13. THE FORAMINIFERA AND SOME ASSOCIATED MICROFOSSILS OF SITES 135 TO 144

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INTRODUCTION AND ACKNOWLEDGMENTS

A total of 465 samples, all collected on shipboard, were available for examination of the foraminifera and associated microfossils. On the average, this amounts to one sample for slightly less than one meter of recovered core. Most of the washed residues were separated into two fractions (retained in the 80 mesh and 230 mesh sieves). Only a few samples were too hard for conventional washing methods and had to be studied in thin section (Site 139, Core 6; Site 144, Core 6). A set of charts showing the composition and preservation of the microfauna for each sample, with special emphasis on the foraminifera, has been prepared and is reproduced here on Tables 2 to 11. These tables also include the determinations of the zones and ages. The figures indicating the planktonic/benthonic ratios and the percentage of foraminifera (of the total fauna in the 80-mesh fraction) are in most cases estimates rather than counts. For some samples, the record of the foraminiferal species has been left incomplete or omitted altogether. Such samples are marked in the last columns ("Remarks") by the letters "P"—partially examined or "n"—not examined. Omissions of this kind will be found in monotonous sequences of rich faunas, or where an occasional sample was poorly preserved. Their purpose was to save time without losing essential data.

Apart from these tables, this volume contains summaries of the foraminifera and some associated microfossils for each core recovered. These summaries, which are both descriptive and interpretative, are incorporated in the appropriate Site Reports (Chapters 2 to 10).

The ages of the foraminiferal faunas recovered on Leg 14 range from the Aptian/Albian to the Quaternary, but the majority of the good assemblages represent the Neogene and the Cretaceous. The best sections for detailed biostratigraphic study are in the Cenomanian-Upper Albian of Site 137, the Upper Cretaceous of Site 144, and the Pliocene-Pleistocene of Site 141. The most completely cored stratigraphic section, with good calcareous microfaunas throughout, is that of Site 144, but since several unconformities were penetrated, the stratigraphic record is not continuous.

The preservation of the faunas is variable. In the majority of the samples, the calcareous shells appear to be more or less affected by solution. In the Pliocene of Site 141, an excellent example of gradual loss of the calcareous component, involving progressive etching, breaking up, and final disappearance of the foraminifera, can be observed.

Apart from the common planktonic deep-water faunas, a fair number of predominantly benthonic assemblages were encountered. Some of these appear to have been moved downslope from a shallower environment (examples in Sites 135, 140 and 142). Other benthonic faunas are entirely noncalcareous and consist essentially of agglutinated deep-water foraminifera (Sites 137, 140 and 141). In the Aptian/Albian faunas (Sites 136, 144), the benthonic element is generally more conspicuous than elsewhere. These may at least in part be autochthonous deposits of the neritic to upper bathyal realm.

In addition to the Leg 14 cores, about thirty samples from piston cores collected by the research vessel *Vema* were kindly supplied by the Lamont-Doherty Geological Observatory (Palisades, New York). I wish to thank this institution for making available this most useful comparison material. I am also indebted to G. F. Elliott (British Museum, London), A. J. Keij, R. Lagaaji (both Shell-BIPM, Den Haag), and H. J. Oertli (SNPA, Pau, France) for their help in determining the calcareous algal fragments and bryozoans of Site 142, as well as some Cretaceous ostracods of Site 144. Helpful information was received in discussions with M. B. Cita (University of Milano) and F. Roegl (ETH, Zurich). E. A. Pessagno (University of Texas, Dallas) made available his shore lab determinations of samples from Sites 137 and 144. In particular, I wish to thank H. M. Bolli (ETH, Zurich) for his advice on many problems including taxonomy, biostratigraphy and the stratigraphy of the Caribbean area.

BIOSTRATIGRAPHY

The biostratigraphic subdivision of the Cretaceous, Tertiary and Quaternary, as used in this report, is shown on Table 1. This table also includes references to the definitions of the zones, as well as the age boundaries agreed upon by the shipboard party.

The sequences of foraminiferal zones adopted for the Tertiary is essentially that proposed by Bolli (1957b, c, d, 1966, 1970). It appears that Bolli's scheme can readily be applied to calcareous planktonic faunas from the warm temperate to tropical regions of the Atlantic Ocean. As can be seen on the last column of Table 1, the distribution of the Leg 14 cores among the zones is quite uneven. The maximum is in the *Globorotalia margaritae* Zone; this could well be an indication that this particular zone represents a longer time interval than most of the others. It may be justified to attempt a further subdivision of this zone.

For the Late Cretaceous, a number of the zones and subzones established by Pessagno (1967) are used. The Early Cretaceous was left unzoned except in Site 137 where the *Rotalipora ticinensis* Zone could be recognized.

SUMMARY REVIEW OF THE FORAMINIFERAL ASSEMBLAGES

Eastern Atlantic Sites (135 to 141)

The tight schedule for drilling these sites left little time for detailed stratigraphic sampling. Nevertheless, on a few

TABLE 1
Planktonic Foraminiferal Zones to be Used in Leg 14 Initial Report

Age		Zone	Definition Used in This Report	Leg 14 Cores
QUATERNARY		*Globorotalia truncatulinoides* Zone	Bolli, 1970, Leg 4 Initial Report	135-1, 141-1, 142-1, 142-2, 142-3
PLIOCENE	Late	*Globorotalia* cf. *tosaensis* Zone	Bolli, 1970, Leg 4 Initial Report	141-2
		Globorotalia exilis/ G. miocenica Zone	Bolli, 1970, Leg 4 Initial Report	139-1, 140-1, 141-2, 141-3
	Early	*Globorotalia margaritae* Zone	Bolli & Bermudez, 1965	135-2, 136-1 139-2, 140-1, 141-3, 141-4, 141-5, 141-6, 142-4, 142-5
MIOCENE	Late	*Globorotalia "dutertrei"* Zone	Bolli & Bermudez, 1965	142-6?
		Globorotalia acostaensis Zone	Bolli & Bermudez, 1965	135-3, 142-7
	Middle	*Globorotalia menardii* Zone	Bolli, 1966	142-8
		Globorotalia mayeri Zone	Bolli, 1966	
		Globigerinoides "ruber" Zone	Bolli, 1966	
		Globorotalia fohsi robusta Zone	Bolli, 1966	139-3, 139-4
		Globorotalia fohsi lobata Zone	Bolli, 1966	
		Globorotalia fohsi praefohsi Zone	Banner & Blow, 1965	
		Globorotalia fohsi peripheroacuta Zone	Banner & Blow, 1965	
		Globorotalia fohsi peripheroronda Zone	Banner & Blow, 1965	135-4, 136-2
	Early	*Praeorbulina glomerosa* Zone	Bolli, 1966	
		Globigerinatella insueta Zone	Bolli, 1966	142-9
		Catapsydrax stainforthi Zone	Bolli, 1957c	140-2
		Catapsydrax dissimilis Zone	Bolli, 1957c	139-7
		Globorotalia kugleri Zone	Bolli, 1957c	
OLIGOCENE	Late	*Globigerina ciperoensis ciperoensis* Zone	Bolli, 1957c	
		Globorotalia opima opima Zone	Bolli, 1957c	
	Middle	*Globigerina ampliapertura* Zone	Bolli, 1966	144B-1

TABLE 1 – *Continued*

Age		Zone	Definition Used in This Report	Leg 14 Cores
EOCENE	Early	*Cassigerinella chipolensis/Hastigerina "micra"* Zone	Bolli, 1966	144A-1, 144A-2, 144B-2, 144B-3
	Late	(Not represented)		
	Middle	*Truncorotaloides rohri* Zone	Bolli, 1957d	144A-2
		Orbulinoides beckmanni Zone	Bolli, 1957d (as *Porticulasphaera mexicana* Z.)	144-1
PALEOCENE	Early	(Not represented)		
	Late	*Globorotalia pseudo-menardii* Zone	Bolli, 1957b	144-2, 144A-3
	Early	(Not represented)		
LATE CRETACEOUS	Maestrichtian	*Globotruncana contusa–stuartiformis* Zone	Pessagno, 1967	135-7?
	Campanian	*Globotruncana fornicata–stuartiformis* Zone	Pessagno, 1967	144-3, 144A-3, 144A-4
	Santonian	*Globotruncana fornicata* Subzone	Pessagno, 1967	
		Marginotruncana concavata Subzone	Pessagno, 1967	136-5, 136-6, 136-7?, 144A-5
	Conician	*Marginotruncana renzi* Zone	Pessagno, 1967	144A-6
	Turonian	*Whiteinella archaeo-cretacea* Subzone	Pessagno, 1967	
		Marginotruncana sigali Subzone	Pessagno, 1967	137-7, 144-4
	Cenomanian	*Rotalipora cushmani – greenhornensis* Subzone	Pessagno, 1967	137-8, 137-9, 137-10, 137-11, 137-12
		Rotalipora evoluta Subzone	Pessagno, 1967	137-12, 137-13, 137-14, 137-15 143A-1, 144-5
EARLY CRETACEOUS	Albian	*Rotalipora ticinensis ticinensis* Zone	Bolli, 1957a	137-16, 137-SW1
	Aptian	(Undifferentiated)		136-8, 144-6, 144-7, 144-8

occasions where efforts were made not to miss important geophysical horizons or the acoustic basement, good sequences of continuous or nearly continuous cores were recovered (Sites 136, 137, 141). In Site 137 (Cores 7 to 16, SW. Core 1), we found a series of excellently preserved Globotruncanidae through the Cenomanian-Late Albian, and from Site 141 (Cores 1 to 7) we have an equally good record of the Pleistocene and Pliocene in calcareous planktonic facies. The wide average core spacing of about 100 meters in some sites (135, 138, 139) makes it difficult to summarize the geological history of the area but nevertheless a few general trends appear to be indicated by the available data:

a. Moderately calcareous faunas, sometimes with a conspicuous benthonic element, are found in late Early Cretaceous time (example: Site 136, Core 8).
b. Rich planktonic faunas in the Cenomanian (Site 137) are followed by impoverished (partially dissolved?) planktonic faunas of the Turonian and lower Senonian (Sites 136, 137).
c. From the latest Cretaceous through the Paleocene-Eocene-Oligocene, we have essentially noncalcareous (deep-sea?) clay deposition (Sites 138, 140) or even nondeposition (Site 136).
d. In the Miocene, calcareous faunas reappear at some sites (at least Sites 135, 136, 139, 140). Usually, the plankton is partially dissolved. Displaced faunas derived from shallower water are found at Sites 139 and 140.
e. In the Pliocene and Quaternary, planktonic foraminifera are in most cases common and fairly well preserved, similar to those of the present day.

On the whole, the sequence of events is comparable to that inferred by Cita (1970) for the North Atlantic sites of Leg 2. In general, the faunas of Leg 14 appear to reflect a distinctly deeper water environment than the contemporaneous faunas known from the West African coast (Reyre, 1966). There are a few intervals, however, where the onshore and offshore faunas seem to have much in common (see Lehmann, 1966, for the Cretaceous; Colom, 1965, for the Miocene *Globorotalia fohsi robusta* Zone). The Eastern Atlantic along the African coast should certainly be an excellent area for studying the effects of climatic changes on the microfaunas, particularly during the Pliocene and Pleistocene. The available samples are too scattered to obtain a reliable pattern. Still, the Leg 14 cores seem to confirm that *Globorotalia miozea* (Site 135 only) is typical of temperate waters. The more tropical species *Globorotalia exilis* and *G. miocenica* were found only as far north as Site 139. The northward extension of *Globorotalia multicamerata* and *Sphaeroidinella dehiscens* goes as far as Site 140. *Pulleniatina* is confined to Site 141.

Western Atlantic Sites (142 to 144)

For the biostratigrapher, Site 142 (Quaternary to Miocene) and the combined Sites 143-144 (Oligocene to Cretaceous) turned out to be a most rewarding source of data. The microfaunas of Site 142 are the reflection of a highly complex sedimentary history (see Table 9). The influx of terrestrial and near-shore material in the early Quaternary, the common redeposited shallow-water fossils in the Pliocene-Late Miocene, and the frequent association of strongly etched and perfectly preserved planktonic foraminifera indicate intensive mixing of material from different sources. Most of these irregularities can be explained by the location of this site off the Amazon Delta and near a submarine ridge (Ceará Rise). In addition, the occurrence of Bryozoans and of many calcareous algal fragments suggests the presence of reef flats or islands at certain times.

After abandonment of the unsuccessful Site 143, extensive coring was carried out at Site 144 from the Oligocene to the Middle Eocene and again from the Paleocene to the Aptian/Albian. Although the section is calcareous and predominantly pelagic, several distinct unconformities were penetrated (Eocene/Oligocene and Cretaceous/Tertiary boundaries). The stratigraphic section and the sequence of microfaunas are similar to those of the Eastern Venezuela basin (Jenks, 1956; Lexico Estratigrafico de Venezuela, 1970; Metz, 1968) and of South Trinidad (Kugler and Bolli, 1967).

Preservation of the Microfaunas and Calcium Carbonate Solution

The preservation of the microfaunas of Leg 14 varies from excellent to very poor. The best preserved faunas are found not only in Quaternary but also in some relatively old sediments (Cenomanian pelagic marls of Site 137; benthonic faunas in the Aptian/Albian of Sites 136 and 144). Excellent preservation is also a characteristic of some displaced microfossils; these were most probably transported in suspension and rapidly buried, and thus escaped both abrasion and solution. Typical examples can be seen in Site 135 (Core 7), Site 140 (Cores A-1 and 2), and Site 142 (Cores 1-3, 5, 6).

The most universal factor which influences the preservation of the calcareous microfossils is certainly the solution of calcite in the deep sea. On Tables 2 to 11, the visible solution effects are recorded for each sample in qualitative terms (very strong, strong, moderate, weak). A more quantitative approach (see, for instance, the solution index in Berger and Parker, 1970) would certainly be desirable, but criteria other than faunal diversity should probably be sought as a measure of solution in fossil material.

A complete sequence of gradual destruction of calcareous shells through progressive solution can be seen in the Pliocene of Site 141 (Cores 4 to 7, particularly). An almost identical process has already been observed in the nearby DSDP Site 12 (Leg 2); it is described in detail by Cita (in press). There can be no doubt that a similar process also acted on older faunas. In the Cenomanian of Site 137, there are a few almost noncalcareous levels interbedded with marls containing perfectly preserved pelagic foraminifera. Yet it is apparently unusual in pre-Neogene sediments to see such good sequences of progressive etching and breaking up of shells as in Site 141. The writer has observed similar differences in the solution pattern between the Paleogene and Neogene faunas of the Central Pacific (DSDP Leg 8).

Very poorly preserved shells of foraminifera and radiolarians (mostly internal casts) are typical of some Upper Cretaceous rocks, particularly at Site 136. In this

this case, factors other than great water depth may be responsible, since the samples are rich in volcanogenic components.

Displaced Faunas

Microfossil assemblages which appear to be partially or even totally allochthonous are fairly common at some of the Leg 14 sites. For descriptions of the lithology and fossil content of such heterogeneous intervals, the reader is referred to the Site Reports of Sites 135, 139, 140 and 142, and also to Tables 2, 6, 7 and 9 in this chapter. Plant fragments and abundant quartz sand are often associated with the displaced microfaunas. In some cases, such faunas may be found interbedded in a noncalcareous red clay sequence (Site 135, Core 7, Center Bit sample). More commonly, however, the allochthonous character is indicated by the coexistence of two or more preservations or colors in one sample, or by the presence of typical shallow water fossils. A typical case is Core 5 of Site 142 with its association of strongly etched planktonic foraminifera (presumably the only autochthonous component) with perfectly preserved, thin-walled globigerinids, calcareous algae, bryozoans and plant remains. Examples of redeposited shallow-water fossils are the Upper Cretaceous orbitoids of Site 135, or the barnacle plates and associated benthonic foraminifera (*Ammonia, Pararotalia, Amphistegina*) in the Miocene of Site 140. Displaced planktonic assemblages are usually recognized by their perfect preservation (Site 142, Cores 1-3, 5, 6) or the predominance of one size grade (Site 135, Core 7).

A combined sedimentological and micropaleontological study of these heterogeneous rocks by members of the shipboard party is planned for later publication.

Samples of *Vema* Piston Cores Located Near Leg 14 Sites

Samples from the following *Vema* piston core stations were also made available for study:
V-27-162 (near Site 136)
V-27-167 (between Sites 137 and 138)
V-23-98 (near Site 139)
V-23-99 (near Site 140)
V-26-41 (near Site 141)
V-24-258, V-25-49, V-25-62, V-25-63, V-25-64 (all near Site 142)
V-25-73, V-25-74, V-25-75, V-25-76, V-25-77 (all near Sites 143, 144)

These samples are a most valuable addition to the Leg 14 cores, since coring operations from the *Challenger* normally started some distance below the sea floor. They made it possible to compare the fossil faunas recovered by the *Glomar Challenger* with recent to Late Pleistocene faunas deposited in the same area and at a similar water depth. All available piston core samples (except V-25-62) are of Quaternary age. In most cases the composition and preservation of their faunas are as expected at their respective locations, but there are a few interesting exceptions:

a. V-27-167, collected in the area between Sites 137 and 138 at a water depth of 5099 meters, contains a fairly rich calcareous planktonic assemblage at the sea floor (sample at 2 to 4 centimeters), and in some deeper zones as well (280, 292.5, and 300 centimeters). The foraminiferal shells in the sea-floor sample, and particularly in the foraminiferal marl at 292.5 centimeters, are much better preserved than one would expect at such a water depth. In the remaining two samples (280 and 300 centimeters) solution effects are much stronger. The fauna at 292.5 centimeters may well be redeposited (the core description mentions some slight grading). The highest cores of Sites 137 and 138 are practically noncalcareous, but a few planktonic foraminifera derived from the Quaternary were found as contamination in Core 1 of Site 138.
b. V-23-99, near Site 140, contains abundant pelecypod shells at 77 to 79 centimeters. These are mostly etched or abraded, but at the same time are associated with abundant well-preserved planktonic foraminifera. Similar mixed assemblages were found in the Miocene of the nearby Site 140.
c. The cores recovered from the abyssal plain near Site 141 (V-24-258, V-25-49, V-25-64) are remarkably different from the Pleistocene cores of Site 142. The latter contain quartz sand, plant fragments, and some shallow water fossils, whereas the piston core samples are practically free of terrigeneous detritus.

The faunas of Piston Core V-25-62, located near the crest of the Ceara Rise, are of Miocene age (*Globorotalia fohsi peripheroacuta* Zone near the top, *Praeorbulina glomerosa* Zone near the bottom at 340 to 343 centimeters).

SPECIES REFERENCE LIST

The majority of the species mentioned in this report are well known in the recent literature. For descriptions, illustrations and synonymies, the reader is referred to the following papers and monographs:

Planktonic foraminifera:	Blow (1969)
	Bolli (1957b, c, d; 1959)
	Pessagno (1967)
Benthonic foraminifera:	Beckmann (1954)
	Frizzell (1954)
	Simon *et al.* (1962)

References to the species not included in these six publications are given below, together with some additional comments.

Planktonic Species

Chiloguembelina cubensis (Palmer).
Gümbelina cubensis Palmer, 1934, Mem. Soc. Cubana Hist. Nat., Vol. 8, p. 74, textfigs. 1 -6.

Chiloguembelina martini (Pijpers).
Textularia martini Pijpers, 1933, Geogr. Geol. Med., Univ. Utrecht, Phys. Geol. Reeks, no. 8, p. 57, figs. 6-10.

Globigerinelloides breggiensis (Gandolfi).
Anomalina breggiensis Gandolfi, 1942, Riv. Ital. Paleontol. Strat., mem. 4, p. 102, textfig. 34 (1-4); pl. 3, fig. 6; pl. 5, fig. 3; pl. 9, fig. 1; pl. 13, figs. 7, 8. Holotype refigured by Caron and Luterbacher (1969).

Globorotalia crassaformis A.
Globorotalia crassaformis A, Bolli, 1970, DSDP Initial Reports, vol. IV, p. 580, pl. 4, figs. 17-20. This is probably a good marker for the base Pleistocene- top Pliocene.

Globorotalia crassata (Cushman).
Pulvinulina crassata Cushman, 1925, Bull. Am. Assoc. Petrol. Geol., vol. 9, p. 300, pl. 7, fig. 4. Lectotype designated by Bandy, 1964, Contrib. Cushman Foun. Foram. Res. vol. 15, p. 34.

Globorotalia margaritae Bolli and Bermudez.
A small and large variety have been distinguished in the present report. The former appears to be characteristic of the lower part of the *G. margaritae* Zone, the latter is confined to the upper part (see also Bolli, 1970, p. 581). A taxonomic revision and biostratigraphic reevaluation of this species is now under way (H. M. Bolli, M. B. Cita; personal communication) and may lead to a more refined subdivision of the Early Pliocene.

Globorotalia pertenuis Beard.
G. pertenuis Beard, 1969, Trans. Gulf Coast Assoc. Geol. Soc., vol. 19, p. 552, pl. 1. figs. 1-6; pl. 2, figs. 5, 6; pl. 3, fig. 4. This species may correspond to the informal category *G. exilis* A of Bolli (1970). It differs from *G. exilis* Blow in having more chambers, which are also more radially elongated, in the final whorl.

Globorotalia pomeroli Tourmarkine and Bolli.
G. cerroazulensis pomeroli Tourmarkine and Bolli, 1970, Rev. Micropaleontol., vol. 13, p. 140, pl. 1, figs. 10-18.

Globorotalia pseudomiocenica Bolli and Bermudez.
G. pseudomiocenica Bolli and Bermudez 1965, p. 140, pl. 1, figs. 13-15.

Globorotalia cf. *tosaensis* Takayanagi and Saito.
The distribution of this species in the Atlantic Ocean is much more erratic than in the Pacific. Also it appears to be rather rare and is certainly not a good species for defining a zone. There are a few specimens in Site 141 which resemble the figures given by Bolli (1970; pl. 3, figs. 16-21).

Globorotalia cf. *tumida/plesiotumida.*
Here are included specimens which are usually slightly smaller and more delicately built than *G. tumida.* Normally, they are found together with *G. margaritae.* Some of the specimens are very close to the holotype of *G. plesiotumida* Blow, but the variability and distribution of this species are not adequately known.

Globorotalia wilsoni (Cole).
Globigerina wilsoni Cole, 1927, Bull. Am. Paleontol., vol. 14, no. 51, p. 34, pl. 4, figs. 8, 9.

Globotruncana caliciformis Vogler.
G. linnei d'Orbigny *calciformis* Vogler, 1941, Palaeontogr., Suppl. Bd, 4, Abt. 4, p. 288, pl. 24, fig. 23.

Globotruncana tricarinata (Quereau).
Pulvinulina tricarinata Quereau, 1893, Beitr. Geol. Karte Schweiz, N.F. 33, p. 89, pl. 5, fig. 3.

Globotruncana ventricosa primitiva Dalbiez.
G. (Globotruncana) ventricosa primitiva Dalbiez, 1955, Micropaleontol., vol. 1, p. 171, textfig. 6.

Hantkenina longispina Cushman.
H. longispina Cushman, 1924, Proc. U.S. Nat. Museum, vol. 66, Art. 30, p. 2, pl. 2, fig. 4.

Hedbergella trocoidea (Gandolfi).
Anomalina lorneiana (d'Orbigny) var. *trocoidea* Gandolfi, 1942, Riv. Ital. Paleontol., Strat., mem. 4, p. 99, pl. 2, fig. 2; pl. 4, figs. 2, 3; pl. 13, figs. 2, 5. Lectotype described and figured by Caron and Luterbacher (1969).

Heterohelix cf. *frizzelli* (Kavary).
"Pseudogumbelina" frizelli Kavary, 1963, Bull. Univ. Missouri School Mines etc., Tech. Ser., no. 102, p. 66, pl. 13, figs. 19, 20. This name refers here to short specimens which consist essentially of two relatively large chambers with only a very small, more or less pointed initial stage. Kavary's description does not go into much detail and seems to overlap with that of another new species, *Pseudotextularia (?) reissi.*

Rotalipora balernaensis Gandolfi.
R. appenninica balernaensis Gandolfi, 1957, Contr. Cushman Found. Foram. Res., vol. 8, p. 60, pl. 8, fig. 3.

Rotalipora brotzeni (Sigal).
Thalmanninella brotzeni Sigal, 1948, Rev. Inst. Fr. Pe'tr., vol. 3, p. 101, pl. 1, fig. 5; pl. 2, figs. 6, 7.

Rotalipora reicheli (Mornod).
Globotruncana (Rotalipora) reicheli Mornod, 1950, Ecology. Geol. Helv., vol. 42, p. 583, textfig. 5 (4), textfig. 6 (1-6); pl. 25, figs. 3, 4.

Rotalipora ticinensis (Gandolfi).
Globotruncana ticinensis Gandolfi, 1942, Riv. Ital. Paleontol. Strat., mem. 4, p. 113, textfig. 39; pl. 2, fig. 3; pl. 4, figs. 10, 11, 23; pl. 5, figs. 2, 4; pl. 8, figs. 4-7; pl. 12, fig. 1; pl. 13, figs. 11, 12, 14. Holotype redrawn by Caron and Luterbacher (1969).

Ticinella raynaudi digitalis Sigal.
T. raynaudi var. *digitalis* Sigal, 1966, Ecolog. Geol. Helv., vol. 59, p. 202, pl. 6, figs. 6-8.

Benthonic Species

Ammonia beccarii (Linné) s.l.
Nautilus beccarii Linné, 1758, Syst. Nat., ed. 10, p. 710. See also Loeblich and Tappan (1964, p. 607).

Amphistegina cubensis Palmer.
A. cubensis Palmer, 1934, Mem. Soc. Cubana Hist. Nat., vol. 8, p. 256, pl. 15, fig. 2; textfigs. 16, 17.

Aragonia velascoensis (Cushman).
Textularia velascoensis Cushman, 1925, Contr. Cushman Lab. Foram. Res., vol. 1, p. 18, pl. 3, fig. 1.

Bandyella greatvalleyensis (Trujillo).
Pleurostomella greatvalleyensis Trujillo, 1960, J. Paleontol., vol. 34, p. 345, pl. 50, figs. 5, 6.

Bolivinoides delicatulus Cushman.
B. decorata (Jones) var. *delicatula* Cushman, 1927, Contr. Cushman Lab. Foram. Res., vol. 2, p. 90, pl. 12, fig. 8.

Bulimina arkadelphiana Cushman and Parker.
B. arkadelphiana Cushman and Parker, 1935, Contr. Cushman Lab. Foram. Res., vol. 11, p. 96, pl. 15, figs. 1, 2.

Clavulina arenata Cushman.
C. arenata Cushman, 1933, Contr. Cushman Lab. Foram. Res., vol. 9, p. 54, pl. 6, fig. 5.

Clavulina gaultina Morozova.
C. gaultina Morozova, 1948, Bull. Soc. Nat. Moscow, N.S. 53, Sect. Geol., 23, p. 36, pl. 1, fig. 4. Reference in Noth (1951).

Elphidium macellum (Fichtel and Moll).
Nautilus macellus Fichtel and Moll, 1798, Test. Micr., p. 66, pl. 10, figs. e-k.

Gavelinella schloenbachi (Reuss).
Rotalia schloenbachi Reuss, 1863, Sitzber. K. Akad. Wiss. Wien, Math. Naturw. Cl., vol. 46, pl. 84, pl. 10, fig. 5.

Glomospira gordialis (Jones and Parker).
Trochammina squamata Jones and Parker var. *gordialis* Jones and Parker, 1860, Quart. J. Geol. Soc. London, vol. 16, p. 304. Parker and Jones, 1865, Phil. Trans., vol. 155, p. 408, pl. 15, fig. 32.

Gyroidina tenera (Brady).
Truncatulina tenera Brady, 1884, Rept. Voy. Challenger, Zool., vol. 9, p. 665, pl. 95, fig. 11.

Haplophragmoides foliaceus (Brady).
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TABLE 2
Site 135. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 135
35° 20.80′ N, 10° 25.46′ W
Water depth: 4152 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Larger foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera, > 80 mesh	Solution effects	*Globigerina nepenthes*	*G. cip. angustiumbilicata*	*G. venezuelana*
G. truncatulinoides	Quaternary	0	1-1	5-7	▲	·		·	·					·			1000	100	·			
			1-1	87-89	■	·			·								1000	100	·			
			1-2	117-119	▲	·			·								100	100	·			
			1-3	120-122	▲	·		·									100	99	●			
		4	1 CC		■	·		·	·								200	99	·			
G. margaritae	Early Pliocene	80	2-1	120-122	▲	·		·						·			100	99	●			
			2-2	120-122	▲	·		·	·								200	99	●			
			2-3	120-122	▲	·		·									200	99	·			
			2-4	120-122	▲	·		·	·								200	99	●			
			2-5	120-122	▲	·											50	100	●			
?			2-6	120-122	▲	·		·									100	99	·			
	Late Miocene	89	2 CC		■	·		·									200	100	●			
G. acostaensis		173	3-1	120-122	●	●		·									2	99	▲	·		
			3-2	120-122	●	·				·							10	98	▲	·		
		182	3 CC		▲	·		·	·					·			50	99	●	·		
G. fohsi peripheroronda	Middle Miocene	259	4-1	140-142	·	·		·	·					·			½	80	▲			
			4-2	120-122	●	·			·								10	95	▲			
		268	4 CC		▲	·			●								50	95	▲			
	Early Miocene or Oligocene?	315	SW. 1		●	●								●			(1)	?	(·)			·
		325	SW. 2		●	●			·					·			(1)	95?	(●)		?	·
	?Eocene	335	5-1	70-72														0				
		341	5 CC				·											?				
	?	341	6 CC											?				0				
		350																				
	Maestrichtian? (?Eocene)	431	7-2	120-122	▲	·	(·)	·	·							●	10	99	●			
			7-3	40-42	▲	·										·	100	?	·			
			7-4	37-39										·		●		0				
		435	7 CC		●	·									·	■	10	100	●			
	?	564	8-1	90-92							·			·				0				
		569	8-1	137-139							·			·				0				
		685	9-1	120-122											●			0				
			9-2	32-34		?										●		0?				
		689	9-2	120-122											●			0				
	?Eocene ?Maestrichtian	?	center bit	(below core 9)			●											?				

											Globoquadrina dehiscens
											Globorotalia acostaensis
											G. archaeomenardii
											G. crassaformis s.s.
											G. crassaformis ronda
											G. cultrata s.l.
											G. fohsi peripheroronda
											G. fohsi peripheroacuta
											G. inflata
											G. margaritae (small)
											G. mayeri
											G. miozea
											G. opima nana
											G. truncatulinoides
											G. cf. *tumida/plesiotumida*
											Globigerinoides obl. extremus
											G. obl. obliquus
											G. ruber
											Catapsydrax dissimilis
											Sphaeroidinellopsis seminulina
											Globotruncana aegyptiaca
											G. arca
											G. contusa
											G. stuarti
											G. stuartiformis
											Heterohelix ultimatumida
											Pseudoguembelina excolata
											P. striata
											Racemiguembelina fructicosa
											Amphistegina cf. *cubensis*
											Gyroidina florealis
											Lepidorbitoides sp.
											Neoflabellina sp. aff. *numismalis*
											Operculina sp.
											Orbitoides spp.
											Siderolites sp.
											Nummulites sp.
c,r?			r? p r?			c c	n		p p		Remarks[a]

[a] c: strong downhole contamination, n: foraminifera not determined, p: foraminifera partially determined, r: reworking.
Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few (moderate) · very scarce (weak)

TABLE 3A
Site 136, Cores 1 to 5. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 136
34° 10.13′ N, 16° 18.19′ W
Water depth: 4169 m

Zone or Subzone	Age	Depth Below Sea Level (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera, > 80 mesh fraction	Solution effects	*Globigerina nepenthes*	*G. venezuelana*	*Globoquadrina altispira*	*G. dehiscens*	*Globigerinoides obliquus* s.l.	*G. ruber*	*Globorotalia acostaensis*	*G. crassaformis*	*G. cultrata* s.l.	*G. f. peripheroronda*	*G. hirsuta*	*G. inflata*	*G. margaritae* (small)	*G. opima nana*	*G. truncatulinoides*	*Sphaeroidinellopsis seminulina*	*S. paenedehiscens*	*Catapsydrax dissimilis*	*Bathysiphon* sp.	*Cibicides* sp.	*Eponides umbonatus*	*Gyroidina* sp.	*Melonis* sp.	*Stilostomella nuttalli*	*Vulvulina* sp.	Remarks[a]
Gr. trunc.	Quat.		bit		▲	·	·	·								1000	99	·						●		●		●	·			●										
G. margaritae	Early Pliocene	130	1-1	120-122	●	·	·									100	99	▲	●															●	·								
			1-2	120-122	●	·		·								100	99	●	●				·											●	·								
			1-3	120-122	●	·										100	99	●	●												·			●	●								
			1-4	120-122	●	·		·								100	99	●	·				·		·						·			·	·								
			1-5	120-122	●	●	·					·				10	95	●	·		·													·	·								
			1-6	95-97	●	·	·	·	·							100	98	●	·						·									·									
		139	1 CC		●	·		·	·			·				100	99	●	●		·		·											●	·								
G. fohsi peripheroronda ?	Mid-Miocene (trans. Early Miocene)	216	2-1	120-122	●	·		●				·				10	90	●		·	·	●						·					·						·			
			2-2	120-122	●	●		·				·				2	95	●		·		·											·						·	·	·	
			2-3	bottom	●	●		·				·				2	95	●		·		·						·					·								·	
			2-5	120-122	·	●										1/2	100	▲				●						·					·					·	·	·		
			2-6	120-122	·	●		·				·				1/3	90	▲				●						·										·		·		
		225	2 CC		·	●						·				1/4	95	▲				·						·					·					·	·	·	·	
	Early Miocene ?	235	3-2	120-122	·	●						●				1/100	90	▲		·								·								?				·		
			3-3	120-122	·	●						●				1/500	90	▲														·							·		
			3-4	92-94	·	●						●				1/500	80	▲																					·	·	
		244	3 CC		·							▲				0	(20)	▲																					·		c
	·?	244	4-1	86-88		?						●		●			(0)																									
			4-2	88-90								▲		●			0																									
			4-3	110-112		·						▲				0	10	▲																									
		253	4 CC									●		·			0																									
	Late Cretaceous	253	5-1	37-39		·						·				0	(2)	(●)																									
			5-1	75-77		} on Table 3B																																					
			5-5	50-52																																					
		262	5 CC																																						

[a] c: strong downhole contamination

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 3B
Site 136, Cores 5 to 8. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 136
34° 10.13′ N, 16° 18.19′ W
Water depth: 4169 m

Zone or Subzone	Age	Depth Below Sea Level (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera, > 80 mesh fraction	Solution effects	*Globigerinelloides tururensis*	*Globotruncana canaliculata*	*G. cf. fornicata*	*G. indica*	*G. linneiana*	*G. pseudolinneiana*	*G. renzi*	*Hedbergella amabilis*	*H. cf. bosquensis*	*H. planispira*	*Heterohelix globulosa*	*H. pulchra*	*Ammodiscus gaultinus*	*Bandyella greatvalleyensis*	*Bathysiphon* sp.	*Dorothia* cf. *gradata*	*Gavelinella intermedia*	*G.* cf. *schloenbachi*	*Haplophragmoides* sp.	*Lenticulina dubiensis*	*L. saxocretacea*	*L. secans*	*L. subangulata*	*Lingulina loryi*	*Marssonella* cf. *kummi*	*Pseudonodosaria manifesta*	*Stensioeina* cf. *exsculpta gracilis*	Remarks[a]
	?	253	5-1	37-39	(See preceding chart)																																							
	Coniacian – Santonian ?		5-1	75-77		•				?			•			0	(2)	?																											
			5-5	50-52	•	•				•							(5)	(10)	▲			•			?																				
		262	5 CC		●	•				●						10	(20)	●		•	•				•							•												•		
M. renzi ?		262	6-1	60-62		•							•			0	(10)	?														•						•							
			6-1	120-122						?			•			0																													
			6-2	90-92	•					●						(∞)	20	•			•	•	?	•	?	•																			
			6-2	128-130	•					●						(∞)	10	(▲)																												
		271	6 CC		•	•				●						10	20	●		•					•	•	•	•		•															
	Turonian to Santonian ?	271	7-1	139-141									?				0																												
			7-4	144-146						●							0																												
		280	7 CC		•					●			•			(∞)	20	▲									•		•																
		280	8-1	8-10	•					●						(∞)	20	●		?						?																			
			8-1	109-111	•					●						(∞)	20	●									•		•	•																
			8-2	118-120						●			•				0																												
	Albian ?		8-2	144-146	●	•		•					•	●		50	10		•								•	?									•							
			8-5	42-44	●	•			•				•	?		10	20		•							•		•												•				
			8-6	116-118	▲	●			•	●			•			50	50		•							•		●		•				•	•								
		289	8 CC		●	•				•					●	50	5		●									●																	c

[a] c: strong downhole contamination.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce, (weak)

TABLE 4A
Site 137, Cores 1 to 7. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 137
25° 55.53′ N, 27° 03.64′ W
Water depth: 5361 m

Zone or Subzone	Age	Depth Below Sea Level (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Bethonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Planktonic/benthonic ratio	% foraminifera, in >80 mesh fraction	Solution effects	*Globigerinelloides caseyi*	*Globotruncana* cf. *difformis*	*G.* cf. *imbricata*	*G.* cf. *sigali*	*Hedbergella amabilis*	*H. planispira*	*Heterohelix moremani*	*H.* cf. *pulchra*	*Ammoglobigerina* sp.	*Bathysiphon* sp.	*Cyclammina* cf. *deformis*	*Glomospira charoides*	*Haplophragmoides* sp.	*Lituotuba lituiformis*	*Marssonella oxycona*	*Pelosina* sp.	*Pseudotextulariella* ? sp.	*Reophax* sp.	*Textularia* sp.	*Trochamminoides coronatus*	Remarks
	?	52	1-1	118-120		•							•		0	(10)	(■)										?	•									
			1-3	120-120		?							●			?	?														?						
			1-5	120-122									●			0																					
		61	1 CC										●			0																					
		99	2-1	134-136									•			0																					
		101	2 CC										•			0																					
		135	3-1	122-124		●									0	100	▲									•	●	•		•		•			•		
			3-2	120-122		●							●		0	90	▲									•	•	•	•			•			•		
			3-3	120-122		●							●		0	90	■										•		•	•		•			•		
			3-4	120-122		●							•		0	90	■									•		•	•	•							
			3-5	120-122		•							•		0	?	▲									•		•	•				•				
			3-6	139-141		•							●		0	80	■											•	•								
		144	3 CC			●							●		0	90	▲										•		•	•						•	
		165	4-1	120-122		•				●					0												•				•					
			4-2	120-122						▲																											
		173	4 CC			•				•					0	(100)	(▲)										•					•				
		209	5 CC			•				▲					0	5	?																	•		
		218																																			
		218	6-1	22-24		?				●						(5)	?																			
			6-1	119-121						●						0																				
	Turonian to Campanian	225	6 CC			•	•			●					?	5	(●)			•					•				?	?				•	•	
M. sigali ?		256	7-1	83-85	●					•						(100)	?	●	•	•	•	•	●	•	•												
			7-1	143-144		•				▲					0	5	?																				
	?	265	7 CC			•	●			▲					1/50	30	?					?	•								•		•			

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce, (weak)

TABLE 4B
Site 137, Cores 8-12. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 137
25° 55.53′ N, 27° 03.64′ W
Water depth: 5361 m

Zone or Subzone	Age	Depth Below Sea Level (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid remains	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Quartz sand	Planktonic/benthonic ratio	% foraminifera, in >80 mesh fraction	Solution effects	*Globigerinelloides caseyi*	*G. bentonensis*	*Hedbergella amabilis*	*H. brittonensis*	*H. gautierensis*	*H. planispira*	*Heterohelix moremani*	*Planomalina buxtorfi*	*Praeglobotruncana stephani*	*P. delrioensis*	*Rotalipora appenninica*	*R. balernaensis*	*R. brotzeni*	*R. cushmani*	*R. evoluta*	*R. greenhornensis*	*R. reicheli*	*Schackoina cenomana*	*Clavulina gaultina*	*Gavelinella* cf. *schloenbachi*	*Osangularia* sp.	*Pseudotextulariella?* sp.	*Spiroplectammina anceps*	Remarks
Rotalipora cushmani - greenhornensis	Late Cenomanian	265	8-1	19-21						●						0																								
			8-1	44-46	▲							·			8	95		·		·	●	●	·	●			●	·			·		●								
			8-2	31-33	●	●						·			1	(95)	(●)				·	·					·														
			8-2	102-104	▲	·				·		·			100	98					·	●	●	·			●	·			·		●			·					
		274	8 CC		●					●		●			8	80					·		·	·			·	·			·		·								
		274	9-1	27-29	·	●						●			1/100	50	·																?								
			9-1	36-38	·	·						▲			1/5	25	●					·																				
			9-3	120-122		·				·		▲			0	60	●																								
			9-5	120-122	▲	·		·				·			100	95		·		·		·	●				●	●	·		·					·		·			
			9-6	120-122	·	·						●			1/2	95											·														
		283	9 CC		▲	·		·				·			50	100		●	·	●			·	·	●	·	●	●	·	·	·		?	·	●	?	·	●	·		
		283	10-1	107-109	●	·						●			5	80		·					●					·							·						
			10-1	122-124	●	●						●			2	80	·																								
			10-2	42-44	▲	·						·			1000	99		●		●			●	·											·						
			10-2	120-122	●	·						●			5	80							·																		
			10-3	124-126	▲	·		·				·			1000	100	·	●		·		·	●		·		●	●		·						·		·	·		
		292	10 CC		▲	·						·			100	100						·			·		●	●		·	·						·	·		
		292	11-1	116-118	▲	·				·					500	100		●		●		·	·	·	·		●	●	·	·	·				·				·		
			11-2	121-123	●	·						●			50	90		·					●	·			·														
			11-3	120-122		·				●		●			0	30																				·		·	·		
			11-4	119-121	▲	·									200	100		·				●	●		·	·	●	●	·					?					·		
			11-5	119-121	▲	·						·			200	100		·	?	·		●	●		●		●	●	·	·	·	?			·	·	?	·	·		
			11-6	120-122	▲	·									500	100		·				●	●	·			●	●										·			
		301	11 CC		▲	·									200	100		●		·		●	●	·	·		●	·		·		·			·	·					
		301	12-1	95-97	▲	·	·	·							200	99		·		●		●	·	·	·		●	●		·	·			·	·	·	·	·	·		
R. evoluta	Early Cenomanian		12-1	122-124	▲	·						·			100	100	·	·		·		·	·				·							·	·	·			·		
			12-2	11-13	▲	·									1000	100	·	·		·		·	●	·			●	·						·	·						
			12-2	50-52	●	·						●			20	80		·					·	·								·									
			12-3	86-88	▲	·						·			500	100		·		·		●	·	·			●	●				·			·						
			12-4	90-92	▲	●									100	100	·	·		●			·				●	●				·			·	·	·	·	·		
			12-5	10-12	▲	·				·		·			200	90		·		●		·	·				·	·				·						·			
			12-5	120-122	●	·						·			5	90	·			·		·	·					·	●									·	·		
			12-6	9-11	▲	·									100	100							●					·													
		310	12 CC		●	·				●					(100)	10	·											·				·									

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 4C

Site 137, Cores 13 to 16, SW. Core 1. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera.

DSDP Site 137

25° 55.53′ N, 27° 03.64′ W
Water depth: 5361 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera, in >80 mesh fraction	Solution effects	*Globigerinelloides caseyi*	*G. breggiensis*	*Hedbergella amabilis*	*H. gautierensis*	*H. planispira*	*H. trocoidea*	*Planomalina buxtorfi*	*Praeglobotruncana bronnimanni*	*P. delrioensis*	*Rotalipora appenninica*	*R. brotzeni*	*R. evoluta*	*R. ticinensis*	*Schackoina cenomana*	*Ticinella raynaudi digitalis*	*Clavulina gaultina*	*Gavelinella* cf. *schloenbachi*	*Osangularia* sp.	*Pleurostomella subnodosa*	*Pseudotextulariella?* sp.	*Spiroplectammina anceps*	*Tritaxia tricarinata*	Remarks
Rotalipora evoluta	Early Cenomanian	320	13-1	128-130	●	•							•			200	100				•	●	●				•	•	•	•				•	•					
			13-2	8-10	▲	•							•			100	100					•	●					•		•										
			13-2	85-87	▲				•							8	95				●	•	●					•		•		•								
			13-3	120-122	●	•		•								20	98						●					•		•				•	•	•				
			13-4	104-106	▲	•		•								100	99		•		•		●					•	•	•		•		•		•		•		
		329	13 CC		▲	•		•	●							200	90				●	•	●					•		•		•								
		339	14-1	101-103	•	•				▲						1/5	5																							
			14-1	122-124	●	•				•						200	100				•		●																	
			14-2	120-122	▲	•				•						500	98		●		●		●		•			•		●										
			14-3	18-20	●	●				●			●			50	90		•															•				•		
			14-3	110-112	●	•							•			200	100		•		•	•	•					•	•											
			14-4	141-143	•					■						8	0																							
			14-5	120-122	▲	•				•						500	100				•	•	•								●									
			14-6	88-90	▲	•		•		•						200	95				●	•	●							•	•							•		
		348	14 CC		▲	•										500	100						●					•	•	•										
		348	15-1	114-116	▲	•										1000	100		●			•	●							•		●								
			15-1	122-124	●	•										100	100		•						•					•										
			15-2	37-39	●	•							•			20	90						•		•														
			15-2	119-121	●	•							•			10	90		•																				
		357	15 CC		▲	•										100	100		●		●		●					●	•	●							●			
		375	16-1	118-120		•				▲			•			0	5																							
			16-2	26-28	•	●				●			•			1/2	30		•									?		?										
			16-2	120-122	•	●							•			1/2	90						•															•	
			16-3	15-17	•	●				●			●			1/5	(50)		•																				•	
R. ticinensis	Vraconian		16-3	125-127	▲	•				•						200	100		•		●		•		●					•										
			16-4	120-122	▲	•			•	•			•			1000	99			•			●	•	●					●										
		382	16 CC		▲	•		•		•			•			50	99		•		●		●	●	●	•				•	•		●	•			•		•	•	
	Late Albian	393	SW. 1		▲	•	•			●						100	99			●				●							●			•	•	•	•	•			

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce (weak)

TABLE 5
Site 138. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 138
25° 55.37′ N, 25° 33.79′ W
Water depth: 5288 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in >80 mesh fraction	Solution effects	*Globigerina* sp.	*Globorotalia* cf. *acostaensis*	*G. truncatulinoides*	*Pulleniatina* sp.	*Ammodiscus* sp.	*Bathysiphon* sp.	*Psammosphaera* sp.	*Reophax* sp.	*Lituotuba* sp.	Remarks
		52	1-1	120-122		?							·		·		?							?				
			1-2	120-122									·		●		0											
			1-3	75-77	(·)								·		▲		?			(·)								
			1-3	120-122	(·)								·		▲		?				(·)	(·)						
			1-4	120-122		(·)			?				·		▲		?							?				
			1-5	120-122									·		▲		0											
	?		1-6	120-122	(·)					·			·		▲		?		(·)									
		61	1 CC							●					▲		0											
		110	2-1	119-121						●			●		▲		0											
			2-2	120-122						▲	·						0											
			2-3	120-122						▲	●		·				0											
			2-4	120-122						▲	·		·				0											
			2-5	120-122						●	■	?					0											
			2-6	120-122						▲	●	·					0											
		119	2 CC							▲	●	·					0											
		183	3-1	122-124													0											
		190	3 CC														0											
	?	255	4-1	33-35						·							0											
		264	4 CC							●							0											
		332	5-1	118-120		·				▲						0	2	(■)					·					
		341	5 CC							▲							0											
		425	6-1	121-122		·				·			·			0	(20)	■						·	·	·	·	
			6-2	44-46		?				●				?			0							?		?		
			6-3	10-12		·				●			·	?		0	(5)	■						·			·	
		431	6-3	120-122		·				?						0	1	(■)						·				

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 6
Site 139. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 139
23° 31.14′ N, 18° 42.26′ W
Water depth: 3047 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Catapsydrax dissimilis*	*Globigerina venezuelana*	*Globigerinoides obliquus* s.l.	*G. primordius*	*G. ruber*	*G. subquadratus*	*G. trilobus* s.l.	*Globoquadrina altispira*	*G. dehiscens*	*G. praedehiscens*	*Hastigerina siphonifera*	*Sphaeroidinellopsis seminulina*	*Globorotalia acostaensis*	*G. crassaformis*	*G. crassula*	*G. cultrata*	*G. exilis*	*G. fohsi lobata*	*G. fohsi robusta*	*G. hirsuta*	*G. humerosa*	*G. margaritae* (large)	*G. mayeri*	*G. miocenica*	*G. praemenardii*	*G. tumida*	*Epistominella* sp.	*Gyroidina* spp.	*Nonionella* sp.	*Plectofrondicularia* sp.	*Uvigerina asperula*	*Uvigerina* spp.	Remarks[a]
G. exilis/ mioc.	Late Pliocene	114	1-1	120-122	■ ·					●	●					200	100	·					●		●				●			·	·	·	?		·	●			·									
			1-1	120-122	■ ·			·		●	●	·				100	99	·					●		●				·			·					·	·			·									
		123	1 CC		■ ●	·	·			●	●	·				50	98	·			·		●		●				·			·	·	·	·		●	·	?		●									
G. margaritae	Early Pliocene	225	2-1	120-122	■ ●			·								50	99	·		·	·				·	●					●			·								?				·				
			2-2	120-122	■ ●	·		·								100	99	·		·	·				·	·					·			·												·				
			2-3	120-122	▲ ●			·								20	98	·			·		·		●						●			·							●						●		
			2-4	120-122	▲ ·			·	·							100	99	·		·	·		·		●						●			·							·								
		234	2 CC		■ ●			●	·							50	98	·		·	·		·		●	·				·	●			·							·	?	·				·		
G. fohsi robusta	Middle Miocene	345	3 CC		▲ ●	·	·			●	●					20	98	·		·					·		·							·						●	·							
		354																																																
		455	4 CC		▲ ·		·			▲	▲	·	·			50	99	·		·					·	·											?	·			·		·						c?
		463																																															
	?	530	SW. 1		· ·		·			●	▲	·			▲	1/10	80	●							·																		·	·	·		·		
C. stainforthi or older	Early Miocene	570	5-1	136-138	(·)●					●	■					0?	50	●																									·		·		·		
		576	5 CC		· ●					●	■					1/100	80	·	·																								·	·	·	●		●		
		607	6-1	17-19	·										▲	0	?	?																														s
		612	6-1	30-32	·										▲	0	?	?																														s
		656	7-1	52-54						●	■				▲		0																																
			7-2	121-123						·	●				▲		0																																
			7-3	122-124						·					■		0																																
			7-4	128-130						·	●				■		0																																
			7-5	122-124						·	·				▲		0																																
			7-6	114-116	·					●	●		·		▲	0	50																																
			7-6	145-147	● ●	·				▲	▲	●	·		▲	1	25	●	●	·																									·	·				·	
		665	7 CC		● ●	·				▲	▲				▲	2	50	●	●	·		·		·		·		·																·		·		·	

[a] c: strong downhole contamination, s: thin section only.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce (weak)

TABLE 7
Site 140. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 140
21° 44.97′ N, 21° 47.52′ W
Water Depth: 4483 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Barnacle plates	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Catapsydrax dissimilis*	*Globigerina praebulloides*	*G. venezuelana*
G. exilis/ miocenica	Pliocene	89	1-1	53-55	▲	•	•	•						•			50	99	•			
			1-2	120-122	■	•											1000	100	•			
			1-4	116-118	■	•	•	•									1000	100	•			
			1-5	120-122	▲	•	•	•									100	99	•			
G. margaritae		98	1 CC		■	•	•	•									500	100	•			•
	?M – Late Miocene	150	A1-1	78-80	●	●	•	•	●	•							1/2	80	?		●	
		159	A1 CC		•	•			•	•							1/4	50	?			
C. stainforthi or *C. dissimilis*	Early Miocene	201	2-1	114-116	•	●		•			●	▲				●	1/5	90	•	•		•
			2-2	120-122	•	●					●	●				▲	1/20	70		•		•
			2-3	120-122	•	●					●	▲		•		▲	1/10	90	•	•		•
			2-4	120-122	•	●		•			●	●				●	1/5	80	•	•		
			2-6	120-122	•	●					●	●				●	1/10	90		•		•
		210	2 CC		•	●					●	▲		•		▲	1/5	80	•	•		•
	?	235	A2-1	116-118									•	●				0				
			A2-3	120-122							▲		•	•				0				
			A2-5	120-122							▲		●	•				0				
		244	A2 CC								▲		•	•		•		0				
		311	3-1	105-107							●			•		●		0				
			3-2	140-142							▲							0				
			3-3	98-100							▲		•					0				
		318	3 CC								●		•			●		0				
		368	4-1	59-61							▲							0				
			4-3	93-95							▲							0				
		373	4-3	143-146							▲			•				0				
		427	5 CC											•				0				
		432																				
		510	6-2	120-122														0				
		519	6 CC															0				
		585	7-1	147-149		•					•						0	(20)				
		587	7 CC			•					●						0	100	?			
	Campanian to Paleocene	645	8-1	42-44		•								•		●	0	95	?			
			8-1	104-106		•					•					•	0	(90)	?			
			8-2	106-108		•					•			•		●	0	(90)	?			
		651	8 CC			•										•	0	(100)	?			

								•	• • •	*Globigerinoides obliquus* s.l.
									• • • •	*G. ruber*
							• • •			*G. subquadratus*
							• • • • •		• • • • •	*G. trilobus* s.l.
							•		•	*Globoquadrina altispira*
							•			*Gq. praedehiscens*
							? ?			*Globigerinatella insueta*
									• • • • •	*Orbulina universa*
									• •	*Sphaeroidinella dehiscens*
									• • • • •	*Globorotalia acostaensis*
									• • • •	*G. crassaformis* s. str.
									•	*G. crassaformis ronda*
								•		*G. cultrata* s.l.
									•	*G. exilis*
							• • • • •			*G. fohsi peripheroronda*
									• • • •	*G. humerosa*
									•	*G. margaritae* (large)
							• •		•	*G. mayeri*
									• • • • •	*G. miocenica*
									•	*G. multicamerata*
									• • • •	*G. pertenuis*
									• • • •	*G. pseudopima*
								•		*Ammonia beccarii*
• • • •	•									*Bathysiphon* spp.
							• • •			*Bolivina* spp.
•										*Clavulina* cf. *arenata*
							•	•		*Elphidium* cf. *macellum*
• • •	•						• • • • •			*Epistominella* sp.
										Glomospira gordialis
• • • •	•						• • •			*Gyroidina* spp.
										Haplophragmoides sp.
• •	•									*Lituotuba* sp.
								• •		*Pararotalia* spp.
• •	•									*Pelosina complanata*
•	•									*Rzehakina epigona lata*
								•		*Spiroplectammina carinata*
	•									*S. mexiaensis*
• • •	•									*Trochamminoides irregularis*
							• • • • • •			*Uvigerina* spp.
• •										*Verneuilinoides* sp.
								•		*Vulvulina* sp.
							c			Remarks[a]

[a]c: strong downhole contamination.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce, (weak)

TABLE 8A
Site 141, Cores 1 to 4. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 141
19° 25.16′ N, 23° 59.91′ W
Water depth: 4148 m

Zone or Subzone	Age	Depth (in meters) Below Sea Floor	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish remains	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fractions	Solution effects	*Globigerina dutertrei*	*G. venezuelana*	*Globigerinoides conglobatus*	*G.* cf. *fistulosus*	*G. obliquus obliquus*	*G. obliquus extremus*	*G. ruber*	*Globoquadrina altispira*	*Globorotalia acostaensis*	*G. crassaformis* s.s.	*G. crassaformis* A	*G. crassaformis ronda*	*G. crassula viola*	*G. cultrata*	*G. exilis*	*G. hirsuta*	*G. humerosa*	*G. inflata*	*G. margaritae* (large)	*G. margaritae* (small)	*G. miocenica*	*G. multicamerata*	*G. pertenuis*	*G. pseudopima*	*G.* cf. *tosaensis*	*G. tumida*	*G. truncatulinoides*	*Orbulina universa*	*Pulleniatina finalis*	*P. obliquiloculata*	*P. primalis*	*Sphaeroidinella dehiscens*	Remarks[a]
G. truncatulinoides	Pleistocene	5	1-1	105-106	■	•	•									1000	100	•	●		•				●							•																			
			1-1	134-136	■	•										1000	100	•	●						●																										
			1-2	120-122	■	•										1000	100	•	●		•				●																										
			1-3	120-122	■	•		•	•							1000	100	•	●						●					?						?														
			1-4	120-122	■	•										1000	100	•	●		•				●																										
			1-5	120-122	■	•										1000	100	•	●						●								?			?														
			106	120-122	■	•		•	•							1000	100	•	●		•				●																										
		14	1 CC		■	•			•							500	100	•	●						●					•																				
	?	14	2-1	80-82	■	•										1000	100	•	●		•				●																										
			2-1	120-122	■	•		•	•							1000	93	•	•						●																										
			2-2	45-47	■	•										1000	100	•	●						●												?														
			2-2	120-122	▲	•		•								200	100	•	●						●																										
G. cf. *tosaensis*	Late Pliocene		2-3	45-47	■	•		•								1000	100	•	●						●												?														
			2-3	120-122	■	•		•	•							1000	100	•	●						●																										
			2-4	45-47	■	•										1000	100	•	●				?		●																										
			2-4	120-122	■	•										1000	100	•	●						●																										
G. exilis/G. miocenica			2-5	45-47	■	•			•							100	100	•	●						●									●		●														
			2-5	120-122	■	•		•								500	100	•	●						●																										
			2-6	120-122	■	•		•								200	99	•	•						●									●															
		23	2 CC		■	•			•							1000	100	•	•						●									●		●														
		23	3-1	123-125	■	•										1000	100	•	•		•				●				●																						
			3-2	120-122	■	•										200	100	•	•						●							•			?	●														
			3-3	120-122	■	•		•								200	100	•	•		•				●										?	●														
			3-4	120-122	■	•		•								1000	100	•	•						●									●		●														
			3-5	120-122	■	•		•								1000	100	•	•		•				●										?	●														
			3-6	120-122	■	•		•	•							200	100	•	•						●							•																		
		32	3 CC		■	•		•	•							200	93	•	•		•				●										?	●														
G. margaritae	Early Pliocene	32	4-1	top	■	•			•							1000	100	•	•	•					•																										P
			4-2	120-122	■	•			•							1000	100	•	●	•					•							•																		
			4-3	120-122	■	•		•								1000	100	●	•			●			•																										
			4-4	top	■	•										1000	100	•	•		•		●		•																										
			4-5	top	■	•			•							1000	100	•	•						•																										P
			4-6	top	■	•			•							1000	100	●	•	•					•																										
		41	4 CC		■	•			•							1000	100	•	●		•				●																										

[a]p: foraminifera partially determined.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce, (weak)

TABLE 8B
Site 141, Cores 5 to 9, SW. Core 1. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 141
19° 25.16′ N, 23° 59.91′ W
Water depth: 4148 m

Zone or Subsone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid remains	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Candeina nitida*	*Globigerina venezuelana*	*G. nepenthes*	*Globigerinoides conglobatus*
G. margaritae	Early Pilocene	41	5-1	120-122	■	•		•								1000	100	●		●		•
			5-2	120-122	■	•										500	100	●				•
			5-3	120-122	■	•	•									200	99	●		●		
			5-4	120-122	■	•		•								500	99	●				
			5-5	120-122	■	•	•									500	100	●		●		•
			5-6	120-122	▲	•	•									500	99	●				•
		50	5 CC		▲	•		•								200	99	●		•		
		59	6-1	75	▲	•	•	•								100	100	●		•		
			6-2	150	▲	•	•	•					•			50	98	▲			•	
			6-3	120-122	▲	•	•	•								100	99	●		●	•	
			6-4	120-122	▲	•		•								200	98	●			•	
			6-5	120-122	▲	•	•	•					•			20	95	▲			•	
			6-6	5-7	▲	•	•									100	100	▲		•	•	
			6-6	120-122	▲	•		•								50	98	▲		•	•	•
		68	6 CC		▲	•	•									100	100	●	•	●	•	•
	Early Pliocene or Late Miocene	79	7-1	5-7	▲	•		•					•			20	90	▲		•	●	
			7-1	120-122	●	•							•			(2)	(80)	▲		•	•	
			7-2	5-7	●	•							•			5	90	▲			?	
			7-2	120-122	●	•							•			5	(80)	▲				
			7-3	5-7	●	•							•			(10)	(80)	▲				
			7-3	120-122	•	•				•			●			?	(10)	■		•		
			7-4	120-122	(•)	(•)							•			?	(0)	(■)				
			7-5	120-122	•								•			?	10	■				
			7-6	53-55	(•)								•			?	(0)	?				
	?	88	7 CC		(•)											?	(0)	?				
		117	8-1	85-87									•				0					
			8-1	135-137									•				0					
			8-2	60-62		•							•			0	(20)	?				
			8-2	120-122		?							•				?					
		123	8 CC										•				0					
	?	191	9-1	120-122									•				0					
			9-2	120-122	•								•			0		(■)				
			9-3	120-122	•								•			0		?				
			9-4	120-122	●								•			0		?				
			9-5	120-122	●								•			0		?				
		200	9 CC		●								•			0		?				
	?	287	SW. 1													0						

						G. cf. *fistulosus*
						G. obliquus obliquus
						G. obliquus extremus
						G. ruber
						Globoquadrina altispira
						G. dehiscens
						Globorotalia acostaensis
						G. crassaformis s.s.
						G. crassaformis ronda
						G. crassula viola
						G. cultrata
						G. exilis
						G. humerosa
						G. margaritae (small)
						G. miocenica
						G. multicamerata
						G. pertenuis
						G. pseudopima
						G. tumida
						Orbulina universa
						Pulleniatina primalis
						Sphaeroidinella dehiscens
						Sphaeroidinellopsis seminulina
						S. paenedehiscens
						Ammodiscus incertus
						Ammoglobigerina sp.
						Bathysiphon sp.
						Cyclammina cf. *deformis*
						Gaudryina cf. *bentonensis*
						Glomospira charoides
						G. gordialis
						Gyroidina spp.
						Haplophragmoides eggeri
						H. cf. *foliaceus*
						Laticarinina sp.
						Pelosina dubia
						Stilostomella spp.
						Trochamminoides irregularis
						Remarks[a]

[a]p: foraminifera partially determined.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) . very scarce, (weak)

TABLE 9A
Site 142, Cores 1 to 5. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 142
3° 22.15′ N, 42° 23.49′ W
Water depth: 4372 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core - Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid remains	Mollusk remains	Bryozoa	Calcareous algae	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Candeina nitida*	*Globigerina dutertrei*	*G. venezuelana*	*Globigerinoides conglobatus*	*G. obliquus obliquus*	*G. obliquus extremus*	*G. ruber*	*Globoquadrina altispira*	*Globorotalia acostaensis*	*G. conomiozea*	*G. crassaformis* s.s.	*G. crassaformis* A	*G. crassula*	*G. cultrata*	*G. exilis*	*G. humerosa*	*G. margaritae* (small)	*G. multicamerata*	*G. pertenuis*	*G. pseudopima*	*G. truncatulinoides*	*G.* cf. *tumida/plesiotumida*	*Orbulina universa*	*Pulleniatina finalis*	*P. obliquiloculata*	*P. primalis*	*Sphaeroidinella dehiscens* s.s.	*S. dehiscens* f. "immatura"	*Sphaeroidinellopsis seminulina*	*S. paenedehiscens*	*Amphistegina* sp.	*Angulogerina* sp.	*Bolivina* spp.	*Epistominella* sp.	*Gyroidina tenera*	*Haplophragmoides* sp.	Remarks[a]
G. truncatulinoides	Quaternary	98	1-1	120-122	●	·		·	·							●	●	20	90	·							●							●							●		·														
			1-2	120-122	▲	·	·	·	·	·						●	▲	100	95	·	·	●		·			●						·	·							·		·	·	●												
			1-3	120-122	▲	·	·		·	·						●	▲	1000	95	·													·	·													·										p
			1-4	120-122	●	·			·	?						▲	▲	100	95	(●)															·						·																p
			1-5	120-122	▲	·												1000	100	●		●		·			·			●										·	·		·	●	·		·										
			1-6	90-92	●	·		·								?		100	95	▲																																					n
		106	1 CC		▲	●	·	·	·							▲	·	50	80	●		·		·					?	●				·							·				●		·										
		200	2-1	135-137	▲	·		·	·	·						·	■	100	90	●		●		·			●			·			?	·	?					·	·		·		●		●										
			2-2	60-62	▲	·		·	·	·							■	500	95	·																																					n
			2-2	120-122	▲	·												500	100	●		●	?	·			·			·											·		·	·	●		●		?								
			2-3	60-62	▲	·												100	100	▲																					·			·	●												p
			2-4	137-139	■	·												1000	100	·		●		·			·		?	·										·	·		·	·	▲		▲										
		209	2 CC		▲	·	·	·								·	●	200	98	●		●					·			·				·							·				●		●										
		293	3-1	63-65	▲	·												1000	100	●		·		·		·	●					·				·				·	·		·		●		▲	·									
			3-1	136-138	●	?	·									●		?	(2)	?											·																										
		301	3 CC		▲	●		·							·			20	90	▲				·			●					·				·					·		·		·		●							·	·	·	
G. margaritae	Early Pliocene	369	4-1	120-122	■	·												200	100	·			●	·	·	●	·	·			·					·	?	·				●				·	·	·	·	·			●				
			4-2	120-122	■	·												1000	100	·																																					n
			4-3	120-122	■	·												1000	100	·			●	·	·	●		·	·		·					·		●				●	·			●		·	·								
			4-4	120-122	■	·												1000	100																																		●				p
			4-5	120-122	■	·												500	100		·		·	·	·	●	·	●			·					·	·	●				●	·					·	·	●							
		376	4 CC		■	·												500	100	·			·	·	·	·		·			·		?	·	·	·	?	●	·			·	·						·	·							
		423	5-1	28-30	■	·		·		·	●							500	80	●			·	·	●	·	·	●			·			?		·	·	●	·			●	·			●			●	●	·						
			5-1	64-66	▲	·		·		·	·							100	99	▲					·			·						?		·			·			·				·		·	●	●	·						
			5-1	108-110	▲	·					●					·		500	90	·	·				●			●						●		·	·									·				·		·	●				
		429	5 CC		▲	·	·									?	●	50	100	●			●	·		●	·	·	·							·		●				●			?	·	(·)		●	●			·				

[a]n: foraminifera not determined; p: foraminifera partially determined.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 9B

Site 142, Core 6 to total depth. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 142

3° 22.15′ N, 42° 23.49′ W
Water depth: 4372 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid remains	Mollusk fragments	Bryozoa	Calcareous algae	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects
	Late Miocene or Early Pliocene	451	6-1	36-38	●	●					·				●		·	1	60	▲
			6-1	120-122	▲	●	·		·	·	●							5	80	
			6-2	8-10	●	·									·			10	100	●
			6-2	90-92	▲	●		·							·		●	10	95	●
			6-2	128-130	●	●									·		·	5	95	▲
			6-2	143-145	▲	▲												1	100	
		457	6 CC		▲	▲											·	2	98	●
G. acostaensis or *G. "dutertrei"*	Late Miocene	479	7-1	108-110	■	·												1000	100	●
			7-2	80-83	▲	·	·											1000	100	·
			7-3	53-55	■	·												200	100	·
			7-4	120-122	■	·												1000	100	●
			7-5	120-122	▲	·	·											1000	100	·
			7-6	120-122	▲	·												1000	100	·
		487	7 CC		■	·												1000	100	●
	Middle (to Late ?) Middle	529	8-1	0-2	▲	·												500	100	●
			8-1	40-42	●	·									·			10	80	▲
			8-1	108-110	●	·									·			100	100	▲
			8-1	143-145	▲	·	·								·			100	100	▲
			8-2	55-57	●	·									·			10	90	▲
			8-2	93-95	·	·									●			1/2	50	▲
		538	8 CC		·	●									●		·	1/5	80	▲
Globigerinatella insueta	Early Miocene	575	9-1	62-64	▲	●						▲			·			50	90	▲
			9-2	8-10	●	·						●						20	100	▲
			9-2	92-94	▲	·	·					●						200	99	●
			9-3	80-82	●	●						●			·			2	70	●
		581	9 CC		▲	·	·					●						200	100	●
		?	c. bit below c. g.		(●)													?	?	·

Core – Section	Sample Interval (in cm)	*Candeina nitida*	*Catapsydrax dissimilis*	*Globigerina nepenthes*	*G. venezuelana*	*Globigerinoides conglobatus*	*G. obliquus obliquus*	*G. obliquus extremus*	*G. ruber*	*G. sicanus*	*G. subquadratus*	*Globoquadrina altispira* s.s.	*G. altispira globosa*	*G. dehiscens*	*Globigerinatella insueta*	*Globigerinita* sp.	*Globorotalia acostaensis*	*G. birnagae*	*G. cultrata*
6-1	36-38	·					·	·											
6-1	120-122			·	·		·	·	·			·	·				·		●
6-2	8-10					·	·	·				·							·
6-2	90-92			·			·	·									·		·
6-2	128-130			·	·	·	·	·				·							●
6-2	143-145						·	·											·
6 CC				·		·	·	·				·					·		●
7-1	108-110																·		●
7-2	80-83	·		·	●		●	·				·	·	·			●		●
7-3	53-55																		●
7-4	120-122																·		●
7-5	120-122			·	●		●	·				·	●	·			·		●
7-6	120-122																		
7 CC				·	●		●					·	·				●		●
8-1	0-2			●	·		●	·				·	·	·			?		·
8-1	40-42			·			·												·
8-1	108-110			·										·					
8-1	143-145			●	·		●							·		·			·
8-2	55-57			·			·				·								·
8-2	93-95			?			·				·						?		·
8 CC							·							·			?		·
9-1	62-64				·									·	·				
9-2	8-10				·								·					·	
9-2	92-94				●				·	·	·			·	·			?	
9-3	80-82																		
9 CC					·				●	●	·			·	●				
c. bit below c. g.			·												?	·			

Core – Section	Sample Interval (in cm)	*G. fohsi peripheroronda*	*G. fohsi praefohsi*	*G. humerosa*	*G. margaritae* (small)	*G. mayeri*	*G. lenguaensis*	*G. pseudomiocenica*	*G.* cf. *tumida/plesiotumida*	*Orbulina universa*	*Sphaeroidinellopsis seminulina*	*S. paenedehiscens*	*Amphistegina* sp.	*Angulogerina* sp.	*Bathysiphon* sp.	*Bolivina* spp.	*Cyclammina* sp.	*Elphidium* sp.	*Epistominella* sp.	Remarks[a]
6-1	36-38			·								·							·	
6-1	120-122			·	?				·	●	?		·	·		·		·		
6-2	8-10								·	·	·					·				
6-2	90-92			·	?				·	·	·					●				
6-2	128-130			·					·		●									
6-2	143-145			·					·	·	·					▲				
6 CC				·	?					·	·	?		·		▲				
7-1	108-110						·													p
7-2	80-83				?			·		·	·									
7-3	53-55									●										p
7-4	120-122																			p
7-5	120-122						●	·		●	●									
7-6	120-122																			n
7 CC								·		·	●									
8-1	0-2		·				?	·		·	●									r?
8-1	40-42					·		?			·									
8-1	108-110						·			·	●				·					
8-1	143-145	·				·	·			·	●									r?
8-2	55-57					·									·					
8-2	93-95					·									·		·			
8 CC																				
9-1	62-64	·				●														
9-2	8-10					·														p
9-2	92-94	?				●														
9-3	80-82																			n
9 CC		●				·														
c. bit below c. g.						●														c

[a]c: strong downhole contamination, n: foraminifera not determined, p: foraminifera partially determined, r: reworking.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) . very scarce (weak)

TABLE 10
Site 143. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 143
9° 28.45′ N, 54° 18.71′ W
Water depth: 3493 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Coproliths	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant fragments	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Globigerina dutertrei*	*Globigerinoides conglobatus*	*G. ruber* (red colored)	*G. sacculifer*	*Globorotalia cultrata*	*G. truncatulinoides*	*G. tumida*	*Globigerinelloides eaglefordensis*	*G.* sp.	*Hedbergella amabilis*	*H. planispira*	*H.* sp.	*Epistomina lacunosa*	*Flabellammina* sp.	*Neobulimina minima*	Remarks[a]
	Albian-Cenomanian	14	A1-1	114-116	(▲)	·											?	?	?	(●)	(·)	(●)	(●)	(·)	(·)	(·)									c
			A1-1	139-141	?	?			·					·		●	?	(0)	?	(·)	(·)		(·)	(·)	(·)	(·)									c
			A1-2	100-102	●	·								·	·	●	?	?		(·)			(·)	(·)											c
			Al outside liner		▲	●			●	·				●	●	▲	(5)	?		(●)	(·)	(·)	(·)	(●)	(·)	(·)	(·)	·	·	●	●	●	·			c
			Al CC	(gray)	▲	●			·	·				●	·		?	?		(·)	(·)	(●)		(·)		(·)					●		?		c
		25	Al CC	(yell.-brn.)	(▲)	·		·						·			?	?	?	(●)	(·)	(●)	(●)		(·)										●	c

[a] c: strong downhole contamination.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 11A
Site 144, Cores B1 to A2. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 144
9° 27.23′ N, 54° 20.52′ W
Water depth: 2957 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects
Globigerina ampliapertura	Early to Middle Oligocene	0	B1-1	top	▲	·										1000	100	
			B1-1	bottom	(▲)	·										?	(100)	
			B1-2	top	▲	·										(1000)	(100)	
			B1-3	top	▲	·		·								(500)	(100)	
			B1-4	120-122	▲	·	·	·								500	100	
			B1-5	top	▲	·	·									1000	100	
			B1-6	120-122	▲	·	·									500	99	
		9	Bl CC		■	·	·									1000	100	
Cassigerinella chipolensis/Hastigerina "micra"		10	B2-1	120-122	▲	·	·	·		●			·			1000	98	●
			B2-2	130-132	▲	·		·		·		·	·			1000	98	·
			B2-3	125-127	▲	·	·			●			·			1000	98	●
			B2-4	top	▲	·	·			·		·	·			1000	99	·
			B2-5	top	▲	·				●			·			1000	98	·
			B2-6	top	▲	·				·			·			1000	99	·
		19	B2 CC		▲	·				●		·				1000	95	●
		20	A1-1	5-7	▲	·										1000	100	
			A1-1	32-33	▲	·				●			·			1000	98	●
			A1-2	116-118	▲	·				·						1000	99	●
			A1-3	118-120	▲	·	·			·			·			1000	100	·
			A1-4	117-119	▲	·		·				·				1000	100	·
			A1-5	132-134	▲	·		·					·			1000	100	●
		29	A1 CC		▲	·	·					·				1000	100	·
		27	B3-1	120-122	▲	·						·				1000	100	·
			B3-2	120-122	▲	·	·	·				·				1000	100	·
			B3-3	120-122	▲	·	·			·		·	·			1000	100	·
			B3-4	120-122	▲	·	·						·			1000	100	●
			B3-5	top	▲	·	·			·		·				1000	100	·
			B3-6	68-70	▲	·		·								1000	100	●
		36	B3 CC		▲	·				·			·			1000	99	●
		38	A2-1	top	▲	·				·						1000	100	·
			A2-2	top	▲	·				·		·				1000	100	·
			A2-3	top	▲	·		·		·						1000	99	·
			A2-4	120-122	▲	·		·		·						1000	98	●
			A2-5	120-122	▲	·				●		·				500	98	·
			A2-6	40-42	▲	·		·		·		·				500	100	·
			A2-6	110-112	▲	·	·	·		·		·				1000	100	·
			A2-6	120-122	▲	·	·			·			·			1000	99	
			A2-6	130-132	▲	·	·			●			·			500	100	
T. rohri	Middle Eocene	47	A2 CC		■	·				●						500	99	·

	Remarks[a]
	Cassigerinella chipolensis
	Catapsydrax dissimilis
	Chiloguembelina cubensis
	C. martini
	Globigerina ampliapertura
	G. nepenthes
	G. senni
	G. venezuelana
	Globigerinoides conglobatus
	G. obliquus obliquus
	G. obliquus extremus
	G. ruber
	G. sacculifer
	Globigerinatheka barri
	Globoquadrina altispira
	Globorotalia crassata
	G. cultrata
	G. exilis
	G. fohsi peripheroacuta
	G. gemma
	G. miocenica
	G. pomeroli
	Gr. renzi
	G. truncatulinoides
	G. tumida
	G. wilsoni
	Hantkenina longispina
	Pseudohastigerina barbadoensis
	P. micra
	Orbulina universa
	Sphaeroidinella dehiscens
	Sphaeroidinellopsis seminulina
	Truncorotaloides rohri
	T. topilensis
p	p
n	p
n	p
n	p
n	p
n	p
n	p
n	c
n	c
n	c

[a] c: strong downhole contamination; n: foraminifera not determined; p: foraminifera partially determined.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) · very scarce, (weak)

TABLE 11B
Site 144, Cores 1 to A4. Foraminiferal Biostratigraphy, Nature of Residue, and Important Foraminifera

DSDP Site 144
9° 27.23'N, 54° 20.52'W
Water depth: 2957 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid spines	Mollusk fragments	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Catapsydrax dissimilis* s.l.	*Chiloguembelina martini*	*Globigerina velascoensis*	*G. senni*
Orbulinoides beckmanni	Middle Eocene	57	1-1	101-103	▲	•	•			▲		•				500	95		•	•		•
			1-2	75	▲	•		•		■		•				500	80	●				
			1-3	120-122	▲	•				▲		•				500	70	●	•			
			1-4	90-92	▲	•				▲						200	90	●		•		•
			1-5	120-122	▲	•				▲						200	90	●				
			1-6	120-122	▲	•		•		■						200	40	▲				
		65	1 CC		▲	•	•			▲		•				200	70	●				•
G. pseudomenardii	Late Paleocene	104	2-1	bottom	■	•	•	•		•		•				500	100					
			2-3	bottom	▲	•	•	•		•		•				500	99					
			2-5	bottom	▲	•		•	?	●		•	•			500	100					
		112	2 CC		■	•			?				•			500	100				•	
		140	A3-1	120-122	■	•	•			?						500	99				•	
			A3-2	125-127	■	•	•									500	100	●				
			A3-3	120-122	■	•	•									500	100	•				
			A3-4	120-122	▲	●	•	•					•			100	98	•				
			A3-5	26-28	▲	•	•									500	100	•				
			A3-5	60-62	▲	•										(500)	100					
			A3-5	96-98	▲	•	•						•			200	99	▲				
			A3-5	98-100	■	●	•	•					•			100	98	●				
			A3-5	112-114	■	●		•								200	100	•				
			A3-5	119-121	▲	•	•									1000	100	•				
			A3-5	129-131	▲	•		•								500	100	●				
			A3-5	135-137	■	●	•	•								500	100	●				
			A3-6	120-122	▲	•	•	•								50	99	●				
		149	A3 CC		▲	•	•									100	99	▲				
G. fornicata-stuartiformis	Late Campanian to Early Maestrichtian	162	3-1	109-111	▲	●	•	•								20	98	•				
			3-2	35-37	▲	●	•		•	●			•			10	98	•				
		166	3 CC		▲	▲	•			●			•			5	98					
		171	A4-1	98-100	▲	●	•	•								100	100	•				
			A4-1	132-134	●	▲	•	•		●			•			1/5	90	●				
			A4-2	100-102	▲	▲		•	?	●			•			1	95	●				
		180	A4 CC		•	●		•		▲			•			1/100	95	▲				

Remarks[a]	
	Globigerinelloides yaucoensis
	Globorotalia aequa
	G. crassata
	G. ehrenbergi
	G. pomeroli
	G. pusilla pusilla
	G. pusilla laevigata
	G. pseudomenardii
	G. renzi
	G. trinidadensis
	G. uncinata
	G. velascoensis
	G. whitei
	Globotruncana aegyptiaca
	G. caliciformis
	G. fornicata
	G. havanensis
	G. linneiana
	G. plummerae
	G. stephensoni
	G. arca
	G. stuartiformis
	G. tricarinata
	Heterohelix globulosa
	H. punctulata
	H. ultimatumida
	Orbulinoides beckmanni
	Pseudoguembelina costulata
	Rugoglobigerina hexacamerata
	R. rugosa
	Rugotruncana subpennyi
	Truncorotaloides rohri
	T. topilensis
	Aragonia velacoensis
	Bolivina incrassata
	Bolivinoides delicatulus
	Bulimina arkadelphiana
	B. taylorensis
	Neoflabellina sp. aff. *numismalis*
	Pyramidina szajnochae
	Rzehakina epigona lata
n n n	
n n p	
c n r p p	

[a]c: strong downhole contamination, n: foraminifera not determined, p: foraminifera partially determined, r: reworking.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) . very scarce, (weak)

TABLE 11C

Site 144, Cores A5 to 8. Foraminiferal Biostratigraphy, Nature of Residue and Important Foraminifera

DSDP Site 144

9° 27.23′ N, 54° 20.52′ W
Water Depth: 2957 m

Zone or Subzone	Age	Depth Below Sea Floor (in meters)	Core – Section	Sample Interval (in cm)	Planktonic foraminifera	Benthonic foraminifera	Ostracoda	Echinoid remains	Mollusks	Radiolaria	Diatoms	Sponge spicules	Fish debris	Plant remains	Quartz sand	Planktonic/benthonic ratio	% foraminifera in > 80 mesh fraction	Solution effects	*Globigerinelloides bentonensis*	*G. caseyi*	*Globotruncana difformis*	*G. cf. fornicata*	*G. indica*	*G. renzi*	*G. ventricosa primitiva*	*Guembelitria harrisi*	*Hedbergella amabilis*	*H. brittonensis*	*H. delrioensis*	*H. gautierensis*	*H. planispira*	*H. washitensis*	*Heterohelix* cf. *frizzelli*	*H. globulosa*	*H. moremani*	*H. pulchra*	*H. reussi*	*Coptocampylodon lineolatus*	*Discorbis minutissima*	*Epistomina lacunosa*	*Lenticulina saxocretacea*	*L.* cf. *taylorensis*	*Lingulina nodosaria*	*Lituola subgoodlandensis*	*Neobulimina minima*	*Patellina subcretacea*	*Quinqueloculina sabella*	*Spiroplectammina alexanderi*	*Textularia rioensis*	*T. washitensis*	*Valvulineria plummerae*	n. gen. (fam. *Orbitolinidae*?)	Remarks[a]
M. renzi?	Coniacian – ? Santonian	180	A5-1	128-130	▲	(•)		?	?			•				(∞)	95				•		•				•		•	?	•			●		●	●																	
			A5-1	138-140	▲			?	•			●				(∞)	30													•				●																				p
		189	A5 CC		▲	•		?	•			●				200	50				•		•				•		•	?	•			●			●																	
		189	A6-1	113-115	■	•						•				1000	95					•	•	•	•		•		•	?	●		•				●				•												
			A6-1	136-138	▲	•						•				500	60							•		?			•																								p
		197	A6 CC		●	•						●				50	50							?					•				•																				
	Late Cenomanian – Early Turonian	213	4-1	–	▲							•				∞	100											●	●				●		●	●																	
			4-2	120-122	▲				●			●				∞	20			•									●						•																	
			4-3	120-122	▲											∞	100												?						•	?															
		219	4 CC		▲			•	•			●				∞	60		●	•									●				•		•	?	?															
	Albian to Early Cenomanian	264	5-1	34-36	●	•	•	•	•			•			•	3	50													•	•							•	•														
			5-1	108-110					•			•					0																																				
		270	5 CC		▲	●	•	●	•			•				10	50		•	•									?	●	●	•						•	•				●							•			
		295	6-1	10-12		•		•	●						▲	0																																				s
			6-1	20-22		•	•	•	•						▲	0																																				s
			6-1	27-28			•		•						●		0																																				s
			6-1	30-32			•	•	●						▲		0																																				s
			6-1	134-137	(•)	●	•	•	•				•	?	▲	(0)	80															•							•	•				•		?			●		•	
		298	6 CC			•	●	●	•						●	0	65																																				
	Albian (or Late Aptian ?)	298	7-1	94-96	(•)	•	•	●	●	(•)		•	?	•		(0)	(5)																												?								
			7-1	128-130		•	●	•	▲						•	0	(5)																																				
		300	7-1	147-149			•	•	▲						•	0	(2)																																				
		325	8-1	90?			•	•	•					•	●		0																																				
			8-2	138-140		•	•	•	●					•	■	0	(5)																																				c
			8-3	80-82	(•)	•	●	●	•					•	▲	(0)	(2)															?																				
		327	8 CC			•	●	•	•					•	•	•	1/10	50							●						?						●	•						●		•	•	•	•		

[a] c: strong downhole contamination, p: foraminifera partially determined, s: thin section only.

Symbols: ■ abundant, (very strong) ▲ common, (strong) ● few, (moderate) • very scarce (weak)