

5. DATA REPORT: PLIOCENE PLANKTONIC FORAMINIFERS FROM THE CALIFORNIA MARGIN: SITE 1021¹

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ABSTRACT

This report is an initial investigation of the planktonic foraminifers from the late Pliocene of Ocean Drilling Program Hole 1021C. Planktonic foraminifer assemblages show fair preservation in many samples. Assemblages are quantitatively dominated by *Globigerina bulloides*, dextral coiling *Neogloboquadrina atlantica*, and *Globorotalia inflata* and alternate between cool temperate and subarctic conditions.

INTRODUCTION

Our study was done on a sequence from the upper Pliocene of Ocean Drilling Program (ODP) Hole 1021C (Lyle, Koizumi, Richter, et al., 1997). Magnetic susceptibility, color reflectance, and gamma-ray attenuation porosity evaluator bulk density time series from the upper Pliocene of this hole reveal coherent 40-k.y. cycles or patterns that might be linked to environmental changes. As part of a larger paleoclimate project, the U.S. Geological Survey is involved in calibrating physical properties records with faunal and other proxy climate data to determine whether the physical properties cycles reflect a paleoceanographic signal. In this report, we provide a semiquantitative census of planktonic foraminifers from Core 167-1021C-10H and quantitative census data for Section 167-1021C-10H-2, which can be used for paleoenvironmental reconstructions (Dowsett and Poore, 1990; Dowsett and Robinson, 1998).

SITE 1021

Site 1021 is located 100 km south of the Mendocino Fracture Zone and 360 km from the California coast at 39°5.246'N and 127°46.982' W, in 4213 m of water (Fig. 1). The core site lies at the seaward margin of the California Current and thus is ideally located to monitor changes in that system. Sea-surface temperatures average 11.64°C during winter and 16.99°C during summer (Reynolds and Smith, 1995). Geomagnetic reversal data from Hole 1021C have been interpreted to show the termination of the Gauss Chron (C2An.1n; 2.581 Ma; Cande and Kent, 1995) between 76.85 and 76.15 meters below seafloor (mbsf) and the termination of the Kaena (C2An.1r; 3.040 Ma; Cande and Kent, 1995) between 92.65 and 92.45 mbsf (Shipboard Scientific Party, 1997). Assuming a linear rate of accumulation (3.496 cm/k.y.), Core 167-1021C-10H spans the interval from ~2.92 to 2.65 Ma. Section 167-1021C-10H-2 covers a 40-k.y. interval between 2.725 and 2.685 Ma.

METHODS

All samples were processed by first oven drying ($\leq 50^{\circ}\text{C}$) and then soaking in dilute Calgon solution for several hours to disaggregate the

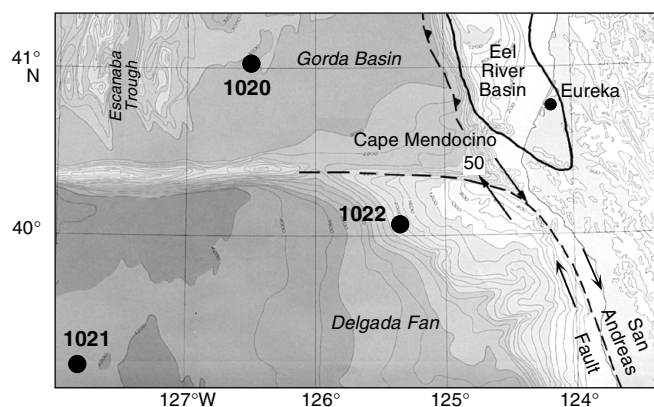


Figure 1. Site 1021 location map (from Shipboard Scientific Party, 1997).

sediment. Dissaggregated sediment was washed through a 150- μm mesh and oven dried at $\leq 50^{\circ}\text{C}$. If necessary, samples were split using a CARPCO microsampler to obtain ~300 specimens of planktonic foraminifers. Otherwise all specimens of planktonic foraminifers were placed in a standard 60-square micropaleontological slide and scanned for occurrences. The relative abundance of individual species were estimated as follows:

- A = abundant, >75 specimens;
- C = common, 25–75 specimens;
- F = few, 5–25 specimens; and
- R = rare, <5 specimens.

Samples from Section 167-1021C-10H-2 were fixed to a standard 60-square micropaleontological slide based upon their designation as species. The taxonomies of Parker (1962, 1967) and Blow (1969) were used.

Planktonic Foraminifers

Core 167-1021C-10H was sampled every 15 cm for planktonic foraminifers. Occurrences were recorded for 27 categories from a total of 64 samples (Table 1). In general, dissolution was strong throughout this interval, and the recovered planktonic foraminiferal fauna is skewed toward dissolution-resistant forms. The dominant taxa throughout the core are *Globigerina bulloides*, *Globorotalia inflata* s.l., and dextral coiling *Neogloboquadrina atlantica*. Other less common taxa include *Orbulina universa*, *Globigerina pseudobesa*, *Globigerina umbilicata*, dextral coiling *Neogloboquadrina pachy-*

¹Lyle, 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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derma, *Neogloboquadrina acostaensis*, *Globigerinita glutinata*, and *Turborotalita quinqueloba*. Other taxa occur sporadically and are generally rare (Tables 1, 2).

The occurrences shown in Tables 1 and 2 are consistent with a mid-latitude temperate zone planktonic foraminifer fauna. *G. bulloides* dominates the fauna in almost all samples. *N. atlantica* (cool, subpolar form) alternates with *G. inflata* (warm, subtropical form). Because of the location of Site 1021 on the ocean side margin of the cool southward flowing California Current, the increases in *G. inflata* may indicate a weakening of the California Current and the influence of the warmer gyre waters to the west. Accordingly, increases in *N. atlantica* may indicate that a broader California Current bathed Site 1021 with cooler temperatures (Poore, 1999).

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Table 1. Planktonic foraminifer occurrence data from Core 167-1021C-10H.

Core, section, interval (cm)	<i>Orbulina</i> sp.	<i>Globigerinoides ruber</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides sacculifer</i>	<i>Globigerina woodi/apertura</i>	<i>Globigerina pseudobesa</i>	<i>Globigerina falconensis</i>	<i>Globigerina umbilicata</i>	<i>Globigerina</i> aff. <i>umbilicata</i>	<i>Globigerina bulloides</i>	<i>Globigerina praeditata</i>	<i>Globorotalia inflata/punctulata</i>	<i>Globorotalia crassaformis</i>	<i>Globorotalia scitula</i>	<i>Globorotalia tosaensis</i>	<i>Neogloboquadrina pachyderma</i> (d)	<i>Neogloboquadrina pachyderma</i> (s)	<i>Neogloboquadrina "dupac"</i>	<i>Neogloboquadrina atlantica</i> (d)	<i>Neogloboquadrina atlantica</i> (s)	<i>Neogloboquadrina</i> spp.	<i>N. acostaensis/humerosa</i>	<i>Globigerinita glutinata</i>	<i>Globigerinita aquilateralis</i>	<i>Turborotalita quinqueloba</i>	<i>Turborotalita</i> aff. <i>quinqueloba</i>	<i>Sphaeroidinellopsis</i> sp.
167-1021C-																											
10H-1, 5-7	F				R											F	R	F	C			F	F		F		
10H-1, 20-22	F	R			R	F		C		A		C	R					C	R			F	R				
10H-1, 35-37	C				R	F		C		A		A						C	C			R	R		R		
10H-1, 50-52	C				R					C		A						R	C	R			R				
10H-1, 65-67		R								F		F							F	F							
10H-1, 80-82	F					R				F		F							F	F			R				
10H-1, 95-97	C	R				R	R			A		C		R				R	C			R	R		R		
10H-1, 110-112	C	F				R	R	F		A		C		R		R		R	C			R	R		F		
10H-1, 125-127	C	F				R	R	F		A		C				R		R	C			R	F		F		
10H-1, 140-142	C				R	R	R	F		A		A		R		R		R	F			R	F		R		
10H-2, 5-7	C				C	F		F		A		A				R		R	C	R		F	F		F		
10H-2, 20-22	C	R		R	C	F		R		A		C	R			R		R	A	R		R	R		R		
10H-2, 35-37	F				F	R	R	R		A		C	R			R		R	A	R		R	R		R		
10H-2, 50-52	F				R	R		R		A		C	R			R		R	A	R		R	R		R		
10H-2, 65-67	R				F			R		A		C	R			R		R	F	R		R	F		R		
10H-2, 80-82	R	R			F	R	R	R		A		A		R		R		F	F			R	R		R		
10H-2, 95-97	R	R			F	F	R	R		A		C	R			R		R	A	R		R	R		R		
10H-2, 110-112	R	F			F	R	R	R	R	A		A				R		F	F	C	R	R	R		R		
10H-2, 125-127	R	F			F	R	R	F	R	A		C	R			R		F	R	A		R	F		R		
10H-2, 140-142	C				R	R		R		C		A		R		R		R	F			R	R		R		
10H-3, 5-7	R				R	R		R		C		F				R		R	F			R	R		R		
10H-3, 20-22	F	F			R	F		R		A		C	R	R		R		R	C	R		R	F		R		
10H-3, 35-37	F	R			F	F		R		A		F	R	R		R		F	C	R		R	F		R		
10H-3, 50-52	C	R			R	F		F		A		C	R	R		R		R	C	C	R	R	F		R		
10H-3, 65-67	C	R			R	F		R		A		F	R	R		R		R	C	C		R	F		R		
10H-3, 80-82	F	R			R	R		F		A		F	R			R		R	R	R		R	F		R		
10H-3, 95-97	F				R	R				C		F				R		F	C	C		R	F		R		
10H-3, 110-112	F				R	R	R	F		A		F				R		R	C	C		R	F		R		
10H-3, 125-127	C				R	R				C		F				R		R	C	C		R	R		R		
10H-3, 140-142	F				R	R				A		C		R		R		R	C	C		R	F		R		
10H-4, 5-7	A				R	R			R	A		C		R		F		F	F			R	F		F		

Table 1 (continued).

Core, section, interval (cm)	<i>Orbulina</i> sp.	<i>Globigerinoides ruber</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides sacculifer</i>	<i>Globigerina woodi/apertura</i>	<i>Globigerina pseudobesa</i>	<i>Globigerina falconensis</i>	<i>Globigerina umbilicata</i>	<i>Globigerina aff. umbilicata</i>	<i>Globigerina bulloides</i>	<i>Globigerina praeditata</i>	<i>Globobulimina inflata/puncticulata</i>	<i>Globobulimina crassaformis</i>	<i>Globobulimina scitula</i>	<i>Globobulimina rosacensis</i>	<i>Neoglobobulimina pachyderma</i> (d)	<i>Neoglobobulimina pachyderma</i> (s)	<i>Neoglobobulimina "dupac"</i>	<i>Neoglobobulimina atlantica</i> (d)	<i>Neoglobobulimina atlantica</i> (s)	<i>Neoglobobulimina</i> spp.	<i>N. acostaensis/humerosa</i>	<i>Globigerinita glutinata</i>	<i>Globigerinita aquilateralis</i>	<i>Turborotalita quinqueloba</i>	<i>Turborotalita aff. quinqueloba</i>	<i>Sphaeroidinellopsis</i> sp.
10H-4, 20-22	F					R	R		A		C	R	F	R	F	R	F	C				R	R				
10H-4, 35-37	F					R	R		A		C				F	R	F	C				R	F	R			
10H-4, 50-52	F					R	R	F	A		C				F	R	F	C				R	F	R			
10H-4, 65-67	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-4, 80-82	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-4, 95-97	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-4, 110-112	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-4, 125-127	C					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-4, 140-142	F					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 5-7	C					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 20-22	C	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 35-37	C					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 50-52	F	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 65-67	C	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 80-82	A	R	R			R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 95-97	A	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 110-112	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 125-127	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-5, 140-142	R	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 5-7	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 20-22	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 35-37	R	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 50-52	F					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 65-67						R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 80-82	Barren					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 95-97	Barren					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 110-112	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 125-127	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-6, 140-142	R					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-7, 5-7						R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-7, 20-22	F					R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-7, 35-37	F	R				R	R	F	A		C	R			F	R	F	C				R	F	R			
10H-7, 50-52	F					R	R	F	A		C	R			F	R	F	C				R	F	R			

Note: A = abundant, >75 specimens; C = common, 25–75 specimens; F = few, 5–25 specimens; R = rare, <5 specimens.

Table 2. Planktonic foraminifer census data from Section 167-1021C-10H-2.

Core, section, interval (cm)	<i>Orbulina</i> sp.	<i>Globigerinoides ruber</i>	<i>Globigerinoides sacculifer</i>	<i>Globigerina woodi/apertura</i>	<i>Globigerina pseudobesa</i>	<i>Globigerina falconensis</i>	<i>Globigerina umbilicata</i>	<i>Globigerina aff. umbilicata</i>	<i>Globigerina bulloides</i>	<i>Globobulimina inflata/puncticulata</i>	<i>Globobulimina crassaformis</i>	<i>Globobulimina scitula</i>	<i>Neoglobobulimina pachyderma</i> (d)	<i>Neoglobobulimina pachyderma</i> (s)	<i>Neoglobobulimina "dupac"</i>	<i>Neoglobobulimina atlantica</i> (d)	<i>Neoglobobulimina atlantica</i> (s)	<i>Neoglobobulimina</i> spp.	<i>Neoglobobulimina acostaensis/humerosa</i>	<i>Globigerinita glutinata</i>	<i>Turborotalita quinqueloba</i>	<i>Turborotalita aff. quinqueloba</i>	<i>Globigerinita aquilateralis</i>	Non ID	Total
167-1021C-																									
10H-2, 5-7	20	0	0	22	0	5	2	0	99	110	1	0	2	0	0	53	3	0	0	14	10	0	0	4	345
10H-2, 20-22	20	0	1	16	2	2	2	0	105	37	0	0	1	0	0	86	5	0	0	2	1	0	0	2	282
10H-2, 35-37	8	0	0	7	0	1	4	0	134	51	0	3	0	0	0	54	3	0	0	7	2	0	0	0	274
10H-2, 50-52	13	0	0	3	1	0	0	0	138	22	0	0	0	0	3	72	2	0	4	5	4	0	0	2	269
10H-2, 65-67	6	0	0	13	6	0	6	0	140	52	0	2	0	0	3	18	2	0	2	9	2	0	0	2	263
10H-2, 80-82	2	2	0	9	3	1	2	0	149	63	0	0	1	0	0	10	0	0	0	7	1	0	1	5	256
10H-2, 95-97	6	2	0	0	11	0	3	0	178	16	4	0	8	0	2	92	3	0	0	5	0	2	0	6	338
10H-2, 110-112	6	8	0	0	13	1	7	2	104	50	0	0	11	0	11	46	1	0	3	3	4	5	0	8	283
10H-2, 125-127	4	6	0	1	13	1	12	2	165	22	0	1	17	1	6	69	0	2	4	7	0	0	0	6	339
10H-2, 140-142	19	0	0	1	1	0	5	0	35	132	0	1	0	0	0	17	0	0	0	3	8	0	0	0	222

Note: Non ID = not identified.