3. SITE 512[1]

Shipboard Scientific Party[2]

HOLES 512, 512A

Date occupied: 22 January 1980; 1105 hr. (beacon dropped)

Date departed: 27 January 1980; 1345 hr. (underway)

Number of holes: 2

Time on hole: 122.5 hr.

Position: 512 49°52.194′S; 40°50.713′W
512A 49°52.170′S; 40°50.710′W

Water depth (sea level; corrected m, echo-sounding): 1846

Water depth (rig floor; corrected m, echo-sounding): 1844

Bottom felt (m, drill pipe): 1844

Penetration (m): 512 78
512A 90

Number of cores: 512 19
512A 2

Total length of cored section (m): 512 78
512A 17

Total core recovered (m): 512 68.0
512A 7.8

Core recovery (%): 512 86
512A 45

Oldest sediment cored:
Depth sub-bottom (m): 512 78
512A 90
Nature: Siliceous-nannofossil ooze
Age: Middle Eocene
Measured velocity (km/s): ~1.6

Principal results: Holes 512, 512A—Continuous hydraulic piston coring was carried out in the northeastern part of the Maurice Ewing Bank to a sub-bottom depth of 77.9 meters and rotary drilling to a sub-bottom depth of 89.3 meters. A thin veneer of ice-rafted sands and gravels and diatomaceous ooze of Pliocene and Quaternary age is underlain by diatomaceous ooze and siliceous and nannofossil ooze of late and middle Miocene age. These are underlain by more indurated siliceous-nannofossil ooze of middle Eocene age. The oozes are rich in planktonic foraminifers, nannofossils, radiolarians, diatoms, and silicoflagellates that make it possible to correlate their zonal schemes as well as to compare them with the New Zealand Eocene. Four hiatuses are recognized; one separating Pleistocene and Pliocene sediments, a second within the Pliocene, another separating lower Pliocene and upper Miocene, and a fourth between the middle Miocene and middle Eocene. Unfortunately, a strong current aligned at a high angle to the wind and swell prevented the vessel from maintaining position, and the site was abandoned before all objectives could be reached.

BACKGROUND AND OBJECTIVES

Maurice Ewing Bank is a domelike feature located at the eastern end of the Falkland Plateau (Fig. 1). Drilling by *Glomar Challenger* (Leg 36, Site 327) showed the bank to consist of a thick sequence of carbonate and siliceous sediments of Tertiary and Cretaceous through Neocomian age. As such, it provides a reference section from which to study the sedimentary and paleoenvironmental history of the South Atlantic.

From the analyses of piston cores, seismic reflection data, and Leg 36 results, Ciesielski and Wise (1977) conclude that marked changes in lithologic facies, ranging from coccolith ooze in the crestal zone of the bank to diatom ooze and zeolitic clay on its flanks, are the result of a high calcium carbonate compensation depth (CCD) coupled with significant variation in topography across the bank during the Tertiary. Strong bottom currents associated with the early Miocene opening of the Drake Passage and the late Miocene Antarctic glaciation caused erosion of significant amounts of sediment.

Site 512 was chosen to define more precisely the major Tertiary erosional events and fluctuations of the CCD at a high-latitude site in the South Atlantic, to establish the biostratigraphy of high-latitude calcareous microfossils, and to correlate microfossil with oxygen isotope and paleomagnetic records. Because this site lies well above the present-day CCD, its results can be compared with those from DSDP Hole 327A, drilled in deeper water on the bank near the present-day CCD. Because the sequence is in shallower water, it makes possible better age definitions through study of calcareous nannofossils. Furthermore, the sequence should also assist in the study of biogeographic differentiation of planktonic fauna and flora before and after the development of the Antarctic Circumpolar Current. The objectives of drilling at the site were to penetrate and core (1) the Miocene/Oligocene boundary, in order to determine the paleoceanographic changes associated with the opening of the Drake Passage and the establishment of the Antarctic Circumpolar Current (geophysical evidence suggests that this occurred near the Miocene/Oligocene boundary ~22 Ma); (2) the Eocene section, in order to establish the Eocene biostratigraphic record and to observe fluctuations of the CCD (the Eocene is almost unrepresented in Antarctic sites); (3) the Paleo-

[1] Ludwig, W. J., Krasheninnikov, V. A. et al., *Init. Repts. DSDP*, 71: Washington (U.S. Govt. Printing Office).

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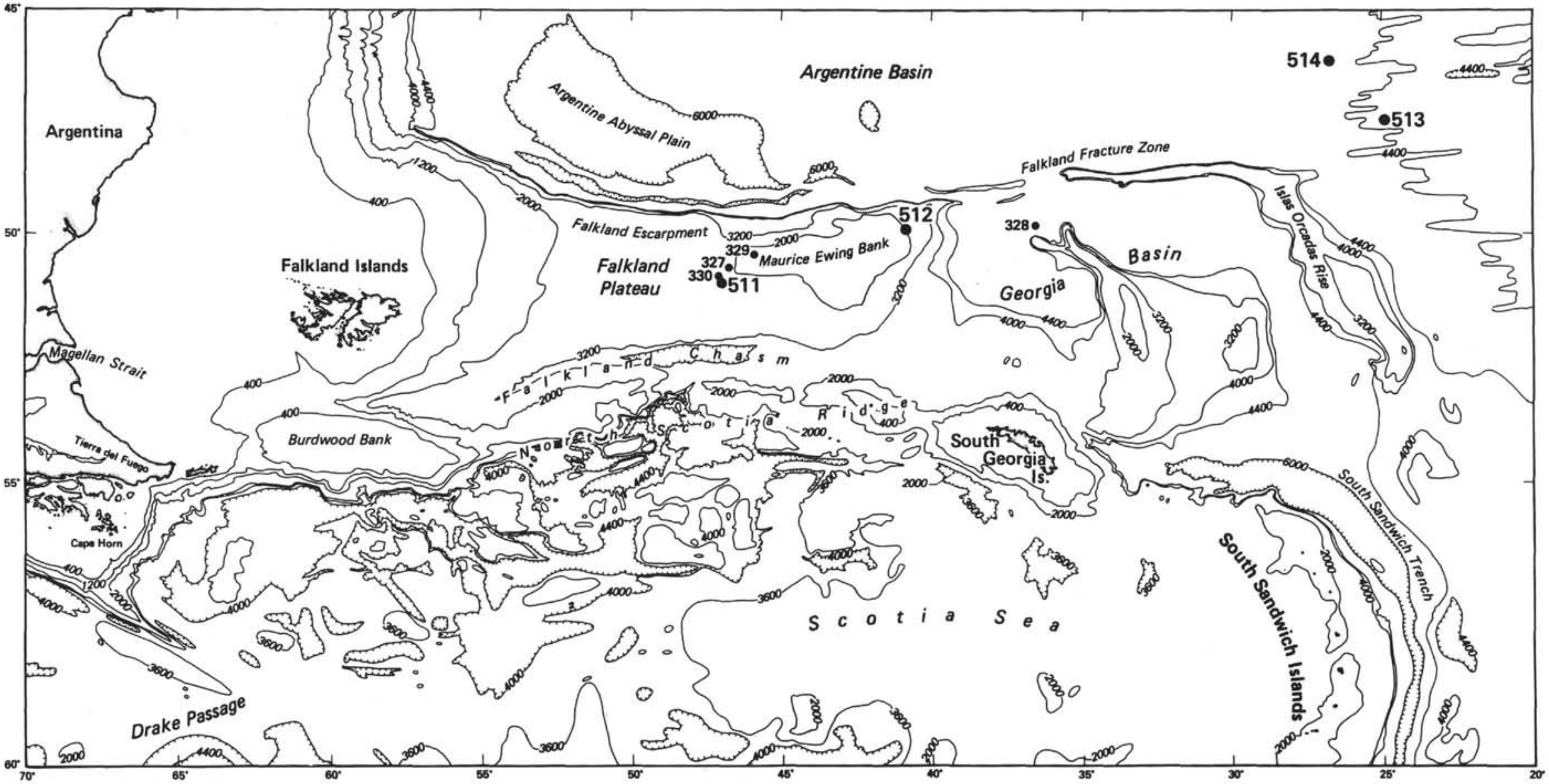

Figure 1. Locations of Site 512 and other Leg 71 drill sites.

cene section, in order to establish its calcareous microfossil biostratigraphy; and (4) the Cretaceous/Tertiary boundary, in order to define the major erosional event associated with this boundary and to establish the history of CCD fluctuations.

SURVEY AND OPERATIONS

Glomar Challenger left Site 511 at 0342 hr. on 21 January, in good weather. Site 512 was located 245 mi. to the east–northeast, and the transit was slowed by deteriorating weather. A strong gale was blowing as the vessel approached the drill site, located at the 0915 position of the *Vema* 31–03 single-channel seismic reflection profile of Maurice Ewing Bank (Fig. 8). The beacon was dropped at 1105 hr. on 22 January, approximately one-half mile southwest of the *Vema* site (Fig. 2). Depths to seafloor and sub-bottom reflectors observed on the *Challenger* seismic line approaching the site matched ex-

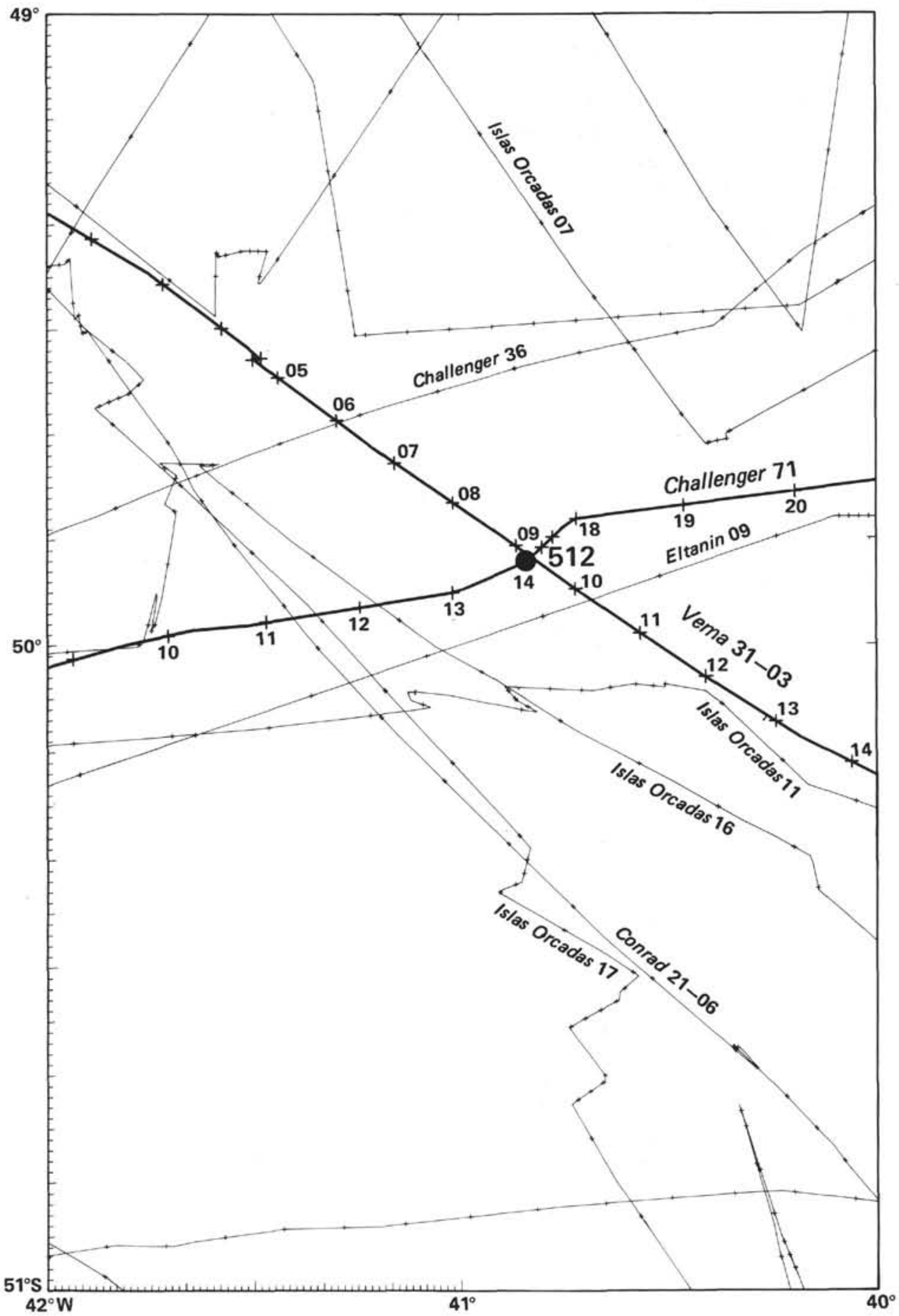

Figure 2. Locations of lines of seismic reflection measurements near Site 512.

actly those of the *Vema* line, and no offset was made from the beacon once the site was occupied.

When the vessel turned to return to the beacon after the seismic gear was retrieved, it was unable to reacquire the beacon signal. As weather conditions had become too rough for pipe operations, the vessel hove to to ride out the gale. Although the depression was not particularly intense for the locality, the ship's barometer reading went off the scale at 965 mb. Wind velocity reached approximately 55 kn., but conditions moderated within about 12 hr. The vessel drifted about 40 mi. off site, and about 6.5 hr. were spent in returning to the location and reacquiring the beacon signal. An additional 14 hr. were then spent positioning on the beacon while conditions improved to the point where vessel motion and stationkeeping remained within the limits required for pipe operations. The pipe trip began at 2330 hr., 23 January.

At the beginning of the pipe trip, weather conditions were marginal but apparently improving. However, it was necessary to interrupt the trip on two occasions to reposition the ship and to find the optimum heading to minimize roll. These problems were due primarily to a strong current aligned at a high angle to the wind and swell.

The corrected precision depth recorder (PDR) reading at Site 512 was 1846 m below sea level. A 12 kHz beacon strapped to the drill pipe was employed to improve the accuracy of the depth determination and in the hope of avoiding time lost on "water cores." The reading, when the beacon was used in conjunction with the PDR recorder, was 1844 meters. Accordingly the first hydraulic piston coring attempt covered an interval from 1842–1846.4 meters. A sediment core was recovered, establishing the water depth at 1845.9 meters.

The piston corer recovered 9.3 meters of ice-rafted sand, gravel, and cobbles before encountering an interval of ooze and chalky ooze. This material was older and consequently stiffer and dryer than expected. After a total penetration of 77.9 meters (Table 1), the sediment was judged to be too well indurated to warrant further piston coring operations.

The hole was filled with drilling mud and the pipe was retrieved for the conversion to a conventional rotary-coring bottom hole assembly (BHA). During the round trip it was again necessary to shut down twice to position the vessel and minimize roll.

Hole 512A, offset 30 meters to the north of Hole 512, was spudded at 2206 hr., 25 January. The interval previously cored was drilled to 50.5 meters below seafloor. After further drilling to 72.5 meters, continuous coring began. The inner core barrel retrieved from the first 9.5-meter attempt contained only water. The previous inner barrel, which had been in place during the drilling, had contained several cobbles and pebbles in the core catcher. It was believed that some of the ice-rafted material from near the seafloor could have fallen to the bottom of the hole and subsequently jammed the throat of the core bit. A bit deplugger was therefore made up on an inner barrel and pumped down to punch out any obstruction. A normal seating pressure kick was noted, indicating that the obstruction had been cleared or had not existed.

Table 1. Coring summary, Site 512.

Core No.	Date (Jan. 1980)	Time	Depth from Drill Floor (m)	Depth below Seafloor (m)	Length Cored (m)	Length Recovered (m)	Core Recovered (%)
Hole 512							
1	24	1402	1843.9–1846.4	0–2.5	2.5	2.50	100
2	24	1545	1846.4–1850.8	2.5–6.9	4.4	4.34	98.6
3	24	1650	1850.8–1855.2	6.9–11.3	4.4	4.32	98.1
4	24	1746	1855.2–1859.6	11.3–15.7	4.4	3.43	77.9
5	24	1900	1859.6–1864.0	15.7–20.1	4.4	3.20	72.7
6	24	1950	1864.0–1868.4	20.1–24.5	4.4	1.95	44.3
7	24	2055	1868.4–1872.8	24.5–28.9	4.4	4.31	97.9
8	24	2140	1872.8–1874.8	28.9–30.9	2.0	1.72	86
9	24	2232	1874.8–1879.2	30.9–35.3	4.4	3.87	86.3
10	24	2323	1879.2–1882.2	35.3–38.3	3.0	2.56	85.3
11	25	0022	1882.2–1886.6	38.3–42.7	4.4	3.98	90.4
12	25	0135	1886.6–1891.0	42.7–47.1	4.4	3.95	89.7
13	25	0303	1891.0–1895.4	47.1–51.5	4.4	3.31	75.2
14	25	0400	1895.4–1899.8	51.5–55.9	4.4	3.79	86.1
15	25	0455	1899.8–1904.2	55.9–60.3	4.4	3.91	88.8
16	25	0600	1904.2–1908.6	60.3–64.7	4.4	3.17	72.0
17	25	0645	1908.6–1913.0	64.7–69.1	4.4	4.31	97.9
18	25	0745	1813.0–1917.4	69.1–73.5	4.4	4.70	106.8
19	25	0845	1917.4–1921.8	73.5–77.9	4.4	4.51	102.5
Total					77.9	66.8	85.8
Hole 512A							
1	28	0355	1916.0–1925.5	72.0–81.5	9.5	0	0
2	28	0750	1925.5–1935.0	81.5–89.3	7.8	7.77	100
Total					17.3	7.77	44.9

During this time the strong crosscurrent and a freshening wind had renewed positioning problems. A satisfactory heading was found only after a 30-min. delay, and Core 2 was attempted. However, the wind soon increased to 35 kn., taxing the positioning system to its limits. Coring halted before the full 9.5 meters had been cut. The hole was quickly filled with mud, and one joint of drill pipe was set back. At this point the wind had decreased somewhat and the core was retrieved. Full core recovery had been achieved, but the weather lull proved to be only temporary. The vessel was being pushed off station, and it was necessary to pull the bit above the seafloor for the safety of the drilling assembly. Then 6 hr. were spent waiting for a change in weather and current that would enable the vessel to maintain station and stay within roll limitations. There was finally no alternative but to recover the drill string while the ship maintained a minimum roll heading, being pushed slowly off the site by the current.

Three hours after the pipe had been recovered, conditions had moderated and the pipe was run back for an attempt at a third hole. Before the trip to the seafloor was completed, however, the current had again strengthened. The interaction of the current with two sets of swells and a relatively light wind simply would not permit the vessel to maintain station on any heading without excessive roll. After a frustrating additional 5 hr. of alternately repositioning the ship and resuming the trip, it became apparent that sustained drilling operations would be thwarted by the conditions prevailing at Site 512. Therefore, because time was limited and the forecast was for worsening weather, we recovered the drill string and abandoned the site at 1345 hr., 27 January.

LITHOLOGICAL SUMMARY

Continuous hydraulic piston coring was carried out at Hole 512 to a sub-bottom depth of 77.9 meters, through a thin veneer of ice-rafted sands and gravels of

Plio–Pleistocene age into siliceous–nannofossil oozes of middle Eocene and middle to early late Miocene age.

A summary of the major features of the lithologic units at Holes 512 and 512A is given in Figure 3.

Unit 1

The surficial unit of Hole 512 consists of 93 cm of olive gray (5Y 5/2) to light gray (5Y 7/1), gravelly, foraminifer-rich quartzose sands. Pebbles, generally smaller than 2 cm, are subangular to angular and of mixed lithologies, including dark, fine-grained clastics, and pink granitic and green metamorphic rocks. A very large pebble (8 × 5 × 5 cm) of dark, very fine-grained sandstone was sampled in Section 512-1-1.

This sandy unit becomes more diatomaceous and lighter in color (pale yellow to light olive gray) in the lowermost 10 cm. The contact with the underlying unit is sharp.

Unit 2

This unit extends to the bottom of the hole and is subdivided into three subunits on the basis principally of color and carbonate content.

Subunit 2A

The uppermost 10 cm of Unit 2 (Core 1, Section 1, 93–103 cm) consist of a pale olive (5Y 6/3), soft, noncalcareous, diatomaceous ooze which conformably overlies Subunit 2B.

Subunit 2B

Subunit 2B (Core 1, Section 1, 103 cm through Core 5) consists of massive, white (5GY 8/1–8/2) to olive gray (5Y 5/2) diatomaceous and siliceous nannofossil oozes. Locally, particularly in the uppermost sections, concentrations of diatoms are great, giving a "cottony" appearance to the split core surface. Carbonate contents in these zones were as low as 7%.

This subunit is characterized in general by very minor bioturbation. The upper parts are more massive in appearance and lighter in color than the deeper parts, which tend to be light gray to olive gray. Small manganese nodules and manganiferous sediments were found in the uppermost part of the unit (Section 512-2-1), and occasional lenses of fine volcanic ash occur throughout. In the top several cores, voids and soupy zones of pebbles and sand occur frequently; the latter are thought to have been derived from material caving in from the surficial Unit 1. The contact between Subunits 2B and 2C is sharp, lying at the base of a 10-cm zone of dark greenish gray (5G 4/1) siliceous ooze at the top of Core 6.

Subunit 2C

Lithologically, Subunit 2C (Core 6, Section 1, 10 cm to Core 19), 69 m thick, differs principally only in color and induration from Subunit 2B. It is generally firmer and ranges from a greenish gray (5G 6/1) to a light greenish gray (5GY 8/1) siliceous–nannofossil ooze. Carbonate contents are somewhat higher than those in Subunit 2A, averaging 54%, compared to values of 38% and 48% for the more calcareous zones in Subunit 2B.

This subunit, too, is characterized by minor to moderate bioturbation. Solid burrows of dark gray, light brown, and greenish gray are most common, but a concentration of conspicuous "ring burrows" was encountered in Section 512-17-2. Stratification is, in general, more apparent in this unit than in Subunit 2B, with grayish green laminae (0.5–1 cm) and zones (up to 10 cm) becoming more common with depth.

Dark gray, well-rounded pumice fragments (0.5–1.5 cm) were observed in Sections 512-16-1 and 512-18-1.

In many cores (particularly below Core 13), as sediments become more indurated, core disturbance resulting from flow-in frequently occurred, affecting up to 50% of the recovered cores.

In Hole 512A, rotary drilling was begun in an attempt to continue coring below the depth reached by hydraulic piston coring. Only one core (Core 2) was successfully retrieved, reaching a sub-bottom depth of 89.3 meters; although highly disturbed, it appears lithologically identical to the lowest interval cored at Site 512.

PALEONTOLOGY

Biostratigraphy Summary

Site 512 was drilled in 1846 meters of water on the northeastern flank of the Maurice Ewing Bank. Nineteen HPC cores from one hole and one conventional core from another penetrated approximately 90 meters of sediment consisting of sandy diatomaceous ooze, diatomaceous ooze, diatomaceous–nannofossil ooze, and siliceous–nannofossil ooze.

All microfossil groups are present throughout the recovered section except between 95 and 103 cm in Core 1 and 0–10 cm in Core 6, Section 1. At these horizons, only siliceous microfossils are present in two dissolution zones just below or at unconformities. Preservation is good and diversity and abundance high for siliceous microfossils throughout Holes 512 and 512A. In contrast, foraminifers and nannofossils are only moderately well preserved; they are less diverse and fewer.

The objectives at Site 512 were to recover a continuously cored Paleogene section of mixed calcareous and siliceous oozes, in order to establish high-latitude zonations that would allow integration with standard low-latitude biostratigraphies. In addition, we were to examine the erosional history of the Maurice Ewing Bank, in order to establish the timing of significant paleoceanographic events.

Results

Quaternary–Neogene

Core 1 at Hole 512 consists of a sequence of intercalated sandy diatomaceous ooze, diatomaceous ooze, and diatomaceous–nannofossil ooze. The upper 36 cm falls within the *Coscinodiscus lentiginosus* diatom Zone. This interval is unconformable on 43 cm of middle Pliocene diatomaceous ooze representative of the lower *Nitzschia interfrigidaria/C. vulnificus* diatom Zone.

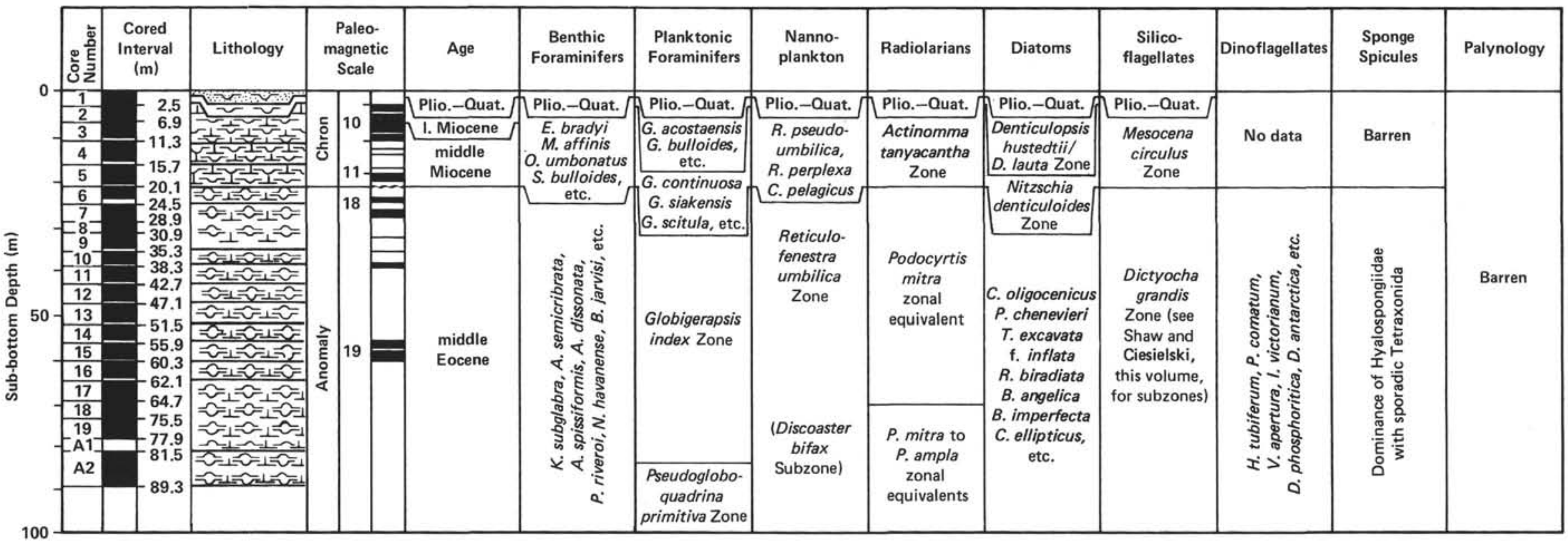

Figure 3. Columnar section of Hole 512 showing the lithology recovered and biostratigraphic correlations. (Refer to Ludwig et al., Introduction, this volume, for a key to the lithologic symbols.)

This section is further separated downcore by an unconformity below which 11 cm of lower Pliocene sediment were recovered (late Gilbert paleomagnetic polarity Zone, *N. angulata* diatom Zone). The final hiatus in Core 1 is identified at approximately 93 cm. Below this horizon, 1.5 meters of early late Miocene diatomaceous and diatom–nanno ooze were recovered, representing a portion of the *Denticulopsis hustedtii/D. lauta* diatom Zone.

Calcareous nannofossils were also examined at the top of Core 1. The *Emiliania huxleyi* nannofossil Zone was recognized, along with a typical cool-water Quaternary foraminiferal assemblage.

Samples 512-1,CC through 512-5,CC are dated as late middle to early late Miocene in age (Fig. 4). All microfossil groups are represented in these sediments. One radiolarian and silicoflagellate zone (*Actinomma tanyacantha* [r] and *Mesocena circulus* [s]) and two diatom zones (*D. hustedtii/D. lauta* and *N. denticuloides*) are recognized. Calcareous nannofossils and foraminifers are also present throughout these cores. Nannofossils are represented by a restricted cool-water assemblage, low in diversity and consisting of long-ranging species. Foraminifers, although of low diversity and moderate preservation, do provide data relevant to the location of the middle/late Miocene boundary. The first appearance of *Globorotalia acostaensis* (base of N16) is recorded in Core 2, Section 1 and the last occurrence of *G. siakensis* (top of N14) in Sample 512-3,CC. Therefore, the middle/late Miocene boundary must fall between these two horizons.

Paleogene

A hiatus of approximately 30 m.y. separates Core 5 from Core 6. Considerable reworking and mixing of Eocene and Miocene sediments is observed in Sample 512-5,CC and the top 10 cm of Core 6.

Cores 6 through 19 in Hole 512 and Core 2 in Hole 512A are middle Eocene (Fig. 5). These cores are composed of siliceous–nannofossil ooze containing all microfossil groups. Calcareous and siliceous microfossils have temperate affinities, with some warm-water, low-latitude constituents. Diatoms, radiolarians, and silicoflagellates are common, well preserved, and diverse throughout this section, whereas foraminifers and nannofossils are only moderately well preserved and of relatively low diversity. Middle Eocene sediments can be subdivided using the established New Zealand foraminiferal zonal scheme (Jenkins, 1971). Radiolarians are indirectly correlated to Riedel and Sanfilippo's (1978) low-latitude zonation using secondary marker species. Hole 512, Cores 6 through 19 and Hole 512A, Core 2 equate approximately to the P11 and P12 foraminiferal zones and the NP15 and NP16 nannofossil zones at low latitudes. Most of this section corresponds to Jenkin's (1971) *Globigerapsis index index* and *Pseudoglobo-quadrina primitiva* New Zealand foraminiferal zones. The calcareous nannofossils are assigned to the *Discoaster bifax* Subzone of Bukry's (1973) *Reticulofinestra umbilica* Zone of the low latitudes.

The silica-rich interval represented in Holes 512 and 512A (middle Eocene), with its high sedimentation rate,

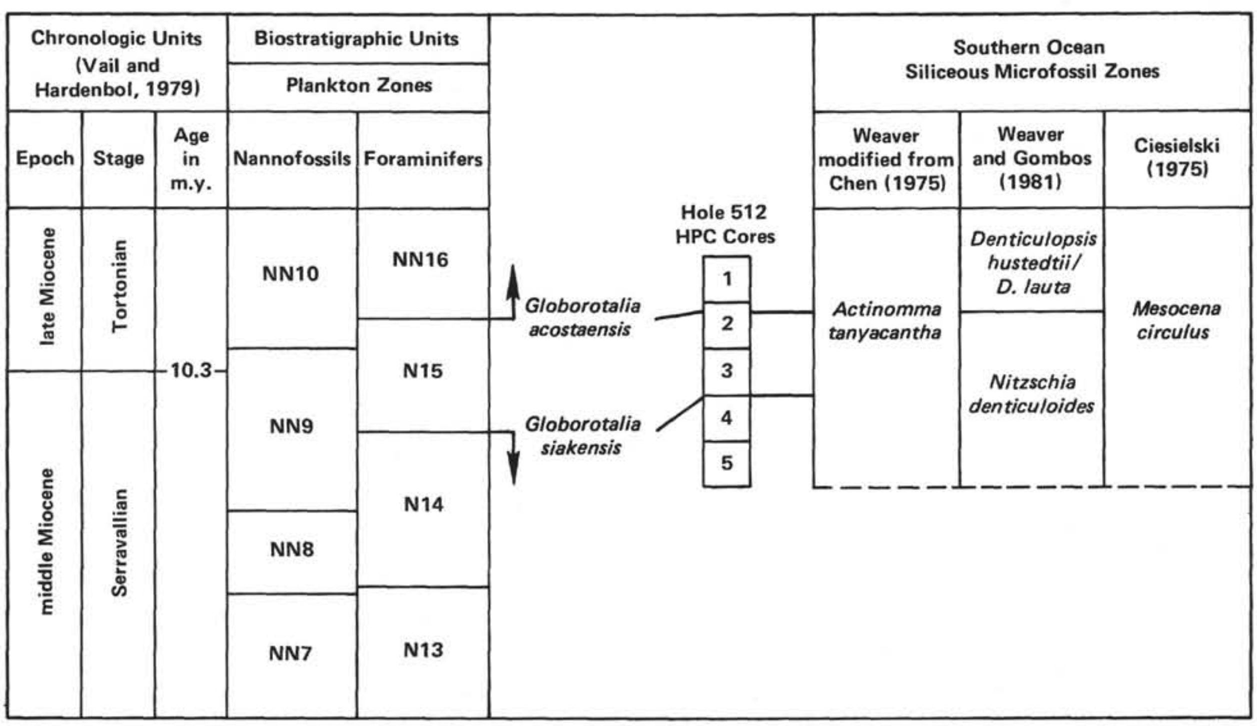

Figure 4. Age and zonal correlations of Miocene sediments at Site 512.

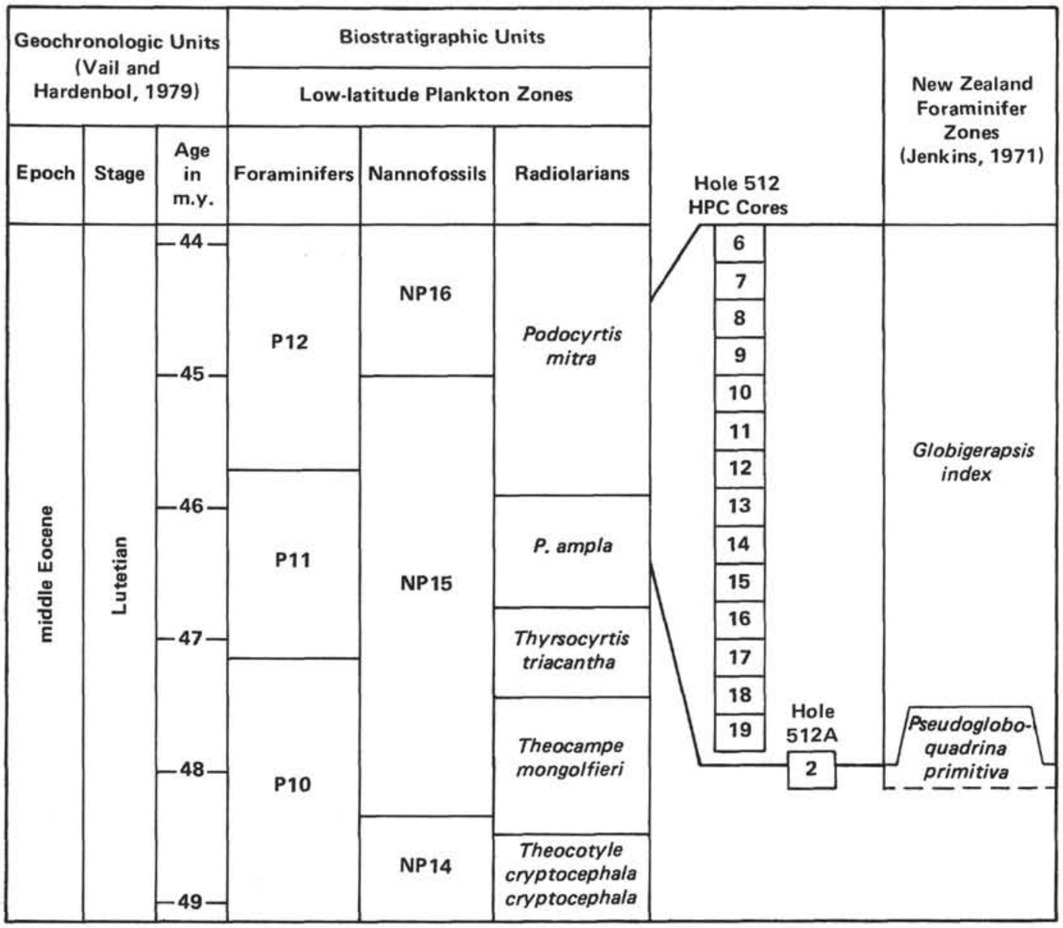

Figure 5. Age and zonal correlations of middle Eocene sediments at Site 512.

is part of a widespread global depositional phenomenon. This interval is coeval with deposits of the Kellogg Shale in California, Site 206 in the Tasman Sea, the Exxon Production Research Company's Atlantic margin Corehole 15 (Gombos, 1980), and Site 340 in the Norwegian Sea; in all these sites widespread siliceous deposition in the upper P11 and lower P12 zones corresponds to a significant cooling on a global scale, well documented by oxygen isotope studies as dating to 44–46.5 Ma.

Sedimentation Rates

Based on average sedimentation rate calculations used previously to date siliceous microfossil zonal boundaries in the middle and upper Miocene, the maximum duration of sedimentation represented by Samples 512-1,CC through 512-5,CC is 2–2.5 m.y. The rate of sedimentation is calculated to be 6–9.5 m/m.y. for these diatomaceous-nannofossil oozes (Fig. 6). A high sedimentation rate (20–29 m/m.y.) is calculated for Cores 6 through the base of Hole 512A.

Conclusion

Four unconformities are recognized at Site 512. The first separates Pleistocene and Pliocene sediments, the second is within the Pliocene, the third separates Pliocene from upper Miocene, and the fourth, middle Miocene from middle Eocene sediments. The unconformities are likely to be related to periodic intensification of the Circumpolar Deep Water of the Antarctic Circumpolar Current which eroded and/or prevented deposition on the Maurice Ewing Bank. Because of the duration of these unconformities, it is impossible to establish whether each can be associated with one or several paleoceanographic events.

Unfortunately, a continuous Neogene mixed ooze sequence was not recovered for biostratigraphic purposes in Holes 512 and 512A. However, sediments in Cores 1 through 5 do provide some significant paleontological information. Foraminiferal datums in these cores allow correlation of established siliceous microfossil zonations to the middle/upper Miocene boundary (Fig. 6). Previously, this boundary correlation had only been estimated.

In addition, mixed middle Eocene siliceous-nannofossil oozes provide, for the first time, an opportunity to correlate siliceous microfossil zonations with the foraminiferal and calcareous nannofossil stratigraphy of New Zealand.

Foraminifers

Planktonic and benthic foraminifers were found in all cores from Hole 512 (Fig. 7). Preservation is generally moderate, poor in some samples, and very good in Core 1 (top) (Quaternary). Species diversity of planktonic foraminifers is low and reaches its maximum (about 20 species) in the middle Eocene (Cores 6–10 and 15–19), with no more than 10–12 species in one sample. The quantity of planktonic foraminifers fluctuates from abundant to common in Cores 1, 11, 12, 13, 16, 17, and 18 and from few to sparse in other cores. Benthic foraminifers are common in Cores 16 and 17, common to few in Cores 1 to 5, and rare or very rare in other cores.

In Core 512-1 (top), the assemblage of planktonic foraminifers consists of Recent cold- and temperate-water species: *Globigerina pachyderma, G. bulloides, Globigerinita uvula, Globorotalia inflata*, and *G. truncatulinoides*. The latter is represented by low-conical specimens as in Site 511 Quaternary sediments. This morphological variety was previously noted in Quaternary sediments of high latitudes by Herb (1968). Benthic foraminifers are more diverse. Their assemblages contain bathyal-water species: *Eggerella bradyi, Lagena gracillima, Pullenia bulloides, P. quinqueloba, Gyroidina orbicularis, Cibicidoides wuellerstorfi, Trifarina angulosa, Cassidulina laevigata*, and *Bulimina aculeata*. A similar assemblage was described by Herb (1971) from the bathyal zone to the north of the Antarctic convergence.

Samples 512-1-1, 131–133 cm to 512-1,CC contain a low-diversity assemblage of planktonic foraminifers:

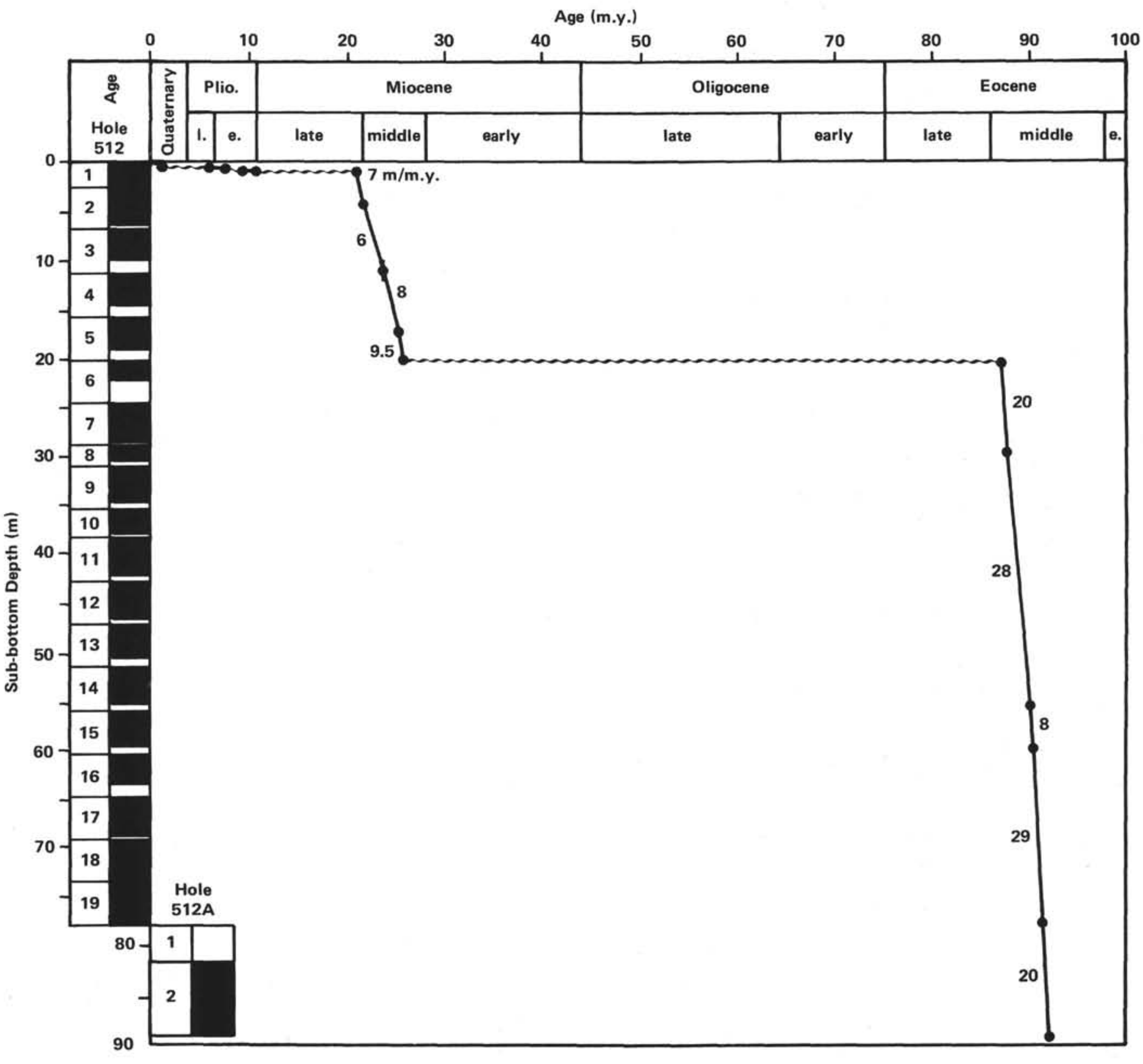

Figure 6. Sedimentation rates at Site 512.

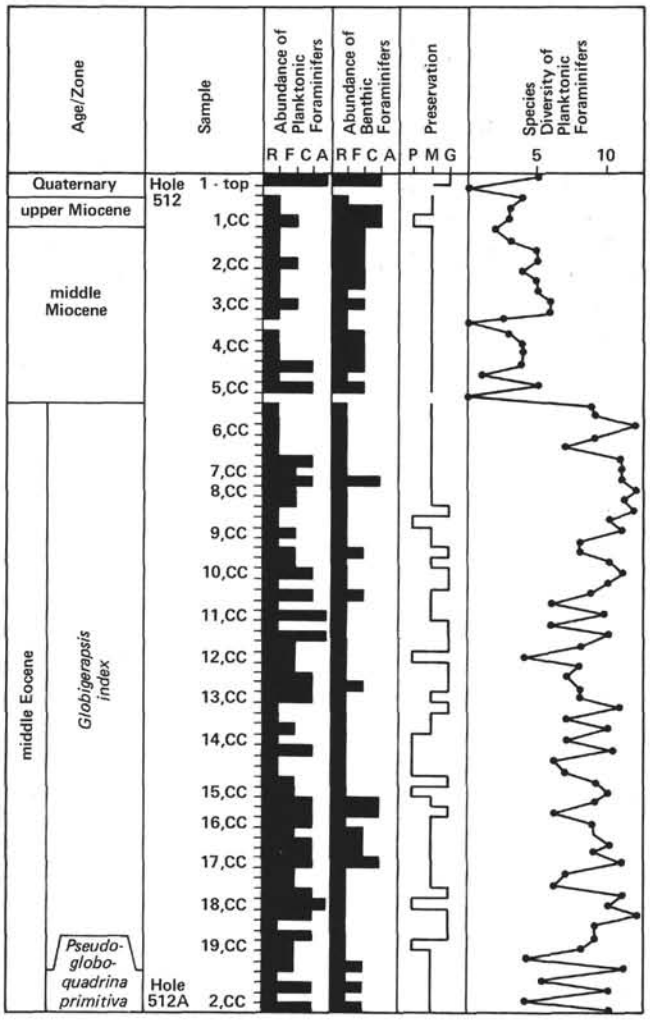

Figure 7. Abundance, preservation, and species diversity of foraminifers at Site 512. (Abundance: R, rare; F, few; C, common; A, abundant. Preservation: P, poor; M, medium; G, good.)

Globigerina bulloides, Globorotalia acostaensis, and forms transitional between *G. acostaensis* and *G. pachyderma* (upper Miocene).

In Cores 2–5 and in Sample 512-6-1, 1–3 cm, planktonic foraminifers are more diverse; they include *Globigerina bullodies, Globorotalia siakensis, G. continuosa, G. scitula, G. zealandica*, and *Globigerinita uvula* (middle Miocene).

Compared to the Quaternary microfauna, middle and upper Miocene sediments are characterized by a more diverse and well-preserved assemblage of benthic foraminifers composed of bathyal species, among which *E. bradyi, Karreriella bradyi, P. bulloides, P. quinqueloba, Melonis affinis, Oridorsalis umbonatus, Cibicidoides kulenbergi, Gyroidina soldanii, Sphaeroidina bulloides, Angulogerina esnurensis*, and *Bradynella subglobosa* occur most often. Common also are *Martinottiella antarctica, Pyrgo myrrhina, Laticarinina pauperata, Bulimina inflata*, and *Smyrnella crassa*.

Samples 512-6-1, 70–72 cm to 512-19,CC and Core 512A-1 are assigned to the middle Eocene. Subdivisions for the sediments of this interval according to their foraminiferal content follow.

In Samples 512-6-1, 70–72 cm to 512A-2-2, 69–71 cm, the planktonic foraminiferal assemblage is rather diverse, and composed of common to few *Globigerina boweri, G. frontosa, G. angiporoides, G. angiporoides minima, Pseudogloboquadrina primitiva, Pseudohastigerina micra, Globigerapsis index*, and *Globorataloides suteri*. The following species are few to rare and their distribution is sporadic: *G. linaperta, G. pseudoeocaena, Globigerinita howei, G. unicava primitiva, Chiloguembelina cubensis, Acarinina* spp., and *Hantkenina* sp. Co-occurrence of *Pseudogloboquadrina primitiva* and *A.* spp. in this assemblage testifies to the middle Eocene age of the sediments. The presence of *Globigerapsis index* throughout this interval allows us to assign these sediments to the *Globigerapsis index* Zone of the New Zealand foraminiferal zonal scale (Jenkins, 1971). Specimens of *P. primitiva* are present up to the very top of the middle Eocene sediments at Site 512, although in the upper layers their quantity is insignificant; *Globorotalia (Testacarinata) inconspicua* is missing in these layers. Taking into consideration this fact, it is hardly possible to attribute the uppermost part of the middle Eocene section to the overlying *G. inconspicua* Zone. The lower boundary of the *Globigerapsis index* Zone is determined by the initial appearance of the name species, in accordance with Jenkin's definition of the zone; nevertheless, in basal layers of the *G. index* Zone this species is very rare.

The last four samples (Samples 512A-2-3, 69–71 cm to 512A-2,CC) are characterized by *Globigerina angiporoides minima, G. pseudoeocaena, G. boweri, Globorotaloides suteri, P. primitiva, A. pseudotopilensis, A.* sp., *Pseudohastigerina micra, C.* sp., and *Zeauvigerina* aff. *parri; Globigerapsis index* is absent. Sediments can be correlated with the *Pseudogloboquadrina primitiva* Zone of the New Zealand zonal scale (the base of the middle Eocene).

It is necessary to keep in mind that zones of the New Zealand zonal scale are based not only on the evolutionary appearance or disappearance of planktonic foraminifers but also on local peaks in their development. Therefore it is possible that the boundaries of these zones, which have similar names in the Paleogene sections of the Falkland Plateau and New Zealand, do not correlate precisely.

Middle Eocene sediments contain assemblages of rather diverse benthic foraminifers which have a species composition quite different from that of the Miocene. The most common species are *Pullenia quinqueloba, P. riveroi, Anomalinoides semicribrata, A. spissiformis, Nonion havanense, Alabamina dissonata, O. ecuadorensis, Gyroidina girardana, G. planulata, Bulimina inflata, B. jarvisi, Trifarina* sp., *Uvigerina peregrina, Stilostomella gracillima, S. caribea, Orthomorphina rohri*, and *Bradynella subglobosa*. Most of these species individually, plus the nearly complete absence of the arenaceous species, suggest a bathyal water depth.

Taking into consideration the moderate to good preservation of benthic and planktonic foraminifers, the presence of numerous thick-walled benthic species, and the high carbonate content (50–70%) of sediments, we suggest that the dissolution effect was minimal during the middle Eocene interval and that Site 512 was located well above the CCD.

Calcareous Nannofossils

The 18-cm interval of calcareous ooze near the top of Core 1, Section 1 in Hole 512 contained coccoliths of the *Emiliania huxleyi* Zone; the remainder of the Plio-Pleistocene sediments of Lithologic Unit 1 were barren of calcareous nannofossils. The diatomaceous nannofossil ooze beginning at Core 1, Section 1, 93 cm and extending down through Core 5 (Lithologic Subunit 2B) contains an abundant but highly restricted cool-water assemblage of Miocene coccoliths dominated by *Reticulofenestra pseudoumbilica gelida, R. perplexa*, and *Coccolithus pelagicus*. This assemblage is identical to that sampled at DSDP Site 329 on the western end of the Maurice Ewing Bank. A 9-cm interval of dark greenish gray diatomaceous mud at the top of Core 6, Section 1 contained Miocene coccoliths of the assemblage just described, mixed with Miocene and Eocene siliceous microfossils. The base of this layer of mixed assemblages, therefore, represents an erosional disconformity separating the Miocene above from Eocene sediments below.

Lithologic Subunit 2C (Cores 6–19, plus Core 2 from Hole 512A) contains a rather uniform assemblage of middle Eocene coccoliths in which few assemblage changes are noted. The assemblage is dominated by *Chiasmolithus solitus* (see Edwards and Perch-Nielsen, 1975) and *R. umbilica*. Other coccoliths which occur consistently throughout this sequence are *Coccolithus formosus, C. pelagicus, Zygrhablithus bijugatus, Zygolithus dubius, Pontosphaera planus, Blackites spinosus, Discoaster distinctus*, and an eight-rayed *Discoaster* which is transitional between *D. saipanensis* and *D. barbadiensis*. The ranges of these latter two species overlap from Cores 6 to 16. Such an overlap has not been recorded in New Zealand (Edwards, 1971) but does occur in lower latitudes. This may indicate that oceanographic conditions were somewhat warmer during the middle Eocene at Site 512 than in the area of New Zealand.

Because *R. umbilica* is present throughout the Eocene section, the cores can be assigned to the *D. distinctus/R. hampdenensis* zones of Edwards (1971). Edwards and Perch-Nielsen (1975) found these two zones impractical to separate in their DSDP Leg 29 study. The co-occurrence of *R. umbilica* and *Chiasmolithus solitus* also allows the section to be correlated with the *Discoaster bifax* Subzone of the *R. umbilica* Zone of the lower latitudes (Bukry, 1973).

Aside from the species just described, a few other coccoliths were present at irregular intervals. Specimens of *Chiasmolithus grandis* were present in samples from Cores 7, 8, and 13. This species was recorded only in the lower Eocene of New Zealand (Edwards, 1971), but its extinction marks the top of the middle Eocene in lower latitudes. Although rare, it is a useful marker for the middle Eocene in the oceanic section examined here. *D. Sphenolithus furcatolithoides* and probable *D. bifax* were noted near the base of the sequence.

Radiolarians

Radiolarians are encountered in all cores recovered in Holes 512 and 512A. In all samples examined, preservation is good to excellent and abundance and diversity are high.

Miocene

Samples 512-1,CC through 512-5,CC are correlated to the Miocene *Actinomma tanyacantha* radiolarian Zone of Chen (1975; modified by Weaver, this volume). This zone spans the middle/upper Miocene boundary (Fig. 5). The assemblage encountered in Cores 1 through 5 is dominated by *Dendrospyris haysi, Prunopyle hayesi, Antarctissa conradae, Theocalyptra bicornis, Eucyrtidium cienkowskii* group, and *Lithomitra lineata* group. Less abundant species include *Actinomma tanyacantha, Euchitonia* cf. *muelleri, Lithostrobus serriatus*, and *Collosphaera* spp. The only significant change in species composition occurred in Sample 512-2,CC where an abundance peak of *Cyrtocapsella japonica* is noted.

Reworking of Eocene radiolarians into Miocene sediments is observed in the base of Core 5.

Eocene

Cores 6 through 19 in Hole 512 and Core 2 in Hole 512A contain excellently preserved radiolarians dated as middle Eocene. No Paleogene zones exist at middle to high latitudes, and no direct correlation to Riedel and Sanfilippo's (1978) low-latitude zonation is possible because of the paucity of stratigraphically important low-latitude index species. However, an indirect correlation is possible through secondary marker species that occur rarely in Cores 6 through 19 in Hole 512 and in Core 2 in Hole 512A. These species include *Eusyringium fistuligerum, Lophocyrtis biaurita*, and *Lithapium mitra* (see Weaver, this volume).

E. fistuligerum and *Lophocyrtis biaurita* are found to range throughout Cores 6 through 19 in Hole 512 and Core 2 in Hole 512A. *Lithapium mitra* is encountered in Core 17 of Hole 512. On the basis of radiolarian distributions at low latitudes, the highest occurrence of *Lophocyrtis biaurita* and the lowest occurrence of *Lithapium mitra* is within the *Podocyrtis mitra* to possibly the *P. ampla* zones of Riedel and Sanfilippo (1978). This interval is correlated to the P11 and P12 foraminiferal zones and the NP15 and NP16 nannofossil zones. *E. fistuligerum* first occurs at low latitudes within the upper *Thyrsocyrtis triacantha* radiolarian Zone. Because of the occurrence of these three species, therefore, Cores 512-6–19 and 512A-2 are constrained to the *P. mitra* to upper *T. triacantha* radiolarian zones of low-latitude usage (Fig. 6).

The composite middle Eocene radiolarian assemblage in Holes 512 and 512A is dominated by the following species: *Calocyclas* cf. *semipolita, Cyclampterium* sp. *A, C. longiventer, Diplocyclas* sp. A group, *Lophocorys* cf. *norvegiensis, L. babylonis* group, *Lychnocanoma amphitrite, L. bellum, L.* cf. *bellum, Periphaena* sp.

group, *Theocotyle* cf. *ficus*, and *Theocampe mongolfieri*. Most species just listed range throughout the middle Eocene sediments recovered at Site 512, except for *Lychnocanoma bellum*, which occurs only below Core 10, and *Lophocorys babylonis*, which is restricted to below Core 9.

Diatoms

Eight samples examined from Hole 512, Core 1 are assigned to four diatom zones, with a hiatus occurring between each zone. Samples 512-1-1, 13–14 cm, 24–25 cm, and 34–35 cm contain poorly to moderately preserved diatoms that are assigned to the Quaternary *Coscinodiscus lentiginosus* Zone of McCollum (1975). This zonal assignment places a maximum age of 620,000 y. ago on these samples. Abundant and moderately preserved diatoms observed in Sample 512-1-1, 63–64 cm include *Rhizosolenia barboi, Cosmiodiscus insignis, Coscinodiscus vulnificus, Nitzschia weaveri*, and one specimen of *N. interfrigidaria*. This assemblage represents the *N. interfrigidaria/C. vulnificus* Zone and is correlated to the mid-Gauss Chronozone (~3.10–2.8 Ma. Sample 512-1-1, 80–81 cm contains a mixed assemblage of diatoms from the early Pliocene and late Miocene; it appears to represent the *N. angulata* Zone (Weaver, 1976), with numerous late Miocene diatoms, reworked by drilling. Sample 512-1-1, 88–89 cm, taken slightly lower, contains abundant and moderately preserved *N. angulata, N. praeinterfrigidaria, N. reinholdii, Stephanopyxis turris*, and *Coscinodiscus marginatus*. This sample contains rare reworked microfossils and is confidently correlated to the *N. angulata* Zone. The limited lower Pliocene stratigraphic range of this zone restricts the age of Sample 512-1-1, 88–89 cm and probably also of Sample 512-1-1, 80–81 cm to approximately 4.3–4.0 Ma (Gilbert Chron). Finally, Samples 512-1-1, 100–102 cm, and 512-1,CC contain a well-preserved assemblage of late Miocene diatoms, the most common of which include *Denticulopsis lauta, D. hustedtii, D. dimorpha*, and abundant *Thalassiothrix* spp. These latter samples are assigned to the upper Miocene *D. hustedtii/D. lauta* Zone of Weaver and Gombos (in press).

The diatom stratigraphy of Core 1 suggests the following sediment age, sedimentology, and hiatus relationships.

Interval (cm)	Age	Sediment Type
0–36	<620,000 y.	Diatomaceous to foraminiferal quartz sand
Hiatus	<620,000 y.–~2.8 m.y.	
37–79	~2.8–3.1	Diatomaceous sandy gravel
Hiatus	~3.1–4.0 m.y.	
79–93	~4.0–4.3 m.y.	Muddy sandy diatomaceous ooze
Hiatus	~4.3–10.3 m.y.	
93–1,CC	~10.0 m.y.	Diatomaceous ooze and diatomaceous nannofossil ooze

Sample 512-2-1, 110–112 cm through Sample 512-5,CC contains an assemblage indicative of the *N. denticuloides* Zone of Weaver and Gombos (1981). Among the common species present are *T.* spp., *N. denticuloides, D. dimorpha, D. lauta, D. hustedtii, R. styliformis, C. marginatus, C. endoi, Brunia mirabilis*, and *Actinocyclus ingens*.

The thinness of the upper Miocene *D. hustedtii/D. lauta* Zone (between Samples 512-1-1, 93 cm and 512-1,CC) suggests that another disconformity may exist between this zone and the underlying *N. denticuloides* Zone; however, diatom evidence suggests otherwise. First, the absence of *Thalassiosira* sp. 10 and the presence of *D. dimorpha* and sparse *N. denticuloides* indicate that only the lower portion of the *D. hustedtii/D. lauta* Zone is present in Cores 1 and 2. Secondly, the scarcity of *D. maccollumii* in Cores 2 through 5 limits this interval to the uppermost portion of the *N. denticuloides* Zone. Thus Core 1, Section 1, 93 cm through Sample 512-5,CC, contains the lower portion of the *D. hustedtii/D. lauta* Zone and the uppermost *N. denticuloides* Zone, with a possible conformable boundary between 512-1,CC and 512-2-1, 110–112 cm. Correlation of the magnetic polarity sequence of this interval to the standard paleomagnetic time scale (Ledbetter, this volume) indicates that this interval represents most of paleomagnetic Chron 10 and upper Chron 11. The upper boundary of the *N. denticuloides* Zone approximates the first occurrence of *Neogloboquadrina acostaensis* in Sample 512-2-1, 106 cm (R. C. Thunell, personal communication, 1981).

An unconformity occurs in Hole 512 between Cores 5 and 6; it separates middle Miocene diatomaceous nannofossil ooze of the *Nitzschia denticuloides* Zone of Weaver and Gombos (1981) from the middle Eocene siliceous–nannofossil ooze. Sediments in Hole 512, Cores 6 through 19 and Hole 512A, Core 2 are Lutetian and correlate to the P11 and P12 foraminifer and NP15 and NP16 nannofossil zones. The middle Eocene section at Site 512 was continuously cored and contains abundant and well-preserved diatoms throughout. The section from this site provides the most continuous record known of middle Eocene diatom stratigraphic events in the South Atlantic (see Gombos, this volume).

The occurrence and relative abundance of more than 60 diatom species have been determined for the middle Eocene at Site 512 and are presented in detail by Gombos (this volume). Sixteen species have been determined to be characteristic of the middle Eocene sediments at Site 512. Of these, seven range throughout the section: *Pyxilla prolongata, Melosira architecturalis, Trinacria simulacrum, Triceratium unguiculatum, Tubaformis unicornis, Asterolampra uraster*, and *Craspedodiscus moelleri. Coscinodiscus oligocenicus, Triceratium chenevierii*, and *Trinacria excavata* f. *inflata* range from Hole 512, Core 6 down through Cores 14, 12, and 11 respectively. *Trinacria excavata* f. *tetragona* occurs most frequently in Core 9 and *Rylandsia biradiata* in Core 10; both range down through Hole 512, Core 2. *Bergonia* *angelica* ranges from Hole 512, Core 10 through Core 18, and *Brightwellia imperfecta* ranges from Core 15 to Core 16. *Rhizosolenia robusta* ranges from the middle of Core 17 down through Hole 512A, Core 2. *Craspedodiscus ellipticus* occurs only in Hole 512A, Core 2.

Silicoflagellates

Silicoflagellates are sparse throughout the Quaternary to upper middle Miocene sediments of Cores 1-5 and common to abundant in the middle Eocene sediments of Cores 6-19. Preservation is poor and diversity low in Core 1, Section 1. Upper to upper middle Miocene sediments examined between Sample 512-1-1, 100-101 cm and Sample 512-5,CC contain an excellently preserved but low-diversity assemblage of silicoflagellates. Cores 6-19 contain an assemblage of middle Eocene silicoflagellates that is characterized by high diversity, great abundance, and excellent preservation.

Six samples from the thin Quaternary-Pliocene sequence of Core 1, Section 1 were examined for their silicoflagellate content. Five of the samples (512-1-1, 13-14 cm, 24-25 cm, 34-35 cm, 64-65 cm, and 80-81 cm) contain a sparse assemblage of silicoflagellates, consisting of rare to few *Distephanus speculum* and rare *Dictyocha aculeata, D. perlaevis, Distephanus polyactis, D. boliviensis*, and *D. quinquangellus*. No zonal designation is given to this interval, which Ciesielski (this volume) correlates to the Matuyama Chronozone and middle portion of the Gauss Chronozone. Sample 512-1-1, 88-89 cm contains a few *D. boliviensis, Mesocena diodon*, and *Dictyocha perlaevis*. Ciesielski (this volume) assigns this sample to the *Nitzschia angulata* diatom zone of the Gilbert Chronozone, thus indicating that *M. diodon* is reworked.

Sample 512-1-1, 100-101 cm contains *M. circulus* and a diatom and radiolarian assemblage indicative of the upper Miocene; therefore, a disconformity exists between this sample and the lower Pliocene of Sample 512-1-1, 88-89 cm. The disconformity between 89 cm and 100 cm in Section 1 probably coincides with a change in lithology at 93 cm from diatomaceous quartz sand above to diatomaceous ooze below. The interval from Sample 512-1-1, 100-101 cm through 512-5,CC is assigned to the *M. circulus* Zone. The paleomagnetic polarity record of this sequence is presented by Ledbetter (this volume).

The lithologic boundary between Lithologic Subunit 2B and Subunit 2C corresponds to a disconformity separating the upper middle Miocene of Core 5 from the middle Eocene of Core 6. Samples from 512-6-1, 78-80 cm to the base of Hole 512 and all of Hole 512A are assigned to the new *Dictyocha grandis* Zone. The silicoflagellate assemblage of this middle Eocene siliceous nannofossil ooze is characterized by the presence of *D. grandis* n. sp.

The *D. grandis* Zone is subdivided into three subzones; the *D. stelliformis* Subzone, the *D. stelliformis-M. apiculata* Subzone, and the *M. apiculata* Subzone. Sample 512-6-1, 78-80 cm through Sample 512-13-1, 42-44 cm contain the *M. apiculata* Subzone. In the rest of Core 13 down through Sample 512-16-2, 15-17 cm there is a silicoflagellate flora characteristic of the *D. stelliformis/M. apiculata* Subzone, which lies between the last occurrence of *D. stelliformis* n. sp., in Sample 512-17-1, 28-30 cm, and the first occurrence of *M. apiculata*. The *D. stelliformis* Subzone is present in Sample 512-17-1, 28-30 cm through Core 19, and in Hole 512A.

Ledbetter (this volume) has determined the polarity reversal pattern for the middle Eocene section recovered from Hole 512 and has correlated the results to the paleomagnetic time scale. By means of the foraminiferal biostratigraphy derived from these sediments (Krasheninnikov and Basov, this volume), the paleomagnetic polarity of the sediment from Cores 6 through 19 was compared to the magnetic anomaly reversal pattern for Anomalies 16-20 of LaBrecque et al. (1977) and Ness et al. (1980). On the basis of Ledbetter's results, it can be seen that the section of Hole 512 from Cores 6 through 19 correlates to the interval from Magnetic Anomaly 18 to a time slightly younger than Magnetic Anomaly 20, spanning from 43.7 Ma to 40.9 Ma.

Sponge Spicules

Sponge spicules were observed in middle Eocene deposits only; in Neogene and Quaternary sediments they are completely missing. Their content in each of the samples (10 cm^3) is not high—from 15 to 20 skeleton fragments.

Predominant are spicules of sixradiate sponges (Hyalospongidae). Spicules of tetraradiate sponges (order Tetraxonida) are sporadic and very rare. Among sixradiate sponges the most common are spicules of the following types: pentactines, hexactines, and oxidiasters with three, four, and five rays. Rather peculiar are sinuslike curved spicules with protuberances in a pericline of the sinusoid bend.

The impoverished composition of spicules does not allow the subdivision of middle Eocene deposits into smaller units. Noteworthy is the presence of amphidiscs and scarce specimens of spongils in the lower part of the section (Cores 13-18). The middle Eocene complex of sponge spicules of Site 512, however, sharply differs from that of the upper Eocene sediments of Site 511, where spicules of sixradiate sponges with a compact skeleton and protruding rays are almost completely missing.

Palynology

From Site 512, 58 samples were selected for palynological analysis; spores and pollen were, however, practically missing. Only in 14 samples were there very scarce pollen grains (Pinaceae, *Podocarpus* sp., *Dacrydium* sp., Myrtaceae, *Nothofagus* sp., *Tricolpites* sp., *Tricoporopollenites* sp.) and spore grains *(Cyathea* sp., *Gleichenia* sp., *Leiotriletes* sp., *Baculatisporites* sp., *Reticulatosporites* sp., Polypodiaceae, *Goczanisporis baculopilosus)* that indicate a Cenozoic age for these sediments.

PALEOMAGNETISM

Almost 78 meters of sediment were retrieved at Site 512 using the hydraulic piston corer. It was hoped that this method of coring would make possible the recovery of undisturbed sediment in cores whose relative orientation could be preserved; then the declination of magnetic remanence could be used to determine polarity. Relative orientation is calculated from an indentation made on an aluminum ring by a steel tooth when the core barrel reaches its operating position in the bit. Before each core is taken the drill pipe is rotated to the same position, so that the tooth remains in the same place with respect to the ship's heading. Unfortunately the core barrel seems to have rotated while in its operating position, causing a number of marks to appear on each aluminum ring. Consequently it was not possible to determine relative declination directly.

Most core sections were measured, before being split, with the Digico long core spinner magnetometer. Measurements of declination and intensity of the horizontal component of magnetization were carried out at 10-cm intervals, using integration times corresponding to 2^8 spins. Intensities show a great deal of variation, from less than 1 μG to over 1000 μG. Higher intensities are generally concentrated toward the top of Section 1 in each core, where large amounts of rust flakes settled after having been scraped off the inside of the drill pipe by the descending core barrel. Rust contamination was not, however, limited to the top of each core. Flakes appear to have been washed down the inside of the core between the sediment and the plastic core tube, and in some cases this contamination has affected the discrete samples taken in plastic cylinders. Anomalously high intensities are occasionally seen in samples from both the top and the bottom of the cores. Declination values measured by the long core spinner magnetometer do not show any consistency within core sections because of the rust contamination, and possibly also because of slippage of the sediment within the core liner during measurement. We were unable to obtain any paleomagnetic information from the whole-core measurements of natural remanent magnetization (NRM).

Thirty-one samples were taken for further study; measurement of these discrete samples was by methods described in the Site 511 report. NRM intensities are low (generally between 0.1 and 0.4 μG). Inclinations, which are evenly distributed between $-90°$ and $90°$, record three broad magnetic intervals: two zones of reversed polarity, one in the Miocene and one in the lower part of the middle Eocene section, separated by normal polarity in the upper part of the middle Eocene (Cores 7-11). Two samples were demagnetized. Sample 512-4-2, 124-126 cm shows that the NRM is stable, and probably primary; however, Sample 512-17-1, 94-96 cm shows the presence of a secondary magnetization, which is removed by demagnetization up to 150 Oe. The weak intensities and uncertain stability of remanence make the correlation of magnetic reversals difficult.

ORGANIC GEOCHEMISTRY

Sediments in Holes 512 and 512A were suitable only for analyses of organic carbon. There were no gas pockets within the soft sediments. Organic carbon values are extremely low; they vary between 0.1% and 0.25% in the uppermost part of the section and then drop to constant, low values of about 0.1%. The oxygenated depositional environment, combined with a very small portion of terrigenous input (50-80% carbonates), is apparently the reason for extremely low carbon contents. It should also be noted that the first three cores of the HPC are contaminated by diesel fuel.

PHYSICAL PROPERTIES

Although only 19 piston cores were recovered from Hole 512, two of the discontinuities in the section, Pleistocene/Miocene and Miocene/Eocene, are well documented in physical properties. As in Site 511, the following measurements were taken:

Wet-bulk density (g/cm^3), water content (% wet weight);
Porosity (% wet volume), shrinkage (% wet weight);
Sound velocity (km/s);
Penetration (min.) (falling weight 1 m);
Shear strength (g/cm^2);
Thermal conductivity (W/ms), (mcal/ms).

The data are given in the core summaries at the end of this chapter. Except for sound velocity, all other parameters behave normally with respect to one another. Within the Miocene, water content increases 10 meters below sea bottom. This increase reduces bulk densities and increases porosity because of a decrease in carbonate content and an increase in clay content, as indicated from smear slides.

Penetration and shear strength have minimum values at about 5 meters depth in unconsolidated diatomaceous ooze. Both parameters increase within the more clay-rich interval. The Miocene/Eocene boundary is indicated by the higher consolidation state of the Eocene nannofossil ooze reflected by all parameters. In the 60 meters of recovered Eocene sediments, physical properties indicate a well-developed consolidation gradient. Higher penetration and reduction in shear strength in the lowermost core are probably due to drilling disturbance by flow-in (core recovery $>100\%$).

Sound velocity, unlike the other parameters, shows a stable gradient below the uppermost 5 meters of the site.

CORRELATION OF REFLECTION PROFILE WITH LITHOLOGY

Site 512 is located near the northeastern end of the Maurice Ewing Bank. Only the top 78 meters of the section were cored with the HPC. Repeated attempts to rotary-drill deeper were thwarted by persistent current and long-period swells, which caused the vessel to roll excessively and/or stray off the beacon.

An interpreted version of the single-channel *Vema* 31-03 seismic record is shown in Figure 8. Above a southward-dipping (acoustic) basement Layer E is a wedge of weakly stratified sediments, Layers C and D, which onlap Layer E. Layer C is unconformably overlain by Layer B, which in turn is conformably overlain by Layer A.

The first two or three events below seafloor result from bubble pulse oscillations of the sound source, in this instance a single 25 cu. in. airgun. Our 78 meters of

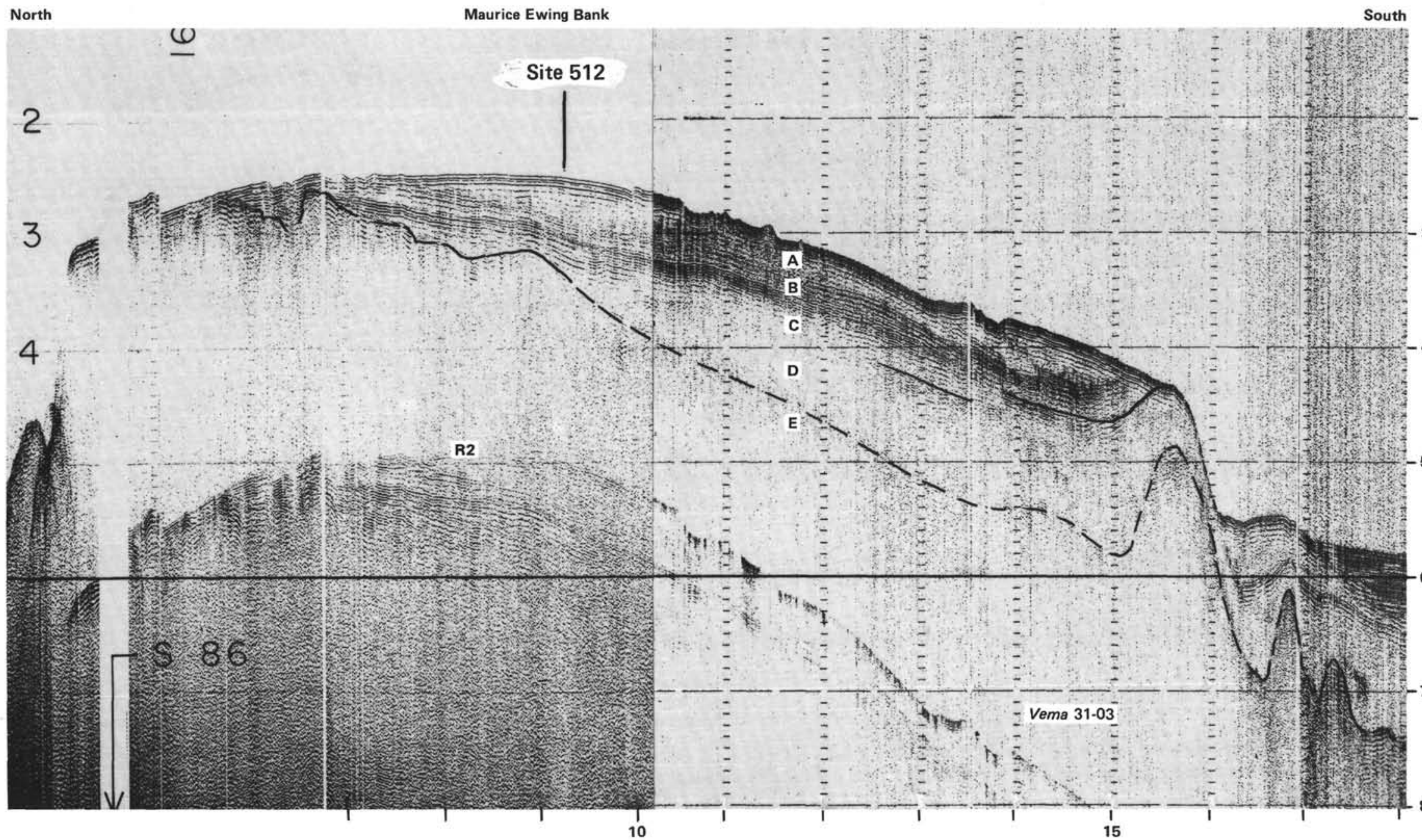

Figure 8. *Vema* 31-03 seismic reflection profile of Site 512. See Figure 3 for location. (Sediment layers A-E are described in the text. R2 is multiple reflection from the seafloor.)

penetration would represent about 0.1 s in two-way travel time on the record.

From examination of the *Challenger* seismic line made between Sites 511 and 512 and other seismic lines on the bank (Fig. 2), it may be possible to correlate the main reflectors observed with time-stratigraphic units. The A–B reflector may represent the Tertiary/Cretaceous boundary; B–C, the Albian/Aptian boundary; and C–D, the Cretaceous/Jurassic boundary. This interpretation would imply that the section here consists of a wedge of Jurassic sediments which is draped by pelagic sediments dating from the Cretaceous and the Tertiary through the Eocene. Erosion may have exposed the proximal part of the wedge.

SUMMARY AND CONCLUSIONS

Summary

Site 512 (49°52.194′S; 40°50.713′W) lies in the northeastern part of the Maurice Ewing Bank, in 1846 meters of water. Earlier drilling at nearby DSDP Site 327 (Leg 36) showed that the bank consisted of a thick sequence of calcareous and siliceous sediments of Tertiary through Neocomian age in which at least two major erosional events are recorded. Site 512 was chosen to investigate further the depositional and erosional history of the Falkland Plateau.

Continuous hydraulic piston coring was carried out to a sub-bottom depth of 77.9 meters; rotary drilling continued to a sub-bottom depth of 89.3 meters. The site was abandoned when the unfavorable combination of strong surface current, dual opposing swells, and weather conditions prevented further operations.

Lithostratigraphy

The biogenic sedimentary sequence at Site 512 is divided into two lithologic units (Fig. 3).

Unit 1. This unit consists of a surficial 93 cm of upper Pleistocene to lower Pliocene, olive gray to light gray gravelly quartzose sands, rich in foraminifers, that become more diatomaceous and lighter in color in the lowermost 11 cm; abundant ice-rafted terrigenous material in the upper portion of the unit consists of angular to subangular pebbles and sand of mixed igneous, metamorphic, and sedimentary origins. The base of the unit is sharply unconformable on Unit 2. In addition to that unconformity, this thin unit contains two other hiatuses. The topmost, at ~36 cm, separates upper Pleistocene from middle Pliocene; the second at ~79 cm, marks a break between the middle Pliocene and the lower Pliocene; the hiatus at the base of Unit 1 separates lower Pliocene from the lower upper Miocene sediments of Unit 2.

Unit 2. This unit consists of pelagic biogenic sediments and is subdivided into three subunits on the basis of color and carbonate content. *Subunit 2A* consists of 10 cm of pale olive soft noncalcareous diatomaceous ooze of early late Miocene age. *Subunit 2B* (19 m) includes massive white to olive gray diatomaceous and siliceous-nannofossil oozes of late to middle Miocene age. Concentrations of diatoms are sometimes great, giving a "cottony" appearance to the split core surface. In these zones, the carbonate content is as low as 7%, whereas carbonate values for the subunit range from 8.3–48%. *Subunit 2C* (69 m), of middle Eocene age, differs from Subunit 2B only in induration and color of the siliceous—nannofossil oozes. They are generally more firm, greenish gray to light greenish gray in color, and average 54% in carbonate content.

Conclusions

The record thus shows that throughout most of the Eocene–Pleistocene, Site 512 was above the CCD and far from a terrigenous source. The upper and middle Miocene interval is characterized by a low biogenic sedimentation rate (6.6 m/m.y.); in the middle Eocene, rates of sedimentation were considerably higher, as much as 32 m/m.y. (Fig. 6).

The four unconformities recognized at Site 512 (upper Pleistocene/middle Pliocene, middle to lower Pliocene, lower Pliocene/upper Miocene, and middle Miocene/middle Eocene) appear to be related to periods of Antarctic Circumpolar Current intensifications that prevented deposition or eroded sediments on the northeastern part of the Maurice Ewing Bank.

Although the section of Cenozoic sediments cored at Site 512 is small, it provides valuable stratigraphic and paleontologic information. Mild climatic conditions prevailing in the middle Eocene account for the coexistence of various groups of calcareous and siliceous microfossils. Comparison of zonal schemes based on planktonic foraminifers, nannofossils, radiolarians, diatoms, and silicoflagellates and correlation with other DSDP sites as well as with New Zealand sections will improve middle Eocene biostratigraphy of the temperate belt of the Southern Hemisphere. Very low species diversity among planktonic foraminifers and nannoplankton in the upper middle to upper Miocene sediments testifies to much more severe climatic conditions during that interval. The abundant siliceous microfossils in that part of the section are consequently of considerable stratigraphic significance.

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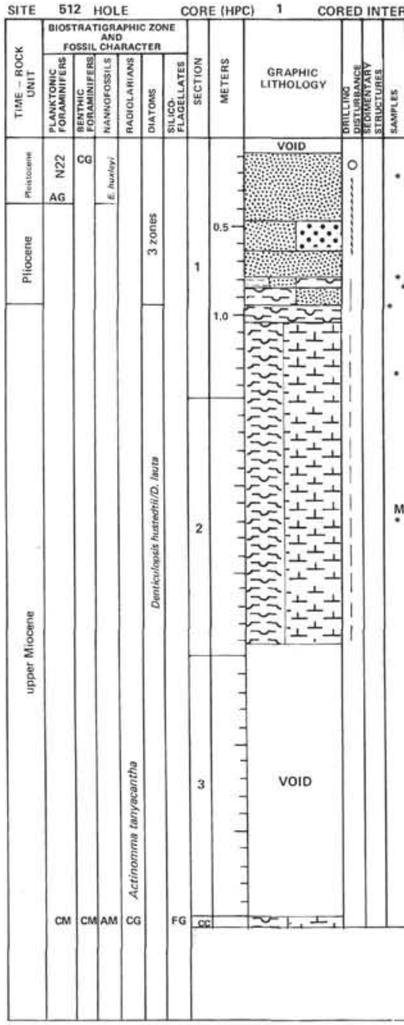
SITE 512 HOLE CORE (HPC) 1 CORED INTERVAL 0.0–2.5 m



LITHOLOGIC DESCRIPTION

SAND, DIATOMACEOUS OOZE AND DIATOMACEOUS NANNOFOSSIL OOZE.

Section 1, 8–93 cm: medium-grained quartz sand, dark to light olive gray or light gray; locally fine-grained or gravelly, or diatomaceous.

- 8–18 cm: dark olive gray (5Y 3/2) well sorted abundant heavy minerals.
- 18–36 cm: light gray (5Y 7/1), foraminifer-rich.
- 36–46 cm: olive gray (5Y 5/2), fine to medium.
- 46–57 cm: dark gray (5Y 4/1) sandy gravel; angular to subangular pebbles to 2 cm, mixed lithics, i. e. igneous, metamorphics, etc.
- 57–62 cm: single subangular pebble.
- 62–71 cm: light olive gray (5Y 6/2) medium.
- 71–79 cm: dark, subangular pebble.
- 79–82 cm: pale yellow (5Y 7/4) muddy, sandy diatom ooze, gradational into Section 1, 82–93 cm.
- 82–93 cm: light olive gray (5Y 6/2) fine, diatomaceous quartz sand; minor granules, fine pebbles and heavy minerals.

DIATOMACEOUS OOZE

Section 1, 93–103 cm: pale olive (5Y 6/3), soft.

DIATOMACEOUS NANNOFOSSIL OOZE

Section 1, 103 cm–Section 2, 92 cm and Core-Catcher: white (5Y 8/1–8/2) massive, faintly stratified.

Quartz filled burrow at Section 1, 105 cm. Local, "cottony" zones, very rich in diatoms at Section 1, 121–122, 135–136, 147–148 cm, and Section 2, 41–50, 61–64, and 68–70 cm.

SMEAR SLIDE SUMMARY

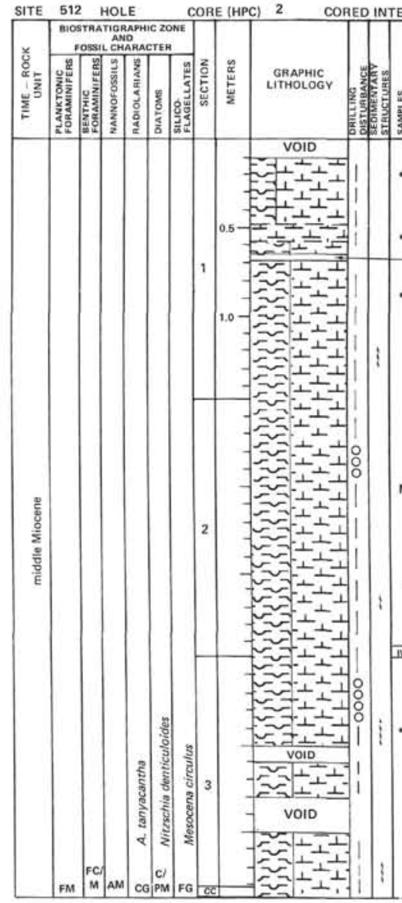
	1-25	1-80	1-84	1-97	1-135	2-70
	M	M	M	M	D	D
Sand	60	2	40	2	–	–
Silt	25	58	40	68	–	–
Clay	15	40	20	30	–	–
Quartz	35	15	35	15	TR	
Mica	–	–	TR	–	–	–
Heavy minerals	10	–	–	–	–	–
Clay minerals	10	39	17	29	5	5
Zeolites	–	1	1	1	–	–
Carbonate unspec.	–	–	–	5	–	–
Foraminifers	45	–	–	–	–	TR
Nannofossils	–	–	–	–	65	65
Diatoms	–	45	45	50	30	30
Radiolarians	–	–	2	–	–	–
Sponge spicules	–	TR	TR	–	–	–

CARBONATE BOMB:
2, 60–61 (61)

MAGNETIC DATA: 2-77
Inclination 67.6
Declination 111.1
Intensity (emu/cc) 0.370E–06

GRAIN SIZE:
2-21 (1, 31, 69)

SITE 512 HOLE CORE (HPC) 2 CORED INTERVAL 2.5–6.9 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS NANNOFOSSIL OOZE generally light gray (5Y 7/2–5YR 7/2) with local zones of white to light gray (5Y 8/1–10YR 8/1).

Section 1, 47–65 cm: very pale brown (10YR 7/3); the upper half of this interval is a nannofossil ooze, grading down into diatomaceous nannofossil ooze.

Local small Mn nodule and manganiferous zones in Section 1. Scattered contaminate pebbles – basalts, granite, metamorphics – throughout core.

Sediment mostly massive and featureless; local faint stratification; local mottling.

SMEAR SLIDE SUMMARY

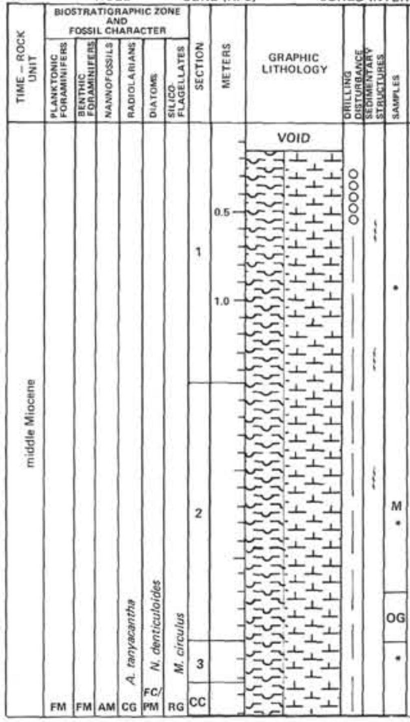
	1-20	1-56	1-90	2-110	3-44
	D	D	D	D	D
Quartz	TR	2	2	TR	TR
Mica	–	–	–	–	TR
Clay minerals	–	13	3	3	–
Foraminifers	TR	–	5	1	–
Nannofossils	74	40	60	55	69
Diatoms	23	5	30	40	25
Radiolarians	2	–	–	1	6
Silicoflagellates	1	–	–	–	TR
Sponge spicules	TR	–	–	–	TR
Undetermined mineral	–	40	–	–	–
Volcanic glass	–	–	–	TR	TR

CARBONATE BOMB:
1, 144–145 (48)
3, 32–34 (57)

MAGNETIC DATA: 2-67
Inclination 3.6
Declination 230.1
Intensity (emu/cc) 0.170E–06

GRAIN SIZE:
2-111 (2, 24, 74)

SITE 512 HOLE CORE (HPC) 3 CORED INTERVAL 6.9–11.3 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS NANNOFOSSIL OOZE light gray (2.5Y 7/0) grading downward to light olive gray (5Y 6/2); diatom content increases downward through Sections 2 and 3. Mottling sparse throughout; sediment generally massive and featureless. Occasional contaminate lithic granules.

SMEAR SLIDE SUMMARY

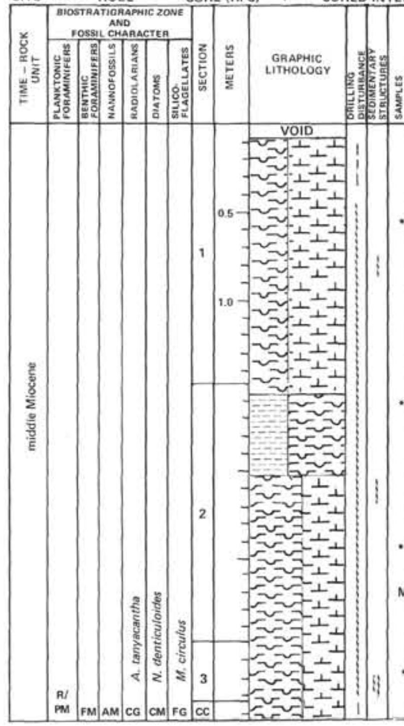
	1-90	2-80	3-10
	D	D	D
Quartz	TR	TR	TR
Carbonate unspec.	2	2	–
Foraminifers	1	TR	3
Nannofossils	78	70	63
Diatoms	17	24	30
Radiolarians	2	4	4
Silicoflagellates	TR	TR	TR
Sponge spicules	TR	TR	TR
Volcanic glass	TR	TR	TR

CARBONATE BOMB:
1, 141–143 (71)
2, 85–86 (38)

MAGNETIC DATA:	2-70
Inclination	65.6
Declination	254.7
Intensity (emu/cc)	0.430E–06

GRAIN SIZE:
1-31 (31, 18, 51)

SITE 512 HOLE CORE (HPC) 4 CORED INTERVAL 11.3–15.7 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS NANNOFOSSIL OOZE
As in previous Core 3; light gray (5Y 7/2–7/1) with intervals of olive gray (5Y 4/2–5/2) and local black (5Y 2/1) stringers high in ash content – i.e. Section 2, 119–122 cm. Mottling sparse throughout; moderate in Section 3, 0–14 cm. Vertical dark lineations in Section 1 indicate high degree of drilling disturbance.

MUDDY DIATOMACEOUS OOZE
Section 2, 7–52 cm: olive gray (5Y 4/2) with pale yellow (5Y 7/3) mottles and gray and black streaks. Interval has "cotton" texture, high in diatoms. Thin layers of similar ooze in Section 3.

SMEAR SLIDE SUMMARY

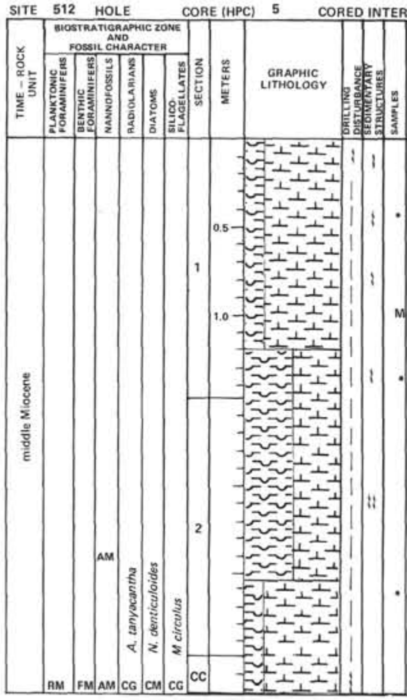
	1-56	2-12	2-91	3-19
	D	D	D	M
Quartz	TR	3	1	–
Mica	TR	TR	TR	–
Clay minerals	–	19	–	61
Carbonate unspec.	1	1	1	–
Foraminifers	1	–	1	–
Nannofossils	63	11	45	–
Diatoms	30	60	45	35
Radiolarians	4	5	6	2
Silicoflagellates	TR	TR	TR	TR
Sponge spicules	TR	TR	TR	TR
Volcanic glass	1	1	1	2

CARBONATE BOMB:
1, 80–82 (40)
2, 146–147 (7)

MAGNETIC DATA:	2-125
Inclination	2.0
Declination	152.5
Intensity (emu/cc)	0.281E–06

GRAIN SIZE:
1-51 (0, 26, 74)

SITE 512 HOLE CORE (HPC) 5 CORED INTERVAL 15.7–20.1 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS NANNOFOSSIL OOZE
Section 1, 0–120 cm: gray (5Y 6/1); slight mottling throughout; ash stringers present. Contaminate rock pebbles present.

Section 1, 120 cm – Section 2, 103 cm: diatoms and nannofossils in about equal amounts; olive gray (5Y 4/2); slight mottling, becoming moderate downward. Occasional layer (~ 1 cm) of pale yellow (5Y 7/3), white (2.5Y 8/0), and very dark gray (2.5Y 3/0); crude, vague stratification throughout.

Section 2, 103–150 cm: diatomaceous nannofossil ooze; white (2.5Y 8/0) to 137 cm; light gray (5Y 7/1) below. Rare pale yellow layers.

SMEAR SLIDE SUMMARY

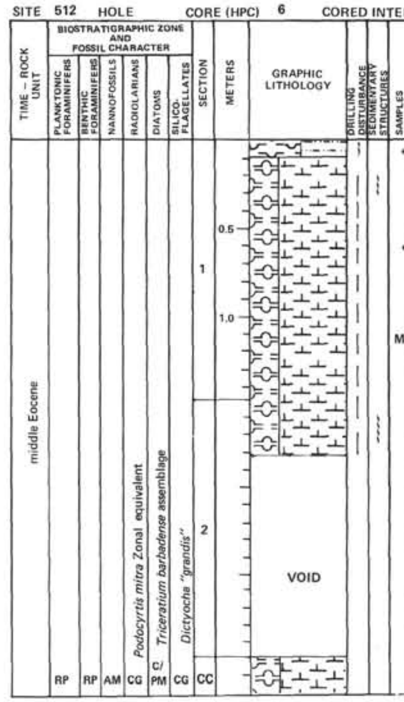
	1-45	1-136	2-112
	D	D	D
Quartz	TR	1	TR
Clay minerals	–	5	–
Carbonate unspec.	–	1	–
Foraminifers	TR	TR	3
Nannofossils	81	48	71
Diatoms	17	40	20
Radiolarians	2	5	5
Silicoflagellates	TR	TR	TR
Sponge spicules	TR	TR	TR
Volcanic glass	TR	–	–

CARBONATE BOMB:
1, 117–118 (18)
2, 111–112 (54)

MAGNETIC DATA:	1-91
Inclination	54.3
Declination	298.5
Intensity (emu/cc)	0.800E–07

GRAIN SIZE:
1-51 (0, 27, 73)

SITE 512 HOLE CORE (HPC) 6 CORED INTERVAL 20.1–24.5 m



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD
Section 1, 0–9 cm: highly disturbed, dark greenish gray (5GY 4/1).

SILICEOUS NANNOFOSSIL OOZE
Section 1, 9 cm–Section 2, 32 cm: greenish gray (5GY 6/1); massive, only very slightly mottled.

SMEAR SLIDE SUMMARY

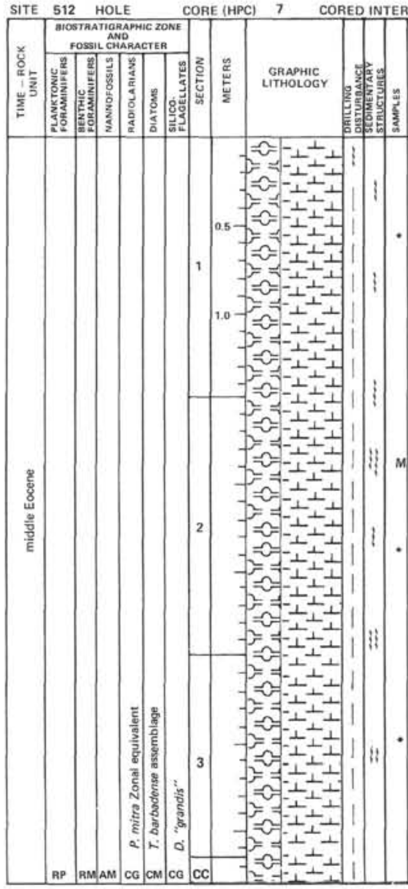
	1-5	1-60
	D	D
Quartz	TR	TR
Clay minerals	53	3
Carbonate unspec.	4	3
Foraminifers	–	2
Nannofossils	10	75
Diatoms	25	10
Radiolarians	8	7
Silicoflagellates	TR	–
Sponge spicules	TR	–

CARBONATE BOMB:
1, 92–93 (50)

MAGNETIC DATA:	1-111
Inclination	8.3
Declination	29.5
Intensity (emu/cc)	0.150E–06

GRAIN SIZE:
1-61 (1, 30, 69)

SITE 512 HOLE CORE (HPC) 7 CORED INTERVAL 24.5–28.9 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE greenish gray (5GY 6/1), massive; very slightly mottled, becoming moderate downward. Lenses ~2 cm greenish black (?ash) sparse throughout.

Section 1, 0–17 cm: many lithic fragments – ?contaminates.

SMEAR SLIDE SUMMARY

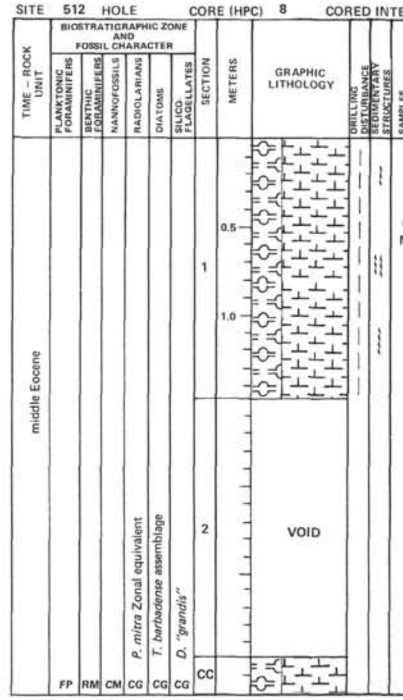
	1-60	2-90	3-50
	D	D	D
Quartz	TR	TR	TR
Clay minerals	2	2	3
Carbonate unspec.	–	2	–
Foraminifers	2	TR	3
Nannofossils	77	76	76
Diatoms	10	12	7
Radiolarians	7	6	8
Silicoflagellates	1	1	2
Sponge spicules	1	1	1

CARBONATE BOMB:
2, 63–64 (48)
3, 100–102 (57)

MAGNETIC DATA:	2-40
Inclination	–42.4
Declination	196.9
Intensity (emu/cc)	0.110E–06

GRAIN SIZE:
1-71 (1, 34, 65)

SITE 512 HOLE CORE (HPC) 8 CORED INTERVAL 28.9–30.9 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE greenish gray (5GY 6/1), massive, slight to moderate mottling; dark (?)ash lines.

SMEAR SLIDE SUMMARY

	1-50
	D
Quartz	TR
Clay minerals	3
Carbonate unspec.	2
Foraminifers	3
Nannofossils	74
Diatoms	8
Radiolarians	8
Silicoflagellates	1
Sponge spicules	1

CARBONATE BOMB:
1, 89–90 (50)

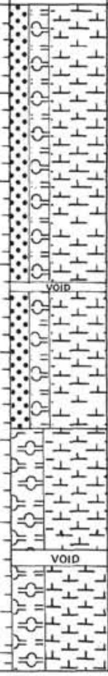
MAGNETIC DATA:	1-51
Inclination	–74.6
Declination	267.3
Intensity (emu/cc)	0.900E–07

GRAIN SIZE:
1-11 (0, 32, 68)

SITE 512 HOLE CORE (HPC) 9 CORED INTERVAL 30.9–35.3 m

TIME – ROCK UNIT	PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Eocene				*P. mitra* Zonal equivalent	*T. barbadense* assemblage	*D. "grandis"*	1, 2, 3, CC	0.5, 1.0				OG, •, M
	RF/PM	RM	C/PM	CG	CG	CG						

BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE, highly disturbed and with numerous lithic pebbles ~1 cm but up to 5 cm, varying lithologies, many of them dark chert; indurated ooze/chalk fragments, olive (5Y 5/4), high in clay and quartz, moderately abundant in Section 1, 0–75 cm, sparse below. This mixed lithology continues to Section 2, 93 cm below which disturbance is much less, although lithic fragments still present. Section 3, 0–77 cm, greenish gray (5GY 6/1) slightly mottled siliceous nannofossil ooze as in preceding and succeeding cores.

SMEAR SLIDE SUMMARY

	3-50
	D
Quartz	TR
Clay minerals	3
Carbonate unspec.	1
Foraminifers	3
Nannofossils	76
Diatoms	9
Radiolarians	6
Silicoflagellates	2
Sponge spicules	TR

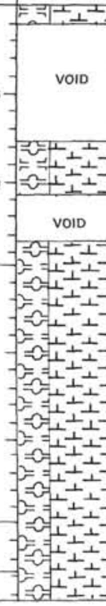
MAGNETIC DATA:	3-54
Inclination	−47.3
Declination	95.1
Intensity (emu/cc)	0.900E−07

GRAIN SIZE:
3-51 (0, 30, 70)

SITE 512 HOLE CORE (HPC) 10 CORED INTERVAL 35.3–38.3 m

TIME – ROCK UNIT	PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Eocene	*Globigerapsis index*			*P. mitra* Zonal equivalent	*T. barbadense* assemblage	*D. "grandis"*	1, 2, 3, CC	0.5, 1.0				•, M, •
	RM	RM	CM	CG	CM	CG						

BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE greenish gray (5GY 6/1); Section 1 greatly disturbed; black cherty fragments throughout. Sections 2 and 3 less disturbed, greenish gray as above, moderate mottling throughout. Ash lenses and laminae sparse.

SMEAR SLIDE SUMMARY

	2-75	3-20
	D	D
Quartz	TR	1
Mica	TR	–
Clay minerals	4	4
Carbonate unspec.	2	2
Foraminifers	2	3
Nannofossils	72	68
Diatoms	12	12
Radiolarians	5	7
Silicoflagellates	2	2
Sponge spicules	1	1

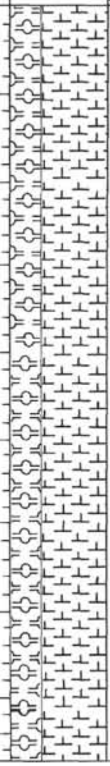
CARBONATE BOMB:
1, 145–147 (56)

MAGNETIC DATA:	2-114
Inclination	−31.1
Declination	84.6
Intensity (emu/cc)	0.200E−07

GRAIN SIZE:
2-76 (0, 32, 68)

SITE 512 HOLE CORE (HPC) 11 CORED INTERVAL 38.3–42.7 m

TIME – ROCK UNIT	PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Eocene	*G. index*			*P. mitra* Zonal equivalent	*T. barbadense* assemblage	*D. "grandis"*	1	0.5, 1.0				*, M
							2					M, *
							3					M, *
	CM	RM	CM	CG	CG	CG	CC					



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

Continuation of same lithology as in Core 10, greenish gray, slightly mottled. Olive (5Y 5/3) lenses high in clay and quartz in Section 1, 29–33 cm. Ash stringers sparse throughout core. Chert clast (3.5 cm), subangular, in Section 1, 22–26 cm.

SMEAR SLIDE SUMMARY

	1-70	2-45	3-50
	D	D	D
Quartz	TR	TR	TR
Clay minerals	4	3	3
Carbonate unspec.	–	1	2
Foraminifers	3	3	–
Nannofossils	75	75	72
Diatoms	8	7	7
Radiolarians	8	9	14
Silicoflagellates	1	1	2
Sponge spicules	1	1	TR

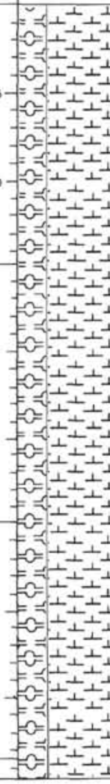
CARBONATE BOMB:
2, 103–104 (56)

MAGNETIC DATA:	1-91	2-26	3-26
Inclination	34.9	4.6	69.2
Declination	78.4	214.8	237.5
Intensity (emu/cc)	0.600E–07	0.250E–06	0.400E–07

GRAIN SIZE:
1-18 (1, 39, 60)

SITE 512 HOLE CORE (HPC) 12 CORED INTERVAL 42.7–47.1 m

TIME – ROCK UNIT	PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Eocene	*G. index*			*P. mitra* Zonal equivalent	*T. barbadense* assemblage	*D. "grandis"*	1	0.5, 1.0				*, M
							2					M, *, IW
							3					*, M
	FM	RM	CM	CG	CG	CG	CC					



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

Continuation of Core 11; light greenish gray (5G 8/1), slightly mottled; cave-in pebbles in Section 1, 10–15 cm. Ash sparse; greenish black (5GY 2/1) stringer in Section 1, 53–57 cm. Light gray (5Y 7/2) color banding, ~horizontal through Section 2. Mottling sparse to moderate in Sections 2 and 3.

SMEAR SLIDE SUMMARY

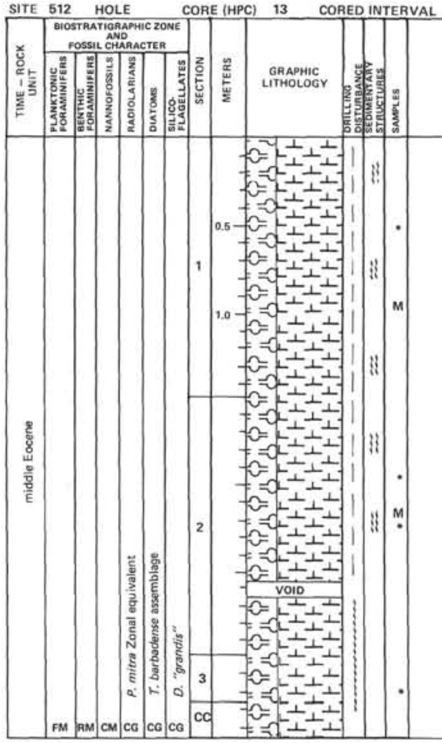
	1-40	2-80	3-50
	D	D	D
Quartz	TR	TR	TR
Clay minerals	3	2	2
Carbonate unspec.	2	2	1
Foraminifers	1	4	3
Nannofossils	75	69	76
Diatoms	10	14	10
Radiolarians	7	7	7
Silicoflagellates	1	1	1
Sponge spicules	1	1	TR

CARBONATE BOMB:
1, 84–85 (48)

MAGNETIC DATA:	1-50	2-50	3-50
Inclination	52.8	36.4	–42.9
Declination	175.4	12.4	117.7
Intensity (emu/cc)	0.190E–06	0.380E–06	0.120E–06

GRAIN SIZE:
1-41 (1, 34, 65)

SITE 512 HOLE CORE (HPC) 13 CORED INTERVAL 47.1–51.5 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE
Continuation of Core 12; slightly darker zones in Sections 2 and 3; light greenish gray to greenish gray (5GY 6/1–8/1) in Sections 1, 2, and 3. Homogeneous; moderately bioturbated; very firm. Scattered angular pebble clasts, <1 cm, in Section 2.

In Section 2, 126–150 cm, and in Section 3 and Core-Catcher: highly disturbed "flow-in", very soft.

Section 2, 119–126 cm: relatively firm and not as highly disturbed.

SMEAR SLIDE SUMMARY

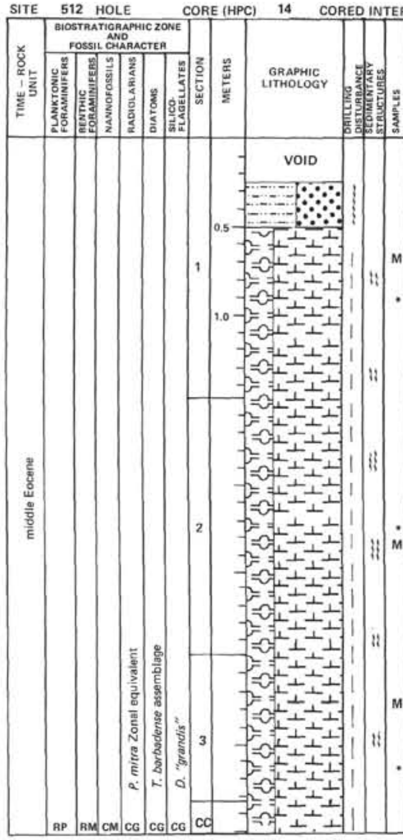
	1-55	2-46	2-75	3-20
	D	M	D	D
Quartz	1	–	–	1
Clay minerals	1	2	TR	–
Foraminifers	2	7	5	1
Nannofossils	72	70	70	90
Diatoms	15	15	15	3
Radiolarians	7	5	10	5
Silicoflagellates	1	1	–	–
Sponge spicules	1	–	TR	–

CARBONATE BOMB:
1, 122–123 (56)

MAGNETIC DATA:	1-99	2-70
Inclination	38.6	–2.3
Declination	225.5	244.5
Intensity (emu/cc)	0.200E–07	0.150E–06

GRAIN SIZE:
1-51 (2, 40, 58)

SITE 512 HOLE CORE (HPC) 14 CORED INTERVAL 51.5–55.9 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE
Continuation of previous cores; light greenish gray to greenish gray (5GY 8/1–6/1); moderate bioturbation; dark gray and brown burrows. Very firm, with stiffer zones in Section 1, 55–60 cm, 126–127 cm, and Section 3, below 54 cm. Occasional gray, subhorizontal laminae (~5°) in Section 2.

Section 1, 27–49 cm: mixed ooze and cave-in gravel (< 0.5 cm), light greenish gray.

SMEAR SLIDE SUMMARY

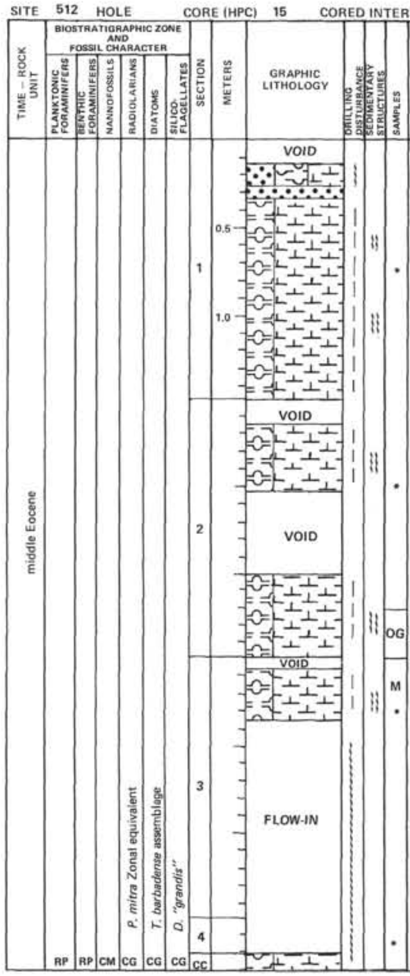
	1-90	2-75	3-65
	D	D	D
Quartz	TR	1	–
Clay minerals	–	2	1
Zeolites	–	TR	–
Carbonate unspec.	–	TR	–
Foraminifers	TR	2	5
Nannofossils	75	75	70
Diatoms	20	10	7
Radiolarians	5	10	15
Silicoflagellates	TR	TR	1
Sponge spicules	TR	–	1

CARBONATE BOMB:
2, 62–63 (49)

MAGNETIC DATA:	1-74	2-77	3-34
Inclination	20.9	– 0.2	– 2.4
Declination	256.9	55.9	256.4
Intensity (emu/cc)	0.110E–06	0.900E–07	0.130E–06

GRAIN SIZE:
2-31 (1, 39, 60)

SITE 512 HOLE CORE (HPC) 15 CORED INTERVAL 55.9–60.3 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE
As in previous cores; greenish gray (5GY 6/1), firm to stiff, moderately bioturbated.

PEBBLY SILICEOUS NANNOFOSSIL OOZE
Section 1, 12–29 cm: greenish gray to light greenish gray; stiff. Underlain by 3 cm of slightly muddy, fine gravel (2–4 mm) of mixed lithologies, mainly mafic types.

SMEAR SLIDE SUMMARY

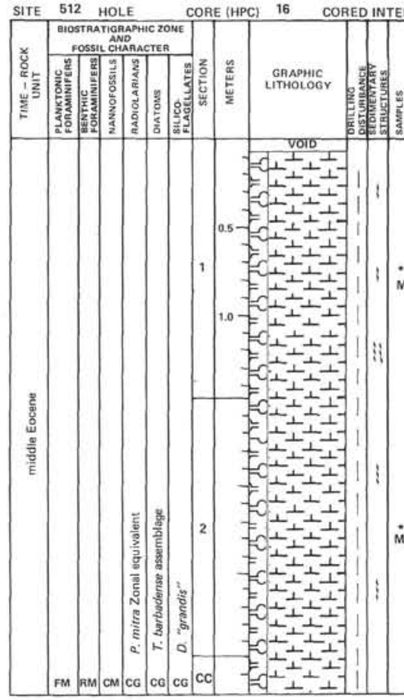
	1-75	2-50	3-30	4-15
	D	D	D	D
Quartz	TR	TR	–	TR
Zeolites	–	TR	TR	–
Foraminifers	2	2	2	1
Nannofossils	72	75	72	82
Diatoms	10	7	10	5
Radiolarians	15	15	15	10
Silicoflagellates	1	1	1	1
Sponge spicules	–	–	TR	1

CARBONATE BOMB:
3, 29–30 (60)

MAGNETIC DATA:	**3-25**
Inclination	48.3
Declination	7.8
Intensity (emu/cc)	0.198E–04

GRAIN SIZE:
1-130 (1, 35, 64)

SITE 512 HOLE CORE (HPC) 16 CORED INTERVAL 60.3–64.7 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE
As in previous cores; light greenish gray (5GY 8/1); very firm, moderate bioturbation; in Section 1, 137 cm grades into greenish gray to light olive gray (5GY 6/1–5Y 6/1) ooze containing green laminae and mottles; this continues to Section 2, 25 cm where it grades back to light greenish gray to greenish gray.

In Section 1, 106 cm: a ~1.5 cm well rounded pumice "pebble".

SMEAR SLIDE SUMMARY

	1-75	2-75
	D	D
Foraminifers	2	2
Nannofossils	82	80
Diatoms	5	7
Radiolarians	10	10
Silicoflagellates	TR	1
Sponge spicules	1	–

CARBONATE BOMB:
2, 64–65 (57)

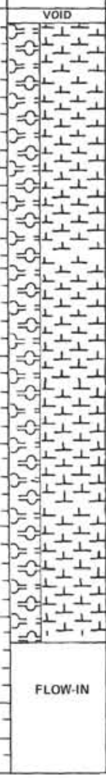
MAGNETIC DATA:	**1-73**	**2-73**
Inclination	29.8	24.6
Declination	100.0	2.1
Intensity (emu/cc)	0.900E–07	0.460E–06

GRAIN SIZE:
1-44 (1, 38, 61)

SITE 512 HOLE CORE (HPC) 17 CORED INTERVAL 64.7–69.1 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER: PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS
middle Eocene	FM	CM	CM	P. mitra Zonal equivalent (CG)	T. barbadense assemblage (CG)	D. "grandis" (CG)	1, 2, 3, CC	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

As in previous cores; light greenish gray to greenish gray (5GY 8/1–6/1), firm and moderately bioturbated; occasional green or gray laminae (0.5 cm).

"Flow-in", Section 3, below 67 cm and in Core-Catcher.

Section 2, 98–108 cm: zone of prominent "ring burrows".

(Liner broken Section 3, 119–122 cm.)

SMEAR SLIDE SUMMARY

	1-50 D	2-75 D	3-55 D
Foraminifers	1	1	2
Nannofossils	78	75	76
Diatoms	10	7	7
Radiolarians	10	15	15
Silicoflagellates	1	1	–
Micronodules	–	1	–

CARBONATE BOMB:
2, 59–60 (68)

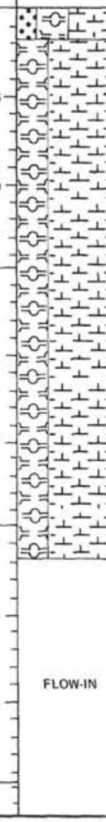
MAGNETIC DATA:	1-95	2-78	3-55
Inclination	34.6	36.7	37.6
Declination	59.3	21.8	0.3
Intensity (emu/cc)	0.114E–05	0.890E–06	0.310E–06

GRAIN SIZE:
2-10 (1, 39, 60)

SITE 512 HOLE CORE (HPC) 18 CORED INTERVAL 69.1–73.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER: PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS
middle Eocene	FC/MP	RM	CM	P. mitra to Thyrocyrtis triacantha (CG)	T. barbadense assemblage (CG)	D. "grandis" (CG)	1, 2, 3, CC	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

As in previous cores, but light bluish gray (5B 7/1) to light greenish gray (5G 8/1); very firm, moderately bioturbated. Gray or green zones and laminae at: Section 1, 57–62 and 56–57 cm and Section 2, 64–65, 92–93, and 104–105 cm.

Section 1, 0–19 cm: contains abundant pebbles (<1 cm) and granules of dark colored mafic-bearing lithologies; pebbles angular; probably cave-in.

Section 1, 119 cm: 0.5 cm pumice fragment.

Section 2, 0–28 cm and 110–131 cm: more greenish than other parts of the core.

SMEAR SLIDE SUMMARY

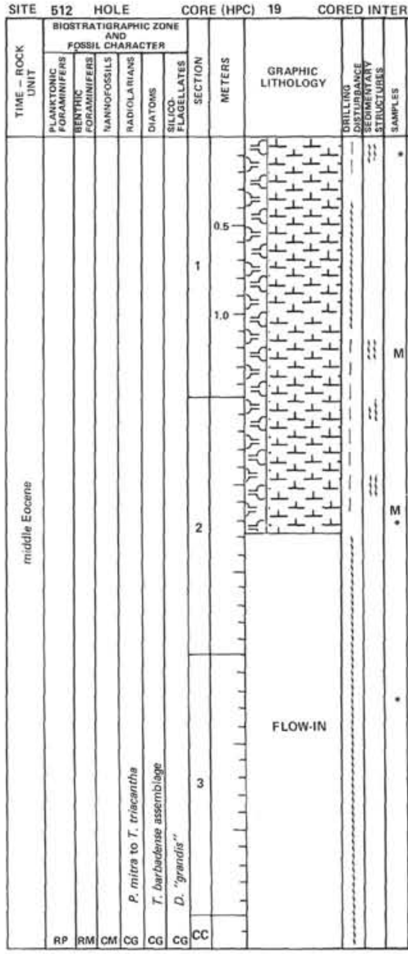
	1-50 D	1-90 D	2-75 D	3-10 D
Quartz	TR	TR	–	–
Clay minerals	1	1	–	1
Foraminifers	2	2	2	3
Nannofossils	80	77	77	73
Diatoms	7	10	10	7
Radiolarians	10	10	10	15
Silicoflagellates	–	–	TR	–
Sponge spicules	–	–	1	1

CARBONATE BOMB:
3, 59–60 (66)

MAGNETIC DATA:	1-71	2-71
Inclination	61.4	16.8
Declination	215.4	6.1
Intensity (emu/cc)	0.280E–06	0.800E–07

GRAIN SIZE:
2-44 (1, 37, 62)

SITE 512 HOLE CORE (HPC) 19 CORED INTERVAL 73.5–77.9 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

As in previous cores; light greenish gray (5G 8/1), firm, moderately bioturbated. Highly disturbed in Section 1, 29–104 cm, Section 2, 79–150 cm, Section 3, and Core-Catcher.

SMEAR SLIDE SUMMARY

	1-10	2-75	3-25
	D	D	D
Quartz	–	1	–
Clay minerals	–	2	2
Foraminifers	5	2	5
Nannofossils	78	82	77
Diatoms	5	5	5
Radiolarians	10	7	10
Silicoflagellates	1	–	–
Sponge spicules	1	1	1

CARBONATE BOMB:
1, 120–121 (60)

MAGNETIC DATA:	1-129	2-32
Inclination	–14.7	–30.6
Declination	204.0	182.7
Intensity (emu/cc)	0.500E–06	0.900E–07

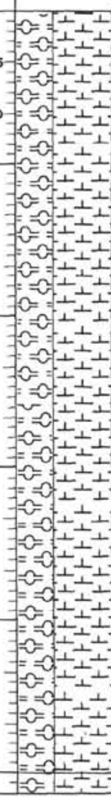
GRAIN SIZE:
1-24 (2, 39, 58)

SITE 512 HOLE A CORE 1 CORED INTERVAL 72.0–81.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER: PLANKTONIC FORAMINIFERS	BENTHIC FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
			CM				1, 2, 3	0.5, 1.0	VOID				

SITE 512 HOLE A CORE 2 CORED INTERVAL 81.5–89.3 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE AND FOSSIL CHARACTER: PLANKTONIC FORAMINIFERS	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Eocene	*Pseudogloboquadrina primitiva* F/PM	RM	CM	*Podocyrtis mitra* to *Thyrsocyrtis triacantha* CG	*T. barbadense* assemblage CG	*D. "grandis"* CG	1, 2, 3, 4, 5, CC	0.5, 1.0				* * *



LITHOLOGIC DESCRIPTION

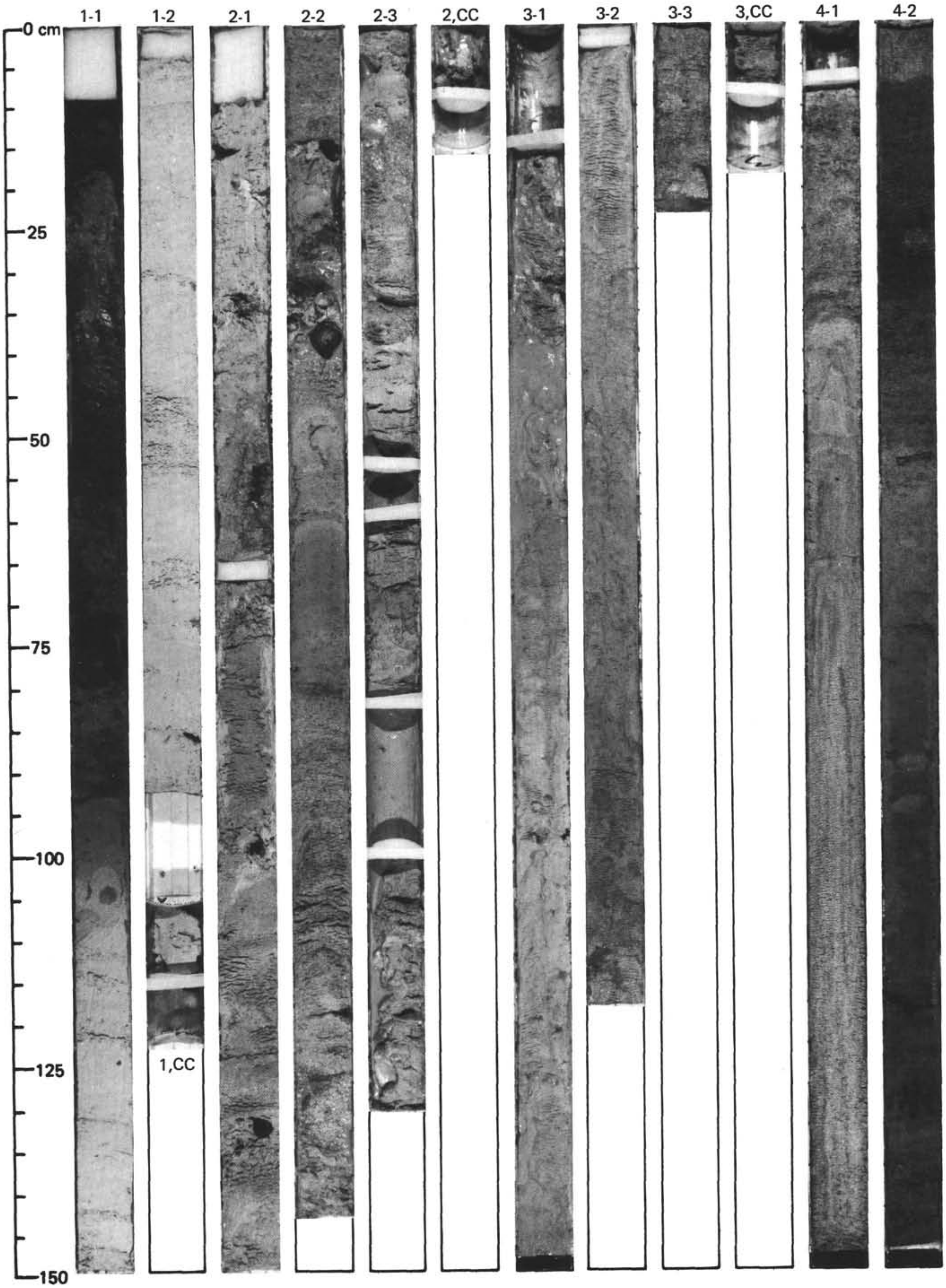
SILICEOUS NANNOFOSSIL OOZE

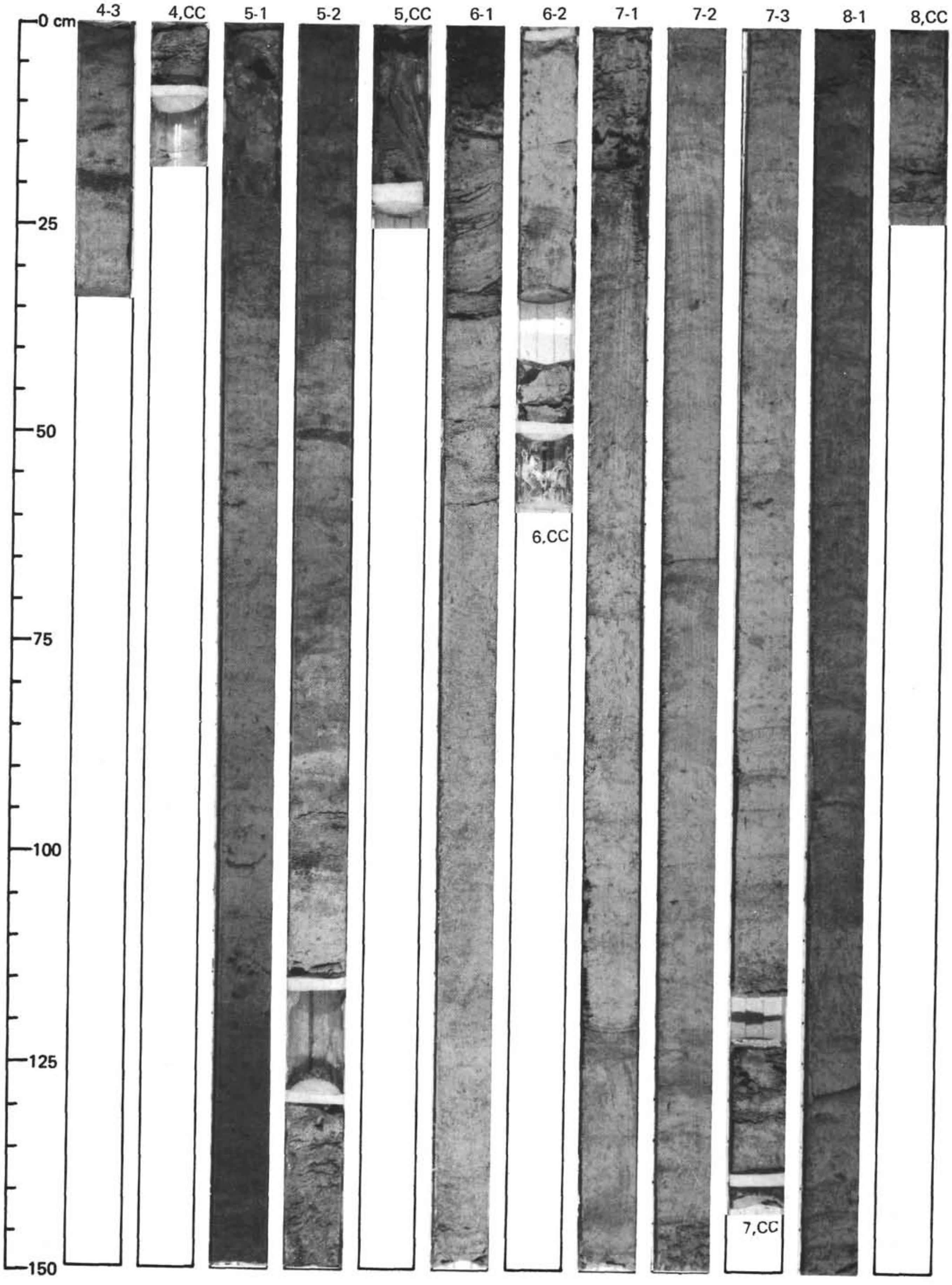
As in Hole 512 lower cores; light greenish gray to greenish gray (5G 8/1–6/1); moderately bioturbated, with dark gray and light olive gray (5Y 6/1) burrows and mottles. Core highly disturbed except Section 1, 0–93 cm and Section 2, 61 cm–Section 3, 23 cm, and Section 4, 57–150 cm, which are less disturbed.

SMEAR SLIDE SUMMARY

	1-35	2-85	5-65
	D	D	D
Quartz	TR	1	TR
Clay minerals	3	5	5
Foraminifers	5	5	2
Nannofossils	72	73	73
Diatoms	10	5	10
Radiolarians	10	10	10
Sponge spicules	–	TR	–

CARBONATE BOMB:
2, 138–140 (61)
3, 56–57 (56)


1-1
1-2
2-1
2-2
2-3
2,CC
3-1
3-2
3-3
3,CC
4-1
4-2
0 cm
25
50
75
100
125
150
1,CC


0 cm
25
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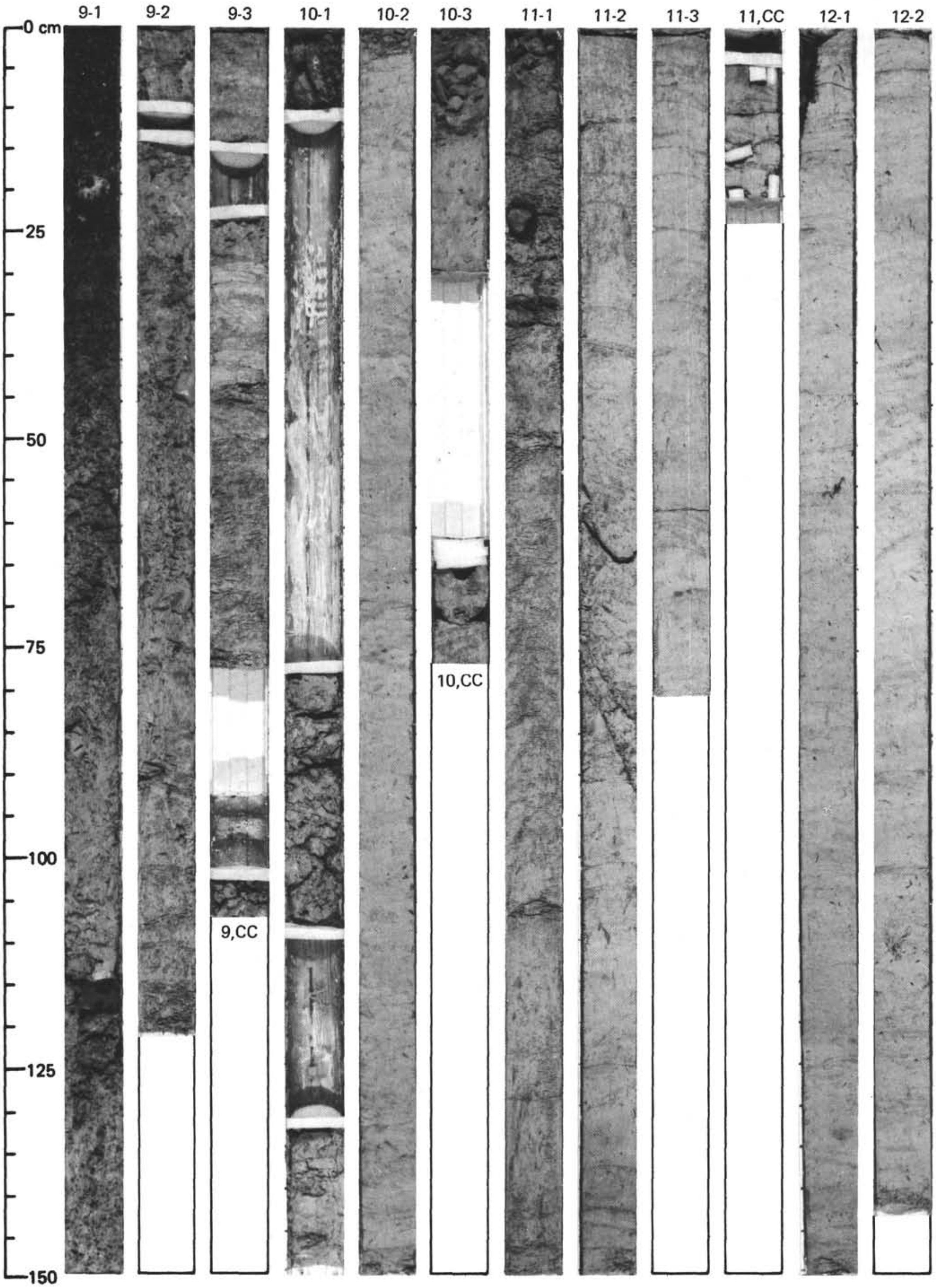
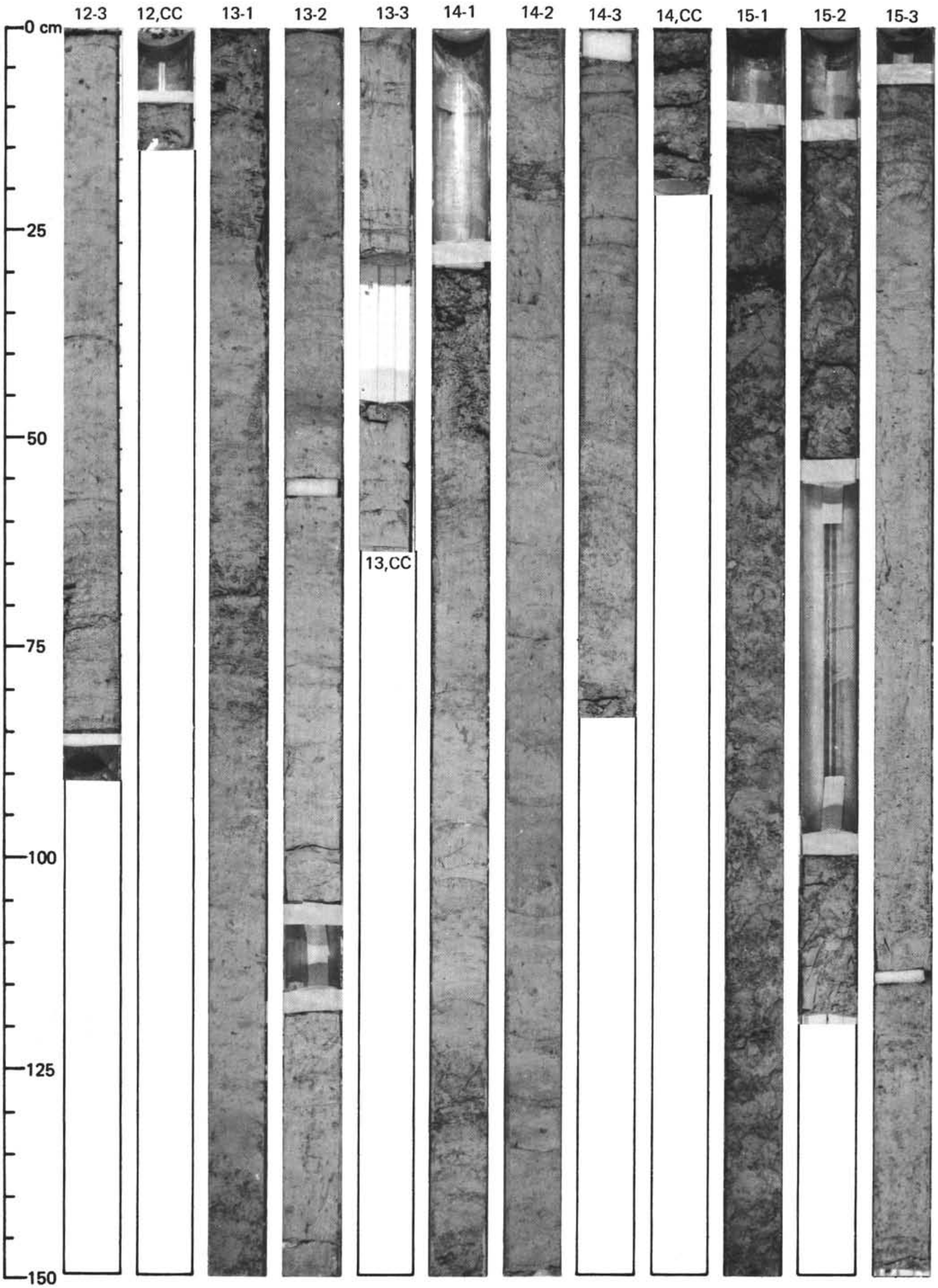
75
100
125
150
4-3
4,CC
5-1
5-2
5,CC
6-1
6-2
6,CC
7-1
7-2
7-3
7,CC
8-1
8,CC


9-1
9-2
9-3
10-1
10-2
10-3
11-1
11-2
11-3
11,CC
12-1
12-2
0 cm
25
50
75
100
125
150
9,CC
10,CC



12-3
12,CC
13-1
13-2
13-3
14-1
14-2
14-3
14,CC
15-1
15-2
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13,CC
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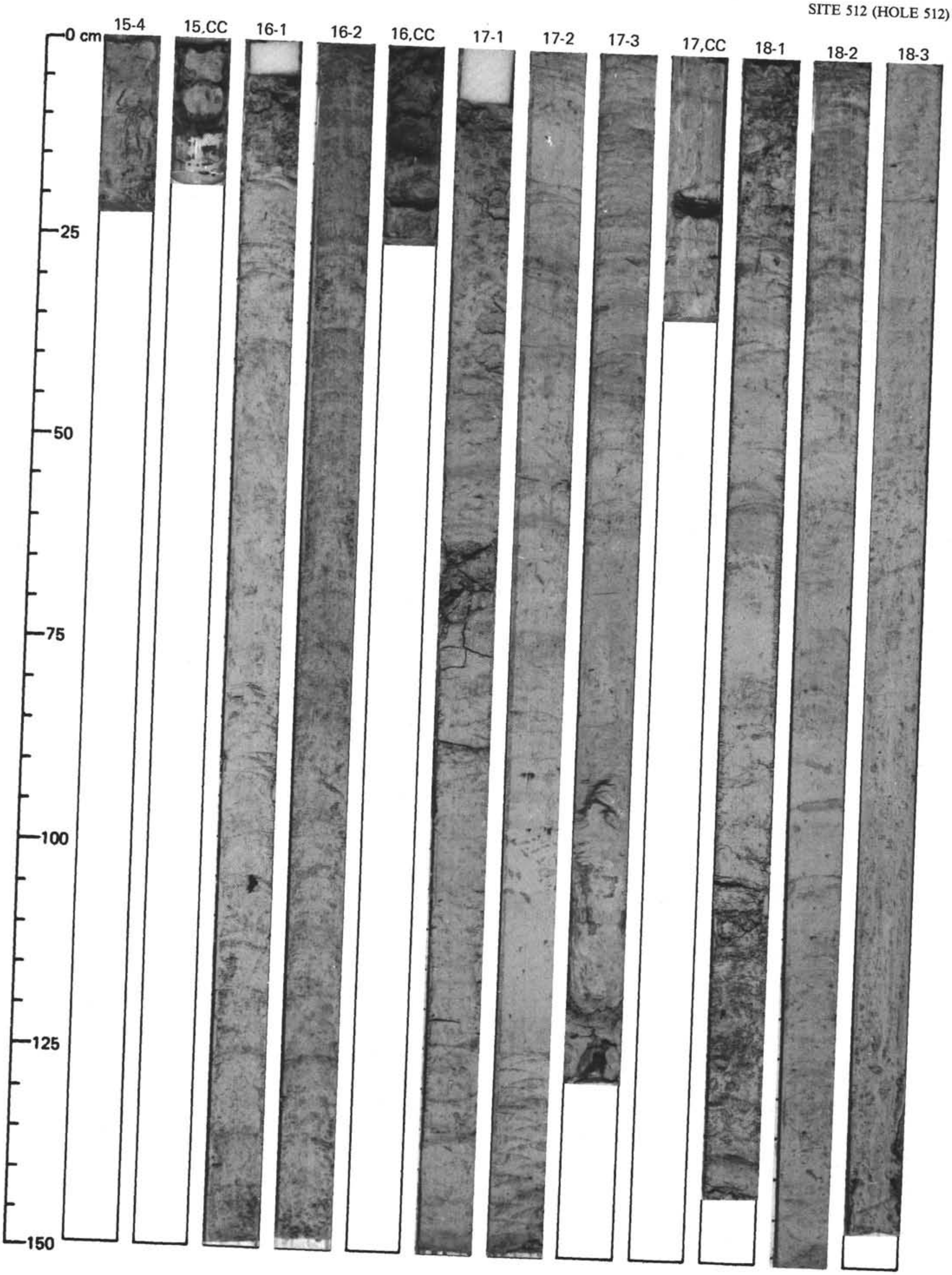
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16-2
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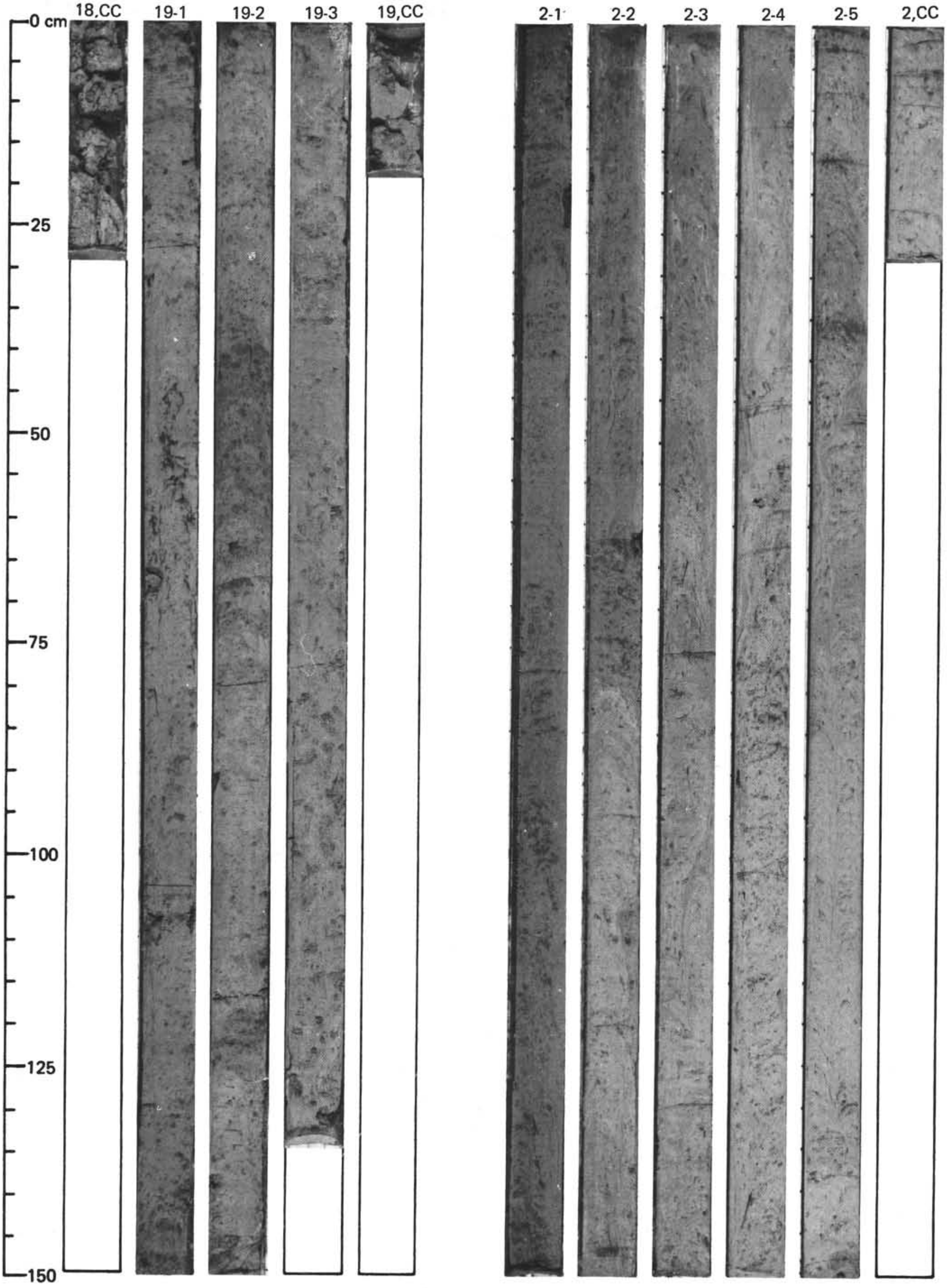
17-1
17-2
17-3
17,CC
18-1
18-2
18-3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75
100
125
150
18,CC
19-1
19-2
19-3
19,CC
2-1
2-2
2-3
2-4
2-5
2,CC