15. STABLE ISOTOPIC RESULTS ON UPPER MIOCENE AND LOWER PLIOCENE FORAMINIFERS FROM HOLE 552A[1]

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INTRODUCTION

This chapter summarizes preliminary stable isotopic results on benthic and planktonic foraminifers from the upper Miocene and lower Pliocene sections of DSDP Hole 552A. Shackleton and Hall (this volume) has provided considerable isotopic detail from a section stratigraphically higher in Hole 552A (middle Pliocene–Pleistocene).

Study of this site was undertaken as part of a general study of Neogene stable isotopic change in open ocean North Atlantic sites. Blanc et al. (1980) published results from the only previously drilled North Atlantic location, DSDP Site 116. Other studies concentrated on the isotopic records from marginal seas (Gulf of Mexico, Brunner and Keigwin, 1981; Caribbean, Keigwin, 1982; Mediterranean Sea, Keigwin and Thunnell, 1979) or from nearshore locations (continental margin off West Africa, Shackleton and Cita, 1979). Results from Blanc et al. (1980) reveal general trends in Neogene isotopic history of the North Atlantic, but since Site 116 was only spot-cored, detailed study of specific isotopic features is difficult.

Within upper Miocene and lower Pliocene sections of other DSDP sections, previous studies have revealed changes in $\delta^{18}O$ and $\delta^{13}C$ of foraminifers which may have resulted from changing oceanographic or climatic conditions. For example, Kennett et al. (1979) noted small $\delta^{18}O$ changes in Pliocene sediments of ~3.5 m.y. age and in latest Miocene sediments at southwest Pacific DSDP Site 284. Several increases and decreases of ~0.5‰ in $\delta^{18}O$ were found in upper Miocene sediments at eastern equatorial Pacific DSDP Site 158 (Keigwin, 1979), and an enrichment in ^{18}O of planktonic foraminifers at DSDP 502 was thought to be the result of an increase in Caribbean salinity in the early Pliocene (Keigwin, 1982). A decrease in $\delta^{13}C$ of latest Miocene foraminifers has been found throughout the Indo-Pacific region (for example, Keigwin, 1979; Bender and Keigwin, 1979; Vincent et al., 1980) but has not yet been clearly identified in open ocean North Atlantic sediments.

It is important to know if these late Miocene and early Pliocene isotopic events are local, basinwide, or oceanwide in extent. Hole 552A was sampled at coarse intervals (on the order of meters, equal to time-spacing of hundreds of thousands of years) to determine the general nature of oxygen and carbon isotopic variation in foraminifers for comparison with other locations. The results of this preliminary study are being used as a framework for a detailed study now in progress.

METHODS

Samples of about 10 cm^3 were taken from intervals of ~2 cm thickness, disaggregated in hot sodium metaphosphate, and washed over a 63 μm sieve. A portion of the < 63 μm fraction was saved for future use, including study of diatoms (Baldauf, this volume). The coarse fraction was dried and the benthic foraminiferal genus *Cibicidoides* was picked from the > 150 μm fraction. *Globigerina bulloides* was picked from the same fraction and later sieved again at 300 μm for isotopic analysis within a discrete size fraction.

Stable isotopic analysis followed standard procedures (Keigwin, 1979) with the following modifications: all samples were cleaned ultrasonically in methanol, benthic foraminifers were crushed with a glass rod in methanol in the sample-carrying boats prior to roasting *in vacuo* at 370°C for one hour, and condensibles were frozen in liquid nitrogen as the calcite dissolved. Results were converted to PDB via the secondary standard NBS-20.

RESULTS AND DISCUSSION

Results of stable isotopic analyses at this site are presented in Table 1 and Figure 1. Oxygen isotopic results of benthic and planktonic foraminifers each fall within about 1‰ limits, consistent with results at other sites which show the late Miocene and early Pliocene (~10 to 3 m.y.) to be times of zero net growth in continental ice. The apparent covariance of $\delta^{18}O$ between benthics and planktonics is suggestive of a seawater compositional effect resulting from growth and decay of continental ice, but synchronous temperature changes between the near surface and deep sea cannot be ruled out. It is not yet possible to correlate variability in $\delta^{18}O$ between different upper Miocene and lower Pliocene sections, because changes are small compared to those found in middle Miocene and upper Pliocene to Quaternary sections. Of possible significance is $\delta^{18}O$ evidence of two upper Miocene coolings—one at ~120 m and one at the Miocene/Pliocene boundary (Fig. 1).

Carbon isotopic composition of benthic and planktonic foraminifers also covaries (Fig. 1). A general trend of decreasing $\delta^{13}C$ exists, as is seen at other sites (see for example: Keigwin, 1979; Shackleton and Cita, 1979; Shackleton and Kennett, 1975; Woodruff, et al., 1981), but it is not yet clear how the record at Hole 552A correlates with these others. For example, the negative carbon isotopic change ("carbon shift") dated at ~6 m.y. at other locations (Loutit and Kennett, 1979; Keigwin and Shackleton, 1980) is not a prominent feature at Hole 552A. In fact, there appear to be three $\delta^{13}C$ decreases at this site, at ~140 m, 120–130 m (planktonic foraminifers only), and ~90 m. The position of the

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Table 1. Stable isotopic results, Hole 552A foraminifers (PDB, ‰).

Sample	Depth (m)	*G. bulloides* $\delta^{18}O$	*G. bulloides* $\delta^{13}C$	*C. wuellerstorfi* $\delta^{18}O$	*C. wuellerstorfi* $\delta^{13}C$	*C. kullenbergi* $\delta^{18}O$	*C. kullenbergi* $\delta^{13}C$
14-1, 102	63.02	1.26	−0.68	2.18	0.65		
14-2, 101	64.51	1.39	−0.38	2.63	0.87	2.87	−0.01
14-3, 102	66.02	1.19	0.16	2.42	0.94		
15-1, 098	67.98	1.04	−0.23	1.91	0.69		
15-2, 102	69.52	1.45	−0.11	2.31	0.89		
15-3, 105	71.05	1.04	−0.48	2.35	0.98		
16-1, 102	73.02	1.07	−0.21	2.20	0.74		
16-2, 104	74.55	1.27	−0.02	2.48	1.14		
16-3, 103	76.03	1.11	−0.07	2.47	0.92		
17-3, 100	78.00	1.18	0.01	2.30	1.24		
18-3, 103	86.03	1.21	−0.20	2.42	0.88		
19-3, 146	91.46	1.42	0.46	2.43	1.25		
20-3, 005	95.05	1.51	0.28	2.33	1.14		
21-2, 105	97.55	1.40	0.19	2.54	1.19	2.44	0.61
22-2, 097	101.47	1.71	0.24	2.48	1.19	2.69	1.11
23-1, 103	105.03	1.82	0.10	2.54	0.84		
23-2, 102	106.52	1.90	0.27	2.82	1.24	2.69	1.11
23-3, 106	108.06	1.59	−0.03	2.51	0.62		
24-1, 102	109.52	1.25	0.22	2.61	0.98		
24-2, 102	111.02	1.27	0.19	2.31	0.97		
24-3, 106	112.56	1.44	0.03	2.45	0.93		
25-1, 144	114.94	1.43	0.21	2.48	0.76		
25-2, 144	116.44	1.36	0.12	2.38	1.09		
25-3, 144	117.94	1.24	0.19	2.29	1.09		
26-1, 032	118.82	1.71	−0.01	2.91	0.88		
26-2, 032	120.32	1.67	−0.36	2.59	0.75		
26-3, 032	121.82	1.27	−0.16	2.57	0.83		
27-1, 034	123.84	1.57	0.00	2.38	0.86		
27-2, 034	125.34	1.62	−0.10	2.56	0.97		
27-3, 034	126.84	1.40	−0.06	2.50	0.80		
28-2, 022	130.22	1.29	0.46	2.31	0.75		
28-3, 022	131.72	1.37	0.35	2.38	1.07		
28-4, 022	133.22	1.66	0.11	2.26	1.09		
29-1, 046	133.96	1.28	0.09	2.37	0.77		
29-2, 046	135.46	1.44	0.28	2.38	0.99		
29-3, 046	136.96	1.51	−0.04	2.31	0.88		
31-3, 090	147.40	1.41	0.64	2.20	1.16		
32-2, 110	151.10			2.14	1.34		
33-1, 080	154.30	1.43	0.74	2.32	1.20		
34-2, 130	161.30	1.22	0.45	2.34	1.16		

middle/upper Miocene and Miocene/Pliocene boundary (taken from results produced onboard ship) would argue that change between 120 and 130 m is time-equivalent with that at other locations. In contrast to Caribbean Site 502 (Keigwin, 1982) and western North Atlantic 410,the *Cibicidoides* do not show a negative shift in the uppermost Miocene. This may result from different watermass histories for Sites 502 and 410, which underlie water of western North Atlantic origin unlike eastern North Atlantic Hole 552A. Alternatively, the preliminary stratigraphy used in Figure 1 might be in error, and the $\delta^{13}C$ shift dated at ~6 m.y. could be at ~140 m.

SUMMARY

Generally, small and frequent changes in upper Miocene and lower Pliocene foraminiferal $\delta^{18}O$ and $\delta^{13}C$ in Hole 552A are not easily interpreted without correlation with other sites. At present the best guess is that sediment time-equivalent with the late Miocene $\delta^{13}C$ shift occurs between ~120 and 130 m down core. Cores 25 through 28 have been sampled every 10 cm for further study. It is hoped that this interval will be correlated with results from North Atlantic DSDP Site 610E, where magnetic epochs 5 and 6 have been recognized. Results

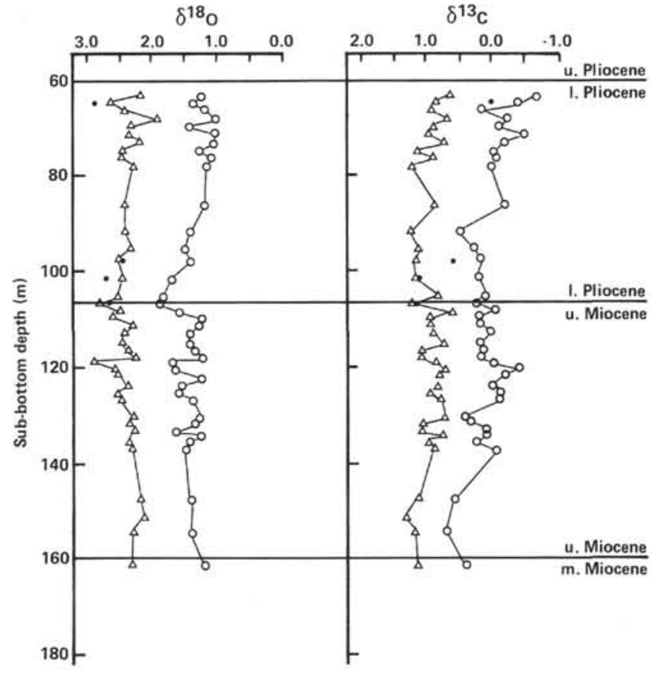

Figure 1. Oxygen and carbon isotopic results on *G. bulloides* (open circles), *C. wuellerstorfi* (triangles), and *C. kullenbergi* (solid points), DSDP Hole 552A.

of this comparison will appear in the *Initial Reports* of Leg 94.

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