Cochran, J. R., Stow, D.A.V., et al., 1990
Proceedings of the Ocean Drilling Program, Scientific Results, Vol. 116

16. BENTHIC FORAMINIFERS AND IMPLICATIONS FOR INTRAPLATE DEFORMATION, SITE 717, DISTAL BENGAL FAN[1]

D. B. Scott[2] and G. T. Leger[3]

ABSTRACT

We report on benthic foraminifer results from Site 717 in the Distal Bengal Fan. Only 80 out of 380 samples contained useful benthic foraminifer information. However, we were able to identify four assemblages: 1. A present-day one dominated by *Nuttallides umbonifera* with some North Atlantic species; 2. An agglutinated fauna consisting of one species; 3. A reworked assemblage consisting of shallow-water forms; and 4. A reworked fauna consisting of an abundance of all kinds of forms including Cretaceous species. The reworked assemblage 4, we believe, represents a period when fan sediments were blocked from this area by east-west trending intraplate deformation. In the remainder of the core section, sedimentation appears to be dominated by Fan deposition with abundant terrestrial debris. In the infrequent pelagic intervals, it appears that abyssal water masses changed little since the late Miocene.

INTRODUCTION

Although the Bengal Fan is the largest deep-sea fan in the world, it is poorly sampled for subsurface material. Fewer than 100 short cores have been retrieved (Curray and Moore, 1971; Curray et al., 1981), and only one spot-cored DSDP site (Leg 22, Site 218) has been drilled in the Fan.

Leg 116 had several objectives and the one that is partially addressed here is the first one listed in Cochran, Stow, et al. (1989): to determine the age of intraplate deformation. With benthic foraminifers, we may be able to delineate when sediment sources to the north (i.e., the head of the Fan) were cut-off and other sources introduced. However, our own objective here was to determine Neogene paleoceanographic characteristics and possibly link the Antarctic region with this one using samples collected subsequently on Leg 119.

This chapter focuses on Site 717 (Holes A, B, C) with a few additional samples from the lower sections of Hole 718C. Shipboard biostratigraphy indicates the oldest sediments here to be upper Miocene (Cochran, Stow, et al., 1989). In Site 717, Holes A and B, only one core (10 m) was recovered while at Hole C there were 91 cores with a recovery of 58.9% and one hole depth of 828.2 m (Cochran, Stow, et al., 1989). Based on preservation of carbonate at these sites, the carbonate compensation depth (CCD) has been at or slightly below these sites throughout the record represented here. Site 717, Holes A and B, recovers only the Holocene-late Pleistocene; recovery in the upper 50 m of Site 717, Hole C, was about 10% so there is a sampling gap between 10 and 50 m at this site. However, Site 717 had the most continuous sediment record and it was chosen as our reference site.

We report on the benthic foraminifer distributions of the Neogene of Site 717 (Holes A–C) and possible implications for deformation history together with paleoceanographic implications.

PREVIOUS WORK

There has been an abundance of previous work done recently on plate deformation and other structural problems in this region (e.g., McAdoo and Sandwell, 1985; Neprochnov et al., 1988; and Zuber, 1987). We discuss only a few of these in the discussion section where necessary.

In terms of paleoceanography, relatively little has been done in the Bengal Fan region; the sites in this leg are almost the only cores to penetrate past the Holocene. However, there has been some excellent baseline work done on modern benthic foraminifer distributions that are essential to interpreting the core sequences (Corliss, 1979a, b; 1983); Peterson, 1984).

PHYSIOGRAPHY AND HYDROGRAPHY

A brief description of physiography and hydrography is included here to facilitate later discussion on paleoceanographic interpretations. The largest structural feature in the area is the Ninetyeast Ridge (Fig. 1) and it affects the deep-water circulation profoundly. Peterson (1984) suggests two sources of possible contamination of deep-sea sediments here—distal turbidites originating from the Bengal Fan and downslope transport from the relatively steep slopes of the Ninetyeast Ridge. Additional sources are suggested by Cochran, Stow, et al. (1989) to be different continental sources (i.e., shelf edge off Sri Lanka) or adjacent seamounts. We have evidence for three of these sources in the Neogene of Site 717 but not from the seamounts. One of the controls on these sources is suggested to be east-west trending ridges caused by intraplate deformation and blocking of sediments from the north by up-thrown blocks. We believe the foraminifer data show evidence of this blocking.

Hydrographically the Bengal Fan is a complex area controlled by a variety of different bottom-water sources but also by sills and the Ninetyeast Ridge. Peterson (1984) notes that the deep waters of this area of the central Indian Basin all originate externally, either in the Antarctic or the Atlantic Ocean. The central Indian Basin is largely closed to the south below 3500 m water depth, blocking deep Antarctic water (Kamaev et al., 1977; Warren, 1981a). Warren (1981a, b) suggest bottom waters in the eastern part of the central Indian Basin are derived from a boundary current in the

[1] Cochran, J. R., Stow, D.A.V., et al., 1990. *Proc. ODP, Sci. Results*, 116: College Station, TX (Ocean Drilling Program).
[2] Centre for Marine Geology, Dalhousie Univ., Halifax, N.S. B3H 3J5, Canada.
[3] Dept. of Oceanography, Dalhousie Univ., Halifax, N.S. B3H 3J5, Canada.

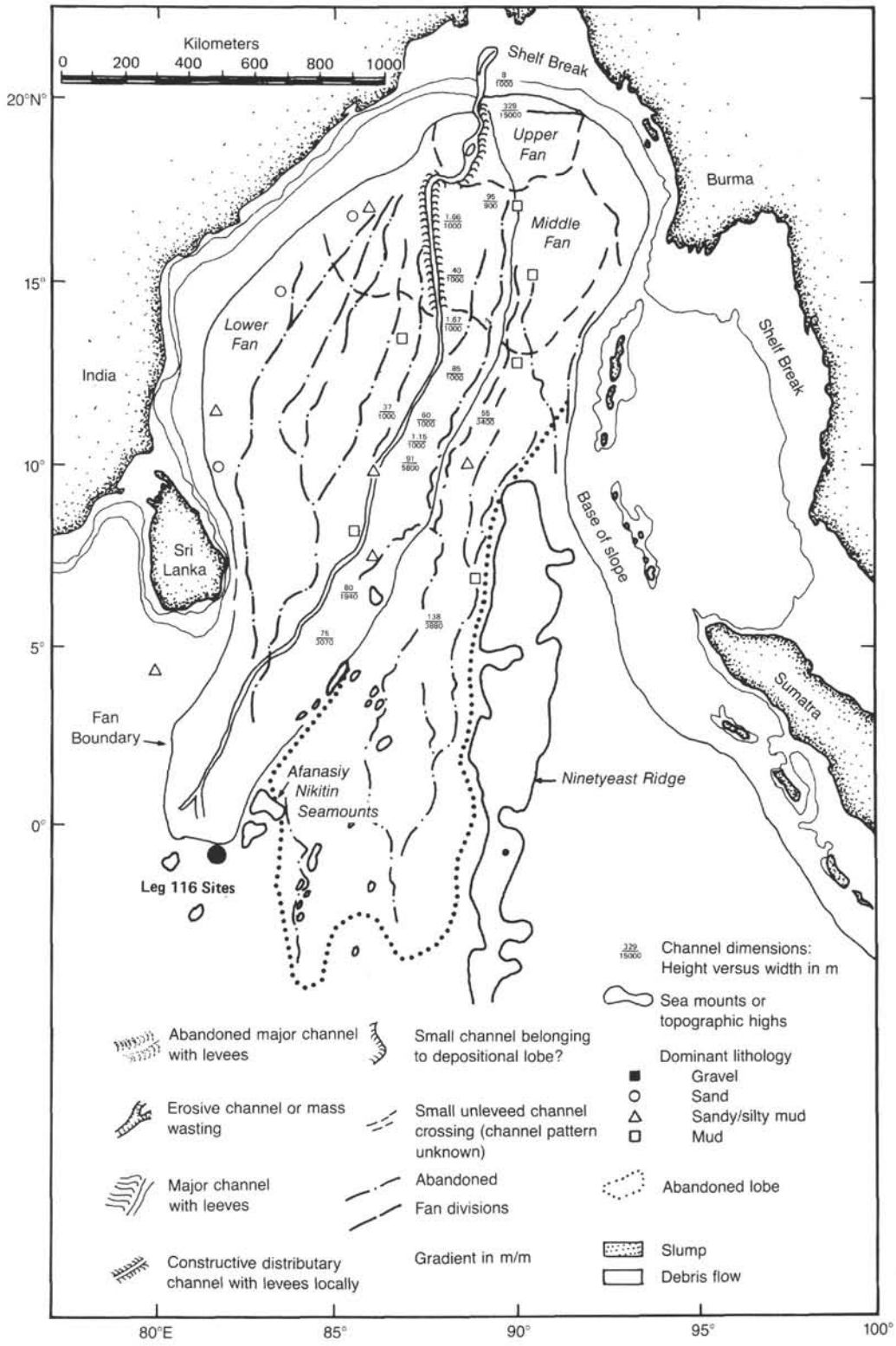

Figure 1. Map of the central Indian Ocean Basin with Leg 116 sites indicated.

Wharton-Cocos Basin east of the Ninetyeast Ridge, that overflows through saddles in the Ninetyeast Ridge into the central Indian Basin. These saddles were identified by Sclater and Fisher (1974) to be about 3500 to 4000 m water depth. Bathymetric profiles of different physical characteristics of the seawater (e.g., salinity, temperature) show that water in both basins is essentially uniform below 3800 m (Peterson, 1984). Peterson (1984) notes that deep and bottom water can be distinguished by their physical properties in this region but suggests that they are each in reality a mixture of Antarctic and Atlantic water and the transition is not as distinct as in the Atlantic.

METHODS

Ten-cm^3 samples were processed for study of benthic foraminifers. All material was stored in a cold room subsequent to processing. Sediment was wet sieved through a 63-μm (#230 mesh) screen to remove silt and clay material.

Most samples contained so little sand that they were examined in liquid medium, which ensures the preservation of delicate and organic forms (e.g., *Rhizammina algaeformis* inner linings). In samples with excess sand, the samples were dried and foraminifers separated using the floatation method with carbon tetrachloride.

A total of 13 samples from Hole 717A, 10 from 717B, 339 from 717C, and 18 from 718C were examined. Samples from Site 717 (all three holes) containing foraminifers are reported quantitatively in Table 1 (Cores 1–30). Below Core 30 only six samples warranted quantitative examination—these are also in Table 1. Data are reported as total absolute abundances with relative percentages for each individual species. Qualitative results are reported for the remaining samples, in Table 2. All samples in the tables are identified with core-section number together with interval within the section and the sub-bottom hole depth.

The most common hemipelagic benthic foraminifer species are illustrated in Plate 1. Photomicrographs were taken on a scanning light microscope (SLM) manufactured by Irvine Optical. Details of the method are available from the senior author or in Gerakaris (1986).

RESULTS

As noted in shipboard reports, the Leg 116 sites were not attractive for biostratigraphic study. Of the 380 samples examined in this chapter, only 80 warranted thorough quantitative treatment (Table 1). Total numbers per 10 cm^3 in Table 1 range from 1 to 99,200 but many samples, especially in the upper part of the section, had less than 10 individuals. Samples with high numbers were usually those with mostly reworked specimens. Given the poor data set there is still a valuable contribution from microfossils, in this case benthic foraminifers, for Leg 116, although biostratigraphic information is limited.

Several types of fauna exist and the occurrence of each is described here.

1. Present-Day Fauna: This assemblage is usually dominated by *Nuttailides umbonifera* with *Epistominella exigua* and *Eponides weddellensis* as secondary species. *Oridorsalis umbonatus*, *Planulina wuellerstorfi*, *Pullenia subcarinata*, *Cassidulina subglobosum*, *Gyroidina soldanii*, and *Eponides tumidulus* all occur in low but consistent abundances. Another species, never reported from this area previously, also occurs commonly in the late Pleistocene (717A, B)—*Stetsonia horvathi*. This is an Arctic Ocean species (Lagoe, 1977) that sometimes enters the North Atlantic (Scott et al., 1989) and its presence here indicates deep arctic water may have an influence even in the Indian Ocean. The present-day fauna occurs most consistently in Holes 717A and B but also sporadically throughout the entire section of Site 717 down to upper Miocene (Sample 116-717-70X-6, Table 1). Planktonic foraminifers in these samples are always fragmented and poorly preserved. Total numbers of benthics are moderate, usually more than 100/10 cm^3.

2. Agglutinated Fauna: This assemblage occurs sporadically through the entire section of Site 717. It consists of one species—inner linings of *Rhizammina algaeformis*. This fauna exists where no carbonate is preserved. It might also be present in some sections of Site 717 where there are unidentified pyrite tubes. Total numbers are usually low (<100/10 cm^3).

3. Reworked Fauna I: This assemblage occurs as a strong component of the Holocene fauna and is most prominent in the upper Pleistocene (Holes 717A and 717B). It is dominated by *Bolivina* spp. and shallow-water Holocene species (*Ammonia beccarii*, *Elphidium* spp., Table 1) in low numbers (usually less than 100/10 cm^3).

4. Reworked Fauna II: This assemblage is the most stratigraphically limited of all the faunas, being confined between Cores 20 and 30 in Site 717C. It consists of a highly varied assemblage with virtually every kind of Cenozoic benthic foraminifer type represented, as well as some Cretaceous forms. Most dominant is the *Bolivina* spp. component that probably comprises six to eight species (not differentiated here) of *Bolivina*, some Pleistocene forms, some Tertiary. Together with these are two well-known Cretaceous genera, *Heterohelix* and *Guembelitria*. Also there are usually about 100 times as many well-preserved minute planktonic foraminifers as benthics, unlike the pelagic assemblage here where planktonics are mostly fragments. Total numbers here are highly variable (1 to 99,000/10 cm^3) but are often in excess of 1000/10 cm^3 (Table 1). This type of fauna only occurs in two samples outside the 150- to 250-m interval (Cores 116-717C-49X-1, -717C-49X-2, Table 2).

5. Barren Intervals: These are not classified as assemblages but most of the cores consist of this type of unit, especially below Core 30 from Hole 717C. However, the barren intervals are not all the same—some contain large amounts of terrestrial material, including wood fragments; some contain a lot of pyrite and pyrite tube fillings; and others contain absolutely nothing after they are wet sieved through a 63-μm screen. More details are provided in Table 2.

DISCUSSION

The present-day fauna described here (No. 1) is very similar to that reported by Peterson (1984) for this area except that Peterson (1984) did not see some of the smaller species, in particular *E. weddellensis*, because he used the fraction >150 μm. He did not see *Stetsonia horvathi* either, but this might be a result of this species not occurring in modern faunas, as it does not occur in modern faunas of the Atlantic, either. The correlation between the Pleistocene faunas here and Peterson's (1984) data is not unexpected, but we were unable to detect any changes in this fauna throughout the entire section—i.e., we cannot distinguish glacial/interglacial faunas. This more than likely results from the rare occurrences of this fauna (in 19 samples out of 380), which makes it virtually impossible to identify any but the most general paleoceanographic trends. Perhaps the most interesting section is 116-717C-70X-6 (Table 1), which contains an exceptionally well-preserved, abundant *N. umbonifera* fauna, identical to the modern one but late Miocene in age, suggesting that the present circulation pattern might have been in existence since late Miocene. The composition of this assemblage attests to its multi-source origin with both Antarctic and North Atlantic species being common, although the Antarctic bottom-water indicator, *N. umbonifera*, is the most dominant form.

Oxygen isotope study of the *N. umbonifera* from the pelagic intervals was not attempted because in most cases the foraminifer tests were badly etched and we do not have anything like a continuous record.

The agglutinated fauna observed in some sections probably result from changing levels of the CCD. This is similar to a *Rhizammina* fauna observed in Baffin Bay during low-carbonate periods (Scott et al., 1989). Identifications are tenuous because we are dealing only with inner linings.

By far the most dominant fossil elements in the sediments of Site 717 are the reworked components. In the upper

Table 1. Percentage occurrences of benthonic foraminifera in ODP Site 717. X = less than 1%.

Core-section #	1-1	1-2	1-3	1-5	1-5	1-6	1-7	1-1	1-3	2-1
Depth in core (cm)	104–110	4–10	4–10	4–10	104–110	4–10	4–10	23–28	23–28	21–25
Depth below seafloor (m)	1.04	1.54	3.04	6.04	7.04	7.54	9.04	0.23	3.23	4.21
Number of species	22	1	19	14	14	11	5	1	15	11
Number of individuals/10 cm^3	295	1	714	113	34	17	7	1	37	95
Nonreworked specimens	Hole 717A							Hole 717A		
Bulimina striata										
Cassidulina subglobosum			2	2		6	14			2
Chilostomella oolina	1								3	
Cibicides robertsonianus	1									
Dentalina spp.			X							
Eggerella bradyi	1		X							1
Epistominella exigua	16		34	37					14	32
E. takayanagii	1									
Eponides tumidulus	4		2	3						
E. weddellensis	20		19	12	3				14	19
Fissurina spp.	2		1	2					5	
Fursenkoina fusiformis	1		X	1	12				5	
Gyroidina soldanii	4		1	1					8	4
Karreriella bradyi										
K. novangliae										
Lagena spp.	1			1	3					
Laryngosigma spp.										
Nonion barleeanum			2	1						
Nuttallides umbonifera	8		27	29					11	29
Oridorsalis umbonatus	2		2						8	
Planulina wuellerstorfi	4		X	2						1
Pullenia bulloides	X		1							
P. subcarinata	6		4	3		6			3	4
Pyrgo williamsoni						6				1
Quinqueloculina cultrata	1									
Q. seminulum	2				3				3	
Reophax guttifer								100		
R. scottii									3	
Rhizammina algaeformis										
Robertinoides charlottensis	1									1
Robulus sp.			X							
Siphotextularia rolshauseni	1									
Sphaeroidina bulloides			X							
Spiroloculina spp.										
Spiroplectammina biformis									3	
Stetsonia horvathi	27		4	5					14	5
Tosaia hanzawai	X			3					5	
Triloculina sp.										
Reworked specimens										
Ammonia beccarrii					15	23	28			
Bolivina spp. (some T-K)					9	6	28			
Buccella frigida					3					
Bulimina marginata					9	6				
Buliminoides sp. (T-K)										
Cassidulina californica						6	14			
C. laevigata					15	6				
Centropyxis aculeata		100								
Cibicides bradyi										
C. lobatulus					3	6				
Cyclogyra involvens										
Discorbis sp.										
Ehrenbergina sp.										
Elphidium spp.			X		3	18				
Florilus sp.							14			
Frondicularia sp.										
Gavelinopsis translucens										
Glabratella sp.										
Guembelitria sp. (T-K)										
Hanzawaia mexicana										
Haynesina spp.						12				
Heterohelix spp. (K)										
Hyalinea balthica										
Lenticulina sp.										
Nodosaria sp.										
Nonion sp.					12					
Nonionella spp.					9					
Oolina hexigona										
Oolina spp.										
Patellina corrugata										
Praebulimina sp. (T-K)										
Pyramidina sp. (T-K)										
Quinqueloculina stalkeri										
Reussella sp.										
Rosalina sp.										
Spirillina vivipara										
Stilostomella sp.										
Trifarina sp.					3					
Uvigerina asperula										
U. peregrina										
Valvulineria arctica										
V. laevigata										

Table 1 (continued).

Core-section #	2-2	2-3	2-4	2-5	2-6	2-7	5-1	6-1	6-2	6-3
Depth in core (cm)	3–9	3–9	3–9	3–9	3–9	3–9	3–8	3–9	3–9	3–9
Depth below seafloor (m)	5.53	7.03	8.53	10.03	11.53	13.03	36.53	46.03	47.53	48.13
Number of species	1	4	1	1	1	2	5	10	9	1
Number of individuals/10 cm^3	202	8	2	1	2	3	6	55	45	1
	Hole 717B						Hole 717C			
Nonreworked specimens										
Bulimina striata										
Cassidulina subglobosum							17	5		
Chilostomella oolina										
Cibicides robertsonianus										
Dentalina spp.										
Eggerella bradyi										
Epistominella exigua								24		
E. takayanagii										
Eponides tumidulus										
E. weddellensis						33		16		
Fissurina spp.										
Fursenkoina fusiformis							17			
Gyroidina soldanii										
Karreriella bradyi										
K. novangliae										
Lagena spp.										
Laryngosigma spp.										
Nonion barleeanum										
Nuttallides umbonifera		12		100				25	2	
Oridorsalis umbonatus								2		
Planulina wuellerstorfi							33	2		
Pullenia bulloides		12					17	2		
P. subcarinata								11		
Pyrgo williamsoni										
Quinqueloculina cultrata								4		
Q. seminulum										
Reophax guttifer										
R. scottii										
Rhizammina algaeformis	100	62	100							
Robertinoides charlottensis										
Robulus sp.										
Siphotextularia rolshauseni										
Sphaeroidina bulloides										
Spiroloculina spp.										
Spiroplectammina biformis										
Stetsonia horvathi		12						9		
Tosaia hanzawai										
Triloculina sp.										
Reworked specimens										
Ammonia beccarii									64	100
Bolivina spp. (some T-K)					100	66			2	
Buccella frigida										
Bulimina marginata									2	
Buliminoides sp. (T-K)										
Cassidulina californica										
C. laevigata										
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens										
Discorbis sp.										
Ehrenbergina sp.										
Elphidium spp.									7	
Florilus sp.							17		9	
Frondicularia sp.										
Gavelinopsis translucens										
Glabratella sp.										
Guembelitria sp. (T-K)										
Hanzawaia mexicana										
Haynesina spp.										
Heterohelix spp. (K)										
Hyalinea balthica										
Lenticulina sp.										
Nodosaria sp.										
Nonion sp.										
Nonionella spp.									9	
Oolina hexigona										
Oolina spp.										
Patellina corrugata										
Praebulimina sp. (T-K)									2	
Pyramidina sp. (T-K)										
Quinqueloculina stalkeri										
Reussella sp.										
Rosalina sp.										
Spirillina vivipara										
Stilostomella sp.										
Trifarina sp.									2	
Uvigerina asperula										
U. peregrina										
Valvulineria arctica										
V. laevigata										

Table 1 (continued).

Core-section #	7-1	7-2	8-1	14-1	16	19-1	20-1	20-4	20	21-1
Depth in core (cm)	3–9	3–9	24–30	3–9	CC	3–9	3–9	3–9	CC	3–9
Depth below seafloor (m)	55.53	57.03	65.24	103.03	123.60	141.03	150.55	155.03	155.80	160.03
Number of species	3	1	1	3	3	2	3	21	30	17
Number of individuals/10 cm^3	9	1	1	3	3	2	3	183	677	68
	Hole 717C									
Nonreworked specimens										
Bulimina striata										
Cassidulina subglobosum					33			6	9	10
Chilostomella oolina										
Cibicides robertsonianus										
Dentalina spp.										
Eggerella bradyi										
Epistominella exigua								12	2	3
E. takayanagii										
Eponides tumidulus								X		
E. weddellensis				33				9	7	7
Fissurina spp.								2	1	1
Fursenkoina fusiformis								4	4	4
Gyroidina soldanii								7	3	3
Karreriella bradyi										
K. novangliae										
Lagena spp.								X		1
Laryngosigma spp.										
Nonion barleeanum										
Nuttallides umbonifera	44			33				9	1	
Oridorsalis umbonatus								2	X	
Planulina wuellerstorfi	11			33				2	4	1
Pullenia bulloides								X		
P. subcarinata								5	4	3
Pyrgo williamsoni										
Quinqueloculina cultrata										
Q. seminulum								X	2	
Reophax guttifer										
R. scottii										
Rhizammina algaesormis										
Robertinoides charlottensis										
Robulus sp.						50			X	
Siphotextularia rolshauseni										
Sphaeroidina bulloides										
Spiroloculina spp.									X	
Spiroplectammina biformis										
Stetsonia horvathi									1	3
Tosaia hanzawai								X	X	
Triloculina sp.										
Reworked specimens										
Ammonia beccarrii	44	100				50	33		1	
Bolivina spp. (some T-K)			100					27	38	29
Buccella frigida										
Bulimina marginata								X	X	
Buliminoides sp. (T-K)									2	1
Cassidulina californica										
C. laevigata								2	4	
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens										
Discorbis sp.					33				3	
Ehrenbergina sp.										
Elphidium spp.									X	1
Florilus sp.										
Frondicularia sp.										
Gavelinopsis translucens										
Glabratella sp.										
Guembelitria sp. (T-K)								7	8	20
Hanzawaia mexicana										
Haynesina spp.							33			
Heterohelix spp. (K)									2	4
Hyalinea balthica										
Lenticulina sp.										
Nodosaria sp.									X	
Nonion sp.										
Nonionella spp.							33	X	1	3
Oolina hexigona								1		1
Oolina spp.										
Patellina corrugata									X	
Praebulimina sp. (T-K)									1	
Pyramidina sp. (T-K)										
Quinqueloculina stalkeri										
Reussella sp.										
Rosalina sp.										
Spirillina vivipara										
Stilostomella sp.					33					
Trifarina sp.								X		
Uvigerina asperula										
U. peregrina										X
Valvulineria arctica										
V. laevigata										

Table 1 (continued).

Core-section #	21-2	21-3	21-4	21	22-1	22-2	22-3	22-4	22-5	23-1
Depth in core (cm)	120–125	100–105	42–48	CC	40–46	3–9	3–9	3–9	6–12	3–9
Depth below seafloor (m)	162.70	164	164.42	166	169.96	171.03	172.53	174.03	175.56	179.03
Number of species	4	17	1	24	17	25	29	23	22	11
Number of individuals/10 cm^3	11	105	6	2202	1042	340	161	189	476	32
	Hole 717C									
Nonreworked specimens										
Bulimina striata										
Cassidulina subglobosum		1		10	1	11	10	9	9	
Chilostomella oolina										
Cibicides robertsonianus										
Dentalina spp.					X		1		1	
Eggerella bradyi					X		1	X		
Epistominella exigua		1		4	12	2	4	5	2	3
E. takayanagii										
Eponides tumidulus					1	X	3	X		
E. weddellensis	9			5	3	4	7	7	4	3
Fissurina spp.		1		1	1	3	2	X	X	
Fursenkoina fusiformis		1		1		1	1	2	1	
Gyroidina soldanii		2		2	1	2	3	1		
Karreriella bradyi										
K. novangliae										
Lagena spp.				2		X	2			
Laryngosigma spp.										
Nonion barleeanum					X					
Nuttallides umbonifera	27	22		2	74	7	17	14	8	12
Oridorsalis umbonatus				X	1		1	X	2	
Planulina wuellerstorfi		1		2	1	2	4	3	6	
Pullenia bulloides										
P. subcarinata	36	4		3	3	1	4	6	1	
Pyrgo williamsoni										
Quinqueloculina cultrata										
Q. seminulum				4		1			2	
Reophax guttifer										
R. scottii										
Rhizammina algaeformis	27		100							
Robertinoides charlottensis										
Robulus sp.									X	
Siphotextularia rolshauseni										
Sphaeroidina bulloides										
Spiroloculina spp.										
Spiroplectammina biformis										
Stetsonia horvathi					X					
Tosaia hanzawai							1			
Triloculina sp.						X				
Reworked specimens										
Ammonia beccarii										
Bolivina spp. (some T-K)		22		44		39	22	28	35	28
Buccella frigida										
Bulimina marginata				2		X		2	4	
Buliminoides sp. (T-K)		1		1		2	1	2	1	3
Cassidulina californica										
C. laevigata		7		4		4	3	3	10	6
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens										
Discorbis sp.		2		3		3	1	1	X	
Ehrenbergina sp.										
Elphidium spp.		2			X	1				
Florilus sp.										
Frondicularia sp.										
Gavelinopsis translucens				X				X		
Glabratella sp.										
Guembelitria sp. (T-K)		27		2		2	1	5	2	
Hanzawaia mexicana										
Haynesina spp.										
Heterohelix spp. (K)		5		6	X	12	4	10	7	25
Hyalinea balthica										
Lenticulina sp.					X					
Nodosaria sp.							1			
Nonion sp.										
Nonionella spp.				1		X	1			
Oolina hexigona										
Oolina spp.										
Patellina corrugata				X		X	1			
Praebulimina sp. (T-K)		2		X			1			3
Pyramidina sp. (T-K)									X	
Quinqueloculina stalkeri										
Reussella sp.										
Rosalina sp.										
Spirillina vivipara										
Stilostomella sp.							1	1	1	9
Trifarina sp.							1	X		3
Uvigerina asperula								1		
U. peregrina		2					X	2		2
Valvulineria arctica										
V. laevigata				1		X	1			3

Table 1 (continued).

Core-section #	23-2	23-3	23-7	24-1	24-3	24-4	24-5	24-6	24-7	25-1
Depth in core (cm)	3–9	3–9	3–9	6–12	5–11	100–104	9–15	31–37	3–9	60–65
Depth below seafloor (m)	180.53	182.03	188.05	188.51	191.55	194	194.59	196.31	197.53	198.60
Number of species	32	38	28	31	1	24	1	1	27	16
Number of individuals/10 cm^3	446	99200	1128	10096	1	2488	44	14	832	312
	Hole 717C									
Nonreworked specimens										
Bulimina striata		X							X	
Cassidulina subglobosum	8	10	7	9		11			10	4
Chilostomella oolina										
Cibicides robertsonianus										
Dentalina spp.	X	X	X			X				
Eggerella bradyi										
Epistominella exigua	2	1	1	2		7			3	13
E. takayanagii	X		X			X				
Eponides tumidulus	X	X				X				1
E. weddellensis	6	6	3	7		17			8	8
Fissurina spp.	2	1	X	1		2			1	1
Fursenkoina fusiformis	1	1	4	1		X			1	
Gyroidina soldanii	3	2	1	1		6			2	4
Karreriella bradyi										
K. novangliae										
Lagena spp.	X		X	X						X
Laryngosigma spp.										
Nonion barleeanum										
Nuttallides umbonifera	4	5	1	2		4			1	59
Oridorsalis umbonatus	1	X		X		X				2
Planulina wuellerstorfi	5	6	2	3		4			4	X
Pullenia bulloides						X				1
P. subcarinata	2	2	2	2		6			2	4
Pyrgo williamsoni									X	
Quinqueloculina cultrata										
Q. seminulum	1	2	2	3		X			3	
Reophax guttifer										
R. scottii										
Rhizammina algaeformis					100		100	100		
Robertinoides charlottensis		X								
Robulus sp.	X	1				X				
Siphotextularia rolshauseni										
Sphaeroidina bulloides										
Spiroloculina spp.	X									
Spiroplectammina biformis										
Stetsonia horvathi	X		X						X	
Tosaia hanzawai										1
Triloculina sp.		1								
Reworked specimens										
Ammonia beccarii		X	X	1					X	
Bolivina spp. (some T-K)	34	32	44	44		27			42	X
Buccella frigida										
Bulimina marginata	2	2	2	1					1	
Buliminoides sp. (T-K)	1	1	3	1					1	
Cassidulina californica										
C. laevigata	6	8	4	8		2			3	1
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens										
Discorbis sp.	1	2	2	1		2			3	
Ehrenbergina sp.										
Elphidium spp.		2		1						
Florilus sp.										
Frondicularia sp.										
Gavelinopsis translucens		4	1	2					1	
Glabratella sp.	X									
Guembelitria sp. (T-K)	X	X				X			1	
Hanzawaia mexicana		X		X						
Haynesina spp.										
Heterohelix spp. (K)	14	4	15	7		4			9	
Hyalinea balthica										
Lenticulina sp.										X
Nodosaria sp.	1								X	
Nonion sp.										
Nonionella spp.	1	X	1	X		2			X	
Oolina hexigona		X								
Oolina spp.										
Patellina corrugata	X	X		X					1	
Praebulimina sp. (T-K)		1	1	X					X	
Pyramidina sp. (T-K)	X	X								
Quinqueloculina stalkeri				X						
Reussella sp.		X		X						
Rosalina sp.		1								
Spirillina vivipara										
Stilostomella sp.	2	1	1	1		1				
Trifarina sp.	X	X	X	X						
Uvigerina asperula										
U. peregrina		2	X	1		1			1	
Valvulineria arctica										
V. laevigata			X							

Table 1 (continued).

Core-section #	25-3	25-4	25-5	26-1	26-3	26-6	26-7	26	27-1	27-3
Depth in core (cm)	100–105	37–42	84–89	106–111	8–13	134–139	2–7	CC	3–8	3–8
Depth below seafloor (m)	202	202.87	204.84	208.56	210.58	216.31	216.52	216.80	217.03	220.03
Number of species	21	22	22	18	1	13	26	20	20	6
Number of individuals/10 cm^3	1146	2854	111	92	3	107	376	247	654	7
Nonreworked specimens	Hole 717C									
Bulimina striata	X									
Cassidulina subglobosum	4	2	4	10		7	6	6	2	
Chilostomella oolina				1						
Cibicides robertsonianus										
Dentalina spp.		X	1				X	X		
Eggerella bradyi		X		3						
Epistominella exigua	11	21	4			5	X	1		
E. takayanagii			1				X	X	1	
Eponides tumidulus	2	3		12		2				
E. weddellensis	17	10	14	22		8	5	3	3	14
Fissurina spp.	1	2	4	1			3	3	1	
Fursenkoina fusiformis	X	1	5	1			1	1	2	
Gyroidina soldanii	10	6	2	6		2	1	1	1	28
Karreriella bradyi		X				1				
K. novangliae	X									
Lagena spp.	1	X		1			X			
Laryngosigma spp.						1				
Nonion barleeanum	2	X		2		2				
Nuttallides umbonifera	27	30	4	9		52	1	1	3	
Oridorsalis umbonatus	4	7		13					1	
Planulina wuellerstorfi	6	2	2	3		1	1	2	2	
Pullenia bulloides	1	3		1		5				
P. subcarinata	11	10	5	11		13	7	7	4	
Pyrgo williamsoni	X									
Quinqueloculina cultrata										
Q. seminulum		X	3				1	2		
Reophax guttifer										
R. scottii										
Rhizammina algaeformis					100					
Robertinoides charlottensis										
Robulus sp.										
Siphotextularia rolshauseni	X	X		1						
Sphaeroidina bulloides										
Spiroloculina spp.										
Spiroplectammina biformis										
Stetsonia horvathi	X	X	1				1	1		
Tosaia hanzawai	1	1		1		1				
Triloculina sp.		X								
Reworked specimens										
Ammonia beccarrii									1	
Bolivina spp. (some T-K)			33	1			43	40	52	14
Buccella frigida										
Bulimina marginata							1		2	
Buliminoides sp. (T-K)			5				1	1	2	
Cassidulina californica										
C. laevigata			1				3	4	7	14
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens							X	1		
Discorbis sp.			2				4	4	2	14
Ehrenbergina sp.										
Elphidium spp.							X			
Florilus sp.										
Frondicularia sp.										
Gavelinopsis translucens										
Glabratella sp.										
Guembelitria sp. (T-K)			2				2			
Hanzawaia mexicana										
Haynesina spp.										
Heterohelix spp. (K)			1				24	21	13	14
Hyalinea balthica										
Lenticulina sp.			1							
Nodosaria sp.										
Nonion sp.										
Nonionella spp.	X									
Oolina hexigona										
Oolina spp.										
Patellina corrugata							X			
Praebulimina sp. (T-K)								X	1	
Pyramidina sp. (T-K)										
Quinqueloculina stalkeri										
Reussella sp.										
Rosalina sp.										
Spirillina vivipara							X			
Stilostomella sp.			4				X		X	
Trifarina sp.									X	
Uvigerina asperula										
U. peregrina			1							
Valvulineria arctica										
V. laevigata										

Table 1 (continued).

Core-section #	27-4	27-5	27-6	27	28-1	29-1	29-2	29-3	29-5	29
Depth in core (cm)	3–8	3–8	3–8	CC	3–9	3–9	3–8	3–8	3–8	CC
Depth below seafloor (m)	221.53	223.05	224.53	226.20	226.53	236.03	237.53	239.03	242.03	245.40
Number of species	1	29	10	1	23	1	6	17	21	19
Number of individuals/10 cm^3	2	950	46	1	5616	1	11	79	4864	490
	Hole 717C									
Nonreworked specimens										
Bulimina striata										
Cassidulina subglobosum		5	4		3			2	3	2
Chilostomella oolina										
Cibicides robertsonianus										
Dentalina spp.		X	2					1		
Eggerella bradyi										
Epistominella exigua		X	2		3			1	1	2
E. takayanagii								2		X
Eponides tumidulus		2								X
E. weddellensis		9			3			1	3	3
Fissurina spp.		X			X				2	2
Fursenkoina fusiformis		3			2			16	2	4
Gyroidina soldanii		3			X	100	9		1	1
Karreriella bradyi										
K. novangliae										
Lagena spp.		1						4		
Laryngosigma spp.										
Nonion barleeanum		X					9			
Nuttallides umbonifera		5	13		3		36		3	
Oridorsalis umbonatus		4			X			1	X	
Planulina wuellerstorfi		2	2		3			1	1	1
Pullenia bulloides		X								
P. subcarinata		10	9		4		27	4	6	2
Pyrgo williamsoni										
Quinqueloculina cultrata										
Q. seminulum		X			1					
Reophax guttifer										
R. scottii										
Rhizammina algaeformis	100									
Robertinoides charlottensis										
Robulus sp.										
Siphotextularia rolshauseni										
Sphaeroidina bulloides										
Spiroloculina spp.										
Spiroplectammina biformis										
Stetsonia horvathi									X	
Tosaia hanzawai		X					9			
Triloculina sp.										
Reworked specimens										
Ammonia beccarii										
Bolivina spp. (some T-K)		32	52		57		9	19	64	74
Buccella frigida										
Bulimina marginata					X			2	X	5
Buliminoides sp. (T-K)		2			X			32	X	X
Cassidulina californica										
C. laevigata		7	11		9				2	2
Centropyxis aculeata										
Cibicides bradyi										
C. lobatulus										
Cyclogyra involvens										
Discorbis sp.		1			4			1	6	X
Ehrenbergina sp.										
Elphidium spp.			2		1			1		
Florilus sp.										
Frondicularia sp.		X								
Gavelinopsis translucens					X				X	
Glabratella sp.		1								
Guembelitria sp. (T-K)					X					
Hanzawaia mexicana										
Haynesina spp.										
Heterohelix spp. (K)		5			1				3	X
Hyalinea balthica				100	X				X	
Lenticulina sp.										
Nodosaria sp.										
Nonion sp.										
Nonionella spp.		1								1
Oolina hexigona										
Oolina spp.										
Patellina corrugata		X								
Praebulimina sp. (T-K)		X						2		
Pyramidina sp. (T-K)										
Quinqueloculina stalkeri										
Reussella sp.									X	X
Rosalina sp.										
Spirillina vivipara										
Stilostomella sp.		1	2		1			6	X	X
Trifarina sp.					X					
Uvigerina asperula										
U. peregrina		X								
Valvulineria arctica										
V. laevigata										

Table 1 (continued).

Core-section #	30-1	30-2	30-3	52-3	53-6	54-2	54-6	65-5	70-6
Depth in core (cm)	3–9	2–8	3–9	3–8	3–8	3–8	2–8	3–8	3–9
Depth below seafloor (m)	245.53	247.02	248.53	457.53	471.53	475.03	481.03	584.03	633.03
Number of species	13	14	24	9	1	9	3	24	9
Number of individuals/10 cm^3	47	84	1260	48	32	28	11	726	43
	Hole 717C								
Nonreworked specimens									
Bulimina striata									
Cassidulina subglobosum	11	2	4	6				2	
Chilostomella oolina				4					
Cibicides robertsonianus				2					
Dentalina spp.								X	
Eggerella bradyi						7		X	
Epistominella exigua		5	1					14	5
E. takayanagii								X	
Eponides tumidulus								3	
E. weddellensis	4	8	5				18	28	5
Fissurina spp.		2	2			4		X	
Fursenkoina fusiformis			7					1	
Gyroidina soldanii	2	4	1	2		7		2	5
Karreriella bradyi						4			
K. novangliae									
Lagena spp.	2	1							
Laryngosigma spp.									
Nonion barleeanum		2		4				2	5
Nuttallides umbonifera	4	51	1	69		54	73	32	58
Oridorsalis umbonatus		5		4		7		4	9
Planulina wuellerstorfi		2	1	6		7	9	3	7
Pullenia bulloides		7				7		2	
P. subcarinata	6	7	2					3	
Pyrgo williamsoni									
Quinqueloculina cultrata									
Q. seminulum			X						
Reophax guttifer									
R. scottii									
Rhizammina algaeformis					100				
Robertinoides charlottensis									
Robulus sp.									
Siphotextularia rolshauseni									
Sphaeroidina bulloides									
Spiroloculina spp.									
Spiroplectammina biformis									
Stetsonia horvathi			1					X	
Tosaia hanzawai		1				4		1	
Triloculina sp.									
Reworked specimens									
Ammonia beccarii									
Bolivina spp. (some T-K)	47		62						5
Buccella frigida									
Bulimina marginata	2		1						
Buliminoides sp. (T-K)	11		1						
Cassidulina californica									
C. laevigata	2		5						
Centropyxis aculeata									
Cibicides bradyi								X	
C. lobatulus									
Cyclogyra involvens									
Discorbis sp.			1						
Ehrenbergina sp.			1						
Elphidium spp.			X						
Florilus sp.									
Frondicularia sp.									
Gavelinopsis translucens			1						
Glabratella sp.									
Guembelitria sp. (T-K)									
Hanzawaia mexicana									
Haynesina spp.									
Heterohelix spp. (K)	4		1						
Hyalinea balthica			X						
Lenticulina sp.								X	
Nodosaria sp.	2								
Nonion sp.									
Nonionella spp.									
Oolina hexigona									
Oolina spp.					2			1	2
Patellina corrugata	2		X						
Praebulimina sp. (T-K)			2						
Pyramidina sp. (T-K)									
Quinqueloculina stalkeri									
Reussella sp.									
Rosalina sp.									
Spirillina vivipara									
Stilostomella sp.			1					X	
Trifarina sp.									
Uvigerina asperula									
U. peregrina		1							
Valvulineria arctica								X	
V. laevigata								1	

Table 2. Qualitative data for Cores 116-717C-30X to -91X and selected levels of Hole 718C. A = Abundant, C = Common, R = Rare, T = Terrestrial, F = Foraminifer, W = Worm, VA = Very Abundant, RW = Reworked, Frags = Fragments, B = Benthic, P = Planktonic, ** = refers to data in Table 1.

Site 717C								
							Foraminifers	
Core	Interval (cm)	Hole depth (mbsf)	Org.	Pyrite	Tubes	Sand	-B	-P
31X-1	3–9	255.03	—	C	—	—	—	—
31X-2	3–9	256.53	C	—	—	—	—	—
32X-1	3–9	264.53	—	—	—	—	—	—
32X-2	3–9	266.03	—	—	—	—	—	—
32X-3	3–9	267.53	—	—	—	—	—	—
32X-4	3–9	269.03	A	—	—	—	—	—
33X-1	3–9	274.03	A	—	—	—	—	—
33X-2	3–9	275.53	A	—	—	—	—	—
33X-3	3–9	277.03	A-T	—	—	—	—	—
33X-4	3–9	278.53	A-T	—	—	—	—	—
33X-5	3–9	280.03	A-T	—	—	—	—	—
33X-6	3–9	281.53	R	—	—	—	—	—
33X-7	3–9	283.03	—	—	—	—	—	R
34X-1	3–9	283.53	C	—	—	—	—	—
34X-2	3–9	285.03	A-T	—	—	—	—	
34X-3	3–9	286.53	—	—	—	—	—	—
34X-4	3–9	288.03	A	—	—	—	—	—
34X-5	3–9	288.43	A	—	—	—	—	—
35X-1	3–9	293.03	—	—	—	C	—	R
35X-2	3–9	294.53	R	—	—	—	—	—
35X-3	3–9	296.03	A-T	—	—	—	—	—
35X-4	3–9	297.53	A-T	—	—	—	—	—
35X-4	80–85	298.03	—	—	C-F	—	—	—
35X-5	3–9	299.03	—	—	—	—	—	—
35X-6	3–9	300.53	C	—	—	—	—	—
36X-1	3–8	302.53	R	—	—	—	—	—
36X-2	3–8	304.03	C	—	—	—	—	—
36X-3	3–8	305.53	R	—	—	—	—	—
36X-4	3–8	307.03	—	—	R-F	—	—	—
36X-6	3–8	310.03	—	—	C-?	—	—	—
37X-1	3–8	312.03	—	—	—	C	—	—
37X-2	3–8	313.53	C	—	—	—	—	—
37X-3	3–8	315.03	C	—	—	—	—	—
37CC		315.83	A	—	—	—	—	—
38X-1	3–8	321.53	—	—	—	C	—	—
38X-2	3–8	323.03	—	—	—	—	—	—
38X-3	3–8	324.53	—	—	—	—	—	—
38X-4	3–9	326.03	—	—	—	C	—	R
39X-1	3–7	331.03	—	—	—	C	—	—
40X-1	3–8	340.53	—	—	A-W	—	—	—
40X-2	1–6	342.02	—	—	—	—	—	—
40X-3	3–8	343.53	—	—	—	—	—	—
40X-4	53–58	345.53	—	—	—	—	—	—
40X-5	3–8	346.53	—	—	—	—	—	—
40X-6	60–65	348.60	C-T	—	—	—	—	—
40X-7	3–8	349.53	R	—	—	—	—	—
40CC	6–8	349.86	—	—	C-?	—	—	—
41X-1	2–7	350.02	R	—	—	—	—	—
41CC	0–8	350.40	R	—	—	—	—	—
42X-1	4–9	359.54	R	—	—	C	—	—
42X-3	3–8	362.53	—	—	—	—	—	R
42X-4	68–78	364.68	—	C	—	—	—	—
42X-5	46–54	365.96	R	—	—	C	—	—
42X-6	3–8	367.03	A-T	—	—	—	—	—
42X, CC	0–8	368.50	R	—	—	—	—	—
43X-1	3–9	369.03	R	—	—	—	—	—
43X-1	50–52	369.50	C	—	—	—	—	—
43X-2	3–9	370.52	R	—	—	—	—	—
43X-3	3–9	372.03	R	—	—	—	—	—
43X-4	3–9	373.53	—	C	C-W	—	—	—
43X-5	3–9	375.03	R	—	—	—	—	—
43X-6	3–9	376.53	—	—	—	—	—	—
43X, CC	0–8	378.30	R	—	—	—	—	—
44X-1	3–9	378.53	A	A	—	—	—	—
44X-2	3–9	380.03	C	C	—	—	—	—
44X-3	3–9	381.53	A-T	—	—	A	—	—
44X-4	3–9	383.03	R	—	—	—	—	—
44X-6	3–9	386.03	R	—	—	—	—	—
45X-1	3–9	388.03	—	—	—	A	—	—
45X-2	3–9	389.53	—	—	A-W	—	—	—
45X-3	3–9	391.03	—	—	—	—	—	—

Table 2 (continued).

Site 717C								
Core	Interval (cm)	Hole depth (mbsf)	Org.	Pyrite	Tubes	Sand	Foraminifers -B	Foraminifers -P
45X-4	3–9	392.53	—	—	—	—	—	—
45X-5	3–9	394.03	R	—	—	—	—	—
45X-6	3–9	395.53	—	—	—	—	—	—
46X-1	3–9	397.53	R	—	—	—	—	—
46X-2	3–9	399.03	—	—	—	—	—	—
46X-3	3–9	400.53	C	—	—	—	—	—
46X-4	3–9	402.53	C	—	—	—	—	—
46X, CC	3–9	402.87	—	C	C-W	—	—	—
47X-1	3–9	407.03	A-T	—	—	—	—	—
47X-2	3–9	408.53	—	—	—	—	—	—
47X-3	3–9	410.03	R	—	R	—	—	—
56X-3	3–8	495.45	—	C	C-W	—	? Tubes	—
56X-4	3–8	497.03	—	—	—	—	—	—
56X-5	3–8	498.53	—	—	—	—	—	—
56X-6	3–8	500.13	—	R	R-W	—	—	—
56X-7	3–8	501.53	—	—	—	—	—	—
57X-1	3–9	502.03	—	C	—	—	—	—
57X-2	3–9	503.53	—	C	C-W	—	? Tubes	?
57X-3	3–9	505.03	—	—	—	—	—	—
57X-4	3–9	506.53	—	C	C-W	—	—	—
57X-5	3–9	508.03	C-T	—	—	—	—	—
57X-6	3–9	509.53	—	—	—	—	—	—
58X-1	3–9	511.53	—	R	R-W	—	—	—
58X-2	3–9	513.03	C	—	—	—	—	—
58X-3	3–9	514.53	C-T	—	—	—	—	—
58X-4	3–9	516.03	—	C	C-W	—	—	—
58X-5	3–9	517.53	A-T	—	—	—	—	—
58CC		518.47	—	—	—	—	—	—
59X-1	3–9	521.03	R-T	—	—	—	—	—
59X-2	3–9	522.53	—	—	—	—	—	—
59X-3	3–9	524.03	C-T	—	—	—	—	—
59X-4	3–9	525.53	—	A	—	—	—	—
59X-5	3–9	527.03	—	A	C-W	—	—	—
59X-6	3–9	528.53	—	—	—	—	—	—
60X-1	2–8	530.53	A-T	—	—	—	—	—
60X-2	3–9	532.03	C-T	—	—	—	—	—
60X-3	13–19	533.63	—	—	—	C	—	—
62X-1	35–40	549.85	A-T	—	—	—	—	—
63X-2	3–8	560.53	A-T	—	—	C	—	R
63X-3	3–8	561.70	A-T	—	—	C	—	R
64X-1	3–8	568.53	—	—	—	—	—	—
64X-2	3–8	570.03	C	—	—	—	—	—
64X-3	3–8	571.53	A-T	—	—	—	—	—
64X-4	3–8	573.80	—	—	—	—	—	—
65X-1	3–8	578.03	A-T	—	—	—	—	—
65X-2	3–8	579.53	R	—	—	—	—	—
65X-3	3–9	581.03	R	—	—	—	—	—
65X-4	3–8	582.53	R	C	C-W	—	? Tubes	—
65X-5	3–8	584.03	—	—	—	—	A-**	R-Frags
65X-6	3–8	585.53	—	—	—	—	—	—
66X-1	6–11	587.56	C-T	—	—	—	—	—
66X-2	2–7	589.02	R-T	—	—	—	—	—
66X-3	4–9	590.54	—	R	R-W	—	—	—
66X-4	1–6	592.01	C-T	—	—	—	—	—
66X-5	3–8	593.53	—	R	R-W	—	—	—
68X-1	6–11	606.56	C-T	—	—	C	—	R
68X-2	3–8	608.03	—	—	—	—	—	R
47X-3	48–50	410.48	—	—	R	—	—	—
48X-1	10–15	416.60	R	C	C	—	—	—
48X-2	3–8	418.03	—	—	—	—	—	—
48X-3	3–8	419.53	A-T	A	—	—	—	—
48X-4	3–8	421.03	—	A	A-W	—	—	—
48X-5	3–8	422.53	R	C	A-F?	—	—	—
48X-6	3–8	424.03	A-T	—	—	—	—	—
49X-1	3–8	426.03	C	—	—	—	—	—
49X-1	138–140	427.38	—	—	—	—	VA-RW	VA-RW
49X-2	3–8	427.53	—	—	—	—	VA-RW	VA-RW
49X-3	3–8	429.03	—	—	—	—	—	—
49X-4	3–8	430.53	—	R	R-W	—	—	—
49X-5	3–8	432.03	R-T	—	—	—	—	—
50X-1	3–8	435.53	—	—	—	—	—	—
50X-2	3–8	437.03	A-T	—	—	—	—	—
50X-3	3–8	438.53	—	—	—	—	—	—
50X-4	3–8	440.03	A-T	—	—	—	—	—
50X-5	3–8	441.53	—	—	—	—	—	—

Table 2 (continued).

Site 717C								
							Foraminifers	
Core	Interval (cm)	Hole depth (mbsf)	Org.	Pyrite	Tubes	Sand	-B	-P
50X-6	3–8	443.03	A-T	R	R-W	—	—	—
51X-1	3–8	445.03	—	—	—	—	—	—
51X-2	3–8	446.53	—	C	C-W	—	—	—
51X-3	3–8	448.03	—	C	C-W	—	—	—
51X-4	3–8	449.53	C-T	—	R-W	—	—	—
51X-5	3–8	450.83	—	C	C-W	—	—	—
52X-1	3–8	454.53	R	—	—	—	—	—
52X-2	4–7	456.04	—	—	—	—	—	—
52X-3	3–8	457.04	—	—	—	—	C-**	C-Frags
53X-1	3–9	464.03	—	R	R-W	C	—	—
53X-2	3–8	465.53	R	—	—	—	—	—
53X-3	3–8	467.03	A	—	—	—	—	—
53X-4	3–8	468.53	A-T	—	—	—	—	—
53X-5	3–8	470.03	C	R	R-W	—	—	—
53X-6	3–8	471.53	—	C	C-F	—	C-**	—
53X-7	3–8	473.03	C-T	—	—	—	—	—
54X-2	5–8	475.03	—	—	—	—	C-**	—
54X-3	2–7	476.52	—	A	—	—	—	—
54X-4	2–8	478.03	—	—	—	—	—	—
54X-5	2–8	479.53	A-T	—	—	—	—	—
54X-6	2–8	481.03	—	—	—	—	C-**	R
54X-7	2–8	482.53	—	—	—	—	—	—
55X-1	3–8	483.03	C	—	—	—	—	—
55X-2	3–8	484.53	—	C	C-W	—	—	—
55X-3	3–8	486.03	C-T	—	—	—	—	—
55CC	17–19	486.77	—	C	C-W	—	—	—
56X-1	3–8	492.53	C-T	—	—	—	—	—
56X-2	3–8	494.53	—	C	C-W	—	—	—
68X-3	3–8	609.53	—	—	—	—	—	—
68X-4	3–8	611.03	A-T	—	—	C	—	—
68X-5	8–13	612.58	A	—	—	—	—	—
68X-6	3–8	614.03	R-T	—	—	—	—	—
69X-1	20–25	616.20	R	—	—	R	—	—
69X-2	3–8	617.53	C-T	—	—	—	—	—
69X-3	3–8	619.03	A-T	—	—	—	—	—
69X, CC		620.12	A-T	—	—	C	—	—
70X-1	3–9	625.53	—	—	—	—	—	R
70X-2	3–9	627.53	—	—	—	—	—	—
70X-3	3–9	628.53	C-T	—	—	—	—	—
70X-4	3–9	630.03	C	C	—	—	—	—
70X-5	3–9	631.53	R	—	—	—	—	—
70X-6	3–9	633.03	—	—	—	—	C-**	C-Frags
71X-1	3–9	635.03	—	—	—	—	—	—
71X-2	3–9	636.53	—	—	—	—	—	—
71X-3	3–9	638.03	—	—	—	—	—	—
71X-4	3–9	639.53	C-T	—	—	—	—	—
71X-5	3–9	641.03	A-T	—	—	A	—	—
71X-6	3–9	642.53	C-T	—	—	—	—	R
72X-1	8–13	644.58	—	—	—	—	—	—
72X-3	3–9	647.53	—	—	—	—	—	—
73X, CC	3–9	656.21	—	—	—	—	—	—
74X-1	8–14	663.58	—	—	—	—	—	—
74CC		665.33	A-T	—	—	C	—	—
75X-1	5–10	673.05	C-T	—	—	—	—	—
75X-2	37–42	674.87	C-T	—	—	C	—	—
75X-3	3–9	676.03	—	—	—	—	—	—
75X-4	3–9	677.53	—	—	—	—	—	—
75CC		678.29	A-T	—	—	—	—	R
76X-1	3–9	682.53	C-T	—	—	R	—	—
76X-2	3–9	684.02	A-T	—	—	C	—	—
76X-2	50–52	684.50	A-T	—	—	C	—	—
76X-3	3–9	685.53	C-T	—	—	—	—	—
76X-4	3–9	687.03	C	—	—	A	—	—
77X-1	3–9	692.03	R	—	—	—	—	—
77X-2	3–9	693.53	—	—	—	—	—	—
77X-3	3–9	695.03	C-T	—	—	C	—	—
77X-4	3–9	696.53	R	R	R-W	—	—	—
77X-5	3–9	698.03	—	—	—	—	—	—
77X-6	3–9	699.53	—	—	—	—	—	—
77X-7	3–9	701.03	A-T	—	—	—	—	—
78X-1	17–21	701.67	—	R	R-W	—	—	—
78X-6	3–8	709.03	A-T	—	—	A	—	—
78X-7	3–8	710.53	C-T	—	—	—	—	—
79X-1	11–17	711.11	R-T	R	C-W	—	—	—
79X-2	14–19	712.64	C-T	—	—	—	—	—

Table 2 (continued).

Site 717C								
							Foraminifers	
Core	Interval (cm)	Hole depth (mbsf)	Org.	Pyrite	Tubes	Sand	-B	-P
79X-3	3–8	714.03	A-T	—	—	A	—	—
79X-4	3–8	715.53	—	—	—	—	—	—
79X-5	3–8	717.03	—	—	—	—	—	—
79X-6	3–8	718.53	A	—	—	A	—	—
80X-1	3–7	720.53	C-T	—	—	—	—	—
80X-2	9–13	722.09	—	—	—	—	—	—
80X-3	3–8	723.53	C-T	—	—	A	—	—
80X-4	2–8	725.02	—	—	—	—	—	—
80X, CC		725.18	—	—	—	—	—	—
81X, CC		730.93	A-T	—	—	A	—	R
83X-1	3–8	749.03	R	—	—	—	—	R
84X-1	10–15	758.60	—	—	—	—	—	—
84X-2	3–9	760.03	R-T	R	R-W	—	—	—
84X-3	13–18	761.63	A-T	—	—	—	—	—
85X-1	3–9	768.03	A-T	—	—	—	—	—
85X-2	3–9	769.53	R	—	—	A	—	—
85X-3	3–9	771.03	R	—	—	A	—	—
85X-4	3–9	772.53	R-T	—	—	—	—	—
85X-5	3–9	774.03	—	—	—	—	—	—
85X-6	3–9	775.53	A-T	—	—	—	—	—
86X, CC		777.87	C-T	—	—	A	—	—
87CC	11–16	790.11	R-T	—	—	—	—	—
88X-1	3–8	796.53	C	—	—	—	—	—
89X-1	3–9	806.03	—	—	—	—	—	—
90X-1	15–20	809.35	C-T	—	—	—	—	—
90X, CC	15–30	810.93	C-T	—	—	—	—	—
91X-1	10–14	818.80	—	—	—	—	—	—
91X-2	3–8	820.23	—	—	—	—	—	—
91X-3	3–8	821.73	—	—	—	—	—	—
91X-4	3–8	823.23	A-T	—	—	—	—	—

Site 718C								
							Foraminifers	
Core	Interval (cm)	Hole depth (mbsf)	Org.	Pyrite	Tubes	Sand	-B	-P
55X-2	3–9	523.83	A-T	—	—	A	—	—
56X-1	77–82	532.57	—	—	—	—	—	R
57X-3	31–36	544.61	C-T	—	—	—	—	R
59X-1	5–10	560.35	—	C	C-W	—	R	R
61X-1	48–50	579.78	A-T	—	—	—	—	R
62X-1	8–13	588.88	—	—	—	—	—	—
63-6	48–53	606.28	—	—	—	—	—	—
64X-1	3–8	607.11	—	—	—	—	—	—
65X-1	3–8	617.33	—	—	—	—	—	R
68X-2	44–49	647.76	C-T	—	—	—	—	—
67X-1	6–12	636.36	—	—	—	—	R	—
69X-1	69–71	655.99	R	—	—	—	—	—
90X-1	123–125	856.03	R	—	—	C	R	—
91X-1	30–35	864.60	R	C	—	—	—	—
94X-1	22–24	887.72	—	—	—	—	—	—
94X-3	77–79	891.27	—	—	—	—	—	R
98X, CC	32–35	925.82	—	—	—	—	—	R

sections, recent shallow-water forms such as *Ammonia beccarii* probably originating from the continental edge of India, are most prominent. However, in the 150- to 250-mbsf interval of Hole 717C, an extremely diverse reworked fauna occurs with all age ranges from Cretaceous to Holocene in sediments that are relatively carbonate-rich. It had been suggested (Cochran, Stow et al., 1989) that the carbonate-rich material came from a nearby seamount; however, these seamounts have no proven Cretaceous material while the Ninetyeast Ridge does have some Cretaceous material, fairly close to the Leg 116 drilling sites (McGowran, 1977), and we believe that this is the most likely source of most of the sediments in the 150- to 250-mbsf interval of Site 717. It is also possible that material has come from the west—the Chagos-Laccadive Ridge—but no Cretaceous is reported from there (McGowran, 1977).

The source of the reworked material in the 150- to 250-mbsf interval might be related to the deformation history of the area. It was suggested in a preliminary report that deformation started at about 7.5-8.0 Ma (Cochran, Stow et al., 1988). As long as the deformation (i.e., ridges uplifting) took place slowly, the sediment from the Bengal Fan could continue to override any gradual uplift, but if the ridge uplift accelerated it might have blocked off sediment supply from the north and allowed sediment from the east (the Ninetyeast Ridge) to be the dominant source. We believe this is what the 150- to 250-mbsf interval represents. Figure 2 (adapted from Fig. 24, p. 182, Cochran, Stow et al., 1989), shows the approximate position of these sediments, which corresponds with seismic unit III of Cochran, Stow et al. (1989). Chronostratigraphically this corresponds with mid-Pliocene to the base

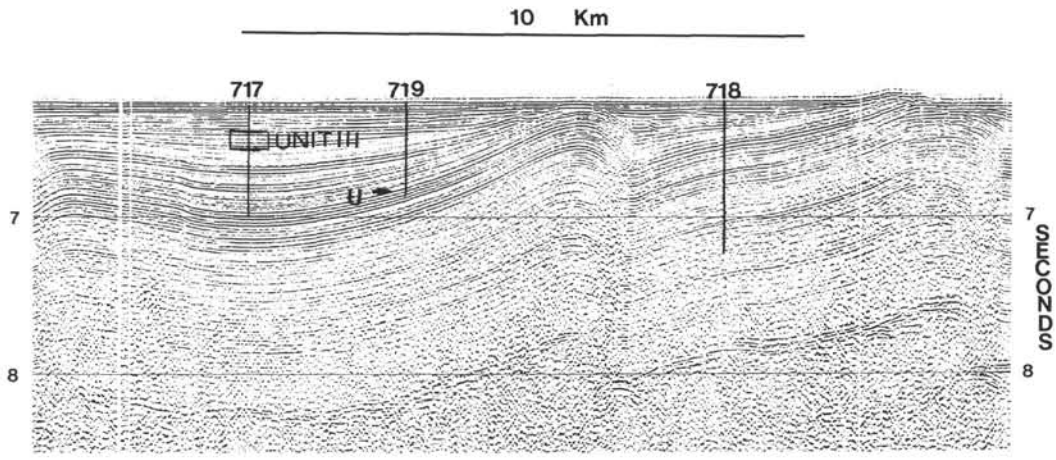

Figure 2. Seismic section across the Leg 116 area with Unit III (Cochran, Stow et al., 1989) indicated.

of the Pleistocene, apparently confirming the preliminary suggestion that accelerated deformation took place until 2 Ma. However, it also seems to indicate that this accelerated uplift was rather short in duration. This duration might be illusionary because sedimentation rates in the 150- to 250-mbsf interval might have been much lower than in the remainder of the section. This sediment unit also corresponds chronologically with the onset of Northern Hemisphere glaciation but does not continue into the Pleistocene, so we believe it is coincidental. In fact, there is probably continuous input from the east, but the usually high sediment input from the fan to the north may dilute the reworked fossils so as to make them nondetectable when the northern source is not cut off. Increased earthquakes during more rapid deformation may contribute to increased input from the Ninetyeast Ridge as well.

Further evidence of sediment blocking in this interval can be found in the seismic record itself. In this short interval, reflectors are definitely noncontinuous over the small deformation to the south of Site 717 in Figure 2. Other reflectors above and below also appear to pinch out but none so clearly as the interval marked Unit III in Figure 2.

We believe it is clear that the 150- to 250-mbsf interval represents a change in sediment supply that is probably related to intraplate deformation. However, it is difficult to identify the exact age because of poor biostratigraphic resolution.

Foraminifer-barren intervals dominate Site 717, but other elements occur in the sediments that can be useful. These can be terrestrial sediments, especially prominent in the lower half of Site 717C or in some cases sediments full of pyrite that is probably secondary in nature. Sieser (1978) identified several types of pyrite, including tubes as we see, from sediments in DSDP Leg 40. We saw few of the crystals of pyrite but many of the "worm" tubes that Siesser (1978) illustrates. The terrestrial organics can have only one source, the Ganges River, and their presence indicates a northern source for most of the sediments at Site 717.

ACKNOWLEDGMENTS

I. Kaczmarska participated in ODP Leg 116 and obtained these samples for us. C. Younger painstakingly processed all these samples so that they were easy to examine. We thankboth the scientific and drilling crews of Leg 116 for making this work possible. Funding came from a Collaborative Special Project grant (Natural Sciences and Engineering Research Council, Canada) to Scott, Kaczmarska, and Medioli.

REFERENCES

Cochran, J. R., Stow, D.A.V., et al., 1989. Intraplate deformation and Bengal Fan sedimentation: background and objectives. In Cochran, J. R., Stow, D.A.V., et al., *Proc. ODP, Init. Repts.*, 116: College Station, TX (Ocean Drilling Program), 3–12.

Corliss, B. H., 1979a. Recent deep-sea benthonic foraminifer distributions in the southeast Indian Ocean: inferred bottom-water routes and ecological implications. *Mar. Geol.*, 31:115–138.

_____, 1979b. Taxonomy of Recent deep-sea benthonic foraminifera from the southeast Indian Ocean. *Micropaleontology*, 25:1–19.

_____, 1983. Distribution of Holocene deep-sea benthonic foraminifera in the southwest Indian Ocean. *Deep-Sea Res.*, 30:95–117.

Curray, J. R., Emmel, F. J., Moore, D. G., and Raitt, R. W., 1982. Structure, tectonics and geological history of the northeastern Indian Ocean. *In* Nairn, A.E.M., and Stehli, F. G. (Eds.), *The Ocean Basins and Margins* (Vol. 6): New York (Plenum), 399–450.

Curray, J. R., and Moore, D. G., 1971. Growth of the Bengal deep-sea fan and denudation of the Himalayas. *Geol. Soc. Am. Bull.*, 82:563–572.

Gerakaris, J., 1986. Stereo techniques to enhance scanning photomacrography. *J. Biol. Photog.*, 54:123–126.

Kanaev, V. F., et al., 1977. *Indiiskii Okean bathymetric map on scale of 1:10,000*. Moscow (Academy of Sciences of the USSR, O.U. Schmidt Inst. of the Physics of the Earth and P. P. Shirshov Inst. of Oceanol. 4 sheets.

Lagoe, M. B., 1977. Recent benthic foraminifera from the central Arctic Ocean. *J. Foram. Res.*, 7:106–124.

Leg 116 Scientific Drilling Party, 1988. Scientists explore Himalayan uplift. *Geotimes*, 33:9–12.

McAdoo, D. C., and Sandwell, D. T., 1985. Folding of oceanic lithosphere. *J. Geophys. Res.*, 90:8563–8569.

McGowran, B., 1977. Maastrichtian to Eocene foraminiferal assemblages in the northern and eastern Indian Ocean region: correlations and historical patterns. *In* Heirtzler, J. R., et al. (Eds.), *Indian Ocean Geology and Biostratigraphy*: Washington (Am. Geophys. Union), 417–458.

Neprochnov, Y. P., Levchenko, O. V., Merklin, L. R., and Sedov, V. V., 1988. The structure and tectonics of the intraplate deformation area in the Indian Ocean. *Tectonophysics*, 156:89–106.

Peterson, L. C., 1984. Recent abyssal benthic foraminiferal biofacies of the eastern equatorial Indian Ocean. *Mar. Micropaleontol.*, 8:479–519.

Sclater, J. G., and Fisher, R. L., 1974. The evolution of the east central Indian Ocean with emphasis on the tectonic setting of the Ninety East Ridge. *Geol. Soc. Am. Bull.*, 85:638–702.

Scott, D. B., Mudie, P. J., deVernal, A., Hillaire-Marcel, C., Baki. V., MacKinnon, K. D., Medioli, F. S. and Mayer, L., 1989. Lithostratigraphy, biostratigraphy and stable isotope stratigraphy

of cores from ODP Leg 105 site surveys, Labrador Sea-Baffin Bay. *Proc. ODP, Sci. Results*, 105: College Station, TX (Ocean Drilling Program), 561–582.

Siesser, W. G., 1978. Petrography and geochemistry of pyrite and marcasite in Deep Sea Drilling Project Leg 40 sediments. *In* Bolli, H. M., Ryan, W.B.F., et al., *Init. Repts. DSDP*, Suppl. to Vols. 38, 39, 40, and 41: Washington (U.S. Govt. Printing Office), 767–775.

Warren, B. A., 1981a. Trans-Indian hydrographic section at Lat.18°S: property distributions and circulation in the southern Indian Ocean. *Deep-Sea Res.*, 28A:759–788.

_____, 1981b. Deep circulation in the world ocean. *In* Warren, B. A., and Wunsch, C. (Eds.), *Evolution of Physical Oceanography*. Cambridge (MIT Press), 6–42.

Zuber, M. T., 1987. Compression of oceanic lithosphere: an analysis of intraplate deformation in the central Indian Ocean. *J. Geophys. Res.*, 92:4817–4825.

Date of initial receipt: 16 March 1989
Date of acceptance: 30 November 1989
Ms 116B-127

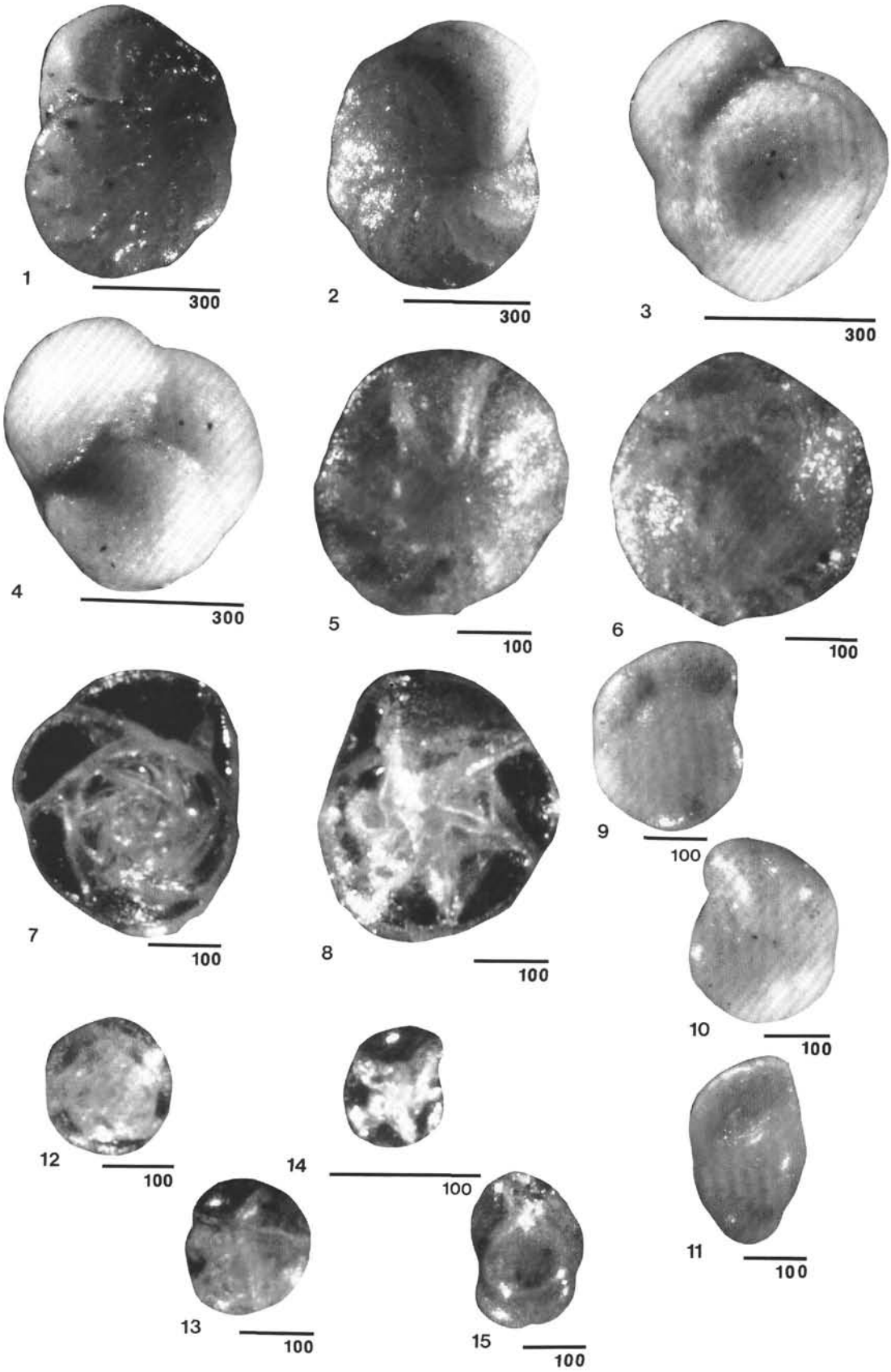

Plate 1. 1, 2. *Planulina wuellerstorfi*, **1.** ventral view, **2.** dorsal view; 3, 4. *Eggerella bradyi*, **3.** side view, **4.** apertural view; 5, 6. *Nuttallides umbonifera*, **5.** ventral view, **6.** dorsal view; 7, 8. *Epistominella exigua*, **7.** dorsal view, **8.** ventral view; 9–11. *Gyroidina soldanii*, **9.** dorsal view, **10.** ventral view, **11.** apertural view; 12, 13. *Eponides weddellensis*, **12.** dorsal views, **13.** ventral view; **14.** *Stetsonia horvathi*, ventral view; **15.** *Cassidulina subglobosum*, apertural view. Scale bars are in micrometers.