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40. *DATA REPORT:* OXYGEN AND CARBON ISOTOPE RECORDS OF THE UPPER MAESTRICHTIAN TO LOWER EOCENE BENTHIC FORAMINIFERS AT SITE 752 IN THE EASTERN INDIAN OCEAN[1]

Koji Seto,[2] Ritsuo Nomura,[3] and Nobuaki Niitsuma[4]

ABSTRACT

Oxygen and carbon isotope ratios of benthic foraminifers were measured on the continuous middle to lower bathyal sedimentary sequence dated from the upper Maestrichtian to lower Eocene which was recovered at Site 752 in the eastern Indian Ocean. The changes in the carbon isotope values can be correlated with the faunal changes of the benthic foraminifers.

INTRODUCTION

Continuous middle to lower bathyal sediments from upper Maestrichtian to lower Eocene were recovered at Site 752 at Broken Ridge in the eastern Indian Ocean (35°53.475′S; 93°34.625′E, 1086 m water depth; Fig. 1; Peirce, Weissel, et al., 1989).

The benthic foraminiferal fauna in this sedimentary sequence has been investigated and distinct changes were determined (Nomura, this volume). Such faunal changes should be related to the paleoceanographic changes, which also can be observed in the oxygen and carbon isotopic records.

The isotopic studies of benthic foraminifers from the Cretaceous to Paleogene in the eastern Indian Ocean have been made by Corliss and Keigwin (1986), Keigwin and Corliss (1986), and Oberhänsli (1986). However, the isotopic studies for the Paleocene to lower Eocene sections are not constrained tightly enough to compare with the detailed faunal changes.

This report presents the oxygen and carbon isotopic data on the benthic foraminifers from the same samples used for the faunal analysis in the sedimentary sequence (Nomura, this volume).

METHODS

The benthic foraminiferal species used for the isotopic analysis are *Anomalinoides danicus* (Brotzen) and *Stensioina beccariiformis* (White).

The tests of *S. beccariiformis* are large enough (380–580 μm in diameter) for isotopic measurements to be conducted on a single specimen in the Paleocene sequence. However, this species is smaller in the Maestrichtian (less than 350 μm). In this study, three sets of isotopic measurements were carried out based on a single specimen of this species from the Paleocene to lower Eocene and for a part of Maestrichtian. The measurements made in the Maestrichtian horizon were based on 10 specimens of this species with diameters from 250 to 350 μm.

Because the tests of *A. danicus* are sufficiently large—400–770 μm in diameter (single specimen measurements)—three sets of single specimen measurements were carried on the Eocene and Paleocene samples to compare with the isotopic values from *S. beccariiformis*.

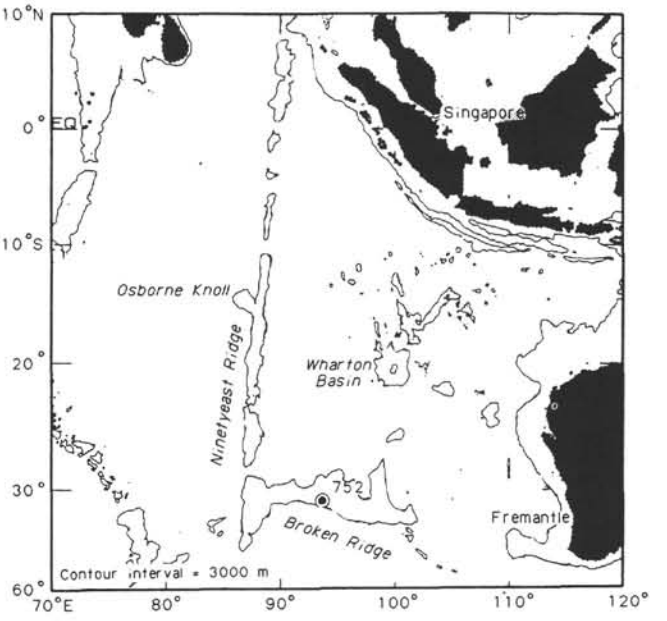

Figure 1. Index map of Site 752.

The sampled foraminiferal test was put in a stainless steel thimble. Methyl alcohol was dropped into the thimble, the test was disaggregated with a thin needle, and cleaned using ultrasonic waves.

The isotopic measurement followed the procedure described by Wada et al. (1984). The carbonate test (shell) was reacted in saturated pryo-phosphoric acid at 60.00°C, and the resulting CO_2 gas was analyzed using a Finnigan MAT-250 mass spectrometer modified for ultra-small sample analysis. The value thus obtained was converted into a value against a Pee Dee belemnite (PDB) standard by using NBS 20. The converted values are –4.18‰ for $\delta^{18}O$ and –1.07‰ for $\delta^{13}C$ (Craig, 1957). A single foraminiferal specimen was measured with a precision of 0.05‰ for oxygen and 0.02‰ for carbon isotopes.

RESULTS

The results of the measurements are tabulated in Tables 1 and 2, and plotted vs. depths in meters below seafloor (mbsf) in Figure 2.

There are no systematic differences in the $\delta^{18}O$ values between the two species, and between the single-specimen measurements

[1] Weissel, J., Peirce, J., Taylor, E., Alt, J., et al., 1991. *Proc. ODP, Sci. Results,* 121: College Station, TX (Ocean Drilling Program).

[2] Institute of Geology and Mineralogy, Hiroshima University, Hiroshima, 730 Japan.
[3] Department of Earth Sciences, Faculty of Education, Shimane University, Matsue, 690 Japan.
[4] Institute of Geosciences, Shizuoka University, Shizuoka, 422 Japan.

Table 1. Oxygen isotope ($\delta^{18}O$) values in PDB from Site 752.

Hole-Core-Section, Interval (cm)	Sub-bottom depth (m)	$\delta^{18}O$ *Anomalinoides danicus* No. 1	No. 2	No. 3	Average	*Stensioina beccariiformis* No. 1	No. 2	No. 3	Average	10 specimens
752A-13X-1, 70-75	113.60	-0.770	-0.935	-0.816	-0.840					
752A-13X-4, 62-67	118.02	-1.021	-0.875	-0.673	-0.856					
752A-14X-1, 70-75	123.30	-1.456	-1.233	-1.255	-1.315					
752A-14X-3, 70-75	126.30	-0.851	-1.214	-0.930	-0.998					
752A-15X-1, 70-75	133.00	-1.218	-1.012	-1.148	-1.126					
752A-15X-5, 70-75	139.00	-0.622	-0.748	-0.730	-0.700					
752A-16X-1, 70-75	142.70	-0.963	-0.728	-0.893	-0.861					
752A-16X-5, 25-30	148.25	-0.778	-0.663	-0.864	-0.768					
752A-17X-1, 70-75	152.40	-1.568	-1.343	-1.311						
752A-17X-1, 70-75*	152.40	-1.459			-1.420					
752A-17X-3, 70-75	155.40	-0.532	-0.821	-0.683	-0.679					
752A-18X-1, 71-75	162.11	-1.226	-0.379	-0.637	-0.747					
752A-18X-2, 67-70	163.57	-0.621	-0.501		-0.561					
752A-19X-1, 70-75	171.80	-0.718	-0.748	-0.733						
752A-19X-1, 70-75*	171.80	-0.589	-0.570		-0.672					
752A-19X-3, 75-79	174.85	-0.848	-0.672	-0.786	-0.769					
752A-20X-1, 70-75	181.40	-0.008	-0.112	-0.447	-0.189	-0.853	-0.675	-0.568	-0.699	
752A-21X-1, 70-75	191.10	-0.420	-0.403	-0.343	-0.389	-0.468	-0.387	-0.745	-0.533	
752A-22X-1, 70-75	200.80	-0.590	-0.643	-0.499	-0.577	-0.586	-0.562	-0.549	-0.566	
752A-22X-3, 70-75	203.80	-1.412	-0.701	-0.397	-0.837	-0.436	-0.649	-0.715	-0.600	
752A-23X-1, 54-56	210.34	-0.845			-0.845	-0.710	-0.567	-0.820	-0.699	
752A-24X-1, 70-73	220.20					-0.468	-0.390	-0.399	-0.419	
752A-25X-1, 79-84	229.89					-0.492	-0.347	-0.417	-0.419	
752A-25X-3, 79-84	232.89									
752A-26X-1, 97-100	239.77					-0.623	-0.717	-0.319	-0.553	
952A-26X-5, 97-100	245.77					-0.402	-0.413	-0.351	-0.389	
752A-27X-1, 70-75	249.10					-0.492	-0.323	-0.440	-0.418	
752A-27X-3, 70-75	252.10					-0.268	-0.277	-0.546	-0.364	
752A-28X-1, 70-75	258.80	-0.714	-0.289		-0.502	-0.182	-0.323	-0.226	-0.244	
752A-28X-5, 70-75	264.80	-0.554	-0.527	-0.364	-0.482	-0.416	-0.409	-0.305	-0.377	
752A-29X-1, 70-73	268.40	-0.562	-0.772	-0.492	-0.609	-0.576	-0.845	-0.423	-0.615	
752A-29X-5, 70-73	274.40	-0.816	-0.596	-0.495	-0.636	-0.408	-0.913	-0.844	-0.722	
752A-30X-1, 73-76	278.13	-0.355	-0.567		-0.461	-0.574	-0.361	-0.743	-0.559	
752A-31X-1, 70-75	280.10	-0.798	-0.537	-0.718	-0.684	-0.773	-0.785	-0.881	-0.813	
752A-31X-5, 70-75	286.10	-0.644			-0.644	-1.021	-0.689	-0.641	-0.784	
752A-32X-1, 70-75	289.40	-1.069	-1.101	-0.801		-0.800	-0.476	-0.861	-0.712	
752A-32X-1, 70-75*	289.40	-0.883			-0.964					
752A-32X-5, 70-75	295.40	-0.821			-0.821					
752A-33X-1, 68-71	299.08					-0.976			-0.976	
752A-33X-3, 57-60	301.97					-1.334	-0.922	-0.797	-1.018	
752B-5R-3, 50-53	300.50					-0.892	-0.707	-0.932		
752B-5R-3, 50-53*	300.50					-0.701	-0.896		-0.826	
752B-6R-1, 44-47	307.04					-1.306	-1.242	-1.201	-1.250	
752B-6R-3, 99-102	310.59					-1.428	-1.380	-0.839	-1.216	
752B-7R-1, 82-85	316.92					-0.811	-0.789	-1.073	-0.891	
752B-7R-5, 76-78	322.86					-1.672	-1.177	-1.259	-1.369	
752B-8R-2, 81-94	326.85					-1.152	-1.122	-1.087	-1.120	
752B-8R-6, 101-104	332.91					-1.018	-0.858	-1.330	-1.069	
752B-9R-1, 42-45	335.82					-1.020	-1.134	-0.872	-1.009	-1.040
752B-10R-1, 105-108	346.15					-1.187	-1.399	-1.170	-1.252	-1.258
752B-10R-3, 112-115	349.22					-1.328	-0.986	-1.320	-1.211	-1.479
752B-10R-4, 79-81	350.39					-1.872	-1.508	-1.588	-1.656	-1.445
752B-11R-1, 44-47	355.24									-0.727
752B-11R-2, 44-47	356.74					-1.230	-0.973	-1.970	-1.391	-1.136
752B-11R-3, 38-41	358.18					-0.726	-1.019		-0.873	-0.746
752B-11R-3, 64-66	358.44					-1.238	-1.511		-1.375	-1.056
752B-11R-3, 112-114	358.92					-1.695	-0.962	-1.099	-1.252	-1.344
752B-12R-1, 104-107	365.44					-1.284	-1.532	-1.603	-1.473	-1.303
752B-12R-3, 10-13	367.50					-0.807	-1.182	-0.956	-0.982	-1.206
752B-12R-5, 54-59	370.94					-1.310	-0.949	-1.110	-1.123	-1.010
752B-13R-1, 40-43	374.40					-1.823	-1.223		-1.523	-1.416
752B-13R-5, 65-68	380.65					-0.506			-0.506	-0.805
752B-14R-1, 69-72	384.29					-0.743	-0.403	-1.016	-0.721	-0.938
752B-14R-5, 62-65	390.22									-1.005
752B-15R-1, 119-122	394.49									-1.259
752B-15R-5, 112-115	400.42					-1.153	-0.834	-0.958	-0.982	-1.049
752B-16R-1, 15-18	403.15									-1.047
752B-16R-3, 136-138	407.36					-0.870	-1.246		-1.058	-0.979
752B-17R-1, 103-106	413.63									-0.841
752B-17R-5, 66-69	419.26					-0.797	-0.647		-0.722	-0.819
752B-19R-1, 42-45	432.02									-1.056
752B-19R-3, 49-52	435.09									-1.581

* continued

Table 2. Oxygen isotope ($\delta^{13}C$) values in PDB from Site 752.

			$\delta^{13}C$								
Hole-Core-Section, Interval (cm)	Sub-bottom depth (m)	*Anomalinoides danicus*				*Stensioina beccariiformis*				
		No. 1	No. 2	No. 3	Average	No. 1	No. 2	No. 3	Average	10 specimens
752A-13X-1, 70-75	113.60	0.314	0.050	0.146	0.170					
752A-13X-4, 62-67	118.02	-0.072	0.081	0.229	0.079					
752A-14X-1, 70-75	123.30	-0.890	-0.684	-0.022	-0.532					
752A-14X-3, 70-75	126.30	0.228	-0.239	0.074	0.021					
752A-15X-1, 70-75	133.00	-0.287	-0.137	-0.267	-0.230					
752A-15X-5, 70-75	139.00	0.412	0.164	0.254	0.277					
752A-16X-1, 70-75	142.70	0.216	0.343	0.143	0.234					
752A-16X-5, 25-30	148.25	0.283	0.421	0.480	0.395					
752A-17X-1, 70-75	152.40	-0.833	-0.634	-0.702						
752A-17X-1, 70-75*	152.40	-0.815			-0.746					
752A-17X-3, 70-75	155.40	0.507	0.370	0.376	0.418					
752A-18X-1, 71-75	162.11	0.281	0.824	0.820	0.642					
752A-18X-2, 67-70	163.57	0.794	0.825		0.810					
752A-19X-1, 70-75	171.80	1.009	1.024	0.979						
752A-19X-1, 70-75*	171.80	1.031	1.163		1.041					
752A-19X-3, 75-79	174.85	0.769	0.647	0.679	0.698					
752A-20X-1, 70-75	181.40	2.129	2.025	1.513	1.889	0.345	1.014	0.749	0.703	
752A-21X-1, 70-75	191.10	2.127	2.109	2.079	2.105	1.386	1.431	1.448	1.422	
752A-22X-1, 70-75	200.80	2.375	2.410	2.160	2.315	1.652	1.594	1.498	1.581	
752A-22X-3, 70-75	203.80	1.912	1.994	2.306	2.071	1.294	1.557	1.546	1.466	
752A-23X-1, 54-56	210.34	2.284			2.284	1.755	1.654	1.659	1.689	
752A-24X-1, 70-73	220.20					1.293	1.276	1.156	1.242	
752A-25X-1, 79-84	229.89					1.191	1.428	1.135	1.251	
752A-25X-3, 79-84	232.89									
752A-26X-1, 97-100	239.77					0.866	0.914	0.978	0.919	
752A-26X-5, 97-100	245.77					0.814	0.591	1.187	0.864	
752A-27X-1, 70-75	249.10					0.255	0.813	0.384	0.484	
752A-27X-3, 70-75	252.10					0.739	0.660	0.897	0.765	
752A-28X-1, 70-75	258.80	1.568	1.704		1.636	0.952	0.715	0.821	0.829	
752A-28X-5, 70-75	264.80	1.903	1.970	2.155	2.009	0.606	0.943	1.111	0.887	
752A-29X-1, 70-73	268.40	1.817	1.862	1.890	1.856	0.941	1.090	1.071	1.034	
752A-29X-5, 70-73	274.40	1.568	1.627	1.613	1.603	0.800	0.623	0.366	0.596	
752A-30X-1, 73-76	278.13	1.640	1.715		1.678	0.986	0.932	1.058	0.992	
752A-31X-1, 70-75	280.10	1.725	1.908	1.566	1.733	0.943	0.779	0.908	0.877	
752A-31X-5, 70-75	286.10	1.443			1.443	0.839	0.721	0.558	0.706	
752A-32X-1, 70-75	289.40	1.294	1.244	0.841		0.583	0.847	0.627	0.686	
752A-32X-1, 70-75*	289.40	1.096			1.119					
752A-32X-5, 70-75	295.40	1.432			1.432					
752A-33X-1, 68-71	299.08					0.568			0.568	
752A-33X-3, 67-60	301.97					0.843	0.822	0.250	0.638	
752B-5R-3, 50-53	300.50					0.596	0.601	0.616		
752B-5R-3, 50-53*	300.50					0.546	0.458		0.563	
752B-6R-1, 44-47	307.04					0.562	0.255	0.358	0.392	
752B-6R-3, 99-102	310.59					0.695	0.709	0.796	0.733	
752B-7R-1, 82-85	316.92					1.098	1.123	1.155	1.125	
752B-7R-5, 76-78	322.86					1.141	1.091	1.094	1.109	
752B-8R-2, 81-94	326.85					0.869	0.922	1.077	0.956	
752B-8R-6, 101-104	332.91					0.918	1.029	0.985	0.977	
752B-9R-1, 42-45	335.82					0.792	0.929	0.868	0.863	0.826
752B-10R-1, 105-108	346.15					1.186	1.125	1.420	1.244	1.145
752B-10R-3, 112-115	349.22					1.300	1.199	1.147	1.215	1.145
752B-10R-4, 79-81	350.39					1.262	1.201	1.337	1.267	1.203
752B-11R-1, 44-47	355.24									0.715
752B-11R-2, 44-47	356.74					0.977	1.159	0.577	0.904	1.082
752B-11R-3, 38-41	358.18					1.375	1.373		1.374	1.468
752B-11R-3, 64-66	358.44					1.211	0.808		1.010	1.325
752B-11R-3, 112-114	358.92					1.239	1.487	1.032	1.253	1.097
752B-12R-1, 104-107	365.44					0.958	1.133	0.966	1.019	0.809
752B-12R-3, 10-13	367.50					0.903	0.879	0.653	0.812	0.861
752B-12R-5, 54-59	370.94					1.104	0.929	1.218	1.084	0.949
752B-13R-1, 40-43	374.40					1.012	0.618		0.815	1.159
752B-13R-5, 65-68	380.65					1.113			1.113	0.916
752B-14R-1, 69-72	384.29					0.722	0.707	1.039	0.823	0.803
752B-14R-5, 62-65	390.22									0.840
752B-15R-1, 119-122	394.49									0.889
752B-15R-5, 112-115	400.42					0.836	1.064	1.100	1.000	0.867
752B-16R-1, 15-18	403.15									0.660
752B-16R-3, 136-138	407.36					0.479	0.850		0.665	0.576
752B-17R-1, 103-106	413.63									0.279
752B-17R-5, 66-69	419.26					0.221	0.357		0.289	0.192
752B-19R-1, 42-45	432.02									0.189
752B-19R-3, 49-52	435.09									0.336

* continued

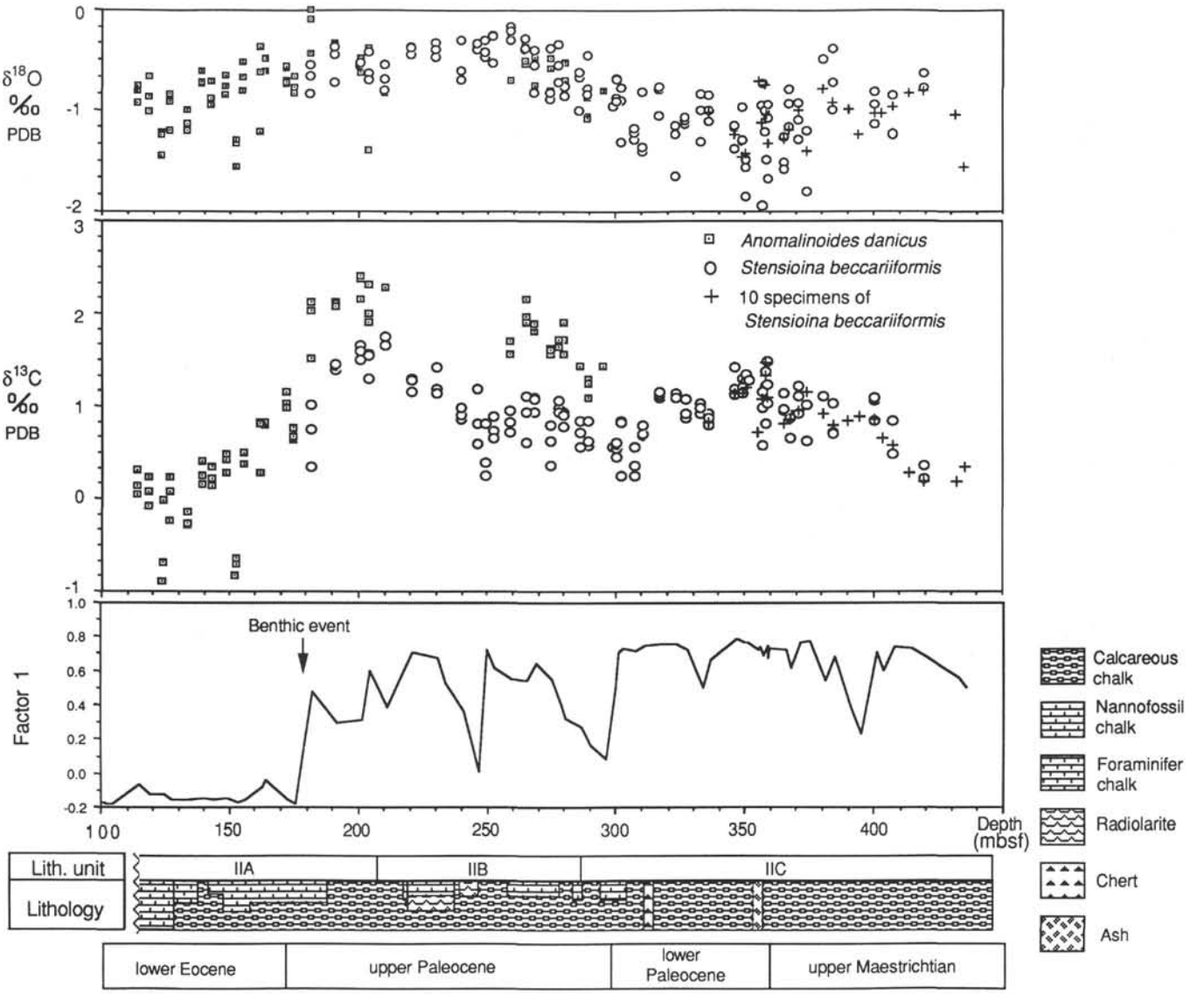

Figure 2. Oxygen and carbon isotope records measured on a single individual test and on 10 specimens of benthic foraminifers, accompanied by benthic foraminiferal faunal change expressed as factor 1 (Nomura, this volume) from Site 752. Lithology and lithological units are based on Peirce, Weissel, et al. (1989).

on the large-size test and 10 specimens on the small-size tests of *S. beccariiformis*. However, the $\delta^{13}C$ of *S. beccariiformis* is systematically depleted by 0.8‰ with respect to *A. danicus*.

Oxygen Isotope

$\delta^{18}O$ values range from –2‰ to 0‰ PDB. The minimal values of the $\delta^{18}O$ appear at the Maestrichtian/Paleocene (Cretaceous/Tertiary) boundary, and the maximal values appear in the upper Paleocene. The variations within a single sample as well as among the samples are narrower in the upper Paleocene.

Carbon Isotope

$\delta^{13}C$ values range from –1‰ to 3‰ PDB. Four high values appear at the Maestrichtian/Paleocene boundary, in the middle part of the lower Paleocene, at the lower and upper Paleocene boundary, and at the uppermost Paleocene. A distinct drop in $\delta^{13}C$ of 1.20‰ is detected between the Samples 121-752A-20X-1, 70–75 cm, and 121-752A-19X-3, 75–79 cm, just below the Paleocene/Eocene boundary, accompanied by the disappearance of *S. beccariiformis*. The minimal horizons in the lower Paleocene, Sample 121-752B-6R-1, 44–47 cm, and middle Paleocene, Sample 121-752A-27X-1, 70–75 cm, are also determined. The above changes in $\delta^{13}C$ can be correlated with the faunal changes, particularly the benthic event near the Paleocene/Eocene boundary, obtained by factor analysis of the benthic foraminifers (Fig. 2).

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