13. COCCOLITH STRATIGRAPHY LEG 11 DEEP SEA DRILLING PROJECT[1]

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Leg 11 of the Deep Sea Drilling Project, April-June 1970, from Miami to Hoboken, recovered 149 cores at ten drilling sites in the western Atlantic Ocean (Figure 1). Light-microscope techniques were used to study the coccoliths of 215 samples from these cores. Zonal assignment of cores from Leg 11 is summarized in Table 1.

SITE 98
(lat 25°22.95'N., long 77°18.68'W., depth 2769 meters)

Site 98 was cored in the Northeast Providence Channel northeast of Andros Island in the Bahamas to investigate the sedimentologic history of the Bahama Banks. Coccoliths are abundant in samples from Cores 1 to 14, which range in age from Pleistocene to Late Cretaceous (Campanian) and indicate a continuing dominance of deep-water pelagic sedimentation, suggesting that the channel has been long lived. Shipboard scientists report that Core 15, which I have not examined, bottomed in Upper Cretaceous (Senonian) reef rock at 357 meters below the sea floor.

Samples from Core 1 (0 to 9 meters below sea floor) contain a warm-water assemblage of the Pleistocene *Gephyrocapsa oceanica* Zone overlying lower Pliocene and upper Miocene assemblages of the *Ceratolithus rugosus* Zone and *Ceratolithus tricorniculatus* Zone. The common occurrence of *Rhabdosphaera* and *Scyphosphaera* indicates warm-water oceanic deposition. Cores 2 and 3 were taken in sequence (9 to 27 meters) and also recovered upper Miocene assemblages containing *Discoaster perplexus* Bramlette and Riedel and species of *Rhabdosphaera* and *Scyphosphaera.* Core 4 (55 to 64 meters) contains an upper miocene assemblage of the *Discoaster quinqueramus* Zone characterized by the occurrence of *Discoaster pentaradiatus* Tan, *D. quinqueramus* Gartner, *Rhabdosphaera* sp., and *Scyphosphaera pulcherrima* Deflandre. In Core 5 (93 to 102 meters), a moderately shallow oceanic assemblage of the upper Oligocene *Sphenolithus ciperoensis* Zone is present. The common occurrence of *Helicopontosphaera truncata* (Bramlette and Wilcoxon), *Braarudosphaera rosa* Levin and Joerger, and *Micrantholithus* sp. indicates fairly shallow deposition. Shallow oceanic assemblages of lower upper Eocene and upper middle Eocene are present in Core 6 (130 to 139 meters). The diversity of the assemblage is comparable to that of coeval deposits from the Blake Plateau (Table 2). The following taxa serve to indicate that the depth of deposition was more comparable with Gulf Coast neritic assemblages than with deep-ocean assemblages: *Braarudosphaera* sp., *Corannulus germanicus* Stradner, *Cyclococcolithina protoannula* Gartner, *Lanternithus minutus* Stradner, *Micrantholithus basquensis* Martini, *M. procerus* Bukry and Bramlette, *M. stradneri* Chang, *Pedinocyclus larvalis* (Bukry and Bramlette), *Pemma papillatum* Martini, and *Peritrachelina joidesa* Bukry and Bramlette. Core 7 (167 to 176 meters) recovered a typical middle-middle Eocene assemblage containing *Braarudosphaera discula* Bramlette and Reidel, *Campylosphaera dela* (Bramlette and Sullivan), *Chiasmolithus grandis* (Bramlette and Reidel), *Chiphragmalithus* sp., *Lophodolithus rotundus* Bukry and Percival, *Reticulofenestra samodurovi* (Hay, Mohler, and Wade), *Thoracosphaera prolata* Bukry and Bramlette, *Triquetrorhabdulus inversus* Bukry and Bramlette, and *Sphenolithus furcatolithoides* Locker. It compares most closely with shallow oceanic deposits, such as those from Leg 10 in the Gulf of Mexico that have undergone little solution (Table 3).

Cores 8 to 12 were cut continuously from 207 to 241 meters in lower Eocoene and upper Paleocene chalk ooze. Whereas the assemblage of Cores 8 and 9 is mainly that of the *Tribrachiatus orthostylus* Zone, Cores 10 and 11 contain mixed elements of the *Tribrachiatus orthostylus* Zone, *Discoaster diastypus* Zone, and *Discoaster multiradiatus* Zone. A sample from Core 12 contains *Braarudosphaera* sp., *Discoaster multiradiatus* Bramlette and Riedel, *D. ornatus* Stradner, *Fasciculithus tympaniformis* Hay and Mohler, and *Toweius craticulus* Hay and Mohler; and it is assigned to the upper Paleocene *Discoaster multiradiatus* Zone.

Core 13 (272 to 281 meters) contains an upper Campanian coccolith ooze assigned to the *Tetralithus gothicus trifidus* Zone (=*Tetralithus nitidus trifidus* Zone). Characteristic taxa include: *Arkhangelskiella*

[1]Publication authorized by the Director, U.S. Geological Survey.

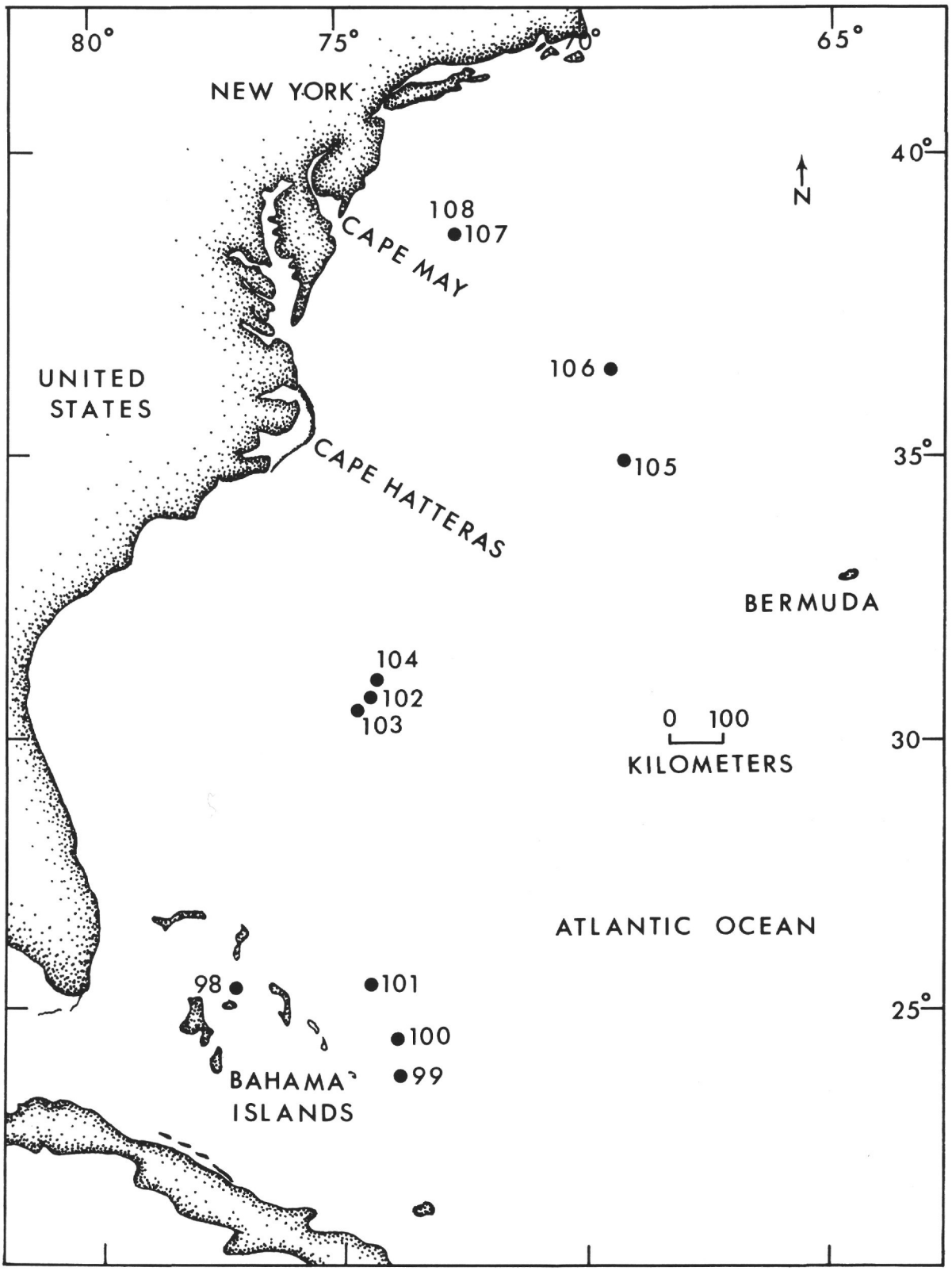

Figure 1. *Location of coring sites for Leg 11, Deep Sea Drilling Project.*

TABLE 1
Geologic Age and Zone or Stage Assignment of Cores from Leg 11 Based on Coccoliths in Samples Examined

Age	Zone or Stage \ DSDP HOLE	98	99A	100	101	101A	102	103	104	105	106	106B	108
Pleistocene and Holocene	Emiliania huxleyi												
	Gephyrocapsa oceanica	1	1A				1-2						2
	Coccolithus doronicoides		1A				3-8			2	1-6		
Pliocene	Discoaster brouweri		2A		1	1A	9-12					1B	
	Reticulofenestra pseudoumbilica		2A				13-14	1				2B	
	Ceratolithus rugosus	1			2		14-15			3			
Miocene	Ceratolithus tricorniculatus	1-3				1A-2A	16-19						
	Discoaster quinqueramus	3-4				3A		2-4	1?			3B	
	Discoaster neohamatus							5	2				
	Discoaster hamatus											4B-5B	
	Catinaster coalitus								3-9				
	Discoaster exilis												
	Sphenolithus heteromorphus								10				
	Helicopontosphaera ampliaperta												
	Sphenolithus belemnos												
	Triquetrorhabdulus carinatus												
Oligocene	Sphenolithus ciperoensis	5											
	Sphenolithus distentus												
	Sphenolithus predistentus												
	Helicopontosphaera reticulata												
Eocene	Discoaster barbadiensis	6											
	Reticulofenestra umbilica	6?											
	Chiphragmalithus quadratus	7											1
	Discoaster sublodoensis												
	Discoaster lodoensis												
	Tribrachiatus orthostylus	8-9											
	Discoaster diastypus	9-11											
Paleocene	Discoaster multiradiatus	12											
	Discoaster mohleri												
	Heliolithus riedeli												
	Heliolithus kleinpelli												
	Cruciplacolithus tenuis												
Cretaceous	Campanian	13-14											
	Albian or Aptian									17-18			
	Hauterivian									18			
	Valanginian		8A-9A	1						20-32			
Jurassic	Tithonian or Portlandian			4-10						33-35			
	Kimmeridgian or Oxfordian									35-39			

TABLE 2
Comparison of Three Upper Eocene Coccolith Assemblages[a]

UPPER EOCENE LOCALITIES / COCCOLITH TAXA	JOIDES Blake Plateau Hole J6 (74 meters)	Deep Sea Drilling Project Hole DSDP 98 (130-139 meters)	Deep Sea Drilling Project Hole DSDP 19 (76-85 meters)
Braarudosphaera rosa	X	X	
Bramletteius serraculoides	X	X	X
Corannulus germanicus		X	
Cyclococcolithina formosa	X	X	X
Cyclococcolithina protoannula		X	
Cyclococcolithina reticulata	X	X	
Dictyococcites bisectus	X	X	X
Discoaster barbadiensis	X	X	X
Discoaster tani tani	X	X	X
Discolithina plana	X		
Helicopontosphaera compacta	X	X	X
Helicopontosphaera reticulata		X	
Isthmolithus recurvus	X		X
Lanternithus minutus		X	
Micrantholithus aequilis	X	X	
Micrantholithus basquensis		X	
Micrantholithus procerus	X	X	
Pedinocyclus larvalis		X	
Pemma papillatum	X	X	
Peritrachelina joidesa	X	X	
Reticulofenestra umbilica	X	X	X
Rhabdosphaera tenuis	X		
Sphenolithus pseudoradians		X	X
Syracosphaera labrosa	X		
Zygrhablithus bijugatus	X	X	

[a]DSDP Hole 98, a well-preserved assemblage of JOIDES Blake Plateau Hole J4, and a partly dissolved assemblage of DSDP Hole 19 in the South Atlantic.

TABLE 3
Comparison of Three Middle Middle Eocene Coccolith Assemblages[a]

MIDDLE EOCENE LOCALITIES / COCCOLITH TAXA	Deep Sea Drilling Project Hole DSDP 98 (167-176 meters)	Deep Sea Drilling Project Hole DSDP 94 (433-460 meters)	Formación Aragón Mexico
Braarudosphaera discula	X	X	
Campylosphaera dela	X	X	X
Chiasmolithus grandis	X	X	X
Chiasmolithus solitus	X	X	X
Chiphragmalithus cristatus	X	X	X
Chiphragmalithus quadratus	X	X	X
Coccolithus cribellum		X	X
Coccolithus pseudogammation	X	X	X
Cyclolithella bramlettei	X	X	X
Discoaster barbadiensis	X	X	X
Discoaster stradneri		X	X
Discoaster tani nodifer	X	X	X
Discolithina distincta		X	X
Helicopontosphaera seminulum		X	X
Lophodolithus acutus		X	X
Lophodolithus rotundus	X	X	
Reticulofenestra samodurovi	X	X	X
Rhabdosphaera morionum			X
Rhabdosphaera tenuis		X	X
Spenolithus furcatolithoides	X	X	X
Sphenolithus radians	X	X	X
Thoracosphaera prolata	X		
Triquetrorhabdulus inversus	X	X	X

[a]Assemblages of DSDP Hole 98 are similar to those of DSDP Hole 94 in the Gulf of Mexico and the Formación Aragon of Mexico.

cymbiformis Vekshina, *Broinsonia parca* (Stradner), *Lucianorhabdus cayeuxi* Deflandre, *Tetralithus gothicus gothicus* Stradner, and *Tetralithus gothicus trifidus* Stradner and Papp. The deepest sample studied, from Core 14 (311 to 318 meters), also contains a Campanian assemblage that appears to be somewhat older. Taxa present include *Arkhangelskiella cymbiformis, Broinsonia parca, Eiffellithus augustus* Bukry, *Tetralithus gothicus trifidus, Tetralithus pyramidus* Gardet, and *Watznaueria biporta* Bukry.

SITE 99
(lat 23°41.14′N., long 73°50.99′W., depth 4914 meters)

In the area east of San Salvador Island, Bahamas, Mesozoic oceanic strata occur at relatively shallow depths below the sea floor. Coring these strata was the main objective at this site. No cores were obtained from the first hole cut, but coring in Hole DSDP 99A was successful. The two shallowest cores, 1A and 2A, cut from 0 to 15 meters below the sea floor, contain middle Pleistocene to lower Pliocene assemblages, that show evidence of mixed preservation, dilution and reworking. *Discoaster* species in the same sample are partly overgrown and dissolved. The lowest sample available from Core 2A contains an assemblage of the lower Pliocene *Discoaster asymmetricus* Subzone of the *Reticulofenestra pseudoumbilica* Zone containing reworked Lower Cretaceous taxa, such as *Nannoconus steinmannii* Kamptner, *Parhabdolithus embergeri* Noël, and *Watznaueria barnesae* (Black). The only other samples available from this site contain sparse Lower Cretaceous (Valanginian) assemblages, that include *Discolithus cuvillieri* Manivit, *N. steinmannii, P. embergeri, W. barnesae,* and *Coccolithus? deflandrei* Manivit. These assemblages are from Cores 8A and 9A from 94 and 131 meters. Shipboard scientists report the absence of *Nannoconus* in Cores 13A and 14A and the presence of an Upper Jurassic pollen flora.

SITE 100
(lat 24°41.28′N., long 73°47.95′W., depth 5325 meters)

Site 100 between the Hatteras Abyssal Plain and the Bahama Platform was intended to recover Mesozoic strata. Coring was begun after 203 meters penetration into the sea floor. Core 1 contains a diverse coccolith assemblage indicative of earliest Cretaceous (Valanginian) age. Taxa include: *Coccolithus? deflandrei* Manivit; *Corollithion* sp. of Bukry and Bramlette 1969, Plate 5, Figure B; *Cyclagelosphaera margereli* Noël; *Diazomatolithus lehmani*, Noël; *Discolithus cuvilleri* Manivit; *Nannoconus* sp. 1 of Manivit, Charollais, and Steinhauser, 1969, Plate 2, Figure 2, [Berriasian]; *N. globulatus* Brönnimann; *N. steinmannii* Kamptner; *Parhabdolithus embergeri* Noël; *Stephanolithion laffittei* Noël; *Watznaueria barnesae* (Black); *W. britannica* (Stradner). The next deeper sample studied is from Core 4, at 260 meters, in which coccolith diversity and abundance is greatly reduced. Except for an occurrence of *Stephanolithion bigoti* Deflandre in Cores 7 and 8, the assemblage of Cores 4 to 10 consists mainly of *Watznaueria barnesae, W. britannica* and *C. deflandrei*. The presence of *Stephanolithion bigoti, Watznaueria britannica* and *Coccolithus? deflandrei* together with the absence of *Parhabdolithus embergeri* indicates the lower Upper Jurassic (Callovian to Kimmeridgian).

SITE 101
(lat 25°11.93′N., long 74°26.31′W., depth 4868 meters)

Coring at the south end of the Blake-Bahama Outer Ridge was carried out in Hole 101 and Hole 101A. Only two cores were taken at Hole 101. Core 1 is upper Pliocene containing *Ceratolithus rugosus* Bukry and Bramlette, *Coccolithus pelagicus* (Wallich), *Cyclococcolithina macintyrei* (Bukry and Bramlette), *Discoaster brouweri,* Tan, *D. pentaradiatus* Tan, *Helicopontosphaera sellii* Bukry and Bramlette, and *Rhabdosphaera clavigera* Murray and Blackman. Core contains a lower Pliocene or upper Miocene *Ceratolithus rugosus* Zone assemblage that includes *Ceratolithus rugosus, C. tricorniculatus* Gartner, *Reticulofenestra pseudoumbilica* (Gartner), and *Sphenolithus neoabies* Bukry and Bramlette. Cores 1A to 3A of Hole 101A recovered an upper Miocene section including the *Discoaster quinqueramus* Zone and the *Ceratolithus tricorniculatus* Zone. Most specimens show evidence of calcite solution and breakage. Core 4A contains a residual Upper Cretaceous assemblage that shows the effects of extensive calcite solution. Taxa include *Apertapetra gronosa* (Stover), *Cretarhabdus crenulatus* Bramlette and Martini, *Eiffellithus turriseiffeli* (Deflandre), *Watznaueria barnesae* (Black), and *Zygodiscus* spp. Samples of clay available from the deeper Cores 5A to 8A are essentially barren, but contain rare specimens of *W. barnesae.* Although the entire section could represent a reworked and selectively dissolved deposit of any age from Cenomanian to Miocene, the great abundance of *Apertapetra gronosa* and *Watznaueria barnesae* in Core 4A suggests that the material is probably a solution residuum which is stratigraphically in place.

SITE 102
(lat 30°43.93′N., long 74°27.14′W., depth 3426 meters)

Site 102 and the following two sites, 103 and 104, were cored to determine the constructional history of the Blake-Bahama Outer Ridge. At Site 102 the upper eight cores from the sea floor to a depth of 228 meters recovered Pleistocene coccolith assemblages which vary in specimen size, detrital dilution, degree of solution, and diversity. Apparent warm- and cool-water assemblages are interspersed. A nearly complete Pliocene

section in Cores 9 to 15 (266 to 548 meters) contains *Ceratolithus rugosus* Bukry and Bramlette, *Coccolithus pelagicus* (Wallich), and *Rhabdosphaera* spp. Upper Miocene *Ceratolithus tricorniculatus* Zone assemblages in Cores 16 to 19 (584 to 661 meters) are diluted by an abundance of clay and silt. As in the Pliocene cores, *Coccolithus pelagicus* occurs with *Rhabdosphaera* spp. and *Scyphosphaera* spp., which represent a mixing of cool- and warm-water elements (McIntyre and Bé, 1967).

SITE 103
(lat 30°27.08′N., long 74°34.99′W., depth 3964 meters)

Coccolith assemblages at Site 103 range in age from the early Pliocene *Discoaster asymmetricus* Subzone of the *Reticulofenestra pseudoumbilica* Zone in Core 1 (0 to 8 meters) to the early late Miocene *Discoaster neohamatus* Zone in Core 5 (247 to 256 meters). A single specimen of *Discoaster variabilis* Martini and Bramlette (middle Miocene to Pliocene) was noted in clay and silt from Core 6 (343 to 352 meters). Many samples from this site contain only sparse partly dissolved specimens, but the superposition of resistant *Discoaster* populations permits zonal assignment. The *Discoaster neohamatus* Zone assemblage of Core 5 contains *Discoaster bellus* Bukry and Percival, *D. bollii*, Martini and Bramlette, *D. braarudii* Bukry, *D. brouweri* Tan s.l., *D. neohamatus* Bukry and Bramlette, *D. pentaradiatus* Tan, and *D. variabilis* Martini and Bramlette. The *Discoaster quinqueramus* Zone of Cores 2 to 4 contains *D. berggrenii* Bukry, *D. braarudii, D. brouweri s.l., D. pentaradiatus, D. quinqueramus* Gartner, *D. surculus* Martini and Bramlette, and *D. variabilis,* and the *Discoaster asymmetricus* Subzone of Core 1 contains *D. asymmetricus* Gartner, *D. brouweri, D. pentaradiatus,* and *D. surculus*.

SITE 104
(lat 30°49.65′N., long 74°19.64′W., 3811 meters)

Coccolith assemblages in the ten cores taken at Site 104 range in age from late Miocene (*Discoaster quinqueramus* Zone, Core 1, 0 to 9 meters) to early middle Miocene (*Sphenolithus heteromorphus* Zone, Core 10, 615 to 615 meters). The intervening samples contain mostly sparse assemblages of long-ranging taxa (middle Miocene to middle Pliocene) diluted in a matrix composed of large numbers of diatoms. Diagnostic assemblages in Core 2 (36 to 45 meters), indicating the late Miocene *Discoaster neohamatus* Zone, include rare *Discoaster calcaris* Gartner, common *D. neohamatus* Bukry and Bramlette, and common *D. variabilis* Martini and Bramlette. The early middle Miocene age for the deepest sample is indicated by the co-occurrence of *Coccolithus eopelagicus* (Bramlette and Riedel), *Cyclococcolithina neogammation* (Bramlette and Wilcoxon), *Discoaster braarudii* Bukry, *D. exilis* Martini and Bramlette, *D. signus* Bukry, *D. variabilis* Martini and Bramlette, and *Sphenolithus heteromorphus* Deflandre.

SITE 105
(lat 34°53.72′N., long 69°10.40′W., depth 5251 meters)

Site 105 is located at the northern end of the Hatteras Abyssal Plain, nearly 600 kilometers east of Cape Hatteras. The main obejctives, to sample Mesozoic strata and to determine the nature of acoustic reflecting horizons, were successfully accomplished by the cutting of 39 sediment cores and 4 cores into the underlying basalt. The majority of the cores are Upper Jurassic and Lower Cretaceous.

Samples available from Cores 2 and 3 respectively contain coccolith assemblages of Pleistocene and early Pliocene age. Samples available from Cores 4 to 16 (91 to 392 meters) are all barren. The remainder of the cored material contains abundant coccoliths starting with the Lower Cretaceous. *Micrantholithus obtusus* Stradner occurs in Core 18 (421 to 430 meters), indicating the Hauterivian. Valanginian assemblages in Cores 20 to 33 are characterized by the occurrence of *Discolithus cuvilleri* Manivit, *Parhabdolithus embergeri* Noël, *Stephanolithion laffittei* Noël, *Watznaueria barnesae* (Black), *Watznaueria britannica* (Stradner), and *Coccolithus? deflandrei* Manivit. Nannoconids are present in samples from Cores 27, 31, and 32. The Upper Jurassic species *Stephanolithion bigoti* Deflandre ranges through Cores 36 to 39, where *Coccolithus? deflandrei* and *Watznaueria britannica* are especially abundant. Some samples, such as Sample 11-105-36-2, 14 to 15 centimeters, contain diverse assemblages that include *Parhabdolithus* spp. and *Rhabdosphaera* spp. In Europe the first common *Nannoconus* spp. appeared in the Tithonian and the last common *Stephanolithion bigoti* in the Kimmeridgian or Oxfordian. On this basis, Cores 33 to 35 are considered Tithonian or Portlandian, and Cores 35 to 39 Kimmeridgian or Oxfordian.

SITE 106
(lat 36°26.01′N., long 69°27.69′W. depth 4500 meters)

Site 106 was drilled on the lower continental rise east of Norfolk to determine whether the 70-million-year hiatus in the section at Site 105 extends to the continental rise.

Six cores cut in Hole 106 (0 to 349 meters) all contain lower Pleistocene assemblages that include *Coccolithus doronicoides* Black and Barnes, *C. pelagicus* (Wallich),

Emiliania annula (Cohen), and *Gephyrocapsa caribbeanica* Boudreaux and Hay. Sample 11-106-3-5, 35 to 36 centimeters contains a diverse reworked Eocene assemblage and some reworked Pliocene specimens. The reworked Eocene taxa include: *Chiasmolithus solitus* (Bramlette and Sullivan), *Cyclococcolithina formosa* (Kamptner), *Dictyococcites scrippsae* Bukry and Percival, *Discoaster barbadiensis* Tan, *Isthmolithus recurvus* Deflandre, *Reticulofenestra hillae* Bukry and Percival, *Reticulofenestra umbilica* (Levin), *Transversopontis pulcher* (Deflandre), and *Zygolithus dubius* Deflandre.

Coccolith assemblages in samples from Hole 106B range in age from late Pliocene in Core 1 (366 to 375 meters) to middle or late Miocene in Core 5 (935 to 944 meters). The coccolith specimens are poorly preserved. The sediment is composed mainly of nonorganic clay and silt. Assemblages of the lower Pleistocene *Reticulofenestra pseudoumbilica* Zone or *Ceratolithus rugosus* Zone are present in Core 2B. *Discoaster quinqueramus* Gartner and *D. surculus* Martini and Bramlette occur throughout Core 3B, indicating the upper Miocene *Discoaster quinqueramus* Zone. Samples from deeper cores are barren [Cores 6B and 7B] or contain generalized assemblages of upper Miocene aspect [Core 4B: *Catinaster mexicanus* Bukry, *Discoaster* sp. cf. *D. pentaradiatus* Tan, *D. perclarus* Hay, *D. variabilis* Martini and Bramlette, *Reticulofenestra pseudoumbilica* (Gartner)] or middle Miocene aspect [Core 5B: *Coccolithus eopelagicus* (Bramlette and Riedel), *Discoaster* sp. cf. *D. bollii* Martini and Bramlette, *Discoaster* sp. cf. *D. deflandrei* Bramlette and Riedel, *D. variabilis, R. pseudoumbilica*].

SITE 108
(lat 38°48.27′N., long 72°39.21′W., depth 1845 meters)

Site 108 was drilled on the continental slope east of Cape May to sample strata of Mesozoic age. Owing to mechanical problems, sediment was recovered in only two cores. Core 1 (39 to 57 meters) contains a very diverse assemblage of shallow bathyal coccoliths of the middle middle Eocene *Chiphragmalithus quadratus* Zone. Species include:

Braarudosphaera bigelowi (Gran and Braarud)
B. discula Bramlette and Riedel
B. rosa Levin and Joerger
Campylosphaera dela (Bramlette and Sullivan)
Chiasmolithus expansus (Bramlette and Sullivan)
C. grandis (Bramlette and Riedel)
C. solitus (Bramlette and Sullivan)
Chiphragmalithus cristatus Bramlette and Sullivan
C. quadratus Bramlette and Sullivan
C. spinosus (Stradner)
Coccolithus eopelagicus (Bramlette and Riedel)
C. pseudogammation Bouché
Cyclococcolithina formosa (Kamptner)
Cyclolithella bramlettei (Hay and Towe)
Discoaster barbadiensis Tan
D. distinctus Martini
D. martinii Stradner
D. tani nodifer Bramlette and Riedel
D. wemmelensis Acuthan and Stradner
Discolithina oamaruensis (Deflandre)
Helicopontosphaera lophota (Bramlette and Sullivan)
H. seminulum (Bramlette and Sullivan)
Lophodolithus acutus Bukry and Percival
Markalius inversus (Deflandre)
Micrantholithus aequalis Sullivan
Reticulofenestra samodurovi (Hay, Mohler, and Wade)
Rhabdosphaera tenuis Bramlette and Sullivan
Sphenolithus furcatolithoides Locker
Syracosphaera labrosa Bukry and Bramlette
Transversopontis pulcheroides (Sullivan)
Triquetrorhabdulus inversus Bukry and Bramlette
Zygolithus dubius Deflandre
Zygrhablithus bijugatus (Deflandre)

A sample from Core 2 (11-108-2-1, 35 to 36 centimeters) is an essentially barren silt and clay that contains a few specimens of Pleistocene *Gephyrocapsa caribbeanica* Boudreaux and Hay and rare *Helicopontosphaera kamptneri* Hay and Mohler. Rare specimens of middle Eocene taxa are also present: *Chiasmolithus solitus, Helicopontosphaera lophota*, and *Zygolithus dubius.* As this sample is from near the top of Core 2, the Pleistocene components indicate that inhole slumping occurred from higher strata before this core was cut. No Pleistocene species were found in samples from Core 1.

REFERENCES

Bukry, D. and Bramlette, M. N., 1969. Coccolith age determinations Leg 1, Deep Sea Drilling Project. **In** M. Ewing *et al.*, 1969. *Initial Reports of the Deep Sea Drilling Project, Volume I.* Washington (U.S. Government Printing Office), 369.

———, 1970. Coccolith age determinations Leg 3, Deep Sea Drilling Project. **In** Maxwell *et al., Initial Reports of the Deep Sea Drilling Project, Volume III.* Washington (U.S. Government Printing Office), 589.

Manivit, H., Charollais, J. and Steinhauser, N., 1969. Associations de nannofossiles calcaires dans les formations Néocomiennes des chaines subalpines entre l'Arve et l'Isère (France). *Proc. First Intern. Conf. Planktonic Microfossils.* **2**, 26.

McIntyre, A. and Bé, A. W. H., 1967. Modern Coccolithophoridae of the Atlantic Ocean—I. Placoliths and Cyrtoliths. *Deep-Sea Res.* **14**, 561.