3. SITE 495: COCOS PLATE—MIDDLE AMERICA TRENCH OUTER SLOPE[1]

Shipboard Scientific Party[2]

HOLE 495

Date occupied: 26 May 1979

Date departed: 30 May 1979

Time on hole: 99.4 hr.

Position: 12°29.78′N; 91°02.26′W

Water depth (sea level; corrected m, echo sounding): 4140

Water depth (rig floor; corrected m, echo sounding): 4150

Bottom felt (m, drill pipe): 4150

Penetration (m): 446.5

Number of cores: 49

Total length of cored section (m): 446.5

Total core recovered (m): 332.72

Core recovery (%): 74.5

Oldest sediment cored:
Depth sub-bottom (m): 428
Nature: Pale brown calcareous ooze
Age: Early Miocene
Measured velocity (km/s): 1.5–1.7

Basement:
Depth sub-bottom (m): 428–446.5
Nature: Basalt
Velocity range (km/s): 2.0(?)–2.8

Principal results: A continuous sedimentary sequence from the Quaternary through the lower Miocene was recovered. The age of Cocos Plate crust now entering the trench is early Miocene. Site 495, the oceanic reference site, is on oceanic crust on an isolated ridge or hill formed by a horstlike structure 22 km seaward of the trench axis and about 1925 meters above it (Fig. 1). The sediment cover is of generally uniform thickness (0.4 s), mimicking basement topography, as is typical in areas of pelagic sedimentation. Magnetic anomalies at the site are known only from reconnaissance data and are indicated to be Eocene.

Forty-nine cores were obtained with 75% recovery. The lower sequence of sediment is typical of low-latitude oceanic areas, and it has a hemipelagic cover:

1) 0 to 171 meters: Hemipelagic, diatomaceous green and olive gray mud.

2) 171 to 177 meters: Abyssal brown clay.

3) 177 to 406 meters: Chalky carbonate ooze with chert in the lower section.

4) 406 to 428 meters: Manganiferous chalk and chert.

5) 428 to 446.5 meters: Basalt.

The microfossil assemblages recovered suggest an unbroken sediment sequence from Quaternary to lower Miocene. Foraminiferal and nannoplankton assemblages are well preserved except in the middle and upper Miocene section, where poorly preserved foraminifers are an indication that the site was at depths near the carbonate compensation depth (CCD). Assemblages of benthic foraminifers indicate a gradual increase in depth with perhaps a slight uplift at the end of the Quaternary. Tertiary movement of the Cocos Plate with respect to the equatorial belt of high productivity is indicated by an early and middle Miocene increase in the rate of biogenic sedimentation (50 m/m.y.). Today, this belt is near the Galapagos Archipelago in an area where water depths range between about 2500 and 3000 meters. A contrasting section of abyssal clay and slow rates of sedimentation (in m/m.y.) in the late Miocene may correspond to the environments presently found in the region of 10°N to 15°N, just beyond the carbonate belt. These abyssal clays are thin and immediately overlain by hemipelagic sediment. The biogenic component of the hemipelagic sediment may correspond to the present belt of upwelling near the coast of Central America.

BACKGROUND AND OBJECTIVES

Site 495 is situated on the seaward slope of the Middle America Trench in about 4150 meters of water on a small hill or ridge. The ridge is about 2000 meters above and 22 km from the trench axis. The site was chosen to serve as a reference section for the oceanic sediment that would be recovered in cores from the continental margin.

Proceeding seaward from the trench axis, multichannel seismic records show a horst more than 900 meters above the trench, then a small graben 200 meters deep, and another horst almost 2000 meters above the trench floor. To avoid fault zones and deformed sequences, Site 495 is situated at the center of the latter horst. The sediment sequence appears to be about 400 meters thick on seismic records and is underlain by a strong reflector assumed to represent igneous ocean crust.

In addition to using Site 495 material as a reference section, our second objective was to find the oldest sediment resting upon the oceanic crust. That sediment could provide a minimal crustal age for this region where magnetic information is poor. A third objective was to test the extent of terrigenous sedimentation seaward of the trench. A thick sequence of terrigenous sediment seaward of the Middle America Trench was discovered off

[1] Aubouin, J., von Huene, R., et al., *Init. Repts. DSDP*, 67: Washington (U.S. Govt. Printing Office).

[2] Roland von Huene (Co-Chief Scientist), U.S. Geological Survey, Menlo Park, California; Jean Aubouin (Co-Chief Scientist), Département de Géologie Structurale, Université Pierre et Marie Curie, Paris, France; Jacques Azéma, Département de Géologie Structurale, Universite Pierre et Marie Curie, Paris, France; Grant Blackinton, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii; Jerry A. Carter, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii; William T. Coulbourn, Deep Sea Drilling Project, Scripps Institution of Oceanography, La Jolla, California; Darrel S. Cowan, Department of Geological Sciences, University of Washington, Seattle, Washington; Joseph A. Curiale, Department of Geology, University of Oklahoma, Norman, Oklahoma (present address: Union Oil Company of California, P.O. Box 76, Brea, Ca.); Carlos A. Dengo, Department of Geology and Center for Tectonophysics, Texas A&M University, College Station, Texas; Richard W. Faas, Department of Geology, Lafayette College, Easton, Pennsylvania; William Harrison, Department of Geology, University of Oklahoma, Norman, Oklahoma; Reinhard Hesse, Lehrstuhl für Geologie, Technische Universität, Münich, Federal Republic of Germany, and Department of Geological Sciences, McGill University, Montreal, Quebec, Canada; Donald M. Hussong, Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii; John W. Ladd, The University of Texas, Marine Science Institute, Galveston, Texas (present address: Lamont-Doherty Geological Observatory, Palisades, New York); Nikita Muzylöv, Geological Institute, U.S.S.R. Academy of Sciences, Moscow, U.S.S.R.; Tsunemasa Shiki, Department of Geology and Mineralogy, Faculty of Science, Kyoto University, Kyoto, Japan; Peter R. Thompson, Lamont-Doherty Geological Observatory, Palisades, New York; and Jean Westberg, Geological Research Division, Scripps Institution of Oceanography, La Jolla, California.

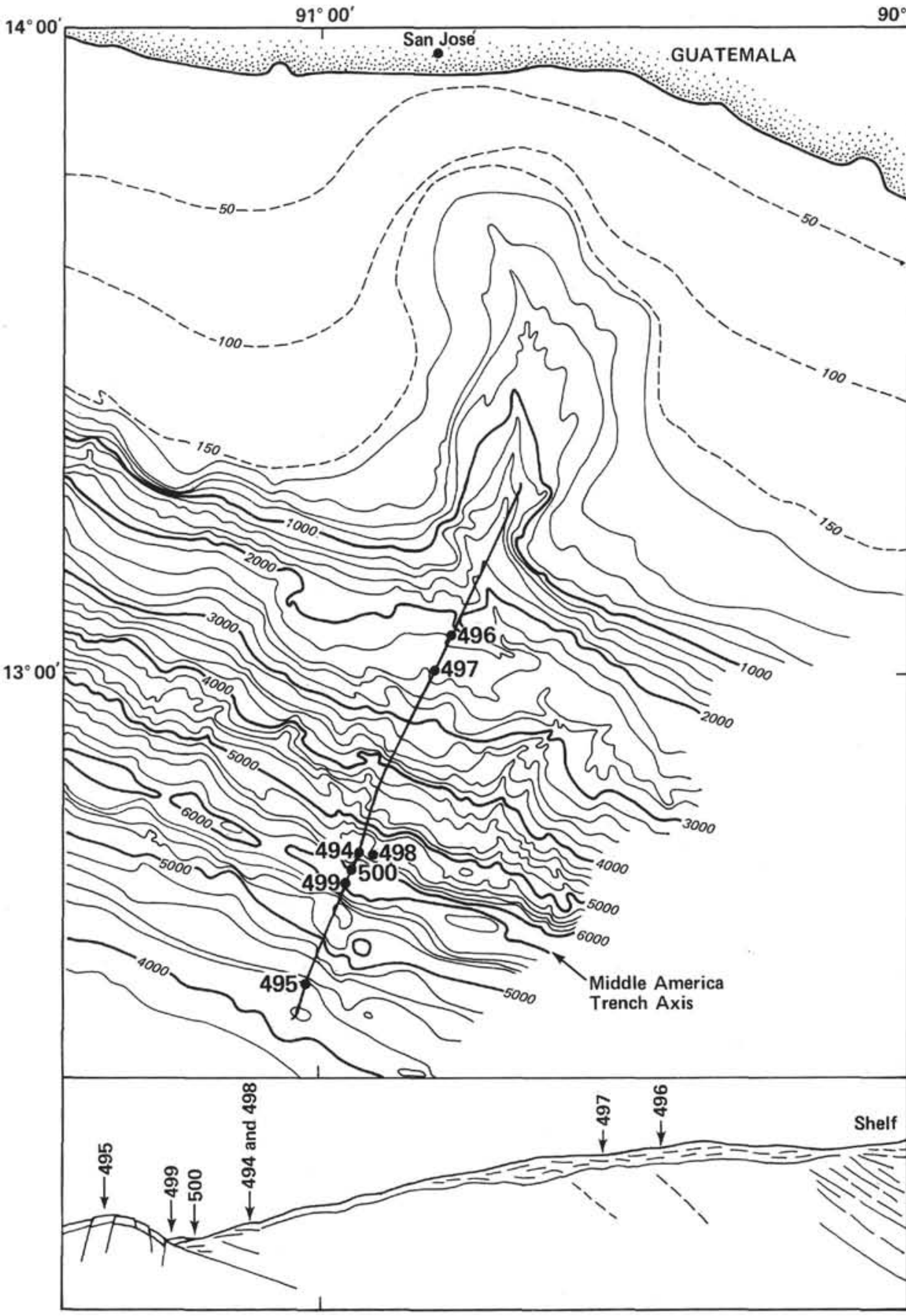


Figure 1. Location of Site 495.

Oaxaca (Leg 66) and also seaward of the Japan Trench (Leg 56).

OPERATIONS

Glomar Challenger departed from Site 494 on May 24, 1110L (Local Time) during the deployment of the HIG downhole seismometer and moved to a position 1.4 mi. northeast of the site where the deployment was completed. The departure included test shooting with *Kana Keoki* (see the Operations section in the Site 494 report). On May 25, 1812L, *Challenger* got underway to Site 495, steaming over the beacon at Site 494 to get a position. Seismic line GUA-13 was used as the basis for site location. Although positioning seemed good from dead reckoning and bathymetry, the seismic record and bathymetric profile at the site position did not match that in the site survey record. After a second pass the beacon was dropped at 2237L on 25 May despite the disparity between the onboard bathymetry and the previous seismic record. Navigation during the pre-drilling University of Texas Marine Science Institute site survey was sometimes uncertain, and because the exact position of the seaward reference site was not critical, no more time was spent surveying with *Challenger*.

The first core was recovered from Hole 495 at 0600L May 26. Basalt was reached at about 1600L May 28 (Table 1). The last logging attempt was completed about 1800L May 29; and after retrieving the drill pipe, *Challenger* left the site about 0400L May 30 on a direct course along seismic record GUA-13 for Site 496.

LITHOSTRATIGRAPHY

Sediments and Sedimentary Rocks

Site 495 is located 28 km SSW (south-southwest) of Site 494 and approximately 22 km seaward from the trench axis at a water depth of 4150 meters. It is about 1925 meters above the trench floor on a small horstlike structure of oceanic crust trending 130°N to 140°E, which is at an angle of about 20° to the trench axis (Aubouin et al., this volume).

The objective at this site—to provide a reference section for the "oceanic" sediments and rocks, hemipelagic and pelagic sediment that accumulated on the oceanic crust of the Cocos Plate—was successfully accomplished. The average recovery for the 49 cores drilled to a total sub-bottom depth of 446.5 meters is 75.0%.

The sequence of sediments and rocks at Site 495 consists of the following five lithologic units (Fig. 2):

1) Hemipelagic, diatomaceous greenish gray to olive gray mud (0–171 m sub-bottom depth);

2) thin (approximately 7 m), brown abyssal clay (171–178 m sub-bottom depth);

3) light colored, chalky carbonate ooze that becomes chalk with increasing depth (178–406 m sub-bottom depth);

4) thin (22.5 m), pale brown manganiferous chalk (406–428.5 m sub-bottom depth); and

5) basalt (428.5 m sub-bottom depth to bottom of the hole at 446.5 m).

Unit 1 (Cores 0 to 18, 0–171 m sub-bottom depth; Pleistocene, Pliocene, and upper Miocene)

These upper 18 cores are composed of hemipelagic muds containing substantial biogenic components that consist of diatoms, radiolarians, sponge spicules, cal-

Table 1. Coring summary for Hole 495.

Core No.	Date (May, 1979)	Local Time (L)	Depth from Drill Floor (m; top–bottom)	Sub-bottom Depth (m; top–bottom)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	26	0712	4150.0–4159.5	0.0–9.0	9.5	0.0	0
2	26	0826	4159.5–4169.0	9.5–19.0	9.5	0.01	>1
3	26	0928	4169.0–4178.5	19.0–28.5	9.5	7.72	81
4	26	1051	4178.5–4188.0	28.5–38.0	9.5	7.68	81
5	26	1152	4188.0–4197.5	38.0–47.5	9.5	9.19	97
6	26	1311	4197.5–4207.0	47.5–57.0	9.5	5.36	56
7	26	1424	4207.0–4216.5	57.0–66.5	9.5	5.42	57
8	26	1536	4216.5–4226.0	66.5–76.0	9.5	0.40	4
9	26	1651	4226.0–4235.5	76.0–85.5	9.5	8.28	83
10	26	1803	4235.5–4245.0	85.5–95.0	9.5	9.32	98
11	26	1914	4245.0–4254.5	95.0–104.5	9.5	3.82	40
12	26	2031	4254.5–4264.0	104.5–114.0	9.5	9.13	96
13	26	2149	4264.0–4273.5	114.0–123.5	9.5	7.60	80
14	26	2307	4273.5–4283.0	123.5–133.0	9.5	6.50	68
15	27	0023	4283.0–4292.5	133.0–142.5	9.5	9.17	96
16	27	0200	4292.5–4302.0	142.5–152.0	9.5	9.76	100
17	27	0250	4302.0–4311.5	152.0–161.5	9.5	9.48	99
18	27	0415	4311.5–4321.0	161.5–171.0	9.5	9.40	99
19	27	0518	4321.0–4330.5	171.0–180.5	9.5	8.40	88
20	27	0640	4330.5–4340.0	180.5–190.0	9.5	9.42	99
21	27	0740	4340.0–4349.5	190.0–199.5	9.5	9.50	100
22	27	0853	4349.5–4359.0	199.5–209.0	9.5	9.50	100
23	27	1000	4359.0–4368.5	209.0–218.5	9.5	9.50	100
24	27	1103	4368.5–4378.0	218.5–228.0	9.5	9.86	100
25	27	1212	4378.0–4387.5	228.0–237.5	9.5	9.48	99
26	27	1326	4387.5–4397.0	237.5–247.0	9.5	8.80	84
27	27	1440	4397.0–4406.5	247.0–256.5	9.5	7.71	81
28	27	1550	4406.5–4416.0	256.5–266.0	9.5	9.70	100
29	27	1704	4416.0–4425.5	266.0–275.5	9.5	9.51	100
30	27	1818	4425.5–4435.0	275.5–285.0	9.5	3.23	34
31	27	1935	4435.0–4444.5	285.0–294.5	9.5	9.10	96
32	27	2054	4444.5–4454.0	294.5–304.0	9.5	7.37	78
33	27	2209	4454.0–4463.5	304.0–313.5	9.5	8.21	86
34	27	2325	4463.5–4473.0	313.5–323.0	9.5	6.67	70
35	28	0036	4473.0–4482.5	323.0–332.5	9.5	5.55	58
36	28	0154	4482.5–4492.0	332.5–342.0	9.5	6.20	65
37	28	0255	4492.0–4501.5	342.0–351.5	9.5	6.77	71
38	28	0410	4501.5–4511.0	351.5–361.0	9.5	6.22	65
39	28	0537	4511.0–4520.5	361.0–370.5	9.5	5.79	61
40	28	0650	4520.5–4530.0	370.5–380.0	9.5	0.07	>1
41	28	0810	4530.0–4539.5	380.0–389.5	9.5	9.42	99
42	28	0918	4539.5–4549.0	389.5–399.0	9.5	7.90	83
43	28	1025	4549.0–4558.5	399.0–408.5	9.5	9.58	100
44	28	1133	4558.5–4568.0	408.5–418.0	9.5	9.20	97
45	28	1251	4568.0–4577.5	418.0–427.5	9.5	7.28	77
46	28	1419	4577.5–4578.5	427.5–428.5	1.0	1.30	13
47	28	1647	4578.5–4586.5	428.5–436.5	8.0	0.86	11
48	28	2120	4586.5–4596.0	436.5–446.0	9.5	4.50	47
49	28	2320	4596.0–4605.5	446.0–455.5	9.5	1.50	16

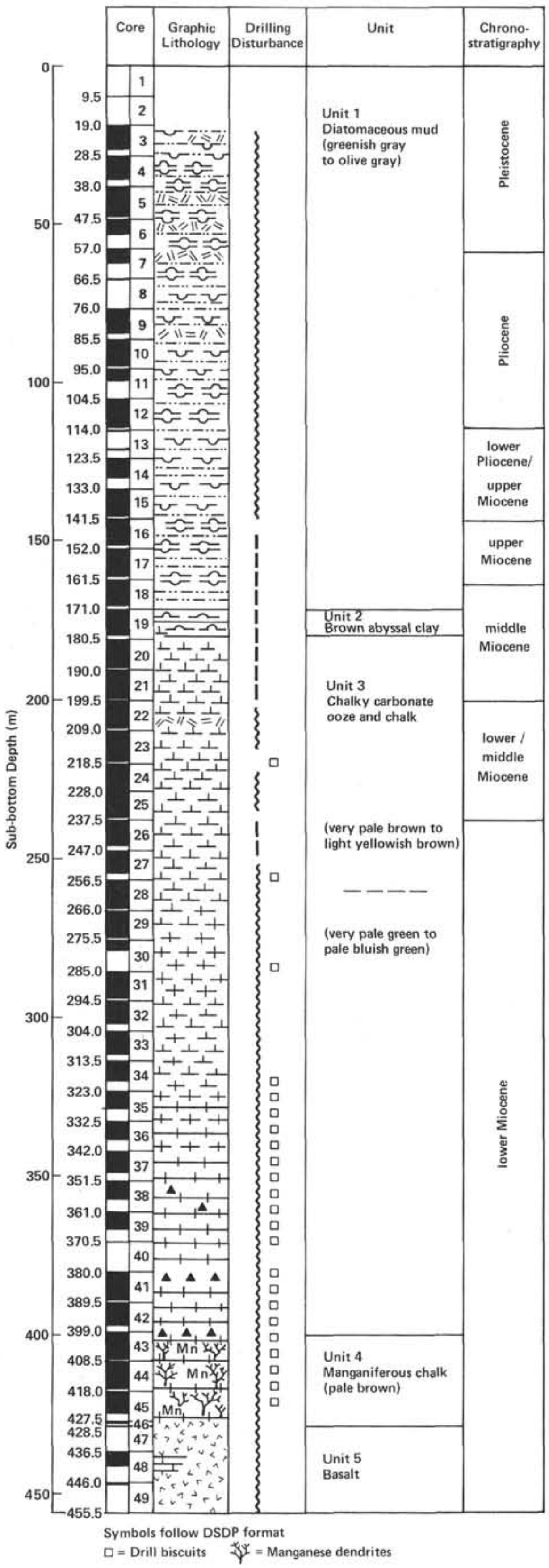


Figure 2. Summary lithologic column for Site 495.

careous nannoplankton, and foraminifers, in order of decreasing abundance. Foraminifers in Cores 1 and 2 include lower to middle bathyal benthic species. In Core 4 the terrigenous sediment fraction (quartz, feldspar, detrital clay minerals, land-derived volcanogenic debris) predominates (> 50%), and the sediment may be termed hemiterrigenous. Prevailing sediment colors in Unit 1 are greenish gray (5GY 4/1 to 5GY 5/1 or 5G 4/2) and grayish olive green (5GY 3/2) to olive gray (5Y 3/2). The sediment is fine-grained (average sand:silt:clay ratio = 1:1.8:32), with the dominant grain size being silt. Patches and layers less than 2 cm thick of light gray to dark gray volcanic ash occur in the upper part of Unit 1 (Cores 5, 6, 7, and 9).

The outstanding structural characteristic of these sediments is their high degree of bioturbation, evident from color mottling in Cores 3 to 15. Burrowing intensity increases downwards, however, distinct types of burrows or trace fossils were not observed until Core 16. At that depth (142.5 m sub-bottom), core sections could be cut by saw due to the increased degree of compaction; visibility of sedimentary structures improved dramatically, because the saw-cut surface is smoother than that cut with cheese-wire. A variety of burrows and trace fossils was revealed in Cores 16 to 18 of Unit 1 as well as in Units 2 to 4. Bioturbation of Cores 16, 17, and partly of 18 has obliterated any primary sedimentary structures that might once have existed. The core sediment also suffered disturbance during drilling; this disturbance was manifest in the abrupt offsets along disk fractures and plastic deformation of burrows. Those offsets are clearly artificial and are not to be mistaken for tectonic deformation (see the section on Lithostratigraphy, Site 494 report).

Unit 2 (Core 19, Sections 0–5, 171–177 m sub-bottom depth; middle Miocene)

Unit 2 is restricted to the upper five sections of Core 19 and consists of carbonate-poor to carbonate-free abyssal, brown clay (color 10YR 4/4). At the top of Unit 2, drill cuttings of green hemipelagic mud from overlying Unit 1 are admixed. The lower boundary is indistinct because of drilling disturbance, which in the lowermost two sections (lower half of Section 5 and Section 6) produced a mixture of brown abyssal clay and light colored chalky nannofossil ooze from underlying Unit 3.

Microfossils recovered from the brown abyssal clay are radiolarians and diatoms. The predominant minerals are zeolites and clay minerals. Disseminated hematite, limonite, and ferromanganese particles create the brown pigment. Color variations indicate intense bioturbation and sediment mixing, enhanced by drilling disturbance. Very well-preserved burrows display sloping structures.

Unit 3 (Cores 19 to 43, 177 to 406 m sub-bottom depth; lower Miocene)

Units 3 and 4 are middle to uppermost Miocene light colored calcareous oozes and chalks that are subdivided on the basis of color and ferromanganese mineral content. The boundary between the two units is the first appearance of dendritic ferromanganese mineralization in Core 43 at 406 meters sub-bottom depth. Color changed from very pale bluish green (5BG 7/1) and very pale green (5GY 7/1) above to pale yellow (5Y 8/3) below at 395.5 meters sub-bottom depth, i.e., in Core 42.

Unit 3 is a nannofossil–foraminiferal ooze, which, through progressive downward lithification, becomes chalk. Lithification affects various layers to a different extent, leaving poorly lithified ooze adjacent to better-cemented chalk in the same core section.

Lithification increases downcore until only thin layers of poorly cemented chalky ooze are present at the bottom of Unit 4. The chalky ooze serves as shear planes along which differential rotation of individual core segments takes place, producing "drill-biscuits" separated by disk fractures. Higher up in the carbonate sequence, where only small portions of core are lithified, chalk drill-biscuits are isolated between longer segments of drill-deformed ooze. Lower in the sequence drill-biscuits are stacked one on top of the other, separated by only thin veneers of soft, deformed sediment that may have originated from remolding of chalk.

Unit 3 may be subdivided on the basis of color variation into an upper sub-unit that is very pale brown (10YR 7/2 to 10 YR 8/4 and 10 YR 8/3), light brownish gray (10 YR 6/2), to light yellowish brown (10 YR 4/4) or pinkish white (7.5 YR 8/2), to white (10 YR 8/2) nannofossil foraminiferal ooze and chalk, and a lower sub-unit that is greenish gray (5 GY 6/1), very pale green (5 GY 7/1), to very pale bluish green (5 BG 7/1) variety starting at 258.5 meters in Core 28. The upper sub-unit, of yellow and brown hues, makes up 87.5 meters of the stratigraphic section, and the lower sub-unit, of greenish hue, encompasses 147.5 meters.

Nannofossils and foraminifers are the dominant sediment constituents of Unit 3. Siliceous microfossils, including radiolarians, diatoms, and sponge spicules, occur to a sub-bottom depth of 351.5 meters (Core 37), and below that they are absent. This disappearance coincides with the first occurrence of chert in Core 38 at 352 meters. Nodules and strings of chert or porcellanite less than 5 cm thick occur also in Cores 41 to 44 and display similar hues as the surrounding sediment. Nonbiogenic sediment constituents are extremely rare and usually restricted to trace amounts of zeolites or clays. These are more abundant, however, in association with thin ash layers observed in the upper part of the carbonate sequence, for example in Core 22.

Bioturbation is the dominant sediment structure in Units 3 and 4, including many examples of distinct types of trace fossils such as Zoophycos and Chondrites.

In contrast to sedimentary Units 1 and 2, distinct primary laminations are preserved in certain intervals of Cores 34, 35, 36, and 38, attesting to the temporary absence of a bottom-dwelling infauna in the lower subdivision of Unit 3. The structures consist of horizontal or subhorizontal laminations that may be faint and hardly visible or may be very pronounced, having dark green or purple black colors that contrast with the light colored carbonate ooze. They do not seem to be related to turbidites. The temporary absence of bottom-dwelling organisms remains unexplained, but it might be related to poisoning of the environment by volcanic or hydrothermal exhalations. Near the base of Unit 3, there is an intraformational conglomerate with well-rounded carbonate clasts.

Unit 4 (Cores 43 to 46, 406–428 m sub-bottom depth; lower Miocene)

This unit is similar to Unit 3 in composition and structure except for the development of dendritic ferromanganese mineral precipitates and somewhat darker brown sediment colors, which were thought significant enough to establish a separate lithologic unit. No evidence has been found that these sediments immediately overlying the basalt of Unit 5 have been baked.

Unit 5 is basalt described in the following section (Igneous Petrology).

Igneous Petrology

Approximately 6.8 meters of fresh, altered, or locally glassy basalt was recovered in Cores 46 through 49 at Site 495. The contact of overlying lower Miocene chalk with basalt was not recovered intact, but the lowermost sediment contains well-preserved microfossils and is not baked. Two pieces of very firm, creamy, white chalk occur in the midst of basalt in Section 495-47-1. They contain black, dendritic Mn-oxide stains and angular 2-to-5-mm fragments of greenish brown glass, largely altered to waxy clay but still containing tiny plagioclase microlites. This interflow or interpillow chalk contains poorly preserved foraminifers and is devoid of calc–silicate, contact-metamorphic minerals. Soft oozes were probably mixed with broken fragments of quickly chilled glass that formed during eruption of basalt.

Mesoscopic Description

The rock ranges from a dark gray, relatively fresh, microphyric basalt to an altered, reddish brown variety. Although the proportion of phenocrysts varies, fresh rock typically contains: (1) 5% or less olivine phenocrysts 0.5 to 2 mm in diameter, altered to green clay or orange brown aggregates of clay and iron oxides, and (2) 3% or less of plagioclase laths up to 4 mm long. Phenocrysts are not important constituents of this basalt. Groundmass is very finely crystalline and locally aphanitic. Several pieces preserve 1-cm-thick rims of dark brownish black basaltic glass locally altered to orange brown clay. The amount of reddish brown alteration in basalt is variable, but in some pieces it is clearly localized adjacent to 1-to-2-mm white veins; in others it progressively decreases away from aphanitic and glassy rims. The alternation of glassy rims, altered zones, and fresh basalt in each section suggests that the drill penetrated pillow basalts or a series of thin flows. One-to-three-mm vesicles filled with waxy green clay are rare, as are cavities and vesicles up to 2 cm wide partially to completely filled with drusy or crystalline calcite. The freshest basalt seems to be Pieces 1 to 5, inclusive, in Section 495-48-4.

Petrography

Five thin sections of fresh basalt, cut from paleomagnetic cores, were examined (Samples 495-46-1, 117–121 cm; 495-48-1, 13–15 cm; 495-48-2, 101–103 cm; 495-48-3, 98–100 cm; 495-48-4, 75–77 cm). The petrology is monotonously similar, therefore a detailed description of only Section 495-46-1 is presented as representative of the entire suite. The microlitic groundmass consists of 58% fresh subhedral to euhedral plagioclase laths averaging 0.3 mm in length; 33% fresh pale brown intergranular to subophitic clinopyroxene that typically displays an acicular or plumose habit; 4% subhedral to euhedral Fe-Ti oxide grains about 0.03 mm in diameter and generally closely associated with clinopyroxene; and 5% brilliant orange clay with an intersertal habit, suggesting that it represents altered glass. Less than 1% of the rock is plagioclase phenocrysts up to 1 mm long (composition $\sim An_{75}$) and relict olivine phenocrysts completely altered to reticulated intergrowths of iron oxides and clay.

The other thin sections have these minor differences from the "standard": Sample 495-48-1, 13–15 cm—slightly larger groundmass plagioclase microlites; Sample 495-48-2, 101–103 cm—smectite (replacing glass?) < 1%; Sample 495-48-3, 98–100 cm—1% olivine microphenocrysts, totally replaced by oxides and clay, plagioclase phenocrysts, 1 mm long, and pale green clay in 0.3-mm veinlet; and Sample 495-48-4, 75–77 cm—7% pale greenish gray intersertal clay (altered glass?).

Petrographic analysis of reddish brown altered basalt adjacent to a reddish white vein (Sample 495-48-1, 141 cm) showed that the groundmass consists of intergranular clinopyroxene nearly completely altered to dense brownish red clay, which is locally invading plagioclase microlites as well. The vein filling consists of calcite, clay minerals, and radiating, crystalline sheaves of a zeolite with very low birefringence and strong negative relief.

All of the alteration and veining in these basalts is of low-temperature origin and rather typical of that encountered on other DSDP legs. No higher-temperature alteration products, such as epidote, pumpellyite, or chlorites, were found.

PHYSICAL PROPERTIES

Bulk Density, Water Content, and Sound Velocity

Figure 3 is a detailed plot of GRAPE density and water content. Data points plotted are average values obtained from three measurements per core section. Bulk density was also measured with a downhole density log. Figure 4 shows the plot of GRAPE density with the downhole density plot superimposed. Correspondence between the two techniques is excellent. The sediment column can be subdivided into six distinct units, each differing from the other in one or more of the physical properties (Table 2).

Unit 1. Extends from the mud line through and including Core 6 (55 m sub-bottom depth). Bulk density is low (1.43 Mg/m^3) (Fig. 3A), and water content is high (average 138.4% dry wt.) (Fig. 3B).

Unit 2. Extends from Core 7 through and including Core 19 (180 m sub-bottom depth). The unit is rather unusual in that it exhibits a very low average bulk density (1.35 Mg/m^3) and very high water content (average 188.5% dry wt.).

Unit 3. Extends from Core 20 through and including Core 25. A sharp increase in bulk density serves to differentiate this unit from the preceding unit.

Unit 4. Extends from Core 26 through and including Core 32. Further reduction in water content and increase in bulk density occurs through this unit. Lithification increases until it is no longer possible to make shear-strength measurements (Fig. 5).

Unit 5. Extends from Core 33 through and including Core 37. Bulk density increases to an average of 1.79 Mg/m^3 and remains consistent through the unit.

Unit 6. Extends from Core 38 through Core 46 immediately overlying the basalt basement. Density averages 1.91, and compressional-wave velocity (Vc) averages 1.73 km/s. Impedance averages 3.31, the highest of all the units (Table 3).

Shear Strength

The shear-strength profile (Fig. 5) shows a unit of low strength extending from the mud line through Core 7. This is followed by a relatively high-strength unit, extending to Core 17. Below Core 17, shear strength increases linearly with depth to about Core 27 where lithification becomes significant. The shear strength closely follows the lithology. The upper, low-strength sediments are hemiterrigenous silty muds with variable silica contents. The intermediate unit is composed of highly siliceous muds, generally diatomaceous and radiolarian oozes, with interbedded foraminiferal and nannofossil oozes, the latter dominating below Core 27 and extending to the base of the hole, becoming well-lithified above the basalt basement.

Table 4 summarizes Site 495 physical properties.

GEOPHYSICS

Site 495 lies seaward of the Middle America Trench floor in 4150 meters of water, on one of a series of fault blocks bounded by apparent normal faults that step down to the trench. The drill site was positioned to correspond with seismic line GUA-13 (Fig. 6), which parallels seismic line GUA-18 about two nautical miles away. The similarity of these two seismic lines indicates that the fault blocks are laterally continuous over at least the two-mile line separation. Seabeam bathymetry collected after the drilling indicates a much greater extent of the fault block (Aubouin et al., this volume).

Seismic line GUA-13 reveals a 0.37-s reflection sequence overlying an irregular high-amplitude basal reflection. A density log run in the hole was verified by laboratory density measurements and suggests that there are two and possibly three acoustic impedance boundaries that should give rise to strong seismic reflections. The strongest density contrast is at the basalt/chalk boundary, at 428 meters sub-bottom depth; presumably, it should also have the strong impedance contrast that gives rise to the high-amplitude irregular reflection at 0.37 s sub-bottom depth. These assumptions would re-

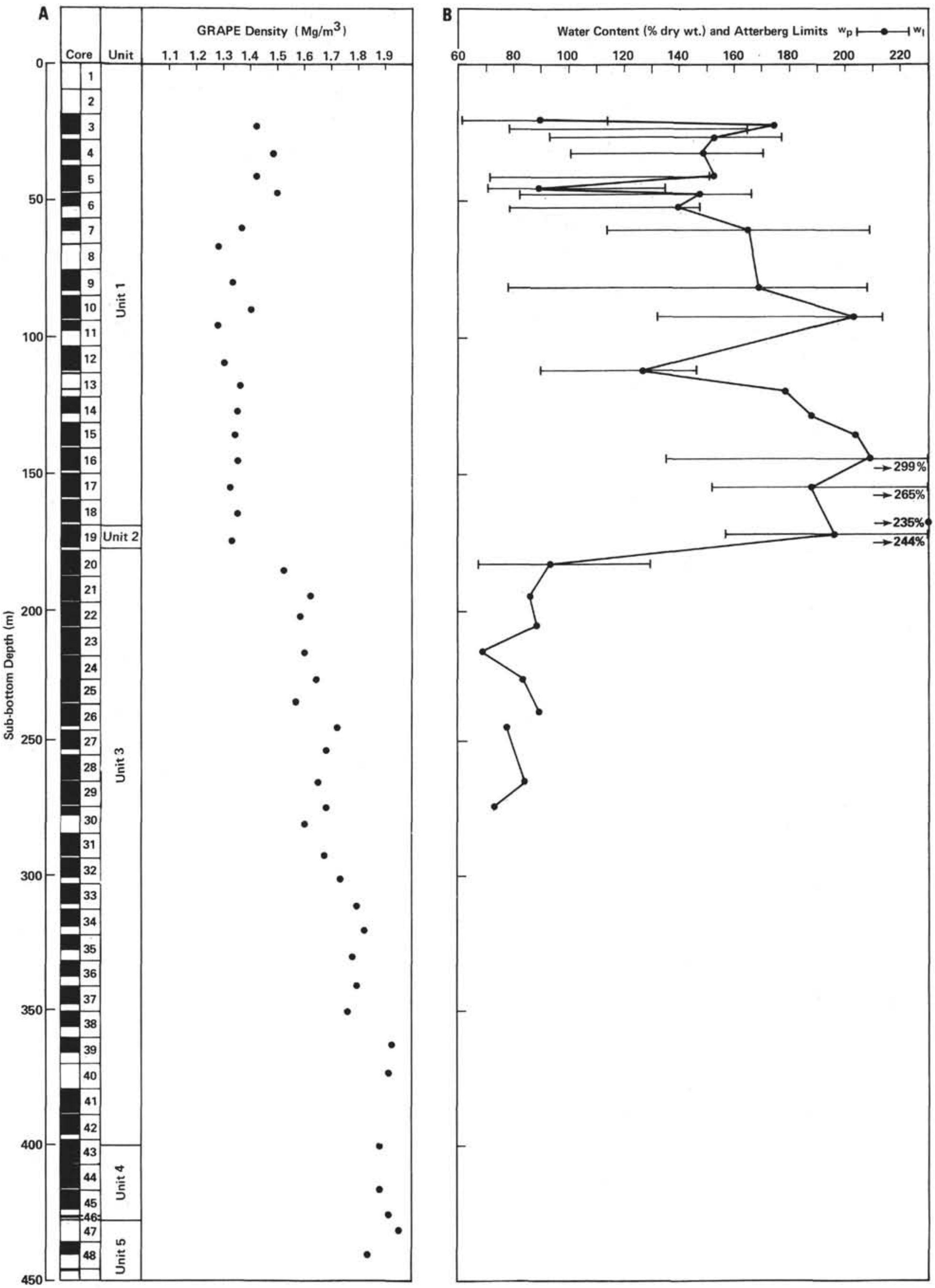


Figure 3. Physical properties for Site 495. A. GRAPE density. B. Water content.

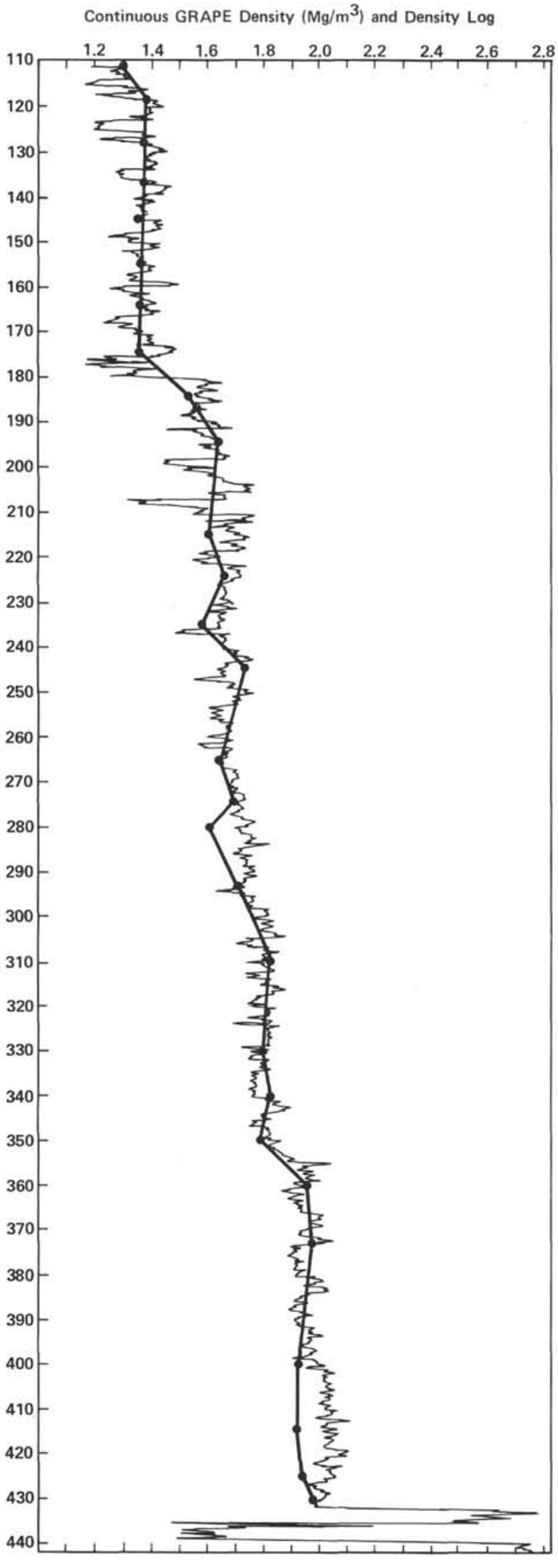


Figure 4. Downhole density log superimposed on GRAPE density plot, Site 495.

Table 2. Physical properties, Site 495.

Sedimentary Units	GRAPE Density (Mg/m^3)	Water Content (% dry wt.)	Porosity (%)	Shear Strength (kPa)
Unit 1: Mud line through Core 6				
Mean ($\bar{x}$)	1.43	138.4	79.7	11.84
Std. Dev. (s)	0.06	29.5	8.7	2.55
No. Samples (n)	12	9	9	12
Unit 2: Core 7 through Core 19				
Mean (x)	1.35	188.5	82.9	23.29
Std. Dev. (s)	0.03	24.9	2.1	9.53
No. Samples (n)	23	15	15	23
Unit 3: Core 20 through Core 25				
Mean ($\bar{x}$)	1.60	84.4	68.4	29.16
Std. Dev. (s)	0.05	8.5	2.4	12.07
No. Samples (n)	11	6	6	11
Unit 4: Core 26 through Core 32				
Mean ($\bar{x}$)	1.58	77.8	66.7	32.87
Std. Dev. (s)	0.34	5.8	1.5	14.72
No. Samples (n)	10	3	3	3
Unit 5: Core 33 through Core 37				
Mean ($\bar{x}$)	1.79	—	—	—
Std. Dev. (s)	0.02	—	—	—
No. Samples (n)	5	—	—	—
Unit 6: Core 38 through Core 46				
Mean ($\bar{x}$)	1.91	—	—	—
Std. Dev. (s)	0.10	—	—	—
No. Samples (n)	10	—	—	—

Note: — indicates no data available.

Table 3. Acoustic property averages per sedimentary unit.

Unit	Vc (km/s)	Impedance ($\times 10^5 g/cm^2 \cdot s$)
Unit 1		
x	1.548	2.21
s	0.021	0.11
n	10	10
Unit 2		
x	1.523	2.07
s	0.072	0.08
n	13	13
Unit 3		
x	1.523	2.48
s	0.011	0.08
n	5	5
Unit 4		
x	1.637	2.74
s	0.135	0.22
n	8	8
Unit 5		
x	1.639	2.940
s	0.048	0.110
n	5	5
Unit 6		
x	1.727	3.31
s	0.027	0.19
n	10	10

Note: x = mean, s = standard deviation, n = number of samples.

quire an average velocity of 2.3 km/s for the overlying sediment section. Such a velocity is much higher than the 1.5 to 1.7 km/s measured on core samples in the laboratory. A weaker reflection at 0.14 s sub-bottom depth may be caused by an impedance contrast at 180 meters in the hole. This impedance contrast suggested by the density log corresponds to the boundary between Miocene red brown clay and calcareous ooze. If this correlation of reflection to density contrast is correct,

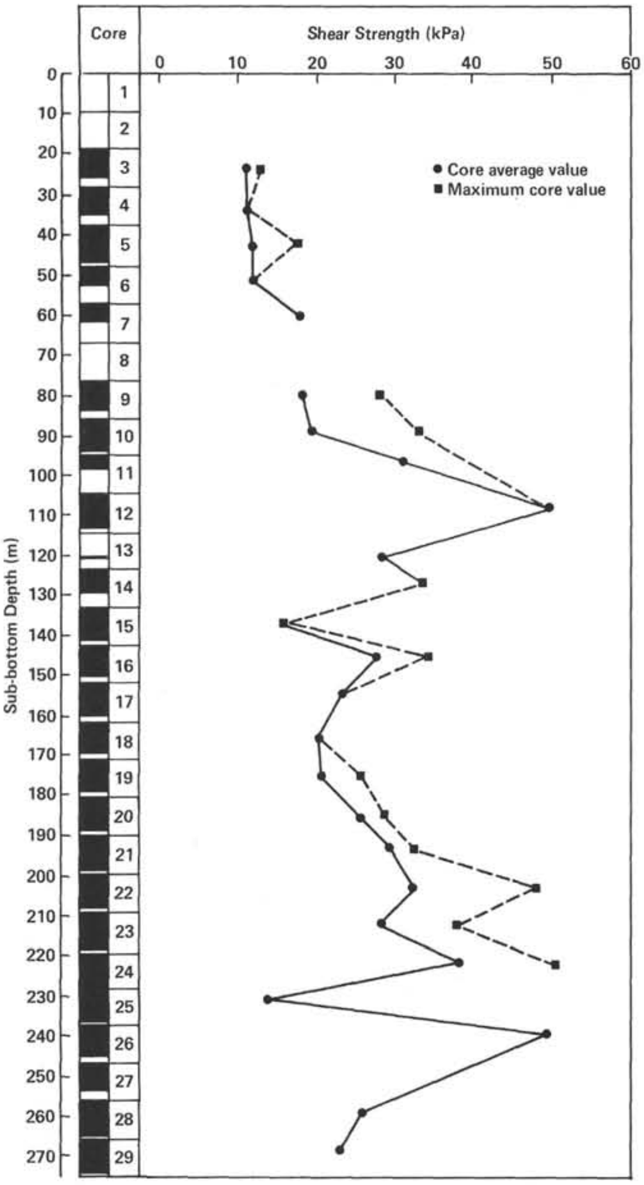


Figure 5. Shear strength, Site 495.

then the velocity of the section above 180 meters sub-bottom depth is 2.6 km/s, and the velocity between the mid-Miocene horizon and the lower Miocene chalk/basalt contact is 2.2 km/s. These velocities seem unreasonably high for semiconsolidated pelagic sediments. Hole 495 apparently was not drilled exactly on seismic line GUA-13 but in an area of slightly thicker sediments or it was drilled in a local deep not resolved by the seismic technique. In addition, local variability of the sediment section is suggested by a detailed comparison of the depths to basement in seismic lines GUA-13 and GUA-18.

According to the map of magnetic lineations of the oceans (Pitman et al., 1974), Site 495 should be on ocean crust older than Anomaly 13 time, or late Eocene. The good early Miocene date obtained for sediment immediately overlying basalt at Site 495 indicates the need for further study of magnetic lineations in this basin.

Table 4. Physical properties, Site 495.

Sample (core-section, interval [cm])	GRAPE Wet-Bulk Density (Mg/m^3)	*P*-Wave Velocity (km/s)	Acoustic Impedance ($\times 10^5$g/cm^2•s)	Shear Strength (kPa)	Water Content (% dry wt.)	Porosity (vol. %)
3-1, 67–70	1.45	—	—	12.06	89.5	69.8
3-2, 142–145	1.45	1.543	2.24	12.06	—	—
3-3, 115–117	1.45	1.529	2.22	8.62	175.4	81.9
3-4, 92–95	1.45	1.524	2.21	10.72	—	—
3-5, 138–140	1.49	1.541	2.30	13.02	—	—
3-6, 132–136	1.41	1.534	2.16	13.02	153.3	79.8
4-3, 140–143	1.45	1.538	2.23	11.50	149.0	79.4
4-5, 63–66	1.29	1.541	1.99	11.50	148.9	79.4
5-1, 17–21	1.43	—	—	7.30	152.5	79.8
5-3, 128–132	1.50	1.595	2.39	17.81	88.7	69.6
5-5, 127–131	1.34	1.565	2.10	12.06	148.7	79.3
6-4, 59–63	1.44	1.567	2.26	12.45	139.5	78.3
7-4, 70–76	1.40	1.561	2.18	18.00	165.0	84.1
8-1, 30–32	1.27	—	—	14.40	176.1	82.0
9-1, 135–138	1.36	1.545	2.10	5.88	—	—
9-2, 135–138	1.28	—	—	13.79	—	—
9-3, 135–138	1.35	—	—	17.00	—	—
9-4, 135–138	1.30	—	—	28.73	—	—
9-6, 45–50	1.37	1.561	2.14	28.73	169.4	81.4
10-1, 20–25	1.39	1.400	1.95	23.94	—	—
10-3, 20–25	1.39	—	—	21.07	—	—
10-6, 20–25	1.39	1.388	1.93	33.52	203.2	84.0
11-3, 50–55	1.35	1.539	2.08	30.64	194.4	83.4
12-2, 50–55	1.35	1.465	1.98	49.79	125.7	76.5
13-5, 60–65	1.35	1.454	1.96	28.73	177.3	82.1
14-3, 100–105	1.35	—	—	33.52	188.5	83.0
15-1, 139–141	1.35	1.550	2.09	14.36	—	—
15-3, 139–141	1.35	—	—	16.30	—	—
15-6, 132–134	1.35	1.540	2.08	17.24	204.4	84.1
16-3, 133–135	1.35	—	—	21.54	208.9	84.4
16-7, 142–145	1.37	—	—	34.47	206.7	84.2
17-5, 133–135	1.34	1.560	2.09	22.98	187.9	82.9
18-5, 139–141	1.35	1.620	2.19	20.11	235.5	85.9
19-1, 131–133	1.35	1.563	2.11	26.81	196.4	83.5
19-3, 138–140	1.35	—	—	14.36	187.2	82.9
20-3, 140–142	1.52	—	—	21.36	92.6	70.5
20-6, 140–142	1.58	1.516	2.39	28.72	—	—
21-2, 128–130	1.65	1.539	2.54	32.55	—	—
21-5, 128–130	1.63	—	—	26.81	85.1	68.8
22-1, 128–130	1.60	—	—	17.23	—	—
22-4, 78–81	1.51	—	—	47.88	88.2	69.5
23-1, 120–125	1.60	1.513	2.42	17.23	—	—
23-5, 120–125	1.70	1.515	2.57	38.30	68.6	63.9
24-1, 120–123	1.60	—	—	26.81	—	—
24-6, 120–123	1.63	1.530	2.49	49.79	82.2	67.9
25-1, 110–114	1.60	—	—	13.90	—	—
25-4, 70–74	1.56	—	—	—	89.6	69.9
26-5, 120–123	1.74	—	—	49.79	77.5	66.7
28-3, 133–136	1.66	1.89	3.14	25.85	83.8	68.3
28-7, 23–26	1.65	1.78	2.94	—	—	—
29-4, 139–141	1.68	—	—	22.98	72.2	65.2

Site 495 should coincide with Anomaly 6, if the age of the ocean crust is indeed early Miocene.

BIOSTRATIGRAPHY

Drilling at ocean reference Site 495 recovered a complete Quaternary to lower Miocene sedimentary sequence and terminated in basalt of the Cocos Plate (Fig. 7). Cores 1 to 16 contain hemiterrigenous dark-colored, siliceous muds with nannoplankton, foraminifers, and radiolarians deposited during the late Pleistocene to late Miocene. Cores 16 to 18 are intensely bioturbated, dark muds containing poor nannofossil assemblages, agglutinated benthic foraminifers of abyssal depth ranges, and abundant, well-preserved upper to middle Miocene radiolarians. Core 19 is a brown, carbonate-poor, abyssal clay, rich in middle Miocene radiolarians. From Cores 20 through 37, middle to lower Miocene radiolarians co-occur with a partially dissolved planktonic foraminiferal fauna and middle bathyal benthic taxa. Cores 38 through 46 are low Miocene carbonate sediments of well-preserved planktonic foraminifers and nannofossils with strong carbonate overgrowth on discoasters; radiolarians are absent.

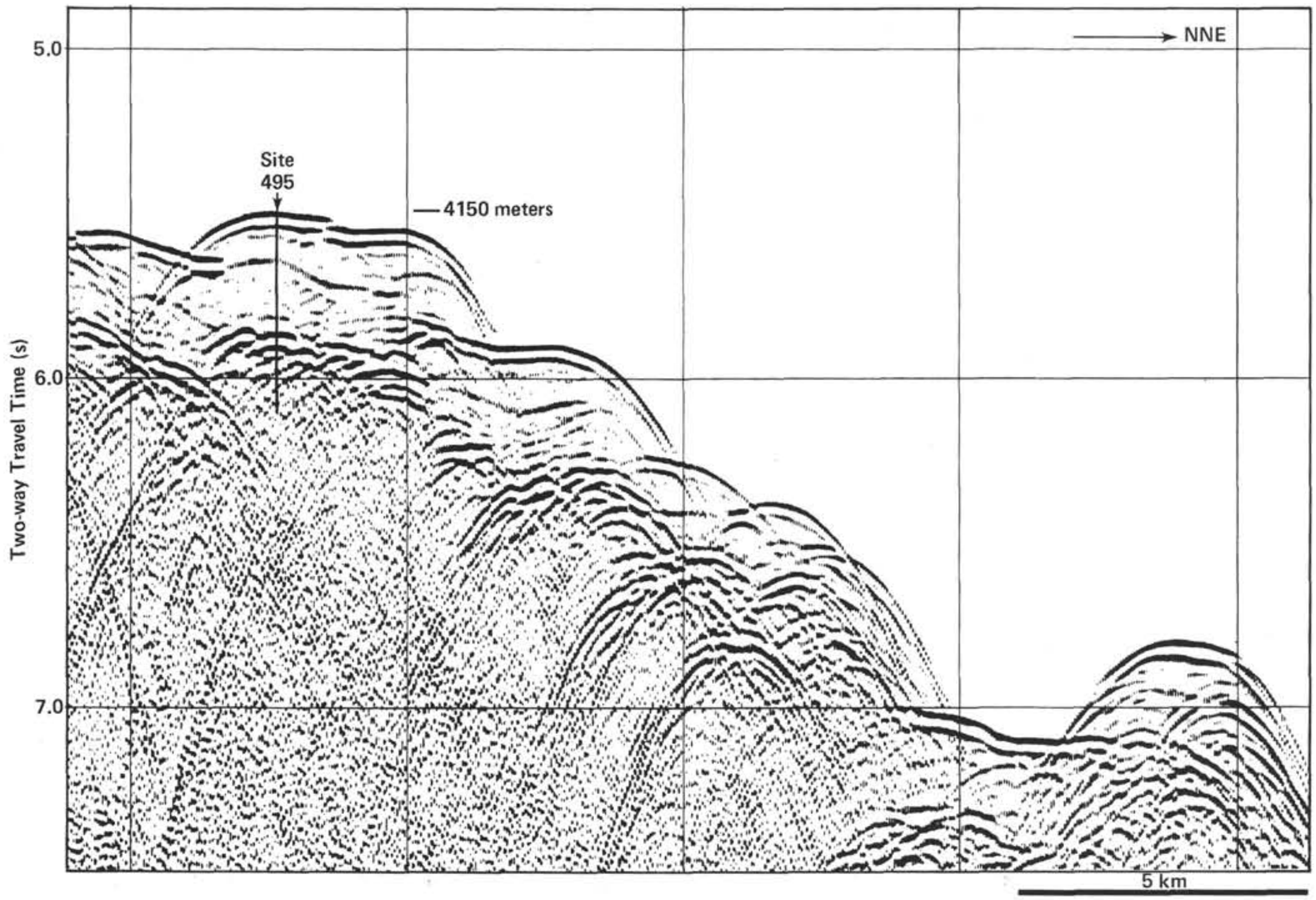


Figure 6. Seismic-reflection profile GUA-13 indicating location of Site 495 seaward of the Middle Atlantic Trench.

The Tertiary motions of the Cocos Plate are evident in the sedimentary record of Site 495. High rates of accumulation between Cores 36 and 46 (Fig. 8) are comparable to late Pleistocene sedimentation rates in the equatorial carbonate belt near the Galapagos for water depths near the lysocline (ca., 2500–3000 m). An increase in radiolarian content and a concomitant loss of foraminiferal biostratigraphic resolution between Cores 31 and 20 is consistent with plate motion away from the carbonate belt into subtropical waters. Gradual deepening of the site may further increase the intensity of dissolution of both foraminifers and nannofossils, causing the chronostratigraphic ranges of many taxa to be reduced severely. Many of the taxa within this interval may have become biogeographically restricted during the middle Miocene due to polar ice buildups (and also due to modified circulation caused by the gradual closing of the Middle American Seaway).

Cores 19 through 16 contain sediments laid down below the CCD (ca., 3000–3500 m) in the region today located between 10° to 15°N latitude, an area just north of the carbonate belt. Nannofossil assemblages of these cores are very poor. Abyssal agglutinated foraminifers are rare, but radiolarians are well preserved.

Cores 15 through 3 show a gradual increase in accumulation rate and carbonate content as the Cocos Plate came under the influence of coastal upwelling near the trench during the late Miocene. A slight shallowing of the seafloor may also be inferred by the progressive appearance of lower bathyal calcareous benthic foraminifers (Fig. 9).

Foraminifers

Pelagic chalks rest conformably on basalt basement (Sample 495-46-1, 112 cm) with little apparent metamorphism of the carbonate. Benthic foraminifers are absent in the basal layer, suggesting that the pelagic sediments began accumulating before benthic species appeared in the area. The lowermost sample of chalk is rich in species that span the Oligocene/Miocene boundary: *Globigerina angustiumbilicata, G. binaiensis, G. tripartita, G. venezuelana, Globorotalia nana*, and *G. siakensis*. The combination of two important marker taxa, *Globigerinoides* spp. and *Globorotalia kugleri*, however, identify the lowest Miocene N4 Zone. The base of the chalk sequence is dated at about 22.0 m.y., relative to a 22.5-m.y. age for the Oligocene/Miocene boundary. The top of Zone N4, defined by the extinction of *G. kugleri* 20.5 Ma, is between Cores 36 and 37, giving an accumulation rate at the bottom of this site of 85 m/1.5 m.y.

The interval between Cores 34 and 20 is characterized by intense carbonate dissolution, which has destroyed many of the planktonic foraminiferal taxa that might be used to zone the middle Miocene at Site 495. Zones N6

Series	Sample (hole-core-section)	Approximate Sub-bottom Depth of Boundary (m)	Basis for Boundary Position
Quaternary	495-1 → 495-6		
		57	Base of *C. doronicoides* Zone
upper Pliocene	495-7-1 → 495-11,CC		
		100	Base of *D. brouweri* Zone
lower Pliocene	495-12-1 → 495-12,CC		
		114	Presence of *D. berggrenii*
lower Pliocene/ upper Miocene	495-13 → 495-15		
		142.5	Forams: *G. plesiotumida* Zone Nannos: *D. quinqueramus* Zone Rads: *S. pentas* Zone
upper Miocene	495-16 → 495-17		
		161.5	Top of *D. petterssoni* Zone
middle Miocene	495-18 → 495-21		
		199.5	Foram Zone N9
lower/middle Miocene	495-22 → 495-25		
		237.5	Bottom of *Sphenolithus heteromorphus* Zone Foram Zone N7
lower Miocene	495-26 → 495-46-1		
		428.5	Forams: presence of *Globigerinoides* Nannos: *D. deflandrei* Subzone
		T.D. 446.5	

Figure 7. Stratigraphic series at Site 495.

through N8 are based on the ranges of taxa accompanying *Globigerinatella insueta*, but this dissolution-susceptible form only appears between Cores 23 and 26, overlapping with *Globigerinoides sicanus* (Zone N8). The *Globorotalia fohsi* group, used to define Zones N10 to N12, was only observed in Cores 20 and 21. Thus the dissolution across this portion of Site 495 has greatly reduced the vertical ranges of age-diagnostic taxa to lithostratigraphic limits within the site. More resistant microfossils, such as diatoms and radiolarians, provide more reliable dates.

Cores 16 to 19 were barren of planktonic foraminifers and contained only low abundances of agglutinated benthic taxa such as *Martinottiella communis, Cyclammina, Reophax*, and *Haplophragmoides*.

Lower bathyal calcareous benthic foraminifers such as *Melonis, Uvigerina, Globobulimina, Pyrgo*, and *Planulina* gradually appear in the interval from Cores 15 to 3, and agglutinated forms disappear above Sample 10, CC. The Miocene/Pliocene boundary is identified by the last occurrence of *Globorotalia plesiotumida* in Core 14, Section 5. The Pliocene/Pleistocene boundary is placed in Core 6, on the basis of *Globorotalia exilis* (Pliocene) occurring in Sample 7,CC and *Neogloboquadrina eggeri* (Pleistocene) in Core 5, Section 6 (Core 6 itself had no planktonic tests). High carbonate dissolution near the CCD and the cooling influences of the California Current have greatly limited the abundances of species of planktonic foraminifers accumulating on the bottom from the Pliocene to the Holocene; many age-diagnostic species—*Globigerina nepenthes, Globoquadrina altispira, Globorotalia truncatulinoides*, and *Globoquadrina pseudofoliata*—were not present in the cores. The modern fauna of the Panama Basin region is dominated by *Globorotalia menardii* and *N. eggeri*, hence the use of the latter to identify the Pleistocene. The top of Core 3, Section 1 is considered to be the youngest semiconsolidated unit at Site 495, estimated to be older than 125,000 years on the basis of the occurrence of pink-pigmented *Globigerinoides ruber*. In Cores 1 and 2, an assortment of middle and lower bathyal benthic taxa occur, such as *Uvigerina senticosa, Lagena,*

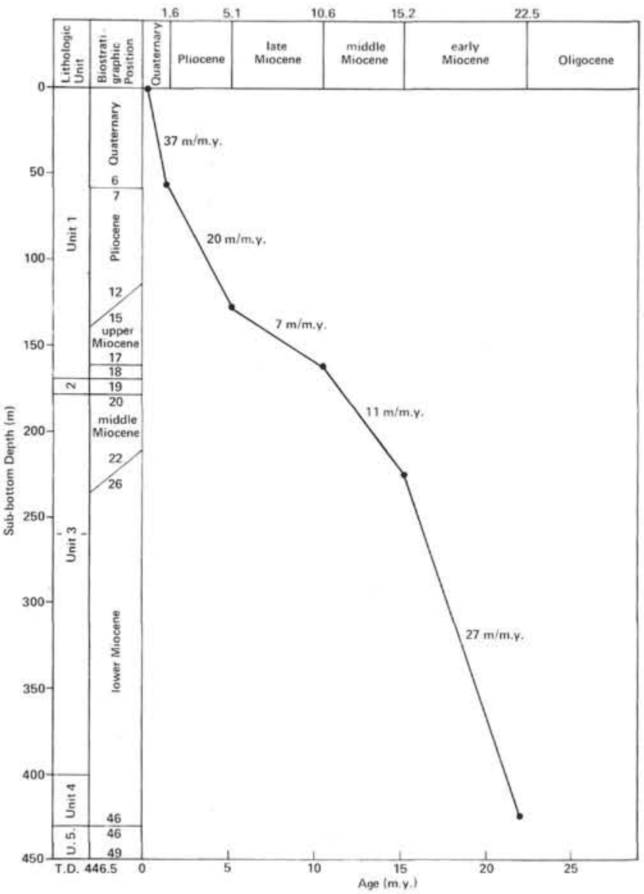


Figure 8. Sedimentation rate for Site 495. (Numbers in Biostratigraphic Position column refer to cores in Hole 495.)

Bolivina costata, and *Angulogerina*. The lack of pink-pigmented *G. ruber* suggests that the upper two cores are younger than 125,000 years.

Radiolarians

The first 37 of 49 cores drilled at Site 495 contain typical low-latitude radiolarian assemblages. The upper 171 meters, Cores 1 through 18, are a hemipelagic green and olive gray mud, with radiolarian assemblages occasionally diluted by terrigenous components or diatoms, but for the most part the fossils are common and well to moderately well preserved.

Species indicative of the upper two Quaternary zones are absent at Site 495, and the first samples contain *Axoprunum angelinum*, suggesting an age greater than 400,000 years. Core 3 is placed in the *Amphirhopalum ypsilon* Zone by the absence of *Anthocyrtidium angulare*. Very rare occurrences of *A. angulare* in Cores 4 through 6 indicate the lowest Quaternary, *A. angulare* Zone. The Pliocene/Pleistocene boundary, and the top of the *Pterocanium prismatium* Zone, is placed between Samples 495-7-1, 70–72 cm and 495-7-3, 70–72 cm by the last occurrence of *Pterocanium prismatium*. This designation, however, is tenuous due to the extreme rareness of *P. prismatium* and *A. angulare*.

The last occurrence of *Stichocorys peregrina* marks the bottom of the *P. prismatium* Zone between Samples 495-9-3, 75–77 cm and 495-9-6, 26–28 cm.

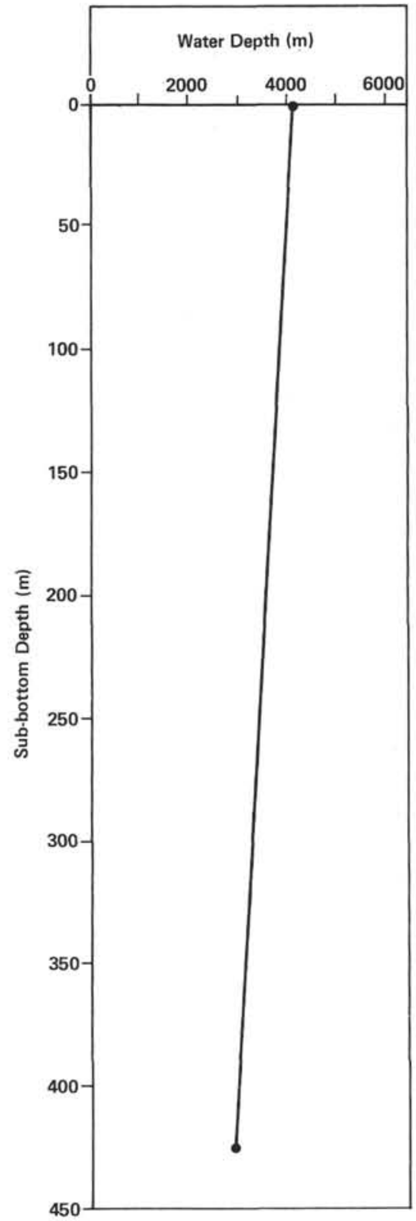


Figure 9. Paleobathymetry on the basis of benthic foraminifers at Site 495.

The events indicating the bottom of the *Spongaster pentas* Zone and *Stichocorys peregrina* Zone, namely the evolutionary transitions between *Spongaster berminghami* and *S. pentas*, and between *Stichocorys delmontensis* and *S. peregrina*, occur in the same interval between Sample 495-16-2, 30–32 cm and Sample 495-15-5, 30–32 cm, suggesting that the *S. peregrina* Zone may be missing. This conclusion is substantiated by the last occurrence of the *Calocycletta robusta* group in that same interval, an event known to occur in the *S. peregrina* Zone.

The bottom of the *Didymocyrtis penultima* Zone is indicated by the last occurrence of *Diartus hughesi* between Sample 495-16-6, 30–32 cm and Sample 495-17-1, 30–32 cm. *Didymocyrtis antepenultima* Zone extends from that interval down to the transition of *Diartus pet-*

terssoni to *D. hughesi* between Samples 495-18-2, 90–92 cm and 495-17-6, 30–32 cm.

The sediments of Core 18, and the carbonate-poor radiolarian clay of Core 19 belong to the *D. petterssoni* Zone of the middle Miocene. The first occurrence of *D. petterssoni* marks the bottom of this zone, between Samples 495-19-6, 8–10 cm and 495-20-1, 60–62 cm.

Cores 20 through 37 are chalky carbonate ooze with chert in the lower section, and they continue a complete record of middle and early Miocene radiolarian zones. The transition of *Dorcadospyris dentata* to *D. alata*, between Samples 495-23-6, 40–42 cm and 495-24-1, 15–17 cm, indicates the bottom of the *D. alata* Zone. The first occurrence of *Calocycletta costata* between Samples 495-29-5, 19–21 cm and 495-30-1, 30–32 cm marks the bottom of the *C. costata* Zone. The morphotypic bottom of *Stichocorys wolffii* marks the bottom of the *S. wolffii* between Samples 495-32-2, 39–41 cm and 495-32-5, 39–41 cm. The remaining cores through Section 495-37-3 belong to the *S. delmontensis* Zone. Samples taken from Cores 38 through 43 and from 46 were all barren of radiolarians. The assemblage in Core 37 is a well preserved and diverse one; there is no gradual decline in preservation, rather a sudden disappearance of siliceous fossils accompanied by the first appearance of cherts.

Nannoplankton

The nannoplankton succession from Holocene to lowermost Miocene is recorded in Hole 495. The upper part of the hole, Cores 1 to 18, is mainly diatomaceous mud; species diversity and abundance of nannoplankton are variable. High species diversity and abundance characterize nannoplankton assemblages in the lower part of the hole, Cores 18 to 46.

The interval from Core 1 to Core 6 is Quaternary, and, as mentioned, the abundance of nannoplankton is variable. The boundary between upper and lower Pleistocene is placed in the lower part of Core 3.

Nannoplankton of *Discoaster brouweri* Zone (upper Pliocene) are common in the interval from Core 7 to Core 11. The total assemblage includes *D. brouweri, D. pentaradiatus, D. asymmetricus, D. surculus, D. variabilis, Helicopontosphaera kamptneri* and others.

Core 12 to Sample 495-13-3, 30–32 cm are lower Pliocene and uppermost Miocene. In Samples 495-12-1, 60–62 cm to 495-12-3, 60–62 cm, small sphenoliths are presented (*Reticulofenestra pseudoumbilica* Zone). *Ceratolithus acutus* was found in Sample 495-12-6, 60–62 cm. The range of this species is narrow, a border interval between the Pliocene and Miocene (*Ceratolithus acutus* Subzone of *Ceratolithus tricorniculatus* Zone).

Sections 495-13-4 to 495-17-4 are assigned to the *D. quinqueramus* Zone (upper Miocene). The nannoplankton assemblage includes *D. quinqueramus, D. berggrenii, D. variabilis, D. brouweri*, and others. Sections 4 to 6 of Core 17 contain specimens of *D. loeblichi* and may belong to the *Discoaster neohamatus* Zone.

Beginning in Core 19 and below, rich assemblages of nannoplankton were found. Samples 495-19-6, 60–62 cm to 495-20-1, 30–32 cm contain nannoplankton of the *D. kugleri* Subzone of the *D. exilis* Zone: *D. exilis, D. kugleri, D. variabilis, D.* aff. *signis*. A similar assemblage but without *D. kugleri*, is found in Sections 495-20-2 to 495-21-7. This is the *Coccolithus miopelagicus* Subzone of the *D. exilis* Zone.

Sections 495-21-8 to 495-25-1 contain *Sphenolithus heteromorphus, D. exilis, D. variabilis, D. deflandrei*, and *D. signus*. This assemblage is typical of the *S. heteromorphus* Zone (lower middle Miocene).

The boundary between *Sphenolithus heteromorphus* Zone and *Helicopontosphaera ampliaperta* Zone (Cores 25–29) is determined as the limit of the last occurrence of *H. ampliaperta*. In Hole 495 that level is conjectural because of the extreme rarity of *H. ampliaperta* specimens. In the *Sphenolithus belemnos* Zone (Samples 495-30-2, 40–42 cm to 495-31-4, 40–42 cm) the zonal species occurs and *S. heteromorphus* is wholly absent.

Cores 30 to 46 correlate with the *Triquetrorhabdulus carinatus* Zone. The assemblage of *D. druggii* Subzone (lower Miocene) with *D. druggii, D. deflandrei, T. carinatus, Orthorhabdulus serratus. S. moriformis* characterizes the interval between Samples 495-31-5, 40–42 cm and 495-43-5, 52–54 cm. A similar assemblage, but without *D. druggii* and with common *T. carinatus* is found in the lowermost part of the hole (Section 495-43-7 and below).

The lower boundary of the *Discoaster deflandrei* Subzone is coincident with the Miocene/Oligocene limit. The underlying basalts recovered in this hole may be identified as lowermost Miocene.

GEOCHEMISTRY

Organic Geochemistry

Gas samples were analyzed by the same method described for Site 494. None of the samples analyzed contained gaseous hydrocarbon components in concentrations greater than those found in blank runs.

Inorganic Geochemistry

Figure 10 shows the results obtained from interstitial water samples. None of the measured parameters indicate significant differences in pore water chemistry throughout the penetrated section. The shipboard carbonate bomb data are shown in Figure 11. Cores 3 through 18 are characterized by carbonate concentrations of 0% to 8%. The calcareous ooze penetrated by Cores 19 to 46 has carbonate levels of 65% to 95%. Such values are normal for calcareous ooze.

SUMMARY AND CONCLUSIONS

Site 495 is the oceanic reference for the Middle America Trench transect off Guatemala. It is on an isolated ridge, a horst, formed of ocean crust, 22 km seaward and 1925 meters above the trench axis.

Bathymetric profiles made as the *Challenger* came on site indicated a seafloor depth within 25 meters of that at the position selected in seismic record GUA-13, however, the morphology around the site seems to differ somewhat from that in the record. The sediment cover is of generally uniform thickness (0.4 s), mimicking topography that is typical in oceanic pelagic areas. Magnetic

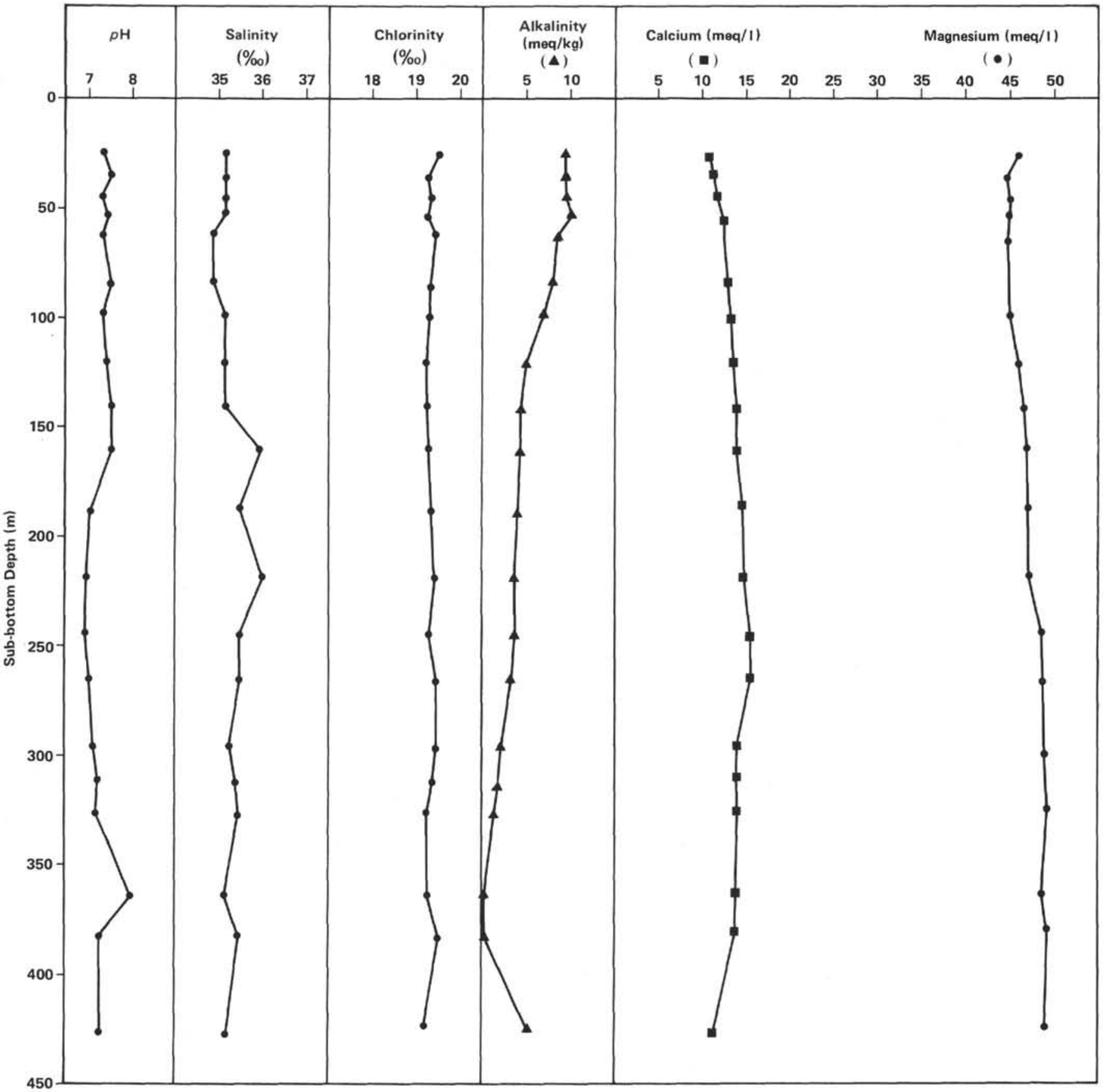


Figure 10. Interstitial water data at Site 495.

anomalies at the site are only known from reconnaissance data and prior to drilling at Site 495 were thought to be Eocene (see map in Pitman et al., 1974).

Forty cores with 75% recovery were obtained. The sediment sequence is carbonate ooze typical of low-latitude oceanic areas, and it has a hemipelagic cover.

1) 0 to 171 meters: Hemipelagic, diatomaceous green and olive gray mud.

2) 171 to 177 meters: Brown abyssal clay.

3) 177 to 406 meters: Chalky carbonate ooze with chert in the lower section.

4) 406 to 428 meters: Manganiferous chalk and chert.

5) 428 to 446.5 meters: Basalt.

The sediment is highly bioturbated in general, but some thin intervals of nonbioturbated, finely laminated material were recovered. Immediately above the basalt, and in the thin chalk layer intercalated between flows, no baked sediment was recovered.

Microfossil assemblages indicate an unbroken sequence from Quaternary to lower Miocene. Foraminifers are well preserved except in the middle and upper

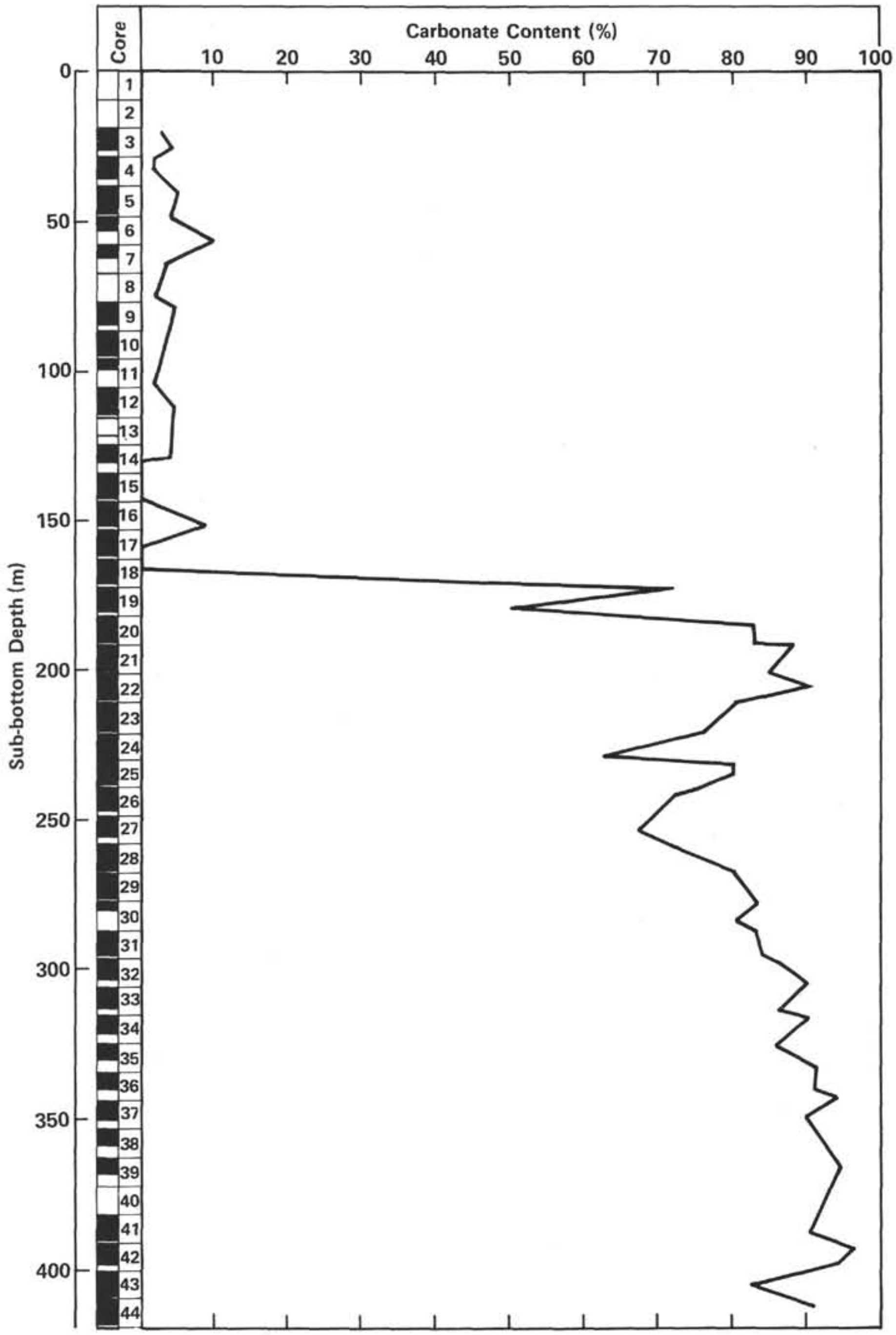


Figure 11. Carbonate bomb data at Site 495. (The carbonate bomb technique has an approximate error of ±3%.)

Miocene section. Benthic assemblages indicate a gradual increase in depth with perhaps a slight uplift at the end of the Quaternary. Radiolarians are common to abundant through most of the section and are absent in the lower part where chert layers were drilled. Nannoplankton occur throughout the section and are well preserved. Tertiary movement of the Cocos Plate with respect to the equatorial belt of high productivity is recorded by an early and middle Miocene increase in the rate of biogenic sedimentation (50 m/m.y.). Today this belt is near the Galapagos and at water depths between about 2500 to 3000 meters. A pronounced absence of carbonate sediment and slow rates of sedimentation (8 m/m.y.) in the late Miocene may correspond to the environments presently found in the region between 10° to 15°N, just beyond the carbonate belt. In the hemipelagic sediment the biogenic component may correspond to the present belt of upwelling near the Central American continent.

This section shows a regular increase in density with depth, according to the GRAPE and logging data. Velocities could only be measured in the lab because the sonic velocity downhole logging tool malfunctioned. Unfortunately, there is little information with which to resolve the disparity between the depth to basalt indicated by drilling (428 m) and the depth indicated by calculations (320 m) using laboratory velocities (averaging 1.7 km/s) and the basement reflection intercept time (0.38 s). Plots of effective overburden as a function of depth suggest that the Quaternary sediment may be underconsolidated, and the section below, normally consolidated.

Essentially no measurable quantities of gaseous hydrocarbon were found at this site.

The sediment section at Site 495 records the northward passage of the Cocos Plate through the equatorial carbonate belt to an environment of slower pelagic deposition and finally to an environment in the proximity of a terrigenous source. Superimposed on this trajectory are the effects of subsidence as the newly formed ocean crust moved away from the ocean ridge.

The 170-meter-thick hemipelagic cover is difficult to explain because the site is almost 2,000 meters above the trench and 22 km seaward. As the Middle America Trench is about 3,000 km long, silt- and even sand-sized material must have been transported across the trench and not around it. If the present rate of convergence, 9 cm/yr., were constant during the entire interval of hemipelagic sedimentation (10 m.y.), the site would have been 900 km away when hemipelagic sediment first reached it. Transport of hemipelagic sediment such a great distance is not recorded at other DSDP drilling sites in the region. For instance, only volcanic ash and no hemipelagic mud was recovered from Sites 156 and 157, about 500 km off South America, and from Sites 84 and 158, which are 240 km and 300 km from land, respectively. Thus projecting present plate-convergence rates and directions 10 m.y. back in time may be too simplistic.

The age of the crust now entering the trench is firmly established as earliest Miocene or possibly late Oligocene by the drilling results from Site 495 and other Leg 67 sites.

REFERENCES

Pitman, W. C., III, Larson, R. L., and Herron, E. M., 1974. The age of the ocean basins. *Geol. Soc. Am. Map.*

SITE 495 HOLE CORE 2 CORED INTERVAL 9.5–19.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES
HOLOCENE		AG	CG	AG		CC			•

FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS

LITHOLOGIC DESCRIPTION

SITE 495, CORE 1, 0.0–9.5 m: NO RECOVERY.

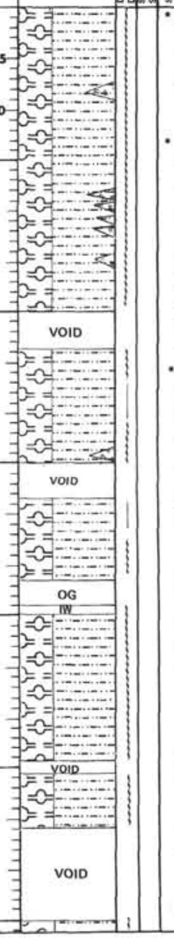
Core-Catcher: Mostly rust chips off inside of pipe.
Color: light olive gray–olive gray (5Y 4/2).

SMEAR SLIDE SUMMARY

	CC
TEXTURE:	
Sand	5
Silt	35
Clay	60
COMPOSITION:	
Quartz	2
Feldspar	1
Pyrite	2
Other heavy minerals	TR
Clay minerals	55
Volcanic glass	15
Glauconite	3
Calc.-Dolo.-Arag.	TR
Foraminifers	1
Calc. nannofossils	TR
Diatoms	10
Radiolarians	7
Sponge spicules	4
Plant debris	TR

SITE 495 HOLE CORE 3 CORED INTERVAL 19.0–28.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
UPPER PLEISTOCENE	*E. huxleyi* (N) *A. ypsilon* (R)	CM	CG	AG		1	0.5, 1.0
						2	
	N. eggeri (F)					3	
						4	
						5	
			CG	AG		6	
	G. oceanica (N) *A. angulare* (R)	AG				CC	



GRAPHIC LITHOLOGY; DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

LITHOLOGIC DESCRIPTION

5G 5/2
5Y 4/1
Clayey siliceous
5G 5/1–5G 5/2
5Y 3/2
5Y 4/1–5Y 3/2
5Y 4/2
Vitric ash
5Y 4/2
5G 5/1
5GY 4/1–5Y 3/1
5GY 4/1 (partly)
5Y 5/1–5Y 4/2
5G 5/1
Clayey, calcareous, siliceous
5G 5/2
5G 4/1
5G 6/2
5Y 5/1–5G 5/2
5Y 3/1–5GY 4/1
5Y 3/2–5GY 4/1
5Y 3/2
5Y 2/2–5GY 4/1
5Y 3/2

HEMIPELAGIC MUD

Greenish-olive green gray diatomaceous hemipelagic mud dominant. Very dark brown slightly calcareous siliceous mud is relatively minor. Transgression and sharp contact of them are both observed. Existence of terrigenous material noted. Several ash spots in Sections 2 and 3.

SMEAR SLIDE SUMMARY

	1-1	1-113	3-54
TEXTURE:			
Sand	20	11	60
Silt	40	40	20
Clay	40	49	20
COMPOSITION:			
Quartz	–	1	10
Feldspar	1	TR	3
Mica	–	–	2
Pyrite	3	3	3
Other heavy minerals	2	–	–
Clay minerals	17	21	–
Volcanic glass	10	5	60
Glauconite	–	5	2
Zeolite	17	10	20
Calc.-Dolo.-Arag.	3	3	–
Foraminifers	4	2	–
Calc. nannofossils	1	15	–
Diatoms	20	20	–
Radiolarians	10	5	–
Sponge spicules	5	10	–
Plant fragments	TR	–	TR
Fecal pelets	5	TR	–

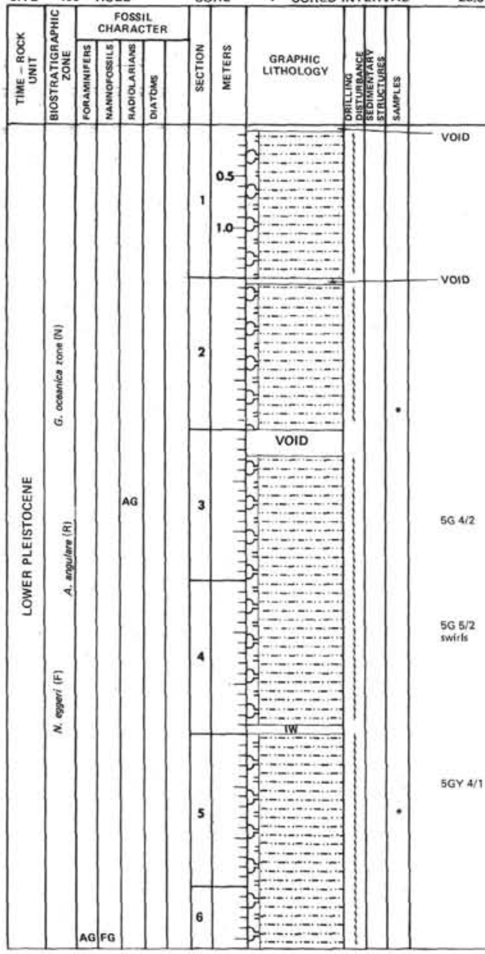
CARBONATE BOMB (%)

1, 23–25 = 2
1, 20–22 = 2
6, 36–38 = 4
6, 42–44 = 5

CARBON-CARBONATE (%)

	1, 20–22	6, 42–44
Organic Carbon	1.38	2.21
Total Carbonate	2	5

SITE 495 HOLE CORE 4 CORED INTERVAL 28.5–38.0 m



LITHOLOGIC DESCRIPTION

HEMITERRIGENOUS BIOGENIC SILTY MUD

Predominantly greenish gray (5G 5/1, 4/1, and 5GY 4/1) with minor swirls of dark olive gray (5Y 3/2). Section 1 is mainly darker clay with drilling disturbance throughout. Proportions of coccoliths, radiolaria, diatoms variable, but biogenic debris present throughout. Abundant coccoliths and diatoms noted in Section 4, 16 cm.

SMEAR SLIDE SUMMARY

	2-128	5-78
TEXTURE:		
Sand	12	7
Silt	35	28
Clay	53	65
COMPOSITION:		
Quartz	1	TR
Feldspar	7	2
Pyrite	5	3
Other heavy minerals	–	TR
Clay minerals	50	60
Volcanic glass	5	1
Glauconite	1	1
Zeolite	1	–
Calc.-Dolo.-Arag.	6	2
Foraminifers	2	2
Calc. nannofossils	5	10
Diatoms	10	7
Radiolarians	5	8
Sponge spicules	–	4
Others	2	TR

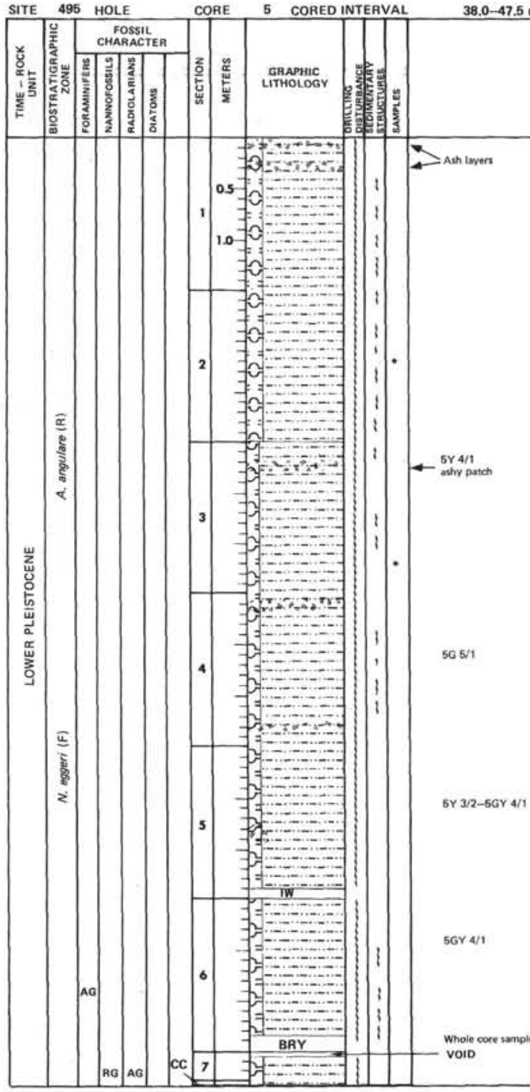
CARBONATE BOMB (%)

3, 126–128 = 2
5, 20–22 = 2

CARBON-CARBONATE (%)

	5, 20–22
Organic Carbon	1.08
Total Carbonate	2

SITE 495 HOLE CORE 5 CORED INTERVAL 38.0–47.5 m



LITHOLOGIC DESCRIPTION

SILTY MUD WITH VARIABLE SILICEOUS BIOGENIC COMPONENT (15–20%)

Drilling disturbed ash layers (light gray, 5Y 5/1), probably originally 0.5–2 cm thick. Entire core is swirled monotonously by drilling disturbance and characterized by color variations. In Sections 1 and 2, greenish gray (5GY 3/2) mud predominates; Section 3 darker gray (5Y 3/2) predominantes; Section 4, lighter grayish green (5G 5/1), with mottled 5Y 3/2 below 100 cm; Section 5 predominantly 5Y 3/2; and Section 6 light (5GY 4/1) above 90 cm and darker (5Y 3/2). Some slight bioturbation mottling noted in Sections 1, 2, 3, and 4. Core-Catcher: 2 cm disturbed mud.

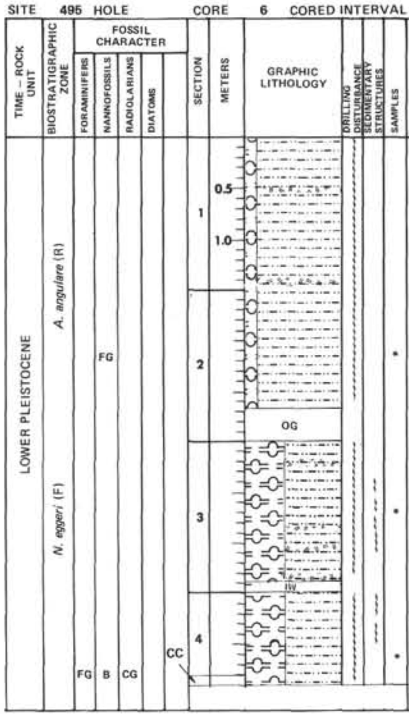
SMEAR SLIDE SUMMARY

	2-69	3-116
TEXTURE:		
Sand	4	23
Silt	21	24
Clay	75	53
COMPOSITION:		
Quartz	–	1
Feldspar	TR	1
Pyrite	1	1
Other heavy minerals	TR	TR
Clay minerals	75	51
Volcanic glass	3	25
Glauconite	1	1
Zeolite	–	5
Calc.-Dolo.-Arag.	1	–
Diatoms	6	6
Radiolarians	13	8
Plant debris	TR	1

CARBON-CARBONATE (%)

	4, 20–22	4, 22–24
Total Carbonate	4.5	3.5

SITE 495 HOLE CORE 6 CORED INTERVAL 47.5–57.0 m



LITHOLOGIC DESCRIPTION

5Y 3/1

5Y 5/1

BIOGENIC SILTY MUD (10–40% siliceous biogenic debris) AND VITRIC ASH LAYERS
Moderately swirled and mottled by drilling throughout. Monotonous mixing of dark olive gray (5Y 3/2) and greenish gray (5GY 5/1) and some intermediate mixtures: Section 3, 35–90 cm predominantly greenish gray. Ash layers disrupted by drilling and therefore shown diagramatically. At Section 3, 25 cm dark gray (5Y 4/1) vesicular and pyritic ash; in lower part of Section 3, light gray (5Y 6/1).

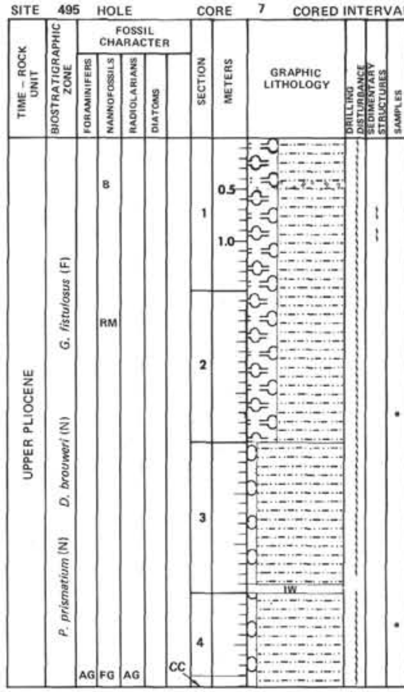
SMEAR SLIDE SUMMARY

	2-65	3-65	4-63
TEXTURE:			
Sand	10	25	60
Silt	25	25	20
Clay	65	50	20
COMPOSITION:			
Quartz	3	2	2
Feldspar	10	3	1
Pyrite	3	1	8
Other heavy minerals	TR	TR	TR
Clay minerals	65	49	13
Volcanic glass	1	4	73
Glauconite	2	TR	–
Calc.-Dolo.-Arag.	1	TR	–
Calc. nannofossils	1	–	–
Diatoms	8	27	1
Radiolarians	3	12	2
Sponge spicules	1	1	–
Others	2	1	–

CARBON-CARBONATE (%)

	3, 60–62	4, 27–29
Organic Carbon	0.76	4.0
Total Carbonate	–	0

SITE 495 HOLE CORE 7 CORED INTERVAL 57.0–66.5 m



LITHOLOGIC DESCRIPTION

5GY 4/1

SILICEOUS BIOGENIC SILTY MUD
All disturbed (swirled and mottled) by drilling. Predominantly grayish green (5GY 4/1–5GY 3/2), swirled with dark olive gray (5Y 3/2). One disturbed ash layer (1 cm), 5Y 4/1 at 45 cm in Section 1. Section 3 predominantly greenish gray (5GY 4/1) silty mud with 25% mottled patches of lighter greenish gray. Section 4: dark gray (5Y 3/2) with patches and streaks of lighter gray (5GY 5/1).

SMEAR SLIDE SUMMARY

	2-120	4-27
TEXTURE:		
Sand	13	7
Silt	32	23
Clay	55	70
COMPOSITION:		
Quartz	TR	1
Feldspar	TR	1
Pyrite	–	5
Other heavy minerals	–	TR
Clay minerals	54	67
Volcanic glass	5	9
Glauconite	7	1
Calc.-Dolo.-Arag.	1	2
Foraminifers	–	2
Calc. nannofossils	TR	TR
Diatoms	14	5
Radiolarians	16	4
Sponge spicules	3	1
Plant debris	TR	2

CARBONATE BOMB (%)
3, 113–115 = 10.5

SITE 495 **HOLE** **CORE** 8 **CORED INTERVAL** 66.5–76.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
UPPER PLIOCENE		CM				1					•

LITHOLOGIC DESCRIPTION

DIATOMACEOUS SILTY MUD (biogenic material 30–35%)
All disturbed by drilling.
0–14 cm: olive gray (5Y 4/2)
14–39 cm: dark olive gray (5Y 3/2)

SMEAR SLIDE SUMMARY

	1-35
TEXTURE:	
Sand	5
Silt	20
Clay	75
COMPOSITION:	
Quartz	4
Feldspar	1
Mica	1
Pyrite	1
Other heavy minerals	TR
Clay minerals	60
Volcanic glass	3
Calc. nannofossils	TR
Diatoms	18
Radiolarians	5
Sponge spicules	5
Silicoflagellates	2

CARBONATE BOMB (%)
1, 37–39 = 2
1, 133–135 = 2

CARBON-CARBONATE (%)

	1, 22–24
Organic Carbon	2.34
Total Carbonate	3.5

SITE 495 **HOLE** **CORE** 9 **CORED INTERVAL** 76.0–85.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
UPPER PLIOCENE	*P. prismatium* (R)					1	0.5, 1.0				
	D. brouweri (N)					2					
						3					•
	G. fistulosus (F)					4					
	S. pentas (R)		CG			5		OG			
		CG	CG			6					•
						CC					

IW

5Y 7/2 ash

LITHOLOGIC DESCRIPTION

5GY 5/2 with stains of 5Y 7/4

DIATOMACEOUS SILTY MUD
All disturbed by drilling. Dusky yellow green (5GY 5/2) predominant with stains of pale yellow (5Y 7/4). Section 6, 33 cm: Vitric ash layer. Core-Catcher: 12 cm as above.

SMEAR SLIDE SUMMARY

	3-43	6-34
TEXTURE:		
Sand	7	TR
Silt	35	95
Clay	58	5
COMPOSITION:		
Quartz	1	3
Feldspar	TR	1
Pyrite	TR	1
Other heavy minerals	TR	1
Clay minerals	50	5
Volcanic glass	TR	85
Glauconite	TR	TR
Calc. nannofossils	TR	TR
Diatoms	42	3
Radiolarians	5	1
Sponge spicules	1	–
Silicoflagellates	1	–

CARBONATE BOMB (%)
3, 100–102 = 2

CARBON-CARBONATE (%)

	5, 20–22
Organic Carbon	0.68
Total Carbonate	5.5

SITE 495 HOLE CORE 10 CORED INTERVAL 85.5–95.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
UPPER PLIOCENE	*G. fistulosus* (F) / *S. pentas* (R) / *D. brouweri* (N)					1	0.5, 1.0
						2	
						3	
						4	
						5	
				CG		6	
		AG	CG	FM		7, CC	

GRAPHIC LITHOLOGY

DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5GY 5/2 with 5Y 7/4 stains

DIATOMACEOUS SILTY MUD

All the core disturbed by drilling. Dusky yellow green (5GY 5/2) with light yellow (5Y 7/4) stains in Sections 1 and 2 particulary.

SMEAR SLIDE SUMMARY

	5-90
TEXTURE:	
Sand	TR
Silt	25
Clay	75
COMPOSITION:	
Quartz	1
Feldspar	TR
Pyrite	TR
Clay minerals	75
Volcanic glass	3
Diatoms	17
Radiolarians	3
Silicoflagellates	1

CARBONATE BOMB (%)

1, 124–126 = 1

4, 106–108 = 3.5

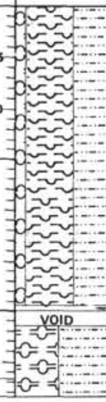
CARBON-CARBONATE (%)

	4, 103–105
Organic Carbon	1.26
Total Carbonate	3.5

SITE 495 HOLE CORE 11 CORED INTERVAL 95.0–104.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
PLIOCENE	*S. pentas* (R)	FG				1	0.5, 1.0
		FG				2	
						3	
		RG	B	FM		CC	

GRAPHIC LITHOLOGY



VOID

DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5G 5/2

5GY 5/1

IW

DIATOMACEOUS SILTY MUD

Predominantly greenish gray (5G 5/2) with 10–20% irregular, drilling-swirled grayish black (5GY 4/1–N2) mud. Siliceous component predominantly diatoms but 18% radiolarians at Section 3, 53 cm. Section 3: **SILICEOUS MUD**, greenish gray (5GY 5/2).

SMEAR SLIDE SUMMARY

	2-104	3-53
TEXTURE:		
Sand	3	5
Silt	9	5
Clay	88	90
COMPOSITION:		
Quartz	4	8
Feldspar	TR	TR
Mica	TR	TR
Pyrite	TR	–
Other heavy minerals	–	TR
Clay minerals	33	41
Volcanic glass	–	5
Glauconite	TR	–
Calc. nannofossils	TR	TR
Diatoms	50	25
Radiolarians	5	18
Sponge spicules	3	2
Silicoflagellates	1	–

CARBONATE BOMB (%)

2, 136–138 = 1.5

CARBON-CARBONATE (%)

	2, 132–134
Organic Carbon	0.50
Total Carbonate	3

SITE 495 HOLE CORE 12 CORED INTERVAL 104.5–114.0 m

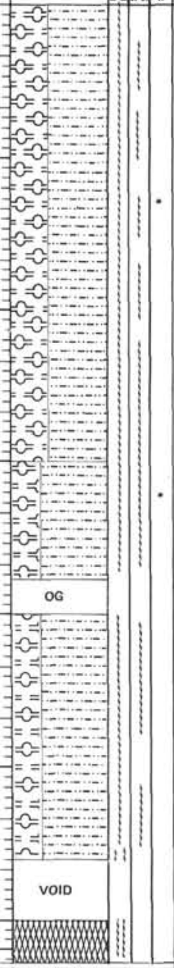
TIME-ROCK UNIT: LOWER PLIOCENE

BIOSTRATIGRAPHIC ZONE: *R. pseudoumbilica* (N), *S. pentas* (R); *C. tricorniculatus* (N)

FOSSIL CHARACTER (FORAMINIFERS / NANNOFOSSILS / RADIOLARIANS / DIATOMS): FM; FG; RG; RM RG

SECTION: 1, 2, 3, 4, 5, 6, 7, CC

METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

SILICEOUS MUD

Section 1 through Section 6, 82 cm: Monotonous siliceous mud, generally distinctly greenish in color, with varying proportions of siliceous biogenic debris (usually diatoms to radiolarians) and silt. Drilling disturbance results in varicolored swirling throughout, with color mottling approximately distributed as follows: 60% grayish green (5G 5/2); 20% greenish gray (5GY 4/1); and 20% dark olive gray (5Y 3/2). Section 6, 83 cm–base of core: Soupy drilling breccia with 5G 5/1 firmer mud fragments up to 5 mm diameter.

SMEAR SLIDE SUMMARY

	2-40	4-33
TEXTURE:		
Sand	3	3
Silt	8	3
Clay	89	94
COMPOSITION:		
Quartz	5	6
Feldspar	TR	–
Mica	TR	TR
Pyrite	TR	TR
Other heavy minerals	TR	TR
Clay minerals	45	55
Volcanic glass	8	5
Foraminifers	TR	–
Calc. nannofossils	TR	–
Diatoms	9	10
Radiolarians	25	17
Sponge spicules	6	6
Silicoflagellates	TR	TR

CARBONATE BOMB (%)

4, 31–33 = 2.5
2, 90–118 = 4

CARBON-CARBONATE (%)

	4, 28–30
Organic Carbon	0.65
Total Carbonate	0

SITE 495 HOLE CORE 13 CORED INTERVAL 114.0–123.5 m

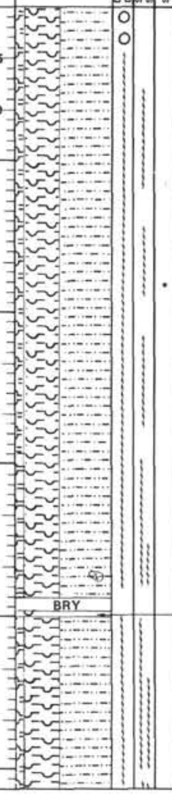
TIME-ROCK UNIT: UPPER MIOCENE TO LOWER PLIOCENE

BIOSTRATIGRAPHIC ZONE: *C. tricorniculatus* (N); *S. pentas* (R); *D. quinqueramus* (N)

FOSSIL CHARACTER (FORAMINIFERS / NANNOFOSSILS / RADIOLARIANS / DIATOMS): CG; RG; CM

SECTION: 1, 2, 3, 4, 5, CC

METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD

Smeared mottled pattern (old worm tubes?). Monotonous greenish gray section slowly increasing proportions of nannofossils. Three colors (marbled): light-green gray (5G 5/1), olive-green gray (5Y 3/2–5Y 4/2), and yellow-green gray (5Y 4/3).

SMEAR SLIDE SUMMARY

	2-120
TEXTURE:	
Sand	4
Silt	5
Clay	91
COMPOSITION:	
Quartz	6
Mica	TR
Pyrite	2
Other heavy minerals	TR
Clay minerals	28
Volcanic glass	3
Foraminifers	TR
Calc. nannofossils	15
Diatoms	35
Radiolarians	6
Sponge spicules	2
Silicoflagellates	2

CARBONATE BOMB (%)

3, 36–38 = 4.5

SITE 495 HOLE CORE 14 CORED INTERVAL 123.5–133.0 m

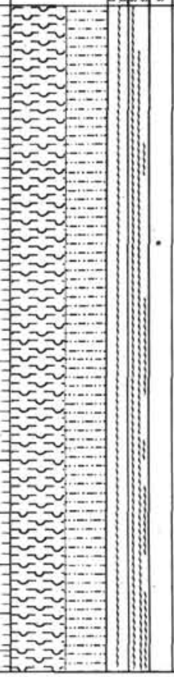
TIME – ROCK UNIT: UPPER MIOCENE TO LOWER PLIOCENE

BIOSTRATIGRAPHIC ZONE: *S. pentas* (R); *D. quinqueramus* (N)

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CG; FG CG

SECTION: 1, 2, 3, 4, 5, CC — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY — DRILLING DISTURBANCE — SEDIMENTARY STRUCTURES — SAMPLES



LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD

Smeared mottled pattern as in Core 13 (old worm tubes?). Monotonous gray-green section. Three colors: Approximately 40% light green gray (5G 5/1); approximately 30% olive green gray (5Y 3/2–5Y 4/2; and approximately 30% yellow green gray (5Y 4/3). These colors are marbled throughout core.

SMEAR SLIDE SUMMARY

	2-80
TEXTURE:	
Sand	2
Silt	25
Clay	73
COMPOSITION:	
Quartz	4
Pyrite	TR
Clay minerals	28
Volcanic glass	1
Calc. nannofossils	4
Diatoms	55
Radiolarians	3
Sponge spicules	2
Silicoflagellates	2

CARBONATE BOMB (%)

1, 57–59 = 4.5
3, 0–10 = 16.5

CARBON-CARBONATE (%)

	2, 30–32
Organic Carbon	0.70
Total Carbonate	4.5

SITE 495 HOLE CORE 15 CORED INTERVAL 133.0–142.5 m

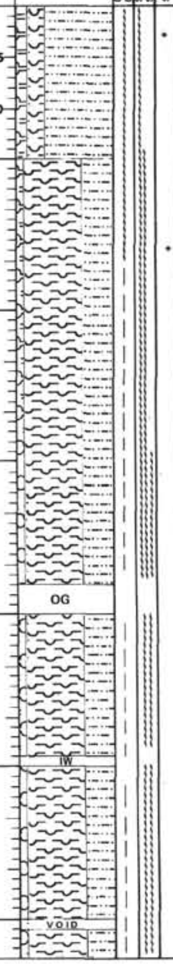
TIME – ROCK UNIT: UPPER MIOCENE TO LOWER PLIOCENE

BIOSTRATIGRAPHIC ZONE: *D. quinqueramus* (N); *S. pentas* (R); *G. plesiotumida* (F)

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CG; FG; CG

SECTION: 1, 2, 3, 4, 5, 6, 7 — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY — DRILLING DISTURBANCE — SEDIMENTARY STRUCTURES — SAMPLES



Strong color mottling

LITHOLOGIC DESCRIPTION

DIATOMACEOUS MUD

Mottled appearance stronger than above core with addition of black streaks (see smear slide). Marbled: Black (5Y 2/1), pale olive (5Y 6/3), dark gray (5Y 4/1), and blue gray (5G 6/1–6/2). Color marbled throughout.

SMEAR SLIDE SUMMARY

	1-25	2-90†
TEXTURE:		
Sand	10	2
Silt	60	65
Clay	30	33
COMPOSITION:		
Quartz	–	3
Feldspar	–	TR
Mica	–	TR
Pyrite	TR	3
Clay minerals	20	25
Volcanic glass	42	3
Zeolite	5	–
Calc.-Dolo.-Arag.	2	–
Calc. nannofossils	1	TR
Diatoms	15	55
Radiolarians	10	6
Sponge spicules	5	2
Silicoflagellites	–	1

† Smear slides from dark gray color band.

CARBONATE BOMB (%)

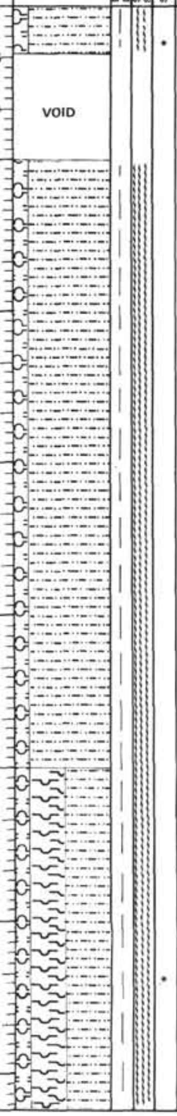
1, 52–54 = 0

CARBON-CARBONATE (%)

	1, 30–32
Organic Carbon	0.49
Total Carbonate	4

SITE 495 HOLE CORE 16 CORED INTERVAL 142.5–152.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
UPPER MIOCENE	*D. antepenultima* (R)	RM	FG, B	AG		1–8	0.5, 1.0



LITHOLOGIC DESCRIPTION

SILICEOUS MUD
Bioturbated. Matrix: dark gray (5Y 4/1). Burrow fill: blue gray (5B 6/1) and olive gray (5Y 5/2). Moderate drilling deformation obvious in down-turned burrows at core liner boundaries. Same color combination throughout. Note: First core cut with saw.

SMEAR SLIDE SUMMARY

	1-32	7-52
TEXTURE:		
Sand	12	8
Silt	12	42
Clay	76	50
COMPOSITION:		
Quartz	–	1
Pyrite	2	TR
Clay minerals	73	39
Volcanic glass	–	7
Calc.-Dolo.-Arag.	3	–
Foraminifers	TR	–
Calc. nannofossils	–	TR
Diatoms	2	35
Radiolarians	10	12
Sponge spicules	5	5

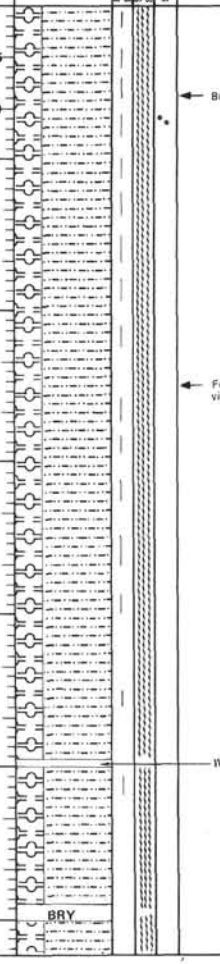
CARBONATE BOMB (%)
7, 26–28 = 0

CARBON-CARBONATE (%)

	7, 33–35
Organic Carbon	0.38
Total Carbonate	0

SITE 495 HOLE CORE 17 CORED INTERVAL 152.0–161.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
UPPER MIOCENE	?*D. neohamatus* to *D. quinqueramus* (N); *D. penultima* (R)	FM	CG, FG	AG		1–7	0.5, 1.0



LITHOLOGIC DESCRIPTION

SILICEOUS MUD
Bioturbated. Matrix: dark olive gray (5Y 3/2). Nearly horizontal burrow at 92 cm in Section 1 suggests that drilling deformation is only slight. Mottling includes the following: 5G 6/2, 5/2, 4/2; 5GY 5/1, 4/1; and 5Y 4/2, 3/2, 2/3 etc. Fracturing: expressed as healed fractures offsetting worm tubes and burrows.

SMEAR SLIDE SUMMARY

	1-103†	1-106††
TEXTURE:		
Sand	10	15
Silt	23	20
Clay	67	65
COMPOSITION:		
Pyrite	TR	–
Other heavy minerals	–	1
Clay minerals	52	63
Volcanic glass	–	2
Glauconite	–	1
Zeolite	5	–
Calc.-Dolo.-Arag.	5	5
Foraminifers	TR	TR
Calc. nannofossils	5	1
Diatoms	10	–
Radiolarians	15	20
Sponge spicules	2	2
Fecal pellets	5	5

† Burrow fill
†† General matrix

CARBONATE BOMB (%)
6, 45–46 = 8.5

SITE 495 HOLE CORE 18 CORED INTERVAL 161.5–171.0 m

TIME – ROCK UNIT: MIDDLE MIOCENE

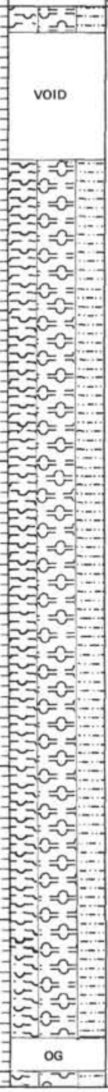
BIOSTRATIGRAPHIC ZONE: *D. pettersoni* (R)

FOSSIL CHARACTER: FORAMINIFERS: FM; RADIOLARIANS: CM

SECTION: 1, 2, 3, 4, 5, 6, 7, 8

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:



LITHOLOGIC DESCRIPTION

Uniform gray (5G 5/1) section

Dark gray (5Y 4/1)

Gray (5G 5/1) matrix

Olive gray (5Y 4/2) Stopping features in drill biscuits

Darkening 5B 4/1

5Y 4/1

SILICEOUS MUD

Bioturbated. Section 4: Burrows filled, light brown gray (10YR 6/2) ash rich layers. Color contrast outlines burrows strongly.

SMEAR SLIDE SUMMARY

	2-83†	4-67††
TEXTURE:		
Sand	24	60
Silt	46	30
Clay	30	10
COMPOSITION:		
Quartz	1	15
Feldspar	1	10
Pyrite	1	1
Other heavy minerals	TR	5
Clay minerals	25	7
Volcanic glass	2	60
Glauconite	TR	–
Calc.-Dolo.-Arag.	TR	–
Diatoms	30	–
Radiolarians	35	–
Sponge spicules	3	
Fecal pellets	1	–

† green matrix

†† light-colored burrow-fill

CARBONATE BOMB (%)

5, 22–24 = 0

5, 31–33 = 0

SITE 495 HOLE CORE 19 CORED INTERVAL 171.0–180.5 m

TIME – ROCK UNIT: UPPER MIDDLE MIOCENE; MIDDLE MIOCENE

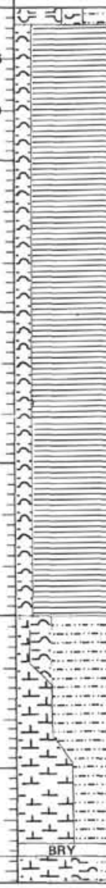
BIOSTRATIGRAPHIC ZONE: *D. pettersoni* (R); *D. exilis* (N), *C. pettersoni* (R)

FOSSIL CHARACTER: RADIOLARIANS: CM; FORAMINIFERS: FM, NANNOFOSSILS: AG, RADIOLARIANS: FM (CC)

SECTION: 1, 2, 3, 4, 5, 6, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:



LITHOLOGIC DESCRIPTION

Gray siliceous mud

← Facies change

Red-brown pelagic clay

10YR 4/4

Facies change obscured by drilling deformation

RADIOLARIAN OOZE

Minor variations due to mottling. Color: 10YR 4/4 goes to very pale brown (10YR 8/3) as nannofossil ooze dominates. Approximately 5% irregular patches of lighter red-brown. Soft sediment deformation – nannofossil ooze has been sucked up into red-brown clays.

SMEAR SLIDE SUMMARY

	1-8	1-31	3-80	5-89
TEXTURE:				
Sand	40	20	5	10
Silt	45	20	25	10
Clay	15	60	70	80
COMPOSITION:				
Quartz	2	1	2	TR
Feldspar	1	–	1	–
Other heavy minerals	–	–	–	TR
Clay minerals	15	–	1	–
Volcanic glass	5	14	14	5
Glauconite	1	–	–	–
Zeolite	–	57	67	–
Calc.-Dolo.-Arag.	–	12	TR	–
Calc. nannofossils	–	–	–	80
Diatoms	26	3	1	TR
Radiolarians	36	10	10	15
Sponge spicules	10	2	1	TR
Organic	1	–	1	–
Manganese	1	1	–	TR

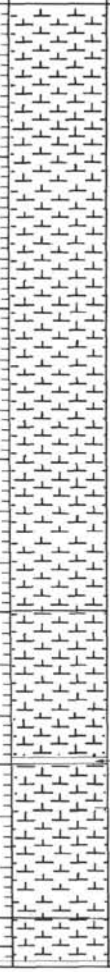
CARBONATE BOMB (%)

2, 25–27 = 0

SITE 495 HOLE CORE 20 CORED INTERVAL 180.5–190.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
MIDDLE MIOCENE	lower *D. exilis* (N) upper *D. alata* (R)	AG	AG	CM		1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

10YR 7/2, 10YR 8/4

10YR 6/2, 10YR 7/2

10YR 8/3

Lighter 10YR 8/4
Darker 10YR 7/4

10YR 7/3

10YR 6/4
Contains wisps and 1–2 mm patch

10YR 8/4

IW

10YR 5/4
Clay-rich ashy

10YR 6/3

10YR 6/1 and 10YR 8/4 mixed

10YR 8/2

NANNOFOSSIL OOZE
Color: 10YR 8/2, 8/3, 8/4, 7/3, and 7/4. Mottled intensely. Moderately drill disturbed. Section 3, 90–150 cm: Some vague biogenic turbation especially hear. Section 5, 102 cm–Section 7, 45 cm: Clay-rich, ashy, siliceous clay (10YR 5/4) portion. Section 5, 35–90 cm: Contains wisps 1–2 mm (probably chondrites bioturbated, 10YR 6/4. Clay rich in top also.

SMEAR SLIDE SUMMARY

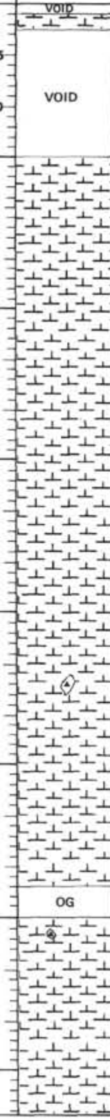
	1-130	3-130	5-123
TEXTURE:			
Sand	13	6	10
Silt	13	45	30
Clay	74	49	60
COMPOSITION:			
Quartz	–	TR	1
Other heavy minerals	2	–	–
Clay minerals	–	20	16
Volcanic glass	1	1	5
Zeolite	10	4	50
Calc.-Dolo.-Arag.	10	5	3
Foraminifers	–	1	–
Calc. nannofossils	64	55	5
Diatoms	2	3	5
Radiolarians	5	10	13
Sponge spicules	–	1	–
Fecal pellets	5	–	–
Organic	1	–	1
Manganese	–	–	1

CARBONATE BOMB (%)
1, 18–20 = 72
5, 53–55 = 1
5, 117–119 = 50

SITE 495 HOLE CORE 21 CORED INTERVAL 190.0–199.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
MIDDLE MIOCENE	lower *D. alata* (R); *D. exilis* (N)	AG		CG		1, 2, 3, 4, 5, 6, 7, 8	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

7.5YR 8/2

Drill swirls marble pattern 10YR 7/1 with 7.5YR 8/2

← Fragment (chert?)

NANNOFOSSIL OOZE
White (10YR 8/2).

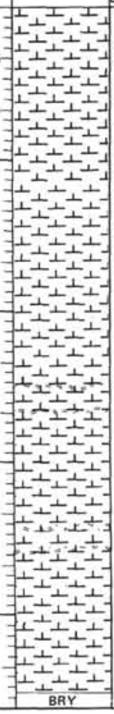
SMEAR SLIDE SUMMARY

	5-50	5-69
TEXTURE:		
Sand	12	3
Silt	40	52
Clay	48	45
COMPOSITION:		
Quartz	TR	–
Other heavy minerals	–	TR
Clay minerals	3	45
Volcanic glass	–	54
Calc.-Dolo.-Arag.	4	–
Foraminifers	12	–
Calc. nannofossils	72	–
Diatoms	1	–
Radiolarians	4	–
Manganese	4	TR

CARBONATE BOMB (%)
3, 90–92 = 77
4, 19–21 = 83

SITE 495 **HOLE** **CORE** 22 **CORED INTERVAL** 199.5–209.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LOWER MIDDLE MIOCENE	*S. heteromorphus* (N) lower *D. alata* (R)	AG	AG	CM		1–5	0.5, 1.0					



10YR 8/2

10YR 8/2 + 10YR 6/1

Ash layers

10YR 7/3 + 10YR 6/1

7.5YR 5/2 and 10YR 7/2–7/3

Ash layers

10YR 6/3 + 10YR 7/3

10YR 6/2 and 10YR 7/3

NANNOFOSSIL OOZE

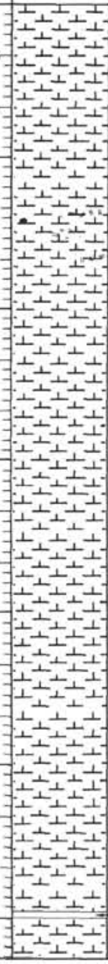
SMEAR SLIDE SUMMARY

	3-80
TEXTURE:	
Sand	25
Silt	5
Clay	70
COMPOSITION:	
Quartz	TR
Other heavy minerals	1
Volcanic glass	27
Foraminifers	TR
Calc. nannofossils	70
Radiolarians	2
Manganese	TR

CARBONATE BOMB (%)
1, 34–36 = 83
1, 98–100 = 88

SITE 495 **HOLE** **CORE** 23 **CORED INTERVAL** 209.0–218.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
LOWER TO MIDDLE MIOCENE	N7 (F) lower *D. alata* (R)	AG		AG		1–7	0.5, 1.0					



10YR 7/4 + 10YR 6/2

Pumice fragment

10YR 7/3 and 10YR 6/2

10YR 6/3 and 10YR 6/1

10YR 8/2–10YR 6/3

Light gray (10YR 7/2)

10YR 8/2

10YR 8/4 and 10YR 8/3

IW

NANNOFOSSIL OOZE

SMEAR SLIDE SUMMARY

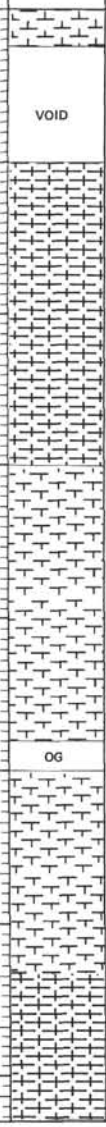
	2-77	5-64
TEXTURE:		
Sand	3	8
Silt	25	15
Clay	72	77
COMPOSITION:		
Clay minerals	5	–
Volcanic glass	–	TR
Foraminifers	5	10
Calc. nannofossils	85	89
Radiolarians	5	1
Manganese	TR	–

CARBONATE BOMB (%)
1, 24–26 = 85
1, 27–29 = 86
1, 98–100 = 22
6, 70–72 = 90

SITE 495 HOLE CORE 24 CORED INTERVAL 218.5–228.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER TO MIDDLE MIOCENE	N.7 (F); *S. heteromorphus* (N); *C. costata* (R); M. Miocene	AG	AG	CG		1, 2, 3, 4, 5, 6, 7, 8, CC	0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

7.5YR 8/2–8/4

Light gray (10YR 7/2)

Light-brownish gray (10YR 6/2)

NANNOFOSSIL-FORAMINIFERAL OOZE
Pinkish white (7.5YR 8/2–8/4)
Section 1: nannofossil ooze. Sections 2 and 3: nannofossil-foraminiferal ooze. Sections 4, 5, and 6: foraminiferal ooze, light gray (10YR 7/2). Sections 7, 8, and Core-Catcher: nannofossil-foraminiferal ooze, light-brownish gray (10YR 6/2).

SMEAR SLIDE SUMMARY

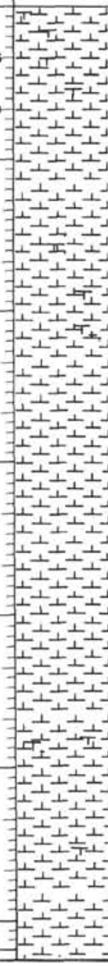
	7-121
TEXTURE:	
Sand	25
Silt	50
Clay	25
COMPOSITION:	
Foraminifers	63
Calc. nannofossils	29
Radiolarians	7
Sponge spicules	TR
Manganese	1

CARBONATE BOMB (%)
2, 34–37 = 13
4, 90–92 = 80
4, 92–94 = 71

SITE 495 HOLE CORE 25 CORED INTERVAL 228.0–237.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER TO MIDDLE MIOCENE	*S. heteromorphus* (N); *C. costata* (R); N.7 (F); *H. ampliaperta* (R)	AG		CG	CC	1, 2, 3, 4, 5, 6, 7	0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

10YR 7/3 and 10YR 8/4

10YR 8/3 and 10YR 8/4

← Locally foraminiferal-ooze patch

10YR 8/4

10YR 6/4

10YR 6/4 and 10YR 7/3

10YR 7/4–7/3

10YR 7/2–7/4

10YR 8/6 + 10YR 6/3

10YR 6/1

10YR 8/4

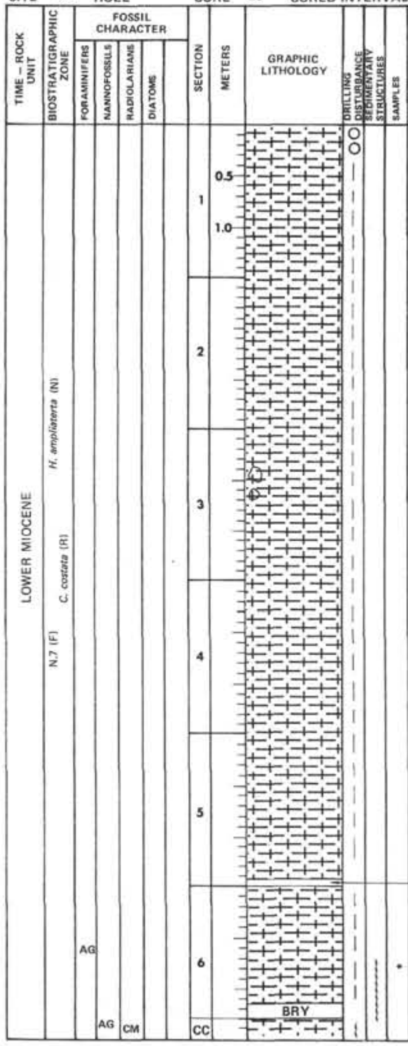
NANNOFOSSIL OOZE
Patches of foraminiferal ooze.

SMEAR SLIDE SUMMARY

	6-90
TEXTURE:	
Sand	2
Silt	25
Clay	73
COMPOSITION:	
Clay minerals	12
Volcanic glass	2
Zeolite	4
Calc.-Dolo.-Arag.	3
Foraminifers	2
Calc. nannofossils	68
Diatoms	2
Radiolarians	5
Sponge spicules	1
Manganese	TR

CARBONATE BOMB (%)
2, 4–6 = 74
2, 6–8 = 78

SITE 495 HOLE CORE 26 CORED INTERVAL 237.5–247.0 m



LITHOLOGIC DESCRIPTION

10YR 8/3

← Some manganese in foraminifers

↕ Gradual color change: 10YR 8/2

← Dark yellowish brown (10YR 4/4) patches

No distinct structure

IW

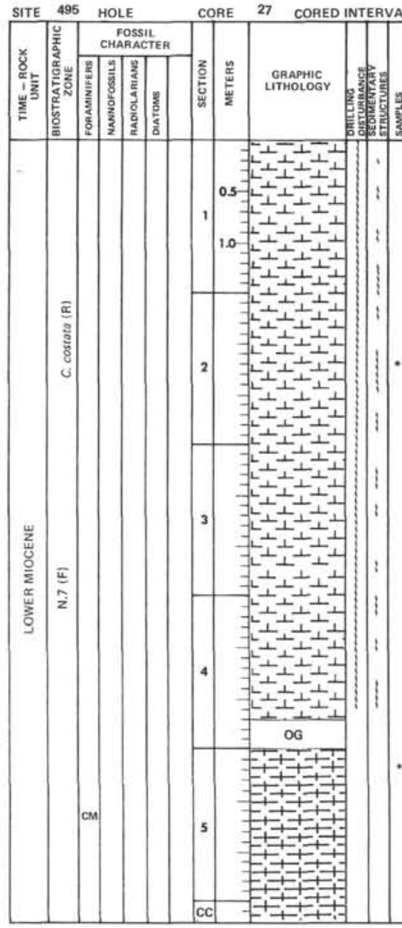
NANNOFOSSIL-FORAMINIFERAL OOZE
Very pale brown (10YR 8/3)

SMEAR SLIDE SUMMARY

	6-72
TEXTURE:	
Sand	25
Silt	20
Clay	55
COMPOSITION:	
Volcanic glass	TR
Zeolite	8
Foraminifers	29
Calc. nannofossils	57
Radiolarains	6
Sponge spicules	TR

CARBONATE BOMB (%)
1, 35–37 = 62
3, 100–102 = 80
6, 80–82 = 78.5

SITE 495 HOLE CORE 27 CORED INTERVAL 247.0–256.5 m



LITHOLOGIC DESCRIPTION

10YR 8/3

10YR 8/2 to 10YR 8/3

10YR 8/3

10YR 8/2

10YR 8/2 to 10YR 8/3

10YR 8/2

← 10YR 7/3

10YR 7/3

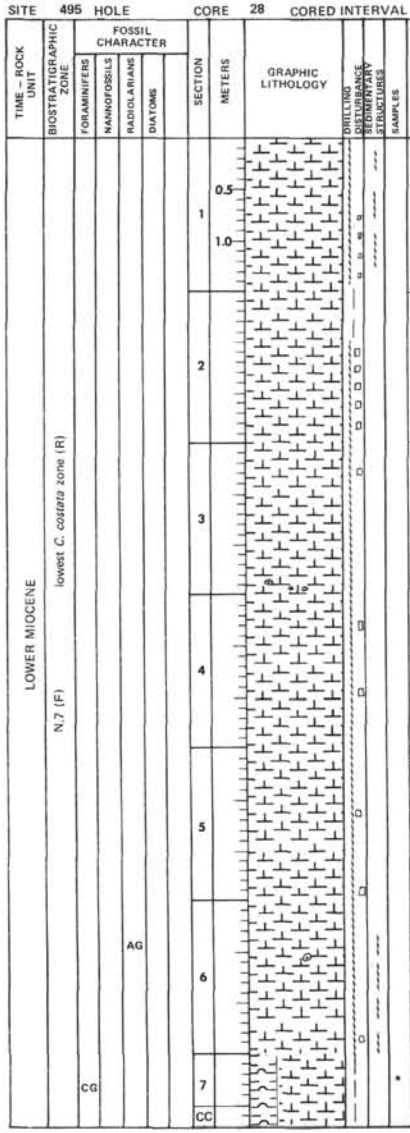
NANNOFOSSIL OOZE
Traces of bioturbation. Localized chalky areas.

SMEAR SLIDE SUMMARY

	2-65	5-14
TEXTURE:		
Sand	2	18
Silt	12	16
Clay	86	66
COMPOSITION:		
Quartz	TR	–
Volcanic glass	TR	1
Foraminifers	6	15
Calc. nannofossils	90	69
Radiolarians	4	15
Sponge spicules	TR	TR

CARBONATE BOMB (%)
1, 35–37 = 29
3, 39–41 = 75.5
5, 100–102 = 72

SITE 495 HOLE CORE 28 CORED INTERVAL 256.5–266.0 m



LITHOLOGIC DESCRIPTION

10YR 8/2

Ooze
Color change and induration contrast
Chalk

Light bluish gray (5GY 7/1)

← Small pumice pebbles

← Volcano structure

10YR 7/3

← Pumice

2.5Y 8/2

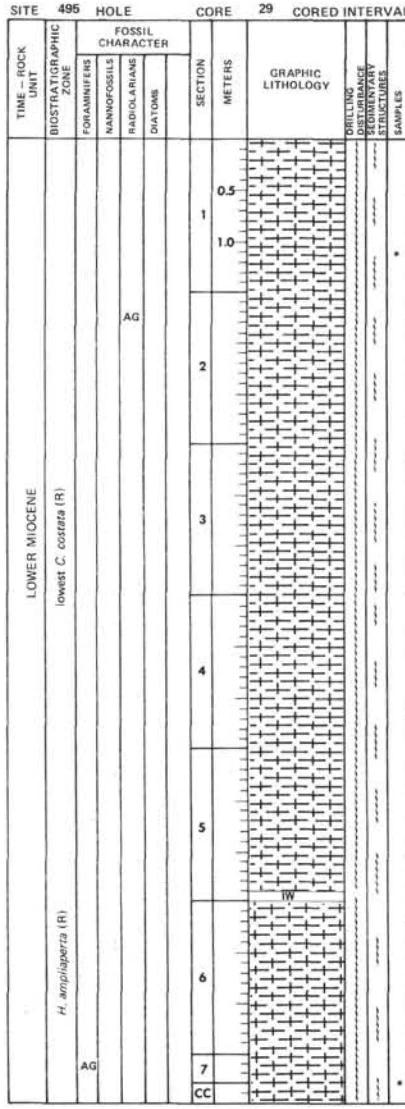
NANNOFOSSIL OOZE/CHALK
White (10YR 8/2). Transitional degree of induration.

SMEAR SLIDE SUMMARY

	7-20
TEXTURE:	
Sand	8
Silt	40
Clay	52
COMPOSITION:	
Volcanic glass	TR
Zeolite	15
Foraminifers	8
Calc. nannofossils	52
Radiolarians	25

CARBONATE BOMB (%)
5, 70–72 = 67
5, 73–75 = 67

SITE 495 HOLE CORE 29 CORED INTERVAL 266.0–275.5 m



LITHOLOGIC DESCRIPTION

5GY 7/1

← 5GY 7/1 + 10YR 6/3

← 5GY 6/1

FORAMINIFERAL NANNOFOSSIL OOZE
Light bluish gray (5GY 7/1) in color. Note: sometimes chalk layers.

SMEAR SLIDE SUMMARY

	1-110	7-27
TEXTURE:		
Sand	8	22
Silt	25	25
Clay	67	53
COMPOSITION:		
Quartz	–	TR
Volcanic glass	1	TR
Zeolite	–	2
Foraminifers	16	25
Calc. nannofossils	79	71
Radiolarians	4	2
Silicoflagellates	TR	TR

CARBONATE BOMB (%)
2, 9–12 = 1
4, 24–26 = 70
4, 25–27 = 74

SITE 495 HOLE CORE 30 CORED INTERVAL 275.5–285.0 m

TIME – ROCK UNIT: LOWER MIOCENE

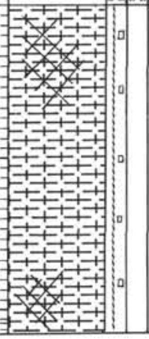
BIOSTRATIGRAPHIC ZONE: *S. wolffii* (R); *S. belemnos* (N)

FOSSIL CHARACTER (FORAMINIFERS / NANNOFOSSILS / RADIOLARIANS / DIATOMS): AG; CM

SECTION: 1, 2, 3, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

5GY 7/1

← Conjugate fracture

FORAMINIFERAL-NANNOFOSSIL OOZE AND CHALK

Color: light blue gray (5GY 7/1). Chalky intervals behave as biscuits.

CARBONATE BOMB (%)

2, 117–119 = 74

3, 8–10 = 85

SITE 495 HOLE CORE 31 CORED INTERVAL 285.0–294.5 m

TIME – ROCK UNIT: LOWER MIOCENE

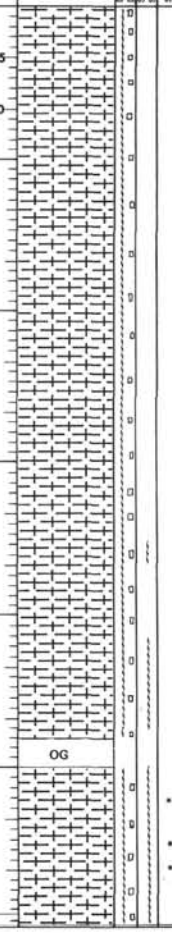
BIOSTRATIGRAPHIC ZONE: *S. belemnos* (N); *S. wolffii* (R); N.7 (F); *T. carinatus* (N)

FOSSIL CHARACTER (FORAMINIFERS / NANNOFOSSILS / RADIOLARIANS / DIATOMS): AG AG CG

SECTION: 1, 2, 3, 4, 5, 6, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

5GY 7/1

← Mottled small patches colored: 10YR 7/6

FORAMINIFERAL-NANNOFOSSIL OOZE

Color: light bluish gray (5GY 7/1). Same as *Core 30 except more indurated portions have* behaved as biscuits.

SMEAR SLIDE SUMMARY

	6-30†	6-75††	6-96†††
TEXTURE:			
Sand	10	12	15
Silt	10	14	25
Clay	80	74	60
COMPOSITION:			
Mica	–	TR	TR
Other heavy minerals	–	TR	–
Volcanic glass	1	–	–
Zeolite	19	15	10
Calc.-Dolo.-Arag.	5	3	5
Foraminifers	5	10	10
Calc. nannofossils	45	61	45
Diatoms	8	3	2
Radiolarians	7	5	5
Sponge spicules	5	1	1
Fecal pellets	5	TR	2
Manganese	–	–	20

† brown clast

†† groundmass

††† dark bands

CARBONATE BOMB (%)

4, 51–53 = 83

SITE 495 HOLE CORE 32 CORED INTERVAL 294.5–304.0 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS) | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

LOWER MIOCENE

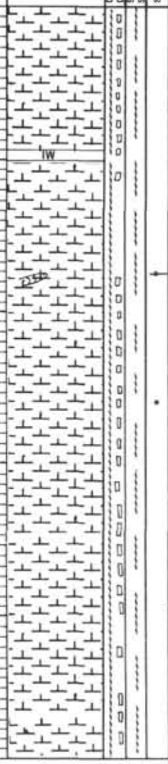
N.6 (F)

S. delmontensis (R)

AG AG AG

Sections: 1, 2, 3, 4, 5, CC

Meters: 0.5, 1.0



IW

5GY 7/1

← Burrow very clear

5BG 7/1

NANNOFOSSIL OOZE
Color: light bluish gray (5GY 7/1). Note: Sometimes chalk layers. Traces of bioturbation in all the core.

SMEAR SLIDE SUMMARY

	2-110	3-85
TEXTURE:		
Sand	20	12
Silt	25	12
Clay	55	76
COMPOSITION:		
Mica	TR	–
Volcanic glass	2	3
Zeolite	22	14
Calc.-Dolo.-Arag.	1	–
Foraminifers	8	1
Calc. nannofossils	52	63
Diatoms	6	8
Radiolarians	4	7
Sponge spicules	3	1
Manganese	TR	TR

CARBONATE BOMB (%)
1, 41–43 = 81
3, 107–109 = 83

SITE 495 HOLE CORE 33 CORED INTERVAL 304.0–313.5 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS) | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

LOWER MIOCENE

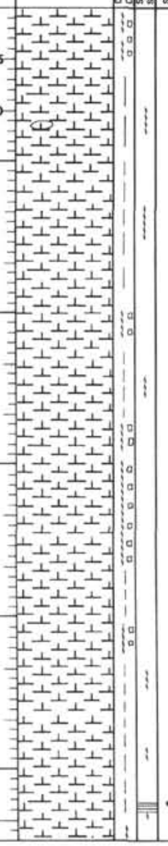
S. delmontensis (R)

AG

AG CM

Sections: 1, 2, 3, 4, 5, 6, CC

Meters: 0.5, 1.0



5BG 7/1

← Clast of red-brown clay (worm tube)

Mottled + drilling induced fractures

Mottled

← Drilling laminations

NANNOFOSSIL OOZE
Color: light-bluish gray (5BG 7/1).

SMEAR SLIDE SUMMARY

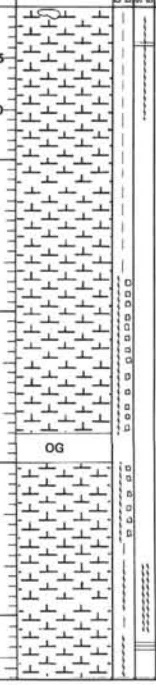
	6-30
TEXTURE:	
Sand	10
Silt	15
Clay	75
COMPOSITION:	
Volcanic glass	1
Zeolite	15
Foraminifers	1
Calc. nannofossils	65
Diatoms	12
Radiolarians	2
Sponge spicules	2

CARBONATE BOMB (%)
3, 11–13 = 84
4, 21–23 = 85.5

SITE 495 HOLE CORE 34 CORED INTERVAL 313.5–323.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER MIOCENE	*S. delmontensis* (R)	AG	AG	AG, CM		1, 2, 3, 4, 5, CC	0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Manganese laminations

5BG 7/1

Drilling induced fractures of incipient biscuiting

Faint mottling

NANNOFOSSIL OOZE
Color: light bluish gray (5BG 7/1).

SMEAR SLIDE SUMMARY

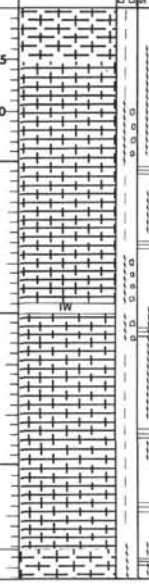
	2-65
TEXTURE:	
Sand	2
Silt	12
Clay	86
COMPOSITION:	
Quartz	TR
Volcanic glass	TR
Foraminifers	6
Calc. nannofossils	90
Radiolarians	4
Sponge spicules	TR

CARBONATE BOMB (%)
3, 11–13 = 90
3, 16–18 = 90.5

SITE 495 HOLE CORE 35 CORED INTERVAL 323.0–332.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER MIOCENE	N.5 (F)	AG	AG			1, 2, 3, 4, CC	0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Increasing concentration of manganese bluish-black tint

FORAMINIFERAL–NANNOFOSSIL OOZE AND CHALK
First indurated core of sequence brittle fracture in Section 1. Color: bluish gray (5BG 7/1). Section 2: 5BG 7/2, 80–90 cm: thin laminations showing original bedding, with deformation near the top of biscuit. Lamination color: 2.5Y 5/0. Bioturbation, distinct elliptical cross-sections of burrows to 2 cm in diameter. Traces of manganese.

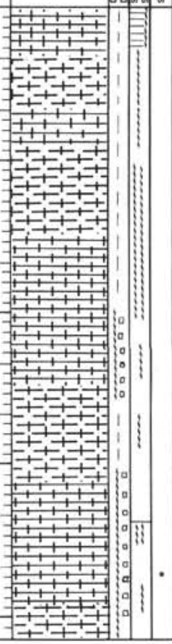
SMEAR SLIDE SUMMARY

	1-80
TEXTURE:	
Sand	15
Silt	5
Clay	80
COMPOSITION:	
Volcanic glass	2
Zeolite	5
Calc.-Dolo.-Arag.	5
Foraminifers	10
Calc. nannofossils	70
Diatoms	3
Radiolarians	2
Sponge spicules	1
Fecal pellets	5

CARBONATE BOMB (%)
3, 21–23 = 85
4, 18–20 = 90

SITE 495 HOLE CORE 36 CORED INTERVAL 332.5–342.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER MIOCENE	N.5 (F); *S. delmontensis* (R)	AG		CM		1, 2, 3, 4, CC	0.5, 1.0



5G 7/1 and N7/1

Biscuit and flow structure

NANNOFOSSIL OOZE–CHALK
Color: 5G 7/1 and N7/1, a light gray, somewhere between these 2 color and lighter than both. Biscuits are indurated enough to behave as chalk, but sediment between has behaved plastically as nannofossil ooze and is quite soft.

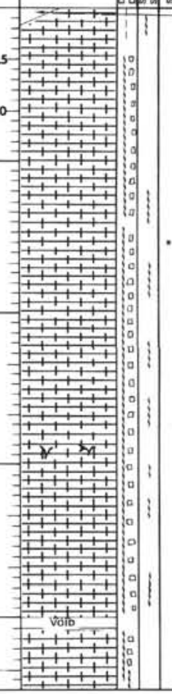
SMEAR SLIDE SUMMARY

	4-105
TEXTURE:	
Sand	10
Silt	30
Clay	60
COMPOSITION:	
Volcanic glass	1
Zeolite	20
Foraminifers	5
Calc. nannofossils	50
Diatoms	12
Radiolarians	5
Sponge spicules	6

CARBONATE BOMB (%)
4, 41–43 = 86

SITE 495 HOLE CORE 37 CORED INTERVAL 342.0–351.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
LOWER MIOCENE	*S. delmontensis*; N.7 (F)	AG	AG			1, 2, 3, 4, 5, CC	0.5, 1.0



Traces of manganese

Pebbles

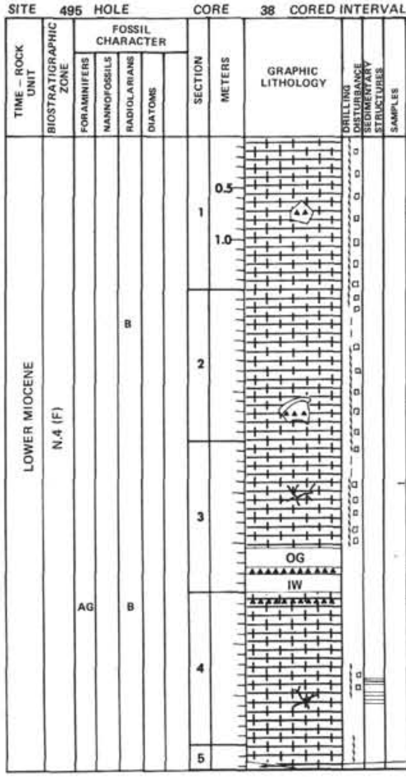
FORAMINIFERAL-NANNOFOSSIL CHALK
Light blue gray (5BG 7/1–5Y 7/1–5G 7/1).

SMEAR SLIDE SUMMARY

	2-80
TEXTURE:	
Sand	15
Silt	10
Clay	75
COMPOSITION:	
Glauconite	TR
Zeolite	20
Calc.-Dolo.-Arag.	5
Foraminifers	15
Calc. nannofossils	40
Diatoms	1
Radiolarians	5
Sponge spicules	1
Fecal pellets	13

CARBONATE BOMB (%)
4, 31–33 = 90
4, 37–39 = 93.5

SITE 495 **HOLE** **CORE** 38 **CORED INTERVAL** 351.5–361.0 m



LITHOLOGIC DESCRIPTION

5G 7/1

← Chert

← Chert with alteration rind

← Dendritic manganese

← Chert cobble

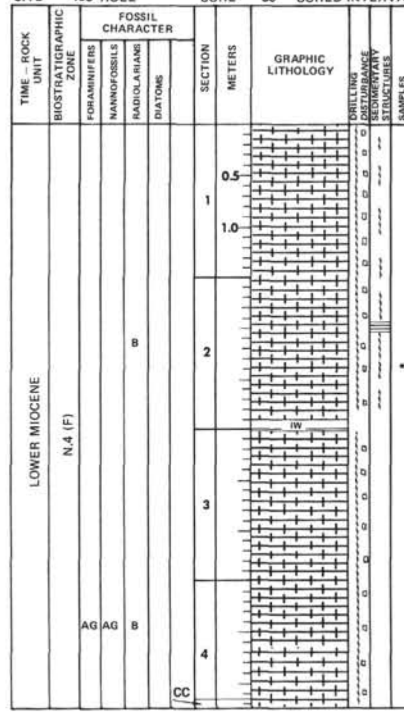
← Small bits of chert in calcareous matrix

VOID

FORAMINIFERAL-NANNOFOSSIL CHALK
Light bluish gray (5G 7/1) in color. Colors (*Section 1*): *moderate olive brown* (5Y 4/4) with rim of greenish black (5GY 2/2) more intense outward and terminating abruptly against grayish green (5G 5/2). Note: Sample taken (IW), subsequently returned to core, but it is not in photograph.

CARBONATE BOMB (%)
3, 24–26 = 91.5
5, 5–7 = 93.5

SITE 495 **HOLE** **CORE** 39 **CORED INTERVAL** 361.0–370.5 m



LITHOLOGIC DESCRIPTION

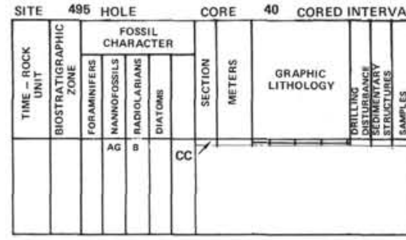
NANNOFOSSIL-FORAMINIFERAL CHALK
Light bluish gray (5G 7/1) in color. Biscuiting is probably the most noticible feature of the entire core.

SMEAR SLIDE SUMMARY

	2-89
TEXTURE:	
Sand	30
Silt	10
Clay	60
COMPOSITION:	
Glauconite	2
Zeolite	18
Foraminifers	30
Calc. nannofossils	40
Fecal pellets	10

CARBONATE BOMB (%)
2, 96–98 = 89.5

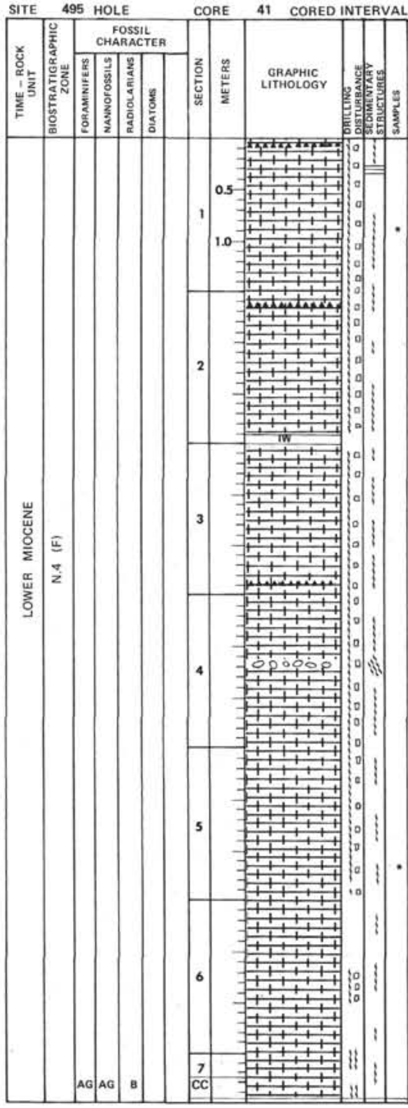
SITE 495 **HOLE** **CORE** 40 **CORED INTERVAL** 370.5–380.0 m



LITHOLOGIC DESCRIPTION

FORAMINIFERAL-NANNOFOSSIL CHALK
Seven cm recovery. Totally disrupted. Explanation is that chert blocked the bit opening, was eventually ground up and recovered in the top of Core 41, whicli is full.

SITE 495 HOLE CORE 41 CORED INTERVAL 380.0–389.5 m



LITHOLOGIC DESCRIPTION

Manganese-rich laminations

5G 7/1

5G 7/1–8/1

Rounded clasts?, resedimentation?, and burrowing?

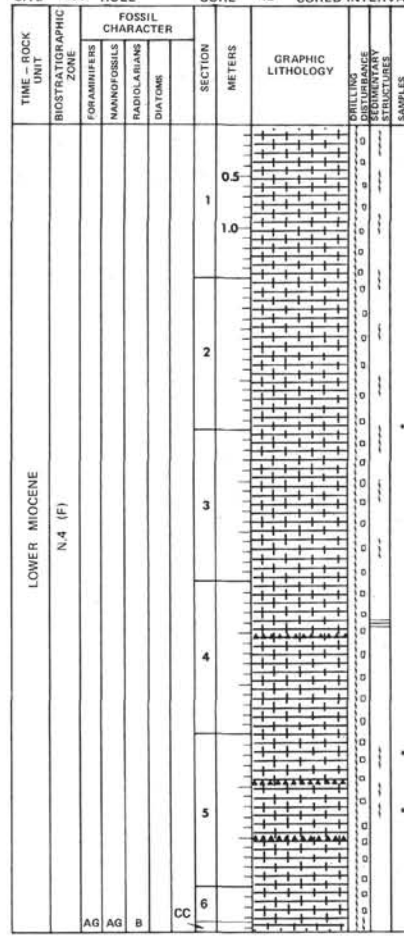
FORAMINIFERAL-NANNOFOSSIL CHALK
Color: light bluish gray (5G 7/1).
Core broken into large biscuits.

SMEAR SLIDE SUMMARY

	1-89	5-116
TEXTURE:		
Sand	20	35
Silt	2	4
Clay	78	61
COMPOSITION:		
Feldspar	–	TR
Zeolite	10	–
Calc.-Dolo.-Arag.	–	1
Foraminifers	10	37
Calc. nannofossils	70	62
Radiolarians	TR	–
Fecal pellets	10	–

CARBONATE BOMB (%)
1, 66–68 = 93.5
1, 71–73 = 93

SITE 495 HOLE CORE 42 CORED INTERVAL 389.5–399.0 m



LITHOLOGIC DESCRIPTION

5GY 7/1–5G 7/1

5Y 8/3

5Y 8/4

FORAMINIFERAL-NANNOFOSSIL CHALK
Color: 5GY 7/1–5G 7/1, changes to pale yellow (5Y 8/3–8/4) in Section 5 downward.

SMEAR SLIDE SUMMARY

	2-142	5-15	5-71
TEXTURE:			
Sand	12	13	8
Silt	30	28	25
Clay	58	59	67
COMPOSITION:			
Clay minerals	TR	–	2
Volcanic glass	–	1	–
Zeolite	–	6	–
Calc.-Dolo.-Arag.	5	8	7
Foraminifers	15	20	17
Calc. nannofossils	80	65	74

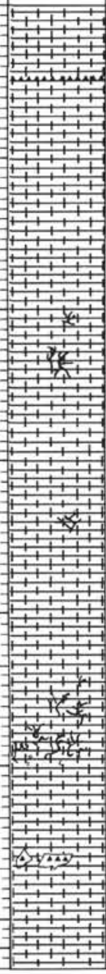
CARBONATE BOMB (%)
5, 58–60 = 94.5
5, 70–72 = 89

SITE 495 HOLE CORE 43 CORED INTERVAL 399.0–408.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION
LOWER MIOCENE	N.4 (F)	AG	AG	B		1, 2, 3, 4, 5, 6, 7, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

2.5Y 8/2–10YR 8/3

FORAMINIFERAL-NANNOFOSSIL CHALK
Deposition of dendritic manganese, especially in Section 5.

SMEAR SLIDE SUMMARY

	4-86	5-144
TEXTURE:		
Sand	2	7
Silt	20	15
Clay	78	7
COMPOSITION:		
Clay minerals	17	12
Volcanic glass	1	1
Zeolite	TR	–
Foraminifers	1	5
Calc. nannofossils	80	78
Radiolarians	TR	TR
Sponge spicules	1	TR
Manganese	–	4

CARBONATE BOMB (%)
4, 42–45 = 88
4, 45–47 = 93

2.5Y 8/4

2.5Y 4/3

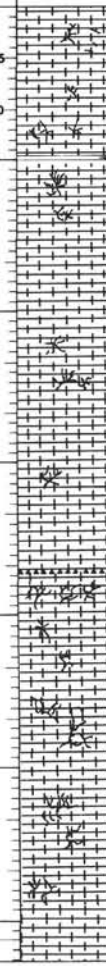
2.5Y 8/4

SITE 495 HOLE CORE 44 CORED INTERVAL 408.5–418.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION
LOWER MIOCENE	N.4 (F)	AG	AG			1, 2, 3, 4, 5, 6, 7, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

5Y 8/2

← Contains dendritic manganese

— VOID

2.5Y 8/2–5Y 8/3

← Foraminifera-rich patches

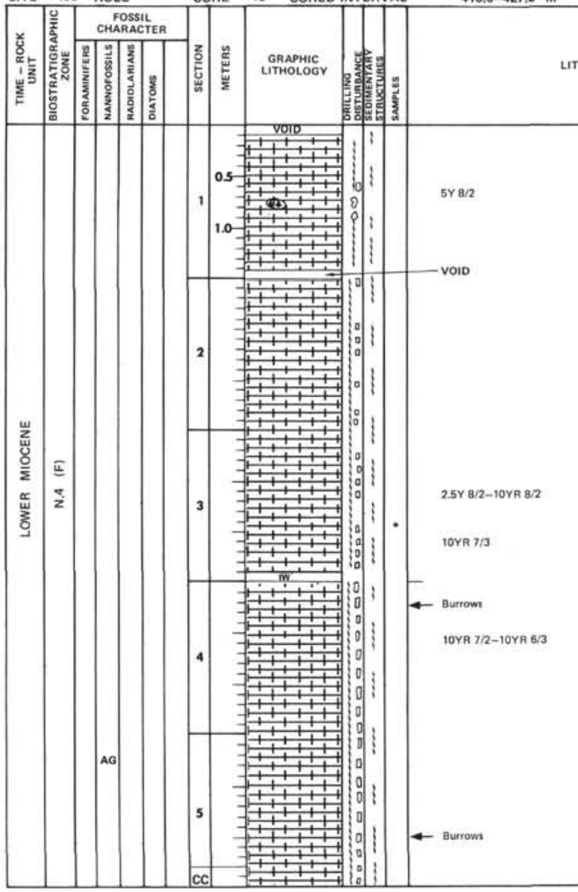
FORAMINIFERAL-NANNOFOSSIL CHALK
White (5Y 8/2).

SMEAR SLIDE SUMMARY

	2-76	5-87
TEXTURE:		
Sand	1	20
Silt	10	7
Clay	89	73
COMPOSITION:		
Volcanic glass	1	TR
Zeolite	12	11
Calc.-Dolo.-Arag.	–	TR
Foraminifers	1	19
Calc. nannofossils	85	70
Radiolarians	TR	–
Sponge spicules	–	TR

CARBONATE BOMB (%)
1, 70–72 = 96
6, 20–22 = 93.5
6, 22–24 = 95.5

SITE 495 HOLE CORE 45 CORED INTERVAL 418.0–427.5 m



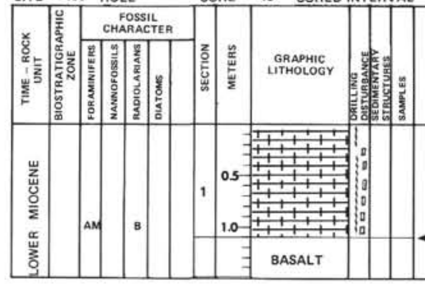
FORAMINIFERAL-NANNOFOSSIL CHALK
Dendritic manganese especially in Section 4.

SMEAR SLIDE SUMMARY

	3-95
TEXTURE:	
Sand	5
Silt	12
Clay	83
COMPOSITION:	
Clay minerals	14
Volcanic glass	1
Zeolite	1
Calc.-Dolo.-Arag.	TR
Foraminifers	4
Calc. nannofossils	80
Manganese	TR

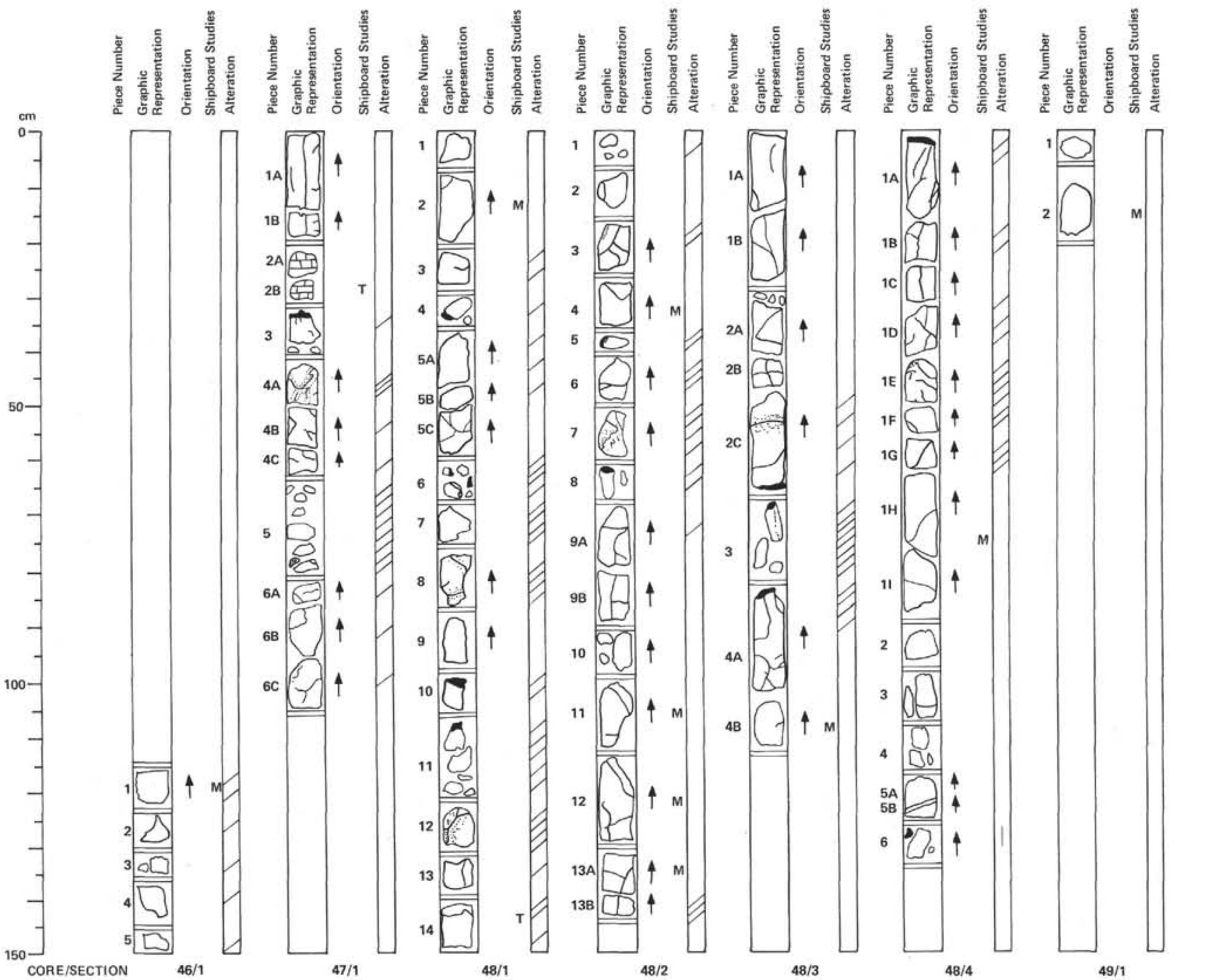
CARBONATE BOMB (%)
4, 94–96 = 82
4, 96–98 = 82

SITE 495 HOLE CORE 46 CORED INTERVAL 427.5–428.5 m



NANNOFOSSIL-FORAMINIFERAL CHALK

CARBONATE BOMB (%)
1, 31–33 = 87
1, 33–35 = 93.5



67-495-46 **Depth: 427.5–428.5 m**

SECTION 1

Macroscopic Description

Microphyric basalt dark gray, groundmass is crystalline and microlitic and contains <7% olivine microphenocrysts <1 mm in diameter and <4% plagioclase microphenocrysts average 2 mm long. Olivine phenocrysts locally clustered and altered to orange-brown material. Piece 1 contains cavities completely filled with crystalline white calcite. The actual contact of basalt and foraminiferal nannofossil chalk is not preserved, but lowest chalk contains abundant well-preserved foraminifera.

67-495-47 **Depth: 428.5–436.5 m**

SECTION 1

Macroscopic Description

Dark gray to tan basalt. Groundmass varies from microlitic and very finely crystalline to aphanitic. Generally phyric; proportions of phenocrysts variable through section but average: 5% olivine, partly altered to orange brown clay(?), 2 mm or less; 3% plagioclase laths up to 4 mm long. Piece 3 top has a 1 cm glassy rim, dark brown-black, partly altered to orange-brown clay. A piece in Piece 5 is also partly glassy. One mm and less white crystalline vein in Piece 4A is surrounded by tan altered groundmass. Some pieces in Piece 5 similarly altered and colored. Pieces 2A and 2B are creamy white firm, possibly baked chalk, with black dendritic oxide stains and angular 2–5 mm fragments of greenish-yellow waxy material.

67-495-48 **Depth: 436.5–446.0 m**

SECTION 1

Macroscopic Description

Predominantly dark gray, fresh phyric basalt. Locally, smaller pieces (as in Piece 6) are altered throughout and reddish brown in color. Pieces such as 12 and 8 show similar alteration related to 1–2 mm white crystalline veins. Olivine phenocrysts <2 mm 5%, locally replaced by orange-brown alteration materials. Plagioclase laths up to 3 mm long 2% average. Pieces 4, 6, and 10 have glassy, brown-black rims up to 1 cm thick locally altered to orange-brown clay. A fragment in Piece 11 contains 1–3 mm vesicles filled with green waxy clay. Alternating glassy and fresh pieces suggest pillow lava.

SECTION 2

Macroscopic Description

Pieces 1–8, generally altered to pale brown to red brown. Pieces 9–13, fresh dark gray basalt. Phyric basalt with microlitic groundmass, <5% olivine phenocrysts up to 2 mm diameter; <2% plagioclase phenocrysts up to 4 mm long. One cm glassy rim in pieces 5, 6, 8; olivine becomes altered to orange-brown clay approaching rim. Piece 6 has 2 cm patch of drusy calcite coating indentation in glassy rim. Piece 7 contains 1–2 mm white veins with adjacent red brown altered zones.

SECTION 3

Macroscopic Description

Phyric basalt, dark gray where fresh; microlitic groundmass; <5% olivine phenocrysts <2 mm, locally altered to red brown clay; 2% plagioclase microphenocrysts up to 2 mm long. Basalt locally altered to reddish brown; altered in vicinity of vein in Piece 2C. Piece 1A contains 3 mm vesicles and patches filled with drusy calcite. Glassy rims on Pieces 2, 3, and 4; probably all pillow basalts.

SECTION 4

Macroscopic Description

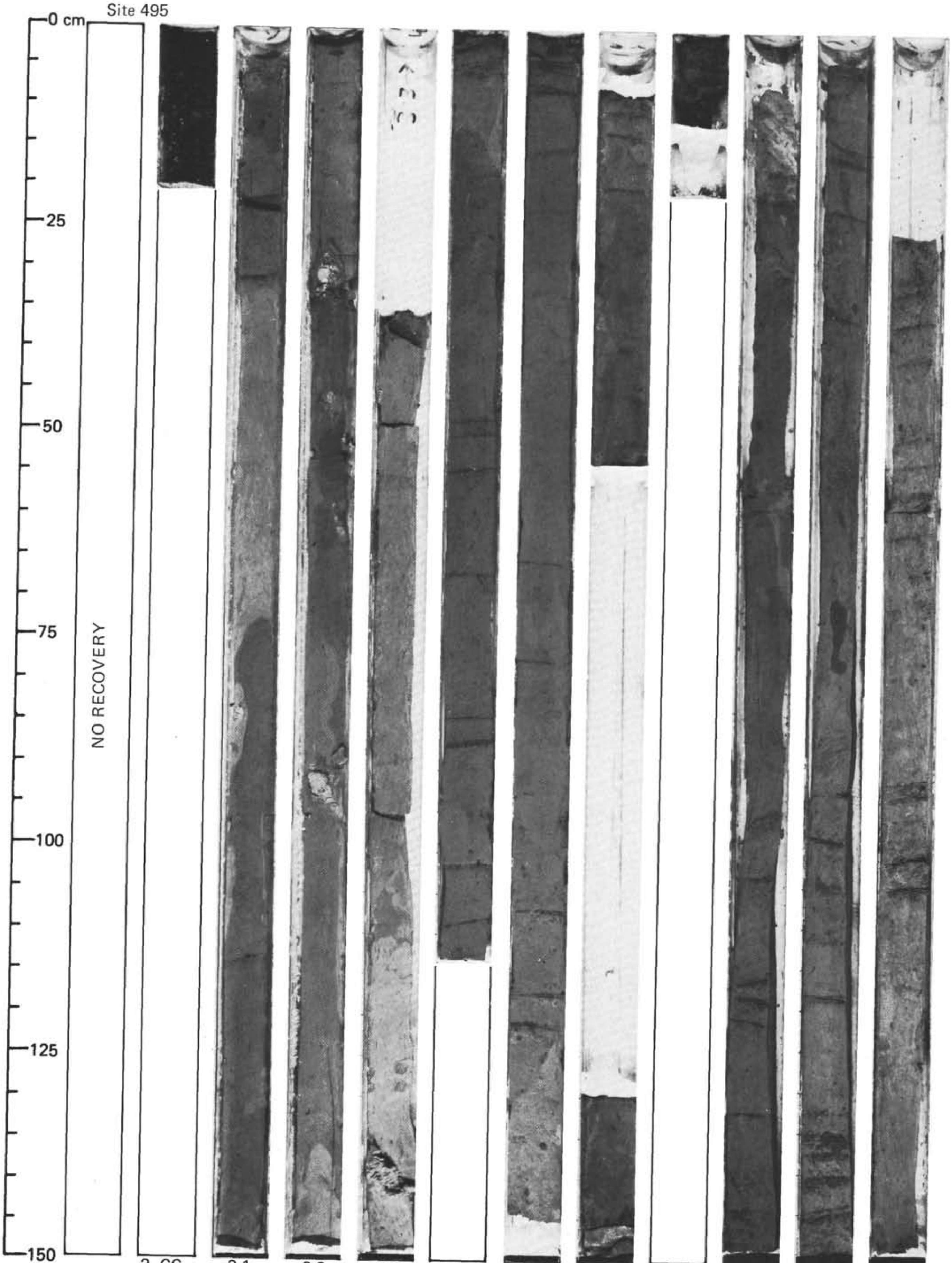
Phyric dark gray to red brown (altered) basalt. Microlitic groundmass, 2% olivine phenocrysts <1 mm; 2% plagioclase phenocrysts up to 4 mm long. Pieces 1A–1G are altered and partly reddish brown; glassy selvages are probably chilled rims of pillows. Olivines altered to reddish brown and green clay. Some fractures in Pieces 1B and 1C coated with greenish clay. Piece 1B has a 2 cm cavity lined with calcite crystals; Piece 1C has a 1 x 2 cm large cavity filled with creamy calcite. Pieces 1H–5 are extremely fresh. Piece 6 is moderately altered.

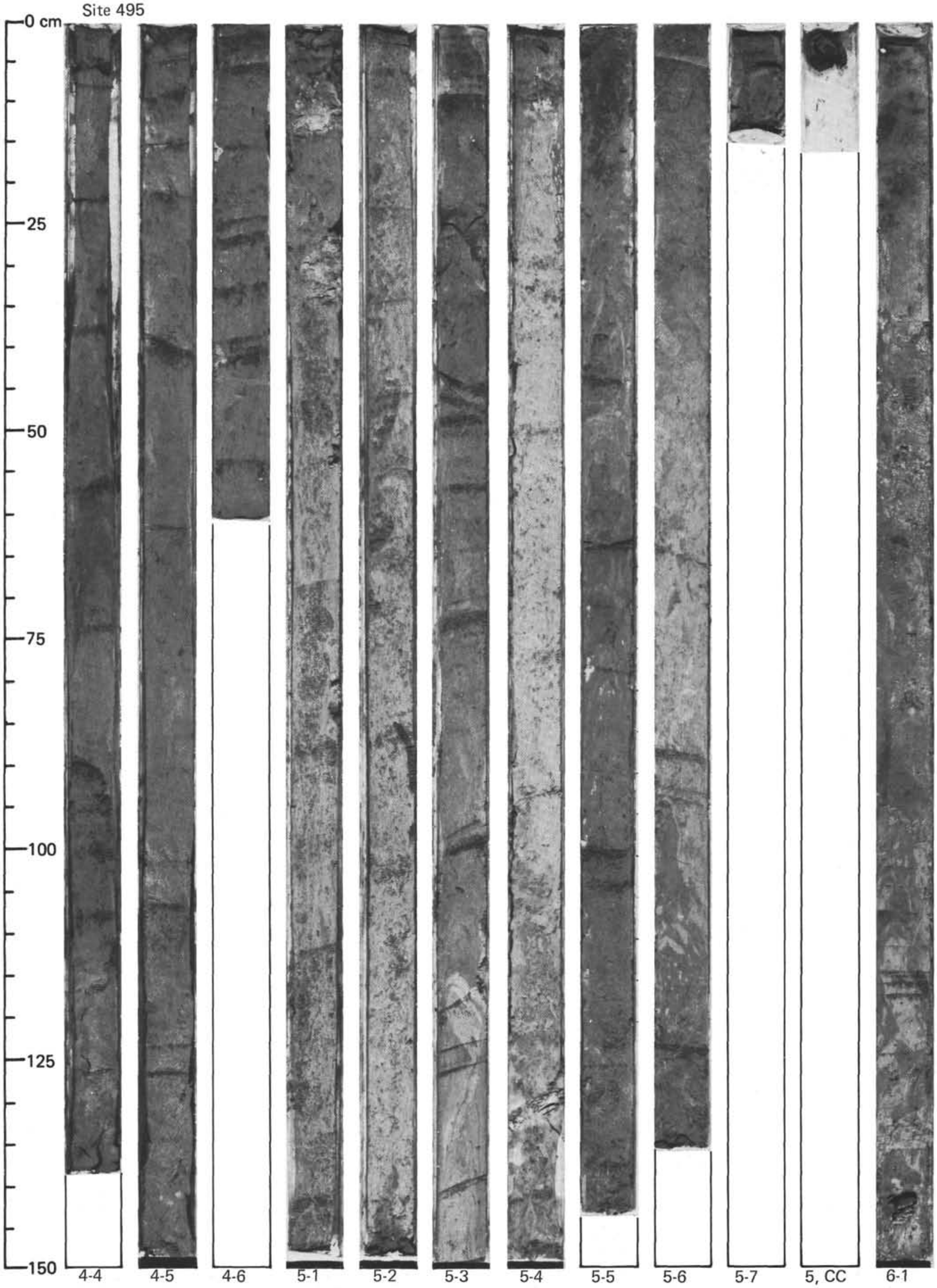
67-495-49 **Depth: 446.0–446.5 m**

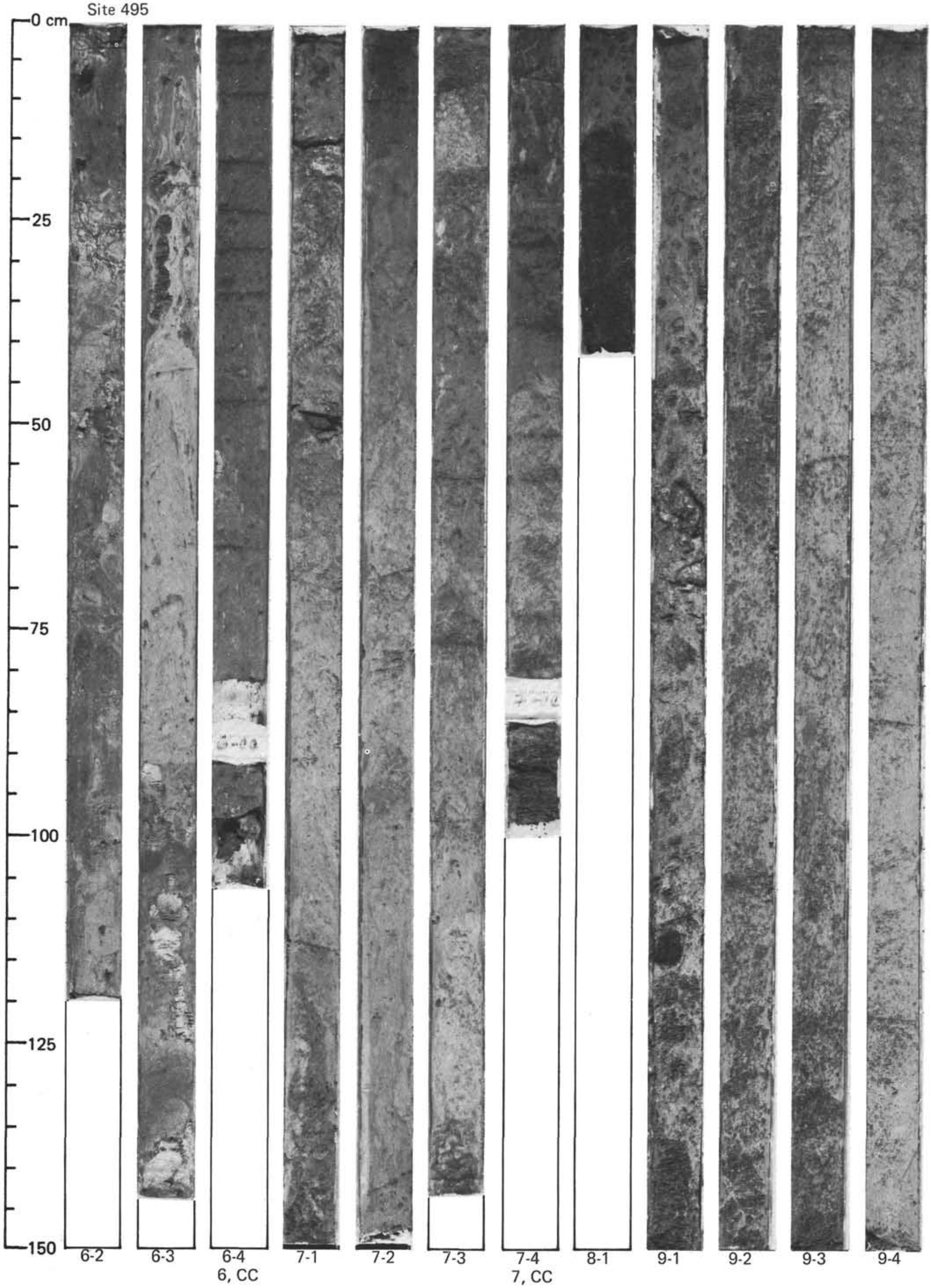
SECTION 1

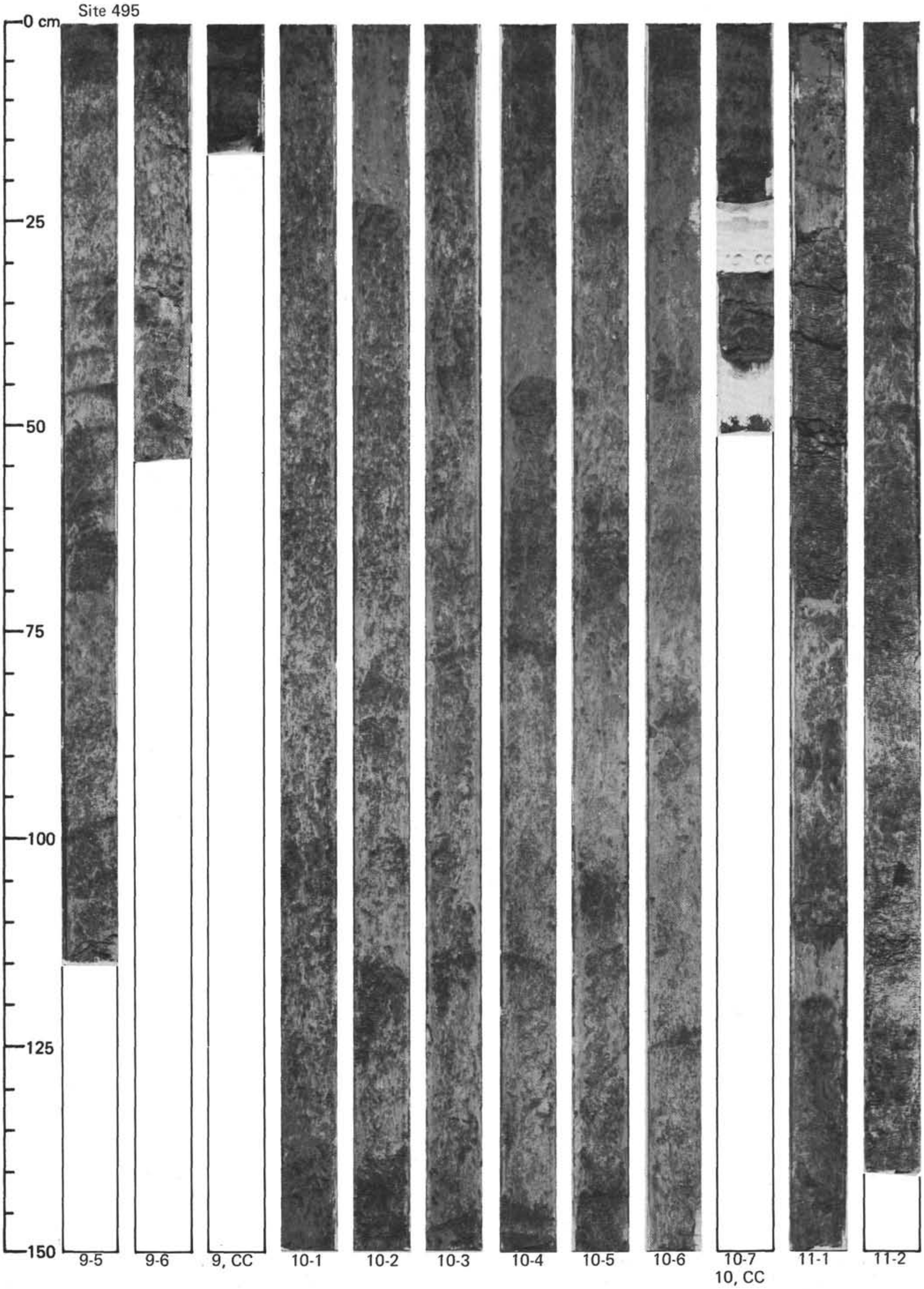
Macroscopic Description

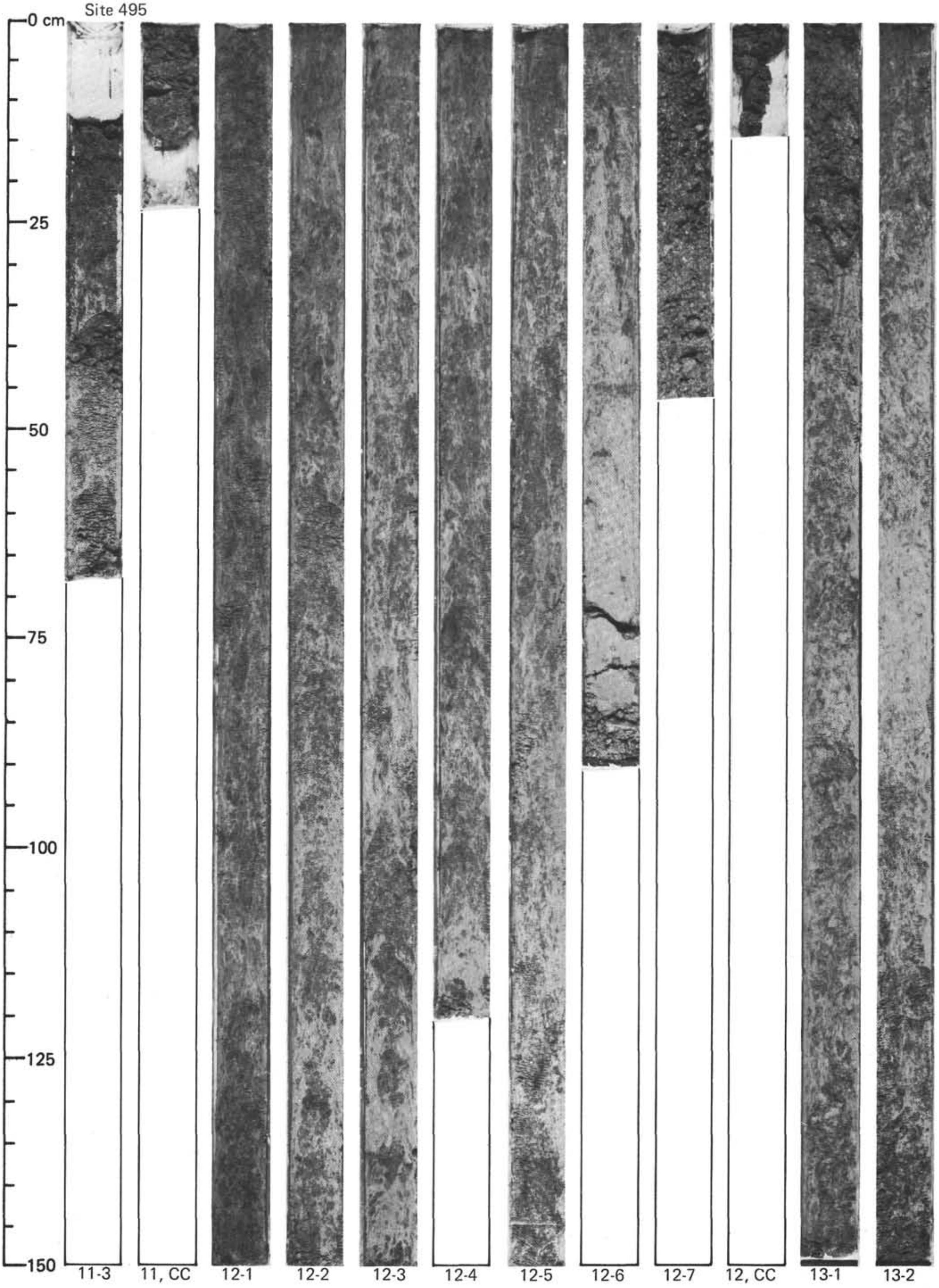
Phyric medium- to fine-grained dark gray fresh basalt, olivine phenocrysts up to 2 mm, 5%; plagioclase laths up to 2 mm long, 1%. Groundmass locally variolitic. Fractures locally coated with olive green clay.

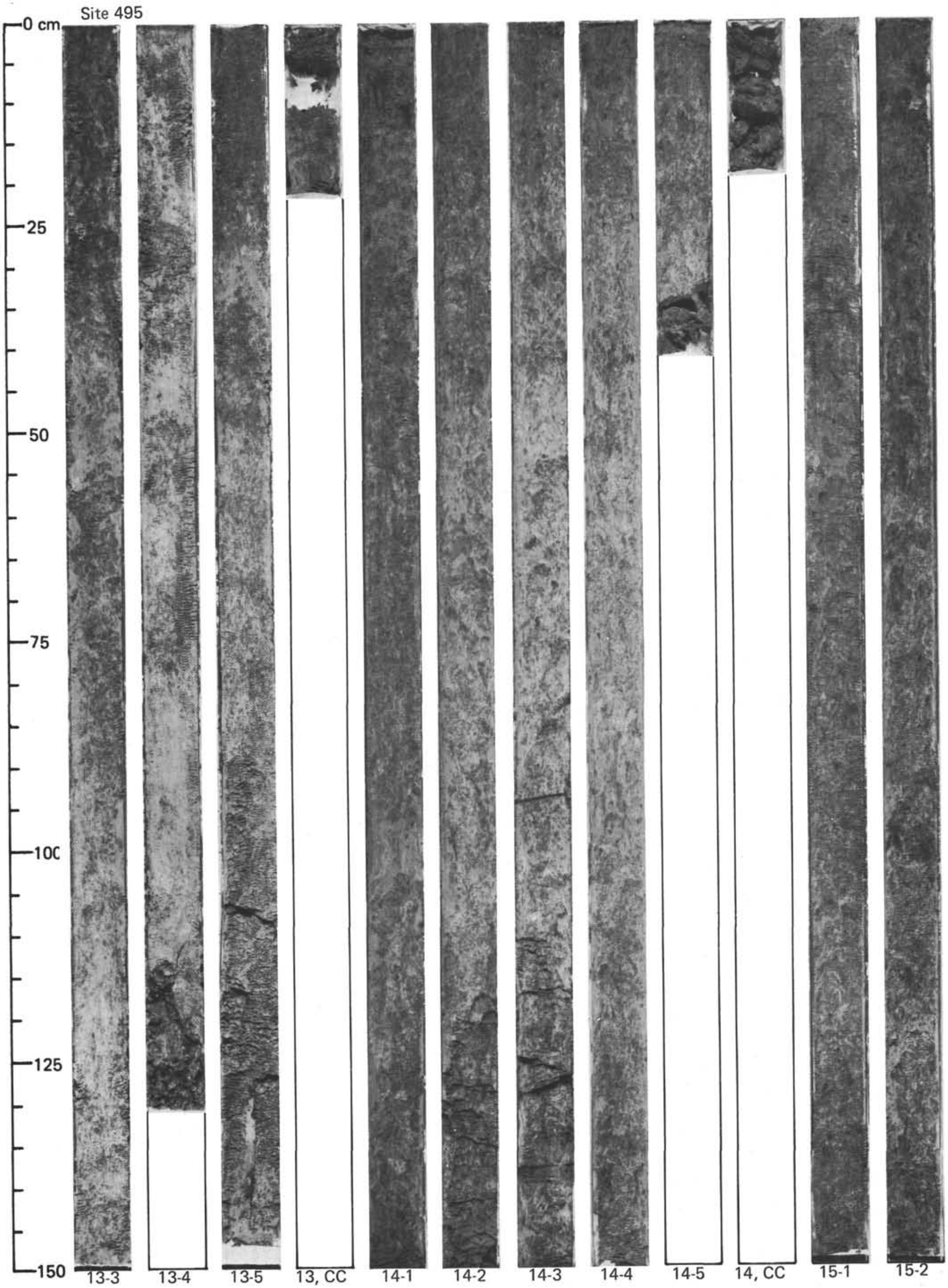

Site 495
0 cm
25
50
75
100
125
150
NO RECOVERY
2, CC
3-1
3-2
3-3
3-4
3-5
3-6
3, CC
4-1
4-2
4-3

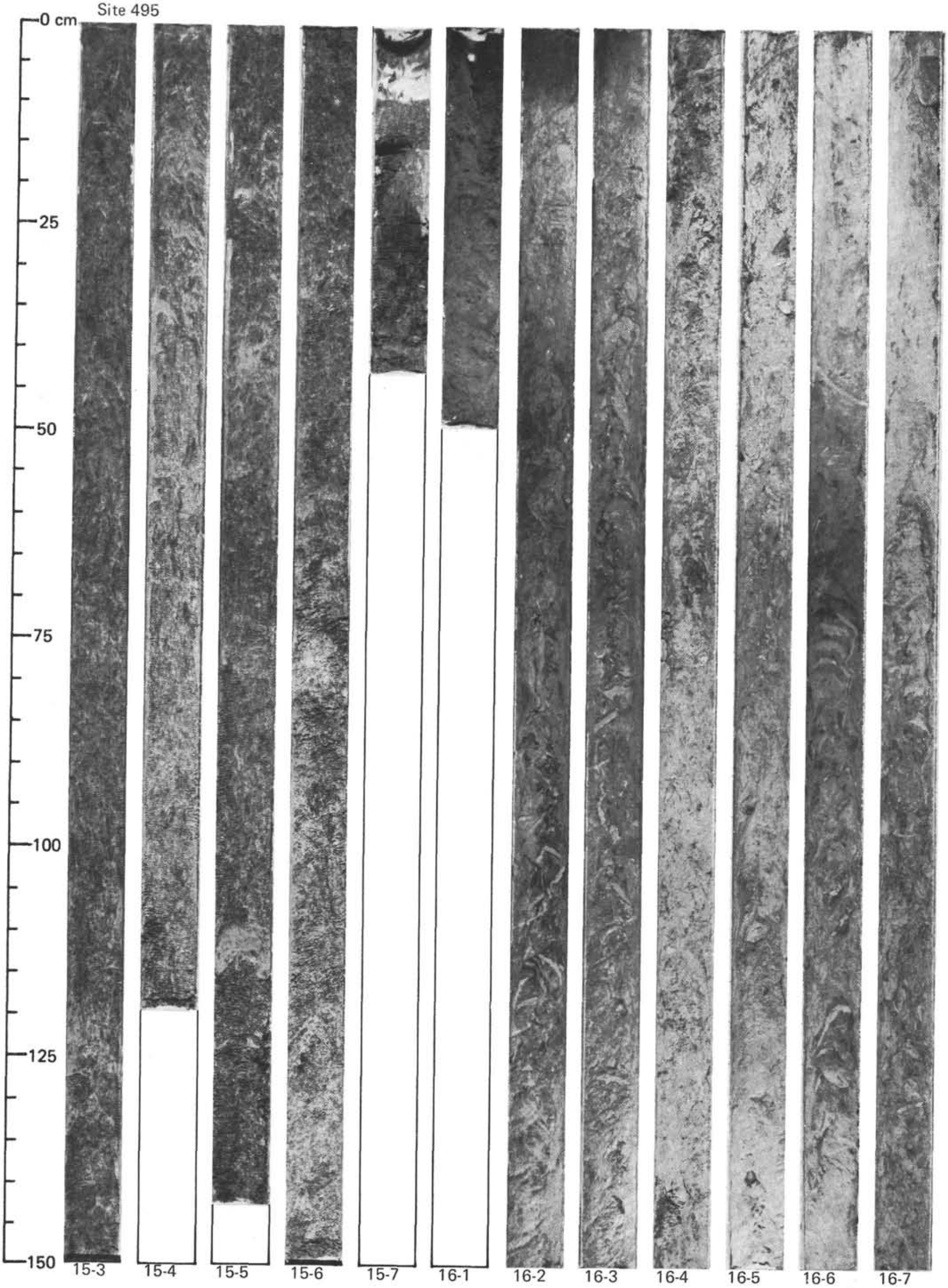

Site 495
0 cm
25
50
75
100
125
150
4-4
4-5
4-6
5-1
5-2
5-3
5-4
5-5
5-6
5-7
5, CC
6-1

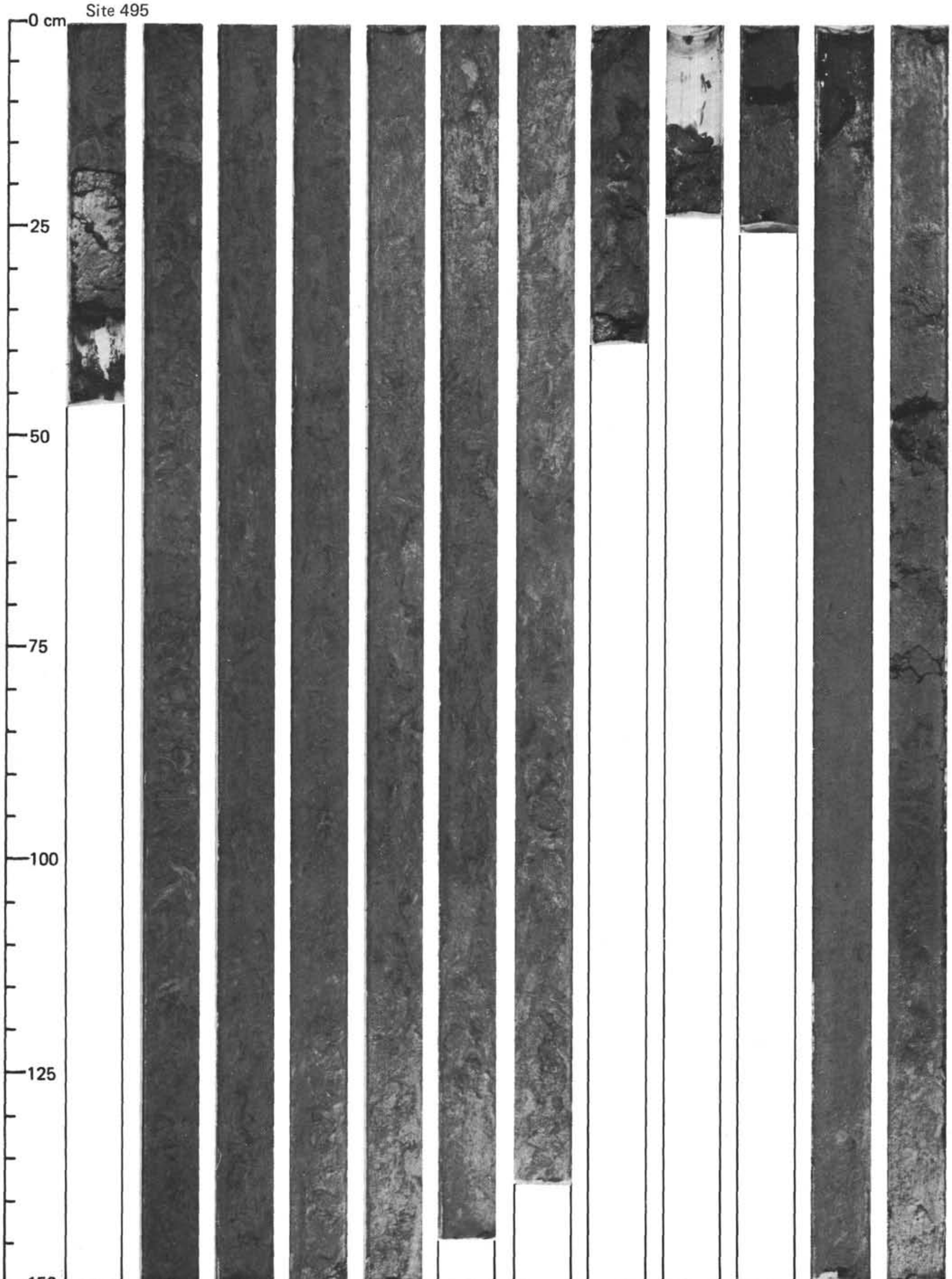

Site 495
0 cm
25
50
75
100
125
150
6-2
6-3
6-4
6, CC
7-1
7-2
7-3
7-4
7, CC
8-1
9-1
9-2
9-3
9-4

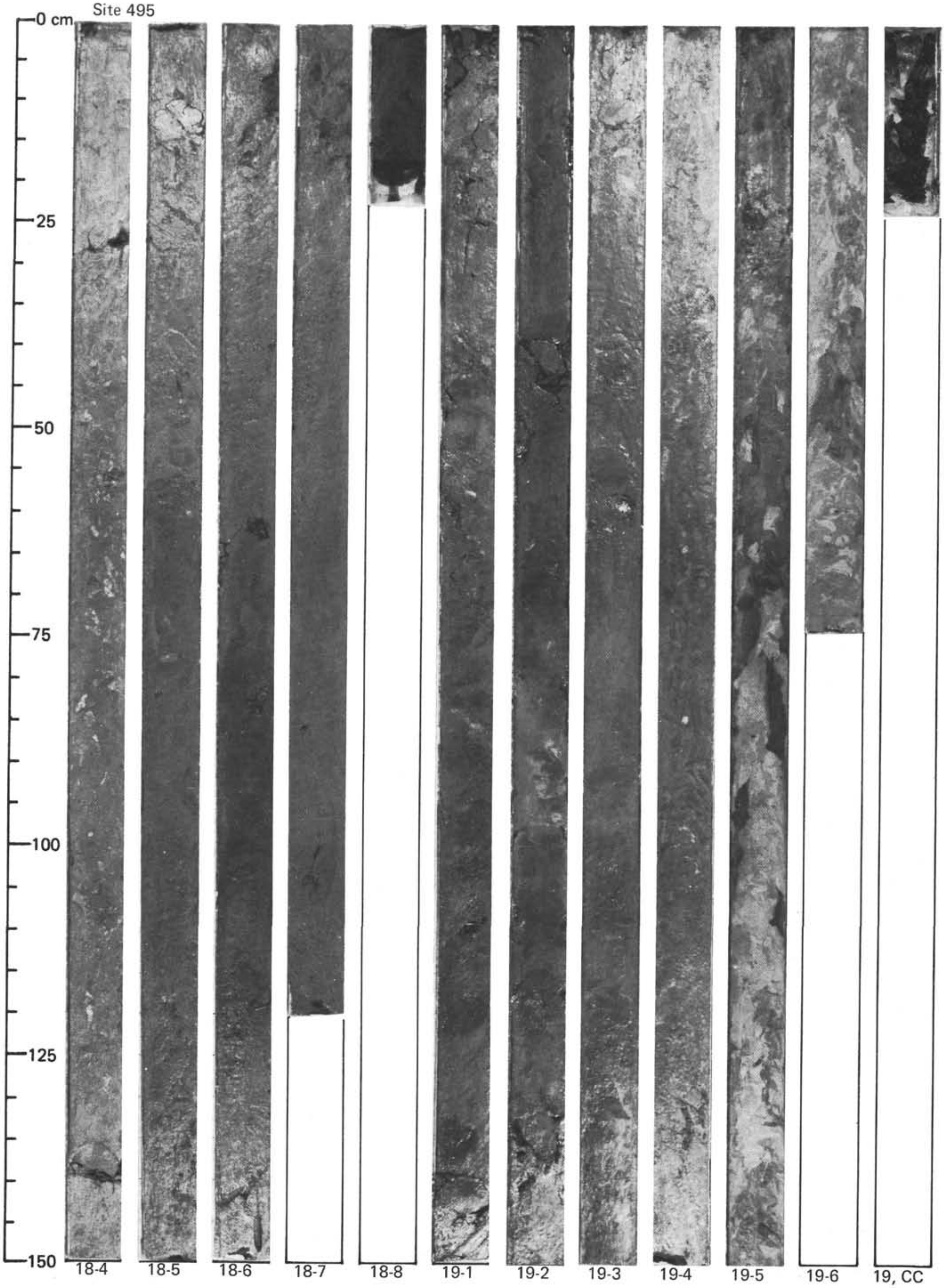

Site 495
0 cm
25
50
75
100
125
150
9-5
9-6
9, CC
10-1
10-2
10-3
10-4
10-5
10-6
10-7
10, CC
11-1
11-2

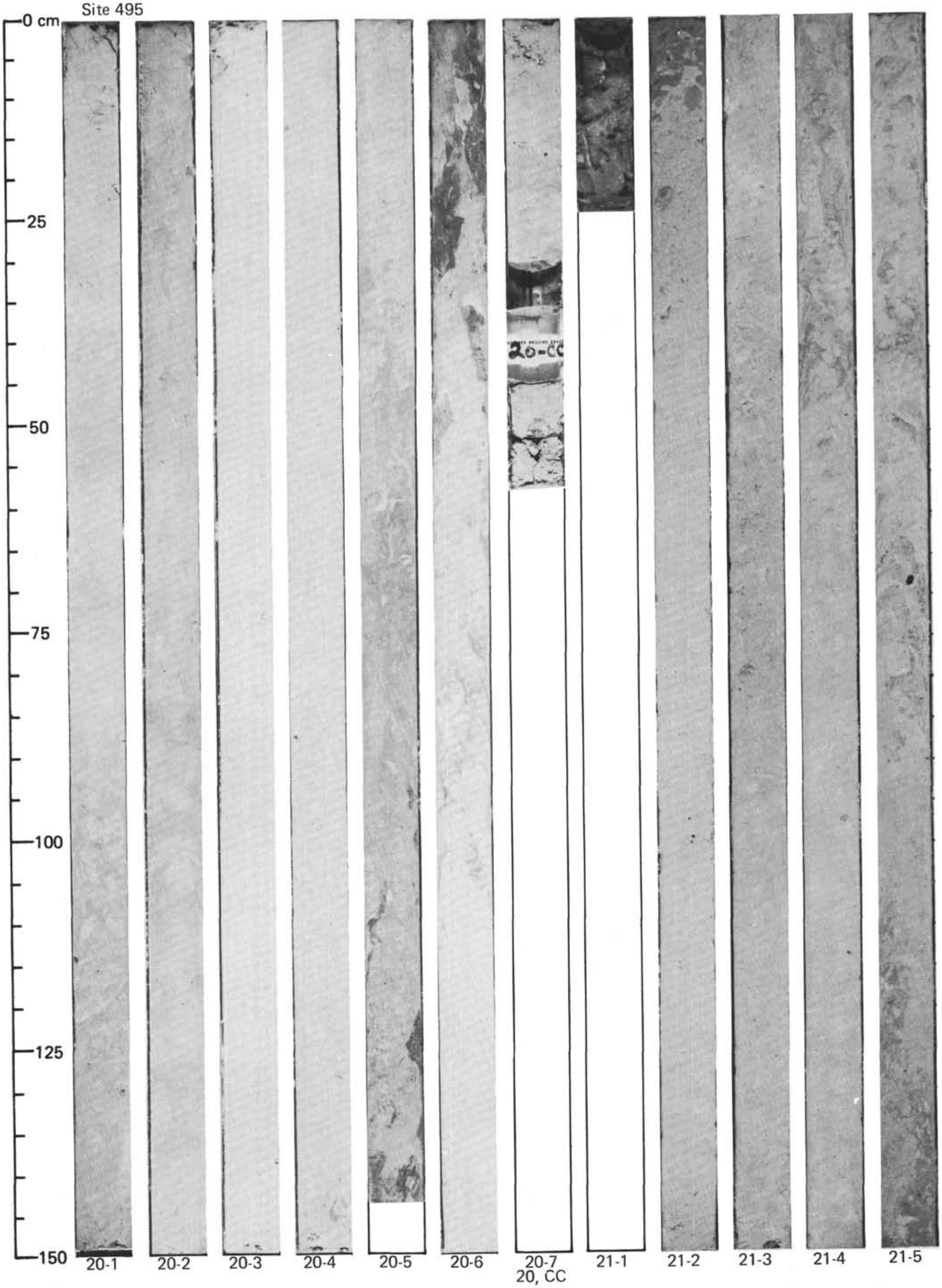

Site 495
0 cm
25
50
75
100
125
150
11-3
11, CC
12-1
12-2
12-3
12-4
12-5
12-6
12-7
12, CC
13-1
13-2

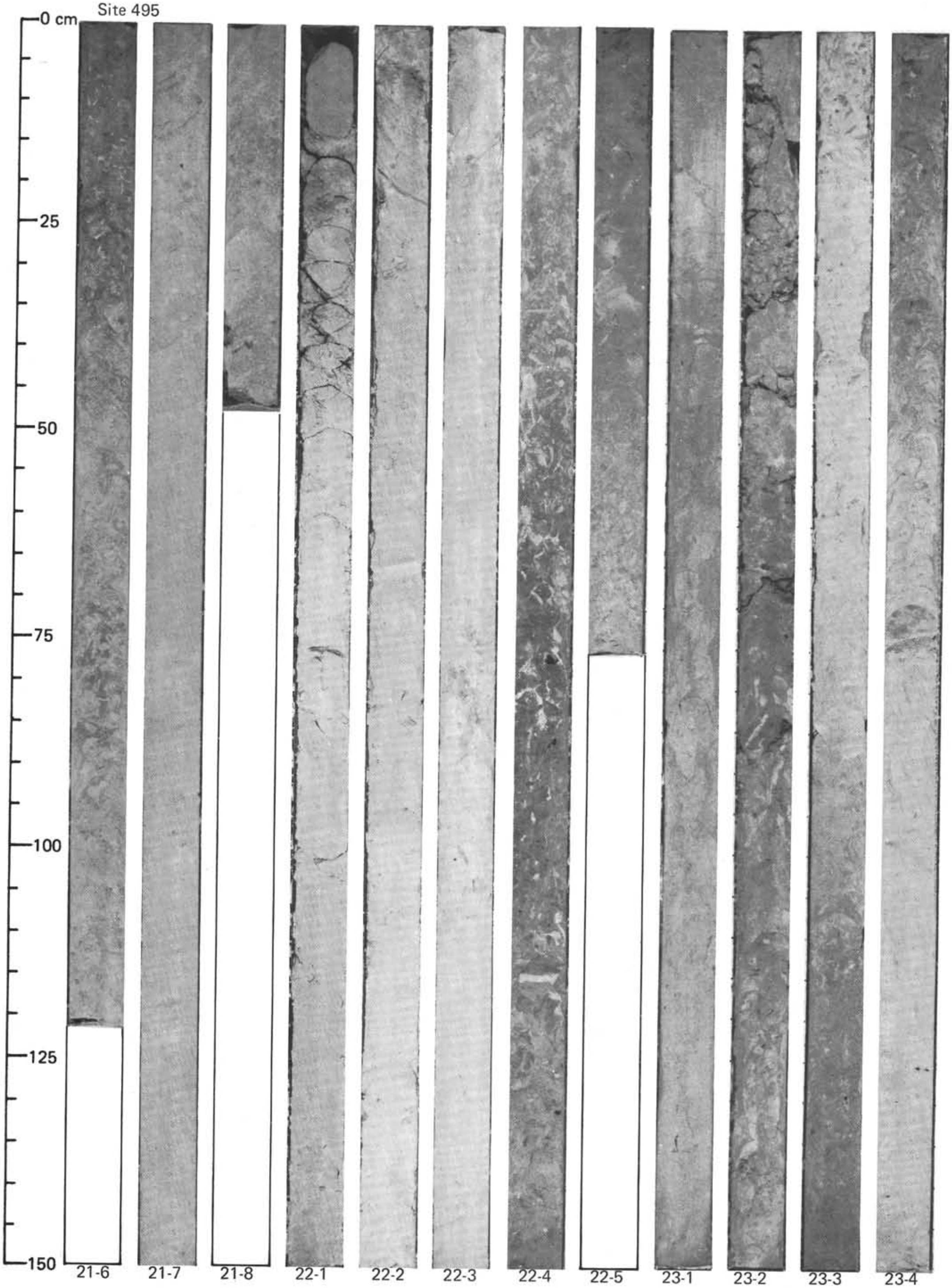

Site 495
0 cm
25
50
75
100
125
150
13-3
13-4
13-5
13, CC
14-1
14-2
14-3
14-4
14-5
14, CC
15-1
15-2

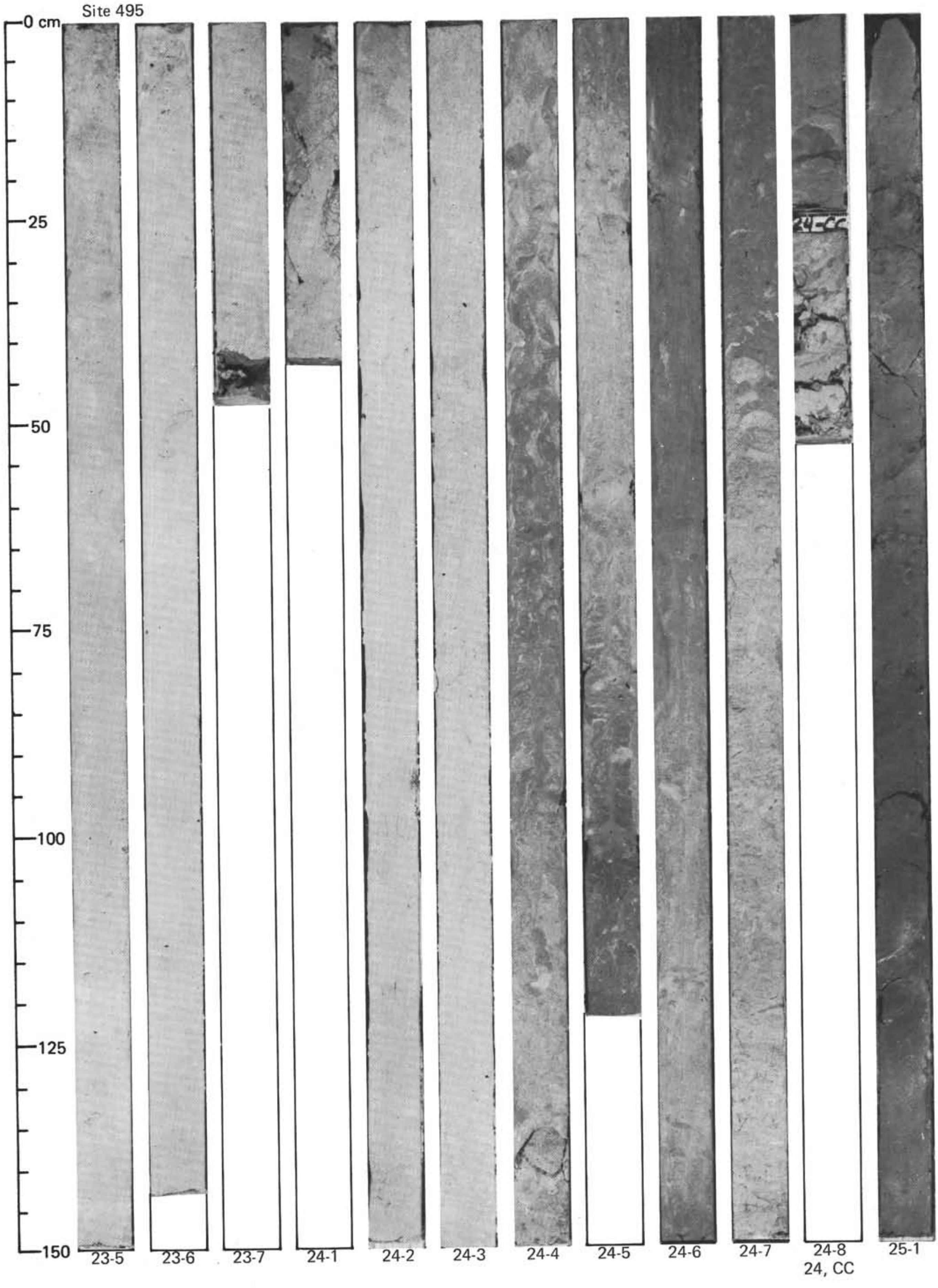

Site 495
0 cm
25
50
75
100
125
150
15-3
15-4
15-5
15-6
15-7
16-1
16-2
16-3
16-4
16-5
16-6
16-7

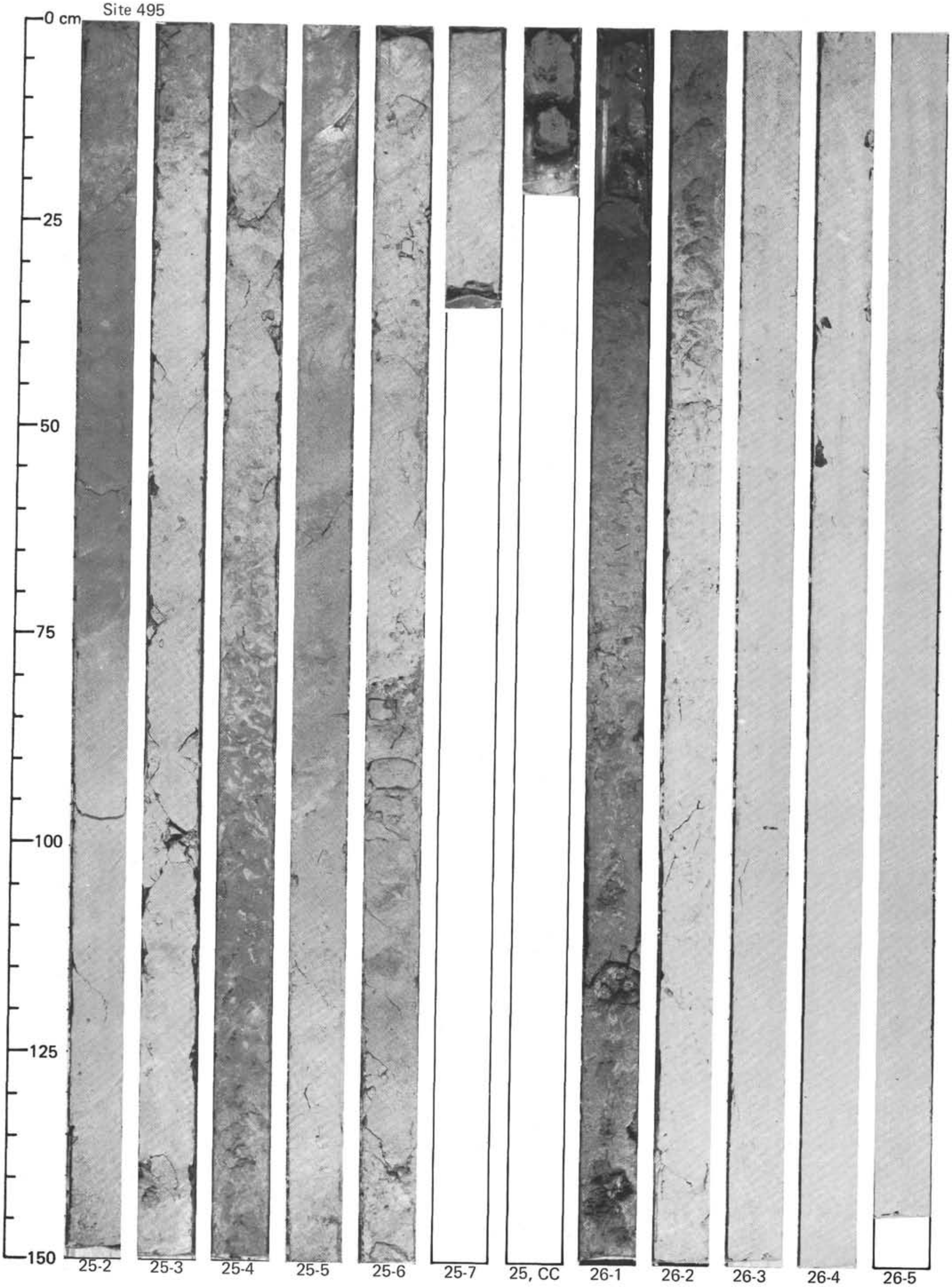

Site 495
0 cm
25
50
75
100
125
150
16-8
17-1
17-2
17-3
17-4
17-5
17-6
17-7
17, CC
18-1
18-2
18-3

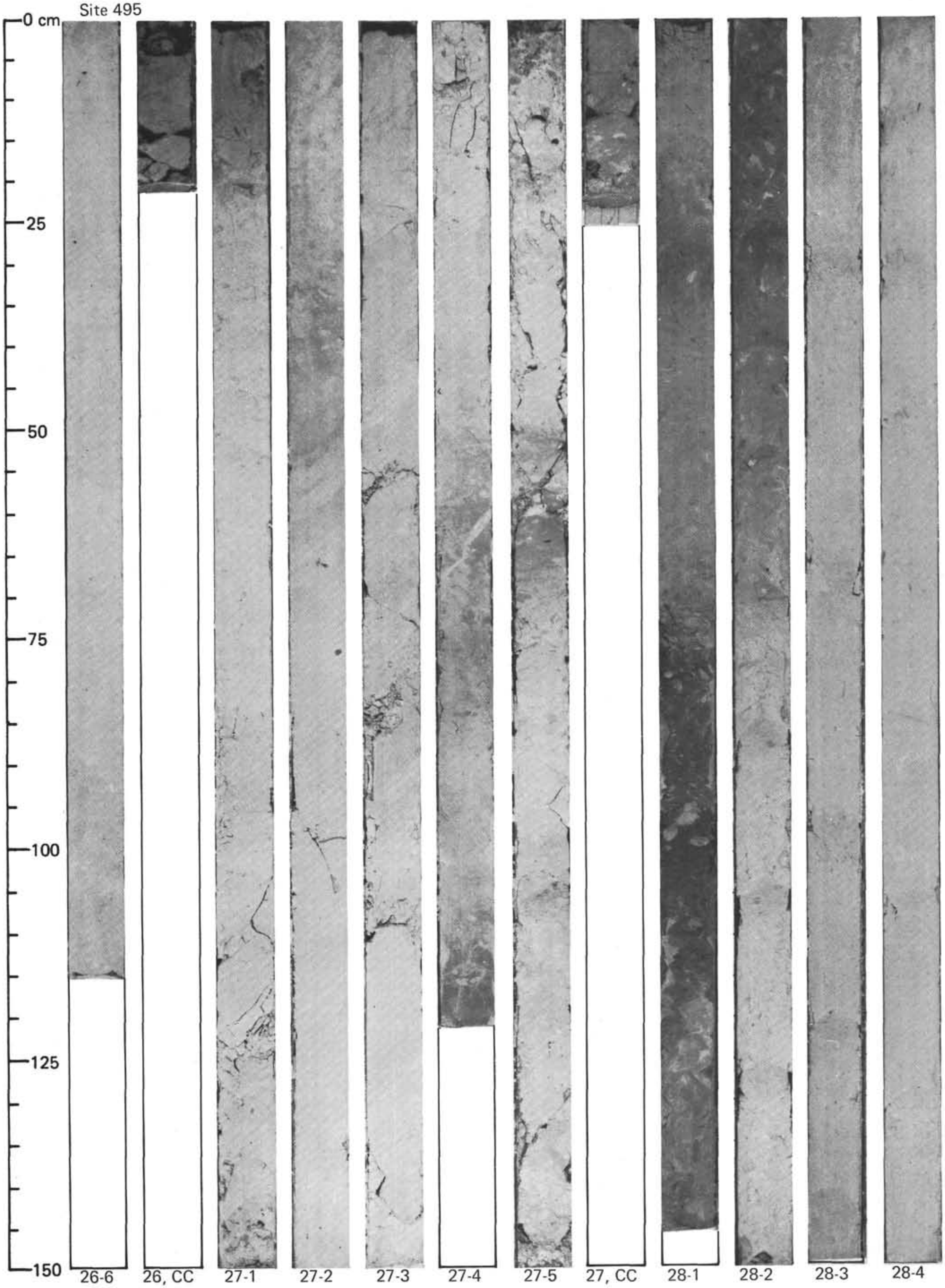

Site 495
0 cm
25
50
75
100
125
150
18-4
18-5
18-6
18-7
18-8
19-1
19-2
19-3
19-4
19-5
19-6
19, CC

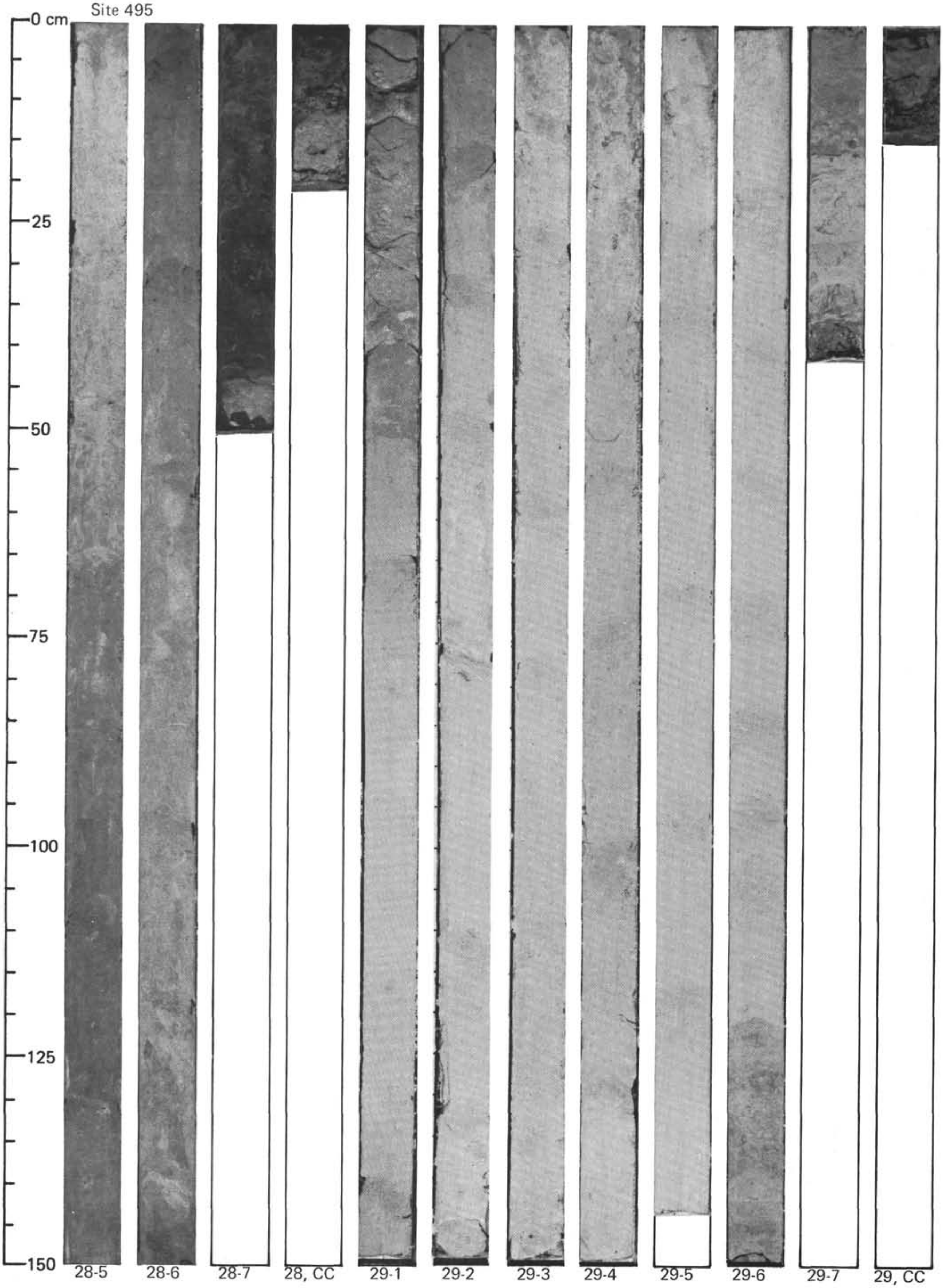

Site 495
0 cm
25
50
75
100
125
150
20-1
20-2
20-3
20-4
20-5
20-6
20-7
20, CC
21-1
21-2
21-3
21-4
21-5

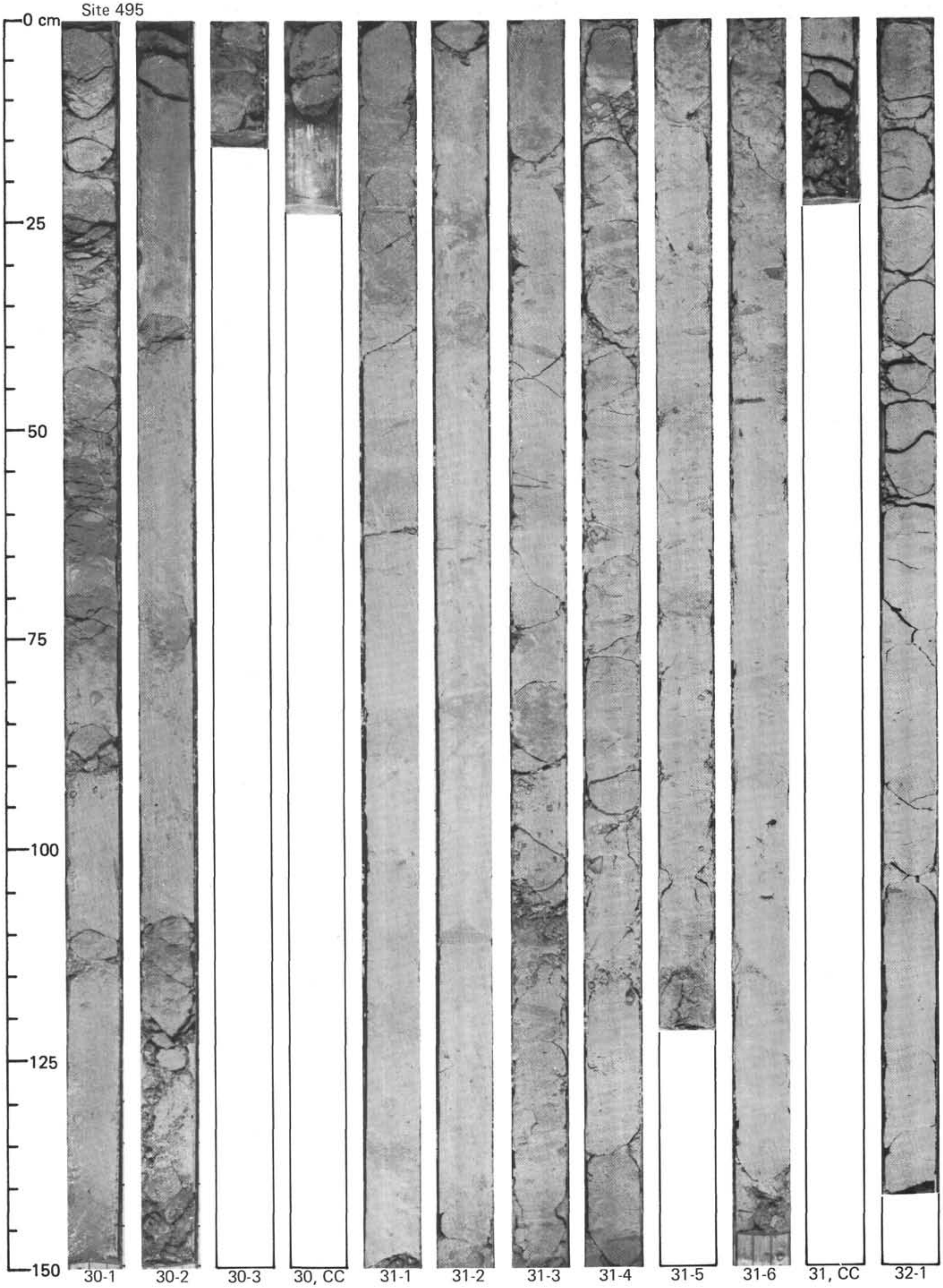

Site 495
0 cm
25
50
75
100
125
150
21-6
21-7
21-8
22-1
22-2
22-3
22-4
22-5
23-1
23-2
23-3
23-4

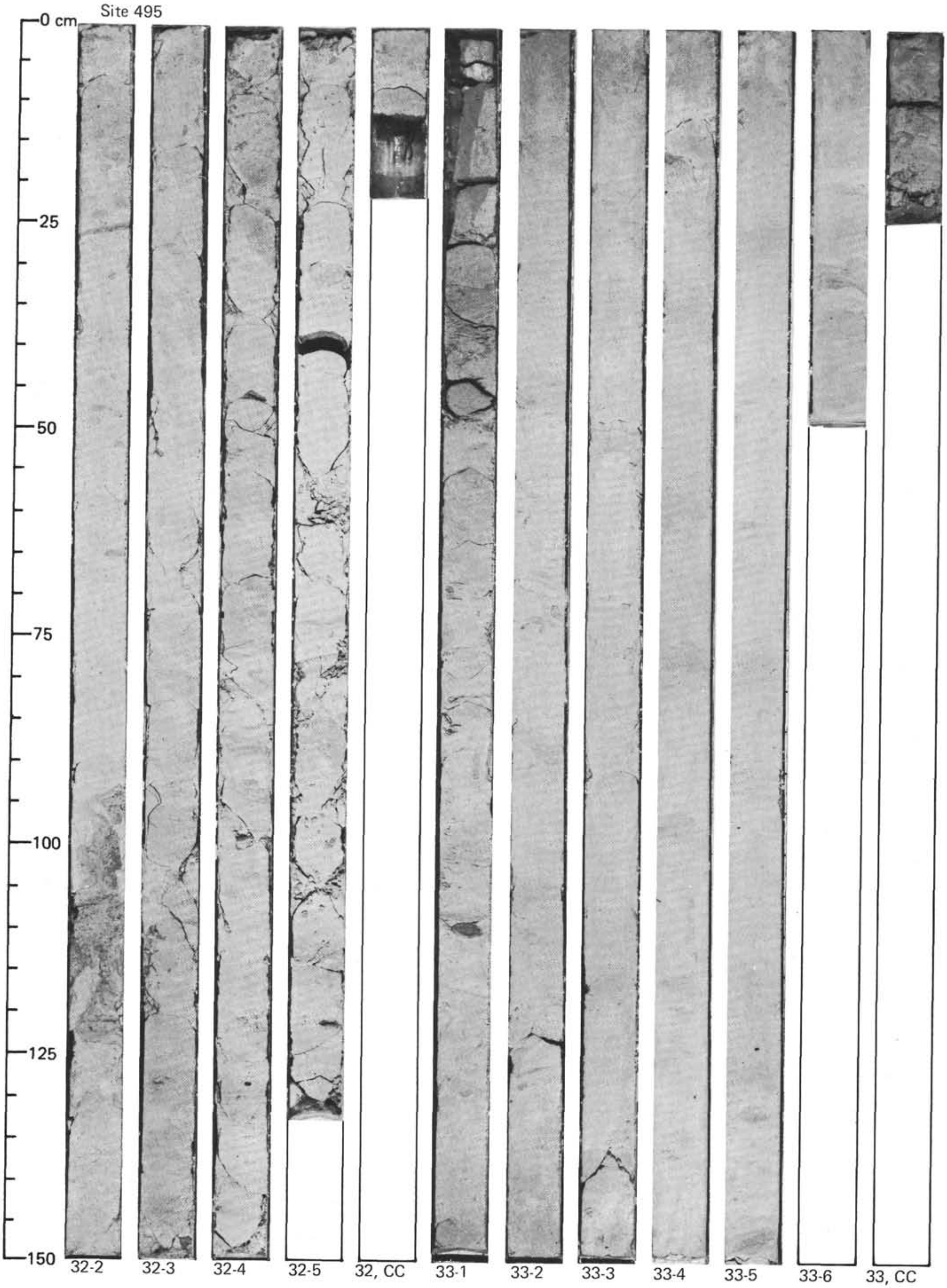

Site 495
0 cm
25
50
75
100
125
150
23-5
23-6
23-7
24-1
24-2
24-3
24-4
24-5
24-6
24-7
24-8
24, CC
25-1

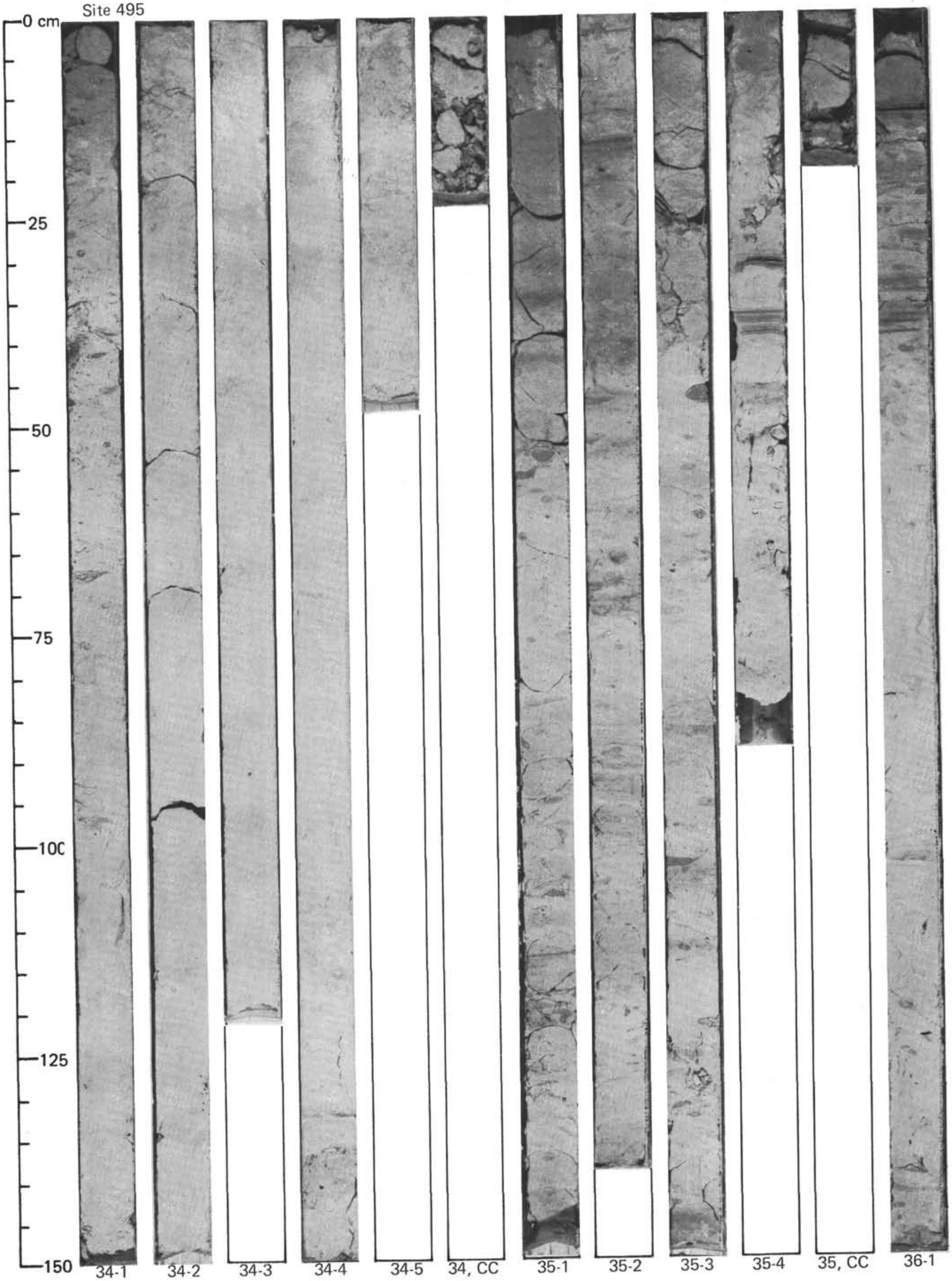

0 cm
Site 495
25
50
75
100
125
150
25-2
25-3
25-4
25-5
25-6
25-7
25, CC
26-1
26-2
26-3
26-4
26-5

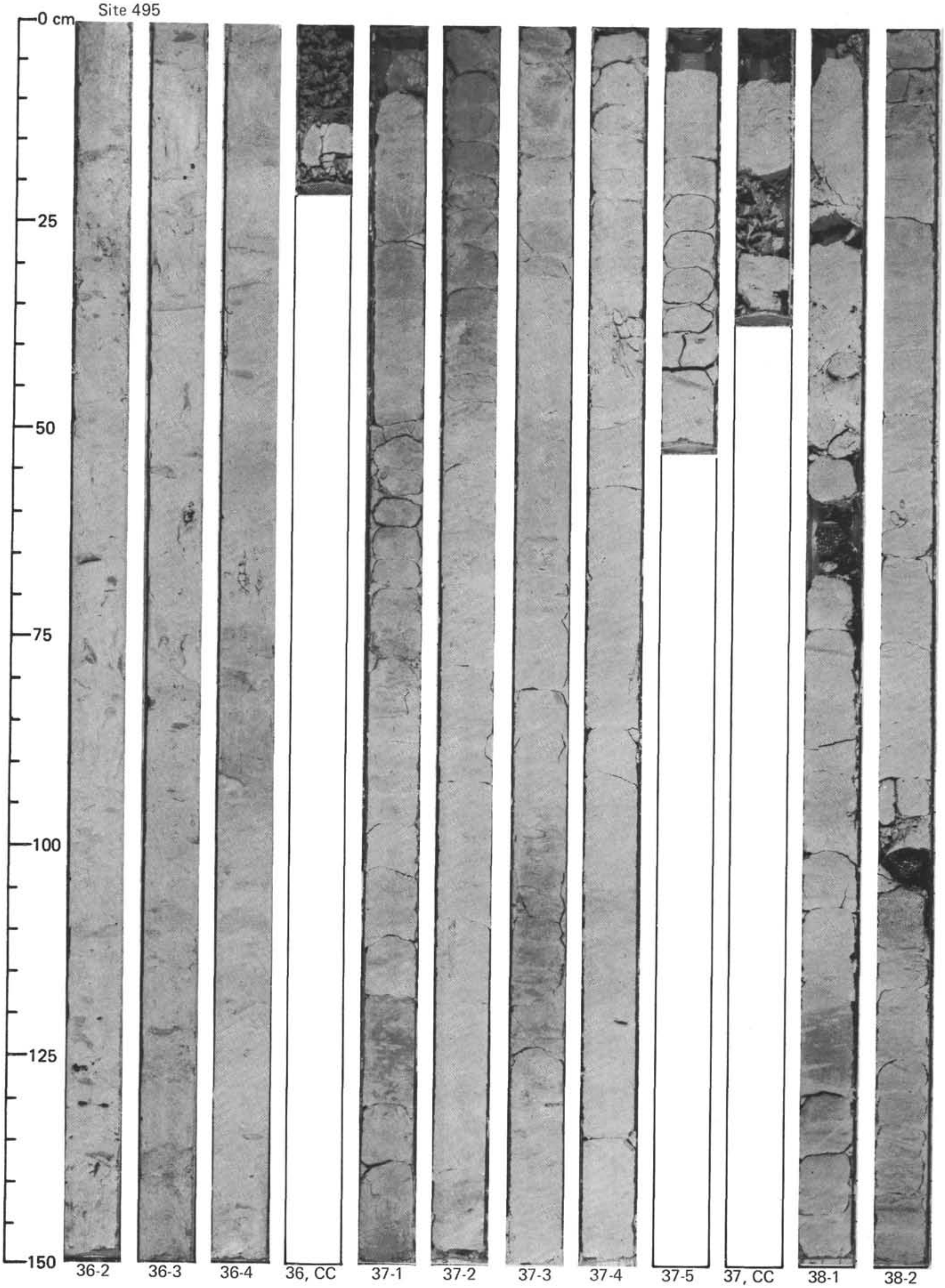

Site 495
0 cm
25
50
75
100
125
150
26-6
26, CC
27-1
27-2
27-3
27-4
27-5
27, CC
28-1
28-2
28-3
28-4

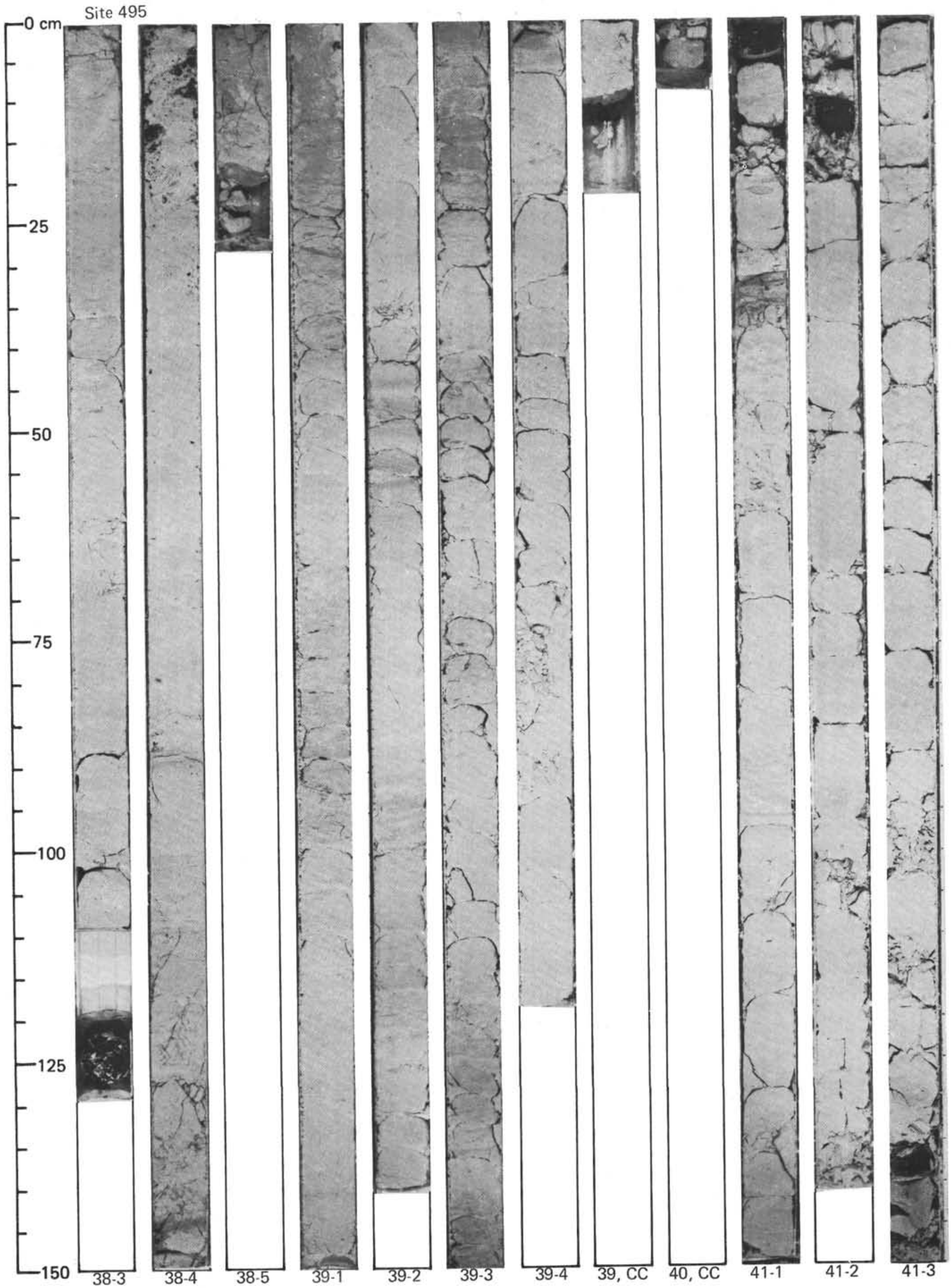

Site 495
0 cm
25
50
75
100
125
150
28-5
28-6
28-7
28, CC
29-1
29-2
29-3
29-4
29-5
29-6
29-7
29, CC

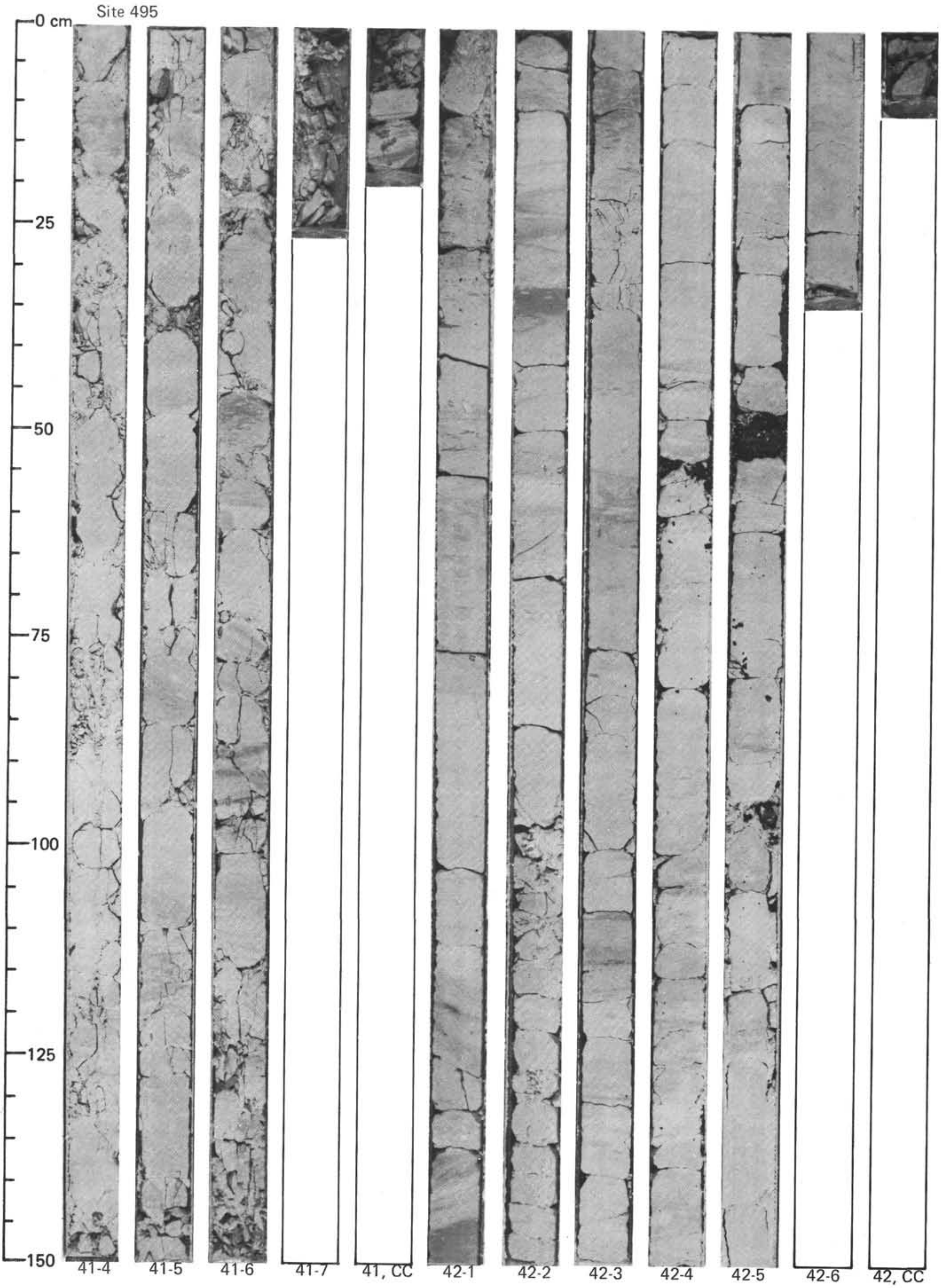

Site 495
0 cm
25
50
75
100
125
150
30-1
30-2
30-3
30, CC
31-1
31-2
31-3
31-4
31-5
31-6
31, CC
32-1

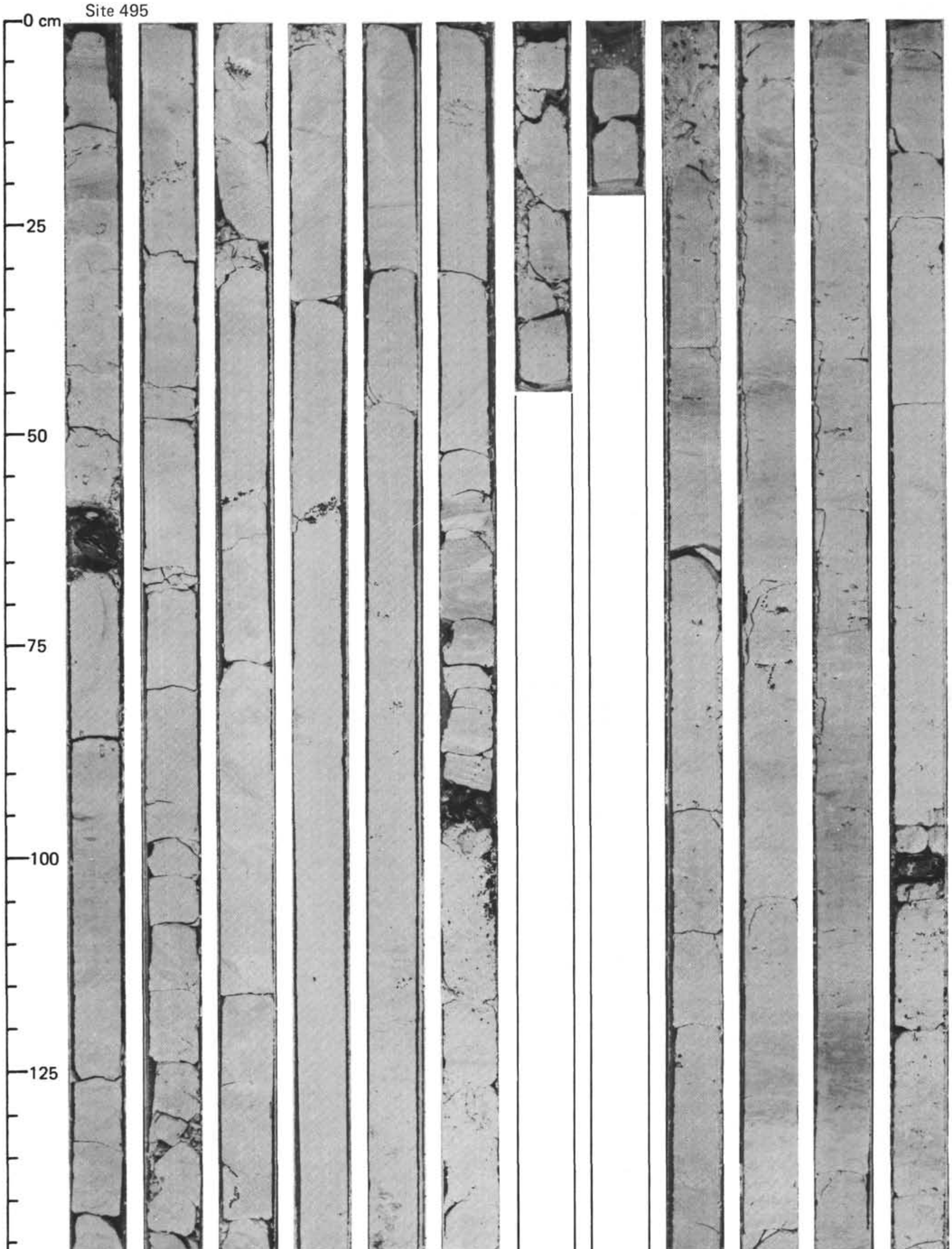

Site 495
0 cm
25
50
75
100
125
150
32-2
32-3
32-4
32-5
32, CC
33-1
33-2
33-3
33-4
33-5
33-6
33, CC

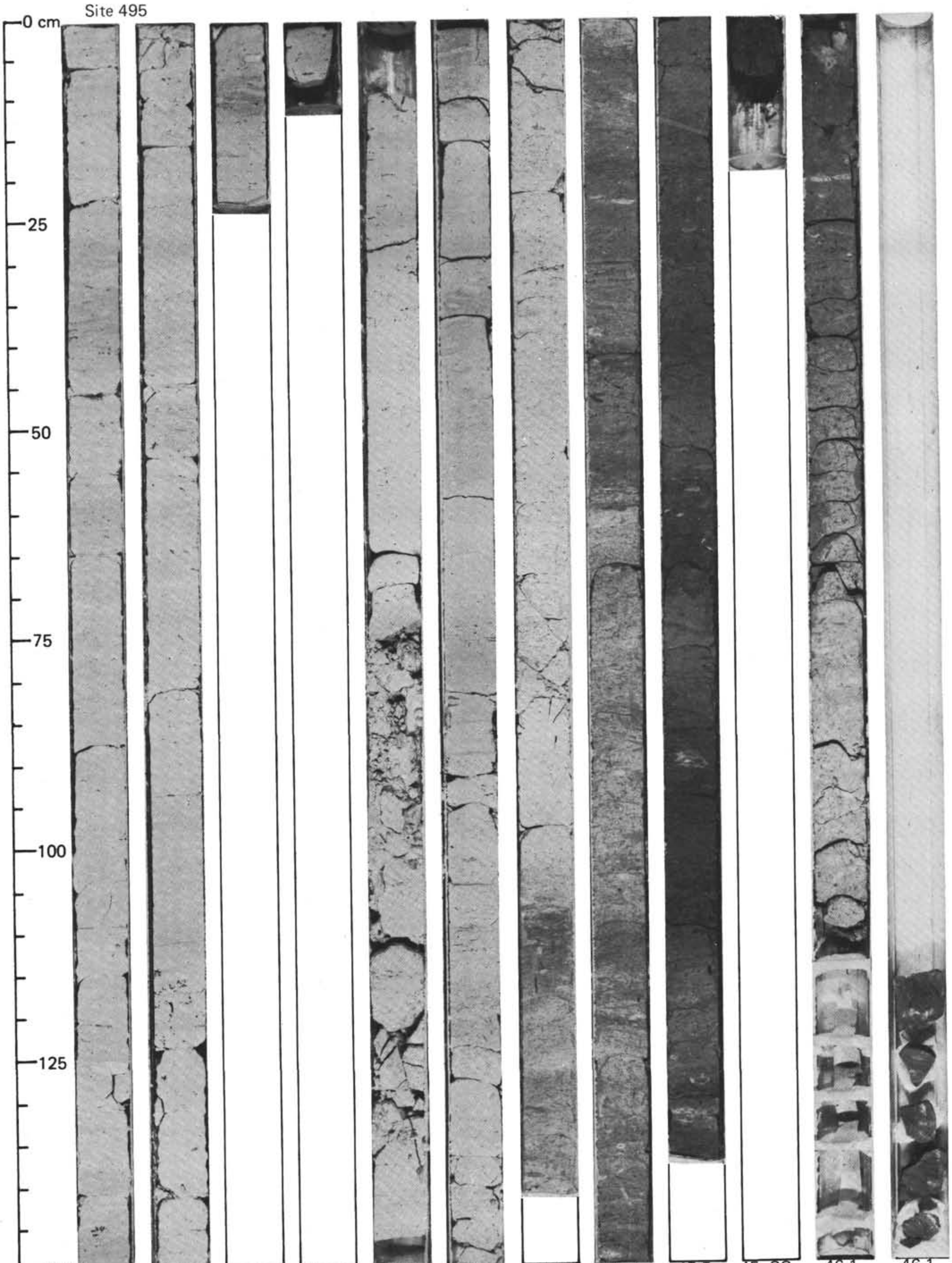

Site 495
0 cm
25
50
75
100
125
150
34-1
34-2
34-3
34-4
34-5
34, CC
35-1
35-2
35-3
35-4
35, CC
36-1

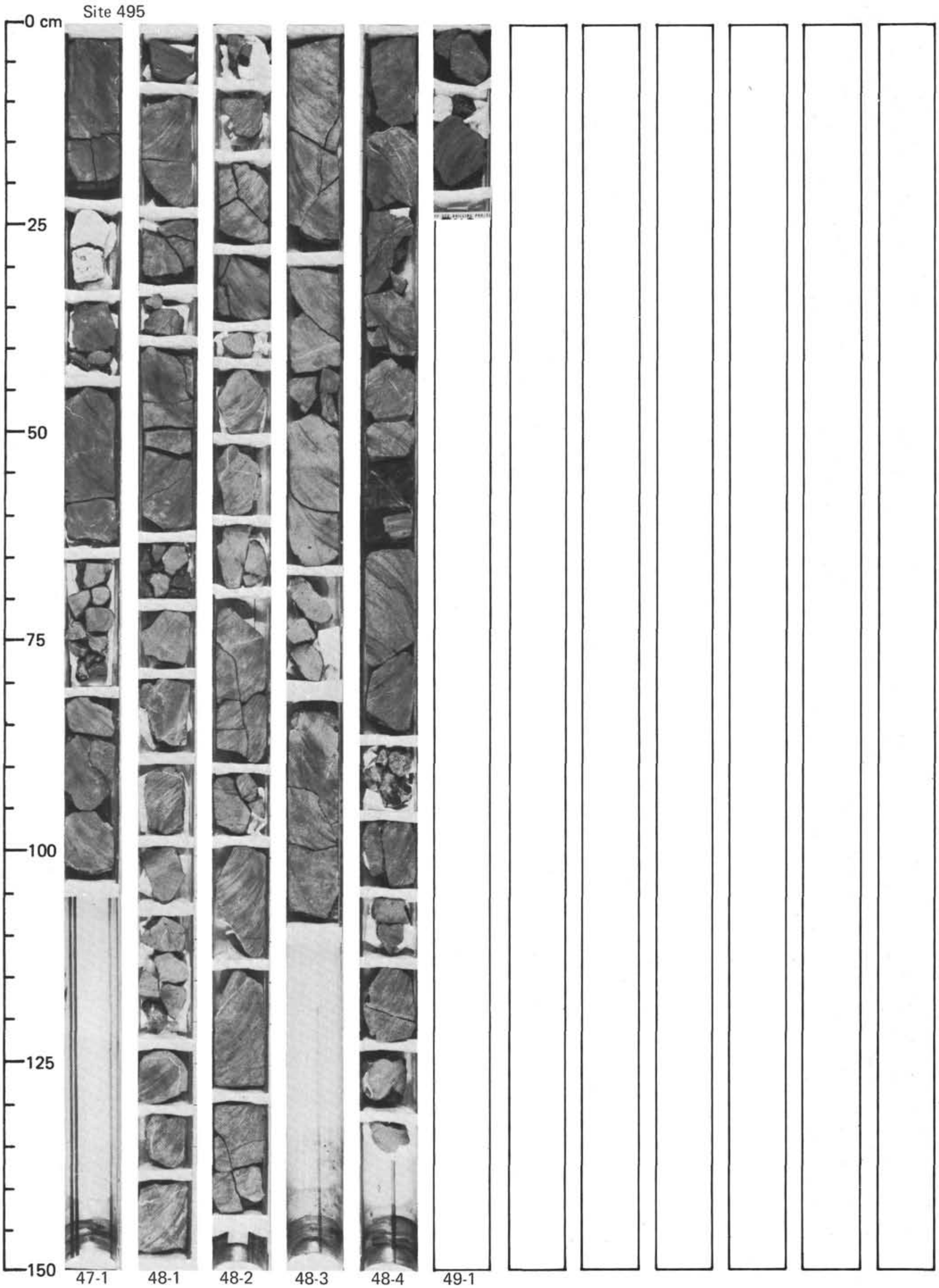

Site 495
0 cm
25
50
75
100
125
150
36-2
36-3
36-4
36, CC
37-1
37-2
37-3
37-4
37-5
37, CC
38-1
38-2


Site 495
0 cm
25
50
75
100
125
150
38-3
38-4
38-5
39-1
39-2
39-3
39-4
39, CC
40, CC
41-1
41-2
41-3


Site 495
0 cm
25
50
75
100
125
150
41-4
41-5
41-6
41-7
41, CC
42-1
42-2
42-3
42-4
42-5
42-6
42, CC


Site 495
0 cm
25
50
75
100
125
150
43-1
43-2
43-3
43-4
43-5
43-6
43-7
43, CC
44-1
44-2
44-3
44-4


Site 495
0 cm
25
50
75
100
125
150
44-5
44-6
44-7
44, CC
45-1
45-2
45-3
45-4
45-5
45, CC
46-1
46-1


Site 495
0 cm
25
50
75
100
125
150
47-1
48-1
48-2
48-3
48-4
49-1