6. SITE 523[1]

Shipboard Scientific Party[2]

HOLE 523

Date occupied: 1230, 15 May 1980

Date departed: 1015, 20 May 1980

Time on site: 118 hr.

Position: 28°33.131′S; 2°15.078′W

Water depth (sea level; corrected m; echo-sounding): 4562

Water depth (rig floor; corrected m; echo-sounding): 4572

Bottom felt (m, drill pipe): 4572

Penetration (m): 193.5

Number of cores: 51

Total length of cored section (m): 182.5

Total core recovery (m): 149.2

Core recovery (%): 81.9

Oldest sediment cored:
Depth sub-bottom (m): 190.5
Nature: Nannofossil ooze
Age: middle Eocene

Principal results:

1. Obtained hydraulic piston cores from a pelagic sedimentary sequence Quaternary to middle Eocene in age and extended the calibration of the Tertiary biostratigraphic zones to Magnetostratigraphic Chron C-20-R.
2. Recognized a significant paleoceanographic event during the late middle Eocene, suggesting ocean cooling and/or that the formation of significant amounts of Antarctic ice might have started about 43 Ma (magnetostratigraphic age) or 39 Ma (radiometric age).
3. Confirmed an increase in abundance in the benthic foraminifer *Nuttalides umbonifera* when the site subsided to a given level, suggesting that species abundance might be related to the subsidence history at each site.
4. Found significant discrepancies between magnetostratigraphic and radiometric ages. With magnetostratigraphic ages based on the assumption that the Cenozoic started 66.5 Ma in parentheses, the magnetostratigraphic and radiometric ages are respectively 41 (39) Ma and 37 Ma for the middle/upper Eocene boundary and 46 (43.57) Ma and 41 Ma for the top of NP15.

BACKGROUND AND OBJECTIVES

One of the objectives of Leg 73 drilling was to investigate the middle and late Eocene paleoceanography of the Mid-Atlantic Ridge in the Southeast Atlantic. As mentioned in the Site 522 chapter, drilling at two previous sites was done to sample upper Eocene and Oligocene sediments deposited on or near ridge crest. It was hoped that these sediments would lie above the foraminifer lysocline so they would provide materials that permitted the terminal Eocene crisis to be investigated. The primary objective of drilling at Site 523 was to sample early middle Eocene sediments to permit the investigation of the middle Eocene event. The terminal Eocene crisis was a sudden drop of ocean temperature of 4 to 5°C (Douglas and Savin, 1975; Shackleton and Kennett, 1975). The middle Eocene event, on the contrary, was a short episode when ocean temperatures were warmer (by 2–4°C) than before or immediately after (Shackleton and Kennett, 1975). We hoped to obtain samples of a continuous sequence of calcareous sediments of upper and middle Eocene age to investigate this paleoclimatic event.

Two drill sites, SA IV-6 and SA IV-7, were proposed to make sure that we would succeed in acquiring calcareous sediments that would permit us to study the crisis. The crust at SA IV-7, on Anomaly 21, was certainly older than both the middle and terminal Eocene events. The terminal Eocene sediments at SA IV-6, on Anomaly 20, may have been deposited while the site was at a ridge crest position. Dissolution at this site would be at a minimum for this event, but the ocean crust might be too young to give a sedimentary record of the earlier event. If ship time was adequate, the plans called for drilling at both sites. If, on the other hand, ship time was limited, we were to consider whether other objectives had higher priority and whether one of the two sites would fulfill the objective satisfactorily. During the cruise it became clear that only two more sites could be adequately investigated in the time remaining. For reasons given in the Site 524 chapter, we decided to drill only one of the two middle Eocene sites. Of the two we chose SA IV-7. First, the crust at this site was certain to be old enough to record the middle Eocene event. Second, previous drilling indicated that the calcite compensation depth (CCD) did not vary very much during the Eocene; thus, the degree of dissolution in sediments deposited on crust

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[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP*, 73: Washington (U.S. Govt. Printing Office).

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differing in age by only 3 m.y. would not be much different. Third, as the older site, Site IV-7 would provide the longer record for the correlation of bio- and magnetostratigraphy and for the correlation of the latter with seafloor lineations. It was deemed especially important to acquire samples of late middle Eocene sediments to evaluate a part of the biostratigraphic–magnetostratigraphic correlation that was revealed by previous DSDP holes to be in error. Finally, drilling at Site IV-7 might provide evidence as to whether the seafloor spreading rate had deviated from linearity during the Eocene and Paleocene in the South Atlantic.

Another consideration in our planning was that Site IV-6 was very close to Site IV-7. If for some unforeseen reason we failed completely to achieve our primary objective at Site IV-7, we could steam back to Site IV-6 without losing a great deal of time.

The original location for Site IV-7 was chosen on the basis of continuous seismic profiling by the University of Texas Marine Science Institute (UTMSI). However, it was realized as early as the last meeting of the Ocean Paleoenvironment (OP) Panel that the sediment thickness there was minimal and might consist of only a thin veneer of Pliocene–Quaternary ooze. However, John LaBrecque was able to find alternate sites on Anomalies 20 and 21 on an *Atlantis II* profile (Cruise 67, Leg 5) where thicker drape sediments were present. We designated these locations Sites IV-6 alternate and IV-7 alternate, and during the cruise we obtained permission through telegraphic messages from JOIDES to drill at the alternate sites. Site IV-7 alternate was finally drilled as Site 523.

The seismic profiling (Fig. 1) shows a local plateau apparently covered by a uniform blanket of sediments about 200 m thick. By the time we were ready to drill we had begun to hope that we could drill the entire section above the basement with the hydraulic piston corer (HPC). Furthermore, we were not sure we could wash through such durable layers as the Miocene clay without attaching the dummy drill bit to the HPC, and this drill bit could not be attached after a remote rotary-to-HPC conversion. Therefore, we attached the HPC assembly to the drill string. We decided that if we met obstructions that prevented us from attaining (or nearly attaining) our goal, we would trip the drill string for rotary drilling and coring.

To recapitulate, our primary objective was to use the HPC to obtain a continuous sequence of upper and middle Eocene sediments. We wanted to sample sediments that had been deposited at a nearly uniform rate, were relatively free of contamination by resedimentation, and contained sufficient calcareous fossils to study the biostratigraphy, magnetostratigraphy, and paleoceanography of the mid-Eocene event. In addition, we wanted (1) to study the symmetry (or lack of it) in South Atlantic sedimentation, (2) to gather additional data concerning the terminal Eocene crisis and middle Miocene CCD crisis, (3) to sample diatom floras, if available, to provide data on the gradients of surface currents, (4) to date the seafloor lineations here (on Anomaly 21) and to clarify their temporal relation to biostratigraphic zonations, and (5) to obtain a clear and detailed history of South Atlantic seafloor spreading.

Because of poor weather and numerous difficulties with equipment, we did not satisfy all of our objectives completely. Nevertheless, the results were satisfactory. The shipboard staff therefore preferred to invest the remainder of ship time in drilling at the Cape Basin site, Site II-6, rather than in resampling at this location or in drilling at Site IV-6 alternate.

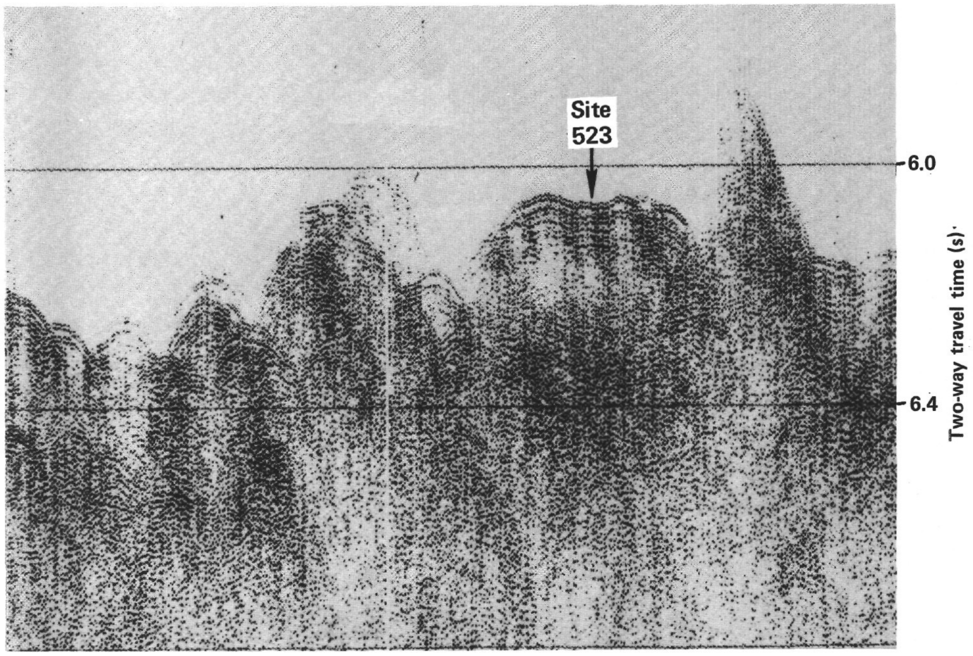

Figure 1. *Glomar Challenger* seismic profile over Site 523.

OPERATIONS

Site Approach

Site 523 was chosen from a profile of *Atlantis II* (Cruise 67, Leg 5, at 0600Z), which showed a particularly attractive pelagic drape over Magnetic Anomaly 21 basement. In order to locate the desired section, the *Glomar Challenger* steamed to a point 28°36′S and 2°21′W and took a course of 58° to follow the *Atlantis II* track (Fig. 2). The seismic equipment included 10- and 5-in.^{3} air guns. We lacked proper satellite fixes, which made navigation difficult, but with the excellence of navigation we had come to expect we passed directly over the profile. A beacon was dropped at 0959Z on 15 May 1980. A short survey was conducted after the beacon was dropped to make sure that relief in the area was minimal.

Coring Summary

The *Glomar Challenger* arrived on site and was in automatic positioning at 1230Z on 15 May. However, the weather, with northwesterly winds and a southwesterly swell, was unfavorable for positioning. The ship was able to hold position, but she rolled 6 to 10° at times. Toward evening, the wind shifted to the southwest, reducing pitch and roll. At 1854Z the drill crew started to make up the bottom hole assembly and prepared to run the pipes down. At 0615Z on 16 May, Hole 523 was spudded in. The HPC was started at a water depth of 4572 m (Table 1). The first core came up at 0645, but only traces of Quaternary ooze were attached to the core catcher. At 0800, the HPC bit stuck. When it was finally pulled free and recovered, it was found that the aluminum ring used to mark the orientation of the HPC had jammed in the seal sleeve. Hydraulic piston coring continued despite bad weather, but recovery was poor and the cores were disturbed. The recovery problem was resolved at 1830Z, when tool pusher Bill Lee discovered that the shear pins were malfunctioning and took remedial action. However, the core disturbance continued, apparently because the heavy swell (which was up to 12 ft. high) continued to come in from the southwest. These conditions persisted throughout the day of 17 May. Nevertheless, the vessel was able to hold position and to keep roll and pitch within safe operating limits.

At 0500Z on 17 May, the HPC bit encountered a hard layer at 56.4 m sub-bottom, presumably the middle Oligocene *Braarudosphaera* chalk that was expected at about this depth. The bit was able to drill through the layer, and the HPC could proceed after 3 m of interruption. Poor recovery continued; at 0940Z only a trace of ooze was recovered from Core 18 (which penetrated from 63.4 to 65.4 m sub-bottom). Some difficulty was experienced in washing from 63.4 to 65.4 sub-bottom, suggesting that a durable layer was present. Recovery in Core 19 was good, with a clump of *Braarudosphaera* chalk, mixed with pipe rust and other drilling debris, on top of Section 1. The chalk layer, which can probably be correlated with the third *Braarudosphaera* chalk bed at Site 522, was apparently the reason for the poor recovery in Core 18.

During the day the weather became calmer. Recovery percentages and core quality both improved with the weather. After Core 22 was taken the HPC samples be-

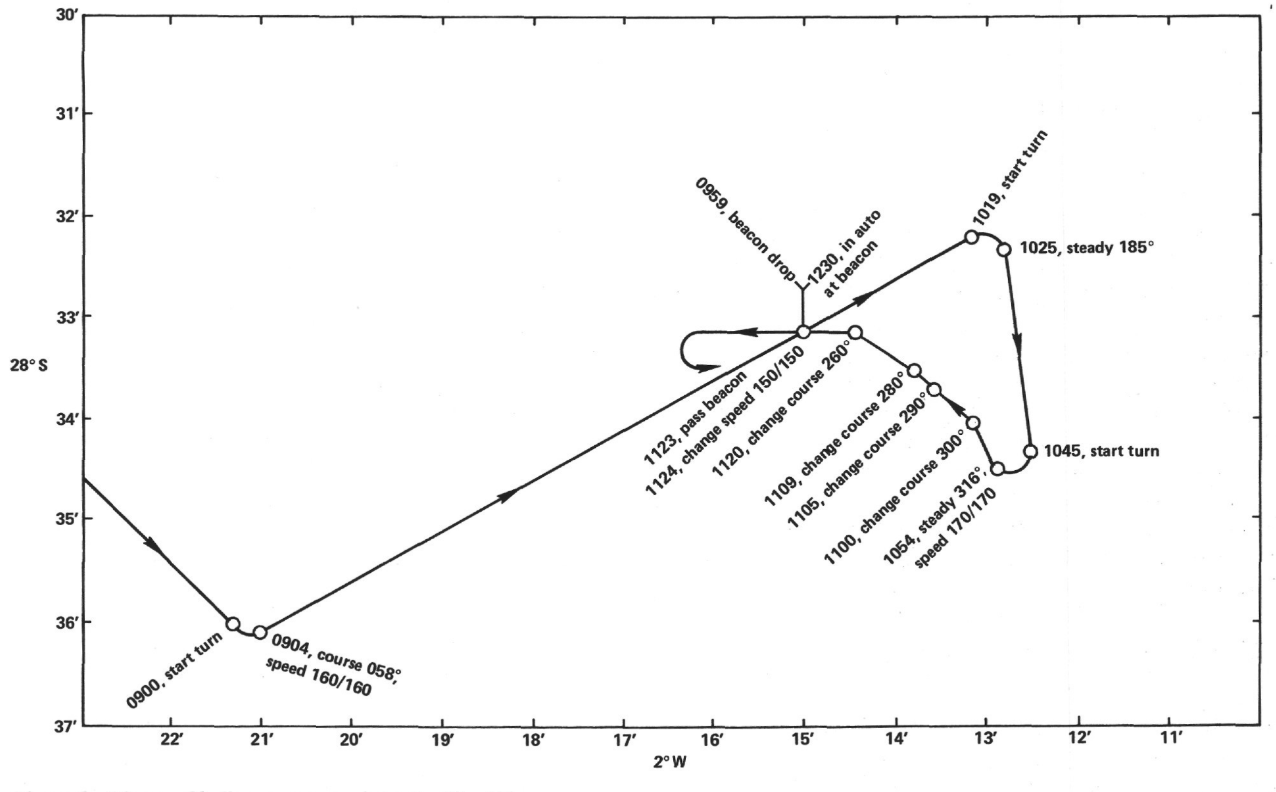

Figure 2. *Glomar Challenger* approach track, Site 523.

Table 1. Coring summary, Hole 523.

Core	Date (May 1980)	Time (hr.)	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Recovery (%)
1	16	0645	4572.0–4576.0	0–4.0	4.0	Tr	1
2	16	0844	4576.0–4580.4	4.0–8.4	4.4	2.3	52
3	16	1025	4580.4–4584.8	8.4–12.8	4.4	3.3	75
4	16	1152	4584.8–4589.2	12.8–17.2	4.4	4.1	93
5	16	1320	4589.2–4593.6	17.2–21.6	4.4	0.4	09
6	16	1440	4593.6–4598.0	21.6–26.0	4.4	4.1	93
7	16	1600	4598.0–4602.4	26.0–30.4	4.4	4.3	97
8	16	1720	4602.4–4606.0	30.4–34.0	3.6	3.7	102
9	16	1840	4606.0–4606.0	34.0–34.0	0.0	tr	—
10	16	2020	4606.0–4610.4	34.0–38.4	4.4	4.3	97
11	16	2140	4610.4–4613.9	38.4–41.9	3.5	3.4	97
12	16	2310	4613.9–4617.4	41.9–45.4	3.5	3.4	97
13	17	0035	4617.4–4621.4	45.4–49.4	4.0	4.6	115
14	17	0158	4621.4–4625.4	49.4–53.4	4.0	3.5	87
15	17	0325	4625.4–4626.4	53.4–54.4	1.0	tr	—
16	17	0500	4626.4–4628.4	54.5–56.4	2.0	2.1	105
—	17	—	4628.4–4631.4	56.4–49.4	Drill through hard layer		
17	17	0810	4631.4–4635.4	49.4–63.4	4.0	2.7	67
18	17	0940	4635.4–4637.4	63.4–65.4	2.0	tr	—
19	17	1115	4637.4–4741.4	65.4–69.4	4.0	3.5	87
20	17	1238	4741.4–4644.9	69.4–72.9	3.5	3.3	94
21	17	1400	4644.9–4649.3	72.9–77.3	4.4	4.1	93
22	17	1530	4649.3–4652.8	77.3–80.8	3.5	3.0	85
23	17	1730	4652.8–4656.8	80.8–84.8	4.0	3.7	92
24	17	1852	4656.8–4660.8	84.8–88.8	4.0	3.7	92
25	17	2030	4660.8–4664.8	88.8–92.8	4.0	4.1	100
26	17	2205	4664.8–4666.8	92.8–94.8	2.0	2.1	100
27	17	2350	4666.8–4670.8	94.8–98.8	4.0	3.0	75
28	18	0130	4670.8–4674.8	98.8–102.8	4.0	4.6	110
29	18	0310	4674.8–4678.8	102.8–106.8	4.0	tr	0
30	18	0440	4678.8–4682.8	106.8–110.8	4.0	3.1	77
31	18	0600	4682.8–4686.8	110.8–114.8	4.0	3.4	85
32	18	0730	4686.8–4689.8	114.8–117.8	3.0	2.5	83
33	18	0900	4689.8–4693.8	117.8–121.8	4.0	2.6	65
34	18	1030	4693.8–4696.8	121.8–124.8	3.0	1.9	63
35	18	1140	4696.8–4700.3	124.8–128.3	3.5	3.2	91
36	18	1320	4700.3–4702.8	128.3–130.8	2.5	1.6	64
37	18	1450	4702.8–4707.2	130.8–135.2	4.4	3.9	88
38	18	1802	4707.2–4711.2	135.2–139.2	4.0	3.2	85
39	18	1934	4711.2–4715.2	139.2–143.2	4.0	3.4	85
40	18	2104	4715.2–4718.7	143.2–146.7	3.5	2.8	85
41	18	2240	4718.7–4723.2	146.7–151.2	4.5	4.2	93
42	19	0055	4723.2–4727.2	151.2–155.2	4.0	4.4	110
43	19	0225	4727.2–4730.7	155.2–159.7	4.5	4.3	95
44	19	0350	4730.7–4735.2	159.7–162.2	3.5	3.3	94
45	19	0457	4735.2–4739.7	162.2–166.7	4.5	4.1	91
46	19	0623	4739.7–4743.2	166.7–170.2	3.5	2.1	60
47	19	0805	4743.2–4747.6	170.2–174.6	4.4	4.1	93
—	19	—	4747.6–4752.6	—	Wash—broken pipe		—
48	19	1424	4752.6–4754.1	180.6–182.1	1.5	2.3	153
49	19	1536	4754.1–4758.5	182.1–186.5	4.4	4.3	97
50	19	1705	4758.5–4762.5	186.5–190.5	4.0	3.5	87
51	19	—	4762.5–4765.5	190.5–193.5	0	0	0
Total					182.5	149.2	81

Note: Dash denotes not applicable or unknown.

came suitable again for precision magnetostratigraphy. However, when Core 29 came up (at 0130Z on 18 May), the barrel was empty again, probably because the core catcher failed to prevent the cored sediment from falling out of the barrel. Throughout the drilling we had found crushed core liners, and several remedies were attempted without success. When Core 29 came up empty we changed to the flapper type of core catcher, which provided better sediment retention by minimizing the circulation of water through the cracked liners. Otherwise, hydraulic piston coring continued steadily, with good or average recovery, despite the presence of slightly lithified nodules in the oozes. At 1030Z on 19 May Core 48 was supposed to arrive on deck, but no sediments were recovered because the HPC barrel had broken near the top.

The staff met to make plans. We decided to try to drill down to the basement at this site before proceeding to drill the next site in Cape Basin. Meanwhile, an attempt to retrieve the broken barrel failed. However, the tool sent down was smeared with ooze when it was brought up, an indication that the broken core barrel had fallen out of the drill collar. An attempt to wash 5 m down, past the broken barrel, was successful. At 1240Z, another HPC barrel was pumped down. The barrel was retrieved at 1424Z with good recovery. It was thought that the problem had been solved.

Two more cores came up, the last (Core 50) at 1705Z. Then we began to have further difficulties. First the HPC seemed to have malfunctioned. Then the sand line sent down to retrieve the core barrel came back with the end broken and the drill string had to be brought back to the rig floor. Meanwhile it was decided to wash ahead a little to "feel" the basement. However, after the string was raised a few meters, the downhole HPC barrel gave an indication of being properly seated. We had one last chance to sample the sediment above the basement. Since both seismic and magnetic data suggested that the basement was only 5 to 20 m down, we decided to wash ahead for 3 m before firing the last shot. After washing for 1.5 m the drill string seemed to encounter a hard object. It was probably the broken core barrel, because we were able to bypass the object and fire off the shear pins of the HPC (we thought). However, there was no indication that a full stroke had been achieved. At 2259Z on 19 May, having exhausted all possibilities, we terminated the drilling. The crew set back the Bowen subassembly to pull out of the hole. The drill string cleared the mudline at 2300Z, and the drill bit was on deck at 0850Z. The crew had difficulty retrieving the core barrel, which had been broken and was empty. A smear of ooze that was scraped off the core barrel and belonged to NP15 was the last core. At 1015Z on 20 May, after all the gear was secured on the rig floor, the vessel departed for Site 524.

LITHOLOGY

The dominant lithologies at Site 523 are nannofossil ooze, marly nannofossil ooze, and red clay. They range in age from middle Eocene to Quaternary. We divided the section into three lithologic units on the basis of calcium carbonate content, fossil composition, and color. The characteristics of these units are summarized in the composite sedimentary column shown in Figure 3.

Unit 1 (Cores 1–7, 0–30.2 m sub-bottom) consists of very pale brown, light yellowish brown, yellowish brown, and brownish yellow foraminifer-nannofossil ooze, nannofossil ooze, and marly nannofossil ooze. The calcium carbonate content of these pelagic sediments varies between 72 and 98%. Bioturbation features are recognized throughout the unit. Burrowing structures are most distinct in areas where alternating dark and light ooze provided sufficient color contrast to manifest the sediment mixing (e.g., Core 3).

Dark brown to dark reddish brown clay and reddish brown nannofossil clay characterize Unit 2 (Cores 8–20; 30.2–72.9 m sub-bottom). The shallowest occurrence of the dark brown clay in Core 8 defines the top of the unit. This clay, which has a carbonate content near 0%, forms the main lithology in Cores 8 through 12. The lower part of Unit 2 (Cores 13–20) consists of alternat-

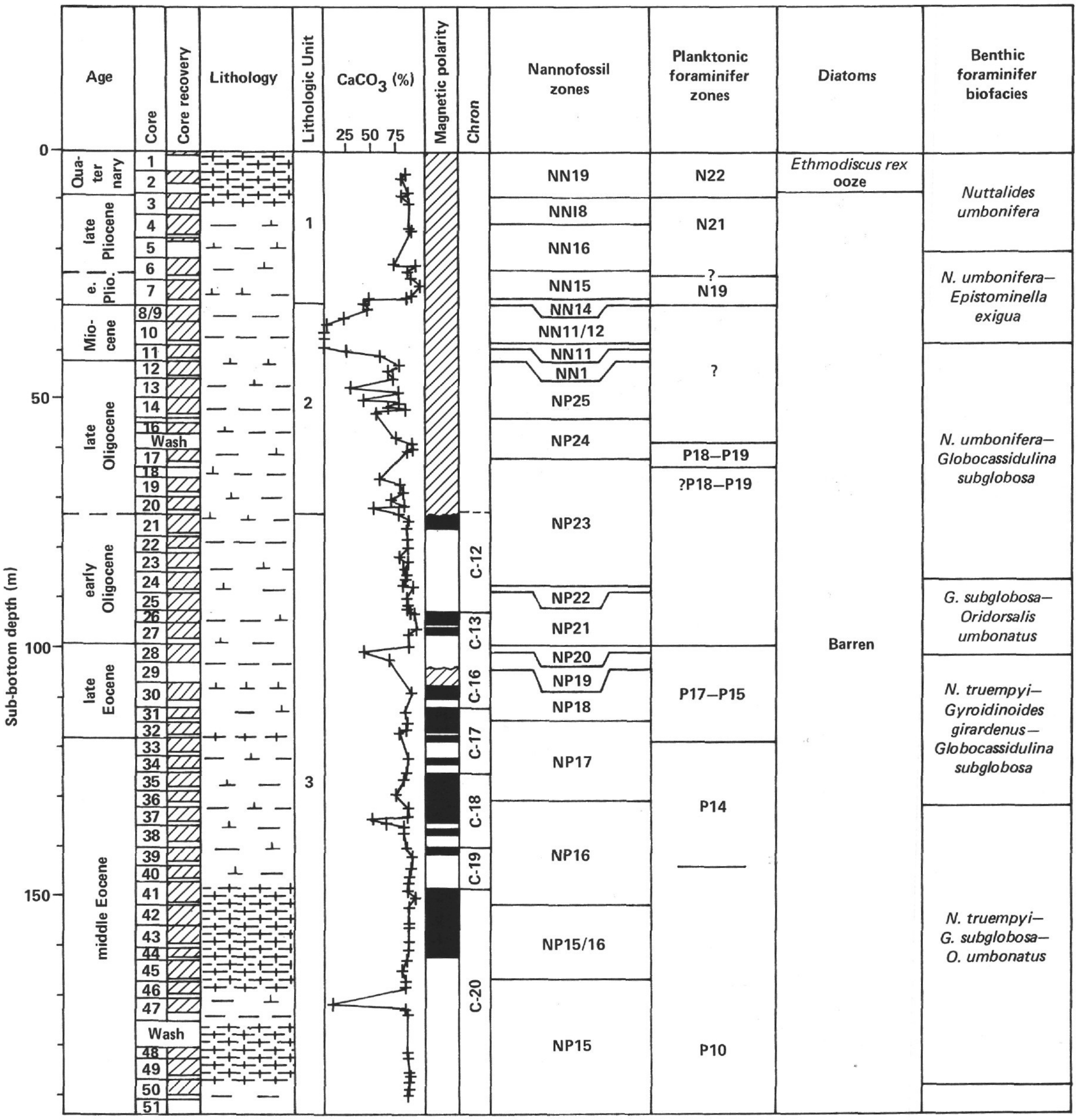

Figure 3. Stratigraphic summary, Site 523. Lithology and magnetic chronology are defined in Hsü, LaBrecque, et al. (this vol.). Solid blocks denote intervals of normal polarity; striped blocks, intervals of unknown polarity.

ing very pale brown and light yellowish brown marly nannofossil ooze and minor brown nannofossil clay. The calcium carbonate content varies between 60 and 85% for the marly nannofossil ooze and 20 and 40% for the nannofossil clay. The sediments of Unit 2 show faint burrowing; bioturbation is more visible in the areas where color changes occur. A few centimeters of white *Braarudosphaera* ooze were found in Core 19.

The main lithology of Unit 3 (Cores 21–50, 72.9–190.5 m sub-bottom) is a very pale brown and light yellowish brown nannofossil ooze and a yellowish brown marly nannofossil ooze. The calcium carbonate content varies between 76 and 96%. Several layers of brown and dark reddish brown clay up to 80 cm thick are intercalated with the nannofossil ooze sequence between 100 and 145 m sub-bottom (Cores 28, 32, 37, and 40). The carbonate content of these layers ranges from 41 to 68%.

The percentage of foraminifers increases slightly in the lower part of Unit 3, where foraminifer–nannofossil ooze alternates with nannofossil ooze. Distinct layers of foraminifer ooze up to several centimeters thick occur in Cores 41 to 50. These layers often pass upward to nannofossil ooze that is virtually free of foraminifers. An interval rich in clay, pyroxenes, and feldspars in Core 47 is interpreted as an altered volcaniclastic layer.

BIOSTRATIGRAPHY

Summary

A middle Eocene to Quaternary sequence was cored by HPC at Site 523 (Figs. 3 and 4). The 50 cores yield

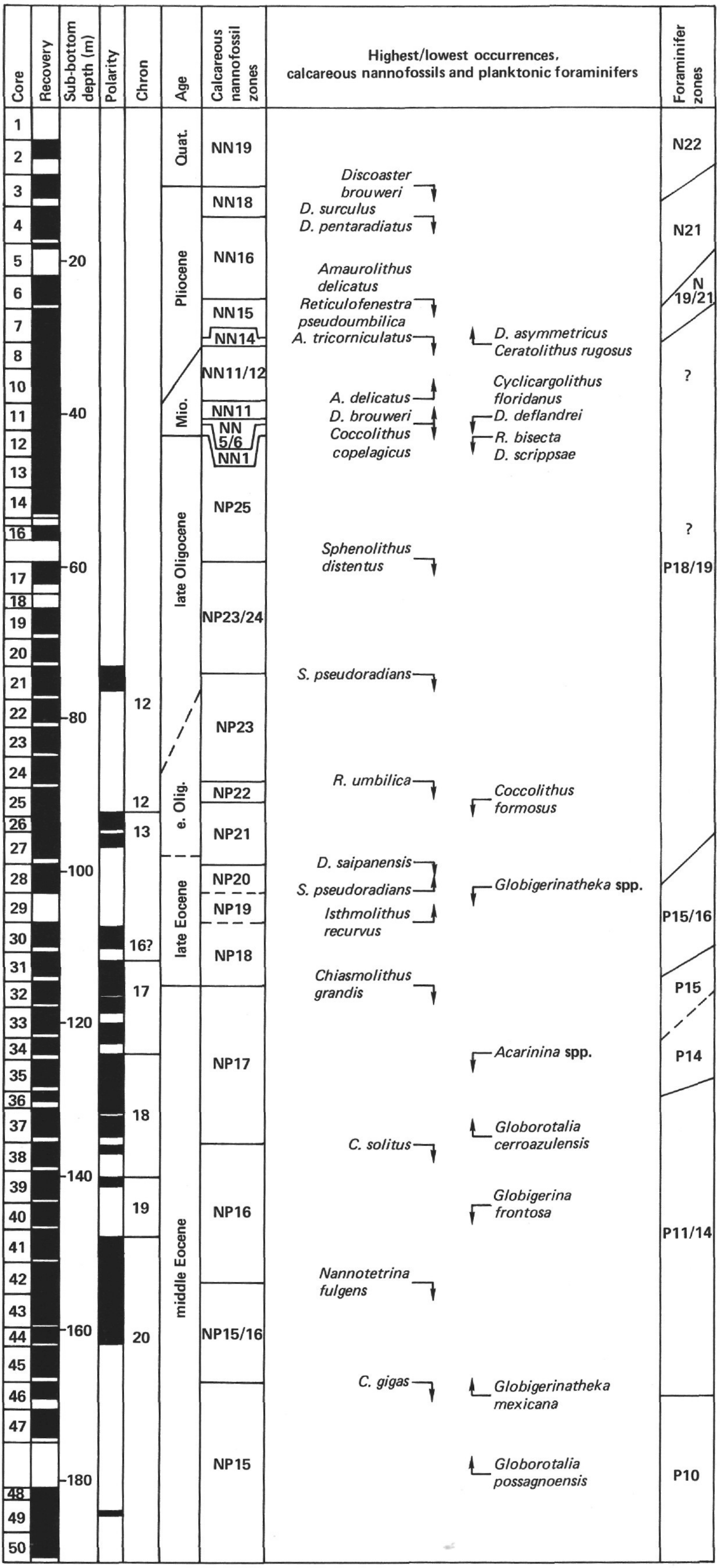

Figure 4. Biostratigraphic summary of significant calcareous and planktonic microfossils, Hole 523. Magnetic chronology as defined in Hsü, LaBrecque, et al. (this vol.). Polarity as in Fig. 3.

sediments that vary from easily zoned oozes with many well preserved microfossils to unzonable red clays with few microfossils.

The well preserved Quaternary section (Cores 1 and 2) is distinguished from the underlying well preserved upper Pliocene by the first appearance datum (FAD) of *Globorotalia truncatulinoides* in Sample 523-2,CC and the last appearance datum (LAD) of *Discoaster brouweri* in Core 3. Increasing dissolution and downhole contamination preclude planktonic foraminiferal recognition of the lower Pliocene. The top of the lower Pliocene is believed to occur in Core 6, where *Reticulofenestra pseudoumbilica* is present but *Amaurolithus tricorniculatus* is not.

Biostratigraphic control is poor for the Miocene section at Site 523. Neither of the epoch's boundaries can be located with any certainty. The upper Miocene is recognized by the absence of *Ceratolithus* spp. and the presence of *Amaurolithus* spp. in Core 8. Precise zonation of the remainder of the Miocene is equivocal because of the dissolution of the planktonic foraminifers.

The first certain Oligocene sediment was encountered in Core 12, which was recognized as belonging to NP25 (late Oligocene). Although nannofossil zonation is clear down to the upper/lower Oligocene boundary (between Samples 523-21,CC and 523-23,CC), the foraminiferal fauna in this same sequence is subject to strong dissolution except in Sample 523-17,CC, which is zoned as P18/19. The planktonic foraminiferal fauna between Samples 523-23,CC and 523-26,CC is little better preserved, but it also appears to belong to Zones P18/19. The nannofossils in this sequence yield progressively older assemblages until Zone NP20 (late Eocene) is encountered. This zone, which is recognized by the presence of *D. saipanensis* and *D. barbadiensis*, occurs in Sample 523-28,CC. The first downhole occurrence of *Globigerinatheka*, a solution-resistent genus, in the foraminiferal assemblage in Sample 523-28,CC provides added confirmation of the late Eocene data.

The late/middle Eocene boundary is tentatively placed between Samples 523-31,CC and 523-32,CC on the basis of the occurrence of *Chiasmolithus grandis* at the top of Core 32 and the occurrence of *G. semiinvoluta* in Core 31. Strong dissolution has reduced the diversity of the planktonic foraminifers in this interval.

Although the hole terminated in middle Eocene sediments not far above basement, the presence of reworked lower Eocene planktonic and benthic foraminifers suggests the presence of a lower Eocene section just above the basement.

Calcareous Nannoplankton

Samples 523-1,CC to 523-3-1, 102–103 cm are Quaternary in age and zoned as NN19 because of the presence of *Pseudoemiliania lacunosa* Gartner.

Samples 523-3-2, 25–26 cm to 523-3,CC are late Pliocene in age and zoned as NN18 because of the occurrence of *Discoaster brouweri* Tan Sin Hok. The interval from Sample 523-4-2, 100–101 cm to 523-6-2, 71–72 cm is assigned to the late Pliocene and Zone NN16 because of the presence of *D. surculus* Martini and Bramlette. The occurrence of *Reticulofenestra pseudoumbilica* Gartner in the interval from Sample 523-6-3, 71–72 cm to 523-7-3, 39–40 cm means it belongs to the early Pliocene and Zone NN15. Sample 523-7,CC belongs to the early Pliocene and Zone NN14 because of the co-occurrence of *D. asymmetricus* Gartner and *Amaurolithus tricorniculatus* (Gartner).

The interval from Sample 523-8-1, 51–52 cm to Sample 523-10-3, 50–51 cm is assigned to the late Miocene and Zones NN11/12 because of the presence of *Amaurolithus* spp. and the absence of *Ceratolithus* spp. Samples 523-10,CC to 523-11-1, 145–146 cm are late Miocene in age and belong to Zone NN11 according to the occurrence of *D. quinqueramus* Gartner. Sediments that belong to the early to middle Miocene and Zones NN5/6 occur in Sample 523-11-2, 60–61 cm, as indicated by the co-occurrence of *Cyclicargolithus floridanus* (Hay and Roth), *D. brouweri* Tan Sin Hok, and *D. deflandrei* Bramlette and Riedel. Early Miocene NN1 sediments are found from Sample 523-11-3, 5–6 cm to 523-11,CC according to the occurrence of *Coccolithus eopelagicus* Bramlette and Riedel.

Sediments from Sample 523-12-1, 120–121 cm to 523-14,CC are assigned to the late Oligocene and Zone NP25 because of the presence of *R. bisecta* (Hay, Mohler, and Wade) and *Dictyococcites scrippsae* Bukry and Percival. The core catcher samples from Cores 15 to 16 are placed in the late Oligocene and Zone NP24 because of the presence of *Sphenolithus predistentus* Bramlette and Wilcoxon and *S. distentus* Bramlette and Wilcoxon. Samples 523-17,CC to 523-24-2, 94–95 cm belong to Zone NP23 because of the presence of *S. pseudoradians* Bramlette and Wilcoxon. The *Braarudosphera* ooze occurs in Sample 523-19-1, 52–53 cm. Early Oligocene sediments belonging to Zone NP22 occur from Sample 523-24-3, 52–53 cm to 523-25-1, 82–83 cm because of the presence of *R. umbilica* (Levin). *Cyclococcolithina formosa* (Kamptner) marks the early Oligocene and Zone NP21 for the interval from Sample 523-25-2, 82–83 cm to 523-27,CC.

The presence of *D. saipanesis* Bramlette and Riedel indicates that late Eocene NP20 sediment is found from Sample 523-28-1, 72–73 cm to 523-28,CC. The core catcher sample from Core 29 belongs to Zone NP19 according to the absence of *S. pseudoradians* Bramlette and Wilcoxon. The interval from Sample 523-30-1, 120–121 cm to 523-31,CC is assigned to the late Eocene and Zone NP18 because of the absence of *Isthmolithus recurvus* Deflandre. Samples 523-32-1, 57–58 cm to 523-37,CC are assigned to the middle Eocene and Zone NP17 because of the presence of *Chiasmolithus grandis* (Bramlette and Riedel). Samples 523-38-1, 89–90 cm to 523-46-1, 60–61 cm are middle Eocene and belong to Zone NP16 because of the occurrence of *C. solitus* (Bramlette and Sullivan). Samples 523-42-3, 54–55 cm to 523-45,CC are undifferentiated Zones NP15/16 because of the occurrence of *Nannotetrina fulgens* (Stradner). *C. gigas* (Bramlette and Sullivan), a Zone NP15 marker species, is found from Sample 523-46-1, 70–71 cm to Sample 523-50,CC.

Planktonic Foraminifers

Quaternary through middle Eocene planktonic foraminifers were recovered in Hole 523 (Fig. 3). In general, the middle Eocene, late Pliocene, and Quaternary assemblages are relatively diverse and moderately well preserved, whereas the late Eocene, Oligocene, Miocene, and early Pliocene assemblages are sparse and poorly preserved because of intense dissolution.

The Quaternary assemblages in Samples 523-1,CC and 523-2,CC contain abundant specimens of *Globorotalia crassaformis, G. inflata, G. truncatulinoides*, and *Globigerina bulloides.* Samples 523-3,CC through 523-6,CC yield similar assemblages but lack *Globoratalia truncatulinoides.* Samples 523-3,CC through 523-6,CC are thus assigned to the Pliocene, and the Pliocene/Quaternary boundary is between Samples 523-3,CC and 523-2,CC.

Sample 523-7,CC contains sparse Pliocene microfossils, but the core is highly disturbed and the foraminifers may be present because of downhole cavings. Samples 523-8,CC through 523-10,CC contain fragments of planktonic foraminifers and a few moderately well preserved Pliocene and Quaternary taxa (such as *Globorotalia tosaensis* and *G. inflata*). Intact specimens of planktonic foraminifers in Samples 523-8,CC through 523-10,CC are clearly downhole contaminants.

Strongly dissolved assemblages continue in Samples 523-11,CC through 523-16,CC. Only a few specimens of such long ranging early Miocene to Eocene taxa as *Catapsydrax dissimilis* and *Globorotaloides suteri* were found in this interval. The calcareous nannofossils suggest that the Oligocene/Miocene boundary occurs between Samples 523-11,CC and 523-12,CC.

A well preserved Oligocene (Zone P18/P19) assemblage occurs in Sample 523-17,CC, but strongly dissolved assemblages return again down to Sample 523-23,CC. Pliocene and Quaternary contaminants occur sporadically throughout this interval. Samples 523-24,CC through 523-26,CC contain meager assemblages that are referred to Zones P18/P19 because of the associated Oligocene nannofossils. Sample 523-27,CC is barren, and *Globigerinatheka* spp. occur in Sample 523-28,CC. Calcareous nannofossils place the Eocene/Oligocene boundary between Samples 523-27,CC and 523-28,CC.

Samples 523-28,CC through 523-32,CC consist almost exclusively of specimens and fragments of *Globigerinatheka.* These low diversity assemblages are the product of intense dissolution. The preservation of the foraminifers improves in Samples 523-33,CC to 523-35,CC, and representatives of *Acarinina* and *Subbotina* begin to appear in the fauna. The middle/late Eocene boundary is placed between Sample 523-31,CC and 523-32,CC, but the position of this boundary may be primarily a function of dissolution intensity. Samples 523-36,CC and 523-37,CC are almost barren of planktonic foraminifers.

Planktonic foraminifers are common and moderately well preserved in Samples 523-38,CC through 523-50,CC. *A. bullbrooki, Globigerina frontosa, Globigerinatheka senni*, other *Globigerinatheka* spp., and *Pseudohastigerina micra* are common to abundant in most samples. Specimens of *Globigerinatheka* are common to abundant in Samples 523-38,CC through 523-45,CC, whereas they occur sparsely in Samples 523-46,CC through 523-50,CC.

Besides being made more difficult by repeated instances of downhole contamination, the interpretation of the middle Eocene fauna in Hole 523 is complicated by reworking. For example, the early Eocene taxa *Morozovella marginodentata* and *M. subbotinae* occur in Sample 523-41,CC. In addition, several key zonal markers, such as *Orbulinoides beckmanni* and *M. aragonensis*, are absent or poorly represented, although they are described as being present in Site 19 on the west side of the ridge.

Diatoms

At Site 523, *Ethmodiscus rex* ooze is abundant in Sample 523-1,CC and common in Sample 523-2,CC. In both of these cores, clay particles are a major constituent of the sediment. All other core samples are barren of diatoms.

Benthic Foraminifers

The benthic foraminifers in Hole 523 are common, reasonably diverse, and generally well preserved. The predominant faunal elements of the upper Miocene to Quaternary sequence are *Nuttalides umbonifera, Globocassidulina subglobosa, Oridorsalis umbonatus*, and *Epistominella exigua*. In the upper part of the sequence *N. umbonifera* comprises from 40 to 65% of the assemblage. In the lower part of the sequence, this species comprises less than 20% of the fauna; it is a significant contributor to the fauna but does not dominate, as it does in the upper sequence. The proportional contribution of *E. exigua* increases significantly in this lower sequence. The transition between the upper and lower assemblages occurs at 23 m sub-bottom (Section 523-6-2). It can be inferred, by interpolation from the sedimentation rate curve (Fig. 5), that this transition occurred 3.3 Ma. By analogy with recent abyssal foraminiferal distributions (Schnitker, 1980), this mid-Pliocene transition would seem to mark an influx of Antarctic Bottom Water (AABW) into the eastern South Atlantic. It was at approximately this time that the AABW was being generated by increased glacial activity in Antarctica (Watkins and Kennett, 1972). Lying just above this interval in Hole 523 is alternating light and dark calcareous ooze that may be the product of glacially induced fluctuations in dissolution. Evidence of glaciation also occurs in the North Atlantic at this time (Berggren, 1972).

Most of the Miocene section in Hole 523 is greatly condensed as a result of dissolution. The only well preserved benthic foraminifer fauna occurs in the uppermost Miocene, as described above, and the lowest Miocene. The early Miocene fauna, as well as the fauna of the late Miocene and part of the early Oligocene, was dominated by *N. umbonifera* and *G. subglobosa*, with subordinate but significant amounts of *O. umbonatus*

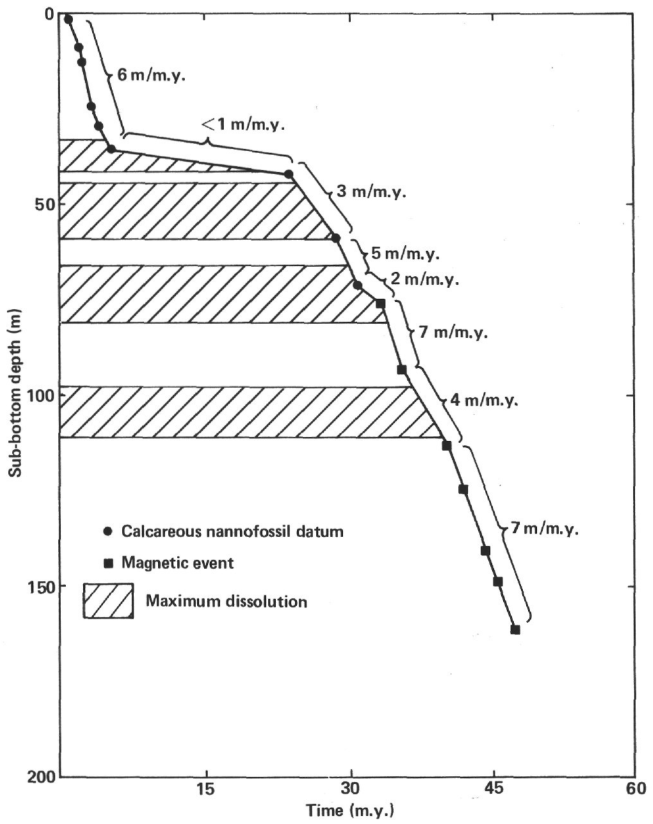

Figure 5. Sediment rates (not corrected for compaction), Hole 523.

and *Gyroidinoides girardenus*. This fauna persists downhole to the interval between Cores 22 and 27 (79–97 m sub-bottom), where the proportion of *N. umbonifera* declines from an average value of 15% to a value of 3%. The remainder of the early Oligocene fauna that occurs below this interval is characterized by *O. umbonatus* and *Globocassidulina subglobosa*, with subordinate amounts of *Nonion havaneuse, Gyroidinoides girardenus*, and *Astrononion pusillum*. By interpolation from the sedimentation rate curve (Fig. 5), this downhole decline in *Nuttalides umbonifera* occurs between 34.6 and 37.1 Ma.

It was during this part of the latest Eocene to earliest Oligocene that Antarctic ice began to build up and the Antarctic Bottom Water began to form (Kennett et al., 1972). If the abundance of *N. umbonifera* was as indicative of the presence of AABW in the Oligocene as it is today, the early Oligocene increase in specimens of this species in Hole 523 may be a consequence of bottom water formation at this time. Site 523 lay at a depth of 3450 to 3550 m at this time (Fig. 6).

The upper Eocene and part of the middle Eocene sequence in Hole 523 (down to Core 37) is characterized by *N. truempyi*, with accessory amounts of *O. umbonatus, G. girardenus*, and *Globocassidulina subglobosa*. A significant shift in the subordinate fauna occurs in Core 37 (134 m sub-bottom; interpolated age of 44.0 m.y.), where *Gyroidinoides girardenus* declines and the dominant assemblage is *N. truempyi-Globocassidulina subglobosa-O. umbonatus*.

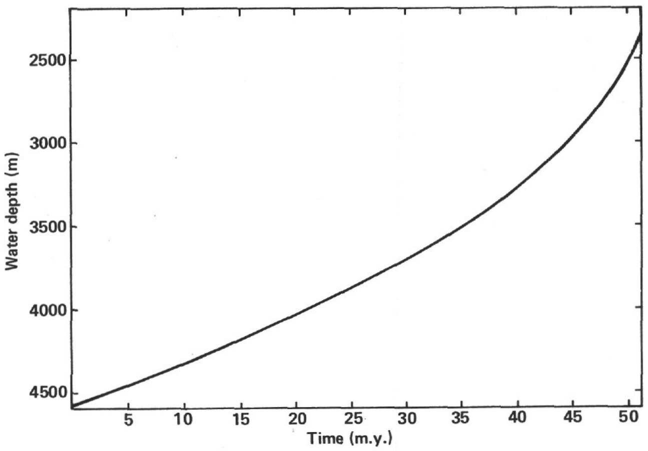

Figure 6. Bathymetry of Site 523 based on subsidence curves which are corrected for sediment load (Berger and von Rad, 1972).

Dissolution

At least three parameters provide indices of dissolution at Site 523: (1) the ratio of benthic to planktonic foraminifers (the proportion of benthic foraminifer tests); (2) the ratio of fragments to whole tests in the planktonic foraminifers; and (3) calcium carbonate content. Figure 7 illustrates the first two parameters. The curves behave sympathetically, with the percentage of fragments a more sensitive measure of dissolution during episodes of low to moderate dissolution and the percentage of benthic foraminifers a more sensitive indicator during episodes of moderate to intense dissolution. The fluctuations in calcium carbonate content are illustrated in Figure 3. These indices reveal that Site 523 lay below the CCD during the earliest Pliocene and late Miocene and at or near the CCD twice in the late Oligocene and during the latest Eocene.

The Quaternary and upper Pliocene section is characterized by fluctuating levels of dissolution (e.g., 10–15 m sub-bottom) as a consequence of glacial epochs. The sediments in this interval are alternately light and dark as a result of these dissolution fluctuations. The samples in this sequence are spaced too far apart to permit the distinction of individual epochs.

The intervals in intense dissolution in the middle and upper Miocene are merged in Hole 523 in a condensed interval characterized by very low carbonate content (Fig. 3) and almost no foraminifers. There are two intervals of strong dissolution in the Oligocene section. The uppermost occurs between 42 and 58 m sub-bottom in the uppermost Oligocene section (Nannofossil Zone NP25). The lower interval lies between 65 and 80 m sub-bottom, just above the upper/lower Oligocene boundary (in Nannofossil Zone NP23/24, just above(?) Magnetic Chron C-12).

A broad dissolution peak lies in the upper Eocene between 97 and 110 m sub-bottom. Below this peak the dissolution indices decline gradually, and the preservation of calcareous microfossils is quite good below 140 m sub-bottom (in the middle Eocene sequence). There is a sharp spike at 133 to 134 m sub-bottom. It is not clear if

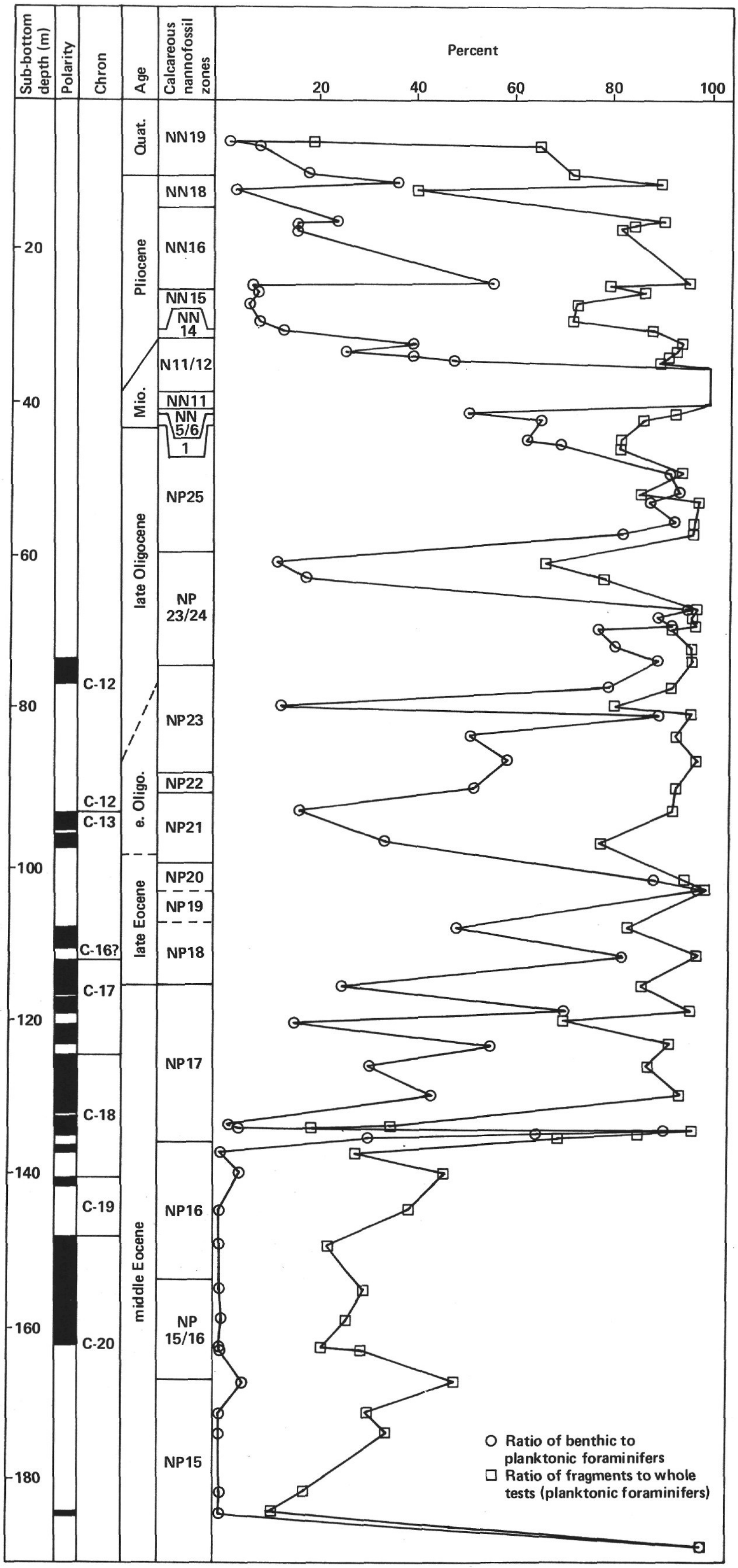

Figure 7. Dissolution indices, Hole 523. See text for discussion. Polarity as in Fig. 3.

this very marked and short-lived change in dissolution indices is a product of middle Eocene ocean chemistry or post-depositional diagenesis.

There is a curious clay layer in the middle Eocene part of Hole 523. It occurs at 134 m sub-bottom (interpolated age of 44.0 m.y.) and exhibits low carbonate content (47%) and a high dissolution index from the foraminiferal data. The curious feature of this interval is the remarkably low dissolution that occurs immediately above and below the clay layer. This sharp increase in dissolution over a very short interval (interpolated duration of 0.4 m.y.) is difficult to explain. It may represent an extremely rapid and short-lived rise in CCD during the mid-Eocene, or it may represent diagenetic effects.

SEDIMENTATION RATES

Sedimentation rates in Hole 523 were calculated from calcareous nannofossil datums in the Miocene to Quaternary portion of the hole and from magnetic polarity reversal events in the mid-Eocene to Oligocene portion (Fig. 5). The chronology of the paleomagnetic datums is essentially that of LaBrecque et al. (1977) as modified by Mankinen and Dalrymple (1979) using the new decay and abundance constants recommended by the Internation Union of Geological Sciences Subcommission on Geochronology.

The early Pliocene to Quaternary rates are generally similar to those of the mid-Eocene to Oligocene, whereas sedimentation rates in the Miocene, especially in the upper Miocene, are very low (<1 m/m.y.) because of strong dissolution during this interval. Episodes of mild dissolution in the late Oligocene and late Eocene are reflected in the reduced sedimentation rates at these times.

PALEOMAGNETISM

Figure 8 summarizes the magnetic polarity stratigraphy at Site 523. All samples from Cores 19 through 50 (~60 m sub-bottom to the bottom of the hole) were demagnetized in an alternating field of 175 Oe. Paleomagnetic results from the overlying 60 m (Cores 1–18) are not included in this discussion because poor core recovery did not permit a continuous and detailed magnetic stratigraphy to be developed. Discrete polarity

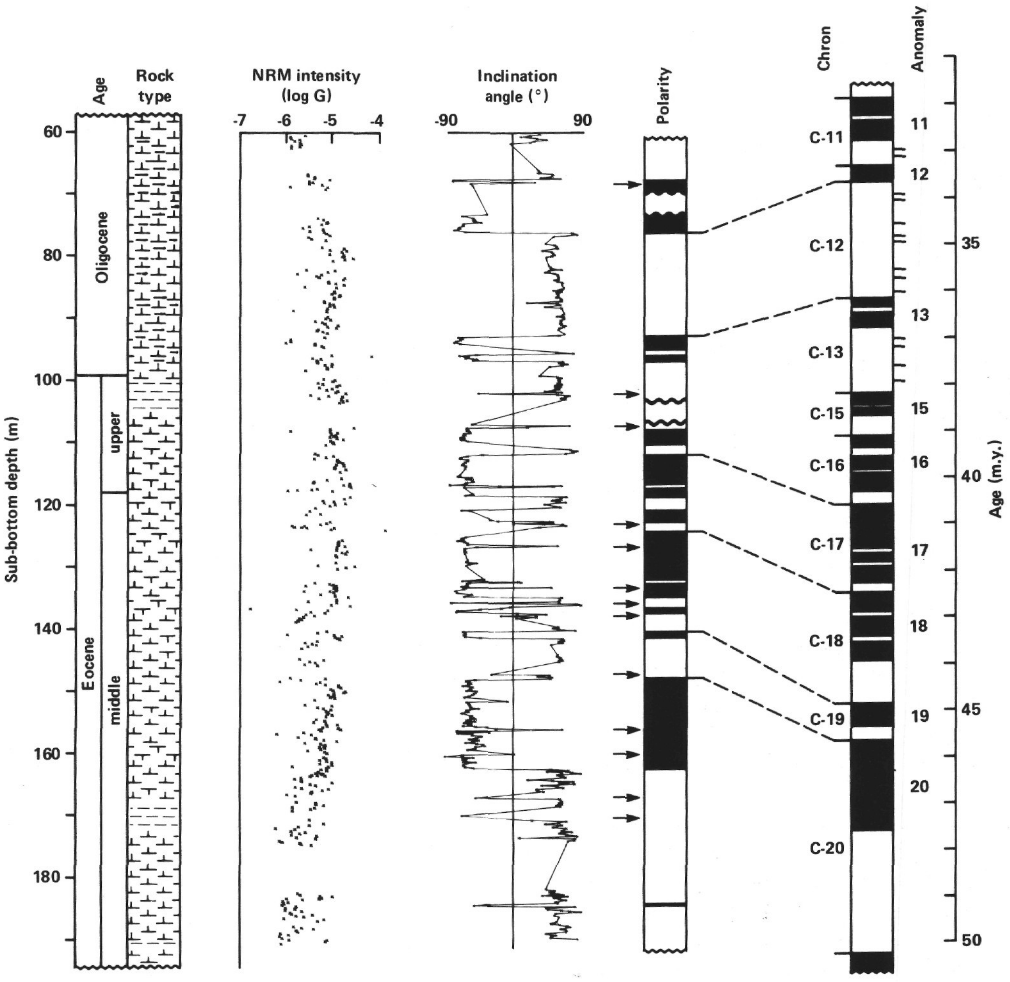

Figure 8. Summary of magnetic polarity stratigraphy at Site 523. Polarity as in Fig. 3. Lithology is defined in Hsü, LaBrecque, et al. (this vol.). Arrows identify the positions of polarity units that are defined by single samples and are therefore tentative (see Tauxe et al., this vol.).

measurements for this upper interval are given in the core description forms.

Chrons C-11 through C-20 are represented by the Oligocene–middle Eocene sediments recovered at Site 523. Although the site was located on Marine Magnetic Anomaly 21, equipment failures precluded the recovery of sediment all the way to basement (Chron C-21). From about 80 m sub-bottom downward, the principal trend in the sedimentary sequence is a decrease in NRM intensity and an increase in sedimentation rate.

The paleomagnetic results from Site 523 extend the Paleogene magnetostratigraphy well into the middle Eocene. When combined with the results from Sites 522 and 524, these data provide one of the better Paleogene paleomagnetic sequences published to date.

PHYSICAL PROPERTIES

Core recovery was poor in the upper part of the section because of fairly heavy seas. Water cores, mush, and vertical bedding characterize these cores. As the sea calmed recovery improved. Sediments were more indurated at this site than at the other sites drilled on this leg; the induration is reflected in the higher values of bulk density and lower values of water content. The induration is not reflected in the acoustic velocities measured throughout the column, however; these values remain comparable to those measured at the previously drilled sites. The physical property data are summarized in Figure 9.

Several measurements of thermal conductivity were carried out on the sediments recovered from the lower part of the hole. The results are given in Table 2. The average and range are consistent with the values observed for the previous sites. There appears to be little variation in thermal conductivity with increasing depth or age.

INORGANIC GEOCHEMISTRY

The results of the analysis of the interstitial water chemistry of three samples from Site 523 are summarized in Table 3. No significant downhole trends are evident in this short section of sediments.

CORRELATION OF GEOPHYSICAL DATA TO DRILLING RESULTS

The site originally proposed for Site IV-7 was inappropriate because the seismic data for the site indicated a high probability that nearly all of the sediment cover was missing. The site eventually drilled is midway through Anomaly 21 at a water depth of 4573 m. The age of the site was predicted to be 50 m.y., middle Eocene.

The seismic data were gathered with 5- and 10-in.^{3} air guns with a band pass of 80 to 200 cps. As can be seen from Figure 1, the site is in a region of pelagic drape with a minimum of regional relief. The site was chosen for this reason because of our experience at previous sites, Site 522 in particular. The seismic data indicate 0.25 s or approximately 190 m of sediment. A more exact estimate is difficult to make because the reflections off the acoustic basement are diffuse, probably as a result of the increasing frequency of turbidite deposits observed near the bottom of the drilled section. The turbidites may have come from the adjacent minor peak during the early history of the basement. A reflector at 0.08 s may correspond to the layer of *Braarudosphaera* ooze.

Although the hole did not reach the basement, extrapolated sedimentation rates indicate that the basement is 200 m sub-bottom.

SUMMARY AND CONCLUSIONS

The primary objective of drilling at Site 523 was to obtain a precisely dated calcareous Oligocene and Eocene sequence for studies in paleoceanography. On the whole, we achieved this aim, but the preservation of the foraminifers was poor in some of the upper Oligocene and upper Eocene sediments. The correlation of the biostratigraphy and magnetostratigraphy is good for 60 m of the section ranging from middle Oligocene to middle Eocene in age.

Lithostratigraphy

The draped sediments at this site are entirely pelagic. The sequence is divided into three units: (1) Pliocene–Quaternary oozes, (2) Miocene red clays, and (3) Eocene–Oligocene oozes. The first unit is equivalent to the A(lbatross), B(lake), and C(hallenger) formations, the second is equivalent to the D(iscovery) formation, and the lowest is equivalent to the E(ndeavor), F(ram), G(azzelle), and G(rampus) formations at Sites 17 to 20, which were drilled during Leg 3 (see Maxwell et al., 1970). The threefold division is a manifestation of the effect of the Miocene CCD rise.

Correlation of Biostratigraphy and Magnetostratigraphy with Seafloor Lineations

Recovery was less than perfect in the upper third of the cored section, and core disturbance rendered the quality of the paleomagnetic data fair to poor. Furthermore, much of the Neogene section had undergone extensive dissolution. Therefore, we did not compare the magnetostratigraphy of the upper 60 m of sediments to the pattern of the seafloor lineations. Magnetostratigraphic Chrons C-11 to C-20 were recognized in the lower sequence. The correlation of the magnetostratigraphy to seafloor anomaly patterns is excellent from Chron C-17 to C-20 (Tauxe et al. and Poore et al., this vol.). The datum levels (highest occurrences, HOs, and lowest occurrences LOs) of the following key species (species useful for zonation) have been calibrated magnetostratigraphically: HO *Sphenolithus distentus*, HO *S. pseudoradians*, HO *Reticulofenestra umbilica*, HO *Coccolithus formosus*, HO *Discoaster saipanensis*, LO *S. pseudoradians*, LO *Isthmolithus recurvus*, HO *Chiasmolithus grandis*, HO *C. solitus*, HO *Nannotetrina fulgens*, HO *C. gigas*, HO *Globigerinatheka* spp., HO *Acarinina* spp., LO *Globorotalia cerroazulensis*, HO *Globigerina frontosa*, LO *Globorotalia possagnoensis*, and LO *Globigerinatheka mexicana*. Interested readers should refer to

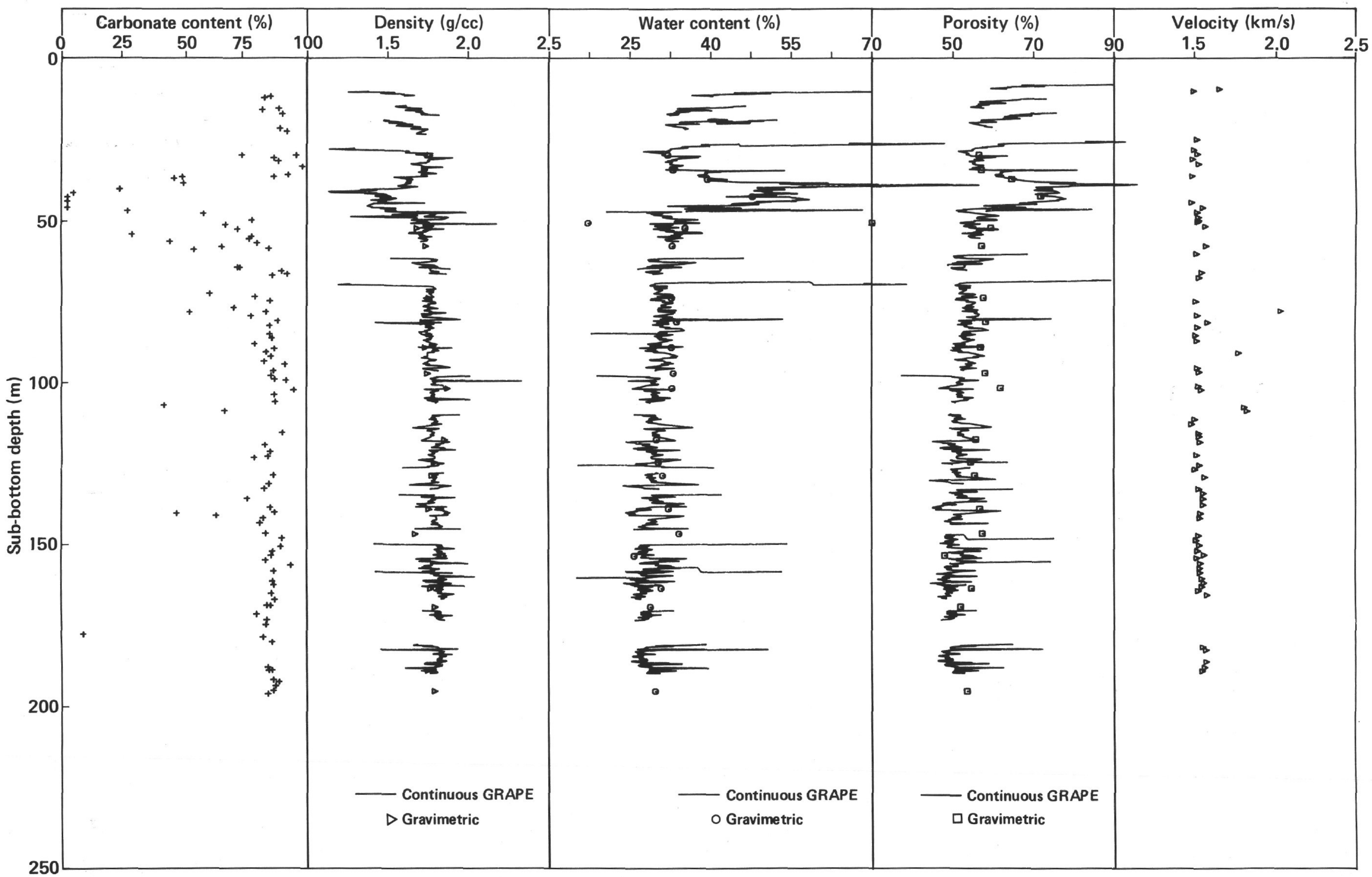

Figure 9. Summary of physical properties, Site 523. Velocity data are for perpendicular beds.

Table 2. Thermal conductivity measurements at Site 523.

Core-Section	Thermal conductivity^a (W/m °C)
42-2	1.93
45-2	1.30
47-2	1.47
50-2	1.63

^{a} Average value: 1.58; standard deviation: 0.63.

Table 3. Summary of shipboard geochemical data.

Core-Section (intervals in cm)	Sub-bottom depth (m)	pH	Alkalinity (meq/l)	Salinity (‰)	Calcium (mmol/l)	Magnesium (mmol/l)	Chlorinity (‰)
8-1, 144–150	30.4–34.0	7.338	2.577	38.0	10.66	49.91	19.37
21-2, 144–150	72.9–77.3	7.236	2.494	35.5	10.51	53.73	19.61
30-2, 143–150	106.8–110.8	7.282	2.294	36.8	10.80	51.45	19.20

the summary of the biostratigraphy of this site and of this cruise (Poore et al., this vol.), as well as to range charts, for further information.

The magnetostratigraphy of the deep-sea Paleogene sequence is being worked out for the first time. The study of the Contessa sections near Gubbio, Italy (Lowrie et al., in press) affords the only comparison. We note a number of discrepancies. For example, the HO of *C. grandis* was found near the top of Chron C-18 at Contessa, but it is well up in Chron C-17 at Site 523. We suspect that the upper range has been truncated at Contessa; the dissolution of nannofossils there is considerable (Perch-Nielsen, pers. comm., 1982). For that reason we believe the nannofossil datum levels at Site 523 to be more reliable.

The planktonic foraminifers at Site 523 have been subjected to various degrees of dissolution, and the dissolution causes difficulties when one tries to correlate the nannofossil foraminifer zones. For example, the middle/late Eocene boundary is usually placed at either the top of the range of the foraminifer *Truncorotaloides rohri* (P14/P15 boundary) or the top of the range of the nannofossil *C. grandis* (NP17/NP18 boundary; see Hardenbol and Berggren, 1978). At this site, the P14/P15 foraminifer zonal boundary was defined by the HO of *Acarinina* spp.; the last common occurrence of this species is at the bottom of Chron C-17, considerably lower than the HO of *C. grandis*, which is near the top of Chron C-17. Rare occurrences of the foraminifer species in overlying cores suggest that the species LAD might indeed be higher and that the position of the HO in the biostratigraphic summary of this site report may be due to the truncation of the range by dissolution.

Calcite Dissolution

The Neogene record of dissolution is obscured by the slow sedimentation rate (see Fig. 10). The seafloor at Site 523 subsided to greater depths during the Miocene than at the other Leg 73 sites, so the sediments of the whole epoch belong to the pleistolytic or hololytic red clay facies. One specimen barren of nannofossils was recognized from NN11/12, indicating the rise of the

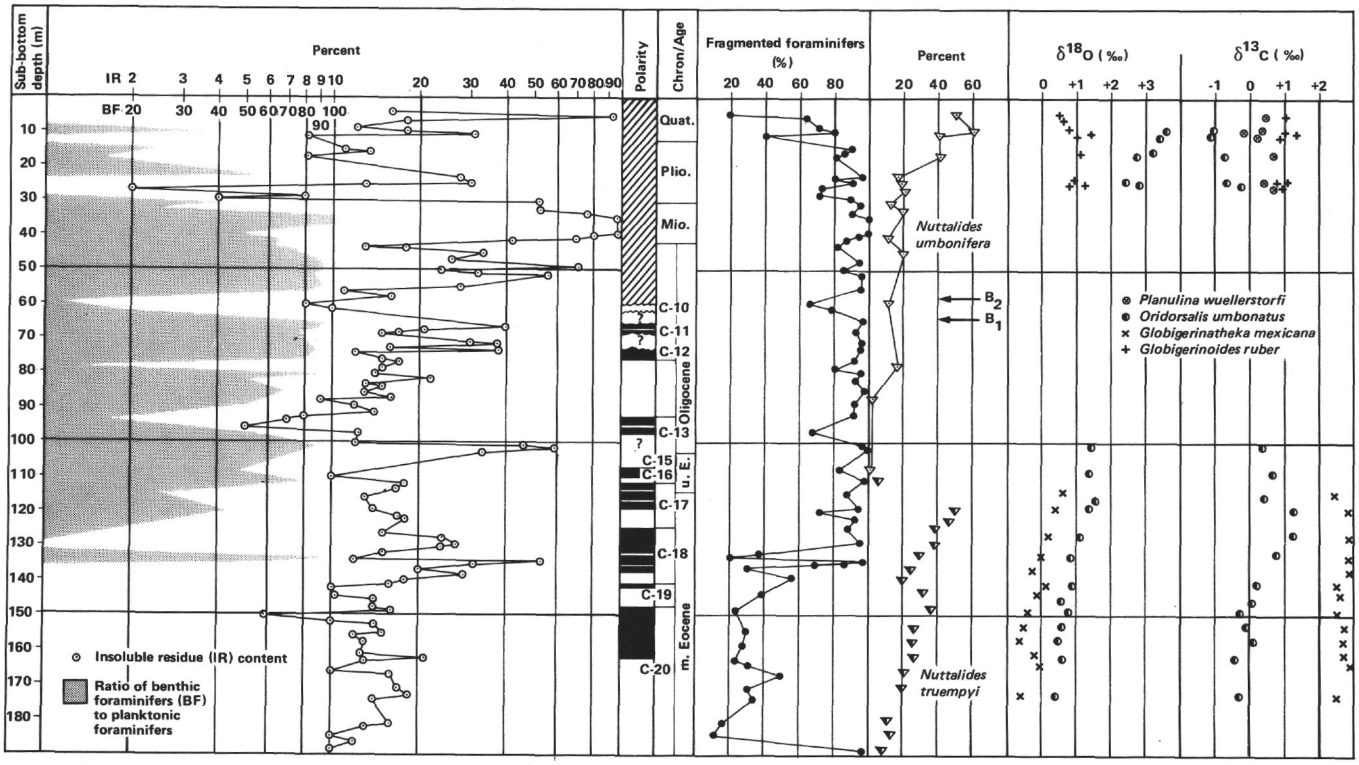

Figure 10. Paleoceanographic data, Site 523. Polarity as in Fig. 3. Arrows B_1 and B_2 indicate the stratigraphic levels of two *Braarudosphaera* chalk layers.

CCD above 4200 m during that time. Nannofossil Zones NN2 to 4 and NN7 to 10 were not identified. Either the marker fossils for those zones are more susceptible to dissolution or dissolution was more intense during those times.

Insoluble residue (IR) content indicates that episodes of dissolution took place during the early Oligocene shortly before the *Braarudosphaera* blooms (Chrons C-11 and C-12). A more significant event coincided approximately in timing with the Eocene/Oligocene boundary (Chron C-13-R). This boundary event produced marls with 60% IR content, 90% benthic foraminifer (BF) content, and almost 100% fragmented foraminifer tests (FFT). The equivalent late Eocene facies on the other side of the Mid-Atlantic Ridge (Site 19) has been named Gazelle ooze, and it has an average IR content of only 32%, with a maximum close to 50% (Hsü and Andrews in Maxwell, Von Herzen, Andrews, et al., 1970, p. 449; Pimm, 1970, p. 502). Thus, during the Eocene, as in later times, dissolution seems to have been more intense on the east than the west side of the Mid-Atlantic Ridge.

Another sharp dissolution event during the late middle Eocene is evident from the sediment at 135 m subbottom, a horizon that has been dated as belonging to Chron C-18-N2 and lies near the top of NP16, within the *Truncorotaloides rohri* zone. Insoluble residue content increased from about 10 to 50%, benthic foraminifer content from less than 10 to more than 90%, and foraminifer test fragments from about 50 to more than 90%. As Figure 10 shows, this event coincides in timing with the beginning of shifts in oxygen and carbon isotopes; it also coincides with the beginning of an increase in the proportion of *Nuttalides truempyi* in the benthic assemblage. The water depth of the site at that time was about 3050 m, and this dissolution event marked a brief but significant excursion of the lysocline to a water depth of less than 3000 m. A corresponding dissolution event has been found at Site 19 at 99.6 m sub-bottom (Sample 19-7-4, 3–4 cm), the base of the Gazelle ooze. The mesolytic sediment there lies within Nannofossil Zone NP16 and the *T. rohri* Foraminifer Zone, and it has an IR content of about 50% (Pimm, 1970, p. 502).

The calcite dissolution has greatly affected the sedimentation rate. The Pliocene–Quaternary sediments were deposited at an average rate of 6 m/m.y. (1.2 m/m.y. for IR). The Miocene sediments are less than 12 m thick and were deposited at a rate of about 0.65 m/m.y. (0.5 m/m.y. for IR). The Oligocene sediments were deposited at a rate of 4.5 m/m.y. (1.0 m/m.y. for IR). The Eocene rate was about 8 m/m.y. (1.2 m/m.y for IR). As at other Leg 73 sites, the rate at which insoluble residue accumulated was reduced during the Miocene.

Paleoceanography

A significant change in oceanic environments took place during the late Eocene some 45 Ma (Chron C-18-N2). The benthic population began to change; toward the end of middle Eocene it was dominated by *Nuttalides truempyi*. Both the benthic and planktonic foraminifers show oxygen-isotope shifts of about 1 ‰ during the late middle Eocene, indicating a rapid cooling of ocean temperatures and/or the first significant accumulation of Antarctic ice. The temperatures remained little changed during the late Eocene and probably began to decrease again toward the beginning of the Oligocene (as shown by the evidence from Site 522). An increase in *N. umbonifera* took place 3 to 4 m.y. later, in the early Oligocene, when the site sank to a water depth of 3500 m, but the increase still took place 3 to 4 m.y. earlier than at Site 522. At each site, the abundance of this species is clearly related to the history of subsidence. The trend of the oxygen-isotope shift during the Eocene is in general agreement with that noted by Shackleton and Kennett (1975) for the Southern oceans and by Boersma and Shackleton (1977) for the South Atlantic. The shifts in the carbon isotopes of the benthic foraminifers were parallel to the oxygen shifts in the isotopes, and both trends were positive during the late middle Eocene.

We found no clear correlation between the dissolution events and paleoclimatic temperatures. Although the beginning of the late middle Eocene oxygen shift was marked by a dissolution event, the CCD change seems to have reversed direction soon after the rise, so that much of the upper middle and upper Eocene sediments are oligolytic (<20% IR). The early Oligocene cooling was also marked by a very brief dissolution event, followed by a dramatic depression of CCD. Oligocene dissolution events took place before and after the *Braadrudosphaera* blooms. Apparently the seafloor at Site 523 was positioned near the Oligocene lysocline, so that slight changes in levels produced rapid facies changes.

Two *Braarudosphaera* chalk layers have been identified at Site 523. Both appear during Chron C-10, and they have ages of about 30.5 and 31.5 m.y., respectively. They can be correlated with the upper two *Braarudosphaera* chalk layers at Site 522. The blooms took place at times when the CCD was deep.

During the Miocene, the seafloor remained below the lysocline, and at times it was below the CCD, so only pleistolytic and hololytic sediments accumulated. The lysocline rapidly became depressed during the early Pliocene, so the sediments changed from pleistolytic to mesolytic to oligolytic within 1 m.y. or so. This remarkable depression in CCD, which is well known, is discussed in Hsü et al. (this vol.).

Basement Age and Seafloor Spreading Rate

The basement was not reached by drilling because of mechanical failures. We penetrated a thick section of sediments belonging to Chron C-20-R but did not reach the oldest sediment at the site, which lies on Seafloor Anomaly 21. However, the drilling depth lies very close to the seismically predicted basement depth, and the drill hole may have bottomed a few meters above the basement.

The ages of several magnetostratigraphically calibrated datums can be compared with radiometric dates to yield information on the question of seafloor spreading rate. LaBrecque et al. (1977) noted that the Eocene magnetostratigraphic ages predicted on the basis of a linear rate of seafloor spreading during the Cenozoic are consistently older than the corresponding radiometric ages. They suspected significant deviations from a linear seafloor spreading rate. If we use the HO of *Chiasmolithus grandis* near the top of Chron C-17 as the middle/late Eocene boundary, the magnetostratigraphic age would be about 41 m.y., appreciably younger than that indicated by Bolli, Ryan, et al. (1978). However, the age is still significantly older than the radiometric age given by Odin and Curry (1981) for the NP17/NP18 boundary (37 ± 1.5 m.y.). In addition, magnetostratigraphy indicates that the top of NP15, although not accurately dated, should not be higher than the top of Chron C-20-N; in other words, it should be older than 46 m.y. (Tauxe et al., this vol.). Radiometry, however, indicates that the datum should be younger than 41 m.y. If the minimum probable age of 63.5 m.y. is used for the beginning of the Cenozoic, the magnetostratigraphic ages for the tops of NP17 and NP15 would be 39 and 43.5 m.y., respectively. The discrepancies are reduced to 2 and 2.5 m.y., respectively, but they still lie outside the quoted experimental error of radiometric dating. We cannot rule out the possibility that seafloor spreading did deviate slightly from linearity during the middle Eocene. More probably the radiometric dates by Odin and Curry are too young (see Hsü et al., this vol.).

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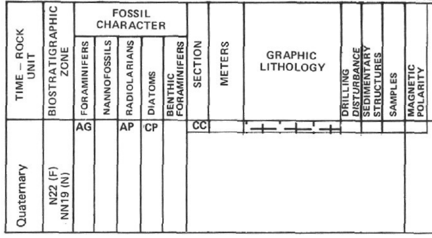
Date of Initial Receipt: August 12, 1982

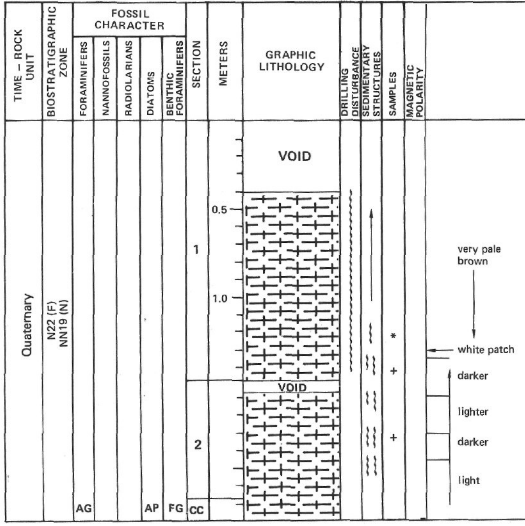
SITE 523 HOLE CORE (HPC) 1 CORED INTERVAL 0.0–4.0 m



LITHOLOGIC DESCRIPTION

Trace of FORAMINIFER NANNOFOSSIL OOZE in Core-Catcher.

SITE 523 HOLE CORE (HPC) 2 CORED INTERVAL 4.0–8.4 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-NANNOFOSSIL OOZE, very pale brown (10YR 7/4–7/6–8/3) alternating with darker, light yellowish brown (10YR 6/4) intervals in Section 2. Burrows common throughout but best seen along color contacts. Top Section 1 disturbed by drilling.

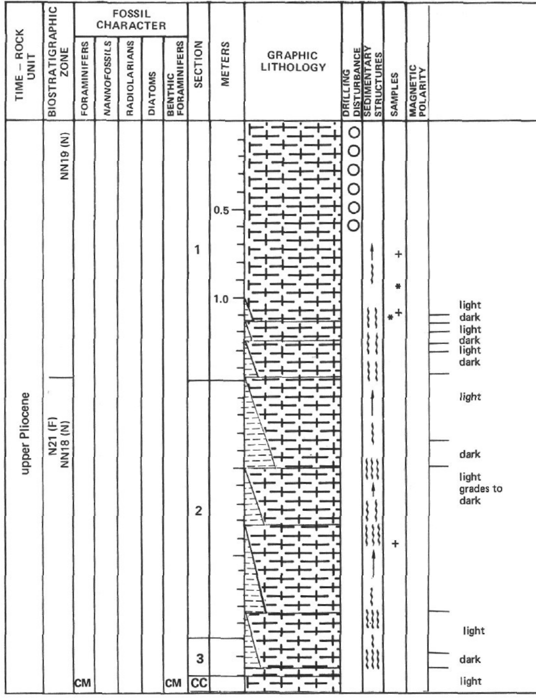
SMEAR SLIDE SUMMARY

	1-126
	D
TEXTURE:	
Sand	5
Silt	85
Clay	10
COMPOSITION:	
Clay	5
Carbonate unspec.	5
Foraminifers	5
Calc. nannofossils	85
Diatoms	TR
Iron-oxides	TR

ORGANIC CARBON AND CARBONATE

	1-146	2-36
Organic carbon	–	–
Carbonate	85	83

SITE 523 HOLE CORE (HPC) 3 CORED INTERVAL 8.4–12.8 m



LITHOLOGIC DESCRIPTION

FORAMINIFER NANNOFOSSIL OOZE, very pale brown (10YR 7/3–8/3) alternating with (darker) light yellowish brown (10YR 6/4) MARLY NANNOFOSSIL OOZE *on scale of 5–50 cm.* Alternations usually consist of darker intensely burrowed marly ooze grading upward into lighter less distinctly burrowed ooze with burrowed but relatively sharp upper contact with overlying marly ooze. Top 60 cm of Section 1 are soupy, but contain some zones of brown (10YR 4/3) MARLY NANNOFOSSIL OOZE.

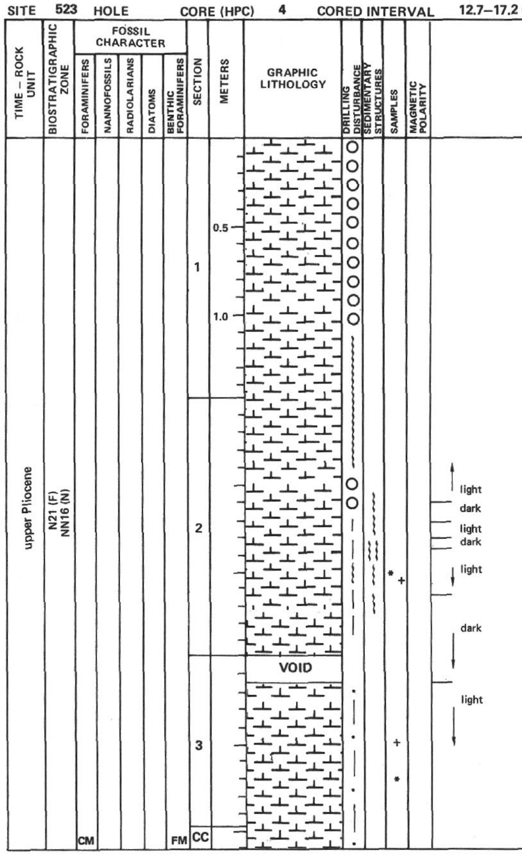
SMEAR SLIDE SUMMARY

	1-98	1-112
	D	D
TEXTURE:		
Sand	10	10
Silt	85	80
Clay	5	10
COMPOSITION:		
Clay	5	5
Carbonate unspec.	–	5
Foraminifers	10	5
Calc. nannofossils	80	80
Iron-oxides	–	5

ORGANIC CARBON AND CARBONATE

	1-76	1-110	2-96
Organic carbon	–	–	–
Carbonate	88	82	90

SITE 523 HOLE CORE (HPC) 4 CORED INTERVAL 12.7–17.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/3) to yellowish brown (10YR 5/4) with some light-dark alternations in Section 2 (very pale brown [10YR 8/4] alternates with light yellowish brown [10YR 6/4]). Color changes are gradual and show burrowing best. Much of core is highly disturgbed by drilling; contorted layers in Section 3 due to drilling deformation.

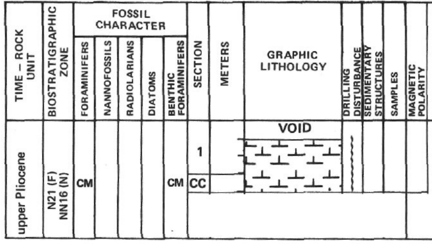
SMEAR SLIDE SUMMARY

	2-102 D	3-73 D
TEXTURE:		
Sand	5	5
Silt	90	90
Clay	5	5
COMPOSITION:		
Clay	5	5
Foraminifers	5	5
Calc. nannofossils	90	90

ORGANIC CARBON AND CARBONATE

	2-105	3-50
Organic carbon	–	–
Carbonate	89	92

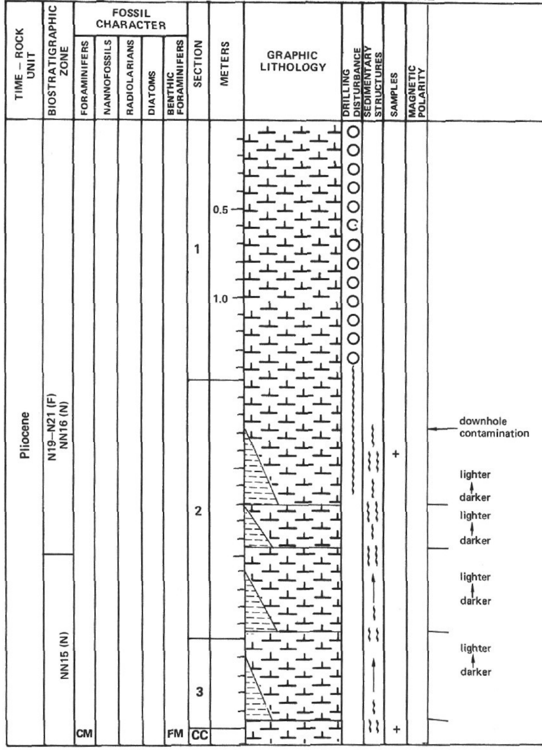
SITE 523 HOLE CORE (HPC) 5 CORED INTERVAL 17.2–21.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 8/4), very deformed by drilling.

SITE 523 HOLE CORE (HPC) 6 CORED INTERVAL 21.6–26.0 m



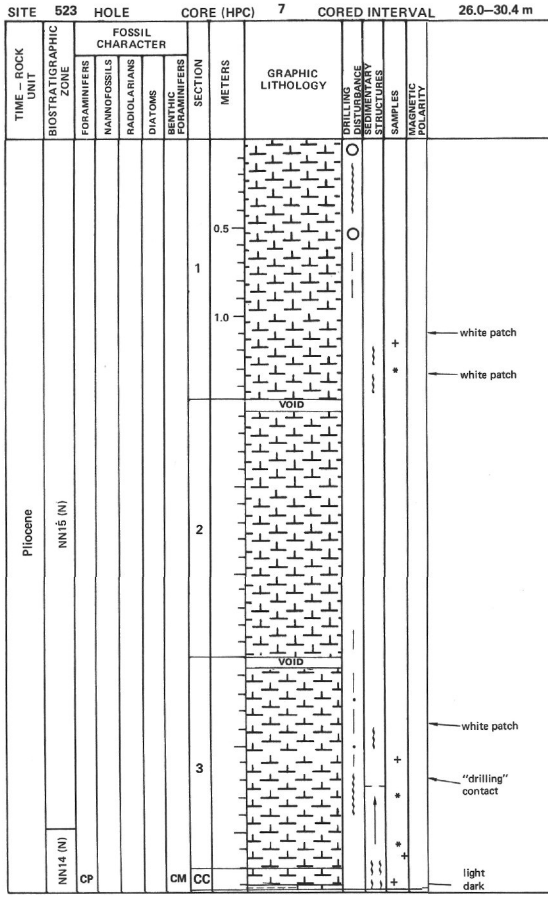
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/3) alternating with several zones of brownish yellow (10YR 6/6) MARLY NANNOFOSSIL OOZE in Sections 2 and 3. Darker, carbonate-poor ooze grades upward to light ooze in each alternation. Base of dark zone is intensely burrowed; light ooze is moderately burrowed. Intense drilling deformation in Section 1 and top Section 2. Piece, 6 cm long, of dark yellowish brown (10YR 4/4) MARLY NANNOFOSSIL OOZE at approximately 40 cm in Section 1 is downhole contamination.

ORGANIC CARBON AND CARBONATE

	2-44	3-50
Organic carbon	–	–
Carbonate	73	96

SITE 523 HOLE CORE (HPC) 7 CORED INTERVAL 26.0–30.4 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, white (10YR 8/2), homogeneous down to approximately 149 cm, Section 2. Faintly burrowed in places. Color changes to very pale brown (10YR 8/3), top Section 3 then to white (10YR 8/1) and light gray (10YR 7/2) between 70 and 100 cm in Section 3 across deformed "drilling" contact. Intense burrowing in mixed white/light gray ooze below 70 cm, Section 3. Color changes again to light yellowish brown (10YR 6/4) at 106 cm Section 3 then to dark reddish brown (5YR 3/3) NANNOFOSSIL CLAY in Core-Catcher. Top 90 cm Section 1 and parts of Section 3 disturbed by drilling.

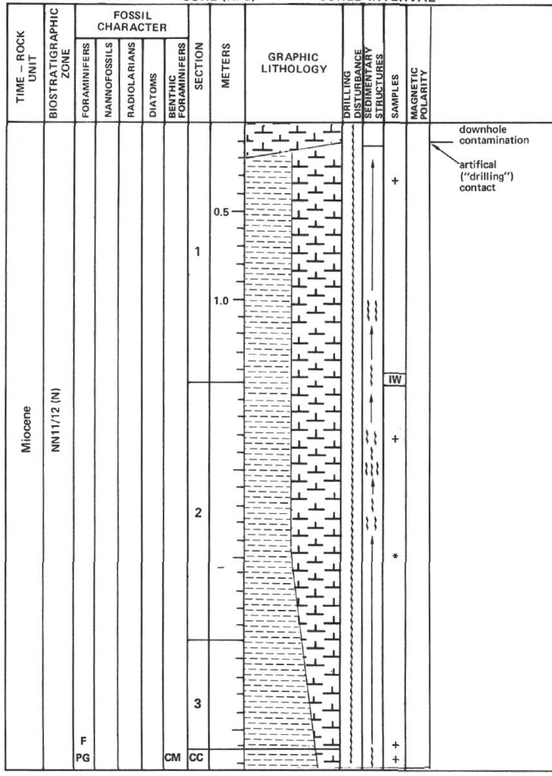
SMEAR SLIDE SUMMARY

	1-130	3-80	3-110
	D	D	D
TEXTURE:			
Sand	1	2	TR
Silt	94	93	95
Clay	5	5	5
COMPOSITION:			
Clay	5	5	5
Pyrite	–	TR	–
Micronodules	–	3	–
Foraminifers	1	1	TR
Calc. nannofossils	93	91	92
Iron-oxides	1	–	3

ORGANIC CARBON AND CARBONATE

	1-113	3-59	3-115	CC, 11
Organic carbon	–	–	–	–
Carbonate	98	92	87	49

SITE 523 HOLE CORE (HPC) 8 CORED INTERVAL 30.4–34.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CLAY, dark brown (10YR 4/3) homogeneous with scattered, light-colored burrows and dark pyrite(?) patches throughout. All burrows and structures intensely deformed along core axis by drilling deformation. Top 20 cm Section 1 is very pale brown (10YR 8/3) NANNOFOSSIL OOZE – downhole contamination.

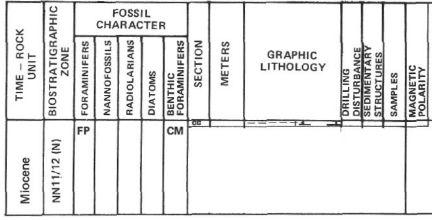
SMEAR SLIDE SUMMARY

	2-100
	D
TEXTURE:	
Sand	5
Silt	20
Clay	75
COMPOSITION:	
Quartz	TR
Clay	75
Micronodules	TR
Carbonate unspec.	2
Calc. nannofossils	20
Diatoms	TR
Sponge spicules	TR
Iron-oxides	3

ORGANIC CARBON AND CARBONATE

	1-31	2-31	3-59	CC
Organic carbon	–	–	–	–
Carbonate	45	49	23	23

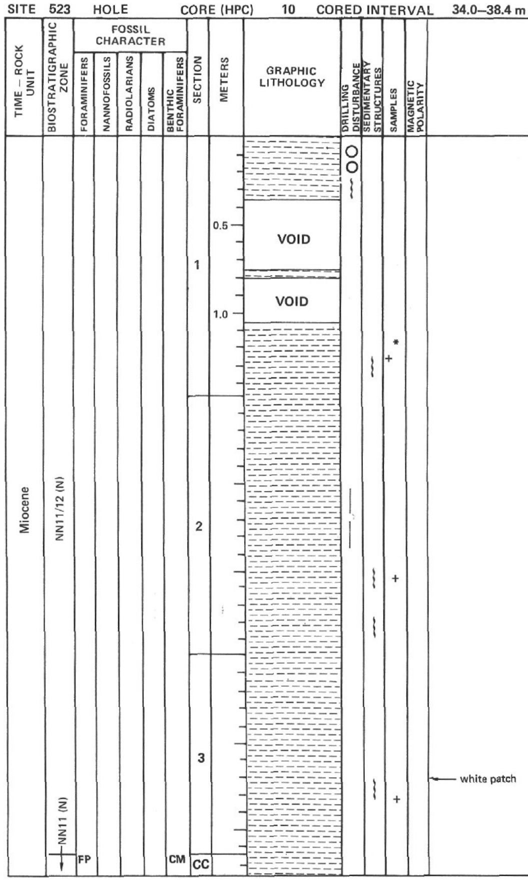
SITE 523 HOLE CORE (HPC) 9 CORED INTERVAL 34.0–34.0 m



LITHOLOGIC DESCRIPTION

Trace of dark brown (10YR 4/3) NANNOFOSSIL CLAY in Core-Catcher.

SITE 523 HOLE CORE (HPC) 10 CORED INTERVAL 34.0–38.4 m



LITHOLOGIC DESCRIPTION

CLAY, dark reddish brown (5YR 3/2), homogeneous with scattered burrowed intervals. Section 1 deformed by drilling; Section 2 partly fractured by drilling but otherwise intact. Scattered black pyrite(?) specks throughout Section 2. Zeolites occur in clay.

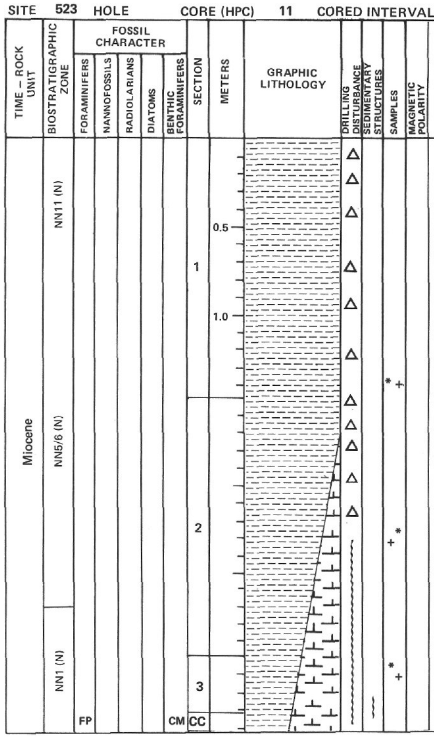
SMEAR SLIDE SUMMARY

	1-120
	D
TEXTURE:	
Sand	2
Silt	20
Clay	78
COMPOSITION:	
Quartz	1
Clay	78
Volcanic glass	3
Zeolite	5
Carbonate unspec.	2
Calc. nannofossils	1
Iron-oxides	10

ORGANIC CARBON AND CARBONATE

	1-129	2-102	3-87
Organic carbon	–	–	–
Carbonate	4	2	2

SITE 523 HOLE CORE (HPC) 11 CORED INTERVAL 38.4–41.9 m



LITHOLOGIC DESCRIPTION

Dark reddish brown (5YR 3/3) CLAY grading down core to reddish brown (5YR 5/4) NANNOFOSSIL CLAY and yellowish brown (10YR 5/6) MARLY NANNOFOSSIL OOZE. Section 1 and top Section 2 are drilling breccia of CLAY. Faint burrowing in Section 3. Core-Catcher is drilling mixture of ooze and clay.

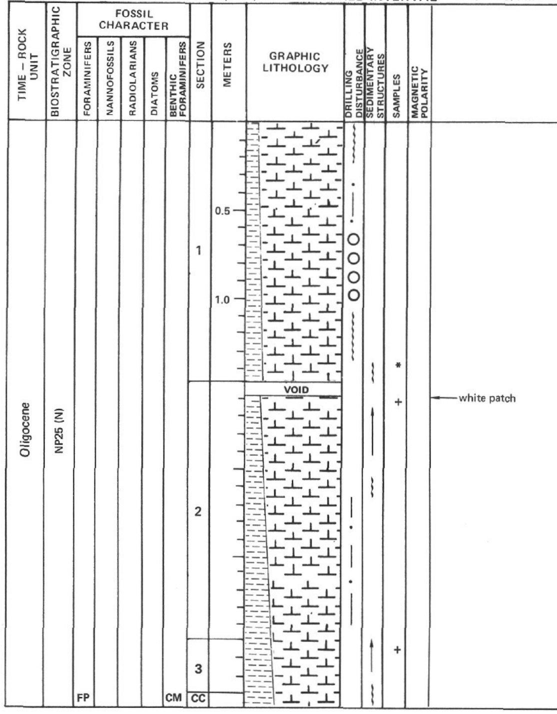
SMEAR SLIDE SUMMARY

	1-145	2-80	3-10
	D	D	D
TEXTURE:			
Sand	TR	1	TR
Silt	25	40	60
Clay	75	59	40
COMPOSITION:			
Quartz	TR	TR	–
Clay	75	59	40
Volcanic glass	1	1	2
Palagonite	1	1	2
Micronodules	5	3	1
Zeolite	1	1	TR
Carbonate unspec.	2	5	5
Foraminifers	TR	TR	TR
Calc. nannofossils	10	30	47
Iron-oxides	5	TR	3
Dolomite(?)	TR	–	–

ORGANIC CARBON AND CARBONATE

	1-142	2-84	3-11
Organic carbon	–	–	–
Carbonate	2	26	58

SITE 523 HOLE CORE (HPC) 12 CORED INTERVAL 41.9–45.4 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) to yellowish brown (10YR 5/4), scattered burrowed intervals. Section 1 and part Section 2 moderately to intensely deformed by drilling. Some zeolites noted in smear slide.

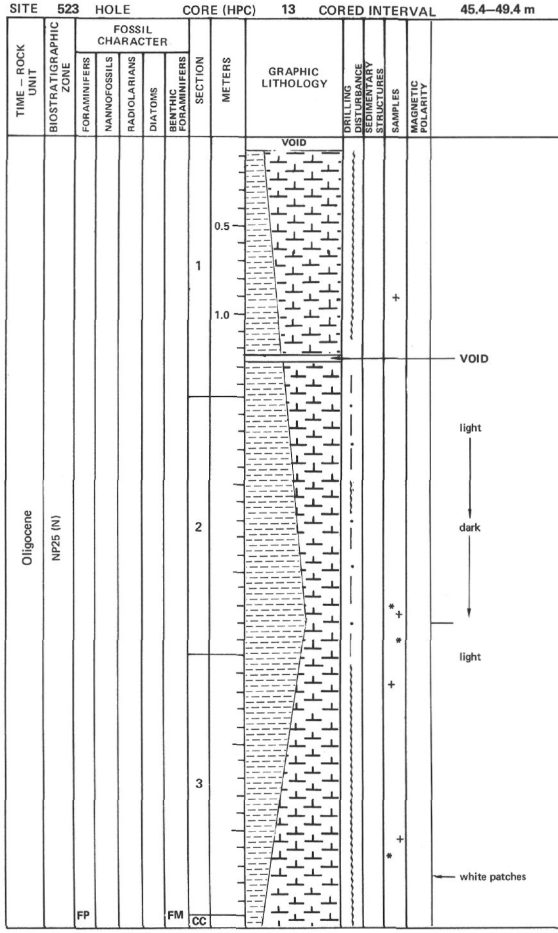
SMEAR SLIDE SUMMARY

	1-140 D
TEXTURE:	
Sand	1
Silt	69
Clay	30
COMPOSITION:	
Clay	30
Volcanic glass	2
Palagonite	TR
Micronodules	2
Zeolite	TR
Carbonate unspec.	5
Calc. nannofossils	59
Iron-oxides	2

ORGANIC CARBON AND CARBONATE

	2-15	3-8
Organic carbon	–	–
Carbonate	77	67

SITE 523 HOLE CORE (HPC) 13 CORED INTERVAL 45.4–49.4 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, pink (7.5YR 7/4), light brown (2.5YR 6/4) and brown (7.5YR 5/4) deformed and mixed by drilling. Section 2 is somewhat intact, showing gradational changes from light yellowish brown (10YR 6/4) and very pale brown (10YR 7/4) ooze to brown (7.5YR 5/4) and dark brown (7.5YR 4/4) marly ooze. Several white patches mixed in lithology in base Section 3. Drilling disturbance obscures sedimentary structures.

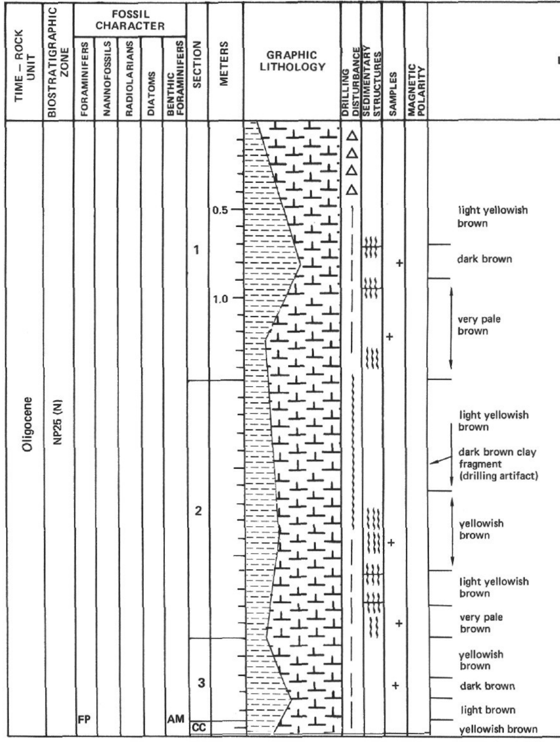
SMEAR SLIDE SUMMARY

	2-125 D	2-140 D	3-120 M
TEXTURE:			
Sand	10	5	5
Silt	50	85	90
Clay	40	10	5
COMPOSITION:			
Quartz	5	TR	–
Clay	20	5	–
Volcanic glass	5	5	TR
Palagonite	5	5	–
Micronodules	5	TR	–
Carbonate unspec.	20	25	10
Foraminifers	–	–	5
Calc. nannofossils	30	55	85
Diatoms	TR	–	–
Sponge spicules	5	TR	–
Fish remains	TR	TR	–
Iron-oxides	5	5	TR

ORGANIC CARBON AND CARBONATE

	1-95	2-121	3-21	3-105
Organic carbon	–	–	–	–
Carbonate	72	28	77	76

SITE 523 HOLE CORE (HPC) 14 CORED INTERVAL 49.4–53.4 m



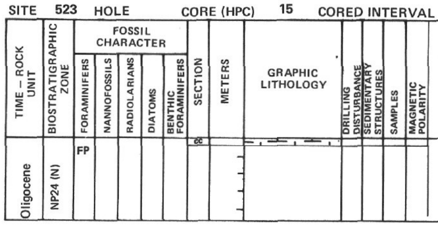
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE and MARLY NANNOFOSSIL OOZE, alternating very pale brown (10 YR 7/4) and light yellowish brown (10YR 6/4) with two dark brown intervals between 70–87 cm, Section 1 and 25–35 cm, Section 3. Burrows common in areas where color changes. Fragment, 10 cm long, of dark brown clay between 50–60 cm Section 2, is drilling artifact. Top 50 cm Section 1 is drilling debris; remainder of core moderately to slightly disturbed.

ORGANIC CARBON AND CARBONATE

	1-121	1-81	2-94	2-141	3-30
Organic carbon	–	–	–	–	–
Carbonate	78	44	65	85	54

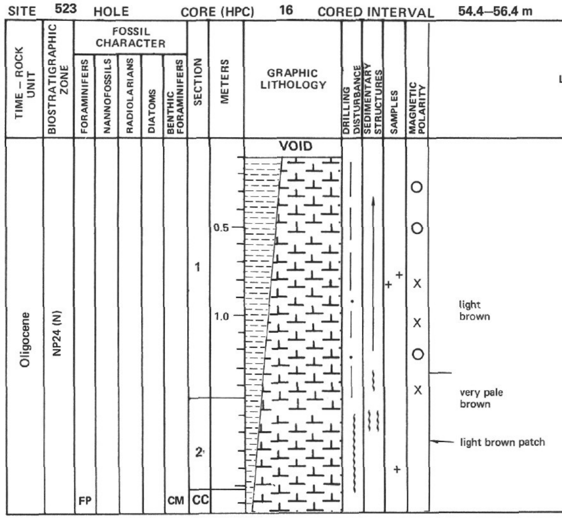
SITE 523 HOLE CORE (HPC) 15 CORED INTERVAL 53.4–54.4 m



LITHOLOGIC DESCRIPTION

Trace of very pale brown (10YR 7/4) NANNOFOSSIL OOZE in Core-Catcher.

SITE 523 HOLE CORE (HPC) 16 CORED INTERVAL 54.4–56.4 m



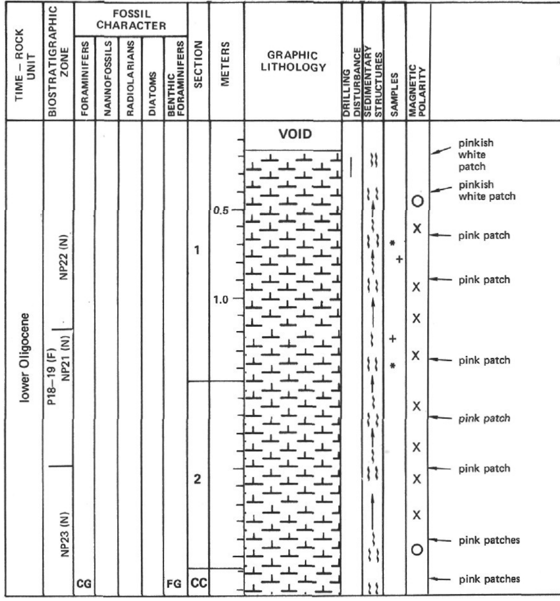
LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE and NANNOFOSSIL OOZE, light brown (7.5YR 6/4) to very pale brown (10YR 7/4), moderately burrowed throughout. Some mixing of colors by drilling disturbance.

ORGANIC CARBON AND CARBONATE

	1-78	1-80	2-40
Organic carbon	–	–	–
Carbonate	73	90	72

SITE 523 HOLE CORE (HPC) 17 CORED INTERVAL 59.4–63.4 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 8/4) with scattered pink (5YR 8/3) and gray patches which appear compositionally similar to enclosing ooze. Only slight drilling deformation in top Section 1.

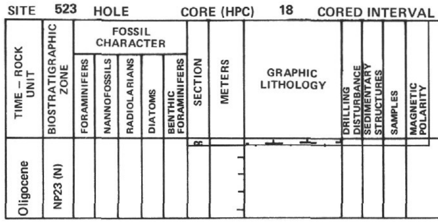
SMEAR SLIDE SUMMARY

	1-71 D	1-140 M
TEXTURE:		
Sand	–	TR
Silt	100	90
Clay	–	10
COMPOSITION:		
Quartz	TR	–
Clay	–	5
Volcanic glass	TR	3
Palagonite	–	2
Micronodules	–	TR
Carbonate unspec.	20	20
Foraminifers	–	15
Calc. nannofossils	80	55
Sponge spicules	–	TR
Fish remains	–	TR

ORGANIC CARBON AND CARBONATE

	1-80	1-124
Organic carbon	–	–
Carbonate	92	86

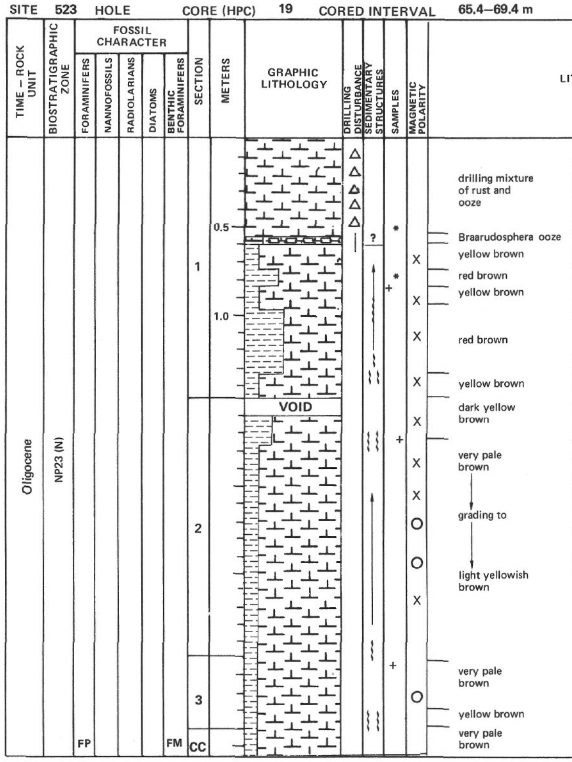
SITE 523 HOLE CORE (HPC) 18 CORED INTERVAL 63.4–65.4 m



LITHOLOGIC DESCRIPTION

Trace of NANNOFOSSIL OOZE in Core-Catcher.

SITE 523 HOLE CORE (HPC) 19 CORED INTERVAL 65.4–69.4 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, yellowish brown (10YR 5/6), light yellowish brown (10YR 6/4) to very pale brown (10YR 7/4) alternating with MARLY NANNOFOSSIL OOZE that is reddish brown (5YR 5/4) to dark yellowish brown (10YR 4/6) as shown. Burrows scattered throughout. White (10YR 8/1) BRAARUDOSPHAERA OOZE occurs in Section 1, 55–64 cm; highly disturbed by drilling. Upper contact with drilling debris is artifically sharp. Lower contact with ooze is disturbed but may be original.

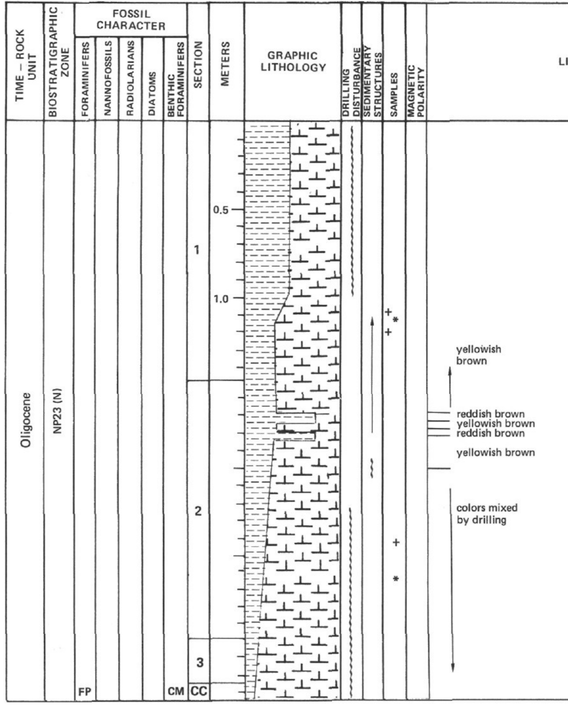
SMEAR SLIDE SUMMARY

	1-55 M	1-80 M
TEXTURE:		
Sand	–	–
Silt	100	70
Clay	–	30
COMPOSITION:		
Clay	–	30
Volcanic glass	–	TR
Micronodules	–	TR
Carbonate unspec.	90	–
Calc. nannofossils	10	69
Iron-oxides	–	1

ORGANIC CARBON AND CARBONATE

	1-86	2-27	3-7
Organic carbon	–	–	–
Carbonate	60	79	85

SITE 523 HOLE CORE (HPC) 20 CORED INTERVAL 69.4–72.9 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, yellowish brown (10YR 5/8) alternating with reddish brown (10YR 4/4) NANNOFOSSIL CLAY in top Section 2. Drilling has mixed the two colors (lithologies between 55–150 cm Section 2 and all of Section 3 plus Core-Catcher). Burrows common in undisturbed sediments. Top 84 cm Section 1 is drilling debris.

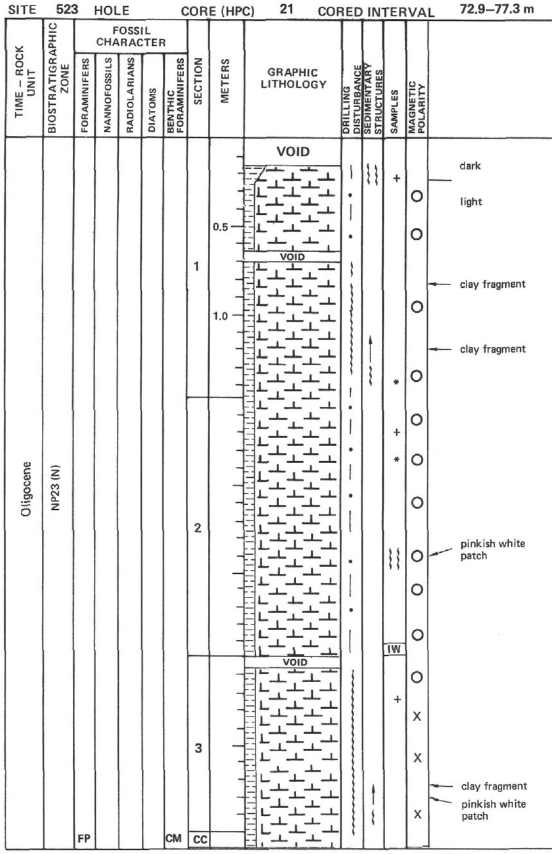
SMEAR SLIDE SUMMARY

	1-116	2-116
	D	D
TEXTURE:		
Sand	–	2
Silt	70	48
Clay	30	50
COMPOSITION:		
Clay	30	50
Volcanic glass	–	1
Palagonite	–	1
Micronodules	1	1
Calc. nannofossils	68	47
Iron-oxides	1	–
Dolomite(?)	–	TR

ORGANIC CARBON AND CARBONATE

	1-107	1-120	2-95
Organic carbon	–	–	–
Carbonate	70	52	84

SITE 523 HOLE CORE (HPC) 21 CORED INTERVAL 72.9–77.3 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, very pale brown (10YR 7/4), burrowed with scattered pinkish white (5YR 8/2) patches and occasional fragments (drilling contacts) of dark yellowish brown (10YR 4/4) NANNOFOSSIL CLAY mixed in; fragments up to 10 cm long.

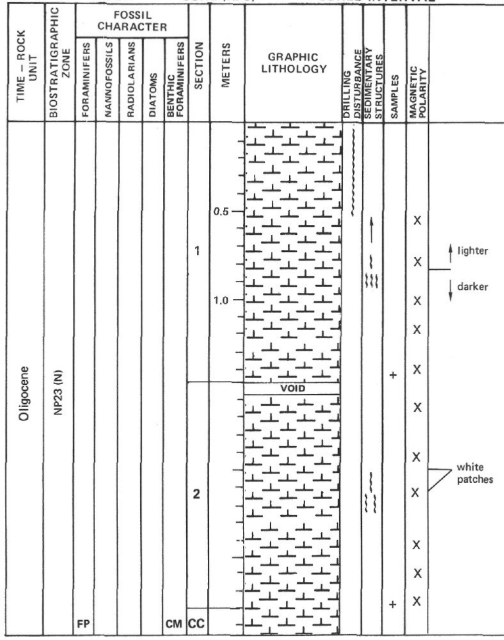
SMEAR SLIDE SUMMARY

	1-141	2-40
	D	D
TEXTURE:		
Sand	5	1
Silt	30	84
Clay	15	15
COMPOSITION:		
Clay	15	15
Carbonate unspec.	12	2
Foraminifers	3	–
Calc. nannofossils	70	82
Iron-oxides	–	1

ORGANIC CARBON AND CARBONATE

	1-24	2-20	3-24
Organic carbon	–	–	–
Carbonate	77	88	85

SITE 523 HOLE CORE (HPC) 22 CORED INTERVAL 77.3–80.8 m



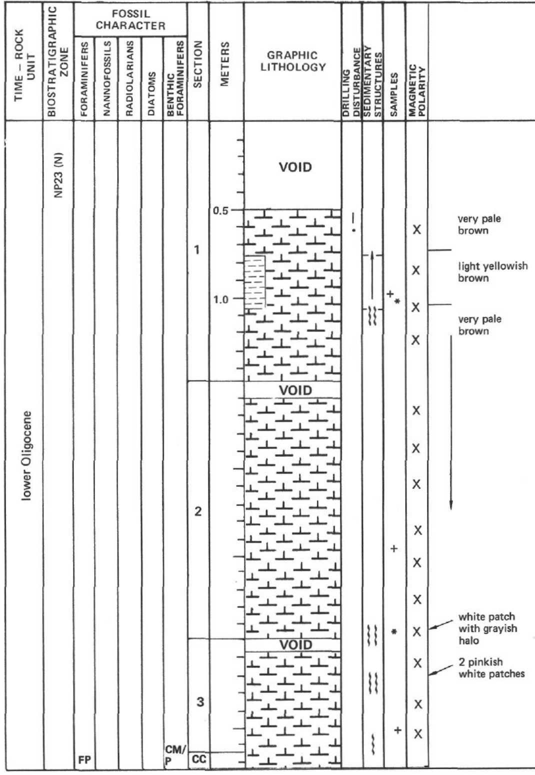
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4–8/4), homogeneous, faintly burrowed with scattered white patches in Section 2; white patches have grayish haloes. Slight color change from lighter to darker ooze in Section 1 as noted. Top 50 cm Section 1 is drilling debris.

ORGANIC CARBON AND CARBONATE

	1-142	2-121
Organic carbon	–	–
Carbonate	85	86

SITE 523 HOLE CORE (HPC) 23 CORED INTERVAL 80.8–84.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) with one marly, light yellowish brown (10YR 6/4) interval in Section 1. Burrows common between 84–105 cm, Section 1 but faint or sparse *throughout rest of core. Pinkish white patches in* base Section 2 and in Section 3. Minimal drilling deformation.

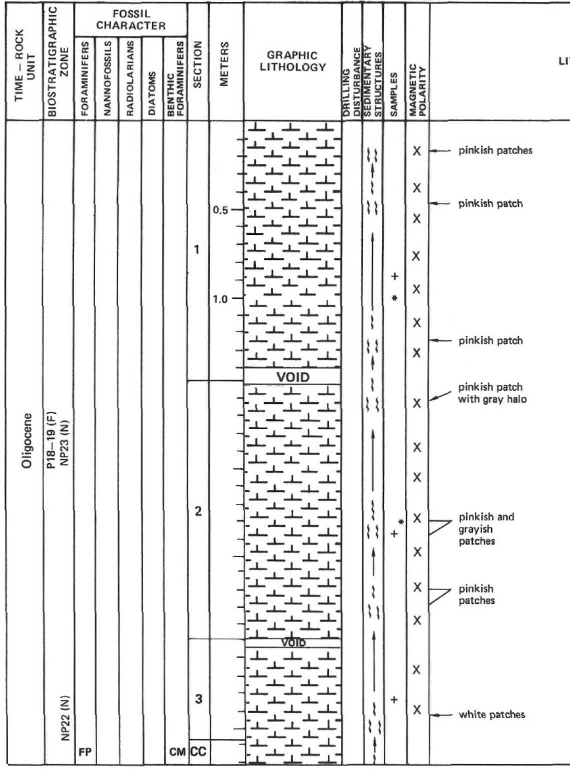
SMEAR SLIDE SUMMARY

	1-100 D	2-144 M
TEXTURE:		
Sand	–	1
Silt	85	90
Clay	15	9
COMPOSITION:		
Clay	15	9
Palagonite	TR	–
Micronodules	1	–
Carbonate unspec.	2	–
Foraminifers	TR	TR
Calc. nannofossils	82	90
Iron-oxides	–	1

ORGANIC CARBON AND CARBONATE

	1-98	2-98	3-52
Organic carbon	1-98	2-98	3-52
Carbonate	79	87	84

SITE 523 HOLE CORE (HPC) 24 CORED INTERVAL 84.8–88.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) with scattered 1–5 cm pinkish white (5YR 8/2) patches mixed or haloed with grayish ooze. Pink color possibly from rhodochrosite (not obvious in smear slides). Abundant diffuse, yellowish brown (10YR 5/4) spots (3–5 mm across) scattered throughout ooze may be bioturbation features. Minimal core disturbance.

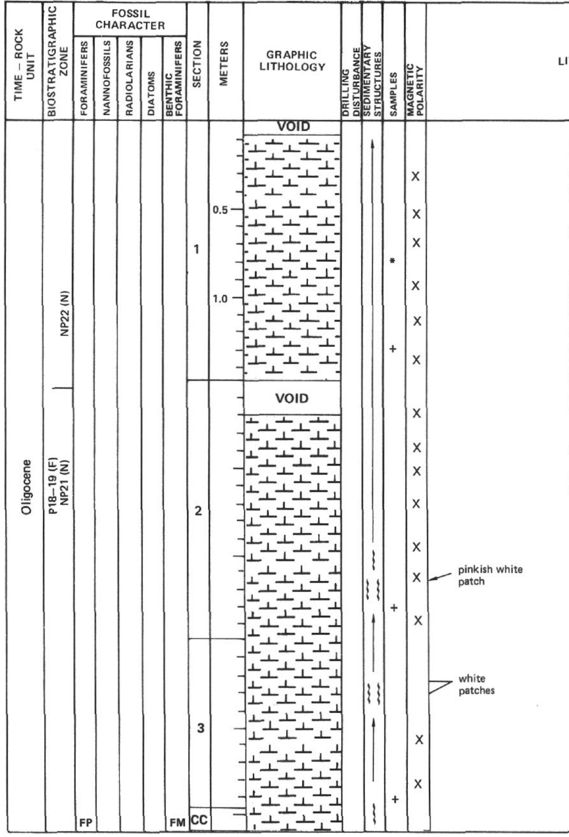
SMEAR SLIDE SUMMARY

	1-100	**2-88**
	D	**D**
TEXTURE:		
Sand	3	4
Silt	87	80
Clay	10	16
COMPOSITION:		
Clay	8	11
Carbonate unspec.	10	5
Foraminifers	2	4
Calc. nannofossils	80	80

ORGANIC CARBON AND CARBONATE

	1-89	**2-89**	**3-32**
Organic carbon	–	–	–
Carbonate	86	93	91

SITE 523 HOLE CORE (HPC) 25 CORED INTERVAL 88.8–92.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4), abundant yellowish brown (10YR 6/4) spots suggest bioturbation. Few scattered pinkish white patches noted in Sections 2 and 3. Core very similar to Core 24. Minimal drilling disturbance.

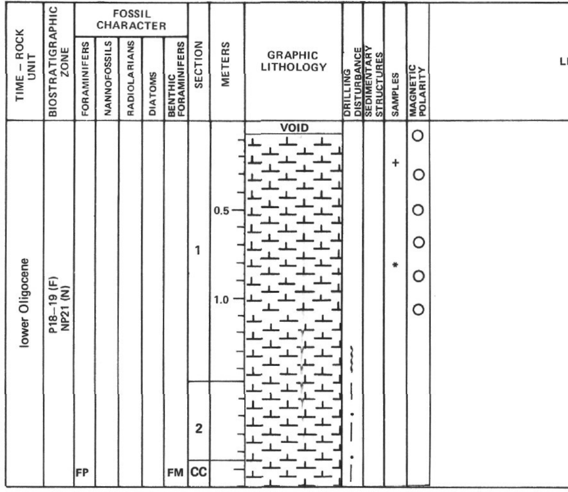
SMEAR SLIDE SUMMARY

	1-80
	D
TEXTURE:	
Sand	–
Silt	90
Clay	10
COMPOSITION:	
Clay	10
Foraminifers	TR
Calc. nannofossils	90
Iron-oxides	TR
Dolomite(?)/ rhodochrosite(?)	TR

ORGANIC CARBON AND CARBONATE

	1-130	**2-130**	**3-92**
Organic carbon	–	–	–
Carbonate	87	86	87

SITE 523 HOLE CORE (HPC) 26 CORED INTERVAL 92.8–94.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 8/4), homogeneous. (Liner jammed in core barrel requiring core to be extruded into new liner; Section 1 intact except for base; Section 2 disturbed – orientation uncertain).

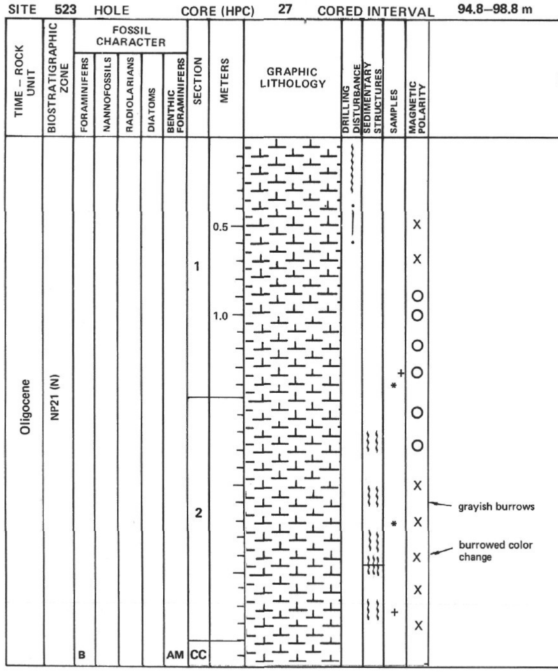
SMEAR SLIDE SUMMARY

	1-80
	D
TEXTURE:	
Sand	1
Silt	94
Clay	5
COMPOSITION:	
Clay	5
Micronodules	TR
Foraminifers	1
Calc. nannofossils	94
Iron-oxides	TR

ORGANIC CARBON AND CARBONATE

	1-26
Organic carbon	–
Carbonate	92

SITE 523 HOLE CORE (HPC) 27 CORED INTERVAL 94.8–98.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 8/3–10YR 7/3) homogeneous with occasional white burrows scattered throughout, especially Section 2. Top 35 cm disturbed by drilling.

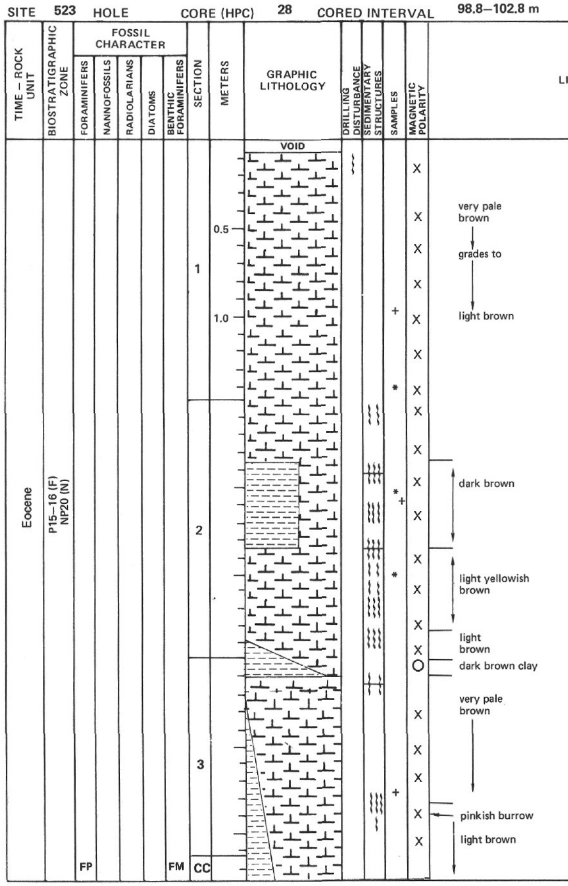
SMEAR SLIDE SUMMARY

	1-140	**2-72**
	D	**M**
TEXTURE:		
Sand	5	5
Silt	90	90
Clay	5	5
COMPOSITION:		
Quartz	TR	TR
Clay	TR	5
Volcanic glass	3	3
Palagonite	2	2
Micronodules	–	5
Carbonate unspec.	15	15
Foraminifers	5	5
Calc. nannofossils	75	65
Sponge spicules	TR	TR
Fish remains	TR	TR
Iron-oxides	TR	–

ORGANIC CARBON AND CARBONATE

	1-130	**2-126**
Organic carbon	–	–
Carbonate	95	87

SITE 523 HOLE CORE (HPC) 28 CORED INTERVAL 98.8–102.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE and CLAY, very pale brown (10YR 7/4) to light brown (7.5YR 6/4), light yellowish brown (10YR 6/4) as shown. Abundant burrows in Section 2 where color changes common. Dark brown clay at top Section 3 has burrowed lower contact. Large (2 cm) pinkish burrow in Section 3.

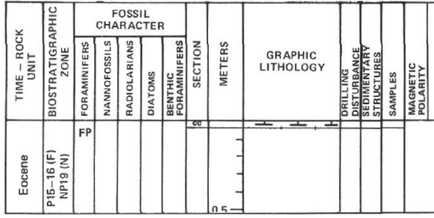
SMEAR SLIDE SUMMARY

	1-140	**2-55**	**2-100**
	D	**M**	**D**
TEXTURE:			
Sand	5	10	5
Silt	90	40	90
Clay	5	50	5
COMPOSITION:			
Quartz	–	5	TR
Clay	3	25	10
Volcanic glass	TR	5	3
Palagonite	TR	5	2
Micronodules	–	5	TR
Carbonate unspec.	10	10	10
Foraminifers	–	TR	–
Calc. nannofossils	85	30	70
Sponge spicules	TR	TR	–
Fish remains	TR	TR	TR
Iron-oxides	2	15	5

ORGANIC CARBON AND CARBONATE

	1-95	**2-54**	**3-78**
Organic carbon	–	–	–
Carbonate	87	42	67

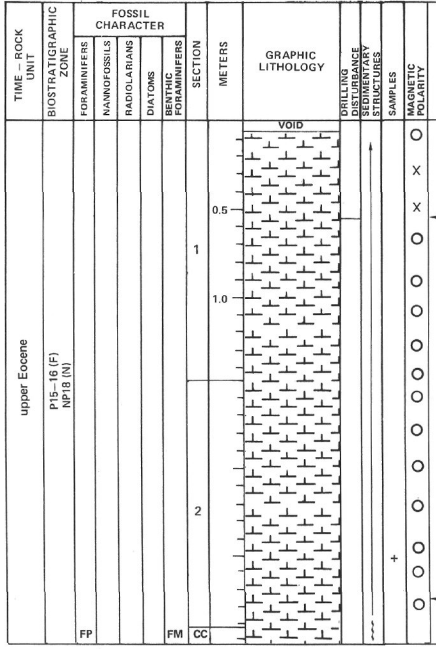
SITE 523 HOLE CORE (HPC) 29 CORED INTERVAL 102.8–106.8 m



LITHOLOGIC DESCRIPTION

Trace of NANNOFOSSIL OOZE in Core-Catcher.

SITE 523 HOLE CORE (HPC) 30 CORED INTERVAL 106.8–110.8 m



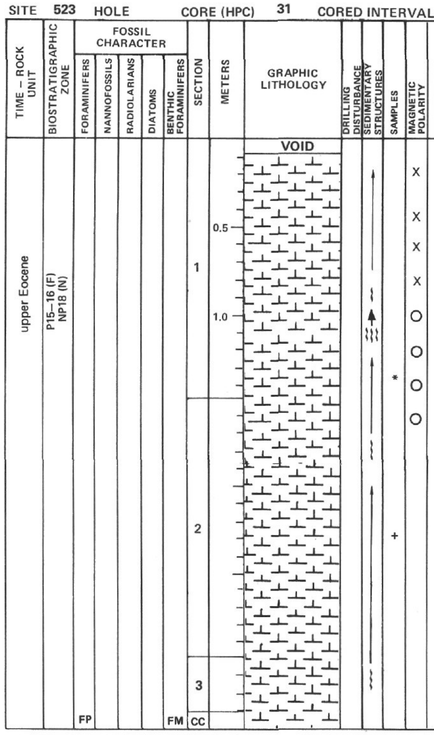
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4), burrowed throughout, with single large pink (7.5YR 8/4) burrow between 120–130 cm, Section 2. Thin layer of drilling rust at 55 cm Section 1 intruded in core.

ORGANIC CARBON AND CARBONATE

	2-100
Organic carbon	–
Carbonate	90

SITE 523 HOLE CORE (HPC) 31 CORED INTERVAL 110.8–114.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) to light yellowish brown (10YR 6/4), burrowed throughout. Minimal core disturbance.

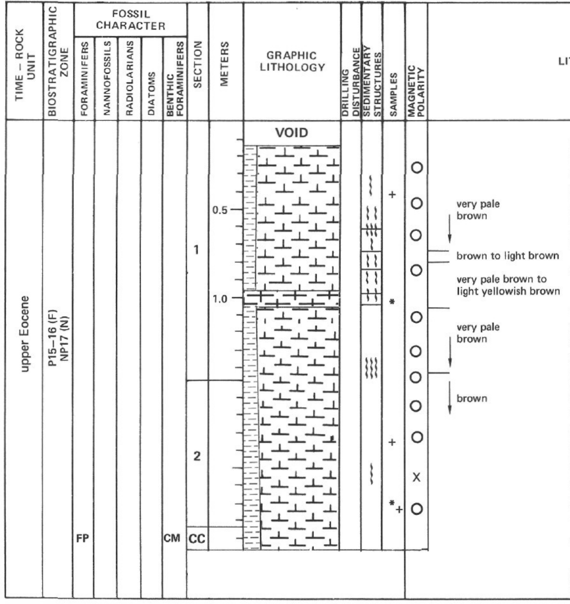
SMEAR SLIDE SUMMARY

	1-140 **D**
TEXTURE:	
Sand	5
Silt	90
Clay	5
COMPOSITION:	
Quartz	TR
Clay	5
Volcanic glass	3
Palagonite	2
Carbonate unspec.	15
Calc. nannofossils	75
Fish remains	TR
Iron-oxides	TR

ORGANIC CARBON AND CARBONATE

	2-80
Organic carbon	–
Carbonate	83

SITE 523 HOLE CORE (HPC) 32 CORED INTERVAL 114.8–117.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) changing to brown (7.5YR 5/4) MARLY *NANNOFOSSIL OOZE in Section 2. Thin interval* of marly ooze also in Section 1 as shown. Very pale brown to light yellowish brown (10YR 6/4) FORAMINIFER-NANNOFOSSIL OOZE between 98–102 cm, Section 1 has sharp basal contact and gradational top. Burrows common throughout ooze.

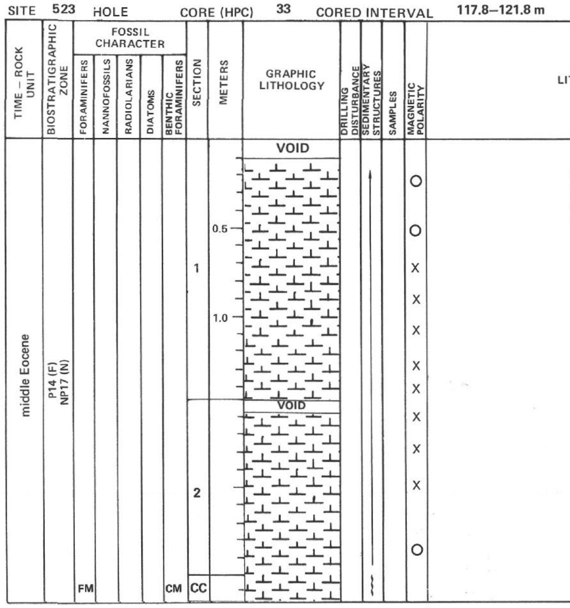
SMEAR SLIDE SUMMARY

	1-100	2-70
	D	D
TEXTURE:		
Sand	25	20
Silt	70	80
Clay	5	10
COMPOSITION:		
Quartz	–	TR
Clay	5	10
Volcanic glass	3	3
Palagonite	2	2
Micronodules	5	TR
Carbonate unspec.	10	15
Foraminifers	25	5
Calc. nannofossils	50	60
Fish remains	TR	5
Iron-oxides	TR	TR

ORGANIC CARBON AND CARBONATE

	1-40	2-36	2-70
Organic carbon	–	–	–
Carbonate	85	84	79

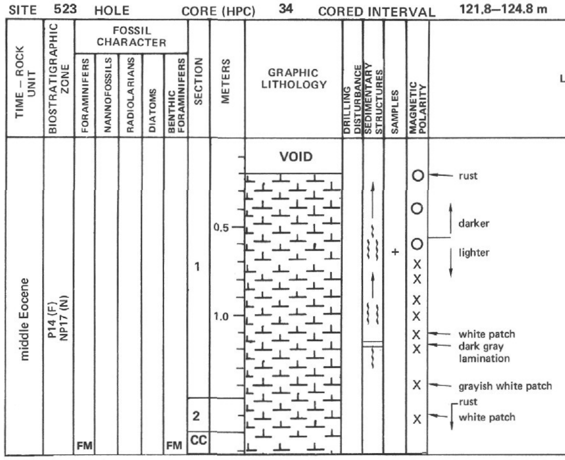
SITE 523 HOLE CORE (HPC) 33 CORED INTERVAL 117.8–121.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) to very pale brown (10YR 7/4), homogeneous with faint burrows throughout. Foraminifers common (approximately 5%).

SITE 523 HOLE CORE (HPC) 34 CORED INTERVAL 121.8–124.8 m



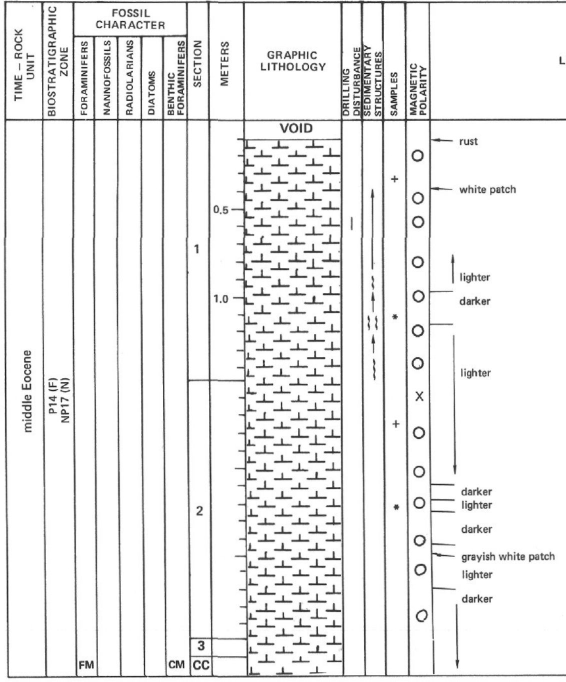
LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) to yellowish brown (10YR 7/4), burrowed throughout with scattered white patches. Dark gray (pyrite?) lamination at 117 cm in Section 1.

ORGANIC CARBON AND CARBONATE

	1-64
Organic carbon	–
Carbonate	87

SITE 523 HOLE CORE (HPC) 35 CORED INTERVAL 124.8–128.3 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, alternating light yellowish brown (10YR 6/4) and yellowish brown (10YR 5/4), burrowed with scattered white patches. Color variations gradual especially dark to overlying light. Grayish white patch in Section 2 (101 cm) has grayish center and halo.

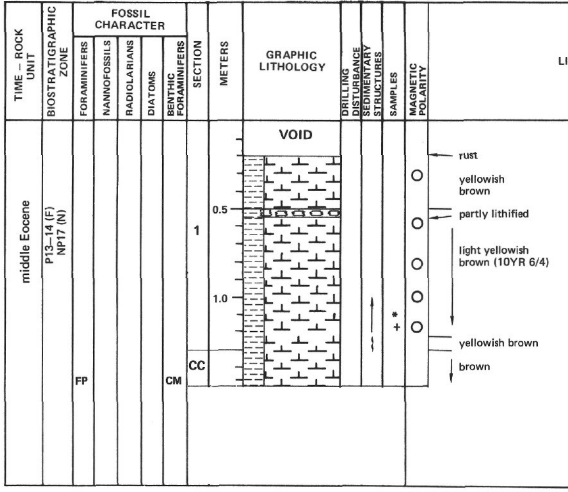
SMEAR SLIDE SUMMARY

	1-117	2-75
	D	D
TEXTURE:		
Sand	5	–
Silt	80	90
Clay	15	10
COMPOSITION:		
Clay	10	10
Carbonate unspec.	5	10
Foraminifers	5	–
Calc. nannofossils	80	80
Iron-oxides	–	TR

ORGANIC CARBON AND CARBONATE

	1-32	2-26
Organic carbon	–	–
Carbonate	85	83

SITE 523 HOLE CORE (HPC) 36 CORED INTERVAL 128.3–130.8 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, yellowish brown (10YR 5/8) to light yellowish brown (10YR 6/4), burrows common between 100–125 cm. Partly lithified interval (NANNOFOSSIL MARL) 50–55 cm. Core-Catcher is brown (7.5YR 5/4) marly ooze.

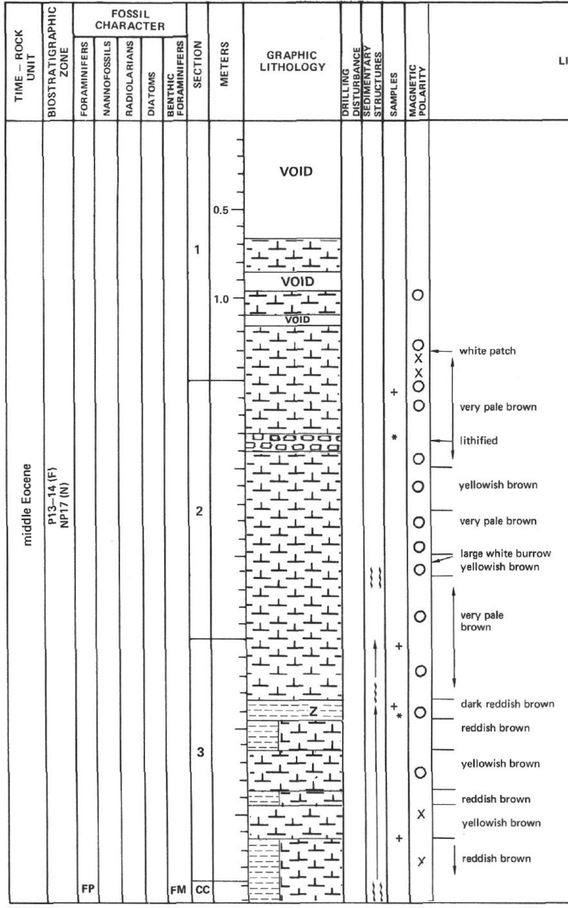
SMEAR SLIDE SUMMARY

	1-110
	D
TEXTURE:	
Sand	–
Silt	85
Clay	15
COMPOSITION:	
Clay	15
Carbonate unspec.	10
Foraminifers	TR
Calc. nannofossils	75
Iron-oxides	TR

ORGANIC CARBON AND CARBONATE

	1-110
Organic carbon	–
Carbonate	76

SITE 523 HOLE CORE (HPC) 37 CORED INTERVAL 130.8–135.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) to yellowish brown (10YR 5/6) alternating with reddish brown (5YR 4/4) to dark reddish brown (5YR 3/2) NANNOFOSSIL CLAY and ZEOLITE-BEARING CLAY in Section 3. Ooze is moderately burrowed throughout with occasional large (7 cm) burrows filled with white ooze (e.g. 113 cm, Section 2). Ooze partly lithified to MARL 30–40 cm, Section 2. CLAY is stiff and contains few nannofossils. Clay between 38–48 cm, Section 3 contains phillipsite(?). Most ooze-clay transitions in Section 3 are gradational. Few sharp contacts are intensely burrowed.

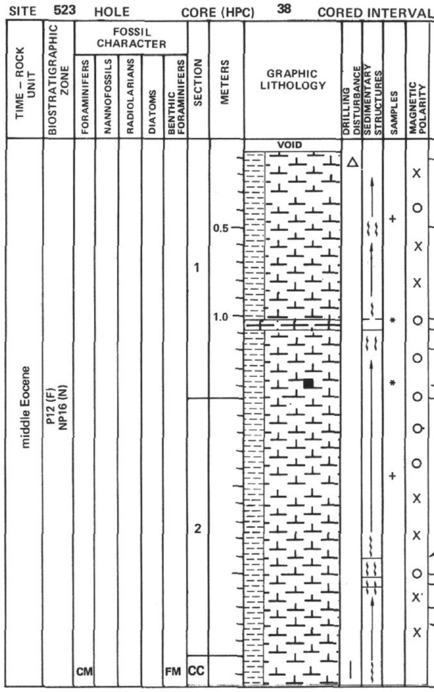
SMEAR SLIDE SUMMARY

	2-37	3-46
	D	M
TEXTURE:		
Sand	1	3
Silt	79	17
Clay	20	80
COMPOSITION:		
Clay	20	80
Zeolite	–	3
Carbonate unspec.	5	5
Foraminifers	TR	–
Calc. nannofossils	74	5
Iron-oxides	1	7

ORGANIC CARBON AND CARBONATE

	2-9	3-9	3-42	3-115
Organic carbon	–	–	–	–
Carbonate	85	87	47	63

SITE 523 HOLE CORE (HPC) 38 CORED INTERVAL 135.2–139.2 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/4) to yellowish brown (10YR 5/4) as shown. Burrows common throughout; most intense burrowing seen at color changes. Thin layer of NANNOFOSSIL-FORAMINIFER OOZE in Section 1 has sharp base and gradational top; not obviously graded. Altered (clays in XRD) basaltic glass fragment occurs near base Section 1.

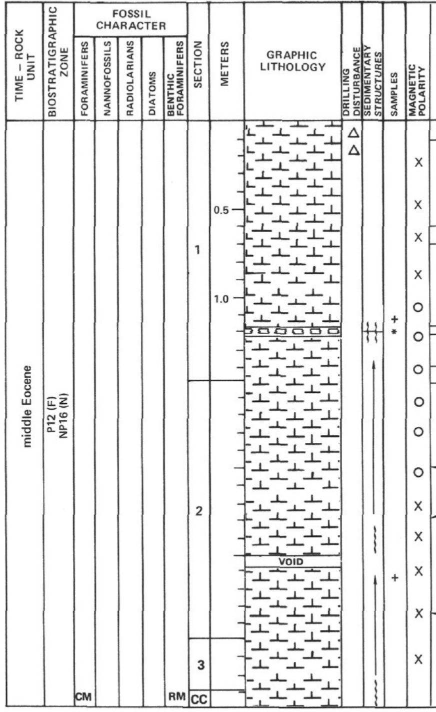
SMEAR SLIDE SUMMARY

	1-109 M	1-140 D
TEXTURE:		
Sand	60	8
Silt	40	82
Clay	–	10
COMPOSITION:		
Clay	–	10
Zeolite	–	TR
Carbonate unspec.	10	10
Foraminifers	60	5
Calc. nannofossils	30	75

ORGANIC CARBON AND CARBONATE

	1-49	2-49
Organic carbon	–	–
Carbonate	83	81

SITE 523 HOLE CORE (HPC) 39 CORED INTERVAL 139.2–143.2 m



LITHOLOGIC DESCRIPTION

NANNOOSSIL OOZE, yellowish brown (10YR 5/4, light–10YR 5/8, dark), with faint burrows throughout. Scattered white patches, some with grayish haloes. Ooze is partly lithified to CHALK between 118–121 cm, Section 1; contains 2 cm thick dark layer. Thin (0.5 cm) foraminifer-rich lamination at 114 cm Section 1. Top 15 cm, Section 1 is rust and drilling debris.

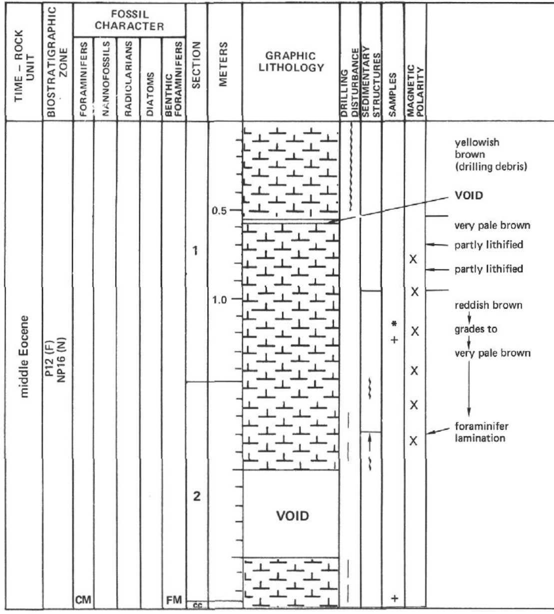
SMEAR SLIDE SUMMARY

	1-120 D
TEXTURE:	
Sand	4
Silt	76
Clay	20
COMPOSITION:	
Clay	15
Carbonate unspec.	20
Foraminifers	3
Calc. nannofossils	62

ORGANIC CARBON AND CARBONATE

	1-115	2-115
Organic carbon	–	–
Carbonate	84	90

SITE 523 HOLE CORE (HPC) 40 CORED INTERVAL 143.2–146.7 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very pale brown (10YR 7/4) partly lithified in Section 1 to MARL. Color change at 98 cm Section 1 to reddish brown (5YR 4/4) marly ooze; grades to very pale brown ooze down section. Thin (0.5 cm) foraminifer-rich lamination at 29 cm Section 2; ooze below is burrowed, above is homogeneous.

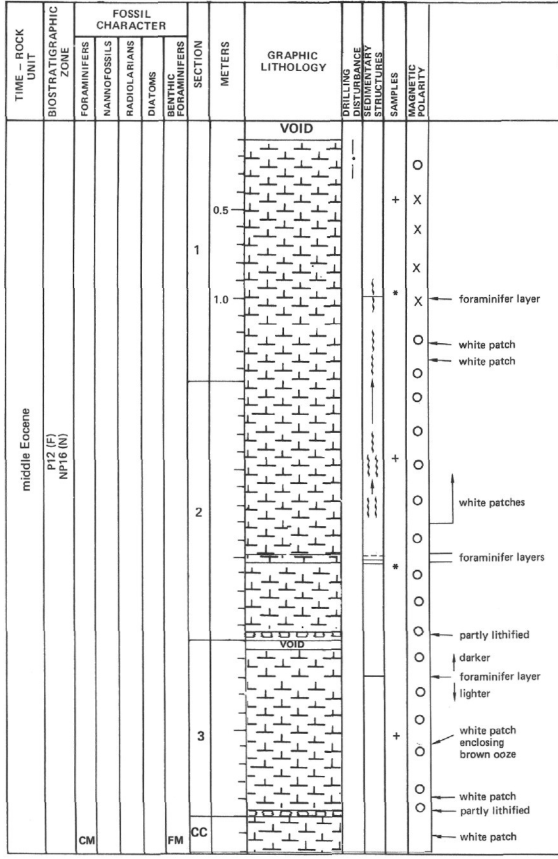
SMEAR SLIDE SUMMARY

	1-116 D
TEXTURE:	
Sand	–
Silt	90
Clay	10
COMPOSITION:	
Clay	10
Carbonate unspec.	5
Foraminifers	TR
Calc. nannofossils	85

ORGANIC CARBON AND CARBONATE

	1-122	2-123
Organic carbon	–	–
Carbonate	90	86

SITE 523 HOLE CORE (HPC) 41 CORED INTERVAL 146.7–151.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, yellowish brown (10YR 5/6), moderately burrowed with thin (0.2–3 cm) layers of very pale brown (10YR 7/3) NANNOFOSSIL FORAMINIFER OOZE; thickest foraminifer-rich layer (100–103 cm, Section 2) has sharp irregular basal contact (scoured?) and mixed, gradational top. Other foraminifer layers too thin to show clear sediment structures. Bases of Sections 2 and 3 partly lithified to CHALK. Top 20 cm Section 1 moderately disturbed by drilling.

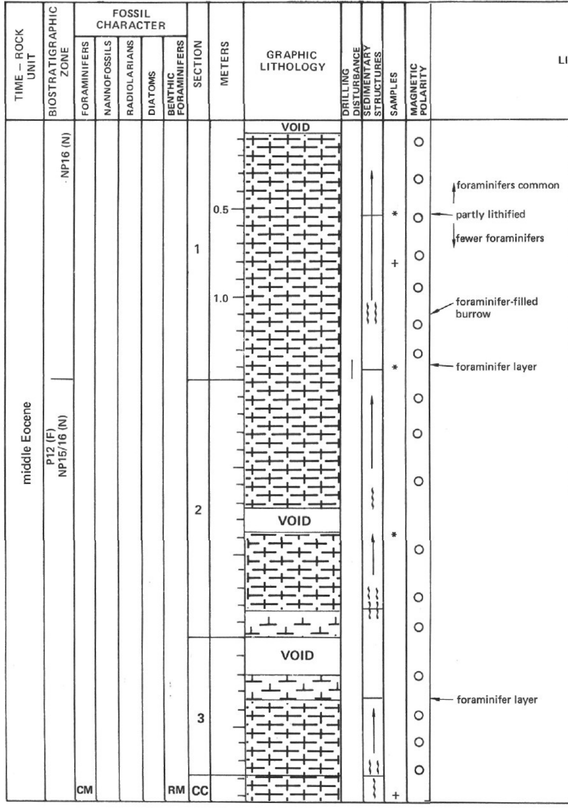
SMEAR SLIDE SUMMARY

	1-99 M	2-106 M
TEXTURE:		
Sand	70	30
Silt	30	60
Clay	–	10
COMPOSITION:		
Clay	TR	10
Carbonate unspec.	10	10
Foraminifers	30	30
Calc. nannofossils	20	50
Diatoms	TR	–
Iron-oxides	TR	TR
Dolomite(?)	–	TR

ORGANIC CARBON AND CARBONATE

	1-44	2-44	3-50
Organic carbon	–	–	–
Carbonate	86	84	94

SITE 523 HOLE CORE (HPC) 42 CORED INTERVAL 151.2–155.2 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-NANNOFOSSIL OOZE and NANNOFOSSIL OOZE, brownish yellow (10YR 6/6) to yellowish brown (10YR 5/4); foraminifer content variable and appears to be mixed by burrowing. Several thin, concentrated layers of foraminifers noted; above these foraminifer content decreases gradually.

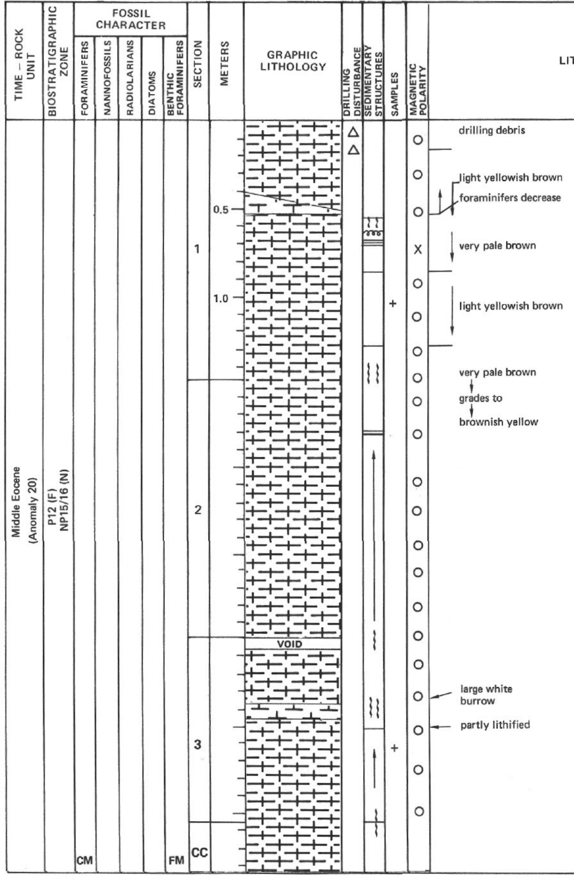
SMEAR SLIDE SUMMARY

	1-53	1-140
	D	D
TEXTURE:		
Sand	10	5
Silt	80	75
Clay	10	20
COMPOSITION:		
Quartz	TR	TR
Clay	10	5
Volcanic glass	3	TR
Palagonite	2	TR
Micronodules	TR	TR
Carbonate unspec.	10	15
Foraminifers	10	5
Calc. nannofossils	65	70
Sponge spicules	TR	TR
Fish remains	TR	TR
Iron-oxides	TR	5

ORGANIC CARBON AND CARBONATE

	1-80	CC
Organic carbon	–	–
Carbonate	87	86

SITE 523 HOLE CORE (HPC) 43 CORED INTERVAL 155.2–159.7 m



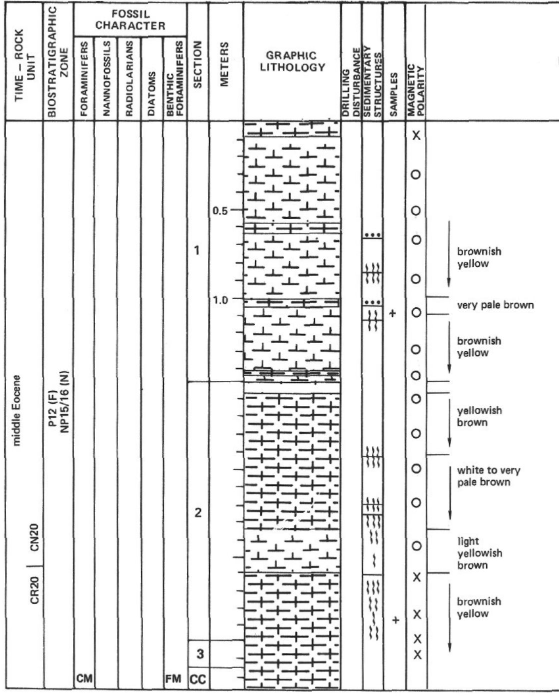
LITHOLOGIC DESCRIPTION

FORAMINIFER-NANNOFOSSIL OOZE and NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) and very pale brown (10YR 7/4) grading to brownish yellow (10YR 6/8) in Section 2. Foraminifers common throughout. Foraminifer-rich layer with base at 51 cm Section 1 grades upward to nannofossil ooze. Section 1, 51–67 cm is mixed (burrowed) and partly laminated white foraminifer-nannofossil ooze and brown marly ooze. Burrows common. Top 20 cm Section 1 is drilling debris.

ORGANIC CARBON AND CARBONATE

	1-105	3-65
Organic carbon	–	–
Carbonate	87	86

SITE 523 HOLE CORE (HPC) 44 CORED INTERVAL 159.7–162.2 m



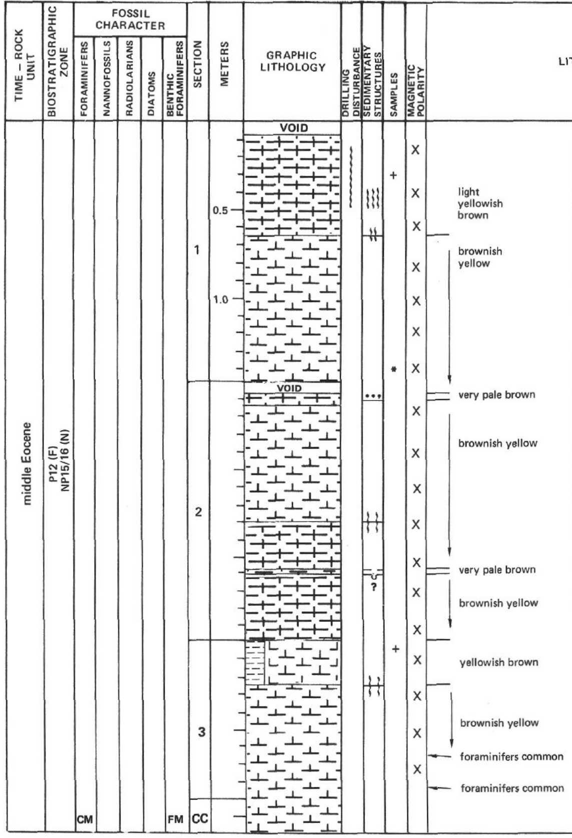
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE and FORAMINIFER NANNOFOSSIL OOZE, very pale brown (10YR 7/4) and light yellowish brown (10YR 6/4) to yellowish brown (10YR 6/6) and brownish yellow (10YR 6/6). Foraminifer layers usually approximately 2–3 cm thick. These grade upward to less foraminifer-rich nannofossil ooze. Base of foraminifer layers sharp. Intensely burrowed intervals common.

ORGANIC CARBON AND CARBONATE

	1-107	2-139
Organic carbon	–	–
Carbonate	87	85

SITE 523 HOLE CORE (HPC) 45 CORED INTERVAL 162.2–166.7 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-NANNOFOSSIL OOZE and MARLY NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4), yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6), alternating as shown. Sharp burrowed contacts between colors/lithologies. Several thin (graded?) foraminifer layers in Section 2 are very pale brown; these grade upward to less foraminifer-rich nannofossil ooze. Possible scoured base of foraminifer layer at 111 cm, Section 2.

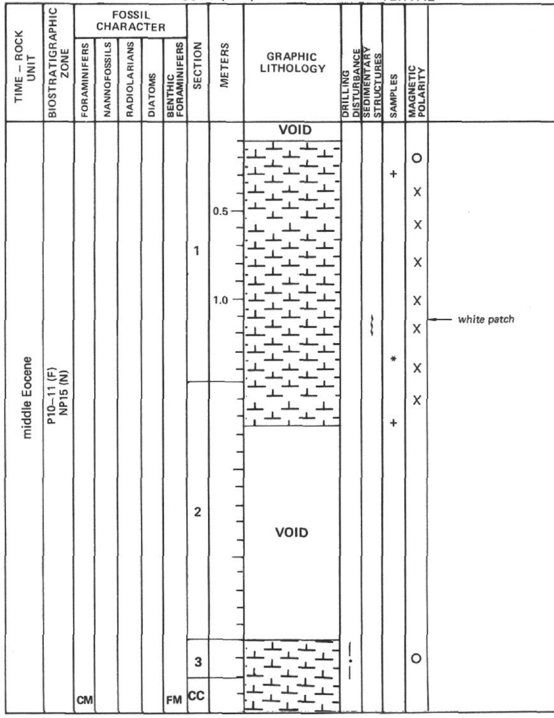
SMEAR SLIDE SUMMARY

	1-140 D
TEXTURE:	
Sand	5
Silt	45
Clay	50
COMPOSITION:	
Clay	5
Volcanic glass	3
Palagonite	2
Micronodules	TR
Carbonate unspec.	15
Foraminifers	5
Calc. nannofossils	70
Sponge spicules	TR
Fish remains	TR

ORGANIC CARBON AND CARBONATE

	1-30	3-5
Organic carbon	–	–
Carbonate	84	80

SITE 523 HOLE CORE (HPC) 46 CORED INTERVAL 166.7–170.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) and brownish yellow (10YR 6/6), homogeneous with occasional burrows and white patches. (Section 3 fell out of core barrel and liner but remained intact).

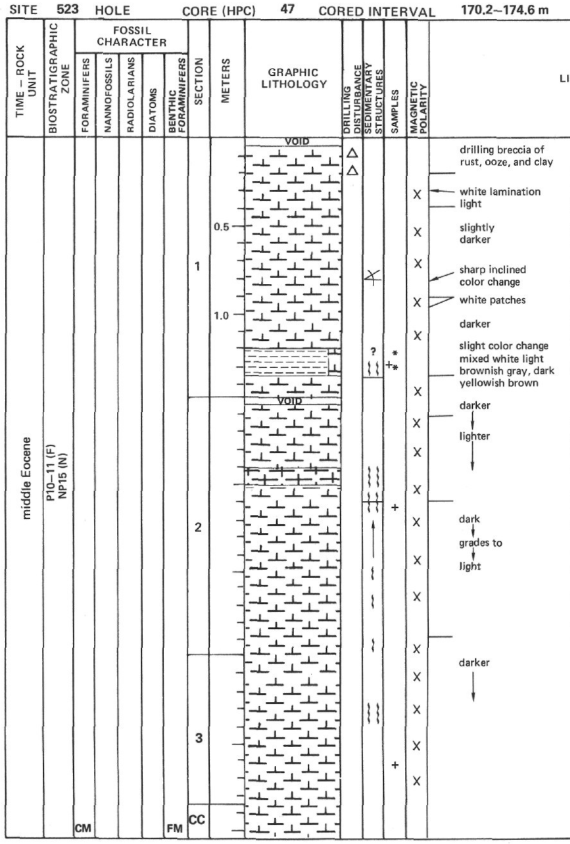
SMEAR SLIDE SUMMARY

	1-130
	D
TEXTURE:	
Sand	1
Silt	90
Clay	9
COMPOSITION:	
Clay	9
Volcanic glass	TR
Carbonate unspec.	10
Calc. nannofossils	80
Iron-oxides	1

ORGANIC CARBON AND CARBONATE

	1-30	2-26
Organic carbon	–	–
Carbonate	84	84

SITE 523 HOLE CORE (HPC) 47 CORED INTERVAL 170.2–174.6 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, yellowish brown (10YR 5/6) to light yellowish brown (10YR 6/4) as shown; burrowed intervals common. FORAMINIFER-NANNOFOSSIL OOZE between 40–50 cm, Section 2 mixed by burrowing. Complex interval between 121–135 cm, Section 1 includes mixed (burrowed?) white (10YR 8/1) nannofossil ooze, light brownish gray (10YR 6/2) clay (XRD) and dark yellowish brown (10YR 4/4) marly ooze; basal contact sharp (white above dark yellowish brown), upper contact gradational and mixed. Grayish clay may be altered volcanic glass. Top 20 cm Section 1 is drilling debris.

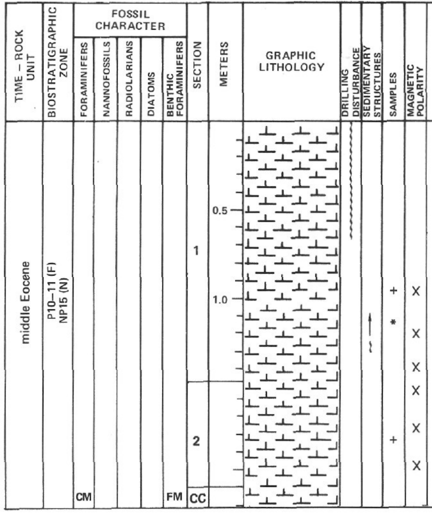
SMEAR SLIDE SUMMARY

	1-125	1-130
	M	
TEXTURE:		
Sand	5	40
Silt	65	20
Clay	30	40
COMPOSITION:		
Heavy minerals	–	TR
Clay	10	85
Volcanic glass	–	5
Carbonate unspec.	20	–
Foraminifers	5	–
Calc. nannofossils	65	5
Sponge spicules	–	5

ORGANIC CARBON AND CARBONATE

	1-128	2-62	3-62
Organic carbon	–	–	–
Carbonate	9	83	86

SITE 523 HOLE CORE (HPC) 48 CORED INTERVAL 180.6–182.1 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light yellowish brown (10 YR 6/4), slightly burrowed, homogeneous.

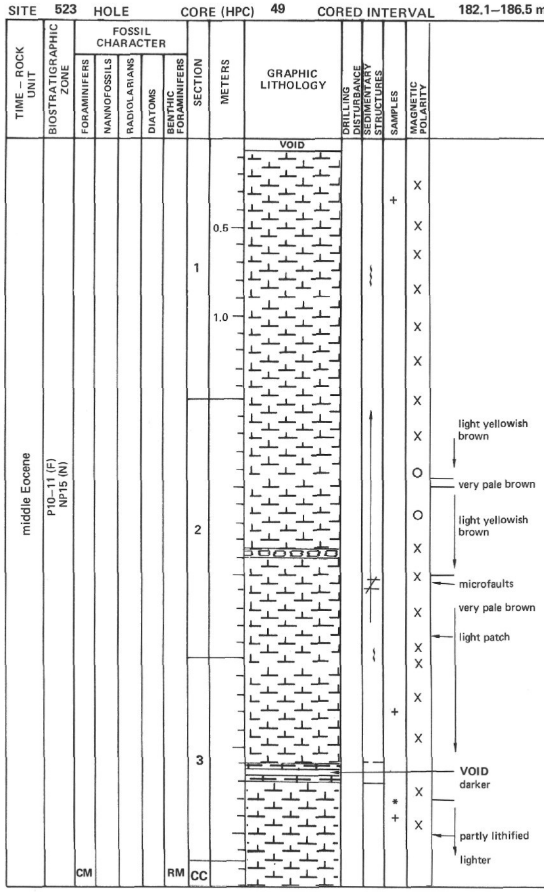
SMEAR SLIDE SUMMARY

	1-116
	D
TEXTURE:	
Sand	3
Silt	87
Clay	10
COMPOSITION:	
Clay	10
Carbonate unspec.	5
Foraminifers	3
Calc. nannofossils	82
Iron-oxides	TR

ORGANIC CARBON AND CARBONATE

	1-95	**2-35**
Organic carbon	–	–
Carbonate	84	86

SITE 523 HOLE CORE (HPC) 49 CORED INTERVAL 182.1–186.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) to very pale brown (10YR 7/4–7/3), partly lithified to MARL in places. Thin layer of FORAMINIFER-NANNOFOSSIL OOZE in Section 3 has sharp basal contact and gradational top. Burrows common in Section 2. Contorted laminations and microfaults at 100–110 cm, Section 2.

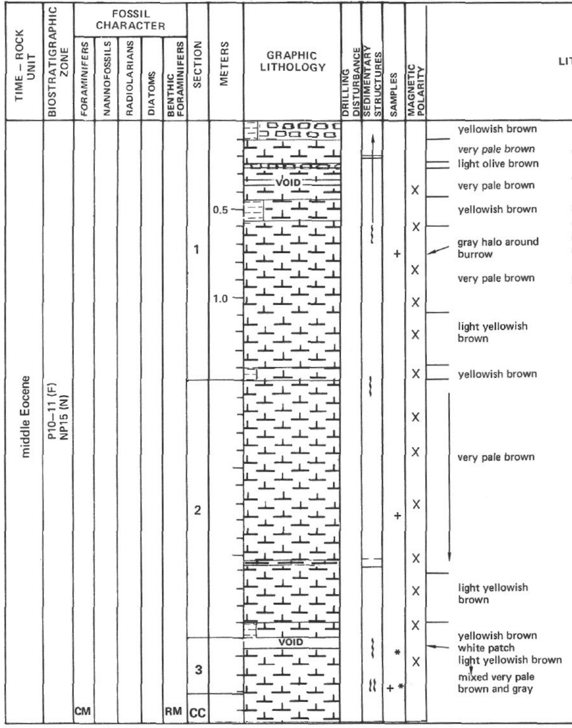
SMEAR SLIDE SUMMAR

	3-83
	D
TEXTURE:	
Sand	2
Silt	85
Clay	13
COMPOSITION:	
Clay	10
Palagonite	TR
Carbonate unspec.	15
Foraminifers	2
Calc. nannofossils	73

ORGANIC CARBON AND CARBONATE

	1-32	**3-30**	**3-87**
Organic carbon	–	–	–
Carbonate	85	87	87

SITE 523 HOLE CORE (HPC) 50 CORED INTERVAL 186.5–190.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE and MARLY NANNOFOSSIL OOZE, yellowish brown (10YR 5/6), light yellowish brown (10YR 6/4) to very pale brown (10YR 7/3); several intervals lithified to MARL in Section 1 – one piece at approximately 25 cm appears nodular and has dark, clay-rich horizontal layer in it. Thin FORAMINIFER-NANNOFOSSIL OOZE with sharp basal contact occurs in Section 2. Base Section 3 and Core-Catcher is mixed very pale brown (10YR 7/3) and gray (pyrite?) ooze.

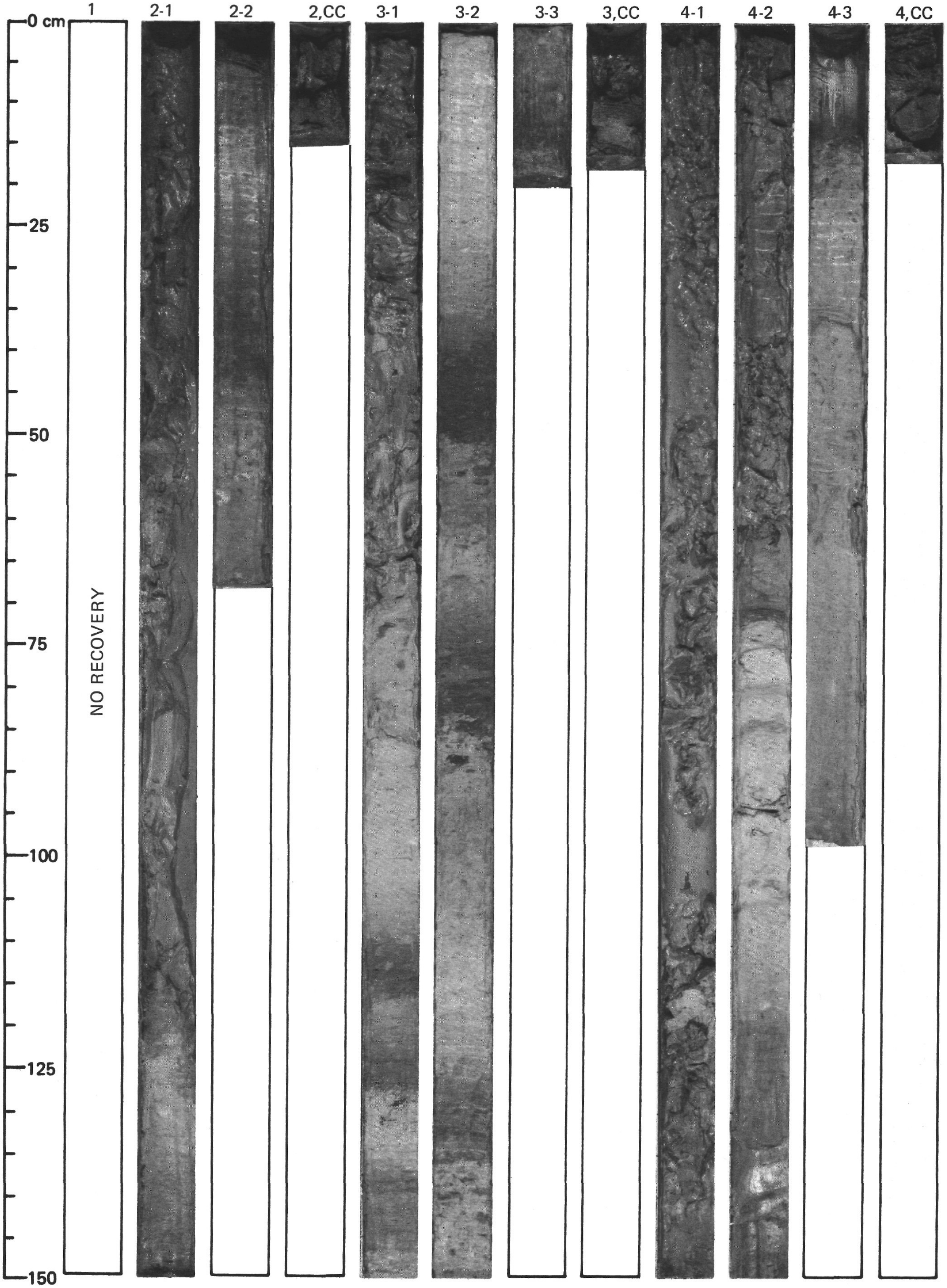
SMEAR SLIDE SUMMARY

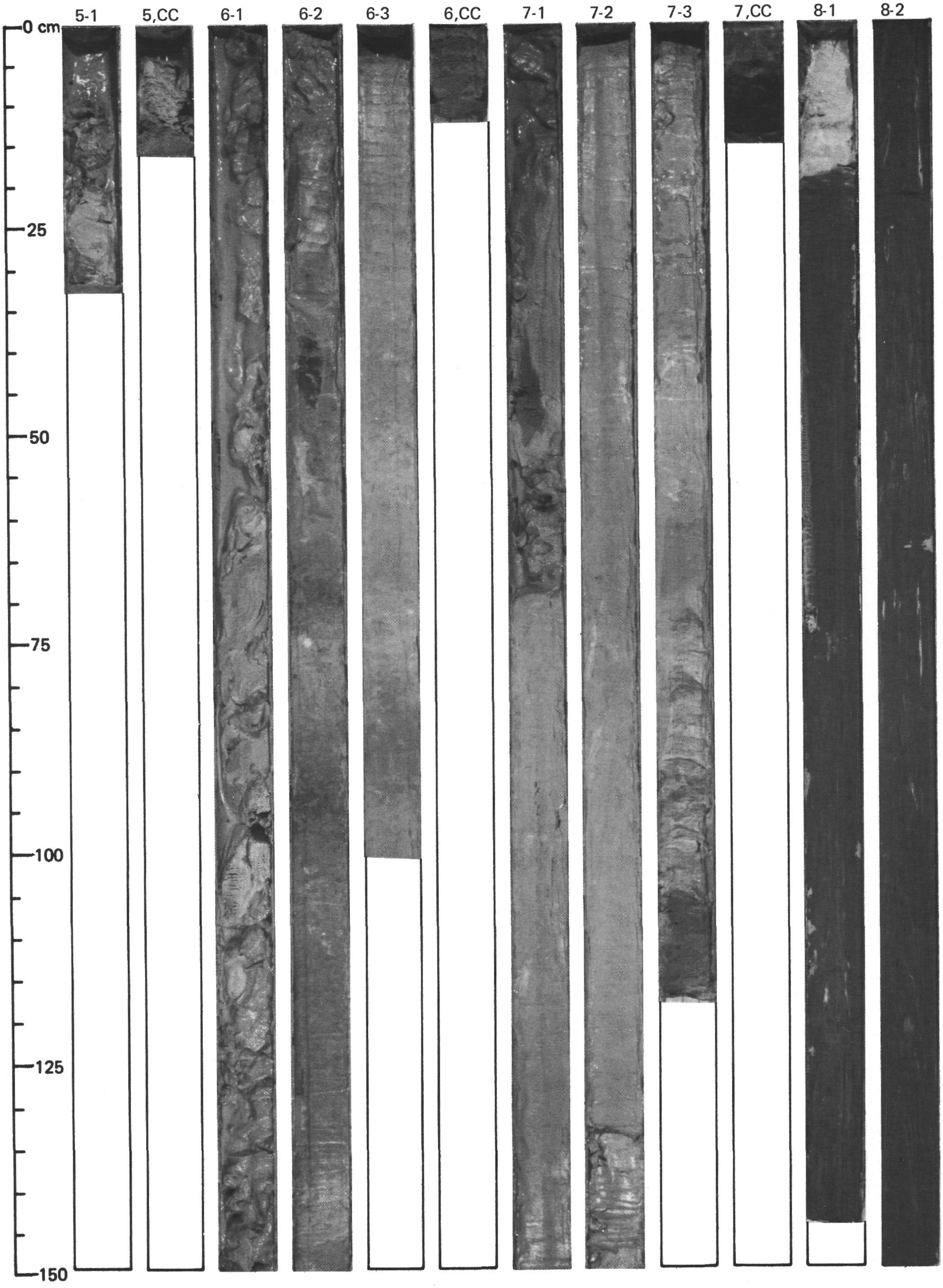
	3-4 D	3-29 M
TEXTURE:		
Sand	5	5
Silt	85	85
Clay	10	10
COMPOSITION:		
Clay	10	10
Palagonite	TR	–
Carbonate unspec.	25	25
Foraminifers	5	5
Calc. nannofossils	60	60

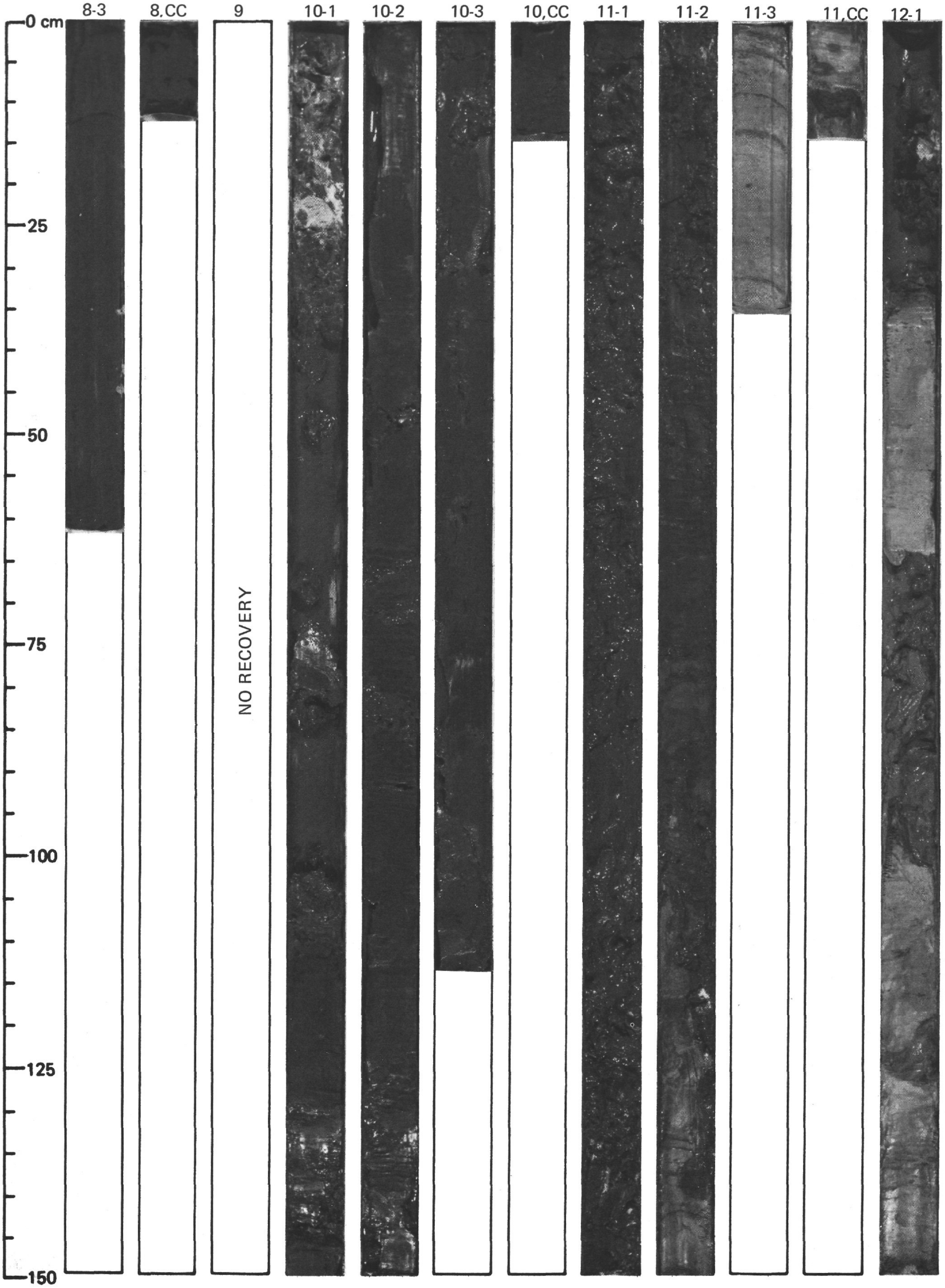
ORGANIC CARBON AND CARBONATE

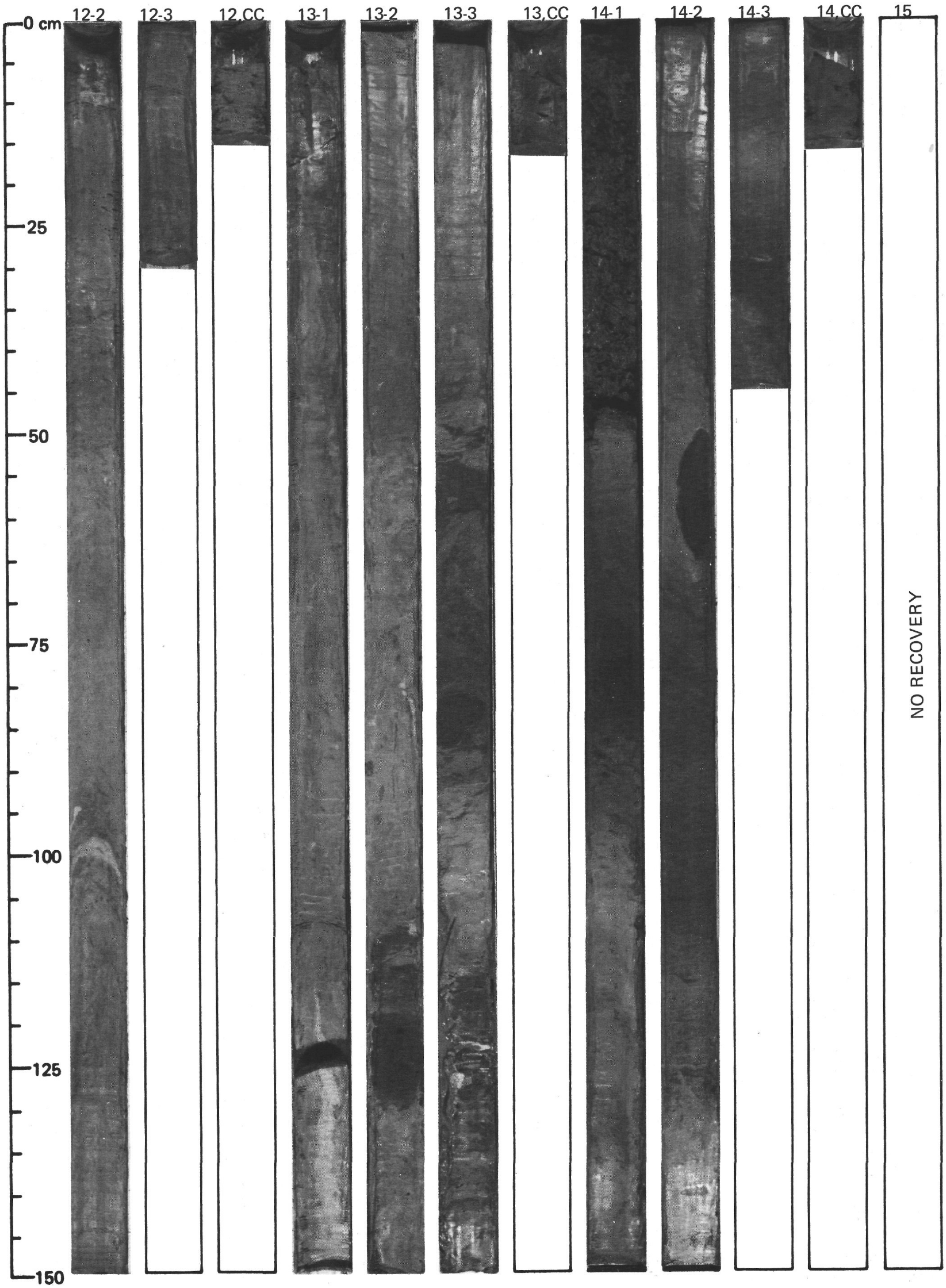
	1-79	2-79	3-29
Organic carbon	–	–	–
Carbonate	88	87	84

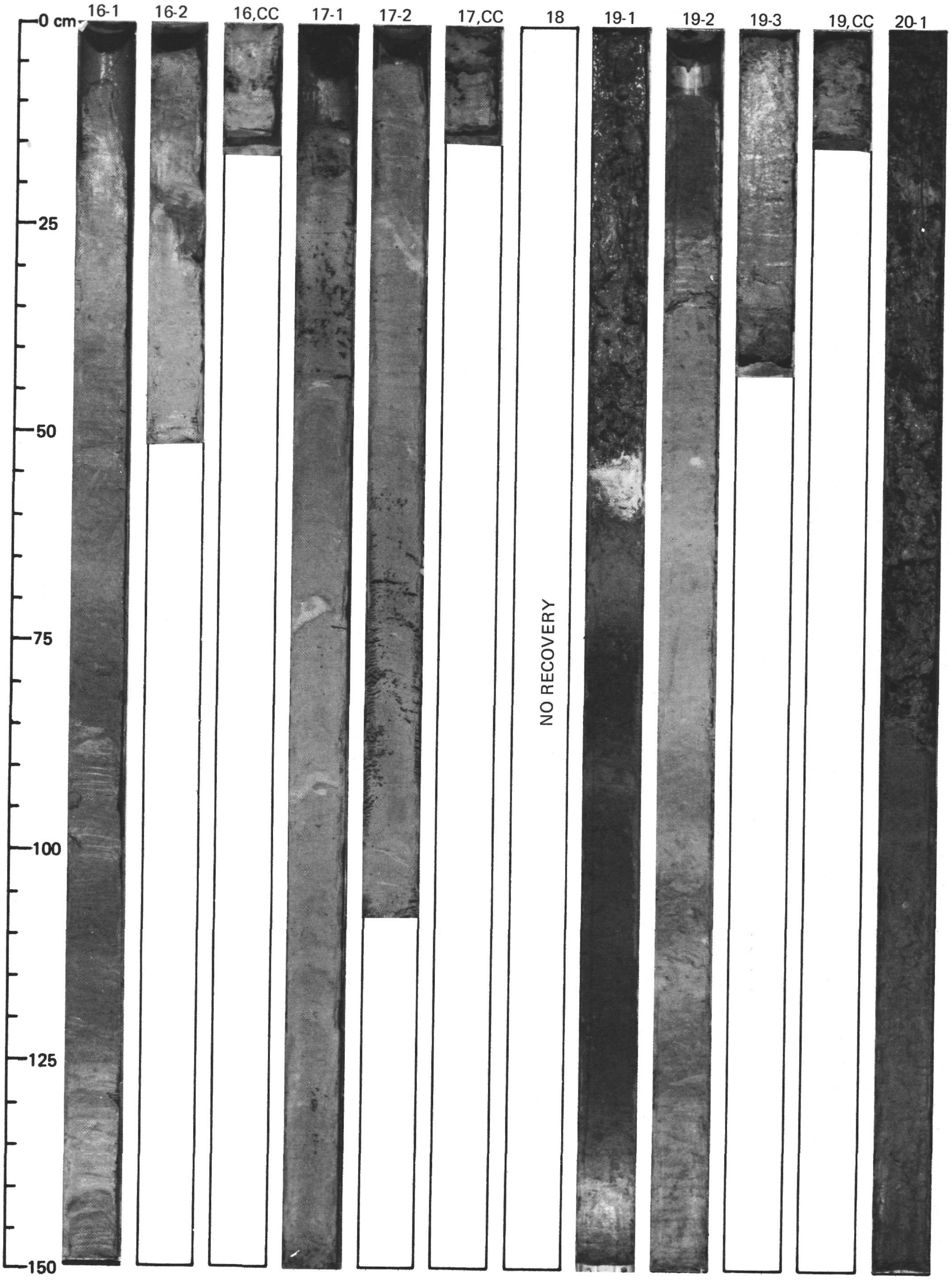
NOTE: Core 51, 193.5–197.8 m: No recovery.

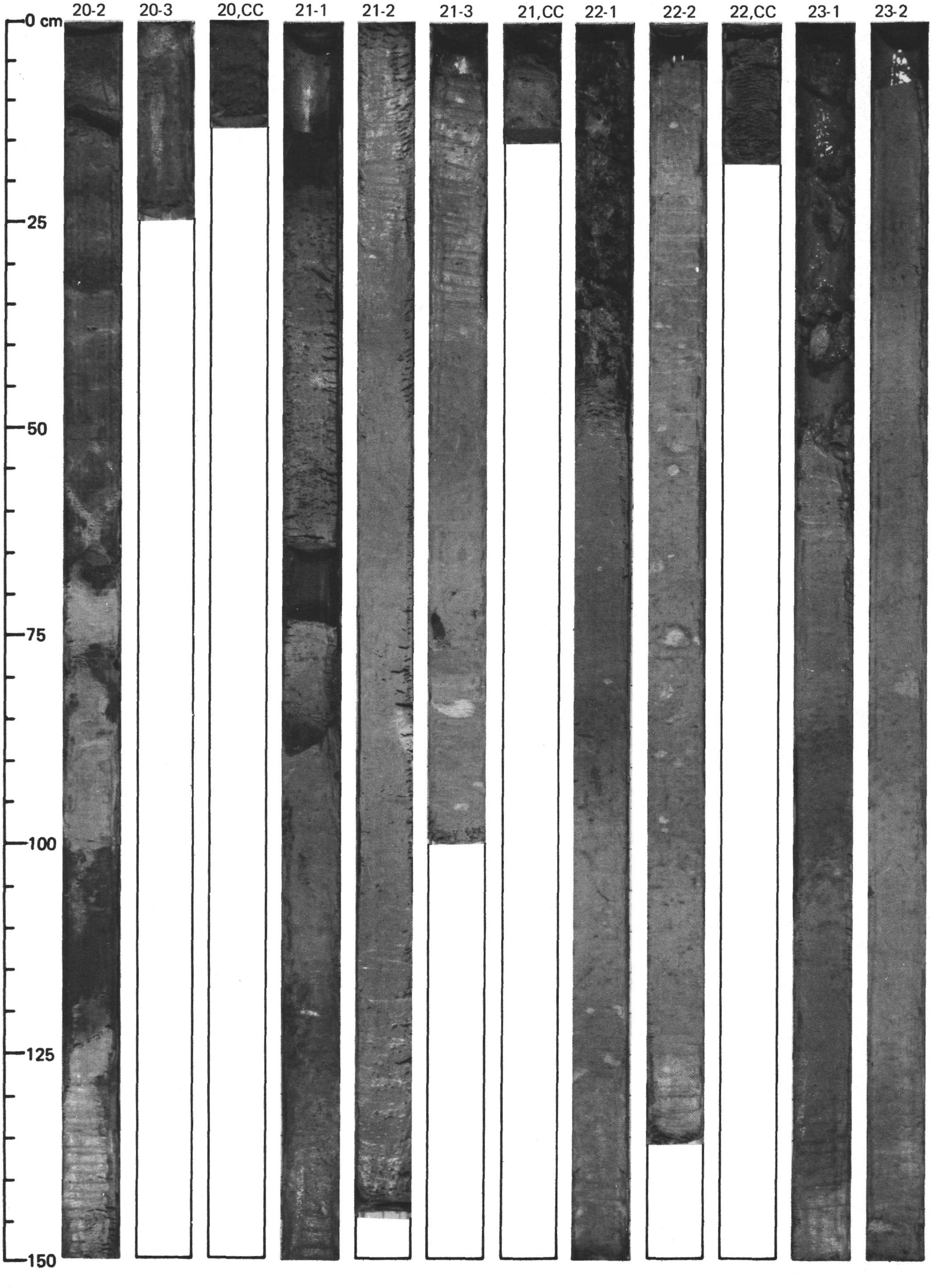

0 cm
25
50
75
100
125
150
1
2-1
2-2
2,CC
3-1
3-2
3-3
3,CC
4-1
4-2
4-3
4,CC
NO RECOVERY

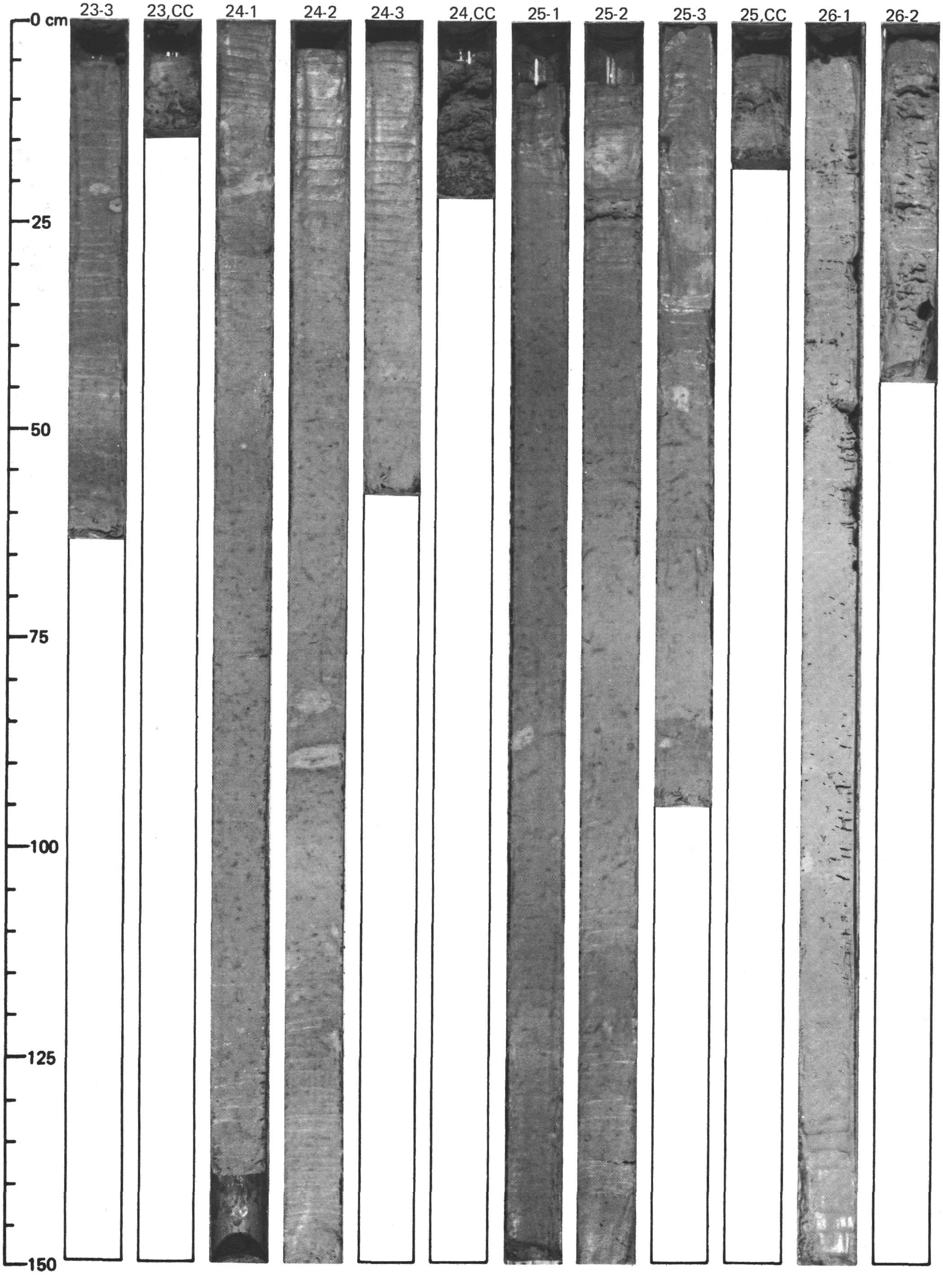

5-1
5,CC
6-1
6-2
6-3
6,CC
7-1
7-2
7-3
7,CC
8-1
8-2
0 cm
25
50
75
100
125
150


8-3
8,CC
9
10-1
10-2
10-3
10,CC
11-1
11-2
11-3
11,CC
12-1
0 cm
25
50
75
100
125
150
NO RECOVERY


12-2
12-3
12,CC
13-1
13-2
13-3
13,CC
14-1
14-2
14-3
14,CC
15
0 cm
25
50
75
100
125
150
NO RECOVERY


0 cm
25
50
75
100
125
150
16-1
16-2
16,CC
17-1
17-2
17,CC
18
NO RECOVERY
19-1
19-2
19-3
19,CC
20-1


20-2
20-3
20,CC
21-1
21-2
21-3
21,CC
22-1
22-2
22,CC
23-1
23-2
0 cm
25
50
75
100
125
150


23-3
23,CC
24-1
24-2
24-3
24,CC
25-1
25-2
25-3
25,CC
26-1
26-2
0 cm
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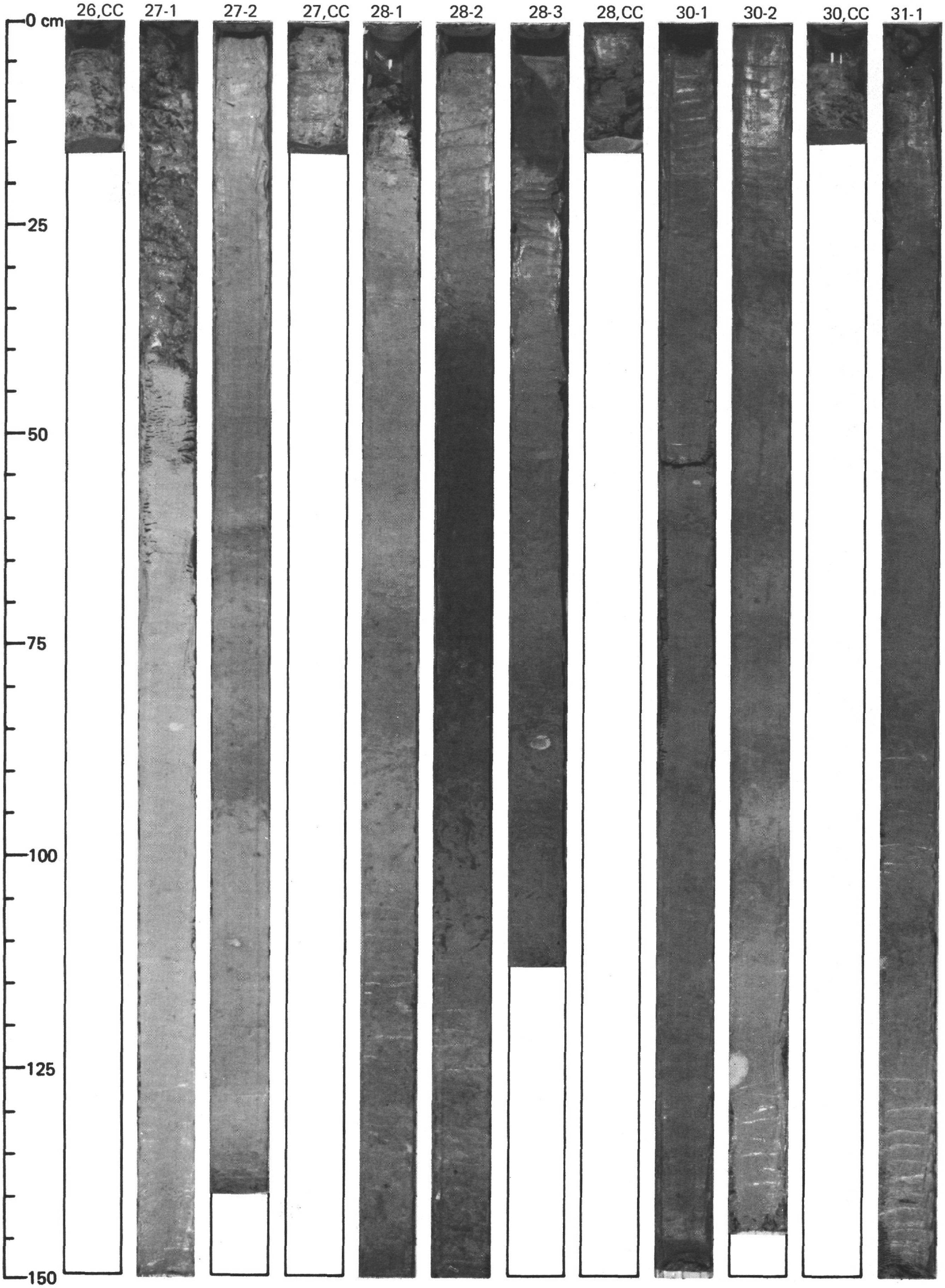
50
75
100
125
150


26,CC
27-1
27-2
27,CC
28-1
28-2
28-3
28,CC
30-1
30-2
30,CC
31-1
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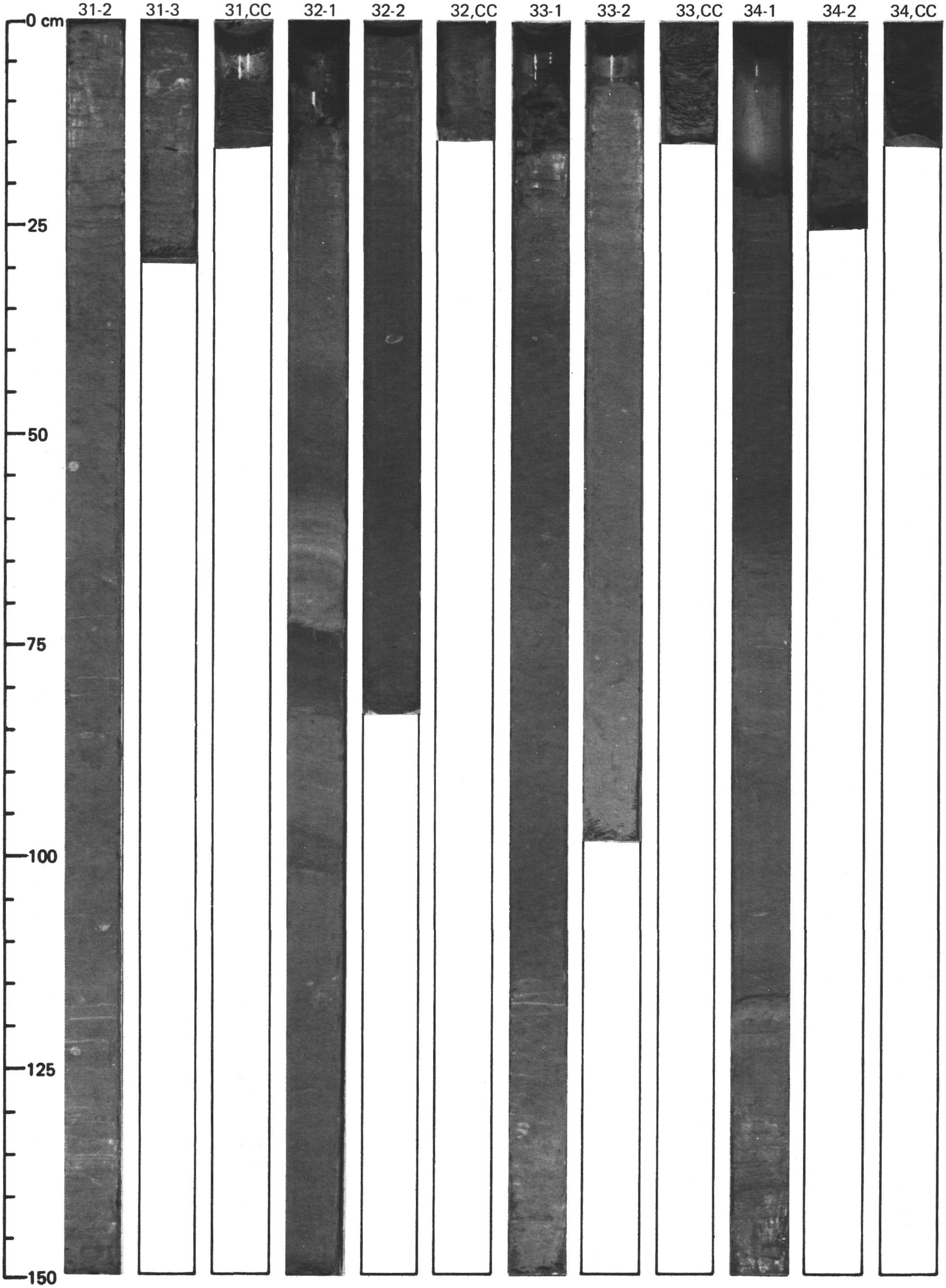
25
50
75
100
125
150


31-2
31-3
31,CC
32-1
32-2
32,CC
33-1
33-2
33,CC
34-1
34-2
34,CC
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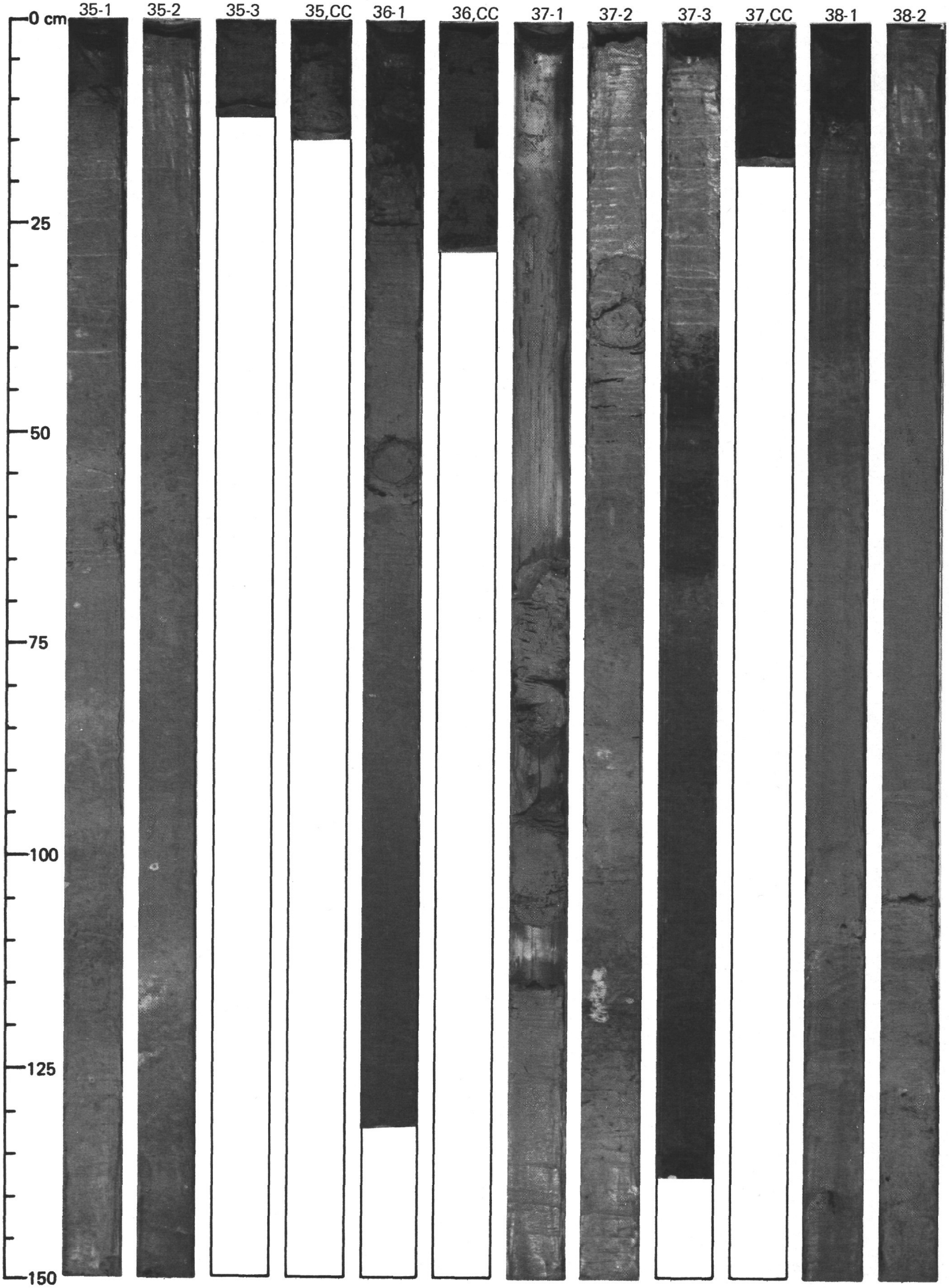
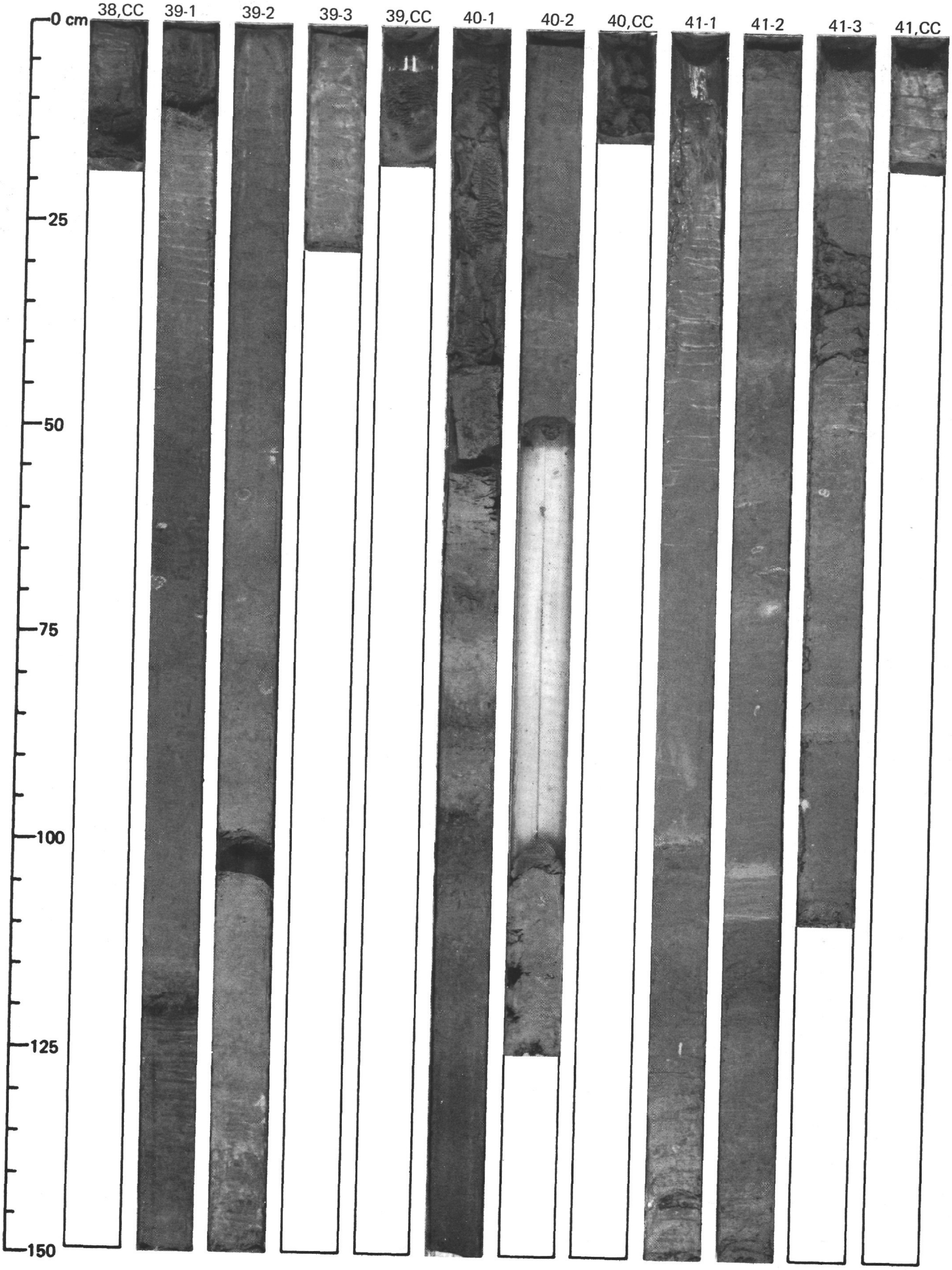
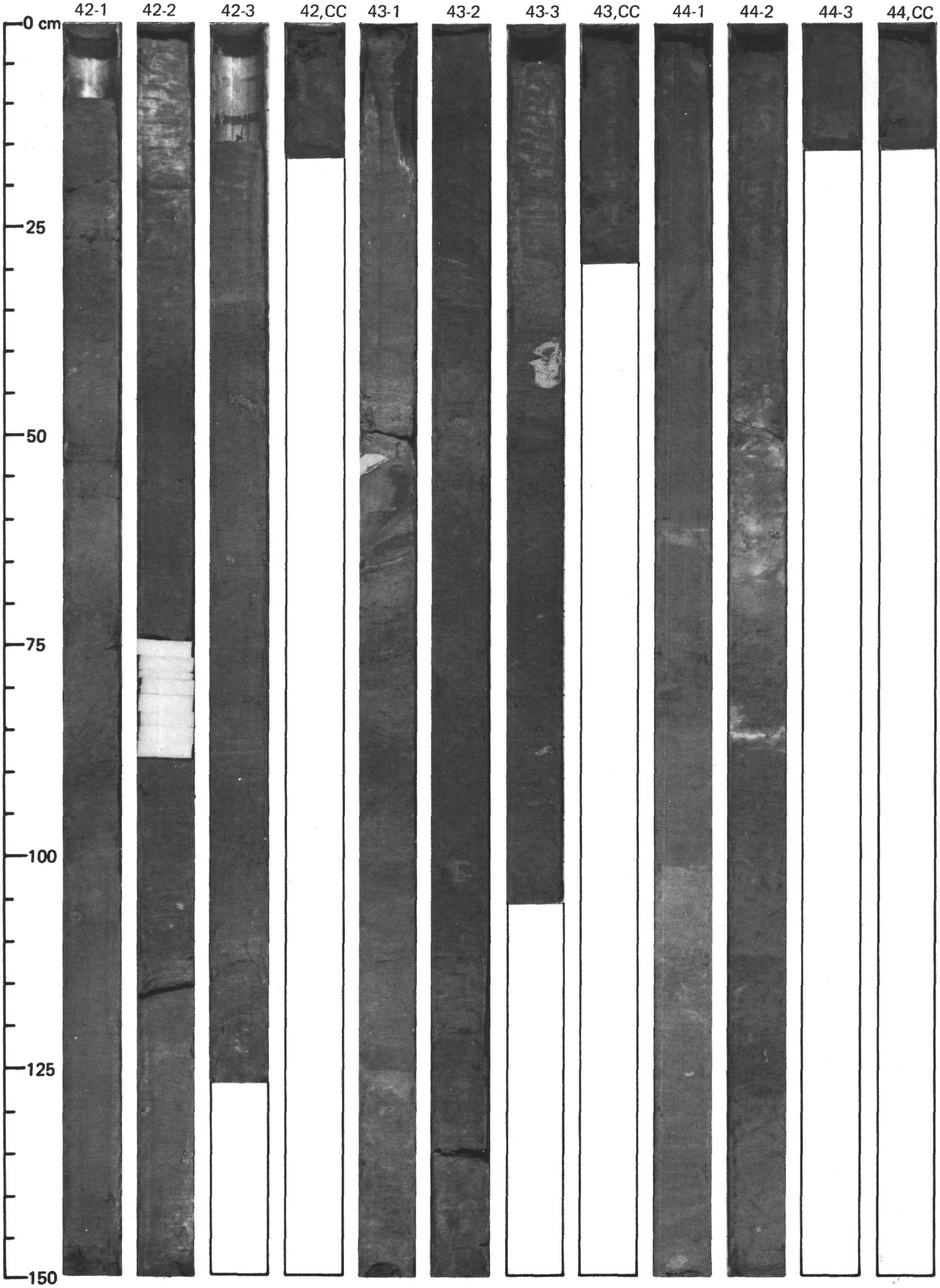
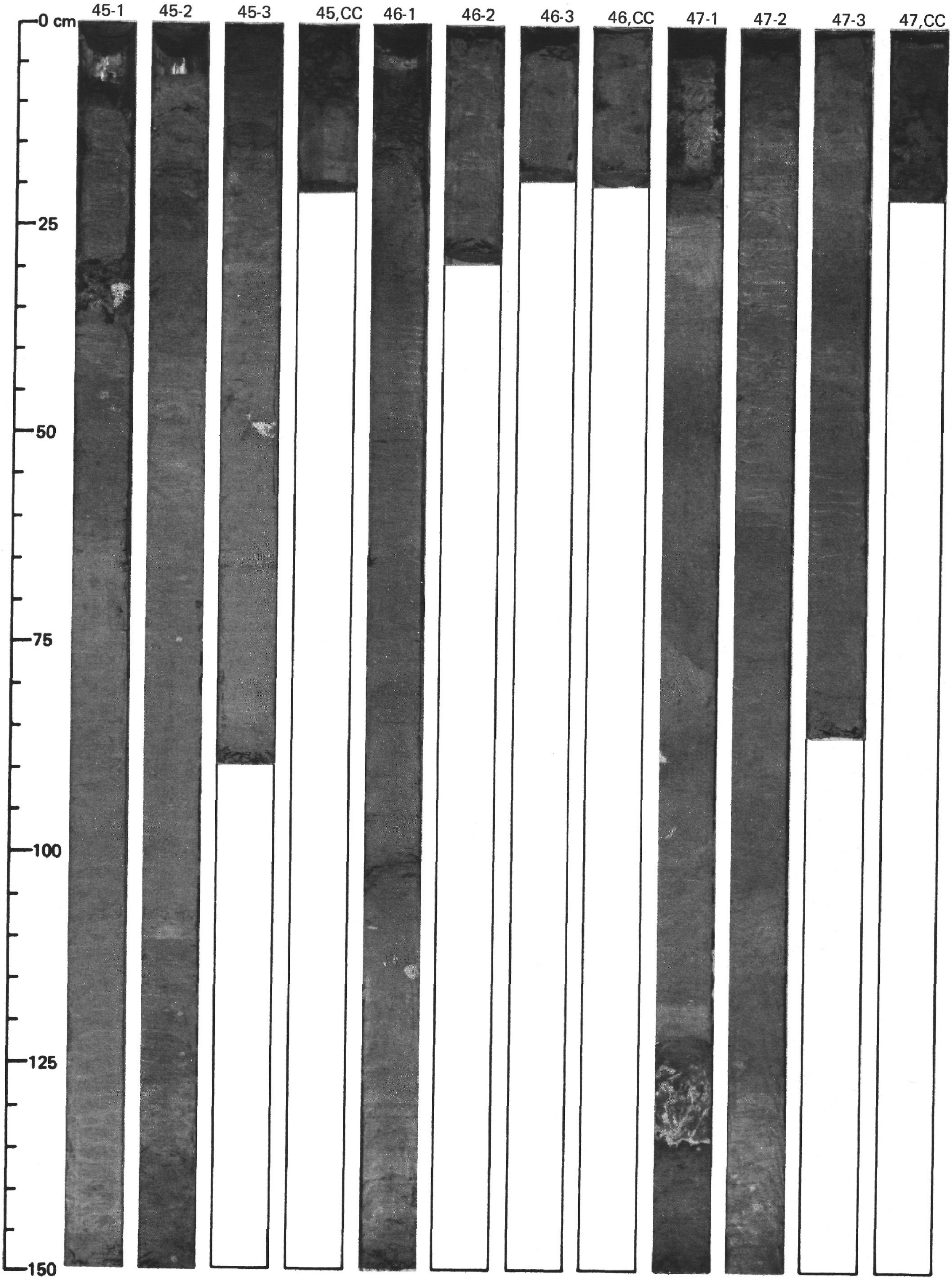
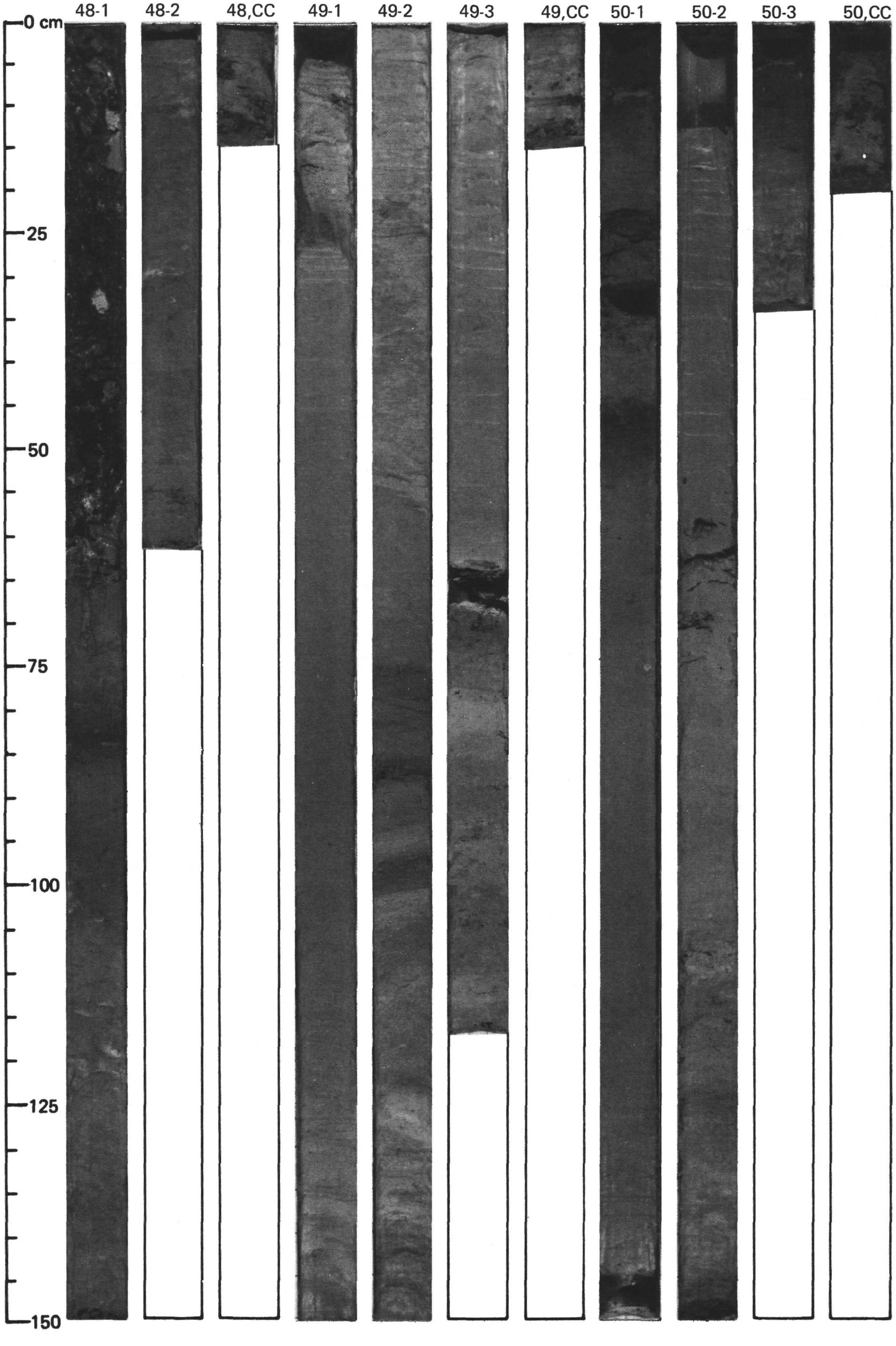
25
50
75
100
125
150


35-1
35-2
35-3
35,CC
36-1
36,CC
37-1
37-2
37-3
37,CC
38-1
38-2
0 cm
25
50
75
100
125
150


0 cm
25
50
75
100
125
150
38,CC
39-1
39-2
39-3
39,CC
40-1
40-2
40,CC
41-1
41-2
41-3
41,CC


42-1
42-2
42-3
42,CC
43-1
43-2
43-3
43,CC
44-1
44-2
44-3
44,CC
0 cm
25
50
75
100
125
150


45-1
45-2
45-3
45,CC
46-1
46-2
46-3
46,CC
47-1
47-2
47-3
47,CC
0 cm
25
50
75
100
125
150


48-1
48-2
48,CC
49-1
49-2
49-3
49,CC
50-1
50-2
50-3
50,CC
0 cm
25
50
75
100
125
150