30. SHORE LABORATORY REPORT ON CENOZOIC PLANKTONIC FORAMINIFERA: LEG 22

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INTRODUCTION

Calcareous sediments from Sites 212, 213, 214, 215, 216, and 217 were examined for Cenozoic planktonic foraminifera. The results are plotted on data sheets and given as Tables 1 through 7 at the end of this chapter. An explanation of the way in which data is recorded on these data sheets is given below.

The total abundance data is a visual estimate of the numbers of planktonic foraminifera in a strew on a 60 hole, 28 ply slide, 0.149 micron (100 mesh) screen size. Standard sample size for shore-lab work is 2 cc. It is intended as an approximate indication of whether a particular sample (level) is rich or poor in planktonic foraminifera. The following numerical scheme has been adopted for expressing this abundance: *0* = Absent, *1* = $<10^1$ specimens, *2* = $10^1 - 10^2$ specimens, *3* = $10^2 - 10^3$ specimens, and *4* = $10^3 - 10^4$ specimens. *D, M,* and *R,* are used to indicate the state of preservation in the same manner as described for individual taxon below.

The relative abundance of each taxon in a strew on a 60 hole, 28 ply slide, 0.149 micron (100 mesh) screen size, is shown by a number and the state of preservation by a letter. In some instances, only small specimens are preserved ($>149\mu$) due to dissolution or size-sorting. In this case, and in instances where stratigraphically important species are recorded on $>149\mu$ fractions, notation is made to this effect. If preservation is good no letter notation is made. The following scheme has been adopted for expressing relative abundance and preservation:

Relative Abundance	Specimens	Preservation
0 = Absent		
1 = Rare	1-10	D = Dissolution
2 = Moderately rare	11-25	M = Mechanical erosion
3 = common	26-50	
4 = Abundant	51-100	R = Reworked
5 = Very abundant	>100	
*5 = Hundreds to thousands of specimens		

RESULTS

Site 212

Samples were examined from Cores 1 through 14 with a few exceptions. Dissolution is strong in Cores 1 to 12. The planktonic foraminiferal associations are anomalous and contain forms which normally do not occur together. Their occurrence may be due to the action of bottom currents or slumping. The entire stratigraphic sequence appears to be of Neogene age. In Section 2 of Core 14, several lower Eocene and late Paleocene species were recorded.

Site 213

Samples were examined from the lower part of Core 14 through Core 16. Well-preserved specimens of early Eocene and late Paleocene assemblages are present in this material although dissolution is moderately strong in the lower part of Core 14 and samples in Sections 2 and 4 of Core 15.

Well-preserved specimens of *Morozovella lensiformis, M. formosa formosa,* and specimens transitional between *M. lensiformis* and *M. aragonensis* indicate that the lower part of Core 14 and Core 15 through Section 4 belong to Zone P.7 of early Eocene age.

There is a faunal break between Sections 4 and 5 in Core 15. In Section 5 of Core 15, we record the uppermost occurrence of *Morozovella subbotinae, M. aequa, M. formosa gracilis*, and *M. marginodentata.* Neither *M. lensiformis* nor *M. formosa*, which are typical of Zone P.7, nor *M. velascoensis*, which occurs in Zones P.5 and P.6a, were found. Therefore, we assign Section 5 of Core 15, as well as Section 6 of Core 15 and Section 1 of Core 16, to Zone P.6b. The youngest occurrence of *Morozovella velascoensis* occurs in Section 2 of Core 16, and we place the boundary between Zones P.6a and P.6b between Sections 1 and 2 of Core 16. Section 3 of Core 16 contains abundant specimens of *Morozovella aequa* and specimens transitional between *Morozovella aequa* and *subbotinae.* The same is true of the lowest sample which we have studied in Section 4 of Core 16. It is difficult to determine whether Sections 3 and 4 of Core 16 belong to Zone P.6a or Zone P.5. We have arbitrarily drawn the boundary between Sections 3 and 4.

Inasmuch as Core 16 lies immediately above basaltic basement at this site, a maximum age of 54 m.y. is suggested for the oldest sediment at this site.

Site 214

Thirty-eight cores (3-40) were examined from Site 214. Well-preserved, tropical, late Neogene assemblages are present in Cores 3 through 15. Moderate dissolution occurs in middle Miocene assemblages (Cores 17 through 20). Strong dissolution is present in Oligocene and late Eocene assemblages (Cores 24 through 28). Rich assemblages characterize the middle and early Eocene (Cores 30 through 35), although specific diversity is relatively low.

Core 3 represents basal Pleistocene (Zone N.22) based on the occurrence of *Globorotalia truncatulinoides* (primitive forms), *Globorotalia tosaensis* with a tendency to

develop a keel on the ultimate chamber, and *Globigerinoides fistulosa.* The presence of *Globorotalia tosaensis*, the absence of *Sphaeroidinellopsis* spp., and the earliest appearance of *Globoquadrina dutertrei* suggest that Core 4 belongs to Zone N.21. The initial appearance of *Sphaeroidinella dehiscens* (with a large flange) and specimens referable to *Globorotalia pseudopima* suggest that Core 5 is referable to Zone N.20.

Cores 6 through 10 may be definitely placed within Zone N.19. Within this interval the progressive enlargement of the supplementary aperture in *Sphaeroidinella dehiscens* may be followed. The extinction of *Globigerina nepenthes* (3.7 m.y.) occurs in Core 8 and that of *Globorotalia margaritae* (3.3 m.y.) occurs in Core 6. These two datum levels are useful for subdivision within the lower Pliocene.

We have found it difficult to identify the exact location of the Miocene/Pliocene (N.17/N.18) boundary. Core 13 appears to belong to Zone N.17 based on the common occurrence of *Globorotalia plesiotumida* and *Globoquadrina venezuelana* and the absence of *Globorotalia tumida. Globorotalia plesiotumida* is recorded from Cores 11 and 12. Specimens which appear transitional to *Globorotalia tumida* appear also in Cores 11 and 12. *Sphaeroidinellopsis subdehiscens* and *S. seminulina* also appear commonly in this interval. We have not been able to identify *Sphaeroidinella dehiscens forma immatura* with certainty in Cores 11 and 12, however. Cores 13 through 16 are assigned to the late Miocene. The occurrence of *Globorotalia plesiotumida* in Cores 13 through 15 indicates a rather extensive range for this zone at this site.

The middle Miocene is represented by Cores 17 through 21. Core 18 is assigned to Zone N.14 on the basis of the earliest occurrence of *Globigerina nepenthes.* Cores 19 and 20 are assigned to Zone N.13, based on the cooccurrence of *Globorotalia fohsi, Globigerina druryi, Sphaeroidinellopsis subdehiscens.* Core 21 is assigned to middle Miocene, Zone N.9, based on the cooccurrence of *Globorotalia peripheroronda,* and *Globorotalia archaeomenardii*, although the genus *Orbulina* has not been observed from this level.

There appears to be a stratigraphic gap within or between Cores 21 and 22. Core 22 is assigned to Zone N.5; Core 23 to Zone N.4. *Globorotalia kugleri* ranges through Cores 3 and 4.

The Oligocene/Miocene boundary is drawn somewhat arbitrarily between Cores 23 and 24. The Oligocene appears to be extremely condensed at this location. Cores 24 and 25 are assigned to the late Oligocene and Core 26 to the early Oligocene. The faunas are generally poorly preserved due to strong dissolution so that accurate age determination is difficult.

The Eocene/Oligocene boundary occurs between Cores 26 and 27 and is based on the youngest occurrence within Core 27 of *Globigerina gortanii.* The youngest occurrence of the genus *Globigerapsis* occurs in Core 28 and also denotes a level within the late Eocene. Middle Eocene faunas occur in Cores 29 through 32. Rich early Eocene assemblages occur in Cores 33 through 35 and are characterized by *Morozovella aragonensis, Morozovella caucasica,* and *Acarinina angulosa.* The presence of Zone P.7 is indicated by the presence of the nominate taxon *Morozovella formosa formosa* and *lensiformis* and *Acarinina coalingensis.*

There appears to be a stratigraphic break or a compressed stratigraphic interval between Cores 35 and 36. Core 36 contains a fauna which may be assigned to Zone P.4, based on the occurrence of *Planorotalites pseudomenardii* and *Acarinina mckannai.* Planktonic foraminiferal faunas *are present only in the fine fraction in Cores 37* through 40 and appear to be developed in a relatively shallow-water facies characterized by abundant glauconite. The presence of keeled species of *Morozovella* within this interval indicate that the oldest sample examined (Core 40) is still no older than Zone P.3.

Site 215

Samples have been examined from Cores 10 through 22 at this site. Rich early Eocene assemblages with *Morozovella subbotinae* and *M. marginodentata* and abundant acarininids (*A. soldadoensis, A. angulosa, A. pseudotopilensis*, and *A. coalingensis*) occur in Cores 10 and 11 and are indicative of Zone P.6. The Paleocene/Eocene boundary is drawn between Cores 11 and 12 on the basis of the youngest occurrence of *Morozovella velascoensis* in Core 12. The boundary between Zones P.4 and P.5 is placed between Cores 12 and 13 based on the youngest occurrence of *Planorotalites pseudomenardii* in Core 13. This species occurs commonly together with *Morozovella albeari* (=*M. pusilla laevigata*) throughout Cores 13 through 16. *Acarinina mckannai* is also typical of this interval together with specimens of *Subbotina triangularis*, which in some instances resemble *S. triloculinoides*, and *S. velascoensis.* Core 16 lies immediately atop basaltic basement at this site. The maximum age of the oldest sediment at this site is about 58 m.y.

Site 216

Samples have been examined from Holes 216 and 216A at this site. Cores 1 to 4 of Hole 216 were discontinuously cored and are of late Neogene age. Cores 5 through 24 were continuously cored in Hole 216 and represent a relatively complete, if somewhat condensed, section from the early Miocene to the base of the Paleocene. Six cores were examined from Hole 216A (Cores 1 through 6). Core 3 of Hole 216A is approximately equivalent to Core 4 of Hole 216 and is of middle Miocene age.

Typical tropical Pleistocene assemblages occur in Core 1, Hole 216. Mid Pliocene assemblages dominated by *Globorotalia multicamerata* and *Globorotalia altispira* occur in Core 2. The absence of *Globorotalia margaritae* and *Globorotalia nepenthes* suggests that this interval is within the upper part of Zone P.19, somewhere between 3 and 3.4 m.y. This interval should be equivalent to the *Discoaster surculus* or *Reticulofenestra pseudoumbilica* Zone. Late Miocene (Zone N.17) is present in Core 3. *Globorotalia plesiotumida* and *Globoquadrina dehiscens* are common components of the fauna at this level. Middle to late Miocene is present in the stratigraphic interval cored at Hole 216A (Cores 1 through 6) as well as Core 4 of Hole 216. Species of *Globoquadrina* and *Globorotalia* dominate

the assemblages throughout this sequence. This, plus the scarcity of other genera and the abundance of fragments in the <149μ size fraction indicates a moderate amount of dissolution, especially in the early and middle Miocene. The range of *Globorotalia plesiotumida* at this site suggests that Zone N.16 may be extremely condensed here and that N.15 may be absent. Zone N.14 appears to be present in the lower part of Core 4 in Hole 216 and in Core 3 in Hole 216A based on the initial appearance of *Globigerina nepenthes*. Elements of the *Globorotalia fohsi* lineage are found in Cores 4 and 5 of Hole 216A. It appears that the Zone N.8/N.9 boundary occurs somewhere within the lower part of Core 5 in Hole 216A, but due to the rarity of praeorbulinids, this level could not be more accurately determined. Core 6 in Hole 216A belongs primarily to Zone N.7 and is stratigraphically immediately suprajacent to Core 5 in Hole 216, in which the youngest *Globigerinita dissimilis* is found. This marks the top of Zone N.6.

The remainder of the discussion concerns Hole 216. The presence of *Globoquadrina praedehiscens* in the lower part of Core 5 and in Core 6, together with *Globigerina binaensis* in Core 6 suggest that the lower part of Core 5 and Core 6 belong to Zone N.5. The youngest occurrence of *Globorotalia kugleri* is at the top of Core 7 so that the boundary between Zones N.4 and N.5 is placed between Cores 6 and 7. Strong dissolution occurs in Cores 8 through 15 and zonal subdivision is difficult. *Globorotalia kugleri* has been observed as low as Section 2 of Core 9 and the Oligocene/Miocene boundary is arbitrarily drawn between Sections 2 and 3 of Core 9 on the basis of its initial occurrence. The poorly preserved late Oligocene assemblages are dominated by specimens of *Globigerinita unicava, G. dissimilis,* and *G. opima nana.* The early/late Oligocene boundary is drawn between Cores 12 and 14, based on the youngest occurrence in Core 14 of *Pseudohastigerina* and *Chiloquembelina.* At these levels, dissolution has obliterated all but the smallest specimens in the material. The lower part of Core 15 and Core 16 contains relatively undiagnostic assemblage of globigerinids, and the Eocene/Oligocene boundary is somewhat arbitrarily drawn between Cores 15 and 16. There is a sampling gap between Cores 17 and 19. Cores 20, 21, and 22 are composed of indurated chalk in which preservation of the planktonic foraminifera is marginal. The assemblages are dominated by *Morozovella velascoensis* and *Acarinina coalingensis.* The presence of *Planorotalites pseudomenardii* indicates that Cores 20 through 22 belong to Zone P.4. Cores 23 and 24 are composed of indurated, recrystallized chalk, in which there are virtually no free specimens of planktonic foraminifera, save in the fine fraction. Here the material is encrusted and overgrown with calcite crystals and specific determination has been found impossible. Small globigerinids dominate the faunas and it appears that these levels are of early Paleocene (Danian) age and are the equivalent of Zone P.1.

Site 217

Samples have been examined from Cores 1 through 16 at Site 217. Well-preserved tropical Pleistocene faunas are present in Core 1. Typical early Pliocene (late Zone N.19) assemblages with *Globorotalia multicamerata* and neither *Globigerina nepenthes* nor *G. margaritae* occur in Core 2, and this level is probably of the same age as Core 2 in Hole 216. The presence of *Globorotalia plesiotumida* in Core 3 suggests that this level belongs to Zone N.17. Core 4 contains an N.16 fauna with *Globorotalia acostaensis, G. merotumida,* and *Candeina praenitida.* There was no sample available from Core 5. Core 6 occurs in a chalk in which preservation is good in Section 1 (allowing age determination of Zone N.5) but below which the sediments are highly dissolved and only fragments of species are present in some instances. Cores 7 through 9 are strongly dissolved and age determination is rather difficult. Core 8 contains a rather typical late Oligocene assemblage with *Globigerina euapertura, G. tripartita, G. venezuelana,* and *Globoquadrina globularis.* The youngest occurrence of *Pseudohastigerina* and *Chiloguembelina* in Section 1 of Core 9 indicates the approximate position of the early/late Oligocene boundary as well as the boundary between Zone P.21/P.19-20.

An early/middle Eocene age is suggested for Core 10, Section 6 based on the presence of *Morozovella aragonensis.*

Cores 13 and 14 are of middle to late Paleocene age based on the presence of *Subbotina velascoensis, Planorotalites pseudomenardii, Morozovella albeari, Morozovella angulata, M. velascoensis* and *M. acuta.* The absence of *M. velascoensis, M. acuta* and *P. pseudomenardii* and the presence of *Morozovella abundocamerata* with *Planorotalites ehrenbergi* in Core 15 indicates that this level belongs to the upper part of Zone P.3.

Core 16 is an indurated chalk with few free specimens in the coarse fraction. They are present in the fine fraction but poorly preserved. These small globigerinids are probably of early Paleocene (Danian *s.l.*) age.

TABLE 1
Distribution of Cenozoic Planktonic Foraminifera, Site 212

Age	Miocene																		
Zone	?																		
Lithology																			
Sample	1-1 ?	3-1, 94-96	5-1, 71-72	7-1, 60-62	8-1, 70-72	8-2, 78-80	8-3, 80-82	10-1, 68-70	10-2, 80-82	10-3, 88-90	10-4, 90-92	10-5, 48-50	10-6, 48	11-2, 80-82	11-3, 80-82	11-4, 80-82	12-2, 86-88	12-3, 74-76	12-4, 77-79
Total Abundance/ Preservation	0 D	0 D	1 D	1 D	0	0 D	0 D	1 D	2 D	2 D	2 D	2 D	2 D	1 D	1 D	1 D	3 D	2 D	3 D
Orbulina universa			1										1					1	1
Globigerina nepenthes				1 cf							1	1					1 cf		1
G. bulloides																	1		
Globigerinoides sicanus																			1
G. quadrilobatus																			1
Sphaeroidinellopsis seminulina								1	1	1									
S. subdehiscens													1	1					
Globigerinita glutinata				1					1	1		1	1				2	1	2
Globorotalia scitula			1																
G. conoidea								1	1	1	1	1 cf	1		1	1 cf			
G. continuosa									1	1	1						1 cf		1 cf
G. peripheroronda																	1		1
G. praemenardii																	1		1 cf
Globoquadrina dehiscens								1 cf	1	1	1	1	1	1 cf	1	1	1	1 cf	1 cf
Globigerina druryi																			1
G. apertura																			1

TABLE 1 – *Continued*

Age	Early-Mid Miocene								
Zone									
Lithology	Limestone and chalk								
Sample	12-5, 87-90	13-2, 67-70	13-3, 77-79	13-4, 80-82	14-2, 81-83	14-3, 88-90	14-4, 81-84	14-5, 80-83	14-6, 80-83
Total Abundance/ Preservation	2 D	4	4	4	4	0 D	0 D	0 D	0 D
Globigerina apertura			1	1					
G. bulloides	1	1							
G. druryi		1	1	3					
Orbulina suturalis		1	3	4					
Sphaeroidinellopsis seminulina			1						
Globigerinita glutinata	1	5	5	5					
Globorotalia peripheroronda	1	2	2	1					
G. praescitula	1 cf	2	2	1					
G. continuosa		3	2						
G. conoidea			3	3					
Globoquadrina dehiscens	1	1 cf	1	2					
Globorotalia siakensis			1	4					
Globigerinoides trilobus			3	4					
Subbotina linaperta					3_R				
Morozovella broedermanni					2_R				
Planorotalites pseudomenardii					2_R				
Morozovella aequa					2_R				
M. sp.					2_R				

TABLE 2
Distribution of Cenozoic Planktonic Foraminifera, Site 213

Age	Early Eocene									Late Paleocene		
Zone	P.7						P.6b			P.6a		P.5-6
Lithology	Foraminiferal ooze											
Sample	14-6, 80-82	15-2, 130-132	15-3, 46-48	15-3, 125-127	15-4, 40-42	15-4, 136-138	15-5, 82-84	15-6, 94-96	16-1, 104-106	16-2, 88-90	16-3, 84-86	16-4, 30-32
Total Abundance/ Preservation	4 D	4 D	4 D	4[a] D	2 D	2 D	4	5	5	5	5	5
Acarinina coalingensis	5[a]	5[a]	5		4	4	3	3	3	3	3	3
Morozovella lensiformis	4	4	3	5	2	2						
M. formosa formosa				5	1	1						
M. lensiformis-aragonensis trans.				5	1	1						
Acarinina pseudotopilensis				4	1	1	1	1	1	1		
A. pentacamerata				3	1	1	1	1	1	1		
Subbotina potogonica							3	3	3	3	3	4
Morozovella subbotinae							5	5	5	5	–	aff.
M. aequa							5	5	5	5	5	5
M. formosa gracilis							2	2	2			
Acarinina soldadoensis							2	2	2	2	1	1
Morozovella marginodentata								3	3			
M. velascoensis										3	4	5
M. aequasubbotinae trans.											4	5
M. occlusa											3	3

[a]Nearly all specimens on $> 149\mu$ dissolved – only small specimens preserved.

TABLE 3
Distribution of Cenozoic Planktonic Foraminifera, Site 214

Age	Pleistocene		Late Pliocene	
Zone	N.22		N.21	N.20
Lithology	Foraminiferal nannofossil ooze			
Sample	3-1	3-2, 80-82	4-1, Top	5-1, 80-82
Total Abundance/ Preservation	4	4	4	4
Orbulina universa	3	3	3	3
Globigerinita glutinata	3	4	5	3
Sphaeroidinella dehiscens	3	4	4	4
Globigerinoides ruber	5	5	5	5
G. trilobus	4	4	4	4
G. succulifer	3	5	4	2
G. fistulosus	3	2	2	2
G. conglobatus	3	3	3	3
G. obliquus	2	2	1	3
Pulleniatina primalis			1	1
P. obliquiloculata	4	3	3	2
Globorotalia scitula	1	1	2	1
G. menardii group	3	3	3	3
G. crassaformis group	2	2	3	2
G. multicamerata			2	3
G. tumida	3	3	4	4
G. ungulata	3	2	1	
G. truncatulinoides	1	1		
G. tosaensis	3	3	2	
G. humerosa	1	1	1	3
G. acostaensis pseudopima	1		1	1
Globogoquadrina dutertrei	5	4	3	
Globorotaloides hexagona		3	2	2
Hastigerina siphonifera	2	3	2	2

TABLE 3 – *Continued*

Age	Pliocene				
Zone	N.19-20	N.19			
Lithology	Foraminiferal nannofossil ooze				
Sample	6-1, 80-82	7-1, 80-82	8-2, 80-82	9-1, 80-82	10-1, 80-82
Total Abundance/ Preservation	4	4	4	4	4
Orbulina universa	1	3	3	4	3
Globigerinita glutinata	2	3	3	3	3
Sphaeroidinella dehiscens	2	2	1	1	1
Sphaeroidinellopsis subdehiscens	3	3	3	3	3
S. seminulina	3	3	3	4	4
Globigerina nepenthes			2	2	3
Globigerinoides ruber	4				
G. trilobus	3	4	4	4	4
G. sacculifer	4	4	3	5	4
G. conglobatus	1	2	2	2	2
G. obliquus	4	4	5	4	4
Pulleniatina primalis	2	2	3	3	3
P. obliquiloculata	1	1	1 cf		
Globorotalia scitula			1	1	2
G. menardii group	4	4	4	3	4
G. crassaformis group	2	1			
G. multicamerata	3	3	3	3	3
G. tumida	4	3	4	4	5
G. margaritae	1	2			
G. humerosa	2	2	3	3	3
G. acostaensis pseudopima	1				
G. acostaensis			1	1	1
Globoquadrina conglomerata	5	3	3	3	3
G. altispira	4	4	4	5	4

TABLE 3 – *Continued*

Age	a	Late Miocene			
Zone	N.18-17 ?	N.17			N.16
Lithology	Foraminiferal nannofossil ooze				
Sample	11-1, 80-82	12-1, 90-92	13-2, 80-82	14-1, 80-82	15-2, 80-82	16-1, 85-87
Total Abundance/ Preservation	4	4	4	4	4	4 D
Orbulina universa	2	4	3	3	3	3
Globigerinita glutinata	3	4	3	3	3	3
Sphaeroidinellopsis subdehiscens	3	3	3	2	2	2
S. seminulina	3	4	4	4	4	4
Globigerina nepenthes	2	3	2	3	2	2
Globigerinoides trilobus	3	4	4	5	3	2
G. sacculifer	4	4	3	3	5	3
G. conglobatus	1	1				1
G. obliquus	4	5	4	5	4	2
Pulleniatina primalis	2	1				
Globorotalia scitula	2	2	2	1	2	
G. menardii	4	4	3	4	4	2
G. cultrata	3	5	2	2	2	2
G. merotumida	1			1	1	1
G. plesiotumida	2	2	3	3	1	2 cf
G. tumida	1 cf	2 cf	1 cf			
G. miozea	2	2	1			
G. humerosa	1	3	2 cf	2 cf		
G. continuosa	1	2	2	2	2	2
G. acostaensis	2	3	3	3	3	3
Globoquadrina venezuelana	4	4	5	5	4	5
G. altispira	3	5	5	5	5	5
G. dehiscens	1			1		
Hastigerina siphonifera	1	2	1	1	2	

[a]Late Miocene – Pliocene .

TABLE 3 – *Continued*

Age	Middle Miocene			
Zone	N.15	N.14	N.13	
Lithology	Foraminiferal nannofossil ooze			
Sample	17-1, 80-82	18-1, 80-82	19-1, 130-132	20-1, 80-82
Total Abundance/ Preservation	4 D	4 D	4 D	4 D
Orbulina universa	2	2	3	1
Globigerinita glutinata	3	3	2	2
Spheroidinellopsis subdehiscens	2	1	2	1
S. seminulina	4	4	3	3
Globigerina nepenthes	3	2		
G. druryi	1 cf	1	1	1 cf
Globigerinoides trilobus	2	4	3	3
G. sacculifer	2			
G. obliquus	1	1		
G. subquadratus		1	1	2
Globorotalia scitula	1	1		1
G. menardii	3	2	1 cf	
G. cultrata	2	3		
G. merotumida	1 cf			
G. miozea		2 cf	2	2
G. continuosa	1	2	1 cf	
G. mayeri		4	5	5
G. siakensis		3	3	3
G. fohsi			1	2
Globoquadrina venezuelana	5	5	5	3
G. altispira	4	1	5	4
G. dehiscens	2	3	3	2

TABLE 3 – *Continued*

Age	Early Miocene			a		b	c		Middle Eocene			
Zone	d	N.5	N.4	P.23-P.22		P.18	P.16	P.15	e	P.12	P.11	P.10
Lithology	Foraminiferal ooze – chalk											
Sample	21-1, Top	22-1, 80-82	23-2, 80-82	24-2, 80-82	25-2, Top	26-2, Top	27-1, Top	28-2, Top	29-2, Top	30-1, 80-82	31-1, 80-82	32-1, 80-82
Total Abundance/ Preservation	4	4	4	2 D	2 D	1 D	1 D	1 D	2	2	3	3
Globoquadrina globosa	5[f]	5[f]										
G. altispira	5	5	1		2							
G. venezuelana	4		3									
Globorotalia siakensis	3		4									
Globigerinoides subquadrata	3											
G. triloba	5	5[f]										
Globorotalia archaeomenardii	5											
G. peripheroranda	5	1										
Globoquadrina praedehiscens			5		4							
Globigerinita dissimilis			3	2								
Globorotalia kugleri			5	1								
Globigerinita unicava					2							
Globigerina tapuriensis						1						
G. tripartita						1		1 aff				
G. galavisi							1	1				
G. gartanii							1					
G. senilis							1					
Globigeropsis sp.								1	1	1		
G. index								1	1	1		
G. tropicalis									1			
Globigerina praeturritilina									1	1		
Morozovella spinulosa (of Cushman)										2		
"Globigerina" senni										3	2	
Acarinita densa										2	2	2

[a]Late Oligocene
[b]Early Oligocene
[c]Late Eocene
[d]N.6-N.9
[e]P.13-P.14
[f]>149μ fraction only.

TABLE 3 – *Continued*

Age	Middle Eocene			Early Eocene			Late–middle Paleocene				
Zone	P.12	P.11	P.10	P.9	P.8	P.7	P.4	? P.4-P.3			
Lithology	Nannofossil ooze						Glauconitic–detrital chalk				
Sample	30-1, 80-82	31-1, 80-82	32-1, 80-82	33-1, 80-82	34-1, 80-82	35-1, 69-71	36-4, Top	37-2, Top	38-3, Top	39-2, Top	40-2, Top
Total Abundance/ Preservation	4	4	4	4	4	4	4[a]	2[a]	2	2	2
Truncorotaloides rohri	2	2	2								
Globigeropsis kugleri	1	5	–								
Subbotina frontosa			5								
S. patagonica			3			3					
Hantkenina araganensis			1								
Morozovella aragenensis				4	3						
M. caucasica				3	4						
Acarinina soldadoensis angulosa				3	3	3					
A. soldadoensis					3	3					
A. coalingensis						3					
Morozovella lensiformis						3					
M. formosa formosa						2					
Acarinina mckannai							4				
Planorotalites pseudomenardii							2				
Subbotina sp.							4	2	2	2	2
Morozovella sp.											1

[a] >149μ fraction only.

TABLE 4
Distribution of Cenozoic Planktonic Foraminifera, Site 215

Age	Early Eocene									Late Paleocene									
Zone	P.6									P.5						P.4			
Lithology	Foraminifera chalk and ooze																		
Sample	10-2, 70-72	10-3, 88-90	11-1, 70-72	11-2, 70-72	11-3, 70-72	11-4, 70-72	11-5, 70-72	11-6, 70-72	12-1, 70-72	12-2, 70-72	12-3, 70-72	12-4, 70-72	12-5, 70-72	12-6, 70-72	13-2, 70-72	13-3, 70-72	14-1, 70-72	14-2, 70-72	14-3, 70-72
Total Abundance/ Preservation	4	4	4	4	4	4	4	4	1	4	3 D	3 D	2 D	4	4	4	4	1 D	4
Acarinina soldadoensis	5	5	5	5	5	5	5	5		5	2	3					1		
A. soldadoensis angulosa	5	5	5	5	5	4	5	5											
A. coalingensis	4	4	4	3	3	2	5	5		3	3	3							
A. wilcoxensis	4	4																	
A. pseudotopilensis	3	3	3	2	2														
A. mckannai											2	1	2	2	3	3	5		4
Subbotina patagonica	5	5	3	3	2	2	2	2											
S. velascoensis		1	3	5	2	2	4	5		1		2 cf		3	3	2	5		5
S. triangularsis			3	3	4	4	4	4		5				1	5	4	5		5
S. quadrata																	1		4 cf
Morozovella broedermanni		4																	
M. subbotinae	4	4	4	3	2	3	1	1											
M. aequa					2	1	1	1		2 cf			1	3	1				
M. marginodentata	4	4	5	5	3	4	3	3											
M. formosa gracilis	2	3	2																
M. albeari																2	2		2
M. abundocamerata																			
M. velascoensis										1	1 cf			2	2	1	3		1
M. angulata																			
M. occlusa														2					
M. conuexa															1				
Planorotalites chapmani																	1		2
P. pseudomenardii															2		3		3
Chiloguembelina wilcoxensis	2	3	3	3	2	2	2	3											

TABLE 4 – *Continued*

Age	Late Paleocene							
Zone	P.4							
Lithology								
Sample	14-4, 73-75	14-5, 70-72	14-6, 70-72	15-2, 70-72	15-3, 70-72	15-4, 58-60	16-2, 70-72	16-4, 70-72
Total Abundance/ Preservation	4 D	4	4	3 D	3 D	0	4	4
Acarinina soldadoensis								3
A. mckannai	4	5	4	3	3 cf		5	1
Subbotina velascoensis	2	5	4				1	
S. triangularis	4	5	4	2	2		4	3
S. quadrata							3	3
Morozovella alberia	1	3	2		1 cf			2
M. abundocamerata								1
M. velascoensis			2				3 cf	
M. angulata		2	1					
Planorotalites chapmani							2 cf	
P. pseudomenardii	1	2	2				2	2

TABLE 5
Distribution of Cenozoic Planktonic Foraminifera, Site 216

Age	a		Early Pliocene					
Zone	b		N.20 - N.19					
Lithology	Foraminiferal ooze							
Sample	1-5, 80-82	1-6, 80-82	2-1, 80-82	2-2, 80-82	2-3, 80-82	2-4, Top	2-5, 80-82	2-6, 80-82
Total Abundance/ Preservation	4	4	4	4	4	4	4	4
Globorotalia menardii	5	5						
G. cultrata	5	5						
Globoquadrina conglomerata	5	5	2	2	1	1	1	1
Globigerinoides conglobata	4	4	2	2	2	2	2	2
Hastigerina siphonifera	1	1						
Sphaeroidinella dehiscens	1	1	1	1	1	1	1	1
Candeina nitida	1	1			1	1	1	1
Globigerinoides rubra	2	2						
G. sacculifera	3	3	2	2	3	3	3	3
Orbulina universa	4	4	4	4	4	4	4	4
Neogloboquadrina dutertrei	4	4						
Pulleniatina obliquiloculata	4	4						
Globorotalia tumida	1	1				1	1	1
Globorotaloides hexagona	1	1						
Globorotalia crassaformis	1	1						
G. multicamerata			4	4	4	4	4	4
G. pertenuis			2	2	2	2	1	1
G. tumida flexuosa			3	3	3	3	2	2
Globoquadrina altispira			2	2	2	2	2	2
Sphaeroidinellopsis subdehiscens			3	3	3	3	3	3
S. seminulina			1	1	1	1	1	1
Globigerinoides obliqua			2	2	2	2	2	2
Neogloboquadrina numerosa			3	3	3	3		
Pulleniatina primalis			2	2	2	2	1	1

[a]Pleistocene
[b]N.22 - N.23

TABLE 5 – *Continued*

Age	a	Middle Miocene						Early Miocene									
Zone	b	c	N.14					N.6	N.5								
Lithology		Foraminiferal ooze						Chalk and ooze									
Sample		3-2, 80-82	4-1, 78-80	4-2, 80-82	4-3, 80-82	4-4, Top	4-5, 80-82	4-6, 80-82	5-2, 83-85	5-3, 80-82	5-4, Top	5-5, 80-82	5-6, 80-82	6-1, 80-82	6-2, 80-82	6-3, 80-82	6-4, Top	6-5, 80-82	6-6, 80-82
Total Abundance/ Preservation	4	3	3	3	3	4	4	3	3	4	4	4	4	4	4	2 D	4	4
Globoquadrina venezuelana	4	3	3	3	3	3	3	3	3	2	2	2	3	3	3	3	3	
G. altispira	3	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	1	
G. dehiscens ehiscens	2	3	3	3	3	3	3	1	1	1	1	1						
Orbulina universa	4	1	1	1	1	1	1											
Globigerinoides obliqua	2	2	2	2	2	2	2											
G. sacculifera	3																	
Sphaeroidinellopsis subdehiscens	3	4	3	3	3	3	3											
Globorotalia menardii	3	2	2	2	2	2	2											
G. plesiotumida	2																	
G. acostaensis	3																	
Neoglobоquadrina humerosa	2																	
Globorotalia scitula	2																	
Sphaeroidinellopsis seminulina	1	3	3	3	3	3	3											
Globorotalia continuosa		3	2	2	2	2	2											
G. cf. *merotumida*		2	2	2	2	2	2											
Globigerinoides triloba		2	2	2	2	2	2	2	2	2	3	2	3	3	3	3	3	
Globorotalia mayeri			2	2	2	2	2											
Globigerina woodi								1	1	1	1	1						
Globorotalia siakensis								4	4	4	4	3	3	3	3	3	3	
Globigerinita dissimilis								2	2	2	2	2	2	2	2	2	2	
Globoquadrina globosa								3	3	3	3	2	1	2	1	1	1	
G. praedehiscens										3	3	5	3	3	3	3	3	
Globorotalia opimanana										2	2	5	5	2	2	2	3	
Globoquadrina niraensis													2	2	2	2	2	

[a]Late Miocene

[b]N.17

[c]N.16?

TABLE 5 – *Continued*

Age	Early Miocene					?	Late Oligocene				Early Oligocene				Late Eocene		
Zone	N.4					?	P.22 - P.21				a				b		
Lithology	Nannofossil chalk and ooze																
Sample	7-1, 102-104	7-2, Top	8-2, 80-82	9-1, 76-78	9-2, 68-69		9-3, Top	10-1, 79-81	10-2, Top	12-2, Top	14-2, Top	14-3, 72-74	15-2, Top	15-3, Top	16-1, 31-33	16-2, 70-72	16-3, Top
Total Abundance/ Preservation	2 D	2 D	2 D	2 D	2 D		1 D	4 D	2 D	2 D	1 D	1 D	1 D	3	3	3	2
Globigerinita unicava	2		1		1			3		2			1		3		
Globoquadrina praedehiscens	2																
Globorotalia kugleri	2	3	2		2												
G. opima nana			2	1	1			3		1							
Globigerinita dissimilis				1				3		2							
Globorotalia siakensis				2	2												
Globigerina tripartita														1	3	2	3
G. evapertura								2						3			
G. senilis														3			
G. winkleri														3	2		
Globigerinita pera															2		
Globigerina pseudovenezuelana																3	2
G. galavisi																1	1
[c]*Pseudohastigerina* sp.											2	2	2	2	2	2	2
[c]*Chiloguembelina* sp.											2	2	2	2	2	2	2

[a]P.19/20 - P.18

[b]P.17 - P.16

*per fraction

TABLE 5 – *Continued*

Age	Mid-late Paleocene					Early Paleoc.	
Zone	P.4					P.1	
Lithology	a					b	
Sample	20-2, 80-82	20-3, 80-82	21-2, 80-82	22-2, 80-82	22-3, 80-82	23-3, 83-85	24-3, 86-89
Total Abundance/ Preservation	3	3	3	3	3	0[c]	0[c]
Morozovella velascoensis	3	3	3	3	3		
Acarinina coalingensis	3	3	3				
Morozovella acava	2	2	2				
Subbotina velascoensis	2	2	2	2	2		
S. triangularis	2	2	2	2	2		
Planorotalites pseudomenardii	1	1	1	1	1		
Morozovella acutispira				1	1		
Subbotina varianta				2	2		
Planorotalites chapmani				2	2		
Small globigerinids						5[c]	5[c]

[a]Nannofossil-foraminiferal chalk

[b]Chalk recrystall.

[c]Recrystallized chalk specimens in fine fraction only - encrusted, surface morphology destroyed.

TABLE 6
Distribution of Cenozoic Planktonic Foraminifera, Hole 216A

Age	Late Miocene													
Zone	N.17											N.16		
Lithology														
Sample	1-1, 120-122	1-2, 87-89	1-3, 74-76	1-4, 90-92	1-5, 90-92	1-6, 78-80	2-1, 83-85	2-2, 87-89	2-3, 74-76	2-4, 84-86	2-5, 80-82	2-6, 65-67	3-1, 145-147	3-2, 80-82
Total Abundance/ Preservation	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Orbulina universa	2	3	3	2	2	3	3	3	3	3	4	3	2	3
Globigerina nepenthes	1		2	1	1	2						2	1	
Sphaeroidinellopsis subdehiscens	4	1	2	4	2	2	3	4	3	1	3	2	3	2
S. seminulina	3	1	2	1	3	3	2	4	4	3	3	2	3	3
Globigerinoides ruber											1			
G. obliquus	4	3	3	2	3	2	4	4	3	3	2		2	2
G. sacculifer	3	3	4	2	1	3	1	3	3	3	4	1		
G. trilobus		1	1	3	2	1	4	1	1	2	1	2		
Globoquadrina altispira	5	5	5	5	1	1	1	5	5	5	5	5	5	5
G. venezuelana	5	5	5	5	5	5	5	5	5	4	5	5	5	5
G. cf. *venezuelana*	3	2	1		2	2	3	2	3	3	3	4	3	4
G. dehiscens												2	2	2
Globorotalia plesiotumida	3cf	1cf			1cf	3	5	2	3	1	3	3cf	2cf	
G. acostaensis	5	5	5	5	4	4	1	2	2	4		3		3cf
G. continuosa	5	4	4	4	2	3	5	1	1	3	1	1	1cf	
G. pseudomiocenica	2		3	2										
G. aff. *miocenica*	2			4										
G. cultrata	5	4	4	5	3	3	5	5	5	5	5	5	5	5
G. menardii	5	4	2	4	4	2	5	5	5	5	5	5	4	4
G. scitula	2	1	1		1	3	1					3		
G. exillis		2cf	2cf	2cf										
G. tumida		1cf												
G. merotumida						2cf	1	2	1	1	1	1	2	3

TABLE 6 – *Continued*

Age	Middle Miocene									
Zone	N.14			a		N. 13			N.12	
Lithology										
Sample	3-3, 84-86	3-4, 86-88	3-5, 80-82	3-6, 90-92	4-1, 80-82	4-2, 78-80	4-3, 79-81	4-4, 72-74	4-5, 79-81	4-6, 103-105
Total Abundance/ Preservation	4	4	4	4	4	4	4	4	4	4
Orbulina universa	3	2	3	1		1				
Globigerina nepenthes	1		1			1				
Sphaeroidinellopsis subdehiscens	3		2			1	2	1		
S. seminulina	3	3	3	3	3	2	4	3	4	4
Orbulina suturalis							1			2
Globigerinoides obliquus	2		2	2						
G. trilobus	1					1	1	4	1	5
G. subquadratus						2	4	1	1	
Globoquadrina altispira	5	3	5	5	5	5	5	5	5	5
G. venezuelana	5	5	5	5	5	4	5	5	5	
G. cf. *venezuelana*	1	2	2	3	1	1	1			5
G. dehiscens	1	2	3	4	3	2	1		2cf	1cf
Globorotalia continuosa	3	3	4	3	3	4	1			
G. siakensis	5	4	3	3	4	4	3	3	3	5
G. mayeri		1cf	3	2	3	3	5	4	2cf	
G. miozea					3	1	1	2	4	3
G. cultrata	3	5	5	3						
G. scitula		1		1			1cf			
G. menardii		2	5	4						
G. peripheroronda										1
G. peripheroacuta								2	1	3
G. praefohsi							1		4	2
G. fohsi					4	4	3	5	2	5

[a]N.14?

TABLE 6 – *Continued*

Age	Middle Miocene				Early Miocene						
Zone	N.11	N.10			N.9 - N.8				N.7		
Lithology	Chalk										
Sample	5-1, 78-80	5-2, 86-88	5-3, 75-77	5-4, 81-83	5-5, 80-82	5-6, 65-67	6-1, 74-76	6-3, 80-82	6-4, 80-82	6-5, 78-80	6-6, 78-80
Total Abundance/ Preservation	4	4	4	4	4	4	4	4	4	4	4
Globigerinoides obliquus	2cf	1cf									
G. trilobus	2	2	2	1		1		1	1		
G. sicanus							2	2		1cf	
G. subquadratus				1		2	4	5	1	2	
G. diminuta										1	
Orbulina suturalis	2										
Sphaeroidinellopsis seminulina									2		
Globoquadrina altispira	5	5	5	5	5	5	5	5	5	5	5
G. cf. *venezuelana*	5	5	5	5	5	5	3	5	5	4	5
G. cf. *dehiscens*	4	4	4	4	4	4	3	2	3	2	1
G. dehiscens		4								1	
Globorotalia continuosa						1					
G. peripheroronda	4	4	3	5	5	5	5	5	5	5	5
G. peripheroacuta	4	3	3	2cf	1cf	1cf					
G. praefohsi	1										
G. praescitula							1	2	1		1
G. praemenardii	3	2	2								
G. archeomenardii		1	1	3		3					
G. bermudezi	2				1		1cf				
G. mayeri				1cf	1cf	1cf	1cf				
G. siakensis	5	5	5	3	4	5	5	3	5	3	3
Globigerinita glutinata							1	2			
Globigerinatella insueta						1	1	2	2	3	
Globorotaloides cf. *suteri*							1		2	3	

TABLE 7
Distribution of Cenozoic Planktonic Foraminifera, Site 217

Age	Pleistocene					Early Pliocene		
Zone	N.22 - N.23					N.20 - N.19		
Lithology	Foraminiferal ooze							
Sample	1-1, 60-62	1-2, 60-62	1-4, Top	1-5, Top	1-6, Top	2-2, 60-62	2-3, 60-62	2-4, 60-62
Total Abundance/ Preservation	4	4	4	4	4	4 D	4 D	4 D
Orbulina universa	4	4	3	4	2	2	2	2
Globorotalia menardii	5	5	5	5	5			
Pulleniatina obliquiloculata	3	3	3	4	2			
Globigerinoides sacculifera	5	5	2	5	4	3	3	3
G. conglobata	2	5	3	4	4			
G. rubra	2	2	2	3	1			
Sphaeroidinella dehiscens	2	5	1	2	3	4	4	4
Globoquadrina dutertrei	4	2	4	3	2			
Globorotalia tumida	2	1	3	3		1	1	1
Hastigerina siphonifera	2	2	2	3	1			
Globoquadrina conglomerata	2	5	5	3	2	1	1	1
Globorotalia crassaformis	1		1					
G. crassula					2			
G. tumida flexuosa						4	4	4
Sphaeroidinellopsis subdehiscens						4	4	4
Globorotalia multicamerata						5	5	5
Globoquadrina altispira						1	1	1
Globigerinoides obliqua extrema						2	2	2
Candeira nitida								
Pulleniatina primalis							4	4
Neogloboquadrina numerosa							2	2
Globorotalia plesiotumida								
Globoquadrina venezuelana								
Globigerina nepenthes								

TABLE 7 – *Continued*

Age	Late Miocene					Early Miocene			
Zone	N.17	N.16				N.5			
Lithology	Foraminiferal-radiolarian ooze					Nannofossil chalk			
Sample	3-1, 60-62	4-2, 60-62	4-3, 60-62	4-5, 90-92	4-6, 60-62	6-1, 60-62	6-2, 60-62	6-3, 60-62	6-5, 80-82
Total Abundance/ Preservation	4 D	4 D	4 D	4 D	2	4	2 D	1 D	2 D
Orbulina universa	3	4	2	3	2				
Globorotalia menardii gp.	5	5	3	4	1				
Globigerinoides sacculifera	3	4	4	4					
G. conglobata	1								
Sphaeroidinellopsis subdehiscens	4	2	3	3	1				
S. seminulina	3		4	3	1				
Globoquadrina altispera	4	3	4	3	2				
Globorotalia venezuelana	3	3	2	3	3				
Globoquadrina dehiscens	2	2	2						
Globigerinoides obliqua extrema	3	4	4	3					
Candeina nitida	2	3							
Globorotalia plesiotumida	1								
Globigerina nepenthes	1			1	1				
Globorotalia acostaensis	3	4	3	3					
Hastigerina siphonifera		2		1					
Globorotalia merotumida		2	4	3	1				
Candeira praenitida		3			1				
Globigerina binaensis						4	0	0	0
Globigerinoides triloba						3	0	0	0
Globigerinita dissimilis						3	0	0	3
Globoquadrina globosa						4	0	0	0
Globigerinita stainforthi						3	0	0	0
Globigerina sp. cf. *G. angustiumbilicata*						2	0	0	0
Globoquadrina praedehiscens						3	3	0	2
Globorotalia siakensis						3	2	0	3
Globoquadrina venezuelana						2	2	0	2

TABLE 7 – *Continued*

Age	Early Miocene - Late Oligocene						Late Oligocene				Early Oligocene			a	Late - Middle Paleocene				
Zone	? 4-P. 22						P. 21				P. 19/20			b	P. 4				P. 3
Lithology	Nannofossil chalk and ooze										Nannofossil chalk and chert								
Sample	6-6, 78-80	7-2, 81-82	7-3, 79-81	7-4, 81-83	7-5, 78-80	7-6, 81-83	8-1, 80-82	8-2, 80-82	8-3, 60-62	8-5, 80-82	9-1, 78-80	9-3, 58-60	9-5, 85-87	10-6, 79-81	13-1, 104-106	14-1, 90-92	14-3, 80-82	14-5, 80-82	15-2, 80-82
Total Abundance/ Preservation	2 D	1 D	2 D	2 D	1 D	1 D	3 D	3 D	3 D	3 D	3 D	4 D	3 D	3[c]	3	3	3	3	3
Globigerina evapertura							1	1	1	1	1	1	1						
G. tripartita							3	3	3	3	2	2	2						
G. sellii							1	1	1	1									
Globoquadrina venezuelana							1	1	1	1	1	1	1						
G. globularis							1	1	1	1									
G. haroemaenensis							1	1	1	1									
Globorotalia opima nana							1	1	1	1	1	1	1						
Globigerinita dissimilis							1	1	1	1	1	1	1						
G. unicava							1	1	1	1	1	1	1						
Globigerinina ampliapertura											1	1	1						
G. galavisi											1	1	1						
Globigerinita pera											1	1	1						
Pseudohastigerina sp.											4[d]	4[d]	4[d]						
Chiloguembelina sp.											3[d]	3[d]	3[d]						
Morozovella aragonensis														4					
Acarinina sp.														2					
Subbotina velascoensis															2	2	3	3	
Acarinina mckannai															2				
Planorotalites pseudomenardii															1cf	1	2	2	
Morozovella albeari															2				
M. acutispira															2				
M. angulata															2	2	4	4	4
M. velascoensis															3	3	4	4	
M. acuta															2	2	3	3	

[a]Mid-Eocene

[b]P. 10-P. 11

[c]Calcite crust overgrowth; poor preservation.

[d]In pen fraction only.

TABLE 7 – *Continued*

Age	Late - Middle Paleocene				Early Paleocene ? Danian Sil.					
Zone	P.4			P.3	? P.1 - P.2					
Lithology	Nannofossil chalk and chert									
Sample	14-1, 90-92	14-3, 80-82	14-5, 80-82	15-2, 80-82	16-1, 80-82	16-2, 80-82	16-3, 90-92	16-4, 97-99	16-5, 60-62	16-6, 80-82
Total Abundance/ Preservation	3	3	3	3						
Subbotina quadrata	3	3	3							
S. triloculinoides		3	3	3						
Morozovella abundocamerata				4						
Planorotalites ehrenbergi				4						
Subbotina inconstans				2						
Small Gobigerinids					5	5	5	5	5	5