

8. CRETACEOUS FORAMINIFERAL STRATIGRAPHY, DSDP LEG 33, HOLES 315A, 316, 317A

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INTRODUCTION

Cretaceous rocks were drilled at three Sites during Leg 33, as listed below and shown in Figure 1. Hole 315A was spudded at a point about 40 miles east-northeast of Fanning Island in the central portion of the Line Islands chain. Site 316 was chosen on the west side of the chain, near its southern end. Hole 317A is located in the central portion of the Manihiki Plateau, about 80 miles southwest of Manihiki Island.

Hole	General Location	Latitude	Longitude
315A	Central Line Islands chain	4°10.26'N	158°31.54'W
316	Southern Line Islands chain	0°05.44'N	157°07.71'W
317A	Central Manihiki Plateau	11°00.09'S	162°15.78'W

The first two sites were chosen to provide a thick record of sediments from the Line Islands and coastal waters. The Cretaceous succession is generally turbiditic and/or volcanogenic, of which the latter aspect becomes conspicuous below the upper Campanian in both locations.

The third site was chosen to obtain information on the relatively thick, pelagic section over a very prominent feature, the Manihiki Plateau. Although the basal 250 meters of the succession is highly volcanogenic, the overlying 100 meters of Cretaceous is pelagic and quite different from the successions of Hole 315A and Site 316. Foraminiferal faunas vary sharply with lithology, which includes a thin, uppermost, Cretaceous chalk, underlying dark clays and clayey chinks, and Aptian-Albian carbonates overlying the basal volcanogenic section.

Relatively few of the Cretaceous planktonic foraminiferal zones could be recognized. Those proposed for the Upper Cretaceous follow the definitions of Cita and Gartner (1971) and those for the Lower Cretaceous follow van Hinte (1971).

QUALITY OF DATA

The recovery of foraminifers from samples was very poor, as indicated by the fact that only 54 of 193 samples yielded usable material. As a consequence of these poor recoveries, faunal intervals and zonal identifications are based upon very few samples in most cases. Accordingly, faunas will be presented in text only, except for the Aptian-Albian. Recoveries from this succession are

somewhat better; the information is more important and is presented in a distribution chart (Table 1).

TREATMENT OF SAMPLES

Treatment with petroleum ether (paint thinner, dry cleaning fluid, etc.) was found more effective than any other method. Samples were crushed if indurated, heated to some degree of cracking from desiccation, and immersed in petroleum ether for 24 hr, if time was available. Then the ether was decanted and samples were immersed in water, preferably distilled. Ideally disaggregation begins immediately upon water immersion and can be readily observed. If disaggregation is incomplete after 24 hr of immersion in water, the sample should be decanted, dried, and treated again. Adequate heating and drying appears to be quite important.

Residues were washed on a No. 200 screen and were picked in conventional manner; faunal slides were prepared in all cases.

FAUNAL INTERVALS

Line Islands Chain

Hole 315A

Interval of Core 18 to 19-2, 29-30 cm (806.5-817.9 m)

Correlation: Maestrichtian

Contributory Samples: 19-1, 139-140 cm; 19-2, 29-30 cm

Fauna: Planktonics

Globotruncana aegyptiaca Nakkady, *G. arca* (Cushman), *G. elevata* (Brotzen), *G. falsostuarti* Sigal, *G. fornicata* Plummer, *G. lapparenti* Brotzen, *G. rosetta* (Carsey)?, *G. stuartiformis* Dalbiez, *Pseudoguembelina costulata* (Cushman).

Fauna: Benthonics

Clavulinoides asper (Cushman), *Gaudryina pyramidata* Cushman, *Marssonella* sp., *Nuttallides florealis* (White), *N. texana* (Cushman), *?Oridorsalis umbonatus* (Reuss), *Rotorbinella supracretacea* (Schijfsma).

Because of abundant chert, core recovery for the interval from the top of Core 10 through Core 17 was poor and no foraminiferal samples were available. Recovery was good for Core 18, but none of the five samples yielded adequate foraminifers in residues despite the evident presence of abundant, recrystallized specimens in untreated cores. However, nannofossil data indicates Cretaceous species in Cores 16, 17, and 18, and this information is employed in selecting the top of the foraminiferal Maestrichtian.

The planktonics of this fauna were derived from one sample, 19-2, 29-30 cm. They suggest a *G. arca*-*G. gansseri* boundary shortly above, but this cannot be verified from residues of beds above and below this sample.

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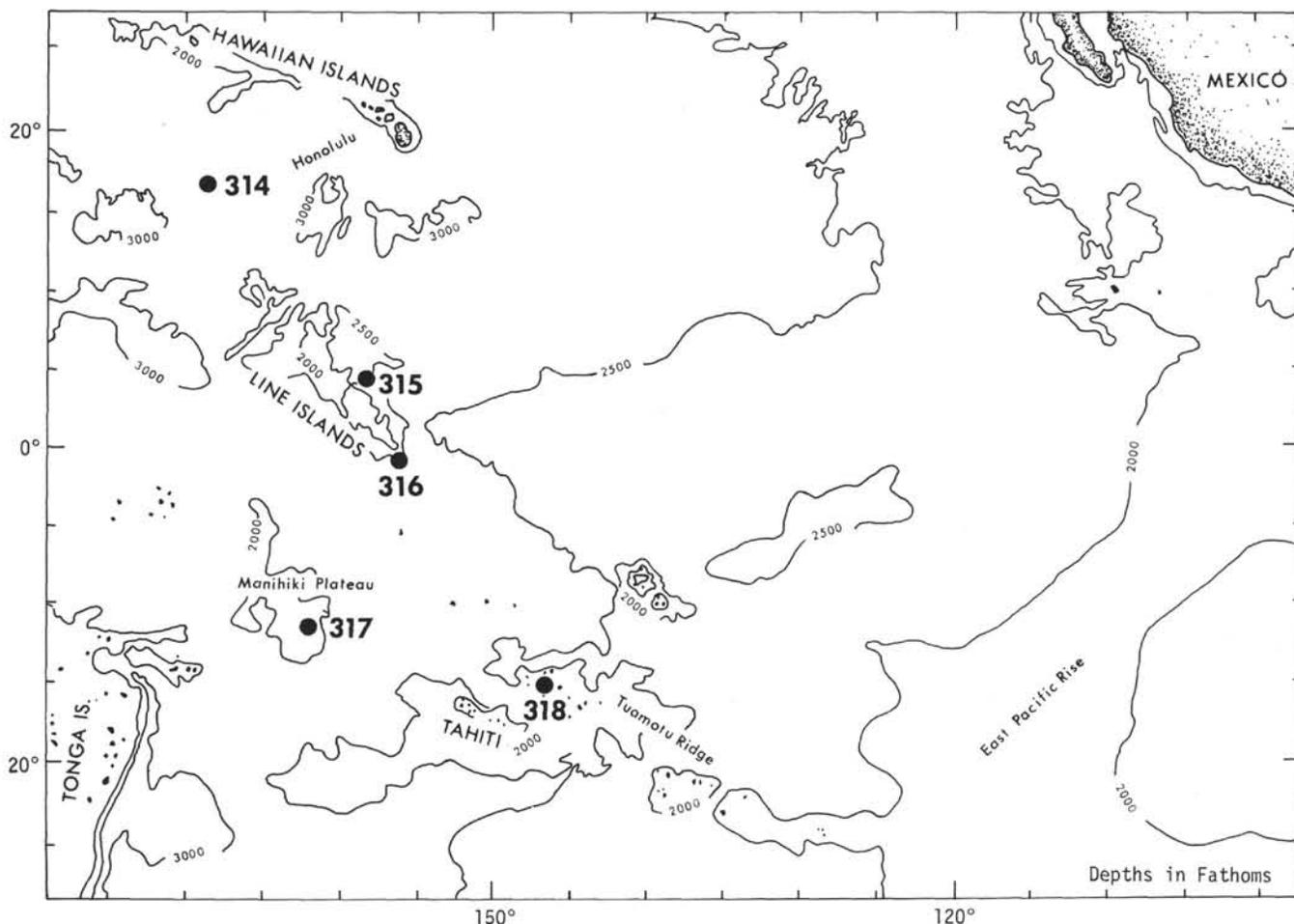


Figure 1. Location of sites drilled during Deep Sea Drilling Project Leg 33.

In addition to the benthonics listed above, residues contain many large, poorly preserved and unidentifiable discorbids and other rotaliiforms. Reefal larger foraminifers, which are discussed by Beckmann (this volume), were observed in thin sections and untreated cores (17-2, 117-119 cm and 18-2, 89-91 cm).

Interval of 19-3, 38-40 cm through 21-5, 119-120 cm (819.38-842.7 m)

Correlation: Upper Campanian, *Globotruncana calcarata* Zone

Contributory Samples: 19-3, 38-40 cm; 19-5, 140-142 cm; 21-3, 5-7 cm; 21-5, 119-120 cm

Fauna: Planktonics

Globotruncana arca (Cushman), *G. calcarata* Cushman, *G. elevata* (Brotzen), *G. fornicata* Plummer, *G. lapparenti* Brotzen, *G. linneiana* (d'Orbigny), *G. stuartiformis* Dalbiez, *G. ventricosa* White, *Heterohelix pulchra* (Brotzen), *H. punctulata* (Cushman), *H. striata* (Ehrenberg), *Planoglobulina multicamerata* de Klasz, *Pseudoguembelina costulata* (Cushman), *Pseudotextularia elegans* (Rzehak).

Fauna: Benthonics

Aragonia trinitatensis (Cushman and Jarvis), *Bulimina reussi* Morrow, *Dorothia trochoides* (Marsson), *Ellipsodimorphina subcompacta* Liebus, *Ellipsoglandulina velascoensis* Cushman, *Gaudryina pyramidata* Cushman, *Gyroidina globosa* (Hagenow), *Pleurostomella subnodosa*

Reuss, *Reussella szajnochae* (Grzybowski), *Semivulvulina dentata* (Alth), *Spiroplectammina spectabilis* (Grzybowski), *Stensioina excolata* (Cushman), *Textularia ripleysensis* W. Berry, *Vulvulina spinosa* Cushman.

This is a total-range zone and was confined to limits of appearance (21-5, 120 cm) and extinction (19-3, 38 cm) of the nominate species, which is relatively common and persistent in samples of the zone.

Evidently the Campanian-Maestrichtian boundary lies between 19-3, 38-40 cm and 19-2, 29-30 cm, or at about 818 meters.

Interval of 21-5, 119-120 cm to basalt (842.7-996 m)

Correlation: Lower Campanian, *Globotruncana elevata* Zone

Contributory Samples: 23-3, 0-2 cm; 24-3, 16-18 cm

Fauna: Planktonics

Archaeoglobigerina blowi Pessagno, *Globigerinelloides asper* (Ehrenberg), *Globotruncana fornicata* Plummer, *G. stuartiformis* Dalbiez, *G. lapparenti* Brotzen.

Fauna: Benthonics

Aragonia trinitatensis (Cushman and Jarvis), *Dentalina megalopolitana* Reuss, *Dorothia trochoides* (Marsson), *Gaudryina pyramidata* Cushman, *Gyroidina globosa* (Hagenow), *Nodosarella gracillima* Cushman, *Nuttalides texana* (Cushman), *Pleurostomella subnodosa* Reuss, *Pseudoclavulina amorpha* Cushman, *Reussella Szajnochae*

val had no globotruncanids, and only a few Tertiary planktonics. Still other samples from the interval contain a mixture of Cretaceous and Tertiary nannofossils in which the latter are rare. Apparently the interval is one of reworking, and possibly contamination as well, that could be either Cretaceous or Tertiary.

The base of the interval is taken from nannofossil information because samples from the bottom of Core 18 yielded no foraminifers.

Interval of Core 18-4 through 22 (594.5-656.5 m)

Correlation: Maestrichtian

Contributory Samples: 19-1, 20-23 cm (poor); 20-4, 42-44 cm; 20, CC; 21-1, 132-134 cm; 21-4, 112-114 cm

Fauna: Planktonics

Globotruncana aegyptiaca Nakkady, *G. arca* (Cushman), *G. contusa* (Cushman), *G. falsostuarti* Sigal, *G. elevata* (Brotzen), *G. fornicata* Plummer, *G. gagnebini* Tilev?, *G. gansseri* Bolli, *G. lapparenti* Brotzen, *G. linneiana* (d'Orbigny), *G. stuartiformis* Dalbiez, *Pseudoguembelina excolata* (Cushman), *Pseudotextularia deformis* (Kikoine), *P. elegans* (Rzehak).

Fauna: Benthonics

Bulimina velascoensis (Cushman), *Lenticulina velascoensis* (Cushman), *Marssonella* sp., *Nodosarella* cf. *N. coalinguensis* Cushman and Church, *Nuttalides florealis* (White), *N. texana* (Cushman), *Vulvulina spinosa* Cushman.

Samples from this interval contain mixed faunas in which contaminants could not be separated from reworked specimens with confidence. Core 21 appears to represent the *G. gansseri* Zone, but 19 and 20 are mixed and 22 yielded no material.

Interval of 23-1, 138-140 cm through 27-4, 133-135 cm (667.38-747.85 m)

Correlation: Upper Campanian, *Globotruncana calcarata* Zone

Contributory Samples: 23-1, 138-140 cm; 23-2, 17-19 cm; 23-4, 148-150 cm; 27-3, 67-69 cm; 27-4, 133-135 cm

Fauna: Planktonics

Globotruncana arca (Cushman), *G. calcarata* Cushman, *G. elevata* (Brotzen), *G. fornicata* Plummer, *G. lapparenti* Brotzen, *G. rosetta* (Carsey), *G. stuartiformis* Dalbiez, *G. ventricosa* White, *Heterohelix striata* (Ehrenberg), *Planoglobulina multicamerata* de Klasz, *Pseudoguembelina costulata* (Cushman), *Pseudotextularia elegans* (Rzehak), *Rugoglobigerina rugosa* (Plummer).

Fauna: Benthonics

Aragonia trinitatis (Cushman and Church), *Reussella szajnochae* (Grzybowski), *Vulvulina spinosa* Cushman.

Globotruncana calcarata was first encountered in 23-1, 138-140 cm. As noted in the discussion of the form under 315A, it is employed to define the upper Campanian. In this case, however, there is an uncored interval of 9.5 meters between Core 23 and Core 22, and the boundary may lie anywhere in the interval. Also there is no foraminiferal material from Cores 24, 25, and 26, but *G. calcarata* is relatively common in 27-3, 67-69 cm and 27-4, 133-135 cm, providing adequate evidence of first appearance.

Interval of base of Sample 27-4, 133-135 cm to total depth (747.85-837.0 m)

Correlation: Lower Campanian, *Globotruncana elevata* Zone?

Contributory Sample: 30, CC

Fauna: Planktonics

None.

Fauna: Benthonics

Aragonia trinitatis (Cushman and Church), *Reussella szajnochae* (Grzybowski), *Spiroplectamina* sp., unidentified robust discorbids (contaminants).

Rocks of this interval are coarse-grained volcanogenic clastics, from which only Sample 30, CC yielded a sparse and restricted assemblage of benthonics, notable only in the exceptional size and relative abundance of *R. szajnochae*. Assignment to lower Campanian is based solely on position with respect to Core 27 and the overlying appearance of *G. calcarata*.

Manihiki Plateau

Hole 317A

Interval of base of Core 2 through Core 3 (563.5-573.0 m)

Correlations: Maestrichtian, mixed

Contributory Samples: 2, CC; 3-1, 96-98 cm; 3-2, 40-42 cm; 3-4, 8-10 cm; 3, CC

Fauna: Planktonics

Globotruncana arca (Cushman), *G. contusa* (Cushman), *G. fornicata* Plummer, *G. gansseri* Bolli, *G. linneiana* (d'Orbigny), *G. mayaroensis* Bolli, *G. stuarti* (de Lapparent), *G. stuartiformis* Dalbiez, *Gublerina cuvillieri* Kikoine, *Heterohelix punctulata* (Cushman), *Planoglobulina multicamerata* de Klasz, *P. carseyae* (Plummer), *Pseudoguembelina excolata* (Cushman), *P. elegans* (Rzehak), *Racemiguembelina fructifera* (Egger), *Rugoglobigerina rotundata* Bronnimann, *Rugotruncana subcircumnodifer* (Gandolfi), *Rugotruncana subpennyi* (Gandolfi).

Fauna: Benthonics

Aragonia trinitatis (Cushman and Jarvis), *Dorothyia trochoides* (Marsson), *Verneuilina cretacea* Karrer, *Vulvulina spinosa* Cushman.

Cretaceous foraminifers were encountered first in Sample 2, CC, which yielded a mixed Maestrichtian fauna. Eocene forms occur in Core 2, but it could have come from far uphole inasmuch as the core followed a long interval of washing down. The Cretaceous is associated with a drilling break.

Samples from Core 3 contain the nominate species from all three foraminiferal zones of the Maestrichtian, suggesting slow and unstable sedimentation.

Interval of Cores 4, 5, and 6 (573.0-592.0 m)

Correlations: Campanian

Contributory Samples: 4, CC; 5-1, 126-128 cm; 5, CC; 6-2, 4-6 cm

Fauna: Planktonics

None.

Fauna: Benthonics

Aragonia trinitatis (Cushman and Jarvis), *Dorothyia trochoides* (Marsson), *Gaudryina* sp., *Gyroidina globosa* (Hagenow), *Gyroidina nitida* (Reuss), *Marssonella* sp., *Nuttalides florealis* (White), *Pleurostomella subnodosa* Reuss, *Pullenia quinqueloba* Reuss, *Rotorbina supra-cretacea* (Schijfsma), *Stensioina excolata* (Cushman), *Verneuilina cretacea* Karrer, *Vulvulina spinosa* Cushman?

Cores 4, 5, and 6 are composed of dark clays and clayey chalk that yield tiny residues. When present, foraminifers are small, recrystallized benthonics that may misrepresent both age and environment.

The fauna of this interval contains neither planktonics nor benthonics of restricted range. However, it is suggestive of Senonian in a broad sense and, by position beneath the Maestrichtian, may be suggested as Campanian.

Interval of Cores 7, 8, and 9 (592.0-620.5 m)

Correlation: Middle-upper Albian

Contributory Samples: 7, CC; 8-1, 105-107 cm, 8, CC; 9-1, 49-51 cm

Fauna: Planktonics

Hedbergella simplex (Morrow) (one specimen), *Sphaeroidina* sp.

Fauna: Benthonics

Arenobulimina preslii (Reuss), *Conorbina brotzeni* (Gandolfi), *Dorothia hostaensis* (Morozova), *Gavelinella intermedia* (Berthelin), *Gyroidina nitida* (Reuss), *Lenticulina gevini* Moullade, *L. acuta* Reuss?, *Nodosaria obscura* Reuss, *Ramulina aculeata* Wright Form b Bartenstein, *Pleurostomella subnodosa* Reuss, *Pseudoclavulina* sp. 2, *P. mendrisiensis* (Gandolfi), *P. gaultina* (Morozova), *Verneuilina* sp.

The verneuilinids dominate the skimpy material. They bring to mind some of Gandolfi's (1942) forms from the Scaglia Variegata and Bianca and, particularly, Scheibnerová's (1974) fauna from Leg 27, which is Albian. *C. brotzeni* and *G. intermedia* indicate Albian, although the latter continues into the lower Cenomanian.

The top of this interval is questionable because one sample, 7-1, 7-9 cm, contains a sparse Santonian fauna unlike anything else in Hole 317A. One to three specimens of several neritic species from Texas suggest contamination in laboratory treatment. Were it not for the fact that nannofossils also indicate Santonian for the upper part of Core 7, the sample would be rejected entirely.

The base of the interval is arbitrarily set at the base of Core 9, although it could be anywhere between 9-1, 49-51 cm and 10-1, 145-147 cm.

Beginning with this interval, selected species are presented in a distribution chart (Table 1).

Interval of 10-1, 0 cm through 10-2, 150 cm (620.5-623.5 m)

Correlation: Middle Albian

Contributory Samples: 10-1, 119-120 cm; 10-1, 145-147 cm

Fauna: Planktonics

Rare, fragmentary.

Fauna: Benthonics

Conorbina brotzeni Gandolfi, *Dentalina communis* d'Orbigny, *D. distincta* Reuss, *D. soluta* Reuss, *Dorothia gradata* (Berthelin), *D. hostaensis* (Morozova), *D. hyperconica* Risch, *Gavelinella intermedia* (Berthelin), *Gyroidina nitida* (Reuss), *Lenticulina acuta* (Reuss), *Pseudonodosaria mutabilis* (Reuss), *Spiroplectinata* sp.

This fauna differs from that of the previous interval in its lack of the distinctive verneuilinids and presence of large lagenids. Presumably, this is a reflection of environment rather than age, considering the change in

lithology from dark clays of the previous interval, to limestones of this interval.

Interval of 10-3, 20-22 cm through 11-2, 70-72 cm (622.70-632.22 m)

Correlation: Aptian-Albian, *Ticinella roberti*-*Hedbergella trocoidea* zones

Contributory Samples: 10-3, 20-22 cm, 10-3, 112-114 cm, 10, CC, 11-1, 104-106 cm, 11-2, 70-72 cm

Fauna: Planktonics

Hedbergella gorbachiki Longoria, *H. infracretacea* Glaessner.

Fauna: Benthonics

Dentalina communis d'Orbigny, *Dorothia gradata* (Berthelin), *D. hostaensis* (Morozova), *Gaudryina dividens* Grabert, *Gavelinella barremiana* Bettenstaedt, *G. intermedia* (Berthelin), *Gyroidina nitida* (Reuss), *L. subgaultina* Bartenstein, *Marginulina exocentrica* (Cornuel), *M. incurvata* (Reuss), *Marssonella subtrochus* Bartenstein, *Osangularia utaturensis* (Sastri and Sastri), *Pseudoclavulina* sp. 1, *Pseudonodosaria humilis* (Roemer), *P. mutabilis* (Reuss), *Pyrulina cylindroides* (Roemer), *Ramulina aculeata* Wright Form b Bartenstein, Bettenstaedt, and Bolli, *Saracenaria spinosa* (Eichenberg), *Spiroplectinata* sp.

The nature and range of *H. gorbachiki* has recently been established by Longoria (1972). The species occurs in the upper Aptian and lower Albian. Because of the presence of *G. algerianus* and *G. ferreolensis* in the interval below, the presence of *H. gorbachiki* in this interval can be associated with the Albian and uppermost Aptian part of its range, or essentially the *Ticinella roberti* and *Hedbergella trocoidea* zones. The species is common to abundant in Core 10 and occurs throughout the *G. algerianus* Zone below (see Table 1).

Interval of 11-4, 139-140 cm through 12-3, 28-30 cm (635.89-641.30 m)

Correlation: Middle Aptian; *Globigerinelloides algerianus* Zone

Contributory Samples: 11-4, 139-140 cm; 11-5, 145-147 cm; 11, CC; 12-1, 135-137 cm; 12-2, 61-62 cm; 12-2, 144-145 cm; 12-3, 28-30 cm; 12-4, 122-124 cm; 12-5, 97-99 cm; 12-6, 120-122 cm

Fauna: Planktonics

Globigerinelloides algerianus Cushman and Ten Dam, *G. blowi* (Bolli), *G. ferreolensis* (Moullade), *G. maridalensis* (Bolli), *Hedbergella gorbachiki* Longoria, *H. infracretacea* Glaessner.

Fauna: Benthonics

Dentalina communis d'Orbigny, *D. cylindroides* Reuss, *D. distincta* Reuss, *D. soluta* Reuss, *D. subguttifera* Bartenstein, *Dorothia gradata* (Berthelin), *D. hostaensis* (Morozova), *Gaudryina dividens* Grabert, *Gavelinella barremiana* Bettenstaedt, *Gyroidina nitida* (Reuss), *Lenticulina acuta* (Reuss), *L. subgaultina* Bartenstein, *M. exocentrica* (Cornuel), *M. incurvata* Reuss, *M. linearis* Reuss, *Marssonella subtrochus* Bartenstein, *M. oxycona* (Reuss), *Pseudonodosaria humilis* (Roemer), *P. mutabilis* (Reuss), *Pyrulina cylindroides* (Roemer), *Ramulina aculeata* Wright Form b, *R. aculeata* Wright Form e, *Saracenaria spinosa* (Eichenberg), *Tristix acutangula* (Reuss).

Although Longoria (1972) has presented sound bases for distinction between *Globigerinelloides barri* (Bolli,

Loeblich, and Tappan), *G. ferreolensis* (Moullade), and *G. algerianus* Cushman and Ten Dam, they are easily confused. The ranges reported here, understandably, varied (Bandy, 1967; Longoria, 1972, van Hinte, 1971). Coupling these facts with the generally poor preservation of material from this interval, it seems wise to infer a general middle Aptian correlation.

The benthonics are quite poorly preserved. This combines with a chaotic taxonomy to make identifications uncertain, and they should be regarded with question.

Interval of 12-4, 122-124 cm through 12-6, 120-122 cm (645.20-648.22 m)

Correlation: Lower Aptian; *Leupoldina cabri* Zone

Contributory Samples: 12-4, 122-124 cm; 12-5, 97-99 cm; 12-6, 120-122 cm

Fauna: Planktonics

Globigerinelloides ferreolensis (Moullade), *G. maridalensis* (Bolli), *Leupoldina pustulans* (Bolli).

Fauna: Benthonics

Dentalina communis d'Orbigny, *D. cylindroides* Reuss, *D. distincta* Reuss, *D. soluta* Reuss, *D. subguttifera* Bartenstein, *Dorothia gradata* (Berthelin), *Gavelinella barremiana* Bettenstaedt, *Gyroidina nitida* (Reuss), *Lenticulina subgaultina* Bartenstein, *M. excentrica* (Cornuel), *M. incurvata* (Reuss), *M. linearis* Reuss, *Marssonella subtrochus* Bartenstein, *Pseudonodosaria humilis* (Roemer), *P. mutabilis* (Reuss), *Pyrulina cylindroides* (Roemer), *Ramulina aculeata* Wright Form b, *R. aculeata* Wright Form c, *R. aculeata* Wright Form d, *R. aculeata* Wright Form f, *Saracenaria spinosa* (Eichenberg).

The nominate species of the *L. cabri* Zone was not observed and the shorter ranging *L. pustulans* is very rare and poorly preserved.

The total range of *Leupoldina pustulans* is unclear from the literature (van Hinte, 1972 versus Longoria, 1972), but is much lower than some previous suggestions (Bandy, 1967). It is, however, associated with *L. cabri*, which van Hinte (1971) assigns to the lower Aptian and Longoria (1972) to the middle Aptian.

Interval of Core 13 to basalt (647.0-896.0 m)

Correlation: Lower Aptian, ?Barremian

Contributory Samples: 13-1, 128-129 cm; 13-4, 07-09 cm

Fauna: Planktonics

Rare, fragmentary, unidentifiable.

Fauna: Benthonics

Rare, fragmentary; see distribution chart, Table 1.

The cores contain considerable fragmentary ostracode and pelecypod material in the upper part of this interval (Cores 13-16), but yielded only rare, fragmentary, mostly benthonic foraminifers. By superposition, the succession is older than the *L. cabri* Zone, but provided no direct evidence of correlation.

SUMMARY

Table 2 shows the planktonic zones recognized at 315A, 316, and 317A.

At Line Islands Sites 315A and 316, the Cretaceous-Tertiary boundary is associated with an interval of mixed Cretaceous and Tertiary species. Middle Maestrichtian forms of the *G. gansseri* Zone are prominent at

TABLE 2
Planktonic Foraminiferal Zones, Leg 33 Site 315A, 316, 317A

	315A	316	317A
Maestrichtian	<i>G. gansseri</i> (19-2, 29-30)	<i>G. gansseri</i> (20, CC-21, CC)	mixed zonal species (Core 3)
Campanian	<i>G. calcarata</i> (19-3, 138 - 21-5, 120)	<i>G. calcarata</i> (23-1, 138 - 27-4, 135)	
	<i>G. elevata</i> (21-5, 120 - total depth)	<i>G. elevata</i> (27-4, 135 - total depth)	
	no planktonics		
Aptian			<i>G. algerianus</i> (11-4, 139 - 12-3, 30) <i>L. cabri</i> (12-4, 122 - 12-6, 122)

both locations. Samples indicate some *G. arca* Zone in 315A and possibly in 316, but no evidence of the *G. mayaroensis* Zone was observed. The *G. calcarata* Zone is present and sharply defined by the nominate species in relative abundance. The *G. elevata* Zone is presumed from subjacent position and a few appropriate but not exclusive forms. A definitive base of the zone, in the form of *G. concavata*, did not occur before total depth in both holes. The *G. calcarata* Zone thickens from 25 meters at 315A in the north to 195 meters in 316 at the south.

Foraminiferal faunas vary sharply with lithology in Hole 317A, which includes a thin, uppermost chalk, a broken section of dark, barren clays and clayey chalk, an Aptian-Albian carbonate unit, and a basal volcanogenic, clastic section.

The Cretaceous-Tertiary boundary is sharp in Hole 317A. Samples from the uppermost chalk, only 9.5 meters thick, contain nominate and other elements of all three Maestrichtian planktonic stages, making it difficult to distinguish between contamination and reworking. The relatively long, dark clay unit yielded only sparse faunas of small, recrystallized benthonics. The upper part of this unit, Cores 4-6, contains undifferentiated Senonian benthonics. The lower part, Cores 7-10, contains, with the questionable exception of 7-1, Albian benthonics. Faunas of the Aptian-Albian chalks and limestones are dominated by large, diverse lagenids of poor preservation and uncertain identification. However planktonics are present, and are sporadically abundant, allowing the recognition of the *Globigerinelloides algerianus* Zone and the *Leupoldina cabri* Zone. The benthonic faunas of the dark clays resemble faunas reported from the Mediterranean and, recently,

from Australian-Indian Ocean sites. The Aptian-Albian faunas resemble those of Trinidad and the Caribbean, but are similar also to many of Tethyan Europe.

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PLATE 1

- Figures 1, 2 *Globigerinelloides algerianus* Cushman and Ten Dam.
Sample 317A-12-2, 144-145 cm; $\times 123$.
- Figure 3 *Globigerinelloides ferreolensis* (Moullade).
Sample 317A-12-1, 135-137 cm; $\times 123$.
Does not show as much evolution of final chambers as occurs elsewhere.
- Figures 4, 5 *Globigerinelloides blowi* (Bolli)
Sample 317A-12-2, 144-145 cm; $\times 123$.
Interpreted here as by Longoria (1972), not as by Moullade (1966).
- Figure 6 *Globigerinelloides maridalensis* (Bolli).
Sample 317A-12-4, 122-124 cm; $\times 123$.
- Figures 7-9 *Hedbergella gorbachiki* Longoria.
Sample 317A-10-3, 20-22 cm.
7. $\times 164$.
8. $\times 205$.
9. $\times 123$.
- Figure 10 *Leupoldina pustulans* (Bolli).
Sample 317A-12-5, 97-99 cm; $\times 164$.
This species is rare; poor preservation obscures secondary chamber relationships.
- Figure 11 *Gaudryina dividens* Grabert.
Sample 317A-11-5, 145-147 cm; $\times 82$.
- Figure 12 *Gaudryina dividens* Grabert.
Sample 317A-11-2, 70-72 cm; $\times 82$.
This species appears to vary into forms that approach *Spiroplectinata*.

PLATE 1

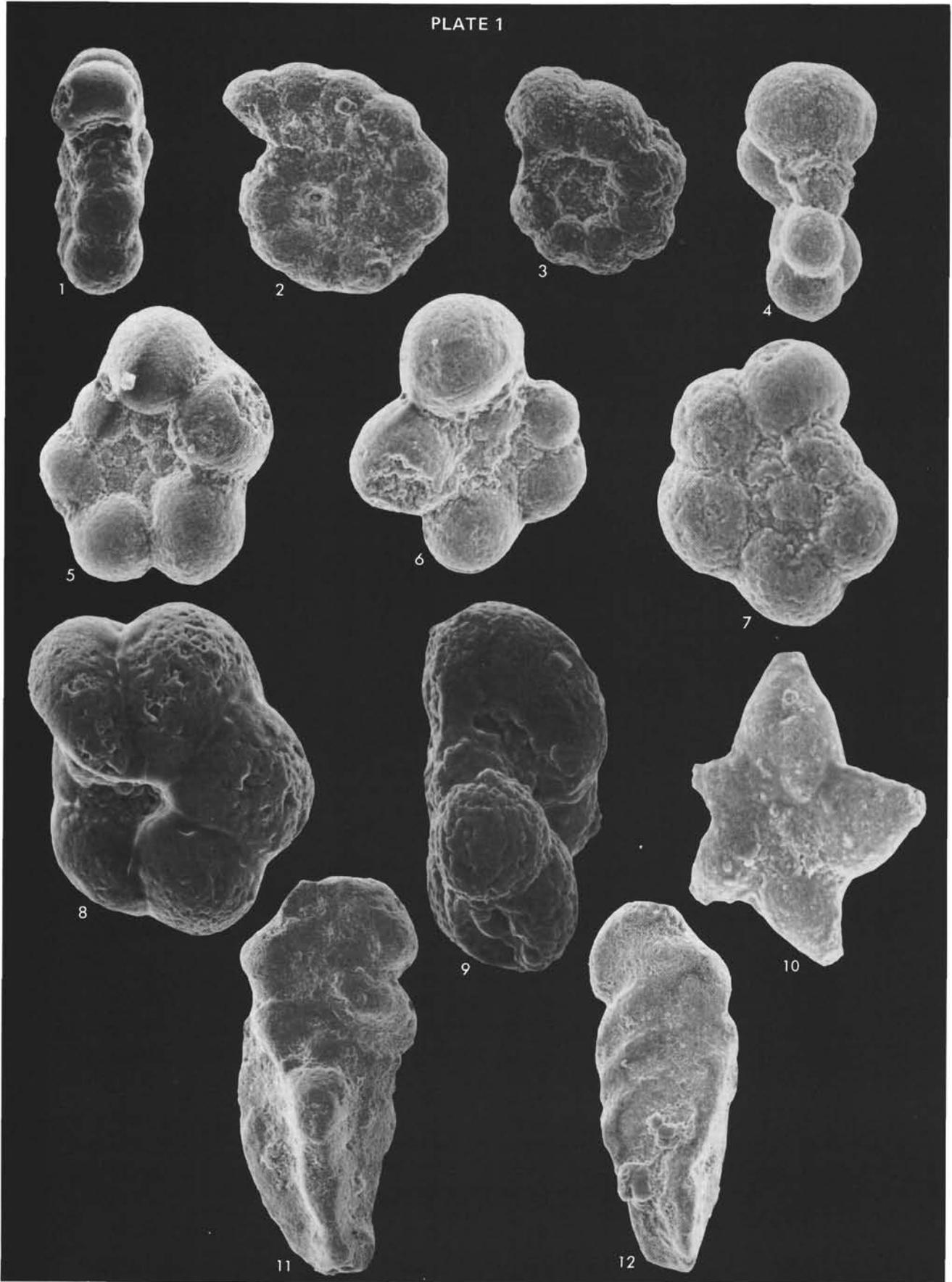


PLATE 2

- Figure 1 *Spiroplectinata* sp.
Sample 317A-10-3, 20-22 cm; $\times 82$.
- Figure 2 *Pseudoclavulina gaultina* (Morozova).
Sample 317A-9-1, 49-51 cm; $\times 82$.
- Figures 3, 4 *Pseudoclavulina* sp. 2.
Sample 317A-8-1, 105-107 cm; $\times 66$.
This form is very distinctive because of the shape of the uniserial chambers. It appears synonymous with the form that Gandolfi (1942, p. 43) identified as *Pseudoclavulina eggeri* in text and as *Clavulina parisiensis* in illustrations (1942, pl. XI, fig. 5, 6; pl. XII, fig. 3, 4), but it is neither of these. It is the form that Scheibnerova (1947, p. 722, pl. 2, fig. 5-8) assigned to *Pseudoclavulina gabonica* but it differs markedly from that species (Le Calvez, de Klasz, and Brun, 1971, p. 308, pl. I, fig. 7 and 9) in uniserial chambers.
- Figure 5 *Pseudoclavulina mendrisiensis* (Gandolfi).
Sample 317A-10, CC; $\times 49$.
The concept herein is restricted to the terminal form of the Gandolfi (1942, p. 42) variation of the species in which the biserial stage is very suppressed, the uniserial stage is relatively short, and the chambers are more overlapping and ill defined. This concept is similar to *Clavulina gabonica* Le Calvez, de Klasz, and Brun (1971).
- Figure 6 *Gavelinella barremiana* Bettenstaedt.
Sample 317A-12-2, 144-145 cm; $\times 164$.
- Figure 7 *Gavelinella barremiana* Bettenstaedt.
Sample 317A-12-2, 144-145 cm; $\times 164$.
- Figures 8, 9 *Pseudoclavulina* sp. 1.
Sample 317A-11-2, 70-72 cm; $\times 49$.
This form appears inseparable from gaudryinelline accompanying forms, of which some approach *Gaudryina angustata* Akimez.
- Figure 10 *Dorothia hyperconica* Risch.
Sample 317A-12-4, 28-30 cm; $\times 82$.

PLATE 2

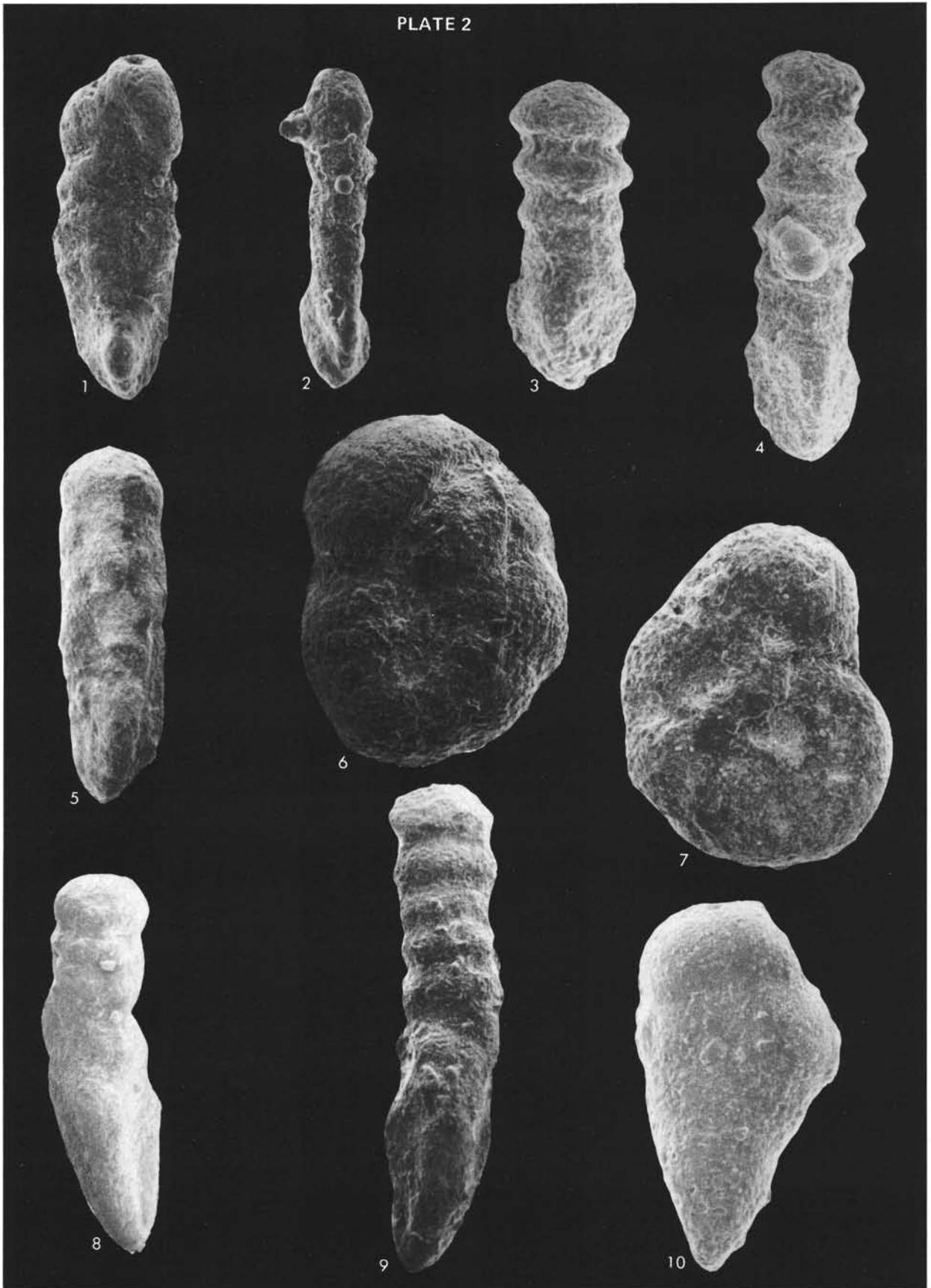


PLATE 3

- Figure 1 *Dorothia gradata* (Berthelin).
Sample 317A-12-1, 135-137 cm; ×82.
- Figure 2 *Marssonella subtrochus* Bartenstein.
Sample 317A-12-4, 122-124 cm; ×123.
- Figure 3 *Dentalina cylindroides* Reuss.
Sample 317A-11, CC; ×62.
- Figure 4 *Lenticulina subgaultina* Bartenstein?.
Sample 317A-12-1, 135-137 cm; ×82.
- Figures 5-7 *Marginulina excentrica* (Corneul).
Sample 317A-12-2, 61-62 cm; ×82.
This form has many short, strongly oblique chambers in the uncoiled portion, but they are only faintly preserved in Hole 317A material. With inclusion of *M. prima* (d'Orbigny) as a junior synonym (Bartenstein, 1966, p. 149), *M. excentrica* varies from strongly astacoline to strongly marginuline.
- Figure 8 *Marginulina incurvata* (Reuss).
Sample 317A-12-2, 144-145 cm; ×82.
- Figure 9 *Marginulina linearis* Reuss.
Sample 317A-12-6, 120-122 cm; ×82.

PLATE 3

