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6. CRETACEOUS TO QUATERNARY PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY OF LEG 149, IBERIA ABYSSAL PLAIN[1]

Elisabeth Gervais[2]

ABSTRACT

This paper presents the results of a biostratigraphic analysis, based on planktonic foraminifers, of Ocean Drilling Program Leg 149 Sites 897- 900 in the Iberia Abyssal Plain, off the coast of Portugal. Dissolution and changes in water-mass temperatures affect the quality of biozonation in some levels of the Pliocene, Miocene, and Paleocene/lower Eocene. Important hiatuses occur in the upper Cretaceous, Paleocene to middle/lower upper? Eocene and uppermost middle to lower upper Miocene in all the sites studied. A major hiatus in Hole 898A, spanning the Pliocene, late Miocene and the latest part of the middle Miocene, could be caused by erosion triggered by climatic cooling and/or erosion connected with middle-late Miocene local tectonic activity.

INTRODUCTION

Planktonic foraminifers from sediments of Ocean Drilling Program (ODP) Sites 897, 898, 899 and 900 were studied in order to establish the biostratigraphic succession of the Iberia Abyssal Plain. Site 901 was not included in this study, as too little sediment was recovered above basement. The site locations are shown in Figure 1. Three holes were drilled at Site 897, one hole at Site 898, two holes at Site 899, and one hole at Site 900. Hole 900A contained the best preserved foraminifers throughout the entire sequence and it was more densely sampled.

The distribution of preserved foraminiferal assemblages, which vary in diversity and in quantity, is influenced both by dissolution and by differences in the temperature of the water masses. Complete to partial dissolution of delicate forms, accompanied by a concentration of resistant species, such as *Globoquadrina dehiscens, Globigerina nepenthes, Globoquadrina venezuelana, Catapsydrax dissimilis/unicava,* and *Globorotalia menardii,* was found in the studied holes, especially in Holes 897C and 899A, as was also seen at the nearby Site 398 (Iaccarino and Salvatorini, 1979). Dissolution features were recorded at some levels in the Pliocene, throughout the Miocene and in the lower Eocene. Changes in water-mass temperatures are reflected by influxes of assemblages dominated by *Neogloboquadrina atlantica* (in the Pleistocene to upper Miocene), *Pulleniatina obliqueloculata* (in the Pleistocene), and orbulinas (Miocene to Pleistocene) or by assemblages devoid of *Globorotalia truncatulinoides* (in the early Pleistocene). In the Miocene to Holocene, tropical and subtropical forms such as *Globorotalia cultrata, Globorotalia miocenica, Globorotalia exilis, Sphaeroidinella dehiscens, Globorotalia tumida, Pulleniatina* spp., and *Neogloboquadrina dutertrei* are rare to absent. Arctic species such as *Globorotalia inflata/triangula* and *Neogloboquadrina pachyderma* were found in abundance in Pliocene to Holocene sediments.

[1]Whitmarsh, R.B., Sawyer, D.S., Klaus, A., and Masson, D.G. (Eds.), 1996. *Proc. ODP, Sci. Results,* 149: College Station, TX (Ocean Drilling Program).
[2]J&G Consultants, J. Rosenkrantzlaan 35, 2104 CC Heemstede, The Netherlands. strats@xs4all.nl

METHODS

The Oligocene to Holocene sediments are dominated by turbidites and therefore, as far as possible, samples were taken from the hemipelagic/pelagic tops of the turbidite sequences. The older sediments were preferentially sampled at carbonate-rich levels. Approximately two samples per core were taken from Holes 897 and 899, three samples per core from Hole 898, and one sample per section from Hole 900, except in Pliocene to Holocene sediments, where two samples per core were taken. All samples (of approximately 10 cm^3) were washed through 63- and 125-µm sieves. Harder samples required boiling in water enriched with sodium pyrophosphate before washing. The residues >125 µm were analyzed for their planktonic foraminiferal contents. The 63-125-µm residues were studied only if the marker species were very small (e.g., *Pseudohastigerina micra).*

BIOSTRATIGRAPHY

Planktonic Zonation and Chronostratigraphy

The Cenozoic biozonation according to Blow (1969) is used in this study, with slight modifications by Kennett and Srinivasan (1983) for the Neogene, Bolli and Saunders (1985) for the Oligocene to Holocene, and Toumarkine and Luterbacher (1985) for the Paleocene to Eocene. The late Cretaceous biozonation is based on Robaszynski et al. (1984) and the early Cretaceous biozonation on Robaszynski and Caron (1979). The time scale of Harland et al. (1990) was used.

Summaries of sediment recovery, planktonic foraminiferal zones, and ages for Sites 897, 898, 899, and 900, are shown in Figs. 2A-D.

Distribution charts for Holes 897A, 897C, 897D, 898A, 899A, 899B, and 900A are summarized in Tables 1 through 16. Some species names used are discussed in the section "Taxonomic Notes;" all species names used are listed in the Appendix.

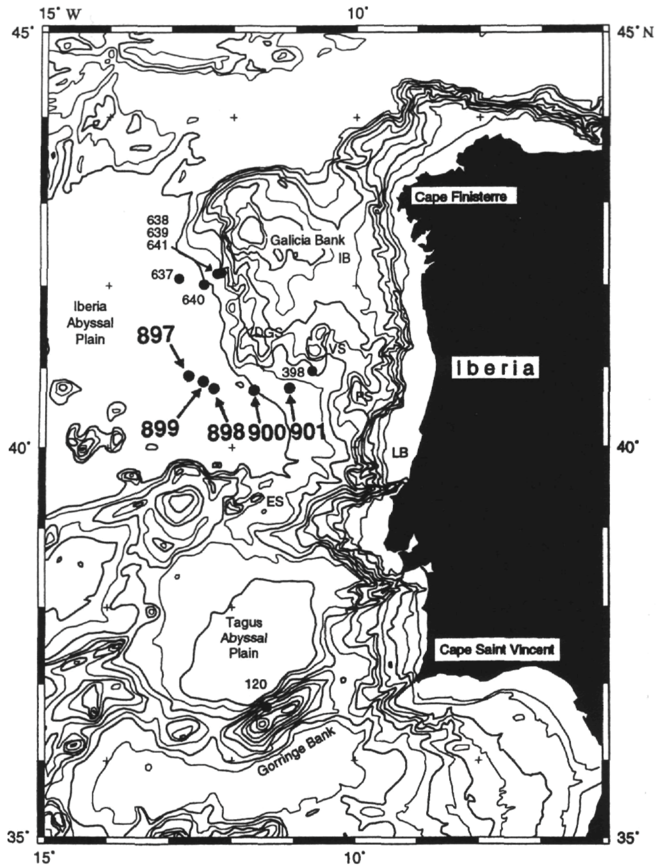

Figure 1. Location map of Leg 149 Sites 897, 898, 899, 900, and 901 in the Iberia Abyssal Plain. The contours of the regional bathymetric chart are at 500-m intervals (the 1000-m contours are in bold). Smaller numbers refer to previous DSDP/ODP drill sites. IB = Interior Basin, VDGS = Vasco da Gama Seamount, VS = Vigo Seamount, PS = Porto Seamount, LB = Lusitanian Basin, ES = Estremadura Spur.

Zonation

Hole 897A

The interval of Samples 149-897A-1R-1, 107-109 cm, to 149-897A-6R-CC is characterized by the presence of *Globorotalia truncatulinoides* and can be assigned to the N22 and N23 Zones, which are of latest Pliocene to Holocene age (Table 1; Fig 2A). Relatively rare to few specimens of *Globorotalia tosaensis* were recorded through the whole interval, and it is not clear if their presence resulted from reworking or if the range of this species has to be extended into the N23 Zone.

Hole 897C

The interval of Samples 149-897C-1R-2, 8-10 cm, to 149-897C-17R-1,127-129 cm, is characterized by the presence of *Globorotalia truncatulinoides* and can be assigned to the N22 and N23 Zones, which are of latest Pliocene to Holocene age (Tables 2, 3; Fig. 2A). As in Hole 897A, specimens of *Globorotalia tosaensis* were found throughout this interval, although their occurrence was relatively rare and patchy. Acmes of *Pulleniatina obliquiloculata* (Sample 149-897C-8R-3, 60-62 cm), *Neogloboquadrina atlantica* (Samples 149-897C-11R-4, 89-91 cm, and 149-897C-17R-1, 127-129 cm), *Orbulina universa* (Sample 149-897C-12R-5, 140-142 cm), and *Globigerina bulloides* (Sample 149-897C-14R-2, 81-83 cm) were also noted.

The interval of Samples 149-897C-17R-CC to 149-897C-19R-1, 73-75 cm, is characterized by the absence of *Globorotalia truncatulinoides* and the presence of *Globorotalia inflata.* According to Bolli and Saunders (1985), the first appearance datum (FAD) of *Globorotalia inflata* occurs at the base the N20 Zone. Therefore, this interval is assigned to the N20 and N21 Zones, which are of late Pliocene age. *Sphaeroidinellopsis seminulina* has its LO in this interval.

The interval of Samples 149-897C-19R-CC to 149-897C-26R-1, 90-92 cm, is characterized by the absence of *Globorotalia inflata* and the presence of *Globorotalia puncticulata, Sphaeroidinellopsis paenedehiscens,* and *Globorotalia crassaformis crassaformis,* and can be assigned to the N19/20 Zone, which is of early to early late Pliocene age. *Globorotalia margaritae margaritae* is absent in this hole and in Hole 898A but is present in Holes 899A and 900A. The top occurrence of *Globorotalia puncticulata* is found in Sample 149-897C-22R-2, 70-72 cm. Therefore, I see no overlap between *G. puncticulata* and *G. inflata,* which is in accordance with the findings of Stainforth et al. (1975). Bolli and Saunders (1985), however, overlapped the ranges of *G.* sp. cf. *G. bononiensis* (syn. *G. puncticulata*?) and *G. inflata* in Zone N20. *Globigerina decoraperta* has its top occurrence in this interval.

Sample 149-897C-26R-CC contains only *Globorotalia crassaformis ronda.* As specimens of *Globorotalia* are rare in this sample, the absence of *Globorotalia crassaformis crassaformis* cannot be reliably used to separate the N18 and N19 Zones.

The interval of Samples 149-897C-27R-1, 25-27 cm, to 149-897C-28R-2, 19-21 cm, is barren of foraminifers (both planktonic and benthic), except for Sample 149-897C-27R-CC, which contains relatively rare foraminifers, none of which are marker species. No age can be assigned to this interval.

Sample 149-897C-28R-CC is characterized by the presence of *Neogloboquadrina acostaensis* and *Neogloboquadrina pachyderma* and absence of *Globorotalia crassaformis ronda.* It is assigned to the N16 and N17 Zones, which are of late Miocene age. The species tops of *Globoquadrina venezuelana* and *Globorotalia merotumida* were recorded here.

Samples 149-897C-29R-4, 122-124 cm, and 149-897C-29R-CC have *Globorotalia mayeri,* but no *Globigerina nepenthes,* and are assigned to Zones N9 to N13, which are of middle Miocene age. In the absence of other marker species, a more precise zonal assignment is not possible.

Sample 149-897C-30R-4, 52-54 cm, contains *Praeorbulina transitoria.* This species ranges from the upper part of Zone N7 to the top of Zone N8 (Bolli and Saunders, 1985), of latest early to earliest middle Miocene age. The species tops of *Globoquadrina dehiscens dehiscens* and *Globorotalia miozea/conoidea* were recorded here.

Rare *Catapsydrax stainforthi* was recorded at the top of the interval of Samples 149-897C-30R-6, 25-27 cm, to 149-897C-31R-CC. The species tops of *Globigerina praebulloides, Globigerina woodi woodi, Globigerinoides subquadratus, Globorotalia fohsi peripheroronda, Globorotalia obesa, Globorotalia praescitula,* and *Globorotalia siakensis* are also recorded. *Catapsydrax stainforthi* is used here as a secondary marker, as this species became extinct near the top of Zone N7. Therefore, this interval is placed in the N7 Zone, which is of early Miocene age.

The interval of Samples 149-897C-33R-6, 130-132 cm, to 149-897C-35R-2, 75-77 cm, has the tops of rare *Catapsydrax dissimilis* and *Globoquadrina altispira altispira.* It may be assigned to the N5 and N6 Zones, which are of early Miocene age.

Sample 149-897C-35R-CC contains rare *Globigerinoides primordius* and may represent the N4 Zone and the lower part of the N5 Zone, of latest Oligocene to early early Miocene age. According to Bolli and Saunders (1985), *G. primordius* became extinct in the lower part of Zone N5. The absence of *Globorotalia kugleri* (in this hole)

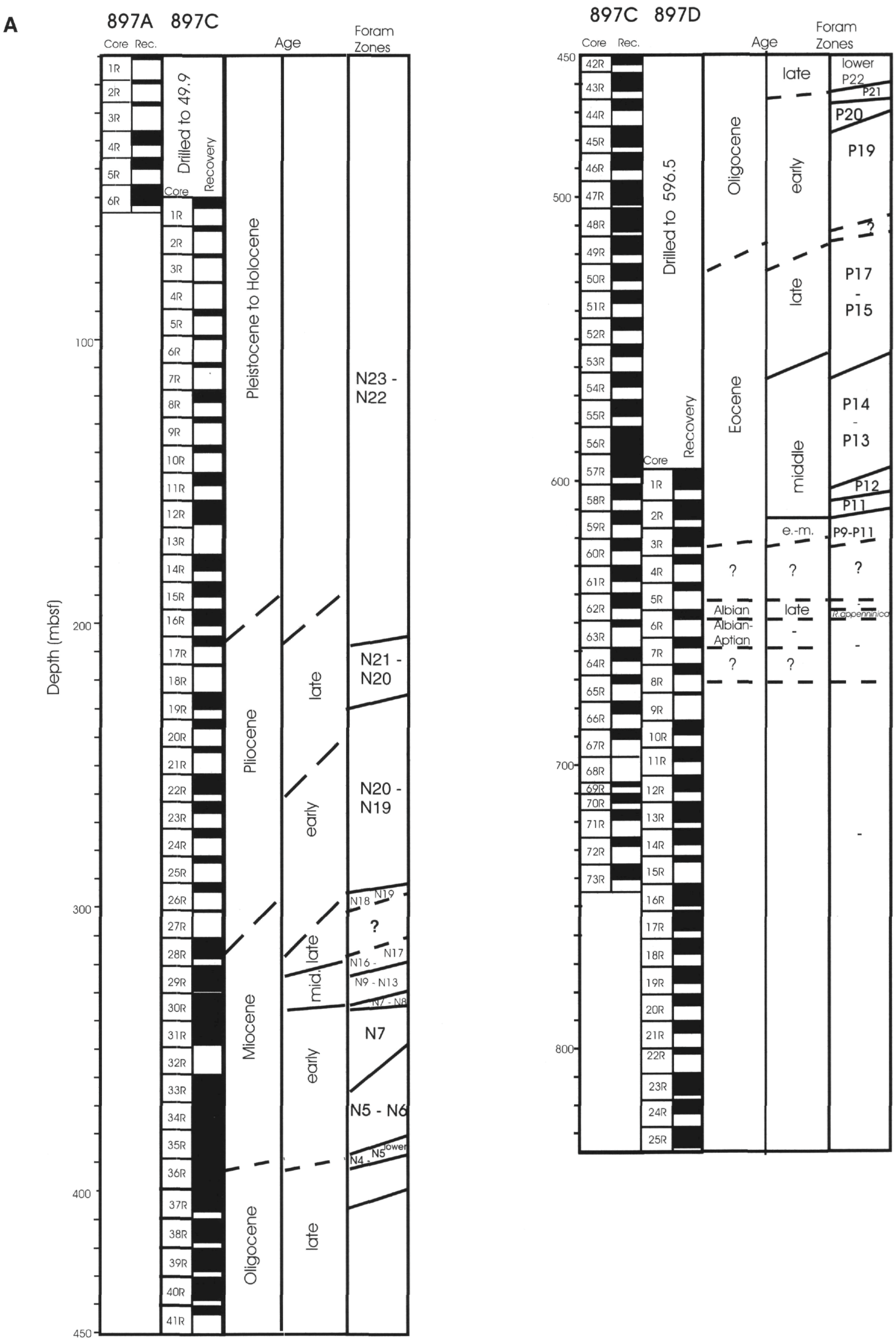

Figure 2. **A.** Summary of sediment recovery, planktonic foraminiferal zones, and ages at Site 897. In the column "Foram Zones," diagonal lines denote uncertainty of the exact position of a zonal boundary. The uncertainty equals the sample gap. In the column "Age," diagonal lines denote either uncertainty of chronostratigraphic boundary due to a sample gap or chronostratigraphic age uncertainty connected with applying the standard chronostratigraphic chart of Harland et al. (1990).

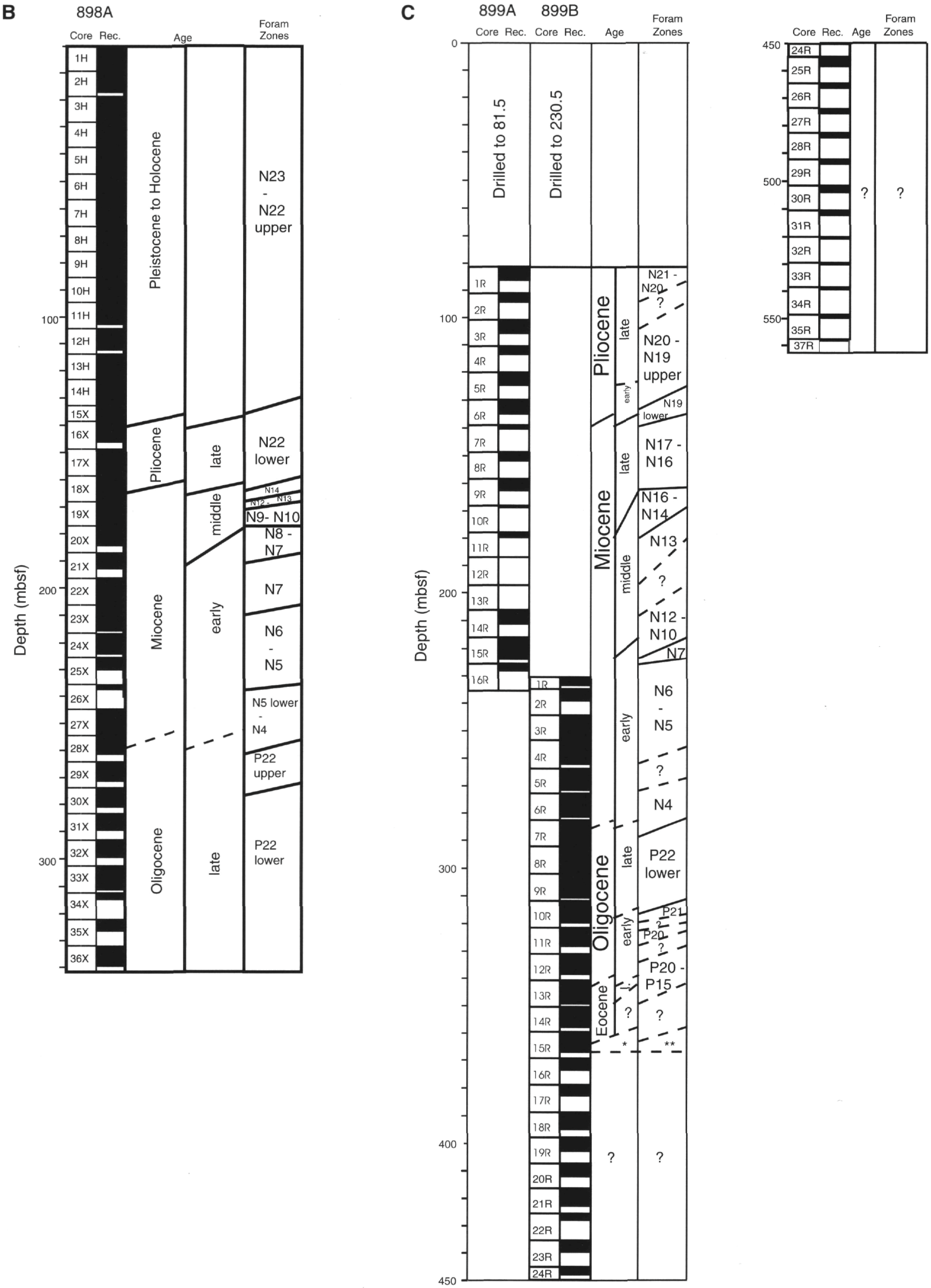

Figure 2 (continued). **B.** Summary of sediment recovery, planktonic foraminiferal zones, and ages at Site 898. **C.** Summary of sediment recovery, planktonic foraminiferal zones, and ages at Site 899. * = Campanian to Maastrichtian. ** = *Globotruncana elevata* to upper part of *Gansserina gansseri.*

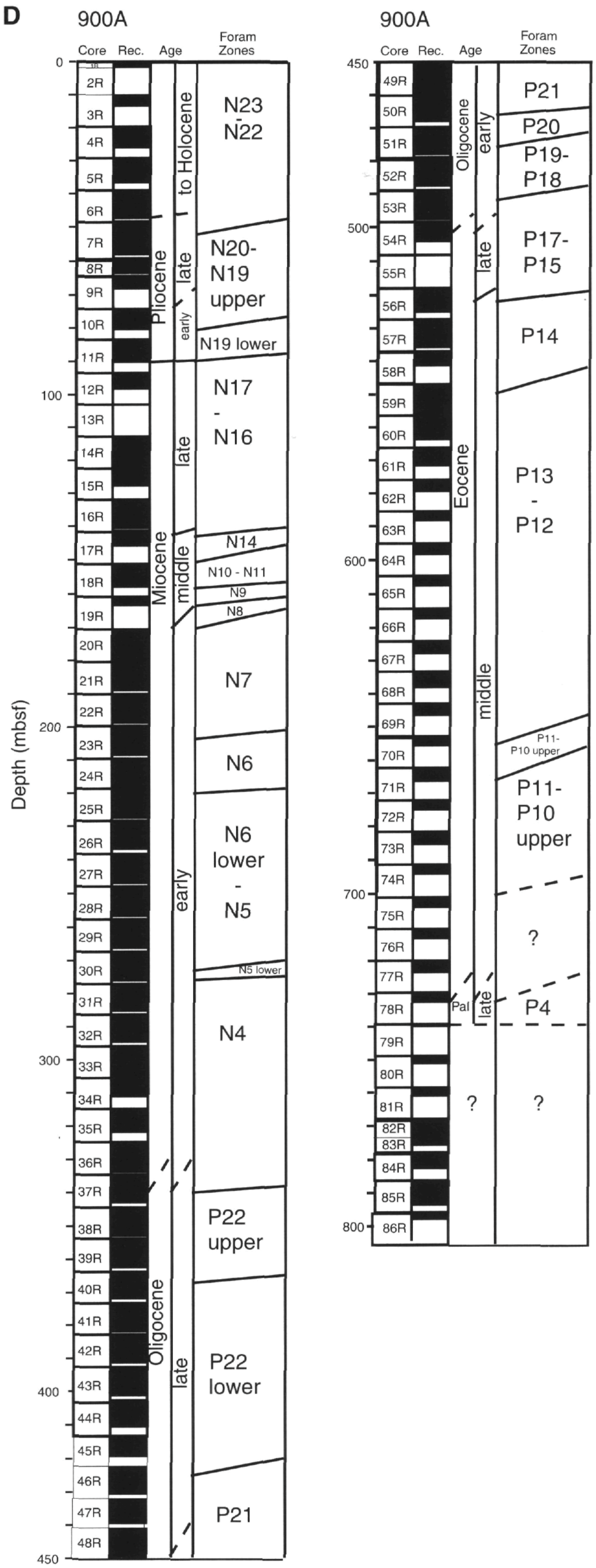

Figure 2 (continued). **D.** Summary of sediment recovery, planktonic foraminiferal zones, and ages at Site 900.

may be the result of preservational or paleoenvironmental conditions and cannot be used to subdivide the N4/N5 Zone. The first appearance of the genus *Globigerinoides* is used here to define the base of the N4 Zone.

The interval of Samples 149-897C-36R-5, 131-133 cm, to 149-897C-36R-CC does not contain *Globigerinoides* spp. or *Globigerina ciperoensis angulisuturalis* and can be assigned to the upper part of the P22 Zone, which is of late Oligocene age (see Table 3).

The interval of Samples 149-897C-37R-6, 30-32 cm, to 149-897C-43R-4, 82-84 cm, is characterized by the presence of *Globigerina ciperoensis angulisuturalis* and the absence *of Globorotalia opima opima,* which indicates that this interval belongs to the lower part of the late Oligocene P22 Zone. Species tops recorded in this interval were: *Globigerina binaiensis, Globigerina ciperoensis angulisuturalis, Globigerina ciperoensis ciperoensis, Globigerina tripartita, Globoquadrina globularis, Globorotalia opima nana* (Sample 149-897C-42R-2, 32-34 cm), and *Globorotaloides suteri.*

Samples 149-897C-43R-CC and 149-897C-44R-1, 129-131 cm, contain *Globorotalia opima opima* and are assigned to the P21 Zone, which is of late early to early late Oligocene age. *Globigerina sellii* and *Globorotalia opima nana/opima opima* transition have their top occurrences in this interval.

The absence of *Globorotalia opima opima* and *Pseudohastigerina micra* in Samples 149-897C-44R-2, 0-2 cm, and 149-897C-44R-CC suggests that they represent the early Oligocene P20 Zone.

The interval of Samples 149-897C-45R-2, 86-88 cm, to 149-897C-48R-3, 58-60 cm contains *Pseudohastigerina micra* and can be assigned to the early Oligocene P18/19 Zones. *Globigerina ciperoensis* s.l., *Globigerina eocaena, Globigerina yeguaensis,* and *Globorotalia increbescens* have their top occurrences in this interval.

Sample 149-897C-48R-CC is barren of planktonic foraminifers. Therefore, no age can be assigned to it.

The top of the interval of Samples 149-897C-49R-1,125-127 cm, to 149-897C-53R-3, 81-83 cm is marked by the presence of *Globorotalia cerroazulensis cocoaensis/cunialensis* transition, which assigns it to the P14 to P17 Zones of late Eocene to earliest Oligocene age. Other species tops recorded were: *Globigerina ampliapertura, Globigerina cryptomphala, Globigerina hagni, Globigerina ouachitaensis,* and *Globorotalia cerroazulensis cerroazulensis.*

The top of the interval of Samples 149-897C-54R-3, 4-6 cm, to 149-897C-57R-4, 87-89 cm, is marked by the presence of *Truncorotaloides rohri,* which places it in the middle Eocene P13/P14 Zones. *Acarinina bullbrooki, Globigerina linaperta, Globigerina senni, Globigerinatheka index, Morozovella spinulosa,* and *Truncorotaloides topilensis* have their top occurrences here.

Sample 149-897C-58R-2, 118-120 cm, has *Globorotalia cerroazulensis frontosa* and *Globigerinoides higginsi* but no *Morozovella aragonensis.* According to Tourmakine and Luterbacher (1985), *G. cerroazulensis frontosa* and *G. higginsi* became extinct at the end of the P12 Zone. Therefore, this sample is assigned to the middle Eocene P12 Zone.

The interval of Samples 149-897C-58R-CC to 149-897C-59R-3, 73-75 cm, contains *Morozovella aragonensis, Acarinina pentacamerata, Acarinina broedermanni,* and *Acarinina pseudotopilensis,* indicating that it belongs to the middle Eocene P11 Zone. The top occurrence of *A. pentacamerata* in the lower part of the interval (Sample 149-897C-59R-3, 73-75 cm), confirms the view of Tourmakine and Luterbacher (1985) who question its range in the middle Eocene P12 Zone and the upper part of the P11 Zone.

Samples 149-897C-59R-4, 35-37 cm, and 149-897C-59R-CC contain no marker species. The presence of *Morozovella spinulosa* in Sample 149-897C-59R-CC suggests that this level is not older than the latest early Eocene P9 Zone.

The interval of Samples 149-897C-60R-CC to 149-897C-62-2, 64-66 cm, is barren of planktonic foraminifers. Therefore, no age can be assigned to this interval.

Table 1. Distribution chart for Hole 897A (latest Pliocene to Holocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Beella digitata*	*Beella praedigitata*	*Globigerina bulloides*	*Globigerina falconensis*	*Globigerina megastoma cariacoensis*	*Globigerinoides elongatus/obl. extremus*	*Globigerinoides ruber (white)*	*Globorotalia inflata*	*Globorotalia scitula*	*Globorotalia triangula*	*Globorotalia truncatulinoides*	*Hastigerina siphonifera*	*Neogloboquadrina acostaensis*	*Neogloboquadrina dutertrei*	*Neogloboquadrina humerosa*	*Neogloboquadrina pachyderma*	*Orbulina bilobata*	*Orbulina universa*	*Globigerinoides sacculifer*	*Globorotalia crassaformis crassaformis*	*Globorotalia tosaensis*	*Globigerinoides fistulosus*	*Globigerinoides ruber (pink)*	*Globigerinoides trilobus/immaturus*	*Globorotalia crassaformis ronda*	*Globorotalia crassaformis s. l.*	*Hastigerina aequilateralis*	*Orbulina suturalis*	*Pulleniatina obliquiloculata*	*Globigerinoides conglobatus*	*Globorotalia cf. hirsuta*	*Globorotalia menardii*
latest Pliocene to Holocene	N22 to N23	1R-1, 107-109	C	G	R	R	F	R	R	R	F	F	R	R	R	R	R	R	R	F	R	R														
		1R-CC	A	G			F				R	F	R	F	F		R			F		F	R													
		2R-CC	A	G			F				R	F	R	F	F		F	R		C		C		R	F											
		3R-CC	C	G			F			R	R	F	R	F	F		F	R		C		C			F	R										
		4R-1, 119-120	A	G		R	F		R	R	F	F	R	F	F	R	F	R	R	F		F			R		R	R	R	R	R	R	R			
		4R-CC	A	G			F			R	R	F	R	F	F		F	R		C		C		R	F											
		5R-2, 32-34	A	G		R	F		F	R	F	F	F	F	F	F	F	R	F	C	R	C							R	R	R	R				
		5R-CC	A	G			C			R	R	F	R	F	F		F		R	C		C			F							R				
		6R-4, 148-150	A	M		R					R	F		F	R	R	F	R		C		R							R	R	R			?	R	R
		6R-CC	F	P													R			R																

Note: P = poor, M = moderate, G = good, B = barren, R = rare, F = few, C = common, A = abundant, ? = questionable, RW = reworked, X = hard rock, - = not applicable, * = only juvenile planktonic foraminifers.

Sample 149-897C-62R-4, 54-56 cm, contains an assemblage of very small specimens of *Hedbergella simplex* (rare), *Hedbergella planispira* (rare) and *Hedbergella delrioensis* (few). The presence of *Hedbergella simplex* and the absence of Cenomanian species restricts this interval to an Albian age.

The interval of Samples 149-897C-62R-CC to 149-897C-65R-CC is barren of foraminifers (planktonic and benthic). No age can be assigned to this interval.

Hole 897D

The interval of Samples 149-897D-1R-3, 23-25 cm, to 149-897D-2R-3, 50-52 cm, is characterized by the presence of *Globigerinoides higginsi* and *Globorotalia cerroazulensis frontosa* and its FO is defined by the top of *Morozovella aragonensis,* placing it in the middle Eocene P12 Zone (Table 4; Fig. 2A).

The interval of Samples 149-897D-2R-5, 9-11 cm, to 149-897D-3R-4, 20-22 cm, contains *Morozovella aragonensis* and *Morozovella spinulosa,* which assigns it to the P9 to P11 Zones of late early to early middle Eocene age. The species tops of *Globigerina cryptomphala, Globigerina inaequispira, Globorotalia bolivariana, Pseudohastigerina micra, Pseudohastigerina wilcoxensis,* and *Truncorotaloides topilensis* were recorded in this interval. Sample 149-897D-3R-4, 20-22 cm, has rare reworked Cretaceous species (*Marginotruncana* spp. and *Hedbergella* spp.).

The interval of Samples 149-897D-3R-CC to 149-897D-5R-CC is barren of planktonic foraminifers and no age can be assigned to this interval. Sample 149-897D-3R-CC contains rare ichthyoliths, and Samples 149-897D-4R-CC and 149-897D-5R-CC contain rare agglutinated foraminifers (*Glomospira* spp. and *Recurvoides* spp.).

Sample 149-897D-6R-3, 59-61 cm, contains few *Hedbergella delrioensis* and rare *Rotalipora appenninica, Hedbergella simplex* and *Hedbergella planispira.* Radiolarians are relatively common. The presence of *Rotalipora appenninica* and the absence of Cenomanian species places this interval in the late Albian *Rotalipora appenninica* Zone (LCI9).

Samples 149-897D-6R-CC and 149-897D-7R-1, 41-43 cm, contain rare *Globigerinelloides* spp. and *Hedbergella* spp. Based on the presence of specimens belonging to these two genera and the fact that upper Albian strata had already been penetrated in the overlying interval, an Aptian to Albian age is assigned to this interval. A few cone-shaped radiolarians were found in Sample 149-897D-6R-CC. Rare arenaceous and calcareous benthic foraminifers and ostracods, few radiolarians, and abundant wood fragments are found in Sample 149-897D-6R-3, 59-61 cm.

The interval of Samples 149-897D-7R-CC to 149-897D-10R-4, 140-142 cm, is barren of planktonic foraminifers and no age can be given. Sample 149-897D-7R-CC contains pyritized radiolarians and diatoms. Sample 149-897D-8R-2, 51-53 cm, contains rare pyritized radiolarians and a few agglutinated and calcareous benthic foraminifers. Sample 149-897D-8R-CC is barren of any fauna. Samples 149-897D-10R-3, 148-150 cm, and 149-897D-10R-4, 140-142 cm, contain a few radiolarians and ichthyoliths.

Hole 898A

The interval of Samples 149-898A-1H-2, 60-61 cm, to 149-898A-14H-6,64-66 cm, is characterized by the presence of *Globorotalia truncatulinoides* and *Globigerina bermudezi* (Tables 5, 6; Fig. 2B). According to Bolli and Saunders (1985) the FAD of *G. bermudezi* occurs in the middle of the N22 Zone; therefore, this interval is restricted to the upper part of the N22 Zone and the N23 Zone, which are of Pleistocene to Holocene age. Acmes of *Pulleniatina obliquiloculata* (6H- 4, 89-91), *Neogloboquadrina atlantica* (Sam-

Table 2. Distribution chart of Hole 897C (latest Oligocene to Holocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Beella digitata*	*Beella praedigitata*	*Globigerina bulloides*	*Globigerina falconensis*	*Globigerina megastoma cariacoensis*	*Globigerinoides elongatus/obl. extremus*	*Globigerinoides obliquus obliquus*	*Globigerinoides ruber (white)*	*Globigerinoides trilobus/immaturus*	*Globorotalia cf hirsuta*	*Globorotalia crassaformis crassaformis*	*Globorotalia crassaformis ronda*	*Globorotalia crassaformis s. l.*	*Globorotalia inflata*	*Globorotalia scitula*	*Globorotalia tosaensis*	*Globorotalia triangula*	*Globorotalia truncatulinoides*	*Hastigerina aequilateralis*	*Hastigerina siphonifera*	*Marginotruncana spp*	*Neogloboquadrina acostaensis*	*Neogloboquadrina dutertrei*	*Neogloboquadrina humerosa*	*Neogloboquadrina pachyderma*	*Orbulina bilobata*	*Orbulina suturalis*	*Orbulina universa*	*Pulleniatina finalis*	*Rotalipora spp*	*Globigerinita naparimaensis*	*Globigerinoides conglobatus*	*Globorotalia crassaformis hessi*	*Pulleniatina obliquiloculata*	*Pulleniatina primalis*	*Neogloboquadrina atlantica*	*Globorotalia tumida*	*Sphaeroidinella dehiscens*	*Sphaeroidinellopsis seminulina*	*Sphaeroidinellopsis paenedehiscens*	*Globigerinoides primordius*	*Globigerina decoraperta*	*Globorotalia puncticulata*	*Globigerina spp*	*Globoquadrina venezuelana*	*Globorotalia merotumida*	*Globigerina cip. angustiumbilicata*	*Globorotalia mayeri*	*Globigerinoides spp*	*Globoquadrina dehiscens dehiscens*	*Globorotalia miozea/conoidea*	*Praeorbulina transitoria*	*Catapsydrax stainforthi*	*Globorotalia fohsi peripheroronda*	*Globorotalia praescitula*	*Globigerina praebulloides*	*Globigerina woodi woodi*	*Globigerinoides subquadratus*	*Globorotalia obesa*	*Globorotalia siakensis*	*Hastigerina praesiphonifera*	*Globoquadrina spp*	*Catapsydrax dissimilis*	*Catapsydrax spp*	*Globoquadrina altispira altispira*	*Catapsydrax unicavus*
latest Pliocene to Holocene	N22 to N23	1R-2, 8-10	A	G	R	F	C	R	F	R	R	F	R	R	R	R	R	C	F	R	F	F	F	F	RW	F	R	R	C	R	R	F	R	RW																																						
		2R-1, 129-130	A	M		R	R		R	R	R	F						F		R	F	F	R	R		F			C			R			R																																					
		3R-1, 54-56	A	G	R	F	F		R	R		R		R				C	R			F		R		F	R	F	C			F																																								
		4R-1, 22-24	A	G		R	C		F	R	F	F			C	R	F	C	F		F	F	F	F		F	R	F	F	R	R	C																																								
		5R-2, 60-61	C	M		R	F					R			R	R	F	C			F		?			R			R																																												
		6R-1, 92-94	B																																																																						
		7R-1, 103-105	F	M			R	R	R			R			R	R		R			R		R			R	?		F		R	R																																								
		8R-3, 60-62	A	M			F			F	R	C				R	R	C			C	F	R	R		F		R	C			R	R			R	R	F	R																																
		9R-2, 4-6	C	M												F	R	F		R	F								F								R																																			
		10R-1, 111-113	A	G			C	R	F	F	F	C			F	R	F	C	F	R	C	F	C	C		F	F	F	C	R		C	R				R	R																																		
		11R-4, 89-91	A	G	R	R	F			F	F	F			F	F	R	C			C	R	R	R		F			C		R	F				R				C																																		
		12R-5, 140-142	A	G		R	F		F	F	F	C			F	R	F	C	R	?	C	F	F	R		F		R	F		F	C				R				F																																		
		14R-2, 81-83	A	M		R	C	R	R	R		F			F		R	C			C		F	F		R			F		F	C				?				F																																		
		15R-2, 116-118	A	G		R	C	R	F	F	F	F						C			C		F	F		F			F	R	F	C				F				R																																		
		16R-1, 104-106	C	M		R									R	F	R									F			C		R	F								R																																		
		17R-1, 127-129	C	M			F			R	R	F	R	R	R		R	F	R	?	F	R		R		F			C		R	F								F	R	R																															
late Pliocene	N20 to N21	17R-CC	*	M																																																																			
		18R-1, 24-25	F	M										R				R			R								F																																											
		18R-CC	C	M																									F			R											R																														
		19R-1, 73-75	C	P														F			C								F		R	R																																								
early to e. late Pliocene	N19 to N20	19R-CC	C	M																						R						R												R																										
		20R-1, 135-137	A	M		R	F	R		R	R	F	R		R	R	F									F	?		F		R	F				R					R	F			RW																									
		21R-1, 121-122	B																																																																						
		22R-2, 70-72	A	M			F	R		R		F	R	R			R		F					R		F			C		R	R				R										R	R																							
		23R-1, 104-106	F	P			R									R										R			F		R	F												?																										
		24R-1, 27-29	F	M			F	?								R														R	R	R															?																							
		25R-1, 9-11	R	P																																												R																						
		26R-1, 90-92	F	P											R	R																R															F																							
1)	N18-19	26R-CC	C	M												R																											R																											
?	?	27R-1, 25-27	B																																																																					
		27R-CC	*	M																																																																				
		28R-2, 19-21	B																																																																					
late Miocene	N16-17	28R-CC	C	M																						F			F		R	R									R								R	R																				
middle Miocene	N9 to N13	29R-4, 122-124	R	M																																														R	R																		
		29R-CC	*	P																																																																				
2)	4)	30R-4, 52-54	F	P			?						R																																								R	F	F	R														
early Miocene	N7	30R-6, 25-27	F	P																																											R					R	R																
		30R-CC	C	M																																												R			R					R	R	R											
		31R-2, 33-35	F	P									R																						F														?		R			R				R	R	R	R	R	R	R	?					
		31R-3, 30-32	R	P																																																															R				
		31R-CC	B																																																																					
	N5 to N6	33R-6, 130-132	R	P																																																																R	R	R	
		34R-4, 37-39	*	P																																																																					
		35R-2, 75-77	B																																																																						
3)	5)	35R-CC	A	M																																									R				R		R	F																		R

Notes: 1= latest Miocene to early Pliocene, 2 = latest early to earliest middle Miocene, 3 = latest Oligocene to early early Miocene, 4 = upper N7 to N8, 5 = N4 to lower N5. For legend of abbreviations, see Table 1 notes.

Table 3. Distribution chart of Hole 897C (Early Cretaceous, early Eocene to late Oligocene).

Age	Zone	Core - Section, interval (cm)	Abundance	Preservation	*Catapsydrax unicavus*	*Globigerina spp*	*Globoquadrina venezuelana*	*Globorotalia fohsi peripheroronda*	*Globorotalia mayeri*	*Globorotalia siakensis*	*Catapsydrax dissimilis*	*Catapsydrax spp*	*Globigerina cip. angulisuturalis*	*Globigerina cip. angustiumbilicata*	*Globigerina gortanii*	*Globigerina praebulloides*	*Globorotalia opima nana/continuosa trans.*	*Globorotaloides suteri*	*Globigerina ciperoensis ciperoensis*	*Globigerina binaiensis*	*Globorotalia opima nana*	*Globigerina tripartita*	*Globoquadrina spp*	*Globoquadrina globularis*	*Globorotaloides spp*	*Globorotalia opima opima*	*Globigerina sellii*	*Globorotalia obesa*	*Globorotalia opima nana/opima opima trans.*	*Globigerina ciperoensis s.l.*	*Globorotalia increbescens*	*Morozovella spinulosa*	*Pseudohastigerina micra*	*Globigerina eocaena*	*Globigerina yeguaensis*	*Acarinina pentacamerata*	*Acarinina pseudotopilensis*	*Globigerina ampliapertura*	*Globigerina cryptomphala*	*Globigerina hagni*	*Globigerina ouachitaensis*	*Globorotalia cerroazulensis s.l.*	*Globorotalia cocoaensis/cunialensis trans.*	*Marginotruncana spp*	*Hantkenina spp*	*Globorotalia cerroazulensis cerroazulensis*	*Truncorotaloides rohri*	*Globigerina linaperta*	*Globigerina senni*	*Truncorotaloides topilensis*	*Globigerinatheka index*	*Morozovella spp*	*Acarinina bullbrooki*	*Acarinina spp*	*Globigerinoides higginsi*	*Globorotalia cerroazulensis frontosa*	*Morozovella aragonensis*	*Acarinina broedermanni*	*Hedbergella delrioensis*	*Hedbergella planispira*	*Hedbergella simplex*
late Oligocene	P22 upper	36R-5, 131-133	F	M	R	R	R	R	R	R																																																		
		36R-CC	B																																																											
	P22 lower	37R-6, 30-32	F	P		R	R	R	R		R	R	R	R	?	R	R	R																																												
		38R-3, 85-87	R	M		R				R				R			R																																													
		39R-3, 130-132	F	M	R	R	R		R		R	R	R	R		R		R	R																																											
		40R-3, 63-65	R	P		R	R					R								R																																										
		41R-1, 102-104	R	P														R																																												
		42R-2, 32-34	F	M					R		R	R		R		R	R	R			R																																									
		42R-3, 63-65	R	M					R							R					R	R	R																																						
		43R-4, 82-84	F	M		R	R			R			R			R			R		R			R	R																																				
1)	P21	43R-CC	A	G							R								F		R					R																																			
		44R-1, 129-131	F	G		R					R			R		F		R	R		F	R		R		R	R	R	R																																
early Oligocene	P20	44R-2, 0-2	R	P																	R						R																																	
		44R-CC	*	P																																																							
	P18 to P19	45R-2, 86-88	F	M										R					R		R									R	R	RW	R																												
		46R-2, 39-41	R	M														R																?																											
		47R-3, 76-78	F	M							R			R				R	R		R	R										RW		R	R																										
		48R-3, 58-60	F	M	R		R				R					R		R			R				R									R	R																										
?	?	48R-CC	B																																																											
late Eocene to earliest Oligocene	P15 to P17	49R-1, 125-127	C	M			F				R	R						R			R	R									F	RW	F	F	F	RW	RW	F	F	R	R	R	R	RW																	
		50R-3, 27-28	F	M			R				R																						F	R					R																						
		51R-1, 13-15	F	P			R											R				R												R	R										R																
		51R-3, 26-28	F	P														?															R	R							R					R															
		52R-1, 103-105	F	P																														R	R						R					R															
		53R-3, 81-83	*	P		R																																																							
middle Eocene	P13 to P14	54R-3, 4-6	F	M												R					R	R												R				?									R														
		55R-4, 69-71	C	P							R	R						R			R											F		F							R	R					C	R	R	R											
		56R-6, 98-100	F	M																												R		?							?						R				R										
		57R-2, 133-135	F	P														R														R	R														R	?	?			R									
		57R-4, 87-89	R	P																												R																				R	R								
	P12	58R-2, 118-120	F	M																					R							R															R		R				R	R	R	R					
	P11	58R-CC	F	M																												F					R														R						R				
		59R-3, 73-75	F	M								R													R							R				R				R							R						R		R	R		R			
2)	P9 to P11	59R-4, 35-37	R	P																																																	R	R	?						
		59R-CC	F	M																												R																													
?	?	60R-CC	B																																																											
		61R-CC	B																																																											
		62R-2, 64-66	B																																																											
Albian	-	62R-4, 54-56	F	P																																																						F	R	R
?	?	62R-CC	B																																																											
		63R-2, 35-37	B																																																											
		63R-CC	B																																																											
		64R-1, 90-92	B																																																											
		64R-CC	B																																																											
		65R-2, 107-109	B																																																											
		65R-CC	B																																																											

Notes: 1 = late early to early late Oligocene, 2 = late early to early middle Eocene. For legend of abbreviations, see Table 1 notes.

Table 4. Distribution chart of Hole 897D (Early Cretaceous and Eocene).

Age	Zone	Core-section, interval (cm)	Abundance	Preservation	*Acarinina broedermanni*	*Acarinina bullbrooki*	*Acarinina pentacamerata*	*Acarinina primitiva*	*Acarinina pseudotopilensis*	*Globigerina eocaena*	*Globigerina linaperta*	*Globigerina senni*	*Globigerinoides higginsi*	*Globorotaloides spp*	*Morozovella spinulosa*	*Truncorotaloides rohri*	*Globigerina cryptomphala*	*Globorotalia cerroazulensis frontosa*	*Globorotalia cerroazulensis s.l.*	*Morozovella lehneri*	*Planorotalites pseudoscitula*	*Globigerina spp*	*Morozovella aragonensis*	*Pseudohastigerina micra*	*Catapsydrax spp*	*Globigerina inaequispira*	*Globorotalia bolivariana*	*Pseudohastigerina wilcoxensis*	*Truncorotaloides topilensis*	*Hedbergella spp*	*Marginotruncana spp*	*Hedbergella delrioensis*	*Hedbergella planispira*	*Hedbergella simplex*	*Rotalipora appenninica*	*Globigerinelloides spp*
middle Eocene	P12	1R-3, 23-25	F	G	R	R	R	R	R	R	R	R	R	R	F	F																				
		1R-CC	C	M	F	F	F	R		F	F	R	F	R	F	F	?	R	R	R	R															
		2R-1, 46-48	R	M	R	R									R							R														
		2R-3, 50-52	B																																	
l. early to e. middle Eocene	P9 to P11	2R-5, 9-11	F	M		R	R	?		R					R	R		R					R													
		2R-CC	F	M	R	R	R			R					R									R												
		3R-3, 72-74	A	G	F	F	F	R		F	R	R	F	R	C	F	R	R	R		R			C	R	R	R	F	R							
		3R-4, 20-22	C	M	R	R	F			R			R		F	R		R			R			R	R		R			RW	RW					
?	?	3R-CC	B																																	
		4R-CC	B																																	
		5R-CC	B																																	
late Albian	1)	6R-3, 59-61	F	P																												F	R	R	R	
Aptian to Albian	-	6R-CC	F	P																										C		R	R			F
		7R-1, 41-43	R	P																										R						R
?	?	7R-CC	B																																	
		8R-2, 51-53	B																																	
		8R-CC	B																																	
		10R-3, 148-150	B																																	
		10R-4, 140-142	B																																	

Notes: 1 = *Rotalipora appenninica.* For legend of abbreviations, see Table 1 notes.

ples 149-898A-13H-4, 135-137 cm, and 149-898A-17X-6, 33-36 cm), and *Orbulina universa* (Sample 149-898A-14H-6, 64-66 cm), are recognized in this interval.

The interval of Samples 149-898A-15X-4, 66-68 cm, to 149-898A-18X-1, 148-150 cm, has *Globorotalia truncatulinoides,* but no *Globigerina bermudezi.* It can be assigned to the lower part of the N22 Zone, which is of latest Pliocene to Pleistocene age. *Sphaeroidinella dehiscens* has its top occurrence in this interval.

Sample 149-898A-18X-5, 56-60 cm, contains small specimens of *Globigerina nepenthes* and *Globorotalia mayeri,* which indicates that it belongs to the middle Miocene Zone N14. The species tops of *Globigerina decoraperta* and *Globorotalia miozea* were found (see Table 6).

Sample 149-898A-18X-CC contains *Globoquadrina dehiscens dehiscens, Globorotalia mayeri,* and *Sphaeroidinellopsis disjuncta.* The absence of *Globigerina nepenthes* (which appears near the base of Zone N14) and *Globorotalia acrostoma* (a species that, according to Kennett and Srinivasan [1983], became extinct at the top of Zone N11), place this sample in the middle Miocene N12 to N13 Zones.

The interval of Samples 149-898A-19X-3, 145-147 cm, to 149-898A-19X-CC has *Globorotalia acrostoma,* but no *Praeorbulina sicana,* which assigns it to the middle Miocene N9 to N11 Zones. Many species have their top occurrences in this interval (see Table 6).

The presence of *Praeorbulina sicana* and *Praeorbulina transitoria* in the interval of Samples 149-898A-20X-1, 75-77 cm, to 149-898A-21X-1, 96-98 cm, indicates that this interval belongs to the upper part of the N7 Zone and the N8 Zone, which are of late early to early middle Miocene age. *Globigerina praebulloides, Globigerinoides altiaperturus, Globorotalia fohsi peripheroronda, Globorotalia obesa,* and *Globorotaloides suteri* have their top occurrences in this interval.

The absence of praeorbulinids and *Catapsydrax dissimilis* in the interval of Samples 149-898A-21X-3, 99-101 cm, to 149-898A-22X-CC, place it in the early Miocene N7 Zone. The species tops of *Cassigerinella chipolensis* and *Globorotalia continuosa* were recorded.

The top of the interval of Samples 149-898A-23X-4, 94-96 cm, to 149-898A-26X-1, 104-105 cm, is marked by the presence of *Catapsydrax dissimilis,* which assigns it to the early Miocene N5 to N6 Zones. *Catapsydrax stainforthi, Catapsydrax unicavus,* and *Globigerina opima nana/continuosa* transition have their top in this interval.

The interval of Samples 149-898A-26X-2, 22-23 cm, to 149-898A-28X-2, 52-54 cm, is characterized by the presence of *Globigerinoides primordius* and *Globigerinoides* spp., and is assigned to the N4 Zone and the lower part of the N5 Zone, which are of latest Oligocene to early early Miocene age. As *Globorotalia kugleri* is absent, the top of Zone N4 cannot be identified in this hole.

The interval of Samples 149-898A-28X-CC to 149-898A-29X-CC contains no marker species. The absence of *Globigerinoides* spp. and *Globigerina ciperoensis angulisuturalis,* may place this interval in the upper part of the late Oligocene P22 Zone.

The interval of Samples 149-898A-30X-2, 11-13 cm, to 149-898A-36X-CC contains *Globigerina ciperoensis angulisuturalis* and *Globigerina ciperoensis ciperoensis,* which assigns it to the lower part of the late Oligocene P22 Zone. The species top of *Globorotalia opima nana* was found in the lower part of the interval (Sample 149-898A-36X-2, 114-116 cm).

Hole 899A

The absence of *Globorotalia truncatulinoides* and presence of *Globorotalia inflata* in Sample 149-899A-1R-CC, place this sample in the N20 and N21 Zones, which are of late Pliocene age (Table 7; Fig. 2C).

Table 5. Distribution chart of Hole 898A (latest Pliocene to Holocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Beella digitata	Globigerina bulloides	Globigerina calida	Globigerina megastoma cariacoensis	Globigerinita naparimaensis	Globigerinoides elongatus/obl. extremus	Globigerinoides ruber (white)	Globorotalia hirsuta	Globorotalia inflata	Globorotalia scitula	Globorotalia tosaensis	Globorotalia triangula	Globorotalia truncatulinoides	Globorotalia tumida	Hastigerina aequilateralis	Hastigerina siphonifera	Neogloboquadrina acostaensis	Neogloboquadrina dutertrei	Neogloboquadrina humerosa	Neogloboquadrina pachyderma	Orbulina suturalis	Orbulina universa	Beella praedigitata	Globigerina bermudezi	Globigerinoides elongatus	Globigerinoides ruber (pink)	Globigerinoides trilobus/immaturus	Globorotalia crassaformis crassaformis	Globorotalia crassaformis ronda	Globorotalia crassaformis s. l.	Globigerinoides conglobatus	Globorotalia cf. hirsuta	Orbulina bilobata	Globigerinoides obliquus obliquus	Pulleniatina obliquiloculata/finalis trans.	Globigerina cip. angustiumbilicata	Globigerina falconensis	Pulleniatina obliquiloculata	Pulleniatina primalis	Pulleniatina finalis	Globigerina tripartita	Globoquadrina venezuelana	Globorotalia crassaformis hessi	Marginotruncana spp	Globigerinoides sacculifer	Neogloboquadrina atlantica	Globorotalia menardii	Sphaeroidinella dehiscens
Pleistocene to Holocene	N22 upper to N23	1H-2, 60-61	A	G	R	F	R	R	R	R	F	R	C	F	R	C	F	?	R	R	C	F	R	C	R	F																										
		1H-4, 56-58	A	G	R	F		R	F		C		C	F	R	C	C		R	R	C	F	F	C		F																										
		1H-5, 135-137	A	G	R	C	R	F	R		C		F	F		F	F		F	F	C	F	F	C	R	F	R	R	R	R	R	R																				
		2H-2, 137-139	F	M		F		R			R		F		R	R	R	R			R	R	R	F		R	R	?					R	R																		
		2H-4, 59-61	A	M		F		F		R	F	R	C		R	C	F	R	R	R	F	R		C		F	R				R		F	R	R	R																
		3H-4, 12-14	A	G		F				F	F		C	R	R	F	F				F	R	R	C	R	F					R	F	R	F			R															
		3H-6, 114-116	A	G	R	F	R			R	F		C		R	C	C		R	R	F		R	C	F	C						R	F	F	R		R	R	R													
		4H-2, 132-134	A	G	R	C		F		F	C		C	C	R	C	C		F	F	F		R	C	R	C						R	R	R	R	R	R	F														
		4H-5, 92-93	A	M		F				R	F		C		R	C	F		R	R	R		R	C		F					R	R	R	R		R		R														
		5H-2, 119-121	F	M									F			F			R	R				F		R																										
		5H-5, 92-94	F	M									R								R			R																										
		6H-4, 89-91	A	M		F		R		F	C		C		R	C	F		R	F	R			C		R	R				R		F	R	R			F		R	R	F	R									
		7H-6, 106-108	A	G		F		F	R	F	C		C	F	R	C	F	R	C	F	F	R	F	F		C						R	R	F			R	R				F	R	R								
		8H-1, 110-112	A	G		C		F		F	F		C	F	R	C	F		F	F	F		R	F		C		?				R	F	F	R			F			R	R										
		8H-5, 107-109	F	P									F			F																																				
		9H-6, 99-101	A	G		C		F		F	C		C	F	R	C	F		C	F	F		F	C		F	R	R			R	F	F	F				R			R				RW	RW	R	RW				
		9H-7, 61-63	C	G		F	R	R	R	R	C		R	F	?	R	R			R	F		R	C								R				R				R	R											
		10H-3, 87-89	F	P									R							R	R		R	F									R	R																		
		10H-5, 83-85	B																																																	
		11H-1, 108-110	F	M		R							R	R										R		R						R																				
		11H-4, 16-18	F	P									R			R								R	R	R							R	R																		
		12H-3, 107-109	A	G		F				F	F		F	R	R	F	F		R	R	R			C	R	C						R	F	R		R	R	R									F					
		13H-1, 91-93	A	G		C		F	R	F	C		F	F	R	F	F		C		C		R	C	R	C	R				F	F	F	F		R	R	R											R			
		13H-4, 135-136	A	G		C		F		F	C		C	R		C			R	R	F		R	C	R	C						F	R	F	R		R	R			R									C		
		14H-3, 94-96	A	G		R				R	F		C		R	C	R			R				C	R	F									F								R							C		
		14H-6, 64-66	A	G		C		C		F	C		C	F		C		?	C	F	R	R		C	R	C		R			R	R	R	R			R	R			R									R	R	
latest Pliocene to Pleistocene	N22 lower	15X-4, 66-68	C	P		R					R		F	R		R			R	R				F	R	F									R															F		
		16X-1, 33-35	A	G		F		R	R		F		C	R		F			F	R	R			C	F	F								R			R													R		
		16X-4, 105-107	A	G		C	R	F		F	F		C	R	R	C			C	F		F		C	F	C	R								R		F	R		R	R									R		
		17X-2, 136-138	A	M		F					F		C		R	C						R		C	F	F						R	R	F																F		R
		17X-6, 33-36	A	G	R	C	R	F		F	C		C	R	R	C	R		C	R	R	F		C	F	C	R								R		F	R			R									C		R
		18X-1, 148-150	A	G	R	C		F		F	C		C	C	F	C	R		F	R		R		C	R	C											F	R			R									F		

Note: For legend of abbreviations, see Table 1 notes.

Table 6. Distribution chart of Hole 898A (late Oligocene to middle Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Globigerina decoraperta*	*Globigerina falconensis*	*Globigerina nepenthes* (small)	*Globigerinoides ruber* (white)	*Globorotalia inflata*	*Globorotalia mayeri* (small)	*Globorotalia miozea*	*Globorotalia* spp	*Hedbergella* spp	*Globigerina megastoma cariacoensis*	*Globoquadrina dehiscens dehiscens*	*Globorotalia mayeri*	*Orbulina suturalis*	*Sphaeroidinellopsis disjuncta*	*Globigerina bulloides*	*Globigerinita naparimaensis*	*Globigerinoides sacculifer*	*Globigerinoides* spp	*Globigerinoides subquadratus*	*Globigerinoides trilobus/immaturus*	*Globoquadrina altispira altispira*	*Globoquadrina altispira globosa*	*Globoquadrina altispira* s.l.	*Globoquadrina baroemoenensis*	*Globoquadrina dehiscens praedehiscens*	*Globoquadrina dehiscens* s.l.	*Globoquadrina venezuelana*	*Globorotalia acrostoma*	*Globorotalia praescitula*	*Globorotalia scitula* s. l.	*Globorotalia siakensis*	*Globorotaloides* spp	*Globorotaloides suteri*	*Globigerina druryi*	*Globigerina woodi woodi*	*Globorotalia scitula*	*Sphaeroidinellopsis seminulina*	*Globigerina praebulloides*	*Globigerinoides altiaperturus*	*Globorotalia obesa*	*Praeorbulina sicana*	*Globigerina cip. angustiumbilicata*	*Globorotalia fohsi peripheroronda*	*Praeorbulina transitoria*	*Globoquadrina* spp	*Globorotalia continuosa*	*Cassigerinella chipolensis*	*Catapsydrax stainforthi*	*Globorotalia opima nana*	*Globigerina ciperoensis ciperoensis*	*Catapsydrax dissimilis*	*Catapsydrax* spp	*Catapsydrax unicavus*	*Globigerina* spp	*Globorotalia opima nana/continuosa trans.*	*Marginotruncana* spp	*Globigerina tripartita*	*Globigerinoides primordius*	*Globigerina cip. anguliisuturalis*	*Globigerina sellii*	*Globigerina ciperoensis* s.l.
middle Miocene	N14	18X-5, 56-60	F	M	R	R	R	R	M	R	R	R	RW																																																						
	1)	18X-CC	F	P							R	F		M	F	R	R	R																																																
	N9 to N11	19X-3, 145-147	A	M							R		RW		F	C	R	R	F	F	R	R	R	F	R	R	R	R	R	R	R	R	F	R	R	R	?																													
		19X-6, 117-119	F	M											F	R				R				R			R				R	R	R			R		R	R																												
		19X-CC	F	M																																				R	R																								
l. early to e. middle Miocene	N7 upper to N8	20X-1, 75-77	F	M							F				F					R		R	R	R	R	R	R	R			R		R			R	R	R				R	R	R	R																				
		20X-3, 46-48	F	P											F																																																	
		21X-1, 96-98	F	M							?	R			R	R			R				R	R									R		R		?	R	R								R	R	R																		
early Miocene	N7	21X-3, 99-101	F	P											R	F				R											R	R	R				R					R					?		R	R																
		21X-CC	F	M												R		R		R																R					R								R	R														
		22X-2, 71-73	F	P												R																					R						R				R				R		?	RW													
		22X-4, 115-117	C	M											F	C				F	?			F	R			?			R			R	R						C				R	R		F	R				RW											
		22X-CC	B																																																															
	N5 to N6	23X-4 ,94-96	F	M												R				R											R					R	R															R			R	R	R	R	R	RW					
		23X-6, 0-3	B																																																															
		24X-2, 20-22	R	M												R									R						R	R																										R				R		RW				
		24X-3, 6-8	R	P																					R														R																									R					
		25X-2, 78-80	R	M																													R																																	
		25X-3, 36-38	R	P																																								R													R	R									
		26X-1, 104-105	R	M												R																										R									R							R					
latest Oligocene to e. early Miocene	N4 to N5 lower	26X-2, 22-23	C	M											F	C				R		R		R						R	R					F	R					F					F			R						F		R	F	R			R			
		27X-4, 108-110	R	M												R				R																	?					R										R				R	R									
		28X-2, 52-54	F	M												R								R					R								?										R																													
late Oligocene	P22 upper	28X-CC	F	M											R	R															R															R									R				R					
		29X-4, 73-75	F	M												R																										R				R									?			R	R					
		29X-CC	F	M																																																													
	P22 lower	30X-2, 11-13	F	M												R															R											R				R												R	R				R	
		31X-4, 104-106	F	M												R															R				R	R					R				R								R	R	R		R	R				R	?	
		32X-3, 141-143	R	M												R																									R												R										
		33X-2, 104-106	F	P												R																														R											R					R		?
		34X-1, 79-81	C	P												?																					?					R																	R						?
		35X-1, 86-88	F	M												R															R											R				R										R		R					
		36X-2, 114-116	F	M												R															R				R	R									R							R				R	R					
		36X-4, 136-138	B																																																															
		36X-CC	F	M												R																																									R	R				R				R		

Notes: 1 = N12 to N13. For legend of abbreviations, see Table 1 notes.

Table 7. Distribution chart of Hole 899A (early Miocene to late Pliocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Globigerinoides conglobatus	Globigerinoides elongatus/obl. extremus	Globigerinoides ruber (white)	Globorotalia crassaformis crassaformis	Globorotalia inflata	Globorotalia scitula	Neogloboquadrina acostaensis	Neogloboquadrina pachyderma	Orbulina universa	Beella praedigitata	Globigerina bulloides	Globigerina decoraperta	Globigerina eocaena	Globigerina falconensis	Globigerina megastoma cariacoensis	Globigerinelloides spp	Globigerinita naparimaensis	Globigerinoides trilobus/immaturus	Globoquadrina altispira altispira	Globoquadrina venezuelana
late Pliocene	N20/N21	1R-CC	A	G	R	F	F	R	C	R	R	F	C											
Pliocene	?	2R-CC	R	M							R	R												
l. early to e. late Pliocene	N19 upper to N20	3R-3, 113-115	A	M			F	F		F	R	C	F	R	C	R	RW	R	R	RW	R	R	R	R
		3R-CC	C	M							R	C	R											
		4R-2, 118-120	C	M			R	F		R	R	C	F		F									
		4R-CC	A	M				C		R	R	F	F											
		5R-2, 103-105	C	M			R			R		R	R		R					RW		R		
		5R-CC	A	M				F			R	F	F											
early Pliocene	N19 lower	6R-3, 0-2	A	G		R	F	C		R	F	F	F	R		C					R	F	R	
		6R-CC	A	M		R		F		R	R	F	R								R	R		
late Miocene	N16 to N17	7R-1, 50-52	F	M								F	R											
		7R-CC	C	M								F	R											
		8R-2, 57-59	F	M						R		F	R		R									
		8R-2, 65-67	A	G			F			F	C	C	F		C	F	RW					F	F	F
		8R-CC	C	M								R												
		9R-1, 97-99	F	M									R											
		9R-3, 68-70	R	M							R				R									
l. middle to late Miocene	N14 to N16	9R-CC	F	M																				
		10R-1, 61-63	R	P																				
		10R-CC	C	M																				R
middle Miocene	N13	11R-2, 14-16	F	P																				
		11R-CC	F	M																				F
	?	13R-CC	F	P																				
	N12	14R-2, 71-73	F	M			F			R												F	R	
		14R-CC	C	M						R											R			
	N10/N12	15R-1, 134-136	F	M						R												R	R	R
early Miocene	N7	15R-CC	A	M																		F	R	R
	N5/N6	16R-1, 39-42	F	G																	R			R
?	?	16R-CC	B																					

Core-Section, interval (cm)	Globorotalia crassaformis s. l.	Globorotalia mayeri	Globorotalia obesa	Globorotalia pseudomiocenica	Globorotalia puncticulata	Globorotalia siakensis	Globorotaloides spp	Hastigerina siphonifera	Marginotruncana spp	Morozovella spinulosa	Neogloboquadrina atlantica	Neogloboquadrina dutertrei	Orbulina bilobata	Orbulina suturalis	Truncorotaloides topilensis	Candeina nitida	Globigerinoides obliquus obliquus	Globorotalia crassaformis ronda	Hastigerina aequilateralis	Neogloboquadrina humerosa
1R-CC																				
2R-CC																				
3R-3, 113-115	R	RW	R	R	F	RW	R	R	RW	RW	R	R	R	F	RW					
3R-CC																				
4R-2, 118-120	R				F			F			R		R	F		R	R	R	R	R
4R-CC	R													R						
5R-2, 103-105	R				R					RW				R						
5R-CC	F				R															
6R-3, 0-2	R				F	RW		R	RW	RW		R		R			F	?		R
6R-CC																	R	R		
7R-1, 50-52														R						
7R-CC													R							
8R-2, 57-59		RW												R						
8R-2, 65-67			R			RW		R	RW	RW		R		F			F			R
8R-CC																				
9R-1, 97-99						RW								R						
9R-3, 68-70																				
9R-CC																				
10R-1, 61-63																				
10R-CC																				
11R-2, 14-16		R																		
11R-CC		R																		
13R-CC		R											R	R						
14R-2, 71-73																				
14R-CC		R																		
15R-1, 134-136		F				R														
15R-CC			F			C														
16R-1, 39-42		F	?			R														
16R-CC																				

Core-Section, interval (cm)	Globorotalia bononiensis	Globorotalia triangula	Globigerina apertura	Globigerina woodi woodi	Globigerinoides sacculifer	Globoquadrina altispira s.l.	Globorotalia cf. hirsuta	Globorotalia margaritae margaritae	Globorotalia plesiotumida	Globotruncana spp	Globigerina nepenthes	Globorotalia merotumida	Sphaeroidinellopsis seminulina	Sphaeroidinellopsis paenedehiscens	Acarinina bullbrooki	Catapsydrax dissimilis	Globigerinoides subquadratus	Globoquadrina altispira globosa	Globoquadrina dehiscens dehiscens	Globorotalia acrostoma
1R-CC																				
2R-CC																				
3R-3, 113-115																				
3R-CC																				
4R-2, 118-120																				
4R-CC																				
5R-2, 103-105	C	R																		
5R-CC																				
6R-3, 0-2	C		F	R	R	R	R	C	?	RW										
6R-CC					R			R			R	R	R							
7R-1, 50-52											R			R						
7R-CC											R		R							
8R-2, 57-59											R									
8R-2, 65-67									R		F	?	R	R	RW	RW	RW	R	F	RW
8R-CC											R		R							
9R-1, 97-99											F	R	R						R	
9R-3, 68-70																				
9R-CC											F									
10R-1, 61-63																			R	
10R-CC																			R	
11R-2, 14-16													R						R	
11R-CC																			R	
13R-CC													R						R	
14R-2, 71-73				R															F	
14R-CC				R																
15R-1, 134-136																		R	R	R
15R-CC				R	F												R	R	F	
16R-1, 39-42																R			F	R
16R-CC																				

Core-Section, interval (cm)	Globorotalia opima opima	Morozovella aragonensis	Sphaeroidinellopsis disjuncta	Globorotalia conoidea	Globorotalia miozea	Globorotalia spp	Globorotalia menardii	Globigerina praebulloides	Globigerina venezuelana	Globigerinoides spp	Globorotalia archaeomenardii	Globorotalia continuosa	Globorotalia praemenardii	Cassigerinella chipolensis	Globoquadrina baroemoenensis	Catapsydrax stainforthi	Catapsydrax unicavus	Globoquadrina altispira conica	Globoquadrina spp	Globorotalia fohsi peripheroronda
1R-CC																				
2R-CC																				
3R-3, 113-115																				
3R-CC																				
4R-2, 118-120																				
4R-CC																				
5R-2, 103-105																				
5R-CC																				
6R-3, 0-2																				
6R-CC																				
7R-1, 50-52																				
7R-CC																				
8R-2, 57-59																				
8R-2, 65-67	RW	RW	R																	
8R-CC																				
9R-1, 97-99																				
9R-3, 68-70																				
9R-CC																				
10R-1, 61-63																				
10R-CC			R	R																
11R-2, 14-16			R		R	R														
11R-CC			R	R																
13R-CC				F			R													
14R-2, 71-73				R	F			R	R	R	R	R	R							
14R-CC												R		R	R					
15R-1, 134-136					R															
15R-CC												F			R	R				
16R-1, 39-42								R									R	R	R	R
16R-CC																				

Note: For legend of abbreviations, see Table 1 notes.

Sample 149-899A-2R-CC contains no markers, so no age can be assigned to it.

The interval of Samples 149-899A-3R-3, 113-115 cm, to 149-899A-5R-CC has *Globorotalia puncticulata* and *Globorotalia bononiensis,* but lacks *Globorotalia margaritae margaritae.* It can be assigned to the upper part of the N19 Zone and the N20 Zone, of late early to early late Pliocene. Other species were listed in Table 7.

The interval of Samples 149-899A-6R-3, 0-2 cm, to 149-899A-6R-CC is characterized by the presence of *Globorotalia margaritae margaritae* and *Globorotalia crassaformis crassaformis,* which assigns it to the lower part of the early Pliocene N19 Zone. The species tops of *Globigerina apertura, Globigerina nepenthes, Globigerina woodi woodi, Globigerinoides sacculifer, Globoquadrina altispira* s.l., *Globorotalia* cf. *hirsuta, Globorotalia merotumida,* and *Sphaeroidinellopsis seminulina* were recorded here.

The presence *of Neogloboquadrina acostaensis* in the interval of Samples 149-899A-7R-1, 50-52 cm, to 149-899A-9R-3, 68-70 cm, where *Globorotalia crassaformis* s.l. is absent, assign this interval to the late Miocene N16 and N17 Zones. *Globoquadrina altispira globosa, Globoquadrina dehiscens dehiscens, Globorotalia plesiotumida, Sphaeroidinellopsis disjuncta,* and *Sphaeroidinellopsis paenedehiscens* have their top occurrences in this interval.

The interval of Samples 149-899A-9R-CC to 149-899A-10R-CC contains only the species *Globigerina nepenthes, Globigerina dehiscens dehiscens, Sphaeroidinellopsis disjuncta,* and *Globorotalia conoidea,* which are resistant to dissolution. This interval is placed in the N14 to N16 Zones, of middle to late Miocene age.

The interval of Samples 149-899A-11R-2, 14-16 cm, and 149-899A-11R-CC contains *Globorotalia mayeri,* but no *Globigerina nepenthes,* and is assigned to the middle Miocene N13 Zone. The top occurrence of *Globorotalia miozea* was recorded here.

Sample 149-899A-13R-CC contains *Globoquadrina dehiscens dehiscens, Globorotalia conoidea, Globorotalia mayeri, Globorotalia menardii, Orbulina suturalis, Orbulina bilobata,* and *Sphaeroidinellopsis seminulina,* but marker species are absent. Considering the age of the zones above and below, a middle Miocene age is inferred.

Globorotalia praemenardii was found at the top of the interval between Samples 149-899A-14R-2, 71-73 cm, and 149-899 A-14R-CC, which assigns it to the middle Miocene N12 Zone. The species tops of *Cassigerinella chipolensis, Globigerina praebulloides, Globoquadrina venezuelana, Globoquadrina baroemoenensis, Globorotalia acrostoma, Globorotalia archaeomenardii, Globorotalia* sp. cf. *G. archaeomenardii,* and *Globorotalia continuosa* were found.

Sample 149-899A-15R-1, 134-136 cm, is characterized by the presence of *Globorotalia acrostoma* and the absence of *Globorotalia fohsi peripheroronda* (a species found lower in this hole) and is assigned to the middle Miocene N10 and N11Zones. The top occurrence of *Globorotalia siakensis* was recorded here.

Sample 149-899A-15R-CC contains *Catapsydrax stainforthi* and is assigned to the early Miocene N7 Zone. *Globigerinoides subquadratus* has its top occurrence in this sample.

Sample 149-899A-16R-1, 39-42 cm, contains *Catapsydrax dissimilis, Catapsydrax unicavus, Globoquadrina altispira conica,* and *Globorotalia fohsi peripheroronda.* The presence of *Catapsydrax dissimilis* places this interval in the early Miocene N5 to N6 Zones.

Sample 149-899A-16R-CC is barren of planktonic foraminifers and no age can be assigned.

Hole 899B

The top of the interval of Samples 149-899B-1R-2, 132-134 cm, to 149-899B-4R-2, 68-70 cm, is marked by the presence of *Catapsydrax dissimilis,* indicating that this interval represents the early Miocene N5 to N6 Zones (Table 8; Fig. 2C).

Samples 149-899B-4R-CC to 149-899B-5R-4, 136-138 cm, are either barren or contain relatively rare, poorly preserved planktonic foraminifers, none of which are zonal markers. No age can be assigned.

The presence of *Globorotalia kugleri* and *Globigerinoides* spp. in the interval of Samples 149-899B-5R-CC to 149-899B-6R-CC, assigns it to the N4 Zone which is of latest Oligocene to earliest Miocene age. The species tops of *Catapsydrax unicavus, Globorotalia opima nana/continuosa* transition, *Globigerina woodi woodi, Globigerinoides primordius, Globoquadrina baroemoenensis, Globoquadrina dehiscens praedehiscens, Globoquadrina venezuelana,* and *Globorotaloides suteri* were recorded in this interval.

The top of the interval of Samples 149-899B-7R-6, 129-131 cm, to 149-899B-9R-CC is characterized by the presence of *Globigerina ciperoensis angulisuturalis,* which places it in the lower part of the late Oligocene P22 Zone. The species tops of *Globigerina ciperoensis ciperoensis, Globigerina gortanii, Globigerina sellii, Globigerina tripartita,* and *Globorotalia opima nana* were recorded.

Sample 149-899B-10R-4, 71-73 cm, contains *Globorotalia opima opima* and can be assigned to the P21 Zone, which is of late early to early late Oligocene age.

Sample 149-899B-10R-CC is barren of planktonic foraminifers. Based on its stratigraphic position, an Oligocene age is inferred.

The presence of *Globigerina yeguaensis,* a species that, according to Bolli and Saunders (1985), becomes extinct near the base of the early Oligocene P20 Zone, assigns an early Oligocene age to Sample 149-899B-11R-1, 83-85 cm. *Pseudohastigerina micra,* which is the marker species that defines the top of the P19 Zone, was not recorded in this hole.

Sample 149-899B-11R-CC is barren of planktonic foraminifers and no age can be assigned.

The interval of Samples 149-899B-12R-3, 54-56 cm, to 149-899B-13R-2, 120-122 cm, contains *Catapsydrax dissimilis* and *Globorotalia opima nana,* which assigns it to between the P15 (because of the absence of *Truncorotaloides rohri*) and the P20 Zones of late Eocene to early Oligocene age.

Sample 149-899B-13R-CC is barren and Sample 149-899B-14R-4, 103-105 cm, contains only *Globoquadrina venezuelana* (149-899B-14R-4, 103-105 cm), which allows an Eocene to early Oligocene age interpretation for these samples.

Sample 149-899B-14R-CC is barren of planktonic foraminifers and has only agglutinated foraminifers (e.g., *Bathysiphon* spp., *Glomospira charoides,* and *Cyclammina* spp.). No age can be assigned to it.

Sample 149-899B-15R-3, 147-149 cm, has *Archaeoglobigerina cretacea, Globotruncana linneiana, Globotruncana orientalis, Hedbergella holmdelensis,* and *Marginotruncana marginata.* The presence of *G. orientalis* and *G. linneiana* assigns this sample to the interval of the *Globotruncana elevata* Zone to the lower part of the *Gansserina gansseri* Zone (Robaszynski et al., 1984), which are of Campanian to early Maastrichtian age.

Sample 149-899B-15R-CC is barren of any fauna.

Hole 900A

The presence of *Globorotalia truncatulinoides* in the interval of Samples 149-900A-1R-1, 34-36 cm, to 149-900A-6R-CC assigns it to the N22 and N23 Zones, which are of latest Pliocene to Holocene age (Tables 9-16; Fig. 2D). Note that *Globorotalia inflata* and *Globorotalia triangula* have their FO in Sample 149-900A-6R-CC, at the bottom of the interval. As in Holes 897C and 898A, the acmes of *Pulleniatina obliquiloculata* (Sample 149-900A-4R-1, 116-118 cm) and *Neogloboquadrina atlantica* (certain in Sample 149-900A-5R-1, 115-117 cm, but not so evident in Sample 149-900A-6R-4, 57-59 cm) were recorded.

The interval of Samples 149-900A-7R-3, 124-126 cm, to 149-900A-10R-2, 91-93 cm, is characterized by the absence of *Globoro-*

Table 8. Distribution chart of Hole 899B (Late Cretaceous, Eocene to early Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Catapsydrax dissimilis	Catapsydrax spp	Globigerina cip. angustiumbilicata	Globigerina falconensis	Globigerina praebulloides	Globigerina spp	Globigerinoides subquadratus	Globorotalia obesa	Globorotalia mayeri	Globorotalia siakensis	Globigerinita naparimaensis	Globigerinoides spp	Globoquadrina dehiscens dehiscens	Globorotalia fohsi peripheroronda	Globorotaloides suteri	Catapsydrax unicavus	Globigerina woodi woodi	Globoquadrina baroemoenensis	Globoquadrina dehiscens praedehiscens	Globoquadrina venezuelana	Globorotalia kugleri	Globigerina sellii	Globigerinoides primordius	Globoquadrina spp	Globorotalia opima nana/continuosa trans.	Truncorotaloides rohri	Globigerina cip. angulisuturalis	Globigerina ciperoensis ciperoensis	Globorotalia opima nana	Globigerina gortanii	Globigerina tripartita	Globorotaloides spp	Globorotalia opima opima	Globigerina yeguaensis	Archaeoglobigerina cretacea	Globotruncana linneiana	Globotruncana orientalis	Heabergella holmdelensis	Marginotruncana marginata
early Miocene	N5 to N6	1R-2, 132-134	R	P	R	R																																					
		1R-CC	B																																								
		2R-2, 88-90	R	M			R	R	R	R	R	R																															
		2R-CC	R	M									R	R																													
		3R-1, 51-53	R	P	R		R	?	R		?																																
		3R-CC	R	M									R																														
		4R-2, 68-70	F	M	R					R	R	R	R		R	R	R	R	?																								
?	?	4R-CC	B																																								
		5R-4, 136-138	R	P	R					R																																	
Late Oligocene to early Miocene	N4	5R-CC	F	M	R								R	F		R				R	R	R	R	R	R																		
		6R-3, 91-93	C	M		R	F		F	R		R	F	R				R	R					?		RW	R	R	R	RW														
		6R-CC	A	M									F			R				R				R					F														
late Oligocene	P22 lower	7R-6, 129-131	C	P			F		R			R	R																F		R	R	R										
		7R-CC	B																																								
		8R-1, 48-51	F	M		R				R			R						R					R									R										
		8R-1, 114-116	F	M	R		R		R	F									R					R						RW	R	R	R										
		8R-CC	B																																								
		9R-3, 85-87	F	M	R				R	R									R	R				R		R	R		R					R	?	R							
		9R-4, 124-126	A	M	R		F		R	R									R	R				R					F		F	F	R		R								
		9R-CC	R	P																																							
1)	P21	10R-4, 71-73	R	M		R																		R					R			R	R				R						
Oligocene	?	10R-CC	B																																								
E. Oligocene	P20	11R-1, 83-85	R	M																R												R	R					R					
?	?	11R-CC	B																																								
late Eocene to early Oligocene	P15 to P20	12R-3, 54-56	R	P	R																																						
		12R-CC	B																																								
		13R-2, 120-122	R	P																													R										
Eocene	?	13R-CC	B																																								
		14R-4, 103-105	R	M																				R																			
?	?	14R-CC	B																																								
2)	3)	15R-3, 147-149	R	P																																			R	R	R	R	R
?	?	15R-CC	B																																								

Notes: 1 = latest early to early late Oligocene, 2 = Campanian to early Maastrichtian, 3 = *Globotruncana elevata* to upper part of *Gansserina gansseri.* For legend of abbreviations, see Table 1 notes.

talia inflata and *Globorotalia margaritae margaritae.* The top occurrence of *G. puncticulata* is found in Sample 149-900A-8R-3, 46-48 cm, which means that in the upper part of this interval this marker species is absent (see discussion of Zones N19/N20 of Hole 897C and 899B). This interval is assigned to the upper part of the N19/N20 Zone, which is of late early to early late Pliocene age. The same situation is seen in Hole 897C, where *G. inflata* and *G. puncticulata* are missing in the upper part and *G. puncticulata* is present in the lower part of equivalent interval. The species tops of *Globigerina ciperoensis angustiumbilicata, Globigerina decoraperta,* and *Globigerinoides trilobus/sacculifer* transition were recorded.

The presence of *Globorotalia margaritae margaritae* and *Globorotalia crassaformis crassaformis* in the interval of Samples 149-900A-10R-4, 22-24 cm, to 149-900A-11R-5, 11-13 cm, places it in the lower part of the early Pliocene N19 Zone. The top occurrences of *Globigerina apertura, Globigerinoides sacculifer, Globoquadrina venezuelana, Globorotalia margaritae margaritae, Globorotalia obesa, Sphaeroidinellopsis paenedehiscens,* and *Sphaeroidinellopsis seminulina* were found.

The interval of Samples 149-900A-11R-CC to 149-900A-16R-CC contains *Neogloboquadrina atlantica,* but lacks *Globorotalia crassaformis* s.l. (see Table 10). It can be assigned to the upper part of the N16 Zone (FAD of *N. atlantica)* to the N17 Zone (absence *G. crassaformis* s.l.), which are of late Miocene age. *Neogloboquadrina acostaensis* and *Neogloboquadrina pachyderma* were found and *Globigerina nepenthes, Globigerina praebulloides, Globoquadrina altispira altispira, Globoquadrina dehiscens dehiscens, Globorotalia conoidea, Globorotalia menardii, Globorotalia merotumida, Globorotaloides* spp., *Sphaeroidinellopsis disjuncta,* and *Sphaeroidinellopsis subdehiscens* have their tops in this interval.

The co-occurrence of *Globigerina nepenthes* and *Globorotalia mayeri* in the interval of Samples 149-900A-17R-1, 5-7 cm, and 149-900A-17R-CC assigns it to the middle Miocene N14 Zone. The species tops of *Globigerina druryi, Globigerina woodi woodi, Globoro-*

Table 9. Distribution chart of Hole 900A (early Pliocene to Holocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Beella digitata*	*Beella praedigitata*	*Globigerina bulloides*	*Globigerina falconensis*	*Globigerina megastoma cariacoensis*	*Globigerinita naparimaensis*	*Globigerinoides conglobatus*	*Globigerinoides elongatus/obl. extremus*	*Globigerinoides primordius*	*Globigerinoides ruber (pink)*	*Globigerinoides ruber (white)*	*Globigerinoides trilobus/immaturus*	*Globorotalia crassaformis crassaformis*	*Globorotalia crassaformis s. l.*	*Globorotalia hirsuta*	*Globorotalia inflata*	*Globorotalia scitula*	*Globorotalia triangula*	*Globorotalia truncatulinoides*	*Hastigerina aequilateralis*	*Hastigerina siphonifera*	*Neogloboquadrina acostaensis*	*Neogloboquadrina dutertrei*	*Neogloboquadrina humerosa*	*Neogloboquadrina pachyderma*	*Orbulina universa*	*Globigerina bermudezi*	*Orbulina bilobata*	*Orbulina suturalis*	*Globorotalia crassaformis hessi*	*Globorotalia crassaformis ronda*	*Globorotalia tosaensis*	*Pulleniatina obliquiloculata*	*Pulleniatina primalis*	*Globoquadrina altispira altispira*	*Neogloboquadrina atlantica*	*Sphaeroidinella dehiscens*	*Globigerinoides obliquus obliquus*	*Globigerina decoraperta*	*Globorotalia puncticulata*	*Globigerinoides trilobus/sacculifer trans.*	*Globigerina cip. angustiumbilicata*	*Globoquadrina venezuelana*	*Globorotalia margaritae margaritae*	*Globorotalia obesa*	*Globigerinoides sacculifer*	*Sphaeroidinellopsis paenedehiscens*	*Sphaeroidinellopsis seminulina*	*Globigerina apertura*	*Globotruncana marginata*
latest Pliocene to Holocene	N22 to N23	1R-1, 34-36	A	G	R	R	C	R	R	R	R	R	RW	R	C	F	R	F	F	C	R	C	C	F	F	F	R	R	C	C																								
		2R-1, 41-43	F	P							R						R			R		R	R						R	R																								
		3R-1,5-7	A	G			F		R						F		R	F		C		C	F	R		F			C	F	R	R	R																						
		4R-1, 116-118	A	G								R			R					C		C	F	R	R	F			C	C		R	R	F	R	R	F	R																	
		5R-1, 114-116	A	G			F				F	R			F		R	R		C		C	F		R	R	R		C	C			R	F	F	R		R	RW	C	F													
		6R-4, 57-59	A	G			C		F		R	R			F					C	R	C		F	R		R		C	C		F	R							F	R	R												
		6R-CC	A	M							R						R			C	R		R				R		F	R																								
l. early to e. late Pliocene	N19 upper to N20	7R-3, 124-126	A	M			F	R			R	R			F			R									R		C	R			R		R						R													
		7R-CC	C	M											R													R		F	R												R												
		8R-3, 46-48	F	G			C	R	F	R	R	R			C	R	C	F			C			F	F	R	R		F	C		R	F							R		R	R	F										
		9R-2, 23-25	A	M			R												?											F	F			F																						
		9R-CC	C	M		R				R						R	F	R							R		R		R	R			R												F	R										
		10R-2, 91-93	A	M		F	F			R					C	F	F	C			F									C			C										R	R	A	C	F									
early Pliocene	N19 lower	10R-4, 22-24	A	M		R	F	R	R	R	R				F	F		F			R			R	R				C	F			F									R	R		F	R	R	R	R					
		11R-1, 78-80	A	M		R	F	R							F	C	C	F			R			R	R				F	F			F	R							R	R	F		R		R		F	R	R		
		11R-2, 118-120	A	M		R	F	R							F	R	R				R				R				R	F			R	F							R	R	F										
		11R-3, 133-135	C	M			F								F	F	R								R	R		R		F			R	F							R	R	F						R		R	R	RW
		11R-4, 90-92	A	M		R	R	R			R				F	F	R	F						R	R				F			R	F							F	R	F		R				R				
		11R-5, 11-13	C	M		R	F	R			R				F		F				R			R	F		R	R	F			R	F							F		F		R			R	R	R		R	

Note: For legend of abbreviations, see Table 1 notes.

Table 10. Distribution chart of Hole 900A (middle to late Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Globigerina nepenthes	Neogloboquadrina pachyderma	Orbulina suturalis	Beella praedigitata	Globigerina bulloides	Globigerina decoraperta	Globigerinoides conglobatus	Globigerinoides ruber (white)	Globorotalia scitula	Neogloboquadrina acostaensis	Orbulina universa	Sphaeroidinellopsis disjuncta	Sphaeroidinellopsis paenedehiscens	Globigerina cip. angustiumbilicata	Globigerinoides trilobus/immaturus	Globoquadrina venezuelana	Neogloboquadrina atlantica	Globoquadrina dehiscens dehiscens	Globigerina falconensis	Globorotalia obesa	Globigerinoides obliquus obliquus	Sphaeroidinellopsis seminulina	Catapsydrax dissimilis	Globigerina tripartita	Globoquadrina altispira altispira	Globorotalia conoidea	Globorotalia merotumida	Globorotalia siakensis	Globorotaloides spp	Globotruncanita stuartiformis	Hedbergella holmdelensis	Marginotruncana spp	Morozovella spinulosa	Pseudotextularia elegans	Truncorotaloides rohri	Catapsydrax unicavus	Globigerinatella insueta	Globigerinita naparimaensis	Acarinina pentacamerata	Globigerinoides sacculifer	Neogloboquadrina humerosa	Sphaeroidinellopsis subdehiscens	Globorotalia menardii	Globigerinoides trilobus/sacculifer trans.	Globigerina praebulloides	Globigerina ciperoensis ciperoensis	Globigerina apertura	Globigerina druryi	Globigerina woodi woodi	Globorotalia continuosa	Globorotalia mayeri	Globorotalia miozea	Globorotalia acrostoma	Globorotalia praemenardii	Globorotalia fohsi fohsi	Globorotalia ciboaensis	Globigerinoides altiaperturus	Globorotalia fohsi peripheroacuta	Globorotalia fohsi peripheroronda	Praeorbulina glomerosa s.l.	Praeorbulina glomerosa glomerosa	Praeorbulina sicana	Globorotalia archaeomenardii	Globorotalia praescitula	Praeorbulina glomerosa curva
late Miocene	N16 upper to N17	11R-CC	F	G	R	R	R																																																														
		12R-1, 54-56	C	M		F	R	R	R	R	R	F	R	F	F	R	F																																																			
		12R-2, 102-104	F	M		R	R	R						R	R			R	R	R	R																																															
		12R-3, 105-107	C	M	F	R	R						R		R		R				?	R																																															
		12R-4 ,10-12	C	M	F	R	R		F	R	R	R		R	F		R		R	R			R	R																																													
		13R-CC	C	M	F	F	R																		R	R																																											
		14R-1, 53-55	B																																																																	
		14R-2, 30-32	A	M	C		R		R			F		R	F	R	R		R	F		F				F	RW	RW	R	R	R	RW	F	RW	RW	RW	RW	RW	RW																														
		14R-3, 68-70	F	M	F										R	R																	R																																			
		14R-4, 124-126	F	P	F											R														F			R																																			
		14R-5, 144-146	B																																																																	
		14R-6, 68-70	F	P	R	R	R	R	R					R	R								R									RW	R																																			
		14R-7, 43-45	C	M	C		R		R	R		F			F	R	R									R														RW	RW																												
		15R-1, 20-22	C	M	F		R	R									R		R	R		F				R			R		?																																						
		15R-1, 91-93	C	M	F			R	R						R	R		R		R		F				R			?		?											R																											
		15R-2, 76-78	C	M	F	R	R	R	R	R		R	R	R	R		R	R	R			R	R	R		R			R														RW	R	R	R																							
		15R-3, 117-119	C	M	F		R	R							R	R			R			R									?															R	R																						
		15R-4, 8-10	C	M	C		R	R	R					R	R				R			R				R					R															R																							
		15R-4, 60-62	C	M	F				R										R		?	R				R					F		R													R																							
		16R-1, 16-18	C	M	F				R			R	R	F									R								R		R									R						R																					
		16R-1, 138-140	C	M	F		R		R					R		R				R		R				F							R																																				
		16R-2, 76-78	A	P	C		R						R	R	R		R		R			C				F					R														R		R		R																				
		16R-3, 77-79	A	M	C		R								R		R					F				F				R	F																R																						
		16R-4, 124-126	A	M	F	F		R	R					F		R			R		R	F	R			F				R	F		R																																			
		16R-5, 72-74	A	M		R	R	R	R	R			F	F				R	R			F	R	R		R				R	R																R			RW																			
		16R-6, 69-71	A	P	F	R			R							R			R		C	F				F				R	F		R														R																						
		16R-6, 113-115	C	P	R	R									R						F	F								R	R																																					
		16R-CC	A	M	F	R										R	R			R	R	F								F												R																											
middle Miocene	N14	17R-1 ,5-7	A	M	F		R		R	R			F		R	R		R	R			F	R			F							R									R					R		R		R	R	R	F	R	F														
		17R-1, 70-72	F	P	R		R								R							F				R				R																										R													
		17R-2, 81-83	F	P	R		R						R		R							F	?			R						R										R												R	?													
		17R-3, 50-52	A	M	C		R		R	R			R					R		R		C	R			F				R																						F	F	?													
		17R-CC	A	P	F		R									R				R		F								R																	R																						
	N10 to N11	18R-1, 30-32	A	M			R						R									R										F	R																R			R		R	C	R	R	R											
		18R-2, 49-51	A	G			R						R					R	R	R		F		R		R						R										R		R					R			R			C	R		R	R										
		18R-3, 86-88	A	P			R								R				R			C				F						F																				R		R	C	F	R			?									
		18R-4, 47-49	A	P											R				R			C				F						R										R										R		R	C	C		R											
	N10	18R-5, 22-24	A	M			R			R			F		R	R		R	F	?		C		R		F			R			R					RW					R		R								R		F	C	F	R		R		RW	R	R						
	N9	18R-CC	C	M																R		F								R		R										R													R	R	R												
	1)	19R-1, 23-25	C	P												R			R			F				F				?																								R	F	F								R					
	N8	19R-2, 76-78	A	P																R		C				R																												R	F	R									R	R			
		19R-CC	A	M																		F				R																R													F	F									R		R	R	R

Notes: 1 = N9 lower. For legend of abbreviations, see Table 1 notes.

talia continuosa, Globorotalia mayeri, Globorotalia miozea and *Globorotalia siakensis* were recorded.

The interval of Samples 149-900A-18R-1, 30-32 cm, to 149-900A-18R-4, 47-49 cm, contains *Globorotalia acrostoma,* but no *Globorotalia fohsi peripheroronda,* thus assigning it to the middle Miocene N10 and N11 Zones. The species top of *Globorotalia praemenardii* occurs in Sample 149-900A-18R-1, 30-32 cm, and that of *Globorotalia fohsi fohsi* in Sample 149-900A-18R-2, 49-51 cm.

Sample 149-900A-18R-5, 22-24 cm, contains *Globorotalia fohsi peripheroacuta, Globorotalia fohsi peripheroronda* and *Globorotalia fohsi fohsi* and can be assigned to the middle Miocene N10 Zone.

Sample 149-900A-18R-CC does not contain *Globorotalia fohsi fohsi* or praeorbulinids and is interpreted to represent the middle Miocene N9 Zone.

Sample 149-900A-19R-1, 23-25 cm, contains *Praeorbulina glomerosa,* but lacks *Praeorbulina sicana.* It is placed in the lower part of the middle Miocene N9 Zone.

The interval of Samples 149-900A-19R-2, 76-78 cm, to 149-900A-19R-CC is characterized by the presence of *Praeorbulina sicana* and *Praeorbulina glomerosa glomerosa* and indicates that it belongs to the middle Miocene N8 Zone. *Globorotalia archaeomenardii, Globorotalia praescitula,* and *Praeorbulina glomerosa curva* have their tops here.

The absence of *Praeorbulina glomerosa glomerosa* and *Catapsydrax dissimilis* in the interval of Samples 149-900A-20R-1, 61-63 cm, to 149-900A-23R-4, 75-77 cm, suggests that it can be placed in Zone N7, which is of early Miocene age (see Table 11). The species tops of *Catapsydrax stainforthi* (Sample 149-900A-20R-6,68-70 cm), *Globigerinoides subquadratus, Globoquadrina altispira conica, Globoquadrina altispira globosa, Globoquadrina altispira* s.l, *Globoquadrina baroemoenensis, Globoquadrina dehiscens praedehiscens, Globorotalia scitula* s.l., *Globorotaloides suteri, Hastigerina praesiphonifera,* and *Praeorbulina transitoria* were recorded in this interval.

The top of the interval of Samples 149-900A-23R-5,114-116 cm, to 149-900A-25R-1, 122-124 cm, is marked by the presence of *Catapsydrax dissimilis,* which assigns it to the early Miocene Zone N6. *Catapsydrax unicavus* (in Sample 149-900A-23R-5, 114-116 cm) and *Globorotalia opima nana/continuosa* transition (in Sample 149-900A-25R-1, 122-124 cm) have their top occurrences in this interval.

The interval of Samples 149-900A-25R-2, 24-26 cm, to 149-900A-30R-4, 12-14 cm, contains *Catapsydrax dissimilis* and *Globigerinoides altiaperturus,* whereas *Globigerinoides primordius* is absent. It is assigned to Zone N5 and the lower part of Zone N6, which are of early Miocene age, and contains the tops of *Cassigerinella chipolensis, Globigerina euapertura,* and *Globigerina tripartita* (see Table 12).

The interval of Samples 149-900A-30R-4, 84-86 cm, to 149-900A-30R-6, 45-47 cm, is characterized by the presence of *Globigerinoides primordius* and the absence of *Globorotalia kugleri,* and is assigned to the lower part of the early Miocene Zone N5.

The presence of *Globorotalia kugleri* and *Globigerinoides* spp. in the interval of Samples 149-900A-30R-CC to 149-900A-37R-5, 64-65 cm, assigns it to Zone N4, of latest Oligocene to earliest Miocene age. *Globigerina sellii* was first recorded in Sample 149-900A-35R-2, 76-78 cm, in the lower part of the interval (see Table 13).

In the interval of Samples 149-900A-37R-6, 12-14 cm, to 149-900A-40R-2, 74-76 cm. *Globigerinoides* spp. and *Globigerina ciperoensis angulisuturalis* are absent. Therefore, it is assigned to the upper part of the P22 Zone, of late Oligocene age (see Table 14).

The interval of Samples 149-900A-40R-3, 34-36 cm, to 149-900A-45R-CC is characterized by the presence of *Globigerina ciperoensis angulisuturalis* and *Globigerina ciperoensis ciperoensis,* which places it in the lower part of the late Oligocene P22 Zone. *Globigerina gortanii, Globigerina ouachitaensis, Globoquadrina globularis, Globorotalia opima nana/opima opima* transition, and *Globorotalia opima nana* have their tops in this interval.

The top of the interval of Samples 149-900A-46R-2, 3-5 cm, to 149-900A-50R-3, 2-4 cm is marked by the presence of *Globorotalia opima opima* and is assigned to the P21 Zone, which is of late early to early late Oligocene age. *Globigerina eocaena, Globigerina tapuriensis,* and *Globigerina yeguaensis* have their top occurrences here (see Table 15).

In the interval of Samples 149-900A-50R-5, 131-133 cm, to 149-900A-51R-1, 148-150 cm, the marker species *Globorotalia opima opima* and *Pseudohastigerina micra* were not found, which suggests that it represents the early Oligocene P20 interval Zone.

The top of the interval of Samples 149-900A-51R-5,133-135 cm, to 149-900A-52R-CC is marked by the presence of P*seudohastigerina micra,* which places it in the early Oligocene P18 and P19 Zones. The species *Globigerina ampliapertura, Globigerina corpulenta, Globorotalia increbescens* and *Pseudohastigerina naguewichiensis* have their tops here.

The top of the interval of Samples 149-900A-53R-2,133-135 cm, to 149-900A-56R-2, 115-117 cm, is characterized by the presence of *Hantkenina alabamensis/primitiva,* which assigns it to the P15 to P17 Zones of late Eocene to earliest Oligocene age. The species tops of *Globigerina cryptomphala, Globigerinatheka index index* (Sample 149-900A-54R-1, 85-86 cm), *Globorotalia cerroazulensis cocoaensis* (Sample 149-900A-56R-2, 115-117 cm), *Globorotalia cerroazulensis* s.l. (Sample 149-900A-54R-3,120-122 cm), and *Globorotalia cerroazulensis/pomeroli* transition (Sample 149-900A-56R-2, 115-117 cm) were found here (see Table 16).

The presence of *Truncorotaloides rohri* at the top of the interval of Samples 149-900A-56R-4, 125-127 cm, to 149-900A-58R-CC, indicates that this interval represents the middle Eocene P14 Zone. The species *Globigerina linaperta, Globigerina senni, Globigerinatheka barri, Globorotalia cerroazulensis cerroazulensis, Globorotalia cerroazulensis pomeroli, Globorotalia cerroazulensis/cocoaensis* transition, *Morozovella spinulosa, Truncorotaloides rohri/topilensis* transition, and *Truncorotaloides topilensis* have their tops in this interval.

The top of the interval of Samples 149-900A-59R-2, 99-101 cm, to 149-900A-69R-CC is marked by the presence *of Globigerinatheka kugleri,* which assigns it to the middle Eocene P12 and P13 Zones. The tops of *Acarinina broedermanni* (Sample 149-900A-69R-1, 130-132 cm), *Acarinina bullbrooki* (Sample 149-900A-61R-3,74-76 cm), *Globigerinatheka subconglobata subconglobata* (Sample 149-900A-59R-2, 99-101 cm), and *Globigerinoides higginsi* (Sample 149-900A-63R-2, 43-45 cm) were found.

Sample 149-900A-70R-CC, 4-6 cm, contains *Morozovella aragonensis, Globigerinatheka conglobatus conglobatus* and *Globorotalia cerroazulensis frontosa,* placing it in the upper part of the P10 Zone (FAD of *G. conglobatus conglobatus)* to the P11 Zone (LAD of *M. aragonensis),* which are of middle Eocene age.

The interval of Samples 149-900A-71R-4, 9-11 cm, to 149-900A-74R-CC contains *Morozovella aragonensis, Acarinina pentacamerata, Globigerina triloculinoides* and *Morozovella spinulosa* and represents the P9 (FAD of M. *spinulosa)* to P11 (LAD of *M. aragonensis)* Zones, which are of late early to early middle Eocene age.

Poorly preserved planktonic foraminifers, none of which are markers, were found in the interval between Samples 149-900A-75R-1, 37-39 cm, and 149-900A-77R-CC. Therefore, no age can be assigned to this interval. Rare agglutinated *(Glomospira* spp. and *Bathysiphon* spp.) and calcareous benthic foraminifers, radiolarians, and ichthyoliths are present.

The interval of Samples 149-900A-78R-CC to 149-900A-79R-1, 40-42 cm, is characterized by the presence of *Planorotalites pseudomenardii* and *Globigerina linaperta* and can be assigned to the late Paleocene P4 Zone. *Acarinina mckannai, Acarinina primitiva,* and *Morozovella aequa* have their top occurrences here.

Table 11. Distribution chart of Hole 900A (early Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Acarinina pseudotopilensis*	*Globigerina bulloides*	*Globigerina* cip. *angustiumbilicata*	*Globigerina druryi*	*Globigerina falconensis*	*Globigerinita naparimaensis*	*Globigerinoides subquadratus*	*Globigerinoides trilobus/immaturus*	*Globoquadrina dehiscens dehiscens*	*Globoquadrina venezuelana*	*Globorotalia acrostoma*	*Globorotalia continuosa*	*Globorotalia fohsi peripheroronda*	*Globorotalia mayeri*	*Globorotalia opima nana*	*Globorotalia praescitula*	*Globorotaloides suteri*	*Morozovella spinulosa*	*Truncorotaloides topilensis*	*Globoquadrina altispira altispira*	*Globorotalia siakensis*	*Globoquadrina altispira conica*	*Sphaeroidinellopsis disjuncta*	*Catapsydrax stainforthi*	*Globigerinoides spp*	*Globigerina praebulloides*	*Globorotalia obesa*	*Globigerina woodi woodi*	*Globigerinoides altiaperturus*	*Globorotalia miozea*	*Globorotalia scitula s. l.*	*Globigerinoides sacculifer*	*Globoquadrina altispira globosa*	*Globoquadrina baroemoenensis*	*Globorotaloides spp*	*Hastigerina praesiphonifera*	*Praeorbulina sicana*	*Globoquadrina dehiscens praedehiscens*	*Globigerina tripartita*	*Praeorbulina transitoria*	*Globoquadrina altispira s.l.*	*Catapsydrax dissimilis*	*Catapsydrax unicavus*	*Globorotalia archaeomenardii*	*Globorotalia nana/continuosa transition*
early Miocene	N7	20R-1, 61-63	A	M	RW	R	R	F	R	R	?	R	F	R	R	R	R	C	RW	R	R	RW	RW																										
		20R-2, 96-98	C	M						R		R			R			F						?	R																								
		20R-3, 28-30	C	M						R		R	F			F		C		R						R																							
		20R-4, 38-40	C	P							?	F	F					F							R																								
		20R-5, 48-50	F	P																R							?																						
		20R-6, 68-70	C	M						R		R		R				?		R	R			R				R																					
		20R-7, 33-35	F	P		?																							R																				
		21R-1, 96-98	A	M			R	R		R	?	R	C	R	R			C		F				F						R	R																		
		21R-2, 120-122	A	G				F	R	R	F	R	C	R	R	F	R	C		F	R			R	R		F	R		C	F	R	?	F	R														
		21R-3, 137-139	A	M				F	R	R	C	F	F	R			R	F		F										C	R		?	F		R	R	R	R	R	R								
		21R-4, 7-9	A	M				R		R	F	F	F	R	R	R	R	C		F										R	R			F			F	R			R	R							
		21R-5, 46-48	C	M								R	F	R						F														F			R						?	R					
		21R-6, 43-45	C	P			R			R		F	F	R						R										R				?		R		R		R		R	?		R				
		22R-1, 140-142	A	P			R		R	R		R	C	R				R											R																?				
		22R-2, 51-53	C	M			R		R			R	F	R				R		R						R				R												R							
		22R-3, 110-112	C	M			F	R		R	R	F		R		R	?			R						R		R		F	R							R				R		R	R				
		22R-4, 134-136	F	P									F																R		R						R												
		22R-5, 10-12	C	P						R		R	F		?			R		R																									R				
		22R-6, 74-76	F	P				R					R																	R																			
		23R-1, 16-18	F	M				R	R	R	R	R	R			R		R		R					R																				R				
		23R-1, 97-99	F	M						R		R	F	?				R																R											?				
		23R-2, 41-43	C	P								R	C																																				
		23R-3, 99-101	C	M				R		R	R	F	F		F	R	?	F		R					R					R		R		R											R				
		23R-4, 75-77	F	P									F	R				R																R															
	N6	23R-5, 114-116	C	M			R			R		F			F			F		R	R				R					R								R							R	R	R	?	
		23R-6, 90-92	A	M			R			R		F			F	R	R	C		R	R			R	C					F	R	R					R					?					R		
		23R-7, 48-50	R	M						R		R													R																						R		
		24R-1, 11-13	C	M								R			R	F		F		R					C					R	R															R	R		
		24R-2, 62-64	A	M			R			R		R			R	R		F						F	C	R																R							
		24R-3, 25-27	A	M					R			F			F			F						R	C					R												R							
		24R-3, 114-116	C	M						R		R	R		R	R		R			?			R	R					R																R			
		24R-4, 68-70	F	P									R																							R											R		
		24R-5, 47-49	F	P						R		R	R	R							?							R																			?		
		24R-5, 101-103	F	M						R		R	R	R	R	R								R	F						R								R			R				R	R		
		24R-6, 116-118	A	M			R					R	R			R					R			R	F					R	R								R						R		R		
		25R-1, 7-9	C	M						R		R	R	R	R	R									F																					R			
		25R-1, 122-124	C	M						R		R	F	R	R		R	R			R			R	F					R																			R

Note: For legend of abbreviations, see Table 1 notes.

Table 12. Distribution chart of Hole 900A (early Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	*Catapsydrax dissimilis*	*Globigerina cip. angustiumbilicata*	*Globigerina praebulloides*	*Globigerina woodi woodi*	*Globigerinita naparimaensis*	*Globigerinoides altiaperturus*	*Globigerinoides sacculifer*	*Globigerinoides trilobus/immaturus*	*Globoquadrina altispira altispira*	*Globoquadrina altispira conica*	*Globoquadrina baroemoenensis*	*Globoquadrina dehiscens dehiscens*	*Globorotalia obesa*	*Globorotalia siakensis*	*Globorotaloides suteri*	*Globoquadrina altispira s.l.*	*Globorotalia acrostoma*	*Globorotalia continuosa*	*Globorotalia mayeri*	*Globoquadrina venezuelana*	*Globorotaloides spp*	*Catapsydrax unicavus*	*Globoquadrina altispira globosa*	*Globoquadrina dehiscens praedehiscens*	*Globoquadrina dehiscens s.l.*	*Morozovella spinulosa*	*Globigerina spp*	*Globigerinoides spp*	*Globoquadrina spp*	*Catapsydrax spp*	*Cassigerinella chipolensis*	*Globigerina euapertura*	*Globigerina tripartita*	*Globigerinoides subquadratus*	*Catapsydrax stainforthi*	*Globorotalia nana/continuosa transition*	*Globigerinoides primordius*	*Globorotalia fohsi peripheroronda*	*Globorotalia praescitula*
early Miocene	N5 to N6 lower	25R-2, 24-26	C	M	R	F	F	R	R	R	R	F	R	R	R	F	R	R	R																								
		25R-3, 71-73	F	M			R		R			R	R			F		F		R	R	R	R																				
		25R-4, 15-17	F	M			R		R			R				F		R	R		?			R	R																		
		25R-5 ,35-37	F	M				R				R				F		R					R	R																			
		25R-6, 58-60	B																																								
		26R-1, 41-43	A	M	R	F	F	R	C		F	F	R		R	R	R	C	R	F	R	F	F	R	R	R	R	R	R	RW													
		26R-1, 133-135	F	M	R							R																			R	R	R										
		26R-3, 54-56	R	P																											R												
		26R-4, 99-101	C	M	R	R	R				R							R					R	R		R			R					R									
		26R-5, 44-46	C	M		R	R		R		R	R					R	R				R	R		R				R						R								
		26R-6, 23-25	C	M	R	R	F	R		?	R	F					R	R	R				R										R			R	?	R					
		27R-1, 46-48	R	P																											R												
		27R-2, 70-72	C	M	R	R	R		R			R						R	R			R		R	R	R		R	R				R	R		R							
		27R-3, 28-30	B																																								
		27R-4, 61-63	C	M	R		R		F			R						R		R	R	F	F	F	R			F	R				R	R									
		27R-5, 78-80	F	M		R	R					R					R		R				R		R																		
		28R-1, 117-119	C	M		F	F		F	R	R	F				F	F	R	R			R	R	F	F		R	F				F	R						?				
		28R-3, 138-140	F	M	R				R														R		R	R		R						R			R						
		28R-4, 34-36	F	M	R				R	R														R	R			R					R	R									
		28R-5, 102-104	C	M	F		R		F		?	F				F		C	?	R		F	R	R	R	R		R						R			R			R			
		28R-6, 130-132	R	P	R																	?																					
		29R-1, 16-18	R	P															R			R									R			R									
		29R-2, 131-133	R	P	R													?						R					R	RW				R									
		29R-5, 31-33	C	M	R	R	R		R									F	R			F			R	R		R				R	R	R			R						
		29R-6 ,85-87	C	M	R		R		R	R						R	R	R	R			F				?						R		R									
		30R-1, 71-73	B																																								
		30R-2, 38-40	F	P	R		R																	R	R									R									
		30R-3, 120-122	B																																								
		30R-4, 12-14	R	M																											R												
	N5 lower	30R-4, 84-86	C	M	R	R	R		R			R				R	R	R	R			F	R	R			R	R							R		R			R	R	R	
		30R-5, 97-99	C	M	R	R	R					R				R	R	R	R			F											R	R	R							R	?
		30R-6, 45-47	F	M	R	R	R	R	R			R				R		R				R	R	?	R			R	R				R								?	R	

Note: For legend of abbreviations, see Table 1 notes.

Table 13. Distribution chart of Hole 900A (latest Oligocene to earliest Miocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Globigerina praebulloides	Globigerinoides spp	Globoquadrina baroemoenensis	Globoquadrina dehiscens dehiscens	Globorotalia kugleri	Globorotalia mayeri	Globigerina spp	Catapsydrax dissimilis	Catapsydrax spp	Catapsydrax unicavus	Globigerina cip. angustiumbilicata	Globigerina falconensis	Globigerina sellii	Globigerina tripartita	Globigerinoides primordius	Globigerinoides trilobus/immaturus	Globoquadrina dehiscens praedehiscens	Globoquadrina dehiscens s.l.	Globoquadrina spp	Globoquadrina venezuelana	Globorotalia continuosa	Globorotalia fohsi peripheroronda	Globorotalia nana/continuosa transition	Globorotalia obesa	Globorotalia siakensis	Globigerinita naparimaensis	Globorotaloides suteri	Globorotaloides spp	Morozovella spinulosa	Globigerina venezuelana	Globigerinoides altiaperturus	Globoquadrina altispira s.l.	Globigerina woodi woodi
latest Oligocene to earliest Miocene	N4	30R-CC	F	M	R	R	R	R	R	R																											
		31R-1, 30-32	*	M							R																										
		31R-2, 5-7	C	M	F	R		R	R	F		R	R	R	R	R	RW	R	F	R	R	R	R	R	F	R	R	R	R								
		31R-3, 28-30	F	M	R					R		R	R						R				R	R	R	R		R	R	R	?						
		31R-5, 84-86	F	M	R			R		R		R	R		R		?					R		R						R	R						
		31R-6, 38-40	B																																		
		32R-1, 60-62	C	M	R	F		R	R			R	R					R	R	R			R	R	F			R	R		R	R					
		32R-3, 10-12	C	M	F	R		R		R		R			R				R	R		R	R	R	F			R	R		R						
		32R-4, 108-110	R	M	R	R					R							R										R									
		32R-5, 47-49	C	P	R	F		R		R		F	R		R			R	R	R			R	R	F	R	R	R	R	R	R	R	RW				
		32R-6, 5-7	R	M						R														R													
		33R-1, 43-45	F	P						R		R	R						?				R	R	R		R				R						
		33R-2, 29-31	F	M		R					R				R				R				R		R	R											
		33R-3, 63-65	A	G	C	F	R		R	F		R		R				R	R		R	R	R	R	C	F		R	R	R	R	R					
		33R-4, 58-60	F	G	R	R			R	R		R						R	R				R		R	R		R	R	R				R			
		33R-5, 132-134	R	P							R												R							R							
		33R-6, 25-27	C	P																			R	R		R	R	?				R					
		33R-7, 3-5	F	M	R	R				R		R	R					R					R			R	F			R	R						
		34R-1, 111-113	R	M							R															R		R									
		34R-2, 89-91	C	M	R	R				F			R	R				R	R					R	R	R	R	R		R	R	R					
		34R-3, 118-120	F	M	R	R			R			R											R	R	R	F				R	R				R		
		34R-4, 40-42	B																																		
		35R-1, 122-124	F	M								R	R					R	R				R	R		R	R				R	R				R	
		35R-2, 76-78	F	M	R					R		R	R		R		R	R	R								R				R	R					
		35R-4, 115-117	F	M	R					R			R			?		R	R				R	R		R	R	R			R						R
		36R-1, 54-56	F	P						R		R		R				R					R														
		36R-3, 88-90	F	P						R		R	R						R					R		R	R			R	R						
		36R-4, 122-124	R	P	R						R		R				R																				
		36R-6, 30-32	F	M	R					R			R	R		R					?			R		R					R	R					
		37R-1, 100-102	C	P	R	?				R		R		?	R		?	R	?			R	R	R			F	R	R		R						
		37R-4, 57-59	R	P		?					R												R				R				?						
		37R-5, 64-65	A	P	R	R				R		R	R		R								R	R			F				R	R					

Note: For legend of abbreviations, see Table 1 notes.

Sample 149-900A-79R-CC is barren of in situ planktonic foraminifers. The younger planktonic foraminiferal species found in this core catcher are thought to be downhole contamination, and therefore no age is assigned to this sample.

DISCUSSION OF CORRELATIVE HIATUSES AND FACIES-EVENTS

The sequences drilled in the Leg 149 holes contain some correlative hiatuses in the Tertiary (Fig. 3), centering the foraminiferal Zones N14-lower part N16 (latest middle to early late Miocene), Zone N18 (latest Miocene), and possibly Zone N21 (latest Pliocene). The extent of the Paleocene to early Eocene hiatus at Holes 897C and D and the Paleocene hiatus at Hole 900A are uncertain (because of the presence of barren strata). The upper Cretaceous is absent in all the holes, with the exception of a very thin slice of Campanian to lower Maastrichtian sediments in Hole 899B. Lower Cretaceous sediments were only found in Holes 897C and 897D (Aptian to Albian). The late Cretaceous to Paleocene or Eocene hiatus at the different sites could be considered as one single correlative event or several different events (with different ages in the different holes). The hiatuses are based on the absence of foraminiferal zones and are calibrated with nannofossil data (de Kaenel and Villa, Liu et al., and Liu, this volume). A correlative silica-rich floral facies (upper Oligocene to lower Miocene) and an arenaceous foraminiferal facies (Upper Pale-

Table 14. Distribution chart of Hole 900A (late Oligocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Catapsydrax dissimilis	Globigerina spp	Globorotalia mayeri	Globorotalia nana/continuosa transition	Globorotaloides suteri	Catapsydrax unicavus	Globigerina sellii	Globigerina tripartita	Globoquadrina spp	Globoquadrina venezuelana	Cassigerinella chipolensis	Globigerina cip. angustiumbilicata	Globigerina praebulloides	Globorotalia obesa	Globorotalia siakensis	Catapsydrax spp	Globigerina cip. angulisuturalis	Globigerina ciperoensis ciperoensis	Globoquadrina globularis	Hedbergella spp	Morozovella spinulosa	Globigerinoides primordius	Globigerinita naparimaensis	Globorotalia opima nana	Globigerina euapertura	Globorotaloides spp	Globigerina ouachitaensis	Globigerina yeguaensis	Globigerina praeturritilina	Globorotalia op. nana/op. opima trans.	Globigerina gortanii
late Oligocene	P22 upper	37R-6, 12-14	F	P	R	R	R	R	R																										
		38R-1, 76-78	F	P			R		R	R	R	?	R	R																					
		38R-2, 134-136	F	M			R	R					R		R	R	R	R																	
		38R-3, 134-136	F	P		R								R																					
		38R-5, 48-50	R	P													R																		
		38R-6, 71-73	F	P	R	R	R		R					R																					
		39R-1, 78-80	F	P		R			?					R		R	R	R	R																
		39R-3, 68-70	R	P		R								R																					
		39R-4, 100-102	F	M		R	R		R			R	R	R																					
		39R-6, 83-85	F	P	R	R		R	R	R		R	R	R			R		R																
		40R-2, 74-76	C	M		R		F						R	R	F	F																		
	P22 lower	40R-3, 34-36	C	M	R	R	R	R	R	R		R	R	F		R	F	R	R	R	R	R	?	RW	RW										
		40R-4, 69-71	F	M	R	R		R	R		R	R	R	R		R	R		R	R		?													
		40R-5, 121-123	F	M	R	R		R	R	R		R	R	R		R	R	R		R	?	R	R			R									
		41R-1, 41-43	F	P		R		R						R		R		R			R						?								
		41R-2, 14-16	F	P		R		R		?			R	R					R		R														
		41R-3, 3-5	C	M			R	R	R		?		R	R	R	F	R	R	R		F	R	R					R							
		41R-5, 104-106	C	G	R	F		F	R	R		R		R		R	F	R		R	R	R						R	?						
		41R-7, 8-10	C	M	R	R	R	F	R	R		R		R			R	R			R		R					R		R					
		42R-1, 113-115	C	M	R	R				R				R		R	?			R	R		R				?	R							
		42R-2, 144-146	C	M	R	F				R				F		F	F		?	R	R	R	R					F	R		R				
		42R-3, 121-123	C	P	R	F		R		R				R			R		R			R						R			?				
		42R-4, 86-88	F	M	R	R		R								R	R		?		R							R				RW			
		42R-5, 8-10	C	G	R			R						R			R				R	R						R	R						
		42R-6, 127-129	F	P	R	R		R						R			R	?		R								R							
		43R-1, 118-120	F	G	R	R		F						R			R				R	R					?	R							
		43R-2, 63-65	C	G	R	R		R						R		R	R				R	R								R			?	R	
		43R-3, 35-37	C	M	R	R		R	R					R		R	R				R	R	?					R	R						
		43R-4, 97-99	C	G	F	R			R	R	R	F		R			R	R		R	R	R					R	F	?	R					R
		43R-5, 102-104	C	M		R			R			R		R		R	F			R	R	F	R					F							
		43R-6, 113-115	F	G		R			R								R				R	R						R							
		44R-1, 129-131	F	G	R	R			R								R				R	R						R	R	R					
		44R-2, 77-79	F	P		R										R	R			R								R		R				R	
		44R-3, 40-42	F	G	R	R				R						R	R				R	R								R					
		44R-4, 4-6	C	P													R				R	R						R							
		44R-5, 30-32	C	M	R	R			R	R		R		R		R	R			R	?	R						R		R					
		45R-1, 73-75	F	M		R											R			R								R							
		45R-2, 121-123	C	M	R	R	?			R		R		R			R			R	F	R						R							
		45R-4, 33-35	C	M	R	R			R	R		R		R						R	R	R						F		R					?
		45R-5, 119-121	C	M	R	F		R	R	R	R	?				R	F		R	R	F	F						R						R	
		45R-CC	F	P					R								F					R						R							

Note: For legend of abbreviations, see Table 1 notes.

ocene to lower Eocene) were recorded in all the drilled holes. Three correlative planktonic foraminiferal acmes were recognized in the uppermost Pliocene and Pleistocene.

Pliocene and Pleistocene

A hiatus may possibly occur in the latest Pliocene of Hole 900A, where the foraminiferal Zone N21 was not found. However, this zone is difficult to detect, because the FAD of the marker species (*Globorotalia inflata*) depends on the influx of colder water. Calibration with the missing nannofossil Zone NN17 (Liu et al., this volume), which falls within the foraminiferal Zone N21 and therefore is of the same age, poses a problem, because the absence of the nannofossil zone is detected at a lower level (~21 m) than that of the missing foraminiferal zone.

In Hole 898A, a major hiatus (based on foraminifers and nannofossils) beginning in the latest middle Miocene extend into the latest Pliocene.

Table 15. Distribution chart of Hole 900A (early to early late Oligocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Catapsydrax spp	Globigerina cip. angulisuturalis	Globigerina cip. angustiumbilicata	Globigerina ciperoensis ciperoensis	Globigerina ciperoensis s.l.	Globigerina praebulloides	Globigerina yeguaensis	Globorotalia nana/continuosa transition	Globorotalia opima nana	Globorotalia opima opima	Hedbergella spp	Pseudohastigerina micra	Globoquadrina spp	Globorotalia op. nana/op. opima trans.	Globorotaloides suteri	Globigerina spp	Catapsydrax dissimilis	Globigerina ampliapertura	Globigerina tripartita	Catapsydrax unicavus	Globigerina gortanii	Globoquadrina venezuelana	Globorotaloides spp	Globigerina eocaena	Globigerina woodi woodi	Globigerina tapuriensis	Globigerina euapertura	Globigerinelloides spp	Globigerina linaperta	Globorotalia ouachitaensis	Globorotalia increbescens	Pseudohastigerina naguewichiensis	Globigerina corpulenta
		46R-2, 3-5	A	M	R	C	F	C	C	F	R	F	F	R	RW	RW																					
		46R-3, 138-140	F	M		R	R	R	R	R	?	R	R				R	R	R																		
		46R-4, 65-67	R	P																R																	
		46R-5, 34-36	F	M		R	R	R		R	R	R	R	R							R	?	R														
		46R-6, 2-4	F	M		F	F	R		R			R		RW																						
		47R-1, 4-6	F	M	R	R	R	R		R			R						R					R	R												
		47R-2, 12-14	R	P				R					R						R																		
I. early to e. late Oligocene	P21	47R-3, 33-35	R	P					R																												
		47R-4, 120-122	A	M	F	R	R			R			F	F	RW		R	F	R	F	F		R	R	R	F	R										
		47R-5, 34-36	F	M		R		R		R			R	R				R	R	F	R					R		R									
		47R-6, 66-68	F	M	R	R				R	R		R	R				R	R		R				R	R	R										
		48R-2, 106-108	F	P	R		R						R	R							R			R													
		48R-6, 134-136	*	P																																	
		49R-1, 44-46	F	M		R		R									R		R							R	R		R								
		49R-5, 60-62	R	M													R	.	R	R			R														
		50R-3, 2-4	F	M	R								R	R			R		R			?	R			R		R		R							
	P20	50R-5, 131-133	F	M	R														R				R	R		R	R	R			?						
early Oligocene		51R-1, 148-150	F	M			R		R								R		?							R		R									
		51R-5, 133-135	F	P	R		R				R					R					R							R				RW					
	P18 to P19	52R-1, 17-19	F	M	R		R		R	R						R			R		R	R	R			R		R	R				?	R	R	R	
		52R-5, 47-49	F	M							R					R	?		R			R						R			R						
		52R-CC	F	M							R																	F									R

Note: For legend of abbreviations, see Table 1 notes.

Two planktonic foraminiferal acmes of *Neogloboquadrina atlantica* (a subpolar species, according to Poore and Berggren, 1975) and one of *Pulleniatina obliquiloculata* (tropical/subtropical species), were recognized in all the holes where upper Pliocene and Pleistocene sediments were recovered (Holes 897C, 898A, and 900A).

Late Miocene/Early Pliocene Boundary

A latest Miocene to earliest Pliocene hiatus occurs in Holes 898A (in the lower part of Core 18), 899A (in the lower part of Core 6), and 900A (between Cores 26 and 27), where the latest Miocene foraminiferal Zone N18 (which falls within the nannofossil Zone NN12) and the earliest Pliocene nannofossil Zone NN13 (which correlates with the lower part of the foraminiferal Zone N19) were not detected. This hiatus (based on foraminifers and nannofossils) may be caused by turbiditic erosion and/or erosion or nondeposition connected with middle-late Miocene tectonic activity, which resulted in local uplift and hiatuses over basement highs, where the sites were located (Masson et al., 1994). In Hole 897C, the earliest Pliocene nannofossil Zone NN13 is reported missing, but this cannot be confirmed with foraminiferal data (due to poor-to-moderate preservation of foraminifers and barren strata).

Middle/Late Miocene Boundary

An important latest middle to early late Miocene hiatus, found in Hole 900A (Zone N15 to the lower part of Zone N16), is also detected in Hole 897C (approximately Zone N14 to the lower? part of Zone N16). In Hole 898A, Zones N15 to N21, which are of the latest middle Miocene to Pliocene age, are missing. This hiatus is confirmed by nannofossil data (de Kaenel and Villa, this volume) and is also recorded by Iaccarino and Salvatorini (1979) at the nearby Site 398, by Poore (1979) in the North Atlantic (Sites 407 and 408), and in the North Sea (H. Jansen, pers. comm., 1995). This hiatus was not found at Sites 118 and 119 in the Bay of Biscay (Laughton et al., 1972a, 1972b).

In general, the planktonic foraminifers (of late Miocene age) of Holes 897A, 898A, and 900A above the hiatus, are better preserved and show less dissolution than those (which are of early and middle Miocene age) below the hiatus, which could indicate a deepening of the CCD in the late Miocene, caused by a cooling trend starting round the Serravallian/Tortonian boundary. This cooling trend may have triggered extensive erosion, which could be locally enhanced by tectonic uplift (middle-late Miocene tectonic activity, Masson et al., 1994) at Hole 898A, where sediments, representing a considerable amount of time, are missing. Just below the hiatus, a silty layer with an assemblage containing moderately preserved, predominantly small planktonic foraminifers was found on top of sediments containing dissolution-resistant planktonic foraminifers (Holes 897C, 898A, and 900A) and is considered to be a rapidly buried turbiditic layer.

This latest middle to early late Miocene hiatus, found in Holes 900A, 898A and 897C, cannot be detected in Hole 899A because of the extensive dissolution of foraminiferal marker species, which prevents precise zonation.

Table 16. Distribution chart of Hole 900A (late Paleocene to earliest Oligocene).

Age	Zone	Core-Section, interval (cm)	Abundance	Preservation	Globigerina ampliapertura	Globigerina eocaena	Globigerina ouachitaensis	Globigerina yeguaensis	Hantkenina alabamensis/primitiva	Planorotalites palmerae	Pseudohastigerina micra	Catapsydrax spp	Globigerina tripartita	Globigerinatheka index	Globoquadrina venezuelana	Catapsydrax dissimilis	Globigerina corpulenta	Globigerina cryptomphala	Globigerina euapertura	Globorotalia cerroazulensis s.l.	Globorotalia opima nana	Globorotaloides suteri
late Eocene to earliest Oligocene	P15 to P17	53R-2, 43-45	C	M	R	R	F	R	R	RW	R											
		53R-4, 92-94	F	M			R	R	R		R											
		53R-6, 84-86	F	M		R	R		R		R	R	?									
		54R-1, 85-86	F	P		R	R				F		R	R	R							
		54R-3, 120-122	C	P			R				R			R	R	R	R	R	R	R	R	R
		56R-2, 115-117	C	M		R	R	R			F	R		R						R		R
middle Eocene	P14	56R-4, 125-127	C	M		R		R			R			R			R	R		F	R	
		57R-1, 123-125	F	P		R						R								R		
		57R-4, 42-44	F	M		R						R			R			R				R
		58R-1, 75-77	C	M		R		R			F			R		R				R	R	
		58R-2, 97-98	R	P							R											
		58R-3, 91-93	F	M		R						R						R		R	R	
		58R-CC	F	P		R																
	P12 to P13	59R-2, 99-101	F	M							R	R						R				
		59R-6, 134-136	R	P		R																?
		60R-4, 115-117	F	P		R												R		R		
		61R-3, 74-76	C	P		R					R			R						R		R
		62R-1, 128-130	F	P		?								R		R		?				
		63R-2, 43-45	F	P		?						R										
		64R-1, 44-46	R	P		R								?		R		R				
		65R-1, 91-93	F	P								R										
		66R-1, 83-85	F	M										R								
		67R-1, 135-137	B																			
		68R-2, 86-88	B																			
		69R-1, 130-132	F	M																		
		69R-CC	R	P																		
	1)	70R-CC, 4-6	F	M		R																
l. early to e. middle Eocene	P9 to P10	71R-4, 9-11	F	P																		
		71R-CC	F	M										?								
		72R-1, 76-78	R	P																		
		74R-1, 140-142	R	P																		
		74R-CC	F	P																		
?	?	75R-1, 37-39	R	P																		
		76R-1, 21-23	R	P																		
		77R-3, 4-6	R	P																		
		77R-CC	X																			
late Paleocene	P4	78R-CC	C	P																		
		79R-1, 40-42	R	M																		
?	?	79R-CC	B																			

Core-Section, interval (cm)	Globigerina praebulloides	Globigerina sellii	Globorotalia cerroazulensis cocoaensis	Globorotalia cerroazulensis/pomeroli trans.	Globigerinatheka barri	Globigerinatheka spp	Globorotalia cerroazulensis cerroazulensis	Globorotalia cerroazulensis pomeroli	Globorot. cerroazulensis/cocoaensis trans.	Morozovella spinulosa	Truncorotaloides rohri	Truncorotaloides rohri/topilensis trans.	Globigerina linaperta	Globigerina senni	Globorotaloides spp	Truncorotaloides topilensis	Globigerinatheka kugleri	Globigerinatheka subcong. subconglobata	Hantkenina spp	Acarinina primitiva
53R-2, 43-45																				
53R-4, 92-94																				
53R-6, 84-86																				
54R-1, 85-86																				
54R-3, 120-122																				
56R-2, 115-117	R	R	R	R																
56R-4, 125-127					R	R	R	R	R	R	F	R								
57R-1, 123-125								R			R									
57R-4, 42-44				R				R		R	R		R	R	R	R				
58R-1, 75-77							R			R	F		R							
58R-2, 97-98																				
58R-3, 91-93						R	R	R			R		R							
58R-CC					R											R				
59R-2, 99-101						R				R	R	R	R			R	R	R	R	
59R-6, 134-136										R	R									?
60R-4, 115-117					R					F	R			R	R	R	R			
61R-3, 74-76										F	F		R	R		R				
62R-1, 128-130										R	R		R	R						
63R-2, 43-45										R			R		R					
64R-1, 44-46																				
65R-1, 91-93										R										
66R-1, 83-85						R							R	R				R		
67R-1, 135-137																				
68R-2, 86-88																				
69R-1, 130-132										R										
69R-CC										R	R			R						
70R-CC, 4-6										F				R				R		
71R-4, 9-11						R				R				R						?
71R-CC										R										
72R-1, 76-78																				
74R-1, 140-142										R										
74R-CC										F				R						
75R-1, 37-39																				
76R-1, 21-23																				
77R-3, 4-6																				
77R-CC																				
78R-CC																				R
79R-1, 40-42													R							
79R-CC																				

Core-Section, interval (cm)	Acarinina bullbrooki	Globigerinatheka subconglobata s.l.	Catapsydrax unicavus	Acarinina pseudotopilensis	Globigerinoides higginsi	Morozovella lehneri	Acarinina spp	Truncorotaloides spp	Globorotalia cerroazulensis frontosa	Acarinina broedermanni	Acarinina pentacamerata	Morozovella aragonensis	Globigerina spp	Morozovella spp	Globigerina triloculinoides	planktonic foraminifera indet	Acarinina mckannai	Morozovella aequa	Planorotalites pseudomenardii
53R-2, 43-45																			
53R-4, 92-94																			
53R-6, 84-86																			
54R-1, 85-86																			
54R-3, 120-122																			
56R-2, 115-117																			
56R-4, 125-127																			
57R-1, 123-125																			
57R-4, 42-44																			
58R-1, 75-77																			
58R-2, 97-98																			
58R-3, 91-93																			
58R-CC																			
59R-2, 99-101																			
59R-6, 134-136																			
60R-4, 115-117	R	R																	
61R-3, 74-76	R		R																
62R-1, 128-130	R																		
63R-2, 43-45	R			?	R	?													
64R-1, 44-46																			
65R-1, 91-93	R						R	?											
66R-1, 83-85	R								?										
67R-1, 135-137																			
68R-2, 86-88																			
69R-1, 130-132	R						R		?	R									
69R-CC	R																		
70R-CC, 4-6	F						R		R	R	?	R							
71R-4, 9-11	R	R					F		?		R	R							
71R-CC	R											R							
72R-1, 76-78													R	R					
74R-1, 140-142	?											R							
74R-CC	R									R	R				R				
75R-1, 37-39													R						
76R-1, 21-23							R						R	R					
77R-3, 4-6																R			
77R-CC																			
78R-CC																	R	R	R
79R-1, 40-42															R		R		
79R-CC																			

Note: 1 = upper P10 to Pl 1. For legend of abbreviations, see Table 1 notes.

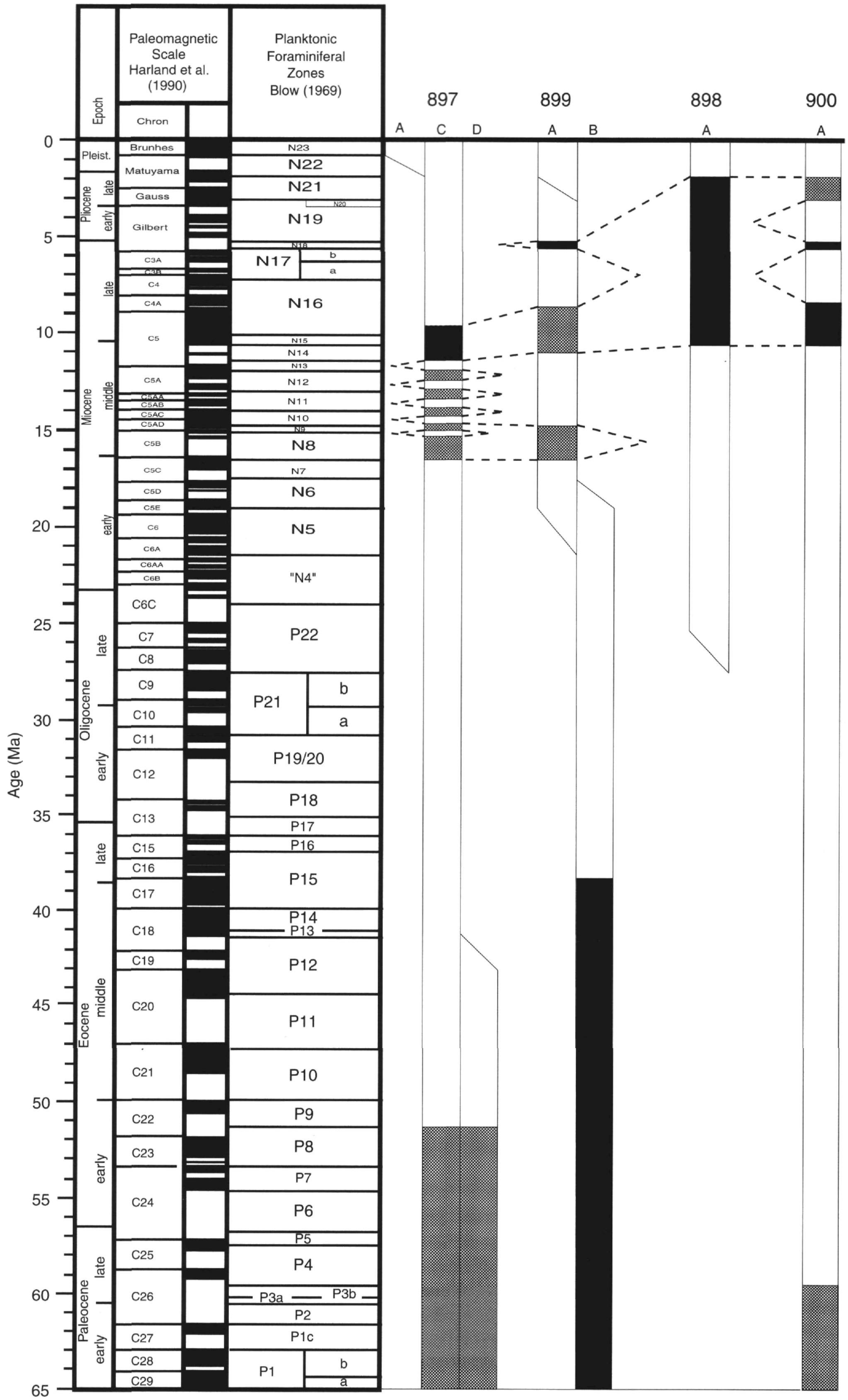

Figure 3. Schematic chronostratigraphic positions and correlation of hiatuses from Holes 897A, 897C, 897D, 898A, 899A, 899B, and 900A. Blocks with black shading = hiatus. Blocks with light gray shading = possible hiatus. Dashed lines = correlation lines.

Lower and Middle Miocene

The undetected foraminiferal zones in middle Miocene sections of the different studied holes, are not of exactly the same age. In Hole 897C, sediments representing foraminiferal Zones N8 to N13 are very thin and probably contain one or more hiatuses. Sediments, which were deposited slowly could easily be eroded by contour currents or turbidites, accentuated by local tectonic movements. In Hole 900A, the foraminiferal Zones N12 and N13 are apparently missing. Considering the slow sedimentation rate of ~0.5 cm/ka measured in the underlying sediments (Zones N9 to N1l), these two undetected zones might still be present in the interval, where sediments were not recovered (sample gap of ~9 m). Nannofossil evidence (de Kaenel and Villa, this volume) confirms that there is no real hiatus within this interval in Hole 900A. In Hole 899A, where the foraminiferal Zones N8 and N9 could not be detected within Core 5 (sample gap ~7.5 m), sedimentation rates in the underlying sediments (Zones N5 to N7) were hard to estimate because the location of one of the zonal boundaries (N4/N5) could not be pinpointed accurately, due to the lack of foraminiferal marker species and barren strata. In Hole 899A, the NN3 nannofossil Zone was not recognized within Core 5, where the foraminiferal Zones N8 and N9 were also apparently absent. Unfortunately, the calibration of nannofossil and foraminiferal zones and ages does not fit very well in the middle Miocene interval of Hole 899A and the validity of this hiatus remains unclear. An unconformity between lower and middle Miocene was recognized at Site 407 in the North Atlantic (Poore, 1979), and the early Miocene foraminiferal Zone N7 was reported to be missing at the nearby Site 398 (Iaccarino and Salvatorini, 1979).

In the lower and upper Miocene, alternating assemblages with more or less broken foraminifers, combined with the influxes of subtropical species *(Globorotalia siakensis, G. mayeri,* and *G. fohsi)* may indicate changing water-mass currents and fluctuation in the CCD, reflecting periodical changes in climate.

Late Oligocene to Early Middle Miocene

The uppermost part of the foraminiferal Zone P22 was not recognized in Hole 899B, but it may be present in the interval which was not sampled (sample gap of ~9 m) and therefore a hiatus cannot be assumed here. No nannofossil zones were reported missing at this level (de Kaenel and Villa, this volume).

Nannofossil zone NP21 (correlating with the upper part of foraminiferal Zone P17 and lower part of Zone P18) was not recognized in Holes 897C, which may be the consequence of reworking of *Ericsonia formosa* (the nannofossil marker for the top of NP21) into younger sediments (Zone NP22). The analysis of moderately preserved foraminifers found at the same level does not support this apparent nannofossil hiatus. In Hole 899B, the NP21 Zone may be present if the findings of Liu et al. (this volume) and de Kaenel and Villa (this volume) concerning the presence and abundance of some species (i.e., *Isthmolithus recurvus* and *Ericsonia formosa)* were combined. The poor preservation or absence of planktonic foraminifers (Hole 899B) prevents recognition of the missing foraminiferal zones, which correlate with the nannofossil Zone NP21.

In all the holes, the upper Oligocene to lower Miocene interval (foraminiferal Zones P22 to N7), contains assemblages with common to abundant sponge spicules and abundant juvenile planktonic foraminifers, in addition to common to abundant radiolarians and diatoms, and few to common silicoflagellates in the upper part of the interval (foraminiferal Zones N4 to N7). This facies is also recognized at the nearby Site 398 (Iaccarino and Salvatorini, 1979; Iaccarino and Premoli Silva, 1979), but not at Sites 118 and 119 in the Bay of Biscay (Laughton et al., 1972a, 1972b), and not at Sites 407 and 408 in the North Atlantic, where the abundant sponge spicules were not recorded. Comparison with the Northeast Atlantic was not possible because insufficient data from this period is available. This silica-rich facies is interpreted to be connected to eutrophic conditions, which may be caused by upwelling. The sediments recovered from Holes 900A and 898A contained more silica than those from Holes 897C, 899A, and 899B.

Cretaceous and Paleocene/Early Eocene

Foraminiferal Zones P1 to P8 (Paleocene to early Eocene) in Holes 897C and D, Zones P1 to P14/15? (Paleocene to middle or early late? Eocene) in Hole 899B, and Zones P1 to P3 (Paleocene) and Zones P5 to P8 (latest Paleocene to early Eocene) in Hole 900A, were not recognized. In Hole 899B, the existence of a hiatus is highly likely, because a transition is found here between lower Maastrichtian and (middle or lower upper?) Eocene sediments within a very short drilling interval (sample gap of ~4.5 m). In this hole, nannofossil evidence suggests that the Paleocene to early late Eocene Zones NP1 to NP18, which correlate with the foraminiferal Zone P1 to the lower part of Zone P15, are missing. In Holes 897C and D, and Hole 900A, it is not exactly clear how much of the Paleocene and lower Eocene is missing—or perhaps appears to be missing—because the lack of calcareous fauna (planktonic and calcareous benthic foraminifers, and nannofossils) prevents recognition of these biozones. The nannofossil data of Holes 897C and D (Liu, this volume) reveals undetected zones, which correlate very well with those based on foraminifers. In Hole 900A, the nannofossil Zones NP10-NP13 (Liu, this volume) and nannofossil Zone NP9 (Shipboard Scientific Party 1994), which correlate with the foraminiferal zones (uppermost part of Zone P4 to lower part of Zone P9), were recognized. This leads to the conclusion that a hiatus, as suggested by foraminiferal data (Zones P5 to P8), is not valid. The nannofossil Zones NP1-NP8, which correlate with the apparently missing foraminiferal Zones P1-P3, were not recognized in Hole 900A (Shipboard Scientific Party, 1994).

At Site 398, a late Paleocene to early Eocene hiatus is suggested by Iaccarino and Premoli Silva (1979). At Site 118 (drilled at the side of a basement high) in the Bay of Biscay, late Paleocene to early Eocene? altered clay devoid of calcareous fauna was recorded by Laughton et al. (1972a). The sediments of Site 119 contain displaced calcareous fauna.

Upper Cretaceous (Cenomanian to Maastrichtian) sediments are completely missing in Holes 897C, 897D, and 900A. They are, for the most part, missing in Hole 899B, apart from a slice of Campanian to lower Maastrichtian. Lower Cretaceous (Aptian and Albian) sediments were recorded in Holes 897C and 897D. At Site 389, a more landward hole than the Leg 149 holes, more lower Cretaceous sediments were recorded (Sigal, 1979).

The late Cretaceous to Paleocene or Eocene hiatus has a different age range at different sites, indicating that the highs on which the holes were drilled were different heights during different periods. Considering this fact and the already mentioned uncertainty in biozonation (at Holes 897C, 897D, and 900A), it is not clear whether this hiatus is correlative or not. It may consist of several different events intercalated by periods of deposition of barren strata.

TAXONOMIC NOTES

The species names discussed below are combined because they include transitional forms, because their separation does not improve the biostratigraphy, or because there is no consensus about the species concept.

Globigerina ouachitensis Howe and Wallace, 1932 (including *Globigerina ouachitensis gnaucki* Blow and Banner, 1962, in Bolli and Saunders, 1985: fig. 13.16).

Globigerinoides elongatus/obliquus extremus. Globigerinoides elongatus (d'Orbigny, 1826) and *Globigerinoides obliquus extremus* Bolli and Bermudez, 1965 are not separated in this study.

Globigerinoides trilobus/immaturus. Globigerinoides trilobus (Reuss, 1850) and *Globigerinoides immaturus* Le Roy, 1939, are not separated.

Globigerinoides trilobus/sacculiferus transition. This is a transitional form between *Globigerinoides trilobus* (Reuss, 1850) and *Globigerinoides sacculiferus* (Brady, 1877).

Globorotalia cerroazulensis/cocoaensis transition (Toumarkine and Luterbacher, 1985: fig. 36.13-15).

Globorotalia cerroazulensis/pomeroli transition (Toumarkine and Luterbacher, 1985: fig. 35.1-3).

Globorotalia cocoaensis/cunialensis transition (Toumarkine and Luterbacher, 1985: fig. 36.7-9).

Globorotalia miozea/conoidea. Globorotalia miozea Finlay, 1939, and *Globorotalia conoidea* Walters, 1965, are not separated.

Globorotalia sp. cf. *G. hirsuta.* Our forms differ from *Globorotalia hirsuta* by having a flat or almost flat spiral side.

Globorotalia fohsi peripheroronda Blow and Banner, 1966. Small specimens of forms close to *Globorotalia kugleri* (also mentioned by Iaccarino and Premoli Silva, 1979, for Hole 398D, Leg 47B) were found in the upper Oligocene to lower Miocene of the studied samples. They are regarded as a variation of *Globorotalia fohsi peripheroronda.*

Globorotalia opima nana/opima opima transition (Bolli and Saunders, 1985: fig. 26.21-23).

Globorotalia tosaensis Takayanagi and Saito, 1962 (including *Globorotalia tosaensis tenuitheca* Blow, 1969, in Bolli and Saunders, 1985: fig. 37.7-9).

Globorotalia truncatulinoides (d'Orbigny, 1839), (including *Globorotalia truncatulinoides pachytheca* Blow, 1985, in Bolli and Saunders, 1985: fig. 37.6).

Neogloboquadrina humerosa Takayanagi and Saito, 1962, including *Neogloboquadrina praehumerosa* Natori, 1976, in Bolli and Saunders, 1985: fig. 27.9. Stainforth et al., 1975, show pictures of both five-chambered (considered to be *N. praehumerosa)* and six-chambered specimens of *N. humerosa* (considered to be *N. humerosa)* in fig. 170.1-6.

Neogloboquadrina pachyderma Ehrenberg, 1861 (including *Globigerina borealis* Brady, 1881, in Iaccarino, 1985: fig. 5.6).

Hantkenina alabamensis/primitiva. The species *Hantkenina alabamensis* Cushman, 1925, and *Hantkenina primitiva* Cushman and Jarvis, 1929, are not separated.

Pulleniatina obliquiloculata/inflata transition. This is a transitional form between *Pulleniatina obliquiloculata* Parker and Jones, 1865, and *Globorotalia inflata* (d'Orbigny, 1939).

Truncorotaloides rohri/topilensis transition. This is a transitional form between *Truncorotaloides rohri* Brönnimann and Bermudez, 1953, and *Truncorotaloides topilensis* (Cushman, 1925).

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APPENDIX
Species List

Acarinina broedermanni (Cushman & Bermudez), 1949
Acarinina bullbrooki (Bolli), 1957
Acarinina mckannai (White), 1928
Acarinina pentacamerata (Subbotina), 1947
Acarinina primitiva (Finlay), 1947
Acarinina pseudotopilensis Subbotina, 1953
Archaeoglobigerina cretacea (d'Orbigny), 1840
Beella digitata (d'Orbigny), 1879
Beella praedigitata Parker, 1967
Candeina nitida d'Orbigny, 1839
Cassigerinella chipolensis (Cushman & Ponton), 1932
Catapsydrax dissimilis (Cushman & Bermudez), 1937
Catapsydrax stainforthi Bolli, Loeblich & Tappan, 1957
Catapsydrax unicavus Bolli, Loeblich & Tappan, 1957
Globigerina ampliapertura Bolli, 1957
Globigerina apertura Cushman, 1918
Globigerina bermudezi Seiglie, 1936
Globigerina binaiensis Koch, 1935
Globigerina bulloides d'Orbigny, 1826
Globigerina calida Parker, 1962
Globigerina ciperoensis angulisuturalis Bolli, 1957
Globigerina ciperoensis angustiumbilicata Bolli, 1957
Globigerina ciperoensis ciperoensis Bolli, 1954
Globigerina corpulenta Subbotina, 1953
Globigerina cryptomphala Glaessner, 1937
Globigerina decoraperta Takayanagi & Saito, 1962
Globigerina druryi Akers, 1955
Globigerina eocaena Guembel, 1868
Globigerina euapertura Jenkins, 1960
Globigerina falconensis Blow, 1959
Globigerina gortanii (Borsetti), 1959
Globigerina hagni Gohrbandt, 1967
Globigerina inaequispira Subbotina, 1953
Globigerina linaperta Finlay, 1939
Globigerina megastoma cariacoensis Rogl & Bolli, 1973
Globigerina nepenthes Todd, 1957
Globigerina ouachitaensis Howe & Wallace, 1932
Globigerina praebulloides Blow, 1959
Globigerina praeturritilina Blow & Banner, 1962
Globigerina sellii (Borsetti), 1959
Globigerina senni (Beckmann), 1953
Globigerina tapuriensis Blow & Banner, 1962
Globigerina triloculinoides Plummer, 1926
Globigerina tripartita Koch, 1926
Globigerina woodi woodi Jenkins, 1960
Globigerina yeguaensis Weinzierl & Applin, 1929
Globigerinatella insueta Cushman & Stainforth, 1945
Globigerinatheka barri Brönnimann, 1952
Globigerinatheka index (Finlay), 1939
Globigerinatheka kugleri (Bolli, Loeblich & Tappan), 1957
Globigerinatheka subconglobata subconglobata (Schutskaya), 1958
Globigerinita naparimaensis Brönnimann, 1951
Globigerinoides altiaperturus Bolli, 1957
Globigerinoides conglobatus (Brady), 1879
Globigerinoides fistulosus Schubert, 1910
"*Globigerinoides*" *higginsi* Bolli, 1957
Globigerinoides elongatus (d'Orbigny), 1826
Globigerinoides immaturus Le Roy, 1939
Globigerinoides obliquus extremus Bolli & Bermudez, 1965
Globigerinoides obliquus obliquus Bolli, 1957
Globigerinoides primordius Blow & Banner, 1962
Globigerinoides ruber d'Orbigny, 1839 (white)
Globigerinoides ruber d'Orbigny, 1839 (pink)
Globigerinoides sacculifer (Brady), 1877
Globigerinoides subquadratus Brönnimann, 1954
Globigerinoides trilobus (Reuss), 1850
Globigerinoides trilobus/sacculifer transition
Globoquadrina altispira altispira (Cushman & Jarvis), 1936
Globoquadrina altispira conica Brönnimann & Resig, 1971
Globoquadrina altispira globosa Bolli, 1957
Globoquadrina baroemoenensis (Le Roy), 1939
Globoquadrina dehiscens dehiscens (Chapman, Parr & Collins), 1934
Globoquadrina dehiscens praedehiscens Blow & Banner, 1962
Globoquadrina globularis Bermudez, 1960
Globoquadrina venezuelana Hedberg, 1937
Globorotalia acrostoma Wezel, 1966
Globorotalia archaeomenardii Bolli, 1957
Globorotalia bolivariana (Petters), 1954
Globorotalia bononiensis Dondi & Pappeti, 1963
Globorotalia cerroazulensis cerroazulensis (Cole), 1928
Globorotalia cerroazulensis cocoaensis Cushman, 1928
Globorotalia cerroazulensis cunialensis Tourmakine & Bolli, 1970
Globorotalia cerroazulensis frontosa (Subbotina), 1953
Globorotalia cerroazulensis pomeroli Toumarkine & Bolli, 1970
Globorotalia cibaoensis Bermudez, 1949
Globorotalia conoidea Walters, 1965
Globorotalia continuosa Blow, 1959
Globorotalia crassaformis crassaformis Galloway & Wissler, 1927
Globorotalia crassaformis hessi Bolli & Premoli Silva, 1973
Globorotalia crassaformis ronda Blow, 1969
Globorotalia fohsi fohsi Cushman & Ellisor, 1939
Globorotalia fohsi peripheroacuta Blow & Banner, 1966
Globorotalia fohsi peripheroronda Blow & Banner, 1966
Globorotalia hirsuta (d'Orbigny), 1839
Globorotalia increbescens (Bandy), 1949
Globorotalia inflata (d'Orbigny), 1939
Globorotalia kugleri Bolli, 1957
Globorotalia margaritae margaritae Bolli & Bermudez, 1965
Globorotalia mayeri Cushman & Ellisor, 1939
Globorotalia menardii Parker, Jones & Brady, 1965
Globorotalia merotumida Blow & Banner, 1965
Globorotalia miozea Finlay, 1939
Globorotalia obesa Bolli, 1957
Globorotalia opima nana Bolli, 1957
Globorotalia opima opima Bolli, 1957
Globorotalia plesiotumida Banner & Blow, 1965
Globorotalia praemenardii Cushman & Stainforth, 1945
Globorotalia praescitula Blow, 1959
Globorotalia pseudomiocenica Bolli & Bermudez, 1965
Globorotalia puncticulata (Deshayes), 1832
Globorotalia scitula (Brady), 1882
Globorotalia siakensis Le Roy, 1939
Globorotalia tosaensis Takanayagi & Saito, 1962
Globorotalia triangula Theyer, 1973
Globorotalia truncatulinoides d'Orbigny, 1839
Globorotalia tumida (Brady), 1877
Globorotaloides suteri Bolli, 1957
Globotruncana linneiana (d'Orbigny), 1939
Globotruncana orientalis El Naggar, 1966
Globotruncana stuartiformis (Dalbiez), 1955
Hantkenina alabamensis Cushman, 1925
Hantkenina primitiva Cushman & Jarvis, 1929
Hastigerina aequilateralis (Brady), 1879
Hastigerina praesiphonifera Blow, 1969
Hastigerina siphonifera (d'Orbigny), 1839
Hedbergella delrioensis (Carsey), 1926
Hedbergella holmdelensis Olsson, 1964
Hedbergella planispira (Tappan), 1940
Hedbergella simplex (Morrow), 1934
Marginotruncana marginata (Reuss), 1845
Morozovella aequa (Cushman & Renz), 1942
Morozovella aragonensis (Nuttall), 1930
Morozovella lehneri (Cushman & Jarvis), 1929
Morozovella spinulosa (Bandy), 1927
Neogloboquadrina acostaensis Blow, 1959
Neogloboquadrina atlantica (Berggren), 1972
Neogloboquadrina dutertrei (d'Orbigny), 1839
Neogloboquadrina humerosa Takanayagi & Saito, 1962
Neogloboquadrina pachyderma (Ehrenberg), 1861
Orbulina bilobata (d'Orbigny), 1846
Orbulina suturalis Brönnimann, 1951
Orbulina universa d'Orbigny, 1939
Planorotalites palmerae (Cushman & Bermudez), 1937
Planorotalites pseudomenardii (Bolli), 1957
Planorotalites pseudoscitula (Glaessner), 1937

Praeorbulina glomerosa curva (Blow), 1956
Praeorbulina glomerosa glomerosa (Blow), 1956
Praeorbulina sicana (de Stefani), 1950
Praeorbulina transitoria (Blow), 1956
Pseudohastigerina micra (Cole), 1927
Pseudohastigerina naguewichiensis (Myatliuk), 1950
Pseudohastigerina wilcoxensis (Cushman & Ponton), 1932
Pseudotextularia elegans (Rzehak), 1891
Pulleniatina finalis Banner & Blow), 1967
Pulleniatina inflata (d'Orbigny), 1939
Pulleniatina obliquiloculata Parker & Jones, 1865
Pulleniatina primalis Banner & Blow, 1967
Rotalipora appenninica (Renz), 1936
Sphaeroidinella dehiscens (Chapman, Parr & Collins), 1865
Sphaeroidinellopsis disjuncta (Finlay), 1940
Sphaeroidinellopsis paenedehiscens Blow, 1969
Sphaeroidinellopsis seminulina (Schwager), 1866
Sphaeroidinellopsis subdehiscens Blow, 1959
Truncorotaloides rohri Brönnimann & Bermudez, 1953
Truncorotaloides topilensis (Cushman), 1925