5. SITE 609[1]

Shipboard Scientific Party[2]

HOLE 609

Date occupied: 0215 hr., 21 July 1983

Date departed: 1430 hr., 23 July 1983

Time on hole: 2.5 days

Position: 49°52.667′N; 24°14.287′W

Water depth (sea level; corrected m, echo-sounding): 3884

Water depth (rig floor; corrected m, echo-sounding): 3899.8

Bottom felt (m, drill pipe): 3883.6

Penetration (m): 399.4

Number of cores: 42

Total length of cored section (m): 399.4

Total core recovered (m): 301.24

Core recovery (%): 75

Oldest sediment cored:
Depth sub-bottom (m): 399.4
Nature: nannofossil chalk
Age: late Miocene (7.0 Ma)
Measured velocity (km/s): 1.8

Basement: not reached

HOLE 609A

Date occupied: 23 July 1983 (2105 hr.)

Date departed: 23 July 1983 (2240 hr.)

Time on hole: 0.1 days

Position: 49°52.667′N; 24°14.287′W

Water depth (sea level; corrected m, echo-sounding): 3883

Water depth (rig floor; corrected m, echo-sounding): 3901.8

Bottom felt (m, drill pipe): No valid mudline core obtained

Penetration (m): 43.0

Number of cores: 2

Total length of cored section (m): 19.2

Total core recovered (m): 17.89

Core recovery (%): 93

Oldest sediment cored:
Sub-bottom depth (m): 43.0
Nature: Nannofossil oozes–marls–muds
Age: late Quaternary (0.7 Ma)
Measured velocity (km/s): 1.52

Basement: Not reached

HOLE 609B

Date occupied: 23 July 1983 (2345 hr.)

Date departed: 26 July 1983 (0430 hr.)

Time on hole: 2.2 days

Position: 49°52.667′N; 24°14.287′W

Water depth (sea level; corrected m, echo-sounding): 3883

Water depth (rig floor; corrected m, echo-sounding): 3901.8

Bottom felt (m, drill pipe): 3906.8

Penetration (m): 354.7

Number of cores: 38

Total length of cored section (m): 354.7

Total core recovered (m): 308.4

Core recovery: (%): 87

Oldest sediment cored:
Sub-bottom depth (m): 354.7
Nature: Nannofossil chalk
Age: late Miocene (6.0 Ma)
Measured velocity (km/s): 1.6

Basement: Not reached

HOLE 609C

Date occupied: 0730 hr., 26 July 1983

Date departed: 0245 hr., 27 July 1983

Time on hole: 0.8 days

Position: 49°52.667′N; 24°14.287′W

Water depth (sea level, corrected m, echo-sounding): 3883

Water depth (rig floor; corrected m, echo-sounding): 3901.8

Bottom felt (m, drill pipe): 3906.8

Penetration (m): 190.4

Number of cores: 7

Total length of cored section (m): 67.2

Total core recovered (m): 34.95

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[1] Ruddiman, W. F., Kidd, R. B., Thomas, E., et al., *Init. Repts. DSDP*, 94: Washington (U.S. Govt. Printing Office).

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Core recovery (%): 52

Oldest sediment cored:

Sub-bottom depth (m): 190.4
Nature: stiff nannofossil ooze-marl
Age: late Pliocene (2.75 Ma)
Measured velocity (km/s): 1.8

Basement: not reached

Principal results: Site 609 is on the upper-middle eastern flank of the Mid-Atlantic Ridge at 49°52.7′N, 24°14.3′W, at a water depth of 3884 m. Four holes were drilled at the site, three of which yielded sections of significant length; two cores were taken from the fourth during the process of feeling for bottom. Hole 609 was cored with the hydraulic piston corer (HPC) to a sub-bottom depth of 130.6 m (1.9 Ma) and then cored with the extended core barrel (XCB) to 399.4 m (7.0 Ma). Hole 609B was cored with the variable-length hydraulic piston corer (VLHPC) to 128.4 m (1.8 Ma) and then XCB-cored to 354.7 m (6.0 Ma). Hole 609C was XCB-cored from 123.2 (1.75 Ma) to 190.4 m (2.8 Ma). Recovery averaged 75% in Hole 609, 87% in Hole 609B, and 52% in Hole 609C. Contorted layering occurs to a depth of 0.1 to 1.0 m in the tops of most cores, and some are entirely contorted. These disturbances appear to be related to pitching of the ship induced by remotely generated swell. Local weather at the site during operations was relatively calm, in general, and never bad.

Paleomagnetic and lithologic tie-lines between holes indicate that we may have a 100% complete composite section to about 130 to 160 m sub-bottom (~2 Ma). Between-core verification of a 100% complete section is made very difficult by the low recovery, the contorted layering, and by complicated coring-related thickening and thinning of the layering from hole to hole (see Ruddiman et al., this volume). All calcareous microfossil zones are well represented, with no hiatuses evident. Preservation of calcareous material is generally very good. The paleomagnetic stratigraphy is exceptional throughout, with very high intensities. The upper 170 m consists of interbedded oozes, marls, and muds of the Pleistocene and upper Pliocene, extending to the top of the Gauss (2.47 Ma) and deposited at a rate of about 69 m/m.y. These are the glacial cycles of the North Atlantic. From 170 (2.47 Ma) to 240 m (3.2 Ma) are upper Pliocene muddy nannofossil oozes deposited at a somewhat faster rate (89 m/m.y.). The muddy component is tentatively attributed to an influx of redeposited fine basaltic-volcanic debris from Maury Channel, the main axis of which lies some 35 km to the east and some 225 m deeper than Site 609. This suggests a possible initiation of downslope deposition in the Maury Channel at about 3.4 Ma, and could be related to the first local glaciation of Iceland. The remainder of the section (240–399.4 m) is lower Pliocene and upper Miocene nannofossil ooze grading to nannofossil chalk; some deformation occurs in the upper Miocene chalks. Deposition rates in this unit are about 32 m/m.y. between 240 and 280 m (3.2–4.5 Ma) and about 56 m/m.y. between 280 and 348 m (4.5–5.7 Ma). No reliable data are available from lower levels. In general, deposition was pelagic, with significant enhancement by local redeposition of contemporaneous sediments as a result of gentle current activity.

BACKGROUND AND OBJECTIVES

Site 609 is on the upper-middle eastern flank of the Mid-Atlantic Ridge, roughly 450 n. mi. west-southwest of Ireland and about 150 mi. south of the Charlie Gibbs Fracture Zone (Fig. 1). *Vema* Cruise 23 crossed the area, taking one piston core (*V*23-83) near the site and providing air-gun records into and out of the region (Fig. 2). The seismic records show a relatively thick sediment cover (500–1000 m; 0.5–1.0 s) over rough basement topography that occasionally protrudes through to the surface. The sediment cover is moderately reflective in the upper part but largely transparent at depth; a deep reflector is locally visible near basement in some areas. The mode of sediment deposition is inferred to have been dominantly pelagic, with some current reworking around basement highs. Flat-lying, highly reflective sediments at and near the surface are visible in the deeper topography near Site 609 (e.g., at 1500 hr. on Fig. 2). These indicate turbidite deposition in Maury Channel, which brought coarse basaltic sands and silts southward from the source in Iceland (Johnson et al., 1971; Ruddiman, 1972; Cherkis et al., 1973). Maury Channel meanders through sediment-covered remnants of the fault-block topography of the Mid-Atlantic Ridge, alternately cutting eastward along fracture zones and southward through fault blocks. Site 609 is situated 200 to 250 m above the depths most affected by this channelized downslope flow. Some increase in reflectivity evident near Site 609 suggests a possible overbank influence of Maury Channel in this area.

The upper Quaternary piston-core sequence consists of calcareous oozes interbedded with glacial marine muds deposited at average rates of 50 m/m.y. The total sediment thickness of 700 m at this site, combined with an estimated basement age of late Eocene (~40 Ma), gives an average deposition rate through the whole sediment column of 17.5 m/m.y. The nearest DSDP site (552) has a hiatus, however, spanning most of the interval from the late Miocene (about 10 Ma) to the Eocene. It may thus be inadvisable to apply an average sedimentation rate to this section; the upper Neogene rates are probably higher than the lower Neogene and Paleogene.

The principal objectives at Site 609 were paleoenvironmental. Site 609 lies along the boundary between the modern subpolar and subtropical gyres and in the middle of the region of largest glacial–interglacial climatic change during the late Quaternary (Bramlette and Bradley, 1941; McIntyre et al., 1976; Ruddiman and McIntyre, 1976, 1984). Interglacial oozes alternate with glacial ice-rafted sediments. Sea-surface temperature (SST) variations in the late Quaternary reached amplitudes of 12°C or more (Sancetta et al., 1973). The rhythm of SST change showed a combination of the 23,000-yr. cycle typical of lower latitudes, the stronger 41,000-yr. cycle characteristic of polar-front movements at the higher mid-latitudes, and the 100,000-yr. cycle prominent in both areas. The primary objective at Site 609 was thus to trace these rhythmic changes back into the late Neogene. Ancillary objectives were (1) to determine the history of deep-water flow on the basis of biotic and isotopic evidence; (2) to provide a detailed sequence of magnetic transitions, for both the primary paleomagnetic stratigraphy and the details of polarity transitions; and (3) to recover long sequences for stable isotope studies and to identify the history of late Neogene ice rafting.

OPERATIONS

After leaving Site 608, we headed north-northwest to a turning point at 50°00.00′N, 24°17′W (Fig. 1). We turned at 1533[3] on 20 July to a course of 270°, toward a second turning point at 50°01′N, 24°33′W. We then turned to a course of 125° and proceeded directly toward Site 609. We passed over the site and dropped a beacon at 1647 hr. We retrieved the underway geophysi-

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[3] All times are local (ship's time).

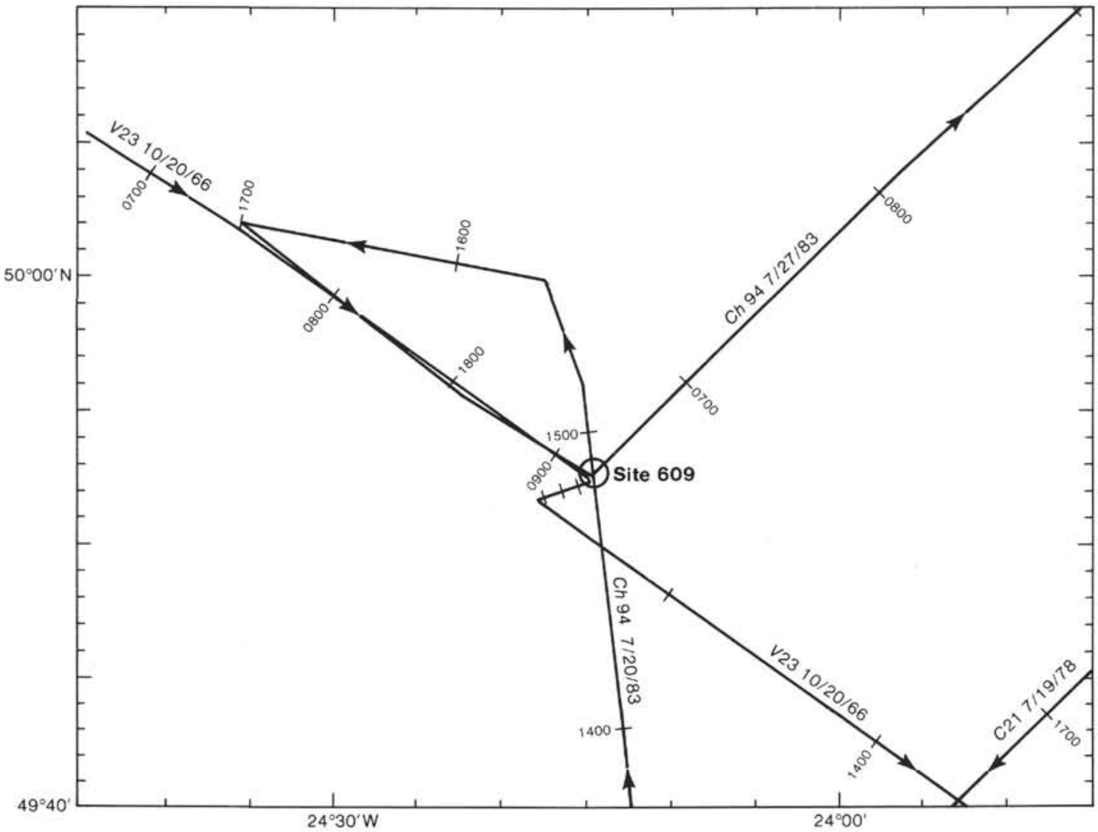

Figure 1. Track lines in the vicinity of Site 609; all times are local.

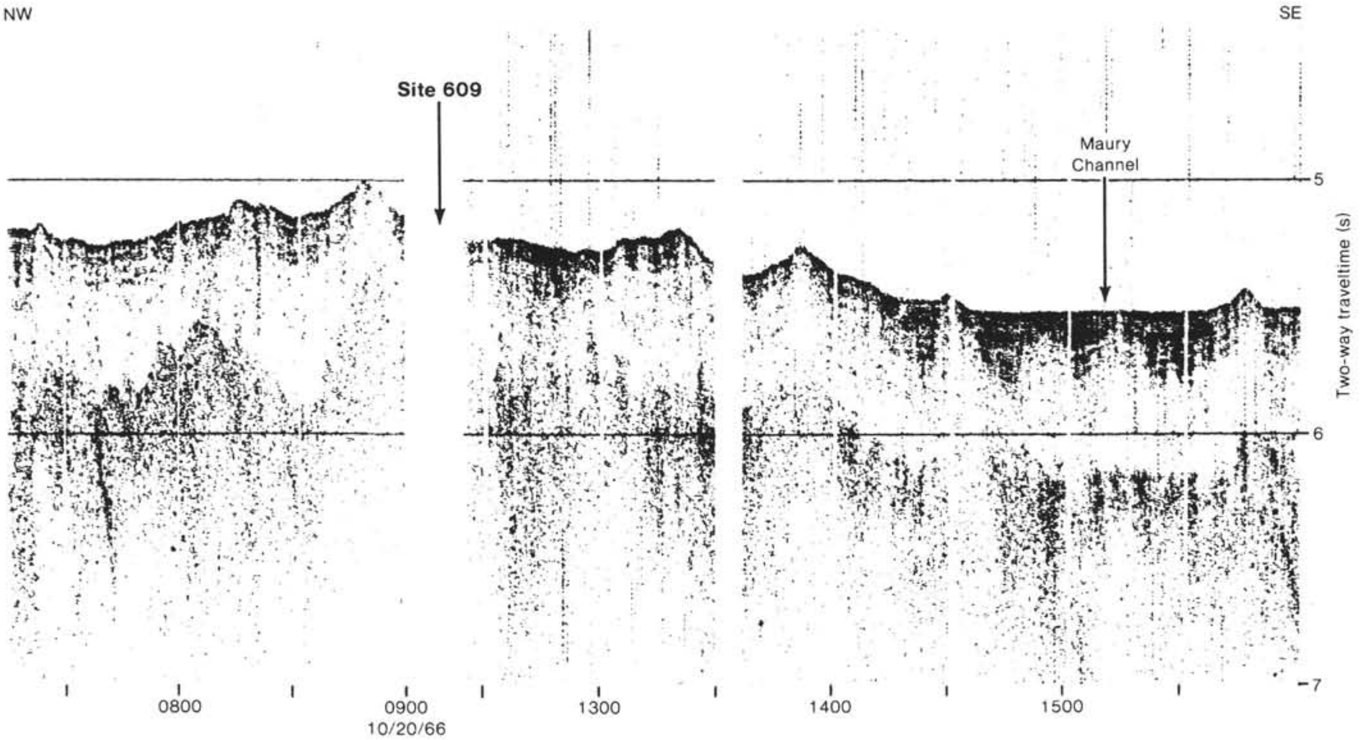

Figure 2. *Vema* 23 air-gun records across Site 609. Note increased reflectivity associated with Maury Channel to the southeast.

cal gear and returned to the beacon at 1815 hr. At 1815 hr., we began running in Hole 609, finishing at 0115 hr., 21 July. We spudded in at 0215 hr., and the first VLHPC core from Hole 609 came on deck at 0325 hr. We cored continuously with the VLHPC until Core 609-14, which registered a 40,000-lbf. over-pull at 130.6 m sub-bottom. We washed over the core barrel and brought Core 609-14 on board at 2045 hr. on 21 July. We then XCB-cored to a total depth of 399.4 m sub-bottom, go-deviling the XCBs for Cores 609-15 through 609-22 and then using the wire line. Core recovery was good through Core 609-17, mostly bad through Core 609-25, and then good again until the last core (609-42), except for Cores 609-31 through -33 (Table 1).

The reasons for the poor recovery at Site 609 varied. No liner was installed for Core 609-18, and we retrieved a short core that had to be extruded on deck. On Core 609-31, the Acker shoe jammed. Several cores had shattered or split liners. Core 609-23 may not have touched bottom. Many cores had glacial pebbles at their tops, especially at depths where we had passed beyond the glacial-age strata. Basically, the low recovery is attributable to (1) glacial pebbles falling down the outside of the drill string and armoring the top of the next core, (2) moderately heavy swell during some parts of the coring operation, and (3) the general difficulty in coring the transition zone between soft sediments and semi-indurated sediments. The last XCB core came on deck at 1351 hr. on 23 July, after which we pulled out of the hole and cleared the mudline at 1430 hr.

We then offset 200 ft. to the northwest of the beacon and attempted to take a mudline core to begin the next hole. After two unsuccessful attempts (in which we recovered full cores containing sediments that should have been about 20 m sub-bottom), we became concerned that this was an area of disturbed surface sediments. We discarded these and repositioned over the beacon. We spudded in for Hole 609A and retrieved Cores 609A-1 and 609A-2 at 2105 and 2230 hr. on 23 July. Again the stratigraphy indicated roughly a 30-m sub-bottom depth, suggesting that the bit was buried in the mud. We then asked the drilling crew to count the on-board drill string pipe, and they found that they had left an extra stand (28.8 m) in the line after pulling out of Hole 609, thus explaining our troubles in getting mudline cores at this hole. We pulled the extra stand of pipe out of Hole 609A from 2230 hr. and cleared the mudline at 2240 hr. on 23 July.

We spudded in for Hole 609B at 2345 hr. and brought back a valid mudline core at 0020 hr. on 24 July, thus ending our misery on Hole 609A. We cored continuously with the VLHPC until Core 609B-14 registered 40,000 lbf. over-pull and was washed over. Core 609B-14 came on deck at 1746 hr. on 24 July. We then cored continuously with the XCB to a sub-bottom depth of 354.7 m, reached with Core 609B-38, which was brought on board at 0020 hr. on 26 July. Recovery from Hole 609B was uniformly very good with the VLHPC and generally good with the XCB, but again certain intervals proved difficult. In this case, we had poor recovery in Cores 609B-16 and -18 and Cores 609B-33 and -37. With few exceptions, the intervals of poor recovery in Hole 609B did

Table 1. Coring summary, Site 609.

Core	Date (July, 1983)	Time (hr.)	Depth from drillfloor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Recovery (%)
			Top Bottom	Top Bottom			
Hole 609							
1	21	0325	3883.6-3890.6	0.0-7.0	7.0	6.98	99.7
2	21	0445	3890.6-3900.2	7.0-16.6	9.6	9.73	101.1
3	21	0550	3900.2-3909.8	16.6-26.2	9.6	9.21	95.9
4	21	0715	3909.8-3919.4	26.2-35.8	9.6	8.18	85.2
5	21	0820	3919.4-3929.0	35.8-45.4	9.6	8.89	92.7
6	21	0940	3929.0-3938.6	45.4-55.0	9.6	9.71	101.1
7	21	1120	3938.6-3948.2	55.0-64.6	9.6	9.25	96.4
8	21	1230	3948.2-3957.8	64.6-74.2	9.6	9.32	97.1
9	21	1351	3957.8-3967.4	74.2-83.8	9.6	8.91	92.9
10	21	1510	3967.4-3977.0	83.8-93.4	9.6	8.84	92.1
11	21	1635	3977.0-3986.6	93.4-103.0	9.6	8.04	83.8
12	21	1752	3986.6-3996.2	103.0-112.6	9.6	8.41	87.8
13	21	1915	3996.2-4005.8	112.6-122.2	9.6	8.55	89.1
14	21	2045	4005.8-4014.2	122.2-130.6	8.4	8.34	99.3
15	21	2252	4014.2-4023.8	130.6-140.2	9.6	9.68	100.8
16	22	0030	4023.8-4033.4	140.2-149.8	9.6	9.31	96.9
17	22	0224	4033.4-4043.0	149.8-159.4	9.6	9.80	102.8
18	22	0415	4043.0-4052.6	159.4-169.0	9.6	1.99	20.7[a]
19	22	0600	4052.6-4062.6	169.0-178.6	9.6	3.32	34.6
20	22	0713	4062.2-4071.8	178.6-188.2	9.6	9.58	99.8
21	22	0843	4071.8-4081.4	188.2-197.8	9.6	0.00	0.0
22	22	1026	4081.4-4091.0	197.8-207.4	9.6	2.29	23.9
23	22	1145	4091.0-4100.6	207.4-217.0	9.6	0.0	0.0
24	22	1315	4100.6-4110.2	217.0-226.6	9.6	4.97	51.8
25	22	1430	4110.2-4119.8	226.6-236.2	9.6	0.00	0.0
26	22	1545	4119.8-4129.4	236.2-245.8	9.6	9.57	99.7
27	22	1701	4129.4-4139.0	245.8-255.4	9.6	5.82	60.6
28	22	1820	4139.0-4148.6	255.4-265.0	9.6	9.59	99.9
29	22	1945	4148.6-4158.2	265.0-274.6	9.6	8.80	91.7
30	22	2105	4158.2-4167.8	274.6-284.2	9.6	9.21	95.9
31	22	2228	4167.8-4177.4	284.2-293.8	9.6	2.21	23.0
32	22	2350	4177.4-4187.0	293.8-303.4	9.6	0.15	1.6
33	23	0110	4187.0-4196.6	303.4-313.0	9.6	0.60	0.2
34	23	0230	4196.6-4206.2	313.0-322.6	9.6	9.24	96.2
35	23	0355	4206.2-4215.8	322.6-332.2	9.6	9.75	101.6
36	23	0500	4215.8-4225.4	332.2-341.8	9.6	9.02	94.0
37	23	0615	4225.4-4235.0	341.8-351.4	9.6	9.77	101.8
38	23	0730	4235.0-4244.6	351.4-361.0	9.6	8.33	86.8
39	23	0900	4244.6-4254.2	361.0-370.6	9.6	8.31	86.6
40	23	1027	4254.2-4263.8	370.6-380.2	9.6	9.26	96.5
41	23	1151	4263.8-4273.4	380.2-389.8	9.6	9.38	97.7
42	23	1315	4273.4-4283.0	389.8-399.4	9.6	8.93	93.5
					399.4	301.24	75
Hole 609A							
1	23	2105	3906.8-3916.4	23.8-33.4[b]	9.6	9.23	96.1
2	23	2230	3916.4-3926.0	33.4-43.0[b]	9.6	8.66	90.2
					19.2	17.89	93
Hole 609B							
1	24	0020	3883.0-3886.6	0.0-3.6	3.6	3.55	98.6
2	24	0145	3886.6-3896.2	3.6-13.2	9.6	9.43	98.2
3	24	0301	3896.2-3905.8	13.2-22.8	9.6	8.96	93.3
4	24	0440	3905.8-3915.4	22.8-32.4	9.6	9.49	98.8
5	24	0545	3915.4-3925.0	32.4-42.0	9.6	9.45	98.4
6	24	0702	3925.0-3934.6	42.0-51.6	9.6	8.09	84.3
7	24	0825	3934.6-3944.2	51.6-61.2	9.6	8.82	91.9
8	24	0947	3944.2-3953.8	61.2-70.8	9.6	8.83	92.0
9	24	1059	3953.8-3963.4	70.8-80.4	9.6	9.30	96.9
10	24	1217	3963.4-3973.0	80.4-90.0	9.6	8.48	88.3
11	24	1332	3973.0-3982.6	90.0-99.6	9.6	8.71	90.7
12	24	1445	3982.6-3992.2	99.6-109.2	9.6	8.99	93.7
13	24	1630	3992.2-4001.8	109.2-118.8	9.6	9.45	98.4
14	24	1746	4001.8-4011.4	118.8-128.4	9.6	9.35	97.4
15	24	1858	4011.4-4016.9	128.4-133.9	5.5	4.31	78.4
16	24	2015	4016.9-4026.5	133.9-143.5	9.6	0.11	1.1
17	24	2141	4026.5-4036.1	143.5-153.1	9.6	8.62	89.8
18	24	2300	4036.1-4045.7	153.1-162.7	9.6	0.00	0.0
19	25	0030	4045.7-4055.3	162.7-172.3	9.6	9.81	102.2
20	25	0212	4055.3-4064.9	172.3-181.9	9.6	6.50	67.7
21	25	0330	4064.9-4074.5	181.9-191.5	9.6	9.85	102.6
22	25	0455	4074.5-4084.1	191.5-201.1	9.6	9.60	100.0
23	25	0612	4084.1-4093.7	201.1-210.7	9.6	9.79	102.0
24	25	0745	4093.7-4103.3	210.7-220.3	9.6	9.59	99.9
25	25	0847	4103.3-4112.9	220.3-229.9	9.6	9.80	102.1
26	25	1005	4112.9-4122.5	229.9-239.5	9.6	9.58	99.8
27	25	1135	4122.5-4132.1	239.5-249.1	9.6	9.92	103.3
28	25	1240	4132.1-4141.7	249.1-258.7	9.6	9.27	96.6
29	25	1400	4141.7-4151.3	258.7-268.3	9.6	9.64	100.4
30	25	1512	4151.3-4160.9	268.3-277.9	9.6	8.79	91.6
31	25	1634	4160.9-4170.5	277.9-287.5	9.6	9.69	100.9
32	25	1752	4170.5-4180.1	287.5-297.1	9.6	9.37	97.6
33	25	1915	4180.1-4189.7	297.1-306.7	9.6	5.54	57.7
34	25	2040	4189.7-4199.3	306.7-316.3	9.6	8.99	93.6
35	25	2225	4199.3-4208.9	316.3-325.9	9.6	9.83	102.4
36	25	2354	4208.9-4218.5	325.9-335.5	9.6	9.40	97.9
37	26	0125	4218.5-4228.1	335.5-345.1	9.6	0.40	4.2
38	26	0300	4228.1-4237.7	345.1-354.7	9.6	9.10	94.8
					354.70	308.40	87

Table 1 (continued).

Core	Date (July, 1983)	Time (hr.)	Depth from drillfloor (m)		Depth below seafloor (m)		Length cored (m)	Length recovered (m)	Recovery (%)
			Top	Bottom	Top	Bottom			
Hole 609C									
1	26	0845	4006.2-4015.8		123.2-132.8		9.6	6.5	67.7
2	26	1005	4015.8-4025.4		132.8-142.4		9.6	7.83	76.9
3	26	1122	4025.4-4035.0		142.4-152.0		9.6	0.00	0.0
4	26	1248	4035.0-4044.6		152.0-161.6		9.6	9.21	96.0
5	26	1403	4044.6-4054.2		161.6-171.2		9.6	5.85	60.9
6	26	1520	4054.2-4063.8		171.2-180.8		9.6	1.23	12.8
7	26	1814	4063.8-4073.4		180.8-190.4		9.6	4.78	49.8
							67.2	34.95	52

[a] No liner was installed; core had to be extruded on deck.
[b] Core shot one stand too low; see text for explanation.

not match those in Hole 609, thus emphasizing the apparent randomness of whatever factors explain the generally poor recovery at Site 609 between 140 and 350 m sub-bottom depth. We began pulling out of Hole 609B at 0300 hr. and cleared the mudline at 0430 hr. on 26 July.

From 0430 to 0530 hr., we offset 100 ft. to begin Hole 609C, and spudded in at 0545 hr. on 26 July. We washed down to the top of our objective at 125 m sub-bottom from 0545 to 0730 hr. and began XCB coring to recover an interval that had been irregularly recovered in both Hole 609 and Hole 609B. Recovery from Hole 609C was fair to poor, except for one good core (609C-4). One possibility is that heave of the ship caused tension in the wire line and unlatching of the XCB. To adjust for this, we began go-deviling the XCBs on Core 609C-5. Although there was no shattering of liners, recovery remained low through Core 609C-7, at which point we decided to terminate the hole and abandon the site. We pulled out of Hole 609C from 1814 hr. on 26 July until 0245 hr. on 27 July, and got underway from Site 609 at 0305 hr.

We ran briefly to the west-southwest to stream the geophysical gear, turned and came back across the site at 0418 hr., and then proceeded to the east-northeast toward Site 610.

In general, the weather was a more important factor at Site 609 than it had been at the first three sites. Although no storms passed over the site location, the swell was often larger than at previous sites. This appears to have contributed to the lower recovery and especially to the significant increase in contorted sections in the HPC cores, suggesting that low-pressure centers hundreds of kilometers away may significantly constrain HPC coring on the *Glomar Challenger* (see also Ruddiman et al., this volume).

SEDIMENT LITHOLOGY

Site 609 lies on the eastern flank of the Mid-Atlantic Ridge at 49°52.7′N, 24°14.3′W, at a water depth of 3884 m. Four holes were drilled. Holes 609 (0–399.4 m) and 609B (0–354.7 m) yielded long, continuously cored sections. Hole 609C was cored from 123.2 to 190.4 m to fill in poorly recovered intervals; Hole 609A is represented by only two cores near the mudline, also to fill gaps in the record.

The sediment column of Site 609 (Fig. 3) can be divided into two major units.

Unit I: Alternating cycles of calcareous ooze and calcareous mud.

Unit II: Nannofossil oozes and chalks. Unit II can be further divided into three subunits (IIA–IIC), as discussed shortly.

Lithologic Description

Unit I (0–171 m sub-bottom, Quaternary–upper Pliocene; ±2.45 Ma)

Unit I consists of Quaternary and upper Pliocene interbedded calcareous muds, marly nannofossil oozes, and nannofossil oozes, and includes the upper 171 m of Holes 609 and 609B. Muddy intervals are olive gray and contain up to about 15% sand. The clay and silt fraction is made up of quartz, feldspar, and clay minerals. Minor constituents include heavy minerals, volcanic glass, and shell fragments. Dropstones (some faceted and striated) were found throughout the entire sequence.

The carbonate is made up of nannofossils and foraminifers, and varies between 80% for the lightest-colored oozes and about 2% for very dark gray, ash-bearing muds. Pure oozes with less than 10% terrigenous detritus are not present.

Indistinct layering and gradational lithologic contacts are typical, and result in numerous intermediate compositions. This seems to be due to intensive bioturbation and the lack of strong bottom-current activity.

Unit II (171 m–399.4 m sub-bottom; Pliocene–upper Miocene)

Unit II differs from Unit I in the following ways: (1) loss of high-frequency color changes caused by cyclic terrigenous input; (2) higher carbonate percentages and lighter color; and (3) lack of dropstones.

Subunit IIA (171–240 m sub-bottom; Pliocene)

Subunit IIA consists of marly nannofossil ooze, light gray with some gradational color changes to pale olive green. Grayish green streaks and bands are common. This subunit grades down section from carbonate percentages of 40 to 50% in the darker sections to about 90% in the white, lower portions. Several oscillations in color (and presumably in carbonate content) occur, but these are more gradual, less frequent, and much less distinct than the marked glacial-climate cycles of Unit I.

Subunit IIB (240–320 m sub-bottom; lower Pliocene)

Sub-unit IIB consists of white, very pure chalky nannofossil ooze with a carbonate content of about 90%. Green laminations and dark gray mottles are common.

Subunit IIC (320–399.4 m sub-bottom; upper Miocene)

Subunit IIC consists of nannofossil chalk, mostly very light gray to white with gradational changes to greenish gray. Well-preserved burrows (Zoophycos) with variably colored halos are present throughout the subunit.

The upper part of the subunit was strongly disturbed by drilling. Drilling deformation may easily be mistaken for slump structures and soft-sediment deformation. Some

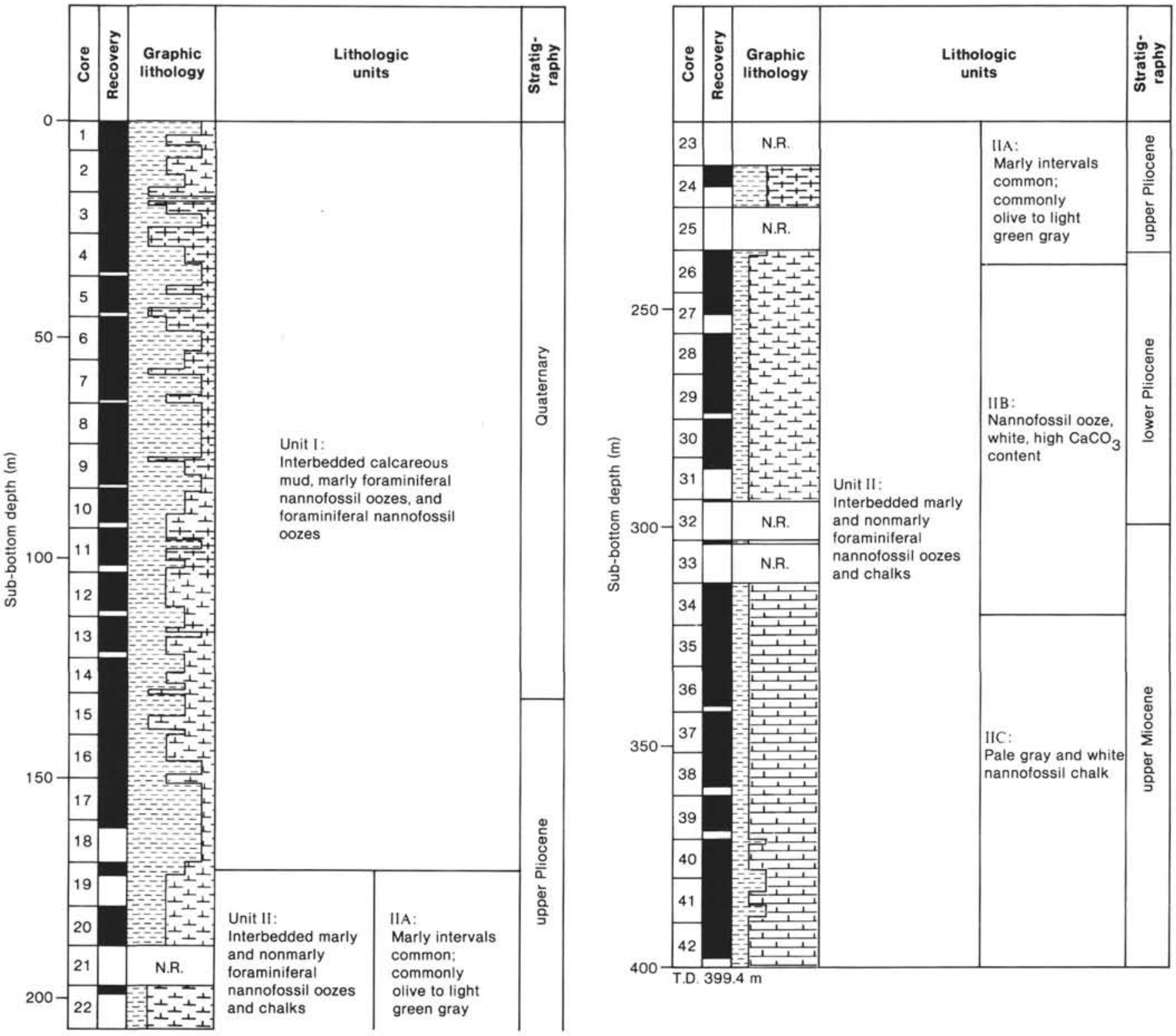

Figure 3. Recovery and lithologic units recognized at Hole 609. (N.R. = not recovered).

oxidized faults in Section 609-40-1 indicate tectonic deformation. The lower part of the unit has increasing interlayers of greenish gray marly nannofossil chalk with carbonate percentages of less than 60%.

PHYSICAL PROPERTIES

The physical properties measured on samples from Site 609 are shown in Figure 4. The measured values of dry water content, wet water content, porosity, and void ratio (Fig. 4A–4D) decrease with depth. The 135% dry water content (Fig. 4A) at the sediment surface decreases rapidly to 90% at about 50 m sub-bottom. From 50 m down to 190 m, the dry water content decreases roughly linearly to 85%. There are no data from 190 to 235 m sub-bottom. Below 240 m, dry water content values average about 50% but decrease at a very slow rate. Wet water content (Fig. 4B) shows the same trend. The large drop in dry water content from 90% at 180 m to 50% at 250 m is probably due to a drop in clay content.

Measured values for porosity (Fig, 4C) are between 65 and 80% for the top 190 m of sediment. Below the data gap from 190 to 235 m, porosity decreases gradually from 60% at 240 m to 55% at 300 m.

Surface sediments have a void ratio (Fig. 4D) of more than 3.5, which drops to about 2.8 at 50 m depth. The void ratio then decreases at a very slow rate to 2.5 at 190 m. Below the data gap from 190 to 235 m, void ratio values average about 1.3 but slowly decrease down to 300 m.

Grain density values (Fig. 4E) average about 0.2 g/cm^3 more than at the previous site; measured values fall between 2.6 and 2.8 g/cm^3.

Wet-bulk density (Fig. 4F) is about 1.5 g/cm^3 for the first 190 m; it then increases linearly from 1.7 g/cm^3 at 240 m to 1.8 g/cm^3 at 300 m.

Measured values for sonic velocity (Fig. 4G) increase linearly with depth from 1.50 km/s at the sediment surface to 1.64 km/s at about 300 m depth in the sediment.

The rate of increase is higher for deeper sediments. The measured sonic velocity at 400 m depth is 1.8 km/s (Fig. 4G).

Shear strength increases with depth, and the major shift toward lower values is observed after the change from VLHPC to XCB coring at 130 m sub-bottom (Fig. 4H).

SEISMIC STRATIGRAPHY

Figure 5 illustrates a portion of the shipboard water-gun seismic profile collected during the approach to Site 609. The central part of the figure is an expanded version of the acoustic section indicated at the left. Three acoustic units (A, B, C) have been identified, and the relevant parts of this acoustic section are matched to the lithology of the site (lithologic Units I and II).

Basement at Site 609 lies beyond the lower limit of the figure (expanded section) at approximately 6.2 s two-way traveltime. It is visible in most of the record shown at the left in Figure 5, then plunges sharply at about 1840 hr., just before Site 609. The total acoustic thickness of sediments above basement is about 1.0 s.

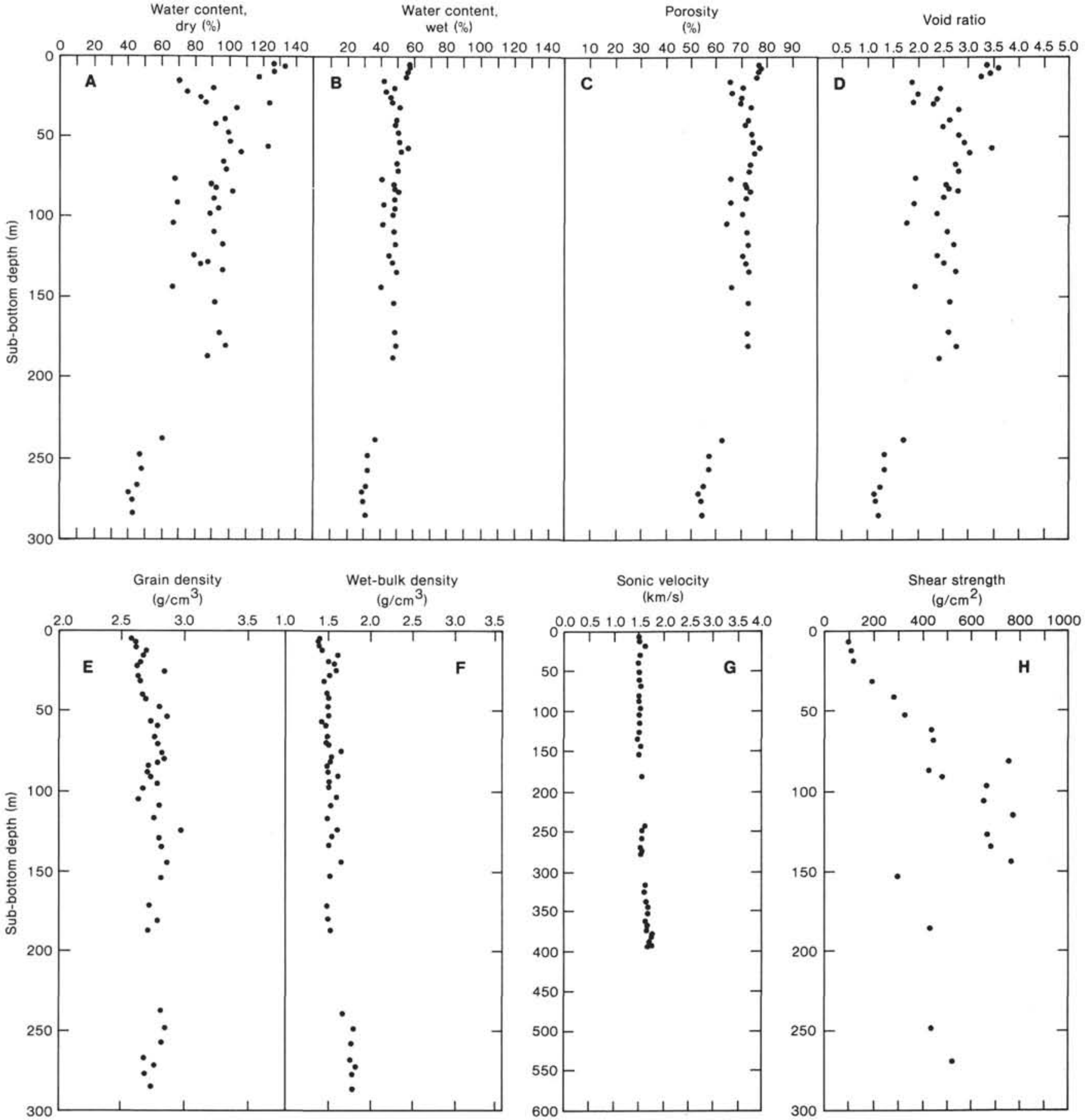

Figure 4. A-H. Physical properties at Site 609.

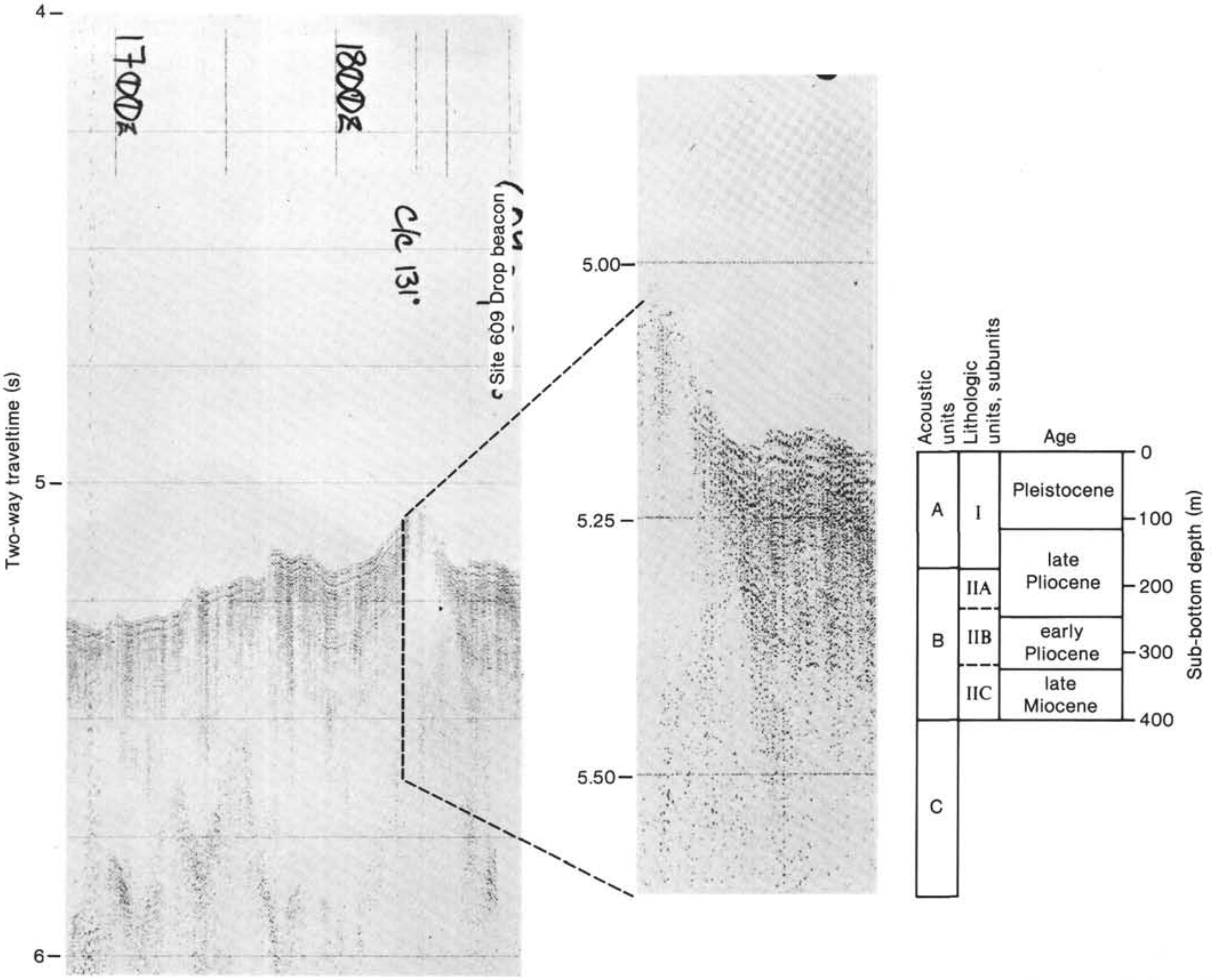

Figure 5. Comparison of acoustic units (A, B, C) with lithologic units (I, II) cored at Site 609. For the shipboard water-gun seismic profile collected during approach to the site, depths in meters are estimated using a seismic velocity of 1.55 km/s.

The seismic section can be divided into three acoustic units (Fig. 5). The upper unit (A) consists of acoustically reverberant reflectors with a slightly wavy form that blend together in a complex pattern. This unit extends from the sediment surface to 0.10 s sub-bottom. The middle unit (B) is similar to A, but it shows somewhat less concentrated, and apparently less reflective, layering that extends from 0.10 to 0.23 s sub-bottom. The lowermost unit (C) is relatively transparent, with scattered returns but no coherent reflectors.

Hole 609 penetrated to a total depth of 399.4 m. At the measured average seismic velocity of 1.55 km/s, this would equate to a depth of 0.31 s sub-bottom in the acoustic record, which is equivalent to the boundary between acoustic Units B and C.

Lithologic Unit I (Pleistocene and upper Pliocene cycles of calcareous ooze and calcareous mud) correlates very closely with acoustic Unit A, suggesting that the $CaCO_3$ variations (and/or numerous dropstones) enhanced the reflectivity of the upper sediments.

Neither lithologic Subunits IIA (marly upper Pliocene nannofossil oozes), IIB (chalky lower Pliocene nannofossil oozes), nor IIC (upper Miocene nannofossil chalks) equates clearly with the acoustic units chosen, except for the upper contact of lithologic Unit II, mentioned previously.

BIOSTRATIGRAPHY

All major microfossil groups occur in the sediment sections recovered from each of the four holes at Site 609, and calcareous nannofossils and foraminifers form the major component of the sediments. Microplankton and nannoplankton assemblages are generally well preserved (Fig. 6)[4].

All sediments recovered yielded abundant coccoliths and discoasters in good to moderate states of preservation and moderate to high diversity. A complete sequence

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[4] For an updated version of the biostratigraphic summary, see Baldauf et al., (this volume).

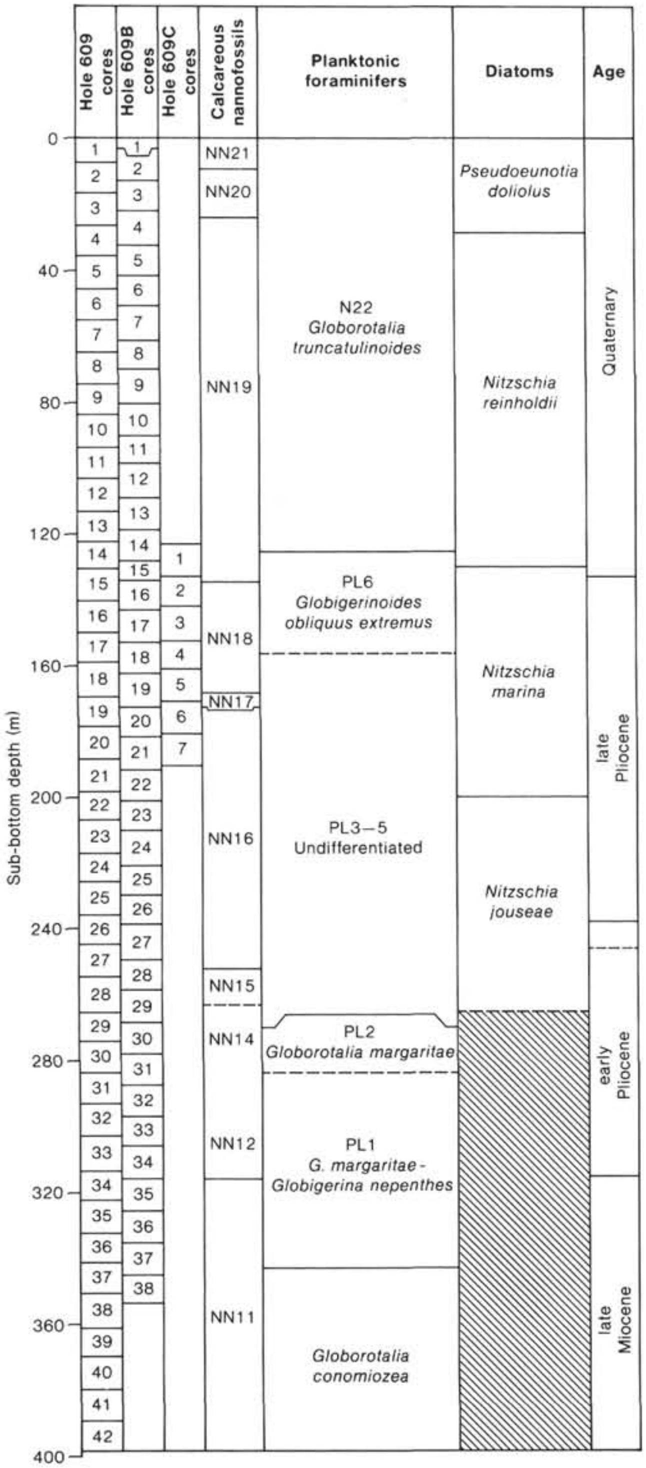

Figure 6. Biostratigraphic summary, Site 609 (for an updated version, see Baldauf et al., this volume). Dashed lines in planktonic foraminifers column indicates the base of Zone PL3–5 in Hole 609B; Zone PL2 is not recognized in this hole. In the Age column, the dashed line indicates basal boundary of the late Pliocene in Hole 609B. Hachures in the Diatoms column indicate that samples are barren or contain rare non-age-diagnostic fragments.

was recognized, from the late Pleistocene *Emiliania huxleyi* Zone (NN21) to the late Miocene *Discoaster quinqueramus* Zone (NN11). Among the calcareous nannofossil zones, however, the distinction between the *Discoaster asymmetricus* Zone (NN14), the *Ceratolithus rugosus* Zone (NN13), and the *Amaurolithus tricorniculatus* Zone (NN12) is uncertain. The bottom of Hole 609 may be placed in the middle of NN11 and approximately dated at 6.9 Ma on the basis of the discoaster assemblage present. The Pliocene/Pleistocene boundary is placed between Samples 609-14,CC and 609-15,CC; between 609B-15,CC and 609B-16,CC; and between 609C-1,CC and 609C-2,CC, on the basis of the last appearance datums (LADs) of discoasters.

Planktonic foraminifers are abundant to 270 m sub-bottom, below which they vary from abundant to rare. Preservation is generally excellent through the Quaternary and good to moderate through the Pliocene. The assemblage is characterized by temperate species throughout. Warm-water species are rare or absent and cold-water species are common, particularly in the Quaternary sediments. Although *Globorotalia truncatulinoides* is very rare in samples from the lower Quaternary, it can still be used to define the base of Zone N22. The last appearance of *Globorotalia margaritae* was earlier here than at sites to the south, so the last occurrence of this species does not define the lower/upper Pliocene boundary.

Benthic foraminifers generally constitute less than 1% of the total foraminiferal faunas. They are relatively numerous, however, in the sequence below Sample 609-30,CC. In general, benthic foraminifers are more abundant in light-colored sediments than in the dark terrigenous sediments. Their state of preservation is excellent in the upper 200 m of the cored interval, and poor below Core 609-30. The species diversity is fairly low, but seems slightly higher below the top of the Gauss. An upsection decrease in abundance of *Nuttallides umbonifera* was found at the level dated about 3.0 Ma.

Rare to abundant, moderately preserved to well preserved diatoms are found in the lower Pliocene to Quaternary sediments. The assemblage is characterized by warm-temperate species with occasional occurrences of cool-temperate forms. The *Pseudoeunotia doliolus, Nitzschia reinholdii, Nitzschia marina*, and *Nitzschia jouseae* zones are recognized at Site 609.

Calcareous Nannofossils

All sediments recovered at Site 609, where four holes were drilled, yielded abundant calcareous nannofossils of moderate to high diversity in good to moderate states of preservation. An almost complete sequence was identified, from the late Pleistocene NN21 *Emiliania huxleyi* Zone to the late Miocene NN11 *Discoaster quinqueramus* Zone. Because of discontinuous occurrences of some marker species, however, the zonal boundaries were difficult to establish in the upper Miocene to lower Pliocene sequences.

Samples 609-1,CC and 609B-1,CC are assigned to the NN21 *Emiliania huxleyi* Zone. *Emiliania huxleyi* and gephyrocapsids are dominant. *Coccolithus pelagicus, Calcidiscus leptoporus, Discolithina japonica, Helicosphaera carteri*, and *Syracosphaera* sp. are frequent. In Samples 609-2,CC, 609B-2,CC and 609B-3,CC very abundant *Gephyrocapsa caribbeanica* occurs together with *G. oceanica, Coccolithus pelagicus, Calcidiscus leptoporus, Helicosphaera carteri*, and *Syracosphaera* sp. On the basis of the absence of *Emiliania huxleyi* and *Pseudoemiliania lacunosa* in this assemblage, these samples are assigned to the NN20 *Gephyrocapsa oceanica* Zone. Samples 609-3,CC through 609-14,CC and 609B-4,CC through 609B-15,CC contain abundant *Pseudoemiliania lacunosa* and no discoasters; this places these intervals in the NN19 *Pseudoemiliania lacunosa* Zone. Among these samples, 609-13,CC and 609B-13,CC have no *Gephyrocapsa oceanica*, and 609-14,CC, 609B-14,CC, 609B-15,CC, and 609-1,CC contain no gephyrocapsids. The former two belong to Bukry's (1973) CN13b *Gephyrocapsa caribbeanica* Subzone and the latter four to the CN13a *Emiliania annula* Subzone. Therefore these samples are assigned to the earliest Pleistocene. *Helicosphaera sellii* is present as high as Samples 609-9,CC and 609B-9,CC, and *Calcidiscus macintyrei* occurs as high as Samples 609-12,CC and 609B-12,CC. The occurrence of *Reticulofenestra pseudoumbilica* in this zone is regarded as due to reworking.

The Pliocene/Pleistocene boundary is placed between Samples 609-14,CC and 609-15,CC, between 609B-15,CC and 609B-16,CC, and between 609C-1,CC and 609C-2,CC. Below this boundary, the nannoflora progressively changes; discoasters increase in abundance. The assemblage in Samples 609-15,CC through 609-19,CC, 609B-16,CC through 609B-18,CC, and 609C-2,CC through 609C-4,CC is characterized by the occurrences of *Coccolithus pelagicus, Calcidiscus leptoporus, C. macintyrei, Discolithina japonica, D. multipora, Helicosphaera carteri, H. sellii, Pseudoemiliania lacunosa*, and *Syracosphaera* sp., together with a few *Discoaster brouweri*; this assemblage places these samples in the upper Pliocene NN18 *Discoaster brouweri* Zone. The presence of *Discoaster brouweri* and *D. pentaradiatus* together in Sample 609C-5,CC places that sample in the NN17 *Discoaster pentaradiatus* Zone. This zone is not recognized in Holes 609 and 609B. Samples 609-20,CC through 609-26,CC, 609B-19,CC through 609B-27,CC, and 609C-6,CC through 609C-7,CC contain comparatively diversified discoaster species such as *Discoaster brouweri, D. pentaradiatus, D. surculus, D. asymmetricus*, and *D. tamalis*. Therefore, these samples belong to the upper Pliocene NN16 *Discoaster surculus* Zone. Sporadic occurrences of *Reticulofenestra* cf. *R. pseudoumbilica* are recognized throughout this interval. Typical *R. pseudoumbilica* was, however, first found in Samples 609-27,CC and 609B-28,CC, together with *Coccolithus pelagicus, Calcidiscus leptoporus, C. macintyrei, Helicosphaera granulata, Discoaster brouweri*, and *D. asymmetricus*. Thus these samples are assigned to the NN15 *Reticulofenestra pseudoumbilica* Zone. *Sphenolithus abies* already occurs in Sample 609-26,CC, slightly above the extinction level of *Reticulofenestra pseudoumbilica*. The underlying Samples 609-28,CC and 609B-29,CC contain *Amaurolithus tricorniculatus*. Therefore these samples belong to the NN14 *Discoaster asymmetricus* Zone. In both holes, the distinction between the *Discoaster asymmetricus* Zone (NN14), the *Ceratolithus rugosus* Zone (NN13), and the *Amaurolithus tricorniculatus* Zone (NN12) is uncertain. In Hole 609B, however, the boundary between NN13 and NN12 seems to be between Samples 609B-32,CC and 609B-33,CC because *Ceratolithus rugosus* occurs down through Sample 609B-32,CC. Samples from 609-34,CC and from 609B-34,CC down to the bottom of Holes 609 and 609B are assigned to the upper Miocene NN11 *Discoaster quinqueramus* Zone because of the presence of the nominate species, *D. quinqueramus*. The assemblage in these samples consists mainly of *Discoaster quinqueramus, D. berggrenii, D. brouweri, D. challengeri, D. intercalaris, D. variabilis, Reticulofenestra pseudoumbilica, Coccolithus pelagicus, Calcidiscus leptoporus, C. macintyrei, Helicosphaera granulata, Sphenolithus abies*, and *S, moriformis*. The stratigraphic distributions of *Discoaster surculus* and *D. pentaradiatus* are limited to the upper half and the uppermost part of this zone, respectively. The deepest sample obtained from Hole 609 (Sample 609-42,CC) contains a more diversified discoaster assemblage. *Discoaster loeblichii, D. neohamatus*, and *D. neorectus* place this sample in the middle part of NN11.

Mazzei et al. (1979) show that *Discoaster hamatus* has its last occurrence near the bottom of the normal-polarity interval of magnetic Epoch 7. Therefore the absolute age of the bottom sediments of Hole 609 approximates 6.9 Ma.

Planktonic Foraminifers

Samples from the Quaternary and upper Pliocene at this site contain abundant, well-preserved planktonic foraminifers. In the lower Pliocene and upper Miocene, specimens vary from abundant to rare; they are particularly rare in the lowest parts of the section. Preservation varies from good to moderate in these samples; broken specimens indicate dissolution at some levels. Sample 609-41,CC contains a nearly monospecific assemblage dominated by *Globorotalia sphericomiozea*, possibly as a result of dissolution or transport.

The fauna is composed of mid-latitude to temperate species throughout. The warm-water species such as *Globigerinoides sacculifer* are virtually absent at this site, and species such as *Globigerinoides ruber* and *Globigerinoides obliquus* are also rare. Conversely, the cold-water species *Neogloboquadrina pachyderma* (sinistrally coiled) is common in the Quaternary at Site 609. Samples were analyzed from oxygen isotope stages 5 and 6 (as established by nannofossil stratigraphy) of Hole 609B to determine extremes of climate change. In the lowermost part of stage 5 (stage 5e), a relatively warm-water assemblage was found containing common *Globorotalia inflata* and *Globorotalia truncatulinoides* and no *N. pachyderma* (s). Other samples from oxygen isotope stage 5, represented by Samples 609B-2-3, 60–64 cm and 609B-2-3, 102–107 cm (probably substages 5c and 5d, respectively), contain faunas similar to the faunas in stage 5e, but with the addition of rare *N. pachyderma* (s), suggesting slightly cooler water. Sample 609-2-4, 18–23 cm was taken from the middle of stage 6 and Sample 609B-2-3, 135–137 cm was taken at the top of stage 6. Both samples were dominated by *N. pachyderma* (s); there were very rare occurrences of other species in the upper stage 6 sample and common to rare *Globigerina bulloides* and *Globigerina quinqueloba* in the mid-stage 6 sample. The area has thus fluctuated from intermediate/subpolar conditions during interglacials to polar glacial conditions.

Globorotalia truncatulinoides occurs rarely at this site and only in the warmer intervals. Enough specimens can be found, however, to define the *G. truncatulinoides* Zone with the first occurrence of the nominate species in Cores 609-14 and 609B-14. This zone contains common *G. bulloides, G. glutinata, G. quinqueloba, N. pachyderma* (d), and *G. inflata; N. pachyderma* (s) dominates the cold intervals. Sample 609B-8,CC is completely dominated by glacial debris, and contains no foraminifers.

Globigerinoides obliquus is very rare at this site and *Globorotalia miocenica* does not occur at all. Thus it is difficult to define Zone PL6. At Site 607, however, the evolutionary transition from *Globorotalia puncticulata* to *G. inflata* took place at approximately the PL6/PL5 zonal boundary. This transition occurs at Site 609 in Cores 609-17 and 609B-18 or 609B-19 (Core 609B-18 was lost as a result of coring problems). The transition is used here to distinguish PL6 and PL5. The fauna of Zone PL6 is very similar to that of the Quaternary, but without sinistrally coiled specimens of *N. pachyderma*. The sinistral form of this species (typically encrusted, with indistinct chambers) first occurs close to the first occurrence of *G. truncatulinoides* (Huddlestun, 1985).

The absence of *Dentoglobigerina* and *Sphaeroidinellopsis seminulina* prevents a subdivision of Zones PL3, PL4, and PL5, which are therefore treated as one unit. The subtropical/temperate zonation of Berggren (1973; 1977) is still used, even though some zones are difficult to identify, because the temperate zonation of Poore and Berggren (1975) has been found not to be applicable to the Leg 94 sites (see Weaver, this volume, for an alternative informal zonation). The fauna of Zone PL3-5 is dominated by *Globorotalia puncticulata, G. crassaformis, Globigerina bulloides*, and neogloboquadrinids (*N. atlantica* and *N. pachyderma*). Specimens of *Globorotalia* cf. *G. pliozea* can be found near the base of this zone. The extinction of *Globorotalia margaritae* marks the base of the zone and occurs in Cores 609-29 and 609B-31.

Zone PL2 (the interval of *G. margaritae* above the extinction of *Globigerina nepenthes*) was found in Sample 609-29,CC, but has not been identified in Hole 609B and so may therefore lie between Samples 609B-30,CC and -31,CC. This zone is therefore very short at this site, and comparison of the range of *G. margaritae* with the paleomagnetic data shows that this is due to an early disappearance of *G. margaritae. G. puncticulata* and *G. crassaformis*, which both appear within Zone PL2 at Sites 607 and 608, here occur first at the base of interval PL3-5.

The first occurrence of *G. margaritae* is in Cores 609-37 and (probably) 609B-37. This is taken as the base of Zone PL1, as at Site 608, although *G. margaritae* is very rare in the lower part of its range. *Globigerina nepenthes* is also very rare throughout this zone, which is dominated by *N. pachyderma*, with *G. bulloides* and *N. atlantica* (sinistral) common in some samples. In the lower part of this zone, the coiling direction of *N. pachyderma* is dominantly sinistral.

Below Zone P11, rare specimens of *Globorotalia* cf. *conomiozea* can be found in Samples 609-37,CC and 609-39,CC. This may suggest the *G. conomiozea* Zone, but the specimens are not typical and are too rare to define a zone accurately. Sample 609-41,CC contains almost exclusively whole and broken specimens of *G. sphericomiozea*, which may indicate dissolution of all the other species or sorting during transport. Samples down to 609-40,CC contain sinistrally coiled *N. atlantica*; Sample 609-42,CC contains dominantly dextral forms. This change in coiling direction therefore occurred much earlier than suggested by Berggren (1972) or Poore (1979).

Benthic Foraminifers

A list of the samples used to study benthic foraminifers is given in Table 2. Benthic foraminifers generally constitute less than 1% of the total foraminiferal fauna in the fraction >63 μm. In samples from 609-30,CC downward, however, benthic foraminifers are relatively numerous and may be only slightly less numerous than planktonic foraminifers in the fraction >150 μm. The benthic as well as the planktonic fauna in these deeper samples consists of small specimens. Generally the dark sediments (with a relatively large terrigenous component) contain fewer benthic foraminifers than the light-colored sediments. This may in part result from dilution by the terrigenous component, which, in the fraction >63 μm, consists of lithic fragments, mineral fragments, volcanic glass (weathered and fresh), and rounded quartz grains with frosted surfaces. All samples except two contain sufficient specimens for counts of 200 individuals. Sample 609-4,CC contained 151 specimens; Sample 609B-2-3, 135-137 cm contained 137 individuals.

The preservation is excellent in the upper 200 m of the cored interval. The mud-line sample contains the aragonitic species *Hoeglundina elegans* and several extremely fragile agglutinated species (*Marsipella elongata, Rhizammina* spp., *Cystammina galeata*). Preservation varies from good to moderate in the lower part of the cored interval. Samples below 609-30,CC generally contain broken and overgrown specimens, and the easily damaged miliolid species are rare in this interval.

The diversity is generally fairly low for deep-sea benthic faunas (between 14 and 39 species at a count of 100, between 14 and 50 species at a count of 200). The lowest values are found in dark brown sediments (Samples 609-4,CC and 609B-2-3, 135-137 cm), but several dark brown samples show diversities as high as light-colored samples (e.g., 609-6,CC and 609B-2-4, 18-23 cm). The diversity tends to be slightly higher below about 170 m sub-bottom, that is, roughly below the top of the Gauss (2.47 Ma).

Table 2. Samples used for the study of benthic foraminifers, Site 609 (intervals in cm).

609B-2-3, 60-64	609-1-1, 0-2	609-11,CC	609-24,CC
609B-2-3, 102-107	609-1,CC	609-12,CC	609-25,CC
609B-2-3, 121-128	609-4,CC	609-16,CC	609-26,CC
609B-2-3, 135-137	609-6,CC	609-20,CC	609-30,CC
609B-2-4, 18-23	609-8,CC	609-22,CC	609-34,CC
		609-38,CC	609-42,CC

The relative abundances of the most common species and species groups show strong fluctuations, similar to those observed at the earlier sites (606–608). At Site 609, *Epistominella exigua, Eilohedra weddellensis, Uvigerina peregrina*, and the biserial group (*Bolivina translucens, Francesita advena, Stainforthia complanata*) vary strongly in relative abundance. The mud-line sample contains an *E. exigua* fauna, the expected Recent fauna in the area (Schnitker, 1974). The sample contains more agglutinated species than were found at the earlier drilled sites of Leg 94.

Nuttallides umbonifera, now abundant in Antarctic Bottom Water in the Atlantic Ocean (Schnitker, 1974), is consistently present below Sample 609-20,CC; the species is common (about 10%) from Sample 609-24,CC down (about 3 Ma). *Ehrenbergina trigona* is present only below Sample 609-26,CC. In conclusion, the benthic fauna becomes gradually somewhat less diverse upsection, and several species that are consistently present in the lower part of the section disappear above Sample 609-26,CC. The inferred changes in bottom-water circulation apparently occurred earlier at Site 609 than at Sites 606 through 608.

At Site 609, as at the earlier sites, there is no obvious correlation between the lithology and the benthic foraminiferal fauna. The faunal composition varies strongly from one lithology to another, but no consistent pattern can be derived. Although the lowest diversity always occurs in dark sediments, some dark layers have highly diverse faunas. No specific assemblage typifies a specific lithology, but some samples from extremely dark muds (609B-2-3, 135–137 cm) contain abundant *E. exigua* (more than 75%). Although not all light-colored sediments contain abundant *Uvigerina*, all observed peaks of this genus occur in white ooze, and no *Uvigerina* peaks were found in dark sediments. The *Uvigerina*-rich samples in section 609B-2-3 contain planktonic faunas typical of warm periods. Therefore, the correlation between high abundance of *Uvigerina* and glacial periods, as described by Streeter and Shackleton (1979), seems not to be universally valid.

Diatoms

Rare to abundant diatoms occur in lower Pliocene to Quaternary sediments recovered from Site 609. Generally, samples examined contain a common, well-preserved diatom assemblage. This assemblage is characterized by warm-temperate species such as *Pseudoeunotia doliolus, Coscinodiscus nodulifer, C. nodulifer* var. *cyclopsis, Hemidiscus cuneiformis*, and the *Thalassiosira convexa* group. In addition to this warm-temperate assemblage, occasional samples also contain cold-temperate species such as *Denticulopsis seminae, D. seminae* var. *fossilis, Rhizosolenia barboi, R. curvirostris, Thalassiosira nidulus*, and *Actinocyclus oculatus*.

The *Pseudoeunotia doliolus* Zone of Burckle (1977) is assigned to Samples 609-1,CC through 609-3,CC and 609B-1,CC through 609B-2,CC. The first occurrence of *P. doliolus*, which defines the base of the *Nitzschia reinholdii* Zone, occurs between Samples 609-14,CC and 609-15-3, 43–45 cm and between 609B-14,CC and 609B-15,CC. Samples 609-4-1, 43–45 cm through 609-14,CC and 609B-4,CC through 609B-14,CC are therefore assigned to the *N. reinholdii* Zone.

Cool-temperate species were found within the examined Quaternary samples from 609-6-1, 43–45 cm through 609-9-3, 43–45 cm and from 609B-6,CC through 609B-7,CC. Species observed include *Rhizosolenia barboi, Denticulopsis seminae*, and *D. seminae* var. *fossilis*. These species are also present at Leg 94 Sites 607, 610 (Hole 610A), and 611, and at Leg 81 Site 552 (Hole 552A) (Baldauf, 1985). They are commonly associated with sediments deposited during the Jaramillo Subchron.

The *Nitzschia marina* Zone of Baldauf (1985) is assigned to the intervals from Sample 609-15-3, 43–45 cm through Sample 609-24,CC and also from 609B-16,CC through Sample 609B-24,CC. Samples 609-25,CC through 609-29,CC and 609B-25,CC through 609B-29,CC are assigned to the *Nitzschia jouseae* zone of Baldauf (1985) on the basis of the occurrence of *Nitzschia jouseae*. Owing to generally poor sample preservation, however, *N. jouseae* does not occur in all samples examined within these intervals. Examined samples stratigraphically below 609-25,CC and 609-29,CC are barren of diatoms.

Two additional holes were drilled at Site 609. The two cores recovered from Hole 609A are assigned to the *N. reinholdii* Zone of Burckle (1977) on the basis of the occurrence together of *P. doliolus* and *Nitzschia reinholdii*.

Seven cores were recovered from Hole 609C. Core 609C-1 contains only a few moderately preserved, stratigraphically useful specimens; this sample is therefore not zoned. Sample 609C-2,CC contains rare fragments, and Core 609C-3 had no recovery. The remaining samples examined from Hole 609C (609C-4 through 609C-7) are assigned to the upper Pliocene *Nitzschia marina* Zone of Baldauf (1985).

Radiolarians

Radiolarians are present in the upper Pliocene to Pleistocene sediments of Site 609. To date, only samples from Hole 609 have been examined. Samples alternate between very well preserved, diverse assemblages including phaeodarians, and poorly preserved assemblages with only a few robust, deep-living forms. Some samples are entirely barren of siliceous fossils, and many of the assemblages are diluted with terrigenous components. Samples with abundant, well-preserved assemblages can be found down to Sample 609-15,CC. Below that level and down through Section 609-23-3, radiolarians are rare and poorly preserved, and sediments below Core 609-26 are barren of siliceous fossils (Table 3).

Most of the forms found in Hole 609 are long-ranging species, but *Amphirhopalum ypsilon, Theocorythium trachelium*, and *T. vetulum*, which are characteristic of Pliocene to Pleistocene assemblages, are present in many of the samples from above Core 609-15. The last occurrence of *Stylatractus universus* is difficult to place, because there are very few radiolarians in samples from Core 609-3, but this event must fall between Samples 609-2,CC and 609-4-3, 40–42 cm.

Table 3. Preservation and abundance of radiolarians in Hole 609.

Sample (core-section, interval in cm)	Abundance[a]	Preservation[b]
1-3, 40–42	R	M
1,CC	A	G
2-3, 40–42	F	M
2,CC	A	G
3-3, 40–42	R	M
3,CC	R	G
4-3, 40–42	F	M
4,CC	B	
5-3, 40–42	C	G
5,CC	F	P
6-2, 40–42	C	G
6,CC	C	M
7-3, 40–42	F	G
7,CC	C	G
8-4, 40–42	C	G
9-4, 40–42	B	
10-3, 40–42	C	G
10,CC	F	G
11-2, 40–42	C	G
11,CC	C	G
12-3, 40–42	A	G
12,CC	F	G
13-3, 40–42	B	
13,CC	F	G
14-4, 40–42	F	G
14,CC	C	G
15-4, 40–42	C	G
15,CC	C	G
16-3, 40–42	B	
16,CC	R	P
17-3, 40–42	R	P
17,CC	R	M
20-3, 40–42	R	P
24-3, 40–42	R	P
27-3, 40-42	B	
28-4, 40–42	B	
29-3, 40–42	B	
30-3, 40–42	B	

[a] Abundance: A = >10,000 specimens/slide; C = 5000–10,000 specimens/slide; F = 1000–5000 specimens/slide; R = <1000 specimens/slide; B = barren.

[b] Preservation: G = good; M = moderate; P = poor.

PALEOMAGNETISM

Hole 609

Over 300 m of core was recovered from Hole 609 that was suitable for paleomagnetic study. A sampling interval of one sample per core section (1.5 m) was maintained throughout the hole. Samples were taken using plastic boxes (7 cm^3), except when the sediment became too stiff and a drill press was required to obtain samples.

Progressive alternating-field (AF) demagnetization studies, based on pilot samples taken throughout the hole, revealed that treatment at 10 mT was sufficient to remove unstable components, isolating stable, univectorial magnetizations. Initial results seem to indicate that sediment in reversed-polarity zones immediately beneath normal-polarity zones is more likely to have acquired a normal overprint than sediment farther downsection. Otherwise, no consistent secondary magnetizations were observed in these sediments.

The inclinations exhibit an excellent, high-resolution record of the polarity reversal history for the last 3.5 m.y. (see Clement and Kent, this volume). The depths of the polarity boundaries are given in Table 4. The exceptional quality of the data, combined with the high sedimentation rates, allows the identification of three very short normal-polarity subchronozones in the Matuyama Chronozone, in addition to the longer Jaramillo and Olduvai Subchronozones. The credibility of these very short subchronozones is enhanced by their existence in the polarity record from Hole 609B. The normal subchronozone observed 10 m below the base of the Jaramillo may be a record of the Cobb Mountain Subchron, which has been recognized in K-Ar-dated lavas on land as well as in deep-sea sediment cored at Site 502. A very short normal subchronozone occurs approximately 16 m above the top of the Olduvai. Another normal subchronozone occurs 12 m below the base of the Olduvai Subchronozone; it probably correlates with the Reunion Subchron.

Poor recovery below 160 m makes correlation with the time scale more difficult, although the Gauss, Gilbert, and Chron 5 Chronozones have been correlated as

Table 4. Depths of reversal boundaries, Site 609.

Reversal		Age (Ma)	Samples (core-section, cm level)	Sub-bottom depth (m)[a]
Hole 609				
Brunhes		0.73	5-5, 98/5-6, 98	42.79/44.29
Jaramillo	(top)	0.91	7-1, 98/7-2, 98	55.99/57.49
	(bottom)	0.98	7-6, 98/8-1, 98	63.49/65.59
Cobb Mtn.	(top)		9-1, 20/9-1, 98	74.41/75.19
	(bottom)		9-2, 18/9-2, 98	75.89/76.69
	(top)		12-1, 20/12-1, 98	103.21/103.99
	(bottom)		12-1, 98/12-2, 20	103.99/104.71
Olduvai	(top)	1.66	13-4, 98/13-5, 98	118.09/119.59
	(bottom)	1.88	15-1, 80/15-2, 98	131.41/133.09
Reunion	(top)		16-4, 20/16-4, 98	144.91/145.69
	(bottom)		16-5, 20/16-5, 98	146.41/147.19
Matuyama/Gauss		2.47	19-2, 68/19-2, 135	171.19/171.86
Kaena	(bottom)	2.99	24-1, 98/24-2, 138	217.89/219.89
Gauss/Gilbert		3.40	26-2, 100/26-3, 100	238.71/240.21
Cochiti	(top)	3.88	28-1, 98/28-2, 98	256.39/257.89
	(bottom)	3.97	28-4, 116/28-5, 116	261.07/262.57
Nunivak	(top)	4.10	28-6, 110/29-1, 98	264.60/265.99
	(bottom)	4.24	29-5, 96/29-6, 96	271.97/273.47
C1	(top)	4.40	30-2, 94/30-3, 114	277.05/278.75
	(bottom)	4.47	30-5, 126/30-6, 72	281.87/282.83
Chron 5	(top)	5.35	35-6, 80/36-1, 87	330.91/333.08
C5, N1	(bottom)	5.54	36-4, 75/36-5, 97	337.46/339.18
C5, N2	(top)	5.68	37-3, 112/37-4, 119	345.93/347.50
Hole 609B				
Brunhes		0.73	6-1, 38/6-1, 98	42.39/42.99
Jaramillo	(top)	0.91	7-4, 60/7-4 110	56.97/57.19
	(bottom)	0.98	8-2, 48/8-2, 98	63.19/63.69
Cobb. Mtn.	(top)		9-2, 98/9-3, 80	73.29/74.61
	(bottom)		9-3, 98/9-4, 98	74.79/76.29
	(top)		12-2, 98/12-3, 98	102.09/103.59
	(bottom)		12-3, 98/12-4, 98	103.59/105.09
Olduvai	(top)	1.66	13-6, 98/14-1, 98	117.69/119.79
Reunion	(bottom)		17-1, 98/17-1, 146	144.49/146.47
Matuyama/Gauss		2.47	19-5, 98/19-6, 98	169.69/171.19
Kaena	(top)	2.92	23-6, 98/24-1, 98	209.59/211.69
	(bottom)	2.99	24-4, 98/24-5, 106	216.19/217.77
Mammoth	(top)	3.08	25-5, 102/25-6, 103	227.33/228.84
	(bottom)	3.18	26-4, 110/26-5, 111	235.51/237.02
Gauss/Gilbert		3.40	27-5, 108/27-6, 108	246.59/248.09
C2	(top)	4.57	32-1, 129/32-2, 106	288.80/290.07
Chron 5	(top)	5.35	36-3, 78/36-4, 81	329.69/331.22
C5, N2	(top)	5.68	38-1, 76/38-2, 33	345.87/346.94
Hole 609C				
Olduvai	(bottom)	1.88	1-4, 98/2-1, 98	128.69/133.79
Reunion	(top)		2-4, 98/2-5, 90	138.29/139.71

[a] Midpoint depths of samples in third column.

indicated in Table 4. As at the previous sites, extremely low magnetic intensities complicate the polarity interpretations through the Gilbert Chronozone (below Core 609-27).

Hole 609A

Paleomagnetic samples were taken at a sampling interval of one per 1.5 m from the two cores obtained from Hole 609A. The samples were AF demagnetized at 10 mT. The consistently normal polarity directions, along with the shallow depth of penetration, indicate that these cores lie completely within the Brunhes Chronozone.

Hole 609B

Paleomagnetic samples were measured from over 308 m of section at this hole. The same procedures were used here as at the two previous holes. Again, the high sedimentation rates provided an excellent record of the polarity reversal history for the last 3.5 m.y. The depths of the polarity boundaries are given in Table 4. The agreement between the results obtained from Holes 609 and 609B are exceptional down to the base of the Gauss. As discussed in the forgoing report on Hole 609, three short normal-polarity subchronozones are observed within the Matuyama Chronozone. A normal subchronozone, correlated with the Cobb Mountain Subchron, occurs 10 m below the base of Jaramillo, and a very short normal interval occurs 15 m above the top of the Olduvai. Recovery of Core 609B-16 was very poor, but this interval is thought to contain the base of the Olduvai and the top of the Reunion, judging by correlation with the results obtained from Hole 609. If this entire interval were to be correlated with the Olduvai Subchron, a marked change in sedimentation rate would be indicated, and, more important, a discrepancy with the biostratigraphy would result, because the Pliocene/Pleistocene boundary is placed within Core 609B-16. For these reasons, it does not seem likely that the Olduvai Subchronozone is this long in this hole; instead, it appears that the normal-polarity interval observed in the top of Core 609B-17 correlates with the Reunion Subchron.

The improved recovery lower in Hole 609B resulted in a complete record of the Gauss Chronozone. Below Core 609B-28, however, recovery problems made correlation of the results of the magnetic polarity time scale difficult, although this interval appears to be within the Gilbert Chron. The occurrence, below 330 m, of two normal-polarity intervals that may be correlated with the normals in the same intervals in Hole 609, suggests the possibility of correlating these with Chron 5. Recovery and noise in the magnetic data (resulting from extremely low intensities) make this a tenuous correlation, however.

Hole 609C

The same procedures were followed at Hole 609C as at the previous holes at this site. Drilling disturbance and poor recovery in general made it impossible to sample a complete section from this hole, so correlation with the polarity time scale is difficult. The depths of polarity boundaries are given in Table 4. Correlation with results obtained for Holes 609 and 609A suggests that the normal interval observed from 123 to 131 m may be a record of the lower part of the Olduvai Subchronozone, and that the normal interval observed 9 m farther downcore may correlate with the Reunion Subchronozone (see Clement and Robinson, this volume).

SEDIMENTATION RATES

Sedimentation rates at Site 609 were generally very high. Within the almost 7 m.y. of record, several discrete intervals of varying deposition rate can be discerned (Fig. 7, Table 5).

The sedimentation rates down to 170 m (2.45 Ma) vary only slightly around a mean of 69 m/m.y. This rate thus characterizes an interval precisely equivalent to lithologic Unit I (representing the North Atlantic glacial cycles of the Pleistocene and late Pliocene). There is, however, evidence of a somewhat slower rate of deposition (~ 55 m/m.y.) in the upper 44 m, deposited during the Brunhes Chron, and then a somewhat faster rate (75 m/m.y.) down to the top of the Gauss Chron (2.47 Ma).

From 170 to 235 m (2.47–3.2 Ma), the accumulation rate increases to about 89 m/m.y. This interval approximately lithologic Subunit IIA (upper Pliocene marly nannofossil ooze).

Table 5. Datum levels used to construct Figure 7 (time scale after Berggren et al., in press).

Number	Datum level	Age (Ma)
1	Top of *Emiliania huxleyi*	0.28
2	Top of *Pseudoemiliania lacunosa*	0.47
3	Top of *Nitzschia reinholdii*	0.65
4	Matuyama/Brunhes	0.73
5	Top of Jaramillo	0.91
6	Bottom of Jaramillo	0.98
7	Top of *Helicosphaera sellii*	1.37
8	Top of *Calcidiscus macintyrei*	1.45
9	Top of Olduvai	1.66
10	Bottom of *Globorotalia truncatulinoides*	1.78
11	Bottom of *Pseudoeunotia doliolus*	1.80
12	Bottom of Olduvai	1.88
13	Top of discoasters	1.90
14	Bottom of *Globorotalia inflata* (Zone PL6)	2.20
15	Top of *Discoaster pentaradiatus*	2.40
16	Top of Gauss	2.47
17	Bottom of Mammoth	3.15
18	Top of *Globorotalia margaritae*	3.40
19	Gilbert/Gauss	3.40
20	Top of *Reticulofenestra pseudoumbilica*	3.50
21	Top of *Amaurolithus tricorniculatus*	3.70
22	Top of Cochiti	3.88
23	Top of *Globigerina nepenthes*	3.90
24	Bottom of Cochiti	3.97
25	Top of Nunivak	4.10
26	Bottom of Nunivak	4.24
27	Top of C1	4.40
28	Bottom of C1	4.47
29	Bottom of *Globorotalia margaritae*	5.30
30	Top of Chron 5	5.35
31	Bottom of Chron 5, N1	5.50
32	Top of *Discoaster quinqueramus*	5.60
33	Top of Chron 5, N2	5.70
B1	Top of Gauss	2.47
B2	Top of Kaena	2.92
B3	Bottom of Kaena	2.99
B4	Top of Mammoth	3.08
B5	Bottom of Mammoth	3.18
B6	Gauss/Gilbert	3.40
B7	Top of C2	4.57
B8	Top of Chron 5	5.35
B9	Top of Chron 5, N2	5.70

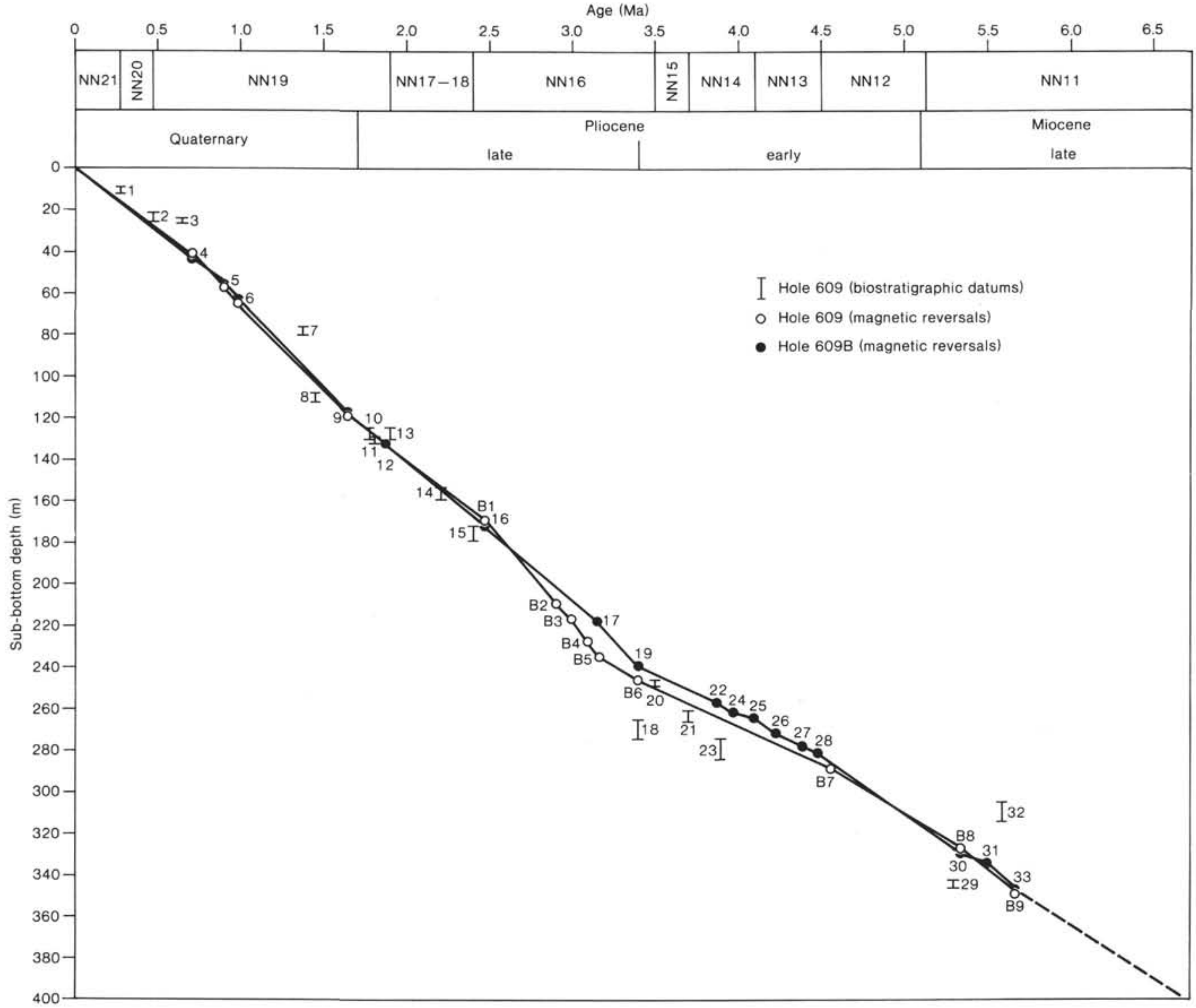

Figure 7. Time-versus-depth plot of cores taken in Holes 609 and 609B, with nannofossil zones shown at the top. The datum levels used to construct the sedimentation rate curve are given in Table 5.

From 235 to 280 m (3.2–4.5 Ma), the rate of sedimentation drops to 32 m/m.y. in the nannofossil oozes at the top of lithologic Subunit IIB. This is followed downsection by an interval from 280 to 348 m (4.5–5.7 Ma) with an average sedimentation rate of roughly 56 m/m.y. in the increasingly indurated nannofossil oozes of Subunits IIB and IIC. No reliable datums exist below 348 m; however, the extrapolated age of the base of Hole 609 is 6.9 Ma.

The time-depth plot shown in Figure 7 was based on 33 datum levels, of which greatest reliance was placed on 17 clearly recorded paleomagnetic reversals in a record of unusual quality.

GEOCHEMISTRY

Carbonate Bomb

The $CaCO_3$ content of Site 609 sediments (Fig. 8) shows considerable variation in the top 180 m, ranging from less than 5% to 80%. Below 180 m, the sediments become more calcareous, and $CaCO_3$ values reach as high as 95%. Below 330 m, the $CaCO_3$ content begins to decrease again, fluctuating between 56 and 95%. $CaCO_3$ values at 30-cm intervals through the upper 250 m of record are reported by Ruddiman et al. (this volume).

Interstitial Water

Analyses of pH, alkalinity, and salinity were performed on board, using samples from Holes 609, 609B, and 609C. All three properties show trends similar to those at other Leg 94 sites in the top 260 m (Fig. 9). Below 260 m, pH increases and the alkalinity decreases relatively sharply. Salinity shows a marked increase at 320 m.

SUMMARY AND CONCLUSIONS

Site 609 is on the upper-middle eastern flank of the Mid-Atlantic Ridge at 49°52.7′N, 24°14.3′W, at a water depth of 3884 m. It was chosen to provide an extend-

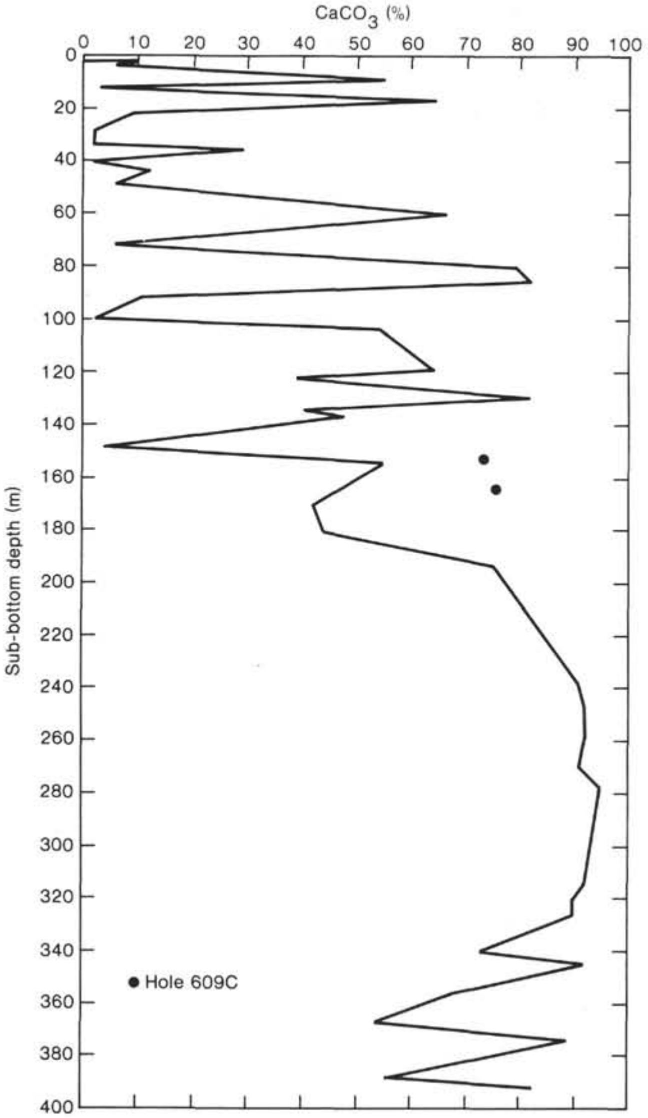

Figure 8. $CaCO_3$ content (from carbonate bomb analyses) plotted versus depth for Holes 609 and 609C.

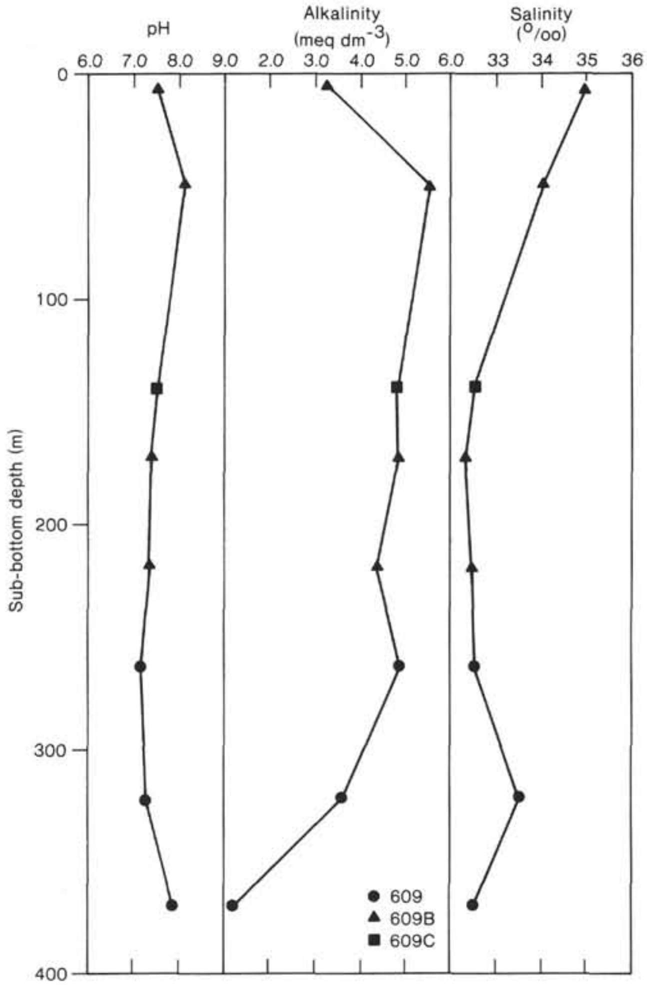

Figure 9. Interstitial water analyses (pH, alkalinity, and salinity) for Site 609.

ed late Neogene paleoclimatic record in the part of the North Atlantic showing the largest glacial-interglacial climatic changes during the late Quaternary. In this region, sea-surface temperature changes exceeded those anywhere else in the world ocean. The deposition rate of ice-rafted detritus during glaciations also exceeded that in any other open-ocean area in the world. As at several previously drilled Leg 94 sites, shipboard conclusions at Site 609 are for the most part limited to an assessment of our success in obtaining a continuous pelagic sequence useful for detailed paleoclimatic studies in years to come.

We obtained long continuous sediment sections from two holes (609, 609B), a shorter sequence from Hole 609C, and two cores just below the mudline from Hole 609A. Hole 609 was HPC-cored to 130.6 m (1.9 Ma) and then XCB-cored to 399.4 m (6.9 Ma). Hole 609B was HPC-cored to 128.4 m (1.8 Ma) and then XCB-cored to 354.7 m (5.7 Ma). Hole 609C was XCB-cored from 123.2 m (1.75 Ma) to 190.4 m (2.7 Ma). Recovery averaged 75% in Hole 609, 87% in Hole 609B, and 52% in Hole 609C.

For the first time on Leg 94, coring disturbances became a major problem in portions of these holes. Contorted layering occurs to a depth of 0.1 to 1.0 m in the tops of most HPC cores; some were entirely contorted. Recovery was especially low in the interval from 130 to 200 m, with many cores entirely lost. These disturbances appear to be related to ship motion and to sediment composition. Although the weather at the site was never bad, considerable incoming swell from storms in other areas induced significant pitching of the ship (3–5° at times). Watery sediments in the upper 50 m, and stiffer but unlithified sediments between 130 and 200 m, may have also been contributing factors in the deformation. At this and a number of the other Leg 94 sites, glacial erratics that dropped down the holes added to the poor recovery in some cores.

Demonstrating that we have obtained 100% continuity of section in the VLHPC and upper XCB levels of these holes is considerably more difficult than at the previous sites, but paleomagnetic and visual tie-lines between holes (see Ruddiman et al., this volume) suggest continuity to at least 130 m (1.8 Ma), probably to 160 m

(2.2 Ma), and possibly to the bottom of the glacial cycles at 171 m (2.47 Ma). Below 171 m, the lack of lithologic tie-lines makes it impossible to check for continuity through the rest of the double-cored interval to 355 m (5.7 Ma).

There are two major lithologic units at Site 609. The first unit (Unit I) spans the upper 171 m and consists of alternating nannofossil oozes, nannofossil marls, and nannofossil muds. The dramatic and distinctive changes from one to another of these sediment types mark the glacial $CaCO_3$ cycles of the Pleistocene and upper Pliocene. As at Site 608, the earliest cycles occur just above the top of the Gauss Magnetic Epoch at 2.47 Ma. Calcium carbonate percentages in this unit vary widely, from 80% to less than 5%. The noncarbonate fraction is clay and silty clay with a wide range of composition, including mostly continent-derived minerals (quartz and feldspar) but also a minor component of "oceanic" basalt and volcanogenic detritus. This lithologic unit is for the most part explained by alternations of glacial polar waters, containing icebergs carrying rock debris, with interglacial temperate waters, yielding biogenic sediments above this site. These alternations began on a large scale at about 2.47 Ma in the North Atlantic.

Unit II extends from 171 m to the total depth of 399.4 m and consists of nannofossil oozes and chalks, (basically pelagic biogenic oozes).

Subunit IIA extends from 171 to 240 m and is differentiated from the underlying nannofossil ooze by its higher content of noncalcareous mud (see Ruddiman et al., this volume). Variations from lighter to darker units occur, but on a far more subdued scale than in the dramatic glacial cycles. This subunit extends in time from 2.47 to 3.4 Ma. The closest Leg 94 sites (608, 610) show no such muddy ooze just beneath the glacial cycles, but rather a very pure carbonate ooze. This indicates a relatively local origin for the detrital muds in Subunit IIA.

One possible explanation involves a Maury Channel source. The Channel passes some 35 km east-southeast of this site at a depth some 225 m greater than Site 609. Downslope flow through this Channel has carried volcanogenic detritus thousands of kilometers southward from sources on Iceland (Ruddiman, 1972; Davies and Laughton, 1972). Drilling farther north at Site 115 (Leg 12) recovered hard Pleistocene volcanic sandstones adjacent to the Channel (Laughton, Berggren, et al., 1972). This suggested that major downslope transport in Maury Channel is largely a late Pliocene to Pleistocene phenomenon and began somewhere in an age range estimated by extrapolation to be 1 to 3 Ma (Laughton, Berggren, et al., 1972). However, glaciation on Iceland is known from at least 3.1 Ma (McDougal and Wensink, 1966), at least 700,000 yr. earlier than the more massive Northern Hemisphere glaciation that produced the North Atlantic glacial cycles beginning at 2.47 Ma.

We suggest that a first significant increase in downslope detrital redeposition in Maury Channel began in the lower Gauss at roughly 3.4 to 3.1 Ma, possibly coincident with the first local glaciations on Iceland. Downslope deposition was presumably enhanced by glacial erosion, by volcanic eruptions under and into ice ("Jøkulhlaups"), and possibly by small drops in eustatic sea level. This contributed a significant component of detrital mud not seen at North Atlantic sites beyond the local effects of Maury Channel.

Then, with more massive Northern Hemisphere glaciation at and after 2.47 Ma, the repeated glaciations of Iceland and more substantial drops in eustatic sea level probably sent even larger volumes of volcanogenic sediment down the Channel, but these were overwhelmed at sites like 609 by the even more dramatic $CaCO_3$ layering produced by the glacial cycles.

This explanation of Subunit IIA is supported by the enhanced reflectivity observed around Site 609. The Maury Channel axis is a very distinctive impenetrable feature in seismic records (Fig. 2), but these profiles also show a distinct region of slightly increased reflectivity in sediments several tens of kilometers away from the main axis and at water depths 200 to 300 m shallower. This is probably the region affected by overbank deposition of clays and fine silts from downslope events in the main channel. (For an additional explanation of $CaCO_3$ trend in Subunit IIA, see Ruddiman et al., this volume.)

Subunit IIB is a carbonate-rich nannofossil ooze extending from 240 to 320 m, at which point increasing induration has turned the ooze into the nannofossil chalk of Subunit IIC. The nannofossil chalk then extends to the total depth of 399.4 m; deformation structures may be observed in several cores.

The paleomagnetic stratigraphy at this site is exceptionally good to 3.4 Ma, owing to unusually high intensities through the Gauss Chronozone and to high rates of deposition. Even short events like the Cobb Mountain and Reunion Subchrons were detected.

Calcareous microfossil preservation is generally excellent to very good through the Pleistocene and good to moderate below. All calcareous nannofossil zones normally present at these latitudes are well represented. Diatoms are moderately preserved to well preserved in lower Pliocene through Pleistocene sediments.

Deposition rates average between 55 and 89 m/m.y. from the surface to 235 m (3.2 Ma) and between 32 and 56 m/m.y. below that depth. The Pleistocene and late Pliocene rates are unusually high. This can be attributed in part to the same kind of enhancement of normal pelagic deposition—by gentle redistribution at the seafloor—that has been noted for Sites 606 and 607. In addition, however, it appears that Maury Channel may have contributed a significant extra component of fine volcaniclastic detritus in the downslope flow. It is not possible from shipboard analyses to estimate the amount of this contribution.

Finally, it appears that the desired high-quality paleomagnetic sequences have been recovered in these cores. The mode of deposition, here again, is not purely "pelagic," but the record will be as useful for paleoceanographic studies as any true pelagic record, and probably more so because of the enhanced depositional rates.

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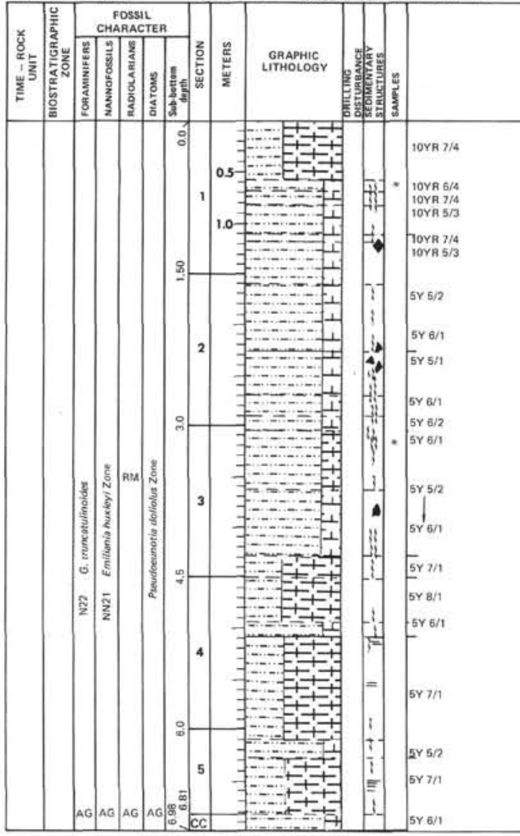
SITE 609 HOLE CORE 1 CORED INTERVAL 0.0–7.0 m



LITHOLOGIC DESCRIPTION

Very pale brown (10YR 7/4), white (5Y 8/1) and light gray (5Y 7/1) MARLY FORAMINIFERAL NANNOFOSSIL OOZE alternating with gray (5Y 6/1, 5Y 5/1) and olive gray (5Y 5/2) NANNOFOSSIL MUD and FORAMINIFERAL NANNOFOSSIL MUD

Dropstones (mostly polished fragments of granite and gneiss) and pumice prominent at 1.1–1.2,~2.5, and ~3.8 m.

Pale green (5G 7/1) and purple (5P 7/1) laminae occur below 6.0 m.

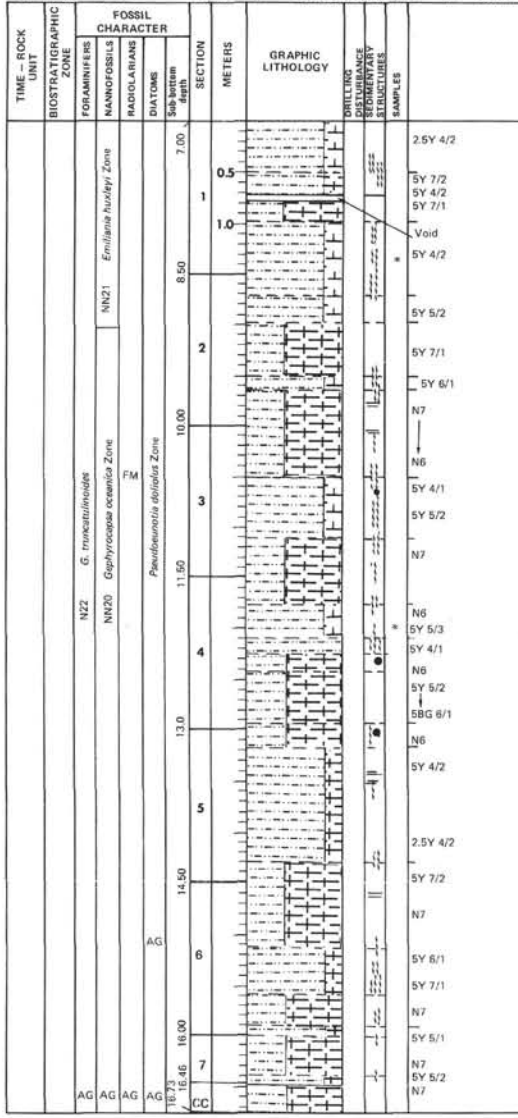
SMEAR SLIDE SUMMARY (%):

	1, 67	3, 15
Texture:		
Sand	15	–
Silt	35	–
Clay	50	–
Composition:		
Quartz	49	45
Feldspar	1	1
Heavy minerals	8	2
Clay	15	25
Volcanic glass	5	1
Carbonate unspec.	3	1
Foraminifers	7	7
Calc. nannofossils	10	18
Diatoms	2	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 33	3, 67
Organic carbon	–	–
Carbonate	10	6

SITE 609 HOLE CORE 2 CORED INTERVAL 7.0–16.6 m



LITHOLOGIC DESCRIPTION

Gray (5Y 7/2, 5Y 4/2, 5Y 6/1, 5Y 4/1, 5Y 5/2, 5Y 5/3, and N6) and dark grayish brown (2.5Y 4/2) CALCAREOUS MUD and light gray (mostly N7) MARLY FORAMINIFERAL NANNOFOSSIL OOZE.
Calcareous component in mud dominated (in decreasing abundance) by nannofossil, foraminifera, and unspecified carbonate.

Occasional laminae (<5 cm) of greenish gray to pale blue (5B 6/1, 5B 6/2, 5BG 7/2, 5GY 4/1).

Dropstones ~ 10.7, 12.3, and 13.1 m.

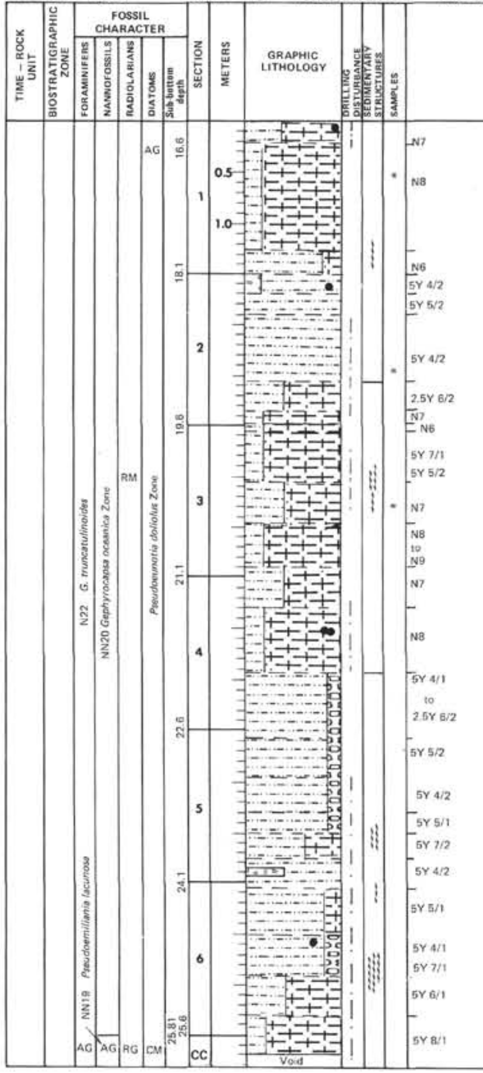
SMEAR SLIDE SUMMARY (%):

	1, 139 D	4, 42 D
Texture:		
Sand	5	10
Silt	15	25
Clay	80	65
Composition:		
Quartz	20	20
Feldspar	1	1
Heavy minerals	2	4
Clay	53	50
Volcanic glass	2	–
Micronodules	–	1
Carbonate unspec.	3	2
Foraminifers	5	7
Calc. nannofossils	14	5
Diatoms	TR	TR
Radiolarians	–	TR
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66	4, 65–66	6, 51–52
Organic carbon	–	–	–
Carbonate	55	3	31

SITE 609 HOLE CORE 3 CORED INTERVAL 16.6–26.2 m



LITHOLOGIC DESCRIPTION

FORAMINIFERAL NANNOFOSSIL OOZE and MARLY FORAMINIFERAL NANNOFOSSIL OOZE in light colors from white (N9) to light gray (5Y 7/2) alternating with MUD and CALCAREOUS MUD. Gradational changing in dark colors from olive gray (5Y 4/2) to light brownish gray (2.5Y 6/2).

Ash-bearing dark muds at Section 2, 10 cm and Section 5, 141–142 cm.

Erratic dropstones at:
Section 1, 5 cm granitic (probably downhole cont.)
Section 2, 14–15 cm siltstone, angular
Section 4, 51 and 54 cm, and Section 6, 60 cm.

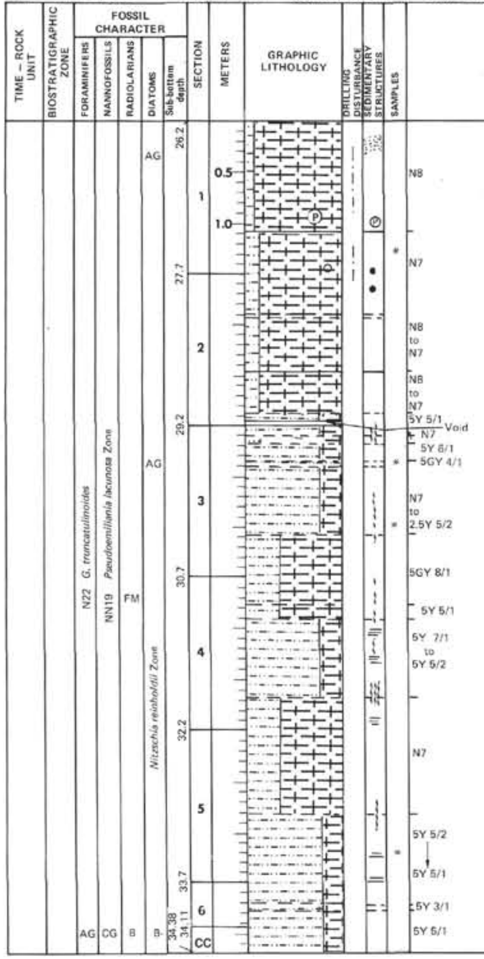
SMEAR SLIDE SUMMARY (%):

	1, 60	2, 93	3, 80
Texture:			
Sand	–	20	10
Silt	–	30	20
Clay	–	50	70
Composition:			
Quartz	2	35	17
Feldspar	–	2	1
Heavy minerals	TR	5	4
Clay	5	46	23
Volcanic glass	TR	3	–
Carbonate unspec.	1	6	6
Foraminifers	15	3	8
Calc. nannofossils	77	–	40
Diatoms	TR	–	1
Radiolarians	TR	–	–
Sponge spicules	–	–	TR
Silicoglagellates	–	–	TR

ORGANIC CARBON AND CARBONATE (%)

	1, 10–11	4, 102–103
Organic carbon	–	–
Carbonate	64	9

SITE 609 HOLE CORE 4 CORED INTERVAL 26.2–35.8 m



LITHOLOGIC DESCRIPTION

Mostly gray (5Y 7/1, 5Y 5/1), grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) FORAMINIFERAL NANNOFOSSIL MUD alternating with lighter gray (N8–7, 5GY 8/1) MARLY FORAMINIFERAL NANNOFOSSIL OOZE.

Occasional green to dark gray (5G 7/1 to N4) laminae throughout.

Metamorphic dropstones~27.7 m.

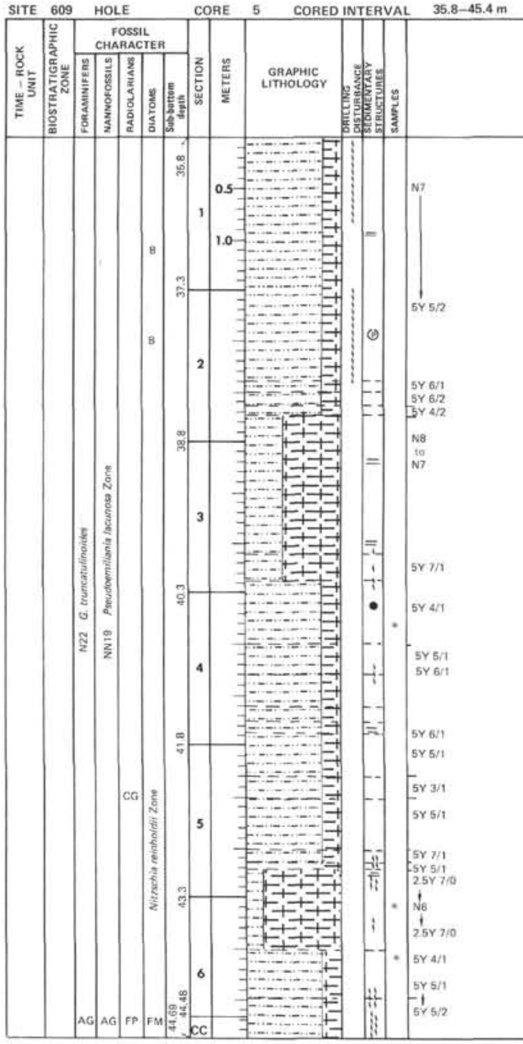
SMEAR SLIDE SUMMARY (%):

	1, 123 D	3, 36 M	3, 95 D	5, 110 D
Texture:				
Sand	–	10	–	21
Silt	–	30	–	30
Clay	–	60	–	49
Composition:				
Quartz	5	35	3	22
Feldspar	TR	2	1	2
Heavy minerals	–	4	2	2
Clay	–	55	15	–
Carbonate unspec.	1	1	2	25
Foraminifers	16	–	10	9
Calc. nannofossils	78	–	66	1
Diatoms	TR	–	1	–
Radiolarians	TR	–	–	–
Sponge spicules	TR	–	TR	–
Silicoflagellates	TR	–	–	–
Opaque oxides	–	3	–	–

ORGANIC CARBON AND CARBONATE (%)

	3, 36–37	6, 24–25
Organic carbon	–	–
Carbonate	2	2

SITE 609 HOLE CORE 5 CORED INTERVAL 35.8–45.4 m



LITHOLOGIC DESCRIPTION

Light gray to very light gray (2.5Y 7/0 to N8) MARLY FORAMINIFERAL NANNOFOSSIL OOZE and FORAMINIFERAL NANNOFOSSIL OOZE alternating with dominantly gray to olive gray (5Y 7/1–5Y 4/2) FORAMINIFERAL NANNOFOSSIL MUD.

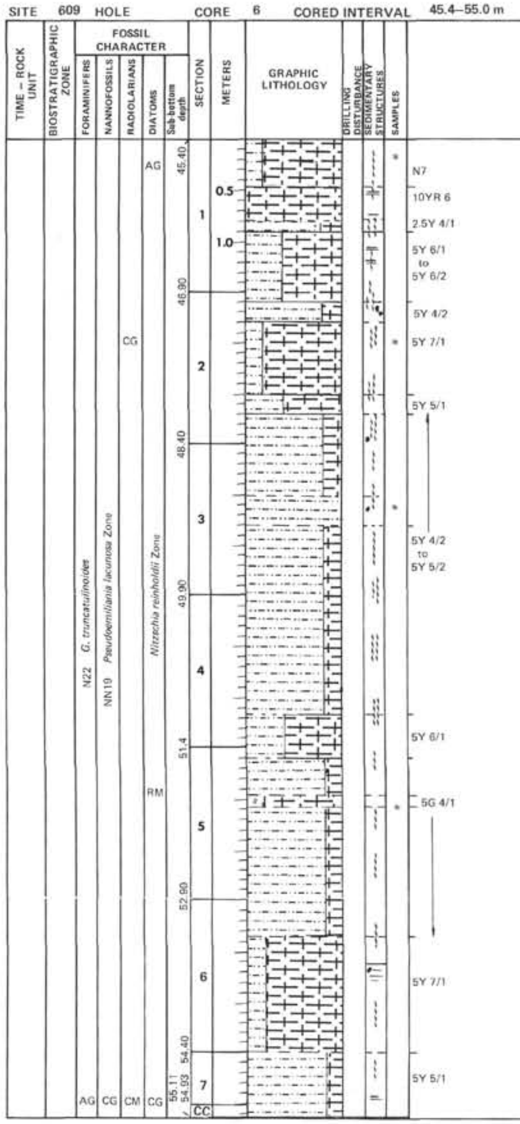
Scattered laminae of various shades of gray and green (eg. 5G 6/1, 5Y 3/2).

Erratic piece of sandstone,~40.4 m.

ORGANIC CARBON AND CARBONATE (%)

	1, 22–23	4, 29–30	6, 56–57
Organic carbon	–	–	–
Carbonate	29	2	12

SITE 609 HOLE CORE 6 CORED INTERVAL 45.4–55.0 m



LITHOLOGIC DESCRIPTION

Light gray (N7, 5Y 7/1) FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 6/1) MARLY FORAMINIFERAL NANNOFOSSIL OOZE, and olive gray (5Y 4/2) and gray (5Y 5/1) FORAMINIFERAL NANNOFOSSIL MUD.

Common gray and green laminae (eg. 5G 6/1, 5GY 4/1). Common ice-rafted pebbles throughout (~47 m, green tuff; 48.3 m, gray slate; ~49 m, striated siltstone; 53.6 m, granite).

Volcanic ash-bearing layer, dark greenish gray (5G 4/1) at 51.9 m.

Recovery > cored interval!

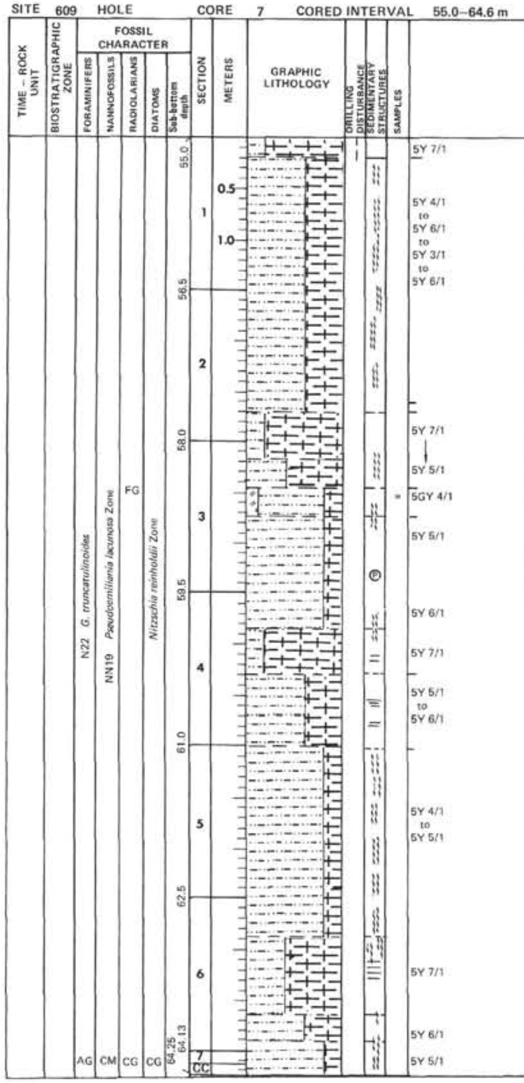
SMEAR SLIDE SUMMARY (%):

	1, 16 D	2, 60 D	3, 60 D	5, 53 M
Texture:				
Sand	10	15	20	10
Silt	40	45	30	45
Clay	50	45	50	45
Composition:				
Quartz	15	10	40	40
Feldspar	–	–	3	20
Heavy minerals	–	TR	5	10
Clay	3	5	26	25
Volcanic glass	2	1	1	3
Glauconite	–	–	TR	–
Carbonate unspec.	–	10	–	–
Foraminifers	10	15	5	–
Calc. nannofossils	68	57	20	2
Diatoms	1	1	TR	–
Radiolarians	1	1	–	–
Sponge spicules	–	TR	–	–

ORGANIC CARBON AND CARBONATE (%)

	3, 60–61
Organic carbon	–
Carbonate	6

SITE 609 HOLE CORE 7 CORED INTERVAL 55.0–64.6 m



LITHOLOGIC DESCRIPTION

Light gray (5Y 7/1) FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 5/1) MARLY FORAMINIFERAL NANNOFOSSIL OOZE, and dark gray to gray (5Y 4/1–5Y 7/1) CALCAREOUS MUD.

Gray and green laminae frequent below 60 m.

Dark green (5GY 4/1) FORAMINIFERAL SAND and VOLCANIC ASH at ~58.4–58.7 m.

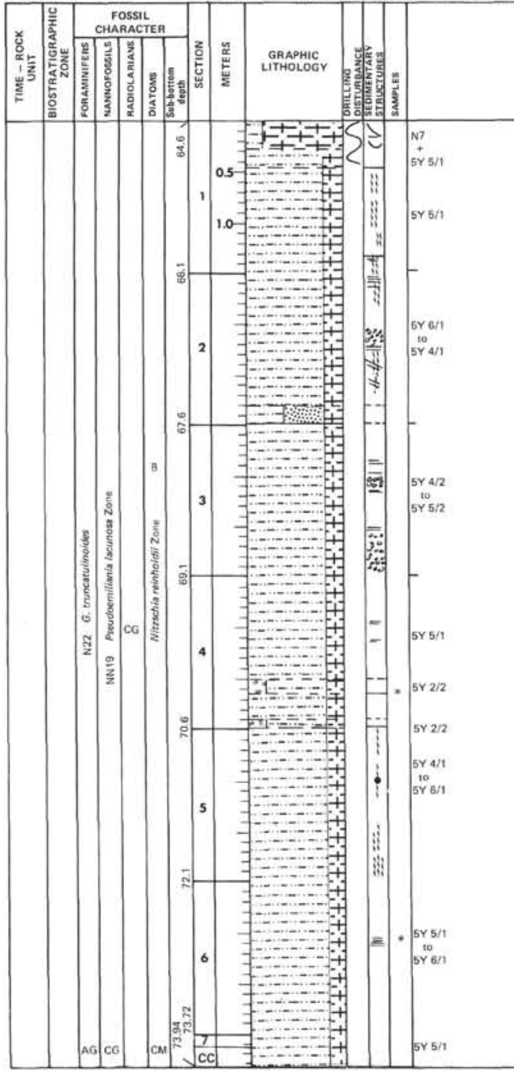
SMEAR SLIDE SUMMARY (%):

	3, 53 M
Composition:	
Quartz	35
Feldspar	2
Heavy minerals	5
Clay	12
Volcanic glass	5
Carbonate unspec.	20
Foraminifers	10
Calc. nannofossils	10
Diatoms	TR
Opaques	1

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66	4, 66–67
Organic carbon	–	–
Carbonate	47	66

SITE 609 HOLE CORE 8 CORED INTERVAL 64.6–74.2 m



LITHOLOGIC DESCRIPTION

Dominantly gray (5Y 4/1–5Y 6/1) CALCAREOUS MUD.

Sandy interval ~67.5 m and volcanic ash-rich intervals at 70.1 to 70.6 m.

Distinct *Chondrites* burrowing at ~66.7 and 68 to 69 m. Green and gray laminae throughout.

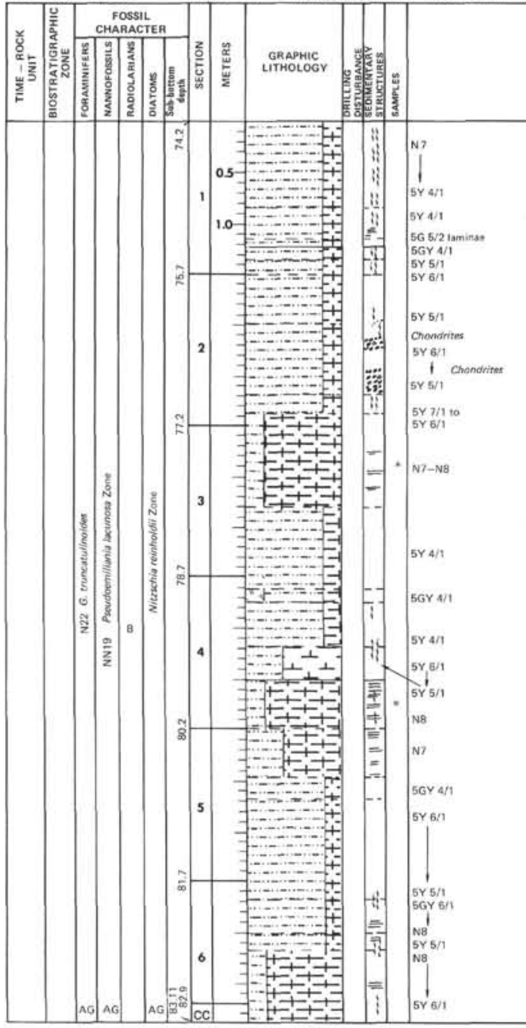
SMEAR SLIDE SUMMARY (%):

	4, 112 M	6, 52 D
Texture:		
Silt	–	10
Clay	–	90
Composition:		
Quartz	20	25
Feldspar	10	3
Heavy minerals	TR	–
Clay	30	38
Volcanic glass	30	3
Foraminifers	TR	1
Calc. nannofossils	5	30
Opaque	5	–

ORGANIC CARBON AND CARBONATE (%)

	5, 94–95
Organic carbon	–
Carbonate	6

SITE 609 HOLE CORE 9 CORED INTERVAL 74.2–83.8 m



LITHOLOGIC DESCRIPTION

Mostly CALCAREOUS MUD, various shades of gray (N7, 5Y 4/1–5Y 7/1) alternating with MARLY FORAMINIFERAL NANNOFOSSIL OOZE and FORAMINIFERAL NANNOFOSSIL OOZE of lighter gray (N7–8).

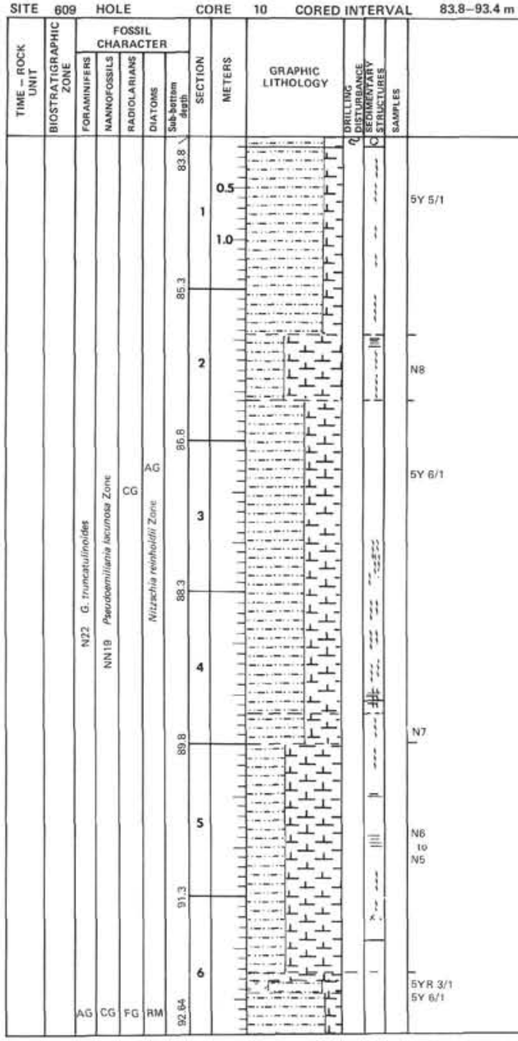
SMEAR SLIDE SUMMARY (%):

	3, 39 D	4, 18 M	4, 121 D
Composition:			
Quartz	–	–	15
Feldspar	–	25	5
Heavy minerals	TR	2	TR
Clay	10	25	TR
Volcanic glass	TR	15	–
Carbonate unspec.	15	10	–
Foraminifers	20	–	17
Calc. nannofossils	55	14	63
Diatoms	–	4	–
Radiolarians	–	TR	–
Sponge spicules	TR	5	–

ORGANIC CARBON AND CARBONATE (%)

	4, 122–123
Organic carbon	–
Carbonate	79

SITE 609 HOLE CORE 10 CORED INTERVAL 83.8–93.4 m



LITHOLOGIC DESCRIPTION

Interlayered CALCAREOUS MUD, MARLY NANNOFOSSIL OOZE and NANNOFOSSIL OOZE

CALCAREOUS MUD predominantly olive gray (5Y 5/1–5Y 7/1), common dark gray (N4) and olive mottles.

MARLY NANNOFOSSIL OOZE, gray to light gray (N5–8).

Green and gray (5GY 7/2, 5GY 8/1, N6) laminae common throughout.

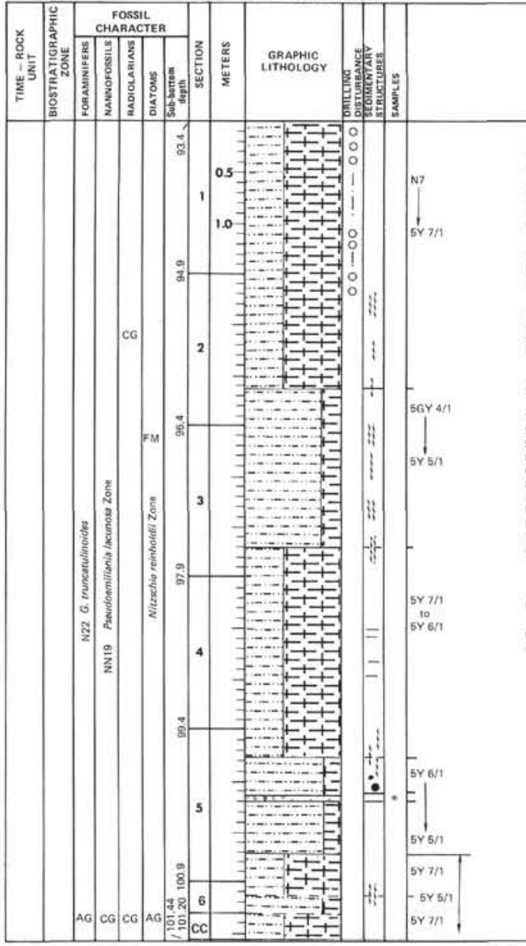
SMEAR SLIDE SUMMARY (%):

	6, 84 M
Composition:	
Quartz	15
Feldspar	10
Heavy minerals	10
Clay	15
Volcanic glass	15
Carbonate unspec.	15
Foraminifers	TR
Calc. nannofossils	20
Sponge spicules	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 80–81	6, 81–82
Organic carbon	–	–
Carbonate	82	11

SITE 609 HOLE CORE 11 CORED INTERVAL 93.4–103.0 m



LITHOLOGIC DESCRIPTION

Interlayered MARLY FORAM-NANNO OOZE and CALCAREOUS MUD

MARLY FORAM-NANNO OOZE, gray (N7) to pale gray (5Y 7/1) predominant, with dark gray (N5) mottles and green (5GY 7/1) laminations.

CALCAREOUS MUD, varicolored, predominantly olive gray (5Y 5/1–5Y 6/1); common green (5G 5/1) mottles and dark gray (N4–6) laminations.

Dark gray (N2) ash-bearing layer at Section 5, 67 cm. Pyritized burrow at Section 2, 129 cm. Glacial erratics at Section 5, 42 cm. Sandstone (0.5 cm) at Section 5, 60 cm. Gneiss (2.5 cm in diameter).

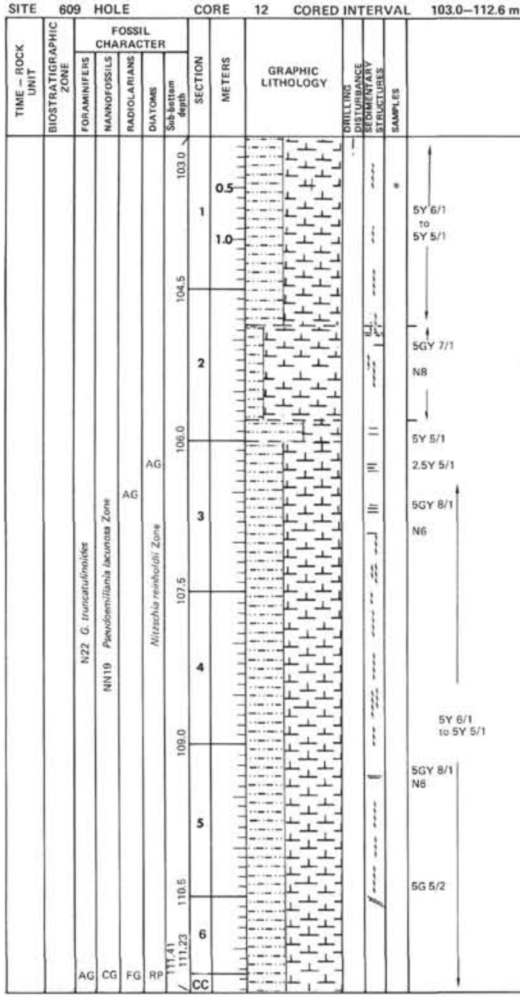
SMEAR SLIDE SUMMARY (%):

	5, 69
Texture:	
Sand	10
Silt	40
Clay	50
Composition:	
Quartz	30
Feldspar	TR
Heavy minerals	5
Clay	25
Volcanic glass	30
Calc. nannofossils	10

ORGANIC CARBON AND CARBONATE (%)

	5, 65–66
Organic carbon	–
Carbonate	2

SITE 609 HOLE CORE 12 CORED INTERVAL 103.0–112.6 m



LITHOLOGIC DESCRIPTION

Marly NANNOFOSSIL OOZE, varicolored, primarily olive gray (5Y 6/1–5Y 5/1); subhorizontal green (5GY 7/1) and gray laminations. Interlayered nannofossil ooze, white (N8) with pyritized burrow Ⓟ and green (5GY 7/1) laminations and dark gray (N5) mottles.

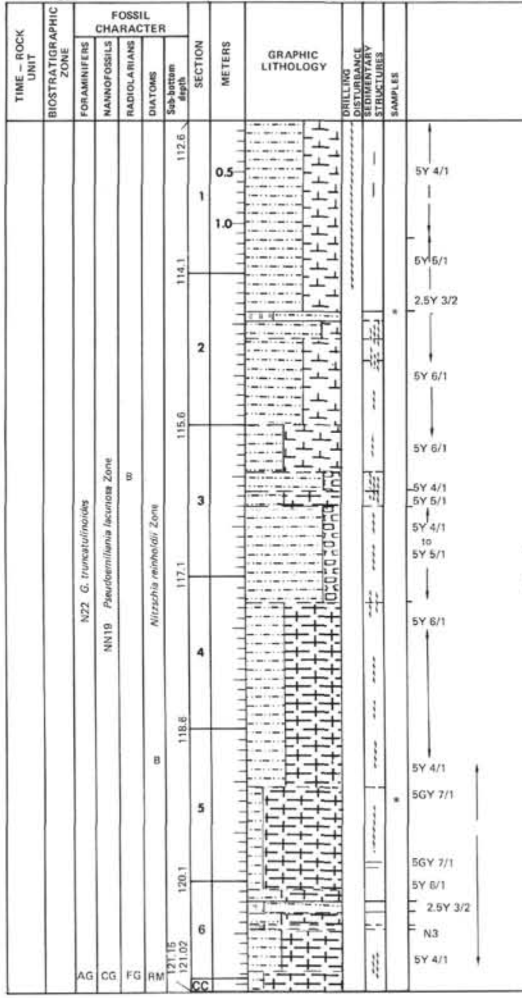
SMEAR SLIDE SUMMARY (%):

	1, 50
Composition:	
Quartz	20
Heavy minerals	1
Clay	15
Volcanic glass	3
Carbonate unspec.	10
Foraminifers	10
Calc. nannofossils	40
Diatoms	TR
Sponge spicules	1

ORGANIC CARBON AND CARBONATE (%)

	1, 50–51
Organic carbon	–
Carbonate	54

SITE 609 HOLE CORE 13 CORED INTERVAL 112.6–122.2 m



LITHOLOGIC DESCRIPTION

MARLY FORAMINIFERAL-NANNOFOSSIL OOZE interlayered with CALCAREOUS MUD and *FORAMINIFERAL-NANNOFOSSIL OOZE*

Very thin ash-bearing mud layers, very dark grayish brown (2.5Y 3/2) and very dark (N3) at: ~141.5, ~120.3, and ~120.5 m.

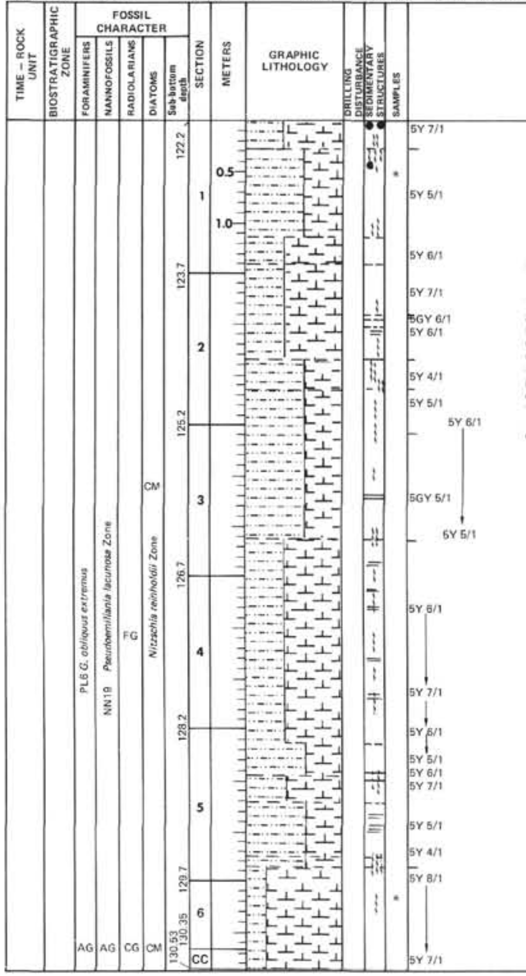
SMEAR SLIDE SUMMARY (%):

	2, 40 M	5, 70 D
Texture:		
Silt	–	10
Clay	–	90
Composition:		
Quartz	30	10
Feldspar	5	–
Mica	TR	TR
Heavy minerals	TR	–
Clay	30	15
Volcanic glass	25	–
Glauconite	TR	–
Carbonate unspec.	5	–
Foraminifers	TR	15
Calc. nannofossils	5	60

ORGANIC CARBON AND CARBONATE (%)

	5, 70–71
Organic carbon	–
Carbonate	64

SITE 609 HOLE CORE 14 CORED INTERVAL 122.2–130.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, MARLY NANNOFOSSIL OOZE, and combinations thereof.

Green (5GY 6/1, 5GY 5/1) laminae common throughout.

Dropstones in upper 0.5 m.

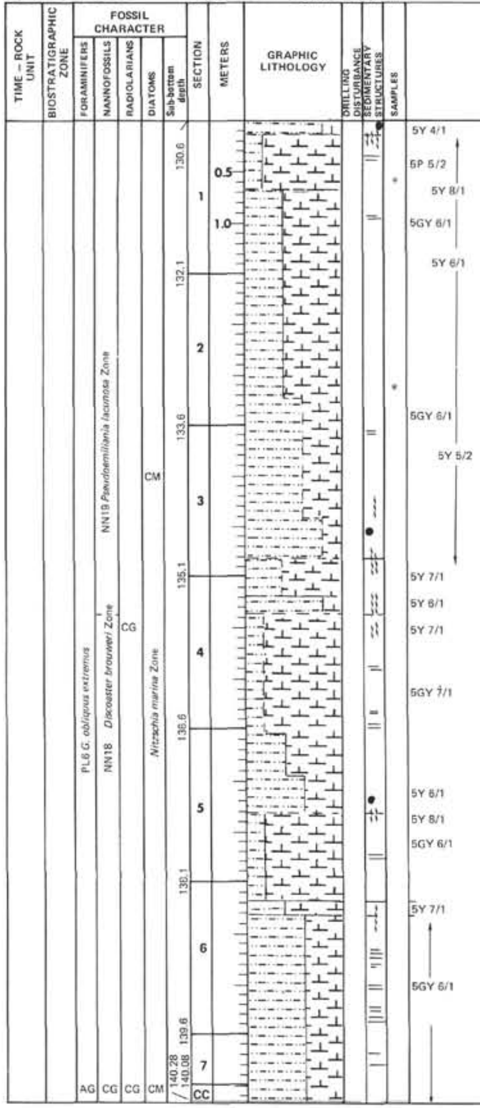
SMEAR SLIDE SUMMARY (%):

	1, 50	6, 20 D
Texture:		
Sand	–	–
Silt	5	–
Clay	95	–
Composition:		
Quartz	25	15
Mica	TR	–
Clay	10	–
Volcanic glass	15	–
Foraminifers	4	20
Calc. nannofossils	46	65
Radiolarians	TR	–

ORGANIC CARBON AND CARBONATE (%)

	1, 50–51	6, 20–21
Organic carbon	–	–
Carbonate	39	82

SITE 609 HOLE CORE 15 CORED INTERVAL 130.6–140.2 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, light gray to gray (5Y 6/1) in gradational transitions to NANNOFOSSIL OOZE, white (5Y 8/1) and CALCAREOUS MUD, olive gray (5Y 5/1).

Bioturbation throughout; lighter layers with dark gray (N3) pyrite rich mottles. Some greenish gray (5GY 6/1) laminae.

Dropstones at: Section 1, 6–9 cm, Section 3, 111 cm (biotite schist), and Section 5, 76 cm (granitic).

Recovery > cored interval!

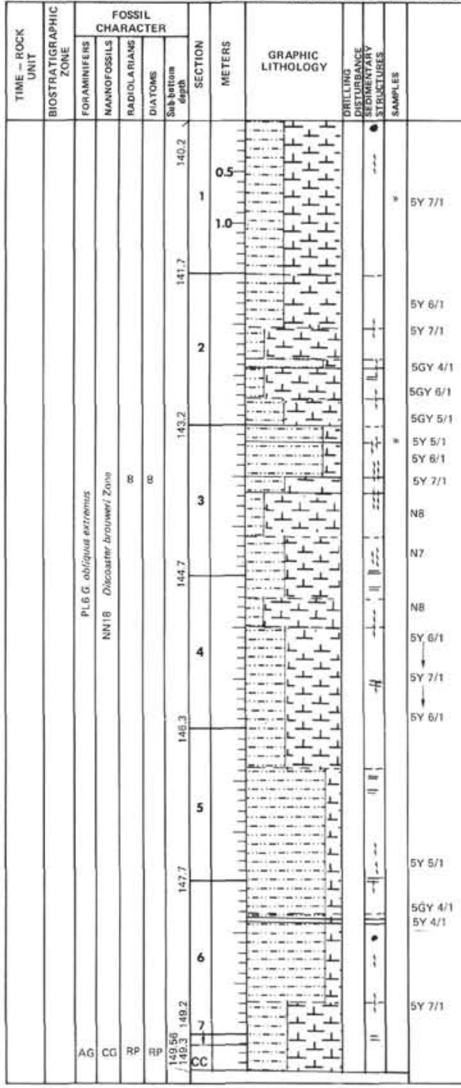
SMEAR SLIDE SUMMARY (%):

	1, 62 D	2, 112
Composition:		
Quartz	22	22
Feldspar	TR	2
Heavy minerals	–	5
Clay	–	40
Volcanic glass	1	3
Carbonate unspec.	TR	1
Foraminifers	8	3
Calc. nannofossils	68	23
Diatoms	1	–
Radiolarians	TR	–
Sponge spicules	TR	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	3, 50–51	5, 50–51
Organic carbon	–	–
Carbonate	40	48

SITE 609 HOLE CORE 16 CORED INTERVAL 140.2–149.8 m



LITHOLOGIC DESCRIPTION

Alternating gray (N7, 5Y 6/1) and light gray (N8, 5Y 7/1) MARLY NANNOFOSSIL OOZE and NANNOFOSSIL OOZE. Less frequent CALCAREOUS MUD which is always darker gray (5Y 5/1 and 5GY 4/1).

Greenish gray (5GY 4/1–5GY 6/1) laminae common below 142.7 m.

Dropstones at 140.2 and 148.2 m.

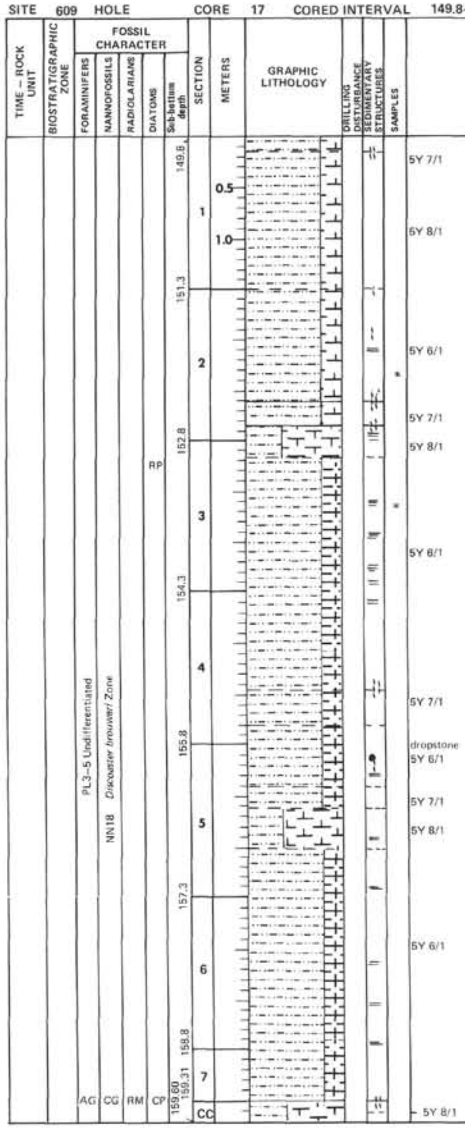
SMEAR SLIDE SUMMARY (%):

	1, 77	3, 11
Texture:		
Sand	8	5
Silt	12	20
Clay	80	75
Composition:		
Quartz	15	30
Feldspar	1	1
Heavy minerals	3	5
Clay	30	57
Volcanic glass	1	2
Carbonate unspec.	TR	1
Foraminifers	8	3
Calc. nannofossils	42	1
Sponge spicules	TR	–

ORGANIC CARBON AND CARBONATE (%)

	2, 89–90	6, 58–59
Organic carbon	–	–
Carbonate	25	4

SITE 609 HOLE CORE 17 CORED INTERVAL 149.8–159.4 m



LITHOLOGIC DESCRIPTION

Dominantly gray (5Y 6/1–5Y 8/1) CALCAREOUS MUD with intervals of light gray (5Y 8/1) MARLY FORAMINIFERAL AND MARLY NANNOFOSSIL OOZE (152.7 to 153.0 and 156.2–156.8 m).

Gray (5GY 6/1) laminae common throughout; black (5Y 2/2) and dark purple (5P 2/2) laminae less common.

Note: recovery >100%.

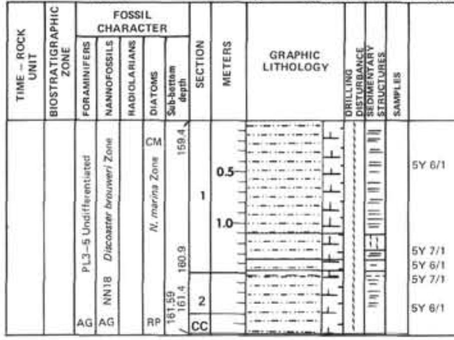
SMEAR SLIDE SUMMARY (%):

	2, 80 D	3, 67
Composition:		
Quartz	26	20
Feldspar	1	1
Heavy minerals	3	3
Clay	38	49
Volcanic glass	1	1
Carbonate unspec.	2	1
Foraminifers	9	7
Calc. nannofossils	20	17
Diatoms	–	1
Radiolarians	–	TR
Sponge spicules	–	TR
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 80–81	4, 13–14
Organic carbon	–	–
Carbonate	36	55

SITE 609 HOLE CORE 18 CORED INTERVAL 159.4–169.0 m

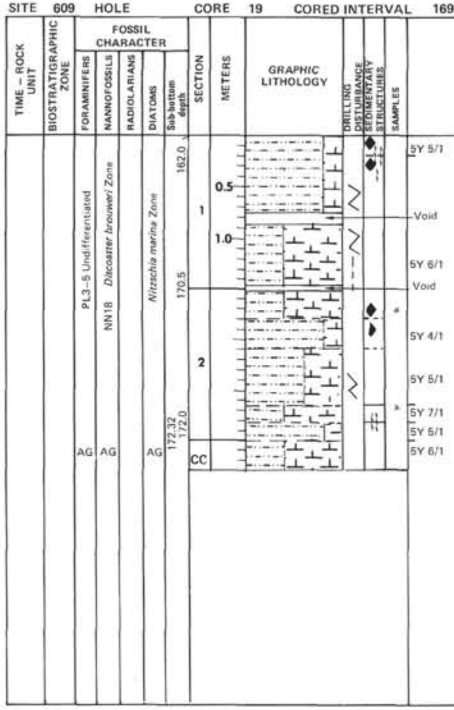


LITHOLOGIC DESCRIPTION

Gray (5Y 6/1–5Y 7/1) CALCAREOUS MUD. Abundant green/gray (5GY 6/1) laminae throughout.

Note: this core taken without a liner in barrel, so it was forcefully extruded.

SITE 609 HOLE CORE 19 CORED INTERVAL 169.0–178.6 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD, gray to dark gray (5Y 6/1–5Y 5/1), with common greenish gray (5GY 6/1) patches and some laminae. Sediment distinctly hardened and fractured during drilling (liner broken).

Ice-rafted dropstones at: Section 1, 4–5 and 24–28 cm, and Section 2, 27 and 41 cm.

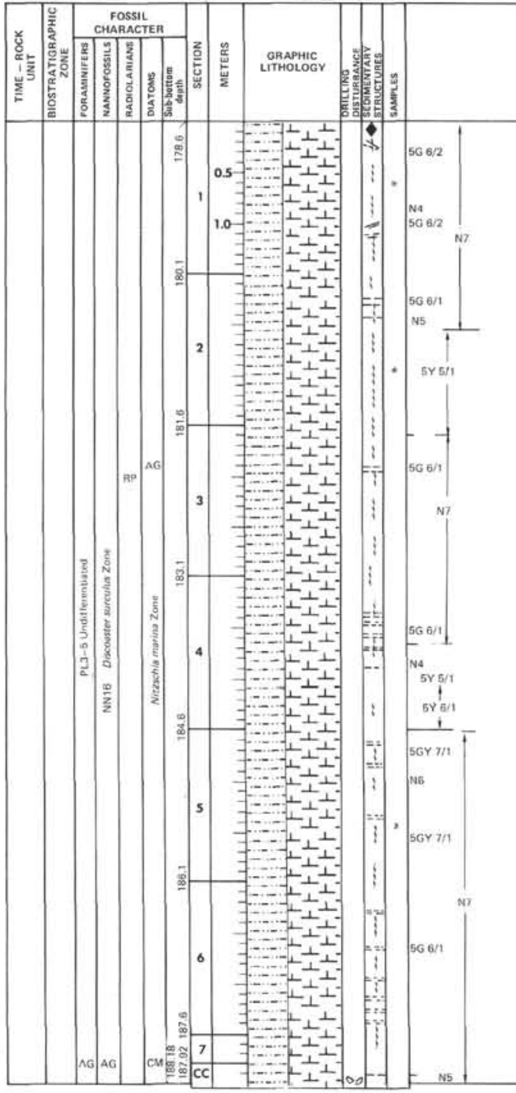
SMEAR SLIDE SUMMARY (%):

	2, 20 D	2, 117 D
Texture:		
Sand	8	–
Silt	15	–
Clay	77	–
Composition:		
Quartz	18	6
Feldspar	1	–
Heavy minerals	2	3
Clay	48	38
Volcanic glass	1	–
Micronodules	TR	–
Carbonate unspec.	1	1
Foraminifers	6	10
Calc. nannofossils	23	39
Diatoms	–	3
Radiolarians	TR	TR
Sponge spicules	–	TR
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 20–21
Organic carbon	–
Carbonate	42

SITE 609 HOLE CORE 20 CORED INTERVAL 178.6–188.2 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE, dominantly light gray (N7) with some gray parts (N5, 5Y 5/1). Grayish green (5G 6/1) streaks and bands are common.

Ⓟ pyritized burrow cast at Section 4, 111–115 cm.

Large dropstone at top (basalt) has probably fallen down hole. No other dropstones detected!

Some spots of very stiff material.

SMEAR SLIDE SUMMARY (%):

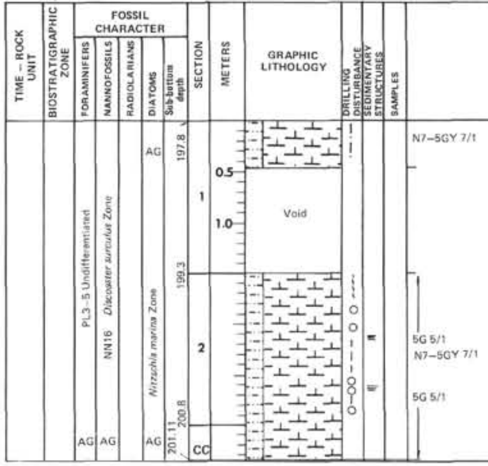
	2, 98	5, 90	1, 74
Composition:			
Quartz	10	12	14
Feldspar	1	TR	1
Heavy minerals	3	–	2
Clay	59	59	50
Carbonate unspec.	–	1	–
Foraminifers	4	8	8
Calc. nannofossils	20	20	22
Diatoms	3	–	3

ORGANIC CARBON AND CARBONATE (%)

	2, 97–98
Organic carbon	–
Carbonate	44

Note: Core 21, 188.2–197.8 m, no recovery.

SITE 609 HOLE CORE 22 CORED INTERVAL 197.8–207.4 m



LITHOLOGIC DESCRIPTION

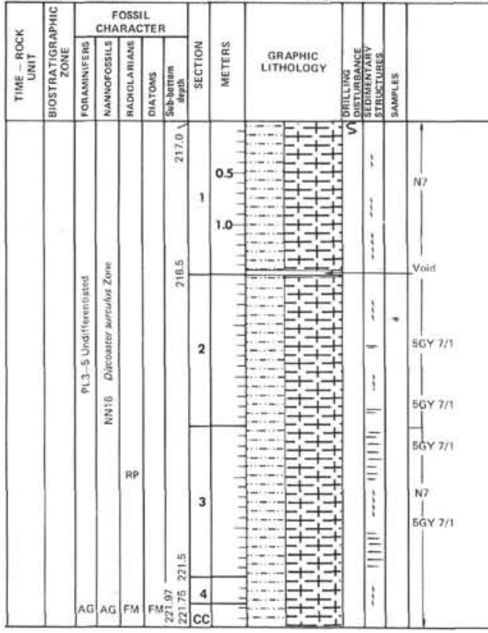
NANNOFOSSIL OOZE, pale gray green (N7–5GY 7/1). Some green (5G 5/1) laminations. Core strongly disturbed.

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66
Organic carbon	–
Carbonate	75

Note: Core 23, 207.4–217.0 m, no recovery.

SITE 609 HOLE CORE 24 CORED INTERVAL 217.0–226.6 m



LITHOLOGIC DESCRIPTION

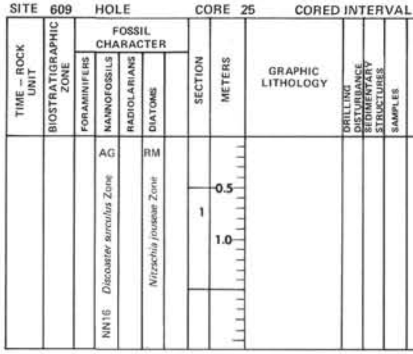
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, predominantly light gray (N7) with common mottles of gray (N5) and light gray (5Y 7/1). Laminae green (5GY 7/1) of about 1 cm thickness in Section 3. All contacts unsharp.

Sediment rather stiff. Drilling biscuits frequent.

SMEAR SLIDE SUMMARY (%):

	2, 53 D
Composition:	
Quartz	10
Feldspar	TR
Mica	TR
Heavy minerals	TR
Clay	20
Volcanic glass	5
Carbonate unspec.	10
Foraminifers	15
Calc. nannofossils	40
Diatoms	TR
Radiolarians	TR
Sponge spicules	TR

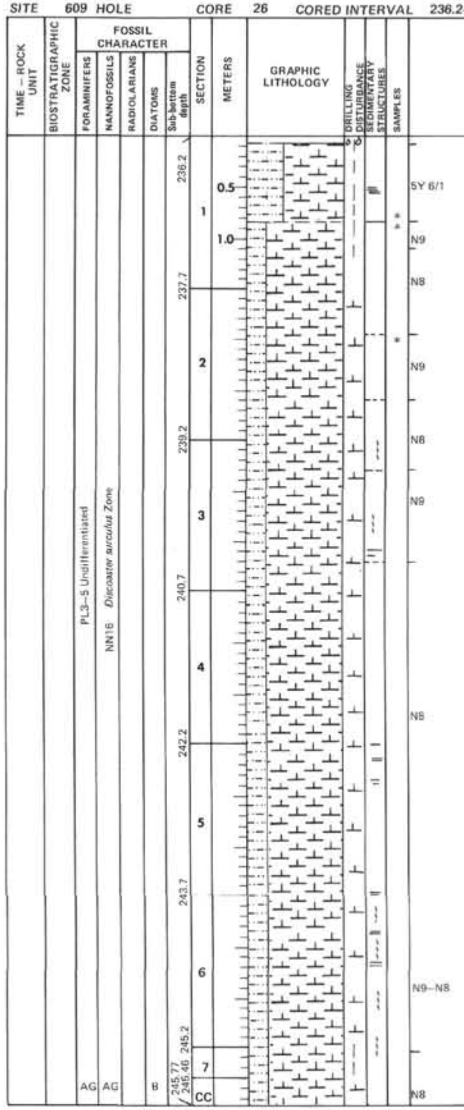
SITE 609 HOLE CORE 25 CORED INTERVAL 226.6–236.2 m



LITHOLOGIC DESCRIPTION

No recovery (only fragments in Core Catcher).

SITE 609 HOLE CORE 26 CORED INTERVAL 236.2–245.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, white (N8–9), very homogeneous with rare greenish (5GY 8/1) faint laminations and some darker gray (N4–5) pyritiferous patches.

Sharp contact to gray (5Y 6/1), marly nannofossil ooze in Section 1 is probably due to drilling disturbances. Top of core (0–3 cm) with washed down gravel. Sediment stiff with drilling biscuits throughout.

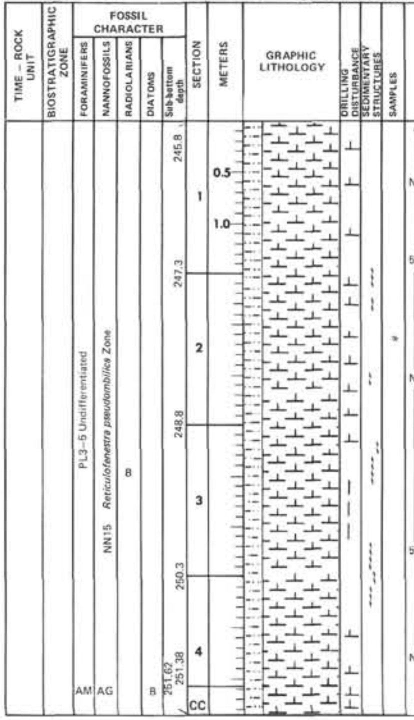
SMEAR SLIDE SUMMARY (%):

	1, 79	1, 82	2, 65
Composition:			
Quartz	35	10	5
Feldspar	–	TR	–
Mica	TR	TR	–
Volcanic glass	–	–	TR
Foraminifers	4	6	5
Calc. nannofossils	59	84	90
Diatoms	1	–	TR
Radiolarians	1	–	TR
Sponge spicules	TR	–	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66
Organic carbon	–
Carbonate	91

SITE 609 HOLE CORE 27 CORED INTERVAL 245.8–255.4 m



LITHOLOGIC DESCRIPTION

N8

5GY 8/1

N8

5GY 8/1

N8

NANNOFOSSIL OOZE, pale gray (N8) with some very gradational changes to pale gray green (5GY 8/1); dark gray mottles (N5–6) scattered throughout.

Sediment stiff and very homogeneous; drilling biscuits throughout.

Section 4 is cut in two parts.

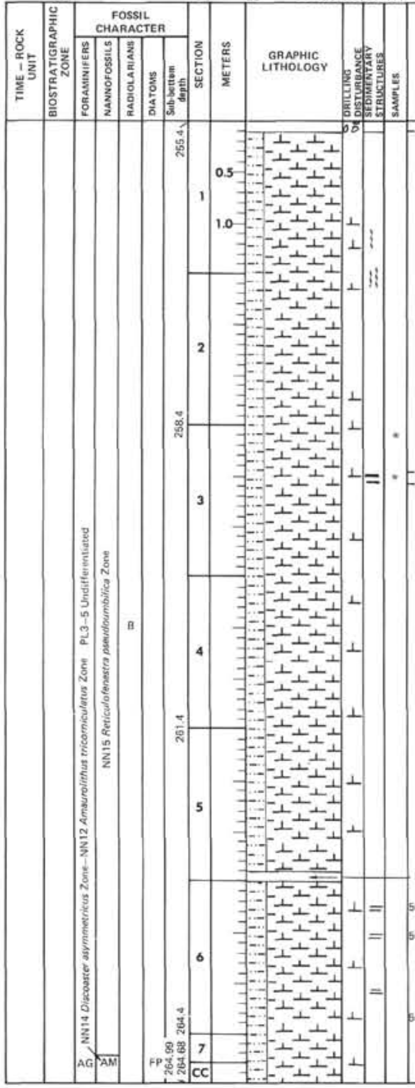
SMEAR SLIDE SUMMARY (%):

	2, 65
	D
Composition:	
Quartz	5
Carbonate unspec.	1
Foraminifers	2
Calc. nannofossils	92

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66
Organic carbon	–
Carbonate	92

SITE 609 HOLE CORE 28 CORED INTERVAL 255.4–265.0 m



LITHOLOGIC DESCRIPTION

N9

N8

N2

N9

N8

N9

IW

5GY 8/1

5GY 8/1

5GY 8/1

NANNOFOSSIL OOZE, very uniform white (N9) with two smaller sections darkening to N8. Dark gray (N4) mottles and faint greenish (5GY 8/1) laminations are rare.

Drilling biscuits common over the whole core.

Top of the core (0–10 cm) mixing of white ooze and washed-down gravel. (Large piece of basalt 5 cm in diameter.)

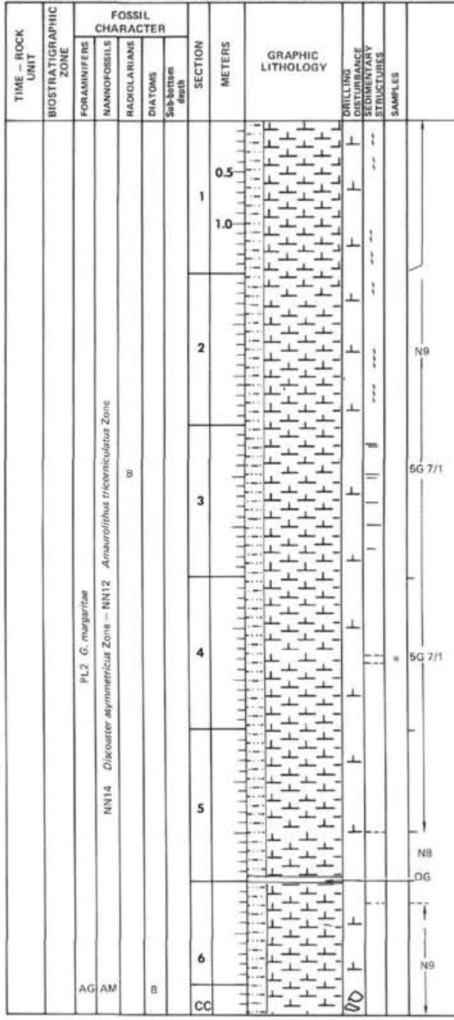
SMEAR SLIDE SUMMARY (%):

	3, 14	3, 49
	D	M
Composition:		
Quartz	5	15
Mica	TR	–
Clay	TR	–
Volcanic glass	1	–
Pyrite	–	15
Carbonate unspec.	1	TR
Foraminifers	3	1
Calc. nannofossils	90	69

ORGANIC CARBON AND CARBONATE (%)

	3, 14–15
Organic carbon	–
Carbonate	92

SITE 609 HOLE CORE 29 CORED INTERVAL 265.0–274.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, white (N9 gradational to N8) with horizontal and subhorizontal greenish (5GY 7/1) diffuse laminations.

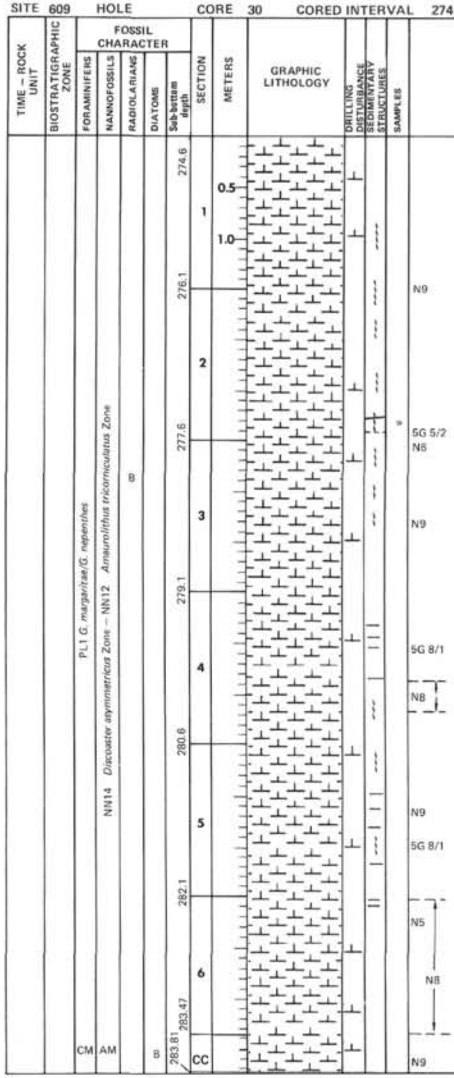
SMEAR SLIDE SUMMARY (%):

	4, 78 D
Composition:	
Quartz	10
Foraminifers	8
Calc. nannofossils	82

ORGANIC CARBON AND CARBONATE (%)

	4, 78–79
Organic carbon	–
Carbonate	91

SITE 609 HOLE CORE 30 CORED INTERVAL 274.6–284.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very uniform white (N9 to N8). Some gray mottles throughout. Some diffuse or sharp contacted, faint laminations green (5G 8/1) or gray (N6–5). Indurated, pyritized green (5G 5/2) layer of about 8 mm thickness at Section 2, 135 cm.

Sediment stiff and drilling biscuits common.

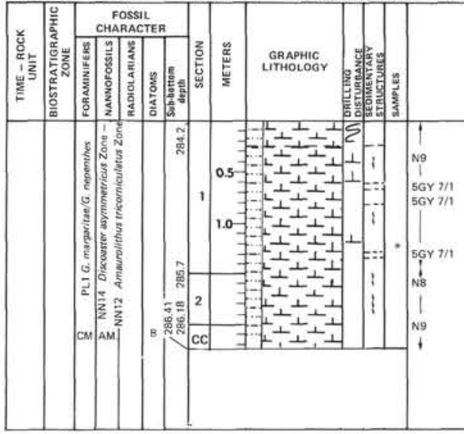
SMEAR SLIDE SUMMARY (%):

	2, 135 M
Composition:	
Quartz	20
Clay	5
Pyrite	20
Foraminifers	2
Calc. nannofossils	53

ORGANIC CARBON AND CARBONATE (%)

	3, 50–51
Organic carbon	–
Carbonate	95

SITE 609 HOLE CORE 31 CORED INTERVAL 284.2–293.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, dominantly white (N9) with some diffuse pale green (5GY 7/1) layers of very dense mottling.

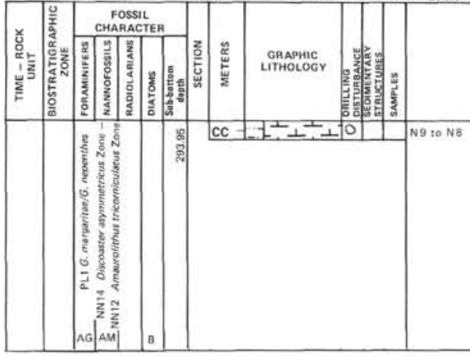
Sediment stiff with drilling biscuits. Top (0–24 cm) soupy.

Sediment stiff with drilling biscuits. Top (0-26 cm) soupy.

SMEAR SLIDE SUMMARY (%):

	1, 123 D
Texture:	
Clay	1
Composition:	
Pyrite	TR
Carbonate unspec.	TR
Foraminifers	2
Calc. nannofossils	97

SITE 609 HOLE CORE 32 CORED INTERVAL 293.8–303.4 m



LITHOLOGIC DESCRIPTION

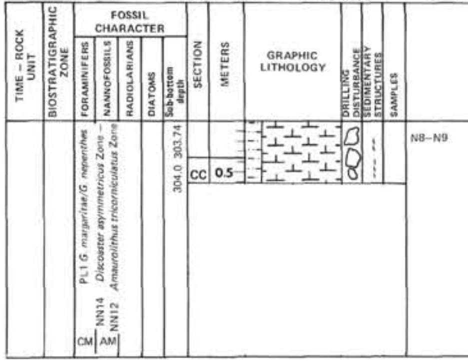
NANNOFOSSIL OOZE, very light gray (N8) and white (N9).

Recovery only 15 cm in Core Catcher. Broken pieces.

SMEAR SLIDE SUMMARY (%):

	CC,13
Texture:	
Clay	3
Composition:	
Pyrite	TR
Foraminifers	3
Calc. nannofossils	94

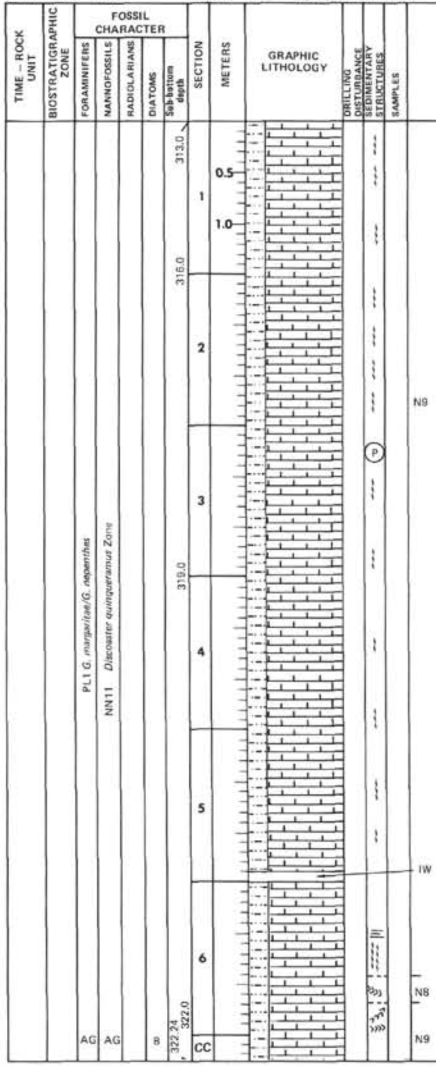
SITE 609 HOLE CORE 33 CORED INTERVAL 303.4–313.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, white (N9 + N8) changing to light gray (2.5Y 7/0). Dark gray (N4) mottles common.

SITE 609 HOLE CORE 34 CORED INTERVAL 313.0–322.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, predominantly white (N9) with occasionally pyrite-rich dark (N4) mottles. Small part of section getting darker (N8) and showing well preserved burrows (*Zoophycos*). Sediment firm. Splitting of core by using saw.

Ⓟ = pyritized burrow cast.

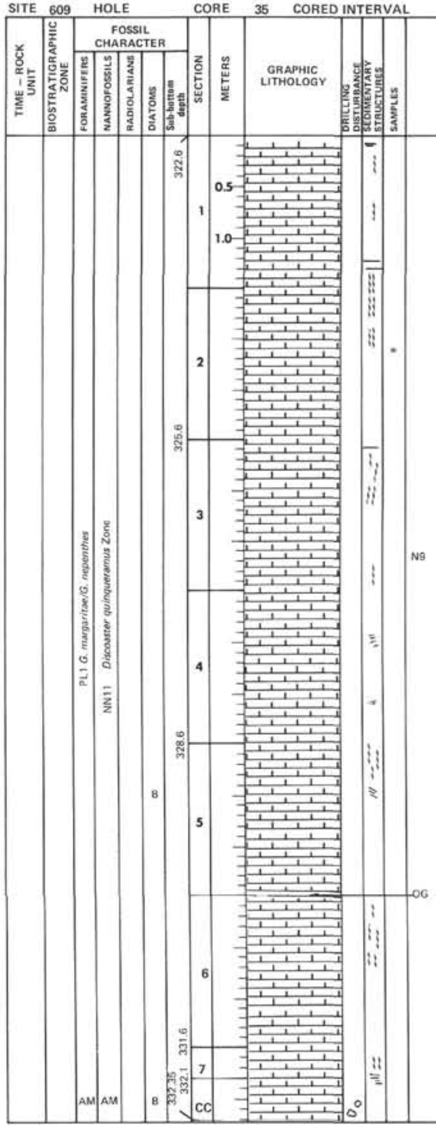
SMEAR SLIDE SUMMARY (%):

	2, 87
Texture:	
Clay	2
Composition:	
Pyrite	TR
Foraminifers	2
Calc. nannofossils	96

ORGANIC CARBON AND CARBONATE (%)

	2, 87–88	4, 37–38	6, 51–52
Organic carbon	–	–	–
Carbonate	92	91	90

SITE 609 HOLE CORE 35 CORED INTERVAL 322.6–332.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK

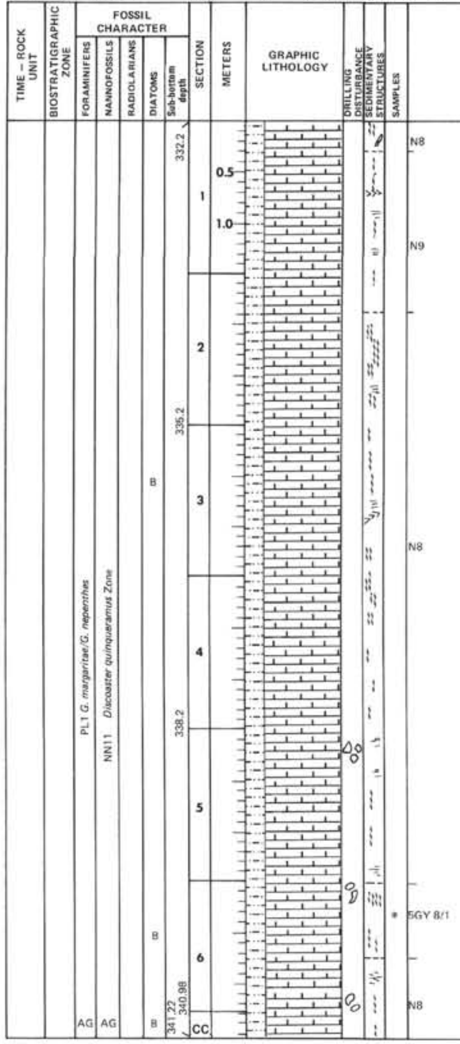
SMEAR SLIDE SUMMARY (%)

	2, 70
Composition:	
Quartz	3
Clay	2
Carbonate unspec.	1
Foraminifers	4
Calc. nannofossils	92

ORGANIC CARBON AND CARBONATE (%)

	3, 74–75
Organic carbon	–
Carbonate	90

SITE 609 HOLE CORE 36 CORED INTERVAL 332.2–341.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, dominantly white (N8) with very gradational changes to white (N9) and very light greenish gray (5GY 8/1).

Very dusky purple (5P 2/2) and light greenish gray (5GY 8/1) in haloes around burrows and in very thin discontinuous laminations.

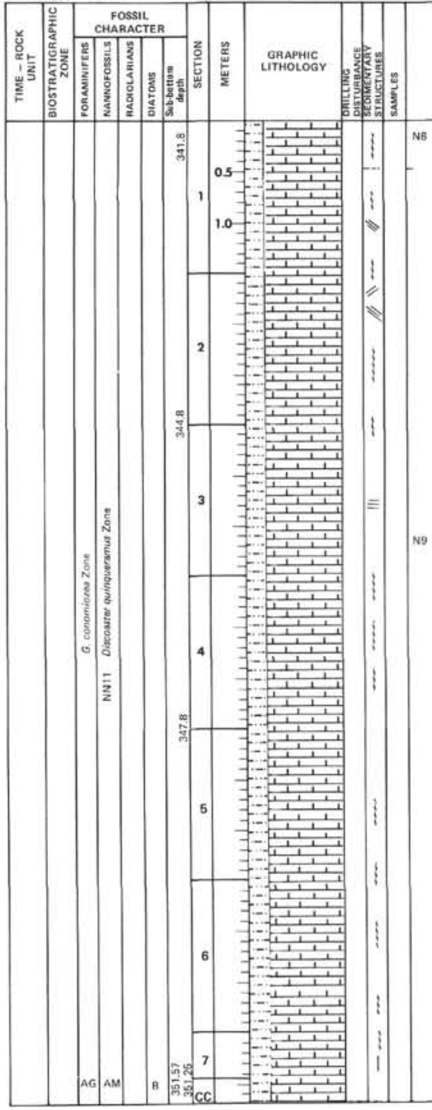
SMEAR SLIDE SUMMARY (%):

	6, 37
Composition:	
Clay	6
Pyrite	1
Carbonate unspec.	2
Foraminifers	2
Calc. nannofossils	89

ORGANIC CARBON AND CARBONATE (%)

	6, 38–40
Organic carbon	–
Carbonate	73

SITE 609 HOLE CORE 37 CORED INTERVAL 341.8–351.4 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK

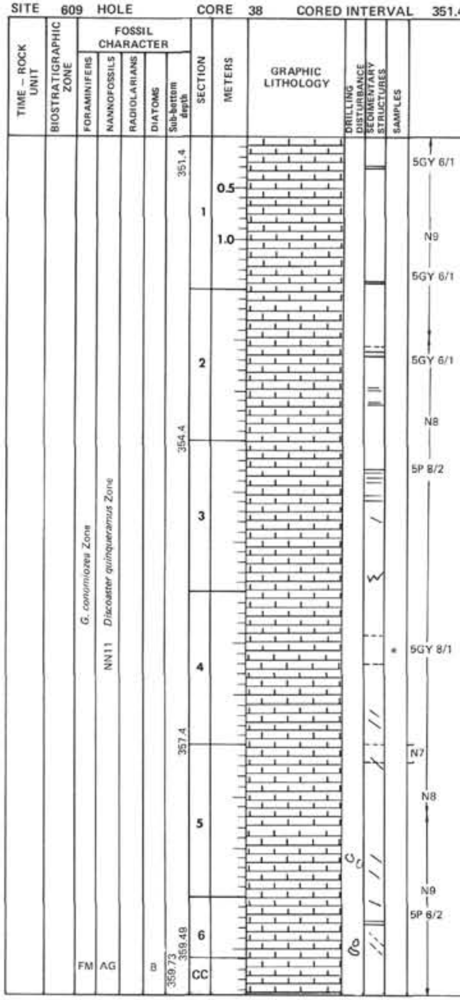
SMEAR SLIDE SUMMARY (%):

	3, 70
Composition:	
Clay	4
Carbonate unspec.	2
Foraminifers	4
Calc. nannofossils	90

ORGANIC CARBON AND CARBONATE (%)

	3, 70–71
Organic carbon	–
Carbonate	92

SITE 609 HOLE CORE 38 CORED INTERVAL 351.4–361.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, dominantly white (N8) with gradual changes to N9 and very light gray (N7).

Thin laminae of greenish gray (5GY 6/1) and pale purple are forming small bands around tectonic fractures, filled with pyrite.

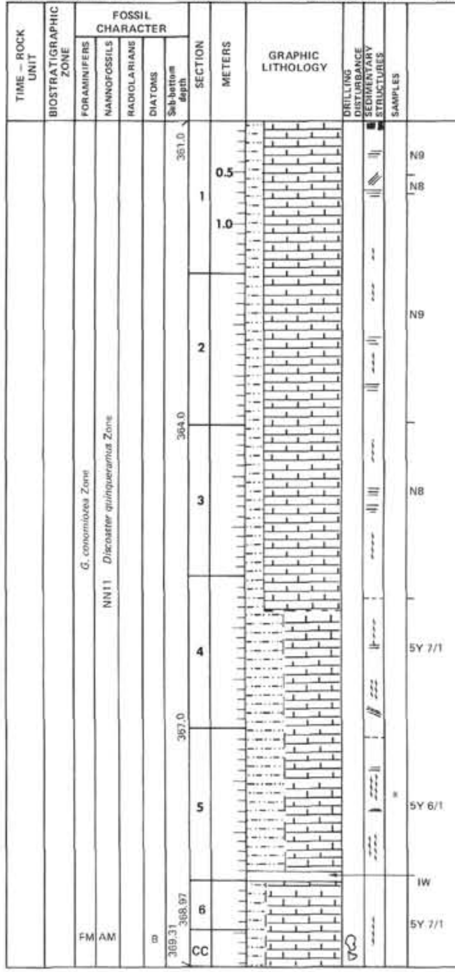
SMEAR SLIDE SUMMARY (%):

	4, 53
Composition:	
Clay	6
Pyrite	1
Carbonate unspec.	2
Foraminifers	TR
Calc. nannofossils	91

ORGANIC CARBON AND CARBONATE (%)

	4, 53–54
Organic carbon	–
Carbonate	68

SITE 609 HOLE CORE 39 CORED INTERVAL 361.0–370.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, predominantly white (N9–8). Gradationally changing to marly nannofossil chalk with pale olive gray (5Y 7/1–5Y 6/1) in the lower part. Abundant greenish gray (5GY 6/1) and pale purple (5P 8/2) laminae forming bands and haloes around burrows.

Dropstones (conglomerate and biotite gneiss) at top are washed down.

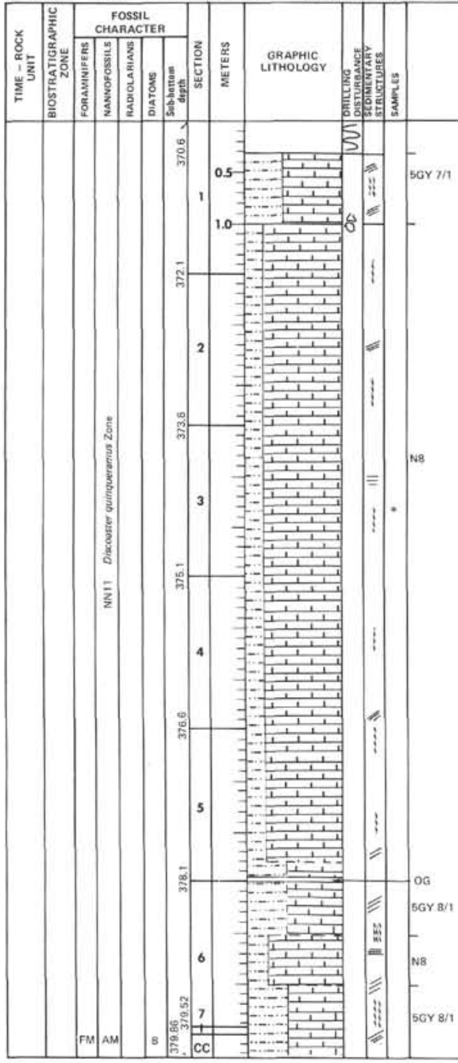
SMEAR SLIDE SUMMARY (%):

	5, 65
Composition:	
Quartz	5
Clay	12
Pyrite	1
Micronodules	TR
Carbonate unspec.	2
Foraminifers	2
Calc. nannofossils	78

ORGANIC CARBON AND CARBONATE (%)

	5, 65–66
Organic carbon	–
Carbonate	54

SITE 609 HOLE CORE 40 CORED INTERVAL 370.6–380.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, white (N8) interlayered with marly nannofossil chalk light greenish gray (5GY 8/1).

Typical are fine greenish gray (5GY 6/1) laminations mostly in form of parallel bands as well as olive (5Y 7/1) and gray (N4–6) burrow mottles.

Top of core (0–30 cm) brecciated down-washed material in oozy matrix.

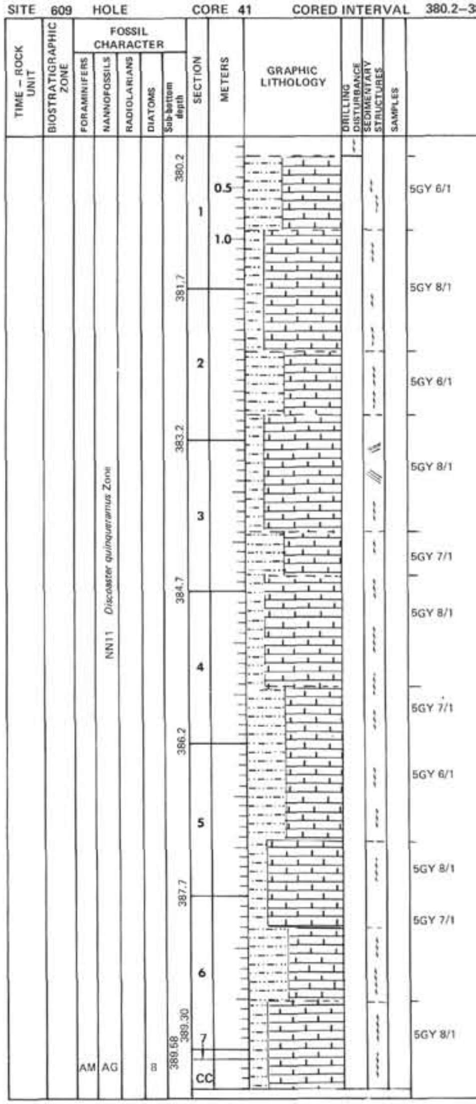
SMEAR SLIDE SUMMARY (%):

	3, 80
Composition:	
Quartz	15
Carbonate unspec.	3
Calc. nannofossils	82

ORGANIC CARBON AND CARBONATE (%)

	3, 77–78
Organic carbon	–
Carbonate	89

SITE 609 HOLE CORE 41 CORED INTERVAL 380.2–389.8 m



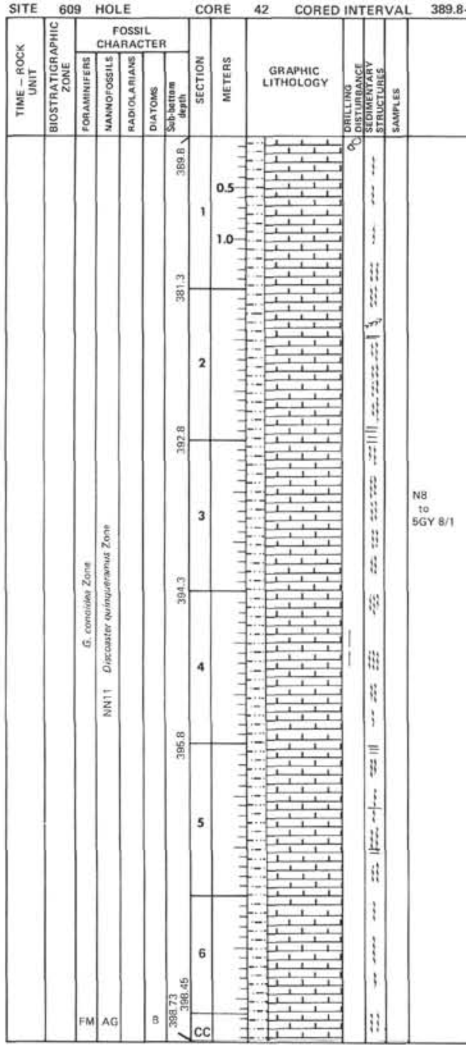
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, very light greenish (5GY 8/1) interbedded with greenish gray (5GY 6/1) marly nannofossil chalk. Strongly bioturbated, all contacts gradational.

ORGANIC CARBON AND CARBONATE (%)

	6, 65–66
Organic carbon	–
Carbonate	56

SITE 609 HOLE CORE 42 CORED INTERVAL 389.8–399.4 m



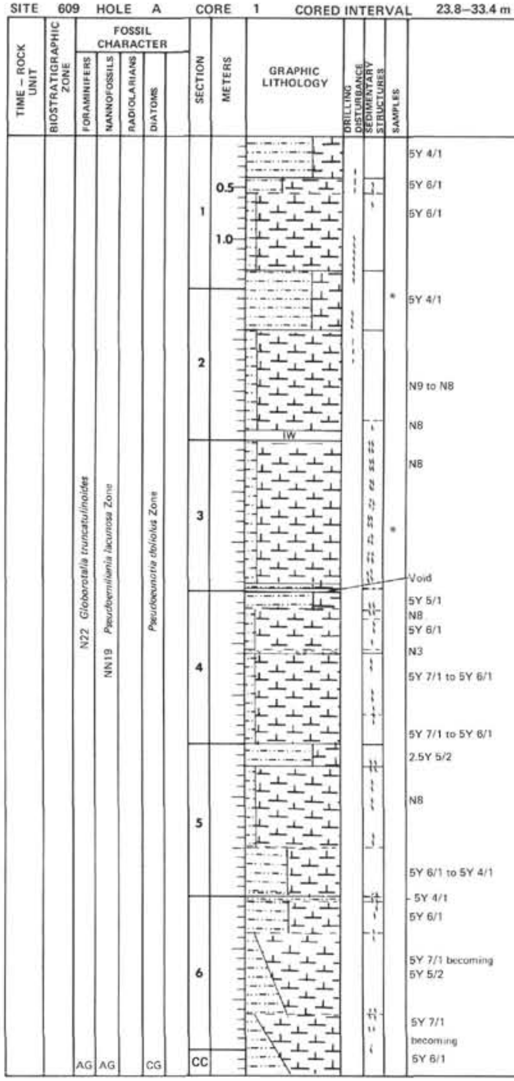
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, predominantly very light gray (N8) to very light greenish gray (5GY 8/1). Large olive gray (5Y 7/1) burrows and lenticular patches with dark halos are as well characteristic as bands of green (5G 6/1) laminations.

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66
Organic carbon	–
Carbonate	83

SITE 609 HOLE A CORE 1 CORED INTERVAL 23.8–33.4 m *



LITHOLOGIC DESCRIPTION

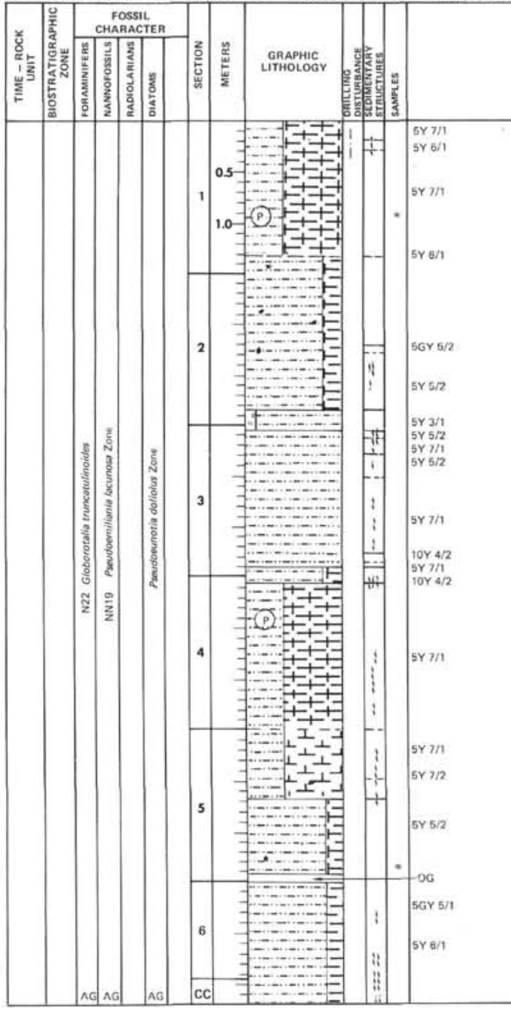
Interbedded CALCAREOUS MUD and NANNOFOSSIL OOZE to MARLY NANNOFOSSIL OOZE. Layer (3 cm) rich in volcanic ash at 4,53 cm; burrows occasionally surrounded by purple halos; dark mottles throughout.

*Core shot one stand too low.

SMEAR SLIDE SUMMARY (%)

	2, 2 M	3, 80 D	4, 57 M	6, 90 M
Texture:				
Sand	15	–	30	–
Silt	40	–	40	–
Clay	45	–	30	–
Composition:				
Quartz	30	10	10	32
Feldspar	5	–	25	3
Mica	5	–	–	–
Heavy minerals	5	–	–	TR
Clay	70	TR	20	–
Volcanic glass	TR	–	5	–
Glauconite	TR	–	–	–
Pyrite	TR	–	–	–
Carbonate unspec.	–	1	10	TR
Foraminifers	5	3	–	5
Calc. nannofossils	10	85	TR	60
Diatoms	–	TR	–	–
Radiolarians	–	1	–	TR
Sponge spicules	–	TR	–	–
Basalt/tuff clasts	–	–	30	–

SITE 609 HOLE A CORE 2 CORED INTERVAL 33.4–43.0 m*



LITHOLOGIC DESCRIPTION

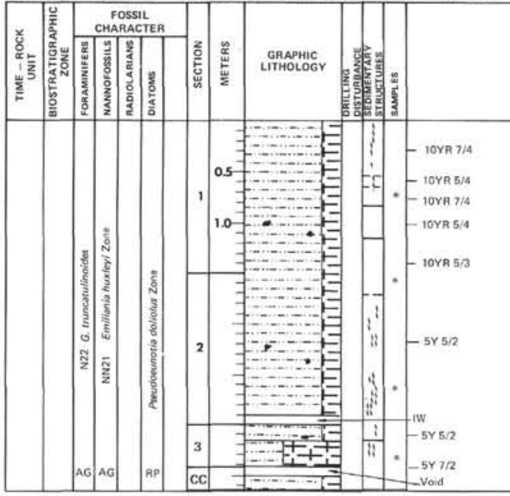
Interbedded CALCAREOUS MUD to MUD and MARLY FORAMINIFERAL NANNOFOSSIL OOZE; occasional dropstones of varying lithologies throughout. Several 1–5 mm laminae of purple (5P 2/2) and green (5GY 6/1) in Sections 4 and 6. Pyritized worm burrows at Section 1, 93 cm and Section 4, 42 cm; 10 cm layer rich in volcanic ash at Section 2, 43 cm.

*Core shot one stand too low.

SMEAR SLIDE SUMMARY (%)

	1, 86 D	2, 137 M	5, 135 D
Texture:			
Sand	–	15	15
Silt	–	25	35
Clay	–	60	50
Composition:			
Quartz	30	7	68
Feldspar	1	1	1
Heavy minerals	2	–	3
Clay	15	20	15
Volcanic glass	2	–	2
Carbonate unspec.	1	2	8
Foraminifers	20	–	2
Calc. nannofossils	29	TR	1
Diatoms	TR	–	–
Sponge spicules	TR	–	–

SITE 609 HOLE B CORE 1 CORED INTERVAL 0.0–3.6 m



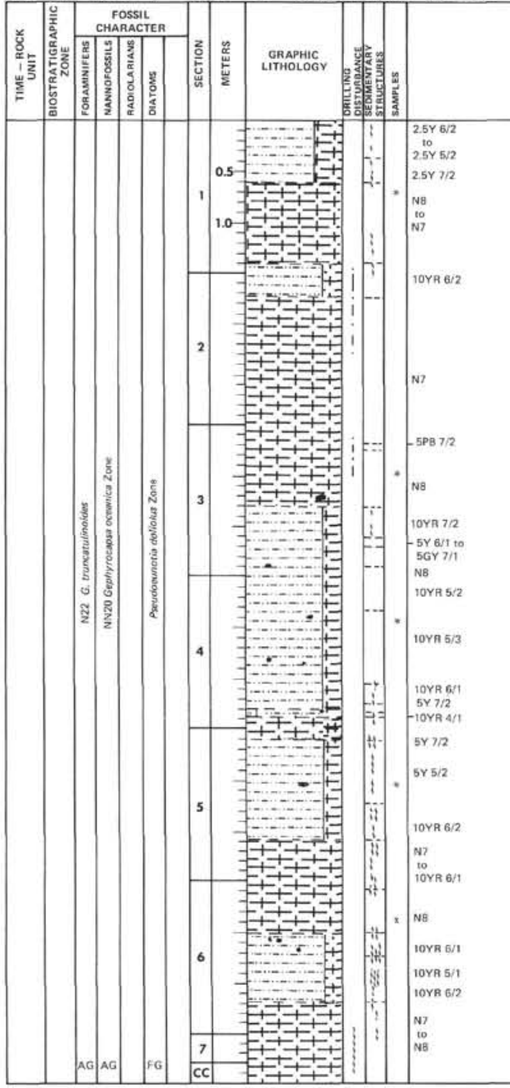
LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and MARLY FORAMINIFERAL NANNOFOSSIL OOZE; occasional dropstones of varying lithologies; up to 6 cm.

SMEAR SLIDE SUMMARY (%)

	1, 71 D	2, 4 D	2, 108 D	3, 35 M
Texture:				
Sand	15	10	5	–
Silt	35	30	25	–
Clay	50	60	70	–
Composition:				
Quartz	50	59	49	2
Feldspar	1	1	TR	1
Heavy minerals	2	3	2	TR
Clay	20	25	30	40
Volcanic glass	1	2	–	–
Carbonate unspec.	14	10	6	–
Foraminifers	6	–	5	15
Calc. nannofossils	6	TR	8	40
Diatoms	–	–	–	2
Sponge spicules	–	–	–	TR
Silicoflagellates	–	–	–	TR

SITE 609 HOLE B CORE 2 CORED INTERVAL 3.6–13.2 m



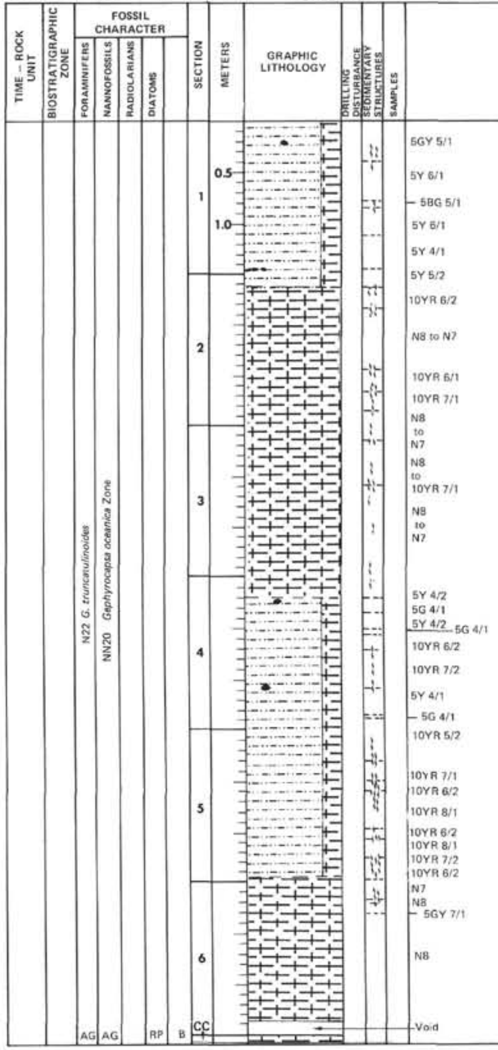
LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and FORAMINIFERAL NANNOFOSSIL OOZE, olive gray to brown and light gray; dropstones of varying lithologies throughout. Occasional 1–2 cm layers of green (5BG 7/2) or purple (5P 4/2) in Sections 1–3.

SMEAR SLIDE SUMMARY (%)

	1, 70 D	3, 43 D	4, 43 D	5, 47 D	6, 37 D
Texture:					
Sand	–	–	15	15	–
Silt	–	–	25	40	–
Clay	–	–	60	45	–
Composition:					
Quartz	1	–	46	50	–
Feldspar	1	TR	2	1	TR
Heavy minerals	TR	TR	2	6	TR
Clay	5	–	20	13	25
Volcanic glass	–	–	1	–	–
Carbonate unspec.	1	–	10	7	TR
Foraminifers	6	16	16	10	19
Calc. nannofossils	83	81	3	8	53
Diatoms	3	3	–	–	3
Radiolarians	TR	TR	–	–	TR
Sponge spicules	–	TR	–	–	TR
Silicoflagellates	TR	TR	–	–	TR

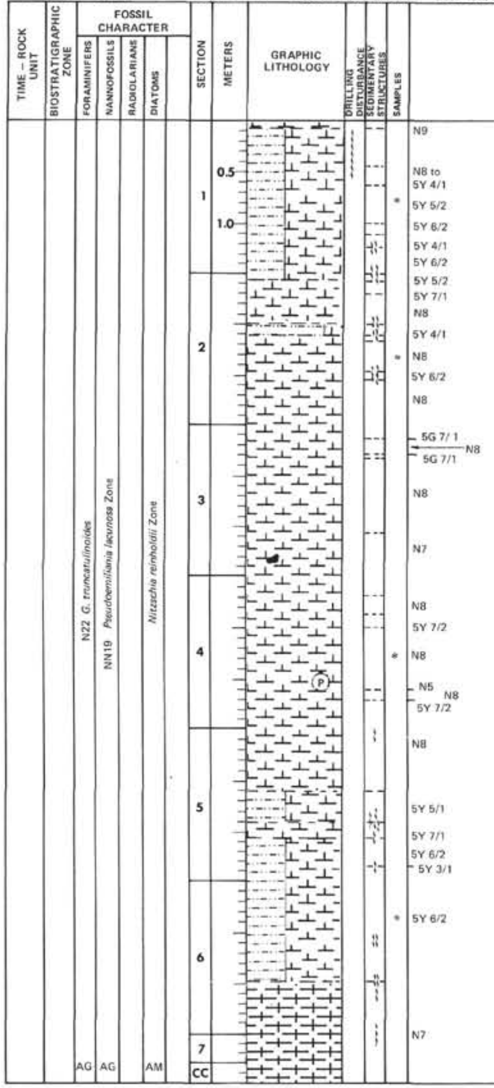
SITE 609 HOLE B CORE 3 CORED INTERVAL 13.2–22.8 m



LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and FORAMINIFERAL NANNOFOSSIL OOZE, olive brown to brown and pale gray. One cm layers of dark greenish gray throughout. Occasional dropstones. Several hard mud clasts at Section 1, 45 cm.

SITE 609 HOLE B CORE 4 CORED INTERVAL 22.8–32.4 m



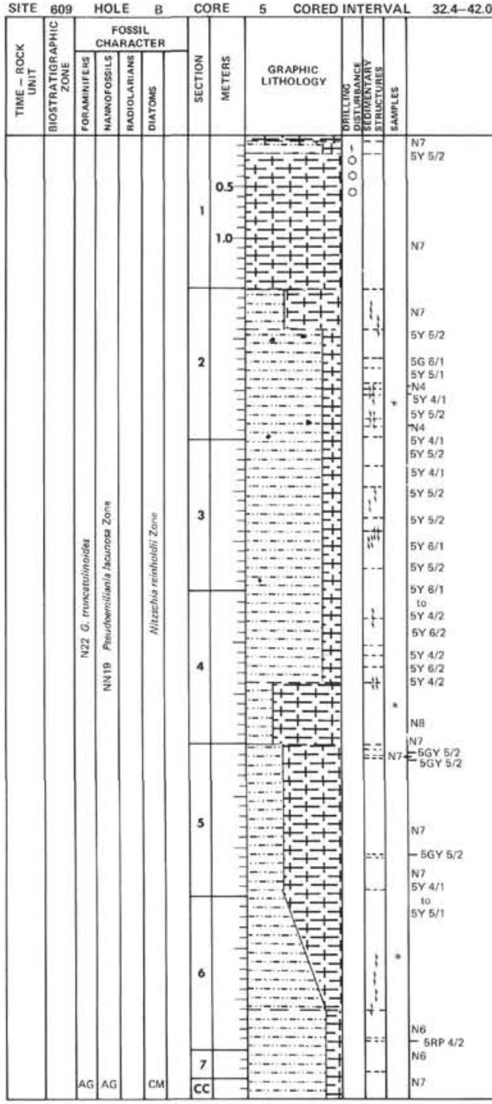
LITHOLOGIC DESCRIPTION

Interbedded NANNOFOSSIL OOZE, MARLY NANNOFOSSIL OOZE and FORAMINIFERAL NANNOFOSSIL OOZE, olive brown to pale gray. Occasional 1–10 mm laminae of dark gray (N5); 4 cm dropstone at Section 3, 135 cm. One cm pyritized burrow at Section 4, 106 cm.

SMEAR SLIDE SUMMARY (%)

	1, 74 M	2, 74 D	4, 76 M	6, 32 M
Composition:				
Quartz	2	–	–	–
Feldspar	TR	–	TR	TR
Heavy minerals	2	–	–	TR
Clay	38	3	4	35
Volcanic glass	TR	TR	–	–
Carbonate unspec.	2	–	–	2
Foraminifers	5	18	10	20
Calc. nannofossils	51	79	85	45
Diatoms	–	TR	1	TR
Radiolarians	TR	TR	TR	TR
Sponge spicules	–	TR	–	TR
Silicoflagellates	–	–	TR	–

SITE 609 HOLE B CORE 5 CORED INTERVAL 32.4–42.0 m



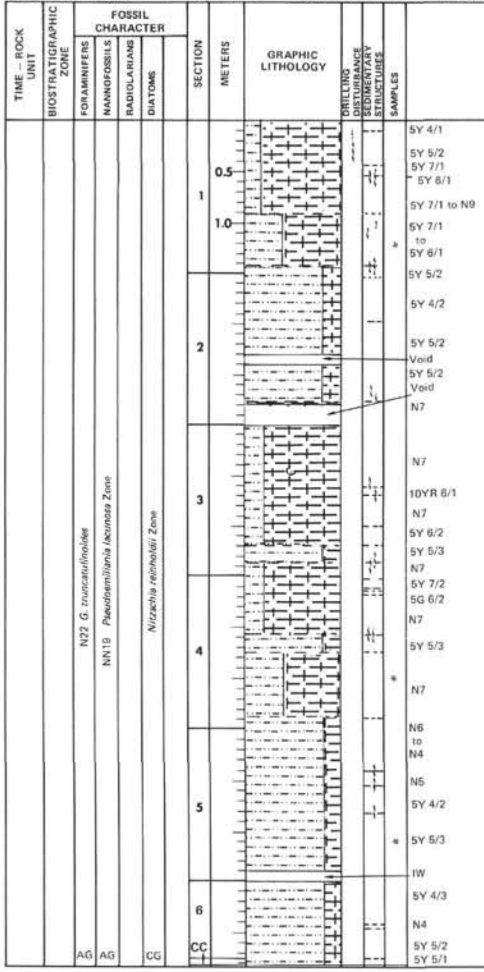
LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and FORAMINIFERAL NANNOFOSSIL OOZE. Dropstones of varying lithologies in Sections 2–3; 1–10 mm pale green (5GY 5/2) laminations in Sections 4, 5, and Core Catcher. 1–10 mm grayish purple (5P 4/2) laminae at Section 4, 49 cm and Section 6, 134–137 cm.

SMEAR SLIDE SUMMARY (%)

	2, 115 D	4, 107 D	6, 56 D
Texture:			
Sand	20	–	20
Silt	40	–	35
Clay	40	–	45
Composition:			
Quartz	47	–	58
Feldspar	1	1	1
Heavy minerals	2	–	3
Clay	20	30	25
Volcanic glass	–	–	2
Carbonate unspec.	3	–	10
Foraminifers	11	25	2
Calc. nannofossils	16	42	–
Diatoms	–	2	–
Radiolarians	–	TR	–
Sponge spicules	–	TR	–
Silicoflagellates	–	TR	–

SITE 609 HOLE B CORE 6 CORED INTERVAL 42.0–51.6 m



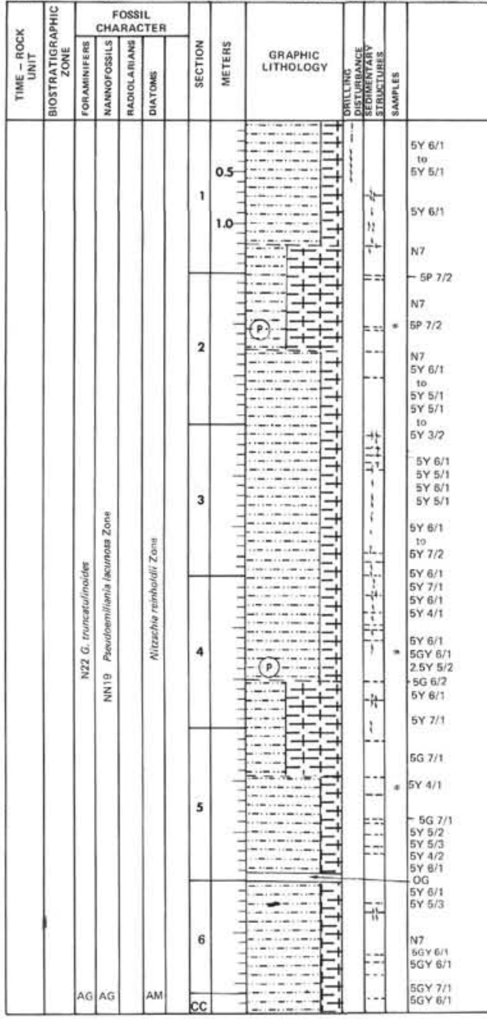
LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and FORAMINIFRAL NANNOFOSSIL OOZE. Olive brown to brown and light to dark gray. 5–10 mm laminae of green to greenish gray (5G 6/2–5BG 7/1) common in Sections 3–4.

SMEAR SLIDE SUMMARY (%)

	1, 119 D	4, 95 M	5, 112 D
Texture:			
Sand	–	–	15
Silt	–	–	30
Clay	–	–	55
Composition:			
Quartz	4	–	35
Feldspar	1	TR	TR
Heavy minerals	2	–	3
Clay	15	35	41
Volcanic glass	TR	–	2
Carbonate unspec.	–	1	8
Foraminifers	16	17	7
Calc. nannofossils	62	43	4
Diatoms	–	4	–
Radiolarians	–	TR	–
Sponge spicules	–	TR	–
Silicoflagellates	–	TR	–

SITE 609 HOLE B CORE 7 CORED INTERVAL 51.6–61.2 m



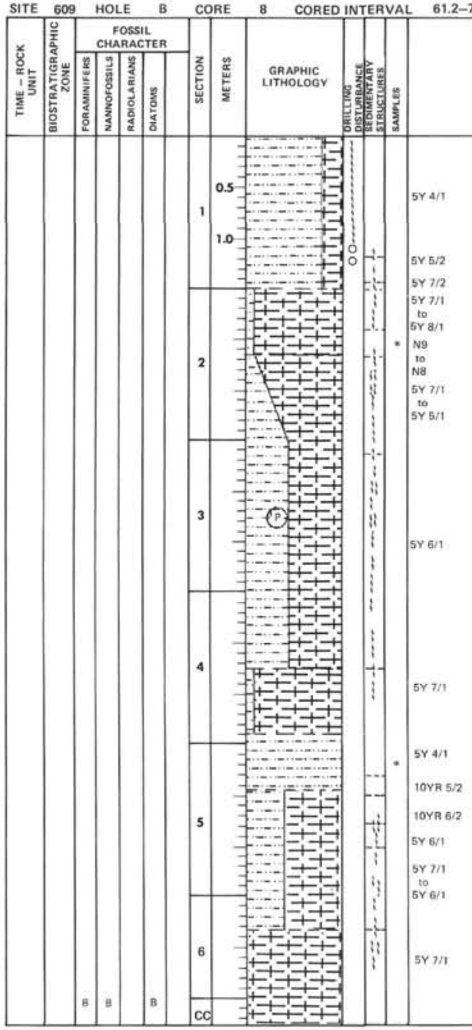
LITHOLOGIC DESCRIPTION

Interbedded CALCAREOUS MUD and MARLY FORAMINIFERAL NANNOFOSSIL OOZE. Olive gray to gray and light gray to gray. Occasional 1 cm pale purple (5P 7/2) and green (5G 6/2) laminae throughout. Pyritized burrows at Section 2, 61 cm and Section 4, 98 cm. Mudstone pebble at Section 6, 22 cm.

SMEAR SLIDE SUMMARY (%)

	2, 43 M	4, 74 D	3, 62 D
Texture:			
Sand	–	10	15
Silt	–	20	25
Clay	–	70	60
Composition:			
Quartz	3	42	51
Feldspar	TR	TR	1
Heavy minerals	–	TR	4
Clay	35	12	20
Carbonate unspec.	–	TR	3
Foraminifers	15	17	15
Calc. nannofossils	44	25	8
Diatoms	3	4	–
Radiolarians	–	TR	–
Sponge spicules	TR	–	–

SITE 609 HOLE B CORE 8 CORED INTERVAL 61.2–70.8 m



LITHOLOGIC DESCRIPTION

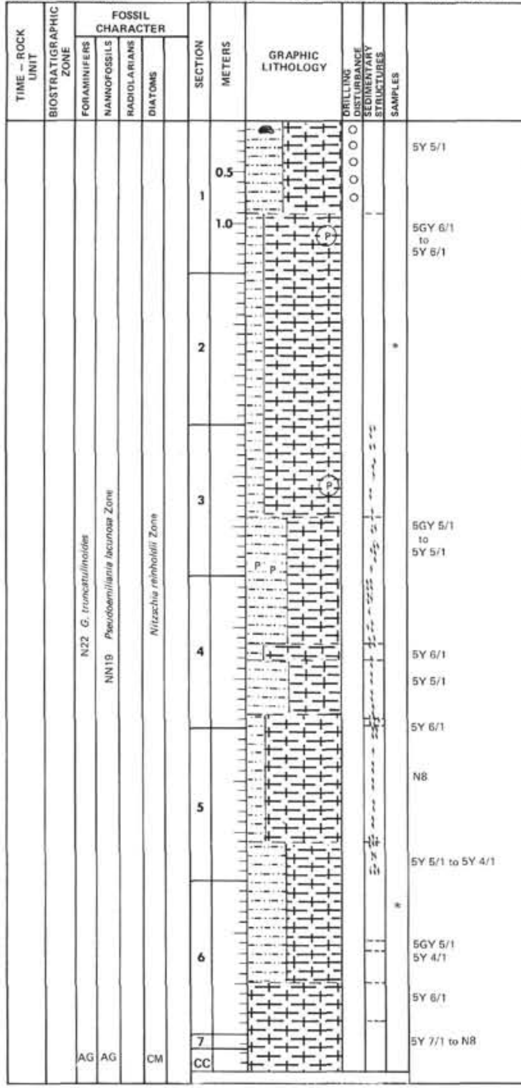
Interbedded CALCAREOUS MUD and FORAMINIFERAL NANNOFOSSIL OOZE to MARLY FORAMINIFERAL NANNOFOSSIL OOZE. 5–10 mm diffuse green (5G 6/1) laminae throughout. Dark gray mottling common in Section 6. Pyritized 3 cm worm burrow at Section 3, 77 cm.

Pebbles in the top of this core are washed down from overlying units during drilling.

SMEAR SLIDE SUMMARY (%)

	2, 52 D	5, 20 M
Texture:		
Sand	–	20
Silt	–	50
Clay	–	30
Composition:		
Quartz	10	71
Feldspar	–	10
Heavy minerals	–	TR
Clay	–	20
Volcanic glass	–	15
Carbonate unspec.	–	1
Foraminifers	10	–
Calc. nannofossils	80	3
Radiolarians	TR	–

SITE 609 HOLE B CORE 9 CORED INTERVAL 70.8–80.4 m



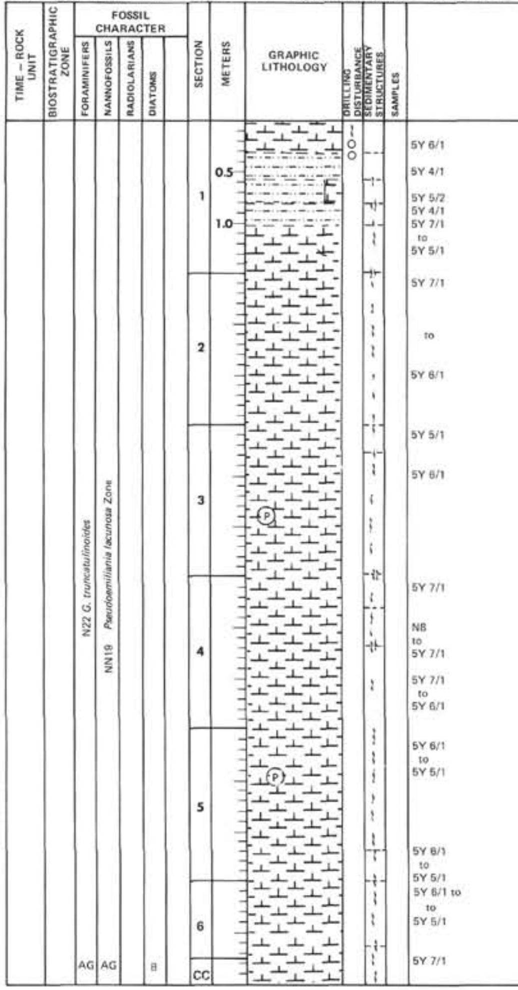
LITHOLOGIC DESCRIPTION

Interbedded FORAMINIFERAL NANNOFOSSIL OOZE and MARLY FORAMINIFERAL NANNOFOSSIL OOZE. Gray (N4–N7) and green (5G 5/2) mottling and occasional 5–20 mm laminae. Pyritized worm burrows at Section 1, 118 cm and Section 3, 63 cm. Abundant 3–5 mm pyrite fragments between Section 2, 137–141 cm. Pebble of vesicular basalt at top of core most likely a downhole contaminant.

SMEAR SLIDE SUMMARY (%)

	2, 70 D	6, 20 M
Texture:		
Sand	–	50
Silt	–	20
Clay	–	30
Composition:		
Quartz	20	40
Mica	TR	–
Heavy minerals	5	TR
Clay	–	15
Volcanic glass	–	20
Pyrite	–	5
Foraminifers	10	5
Calc. nannofossils	61	15
Diatoms	2	–
Radiolarians	TR	–
Sponge spicules	TR	–

SITE 609 HOLE B CORE 10 CORED INTERVAL 80.4–90.0 m



LITHOLOGIC DESCRIPTION

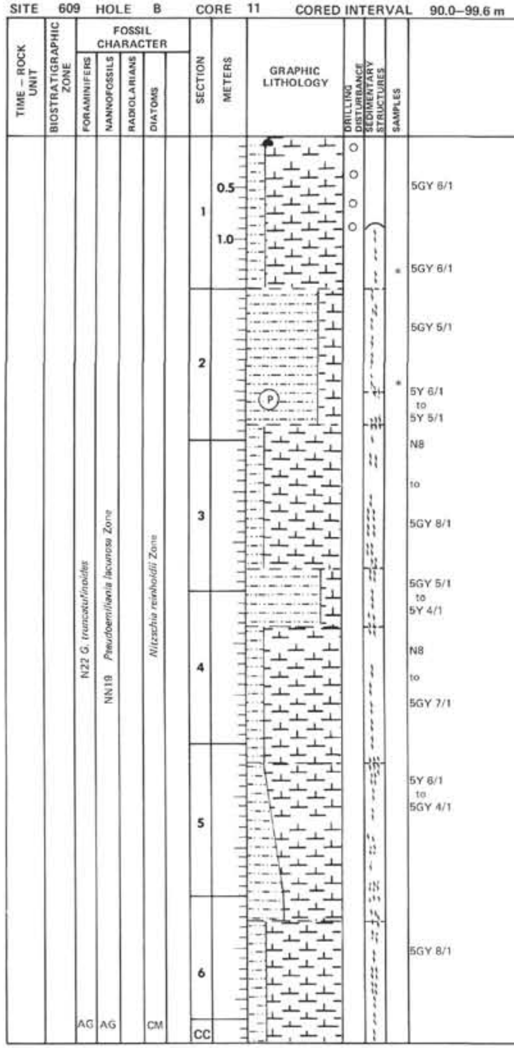
NANNOFOSSIL OOZE, pale brownish gray (5Y 5/1–5Y 7/1). Diffuse 5–10 mm green (5G 5/1–5GY 7/1) laminae common throughout. Gray mottling throughout. Pyritized worm burrows at Section 3, 89 amd and Section 5, 54 cm.

Interbedded MUD and CALCAREOUS MUD, dark olive gray (5Y 4/1–5Y 5/1). Small patches of volcaniclastic sand between Section 1, 55–101 cm.

SMEAR SLIDE SUMMARY (%)

	3, 10 D
Composition:	
Quartz	10
Clay	5
Pyrite	2
Carbonate unspec.	1
Foraminifers	10
Calc. nannofossils	59
Diatoms	12
Radiolarians	TR
Sponge spicules	1
Silicoflagellates	TR

SITE 609 HOLE B CORE 11 CORED INTERVAL 90.0–99.6 m



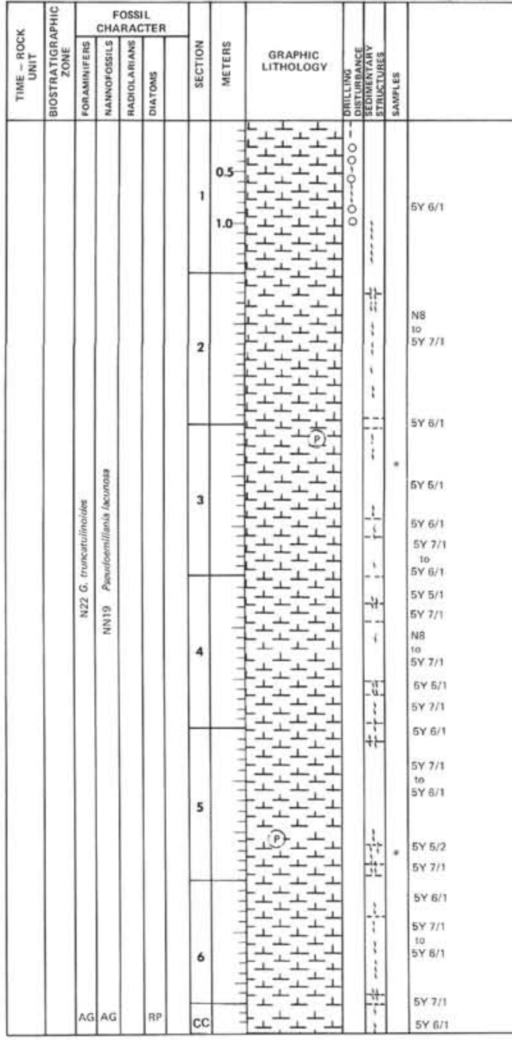
LITHOLOGIC DESCRIPTION

Interbedded NANNOFOSSIL OOZE and CALCAREOUS MUD, pale greenish gray (5GY 6/1) to pale gray (N8) and olive gray (5GY 5/1–5Y 4/1). Diffuse 5–10 mm green to gray (5GY 6/1–N5) laminae throughout Sections 2 and 3. Common dark mottling. Pyritized worm burrow at Section 2, 105 cm. Basalt pebble at top of core is most likely downhole contamination.

SMEAR SLIDE SUMMARY (%)

	1, 130 D	2, 92 M
Texture:		
Sand	–	10
Silt	–	30
Clay	–	60
Composition:		
Quartz	20	51
Feldspar	–	2
Heavy minerals	TR	4
Clay	1	20
Volcanic glass	TR	8
Carbonate unspec.	5	10
Foraminifers	5	TR
Calc. nannofossils	61	5
Diatoms	8	TR
Radiolarians	TR	–
Sponge spicules	TR	TR
Silicoflagellates	TR	–

SITE 609 HOLE B CORE 12 CORED INTERVAL 99.6–109.2 m



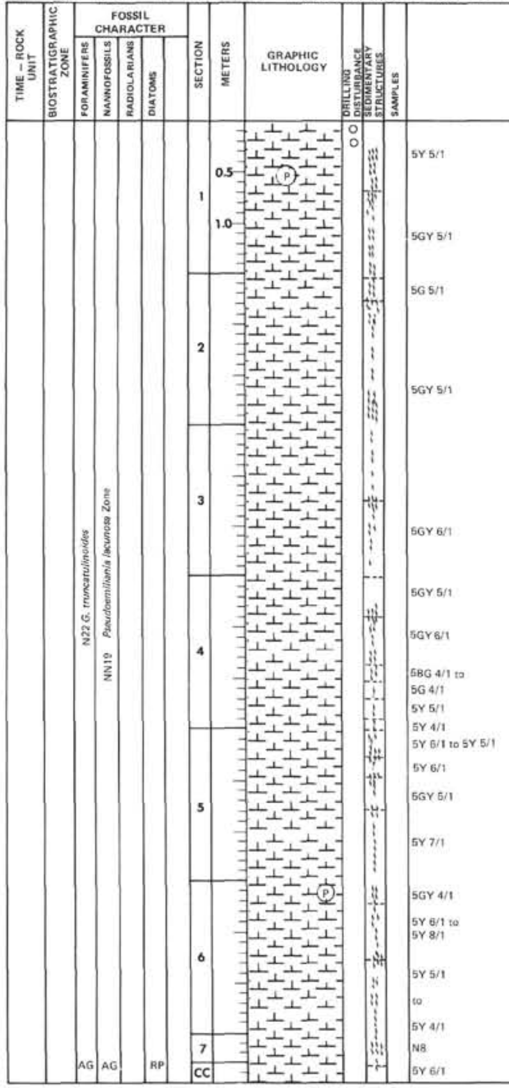
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, pale gray to brown (N8–5Y 5/1). 5–10 mm gray to green (N7–5GY 7/1) laminae throughout. Rare *Zoophycos*, dark gray mottling throughout. Pyritized burrows at Section 3, 10 cm and Section 5, 104 cm.

SMEAR SLIDE SUMMARY (%)

	3, 40 D	5, 120 D
Composition:		
Quartz	25	20
Mica	TR	–
Clay	–	5
Volcanic glass	–	TR
Foraminifers	7	4
Calc. nannofossils	68	71
Diatoms	TR	–
Radiolarians	TR	–
Sponge spicules	TR	–

SITE 609 HOLE B CORE 13 CORED INTERVAL 109.2–118.8 m

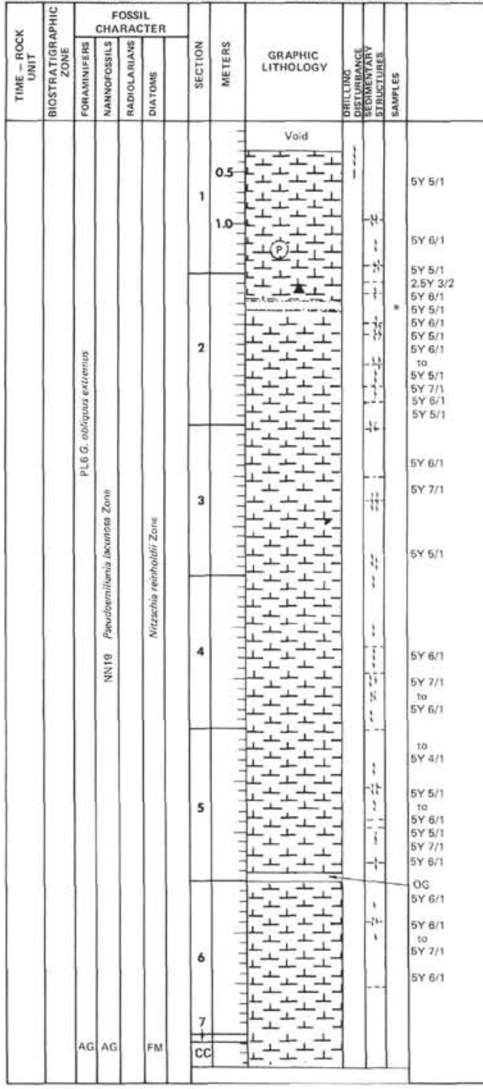


LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, olive gray (5Y 5/1–5GY 6/1). Common diffuse 5–10 mm green (5G 5/1–5GY 6/1) laminae throughout. Dark gray mottles throughout. Pyrite burrows at Section 1, 55 cm and Section 6, 5 cm.

Note: Section 5 is only 140 cm long – not 150 cm (section cut toò short).

SITE 609 HOLE B CORE 14 CORED INTERVAL 118.8–128.4 m



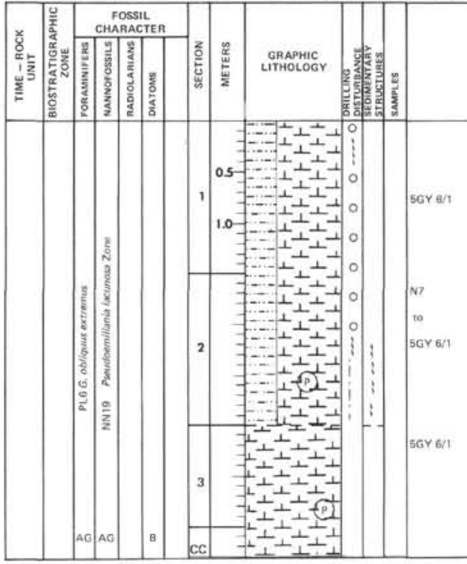
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, grayish brown (5Y 4/1–5Y 7/1). 5–10 mm green to gray (5G 5/1–N7) laminations throughout. Rare *Zoophycos*. Dark gray mottles throughout. Pebbles at Section 2, 13 cm (volcanic) and Section 3, 94 cm (ash-rich mudstone). Pyritized burrow at Section 1, 123 cm.

SMEAR SLIDE SUMMARY (%)

	2, 31
	M
Texture:	
Sand	25
Silt	40
Clay	35
Composition:	
Quartz	52
Feldspar	15
Mica	1
Heavy minerals	TR
Clay	15
Glauconite	TR
Carbonate unspec.	2
Foraminifers	TR
Calc. nannofossils	5

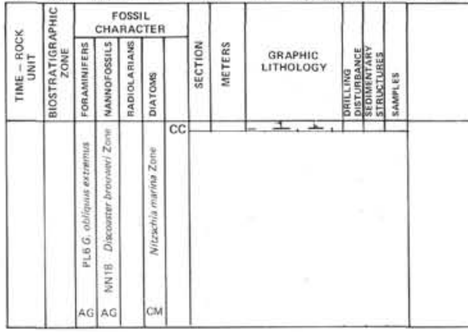
SITE 609 HOLE B CORE 15 CORED INTERVAL 128.4–133.9 m



LITHOLOGIC DESCRIPTION

MARLY NANNOFOSSIL OOZE to NANNOFOSSIL OOZE, gray to grayish green (N7–5GY 6/1). Occasional greenish gray mottles. Pyritized burrows at Section 2, 100 cm and Section 3, 86 cm.

SITE 609 HOLE B CORE 16 CORED INTERVAL 133.9–143.5 m

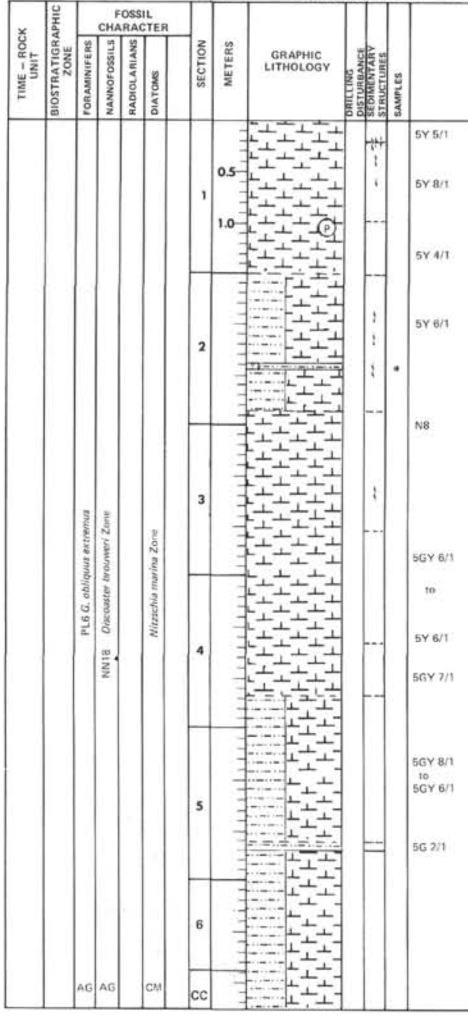


LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, pale gray (N8).

Note: This core consists of a Core Catcher only. Pebbles in catcher are probably downhole contaminants.

SITE 609 HOLE B CORE 17 CORED INTERVAL 143.5–153.1 m



LITHOLOGIC DESCRIPTION

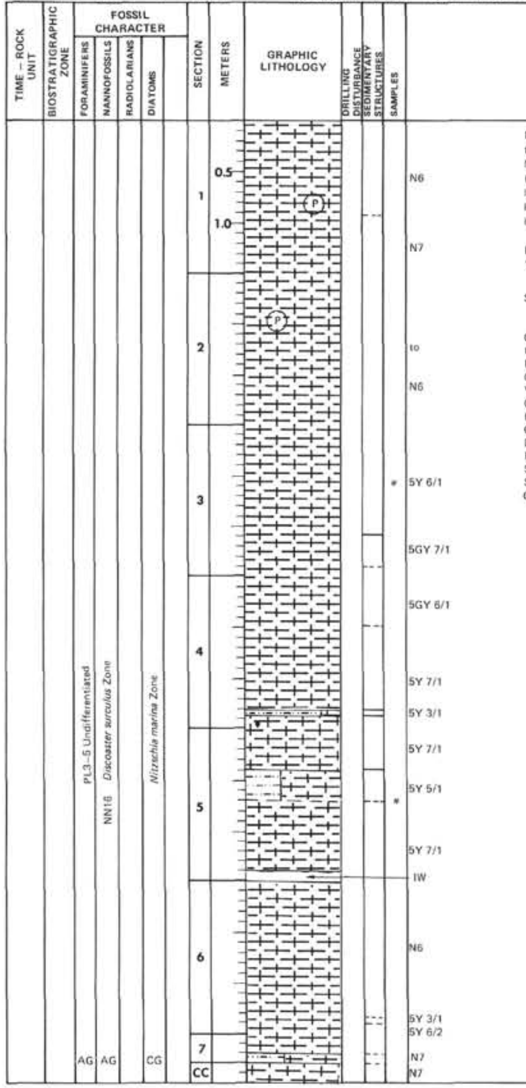
Interbedded NANNOFOSSIL OOZE and MARLY NANNOFOSSIL OOZE. Occasional 5–10 mm green to gray (5G 5/1–N6) laminae throughout. Dark gray to olive mottling throughout. Volcanic-rich mud layer Section 2, 88–91 cm. Mud layer Section 5, 111–119 cm; sharp base. Pyritized burrow at Section 1, 109 cm.

SMEAR SLIDE SUMMARY (%)

	2, 90 M
Texture:	
Sand	10
Silt	50
Clay	40
Composition:	
Quartz	25
Feldspar	15
Heavy minerals	5
Clay	30
Volcanic glass	15
Carbonate unspec.	5
Calc. nannofossils	5

Note: Core 18, 153.1–162.7 m, no recovery.

SITE 609 HOLE B CORE 19 CORED INTERVAL 162.7–172.3 m



LITHOLOGIC DESCRIPTION

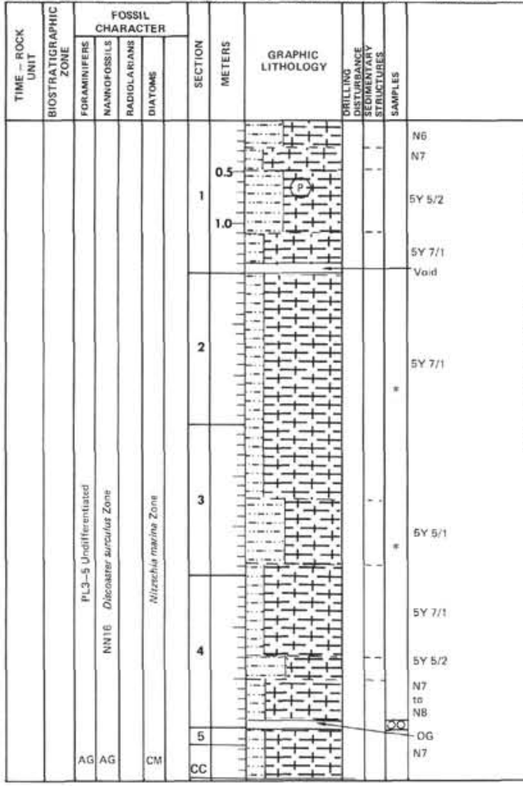
FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (N6–5GY 6/1). Occasionally becoming MARLY FORAMINIFERAL NANNOFOSSIL OOZE (N7–5Y 5/1). 5–10 mm green (10G 6/2–5G 6/2) laminae common throughout. Dark mottling throughout. Pebble (mudstone) at Section 4, 142 cm. Pyritized burrows at Section 1, 85 cm and Section 2, 46 cm.

Layer of CALCAREOUS MUD between Section 4, 125–130 cm.

SMEAR SLIDE SUMMARY (%)

	3, 57 D	5, 64 M
Composition:		
Quartz	2	10
Feldspar	TR	1
Clay	23	30
Volcanic glass	–	TR
Carbonate unspec.	-	2
Foraminifers	12	10
Calc. nannofossils	58	47
Diatoms	4	TR
Radiolarians	TR	TR
Sponge spicules	TR	TR
Silicoflagellates	TR	–
Opaque oxides	1	–

SITE 609 HOLE B CORE 20 CORED INTERVAL 172.3–181.9 m



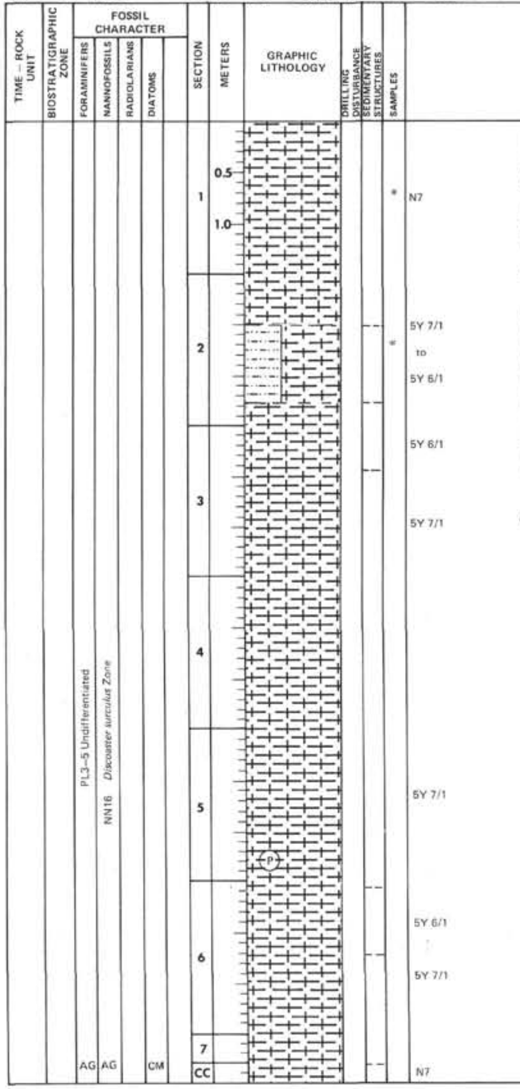
LITHOLOGIC DESCRIPTION

Interbedded FORAMINIFERAL NANNOFOSSIL OOZE and MARLY FORAMINIFERAL OOZE, pale gray to pale brown (N7 to 5Y 5/1). 5–10 mm green (5GY 5/2) laminae throughout. Dark mottles throughout. Pyritized burrow at Section 1, 61 cm.

SMEAR SLIDE SUMMARY (%)

	2, 113 D	3, 118 M
Composition:		
Quartz	–	4
Feldspar	TR	TR
Clay	18	35
Micronodules	TR	TR
Carbonate unspec.	–	1
Foraminifers	10	10
Calc. nannofossils	65	45
Diatoms	6	4
Radiolarians	–	TR
Sponge spicules	TR	TR
Silicoflagellates	–	TR
Opaque oxides	1	1

SITE 609 HOLE B CORE 21 CORED INTERVAL 181.9–191.5 m



LITHOLOGIC DESCRIPTION

FORAMINIFERAL NANNOFOSSIL OOZE, pale gray (N7–5Y 6/1) becoming MARLY FORAMINIFERAL NANNOFOSSIL OOZE (5Y 7/1–5Y 6/1) between Section 2, 50–127 cm.

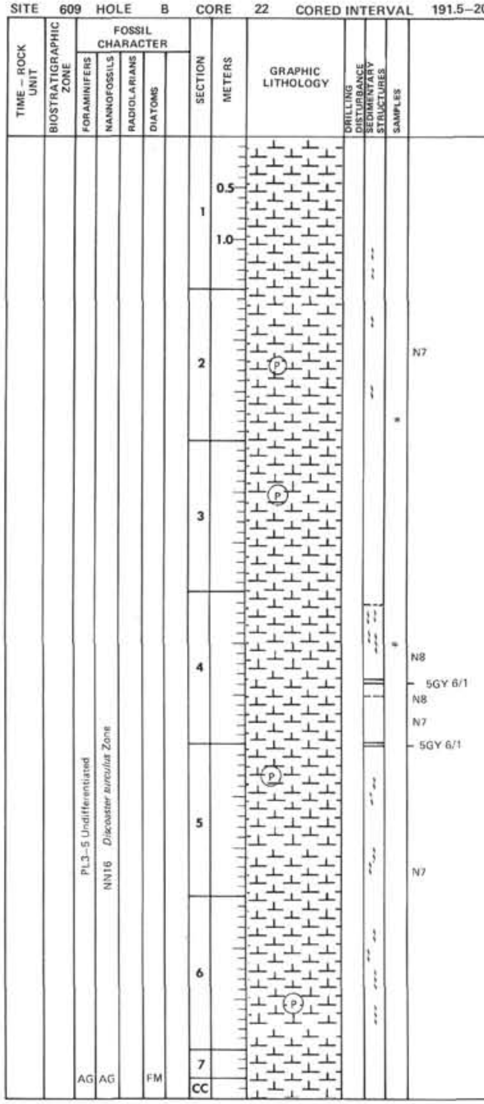
5–10 mm laminae of green (5GY 8/2) common throughout. Dark gray to olive gray mottles throughout. Pyritized burrow at Section 5, 130 cm.

SMEAR SLIDE SUMMARY (%)

	1, 73 D	2, 70 M
Composition:		
Quartz	1	4
Feldspar	TR	TR
Heavy minerals	TR	–
Clay	25	35
Carbonate unspec.	–	TR
Foraminifers	10	10
Calc. nannofossils	61	48
Diatoms	2	2
Radiolarians	TR	TR
Sponge spicules	TR	TR
Silicoflagellates	TR	–
Opaque oxides	1	1

Note: Section 7 is 55 cm long.

SITE 609 HOLE B CORE 22 CORED INTERVAL 191.5–201.1 m



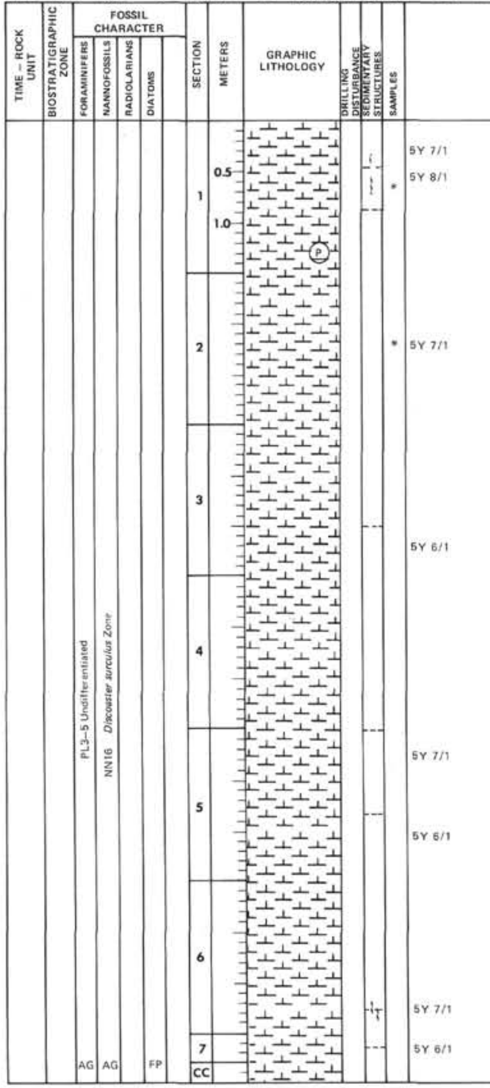
LITHOLOGIC DESCRIPTION

FORAMINIFERAL NANNOFOSSIL OOZE, gray, 5–10 mm laminae of green (5GY 6/1) common throughout. Dark gray (N3) mottles throughout. Pyritized burrows at Section 2, 73 cm, Section 3, 52 cm, Section 5, 30 cm and Section 6, 100 cm.

SMEAR SLIDE SUMMARY (%)

	2, 127 D	4, 47 D
Composition:		
Quartz	5	2
Feldspar	TR	TR
Heavy minerals	TR	–
Clay	12	8
Carbonate unspec.	–	TR
Foraminifers	13	15
Calc. nannofossils	70	75
Diatoms	TR	TR
Silicoflagellates	TR	–

SITE 609 HOLE B CORE 23 CORED INTERVAL 201.1–210.7 m



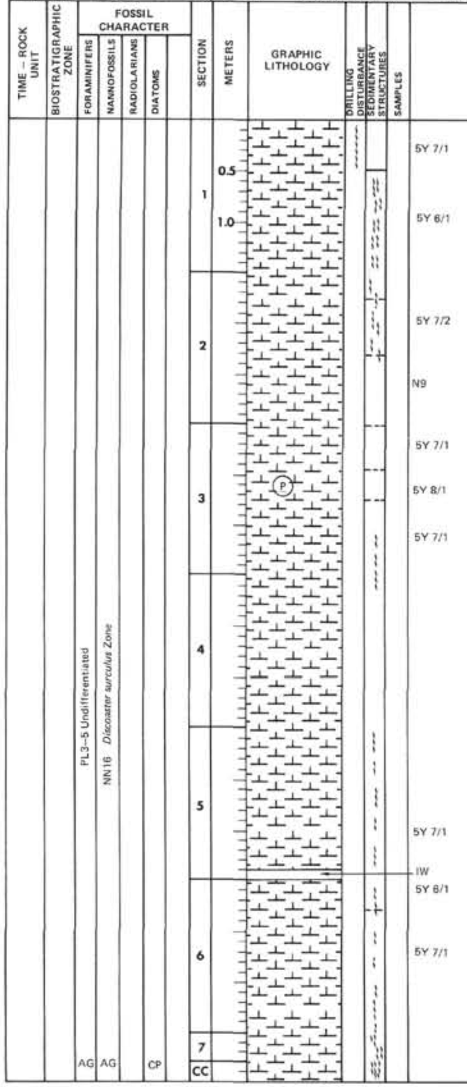
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, pale gray (5Y 8/1–5Y 6/1). 5–15 mm green (10GY 3/2) laminae common throughout. Dark gray (N3) mottles throughout. Pyritized burrow at Section 1, 129 cm.

SMEAR SLIDE SUMMARY (%)

	1, 68	2, 73
Composition:		
Quartz	TR	TR
Feldspar	TR	TR
Heavy minerals	–	TR
Clay	4	6
Micronodules	–	TR
Carbonate unspec.	TR	TR
Foraminifers	8	6
Calc. nannofossils	88	86
Diatoms	TR	2
Radiolarians	–	TR
Sponge spicules	TR	TR
Silicoflagellates	–	TR

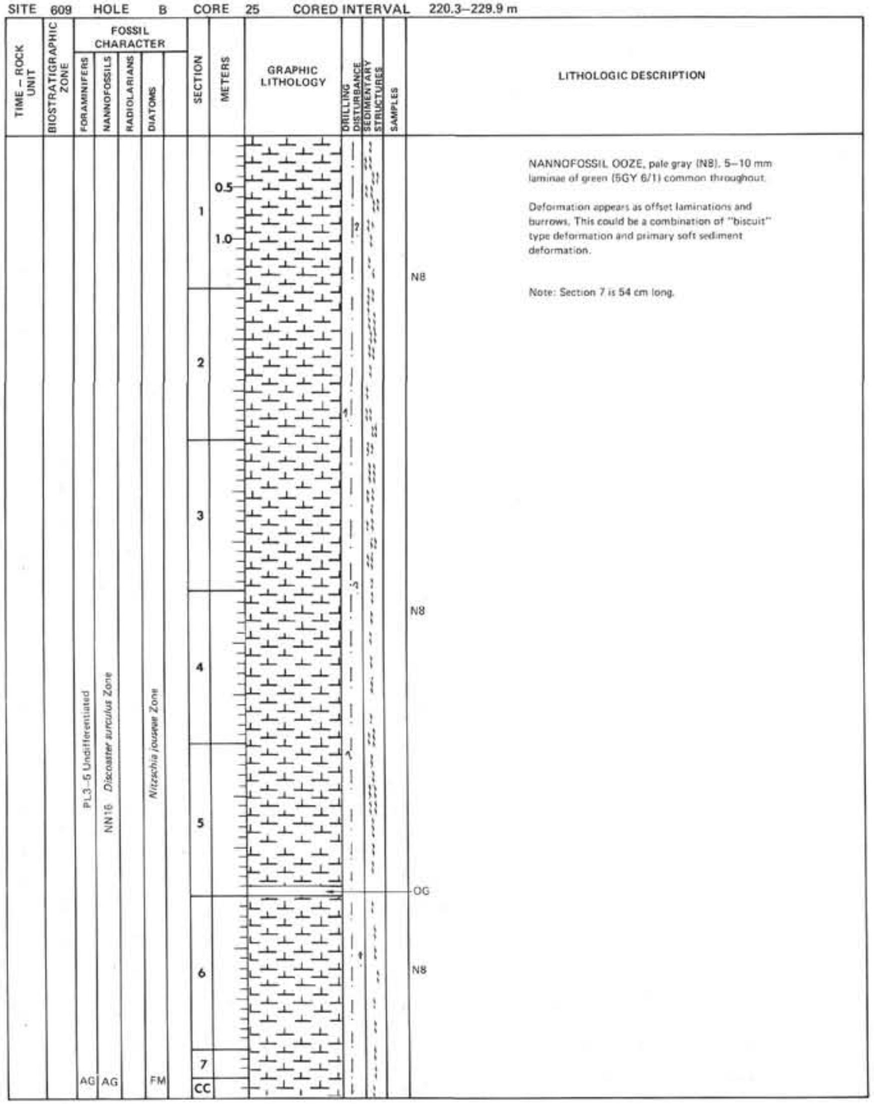
SITE 609 HOLE B CORE 24 CORED INTERVAL 210.7–220.3 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, pale gray (5Y 6/1–5Y 8/1). 5–10 mm green (5Y 5/2) laminae common throughout. Dark gray mottles throughout. Pyritized worm burrow at Section 3, 61 cm. Pebbles abundant in top of core are probably downhole contamination.

SITE 609 HOLE B CORE 25 CORED INTERVAL 220.3–229.9 m

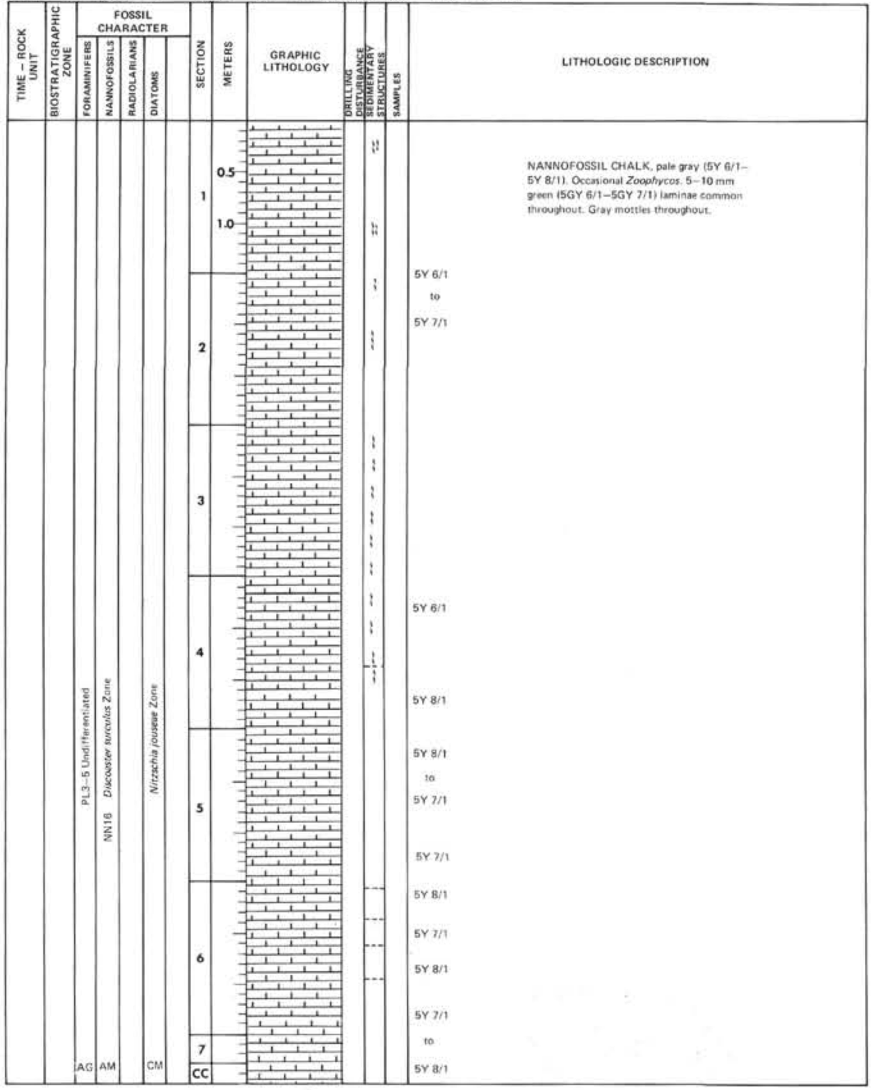


NANNOFOSSIL OOZE, pale gray (N8). 5–10 mm laminae of green (5GY 6/1) common throughout.

Deformation appears as offset laminations and burrows. This could be a combination of "biscuit" type deformation and primary soft sediment deformation.

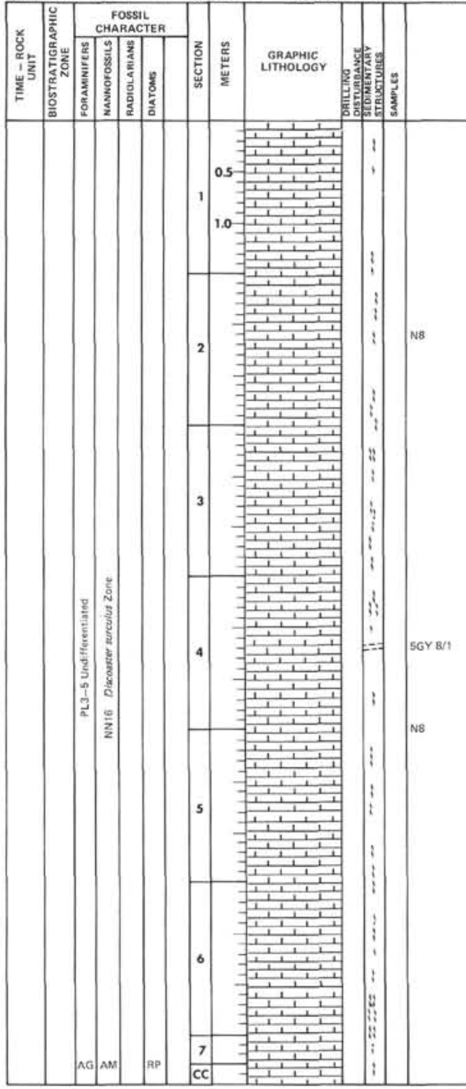
Note: Section 7 is 54 cm long.

SITE 609 HOLE B CORE 26 CORED INTERVAL 229.9–239.5 m



NANNOFOSSIL CHALK, pale gray (5Y 6/1–5Y 8/1). Occasional *Zoophycos*. 5–10 mm green (5GY 6/1–5GY 7/1) laminae common throughout. Gray mottles throughout.

SITE 609 HOLE B CORE 27 CORED INTERVAL 239.5–249.1 m

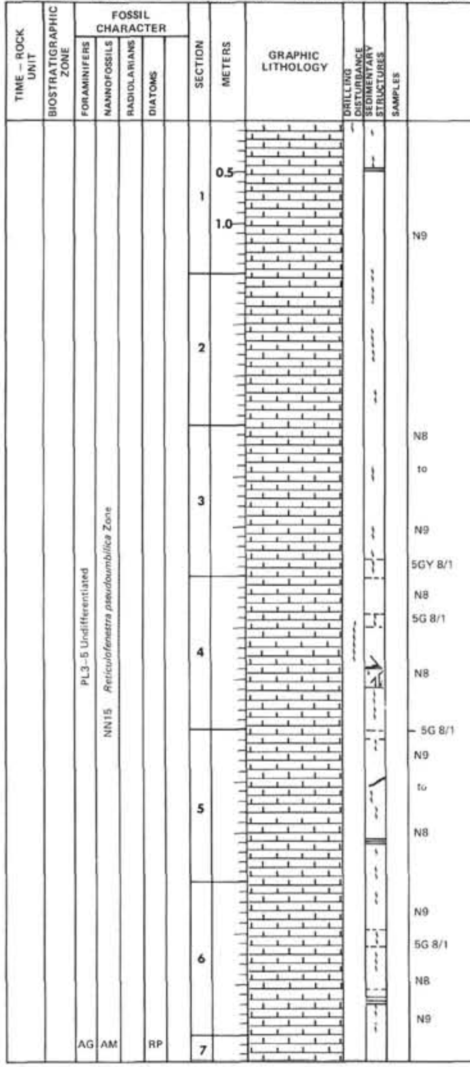


LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, pale gray (N8), faint green (5GY 8/1) 5–10 mm laminae common throughout *Zoophycos*. Dark gray mottling throughout.

Note: Section 7 is 58 cm long.

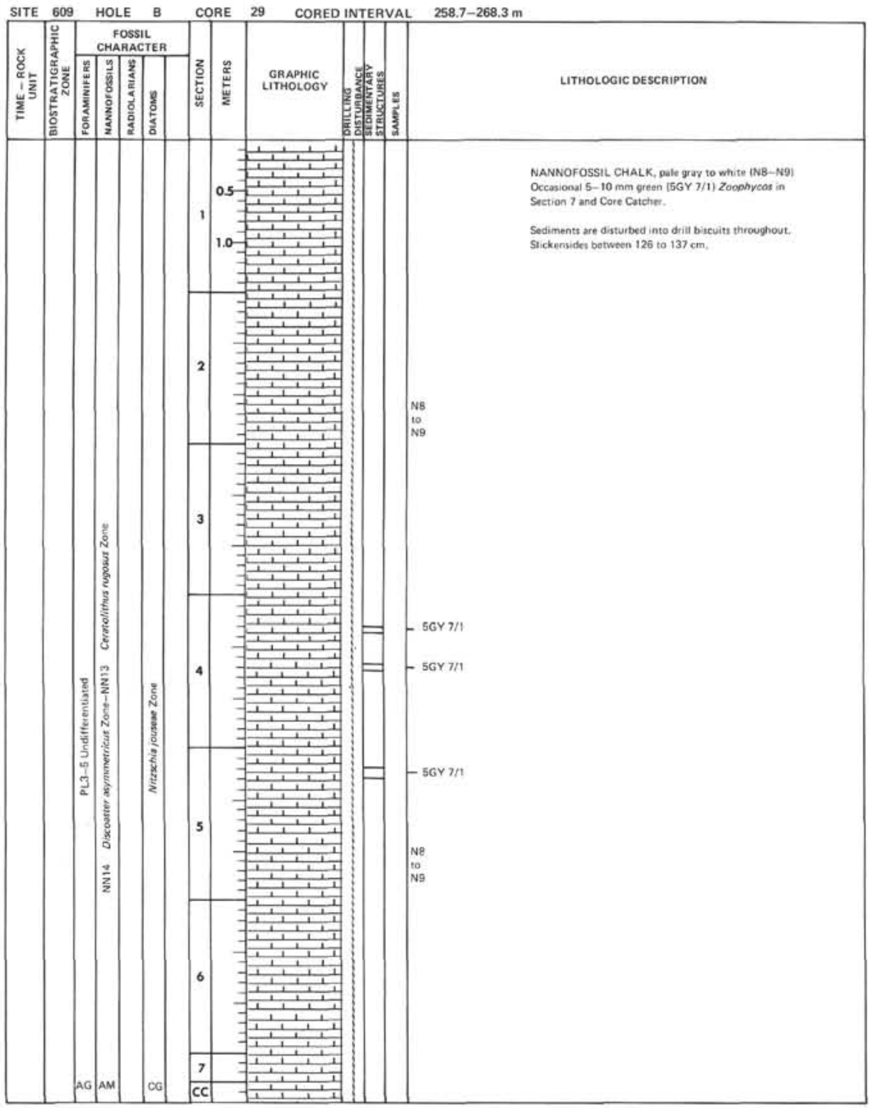
SITE 609 HOLE B CORE 28 CORED INTERVAL 249.1–258.7 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, pale gray (N8–N9) Rare *Zoophycos, Chondrites*. 5–10 mm green (5G 6/1–5G 8/1) laminations throughout. Several series (1 cm) of very thin (<1 mm) green (5G 6/1) laminations throughout. Occasional small faults with slickensides present Section 4, 72–88 cm. Dark gray mottling throughout.

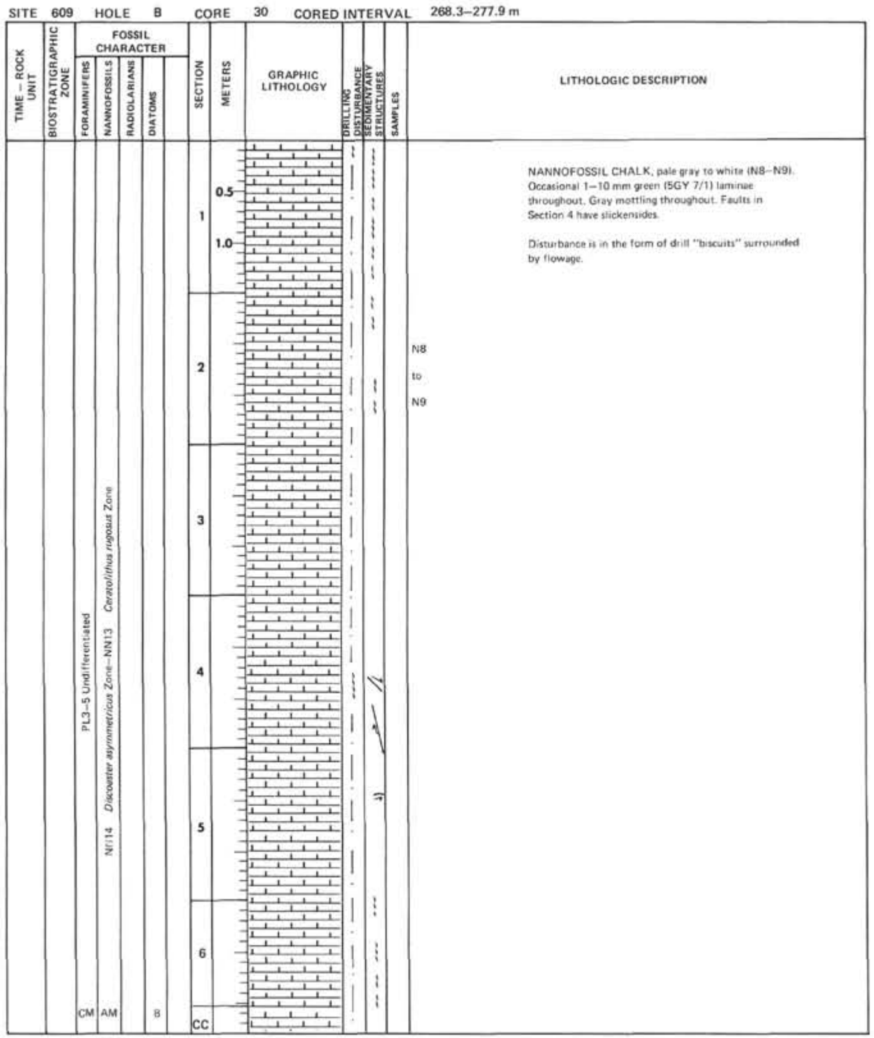
SITE 609 HOLE B CORE 29 CORED INTERVAL 258.7–268.3 m



NANNOFOSSIL CHALK, pale gray to white (N8–N9) Occasional 5–10 mm green (5GY 7/1) *Zoophycos* in Section 7 and Core Catcher.

Sediments are disturbed into drill biscuits throughout. Slickensides between 126 to 137 cm.

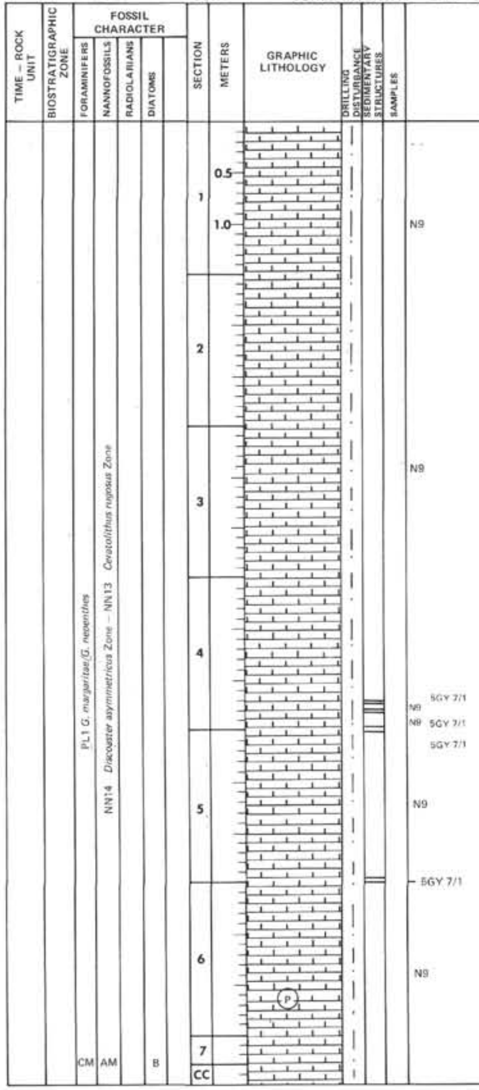
SITE 609 HOLE B CORE 30 CORED INTERVAL 268.3–277.9 m



NANNOFOSSIL CHALK, pale gray to white (N8–N9). Occasional 1–10 mm green (5GY 7/1) laminae throughout. Gray mottling throughout. Faults in Section 4 have slickensides.

Disturbance is in the form of drill "biscuits" surrounded by flowage.

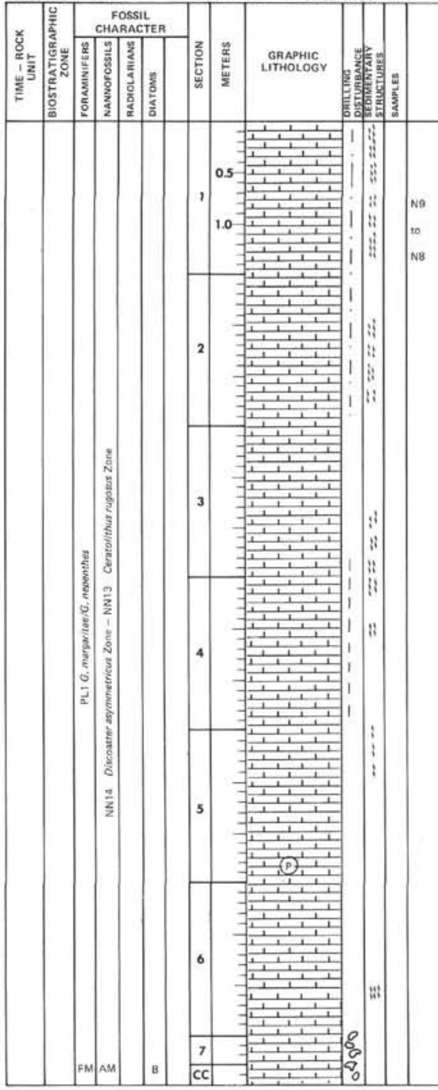
SITE 609 HOLE B CORE 31 CORED INTERVAL 277.9–287.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, white (N9), 5–10 mm green (5GY 7/1) laminations throughout. Rare *Zoophycos*. Gray mottles throughout. Microfractures with oxidized surfaces occasionally throughout. Pyritized burrow at Section 6, 114 cm. Disturbance is in the form of generally large, firm fragments (biscuits?) surrounded by breccia and flowage.

SITE 609 HOLE B CORE 32 CORED INTERVAL 287.5–297.1 m



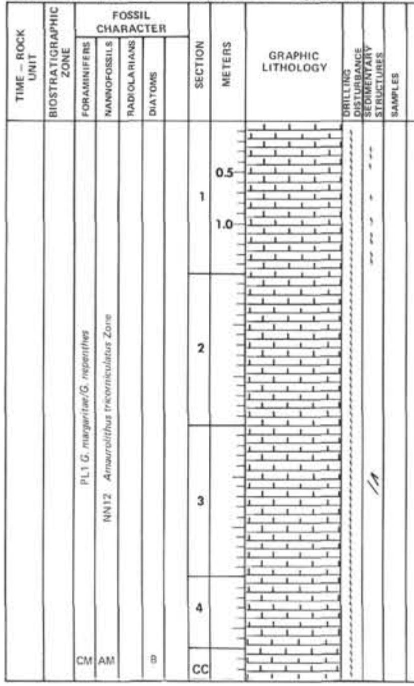
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, white to light gray (N8–N9), 5–20 mm green (5GY 7/1) laminae throughout. Dark mottles common throughout.

Pyritized worm burrow at Section 5, 135 cm.

Disturbance is in the form of large, hard fragments (biscuits) surrounded by flowage.

SITE 609 HOLE B CORE 33 CORED INTERVAL 297.1–306.7 m

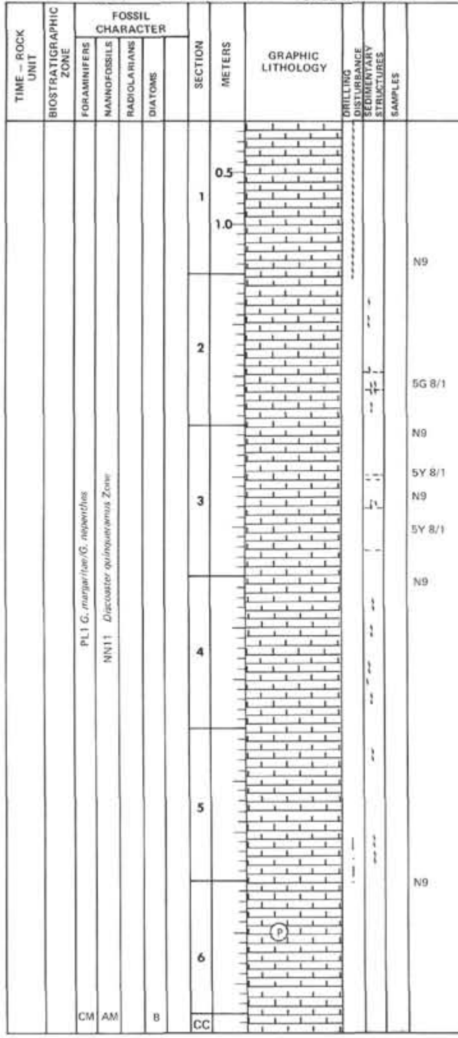


LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, pale gray to white (N8–N9). Dark gray mottles common throughout. Wispy 1–5 mm green (5G 6/1) and gray (N6) laminations throughout. Fault with slickensides between Section 3, 52–59 cm.

Disturbance is in the form of 1–10 cm drill biscuits surrounded by flowage.

SITE 609 HOLE B CORE 34 CORED INTERVAL 306.7–316.3 m



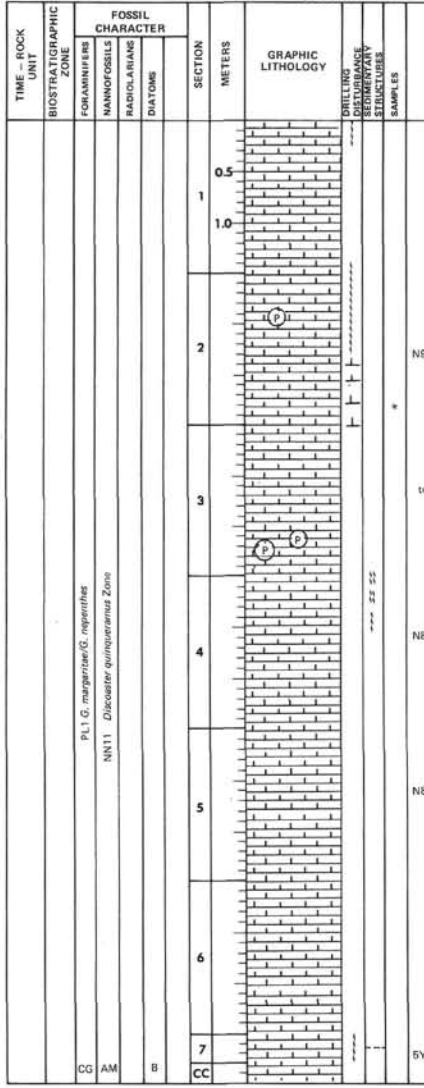
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, white (N9), 5–10 mm wispy green (5G 8/1–5G 6/1) laminations throughout. Gray mottles throughout. Pyrite burrow at Section 6, 52 cm. Disturbance is in the form of "biscuits" – fragments surrounded by flow.

SMEAR SLIDE SUMMARY (%)

	M
Composition:	3
Mica	2
Foraminifers	5
Calc. nannofossils	90

SITE 609 HOLE B CORE 35 CORED INTERVAL 316.3–325.9 m



LITHOLOGIC DESCRIPTION

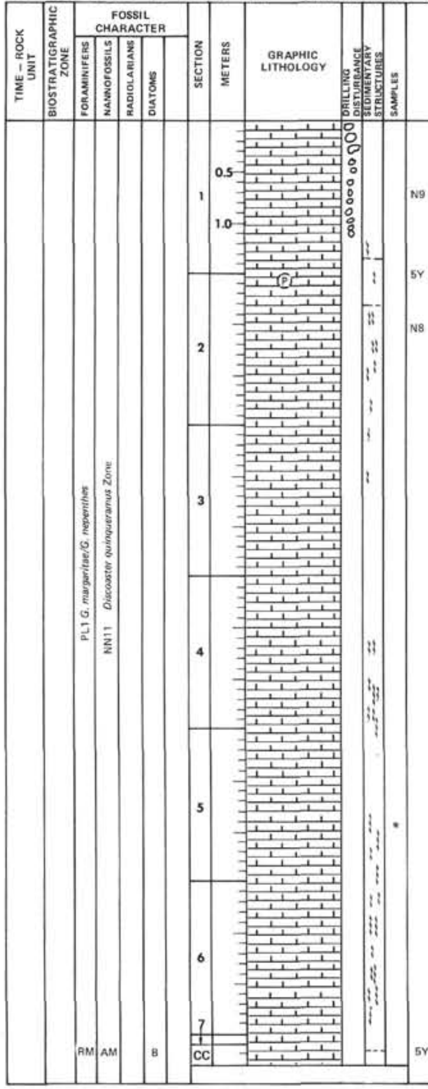
NANNOFOSSIL CHALK, white (N9), 5–15 mm laminae of green (5GY 7/2) throughout. Occasional dark mottling. Disturbance in the form of "biscuits" in Section 2, 80–150 cm. Pyritized burrows at Section 2, 34 cm and Section 3, 117 and 122 cm.

SMEAR SLIDE SUMMARY (%)

	2, 130
	D
Composition:	
Quartz	1
Feldspar	TR
Clay	4
Foraminifers	5
Calc. nannofossils	90

Note: Section 7 is 77 cm long.

SITE 609 HOLE B CORE 36 CORED INTERVAL 325.9–335.5 m



LITHOLOGIC DESCRIPTION

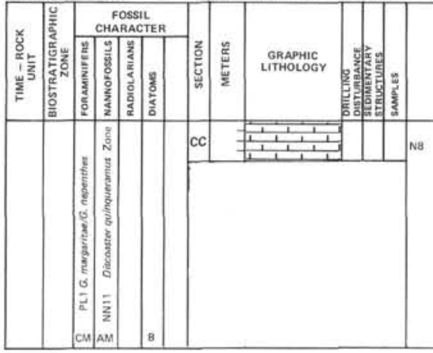
NANNOFOSSIL CHALK, pale gray (N9–N8). 1–2 cm series of ≤1 mm green (5GY 7/1) wispy laminations throughout core. Dark gray mottles throughout. Pyritized worm burrow at Section 2, 9 cm.

Abundant pebbles in top of first section are most likely downhole contamination.

SMEAR SLIDE SUMMARY (%)

	5, 91
Composition:	
Feldspar	TR
Clay	6
Carbonate unspec.	TR
Foraminifers	3
Calc. nannofossils	91

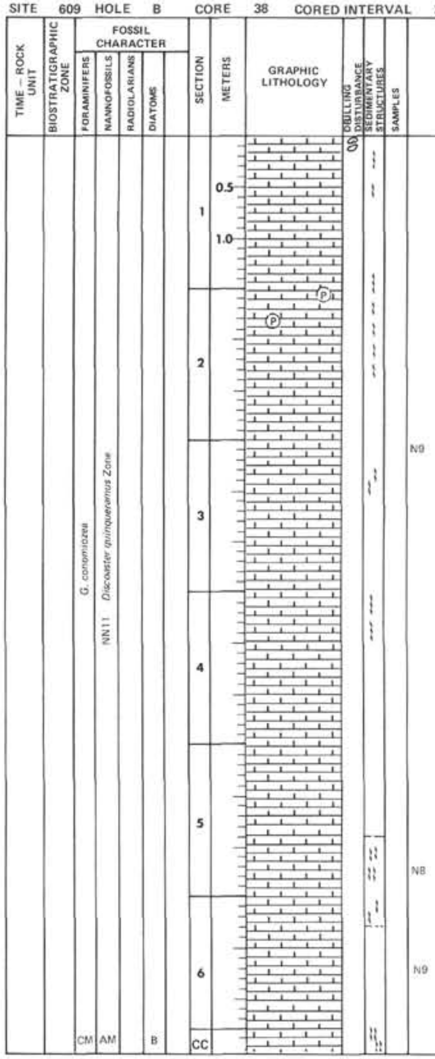
SITE 609 HOLE B CORE 37 CORED INTERVAL 335.5–345.1 m



LITHOLOGIC DESCRIPTION

Nannofossil chalk pale white (N8). Abundant pebbles are most likely downhole contamination.

SITE 609 HOLE B CORE 38 CORED INTERVAL 345.1–354.7 m



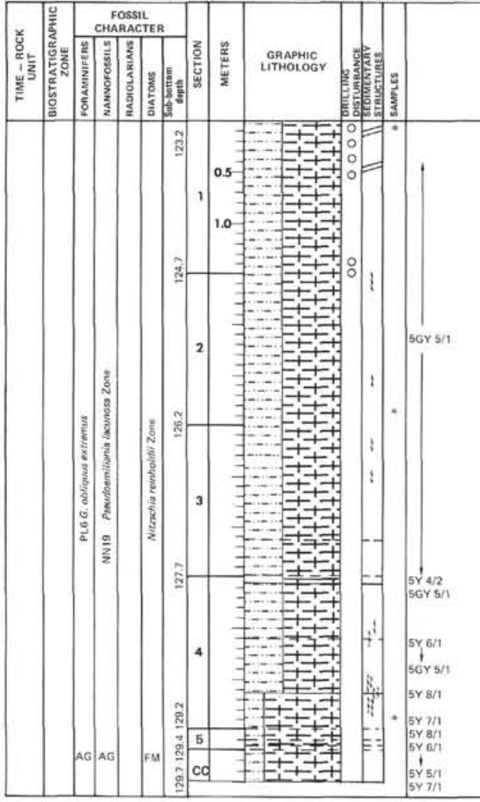
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, pale gray to white (N8–N9), 5–10 mm green (5G 7/1) and purple (5RP 4/2) laminations throughout. Dark gray mottling throughout. Occasional pyritized fractures throughout. *Zoophycos*. Pyritized burrows at Section 2, 5 and 30 cm.

SMEAR SLIDE SUMMARY (%)

	4, 114
	D
Composition:	
Feldspar	TR
Clay	4
Carbonate unspec.	TR
Foraminifers	6
Calc. nannofossils	90

SITE 609 HOLE C CORE 1 CORED INTERVAL 123.2–132.8 m



LITHOLOGIC DESCRIPTION

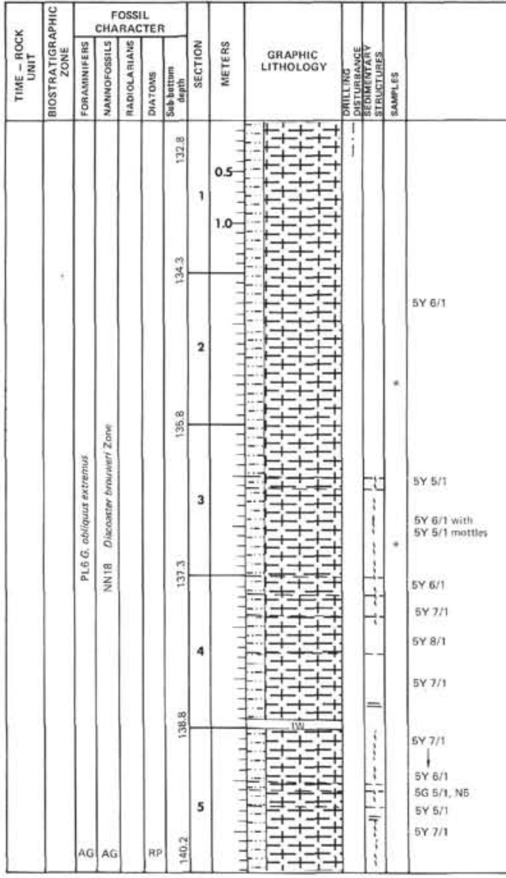
Greenish gray (5GY 5/1) MARLY FORAMINIFERAL NANNOFOSSIL OOZE with small mottles of dark gray (N3) throughout.

Light gray to very light gray (5Y 5/1 to 5Y 8/1) FORAMINIFERAL NANNOFOSSIL OOZE.

SMEAR SLIDE SUMMARY (%)

	1, 12 M	2, 135 D	4, 140 M
Composition:			
Quartz	40	6	TR
Feldspar	–	TR	–
Heavy minerals	5	TR	–
Clay	45	35	6
Volcanic glass	5	–	–
Pyrite	TR	–	–
Micronodules	TR	–	–
Carbonate unspec.	3	TR	TR
Foraminifers	TR	12	11
Calc. nannofossils	1	46	83
Diatoms	–	1	–
Radiolarians	–	TR	–
Opaque oxides	1	–	–

SITE 609 HOLE C CORE 2 CORED INTERVAL 132.8–142.4 m



LITHOLOGIC DESCRIPTION

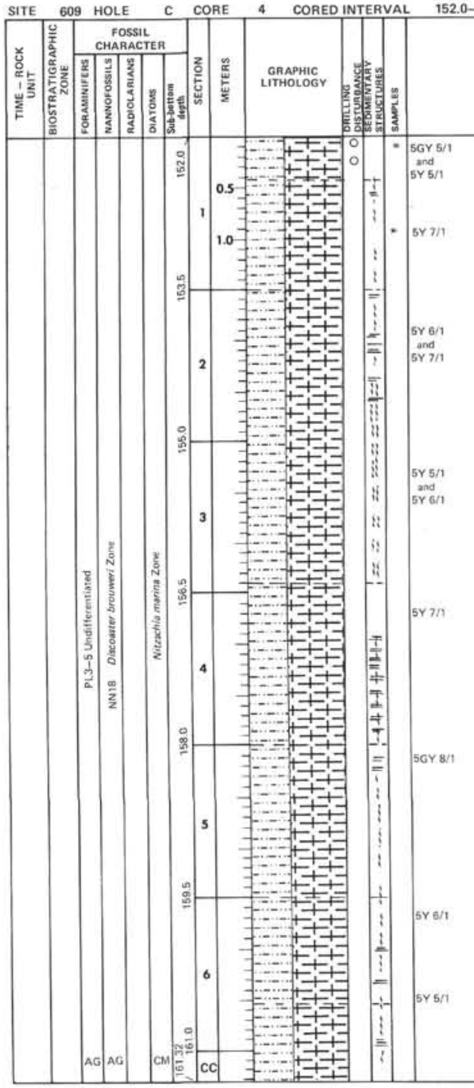
Gray (5Y 5/1–5Y 7/1) FORAMINIFERAL NANNOFOSSIL OOZE. Occasional bluish gray (5B 5/1), and pale green (5G 6/2, 5G 6/1) laminae below 138.5 m.

SMEAR SLIDE SUMMARY (%)

	2, 100 D	3, 125 D
Composition:		
Quartz	TR	10
Feldspar	TR	TR
Clay	14	30
Carbonate unspec.	1	1
Foraminifers	13	12
Calc. nannofossils	72	47

Note: Core 3, 132.8–142.4 m, no recovery.

SITE 609 HOLE C CORE 4 CORED INTERVAL 152.0–161.6 m



LITHOLOGIC DESCRIPTION

Gray to light gray (5Y 5/1 to 5Y 7/1) MARLY NANNOFOSSIL OOZE with light green (5G 5/2) and grayish green (5GY 6/1 to 5GY 8/1) laminae common, especially 157.0 to 158.0 m.

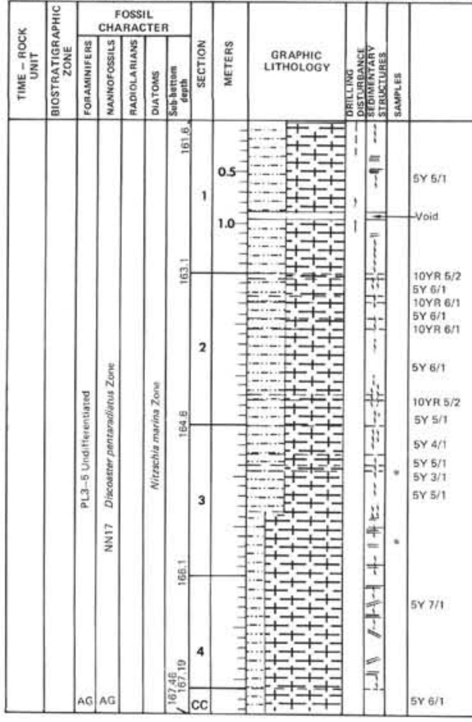
SMEAR SLIDE SUMMARY (%)

	1, 20 D	1, 90 D
Composition:		
Quartz	40	40
Heavy minerals	1	TR
Clay	15	5
Volcanic glass	5	1
Carbonate unspec.	–	TR
Foraminifers	2	5
Calc. nannofossils	37	34
Diatoms	–	5
Radiolarians	–	5
Sponge spicules	TR	3
Silicoflagellates	–	2
Opaques	TR	–

ORGANIC CARBON AND CARBONATE (%)

	1, 93
Organic carbon	–
Carbonate	74

SITE 609 HOLE C CORE 5 CORED INTERVAL 161.6–171.2 m



LITHOLOGIC DESCRIPTION

Gray (5Y 4/1 to 5Y 6/1) MARLY NANNOFOSSIL OOZE, with intervals of brown (10YR 5/2 to 10YR 6/1).

Light gray (5Y 6/1 to 5Y 7/1) NANNOFOSSIL OOZE.

Green (5G 5/1, 5G 6/1) laminae common.

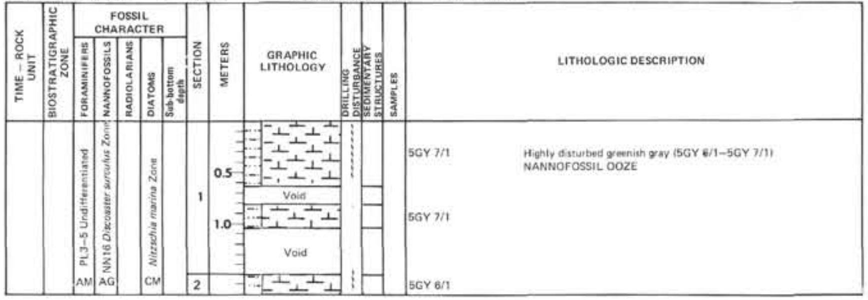
SMEAR SLIDE SUMMARY (%)

	3, 42 M	3, 116 D
Composition:		
Quartz	55	10
Mica	2	–
Clay	30	–
Volcanic glass	7	–
Glauconite	1	–
Foraminifers	TR	1
Calc. nannofossils	5	81
Diatoms	–	3
Radiolarians	–	TR
Sponge spicules	TR	5
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

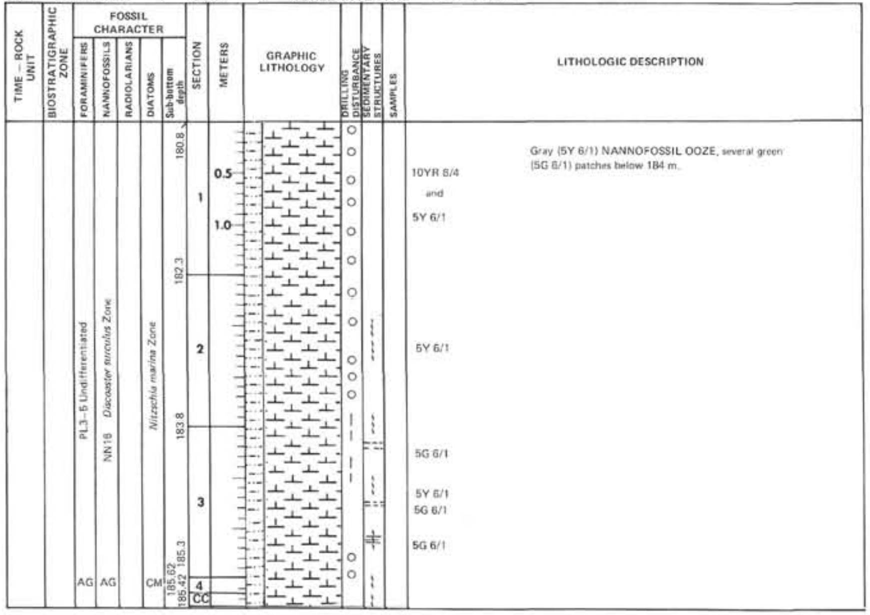
	3, 115
Organic carbon	–
Carbonate	76

SITE 609 HOLE C CORE 6 CORED INTERVAL 171.2–180.8 m

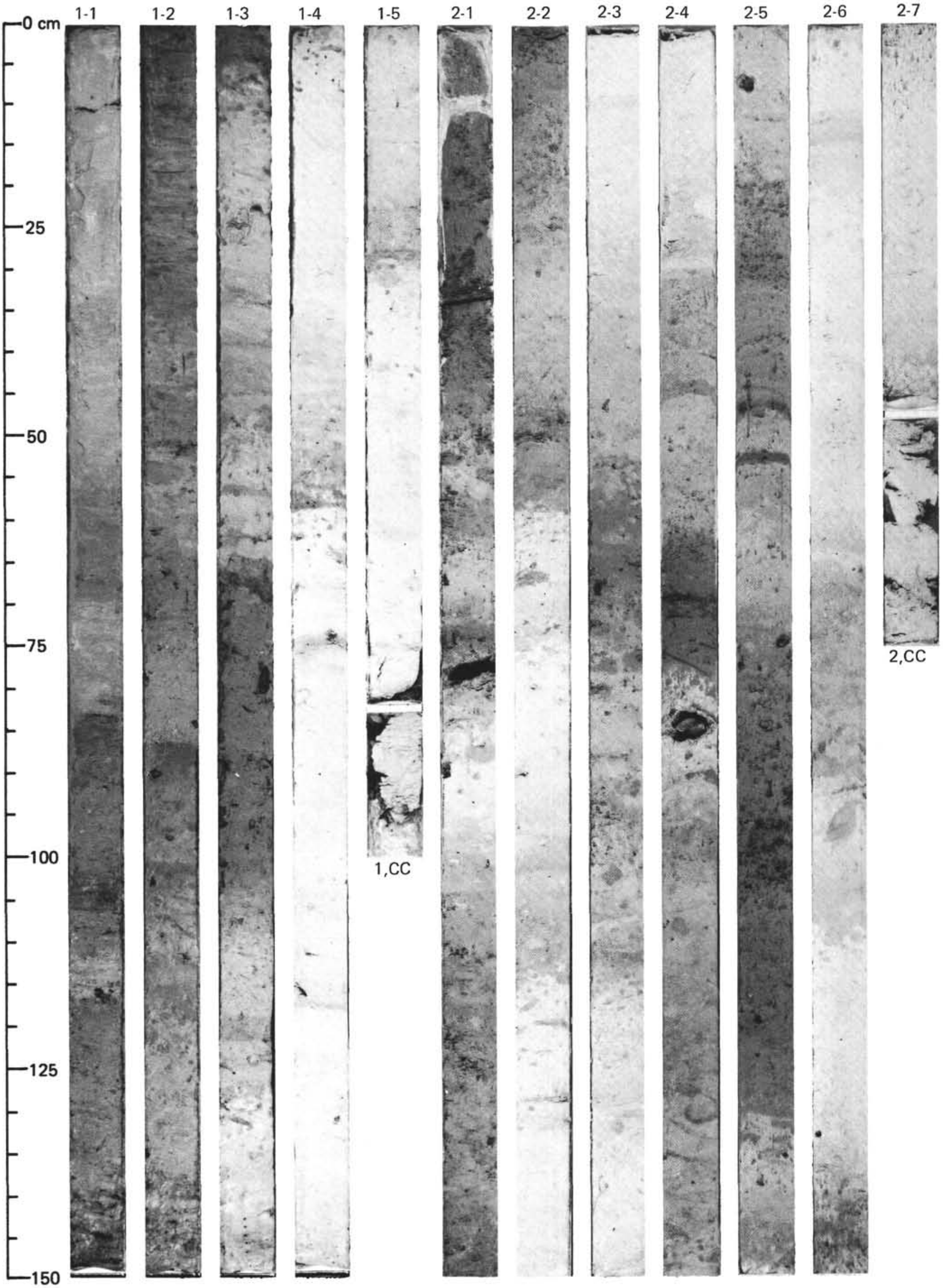


Highly disturbed greenish gray (5GY 6/1–5GY 7/1) NANNOFOSSIL OOZE

SITE 609 HOLE C CORE 7 CORED INTERVAL 180.8–190.4 m



Gray (5Y 6/1) NANNOFOSSIL OOZE, several green (5G 6/1) patches below 184 m.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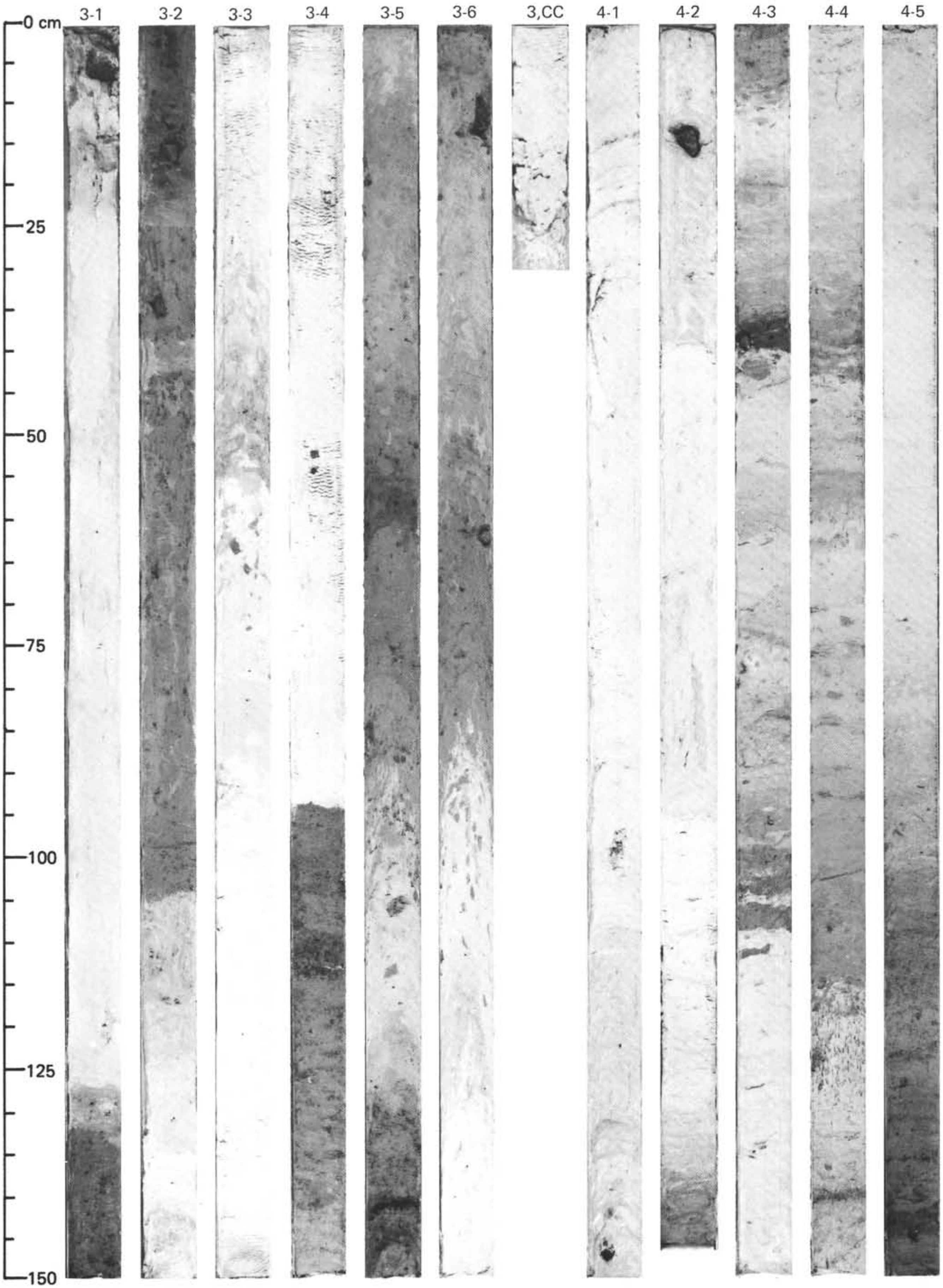
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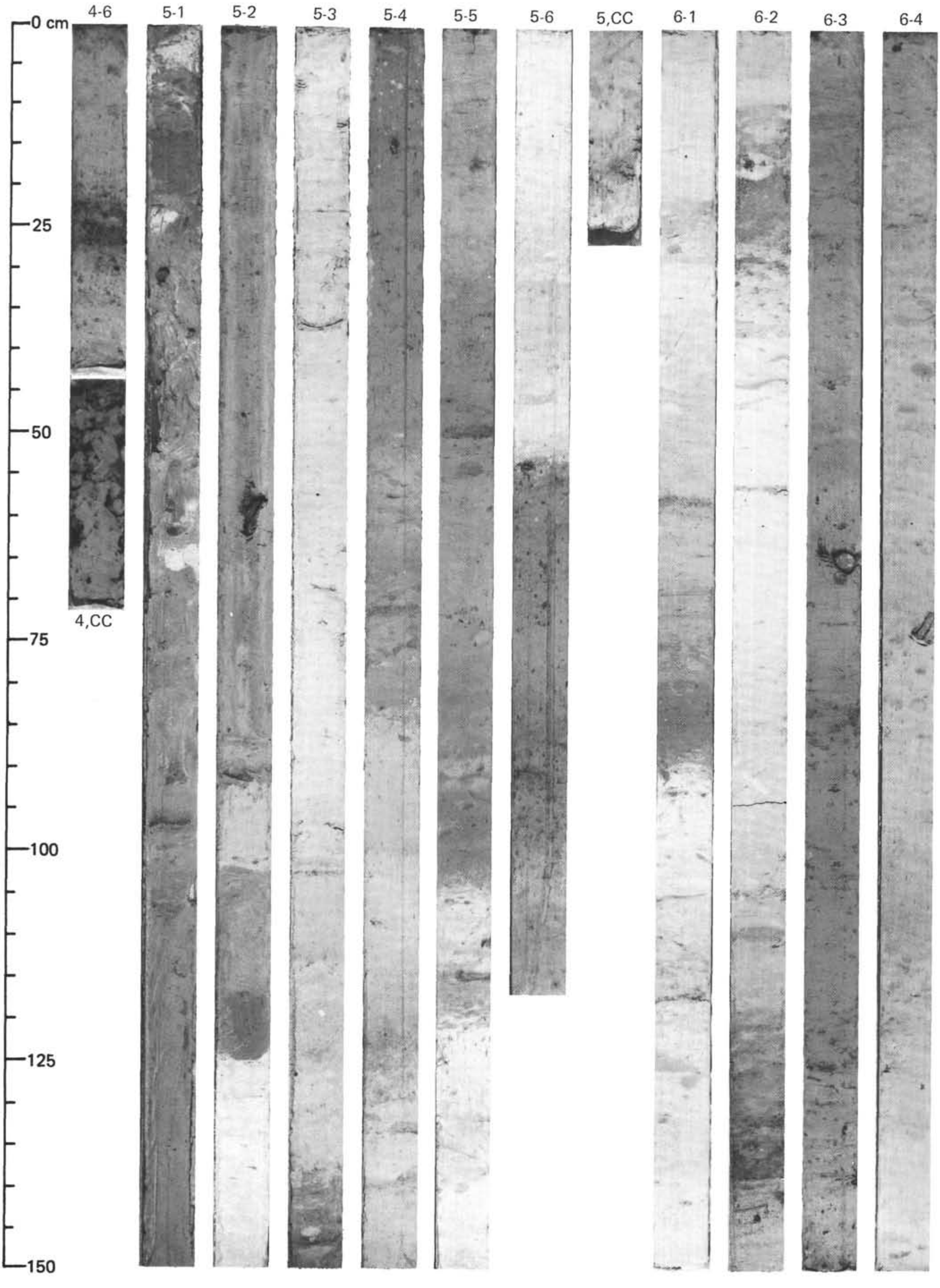
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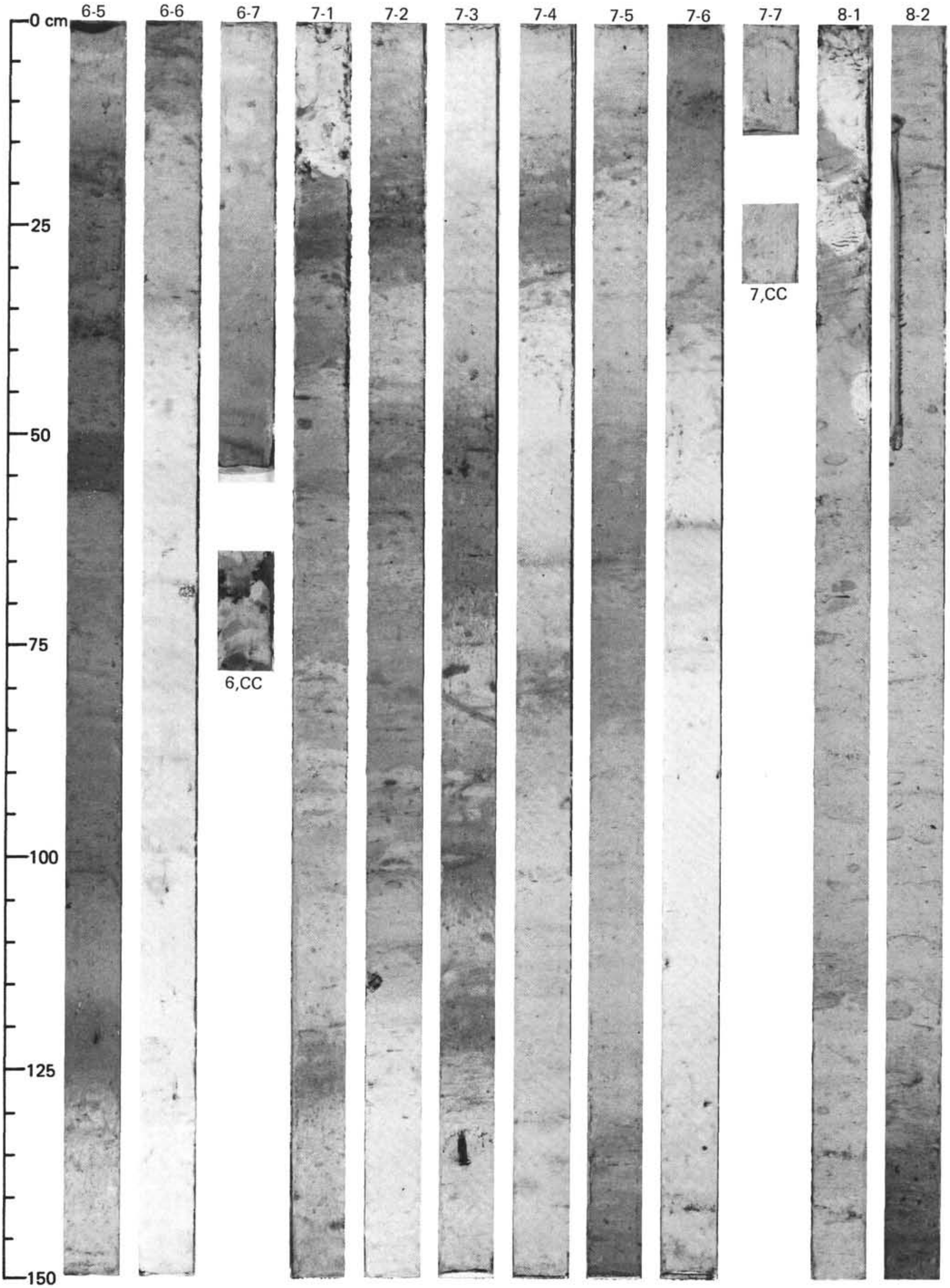
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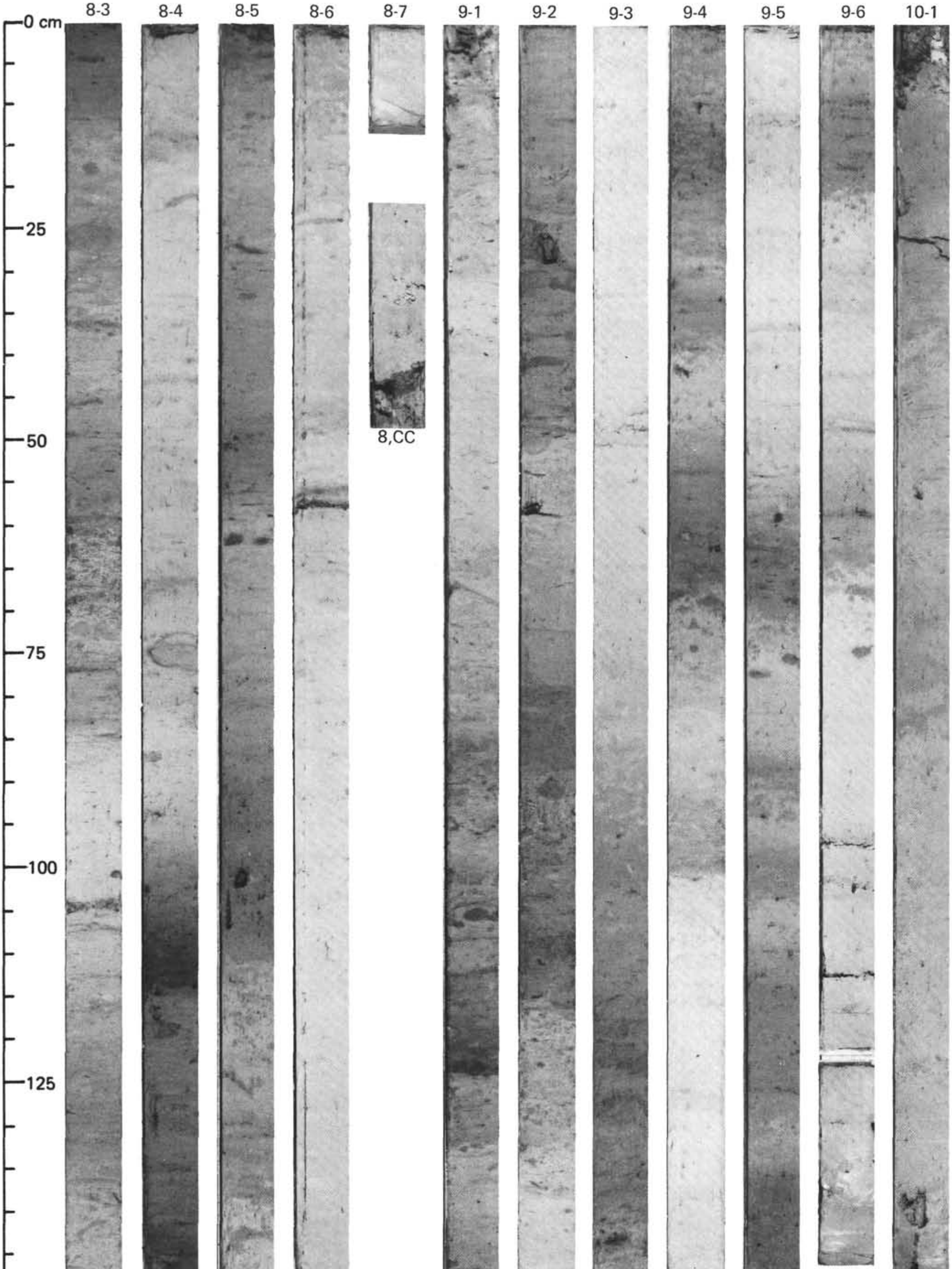
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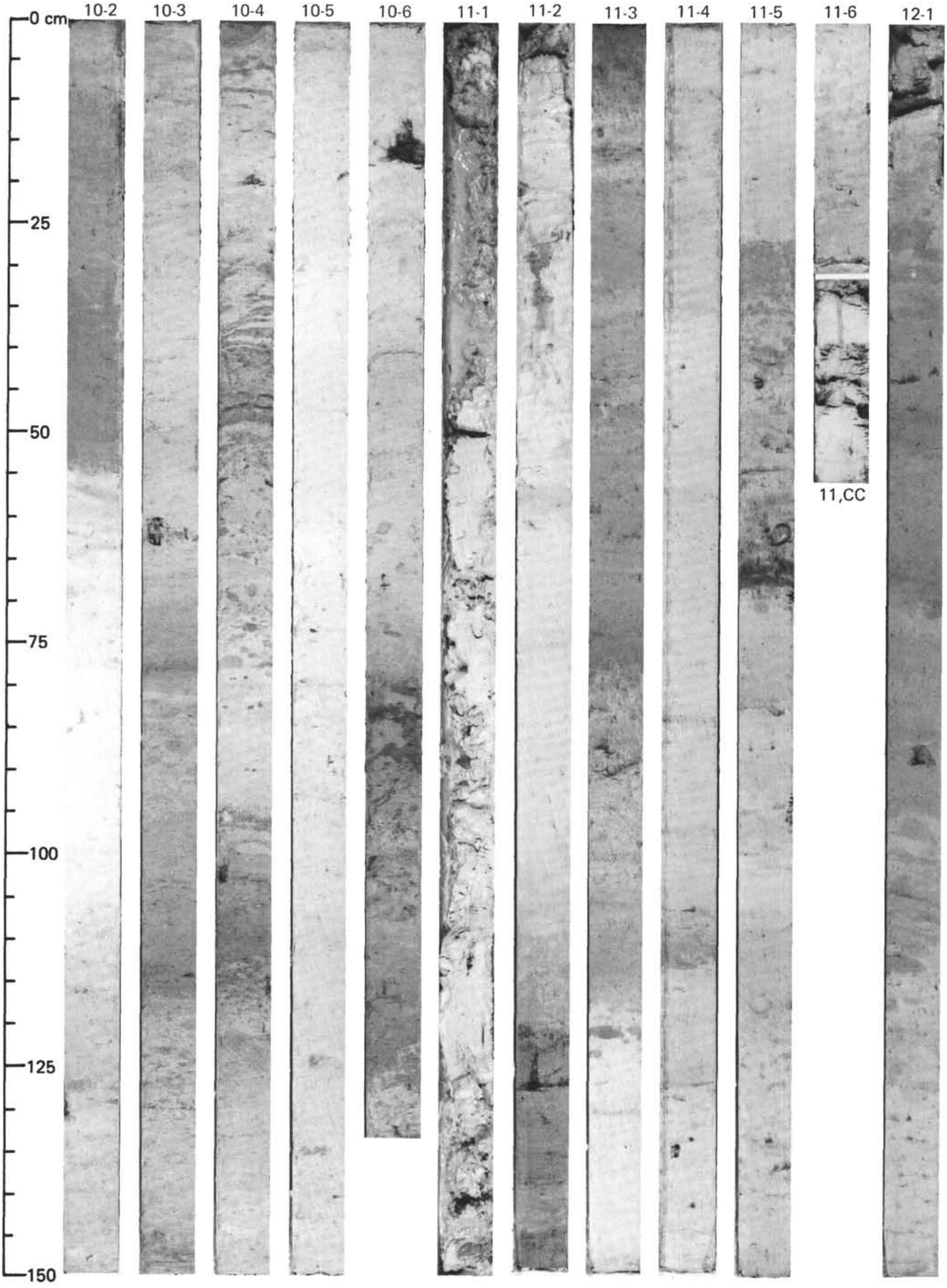
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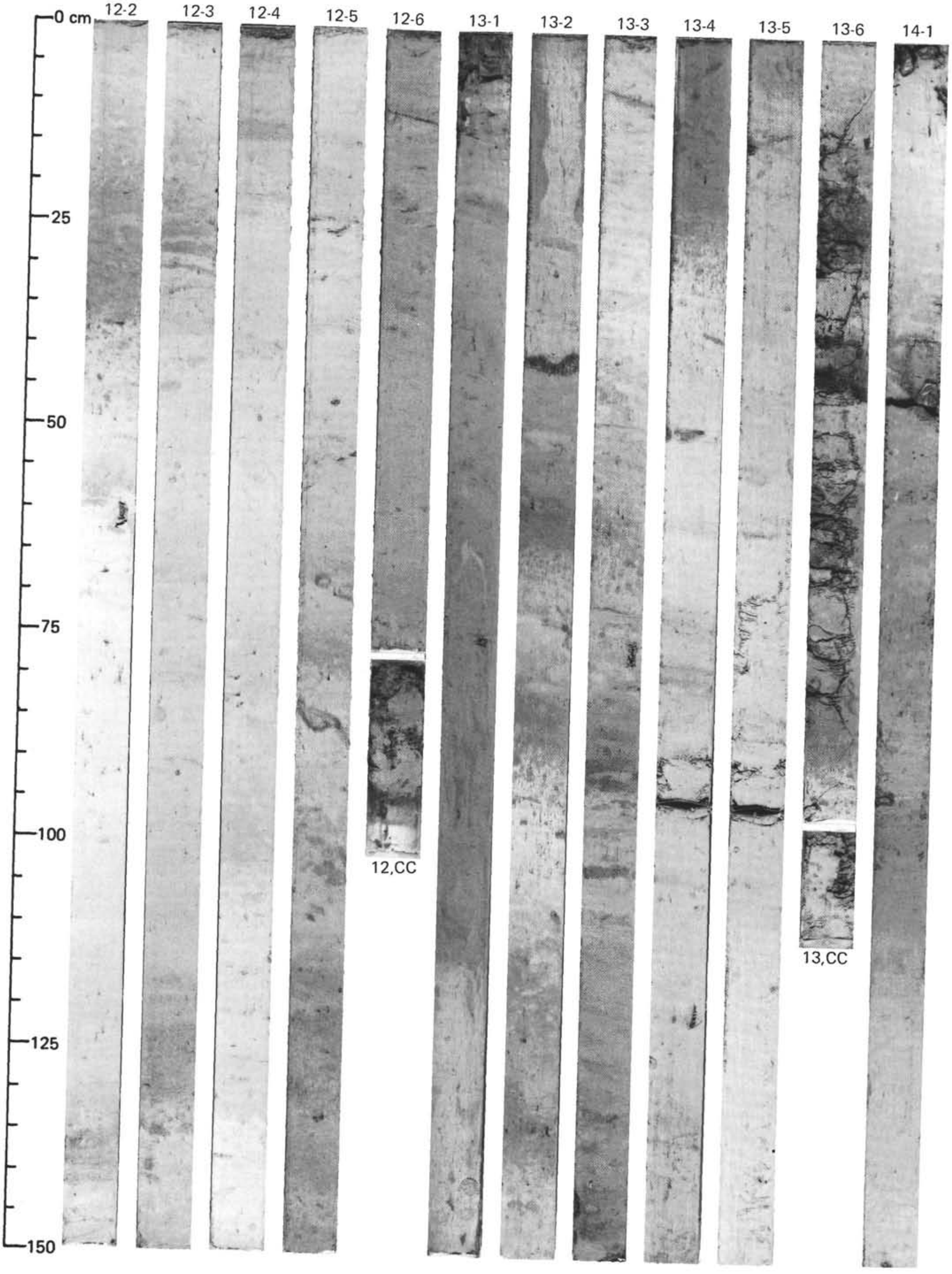
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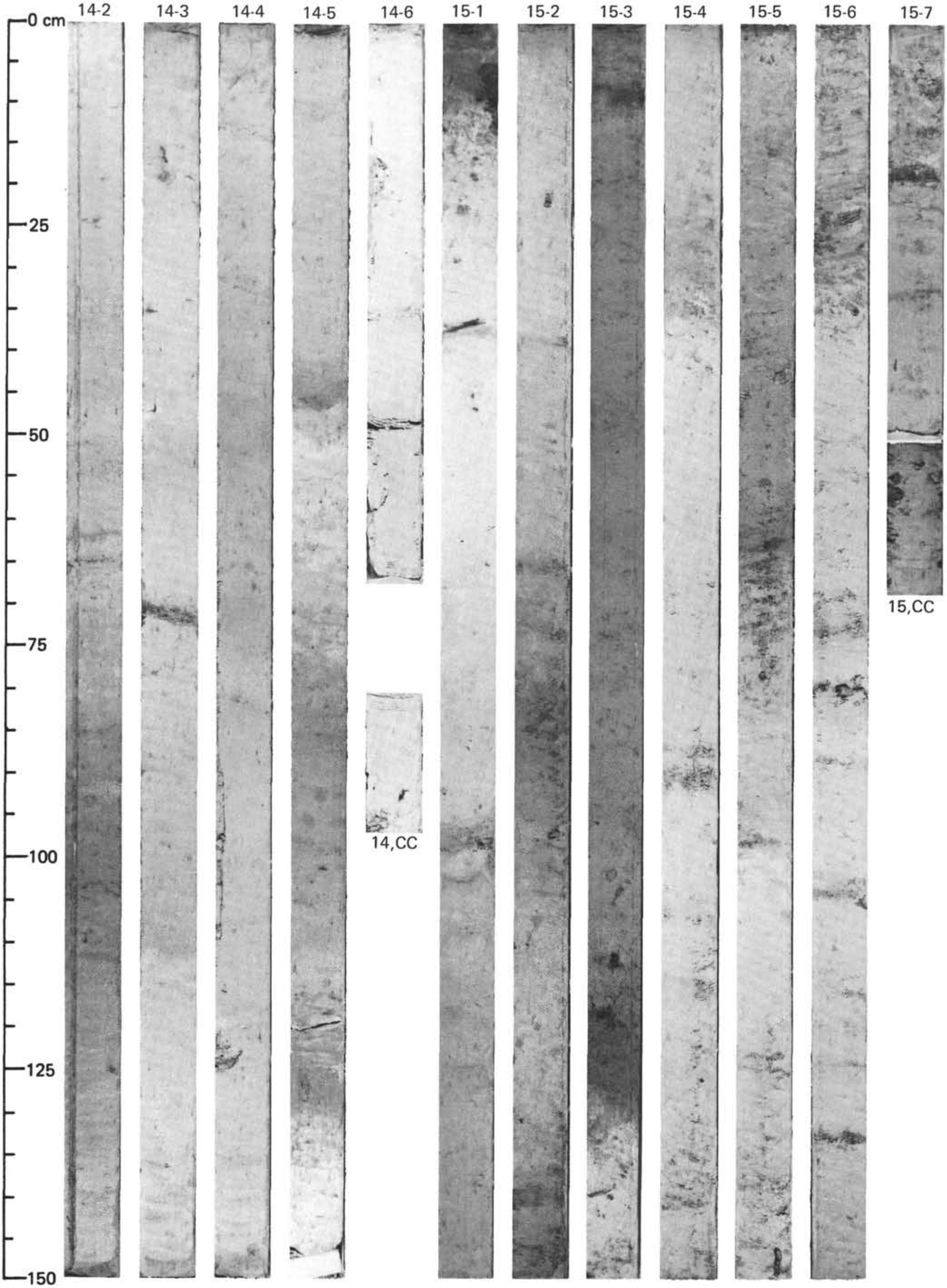
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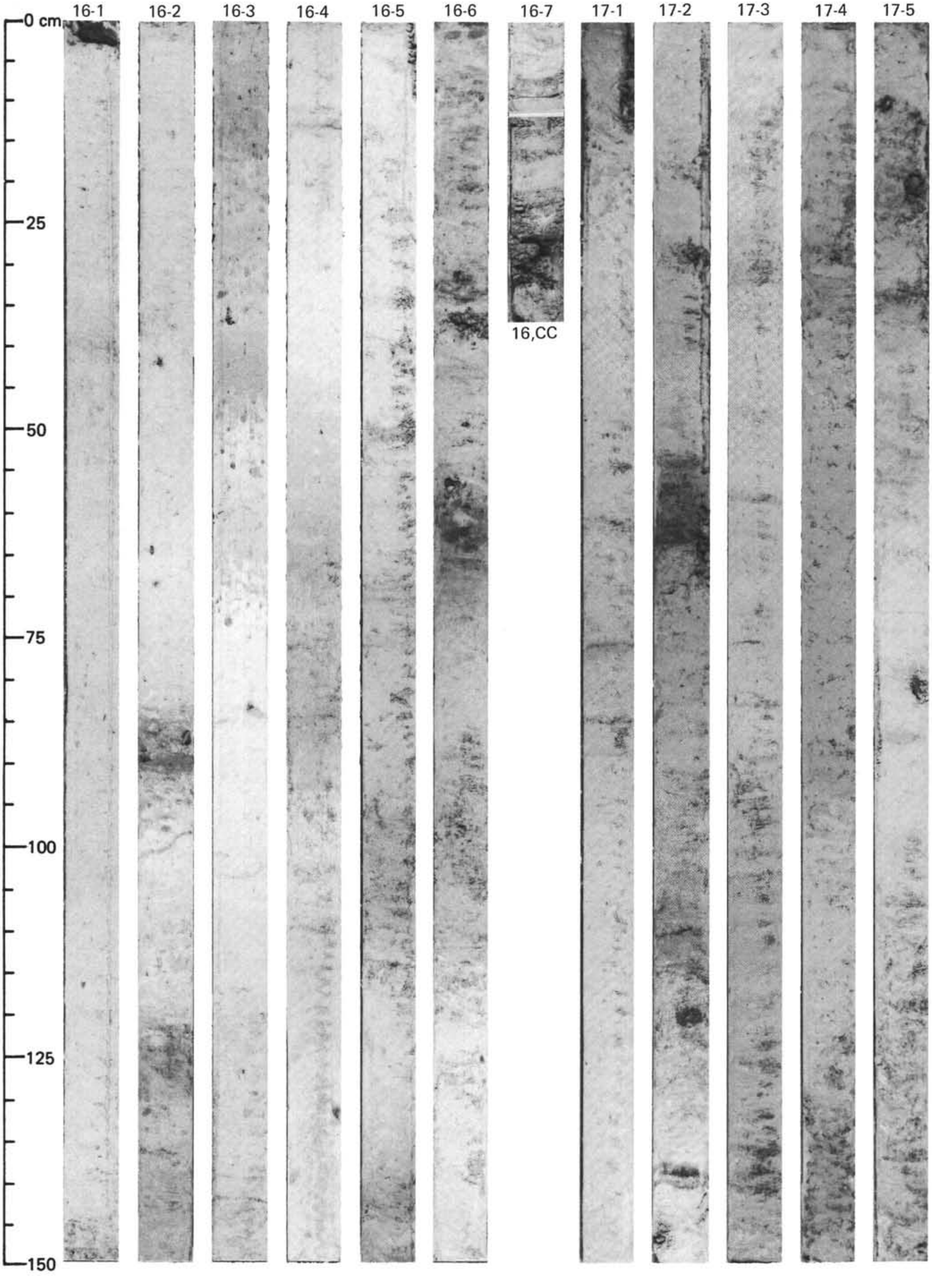
15,CC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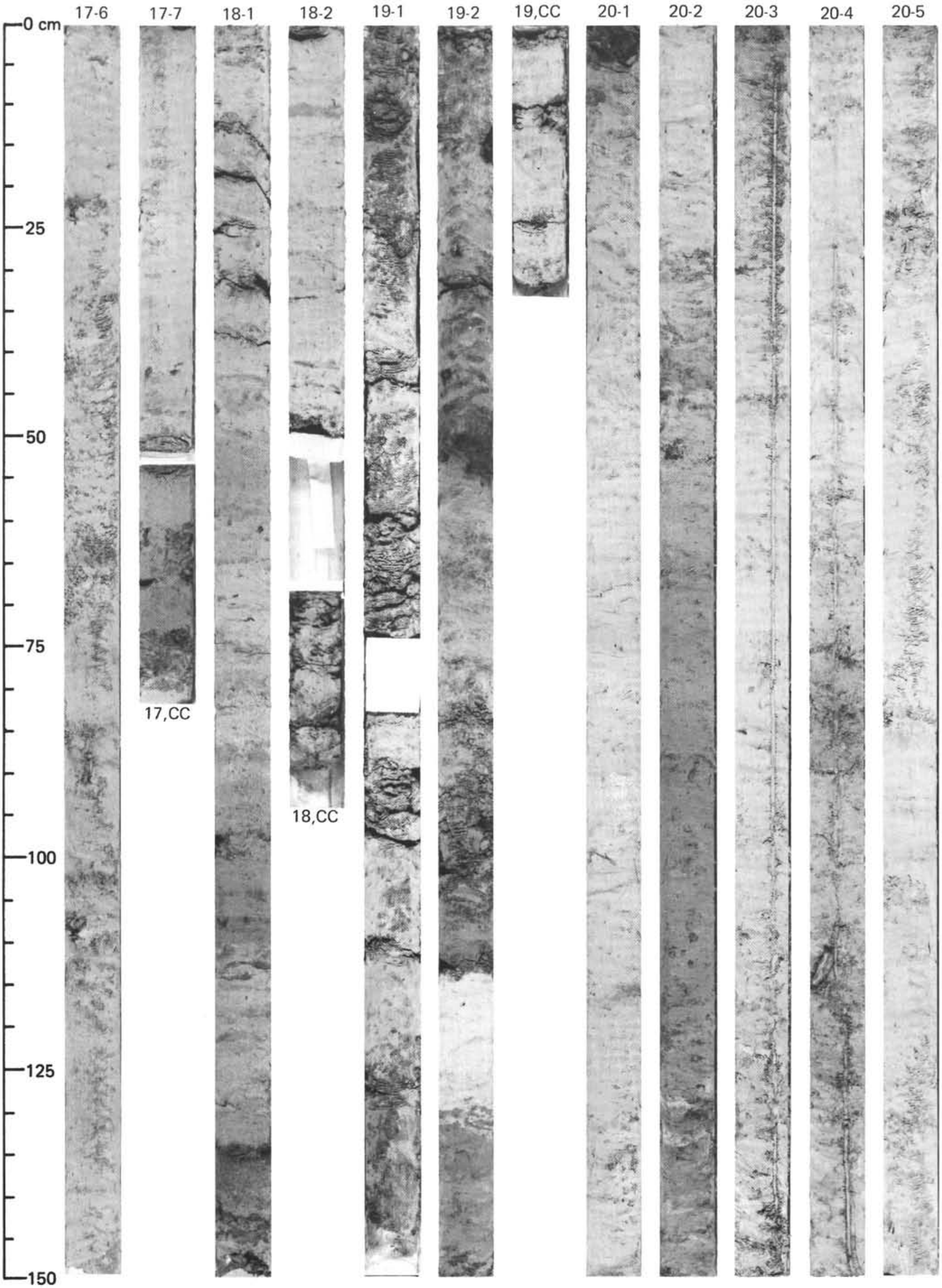
17-5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18-2
18,CC
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19,CC
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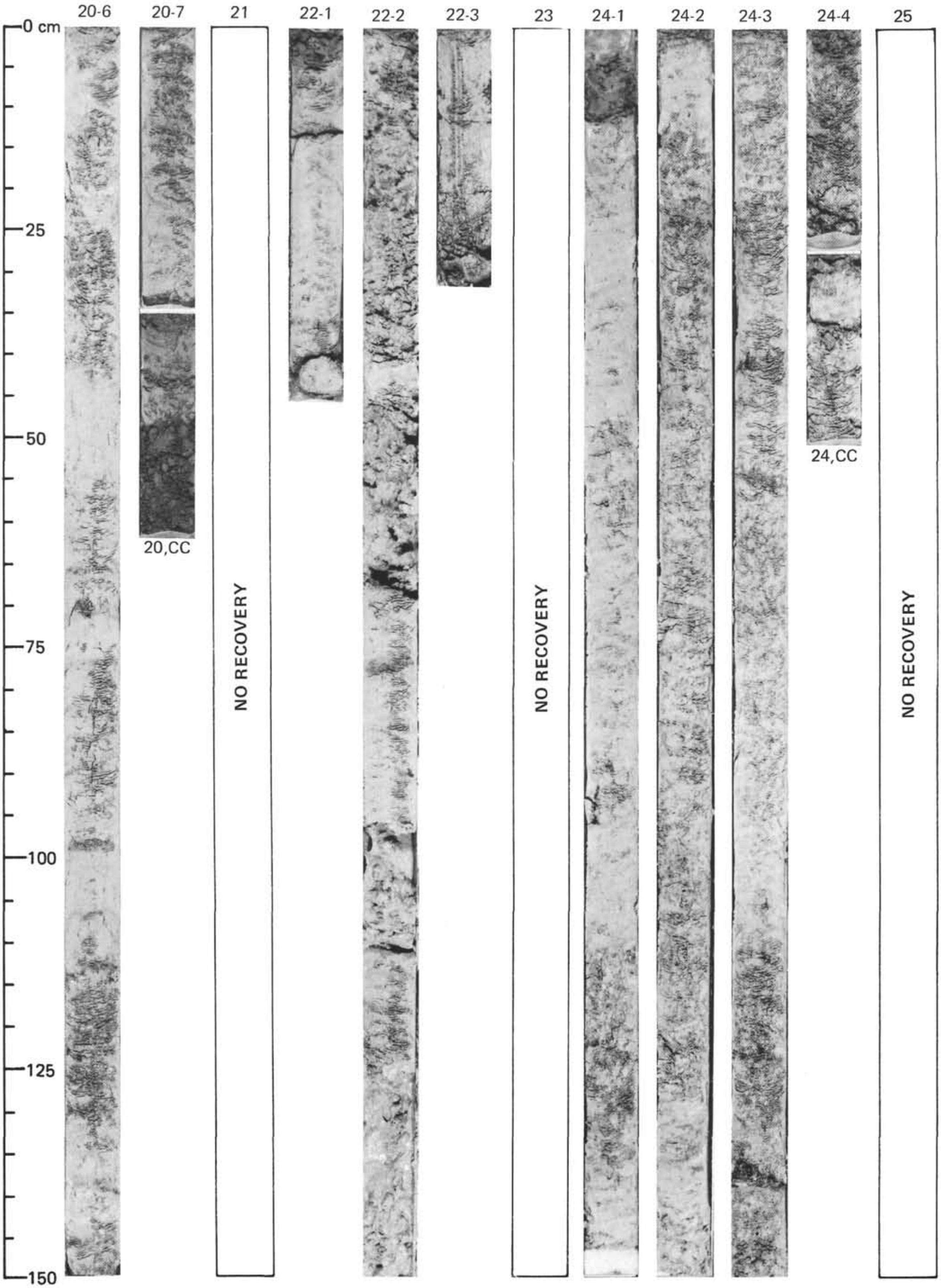
20-5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22-1
22-2
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24-1
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24,CC
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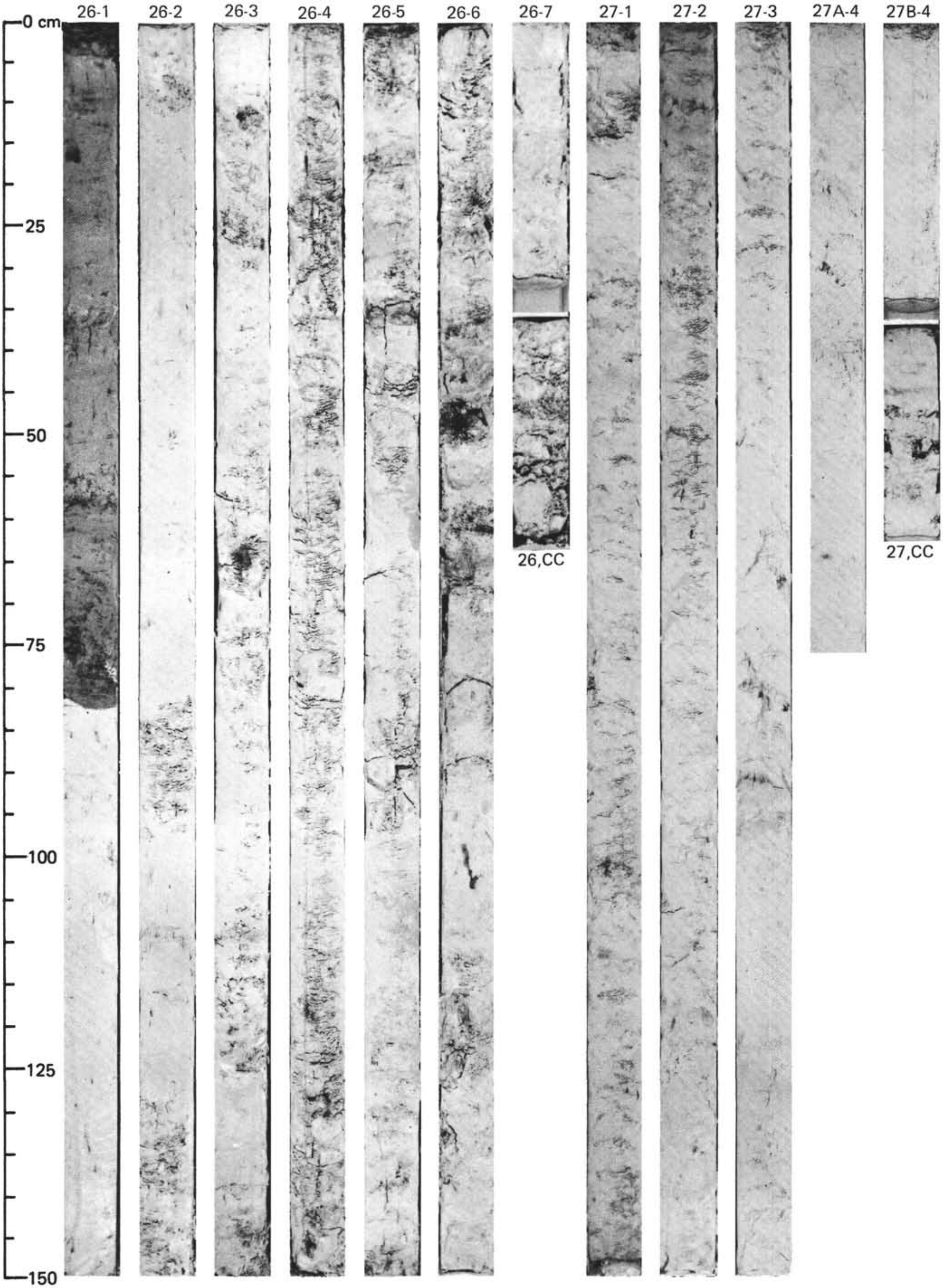
NO RECOVERY
NO RECOVERY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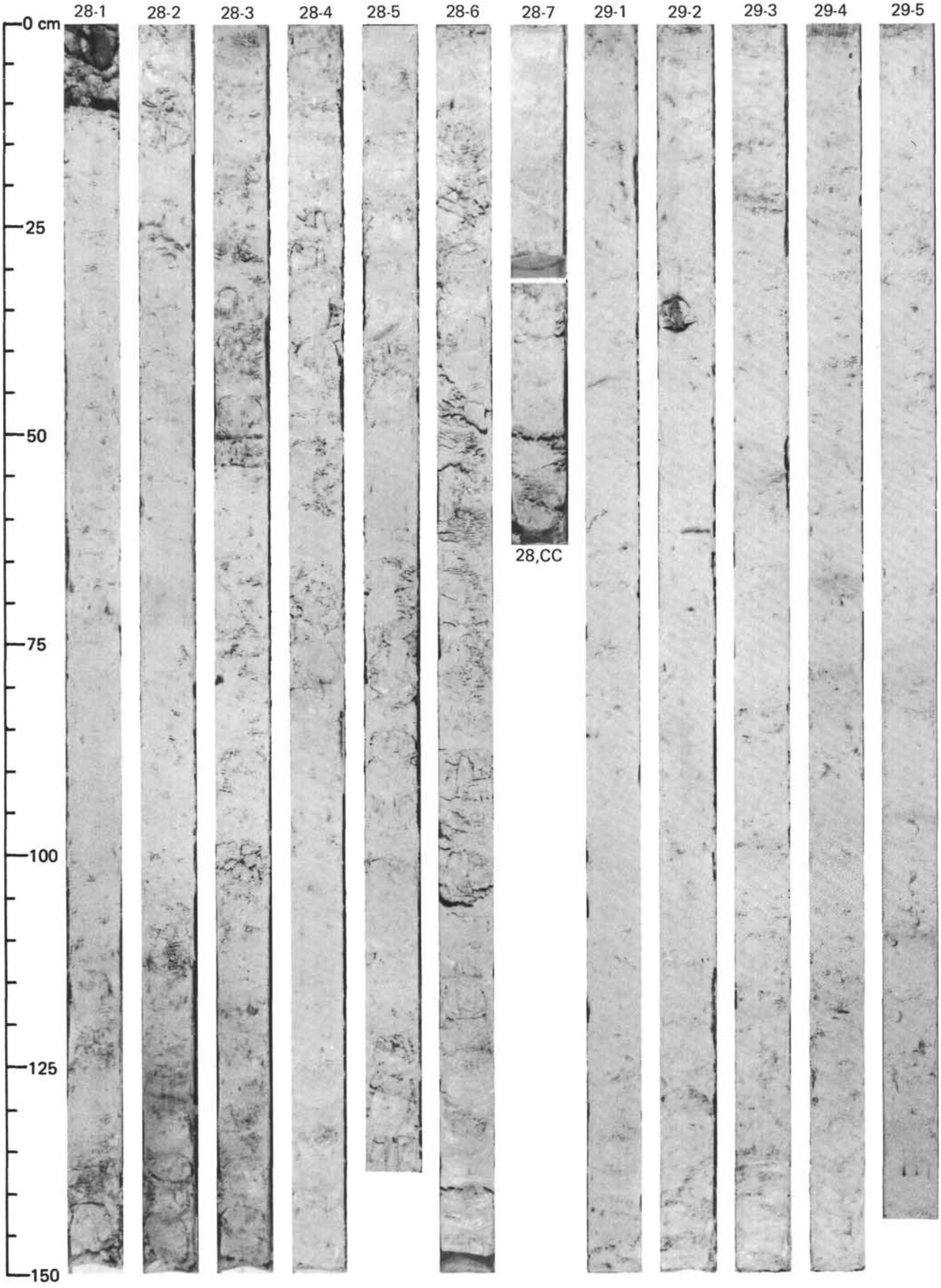
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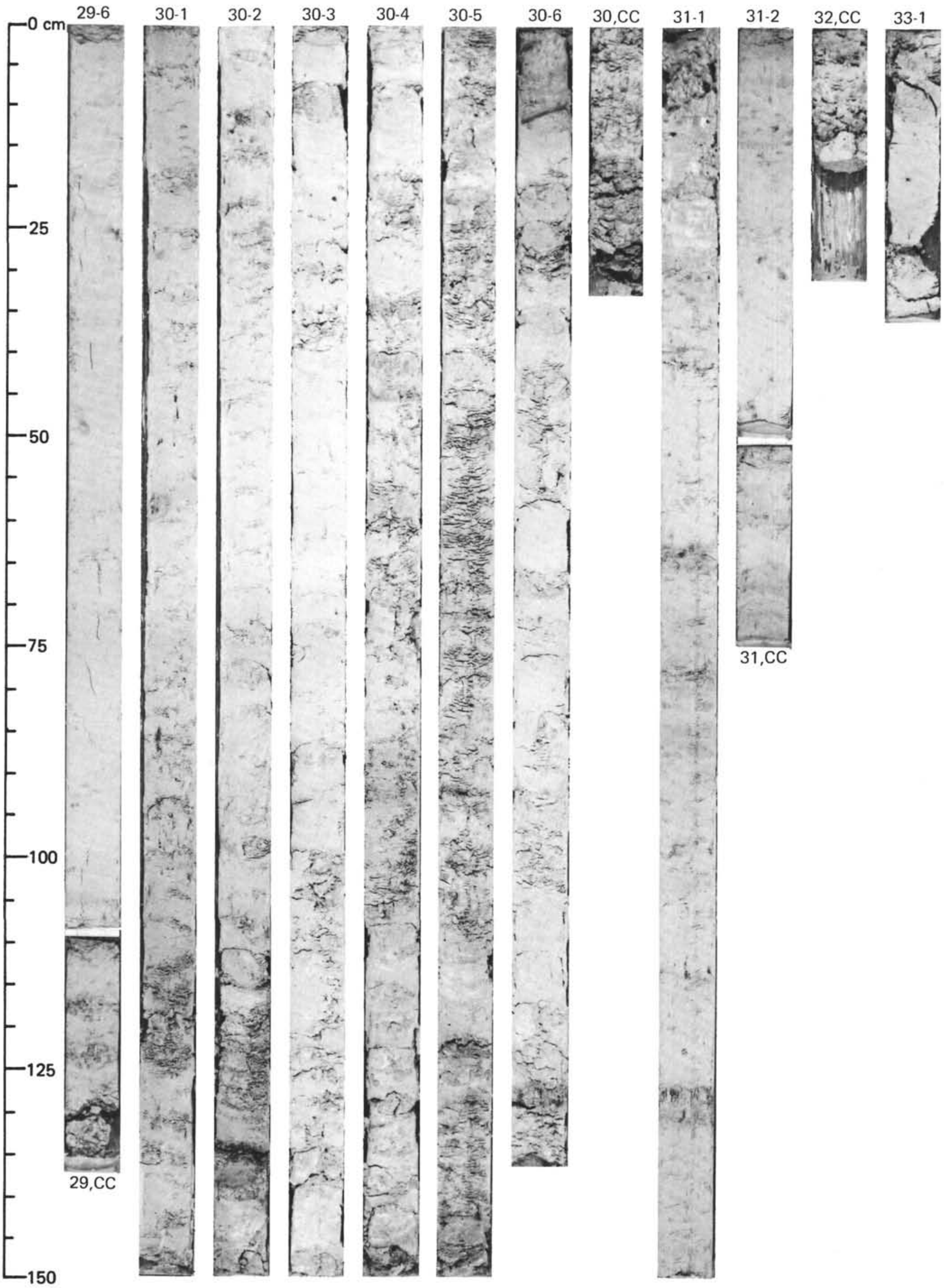
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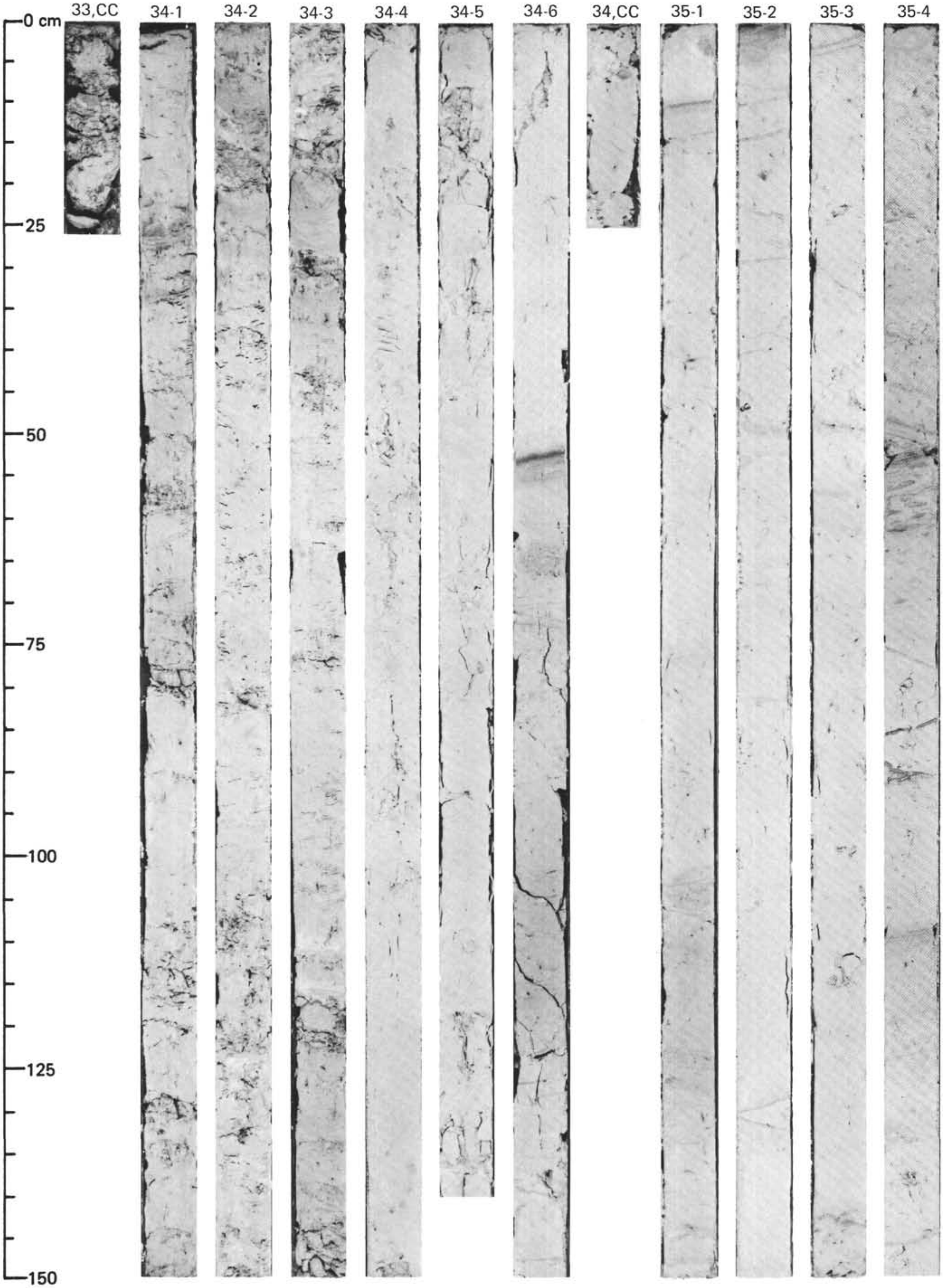
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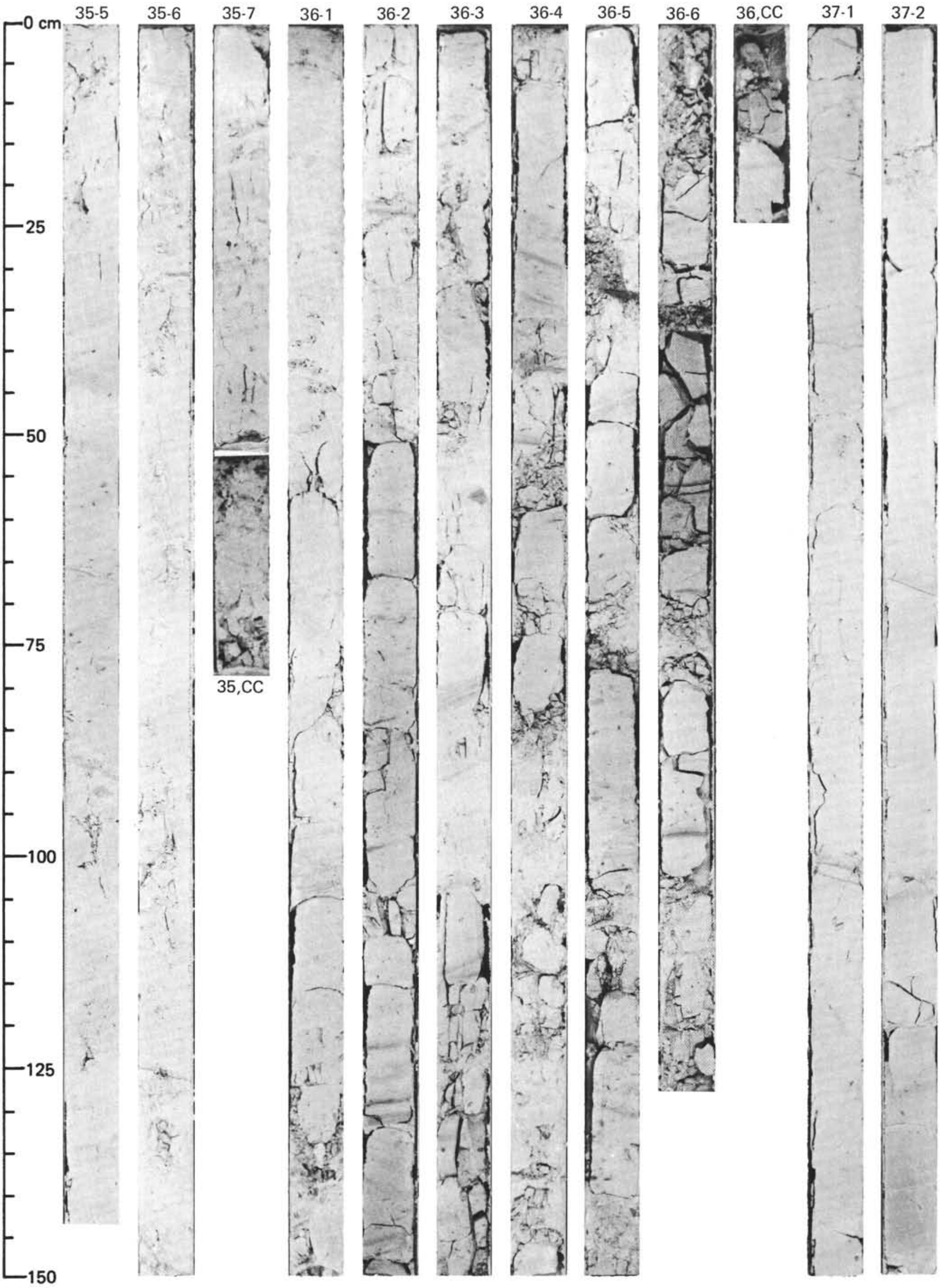
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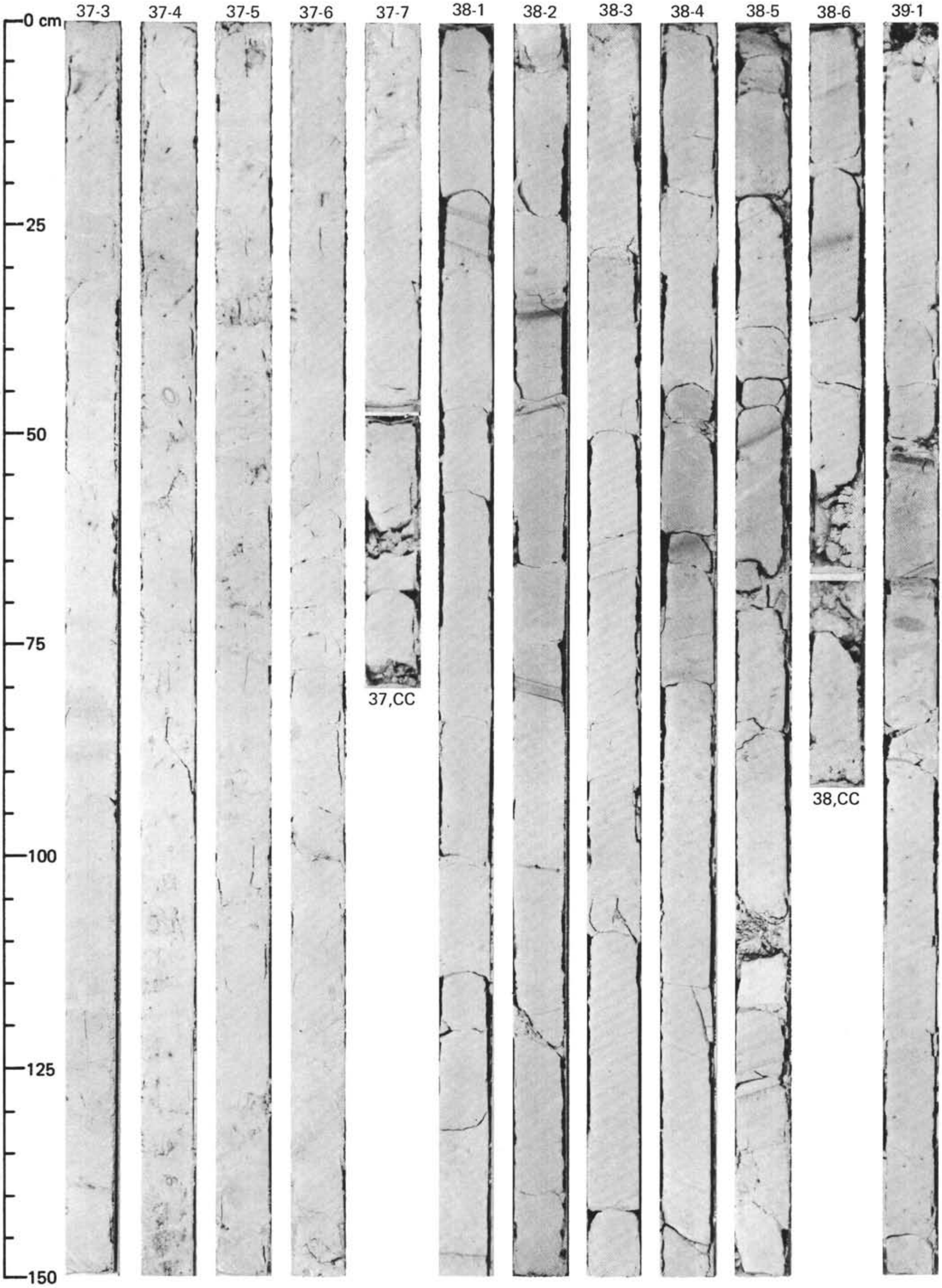
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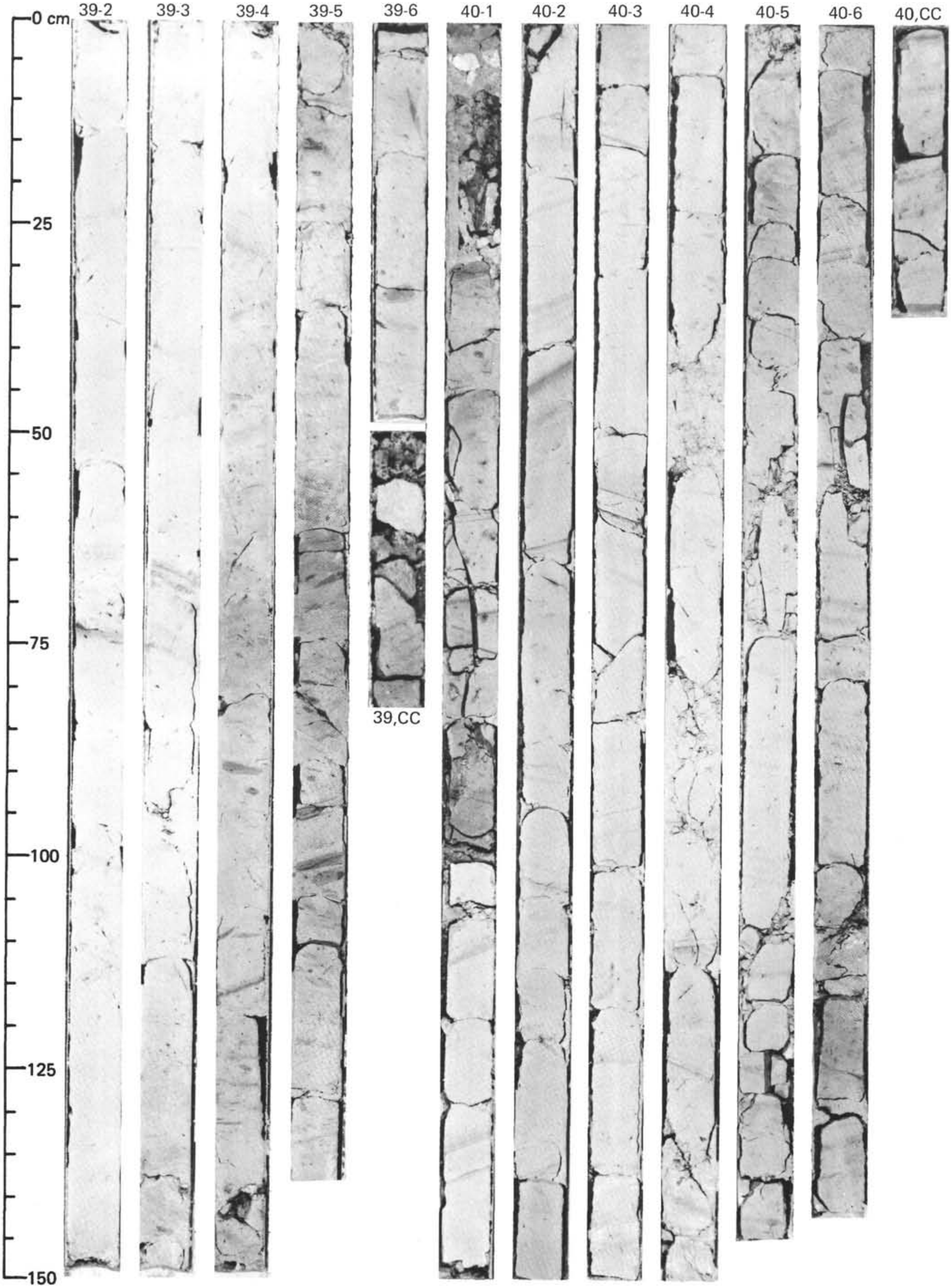
39-1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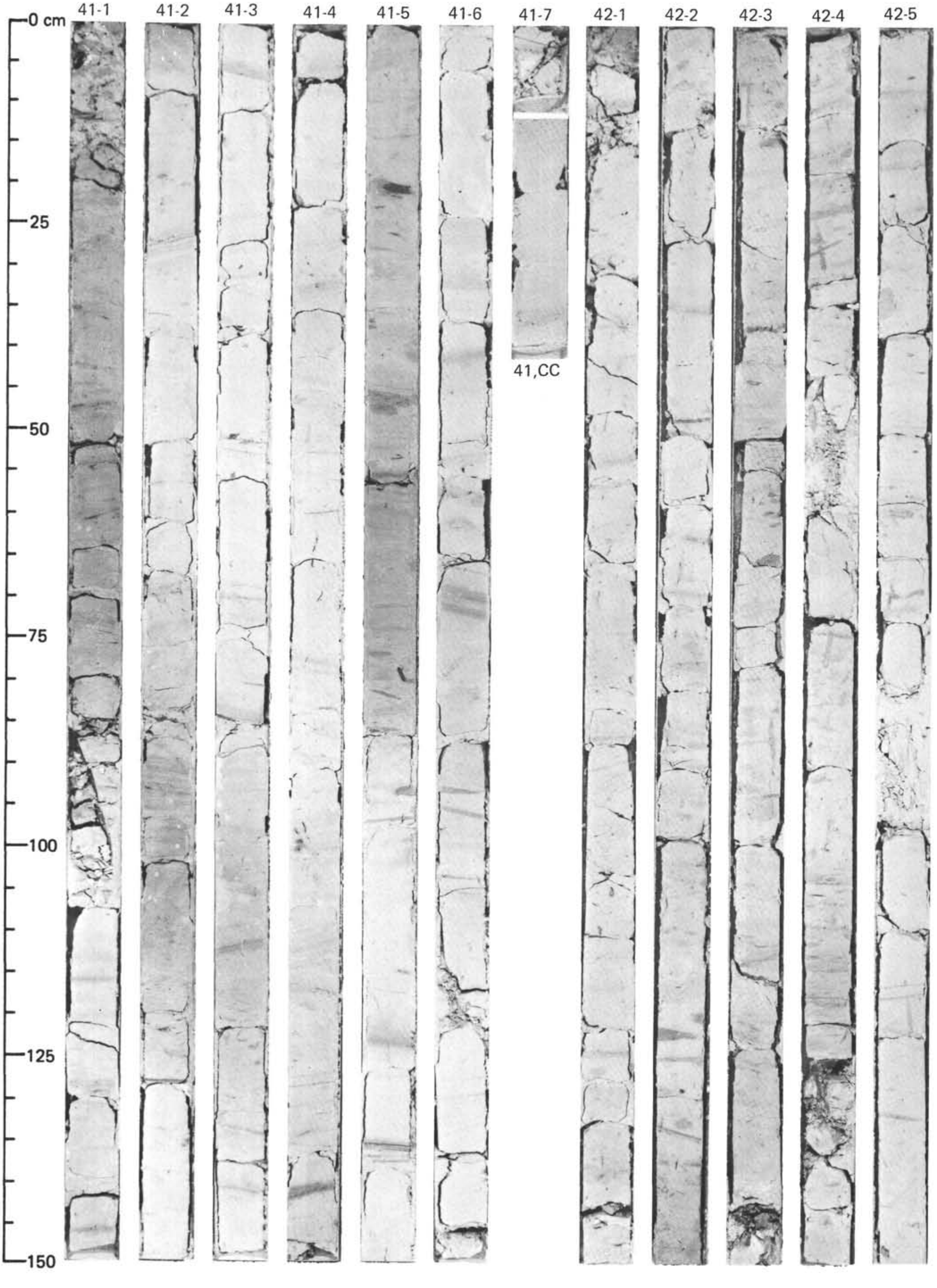
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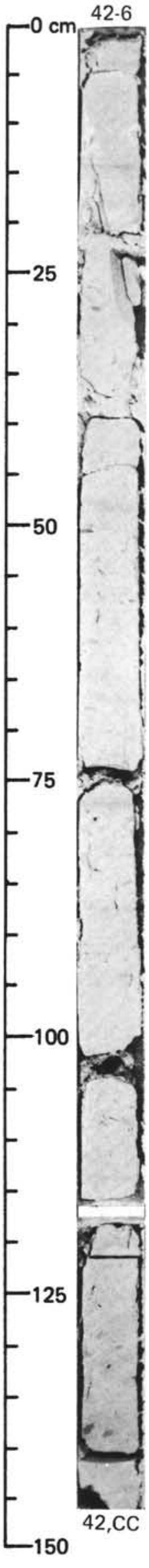
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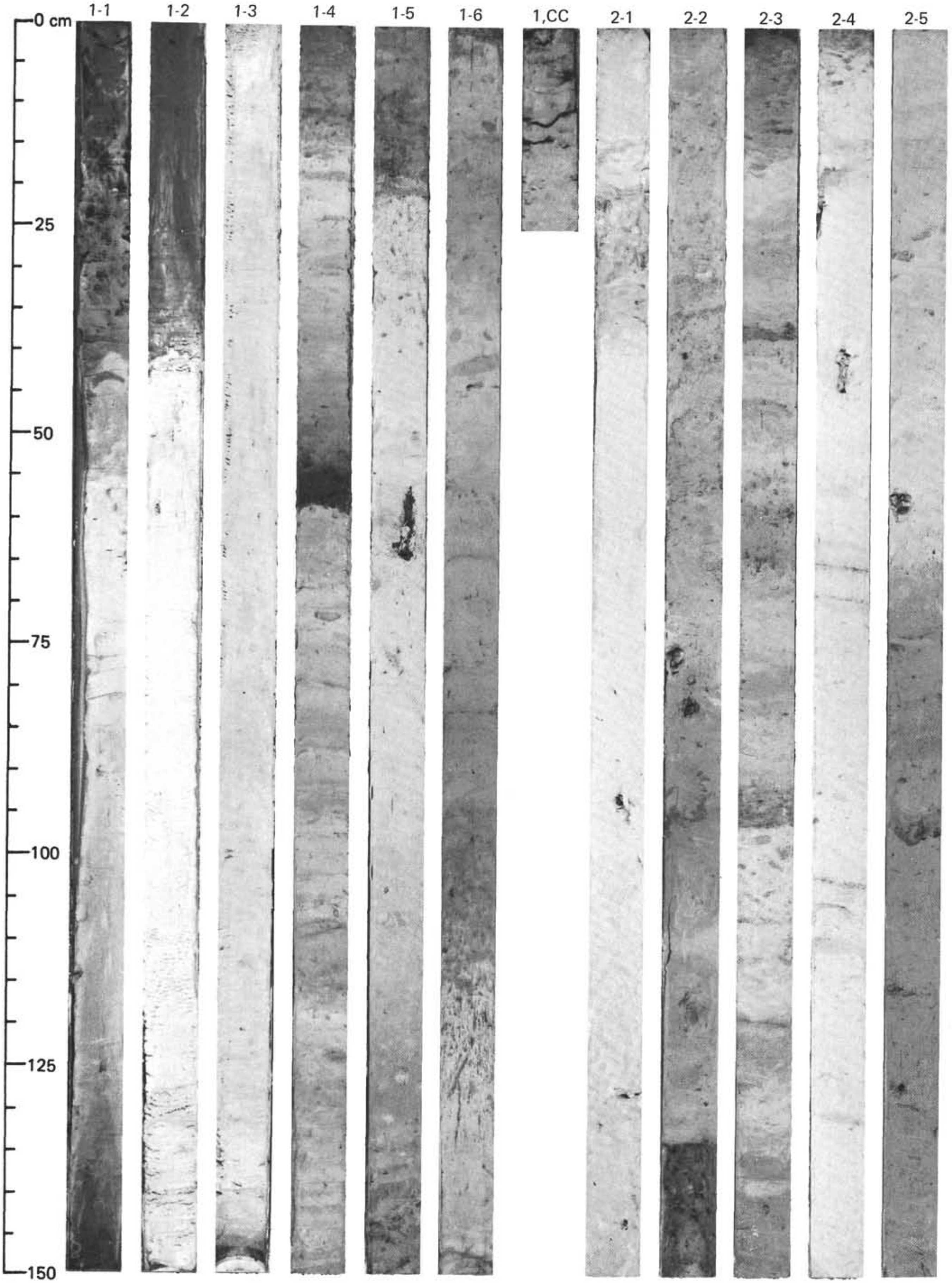
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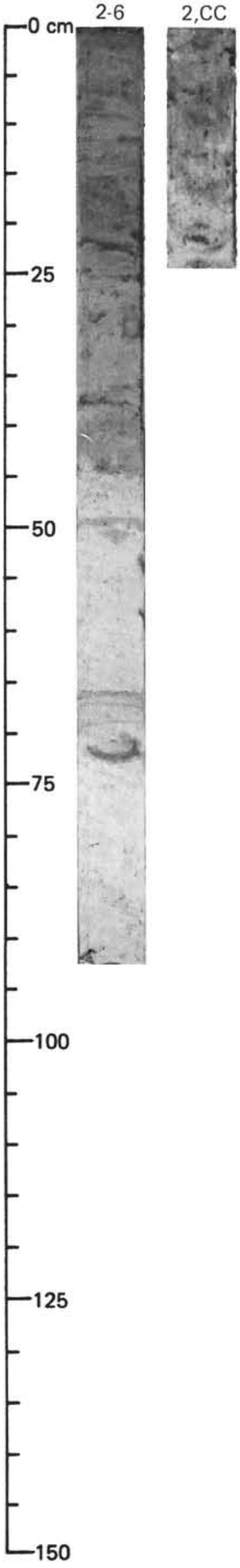
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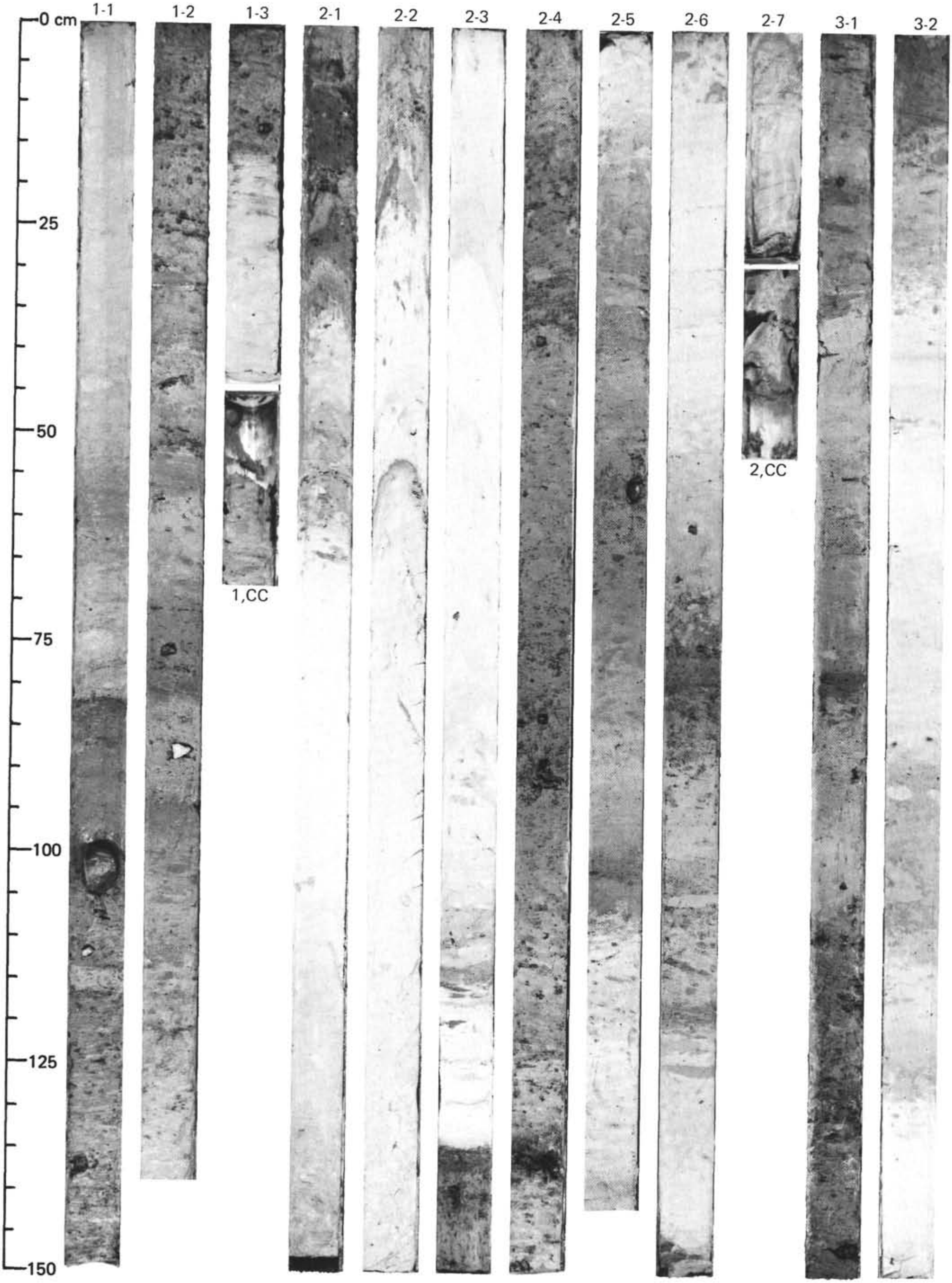
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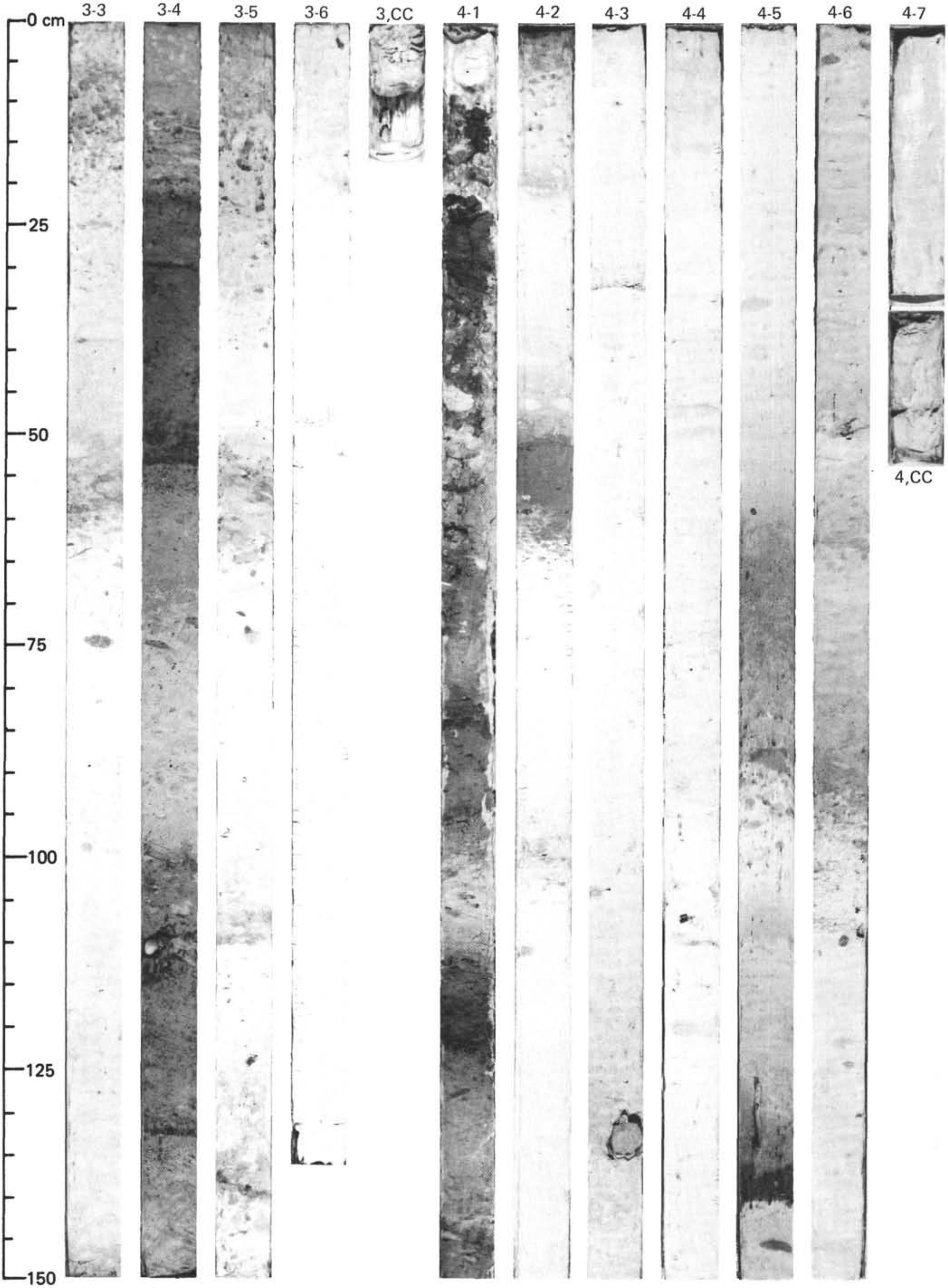
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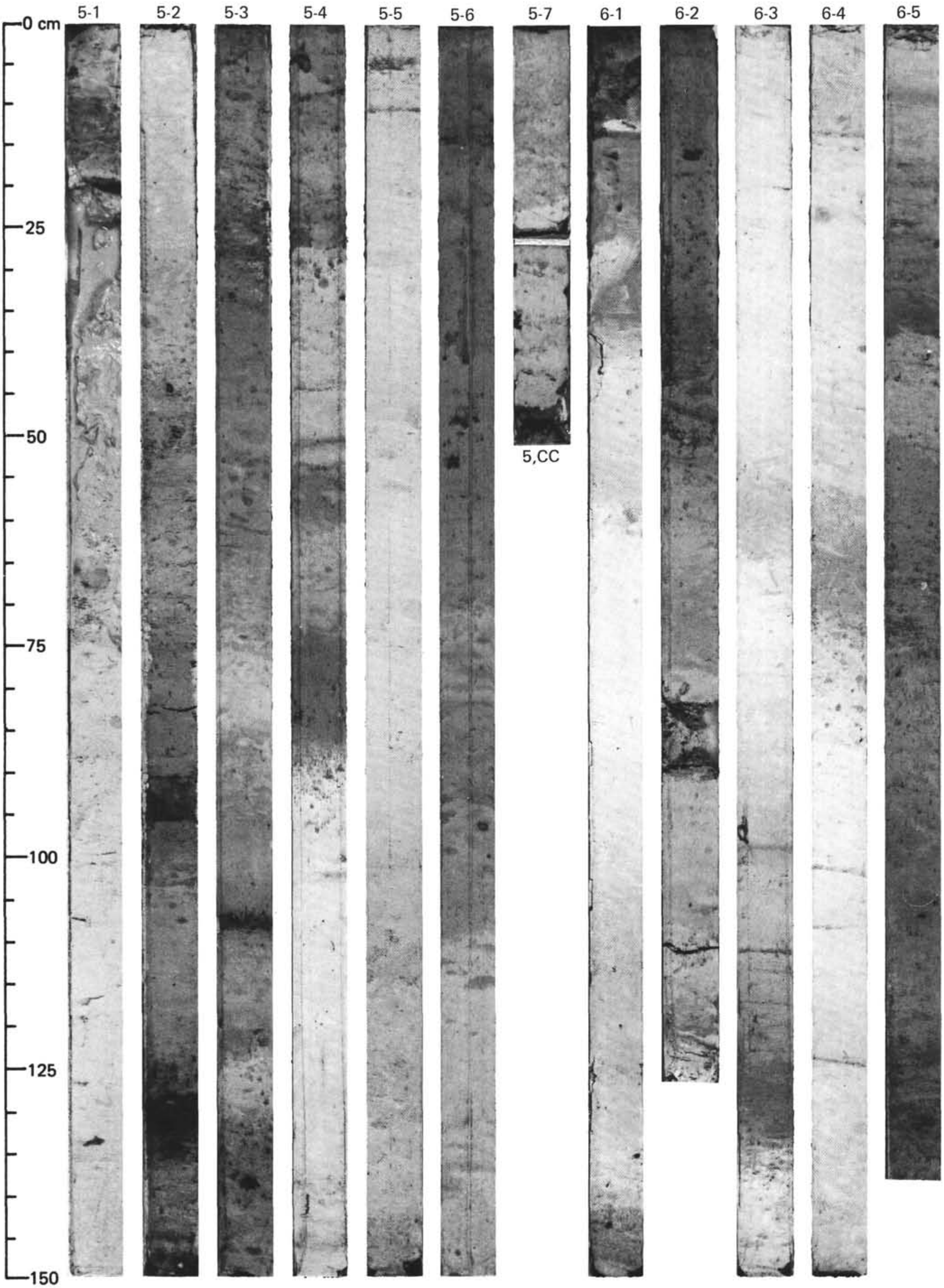
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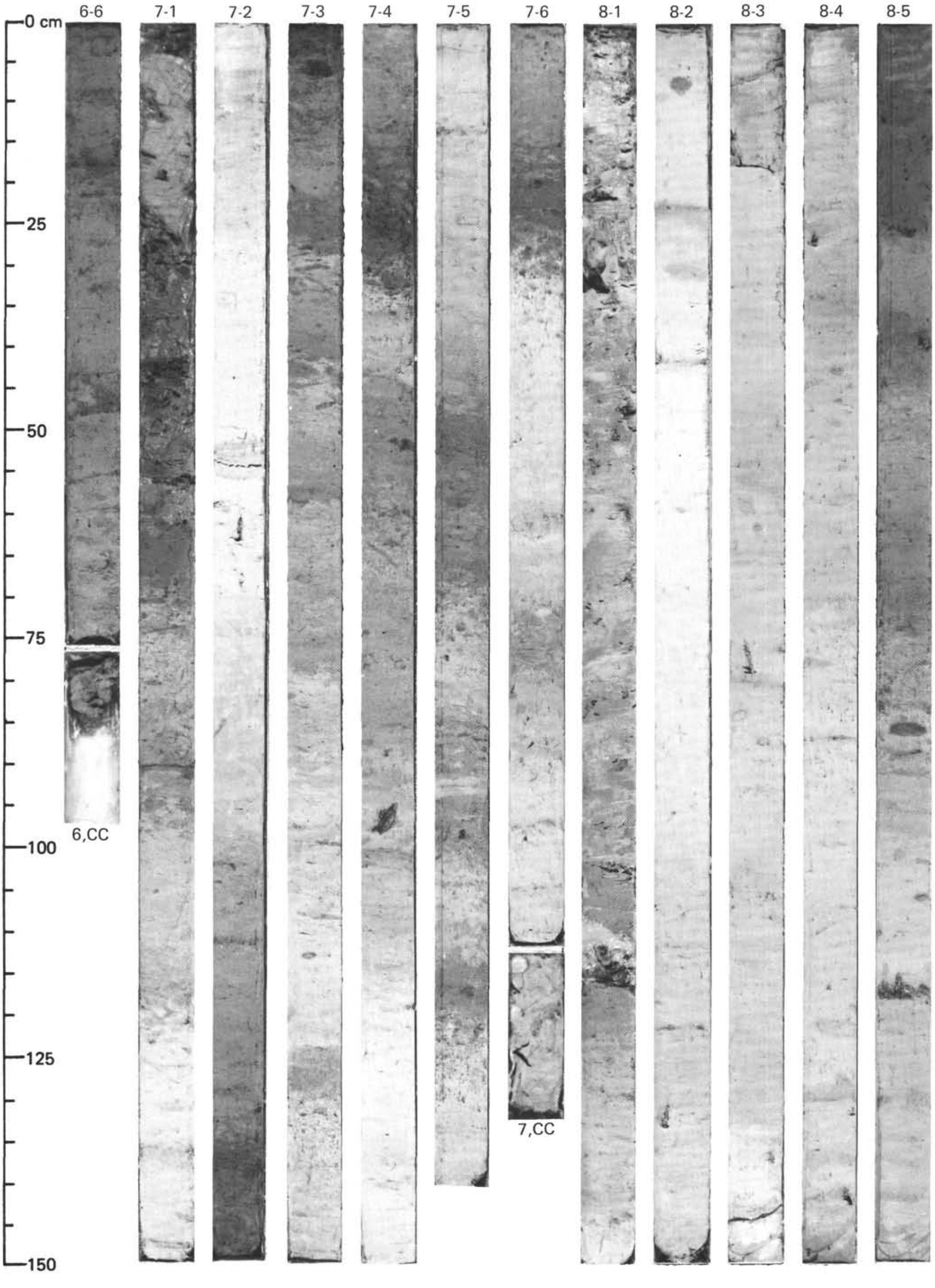
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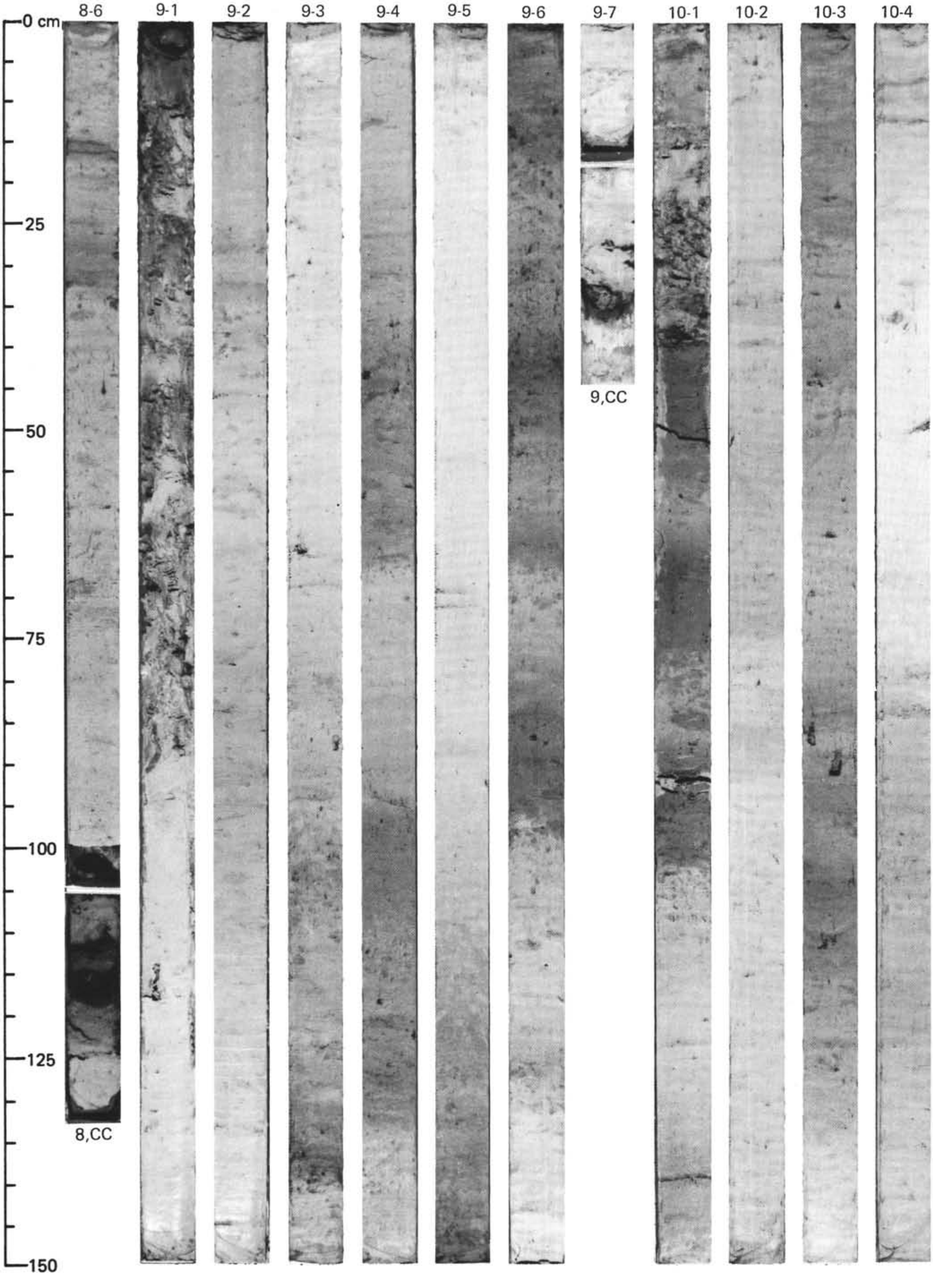
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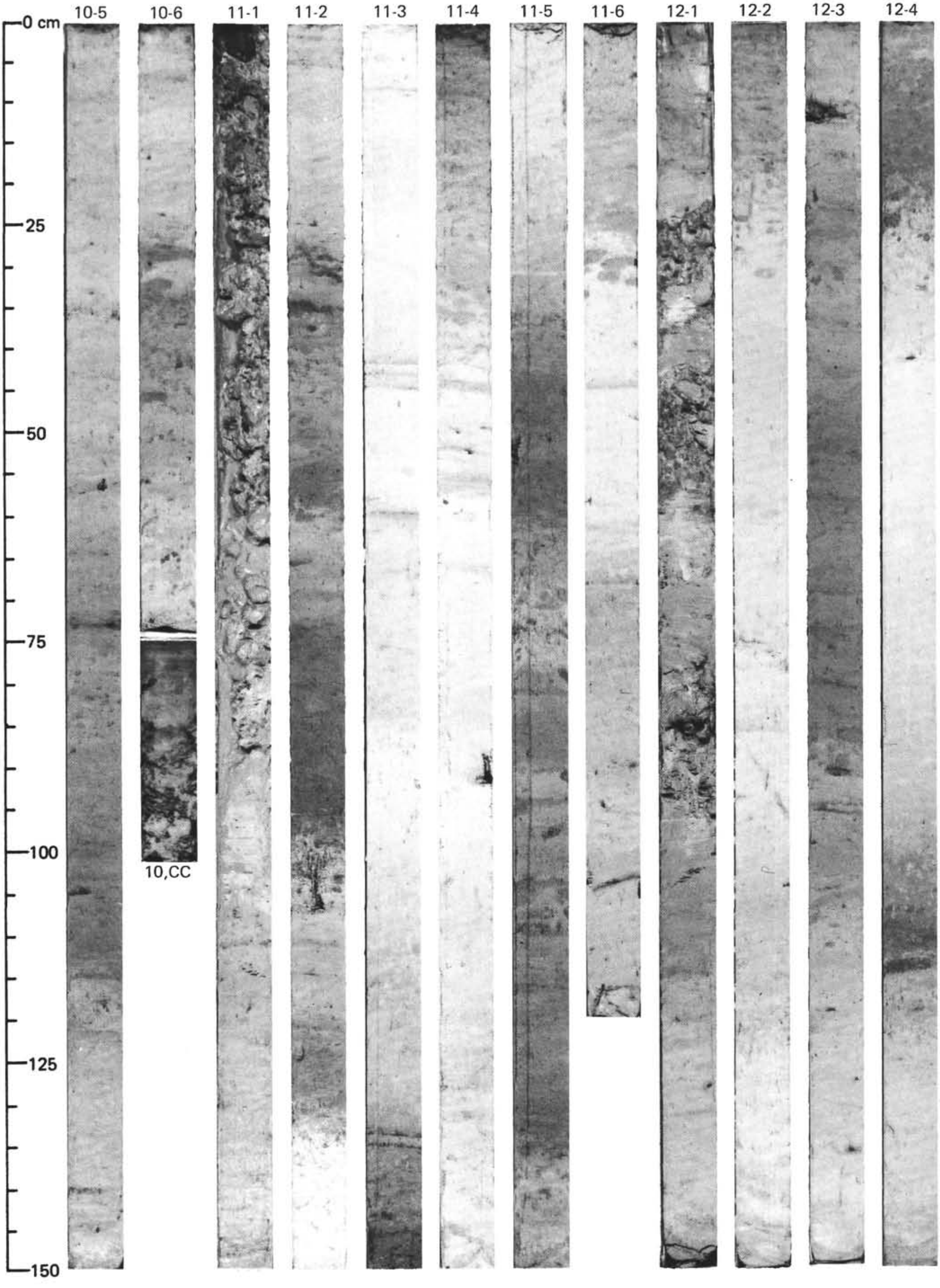
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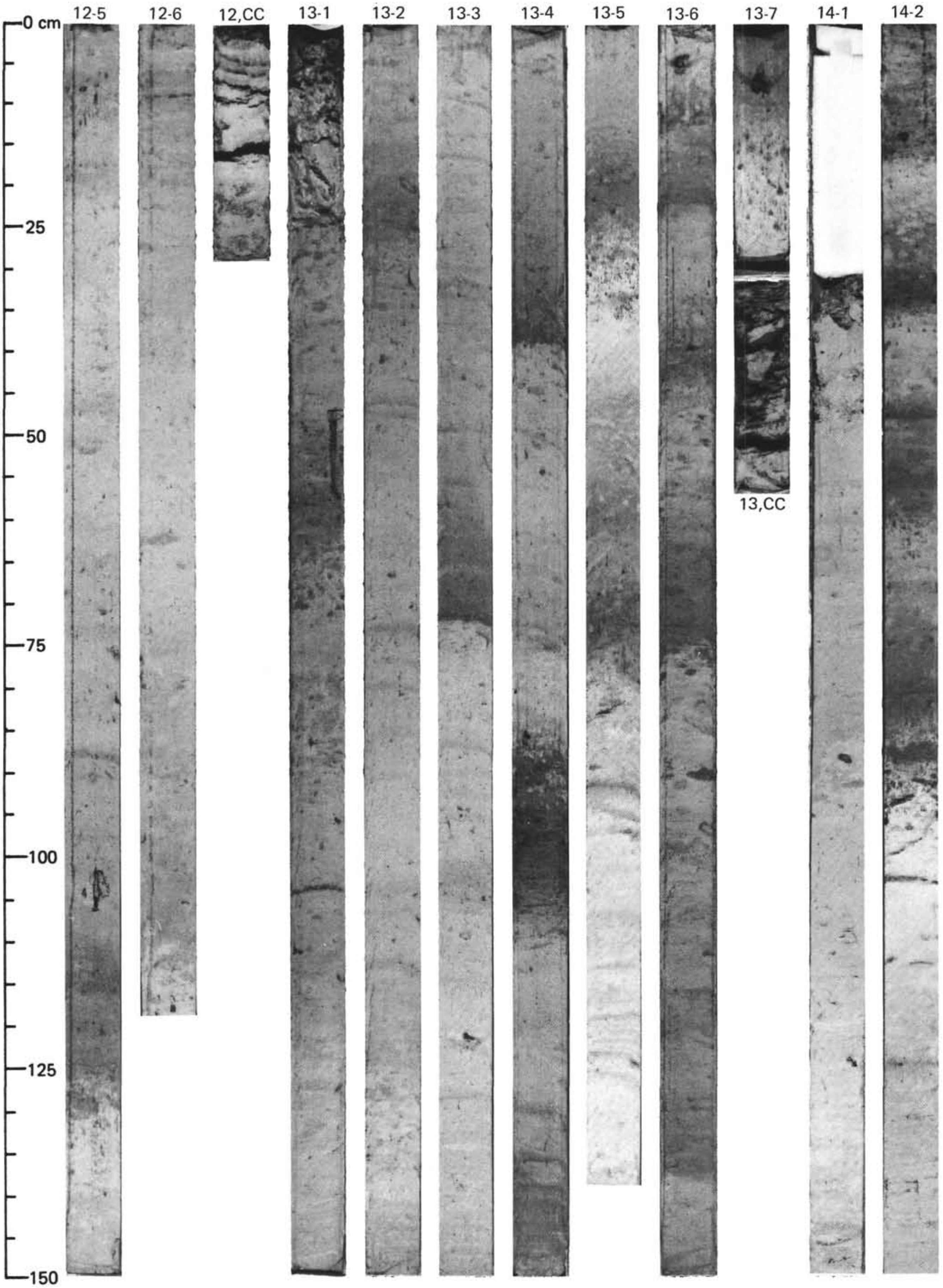

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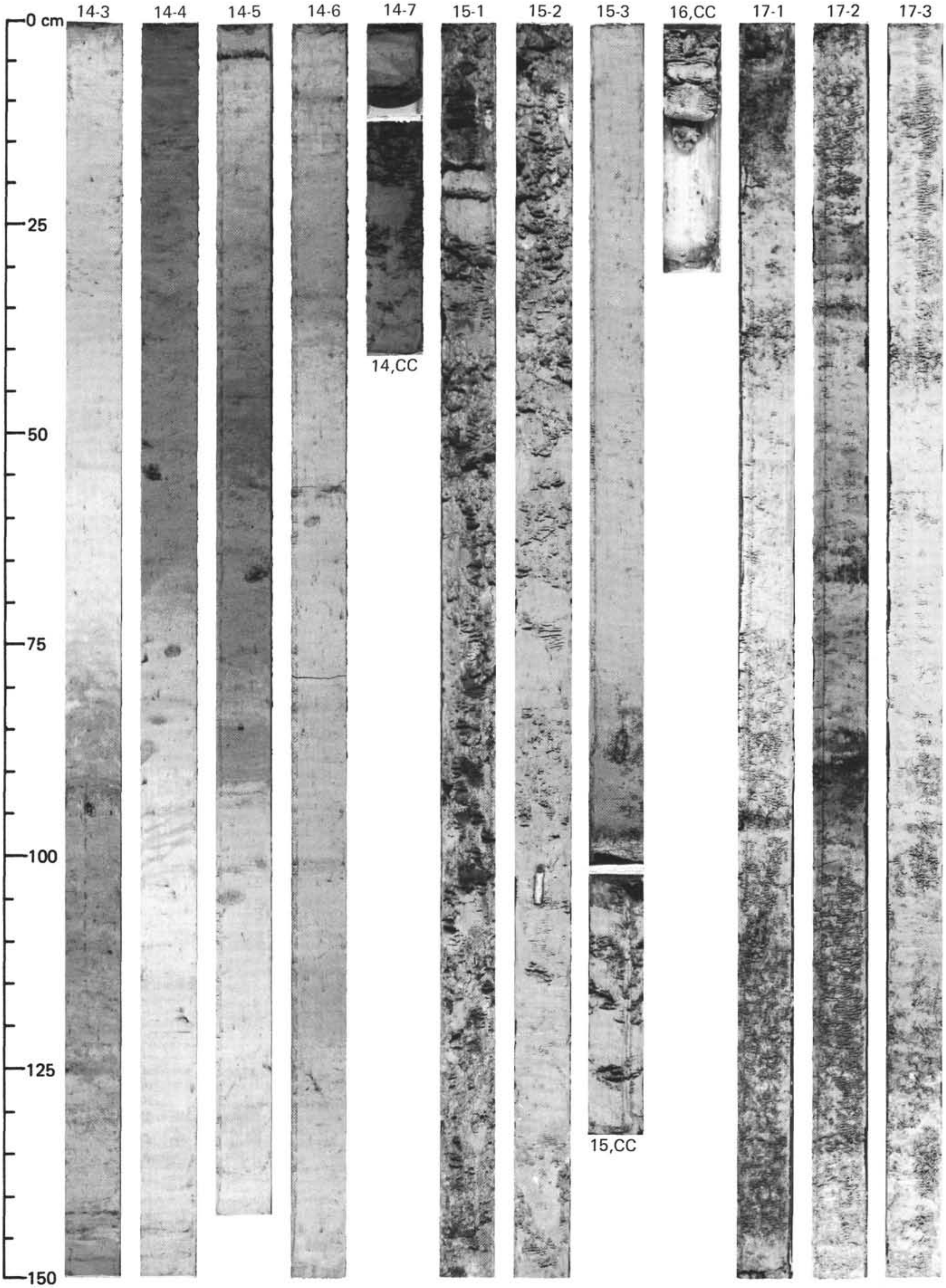
14-2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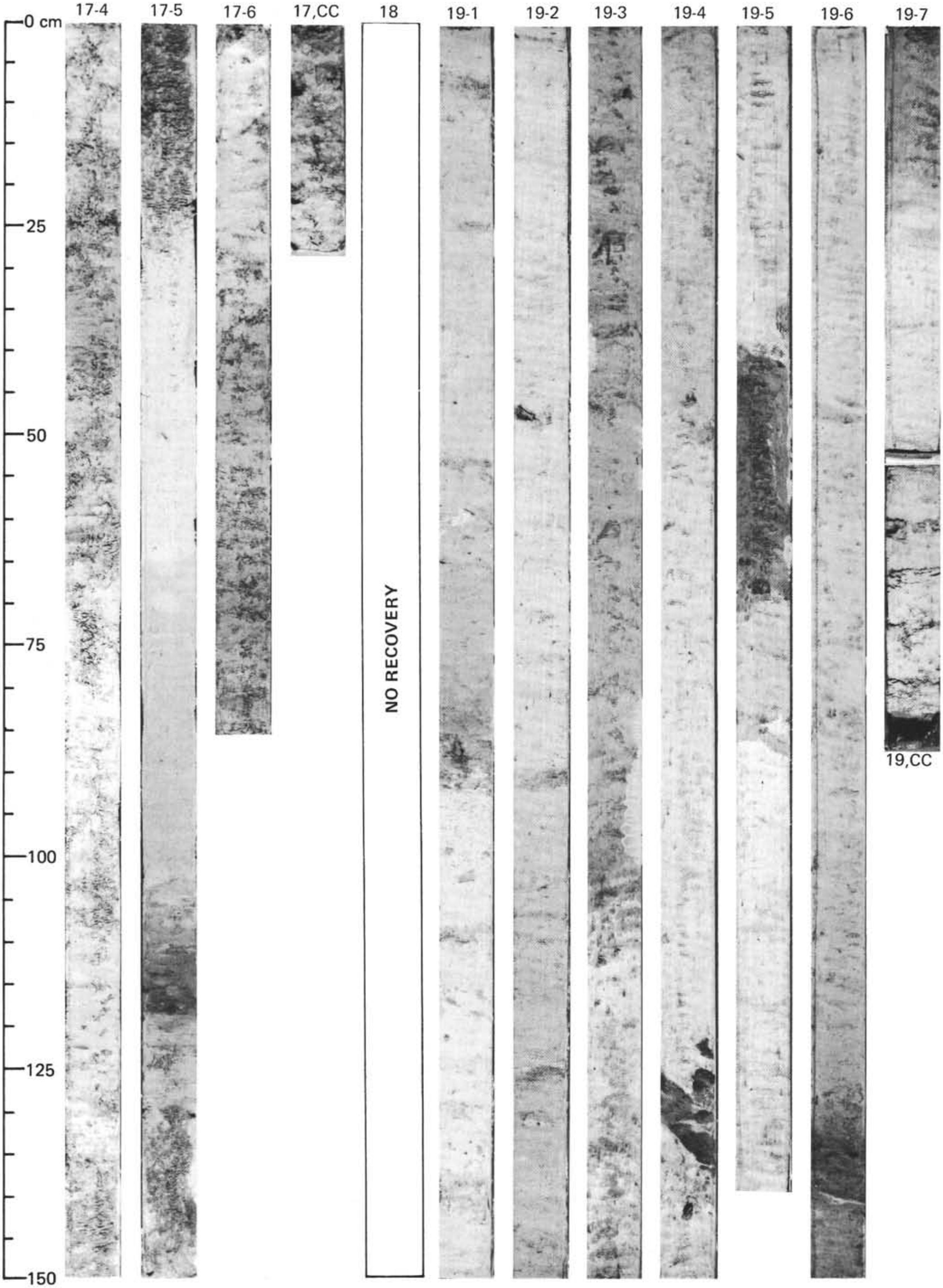
17-2
17-3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17-4
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NO RECOVERY
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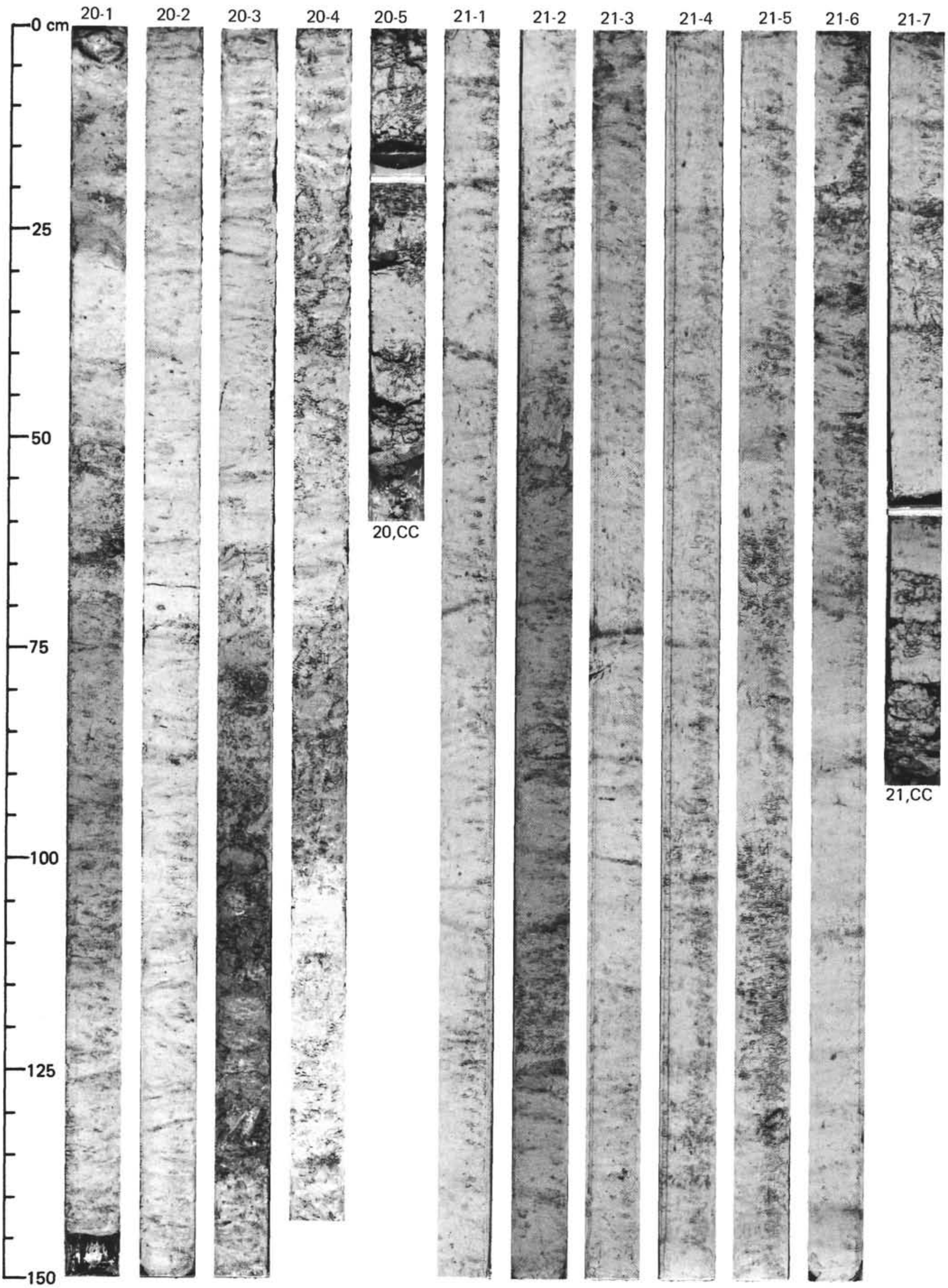
19-4
19-5
19-6
19-7
19,CC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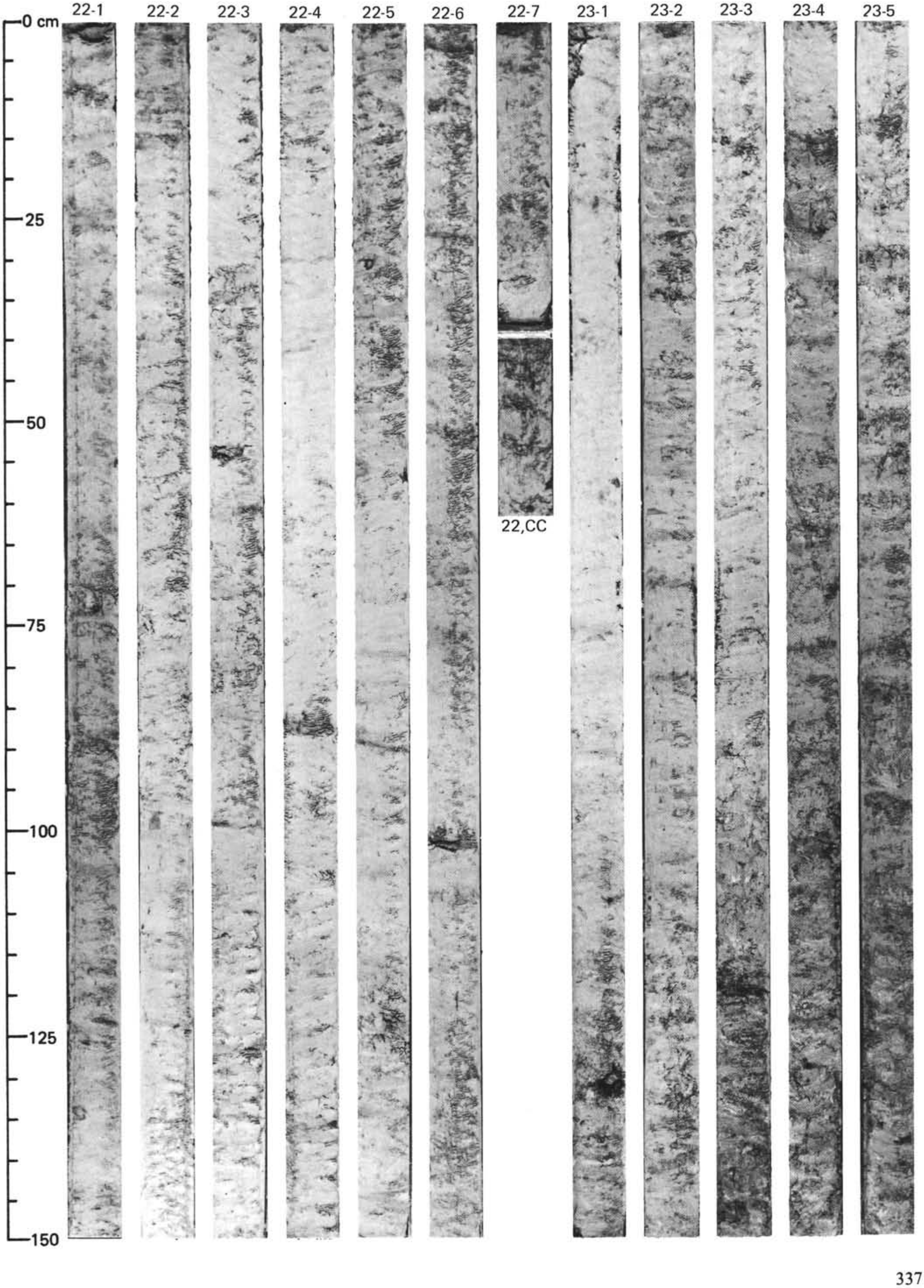
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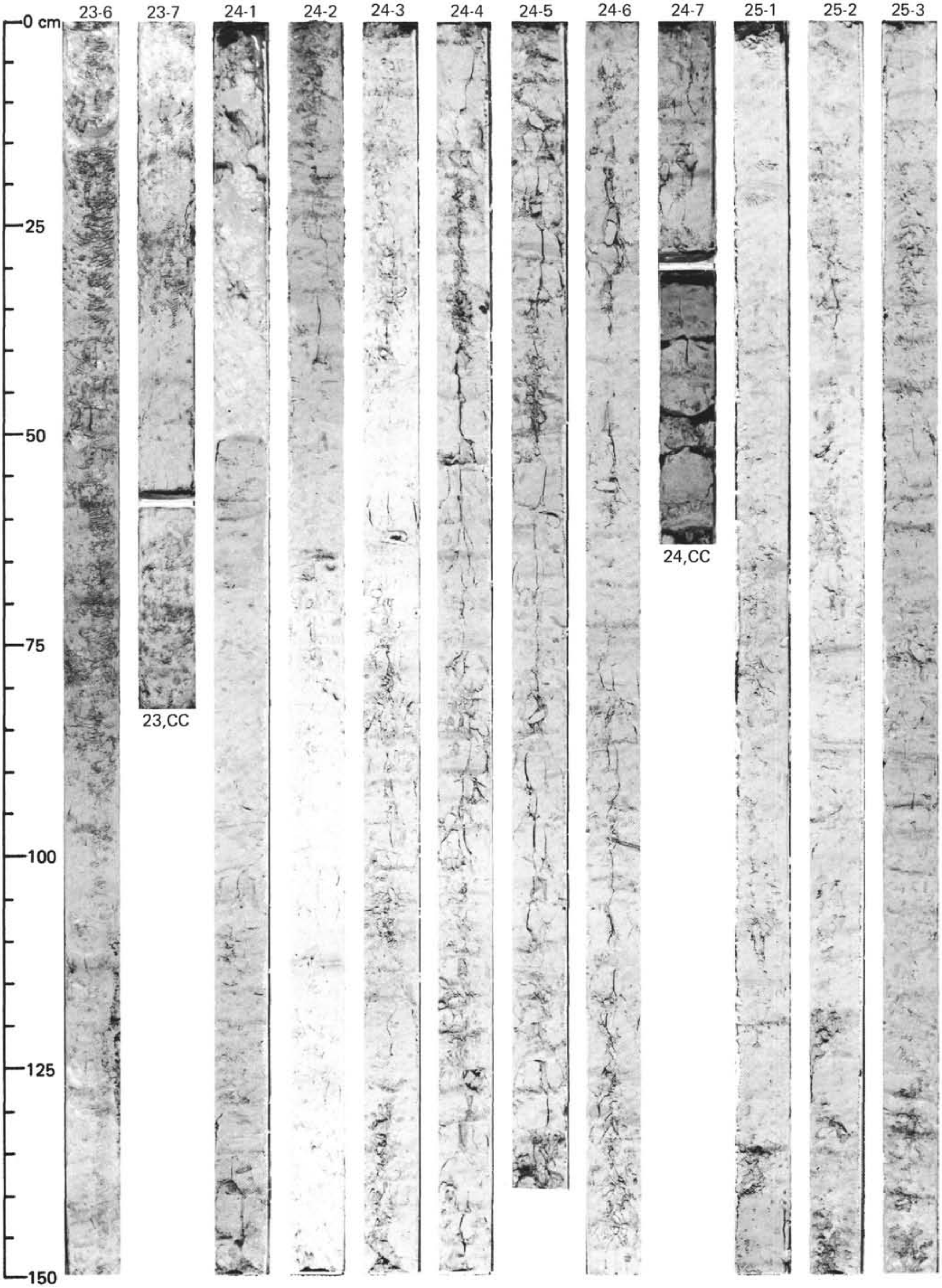
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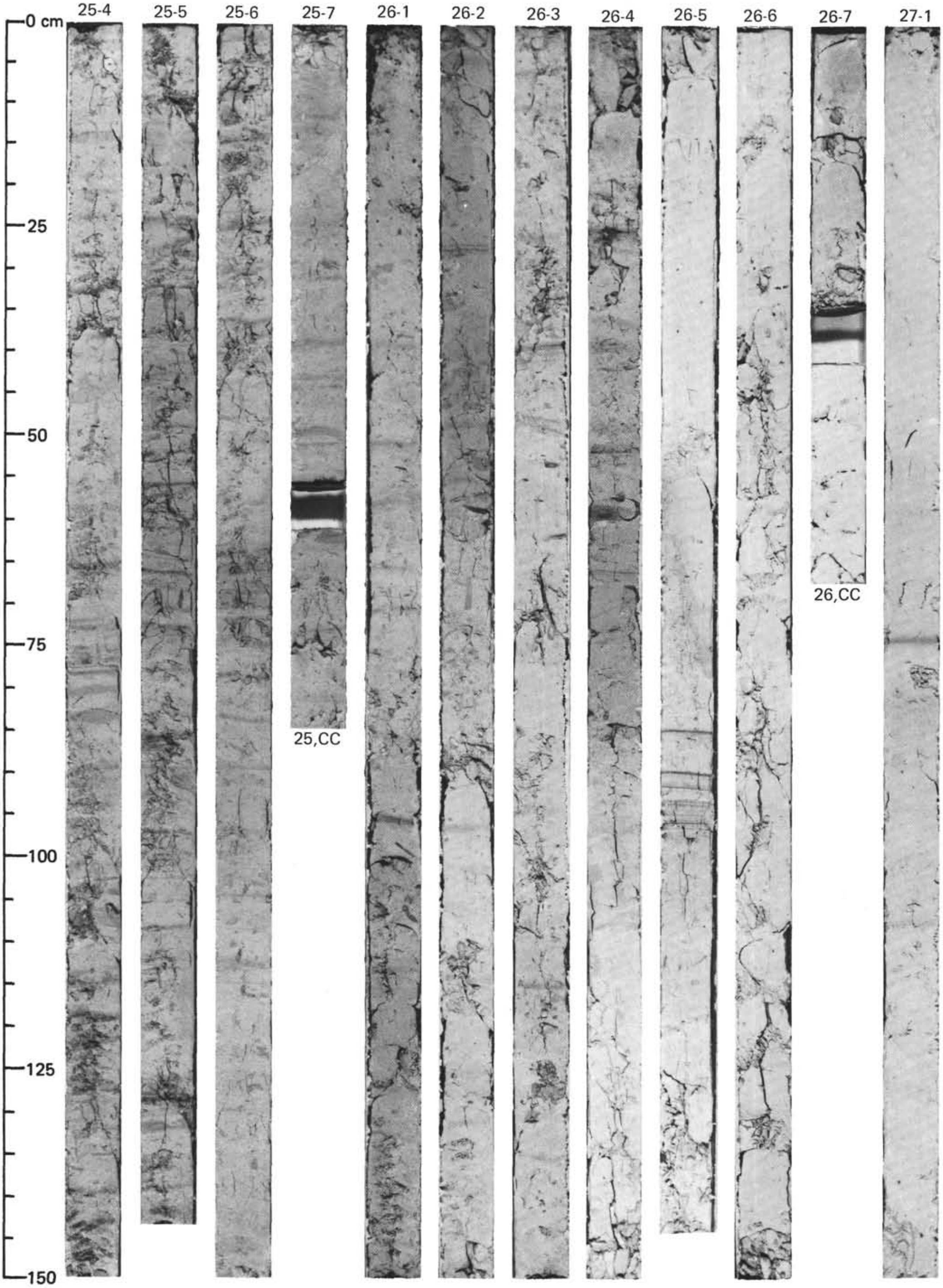
24,CC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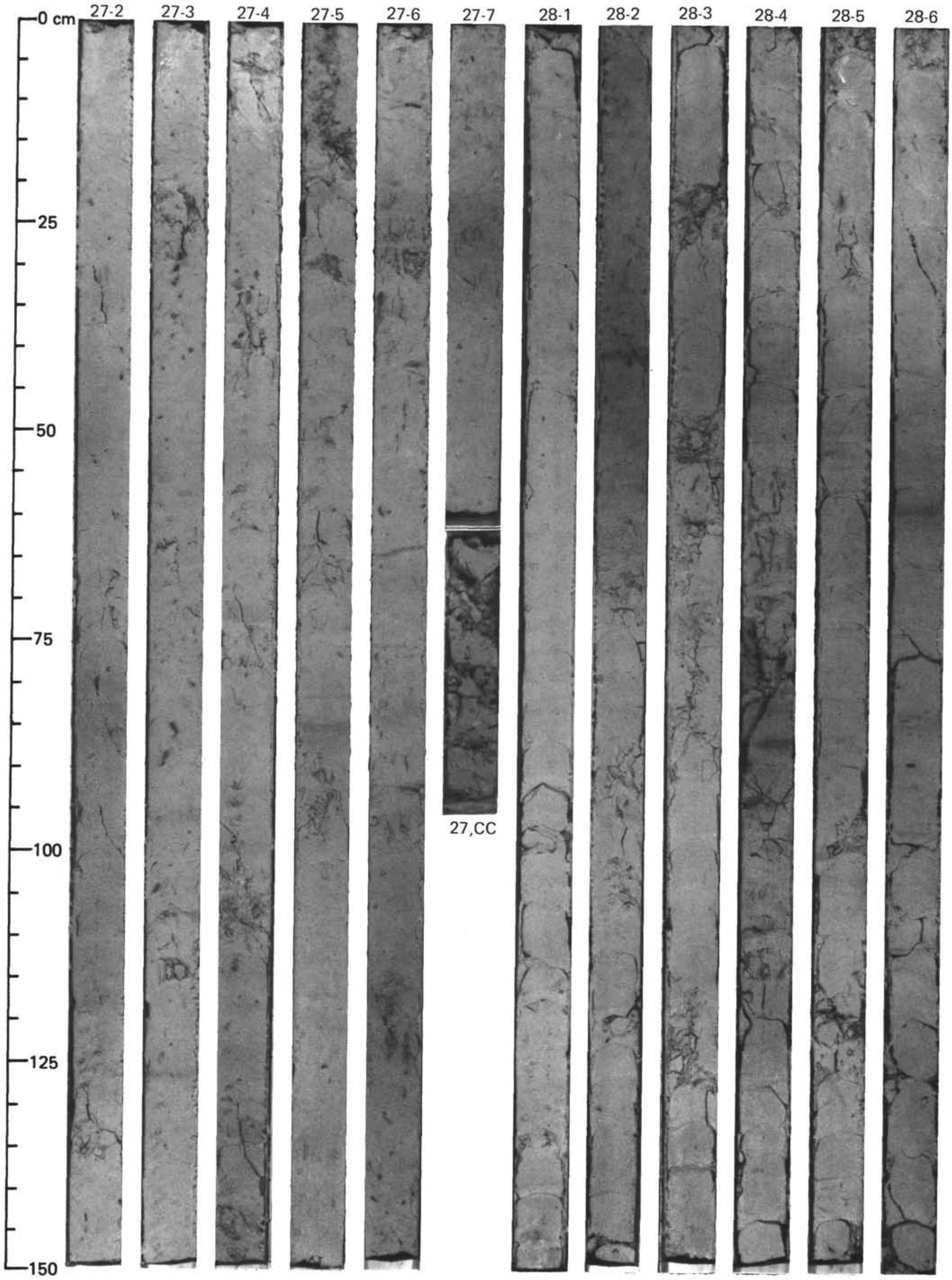
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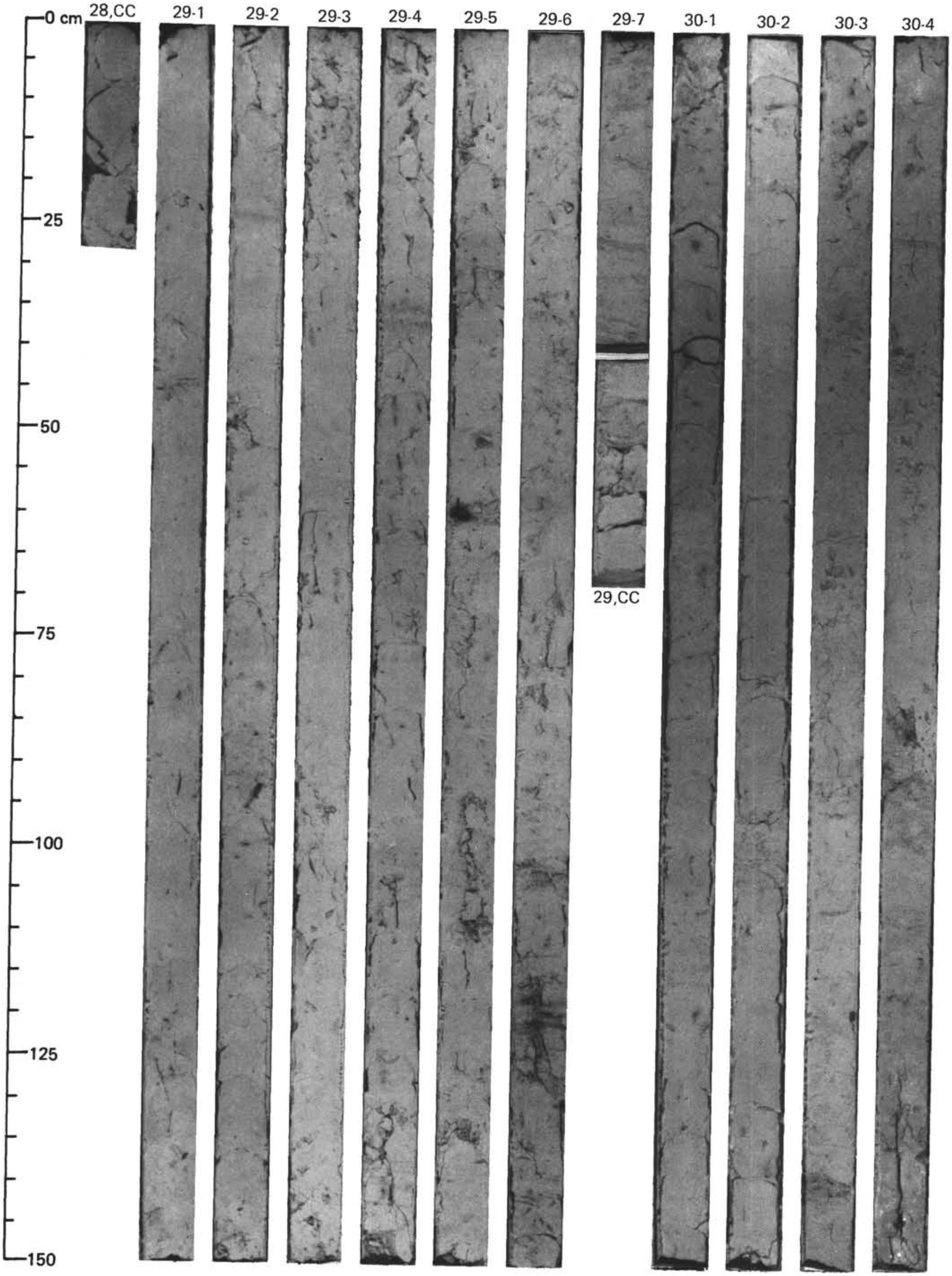
28-6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28,CC
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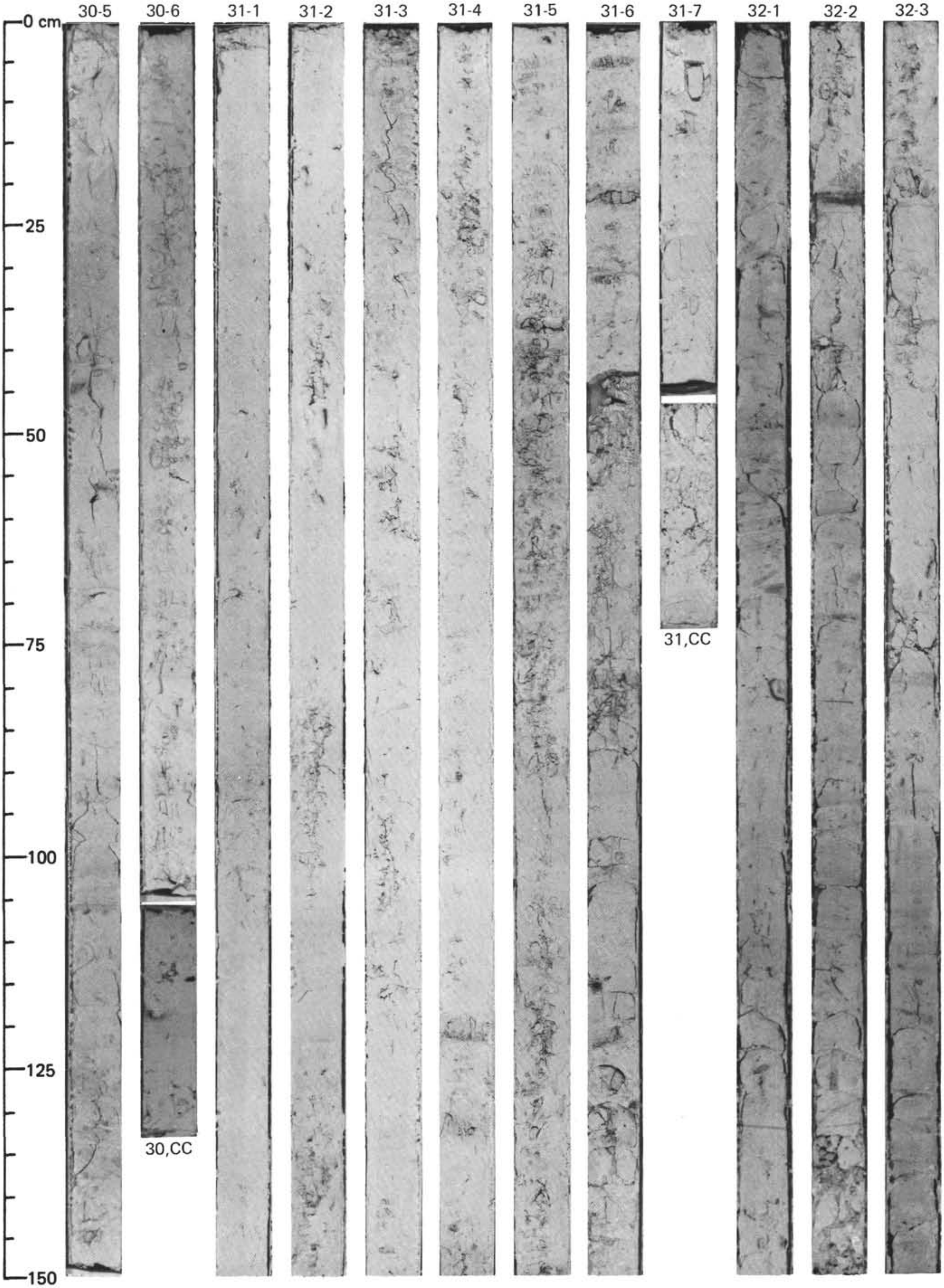
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0 cm
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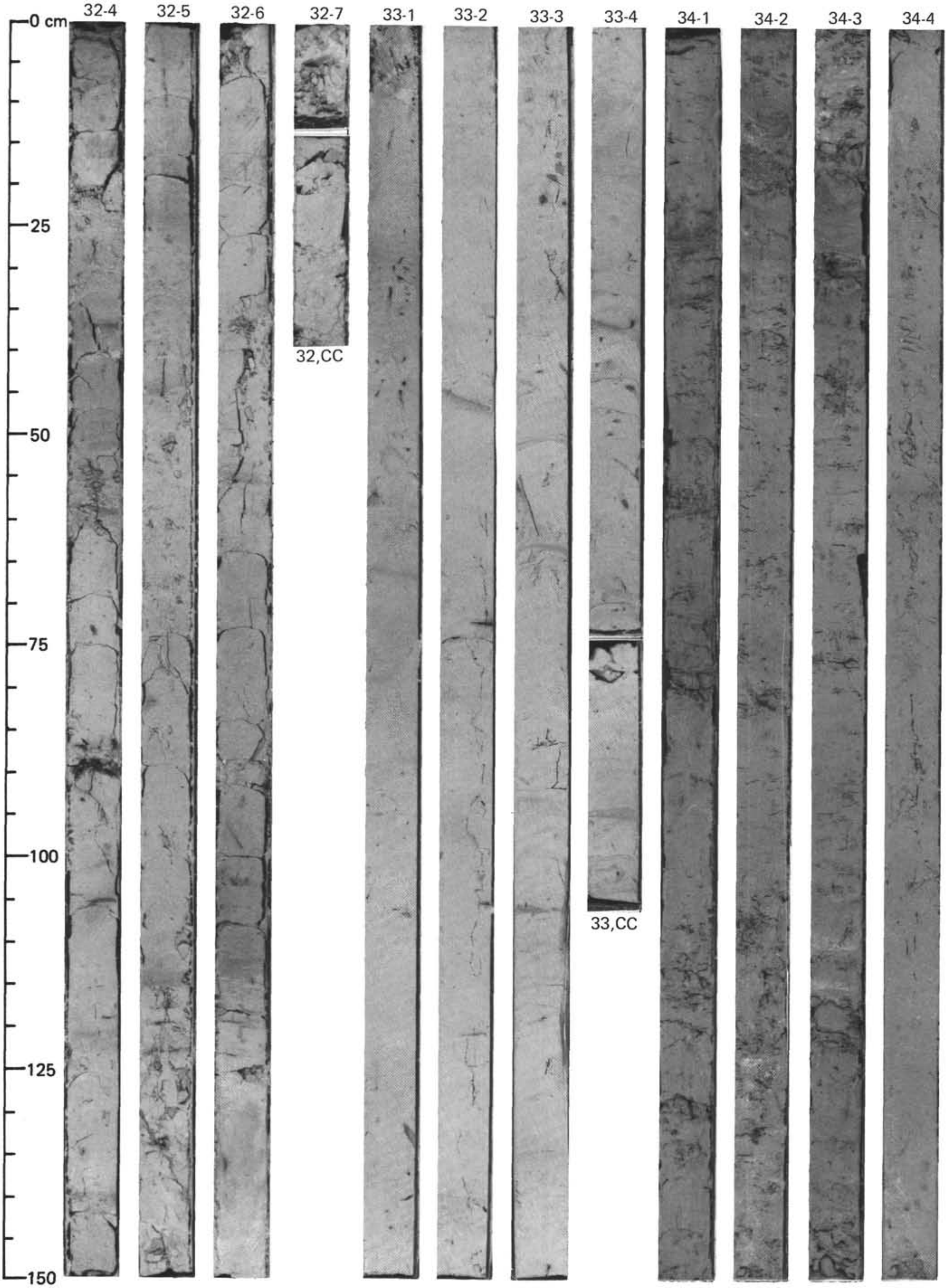
31,CC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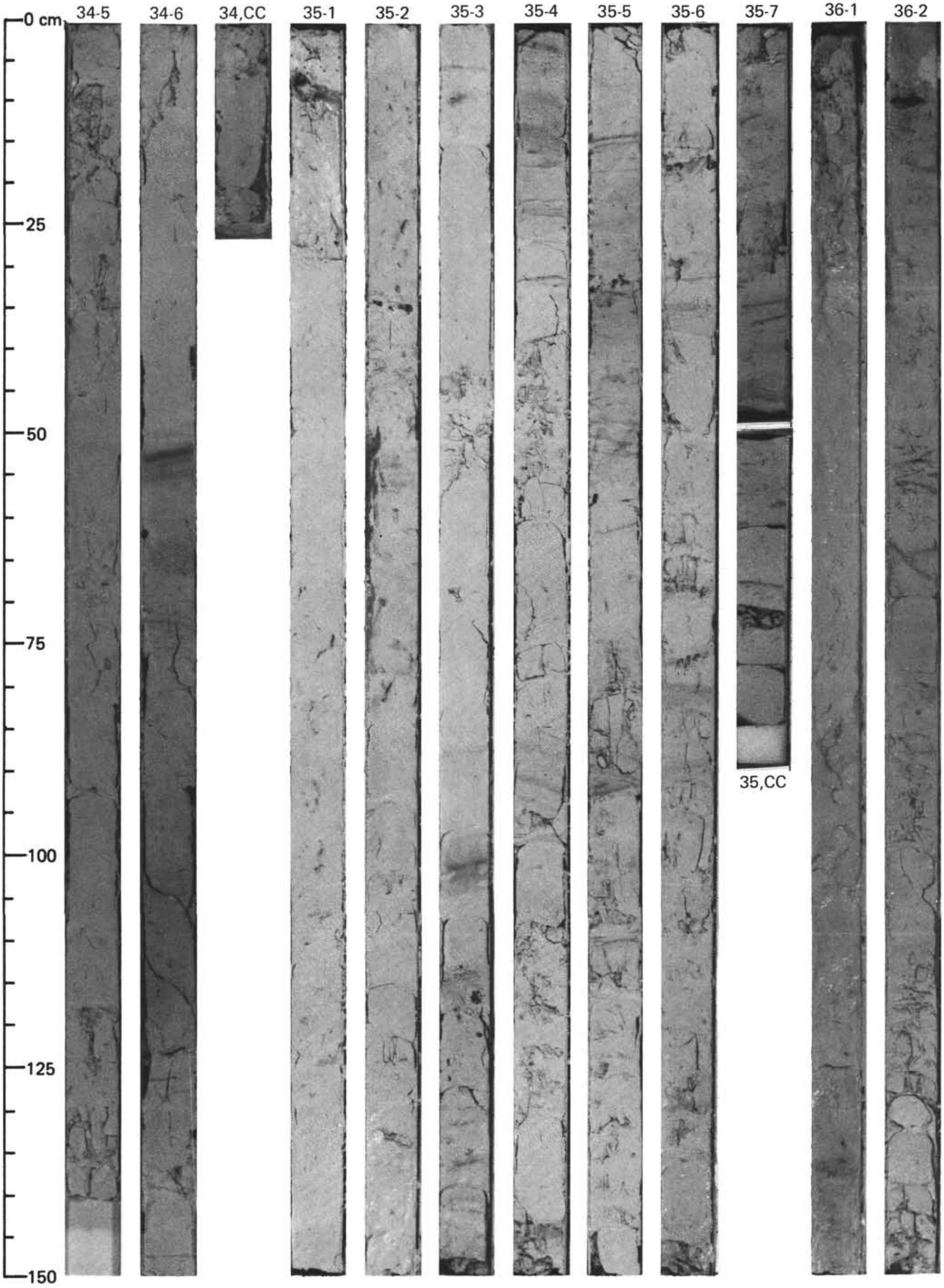
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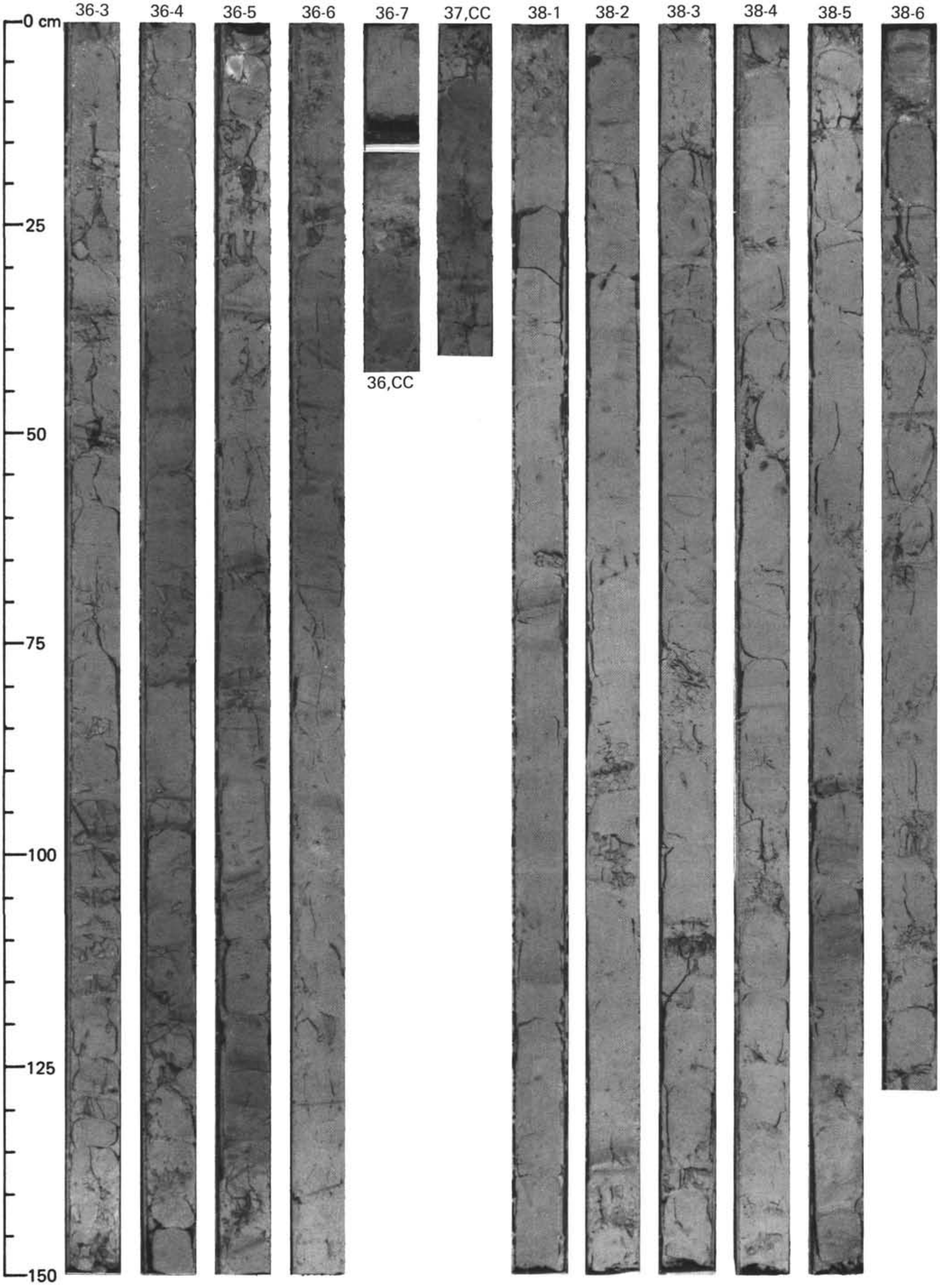
36-2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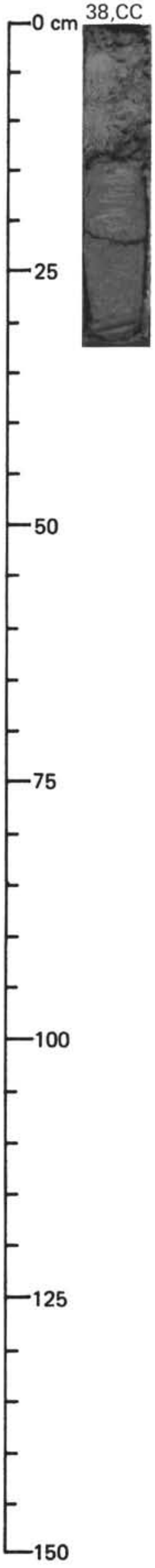
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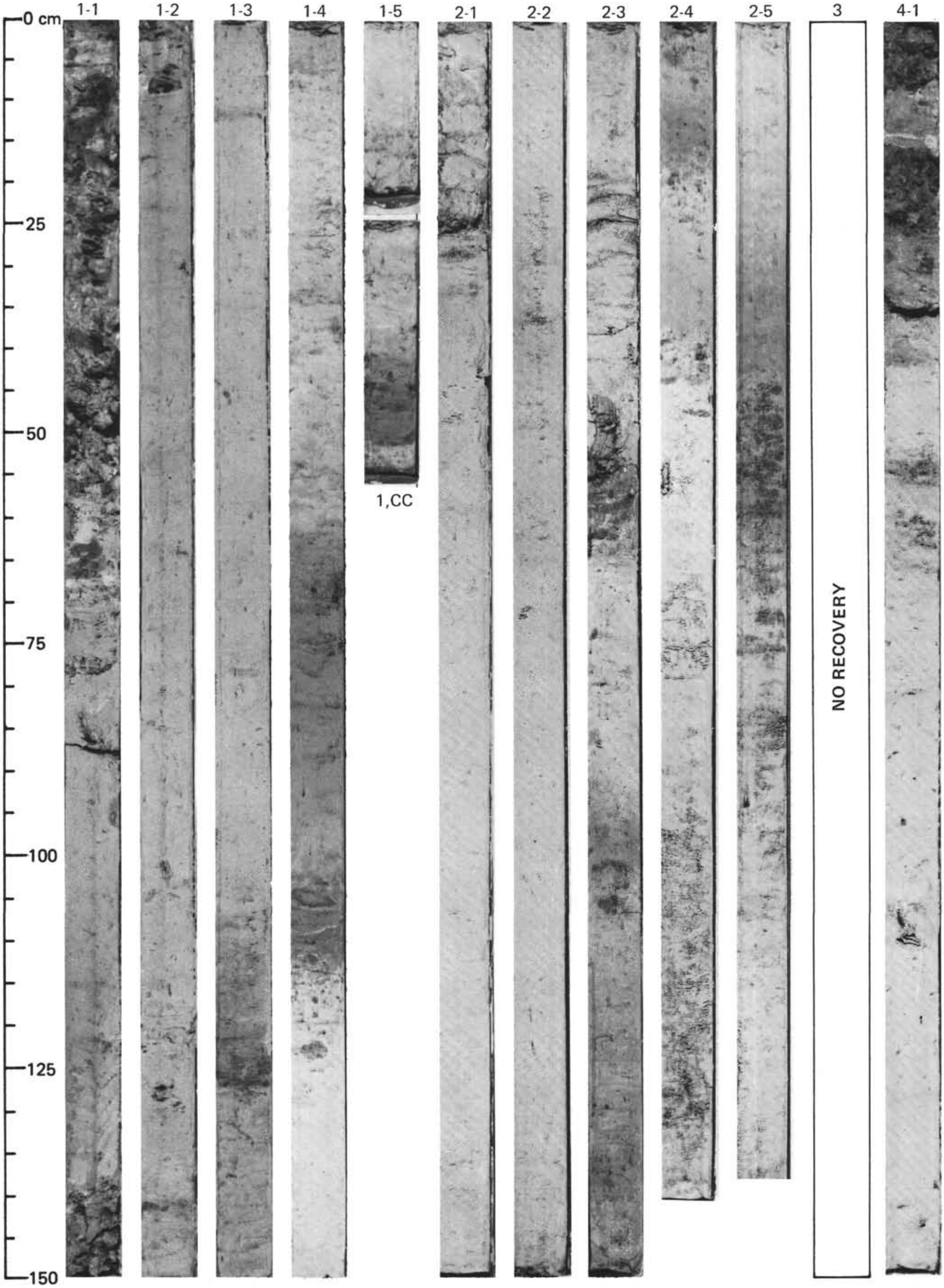
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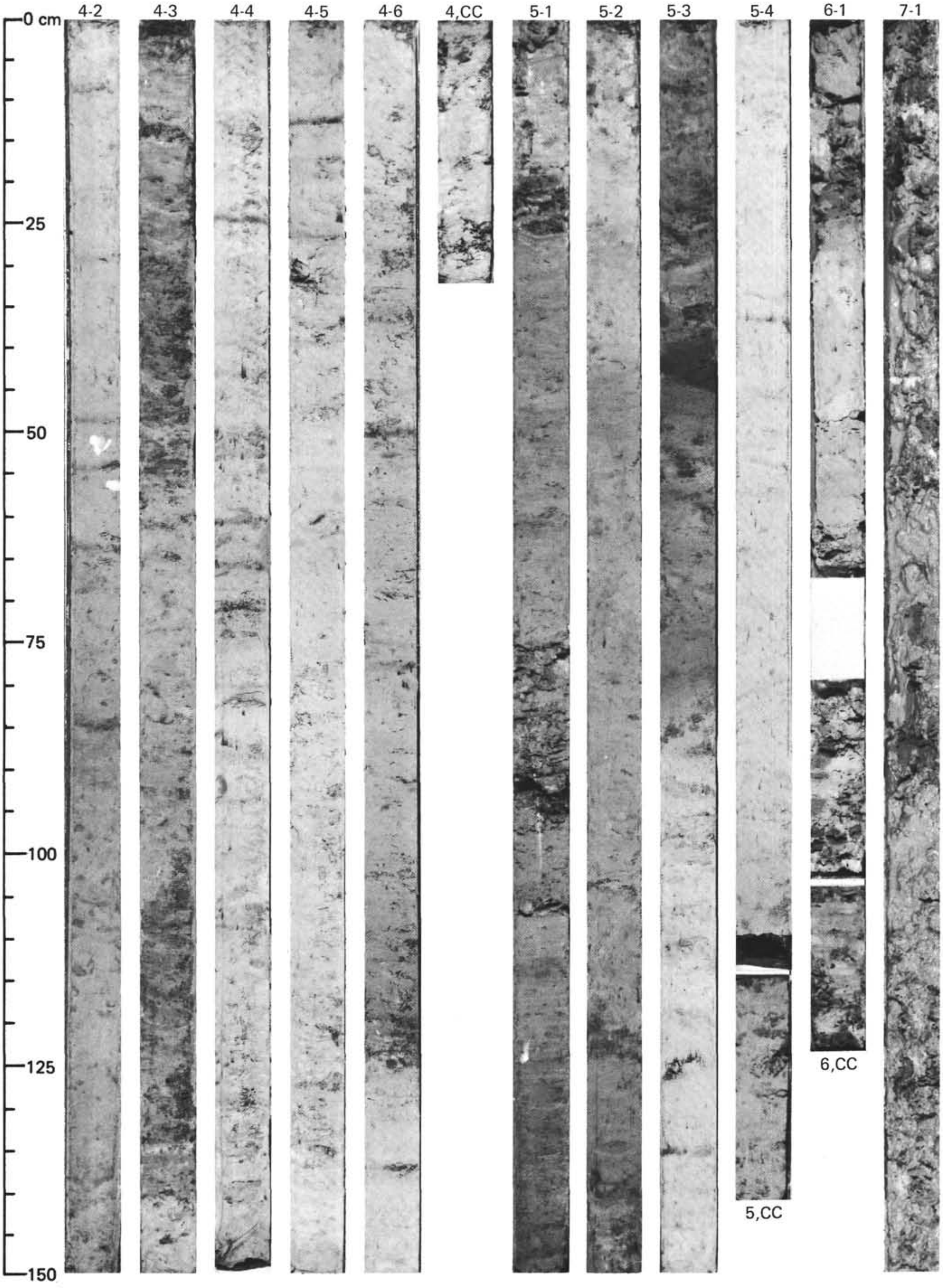
2-5
3
NO RECOVERY
4-1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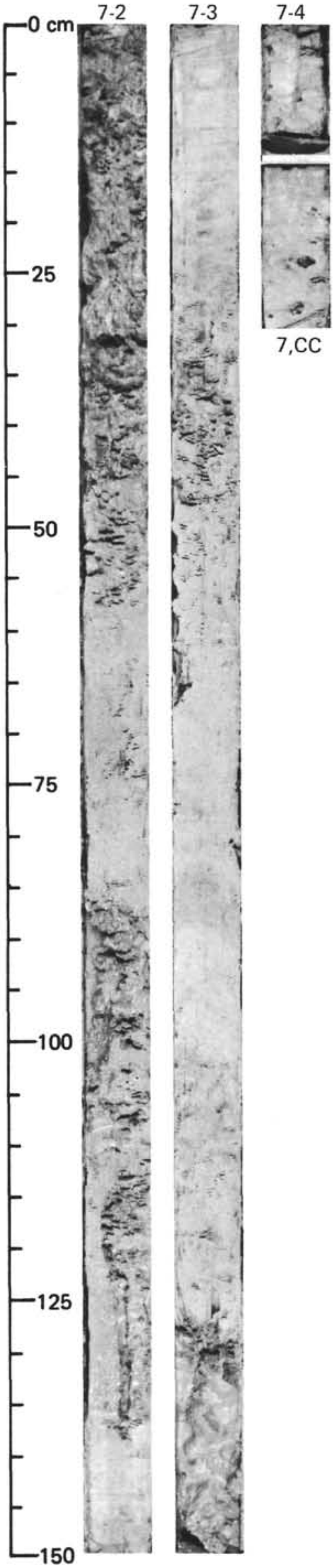
6,CC
7-1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