Lyle, M., Koizumi, I., Richter, C., and Moore, T.C., Jr. (Eds.), 2000
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 167

8. *DATA REPORT:* LATE PLEISTOCENE OXYGEN AND CARBON ISOTOPIC RECORDS FROM SITES 1011, 1012, AND 1018[1]

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INTRODUCTION

Three sites, drilled during Ocean Drilling Program (ODP) Leg 167, were chosen for detailed late Pleistocene paleoceanographic studies of intermediate water along the California margin. These sites are Site 1011 (Animal Basin, 31°17′N, 117°38′W, 2033 m water depth, 1600 m sill depth), Site 1012 (East Cortez Basin, 32°17′N, 118°23′W, 1783 m water depth, 1415 m sill depth), and Site 1018 (Guide Seamount, 36°59′N, 123°17′W, 2476 m water depth; Fig. 1). Here we present carbon and oxygen isotopic measurements of benthic foraminifers from these three sites. We made 135 measurements from Site 1011, 387 measurements from Site 1012, and 231 measurements from Site 1018. This data report includes an explanation of the methods used to generate these isotopic records and the age models for each site. Detailed paleoceanographic interpretations of the isotopic records are currently under way.

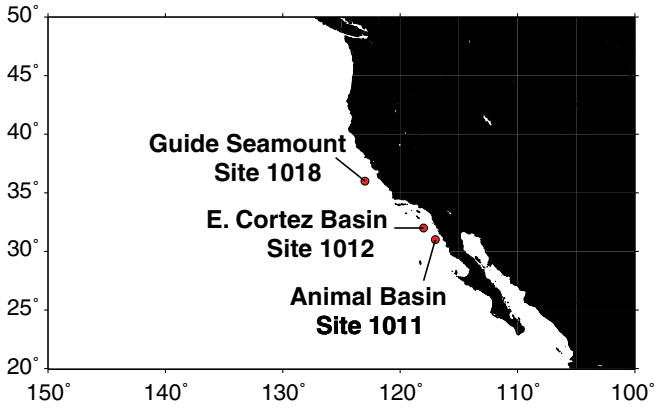

Figure 1. Site location map showing sites for which isotopic analyses reported here were performed.

METHODS

Samples (20 cm^3) were taken every 10 cm from Cores 167-1011C-1H through 3H, 167-1012B-1H through 4H, 167-1012A-3H and 4H and every 10–20 cm from Cores 167-1018C-1H through 5H. High terrigenous clay and organic matter content of the sediments at these sites made disaggregation of the sediments difficult. Disaggregation began with freeze drying the sediment samples. Following freeze drying, sediments were weighed and then soaked in ~200 mL of deionized water. Sediments were subsequently mechanically agitated using an orbital shaker (Thermolyne Bigger BiIl orbital shaker) for 4–16 hr at 170 rpm. Often sediments required further treatment with the addition of 40 mL of buffered Calgon solution (sodium metaphosphate $(NaPO_3)_{\sim 13}Na_2O$) followed by shaking for an additional 2–6 hr. The sand fraction (>63 µm) was separated by passing the disaggregated sediment through a 63-µm sieve in running deionized water with the use of a soft brush. Both coarse (>63 µm) and fine fractions were collected in filter paper and dried overnight at 50°C. The coarse fraction was weighed, and both coarse and fine fractions were transferred into vials for storage.

The coarse fraction was sieved using a 250-µm sieve in preparation for picking of foraminifer shells. Benthic foraminifer species *Cibicidoides wuellerstorfi* (Sites 1011, 1012, and 1018), *Cibicidoides pachyderma* (Site 1018), and *Uvigerina* spp. (Sites 1012 and 1018) were picked from the >250-µm-size fraction. The number of tests analyzed in the mass spectrometer varied from sample to sample depending on the availability of the preferred species *C. wuellerstorfi*. For Site 1018, most analyses were conducted using one or two *C. wuellerstorfi* or three or four *Uvigerina* spp. tests. However, the number of tests of *C. wuellerstorfi* analyzed ranged from shell fragments to four specimens. In addition, occasional analyses were done using species *C. pachyderma* when *C. wuellerstorfi* was scarce. For Site 1012, isotopic analyses were made on a range of one to eight, and an average of two *C. wuellerstorfi* tests. In occasional intervals barren of *C. wuellerstorfi*, three or four specimens of *Uvigerina* spp. were used to supplement the isotope record. For Site 1011, all analyses were conducted on *Cibicidoides wuellerstorfi.* A range of one to ten and an average of four or five tests were measured.

Before isotopic analysis, benthic foraminiferal tests were sonicated in methanol for 5 s to clean them of residual contaminants that may have adhered to the tests. Samples were then dried in an oven at 50°C and transferred into stainless steel boats. Isotopic analyses were conducted on Micromass Mass Spectrometers (models Optima and Prism) in the light stable isotope laboratory directed by Christina Ravelo, Jim Zachos, and Paul Koch at the University of California, Santa Cruz. Both instruments are outfitted with common acid bath automated carbonate devices. Foraminiferal specimens were reacted at 90°C in orthophosphoric acid (H_3PO_4; specific gravity 1.93 g/cm^3 at 20°C) and cryogenically separated from water and noncondensable gases before introduction into the mass spectrometer. Analytical precision on both instruments is ±0.03‰ (1 s) for carbon standards and ±0.08‰ (1 s) for oxygen standards. Carerra Marble, which has been calibrated to National Institute of Standards and Technology isotopic reference material NBS-18 and NBS-19 for conversion to (Vienna) Peedee belemnite (VPDB) scale, is used as the in-house standard. All values reported here are relative to VPDB (Table 1; Fig. 2).

[1]Lyle, M., Koizumi, I., Richter, C., and Moore, T.C., Jr. (Eds.), 2000. *Proc. ODP, Sci. Results,* 167: College Station TX (Ocean Drilling Program).
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Table 1. Isotopic values of benthic foraminifers from Sites 1011, 1012, and 1018.

Leg	Site	Hole	Core	Type	Sect.	Top (cm)	Bottom (cm)	Depth (mcd)	Age (ka)	$\delta^{13}C$	$\delta^{18}O$	Species
167	1011	C	1	H	1	15	18	0.165	2.06	0.11	2.58	*C. wuellerstorfi*
167	1011	C	1	H	1	25	28	0.265	3.48	0.07	2.57	*C. wuellerstorfi*
167	1011	C	1	H	1	35	38	0.365	4.93	–0.21	2.20	*C. wuellerstorfi*
167	1011	C	1	H	1	45	48	0.465	6.40	–0.02	2.89	*C. wuellerstorfi*
167	1011	C	1	H	1	55	58	0.565	9.44	–0.09	2.55	*C. wuellerstorfi*
167	1011	C	1	H	1	75	78	0.765	11.00	–0.18	3.13	*C. wuellerstorfi*
167	1011	C	1	H	1	85	88	0.865	12.62	–0.24	3.66	*C. wuellerstorfi*
167	1011	C	1	H	1	95	98	0.965	14.30	–0.27	3.82	*C. wuellerstorfi*
167	1011	C	1	H	1	105	108	1.065	16.04	–0.19	3.78	*C. wuellerstorfi*
167	1011	C	1	H	1	115	118	1.165	17.85	–0.30	4.13	*C. wuellerstorfi*

Note: Isotopic values reported in this table have not been corrected for species effects.

This is a sample of the table that appears on the volume CD-ROM.

AGE MODELS AND SPLICES

Age models for the benthic isotope stratigraphies (Fig. 3) were constructed by graphical correlation to the SPECMAP stack time series age model (Martinson et al., 1987) using the commercially available software Corpac run on a Sun SPARCstation 10 workstation. Tie points between the SPECMAP $\delta^{18}O$ stratigraphy and the oxygen isotopic time series generated in this study were visually established. Subsequent fine-scale adjustments were made via sinusoidal mapping function correlation (Martinson et al., 1987) after stage identifications were established. Correlation between the SPECMAP stack and all three stratigraphies for sites was high ($r > 0.93$).

At the time that this report was written, the Hole 1018C record contains gaps from missing material between cores and intervals barren of benthic foraminifers. Gaps in the isotope record from Hole 1012B were filled with isotopic data from samples from adjacent Hole 1012A. Because there are only very small gaps in the isotope record from Hole 1011C resulting from missing material between cores, the isotope record from the single hole yields a seemingly continuous, evenly spaced record.

ACKNOWLEDGMENTS

We thank all the crew and staff of the *JOIDES Resolution* that sailed on ODP Leg 167 to the California margin. We also thank all the ODP Leg 167 scientists who helped with postcruise sampling for this study. This work was funded by a JOI/USSSP postcruise research award to A.C.R.

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Martinson, D.G., Pisias, N.G., Hays, J.D., Imbrie, J., Moore, T.C., Jr., and Shackleton, N.J., 1987. Age dating and the orbital theory of the ice ages: development of a high-resolution 0 to 300,000-year chronostratigraphy. *Quat. Res.,* 27:1–29.

Date of initial receipt: 4 November 1998
Date of acceptance: 10 June 1999
Ms 167SR-225

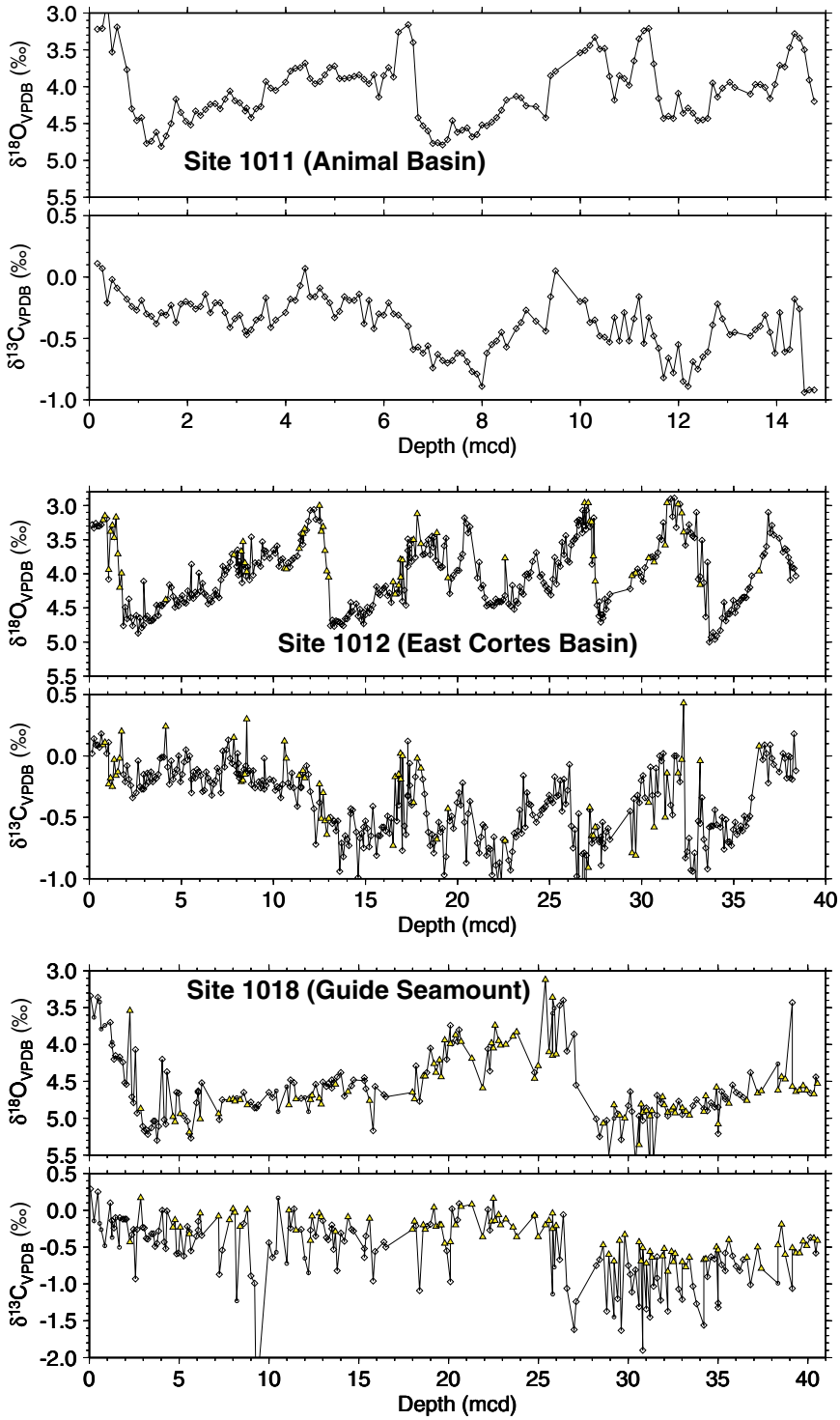

Figure 2. Isotopic data of all benthic foraminifer species measured in this study vs. depth. Plotted $\delta^{18}O$ isotopic values for *Cibicidoides* spp. were corrected by +0.64‰. Plotted $\delta^{13}C$ values of *Uvigerina* spp. were corrected by 0.70‰. VPDB = (Vienna) Peedee belemnite.

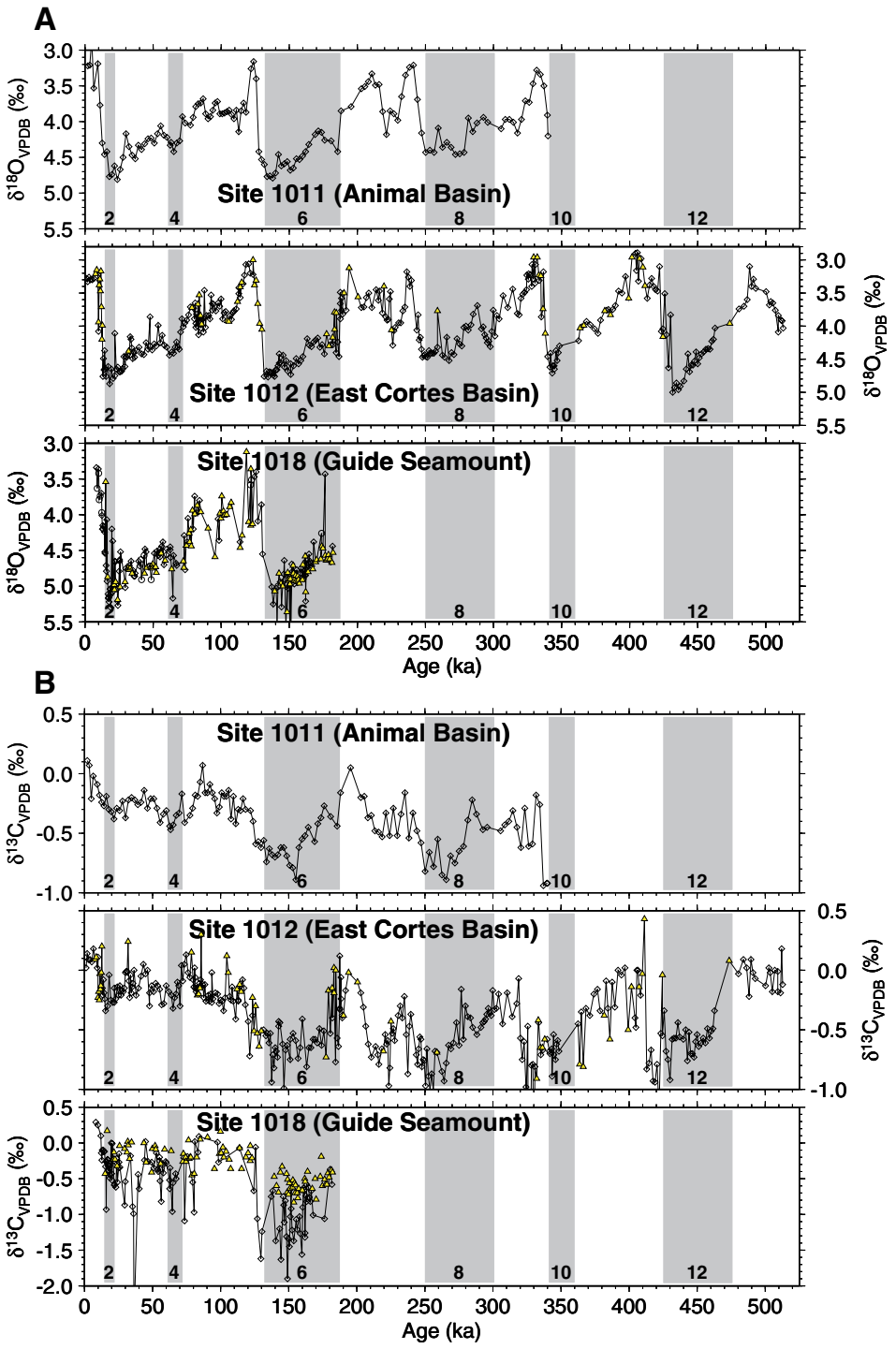

Figure 3. Isotopic data of all benthic foraminifer species measured in this study vs. age. **A.** $\delta^{18}O$ isotopic values for *Cibicidoides* spp. were corrected by +0.64‰. **B.** $\delta^{13}C$ values of *Uvigerina* spp. were corrected by 0.70‰. VPDB = (Vienna) Peedee belemnite. Shaded areas indicate even isotopic stages.