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5. FORAMINIFERAL BIOFACIES, PALEOENVIRONMENTS, AND BIOSTRATIGRAPHY OF NEOGENE–QUATERNARY SEDIMENTS, CASCADIA MARGIN[1]

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ABSTRACT

Five sites along the Cascadia accretionary wedge west of Vancouver Island and Oregon were investigated during Leg 146. Analyses of planktonic and benthic foraminifers provide information on the age, paleoceanography, and paleoenvironments of the sediments obtained along the margin. Upper Quaternary sediments, representing turbidites deposited in a lower bathyal environment under mainly cold surface waters, were recovered at Site 888. A discontinuous sequence of upper Pliocene through Quaternary abyssal plain and interslope basin sediments, deposited in lower bathyal through middle bathyal environments, was drilled at Sites 889/890. Surface water temperatures ranged from cool temperate during the Pliocene to cold during the Pleistocene. Site 891 contains Quaternary turbidites deposited in a lower bathyal environment beneath dominantly cold surface waters. A structurally complex series of lower bathyal sediments, indicative of a variety of ages ranging from Pleistocene to Miocene, and possibly Eocene, was recovered at Site 892.

INTRODUCTION

Drilling on Ocean Drilling Program (ODP) Leg 146 was aimed at investigating fluid flow and sediment deformation within the Cascadia accretionary wedge. Two regions were drilled along the Cascadia margin: three sites off Vancouver Island and two sites off Oregon (Fig. 1). The overall objectives of this leg were to define the budget, sources, and pathways of sediment, water, and dissolved chemicals within the accretionary wedge.

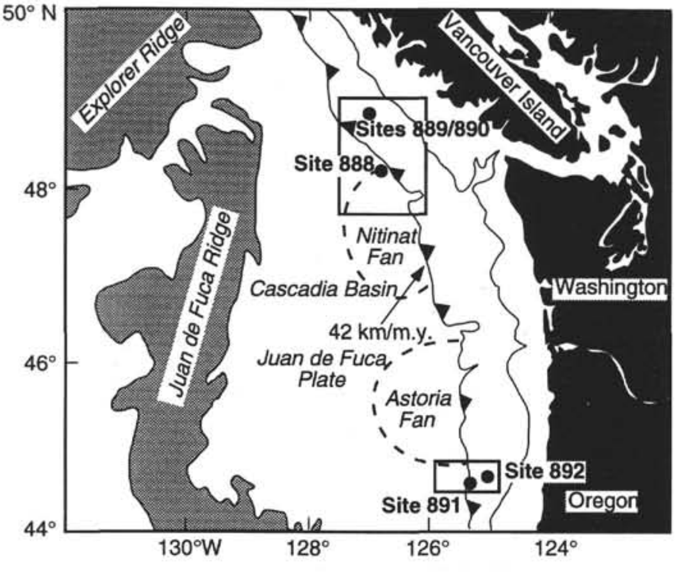

Figure 1. Map of the Cascadia Margin, showing the position of drilling sites off Vancouver Island and Oregon, convergence of the Juan de Fuca Plate, and major physiographic features in the Cascadia Basin.

Detailed age control and paleoenvironmental determinations are fundamental for understanding the geologic history of the Cascadia margin. Age control is essential for documenting the timing of deformational events, and paleobathymetric data can constrain the amount of vertical movement along the margin. Age determinations for Cascadia margin sites are based on the integration of magnetostratigraphy and foraminifer, radiolarian, and diatom biostratigraphy. Paleobathymetry is determined from paleoenvironmentally significant benthic foraminiferal biofacies. Planktonic foraminifers also provide insight into the paleoceanographic and paleoclimatic history of the margin.

This paper describes the distribution of foraminifers obtained on Leg 146. Specific objectives of the foraminiferal analyses are as follows: (1) characterize planktonic foraminiferal faunas in order to determine age relationships and provide insight into the paleoceanographic and paleoclimatic history of the Cascadia margin; and (2) document and analyze benthic foraminiferal assemblages in order to determine paleoenvironments and document changes in paleobathymetry along the margin.

METHODS

The following standard processing technique was used for extracting foraminifers. Approximately 10 cm^3 of sediment was boiled for 30 min in a 4% Calgon and water solution and then wet-sieved over a 63-µm screen. The solvent "Quaternary O" was used to wash indurated samples. The residue was dried in an oven, sieved at 149 µm, and at least 300 foraminifers were picked, abundance permitting. Fossiliferous samples were split with a microsplitter until one tray contained approximately 300 specimens. The fraction that measured between 63 and 149 µm was scanned.

Abundances of planktonic foraminifers are given in absolute counts of the faunas picked. Relative abundances of benthic foraminifers per sample are reported as follows: present (X) = 1 specimen, rare (R) = 2–9 specimens, few (F) = 10–24 specimens, common (C) = 25–74 specimens, and abundant (A) = 75 or more specimens.

Three classes of foraminifer preservation were used: G = good (>90% of the specimens were unbroken and well preserved); M= moderate (30–90% of the specimens were fragmented or showed evidence of dissolution and/or recrystallization); and P = poor (almost

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all of the specimens were fragmented and showed evidence of dissolution and/or recrystallization).

A comprehensive species list is provided in the Appendix. The faunas examined are well illustrated in several publications (Barker, 1960; Haller, 1980; Saito et al., 1981; Kennett and Srinivasan, 1983; Finger, 1990) and are therefore not further illustrated here. Taxonomy of planktonic species follows that of Saito et al. (1981), supplemented by Kennett and Srinivasan (1983).

Chronological Framework

Direct application of low-latitude zonations such as that of Blow (1969) is often difficult or inappropriate for the northeast Pacific Ocean because of the temperate nature of the faunas. Therefore, foraminifer age determinations on Leg 146 were constrained by the chronostratigraphic framework developed by Lagoe and Thompson (1988) for the temperate northeast Pacific (Fig. 2). This framework is based on planktonic foraminifer evolutionary datums (first and last occurrences) and paleoclimatically controlled shifts in *Neogloboquadrina pachyderma.* Lagoe and Thompson (1988) constructed a generalized coiling curve for the northeastern Pacific containing 16 correlative coiling intervals (CD = coiling dominance; Fig. 2). For the purposes of this study, the CD1 to CD7 zones of Lagoe and Thompson were grouped to represent a zone of high-frequency coiling shifts with mixed coiling directions from 367 ka to the present. Ages given by Lagoe and Thompson (1988) were converted to the time scale of Cande and Kent (1992) (see Shipboard Scientific Party, 1994a).

Age determinations based on coiling ratios of *N. pachyderma* are constrained by magnetostratigraphy and radiolarian biostratigraphy described in the *Initial Reports* for Leg 146 (Westbrook, Carson, Musgrave, et al., 1994) and additional microfossil studies (Caulet, this volume; Fourtanier, this volume).

Paleoenvironmental Analyses

Benthic foraminifers were examined to determine paleoenvironments and to infer paleobathymetry. Paleoenvironmental zonation was modified from Ingle (1980) as follows: inner neritic (0–50 m), outer neritic (50–150 m), upper bathyal (150–500 m), upper middle bathyal (500–1500 m), lower middle bathyal (1500–2000 m), lower bathyal (2000–4000 m), and abyssal (4000+). Minimum paleobathymetric estimations are based on the deepest dwelling faunas present in a sample, or in an interval of similar strata (e.g. turbidites).

It is necessary to distinguish paleoenvironmental terminology from terms describing physiography. Paleoenvironments are defined on the basis of benthic foraminifers characteristic of depth-related water masses. Terms indicating depositional environments (shelf, slope, abyssal plain) refer to physiographic features. Many of the sediments recovered during Leg 146 were deposited in an abyssal plain depositional environment, in the lower bathyal paleoenvironmental zone.

Lithostratigraphy and Structural Geology

Paleoenvironmental interpretations are derived from benthic foraminiferal biofacies (see below), but are also constrained by lithostratigraphic and structural data and interpretations. For each site, this paper provides a summary of the lithostratigraphy, interpretation of depositional environments, and relevant structural information derived from the site chapters of the *Initial Reports* for Leg 146 (Westbrook, Carson, Musgrave, et al., 1994).

VANCOUVER MARGIN: SITES 888, 889, AND 890

Site 888

Site 888 is located on the outer part of the Nitinat submarine fan, 7 km seaward of the accretionary wedge off Vancouver Island

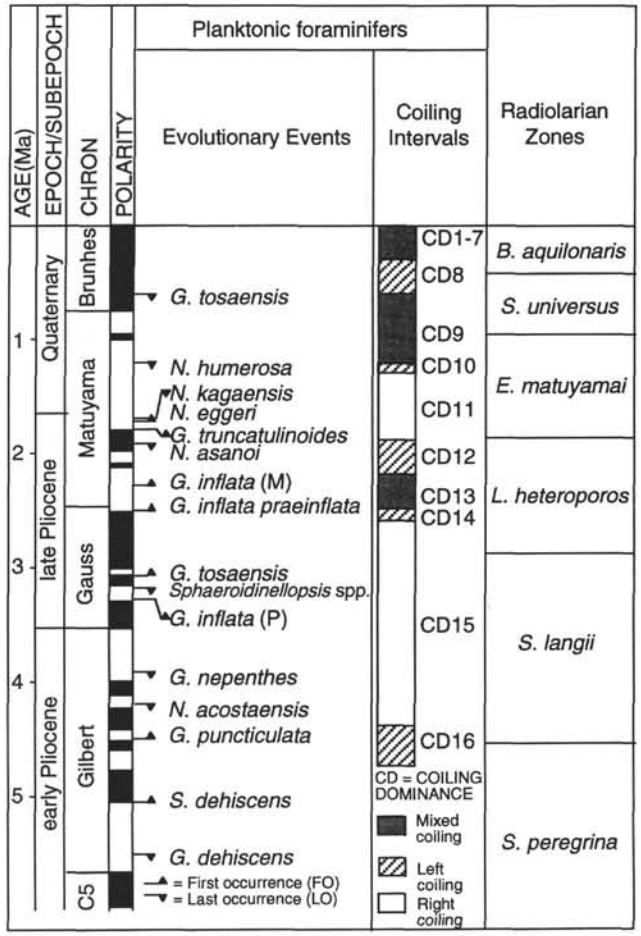

Figure 2. Correlation of radiolarian zones, planktonic foraminiferal evolutionary events, and coiling zones of *Neogloboquadrina pachyderma* as defined by Lagoe and Thompson (1988) to the magnetic polarity time scale of Cande and Kent (1992) (after Lagoe and Thompson, 1988, and Shipboard Scientific Party, 1994a).

(48°10.009'N, 126°39.794'W) at 2516 m below sea level (mbsl) (Fig. 1). This site was selected as a reference site for type, age, and physical properties of sediments that occur within the accretionary wedge.

Three lithostratigraphic units were recognized (Fig. 3). Lithostratigraphic Unit I (0–175.1 meters below seafloor, or mbsf) consists of interbedded clayey silts, medium-grained sands, with some thin beds containing pebbles, volcaniclastic fragments, and plant material. Below Unit I is a transitional zone, marked by an increase with depth in the amount of massive sand. Unit II (193.0–457.0 mbsf) contains poorly sorted, massive, fine- to medium-grained sand with interbeds of clayey silt. The lowest unit, Unit III (457.0–566.9 mbsf), consists of firm clayey silt and sand, laminated with thin interbeds of coarse sand and gravels.

Sediments at Site 888 are interpreted to be turbidites deposited as part of the Nitinat submarine fan system. Unit I represents deposition by low-energy, low-density turbidity currents on the outer or distal portion of the submarine fan. Sediments in Unit II are characteristic of deposition on the middle portion of a submarine fan. Lithostratigraphic Unit III is similar to Unit I, but appears to be more distal than Unit I (based on the amount of sand) and represents an abyssal plain depositional environment.

Planktonic Foraminifers

Moderately to well-preserved Quaternary planktonic foraminifers are rare to abundant in samples from Holes 888A and 888B (Table 1).

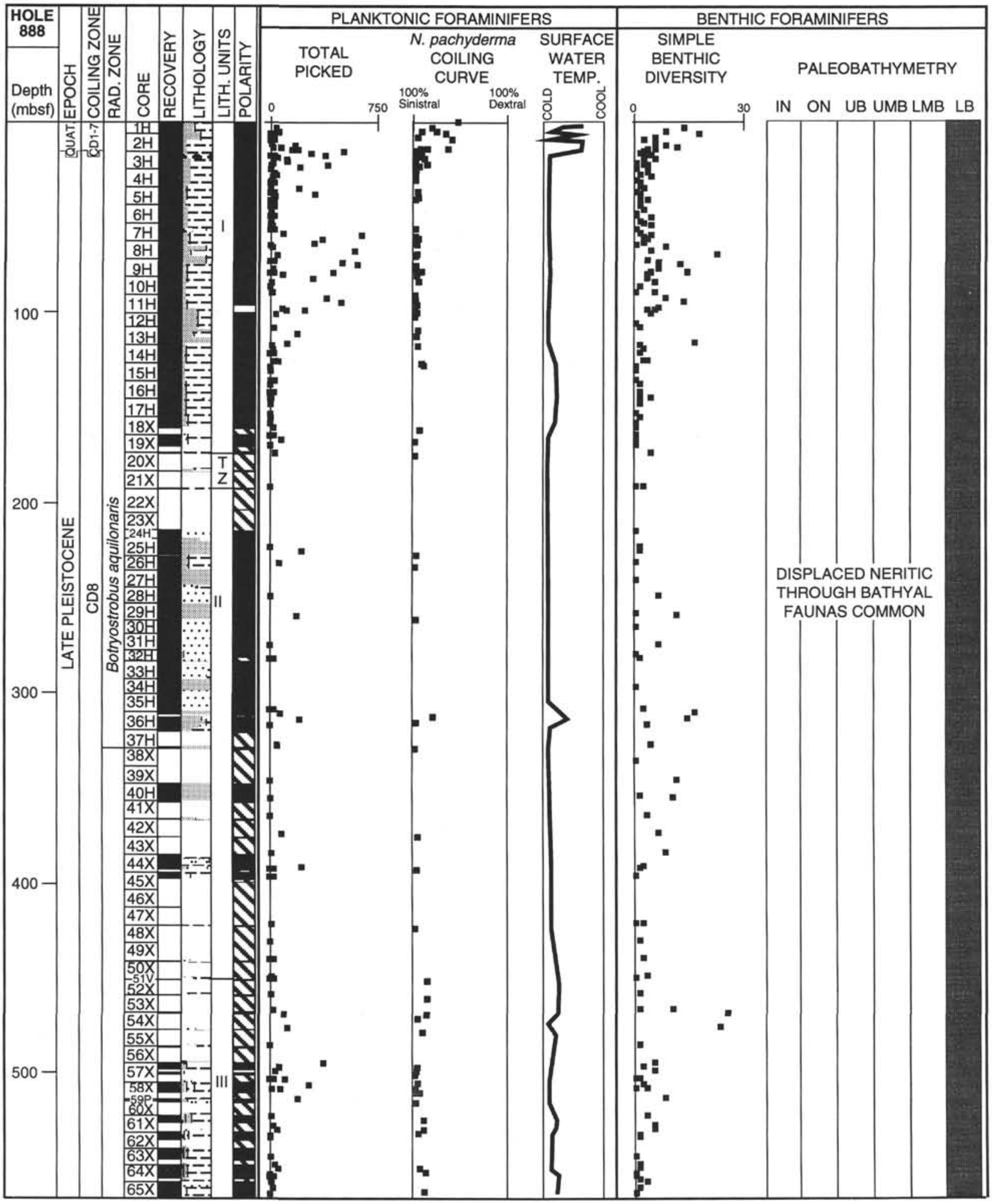

Figure 3. Summary of age zonation, core recovery, lithology, magnetic polarity, foraminiferal distributions, inferred sea-surface temperatures, and paleobathymetry at Site 888. Key to lithologic symbols: thin dashed pattern = silty clay and clayey silt; coarse stipple = silty sand and sandy silt; fine stipple = sand; thick dashed pattern = gravel. Key to polarity units: black = normal polarity; white = reversed polarity; diagonal = undetermined. TZ indicates a transition zone between lithologic Units I and II. See Shipboard Scientific Party (1994b) for radiolarian zonations and more detailed lithologic and paleomagnetic information.

Table 1. Checklist of foraminifers found at Site 888.

Core, section, interval (cm)	Depth (mbsf)	Barren samples = B	Preservation	Agglutinated spp. indeterminate	*Astrononion* sp.	*Bolivina argentea*	*Bolivina interjuncta*	*Bolivina pseudobeyrichi*	*Bolivina seminuda*	*Bolivina* spp.	*Bolivina subspinescens*	*Bolivina translucens*	*Bolvina spissa*	*Buccella frigida*	*Buccella tenerrima*	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina* spp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella elegantissima*	*Buliminella subfusiformis*	Calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina carinata*	*Cassidulina cushmani*	*Cassidulina limbata*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina* spp.	*Cassidulina teretis*	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Cassidulinoides cornuta*	*Chilostomella oolina*	*Chilostomella ovoidea*	*Cibicides* spp.
146-888A-																																							
1H-1, 9-14	0.1		G																																				
1H-3, 80-85	3.8		G			X			X				R	X		R		X		X	X			R			R	X	R	R		R							
1H-4, 116-121	5.7		G			R	R		F		F	F	R				R							F				R	R	C	R			R	R	F			
1H-5, 80-85	6.8		G	X								R						R												X					X	X		X	
1H-6, 107-113	8.6		G	R									X						R		X					X								X				X	X
1H-7, 12-17	9.1		G																																				
1H-CC	9.5		G			X			R					X	X			R						R	R				R	R				R				X	
146-888B-																																							
1H-CC	5.4		G					X	R			C													X					F						R			R
2H-1, 135-140	6.9		G																X						R													X	
2H-2, 98-103	8.0		G					R	C		F	F												F				X		C					R	F			
2H-3, 123-127	9.7		G	X							X												X	R															
2H-4, 125-132	11.3		G																																				
2H-5, 133-135	12.8		G						X																														
2H-6, 135-140	14.4		G																X					X													X		
2H-CC	15.0		G																											X									X
3H-1, 14-19	15.1		G	X									X								R									R		R							X
3H-1, 125-130	16.3		G	X																										R									
3H-2, 17-22	16.7		G	X																	X									R									
3H-2, 128-133	17.8		G																																				
3H-3, 31-36	18.3		G																													R							
3H-3, 118-123	19.2		G	X																																			
3H-4, 31-36	19.8		G	X																																			
3H-4, 88-93	20.4		G	X																																			
3H-5, 8-13	21.1		G																											R									
3H-5, 73-78	21.7		G									X																						X					
3H-6, 11-16	22.6		G	X																																			
3H-6, 83-88	23.3		G																																				
3H-7, 30-35	24.3		G	X																																			
3H-7, 57-62	24.6		G																																				
3H-CC	24.5		G																											R									
4H-1, 110-115	25.6		G														X													X									
4H-2, 102-106	27.0		G																																				
4H-3, 125-130	28.8		G																											X									
4H-4, 100-105	30.0		G																																				
4H-5, 66-72	31.2		G																											X									
4H-6, 124-129	33.3		G																																				
4H-CC	34.0		G																																				
5H-1, 8-14	34.1		G	X																																			
5H-2, 29-34	35.8		G																																				
5H-3, 46-52	37.5		G																					X															
5H-4, 25-30	38.8		G																																				
5H-5, 8-13	40.1		G															X																					
5H-6, 3-8	41.5		G	X																																			
5H-7, 3-9	43.0		G	X																																			
6H-1, 4-8	43.5		G	X																	X																		
6H-2, 4-9	45.0		G	X																																			
6H-3, 2-4	46.5		G	X																																			
6H-4, 1-6	48.0		G	X																																			
6H-5, 50-55	50.0		G																																				
6H-6, 86-91	51.9	B																																					
6H-CC	53.0		G																											X									X
7H-1, 111-116	54.1		G	X																																			
7H-2, 115-120	55.7		G																																				
7H-3, 84-89	56.9		G	X																										X									
7H-4, 135-140	58.9	B																																					
7H-5, 144-149	60.5		G																											R									
7H-6, 125-131	61.8		G																											C									
7H-CC	62.5		G																																				
8H-1, 146-151	64.0		G	X																																			
8H-2, 146-151	65.5		G																											X									
8H-3, 133-138	66.9		G																																				
8H-4, 129-135	68.3		G	X																										R									
8H-5, 146-151	70.0		G																											F									

Note: B = barren samples; see text for explanation of additional abbreviations.

Table 1 (continued).

Cibicidoides mckanni	*Cibicidoides* spp.	*Cibicidoides wuellerstorfi*	*Dorothia* sp.	*Eggerella bradyi*	*Elphidiella hannai*	*Elphidiella oregonense*	*Elphidium excavatum clavatum*	*Elphidium* spp.	*Epistominella exigua*	*Epistominella pacifica*	*Epistominella* sp.	*Eponides healdi*	*Fissurina* spp.	*Fursenkoina bradyi*	*Fursenkoina* sp.	*Glandulina laevigata*	*Globobulimina affinis*	*Globobulimina auriculata*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Gutulina* sp.	*Gyroidina soldanii altiformis*	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Hoeglundina elegans*	*Karrerriella* sp.	*Lagena* spp.	*Lenticulina* sp.	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	*Nonionella globosa*	*Nonionella miocenica*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia* sp.	*Pullenia bulloides*	*Pullenia salisburyi*	*Pyrgo* spp.	*Quinqueloculina* sp.	*Reophax* sp.	*Suggrunda* sp.	*Trichohyalus ornatissima*	*Trifarina angulosa*
		R																	R														X											
X										F												R	X		R		X					R					R							
							X						R	F	F		R		R		R		R		R								A		R							R		
														R					R																									
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										X									X													F												
		X			X		R	R		F									X	R				X											R					X				R
								X		X					F				R													A										R		
										X				X																	R												
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Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	*Triloculina* sp.	*Uvigerina dirupta*	*Uvigerina hispida*	*Uvigerina juncea*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Valvulineria araucana*	Simple Benthic Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia bermudezi*	*Globorotalia inflata*	*Globorotalia scitula*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina universa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
146-888A-																								
1H-1, 9-14	0.1	R							5	11	4		2						17	13	1		48	57
1H-3, 80-85	3.8					F	X		24	44	11		2	1			2		96	20			176	83
1H-4, 116-121	5.7					R			28	13	6								18	5			42	78
1H-5, 80-85	6.8							X	10														0	
1H-6, 107-113	8.6					X			11	30	4		1						40	1			76	98
1H-7, 12-17	9.1								3											2			2	
1H-CC	9.5				X	F			24	17	14		4				3		15	9		1	62	63
146-888B-																								
1H-CC	5.4								13	20							1		28	2			51	93
2H-1, 135-140	6.9			X		X			8	21	10		1				1		29	13		1	75	69
2H-2, 98-103	8.0								17														0	
2H-3, 123-127	9.7								5														0	
2H-4, 125-132	11.3								2														0	
2H-5, 133-135	12.8					X			5	6									5			2	11	
2H-6, 135-140	14.4	X							8	145	10	8	3				1		51	7			225	88
2H-CC	15.0								5	4							1		12	6			23	67
3H-1, 14-19	15.1					R			11	53	3								37	2			95	95
3H-1, 125-130	16.3								5	80			4				2		112	1			199	99
3H-2, 17-22	16.7								3	77	11	2	1						160	1			252	99
3H-2, 128-133	17.8	R							2	429	9	12	10				10		185	12	2		669	94
3H-3, 31-36	18.3								1	191	4		2				4		172				373	100
3H-3, 118-123	19.2								4	164	53	1	20				16		242	7		2	503	97
3H-4, 31-36	19.8					X			3														0	
3H-4, 88-93	20.4								2	52	2								10	1			65	91
3H-5, 8-13	21.1	X							2	92			1						54			10	147	100
3H-5, 73-78	21.7					X			5	5			3						14				22	100
3H-6, 11-16	22.6								2	79	16	2					4		44	6		1	151	88
3H-6, 83-88	23.3								0	11									12				23	100
3H-7, 30-35	24.3								2	225	35	3	6				2		242	10		3	523	96
3H-7, 57-62	24.6								0	4									3				7	
3H-CC	24.5								3														0	
4H-1, 110-115	25.6								3	56	10		3				6		195	1		2	271	99
4H-2, 102-106	27.0								0				1						1	1			3	
4H-3, 125-130	28.8								3	20		3							14				37	100
4H-4, 100-105	30.0								1	29									27				56	100
4H-5, 66-72	31.2								4	2			3						13				18	100
4H-6, 124-129	33.3								0	1			1				1		4				7	
4H-CC	34.0								1														0	
5H-1, 8-14	34.1								1	1												1	1	
5H-2, 29-34	35.8								1	1							1		1				3	
5H-3, 46-52	37.5								2	130	11								115	3		3	259	97
5H-4, 25-30	38.8								0										1				1	
5H-5, 8-13	40.1								1	203	13	3	2				3		180	6		2	410	97
5H-6, 3-8	41.5								1	21									20			1	41	100
5H-7, 3-9	43.0								1	1													1	
6H-1, 4-8	43.5								3	1									1				2	
6H-2, 4-9	45.0								1	3													3	
6H-3, 2-4	46.5								1														0	
6H-4, 1-6	48.0								2	1									3	1			5	
6H-5, 50-55	50.0								0	5		1							4				10	
6H-6, 86-91	51.9								0														0	
6H-CC	53.0								4														0	
7H-1, 111-116	54.1								1	2									3				5	
7H-2, 115-120	55.7	X							2	1									1	2		1	4	
7H-3, 84-89	56.9								4	2									17			1	19	100
7H-4, 135-140	58.9								0														0	
7H-5, 144-149	60.5								1	64		2	1						50				117	100
7H-6, 125-131	61.8								4	445	2	6	4				5		364	13		1	839	97
7H-CC	62.5								2														0	
8H-1, 146-151	64.0								3	233	4	2	3				7		227				476	100
8H-2, 146-151	65.5								2	156	8	1	1				4		228	4		2	402	98
8H-3, 133-138	66.9								0	2									2				4	
8H-4, 129-135	68.3								8	2	7								9			2	18	
8H-5, 146-151	70.0	X							4	452	1	5	3				1		308	5		2	775	

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Barren samples = B	Preservation	Agglutinated spp. indeterminate	*Astrononion* sp.	*Bolivina argentea*	*Bolivina interjuncta*	*Bolivina pseudobeyrichi*	*Bolivina seminuda*	*Bolivina* spp.	*Bolivina subspinescens*	*Bolivina translucens*	*Bolvina spissa*	*Buccella frigida*	*Buccella tenerrima*	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina* spp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella elegantissima*	*Buliminella subfusiformis*	Calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina carinata*	*Cassidulina cushmani*	*Cassidulina limbata*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina* spp.	*Cassidulina teretis*	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Cassidulinoides cornuta*	*Chilostomella oolina*	*Chilostomella ovoidea*	*Cibicides* spp.
8H-CC	71.7		G				X							R	X						R		X	R	R				X	F		X							R
9H-2, 136-142	74.9		G	X																																			
9H-3, 127-133	76.3		G	X																																			X
9H-4, 67-72	77.2		G	X															X		R																		
9H-5, 136-142	79.4		G	X																												R							R
9H-6, 137-143	80.9		G	X									X																	R									X
9H-CC	81.5		G																											X									X
10H-1, 46-50	82.0		G	X																					X					X									
10H-2, 135-140	84.4		G	X																																			
10H-4, 2-8	86.0		G	X										R											X														
10H-6, 2-7	89.1		G																						X														
10H-CC	91.5		G																			X			X					R									
11H-1, 62-66	91.6		G																																				
11H-3, 68-72	94.6		G																						X									R					X
11H-5, 4-8	96.9		G	X															X						X			R	R	F					X				X
11H-7, 2-6	99.9		G	X																										R									
11H-CC	101.0		G																						X					R		X							
12H-1, 73-77	101.2		G																											X									
12H-3, 4-8	103.5		G										X																										
12H-CC	108.6	B																																					
13H-1, 135-139	110.0		G																																				R
13H-4, 65-69	113.8		G	X	X	R	R		X	X			X	R	R			R	X	X	R	R		X	R			X		R	R	R		R					R
13H-CC	118.5		G							R				X	R						R						X			R				R					F
14H-1, 106-110	119.2		G																																				
14H-3, 4-8	121.1		G	X																																	X		
14H-4, 73-77	123.3		G	X																																			
14H-CC	127.9		G																															X					
15H-1, 59-63	128.2		G	X																																			
15H-3, 2-6	130.6		G																																				
15H-4, 52-56	132.6		G																																				
15H-CC	137.6		G																																				
16H-1, 85-89	138.0		G																																				
16H-3, 6-10	140.2		G	X																																			
16H-5, 69-73	143.8		G																																				
16H-CC	147.0		G																											X									
17H-1, 85-90	147.5		G	X																																			
17H-3, 98-103	150.6		G	X																																			
17H-CC	155.8		G																																				
18X-2, 5-9	157.7		G	X																																			
18X-4, 4-8	160.6		G																																				
18X-CC	162.4		G																																				
19X-1, 137-141	167.0	B																																					
19X-3, 24-28	168.9		G																																				
19X-CC	172.0		G																																				
20X-CC	176.0		G																																				
21X-CC	194.1	B																																					
22X-CC	194.2		M																																				
24H-CC	217.4	B																																					
25H-CC	226.0		G																																				
26H-1, 93-98	227.8		G	X																																			
26H-CC	234.1		G																																				
27H-CC	243.3	B																																					
28H-CC	251.8		G																			X	X																
29H-CC	260.8	B																																					
30H-1, 89-93	261.7		G															R												R									R
30H-CC	267.8	B																																					
31H-CC	276.9		G											X																									
32H-CC	282.8	B																																					
33H-2, 2-8	284.1		G																																				X
34H-CC	300.5	B																																					
35H-CC	311.1		M																													X							
36H-4, 45-50	313.2		M	F														R				R																	R
36H-6, 40-44	316.1		G	X													F	C			R														R				
36H-CC	319.8		G											X																									
37H-CC	329.7		G								R							R												C									

Table 1 (continued).

Cibicidoides mckanni	*Cibicidoides* spp.	*Cibicidoides wuellerstorfi*	*Dorothia* sp.	*Eggerella bradyi*	*Elphidiella hannai*	*Elphidiella oregonense*	*Elphidium excavatum clavatum*	*Elphidium* spp.	*Epistominella exigua*	*Epistominella pacifica*	*Epistominella* sp.	*Eponides healdi*	*Fissurina* spp.	*Fursenkoina bradyi*	*Fursenkoina* sp.	*Glandulina laevigata*	*Globobulimina affinis*	*Globobulimina auriculata*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Guttulina* sp.	*Gyroidina soldanii altiformis*	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Hoeglundina elegans*	*Karreriella* sp.	*Lagena* spp.	*Lenticulina* sp.	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	*Nonionella globosa*	*Nonionella miocenica*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia* sp.	*Pullenia bulloides*	*Pullenia salisburyi*	*Pyrgo* spp.	*Quinqueloculina* sp.	*Reophax* sp.	*Suggrunda* sp.	*Trichohyalus ornatissima*	*Trifarina angulosa*
X							F			C					X				R														R	R						X				X
									X	X																																		
		X																														X								R				
		X													X							X								R							R			R				
							R				X	R																																
							R			X					R															X			X		X					X				
							R			R																																		
																																								R				
								X		R																																		
							X			R																																		
		R								R																																		X
		R								R		X			X																													
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															R																	R												
															R																	R												
								X		X																																		
	R	X					F	R		C			X													X	X						R	F					X	X				X
				X			F	R		C										X																				R			X	
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		R													R		R					R	R							R							R							
										X												X								X										X				
										X																																		
R										X		R	X			R			R				R											R			F	X						
	R	R										R							R				R												F									
										X																																		

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	*Triloculina* sp.	*Uvigerina dirupta*	*Uvigerina hispida*	*Uvigerina juncea*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Valvulineria araucana*	Simple Benthic Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia bermudezi*	*Globorotalia inflata*	*Globorotalia scitula*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina universa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
8H-CC	71.7		X			R			22	18			5						43			1?	66	98
9H-2, 136-142	74.9								3	1												1	1	100
9H-3, 127-133	76.3	X							6	307	7	2					4		335	5	1		661	
9H-4, 67-72	77.2	R					R	R	12	367	2		6						421	4		3	800	99
9H-5, 136-142	79.4								6	12									14	1			27	99
9H-6, 137-143	80.9					R	X	R	14	303	1	2	13						253	5		4	577	93
9H-CC	81.5								4														0	98
10H-1, 46-50	82.0								3	66			1						52	1		2	120	
10H-2, 135-140	84.4	R							3	184	16		8				10		172	7		2	397	98
10H-4, 2-8	86.0								5	7									8				15	96
10H-6, 2-7	89.1								1										3				3	
10H-CC	91.5								5	8			1						13				22	
11H-1, 62-66	91.6								0	5			1						7				13	100
11H-3, 68-72	94.6	R					R		8	249	1		3						263	1		4	517	
11H-5, 4-8	96.9	R							13	235	1	1	10				4		396	8		3	655	100
11H-7, 2-6	99.9								6	31	1		1						79			2	112	98
11H-CC	101.0								5	75	1	1	8						225	5			315	100
12H-1, 73-77	101.2								3	93									54			1	147	98
12H-3, 4-8	103.5							X	4	5									46				51	100
12H-CC	108.6								0														0	100
13H-1, 135-139	110.0								1	7									29	1			37	
13H-4, 65-69	113.8		R			C			37	67	3	1							177	3			251	97
13H-CC	118.5					F			16	64	1	1							89	3	1?		158	98
14H-1, 106-110	119.2								1	1	1				17								19	97
14H-3, 4-8	121.1								2	4	4				7		8		4	1			28	
14H-4, 73-77	123.3								1										1				1	
14H-CC	127.9								3	10	10		3		6		18		27	2			76	
15H-1, 59-63	128.2								2	9	7				2		5		10	1			34	93
15H-3, 2-6	130.6								0										2				2	91
15H-4, 52-56	132.6								0	1							1		2	2			6	
15H-CC	137.6								0	14	14						4		5	3			40	
16H-1, 85-89	138.0								0	2							2		1				5	
16H-3, 6-10	140.2								1	1									2				3	
16H-5, 69-73	143.8								1										1				1	
16H-CC	147.0					X			4	3	2		2						2				9	
17H-1, 85-90	147.5								1										3	1			4	
17H-3, 98-103	150.6								1	1	2				2				1				6	
17H-CC	155.8								0	1									1				2	
18X-2, 5-9	157.7								1	2									2	1			5	
18X-4, 4-8	160.6								0										2				2	
18X-CC	162.4								0	10	1						2	1?	19	1			33	
19X-1, 137-141	167.0								0														0	95
19X-3, 24-28	168.9								0	24	5	2			2				72				105	
19X-CC	172.0								0	1									1				2	100
20X-CC	176.0								4	10									37				47	
21X-CC	194.1								0														0	100
22X-CC	194.2								2	1	1								1				3	
24H-CC	217.4								0														0	
25H-CC	226.0								1	1							1		2				4	
26H-1, 93-98	227.8								1	47	7		1		7		1		222	4			289	
26H-CC	234.1								0	18	5					2?		1?	62				85	98
27H-CC	243.3								0														0	100
28H-CC	251.8								6	3	1								3				7	
29H-CC	260.8								0														0	
30H-1, 89-93	261.7						R		11	10									235	3		1	248	
30H-CC	267.8								0														0	99
31H-CC	276.9					X			6	1	1								1				3	
32H-CC	282.8								0														0	
33H-2, 2-8	284.1								1														0	
34H-CC	300.5								0														0	
35H-CC	311.1								2										1				1	
36H-4, 45-50	313.2						C	C	16	37	18		3				1		31	7		2	97	
36H-6, 40-44	316.1					R	F	R	14	52	11		4				2		203	2		4	274	82
36H-CC	319.8					X			3										4				4	99
37H-CC	329.7							R	4						30				40				70	

100

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	Barren samples = B	Preservation	Agglutinated spp. indeterminate	*Astrononion* sp.	*Bolivina argentea*	*Bolivina interjuncta*	*Bolivina pseudobeyrichi*	*Bolivina seminuda*	*Bolivina* spp.	*Bolivina subspinescens*	*Bolivina translucens*	*Bolvina spissa*	*Buccella frigida*	*Buccella tenerrima*	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina* spp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella elegantissima*	*Buliminella subfusiformis*	Calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina carinata*	*Cassidulina cushmani*	*Cassidulina limbata*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina* spp.	*Cassidulina teretis*	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Cassidulinoides cornuta*	*Chilostomella oolina*	*Chilostomella ovoidea*	*Cibicides* spp.
38H-CC	338.5	B																																					
40H-1, 40-46	348.4		G							X			X								R															X			
40X-CC	357.0		G																											X									
41X-CC	357.9		M												X									R					X										
42X-1, 34-40	366.8		G																											X									
43X-CC	376.0		M															F								X				F									
44X-1, 124-130	386.7		G																					X						R									
44X-CC	393.7		G																											C			X						
45X-1, 34-40	395.3		G	X																																			
45X-CC	398.7	B																																					
47X-CC	423.5	B																																					
48X-CC	423.8		G																																				
49X-CC	433.0		G																											X									
50X-CC	442.8		M	X																					X														
51V-CC	452.1		G																																			X	
52X-CC	452.5	B																																					
53X-CC, 36-42	460.9		G	X																																			
53X-CC	469.4		G																																				
54X-1, 2-8	469.4		G	X																	X				X					R									
54X-CC	471.5		M	X									R	X	X					R	R			X	R	X			R										R
55X-CC	478.7		G										X	R			X	R		X	R	X		X						R				X			R		R
56X-CC	488.1		M																										X										
57X-1, 104-110	497.2		G																		X														R		R		X
57X-2, 105-111	498.8		G										X																										
57X-CC	501.3		G										X																	R									
58X-1, 18-23	505.3		G																													X							
58X-1, 60-65	505.7	B																																					
58X-2, 135-140	508.0		G																																				
58X-4, 52-57	510.2		G	X																																			
58X-CC	510.7		G																																				
60X-CC	515.8		G																																				R
61X-2, 38-44	524.7		G																						R														
61X-CC	529.6		G	X																X																			
62X-1, 36-41	532.1		G	X																										X									
62X-3, 63-68	535.1		G	X																																			
62X-CC	536.1		G																																				
63X-CC	546.6		G																																				
64X-1, 92-98	550.1		G																																				
64X-3, 33-39	552.5		G	X																																			
64X-5, 24-30	555.4		G																																				
64X-CC	556.6		G																																				
65X-1, 37-43	558.5		G	X																																			
65X-2, 43-48	560.0		G	X																										X									
65X-4, 51-56	563.1		G	X																																			
65X-CC	566.3		G																																				

Thirty samples are barren of planktonic foraminifers. The abundance of planktonic foraminifers fluctuates, with the greatest abundances in the top 100 m of the sequence (Fig. 3). The planktonic assemblages are characterized by significant percentages of *Globigerina bulloides, N. pachyderma* (sinistral), *Globigerina quinqueloba,* and *Globorotalia scitula,* with scattered or rare occurrences of the other taxa listed in Table 1.

Coiling ratios between sinistral and dextral *N. pachyderma* are used in conjunction with radiolarian distributions and paleomagnetic results (Shipboard Scientific Party, 1994a) to provide age determinations for Site 888. Samples in the top 15 m of Site 888 contain mixed assemblages of *N. pachyderma* with coiling ratios fluctuating between 57% to 98% sinistral (Fig. 3). The mixed coiling, presence of radiolarians of the *Botryostrobus aquilonaris* Zone of Hays (1970), and normal magnetic polarity indicate an assignment to the CD1-7 coiling dominance zones (Fig. 2), that is, younger than 367 ka. Throughout the rest of Hole 888B (from 15 to 567 mbsf), coiling ratios indicate a dominance of *N. pachyderma* (sinistral). Dominant sinistral *N. pachyderma,* the presence of radiolarians of the *B. aquilonaris* Zone, and normal magnetic polarity for the sediments (Shipboard Scientific Party, 1994b) give an assignment to the CD8 coiling dominance zone with a maximum age of 600 ka.

These age assignments yield quite different bulk accumulation rates for sediments deposited at Site 888. The upper 15 m was deposited at a rate of 0.4 m/1000 yr, whereas the remainder of the sediments at this site were deposited at rate of 2 m/1000 yr. Because the

Table 1 (continued).

Cibicidoides mckanni	*Cibicidoides* spp.	*Cibicidoides wuellerstorfi*	*Dorothia* sp.	*Eggerella bradyi*	*Elphidiella hannai*	*Elphidiella oregonense*	*Elphidium excavatum clavatum*	*Elphidium* spp.	*Epistominella exigua*	*Epistominella pacifica*	*Epistominella* sp.	*Eponides healdi*	*Fissurina* spp.	*Fursenkoina bradyi*	*Fursenkoina* sp.	*Glandulina laevigata*	*Globobulimina affinis*	*Globobulimina auriculata*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Guttulina* sp.	*Gyroidina soldanii altiformis*	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Hoeglundina elegans*	*Karreriella* sp.	*Lagena* spp.	*Lenticulina* sp.	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	*Nonionella globosa*	*Nonionella miocenica*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia* sp.	*Pullenia bulloides*	*Pullenia salisburyi*	*Pyrgo* spp.	*Quinqueloculina* sp.	*Reophax* sp.	*Suggrunda* sp.	*Trichohyalus ornatissima*	*Trifarina angulosa*
								X		R											X												X	R										
					R		R			C									X														X				X							
										R																														X				
																			R														X											
						X	X			R																		X																
					X	X																																						
					X		R																																					
										R																																		
							R	R		R																							X							X				
R			R							F										R		X	F								X			X	R					R				R
		X								C												X												X	X		X		X	X				
														X																														
										R																														X				
					X										X																													
								R																											X									
		R					X						X									X	X							R														
										X																	X																	
										R																																		
										X									X																					X				
										X																																		
																																	X											

age at the bottom of the cored section is a maximum estimate and rates were not calculated on decompacted sections, these accumulation rates represent minimum values.

Planktonic foraminifers can provide insight into the Quaternary paleoceanography along the Cascadia margin. Site 888 is located below the divergence of the North Pacific current into the northward-flowing Alaska Current and the southward-flowing California current (Ingle, 1973; Kennett, 1982). Dominantly sinistral populations of *N. pachyderma* from 567 to 15 mbsf indicate cold sea-surface temperatures (~4°–12°C). Planktonic assemblages within this interval (Table 1) are characteristic of Holocene and Pleistocene water masses associated with the Alaska Current system (Ingle, 1973). Sea-surface temperatures in the upper 15 m at this site fluctuated between cold and cool-temperate (12°–20°C) as indicated by fluctuating abundances of dextral *N. pachyderma*. These cool-temperate faunas are more indicative of water masses associated with the California Current system. The high-frequency changes in coiling ratios are due to regional cooling and warming during the past 367 ka and may also reflect migration of the position of the eastward-flowing North Pacific Current.

Benthic Foraminifers

Benthic foraminifers are rare to abundant in 134 samples from the sequence cored at Site 888; 39 samples are barren of benthic foraminifers. Eighty-eight species or species groups were identified (Table 1).

The patchy distribution of benthic foraminifers at Site 888 is consistent with the turbidite origin of the sediments (Fig. 3). Sandy samples from this site are barren or contain sparse faunas and finer

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	*Triloculina* sp.	*Uvigerina dirupta*	*Uvigerina hispida*	*Uvigerina juncea*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Valvulineria araucana*	Simple Benthic Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia bermudezi*	*Globorotalia inflata*	*Globorotalia scitula*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina universa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
38H-CC	338.5								0														0	
40H-1, 40-46	348.4					R	X		11	1									3				4	
40X-CC	357.0								1														0	
41X-CC	357.9					F			10	5									2				7	
42X-1, 34-40	366.8								3										2				2	
43X-CC	376.0							R	6	14	18		1		6		1		68	2			110	97
44X-1, 124-130	386.7		X			X			8	5	1								8				14	
44X-CC	393.7								2	28		1	2		2		1		255	5			294	98
45X-1, 34-40	395.3								1	1													1	
45X-CC	398.7								0														0	
47X-CC	423.5								0														0	
48X-CC	423.8								2	1									11				12	100
49X-CC	433.0								1	3									1				4	
50X-CC	442.8								2										1				1	
51V-CC	452.1								3	4	2								7	1			14	88
52X-CC	452.5								0														0	
53X-CC, 36-42	460.9								1	2			1						7	1			11	88
53X-CC	469.4								1														0	
54X-1, 2-8	469.4					R			10	3	1								22	3		2	29	88
54X-CC	471.5			X		F	R		25	86	4		2			1	1		32	1	2		129	97
55X-CC	478.7					X	X	R	23	34	9					2		2	105	9		1	161	92
56X-CC	488.1								1										1	1			2	
57X-1, 104-110	497.2								5	153	10	1	4				2		312	8		3	490	98
57X-2, 105-111	498.8					X			2	26	2								55	1			84	98
57X-CC	501.3						X		5	18	2	1							29				50	100
58X-1, 18-23	505.3								1	29	1		1						106	3		1	140	97
58X-1, 60-65	505.7								0														0	
58X-2, 135-140	508.0								2	78	10		1				4		266	1		4	360	100
58X-4, 52-57	510.2								3	27	3	1					2		59	3		1	95	95
58X-CC	510.7								0	2	2								16				20	100
60X-CC	515.8					R			8	112	24	7							111	1			255	99
61X-2, 38-44	524.7								3	4			1						10	1			16	91
61X-CC	529.6					R		X	5	5	1		4				1		20	2			33	91
62X-1, 36-41	532.1								5	7	1		2				2		54	2		10	68	96
62X-3, 63-68	535.1								1										7				7	
62X-CC	536.1					X			1		1								6				7	
63X-CC	546.6								0	1	1								7				9	
64X-1, 92-98	550.1								1	4	3								37	2			46	95
64X-3, 33-39	552.5								1	34									40	5			79	89
64X-5, 24-30	555.4								0	1									1				2	
64X-CC	556.6								0										1				1	
65X-1, 37-43	558.5								1	2									6	2			10	
65X-2, 43-48	560.0								3	4	3								9				16	
65X-4, 51-56	563.1								1	5	1								19	2			27	90
65X-CC	566.3								0										2				2	

grained lithologies, representing the upper portions of turbidites, contain common to abundant, moderate-diversity foraminiferal faunas. Most samples contain a large component of faunas transported downslope that are mixed with in situ species.

Assemblages of benthic foraminifers can be generalized into two types based on abundances and simple benthic diversity. Simple benthic diversity is the total number of different species or species groups in a sample. The first assemblage type is characterized by low diversity and low abundances; these samples often contain only broken unilocular agglutinated foraminifers. The second type of assemblage consists of common to abundant benthic foraminifers with higher diversities.

Q-mode cluster analysis was performed on samples from Site 888 that contained common to abundant benthic foraminifers in order to classify these samples based on their contained faunas and to further characterize the paleoenvironmental history of this site. Thirty-three species in 39 samples were analyzed using the Cosine Theta similarity measure and an unweighted pair group method of averaging (UWPGMA). For all cluster analyses in this report, estimates of benthic abundances were converted to semiquantitative values (X = 1, R = 6, F = 20, C = 50, A = 75). The resulting dendrogram consists of three groups, A, B, and C; group B can be further divided into cluster subgroups B1 and B2 (Fig. 4A). Figure 4B shows the stratigraphic distribution of the samples in each cluster along with the distribution of barren samples and those not included in the cluster analysis.

In order to determine the paleoenvironmental significance of the cluster groups and subgroups, it is necessary to identify the taxa that differentiate each cluster group. A measure called the preference index (PI) (M.B. Lagoe, pers. comm., 1994) is used to emphasize taxa that are more common in samples within the cluster as compared to the total data set. The PI for a taxon is the ratio between the mean abundance of the taxon in the cluster group (MAc) to the mean abun-

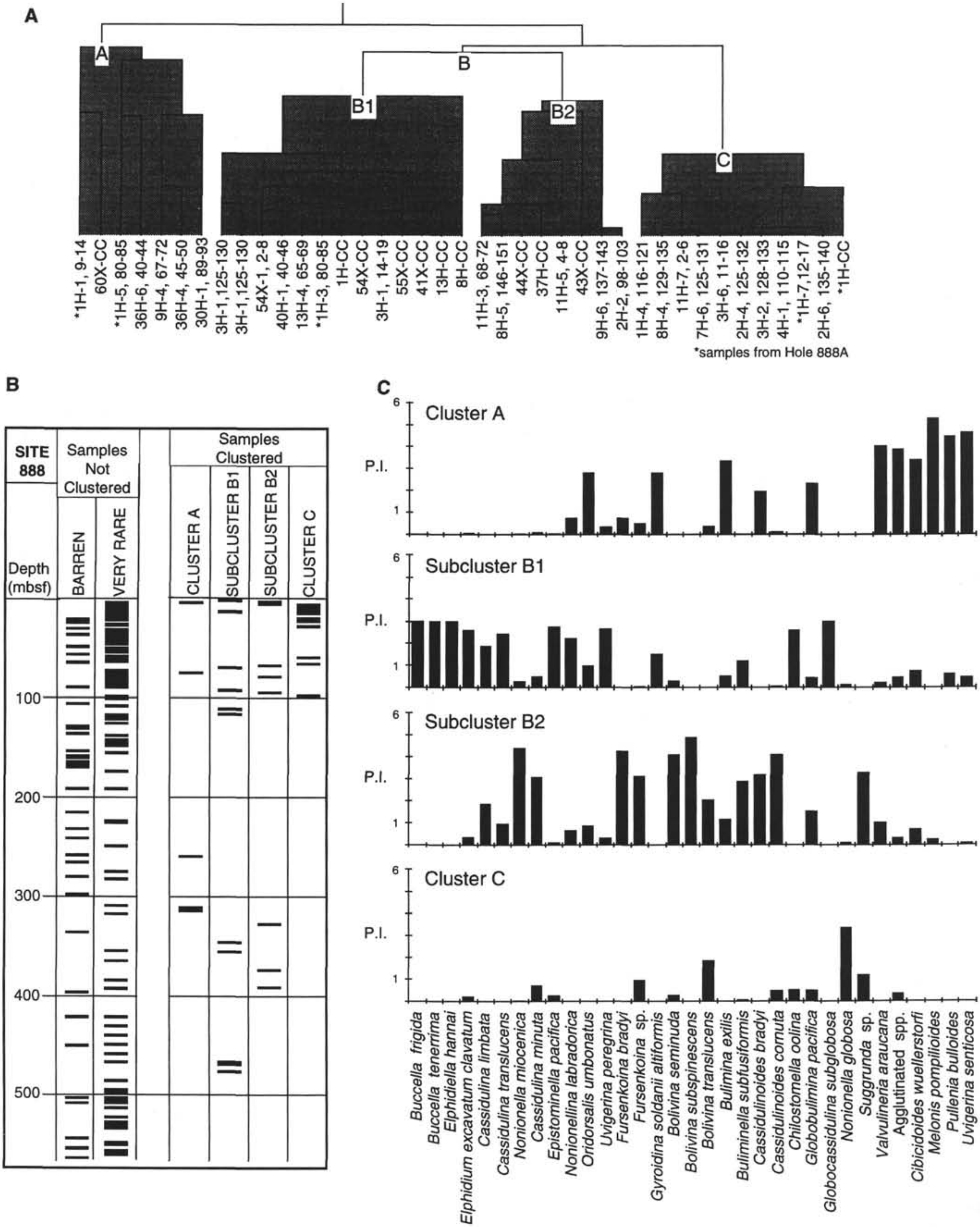

Figure 4. Results of cluster analysis on benthic foraminifers from Site 888. **A.** Dendrogram. **B.** Stratigraphic distribution of clustered and nonclustered samples. **C.** Preference indexes for taxa analyzed by cluster analysis (see text).

Table 2. Checklist of foraminifers found at Hole 889A.

Core, section, interval (cm)	Depth (mbsf)	Preservation	Agglutinated spp. indeterminate	*Bolivina argentea*	*Bolivina interjuncta*	*Bolivina pseudobeyrichi*	*Bolivina seminuda*	*Bolivina* spp.	*Bolivina translucens*	*Bolivinita quadrilatera*	*Bolvina spissa*	*Buccella frigida*	*Buccella tenerrima*	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina fossa*	*Bulimina* spp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella subfusiformis*	Calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina carinata*	*Cassidulina cushmani*	*Cassidulina limbata*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina* spp.	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Cassidulinoides cornuta*	*Chilostomella oolina*	*Chilostomella ovoidea*	*Cibicides* spp.	*Cibicidoides mckanni*	*Cibicidoides wuellerstorfi*	*Dentalina* spp.
146-889A-																																							
1H-CC	30.2	G			R		R	R			R					R		X	R	R		F						R	F		X				R	X		X	
2H-CC	39.9	M		R	R						F										F	R		R								R				R	R		
3H-CC	50	G													R					X		X			R				X			X		R	R				
4H-CC	59.4	G																		F		F						X					X						
5H-CC	68.2	G	F																									R											
6H-CC	78.4	G														R											X												
7H-5,105-107	83.2	G	X																																				
7H-CC	86.4	P	F																																				
8H-2, 96-101	89	G																		X									X										
8H-2, 114-115	89.2	G																	X	R	X								X									X	
8H-4, 64-70	91.6	M							R		X	X							X								X		R		R					R		X	
8H-5, 18-123	93.5	G																						X			R		X	R	F								
8H-CC	94.6	M					X									X						R				R	R	X		R	R								
9H-4, 69-74	98.5	G				R								X					X			R		R	R			R			R					X		R	
9H-7, 61-66	102.7	M				R		X	X		R							X	X	X		R	R					R		R						X		R	
9H-CC	104.8	G									R					R							R				R	F	R		C	R							X
10H-1, 140-144	105.4	G										X	X						R	R							X	R											
10H-4, 108-114	109.3	G																																				R	
10H-CC	114.1	G									R																	R	R			R				X		X	X
11H-3, 85-92	117.4	M														R		R		F		R																X	X
11H-CC	118.8	G																	X	R											X					X			
12H-4, 124-128	123.9	M																											R					X					X
12H-CC	127.5	G									R																												X
13H-CC	127.6	G																				X	R				X				R								R
14H-CC	129	M																												X									X
15P-CC	129.5	M											X																		R								
16H-CC	130	M						X												R								R			R								
17X-CC	139.6	M																		X								X	R							X		X	
18X-CC	147.3	G									X											X						R	F		F								
20X-CC	168	G																																				R	F
22X-CC	186.1	G																		X									R		C	F							
24X-CC	197.7	G				X										R				R								R	C		R								R
25X-CC	200.7	G						R																							R								
26X-CC	215.4	G								R	R								X	X											R					R	R		
28X-CC	226.8	G																																					
30X-CC	235.1	G																																					
31X-CC	246.8	M									R						R						R						C		R	R							R
32X-CC	250.8	G																										X	R		R	R							
34X-CC	261.7	P									X																		F		R								R
36X-CC	268.1	M									R	X																											X
37X-CC	275.4	M									R								R	R									F		X					R			
38X-CC	284.2	M								X										X											R								
39X-CC	301.5	P																		R								X	X		X								
41X-CC	316.4	M																			X			F															X
42X-CC	320.2	P																	X		X		R				X												
43X-CC	337.2	M																			R																		
44X-CC	338.7	M																													X								

Note: B = barren samples; see text for explanation of additional abbreviations.

dance of the taxon in all the samples (MAt), or PI = MAc/MAt. PI values greater than 1.0 show that the taxon is more common in samples within the cluster than in the total data set. PI values of less than 1.0 indicate that the taxon is more common in samples of other cluster groups. A PI value of 1.0 indicates that the taxon has the same average abundance in samples within the cluster group as in the overall data set.

Each cluster group or subgroup can be differentiated by the taxa with the highest PIs. The PI for the taxa in all the cluster groups and subgroups is illustrated graphically in Figure 4C. Once the taxa that are used to differentiate the clusters are known, the paleoenvironmental significance of the dominant assemblages within the clusters can be inferred.

Cluster group A consists of samples with high PIs for *Melonis pompilioides, Uvigerina senticosa, Pullenia bulloides, Cibicidoides wuellerstorfi, Gyroidina soldanii altiformis, Bulimina exilis, Oridorsalis umbonatus,* and *Cassidulinoides bradyi.* This fauna represents deposition within lower middle bathyal to lower bathyal environments.

Samples in subgroup B1 contain a mixture of taxa representing different environments. *Buccella frigida, B. tenerrima, Elphidiella hannai,* and *Elphidium excavatum clavatum* are indicative of an inner

Table 2 (continued).

Elphidiella hannai	*Elphidium excavatum clavatum*	*Elphidium* spp.	*Epistominella pacifica*	*Eponides* spp.	*Fissurina* spp.	*Glandulina* sp.	*Globobulimina affinis*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Gyroidina soldanii altiformis*	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Lagena* spp.	*Lenticulina* spp.	*Martinottiella communis*	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	*Nonionella globosa*	*Nonionella miocenica*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia* spp.	*Pullenia bulloides*	*Pullenia salisburyi*	*Pullenia* sp.	*Pyrgo* sp.	*Quinqueloculina* spp.	*Silicosigmoilina* sp.	*Stilostomella* spp.	*Tosaia hanzawai*	*Trifarina angulosa*	*Triloculina* spp.	*Uvigerina dirupta*	*Uvigerina hispida*	*Uvigerina juncea*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Uvigerina* sp.	*Uvigerina subperegrina*	*Valvulineria araucana*	*Valvulineria* spp.	Simple Benthic diversity
	R	X	F										X								F	R										R					C						23
			F					C					R																					R	R		C				R		16
			R							X	R	R	X							R		C					R	X					X				X						19
	F		A																		F														X		F						9
	X		R				X																										R	X			R						8
	R		R				X		R				X						X		F				X										R		R			R	R		14
																																											1
	R						X	X	R																																		5
	X		C						R												R																R						7
			R		R		X	R													R	X						X						X	X		R						15
X			C				X	R	X			X	R					X										R				R				X	F		X			X	23
R	R		R														X																				R						10
	X		R		X				X		X		X							X								X															16
			F	R	R				C	R	X			R							R	R													R		R	X			R		23
	X		F					R	R		R		X								R												X				F	X			X		24
	F		C																		R					X										R	F				X		16
			C	X				X	X											R		R												X		R	R			X	R		17
								R								X	X	X				X				X	X													R			9
	R		R							X											R	X												R	X		F						15
		R	R						C			X	X			R	R							X	X						R						R	R					18
	R		X					X	X				X									X														R		R			X		13
			X		R			X	R							X								X														X	X				11
				X				R				R				R		X			R									R	X				F	F		R					13
								R										X			R									X							X						10
			X																																								3
			R		X				X			X																															6
	R		F					X				X		X				X						X	X																		12
								X								X																X				R	X						10
	R		R											X				R										R		X						R	C			F			14
			R										X	X				R																								X	7
			C					R															R														R						8
		R	F					R																												R	R						12
			C															R				X	X														R						7
		X	X					R										R			X	R	X		X												X			X			17
								X							X														X														3
			X					X																																			2
			C																				X														C						10
			C			X		R																													F				X		9
			X					R								R																					R						8
			X																				X																		X		6
			F									R										R															C			R	X		12
																		X					X																				5
		X	C																						X												A						8
					R				R	R	X			R								R					R																10
			R									X										X																					7
																																								R			2
																																											1

neritic environment. *Chilostomella oolina, Globocassidulina subglobosa, Gyroidina soldanii altiformis, Nonionellina labradorica,* and *Uvigerina peregrina* are indicative of upper bathyal environments. *Epistominella pacifica* represents deposition in upper middle bathyal environment. This mixing of neritic through bathyal biofacies, from downslope transport, is consistent with the interpretation of turbidites (Shipboard Scientific Party, 1994b) for these sediments.

Subgroup B2 consists of samples with diverse assemblages of taxa that are generally associated with the low-oxygen conditions in the eastern Pacific Ocean (Ingle, 1980). These well-preserved, thin-shelled taxa are *Bolivina subspinescens, Fursenkoina bradyi, B. seminuda, B. translucens, Buliminella subfusiformis, Cassidulinoides bradyi, C. cornuta,* and *Suggrunda* spp. Also present in samples within subgroup B2 are *Nonionella miocenica, Cassidulina minuta,* and *C. limbata* suggesting downslope transport of neritic taxa.

Samples in cluster C contain low diversity assemblages composed of *Bolivina translucens, Nonionella globosa,* and *Suggrunda* spp. This assemblage is also indicative of low-oxygen conditions or associated high-productivity surface waters.

The thin-shelled, low-oxygen indicators in samples from subcluster B2 and cluster C are abundant and well preserved. Larger radiolarians and diatoms are abundant in the washed foraminiferal residues from these samples as well, suggesting original deposition beneath high-productivity surface waters in a middle bathyal environment. Either these faunas are in situ or have been transported downslope. The relatively low amount of organic carbon (<0.8 wt%, Shipboard

Table 2 (continued).

Core, section, interval (cm)	Depth (mbsf)	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia bermudezi*	*Globorotalia inflata* (primitive)	*Globorotalia scitula*	*Globorotalina praeinflata*	*Neogloboquadrina asanoi*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogoboquadrina pachyderma* (d)	*Orbulina universa*	*Pulleniatina obliquiloculata*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
146-889A-																			
1H-CC	30.2	20	1	1	1								91					94	100
2H-CC	39.9													1				1	
3H-CC	50.0	36	2		3								48	7			2	62	87
4H-CC	59.4	11	1										154	1				156	99
5H-CC	68.2	11	2										60	3				65	95
6H-CC	78.4	11					1						25					26	100
7H-5,105-107	83.2	2	2										9	13				24	41
7H-CC	86.4	3											2	1				3	
8H-2, 96-101	89.0												6	4				10	60
8H-2, 114-115	89.2	7	6			1					2		7	5				21	58
8H-4, 64-70	91.6	59	12	1	1						10	1	79	25			3	132	76
8H-5, 18-123	93.5	33		1							8		14	5				28	74
8H-CC	94.6	279	9		3						29		114	127				282	47
9H-4, 69-74	98.5	99	6		1						14		57	33			3	114	63
9H-7, 61-66	102.7	37		1							9		78	64			6	158	55
9H-CC	104.8	4											15	2				17	88
10H-1, 140-144	105.4	4	4						1		11		77	45				138	63
10H-4, 108-114	109.3					1							10	1				12	91
10H-CC	114.1	11									1		66	16				83	80
11H-3, 85-92	117.4	7			1						1		15	19				36	44
11H-CC	118.8	8	1								5		34	6				46	85
12H-4, 124-128	123.9	2											5	5				10	50
12H-CC	127.5	1											2	2				4	
13H-CC	127.6	1											1					1	
14H-CC	129.0																	0	
15P-CC	129.5	1											1					1	
16H-CC	130.0	2												3				3	
17X-CC	139.6																	0	
18X-CC	147.3	20									16		2	36			1	55	5
20X-CC	168.0																	0	
22X-CC	186.1	1											1	2				3	
24X-CC	197.7	5																0	
25X-CC	200.7	39									12			22				34	0
26X-CC	215.4	13											1	29			1	31	3
28X-CC	226.8																	0	
30X-CC	235.1													1				1	
31X-CC	246.8										3		4	5				12	
32X-CC	250.8	29	1	1							12		8	28				50	22
34X-CC	261.7										3			5				8	
36X-CC	268.1												1					1	
37X-CC	275.4	27		2	1						3		13	14			2	35	48
38X-CC	284.2	2									1		1					2	
39X-CC	301.5																	0	
41X-CC	316.4	7						30		4			25	7				66	78
42X-CC	320.2	4						6							1	1		8	
43X-CC	337.2																	0	
44X-CC	338.7	1												1				1	

Scientific Party, 1994b) could argue against preservation of these faunas beneath a high-productivity zone. It is likely that these delicate faunas and the associated siliceous assemblages were transported downslope rapidly from a benthic environment with low oxygen conditions.

Sediments at Site 888 contain a mixture of faunas from neritic through lower bathyal environments. Lower bathyal indicators, which are the deepest dwelling forms at this site, are rare and are scattered throughout the sequence. These mixed faunas, with a dominance of shallower taxa and rarity of in situ faunas, are typical of turbidites. Although lower bathyal indicators are rare, a lower bathyal interpretation is given for this entire site (Fig. 3). This interpretation is further constrained by the present position of this site in a lower bathyal environment on the undeformed abyssal plain portion of the Juan de Fuca Plate.

Sites 889/890

Sites 889 (48°41.958′N, 126°52.098′W) and 890 (48°39.750′N, 126°52.890′W) are located within the accretionary wedge on the continental slope off Vancouver Island in water depths of 1315 and 1326 mbsl, respectively (Fig. 1). Coring at Site 889 recovered almost 387 m of interslope basin sediment and underlying, deformed sediments of the accretionary wedge. The upper 50 m of undeformed interslope basin sediment was recovered at Site 890.

Three lithostratigraphic units are recognized at Sites 889 and 890. Lithostratigraphic Unit I (0–128.0 mbsf) includes clayey silts, fine sands, and diagenetic carbonates. This unit is subdivided into two units, Subunits IA and IB, with Subunit IB distinguished by mud clasts and tilted beds. Unit II (128.0–301.5 mbsf) is similar in composition to Unit I, but is finer grained, more consolidated, and highly

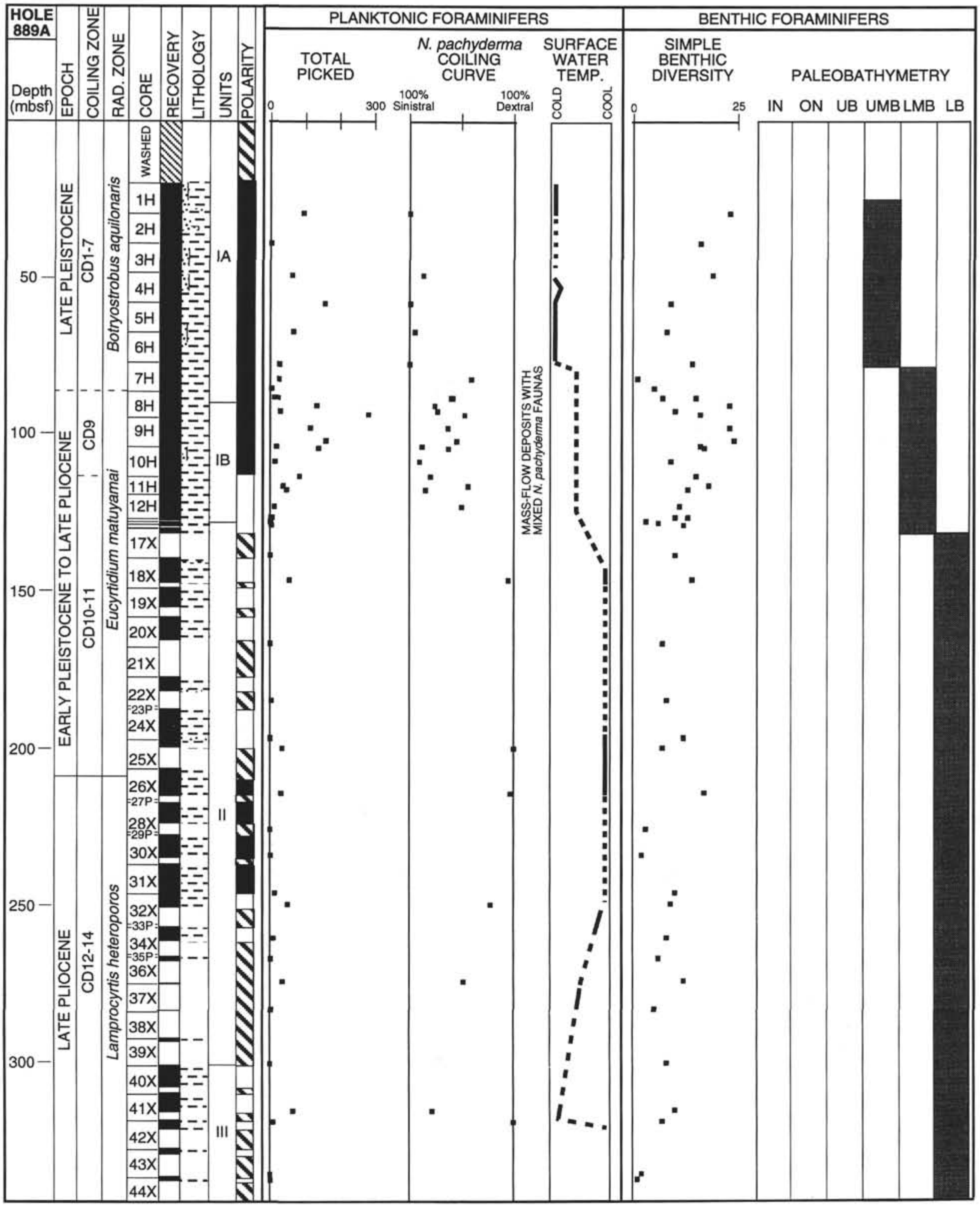

Figure 5. Summary of age zonation, core recovery, lithology, magnetic polarity, foraminiferal distributions, inferred sea-surface temperatures, and paleobathymetry at Site 889. Key to lithologic symbols: thin dashed pattern = silty clay and clayey silt; coarse stipple = silty sand and sandy silt. Key to polarity units: black = normal polarity; white = reversed polarity; diagonal = undetermined. See Shipboard Scientific Party (1994c) for radiolarian zonations and more detailed lithologic and paleomagnetic information.

fractured and brecciated. Lithostratigraphic Unit III (301.5–386.5 mbsf) is similar to Unit II and is marked by an increase in the amount of glauconite and related minerals.

Lithostratigraphic Unit I consists of interslope basin sediments that are hemipelagites, turbidites, and mass-flow deposits (Subunit IB). The sedimentary characteristics of Units II and III are not diagnostic of a particular sedimentary environment but suggest deposition by distal, low-energy turbidity currents. It is postulated that sediments in Units II and III may represent deposition in an abyssal plain environment (Shipboard Scientific Party, 1994c).

Hole 889A

Planktonic Foraminifers

Poorly to well-preserved upper Pliocene through Quaternary planktonic foraminifers are rare to abundant in 39 samples from Hole 889A (Table 2). Six samples are barren of planktonic foraminifers.

Table 3. Checklist of foraminifers found at Hole 889B.

Core, section, interval (cm)	Depth (mbsf)	Preservation	*Bolvina spissa*	*Bulimina* sp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella subfusiformis*	Calcareous sp. indeterminate	*Cassidulina californica*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Chilostomella oolina*	*Cibicides lobatulus*	*Cibicides* spp.	*Cibicidoides wuellerstorfi*	*Dentalina* spp.	*Elphidium excavatum clavatum*	*Epistominella pacifica*	*Eponides healdi*	*Globobulimina affinis*	*Globobulimina auriculata*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Gyroidina* spp.	*Martinottiella communis*	*Nodosaria* spp.	*Oridorsalis umbonatus*	*Plectofrondicularia* spp.	*Pullenia salisburyi*	*Pyrgo* sp.	*Quinqueloculina* sp.	*Reophax* sp.	*Uvigerina hispida*	*Uvigerina juncea*	*Uvigerina peregrina*	*Uvigerina senticosa*
146-889B-																																							
3R-CC	218.1	M											R						X		R																	R	
4R-CC	228.2	M	X									C	R				X				R			R	R												R		
5R-CC	235.2	G	C		X	R	X	R			X	C					X		R		A				R		X		X	C	X							C	
6R-CC	248.2	G	X						R								X				A				R												R	R	
7R-CC	260.2	G			R							R		R						X	C									X								C	
8R-CC	269.4	G	R			R					R	R								R	A											R		R				A	R
9R-CC	273.9	G	R									R					X		R		A						X			R	R							R	
10R-CC	284.4	G		X														X		C	R		X		X					R	X			X				R	
12R-CC	304.2	P														R																							
13R-CC	311.6	M				R													R		R	R				X										R		R	
14R-CC	317.8	P																							X														
15R-CC	326.9	P																							X													X	
17R-CC	343.7	P											R																				X		X			R	
18R-CC	352.1	P								X																										X		X	
19R-CC	360.2	M																										X											
20R-CC	368.9	M																												R									

Note: B = barren samples; see text for explanation of additional abbreviations.

Core, section, interval (cm)	Depth (mbsf)	Simple Benthic Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia inflata* (primitive)	*Globorotalia scitula*	*Globorotalina praeinflata*	*Neogloboquadrina asanoi*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
146-889B-																	
3R-CC	218.1	4	2								1		1	10		14	9.1
4R-CC	228.2	8									2			1		3	
5R-CC	235.2	16	4								1		2	4	1	12	
6R-CC	248.2	7														0	
7R-CC	260.2	7														0	
8R-CC	269.4	10	59						3		12		4	53		131	7.0
9R-CC	273.9	9	4										1	6		11	
10R-CC	284.4	10	3	1							1		12	3		20	80.0
12R-CC	304.2	2														0	
13R-CC	311.6	7														0	
14R-CC	317.8	1														0	
15R-CC	326.9	2														0	
17R-CC	343.7	4														0	
18R-CC	352.1	3														0	
19R-CC	360.2	1	1													1	
20R-CC	368.9	1														0	

Samples in the interval from 20 to 86.4 mbsf are dominated by few to common *G. bulloides* and *N. pachyderma* (sinistral), and rare to few *G. quinqueloba* and *N. pachyderma* (dextral). Sediments in this interval have normal magnetic polarity, contain radiolarians of the *B. aquilonaris* Zone, and have dominantly sinistrally coiled *N. pachyderma*, yielding an age assignment in the CD1-7 coiling zone (Fig. 5).

A hiatus is recognized on the basis of radiolarian biostratigraphy at about 88 mbsf (Shipboard Scientific Party, 1994c). At 88 mbsf upper Pleistocene strata of the *B. aquilonaris* Zone occur above uppermost Pliocene/lower Pleistocene strata belonging to the *Eucyrtidium matuyamai* Zone of Hays (1970). The absence of the *Stylatractus universus* Zone (Hays, 1970) infers a hiatus, lasting about 0.6 m.y.

The interval from 89.2 to 119 mbsf contains rare to abundant *G. bulloides, N. pachyderma* (sinistral), and *N. pachyderma* (dextral) with rare to common occurrences of *N. asanoi* and rare to few *G. quinqueloba.* Also present in this interval are the uppermost Pliocene/lower Pleistocene radiolarian, *E. matuyamai,* and lower Pliocene radiolarians. It is difficult to determine the age of this interval because of the nature of the sediments (mass-flow deposits) and the association of *E. matuyamai, N. asanoi,* mixed sinistral and dextral *N. pachyderma,* and lower Pliocene radiolarians. The first occurrence of *E. matuyamai* and the last occurrence of *N. asanoi* are at 1.9 Ma according to the time scale of Cande and Kent (1992) (Shipboard Scientific Party, 1994c). It is unlikely that the sediments within the interval from 89.2 to 119.0 were deposited within the overlap in ranges of these taxa because of the presence of mixed populations of dextral and sinistral *N. pachyderma.* The short overlap in ranges of *E. matuyamai* and *N. asanoi* occurs within a zone of sinistrally coiled *N. pachyderma,* not one with mixed coiling. Therefore, based on the occurrence of *E. matuyamai,* the mixed sinistral and dextral *N. pachyderma* assemblages, and a normal paleomagnetic signature, the interval from 89.2 to 119.0 mbsf is assigned to the CD9 coiling zone. Although they are common and well preserved, specimens of *N. asanoi* within this interval are considered to be reworked.

Rare to few, poorly to well-preserved *G. bulloides, N. pachyderma* (sinistral and dextral), and *N. asanoi* occur sporadically in the interval from 119 to 338.7 mbsf. Within this interval Sample 146-889A-41X-CC contains a mixture of *Globorotalia inflata* primitive form and *G. inflata praeinflata* (Table 2). The first occurrence of *G. inflata praeinflata,* a transitional form between the *G. inflata* primitive and *G. inflata* modern forms, coincides with the end of the Gauss Chron (Keller, 1980), which makes this sample no older than 2.6 Ma following the Cande and Kent (1992) time scale. This interval is assigned to the CD12-CD14 zone based on the presence of *N. asanoi, N. pachyderma* (sinistral and dextral), *G. inflata* primitive, and *G. inflata praeinflata.*

Several paleoclimatic intervals can be inferred from coiling ratios at Hole 889A. From the sea floor to 78.4 mbsf, dominantly sinistrally coiled *N. pachyderma* indicate cold surface waters. The paleoclimatic signal in the interval from 78.4 to 119 mbsf is difficult to interpret because of resedimentation; however, the mixed sinistral and dextral assemblages suggest cold to cool temperate surface waters. There is a general up hole increase in the number of dextral *N. pachyderma* within the interval from 123.9 to 345.8 mbsf, indicating a warming of surface waters during the late Pliocene to early Pleistocene. This warming trend has been documented throughout the eastern Pacific (Lagoe and Thompson, 1988).

Benthic Foraminifers

Moderately to well-preserved benthic foraminifers are rare to abundant in all samples examined from Hole 889A (Table 2). The benthic assemblages in this hole are dominated by *Epistominella pacifica, Uvigerina peregrina, Cassidulina translucens, C. norcrossi, Globobulimina pacifica, Bulimina subacuminata, and Bolivina spissa.* A Q-mode cluster analysis was performed, but no significant cluster groups were formed due to the homogeneous nature of the faunas at this hole. There are, however, some general differences in the faunas among the three lithostratigraphic units recognized at this hole. *Buliminella subfusiformis, Elphidium excavatum clavatum, Globocassidulina subglobosa, Oridorsalis umbonatus,* and *Nonionellina labradorica* are rare to few in lithostratigraphic Unit I. Subunit IB contains the lower middle bathyal indices *Melonis barleeanum, Gyroidina soldanii rotundimargo,* and *U. hispida,* and also rare, often broken specimens of *Cibicidoides wuellerstorfi, U. senticosa,* and *M. pompilioides.* Broken specimens of *Plectofrondicularia* sp. are only found in lithostratigraphic Unit II. *C. wuellerstorfi, Martinottiella communis, Silicosigmoilina* sp., and *Stilostomella* sp. are also present in Unit II. Lithostratigraphic Unit III contains rare, low diversity calcareous faunas.

Sediments in Subunit IA contain benthic assemblages indicative of an upper middle bathyal environment, similar to present water depths at this site. Assemblages in Subunit IB probably represent a mixture of faunas caused by slumping of older sediments containing lower bathyal faunas into a lower middle bathyal environment. Although lower bathyal indicators are only rare in Units II and III, these distal turbidites were probably formed in a lower bathyal environment (Fig. 5). Thus, there has been a decrease in paleobathymetry of sediments at Site 889 through time as these sediments were uplifted while being accreted to the margin.

Hole 889B

Planktonic Foraminifers

Of the 16 samples examined for planktonic foraminifers in Hole 889B, only seven contain planktonic foraminifers. Planktonic foraminifers are present, in low abundances from 225.3 to 289.3 mbsf, but virtually absent from 301.7 mbsf to the bottom of Hole 889B (Table 3). Where present, planktonic assemblages consist of *N. pachyderma* (dextral and sinistral), *G. bulloides,* and *N. asanoi.* Dextral forms of *N. pachyderma* are more common than sinistral forms except in Sample 146-889B-10R-CC, suggesting cool temperate surface waters. A late Pliocene age is indicated by this assemblage.

Benthic Foraminifers

Benthic foraminifers are rare to abundant in all samples examined from Hole 889B. Low diversity benthic foraminifers are rare to abundant in the interval from 225.3 to 289.3 mbsf, where planktonic foraminifers are also most common. Benthic assemblages are dominated by *Epistominella pacifica, Uvigerina peregrina, Bolivina spissa, Cassidulina norcrossi,* and *Oridorsalis umbonatus.* The neritic species *Elphidium excavatum clavatum* is common in Sample 146-889B-10R-CC, indicating downslope transport from neritic waters. Samples from 307.1 mbsf to the bottom of the hole contain very rare or rare specimens of several different species. An upper middle bathyal environment or possibly deeper is suggested for this section.

Net Uplift at Site 889

Benthic foraminifers indicate shallowing through time at Site 889 (Fig. 5). Although changes in paleoenvironments may reflect either tectonic uplift or water-mass fluctuations, it is most likely, given the structural setting on the accretionary wedge, that the decrease in paleobathymetry through time at Site 889 is due to uplift by accretionary processes. Paleoenvironmental analysis can provide constraints on the amount of net uplift at Site 889. The range of net uplift can be calculated by subtracting the present-day water depth of the site from the upper and lower ranges of the interpreted paleoenvironmental zone for each interval. The present water depth at Site 889 is approximately 1315 mbsl. Therefore, the lower bathyal sediments in Units II and III have been uplifted at least 700 m and possibly as much as 2700 m. Lower middle bathyal sediments within Subunit IB have un-

Table 4. Checklist of foraminifers found at Site 891.

Core, section, interval (cm)	Depth (mbsf)	Barren Samples = B	Preservation	Agglutinated spp. indeterminate	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina striata mexicana*	*Bulimina subcalva*	Calcareous spp. indeterminate	*Cassidulina carinata*	*Cassidulina limbata*	*Cassidulina minuta*	*Cassidulina norcrossi*	*Cassidulina* sp.	*Cassidulinoides bradyi*	*Chilostomella ovoidea*	*Cibicides* spp.	*Cibicidoides mckanni*	*Cibicidoides* sp.	*Cibicidoides wuellerstorfi*	*Dentalina* spp.	*Eggerella bradyi*	*Elphidiella hannai*	*Elphidium excavatum clavatum*	*Elphidium* sp.	*Epistominella pacifica*	*Epistominella* sp.	*Eponides healdi*	*Eponides* spp.	*Fissurina* spp.	*Fursenkoina bradyi*	*Globobulimina affinis*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Gyroidina soldanii altiformis*	*Gyroidina soldanii roundimargo*	*Gyroidina* spp.	*Hoeglundina elegans*	*Karrerriella* sp.
146-891A-																																								
1H-1, 4-6	0.0		G	X			R	X																										R		R				
1H-CC	4.7		G																								X													
2H-CC	7.3		G															X	R										X					R						
3H-1, 39-43	7.7		M	X						X				X				X	R		X								X				X	R		X	X			
3H-CC	9.5		G																					X			R							X						
146-891B-																																								
1X-CC	0.0		G	X		X	X				F							R		R	R								R							R	X			
2X-CC	12.0		G				X											X			R								X		X	X		R						
3X-CC	20.8		G	X						X								X							F		F	X												
4X-CC	29.7		M	X																									X					R			X			
6X-CC	47.3		G	X						X											R		X											R			X			
7X-CC	56.2		G																X				X						X		X			R						
8X-CC	65.6		M																																					
10X-CC	83.6		G																								X													
11X-CC	92.5	B																																						
14X-1, 45-49	110.0		G	X																																				
14X-CC	110.5		G																																					
15X-CC	119.5		G																																					
16X-1, 26-31	127.6		G	X																																				
16X-CC	128.2		G	X																																				
18X-CC	148.7		G	X																																				
19X-CC	154.6		G	X																																				
20X-1, 27-28	163.0		G	X																																				
20X-CC	164.5		G																																					
21N-CC	172.2		G	X				X		X																														
22X-CC	177.1	B																																						
23X-CC	182.8		G		X	X											X	X								R	X							X						
25X-CC	199.3		G																																					
26X-CC	207.6		G																								X													
27X-CC	216.5		G																						R					X										
28X-CC	225.7		G																																					
29X-CC	234.5		G	X																																				
30X-2, 38-43	238.8		G																																					
30X-CC	239.6		G																																					
31X-1, 74-78	243.1		G	X																																				
31X-CC	244.5		G																																					
32X-CC	252.4		G															X				X					X				X									
33X-CC	261.0		G																																			R		
34X-CC	265.0		G																																		X			
35X-CC	270.9		G																						R					R										
37X-CC	279.1		G		X	R		X		R					X	X			R																		R		X	
38X-1, 66-72	287.1		G	X																	X	X									X			X	X					
38X-CC	289.9		M					X		R								X																		X				
39X-1, 75-80	295.9		G																		R													X						
39X-CC	297.4		G			X															R						R		R											
40X-CC	306.1		G							X			X					X	R		X									X						X				
41X-CC	315.6		G													X									X															
42X-1, 61-67	322.2		G																																					
42X-CC	323.1		G																																					
43X-2, 64-70	331.3		G																																					
43X-CC	332.8		G																																					
44X-1, 9-12	339.4		G	X																																				
44X-CC	339.8	B																																						
45X-1, 37-41	348.6		G															X																						
45X-CC	348.9		G																																					
47X-2, 15-20	367.6		G	X																							X													
47X-CC	368.6		M																																		X			
48X-CC	375.8		G																		R								R					R			R	R	R	
49X-CC	384.3		G																						R					X										
50X-CC	393.3		G																								X													
52X-1, 31-35	410.8		G																																					
52X-CC	411.6		M																																					
55X-CC	440.1		G						R			X									R								X											X
56X-CC	447.9		G	X															X															X		X				
57X-CC	455.3		G															X			R				X								X			X				
58X-1, 32-37	463.8		G																																					
58X-CC	465.9		G																																					

Note: B = barren samples; see text for explanation of additional abbreviations.

Table 4 (continued).

Lagena spp.	*Lenticulina* spp.	*Martinottiella communis*	*Melonis barleeanum*	*Melonis pompilioides*	*Nonionella miocenica*	*Oridorsalis umbonatus*	*Pullenia bulloides*	*Pyrgo* sp.	*Quinqueloculina* spp.	*Reophax* sp.	*Sphaeroidina bulloides*	*Triloculina* sp.	*Uvigerina dirupta*	*Uvigerina hispida*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Uvigerina* sp.	*Valvulineria araucana*	Simple Benthic Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globorotalia bermudezi*	*Globorotalia hirsuta*	*Globorotalia menardii*	*Globorotalia scitula*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina universa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
				R				X		R	R	X	R	X					12	2				1						32	9			44	78
																			1						3					80	5			88	94
				R								X				X			7	54	44		2	1				3		148	25			277	86
X				R			R	R			R					F			17	87	20	2	11				11	2		118	33			284	78
																			3				1							3	1			5	
X	R			R		R	R	X			R	X				C			19	79	5		5	2				2		54	9			156	86
				X										X		X		X	11	130	8	2	11		1			5	1	116	13	1		287	90
																			6	7	6		1							5				19	
		X					R				X					R			8	71	14		1	1				1	2	79	9		1	178	90
				R							X					R			9	19			3							35	5			62	88
				R			X				X				X	R			10	50	14		5					2		71	8		1	150	90
				X															1	1	1									4				6	
					X														2	2										6	1		3	9	
																			0															0	
																			1	3														3	
																			0	155	2	2	3							24	1			187	96
																			0	1														1	
																			1	3		1												4	
																			1															0	
																			1	1														1	
																			1	25	2		2							7				36	
																			1	11		1								5				17	
																			0														1	0	
																			3	17	3									18	1		2	39	95
																			0															0	
				X			R		X					X		X			12	8	3		1							45	1			58	98
																			0	5					1					25				31	100
																			1											1				1	
																			2											3			1	3	
																			0											1				1	
																			1											4				4	
																			0	1	1									8				10	
																			0											1				1	
																			1	13	1									15	2			31	88
																			0	1										4	1			6	
				R			R									F			7	27			5							87	6			125	94
				X			X									R			4	8	2		2							42	1			55	98
																			1	6										23	1			30	96
									X								X		4	3										10	1			14	91
				R		X	R								R	F			14	20	6		2							39	3			70	93
				X												R			8	9	2									26	1			38	96
				R			X									R			7	137	28		6			1		7		211	29	1		419	88
				R			X									X			5		1									4				5	
				F			R												6	15	11									55	4			85	93
	X		X	R			R									R			12	70	30		11					1		281	26			419	92
																			2	14	1									101				116	100
																			0											1	1			2	
																			0											4				4	
																			0	21	20		2					1		53	2		2	99	96
																			0											1				1	
																			1											5				5	
																			0															0	
																			1	9	1									97				107	100
																			0	4	1									41				46	100
																R			3				2							18	2			22	90
									R							R			3	7	5									24				36	100
					X		R									F			9	18	1									22	1			42	96
																			2	1										4				5	
																			1															0	
																			0		1									4				5	
																			0	1										3				4	
X				R			R									F		R	10	76	8	2	4							292	10			392	97
				X												R			6	13										73				86	100
				R			R									R			8	199	25		11							330	12			577	96
																			0	2	2									11				15	100
																			0	32	63	1	11							37	2			146	95

dergone between 200 and 700 m of uplift. Site 889 is presently in an upper middle bathyal environment, so sediments in Subunit IA, which are indicative of a middle bathyal environment, have not been uplifted more than 200 m.

Holes 890A and 890B

Planktonic Foraminifers

The five core-catcher samples from Holes 890A and 890B contain well preserved, very abundant faunas dominated by *G. bulloides, N. pachyderma* (sinistral), and *G. quinqueloba.* There are also rare to few occurrences of *G. scitula, G. bermudezi, G. umbilicata,* and *N. pachyderma* (dextral). Radiolarians indicative of the *B. aquilonaris* Zone are present in Sample 146-890A-1H-CC, but are rare or absent in other samples at Site 890. The sequence at Site 890 is considered to be late Pleistocene.

Benthic Foraminifers

Core-catcher samples from Holes 890A and 890B contain assemblages dominated by *Bolivina spissa, B. striata mexicana, Bulimina subcalva, B. exilis, B. subacuminata, Globobulimina pacifica, Epistominella pacifica, Chilostomella oolina, Cassidulinoides bradyi, Cibicidoides mckannai, Oridorsalis umbonatus, Uvigerina peregrina, Cassidulina translucens. Pyrgo* spp., *Quinqueloculina* spp., *Elphidium excavatum clavatum, C. minuta, C. norcrossi* and other neritic taxa are also present. An upper middle bathyal environment with a large component of transported neritic through upper bathyal faunas is indicated for Site 890.

OREGON MARGIN: SITES 891 AND 892

Site 891

Site 891 (44°38.64'N, 125°19.550'W, water depth = 2663 m) is located on the westernmost ridge of the accretionary wedge along the Oregon continental margin (Fig. 1). Total penetration at this site was 472.3 m, however recovery was very poor (11%).

Due to the poor recovery and compositional and textural similarity of all the sediments recovered at Site 891, only one lithostratigraphic unit was recognized. The lithologies at this site are mainly clayey silts and fine- to medium-grained sands, with pebbles and diagenetic carbonate concretions scattered throughout the section. Steeply inclined beds that dip about 60° above 84 mbsf overlie variably dipping beds to 198 mbsf. From 198 to 375 mbsf fractures and two fault zones are recognized in the sequence (Shipboard Scientific Party, 1994d). These sediments probably represent deep-sea fan deposits that were later accreted to the lower slope of the Oregon Margin.

Planktonic Foraminifers

Moderately to well-preserved planktonic foraminifers are rare to abundant in samples from Holes 891A and 891B (Table 4). Five out of 66 samples are barren of planktonic foraminifers.

The abundance of planktonic foraminifers varies greatly throughout the hole (Fig. 6); three intervals, based on abundance, can be recognized at this site. From 0 to 56.2 mbsf, planktonic foraminifers are abundant in most samples. The assemblages are dominated by *N. pachyderma* (sinistral and dextral), *G. bulloides, G. quinqueloba, G. glutinata,* and *G. scitula.* This interval is dominated by sinistral *N. pachyderma,* with the exception of the first sample (146-891A-1H-1, 4–6 cm). The interval from 56.2 to 244.5 mbsf contains lower abundances of planktonic foraminifers, with the exception of Sample 146-891B-14X-CC. This interval contains common *N. pachyderma* (sinistral) and *G. bulloides* with scattered rare occurrences of *N. pachyderma* (dextral), *G. quinqueloba,* and *G. glutinata. G. scitula* is absent in this interval. The last interval, from 244.5 to 465.9 mbsf, consists of similar faunas present in the first interval described. This interval is dominated by sinistrally coiled assemblages of *N. pachyderma.*

The age of the sediments recovered at Site 891 is considered to be late Quaternary, possibly in the CD1-8 zones, based on the occurrence of coeval radiolarians, a normal paleomagnetic signature (Shipboard Scientific Party, 1994d), and the dominance of sinistrally coiled *N. pachyderma.* A more precise age is not possible due to the following factors: (1) poor recovery; (2) absence of zonal markers; (3) structural deformation; and (4) intervals barren of siliceous microfossils.

Benthic Foraminifers

The distribution of benthic foraminifers at Site 891 is similar to that at Site 888; samples from Site 891 are either barren, contain very rare, low to moderate diversity foraminifers, or contain common, moderate diversity assemblages (Fig. 6). Abundances of benthic foraminifers are generally lower at this site, with most taxa being very rare to few in abundance; no benthic species is abundant at this site (Table 4).

Abundance, diversity, and composition of the faunas can be generalized in six intervals. The intervals from 0 to 56.2, 252.4 to 315.6, and 375.8 to 455.3 mbsf contain common, moderate diversity assemblages dominated by *Uvigerina senticosa, Melonis pompilioides, Pullenia bulloides,* and *Cibicidoides wuellerstorfi.* Samples in the intervals from 65.6 to 244.5, 322.2 to 368.8, and 455.3 to 465.9 mbsf are either barren or contain very few benthic foraminifers. Many of these samples contain only broken specimens of unilocular agglutinated benthic foraminifers. Deposition in a lower bathyal environment is suggested by the benthic faunas.

Site 892

A discontinuous, structurally complex sequence of sediments was cored at Site 892, located on the continental slope (44°40.451'N, 125°7.139'W) in a water depth of 674 mbsl (Fig. 1). The site crosses a thrust fault and related faults associated with accretionary processes on the second ridge of the accretionary wedge off Oregon (Shipboard Scientific Party, 1994e). Sediments at Site 892 are mainly terrigenous silty clays and clayey silts with sporadic sand layers, interpreted to be abyssal plain deposits.

Diatom and radiolarian biostratigraphic studies (Fourtanier and Caulet, this volume) show a complicated stratigraphy with fault-juxtaposed sediments of Pleistocene, Pliocene, and Miocene age. The distribution of age-diagnostic foraminifers shows general agreement with ages determined by siliceous microfossils.

Planktonic Foraminifers

Planktonic foraminifers are either common to abundant or absent to rare in samples from both Holes 892A (Table 5, Fig. 7) and 892D (Table 6, Fig. 8). Where common to abundant, planktonic assemblages are dominated by *N. pachyderma* (dextral), *G. bulloides, N. asanoi,* and *N. pachyderma* (sinistral). Coiling directions are mainly to the right or are mixed, indicating cool temperate surface waters (Figs. 7 and 8). Samples in a thick interval in Hole 892D from 39.14 to 119 mbsf are either barren or contain very rare planktonic foraminifers. One sample in this interval, 146-892D-10X-6, 6–67 cm, contains rare specimens of *Catapsydrax* sp. and *Morozovella aragonensis* and Eocene benthic foraminifers (see below).

Direct age assignments of samples to the *N. pachyderma* coiling zones can not be made at Site 892 because the sediments are deformed. However, the coiling zone to which each sample probably belongs can be inferred (Figs. 7 and 8) based on the age determina-

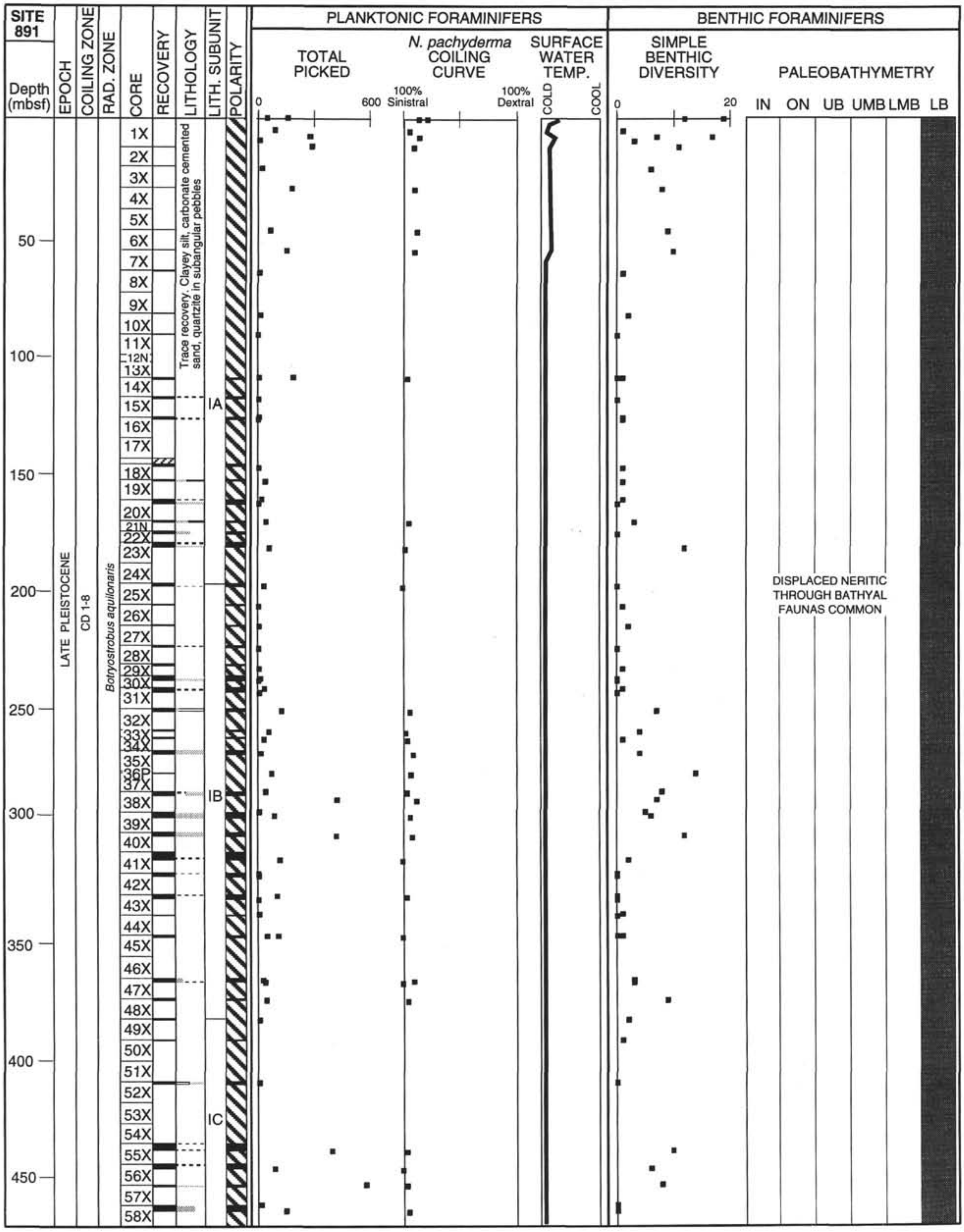

Figure 6. Summary of age zonation, core recovery, lithology, magnetic polarity, foraminiferal distributions, inferred sea-surface temperatures, and paleobathymetry at Site 891. Key to lithologic symbols: fine stipple = mud; coarse stipple = sand; thin dashed pattern = silt. Key to polarity units: black = normal polarity and diagonal = undetermined. Thrust faults are located at 260 mbsf and 275 mbsf. See Shipboard Scientific Party (1994d) for radiolarian zonations and more detailed lithologic, paleomagnetic information, and structural information.

tions provided by radiolarian (Caulet, this volume) and diatom (Fourtanier, this volume) biostratigraphy.

Benthic Foraminifers

Benthic foraminiferal faunas are similar in Holes 892A and 892D (Tables 5 and 6). Most species are rare to common, with only a few abundant occurrences. A Q-mode cluster analysis was done in order to characterize the benthic faunas in these holes. Thirty taxa in 35 samples from Holes 892A and 892D were analyzed using the Cosine Theta similarity coefficient and UWPGMA. Five cluster groups can be recognized in the resulting dendrogram (Fig. 9A). As discussed above, each group can be characterized using a preference index (PI) for each species analyzed (Fig. 9B). In general the five cluster groups have both paleoenvironmental and chronostratigraphic significance (Figs. 7, 8, and 10). In the following discussion, age references are based on diatom biostratigraphy of Fourtanier (this volume).

Cluster group I consists of 12 samples from both holes that have high PIs for *Uvigerina senticosa, Melonis pompilioides, Globobulimina pacifica, U. peregrina,* various buliminids, *Pullenia bulloides, Nodosaria* spp., and *Cibicidoides wuellerstorfi* (Fig. 9A and B). These taxa indicate a lower bathyal environment with downslope transport of faunas from an upper bathyal environment. The ages of samples in this group are Pliocene except for Samples 146-892D-1X-CC and 892D-2X-CC, which are Pleistocene (Figs. 7, 8, and 10).

Cluster group II consists of 10 samples with high PIs for *Bulimina subacuminata, M. barleeanum,* costate *Nodosaria* spp., *Cassidulina norcrossi, Stilostomella* sp., *Plectofrondicularia* sp., *Epistominella pacifica,* and other taxa shown in Figure 9B. This assemblage suggests deposition in a lower bathyal environment with a large component transport of outer neritic through middle bathyal faunas. The ages of samples in this group are Pliocene except for Sample 146-892D-2X-1, 1–6 cm, which is Pleistocene (Figs. 7, 8, and 10).

Only two samples occur in cluster group III. These samples are distinguished on the basis of common *Gyroidina soldanii altiformis* and *C. translucens,* and rare *B. subcalva* in Sample 146-892A-7X-2, 10–15 cm (Fig. 9B). Sample 146-892D-9X-CC clusters with the other sample because of the occurrence of *B. subcalva* and rare *G. soldanii altiformis.* These two samples are both early Pliocene in age and represent deposition in a bathyal environment (Figs. 7, 8, and 10).

The six samples that make up cluster group IV can be characterized by the following taxa: *Buliminella subfusiformis, Nonionellina labradorica, Bolivina spissa, Buccella tenerrima, U. hootsi, Globocassidulina subglobosa, E. pacifica, P. bulloides, Martinottiella communis,* and *C. wuellerstorfi* (Fig. 9B). This assemblage is indicative of a lower bathyal environment with a significant component of transported inner neritic faunas (e.g., *B. tenerrima*). All samples in this group are considered to be Miocene in age (Figs. 7, 8, and 10).

The final cluster group, VI, groups four samples characterized by the occurrence of *Silicosigmoilina* sp. and *M. communis.* Two of the samples in this group are Miocene (Samples 146-892A-8X-CC and 892D-6X-CC) and two are Pliocene in age (Samples 146-892D-7X-CC and 892D-4X-1, 99–105 cm). These taxa represent a lower bathyal environment that is distinctly different, and possibly deeper, than the environments suggested by cluster groups I, II and IV.

One sample was not included in the cluster analysis because it contains a much different assemblage than any other sample at this site (Table 6). Sample 146-892D-10X-6, 63–67 cm, is composed of the following benthic foraminifers indicative of an Eocene age: *Tritaxilina colei, Buccella oregonensis, Bulimina jacksonensis welcomensis, Bulimina microcostata, Cibicides perlucida, Cassidulina globosa, Eponides minima, Gyroidina orbicularis planata, Lenticulina texana,* and *Uvigerina garzaensis.* Also present in this sample are *Plectofrondicularia californica, N. pachyderma* (dextral and sinistral), *N. asanoi, G. bulloides,* indicating the presence of Pliocene faunas as well. The washed residue for this sample has a salt and pepper appearance with mainly very dark, almost black, silty clays mixed with a smaller component of very light-colored silty clays. Most of the other washed residues at this site resemble the lighter component. This sample is in the "most intensely deformed zone recovered" (Shipboard Scientific Party, 1994e, p. 330) at Site 892 and it is suggested that Eocene material occurs in a fault sliver or was brought up within this fault zone and mixed with Pliocene material. Another possibility is that the fauna in Sample 146-892D-10X-6, 63–67 cm represent a land-derived turbidite.

Most of the sediments at Site 892 were deposited in a lower bathyal environment. The present water depth at Site 892 is at 674 mbsl in an upper middle bathyal environment. Therefore, the sediments at Site 892 have undergone a net uplift of 1300 to 3300 m.

SUMMARY

A 600-m sequence of upper Quaternary sediments, representing turbidites deposited in a lower bathyal environment on outer to middle portions of the Nitinat submarine fan, was recovered at Site 888. Assemblages of *N. pachyderma* show a change from dominantly cold surface waters to those that fluctuate between cold to slightly warmer at Site 888. These changes reflect regional paleoclimatic fluctuations and may also indicate changes in the nature of surface currents along the margin. Benthic foraminiferal faunas are rare to abundant, with a large component of displaced faunas from both neritic and bathyal environments deposited in a lower bathyal environment. The occurrence of neritic taxa and wood fragments suggests a shelf origin for some of these turbidites.

A discontinuous sequence of upper Pliocene through Quaternary sediments was cored at Site 889, and an apparently continuous upper Quaternary sequence was cored at Site 890. Surface waters were dominantly cool temperate during the late Pliocene to early Pleistocene at Site 889, with cold surface waters in the late Pleistocene. Benthic foraminifers suggest a decrease in paleobathymetry through time from lower bathyal to upper middle bathyal environments as sediments at Site 889 were uplifted and accreted to the Cascadia accretionary wedge.

Site 891 contains Quaternary turbidites deposited in a lower bathyal environment beneath dominantly cold surface waters.

A structurally complex sequence, containing abyssal plain sediments indicative of a variety of ages ranging from Pleistocene to Miocene, and possibly Eocene, was recovered at Site 892. Cluster analysis was successful in classifying samples from Site 892 on the basis of age and paleobathymetry. Most of the samples contain faunas indicative of deposition in a lower bathyal environment.

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Table 5. Checklist of foraminifers found at Hole 892A.

Core, section, interval (cm)	Depth (mbsf)	Preservation	*Anomalina* sp.	*Bolivina argentea*	*Bolivina* spp.	*Bolivinita quadrilatera*	*Bolvina spissa*	*Bolivina pseudobeyrichi*	*Buccella tenerrima*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina fossa*	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella subfusiformis*	*Bulimina aculeata*
146-892A-																	
1X-CC	4.3	M															
2X-CC	13.2	M			R		R				X		R	X			R
3X-CC	22.9	M				X				R	X			X			
4X-CC	30.4	M					R		C		X					F	
6X-CC	45.7	M															
7X-2, 10-15	50.1	M													R		
7X-CC	57.8	M				R		X				R		X			
8X-CC	64.7	P		X													
9X-CC	68.6	P												R			
11X-CC	81.3	M											R	X			
12X-CC	88.5	M	X														
13X-CC	106.0	P															
14X-CC	107.0	P														X	
15X-CC	117.3	M					X							X			
16X-CC	126.2	M		X													
17X-CC	136.7	P	R														
18X-CC	146.8	P															
20X-1,87-92	164.4	M											R		R		
20X-CC	167.4	M													R		
21X-CC	173.2	M															

Core, section, interval (cm)	Depth (mbsf)	Preservation	*Bulimina inflata*	calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina norcrossi*	*Cassidulina* spp.	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Chilostomella oolina*	*Cibicides* spp.	*Cibicidoides mckanni*	*Cibicidoides* spp.	*Cibicidoides wuellerstorfi*	*Dentalina* spp.	*Dorothia* sp.	*Eggerella bradyi*	*Elphidium excavatum clavatum*	*Epistominella pacifica*	*Eponides healdi*	*Fissurina* spp.	*Glandulina laevigata*	*Globobulimina affinis*	*Globobulimina pacifica*	*Globocassidulina subglobosa*
146-892A-																									
1X-CC	4.3	M					X					X		X											
2X-CC	13.2	M		R				X			X	R		X	X							X	X	R	
3X-CC	22.9	M	X			R	X	X	R		X	X	R		R		R		F	X	X			R	X
4X-CC	30.4	M									X								C	X	R				
6X-CC	45.7	M									R				R										C
7X-2, 10-15	50.1	M						C			R				R					R		X			R
7X-CC	57.8	M			X	R					R	X			R						R	X		X	R
8X-CC	64.7	P									R	R			R						X	R			
9X-CC	68.6	P																	R						
11X-CC	81.3	M								X					X	X				X	X				
12X-CC	88.5	M											X												
13X-CC	106.0	P													X										
14X-CC	107.0	P										X								R	R				
15X-CC	117.3	M									R						X	X	X	X					
16X-CC	126.2	M													X										
17X-CC	136.7	P	R								X										X				
18X-CC	146.8	P												X	X										
20X-1,87-92	164.4	M																	X	X	R	X		X	
20X-CC	167.4	M									X	X		X						X					
21X-CC	173.2	M										X													

Note: B = barren samples; see text for explanation of additional abbreviations.

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APPENDIX

Taxonomic Notes

Original references for species listed in the tables are given below. Individual specimens that could only be identified to genus level are listed on Tables 1 to 6 as "sp." Multiple specimens of the same genus, not identified to species level, are designated as "spp."

Catapsydrax sp. Only one broken specimen found.
Globigerina bulloides d'Orbigny, 1826, p. 277.
Globigerina quinqueloba Natland, 1938, p. 149, pl. 6, fig. 7.
Globigerina umbilicata Orr and Zaitzeff, 1971, p. 18, 19, pl. 1, figs. 1–3.
Globigerinita glutinata (Egger) = *Globigerina glutinata* Egger, 1893, p. 371, pl. 13, figs. 19–21.
Globigerinita uvula (Ehrenberg) = *Pylodexia uvula* Ehrenberg, 1861, p. 206, 207, 308.
Globigerinoides ruber (d'Orbigny) = *Globigerina rubra* d'Orbigny, 1839a, p. 82, pl. 4, figs. 12–14.
Globorotalia bermudezi Rögl and Bolli, 1973, p. 567, pl. 6, figs. 16 20, pl. 16, figs. 1 3, text figs. 6a–6c.
Globorotalia crassiformis (Galloway and Wissler) = *Globigerina crassiformis* Galloway and Wissler, 1927, v. 1, p. 41, pl. 7, fig. 12.
Globorotalia hirsuta (d'Orbigny) = *Rotalina hirsuta* d'Orbigny, 1839b, p. 131, pl. 1, figs. 37–39.
Globorotalia inflata (d'Orbigny) = *Globigerina inflata* d'Orbigny, 1839b, p. 134, pl. 2, figs 7–9.
Globorotalia inflata primitive var. = earliest forms of *Globorotalia inflata* as described by Keller (1980).
Globorotalia menardii (Parker, Jones, and Brady) = *Rotalia menardii* Parker et al., 1865, p. 20, pl. 3, fig. 81.
Globorotalia praeinflata = *Globorotalia inflata* (d'Orbigny) *praeinflata* Maiya et al., 1976, p. 408, pl. 2, figs. 5–7.
Globorotalia puncticulata (Deshayes) = *Globigerina puncticulata* Deshayes, 1832, v. 2, no. 2, p. 170.
Globorotalia scitula (Brady) = *Pulvinulina scitula* Brady, 1882, p. 716.
Morozovella aragonensis = *Globorotalia aragonensis* Nuttall, 1930, v. 4, no. 3, p. 288, pl. 24, figs. 6–8, 10–11.
Neogloboquadrina asanoi (Maiya, Saito, and Sato) = *Globoquadrina asanoi* Maiyo et al., 1976, p. 409, pl. 3, figs. 1a–c, 2a–c, 3.
Neogloboquadrina dutertrei (d'Orbigny) = *Globigerina dutertrei* d'Orbigny, 1839a, p. 84, pl. 4, figs. 19–21.
Neogloboquadrina humerosa (Takayanagi and Saito) = *Globorotalia humerosa* Takayanagi and Saito, 1962, p. 78, pl. 28, figs. 1–2.
Neogloboquadrina pachyderma (Ehrenberg) = *Aristerospira pachyderma* Ehrenberg, 1861, p. 276–277, 303.
Orbulina universa d'Orbigny, 1839a, p. 3, pl. 1, fig. 1.
Pulleniatina obliquiloculata (Parker and Jones) = *Pullenia sphaeroides* var. *obliquiloculata* Parker and Jones, 1865, p. 354, pl. 19, fig. 4.
Bolivina argentea Cushman, 1926b, v. 2, pt. 2, no. 29, p. 42, pl. 6, fig. 5.
Bolivina interjuncta (Cushman) = *Bolivina costata* d'Orbigny var. *interjuncta* Cushman, 1926b, p. 41, pl. 6, fig. 3.
Bolivina pseudobeyrichi Cushman, 1926b, p. 45.
Bolivina seminuda Cushman, 1911, v. 71, pt. 2, p. 34, fig. 55.
Bolivina subspinescens Cushman, 1922a, v. 104, p. 48, pl. 7, fig. 5.
Bolivina spissa Cushman = *Bolivina subadvena* Cushman var. *spissa* Cushman, 1926b, v. 2, pt. 2, p. 45, pl. 6, fig. 8.
Bolivina translucens Phleger, 1951, pt. 1, p. 15, pl. 7, figs. 13–14.
Bolivinita quadrilatera (Schwager) = *Textularia quadrilatera* Schwager, 1866, p. 253, pl. 7, fig. 10.
Buccella frigida (Cushman) = *Pulvinulina frigida* Cushman, 1922b, p. 144.

Table 5 (continued).

Gyroidina soldanii altiformis	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Hoeglundina elegans*	*Lagena* spp.	*Lenticulina* sp.	*Martinottiella communis*	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	costate *Nodosaria* spp.	*Nonionella miocenica*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia* sp.	*Pullenia bulloides*	*Pullenia salisburyi*	*Pullenia* sp.	*Pyrgo* sp.	*Quinqueloculina* sp.	*Sphaeroidina bulloides*	*Stilostomella* spp.	*Textularia* sp.	*Triloculina* sp.	*Uvigerina hispida*	*Uvigerina hootsi*	*Uvigerina* spp.	*Uvigerina peregrina*	*Uvigerina senticosa*	*Uvigerina subperegrina*	*Valvulineria araucana*	*Valvulineria* spp.	Benthic Species Diversity	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerina umbilicata*	*Globigerinita glutinata*	*Globigerinoides ruber*	*Globorotalia inflata*	*Globorotalia inflata* (primitive)	*Globorotalia puncticulata*	*Globorotalia scitula*	*Neogloboquadrina asanoi*
	R			X				X		R					X					R	X			X								11	10	1		4		3				7
				X				R	R		X			X	X			R	R	R			X		R			R				27	78	5	2				5			19
	R		X			R	X		R	R		X	R	R				X	X	X					R							32	15			1	1			5	1	5
					X				X			R			R										C							13	4									1
X		X			R	F			R						R	X				X					C							12										
C						X			R	R	X		R					X										R				15	5									
R	R			X	X		F		R	R			F	R	R						R						R			X		26	21	3		3			11			
						F									X										X							9							2			
X									R	R																						5	2									1
	R					X	R				X				R									X								13	6									
X						X		X						X																		6										
																										X						2										
X			X						X								X				X								X			10										1
	X						X	R	X				X								X						R	R				15	8	2								6
		X				X			X				X																		X	7	2									2
X					X	X			R													X				R						10										
X						R	X		X		R	X					X											R				10	10									
X	X				X			X	R	X	X		R		R			R								X		R				19	3									15
R	X							R	F	R	R		R	X	R				X							X		C			X	18		3		1					1	2
								R	X	X																		R				5										

Buccella oregonensis (Cushman, Stewart, and Stewart) = *Eponides mansfieldi* Cushman var. *oregonensis* Cushman et al., 1947, p. 48, pl. 6, fig. 4.
Buccella tenerrima (Bandy) = *Rotalia tenerrima* Bandy, 1950, p. 278, pl. 42, fig. 3.
Bulimina aculeata d'Orbigny, 1826, p. 269.
Bulimina barbata Cushman 1927b, v. 1, no. 10, p. 151, pl. 2, fig. 11.
Bulimina exilis Brady = *Bulimina elegans* d'Orbigny var. *exilis* Brady, 1884, v. 9, no. 22, p. 399, pl. 50, fig. 50.
Bulimina fossa Cushman and Parker, 1938, v. 14, pt. 3, p. 56, pl. 9, fig. 10.
Bulimina inflata Heron-Allen and Earland, 1913, v. 31, pt. 64, p. 68, pl. 4, fig. 16–19.
Bulimina jacksonensis welcomensis = *Bulimina jacksonensis* Cushman var. *welcomensis* Mallory, 1959, p. 193, pl. 16, fig. 7.
Bulimina microcostata Cushman and Parker, 1936, v. 12, p. 39, pl. 7, fig. 2.
Bulimina striata mexicana Cushman and Parker, 1940, v. 16, p. 16, pl. 3, fig. 9.
Bulimina subacuminata Cushman and R. E. Stewart, *in* Cushman et al., 1930, p. 65, pl. 5, figs. 2–3.
Bulimina subcalva Cushman and K. C. Stewart, *in* Cushman et al., 1930, p. 65, pl. 4, fig. 11.
Buliminella curta Cushman, 1925b, v.1, pt. 2, p. 33, pl. 5, fig. 13.
Buliminella elegantissima (d'Orbigny) = *Bulimina elegantissima* d'Orbigny, 1839a, p. 51, p. 7, figs. 13, 14.
Buliminella subfusiformis Cushman, 1925b, p. 33, pl. 5, fig. 12.
Cassidulina californica Cushman and Hughes, 1925, p. 12, pl. 2, fig. 1.
Cassidulina carinata Silvestri in Todd, 1965, p. 40, pl. 17, fig. 4.
Cassidulina cushmani Stewart and Stewart, 1930, v. 4, p. 71, pl. 9, fig. 5.
Cassidulina limbata Cushman and Hughes, 1925, p. 12, pl. 2, fig. 2.
Cassidulina minuta Cushman, 1933c, p. 92, pl. 10, fig. 3.
Cassidulina norcrossi Cushman, 1933a, p. 7, pl. 2, fig. 7.
Cassidulina teretis Tappan, 1951, p. 7, pl. 1, fig. 30.
Cassidulina translucens Cushman and Hughes, 1925, p. 15, pl. 2, fig. 5.
Cassidulinoides bradyi (Norman) = *Cassidulina* Brady, Norman in Brady, 1881, v. 24, p. 59.
Cassidulinoides cornuta (Cushman) = *Virgulina cornuta* Cushman, 1913, p. 637, pl. 80, fig. 1.
Chilostomella oolina Reuss, 1850, v. 1, p. 380, pl. 48, fig. 12.
Chilostomella ovoidea Reuss, 1850, v. 1, p. 380, pl. 48, fig. 12.
Cibicides perlucida Nuttall, 1932, v. 6, p. 33, pl. 8, figs. 10–12.

Table 5 (continued).

Core, section, interval (cm)	Depth (mbsf)	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina unviersa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
146-892A-							
1X-CC	4.3	4	15			19	21
2X-CC	13.2	9	94		1	#	9
3X-CC	22.9	0	42		3	45	0
4X-CC	30.4					0	
6X-CC	45.7				1	1	
7X-2, 10-15	50.1		3			3	
7X-CC	57.8	7	32		2	41	18
8X-CC	64.7	1				1	
9X-CC	68.6	1	1			2	
11X-CC	81.3			1	1	2	
12X-CC	88.5					0	
13X-CC	106.0					0	
14X-CC	107.0	1	4		1	6	
15X-CC	117.3	13	21		2	36	38
16X-CC	126.2	2				2	
17X-CC	136.7					0	
18X-CC	146.8	3	2			5	
20X-1,87-92	164.4	17	12		4	33	59
20X-CC	167.4	31	48		5	84	39
21X-CC	173.2	2	2		1	5	

Cibicidoides mckannai (Galloway and Wissler) = *Cibicides mckannai* Galloway and Wissler, 1927, p. 65, pl. 10, figs. 5–6.
Cibicidoides wuellerstorfi (Schwager) = *Anomalina wuellerstorfi* Schwager, 1866, p. 258, pl. 7, figs 105, 107.
Dentalina spp. - Specimens of this group are often broken.
Eggerella bradyi (Cushman) = *Verneuilina bradyi* Cushman, 1911, p. 54, fig. 87.
Elphidiella hannai (Cushman and Grant) = *Elphidium hannai* Cushman and Grant, 1927, p. 77, pl. 8, fig. 1.
Elphidiella oregonense (Cushman and Grant)= *Elphidium oregonense* Cushman and Grant, 1927, p. 79, pl. 8, fig. 3.
Elphidium excavatum clavatum = *Elphidium excavatum* (Terquem) forma *clavata* Cushman, 1930 = *Elphidium clavatum* Cushman, 1930, p. 20, pl. 7, fig. 10.
Epistominella exigua (Brady) = *Pulvinulina exigua* Brady, 1884, p. 696, pl. 103, figs. 13–14.
Epistominella pacifica (Cushman) = *Pulvinulinella pacifica* Cushman, 1927b, p. 165, pl. 5, figs. 14–15.
Eponides healdi Stewart and Stewart, 1930, v. 4, no. 1, p. 70, pl. 8, fig. 8.
Eponides minima Cushman, 1933b, p. 17, pl. 2, fig. 5.
Fursenkoina bradyi = *Virgulina bradyi* Cushman, 1922a, v. 104, pt. 3, p. 115, pl. 24, fig. 1.
Glandulina laevigata d'Orbigny, 1826, p. 252, pl. 10, figs. 1–3.
Globobulimina affinis (d'Orbigny) = *Bulimina affinis* d'Orbigny 1839a, p. 105, pl. 2, figs. 25–26.
Globobulimina auriculata (Bailey) = *Bulimina auriculata* Bailey, 1851, p. 12, figs. 25–27.
Globobulimina pacifica Cushman, 1927a, p. 67, pl. 14, fig. 12.
Globocassidulina subglobosa Brady, 1881, p. 60.
Gyroidina orbicularis planata = *Gyroidina orbicularis* d'Orbigny var. *planata* Cushman, 1935, p. 45, pl. 18, fig. 3.
Gyroidina soldanii altiformis = *Gyroidina soldanii* d'Orbigny var. altiformis Stewart and Stewart, 1930, p. 67, pl. 9, fig. 2.
Gyroidina soldanii rotundimargo = *Gyroidina soldanii* d'Orbigny var. *rotundimargo* Stewart and Stewart, 1930, p. 68, pl. 9, fig. 3.
Hoeglundina elegans (d'Orbigny) = *Rotalia (Turbinulina) elegans* d'Orbigny, 1826, p. 276.
"*Lagena*" spp. - Included in this species groups are all unilocular lagenids
Laticarinina pauperata (Parker and Jones) = *Pulvinulina repanda* Fichtel and Moll var. *menardii* d'Orbigny subvar. *pauperata* Parker and Jones, 1865, v. 155, p. 395, pl. 16, figs. 50–51.
Lenticulina texana (Cushman and Applin) = *Cristellaria articulata* Reuss var. *texana* Cushman and Applin, 1926, v. 10, no. 2, pl. 8, fig. 1.
Martinottiella communis (d'Orbigny) = *Clavulina communis* d'Orbigny, 1826, p. 268.
Melonis barleeanum (Williamson) = *Nonionina barleeana* Williamson, 1858, p. 32, pl. 3, figs. 68–69.
Melonis pompilioides (Fichtel and Moll) = *Nautilus pompilioides* Fichtel and Moll, 1798, p. 32, pl. 2, figs. a–c.
Nodosaria spp. - costate forms
Nodosaria spp. - noncostate forms
Nonionella globosa Ishiwada, 1950, v. 1, n. 4, pl. 10, fig. 3.
Nonionella miocenica Cushman, 1926a, p. 64.
Nonionella turgida digitata = *Nonionella turgida* (Williamson) var. *digitata* Nörvang, 1945, p. 29, fig. 4.
Nonionellina labradorica (Dawson) = *Nonionina labradorica* Dawson, 1860, p. 192, tf. 4.
Oridorsalis umbonatus (Reuss) = *Rotalina umbonata* Reuss, 1851, v. 3, p. 75, pl. 5, fig. 35.
Plectofrondicularia californica Cushman and Stewart, 1926, p. 39, pl. 6, figs. 9–11.
Pullenia bulloides d'Orbigny, 1846, p. 107, pl. 5, figs. 9–10.
Pullenia salisburyi Stewart and Stewart, 1930, p. 72, pl. 8, fig. 2.
Sphaeroidina bulloides d'Orbigny, 1826, ser. 1, 7:267.
Tosaia hanzawai Takayanagi, 1953, p. 30, pl. 4, fig. 7.
Trichohyalus ornatissima (Cushman) = *Discorbis ornatissima* Cushman, 1925a, p. 42, pl. 6, figs. 11–12.
Trifarina angulosa (Williamson) = *Uvigerina angulosa* Williamson, 1858, p. 67, pl. 5, fig. 140.
Trifarina hannai (Beck) = *Angulogerina hannai* Beck, 1943, v. 17, n. 6, p. 607, 608, pl. 108, figs. 26, 28.
Tritaxilina colei Cushman and Siegfus, 1935, p. 92, pl. 14, figs. 5–6.
Uvigerina dirupta Todd = *Uvigerina peregrina* Cushman var. *dirupta* Todd, 1948, v. 6, no. 5, p. 267.

Uvigerina garzaensis Cushman and Siegfus, 1939, v. 15, pl. 28, pl. 6, fig. 15.
Uvigerina hispida Schwager, 1866, v. 2, pt. 2, p. 249, pl. 7, fig. 95.
Uvigerina hootsi Rankin *in* Cushman and Kleinpell, 1934, v. 10, pt. 1, p. 22, pl. 3, figs. 8–9.
Uvigerina juncea Cushman and Todd, 1941, p. 78, pl. 20, figs. 4–11.
Uvigerina peregrina Cushman, 1923, p. 166.
Uvigerina senticosa Cushman, 1927b, v. 1, p. 159.
Uvigerina subperegrina Cushman and Kleinpell, 1934, v. 10, p. 12, pl. 2, figs. 9–11.
Valvulineria araucana (d'Orbigny) = *Rosalina araucana* d'Orbigny, 1839c, p. 44, pl. 6, figs. 16–18.

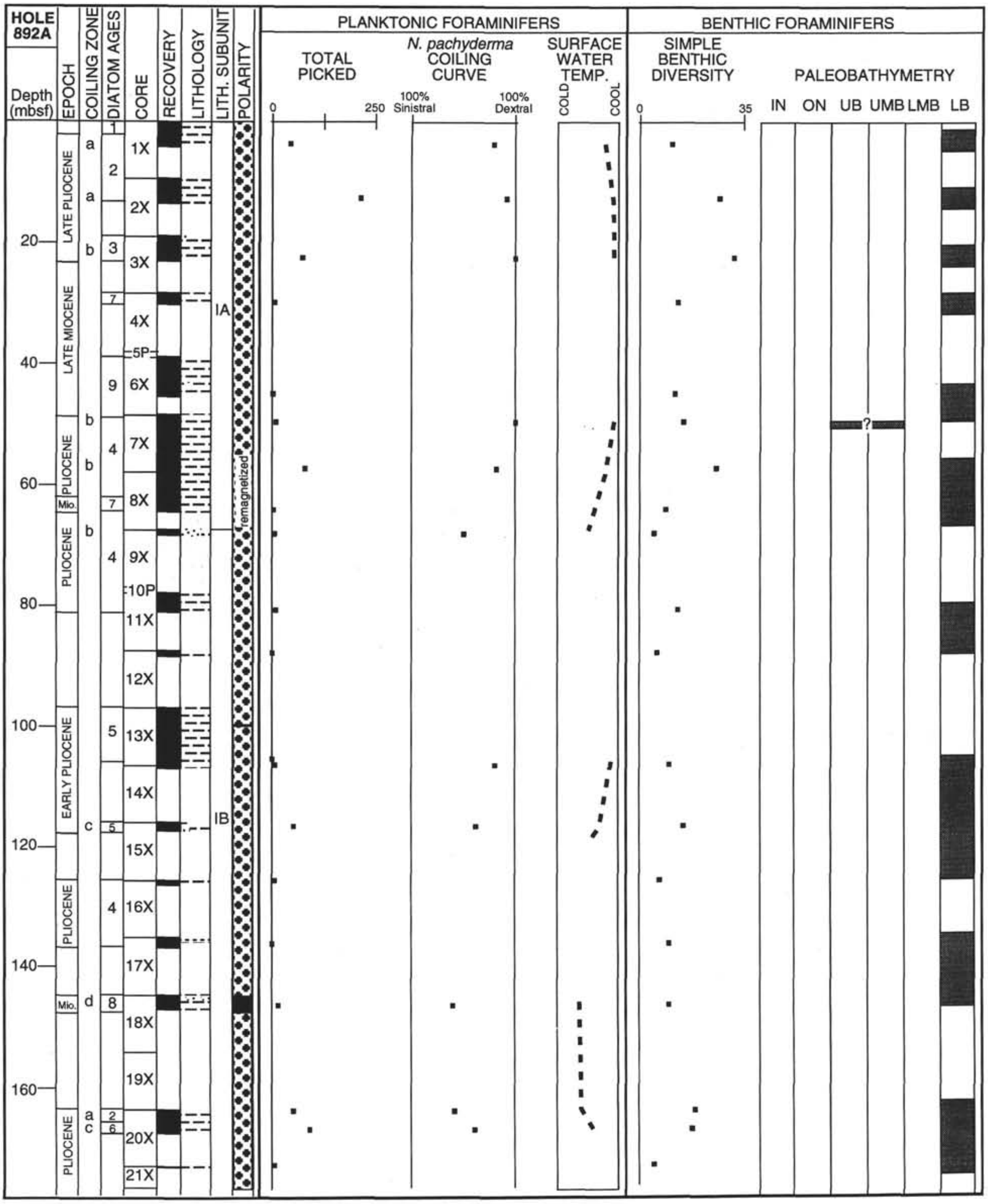

Figure 7. Summary of age zonation, core recovery, lithology, magnetic polarity, foraminiferal distributions, inferred sea-surface temperatures, and paleobathymetry at Hole 892A. Coiling zones, determined by diatom ages (see text), are as follows: a = CD12-14; b = CD15; c = CD15-16; and d = unzoned. Diatom ages (in Ma) are from Fourtanier (this volume) as follows: 1 = 1.6–0.32; 2 = 2.6–1.6; 3 = 2.7–2.6; 4 = 3.7–2.6; 5 = 5.4–3.75; 6 = 5.4–2.6; 7 = 6.2–6.0; 8 = 6.9–6.6; and 9 = 9.2–8.3. Key to lithologic symbols: coarse stipple = sand and thin dashed pattern = silt; Key to polarity units: black = normal polarity and cross pattern = demagnetized. A minor fault occurs at 52 mbsf and a fault zone extends from 106.5 mbsf to 160 mbsf (Shipboard Scientific Party, 1994e). See Shipboard Scientific Party (1994e) for more detailed lithologic, paleomagnetic, and structural information.

Table 6. Checklist of foraminifers found at Hole 892B.

Core, section, interval (cm)	Depth (mbsf)	Barren samples	Preservation	Aggglutinated spp. indeterminate	*Anomalina* sp.	*Bolivina argentea*	*Bolivina* spp.	*Bolivina translucens*	*Bolvina spissa*	*Buccella oregonensis*	*Buccella tenerrima*	*Bulimina aculeata*	*Bulimina barbata*	*Bulimina exilis*	*Bulimina jacksonensis welcomensis*	*Bulimina microcostata*	*Bulimina* sp.	*Bulimina striata mexicana*	*Bulimina subacuminata*	*Bulimina subcalva*	*Buliminella curta*	*Buliminella subfusiformis*	Calcareous spp. indeterminate	*Cassidulina californica*	*Cassidulina carinata*	*Cassidulina globosa*	*Cassidulina limbata*	*Cassidulina norcrossi*	Cassidulina spp.	*Cassidulina translucens*	*Cassidulinoides bradyi*	*Chilostomella oolina*	*Chilostomella ovoidea*	*Cibicides perlucida*	*Cibicides* sp.	*Cibicides* spp.	*Cibicidoides mckanni*	*Cibicidoides* spp.	*Cibicidoides wuellerstorfi*
146-892D-																																							
1X-CC	0.2		G				X					R		R				F	X				R				X			R						X	R	X	
2X-1, 1-6	8.5		M		X		X	X				R	R					F					X									F				X	F	X	
2X-CC	11.8		M				X		R					R				R											X							X		X	X
3X-1, 11-13	18.1	B																																					
3X-CC	18.9		G											R				R												X						X			R
4X-1, 99-105	28.5		M																																				
4X-CC	31.3		M											R				R	R				R		R					R	X					X			X
5X-1, 17-22	37.2		M											R				R	R				X					F		X	R		R						R
5X-2, 64-69	39.1		G						C		C		X	X			X					A							X										
5X-2, 132-135	39.8		G						R		F											C																	X
5X-3, 138-143	41.4		M						R		R																		X								R		
5X-CC	43.1		M								R																												
6X-2, 64-70	48.6		M						X																														
6X-CC	53.5		M																																	R			
7X-4, 140-143	59.7		G						A		R											X								X						R			R
7X-CC	61.6		M						X																			R											
8X-2, 73-78	63.7		G										R						R	R			R																X
8X-CC	67.0	B																																					
9X-4, 27-29	72.9		P																	R																			
9X-CC	76.0		M										X					R		F			R																
10X-6, 63-67	107.0		M	R	X					R					X	R							F			X							X	C	X				
10X-CC	110.7		P																				X																
11X-1, 14-19	109.6	B																																					
11X-2, 38-43	111.4		M														X	R		F																R			
11X-CC	113.1		M																																		X		
12X-2, 85-90	121.4		G											X						R										X						R	X		
12X-CC	124.8		P																				X																
13X-CC	128.8		G																																				
14X-CC	140.1		G			X											X	R			X			X															R
15X-1, 35-40	147.9		M																				X																
15X-3, 65-69	151.2		M										X	X																							X	X	
15X-CC	152.6		M																	R			X																
16X-2, 66-71	158.7		P	x																																			
16X-4, 6-11	161.1		M								R									X								R								X			
16X-CC	164.5		P																				X																

Note: B = barren samples; see text for explanation of additional abbreviations.

Table 6 (continued).

Cyclammina sp.	*Dentalina* spp.	*Eggerella bradyi*	*Elphidium* spp.	*Epistominella pacifica*	*Epistominella* sp.	*Eponides healdi*	*Eponides minima*	*Eponides* sp.	*Fissurina* spp.	*Fursenkoina bradyi*	*Fursenkoina* sp.	*Glandulina laevigata*	*Globobulimina affinis*	*Globobulimina pacifica*	*Globocassidulina subglobosa*	*Gyroidina orbicularis planata*	*Gyroidina soldanii altiformis*	*Gyroidina soldanii rotundimargo*	*Gyroidina* spp.	*Haplophragmoides* spp.	*Hoeglundina elegans*	*Lagena* spp.	*Laticarinina pauperata*	*Lenticulina* spp.	*Lenticulina texana*	*Martinottiella communis*	*Melonis barleeanum*	*Melonis pompilioides*	*Nodosaria* spp.	costate *Nodosaria* spp.	*Nonionella globosa*	*Nonionella miocenica*	*Nonionella turgida digitata*	*Nonionellina labradorica*	*Oridorsalis umbonatus*	*Plectofrondicularia californica*	*Plectofrondicularia* sp.	*Pullenia bulloides*	*Pyrgo* sp.	*Quinqueloculina* sp.	*Silicosigmoilina* sp.	*Sphaeroidina bulloides*	*Stilostomella* spp.	*Tosaia hanzawai*
	X			X					X				X	C			R					R	X			R	R		X			R					R	R					R	
	R	R	X	X				X		R	R	X	X	X	R		X	X				F		X			C	X	F	R					R		R	R	R				F	R
	X								X					F			X											R	X	X							X	R					X	
									R					F													X	R	R						X					X			R	
																										F															F			
	R			F							R		X	R												R	X		X	R	X	X	X	X	R								R	
	R			F								X		R								R				R			R	F	X				R		F						R	
	R			F		X			X			R		R								X							F	X				F			R					X		
	X			R					R			X	X											X										F			X							
				X		X		X						X			R					X				R	X							R			X	R			X			
																										X																		
															X											R															F			
																													X															
	R			R		R		R	R						F		R									R											X	R				X		
	R								X				X	F			R	R						X		C			X															
	R					X								R	X			X									F		R						R		X		X				R	
	R																	X											X				X										X	
	R				R												R					R				X			X										X					
X	X						X		X							X			R	R				R	R				R	X						X				X				
																										X																		
	X					X																					R	R	R						R		X							
	R								X					R				R									X	R	R															
	X			X					X					R				X			X						R	R	R						R			X	X	X			R	
	X																												X															
	R																																											
	R			R	X			X						X				R								X	R		X	R					X		X		X				X	
	X								X																				X	F								R					R	
								X	R								X												R								R	R						
																		X	X							X		R							X									
														X						X																								

Table 6 (continued).

Core, section, interval (cm)	Depth (mbsf)	Barren samples	*Trifarina hannai*	*Triloculina* sp.	*Tritaxilina colei*	*Uvigerina dirupta*	*Uvigerina garzaensis*	*Uvigerina hispida*	*Uvigerina hootsi*	*Uvigerina peregrina*	*Uvigerina senticosa*	*Uvigerina* sp.	*Uvigerina subperegrina*	*Valvulineria araucana*	*Valvulineria* spp.	Simple Benthic Diversity	*Catapsydrax* sp.	*Globigerina bulloides*	*Globigerina quinqueloba*	*Globigerinita glutinata*	*Globigerinita uvula*	*Globogerina umbilicata*	*Globorotalia crassiformis*	*Morozovella aragonensis*	*Neogloboquadrina asanoi*	*Neogloboquadrina dutertrei*	*Neogloboquadrina pachyderma* (s)	*Neogloboquadrina pachyderma* (d)	*Orbulina universa*	Planktonic spp. indeterminate	Total planktonic foraminifers	Sinistral *N. pachyderma* (%)
146-892D-																																
1X-CC	0.2			X		R		R		R			R		X	5		26			1				4		3	36			70	8
2X-1, 1-6	8.5			R				R	R			X	F	R	R	8		129	5	2		1					10	303		27	477	3
2X-CC	11.8								R	X	R		R			4		39	3						15		17	67		1	142	20
3X-1, 11-13	18.1	B														0															0	
3X-CC	18.9										R					1		30	1	1					3			52			87	0
4X-1, 99-105	28.5															0															0	
4X-CC	31.3												X	X	X	4		16		1			1		1		3	15	1		38	17
5X-1, 17-22	37.2			R												0		42									5	29			76	15
5X-2, 64-69	39.1							R	C							2															0	
5X-2, 132-135	39.8								C							1		6													6	
5X-3, 138-143	41.4								R							1		1													1	
5X-CC	43.1												R			1															0	
6X-2, 64-70	48.6								R				X			2															0	
6X-CC	53.5								X							1															0	
7X-4, 140-143	59.7								F				R			2		1													1	
7X-CC	61.6										X	R				2											1				1	
8X-2, 73-78	63.7							R		R		X	R	X		5															0	
8X-CC	67.0	B														0															0	
9X-4, 27-29	72.9									X			X			2												1		2	3	
9X-CC	76.0										X					1												3			3	
10X-6, 63-67	107.0		X		X		R						X			3	1	1						1	1		1	3		1	9	
10X-CC	110.7															0															0	
11X-1, 14-19	109.6	B														0															0	
11X-2, 38-43	111.4										F	R	X			3		1							1		2	4			8	
11X-CC	113.1										R				X	2		3													3	
12X-2, 85-90	121.4							X		R	C			X		4		14	3								8	10			35	44
12X-CC	124.8															0												1			1	
13X-CC	128.8															0									1						1	
14X-CC	140.1															0		1									1	2		1	5	
15X-1, 35-40	147.9															0															0	
15X-3, 65-69	151.2										R					1		43	2			1			1		7	13			67	35
15X-CC	152.6								X		R		R			3		7	3							1	2	12			25	14
16X-2, 66-71	158.7															0															0	
16X-4, 6-11	161.1												F			1											1				1	
16X-CC	164.5															0															0	

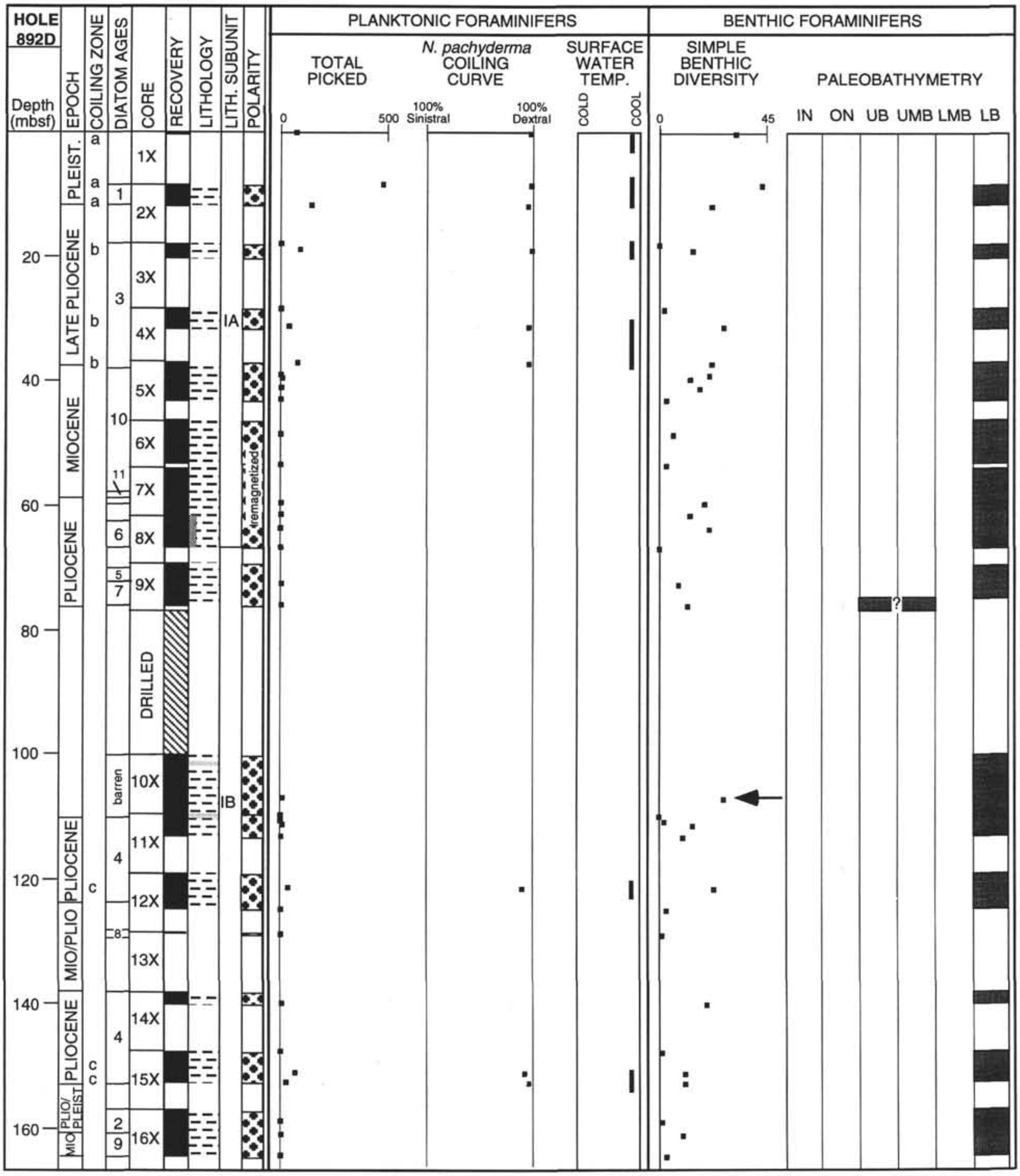

Figure 8. Summary of age zonation, core recovery, lithology, magnetic polarity, foraminiferal distributions, inferred sea-surface temperatures, and paleobathymetry at Hole 892D. Coiling zones, determined by diatom ages (see text), are as follows: a = CD8-11; b = CD11-13; and c = CD13. Diatom ages (in Ma) are from Fourtanier (this volume) as follows: 1 = 1.6–0.32; 2 = 2.0–0.5; 3 = 2.4/2.6–1.6; 4 = 2.7/2.6–1.8; 5 = 3.7–2.0; 6 = 3.7–2.6; 7 = 5.4–3.75; 8 = 6.6–5.4; 9 = 7.45–6.5; 10 = 9.2–8.3; 11 = 12.7–11.4. Key to lithologic symbols: fine stipple = mud and dashed pattern = silt; Key to polarity units: cross pattern = demagnetized. Arrow shows location of Sample 146-892D-10X-6, 63–67 cm. This sample occurs in the top of a fault zone that extends from 100 mbsf to the bottom of the hole (Shipboard Scientific Party, 1994e). See Shipboard Scientific Party (1994e) for more detailed lithologic and paleomagnetic information.

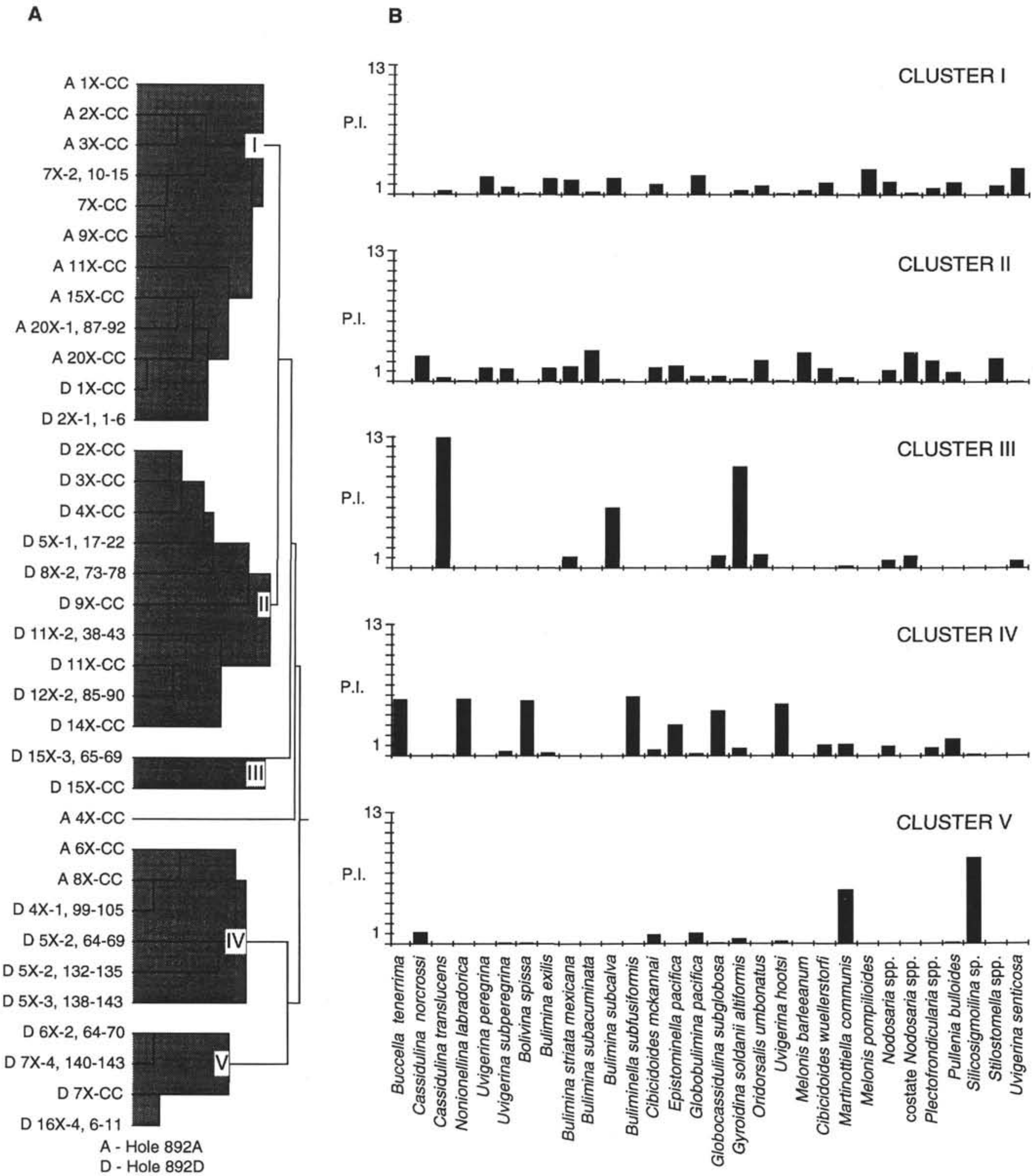

Figure 9. Results of cluster analysis on benthic foraminifers from Site 892. **A.** Dendrogram. **B.** Preference indexes for taxa analyzed by cluster analysis (see text).

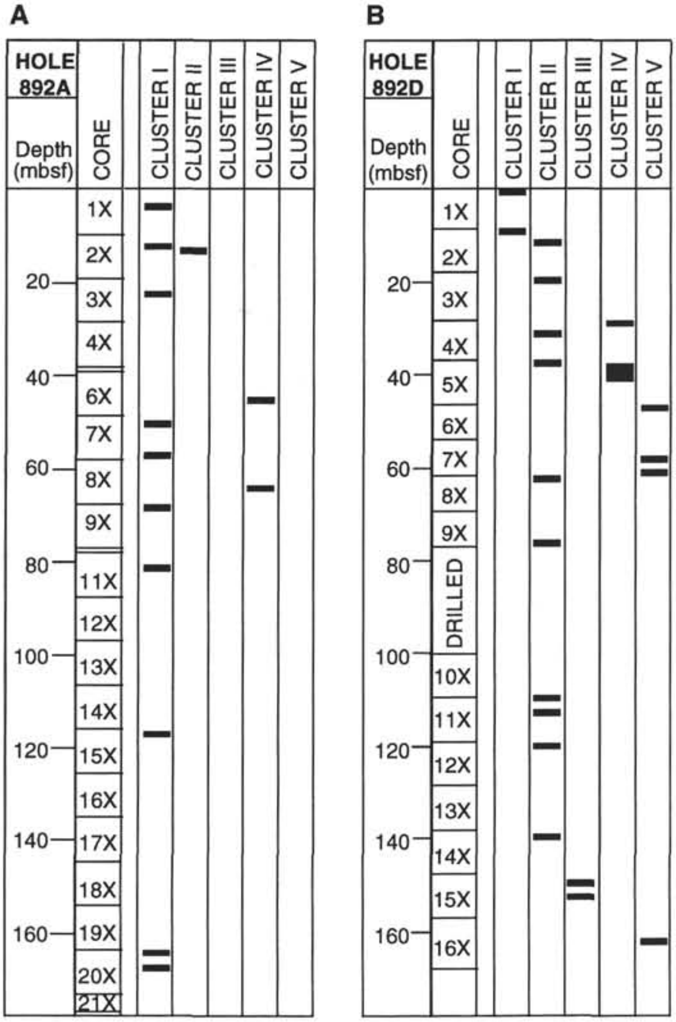

Figure 10. Stratigraphic distribution of samples in each cluster group. **A.** Hole 892A. **B.** Hole 892D.