of the organic matter has not changed significantly in this region over the time interval examined. The organic carbon/nitrogen ratio of phytoplankton living within the surface layer of the ocean ranges from 6-8 (Redfield, 1963). In contrast, the C/N ratio of non-marine organic material ranges from 20-200 (Hedges *et al.*, 1986). Organic matter in the sediments of this study exhibit C/N ratios typical of organic detritus derived from the remains of phytoplankton (Table 9; Fig. 13). C/N ratios >8.0 in marine organic matter result from a loss of nitrogen as organic matter settles below the photic zone because nitrogen-containing proteins are utilized more readily than carbohydrates as organic matter is transported to deeper water (Holm-Hansen, 1969; Gordon, 1970; Riley, 1970; Muller, 1977). This preferential uptake of nitrogen and consequent increase in the C/N ratio of the organic matter is particularly evident in the deeper cores of the eastern basin. In lower productivity regions of the Western Equatorial Atlantic, C/N ratios ≤ 4.0 may reflect the effect of organic compounds adsorbed on clay mineral sites (Muller, 1977; Suess and Muller, 1980).

Compared to the typical range in concentration of organic carbon (~ 0.1 - 0.5%) for marine pelagic sediments (i.e. V25-56 and RC16-66), the range in concentration of organic carbon within the center of Equatorial upwelling is substantially higher, approximately 0.1 - 2.0% . An exceptional amount of organic matter is incorporated into the sediments underlying this highly productive region yet the provenance of the material is unchanged. The C/N ratios indicate marine productivity is the primary source of organic matter in the sediments of this study so that input of non-marine organic material cannot explain discrete variations in organic carbon concentration. To argue for non-marine dilution would require

selective fractionation of marine and non-marine organic matter from the diluting sediments to explain the marine C/N ratio record of the sediments.

Redistribution of Marine Sediments

Redistribution is difficult to document because it may occur subtly and leave ambiguous evidence. Advection of non-marine sedimentary organic matter has already been ruled ineffective by evidence of C/N ratios. Lateral advection of sediments is not a probable mechanism to account for apparent enrichment of biogenous matter in the deeper cores of the upwelling region because of deep ocean current trajectories. For advection to be effective, bottom currents must systematically transport sediments from areas rich in biogenic components towards areas relatively impoverished in the same. Deep currents in the Equatorial Atlantic travel from the western margin, which is relatively deficient in biogenous sediment, towards eastern enriched areas - completely opposite the necessary transport direction.

Downslope transport of marine sediments from relatively shallow depths to deeper regions does not adequately explain depth related increases in sedimentary component concentration. Visual inspection of the cores of the eastern basin reveals neither the graded bedding of turbidites nor winnowed deposits. Analysis of the bathymetry of the sea-floor surrounding cores RC24-01, RC24-07, and RC24-12 reveals a gentle gradient with slopes $<1.5^\circ$ (Fig. 14). Seismic records from the RC24 cruise show sediment layers truncating abruptly at the edge of intermontane basins in the Mid Atlantic Ridge with no fan deposition from these basaltic abyssal highs (Fig. 15). Slope failure (i.e. creep processes) from these topographic highs deposits sediment uniformly over the basin. Although downslope transport of sediment probably occurs, we presume it does so at a relatively steady rate because there is no sedimentary evidence for episodic deposition, either in our cores or seismic reflection profiles.

Productivity

It has been well documented that the last glacial maximum (oxygen isotope Stage 2) was characterized by increased mass accumulation rates of organic carbon in both the Atlantic and Pacific Oceans in regions underlying upwelling centers along the equatorial divergence and beneath eastern boundary currents (Sarnthein, 1982; Muller *et al.*, 1983; Pederson, 1983; Morris *et al.*, 1984; Zahn *et al.*, 1986; Lyle, 1988; Lyle *et al.*, 1988). The "spikes" in biogenic sediment accumulation are interpreted, by the above authors, as reflections of increased production during Stage 2. McIntyre *et al.* (1989), using assemblages of foraminifera, showed variations in SST coherent with orbital periods (100 Ky & 23 Ky) so that when perihelion is aligned with Boreal winter, equatorial divergence is at maximum and cool, nutrient-rich water upwells with great intensity. This relationship occurs at the maximum glacial centered on 21 Ka. Molfino and McIntyre (1990), using the coccolithophorid species *F. profunda*, documented causality between vertical migration of the nutricline in the Equatorial Atlantic and precessional (23 Ky) forcing. Minima in *F. profunda* indicates shallowing of the nutricline during upwelling of cool waters when perihelion is aligned with Boreal winter. The sediments of this study, which use some of the same cores as McIntyre *et al.* (1989) and Molfino and McIntyre (1990), show similar periodicity with enhanced biogenic concentration and accumulation in glacial periods.

The concentration of biogenic opal (primarily diatoms) in deep-sea sediments has often been used to infer changes in paleo-productivity of surface waters. This situation arises from the strong covariance in the spatial distribution of opal concentration of marine sediments with the spatial variation in productivity of overlying surface waters. The data indicate that the relative abundance of opal in modern marine sediments is closely linked to the fertility of overlying waters (Lisitzin, 1972; Leinen, 1986; Takahashi, 1986; Murray, 1987; Lyle *et al.*, 1988; Rea *et al.*, 1991; Abrantes, 1991).

The very formation of siliceous skeletons by marine organisms is problematic in that the ocean is undersaturated with respect to silicon. Formation of opaline silica

($\text{SiO}_2 \cdot n \text{H}_2\text{O}$) occurs in the skeletal structures of diatoms, radiolaria, sponges, and silicoflagellates. In the open ocean, diatoms and radiolarians are the most active of biological agents for the removal of silicon from solution. In order for opal to accumulate in marine sediments, its rate of production in surface waters must exceed the rate of opal dissolution at depth (Broecker and Peng, 1982). The Tropical Atlantic is characterized by a permanent thermocline which severely restricts replenishment of silicon or other nutrients by vertical mixing processes (i.e. from deeper nutrient-rich waters). An exception to this condition occurs at the site of Equatorial Divergence (centered on 10°W) where nutrient rich water upwells seasonally. Our results support the relationship between surface water fertility and opal concentration in sediments underlying this highly productive region.

The numerical models of Kutzbach and Gallimore (1986) and Kutzbach and Guetter (1988) show that trade wind zonality was greater during the last glacial maximum when perihelion was aligned with Boreal winter. These model results are validated by the faunal study by McIntyre *et al.* (1989) which indicates that in the Late Pleistocene, Turbulent Boundary Layer (TBL) thickness, thermocline depth, and surface water productivity were controlled by variations in trade wind velocity, forced by insolation, such that when Boreal winter occurs at orbital perihelion, equatorial divergence is maximum and SST is minimum. Maxima in concentration and calculated flux of organic carbon, nitrogen, opal, and "other" were identified, temporally, in each of our cores and a mean value for the timing of maxima was determined. The mean value for the occurrence of component maxima coincides with the astronomical timing of perihelion in Boreal winter (Table 10). This provides a link between models of orbitally-paced wind stress induced upwelling and surface water productivity in the Tropical Atlantic from ~0-300 Ka.

Preservation-Dissolution

There is no consensus for a model explaining preservation of organic carbon and nitrogen in marine sediments. Heath *et al.* (1977), Muller and Suess (1979), Suess and

Miller (1980), and Sarnthein *et al.* (1987) argue that organic carbon preservation is a function of bulk sediment accumulation and burial such that increasing sedimentation leads to increased preservation by the "sealing" effect of the overburden. Alternately, Emerson (1985), Curry and Lohmann (1983, 1985, 1986, 1990), Emerson *et al.* (1987), and Emerson and Hedges (1988) suggest that low concentrations of dissolved oxygen in sea water may be important for the accumulation of organic matter through decreased enzymatic activity and hence, organic matter degradation rates, in those reactions requiring molecular oxygen. This controversy hinges on two important considerations; i) what are the relative rates of organic matter diagenesis under oxic and anoxic conditions with oxygen as the primary electron acceptor and, ii) what is the comparable efficiency of aerobic versus anaerobic bacteria in scavenging organic matter. Finally, others link organic carbon accumulation in marine sediments to the productivity of overlying waters so that increased biological activity in the surface exports more organic matter to the seafloor (Pedersen, 1983; Morris *et al.*, 1984; Pedersen and Calvert, in press; Calvert and Pedersen, in press; Pedersen *et al.*, 1988; Lyle, 1988; Lyle *et al.*, 1988). However, these contributory factors in organic carbon accumulation need not be mutually exclusive, which explains the lack of consensus.

The preservation of opal in marine sediment is a function of both the rate of opal production in the surface layer of the sea and dissolution at depth by the thermodynamic driving force, although the kinetics are poorly constrained (Hurd, 1973; Hurd and Theyer, 1975; Broecker and Peng, 1982). Opal dissolution shows no depth dependent dissolution in the ocean (Honjo *et al.*, 1982) unlike calcium carbonate, which shows increased solubility with depth due to increased pressure and undersaturation (Peterson, 1966; Berger, 1967).

Organic carbon, opal, and calcium carbonate have disparate chemical characteristics and do not possess similar preservation potentials. Sedimentation buries biogenic components and removes them from the zone of active decomposition therefore, the single

process of burial could act to preserve biogenic components possessing dissimilar chemical decomposition signals. However, this simple model does not suffice because there is no convincing correlation between component concentration and bulk sediment accumulation (Table 11) except, perhaps, with regards to organic carbon in RC24-01 and RC24-07. In these cores, organic carbon and nitrogen may respond to the "sealing" effect with preservation aided by poorly oxygenated sediment pore fluids.

Although difficult to assess quantitatively, it is necessary to evaluate the extent of calcium carbonate dissolution and its effect on our records (i.e. is carbonate dissolution artificially inducing minima and maxima in our biogenous sediment signals). We address this issue from three different perspectives; i) differencing the calcium carbonate records between shallow and deep sites; ii) evaluating the correlation between concentration and accumulation records; and iii) examining a faunal dissolution index.

We stacked (added together and divided by 2) the calcium carbonate concentration records from our shallow (RC24-12 & RC24-16) and deep (RC24-01 & RC24-07) cores in the eastern Equatorial Atlantic (Fig. 16). The stacked records are correlative with each other ($r=0.79$) and highly coherent ($k>0.90$) and in phase ($\phi=0^\circ$) at orbital periods. We then subtracted deep from shallow to produce a "difference" or residual signal. The amplitude difference between glacial and interglacial events is three-fold (i.e. the % difference in Stage 5 is 7 while that of Stage 6 is 22). The residual was smoothed with a 7 point filter and cross-spectrally analyzed against the SPECMAP stacked oxygen isotope record. Our residual signal is correlative ($r=0.65$) with the ice volume signal and highly coherent as well as in phase at the 100 ($k=0.96$, $\phi=0^\circ$) and 22 Ky ($k=0.74$, $\phi=19 \pm 30^\circ$) periods (Fig. 17). Since the residual signal represents the amount of carbonate loss between shallow and deep sites and is correlative with ice volume, we infer that the loss of carbonate is due to dissolution through high latitude control of deep water carbonate chemistry, as discussed in subsequent text.

Concentration and accumulation records of calcium carbonate, organic carbon, and opal were examined with the assumption that component concentration and MAR should be positively correlated if concentration reflects accumulation. The data demonstrates that in the eastern equatorial basin, organic carbon concentration and accumulation are positively correlated (Table 12) indicating that organic carbon concentration reflects accumulation. Opal concentration and MAR show the same relationship (except for RC24-07) as organic carbon indicating that opal concentration is also reflecting opal accumulation. The data shows however that, in the eastern basin, calcium carbonate concentration does **not** reflect carbonate accumulation. Since concentration and accumulation of calcium carbonate are not correlative, these signals must be recording destruction by dissolution. In the west, calcium carbonate concentration and accumulation are better correlated reflecting, perhaps, a process that we do not understand as yet. Admittedly, MAR signals invoke accumulation without any explanation as to the processes leading to accumulation (i.e. is accumulation a function of rain rate and/or preservation) so that, pending models explaining organic carbon and opal preservation in the open ocean, our assumption may be too simplistic.

Finally, recent studies by Matsuoka *et al.* (1991) of the calcareous nannofossil *Calcidiscus leptoporus* in RC24-07 show promise as providing a useful qualitative index of calcium carbonate dissolution in the Equatorial Atlantic. Matsuoka (1990) demonstrated that *C. leptoporus*, an abundant and widely distributed coccolith, mimics the dissolution signal of the planktonic foraminifera *Globorotalia menardii*, as described by Oba (1969). The correlation between *C. leptoporus*, recorded as the ratio of whole (both shields intact) to disintegrated (one shield intact) coccoliths, and calcium carbonate concentration in RC24-07 is high ($r=0.74$, personal communication) inferring that the change in calcium carbonate concentration reflects dissolution.

To summarize, without a tracer unaffected by either production or destruction as are our sediments, proof of cause remains elusive. Even though each piece of evidence we offer to evaluate dissolution in our signals is circumstantial on its own, we suggest that the

body of data supports the hypothesis that the bathymetric decrease in calcium carbonate concentration in the eastern Tropical Atlantic reflects a dissolution overprint on calcium carbonate productivity, **not dilution by the other sedimentary components.**

Phasing of Signals

Signal spectra characterize periodicity in time series. Although a spectrum may contain cycles with periods equivalent to orbital values, this is not proof of cause and effect. Cross-spectral analysis of a time series against the orbital signals is performed to determine if the signal is orbitally forced. If two signals are significantly coherent and phase locked, then the dependent variable is linearly forced by the independent variable at that frequency (Pisias, 1983; Pisias and Leinin, 1984). Accordingly, sediment concentration and MAR data from the cores of this study have been cross-spectrally analyzed against ETP, a composite signal of the orbital measures of eccentricity, obliquity, and precession to investigate the coherency and phasing (timing) of different climate responses to Milankovitch forcing. We use ETP (Fig. 18) to establish the relationship between radiative forcing and the observed response since we have no *a priori* knowledge of the calendric timing of radiative input responsible for producing the periodicity in the geologic time series. The reliability of inferences drawn from cross-spectra at eccentricity periods is questionable given the short temporal nature of the sedimentary record in these cores, so we limit our discussion to precession and obliquity periods.

Results of cross-spectrum analyses are shown in tabular form and plotted in vector format on a phase wheel according to the methods established by SPECMAP (Imbrie *et al.*, 1989). The critical feature of the phase wheel is the choice of zero phase which, by convention, is maximum eccentricity (e), maximum obliquity (ϵ), and June 21 perihelion ($-e \sin \omega$). Orbital geometry associated with forcing towards an interglacial climatic mode is chosen as zero phase because the earth's climate in this mode is better understood than the glacial mode. Response to orbital forcing is depicted as the phase difference measured

clockwise from the zero position (top of wheel). Phases correspond to time according to the relationship;

$$[\text{phase } (^{\circ}) + 360^{\circ}] \cdot [\text{Milankovitch period(Ky)}] = \text{time (Ky)}$$

For example, a 20° phase lag is equivalent to ~1.3 Ky at the precessional period (23 Ky).

To incorporate the SPECMAP convention and preserve a consistent sense of change towards a warm, interglacial climate mode, organic carbon, nitrogen, opal, and "other" concentration and flux signals are plotted on phase wheels as negatives (i.e. reversed). In other words, the response of the coherent amplitude is plotted.

The test statistic for significance of coherency between spectra, in this study, is 0.79 at the 95% confidence interval (CI) and 0.65 at the 80% confidence interval (Jenkins and Watts, 1968). Only those signals which fall at or above these confidence levels are plotted on phase wheels with coherency in parenthesis. Finally, SPECMAP $\delta^{18}\text{O}$ (minimum ice) and T_c (cold Sea Surface Temperature estimates from McIntyre *et al.*, 1989; Molfino and McIntyre, 1990) are plotted on phase wheels for reference.

Responses at precession period (23 Ky)

Precession changes the seasonal earth-sun distance resulting in migration of the equinoxes about the earth's orbit with a periodicity of ~23 Ky. However, the intensity of the precessional component of insolation is modulated by eccentricity (Berger, 1978). The resultant orbital geometry affects incident hemispheric insolation causing seasonal warming/cooling, antithetically, across the equator. The effect is greatest in low latitudes.

ETP

Changes in calcium carbonate, organic carbon, nitrogen, opal, and "other" (concentration and MAR) show strong, statistically significant, coherent linear responses to orbital forcing at precessional periods (Table 13). Calcium carbonate concentration shows a lag of 2.5-5.7 Ky in eastern basin cores (RC24-01, RC24-07, RC24-12, & RC24-16)

clustering about minimum ice volume with a longer lag of ~8.0 Ky for western sited V25-56 (Fig. 19). Organic carbon concentration shows a tight cluster of responses which lag orbital forcing by 1.0-3.0 Ky. These responses are closely aligned with SST (Tc) estimates indicating a phase link between sediment fluxes and inferred upwelling. Opal concentration indicates a more diffuse response pattern than organic carbon with cores in the center of upwelling (RC24-01, RC24-07, & RC24-12) phase locked and lagging orbital forcing by 4.0 Ky responding ~2.2 Ky after cold SST. The remaining opal response, RC24-16, lags forcing by 8.5 Ky. Western cores show no statistically coherent response. Mass Accumulation Rates for the above components show response patterns similar to concentration data but shifted in phase as a result of age modelling artifacts (Fig. 20).

SPECMAP $\delta^{18}O$

To investigate the possible influence of high latitude climate forcing on low latitude sites, concentration and flux records of calcium carbonate, organic carbon, and opal were cross-spectrally analyzed against the SPECMAP stacked oxygen isotope record, a mathematically smoothed and temporally continuous proxy signal for global ice volume (Table 14). Phase wheel conventions are the same as ETP.

Calcium carbonate concentrations in all eastern cores lead changes in ice volume by ~3.0 Ky (Fig. 21). Only western core V25-56 shows a lag to minimum ice volume (~2.5 Ky). Organic carbon concentrations reveal a lead to ice volume of 2.2-4.2 Ky. Opal concentration indicates a lead with respect to SPECMAP ice for upwelling center cores in the east (~1.8 Ky) as well as a lag of 1.7-2.5 Ky for V25-56 and RC24-16.

Calculated fluxes for calcium carbonate, organic carbon, and opal exhibit responses akin to concentration responses with the proviso that phases are shifted and some coherent responses are lost, presumably a result of the square-wave character of MAR signals (Fig. 22).

Boreal Summer Insolation

Concentration and flux records of calcium carbonate, organic carbon, and opal were cross-spectrally analyzed against the radiation curve (Fig. 18) computed for low latitudes, 0-20°N, at Boreal Summer (BSTIM) from Berger (1978) to investigate the role of low latitude incident radiation in producing the observed time series (Table 15). Precession is the dominant insolation forcing at low latitudes so the presence of 23 Ky periodicity in calcium carbonate, organic carbon, and opal time series indicates a possible link to *in situ* insolation. Maxima in Boreal Summer insolation is responsible for suppressed zonal wind circulation whereas minima represent the converse. McIntyre *et al.* (1989) established that Tropical SST is decreased at low latitudes in meteorological summer (mid June - mid September) due to shallowing of the thermocline during periods of heightened upwelling brought about by increased zonal wind stress, **not** to diminished insolation. Cross-spectral results at 23 Ky indicate a highly coherent and patterned response to forcing by insolation. Maxima in calcium carbonate concentration in eastern cores is coherent and in-phase with maxima in insolation while western core, V25-56, lags forcing by 4.8 Ky (Fig. 23). Maxima in organic carbon concentration is in-phase with maximum zonality of winds while opal concentration also responds in-phase in the east but lags forcing by 2.7 Ky in the west.

Examination of calcium carbonate MAR responses at the precessional period reveals calcium carbonate accumulation in the deep eastern basin lagging Boreal Summer insolation by ~3.0 Ky while the western basin lags by ~5.0 Ky (Fig. 24). Organic carbon accumulation is synchronous and in phase with forcing across the equatorial basin. Opal accumulation is in phase with forcing in the east and lags insolation by 5.8 Ky in the west.

In summary, cross-spectral analyses reveal that, in most cores, changes in calcium carbonate, organic carbon, and opal exhibit coherent responses to orbital forcing at the precessional period. Maxima in organic carbon and opaline silica are in phase with low latitude zonal wind stress maxima and hence, upwelling. Calcium carbonate responds in

phase with ice volume which we infer is controlled by high latitude orbital forced mechanisms.

Responses at obliquity period (41 Ky)

Obliquity variations amplify the seasonal cycle in high latitudes of both hemispheres, simultaneously. The strength of the effect is small and 180° out-of-phase in the Tropics (Kutzbach, in press).

ETP

Coherent responses occur in concentration of organic carbon, nitrogen, and opaline silica but not in calcium carbonate (Table 16). Organic carbon and nitrogen show a coherent response only in the cores at the site of maximum equatorial upwelling (Fig. 25). This response lags orbital forcing by 1.1-4.6 and 1.0-3.6 Ky, respectively, with the shallowest core responding first. Opal exhibits a similar spatial and temporal distribution but with an added response from western shallow core, V25-56. Biogenous sediment MAR are coherent only in the deeper cores of the east (Fig. 26).

SPECMAP $\delta^{18}O$

Statistically coherent responses occur only in organic carbon and opal concentration and MAR (Table 17). Organic carbon (wt %) leads ice volume in RC24-01, RC24-07, and RC24-12 by 2.0-4.5 Ky (Fig. 27). As with ETP, these responses are restricted to cores in the center of maximum divergence. Accumulation of these biogenous sediments is coherent only in the deeper cores and leads ice volume (Fig. 28).

Boreal Summer Insolation

McIntyre *et al.* (1989) showed that there is negligible response in SST to Boreal Summer Insolation at 41 Ky. The lack of coherent responses to BSTIM is mirrored in our biogenous sediments by the lack of coherent responses to this forcing at 41 Ky (Table 18).

Annual Insolation at equator (0°)

Although the range in annual insolation at the equator (Fig. 19) is small when compared to high latitudes, the areal extent over which it is integrated is large and the sun's zenith angle is always high. Consequently, a significant amount of energy is received at the Tropics. The annual insolation signal at 0° has a unique signal that is pure obliquity because eccentricity modulated precession cancels out, leaving behind the 41 Ky signal. In order to investigate the response of our signals to this energy flux, we cross-spectrally analyzed our records of calcium carbonate, organic carbon, and opal concentration in RC24-12 and RC24-01 (representative of shallow and deep sites, respectively) against annual insolation at the equator (Table 19). The data indicate that organic carbon and opal are coherent and in-phase with forcing (or slightly lag) while calcium carbonate is not (Fig. 29). Our results indicate that changes in organic carbon and opal, but not calcium carbonate, are forced by annual insolation at the obliquity period. Although curious, these results are not unprecedented as McIntyre *et al.* (1989) found 41 Ky power in equatorial SST and Short *et al.* (1991) postulates that a 41 Ky response should be present at low latitudes. The response of organic carbon and opal may represent an ocean productivity response but without a physical mechanism to explain the response, any model proposed is speculative.

Vertical Structure in Spectra of Biogenics

There are two processes which, singulary or in concert, produce these paleochemical signals from the Tropical Atlantic. Production employs variation of

Tropical insolation to force changes in the intensity of equatorial divergence centered on 23 Ky. Destruction responds to the 100 and 41 Ky corrosive signal advected from high latitudes.

If productivity alone controls the character of biogenic sediment concentration and accumulation signals, why do deep cores show subdued or even absent statistically distinct power peaks at precessional periods? The regional importance of precessional forcing to wind stress and, hence, productivity has been established - the entire equatorial zone experiences 23 Ky forcing. Cross-spectral analyses show that organic carbon, nitrogen, and opal are linearly forced by variations in insolation at orbital, annual, and seasonal time scales in direct response to increased zonal wind circulation and upwelling at precessional and obliquity (?) periods. Yet, at depth within the eastern basin, geochemical signals along the main axis of upwelling show muted 23 Ky power and enhanced 100 Ky periodicity. Time series derived from census counts of foraminifera and coccolithophorida show strong precessional forcing within and without the upwelling regardless of depth below sea-level (McIntyre *et al.*, 1989; Molino and McIntyre, 1990). These biotal records identify the relative abundance of one species over another. Those species with thick-walled calcium carbonate skeletons will escape dissolution, to a greater extent, than their cousins with thinner-walled tests. The biotal signals are more robust to chemical changes (i.e. dissolution) occurring at depth because they are based upon relatively solution-resistant species. Hence the spectral signature of the proxy is nearly invariant.

In shallow sites above ~3700 meters depth, both biogenous and biotic signals faithfully record surface water productivity. At depth, however, biogenous sediment signals record *in situ* effects of deep water chemical processes such as dissolution, which artificially enhance resistant components. Apparently, there is strong bottom water forcing at work in this region which acts to modify original geochemical signals. Principal trajectory of flow for deep water masses in the modern world is west to east across the Equatorial Atlantic Basin through low latitude fracture zones (Fig 30). These structural

sills (i.e. Romanche and Chain Fracture Zones) act as "gateways" of flow for North Atlantic Deep Water (NADW) and Antarctic Bottom Water (AABW). Generalized deep circulation for the region reveals NADW flowing south from high latitude source areas meeting AABW flowing north at ~4000 meters at the western equatorial margin with the depth of the sill in the east at ~3750 meters below sea-level (Metcalf *et al.*, 1964; Warren, 1981). Using GEOSECS, TTO, TAS, and SAVE data sets, Broecker *et al.* (1991) show that water entering the Equatorial Atlantic today at ~3600 meters is composed of 80% NADW and 20% AABW with isolated maxima in NADW composition occurring within the equatorial region (Fig. 31). Additionally, they show strong east-west gradients in radiocarbon suggesting that the western basin is more rapidly ventilated than the eastern margin with calculated dissolved oxygen deficiencies higher in the east than the west (Fig. 32).

If NADW flow was reduced during glacials, as suggested by some (Boyle and Keigwin, 1982, 1985/1986, 1987; Crowley, 1983; Curry and Lohmann, 1983; Corliss *et al.*, 1986; Oppo and Fairbanks, 1987; Duplessy *et al.*, 1988), possibly resulting from ice sheet alteration of atmospheric circulation driving the mixed layer deeper and reducing entrainment (Crowley and Hakkinen, 1988), then the mixing zone between NADW and more corrosive AABW may have migrated north allowing a larger proportion of AABW to overflow the normally restrictive equatorial sills and fill the the Tropical Atlantic below ~3700 meters. Curry and Lohmann (1990) suggest that the proportion of NADW and AABW entering the eastern basin may have shifted from present day ratios of 4:1 to 1:1 during glacial periods.

Calcium carbonate signals are a balance between production (shells of forams and coccoliths) and destruction (dissolution of these shells). Dissolution is a function of i) increasing solubility with increasing pressure (i.e. depth) and ii) water mass carbonate chemistry (Berger, 1973; Farrell and Prell, 1989, 1991). Productivity increased in the equatorial region as previously described. Overprinted on this productivity signal is a

distinct record of calcium carbonate dissolution. Our records demonstrate that carbonate dissolution increased in the Equatorial Atlantic during glacials. The dissolution varies with 100 and 41 Ky periods and is coherent and in phase with $\delta^{18}\text{O}$. This suggests that the calcium carbonate dissolution signal originates at high latitudes. We believe that the mechanism for the observed increase in carbonate dissolution, during glacials, is increased incursion of corrosive AABW into the deep equatorial basin (i.e. ratio of NADW to AABW decreased).

Additionally, if bottom water circulation was reduced during glacials yet surface productivity and rain rate of organic matter to the seafloor were enhanced by surface wind stress, the usually low dissolved oxygen level towards the east would have been further reduced. The distribution of oxygen and carbon dioxide within the ocean is dependent on the exchange between atmospheric and oceanic reservoirs as well as production and destruction of organic matter. Marine organic matter initially produced by the metabolic processes of marine organisms in the photic zone is destroyed at depth by respiration so that the longer a water mass is isolated from the atmosphere and the more organic carbon is oxidized at depth, the lower its dissolved oxygen content. The Rain Ratio Model (Berger and Keir, 1984) predicts that as ocean surface fertility increases, the ratio of calcium carbonate to organic carbon in particulate matter settling from the euphotic zone shifts in favor of organic carbon with the consequence of increasing the total dissolved CO_2 of the deep ocean. This has the double effect of i) lowering the calcium carbonate ion concentration of seawater and making deeper water more corrosive thus increasing dissolution of calcium carbonate and ii) enhancing the preservation potential of organic matter.

Boyle (1988) presents a model which describes a vertical reorganization of nutrients between water masses. In his model, labile nutrients are shifted from intermediate waters (~2500 m), which were enhanced in glacial times as NADW flow diminished (Boyle and Keigwin, 1986), and sequestered in deep waters as remineralization is shifted to depth

during glacials. We believe that this vertical fractionation may be initiated by increased low latitude upwelling spurred by orbital forcing and suggest the following scenario; 1) During glacial times in the Equatorial Atlantic, ocean surface fertility is fed by waters upwelling in response to increased zonal wind circulation; 2) Equatorial bottom waters become enriched in CO₂ due to diminished contribution by northern source water (NADW) and enhanced southern source (AABW) flow as well as increased oxidation of organic matter at the sea-floor; 3) This leads to increased dissolution of calcium carbonate at depth; and 4) The increased flux of organic matter to the sea-floor leads to expansion of the oxygen minimum zone thereby enhancing the preservation potential of organic carbon. The concentration of dissolved oxygen in the water column at depth did not reach anoxia in the eastern basin, however, as evidenced by ubiquitous bioturbation throughout the sedimentary sequence.

Lowered dissolved oxygen levels and increased corrosiveness of advected intermediate and deep waters affects the signals of biogenic sediments from deep cores and provides a deep ocean and high latitude dissolution overprint (100 kyr and 41 Ky) on low latitude *in situ* productivity (23 Ky forced) signals. Precessional periods are muted while obliquity and eccentricity periods are enhanced at depth by this "far-field effect".

CONCLUSIONS

Examination of the biogenous sediments in cores from a zonal/meridional/depth transect in the Equatorial Atlantic Ocean reveal that:

1. Cyclic changes have occurred in the concentration and flux of biogenic components over the past 300 Ky.
2. High-latitude effects of NADW controlled by $\delta^{18}\text{O}$ (ice volume) markedly alters solution prone biogenous sediments (i.e. CaCO₃) directly and at depths as shallow as 3,500 m. This is recorded as the long period variance centered on 100 Ky.
3. Boyle's (1988) model of climate controlled intermediate versus deep water flux/chemical reactivity is corroborated so that during glacials, there is more

intermediate and less deep water formed in the North Atlantic, the latter south of the Polar Front (subpolar waters). Consequently, in glacials, intermediate waters have more, and deep waters less, dissolved oxygen leading to greater preservation of organic carbon in glacial intervals in deep cores.

4. Neither biogenous sediment concentration nor Mass Accumulation Rate signals can be used as unequivocal evidence of primary productivity. In the equatorial Atlantic, primary productivity is a direct response to seasonal divergence controlled by the zonal component of the tropical easterlies on both the annual and orbital time scales. Paleoceanographic evidence documents the dominance of precessional forcing of trade wind controlled productivity. Only in the shallowest records do signals of biogenous sediment concentration contain significant variance at precessional periods.
5. The phasing of the precessional period in these cores clearly demonstrates the interplay of high versus low latitude control. The precessional component in both organic carbon and opaline silica signals is in-phase with low latitude insolation forcing, while that of calcium carbonate is in phase with $\delta^{18}\text{O}$.
6. These two different phase responses of the precessional component indicates that solution of the calcium carbonate signal cannot be invoked to explain the other signals, e.g. a calcium carbonate loss yielding an artificial increase in opal requires that both have the same phase.
7. The different phasing also argues against the idea that the opaline and organic carbon signals represents continental input via winds controlled by high latitude climate. This is corroborated by other evidence; i) opaline silica in these cores is predominantly oceanic diatoms and radiolaria, and ii) the C/N ratio is the Redfield not the continental value.

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Table 1. Core location, depth, studied length, age, and mean sedimentation rate.

core	latitude	longitude	depth (m)	length (cm)	age (Ky)	mean sedimentation rate (cm/Ky)
RC24-01	0°34.0'N	13°39.0'W	3837	762	217	3.6579
RC24-07	1°21.0'S	11°55.0'W	3899	801	205	4.0260
RC24-12	3° 1.0'S	11°25.0'W	3486	742	314	3.1452
RC24-16	5° 2.3'S	10°11.5'W	3559	767	241	3.4175
V25-56	3°33.0'S	35°14.0'W	3512	734	256	3.3043
RC16-66	0° 0.7'S	36°36.0'W	4424	1050	303	4.3379

Table 2. Operating parameters of the UIC Coulometer Model 5011 and Acidification Module 5130 for calcium carbonate analysis of sediment samples.

Sample size	5.0 mg
Acid	4.0 ml of 2N HCl
Nitrogen carrier gas flow rate	100 cc/min
System purge time	2.0 min
Sample vial size	10.0 ml
Heater temperature setting	3.5 (~60°C)
Total analytical time	5.0 min

Table 3. Precision of calcium carbonate determinations by coulometry*.

replicate	wt% CaCO ₃	blank (μg-CaCO ₃)
1	75.2	1.2
2	75.2	1.2
3	75.1	1.2
4	75.1	1.2
5	75.2	1.2
6	75.1	1.2
7	75.2	1.2
8	75.1	1.2
9	75.2	1.2
10	75.1	1.2
Mean	75.15	
S.D.	0.05	

Note: 1) All samples analyzed with UIC Coulometer and operating parameters as outlined in text; 2) Sample is OSU Carbonate Sediment Standard K7905, Site C, core 9BC,0-5 cm, split: #11, SX30121.

Table 4. Age models for the cores of this study based upon SPECMAP stable oxygen isotope chronostratigraphy.

depth (cm)	age (Ka)	sedimentation rate (cm/Ky)	isotopic event
RC24-01 AGE7			
0.0	1.5	-	-
10.0	7.3	1.7241	1.1
40.0	14.9	3.9474	2.0
190.0	43.9	5.1724	3.13
225.0	50.2	5.5556	3.3
285.0	60.5	5.8252	4.22
360.0	79.3	3.9894	5.1
470.0	122.6	2.5404	5.51
505.0	135.1	2.8000	6.2
570.0	153.9	3.4574	-
610.0	163.3	4.2553	-
630.0	169.8	3.0769	-
660.0	179.7	3.0303	-
710.0	193.1	3.7313	7.1
730.0	202.6	2.1053	-
RC24-07 AGE11			
0.0	1.5	-	-
33.0	7.9	5.1163	1.1
73.0	15.2	5.4645	-
90.0	17.8	6.7194	2.2
115.0	21.4	6.9444	-
345.0	54.8	6.8780	3.3
370.0	60.4	4.4643	4.0
430.0	79.2	3.1898	5.1
440.0	90.9	0.8547	-
495.0	110.7	2.7722	-
535.0	125.1	2.7778	5.53
565.0	135.0	3.0581	6.2
620.0	151.0	3.4375	-
640.0	156.8	3.4364	-
690.0	173.0	3.0902	-
705.0	183.0	1.5000	-
765.0	194.0	5.4545	7.1
780.0	197.7	4.0541	-

Table 4. (continued)

depth (cm)	age (Ka)	sedimentation rate (cm/Ky)	isotopic event
RC24-12 AGE18			
0.0	1.5	-	-
33.0	6.2	6.9182	-
75.0	14.0	5.4334	1.1
87.0	17.8	3.1169	2.0
93.0	19.2	4.3796	2.2
108.0	23.1	3.7975	2.21
147.0	36.5	2.9257	-
171.0	53.5	1.4118	3.3
216.0	64.0	4.2493	4.22
255.0	79.2	2.5811	5.1
354.0	122.5	2.2832	5.51
360.0	125.1	4.9669	5.53
381.0	135.1	0.8708	6.2
445.0	162.1	2.3642	-
465.0	167.3	3.8685	-
510.0	186.4	2.3610	-
525.0	192.2	2.5862	-
595.0	233.8	1.6819	-
RC24-16 AGE8			
0.0	1.5	-	-
45.0	12.0	4.2857	2.0
96.0	24.0	4.2500	3.0
111.0	30.8	5.1724	-
123.0	35.7	2.4490	-
132.0	38.2	3.6000	-
147.0	44.3	2.4351	-
201.0	62.0	3.0612	-
216.0	65.0	5.0000	4.2
231.0	70.5	2.7076	-
273.0	82.6	3.4568	-
312.0	99.0	2.3912	5.3
396.0	122.0	3.6522	5.5
441.0	135.0	3.4615	-
477.0	151.0	2.2500	-
534.0	165.0	4.0714	-
639.0	194.0	3.6207	7.1
714.0	225.0	2.4194	-
756.0	238.0	3.2308	7.5

Table 4. (continued)

depth (cm)	age (Ka)	sedimentation rate (cm/Ky)	isotopic event
V25-56 AGE4			
0.0	0.0	-	-
1.5	1.5	0.5357	-
27.0	8.5	4.4737	1.1
47.5	11.5	6.8333	-
63.5	14.3	5.7143	2.0
147.5	24.0	8.6082	3.0
160.0	28.0	3.2500	-
210.0	37.0	5.5556	3.1
255.0	53.0	2.8125	3.3
265.0	65.0	0.8333	4.22
335.0	80.0	4.6667	5.1
370.0	87.0	5.0000	-
445.0	107.0	3.7500	5.53
495.0	122.0	3.3333	5.51
530.0	129.0	4.4304	-
560.0	146.0	1.1863	6.3
575.0	151.0	3.0000	-
650.0	187.0	2.0661	-
657.0	194.0	1.1194	7.1
665.0	205.0	0.6818	-
677.0	216.0	1.1364	-
687.0	228.0	0.8333	-
705.0	238.0	1.7500	7.5
720.0	249.0	1.3636	-
730.0	256.0	1.3699	-
RC16-66 AGE15			
0.0	0.0	-	-
10.0	4.7	2.1277	1.1
30.0	12.0	2.7211	2.0
80.0	17.8	8.6207	2.2
150.0	25.4	9.2470	-
190.0	43.8	2.1668	3.13
220.0	50.2	4.7393	3.3
250.0	55.4	5.7252	3.31
280.0	58.9	8.5470	4.0
290.0	64.0	1.9493	4.22
370.0	79.2	5.2770	5.1
490.0	120.0	2.9448	5.5
550.0	135.1	3.9735	6.2
590.0	152.5	2.2883	-
660.0	170.0	4.0189	6.5
765.0	214.6	2.3543	-
910.0	235.5	6.9246	7.5
940.0	249.0	2.2288	-

Table 5. Comparison of isotopes (δO^{18}) with SPECMAP STACK.

core	r	23 Ky		41 Ky		100 Ky	
		k	ϕ	k	ϕ	k	ϕ
RC24-01	0.89	0.93	-12	0.96	+0.8	0.98	+3
RC24-07	0.89	0.93	-2	0.95	+6	0.98	+9
RC24-12	0.91	0.87	-22	0.96	-9	0.98	-9
RC24-16	0.76	0.76	+24	0.81	+1	0.94	+15
V25-56	0.91	0.96	-16	0.95	-11	0.98	+11
RC16-66	0.75	0.87	-12	0.76	-6	0.83	-2

Note: r = correlation coefficient; k=coherency; ϕ = phase measured clockwise from zero position where (+) indicates lag and (-) lead of SPECMAP STACK.

Table 6. Statistics on downcore sedimentary component concentration*.

	V25-56	RC24-12	RC24-16	RC16-66	RC24-01	RC24-07
	SHALLOW		(east)	(west)	DEEP	(east)
	(west)					
calcium carbonate						
max	71.33	91.57	92.70	62.88	93.88	89.73
min	19.24	73.68	80.30	0.82	52.32	49.54
mean	41.45	85.03	87.96	38.08	71.24	71.87
S.D.	10.85	3.65	2.50	13.65	8.05	8.18
organic carbon						
max	0.50	0.98	0.52	0.53	1.35	1.98
min	0.16	0.09	0.07	0.15	0.17	0.18
mean	0.24	0.35	0.19	0.29	0.65	0.85
S.D.	0.04	0.21	0.09	0.06	0.28	0.42
nitrogen						
max	0.10	0.09	0.06	0.11	0.16	0.21
min	0.03	0.01	0.02	0.02	0.02	0.02
mean	0.07	0.03	0.03	0.05	0.07	0.08
S.D.	0.01	0.01	0.01	0.01	0.03	0.04
opal						
max	1.53	4.80	3.27	1.45	11.13	13.71
min	0.56	1.23	0.94	0.56	2.57	1.45
mean	1.03	2.59	1.59	0.99	5.42	6.48
S.D.	0.20	0.79	0.41	0.19	1.75	2.02
other						
max	79.33	20.87	17.02	97.85	37.99	40.30
min	27.68	6.07	5.93	36.03	2.92	7.31
mean	56.97	11.97	10.22	60.61	22.68	20.87
S.D.	10.73	2.95	2.29	13.60	6.54	6.28

* wt %

Table 9. Statistics on C/N weight ratios.

	V25-56	RC24-12	RC24-16	RC16-66	RC24-01	RC24-07
	(west)	SHALLOW		(west)	DEEP	
		(east)	(east)		(east)	(east)
maximum	6.7	17.0	10.9	8.4	18.2	17.3
minimum	2.0	4.4	2.1	3.7	3.8	4.2
mean	3.4	9.6	5.2	5.7	8.5	10.3
S.D.	0.8	2.1	1.7	0.9	2.2	2.3

Table 10. Astronomical timing (Ka) for coincidence of perihelion with boreal summer and winter¹ and maxima (Ka) in measured concentration and calculated flux of sedimentary component².

Boreal summer (June)	Boreal winter (December)	%C-org MAR	%Nitro MAR	%Opal MAR	%Other MAR
11	21	23	21	22	21
32	45	44	45	45	45
60	70	70	70	68	70
82	93	93	91	94	93
104	115	114	113	114	115
126	138	139	138	140	139
149	162	161	162	163	163
175	186	184	186	186	186

Note: 1) Data from Berger (1978); 2) Represents mean value for timing of maxima in all cores.

Table 11. Correlation coefficient (r) between sedimentary component concentration (wt %), sedimentation rate (cm/1000 yrs), and bulk mass accumulation rate (g/cm²/1000 yrs) in Equatorial Atlantic cores.

sedimentary component	sedimentation rate	Bulk MAR
RC24-01		
calcium carbonate	-0.44	-0.19
organic carbon	0.68	0.56
nitrogen	0.68	0.53
opal	0.51	0.31
other	0.39	0.15
RC24-07		
calcium carbonate	-0.13	0.08
organic carbon	0.52	0.35
nitrogen	0.58	0.42
opal	0.09	-0.09
other	0.10	-0.09
RC24-12		
calcium carbonate	0.09	0.04
organic carbon	-0.05	0.04
nitrogen	-0.04	0.03
opal	-0.04	0.12
other	0.02	-0.09
RC24-16		
calcium carbonate	-0.11	0.08
organic carbon	0.03	0.04
nitrogen	-0.08	-0.11
opal	0.22	0.16
other	0.07	0.06
V25-56		
calcium carbonate	-0.07	0.22
organic carbon	-0.15	-0.17
nitrogen	-0.18	-0.25
opal	-0.31	-0.43
other	0.01	-0.19
RC16-66		
calcium carbonate	-0.11	0.30
organic carbon	-0.04	-0.23
nitrogen	-0.19	-0.22
opal	0.01	0.06
other	0.11	-0.18

Note: 1) Negative correlation indicated by -r; 2) Test statistic for significance at $\geq 95\%$ CI is 0.17 for all data.

Table 12. Correlation between sedimentary component concentration and accumulation.

	V25-56	RC16-66	RC24-12	RC24-16	RC24-01	RC24-07
C-org (%) vs C-org MAR	0.12	0.11	0.86	0.90	0.93	0.85
Opal (%) vs Opal MAR	0.13	0.36	0.64	0.78	0.81	0.50
Carb (%) vs Carb MAR	0.55	0.56	0.13	0.11	0.11	0.30

(Note: C-org is organic carbon; Carb is calcium carbonate)

Table 13. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus ETP at precessional period (23 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	0.91	+73	± 28	(0.55)	(+94)	± 55
RC24-07	0.79	+54	± 36	0.87	+96	± 45
RC24-12	0.77	+40	± 41	(0.60)	(+61)	± 64
RC24-16	0.81	+89	± 52	(0.30)	(+104)	± 64
V25-56	0.87	+124	± 37	(0.58)	(+122)	± 51
RC16-66	(0.38)	(+84)	± 64	(0.17)	(+55)	± 64
(-) organic carbon						
RC24-01	0.86	+30	± 46	0.73	+20	± 54
RC24-07	0.86	+26	± 23	0.73	+32	± 46
RC24-12	(0.60)	(+29)	± 46	(0.63)	(+8)	± 45
RC24-16	0.81	+19	± 64	0.68	+27	± 42
V25-56	0.84	+45	± 45	0.90	+11	± 38
RC16-66	(0.43)	(+2)	± 46	(0.42)	(-52)	± 41
(-) nitrogen						
RC24-01	0.81	+35	± 46	0.73	+27	± 37
RC24-07	0.92	+38	± 43	0.81	+18	± 27
RC24-12	0.65	+43	± 55	(0.60)	(+38)	± 46
RC24-16	(0.58)	(+75)	± 36	(0.64)	+85	± 64
V25-56	0.85	+75	± 36	0.68	+13	± 55
RC16-66	(0.54)	(-4)	± 36	(0.47)	(-39)	± 46
(-) opal						
RC24-01	0.81	+60	± 46	0.73	+43	± 55
RC24-07	0.71	+60	± 50	(0.55)	(-10)	± 65
RC24-12	0.74	+62	± 50	(0.26)	(+93)	± 64
RC24-16	0.65	+133	± 46	0.65	+139	± 55
V25-56	(0.64)	(+108)	± 64	(0.40)	(+20)	± 50
RC16-66	(0.39)	+158	± 64	(0.24)	(+160)	± 64
(-) other						
RC24-01	0.81	+90	± 32	0.68	+63	± 55
RC24-07	0.77	+55	± 46	(0.57)	(-15)	± 55
RC24-12	0.76	+38	± 41	(0.26)	(+82)	± 74
RC24-16	0.83	+84	± 46	0.78	+90	± 65
V25-56	0.84	+122	± 37	(0.28)	(+85)	± 47
RC16-66	(0.34)	(+107)	± 60	(0.14)	(+53)	± 46

Note: 1) Test statistics for significance: k = 0.79 at 95% CI; k = 0.65 at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 14. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus SPECMAP STACK at precessional period (23 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	0.90	-21	± 23	(0.32)	-28	± 64
RC24-07	0.75	-29	± 37	0.73	+10	± 41
RC24-12	0.79	-52	± 64	0.66	-40	± 37
RC24-16	0.70	-1	± 46	(0.27)	(-116)	± 55
V25-56	0.94	+38	± 37	0.78	+36	± 46
RC16-66	(0.17)	(+42)	± 55	(0.14)	(+125)	± 55
(-) organic carbon						
RC24-01	0.92	-62	± 43	0.84	-64	± 33
RC24-07	0.87	-65	± 27	0.78	-79	± 27
RC24-12	0.73	-65	± 41	0.80	-84	± 41
RC24-16	0.80	-67	± 45	0.72	-54	± 48
V25-56	0.67	-35	± 37	0.79	-75	± 47
RC16-66	(0.43)	(-89)	± 45	(0.42)	(-92)	± 47
(-) opal						
RC24-01	0.83	-32	± 41	0.83	-40	± 46
RC24-07	0.70	-25	± 41	(0.50)	(-72)	± 46
RC24-12	0.78	-32	± 41	(0.46)	(-37)	± 45
RC24-16	0.65	+40	± 37	0.74	+48	± 45
V25-56	0.69	+27	± 32	(0.61)	(-50)	± 32
RC16-66	(0.61)	(+34)	± 45	(0.26)	(-31)	± 46

Note: 1) Test statistics for significance: $k = 0.79$ at 95% CI; $k = 0.65$ at 80% CI ;
 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 15. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus BSTIM at precessional period (23 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	0.88	+23	± 36	(0.57)	(+50)	± 50
RC24-07	0.76	+5	± 46	0.87	+46	± 37
RC24-12	0.76	-9	± 46	(0.57)	(+11)	± 41
RC24-16	0.81	+41	± 46	(0.28)	(-14)	± 32
V25-56	0.81	+76	± 46	0.70	+79	± 36
RC16-66	(0.32)	(+35)	± 46	(0.13)	(+94)	± 61
(-) organic carbon						
RC24-01	0.80	-20	± 27	0.68	-32	± 41
RC24-07	0.82	-24	± 27	0.68	-25	± 32
RC24-12	(0.57)	(-22)	± 46	(0.52)	(-47)	± 46
RC24-16	0.85	-30	± 42	0.74	-23	± 32
V25-56	0.86	-3	± 42	0.88	-39	± 47
RC16-66	(0.41)	(-50)	± 37	(0.51)	(-47)	± 28
(-) opal						
RC24-01	0.79	+10	± 37	0.71	-10	± 41
RC24-07	0.71	+9	± 46	(0.55)	(-65)	± 37
RC24-12	0.71	+13	± 64	(0.51)	(-4)	± 55
RC24-16	(0.62)	(+85)	± 46	0.65	+92	± 46
V25-56	0.72	+43	± 28	(0.33)	(+37)	± 46
RC16-66	(0.42)	(+123)	± 54	(0.21)	(+117)	± 36

Note: 1) Test statistics for significance: $k = 0.79$ at 95% CI; $k = 0.65$ at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 16. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus ETP at obliquity period (41 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	(0.63)	(+6)	± 41	(0.38)	(-56)	± 73
RC24-07	(0.52)	(+23)	± 36	(0.26)	(+68)	± 64
RC24-12	(0.61)	(+4)	± 37	(0.43)	(-32)	± 64
RC24-16	(0.38)	(-20)	± 55	(0.20)	(+176)	± 64
V25-56	(0.28)	(+24)	± 36	(0.20)	(+84)	± 64
RC16-66	(0.18)	(+103)	± 37	(0.45)	(-87)	± 42
(-) organic carbon						
RC24-01	0.85	+26	± 18	0.77	+27	± 27
RC24-07	0.72	+41	± 27	(0.61)	(+28)	± 46
RC24-12	0.72	+10	± 55	(0.60)	(+31)	± 64
RC24-16	(0.13)	(+93)	± 37	(0.17)	(-37)	± 60
V25-56	(0.64)	(-15)	± 41	(0.52)	(-54)	± 70
RC16-66	(0.37)	(-167)	± 64	(0.50)	(+101)	± 74
(-) nitrogen						
RC24-01	0.75	+22	± 27	0.70	+29	± 41
RC24-07	0.67	+32	± 32	(0.57)	+25	± 46
RC24-12	0.65	+8	± 73	(0.52)	(+173)	± 42
RC24-16	(0.49)	(+59)	± 46	(0.33)	(+21)	± 64
V25-56	(0.60)	(-95)	± 46	(0.54)	(-68)	± 69
RC16-66	(0.53)	(+173)	± 46	(0.61)	(+116)	± 69
(-) opal						
RC24-01	0.82	+20	± 37	0.88	+28	± 64
RC24-07	0.76	+40	± 38	0.65	+27	± 46
RC24-12	0.78	+10	± 46	(0.53)	(+20)	± 73
RC24-16	(0.41)	(+58)	± 55	(0.26)	(+43)	± 64
V25-56	0.70	+45	± 64	(0.41)	(-42)	± 64
RC16-66	(0.49)	(+33)	± 64	(0.49)	(+84)	± 64
(-) other						
RC24-01	(0.56)	(-4)	± 46	0.69	+22	± 46
RC24-07	(0.38)	(+8)	± 50	(0.55)	(+16)	± 46
RC24-12	(0.46)	(+1)	± 36	(0.23)	(+68)	± 65
RC24-16	(0.38)	(-27)	± 50	(0.30)	(-24)	± 55
V25-56	(0.14)	(+43)	± 36	(0.30)	(-36)	± 64
RC16-66	(0.14)	(+129)	± 69	(0.51)	(+85)	± 64

Note: 1) Test statistics for significance: k = 0.79 at 95% CI; k = 0.65 at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 17. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus SPECMAP STACK at obliquity period (41 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	(0.41)	(-32)	± 27	(0.24)	(-173)	± 60
RC24-07	(0.42)	(-13)	± 28	(0.48)	(+25)	± 40
RC24-12	(0.33)	(-42)	± 51	(0.55)	(-69)	± 41
RC24-16	(0.22)	(-1)	± 45	(0.37)	(-3)	± 55
V25-56	(0.55)	(+11)	± 23	(0.40)	(-20)	± 45
RC16-66	(0.43)	(-49)	± 47	(0.55)	(-123)	± 64
(-) organic carbon						
RC24-01	0.91	-33	± 18	0.89	-32	± 18
RC24-07	0.84	-18	± 18	0.73	-28	± 32
RC24-12	0.77	-40	± 46	(0.62)	(-21)	± 37
RC24-16	(0.46)	(-37)	± 28	(0.39)	(-156)	± 45
V25-56	(0.44)	(-86)	± 45	(0.36)	(-145)	± 55
RC16-66	(0.26)	(-151)	± 55	(0.55)	(+52)	± 46
(-) opal						
RC24-01	0.65	-36	± 23	0.81	-33	± 41
RC24-07	(0.63)	(-19)	± 36	(0.57)	(-48)	± 41
RC24-12	(0.58)	(-45)	± 47	(0.35)	(-37)	± 47
RC24-16	(0.10)	(+54)	± 47	(0.22)	(+149)	± 46
V25-56	(0.55)	(-5)	± 45	(0.05)	(-64)	± 47
RC16-66	(0.62)	(-9)	± 46	(0.57)	(+39)	± 47

Note: 1) Test statistics for significance: $k = 0.79$ at 95% CI; $k = 0.65$ at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 18. Coherency (k) and phase (ϕ) for sediment component concentration and Mass Accumulation Rate (MAR) versus BSTM at obliquity period (41 Ky).

core	concentration			MAR		
	k	ϕ	error	k	ϕ	error
calcium carbonate						
RC24-01	(0.20)	(-83)	± 42	(0.50)	(-123)	± 46
RC24-07	(0.38)	(-138)	± 32	(0.38)	(+57)	± 37
RC24-12	(0.33)	(-157)	± 37	(0.25)	(+150)	± 45
RC24-16	(0.43)	(+127)	± 37	(0.30)	(-17)	± 27
V25-56	(0.16)	(-172)	± 46	(0.52)	(-86)	± 45
RC16-66	(0.14)	(+80)	± 36	(0.42)	(+107)	± 55
(-) organic carbon						
RC24-01	(0.45)	(-118)	± 47	(0.44)	(-111)	± 45
RC24-07	(0.40)	(-109)	± 45	(0.54)	(-110)	± 38
RC24-12	(0.56)	(-163)	± 46	(0.47)	(-135)	± 41
RC24-16	(0.34)	(-109)	± 36	(0.33)	(+89)	± 41
V25-56	(0.56)	(+154)	± 46	(0.49)	(+120)	± 37
RC16-66	(0.27)	(+56)	± 37	(0.43)	(-68)	± 47
(-) opal						
RC24-01	(0.27)	(-108)	± 36	(0.39)	(-100)	± 32
RC24-07	(0.51)	(-124)	± 28	(0.52)	(-70)	± 32
RC24-12	(0.54)	(-175)	± 36	(0.43)	(-5)	± 47
RC24-16	(0.38)	(-170)	± 55	(0.31)	(+178)	± 27
V25-56	(0.55)	(-125)	± 55	(0.47)	(-121)	± 27
RC16-66	(0.61)	(+135)	± 46	(0.45)	(+84)	± 41

Note: 1) Test statistics for significance: $k = 0.79$ at 95% CI; $k = 0.65$ at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

Table 19. Coherency (k) and phase (ϕ) for calcium carbonate, organic carbon and opal concentration versus annual insolation at the equator (0°) at obliquity period (41Ky).

core	k	ϕ	error
calcium carbonate			
RC24-01	(0.60)	(-173)	± 54
RC24-12	(0.60)	(-174)	± 54
(-) organic carbon			
RC24-01	0.78	+23	± 30
RC24-12	0.73	+10	± 30
(-) opal			
RC24-01	0.77	+16	± 30
RC24-12	0.78	+10	± 30

Note: 1) Test statistics for significance: $k = 0.79$ at 95% CI; $k = 0.65$ at 80% CI ; 2) Phasing in degrees measured clockwise 0-180° where (+) indicates lag and (-) lead with respect to zero position; 3) Parentheses indicate responses below 80% CI; 4) Error refers to phase estimates in degrees.

FIGURE CAPTIONS

- Fig. 1 Geographic locations of cores in this study.
- Fig. 2 Principle region of equatorial upwelling as defined by measured heat flux (Watts/m^2) from atmosphere to ocean surface during August (modified from Reverdin, 1985). Triangles depict cores and bold arrows show flow of Equatorial Undercurrent (EUC) and South Equatorial Current (SEC).
- Fig. 3 Oxygen isotopic records ($\delta^{18}\text{O}$, per mil v PDB) for the cores in this study. Numbers indicate isotopic stage boundaries as defined in text.
- Fig. 4 SPECMAP stacked oxygen isotope record ($\delta^{18}\text{O}$, per mil v PDB).
- Fig. 5 Depth (cm) versus modeled age (Ka) in cores.
- Fig. 6 Downcore variation in sedimentary component concentration (wt %) versus age (Ka). Concentration scales differ to allow examination of signal variability. A. calcium carbonate, B. organic carbon, C. nitrogen, D. opal, E. other.
- Fig. 7 Downcore variation in sedimentary component Mass Accumulation Rates versus age (Ka). Mass Accumulation Rates are measured in terms of $\text{g/cm}^2/1000$ yrs except for organic carbon, nitrogen and opal which are measured as $\text{mg/cm}^2/1000$ yrs. Signals are scaled for internally consistent intercore comparisons of sedimentary component accumulation. A. bulk, B. calcium carbonate, C. organic carbon, D. nitrogen, E. opal, F. other.
- Fig. 8 Linear spectrum plots of percent variance versus frequency (1/period) of sedimentary component concentration signals. The spectra are calculated at the 95% confidence level with no pre-whitening using linear detrend and an autocovariance function. A. calcium carbonate, B. organic carbon, C. nitrogen, D. opal, E. other.
- Fig. 9 Linear spectrum plots of percent variance versus frequency (1/period) of sedimentary component concentration signals from RC24-01 calculated at the 95% confidence level, with a prewhitening constant of 0.80, using linear detrend, and an autocovariance function.
- Fig. 10 Cartoon summarizing the spectral response of sedimentary components to orbital forcing across the Equatorial Atlantic Ocean Basin in the cores of this study. Depicted spectra represent measured sedimentary component concentrations. Shaded spectra are from cores within the main body of equatorial upwelling. Depth of structural sill in the eastern Equatorial Atlantic is ~ 3750 meters below sea-level. Drawing is not to scale.
- Fig. 11 Linear spectrum plots of percent variance versus frequency (1/period) of sedimentary component MAR signals. The spectra are calculated at the 95% confidence level with no prewhitening using linear detrend and an autocovariance function. A. bulk, B. calcium carbonate, C. organic carbon,

D. nitrogen, E. opal, F. other.

- Fig. 12 Comparison of time series and spectra for calcium carbonate concentration, accumulation and sedimentation rate in RC24-16. Linear spectra are calculated with $N=240$, $M=80$, and $T=1,000$ yrs.
- Fig. 13 C/N ratios (wt %) in sediments.
- Fig. 14 Detailed bathymetry from the sites of cores RC24-01, RC24-07, RC24-12 and RC24-16 revealing gentle gradients at core sites. Scale: 1° latitude or longitude, at equator, is equivalent to 111 km.
- Fig. 15 Seismic reflection profile for RC24 cruise showing sediment cover over oceanic crust in the Equatorial Atlantic.
- Fig. 16 Stacked records of calcium carbonate concentration. Stacked records were subtracted, deep from shallow, with the difference as residual. Units of measure are wt % calcium carbonate.
- Fig. 17 Coherency spectrum between residual signal (deep - shallow stack) and SPECMAP stacked oxygen isotope record. Coherency (k) is measured along the vertical axis; frequency and period along the horizontal axis. Statistical significance is 0.79 at the 95% confidence interval and 0.65 at the 80% interval.
- Fig. 18 Forcing signals (from Berger, 1978) . A. ETP - a composite signal of the orbital measures of eccentricity, obliquity, and precessional; B. BSTIM - Boreal Summer Insolation at 0-20°N in $\text{cal/cm}^2/\text{day}$; C. Annual Insolation at the equator (0°) in $\text{cal/cm}^2/\text{day}$.
- Fig. 19 Phasing of biogenic sediment concentration versus ETP following SPECMAP convention at precession period. For all phase wheels 0° position indicates forcing at interglacial. Coherency between component and composite orbital signal is indicated in parentheses. SPECMAP $\delta^{18}\text{O}$ is provided for reference as well as Tc (SST cold temperature estimates). Statistical significance is 0.79 at the 95% confidence interval and 0.65 at the 80% interval.
- Fig. 20 Phasing of biogenic sediment MAR versus ETP at precession period.
- Fig. 21 Phasing of biogenic sediment concentration versus SPECMAP $\delta^{18}\text{O}$ at precession period.
- Fig. 22 Phasing of biogenic sediment MAR versus SPECMAP $\delta^{18}\text{O}$ at precession period.
- Fig. 23 Phasing of biogenic sediment concentration versus BSTIM at precession period.
- Fig. 24 Phasing of biogenic sediment MAR versus BSTIM at precession period.

- Fig. 25 Phasing of biogenic sediment concentration versus ETP at obliquity period. Phase wheel conventions the same as for precession except that Tc is not plotted.
- Fig. 26 Phasing of biogenic sediment MAR versus ETP at obliquity period.
- Fig. 27 Phasing of biogenic sediment concentration versus SPECMAP $\delta^{18}\text{O}$ at obliquity period.
- Fig. 28 Phasing of biogenic sediment MAR versus SPECMAP $\delta^{18}\text{O}$ at obliquity period.
- Fig. 29 Phasing of organic carbon and opal concentration versus annual insolation at the equator (0°) at obliquity period.
- Fig. 30 Measured bathymetry and hydrography of the eastern equatorial region showing location of Romanche and Chain Fracture Zones and RC24 series cores sites. Scale: At the equator, 1.0° of latitude or longitude equals 111 km.
- Fig. 31 Map describing relative contribution (%) of northern source water at 3600 and 4000 meters in the Atlantic basin. (from Broecker *et al.*, 1991).
- Fig. 32 Calculated oxygen deficiencies at depths >2000 meters in the Atlantic Ocean. (from Broecker *et al.*, 1991).

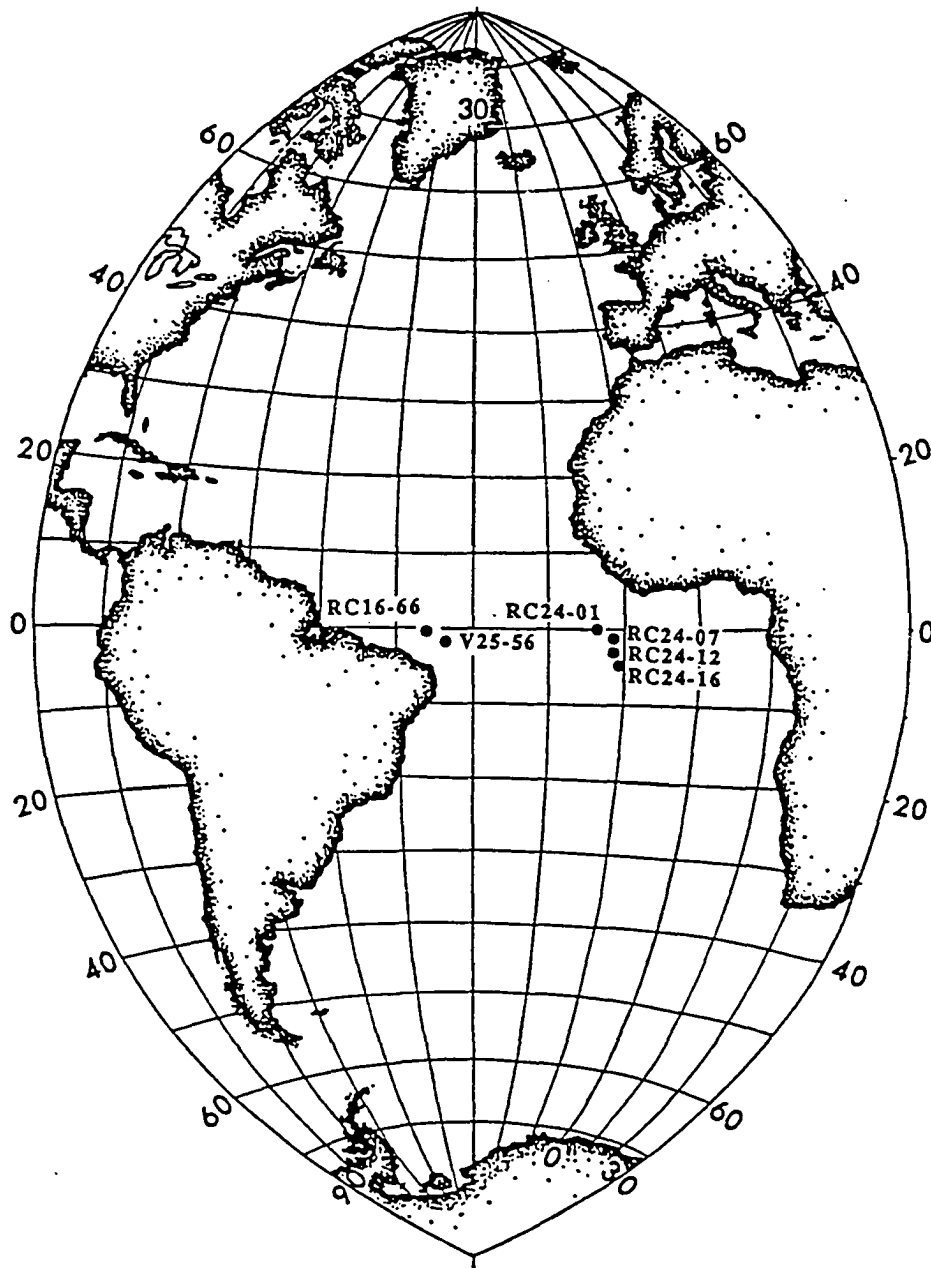


Figure 1

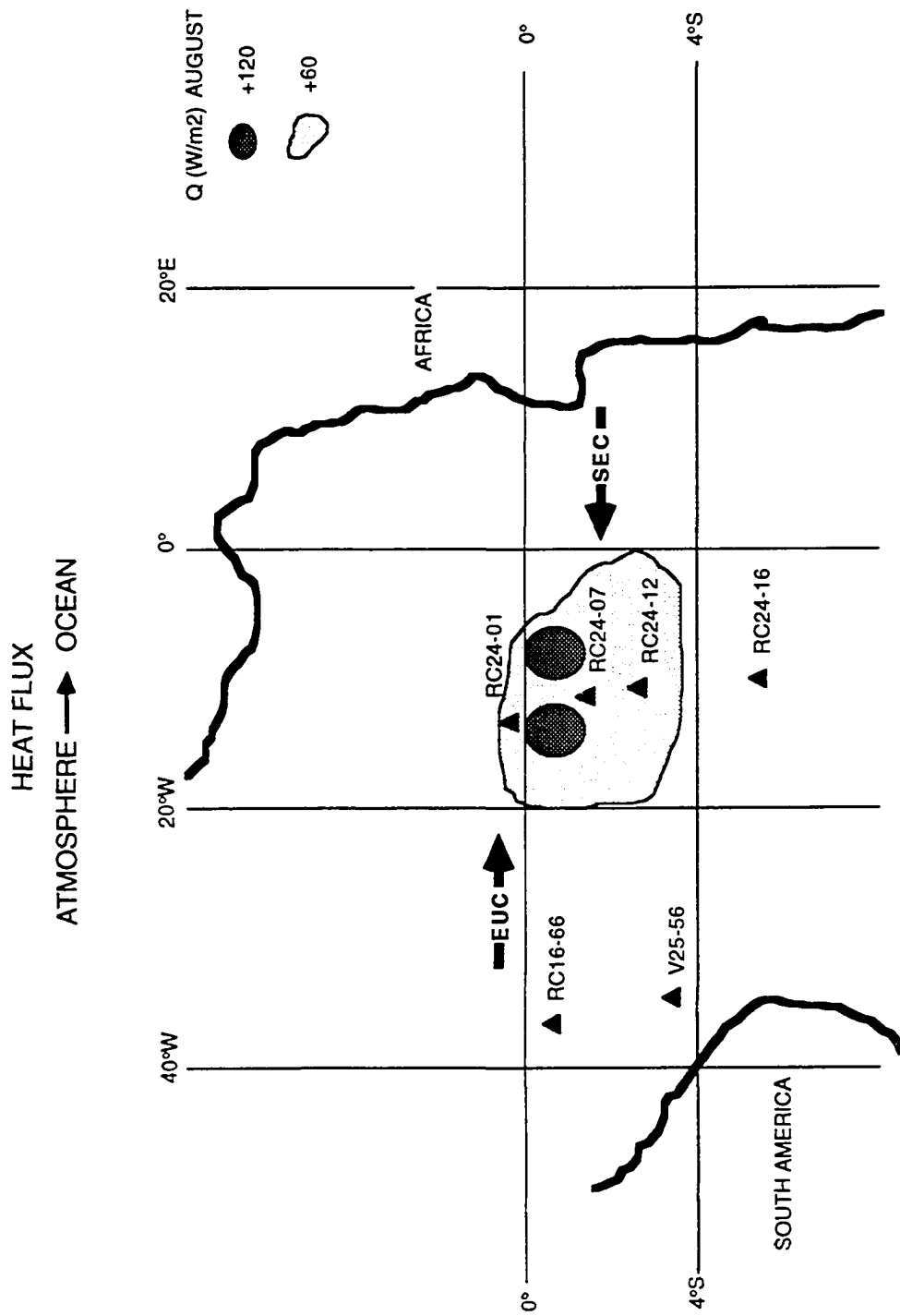


Figure 2

ISOTOPES (del 0-18)

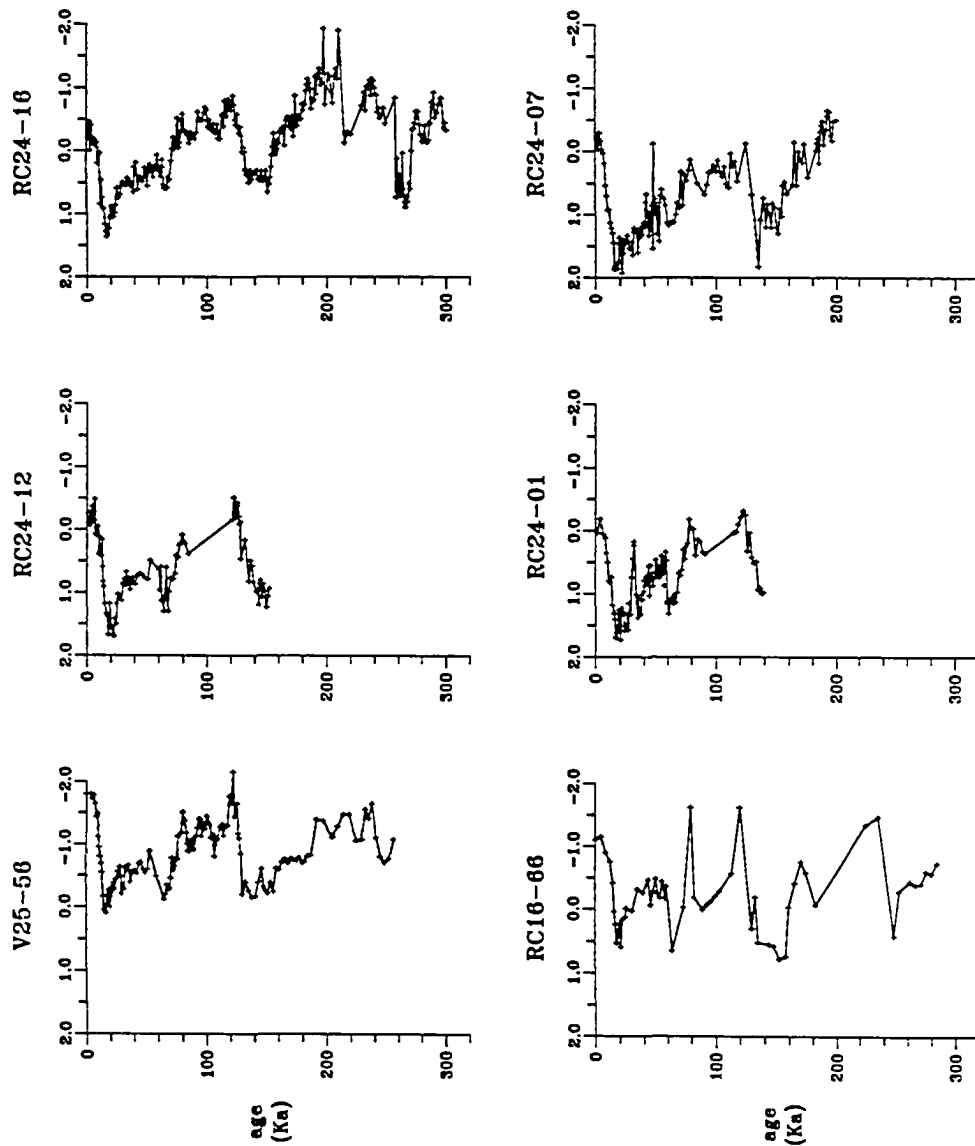


Figure 3

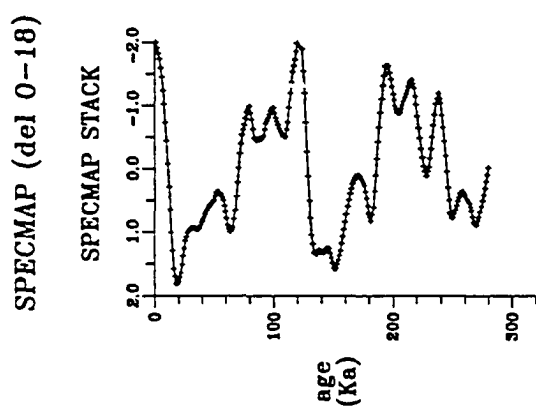


Figure 4

DEPTH VS AGE

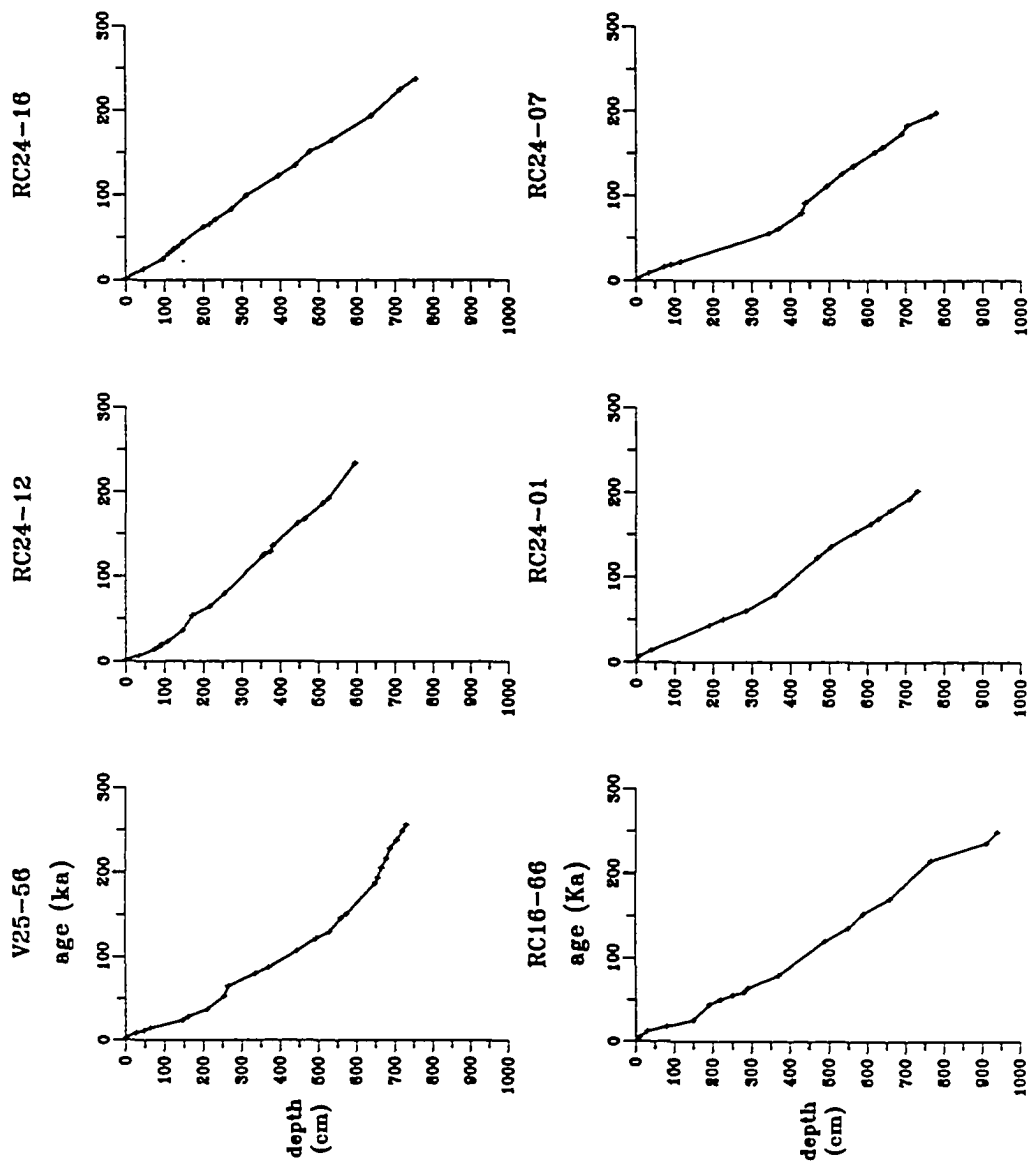


Figure 5

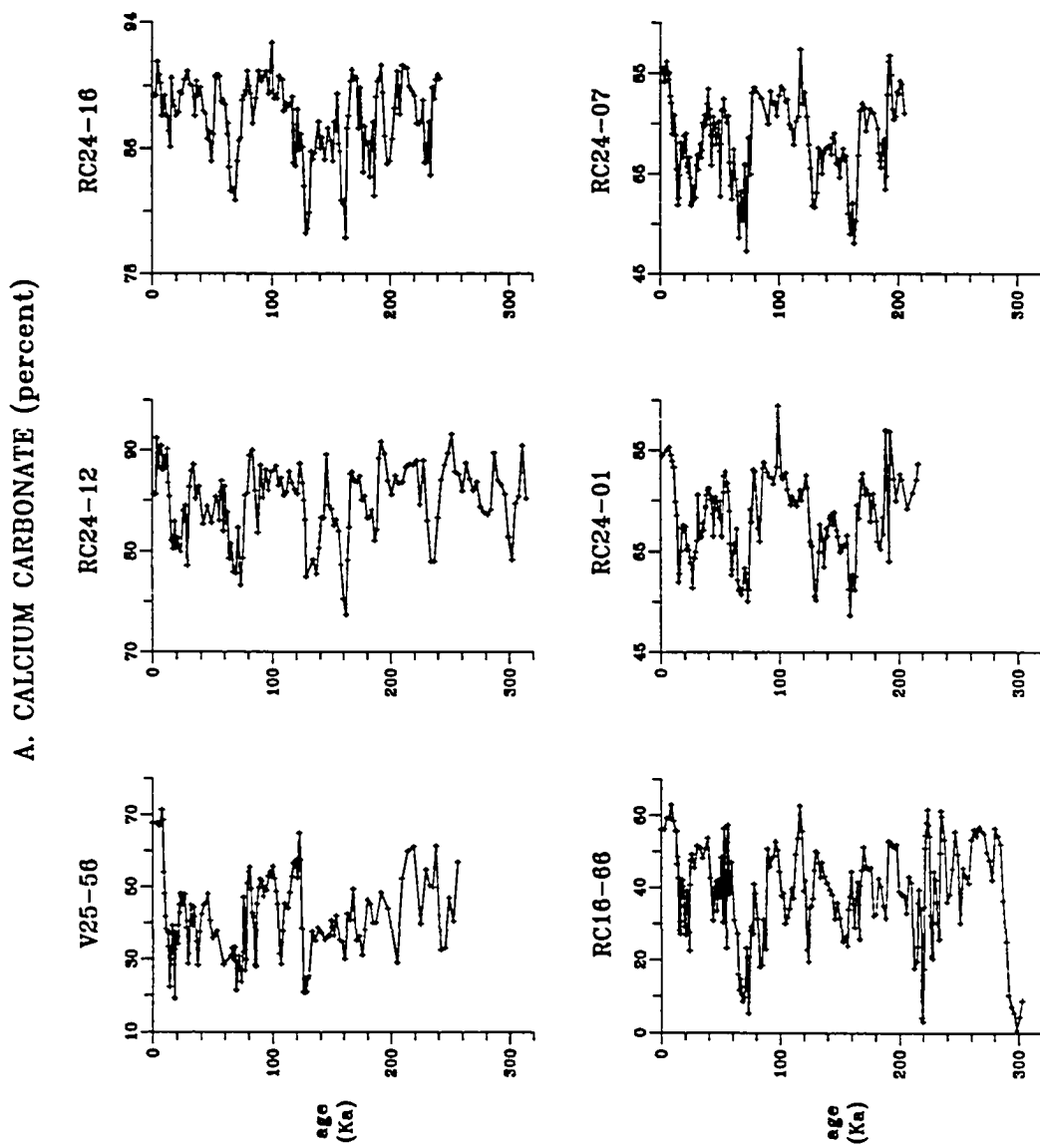


Figure 6

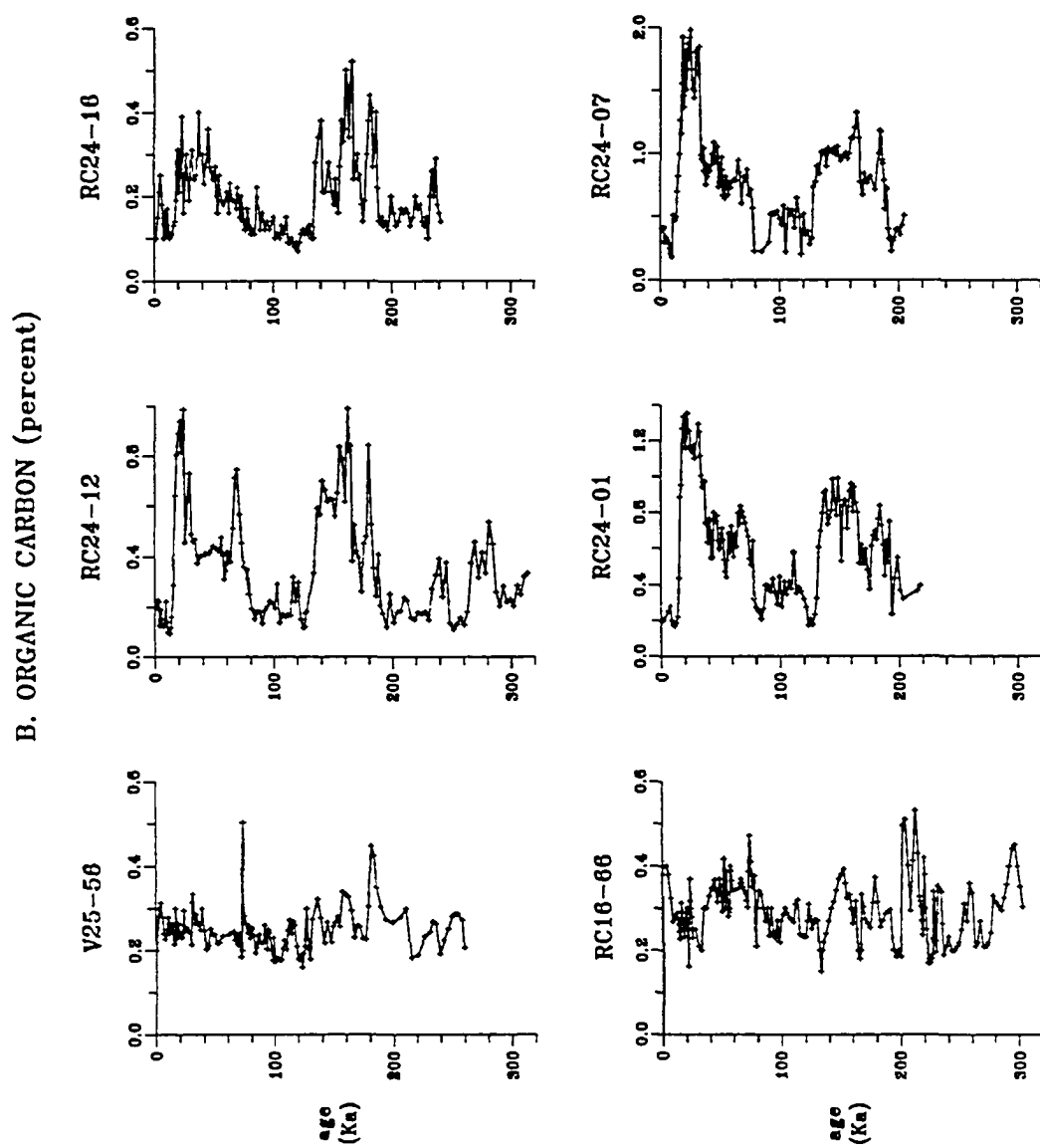


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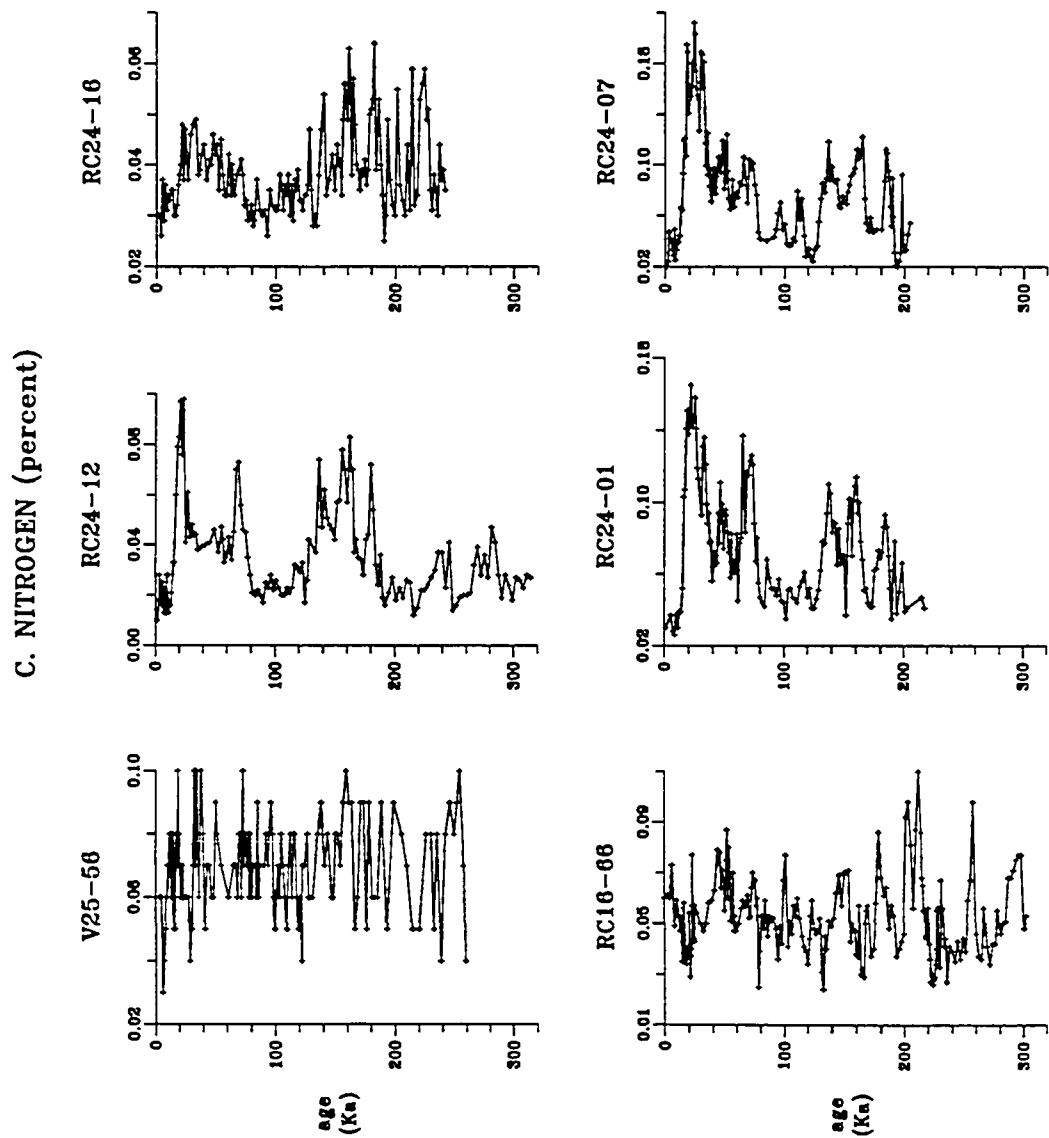


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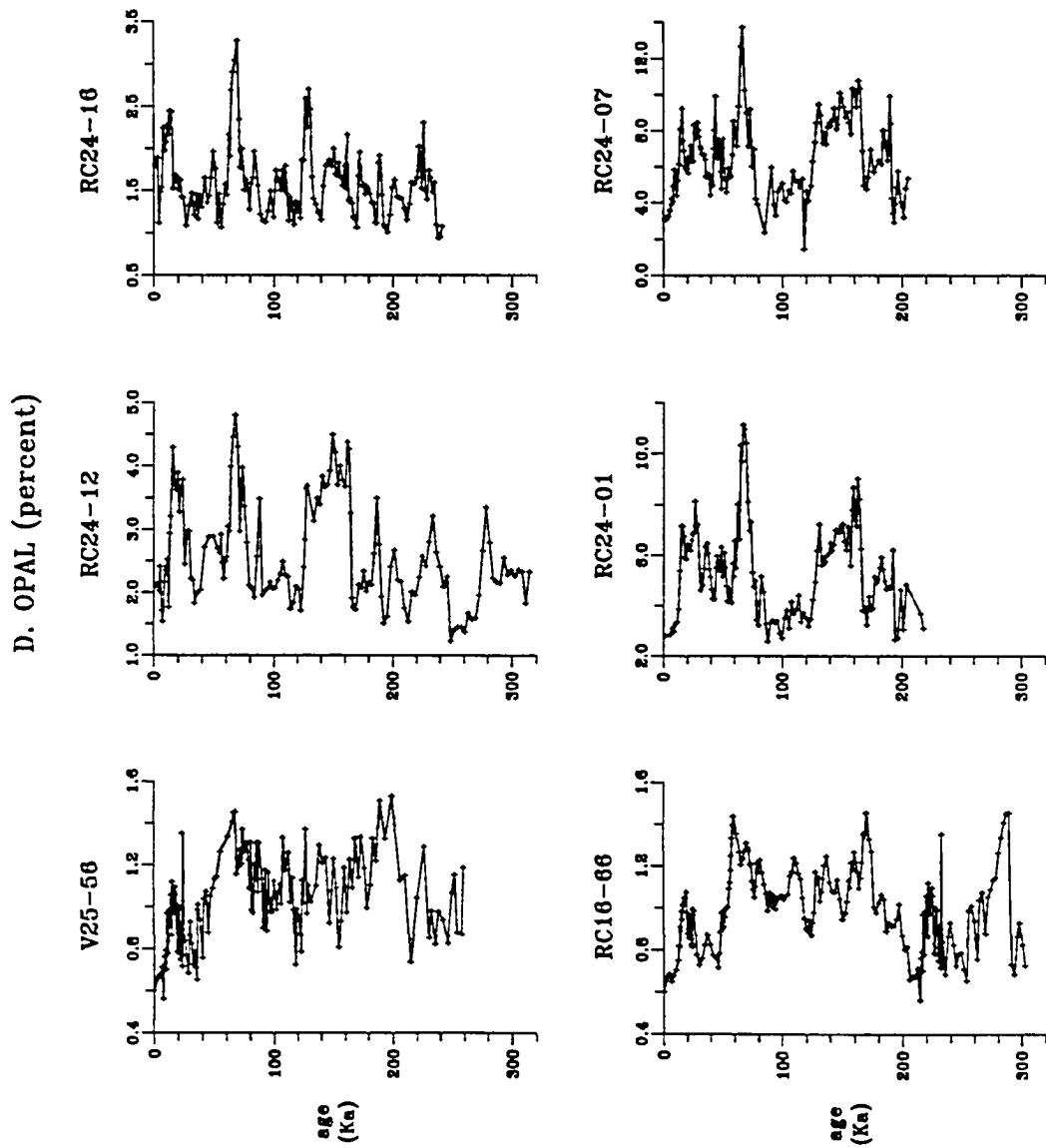


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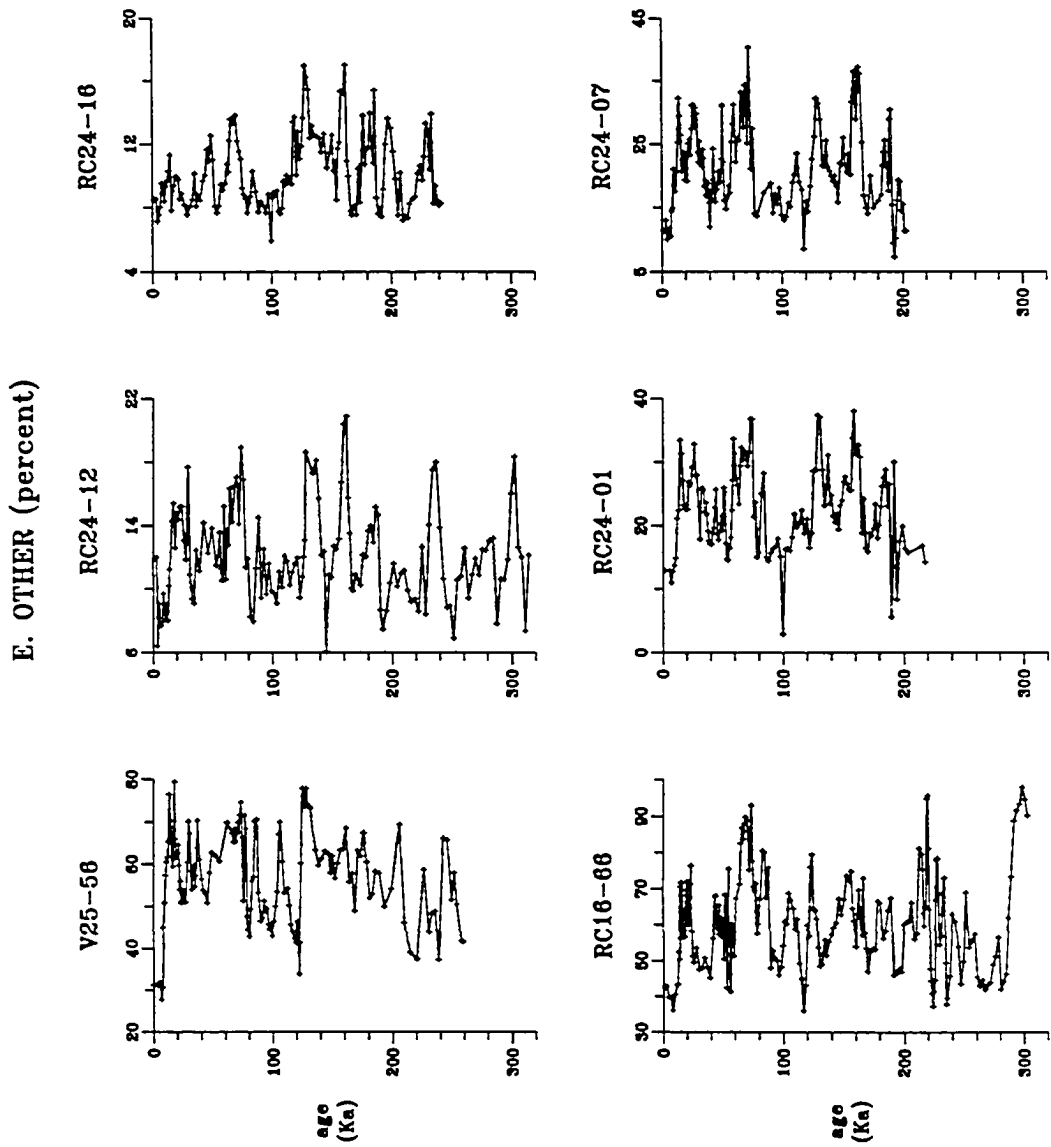


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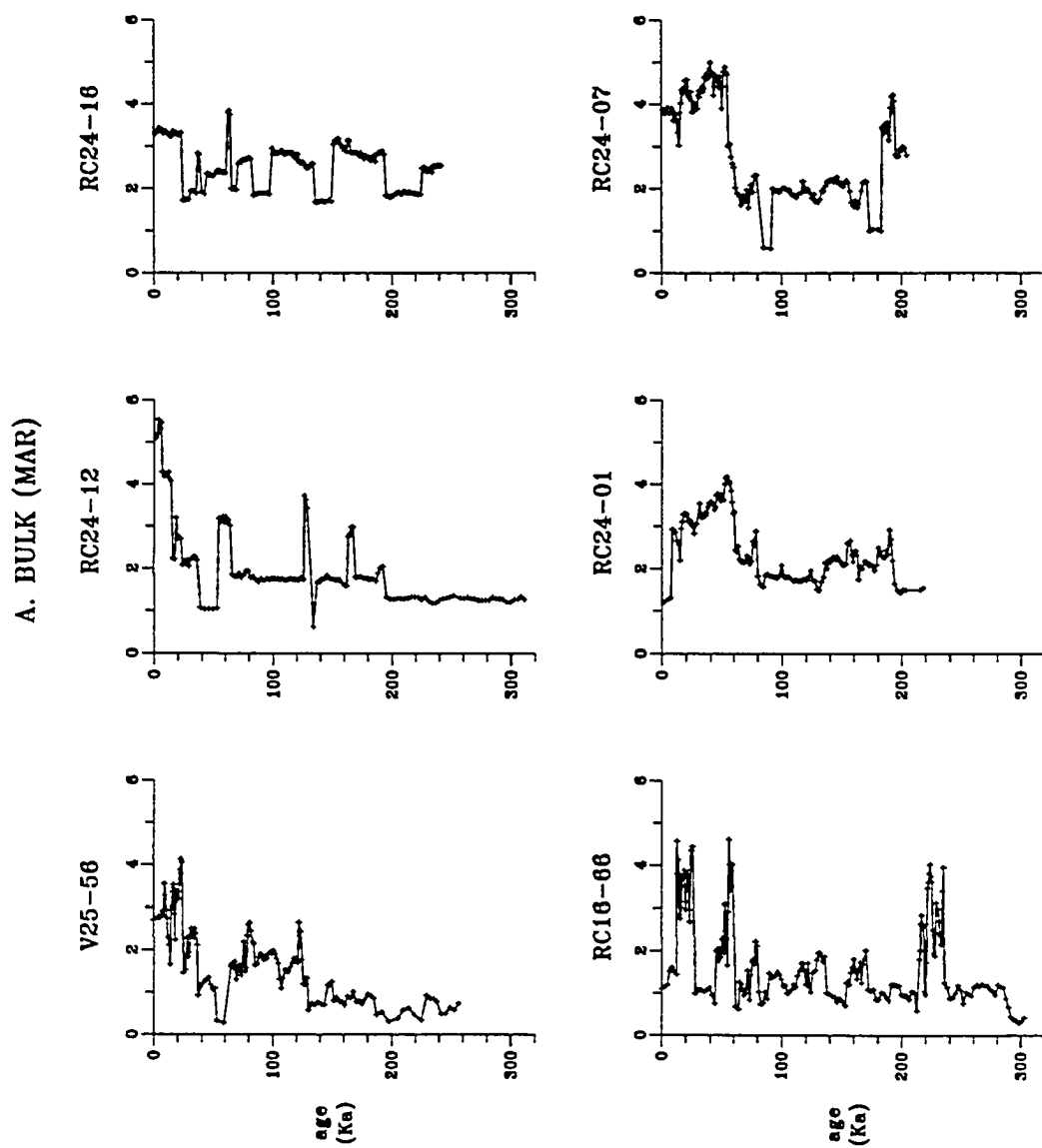


Figure 7

B. CALCIUM CARBONATE (MAR)

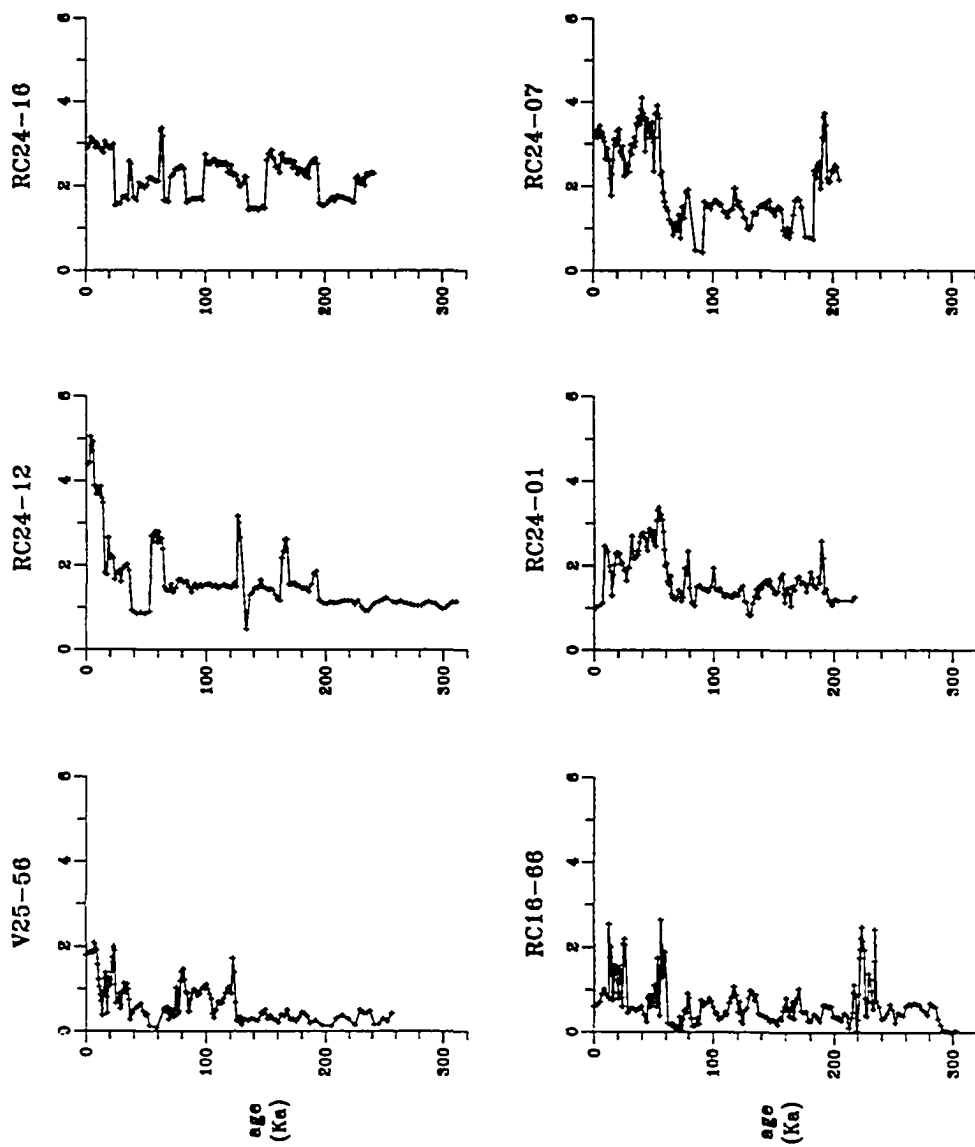


Figure 7 (contd)

C. ORGANIC CARBON (MAR)

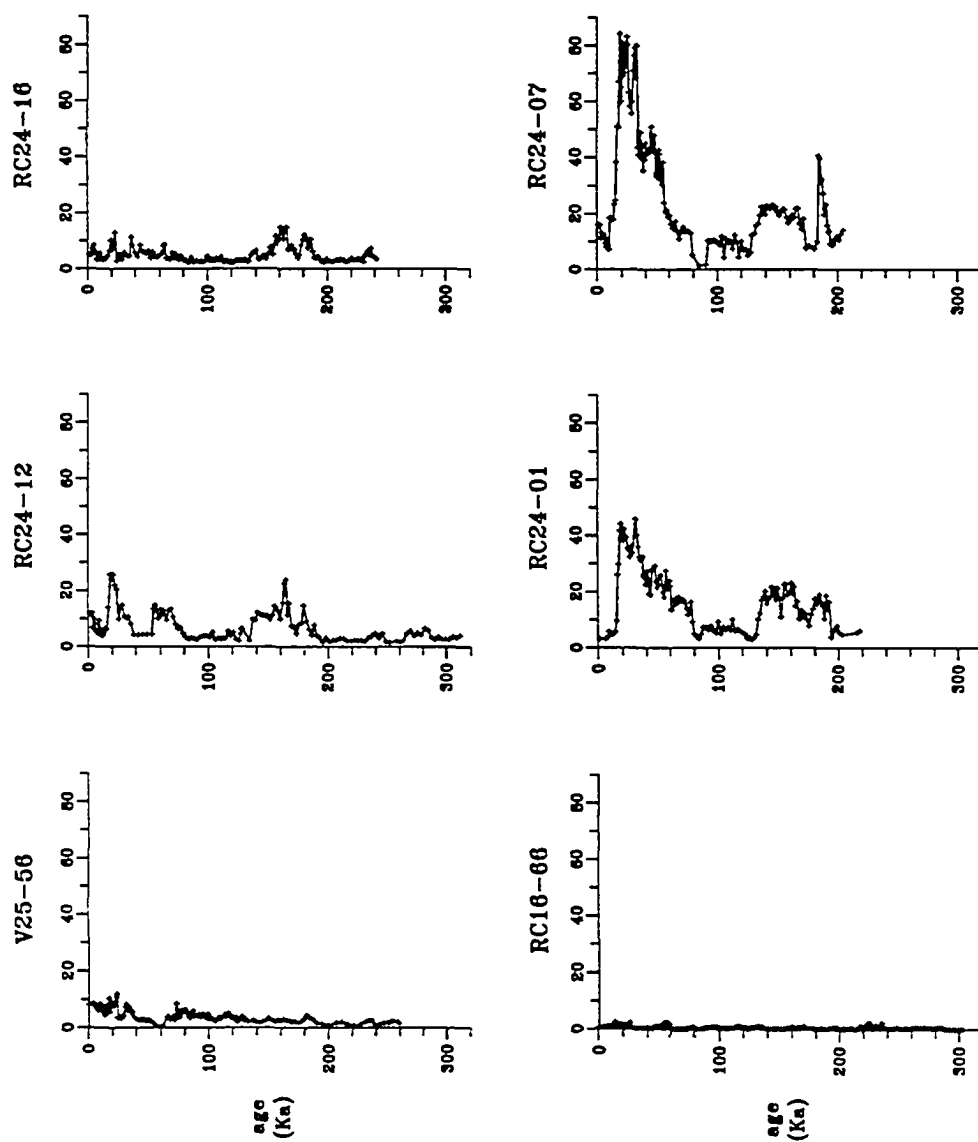


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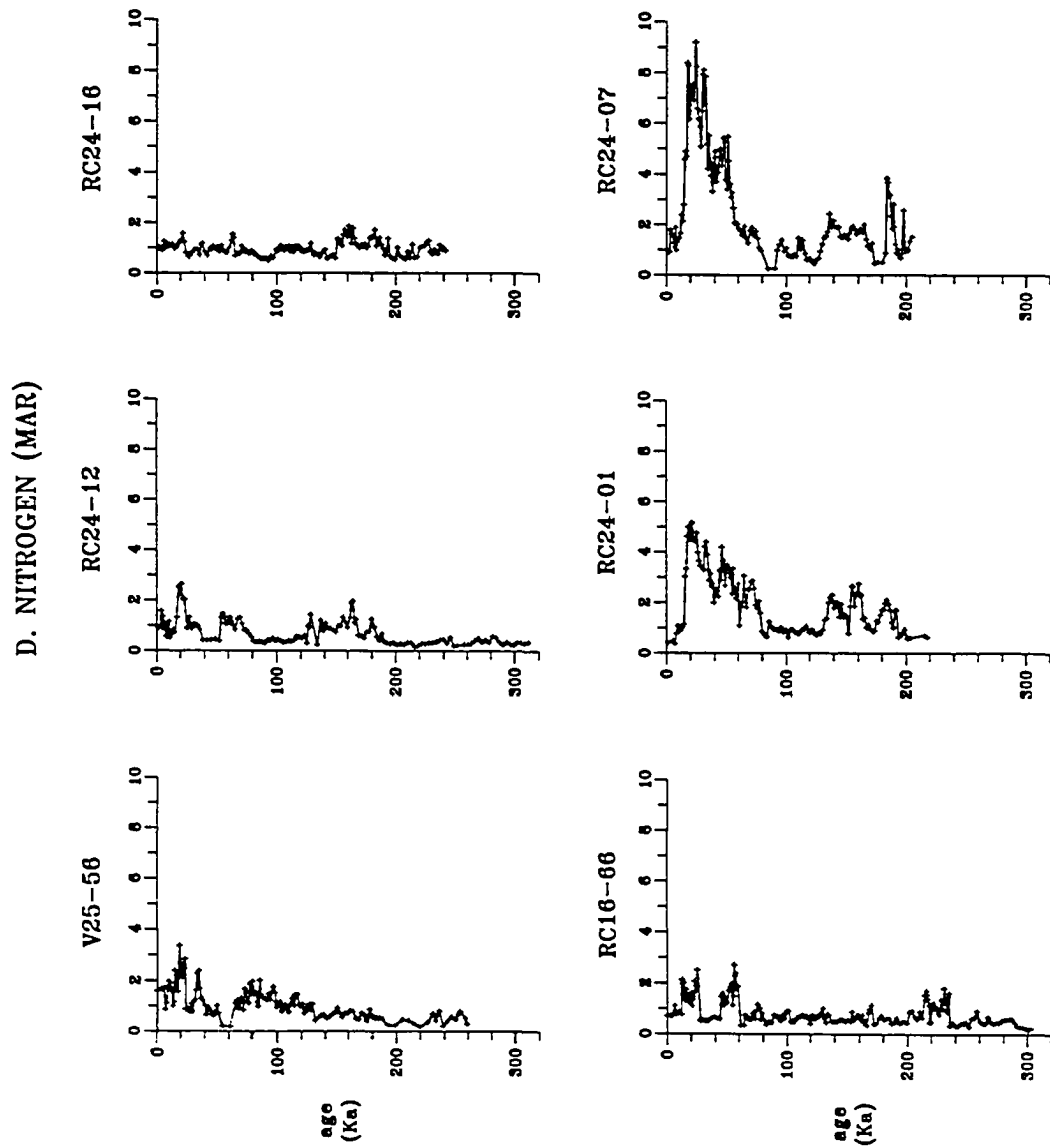


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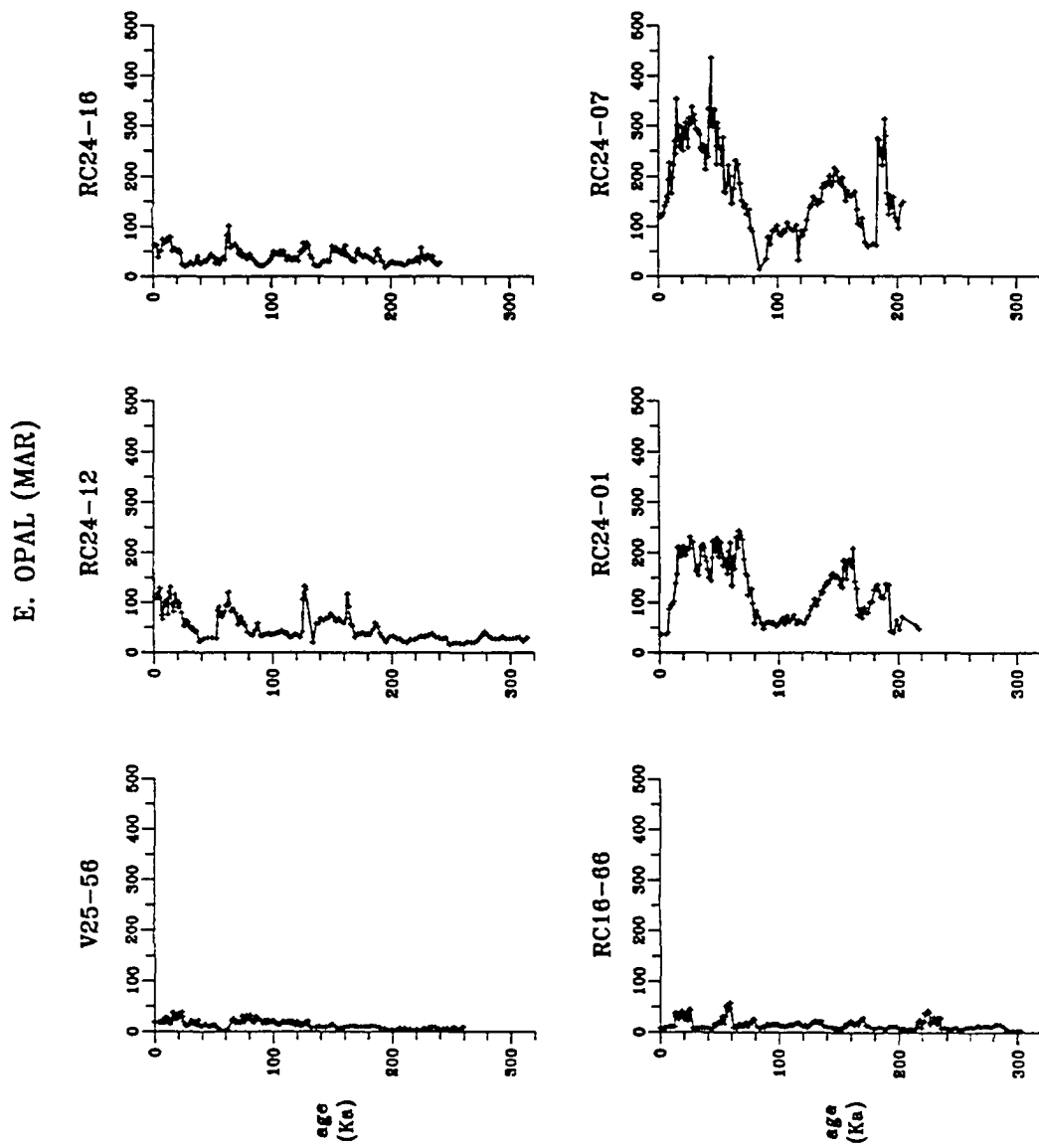


Figure 7 (contd)

F. OTHER (MAR)

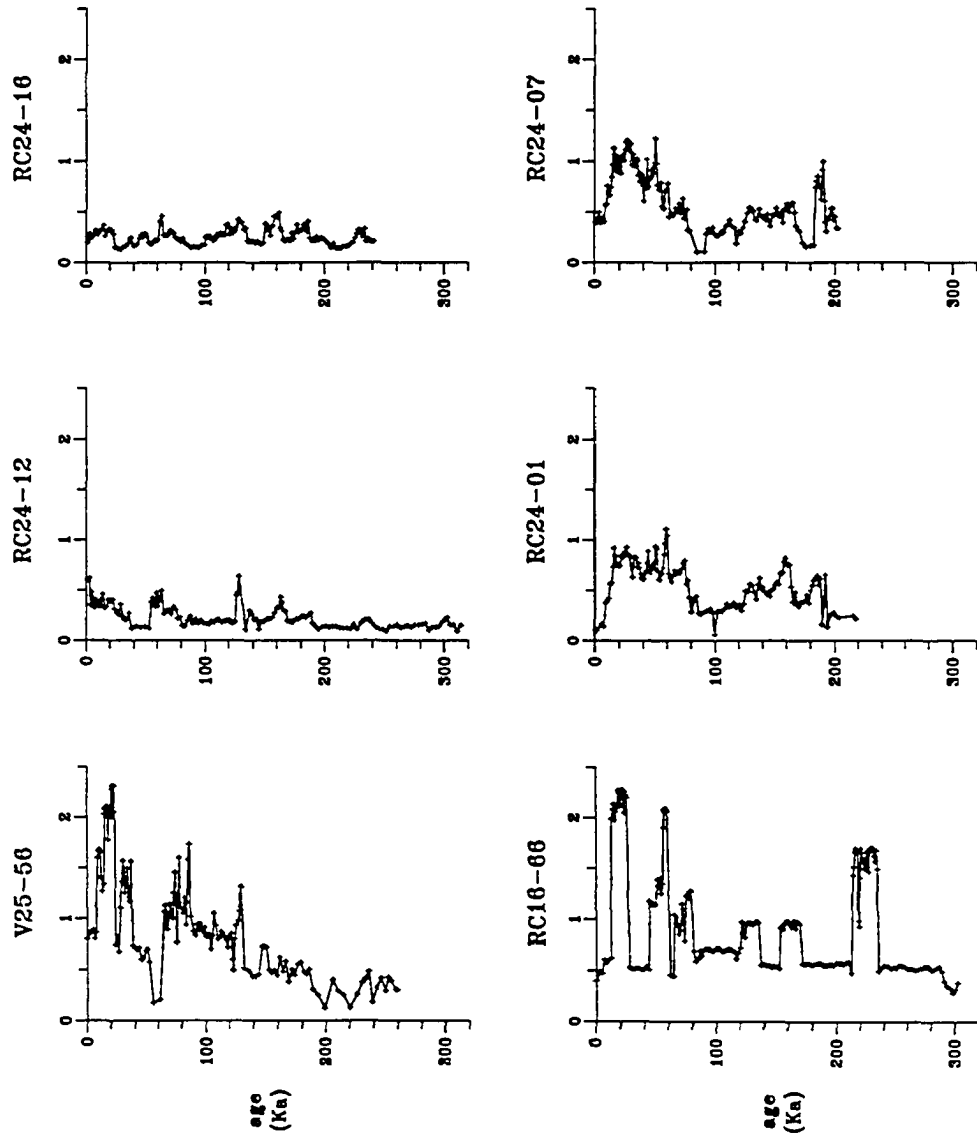


Figure 7 (contd)

A. CALCIUM CARBONATE (PERCENT)

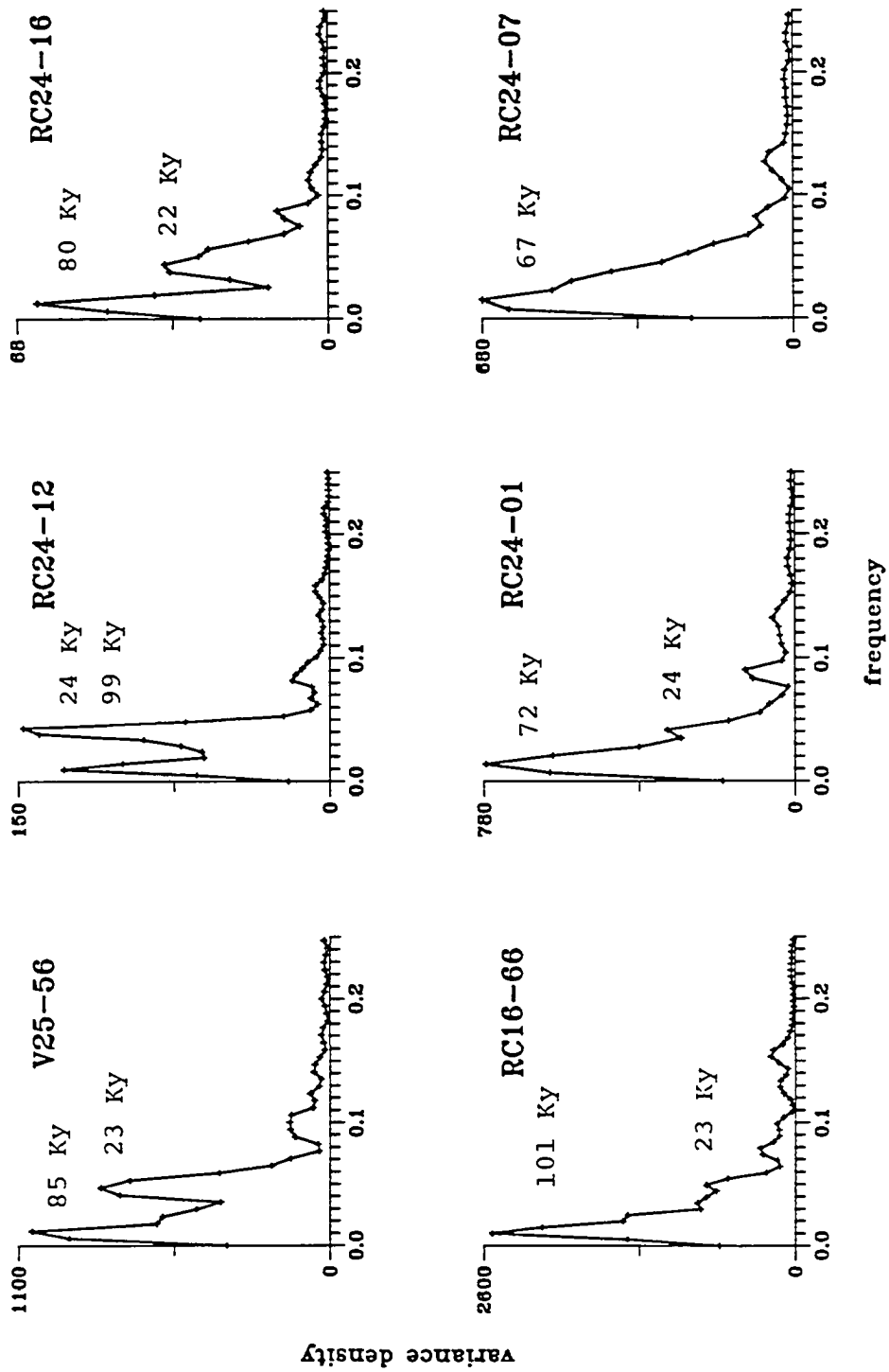


Figure 8

B. ORGANIC CARBON (PERCENT)

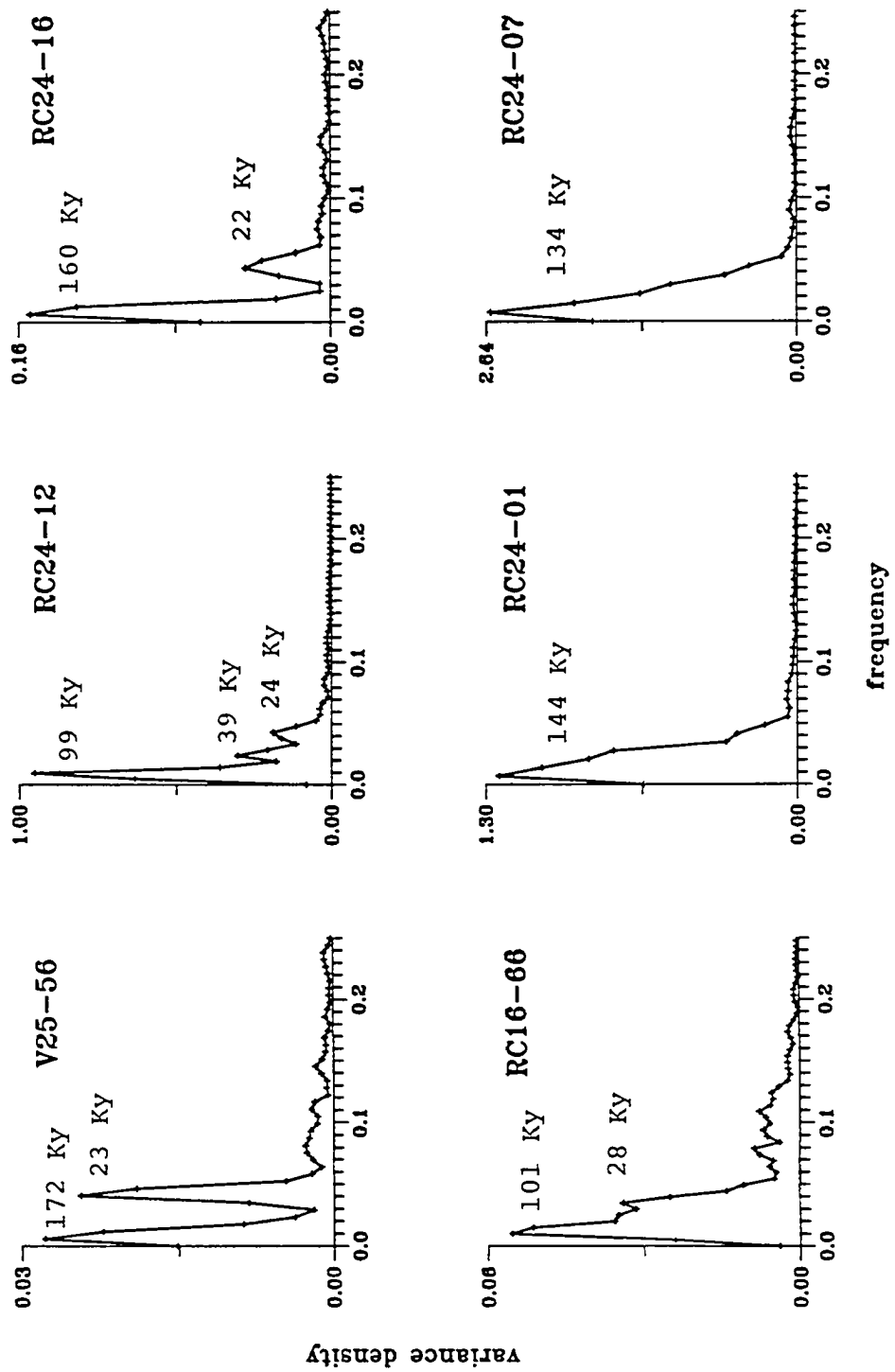


Figure 8 (contd)

C. NITROGEN (PERCENT)

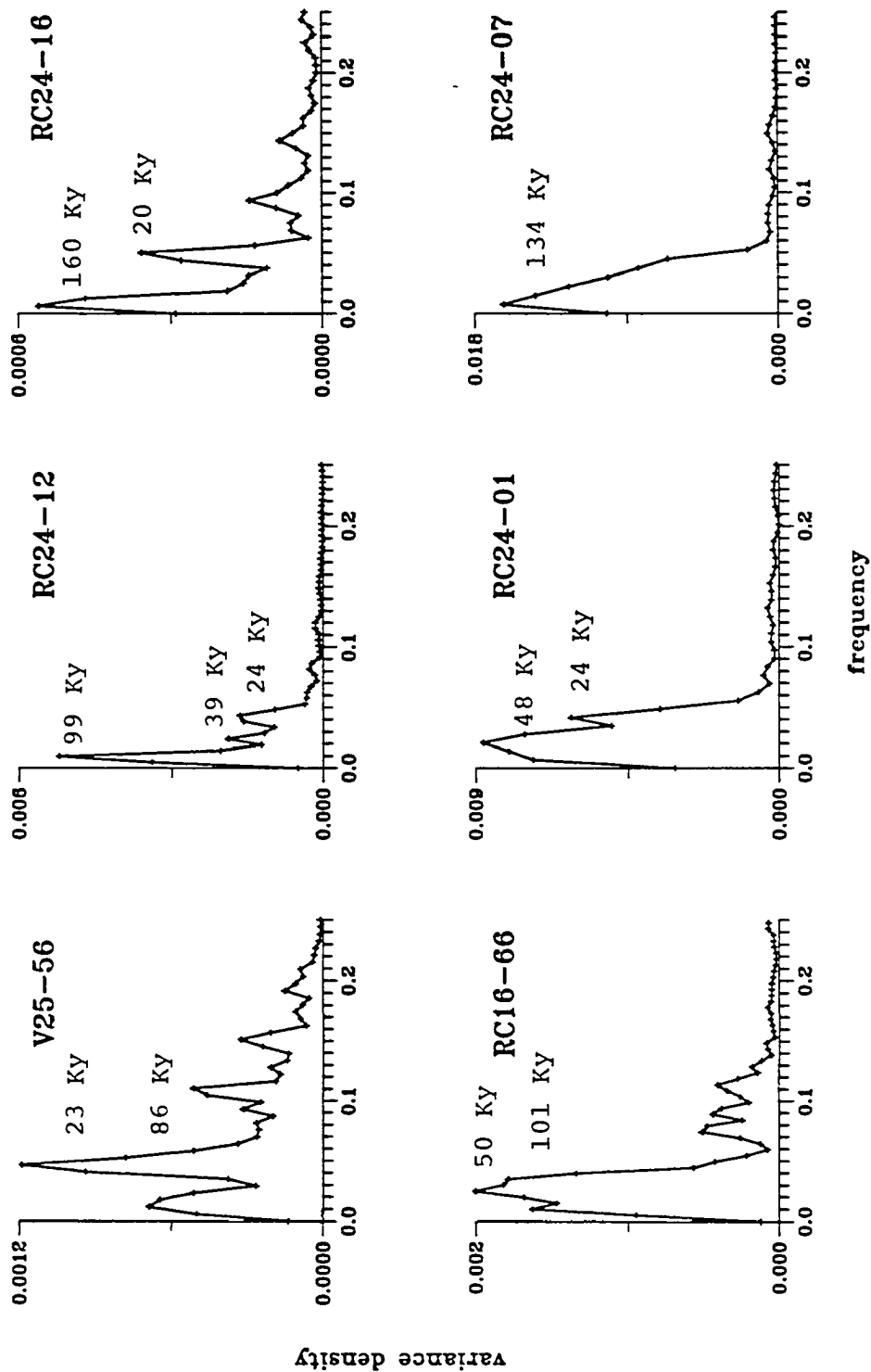


Figure 8 (contd)

D. OPAL (PERCENT)

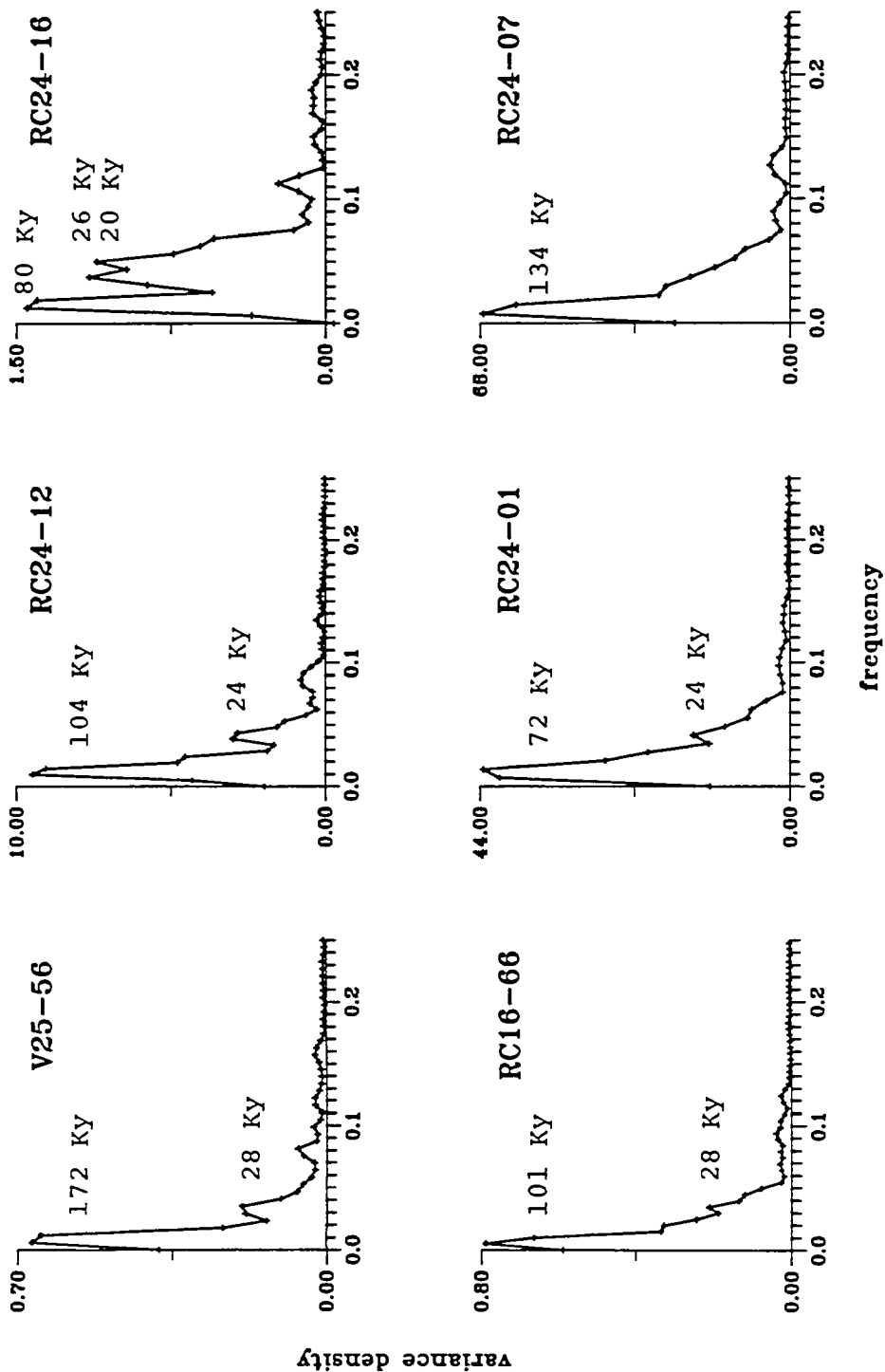


Figure 8 (contd)

E. OTHER (percent)

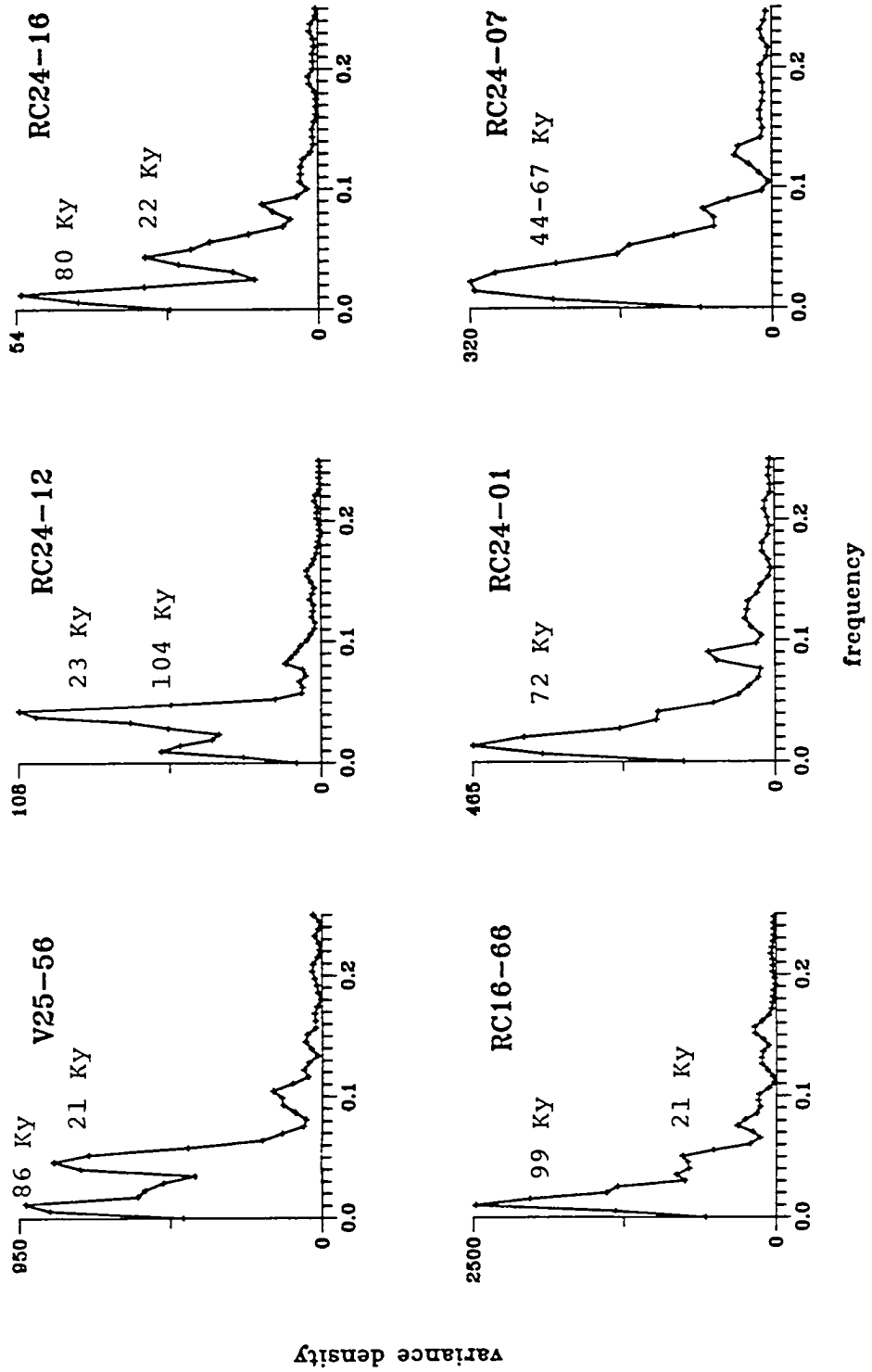
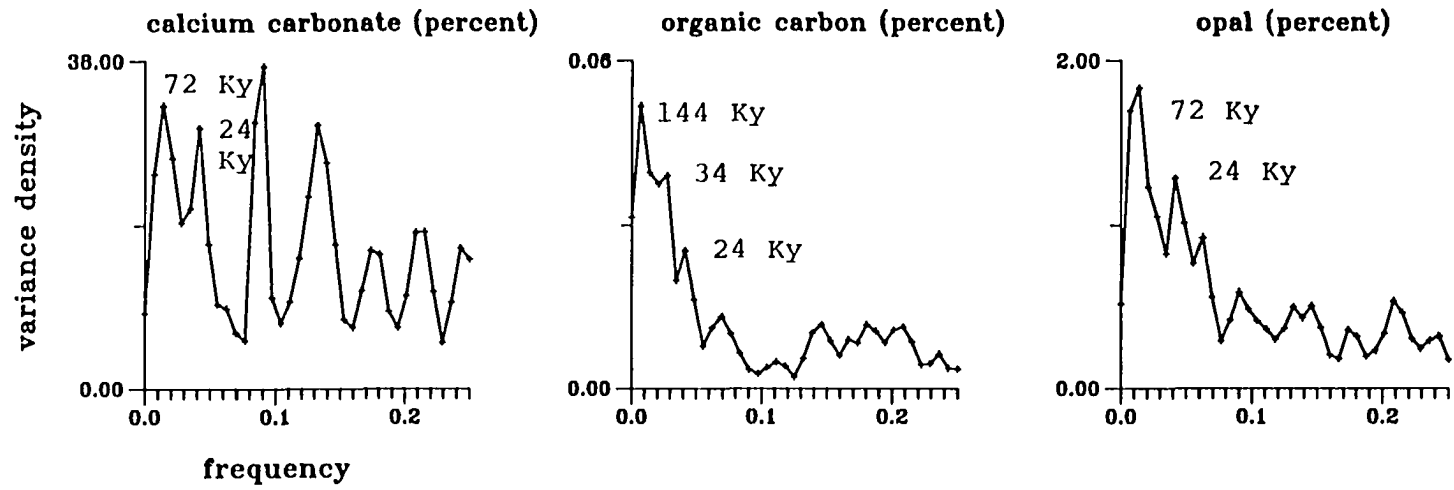


Figure 8 (contd)

RC24-01 PREWHITENED SPECTRA (k=0.80)

Figure 9



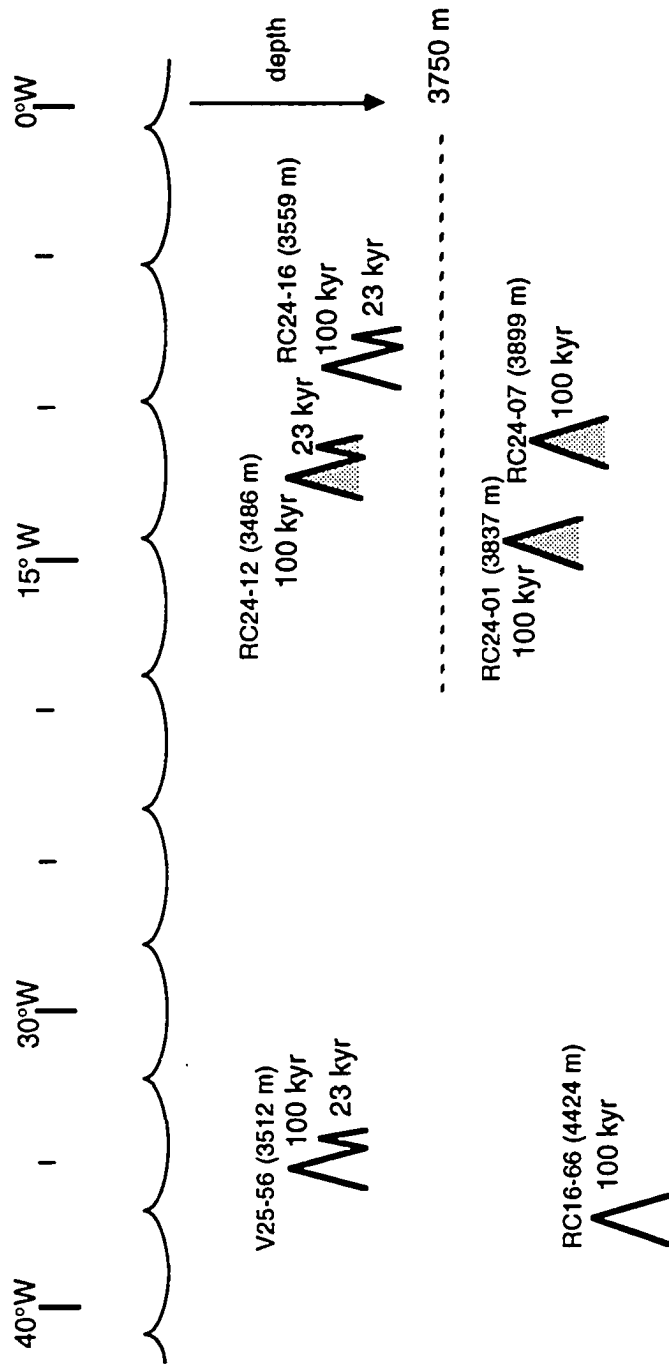


Figure 10

A. BULK (MAR)

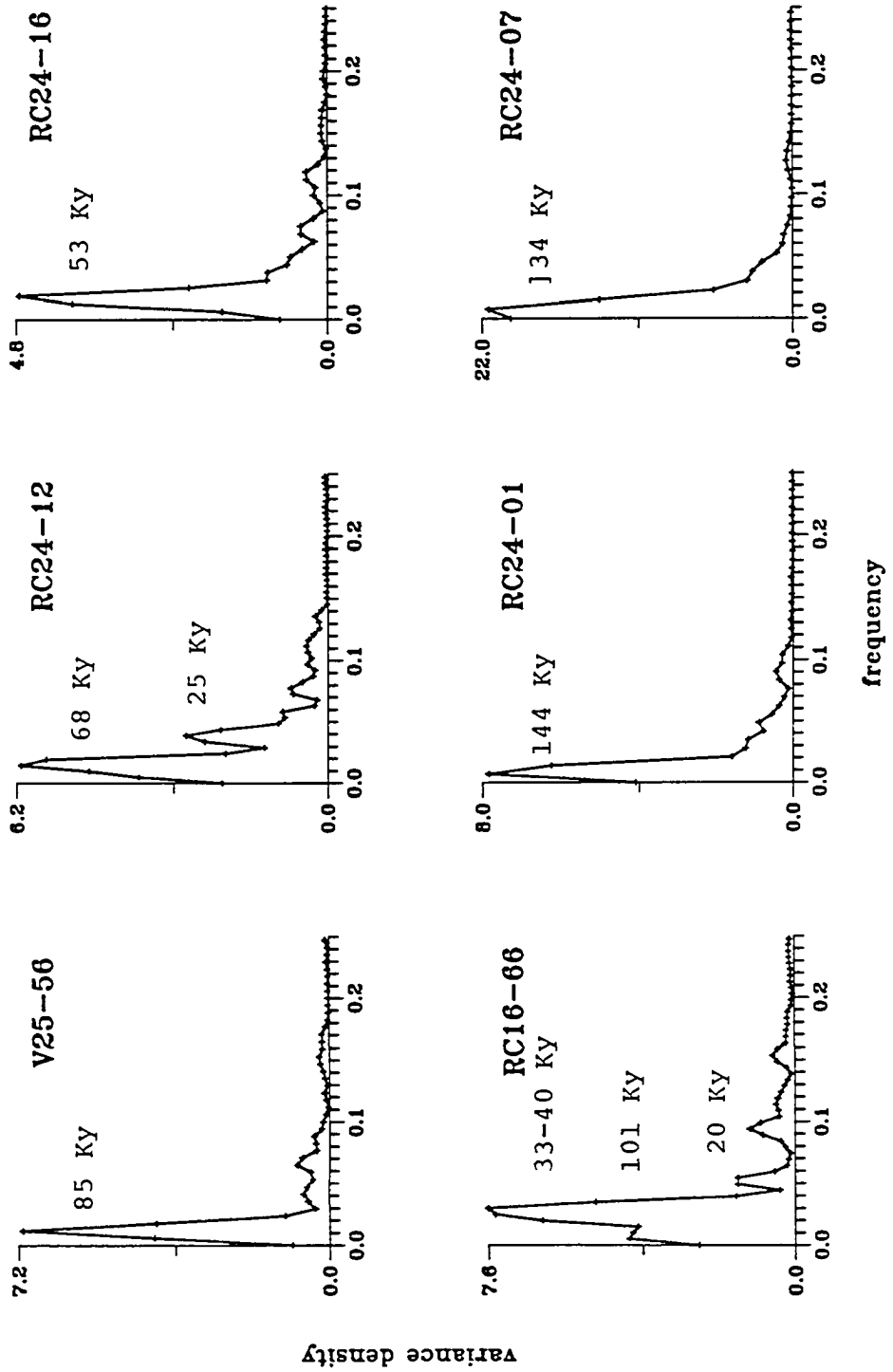


Figure 11

B. CALCIUM CARBONATE (MAR)

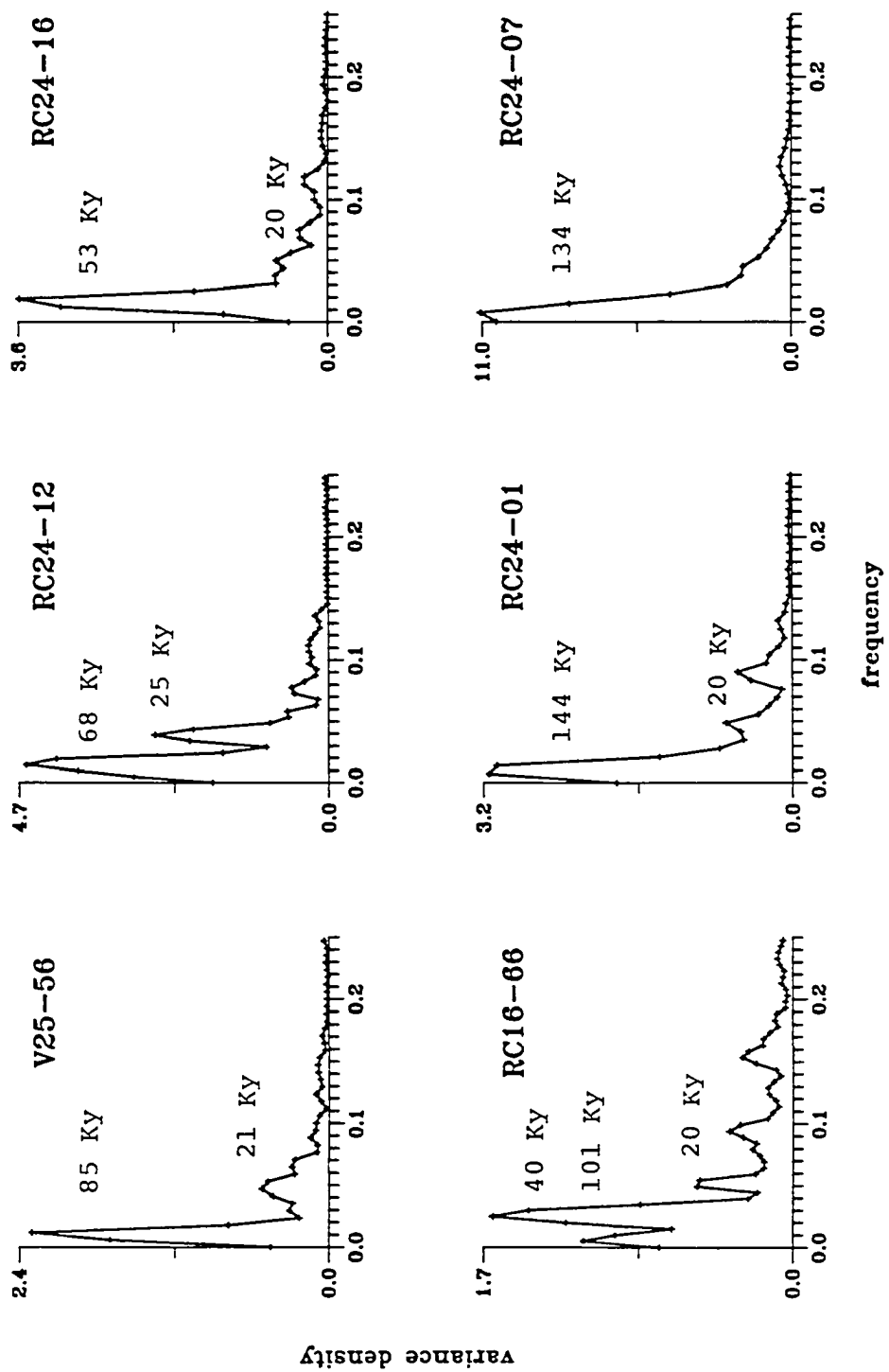


Figure 11 (contd)

C. ORGANIC CARBON (MAR)

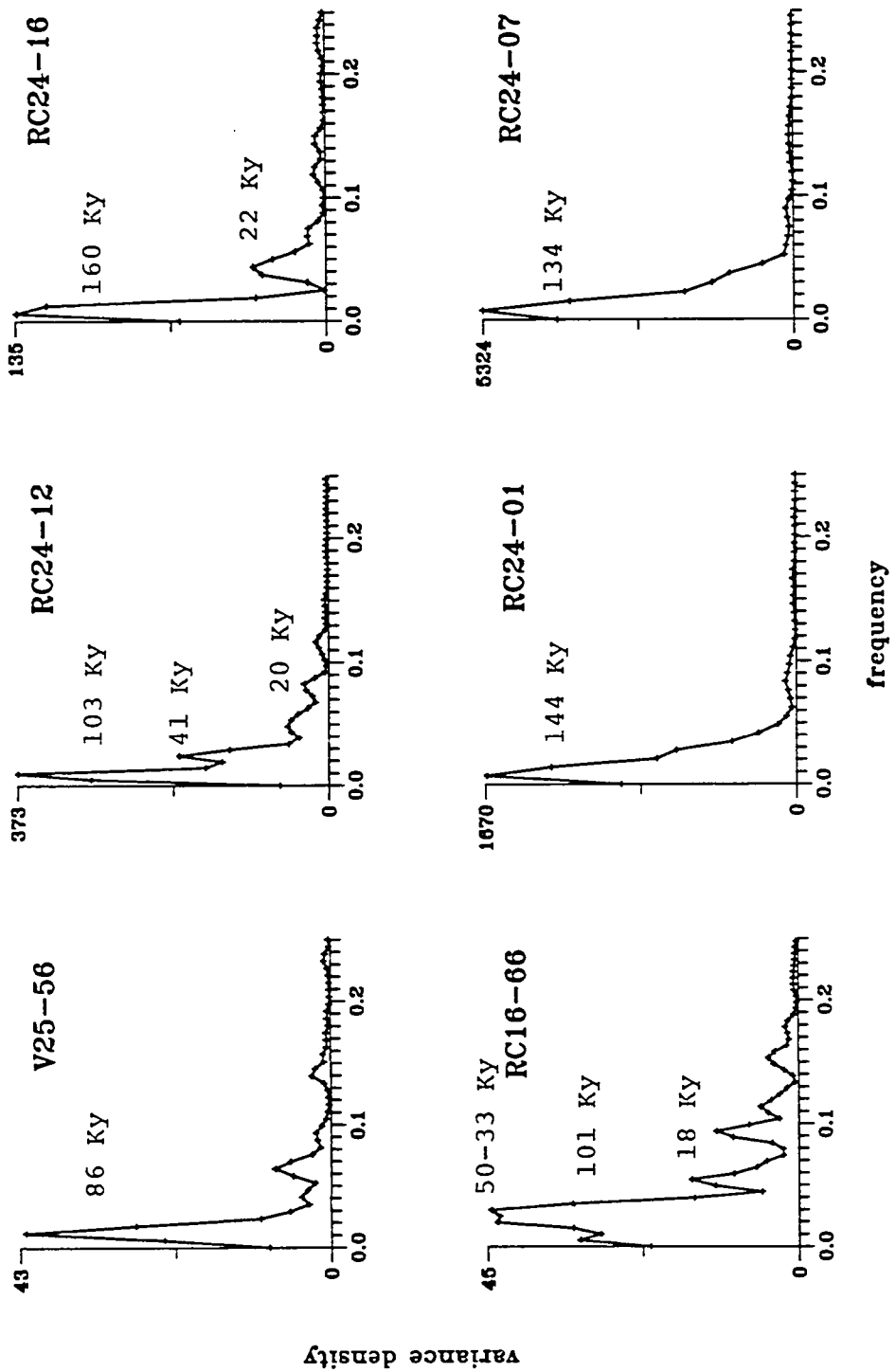


Figure 11 (contd)

D. NITROGEN (MAR)

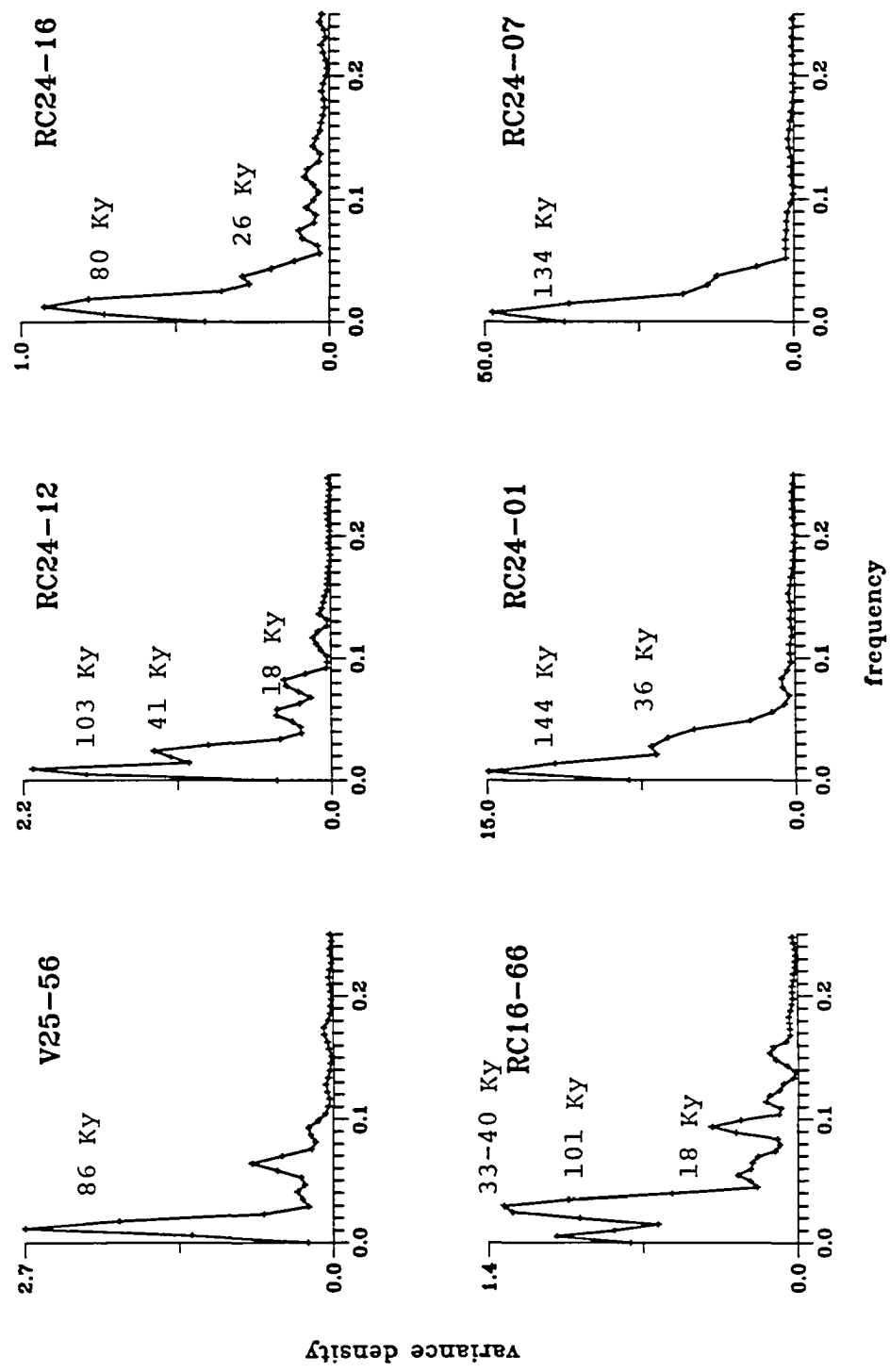
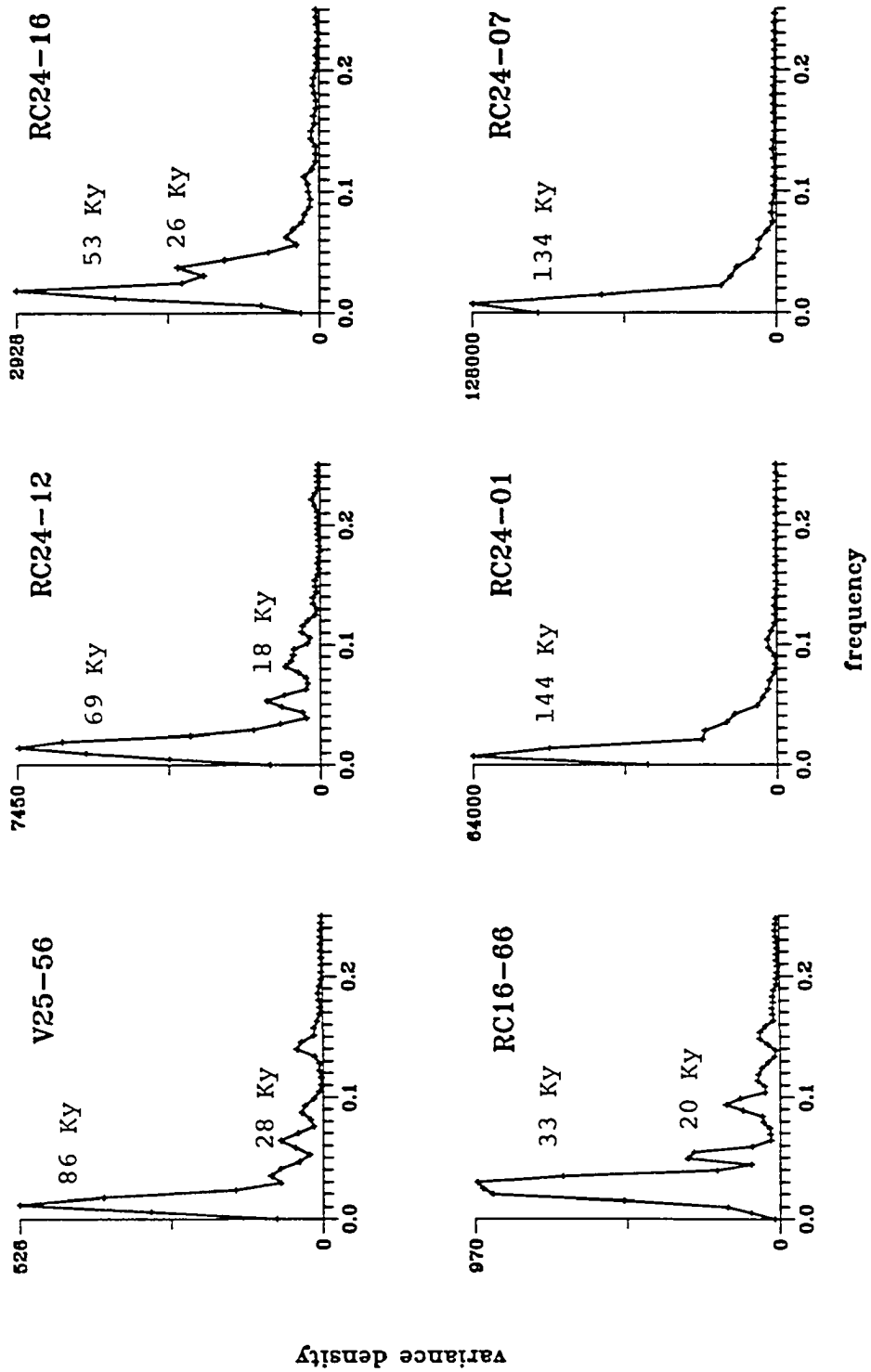


Figure 11 (contd)

E. OPAL (MAR)



variance density

Figure 11 (contd)

F. OTHER (MAR)

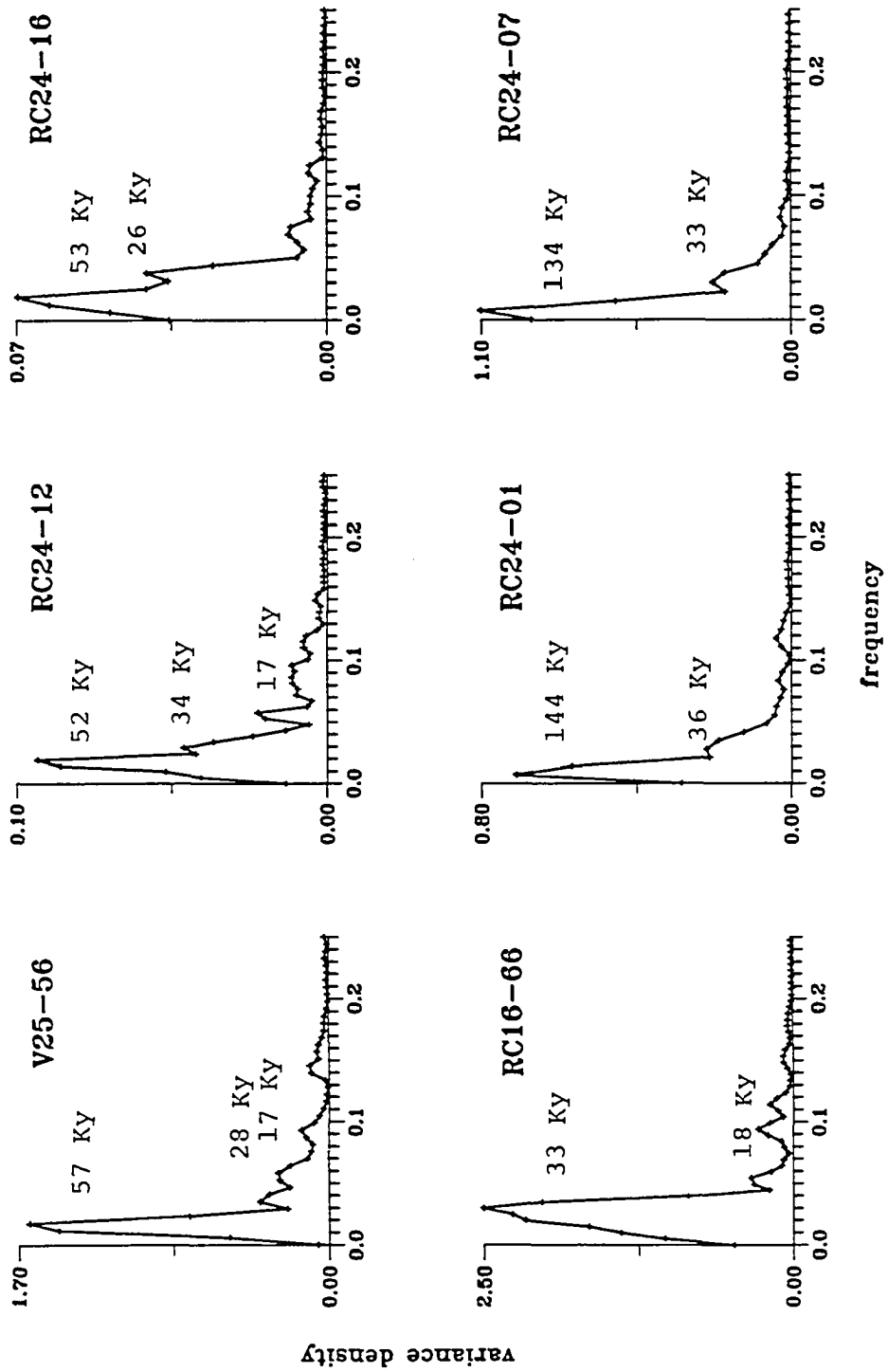


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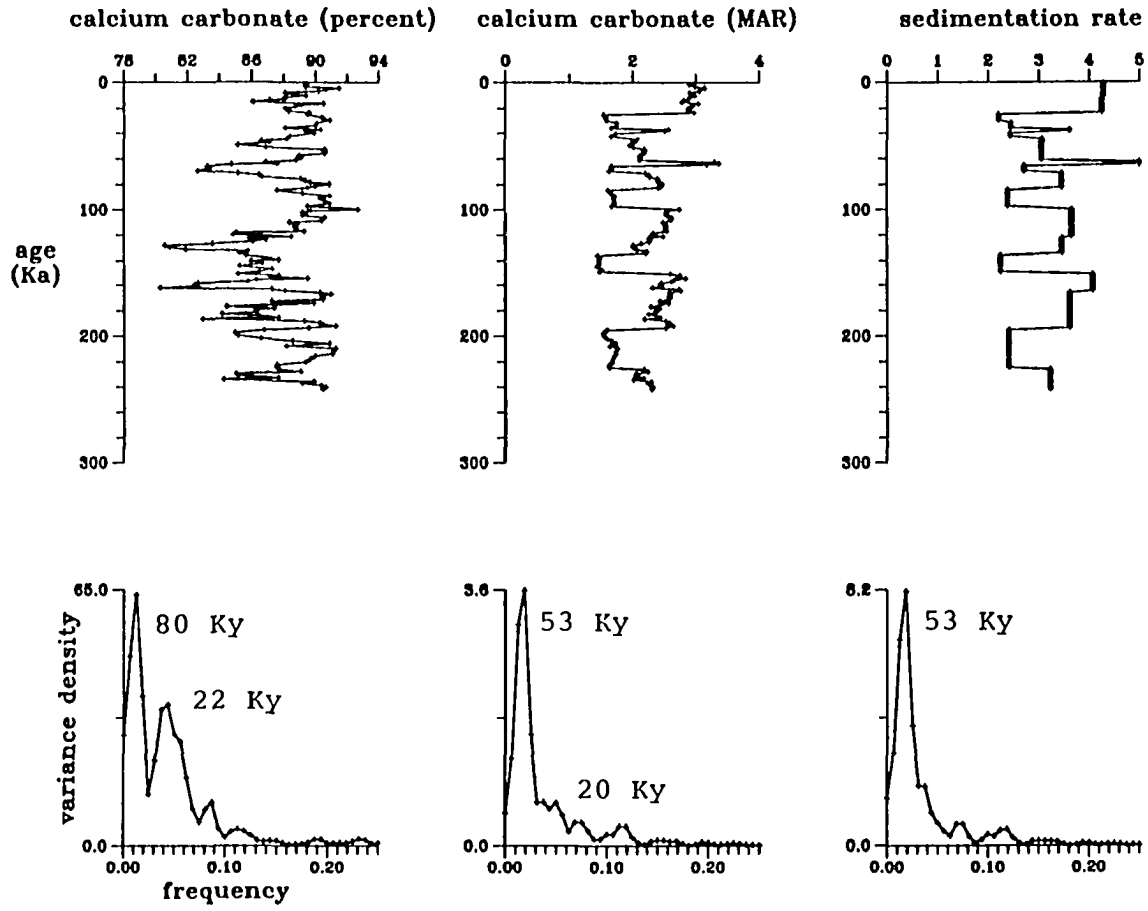


Figure 12

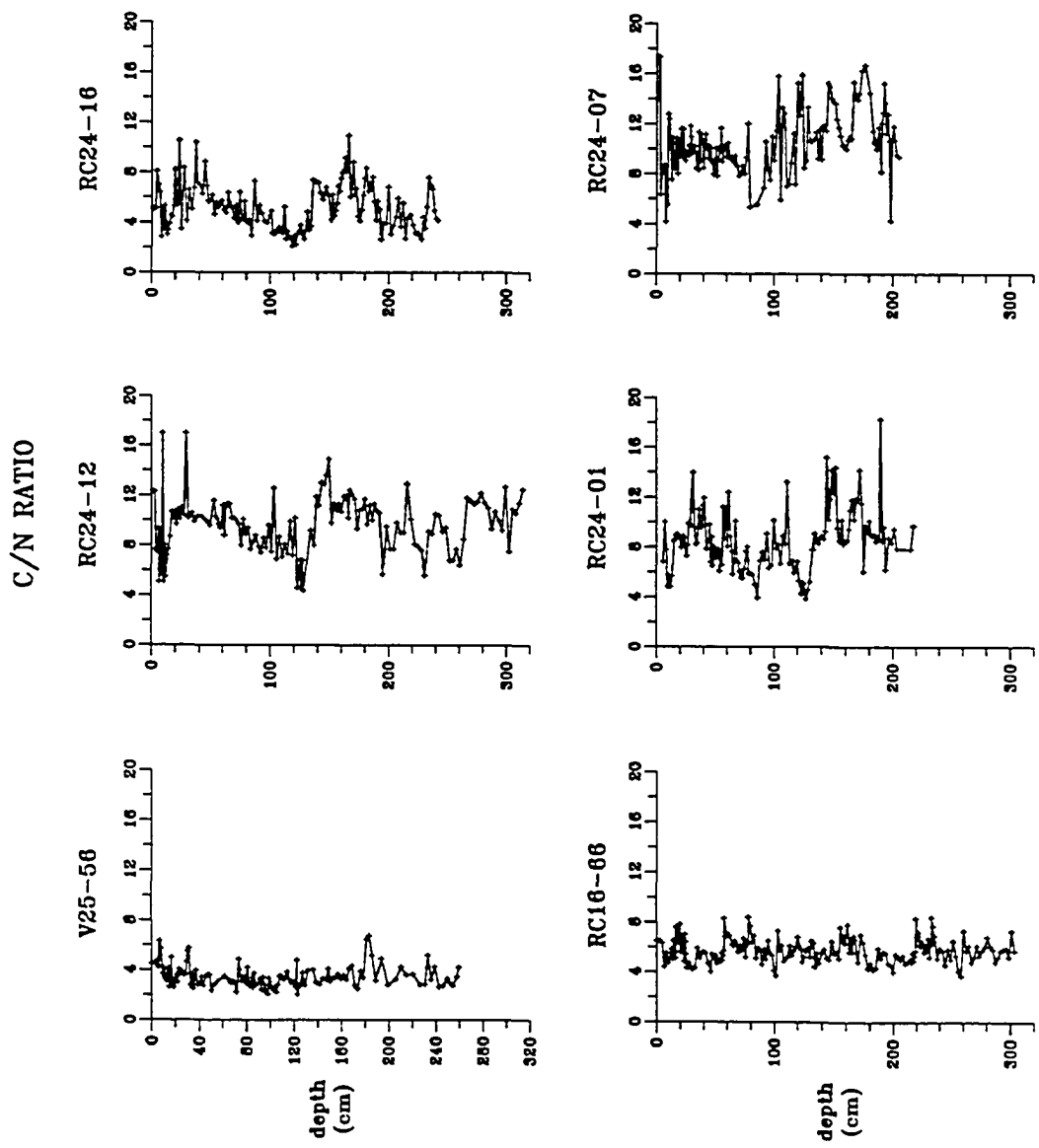


Figure 13

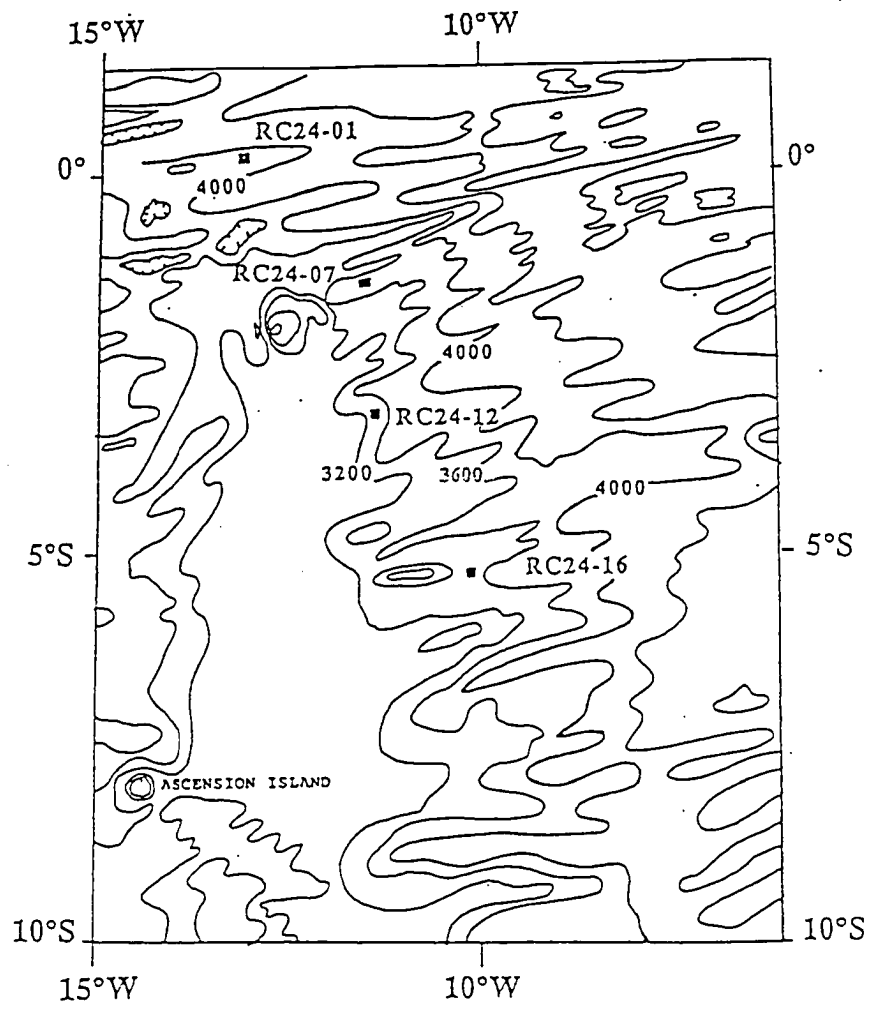


Figure 14

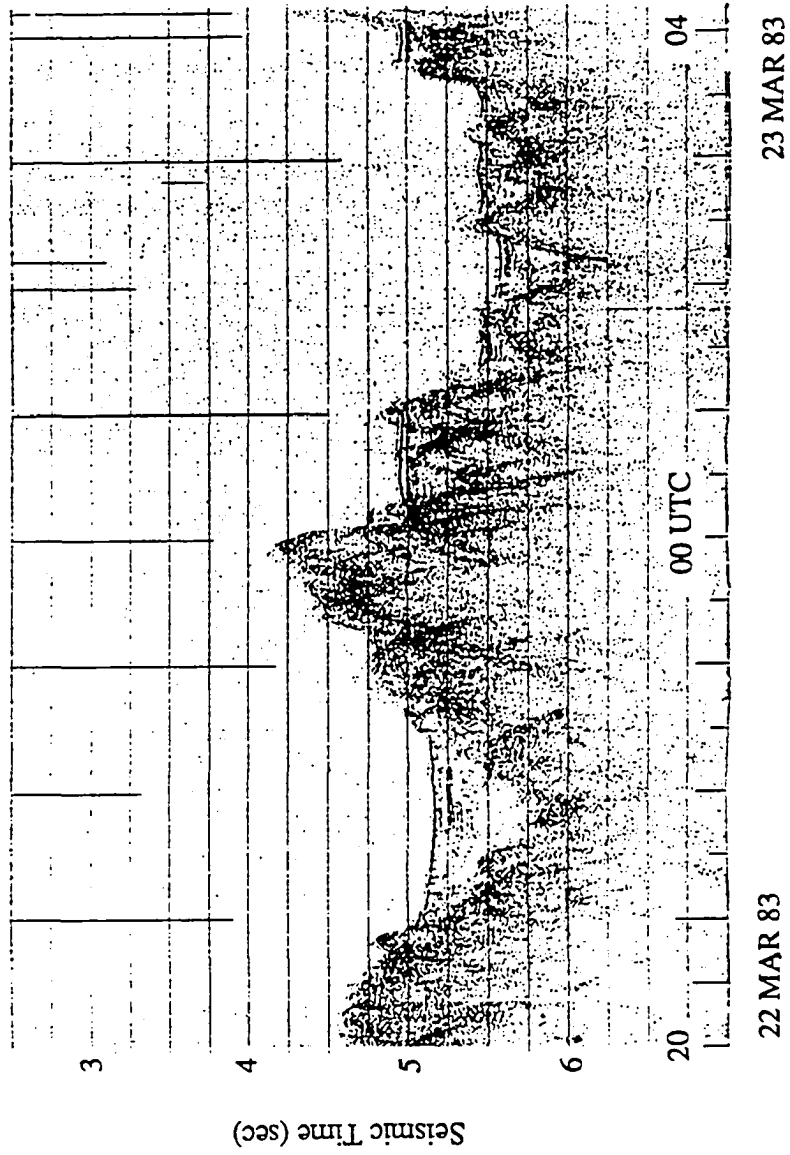


Figure 15

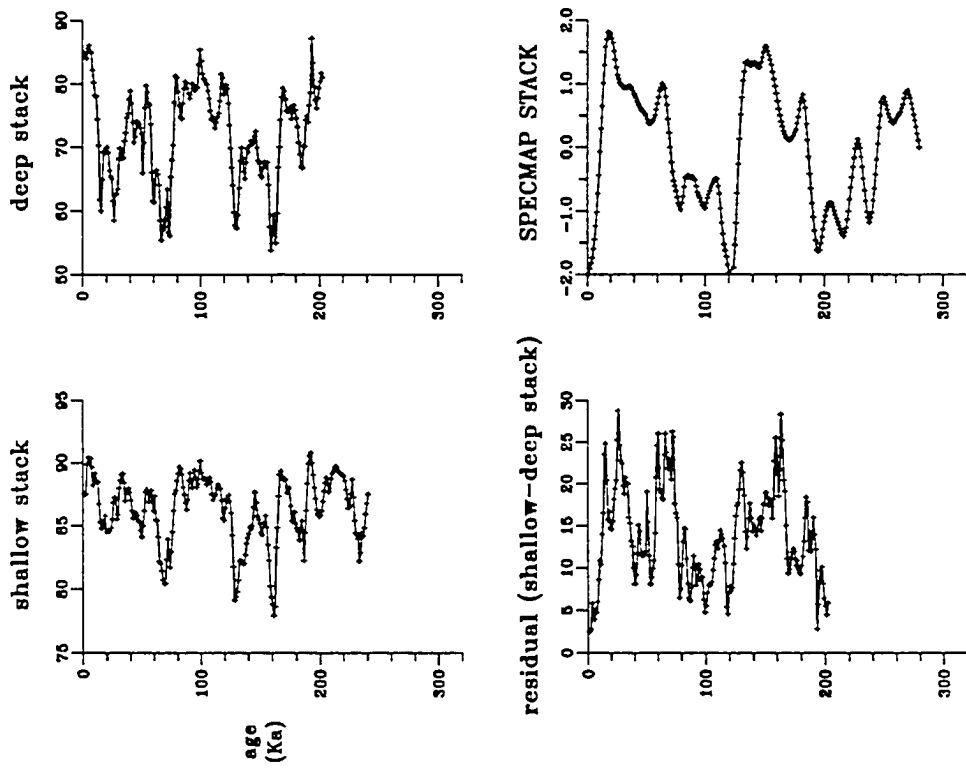
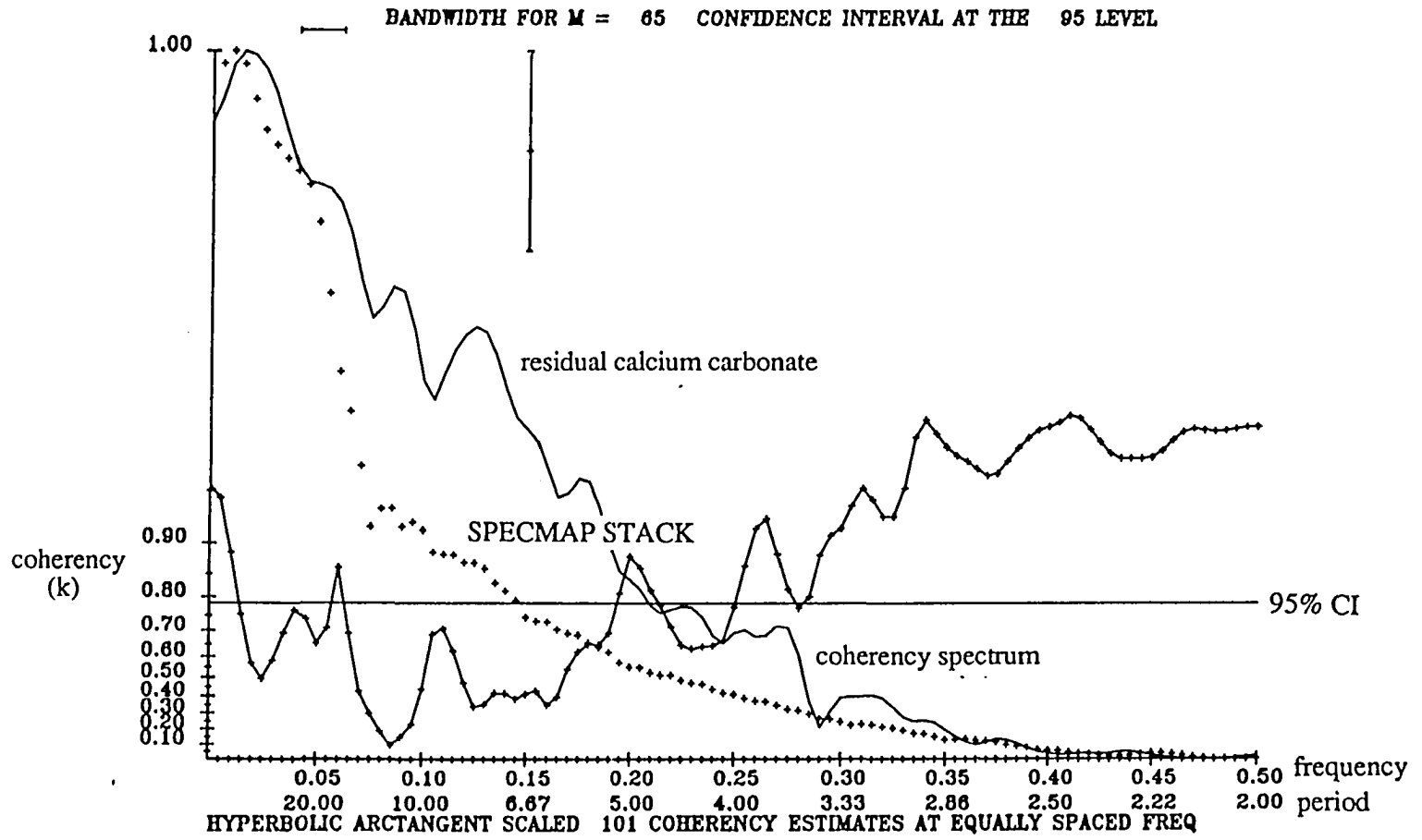


Figure 16

Figure 17



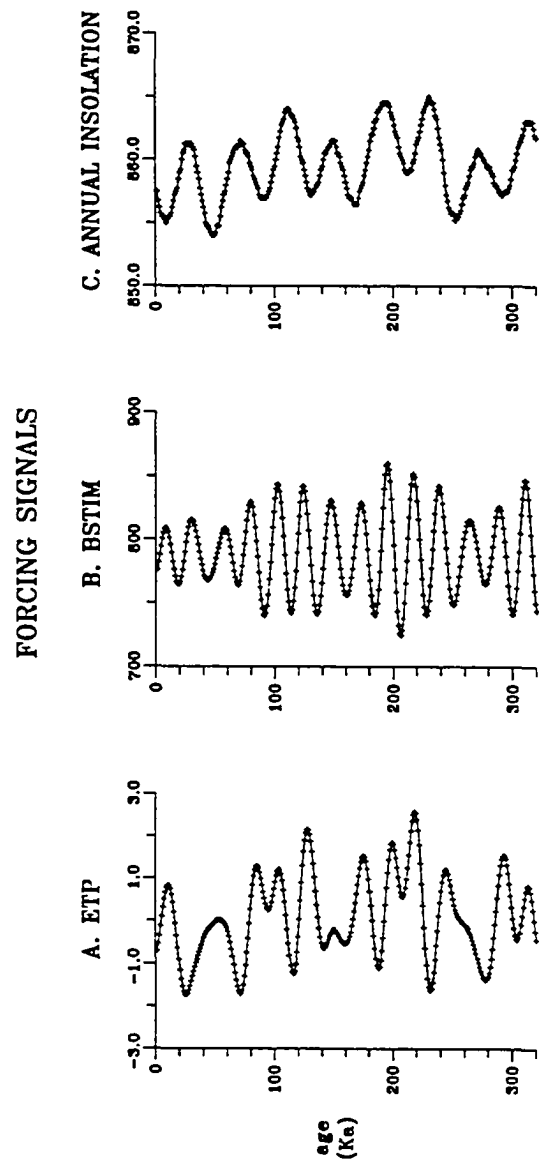
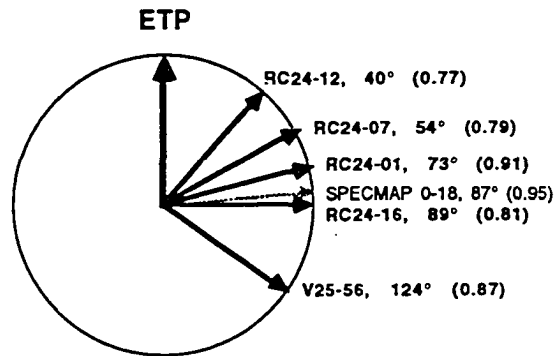


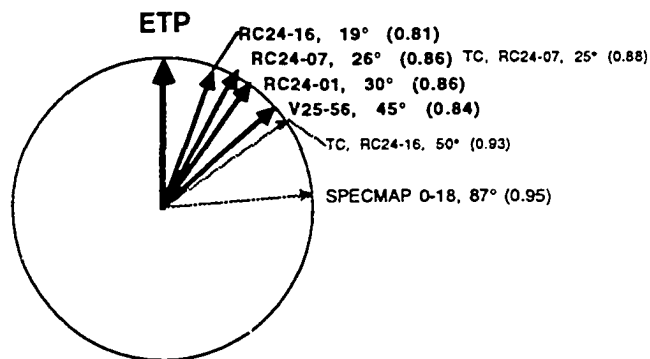
Figure 18

PRECESSION (23 Ky)

CALCIUM CARBONATE (%)



(-) ORGANIC CARBON %



(-) OPAL (%)

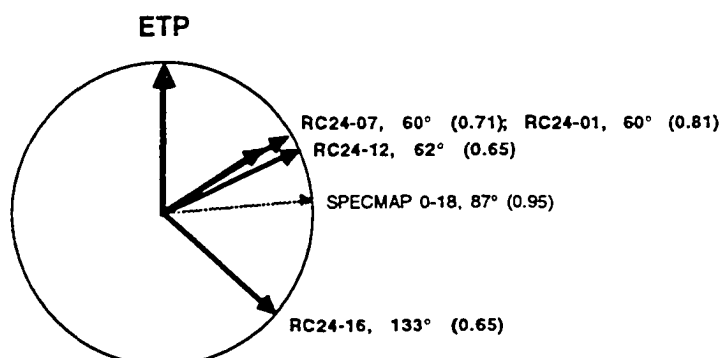
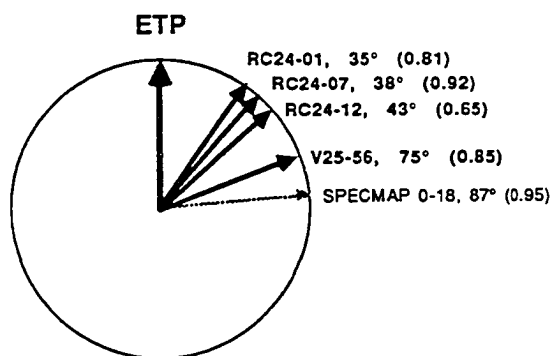


Figure 19

PRECESSION (23 kyr)

(-) NITROGEN (%)



(-) OTHER (%)

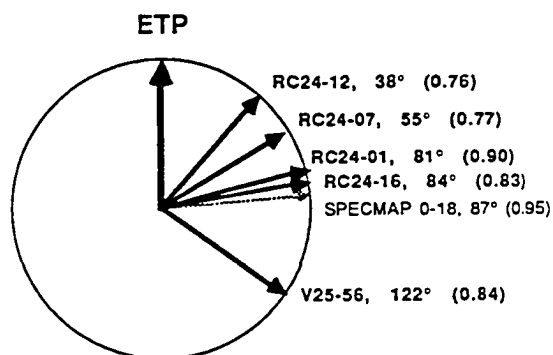
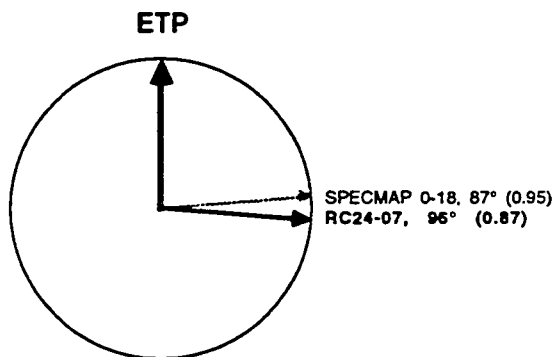


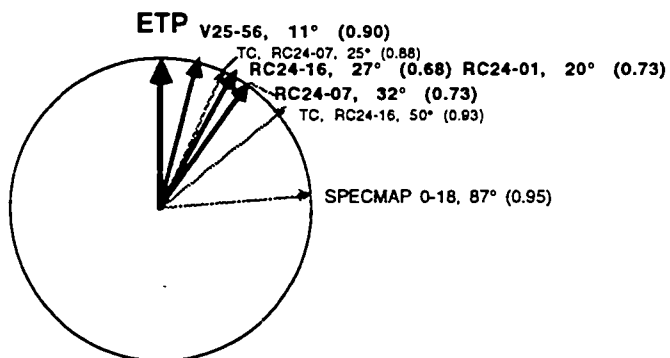
Figure 19 (contd)

PRECESSION (23 Ky)

CALCIUM CARBONATE MAR



(-) ORGANIC CARBON MAR



(-) OPAL MAR

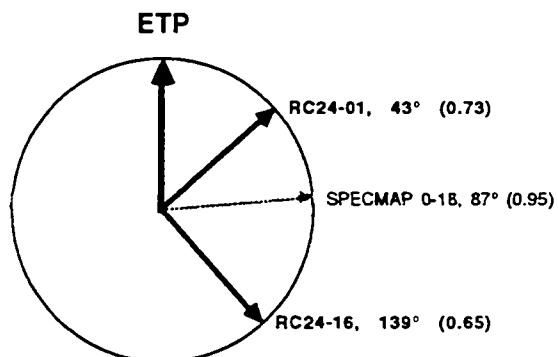
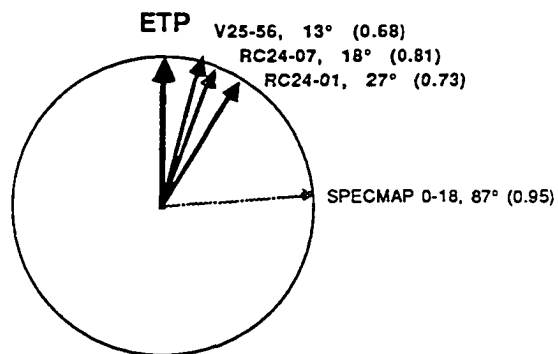


Figure 20

PRECESSION (23 kyr)

(-) NITROGEN MAR



(-) OTHER MAR

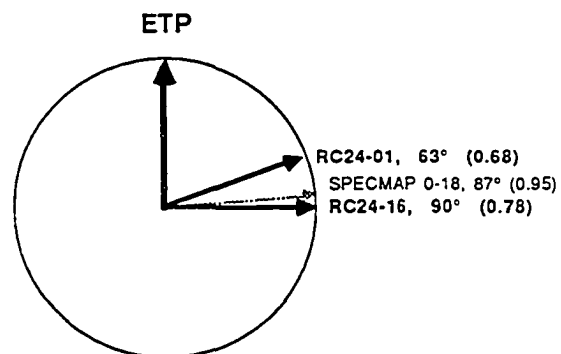
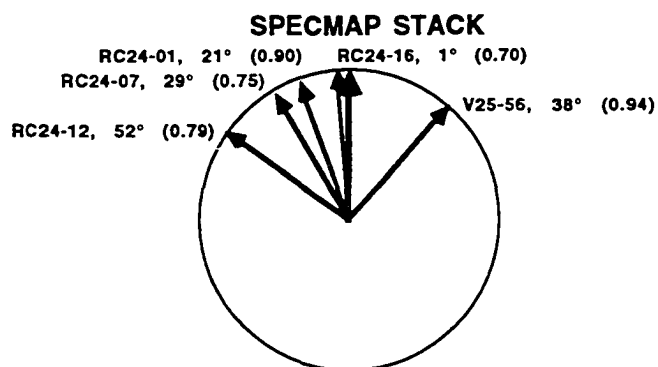


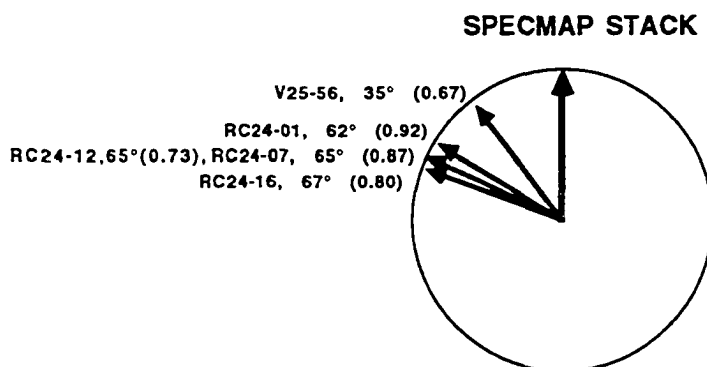
Figure 20 (contd)

PRECESSION (23 Ky)

CALCIUM CARBONATE (%)



(-) ORGANIC CARBON (%)



(-) OPAL (%)

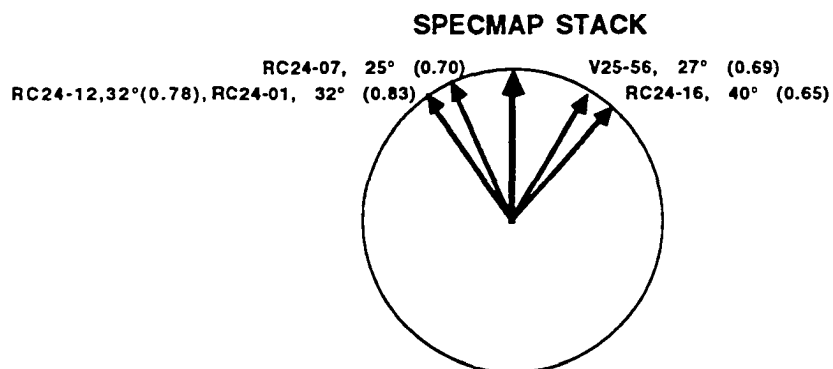
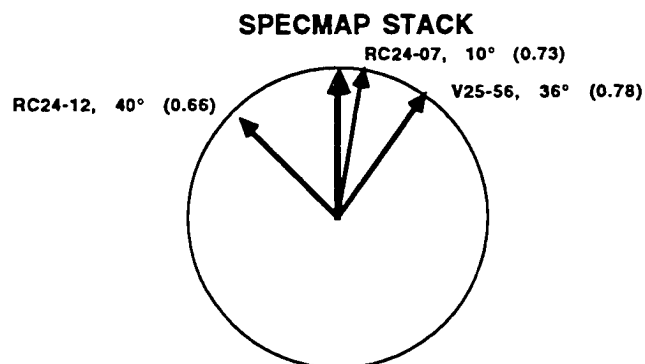


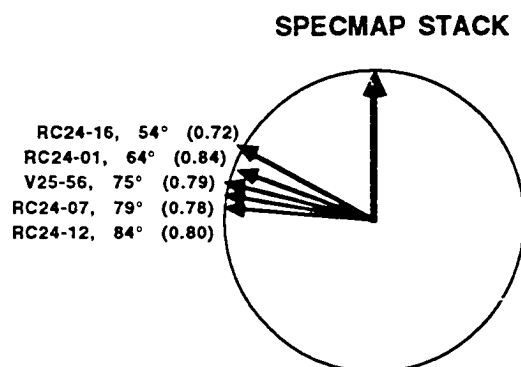
Figure 21

PRECESSION (23 Ky)

CALCIUM CARBONATE MAR



(-) ORGANIC CARBON MAR



(-) OPAL MAR

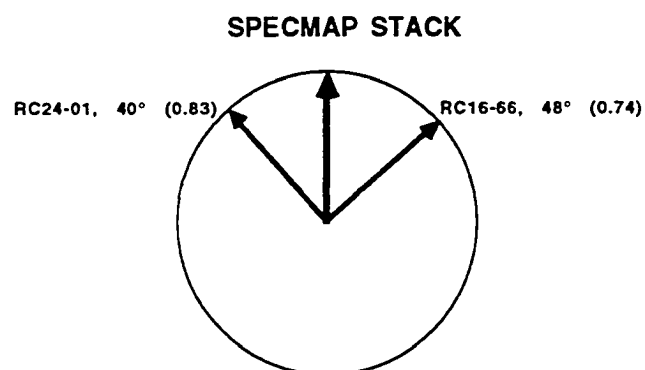
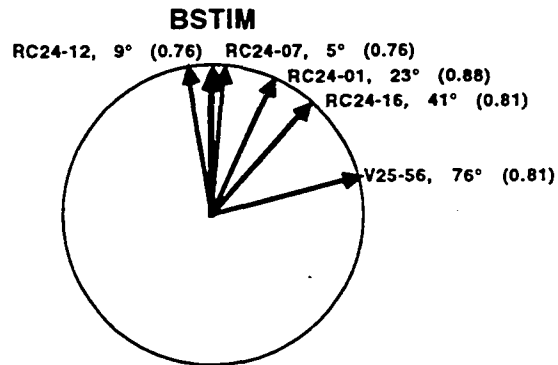


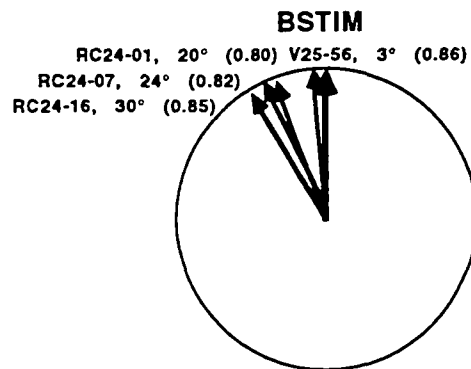
Figure 22

PRECESSION (23 Ky)

CALCIUM CARBONATE (%)



(-) ORGANIC CARBON (%)



(-) OPAL (%)

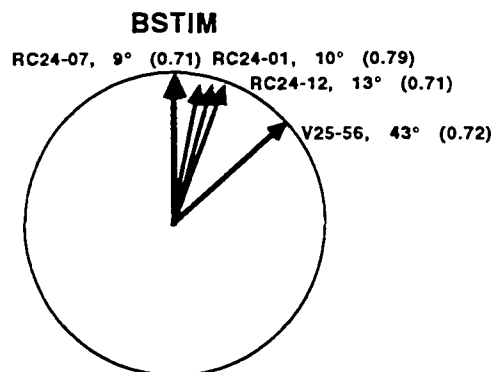
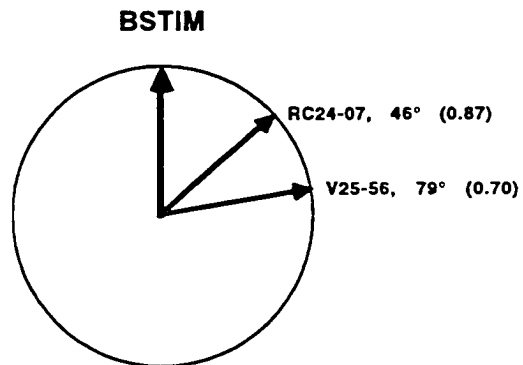


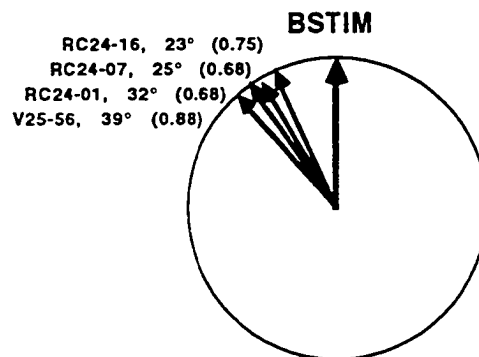
Figure 23

PRECESSION (23 Ky)

CALCIUM CARBONATE MAR



(-) ORGANIC CARBON MAR



(-) OPAL MAR

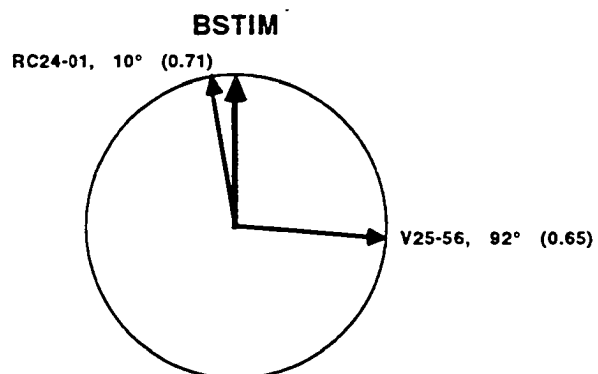
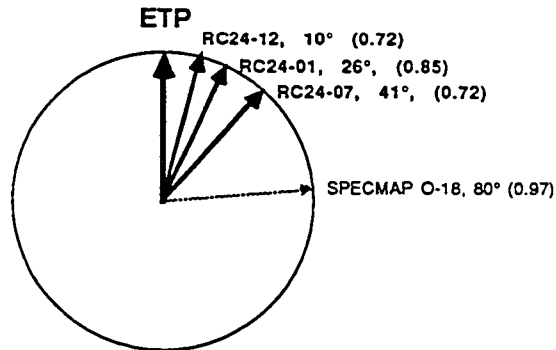


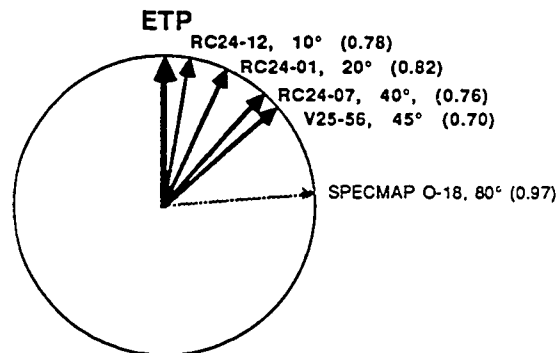
Figure 24

OBLIQUITY (41 kyr)

(-) ORGANIC CARBON (%)



(-) OPAL (%)



(-) NITROGEN (%)

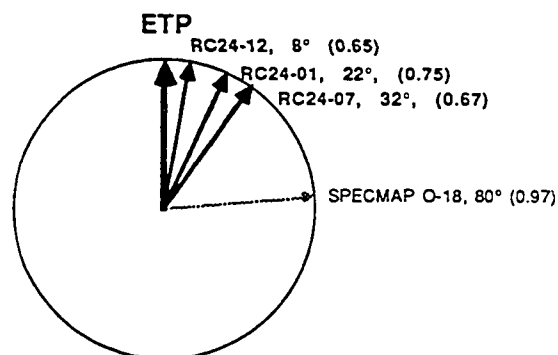
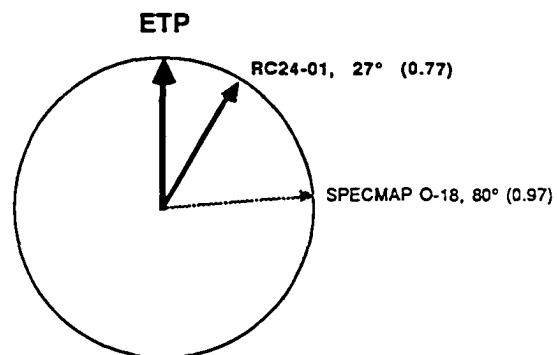


Figure 25

OBLIQUITY (41 kyr)

(-) ORGANIC CARBON MAR



(-) OPAL MAR

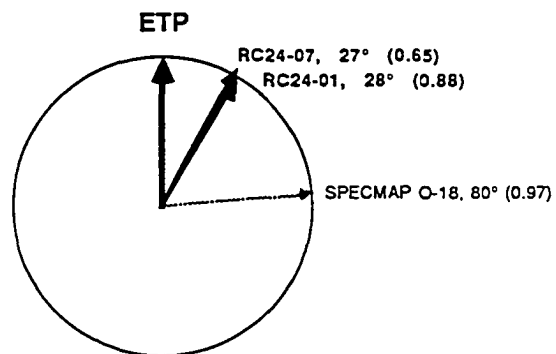
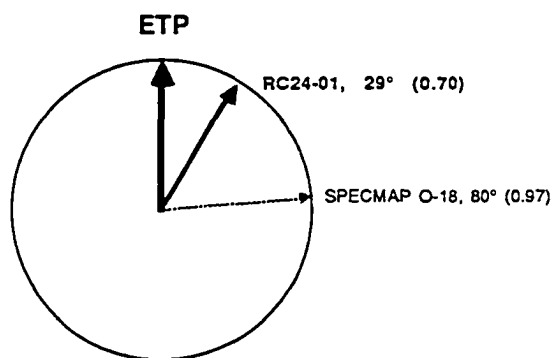


Figure 26

OBLIQUITY (41 kyr)

(-) NITROGEN MAR



(-) OTHER MAR

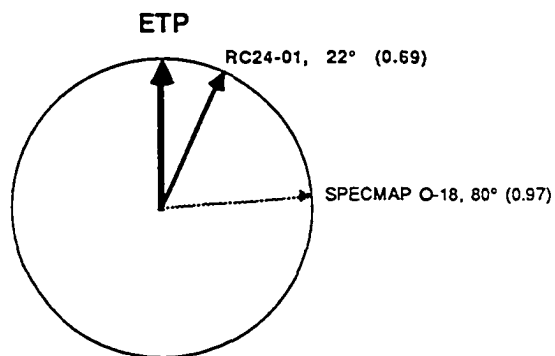
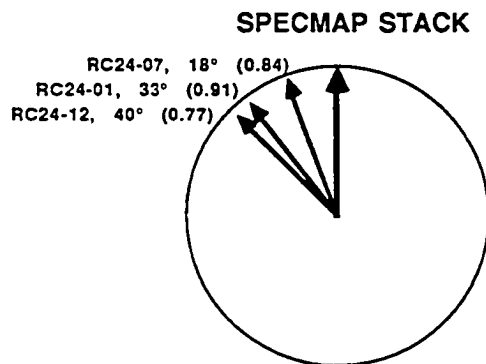


Figure 26 (contd)

OBLIQUITY (41 kyr)

(-) ORGANIC CARBON (%)



(-) OPAL (%)

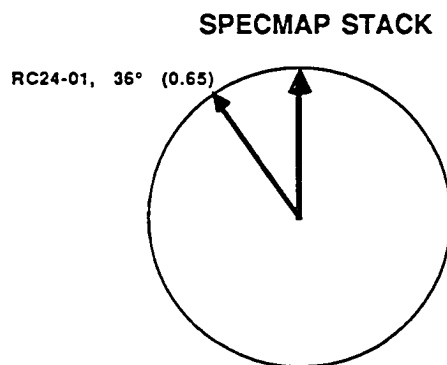
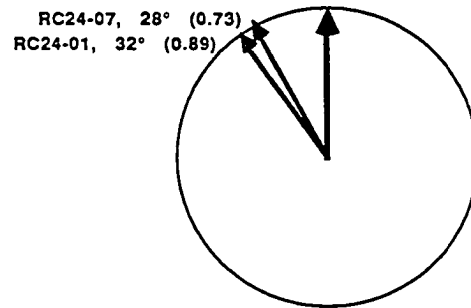


Figure 27

OBLIQUITY (41 kyr)

(-) ORGANIC CARBON MAR

SPECMAP STACK



(-) OPAL MAR

SPECMAP STACK

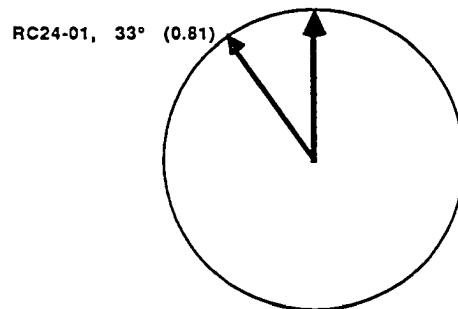
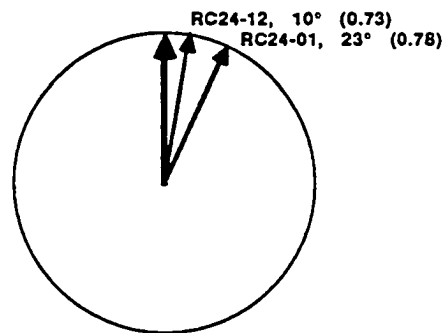


Figure 28

OBLIQUITY (41 kyr)

(-) ORGANIC CARBON (%)

ANNUAL INSOLATION



(-) OPAL (%)

ANNUAL INSOLATION

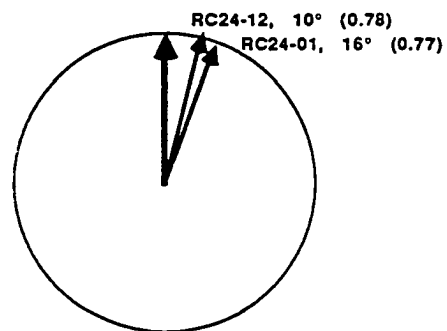


Figure 29

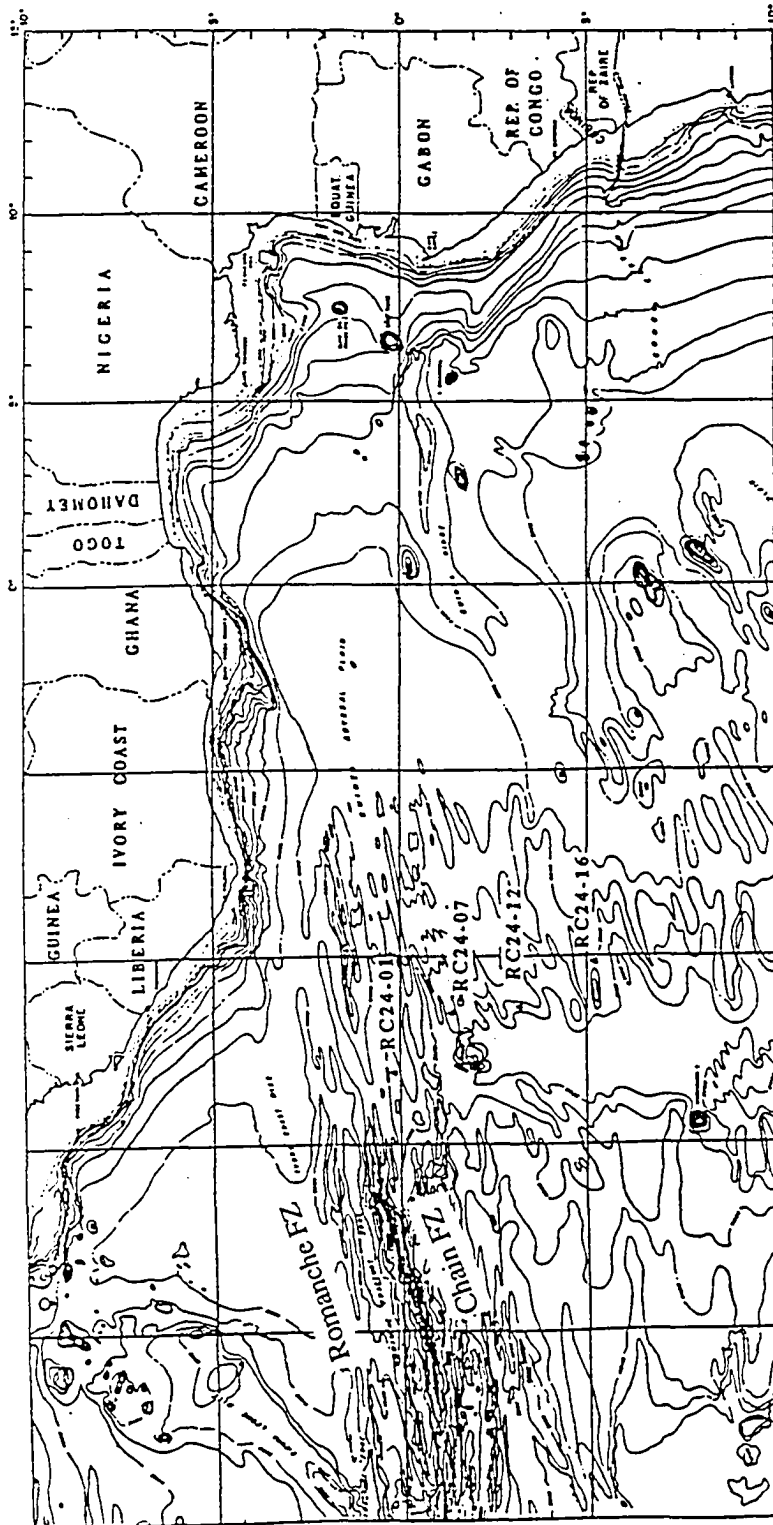


Figure 30

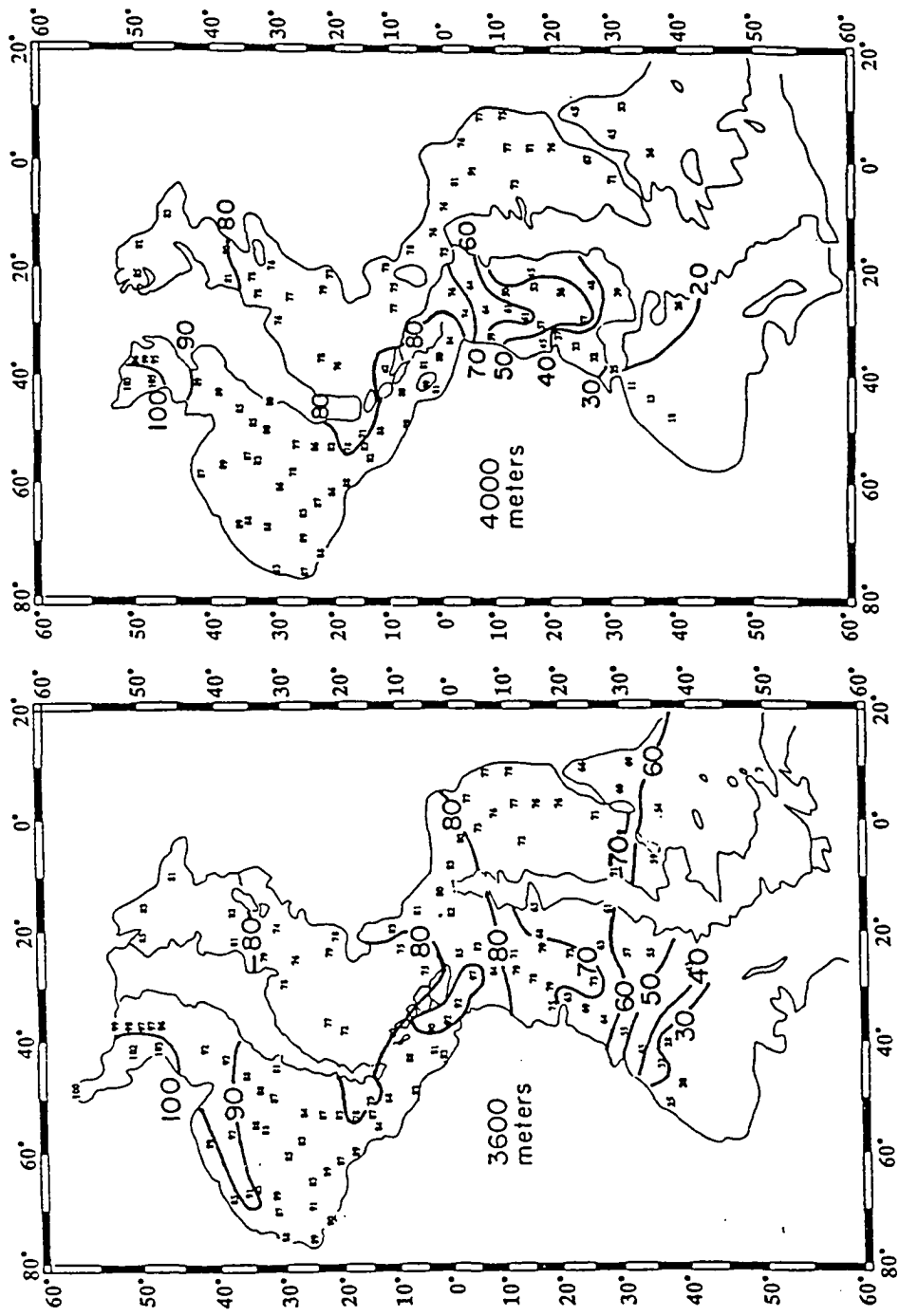


Figure 31

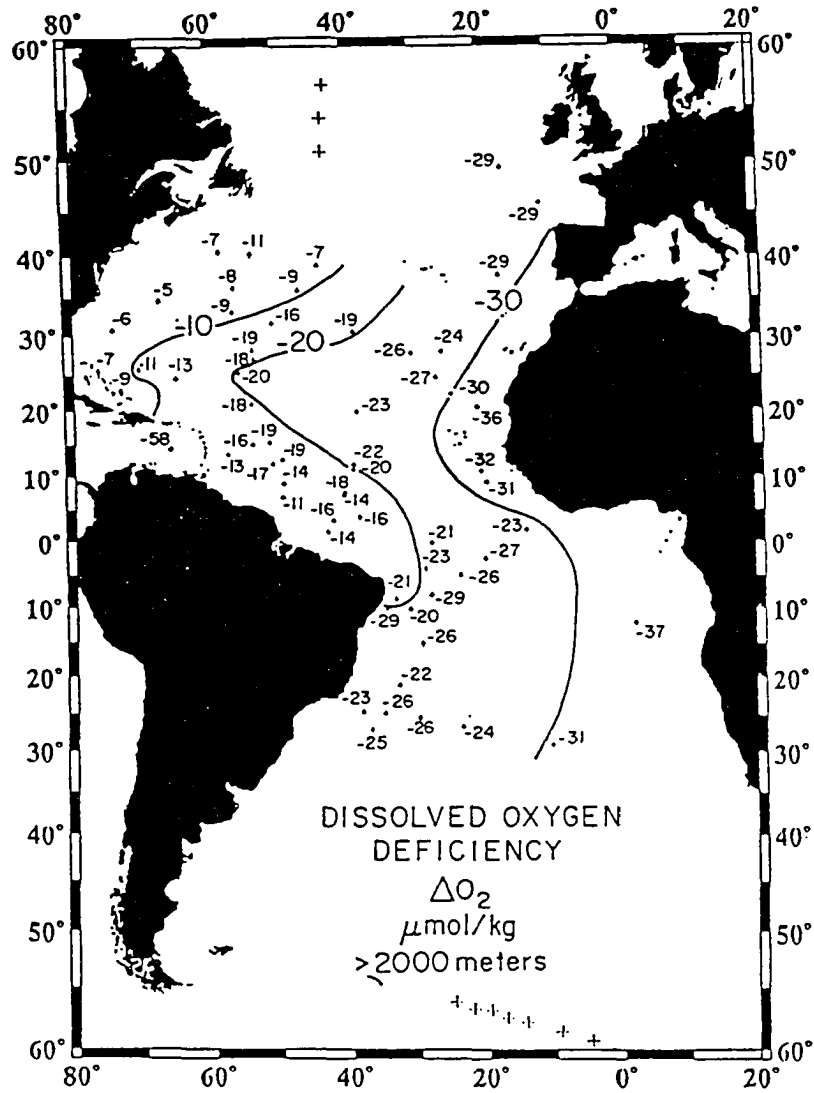


Figure 32

CHAPTER 2

COMPARATIVE METHODS OF DRY BULK DENSITY DETERMINATION IN
MARINE SEDIMENTS OF THE TROPICAL ATLANTIC

Abstract. Three methods for determining the dry bulk density of marine sediment in calcium carbonate rich (>40 %) sequences are presented. Two methods rely on direct physio-chemical analyses of sediment samples while the last predicts dry bulk density from the mathematical relationship between calcium carbonate and dry bulk density. Dry bulk density (g/cm^3) is one of three variables necessary to compute Mass Accumulation Rates (MAR) of sedimentary components according to the relationship;

$$\text{MAR (g/cm}^2\text{/1000 yrs)} = \rho_{\text{dry}} \text{ (g/cm}^3\text{)} \cdot \text{concentration (wt\%)} \cdot \text{sedimentation rate (cm/1000yrs)} + 100$$

where ρ_{dry} is the dry bulk density and concentration refers to the sedimentary component of interest. Regression analysis reveals that, in calcium carbonate rich sequences, MAR is controlled by variations in rate of sedimentation rather than variability in sediment density so that dry bulk density is of secondary importance. A predictive algorithmn calculated from a least-squares regression of calcium carbonate (the major diluting phase in the sediment) concentration versus measured dry bulk density from sediments proximal to the study area produces the equation;

$$\rho_{\text{dry}} \text{ (g/cm}^3\text{)} = 0.0074 \cdot \text{(wt\% CaCO}_3\text{)} + 0.12 \pm 0.01 \text{ g/cm}^3 \quad [r=0.92, n=57].$$

This algorithmn exploits the strong covariance between calcium carbonate concentration and dry bulk density in marine sediments and can be utilized to exclude use of archived core, for additional direct analyses, from the region.

INTRODUCTION

Determination of the dry bulk density of marine sediments is necessary for the computation of Mass Accumulation Rates (MAR). The techniques for the determination of sediment dry bulk density fall into two broad categories which overlap, somewhat. Volume and chloride-ion methods require direct analysis of the sediment sample. The primary disadvantage of the chloride-ion method is its destructive nature which prohibits additional analyses of the same sample. A predictive algorithm can be developed for the computation of dry bulk density which relies on the covariance of calcium carbonate concentration and sediment density. This analysis utilizes direct physical and chemical measurements of sediment properties from a sample sub-set to estimate similar parameters for additional sediment samples not directly tested. In a regional context, this allows extrapolation of physical properties to proximal coring sites and spares other sediment samples from destructive testing.

ANALYTICAL METHODS

Volume measurement

The volume measurement of dry bulk density for marine sediment is valid only when a core possesses its original moisture content. It is best determined at the time of core recovery, although a refrigerated (not frozen) core is suitable. Initially, dry bulk density on each sediment sample was measured, after core recovery and storage, and determined as follows; 1) a core sample (wet) of known volume was obtained, 2) the sample was then dried at 40°C for 24 hours and weighed, and 3) the dry bulk density was determined by the relationship:

$$\rho_{\text{dry}} = \frac{M}{V}$$

where ρ_{dry} (g/cm³) is the dry bulk density of sediment, M (g) is the mass of dried sample and V (cm³) is the initial volume of wet sample.

Regression Analysis

Following the manner of Curry and Lohmann (1986), dry bulk density in marine sediments was determined using least-squares regression analysis of measured dry bulk density versus calcium carbonate concentration in sediments recovered from cores RC24-16 and RC24-30 (Fig. 1; Table 1). The cores possessed a limited number of sediment samples analyzed, shortly after core recovery, for dry bulk density by the volume method described above. These cores were chosen because they are within the oceanographic area of interest and stored refrigerated in a good state of preservation. Regression analysis produced the algorithm:

$$\rho_{\text{dry}} (\text{g/cm}^3) = 0.0074 \cdot (\text{wt\% CaCO}_3) + 0.12 \pm 0.01 \text{ g/cm}^3 \quad [r=0.92, n=57]$$

where ρ_{dry} is the dry bulk density of sediment.

Chloridometry

As an alternative measure, in case cores may have lost their original pore fluid (seawater) content, dry bulk density was determined utilizing the natural Cl^- content and porosity of the sediment sample. This method uses a Buchler-Cotlove Chloridometer with automatic titration which determines the chloride-ion by coulometric titration of Cl^- with Ag^+ ions generated from a sacrificial Ag-wire anode and amperometric endpoint detection. Detection limits are, approximately, 0.25 milli-equivalents of Cl^- . Adjusting volumes and instrument sensitivity, Cl^- in any sample can be determined up to the concentrations found in seawater (558.6 meq/l at 35‰ salinity). Analytical precision is approximately $\pm 0.15\%$ and is primarily limited by pipetting errors. Chloridometry is suitable for use on desiccated core since the chloride-ion concentration is independent of moisture content.

Procedures for chloride-ion measurement

I. Reagents

1. Use doubly-distilled water (pure water, free of Cl^-).

2. HNO₃ Reagent - Add 6.4 ml of concentrated reagent grade HNO₃ to 900 ml of DDW, then add 100 ml of reagent-grade glacial acetic acid. Mix thoroughly and store in a glass bottle, labeled.

3. Gelatin - To 6.2 g of dry powder add 1.0 liter hot DDW, then heat and swirl until dissolved. Store in a wide mouth bottle labeled and dated, in refrigerator. Spoon out enough for each day's work and allow to melt by warming. Prepared gelatin has a refrigerated shelf-life of 6 months. The gelatin ensures dispersion of the AgCl precipitate thereby preventing Ag⁺ or Cl⁻ sorption onto the AgCl micelles by enundating their surface sites. (Note: The dry powder consists of 60.0 g Knox unflavored commercial quality gelatin, 1.0 g Thymol Blue, and 1.0 g Thymol.)

II. Sample Preparation (P. N. Froelich, personal communication)

1. Obtain a 1.0 cm³ core sample.
2. Slurry 1.0 g of dry sediment in 100 ml of doubly-distilled water (DDW) overnight; let settle; decant and filter ≤ 10 ml through a 25 mm x 0.2 μm Nuclepore filter. Sample should be stored in a glass, airtight, impermeable bottle, as concentration by evaporation is the major source of error.

III. Blank Determination

1. Set Chloridometer selector on Medium Range. Fill clean vial with 2.0 ml HNO₃ reagent, 2.0 ml DDW, and 2 drops gelatin.
 2. Adjust (stir) and allow scale to fall off to ≤ 3 μamps.
 3. Titrate and record time.
 4. Clean electrodes with silver polish (commercial quality) and DDW.
- (Note: Run 2-3 blanks until good precision is realized.)

IV. Running Standards

1. Set Chloridometer selector on Medium Range. Fill clean vial with 2.0 ml of prepared 1.0 mEq/l NaCl reagent, 2.0 ml of HNO₃ reagent, and 2 drops gelatin.
2. Adjust (stir) and allow scale to fall off to ≤ 3 μamps.

3. Titrate and record time.
4. Clean electrodes with silver polish and DDW.

V. Running Samples

1. Set selector on Medium Range. Fill clean vial with 2.0 ml of filtered sample, 2.0 ml HNO₃ reagent, and 2 drops gelatin.
2. Adjust (stir) and allow scale to fall off to ≤ 3 μamps.
3. Titrate and record time.
4. Clean electrodes with silver polish and DDW.

VI. Analysis

1. Gross time, in seconds, for each sample is read directly from the instrument timer.
2. Average net time of the standard is calculated as the difference between the average analytical gross time (seconds) of the standard and average analytical time (seconds) for the blank.
3. Calibration factor (K factor) for each sample run is determined by the relationship:

$$K = \frac{\text{ml of NaCl reagent} \cdot \text{concentration of NaCl reagent in mEq/l}}{\text{average net time of standard (sec)}}$$

4. Net time of unknown is derived from the difference between the gross time (seconds) of sample and the average blank time (seconds).
5. Concentration of Chloride in unknown is calculated as:

$$C \text{ (mEq/l)} = \frac{K \cdot \text{net time of unknown (sec)}}{\text{ml of unknown}}$$

6. Porosity is determined as:

$$\phi = \frac{[(B \cdot Cl_{dry})/\rho_{sw}]}{\frac{[B \cdot Cl_{dry}]}{\rho_{sw}} + \frac{[1-(1.8175 \cdot Cl_{dry})]}{\rho_{sed}}}$$

where ϕ (ml/cm^3) is the porosity (i.e. volume of total pore solution per unit volume of *in situ* mud, B is conversion factor from mass of chloride to mass of seawater, Cl_{dry} (g/g) is the dry chloride content (i.e. mass of chloride, extracted into H_2O , per unit mass of dried sediment - grains plus salts), ρ_{sed} (g/cm^3) is the density of sedimentary grains, and ρ_{sw} (g/cm^3) is the density of seawater.

7. Dry bulk density is calculated as:

$$\rho_{\text{dry}} = \rho_{\text{sed}} (1 - \phi)$$

where ρ_{dry} (g/cm^3) is the dry bulk density of dry sediment grains per unit volume of *in situ* mud.

VII. Assumptions

The following assumptions and conditions were used in chloride-ion analyses:

1. All measurements were at 25°C, 1.0 atm.
2. The effect of the expansion of seawater, upon bringing it to the surface, and warming, from bottom water temperatures to 25°C, is small and thus ignored.
3. The density of seawater was taken as 1.02336 g/cm^3 .
4. The expansion of mineral grains is negligible.
5. The following sea salt conventions were used, based on S = 35 per mil; total salt content = 35.174 g/kg ; chloride content = 19.422 g/kg (which includes Cl+Br+F). This recognizes that the analytical scheme (i.e. AgNO_3 titration) used to analyze chloride actually determines Cl+Br+F in seawater.
6. Seawater was assumed to be the pore solution.
7. Density of sedimentary grains is 2.7 g/cm^3 .
8. Conversion factor (B) from mass of chloride to mass of seawater (SW) is:

$$B = 1/[(S/35) \cdot (0.019422)]$$

where S is salinity, per mil. (Note: At 35 per mil, B = 51.489 $\text{g-SW}/\text{g-Cl}$)

RESULTS

Dry bulk densities, as determined by each of the aforementioned methods, are compared in Fig. 2 and Table 2. These bulk densities were used to calculate calcium carbonate Mass Accumulation Rates (MAR) in core RC24-16 (Fig. 3, Table 3) according to the relationship:

$$\text{MAR (g/cm}^2\text{/1000 yrs)} = \rho_{\text{dry}} \text{ (g/cm}^3\text{)} \cdot \text{concentration (wt\%)} \cdot \text{sedimentation rate (cm/1000yrs)} + 100$$

where ρ_{dry} is the dry bulk density of sediment and concentration refers to the sedimentary component of interest. Calcium carbonate MAR, calculated by the various dry bulk densities, are strongly correlative (Table 4). The data indicate that MARs are primarily forced by variations in sedimentation rates as evidenced by the strong positive correlation between sedimentation rate and calcium carbonate MAR (Fig. 4). No such relationship is manifest between dry bulk density and calcium carbonate MAR as evidenced by the weak correlation between these signals (Fig. 5) regardless of the method of dry bulk density calculation. The systematically lower dry bulk densities measured by chloridometry are probably due to loss of salt deposited on the surface of the core when pore fluids are drawn to the evaporative surface of the split core.

CONCLUSIONS

It is evident, from consideration of the calcium carbonate Mass Accumulation Rates for RC24-16, that all methods of dry bulk density determination, while producing somewhat differing magnitudes of carbonate accumulation, would not yield significantly different spectra. This is evidenced by the excellent correlation between MAR signals and illustrates the relative insensitivity of MAR calculation to sediment dry bulk density, at least in calcium carbonate rich sequences. Therefore, the least-squares linear regression equation is used to calculate Mass Accumulation Rates because the algorithm is site specific (i.e. within the oceanographic regime of interest) and produces a strong correlation

between dry bulk density (volume measure) and calcium carbonate concentration with a low standard error in dry bulk density estimation. Since regression analysis predicts dry bulk density so well, it can be used as a viable alternative to additional direct physical/chemical analyses thus saving archived core from this region.

REFERENCES

- Curry, W. B. and G. P. Lohmann, 1986. Late Quaternary carbonate sedimentation at the Sierra Leone Rise (eastern equatorial Atlantic Ocean). *Mar. Geol.*, 70, 223-250.

Table 1. Dry bulk density and calcium carbonate (%) versus depth (cm) downcore.

CORE	DEPTH	CaCO ₃	ρ_{dry}^*	ρ_{dry}^{**}
RC24-16	12	91.25	0.81	0.80
RC24-16	23	91.58	0.78	0.80
RC24-16	41	88.58	0.93	0.78
RC24-16	60	86.87	0.78	0.76
RC24-16	95	89.99	0.80	0.79
RC24-16	112	91.17	0.77	0.79
RC24-16	131	87.91	0.78	0.77
RC24-16	148	89.40	0.86	0.78
RC24-16	190	90.48	0.80	0.79
RC24-16	212	88.93	0.71	0.78
RC24-16	262	91.47	0.78	0.80
RC24-16	271	90.74	0.79	0.79
RC24-16	300	90.40	0.83	0.79
RC24-16	328	88.82	0.73	0.78
RC24-16	358	90.28	0.78	0.79
RC24-16	360	90.67	0.71	0.79
RC24-16	395	90.10	0.84	0.79
RC24-16	420	82.22	0.65	0.73
RC24-16	443	87.33	0.80	0.77
RC24-16	460	89.04	0.81	0.78
RC24-16	488	88.84	0.74	0.78
RC24-16	510	82.74	0.70	0.73
RC24-16	538	89.83	0.81	0.78
RC24-16	561	89.46	0.70	0.78
RC24-16	592	87.25	0.80	0.77
RC24-16	621	89.99	0.75	0.79
RC24-16	681	92.14	0.78	0.80
RC24-16	730	84.50	0.74	0.75
RC24-16	760	90.88	0.77	0.79
RC24-16	801	87.62	0.83	0.77
RC24-16	850	84.43	0.75	0.74
RC24-16	900	91.38	0.86	0.80
RC24-16	970	80.08	0.81	0.71
RC24-16	1000	92.41	0.74	0.80
RC24-16	1030	89.72	0.89	0.78
RC24-30	20	63.44	0.58	0.59
RC24-30	190	58.51	0.53	0.55
RC24-30	240	65.09	0.53	0.60
RC24-30	300	44.38	0.36	0.45
RC24-30	440	62.08	0.59	0.58
RC24-30	480	36.37	0.42	0.39
RC24-30	690	54.60	0.49	0.52
RC24-30	820	67.80	0.55	0.62
RC24-30	930	41.68	0.43	0.43
RC24-30	980	72.17	0.66	0.65

Table 1. (continued)

CORE	DEPTH	CaCO ₃	ρ_{dry}^*	ρ_{dry}^{**}
RC24-30	1020	74.17	0.64	0.67
RC24-30	1080	49.24	0.47	0.48
RC24-30	1120	62.99	0.56	0.59
RC24-30	1190	44.60	0.49	0.45
RC24-30	1250	90.72	0.76	0.79
RC24-30	1320	62.09	0.55	0.58
RC24-30	1370	40.90	0.48	0.42
RC24-30	1400	75.00	0.67	0.68
RC24-30	1470	44.70	0.50	0.45
RC24-30	1480	77.70	0.66	0.69
RC24-30	1500	44.18	0.47	0.45
RC24-30	1530	66.09	0.70	0.61

* measured (volume method)

** predicted (regression equation)

Table 2. Dry bulk density (g/cm³) versus depth (cm) in RC24-16.

Depth (cm)	volume measure	least-squares regression	chloridometry
12	0.81	0.80	0.58
23	0.78	0.80	0.60
41	0.93	0.78	0.66
60	0.78	0.76	0.69
95	0.80	0.79	0.66
112	0.77	0.79	0.61
131	0.78	0.77	0.56
148	0.86	0.78	0.58
190	0.80	0.79	0.62
212	0.71	0.78	0.65
262	0.78	0.80	0.67
271	0.79	0.79	0.61
300	0.83	0.79	0.66
328	0.73	0.78	0.61
358	0.78	0.79	0.68
360	0.71	0.79	0.66
395	0.84	0.79	0.60
420	0.65	0.73	0.58
443	0.80	0.77	0.63
460	0.81	0.78	0.58
488	0.74	0.78	0.64
510	0.70	0.73	0.60
538	0.81	0.78	0.62
561	0.70	0.78	0.66
592	0.80	0.77	0.64
621	0.75	0.79	0.63
681	0.78	0.80	0.63
730	0.74	0.75	0.62
760	0.77	0.79	0.63
801	0.83	0.77	0.66
850	0.75	0.74	0.66
900	0.86	0.80	0.73
970	0.81	0.71	0.70
1000	0.74	0.80	0.60
1030	0.89	0.78	0.75

Table 3. Calcium carbonate Mass Accumulation Rate ($\text{g}/\text{cm}^2/1000$ yrs) versus depth (cm) in RC24-16.

Depth (cm)	Sedimentation rate (cm/1000 yrs)	volume measure	least-squares regression	chloridometry
12	4.080	3.016	2.961	2.159
23	4.080	2.914	2.981	2.242
41	4.080	3.361	2.803	2.385
60	4.080	2.761	2.704	2.446
95	6.670	4.802	4.717	3.962
112	6.670	4.682	4.832	3.709
131	2.760	1.893	1.870	1.359
148	2.760	2.122	1.928	1.431
190	2.760	1.993	1.972	1.548
212	2.100	1.326	1.453	1.214
262	2.500	1.784	1.822	1.532
271	2.140	1.534	1.537	1.185
300	2.700	2.022	1.926	1.611
328	5.380	3.488	3.174	2.915
358	2.730	1.922	1.942	1.676
360	2.730	1.757	1.958	1.634
395	3.500	2.649	2.481	1.892
420	3.800	2.031	2.276	1.812
443	2.500	1.747	1.673	1.375
460	2.500	1.800	1.734	1.291
488	3.500	2.301	2.417	1.990
510	3.500	2.029	2.121	1.738
538	3.500	2.547	2.467	1.949
561	3.500	2.192	2.449	2.067
592	4.300	3.001	2.873	2.401
621	4.100	2.767	2.900	2.324
681	1.800	1.294	1.330	1.045
730	4.500	2.822	2.834	2.358
760	5.000	3.506	3.601	2.863
801	5.000	3.629	3.366	2.891
850	1.000	0.637	0.629	0.557
900	2.800	2.200	2.037	1.868
970	2.300	1.491	1.312	1.289
1000	2.100	1.436	1.560	1.164
1030	2.100	1.679	1.477	1.413

Table 4. Correlation coefficient (r) between calcium carbonate Mass Accumulation Rates in RC24-16 using differing methods of dry bulk density computation.

	volume measure	least-squares regression	chloridometry
volume measure	-	0.97	0.97
least-squares regression	0.97	-	0.98
chloridometry	0.97	0.98	-

FIGURE CAPTIONS

- Fig. 1 (A) Linear fit to a least-squares regression of calcium carbonate (%) versus measured (volume method) dry bulk density (g/cm^3) in RC24-16 and RC24-30 producing the equation:

$$\rho_{\text{dry}} (\text{g/cm}^3) = 0.0074 \cdot (\text{wt\% CaCO}_3) + 0.12 \pm 0.01 \text{ g/cm}^3$$
 [r=0.92,n=57].
- (B) Linear fit to a least-squares regression of measured dry bulk density (volume method) versus predicted (regression equation) dry bulk density [r=0.92,n=57].
- Fig. 2 Downcore measurement of dry bulk density in RC24-16 by (A) volume measurement, (B) least-squares regression, and (C) chloridometry.
- Fig. 3 Calcium carbonate Mass Accumulation Rate ($\text{g/cm}^2/1000$ yrs) versus depth (cm) in RC24-16 using varying methods of dry bulk density determination as outlined in the text.
- Fig. 4 Least-squares linear regression of calcium carbonate Mass Accumulation Rate ($\text{g/cm}^2/1000$ yrs) versus sedimentation rate (cm/1000 yrs) in RC24-16. Dry bulk density is determined by (A) volume measure, (B) least-squares regression, and (C) chloridometry.
- Fig. 5 Least-squares linear regression of calcium carbonate Mass Accumulation Rate ($\text{g/cm}^2/1000$ yrs) versus dry bulk density (g/cm^3) in core RC24-16. Dry bulk density is determined by (A) volume measure, (B) least-squares regression, and (C) chloridometry.

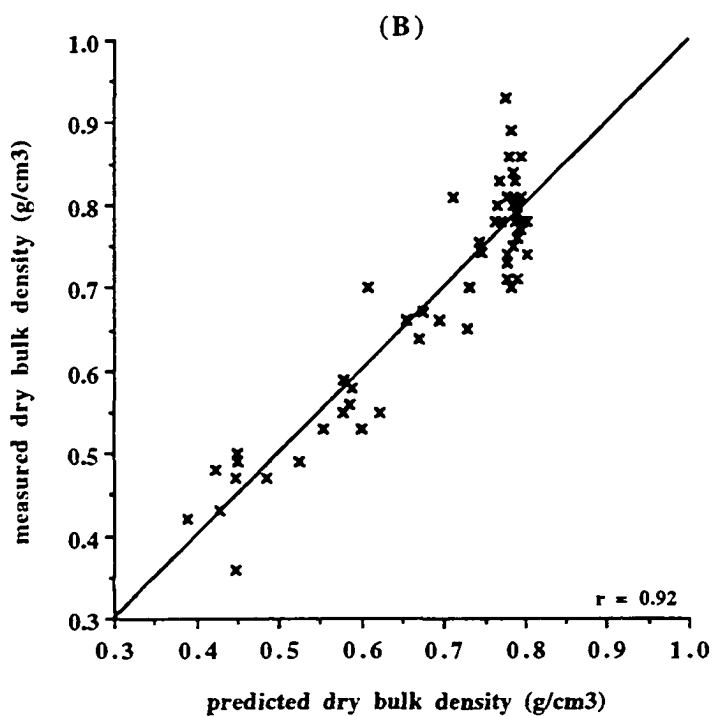
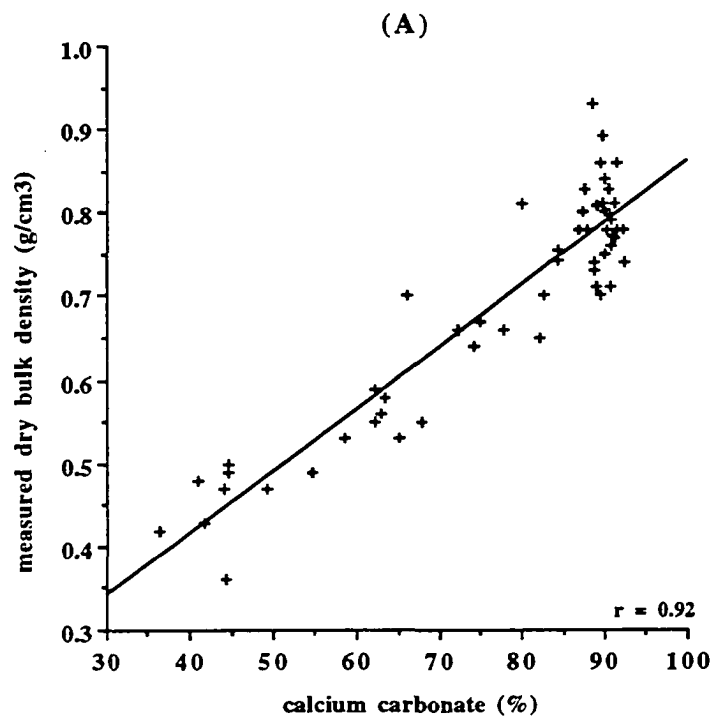


Figure 1

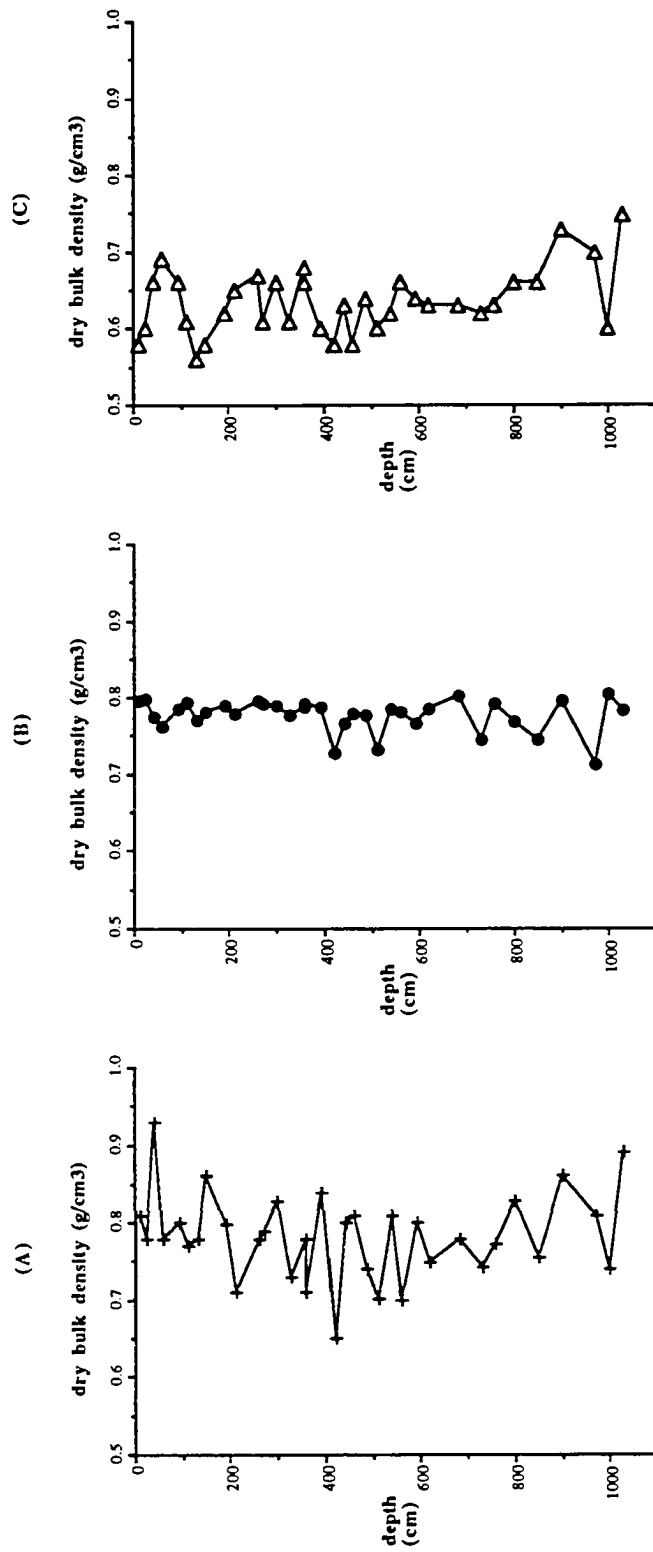


Figure 2

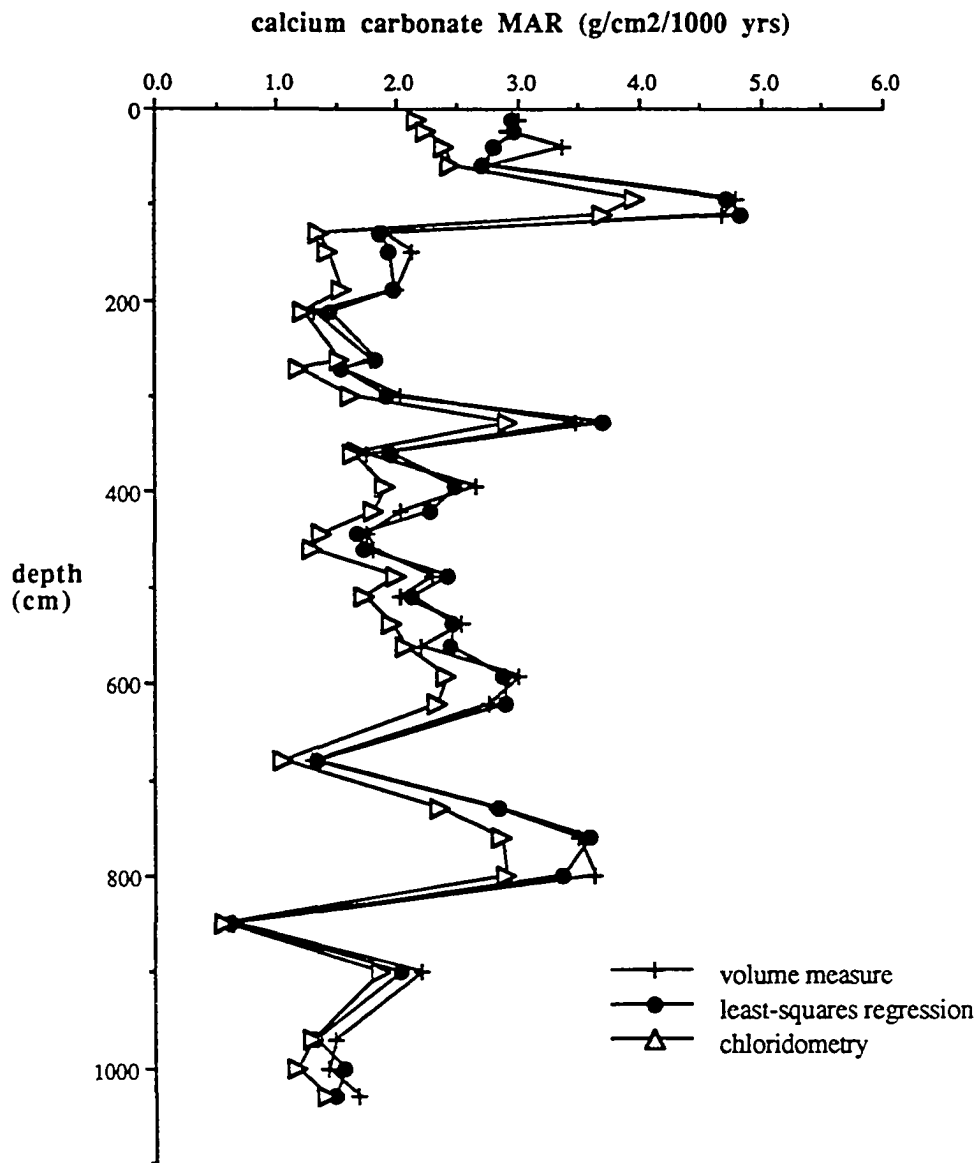


Figure 3

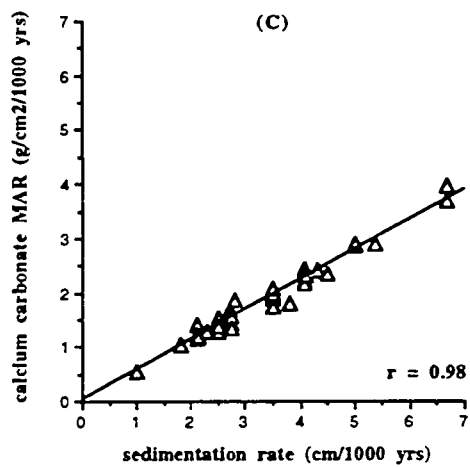
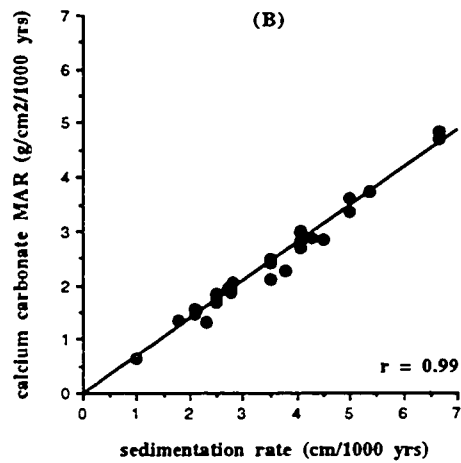
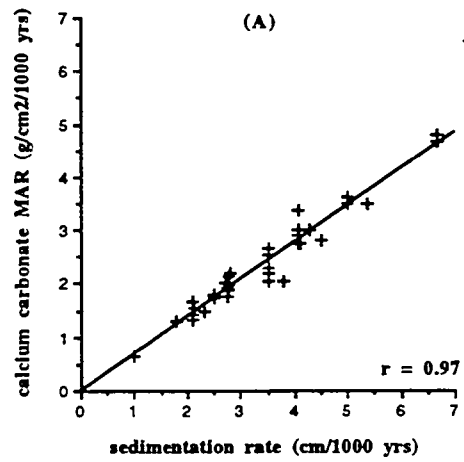


Figure 4

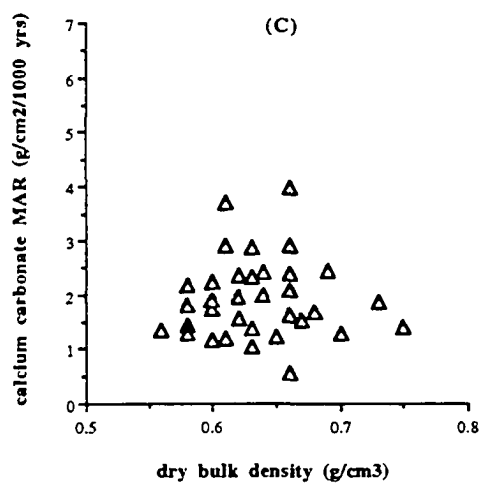
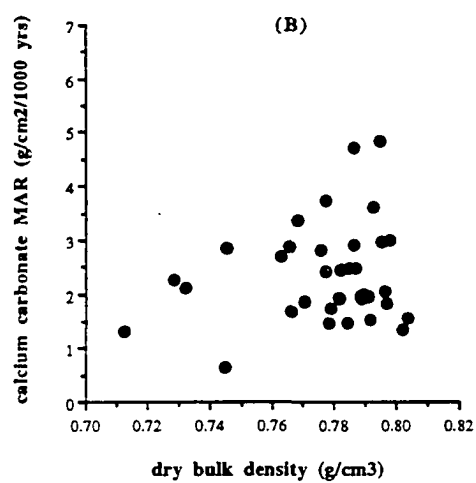
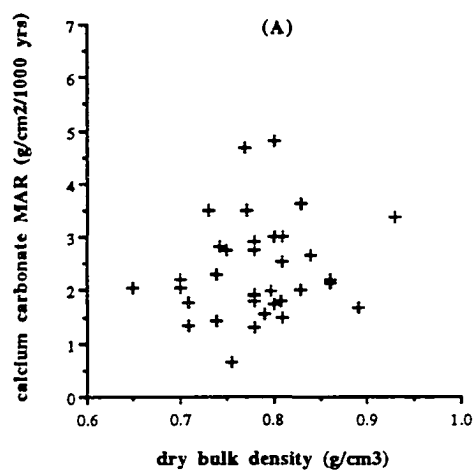


Figure 5

CHAPTER 3

DETERMINATION OF ORGANIC CARBON AND NITROGEN IN MARINE
SEDIMENTS USING THE CARLO-ERBA NA-1500 ANALYZER*

Abstract. A technique is described for the determination of organic carbon and nitrogen in small samples (5 mg) of marine sediments that optimizes the analytical capabilities of the Carlo Erba NA-1500 Elemental Analyzer. This instrument analyzes total carbon, nitrogen and sulfur in solid samples by flash combustion. Organic and inorganic forms of carbon are differentiated by sample manipulation prior to analysis without loss of nitrogen. Organic carbon is determined after removing carbonate carbon by acidification with sulfurous acid *in situ* within aluminum sample cups, thus eliminating loss of acid-soluble organic carbon during carbonate dissolution, or the necessity of determining organic carbon by "difference-on-combustion". Excess acid is volatilized as SO₂ and H₂O upon drying, eliminating the dual problems of retention of waters-of-hydration of calcium salts and "excess" acid. The procedure provides rapid and routine analyses of marine sediments, yielding a relative precision of $\pm 0.3\%$ of the measured value for organic carbon and $\pm 1.6\%$ for nitrogen, and blank levels 0.31 ± 0.085 μg -carbon and 0 μg -nitrogen. Conservatively estimated absolute and relative detection limits are 0.62 μg -carbon (2x mean blank value) and 0.01% carbon, respectively.

* Reprinted with permission from Deep-Sea Research, v. 37, Verardo, D. J., P. N. Froelich, and A. McIntyre, Determination of organic carbon and nitrogen in marine sediments using the Carlo-Erba NA-1500 Analyzer, 1990, Pergamon Press plc, Headington Hill Hall, Headington, Oxford, OX3 0BX.

INTRODUCTION

Carbon in marine sediments occurs as organic carbon intimately linked to the metabolic processes of plants and animals and as carbon contained within biogenic and abiogenic carbonate minerals. Successful determination of organic carbon relies upon the separation of organic from inorganic carbon. The quantitative spatial and temporal distribution of organic carbon in marine sediments is important for paleoceanographic reconstructions of primary production and carbon burial.

Several methods of analyses have been employed for the separation of organic from inorganic forms of carbon. Heath et al. (1977) and Gibbs (1977) relied on ashing to achieve separation of the two forms. The accuracy of this method is temperature dependent, and Gibbs (1977) argued that combustion at temperatures less than 1050°C results in incomplete separation and underestimation errors of 25% for organic carbon determinations. Subsequent methods have relied on separation by various acids (Froelich, 1980; Weliky et al., 1983; Hedges and Stern, 1984). These methods experience problems ranging from water retention by hygroscopic $\text{CaCl}_2 \cdot \text{H}_2\text{O}$ salts to incomplete decalcification.

In our procedure, inorganic carbon is partitioned from organic carbon, while conserving nitrogen, by *in situ* acidification of samples with sulfurous acid. Sulfurous acid is used in decarboxylation for two reasons. First, it removes calcium carbonate from small samples of marine sediments without the development of deliquescent calcium salts that retain water. *In situ* acidification eliminates the necessity of drying and re-weighing residuals. Second, it is a non-oxidizing acid which decomposes to H_2O and SO_2 upon drying. Acidification occurs within a specially constructed sample container utilizing commercial grade aluminum foil. Pre-cleaned aluminum (as opposed to tin or silver) is used in the construction of the sample containers due to its ability to be molded into a pellet after treatment with acid. The method described herein makes use of the analytical capabilities of the Carlo Erba NA-1500 Analyzer to completely fuse aluminum at

temperatures exceeding 1600°C during flash combustion of sample contained within aluminum cups. Analytical precision is good, yielding $\pm 0.3\%$ of the measured value of organic carbon and $\pm 1.6\%$ for nitrogen (Table 1).

The response of the Carlo Erba NA1500 is calibrated for each set of samples ($n=50$) with four (4) standards (Acetanilide) and three (3) blank aluminum cups. The calibration curves for carbon and nitrogen are straight lines with excellent linearity (Fig. 1). The long term (4-6 weeks) instrument sensitivity for carbon is $9.258 \pm 0.617 \times 10^3$ area counts/ $\mu\text{g-C}$ and $3.161 \pm 0.220 \times 10^3$ area counts/ $\mu\text{g-N}$ (Table 2). Approximately 100 samples/week is a fair estimate of the number of completed analyses possible for a researcher working alone.

The analytical operation of the Carlo Erba NA-1500 is based upon "flash combustion" in which a sample, encapsulated in a sample container, is introduced into a combustion column reactor by means of an autosampler (Fig. 2). The stationary phase in the combustion column is composed of a porous layer of the oxidation catalyst chromium trioxide (Cr_2O_3) overlying silvered cobaltous cobaltic oxide ($\text{CO}_3\text{O}_4 + \text{Ag}$) granules maintained at 1050°C (Table 3). At such temperatures, we achieve >99% recovery of carbon from graphite. The sample and the aluminum container melt in a temporarily enriched atmosphere of oxygen (ultra-pure quality). The eluted combustion products, a mixture of CO_2 , NO_x and H_2O , are swept through the combustion reactor by a mobile phase of Helium (high purity quality) carrier gas into a second column, the reduction reactor. In the reduction reactor, which is packed with metallic copper maintained at 650°C, the excess oxygen is removed and the nitrogen oxides are reduced to N_2 . The N_2 , CO_2 and water from the reduction reactor are swept through a water-absorbing filter containing magnesium perchlorate. Gas separation is on a Porapak QS, 6x4 mm (OD/ID), 2 m long chromatographic column maintained at 54°C. Detection is by thermal conductivity. Peak integration is accomplished with a Hewlett-Packard 3390A Integrator (Fig. 3) connected to the 1 volt output from the NA-1500. The integrator is wired to

remotely initiate integration upon sensing a half-second contact closure across pins 5/6 of the NA-1500 auxiliary connection and programmed (i.e. timed events table) to cease integration 300 seconds later.

EQUIPMENT

1. Carlo Erba NA-1500 Analyzer and AS200 Autosampler
2. Integrator (Hewlett-Packard model 3390A)
3. Microbalance (Cahn model C-30)
4. 7/8" (2.22 cm) diameter hand punch
5. Aluminum foil of 0.0001" (2.54×10^{-4} cm) thickness (commercial grade)
6. Brass, or some other inert material, cylindrically shaped mandrel of 1/4" (0.635 cm) diameter
7. Aluminum holding block with 50 positions numbered from 0-49
8. Hammer
9. Forceps
10. Chemical standard (Acetanilide - NBS#141C)
11. Micropipette (Finnpipette 5-50 μ l capacity)
12. Sulfurous Acid - 8% Solution (Baker Reagent #0370-2)
13. Air-tight container (Rubbermaid™ square - 2.8 quart capacity)
14. Wide mouth glass bottle with snap-on cap (50 ml capacity- Fisher #03-319B)

PROCEDURES

I. PREPARATION OF ALUMINUM SAMPLE CUPS

1. Take a piece of aluminum foil and fold it over several times. Using the hammer and hand punch, cut out a series of 7/8" diameter discs weighing approximately 15-18 mg each. We use a diameter of 7/8" for several reasons: 1) the Carlo Erba NA-1500 can manage a sample cup of up to 18 mg and 2) the 7/8" diameter disc will yield, upon molding around a 1/4" diameter form, a sample cup which gives both a broad base for stability and container walls high enough to preclude sediment spillage.

2. Take the aluminum discs formed in Step 1 and mold them, one at a time, around the 1/4" diameter mandrel to form cups. The sample cups must be molded to form a water-tight seal. Place the newly constructed sample cups in a glass beaker.

3. Fill the glass beaker containing the cups with distilled (not deionized) water. Place the beaker in a water bath and sonicate for 2 minutes. The sonication process removes any contaminants clinging loosely to the surface of the cups. Some of the cups may be destroyed in the process - this is acceptable. Decant excess water and carefully pick up each sample cup with clean forceps and place in a separate well in the clean aluminum holding block. It is important to limit the possible contamination of the sample cup. Plans for the machining of the aluminum holding block are included in Figure 4. Place the holding block, complete with its load of cups, in a muffle furnace at 550°C for 24 hours to combust organics which may have contaminated the cups from handling or from organic oils used in the manufacturing process of the aluminum.

4. After the muffle furnace has cooled, remove the holding block with cups and place in an air tight container (Rubbermaid™ type box).

5. Remove the cups in position numbers 0,1,2,3,23,45,46,47,48 and 49 in the holding block. The cups at these locations will house standards and blanks. Place these cups in a wide-mouth glass bottle with a sealable snap-on top and lay aside for now. (We found no systematic carbon or nitrogen blanks after addition of distilled water and

sulfurous acid in forthcoming steps; therefore we isolate the standard/blank sample cups to preclude random contamination.)

II. PREPARATION OF SAMPLES

1. Dry the sediment sample in a drying oven at 60°C overnight. When the sample is dry, crush it in a clean agate mortar and pestle and place in a suitable clean container for storage (i.e. Wheaton #986704 high density polyethylene scintillation vials with linerless screw caps - 20 ml capacity).

2. Using clean forceps, remove a single aluminum cup from the air-tight box and weigh it. If the sample cup's weight exceeds 18 mg, discard it. Otherwise, tare the sample cup and weigh into it 5 to 10 mg of sample.

3. Return the sample cup and its 5-10 mg sample to the holding block, being careful not to spill any sediment and to record its location in the block.

4. After weighing out approximately 40 samples, remove the holding block from the container. At this point the acidification process commences.

5. Under a ventilated hood, carefully pipet 30 µl of distilled water (not deionized) into each sample cup. The drop of distilled water wets the sample and prevents "explosive" sample loss during reaction with acid in the next step. Observe whether any sample is lost from the sample cup. If there is, discard and prepare a new sample.

6. While under the hood, pipet 10 µl of 8% sulfurous acid into each sample cup. Once again, observe the behavior of the sample. As always, if you lose some sample, discard and begin again. Since sulfurous acid readily loses strength by loss of SO₂, it should be kept securely sealed.

7. After all the samples have been acidified once, place the holding block in a drying oven at 60°C until dry, approximately 15 minutes.

8. When the samples are dry, remove them from the oven and acidify once again, as in Step 6, but this time use 30 µl of acid. Dry the samples, as before, in the drying oven.

The volume of acid used in this step is arbitrary in that during the early stages of acidification, a small volume of acid will produce a large degree of effervescence. As the calcium carbonate is dissolved, effervescence intensity decreases and a larger volume of acid may be used until all of the calcium carbonate is dissolved. We use a series of 10 μl , 30 μl , 50 μl , and 100 μl additions. The sequential steps of increased acid addition are necessary to prevent sample loss.

9. Continue the acidification and drying routine until the sample is acidified with a total of 400 μl of acid and no effervescence is noticed in the sample cup. (If the samples continue to effervesce, repeat the acidification and drying steps.)

III. RUNNING SAMPLES, STANDARDS, AND BLANKS

1. After completing Step 9 from the previous section, remove one sample cup from the holding block using clean forceps. Place the cup on a clean surface. Using two forceps, carefully close up the cup. Do not allow any sample spillage.

2. The cup must be folded into a small (5 mm diameter) spherical shape so that samples fall cleanly into the combustion reactor of the Carlo Erba NA-1500. Any spillage of sample into the AS200 autosampler may cause scoring of the teflon slide and the "mirror" polished surfaces in the slide. This can lead to gas leaks within the instrument.

3. Place the sample "ball" into the AS200 autosampler tray. Keep the hood on the sample tray as you load up the samples. This will preclude contaminants from falling into the Autosampler tray.

4. Repeat Steps 1-3 until all of the sample cups are folded and loaded.

5. From the sealed bottle placed aside in Step 5 of the preparation section, remove one sample cup at a time and, after taring, weigh out a series of four (4) standards containing approximately 35, 100, 150 and 200 μg -carbon. Place the standards interspersed within the run. This will provide a calibration curve for the sample run. The recommended standard for use in organic carbon/nitrogen microchemical analysis is

Acetanilide, a National Bureau of Standards certified standard reference material. Close up the sample cups containing the standards as in Steps 1-2 and load into the autosampler.

6. Place several blank sample cups within the run. It is imperative to keep the carbon blank values low and consistent. The mean blank value for carbon will be subtracted from all the samples in the run. If the blanks vary wildly, this will introduce error in the analysis.

We run no more than 50 samples in the NA-1500 at one time so that the residuals from sample combustion do not build up in the combustion chamber and interfere with subsequent analyses. The combustion column (reactor vessel and attendant chemicals) has a lifetime of, approximately, 800 analyses.

ANALYSIS OF DATA

1. After completion of the sample run on the Carlo-Erba, compute linear regressions (least-squares method) of carbon and nitrogen versus area counts. The carbon regression should include both the standards and the empty sample cups because the empty sample cups function as zero standards as well as blanks. It is not necessary to include blanks in the regression for nitrogen as there is no background nitrogen in cleansed aluminum cups, provided high grade O₂ is employed and there are no gas leaks.

2. We use the following algorithms to compute the organic carbon content of samples:

$$A_{COR} = A_{TOT} - A_{BL}$$

$$M_C = (A_{COR}) \times (S)$$

$$\%C = (M_C + M_S) \div 10$$

where A_{COR} is the corrected area counts of sample, A_{TOT} is area counts of sample, A_{BL} is area counts of blank, M_C is mass of carbon in μg , S is slope of standard calibration curve, M_S is the mass of sample in mg and $\%C$ is weight percent organic carbon. (Note: Nitrogen analyses are similar but require no blank correction.)

Analyses of sediment samples for total carbon (TC) does not require sample pre-treatment. A 5-10 mg sample is weighed into an aluminum cup, sealed without acidification and run through the NA-1500. Inorganic (carbonate) carbon is derived from the difference between total carbon and organic carbon. Percent calcium carbonate is then calculated as $\{8.33 \times (TC - C_{org})\}$.

ACKNOWLEDGEMENTS

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Table 1. Precision of organic carbon and nitrogen determinations.

Replicate	wt % C-org	wt % N
1	0.918	0.185
2	0.920	0.183
3	0.923	0.184
4	0.923	0.188
5	0.917	0.190
Mean	0.920	0.186
S.D.	0.003	0.003

NOTE: sample from core RC24-01; depth 593 cm.

Table 2. Long-term stability of Carlo-Erba NA-1500.

Week	No. of Blanks	Blank Value*	No of Standards	Sensitivity**	
				C	N
1	3	0.22 ± 0.007	4	9.994	3.434
2	3	0.23 ± 0.007	4	9.933	3.397
3	3	0.38 ± 0.008	4	9.375	3.176
4	3	0.38 ± 0.010	4	8.529	2.926
5	3	0.25 ± 0.008	4	8.713	2.931
6	3	0.40 ± 0.007	4	9.004	3.102
Mean		0.31		9.258	3.161
S.D.		0.085		0.617	0.220
Relative S.D. (%)		27.4		6.6	6.9

* $\mu\text{g-C} \pm \text{S.D.}$

** $\times 10^3$ area counts/ $\mu\text{g-C,N}$

Note: sensitivity = 1/slope

Table 3. Operating parameters of the Carlo-Erba NA-1500 for organic carbon and nitrogen analysis.

Oxidation furnace temperature	1050° C
Reduction furnace temperature	650° C
GC column oven and detector block temperature	54° C
Filament temperature	190° C
Helium carrier gas flow rate (main)	80 ml min ⁻¹
Helium carrier gas flow rate (reference)	40 ml min ⁻¹
Helium purge gas flow rate	40 ml min ⁻¹
Oxygen gas flow rate	25 ml min ⁻¹
Oxygen loop volume	10 ml
Solute Retention Times:	
N ₂	~2.00 min
CO ₂	~3.00 min
Total analytical time	5.33 min
Chromatogram peak full-width-at-half-maximum:	
N ₂	24 sec (0.20 cm)
CO ₂	24 sec (0.20 cm)
Hewlett-Packard 3390A Program:	
ZERO = 0	
ATT 2 = 0 (1.0 μV)	
CHT SP = 0.5 (cm/min)	
PK WD = 0.16	
THRSH = -1	
AR REJ = 0	
TIMED EVENTS TABLE: STOP COMMAND = 5.00 min	

FIGURE CAPTIONS

- Fig. 1 A) Calibration curve (least-squares regression) of carbon standards (Acetanilide) and B) nitrogen standards (Acetanilide) versus area counts. Slopes represent the inverse of sensitivity and 1 area count = $0.125 \mu\text{Vsec}^{-1}$. For A, slope = $1.00055 \times 10^{-4} \mu\text{g-C/area count}$; $r = 0.9999$; blank = $0.22 \pm 0.007 \mu\text{g-C}$ ($n = 3$). For B, slope = $2.91134 \times 10^{-4} \mu\text{g-N/area count}$; $r = 0.9999$; blank = 0 ($n = 3$). The dynamic range of the instrument is linear to at least 1400 $\mu\text{g-C}$ (1.1×10^7 area counts) and 200 $\mu\text{g-N}$ (5.8×10^5 area counts).
- Fig. 2 Schematic of the Carlo-Erba NA-1500 Analyzer. 1, AS200 Autosampler; 2, combustion reactor; 3, reduction reactor; 4, water absorbant filter; 5, chromatographic column; 6, thermal conductivity detector (modified from Carlo Erba Strumentazione NA-1500 manual).
- Fig. 3 Typical chromatograms.
- Fig. 4 Plans for the machining of the Aluminum holding block with a total of 50 holes of 7/16" diameter. Chamfer two ends to assist in orienting block and use 60/61 grade aluminum for thermal/acid resistance.

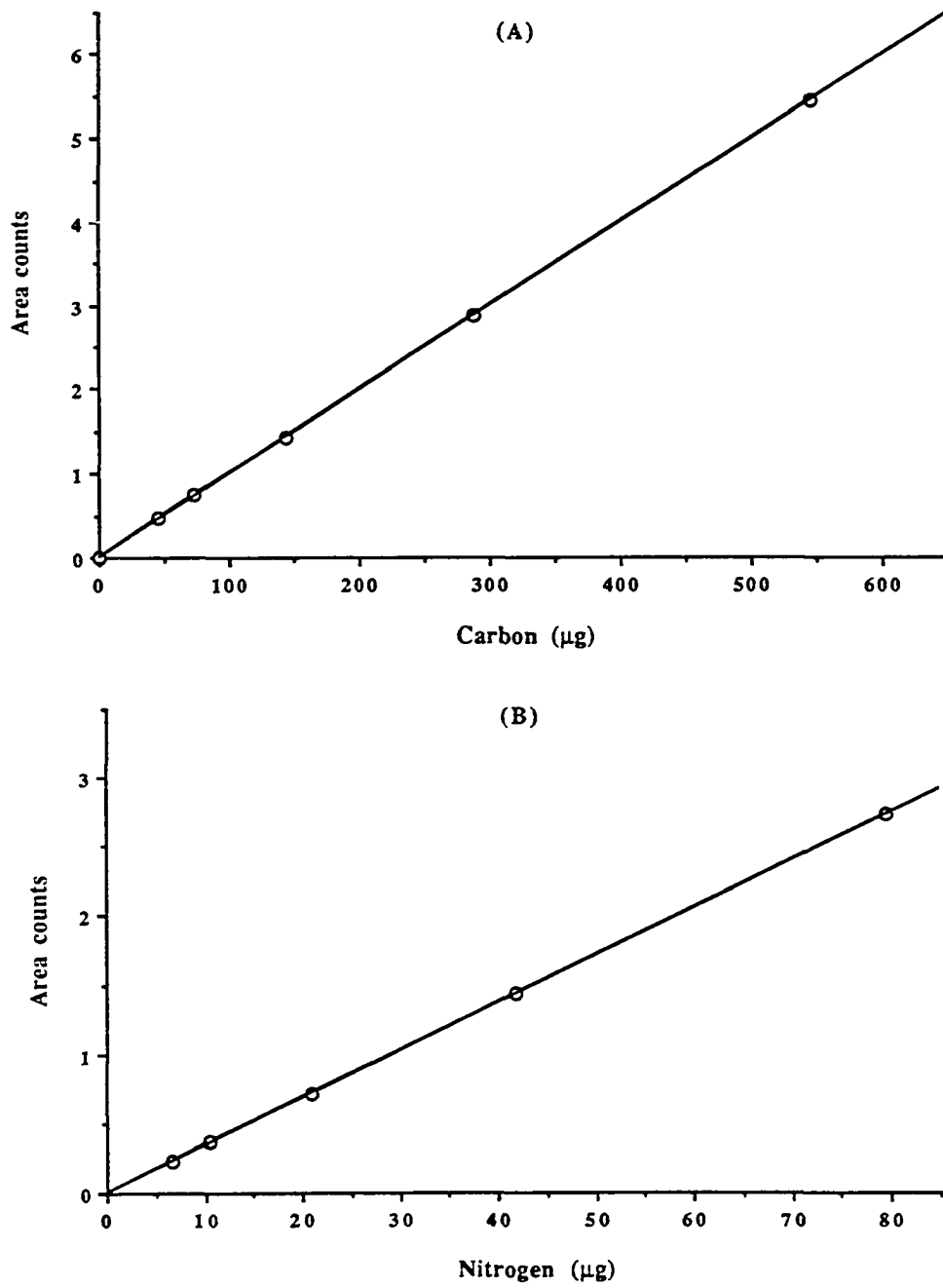


Figure 1

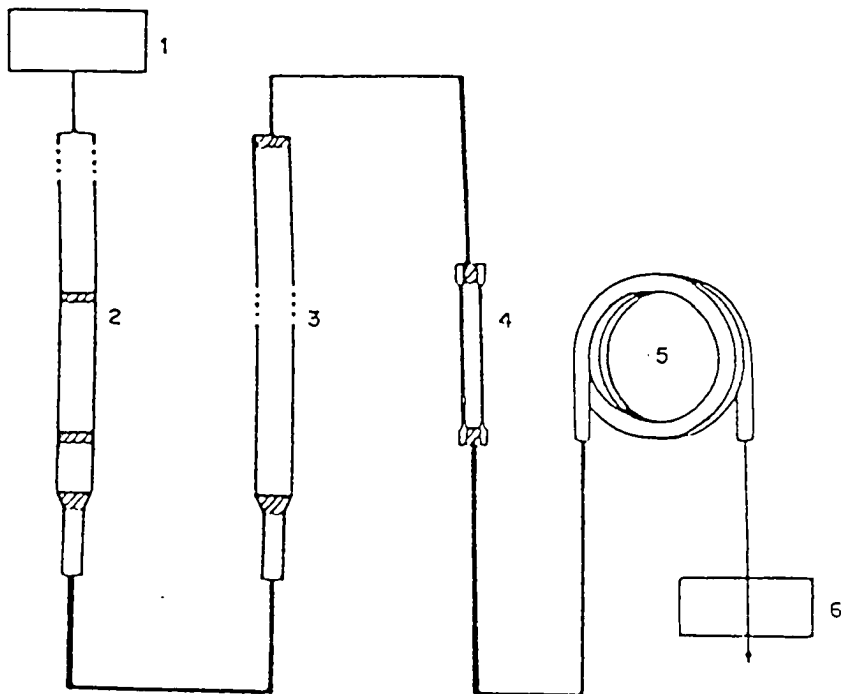
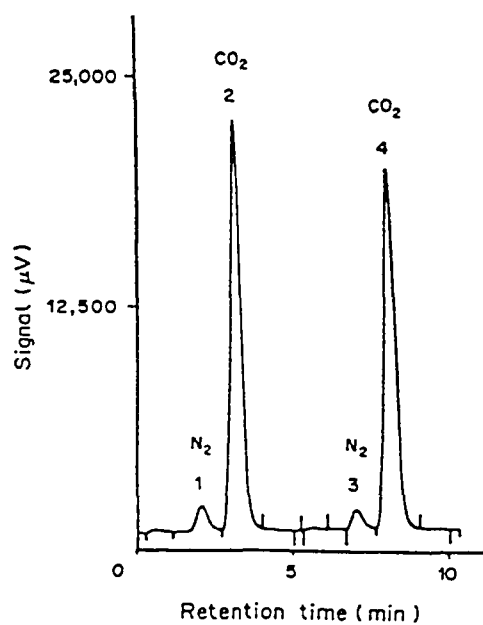


Figure 2



Peak	Area counts	µV	µg-C	µg-N
1	13158	1645	-	4.24
2	183180	22897	19.85	-
3	9434	1179	-	3.04
4	162950	20369	17.60	-

Figure 3

APPENDIX A

STABLE ISOTOPES ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$ - per mil vs PDB) FROM THE PLANKTONIC
FORAMINIFERA *Neogloboquadrina dutertrei* IN CORES OF THE EQUATORIAL
ATLANTIC

Table A1. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in RC24-01.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
0.0	1.5	0.03	1.80
4.0	3.8	-0.19	1.68
8.0	6.1	0.05	1.55
12.0	7.8	0.11	1.58
16.0	8.8	0.35	1.49
20.0	9.8	0.50	1.44
24.0	10.8	0.80	1.10
28.0	11.8	0.81	1.09
32.0	12.8	0.74	1.19
36.0	13.8	1.18	1.08
40.0	14.9	1.31	1.25
44.0	15.6	1.41	1.06
48.0	16.4	1.69	1.20
52.0	17.2	1.62	1.28
56.0	17.9	1.54	1.34
60.0	18.7	1.26	1.27
64.0	19.5	1.34	1.30
68.0	20.3	1.73	1.52
72.0	21.0	1.23	1.25
76.0	21.8	1.31	1.42
80.0	22.6	1.30	1.35
84.0	23.4	1.58	1.35
88.0	24.1	1.52	1.34
92.0	24.9	1.55	1.41
96.0	25.7	1.33	1.26
100.0	26.5	1.57	1.32
105.0	27.4	1.15	1.70
110.0	28.4	1.33	1.63
115.0	29.4	0.74	1.80
120.0	30.3	0.44	2.04
125.0	31.3	0.23	1.89
135.0	33.2	1.01	1.94
140.0	34.2	1.38	1.85
145.0	35.2	1.07	2.05
150.0	36.1	1.34	1.92
155.0	37.1	1.32	1.77
160.0	38.1	1.02	2.08
165.0	39.0	1.09	1.95
170.0	40.0	0.96	1.84
175.0	41.0	0.86	1.81
180.0	41.9	0.73	1.96
185.0	42.9	0.79	1.85
190.0	43.9	0.56	2.03
195.0	44.8	1.03	1.85
200.0	45.7	0.78	2.25

Table A1. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
205.0	46.6	0.67	2.12
211.0	47.6	0.88	2.15
215.0	48.4	0.77	2.17
220.0	49.3	0.74	2.01
225.0	50.2	0.46	2.25
231.0	51.2	0.69	2.18
235.0	51.9	0.56	2.15
241.0	52.9	0.75	1.98
245.0	53.6	0.68	2.09
251.0	54.6	0.40	2.07
255.0	55.3	0.70	2.16
261.0	56.3	0.43	2.14
265.0	57.0	0.49	2.12
271.0	58.0	0.34	2.33
275.0	58.7	0.47	2.12
281.0	59.8	1.16	1.51
285.0	60.5	1.32	1.59
291.0	62.0	1.13	1.92
295.0	63.0	1.08	2.01
301.0	64.5	1.16	2.09
305.0	65.5	1.02	1.97
310.0	66.7	1.14	2.04
315.0	68.0	0.98	2.10
320.0	69.2	0.67	2.14
325.0	70.5	0.71	1.91
330.0	71.7	0.62	2.21
335.0	73.0	0.30	2.10
340.0	74.2	0.45	2.10
345.0	75.5	0.25	2.16
350.0	76.7	0.20	2.27
355.0	78.0	-0.18	2.76
360.0	79.3	-0.05	2.47
365.0	81.2	-0.03	2.49
370.0	83.2	0.39	2.11
375.0	85.2	0.14	2.49
380.0	87.1	0.17	2.33
385.0	89.1	0.34	2.10
390.0	91.1	0.37	1.93
450.0	114.7	0.03	1.89
455.0	116.6	0.02	1.93
460.0	118.6	-0.10	1.89
465.0	120.6	-0.21	2.21
470.0	122.6	-0.31	2.07
475.0	124.3	-0.25	1.87
480.0	126.1	0.32	1.84

Table A1. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
485.0	127.9	0.03	1.78
490.0	129.7	0.42	1.48
495.0	131.5	0.51	2.02
500.0	133.3	0.49	1.99
505.0	135.1	0.94	1.55
510.0	136.5	0.91	1.38
515.0	137.9	1.00	1.51
520.0	139.4	0.98	1.57

Table A2. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in RC24-07.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
0.0	1.5	-0.24	1.45
5.0	2.4	-0.03	1.55
10.0	3.4	-0.29	1.43
15.0	4.4	-0.16	1.58
20.0	5.4	-0.03	1.57
25.0	6.3	0.03	1.54
30.0	7.3	0.19	1.33
35.0	8.3	0.54	1.20
40.0	9.2	0.70	1.17
45.0	10.1	0.93	1.01
50.0	11.0	0.92	1.00
55.0	11.9	1.13	1.10
60.0	12.8	1.21	0.99
65.0	13.8	1.29	0.82
70.0	14.7	1.45	0.94
75.0	15.5	1.86	1.02
80.0	16.3	1.82	1.02
90.0	17.8	1.86	1.30
95.0	18.5	1.75	1.18
100.0	19.2	1.36	0.93
105.0	19.9	1.46	1.13
110.0	20.6	1.63	1.17
115.0	21.4	1.93	1.14
120.0	22.1	1.41	0.90
125.0	22.8	1.61	0.91
130.0	23.5	1.41	1.03
135.0	24.3	1.45	1.31
145.0	25.7	1.33	1.04
155.0	27.2	1.53	1.10
160.0	27.9	1.53	1.15
165.0	28.6	1.54	1.20
170.0	29.3	1.43	0.98
175.0	30.1	1.64	1.06
180.0	30.8	1.27	1.34
185.0	31.5	1.21	1.17
190.0	32.3	1.25	1.13
200.0	33.7	1.27	1.23
205.0	34.4	1.60	1.23
210.0	35.2	1.37	1.31
215.0	35.9	1.36	1.40
220.0	36.6	1.21	1.43
225.0	37.3	1.28	1.44
230.0	38.1	1.32	1.35
235.0	38.8	1.18	1.32
240.0	39.5	1.13	1.37
245.0	40.3	1.19	1.39

Table A2. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
250.0	41.0	1.12	0.98
255.0	41.7	0.80	1.42
260.0	42.4	0.67	1.38
265.0	43.2	1.15	1.10
270.0	43.9	1.33	1.07
275.0	44.6	0.98	1.22
280.0	45.3	0.97	1.48
285.0	46.1	1.24	1.14
290.0	46.8	0.85	1.62
295.0	47.5	1.54	1.23
300.0	48.2	-0.12	0.96
305.0	49.0	0.98	1.48
310.0	49.7	0.75	1.72
315.0	50.4	0.99	1.52
320.0	51.2	1.31	1.22
325.0	51.9	0.88	1.33
330.0	52.6	1.42	0.87
335.0	53.3	0.81	1.43
340.0	54.1	0.70	1.42
345.0	54.8	0.60	1.31
350.0	55.9	0.72	1.42
355.0	57.0	0.75	1.47
360.0	58.2	0.85	1.29
365.0	59.3	1.13	0.98
370.0	60.4	1.17	1.09
375.0	62.0	1.12	1.09
380.0	63.5	1.12	1.25
385.0	65.1	1.12	1.17
390.0	66.7	1.00	1.23
395.0	68.2	0.81	1.22
400.0	69.8	0.89	1.47
405.0	71.4	0.32	1.52
410.0	72.9	0.85	1.30
415.0	74.5	0.37	1.58
420.0	76.1	0.46	1.61
425.0	77.6	0.30	2.03
430.0	79.2	0.14	1.93
435.0	85.1	0.50	1.28
440.0	90.9	0.68	1.45
445.0	92.7	0.53	1.61
450.0	94.5	0.33	1.61
455.0	96.3	0.32	1.65
460.0	98.1	0.23	1.67
465.0	99.9	0.31	1.48
470.0	101.7	0.15	1.50
475.0	103.5	0.32	1.69

Table A2. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
480.0	105.3	0.39	1.83
485.0	107.1	0.25	1.81
490.0	108.9	0.51	1.43
495.0	110.7	0.57	1.39
500.0	112.5	0.04	1.74
505.0	114.3	0.24	1.39
510.0	116.1	0.17	1.23
515.0	117.9	0.47	1.07
535.0	125.1	-0.12	1.31
550.0	130.0	0.68	1.08
565.0	135.0	1.83	0.71
570.0	136.4	1.08	1.05
580.0	139.3	0.74	1.18
585.0	140.8	1.20	1.41
590.0	142.2	0.84	1.33
595.0	143.7	0.98	1.08
600.0	145.1	1.20	1.28
605.0	146.6	0.82	1.30
610.0	148.0	0.88	1.00
615.0	149.5	1.20	1.21
620.0	151.0	1.30	0.99
625.0	152.4	0.91	1.05
630.0	153.9	1.03	0.95
635.0	155.3	0.54	0.76
640.0	156.8	0.48	0.44
645.0	158.4	0.67	0.43
660.0	163.2	0.53	0.66
665.0	164.9	-0.14	1.60
670.0	166.5	0.54	1.20
675.0	168.1	0.01	1.05
680.0	169.7	0.14	1.51
685.0	171.3	0.18	1.41
690.0	173.0	-0.11	1.32
695.0	176.3	0.41	1.62
705.0	183.0	-0.01	0.71
710.0	183.9	-0.13	1.02
715.0	184.8	-0.20	0.17
720.0	185.7	0.19	0.88
725.0	186.6	-0.30	0.69
730.0	187.5	-0.41	1.05
735.0	188.5	-0.47	1.52
740.0	189.4	-0.10	1.13
750.0	191.2	-0.34	1.67
755.0	192.1	-0.55	1.76
760.0	193.0	-0.65	1.74
765.0	194.0	-0.62	1.69

Table A2. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
770.0	195.2	-0.25	1.32
775.0	196.4	-0.16	0.96
780.0	197.7	-0.47	1.29
790.0	200.1	-0.49	0.77

Table A3. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in RC24-12.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
3.0	1.9	-0.19	1.80
6.0	2.3	-0.07	1.99
9.0	2.8	-0.10	1.97
12.0	3.2	-0.27	1.92
15.0	3.6	-0.28	1.95
18.0	4.1	-0.12	1.94
21.0	4.5	-0.37	2.04
24.0	4.9	-0.36	1.93
27.0	5.4	-0.28	1.93
30.0	5.8	-0.14	1.87
33.0	6.2	-0.48	1.87
36.0	6.8	0.07	1.80
39.0	7.3	-0.04	1.84
42.0	7.9	-0.01	2.00
45.0	8.4	0.08	1.87
48.0	9.0	-0.05	1.97
51.0	9.5	0.11	1.86
54.0	10.1	0.39	1.70
57.0	10.6	0.35	1.58
60.0	11.2	0.30	1.66
63.0	11.7	0.41	1.81
66.0	12.3	0.16	1.74
69.0	12.8	0.59	1.52
72.0	13.4	0.83	1.52
75.0	14.0	0.91	1.43
78.0	14.9	1.18	1.31
81.0	15.9	1.34	1.52
84.0	16.8	1.38	1.55
87.0	17.8	1.67	1.52
90.0	18.5	1.55	1.43
93.0	19.2	1.18	1.60
96.0	20.0	1.56	1.48
99.0	20.8	1.55	1.42
102.0	21.5	1.67	1.43
105.0	22.3	1.70	1.56
108.0	23.1	1.42	1.67
111.0	24.1	1.50	1.45
114.0	25.2	1.18	1.58
117.0	26.2	1.03	1.79
126.0	29.3	1.13	1.83
129.0	30.3	0.86	1.72
133.0	31.7	0.79	1.61
135.0	32.3	0.89	1.79
138.0	33.4	0.67	1.62
141.0	34.4	0.87	1.80
144.0	35.4	0.77	1.73

Table A3. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
147.0	36.5	0.95	1.77
150.0	38.6	0.76	1.81
153.0	40.7	0.87	1.70
156.0	42.8	0.73	1.82
159.0	45.0	0.70	1.97
162.0	47.1	0.72	1.60
165.0	49.2	0.77	1.78
168.0	51.3	0.79	1.98
171.0	53.5	0.49	1.78
201.0	60.5	0.65	1.83
204.0	61.2	0.96	1.25
207.0	61.9	0.59	1.66
210.0	62.6	1.13	1.55
213.0	63.3	1.13	1.54
216.0	64.0	1.30	1.44
219.0	65.2	1.06	1.61
222.0	66.4	0.60	1.73
225.0	67.5	1.30	1.86
228.0	68.7	0.99	1.73
231.0	69.9	0.77	1.85
234.0	71.0	0.79	1.76
237.0	72.2	0.78	1.81
240.0	73.3	0.70	1.76
243.0	74.5	0.41	1.85
246.0	75.7	0.44	2.01
249.0	76.8	0.25	2.23
252.0	78.0	0.22	2.15
255.0	79.2	0.08	2.23
258.0	80.5	0.18	2.18
261.0	81.8	0.22	1.80
267.0	84.4	0.38	1.83
351.0	121.2	-0.16	1.75
354.0	122.5	-0.51	1.93
357.0	123.8	-0.19	1.62
360.0	125.1	-0.43	1.67
363.0	125.7	-0.38	1.58
366.0	126.3	-0.21	1.50
369.0	127.0	-0.09	1.37
372.0	127.6	-0.13	1.31
375.0	128.2	0.46	1.27
378.0	131.6	0.16	1.37
381.0	135.1	0.82	1.24
384.0	136.3	0.49	1.39
387.0	137.6	0.57	1.13
390.0	138.9	0.83	1.54
396.0	141.4	0.98	1.45

Table A3. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
399.0	142.7	0.96	1.44
401.0	143.5	1.19	1.26
402.0	143.9	0.86	1.78
404.0	144.8	0.80	1.53
407.0	146.0	1.07	0.98
410.0	147.3	0.86	1.44
413.0	148.6	0.98	1.45
416.0	149.9	1.24	1.24
419.0	151.1	1.06	1.14
422.0	152.4	0.94	1.42

Table A4. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in RC24-16.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
0.0	1.5	-0.21	1.53
3.0	2.2	-0.46	1.65
6.0	2.9	-0.01	1.36
9.0	3.6	-0.41	1.48
12.0	4.3	-0.13	1.17
15.0	5.0	-0.20	1.74
18.0	5.7	-0.12	1.46
21.0	6.4	-0.18	1.63
24.0	7.1	-0.08	1.61
27.0	7.8	-0.13	1.61
30.0	8.5	-0.05	1.54
33.0	9.2	0.20	1.39
36.0	9.9	0.05	1.52
39.0	10.6	0.04	1.55
42.0	11.3	0.84	1.17
45.0	12.0	0.46	1.35
48.0	12.7	0.74	1.25
51.0	13.4	0.90	1.11
54.0	14.1	0.92	1.48
57.0	14.8	1.16	1.11
60.0	15.5	1.28	1.17
63.0	16.2	1.36	1.24
66.0	16.9	1.32	1.42
69.0	17.6	1.22	1.41
72.0	18.3	1.24	1.35
75.0	19.0	1.06	1.29
78.0	19.7	1.02	1.46
81.0	20.4	0.88	1.53
84.0	21.1	0.93	1.46
87.0	21.8	1.05	1.58
90.0	22.5	0.94	1.48
93.0	23.2	0.98	1.36
96.0	24.0	0.86	1.51
99.0	25.3	0.59	1.47
102.0	26.7	0.74	1.43
105.0	28.0	0.69	1.48
108.0	29.4	0.55	1.30
111.0	30.8	0.50	1.38
114.0	32.0	0.53	1.44
117.0	33.2	0.54	1.29
120.0	34.4	0.43	1.30
123.0	35.7	0.44	1.40
126.0	36.5	0.54	1.30
129.0	37.3	0.55	1.44
132.0	38.2	0.50	1.45
135.0	39.4	0.65	1.41

Table A4. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
138.0	40.6	0.26	1.65
141.0	41.8	0.19	1.57
144.0	43.1	0.61	1.65
147.0	44.3	0.42	1.80
150.0	45.3	0.41	1.55
153.0	46.3	0.44	1.74
156.0	47.3	0.48	1.69
159.0	48.2	0.42	1.66
162.0	49.2	0.27	1.80
165.0	50.2	0.38	1.53
168.0	51.2	0.55	1.37
171.0	52.2	0.34	1.58
174.0	53.1	0.22	1.45
177.0	54.1	0.26	1.50
180.0	55.1	0.29	1.58
183.0	56.1	0.41	1.49
186.0	57.1	0.25	1.57
189.0	58.0	0.28	1.58
192.0	59.0	0.07	1.52
195.0	60.0	0.24	1.49
198.0	61.0	0.31	1.45
201.0	62.0	0.40	1.43
204.0	62.6	0.34	1.29
207.0	63.2	0.15	1.49
210.0	63.8	0.27	1.32
213.0	64.4	0.54	1.37
216.0	65.0	0.59	1.51
219.0	66.1	0.59	2.38
222.0	67.2	0.58	1.55
225.0	68.3	0.41	1.61
228.0	69.4	0.45	1.79
231.0	70.5	0.16	1.67
234.0	71.4	-0.03	1.83
237.0	72.2	-0.21	1.82
240.0	73.1	-0.03	1.61
243.0	74.0	-0.13	1.77
246.0	74.8	-0.13	1.86
249.0	75.7	-0.52	1.85
252.0	76.6	-0.05	1.90
255.0	77.4	-0.13	1.79
258.0	78.3	-0.30	1.78
261.0	79.2	-0.48	1.92
264.0	80.0	-0.58	1.81
267.0	80.9	-0.33	1.66
270.0	81.8	-0.31	1.78
273.0	82.6	-0.31	1.59

Table A4. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
276.0	83.9	-0.25	1.51
279.0	85.1	-0.12	1.49
282.0	86.4	-0.29	1.67
285.0	87.7	-0.20	1.79
288.0	88.9	-0.24	1.76
291.0	90.2	-0.19	1.57
294.0	91.4	-0.29	1.64
297.0	92.7	-0.62	1.81
300.0	93.9	-0.50	1.82
303.0	95.2	-0.49	1.97
306.0	96.4	-0.49	1.73
309.0	97.7	-0.60	1.74
312.0	99.0	-0.69	1.72
315.0	99.8	-0.65	1.86
318.0	100.6	-0.48	1.96
321.0	101.4	-0.38	1.71
324.0	102.2	-0.49	1.67
327.0	103.1	-0.41	1.92
330.0	103.9	-0.36	1.89
333.0	104.7	-0.33	1.88
336.0	105.5	-0.44	1.79
339.0	106.3	-0.31	1.92
342.0	107.2	-0.28	1.83
345.0	108.0	-0.34	1.89
348.0	108.8	-0.42	1.73
351.0	109.6	-0.20	1.65
354.0	110.5	-0.28	1.70
357.0	111.3	-0.19	1.51
363.0	112.9	-0.57	1.76
366.0	113.7	-0.54	1.65
369.0	114.6	-0.39	1.62
372.0	115.4	-0.79	1.60
375.0	116.2	-0.77	1.68
378.0	117.0	-0.55	1.76
381.0	117.8	-0.81	1.74
384.0	118.7	-0.80	1.76
387.0	119.5	-0.71	1.58
390.0	120.3	-0.64	1.79
393.0	121.1	-0.72	1.62
396.0	122.0	-0.87	1.80
399.0	122.8	-0.73	1.57
402.0	123.7	-0.49	1.78
405.0	124.6	-0.41	1.82
408.0	125.4	-0.58	1.47
411.0	126.3	-0.37	1.50
414.0	127.2	-0.28	1.13

Table A4. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
417.0	128.0	-0.38	1.40
420.0	128.9	-0.24	1.37
423.0	129.8	0.02	1.29
426.0	130.6	-0.05	1.11
429.0	131.5	0.02	1.01
432.0	132.4	0.30	1.18
435.0	133.2	0.37	1.01
438.0	134.1	0.33	1.21
441.0	135.0	0.50	1.19
444.0	136.3	0.31	1.19
447.0	137.6	0.45	1.20
450.0	139.0	0.34	0.98
453.0	140.3	0.34	1.19
456.0	141.6	0.31	1.14
459.0	143.0	0.44	1.14
462.0	144.3	0.46	1.12
465.0	145.6	0.32	1.07
468.0	147.0	0.47	1.11
471.0	148.3	0.41	1.22
474.0	149.6	0.32	1.11
477.0	151.0	0.65	1.11
480.0	151.7	0.49	1.13
483.0	152.4	0.53	1.16
486.0	153.2	0.42	1.19
489.0	153.9	0.26	1.30
492.0	154.6	0.07	0.94
495.0	155.4	-0.06	1.03
498.0	156.1	-0.27	1.01
501.0	156.8	-0.12	0.94
504.0	157.6	0.06	1.07
507.0	158.3	0.02	1.11
510.0	159.1	-0.03	0.89
513.0	159.8	-0.17	0.92
516.0	160.5	-0.12	0.90
519.0	161.3	-0.30	1.00
522.0	162.0	-0.29	1.18
525.0	162.7	-0.30	1.16
528.0	163.5	-0.36	1.38
531.0	164.2	-0.33	1.17
534.0	165.0	-0.08	1.44
537.0	165.8	-0.39	1.41
540.0	166.6	-0.48	1.51
543.0	167.4	-0.53	1.45
546.0	168.3	-0.52	1.43
549.0	169.1	-0.38	1.53
552.0	169.9	-0.49	1.48

Table A4. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
555.0	170.8	-0.34	1.73
558.0	171.6	-0.55	1.25
561.0	172.4	-0.23	1.49
564.0	173.2	-0.37	1.32
567.0	174.1	-0.87	1.32
570.0	174.9	-0.52	1.18
573.0	175.7	-0.40	1.27
576.0	176.6	-0.50	1.20
579.0	177.4	-0.57	1.16
582.0	178.2	-0.50	1.26
585.0	179.0	-0.51	1.24
588.0	179.9	-0.74	1.03
591.0	180.7	-0.65	1.29
594.0	181.5	-0.75	1.02
597.0	182.4	-0.73	1.02
600.0	183.2	-0.95	1.26
603.0	184.0	-1.05	1.36
606.0	184.8	-1.14	1.14
609.0	185.7	-1.07	1.27
612.0	186.5	-0.98	1.24
615.0	187.3	-0.67	1.30
618.0	188.2	-0.82	1.62
621.0	189.0	-0.78	1.39
624.0	189.8	-0.82	1.59
627.0	190.6	-1.17	1.73
630.0	191.5	-0.90	1.53
633.0	192.3	-1.15	1.80
636.0	193.1	-1.22	1.69
639.0	194.0	-1.30	1.58
642.0	195.2	-1.04	1.51
645.0	196.4	-1.08	1.39
648.0	197.7	-1.93	0.90
651.0	198.6	-0.74	1.26
654.0	200.2	-0.98	1.50
657.0	201.4	-1.22	1.32
660.0	202.6	-1.18	1.48
663.0	203.9	-0.94	1.65
666.0	205.1	-0.76	1.48
669.0	206.4	-1.18	1.07
672.0	207.6	-1.30	1.46
675.0	208.8	-1.14	1.32
678.0	210.1	-1.90	1.09
690.0	215.0	-0.13	1.09
696.0	217.5	-0.30	0.96
702.0	220.0	-0.26	1.14
729.0	229.6	-0.72	0.96

Table A4. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
735.0	231.5	-0.93	1.24
738.0	232.4	-0.65	1.32
741.0	233.3	-1.02	1.35
744.0	234.2	-1.03	1.45
747.0	235.2	-1.00	1.24
750.0	236.1	-1.12	1.44
753.0	237.0	-0.88	1.26
756.0	238.0	-1.14	1.36
759.0	238.9	-1.11	1.28
762.0	239.8	-1.00	1.26
765.0	240.7	-0.91	1.21

Table A5. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in V25-56.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
5.0	3.5	-1.80	2.05
10.0	4.7	-1.73	1.99
15.0	5.8	-1.78	2.03
20.0	6.9	-1.65	2.05
25.0	8.0	-1.44	2.11
30.0	8.9	-1.49	1.78
35.0	9.6	-1.12	1.54
40.0	10.4	-0.95	1.45
45.0	11.1	-0.80	1.51
50.0	11.9	-0.69	1.48
55.0	12.8	-0.55	1.46
60.0	13.6	-0.16	1.43
65.0	14.4	0.05	1.70
70.0	15.0	0.00	1.66
75.0	15.6	0.07	1.65
80.0	16.2	0.10	1.74
85.0	16.7	-0.03	1.67
90.0	17.3	-0.17	1.47
100.0	18.5	-0.26	1.49
105.0	19.1	-0.12	1.66
110.0	19.7	0.00	1.77
115.0	20.2	-0.16	1.67
120.0	20.8	-0.21	1.53
125.0	21.4	-0.29	1.66
130.0	22.0	-0.32	1.61
135.0	22.6	-0.29	1.71
140.0	23.1	-0.38	1.74
145.0	23.7	-0.28	1.80
150.0	24.9	-0.44	1.51
155.0	26.4	-0.56	1.68
160.0	28.0	-0.64	1.73
165.0	28.9	-0.48	1.58
170.0	29.8	-0.21	1.69
175.0	30.7	-0.32	1.60
180.0	31.6	-0.28	1.68
185.0	32.5	-0.63	1.81
190.0	33.4	-0.59	1.71
195.0	34.3	-0.61	1.76
200.0	35.2	-0.66	1.83
205.0	36.1	-0.58	1.66
210.0	37.0	-0.40	1.71
215.0	38.77	-0.56	1.84
220.0	40.5	-0.59	1.82
225.0	42.3	-0.54	1.85
230.0	44.1	-0.69	1.88
235.0	45.8	-0.71	1.64

Table A5. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
240.0	47.6	-0.60	1.54
245.0	49.4	-0.55	1.59
250.0	51.2	-0.60	1.64
255.0	53.0	-0.89	1.43
260.0	59.0	-0.49	1.37
265.0	65.0	-0.12	1.20
270.0	66.0	-0.20	1.31
275.0	67.1	-0.35	1.77
280.0	68.2	-0.28	1.62
285.0	69.2	-0.30	1.98
290.0	70.3	-0.46	2.09
295.0	71.4	-0.78	1.62
300.0	72.5	-0.59	1.90
305.0	73.5	-0.65	1.89
310.0	74.6	-0.76	1.99
315.0	75.7	-0.76	2.09
320.0	76.7	-1.13	1.87
330.0	78.9	-1.18	2.01
335.0	80.0	-1.51	1.95
340.0	81.0	-1.35	1.95
345.0	82.0	-1.38	1.92
350.0	83.0	-1.18	1.96
355.0	84.0	-1.01	1.89
360.0	85.0	-0.89	1.84
365.0	86.0	-1.05	1.75
370.0	87.0	-0.94	1.98
375.0	88.3	-1.08	2.04
380.0	89.6	-0.92	1.79
385.0	91.0	-1.13	1.65
390.0	92.3	-1.26	1.55
395.0	93.6	-1.40	1.52
400.0	95.0	-1.40	1.57
405.0	96.3	-1.14	1.86
410.0	97.6	-1.33	1.66
415.0	99.0	-1.25	2.05
420.0	100.3	-1.45	1.70
430.0	103.0	-1.31	1.64
435.0	104.3	-1.11	1.91
440.0	105.6	-1.16	1.79
445.0	107.0	-0.81	1.65
450.0	108.5	-1.10	1.57
455.0	110.0	-1.09	1.76
460.0	111.5	-1.28	1.76
465.0	113.0	-1.32	1.62
470.0	114.5	-1.14	1.69
475.0	116.0	-1.29	1.58

Table A5. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
480.0	117.5	-1.30	1.59
485.0	119.0	-1.76	1.53
490.0	120.5	-1.66	1.38
495.0	122.0	-2.15	1.50
500.0	123.1	-1.44	1.59
505.0	124.2	-1.57	1.49
510.0	125.3	-1.65	1.45
515.0	126.5	-1.17	1.39
520.0	127.6	-1.10	1.36
525.0	128.7	-0.85	1.08
530.0	129.9	-0.20	0.97
535.0	132.5	-0.40	1.03
540.0	135.2	-0.26	1.10
545.0	137.9	-0.16	1.07
550.0	140.6	-0.17	1.18
555.0	143.3	-0.40	1.16
560.0	146.0	-0.61	1.17
565.0	147.6	-0.33	1.39
570.0	149.3	-0.26	1.36
575.0	151.0	-0.22	1.24
580.0	153.4	-0.39	1.07
585.0	155.8	-0.25	1.52
590.0	158.2	-0.62	1.31
595.0	160.6	-0.60	1.29
600.0	163.1	-0.72	1.21
605.0	165.5	-0.77	1.34
610.0	167.9	-0.71	1.36
615.0	170.3	-0.77	1.38
620.0	172.7	-0.76	1.37
625.0	175.2	-0.75	1.17
630.0	177.6	-0.79	1.14
635.0	180.0	-0.71	1.37
640.0	182.4	-0.74	1.36
645.0	184.8	-0.82	1.26
650.0	187.3	-0.83	1.58
655.0	191.7	-1.40	1.39
660.0	197.6	-1.38	1.61
665.0	205.0	-1.12	1.55
670.0	209.4	-1.29	1.84
675.0	213.8	-1.48	2.02
680.0	219.0	-1.48	1.65
685.0	225.0	-1.06	1.60
690.0	229.4	-1.08	1.83
695.0	232.2	-1.56	1.39
700.0	235.1	-1.42	1.85
705.0	238.0	-1.65	1.58

Table A5. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
710.0	241.6	-1.11	1.25
715.0	245.3	-0.81	1.18
720.0	249.0	-0.71	1.57
725.0	252.6	-0.78	1.27
730.0	256.3	-1.08	1.49

Table A6. Stable isotopes (per mil vs PDB) from *Neogloboquadrina dutertrei* in RC66-66.

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
10.0	4.7	-1.15	1.98
20.0	8.3	-0.90	1.93
30.0	12.0	-0.75	2.04
50.0	14.3	-0.42	1.92
60.0	15.5	0.04	1.76
70.0	16.6	0.25	1.99
80.0	17.8	0.53	2.31
100.0	20.0	0.24	1.88
110.0	21.0	0.59	2.03
120.0	22.1	0.17	1.92
140.0	24.3	0.13	1.97
150.0	25.4	-0.01	1.82
160.0	30.0	0.03	2.00
170.0	34.6	-0.32	1.90
180.0	39.2	-0.26	2.04
190.0	43.8	-0.46	2.06
200.0	45.9	-0.06	1.95
210.0	48.1	-0.28	1.82
220.0	50.2	-0.48	2.17
230.0	51.9	-0.25	1.73
240.0	53.7	-0.18	2.00
250.0	55.4	-0.44	2.09
260.0	56.6	-0.36	1.96
270.0	57.7	-0.17	1.97
280.0	58.9	-0.36	1.82
290.0	64.0	0.65	1.70
340.0	73.5	-0.03	2.00
370.0	79.2	-1.62	1.74
380.0	82.6	-0.18	1.88
400.0	89.4	0.01	1.92
410.0	92.8	-0.06	1.83
420.0	96.2	-0.12	1.95
430.0	99.6	-0.20	1.97
440.0	103.0	-0.28	1.91
470.0	113.2	-0.57	1.73
490.0	120.0	-1.62	1.74
530.0	130.0	0.31	0.98
540.0	132.5	-0.19	1.26
550.0	135.1	0.52	1.27
570.0	143.8	0.55	1.45
580.0	148.2	0.58	1.44
590.0	152.5	0.78	1.39
610.0	157.5	0.74	1.40
620.0	160.0	-0.03	1.47
640.0	165.0	-0.41	1.60
660.0	170.0	-0.75	1.59

Table A6. (continued)

depth (cm)	age (Ka)	$\delta^{18}\text{O}$	$\delta^{13}\text{C}$
670.0	174.2	-0.58	1.52
690.0	182.7	-0.06	1.08
840.0	225.4	-1.34	1.64
910.0	235.5	-1.46	1.70
940.0	249.0	0.42	0.98
950.0	253.4	-0.28	1.57
970.0	262.4	-0.44	1.92
980.0	266.9	-0.38	1.67
990.0	271.4	-0.40	1.68
1000.0	275.9	-0.60	1.67
1010.0	280.4	-0.56	1.66
1020.0	284.8	-0.73	1.38

APPENDIX B

**CONCENTRATION OF CALCIUM CARBONATE, ORGANIC CARBON,
NITROGEN, OPAL, AND "OTHER" AS WELL AS C/N RATIOS IN CORES OF THE
EQUATORIAL ATLANTIC**

Table B1. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in RC24-01.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
7.0	5.5	83.940	0.253	0.037	2.839	12.931	6.8
10.0	7.3	85.610	0.280	0.028	3.099	10.983	10.8
15.0	8.5	84.060	0.202	0.026	2.960	12.752	7.8
20.0	9.8	82.830	0.178	0.037	3.258	13.697	4.8
25.0	11.1	81.600	0.170	0.030	3.350	14.850	5.7
30.0	12.3	74.780	0.188	0.039	3.855	21.138	4.8
35.0	13.6	72.010	0.221	0.039	5.381	22.349	5.7
40.0	14.9	58.890	0.439	0.052	7.172	33.447	8.4
45.0	15.8	60.570	0.886	0.103	7.143	31.298	8.6
50.0	16.8	64.980	0.954	0.107	6.754	27.205	8.9
55.0	17.8	69.510	1.270	0.141	5.919	23.160	9.0
60.0	18.7	70.080	1.337	0.151	5.850	22.582	8.9
65.0	19.7	69.040	1.220	0.138	6.419	23.183	8.8
70.0	20.7	69.770	1.161	0.146	6.417	22.506	8.0
75.0	21.6	65.400	1.355	0.165	6.280	26.800	8.2
80.0	22.6	66.180	1.259	0.142	6.196	26.223	8.9
85.0	23.6	65.330	1.256	0.144	6.588	26.682	8.7
90.0	24.5	62.760	1.174	0.147	6.840	29.079	8.0
95.0	25.5	62.490	1.148	0.158	6.920	29.284	7.3
100.0	26.5	57.750	1.143	0.141	8.146	32.820	8.1
105.0	27.4	63.730	1.176	0.119	7.178	27.797	9.9
110.0	28.4	63.590	1.104	0.113	7.230	27.963	9.8
124.0	31.1	76.150	1.296	0.093	4.617	17.844	13.9
129.0	32.1	68.090	1.252	0.136	4.805	25.852	9.6
140.0	34.2	67.870	1.006	0.121	5.476	25.527	8.2
145.0	35.2	70.510	0.942	0.099	6.358	22.091	8.3
150.0	36.1	69.050	0.967	0.088	6.312	23.583	9.5
153.0	36.7	70.720	0.975	0.094	6.461	21.750	11.0

Table B1. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
158.0	37.7	73.960	0.740	0.077	6.070	19.153	10.4
163.0	38.6	76.080	0.746	0.078	5.448	17.648	9.6
168.0	39.6	77.000	0.633	0.056	5.144	17.167	11.3
173.0	40.6	77.470	0.763	0.064	4.646	17.057	11.9
178.0	41.5	76.080	0.697	0.072	4.270	18.881	9.7
183.0	42.5	75.170	0.549	0.070	4.599	19.612	7.8
188.0	43.5	72.360	0.557	0.066	4.283	22.734	8.4
193.0	44.4	68.000	0.800	0.094	5.506	25.600	8.5
198.0	45.3	74.540	0.753	0.077	5.969	18.661	9.8
203.0	46.2	75.720	0.753	0.111	5.699	17.717	6.8
208.0	47.1	74.790	0.782	0.089	5.381	18.958	8.8
213.0	48.0	73.260	0.643	0.099	5.786	20.212	6.5
218.0	48.9	71.560	0.593	0.074	6.326	21.447	8.0
223.0	49.8	74.890	0.604	0.084	5.155	19.267	7.2
228.0	50.7	68.060	0.682	0.096	5.267	25.895	7.1
233.0	51.5	67.890	0.711	0.093	6.090	25.216	7.6
238.0	52.4	76.590	0.646	0.083	5.508	17.173	7.8
243.0	53.2	79.880	0.540	0.072	4.789	14.719	7.5
248.0	54.1	80.730	0.474	0.078	4.182	14.536	6.1
253.0	55.0	78.160	0.444	0.058	4.660	16.678	7.7
258.0	55.8	78.480	0.536	0.082	4.497	16.405	6.5
263.0	56.7	76.800	0.683	0.061	4.334	18.122	11.2
268.0	57.5	72.920	0.580	0.067	4.119	22.314	8.7
273.0	58.4	66.580	0.586	0.061	5.664	27.109	9.6
278.0	59.2	60.370	0.723	0.065	5.164	33.678	11.1
283.0	60.1	61.350	0.659	0.082	6.567	31.342	8.0
288.0	61.2	66.510	0.557	0.045	5.497	27.391	12.4
293.0	62.5	64.960	0.680	0.077	8.027	26.256	8.8

Table B1. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
298.0	63.7	69.360	0.610	0.080	6.636	23.314	7.6
303.0	65.0	59.350	0.797	0.137	10.320	29.396	5.8
307.0	66.0	57.210	0.734	0.105	9.688	32.263	7.0
311.0	67.0	57.650	0.835	0.083	11.137	30.295	10.1
316.0	68.2	56.440	0.805	0.117	10.949	31.689	6.9
321.0	69.5	57.370	0.773	0.115	10.401	31.341	6.7
326.0	70.7	61.640	0.741	0.123	8.123	29.373	6.0
332.0	72.2	60.650	0.699	0.126	6.977	31.548	5.5
337.0	73.5	55.160	0.666	0.121	7.324	36.729	5.5
342.0	74.7	57.320	0.546	0.088	5.325	36.721	6.2
347.0	76.0	73.300	0.512	0.067	4.746	21.375	7.6
352.0	77.2	70.700	0.641	0.080	4.985	23.594	8.0
357.0	78.5	81.200	0.324	0.055	3.424	14.997	5.9
362.0	80.0	80.720	0.275	0.047	3.226	15.732	5.9
367.0	82.0	69.540	0.254	0.044	5.160	25.002	5.8
372.0	84.0	67.020	0.209	0.042	4.552	28.177	5.0
377.0	85.9	81.420	0.267	0.068	3.285	14.960	3.9
382.0	87.9	82.580	0.399	0.058	2.577	14.386	6.9
387.0	89.9	80.620	0.394	0.052	3.315	15.619	7.6
392.0	91.8	79.780	0.362	0.052	3.416	16.390	7.0
397.0	93.8	79.450	0.434	0.048	3.321	16.747	9.0
402.0	95.8	78.290	0.358	0.057	3.381	17.914	6.3
407.0	97.8	81.660	0.292	0.045	2.912	15.091	6.5
412.0	99.7	93.880	0.445	0.044	2.710	2.921	10.1
417.0	101.7	79.950	0.276	0.035	3.504	16.235	7.9
422.0	103.7	79.270	0.417	0.051	3.815	16.447	8.2
427.0	105.6	80.520	0.346	0.052	3.100	15.982	6.7
432.0	107.6	77.230	0.417	0.047	4.161	18.145	8.9

Table B1. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
437.0	109.6	74.140	0.379	0.046	3.651	21.784	8.2
442.0	111.5	75.820	0.579	0.044	3.852	19.705	13.2
447.0	113.5	74.750	0.354	0.053	4.397	20.446	6.7
452.0	115.5	73.890	0.386	0.056	3.353	22.315	6.9
457.0	117.4	77.100	0.363	0.061	3.730	18.746	6.0
463.0	119.8	75.060	0.321	0.047	3.512	21.060	6.8
468.0	121.8	79.990	0.275	0.052	3.177	16.506	5.3
473.0	123.6	77.520	0.175	0.041	3.466	18.798	4.3
478.0	125.4	66.940	0.209	0.041	4.237	28.573	5.1
483.0	127.2	66.150	0.178	0.046	4.936	28.690	3.9
488.0	129.0	56.140	0.233	0.051	6.182	37.394	4.6
493.0	130.8	55.330	0.325	0.062	7.227	37.056	5.2
498.0	132.6	64.930	0.605	0.078	5.599	28.788	7.8
503.0	134.3	70.230	0.696	0.077	5.902	23.095	9.0
508.0	135.9	67.180	0.796	0.094	5.742	26.188	8.5
513.0	137.4	61.920	0.911	0.110	5.998	31.061	8.3
518.0	138.8	69.480	0.920	0.105	6.065	23.430	8.8
523.0	140.3	68.000	0.733	0.083	6.482	24.702	8.8
528.0	141.7	71.490	0.769	0.089	6.176	21.476	8.6
533.0	143.1	72.170	0.812	0.088	6.414	20.516	9.2
538.0	144.6	70.170	0.986	0.065	6.999	21.780	15.2
543.0	146.0	72.670	0.870	0.085	6.970	19.405	10.2
548.0	147.5	69.170	0.783	0.066	6.916	23.065	11.9
553.0	148.9	67.900	0.989	0.070	7.168	23.873	14.1
558.0	150.4	64.960	0.866	0.070	7.236	26.868	12.4
563.0	151.8	65.230	0.531	0.037	6.534	27.668	14.4
568.0	153.3	66.340	0.838	0.088	6.215	26.519	9.5
573.0	154.6	66.130	0.870	0.102	7.126	25.772	8.5

Table B1. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
578.0	155.7	66.470	0.864	0.101	7.044	25.521	8.6
583.0	156.9	68.100	0.710	0.070	5.578	25.542	10.1
588.0	158.1	57.480	0.831	0.101	7.799	33.789	8.2
593.0	159.3	52.330	0.918	0.109	8.653	37.990	8.4
598.0	160.4	60.240	0.960	0.114	7.405	31.281	8.4
603.0	161.6	60.350	0.806	0.094	7.150	31.600	8.6
608.0	162.8	57.330	0.942	0.100	9.003	32.625	9.4
612.0	163.9	60.060	0.854	0.078	8.228	30.780	10.9
617.0	165.5	74.090	0.801	0.068	6.246	18.795	11.8
622.0	167.2	71.470	0.520	0.051	3.813	24.146	10.2
627.0	168.8	78.970	0.617	0.052	3.933	16.428	11.9
632.0	170.4	80.340	0.519	0.044	3.241	15.856	11.8
637.0	172.1	76.200	0.594	0.042	4.353	18.811	14.1
642.0	173.7	77.280	0.483	0.042	3.837	18.358	11.5
647.0	175.4	76.210	0.374	0.062	3.889	19.465	6.0
652.0	177.0	70.890	0.611	0.063	5.147	23.289	9.7
657.0	178.7	76.340	0.672	0.073	4.919	17.996	9.2
662.0	180.2	74.150	0.696	0.069	5.051	20.034	10.1
667.0	181.5	70.920	0.649	0.072	5.498	22.861	9.0
672.0	182.9	67.060	0.763	0.086	5.924	26.167	8.9
677.0	184.2	66.080	0.837	0.093	5.448	27.542	9.0
682.0	185.5	65.470	0.727	0.086	4.968	28.749	8.5
687.0	186.9	71.650	0.619	0.070	4.652	23.009	8.8
692.0	188.2	68.320	0.451	0.052	4.717	26.460	8.7
697.0	189.6	89.000	0.639	0.035	4.727	5.599	18.3
702.0	190.9	81.190	0.525	0.062	4.738	13.485	8.5
707.0	192.2	63.020	0.748	0.078	6.202	29.952	9.6
712.0	194.0	88.750	0.235	0.038	2.643	8.334	6.2

Table B1. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
717.0	196.4	79.280	0.436	0.050	2.719	17.515	8.7
722.0	198.8	74.930	0.551	0.066	4.613	19.840	8.3
727.0	201.1	80.220	0.368	0.039	3.045	16.328	9.4
732.0	203.5	79.170	0.322	0.041	4.818	15.649	7.9
757.0	215.4	79.130	0.367	0.047	3.675	16.781	7.8
762.0	217.8	82.300	0.397	0.041	3.088	14.174	9.7

Table B2. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in RC24-07.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
6.0	2.6	84.990	0.416	0.024	3.123	11.447	17.3
10.0	3.4	83.410	0.298	0.047	3.249	12.996	6.3
15.0	4.4	86.310	0.334	0.042	3.280	10.034	8.0
19.0	5.2	87.260	0.315	-	3.582	-	-
26.0	6.5	84.790	0.287	0.033	3.876	11.014	8.7
28.0	6.9	83.720	0.250	0.029	4.215	11.786	8.6
32.0	7.7	85.090	0.206	0.049	4.068	10.587	4.2
35.0	8.3	80.480	0.215	0.025	4.911	14.369	8.6
40.0	9.2	79.120	0.183	0.033	5.829	14.835	5.5
45.0	10.1	73.010	0.511	0.040	5.408	21.031	12.8
50.0	11.0	76.590	0.483	0.039	4.403	18.485	12.4
55.0	11.9	76.680	0.473	0.044	5.237	17.566	10.8
60.0	12.8	72.680	0.497	0.066	6.150	20.607	7.5
65.0	13.8	65.890	0.698	0.064	8.070	25.278	10.9
70.0	14.7	58.750	0.822	0.093	8.114	32.221	8.8
75.0	15.5	60.210	0.998	0.119	9.240	29.433	8.4
80.0	16.3	64.720	1.266	0.121	7.459	26.434	10.5
85.0	17.0	71.150	1.160	0.107	6.882	20.701	10.8
90.0	17.8	69.690	1.560	0.195	6.025	22.530	8.0
95.0	18.5	68.280	1.926	0.189	5.878	23.727	10.2
98.0	18.9	69.060	1.563	0.148	5.868	23.361	10.6
101.0	19.3	69.710	1.372	0.141	6.396	22.381	9.7
105.0	19.9	72.470	1.516	0.162	6.481	19.371	9.7
111.0	20.8	69.690	1.817	0.157	5.633	22.703	9.4
115.0	21.4	72.960	1.507	0.154	6.213	19.166	11.6
121.0	22.2	66.450	1.676	0.180	6.596	25.098	9.8
125.0	22.8	67.010	1.874	0.162	7.172	23.782	9.3
131.0	23.7	65.290	1.758	0.182	7.017	25.753	11.6
135.0	24.3	68.260	1.918	0.212	6.307	23.303	9.7

Table B2. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	CN RATIO
141.0	25.1	64.140	1.982	0.203	6.318	27.357	9.0
145.0	25.7	58.670	1.669	0.174	8.326	31.161	9.8
151.0	26.6	59.290	1.514	0.160	7.877	31.159	9.6
155.0	27.2	62.300	1.583	0.155	7.601	28.361	9.5
161.0	28.0	59.780	1.444	0.152	7.890	30.734	10.2
165.0	28.6	62.280	1.500	0.127	8.454	27.639	9.5
171.0	29.5	60.230	1.806	0.165	8.033	29.766	11.8
175.0	30.1	66.650	1.818	0.189	7.673	23.670	10.9
181.0	30.9	68.700	1.824	0.187	7.141	22.148	9.6
185.0	31.5	65.790	1.631	0.161	6.989	25.429	9.8
191.0	32.4	68.440	1.847	0.181	6.728	22.804	10.1
201.0	33.9	70.850	0.985	0.117	6.595	21.453	10.2
205.0	34.4	68.150	0.956	0.099	6.681	24.114	8.4
211.0	35.3	69.680	1.040	0.125	6.391	22.764	9.7
215.0	35.9	75.080	1.044	0.092	5.465	18.319	8.3
221.0	36.8	74.350	0.861	0.096	5.418	19.275	11.3
225.0	37.3	76.640	0.924	0.083	5.476	16.877	9.0
231.0	38.2	75.760	0.753	0.071	5.574	17.842	11.1
235.0	38.8	74.780	0.855	0.080	5.487	18.798	10.6
241.0	39.7	78.940	0.813	0.096	4.413	15.738	10.7
245.0	40.3	81.910	0.896	0.097	5.034	12.063	8.5
251.0	41.1	76.510	0.875	0.082	5.155	17.378	9.2
255.0	41.7	77.850	0.858	0.077	4.955	16.260	10.7
261.0	42.6	76.670	0.908	0.091	6.995	15.336	11.1
265.0	43.2	66.660	0.994	0.097	8.029	24.220	10.0
271.0	44.0	70.710	0.974	0.106	9.912	18.298	9.2
275.0	44.6	76.330	1.088	0.106	6.621	15.855	10.3
281.0	45.5	74.790	0.930	0.101	6.479	17.700	9.2
285.0	46.1	74.180	0.942	0.094	6.863	17.921	10.0

Table B2. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
291.0	46.9	70.830	0.956	0.106	7.485	20.623	9.0
295.0	47.5	72.710	1.052	0.119	7.335	18.784	8.8
301.0	48.4	72.680	0.922	0.116	5.711	20.571	7.9
305.0	49.0	75.400	0.734	0.081	4.776	19.009	9.1
311.0	49.8	69.440	0.768	0.087	7.055	22.650	8.8
315.0	50.4	60.480	0.875	0.087	7.524	31.034	10.1
321.0	51.3	70.820	0.969	0.124	5.902	22.185	7.8
325.0	51.9	77.550	0.868	0.095	5.394	16.093	9.1
331.0	52.8	77.960	0.667	0.073	5.247	16.053	9.1
335.0	53.3	79.870	0.747	0.074	4.565	14.744	10.1
341.0	54.2	77.510	0.642	0.065	5.294	16.489	9.9
345.0	54.8	76.340	0.816	0.070	5.923	16.851	11.7
350.0	55.9	75.180	0.787	0.088	5.591	18.354	8.9
355.0	57.0	76.510	0.672	0.067	5.456	17.295	10.0
360.0	58.2	67.200	0.762	0.074	6.651	25.313	10.3
365.0	59.3	62.540	0.726	0.078	8.541	28.115	9.3
370.0	60.4	59.900	0.774	0.074	8.046	31.206	10.5
375.0	62.0	69.810	0.791	0.086	7.137	22.176	9.2
380.0	63.5	63.900	0.784	0.084	9.345	25.887	9.3
385.0	65.1	60.660	0.944	0.106	12.661	25.629	8.9
390.0	66.7	52.200	0.848	0.090	13.712	33.150	9.4
395.0	68.2	61.470	0.602	0.070	10.238	27.620	8.6
400.0	69.8	55.790	0.814	0.104	8.986	34.306	7.8
405.0	71.4	66.850	0.783	0.097	7.139	25.131	8.1
410.0	72.9	49.540	0.869	0.101	9.184	40.306	8.6
415.0	74.5	72.170	0.670	0.084	5.995	21.081	8.0
420.0	76.1	64.840	0.709	0.076	6.963	27.412	9.3
425.0	77.6	81.150	0.564	0.047	4.216	14.023	12.0
430.0	79.2	82.240	0.225	0.042	3.894	13.599	5.4

Table B2. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
435.0	85.1	80.080	0.222	0.040	2.388	17.270	5.5
440.0	90.9	74.870	0.294	0.043	5.964	18.829	6.8
445.0	92.7	81.410	0.517	0.049	3.909	14.115	10.6
450.0	94.5	79.020	0.518	0.062	3.309	17.091	8.4
455.0	96.3	79.250	0.523	0.070	4.594	15.563	7.5
460.0	98.1	76.560	0.537	0.049	4.815	18.039	11.0
465.0	99.9	80.620	0.480	0.053	5.071	13.776	9.1
470.0	101.7	82.390	0.435	0.038	4.135	13.002	11.4
475.0	103.5	81.840	0.584	0.037	4.025	13.514	15.8
480.0	105.3	79.410	0.218	0.037	4.671	15.664	5.9
485.0	107.1	79.810	0.557	0.042	4.501	15.090	13.3
490.0	108.9	74.810	0.513	0.040	5.746	18.891	12.8
495.0	110.7	73.950	0.549	0.079	5.219	20.203	6.9
500.0	112.5	70.810	0.408	0.057	5.179	23.546	7.2
505.0	114.3	75.400	0.646	0.073	4.848	19.033	8.8
511.0	116.5	76.370	0.493	0.044	5.307	17.786	11.2
515.0	117.9	89.730	0.200	0.028	1.459	8.583	7.1
521.0	120.1	78.910	0.518	0.034	4.640	15.898	15.2
525.0	121.5	81.180	0.355	0.028	4.089	14.348	12.7
531.0	123.7	76.350	0.381	0.024	4.915	18.330	15.9
535.0	125.1	70.760	0.279	0.033	6.287	22.641	8.5
541.0	127.1	66.110	0.326	0.036	7.345	26.183	9.1
545.0	128.4	58.550	0.732	0.055	8.438	32.225	13.3
551.0	130.4	58.310	0.774	0.073	9.460	31.383	10.6
555.0	131.7	61.260	0.898	0.085	8.851	28.906	10.6
561.0	133.6	70.140	0.838	0.078	7.299	21.645	10.7
565.0	135.0	69.480	1.007	0.089	7.882	21.542	11.3
571.0	136.7	65.030	1.088	0.118	7.230	26.534	9.2
575.0	137.9	69.030	1.013	0.088	8.179	21.690	11.5

Table B2. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
581.0	139.6	70.040	0.895	0.098	8.427	20.540	9.1
585.0	140.8	70.240	1.038	0.088	8.235	30.399	11.8
591.0	142.5	70.520	1.019	0.086	8.617	19.758	11.8
595.0	143.7	68.790	1.007	0.088	9.239	20.876	11.4
601.0	145.4	72.190	1.036	0.068	8.087	18.619	15.2
605.0	146.6	73.030	0.991	0.066	8.336	17.577	15.0
611.0	148.3	67.100	1.053	0.075	10.084	21.688	14.0
615.0	149.5	67.880	0.981	0.071	9.791	21.277	13.8
621.0	151.2	64.270	0.941	0.069	9.294	25.426	13.6
625.0	152.4	68.080	0.965	0.078	8.732	22.145	12.4
631.0	154.2	69.940	0.984	0.084	9.014	19.978	11.7
635.0	155.3	67.700	1.006	0.091	8.431	22.772	11.1
641.0	157.1	68.430	0.956	0.093	7.789	22.732	10.3
645.0	158.4	57.040	0.994	0.097	10.317	31.552	10.2
651.0	160.3	53.000	1.118	0.112	10.242	35.528	10.0
655.0	161.6	59.100	1.123	0.105	9.327	30.345	10.7
661.0	163.6	51.150	1.202	0.109	10.765	36.774	11.0
665.0	164.9	55.620	1.321	0.122	10.333	32.604	10.8
671.0	166.8	68.620	1.120	0.073	6.865	23.322	15.3
675.0	168.1	77.550	0.771	0.054	4.959	16.666	14.3
681.0	170.0	78.960	0.669	0.048	4.729	15.594	13.9
685.0	171.3	78.170	0.837	0.058	5.398	15.537	14.4
691.0	173.6	73.490	0.764	0.047	6.930	18.769	16.3
695.0	176.3	77.900	0.817	0.049	5.689	15.545	16.7
701.0	180.3	77.040	0.709	0.049	6.333	15.869	14.5
705.0	183.0	73.920	0.996	0.087	6.139	18.858	11.4
711.0	184.1	69.090	1.178	0.112	8.002	21.618	10.5
715.0	184.8	67.640	1.169	0.109	8.007	23.075	10.7
721.0	185.9	66.240	0.948	0.095	7.341	25.376	10.0

Table B2. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
725.0	186.6	70.960	0.916	0.090	7.113	20.921	10.2
731.0	187.7	70.920	0.784	0.067	6.337	21.892	11.7
735.0	188.5	71.860	0.557	0.052	6.860	20.671	10.7
741.0	189.6	61.860	0.727	0.089	9.897	27.427	8.2
745.0	190.3	64.550	0.712	0.059	8.387	26.292	12.1
751.0	191.4	80.690	0.400	0.031	4.241	14.638	12.9
755.0	192.1	87.240	0.320	0.021	3.436	8.983	15.2
761.0	193.2	88.420	0.328	0.024	2.943	8.285	13.7
765.0	194.0	84.650	0.225	0.020	3.912	11.193	11.2
771.0	195.4	77.830	0.306	0.024	4.853	16.987	12.8
775.0	196.4	75.810	0.329	0.031	5.738	18.154	10.6
781.0	197.9	76.440	0.392	0.092	4.509	18.567	4.3
785.0	198.9	81.330	0.398	0.037	4.032	14.203	10.8
791.0	200.4	80.860	0.389	0.033	3.756	14.962	11.8
795.0	201.4	83.460	0.352	0.033	3.222	12.933	10.7
801.0	202.8	82.820	0.429	0.045	4.785	11.941	9.5
809.0	204.8	77.040	0.505	0.054	5.328	17.073	9.4

Table B3. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in RC24-12.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
10.0	2.9	85.620	0.227	0.018	2.141	11.993	12.3
15.0	3.6	91.230	0.219	0.028	2.128	6.394	7.7
20.0	4.3	89.650	0.126	0.017	2.031	8.176	7.5
25.0	5.1	88.330	0.191	0.025	2.412	9.042	7.5
30.0	5.8	90.150	0.151	0.016	1.991	7.692	9.3
35.0	6.6	90.440	0.129	0.025	1.706	7.699	5.1
40.0	7.5	90.420	0.123	0.013	1.545	7.899	9.2
45.0	8.4	88.000	0.129	0.023	2.160	9.689	5.7
50.0	9.3	88.730	0.222	0.013	2.351	8.684	17.0
55.0	10.3	89.350	0.141	0.027	2.408	8.074	5.1
60.0	11.2	88.340	0.100	0.012	2.533	9.015	8.0
65.0	12.1	90.130	0.093	0.017	1.761	7.999	5.5
70.0	13.0	86.740	0.118	0.016	2.940	10.186	7.2
75.0	14.0	85.380	0.160	0.021	3.209	11.231	7.7
80.0	15.6	81.110	0.287	0.033	4.293	14.277	8.7
85.0	17.2	80.230	0.640	0.060	3.688	15.382	10.7
90.0	18.5	82.900	0.805	0.079	3.620	12.597	10.2
95.0	19.7	80.350	0.889	0.083	3.890	14.788	10.7
100.0	21.0	81.280	0.938	0.096	3.284	14.402	9.7
105.0	22.3	80.290	0.817	0.076	3.665	15.153	10.8
110.0	23.8	79.960	0.986	0.098	3.778	15.178	10.1
115.0	25.5	83.990	0.454	0.041	2.453	13.062	11.0
120.0	27.2	84.490	0.632	0.061	2.959	11.859	10.4
125.0	28.9	78.580	0.730	0.043	2.973	17.673	17.0
130.0	30.6	86.350	0.487	0.048	2.216	10.900	10.2
135.0	32.3	87.950	0.457	0.045	2.189	9.360	10.3
140.0	34.1	88.570	0.468	0.044	1.832	9.086	10.6
145.0	35.8	85.160	0.375	0.038	1.979	12.447	9.9

Table B3. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
150.0	38.6	86.400	0.404	0.039	2.037	11.119	10.3
155.0	42.1	82.630	0.410	0.040	2.719	14.202	10.3
160.0	45.7	84.420	0.414	0.042	2.884	12.240	10.0
165.0	49.2	82.770	0.440	0.046	2.888	13.856	9.6
170.0	52.7	85.360	0.425	0.037	2.699	11.479	11.6
175.0	54.4	84.830	0.425	0.041	2.629	12.075	10.3
180.0	55.6	83.000	0.474	0.047	2.920	13.559	10.1
185.0	56.7	85.790	0.407	0.042	2.470	11.291	9.7
190.0	57.9	86.920	0.311	0.033	2.217	10.519	9.4
195.0	59.1	81.950	0.343	0.035	2.492	15.179	9.8
200.0	60.3	86.400	0.416	0.037	2.559	10.587	11.2
205.0	61.5	82.790	0.376	0.043	3.052	13.739	8.8
210.0	62.6	83.790	0.412	0.037	2.982	12.780	11.1
215.0	63.8	79.280	0.380	0.034	3.987	16.320	11.3
220.0	65.6	80.740	0.509	0.045	4.455	14.251	11.3
225.0	67.5	77.950	0.712	0.070	4.804	16.463	10.2
230.0	69.5	77.830	0.746	0.073	4.305	17.046	10.2
235.0	71.4	82.300	0.565	0.056	2.969	14.110	10.0
240.0	73.3	76.630	0.451	0.046	3.966	18.907	9.7
245.0	75.3	79.320	0.359	0.045	3.365	16.911	8.0
250.0	77.2	85.460	0.351	0.035	2.791	11.363	10.1
255.0	79.2	85.700	0.250	0.028	2.107	11.915	8.9
260.0	81.3	89.480	0.193	0.021	2.060	8.247	9.4
265.0	83.5	89.970	0.152	0.020	1.924	7.934	7.7
270.0	85.7	85.940	0.182	0.022	2.568	11.288	8.3
275.0	87.9	81.790	0.180	0.020	3.494	14.516	8.8
280.0	90.1	88.470	0.135	0.017	1.947	9.431	7.9
285.0	92.3	85.250	0.187	0.025	2.024	12.514	7.4

Table B3. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
290.0	94.5	88.060	0.201	0.023	2.055	9.661	8.6
295.0	96.7	86.000	0.222	0.029	2.161	11.588	7.8
300.0	98.9	87.830	0.216	0.023	2.056	9.876	9.6
305.0	101.0	87.990	0.195	0.026	2.068	9.721	7.5
310.0	103.2	88.410	0.290	0.023	2.192	9.084	12.6
315.0	105.4	86.480	0.137	0.020	2.293	11.070	6.9
320.0	107.6	87.230	0.171	0.020	2.488	10.092	8.7
325.0	109.8	85.480	0.162	0.023	2.273	12.062	7.1
330.0	112.0	85.820	0.168	0.021	2.249	11.742	8.1
335.0	114.2	87.850	0.166	0.023	1.739	10.222	7.3
340.0	116.4	86.740	0.319	0.032	1.835	11.074	9.9
345.0	118.6	86.070	0.222	0.031	2.089	11.588	7.2
350.0	120.8	85.660	0.298	0.029	2.052	11.961	10.2
355.0	122.9	88.650	0.151	0.033	1.706	9.459	4.6
360.0	125.1	86.710	0.117	0.017	2.397	10.759	6.8
365.0	126.1	85.000	0.120	0.026	2.840	12.013	4.6
370.0	127.2	83.080	0.175	0.026	3.645	13.075	6.8
375.0	128.2	77.480	0.183	0.042	3.685	18.610	4.4
380.0	133.9	79.190	0.336	0.037	3.139	17.299	9.2
385.0	136.7	77.720	0.591	0.074	3.501	18.114	8.0
390.0	138.9	80.300	0.565	0.048	3.396	15.691	11.9
395.0	141.0	83.280	0.699	0.063	3.827	12.131	11.2
400.0	143.1	83.260	0.663	0.051	3.656	12.369	13.0
406.0	145.2	89.560	0.617	0.048	3.922	5.853	12.9
410.0	147.3	84.520	0.628	0.046	4.492	10.314	13.6
415.0	149.4	84.120	0.625	0.042	4.208	11.005	14.9
420.0	151.5	82.490	0.559	0.057	3.697	13.198	9.8
425.0	153.7	83.080	0.651	0.057	3.998	12.213	11.3

Table B3. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
430.0	155.8	81.930	0.837	0.077	3.774	13.382	10.8
435.0	157.9	78.650	0.787	0.070	3.666	16.827	11.3
440.0	160.0	75.270	0.615	0.058	4.374	19.684	10.7
445.0	162.1	73.680	0.989	0.083	4.256	20.992	11.9
450.0	163.4	79.120	0.823	0.070	3.256	16.731	11.8
455.0	164.7	82.330	0.841	0.070	1.915	14.844	12.0
460.0	166.0	87.630	0.382	0.037	1.756	10.195	10.2
465.0	167.3	87.800	0.523	0.042	1.733	9.902	12.4
470.0	169.4	86.920	0.418	0.035	2.124	10.503	12.1
475.0	171.5	86.840	0.395	0.034	2.067	10.665	11.7
480.0	173.6	87.410	0.261	0.028	2.341	9.960	9.3
485.0	175.8	85.030	0.449	0.042	2.020	12.460	10.8
490.0	177.9	85.420	0.479	0.044	2.157	11.900	10.9
495.0	180.0	83.270	0.843	0.072	2.123	13.691	11.7
500.0	182.1	83.320	0.525	0.054	2.618	13.483	9.7
505.0	184.2	84.060	0.355	0.032	3.501	12.052	11.2
510.0	186.4	81.090	0.244	0.024	2.759	15.882	10.0
515.0	188.3	82.130	0.408	0.036	1.928	15.498	11.3
520.0	190.2	89.180	0.207	0.019	1.511	9.083	10.8
525.0	192.2	90.830	0.174	0.016	1.615	7.365	10.6
530.0	195.1	89.610	0.121	0.021	2.414	7.834	5.7
535.0	198.1	86.930	0.253	0.027	2.670	10.120	9.5
540.0	201.1	85.570	0.138	0.018	2.203	12.072	7.7
545.0	204.0	87.450	0.178	0.023	2.167	10.182	7.7
550.0	207.0	86.680	0.184	0.019	1.753	11.364	9.8
555.0	210.0	86.820	0.238	0.026	1.536	11.380	9.0
560.0	213.0	88.300	0.226	0.025	2.007	9.442	9.0
565.0	215.9	88.620	0.158	0.012	1.952	9.258	12.9

Table B3. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
570.0	218.9	88.520	0.149	0.015	2.237	9.080	10.1
575.0	221.9	88.960	0.180	0.022	2.573	8.264	8.1
580.0	224.9	84.580	0.173	0.022	2.422	12.802	7.9
585.0	227.8	88.950	0.181	0.024	2.803	8.043	7.6
590.0	230.8	82.970	0.149	0.026	3.208	13.647	5.6
595.0	233.8	78.980	0.273	0.030	2.636	18.081	9.1
600.0	236.7	78.990	0.327	0.037	2.413	18.234	8.9
605.0	239.7	83.290	0.393	0.037	2.090	14.190	10.5
610.0	242.7	87.020	0.241	0.023	2.254	10.462	10.4
615.0	245.7	88.510	0.377	0.042	1.234	9.838	9.1
620.0	248.6	89.690	0.136	0.014	1.396	8.764	9.4
625.0	251.6	91.570	0.110	-	1.452	-	-
630.0	254.6	87.860	0.131	0.019	1.453	10.537	6.8
635.0	257.6	87.600	0.157	0.020	1.370	10.852	7.7
640.0	260.5	85.910	0.128	0.020	1.673	12.269	6.4
645.0	263.5	88.710	0.181	0.021	1.570	9.517	8.5
650.0	266.5	87.130	0.375	0.032	1.593	10.869	11.8
655.0	269.4	86.000	0.456	0.039	1.954	11.551	11.6
660.0	272.4	86.830	0.318	0.028	2.656	10.168	11.3
665.0	275.4	84.390	0.415	0.036	3.351	11.808	11.5
670.0	278.4	83.840	0.335	0.027	2.790	13.007	12.2
675.0	281.3	83.570	0.536	0.047	2.233	13.614	11.4
680.0	284.3	84.070	0.448	0.041	2.164	13.277	11.0
685.0	287.3	89.740	0.258	0.028	2.152	7.823	9.3
690.0	290.3	87.010	0.204	0.019	2.547	10.220	10.7
695.0	293.2	86.540	0.282	0.028	2.282	10.868	10.0
700.0	296.2	85.630	0.218	0.024	2.347	11.782	9.2
705.0	299.2	81.390	0.231	0.018	2.260	16.101	12.7

Table B3. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
710.0	302.1	79.170	0.203	0.027	2.361	18.239	7.5
715.0	305.1	84.700	0.286	0.026	2.334	12.654	10.9
720.0	308.1	85.390	0.249	0.023	1.826	12.512	10.6
725.0	311.1	90.440	0.323	0.028	2.334	6.874	11.4
730.0	314.0	85.170	0.334	0.027	-	-	12.5

Table B4. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in RC24-16.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
7.5	3.2	89.40	0.155	0.030	1.885	8.529	5.1
12.0	4.3	91.50	0.210	0.026	1.122	7.142	8.2
17.5	5.5	90.70	0.258	0.037	1.481	7.524	6.9
23.0	6.8	90.20	0.185	0.029	1.537	8.049	6.4
27.5	7.9	88.10	0.103	0.036	2.244	9.517	2.9
32.5	9.0	88.60	0.161	0.031	1.974	9.234	5.1
37.5	10.2	89.40	0.118	0.034	2.075	8.373	3.5
41.0	11.0	88.20	0.176	0.033	2.266	9.325	5.3
47.5	12.5	88.00	0.107	0.035	2.165	9.693	3.1
52.5	13.7	87.10	0.119	0.035	2.446	10.300	3.4
57.5	14.9	86.10	0.118	0.030	2.434	11.317	3.9
62.5	16.1	90.50	0.137	0.030	1.526	7.807	3.3
67.5	17.2	89.10	0.143	0.032	1.683	9.042	4.4
72.5	18.4	88.70	0.192	0.036	1.671	9.402	5.4
77.5	19.6	88.10	0.312	0.038	1.604	9.947	8.3
82.5	20.8	88.30	0.218	0.040	1.503	9.939	5.5
87.5	22.0	88.30	0.260	0.048	1.626	9.767	5.5
92.5	23.1	89.60	0.390	0.037	1.424	8.549	10.6
97.5	24.6	89.50	0.163	0.047	1.413	8.877	3.4
102.5	26.9	90.40	0.309	0.037	1.088	8.166	8.4
107.5	29.2	90.90	0.190	0.046	1.312	7.553	4.1
112.0	31.2	90.10	0.315	0.048	1.469	8.068	6.5
117.5	33.4	90.00	0.249	0.049	1.211	8.492	5.1
122.5	35.4	88.10	0.256	0.038	1.447	10.159	6.8
127.5	36.9	90.30	0.406	0.039	1.166	8.090	10.5
131.0	37.9	89.40	0.301	0.042	1.447	8.810	7.2
136.5	40.0	89.90	0.306	0.044	1.301	8.449	6.9
142.5	42.5	88.40	0.232	0.037	1.649	9.682	6.2
148.0	44.6	88.20	0.363	0.041	1.357	10.039	8.7

Table B4. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
152.5	46.1	86.60	0.276	0.040	1.436	11.649	6.9
156.5	47.4	87.10	0.262	0.046	1.649	10.943	5.7
162.5	49.4	85.20	0.241	0.042	1.963	12.554	5.7
167.5	51.0	86.90	0.271	0.044	1.761	11.024	6.1
172.5	52.6	90.60	0.163	0.035	1.122	8.080	4.7
177.5	54.3	90.60	0.251	0.045	1.458	7.646	5.6
182.5	55.9	90.60	0.198	0.038	1.065	8.100	5.3
187.5	57.5	89.00	0.186	0.034	1.335	9.445	5.5
192.5	59.2	89.10	0.194	0.034	1.570	9.102	5.7
197.5	60.8	88.80	0.211	0.042	1.447	9.500	5.1
204.5	62.7	86.90	0.164	0.034	2.165	10.736	4.8
208.5	63.5	87.60	0.213	0.040	1.907	10.240	5.3
212.0	64.2	84.80	0.236	0.037	2.693	12.234	6.4
217.5	65.5	83.30	0.190	0.034	2.906	13.569	5.5
222.5	67.4	83.40	0.197	0.038	3.040	13.325	5.2
227.5	69.2	82.70	0.170	0.039	3.276	13.816	4.4
232.5	70.9	85.20	0.220	0.041	2.345	12.194	5.4
237.5	72.4	86.50	0.152	0.038	1.772	11.538	4.0
242.5	73.8	86.70	0.205	0.032	1.997	11.066	6.3
247.5	75.3	89.10	0.142	0.033	1.503	9.222	4.3
252.5	76.7	89.40	0.125	0.029	1.626	8.820	4.4
257.5	78.2	89.70	0.170	0.030	1.525	8.575	5.7
262.0	79.5	90.90	0.132	0.032	1.279	7.657	4.1
267.5	81.0	90.00	0.112	0.028	1.582	8.278	4.0
271.0	82.1	89.50	0.122	0.029	1.649	8.700	4.2
276.5	84.1	87.60	0.110	0.037	1.963	10.290	3.0
282.5	86.6	89.20	0.226	0.031	1.559	8.983	7.2
287.5	88.7	90.90	0.125	0.030	1.223	7.721	4.1
292.5	90.8	90.30	0.167	0.031	1.144	8.358	5.4

Table B4. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
297.5	92.9	90.60	0.123	0.026	1.133	8.118	4.7
302.5	95.0	90.90	0.144	0.035	1.256	7.665	4.1
307.5	97.1	89.50	0.127	0.032	1.492	8.849	3.9
314.5	99.6	92.70	0.141	0.031	1.189	5.938	4.6
318.5	100.7	89.70	0.153	0.031	1.492	8.624	5.0
322.5	101.8	89.20	0.101	0.032	1.739	8.928	3.2
328.0	103.3	89.40	0.119	0.038	1.638	8.805	3.2
332.5	104.6	89.20	0.115	0.036	1.604	9.045	3.2
337.5	105.9	90.60	0.108	0.031	1.503	7.758	3.5
342.5	107.3	90.50	0.130	0.036	1.739	7.596	3.7
347.5	108.7	90.40	0.115	0.034	1.503	7.948	3.4
352.5	110.0	88.40	0.120	0.038	1.795	9.647	3.2
358.0	111.5	88.90	0.158	0.030	1.459	9.454	5.3
362.5	112.8	88.70	0.097	0.036	1.144	10.023	2.7
367.5	114.1	88.80	0.095	0.029	1.413	9.663	3.3
372.5	115.5	88.80	0.104	0.037	1.335	9.724	2.8
377.5	116.9	89.30	0.097	0.035	1.099	9.469	2.8
382.5	118.3	85.10	0.082	0.039	1.368	13.411	2.1
387.5	119.6	84.90	0.096	0.033	1.256	13.715	2.9
392.5	121.0	88.50	0.074	0.033	1.335	10.057	2.2
397.5	122.4	85.90	0.096	0.031	1.178	12.795	3.1
402.5	123.8	86.90	0.113	0.034	1.862	11.091	3.3
407.5	125.3	86.10	0.129	0.034	1.862	11.876	3.8
412.5	126.7	83.60	0.111	0.036	2.591	13.662	3.1
417.5	128.2	80.60	0.126	0.047	2.255	16.972	2.7
422.5	129.5	80.90	0.117	0.035	2.704	16.244	3.3
427.5	131.1	81.90	0.137	0.028	2.468	15.467	4.8
432.5	132.5	85.80	0.101	0.030	1.660	12.409	3.3
437.5	133.9	85.30	0.103	0.028	1.402	13.167	3.6

Table B4. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
443.0	135.8	85.70	0.280	0.038	1.335	12.648	7.4
447.5	137.8	85.85	0.341	0.047	1.245	12.517	7.2
452.5	140.1	86.00	0.387	0.054	1.155	12.404	7.1
456.5	141.8	86.70	0.216	0.034	1.548	11.501	6.3
461.5	144.1	85.30	0.215	0.037	1.795	12.653	5.8
467.5	146.7	87.30	0.285	0.042	1.862	10.511	6.8
472.5	149.0	86.50	0.214	0.035	1.795	11.456	6.2
477.5	151.1	85.20	0.186	0.044	1.997	12.573	4.2
482.5	152.3	87.70	0.249	0.040	1.694	10.318	6.3
488.0	153.7	87.20	0.186	0.041	1.683	10.891	4.6
492.5	154.8	89.50	0.168	0.034	1.828	8.470	5.0
497.5	156.0	86.30	0.271	0.049	1.671	11.709	5.5
502.5	157.2	85.80	0.385	0.056	1.649	12.110	6.9
507.5	158.4	82.70	0.337	0.052	1.559	15.353	6.5
512.5	159.7	82.50	0.368	0.049	1.795	15.288	7.5
517.5	160.9	82.70	0.501	0.063	1.525	15.211	8.0
522.5	162.1	80.30	0.458	0.056	2.165	17.021	8.2
527.5	163.4	87.30	0.348	0.038	1.380	10.934	9.3
532.5	164.6	88.10	0.463	0.057	1.402	9.978	8.2
538.0	166.1	90.30	0.526	0.048	1.346	7.780	10.9
542.5	167.3	91.00	0.241	0.040	1.189	7.530	6.0
547.5	168.7	90.50	0.260	0.039	1.166	8.034	6.7
552.5	170.1	90.50	0.308	0.035	1.065	8.092	8.9
557.5	171.4	90.50	0.242	0.039	1.671	7.547	6.2
562.5	172.8	87.30	0.253	0.038	1.952	10.457	6.7
567.5	174.2	89.90	0.184	0.041	1.559	8.315	4.5
572.5	175.6	87.50	0.148	0.036	1.570	10.747	4.2
577.5	177.0	84.50	0.196	0.039	1.458	13.807	5.0
582.5	178.3	87.40	0.307	0.050	1.548	10.695	6.1

Table B4. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
587.5	179.7	86.30	0.384	0.051	1.514	11.751	7.5
592.0	181.1	86.30	0.442	0.053	1.458	11.747	8.3
597.5	182.5	84.20	0.415	0.064	1.357	13.964	6.5
602.5	183.9	86.50	0.278	0.039	1.346	11.836	7.1
607.5	185.3	87.70	0.311	0.047	1.122	10.820	6.7
611.5	186.4	83.00	0.404	0.053	1.122	15.422	7.7
617.5	188.0	89.30	0.226	0.040	1.828	8.607	5.7
622.5	189.4	90.30	0.142	0.034	1.918	7.606	4.2
627.5	190.8	90.50	0.142	0.025	1.447	7.885	5.6
632.5	192.2	91.30	0.152	0.030	1.099	7.419	5.1
637.5	193.5	89.60	0.130	0.049	1.065	9.156	2.6
642.5	195.4	86.80	0.146	0.037	1.009	12.008	3.9
647.5	197.5	85.00	0.126	0.032	1.211	13.631	3.9
652.5	199.5	85.20	0.204	0.030	1.537	13.030	6.8
657.5	201.6	86.60	0.169	0.055	1.626	11.551	3.1
662.5	203.7	88.60	0.135	0.036	1.424	9.805	3.7
667.5	205.7	90.90	0.146	0.033	1.413	7.508	4.5
672.5	207.8	88.20	0.177	0.030	1.402	10.191	5.8
677.5	209.9	91.30	0.161	0.044	1.290	7.205	3.6
682.5	211.9	91.20	0.172	0.031	1.155	7.442	5.6
687.5	214.0	91.10	0.160	0.059	1.335	7.346	2.7
691.5	215.7	90.00	0.139	0.032	1.593	8.236	4.3
697.5	218.1	89.70	0.156	0.034	1.582	8.529	4.7
702.5	220.2	89.40	0.202	0.053	1.649	8.696	3.8
707.5	222.3	87.60	0.177	0.056	2.019	10.148	3.2
712.5	224.3	87.60	0.189	0.059	1.525	10.628	3.2
717.5	226.0	87.80	0.139	0.049	2.311	9.701	2.9
722.5	227.6	87.10	0.136	0.051	1.492	11.222	2.7
727.5	229.1	85.10	0.155	0.035	1.391	13.319	4.4

Table B4. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
732.5	230.7	85.20	0.109	0.031	1.739	12.921	3.5
737.5	232.2	87.70	0.200	0.038	1.649	10.413	5.3
742.5	233.8	84.30	0.265	0.035	1.481	13.919	7.6
747.5	235.3	89.90	0.208	0.030	1.593	8.269	6.9
752.5	236.9	89.20	0.292	0.044	1.099	9.364	6.6
757.5	238.4	90.40	0.184	0.037	0.942	8.437	4.9
762.5	240.0	90.70	0.169	0.039	0.953	8.140	4.4
767.5	241.5	90.50	0.146	0.035	1.077	8.242	4.1

Table B5. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in V25-56.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
4.0	3.3	67.750	0.299	0.066	0.660	31.225	4.5
9.0	4.4	67.140	0.313	0.066	0.674	31.807	4.7
14.0	5.5	67.180	0.280	0.067	0.673	31.800	4.2
18.0	6.4	71.330	0.241	0.038	0.711	27.680	6.3
23.0	7.6	68.530	0.227	0.040	0.561	30.642	5.7
28.0	8.6	53.980	0.237	0.055	0.762	44.966	4.3
33.0	9.3	48.120	0.250	0.068	0.791	50.771	3.7
38.0	10.1	41.680	0.279	0.068	0.701	57.272	4.1
43.0	10.8	38.220	0.264	0.077	0.968	60.471	3.4
48.0	11.5	37.360	0.243	0.074	0.779	61.544	3.3
53.0	12.4	33.320	0.253	0.081	0.982	65.364	3.1
58.0	13.3	22.310	0.265	0.066	0.911	76.448	4.0
63.0	14.2	29.840	0.259	0.062	1.056	68.783	4.2
68.0	14.8	31.480	0.215	0.081	0.865	67.359	2.7
71.0	15.1	36.750	0.239	0.059	1.118	61.834	4.1
79.0	16.1	39.230	0.226	0.058	1.051	59.435	3.9
84.0	16.6	37.640	0.300	0.060	0.971	61.029	5.0
89.0	17.2	28.350	0.247	0.086	1.068	70.249	2.9
94.0	17.8	19.240	0.252	0.077	1.096	79.335	3.3
98.0	18.3	32.660	0.233	0.075	1.057	65.975	3.1
103.0	18.8	36.150	0.265	0.102	0.786	62.697	2.6
108.0	19.4	37.090	0.246	0.077	0.783	61.804	3.2
112.0	19.9	36.590	0.238	0.080	1.005	62.087	3.0
117.0	20.5	36.090	0.235	0.073	0.906	62.696	3.2
122.0	21.0	34.140	0.241	0.067	0.990	64.562	3.6
127.0	21.6	39.230	0.231	0.068	0.750	59.721	3.4
132.0	22.2	44.950	0.234	0.078	0.813	53.925	3.0
137.0	22.8	42.810	0.261	0.064	0.917	55.948	4.1
142.0	23.4	48.130	0.296	0.077	0.717	50.780	3.8

Table B5. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
147.0	24.0	47.190	0.246	0.066	1.351	51.147	3.7
152.0	25.5	45.060	0.255	0.066	0.839	53.780	3.9
156.0	26.7	47.950	0.246	0.069	0.768	50.967	3.6
162.0	28.3	38.580	0.244	0.067	0.684	60.425	3.6
167.0	29.2	28.770	0.214	0.046	0.864	70.106	4.7
172.0	30.1	31.450	0.314	0.057	0.927	67.252	5.5
177.0	31.0	40.490	0.334	0.058	0.825	58.293	5.8
182.0	31.9	45.040	0.265	0.072	0.725	53.898	3.7
187.0	32.8	40.460	0.283	0.101	0.782	58.374	2.8
192.0	33.7	39.100	0.286	0.078	0.787	59.749	3.7
197.0	34.6	44.260	0.263	0.104	0.710	54.663	2.5
202.0	35.5	41.690	0.265	0.081	0.655	57.309	3.3
206.0	36.2	34.830	0.262	0.079	0.987	63.842	3.3
209.0	36.8	28.360	0.250	0.063	1.010	70.317	4.0
214.0	38.4	37.540	0.300	0.106	0.938	61.116	2.8
219.0	40.2	42.450	0.248	0.085	0.757	56.460	2.9
223.0	41.6	44.890	0.203	0.059	1.037	53.811	3.4
228.0	43.4	45.610	0.213	0.077	1.073	53.027	2.8
233.0	45.1	47.980	0.252	0.072	0.877	50.819	3.5
238.0	46.9	40.710	0.240	0.067	1.052	57.931	3.6
243.0	48.7	35.800	0.239	0.066	1.088	62.807	3.6
248.0	50.5	36.120	0.218	0.092	1.133	62.437	2.4
252.0	51.9	36.440	0.219	0.080	1.144	62.117	2.7
257.0	55.4	37.770	0.235	0.077	1.263	60.655	3.1
262.0	61.4	28.480	0.239	0.068	1.336	69.877	3.5
267.0	65.4	31.030	0.246	0.077	1.407	67.240	3.2
272.0	66.5	32.990	0.225	0.075	1.452	65.258	3.0
277.0	67.5	29.790	0.234	0.077	1.454	68.445	3.0
282.0	68.6	33.220	0.214	0.069	1.156	65.341	3.1

Table B5. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
289.0	70.1	28.640	0.241	0.081	1.189	69.849	3.0
294.0	71.2	30.850	0.185	0.083	1.272	67.610	2.2
298.0	72.0	26.850	0.200	0.065	1.230	71.655	3.1
303.0	73.1	23.660	0.503	0.103	1.206	74.528	4.9
306.0	73.7	31.910	0.283	0.070	1.371	66.366	4.0
313.0	75.2	47.070	0.264	0.085	1.264	51.317	3.1
318.0	76.3	26.860	0.243	0.071	1.294	71.532	3.4
323.0	77.4	29.890	0.259	0.082	1.307	68.462	3.2
328.0	78.5	50.910	0.230	0.067	1.224	47.569	3.4
333.0	79.5	54.160	0.248	0.084	1.090	44.418	3.0
338.0	80.6	55.510	0.253	0.060	1.308	42.869	4.2
343.0	81.6	49.450	0.236	0.077	0.984	49.253	3.1
348.0	82.6	42.750	0.194	0.071	0.971	56.014	2.7
353.0	83.6	41.610	0.207	0.071	1.202	56.910	2.9
358.0	84.6	28.380	0.217	0.064	1.135	70.204	3.4
362.0	85.4	28.120	0.234	0.091	1.306	70.249	2.6
367.0	86.4	27.920	0.239	0.064	1.071	70.706	3.7
372.0	87.5	45.260	0.218	0.079	1.306	53.137	2.8
381.0	89.9	52.110	0.219	0.074	1.133	46.464	3.0
386.0	91.2	51.510	0.261	0.079	0.898	47.252	3.3
391.0	92.6	47.310	0.204	0.083	1.176	51.227	2.5
396.0	93.9	49.900	0.250	0.073	0.886	48.891	3.4
401.0	95.2	49.080	0.242	0.086	1.163	49.429	2.8
406.0	96.6	52.920	0.201	0.090	0.977	45.812	2.2
411.0	97.9	54.190	0.176	0.085	1.038	44.511	2.1
414.0	98.7	52.940	0.230	0.069	0.974	45.787	3.3
418.0	99.8	55.660	0.174	0.057	1.123	42.986	3.1
423.0	101.1	52.330	0.182	0.069	1.066	46.353	2.6
428.0	102.4	48.730	0.181	0.075	0.988	50.026	2.4

Table B5. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
433.0	103.8	45.220	0.177	0.067	1.071	53.465	2.6
438.0	105.1	31.540	0.178	0.080	1.107	67.095	2.2
443.0	106.4	28.700	0.204	0.072	1.014	70.010	2.8
448.0	107.9	37.800	0.224	0.064	1.332	60.580	3.5
453.0	109.4	45.340	0.203	0.059	1.175	53.223	3.4
458.0	110.9	44.590	0.248	0.076	1.210	53.876	3.3
463.0	112.4	44.150	0.273	0.080	1.258	54.239	3.4
468.0	113.9	48.430	0.241	0.063	1.023	50.243	3.8
473.0	115.4	52.860	0.269	0.082	1.139	45.650	3.3
477.0	116.6	54.700	0.261	0.086	0.986	43.967	3.0
482.0	118.1	56.550	0.209	0.068	0.726	42.447	3.1
486.0	119.3	57.370	0.179	0.059	0.990	41.402	3.0
491.0	120.8	52.440	0.179	0.067	0.953	46.361	2.7
496.0	122.2	64.940	0.191	0.040	0.870	33.959	4.8
498.0	122.6	57.500	0.160	0.078	0.787	41.475	2.1
503.0	123.8	38.390	0.193	0.070	1.127	60.220	2.8
508.0	124.9	20.810	0.211	0.078	1.018	77.883	2.7
517.0	126.9	24.480	0.300	0.080	1.371	73.769	3.7
522.0	128.0	20.880	0.203	0.067	0.969	77.881	3.0
527.0	129.2	24.580	0.179	0.065	1.101	74.075	2.8
533.0	131.5	25.300	0.274	0.069	1.024	73.333	4.0
541.0	135.8	35.110	0.322	0.080	1.102	63.386	4.0
546.0	138.4	38.590	0.278	0.092	1.294	59.746	3.0
551.0	141.1	37.130	0.218	0.077	1.210	61.365	2.8
556.0	143.8	35.300	0.268	0.081	1.235	63.116	3.3
563.0	147.0	36.390	0.220	0.068	0.923	62.399	3.2
568.0	148.6	40.660	0.258	0.063	1.077	57.942	4.1
573.0	150.3	36.590	0.267	0.087	1.230	61.826	3.1
578.0	152.4	41.870	0.281	0.084	1.092	56.673	3.3

Table B5. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
582.0	154.3	38.610	0.258	0.077	0.809	60.246	3.4
587.0	156.8	35.350	0.340	0.093	0.932	63.285	3.7
592.0	159.2	34.810	0.334	0.102	1.187	63.567	3.3
597.0	161.6	30.040	0.328	0.092	0.973	68.567	3.6
602.0	164.0	42.590	0.296	0.092	1.226	55.796	3.2
607.0	166.4	40.850	0.231	0.056	1.091	57.772	4.1
612.0	168.9	49.430	0.260	0.060	1.327	48.923	4.3
617.0	171.3	35.220	0.257	0.093	1.141	63.289	2.8
622.0	173.7	36.430	0.229	0.092	1.334	61.915	2.5
627.0	176.1	31.110	0.227	0.058	1.185	67.420	3.9
632.0	178.5	38.140	0.305	0.090	0.996	60.469	3.4
637.0	181.0	46.370	0.447	0.069	1.104	52.010	6.5
642.0	183.4	45.260	0.426	0.063	1.328	52.923	6.8
647.0	185.8	40.040	0.351	0.068	1.220	58.321	5.2
652.0	189.0	40.200	0.305	0.097	1.509	57.889	3.1
657.0	193.5	48.400	0.275	0.056	1.327	49.942	4.9
661.0	199.1	43.990	0.267	0.096	1.532	54.115	2.8
666.0	205.8	29.070	0.281	0.086	1.128	69.435	3.3
671.0	210.2	52.350	0.301	0.071	1.151	46.127	4.2
676.0	214.6	59.920	0.183	0.051	0.739	39.107	3.6
681.0	220.2	61.230	0.190	0.052	1.044	37.484	3.7
686.0	226.2	39.700	0.234	0.083	1.289	58.694	2.8
692.0	230.5	54.840	0.245	0.086	0.855	43.974	2.8
696.0	232.8	50.450	0.269	0.052	0.982	48.247	5.2
701.0	235.7	49.990	0.264	0.082	0.825	48.839	3.2
706.0	238.7	61.460	0.192	0.045	0.979	37.324	4.3
711.0	242.4	32.580	0.225	0.085	0.939	66.171	2.6
716.0	246.0	33.090	0.252	0.092	0.829	65.737	2.7
721.0	249.7	47.000	0.282	0.085	1.069	51.564	3.3

Table B5. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
724.0	251.9	40.480	0.288	0.098	1.155	57.979	2.9
727.0	254.1	48.690	0.288	0.105	0.381	50.536	2.7
732.0	257.7	56.900	0.273	0.079	0.873	41.875	3.5
734.0	259.2	56.900	0.207	0.049	1.189	41.655	4.2

Table B6. Sedimentary component concentration (%) versus depth (cm) and age (Ka) in RC16-66.

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
6.0	2.8	56.180	0.400	0.061	0.669	42.751	6.5
10.0	4.7	59.230	0.380	0.060	0.686	39.704	6.3
15.0	6.5	59.270	0.324	0.073	0.648	39.758	4.4
20.0	8.3	62.880	0.269	0.049	0.678	36.173	5.5
25.0	10.2	58.490	0.280	0.059	0.705	40.525	4.7
30.0	12.0	55.730	0.290	0.053	0.752	43.228	5.5
35.0	12.6	55.510	0.276	0.047	0.820	43.394	5.8
40.0	13.2	46.480	0.262	0.052	0.816	52.442	5.1
45.0	13.7	48.560	0.245	0.049	0.909	50.286	5.0
50.0	14.7	42.600	0.228	0.035	0.891	56.281	6.5
55.0	14.9	28.200	0.271	0.049	0.983	70.546	5.5
60.0	15.5	27.150	0.313	0.056	0.944	71.593	5.6
65.0	16.1	30.550	0.292	0.058	1.013	68.145	5.1
70.0	16.6	41.450	0.271	0.036	1.011	57.268	7.6
75.0	17.2	41.870	0.252	0.038	1.047	56.831	6.6
80.0	17.8	42.190	0.233	0.034	1.030	56.547	6.9
85.0	18.3	40.260	0.255	0.040	1.045	58.440	6.3
90.0	18.9	34.830	0.277	0.040	1.074	63.819	7.0
95.0	19.4	29.110	0.289	0.037	0.979	69.622	7.8
100.0	20.0	26.880	0.301	0.054	0.875	71.944	5.6
105.0	20.5	34.800	0.250	0.038	0.858	64.092	6.7
110.0	21.0	39.060	0.162	0.029	0.898	59.880	5.6
115.0	21.6	37.330	0.253	0.037	0.967	61.450	6.9
120.0	22.1	37.260	0.266	0.040	0.882	61.592	6.6
125.0	22.7	27.550	0.318	0.057	0.851	71.281	5.6
130.0	23.2	22.460	0.370	0.077	0.827	76.343	4.8
135.0	23.7	40.700	0.300	0.043	0.815	58.185	7.0
140.0	24.3	47.440	0.280	0.044	0.995	51.285	6.4
145.0	24.8	47.650	0.230	0.043	0.969	51.151	5.4

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
150.0	25.4	49.240	0.250	0.057	0.986	49.524	4.3
155.0	27.7	45.500	0.250	0.054	0.779	53.471	4.7
160.0	30.0	51.590	0.210	0.050	0.728	47.472	4.2
165.0	32.3	51.140	0.200	0.047	0.760	47.900	4.3
170.0	34.6	48.110	0.300	0.050	0.825	50.765	5.9
175.0	36.9	50.660	0.301	0.058	0.872	48.167	5.1
180.0	39.2	53.650	0.329	0.059	0.826	45.195	5.6
185.0	41.5	42.580	0.348	0.063	0.777	56.295	5.5
190.0	43.8	30.940	0.367	0.079	0.765	67.928	4.7
195.0	44.9	39.870	0.341	0.074	0.760	59.029	4.6
200.0	45.9	41.660	0.315	0.078	0.717	57.308	4.0
205.0	47.0	33.500	0.342	0.064	0.784	65.374	5.4
210.0	48.1	42.060	0.369	0.071	0.884	56.687	5.2
215.0	49.1	36.990	0.331	0.067	0.978	61.701	5.0
220.0	50.2	48.370	0.292	0.055	0.901	50.437	5.3
225.0	51.0	38.130	0.354	0.075	0.911	60.605	4.7
230.0	51.9	30.370	0.417	0.087	0.956	68.257	4.8
235.0	52.8	56.320	0.300	0.060	0.996	42.384	5.0
240.0	53.7	41.720	0.388	0.080	1.001	56.891	4.8
245.0	54.5	23.230	0.335	0.068	1.006	75.429	4.9
250.0	55.4	52.490	0.281	0.051	1.091	46.138	5.5
255.0	56.0	57.310	0.290	0.059	1.122	41.278	4.9
260.0	56.6	46.730	0.299	0.057	1.180	51.791	5.3
265.0	57.2	38.080	0.400	0.070	1.248	60.272	5.7
270.0	57.7	42.660	0.389	0.047	1.335	55.616	8.3
275.0	58.3	38.960	0.366	0.053	1.398	59.276	6.8
280.0	58.9	46.990	0.342	0.047	1.438	51.230	7.2
285.0	61.5	31.040	0.345	0.050	1.354	67.261	6.9
290.0	64.0	27.270	0.348	0.056	1.266	71.116	6.2

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
295.0	65.0	15.950	0.359	0.059	1.206	82.485	6.1
300.0	65.9	11.630	0.370	0.057	1.230	86.770	6.5
305.0	66.9	14.670	0.361	0.057	1.236	83.733	6.3
310.0	67.8	10.460	0.351	0.057	1.269	87.920	6.1
315.0	68.8	8.640	0.343	0.061	1.280	89.737	5.6
320.0	69.7	9.630	0.335	0.059	1.310	88.725	5.7
325.0	70.7	12.510	0.319	0.052	1.288	85.883	6.1
330.0	71.6	23.250	0.303	0.053	1.275	75.172	5.7
335.0	72.6	14.180	0.387	0.064	1.207	84.226	6.0
340.0	73.5	5.380	0.471	0.070	1.207	92.942	6.7
345.0	74.5	20.860	0.411	0.066	1.127	77.602	6.2
350.0	75.4	28.060	0.351	0.067	1.088	70.501	5.2
355.0	76.4	29.190	0.364	0.057	1.052	69.394	6.4
360.0	77.3	27.130	0.377	0.060	1.103	71.390	6.2
365.0	78.3	41.010	0.210	0.025	1.214	57.566	8.4
370.0	79.2	38.320	0.301	0.039	1.170	60.209	7.7
375.0	80.9	31.340	0.341	0.053	1.228	67.091	6.4
380.0	82.6	17.960	0.333	0.048	1.170	80.537	6.9
385.0	84.3	18.520	0.301	0.059	1.113	80.066	5.1
390.0	86.0	31.060	0.270	0.045	1.069	67.601	5.9
395.0	87.7	22.910	0.300	0.053	0.987	75.803	5.7
400.0	89.4	50.760	0.235	0.051	1.075	47.930	4.6
405.0	91.1	45.910	0.300	0.052	1.009	52.781	5.8
410.0	92.8	47.830	0.242	0.048	1.059	50.869	5.0
415.0	94.5	48.690	0.230	0.036	0.996	50.084	6.5
420.0	96.2	52.710	0.271	0.040	1.045	45.934	6.7
425.0	97.9	50.450	0.220	0.042	1.054	48.276	5.3
430.0	99.6	44.490	0.270	0.067	1.059	54.181	4.1
435.0	101.3	37.790	0.285	0.077	1.041	60.884	3.7

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
440.0	103.0	38.420	0.301	0.041	1.055	60.224	7.3
445.0	104.7	29.950	0.290	0.051	1.064	68.696	5.7
450.0	106.4	31.750	0.279	0.046	1.151	66.820	6.1
455.0	108.1	34.050	0.273	0.057	1.173	64.504	4.8
460.0	109.8	39.660	0.267	0.055	1.239	58.779	4.8
465.0	111.5	36.990	0.310	0.060	1.214	61.486	5.2
470.0	113.2	49.260	0.320	0.052	1.164	49.256	6.1
475.0	114.9	53.660	0.239	0.045	1.140	44.961	5.3
480.0	116.6	62.680	0.236	0.041	1.049	36.035	5.7
485.0	118.3	55.680	0.234	0.039	0.950	43.136	6.0
490.0	120.0	39.060	0.232	0.034	0.901	59.807	6.8
495.0	121.2	41.920	0.271	0.044	0.890	56.919	6.1
500.0	122.5	22.740	0.310	0.053	0.938	76.012	5.8
505.0	123.7	19.480	0.281	0.059	0.870	79.369	4.8
510.0	125.0	34.230	0.252	0.048	0.928	64.590	5.2
515.0	126.2	34.890	0.263	0.046	0.978	63.869	5.7
520.0	127.5	36.880	0.274	0.047	1.172	61.674	5.8
525.0	128.8	44.880	0.273	0.047	1.120	53.727	5.9
530.0	130.0	50.080	0.271	0.052	1.147	48.502	5.2
535.0	131.3	49.650	0.200	0.031	1.032	49.118	6.5
540.0	132.5	46.880	0.150	0.024	1.076	51.894	6.3
545.0	133.8	42.820	0.200	0.045	1.140	55.840	4.4
550.0	135.1	47.050	0.220	0.040	1.202	51.528	5.5
555.0	137.2	43.190	0.240	0.051	1.246	55.324	4.7
560.0	139.4	41.250	0.270	0.049	1.123	57.357	5.5
565.0	141.6	39.440	0.300	0.052	1.078	59.182	5.8
570.0	143.8	38.050	0.316	0.062	1.076	60.558	5.1
575.0	146.0	31.330	0.343	0.069	1.133	67.194	5.0
580.0	148.2	35.750	0.369	0.057	1.043	62.838	6.5

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
585.0	150.3	31.610	0.381	0.070	0.944	67.065	5.5
590.0	152.5	25.080	0.393	0.070	0.976	73.551	5.6
595.0	153.8	25.560	0.359	0.071	1.030	73.051	5.1
600.0	155.0	26.420	0.325	0.043	1.129	72.126	7.6
605.0	156.3	23.830	0.329	0.050	1.097	74.744	6.6
610.0	157.5	33.920	0.333	0.048	1.215	64.532	6.9
615.0	158.8	37.520	0.299	0.047	1.187	60.994	6.3
620.0	160.0	44.450	0.264	0.038	1.267	54.019	7.0
625.0	161.2	35.500	0.290	0.037	1.220	62.990	7.8
630.0	162.5	28.960	0.317	0.057	1.172	69.551	5.6
635.0	163.7	36.810	0.200	0.030	1.095	61.895	6.7
640.0	165.0	41.610	0.180	0.032	1.143	57.067	5.6
645.0	166.2	25.730	0.200	0.029	1.218	72.852	6.9
650.0	167.5	40.600	0.333	0.050	1.353	57.714	6.6
655.0	168.7	44.830	0.304	0.055	1.352	53.514	5.6
660.0	170.0	51.240	0.275	0.057	1.456	47.029	4.8
665.0	172.1	45.920	0.264	0.037	1.329	52.487	7.0
670.0	174.2	45.070	0.254	0.040	1.270	53.406	6.4
675.0	176.3	45.550	0.313	0.058	1.006	53.131	5.4
680.0	178.4	32.120	0.373	0.086	0.978	66.529	4.3
685.0	180.6	32.670	0.315	0.068	1.024	65.991	4.7
690.0	182.7	42.510	0.256	0.061	1.063	56.171	4.2
695.0	184.8	40.320	0.271	0.064	1.042	58.367	4.3
700.0	186.9	34.930	0.287	0.048	0.888	63.895	5.9
705.0	189.1	31.460	0.292	0.057	0.929	67.319	5.1
710.0	191.2	52.780	0.297	0.053	0.914	46.009	5.6
715.0	193.3	52.300	0.201	0.037	0.915	46.584	5.5
720.0	195.4	51.220	0.185	0.040	0.946	47.649	4.7
725.0	197.6	51.900	0.200	0.043	1.017	46.883	4.6

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
730.0	199.7	38.950	0.185	0.046	0.868	59.997	4.0
735.0	201.8	38.050	0.495	0.092	0.803	60.652	5.4
740.0	203.9	37.730	0.509	0.098	0.814	60.947	5.2
745.0	206.1	32.950	0.402	0.081	0.660	65.988	5.0
750.0	208.2	43.000	0.295	0.056	0.674	56.031	5.3
755.0	210.3	41.310	0.413	0.087	0.673	57.604	4.7
760.0	212.4	17.680	0.531	0.110	0.711	81.078	4.8
765.0	214.6	19.570	0.430	0.086	0.561	79.439	5.0
770.0	215.3	23.640	0.328	0.068	0.762	75.270	4.8
775.0	216.0	35.780	0.317	0.065	0.791	63.112	4.9
780.0	216.7	39.370	0.305	0.055	0.701	59.624	5.5
785.0	217.4	33.910	0.271	0.055	0.968	64.851	4.9
790.0	218.2	33.820	0.237	0.045	0.779	65.164	5.3
795.0	218.9	4.120	0.250	0.044	0.982	94.648	5.7
800.0	219.6	3.160	0.420	0.050	0.911	95.509	8.3
805.0	220.3	17.470	0.380	0.056	1.056	81.094	6.8
810.0	221.0	34.590	0.300	0.042	0.865	64.245	7.2
815.0	221.8	50.990	0.250	0.036	1.118	47.642	6.9
820.0	222.5	54.450	0.170	0.027	1.051	44.329	6.2
825.0	223.2	58.030	0.180	0.030	0.971	40.819	6.1
830.0	223.9	61.570	0.170	0.026	1.068	37.192	6.5
835.0	224.7	57.360	0.180	0.028	1.096	41.364	6.3
840.0	225.4	54.160	0.180	0.029	1.057	44.603	6.1
845.0	226.1	32.290	0.190	0.034	0.786	66.734	5.6
850.0	226.8	21.080	0.227	0.040	0.783	77.910	5.7
855.0	227.5	20.350	0.340	0.055	1.005	78.305	6.1
860.0	228.3	30.490	0.320	0.056	0.906	68.284	5.7
865.0	229.0	44.380	0.196	0.033	0.990	54.434	6.0
870.0	229.7	42.360	0.222	0.033	0.750	56.668	6.7

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
875.0	230.4	42.000	0.287	0.046	0.813	56.900	6.2
880.0	231.2	35.910	0.353	0.067	0.917	62.820	5.2
885.0	231.9	30.100	0.350	0.055	0.717	68.833	6.4
890.0	232.6	25.510	0.348	0.056	1.351	72.791	6.2
895.0	233.3	25.820	0.343	0.041	0.839	72.998	8.4
900.0	234.0	49.570	0.339	0.044	0.768	49.323	7.7
905.0	234.8	61.240	0.264	0.041	0.732	37.764	6.4
910.0	235.5	59.630	0.190	0.027	0.684	39.496	6.9
915.0	237.7	53.220	0.211	0.041	0.864	45.705	5.1
920.0	240.0	35.960	0.233	0.039	0.927	62.880	5.9
925.0	242.2	38.070	0.200	0.035	0.825	60.905	5.7
930.0	244.5	45.180	0.200	0.043	0.725	53.895	4.6
935.0	246.7	55.520	0.210	0.036	0.782	43.488	5.8
940.0	249.0	49.260	0.220	0.044	0.787	49.733	5.0
945.0	251.2	30.180	0.250	0.039	0.710	68.860	6.5
950.0	253.4	45.390	0.311	0.059	0.655	53.644	5.3
955.0	255.7	43.110	0.270	0.067	0.987	55.633	4.1
960.0	257.9	41.200	0.360	0.098	1.010	57.430	3.7
965.0	260.2	53.230	0.337	0.046	0.938	45.495	7.3
970.0	262.4	56.120	0.210	0.037	0.757	42.913	5.7
975.0	264.7	54.180	0.220	0.036	1.037	44.563	6.1
980.0	266.9	56.750	0.270	0.056	1.073	41.907	4.8
985.0	269.1	55.640	0.210	0.041	0.877	43.273	5.2
990.0	271.4	54.810	0.210	0.034	1.052	43.928	6.1
995.0	273.6	49.740	0.220	0.042	1.088	48.952	5.3
1000.0	275.9	47.460	0.242	0.042	1.133	51.165	5.7
1005.0	278.1	42.110	0.330	0.055	1.144	56.416	6.0
1010.0	280.4	56.390	0.315	0.046	1.263	42.032	6.8
1015.0	282.6	54.230	0.306	0.050	1.336	44.128	6.1

Table B6. (continued)

DEPTH	AGE	CALCIUM CARBONATE	ORGANIC CARBON	NITROGEN	OPAL	OTHER	C/N RATIO
1020.0	284.8	52.040	0.296	0.051	1.407	46.257	5.8
1025.0	287.1	36.360	0.326	0.068	1.452	61.862	4.8
1030.0	289.3	24.980	0.357	0.068	1.454	73.209	5.2
1035.0	291.6	10.210	0.400	0.071	0.732	88.658	5.7
1040.0	293.8	7.260	0.440	0.075	0.684	91.616	5.8
1045.0	296.1	5.460	0.450	0.077	0.864	93.226	5.9
1050.0	298.3	0.820	0.400	0.077	0.927	97.853	5.2
1055.0	300.5	4.410	0.352	0.048	0.825	94.413	7.3
1060.0	302.8	8.810	0.304	0.053	0.725	90.161	5.7

APPENDIX C**MASS ACCUMULATION RATES OF CALCIUM CARBONATE, ORGANIC
CARBON, NITROGEN, OPAL, AND "OTHER" IN CORES OF THE EQUATORIAL
ATLANTIC**

Table C.1. Sedimentary Component Mass Accumulation Rate versus depth (cm) in RC24-01.

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
7.0	1.7241	0.74	1.278	1.073	3.233	0.473	36.278	0.165
10.0	1.7241	0.75	1.299	1.112	3.638	0.364	40.264	0.143
15.0	3.9474	0.74	2.929	2.462	5.917	0.762	86.696	0.374
20.0	3.9474	0.73	2.893	2.396	5.150	1.070	94.269	0.396
25.0	3.9474	0.72	2.857	2.332	4.857	0.857	95.711	0.424
30.0	3.9474	0.67	2.658	1.988	4.997	1.037	102.466	0.562
35.0	3.9474	0.65	2.577	1.856	5.696	1.005	138.669	0.576
40.0	3.9474	0.56	2.194	1.292	9.631	1.141	157.350	0.734
45.0	5.1724	0.57	2.939	1.780	26.040	3.027	209.931	0.920
50.0	5.1724	0.60	3.108	2.020	29.649	3.325	209.894	0.845
55.0	5.1724	0.63	3.281	2.281	41.672	4.627	194.222	0.760
60.0	5.1724	0.64	3.303	2.315	44.162	4.988	193.215	0.746
65.0	5.1724	0.63	3.263	2.253	39.812	4.503	209.457	0.757
70.0	5.1724	0.64	3.291	2.296	38.211	4.805	211.200	0.741
75.0	5.1724	0.60	3.124	2.043	42.329	5.154	196.189	0.837
80.0	5.1724	0.61	3.154	2.087	39.706	4.478	195.415	0.827
85.0	5.1724	0.60	3.121	2.039	39.203	4.495	205.614	0.833
90.0	5.1724	0.58	3.023	1.897	35.489	4.444	206.775	0.879
95.0	5.1724	0.58	3.013	1.883	34.584	4.760	208.462	0.882
100.0	5.1724	0.55	2.831	1.635	32.360	3.992	230.635	0.929
105.0	5.1724	0.59	3.060	1.950	35.986	3.641	219.658	0.851
110.0	5.1724	0.59	3.055	1.942	33.723	3.452	220.864	0.854
124.0	5.1724	0.68	3.535	2.692	45.819	3.288	163.224	0.631
129.0	5.1724	0.62	3.212	2.175	40.218	4.208	167.464	0.825
140.0	5.1724	0.62	3.218	2.184	32.378	3.894	176.231	0.822
145.0	5.1724	0.64	3.319	2.341	31.270	3.286	211.057	0.733
150.0	5.1724	0.63	3.264	2.253	31.559	2.872	206.002	0.770
153.0	5.1724	0.64	3.328	2.353	32.444	3.128	214.991	0.724

Table C1. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
158.0	5.1724	0.67	3.452	2.553	25.542	2.658	209.521	0.661
163.0	5.1724	0.68	3.533	2.688	26.354	2.756	192.475	0.623
168.0	5.1724	0.69	3.568	2.747	22.585	1.998	183.532	0.613
173.0	5.1724	0.69	3.586	2.778	27.361	2.295	166.611	0.612
178.0	5.1724	0.68	3.533	2.688	24.623	2.544	150.834	0.667
183.0	5.1724	0.68	3.498	2.629	19.203	2.449	160.866	0.686
188.0	5.1724	0.66	3.390	2.453	18.884	2.238	145.192	0.771
193.0	5.5556	0.62	3.462	2.354	27.698	3.255	190.648	0.886
198.0	5.5556	0.67	3.731	2.781	28.095	2.873	222.708	0.696
203.0	5.5556	0.68	3.780	2.862	28.461	4.195	215.410	0.670
208.0	5.5556	0.67	3.741	2.798	29.258	3.330	201.327	0.709
213.0	5.5556	0.66	3.679	2.695	23.653	3.642	212.847	0.743
218.0	5.5556	0.65	3.609	2.582	21.399	2.670	228.288	0.774
223.0	5.5556	0.67	3.746	2.805	22.623	3.146	193.072	0.722
228.0	5.8252	0.62	3.633	2.473	24.776	3.488	191.352	0.941
233.0	5.8252	0.62	3.625	2.461	25.777	3.372	220.800	0.914
238.0	5.8252	0.69	4.001	3.064	25.844	3.320	220.335	0.687
243.0	5.8252	0.71	4.142	3.309	22.369	2.983	198.379	0.610
248.0	5.8252	0.72	4.179	3.374	19.809	3.260	174.776	0.607
253.0	5.8252	0.70	4.068	3.180	18.063	2.360	189.594	0.678
258.0	5.8252	0.70	4.082	3.204	21.880	3.347	183.568	0.670
263.0	5.8252	0.69	4.010	3.079	27.386	2.446	173.784	0.727
268.0	5.8252	0.66	3.842	2.802	22.286	2.574	158.272	0.857
273.0	5.8252	0.61	3.569	2.376	20.915	2.177	202.145	0.968
278.0	5.8252	0.57	3.301	1.993	23.869	2.146	170.478	1.112
283.0	5.8252	0.57	3.344	2.051	22.034	2.742	219.560	1.048
288.0	3.9894	0.61	2.442	1.624	13.603	1.099	134.242	0.669
293.0	3.9894	0.60	2.396	1.557	16.296	1.845	192.354	0.629

Table C1. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
298.0	3.9894	0.63	2.526	1.752	15.411	2.021	167.642	0.589
303.0	3.9894	0.56	2.231	1.324	17.780	3.056	230.231	0.656
307.0	3.9894	0.54	2.168	1.240	15.911	2.276	210.001	0.699
311.0	3.9894	0.55	2.181	1.257	18.208	1.810	242.857	0.661
316.0	3.9894	0.54	2.145	1.211	17.267	2.510	234.858	0.680
321.0	3.9894	0.55	2.172	1.246	16.792	2.498	225.952	0.681
326.0	3.9894	0.58	2.298	1.417	17.031	2.827	186.702	0.675
332.0	3.9894	0.57	2.269	1.376	15.862	2.859	158.318	0.716
337.0	3.9894	0.53	2.107	1.162	14.034	2.550	154.326	0.774
342.0	3.9894	0.54	2.171	1.244	11.853	1.910	115.601	0.797
347.0	3.9894	0.66	2.643	1.937	13.530	1.771	125.410	0.565
352.0	3.9894	0.64	2.566	1.814	16.447	2.053	127.905	0.605
357.0	3.9894	0.72	2.876	2.335	9.318	1.582	98.477	0.431
362.0	2.5404	0.72	1.822	1.471	5.011	0.856	58.790	0.287
367.0	2.5404	0.64	1.612	1.121	4.095	0.709	83.181	0.403
372.0	2.5404	0.62	1.565	1.049	3.270	0.657	71.231	0.441
377.0	2.5404	0.72	1.835	1.494	4.901	1.248	60.288	0.275
382.0	2.5404	0.73	1.857	1.534	7.410	1.077	47.870	0.267
387.0	2.5404	0.72	1.820	1.468	7.172	0.947	60.346	0.284
392.0	2.5404	0.71	1.805	1.440	6.533	0.938	61.645	0.296
397.0	2.5404	0.71	1.798	1.429	7.805	0.863	59.733	0.301
402.0	2.5404	0.70	1.777	1.391	6.360	1.013	60.061	0.318
407.0	2.5404	0.72	1.840	1.502	5.373	0.828	53.587	0.278
412.0	2.5404	0.81	2.070	1.943	9.210	0.911	56.079	0.060
417.0	2.5404	0.71	1.808	1.445	4.990	0.633	63.354	0.293
422.0	2.5404	0.71	1.795	1.423	7.485	0.915	68.474	0.295
427.0	2.5404	0.72	1.819	1.464	6.292	0.946	56.379	0.291
432.0	2.5404	0.69	1.757	1.357	7.325	0.826	73.092	0.319

Table C1. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
437.0	2.5404	0.67	1.699	1.259	6.438	0.781	62.008	0.370
442.0	2.5404	0.68	1.730	1.312	10.018	0.761	66.640	0.341
447.0	2.5404	0.67	1.710	1.278	6.054	0.906	75.185	0.350
452.0	2.5404	0.67	1.694	1.252	6.538	0.949	56.801	0.378
457.0	2.5404	0.69	1.754	1.353	6.368	1.070	65.432	0.329
463.0	2.5404	0.68	1.716	1.288	5.508	0.806	60.263	0.361
468.0	2.5404	0.71	1.809	1.447	4.974	0.940	57.450	0.299
473.0	2.8000	0.69	1.942	1.506	3.399	0.796	67.320	0.365
478.0	2.8000	0.61	1.723	1.153	3.601	0.706	73.008	0.492
483.0	2.8000	0.61	1.707	1.129	3.038	0.785	84.234	0.490
488.0	2.8000	0.54	1.499	0.842	3.493	0.765	92.676	0.561
493.0	2.8000	0.53	1.482	0.820	4.818	0.919	107.131	0.549
498.0	2.8000	0.60	1.681	1.092	10.172	1.311	94.140	0.484
503.0	2.8000	0.64	1.791	1.258	12.467	1.379	105.719	0.414
508.0	3.4574	0.62	2.134	1.433	16.984	2.006	122.516	0.559
513.0	3.4574	0.58	1.999	1.238	18.212	2.199	119.900	0.621
518.0	3.4574	0.63	2.192	1.523	20.171	2.302	132.968	0.514
523.0	3.4574	0.62	2.155	1.465	15.794	1.788	139.661	0.532
528.0	3.4574	0.65	2.244	1.604	17.256	1.997	138.587	0.482
533.0	3.4574	0.65	2.261	1.632	18.362	1.990	145.038	0.464
538.0	3.4574	0.64	2.210	1.551	21.792	1.437	154.692	0.481
543.0	3.4574	0.66	2.274	1.653	19.785	1.933	158.499	0.441
548.0	3.4574	0.63	2.185	1.511	17.105	1.442	151.076	0.504
553.0	3.4574	0.62	2.152	1.461	21.284	1.506	154.251	0.514
558.0	3.4574	0.60	2.077	1.349	17.986	1.454	150.292	0.558
563.0	3.4574	0.60	2.084	1.359	11.065	0.771	136.154	0.577
568.0	3.4574	0.61	2.112	1.401	17.700	1.859	131.281	0.560
573.0	4.2553	0.61	2.593	1.715	22.559	2.645	184.783	0.668

Table C1. (continued)

DEPTH	SEDIMENTATION		BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
	RATE ¹	DRY BULK DENSITY ²						
578.0	4.2553	0.61	2.604	1.731	22.496	2.630	183.416	0.664
583.0	4.2553	0.62	2.655	1.808	18.851	1.859	148.111	0.678
588.0	4.2553	0.55	2.321	1.334	19.284	2.344	180.991	0.784
593.0	4.2553	0.51	2.159	1.129	19.815	2.353	186.777	0.820
598.0	4.2553	0.57	2.408	1.450	23.112	2.745	178.283	0.753
603.0	4.2553	0.57	2.411	1.455	19.433	2.266	172.382	0.762
608.0	4.2553	0.54	2.316	1.328	21.816	2.316	208.507	0.756
612.0	3.0769	0.56	1.737	1.043	14.832	1.355	142.891	0.535
617.0	3.0769	0.67	2.056	1.523	16.470	1.398	128.437	0.386
622.0	3.0769	0.65	1.997	1.427	10.382	1.018	76.125	0.482
627.0	3.0769	0.70	2.167	1.711	13.372	1.127	85.241	0.356
632.0	3.0303	0.71	2.165	1.740	11.237	0.953	70.166	0.343
637.0	3.0303	0.68	2.072	1.579	12.310	0.870	90.218	0.390
642.0	3.0303	0.69	2.097	1.620	10.126	0.881	80.456	0.385
647.0	3.0303	0.68	2.073	1.580	7.751	1.285	80.593	0.403
652.0	3.0303	0.65	1.953	1.385	11.935	1.231	100.545	0.455
657.0	3.0303	0.69	2.076	1.584	13.947	1.515	102.087	0.374
662.0	3.7313	0.67	2.495	1.850	17.366	1.722	126.038	0.500
667.0	3.7313	0.65	2.406	1.706	15.615	1.732	132.286	0.550
672.0	3.7313	0.62	2.299	1.542	17.544	1.977	136.217	0.602
677.0	3.7313	0.61	2.272	1.502	19.019	2.113	123.788	0.626
682.0	3.7313	0.60	2.255	1.477	16.397	1.940	112.061	0.648
687.0	3.7313	0.65	2.426	1.738	15.018	1.698	112.858	0.558
692.0	3.7313	0.63	2.334	1.595	10.527	1.214	110.100	0.618
697.0	3.7313	0.78	2.905	2.586	18.564	1.017	137.328	0.163
702.0	3.7313	0.72	2.689	2.184	14.120	1.668	127.435	0.363
707.0	3.7313	0.59	2.188	1.379	16.365	1.707	135.679	0.655
712.0	2.1053	0.78	1.635	1.451	3.843	0.621	43.227	0.136

Table C1. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
717.0	2.1053	0.71	1.488	1.179	6.487	0.744	40.452	0.261
722.0	2.1053	0.67	1.420	1.064	7.824	0.937	65.503	0.282
727.0	2.1053	0.71	1.502	1.205	5.529	0.586	45.750	0.245
732.0	2.1053	0.71	1.486	1.177	4.785	0.609	71.595	0.233
757.0	2.1053	0.71	1.485	1.175	5.451	0.698	54.584	0.249
762.0	2.1053	0.73	1.535	1.263	6.093	0.629	47.401	0.218

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

Table C2. Sedimentary Component Mass Accumulation Rate versus depth (cm) in RC24-07.

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
6.0	5.1163	0.75	3.832	3.257	15.963	0.921	119.840	0.438
10.0	5.1163	0.74	3.772	3.146	11.282	1.779	123.006	0.490
15.0	5.1163	0.76	3.882	3.350	12.987	1.633	127.523	0.389
19.0	5.1163	0.77	3.918	3.419	12.410	-	141.118	-
26.0	5.1163	0.75	3.824	3.243	11.013	1.266	148.716	0.421
28.0	5.1163	0.74	3.784	3.168	9.465	1.098	159.599	0.446
32.0	5.1163	0.75	3.836	3.264	7.905	1.880	156.113	0.406
35.0	5.4645	0.72	3.910	3.147	8.459	0.984	193.225	0.561
40.0	5.4645	0.71	3.855	3.050	7.100	1.280	226.172	0.570
45.0	5.4645	0.66	3.608	2.634	18.430	1.443	195.050	0.759
50.0	5.4645	0.69	3.753	2.874	18.212	1.470	165.998	0.693
55.0	5.4645	0.69	3.756	2.880	17.834	1.659	197.449	0.659
60.0	5.4645	0.66	3.595	2.613	17.925	2.380	221.803	0.740
65.0	5.4645	0.61	3.320	2.188	23.267	2.133	268.989	0.838
70.0	5.4645	0.55	3.031	1.781	24.705	2.795	243.879	0.979
75.0	6.7194	0.57	3.800	2.288	38.224	4.558	353.916	1.115
80.0	6.7194	0.60	4.024	2.605	51.041	4.878	300.735	1.063
85.0	6.7194	0.65	4.344	3.091	50.664	4.673	300.582	0.897
90.0	6.7194	0.64	4.272	2.977	67.086	8.385	259.091	0.960
95.0	6.9444	0.63	4.342	2.965	84.262	8.269	257.167	1.028
98.0	6.9444	0.63	4.382	3.026	68.381	6.475	256.741	1.024
101.0	6.9444	0.63	4.416	3.078	60.025	6.169	279.813	0.991
105.0	6.9444	0.66	4.557	3.303	69.483	7.425	297.027	0.881
111.0	6.9444	0.64	4.415	3.077	80.755	6.978	250.344	1.000
115.0	6.9444	0.66	4.583	3.343	69.070	7.058	284.781	0.878
121.0	6.8780	0.61	4.207	2.796	70.318	7.552	276.738	1.057
125.0	6.8780	0.62	4.236	2.839	79.914	6.908	305.843	1.005
131.0	6.8780	0.60	4.148	2.709	72.549	7.511	289.577	1.070
135.0	6.8780	0.63	4.300	2.935	83.110	9.186	273.291	0.999

Table C2. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
141.0	6.8780	0.59	4.090	2.623	80.430	8.238	256.400	1.122
145.0	6.8780	0.55	3.811	2.236	63.137	6.582	314.968	1.191
151.0	6.8780	0.56	3.843	2.279	58.314	6.163	303.411	1.197
155.0	6.8780	0.58	3.996	2.490	63.150	6.183	303.240	1.134
161.0	6.8780	0.56	3.868	2.312	55.618	5.855	303.894	1.190
165.0	6.8780	0.58	3.995	2.488	59.839	5.066	337.252	1.105
171.0	6.8780	0.57	3.891	2.343	70.804	6.469	314.917	1.155
175.0	6.8780	0.61	4.218	2.811	76.276	7.930	321.945	1.000
181.0	6.8780	0.63	4.322	2.969	79.036	8.103	309.424	0.956
185.0	6.8780	0.61	4.174	2.746	68.430	6.755	293.244	1.059
191.0	6.8780	0.63	4.309	2.949	80.033	7.843	291.540	0.980
201.0	6.8780	0.64	4.431	3.140	43.359	5.150	290.310	0.953
205.0	6.8780	0.62	4.294	2.926	40.767	4.222	284.914	1.038
211.0	6.8780	0.64	4.372	3.046	45.780	5.502	281.333	0.993
215.0	6.8780	0.68	4.647	3.489	48.828	4.303	255.592	0.849
221.0	6.8780	0.67	4.610	3.427	39.677	4.424	249.692	0.889
225.0	6.8780	0.69	4.726	3.622	43.851	3.939	259.883	0.796
231.0	6.8780	0.68	4.681	3.547	35.218	3.321	260.713	0.836
235.0	6.8780	0.67	4.631	3.463	39.401	3.687	252.859	0.872
241.0	6.8780	0.70	4.843	3.823	39.143	4.622	212.465	0.764
245.0	6.8780	0.73	4.994	4.091	44.988	4.870	252.747	0.601
251.0	6.8780	0.69	4.720	3.611	41.526	3.892	244.635	0.819
255.0	6.8780	0.70	4.788	3.727	41.309	3.707	238.540	0.777
261.0	6.8780	0.69	4.728	3.625	43.092	4.319	331.963	0.724
265.0	6.8780	0.61	4.218	2.812	41.704	4.070	336.878	1.024
271.0	6.8780	0.64	4.424	3.128	42.875	4.666	436.311	0.812
275.0	6.8780	0.68	4.710	3.595	50.886	4.958	309.690	0.749
281.0	6.8780	0.67	4.632	3.464	42.857	4.654	298.590	0.822
285.0	6.8780	0.67	4.601	3.413	43.410	4.332	316.276	0.824

Table C2. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
291.0	6.8780	0.64	4.430	3.138	42.082	4.666	329.480	0.916
295.0	6.8780	0.66	4.526	3.291	47.755	5.402	332.951	0.849
301.0	6.8780	0.66	4.525	3.288	41.854	5.266	259.245	0.930
305.0	6.8780	0.68	4.663	3.516	34.329	3.788	223.388	0.886
311.0	6.8780	0.63	4.360	3.027	33.279	3.770	305.717	0.990
315.0	6.8780	0.57	3.904	2.361	34.304	3.411	294.969	1.210
321.0	6.8780	0.64	4.430	3.137	42.655	5.458	259.817	0.985
325.0	6.8780	0.69	4.772	3.701	41.194	4.509	255.972	0.770
331.0	6.8780	0.70	4.793	3.737	32.113	3.515	252.613	0.768
335.0	6.8780	0.71	4.891	3.906	36.479	3.614	222.951	0.721
341.0	6.8780	0.69	4.770	3.698	30.468	3.085	251.245	0.788
345.0	6.8780	0.68	4.711	3.596	38.164	3.273	277.041	0.796
350.0	4.4643	0.68	3.019	2.270	23.891	2.671	169.724	0.553
355.0	4.4643	0.69	3.063	2.344	20.700	2.064	168.058	0.529
360.0	4.4643	0.62	2.756	1.852	21.091	2.048	184.094	0.697
365.0	4.4643	0.58	2.602	1.627	18.798	2.020	221.149	0.733
370.0	4.4643	0.56	2.515	1.506	19.350	1.850	201.156	0.786
375.0	3.1898	0.64	2.031	1.418	16.148	1.756	145.699	0.449
380.0	3.1898	0.59	1.891	1.208	14.755	1.581	175.877	0.490
385.0	3.1898	0.57	1.815	1.101	17.164	1.927	230.202	0.465
390.0	3.1898	0.51	1.615	0.843	13.795	1.464	223.068	0.534
395.0	3.1898	0.57	1.834	1.127	10.945	1.273	186.155	0.508
400.0	3.1898	0.53	1.700	0.948	13.761	1.758	151.913	0.584
405.0	3.1898	0.61	1.961	1.311	15.235	1.887	138.915	0.494
410.0	3.1898	0.49	1.552	0.769	13.582	1.579	143.553	0.624
415.0	3.1898	0.65	2.086	1.506	13.892	1.742	124.291	0.441
420.0	3.1898	0.60	1.913	1.241	13.569	1.455	133.272	0.524
425.0	3.1898	0.72	2.298	1.865	12.953	1.079	96.817	0.322
430.0	3.1898	0.73	2.324	1.911	5.239	0.977	90.674	0.316

Table C2. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
435.0	0.8547	0.71	0.609	0.488	1.347	0.243	14.492	0.105
440.0	0.8547	0.67	0.576	0.431	1.683	0.246	34.152	0.109
445.0	2.7722	0.72	2.003	1.630	10.319	0.978	78.020	0.283
450.0	2.7722	0.70	1.954	1.544	10.052	1.203	64.205	0.334
455.0	2.7722	0.71	1.958	1.552	10.294	1.378	90.425	0.304
460.0	2.7722	0.69	1.903	1.457	10.272	0.937	92.107	0.343
465.0	2.7722	0.72	1.987	1.602	9.581	1.058	101.213	0.273
470.0	2.7722	0.73	2.023	1.667	8.803	0.769	83.682	0.263
475.0	2.7722	0.73	2.012	1.646	11.818	0.749	81.449	0.271
480.0	2.7722	0.71	1.962	1.558	4.291	0.728	91.937	0.307
485.0	2.7722	0.71	1.970	1.572	10.963	0.827	88.596	0.297
490.0	2.7722	0.67	1.867	1.397	9.528	0.743	106.726	0.353
495.0	2.7722	0.67	1.850	1.368	10.196	1.467	96.932	0.373
500.0	2.7778	0.64	1.789	1.267	7.253	1.013	92.079	0.422
505.0	2.7778	0.68	1.883	1.420	12.202	1.379	91.570	0.358
511.0	2.7778	0.69	1.903	1.453	9.449	0.843	101.710	0.338
515.0	2.7778	0.78	2.178	1.954	4.333	0.607	31.623	0.187
521.0	2.7778	0.70	1.955	1.543	10.072	0.661	90.223	0.311
525.0	2.7778	0.72	2.002	1.625	7.100	0.560	81.772	0.287
531.0	2.7778	0.68	1.903	1.453	7.197	0.453	92.839	0.350
535.0	2.7778	0.64	1.788	1.265	4.960	0.586	111.770	0.405
541.0	3.0581	0.61	1.863	1.232	6.081	0.672	137.016	0.488
545.0	3.0581	0.55	1.692	0.991	12.312	0.925	141.920	0.546
551.0	3.0581	0.55	1.687	0.983	13.018	1.228	159.109	0.530
555.0	3.0581	0.57	1.753	1.074	15.653	1.482	154.286	0.508
561.0	3.0581	0.64	1.954	1.371	16.401	1.527	142.858	0.423
565.0	3.0581	0.63	1.939	1.347	19.400	1.714	151.856	0.419
571.0	3.4375	0.60	2.067	1.344	22.440	2.434	149.119	0.549
575.0	3.4375	0.63	2.168	1.497	21.938	1.906	177.118	0.471

Table C2. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
581.0	3.4375	0.64	2.194	1.537	19.690	2.156	185.400	0.450
585.0	3.4375	0.64	2.199	1.545	22.836	1.936	181.179	0.449
591.0	3.4375	0.64	2.206	1.556	22.418	1.892	189.564	0.437
595.0	3.4375	0.63	2.162	1.487	21.808	1.906	200.079	0.451
601.0	3.4375	0.65	2.249	1.623	23.148	1.519	180.686	0.420
605.0	3.4375	0.66	2.270	1.658	22.483	1.497	189.122	0.399
611.0	3.4375	0.62	2.119	1.422	22.442	1.598	214.910	0.458
615.0	3.4375	0.62	2.139	1.452	20.908	1.513	208.681	0.456
621.0	3.4364	0.60	2.047	1.316	19.402	1.423	191.622	0.519
625.0	3.4364	0.62	2.144	1.459	20.560	1.662	186.050	0.476
631.0	3.4364	0.64	2.191	1.532	21.641	1.847	198.253	0.437
635.0	3.4364	0.62	2.134	1.445	21.434	1.939	179.620	0.486
641.0	3.0902	0.63	2.152	1.473	18.612	1.811	151.630	0.507
645.0	3.0902	0.54	1.675	0.956	16.587	1.619	172.162	0.529
651.0	3.0902	0.51	1.583	0.839	17.620	1.765	161.419	0.563
655.0	3.0902	0.56	1.722	1.018	19.434	1.817	161.228	0.522
661.0	3.0902	0.50	1.540	0.788	18.572	1.684	166.330	0.566
665.0	3.0902	0.53	1.643	0.914	21.635	1.998	169.236	0.536
671.0	3.0902	0.63	1.940	1.331	21.804	1.421	133.644	0.452
675.0	3.0902	0.69	2.144	1.663	16.440	1.151	105.740	0.358
681.0	3.0902	0.70	2.176	1.719	14.471	1.038	102.290	0.340
685.0	3.0902	0.70	2.158	1.687	18.105	1.255	116.762	0.335
691.0	1.5000	0.66	2.051	1.508	7.564	0.465	68.610	0.467
695.0	1.5000	0.70	1.045	0.814	8.578	0.515	59.734	0.162
701.0	1.5000	0.69	1.035	0.797	7.338	0.507	65.542	0.164
705.0	1.5000	0.67	1.001	0.740	10.009	0.874	61.697	0.188
711.0	5.4545	0.63	3.443	2.379	40.480	3.849	274.962	0.745
715.0	5.4545	0.62	3.385	2.289	39.533	3.686	270.795	0.781
721.0	5.4545	0.61	3.328	2.205	31.542	3.161	244.239	0.845

Table C2. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
725.0	5.4545	0.65	3.519	2.497	32.476	3.191	252.189	0.734
731.0	5.4545	0.64	3.517	2.494	27.368	2.339	221.211	0.772
735.0	5.4545	0.65	3.555	2.555	19.748	1.844	243.205	0.736
741.0	5.4545	0.58	3.151	1.949	22.999	2.816	313.090	0.863
745.0	5.4545	0.60	3.260	2.104	23.302	1.931	274.483	0.856
751.0	5.4545	0.72	3.911	3.156	15.709	1.217	166.569	0.572
755.0	5.4545	0.77	4.176	3.643	13.440	0.882	144.309	0.374
761.0	5.4545	0.77	4.223	3.734	13.776	1.008	123.603	0.351
765.0	5.4545	0.75	4.071	3.446	9.204	0.818	160.023	0.455
771.0	4.0541	0.70	2.821	2.196	8.684	0.681	137.733	0.478
775.0	4.0541	0.68	2.761	2.093	9.070	0.855	158.191	0.500
781.0	4.0541	0.69	2.780	2.125	10.966	2.574	126.133	0.515
785.0	4.0541	0.72	2.926	2.380	11.617	1.080	117.705	0.416
791.0	4.0541	0.72	2.912	2.355	11.355	0.963	109.625	0.435
795.0	4.0541	0.74	2.990	2.496	10.560	0.990	96.671	0.386
801.0	4.0541	0.73	2.971	2.461	12.696	1.332	141.618	0.355
809.0	4.0541	0.69	2.798	2.155	14.127	1.511	149.041	0.478

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

Table C3. Sedimentary Component Mass Accumulation Rate versus depth (cm) in RC24-12.

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
10.0	6.9182	0.75	5.189	4.443	11.768	0.956	111.104	0.622
15.0	6.9182	0.80	5.535	5.049	12.119	1.577	117.787	0.354
20.0	6.9182	0.78	5.396	4.838	6.797	0.909	109.601	0.441
25.0	6.9182	0.77	5.327	4.705	10.189	1.357	128.463	0.482
30.0	6.9182	0.79	5.465	4.927	8.271	0.894	108.797	0.420
35.0	5.4334	0.79	4.292	3.882	5.541	1.083	73.240	0.330
40.0	5.4334	0.79	4.292	3.881	5.258	0.571	66.338	0.339
45.0	5.4334	0.77	4.184	3.682	5.376	0.951	90.377	0.405
50.0	5.4334	0.78	4.238	3.760	9.409	0.553	99.642	0.368
55.0	5.4334	0.78	4.238	3.787	5.957	1.158	102.049	0.342
60.0	5.4334	0.77	4.184	3.696	4.178	0.519	105.968	0.377
65.0	5.4334	0.79	4.292	3.869	3.992	0.725	75.606	0.343
70.0	5.4334	0.76	4.129	3.582	4.858	0.677	121.416	0.421
75.0	5.4334	0.75	4.075	3.479	6.512	0.846	130.752	0.458
80.0	3.1169	0.72	2.244	1.820	6.440	0.740	96.351	0.320
85.0	3.1169	0.71	2.213	1.775	14.169	1.330	81.609	0.340
90.0	4.3796	0.73	3.197	2.650	25.729	2.523	115.724	0.403
95.0	3.7975	0.71	2.696	2.166	23.963	2.240	104.891	0.399
100.0	3.7975	0.72	2.734	2.222	25.640	2.633	89.795	0.394
105.0	3.7975	0.71	2.696	2.165	22.018	2.041	98.817	0.409
110.0	2.9257	0.71	2.077	1.661	20.484	2.032	78.487	0.315
115.0	2.9257	0.74	2.165	1.818	9.820	0.893	53.116	0.283
120.0	2.9257	0.75	2.194	1.854	13.860	1.329	64.929	0.260
125.0	2.9257	0.70	2.048	1.609	14.955	0.880	60.894	0.362
130.0	2.9257	0.76	2.224	1.920	10.829	1.057	49.272	0.242
135.0	2.9257	0.77	2.253	1.981	10.298	1.003	49.310	0.211
140.0	2.9257	0.78	2.282	2.021	10.670	1.006	41.814	0.207
145.0	2.9257	0.75	2.194	1.869	8.238	0.836	43.431	0.273

Table C3. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
150.0	1.4118	0.76	1.073	0.927	4.338	0.421	21.858	0.119
155.0	1.4118	0.73	1.031	0.852	4.225	0.411	28.019	0.146
160.0	1.4118	0.74	1.045	0.882	4.328	0.435	30.127	0.128
165.0	1.4118	0.73	1.031	0.853	4.534	0.472	29.763	0.143
170.0	1.4118	0.75	1.059	0.904	4.504	0.389	28.574	0.122
175.0	4.2493	0.75	3.187	2.704	13.547	1.321	83.785	0.385
180.0	4.2493	0.73	3.102	2.575	14.692	1.458	90.594	0.421
185.0	4.2493	0.75	3.187	2.734	12.974	1.343	78.707	0.360
190.0	4.2493	0.76	3.229	2.807	10.029	1.067	71.599	0.340
195.0	4.2493	0.73	3.102	2.542	10.644	1.086	77.314	0.471
200.0	4.2493	0.76	3.229	2.790	13.434	1.201	82.655	0.342
205.0	4.2493	0.73	3.102	2.568	11.673	1.322	94.660	0.426
210.0	4.2493	0.74	3.144	2.635	12.942	1.163	93.761	0.402
215.0	4.2493	0.71	3.017	2.392	11.450	1.011	120.279	0.492
220.0	2.5811	0.72	1.858	1.500	9.466	0.840	82.784	0.265
225.0	2.5811	0.70	1.807	1.408	12.867	1.264	86.806	0.297
230.0	2.5811	0.70	1.807	1.406	13.477	1.323	77.777	0.308
235.0	2.5811	0.73	1.884	1.551	10.646	1.063	55.940	0.266
240.0	2.5811	0.69	1.781	1.365	8.025	0.826	70.632	0.337
245.0	2.5811	0.71	1.833	1.454	6.578	0.825	61.673	0.310
250.0	2.5811	0.75	1.936	1.654	6.790	0.673	54.035	0.220
255.0	2.5811	0.75	1.936	1.659	4.848	0.544	40.778	0.231
260.0	2.2832	0.78	1.781	1.594	3.434	0.367	36.685	0.147
265.0	2.2832	0.79	1.804	1.623	2.740	0.357	34.710	0.143
270.0	2.2832	0.76	1.735	1.491	3.157	0.381	44.565	0.196
275.0	2.2832	0.73	1.667	1.363	3.000	0.341	58.234	0.242
280.0	2.2832	0.77	1.758	1.555	2.365	0.299	34.231	0.166

Table C3. (continued)

DEPTH	SEDIMENTATION		BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
	RATE ¹	DRY BULK DENSITY ²						
285.0	2.2832	0.75	1.712	1.460	3.208	0.435	34.655	0.214
290.0	2.2832	0.77	1.758	1.548	3.535	0.410	36.125	0.170
295.0	2.2832	0.76	1.735	1.492	3.853	0.496	37.503	0.201
300.0	2.2832	0.77	1.758	1.544	3.799	0.396	36.143	0.174
305.0	2.2832	0.77	1.758	1.547	3.431	0.455	36.361	0.171
310.0	2.2832	0.77	1.758	1.554	5.105	0.404	38.539	0.160
315.0	2.2832	0.76	1.735	1.501	2.382	0.344	39.790	0.192
320.0	2.2832	0.77	1.758	1.534	3.005	0.345	43.735	0.177
325.0	2.2832	0.75	1.712	1.464	2.767	0.390	38.930	0.207
330.0	2.2832	0.76	1.735	1.489	2.907	0.361	39.029	0.204
335.0	2.2832	0.77	1.758	1.544	2.922	0.401	30.574	0.180
340.0	2.2832	0.76	1.735	1.505	5.527	0.561	31.839	0.192
345.0	2.2832	0.76	1.735	1.494	3.861	0.537	36.245	0.201
350.0	2.2832	0.75	1.712	1.467	5.097	0.497	35.140	0.205
355.0	2.2814	0.78	1.779	1.578	2.692	0.591	30.362	0.168
360.0	2.2814	0.76	1.734	1.503	2.033	0.297	41.556	0.187
365.0	4.9669	0.75	3.725	3.166	4.488	0.982	105.805	0.448
370.0	4.9669	0.73	3.626	3.012	6.342	0.933	132.156	0.474
375.0	4.9669	0.69	3.427	2.655	6.274	1.430	126.307	0.638
380.0	0.8708	0.71	0.618	0.490	2.076	0.227	19.407	0.107
385.0	2.3642	0.70	1.655	1.286	9.784	1.219	57.943	0.300
390.0	2.3642	0.71	1.679	1.348	9.485	0.800	57.002	0.263
395.0	2.3642	0.74	1.750	1.457	12.229	1.094	66.962	0.212
400.0	2.3642	0.74	1.750	1.457	11.606	0.895	63.969	0.216
405.0	2.3642	0.78	1.844	1.652	11.383	0.881	72.319	0.108
410.0	2.3642	0.75	1.773	1.499	11.135	0.818	79.644	0.183
415.0	2.3642	0.74	1.750	1.472	10.937	0.736	73.618	0.193

Table C3. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
420.0	2.3642	0.73	1.726	1.424	9.641	0.982	63.797	0.228
425.0	2.3642	0.73	1.726	1.434	11.229	0.991	69.007	0.211
430.0	2.3642	0.73	1.726	1.414	14.441	1.334	65.127	0.231
435.0	2.3642	0.70	1.655	1.302	13.021	1.157	60.672	0.278
440.0	2.3642	0.68	1.608	1.210	9.884	0.927	70.314	0.316
445.0	2.3642	0.67	1.584	1.167	15.671	1.315	67.418	0.333
450.0	3.8685	0.71	2.747	2.173	22.613	1.910	89.428	0.460
455.0	3.8685	0.73	2.824	2.325	23.763	1.975	54.071	0.419
460.0	3.8685	0.77	2.979	2.610	11.380	1.114	52.302	0.304
465.0	3.8685	0.77	2.979	2.615	15.573	1.251	51.614	0.295
470.0	2.3610	0.76	1.794	1.560	7.501	0.619	38.120	0.188
475.0	2.3610	0.76	1.794	1.558	7.083	0.605	37.084	0.191
480.0	2.3610	0.77	1.818	1.589	4.738	0.510	42.567	0.181
485.0	2.3610	0.75	1.771	1.506	7.952	0.740	35.761	0.221
490.0	2.3610	0.75	1.771	1.513	8.481	0.778	38.194	0.211
495.0	2.3610	0.74	1.747	1.455	14.734	1.263	37.098	0.239
500.0	2.3610	0.74	1.747	1.456	9.172	0.943	45.745	0.236
505.0	2.3610	0.74	1.747	1.469	6.207	0.556	61.171	0.211
510.0	2.3610	0.72	1.700	1.378	4.153	0.415	46.909	0.270
515.0	2.5862	0.73	1.888	1.551	7.705	0.681	36.402	0.293
520.0	2.5862	0.78	2.017	1.799	4.168	0.385	30.480	0.183
525.0	2.5862	0.79	2.043	1.856	3.549	0.334	32.992	0.150
530.0	1.6819	0.78	1.312	1.176	1.583	0.279	31.673	0.103
535.0	1.6819	0.76	1.278	1.111	3.239	0.341	34.126	0.129
540.0	1.6819	0.75	1.261	1.079	1.736	0.225	27.790	0.152
545.0	1.6819	0.77	1.295	1.133	2.303	0.298	28.069	0.132
550.0	1.6819	0.76	1.278	1.108	2.349	0.241	22.410	0.145

Table C3. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
555.0	1.6819	0.76	1.278	1.110	3.037	0.337	19.629	0.145
560.0	1.6819	0.77	1.295	1.144	2.921	0.326	25.992	0.122
565.0	1.6819	0.78	1.312	1.163	2.067	0.160	25.611	0.121
570.0	1.6819	0.78	1.312	1.161	1.956	0.194	29.341	0.119
575.0	1.6819	0.78	1.312	1.167	2.363	0.292	33.760	0.108
580.0	1.6819	0.75	1.261	1.067	2.187	0.279	30.554	0.161
585.0	1.6819	0.78	1.312	1.167	2.370	0.310	36.770	0.106
590.0	1.6819	0.73	1.228	1.019	1.825	0.324	39.389	0.168
595.0	1.6819	0.70	1.177	0.930	3.212	0.352	31.039	0.213
600.0	1.6819	0.70	1.177	0.930	3.847	0.430	28.410	0.215
605.0	1.6819	0.74	1.245	1.037	4.894	0.464	26.010	0.177
610.0	1.6819	0.76	1.278	1.112	3.084	0.297	28.808	0.134
615.0	1.6819	0.77	1.295	1.146	4.881	0.538	15.975	0.127
620.0	1.6819	0.78	1.312	1.177	1.781	0.189	18.310	0.115
625.0	1.6819	0.80	1.346	1.232	1.474	-	19.543	-
635.0	1.6819	0.77	1.295	1.134	2.038	0.264	17.748	0.141
640.0	1.6819	0.76	1.278	1.098	1.634	0.256	21.388	0.157
645.0	1.6819	0.78	1.312	1.164	2.376	0.280	20.599	0.125
650.0	1.6819	0.76	1.278	1.114	4.797	0.406	20.368	0.139
655.0	1.6819	0.76	1.278	1.099	5.827	0.504	24.977	0.148
660.0	1.6819	0.74	1.245	1.081	3.954	0.349	33.055	0.127
665.0	1.6819	0.74	1.245	1.050	5.160	0.448	41.712	0.147
670.0	1.6819	0.74	1.245	1.043	4.172	0.341	34.726	0.162
675.0	1.6819	0.74	1.245	1.040	6.668	0.583	27.794	0.169
680.0	1.6819	0.78	1.312	1.103	5.875	0.533	28.395	0.174
685.0	1.6819	0.76	1.278	1.147	3.298	0.353	27.505	0.100
690.0	1.6819	0.76	1.278	1.112	2.603	0.244	32.560	0.131

Table C3. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
695.0	1.6819	0.75	1.261	1.092	3.561	0.355	28.786	0.137
700.0	1.6819	0.72	1.211	1.037	2.634	0.285	28.423	0.143
705.0	1.6819	0.71	1.194	0.972	2.762	0.217	26.986	0.192
710.0	1.6819	0.75	1.261	0.999	2.563	0.342	29.784	0.230
715.0	1.6819	0.75	1.261	1.068	3.604	0.330	29.446	0.160
720.0	1.6819	0.79	1.329	1.135	3.302	0.310	24.263	0.166
725.0	1.6819	0.75	1.261	1.141	4.076	0.359	29.446	0.087

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

Table C4. Sedimentary Component Mass Accumulation Rate versus depth (cm) in RC24-16.

DEPTH	SEDIMENTATION DRY BULK		BULK ³	CALCIUM		ORGANIC	NITROGEN ⁴	OPAL ⁴	OTHER ³
	RATE ¹	DENSITY ²		CARBONATE ³	CARBON ⁴				
7.5	4.2857	0.78	3.350	2.994	5.196	1.021	63.139	0.286	
12.0	4.2857	0.80	3.416	3.126	7.174	0.873	38.329	0.244	
17.5	4.2857	0.79	3.391	3.075	8.743	1.267	50.217	0.255	
23.0	4.2857	0.79	3.375	3.044	6.248	0.983	51.872	0.272	
27.5	4.2857	0.77	3.308	2.915	3.405	1.189	74.238	0.315	
32.5	4.2857	0.78	3.324	2.945	5.354	1.043	65.619	0.307	
37.5	4.2587	0.78	3.328	2.976	3.927	1.127	69.065	0.279	
41.0	4.2587	0.77	3.291	2.902	5.791	1.091	74.565	0.307	
47.5	4.2500	0.77	3.278	2.884	3.503	1.136	70.960	0.318	
52.5	4.2500	0.76	3.249	2.830	3.862	1.146	79.478	0.335	
57.5	4.2500	0.76	3.218	2.771	3.807	0.973	78.322	0.364	
62.5	4.2500	0.79	3.356	3.037	4.603	0.998	51.213	0.262	
67.5	4.2500	0.78	3.312	2.951	4.732	1.069	55.744	0.299	
72.5	4.2500	0.78	3.300	2.927	6.328	1.177	55.137	0.310	
77.5	4.2500	0.77	3.281	2.890	10.224	1.236	52.623	0.326	
82.5	4.2500	0.77	3.287	2.902	7.181	1.304	49.404	0.327	
87.5	4.2500	0.77	3.287	2.902	8.537	1.564	53.447	0.321	
92.5	4.2500	0.78	3.328	2.982	12.994	1.221	47.390	0.284	
97.5	2.2059	0.78	1.726	1.544	2.812	0.818	24.384	0.153	
102.5	2.2059	0.79	1.740	1.573	5.377	0.640	18.935	0.142	
107.5	2.2059	0.79	1.749	1.589	3.315	0.799	22.941	0.132	
112.0	2.4490	0.79	1.927	1.736	6.069	0.927	28.304	0.155	
117.5	2.4490	0.79	1.925	1.732	4.784	0.936	23.311	0.163	
122.5	2.4490	0.77	1.890	1.666	4.848	0.715	27.355	0.192	
127.5	3.6000	0.79	2.838	2.562	11.509	1.098	33.086	0.230	
131.0	3.6000	0.78	2.814	2.515	8.469	1.175	40.713	0.248	
136.5	2.4351	0.79	1.912	1.719	5.844	0.844	24.878	0.162	
142.5	2.4351	0.77	1.885	1.666	4.372	0.700	31.092	0.183	

Table C4. (continued)

DEPTH	SEDIMENTATION		BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
	DRY BULK DENSITY ²	RATE ¹						
148.0	0.77	3.0612	2.365	2.086	8.586	0.981	32.098	0.237
152.5	0.76	3.0612	2.329	2.017	6.418	0.927	33.446	0.271
156.5	0.76	3.0612	2.340	2.038	6.130	1.077	38.593	0.256
162.5	0.75	3.0612	2.297	1.957	5.535	0.963	45.097	0.288
167.5	0.76	3.0612	2.336	2.030	6.332	1.036	41.135	0.257
172.5	0.79	3.0612	2.420	2.192	3.951	0.837	27.149	0.196
177.5	0.79	3.0612	2.420	2.192	6.070	1.083	35.279	0.185
182.5	0.79	3.0612	2.420	2.192	4.780	0.908	25.770	0.196
187.5	0.78	3.0612	2.383	2.121	4.438	0.803	31.819	0.225
192.5	0.78	3.0612	2.386	2.126	4.622	0.808	37.456	0.217
197.5	0.78	3.6012	2.799	2.485	5.917	1.165	40.495	0.266
204.5	0.76	5.0000	3.815	3.315	6.272	1.313	82.601	0.410
208.5	0.77	5.0000	3.841	3.365	8.180	1.549	73.252	0.393
212.0	0.75	5.0000	3.738	3.169	8.821	1.377	100.646	0.457
217.5	0.74	2.7076	1.994	1.661	3.793	0.687	57.944	0.271
222.5	0.74	2.7076	1.996	1.665	3.934	0.752	60.676	0.266
227.5	0.73	2.7076	1.982	1.639	3.367	0.765	64.927	0.274
232.5	0.75	3.4568	2.594	2.210	5.718	1.064	60.835	0.316
237.5	0.76	3.4568	2.628	2.273	4.001	0.993	46.560	0.303
242.5	0.76	3.4568	2.633	2.282	5.397	0.850	52.574	0.291
247.5	0.78	3.4568	2.694	2.400	3.833	0.886	40.491	0.248
252.5	0.78	3.4568	2.702	2.415	3.390	0.775	43.930	0.238
257.5	0.78	3.4568	2.709	2.430	4.610	0.805	41.318	0.232
262.0	0.79	3.4568	2.740	2.491	3.617	0.873	35.045	0.210
267.5	0.79	3.4568	2.717	2.445	3.048	0.769	42.984	0.225
271.0	0.78	3.4568	2.704	2.420	3.299	0.788	44.593	0.235
276.5	0.77	2.3912	1.837	1.609	2.022	0.676	36.061	0.189
282.5	0.78	2.3912	1.865	1.664	4.221	0.584	29.080	0.168
287.5	0.79	2.3912	1.895	1.723	2.376	0.575	23.181	0.146

Table C4. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
292.5	2.3912	0.79	1.885	1.702	3.140	0.585	21.562	0.158
297.5	2.3912	0.79	1.890	1.712	2.334	0.492	21.415	0.153
302.5	2.3912	0.79	1.895	1.723	2.731	0.664	23.806	0.145
307.5	2.3912	0.78	1.871	1.674	2.375	0.602	27.910	0.166
314.5	3.6522	0.81	2.944	2.729	4.163	0.915	34.999	0.175
318.5	3.6522	0.78	2.863	2.568	4.376	0.881	42.709	0.247
322.5	3.6522	0.78	2.849	2.541	2.891	0.901	49.544	0.254
328.0	3.6522	0.78	2.854	2.552	3.397	1.071	46.755	0.251
332.5	3.6522	0.78	2.849	2.541	3.271	1.028	45.698	0.258
337.5	3.6522	0.79	2.887	2.615	3.127	0.891	43.389	0.224
342.5	3.6522	0.79	2.884	2.610	3.740	1.024	50.155	0.219
347.5	3.6522	0.79	2.881	2.605	3.321	0.968	43.308	0.229
352.5	3.6522	0.77	2.827	2.499	3.397	1.076	50.752	0.273
358.0	3.6522	0.78	2.841	2.526	4.489	0.846	41.437	0.269
362.5	3.6522	0.78	2.835	2.515	2.750	1.030	32.438	0.284
367.5	3.6522	0.78	2.838	2.520	2.704	0.822	40.104	0.274
372.5	3.6522	0.78	2.838	2.520	2.938	1.052	37.890	0.276
377.5	3.6522	0.78	2.852	2.547	2.770	1.005	31.340	0.270
382.5	3.6522	0.75	2.738	2.330	2.242	1.060	37.459	0.367
387.5	3.6522	0.75	2.733	2.320	2.624	0.905	34.324	0.375
392.5	3.6522	0.77	2.830	2.505	2.101	0.947	37.782	0.285
397.5	3.4615	0.76	2.616	2.247	2.507	0.815	30.813	0.335
402.5	3.4615	0.76	2.641	2.295	2.977	0.894	49.182	0.293
407.5	3.4615	0.76	2.621	2.257	3.369	0.885	48.800	0.311
412.5	3.4615	0.74	2.557	2.137	2.829	0.919	66.247	0.349
417.5	3.4615	0.72	2.480	1.999	3.126	1.171	55.923	0.421
422.5	3.4615	0.72	2.488	2.013	2.902	0.869	67.266	0.404
427.5	3.4615	0.73	2.513	2.058	3.434	0.710	62.027	0.389
432.5	3.4615	0.75	2.613	2.242	2.628	0.792	43.378	0.324

Table C4. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
437.5	3.4615	0.75	2.600	2.218	2.670	0.733	36.457	0.342
443.0	2.2500	0.75	1.697	1.454	4.746	0.640	22.654	0.215
447.5	2.2500	0.75	1.688	1.449	5.748	0.795	21.009	0.211
452.5	2.2500	0.76	1.702	1.464	6.581	0.927	19.657	0.211
456.5	2.2500	0.76	1.714	1.486	3.704	0.590	26.526	0.197
461.5	2.2500	0.75	1.690	1.442	3.635	0.628	30.340	0.214
467.5	2.2500	0.77	1.724	1.505	4.904	0.726	32.092	0.181
472.5	2.2500	0.76	1.710	1.479	3.665	0.594	30.699	0.196
477.5	4.0714	0.75	3.056	2.603	5.680	1.355	61.018	0.384
482.5	4.0714	0.77	3.131	2.746	7.788	1.243	53.036	0.323
488.0	4.0714	0.77	3.116	2.717	5.781	1.265	52.438	0.339
492.5	4.0714	0.78	3.185	2.851	5.353	1.078	58.223	0.270
497.5	4.0714	0.76	3.089	2.666	8.375	1.513	51.611	0.362
502.5	4.0714	0.75	3.074	2.637	11.836	1.725	50.683	0.372
507.5	4.0714	0.73	2.980	2.465	10.037	1.536	46.461	0.458
512.5	4.0714	0.73	2.974	2.454	10.959	1.453	53.386	0.455
517.5	4.0714	0.73	2.980	2.465	14.934	1.870	45.448	0.453
522.5	4.0714	0.71	2.908	2.335	13.322	1.630	62.956	0.495
527.5	4.0714	0.77	3.119	2.723	10.863	1.170	43.039	0.341
532.5	4.0714	0.77	3.143	2.769	14.560	1.784	44.063	0.314
538.0	3.6207	0.79	2.854	2.577	15.012	1.376	38.414	0.222
542.5	3.6207	0.79	2.873	2.614	6.913	1.155	34.156	0.216
547.5	3.6207	0.79	2.859	2.588	7.446	1.119	33.339	0.230
552.5	3.6207	0.79	2.859	2.588	8.809	0.992	30.451	0.231
557.5	3.6207	0.79	2.859	2.588	6.929	1.125	47.778	0.216
562.5	3.6207	0.77	2.774	2.421	7.025	1.049	54.139	0.290
567.5	3.6207	0.79	2.843	2.556	5.237	1.175	44.325	0.236
572.5	3.6207	0.77	2.779	2.432	4.107	0.989	43.629	0.299
577.5	3.6207	0.75	2.699	2.280	5.301	1.053	39.344	0.373

Table C4. (continued)

DEPTH	SEDIMENTATION DRY BULK		BULK ³	CALCIUM CARBONATE ³		ORGANIC CARBON ⁴		NITROGEN ⁴	OPAL ⁴	OTHER ³
	RATE ¹	DENSITY ²		CARBONATE ³	CARBON ⁴					
582.5	3.6207	0.77	2.776	2.426	8.528	1.393	42.976	0.297		
587.5	3.6207	0.76	2.747	2.370	10.540	1.397	41.586	0.323		
592.0	3.6207	0.76	2.747	2.370	12.141	1.469	40.047	0.323		
597.5	3.6207	0.74	2.690	2.265	11.170	1.710	36.510	0.376		
602.5	3.6207	0.76	2.752	2.381	7.663	1.079	37.043	0.326		
607.5	3.6207	0.77	2.784	2.442	8.672	1.300	31.239	0.301		
611.5	3.6207	0.73	2.658	2.206	10.736	1.398	29.826	0.410		
617.5	3.6207	0.78	2.827	2.525	6.377	1.124	51.680	0.243		
622.5	3.6207	0.79	2.854	2.577	4.047	0.973	54.738	0.217		
627.5	3.6207	0.79	2.859	2.588	4.068	0.722	41.374	0.225		
632.5	3.6207	0.80	2.881	2.630	4.374	0.862	31.659	0.214		
637.5	3.6207	0.78	2.835	2.540	3.676	1.394	30.194	0.260		
642.5	2.4194	0.76	1.844	1.601	2.695	0.686	18.610	0.221		
647.5	2.4194	0.75	1.812	1.540	2.283	0.588	21.945	0.247		
652.5	2.4194	0.75	1.816	1.547	3.696	0.540	27.907	0.237		
657.5	2.4194	0.76	1.841	1.594	3.105	1.009	29.931	0.213		
662.5	2.4194	0.78	1.877	1.663	2.528	0.674	26.723	0.184		
667.5	2.4194	0.79	1.918	1.743	2.795	0.628	27.098	0.144		
672.5	2.4194	0.77	1.869	1.649	3.301	0.569	26.209	0.191		
677.5	2.4194	0.80	1.925	1.757	3.100	0.852	24.832	0.139		
682.5	2.4194	0.79	1.923	1.754	3.312	0.591	22.212	0.143		
687.5	2.4194	0.79	1.921	1.750	3.066	1.136	25.650	0.141		
691.5	2.4194	0.79	1.902	1.711	2.644	0.613	30.293	0.157		
697.5	2.4194	0.78	1.896	1.701	2.957	0.636	29.999	0.162		
702.5	2.4194	0.78	1.891	1.690	3.826	0.995	31.181	0.164		
707.5	2.4194	0.77	1.859	1.628	3.293	1.036	37.527	0.189		
712.5	2.4194	0.77	1.859	1.628	3.505	1.091	28.345	0.198		
717.5	3.2308	0.77	2.487	2.183	3.457	1.211	57.470	0.241		
722.5	3.2308	0.76	2.470	2.151	3.348	1.252	36.854	0.277		

Table C4. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
727.5	3.2308	0.75	2.422	2.061	3.752	0.850	33.694	0.323
732.5	3.2308	0.75	2.425	2.066	2.640	0.759	42.165	0.313
737.5	3.2308	0.77	2.484	2.179	4.966	0.942	40.968	0.259
742.5	3.2308	0.74	2.403	2.026	6.365	0.835	35.590	0.335
747.5	3.2308	0.79	2.537	2.281	5.283	0.763	40.415	0.210
752.5	3.2308	0.78	2.520	2.248	7.366	1.120	27.698	0.236
757.5	3.2308	0.79	2.549	2.304	4.682	0.946	24.011	0.215
762.5	3.2308	0.79	2.556	2.318	4.314	0.986	24.360	0.208
767.5	3.2308	0.79	2.551	2.309	3.715	0.905	27.478	0.210

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

Table C5. Sedimentary Component Mass Accumulation Rate versus depth (cm) in V25-56.

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
4.0	4.4737	0.62	2.780	1.883	8.311	1.835	18.353	0.868
9.0	4.4737	0.62	2.760	1.853	8.637	1.821	18.593	0.878
14.0	4.4737	0.62	2.761	1.855	7.730	1.850	18.593	0.878
18.0	4.4737	0.65	2.898	2.067	6.985	1.101	20.607	0.802
23.0	4.4737	0.63	2.806	1.923	6.369	1.122	15.727	0.860
28.0	6.8333	0.52	3.550	1.916	8.412	1.952	27.048	1.596
33.0	6.8333	0.48	3.253	1.565	8.133	2.212	25.738	1.652
38.0	6.8333	0.43	2.928	1.220	8.168	1.991	20.536	1.677
43.0	6.8333	0.40	2.753	1.052	7.267	2.120	26.635	1.665
48.0	5.7143	0.40	2.266	0.846	5.505	1.676	17.639	1.394
53.0	5.7143	0.37	2.095	0.698	5.300	1.697	20.559	1.369
58.0	5.7143	0.29	1.629	0.363	4.317	1.075	14.848	1.245
63.0	5.7143	0.34	1.948	0.581	5.044	1.207	20.567	1.340
68.0	8.6082	0.34	2.927	0.921	6.292	2.371	26.295	1.971
71.0	8.6082	0.35	3.038	1.117	7.261	1.793	37.731	1.879
79.0	8.6082	0.39	3.374	1.324	7.625	1.957	37.106	2.005
84.0	8.6082	0.41	3.532	1.329	10.596	2.119	33.310	2.156
89.0	8.6082	0.40	3.431	0.973	8.474	2.950	30.331	2.410
94.0	8.6082	0.33	2.839	0.546	7.154	2.186	24.743	2.252
98.0	8.6082	0.26	2.259	0.738	5.263	1.694	32.910	1.490
103.0	8.6082	0.36	3.113	1.126	8.251	3.176	26.213	1.952
108.0	8.6082	0.39	3.336	1.237	8.206	2.569	26.583	2.062
112.0	8.6082	0.39	3.357	1.228	7.990	2.686	33.481	2.084
117.0	8.6082	0.39	3.396	1.225	7.980	2.479	29.077	2.129
122.0	8.6082	0.39	3.332	1.138	8.030	2.232	34.950	2.151
127.0	8.6082	0.37	3.208	1.258	7.410	2.181	29.225	1.916
132.0	8.6082	0.41	3.532	1.588	8.265	2.755	30.564	1.905
137.0	8.6082	0.45	3.896	1.668	10.169	2.494	37.576	2.180
142.0	8.6082	0.44	3.760	1.810	11.130	2.895	28.944	1.909

Table C5. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
147.0	8.6082	0.48	4.099	1.934	10.164	2.705	52.731	2.096
152.0	3.2500	0.47	1.525	0.687	3.889	1.006	12.941	0.820
156.0	3.2500	0.45	1.474	0.707	3.625	1.017	10.125	0.751
162.0	5.5556	0.47	2.638	1.018	6.437	1.767	12.646	1.594
167.0	5.5556	0.41	2.253	0.648	4.821	1.036	16.928	1.579
172.0	5.5556	0.33	1.849	0.582	5.807	1.054	21.620	1.244
177.0	5.5556	0.35	1.960	0.793	6.545	1.137	20.787	1.142
182.0	5.5556	0.42	2.331	1.050	6.178	1.679	16.893	1.257
187.0	5.5556	0.45	2.518	1.019	7.127	2.544	17.772	1.470
192.0	5.5556	0.42	2.330	0.911	6.664	1.817	19.566	1.392
197.0	5.5556	0.41	2.274	1.007	5.981	2.365	16.907	1.243
202.0	5.5556	0.45	2.486	1.037	6.589	2.014	13.747	1.425
206.0	5.5556	0.43	2.381	0.829	6.237	1.881	18.085	1.520
209.0	5.5556	0.38	2.099	0.595	5.246	1.322	22.321	1.476
214.0	2.8125	0.33	0.928	0.348	2.783	0.983	11.450	0.567
219.0	2.8125	0.40	1.119	0.475	2.775	0.951	9.622	0.632
223.0	2.8125	0.43	1.221	0.548	2.479	0.720	13.349	0.657
228.0	2.8125	0.45	1.272	0.580	2.709	0.979	14.337	0.674
233.0	2.8125	0.46	1.287	0.617	3.243	0.926	10.392	0.654
238.0	2.8125	0.48	1.336	0.544	3.207	0.895	11.393	0.774
243.0	2.8125	0.42	1.185	0.424	2.832	0.782	11.929	0.744
248.0	2.8125	0.38	1.083	0.391	2.360	0.996	12.730	0.676
252.0	2.8125	0.38	1.069	0.389	2.340	0.855	10.638	0.681
257.0	0.8333	0.39	0.325	0.123	0.763	0.250	3.681	0.202
262.0	0.8333	0.40	0.333	0.095	0.796	0.226	4.053	0.192
267.0	4.6667	0.33	1.544	0.479	3.797	1.189	22.357	1.038
272.0	4.6667	0.35	1.632	0.538	3.671	1.224	24.794	1.065
277.0	4.6667	0.36	1.699	0.506	3.976	1.308	18.900	1.163
282.0	4.6667	0.34	1.589	0.528	3.400	1.096	17.900	1.038

Table C5. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
289.0	4.6667	0.37	1.707	0.489	4.114	1.383	19.329	1.192
294.0	4.6667	0.28	1.300	0.401	2.405	1.079	18.919	0.879
298.0	4.6667	0.33	1.549	0.416	3.098	1.007	16.940	1.110
303.0	4.6667	0.35	1.625	0.385	8.176	1.674	20.044	1.211
306.0	4.6667	0.32	1.487	0.475	4.209	1.041	29.969	0.987
313.0	4.6667	0.30	1.377	0.648	3.635	1.171	18.804	0.707
318.0	4.6667	0.36	1.662	0.446	4.039	1.180	20.605	1.189
323.0	4.6667	0.47	2.185	0.653	5.660	1.792	30.299	1.496
328.0	4.6667	0.32	1.488	0.757	3.421	0.997	29.738	0.708
333.0	4.6667	0.34	1.592	0.862	3.949	1.337	26.995	0.707
338.0	5.0000	0.50	2.484	1.379	6.284	1.490	31.781	1.065
343.0	5.0000	0.52	2.604	1.288	6.145	2.005	21.469	1.283
348.0	5.0000	0.53	2.654	1.135	5.149	1.884	20.785	1.487
353.0	5.0000	0.49	2.430	1.011	5.029	1.725	19.828	1.383
358.0	5.0000	0.44	2.182	0.619	4.734	1.396	18.527	1.532
362.0	5.0000	0.44	2.200	0.619	5.148	2.002	29.702	1.545
367.0	5.0000	0.43	2.140	0.597	5.114	1.369	26.124	1.513
372.0	3.7500	0.33	1.238	0.560	2.698	0.978	24.765	0.658
381.0	3.7500	0.33	1.225	0.638	2.682	0.906	21.299	0.569
386.0	3.7500	0.45	1.706	0.879	4.453	1.348	15.835	0.806
391.0	3.7500	0.49	1.830	0.866	3.733	1.519	21.585	0.937
396.0	3.7500	0.51	1.896	0.946	4.740	1.384	16.060	0.927
401.0	3.7500	0.50	1.879	0.922	4.548	1.616	22.309	0.929
406.0	3.7500	0.47	1.763	0.933	3.543	1.587	19.079	0.808
411.0	3.7500	0.49	1.835	0.994	3.229	1.560	19.921	0.817
414.0	3.7500	0.48	1.812	0.959	4.168	1.250	19.425	0.830
418.0	3.7500	0.51	1.919	1.068	3.338	1.094	21.358	0.825
423.0	3.7500	0.52	1.954	1.022	3.556	1.348	19.207	0.906
428.0	3.7500	0.51	1.919	0.935	3.474	1.439	16.837	0.960

Table C5. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
433.0	3.7500	0.53	1.995	0.902	3.530	1.336	14.191	1.066
438.0	3.7500	0.51	1.902	0.600	3.386	1.522	13.799	1.276
443.0	3.7500	0.48	1.802	0.517	3.677	1.298	15.192	1.262
448.0	3.3333	0.45	1.515	0.573	3.395	0.970	20.222	0.918
453.0	3.3333	0.35	1.178	0.534	2.391	0.695	17.616	0.627
458.0	3.3333	0.33	1.108	0.494	2.748	0.842	18.019	0.597
463.0	3.3333	0.40	1.332	0.588	3.637	1.066	20.059	0.723
468.0	3.3333	0.46	1.518	0.735	3.659	0.957	17.422	0.763
473.0	3.3333	0.45	1.500	0.793	4.035	1.230	20.442	0.685
477.0	3.3333	0.45	1.500	0.820	3.914	1.290	17.891	0.660
482.0	3.3333	0.45	1.489	0.842	3.112	1.013	12.295	0.632
486.0	3.3333	0.48	1.595	0.915	2.854	0.941	19.817	0.660
491.0	3.3333	0.51	1.704	0.894	3.050	1.142	17.327	0.790
496.0	4.4304	0.54	2.386	1.549	4.557	0.954	15.578	0.810
498.0	4.4304	0.54	2.413	1.387	3.860	1.882	9.559	1.001
503.0	4.4304	0.51	2.251	0.864	4.344	1.576	15.038	1.355
508.0	4.4304	0.60	2.661	0.554	5.614	2.075	12.386	2.072
517.0	4.4304	0.55	2.417	0.592	7.250	1.933	18.343	1.783
522.0	4.4304	0.40	1.790	0.374	3.634	1.199	13.195	1.394
527.0	4.4304	0.27	1.214	0.298	2.173	0.789	19.450	0.899
533.0	1.8634	0.30	0.561	0.142	1.538	0.387	7.245	0.412
541.0	1.8634	0.27	0.512	0.180	1.647	0.409	8.327	0.324
546.0	1.8634	0.30	0.563	0.217	1.564	0.518	9.519	0.336
551.0	1.8634	0.31	0.572	0.213	1.248	0.441	8.594	0.351
556.0	1.8634	0.40	0.743	0.262	1.997	0.602	8.955	0.469
563.0	3.0000	0.38	1.139	0.415	2.507	0.775	10.782	0.711
568.0	3.0000	0.41	1.217	0.495	3.139	0.767	13.593	0.705
573.0	3.0000	0.39	1.184	0.433	3.162	1.030	14.413	0.732
578.0	2.0661	0.38	0.788	0.330	2.213	0.662	9.700	0.446

Table C5. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
582.0	2.0661	0.38	0.785	0.303	2.025	0.605	6.375	0.473
587.0	2.0661	0.39	0.804	0.284	2.735	0.748	7.271	0.509
592.0	2.0661	0.39	0.804	0.280	2.686	0.820	8.391	0.511
597.0	2.0661	0.42	0.870	0.261	2.852	0.800	8.747	0.596
602.0	2.0661	0.39	0.807	0.344	2.390	0.743	10.700	0.450
607.0	2.0661	0.43	0.888	0.363	2.051	0.497	10.953	0.513
612.0	2.0661	0.38	0.788	0.390	2.050	0.473	10.437	0.386
617.0	2.0661	0.38	0.780	0.275	2.005	0.726	9.187	0.494
622.0	2.0661	0.34	0.707	0.258	1.620	0.651	9.651	0.438
627.0	2.0661	0.44	0.899	0.280	2.041	0.521	9.849	0.606
632.0	2.0661	0.42	0.872	0.333	2.661	0.785	9.534	0.528
637.0	2.0661	0.49	1.004	0.465	4.486	0.693	10.380	0.522
642.0	2.0661	0.38	0.786	0.356	3.350	0.495	11.425	0.416
647.0	2.0661	0.39	0.805	0.322	2.825	0.547	10.527	0.469
652.0	1.1194	0.35	0.392	0.158	1.196	0.380	8.079	0.227
657.0	1.1194	0.40	0.450	0.218	1.238	0.252	6.617	0.225
661.0	0.6818	0.46	0.316	0.139	0.843	0.303	3.499	0.171
666.0	1.1364	0.45	0.517	0.150	1.453	0.445	6.505	0.359
671.0	1.1364	0.42	0.473	0.248	1.424	0.336	7.367	0.218
676.0	1.1364	0.42	0.474	0.284	0.868	0.242	4.811	0.186
681.0	0.8333	0.48	0.398	0.244	0.757	0.207	3.600	0.149
686.0	0.8333	0.45	0.371	0.147	0.869	0.308	5.646	0.218
692.0	1.7500	0.34	0.586	0.322	1.437	0.504	7.382	0.258
696.0	1.7500	0.51	0.888	0.448	2.389	0.462	8.421	0.428
701.0	1.7500	0.56	0.986	0.493	2.603	0.808	8.303	0.482
706.0	1.3636	0.57	0.781	0.480	1.500	0.352	4.819	0.292
711.0	1.3636	0.41	0.564	0.184	1.270	0.480	4.672	0.373
716.0	1.3636	0.53	0.717	0.237	1.807	0.660	5.286	0.471
721.0	1.3699	0.49	0.676	0.318	1.906	0.574	6.145	0.348

Table C5. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
724.0	1.3699	0.49	0.671	0.272	1.933	0.658	8.558	0.389
727.0	1.3699	0.57	0.787	0.383	2.268	0.827	2.973	0.398
732.0	1.3699	0.54	0.740	0.421	2.019	0.584	6.456	0.310
734.0	1.3699	0.54	0.740	0.421	1.531	0.362	8.799	0.308

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

Table C6. Sedimentary Component Mass Accumulation Rate versus depth (cm) in RC16-16.

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
6.0	2.1277	0.54	1.140	0.640	4.560	0.695	7.626	0.487
10.0	2.1277	0.56	1.188	0.704	4.514	0.713	8.149	0.472
15.0	2.7211	0.56	1.520	0.901	4.925	1.110	9.850	0.604
20.0	2.7211	0.59	1.593	1.001	4.284	0.780	10.798	0.576
25.0	2.7211	0.55	1.504	0.880	4.212	0.888	10.605	0.610
30.0	2.7211	0.53	1.449	0.807	4.201	0.768	10.894	0.626
35.0	8.6207	0.53	4.576	2.540	12.629	2.151	37.520	1.986
40.0	8.2607	0.46	3.833	1.781	10.041	1.993	31.274	2.010
45.0	8.6207	0.48	4.132	2.007	10.124	2.025	37.562	2.078
50.0	8.6207	0.44	3.752	1.598	8.555	1.313	33.431	2.112
55.0	8.6207	0.33	2.833	0.799	7.679	1.388	27.853	1.999
60.0	8.6207	0.32	2.766	0.751	8.659	1.549	26.115	1.981
65.0	8.6207	0.35	2.983	0.911	8.711	1.730	30.221	2.033
70.0	8.6207	0.43	3.679	1.525	9.969	1.324	37.192	2.107
75.0	8.6207	0.43	3.706	1.551	9.338	1.408	38.797	2.106
80.0	8.6207	0.43	3.726	1.572	8.681	1.267	38.377	2.107
85.0	9.2470	0.42	3.865	1.556	9.855	1.546	40.384	2.258
90.0	9.2470	0.38	3.493	1.217	9.676	1.397	37.515	2.229
95.0	9.2470	0.34	3.102	0.903	8.964	1.148	30.364	2.159
100.0	9.2470	0.32	2.949	0.793	8.876	1.592	25.804	2.122
105.0	9.2470	0.38	3.491	1.215	8.727	1.327	29.952	2.237
110.0	9.2470	0.41	3.782	1.477	6.128	1.097	33.966	2.265
115.0	9.2470	0.40	3.664	1.368	9.270	1.356	35.431	2.252
120.0	9.2470	0.40	3.659	1.363	9.734	1.464	32.275	2.254
125.0	9.2470	0.32	2.995	0.825	9.524	1.707	25.486	2.135
130.0	9.2470	0.29	2.647	0.594	9.792	2.038	21.887	2.020
135.0	9.2470	0.42	3.895	1.585	11.684	1.675	31.741	2.266
140.0	9.2470	0.47	4.356	2.066	12.196	1.917	43.341	2.234
145.0	9.2470	0.47	4.370	2.082	10.052	1.879	42.347	2.235

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
150.0	9.2470	0.48	4.479	2.205	11.198	2.553	44.163	2.218
155.0	2.1668	0.46	0.990	0.450	2.474	0.534	7.709	0.529
160.0	2.1668	0.50	1.087	0.561	2.283	0.544	7.915	0.516
165.0	2.1668	0.50	1.080	0.552	2.160	0.508	8.208	0.517
170.0	2.1668	0.48	1.031	0.496	3.094	0.516	8.509	0.524
175.0	2.1668	0.49	1.072	0.543	3.228	0.622	9.351	0.517
180.0	2.1668	0.52	1.120	0.601	3.686	0.661	9.253	0.506
185.0	2.1668	0.44	0.943	0.401	3.281	0.594	7.325	0.531
190.0	2.1668	0.35	0.756	0.234	2.775	0.597	5.784	0.514
195.0	4.7393	0.42	1.967	0.784	6.707	1.456	14.949	1.161
200.0	4.7393	0.43	2.030	0.846	6.394	1.583	14.553	1.163
205.0	4.7393	0.37	1.744	0.584	5.963	1.116	13.670	1.140
210.0	4.7393	0.43	2.044	0.860	7.542	1.451	18.067	1.159
215.0	4.7393	0.39	1.866	0.690	6.176	1.250	18.249	1.151
220.0	4.7393	0.48	2.265	1.096	6.614	1.246	20.408	1.142
225.0	5.7252	0.40	2.302	0.878	8.151	1.727	20.975	1.395
230.0	5.7252	0.34	1.974	0.599	8.230	1.717	18.869	1.347
235.0	5.7252	0.54	3.073	1.731	9.219	1.844	30.608	1.303
240.0	5.7252	0.43	2.455	1.024	9.524	1.964	24.570	1.396
245.0	5.7252	0.29	1.671	0.388	5.599	1.136	16.812	1.261
250.0	5.7252	0.51	2.911	1.528	8.179	1.485	31.757	1.343
255.0	8.5470	0.54	4.650	2.665	13.486	2.744	52.177	1.920
260.0	8.5470	0.47	3.981	1.860	11.904	2.269	46.978	2.062
265.0	8.5470	0.40	3.434	1.308	13.736	2.404	42.858	2.070
270.0	8.5470	0.44	3.724	1.589	14.486	1.750	49.713	2.071
275.0	8.5470	0.41	3.490	1.360	12.773	1.850	48.787	2.069
280.0	8.5470	0.47	3.998	1.878	13.672	1.879	57.486	2.048
285.0	1.9493	0.35	0.682	0.212	2.352	0.341	9.230	0.458

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
290.0	1.9493	0.32	0.627	0.171	2.183	0.351	7.941	0.446
295.0	5.2770	0.24	1.256	0.200	4.509	0.741	15.148	1.036
300.0	5.2770	0.21	1.087	0.126	4.023	0.620	13.375	0.944
305.0	5.2770	0.23	1.206	0.177	4.354	0.687	14.907	1.010
310.0	5.2770	0.20	1.042	0.109	3.656	0.594	13.219	0.916
315.0	5.2770	0.18	0.971	0.084	3.329	0.592	12.424	0.871
320.0	5.2770	0.19	1.009	0.097	3.381	0.595	13.222	0.895
325.0	5.2770	0.21	1.122	0.140	3.578	0.583	14.448	0.963
330.0	5.2770	0.29	1.541	0.358	4.670	0.817	19.650	1.159
335.0	5.2770	0.22	1.187	0.168	4.594	0.760	14.327	1.000
340.0	5.2770	0.16	0.843	0.045	3.972	0.590	10.179	0.784
345.0	5.2770	0.27	1.448	0.302	5.951	0.956	16.317	1.124
350.0	5.2770	0.33	1.729	0.485	6.069	1.158	18.811	1.219
355.0	5.2770	0.34	1.773	0.518	6.454	1.011	18.653	1.230
360.0	5.2770	0.32	1.693	0.459	6.381	1.016	18.670	1.208
365.0	5.2770	0.42	2.235	0.916	4.693	0.559	27.129	1.286
370.0	5.2770	0.40	2.130	0.816	6.410	0.831	24.917	1.282
375.0	2.9448	0.35	1.036	0.325	3.534	0.549	12.726	0.695
380.0	2.9448	0.25	0.745	0.134	2.480	0.357	8.714	0.600
385.0	2.9448	0.26	0.757	0.140	2.278	0.447	8.425	0.606
390.0	2.9448	0.35	1.030	0.320	2.782	0.464	11.013	0.696
395.0	2.9448	0.29	0.853	0.195	2.558	0.452	8.415	0.646
400.0	2.9448	0.50	1.460	0.741	3.430	0.744	15.690	0.700
405.0	2.9448	0.46	1.354	0.622	4.061	0.704	13.660	0.715
410.0	2.9448	0.47	1.396	0.668	3.378	0.670	14.780	0.710
415.0	2.9448	0.48	1.414	0.689	3.253	0.509	14.087	0.708
420.0	2.9448	0.51	1.502	0.792	4.070	-	15.696	0.691
425.0	2.9448	0.49	1.453	0.733	3.196	0.610	15.312	0.701

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
430.0	2.9448	0.45	1.323	0.589	3.572	0.886	14.009	0.717
435.0	2.9448	0.40	1.177	0.445	3.354	0.906	12.251	0.717
440.0	2.9448	0.40	1.191	0.457	3.584	0.488	12.561	0.717
445.0	2.9448	0.34	1.006	0.301	2.917	0.513	10.704	0.691
450.0	2.9448	0.35	1.045	0.332	2.916	0.481	12.031	0.698
455.0	2.9448	0.37	1.095	0.373	2.990	0.624	12.849	0.707
460.0	2.9448	0.41	1.218	0.483	3.251	-	15.086	0.716
465.0	2.9448	0.39	1.159	0.429	3.594	0.696	14.076	0.713
470.0	2.9448	0.48	1.427	0.703	4.566	0.742	16.608	0.703
475.0	2.9448	0.52	1.523	0.817	3.639	0.685	17.359	0.685
480.0	2.9448	0.58	1.719	1.078	4.057	0.705	18.035	0.620
485.0	2.9448	0.53	1.567	0.872	3.666	0.611	14.884	0.676
490.0	2.9448	0.41	1.205	0.470	2.795	0.410	10.853	0.720
495.0	3.9735	0.43	1.709	0.717	4.633	0.752	15.214	0.973
500.0	3.9735	0.29	1.145	0.260	3.551	0.607	10.744	0.871
505.0	3.9735	0.26	1.050	0.204	2.949	0.619	9.132	0.833
510.0	3.9735	0.37	1.483	0.508	3.738	0.712	13.765	0.958
515.0	3.9735	0.38	1.503	0.524	3.952	0.691	14.697	0.960
520.0	3.9735	0.39	1.561	0.576	4.278	0.734	18.298	0.963
525.0	3.9735	0.45	1.796	0.806	4.904	0.844	20.120	0.965
530.0	3.9735	0.49	1.949	0.976	5.283	1.014	22.359	0.945
535.0	3.9735	0.49	1.937	0.962	3.873	0.600	19.987	0.951
540.0	3.9735	0.47	1.855	0.870	2.783	0.445	19.963	0.963
545.0	3.9735	0.44	1.736	0.743	3.472	0.781	19.789	0.969
550.0	3.9735	0.47	1.860	0.875	4.093	0.744	22.360	0.959
555.0	2.2883	0.44	1.006	0.434	2.414	0.513	12.534	0.557
560.0	2.2883	0.43	0.973	0.401	2.627	0.477	10.928	0.558
565.0	2.2883	0.41	0.942	0.372	2.827	0.490	10.160	0.558
570.0	2.2883	0.40	0.919	0.350	2.904	0.570	9.887	0.556

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
575.0	2.2883	0.35	0.805	0.252	2.762	0.556	9.122	0.541
580.0	2.2883	0.38	0.880	0.315	3.247	0.502	9.178	0.553
585.0	2.2883	0.35	0.810	0.256	3.086	0.567	7.645	0.543
590.0	2.2883	0.31	0.699	0.175	2.748	0.490	6.825	0.514
595.0	4.0184	0.31	1.242	0.318	4.460	0.882	12.795	0.907
600.0	4.0184	0.32	1.268	0.335	4.120	0.545	14.314	0.914
605.0	4.0184	0.30	1.191	0.284	3.918	0.595	13.063	0.890
610.0	4.0184	0.37	1.491	0.506	4.965	0.716	18.114	0.962
615.0	4.0184	0.40	1.598	0.600	4.778	0.751	18.967	0.975
620.0	4.0184	0.45	1.804	0.802	4.763	0.686	22.856	0.974
625.0	4.0184	0.38	1.538	0.546	4.460	0.569	18.762	0.969
630.0	4.0184	0.33	1.343	0.389	4.258	0.766	15.744	0.934
635.0	4.0184	0.39	1.577	0.580	3.154	0.473	17.266	0.976
640.0	4.0184	0.43	1.720	0.715	3.095	0.550	19.654	0.981
645.0	4.0184	0.31	1.247	0.321	2.495	0.362	15.192	0.909
650.0	4.0184	0.42	1.689	0.686	5.626	0.845	22.859	0.975
655.0	4.0184	0.45	1.815	0.814	5.518	0.998	24.543	0.971
660.0	4.0184	0.50	2.006	1.028	5.516	1.143	29.206	0.943
665.0	2.3543	0.46	1.083	0.497	2.859	0.401	14.393	0.568
670.0	2.3543	0.45	1.059	0.477	2.691	0.424	13.455	0.566
675.0	2.3543	0.46	1.083	0.493	3.390	0.628	10.895	0.575
680.0	2.3543	0.36	0.848	0.272	3.161	0.729	8.289	0.564
685.0	2.3543	0.36	0.848	0.277	2.670	0.576	8.679	0.559
690.0	2.3543	0.43	1.012	0.430	2.592	0.618	10.761	0.569
695.0	2.3543	0.42	0.989	0.399	2.680	0.633	10.303	0.577
700.0	2.3543	0.38	0.895	0.312	2.568	0.429	7.944	0.572
705.0	2.3543	0.35	0.824	0.259	2.406	0.470	7.655	0.550
710.0	2.3543	0.51	1.201	0.634	3.566	0.636	10.974	0.552
715.0	2.3543	0.51	1.201	0.628	2.413	0.444	10.986	0.559

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
720.0	2.3543	0.50	1.177	0.603	2.178	0.471	11.136	0.561
725.0	2.3543	0.50	1.177	0.611	2.354	0.506	11.972	0.552
730.0	2.3543	0.41	0.965	0.376	1.786	0.444	8.378	0.579
735.0	2.3543	0.40	0.942	0.358	4.662	0.866	7.562	0.571
740.0	2.3543	0.40	0.942	0.355	4.793	0.923	7.666	0.574
745.0	2.3543	0.36	0.848	0.279	3.407	0.687	5.594	0.559
750.0	2.3543	0.44	1.036	0.445	3.056	0.580	6.982	0.580
755.0	2.3543	0.43	1.012	0.418	4.181	0.881	6.813	0.583
760.0	2.3543	0.25	0.589	0.104	3.125	0.647	4.185	0.477
765.0	6.9426	0.26	1.800	0.352	7.742	1.548	10.100	1.430
770.0	6.9426	0.29	2.008	0.475	6.587	1.366	15.302	1.512
775.0	6.9426	0.38	2.631	0.941	8.341	1.710	20.814	1.661
780.0	6.9426	0.41	2.839	1.118	8.659	1.561	19.902	1.693
785.0	6.9426	0.37	2.562	0.869	6.943	1.409	24.801	1.662
790.0	6.9426	0.37	2.562	0.867	6.072	1.153	19.959	1.670
795.0	6.9426	0.15	1.039	0.043	2.597	0.457	10.200	0.983
800.0	6.9426	0.14	0.969	0.031	4.072	0.485	8.832	0.926
805.0	6.9426	0.25	1.731	0.302	6.578	0.969	18.281	1.404
810.0	6.9426	0.38	2.631	0.910	7.894	1.105	22.761	1.691
815.0	6.9426	0.50	3.462	1.765	8.656	1.246	38.709	1.650
820.0	6.9426	0.52	3.601	1.961	6.121	0.972	37.844	1.596
825.0	6.9426	0.55	3.809	2.210	6.855	1.143	36.981	1.555
830.0	6.9426	0.58	4.016	2.473	6.828	1.044	42.894	1.494
835.0	6.9426	0.54	3.739	2.145	6.731	1.047	40.983	1.547
840.0	6.9426	0.52	3.601	1.950	6.481	1.044	38.060	1.606
845.0	6.9426	0.36	2.493	0.805	4.736	0.848	19.594	1.664
850.0	6.9426	0.28	1.939	0.409	4.401	0.776	15.181	1.511
855.0	6.9426	0.27	1.870	0.380	6.357	1.028	18.790	1.464
860.0	6.9426	0.35	2.424	0.739	7.756	1.357	21.958	1.655

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
865.0	6.9426	0.45	3.116	1.383	6.107	1.028	30.849	1.696
870.0	6.9426	0.43	2.978	1.261	6.610	0.983	22.332	1.687
875.0	6.9426	0.43	2.978	1.251	8.546	1.370	24.208	1.694
880.0	6.9426	0.39	2.701	0.970	9.533	1.809	24.764	1.697
885.0	6.9426	0.34	2.354	0.709	8.240	1.295	16.881	1.621
890.0	6.9426	0.31	2.147	0.548	7.470	1.202	29.001	1.563
895.0	6.9426	0.31	2.147	0.554	7.363	0.880	18.010	1.567
900.0	6.9426	0.49	3.393	1.682	11.502	1.493	26.059	1.674
905.0	6.9426	0.57	3.947	2.417	10.420	1.618	28.892	1.491
910.0	5.4897	0.56	1.248	0.744	2.371	0.337	8.537	0.493
915.0	2.2288	0.51	1.137	0.605	2.398	0.466	9.821	0.520
920.0	2.2288	0.39	0.869	0.313	2.025	0.339	8.058	0.547
925.0	2.2288	0.40	0.892	0.339	1.783	0.312	7.355	0.543
930.0	2.2288	0.45	1.003	0.453	2.006	0.431	7.271	0.541
935.0	2.2288	0.53	1.181	0.656	2.481	0.425	9.237	0.514
940.0	2.2288	0.48	1.070	0.527	2.354	0.471	8.420	0.532
945.0	2.2288	0.34	0.758	0.229	1.894	0.296	5.380	0.522
950.0	2.2288	0.46	1.025	0.465	3.189	0.605	6.715	0.550
955.0	2.2288	0.44	0.981	0.423	2.648	0.657	9.679	0.546
960.0	2.2288	0.42	0.936	0.386	3.370	0.917	9.455	0.538
965.0	2.2288	0.51	1.137	0.605	3.831	0.523	10.662	0.517
970.0	2.2288	0.54	1.204	0.675	2.527	0.445	9.111	0.516
975.0	2.2288	0.52	1.159	0.628	2.550	0.417	12.019	0.516
980.0	2.2288	0.54	1.204	0.683	3.250	0.674	12.914	0.504
985.0	2.2288	0.53	1.181	0.657	2.481	0.484	10.360	0.511
990.0	2.2288	0.53	1.181	0.647	2.481	0.402	12.427	0.519
995.0	2.2288	0.49	1.092	0.543	2.403	0.459	11.882	0.535
1000.0	2.2288	0.47	1.048	0.497	2.535	0.440	11.869	0.536
1005.0	2.2288	0.43	0.958	0.404	3.163	0.527	10.964	0.541

Table C6. (continued)

DEPTH	SEDIMENTATION RATE ¹	DRY BULK DENSITY ²	BULK ³	CALCIUM CARBONATE ³	ORGANIC CARBON ⁴	NITROGEN ⁴	OPAL ⁴	OTHER ³
1010.0	2.2288	0.54	1.204	0.679	3.791	0.554	15.201	0.506
1015.0	2.2288	0.52	1.159	0.629	3.546	0.579	15.484	0.511
1020.0	2.2288	0.51	1.137	0.592	3.365	0.580	15.993	0.526
1025.0	2.2288	0.39	0.869	0.316	2.834	0.591	12.621	0.538
1030.0	2.2288	0.30	0.669	0.167	2.387	0.455	9.722	0.490
1035.0	2.2288	0.20	0.446	0.046	1.783	0.316	3.263	0.395
1040.0	2.2288	0.17	0.379	0.028	1.667	0.284	2.592	0.347
1045.0	2.2288	0.16	0.357	0.019	1.605	0.275	3.081	0.332
1050.0	2.2288	0.13	0.290	0.002	1.159	0.223	2.686	0.284
1055.0	2.2288	0.15	0.334	0.015	1.177	0.160	2.758	0.316
1060.0	2.2288	0.19	0.423	0.037	1.287	0.224	3.070	0.382

1) cm/1000 yrs; 2) g/cm³; 3) g/cm²/1000 yrs; 4) mg/cm²/1000 yrs.

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