12. SHORE LABORATORY REPORT ON CENOZOIC PLANKTONIC FORAMINIFERA: LEG 33

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INTRODUCTION

Calcareous sediments from Sites 315, 316, 317, and 318 were examined in order to determine the stratigraphic distribution of Cenozoic planktonic foraminifers in cores recovered on Leg 33 of the Deep Sea Drilling Project. These sites are south of the Hawaiian Islands: Sites 315 and 316 located along the Line Islands, Site 317 on the Manihiki Plateau, and Site 318 in an elongate perched basin on the Tuamotu Ridge.

The samples, with a dry weight of 2 to 5 g were washed on a 200-mesh sieve (opening: 0.074 mm) for foraminiferal study. All species encountered in the respective samples are shown in Tables 1 to 5, with indications of their relative abundances. The abundance of each species is shown by a letter symbol as follows:

Relative Abundance	Percent
P (Very rare)	<2
R (Rare)	2-4
C (Common)	4-16
A (Abundant)	16-32
VA (Very abundant)	>32

The number of specimens generally exceeds far more than 400 in each count. However, in the case of samples poor in foraminifers (less than 200 specimens) only presence is indicated by the symbol "+".

LIST OF SPECIES

Abundant well-preserved planktonic foraminifers, ranging in age from Eocene to Pleistocene occur in the examined cores. As far as classification of the Cenozoic forms is concerned, a noteworthy contribution has recently been made by Fleisher (1974). His classification for foraminiferal genera differs somewhat from those of previous workers, but is thus adopted in this report with some reservations for future work. In order to avoid taxonomic confusion, the full species name, author, and date of original publication are listed below, with an indication of the genus in which the species was originally placed.

Acarinina boudreauxi Fleisher, 1974
Acarinina broedermanni (Cushman and Bermudez, 1949) (ex *Globorotalia*)
Acarinina mckannai (White, 1928) (ex *Globigerina*)
Acarinina mattseensis alticonica Fleisher, 1974
Acarinina planodorsalis Fleisher, 1974
Acarinina pseudotopilensis Subbotina, 1953
Acarinina punctocarinata Fleisher, 1974
Acarinina rotundimarginata Subbotina, 1953
Acarinina soldadoensis (Bronnimann, 1952) (ex *Globigerina*)
Acarinina spinuloinflata (Bandy, 1949) (ex *Globigerina*)
Biorbulina bilobata (d'Orbigny, 1846) (ex *Globigerina*)
Candeina nitida d'Orbigny, 1839
Cassigerinella chipolensis (Cushman and Ponton, 1932) (ex *Cassidulina*)
Catapsydrax africanus (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax dissimilis ciporensis (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax dissimilis dissimilis (Cushman and Bermudez, 1937) (ex *Globigerina*)
Catapsydrax globiformis (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax howei (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax martini martini (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax martini scandretti (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax perus (Todd, 1957) (ex *Globigerinita*)
Catapsydrax riveroae (Bermudez, 1961) (ex *Globigerinita*))
Catapsydrax stainforthi Bolli, Loeblich, and Tappan, 1957
Catapsydrax unicavus primitivus (Blow and Banner, 1962) (ex *Globigerinita*)
Catapsydrax unicavus unicavus Bolli, Loeblich, and Tappan, 1957
"*Catapsydrax*" *echinatus* Bolli, 1957
Chiloguembelina cubensis (Palmer, 1934) (ex *Guembelina*)
Globanomalina pseudoscitula (Glaessner, 1937) (ex *Globorotalia*)
Globigerina angulisuturalis Bolli, 1957
Globigerina apertura Cushman, 1918
Globigerina bulloides d'Orbigny, 1826
Globigerina calida Paker, 1962
Globigerina decoraperta Takayanagi and Saito, 1962
Globigerina digitata Brady, 1879
Globigerina druryi Akers, 1955
Globigerina falconensis Blow, 1959
Globigerina nepenthes Todd, 1957
Globigerina officinalis Subbotina, 1953
Globigerina ouachitaensis ciperoensis Bolli, 1957
Globigerina ouachitaensis gnaucki Blow and Banner, 1962
Globigerina ouachitaensis ouachitaensis Howe and Wallace, 1932
Globigerina parabulloides Blow, 1959
Globigerina praebulloides leroyi Blow and Banner, 1962
Globigerina praebulloides occlusa Blow and Banner, 1962

TABLE 1
Distribution of Cenozoic Planktonic Foraminifers, Hole 315A

Age	Late Miocene					Mid. Mio.	Early Miocene								a
Zone	N.17					N.13?	N.12	N.8?	N.6	N.4					P.21
Species \ Sample (Interval in cm)	1-1, 97-99	1-5, 80-82	3-1, 84-86	3-3, 60-62	3-5, 32-34	4-1, 102-104	4-3, 77-79	5-1, 116-118	6-1, 84-86	6-3, 103-105	7-1, 118-120	8-1, 106-108	8-3, 31-33	9-2, 12-14	
Biorbulina bilobata		P	P		P										
Catapsydrax dissimilis ciperoensis											p				
C. dissimilis dissimilis											P	P	P		
C. unicarvus unicarvus											R	P			R
Globigerina angustiumbilicata										R	R	R	A		V
G. decoraperta	C	C	C		R										
G. druryi							P								
G. falconensis	P														
G. nepenthes		R	P	C	P										
G. ouachitaensis ciperoensis												A	R		P
G. parabulloides						P									
G. praebulloides leroyi											R				
G. praebulloides praebulloides												C			P
G. woodi						R									
Globigerinatella insueta								P							
Globigerinella siphonifera siphonifera	P		P												
Globigerinita glutinata	C	C	C	C	V	C	C	R	+	A	V	C	C		
G. uvula			P		C		P		+	C	C		P		
Globigerinoides bollii			P												
G. extremus		P	P												
G. gomitulus		P													
G. obliquus		P	P		P		P								
G. quadrilobatus immaturus			P	P			R								
G. quadrilobatus primordius													P		
G. quadrilobatus sacculifer		C	C	P	P	R	P								
G. quadrilobatus trilobus	R	P	R	P		C	P	P	+						
G. subquadratus							P	P							
Globoquadrina altispira altispira	C	C	R	P	C	C	A	P	+	C					
G. altispira globosa	C	P		C											
G. deshicens advena	C	R	R	P											
G. dehiscens dehiscens					P	C									
G. dehiscens praedehiscens										R	C				
G. galavisi															P
G. tripartita tripartita										P		P	P		
G. venezuelana	P	P	C	C	R	P	C	R	+	C	C	P	C		
Globorotalia acostaensis	C	P	A	C	C										
G. birnageae								V							
G. continuosa						A	C	C							
G. cultrata	P	C	C	C	P	P									
G. fohsi fohsi							R								
G. fohsi lobata							P								
G. kugleri										P	C	V	A		
G. lenguaensis						P									
G. merotumida	C		P	R											
G. miozea cibaoensis			P			R									
G. obesa		P				R	P					P			
G. opima nana													C		
G. opima opima															R
G. peripheroacuta							C								
G. peripheroronda							P		+						
G. prasaepis															R
G. pseudokugleri												P	C		C
G. siakensis						V	A	C	+	A	C	C	R		V
G. cf. *siakensis*						C	C	P	+	A		R			
G. tumida plesiotumida	P		R	C	C										
Globorotaloides hexagonus		P													
G. suteri									+		C	P	R		R
G. valiabilis				P							P				
Orbulina suturalis				P											
O. universa	P	P	R	P	P										
Pulleniatina primalis	R	P	P												
Sphaeroidinellopsis seminulina seminulina	R	C	P	C	P	R	R		+			P			
S. subdehiscens	P	A	C	C	R	R	P								
Subbotina gortanii gortanii															P
Tenuitella clemenciae															P
T. praestainforthi												P	C		R

[a]Oligocene.

TABLE 2
Distribution of Cenozoic Planktonic Foraminifers, Site 316

Age	Pleist.	?	a	b	c		d		
Zone	N.22	?	N.4?	P.22?	P.9?		?		
Species \ Sample (Interval in cm)	1-1, 70-72	1-3, 130-132	1-5, 90-92	2-1, 130-132	3-1, 138-140	4-1, 87-89	9-1, 120-122	10-1, 83-85	12-2, 48-50	14-1, 118-120	16-1, 70-72	17-1, 128-130
Acarinina soldadoensis								+				
Globanomalina pseudoscitula								+				
Globigerina bulloides	P											
G. calida	P	R										
G. decoraperta					+	+						
G. falconensis	C	P	R		+			+				
G. nepenthes									+			
G. rubescens	P			P	+			+				
G. woodi						+						
Globigerinella siphonifera siphonifera	R	C	R		+							
Globigerinita glutinata	A	P	C		+	+		+				
G. uvula			P			+						
Globigerinoides bollii								+				
G. conglobatus		P	P			+						
G. elongatus		P										
G. extremus	P											
G. gomitulus									+			
G. quadrilobatus immaturus	R	R			+							
G. quadrilobatus sacculifer	R	C	R		+			+				
G. quadrilobatus trilobus	P	R										
G. ruber	C	R			+	+		+				
"Globigerinoides" tenellus								+				
Globoquadrina altispira altispira						+						
G. conglomerata		P										
G. pseudofoliata	C	C	P									
G. venezuelana						+						
Globorotalia acostaensis					+	+						
G. cultrata		R	P									
G. dutertrei	C	A	V									
G. imitata								+	+			
G. kugleri					+	+						
G. mayeri								+	+			
G. siakensis						+						
G. tosaensis			P									
G. truncatulinoides	P	C	C									
G. tumida tumida	A	C	C					+				
G. ungulata	R											
Globorotaloides hexagonus	P		P									
Orbulina suturalis			P		+							
O. universa		P	P		+							
Pulleniatina obliquiloculata	A	A	C									
Sphaeroidinella dehiscens		P	R									
Sphaeroidinellopsis seminulina seminulina					+							
S. subdehiscens					+							
Tenuitella minutissima						+						
Turborotalita humilis	P											

[a]Early Miocene.

[b]Oligocene.

[c]Early Eocene.

[d]Paleocene?.

Globigerina praebulloides praebulloides Blow, 1959
Globigerina praedigitata Parker, 1967
Globigerina rubescens Hofker, 1956
Globigerina woodi Jenkins, 1960
Globigerinatella insueta Cushman and Stainforth, 1945
Globigerinatheka index index (Finlay, 1939) (ex *Globigerinoides*)

TABLE 3
Distribution of Cenozoic Planktonic Foraminifers, Hole 317

Species \ Sample (Interval in cm)	1-1, 70-72	1-3, 70-72	1-4, 70-72	1-5, 70-72	2-1, 80-82	2-3, 110-112	2-5, 70-72
Age	Pleistocene				Early Miocene		
Zone			N.22		N.6	N.5	N.4
Biorbulina bilobata	P		P				
Candeina nitida	P						
Catapsydrax dissimilis ciperoensis						P	
C. dissimilis dissimilis					P		
C. unicavus unicavus						P	
Globigerina angustiumbilicata					C	A	V
G. bulloides		P	P				
G. calida	R	P		P			
G. falconensis		P		P			
G. praebulloides leroyi					P		
G. praebulloides occlusa						P	
G. rubescens	P	A	A	A			
G. woodi							C
Globigerinella siphonifera involuta						P	
G. siphonifera siphonifera	C	R	R	P			
Globigerinita glutinata	C	V	A	V	V	A	C
G. iota	P			P			
G. uvula	P	P	P	P	A	A	C
Globigerinoides conglobatus	C	R	C	P			
G. elongatus		P	R	P			
G. quadrilobatus altiaperturus					P	C	
G. quadrilobatus immaturus	A	P	P	P	P	R	
G. quadrilobatus primordius							R
G. quadrilobatus sacculifer	C	P	R	P	P	P	
G. quadrilobatus trilobus	R	R		R			
G. ruber	C	A	A	A			
"Globigerinoides" tenellus	P	R	P	R			
Globoquadrina altispira altispira					P		
G. conglomerata	P						
G. dehiscens dehiscens					P		
G. dehiscens praedehiscens					R	P	P
G. pseudofoliata			P	P			
Globorotalia crassaformis			P	P			
G. cultrata	C						
G. dutertrei	P		P				
G. kugleri							A
G. obesa					P	P	P
G. peripheroronda						P	
G. siakensis					R		
G. tosaensis			P				
G. truncatulinoides	P						
G. tumida tumida	R		R	P			
G. ungulata				P			
Globorotaloides hexagonus			P				
G. suteri					P	P	

TABLE 3 – *Continued*

Species \ Sample (Interval in cm)	1-1, 70-72	1-3, 70-72	1-4, 70-72	1-5, 70-72	2-1, 80-82	2-3, 110-112	2-5, 70-72
Age	Pleistocene				Early Miocene		
Zone			N.22		N.6	N.5	N.4
Orbulina suturalis	P						
O. universa	C	R	C	P			
Pulleniatina obliquiloculata	R		P				
Sphaeroidinella dehiscens	P		R				
Subbotina gortanii gortanii						P	
Tenuitella anfracta	P			P			
T. clemenciae							P
T. minutissima						P	
Turborotalita humilis	P			P			
T. praepumilio	P						

Globigerinatheka index tropicalis (Blow and Banner, 1962) (ex *Globigerapsis*)
Globigerinatheka mexicana barri Brönnimann, 1952
Globigerinatheka mexicana kugleri (Bolli, Loeblich, and Tappan, 1957) (ex *Globigerapsis*)
Globigerinatheka mexicana mexicana (Cushman, 1925) (ex *Globigerina*)
Globigerinatheka semiinvoluta (Keijzer, 1945) (ex *Globigerinoides*)
Globigerinatheka senni (Beckmann, 1953) (ex *Sphaeroidinella*)
Globigerinatheka subconglobata curryi Proto Decima and Bolli, 1970
Globigerinatheka subconglobata luterbacheri Bolli, 1972
Globigerinatheka subconglobata subconglobata (Chalilov, 1958) (ex *Globigerinoides*)
Globigerinella siphonifera involuta (Cushman, 1917) (ex *Globigerina*)
Globigerinella siphonifera siphonifera (d'Orbigny, 1839) (ex *Globigerina*)
Globigerinita glutinata Egger, 1893) (ex *Globigerina*)
Globigerinita iota Parker, 1962
Globigerinita uvula (Ehrenberg, 1861) (ex *Pylodexia*)
Globigerinoides bollii Blow, 1959
Globigerinoides conglobatus (Brady, 1879) (ex *Globigerina*)
Globigerinoides elongatus (d'Orbigny, 1926) (ex *Globigerina*)
Globigerinoides extremus Bolli and Bermudez, 1965
Globigerinoides gomitulus (Seguenza, 1880) (ex *Globigerina*)
Globigerinoides obliquus Bolli, 1957
Globigerinoides quadrilobatus altiaperturus Bolli, 1957
Globigerinoides quadrilobatus fistulosus (Schubert, 1910) (ex *Globigerina*)
Globigerinoides quadrilobatus immaturus LeRoy, 1939

TABLE 4
Distribution of Cenozoic Planktonic Foraminifers, Hole 317B

Age	Pleistocene					Pliocene						Late Miocene						Middle Miocene										
Zone	N.22				N.21	N.19					N.18	N.17				N.16		N.15				N.14			N.13	N.12		
Species \ Sample (Interval in cm)	1-1, 100-102	1-2, 100-102	1-4, 100-102	2-2, 100-102	2-4, 100-102	3-2, 100-102	3-4, 100-102	4-2, 100-102	4-4, 101-103	5-2, 100-102	5-4, 100-102	6-2, 100-102	6-4, 100-102	7-2, 100-102	7-4, 100-102	8-2, 100-102	8-4, 100-102	9-2, 100-102	9-4, 100-102	10-2, 100-102	10-4, 100-102	11-2, 100-102	12-2, 100-102	12-4, 100-102	13-2, 100-102	13-4, 100-102	14-2, 100-102	16-2, 100-102	16-4, 97-99	18-2, 114-116
Acarinina boudreauxi																													
A. broedermanni																													
A. mattseensis alticonica																													
A. punctocarinata																													
A. rotundimarginata																													
A. spinuloinflata																													
Biorbulina bilobata											P	P		P	P	P	R	C	P	P							P		
Candeina nitida			P		P	P	P																						
Cassigerinella chipolensis																													
Catapsydrax africanus																													
C. dissimilis ciperoensis																													
C. dissimilis dissimilis																													
C. globiformis																													
C. howei																													
C. martini martini																													
C. martini scandretti																													
C. perus																													
C. riveroae																													
C. stainforthi																													
C. unicavus primitivus																													
C. unicavus unicavus																													
"Catapsydrax" echinatus																													
Chiloguembelina cubensis																													
Globigerina angulisuturalis																													
G. angustiumbilicata																													P
G. apertura		P		P					C						P														
G. bulloides		R	P													P			P	P	P		P						
G. calida	P	P	P	P		P	R					P																	
G. decoraperta	R			C	P	C		R	A	A		P	A	C	V	C	C	C	V	C	V	C	A	A	C		C		
G. digitata			P																										
G. druryi																								C	C	C	C	A	P
G. falconensis	P	P			P	P			P	P		P					P	P	P				P						
G. nepenthes									R	R	P	P	C	R	R	P	P	C	R	R	R	P	P	R	P	P	P		
G. officinalis																													
G. ouachitaensis ciperoensis																													
G. ouachitaensis gnaucki																													
G. ouachitanensis ouachitaensis																													
G. parabulloides																													
G. praebulloides leroyi																													
G. praebulloides occlusa																													
G. praebulloides praebulloides																													
G. praedigitata					P					P				P	P							P					P		
G. rubescens	A	C	A	P																									
G. woodi																										P			C
Globigerinatheka index index																													
G. index tropicalis																													
G. mexicana barri																													
G. mexicana kugleri																													

TABLE 4 – *Continued*

Early Miocene											Oligocene																					Late Eocene						Mid. Eocene			
N.8			N.7	N.5-N.6	N.4						P.22							P.21				P.20			P.19					P.18		P.17	P.16		P.15			P.13			
18-4, 100-102	19-2, 100-102	19-4, 100-102	20-2, 102-104	20-4, 100-102	22-2, 99-101	22-4, 100-102	23-2, 100-102	23-4, 100-102	24-2, 100-102	24-4, 100-102	25-2, 100-102	25-4, 100-102	26-2, 100-102	27-2, 100-102	27-4, 100-102	28-2, 100-102	28-4, 100-102	29-2, 100-102	29-4, 100-102	30-2, 100-102	30-4, 103-105	31-2, 100-102	31-4, 100-102	32-2, 100-102	32-4, 100-102	33-2, 100-102	33-4, 100-102	34-2, 100-102	34-4, 100-102	35-2, 100-102	35-4, 100-102	36-2, 100-102	36-4, 100-102	37-2, 100-102	37-4, 100-102	38-2, 100-102	38-4, 100-102	39-2, 100-102	39-4, 100-102	40-2, 105-107	40-4, 100-102
																																							P		
																																								R	
																																									C
																																							C	P	
																																				P					
																																			V	V	V			A	C
	P	P												P	P		P	C		P	A	P	P		P	P	P	P	P	P	P										
																																	R	C	P	P		P			
							P					P				R	P		P			P	P																		
				P			P	P	P	P	P	P	P	P		P	R		P	P	P	P	P									P	P			P					
																																	V	P	P						
																					P													P	P	P		P	P		
																																				R					
																						P																			
																				P			P	R	P								P								
																											P				P	P	P								
						P																																			
											P	R							R			P			C	C	C	C	P	P	P	C	R	P	R	R		C	P	R	R
				P				P		P	P	P	P	P	P	C	R	P	C	R	C	C	C	R																	
																																							P		
																				P	C			V	A		C	V	V	V	V	C									
								R			A									C	C																				
R	C	C	C	C	C	C	A	P	A	R	C	A	V	V	V	V	V	V	C			R	R	R				R	R	C	C	P	P								
																			R							C															
P	P																																								
					P																																				
																R				R				P			P	P		R	P		C	C							
						A		V						R		P		P	R	P																					
																								P																	
																											P														
											P																														
		C		P	C	R	C	R		R	P			P				P	P	A	R	P		P	P	P	C	P	C	R	P	P									
															P	P	P			P	P									P	P										P
					C	R	A	C	P	P	P	P				P																									
P	C	R	R	C	P	P																																			
																																	A	C	P	P	R		P	P	R
																																				R					
																																			P	R	P	R	R	P	P
																																						R	C	A	R

TABLE 4 – *Continued*

Age	Pleistocene					Pliocene									Late Miocene										Middle Miocene													
Zone	N.22				N.21			N.19			N.18				N.17				N.16				N.15					N.14							N.13		N.12		
Sample (Interval in cm) / Species	1-1, 100-102	1-2, 100-102	1-4, 100-102	2-2, 100-102	2-4, 100-102	3-2, 100-102	3-4, 100-102	4-2, 100-102	4-4, 101-103	5-2, 100-102	5-4, 100-102	6-2, 100-102	6-4, 100-102	7-2, 100-102	7-4, 100-102	8-2, 100-102	8-4, 100-102	9-2, 100-102	9-4, 100-102	10-2, 100-102	10-4, 100-102	11-2, 100-102	12-2, 100-102	12-4, 100-102	13-2, 100-102	13-4, 100-102	14-2, 100-102	16-2, 100-102	16-4, 97-99	18-2, 114-116							
G. mexicana mexicana																																					
G. semiinvoluta																																					
G. senni																																					
G. subconglobata luterbacheri																																					
G. subconglobata subconglobata																																					
Globigerinella siphonifera siphonifera		R	R	C	C	P	P	R	R	R	C	R	C	P	P	P	P				P		P	P													
Globigerinita glutinata	A	A	A		C	A	C	C	C	A	C	R	C	C	A	A	C	A	A	A	V	A	A	A	C	C	A	C	C	C							
G. iota				P																																	
G. uvula	R				P	P	P		P				P			P	P		R	C	P	R	R		A	R	R		R	R							
Globigerinoides bollii															P				P																		
G. conglobatus	C	C	R	C	C	R	R	R	R	P	R	R	P	R	P	P																					
G. elongatus	R	C	R	C	C	P	R				P																										
G. extermus				C	C	C	R	C	C	C	C	C	C	C		C	C	C	C	C	C																	
G. obliquus				R		R	R	C	C	C	C	C	C	C	C	C	R	C	R	C	C	C	C	C	R	C	R	C	C									
G. quadrilobatus altiaperturus																																					
G. quadrilobatus fistulosus				C	P	C																															
G. quadrilobatus immaturus	C	R	C		C	R	C	A	C	C	A	A	A	A	R	C	C	C	R	C	R	C	C	C	A	V	V	A	A	R						
G. quadrilobatus primordius																																					
G. quadrilobatus sacculifer	P	C	R	A	P	C	A	C	A	C	A	A	C	C	C	R	C	C	C	A	R	C	C	C	P	A	C	C	A	C							
G. quadrilobatus trilobus	P	P			P	R	C	C	R	C	C	C	C	C	R	C	R	C	R	R	P	C	P	R	C	P	R	C	R	C							
G. ruber	A	A	A	A	V	C	C																														
G. sicanus																														P							
G. subquadratus																							P				C	R	A								
"Globigerinoides" tenellus		R		P																																	
Globigerinatella insueta																													P								
Globoquadrina altipsira alitspira						R	C	R	P	R	R	C	R	P		R	C	C	P	C	R	P	R	P	R	C	R	R	R	C							
G. altispira globosa							R	P			R	C				P	P	P		P	P		P	R					P								
G. binaiensis																																					
G. conglomerata			P																																		
G. dehiscens advena																P	R	R				P			P	P	P	P	P								
G. dehiscens dehiscens																P	P	P				P			R	R		R		C						
G. dehiscens praedehiscens																																					
G. galavisi																																					
G. larmeui larmeui												P												P													
G. larmeui obesa																										P				P							
G. pseudofoliata		P			P																																
G. psuedovenezuelana																																					
G. sellii																																					
G. tripartita tapuriensis																																					
G. tripartita tripartita																																					
G. venezuelana						P	P	R	R		P			P			P	P	P		P			P	P	P	P	P	P	R	R						
Globorotalia ampliapertura																																					
G. cerroazulensis pomeroli																																					
G. crassaformis					P																																
G. cultrata	P			P		P	P	P			P		P	P		P		P				P		P	P	P											
G. dutertrei			P		P																																
G. fohsi lobata																												P	P								

TABLE 4 – *Continued*

Early Miocene											Oligocene																					Late Eocene						Mid. Eocene			
N.8			N.7	N.5-N.6	N.4						P.22							P.21				P.20			P.19					P.18		P.17	P.16		P.15			P.13			
18-4, 100-102	19-2, 100-102	19-4, 100-102	20-2, 102-102	20-4, 100-102	22-2, 99-101	22-4, 100-102	23-2, 100-102	23-4, 100-102	24-2, 100-102	24-4, 100-102	25-2, 100-102	25-4, 100-102	26-2, 100-102	27-2, 100-102	27-4, 100-102	28-2, 100-102	28-4, 100-102	29-2, 100-102	29-4, 100-102	30-2, 100-102	30-4, 103-105	31-2, 100-102	31-4, 100-102	32-2, 100-102	32-4, 100-102	33-2, 100-102	33-4, 100-102	34-2, 100-102	34-4, 100-102	35-2, 100-102	35-4, 100-102	36-2, 100-102	36-4, 100-102	37-2, 100-102	37-4, 100-102	38-2, 100-102	38-4, 100-102	39-2, 100-102	39-4, 100-102	40-2, 105-107	40-4, 100-102,
																																	P		P	P					
																																	C	V	V						
																																			R	C	C	C	P	P	R
																																		P	R						
																																				P		P	R	P	P
C	A	A	V	V	C	C	C		C	C	R	C	P	P					P							R										R					
P	P	A	C	V	C	C	C	R	R	P	P	C						R								P										P					
																																				P					
																										P										C					
	P	P		P																																					
P	A	C		P	P		C																													P					
					P	P	R			P																															
C	C	C	R	R	P		P																													P					
C	C	C	C	C	P														P																						
P	P	P																																							
C	P	R																																							
R	P																																								
V	C	C	R	P	P																															P					
C	P		P																																						
			R	R		P		P																																	
P																																									
C		P	C	R																																P					
		P		P		P	P	C			R																														
																P		P				P			C	R		P			P	R				P	P	R	C		
																												C	R			P	R	R	R		P	C			P
										P								P	P							R	R		P												
																												R			P										
								P	R	R		R	P		P	P	C	P	C	C	C	C	R	R	P	R	C			P		R	P		P	P	P				
P	P		P	P				P	P	R	P	R																													
																						C			P		P	P		P											
																																			P		P	C	C	C	R

TABLE 4 – *Continued*

Age	Pleistocene					Pliocene									Late Miocene										Middle Miocene					
Zone	N.22					N.21		N.19				N.18			N.17				N.16			N.15			N.14			N.13	N.12	
Species \ Sample (Interval in cm)	1-1, 100-102	1-2, 100-102	1-4, 100-102	2-2, 100-102	2-4, 100-102	3-2, 100-102	3-4, 100-102	4-2, 100-102	4-4, 101-103	5-2, 100-102	5-4, 100-102	6-2, 100-102	6-4, 100-102	7-2, 100-102	7-4, 100-102	8-2, 100-102	8-4, 100-102	9-2, 100-102	9-4, 100-102	10-2, 100-102	10-4, 100-102	11-2, 100-102	12-2, 100-102	12-4, 100-102	13-2, 100-102	13-4, 100-102	14-2, 100-102	16-2, 100-102	16-4, 97-99	18-2, 114-116
G. humerosa							P	P				P																		
G. inflata	P																													
G. kugleri																														
G. margaritae								P		P																				
G. mendacis																														
G. miozea cibaoensis														P			R													
G. obesa																												R	C	P
G. opima nana																														
G. opima opima																														
G. peripheroronda																														R
G. praemenardii archeomenardii																														P
G. prasaepis																														
G. pseudokugleri																														
G. scitula										P	P																			
G. siakensis																														
G. cf. *siakensis*																														
G. tumida plesiotumida														P		P														
G. tumida tumida		P	P	P	P	P	R	R	P	P	P	R	P																	
G. ungulata		P							P																					
Globorotaloides hexagonus									P							P		P												
G. suteri																														C
G. variabilis																								C		C				
Hantkenina alabamensis																														
Morozovella aragonensis caucasica																														
M. coronata																														
M. lehneri																														
Orbulina suturalis							P		P	P	P	P	P	P		R						P		P	P	P	P	P	P	
O. universa	R	P	R	C	C	R	C	C	R	P	C	C	R	C	C	C	A	C	C	C		P	R	R	P		P	R	R	
Pseudohastigerina micra																														
Pulleniatina obliquiloculata	P	P	P		R	P	P		P																					
P. primalis							P	P	P	P	P		P	P	P	P														
P. spectabilis											P		P																	
Sphaeroidinella dehiscens	P	P	P	C	C	R	C	R	P		P																			
Sphaeroidinellopsis seminulina kochi						P		R	P	P	P	P		P				P		R		P	P	R		P				
S. seminulina seminulina						P	P	C	P	C	R	C	R	C	P	R	C	C	P	C	R	C	P	C	P	R	R		P	
S. subdehiscens								P	P	P	P		P	P	P	C	R	R	R	P	P	P	P	R		P				
Subbotina angioporoides																														
S. gortanii gortanii																														
S. gortanii praeturrilina																														
S. linaperta																														
Tenuitella clemenciae																														
T. gemma																														
T. praestainforthi																														
Truncorotaloides pseudodubius																														
T. topilensis																														
Turborotalita humilis			P	P				P			P																			
T. pumilio				P		C																								
Zeauvigerina zealandica																														

TABLE 4 – *Continued*

Early Miocene											Oligocene																					Late Eocene						Mid. Eocene			
N.8			N.7	N.5-N.6	N.4						P.22							P.21				P.20			P.19					P.18		P.17	P.16		P.15			P.13			
18-4, 100-102	19-2, 100-102	19-4, 100-102	20-2, 102-104	20-4, 100-102	22-2, 99-101	22-4, 100-102	23-2, 100-102	23-4, 100-102	24-2, 100-102	24-4, 100-102	25-2, 100-102	25-4, 100-102	26-2, 100-102	27-2, 100-102	27-4, 100-102	28-2, 100-102	28-4, 100-102	29-2, 100-102	29-4, 100-102	30-2, 100-102	30-4, 103-105	31-2, 100-102	31-4, 100-102	32-2, 100-102	32-4, 100-102	33-2, 100-102	33-4, 100-102	34-2, 100-102	34-4, 100-102	35-2, 100-102	35-4, 100-102	36-2, 100-102	36-4, 100-102	37-2, 100-102	37-4, 100-102	38-2, 100-102	38-4, 100-102	39-2, 100-102	39-4, 100-102	40-2, 105-107	40-4, 100-102
					A	V	A	C	V	V	V	V	R																												
																	P																							
P	P	P	P	P	P		P																																	
																P	P	P	P		P	P	P	P	P	C	R		P	P						P					
																		C	V	C	P					R	P													
	P																																								
																C	P		C	C	C	R	R	C	C	A	C	A	C	C	C					P					
													C	A		P																									
				P										C	C																									
			P					P	P						A	R	P																			P					
																										P														
R	C	C				R				R	R	R	P						R	C							C	C	P	P	C	C	A	C	R	P		P	P	P	P	
P																																					P				
																																								P	
																																								C	C
																																			P	P	C	C	A	C	C
																																							C	C	A
																												P	R	P	P	C	P								
																										C														
																																				P				
																										P		P	P	P	P	C	R	P	P	P	P				
														P	P				P	P	C	P		P	C	P	C	C	R	P	P									
																																P						P	P		
																																			P	R	P	C	P	R	C
		C			P														C	R																			
																				A	C	V	V	V	V	A	V	R	C	C	C	A	P							
							P	P	R	R							P																							
																																						A	C	P	A
																																				P		A	A	C	C
																																R		P							

TABLE 5
Distribution of Cenozoic Planktonic Foraminifers, Site 318

Species \ Sample (Interval in cm)	1-2, 100-102	1-4, 100-102	2-2, 140-142	4-1, 100-102	4-4, 100-102	5-2, 100-102	5-4, 100-102	6-2, 100-102	6-4, 100-102	7-2, 100-102	7-4, 100-102	8-2, 100-102	9-2, 95-97	10-2, 108-110	10-4, 100-102	11-2, 97-99	11-4, 100-102	12-2, 104-106	14-1, 99-101	14-3, 100-102	15-2, 120-122	16-2, 53-55	17-2, 100-102	20-2, 100-102	20-4, 91-93	21-2, 100-102	22-2, 93-95	22-4, 144-146	23-2, 106-108	24-2, 102-104	24-4, 81-83	25-2, 104-106	26-2, 80-82	26-4, 81-83	29-2, 80-82	30-2, 12-14	31-2, 48-50
Acarinina boudreauxi																										+	+				+					
A. makannai																																					+
A. mattseensis alticonica																										+	+									
A. planodorsalis																											+					+				
A. pseudotopilensis																								+								+				
A. punctocarinata																											+					+				
A. soldadoensis																																					+
A. spinuloinflata																											+					+				
Biorbulina bilobata	P				P	R		R	P																											
Candeina nitida		P	P				P																													
Catapsydrax africanus																							+				+									
C. dissimilis ciperoensis																P	P																			
C. dissimilis dissimilis																	P	P			P	P														
C. perus																						P														
C. unicavus primitivus																				+	P	P														
C. unicavus unicavus																	P		P	+	P															
Chiloguembelina cubensis																					A	C														
Globigerina angustiumbilicata														P	R	C	C	C	C		C															
G. apertura				P	P		P																													
G. bulloides							P	P	C	P																										
G. calida	P	C	P	P	P		P																													
G. decoraperta	A	P	C	A	C	P	C	C	A	A	P	C	+																							
G. falconensis		P	P	P			P	P	R	P	R																									
G. nepenthes				R	P	P	R	P	C	C	P	P																								
G. officinalis																			V	+																
G. ouachitaensis ciperoensis															P	C	V	V																		
G. parabulloides											P																									
G. praebulloides leroyi														C	C						P														
G. praebulloides occlusa																			C	+	A														
G. praebulloides praebulloides														P		P	R	C	P			P														
G. rubescens	R																																			
G. woodi														C	C		A	A																		
Globigerinatheka index index																								+												
G. mexicana barri																								+												
G. mexicana kugleri																										+										
G. mexicana mexicana																							+													
G. senni																				+				+			+				+					
G. subconglobata curryi																				+																
Globigerinella siphonifera siphonifera	C	C	C	R	C	R	R	P		P	P																									
Globigerinita glutinata	C	R	C	A	R	R	C	C	A	A	R	C	+	V	A	C	P																			
G. uvula	C							P	R	R		R		C	C	C	P																			
Globigerinoides bollii	P								P	P																										
G. conglobatus	P	C	C	P	P	P	P																													
G. elongatus	R	C	C																																	
G. extremus		P		C	C	A	C	C	C	P																										
G. gomitulus						P																														
G. obliquus	R	P	P	C	C	C	C	C	C	A	A	C																								
G. quadrilobatus altiaperturus														P	C																					
G. quadrilobatus fistulosus	P		C																																	
G. quadrilobatus immaturus	C	A	C	C	C	C	A	C	R	C	C	A		C	C																					
G. quadrilobatus primordius																	P	P	R																	
G. quadrilobatus sacculifer	P	C	C	C	A	C	A	C	R	C	C	A	+	A	A																					
G. quadrilobatus trilobus	C	C	P	C	C	C	C	C	R	C	A	C	+	C	R																					
G. ruber	A	A	A																																	
G. subquadratus										P																										
Globoquadrina altispira altispira	P	P		P	P	R	P	C	C	R	C																									
G. altispira globosa										P					P																					
G. binaiensis														P	P																					
G. dehiscens advena						R	P	R	P	P		P	+		R																					
G. deshicens dehiscens	P					P			P			C	+	P	C																					

TABLE 5 – *Continued*

Age	Pliocene					Late Mio.		Mid. Mio.			Early Miocene			Oligocene			a	Mid. Eocene						?	Early Eoc.			
Zone	N.21		N.19		N.18	N.17	N.16	N.15	N.14	N.9?	N.5	N.4		P.22?	P.20?	P.19?	P.15?	P.14?	P.13?		?		P.11?	P.10?	?		P.7	
Sample (Interval in cm) / Species	1-2, 100-102	1-4, 100-102	2-2, 140-142	4-1, 100-102	4-4, 100-102	5-2, 100-102	5-4, 100-102	6-2, 100-102	6-4, 100-102	7-2, 100-102	7-4, 100-102	8-2, 100-102	9-2, 95-97	10-2, 108-110	10-4, 100-102	11-2, 97-99	11-4, 100-102	12-2, 104-106	14-1, 99-101	14-3, 100-102	15-2, 120-122	16-2, 53-55	17-2, 100-102	20-2, 100-102	20-4, 91-93	21-2, 100-102	22-2, 93-95	22-4, 144-146	23-2, 106-108	24-2, 102-104	24-4, 81-83	25-2, 104-106	26-2, 80-82	26-4, 81-83	29-2, 80-82	30-2, 12-14	31-2, 48-50
G. deshicens praedehiscens											P	R																								
G. larmeui obesa								P																												
G. pseudofoliata			P																																	
G. pseudovenezuelana																P					R															
G. sellii																				+	R															
G. tripartita tripartita																R	P	R	P	+	R	P	+													
G. venezuelana				P					P			P			P	P																				
Globorotalia acostaensis								P	P																											
G. ampliapertura																						R														
G. cerroazulensis pomeroli																							+	+	+	+					+					
G. crassaformis	P		P									P																								
G. cultrata		P	P	R		C	P	P	P																											
G. humerosa			P	P	P																															
G. kugleri																V	A	A																		
G. mendacis																C			P																	
G. miozea cibaoensis						P	P	P																												
G. obesa											P	P						R																		
G. prasaepis																					R	R														
G. pseudoampliapertura																					P	C														
G. scitula								P																												
G. cf. *siakensis*																R																				
G. tumida plesiotumida								P																												
G. tumida tumida		P	C	P	R		P																													
G. ungulata		P					P																													
Globorolotaloides hexagonus	P							P																												
G. suteri													+	C				P	P		P	P														
Hantkenina sp.																																		P		
Morozovella aragonensis aragonensis																								+												
M. aragonensis caucasica																											+									
M. coronata																				+				+		+	+				+					
M. formosa																																				+
M. lehneri																								+		+										
M. cf. *perclare*																																				+
Orbulina suturalis				P								P																								
O. universa		C	C	C	C	C	C	C	R	P	A	P	+																							
Pseudohastigerina micra																						R												+		+
Pulleniatina obliquiloculata		P	P																																	
P. primalis				P	P	C	P																													
P. spectabilis				P	P																															
Sphaeroidinella dehiscens	P		C																																	
Sphaeroidinellopsis seminulina kochi					P			P				P																								
S. seminulina seminulina		P		P	C	C	P	C	R	P	P	C	+																							
S. subdehiscens		R		P	P	R	P	P	P	P	R	P																								
Subbotina angioporoides																						C		+												
S. boweri																															+					
S. gortanii gortanii																				+	P	P														
S. gortanii praeturrilina																											+									
S. linaperta																											+				+					+
S. winkleri																					P															
Tenuitella gemma																					C	P														
T. praestainforthi																P																				
Truncorotaloides cf. *collacteus*																										+	+									
T. topilensis																											+				+					

[a]Late Eocene.

Globigerinoides quadrilobatus primordius Blow and Banner, 1962
Globigerinoides quadrilobatus sacculifer (Brady, 1877) (ex *Globigerina*)
Globigerinoides quadrilobatus trilobus (Reuss, 1850) (ex *Globigerina*)
Globigerinoides ruber (d'Orbigny, 1839) (ex *Globigerina*)
Globigerinoides sicanus de Stefani, 1952
Globigerinoides subquadratus Brönnimann, 1954
"*Globigerinoides*" *tenellus* Parker, 1958
Globoquadrina altispira altispira (Cushman and Jarvis, 1936) (ex *Globigerina*)
Globoquadrina altispira globosa Bolli, 1957
Globoquadrina binaiensis (Koch, 1935) (ex *Globigerina*)
Globoquadrina conglomerata (Schwager, 1866) (ex *Globigerina*)
Globoquadrina dehiscens advena Bermudez, 1959
Globoquadrina dehiscens dehiscens (Chapman, Parr, and Collins, 1938) (ex *Globorotalia*)
Globoquadrina dehiscens praedehiscens Blow and Banner, 1962
Globoquadrina galavisi (Bermudez, 1961) (ex *Globigerina*)
Globoquadrina larmeui larmeui Akers, 1955
Globoquadrina larmeui obesa Akers, 1955
Globoquadrina pseudofoliata Parker, 1967
Globoquadrina pseudovenezuelana (Blow and Banner, 1962) (ex *Globigerina*)
Globoquadrina sellii Borsetti, 1959
Globoquadrina tripartita tapuriensis (Blow and Banner, 1962) (ex *Globigerina*)
Globoquadrina tripartita tripartita (Koch, 1926) (ex *Globigerina*)
Globoquadrina venezuelana (Hedberg, 1937) (ex *Globigerina*)
Globorotalia acostaensis Blow, 1959
Globorotalia ampliapertura (Bolli, 1957) (ex *Globigerina*)
Globorotalia birnageae Blow, 1959
Globorotalia cerroazulensis pomeroli Toumarkine and Bolli, 1970
Globorotalia continuosa Blow, 1959
Globorotalia crassaformis (Galloway and Wissler, 1927) (ex *Globigerina*)
Globorotalia cultrata (d'Orbigny, 1826) (ex *Rotalia*)
Globorotalia dutertrei (d'Orbigny, 1839) (ex *Globigerina*)
Globorotalia fohsi fohsi Cushman and Ellisor, 1939
Globorotalia fohsi lobata Bermudez, 1949
Globorotalia humerosa Takayanagi and Saito, 1962
Globorotalia inflata (d'Orbigny, 1839) (ex *Globigerina*)
Globorotalia imitata Subbotina, 1953
Globorotalia kugleri Bolli, 1957
Globorotalia lenguaensis Bolli, 1957
Globorotalia margaritae Bolli and Bermudez, 1965
Globorotalia mendacis Blow, 1969
Globorotalia merotumida Blow and Banner, 1965
Globorotalia miozea cibaoensis Bermudez, 1949
Globorotalia obesa Bolli, 1957
Globorotalia opima nana Bolli, 1957
Globorotalia opima opima Bolli, 1957
Globorotalia peripheroacuta Blow and Banner, 1966
Globorotalia peripheroronda Blow and Banner, 1966
Globorotalia praemenardii archeomenardii Bolli, 1957
Globorotalia prasaepis (Blow, 1969) (ex *Globigerina*)
Globorotalia pseudoampliapertura (Blow and Banner, 1962) (ex *Globigerina*)
Globorotalia pseudokugleri Blow, 1969
Globorotalia scitula (Brady, 1882) (ex *Pulvinulina*)
Globorotalia siakensis LeRoy, 1939
Globorotalia tosaensis Takayanagi and Saito, 1962
Globorotalia truncatulinoides (d'Orbigny, 1839) (ex ?*Rotalia*)
Globorotalia tumida plesiotumida Blow and Banner, 1965
Globorotalia tumida tumida (Brady, 1377) (ex *Pulvinulina*)
Globorotalia ungulata Bermudez, 1961
Globorotaloides hexagonus (Natland, 1839) (ex *Globigerina*)
Globorotaloides suteri Bolli, 1957
Globorotaloides variabilis Bolli, 1957
Hantkenina alabamensis Cushman, 1925
Morozovella aragonensis aragonensis (Nuttall, 1930) (ex *Globorotalia*)
Morozovella aragonensis caucasica (Glaessner, 1937) (ex *Globorotalia*)
Morozovella coronata Blow (MS: after Fleisher, 1974)
Morozovella formosa formosa Bolli, 1957) (ex *Globorotalia*)
Morozovella lehneri (Cushman and Jarvis, 1929) (ex *Globorotalia*)
Morozovella cf. *perclara* (Loeblich and Tappan, 1957) (ex *Globorotalia*)
Orbulina suturalis Brönnimann, 1951
Orbulina universa d'Orbigny, 1839
Pseudohastigerina micra (Cole, 1927) (ex *Nonion*)
Pulleniatina obliquiloculata (Parker and Jones, 1865) (ex *Pullenia*)
Pulleniatina primalis Banner and Blow, 1967
Pulleniatina spectabilis Parker, 1965
Sphaeroidinella dehiscens Parker and Jones, 1865) (ex *Sphaeroidina*)
Sphaeroidinellopsis seminulina kochi (Caudri, 1934) (ex *Globigerina*)
Sphaeroidinellopsis seminulina seminulina (Schwager, 1866) (ex *Globigerina*)
Sphaeroidinellopsis subdehiscens (Blow, 1959) (ex *Sphaeroidinella*)
Subbotina angiporoides (Hornibrook, 1965) (ex *Globigerina*)
Subbotina boweri (Bolli, 1957) (ex *Globigerina*)
Subbotina gortanii gortanii (Borsetti, 1959) (ex *Catapsydrax*)
Subbotina gortanii praeturritilina (Blow and Banner, 1962) (ex *Globigerina*)
Subbotina linaperta (Finlay, 1939) (ex *Globigerina*)
Subbotina winkleri (Bermudez, 1961) (ex *Globigerina*)
Tenuitella anfracta (Parker, 1967) (ex *Globorotalia*)
Tenuitella clemenciae (Bermudez, 1961) (ex *Turborotalia*)
Tenuitella gemma (Jenkins, 1966) (ex *Globorotalia*)
Tenuitella praestainfohsi (Blow, 1969) (ex *Globigerinita*)
Truncorotaloides pseudodubius (Bandy, 1949) (ex *Globigerinoides*)
Truncorotaloides topilensis (Cushman, 1925) (ex *Globigerina*)

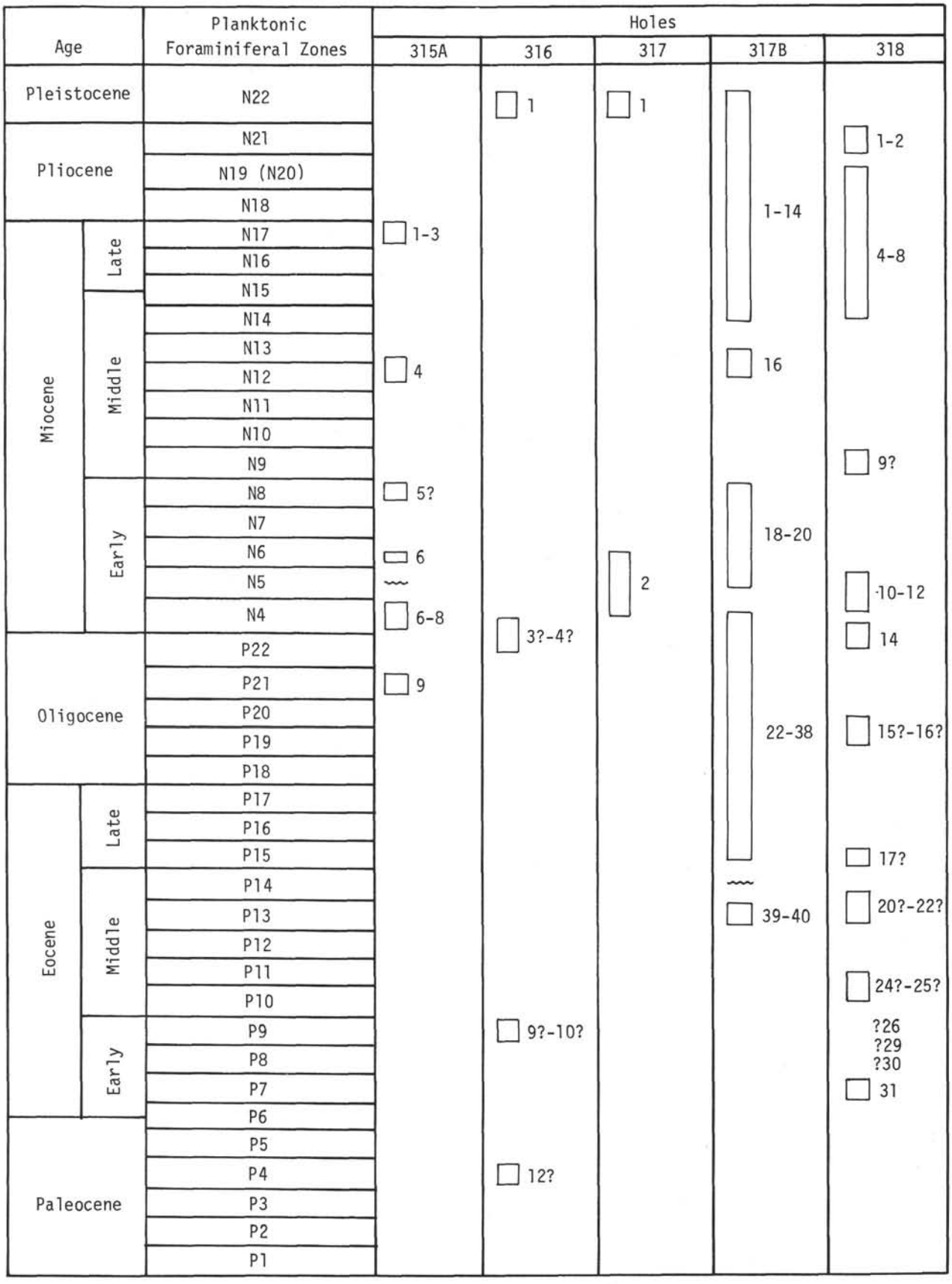

Figure 1. *Cenozoic sediments cored on Leg 33. Only foraminifer-bearing cores are shown in the figure. Cores are represented by numbered rectangles; cores for which ages are indeterminable are not accompanied by rectangles.*

Truncorotaloides cf. *collacteus* (Finlay, 1939) (ex *Globorotalia*)
Turborotalita humilis (Brady, 1884) (ex *Truncatulina*)
Turborotalita pumilio (Parker, 1962) (ex *Globorotalia*)
Zeauvigerina zealandica Finlay, 1939

RESULTS

Site 315 (lat 04°10.26′N, long 158°31.54′W, depth 4162 m)

Only cores 1 to 9 from Hole 315A were examined. Traces of dissolution are more or less observed in all samples, but none is strongly affected. In the sample from Section 1 of Core 6 the number of specimens is meager due to difficulty in the maceration procedure. A stratigraphic break is suggested between Sections 1 and 3 of Core 6. The uppermost occurrence of *Globorotalia kugleri* is marked in Section 3, while Section 1 is characterized by the lowermost occurrence of *Globorotalia peripheroronda* and *Sphaeroidinellopsis seminulina seminulina*. This break may include Zone N.5. Except for Core 9, for which an Oligocene age is suggested, the stratigraphic sequence of Cores 1 through 8 represents the Miocene (Zones N.4 to N.17).

Site 316 (lat 00°05.44′N, long 157°07.71′W, depth 4464 m)

Twelve samples were examined from Cores 1 through 17 at Site 316. A well-preserved assemblage of Pleistocene age (Zone N.22) occurs in Core 1. Heavy dissolution characterizes the rest of the cores and a number of species in these cores are judged to have been brought in through downhole contamination. The presence of *Globorotalia kugleri* in Cores 3 and 4 suggests that they belong in Zones P.22 to N.4. The Oligocene/Miocene boundary is tentatively drawn between Cores 3 and 4. The very poor state of preservation in Cores 9 to 17 makes age assignment very difficult. Diagnostic Paleogene species (*Acarinina soldadoensis*, *Globanomalina pseudoscetula*, and *Globorotalia imitata*) are found in association with several Neogene forms in Core 10, but *G. imitata* is the only Paleogene form in the underlying Core 12. Although the Paleocene/Eocene boundary is provisionally placed between these levels, further investigation is needed for precise age determination.

Site 317 (lat 11°00.09′S, long 162°15.78′W, depth 2625 m)

Samples were examined from Holes 317 and 317B. Cores 1 and 2 of Hole 317 are assigned to the Pleistocene and lower Miocene, respectively, Cores 1 through 40 represent almost continuous coring in Hole 317B, and they encompass a fairly complete sequence from the Pleistocene to the middle Eocene. In comparison with cores from other sites of Leg 33, preservation of specimens is exceptionally good. Dissolution is not as pronounced, even in Eocene assemblages (Cores 32 to 40). A trace of contamination is obvious at some levels within the Paleogene.

Core 1 of Hole 317 and Cores 1 and 2 (only the upper part) of Hole 317B contain Pleistocene assemblage (Zone N.22). Because of the absence of *Globorotalia truncatulinoides*, the Pliocene/Pleistocene (Zone N.21/N.22) boundary is not clearly specified. However, an approximate boundary is estimated between Sections 2 and 4 of Core 2, based on the lowermost occurrence of "*Globigerinoides*" *tenellus* and the uppermost occurrence of *Globigerinoides quadrilobatus fistulosus* near the N.21/N.22 boundary. The N.18/N.19 boundary, defined by the first occurrence of *Sphaeroidinella dehiscens* lies between Cores 5 and 6. The Miocene/Pliocene boundary is here placed at the level of the first occurrence of *Globorotalia tumida tumida* (base of Zone N.18), although opinion on this placement is divided. Regarding this boundary, Berggren (1973) considers that the extinction level of *Globoquadrina dehiscens*, together with *G. tumida tumida* appearance datum, is a reliable indicator. In the present sequence, however, a distinct gap is recognized between these two datums; *G. tumida tumida* appears first in Core 6, while the last occurrence of *G. dehiscens* is recorded in Core 8.

Cores 7 to 10 are referable to Zones N.16 and N.17 based on the initial appearance of *Globigerinoides extremus* in Core 10 and those of *Pulleniatina primalis* and *Globorotalia tumida plesiotumida* in Core 8. The first occurrence of *Globigerina nepenthes* may suggest that Core 14 belongs in Zone N.14. Cores 11 through 14 are thus referable to Zones N.14 and N.15. Core 16 is assigned to Zones N.12 and N.13 on the basis of the limited occurrence of *Globorotalia fohsi lobata*. The concurrence of *Globigerinoides sicanus* and *Globigerinatella insueta* and the absence of the orbulines in Cores 18 and 19 indicate that they represent Zone N.8. The boundary between the lower and middle Miocene is drawn at the top of this zone. The N.6/N.7 boundary, which is indicated by the extinction of *Catapsydrax unicavus unicavus* and *C. dissimilis dissimilis*, lies within Core 20. Although samples are not available to differentiate Zones N.5 and N.6 in the cores from Site 317, the N.4/N.5 boundary is easily recognized as the level of the last occurrence of *Globorotalia kugleri*, both in Holes 317 (within Core 2) and 317B (between Cores 20 and 22).

The Oligocene/Miocene (Zones P.22/N.4) boundary is located between Cores 24 and 25, based upon the initial appearance of *Globigerinoides quadrilobatus primordius*. The Oligocene is represented by Cores 25 through 35, and the Oligocene foraminiferal zones, P.18 to P.22, are clearly defined in the present section. Cores 25 through 28 are assigned to Zone P.22, the base of which is placed just above the extinction level of *Globorotalia opima opima*. *Globorotalia galavisi* and *Globorotalia prasaepis* disappear within the lower part of this interval, and *Globorotalia kugleri* appears first in the upper part. Cores 29 and 30 are referred to Zone P.21, based on the co-occurrence of *Globorotalia opima opima* and *Globigerina angulisuturalis*. The P.20/P.21 boundary is here placed between the horizon of the first occurrence of *G. angulisuturalis* and that of the last occurrence of *Globorotalia ampliapertura*, which marks the top of Zone P.20. *Catapsydrax unicavus unicavus*, shown by Blow (1969) to make its initial appearance at the P.19/P.20 boundary, occurs in Core 32. Core 31 and the upper part of Core 32 (Section 2) are referred to Zone P.20., and contain a characteristic fauna consisting of

species such as *Cassigerinella chipolensis, Catapsydrax dissimilis ciperoensis, C. perus, C. unicavus unicavus, Globigerina angustiumbilicata, G. officinalis, Globoquadrina galavisi, G. sellii, G. tripartita tripartita, Globorotalia ampliapertura, G. prasaepis, Globorotaloides suteri,* and *Subbotina gortanii gortanii*. The initial appearance of *Globoquadrina sellii* within the range of *G. tripartita tapuriensis* in Core 34 (though neither species is common) indicates that Cores 32 (only the lower part—Section 4) to 34 represent Zone P.19. *Globoquadrina pseudovenezuelana, Pseudohastigerina micra,* and *Subbotina angiporoides* have their uppermost occurrences within these cores.

The Eocene/Oligocene (P.17/P.18) boundary is drawn between Cores 35 and 37. Although the first occurrence of *Subbotina gortanii gortanii*, which is supposed to occur at the P.16/P.17 boundary, is observed at the same horizon, the presence of *Cassigerinella chipolensis* suggests that Core 35 is referable to Zone P.18. Section 2 of Core 36 represents probably Zone P.17, as indicated by the presence of *Globigerina praebulloides leroyi* and the absence of a number of species which characterizes the fauna of the underlying Zone P.16. The interval of Section 4 of Core 36 through Core 38 is assigned to Zones P.15 and P.16, based on the co-occurrence of *Catapsydrax africanus,* several species of *Globigerinatheka*, and *Subbotina angiporoides*. A large amount of faunal contamination was noted in Section 2 of Core 38, where numerous specimens of the Neogene species are found. The same type of downhole contamination was also observed in Core 29, Section 4, and Core 33, Section 2, although here it is less distinct. Cores 9 and 40 are judged to belong to Zone P.13 because of the co-occurrence of *Globigerinatheka mexicana kugleri, Morozovella lehneri*, and *Truncorotaloides topilensis*, and the absence of *Globoquadrina tripartita tripartita*. Accordingly, a stratigraphic break equivalent to Zone P.14 is estimated to occur between Cores 38 and 39, where the middle/upper Eocene boundary is placed.

Site 318 (lat 14°49.63′S, long 146°51.51′W, depth 2659 m)

Cores 1 through 31 represent discontinuous coring at Site 318, and include the sequence from lower Eocene to Pliocene. Well-preserved upper Neogene assemblages are present in Cores 1 to 8, but moderate dissolution is obvious in Oligocene to middle Miocene assemblages of Cores 9 to 16. Strong dissolution has affected the Eocene assemblages of Cores 17 through 31, and in some cases foraminifers have been completely removed.

The Pliocene is represented by Cores 1 to 5, and the Miocene/Pliocene (N.17/N.18) boundary is placed between Cores 5 and 6 on the basis of the initial appearance of *Globorotalia tumida tumida*. No zonal subdivision was possible for the Pliocene section because of lack of sufficient zonal indexes. Core 7 is placed within Zone N.17, based on the presence of *Globorotalia tumida plesiotumida* in the lower section. The boundary between Zones N.15/N.16 is drawn between Sections 2 and 4 of Core 7 based on the first occurrence of *Globigerinoides extremus* in Section 2. The presence of *Globigerina nepenthes* may indicate that Core 8 is referable to Zone N.14. A poorly preserved assemblage is found in Core 9, and is questionably referred to Zone N.9. The concurrence of *Globigerinoides quadrilobatus altiaperturus* and *Globoquadrina binaiensis* in Core 10 indicates placement in Zone N.5.

The Oligocene/Miocene (P.22/N.4) boundary is placed within Core 14, because the initial appearance of *Globigerinoides quadrilobatus primordius* is recorded in Section 1 of the core. Cores 11 through 14 (the upper part only), referred to Zone N.4, include *Globorotalia kugleri* and *G. mendacis* in addition to the above-mentioned species. The Oligocene is represented by Cores 14 (Section 3) through 16. Although some reworked fossils are contained in the assemblage, the lower part of Core 14 may belong to Zone P.22. Core 15 is assigned to Zone P.20 on the basis of the co-occurrence of *Catapsydrax unicavus primitivus* and *C. unicavus unicavus*. Core 16 is provisionally assigned to Zone P.19, although all that can be said is that the core is not younger than this zone.

The Eocene/Oligocene boundary is tentatively drawn between Cores 16 and 17. As already stated, age assignment is extremely difficult for the Eocene section at Site 318 because of the strong effects of calcite dissolution. Moreover, many samples include reworked specimens. For these reasons, only a tentative age determination is made based on the following criteria. Core 17 may be placed within Zone P.15, as suggested by the presence of *Catapsydrax africanus* and *Globigerinatheka mexicana mexicana*. Although Core 20 is very poor in foraminifera, it is referred to Zone P.14, based on the assumption that *Globigerinatheka senni* and *Morozovella lehneri* make their last occurrence at this level. In a similar way, Cores 21 and 22 (Section 2) are referred to Zone P. 13, based on the assumed uppermost occurrence of *Globigerinatheka mexicana kugleri* and *Truncorotaloides topilensis*. The co-occurrence of *Acarinina soldadoensis* and *Morozovella formosa* indicates that Core 31 is referable to Zone P.7.

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