5. SITE 568[1]

Shipboard Scientific Party[2]

HOLE 568

Date occupied: 8 February 1982, 1730 hr.

Date departed: 12 February 1982, 1615 hr.

Time on hole: 94 hr., 24 min.

Position: 13°04.33′N; 90°48.00′W

Water depth (sea level; corrected m, echo-sounding): 2010

Water depth (rig floor; corrected m, echo-sounding): 2020

Bottom felt (m, drill pipe): 2031

Penetration (m): 417.7

Number of cores: 44

Total length of cored section (m): 417.7

Total core recovered (m): 308.4

Core recovery (%): 73.8

Oldest sediment cored:
Depth sub-bottom (m): 417.7
Nature: mudstone
Age: earliest Miocene
Measured velocity (km/s): 1.595

Basement: not reached

Principal results: Drilling ended at 417.7 m in order to stay above the base of gas hydrate as required by the Safety Panels.

The main results concern the evolution of gaseous components through the section and the problem of gas hydrates: drilling of Hole 568 was dedicated to this problem. Sequence of gas components is as follows:

—from 0 to 190 m sub-bottom, the composition of gas is normal for a biogenic source;

—from 190 to 345 m, the dominance of methane and ethane, disproportionately low or absent heavier molecules, and the low values of salinity and chlorinity suggest a dispersed hydrate;

—from 345 to 391 m, the composition returns to normal with a normal proportion of heavier hydrocarbons suggesting gas in the free state;

—from 391 to 410 m, hydrates were recovered in sediment with large quantities of methane and ethane, low quantities of heavier molecules, and low values of salinity and chlorinity;

—from 410 to 417.7 m, the section is again not hydrated.

Hydrates form only in relatively porous substratum, either porous sediments such as sandstones and ash layers, or fractured nonporous sediment. The recovered hydrate at Site 568 was in fractures in a tuffaceous mudstone; therefore, hydrates probably do not form a continuous layer at the site; no seal is formed. Temperature measurements and seismic records place the base of gas hydrates from 20 to 40 m below the level where drilling was abandoned.

Other results of the drilling at Site 568 confirm the results from Leg 67, Site 496. The sedimentary sequence consists of an upper underconsolidated green mud from 0 to 182 m of the middle to late Pleistocene, and a lower indurated green mudstone from 182 to 417 m, ranging from early Pliocene to earliest Miocene. The progressive increase of dip with depth reached 70° in Core 43. Seismic data indicate that the site is on a depositional lobe, and slumping at the front of the lobe may contribute to the steep dip seen locally in the core.

The comparison with the early Miocene sediment recovered at Site 567 shows the local origin of reworked material at that site, and suggests that the original unstable topography of the slope was buried during the early Miocene, whereas the sedimentation of overlying formations was more regular. If this is so, the prograded sections at the base of slope deposits could be everywhere considered early Miocene, which thus questions the origin of the paleotopography of the slope.

BACKGROUND AND OBJECTIVES

Site 568 is on the upper part of the Middle America Trench slope, in about 2031 m of water, 4000 m above and about 47 km landward from the Trench axis. It is located about 1 km upslope from Leg 67 Site 496, on the bearing 300°.

Site 496 had been abandoned at a depth of 378 m after a gas composition was encountered that suggested possible thermogenic components and perhaps gas hydrate. After Leg 67, a good base of gas hydrate reflection was found beneath the site. Therefore, the major objective at Site 568 was a detailed monitoring of the gas through the whole section in a study of the formation of gas hydrate.

Seismic record GUA-13 was reprocessed for this purpose to bring out the shallow structure and the base of gas hydrate seismic reflector. Within the Safety Panel recommendations, drilling at Site 568 could penetrate to 100 m above the reflector or the base of hydrate, as calculated from temperature data, and at least to the same depth as at Site 496.

OPERATIONS

Glomar Challenger departed from Site 567 at 1245L (local time), 7 February. At 1600L a 16-kHz beacon was dropped and the ship was in position at 1730L. From 1708, 8 February, to 0330L, 8 February, a new bottom-hole assembly was made up; then until 1000L, 117 joints were moved from between decks to the starboard casing rack. Running in the hole began at 1030L, while

[1] von Huene, R., Aubouin, J., et al., *Init. Repts. DSDP*, 84: Washington (U.S. Govt. Printing Office).

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a new drill string was reconstructed and the remaining joints checked. After spudding the hole at 2100L, drilling began; the first core was recovered at 2236L.

In situ pore water and heat flow measurements were done after recovering Cores 10 (sub-bottom depth 89.4 m); 15 (137.2 m); 20 (185.7 m); 30 (282.3 m); and 38 (359.9 m). A pressure core barrel was used for Cores 11 (sub-bottom depth of 89.4–98.8 m); 21 (185.7–195.4 m); and 31 (282.3–292.0 m).

After recovering a piece of crystallized hydrate at less than 100 m from the base of hydrate reflection, drilling was stopped at 1615L, 11 February, to wait for the decision from DSDP on further drilling. This decision was negative and the hole was given over to logging.

The bit was released from 2030 to 2130L; the hole was filled with weighted mud from 2130 to 2215L, and logging began at 0030L, 12 February.

After sonic, waveform, and density-neutron logs were run, the drill string was retrieved from 1145 to 1600L.

Glomar Challenger departed Site 568 at 1615L, 13 February.

Table 1 shows the coring summary for Site 568.

LITHOSTRATIGRAPHY

Site 568 is located within 1.5 km of Leg 67 Site 496 at a depth of 2031 m (drill pipe) on the upper slope of the Middle America Trench, about 47 km from the Trench axis (Fig. 1). Forty-four cores were drilled with very good recovery to a sub-bottom depth of 418 m. We divide the section penetrated into two lithostratigraphic units.

The contact with the lower unit is identified in Core 20 on the basis of color change, a slightly coarser texture, and a difference in deformation style from swirling of soft mud to breaking of stiff mudstone into squarish "biscuits." Unit I is early–middle Pleistocene at its base in Core 20; Unit II is early Pliocene to middle Miocene in Core 21 (ages based on shipboard analyses of core

Table 1. Coring summary, Site 568.

Core	Date (Jan. 1982)	Time	Depth from drill floor (m) Top Bottom	Depth from seafloor (m) Top Bottom	Length cored (m)	Length recovered (m)	Recovery (%)
1	8	2236	2031.0–2034.4	0.0–3.4	3.4	3.43	100
2	8	2342	2034.4–2044.0	3.4–13.0	9.6	9.55	99
3	9	0055	2044.0–2053.7	13.0–22.7	9.7	8.55	88
4	9	0145	2053.7–2063.3	22.7–32.3	9.6	8.47	88
5	9	0230	2063.3–2073.0	32.3–42.0	9.7	9.57	99
6	9	0325	2073.0–2082.4	42.0–51.4	9.4	7.31	78
7	9	0410	2082.4–2092.1	51.4–61.1	9.7	7.72	80
8	9	0515	2092.1–2101.4	61.1–70.4	9.3	9.70	100
9	9	0610	2101.4–2111.1	70.4–80.1	9.7	7.61	78
10	9	0656	2111.1–2120.4	80.1–89.4	9.3	6.51	70
11	9	0955	2120.4–2129.8	89.4–98.8	9.4	1.05	11
12	9	1045	2129.8–2139.3	98.8–108.3	9.5	6.69	70
13	9	1150	2139.3–2148.8	108.3–117.8	9.5	3.87	41
14	9	1250	2148.8–2158.4	117.8–127.4	9.6	9.90	100
15	9	1358	2158.4–2168.2	127.4–137.2	9.8	6.05	62
16	9	1825	2168.2–2177.9	137.2–146.9	9.7	5.39	56
17	9	1925	2177.9–2187.5	146.9–156.5	9.6	6.46	67
18	9	2028	2187.5–2197.2	156.5–166.2	9.7	6.07	63
19	9	2132	2197.2–2207.0	166.2–176.0	9.8	8.50	87
20	9	2235	2207.0–2216.7	176.0–185.7	9.7	9.56	99
21	10	0205	2216.7–2226.4	185.7–195.4	9.7	1.61	17
22	10	0310	2226.4–2236.1	195.4–205.1	9.7	9.14	94
23	10	0420	2236.1–2245.8	205.1–214.8	9.7	4.62	48
24	10	0525	2245.8–2255.5	214.8–224.5	9.7	9.67	99
25	10	0626	2255.5–2265.2	224.5–234.2	9.7	9.34	96
26	10	0730	2265.2–2274.4	234.2–243.9	9.7	0.00	0
27	10	0830	2274.4–2284.4	243.9–253.4	9.5	5.83	61
28	10	0940	2284.4–2294.1	253.4–263.1	9.7	9.62	99
29	10	1110	2294.1–2303.6	263.1–272.6	9.5	8.51	90
30	10	1220	2303.6–2313.3	272.6–282.3	9.7	9.05	93
31	10	1555	2313.3–2323.0	282.3–292.0	9.7	1.16	12
32	10	1739	2323.0–2332.6	292.0–301.6	9.6	8.86	92
33	19	1900	2332.6–2342.4	301.6–311.3	9.7	9.63	99
34	10	2025	2342.3–2352.2	311.3–321.2	9.9	9.52	96
35	10	2134	2352.2–2362.0	321.2–331.0	9.8	9.03	92
36	10	2254	2362.0–2371.7	331.0–340.7	9.7	9.20	95
37	11	0025	2371.7–2381.2	340.7–350.2	9.5	4.58	48
38	11	0210	2381.2–2390.9	350.2–359.9	9.7	9.61	99
39	11	0550	2390.9–2400.6	359.9–369.6	9.7	3.03	31
40	11	0735	2400.6–2410.3	369.6–379.3	9.7	7.01	72
41	11	1100	2410.3–2420.0	379.3–389.0	9.7	8.83	91
42	11	1245	2420.0–2429.7	389.0–389.7	9.7	6.11	63
43	11	1413	2429.7–2439.4	398.7–408.4	9.7	5.71	59
44	11	1546	2439.4–2448.7	408.4–417.7	9.3	6.77	73
Total					417.7	308.40	74

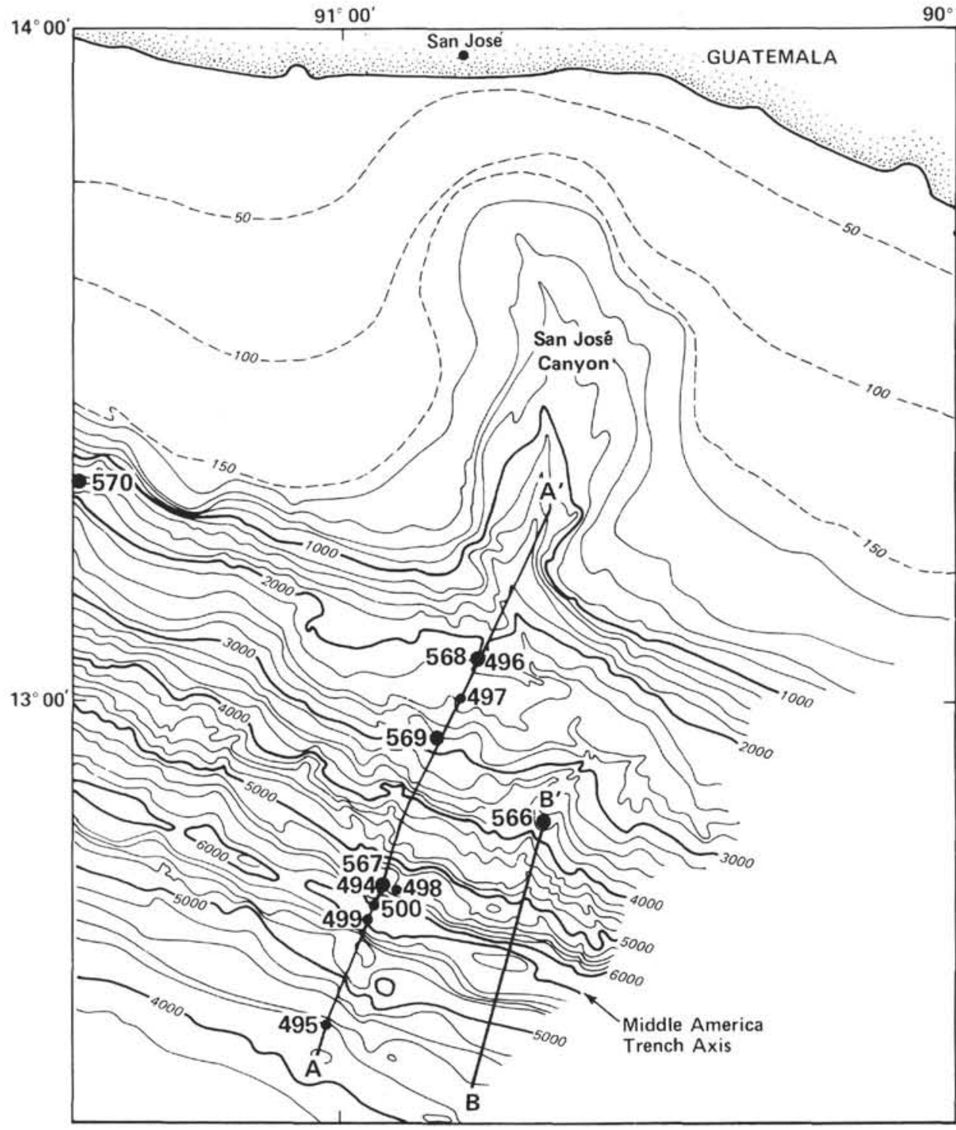


Figure 1. Bathymetry of the Guatemala margin and San José Canyon, showing the UTMSI survey tracks and the locations of Legs 67 and 84 sites off Guatemala.

catchers; see Biostratigraphy) and thus the contact probably represents a hiatus. Figure 2 shows a lithostratigraphic summary of Site 568.

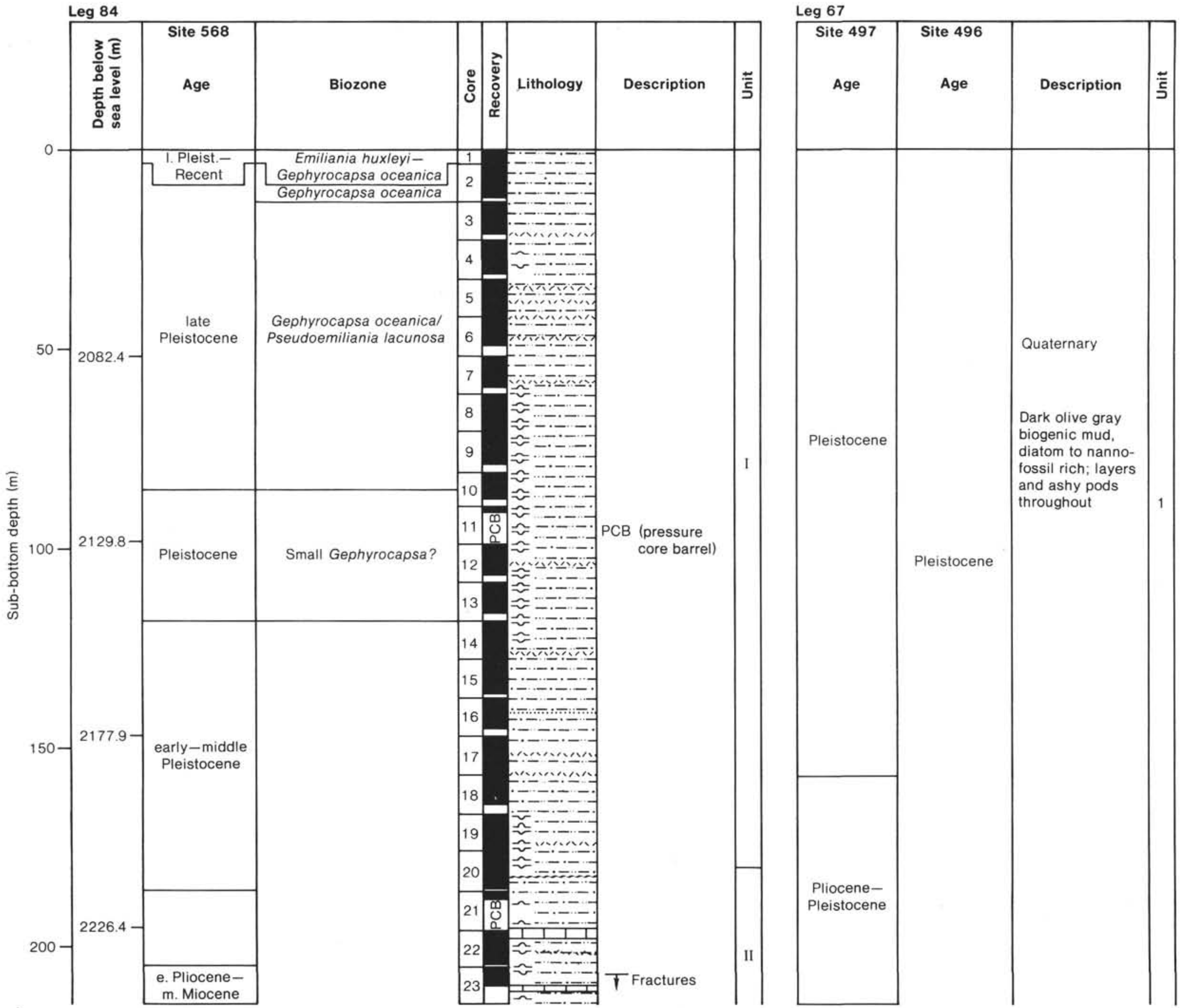
Unit I

Unit I comprises Cores 1 to 20, 0 to 182.0 m sub-bottom depth, from Recent to late Pleistocene, and is composed of a massive, dark olive gray (5Y3/2) mud that is easily deformed into swirled layers during drilling. The average sand-silt-clay composition of the unit (based on shipboard smear-slide analyses) is 6, 29, and 65%, respectively, with a slight coarsening downhole. Siliceous biogenic remains (diatoms, radiolarians, silicoflagellates, and sponge spicules) make up more than 15% of the total sediment in Cores 8 to 17 and 19, and sandy horizons occur in Cores 1, 8, and 16. Foraminifers are dispersed in the sediment and fill a burrow in Core 19. Thin carbonaceous beds and clasts (including carbonaceous wood fragments) occur in Cores 8 and 9. Large (2–4 cm) bivalve shell fragments were found in Cores 1, 2, and 20; in Core 1 two valves are still attached by ligament.

Cores 1 through 3 smelled strongly of H_2S after splitting. Gas expansion cracks (mostly horizontal to subhorizontal and about 1 cm long) occurred in the firmer parts of soft cores. Toward the top of the hole, gas expansion in more indurated mud resulted in coherent breaks across a core creating voids in the cross sections. This phenomenon resulted in a slight exaggeration of the figure for percent of core recovered.

Bedding laminations in otherwise structureless cores are weakly preserved in parts of Cores 1, 2, 8, 12 to 14, and 16 to 18.

Ash layers occur in Cores 3, 5 to 9, 12, 14, and 17 and are somewhat more common in the upper half of the unit. Twenty-three layers of ash or muddy ash and numerous ashy mottles and pumice clasts are discerned. These range in colors from light gray (N7), medium bluish gray (5B 5/1), olive black (5Y 2/1), to pale olive (10Y 4/2).


Leg 84
Site 568
Depth below sea level (m)
Age
Biozone
Core
Recovery
Lithology
Description
Unit
Sub-bottom depth (m)
0
50
100
150
200
2082.4
2129.8
2177.9
2226.4
l. Pleist.— Recent
late Pleistocene
Pleistocene
early—middle Pleistocene
e. Pliocene— m. Miocene
Emiliania huxleyi— Gephyrocapsa oceanica
Gephyrocapsa oceanica
Gephyrocapsa oceanica/ Pseudoemiliania lacunosa
Small Gephyrocapsa?
PCB
PCB (pressure core barrel)
Fractures
I
II
Leg 67
Site 497
Site 496
Age
Age
Description
Unit
Pleistocene
Pliocene— Pleistocene
Pleistocene
Quaternary
Dark olive gray biogenic mud, diatom to nanno-fossil rich; layers and ashy pods throughout
1

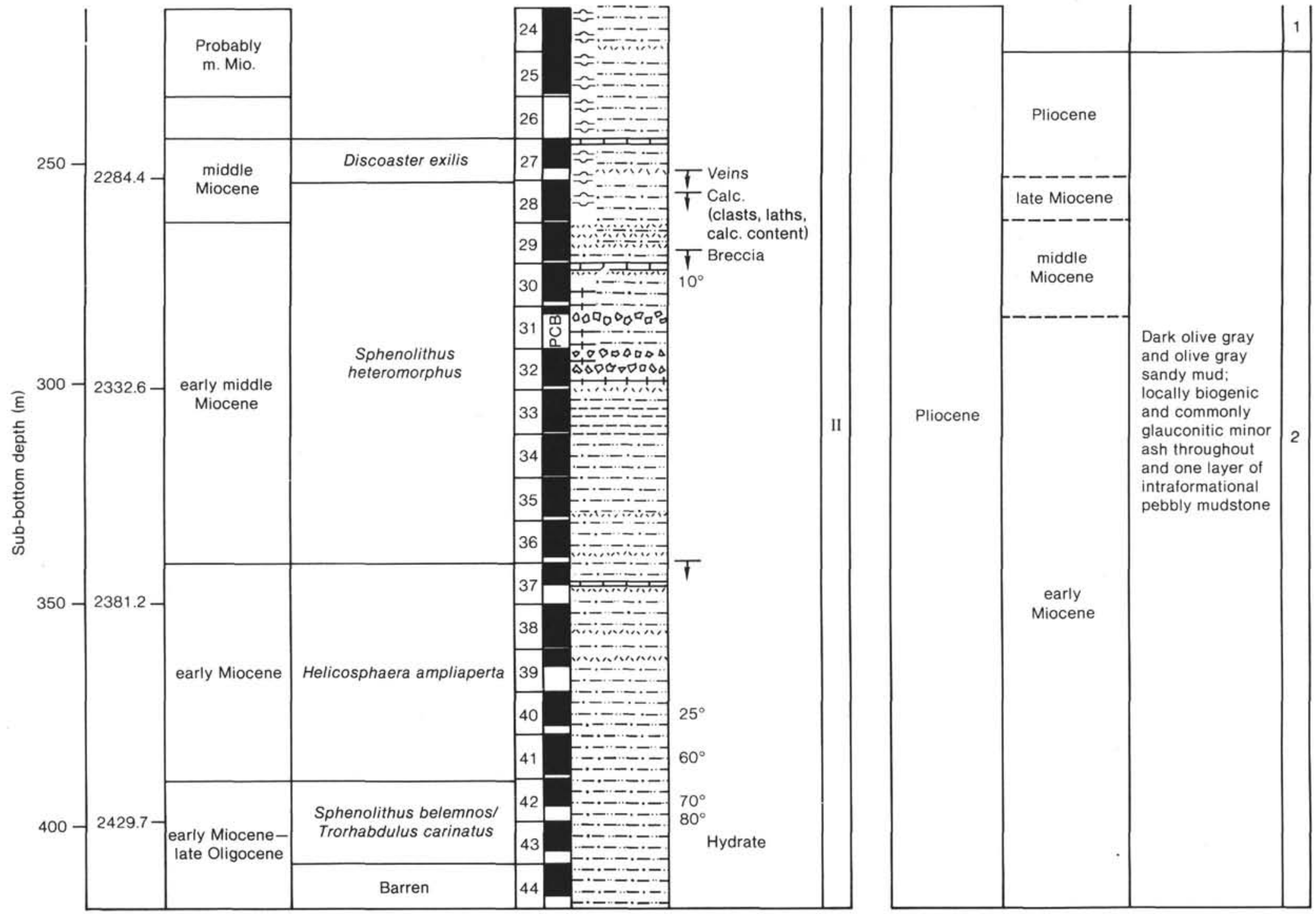


Figure 2. Lithostratigraphic summary of Site 568 and comparison with thicknesses of equivalent-aged sections at Sites 496 and 497. Apparent dip of bedding in Description column noted where observed in the hole adjacent to Lithology column.

Unit II

Unit II (Cores 20 to 44, 182.0–417.7 m sub-bottom depth from early Pliocene to earliest Miocene) is a mottled and bioturbated mudstone, generally grayish olive (10Y 4/2) to grayish blue green (5BG 5/2). These colors occur as mottles and pebble clasts and as matrix material. The average sand-silt-clay composition is 11, 35, and 54%, respectively (as was determined by shipboard smear-slide analyses). This unit contains at least 15% siliceous biogenic remains (diatoms, radiolarians, silicoflagellates and sponge spicules), and several horizons of slightly calcareous mudstone (Cores 20, 21, 22, 28, 29), nannofossil ooze (Cores 21, 31–33), and limestones and limestone conglomerate (Cores 20–23, 30, and 37), as well as isolated limestone clasts throughout the core. Thin mudstone breccia layers with angular to subangular mudstone clasts occur in Cores 31 through 32. The bottom half of Core 33 is very fine-grained calcareous mudstone–claystone composed almost entirely of clay and nannofossils.

Light to moderate olive brown mottling and clasts (5Y 5/6 to 5Y 4/4) occur in Cores 42 through 44. These contain reworked Eocene nannofossil and foraminifer fossils (see Biostratigraphy).

Bedding is roughly horizontal in the upper half of Unit II, but in Cores 29 and 30 the apparent dip of bedding is 10°, Cores 40 to 42 show some apparent dips of 30 to 60°, and in Core 43 locally preserved bedding exhibits apparent dips of 70 to 80°.

We distinguished 25 ash layers (Cores 23, 24, 27, 29, 30, 33, 35–37, and 39) as well as numerous ashy mottles and pumice clasts in the upper part of the unit (above Core 40).

Small-Scale Deformation in Unit II

Small-scale fractures such as those described from Site 566 were observed offsetting beds beginning in Core 22. Undeformed beds commonly overlie fractured beds (Fig.3). The subhorizontal–horizontal scaly fabric observed at Sites 565, 566, and 567 is also observed at Site 568 from Core 20 to the bottom of the hole. As at previous sites, the development of scaly fabric is attributed to the alignment of clays during sediment mass movement. Possible slickenside-type lineation is observed along some of the scaly surfaces, particularly toward the bottom of the hole.

From Core 28 to hole base, deformation structures called "veining" are preserved in mudstone biscuits. Veins are about 1 mm thick and usually 1 to 3 cm long. The veining occurs in two main styles. Figure 4A shows an anastomosing network of small veins of horizontal to subhorizontal orientation relative to bedding. Figure 4B illustrates the second style of veining, where a series of subparallel veins are planar to curviplanar or even sigmoidal. These veins are usually only a few millimeters apart. Orientation of this second type of veining ranges from subhorizontal to vertical relative to bedding planes, with subvertical to vertical orientation increasing in proportion downhole. Cowan (1982) studied the

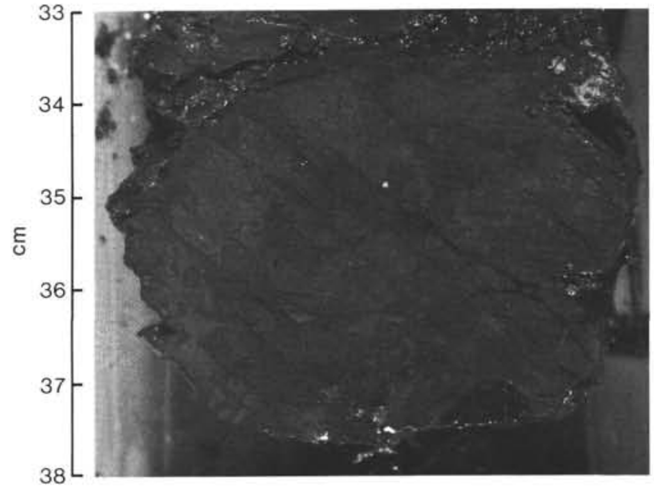


Figure 3. Fractured bed over- and underlain by undisturbed beds (Sample 568-34-1, 33–38 cm).

parallel "veining" of Site 496 in detail for mineralogy and petrographic fabric. The vein fillings were compositionally and texturally similar to the surrounding mud matrix except for very fine-grained phyllosilicates, which are preferentially oriented parallel to vein boundary. Cowan interprets these veins as dewatering conduits geometrically analogous to extension fractures. Deformation of veins may have occurred in response to extension during downslope mass movement of sediments on the upper slope of the Middle America Trench.

Post-Miocene Sedimentation at Site 568

Three observations can be interpreted in several ways to model sedimentation at Site 568. (1) There is a difference of nearly 200 m between thicknesses of Pliocene–Pleistocene section at Sites 568, 496, and 497, all within about 10 km of each other. (2) Seismic stratigraphy shows considerable relief along an acoustic basement that may represent an unconformity (see Geophysics section). (3) Bedding inclination shows an increase concentrated in Core 40 from only about 10° in Cores 29 and 30 to nearly vertical in Cores 42 and 43.

There is abundant indication of mass movement and small-scale deformation in the presence of scaly fabric and fractures, and of nonuniform horizontal pressure on the sediments in the dewatering veins and extension cracks in the Miocene sediments. Such slumping and/or folding of coherent units may account for the high-angle bedding dip observed at Site 568.

Finally, the presence of reworked Eocene material in clasts at the base of the hole can be accounted for by at least two very different origins. The microfossils in sediment from the bottom of the hole indicate an age of early Miocene–late Oligocene (see Biostratigraphy section). Either the reworked material is very locally derived from underlying Eocene basement (in which case the drilling was halted quite close to the unconformity—if that is what the acoustic reflection represents) or it was transported downslope from an upslope exposure

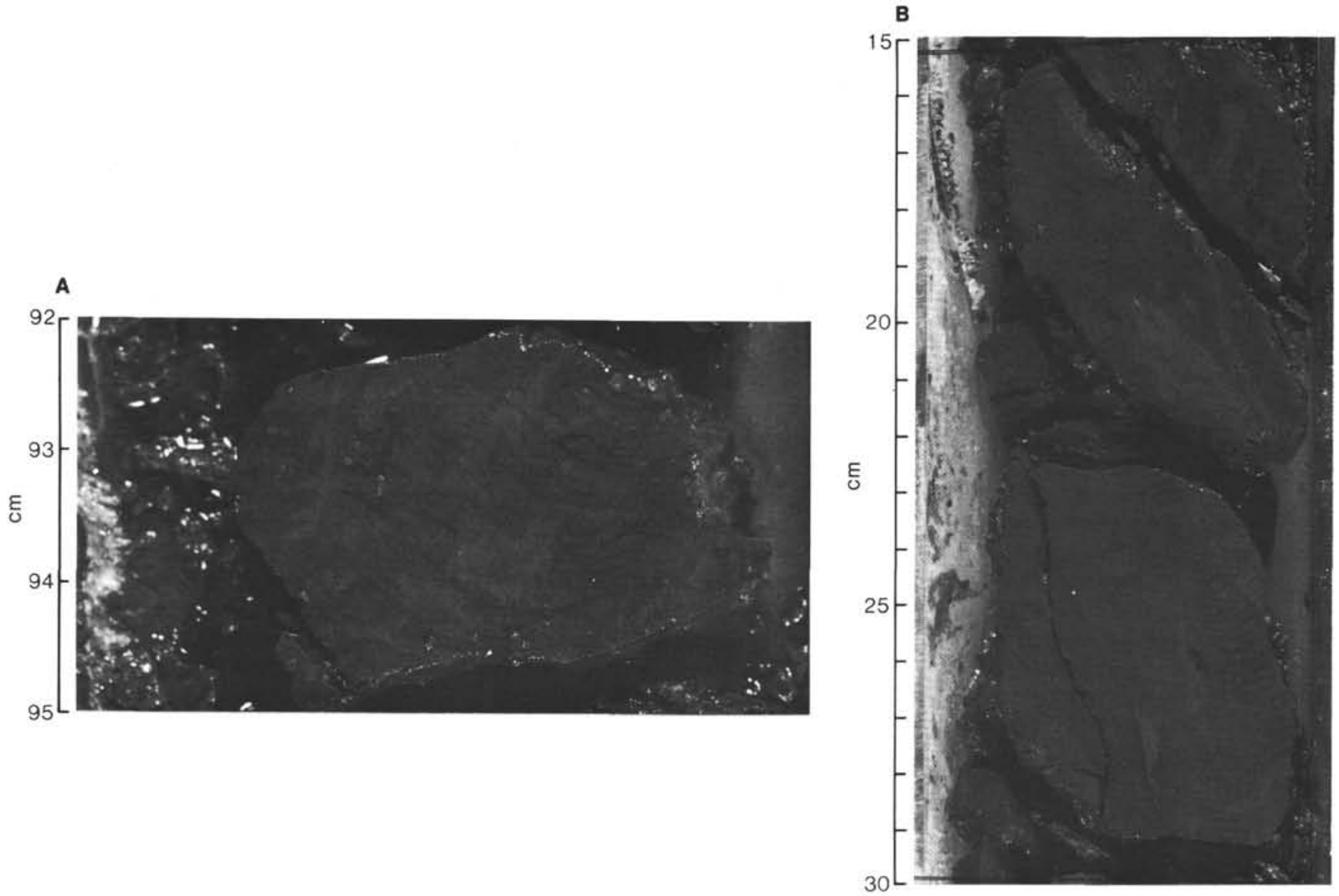


Figure 4. Photo of A. anastomosing (Sample 568-32-6, 92–95 cm) and B. subparallel veining (Sample 568-42-7, 15–30 cm) in sediments.

of Eocene material. The clasts contained pyritized radiolarians similar to those characteristic of the Eocene biostratigraphic facies recovered in the Esso Petrel Well.

BIOSTRATIGRAPHY

Introduction

At Site 568, 417.7 m of Pleistocene through early Miocene–late Oligocene mudstones were recovered (Fig. 5). Calcareous nannofossils, diatoms, and benthic foraminifers are in general age agreement, moderately preserved, and present in rare to common numbers to within 20 m of total depth.

Sections 568-1-2 to 568 21,CC are Pleistocene (1–195.4 m), as indicated by all microfossil disciplines; 568-22,CC is tentatively Pliocene, based on diatoms, whereas 568-23,CC, through 568-24,CC (214.8–224.5 m) are late Miocene, based on benthic foraminifers and diatoms. The barren and/or poorly preserved Samples 568-22-2, 32–36 cm through 568-25,CC delineate one long or several short Pliocene–late Miocene unconformities. Samples 568-25-4, 23 cm through 568-28-2, 11 cm are assigned to the middle Miocene *Discoaster exillis* Zone, 568-28-6, 10 cm through 568-38-2, 147 cm are assigned to the middle Miocene *Sphenolithus heteromorphus* Zone, and 568-38-4, 138 cm through 568-42-3, 126 cm are assigned to the early Miocene *Helicosphaera ampliaperta* Zone. Cores 42 through 44 (398.7–417.7 m) contain rare early Miocene–late Oligocene diatoms (to 568-44,CC), nannofossils (to 568-43,CC) and benthic foraminifers (to 568-44,CC).

Reworking of the microfossils is not significant until Cores 42 through 44, where Eocene diatom species first appear. Very rare Eocene nannofossils and a very sparse benthic foraminiferal assemblage associated with pyritized radiolarians is also present through this interval.

Paleoecologic analysis of Site 568 based on the benthic foraminifers suggests that deposition occurred in the upper middle bathyal (500–1500 m) to abyssal (≥4000 m) biofacies. The oldest sediments recovered in Cores 42 to 44 were deposited in the abyssal biofacies and below the foraminiferal CCD (calcite compensation depth). Foraminifers are extremely rare in these samples, whereas radiolarians are common and are preserved as both siliceous tests and pyritized molds. Benthic foraminiferal assemblages in Cores 21 through 41 suggest a gradual increase in water depths from upper middle bathyal (500–1500 m) to lower bathyal (2000–4000 m). Transported outer shelf material dominates the lower part of this interval. In upper part of the section transported material is principally from the upper slope.

Pleistocene deposition occurs in the lower middle bathyal and abyssal biofacies. In the lower part of this interval, Cores 19 through 7 were deposited in the lower

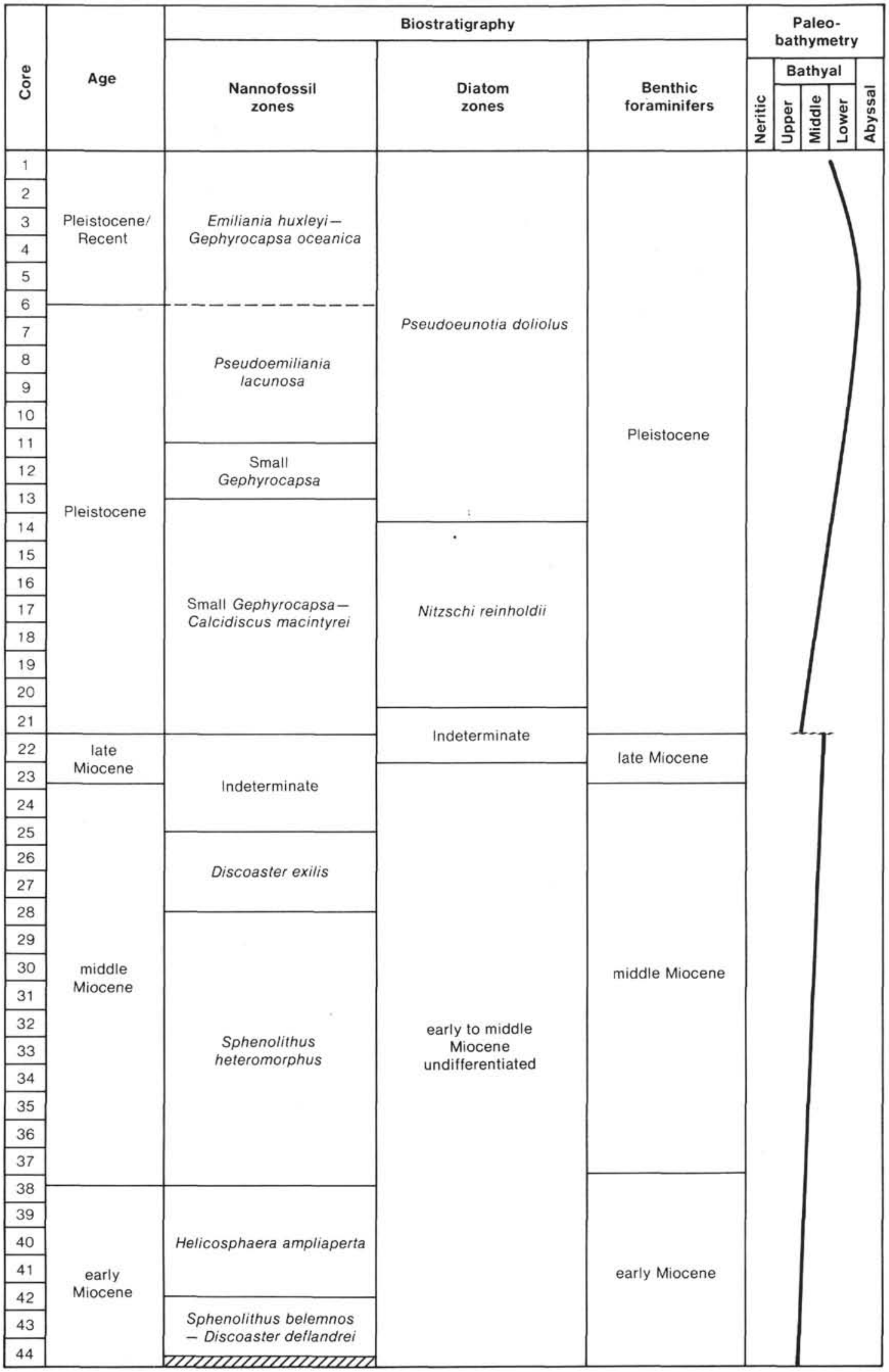


Figure 5. Biostratigraphic and paleoecologic summary, Site 568. Hachures indicate barren intervals.

middle bathyal biofacies (1500–2000 m), and paleobathymetry appears to decrease up section. Between Cores 7 and 6, paleodepths increase rapidly. Abyssal faunas dominate Sections 568-6,CC through 568-2-7. The core catcher of Core 1 contains a fauna indicative of depths intermediate between the present lower bathyal depth and the abyssal depths of Core 2.

Sediment accumulation rates uncorrected for compaction (Fig.6) for the Pleistocene section (0–196 m) are approximately 117 m/m.y. This figure seems low in comparison to Site 496 (205 m/m.y.), unless the entire Pleistocene interval (225 m) from that site is averaged over a 1.65-m.y. time interval. A rate of 136 m/m.y. is then possible for Site 496, which compares favorably to Site 568 sedimentation rates.

Sedimentation rates for the early through middle Miocene section range from 66 m/m.y. (based on a constant sedimentation rate–straight line fit) to 33 m/m.y. (averaged over the entire time period encompassed by successive zones). Early Miocene sedimentation rates approximated at Site 496 were 60 m/m.y. and are in agreement with the higher figure. Paleontologic resolution is not sufficient to allow sedimentation rate calculations for the early Miocene to late Miocene and early Miocene–late Oligocene undifferentiated sediments.

Nannofossils

Abundant nannofossil assemblages are well preserved throughout the Pleistocene (568-1 through 568-21,CC) but lack consistent marker species for detailed zonation.

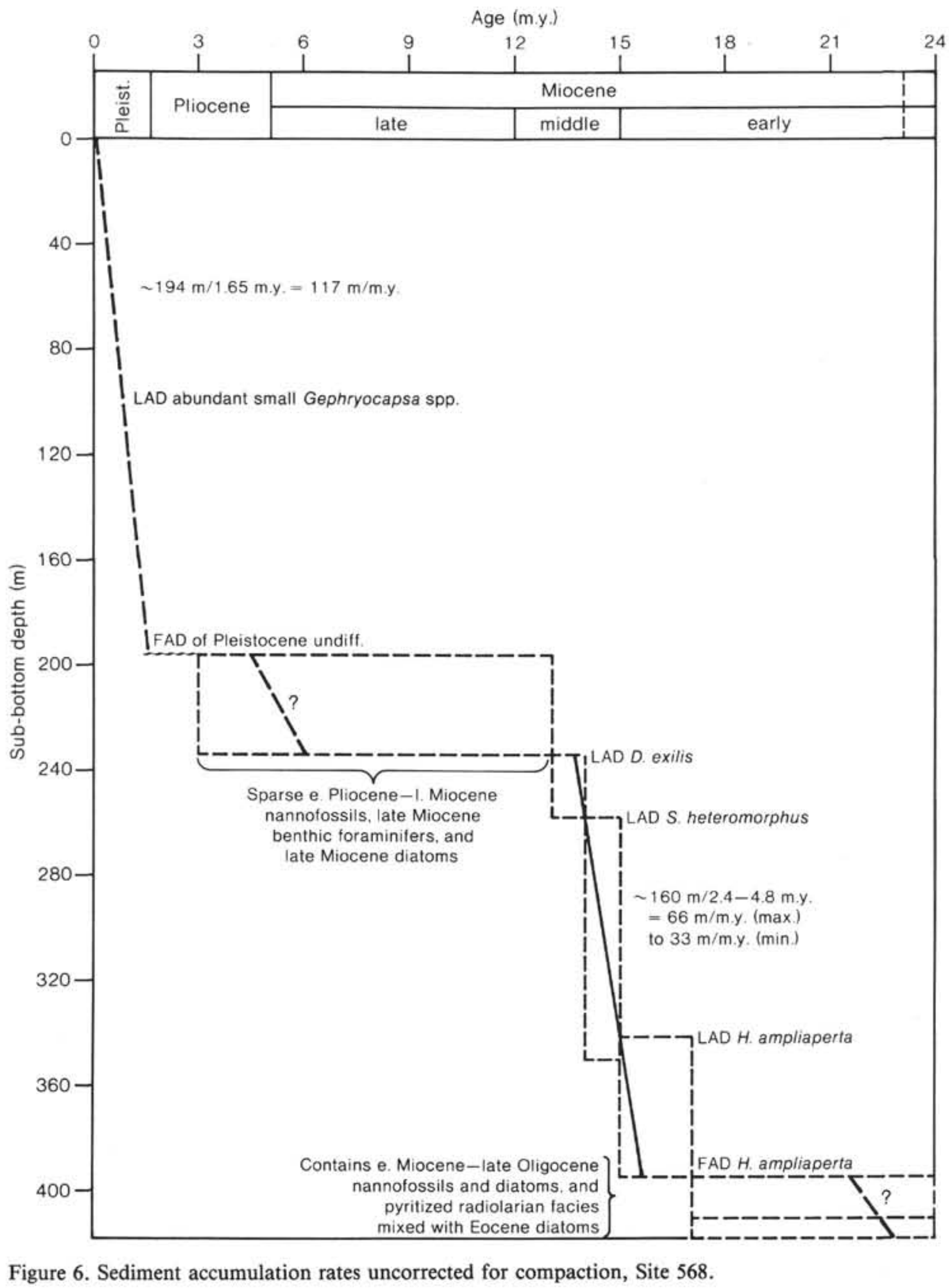


Figure 6. Sediment accumulation rates uncorrected for compaction, Site 568.

Gartner's (1977) Pleistocene zonation was tentatively applied from 568-1-2 through 568-21,CC, whereas Okada and Bukry's (1980) zonation is applicable for the early through middle Miocene interval.

Early Pliocene–middle Miocene nannofossils are rare to absent but are moderately preserved when present in Cores 23 through 25. Middle and early Miocene nannofossils encountered in 568-27 through 568-41,CC contain rare to common moderately preserved nannofossils. Early Miocene-late Oligocene nannofossils in Cores 42 and 43 are rare, and poorly to moderately preserved, whereas 568-44,CC (417.7 m, TD) was essentially barren.

Nannofossil reworking is minimal, with several early Pleistocene to middle Miocene species present in Cores 1 through 5. Very rare fragments of an Eocene *Micrantholithus* sp. are also present in Sample 568-43,CC.

Samples 568-1-2, 80 cm through 568-6-2, 43 cm are assigned to the Recent–late Pleistocene *Emiliania huxleyi* to *Gephyrocapsa oceanica* Zones on the basis of the occurrence of *Geophyrocapsa oceanica, Helicosphaera kamptneri,* small *Gephyrocapsa* spp., and *E.* cf. *huxleyi*. Samples 568-6-4, 43 cm through 568-11-1, 89 cm are assigned to the Pleistocene *Pseudoemiliania lacunosa* Zone, based on the occurrence of this same assemblage, with the addition of *P. lacunosa* and the absence of *E.* cf. *huxleyi*

Core 11 through Sample 568-13-2, 61 cm are tentatively assigned to the small *Gephyrocapsa* Zone because of the dominant abundance of small *Gephyrocapsa* spp. and lack of *G. oceanica.*

Samples 568-13-4, 45 cm through 568-21,CC are assigned to the early Pleistocene. There is little change from the assemblage encountered upsection; and the sporadic, rare occurrence of *P. lacunosa* and *Helicosphaera sellii* makes zonal assignment difficult. Lack of *Calcidiscus macintyrei* suggests that the earliest Pleistocene may be absent.

Samples 568-22-2, 146 cm through 568-23-2, 90 cm are dominated by siliceous microfossils and barren of calcareous nannofossils. And 568-23,CC through 568-25-2, 148 cm are early Pliocene–middle Miocene, given the occurrence of *H. kamptneri, C. leptopora, Discoaster brouweri, Sphenolithus abies,* and *Reticulofenestra pseudoumbilica*.

Samples 568-25-4, 23 cm through 568-28-2, 11 cm are middle Miocene and assigned to the *Discoaster exilis* Zone. Rare *Discoaster exilis, D.challengeri*, and *Discoaster* cf. *bollii* are present in Sample 568-25-4, 23 cm whereas Sample 568-27,CC contains *Coccolithus miopelagicus* and *Discoaster adamanteus* with *D. exilis.*

Samples 568-28-6, 10 cm through 568-38-2, 147 cm are assigned to the middle Miocene *Sphenolithus heteromorphus* Zone. They contain a well-developed assemblage with *S. heteromorphus, D. exilis* s. 1. , *Discoaster signus, C. miopelagicus, H. kamptneri,* and *Discoaster variabilis.*

Samples 568-38-4, 138 cm through 568-42-3, 126 cm are assigned to the early Miocene *Helicosphaera ampliaperta* Zone. They contain *H. ampliaperta, S. heteromorphus, H. intermedia, H. euphratis*, and *Discoaster deflandrei.*

Samples 568-42-7, 40 cm through 568-44-4, 70 cm (firm mudstone lithologies) are considered early Miocene and contain consistent occurrences of *Helicosphaera euphrates, D. deflandrei, Triquetrorhabdulus carinatus*, and *Sphenolithus moriformis*. Specimens of *Cyclicargolithus abisectus* or *Dictyococcites bisectus* are not present, which indicates that Oligocene sediments were not recovered at this depth. Section 568-44,CC is essentially barren of nannofossils.

Diatoms

Hole 568 contains the most diverse assemblage of diatoms to date on Leg 84—about 175 species were observed from the 44 cores.

The Pleistocene is represented by the reliable marker fossil *Pseudoeunotia doliolus*, which is present continuously down through Core 20. The *Nitzschia reinholdii* Zone spans Cores 14 through 20. The last appearance of *Rhizosolenia praebergonii* is in the Pliocene, which is penetrated by Core 22 (21 is a short pressure core), and *Thalassiosira oestrupii* became extinct in the Pliocene, as well.

Hole 23 contains *Rossiella praepaleacea*, which is restricted to the upper Miocene.

Cores 24 to 44 contains diatoms whose ranges are restricted to the middle and lower Miocene (Barron, 1981, and Barron, in press). These include *Actinocyclus ellipticus* var. *javanicus, Annellus californicus, Cestodiscus peplum, Actinocyclus radianovae, Coscinodiscus lewisianus, Craspedodiscus coscinodiscus, Cymatogonia amblyoceros, Denticulopsis nicobarica, Goniothecium odontella, Stephanopyxis grunowii*, and *Synedra jouseana.* According to Barron (in press), *Craspedodiscus coscinodiscus, Coscinodiscus lewisianus*, and *Annellus californicus* have their upper range limits in the lower middle Miocene. These species first occur in Core 24. *Synedra jouseana*, which became extinct in the middle Miocene, ranges from Cores 26 through 44.

Benthic Foraminifers

Benthic foraminiferal assemblages from Site 568 are abundant and well preserved in the majority of samples examined. Poorly preserved assemblages occur particularly in the intervals associated with a hiatus of where deposition occurred below the foraminiferal CCD. Biostratigraphic interpretation indicates that Core 1 through 568-21,CC are Pleistocene, and Samples 568 -22-2, 34–36 cm through 568-23-3, 92–96 cm are probably late Miocene. Samples 568-23,CC through 568-37,CC are early Miocene, and Cores 42 through 44 are earliest Miocene. Paleoecologic analysis indicates a complex bathymetric history with depths ranging from upper middle bathyal to abyssal.

The Pleistocene interpretation (Cores 1 through 21) is based on diagnostic Pleistocene species, the similarity of faunas to Holocene assemblages (Smith, 1964), and the absence of any extinct species. *Uvigerina senticosa, Laticarinina pauperata, Planulina weullerstorffi*, and various bolivinids dominate the upper cores in this interval. This faunal composition indicates deposition occurred in the abyssal biofacies (4000 m) with transport predominately from the upper and lower bathyal biofacies. The benthic foraminiferal fauna similarly changes in Cores 7 through 21 and is characterized by a larger component of lower middle bathyal species and rare abyssal species. Samples 568-22-5, 32–36 cm through 568-25-6, 51–55 cm are poorly preserved and dominated by resistant species or barren. The common occurrence of *Siphogenorina basispinata* in Sample 568-23,CC and subsequent samples suggests that the overlying barren or dissolved interval represents one or more of the Pliocene to middle Miocene hiatuses. Well preserved middle Miocene assemblages are mixed with dissolved or barren samples down to Sample 568-37,CC. In 568-38,CC *Siphogenerina transversa* and nannofossils indicate the early Miocene. Additional diagnostic early Miocene species occur down to 568-41,CC.

Paleoecologic analysis of the Miocene interval at Site 568 suggests that from Cores 21 to 41 there was a transgression with water depths progressing from upper middle bathyal (500–1500 m) in early Miocene to lower bathyal (2000–4000 m) by late Miocene. Transported material is derived from the outer shelf biofacies in the early Miocene. Lenticulinids and various species of *Marginulina* are common components of the transported material. As the water depths increased in the later part of the Miocene, shelf materials were no longer deposited in this area. In the late and middle Miocene, benthic foraminifers were transported principally from the upper slope.

Benthic foraminiferal species in Cores 43 and 44 are rare, poorly preserved, and probably early Miocene. These assemblages could also be diagnostic of the latest Oligocene. Because radiolarians dominate these samples, deposition is believed to have taken place in the abyssal biofacies (4000 m) and below the foraminiferal CCD.

PHYSICAL PROPERTIES

Methods

The suite of measurements performed to determine physical properties consists of bulk density, porosity, water content, sonic velocity, shear and compressive strength, and thermal conductivity. The techniques employed are the same as for previous sites of this leg. Thermal conductivity tests were made on only a limited number of samples.

Results

Bulk densities and their inversely related wet-water contents and porosities are shown in Figure 7. Bulk density increases slowly from 1.31 Mg/m^3 at sub-surface to approximately 1.4 Mg/m^3 at 230 m sub-bottom. At this depth all three index properties show a more rapid change to a sub-bottom depth around 240 m; bulk densities increment in this interval to about 1.55 Mg/m^3. Below this point, the trends once again demonstrate an overall gradual and slow shift to the depth interval between 360 and 375 m, which once again shows a faster rate of

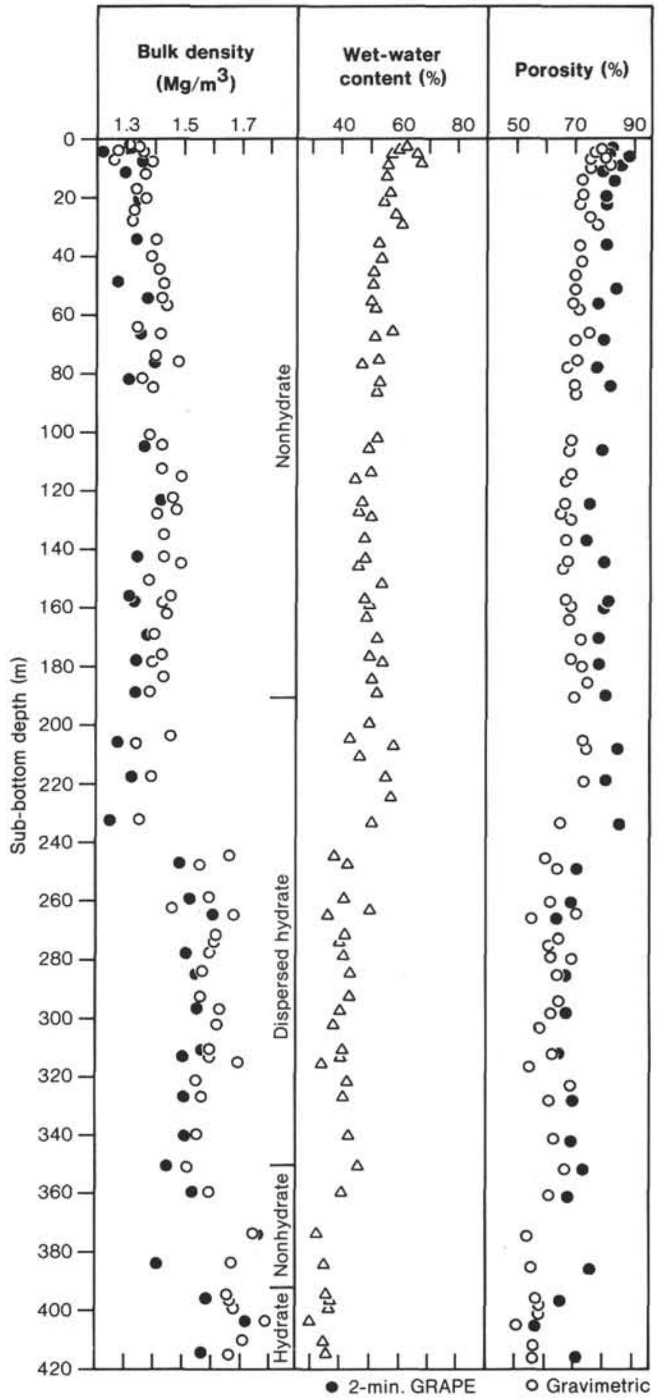


Figure 7. Index properties of Site 568 sediments.

change in index properties, that is, bulk density increases from 1.55 Mg/m^3 to roughly 1.70 Mg/m^3. The remaining data resume the gradual trend of the overall section. Variability occurring around the tendencies may be related to the disturbance caused from degassing of the sediment, drilling, and/or the fractured nature of sediment below 166 m.

Sonic velocities and acoustic impedance are plotted in Figure 8. Sonic velocity data show an overall increase with depth, velocities varying from 1.56 km/s near the

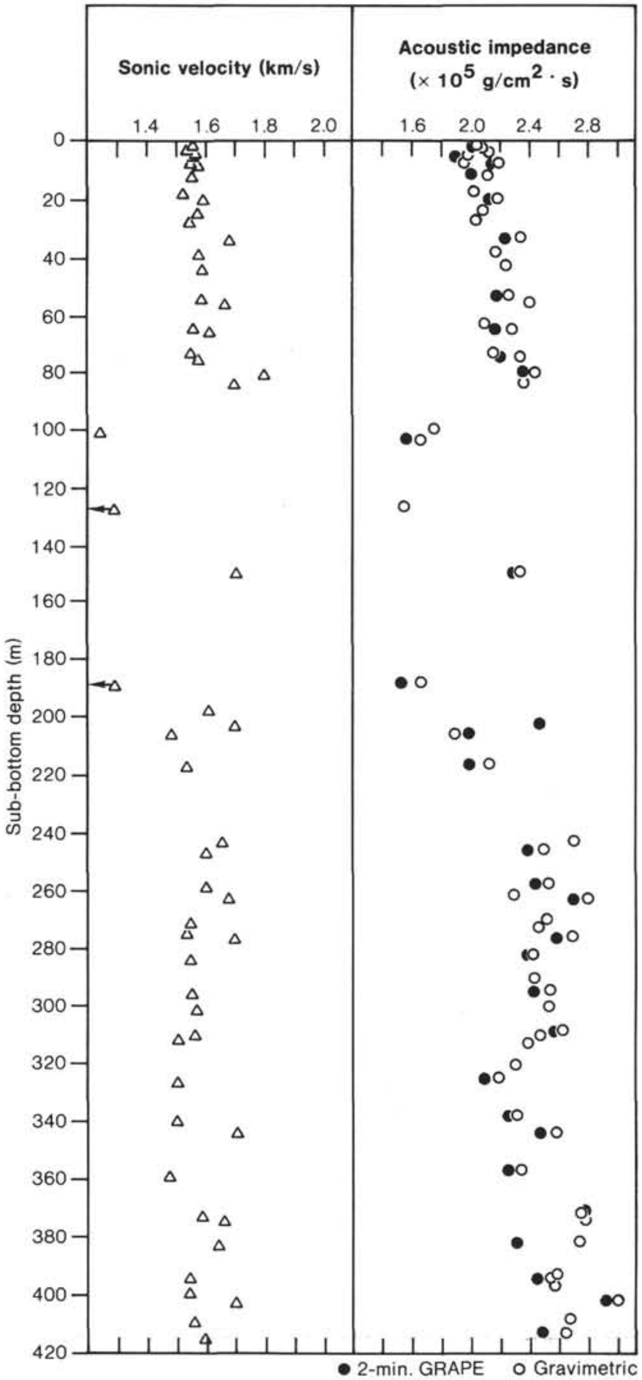


Figure 8. Acoustic characteristics of sediments at Site 568. (Data point with arrow indicates information off the scale.)

mud line to 1.65 to 1.70 km/s at 420 m. A gap between 85 and 198 m with a few widely distributed data points reflects the area in which degassing within the sediment caused excessive attenuation.

Shear and compressive strengths are plotted in Figure 9. These data are incomplete, but those presented reflect the low strengths induced by the aformentioned degassing. A rapid increase in strength is observed between 200 and 230 m sub-bottom, below which the sediment becomes indurated, precluding further measurements.

Thermal conductivities were performed using both the full and half-space probes, depending on the degree of consolidation of sediment. The data obtained are not corrected to *in situ* conditions and are shown in Table 2.

Discussion

The character of physical properties at this site closely resembles that of Site 496 physical properties determined during Leg 67. The Pleistocene/Pliocene boundary is correlated with the upper interval of rapid change in physical properties (230–240 m), as observed here and at Site 496. The lower interval (360–375 m), showing a similar trend, is not directly related to such a feature, however, it does lie near the early/middle Miocene boundary.

The presence of external stress in the system at this site may be appreciated in excess pore pressures monitored by the *in situ* pore-water samples, sigmoidal veins, and fractures. The effect of this stress in the sediment here is linked to the dewatering capabilities of the system and the foliated nature of the sediment and mudstone. *In situ* pore pressure responses to the downhole interstitial water sampler indicated pressures exceeding hydrostatic pressure. These high pressures may be indicative of slow drainage conditions that do not allow dissipation of excess pore fluid (see Taylor and Bryant, this volume).

Physical properties traits linked to hydrates existent at this site are difficult to assess. This difficulty is expected because the hydrate is most likely present in dispersed form in the majority of the section. Chemical analysis of gas molecular composition suggests that dispersed hydrate layers exist between 190 and 345 m and are dispersed with some solid hydrate between 391 and 410 m sub-bottom. Lithostratigraphic observations show interspersed layering of highly fractured units within most cohesive blocks of mudstone, and this may represent the distinct style limiting hydrate distribution. The physical properties of sediment recovered along with the hydrate in Core 43, however, are similar to those of surrounding facies.

GEOPHYSICS

Seismic Reflection Records

Site 568 is located about midway between seismic records GUA-13 and GUA-18; GUA-18 was made using a maxipulse sound source to increase penetration over that obtained in GUA-13. At the position of Site 568 the two lines are plotted about 1 km apart. The multiple satellite fixes recorded during drilling place Site 568 941 m north and 524 m west of Site 496.

Both records GUA-13 and GUA-18 display essentially the same geologic features, and only 13 is shown here (Fig. 10). The GUA-13 display shows a sequence of reflections immediately below the seafloor, representing a hemipelagic unit that laps onto a dipping section of higher amplitude, which represents a sediment lobe. Sonic logging gives a similar result. Using the corrected PDR (precision depth recorder) depth at the site gives a

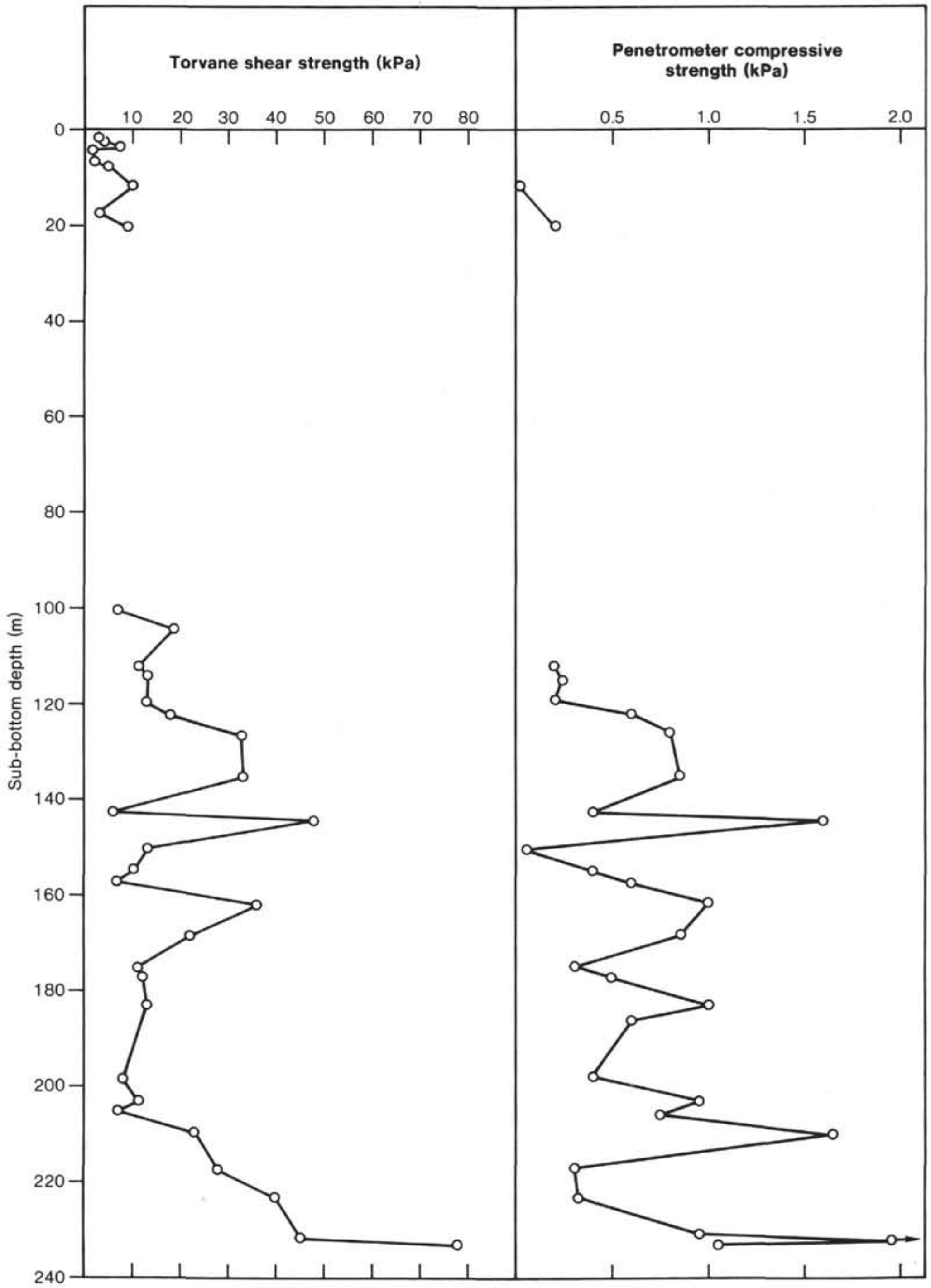


Figure 9. Downhole strength measurements from Site 568 sediments.

BSR (bottom simulating reflection) depth of 469; using the drill stem depth of bottom felt gives a BSR depth of 445. The former is more compatible with the seismic record because it is an acoustic measurement. Therefore drilling at Site 568 ended about 44 m above the base of hydrate reflection. The dipping section of the lobate unit is cut by a strong reflection subparallel to the seafloor. This latter reflection is a BSR that marks the base of the gas hydrate.

Calculations concerning the depth of the BSR were first made using a value from semblance diagrams of 1.8 to 1.85 km/s. This velocity gives a depth to the BSR of about 500 m. During the drilling at Site 568 it became apparent that the semblance velocities for the upper part of the section were high, and by 280 m a good statistical population could be established that showed velocities of 1.5 to 1.6 km/s. Using these values and projecting to a value of 1.8 km/s at the BSR gave a BSR depth of 460 m,

Table 2. Thermal conductivities for Hole 568 sediments.

Section (core-section)	Sub-bottom depth (m)	Thermal conductivity (mcal/cm°C · s)
13-5	114.40	1.626
16-6	144.80	1.557
18-5	162.88	1.874
33-3	304.67	2.955
42-6	397.67	4.691

which agreed, as is discussed later, with the BSR depth determined from a measured temperature gradient.

In Situ Temperature and Pressure

The *in situ* water temperature probe, fitted for the first time with a pressure measuring system, was run six times in Hole 568 (Table 3; Fig. 11). Temperature measurements from the first four lowerings of the probe define a changing gradient with depth that is generally high for a convergent margin and higher than values derived from the drilling at Site 496. The fifth temperature measurement was probably made with incomplete penetration, because the sampler contained seawater. The sixth reading is similarly suspect because of seawater in the sampler and an implied steep temperature gradient. The last two runs were made in stiff sediment as seen in the cores, which may explain the suspect readings.

The temperature gradient defined by the first four runs gives a base of hydrate depth corresponding to the BSR depth of 460 m (see Organic Geochemistry section).

Interpretation of the pressure measurements is reported by von Huene in a chapter on the evidence of elevated pore pressure (this volume).

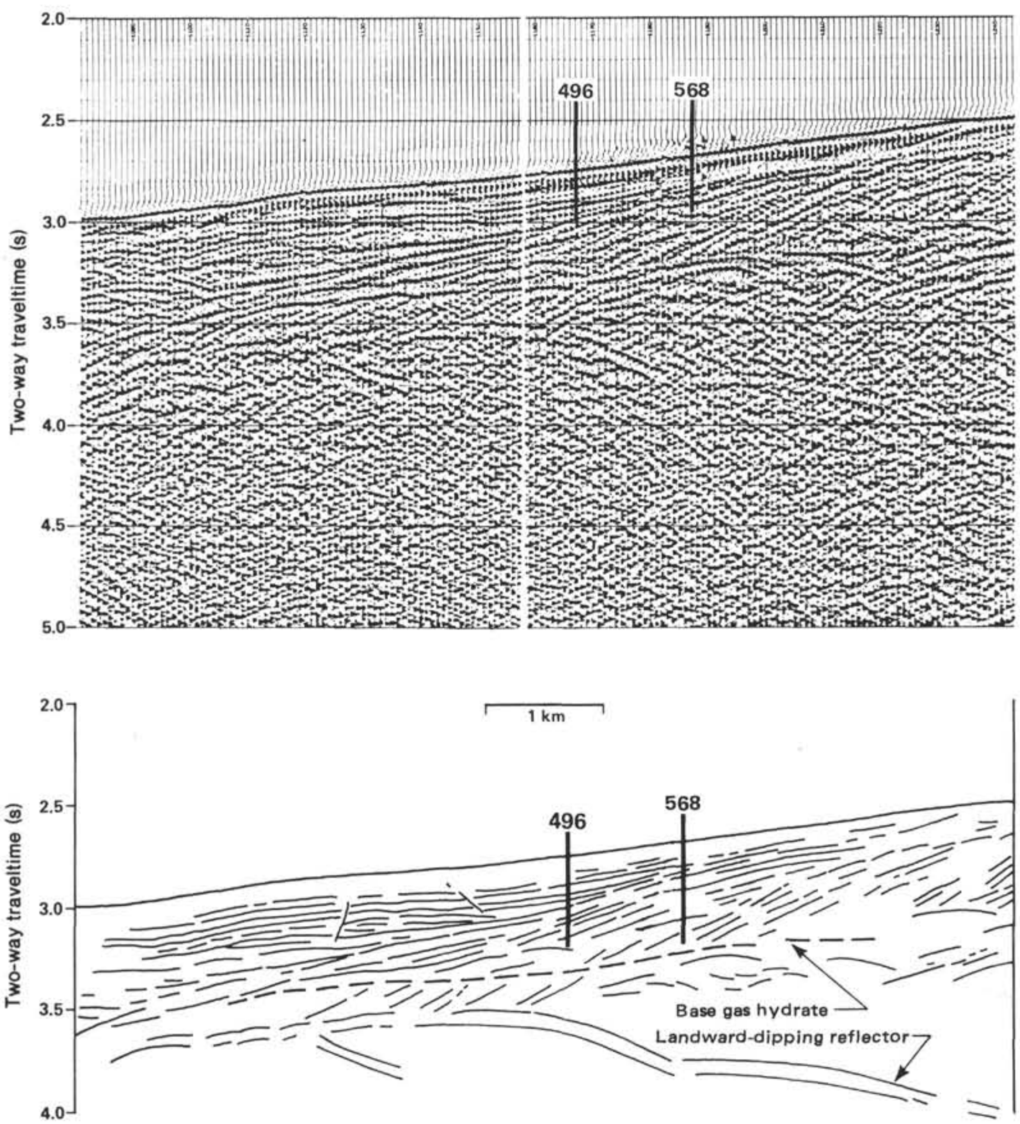


Figure 10. Part of seismic record GUA-13 across the midslope; an interpretive line drawing shows the locations of Sites 496 and 568 and illustrates the structure of the slope deposits and a base of gas hydrate BSR.

Table 3. *In situ* temperature–pressure measurements.

Station	Depth sub-bottom (m)	Bit height (m)	Min. temp. (°C)	Probe temp. (°C)	Mud-line temp. (°C)	Bit pressure (psi)	Probe pressure (psi)	Mud-line pressure (psi)	Comments
1	89.4	10.0	3.6	6.9	2.9	3172	3278	2858 (avg. 2843)	
2	137.2	3.0	2.6	10.1	2.9	3263	3400	2736 (avg. 2771)	
3	186.2	10.5	10.5	13.2 (13.8?)	None	3290	3560	2869 (avg. 2849)	May have pulled out once.
4	282.3	6.0	11.4	16.6	None	3480	3450?	2806 (avg. 2771)	Pressure is suspect.
5	359.9	10.5	2.9	8.7	2.8	3563	3680 (after pore water sampling)	2928 (avg. 2879)	Water sample and temperature are suspect.
6	417.7	6.0	5.2	18.0	None	—	—	—	Water sample and temperature are suspect.

Note: — indicates no data.

Downhole Logging

Two logging runs provided caliper, natural gamma, sonic velocity, formation density, and neutron porosity logs from 85.5 to 410 m (Fig. 12). A cursory study of the caliper, sonic, and density traces was made from field prints. The sonic log reflects the base of the Pliocene unconformity and fixes its time intercept at the contact between the hemipelagic and lobate sediment sequences in the seismic reflection record. Above the contact the sonic trace is without character and has a constant velocity of 1.5 km/s but at the contact a series of thin higher-velocity beds are seen that also deflect the density and caliper logs; below the contact the trace has low amplitude oscillations around a fairly constant 1.6 km/s value. At 365 m, the trace becomes noisy, shows an average velocity of 1.8 km/s, and corresponds to a very rugose part of the hole; no apparent change in lithology is noted for this interval. The section below 365 m has abundant fractures and begins to show local steep dips that may influence the rugosity of the hole.

The formation density trace indicates a density increase at the Pliocene/Pleistocene boundary and again at the Miocene/Pliocene boundary. It reflects well the massive mudstone section between 180 and 305 m; below 305 m the trace appears noisy, corresponding to the rugosity of the hole.

There are no obvious effects from gas hydrate in the logs when the boundaries of dispersed and recovered hydrate are compared with the sonic log and the events that can be attributed to a lithologic change are recognized. There is no increase in velocity at hydrate boundaries, as expected from geophysical studies elsewhere (Kvenvolden and Barnard, 1983). It seems that the hydrate is dispersed in quantities that are insufficient to be detected by the logging instruments but are sufficient to produce a BSR.

PALEOMAGNETISM

At least one oriented sample was taken from each core section that was not clearly disturbed by drilling. Results of stepwise alternating field demagnetization on selected samples are plotted in Figure 13. Several of the samples show significant changes in intensity and direction in low fields, less than 50 Oe, which indicates the presence of low-stability secondary components. It was found that many samples from this hole changed their directions by 50° or more when left for 12 hr. in the ambient magnetic field in the van, which was about 0.4 Oe. Paleomagnetic measurements were made on samples from the first 22 cores. The results appear in Figure 14. Most of the samples were later demagnetized in fields of 150 Oe. The results, even after demagnetization, did not show any systematic stratigraphic pattern and bore a close resemblance to random distribution. It was suspected that drilling disturbance was responsible for at least part of this behavior, although low magnetic stability and the conditions under which the sediments were deposited also play a role.

GEOCHEMISTRY

A major objective at Site 568 was to study the geochemistry related to the occurrence of gas hydrates in oceanic sediments. This site was located near Site 496 of Leg 67 (von Huene, Aubouin et al., 1980) in order to argument the geological and geochemical information obtained previously. Although no gas hydrates were observed directly during drilling at Site 496, salinity and chlorinity measured on pore waters from sediments there were anomalously low, suggesting the presence of gas hydrates (Hesse and Harrison, 1981). In addition, refined interpretations of geophysical records show that a bottom simulating reflector (BSR), indicative of the base of the zone of gas hydrates, is present at the site (von Huene et al., 1982); the BSR had not been recognized at the same time Site 496 was drilled. Thus both chemical and geophysical information indicated that gas hydrates should be present in this part of the landward slope of the Middle America Trench, and Site 568 was drilled to provide detailed data from which to interpret the occurrence and origin of gas hydrates in oceanic sediments offshore Guatemala.

Gas Analyses

Gases were obtained from gas pockets that developed as sediment separated in the core liner because of gas ex-

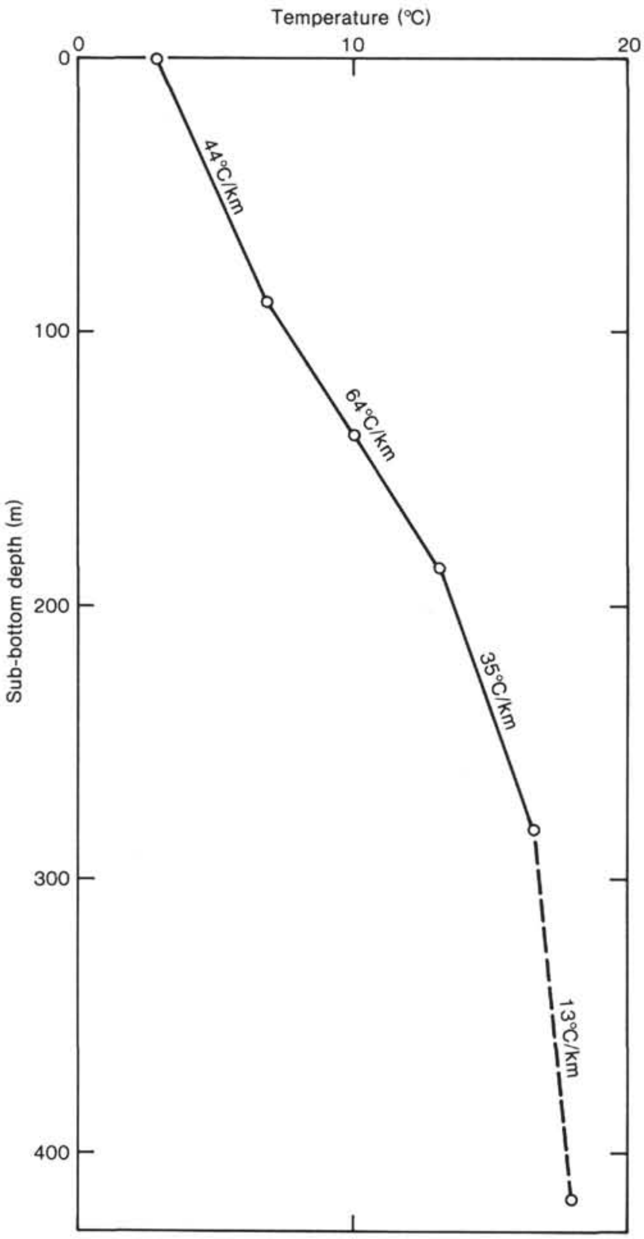


Figure 11. Summary of temperature measurements made with the *in situ* probe. Geothermal gradient between points of measurement is also shown.

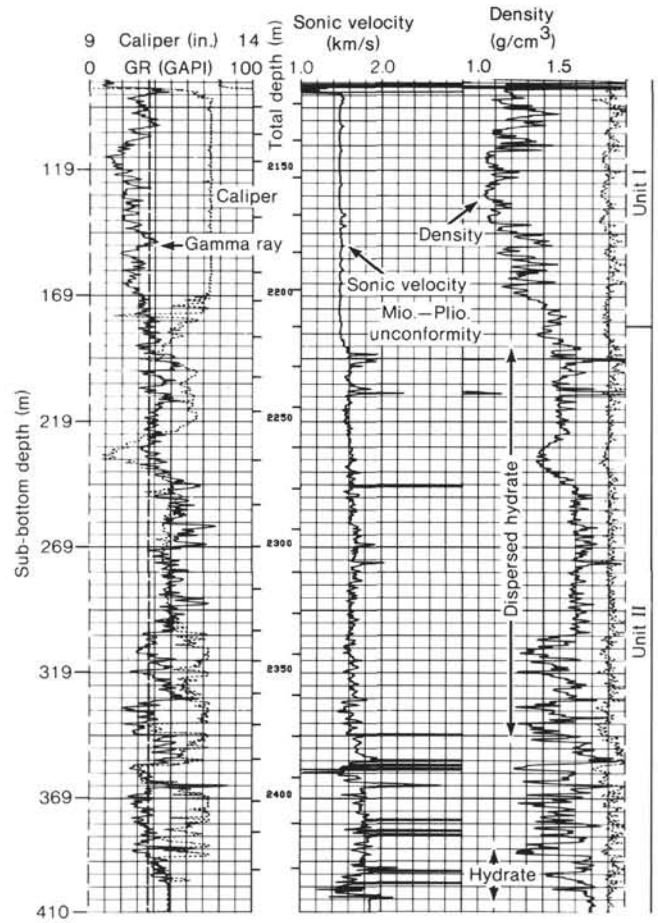


Figure 12. Annotated logs from Site 568.

pansion. Gas pockets were sampled by means of vacutainers, and the collected gases were analyzed by gas chromatography, providing a measure of the volumetric composition of gases within the core liner.

Hydrocarbon gases methane (C_1), ethane (C_2), propane (C_3), isobutane (i-C_4), normal butane (*n*-C_4), neopentane (neo-C_5), isopentane (i-C_5), and normal pentane (*n*-C_5), are present in most samples from Site 568, with C_1 being the most abundant gas found (Table 4). Ratios of C_1/C_2 generally decrease with depth (Fig. 15). The sudden decrease in C_1/C_2 ratios in the interval between 220 and 280 m is because of greatly diminished concentrations of C_1; C_2 concentrations remain about the same, as in samples above and below this interval. Over all, the C_1/C_2 ratios decrease with depth from 20 to 417 m by almost three orders of magnitude.

Gas Hydrates

The relative distributions of hydrocarbon gases in the sediments at Site 568 suggests that gas hydrates are present in the intervals from 190 to 345 and from 391 to 410 m sub-bottom. In these intervals C_1 and C_2 dominate. The larger hydrocarbons are present but in very low concentrations. In contrast, the concentrations of these larger hydrocarbons are greater elsewhere in the core (Table 4). The interpretation of the presence of hydrate is based on consideration of the molecular sizes of cages within the gas hydrate structure (Hand et al., 1974). Results from Site 565 suggested that both structure I and II gas hydrates are present, because gases larger than i-C_4 apparently are excluded. If only structure I gas hydrate were present, gases larger than C_2 would be excluded from the structure. At Site 568 the presence of structure I gas hydrates is suggested in the intervals where C_1 and C_2 dominate and the larger hydrocarbon gases are at low concentrations. No solid gas hydrates were observed, however, in the interval from 190 to 345 m. Rather the fine-grained sediment generally was disrupted because of the presence of gas; the gas hydrate likely had been dispersed in the sediment and had de-

Table 4. Distribution of hydrocarbon gases in Hole 568.

Section (core-section)	Sub-bottom depth (m)	C_1 (%)	C_2 (ppm)	C_3 (ppm)	i-C_4 (ppm)	n-C4 (ppm)	neo-C_5 (ppm)	i-C_5 (ppm)	n-C5 (ppm)
3-5	18	65.0	2.2	1.50	0.25	0.08	—	0.23	0.44
4-4	28	69.0	2.6	2.00	0.46	0.14	—	0.33	0.09
5-5	39	72.0	3.0	3.10	1.10	0.13	—	0.42	0.09
6-4	47	80.0	6.5	4.00	1.30	0.22	0.01	0.71	0.05
7-3	56	75.0	4.3	3.60	1.20	0.20	—	1.40	0.14
8-5	68	71.0	6.3	4.70	1.60	0.38	0.20	0.88	0.07
9-4	75	82.0	6.7	5.60	2.20	0.42	0.10	1.90	0.12
10-4	85	82.0	14.0	6.70	3.00	0.60	0.10	3.20	0.22
12-4	104	75.0	10.0	4.30	1.80	0.37	—	2.70	0.11
13-4	114	69.0	11.0	3.80	1.60	0.34	—	3.30	0.04
14-6	126	95.0	41.0	3.80	2.00	0.35	0.01	2.40	0.14
15-6	135	68.0	41.0	1.70	1.10	0.13	—	0.64	0.09
16-4	145	90.0	54.0	3.50	2.00	0.42	—	0.50	0.13
17-4	153	76.0	49.0	1.70	1.10	0.19	—	1.30	0.17
18-3	160	74.0	56.0	3.30	2.30	0.39	0.09	4.20	0.36
19-7	176	69.0	65.0	1.70	1.30	0.24	0.09	1.80	0.29
20-6	184	50.0	36.0	0.87	0.73	0.12	0.10	0.51	0.08
22-5	203	78.0	130.0	0.79	0.95	0.06	0.10	0.21	0.23
23-2	208	70.0	94.0	0.62	0.65	0.06	0.10	0.04	0.19
24-4	220	72.0	110.0	0.58	0.85	0.03	0.20	0.26	0.04
25-6	232	65.0	95.0	0.61	0.50	0.04	0.10	0.06	0.13
27-3	247	6.2	130.0	0.49	0.79	0.05	0.10	0.13	0.11
28-4	259	3.8	110.0	0.61	0.59	0.04	0.20	0.25	0.06
29-5	270	68.0	110.0	0.56	0.62	—	0.30	0.04	0.08
30-6	281	67.0	150.0	0.52	0.77	0.04	0.24	0.27	0.07
32-6	300	61.0	100.0	0.55	0.19	0.04	0.13	0.04	0.09
33-6	310	71.0	120.0	0.58	0.48	0.05	0.20	0.05	0.20
34-6	319	67.0	140.0	0.71	0.63	0.05	0.20	0.16	0.20
35-4	327	76.0	170.0	0.75	0.75	0.05	0.35	0.25	0.13
36-6	339	68.0	150.0	0.67	0.82	0.05	0.35	0.23	0.09
37-4	346	59.0	116.0	0.67	0.94	0.06	0.45	0.46	0.04
38-6	358	78.0	230.0	0.77	1.20	0.05	0.78	0.48	0.03
39-3	363	70.0	440.0	0.67	0.78	0.05	0.15	0.08	0.04
40-3	374	75.0	560.0	0.97	1.60	0.09	0.53	0.08	0.03
41-5	386	72.0	540.0	1.30	1.50	0.17	0.45	0.32	0.04
42-6	398	76.0	800.0	0.73	1.50	—	0.18	0.14	0.10
43-4	404	65.0	670.0	0.52	0.99	0.03	0.12	—	0.13
44-4	414	78.0	1000.0	0.53	1.60	—	0.25	0.03	0.07

Note: — indicates not detected.

composed during the drilling process. In the interval between 391 and 410 m solid gas hydrate was observed, and the distribution of hydrocarbon gases recovered from the core also indicated the presence of gas hydrates.

Solid pieces of gas hydrates were recovered from fractures in a tuffaceous mudstone in the interval from 403.2 to 404.7 m (Fig. 16). A sample of this gas hydrate was placed in a pressure device. The sample decomposed, producing about 30 volumes of gas to 1 volume of water. This water had a salinity of about 5.5‰. A second sample, which had been decomposing in the laboratory for about 15 min., was also placed in the pressure vessel; the volumetric ratio of gas to water for this sample was about 7. These ratios clearly demonstrate that solid gas hydrate had been found. If these samples had been outgassing water in the form of ice, the maximum possible ratios would have been about 3. The distributional pattern of hydrocarbon gases resulting from the decomposition of the gas hydrate within the pressure device is dominated by C_1 and C_2.

The sub-bottom interval from 410 to 417 m (total depth of the hole) does not contain gas hydrates as indicated by the distribution of gases. This distribution is typical of those intervals observed earlier where gas hydrates are presumed to be absent. In summary, the distribution of hydrocarbon gases at Site 568 are interpreted as follows:

Sub-bottom depth (m)	Gas occurrence
0–190	Biogenic gas followed by gas resulting from early diagenesis
190–345	Gas hydrate dispersed in fine-grained sediment
345–391	Gas in sediments in a nonhydrated state
391–410	Dispersed and solid gas hydrate
410–417	Gas in a nonhydrated state

Pressure Core Barrel

The pressure core barrel (PCB), described in detail by Kvenvolden et al. (1983), was deployed three times at Site 568. Two PCBs recovered pressurized cores from which gas samples were taken. Results are summarized in Table 5, and the details of the experiment are given in Kvenvolden and McDonald (this volume). Aliquots of gas samples from PCB-3 were analyzed by gas chroma-

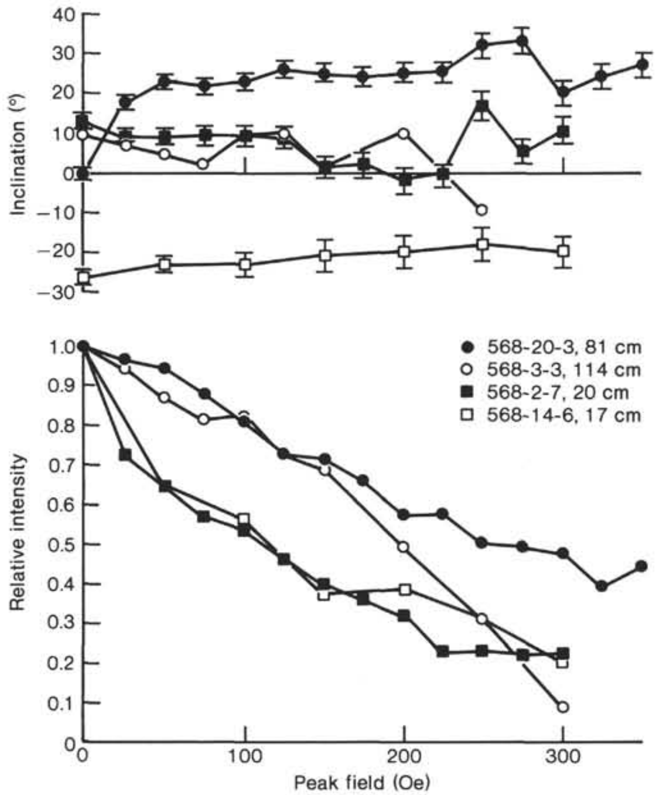


Figure 13. Alternating field demagnetization of selected samples from Hole 568.

tography, and the remaining gas was retained for shore-based isotopic and molecular analyses.

Interstitial Water Chemistry

The inorganic parameters measured were calcium, magnesium, chlorinity, salinity, alkalinity, and pH. The results of these measurements are shown in Figure 17. The results obtained from squeezed sediment samples essentially duplicate the results obtained at Site 496 of Leg 67 (Hesse and Harrison, 1981). This duplication is expected because of the close proximity of Site 496 and Site 568.

Summary

1. Gas hydrates occur in the sediments at Site 568. The molecular distribution of hydrocarbon gases, the low values of chlorinity and salinity, and the disrupted nature of the sediments indicate that gas hydrates are dispersed in sediment at sub-bottom depths between 190 and 345 m.

2. Solid gas hydrate was observed in a fractured tuffaceous mudstone at a depth of about 403 m. When this hydrate decomposed, between 7 and 30 volumes of mainly C_1 were released per volume of water, and this water had a salinity of about 5.5‰, indicating the freshwater nature of the water of the gas hydrate structure. The gas mixture released during decomposition of the gas hydrate contained mainly C_1 and C_2. The presence of dispersed gas hydrate between 190 and 345 m and of solid gas hydrates in fractures between 391 and 410 m suggests that gas hydrates are stratified at Site 568.

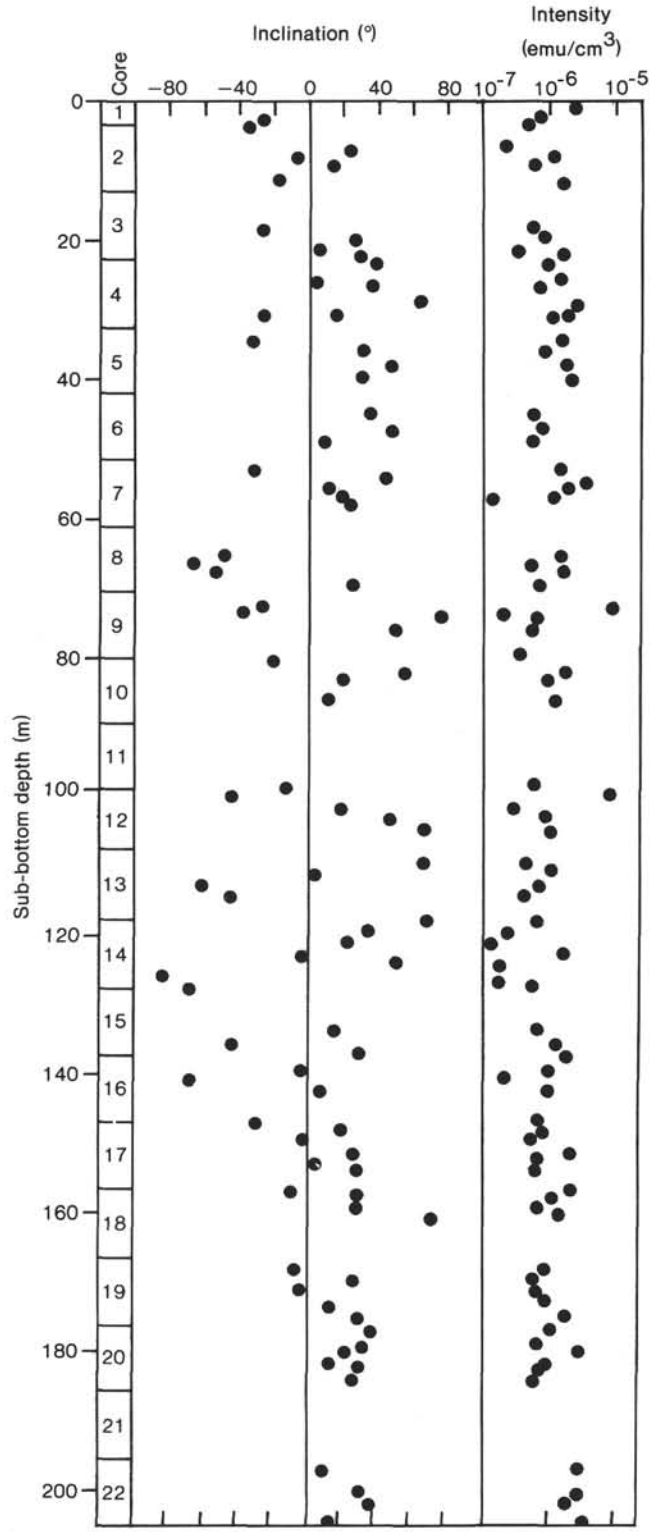


Figure 14. Stratigraphic plot of NRM (natural remanent magnetization) data for Hole 568.

SUMMARY AND CONCLUSIONS

Site 568 is on the upper part of the Middle America Trench slope, in 2031 m of water, 4000 m above and about 47 km landward from the Trench axis. It is lo-

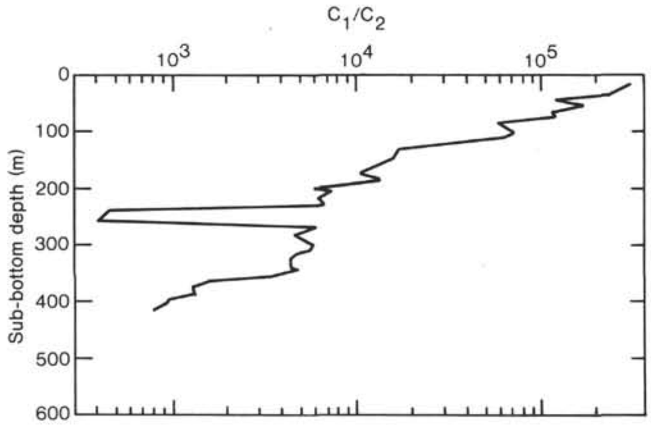


Figure 15. Ratios of methane/ethane (C_1/C_2) with depth at Site 568.

cated about 1 km upslope from Leg 67 Site 496, which had been abandoned after a gas composition was encountered, which suggested possible thermogenic components and perhaps gas hydrate. The major objective at Site 568 was a detailed monitoring of the gas through the whole section to study the formation of gas hydrate. Seismic record GUA-13 was reprocessed to bring out the shallow structure and the base of the gas hydrate seismic reflector. Within the Safety Panel recommendations, Site 568 could be drilled to 100 m above the reflector or to the base of gas hydrate as calculated from temperature data; during the drilling, permission was obtained to penetrate at least to the equivalent depth of Site 496.

Gas hydrates were recognized at Site 568 both from gas composition and as recovered pieces of gas hydrate. The molecular distribution of hydrocarbon gases and the low values of chlorinity and salinity indicate that gas hydrates are dispersed in sediment and coexist as a hydrated and nonhydrated sequence in the 418 m drilled. The sequence encountered is as follows: 0–190 m, biogenic gas followed by gas resulting from early diagenesis; 190–345 m, gas hydrate dispersed in fine-grained sediment; 345–391 m, gas in sediments in a nonhydrated state; 391–410 m, dispersed and solid gas hydrate; 410–417 m, gas in a nonhydrated state. The sediment sequence containing the gas in hydrated and nonhydrated form is a mudstone of very low permeability and porosity: fracturing probably provides the principal porosity and permeability. In the main hydrate section (190-345 m), no hydrate was observed visually despite a careful inspection of each core as soon as it came on deck nor was there an unusual amount of gas in the cores. The hydrate was recognized by a gas composition containing mainly C_1 and C_2. Larger hydrocarbon molecules were present only in low abundance, because they are excluded from the gas-hydrate structure. The hydrate observed visually occurred at about 403 m. It was a white icelike substance filling fractures in a tuffaceous mudstone (50% glass shards). When the hydrate decomposed, between 7 and 30 volumes of mainly C_1 were released per volume of water. The water was fresh, indicating the fresh-water nature of the gas hydrate structure. The quantity of gas relative to water released on decomposition, the composition of the released water and the pore water, and the gas composition demonstrate that gas hydrate had been recovered.

Figure 16. Gas hydrate (white icelike material) embedded in sediment from a sub-bottom depth of about 403 m at Site 568 (Sample 568-43-4, 40–60 cm).

Downhole logging shows that the gas hydrate occurs in concentrations so low that neither velocity nor densi-

Table 5. Results from pressure core barrel, Site 568.

PCB no.	Core	Sub-bottom depth (m)	Core recovered (m)	Core recovered (l)	Initial pressure (psig)	Pressure before venting (psig)	Sediment water (%)	Gas released (l)	Gas/water vol. ratio
1	11	89.4–98.8	1.05	14	3000	3000	50	n.d.	n.d.
2	21	185.7–195.4	1.61	22	2900	3100	52	7.4	0.7
3	31	282.3–292.0	1.16[a]	15	2000	2300	n.d.	n.d.	n.d.

Note: n.d. = not determined.
[a] Unpressurized core.

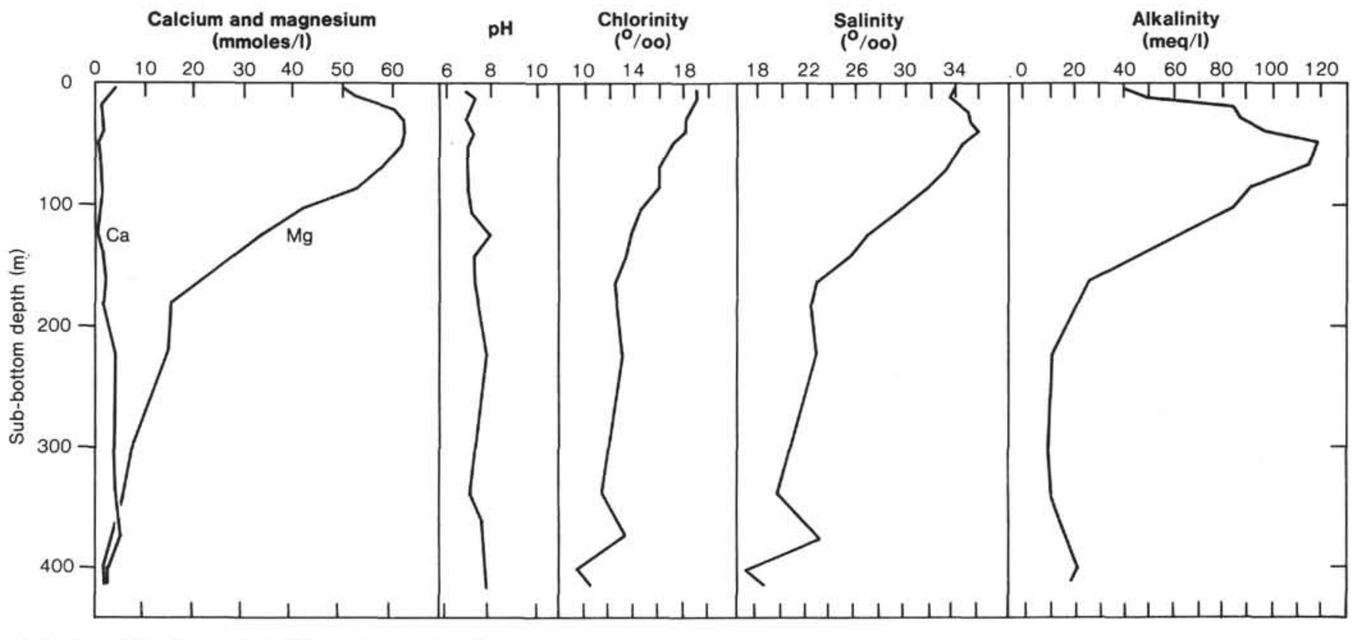


Figure 17. Chemistry of interstitial water at Site 568.

ty are affected by the gas hydrate any more than they are affected by very small changes in lithology. The lithology is very uniform, showing excursion of less than 100 m/s in velocity and 0.2 g/cm^3, in density. Beds of limestone only 10 cm thick in the core are clearly seen in the logs. The hydrate certainly does not occur in sheets of solid material or it would have been seen in the logs and recovered in cores.

The lithology is much like that from Site 496. An upper unit (0–182 m) mainly comprises Recent to late Pleistocene massive olive gray mudstone. This mud is homogeneous, poorly reflective, and shows an almost straight sonic velocity trace at 1500 m/s. The mud is a hemipelagic sequence that unconformably drapes a lobate prograding sequence, as seen in seismic reflection records. The lobate sequence comprises a second lithologic unit (182–418 m) of mudstone that is mottled and bioturbated, although the Pliocene portion appears to belong to the hemipelagic cover. The lower mudstone is Miocene and becomes veined and fractured toward its base with reworked Eocene material. The lower cores show occasional inclined bedding that is near vertical in the last cores. This unit appears to be a Miocene prograding depositional lobe that has been covered by hemipelagic Pliocene and Pleistocene sediment. The lobe is positioned on the northwest bank of San José Canyon, which suggests an overbank feature. Several such lobes can be seen in seismic records as part of the slope sediment covering the acoustic basement surface.

The analysis of benthic foraminifers assemblages indicates subsidence throughout the Miocene, and both uplift and subsidence in the Pliocene and Pleistocene. This history is more varied than that indicated by paleocologic analysis at Site 496 where the same Miocene trend is seen. It seems that the vertical component of motion during Neogene tectonism is more than a simple uplift or subsidence; the preliminary results will be refined and corrected for the effects of sea level change.

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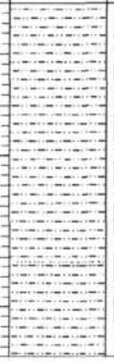
SITE 568 HOLE CORE 1 CORED INTERVAL 0.0–3.4 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Pleistocene/Recent	*Emiliana huxleyi/Gephyrocapsa oceanica*		AM			1, 2, 3, CC	0.5, 1.0				*



sandy layer Black (5G 2/1)

mottling Black (5G 2/1)

LITHOLOGIC DESCRIPTION

Dominant lithology: mud. A few mottled areas occur, but bedding disturbance and mud massivity result in very few sedimentary structures. Bedding occurs in one or two horizons. The smell of H_2S is very strong.

Color: olive gray (5Y 3/2) grading down to dark greenish gray (5GY 4/1) at base of core.

SMEAR SLIDE SUMMARY (%):

	1, 80 D	2, 65 D
Texture:		
Sand	5	10
Silt	30	30
Clay	65	60
Composition:		
Quartz	10	15
Feldspar	2	5
Mica	–	3
Heavy minerals	1	–
Clay	80	66
Volcanic glass	1	–
Glauconite	3	3
Pyrite	1	3
Carbonate unspec.	5	2
Foraminifers	–	Tr
Calc. nannofossils	2	5
Diatoms	3	3
Radiolarians	2	3
Sponge spicules	–	Tr

SITE 568 HOLE CORE 2 CORED INTERVAL 3.4–13.0 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Pleistocene	*Gephyrocapsa oceanica*		CM			1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0				*

Bedding

Laminations with greenish black bed at top of sequence

Void

LITHOLOGIC DESCRIPTION

Dominant lithology: mud, generally massive, structureless, with some lighter mottling. Some bedding and lamination occurs. Strong H_2S odor. Gas expansion cracks throughout the core.

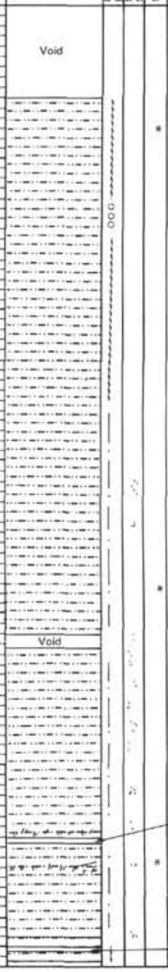
Color: olive gray (5Y 3/2) at top of core, grayish olive (10Y 4/2) in bottom half of Section 3, olive gray below.

SMEAR SLIDE SUMMARY (%):

	1, 104 D	3, 118 D	6, 63 D
Texture:			
Sand	3	2	3
Silt	12	20	12
Clay	85	78	85
Composition:			
Quartz	1	2	3
Feldspar	1	Tr	–
Clay	80	70	80
Volcanic glass	2	1	2
Glauconite	Tr	1	1
Carbonate unspec.	–	5	3
Foraminifers	Tr	Tr	Tr
Diatoms	4	2	4
Radiolarians	2	4	2
Sponge spicules	4	3	1
Silicoflagellates	1	1	1
Fish remains	1	1	Tr

SITE 568 HOLE CORE 3 CORED INTERVAL 13.0–22.7 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Pleistocene	*Gephyrocapsa oceanica/Pseudoemiliana lacunosa*		CM			1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0				



LITHOLOGIC DESCRIPTION

Dominant lithology: massive, structureless mud. H_2S odor throughout core. Gas expansion cracks. Some greenish black (5G 2/1) mottling. Color: olive gray (5Y 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 120	4, 123	6, 93
	D	D	M
Texture:			
Sand	2	1	15
Silt	20	15	20
Clay	78	84	65
Composition:			
Quartz	4	1	2
Feldspar	2	1	–
Mica	Tr	–	–
Heavy minerals	Tr	Tr	–
Clay	73	80	60
Volcanic glass	–	–	25
Glauconite	1	2	1
Pyrite	–	Tr	–
Carbonate unspec.	2	2	–
Calc. nannofossils	5	–	–
Diatoms	4	3	1
Radiolarians	2	1	–
Sponge spicules	1	1	1
Fish remains	1	1	–

5G 2/1 mottle

Void

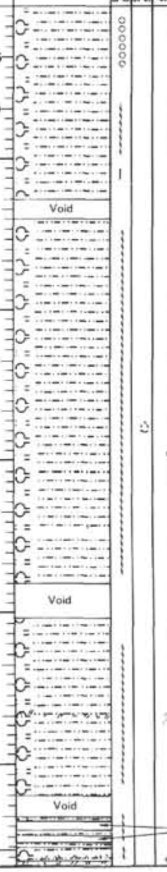
Light gray (N7) ash

10Y 4/2 mottle

Void

SITE 568 HOLE CORE 4 CORED INTERVAL 22.7–32.3 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Pleistocene	*Gephyrocapsa oceanica/Pseudoemiliana lacunosa*	CM				1, 2, 3, 4, 5, 6, CC	0.5, 1.0				



LITHOLOGIC DESCRIPTION

Dominant lithology: mud with high siliceous biogenic component. Mostly massive, structureless. Some mottling throughout. H_2S odor, gas expansion cracks throughout core.

Color: mostly olive gray (5Y 3/2).

SMEAR SLIDE SUMMARY (%):

	3, 145	CC
	D	M
Texture:		
Sand	5	10
Silt	15	20
Clay	80	70
Composition:		
Quartz	5	5
Mica	Tr	–
Heavy minerals	3	1
Clay	68	–
Volcanic glass	10	20
Glauconite	2	2
Foraminifers	1	–
Calc. nannofossils	–	1
Diatoms	5	–
Radiolarians	3	–
Sponge spicules	2	–
Plant debris	1	1

Black (N1) mottle

Greenish black (5GY 2/1) mottle and pale greenish yellow (10Y 8/2) ash

Voids

Ashy layer

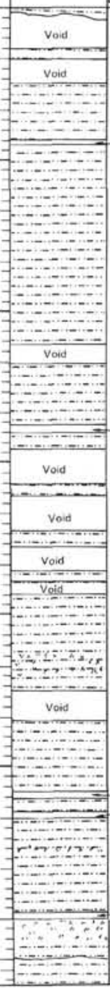
SITE 568 HOLE CORE 5 CORED INTERVAL 32.3–42.0 m sub-bottom

TIME-ROCK UNIT: late Pleistocene

BIOSTRATIGRAPHIC ZONE: *Gephyrocapsa oceanica*

FOSSIL CHARACTER: Foraminifers, Nannofossils (CM), Radiolarians, Diatoms

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



Greenish black mottling

Void

Greenish black layers in this section

Remnant bedding preserved

Void

Pale olive (10Y 4/2) ash

Pale olive beds

Voids

Medium bluish gray (5B 5/1) ash

Void

Medium bluish gray (5B 5/1) ash

LITHOLOGIC DESCRIPTION

Dominant lithology: massive, structureless mud with color mottling throughout the core. Gas expansion cracks.

Color: drill disturbance results in swirled juxta-position of olive gray (5Y 3/2), greenish black (5GY 2/1), grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	6, 38 M	6, 83 M
Texture:		
Sand	5	2
Silt	40	40
Clay	55	58
Composition:		
Quartz	2	1
Clay	50	50
Volcanic glass	35	40
Glauconite	1	1
Diatoms	2	1
Radiolarians	2	1
Sponge spicules	2	–
Fish remains	1	1

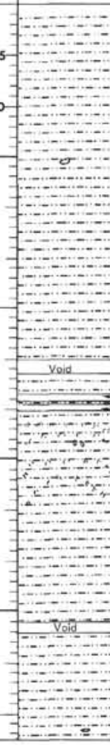
SITE 568 HOLE CORE 6 CORED INTERVAL 42.0–51.4 m sub-bottom

TIME-ROCK UNIT: late Pleistocene

BIOSTRATIGRAPHIC ZONE: *Gephyrocapsa oceanica*/*Pseudoemiliania lacunosa*

FOSSIL CHARACTER: Foraminifers, Nannofossils (CM), Radiolarians, Diatoms

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



Pumice clast

Voids

Ashy beds, pale olive/greenish olive (10Y 5/2)

Greenish gray (5GY 6/1) mud clsts

Black (N1) bed, some bedding

Pumice clast

LITHOLOGIC DESCRIPTION

Dominant lithology: massive, structureless mud. Gas expansion cracks throughout.

Color: predominantly olive gray (5Y 3/2)

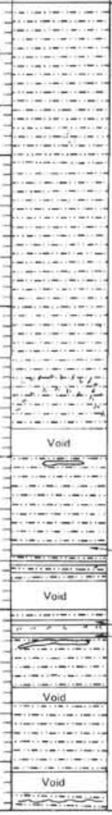
SMEAR SLIDE SUMMARY (%):

	5, 30 M
Texture:	
Sand	10
Silt	70
Clay	20
Composition:	
Quartz	6
Heavy minerals	Tr
Clay	20
Volcanic glass	20
Carbonate unspec.	4
Foraminifers	Tr
Diatoms	Tr
Radiolarians	Tr
Silicoflagellates	Tr
Plant debris	Tr
Rock fragments	50

SITE 568 HOLE CORE 7 CORED INTERVAL 51.4–61.6 m sub-bottom

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Pleistocene	*Gephyrocapsa oceanica/Pseudoemiliania lacunosa*					1	0.5, 1.0
						2	
						3	
						4	
						5	
			CM			CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: mud. Mostly massive, although some lamination occurs throughout the core. Gas expansion cracks.

Color: mostly olive gray (5Y 3/2).

Medium bluish gray (5B 5/1) bed

Ashy beds, light olive (10Y 5/4)

Medium dark gray (N4) bed

Voids

Voids

Pale olive (10Y 6/2)

Silty dark foraminiferal layer

Greenish black (5GY 2/1) layer

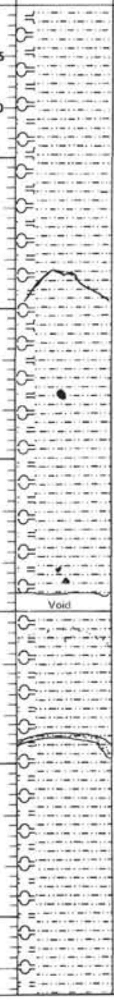
SMEAR SLIDE SUMMARY (%):

	1, 138 M	3, 107 M	5, 47 D
Texture:			
Sand	25	70	2
Silt	35	30	10
Clay	40	–	88
Composition:			
Quartz	20	4	2
Feldspar	5	1	–
Heavy minerals	–	–	1
Clay	35	–	60
Volcanic glass	30	90	–
Glauconite	2	–	1
Carbonate unspec.	–	–	2
Calc. nannofossils	–	–	18
Diatoms	–	–	Tr
Radiolarians	–	–	Tr
Silicoflagellates	–	–	1
Fish remains	–	–	1

SITE 568 HOLE CORE 8 CORED INTERVAL 61.6–70.4 m sub-bottom

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Pleistocene	*Gephyrocapsa oceanica/Pseudoemiliania lacunosa*					1	0.5, 1.0
						2	
						3	
						4	
						5	
						6	
						7	
			CM			CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: massive, structureless mud with high siliceous biogenic content. Gas expansion cracks. Some bedding preserved at intervals.

Color: olive gray (5Y 3/2) at top grading to greenish black (5G 2/1) at base.

Dark (N5) coaley bed

Coaley clast

Coaley clast

Ashy layer and mottles

Sandy layer

SMEAR SLIDE SUMMARY (%):

	1, 112 M	2, 133 M	6, 25 M	6, 93 D
Texture:				
Sand	1	2	–	1
Silt	69	88	90	25
Clay	30	10	10	84
Composition:				
Quartz	3	2	1	–
Feldspar	–	2	5	2
Mica	Tr	1	–	1
Heavy minerals	Tr	–	3	–
Clay	45	63	–	74
Volcanic glass	3	–	80	–
Glauconite	Tr	–	–	–
Pyrite	3	–	1	–
Micronodules	–	–	–	2
Carbonate unspec.	2	1	–	–
Foraminifers	Tr	–	–	–
Calc. nannofossils	2	–	–	1
Diatoms	30	3	–	5
Radiolarians	1	Tr	–	Tr
Sponge spicules	10	8	–	Tr
Silicoflagellates	Tr	–	–	Tr
Coaley material	–	20	–	–
Volcanic fragments	–	–	10	–

SITE 568 HOLE CORE 9 CORED INTERVAL 70.4–80.1 m sub-bottom

TIME – ROCK UNIT: late Pleistocene

BIOSTRATIGRAPHIC ZONE: *Gephyrocapsa oceanica/Pseudoemiliana lacunosa*

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS — Nannofossils: CM

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES

LITHOLOGIC DESCRIPTION

Dominant lithology: mostly massive mud with high siliceous biogenic component.

Color: olive gray (5G 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 43
	D
Texture:	
Sand	1
Silt	25
Clay	74
Composition:	
Feldspar	2
Mica	1
Heavy minerals	1
Clay	78
Pyrite	1
Carbonate unspec.	3
Foraminifers	Tr
Calc. nannofossils	2
Diatoms	2
Radiolarians	1
Sponge spicules	8
Silicoflagellates	1

Grayish blue green (5BG 5/2) beds

SITE 568 HOLE CORE 10 CORED INTERVAL 80.1–89.4 m sub-bottom

TIME – ROCK UNIT: late Pleistocene

BIOSTRATIGRAPHIC ZONE: *Gephyrocapsa oceanica/Pseudoemiliana lacunosa*

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS — Foraminifers: CM

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES

Void

Ashy layer

Ashy mottles

Voids

Light gray (N7) ash

Light gray (N8) ash

Many small voids

Voids

Light olive brown (5Y 5/6) mottling

LITHOLOGIC DESCRIPTION

Dominant lithology: massive mud with high siliceous biogenic content. Mottling in Sections 2, 3, and 5.

Color: grayish olive green (5GY 3/2) with mottling of greenish black (5GY 2/1).

Voids in core are mostly due to gas expansion .

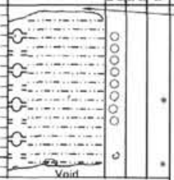
SMEAR SLIDE SUMMARY (%):

	1, 97	4, 130
	M	D
Texture:		
Sand	80	4
Silt	20	20
Clay	–	76
Composition:		
Quartz	–	1
Feldspar	15	3
Heavy minerals	2	1
Clay	–	71
Volcanic glass	80	–
Pyrite	1	–
Micronodules	–	1
Carbonate unspec.	–	5
Foraminifers	–	1
Calc. nannofossils	Tr	2
Diatoms	–	4
Radiolarians	–	1
Sponge spicules	–	8
Silicoflagellates	–	1
Volcanic fragments	2	–

SITE 568 HOLE CORE 11 CORED INTERVAL 89.4–98.8 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
Pleistocene	small *Gephyrocapsa*(?)		CM			1	0.5, 1.0
						CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: massive mud with siliceous biogenic component.

Color: moderate olive brown (5Y 4/4).

This core was taken using the Pressure Core Barrel.

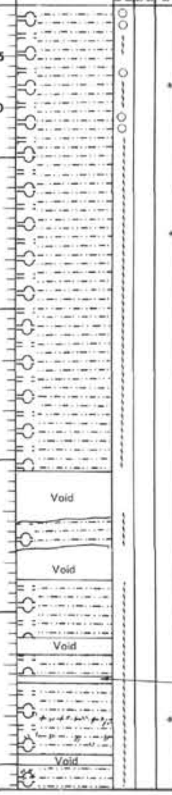
SMEAR SLIDE SUMMARY (%):

	1, 97	CC
	D	M
Texture:		
Sand	8	70
Silt	20	25
Clay	72	5
Composition:		
Quartz	2	–
Heavy minerals	Tr	–
Clay	56	7
Volcanic glass	2	40
Carbonate unspec.	5	–
Calc. nannofossils	20	–
Diatoms	5	1
Radiolarians	Tr	–
Sponge spicules	7	–
Silicoflagellates	Tr	–
Volcanic fragments	2	2

SITE 568 HOLE CORE 12 CORED INTERVAL 98.8–108.3 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
Pleistocene	small *Gephyrocapsa*(?)		CM			1	0.5, 1.0
						2	
						3	
						4	
						5	
						CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: massive, structureless mud with high siliceous biogenic component. Some laminations are preserved. Gas expansion cracks. Most small voids in the core are due to gas expansion.

Color: grayish olive green (5GY 3/2), grading through Section 2 to olive gray (5Y 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 80	2, 80	5, 103
	D	D	M
Texture:			
Sand	5	3	20
Silt	20	17	75
Clay	75	80	5
Composition:			
Quartz	5	4	–
Feldspar	2	–	15
Mica	1	–	–
Heavy minerals	1	–	Tr
Clay	42	55	20
Volcanic glass	2	2	60
Glauconite	3	1	–
Pyrite	3	–	–
Carbonate unspec.	2	8	2
Foraminifers	3	Tr	Tr
Calc. nannofossils	15	3	–
Diatoms	5	4	1
Radiolarians	5	3	Tr
Sponge spicules	1	4	–
Silicoflagellates	–	3	–

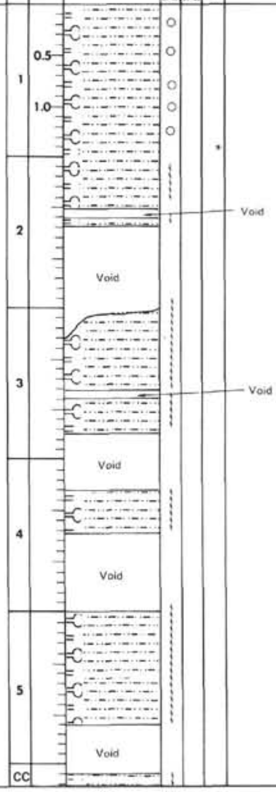
SITE 568 HOLE CORE 13 CORED INTERVAL 108.3–117.8 m sub-bottom

TIME – ROCK UNIT: Pleistocene

BIOSTRATIGRAPHIC ZONE: small *Gephyrocapsa* (?)

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS

SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: predominantly massive mud with high siliceous biogenic component. Some gas expansion-produced voids and mottles containing higher concentrations of foraminifera. Stratification weakly preserved in parts of the core.

Color: olive gray (5Y 3/2) to grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	1, 140
Texture:	
Sand	3
Silt	57
Clay	40
Composition:	
Feldspar	2
Mica	2
Heavy minerals	1
Clay	49
Volcanic glass	2
Glauconite	1
Pyrite	1
Foraminifers	1
Calc. nannofossils	25
Diatoms	8
Radiolarians	1
Sponge spicules	5
Silicoflagellates	2

SITE 568 HOLE CORE 14 CORED INTERVAL 117.8–127.4 m sub-bottom

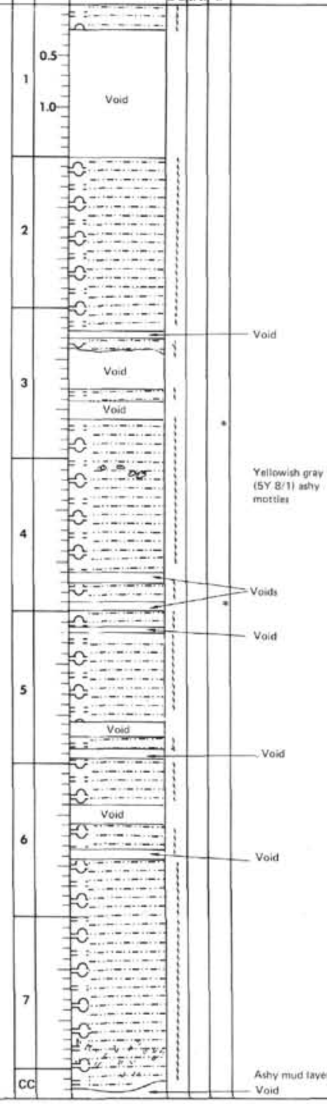
TIME – ROCK UNIT: early–middle Pleistocene

BIOSTRATIGRAPHIC ZONE

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS

NANNOFOSSILS (CC): CM

SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: weakly stratified mud with high siliceous biogenic component. Voids produced in part by gas expansion. Calcareous mottles of slightly lighter color occur throughout core.

Color: olive gray (5Y 3/2) and greenish black (5G 2/1).

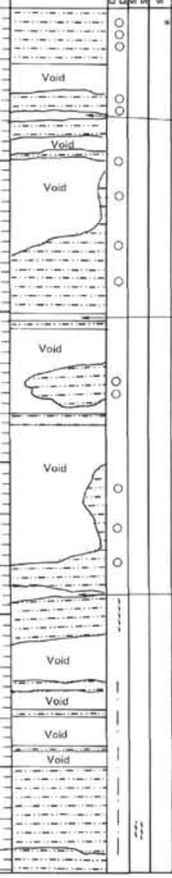
SMEAR SLIDE SUMMARY (%):

	3, 116	4, 143
	D	D
Texture:		
Sand	4	1
Silt	25	25
Clay	61	74
Composition:		
Feldspar	2	2
Clay	65	62
Volcanic glass	1	2
Palagonite	1	1
Glauconite	1	–
Pyrite	2	2
Carbonate unspec.	10	3
Calc. nannofossils	5	10
Diatoms	8	5
Radiolarians	Tr	5
Sponge spicules	5	7
Silicoflagellates	1	1

SITE 568 HOLE CORE 15 CORED INTERVAL 127.4–137.2 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
early–middle Pleistocene		FP				1, 2, 3, 4, 5, 6, CC	0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



Dark (N3) layer

Void

Void

Void

LITHOLOGIC DESCRIPTION

Dominant lithology: soupy mud with darker mud layers. Voids due in most cases to gas expansion.

Color: grayish olive (10Y 4/2) to olive gray (5Y 3/2).

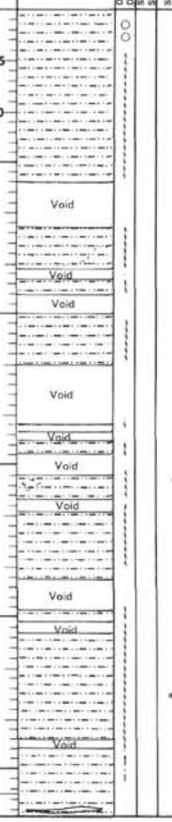
SMEAR SLIDE SUMMARY (%):

	1, 19
	D
Texture:	
Sand	3
Silt	10
Clay	87
Composition:	
Feldspar	1
Heavy minerals	Tr
Clay	62
Volcanic glass	1
Glauconite	1
Pyrite	2
Carbonate unspec.	3
Foraminifers	Tr
Calc. nannofossils	20
Diatoms	4
Radiolarians	2
Sponge spicules	4
Silicoflagellates	Tr

SITE 568 HOLE CORE 16 CORED INTERVAL 137.2–146.9 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
early–middle Pleistocene			FP			1, 2, 3, 4, 5, 6, CC	0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

Dominant lithology: predominantly massive mud with some lamination visible in lower sections.

Color: olive gray (5Y 3/2), interbedding in Sections 5 and 6 with dark greenish gray (5GY 4/1).

SMEAR SLIDE SUMMARY (%):

	4, 18	5, 80
	M	
Texture:		
Sand	20	20
Silt	80	30
Clay	–	50
Composition:		
Quartz	10	15
Feldspar	5	10
Mica	–	Tr
Heavy minerals	3	Tr
Clay	–	44
Volcanic glass	78	1
Glauconite	–	1
Pyrite	2	2
Carbonate unspec.	2	3
Foraminifers	–	1
Calc. nannofossils	–	5
Diatoms	–	4
Radiolarians	–	3
Sponge spicules	–	1

Light greenish gray (5GY 8/1) mottle

Ashy?

Pale greenish yellow (10Y 3/2) ashy mottle

Sandier horizon

Sedimentary breccia

Sandy horizon

Greenish black layer

SITE 568 HOLE CORE 17 CORED INTERVAL 146.9–156.5 m sub-bottom

TIME – ROCK UNIT: early–middle Pleistocene

FOSSIL CHARACTER: CC – Foraminifers: FP

Sections: 1, 2, 3, 4, 5, 6, 7, CC (Meters: 0.5, 1.0)

GRAPHIC LITHOLOGY: Void (Sections 1, 2, 3, 4, 5, 6, 7)

Pale olive (10Y 6/2) burrow

Pumice pebbles and burrowing in this horizon

Ashy layer

Voids

Ashy mud

Light greenish (5G 8/1) ash

LITHOLOGIC DESCRIPTION

Dominant lithology: predominantly massive mud with some faint lamination in most sections. Most small voids due to gas expansion.

Color: olive gray (5Y 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 20	3, 36	CC
	D	D	M
Texture:			
Sand	10	5	10
Silt	20	15	80
Clay	70	80	10
Composition:			
Quartz	10	3	3
Feldspar	5	1	–
Mica	1	Tr	–
Heavy minerals	2	1	–
Clay	64	80	10
Volcanic glass	2	–	87
Glauconite	1	–	–
Calc. nannofossils	2	5	–
Diatoms	1	–	–
Radiolarians	3	3	–
Sponge spicules	4	2	–
Silicoflagellates	–	Tr	–
Fish remains	–	Tr	–
Plant debris	–	Tr	–

SITE 568 HOLE CORE 18 CORED INTERVAL 156.5–166.2 m sub-bottom

TIME – ROCK UNIT: early–middle Pleistocene

FOSSIL CHARACTER: CC – Nannofossils: CP

Sections: 1, 2, 3, 4, 5, CC (Meters: 0.5, 1.0)

GRAPHIC LITHOLOGY: Void (Section 1)

Frothy texture from gas bubbling greenish black (5GY 2/1) burrow

Greenish black mottling

Void

Greenish black (5GY 2/1) mottling

LITHOLOGIC DESCRIPTION

Dominant lithology: predominantly structureless and with faint lamination preserved in Section 4. Voids due to gas expansion.

Color: olive gray (5Y 3/2).

SMEAR SLIDE SUMMARY (%):

	3, 65	3, 100	4, 32
	D	D	D
Texture:			
Sand	20	10	20
Silt	25	15	25
Clay	55	75	55
Composition:			
Quartz	5	3	15
Feldspar	2	2	5
Heavy minerals	1	1	2
Clay	52	63	39
Volcanic glass	1	–	2
Palagonite	2	Tr	–
Glauconite	–	1	3
Pyrite	–	Tr	5
Micronodules	–	Tr	–
Zeolite	–	Tr	–
Carbonate unspec.	–	3	3
Foraminifers	1	Tr	–
Calc. nannofossils	5	–	5
Diatoms	15	10	10
Radiolarians	10	3	10
Sponge spicules	5	9	1

SITE 568 HOLE CORE 19 CORED INTERVAL 166.2–176.0 m sub-bottom

TIME – ROCK UNIT: early–middle Pleistocene

FOSSIL CHARACTER: Nannofossils CM (CC)

Sections: 1–7, CC; Meters: 0.5, 1.0

GRAPHIC LITHOLOGY

LITHOLOGIC DESCRIPTION

Greenish black mottling (Section 2)

Siltier layer (Section 2)

Greenish black mottling (Section 4)

Foraminifer rich layers (Section 5)

Moderate brown (5Y 4/4) mud layer (Section 6)

Dominant lithology: predominantly structureless mud. Siliceous biogenic component significant. Voids due to gas expansion in core liner. Sandy component includes foraminifers that are visible throughout core.

Color: olive gray (5Y 3/2).

Scaley structure in Sections 4 and 5.

SMEAR SLIDE SUMMARY (%):

	1, 150
Texture:	
Sand	5
Silt	20
Clay	75
Composition:	
Quartz	3
Feldspar	2
Mica	Tr
Heavy minerals	1
Clay	57
Volcanic glass	5
Glauconite	1
Carbonate unspec.	3
Foraminifers	1
Clac. nannofossils	15
Diatoms	5
Radiolarians	5
Sponge spicules	2
Silicoflagellates	Tr
Fecal pellets	Tr

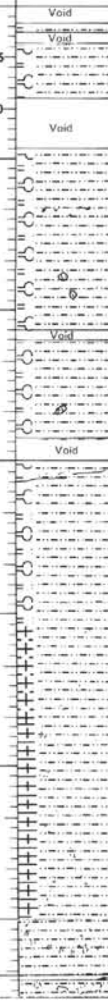
SITE 568 HOLE CORE 20 CORED INTERVAL 176.0–185.7 m sub-bottom

TIME – ROCK UNIT: early–middle Pleistocene

FOSSIL CHARACTER: Nannofossils CM (CC)

Sections: 1–7, CC; Meters: 0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

Coaley clasts

Pumice clast

Bivalve shell

Pumice

Sandy layer

Light ashy layer

Void

Greenish black (5GY 2/1) layer

Dominant lithology: mud with high siliceous biogenic component. Carboniferous clasts scattered throughout core.

Minor lithology: mottled calcareous mud with siliceous biogenic component.

Voids due to gas expansion in core liner.

Color: grayish olive (10Y 4/2) mottled with olive gray (5Y 3/2) in dominant lithology; grayish olive (10Y 4/2) mottled with greenish black (5GY 2/1) in minor lithology.

SMEAR SLIDE SUMMARY (%):

	1, 75 D	3, 100 M	5, 7 M	7, 8 M
Texture:				
Sand	6	5	50	30
Silt	30	40	20	65
Clay	64	50	30	5
Composition:				
Quartz	3	2	7	10
Feldspar	1	2	3	–
Mica	Tr	Tr	Tr	–
Heavy minerals	1	Tr	1	–
Clay	64	36	19	–
Volcanic glass	2	1	2	90
Palagonite	–	Tr	Tr	–
Glauconite	–	1	2	Tr
Pyrite	Tr	Tr	Tr	–
Micronodules	–	Tr	Tr	–
Zeolite	–	Tr	Tr	
Carbonate unspec.	3	3	Tr	–
Foraminifers	2	5	2	–
Calc. nannofossils	Tr	40	Tr	–
Diatoms	5	2	–	–
Radiolarians	15	5	60	Tr
Sponge spicules	3	2	2	–
Silicoflagellates	–	1	1	–
Fish remains	–	–	1	–

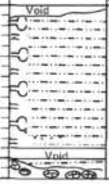
SITE 568 HOLE CORE 21 CORED INTERVAL 185.7–195.4 m sub-bottom

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

Time-rock unit: early–middle Pleistocene

Nannofossils: FM (CC)

Sections: 1, CC — Meters: 0.5, 1.0



* Coaley clasts

Pressure Core Barrel.

Dominant lithology: soupy, structureless mud with high siliceous biogenic content.

Minor lithology: from Core Catcher: calcareous mudstone containing clasts of darker color.

Color: dominant lithology is grayish olive (10Y 4/2), minor lithology is pale olive (10Y 4/2), with darker clast of black to pale green (i. e., N1 to 10G 6/2).

SMEAR SLIDE SUMMARY (%):

	1, 126
Texture:	
Sand	5
Silt	20
Clay	75
Composition:	
Quartz	7
Feldspar	3
Mica	Tr
Heavy minerals	Tr
Clay	73
Glauconite	1
Pyrite	Tr
Micronodules	Tr
Zeolite	Tr
Carbonate unspec.	2
Foraminifers	3
Calc. nannofossils	Tr
Diatoms	Tr
Radiolarians	5
Sponge spicules	3
Silicoflagellates	3

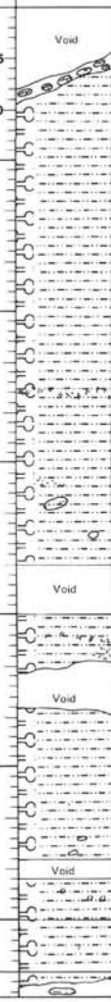
SITE 568 HOLE CORE 22 CORED INTERVAL 195.4–205.1 m sub-bottom

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

Time-rock unit: middle Miocene–early Pliocene

Nannofossils: B (CC)

Sections: 1, 2, 3, 4, 5, 6, 7, CC — Meters: 0.5, 1.0



Dominant lithology: predominantly massive mud with high siliceous biogenic component. Small mudstone clasts and a few sandier horizons occur.

Minor lithology: from top of Section 1, micro-conglomeratic limestone, shot through with fractures.

Color: major lithology is grayish olive green (5GY 3/2) Minor is light olive gray (5Y 5/2).

Dark pebbles in both lithologies are black (N1) to moderate blue green (5BG 4/6).

Light gray (N7) ash layer

Greenish black (5GY 2/1) layer

Ashy mottling in this section

SMEAR SLIDE SUMMARY (%):

	1, 130	3, 77	CC
Texture:			
Sand	5	20	30
Silt	30	40	30
Clay	65	40	40
Composition:			
Quartz	5	15	10
Feldspar	3	5	5
Mica	–	Tr	3
Heavy minerals	Tr	1	Tr
Clay	63	78	72
Volcanic glass	5	40	–
Glauconite	–	1	–
Carbonate unspec.	–	Tr	–
Foraminifers	3	–	Tr
Calc. nannofossils	–	Tr	Tr
Diatoms	3	Tr	3
Radiolarians	5	Tr	Tr
Sponge spicules	9	Tr	2
Silicoflagellates	3	Tr	2
Rock fragments	–	–	3

Ashy layers

Light blue green (5BG 8/8) and moderate blue (5B 5/6) pebbles

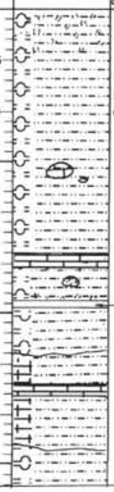
SITE 568 HOLE CORE 23 CORED INTERVAL 205.1–214.8 m sub-bottom

TIME – ROCK UNIT: early Pliocene–middle Miocene

FOSSIL CHARACTER: Nannofossils RM (CC)

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

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

Muddy ash – light greenish gray (5G 8/1)

Limestone and pumice clasts

Ashy layer

Void

Minor lithology: calcareous nanno ooze to limestone/mud. Dominant lithology: mud with siliceous biogenic component.

Minor lithology: calcareous nanno ooze to limestone/mud.

Color: grayish olive green (5GY 3/2) for major lithology, pale olive (10Y 6/2) to light greenish gray (5GY 7/1) for minor lithology.

Fracturing visible in well cemented layers.

SMEAR SLIDE SUMMARY (%):

	1, 54	3, 37
	M	–
Texture:		
Sand	–	–
Silt	20	–
Clay	80	–
Composition:		
Quartz	5	3
Feldspar	3	1
Mica	–	Tr
Clay	11	75
Volcanic glass	–	3
Glauconite	–	1
Pyrite	–	Tr
Micronodules	–	Tr
Zeolite	–	Tr
Carbonate unspec.	60	5
Calc. nannofossils	20	–
Diatoms	Tr	Tr
Radiolarians	Tr	3
Sponge spicules	1	5
Silicoflagellates	Tr	5

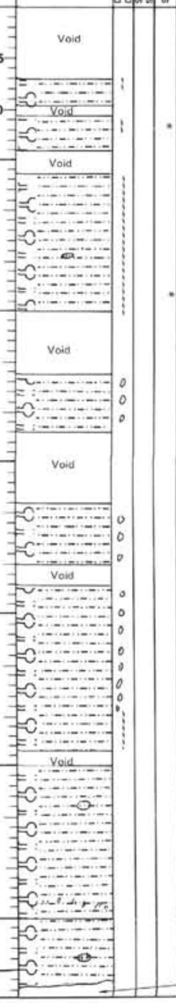
SITE 568 HOLE CORE 24 CORED INTERVAL 214.8–224.5 m sub-bottom

TIME – ROCK UNIT: middle Miocene–early Pliocene

FOSSIL CHARACTER: Nannofossils B (CC)

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

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

Sandy clast

Mudstone

Ashy layer

Pumice clast

Void

Dominant lithology: mudstone with siliceous biogenic component. Some mottling in Section 2. A few clasts of mudstone and pumice. Voids are mainly due to gas expansion.

Color: dusky yellow green (5GY 5/2) to light olive gray (5Y 5/2).

Burrowing observed in Section 6.

Biscuity deformation occurs in lower half of core.

SMEAR SLIDE SUMMARY (%):

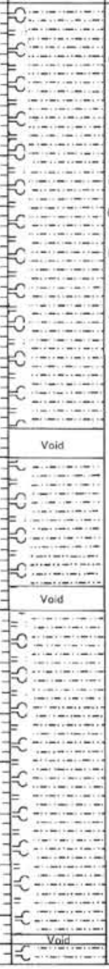
	1, 114	2, 136
Texture:		
Sand	3	3
Silt	15	30
Clay	82	67
Composition:		
Quartz	2	1
Feldspar	5	3
Mica	Tr	1
Heavy minerals	Tr	Tr
Clay	78	55
Volcanic glass	2	2
Glauconite	1	–
Pyrite	–	1
Carbonate unspec.	–	30
Calc. nannofossils	Tr	1
Diatoms	3	5
Radiolarians	2	1
Sponge spicules	5	6
Silicoflagellates	1	–
Rock fragments	1	–

Biscuity deformation occurs in lower half of core.

SITE 568 HOLE CORE 25 CORED INTERVAL 224.5–234.2 m sub-bottom

TIME–ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
probable middle Miocene			RM			1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

Biscuity deformation

Slightly sandier layer

Dominant lithology: mudstone with siliceous biogenic component.

Color: dusky yellow green (5GY 5/2) to grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

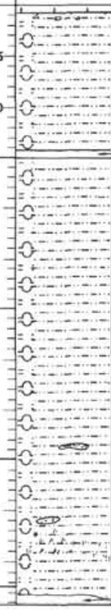
	2, 95	5, 130
	D	D
Texture:		
Sand	2	3
Silt	25	37
Clay	73	61
Composition:		
Feldspar	1	1
Mica	–	Tr
Heavy minerals	–	Tr
Clay	73	67
Volcanic glass	2	–
Glauconite	2	1
Pyrite	1	1
Carbonate unspec.	1	10
Calc. nannofossils	2	5
Diatoms	8	4
Radiolarians	2	1
Sponge spicules	8	6
Silicoflagellates	1	Tr
Volcanic fragments	–	5

Core 26, 342.2–243.9 m sub-bottom: no recovery.

SITE 568 HOLE CORE 27 CORED INTERVAL 243.9–253.4 m sub-bottom

TIME–ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
middle Miocene	*Discoaster exilis*	FP				1, 2, 3, 4, CC	0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

Yellowish gray (5Y 8/1) limestone with tuffaceous component

Light blue (5BG 6/6) pebbles

More indurated layers

Void

Pumice clast

Dark gray, ashy layer

Dark gray ash

Void

Dominant lithology: predominantly mudstone with siliceous fractures and burrowed throughout the core. Sedimentary breccia is observed in several horizons.

Color: grayish blue green (5BG 5/2). Mottling is grayish yellow (5Y 8/4).

Biscuity deformation is common throughout the core.

SMEAR SLIDE SUMMARY (%):

	1, 3
	M
Texture:	
Sand	3
Silt	67
Clay	30
Composition:	
Feldspar	1
Mica	1
Clay	24
Volcanic glass	20
Pyrite	2
Carbonate unspec.	50
Diatoms	1
Sponge spicules	3

SITE 568 HOLE CORE 28 CORED INTERVAL 253.4–263.1 m sub-bottom

TIME-ROCK UNIT: middle Miocene

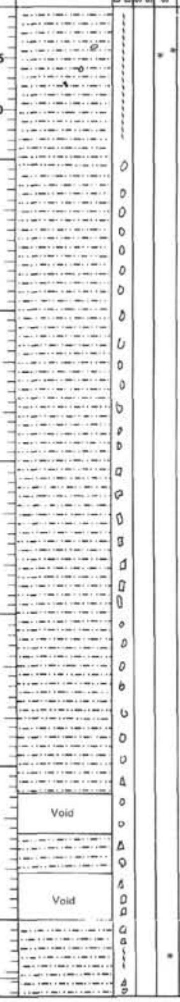
BIOSTRATIGRAPHIC ZONE: *Discoaster exilis*; *Sphenolithus heteromorphus*

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CM

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



Tuffaceous pebbly mudstone

Coaley wood fragment

Slightly calcareous

LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone with breccia containing some burrows.

Color: dusky yellowish green (10GY 3/2) to grayish olive green (5GY 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 45	1, 47	7, 36
Texture:			
Sand	30	8	10
Silt	20	15	10
Clay	50	77	80
Composition:			
Quartz	–	3	2
Feldspar	5	2	–
Mica	–	2	–
Heavy minerals	Tr	–	–
Clay	62	65	70
Volcanic glass	25	10	2
Glauconite	–	1	1
Pyrite	5	–	–
Carbonate unspec.	–	–	5
Foraminifers	–	–	2
Calc. nannofossils	–	–	10
Radiolarians	1	1	1
Sponge spicules	2	–	–
Fish remains	–	–	1

SITE 568 HOLE CORE 29 CORED INTERVAL 263.1–272.6 m sub-bottom

TIME-ROCK UNIT: early middle Miocene

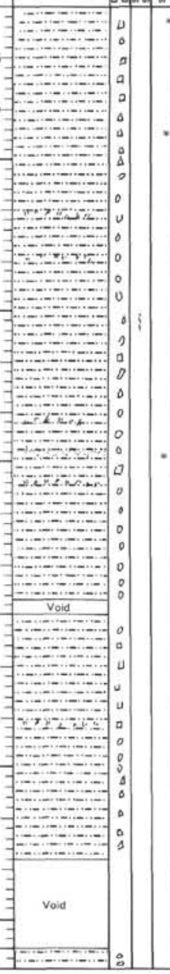
BIOSTRATIGRAPHIC ZONE: *Sphenolithus heteromorphus*

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CM

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



Ashy layer

Ashy layer

Ashy layer

Light olive gray (5Y 6/1) ash

Ashy, sandy layer

Ashy, sandy layer

Disturbed ashy layer

LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone, brecciated in places, laminated in some horizons. Fracturing is common and small veins very common, parallel, and kinked in some occurrences. Tuffaceous admixture through much of the core. Burrowing.

Color: mostly dusky yellow green (5GY 5/2) and grayish green (10GY 5/2). Ash is very pale blue (5B 8/2) to pinkish gray (5YR 8/1).

SMEAR SLIDE SUMMARY (%):

	1, 20 D	1, 127 M	3, 147 M
Texture:			
Sand	5	70	–
Silt	30	30	–
Clay	65	–	–
Composition:			
Quartz	1	–	–
Feldspar	3	15	15
Mica	Tr	2	1
Heavy minerals	–	2	–
Clay	50	–	–
Volcanic glass	–	82	82
Glauconite	Tr	–	–
Pyrite	1	1	2
Micronodules	2	–	–
Carbonate unspec.	20	–	–
Calc. nannofossils	5	–	–
Diatoms	2	–	–
Radiolarians	1	–	–
Sponge spicules	2	–	–

SITE 568 HOLE CORE 30 CORED INTERVAL 272.6–282.3 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
middle Miocene	*Sphenolithus heteromorphus*					1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0	Void; Void			*

LITHOLOGIC DESCRIPTION

Limestone layer

Ashy, glassy layer, 5YR 6/1

10° apparent dip of bedding

Ashy component admixed in mud

Calcareous nodule

Dominant lithology: mudstone criss-crossed with fine veins (dewatering structures?) and burrows. Veins are at all angles. Color: grayish olive green (5GY 4/2).

SMEAR SLIDE SUMMARY (%):

	1, 109
	M
Texture:	
Sand	7
Silt	70
Clay	23
Composition:	
Feldspar	3
Heavy minerals	Tr
Volcanic glass	5
Glauconite	1
Pyrite	2
Micronodules	2
Foraminifers	5
Calc. nannofossils	1
Diatoms	2
Radiolarians	3
Sponge spicules	2

Sub-parallel veination

SITE 568 HOLE CORE 31 CORED INTERVAL 282.3–292.0 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
early middle Miocene	*Sphenolithus heteromorphus*	FM				1	0.5, 1.0				

LITHOLOGIC DESCRIPTION

Breccia

Breccia

Dominant lithology: slightly calcareous mudstone containing breccia layers, burrows, and dewatering veins.

Color: greenish gray (5G 6/1).

Pressure Core Barrel

Anastomosing veination

SITE 568 HOLE CORE 32 CORED INTERVAL 292.0–301.6 m sub-bottom

TIME – ROCK UNIT: early middle Miocene

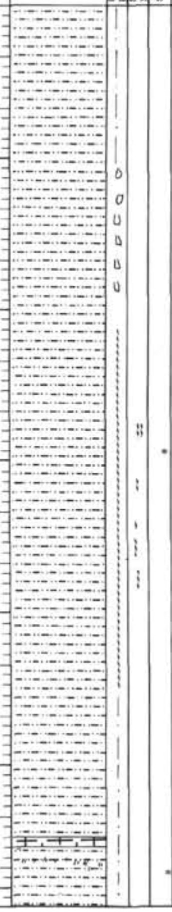
BIOSTRATIGRAPHIC ZONE: *Sphenolithus heteromorphus*

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



Breccia (Section 1)

Yellow (5Y 6/4) burrowing (Section 3)

Breccia (Section 4)

Breccia (Section 5)

Breccia (Section 6)

Pale olive nanno ooze

Ash layer

LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone (effervesces slightly with HC1). Burrowed throughout core, fractured by ubiquitous small veination; these are often kinked, anatomosing, or both.

Color: grayish olive (10Y 4/2) to dark olive gray (5GY 4/1).

SMEAR SLIDE SUMMARY (%):

	3, 142	6, 104
	M	M
Texture:		
Sand	5	50
Silt	20	30
Clay	75	20
Composition:		
Quartz	10	10
Feldspar	5	1
Mica	1	–
Heavy minerals	–	1
Clay	73	10
Volcanic glass	2	–
Glauconite	2	1
Pyrite	2	1
Carbonate unspec.	1	1
Calc. nannofossils	3	5
Diatoms	Tr	Tr
Radiolarians	Tr	Tr
Sponge spicules	1	Tr

SITE 568 HOLE CORE 33 CORED INTERVAL 301.6–311.3 m sub-bottom

TIME – ROCK UNIT: early middle Miocene

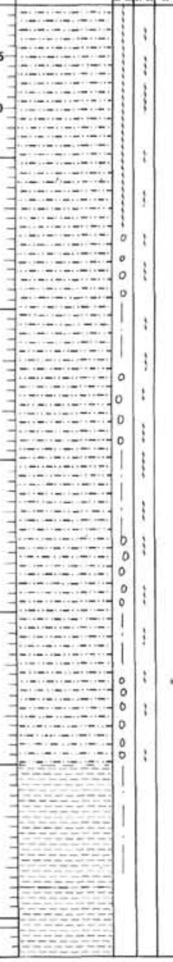
BIOSTRATIGRAPHIC ZONE: *Sphenolithus heteromorphus*

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS | RADIOLARIANS | DIATOMS

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



Breccia (Section 1)

Breccia (Section 3)

Breccia (Section 3)

Burrowed and fractured breccia (Section 4)

Breccia (Section 4)

LITHOLOGIC DESCRIPTION

Dominant lithology: very fine mudstone, cut throughout by small, anastomosing veins. Burrows occur throughout the core. Some scaley fabric.

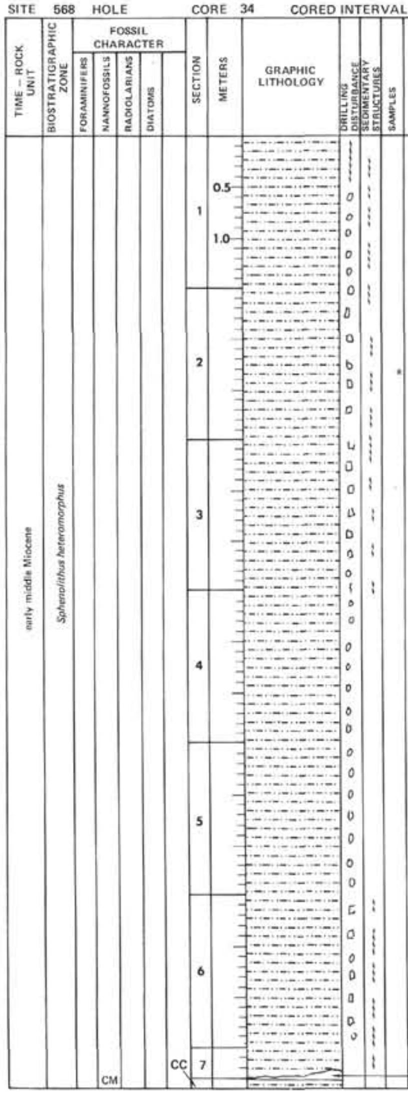
Minor lithology: claystone, in gradational contact with overlying mudstone, and exhibiting same sedimentary structures.

Color: grayish olive (10Y 4/2) to pale olive (10Y 6/4).

SMEAR SLIDE SUMMARY (%):

	5, 70
	D
Texture:	
Sand	–
Silt	–
Clay	99+
Composition:	
Quartz	Tr
Feldspar	Tr
Clay	82
Calc. nannofossils	18

SITE 568 HOLE CORE 34 CORED INTERVAL 311.3–321.2 m sub-bottom



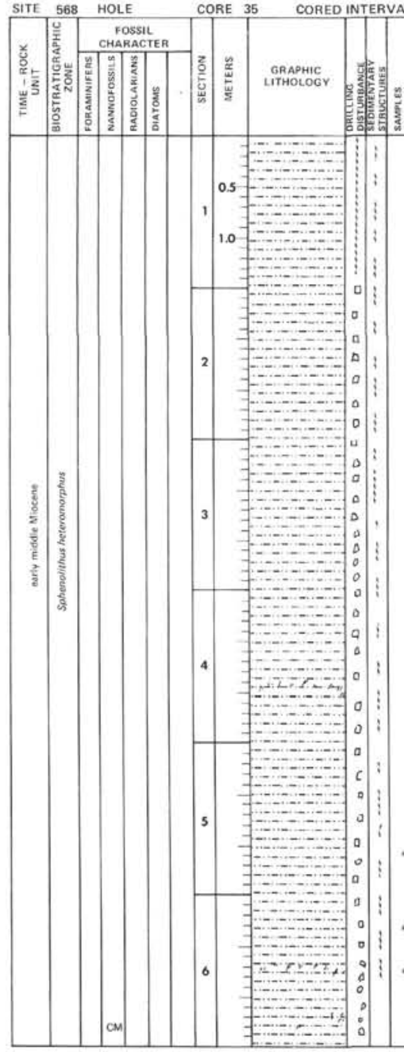
LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone with some burrowing and fracturing especially at top of core. Some scaley fabric. Color: grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	2, 80
Texture:	
Sand	5
Silt	15
Clay	80
Composition:	
Quartz	10
Feldspar	1
Heavy minerals	1
Clay	78
Glauconite	Tr
Pyrite	2
Carbonate unspec.	1
Calc. nannofossils	4
Radiolarians	1
Sponge spicules	1

SITE 568 HOLE CORE 35 CORED INTERVAL 321.2–331.0 m sub-bottom



LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone. Burrows common and small angular pebbles rare. Small scale fracturing ubiquitous in the core.

Color: dusky yellow (5Y 6/4) to light olive gray (5Y 5/2).

SMEAR SLIDE SUMMARY (%):

	5, 110	6, 35	6, 80
	D	D	M
Texture:			
Sand	5	2	10
Silt	15	4	60
Clay	80	94	30
Composition:			
Quartz	3	1	3
Feldspar	2	Tr	2
Mica	Tr	Tr	Tr
Heavy minerals	Tr	–	–
Clay	73	87	22
Volcanic glass	5	1	60
Palagonite	–	–	Tr
Glauconite	Tr	1	1
Pyrite	–	1	–
Carbonate unspec.	5	Tr	2
Foraminifers	Tr	–	–
Calc. nannofossils	10	7	10
Diatoms	Tr	1	1
Radiolarians	Tr	Tr	1
Sponge spicules	1	Tr	Tr
Silicoflagellates	1	–	Tr

SITE 568 HOLE CORE 36 CORED INTERVAL 331.0–340.7 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early middle Miocene	*Sphenolithus heteromorphus*		CM			1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0				*	

Coaley fragment

Pumice clasts

Ash

Pumice clast (N9)

Dark greenish gray (5GY 4/1) ash

Void

Dominant lithology: mudstone, mottled with burrows and shot through with small fractures. Coaley fragments in Section 1.

Color: dusky yellow green (5GY 5/2).

SMEAR SLIDE SUMMARY (%):

	2, 37
	D
Texture:	
Sand	5
Silt	15
Clay	80
Composition:	
Quartz	5
Feldspar	3
Mica	Tr
Heavy minerals	Tr
Clay	78
Volcanic glass	5
Glauconite	2
Pyrite	Tr
Micronodules	Tr
Carbonate unspec.	3
Foraminifers	Tr
Calc. nannofossils	Tr
Diatoms	Tr
Radiolarians	2
Sponge spicules	2
Silicoflagellates	Tr
Fecal pellets	Tr

SITE 568 HOLE CORE 37 CORED INTERVAL 340.7–350.2 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early middle Miocene			B			1, 2, 3, 4, CC	0.5, 1.0					

Dominant lithology: mudstone mottled with burrows and fractured extensively.

Color: grayish blue green (5BG 5/2) with mottles of grayish yellow (5Y 8/4) and light olive gray (5Y 5/2).

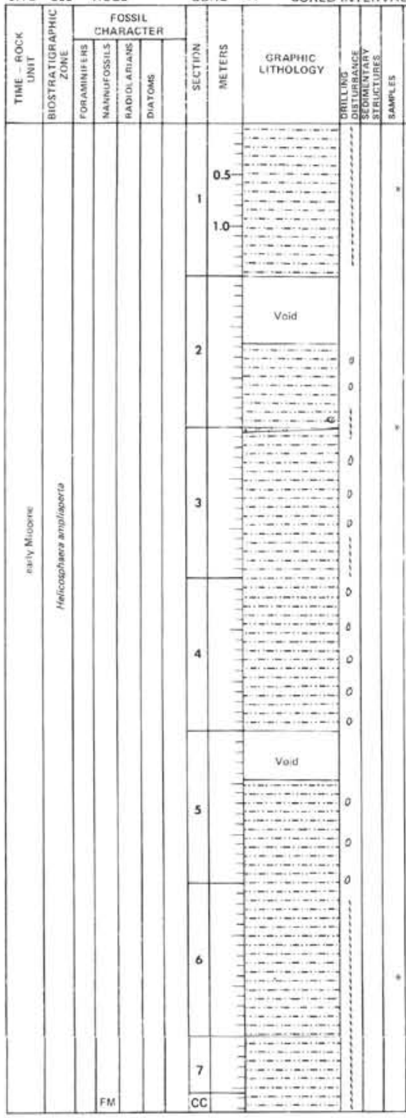
Yellowish gray (5Y 7/2) bed with black (N1) mottling

Void

Light greenish gray (5G 8/1) limestone

Very light gray (N8) ash

SITE 568 HOLE CORE 38 CORED INTERVAL 350.2–359.9 m sub-bottom



LITHOLOGIC DESCRIPTION

White (N9) pumice clast

Light gray (N6) ash layer

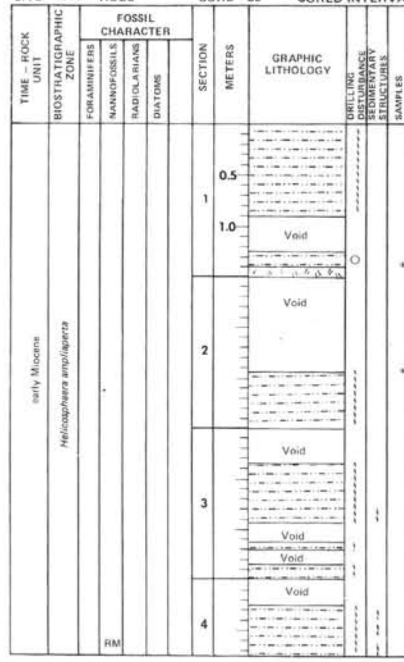
Dominant lithology: mudstone with ash admixture. Drilling disturbance obscures sedimentary structures.

Color: mostly grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	1, 67	3, 4	6, 97
	D	M	M
Texture:			
Sand	20	–	5
Silt	5	30	80
Clay	15	70	15
Composition:			
Quartz	5	10	3
Feldspar	3	–	2
Mica	1	Tr	Tr
Clay	65	45	–
Volcanic glass	12	40	–
Glauconite	–	1	3
Pyrite	–	–	3
Carbonate unspec.	–	5	60
Foraminifers	–	–	5
Calc. nannofossils	10	Tr	15
Radiolarians	3	–	10
Silicoflagellates	Tr	–	–
Fish remains	1	–	–

SITE 568 HOLE CORE 39 CORED INTERVAL 359.9–369.6 m sub-bottom



LITHOLOGIC DESCRIPTION

Ashy layer – light olive gray (5Y 6/1)

Dominant lithology: mudstone containing ash and mottling from bioturbation. Blue green pebbly clasts in Section 1.

Color: grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

		2, 91
	M	D
Texture:		
Sand	20	5
Silt	70	60
Clay	10	35
Composition:		
Quartz	5	2
Feldspar	8	2
Heavy minerals	1	Tr
Clay	62	74
Volcanic glass	7	–
Pyrite	5	1
Micronodules	–	1
Carbonate unspec.	5	4
Foraminifers	–	1
Calc. nannofossils	2	5
Diatoms	1	2
Radiolarians	2	2
Sponge spicules	2	2

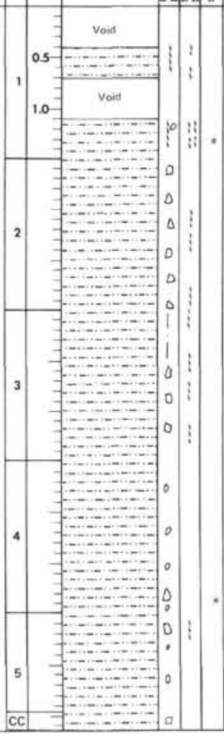
SITE 568 HOLE CORE 40 CORED INTERVAL 369.6–379.3 m sub-bottom

TIME – ROCK UNIT: early Miocene

BIOSTRATIGRAPHIC ZONE: *Helicosphaera ampliaperta*

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): Nannofossils CM

SECTION / METERS / GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



35° apparent dip measured on bedding plane

LITHOLOGIC DESCRIPTION

Dominant lithology: mudstone with veins and fractures throughout the core. Bedding planes are not horizontal. Burrowing is common. Color: grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	1, 134	4, 140
	D	D
Texture:		
Sand	5	–
Silt	35	20
Clay	60	80
Composition:		
Quartz	–	5
Feldspar	1	–
Mica	Tr	–
Heavy minerals	Tr	1
Clay	80	65
Volcanic glass	–	10
Glauconite	Tr	1
Pyrite	1	–
Micronodules	1	–
Carbonate unspec.	2	10
Foraminifers	1	–
Calc. nannofossils	5	–
Diatoms	2	–
Radiolarians	5	–
Sponge spicules	2	1

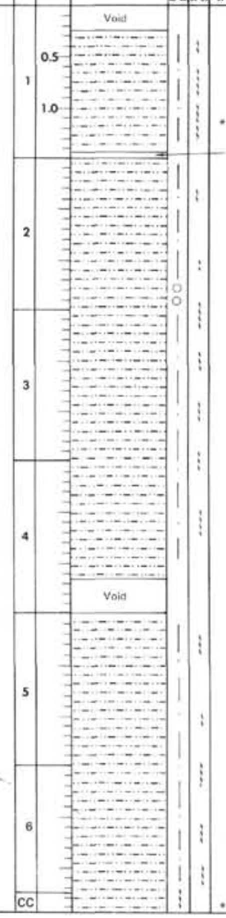
SITE 568 HOLE CORE 41 CORED INTERVAL 379.3–389.0 m sub-bottom

TIME – ROCK UNIT: early Miocene

BIOSTRATIGRAPHIC ZONE: *Helicosphaera ampliaperta*

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): Nannofossils FM

SECTION / METERS / GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



– Void

60° apparent dip measured on bedding plane

LITHOLOGIC DESCRIPTION

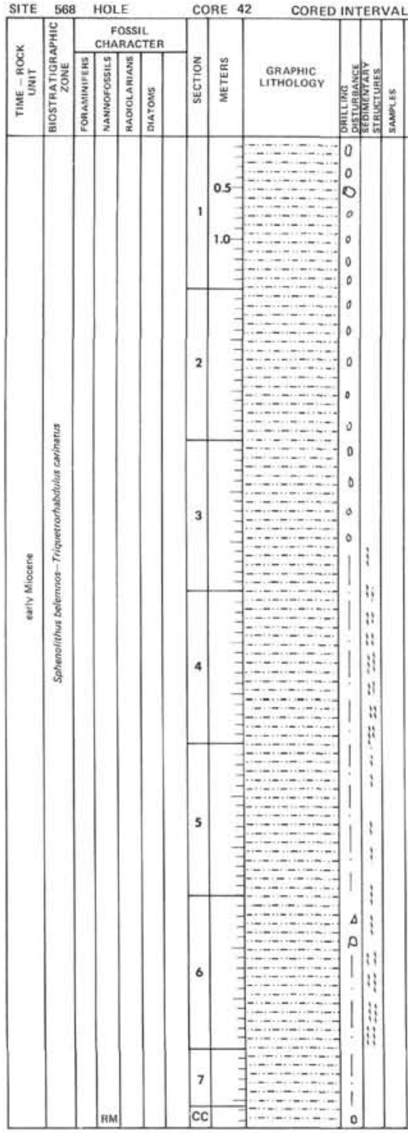
Dominant lithology: mudstone with veining, fractures, and burrow mottling throughout the core. Fracture angles dip about 30°. Scaley deformation.

Color: grayish olive (10Y 4/2).

SMEAR SLIDE SUMMARY (%):

	1, 120	CC
	D	M
Texture:		
Sand	25	90
Silt	60	15
Clay	15	5
Composition:		
Quartz	2	5
Feldspar	3	10
Heavy minerals	Tr	1
Clay	70	5
Volcanic glass	3	40
Glauconite	Tr	5
Pyrite	–	2
Carbonate unspec.	10	10
Foraminifers	2	5
Calc. nannofossils	1	–
Diatoms	2	5
Radiolarians	4	7
Sponge spicules	2	5
Silicoflagellates	1	–

SITE 568 HOLE CORE 42 CORED INTERVAL 389.0–398.7 m sub-bottom



LITHOLOGIC DESCRIPTION

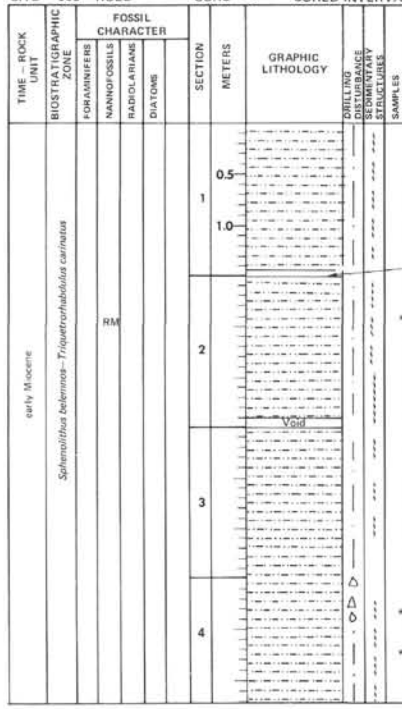
Dominant lithology: mudstone with abundant burrowing. Bedding dips up to 70° to horizontal in several sections. Veination and fracturing are common.

Color: dusky yellowish green (10GY 3/2) with abundant clasts and mottles of light olive brown (5Y 5/6).

70° apparent dip

60° apparent dip

SITE 568 HOLE CORE 43 CORED INTERVAL 398.7–408.9 m sub-bottom



LITHOLOGIC DESCRIPTION

Void

Ashy layer

Gas hydrate crystals

Dominant lithology: mudstone with abundant burrows, veination, and fracturing. Gas hydrate crystals found in Section 4, 45–83 cm.

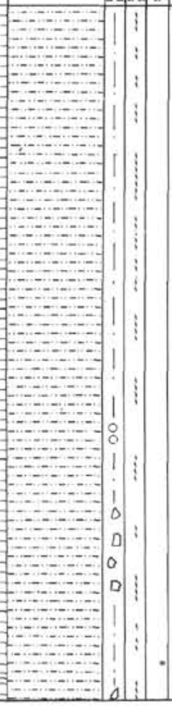
Color: grayish olive green (5GY 3/2) to pale olive (10Y 6/2) with mottles of pale olive (10Y 6/2) to moderate olive brown (5Y 4/4).

SMEAR SLIDE SUMMARY (%):

	2, 40	4, 33	4, 71
	D	D	M
Texture:			
Sand	30	5	50
Silt	40	17	30
Clay	30	78	20
Composition:			
Quartz	34	10	3
Feldspar	15	2	15
Mica	–	–	Tr
Heavy minerals	2	1	2
Clay	27	75	44
Volcanic glass	3	3	20
Glauconite	1	1	–
Pyrite	4	2	1
Carbonate unspec.	3	–	5
Foraminifers	2	1	–
Calc. nannofossils	3	3	2
Diatoms	–	Tr	3
Radiolarians	3	1	1
Sponge spicules	3	1	5

SITE 568 HOLE CORE 44 CORED INTERVAL 408.9–417.7 m sub-bottom

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
						1	0.5 1.0				
						2					
						3					
						4					
						5					*
			B			CC					



LITHOLOGIC DESCRIPTION

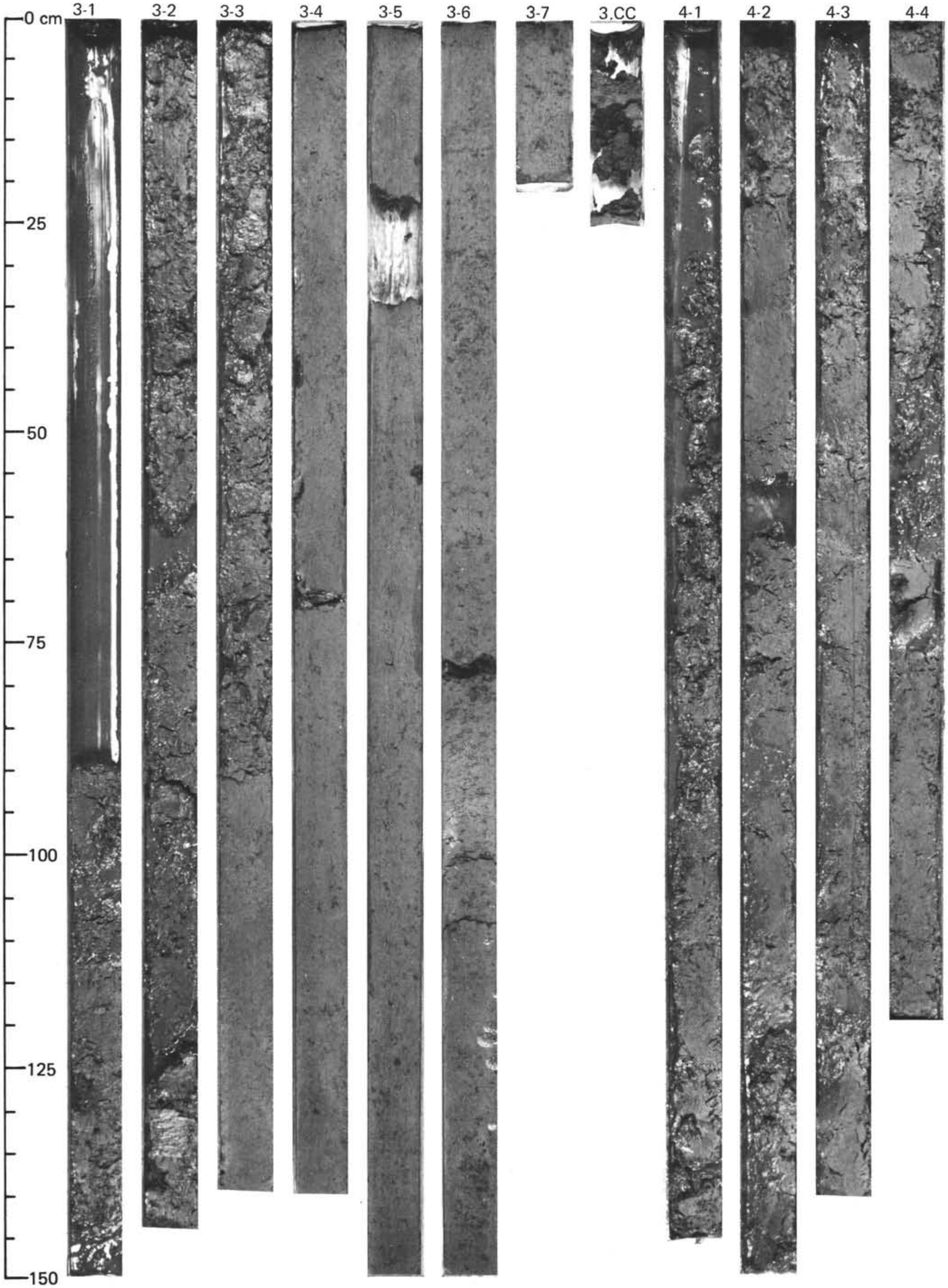
Dominant lithology: mudstone with abundant burrows, veination, and fracturing. Burrows are calcareous. Bedding plane is subvertical.

Color: grayish *olive green* (5GY 3/2) with *mottles* of moderate olive brown (5Y 4/4).

SMEAR SLIDE SUMMARY (%):

	5, 50
Texture:	
Sand	15
Silt	30
Clay	55
Composition:	
Quartz	2
Feldspar	8
Heavy minerals	Tr
Clay	69
Volcanic glass	5
Pyrite	2
Carbonate unspec.	5
Calc. nannofossils	1
Diatoms	2
Radiolarians	1
Sponge spicules	5


0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1,CC
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2,CC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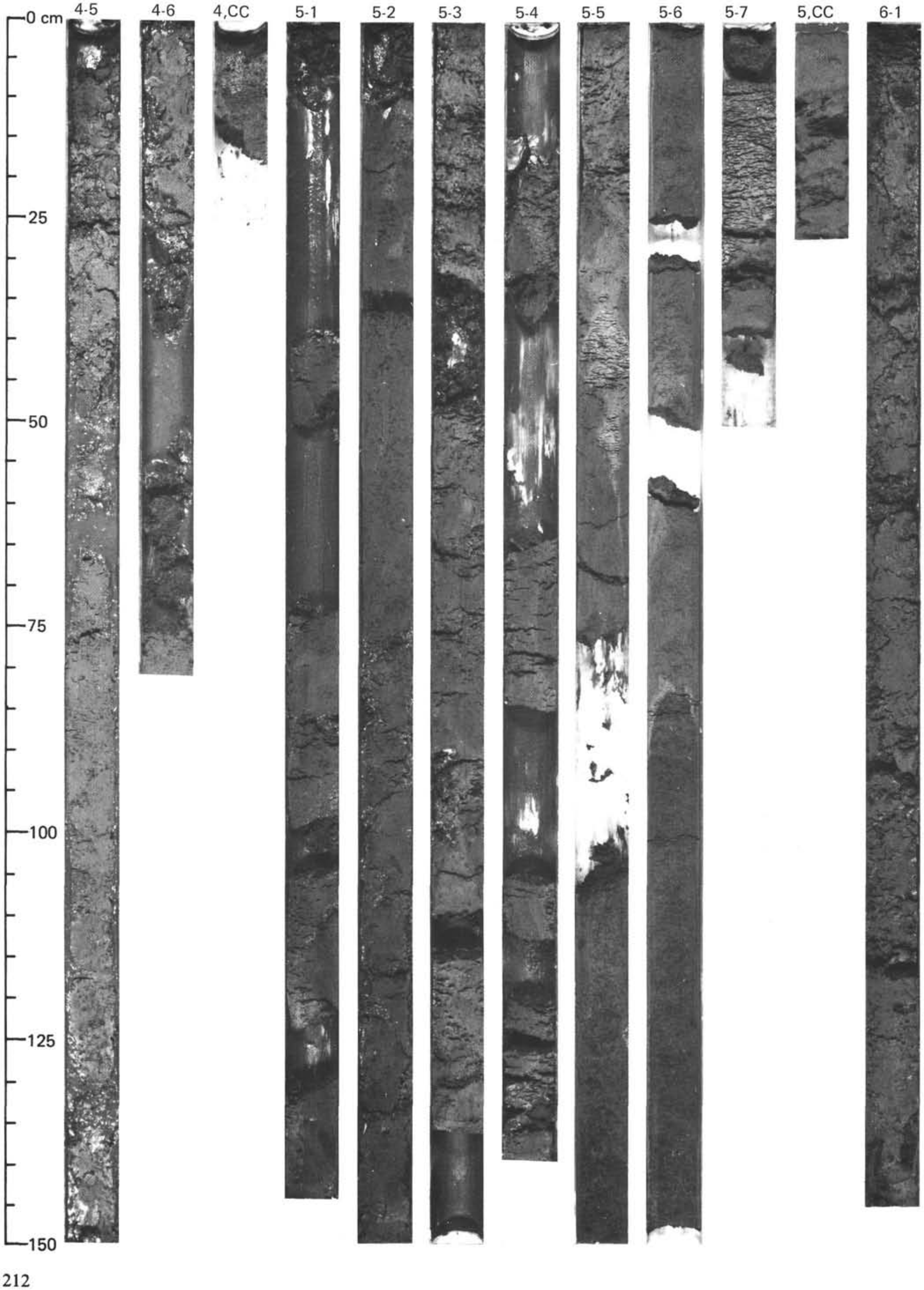
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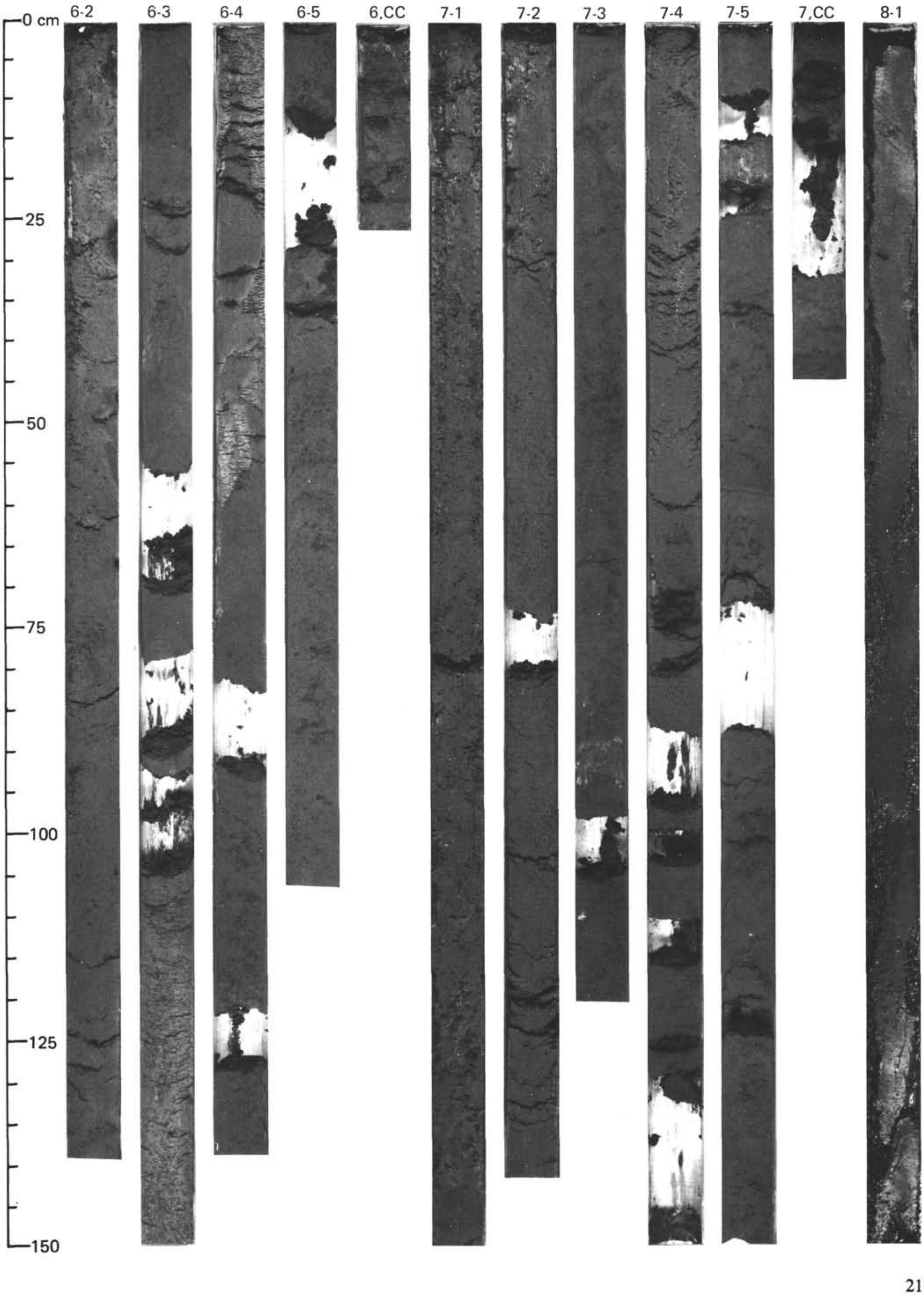
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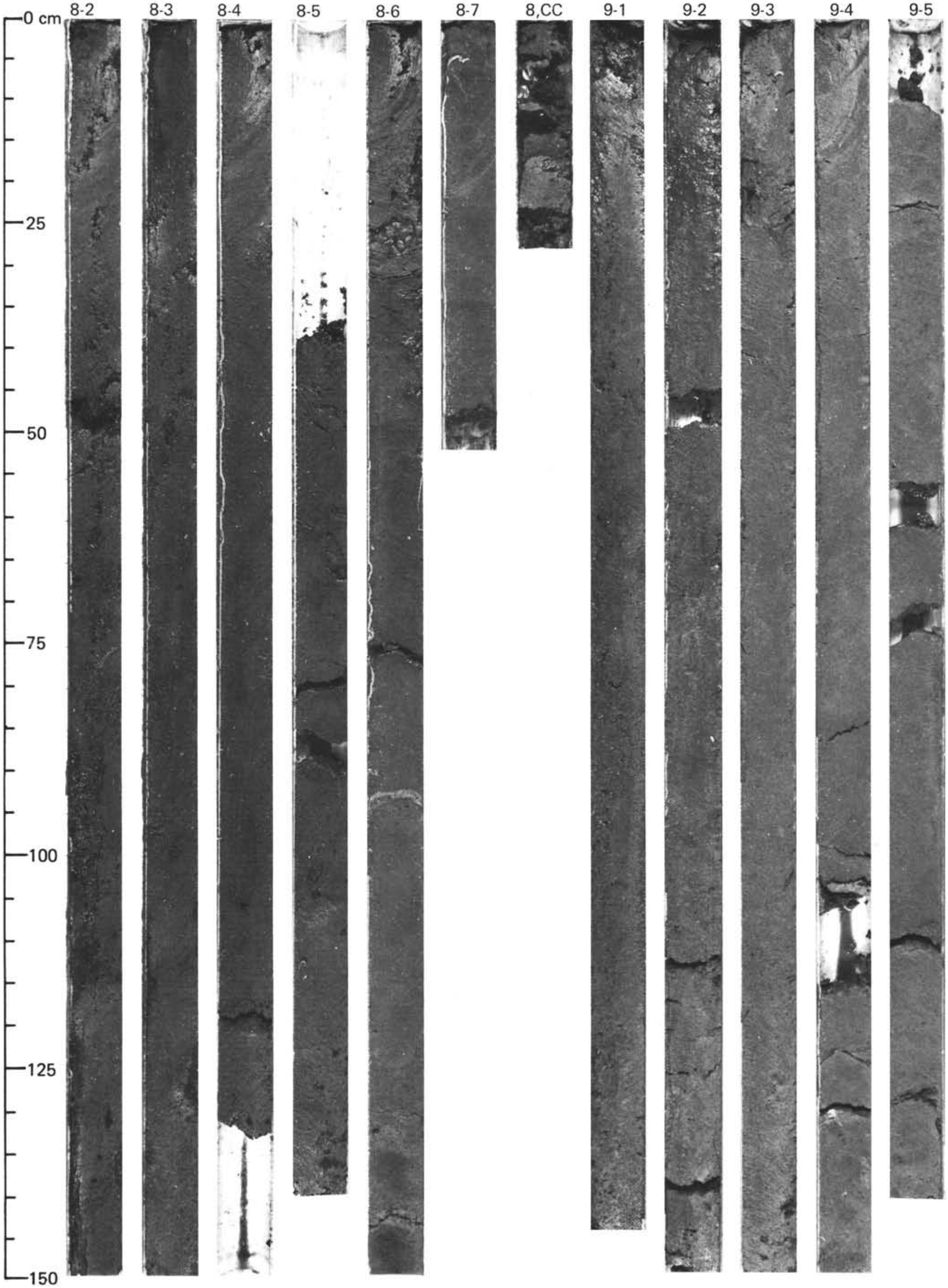
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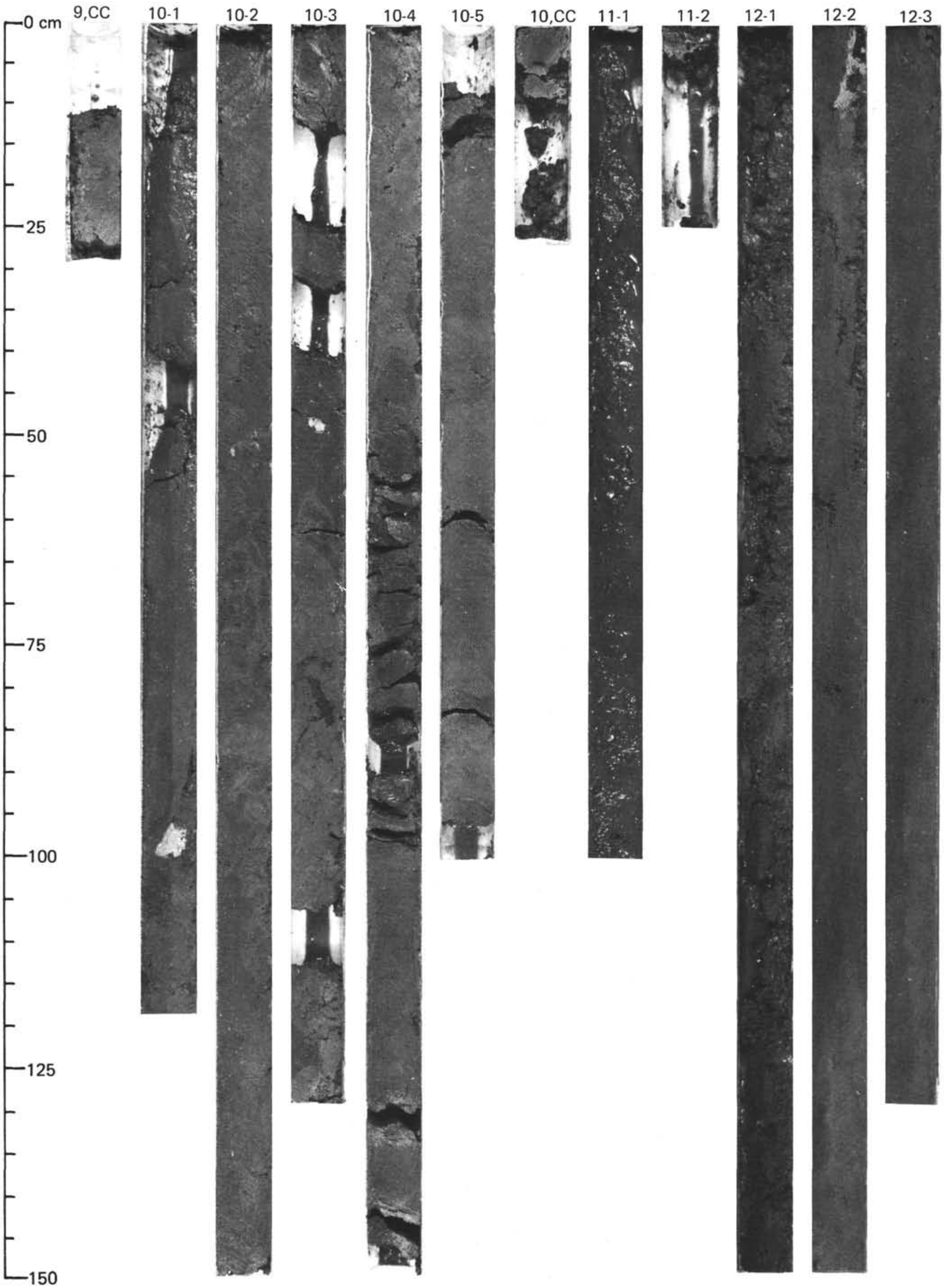
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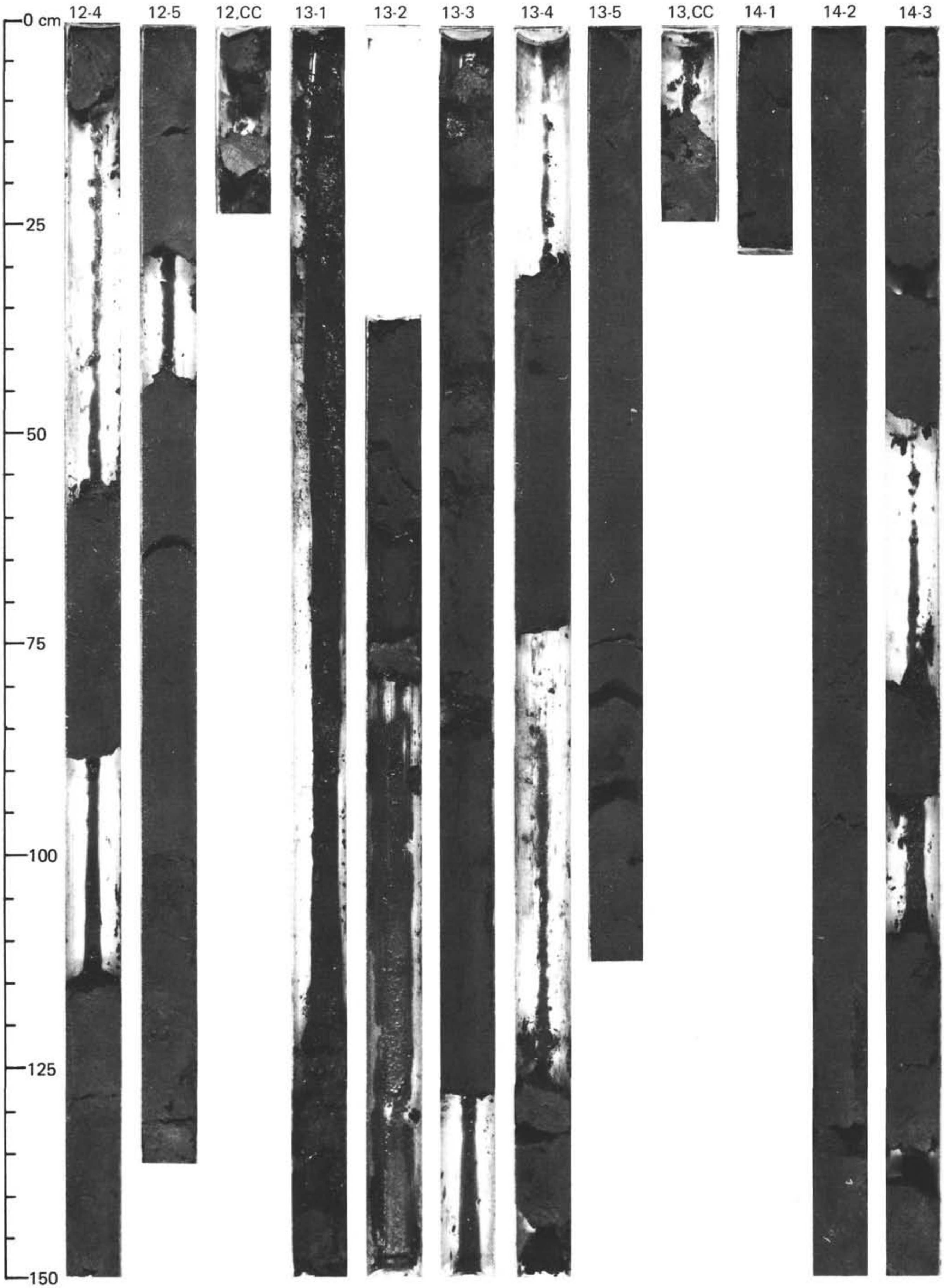
12-2
12-3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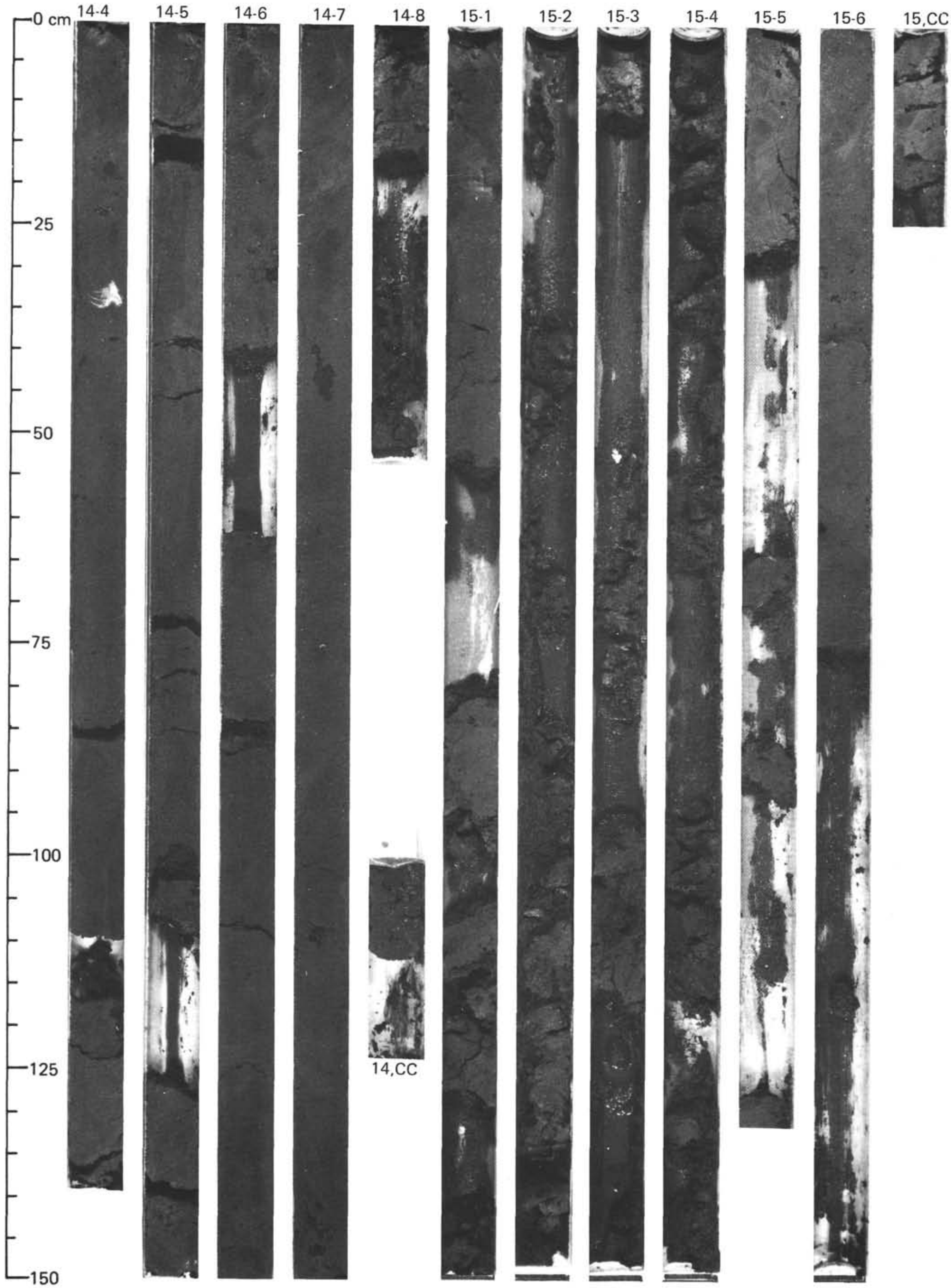
14-3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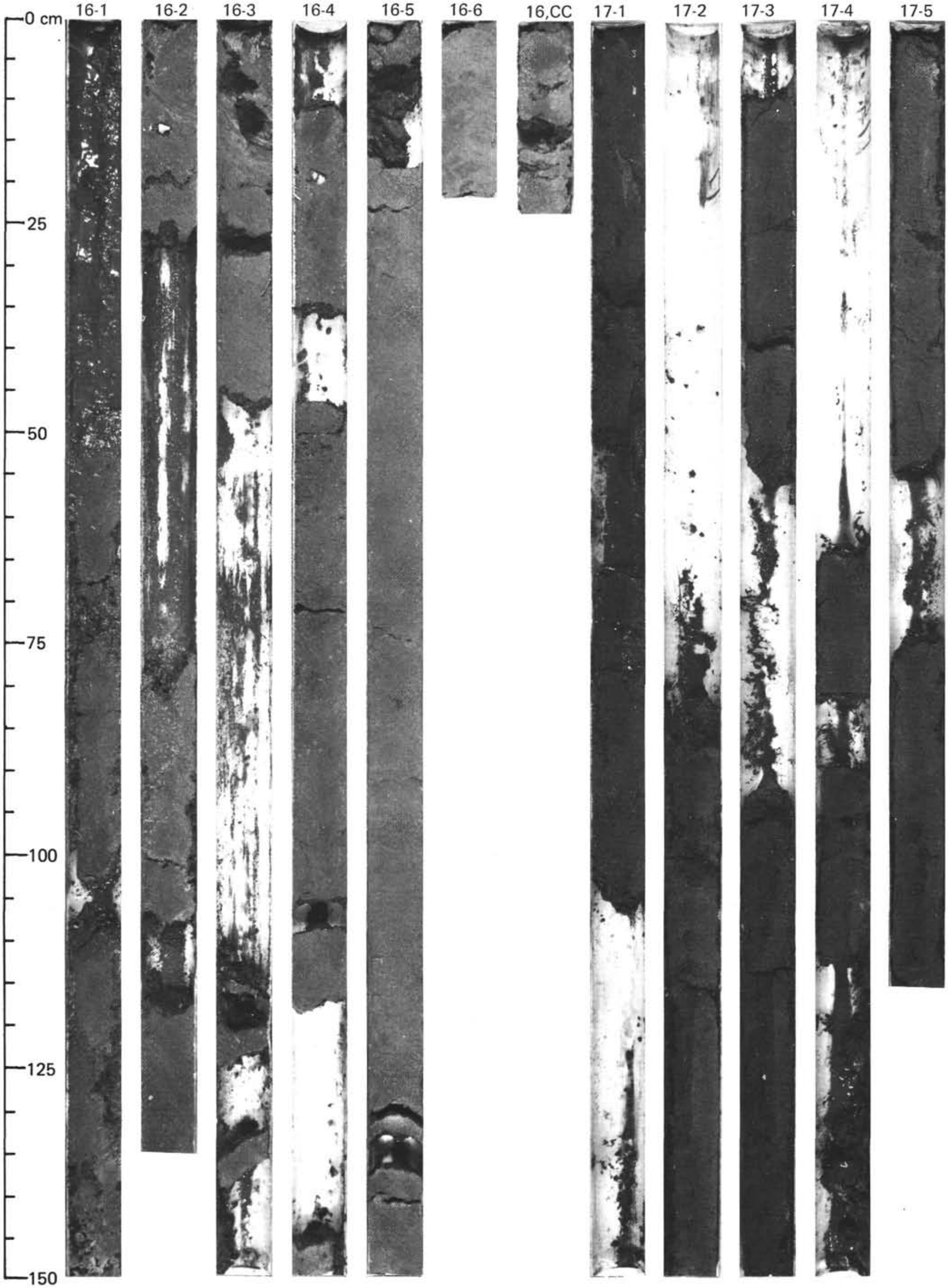
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0 cm
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17,CC
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18,CC
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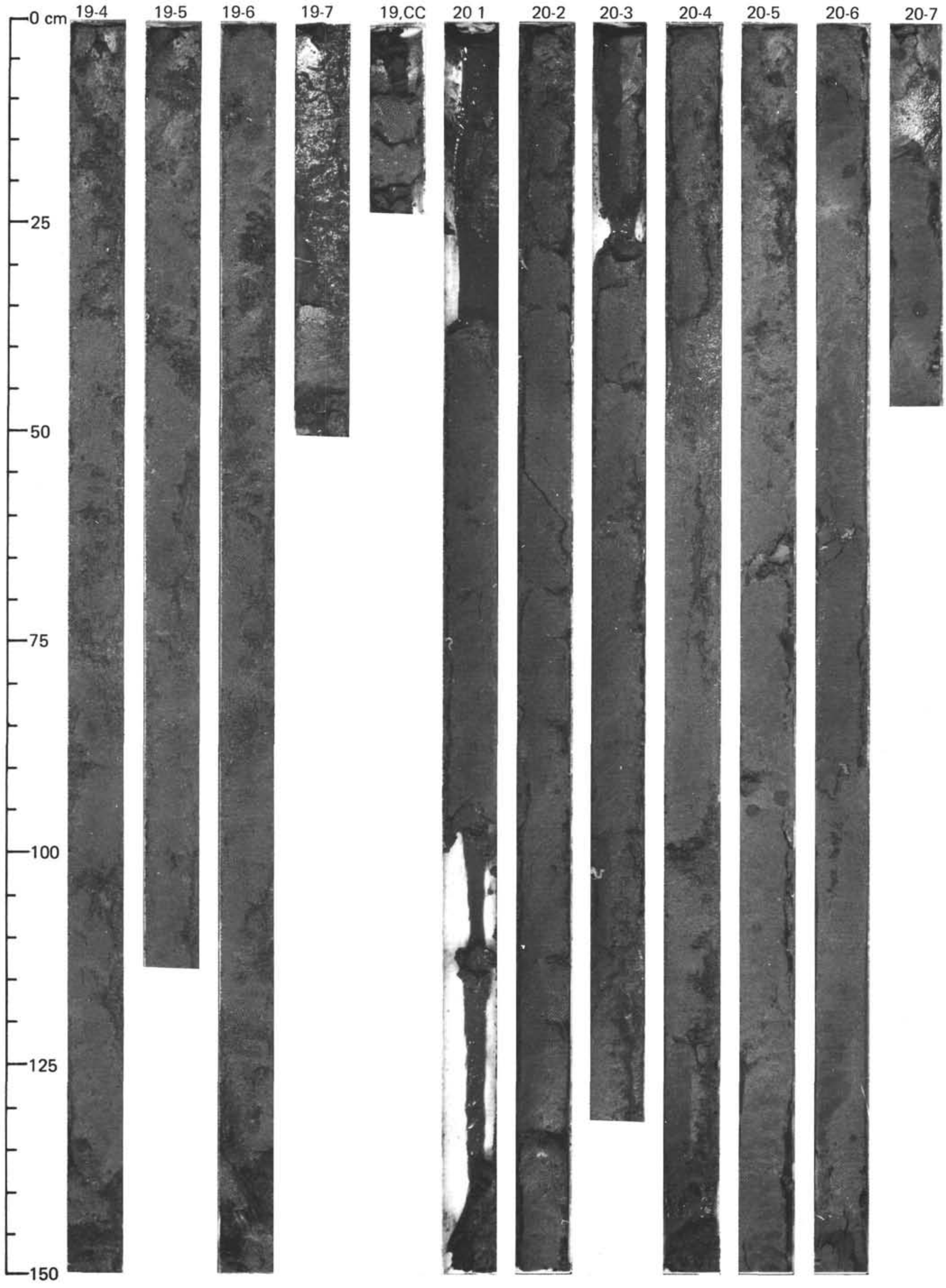
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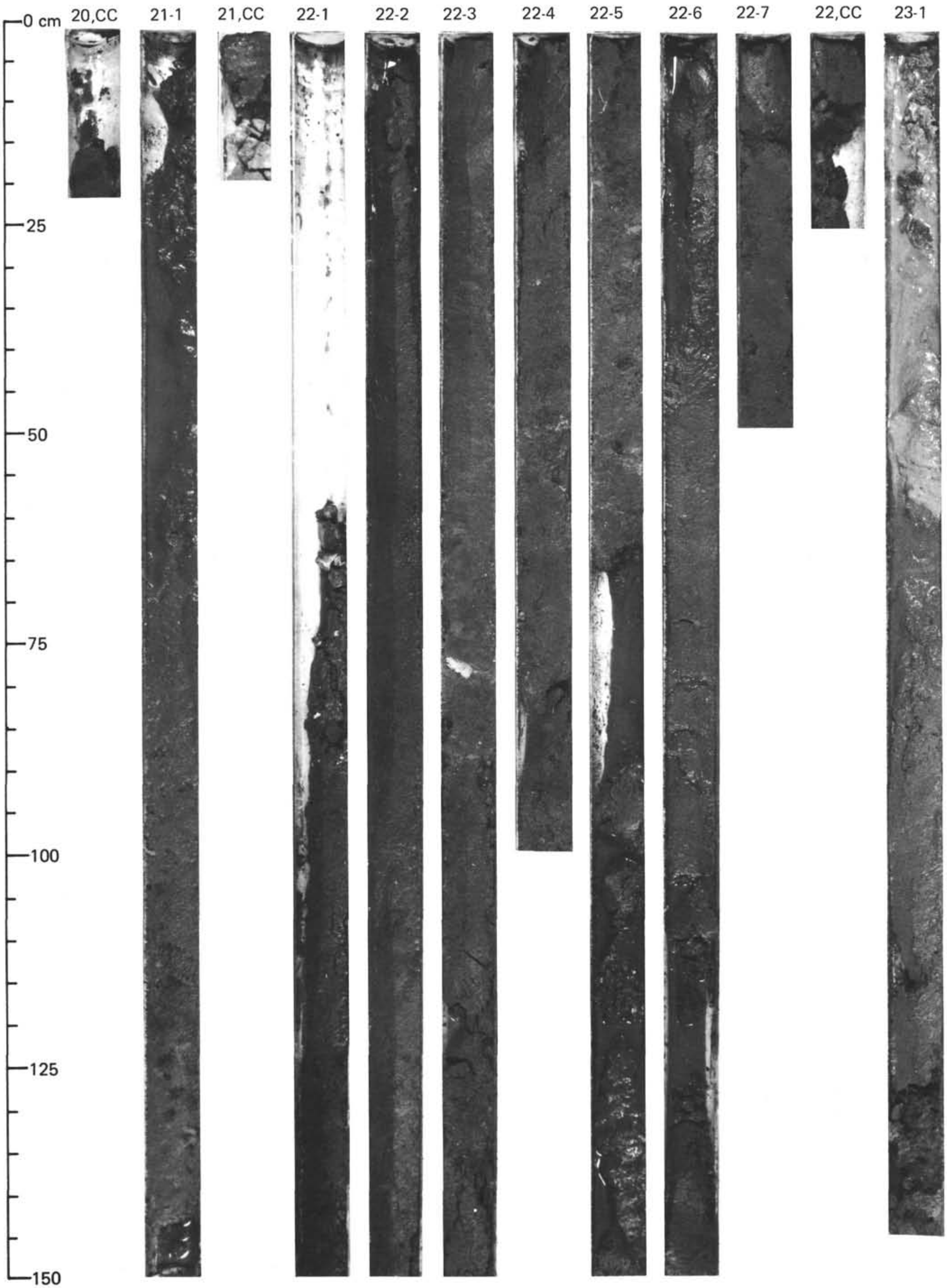
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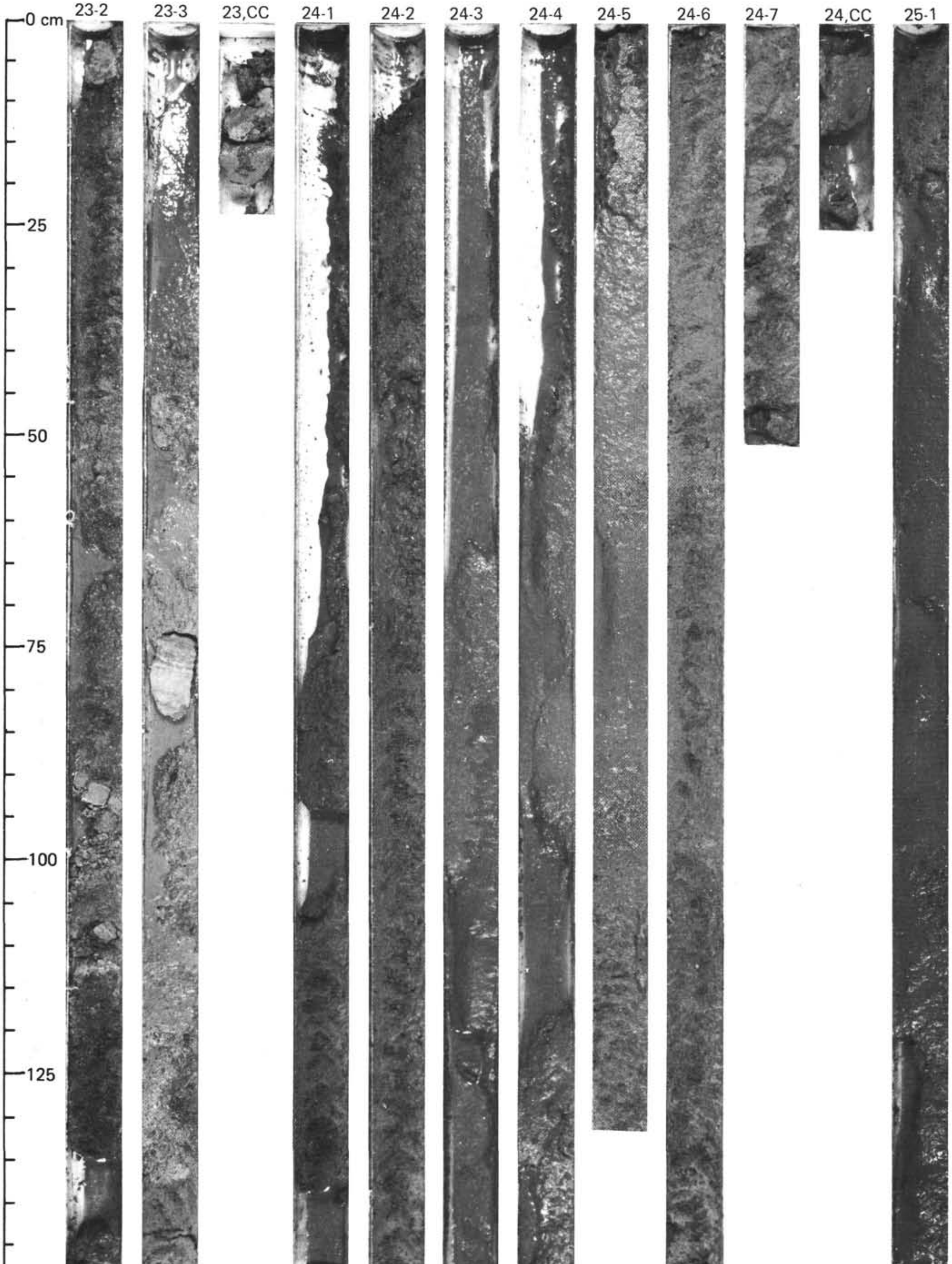
22-7
22,CC
23-1



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24,CC
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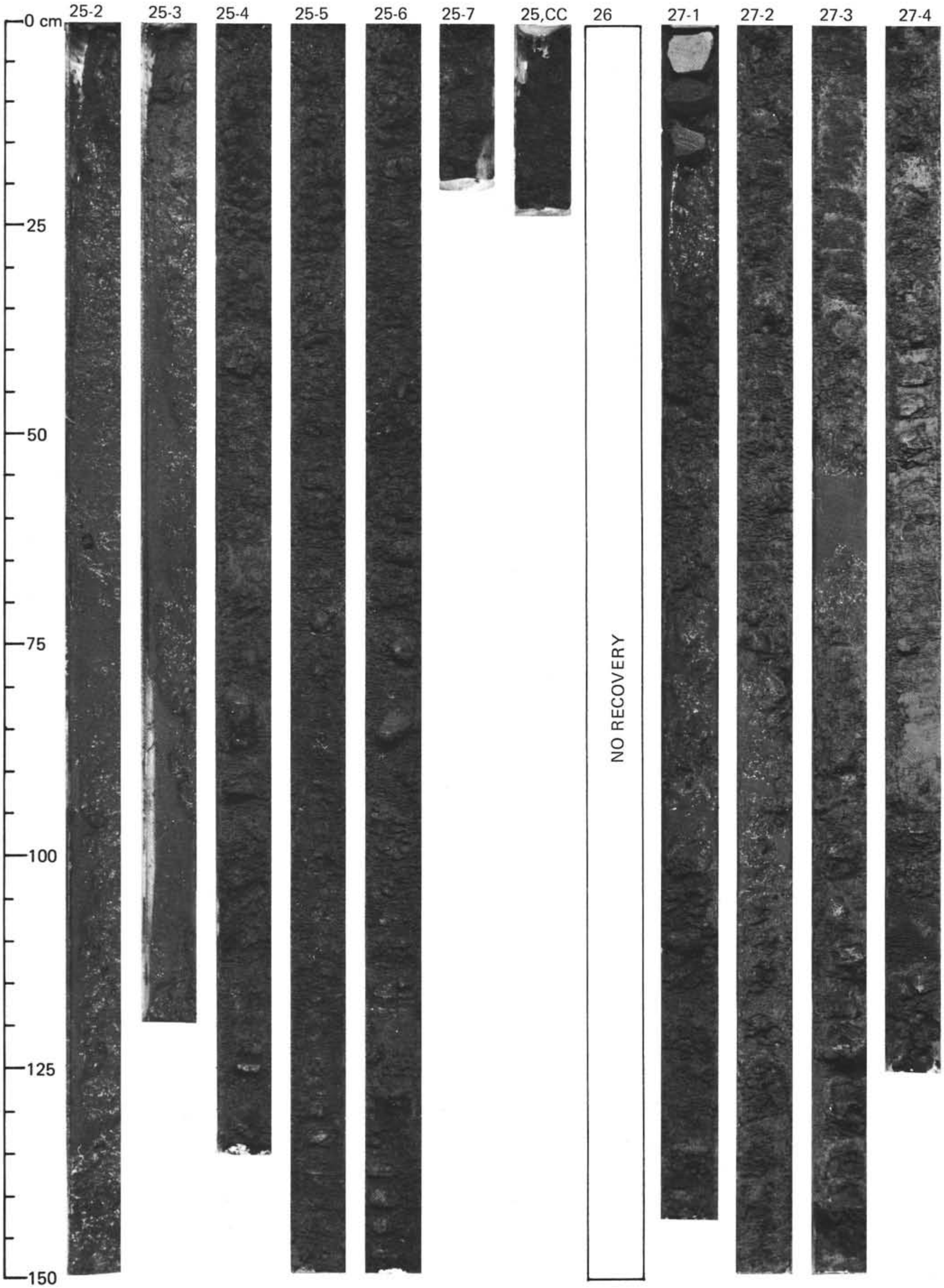
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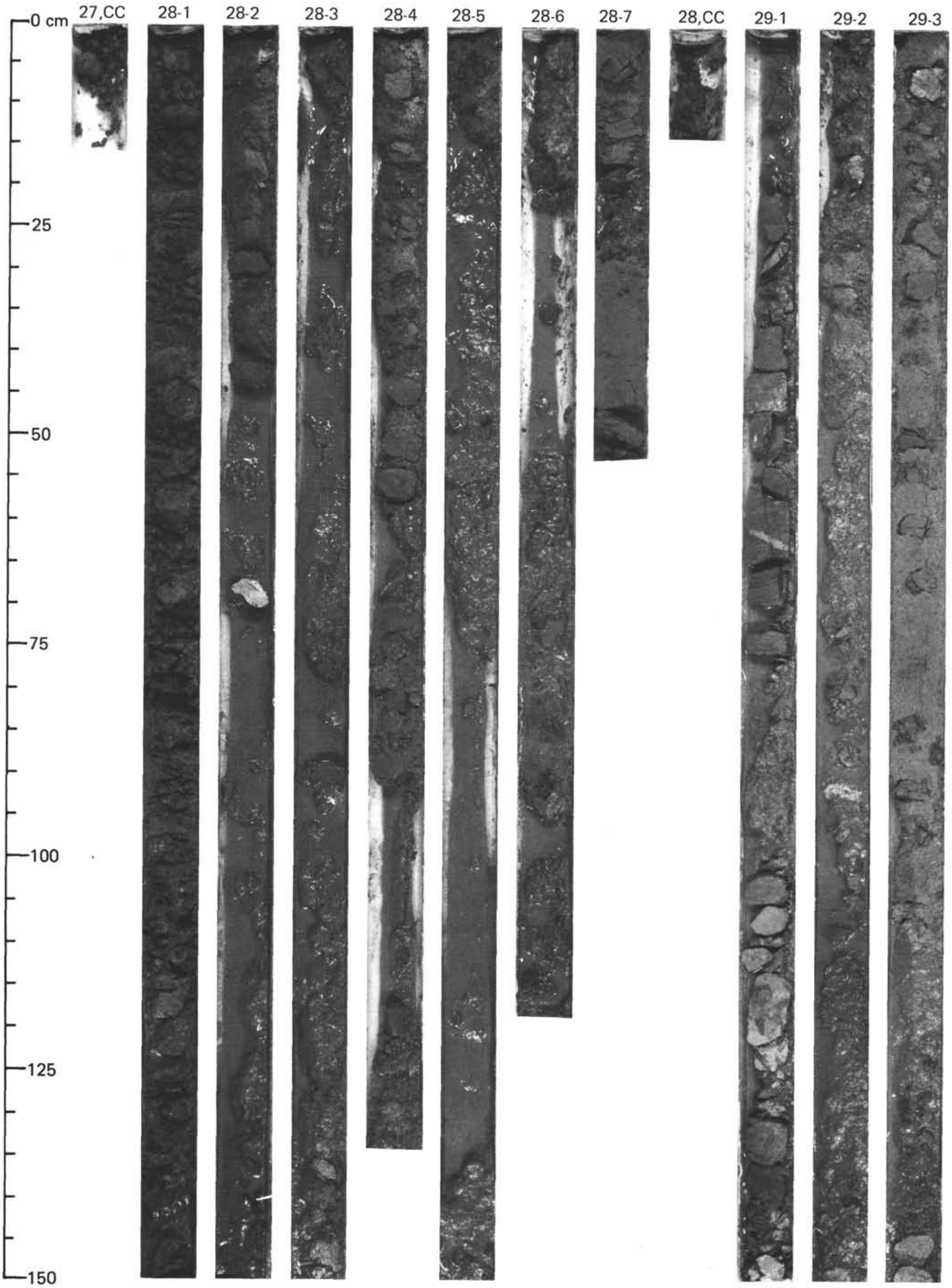
NO RECOVERY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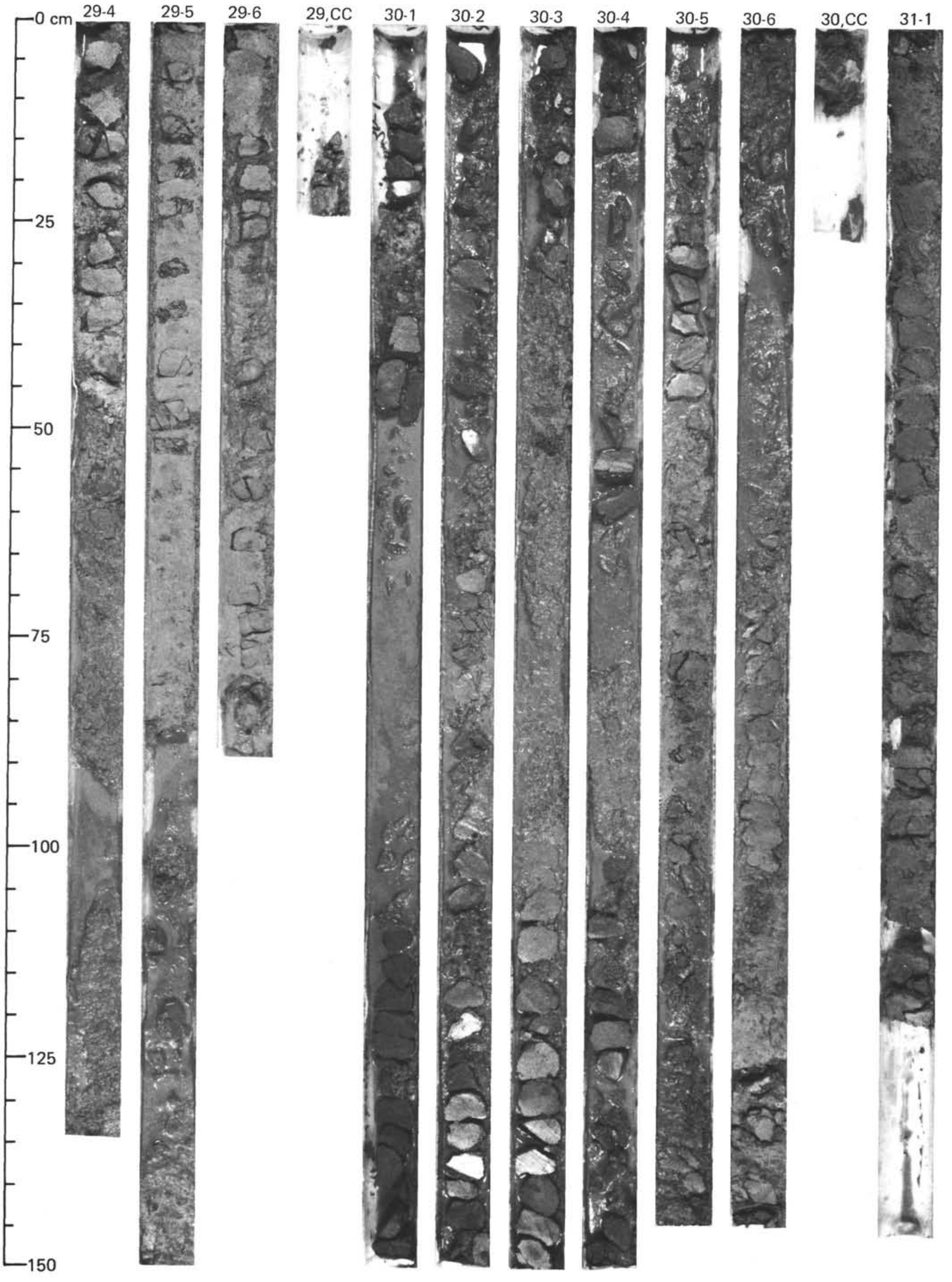
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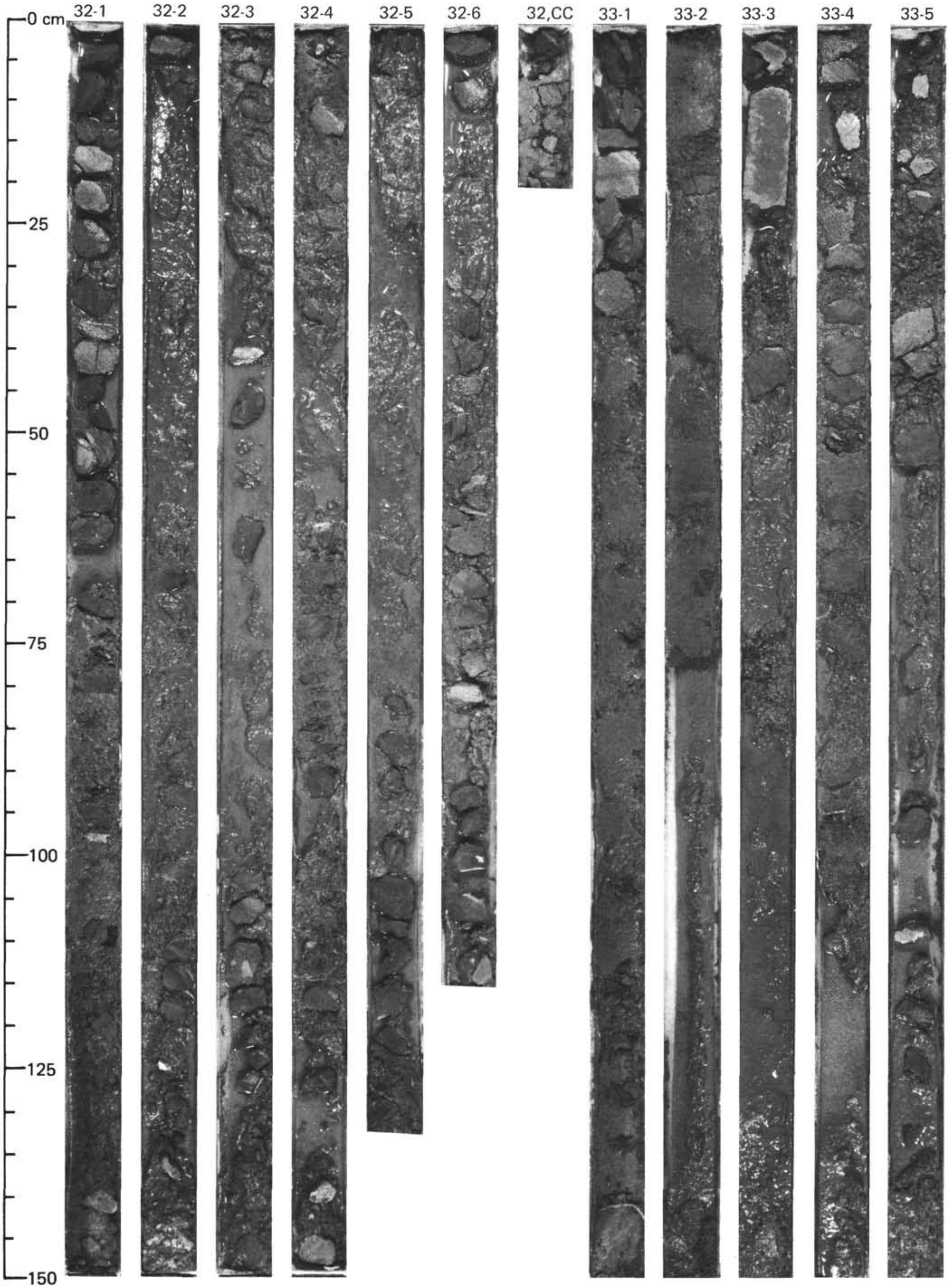
31-1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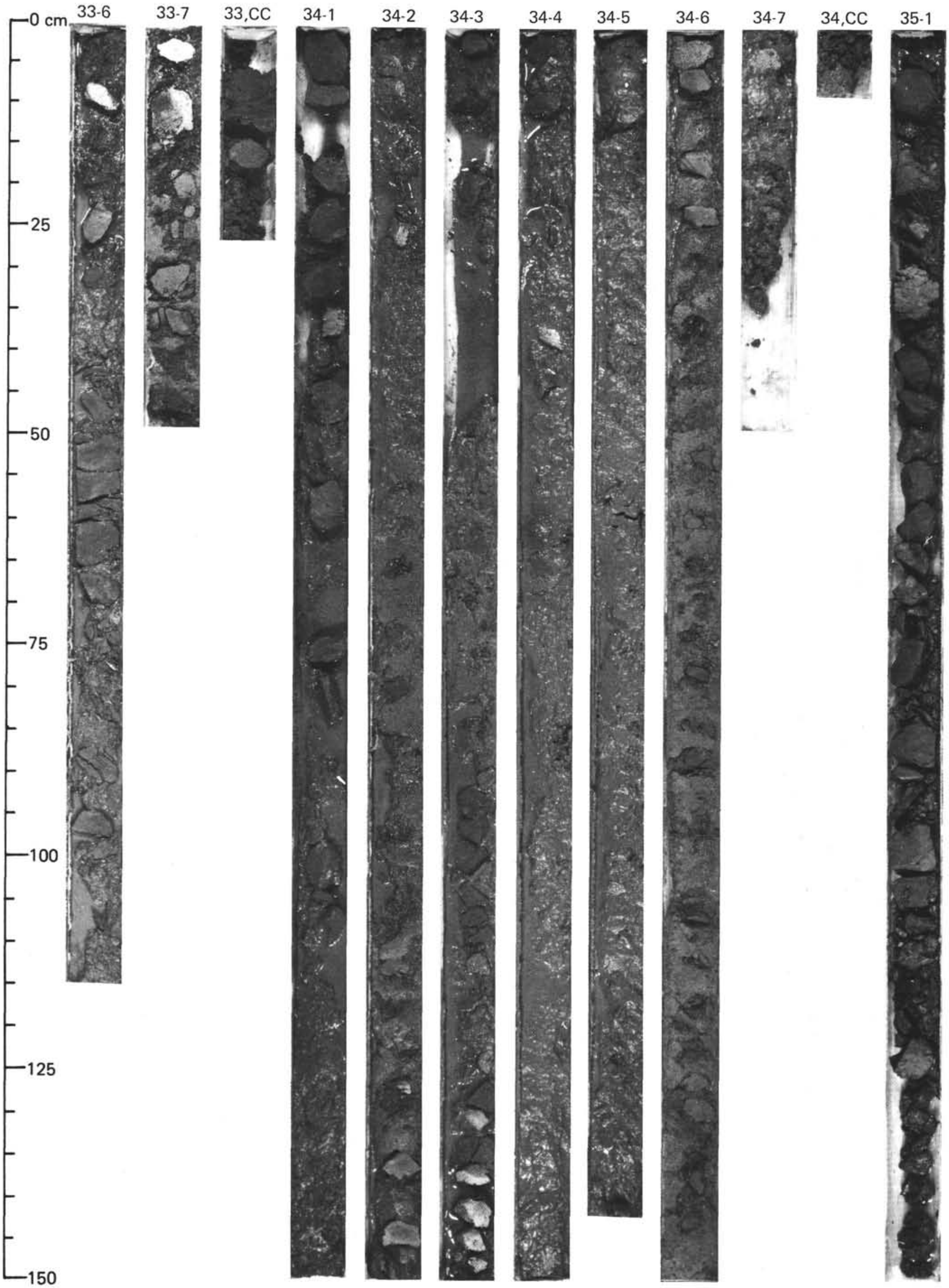
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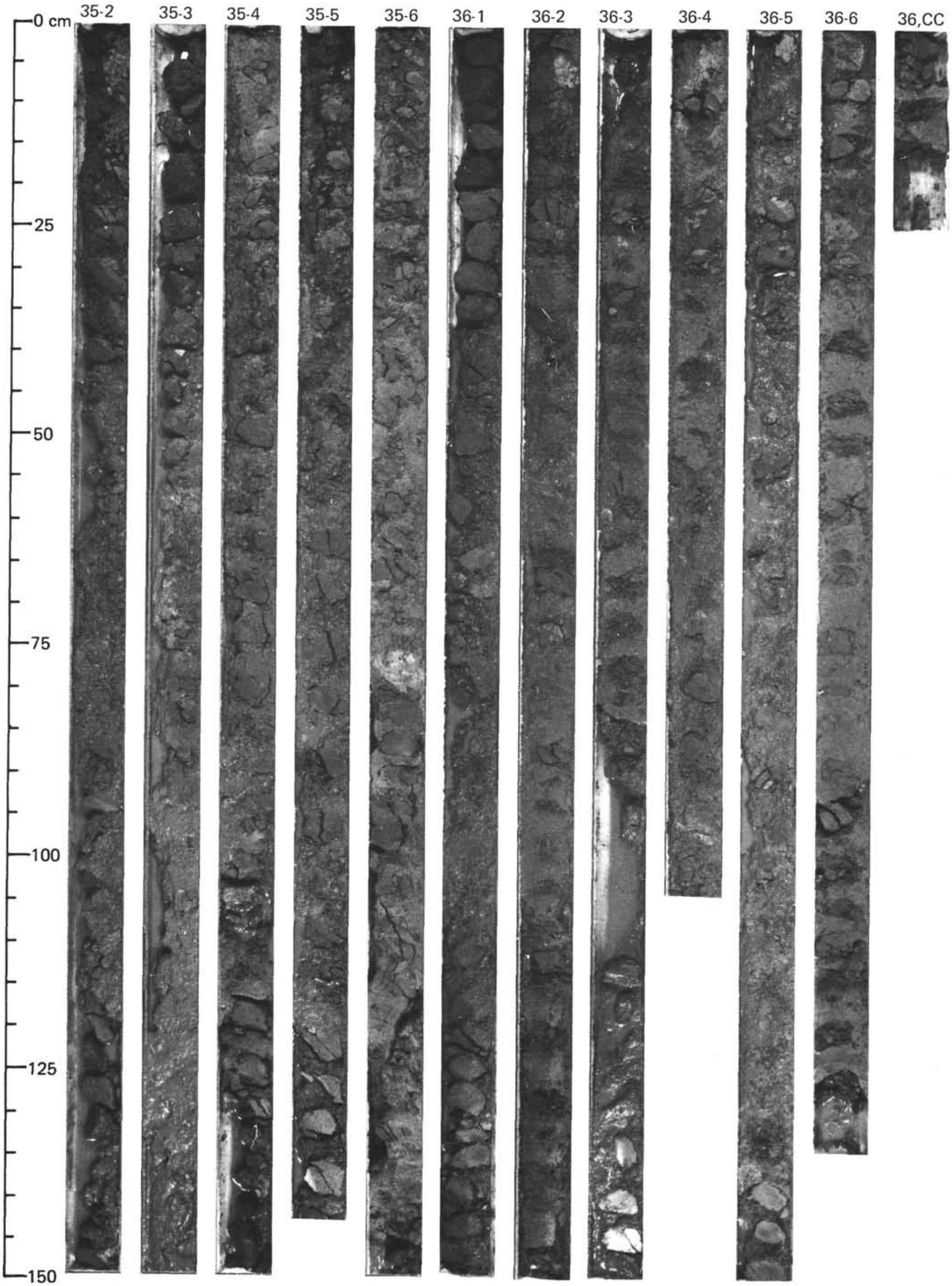
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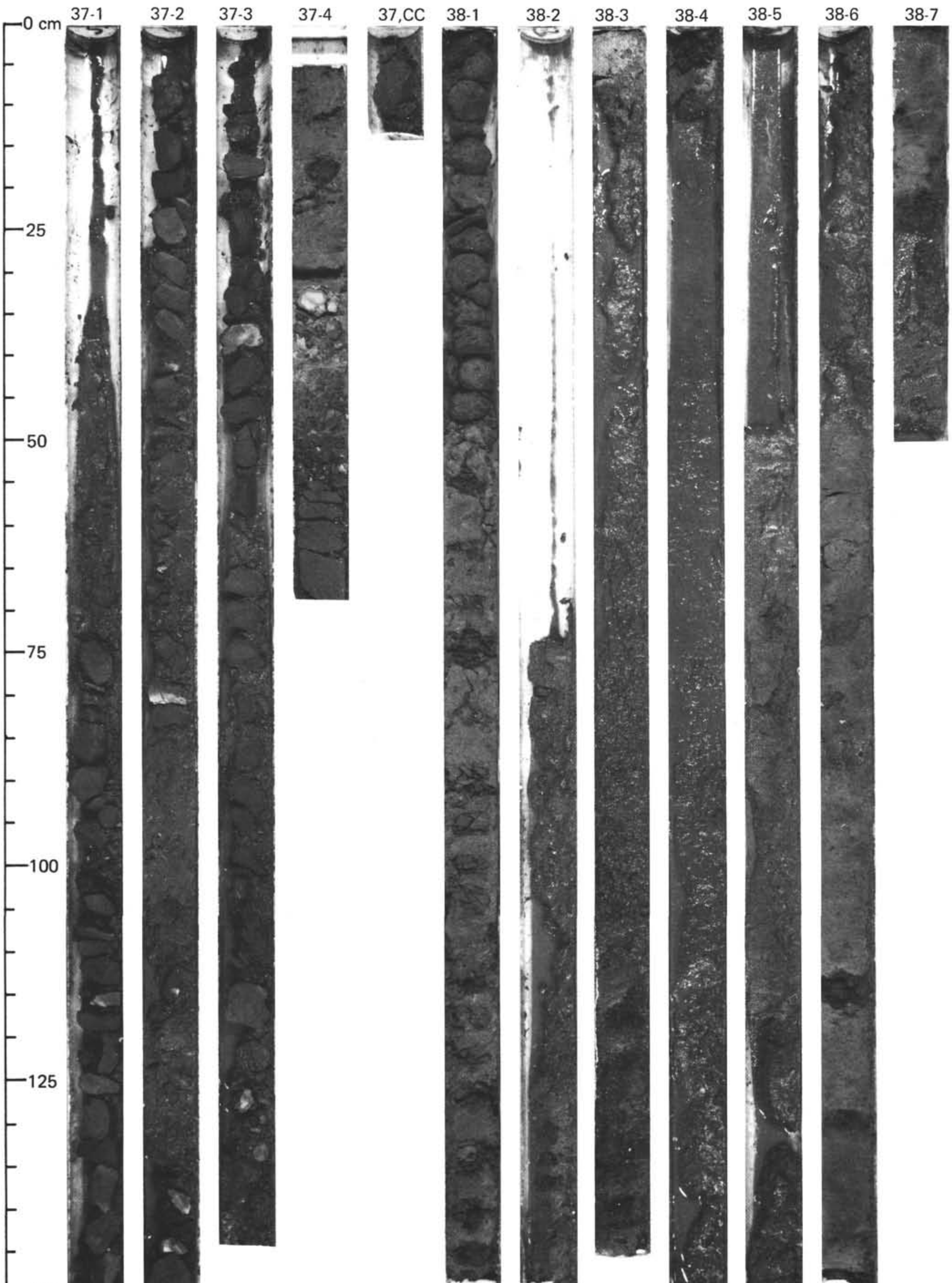
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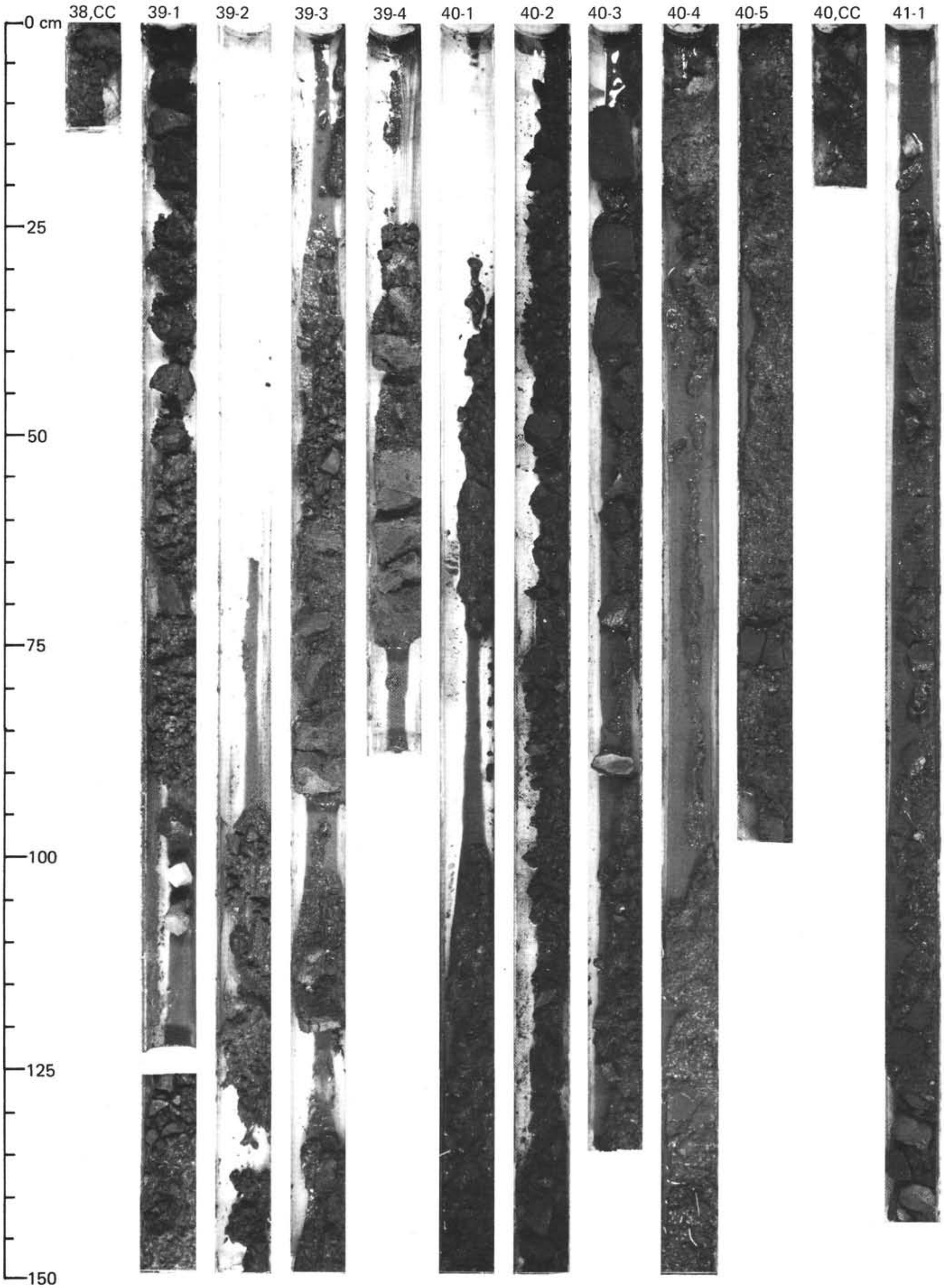
38,CC
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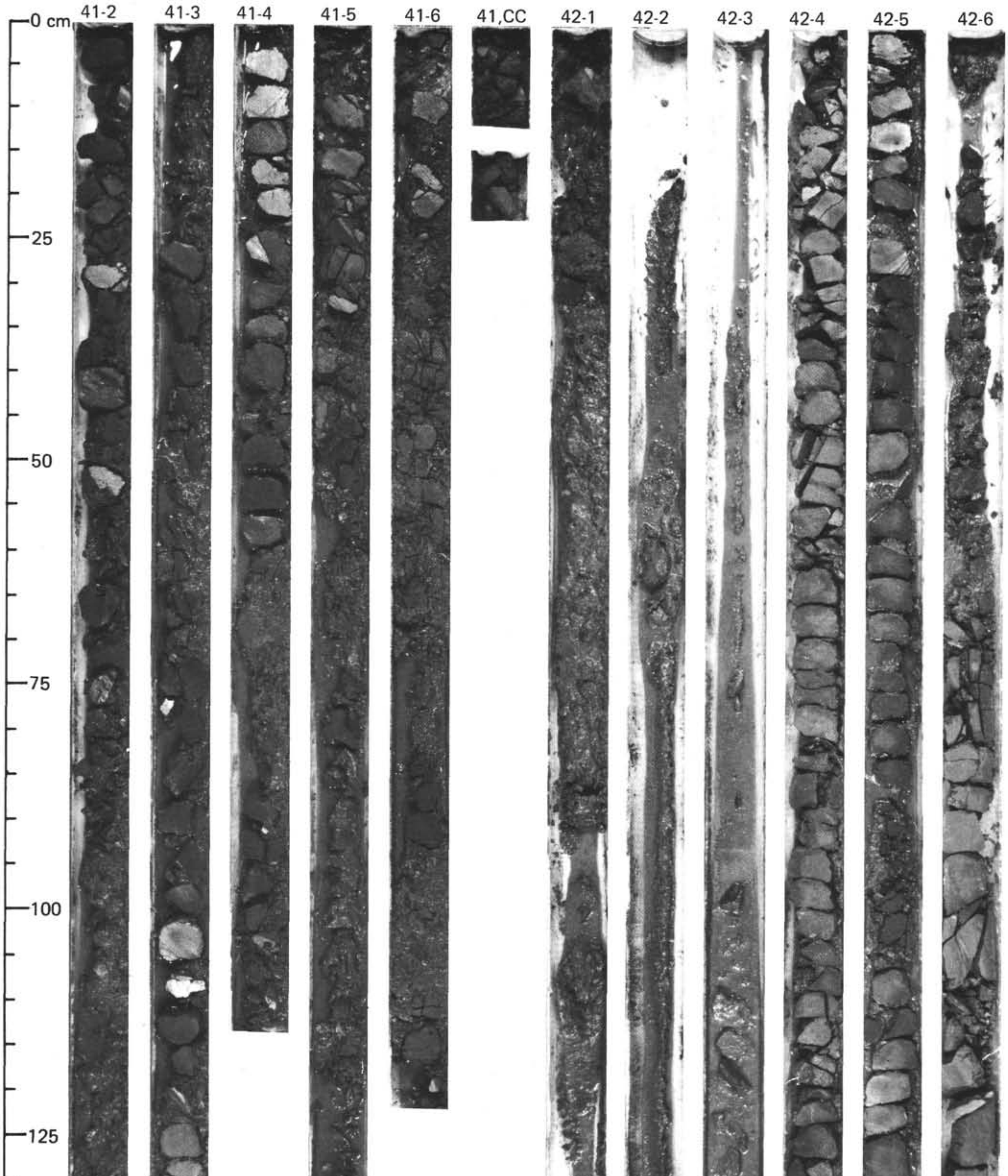
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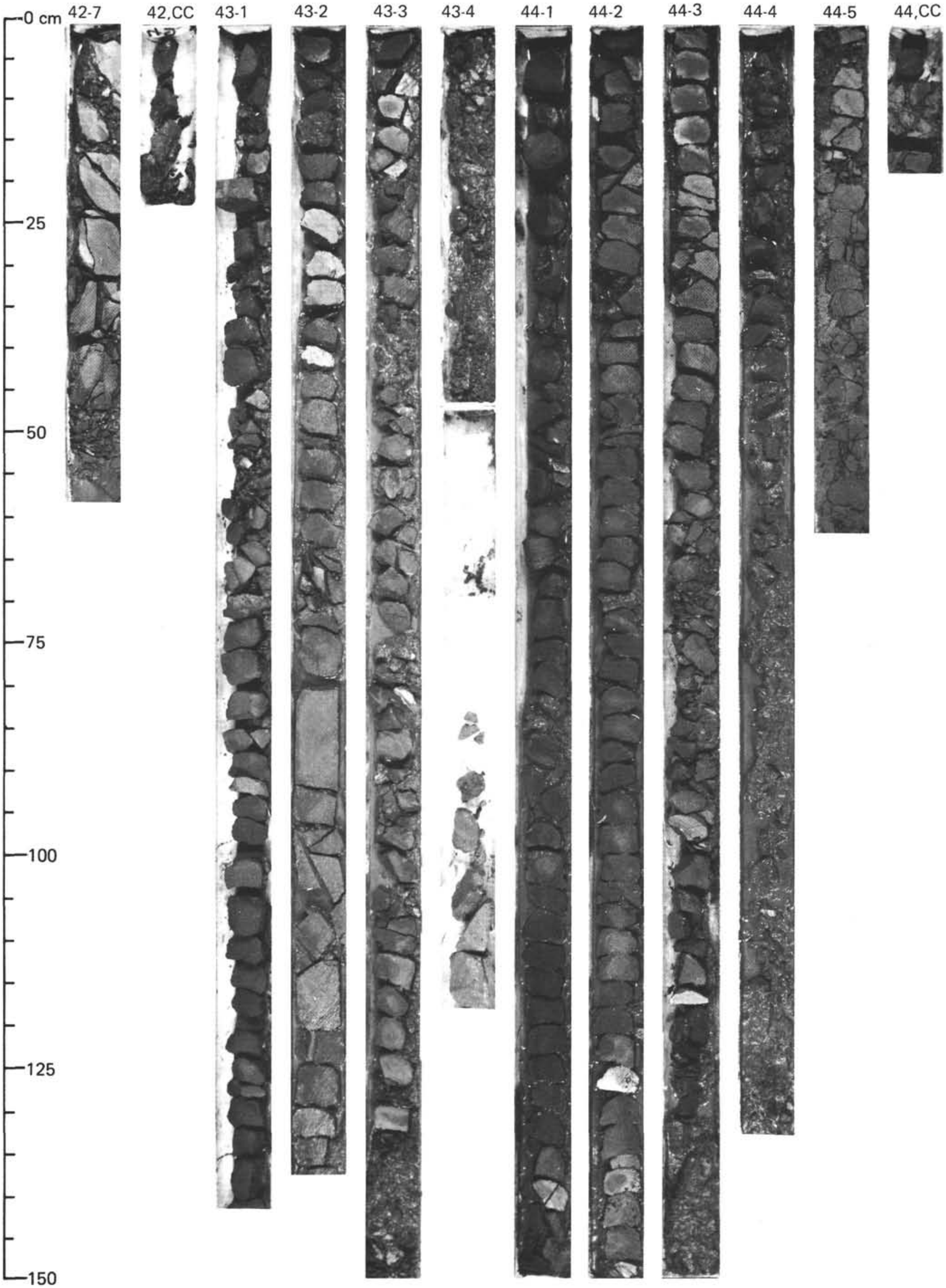
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44-5
44,CC