29. OLIGOCENE PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY, CENTRAL NORTH PACIFIC OCEAN, DSDP LEG 32

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INTRODUCTION

Sedimentary sequences of Oligocene age were recovered only at Sites 305, 310, and 313 during DSDP Leg 32 in the North Pacific Ocean. Planktonic foraminiferal populations of this age at all three sites show evidence of intense carbonate dissolution corresponding to dissolution facies 6 to 8 of Berger and von Rad (1972). Even those assemblages which contain relatively large numbers of specimens are characterized by notably low diversity; no more than a dozen species are to be present in any single sample.

Differential susceptibility to test dissolution among modern planktonic foraminiferal species has been widely recognized, but substantially less attention has been directed toward the patterns and results of dissolution and concentration in early and middle Tertiary assemblages. Clearly, however, the reduction of deep-sea populations has particularly acute ramifications for biostratigraphic correlation and determinations. Most of the zonation systems proposed for the middle Tertiary have been based upon samples from sequences deposited along continental margins. To the extent that they are based on fossil species with readily soluble tests, these systems are inapplicable to deep-sea deposits.

Among these zonation systems, the most seriously affected are those of Blow (1969) and Postuma (1971). Blow's N.4/P.22 boundary frequently cannot be recognized as defined because of the susceptibility to dissolution of *Globigerinoides primordius*; Berger (1970) noted that species of *Globigerinoides* are among the most readily dissolved of modern forms. Even where this species is present, it is rare near the base of its range (Beckmann, 1971; Douglas, 1973) and has been found at widely distributed localities in horizons older than the initial appearance of "*Turborotalia*" *kugleri* (Poag, 1972; Kaneps, 1973; Sieglie, 1973). Clearly, this boundary cannot be consistently delineated, and Zones N.4 and P.22 cannot be recognized in the sense intended by Blow (1969).

Species of *Globigerina* (restricted here to spinose-walled forms; see Fleisher, 1974) are all but completely absent from Leg 32 Oligocene populations, and are commonly rare or absent in deep-sea middle Tertiary faunas. The absence here of *G. angulisuturalis* is particularly important because the initial appearance of this species was used by both Blow (1969) and Postuma (1971) as the basis for zonal boundaries (P.21/P.20 and *G. angulisuturalis* Zone/*G. ampliapertura* Zone, respectively). The sporadic distribution of *G. angulisuturalis* in late Oligocene DSDP samples (Jenkins and Orr, 1972; Kaneps, 1973; Ingle, 1973; Fleisher, 1974) is a reflection of the susceptibility of this species to dissolution.

Jenkins and Orr (1971) proposed a modified system of planktonic foraminiferal zones based on the ranges of dissolution-resistant species. Their zones, however, are essentially identical to those employed by Bolli (1966), and the latter system (see Figure 1) with appropriate nomenclatural changes is employed here. The *Chiloguembelina cubensis* Zone of Jenkins and Orr (1971), equivalent to the lower portion of the "*Turborotalia*" *opima opima* Zone, is not employed here. The absence of *C. cubensis* in many early Oligocene populations at the Leg 32 sites suggests that this species is too readily dissolved to be of major stratigraphic value in these sequences.

The generic taxonomy employed for planktonic foraminifera in this report is somewhat at variance with common usage. The basis upon which these generic assignments have been made has been discussed in an earlier paper (Fleisher, 1974). The arguments proposed in that study will not be repeated here, but a few

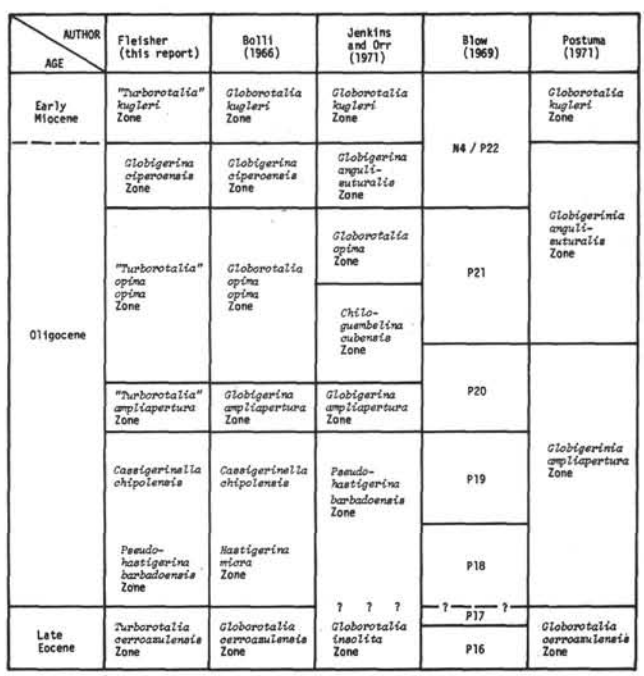

Figure 1. *Oligocene planktonic foraminiferal zonation systems.*

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modifications appear warranted. *Globorotalia siakensis* LeRoy, previously placed in *Turborotalia* (Fleisher, 1974), is here assigned to *Neogloboquadrina*. *N. siakensis* is the earliest clearly recognizable ancestor of the lineage which includes, among other species, *N. continuosa* (Blow), *N. acostaensis* (Blow), and *N. humerosa* (Takayanagi and Saito), and which culminates in *N. dutertrei* (d'Orbigny) and *N. pachyderma* (Ehrenberg). The generic name *Turborotalia* should be retained only for the lineage culminating in *T. cerroazulensis s.l. The ancestry of many middle Tertiary turborotaliform species, including Globorotalia opima, G. opima nana*, and *G. kugleri* among others, is not presently clear. They are placed in "*Turborotalia*" pending clarification of their phylogenetic history. Included here as well are *Globigerina ampliapertura* and *G. euapertura* (= *G. prasaepis*), species which evolved from the turborotaliform "*T.*" *increbescens* (Blow and Banner, 1962; Blow, 1969).

SITE DESCRIPTIONS

Site 305

Oligocene planktonic foraminifera are present in Sample 6-6, 110-112 cm, but the rare tests are probably reworked into younger (middle Miocene) assemblages. A very small in situ fauna occurs, however, in Sample 6-5, 122-125 cm, and a stratigraphic hiatus is clearly present between these two horizons. This population contains well-developed *Neogloboquadrina siakensis* and "*Turborotalia*" *opima nana*, but "*T.*" *opima opima* is absent. Relatively rare specimens of morphologically (and probably phyletically) primitive *Globigerinita boweni* were also observed; the transition to this species from *Tenuitella clemenciae* has been recorded elsewhere from the late Oligocene (Jenkins, 1966; Fleisher, 1974). Similar, but generally smaller, less diverse, and less diagnostic faunas persist throughout Core 7. This fauna should probably be assigned to the *Globigerina ciperoensis* Zone, although it is diagnostic only to the extent that the absence of "*Turborotalia*" *opima opima* results from its prior extinction and not from secondary test destruction.

Planktonic tests are somewhat more common in the sediments recovered in Core 8, but faunal diversity remains relatively low. Core 8, Sections 1 and 2, contain a fauna consisting of long-ranging species dominated by "*Turborotalia*" *euapertura*. No precise zone assignment is possible based directly upon the observed species, but the presence of *Catapsydrax dissimilis ciperoensis* and rare *Chiloguembelina cubensis*, and the absence of *Pseudohastigerina* spp. and "*T.*" *opima opima*, suggest assignment to the "*Turborotalia*" *ampliapertura* Zone. Faunas throughout the interval of Core 8, Section 3 through Core 9, Section 2, 42-44 cm, are similar, except that both *Turborotalia pseudoampliapertura* and *Pseudohastigerina barbadoensis* are present. These samples are placed within the *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. In the remainder of Core 9, planktonic foraminifera are virtually absent, and the very rare specimens in Sample 9, CC and Core 10 are of definite Eocene age. Table 1 summarizes the planktonic foraminifera found at Site 305.

Site 310

Reworked Oligocene specimens are present in the Miocene sediments in Sample 9, CC, but Oligocene populations are present only in portions of Core 10 (Table 2). Planktonic tests are almost absent in Section 1, but are somewhat more common in samples from Sections 2 through 5. Most of the preserved specimens represent long-ranging and nondiagnostic species, notably *Catapsydrax perus*, "*Turborotalia*" *euapertura*, and *Globoquadrina galavisi*. The rare occurrence of *Turborotalia pseudoampliapertura* and *Subbotina angiporoides* provides the basis for tentatively assigning this interval to the *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. *P. barbadoensis* is probably absent because of test dissolution; alternatively, the two species mentioned above may be reworked and the faunas representative of the "*T.*" *ampliapertura* Zone. This assemblage persists as low as Sample 10-6, 30-32 cm, but 20 cm lower in the core the sediments are essentially barren of planktonic foraminiferal tests.

Site 313

Oligocene faunas occur only in Cores 3 and 4 at Site 313 (Table 3). The small faunas of Core 3 are of late Oligocene age, but precise zone assignment is difficult because of low diversity. "*Turbotoralia*" *opima opima* is present in Section 6, 51-54 cm, and probably in Section 5; these samples are assigned to the "*T.*" *opima opima* Zone. The overlying faunas in Core 3, dominated by *Globoquadrina sellii* but lacking *G. binaiensis*, represent the early portion of the *Globigerina ciperoensis* Zone.

Foraminiferal populations in Core 4, similarly, are relatively nondiverse and nondiagnostic. In most samples, *Tenuitella clemenciae* is present; this form appears to be limited to post-early Oligocene horizons in tropical regions (Blow, 1969; Fleisher, 1974), although its range is not fully known. *Globoquadrina sellii* is also present in Sections 4 and 6; in contrast, both "*Turborotalia*" *opima opima* and *Pseudohastigerina* spp. are absent from most samples. This combination suggests assignment to the "*Turborotalia*" *ampliapertura* Zone. The presence of the early Oligocene species *Turborotalia pseudoampliapertura*, *Globoquadrina tapuriensis*, and *Pseudohastigerina barbadoensis* in Sample 4-2, 51-54 cm, indicates an apparent age within the *Cassigerinella chipolensis-P. barbadoensis* Zone, but these forms are not present in the relatively rich samples in Sections 4 and 6. It is suggested here that these specimens are reworked.

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Edith Vincent (Scripps Institution of Oceanography) for her assistance and encouragement during the preparation of this report. This study was supported under Oceanographic Section, National Science Foundation NSF Grant GA-34145.

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TABLE 1
Distribution of Planktonic Foraminiferal Species in Samples from Site 305

Age	Zone	Sample (Interval in cm)	*Catapsydrax dissimilis s.s.*	*C. dissimilis ciperoensis*	*C. unicavus primitivus*	*C. perus*	*C. riveroae*	*C. martini s.s.*	*Chiloguembelina cubensis*	*Globigerinita boweni*	*Globoquadrina sellii*	*G. tripartita*	*G. galavisi*	*G. praedehiscens*	*G. tapuriensis*	*G. pseudovenezuelana*	*Globorotaloides suteri*	*Neogloboquadrina siakensis*	*Pseudohastigerina* spp.	*Subbotina minima*	*S. gortanii s.s.*	*S. angiporoides*	*S. corpulenta*	*S. eocaena*	*S. winkleri*	*Tenuitella clemenciae*	*T. minutissima*	*T. gemma*	*Turborotalia pseudoampliapertura*	*"Turborotalia" opima nana*	*"T." euapertura*	*Turborotalita primitiva*
Late Oligocene	*Globigerina ciperoensis*	6-6, 122-125	X	X						X	X	X						X								X	X			X		
		7-1, 120-123	X		X					X							X									X		?		X	X	X
		7-2, 120-123	X		X	X											X													X	X	
		7-4, 125-127			X	X					?	X														?						X
		7-6, 120-122	X			X											X														X	
		7, CC			X	X	X					X	X				X			X						X		?		X		
Early Oligocene	a_1	8-1, 131-133	X	X	X	X	X							X			X				X										X	
		8-2, 136-138	X	X	X	X			X						?		X					?				X					X	
	b_2	8-3, 135-136				X	X					X			X		X		X										X		X	
		8-6, 136-138				X	X						X			X	X		X				?					X	X		X	
		8, CC	X				X	X								X	X		X										X	X	X	
		9-2, 42-44	X			X							X			X	X		X					X	X				X		X	
?	?	9-3, 120-122																														
		9-4, 120-122											X				X														X	
		9-5, 120-122					X																									
		9-6, 38-40																														

[a] *"Turborotalia" ampliapertura*

[b] *Cassigerinella chipolensis-Pseudohastigerina barbadoensis*

TABLE 2
Distribution of Planktonic Foraminiferal Species in Samples from Site 310

Age	Zone	Sample (Interval in cm)	*Catapsydrax riveroae*	*C. perus*	*C. unicavus primitivus*	*Globoquadrina tripartita*	*G. galavisi*	*G. tapuriensis*	*Globorotaloides suteri*	*Subbotina eocaena*	*S. utilisindex*	*S. angiporoides*	*S. minima*
Early Oligocene	a_1	10-1, 50-52	X			X			X				
		10-2, 121-123		X			X	?	X	X	X		
		10-5, 41-43	X	X						X		X	
		10-6, 30-32	X	X	X					X		X	?

[a] *Cassigerinella chipolensis-Pseudohastigerina barbadoensis*

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TABLE 3
Distribution of Planktonic Foraminiferal Species in Samples from Site 313

Age	Zone	Sample (Interval in cm)	*Cassigerinella chipolensis*	*Catapsydrax dissimilis s.s.*	*C. dissimilis ciperoensis*	*C. perus*	*C. riveroae*	*Chiloguembelina cubensis*	*Globoquadrina galavisi*	*G. sellii*	*G. tripartita*	*G. tapuriensis*	*Globorotaloides suteri*	*Neogloboquadrina siakensis*	*Pseudohastigerina barbadoensis*	*Tenuitella angustumbilicata*	*T. clemenciae*	*T. gemma*	*Turborotalia pseudoampliapertura*	*"Turborotalia" euapertura*	*"T." opima nana*	*"T." opima opima*
Late Oligocene	a_1	3-1, 51-54		X					X	X	X		X			X	X			X	X	
		3-2, 51-54		X	X			?	X	X	X		X	?		X	X			X	X	
	b_2	3-5, 51-54		X		?				X	X		X				X	X		X	X	?
		3-6, 121-124									X		X					X		X	X	X
Early Oligocene	c_3	4-1, 81-84				X			X		X		X					X		X	X	
		4-2, 51-54	X				X	X	X		X	X			X		X	X	X	X		
		4-4, 121-124	X					X	X	X	X		X				X	X	X	X	X	
		4-6, 51-54				X		X	X	X	X		X			X	X	X		X	X	

[a] *Globigerina ciperoensis*

[b] *"Turborotalia" opima opima*

[c] *"Turborotalia" ampliapertura*

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PLATE EXPLANATION

"*D*" represents the maximum diameter or length of the specimen measured on the illustrated orientation. Different figures of the same species are of different specimens unless otherwise indicated. All illustrated specimens have been deposited in the collections of the U.S. National Museum, Washington, D.C.

R.D. Hockett, of Exxon Production Research Co., took the scanning electron micrographs, for which the author is grateful.

PLATE 1

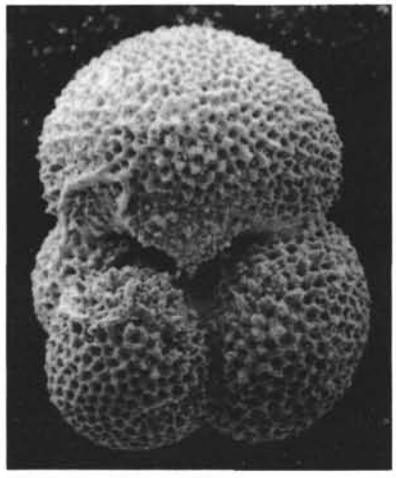
Figures 1, 2 — *Globoquadrina galavisi*, both from Sample 305-9-2, 42-44 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone.
1. ×100; *D* = 0.56 mm. Umbilical view.
2. ×100; *D* = 0.59 mm. Lateral view.

Figure 3 — *Globoquadrina pseudovenezuelana*, Sample 305-9-2, 42-44 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. ×100; *D* = 0.61 mm. Umbilical view.

Figure 4 — *Globoquadrina tripartita*, Sample 313-4-4, 51-54 cm, "*Turborotalia*" *ampliapertura* Zone. ×75; *D* = 0.57 mm. Umbilical view.

Figures 5, 6 — *Globoquadrina sellii*.
5. From Sample 313-3-2, 51-54 cm, *Globigerina ciperoensis* Zone. ×75; *D* = 0.59 mm. Umbilical view.
6. From Sample 313-4-4, 51-54 cm, "*Turborotalia*" *ampliapertura* Zone. ×75; *D* = 0.55 mm. Lateral view.

Figures 7, 8 — *Catapsydrax unicavus primitivus*, Sample 310-10-5, 41-43 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. ×75; *D* = 0.33 mm. Umbilical and lateral views of same specimen.



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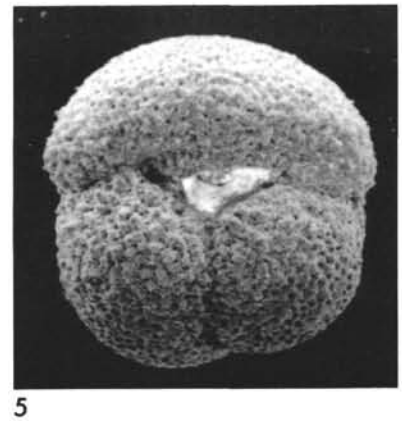

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PLATE 2

Figures 1, 2 — *Catapsydrax riveroae*, Sample 310-10-6, 30-32 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. ×75; *D* = 0.75 mm. Umbilical and lateral views of same specimen. Note the well-developed apertural lip.

Figures 3, 4 — *Catapsydrax dissimilis ciperoensis*, Sample 313-3-2, 51-54 cm, *Globigerina ciperoensis* Zone. ×75; *D* = 0.55 mm. Umbilical and lateral views of same specimen.

Figures 5, 6 — *Catapsydrax perus*, Sample 310-10-5, 41-43 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. ×75; *D* = 0.55 mm. Umbilical and lateral views of same specimen.

Figures 7, 8 — *Turborotalia pseudoampliapertura*, Sample 313-4-4, 51-54 cm, "*Turborotalia*" *ampliapertura* Zone. ×75; *D* = 0.78 mm. Umbilical and lateral views of same specimen.

PLATE 2


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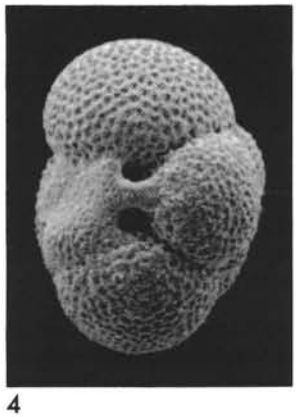
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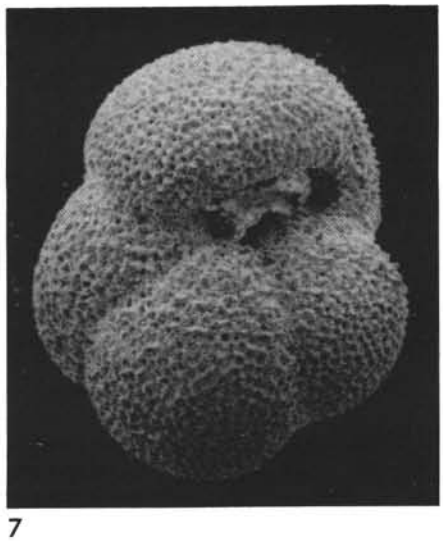
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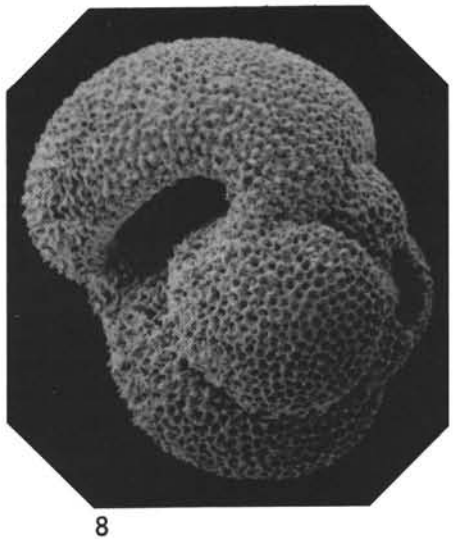
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PLATE 3

Figure 1 — *Globigerinita boweni*, Sample 305-7-1, 120-123 cm, *Globigerina ciperoensis* Zone. ×250; *D* = 0.15 mm. Umbilical view.

Figures 2-4 — *Tenuitella clemenciae*.
2. From Sample 305-7-1, 120-123 cm, *Globigerina ciperoensis* Zone. ×250; *D* = 0.19 mm. Umbilical view.
3. From Sample 313-4-4, 51-54 cm, "*Turborotalia*" *ampliapertura* Zone. ×250; *D* = 0.22 mm. Lateral view.
4. Detail of wall, peripheral margin of first chamber of final whorl, same specimen as Figure 3. ×2000. Note the extremely small pores partially obscured by crystallites.

Figures 5-7 — *Tenuitella gemma*, from Sample 313-4-4, 51-54 cm, "*Turborotalia*" *ampliapertura* Zone. *D* = 0.20 mm.
5. ×250. Umbilical view.
6. Detail of wall, ventral surface of final chamber. ×2000.
7. Detail of wall, ventral surface of penultimate chamber. ×2000. These figures illustrate the progressive growth of pustular crystallites on the test surface; variations over the test indicate that these changes are ontogenetic rather than a result of secondary recrystallization.

Figures 8, 9 — "*Turborotalia*" *euapertura*, both from Sample 305-8-1, 131-133 cm, "*Turborotalia*" *ampliapertura* Zone.
8. ×75; *D* = 0.54 mm. Umbilical view.
9. ×75; *D* = 0.61 mm. Lateral view.

Figure 10 — *Turborotalia pseudoampliapertura*, from Sample 305-9-2, 42-44 cm, *Cassigerinella chipolensis-Pseudohastigerina barbadoensis* Zone. ×100; *D* = 0.44 mm. The dissolution pattern illustrated here, typified by scaling of the outer layer of the test wall, is characteristic not only of this species but of others in the *T. cerroazulensis* lineage as well.

PLATE 3


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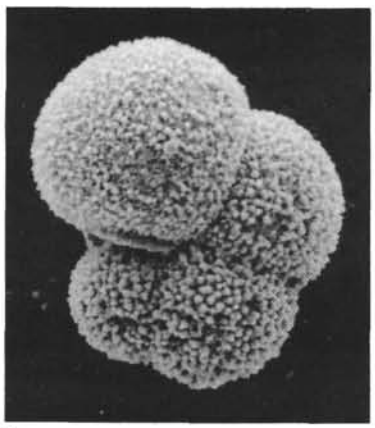
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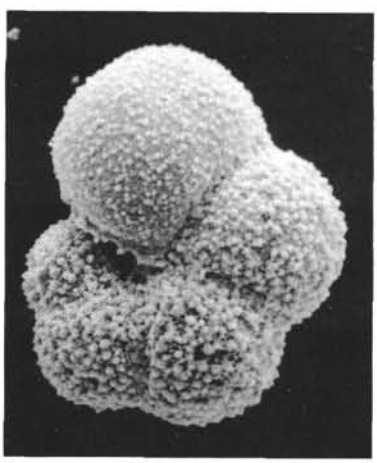
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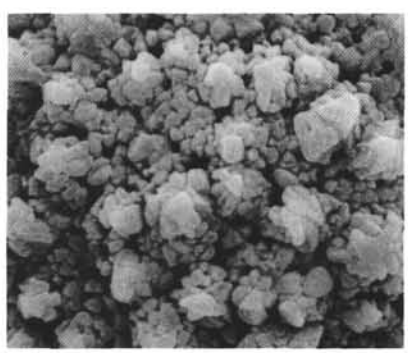
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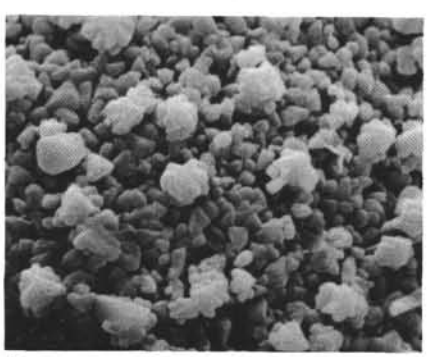
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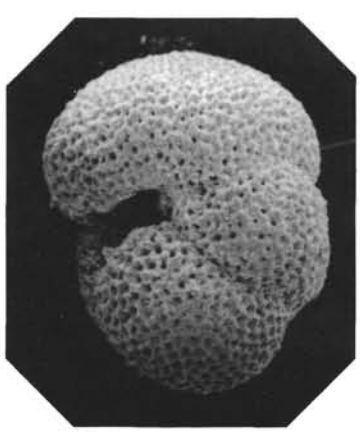
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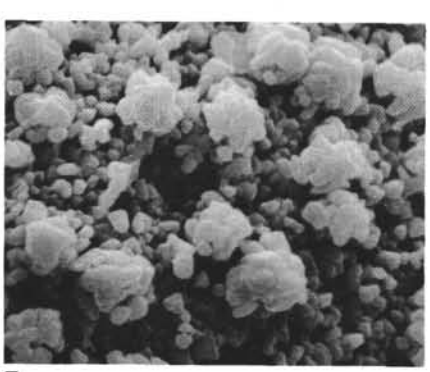
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