4. SITE 588: LORD HOWE RISE, 26°S[1]

Shipboard Scientific Party[2]

HOLE 588

Date occupied: 6 December 1982

Date departed: 8 December 1982

Time on hole: 30 hr.

Position: 26°06.7'S; 161°13.6'E

Water depth (sea level; corrected m, echo-sounding): 1533

Water depth (rig floor; corrected m, echo-sounding): 1543

Bottom felt (m, drill pipe): 1548

Penetration (m): 236.00

Number of cores: 26

Total length of cored section (m): 236.00

Total core recovered (m): 220.76

Core recovery (%): 93.5

Oldest sediment cored:
Depth sub-bottom (m): 236.00
Nature: Foraminifer–nannofossil ooze
Age: middle Miocene
Measured velocity (km/s): 1.617 km/s at 233 m

Basement: Not reached

HOLE 588A

Date occupied: 8 December 1982

Date departed: 8 December 1982

Time on hole: 20 hr.

Position: 26°06.7'S; 161°13.6'E

Water depth (sea level; corrected m, echo-sounding): 1533

Water depth (rig floor; corrected m, echo-sounding): 1543

Bottom felt (m, drill pipe): 1548

Penetration (m): 344.4

Number of cores: 18

Total length of cored section (m): 108.40

Total core recovered (m): 75.30

Core recovery (%): 69.4

Oldest sediment cored:
Depth sub-bottom (m): 344.4
Nature: Foraminifer–nannofossil ooze
Age: early Miocene

Basement: Not reached

HOLE 588B

Date occupied: 8 December 1982

Date departed: 10 December 1982

Time on hole: 31 hr.

Position: 26°06.7'S; 161°13.6'E

Water depth (sea level; corrected m, echo-sounding): 1533

Water depth (rig floor; corrected m, echo-sounding): 1543

Bottom felt (m, drill pipe): 1548

Penetration (m): 277.4

Number of cores: 31

Total length of cored section (m): 277.40

Total core recovered (m): 255.87

Core recovery (%): 93

Oldest sediment cored:
Depth sub-bottom (m): 277.4
Nature: Foraminifer–nannofossil ooze
Age: middle Miocene

Basement: Not reached

HOLE 588C

Date occupied: 10 December 1982

Date departed: 11 December 1982

Time on hole: 12 hr.

Position: 26°06.7'S; 161°13.6'E

Water depth (sea level; corrected m, echo-sounding): 1533

Water depth (rig floor; corrected m, echo-sounding): 1543

Bottom felt (m, drill pipe): 1548

Penetration (m): 488.1

Number of cores: 19

Total length of cored section (m): 182.40

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[1] Kennett, J. P., von der Borch, C. C., et al., *Init. Repts. DSDP*, 90: Washington (U.S. Govt. Printing Office).

[2] James P. Kennett (Co-Chief Scientist), Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882; Christopher C. von der Borch (Co-Chief Scientist), School of Earth Sciences, Flinders University of South Australia, Bedford Park, South Australia 5042; Paul A. Baker, Department of Geology, Duke University, Durham, NC 27708; Charles E. Barton, Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882 (present address: Bureau of Mineral Resources, Geology, and Geophysics, P.O. Box 378, Canberra, A.C.T., Australia); Anne Boersma, Microclimates, Inc., 404 RR1, Stony Point, NY 10980; Jean-Pierre Caulet, Laboratoire de Géologie, Muséum National d'Histoire Naturelle, 43 Rue Buffon, 75005, Paris, France; Walter C. Dudley, Jr., Natural Sciences Division, College of Arts and Sciences, University of Hawaii at Hilo, Hilo, Hawaii 96720; James V. Gardner, Pacific-Arctic Branch of Marine Geology, U.S. Geological Survey, 345 Middlefield Rd., Menlo Park, CA 94025; D. Graham Jenkins, Department of Earth Sciences, Open University, Walton Hall, Milton Keynes, MK7 6AA, Buckinghamshire, United Kingdom; William H. Lohman, Marathon Oil Co., Denver Research Center, P.O. Box 269, Littleton, CO 80160; Erlend Martini, Geologisch-Paläontologisches Institut, Johann-Wolfgang-Goethe Universität, Senckenberg-Anlage 32-34, D-6000 Frankfurt am Main, Federal Republic of Germany; Russell B. Merrill, Deep Sea Drilling Project A031, Scripps Institution of Oceanography, La Jolla, CA 92093 (present address: Ocean Drilling Project, Texas A&M University, College Station, TX 77843-3469); Roger Morin, Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139 (present address: U.S. Geological Survey, Denver Federal Center, Denver, CO 80225); Cambell S. Nelson, Department of Earth Sciences, University of Waikato, Private Bag, Hamilton, New Zealand; Christian Robert, Laboratoire de Géologie Marine, Centre Universitaire de Luminy, Case 901, 13288 Marseille Cedex 09, France; M. S. Srinivasan, Department of Geology, Banaras Hindu University, Varanasi 221 005, India; Rüdiger Stein, Geologisch-Paläontologisches Institut, Universität Kiel, 2300 Kiel, Federal Republic of Germany (present address: Institute of Petroleum and Organic Geochemistry (ICH-5), Kernforschungslage Jülich GmbH, P.O. Box 1913, 5170 Jülich, Federal Republic of Germany); Akira Takeuchi, Department of Earth Sciences, Faculty of Science, Toyama University, Gohuku 3190, Toyama 930, Japan.

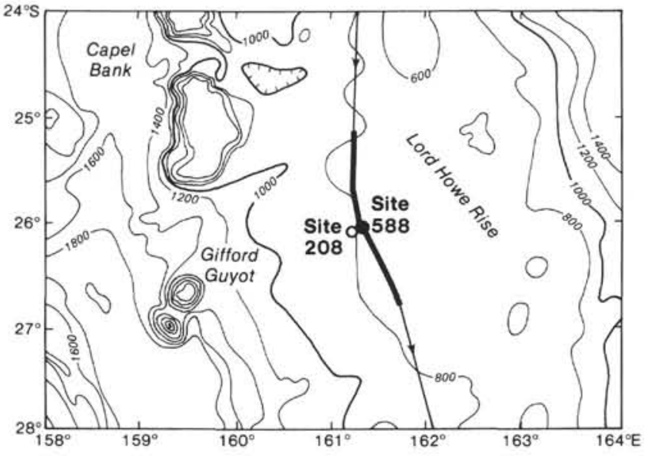

Figure 1. Regional bathymetry (fathoms) around Site 588, after Mammerickx, et al., 1974. *Glomar Challenger* Leg 90 track shown; heavy portion locates water gun seismic profile illustrated in Figure 2.

Total core recovered (m): 135.61

Core recovery (%): 74.3

Oldest sediment cored:
Depth sub-bottom (m): 488.1
Nature: Siliceous foraminifer-bearing nannofossil chalk and foraminifer-bearing chert
Age: middle Miocene

Basement: Not reached

Principal results: Site 588 consists of four holes: Hole 588, which was cored continuously with the HPC from 0 to 236.0 m sub-bottom; Hole 588A, cored continuously with the HPC from 236.0 to 344.4 m; Hole 588B, cored continuously with the HPC from 0 to 277.4 m; and Hole 588C, cored continuously with the rotary drill from 305.7 to 488.1 m BSF.

Site 588 is located at DSDP Site 208, in the warm subtropical water mass at 26°S.

The HPC sequence through carbonate sediments is a record penetration of 315 m, extending from the Quaternary to sediments of late early Miocene age (17 m.y.; Zone NN3 and *Globorotalia miozea* Zone). The overlapping hydraulic piston cores effectively provide 100% recovery of this sequence. Core quality is particularly good in the Miocene, much less so in the Pliocene, and especially poor in the Quaternary, which is soupy. The carbonate fossil sequence is exquisite through the Neogene, but less so in Oligocene sediments. Foraminiferal and calcareous nannofossil zonal sequences are complete, suggesting that there are no hiatuses above the upper Oligocene (NP24). A paleomagnetic polarity stratigraphy has been identified down to the upper part of the Gilbert Chron (about 3.5 m.y.).

Two sedimentary units are distinguished, the upper one divided into three subunits. Subunit IA is a brownish, foraminifer-rich nannofossil ooze in an oxidized and winnowed environment. Subunit IB, comprising most of the sediment column, is a foraminifer-bearing nannofossil ooze. Subunit IC is chalk. There are many thin volcanic ash layers throughout the Miocene sequence; they occur as singlets, doublets, or triplets and exhibit quasi-regular perodicites in some intervals. Most are completely undisturbed by bioturbation, which is unusually limited in this site. Unit II is a light greenish gray, siliceous foraminifer-bearing nannofossil chalk and associated chert of Eocene age.

Iron sulfides are persistent throughout the section and have a close association with volcanic ash layers. The site terminated in middle Eocene silica-rich chalks and cherts.

Textbook examples of microfaults and slickensides occur in three upper lower Miocene cores in a zone where ooze grades downward into chalks. Surfaces are occasionally mineralized by iron sulfide and possibly rhodochrosite.

The uncorrected rate of sedimentation is as follows: early Oligocene–early Miocene, 20.6 m/m.y.; early Miocene, 14.4; middle Miocene–early Pliocene, 17.4, lower Pliocene, 29.5; Quaternary, 12.2.

BACKGROUND AND OBJECTIVES

Site 588 (Fig. 1) was drilled at the same location as Site 208 on the northern part of Lord Howe Rise (26°06′S; 161°13′E) to obtain a high-quality, continuously cored sequence through the upper Paleogene and Neogene. The chosen site overlies a relatively thick sequence of acoustically transparent sediments (Figs. 2 and 3). Previous investigations have demonstrated that the planktonic foraminiferal assemblages at this latitude are made up of both tropical and temperate elements. Site 588 is now located in the warm subtropical water mass which lies between the true tropical water masses to the north and transitional water masses to the south. However, Site 588 experienced 5–10° of northernly movement during the Neogene in association with movements of the Indian Plate (Sclater et al., in press). During the early Miocene, Site 588 was located at about 36°S in the present-day temperate area and within the zone of westerly winds. This northward movement from higher to lower latitudes must have had a major effect upon the ancient biogeography of the planktonic microfossil assemblages.

The section at Site 208 consists of about 430 m of Neogene and 58 m of upper Oligocene foraminiferal–nannofossil oozes which make up Unit 1 as defined by the Leg 21 sedimentologists. Unit 1 is underlain by Unit 2, which is made up of Upper Cretaceous to lower middle Eocene siliceous-fossil-bearing nannofossil chalk. Unit 1 is separated from Unit 2 by the regional unconformity. The Site 208 sequence was continuously rotary cored from the Quaternary to the uppermost Miocene, then discontinuously cored to the base of the sequence. Rotary coring produced the usual mechanical disturbance of sediments; in addition, there are many long coring gaps in the section at Site 208.

The plan for Site 588 was to core two separate holes using the HPC in the upper part of the sequence, followed by continuous rotary coring in one hole to the level immediately below the regional unconformity separating the middle Eocene from the upper Oligocene at 488 m sub-bottom depth. Such a sequence would include all of Unit 1 as defined by the Leg 21 shipboard party.

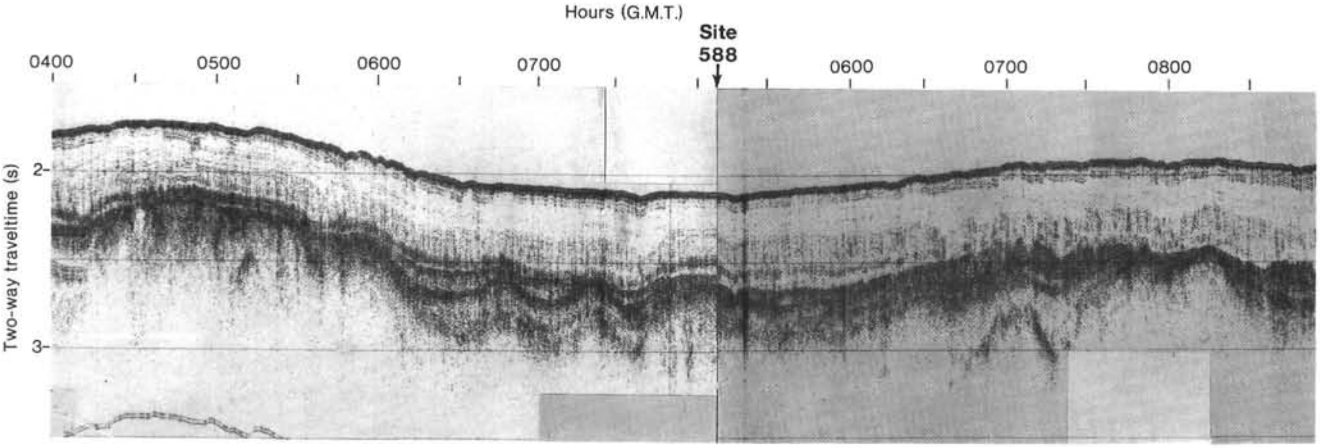

Figure 2. Water gun seismic profile (*Glomar Challenger*) near Site 588; bandpass filter 40–160 Hz.

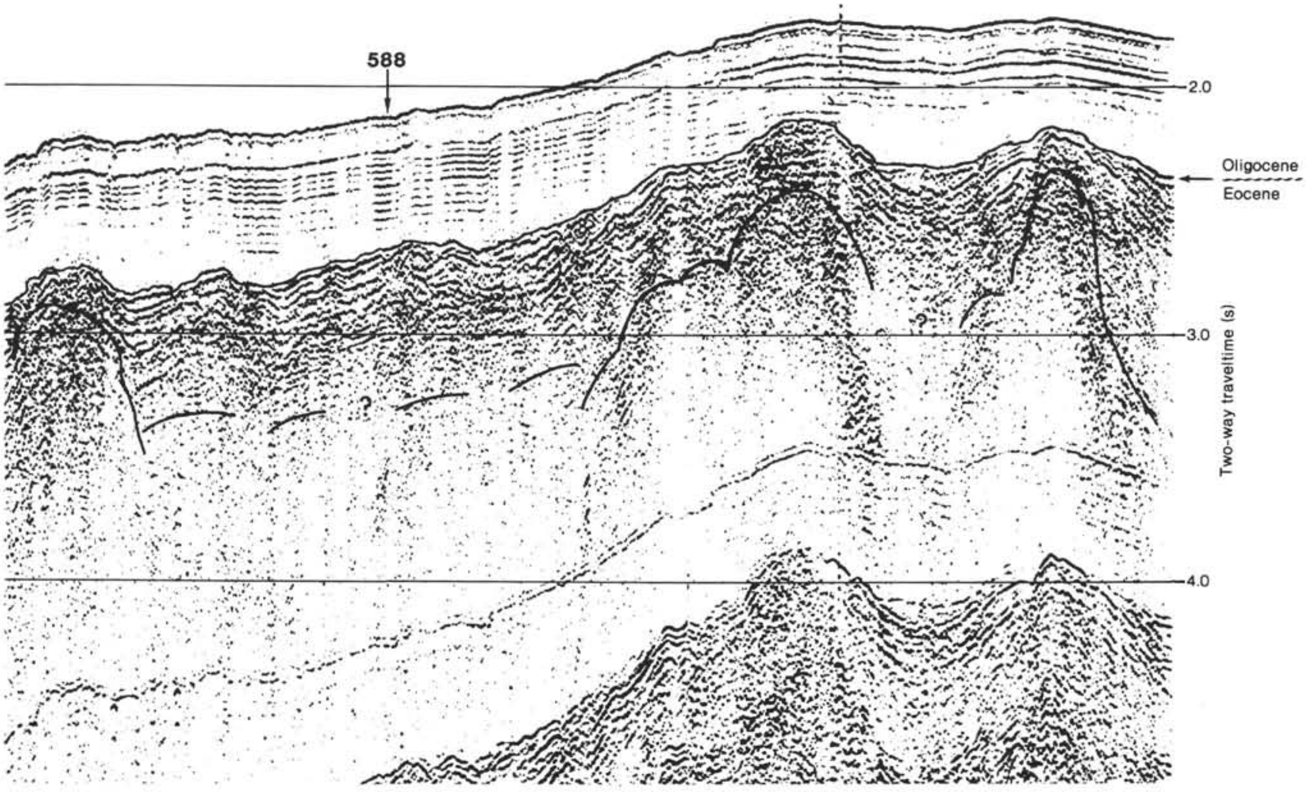

Figure 3. Location of Site 588 on *Sonne* multichannel seismic Profile SO-7-13. Courtesy of S. Hinz, Bundesanstalt für Geowissenschaften und Rohstoffe, FRG.

OPERATIONS

Site 587 to Site 588

Steaming between sites was routine, with ideal Tasman Sea summer weather and a quartering current. The ship covered the 295.6 n. mi. at an average speed of 10.5 knots. Routine underway geophysical data were collected between Sites 587 and 588, as described in the Operations Chapter for Site 587.

Site 588 was designed to reoccupy and utilize the HPC at Site 208, drilled during DSDP Leg 21. Several excellent seismic profiles were available for site selection (*Conrad* 12; *Glomar Challenger*, Leg 21; *Sonne* 50-7-12). The combination of simple Neogene stratigraphy, relatively flat topography, and uniformity of condition combined to make it unnecessary to carry out a presite survey. *Glomar Challenger* approached Site 588 from the north and dropped the beacon at 1921 hr., 6 Dec. 1982.

Site 588 (SW-7): Northern Lord Howe Rise

As at Site 587, a special bottom-hole assembly (BHA) was run, compatible with both piston coring and extended core barrel (XCB) rotary coring. The operational plan for Site 588 called for taking duplicate unbroken piston-cored sequences through the Neogene, followed by rotary coring to the base of the Miocene.

The first variable-length (VL) HPC shot was taken with the bit at 1544 m; it recovered a 5.65-m core which established the mud line at 1548 m (Table 1). Piston coring continued easily through calcareous ooze ranging from soupy to stiff for the first 216.8 m. Recovery was consistently nearly 100%, except for Core 588-8, which came up empty. During this interval, 23 9.5-m VLHPC cores were taken. Full stroke on all was achieved using only two shear pins. Cores 588-24 and 588-25 were shot using three shear pins. Overpulls to free the tool after shoot-off slowly increased to a maximum of 20,000 lbs.[3]

At Core 588-26, somewhat more than 100,000 lbs. overpull was applied to free the tool before the driller could stop the draw-works. The piston corer was recovered with its lower core-containing section missing, because the excessive tensile load associated with the overpull had caused a mechanical failure. The hole had to be terminated at this point.

Hole 588A

The bit was pulled to the mud line and Hole 588A was spudded at 0025 hr., 8 December, and washed to the termination point of Hole 588—236.0 BSF. One more 9.5-m VLHPC was deployed. When it experienced full stroke followed by excessive overpull, the bit was washed down over the entire 9.5 m until the tool was washed free.

It was then decided to employ the 5-m VLHPC as far as possible. Overpull was taken to a limit of 20–30,000 lbs. on each core. If the corer could not be freed by pulling at that limit, the bit was washed over the extended section.

A new record depth for piston coring was reached in this manner—315.6 m BSF—and the oldest sediments ever successfully piston cored were recovered (upper lower Miocene). However, as the sediments stiffened, it became impossible to wash the bit over the protruding inner barrel without gouging the extended tool. Therefore, VLHPC work was terminated at Core 588A-15. Surprisingly, full stroking continued throughout the piston-cored sequence, despite the record total depth of penetration.

The XCB was then deployed for Cores 588A-16 to -18. Poor recovery coupled with other symptoms indicated that the XCB was not functioning correctly, and it was decided to terminate Hole 588A and perform the repeat piston core sequence, using the time to modify the XCB system.

Hole 588B

Once again the bit was pulled to the mud line to spud a new hole. The vessel was offset 100 ft. to the north to assure a clean seafloor for a mud line core and Hole 588B was spudded at 2210 hr., 8 December. A good mud line core was shot from 1546 m to be certain that the coring sequence was staggered with respect to Holes 588 and 588A.

Piston coring proceeded smoothly again through calcareous ooze with scattered ash layers. Again full stroke of the 9.5 m VLHPC was routinely achieved with two

Table 1. Coring summary, Site 588.

Core No.	Date (Dec. 1982)	Time	Depth from drill floor (m) Top Bottom	Depth below seafloor (m) Top Bottom	Length cored (m)	Length recovered (m)	Percentage recovered
Hole 588							
1	7	0200	1548.0–1553.6	0.0–5.6	5.6	5.65	100
2	7	0250	1553.6–1563.2	5.6–15.2	9.6	9.64	100
3	7	0340	1563.2–1572.8	15.2–24.8	9.6	9.18	95.6
4	7	0420	1572.8–1582.4	24.8–34.4	9.6	9.43	98.2
5	7	0510	1482.4–1592.0	34.4–44.0	9.6	9.11	94.9
6	7	0600	1592.0–1601.6	44.0–53.6	9.6	9.38	97.7
7	7	0650	1601.6–1611.2	53.6–63.2	9.6	9.05	94.2
8	7	0730	1611.2–1620.8	63.2–72.8	9.6	0.0	0.0
9	7	0820	1620.8–1630.4	72.8–82.4	9.6	9.48	98.7
10	7	0910	1630.4–1640.0	82.4–92.0	9.6	8.78	91.4
11	7	1000	1640.0–1649.6	92.0–101.6	9.6	9.49	98.8
12	7	1050	1649.6–1659.2	101.6–111.2	9.6	9.54	99.4
13	7	1130	1659.2–1668.8	111.2–120.8	9.6	9.49	98.5
14	7	1220	1668.8–1678.4	120.8–130.4	9.6	9.71	100
15	7	1320	1678.4–1688.0	130.4–140.0	9.6	9.44	98
16	7	1415	1688.0–1697.6	140.0–149.6	9.6	5.8	61
17	7	1510	1697.6–1707.2	149.6–159.2	9.6	9.63	100
18	7	1555	1707.2–1716.8	159.2–168.8	9.6	9.38	98
19	7	1630	1716.8–1726.4	168.8–178.4	9.6	9.64	100+
20	7	1735	1726.4–1736.0	178.4–188.0	9.6	9.77	100+
21	7	1820	1736.0–1745.6	188.0–197.6	9.6	9.78	100+
22	7	1930	1745.6–1755.2	197.6–207.2	9.6	9.81	100+
23	7	2015	1755.2–1764.8	207.2–216.8	9.6	9.82	100+
24	7	2100	1764.8–1774.4	216.8–226.4	9.6	9.66	100+
25	7	2140	1774.4–1785.0	226.4–236.0	9.6	10.04	100+
			(tool left in hole)				
					236.00	220.76	93.5
Hole 588A							
1	8	0300	1784.0–1793.6	236.0–245.6	9.6	9.76	100+
2	8	0400	1793.6–1798.6	245.6–250.6	5.0	5.16	100+
3	8	0500	1798.6–1803.6	250.6–255.6	5.0	5.23	100+
4	8	0550	1803.6–1808.6	255.6–260.6	5.0	4.91	98.2
5	8	0645	1808.6–1813.6	260.6–265.6	5.0	4.39	100+
6	8	0740	1813.6–1818.6	265.6–270.6	5.0	5.18	100+
7	8	0830	1818.6–1823.6	270.6–275.6	5.0	5.19	100+
8	8	0920	1823.6–1828.6	275.6–280.6	5.0	5.27	100+
9	8	1010	1828.6–1833.6	280.6–285.6	5.0	4.96	99.2
10	8	1115	1833.6–1838.6	285.6–290.6	5.0	5.20	100+
11	8	1210	1838.6–1843.6	290.6–295.6	5.0	4.22	84.4
12	8	1308	1843.6–1848.6	295.6–300.6	5.0	5.19	100+
13	8	1415	1848.6–1853.6	300.6–305.6	5.0	5.21	100+
14	8	1500	1853.6–1858.6	305.6–310.6	5.0	3.78	76
15	8	1545	1858.6–1863.6	310.6–315.6	5.0	5.22	100+
16	8	1720	1863.6–1873.2	315.6–325.2	9.6	0.16	2
17	8	1850	1873.2–1882.8	325.2–334.8	9.6	2.35	24
18	8	1930	1882.8–1892.4	334.8–344.4	9.6	2.89	30
					108.40	84.27	77.7
Hole 588B							
1	8	2250	1547.8–1555.6	0.0–7.8	7.8	7.79	100
2	8	2350	1555.6–1565.2	7.8–17.4	9.6	9.63	100+
3	9	0025	1565.2–1574.8	17.4–27.0	9.6	9.57	99.6
4	9	0120	1574.8–1584.4	27.0–36.6	9.6	8.91	92.8
5	9	0200	1584.4–1594.0	36.6–46.2	9.6	9.70	100+
6	9	0305	1594.0–1603.6	46.2–55.8	9.6	7.92	82.5
7	9	0345	1603.6–1613.2	55.8–65.4	9.6	9.17	95.5
8	9	0430	1613.2–1622.8	65.4–75.0	9.6	9.58	100
9	9	0520	1622.8–1632.4	75.0–84.6	9.6	9.58	99.7
10	9	0600	1632.4–1642.0	84.6–94.2	9.6	4.04	42.0
11	9	0648	1642.0–1651.6	94.2–103.8	9.6	9.49	98.8
12	9	0740	1651.6–1661.2	103.8–113.4	9.6	9.83	100+
13	9	0830	1661.2–1670.8	113.4–123.0	9.6	9.42	98.1
14	9	0920	1670.8–1680.4	123.0–132.6	9.6	9.69	100+
15	9	1000	1680.4–1690.0	132.6–142.2	9.6	9.30	96.8
16	9	1053	1690.0–1699.6	142.2–151.8	9.6	9.14	95.2
17	9	1310	1699.6–1709.2	151.8–161.4	9.6	9.68	100+
18	9	1400	1709.2–1718.8	161.4–171.0	9.6	9.45	98
19	9	1450	1718.8–1728.4	171.0–180.6	9.6	9.60	100
20	9	1545	1728.4–1738.0	180.6–190.2	9.6	9.80	100+
21	9	1630	1738.6–1747.6	190.2–199.8	9.6	9.47	99
22	9	1725	1747.6–1757.2	199.8–209.4	9.6	9.30	97
23	9	1815	1757.2–1766.8	209.4–219.0	9.6	9.66	100+
24	9	1925	1766.8–1776.4	219.0–228.6	9.6	8.91	93
25	9	2015	1776.4–1781.4	228.6–233.6	5.0	5.15	100+
26	9	2104	1781.4–1786.4	233.6–238.6	5.0	5.27	100+
27	9	2205	1786.4–1791.4	238.6–243.6	5.0	5.15	100+
28	9	2300	1791.4–1796.4	243.6–248.6	5.0	5.20	100+
29	10	0145	1796.4–1806.0	248.6–258.2	9.6	6.95	72.3
30	10	0250	1806.0–1815.6	258.2–267.8	9.6	3.79	39.4
31	10	0415	1815.6–1825.2	267.8–277.4	9.6	5.73	59.6
					277.40	255.87	93.0
Hole 588C							
1	10	1630	1853.5–1863.1	305.7–315.3	9.6	9.42	98
2	10	1735	1863.1–1872.1	315.3–324.9	9.6	8.99	94
3	10	1830	1872.7–1882.3	324.9–334.5	9.6	8.94	93

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[3] The overpull is a measure of the force required to overcome the adhesion and suction which the sediment exerts on the extended section of the piston corer when it is implanted.

Table 1. (Continued).

Core No.	Date (Dec. 1982)	Time	Depth from drill floor (m) Top Bottom	Depth below seafloor (m) Top Bottom	Length cored (m)	Length recovered (m)	Percentage recovered
Hole 588C (Cont.)							
4	10	1925	1882.3-1891.9	334.5-344.1	9.6	8.82	92
5	10	2025	1891.9-1901.5	344.1-353.7	9.6	9.02	94
6	10	2130	1901.5-1911.1	353.7-363.3	9.6	9.63	100+
7	10	2210	1911.1-1920.7	363.3-372.9	9.6	5.88	61.2
8	10	2325	1920.7-1930.3	373.9-382.5	9.6	9.43	98.2
9	11	0002	1930.3-1939.9	382.5-392.1	9.6	9.62	100+
10	11	0052	1939.9-1949.5	392.1-401.7	9.6	7.42	80.6
11	11	0245	1949.5-1959.1	401.7-411.3	9.6	4.44	46.2
12	11	0355	1959.1-1968.7	411.3-420.9	9.6	8.13	84.6
13	11	0455	1968.7-1978.3	420.9-430.5	9.6	8.88	92.5
14	11	0550	1978.3-1987.9	430.5-440.1	9.6	7.20	75.0
15	11	0640	1987.9-1997.5	440.1-449.7	9.6	6.40	66.6
16	11	0743	1997.5-2007.1	449.7-459.3	9.6	5.32	55.4
17	11	0835	2007.1-2016.7	459.3-468.9	9.6	5.60	58.3
18	11	0950	2016.7-2026.3	468.9-478.5	9.6	0.62	6.4
19	11	1040	2026.3-2035.9	478.5-488.1	9.6	0.85	8.85
					182.40	134.61	73.8

shear pins. The same scenario of increasing overpull requirements was experienced as in the previous hole, this time beginning about 30 m higher. Cores 588B-25 to 588B-28 were taken with the 5-m VLPHC. Piston coring was then terminated.

Again the XCB was deployed, now modified to allow proper venting. Cores were taken on all three deployments but they were not of good quality. Partial collapse and splitting of the plastic core liners occurred on all three attempts. The XCB obviously needed further work and the scientific objective of rotary coring to the Neogene/Paleogene unconformity had not yet been reached, so it was decided to trip the pipe in order to change the bit and BHA for conventional rotary coring.

Hole 588C

The pipe was tripped and a standard BHA with a long-tooth, tungsten carbide insert F93CK bit was assembled and run back to the seafloor. Hole 588C was spudded at 1307 hr., 10 December. The bit was quickly washed to a depth of 305.7 m BSF to provide a slight overlap with the deepest penetration of the piston coring done earlier.

Routine rotary coring then followed, with good core recovery through foraminifer-bearing nannofossil chalk with green ash layers and abundant burrows. The only delay was a 45 min. wait on weather while the vessel took a 400 ft. excursion under the influence of a brief but dramatic line squall bearing 50 m.p.h. winds. At 488.1 m BSF the scientific objective was reached and the hole was terminated. The pipe was tripped and the vessel got under way for Site 589 at 1536 hr., 11 December.

LITHOSTRATIGRAPHY

Site 588 consists of four holes: Hole 588 was cored continuously with the HPC from 0 to 236.0 sub-bottom; Hole 588A was cored continuously with the HPC from 236.0 to 344.4 m; Hole 588B was cored continuously with the HPC from 0 to 277.4 m; and Hole 588C was cored continuously with the rotary drill from 305.7 to 488.1 m sub-bottom. The recovered sequence is divided into two lithostratigraphic units, based upon color and composition (Fig. 4; Table 2).

Subunit IA is a foraminifer-bearing nannofossil ooze to nannofossil-bearing foraminiferal ooze extending from the seafloor to 6.5 or 6.8 m BSF. It is distinguished by its color, which ranges from orange to brown, whereas that of the underlying Subunit IB is white to light gray. Within Subunit IA, a color gradation exists from grayish orange (10Y 7/4, 10Y 7/3) and pale yellowish brown (10Y 6/2) in the topmost meter of the sediment column to very pale orange (10Y 8/2) in the remainder of the subunit.

There are several distinct beds within Subunit IA that differ in color, grain size, and composition. The beds are generally separated from each other by sharp contacts. The foraminifers vary in abundance from 5 to 75% and usually form about 25% of the sediment (estimated from smear slides; see Fig. 5). High abundance (75%) was seen only in Sample 588B-1-4, 115-150 cm, which contains the coarsest sediment found at Site 588. Calcareous nannofossils comprise the bulk (25 to 95%) of the remaining sediment. Noncarbonate components in this subunit include traces of quartz, feldspar, heavy minerals, and sponge spicules.

The preliminary interpretation is that Subunit IA is an oxidized and winnowed facies. The sharp color contrast that separates Subunit IA from underlying Subunit IB represents a fundamental change in diagenetic environment as well as in sedimentological environment. Increased current caused winnowing and concentrated the foraminifers. As a result of the coarser grain size, oxidation of organic matter in these sediments was complete within 7 m of the seafloor.

Subunit IB comprises much of the sediment column at Site 588 (6.5 to about 250 m). It is predominantly a foraminifer-bearing nannofossil ooze; rarely, it is a foraminifer–nannofossil ooze or a nannofossil ooze. It is distinguished from underlying Subunit IC by its softness: Subunit IC is a chalk. Subunit IC grades from soft ooze at its top to firm ooze at about 150 to 180 m (Holes 588 and 588B, respectively) to chalk at about 215 to 260 m (Holes 588 and 588B, respectively). Foraminifer abundances typically vary between 5 and 25% in both subunits. Siliceous microfossils are almost entirely absent. The only noncarbonate components that occur in greater than trace amounts are volcanic ash and iron sulfide minerals. The changing abundance of these components is responsible for the overall color changes within Subunits IB and IC. The volcanic ash imparts a green color to the normally white sediment, in shades from very light greenish gray to dark bluish green. The iron sulfide imparts a gray color to the sediment, in shades varying from very light gray to dark gray. Because these components are generally less than 10% in abundance, the light colors prevail.

Sedimentary structures in Subunits IB and IC include bedding and burrowing features. Some beautiful examples of Zoophycos and Chondrites burrows occur throughout this unit, as do a number of circular or ovoid (0.5–3.0 cm across) burrow sections and mottles. Some flaser-

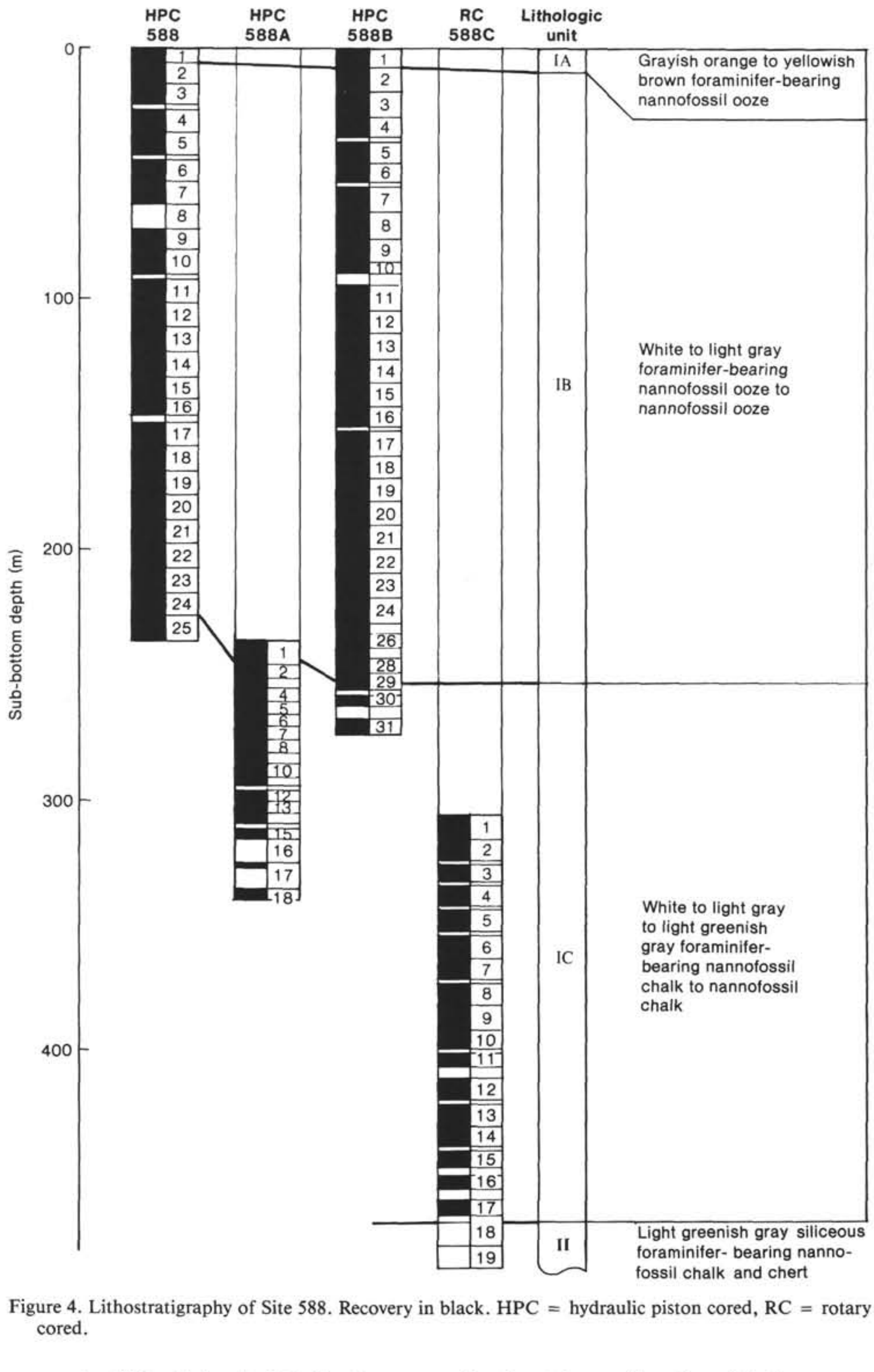

Figure 4. Lithostratigraphy of Site 588. Recovery in black. HPC = hydraulic piston cored, RC = rotary cored.

like bedding is apparent within Subunit IC (Sections 588C-5-3 and 588C-18-1).

Disseminated volcanic ash or glass is present throughout Subunits IB and IC. Glass occurs as ovoid bubbles and as angular shards in the uppermost parts of the unit (e.g., 588-4-1, 81 cm). In addition, thin (0.5–15 mm thick), light greenish gray laminae, possibly composed of altered volcanic ash, are common below about 160 m sub-bottom to the base of the unit. These layers almost exclusively occur in singlets, doublets, and triplets within about 2 cm of section. Furthermore, the layers occur throughout the section with quasi-regular frequency.

Iron sulfide minerals have been diagenetically formed throughout the unit as a result of mild degrees of microbial sulfate reduction. These minerals occur in blebs, pockets, and burrows. Small, solid tubes (1 to 2 mm in diameter, several cm long) of black iron sulfide fill many of the small burrows. One large (3 to 5 cm) pyrite nodule in Section 588-17-2 containing well-formed pyrite crystals is a burrow fill. A close stratigraphic association oc-

Table 2. Lithostratigraphy at Site 588.

Lithologic units	Cores[a]	Sub-bottom depth (m)	Description	Age
IA	1-2	0.0-6.6	Grayish orange to yellowish brown (oxidized), foraminifer-bearing nannofossil ooze	Quaternary
	1B	0.0-6.8		
IB	2-24	6.6-226.4	White to light gray, foraminifer-bearing nannofossil ooze to nannofossil ooze	Quaternary to middle Miocene
	1A	236.0-245.6		
	1B-29B	6.8-253.0		
IC	25	226.4-236.0	White to light gray to light greenish gray, foraminifer-bearing nannofossil chalk to nannofossil chalk	middle Miocene to late Oligocene
	2A-18A	245.6-344.4		
	29B-31B	253.0-277.4		
	1C-18C	305.7-469.0		
II	18C-19C	469.0-488.1	Light greenish gray, siliceous foraminifer-bearing nannofossil chalk and chert	middle Eocene

[a] Letters following core number refer to the hole from which core is taken.

curs between iron sulfide and light greenish gray ash(?) layers. In most instances, iron sulfide streaks occur below these layers (but not often above them). This association suggests that the ash(?) layers are a source of iron during diagenesis.

Hole 588A was terminated at about 335 m (Core 588A-18) when the HPC ceased to penetrate, possibly because chert was present. A fist-sized nodule found in Section 588A-18-2 was the only occurrence of chert in Unit I. No chert was found during rotary drilling at an equivalent depth in Hole 588C.

One of the most controversial shipboard sedimentological problems encountered at Site 588 centers on the origin of the microfaults and slickensides observed in Cores 588C-3 through 588C-5. In this interval there are several faults with apparently normal dip-slip offsets of 5 to 10 mm, usually occurring along highly angled surfaces (about 60°). The faces of these surfaces are often slickensided and occasionally mineralized by iron sulfide and possibly rhodochrosite. Two hypotheses for their origin prevail: either the features were produced naturally by tectonism, or the features were produced artificially by drilling. One argument favoring the tectonic origin of these features is the known Neogene tectonism in nearby areas. For example, the Leg 90 water gun seismic profiles illustrate active graben formation extending to Recent times in an area 170 n. mi. north of Site 588. The healed microfaults are also strong evidence for the tectonic origin of most of these features. On the other hand, the interval is quite disturbed by rotary drilling, and a number of cracks are clearly artificial.

Unit II consists of siliceous foraminifer-bearing nannofossil chalks and foraminifer-bearing cherts. This unit was encountered only at the bottom of Hole 588C, and less than one meter of it was recovered. This lithostratigraphic unit is characterized by the presence of siliceous sponge spicules, diatoms, and diagenetic chert. This unit coincides with Unit 2 of DSDP Site 208 (Burns, Andrews, et al., 1973). The color varies from light greenish gray to grayish yellow green. A few burrows occur in samples from Core 588C-19.

PHYSICAL PROPERTIES

Standard DSDP methods (Boyce, 1976; Boyce, 1977) were employed for the measurements of physical properties at Site 588 (see Introduction and Explanatory Notes for specific techniques). The properties measured include sonic velocity, thermal conductivity, and calcium carbonate content. Wet-bulk density, grain density, and porosity were determined by gravimetric analyses, and saturated bulk density was also measured by GRAPE. All of the properties are analyzed and cross-correlated in detail by Morin (this volume).

The values of GRAPE porosity are derived from the GRAPE saturated bulk density results, assuming a grain density of 2.691 g/cm^3. This is a reasonable approximation, since the percentage of $CaCO_3$ in the sediments is very high (Fig. 6A). The porosity data are plotted versus depth (points) in Figure 6B, and are subsequently averaged across each meter (solid line). GRAPE porosity for Holes 588 and 588A is compared with that for Holes 588B and 588C in Figure 6C.

Compressional wave velocities demonstrate a sharp increase at the beginning of Hole 588C (Fig. 6D). These data are correlated with those of Figure 6C in an effort to establish a relationship between P-wave velocity and porosity (Fig. 6E). Combining the GRAPE bulk density profile with the sonic velocity values provides a plot of impedance versus depth (Fig. 6F). This latter figure depicts a smooth, gradual increase in impedance through the 488 m of the sediment column.

SEISMIC STRATIGRAPHY

Figure 7 illustrates portion of the shipboard water gun seismic profile collected during the approach to Site 588. Five acoustic units (A, B, C, D, and E) have been identified, analogous to acoustic Units A to E of Willcox et al., 1980. Acoustic units are correlated with the lithology of Site 588, Units I and II.

Acoustic Unit A appears as an acoustically transparent layer at frequencies recorded on the seismic profile. Faint, coherent reflections occur down to 0.1 s[4] sub-bottom.

Acoustic Unit B (the "chaotic" unit of Willcox et al., 1980) exhibits diffuse, sometimes coherent but generally chaotic reflections. A more reflective zone that occurs between 0.37 and 0.42 s sub-bottom can be traced for some tens of miles to the north on the underway water gun seismic profile.

Acoustic Unit C, comprising high-amplitude, relatively coherent reflectors, is a unit which can be identified throughout the region. The boundary between Unit C and overlying Unit B is relatively sharp. On the Lord Howe Rise, adjacent to and some 160 mi. north of Site 588, the water gun profile shows major graben structures which appear to contain Unit C downfaulted into the grabens.

Acoustic Unit D comprises a high-amplitude, relatively coherent set of reflectors with an appearance similar to that of Unit C. Overlying basement lows (possible graben structures), Unit D is separated from overlying Unit C by a lenticular low-amplitude graben-filling seismic unit (Fig. 7).

Acoustic Unit E is a low-amplitude (relatively transparent) zone overlying acoustic basement, a relationship

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[4] Depths quoted in text as seconds below seafloor have been measured below Site 588.

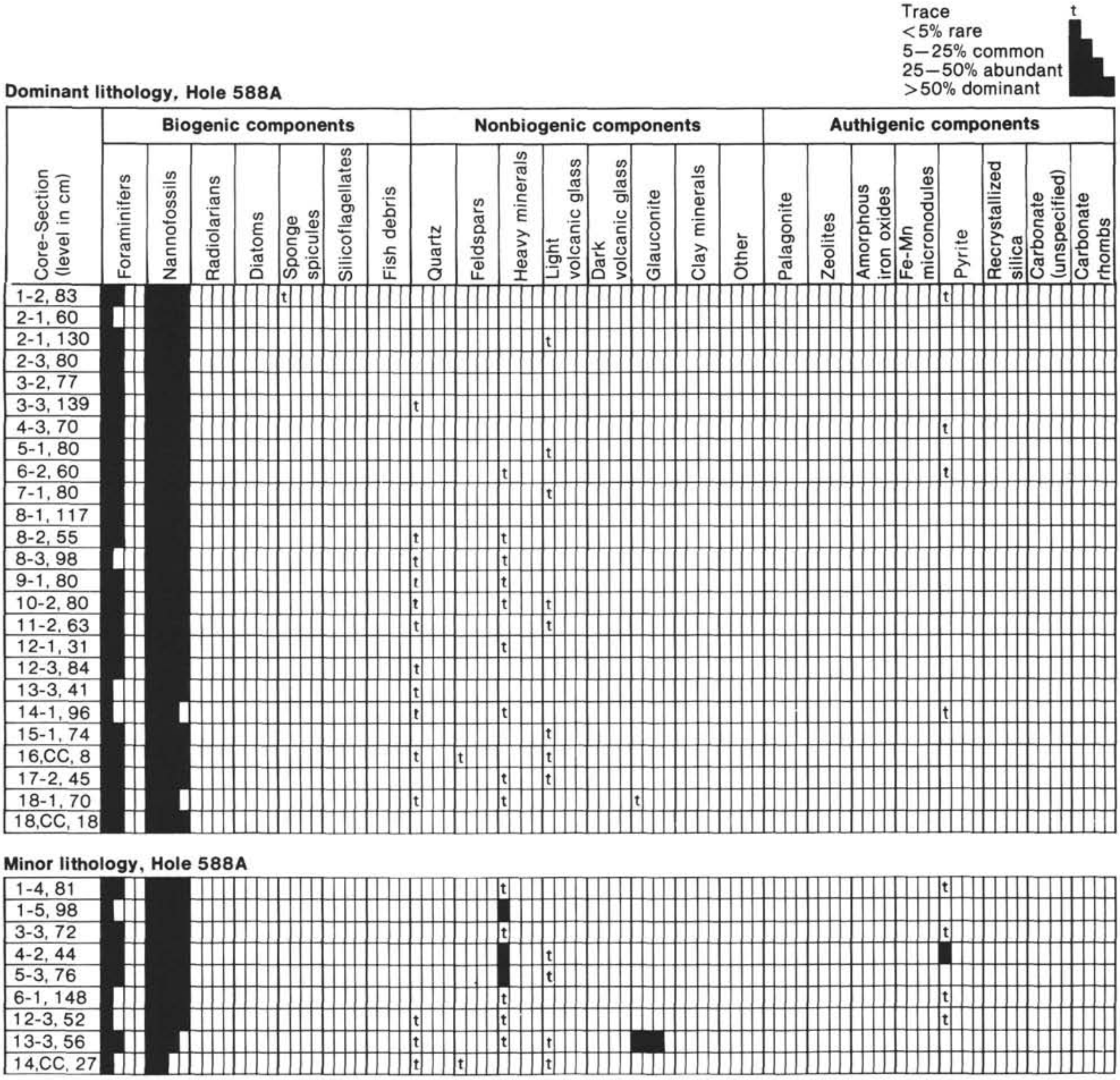


Figure 5. Smear slide summaries, Holes 588A, B, C.

which is not particularly evident in Figure 7. Similar to the transparent zone between Units C and D, Unit E appears to be a graben-filling unit, showing an onlap relationship with basement. This unit is poorly represented or entirely absent over structural highs, where the high-amplitude zones of Units C and D tend to coalesce.

Acoustic basement below Site 588 is inferred to lie at about 0.77 s sub-bottom.

Site 588 was drilled to a total depth of 488.1 m (Hole 588C). The stratigraphic section is divided into two lithologic units.

Unit IA is an oxidized foraminifer-bearing nannofossil ooze of Quaternary age, restricted to the uppermost 6.8 m of section. Unit IB is a light-colored foraminifer-bearing nannofossil ooze to nannofossil ooze, ranging in age from Quaternary to middle Miocene. Unit IC is a middle Miocene to upper Oligocene foraminifer-bearing nannofossil chalk to nannofossil chalk. Unit II comprises a siliceous foraminifer-bearing nannofossil chalk and chert.

An interval velocity of 1700 m/s has been determined by averaging shipboard velocimeter mesurements on cores. The stratigraphic column in Figure 7 has been prepared using this velocity value. However, no positive correlation is apparent between acoustic and lithostratigraphic units, with the possible exception of the Eocene/Oligocene boundary. This boundary is obscured by an interval of strong reflections in the vicinity of Site 588, but the left-hand extremity of the profile on Figure 7 shows a reflector which, on extrapolation to the site, may rep-

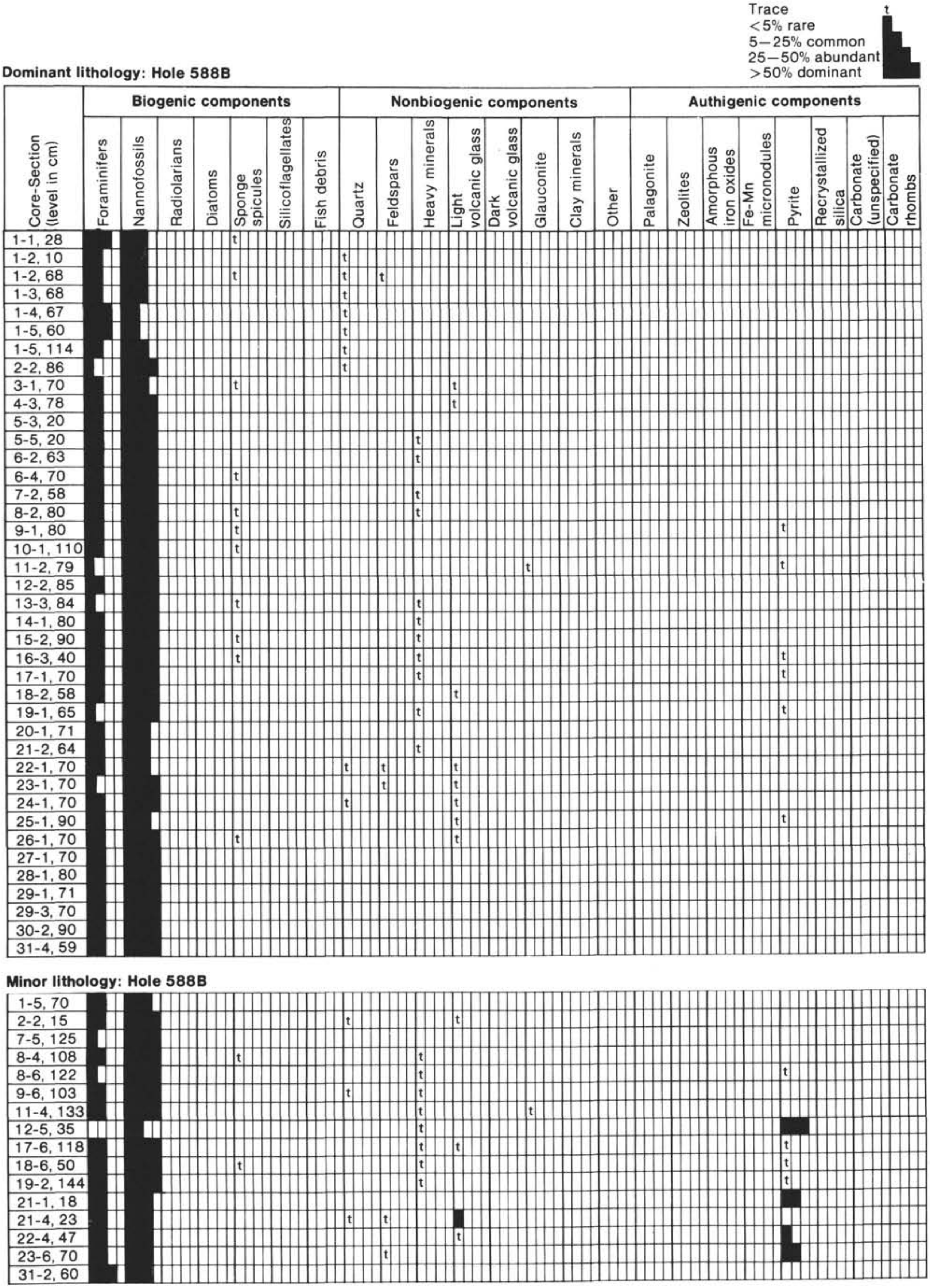


Figure 5. (Continued).

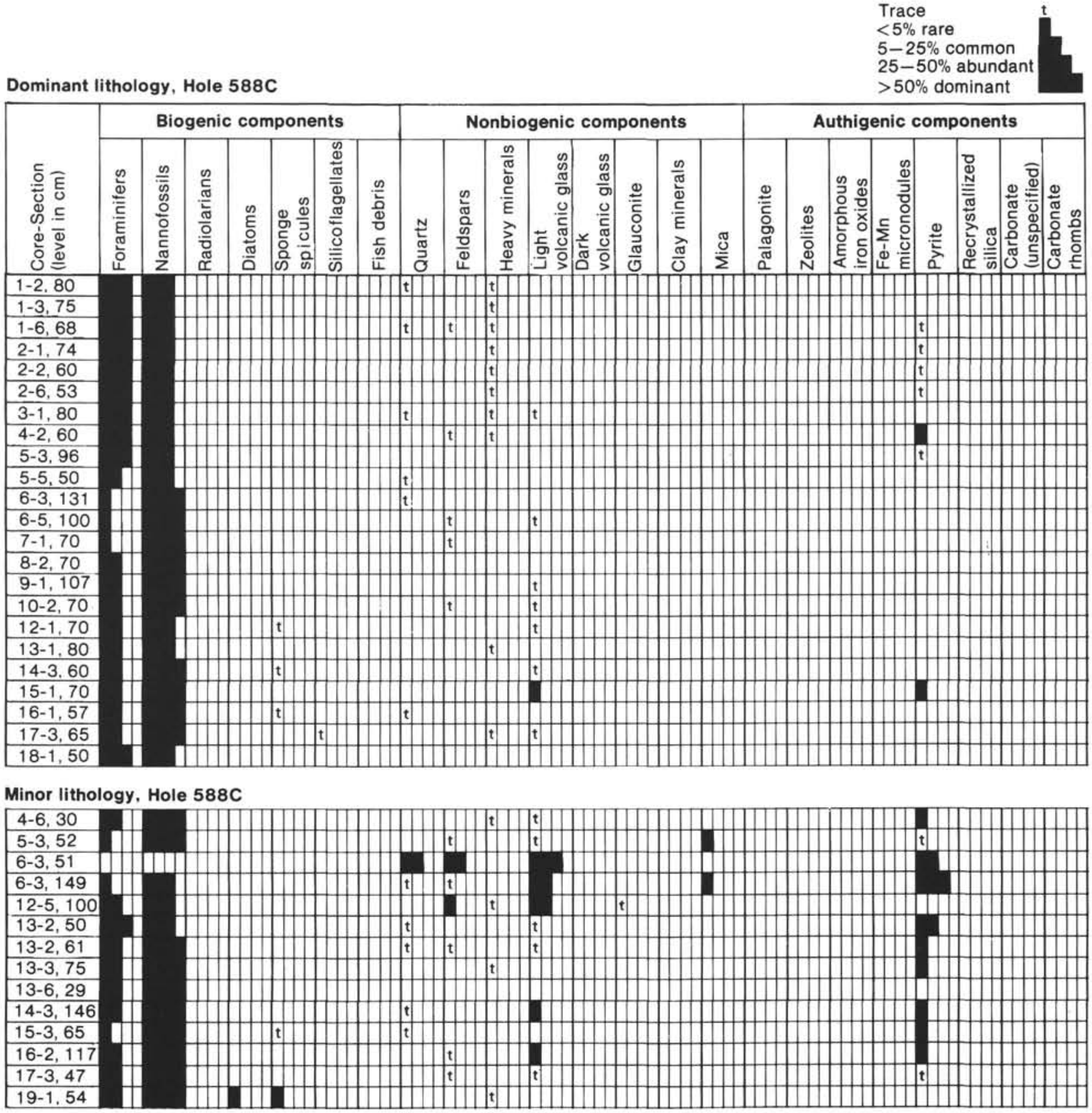


Figure 5. (Continued).

resent the onset of chert development in the middle Eocene; this in turn may correlate with the boundary between acoustic Units C and D.

BIOSTRATIGRAPHY

A complete calcareous sequence from the late Oligocene through Recent was recovered from the four holes drilled at Site 588. It is underlain by a siliceous–calcareous sequence of middle Eocene age from which it is separated by a disconformity at approximately 470 m subbottom. The deepest hole, Hole 588C, was terminated at 488.1 m BSF in middle Eocene sediments. The completeness of the sequence, which is far superior to that in Hole 208, drilled on Leg 21, resulted in a very detailed planktonic foraminifer and calcareous nannoplankton zonation, and has provided material for an evaluation of the paleoenvironmental history of warm subtropical waters of the southern hemisphere during the late Oligocene to Recent. The calcareous sediments between 0 and about 470 m contain exclusively foraminifers, calcareous nannoplankton, calcareous dinoflagellates (calcispheres), and at certain levels also ostracodes and pteropods. Below the disconformity at 470 m, down to the terminal depth of 488.1 m, foraminifers and calcareous nannoplankton are associated with diatoms, radiolarians, silicoflagellates, ebridians, and sponge spicules in the middle Eocene.

Preservation of the calcareous fossils is excellent in the upper part of the sequence, and is fairly good for the foraminifers as well in the lower part of the calcareous sequence, where calcareous nannoplankton show considerable calcite overgrowth, especially in the upper Oligocene sediments. Preservation is good again for the calcareous nannoplankton in the middle Eocene, where the sequence contains a considerable amount of siliceous constituents. Calcareous nannoplankton and planktonic foraminiferal zones in the four holes of Site 588 are correlated in Figure 8.

Foraminifers

Planktonic Foraminifers

Zones

The zonal scheme used at Site 588 has been adapted from Kennett (1973) and Srinivasan and Kennett (1981a, b) (Fig. 9). The following changes have been made.

Globorotalia puncticulata Zone: It appears that the zonal marker made a late appearance at Site 588 as compared to the temperate sites of the southwest Pacific where it evolved; its immediate ancestor *Globorotalia sphericomiozoa* is not present.

Globorotalia plesiotumida Zone: At Site 588 *G. conomiozea* with a squarer outline in peripheral view made a late appearance within the range of the *G. margaritae* Zone and so the *G. conomiozea* Zone of Kennett (1973) and Srinivasan and Kennett (1981a, b) was not used. The *G. plesiotumida* Zone of the late Miocene is therefore equivalent to the lower part of their *G. conomiozea* Zone and the entire *Globigerina nepenthes* Zone.

Globorotalia fohsi s.l. Zone is equivalent to the upper part of the *Orbulina suturalis* Zone of Kennett (1973) and to the *Globorotalia fohsi* s.l. Zone and the *G. peripheroacuta* Zone of Srinivasan and Kennett (1981a, b). The main reason for "lumping" the zones together was the difficulty in consistently identifying the keeled *G. fohsi* in the upper part of the *G. fohsi* s.l. Zone at Site 588.

The following zones have been added to the lower part of the sequence in the Oligocene.

Globigerina angulisuturalis Zone: This is a gap zone, with the base defined by the extinction of *Chiloguembelina cubensis* and the top by the first appearance of *Globorotalia kugleri.*

Chiloguembelina cubensis Zone: The top is defined by the extinction of the zonal marker and the base is undefined. The index species *G. munda* is present in the zone.

Faunas

Globorotalia truncatulinoides Zone: The zone fossil is common, as are *Globigerina calida, Globorotalia inflata, G. menardii, G. tumida*, and *Pulleniatina obliquiloculata.*

Globorotalia truncatulinoides–G. tosaensis Zone: The zone is marked by the overlap of the two zonal taxa, which are common in the zone. Other common species include *G. inflata* and *Neogloboquadrina dutertrei.*

Globorotalia tosaensis Zone: The zone fossil is abundant. There is evidence at the base of the zone of its evolution from *G. crassaformis*. Other important species in the zone include *P. obliquiloculata* and *G. menardii; Globigerinoides extremus* and *Dentoglobigerina altispira* became extinct in the lower part of the zone.

Globorotalia inflata Zone: The zone fossil is well represented in the zone, but its entry at the base was probably late compared with its evolutionary appearance further south in the southwest Pacific. Other species present include *Globorotalia menardii, G. crassaformis*, and *Neogloboquadrina dutertrei.*

Globorotalia crassaformis Zone: The zone fossil made a late appearance compared with its evolutionary appearance further south; other species present in the zone, included *Globorotalia pliozea*, which became extinct in the lower part of the zone, and *Globigerina nepenthes.*

Globorotalia puncticulata Zone: The zone fossil is rare in the zone and occurred with *G. crassaformis, G. tumida*, and *P. primalis.*

Globorotalia margaritae Zone: This zone is well represented with excellent faunas which include the zone fossil. *Globorotalia cibaoensis* became extinct within the zone and *P. primalis* made its entry in the lower part of the zone.

Globorotalia plesiotumida Zone: The zone fossil is comparatively rare. This was especially true in the lower part of the zone; other species in the zone include *G. miotumida* and *G. menardii.*

Neogloboquadrina continuosa Zone: The zone fossil is fairly rare within the zone and became extinct at the top of the zone; other important species include *Candeina nitida, Globigerinatella aequilateralis*, and *N. nympha*, the probable immediate ancestor of *N. acostaensis; Globoquadrina dehiscens* became extinct within the zone.

Globorotalia mayeri Zone: The zone fossil is fairly rare within the zone, which marks the first appearance of *Neogloboquadrina*; other species present include *G. menardii, G. miotumida*, and *G. panda.*

Globorotalia fohsi s.l. Zone: The zonal markers include *G. peripheroacuta* and *G. fohsi* s.l.; the latter form occurs sporadically throughout the zone. Both *G. miotumida, G. panda*, and *G. menardii* made their first appearance within the zone, whereas *G. miozea* became extinct.

Orbulina suturalis Zone: The zone fossil is common within the zone. Also present are *G. peripheroronda* and *G. miozea.*

Praeorbulina glomerosa curva Zone: The zone fossil is common within the zone, in association with *G. praescitula, G. miozea*, and *G. siakensis.*

Globorotalia miozea Zone: The zone fossil is common within the zone; other taxa include *Globoquadrina dehiscens, Globorotalia praescitula*, and *G. peripheroronda*, which made its initial appearance in the zone.

Catapsydrax dissimilis Zone: The zone fossil is common in the zone and occurs in association with *G. semivera* and *G. siakensis.*

Globoquadrina dehiscens Zone: The zone fossil is common within the zone and occurs in association with *Globigerinoides primordius, G. altiaperturus*, and *Globorotalia kugleri.*

Globigerinoides primordius Zone: The zone fossil is rare and occurs with *Globigerina woodi, Globorotalia*

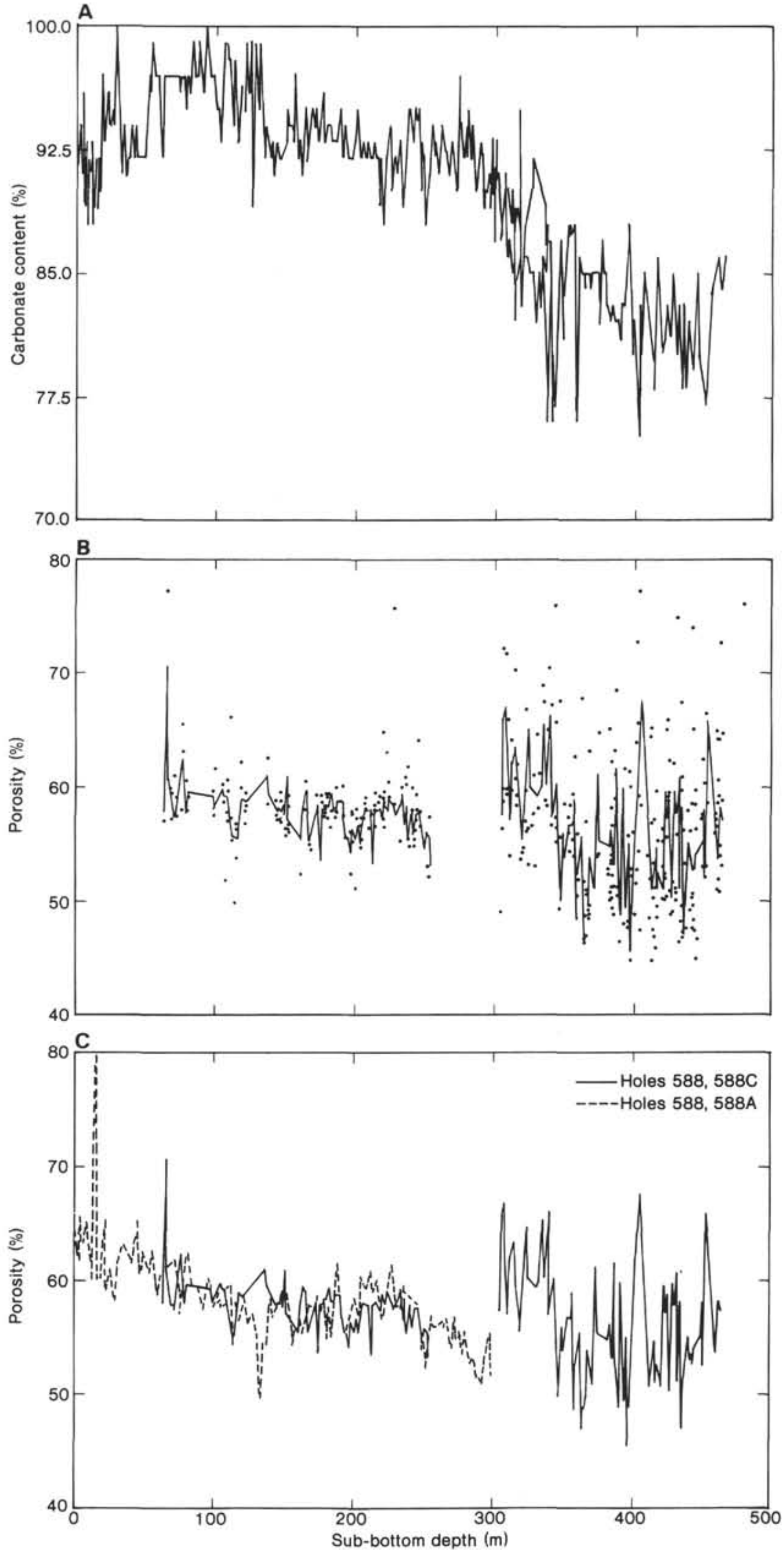
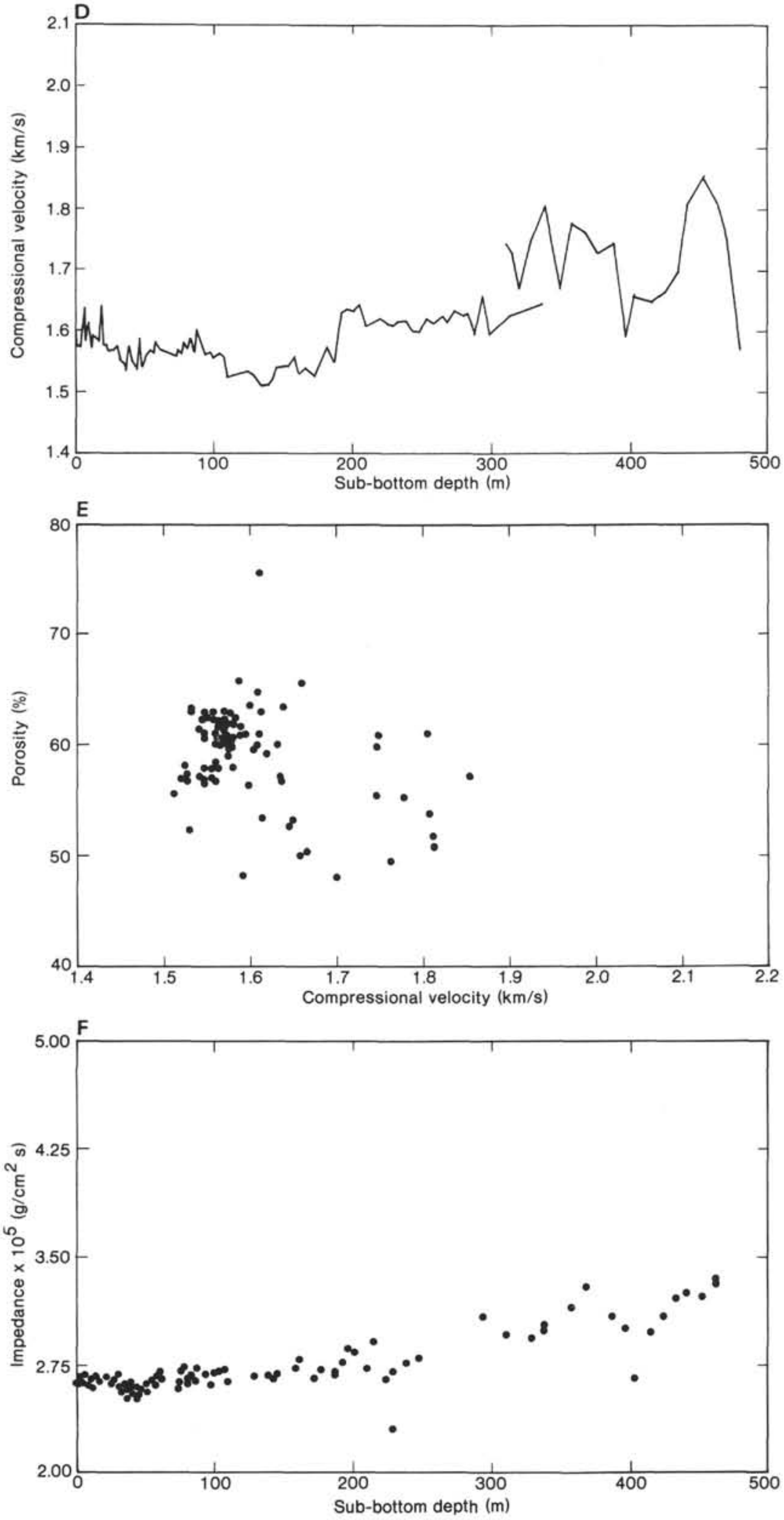


Figure 6. Physical properties, Site 588. A. Carbonate content versus sub-bottom depth for Site 588. B. GRAPE porosity versus sub-bottom depth for Holes 588B and 588C. C. GRAPE porosity versus sub-bottom depth for Holes 588, 588A, 588B and 588C. D. Compressional velocity versus sub-bottom depth for Site 588. E. Porosity versus compressional velocity for Site 588. F. Acoustic impedance versus sub-bottom depth for Site 588.



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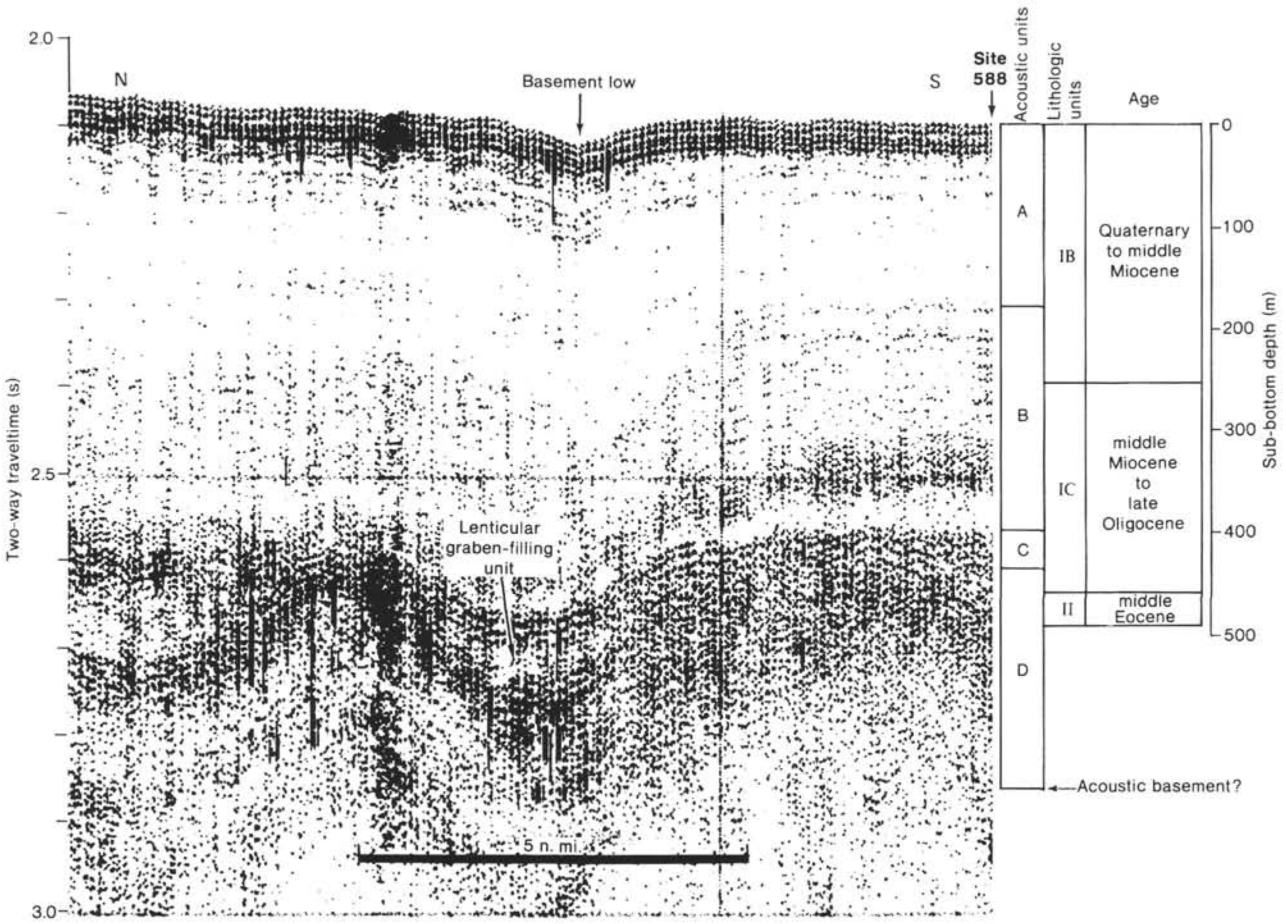

Figure 7. Comparison of acoustic Units A–E with lithologic Units I–II cored at Site 588; shipboard water gun seismic profile, collected during site approach; depths in meters estimated by assuming a sediment sound velocity of 1700 m/s.

kugleri, and *Globoquadrina* sp., the possible ancestor of *G. dehiscens*.

Globigerina angulisuturalis Zone: The zone fossil is common within the zone. The related species *Globigerina ciperoensis* is very rare. Other species present include *G. euapertura, Globorotalia nana, Globorotaloides suteri*, and *Globorotalia testarugosa*.

Chiloguembelina cubensis Zone: The zone fossil is common and occurs with *G. munda; G. opima* is rare.

Paleobiogeography

The late Oligocene yields a cosmopolitan fauna with an element of the southern cooler-water species such as *Globigerina woodi* and *Globorotalia munda*; the fauna lacks *Globigerina ciperoensis* and there are only a few specimens of *Globorotalia opima*.

The early Miocene was dominated by cooler-water southern taxa such as *G. zealandica* and *G. miozea* and marked by the absence of such warm-water forms as *Catapsydrax stainforthi, Globigerinatella insueta*, and *Hastigerinella bermudezi*.

The middle Miocene keeled *Globorotalia* fauna is dominated by the *G. miotumida* group and to a much lesser extent by *G. menardii*; the tropical *G. fohsi lobata* and *G. fohsi robusta* are absent.

The late Miocene appears to have been cooler, because of the predominance of the southern *G. miotumida* group and the absence of such species as *Pulleniatina primalis*.

There was a marked change in fauna at about the Miocene/Pliocene boundary; *G. conomiozea* with a squarer outline in peripheral view became extinct and the tropical *G. tumida* appeared.

The Pliocene–Pleistocene forms were a mixture of warm subtropical–tropical species such as *G. tumida, G. menardii*, and *P. obliquiloculata* with a minor cooler-water element represented by *G. inflata* and *Neogloboquadrina pachyderma*.

Major Stratigraphic Boundaries

At this site the major boundaries were marked by the following species.

1. Pliocene/Pleistocene boundary: first appearance of *Globorotalia truncatulinoides*.

2. Miocene/Pliocene boundary: Kennett (1973) and Srinivasan and Kennett (1981a, b) placed the boundary at the first appearance of *G. margaritae*, which coincided with the extinction of *G. conomiozea*. In Site 588 we have, instead, observed overlapping ranges of *G. margaritae* and a local morphotype of *G. conomiozea* and have placed the boundary after the extinction of *G. conomio-*

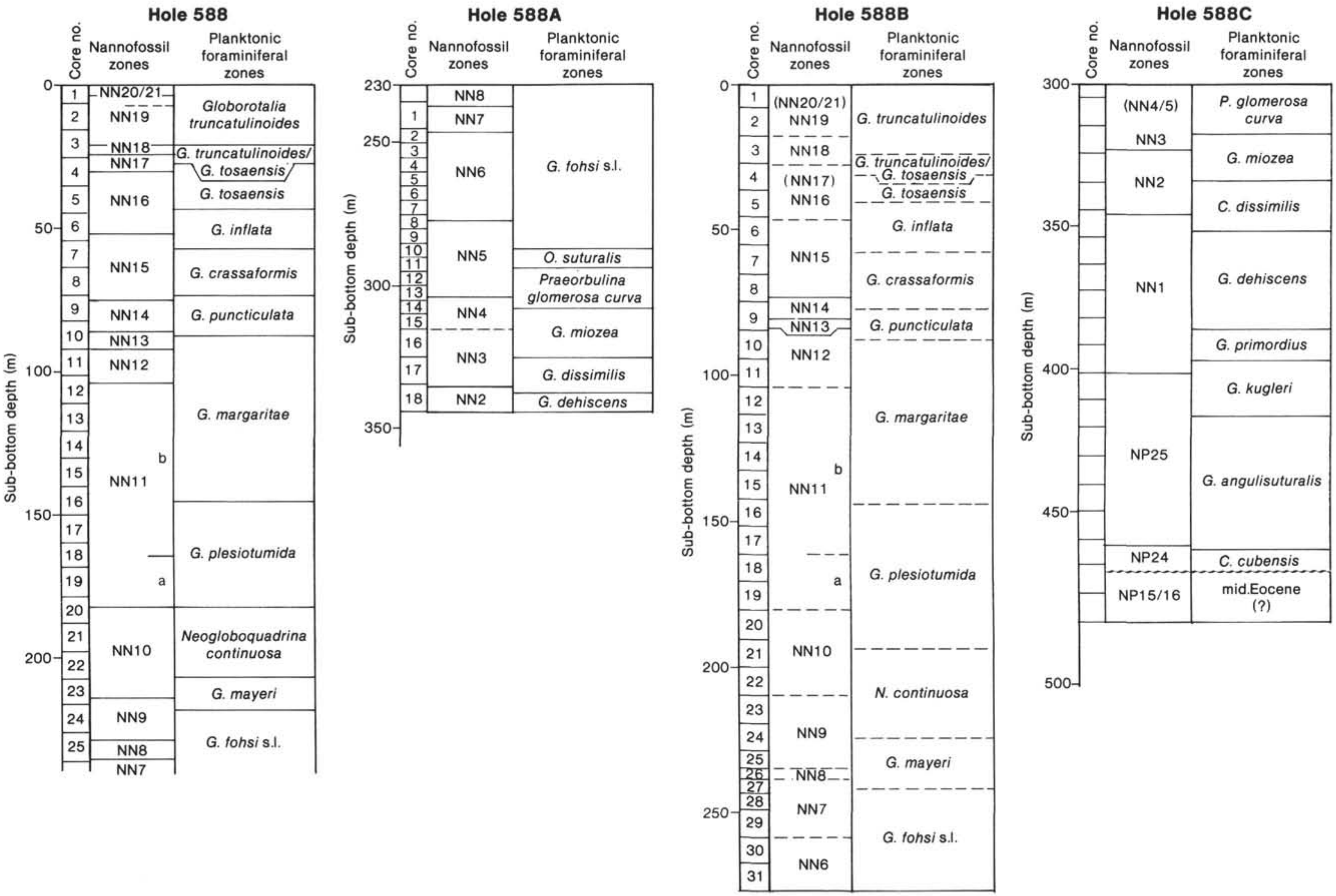

Figure 8. Biostratigraphy for Site 588. No radiolarians were encountered.

	Kennett (1973): warm subtropical zones	**Srinivasan and Kennett (1981a, b)**	**This volume**
Pleistocene	*Globorotalia truncatulinoides*		*G. truncatulinoides*
	G. truncatulinoides–G. tosaensis	*G. truncatulinoides–G. tosaensis*	*G. truncatulinoides–G. tosaensis*
late Pliocene	*G. tosaensis*	*G. tosaensis*	*G. tosaensis*
	G. inflata	*G. inflata*	*G. inflata*
early Pliocene	*G. crassaformis*	*G. crassaformis*	*G. crassaformis*
	G. puncticulata	*G. puncticulata*	*G. puncticulata*
	G. margaritae	*G. margaritae*	*G. margaritae*
late Miocene	*G. conomiozea*	*G. conomiozea*	
	Globigerina nepenthes		*G. plesiotumida*
	Globorotalia continuosa	*Neogloboquadrina continuosa*	*N. continuosa*
middle Miocene	*G. mayeri*	*G. mayeri*	*G. mayeri*
	Orbulina suturalis	*G. fohsi* s.l.	*G. fohsi* s.l.
		G. peripheroacuta	
		O. suturalis	*O. suturalis*
early Miocene	*Globigerinoides trilobus*	*Praeorbulina glomerosa curva*	
		G. miozea	*G. miozea*
		Catapsydrax dissimilis	
		Globoquadrina dehiscens	
late Oligocene		*Globigerinoides primordius*	
		Globorotalia kugleri	
			G. angulisuturalis
			Chiloguembelina cubensis

Figure 9. Planktonic foraminiferal zones used at Site 588.

zea. This level also coincides with the first appearance of *G. tumida*.

3. Oligocene/Miocene boundary: first appearance of *Globoquadrina dehiscens* as in Srinivasan and Kennett (1981b, 1983).

Benthic Foraminifers

Benthic foraminifers were examined in aliquots of the fractions less than 63 μm in core catchers from Holes 588, 588A, and 588C (Table 3). The benthics are well preserved in most core catchers down to the lower Miocene (Section 588A-2 through Sample 588A-18,CC and 588C-8 through 588C-19,CC). Below this point diagenetic alteration of the sediments has removed nearly 50% of the coarse fraction and, in the lower samples, a large percentage of the intermediate size-fraction as well.

From the top of the section down to the middle Miocene, faunas are very similar; they are dominated by species of *Oridorsalis, Globocassidulina, Pullenia*, and *Melonis*. Diversity varies from a high of 25 species in the late Pliocene (Sample 588-6,CC) to a low of four species in a rich plankton ooze at the base of the *Globorotalia plesiotumida* Zone (Sample 588-19,CC). In general, both the diversity of the benthic faunas and the abundance of benthic specimens in the aliquots decrease down the section as the preservation of the carbonates worsens.

In the Pliocene (Samples 588-4 through 588-15,CC) there are three episodes of marked faunal change. In the *G. inflata* Zone (equivalent to the NN15/NN16 boundary in Sample 588-6,CC) there occurs a marked increase in both diversity and faunal abundance and many species disappear from the faunas. These include *Anomalinoides semipunctata, Cibicides lobatulus, Osangularia culter, Karreriella bradyi, Hopkinsina mioindex*, and *Stilostomella insecta*. Two of these species. *O. culter* and *A. semipunctata*, are very rare at this site, appear for a short time only in the lower and mid-Pliocene, and then disappear. Both *O. culter* and *A. semipunctata* were found at the shallow Site 587, but not at the deeper Site 586. Their presence at the initiation of the glacial Pliocene at Site 588 may represent downward migration of these species and/or increased downslope movement of sediments.

A second episode of increased faunal abundance (Sample 588-8,CC) in the *G. crassaformis* Zone is accompanied by the unusual appearance of two species, *Pullenia quinqueloba* and *Melonis pompiliodes*, which are typical of the faunas at the deeper Site 586, but do not appear in the faunas from the shallow Site 587. The rare appearances of these species, as in Sample 588-8,CC, may indicate upward migration of benthics because of some ecologic change. The proportions of other species in the samples need to be counted to test this idea.

In the top of the *G. margaritae* Zone (Sample 588-10,CC), there is an episode of faunal overturn involving the upward disappearance of several important species: *Ehrenbergina pacifica, Uvigerina spinulosa*, and *Rectuvigerina multistriata*, among others. At the shallower Site 587, *R. multistriata* disappears later, at the beginning of the glacial (= NN15/NN16).

In the Miocene there are also three episodes of marked faunal change: at the base of the *Neogloboquadrina continuosa* Zone, in the *G. fohsi* s.l. Zone, and in the *G. miozea* Zone. Otherwise the Miocene faunas are very consistent. Diversity and faunal abundance are consistent except in those poorly preserved samples lower in the section. Very few new species appear above the base of the middle Miocene.

Toward the base of the *N. continuosa* Zone (Cores 588-21 through 588-23) there is a second influx of *M. pompilioides, P. quinqueloba*, and several other species suspected of representing a deeper faunal influence. There is no apparent change in benthic diversity or abundance during this faunal change.

Faunal changes in the *G. fohsi* s.l. Zone (Samples 588A-2 through 588A-9 and 588C-1 through 588C-9) are difficult to evaluate because carbonate preservation worsens in this zone. Diversity and faunal abundances are generally lower than in overlying samples. The character of faunas alters slightly because *Ehrenbergina* spp., small virgulinids, large nodosarids and *Quinqueloculina* increase in abundance upward. The significance of these forms is not known. In addition, several species disappear from the faunas at this time; these include *Heterolepa trinitatensis, Siphonodosaria modesta, Bulimina tuxpamensis, B. semicostata*, and *Cibicidoides* sp. Upward migration of benthic species is not evident in the material seen so far.

The elimination of typical Eocene–Oligocene benthic species occurs in the base of the *G. miozea* Zone (588A-15 to 588A-16,CC). In these samples both faunal abundance and diversity are highest for the early Miocene. Species which terminate in this zone are *Planulina renzi, Sipho-*

nina pulchra, H. hunteri, B. jarvisi, O. mexicana, and *Plectofrondicularia* sp.

The lowermost Miocene and the Oligocene at Holes 588A and 588C cannot be compared with overlying sediments because of the degree of dissolution in the older samples. In both holes sediments of this age have lost nearly 50% of their coarse fractions, including a large percentage of benthic species. In the Oligocene (588C-9 through 588C-17,CC) the intermediate size-fraction is also largely missing. Glauconite is occasionally present and a large proportion of the fossils are fragmented. Benthic species present include *Oridorsalis umbonatus, Globocassidulina subglobosa, C. tuxpamensis, Pullenia coryelli, B. semicostata,* and *P. quadriloba.*

Calcareous Nannoplankton

Core-catcher samples along with enough additional samples to determine zonal boundaries were examined for calcareous nannoplankton. All zonal indicators are present, with the exception of *Helicosphaera ampliaperta*. The upper boundary of the *Helicosphaera ampliaperta* Zone (NN4) is determined instead by the first occurrence of *Discoaster exilis*. Calcareous nannoplankton are abundant and well preserved throughout the upper part of the section.

Hole 588

Pleistocene

The presence of *Emiliania huxleyi* in Sample 588-1-1, 85–86 cm places this sample in the late Pleistocene *Emiliania huxleyi* Zone (NN21). Sample 588-1-2, 85–86 cm is placed in the late Pleistocene *Gephyrocapsa oceanica* Zone (NN20). The presence of *E. ovata* and the absence of *Calcidiscus macintyrei* in Samples 588-1-3, 85–86 cm and 588-1,CC place these samples in the upper subzone of the early Pleistocene *E. ovata* Zone (NN19b). The addition of *C. macintyrei* in Samples 588-2-1, 85–86 cm to 588-3-4, 0–1 cm places these samples in the lower subzone of the *E. ovata* Zone (NN19a).

Pliocene

The last occurrence of *Discoaster brouweri* in Sample 588-4-2, 0–1 cm and the last occurrence of *D. pentaradiatus* in Sample 588-3,CC place Samples 588-3-5, 0–1 cm and 588-4-1, 0–1 cm in the late Pliocene *Discoaster brouweri* Zone (NN18). The presence of *D. brouweri* together with *D. pentaradiatus* in Sample 588-4-2, 0–1 cm places this sample in the late Pliocene *D. pentaradiatus* Zone (NN17).

The last occurrence of *Reticulofenestra pseudoumbilica* in Sample 588-6-6, 0–1 cm places Samples 588-4-3, 0–1 cm to 588-6-5, 0–1 cm in the late Pliocene *Discoaster surculus* Zone (NN16). Samples 588-6-6, 0–1 cm to 588-9-2, 0–1 cm, above the last occurrence of *Amaurolithus tricorniculatus*, are placed in the early Pliocene *Reticulofenestra pseudoumbilica* Zone (NN15). The interval from Sample 588-9-3, 0–1 cm to the first occurrence of *D. asymmetricus* in Sample 588-11-1, 0–1 cm is placed in the early Pliocene *D. asymmetricus* Zone (NN14). The interval from Sample 588-11-2, 0–1 cm to the first occurrence of *Ceratolithus rugosus* in Sample 588-11-3, 0–1 cm in placed in the early Pliocene *Ceratolithus rugosus* Zone (NN13). The early Pliocene *Amaurolithus tricorniculatus* Zone (NN12) includes Samples 588-11-4, 0–1 cm to 588-12-1, 0–1 cm above the last occurrence of *D. quinqueramus.*

Miocene

The last occurrence of *Discoaster quinqueramus* in Sample 588-12-2, 0–1 cm and the first occurrence of *Amaurolithus primus* in Sample 588-18-3, 0–1 cm places Samples 588-12-2, 0–1 cm to 588-18-3, 0–1 cm in the upper subzone of the late Miocene *Discoaster quinqueramus* Zone (NN11b). The interval from Sample 588-18-4, 0–1 cm to the first occurrence of *D. quinqueramus* in Sample 588-20-7, 0–1 cm is placed in the lower subzone of the late Miocene *D. quinqueramus* Zone (NN11a). Samples 588-20,CC to 588-23-4, 0–1 cm, above the last occurrence of *D. hamatus*, are placed in the late Miocene *D. calcaris* Zone (NN10).

The middle Miocene *D. hamatus* Zone (NN9) includes Samples 588-23-5, 0–1 cm to 588-25-3, 0–1 cm, based upon the occurrence of *D. hamatus*. The interval from Sample 588-25-4, 0–1 cm to the first occurrence of *Catinaster coalitus* in Sample 588-25-6, 0–1 cm is placed in the middle Miocene *Catinaster coalitus* Zone (NN8). Sample 588-25,CC is placed in the middle Miocene *D. kugleri* Zone (NN7). Hole 588 was terminated at a depth of 236.0 m BSF.

Hole 588A

Hole 588A continues downsection from where Hole 588 ended. However, the presence of *Catinaster coalitus* in Sample 588A-1-1, 0–1 cm suggests a slight stratigraphic overlap between the two holes, because its apparent first occurrence was in Sample 588-25-6, 0–1 cm. The middle Miocene *Discoaster kugleri* Zone (NN7) is continued from Sample 588A-1-2, 0–1 cm to the first occurrence of *Discoaster kugleri* in Sample 588A-2-4, 0–1 cm. The interval from Samples 588A-2,CC to 588A-8,CC, above the last occurrence of *Sphenolithus heteromorphus* in Sample 588A-9-1, 0–1 cm, is placed in the middle Miocene *D. exilis* Zone (NN6). the interval from Sample 588A-9-1, 0–1 cm to the first occurrence of *D. exilis* in Sample 588A-12,CC is placed in the middle Miocene *Sphenolithus heteromorphus* Zone (NN5). The early Miocene *Helicosphaera ampliaperta* Zone (NN4) includes Samples 588A-13,CC to 588A-15,CC, above the last occurrence of *S. belemnos* in Sample 588A-16,CC. The interval from Samples 588A-15,CC to 588A-17,CC, above the last occurrence of *Triquetrorhabdulus carinatus* in Sample 588A-18-1, 0–1 cm, is placed in the early Miocene *S. belemnos* Zone (NN3). Samples 588A-18-1, 0–1 cm and 588A-18,CC are placed in the early Miocene *D. druggii* Zone (NN2). Hole 588A was terminated at a depth of 344.4 m BSF.

Hole 588B

Hole 588B duplicates all of Hole 588 and the upper part of Hole 588A; therefore, only the 31 core-catcher samples were examined. The zonal boundaries (NN21/

NN6) encountered in this hole are essentially the same as those of Holes 588 and 588A. Hole 588B was terminated at a depth of 277.4 m BSF.

Hole 588C

Hole 588C stratigraphically overlaps the lower part of Hole 588A and begins with Sample 588C-1,CC in the middle Miocene *Sphenolithus heteromorphus* Zone (NN5). The interval from Sample 588C-2-1, 0–1 cm, below the first occurrence of *Discoaster exilis* in Sample 588C-1,CC to 588C-2-5, 0–1 cm above the last occurrence of *Sphenolithus belemnos* in Sample 588C-2-6, 0–1 cm is placed in the early Miocene *Helicosphaera ampliaperta* Zone (NN4). The presence of *S. belemnos* and the absence of *Triquetrorhabdulus carinatus* in the interval from Sample 588C-2-6, 0–1 cm to 588C-3-6, 0–1 cm places these samples in the early Micene *S. belemnos* Zone (NN3). The interval from the last occurrence of *T. carinatus* in Sample 588C-3,CC and the first occurrence of *D. druggii* in Sample 588C-5-1, 21–22 cm is placed in the early Miocene *Discoaster druggii* Zone (NN2). Samples 588C-5-2, 0–1 cm to 588C-10,CC, above the late Oligocene in Sample 588C-10-4, 0–1 cm, are placed in the early Miocene *Triquetrorhabdulus carinatus* Zone (NN1).

The Oligocene/Miocene boundary, taken at the base of nannoplankton Zone NN1 (*T. carinatus* Zone) was encountered at approximately 400 m sub-bottom in Hole 588C. The last occurrences of *Helicosphaera recta, Sphenolithus ciperoensis*, and *Zygrhablithus bijugatus* were found in the lower part of Core 588C-10. In 588C-17 *S. distentus* and *S. predistentus* occur together with *S. ciperoensis*, indicating the presence of Zone NP24 (*Sphenolithus distentus* Zone).

Sphenoliths are not very common in the late Oligocene at this site, but this may be the result of the poor preservation in certain levels. *Z. bijugatus*, which is known to occur in shallow water, is rather common in the entire late Oligocene. Rare reworked Eocene nannoplankton were found in most late Oligocene samples.

At the top of Core 588C-18, a disconformity was noted between the upper and middle Eocene. The Eocene assemblage, also present in the lowest Core 588C-19, contains, among others, *D. barbadiensis, Reticulofenestra umbilica, Chiasmolithus solitus, Neococcolithus dubius*, and *C. grandis*, indicating a position within nannoplankton Zones NP15 (*Chiphragmalithus alatus* Zone) and NP16 (*D. tani nodifer* Zone). In the late Oligocene, the calcareous nannoplankton is heavily overgrown by secondary calcite, discoasters showing alternating rays fused together and sphenoliths partly fragmented in certain levels. The preservation of calcareous nannoplankton in the middle Eocene is fairly good again, probably because siliceous biogenic constituents, are present.

Diatoms and Silicoflagellates

Diatoms and silicoflagellates were found only in the middle Eocene part of Hole 588C (Cores 588C-18 and 588C-19) and are associated with ebridians and sponge spicules. Diatoms are especially common in Core 588C-19, and include representatives of the genera *Triceratium, Actinoptychus, Trochosira*, and *Thalassiosira* among the well-diversified assemblage. Silicoflagellates were encountered in several samples of 588C-19. The assemblage, containing *Naviculopsis foliacea* and *Corbisema spinosa*, can be placed in the middle Eocene *Naviculopsis foliacea* Zone.

Radiolarians

Radiolarians occur only in the middle Eocene part of Hole 588C (Cores 18 and 19).

PALEOMAGNETISM

All well-preserved core sections (i.e., those not fluid or obviously deformed) from Holes 588, 588A, and 588B were measured on the shipboard Digico long-core spinner magnetometer. Apart from the regions of higher intensity (discussed below), the signal was not sufficiently above the noise and contamination levels to give reproducible results in adjacent cores. Long-core measurements were discontinued after this site.

Holes 588, 588A, and 588C were subsampled at two specimens per section (usually), and Hole 588B at one specimen per section. Laboratory NRM measurements have been completed on Holes 588 and 588A (Barton and Bloemendal, this volume). Absolute orientations were attempted on most cores using the Kuster tool, with results as follows: for Hole 588, 21 attempts, 15 successes; for Hole 588A, 8 attempts, all successful; for Hole 588B, 16 attempts, 9 successes and 2 suspect results. This success rate is better than has often been obtained but still needs to be improved.

Intensities of magnetization were generally very low, though noticeably higher than for previous sites on this leg. NRM statistics for the sequence measured are presented in Table 3.

In common with other sites, there is a high-intensity zone (1–~15 μG), at the top of the sequence, but here it is longer, extending to the bottom of Core 588-4. Intensities then become extremely weak (typically 0.05 μG), with high directional scatter down to Core 588-21 near the mid/late Miocene boundary. Below this, intensities increase monotonically to values of around 15 μG at the bottom of the section. Prominent intensity spikes were common in the sequence. The most obvious ones in the subsample data are listed in Table 4. There was no general correlation between these "high" intensity spikes and the occurrence of ash layers and iron sulfide nodules. One exception was the prominent ash layer in Core 588-23-2, 145 cm. Iron sulfide nodules removed from various cores had only weak magnetic moments, sometimes barely higher than that of the surrounding sediments. This suggests that pyrrhotite, the only common ferromagnetic iron sulfide, is not a major component.

Table 3. NRM statistics at Site 588.

	Hole 588	Hole 588A
Geometric mean intensity (μG)	0.150	1.552
Scalar mean inclination	−5.0 ± 39.7°	−6.7 ± 51.6° s.d.
Axial dipole inclination	−44.4°	—
Mean angle between repeats	4.6°	—

Table 4. Prominent magnetization intensity spikes observed in Hole 588.

Core-Section (level in cm)	Depth (m)	Intensity (μG)
2-1, 25	5.85	14.548
2-5, 100	12.60	3.275
4-5, 125	32.05	3.044
5-7, 125	44.65	1.368
9-1, 25	73.05	0.308
9-5, 25	79.05	0.283
11-3, 125	96.25	0.215
11-6, 25	99.75	0.383
12-6, 125	110.35	0.523
13-1, 25	111.45	0.916
13-2, 125	113.95	0.327
14-3, 25	124.05	0.468
14-6, 125	129.55	0.388
19-6, 125	177.55	0.443
21-3, 125	192.25	0.341
23-2, 25	208.95	1.642

Note: Other spikes were apparent in the long-core records.

It was possible to identify a polarity stratigraphy only down to the end of the Gilbert Chron (Fig. 10A). Below this, to the top of the high-intensity zone (around Core 588-22), directions were more scattered and no unambiguous polarity interpretation was possible. It may be possible to improve on this when results from the adjacent HPC become available. Below Core 588-21 it was again possible to identify a polarity stratigraphy (Fig. 10A), but it is not clear how this should be matched to the polarity time scale. The very long normal-polarity interval in Cores 588-24 and -25 would appear to correspond to Chron 9 (8.92 to 10.42 m.y.), but this interpretation conflicts with the foraminifer and nannoplankton zones. The quality of the paleomagnetic record deteriorates markedly in the denser sediments cored with the 5-m HPC in Hole 588A, despite the high intensities. Directional scatter is high and there is a marked negative (normal) bias to inclinations, suggesting viscous overprinting in the present-day field. No polarity interpretation was possible for Hole 588A.

The increase in intensity at the top of the section is presumably due to the reasons discussed in the Introduction. The origin of higher intensities prior to the late Miocene is not clear. Two possibilities are (1) enhanced input of terrigenous material, and (2) inhibition of the reducing conditions which are probably responsible for the falloff in intensity as a function of depth at the top of the section.

SEDIMENTATION RATES

Sedimentation rates were calculated from calcareous nannoplankton zonal boundaries for the four holes drilled at Site 588. Hole 588B (Fig. 11C) duplicated the results from Hole 588. However, since zonal boundaries in Hole 588B were based only on core-catcher samples, sedimentation rates for this particular hole are less reliable than those for the other three holes.

Ages of nannoplankton boundaries used to determine sedimentation rates are the same as those used during Leg 59 (Martini, 1981) with some minor improvements. Middle Eocene sedimentation rates could not be calculated in the calcareous-siliceous sediments, because the section (Cores 588C-17 and 588C-18) was too short and no zonal boundaries were detected.

In the late Oligocene to early Miocene interval (Hole 588C, nannoplankton Zones NN2 top to NN24 top), the sedimentation rate is 20.6 m/m.y. in calcareous sediments, based on four boundary datums (Fig. 12D). The mean sedimentation rate in the early Miocene (Hole 588A, nannoplankton Zones NN2 top to NN7 top), based on six boundary datums, shows a slight decrease to 14.4 m/m.y., also in calcareous sediments (Fig. 11B). The sedimentation rate in the middle Miocene to early Pliocene interval (Hole 588, nannoplankton Zones NN7 top to NN13 top) is constant at 17.4 m/m.y., based on six datum levels (Fig. 11A). In the late Pliocene (Hole 588, nannoplankton Zones NN13 top to NN18 top) the sedimentation rate increases rather abruptly to 29.5 m/m.y., and drops off to only 12.2 m/m.y. in the Quaternary interval (Hole 588, above nannoplankton Zone NN18 top), both in calcareous sediments. The two latter sedimentation rates are based on eight datum levels (Fig. 11A). The comparatively low sedimentation rate in the Quaternary may be unreliable, and may have resulted from drilling disturbance in the uppermost layers or from winnowing of finer sediments.

SUMMARY AND CONCLUSIONS

Site 588 was drilled at the same location as Site 208 in order to obtain a high-quality, continuously cored sequence through the late Paleogene and Neogene. Previous investigations have demonstrated that the planktonic foraminiferal assemblages at this latitude are made up of both tropical and temperate elements. At the present time, Site 588 is located in the warm subtropical water mass which lies between the true tropical water masses to the north and transitional water masses to the south. However, Site 588 experienced 5–10° of northerly movement during the Neogene in association with movements of the Indian Plate (Sclater et al., in press). During the early Miocene, Site 588 was located at about 36°S in the present-day temperate area and within the zone of westerly winds. This northward movement from higher to lower latitudes must have had a major effect upon the biogeography of the planktonic microfossil assemblages.

Site 588 consists of four holes (Fig. 12): Hole 588, cored continuously with the HPC from 0–236.0 m subbottom; Hole 588A, cored continuously with the HPC from 236.0–344.4 m; Hole 588B, cored continuously with the HPC from 0–277.4 m; and Hole 588C cored continuously with the rotary drill from 305.7–488.1 m subbottom.

The HPC sequence through carbonate sediments is a record penetration of 315 m, extending from the Quaternary to the late early Miocene at 17 m.y. (Zone NN3 or *Globorotalia miozea* Zone). The overlapping hydraulic piston cores effectively provide 100% recovery of this sequence (Fig. 12). There is particularly good core quality in the Miocene, much less so in the Pliocene, and especially poor quality in the Quaternary, which is soupy. The carbonate fossil sequence is exquisite through the

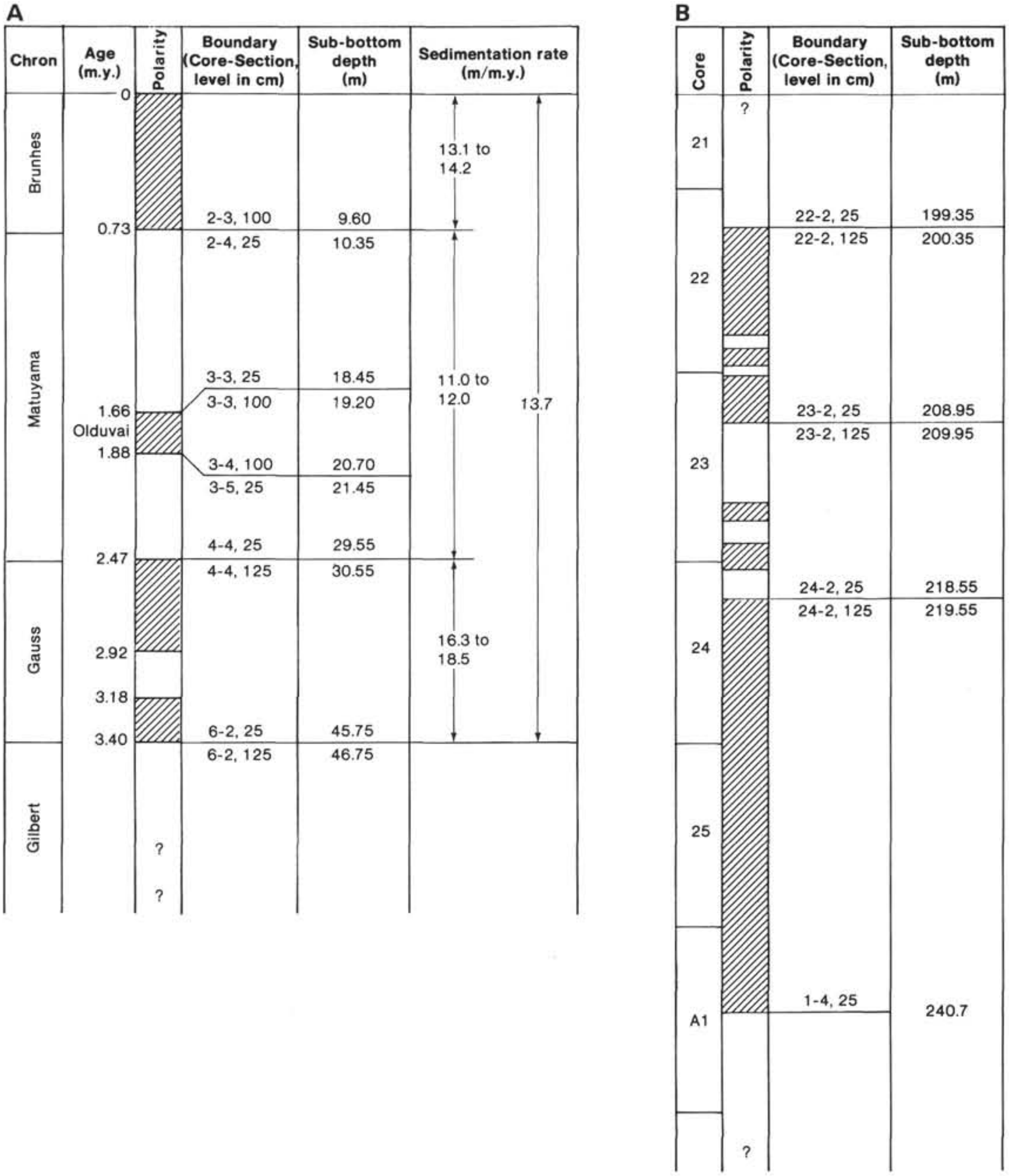

Figure 10. A. Magnetic polarity boundaries for the upper part of Hole 588. B. Polarity zonations at the bottom of Hole 588 and the top of 588A. Shaded zones are normal polarity.

Neogene but less so in the Oligocene. The foraminiferal and calcareous nannofossil zonal sequences are complete (Fig. 12), suggesting that there are no hiatuses above the upper Oligocene (NP24). A paleomagnetic polarity stratigraphy has been identified down to the upper part of the Gilbert Chron (about 3.5 m.y.).

Two sedimentary units are distinguished (Fig. 12), the upper one divided into three subunits. Subunit IA is a foraminifer-bearing nannofossil size to a nannofossil-bearing foraminiferal ooze in an oxidized and winnowed environment. Subunit IB, comprising much of the sediment column at Site 588, is largely a foraminifer-bearing nannofossil ooze, distinguished from Subunit IC by its softness. Subunit IC grades from soft ooze at its top to firm ooze at about 150 to 180 m (Holes 588 and 588B, respectively) to chalk at about 215 to 260 m (Holes 588 and 588B, respectively).

At the bottom of Site 588 (Hole 588C) is Unit II which is separated from overlying Unit IC by the regional unconformity that separates middle or late Eocene from late or middle Oligocene sediments. At Site 588 the unconformity separates sediments of middle Eocene (NP15–16) from late Oligocene (NP24) age.

The middle Eocene sediments consist of siliceous foraminifer-bearing nannofossil chalks and foraminifer-bearing cherts. Less than 1 m of Unit II was recovered before the site was terminated. This lithostratigraphic unit is characterized by the presence of siliceous sponge spicules, diatoms, and diagenetic chert, and coincides with Unit 2 of DSDP Site 208 (Burns, Andrews, et al., 1973).

Textbook examples of microfaults and slickensides occur in three upper lower Miocene cores in a zone where ooze grades into chalks. Surfaces are occasionally mineralized by iron sulfide and possibly rhodochrosite.

There are many thin volcanic ash layers through the Miocene sequence, occurring as singlets, doublets, or triplets and with groups exhibiting quasi-regular perodicities in some intervals. Most are completely undisturbed by bioturbation, which is unusually limited in this site and is an ineffective agent of sediment homogenization. Nevertheless, excellent examples of Zoophycos and Chondrites burrows occur throughout this sequence, as well as relatively sparse larger circular or ovoid (0.5–3.0 cm across) burrow sections and mottles.

Iron sulfides are persistent through the section and have a close association with volcanic ash layers. Drilling terminated in middle Eocene siliceous-rich chalks and cherts.

The uncorrected rates of sedimentation are as follows: lower Oligocene–early Miocene, 20.6 m/m.y.; early Miocene, 14.4; middle Miocene–early Pliocene, 17.4, lower Pliocene, 29.5; Quaternary, 12.2 m/m.y.

In general, the diversity of the benthic faunas and their abundance decrease down the section. Changes in the benthic foraminiferal assemblages provide useful information about changes in intermediate water masses during the Neogene. Elimination of typical Eocene–Oligocene benthic forms occurred in the late early Miocene. During the early late Miocene there was an influx of several species of deeper-water origin. During the Pliocene there was an upward disappearance of several important benthic species and a large number of species disappeared during the late Pliocene, at about 3 m.y.

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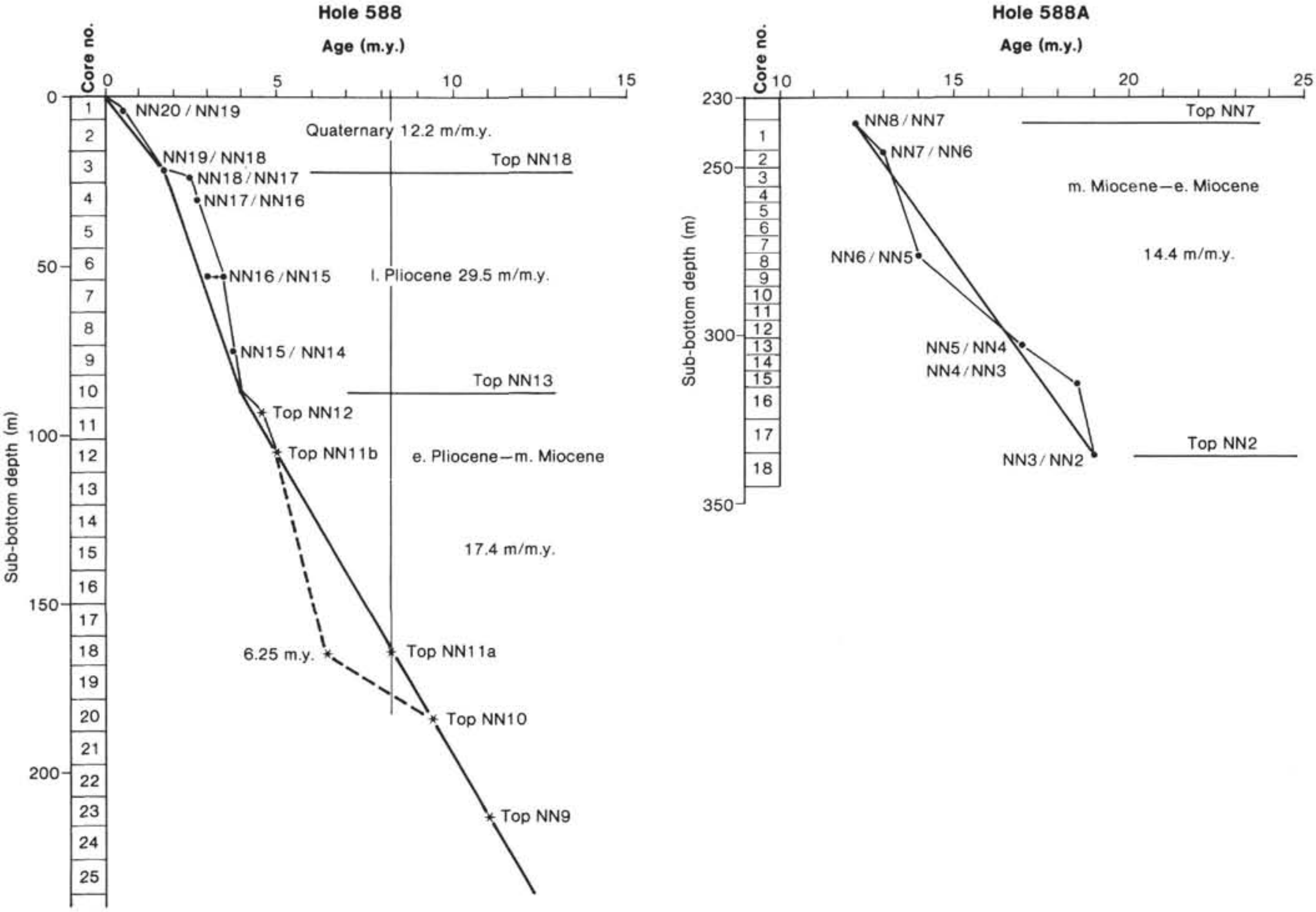


Figure 11. Sedimentation rates at Site 588.

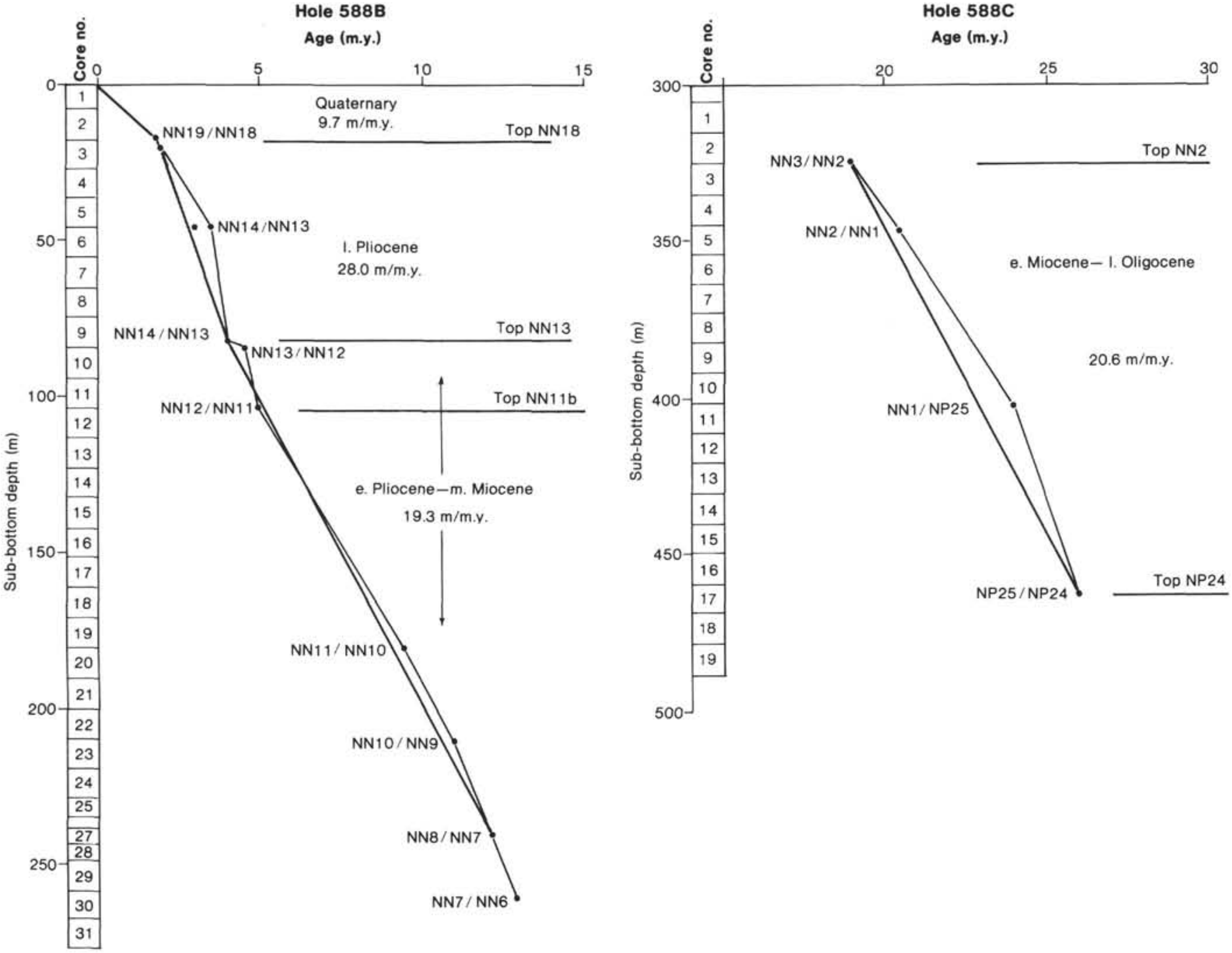


Figure 11. (Continued).

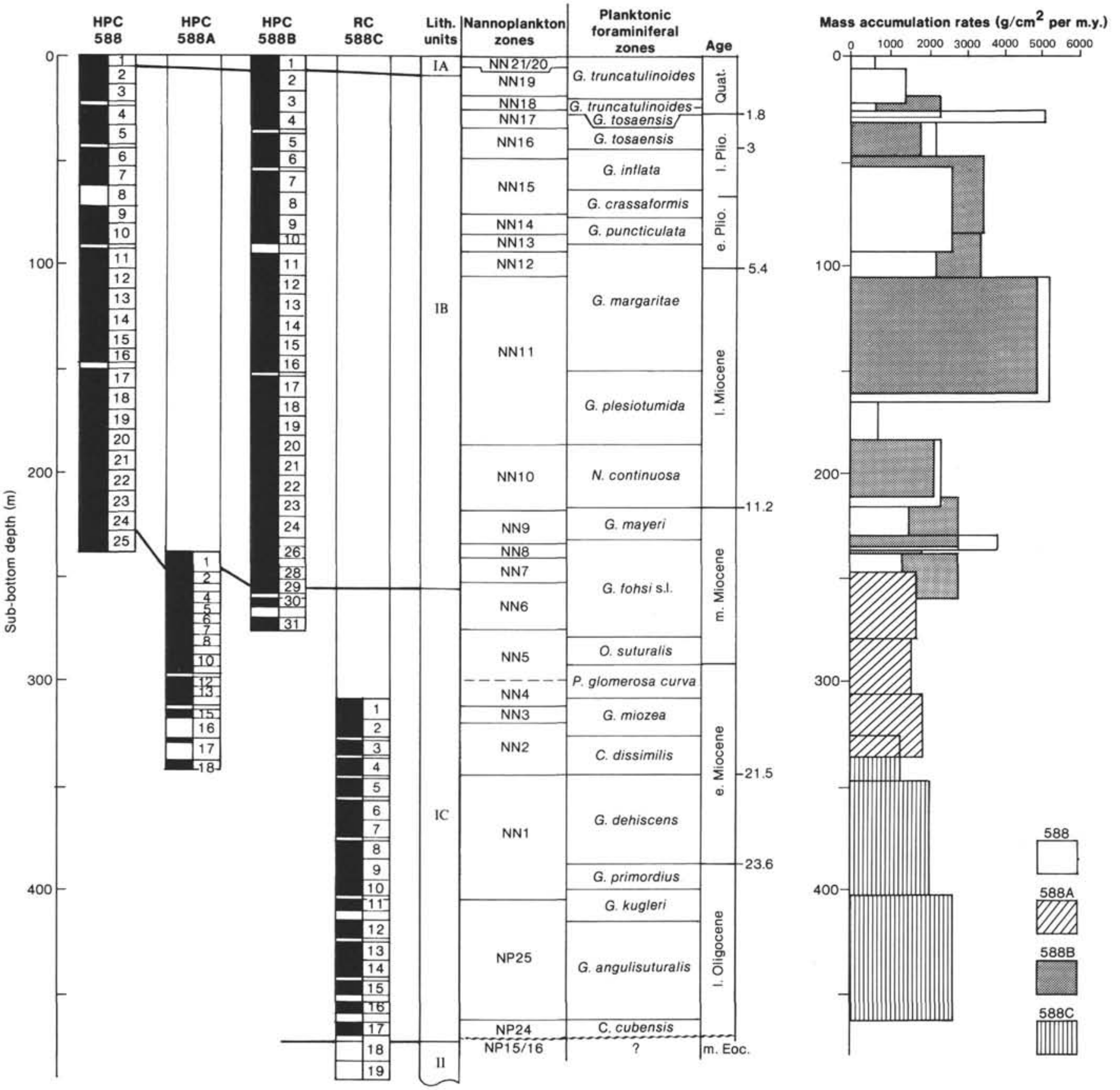
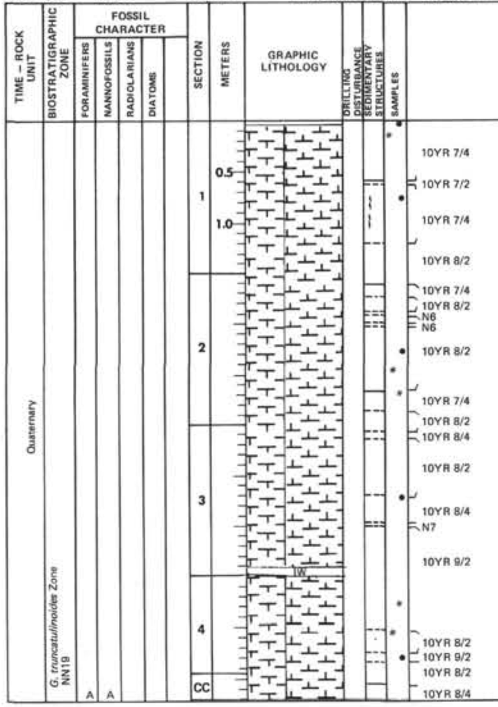


Figure 12. Summary biostratigraphy, lithology, and mass accumulation rates at Site 588.

SITE 588 HOLE CORE 1 CORED INTERVAL 0.0–5.6 m



LITHOLOGIC DESCRIPTION

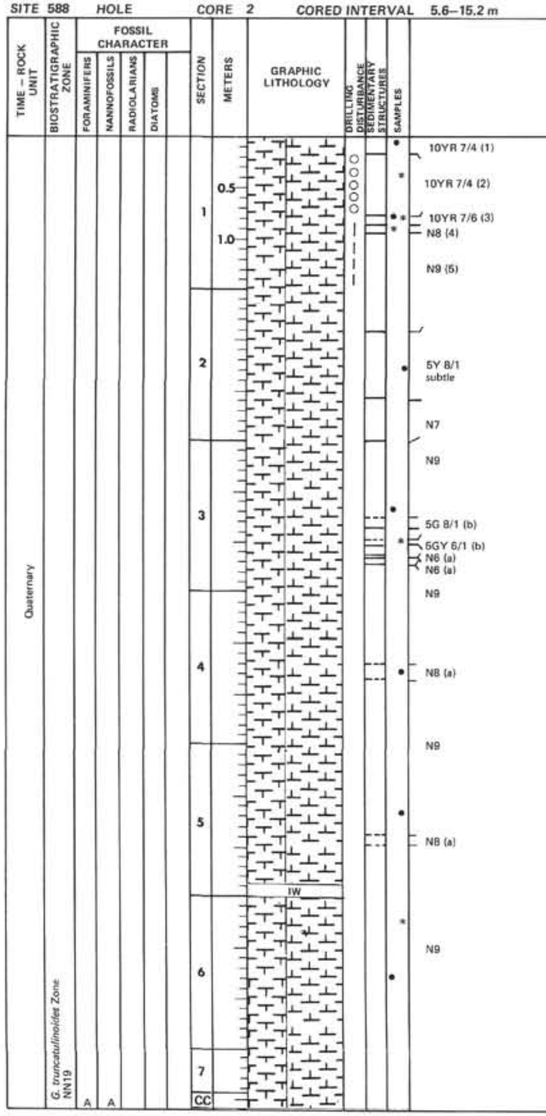
FORAMINIFER-BEARING NANNOFOSSIL OOZE TO FORAMINIFER NANNOFOSSIL OOZE, soft, coarse-grained, oxidized, various shades of orange becoming paler orange downcore.

Some burrowing, bedding, and ash(?) layers.

SMEAR SLIDE SUMMARY:

	1, 22 D	2, 103 D	2, 127 D	4, 35 D	4, 60 M
Composition:					
Quartz	–	T	–	–	–
Heavy minerals	–	–	T	–	–
Foraminifers	A	C	C	C	A
Calc. nannofossils	A	D	A	A	A
Sponge spicules	T	T	T	T	–

SITE 588 HOLE CORE 2 CORED INTERVAL 5.6–15.2 m



LITHOLOGIC DESCRIPTION

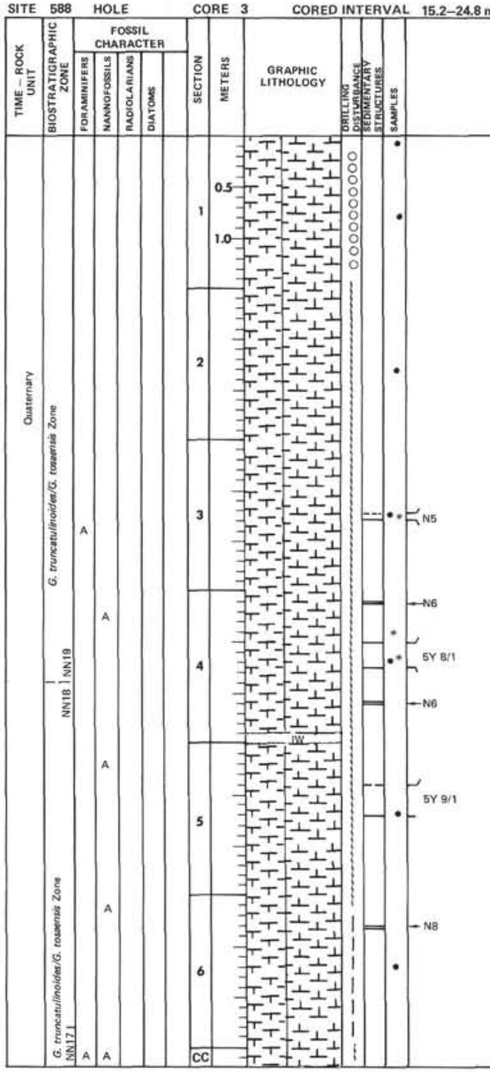
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9), with the sublithologies as noted:

1. stiff, grayish orange, oxidized, similar to previous core
2. very soupy (but in-place), grayish orange, with sharp bottom and top contacts
3. yellowish orange (10YR 7/6), highly oxidized, stiffer, foram nanno ooze
4. coarser, very light gray (N8), foram nanno ooze, sharp contact with:
5. major lithology with subtle color variations due to:
    - (a) iron sulfide (N6)
    - (b) ash/glass layers; greenish hues (5G or 5GY)

SMEAR SLIDE SUMMARY:

	1, 41 M	1, 78 M	1, 88 M	3, 99 M	6, 30 D
Composition:					
Quartz	–	T	T	T	–
Volcanic glass	–	T	T	T	–
Carbonate unspec.	C	–	–	–	–
Foraminifers	C	A	A	C	C
Calc. nannofossils	A	A	A	A	D
Sponge spicules	–	T	–	–	T

SITE 588 HOLE CORE 3 CORED INTERVAL 15.2–24.8 m



LITHOLOGIC DESCRIPTION

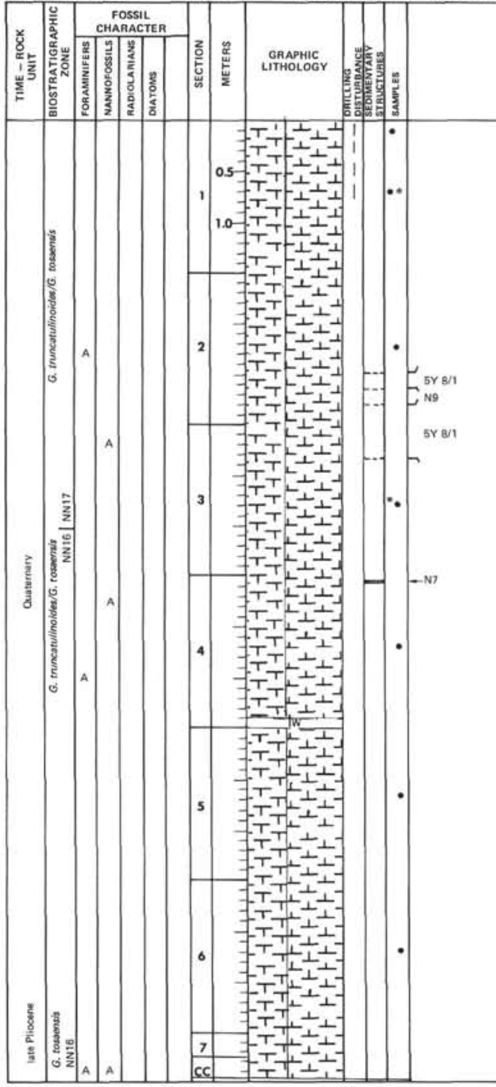
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) with iron-sulfide pockets and layers (N5 and N6).

Badly deformed but probably stratigraphically – coherent.

SMEAR SLIDE SUMMARY:

	3, 77 M	4, 33 D	4, 65 M
Composition:			
Quartz	T	–	–
Volcanic glass	–	–	T
Foraminifers	A	C	C
Calc. nannofossils	A	D	A
Sponge spicules	–	T	–

SITE 588 HOLE CORE 4 CORED INTERVAL 24.8–34.4 m



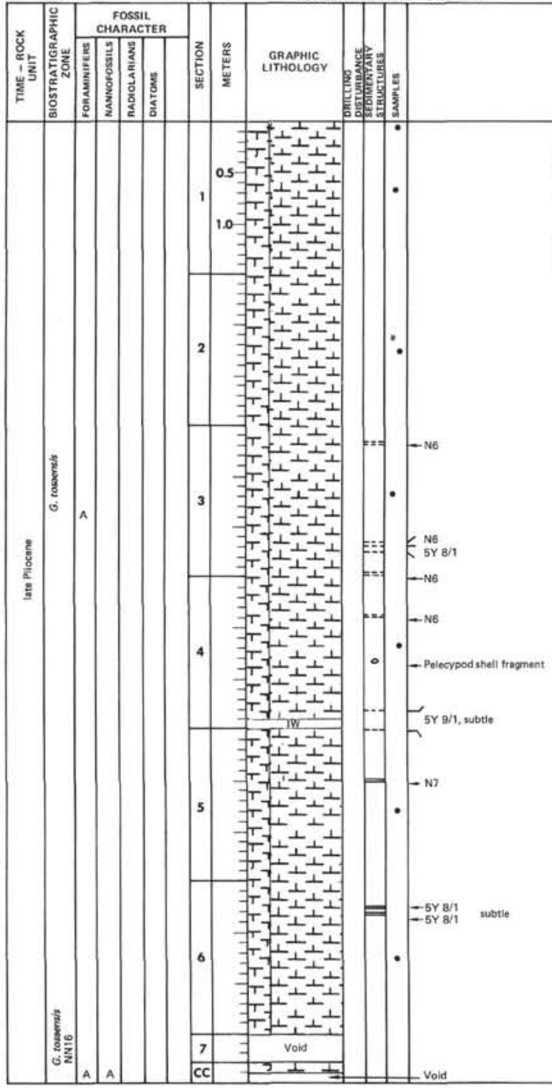
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very soft, white (N9), homogeneous throughout except for small blebs of volcanic glass and iron sulfide abundant. Glass occurs in the form of bubbles.

SMEAR SLIDE SUMMARY:

	1, 35 M	3, 75 D
Composition:		
Quartz	T	–
Volcanic glass	C	–
Foraminifers	C	C
Calc. nannofossils	A	D

SITE 588 HOLE CORE 5 CORED INTERVAL 34.4–44.0 m



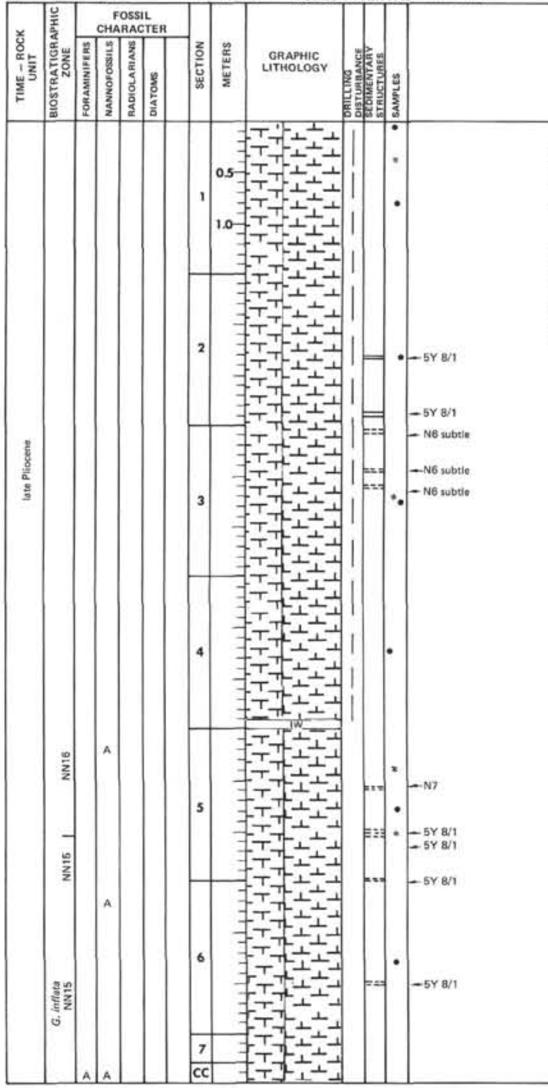
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9), iron sulfide abundant throughout; otherwise homogeneous.

SMEAR SLIDE SUMMARY:

	2, 67
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE CORE 6 CORED INTERVAL 44.0–53.6 m



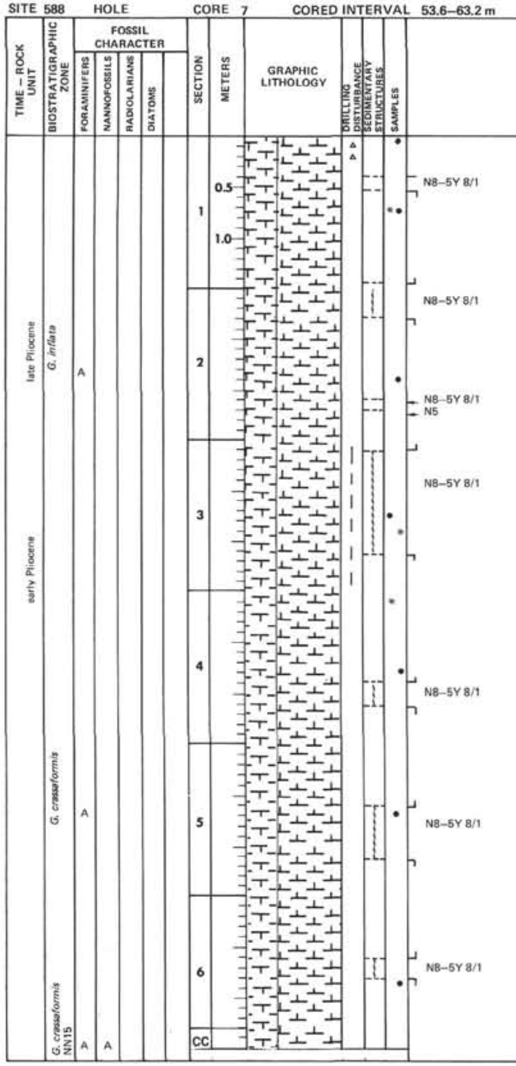
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, still very wet and high porosity, specked with iron sulfide, slight deformation of most of Core 6, white (N9).

SMEAR SLIDE SUMMARY:

	1, 40	3, 65	5, 40	5, 100
	D	D	D	M
Texture:				
Sand	—	—	—	—
Silt	C	—	—	C
Clay	D	—	—	D
Composition:				
Foraminifers	C	C	C	C
Calc. nannofossils	D	D	D	D

SITE 588 HOLE CORE 7 CORED INTERVAL 53.6–63.2 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8).

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

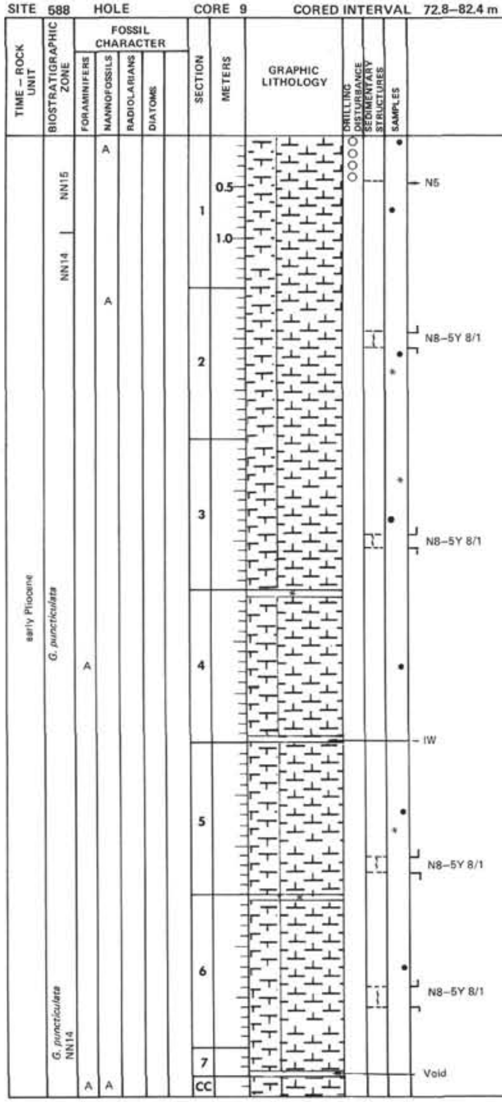
Medium gray (N5) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	1, 82 D	3, 96 M	4, 16 M
Texture:			
Sand	–	–	–
Silt	C	C	C
Clay	D	D	D
Composition:			
Foraminifers	C	C	C
Calc. nannofossils	D	D	D

Note: Core 8: 63.2–72.8 m: no recovery.

SITE 588 HOLE CORE 9 CORED INTERVAL 72.8–82.4 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8).

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

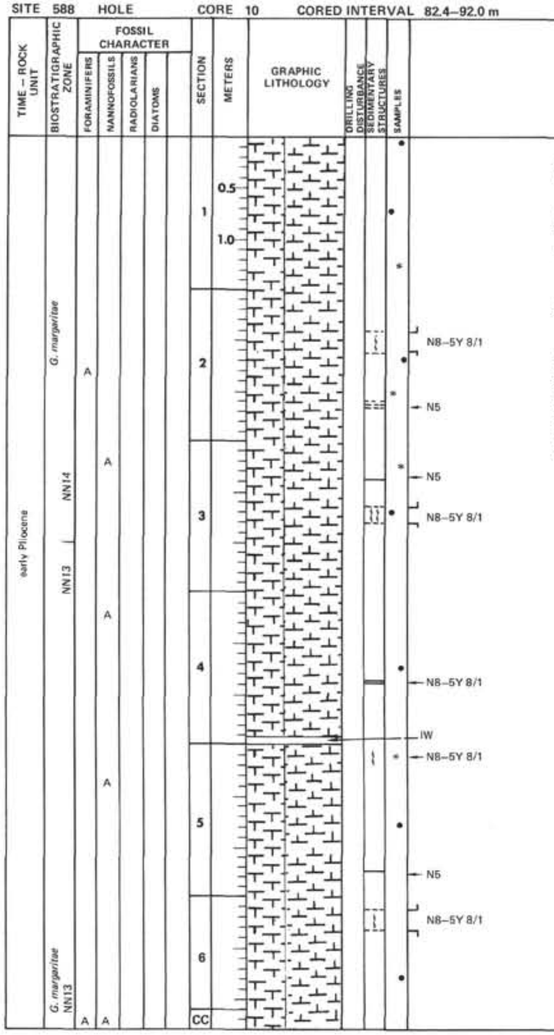
Medium gray (N5) laminae along the core (iron sulfide).

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	3, 42 D	2, 82 M	5, 79 M
Texture:			
Sand	–	–	–
Silt	C	C	C
Clay	D	D	D
Composition:			
Pyrite	T	–	–
Foraminifers	C	C	C
Calc. nannofossils	D	D	D
Other	–	–	T

SITE 588 HOLE CORE 10 CORED INTERVAL 82.4–92.0 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8).

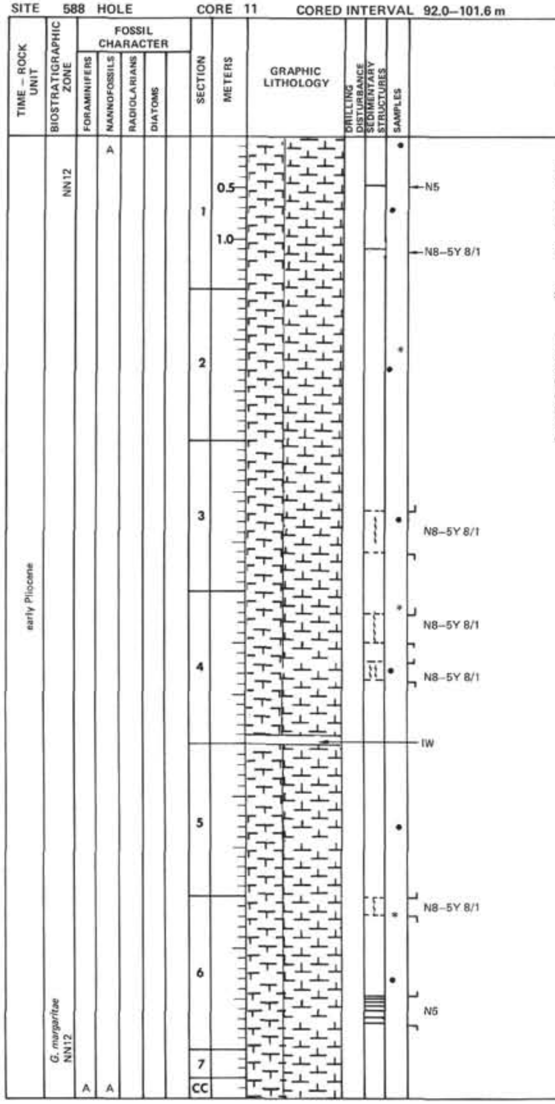
Very light gray to yellowish gray (N8 to 5Y 8/1) laminae and burrows.

Medium gray (N5) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	2, 110 D	1, 130 M	3, 31 M	5, 14 M
Texture:				
Sand	–	–	–	–
Silt	C	C	C	C
Clay	D	D	D	D
Composition:				
Pyrite	–	R	–	–
Foraminifers	C	C	C	C
Calc. nannofossils	D	D	D	D

SITE 588 HOLE CORE 11 CORED INTERVAL 92.0–101.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8).

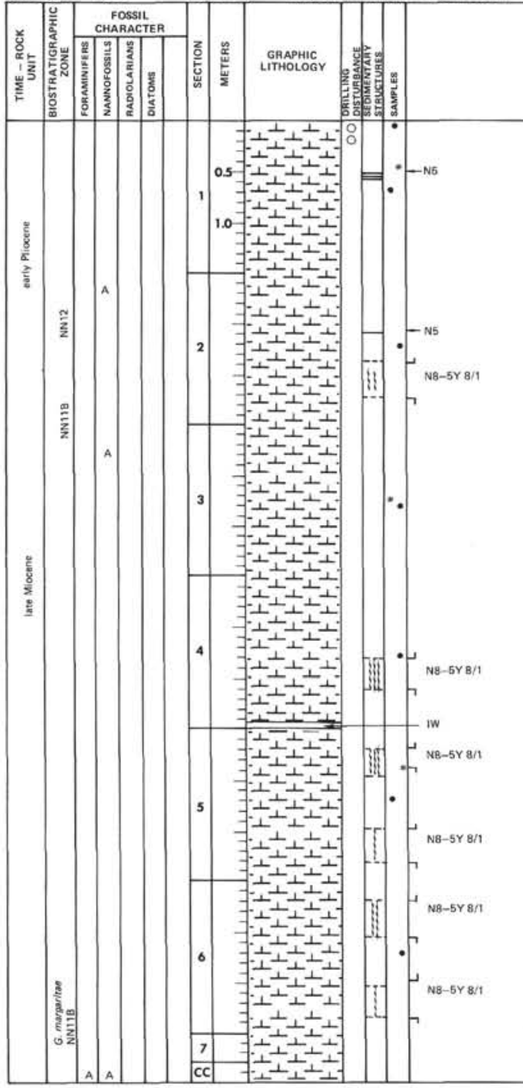
Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

Medium gray (N5) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	2, 68 D	4, 25 M	6, 25 M
Texture:			
Sand	–	–	–
Silt	C	C	C
Clay	D	D	D
Composition:			
Pyrite	–	T	T
Foraminifers	C	C	R
Calc. nannofossils	D	D	D

SITE 588 HOLE CORE 12 CORED INTERVAL 101.6–111.2 m



LITHOLOGIC DESCRIPTION

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

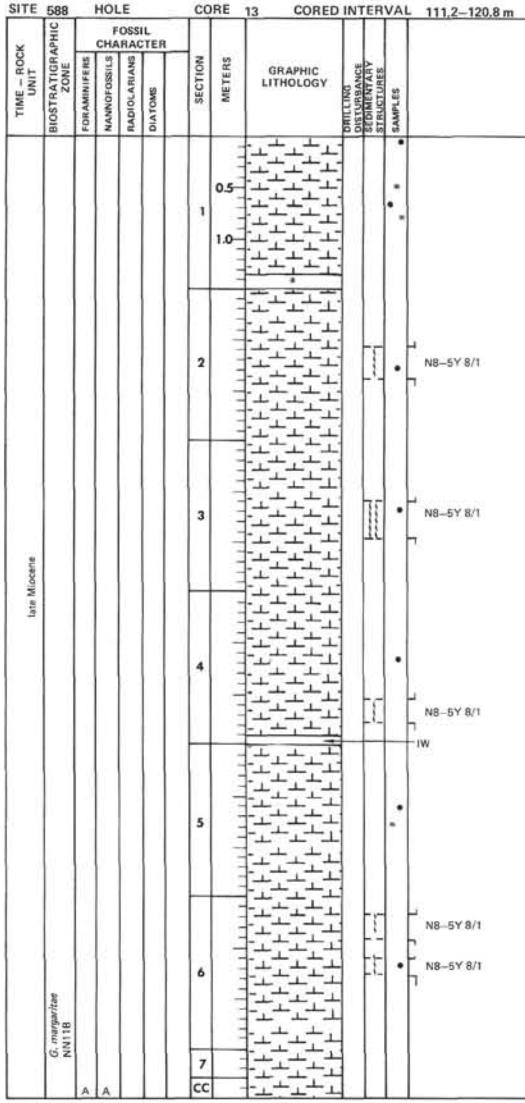
Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

Medium gray (N5) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	1, 46 D	3, 80 D	5, 37
Texture:			
Sand	T	–	–
Silt	C	C	C
Clay	D	D	D
Composition:			
Foraminifers	R	R	R
Calc. nannofossils	D	D	D

SITE 588 HOLE CORE 13 CORED INTERVAL 111.2–120.8 m



LITHOLOGIC DESCRIPTION

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

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

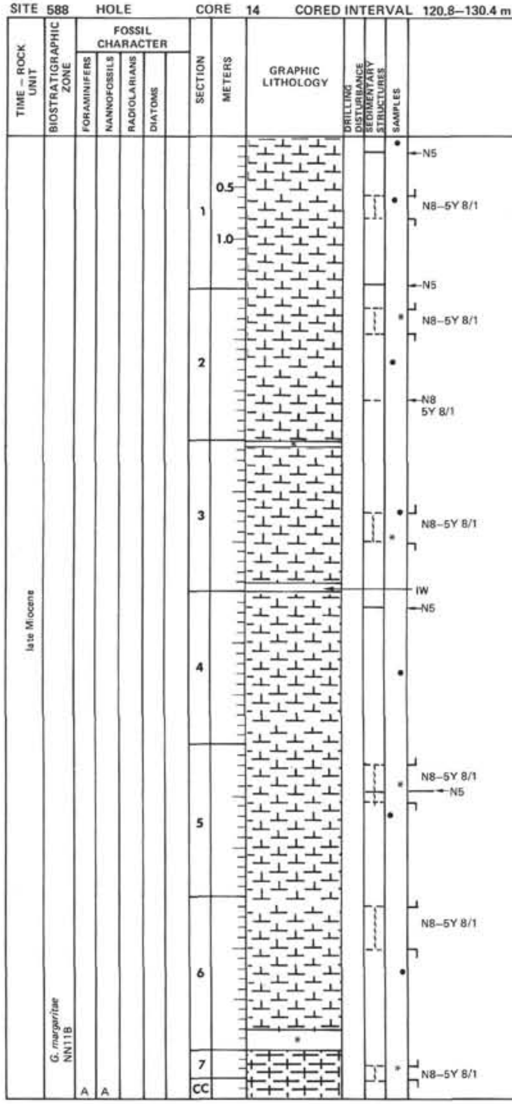
Medium gray (N5) laminae of iron sulfide along the core.

*Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	1, 78 D	5, 80 D	1, 56 M
Texture:			
Sand	–	–	–
Silt	C	C	C
Clay	D	D	D
Composition:			
Heavy minerals	–	–	T
Pyrite	–	T	A
Foraminifers	R	R	R
Calc. nannofossils	D	D	A

SITE 588 HOLE CORE 14 CORED INTERVAL 120.8–130.4 m



LITHOLOGIC DESCRIPTION

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

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

Medium gray (N5) laminae of iron sulfide along the core.

Gradual transition to:

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8).

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

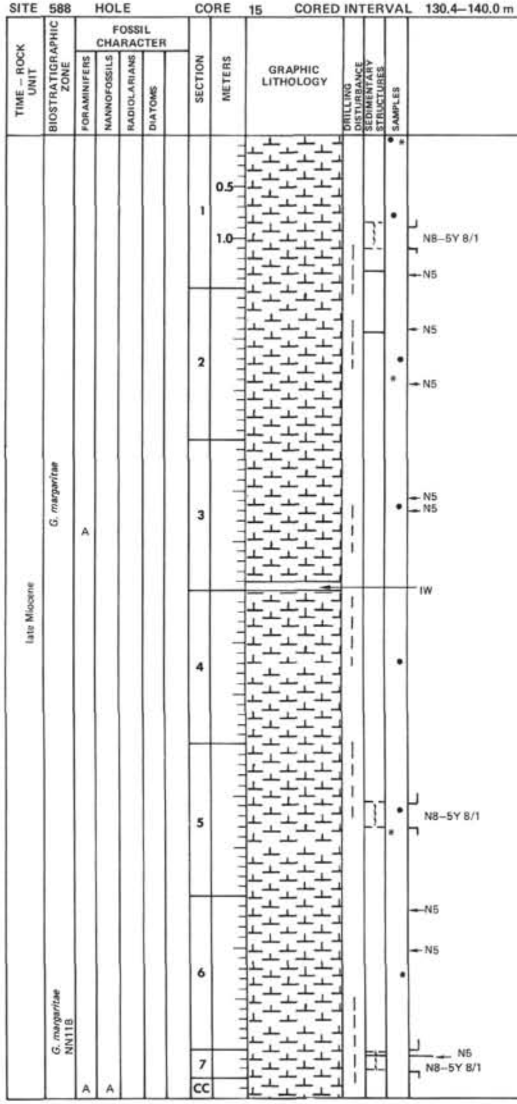
Medium gray (N5) laminae of iron sulfide along the core.

*Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 37 D	3, 104 D	5, 40 D	7, 9 D
Texture:				
Sand	—	—	—	—
Silt	C	C	C	C
Clay	D	D	D	D
Composition:				
Heavy minerals	—	R	—	—
Pyrite	—	—	—	T
Foraminifers	R	T	R	C
Calc. nannofossils	D	D	D	D

SITE 588 HOLE CORE 15 CORED INTERVAL 130.4–140.0 m



LITHOLOGIC DESCRIPTION

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

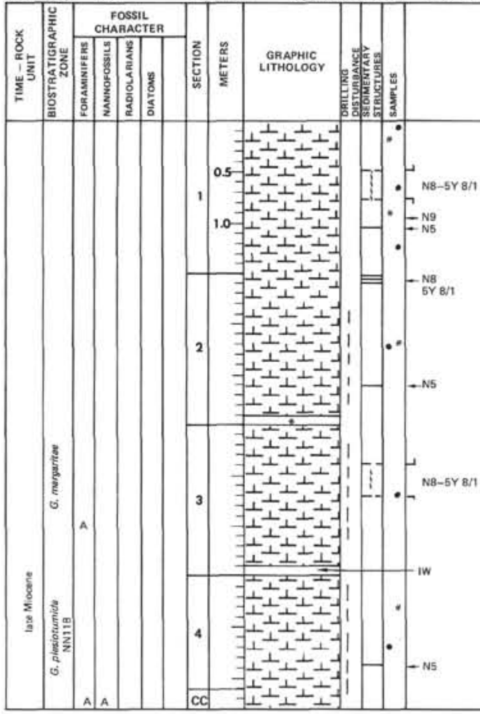
Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

Medium gray (N5) laminae of iron sulfide.

SMEAR SLIDE SUMMARY:

	2, 90 D	5, 92	1, 5 M
Texture:			
Sand	—	—	—
Silt	C	R	C
Clay	D	D	D
Composition:			
Foraminifers	T	T	T
Calc. nannofossils	D	D	D

SITE 588 HOLE CORE 16 CORED INTERVAL 140.0–149.6 m



LITHOLOGIC DESCRIPTION

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

Very light gray to yellowish gray (N8 to 5Y 8/1) burrows and laminae.

Medium gray (N5) laminae of iron sulfide along the core.

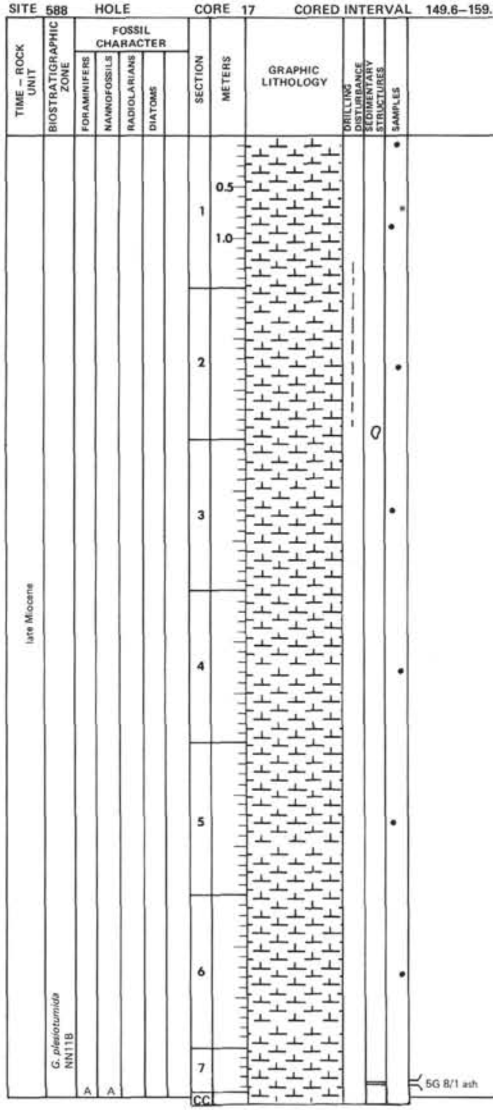
Grayish green to pale yellowish green (10GY 5/2 to 10GY 7/2) nodule at 21 cm in Section 1.

*Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 70 D	4, 29 D	1, 22 M	1, 88 M
Texture:				
Sand	–	–	C	–
Silt	R	R	C	C
Clay	D	D	D	D
Composition:				
Pyrite	T	–	–	C
Foraminifers	T	R	C	C
Calc. nannofossils	D	D	D	D

SITE 588 HOLE CORE 17 CORED INTERVAL 149.6–159.2 m



LITHOLOGIC DESCRIPTION

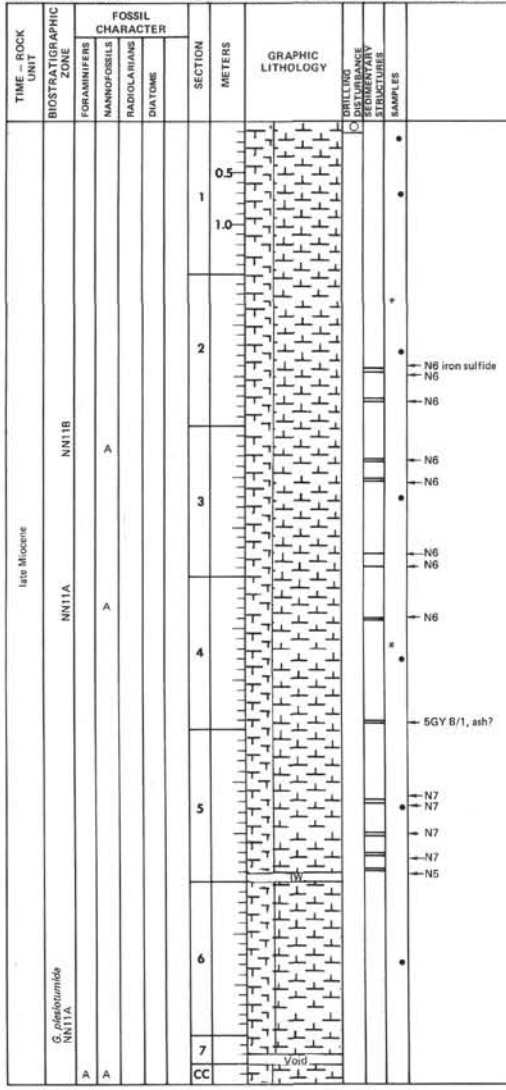
NANNOFOSSIL OOZE, firm, white (N9) with abundant iron sulfide blebs throughout, yellowish gray (5Y 8/1) burrows and laminations also abundant.

Massive pyrite nodule at base of Section 2. Several hard iron sulfide dark gray (N3) burrow fills in Section 3.

SMEAR SLIDE SUMMARY:

	1, 77 D
Texture:	
Sand	–
Silt	C
Clay	D
Composition:	
Foraminifers	R
Calc. nannofossils	D

SITE 588 HOLE CORE 18 CORED INTERVAL 159.2–168.8 m



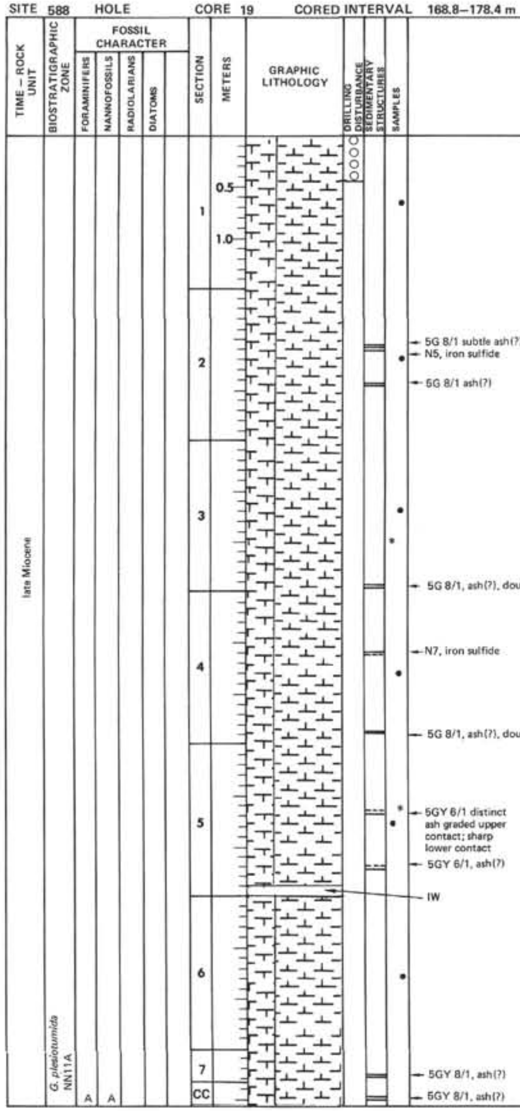
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, moderately soft, but dewatered; white (N9); abundant blebs of iron sulfide (N6) and abundant yellowish gray burrows (5Y 8/1).

SMEAR SLIDE SUMMARY:

	2, 35 D	4, 71 D
Composition:		
Quartz	–	T
Feldspar	T	T
Foraminifers	C	C
Calc. nannofossils	D	D

SITE 588 HOLE CORE 19 CORED INTERVAL 168.8–178.4 m



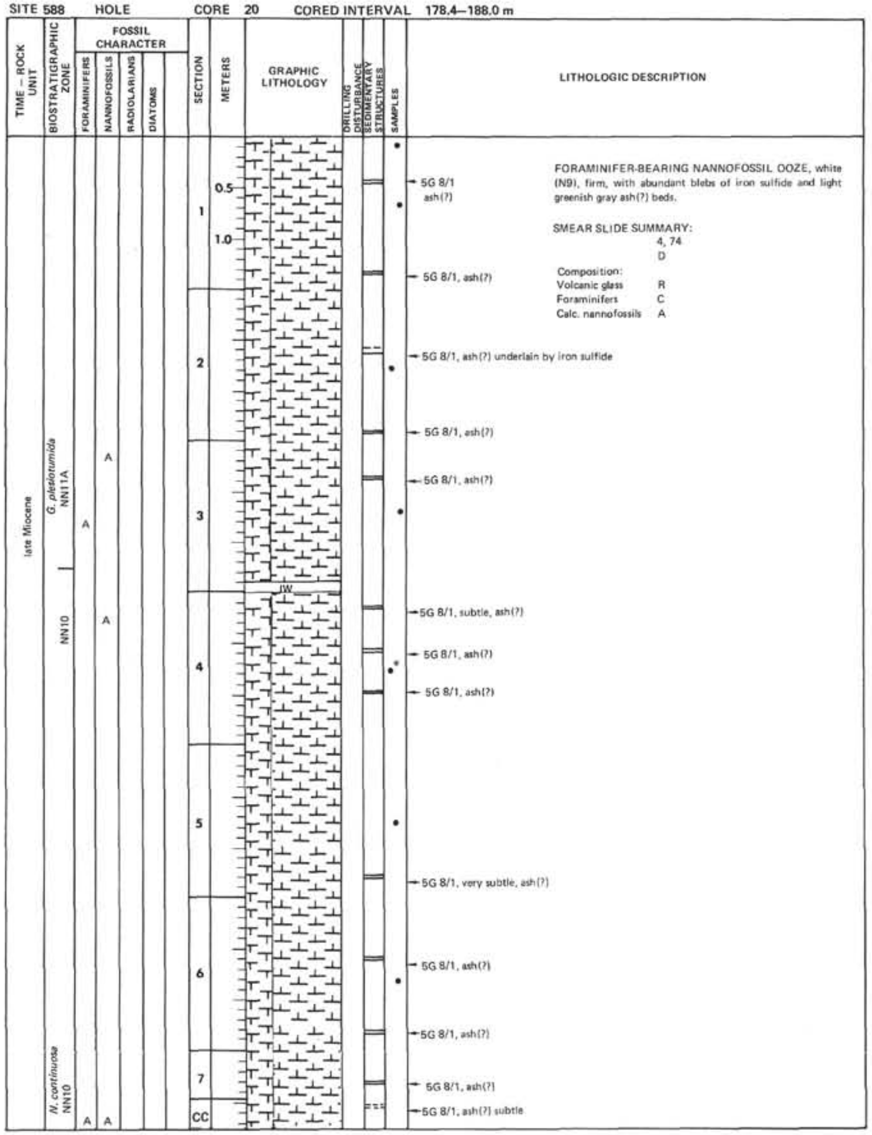
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), firm, iron sulfide and burrows abundant; picking up some ash(?) layers in Section 2.

SMEAR SLIDE SUMMARY:

	3, 101 D	5, 63 M
Composition:		
Volcanic glass	–	C
Foraminifers	C	C
Calc. nannofossils	D	A

SITE 588 HOLE CORE 20 CORED INTERVAL 178.4–188.0 m

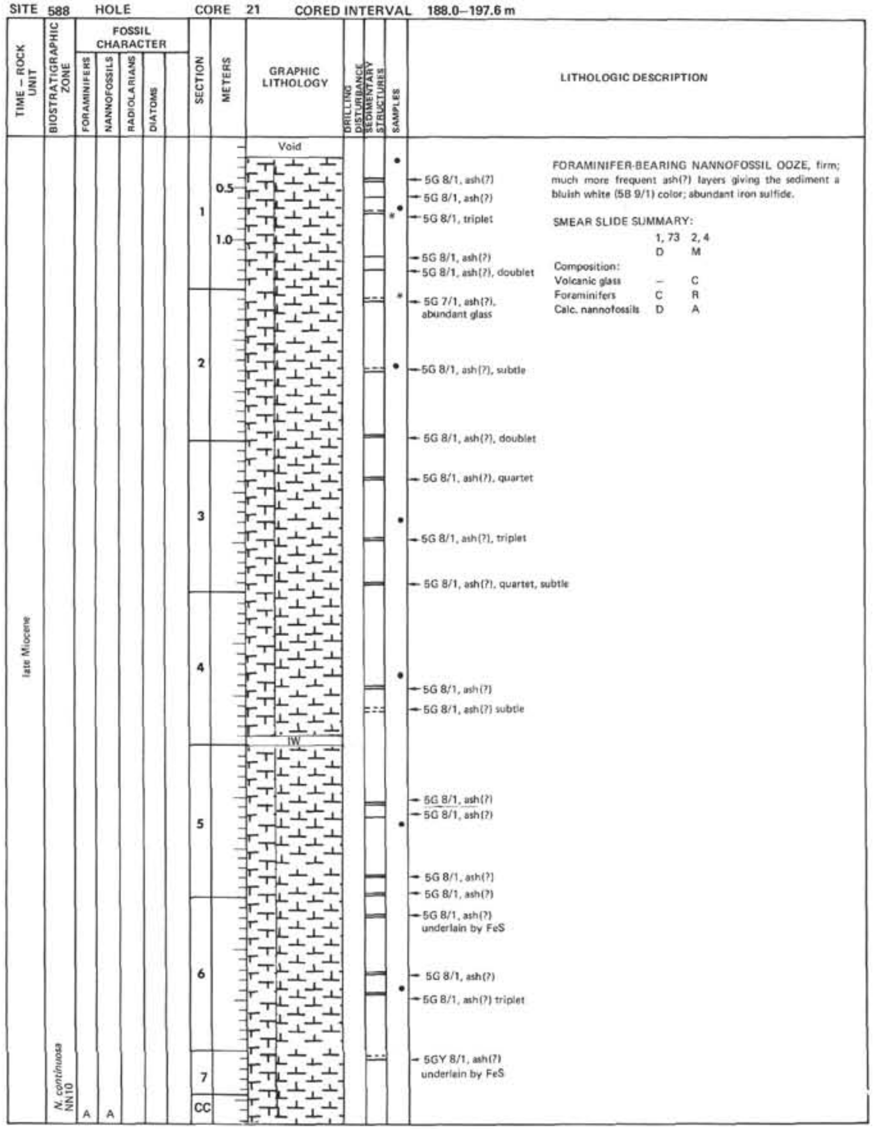


FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), firm, with abundant blebs of iron sulfide and light greenish gray ash(?) beds.

SMEAR SLIDE SUMMARY:

	4, 74
	D
Composition:	
Volcanic glass	R
Foraminifers	C
Calc. nannofossils	A

SITE 588 HOLE CORE 21 CORED INTERVAL 188.0–197.6 m

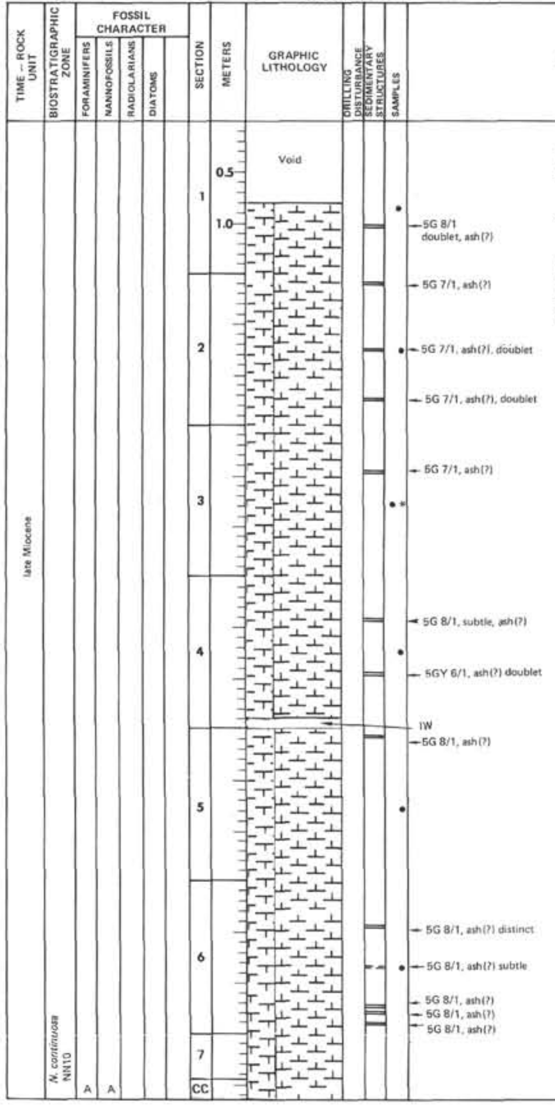


FORAMINIFER-BEARING NANNOFOSSIL OOZE, firm; much more frequent ash(?) layers giving the sediment a bluish white (5B 9/1) color; abundant iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 73	2, 4
	D	M
Composition:		
Volcanic glass	–	C
Foraminifers	C	R
Calc. nannofossils	D	A

SITE 588 HOLE CORE 22 CORED INTERVAL 197.6–207.2 m



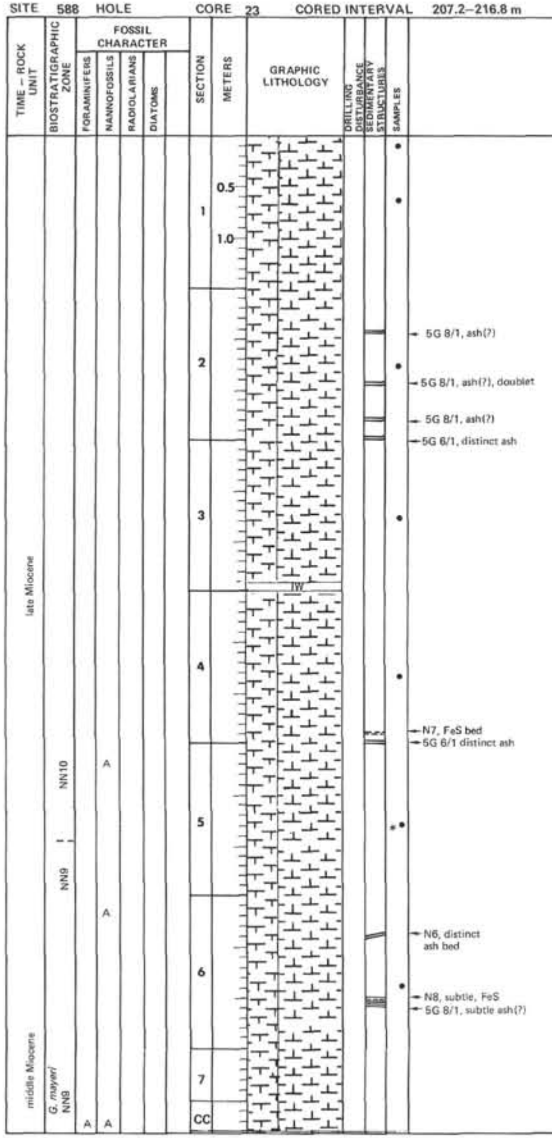
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, firm, very light greenish gray (5GY 8/1) becoming whiter (N9) and having less iron sulfide downcore.

SMEAR SLIDE SUMMARY:

	3, 81
	D
Composition:	
Quartz	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	A

SITE 588 HOLE CORE 23 CORED INTERVAL 207.2–216.8 m



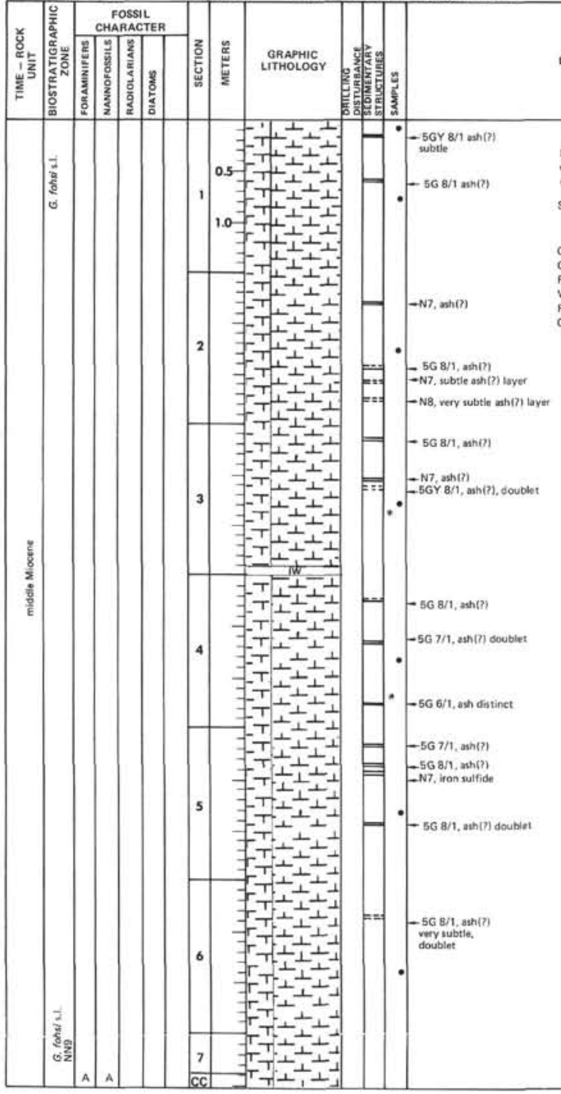
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, wite (N9), little iron sulfide, very homogeneous.

SMEAR SLIDE SUMMARY:

	5, 77
	D
Composition:	
Volcanic glass	R
Foraminifers	C
Calc. nannofossils	A

SITE 588 HOLE CORE 24 CORED INTERVAL 216.8–226.4 m



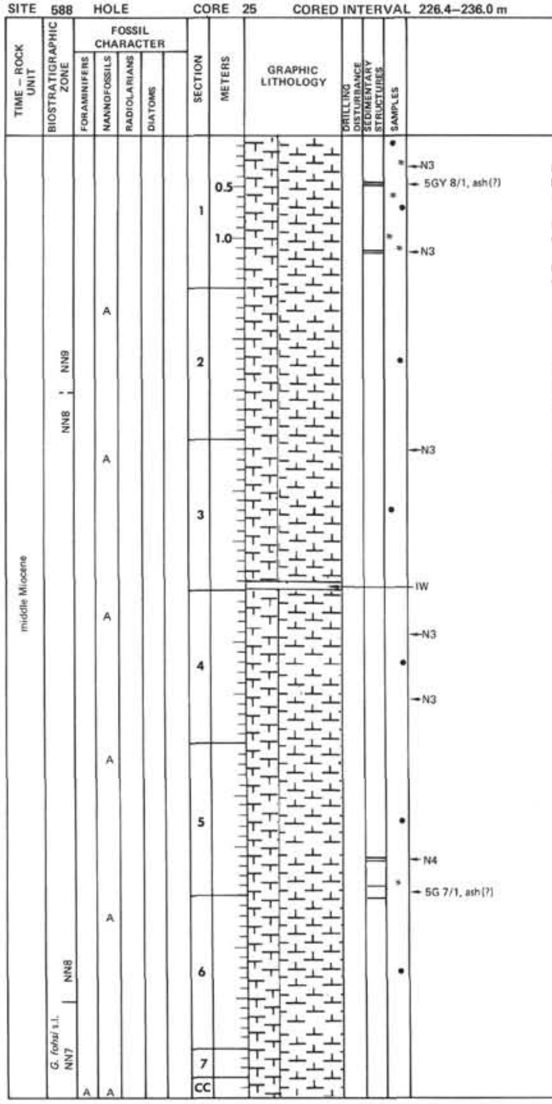
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, somewhat softer than overlying core, very light greenish gray (5GY 9/1).

SMEAR SLIDE SUMMARY:

	3, 82 D	4, 128 M
Composition:		
Quartz	T	T
Feldspar	–	T
Volcanic glass	T	R
Foraminifers	C	C
Calc. nannofossils	A	A

SITE 588 HOLE CORE 25 CORED INTERVAL 226.4–236.0 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous. Very light gray to very light greenish gray (N8 to 5GY 8/1).

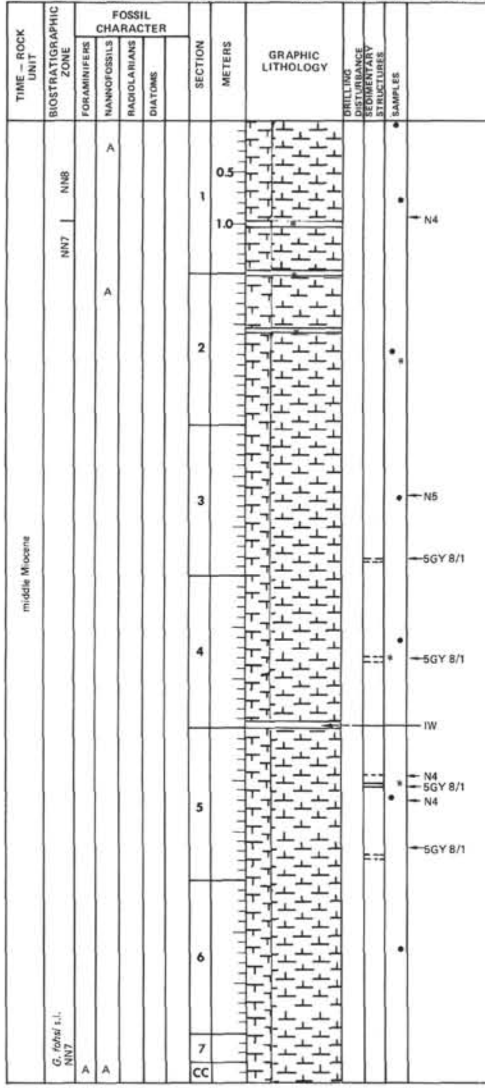
Light greenish gray (5GY 8/1) laminae containing rare or traces volcanic elements.

Dark gray (N3 to N4) laminae and nodules of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 32 M	1, 64 D	1, 107 –	1, 108 –	5, 148 –
Texture:					
Sand	–	C	C	R	–
Silt	C	A	A	C	–
Clay	D	D	A	D	–
Composition:					
Heavy minerals	–	–	–	–	T
Volcanic glass	–	–	–	–	T
Pyrite	A	–	T	–	T
Foraminifers	T	C	C	C	C
Calc. nannofossils	A	D	D	D	D

SITE 588 HOLE A CORE 1 CORED INTERVAL 236.0–245.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, firm, homogeneous.

Very, light gray to light greenish gray (N8 to 5GY 8/1).

Light greenish gray (5GY 8/1) laminae: rare volcanic elements.

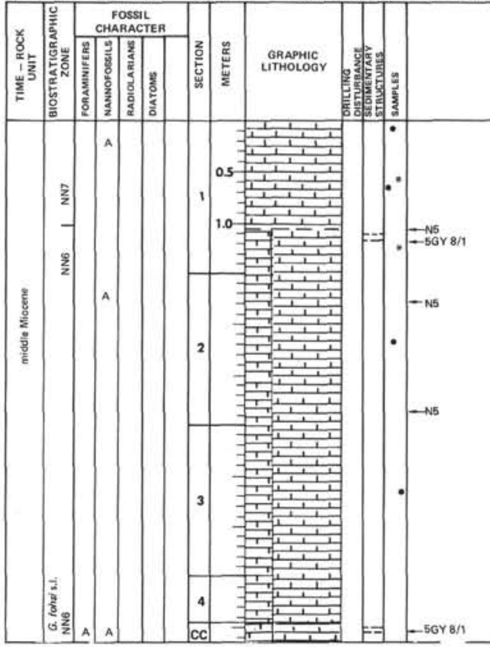
Dark gray (N3 to N4) laminae and nodules of iron sulfide.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 83 D	4, 81 M	5, 48 M
Texture:			
Silt	C	C	C
Clay	D	D	D
Composition:			
Heavy minerals	–	T	R
Pyrite	T	T	–
Foraminifers	C	C	R
Calc. nannofossils	D	D	D
Sponge spicules	T	–	–

SITE 588 HOLE A CORE 2 CORED INTERVAL 245.6–250.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

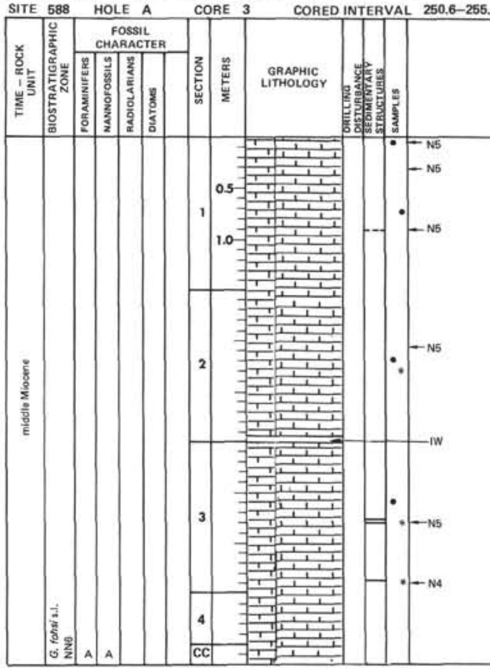
Light greenish gray laminae (5GY 8/1).

Gray laminae and nodules (N5) of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 60 D	1, 130 D	3, 80
Texture:			
Silt	–	C	C
Clay	–	D	D
Composition:			
Volcanic glass	–	T	–
Foraminifers	R	C	C
Calc. nannofossils	D	D	D

SITE 588 HOLE A CORE 3 CORED INTERVAL 250.6–255.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

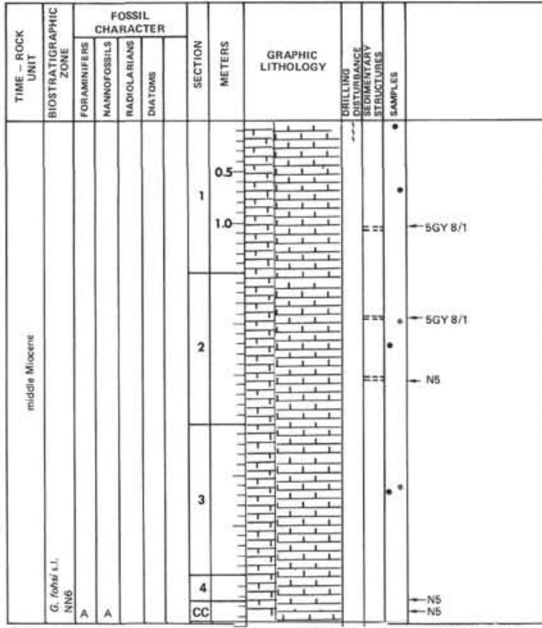
Very light gray (N8) to very light greenish gray (5GY 8/1).

Light gray (N7) to dark gray (N3) laminae and nodules of iron sulfide.

SMEAR SLIDE SUMMARY:

	2, 77 D	[1]3, 72 M	3, 139 D
Texture:			
Silt	C	C	C
Clay	D	D	D
Composition:			
Quartz	–	–	T
Heavy minerals	–	T	–
Pyrite	–	T	–
Foraminifers	C	C	C
Calc. nannofossils	D	D	D

SITE 588 HOLE A CORE 4 CORED INTERVAL 255.6–260.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

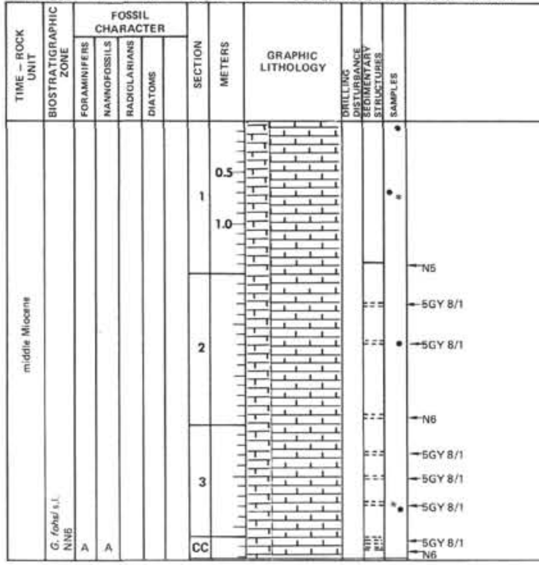
Light greenish gray (5GY 8/1) laminae

Medium gray (N5) laminae of iron sulfide.

SMEAR SLIDE SUMMARY:

	2, 44	3, 70
	M	D
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Heavy minerals	R	–
Volcanic glass	T	–
Pyrite	R	T
Foraminifers	C	C
Calc. nannofossils	D	D

SITE 588 HOLE A CORE 5 CORED INTERVAL 260.6–265.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

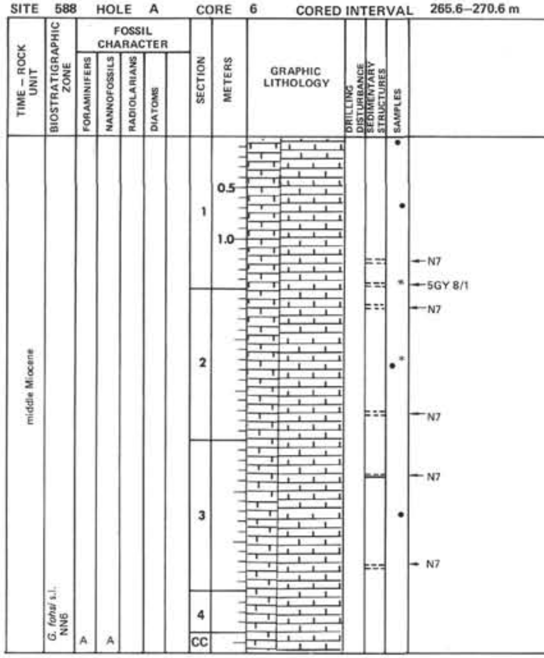
Light greenish gray (5GY 8/1) laminae.

Medium gray (N5–N6) laminae of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 80	3, 76
	D	M
Texture:		
Silt	–	C
Clay	–	D
Composition:		
Heavy minerals	–	R
Volcanic glass	T	T
Foraminifers	C	C
Calc. nannofossils	D	D

SITE 588 HOLE A CORE 6 CORED INTERVAL 265.6–270.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

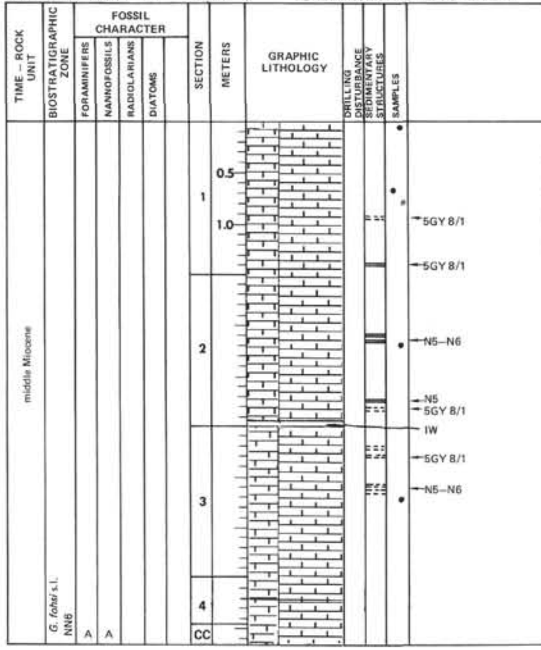
Light greenish gray (5GY 8/1) laminae.

Light gray (N7) laminae of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 148	2, 60
	M	D
Composition:		
Heavy minerals	T	T
Pyrite	T	T
Foraminifers	R	C
Calc. nannofossils	C	D

SITE 588 HOLE A CORE 7 CORED INTERVAL 270.6–275.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

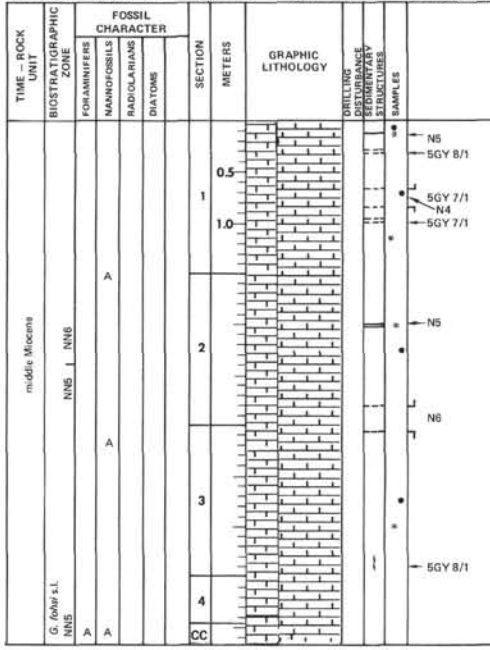
With light greenish gray (5GY 8/1) laminae.

Medium gray (N4–N6) laminae of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 80
	D
Texture:	
Silt	C
Clay	D
Composition:	
Heavy minerals	R
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 8 CORED INTERVAL 275.6–280.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

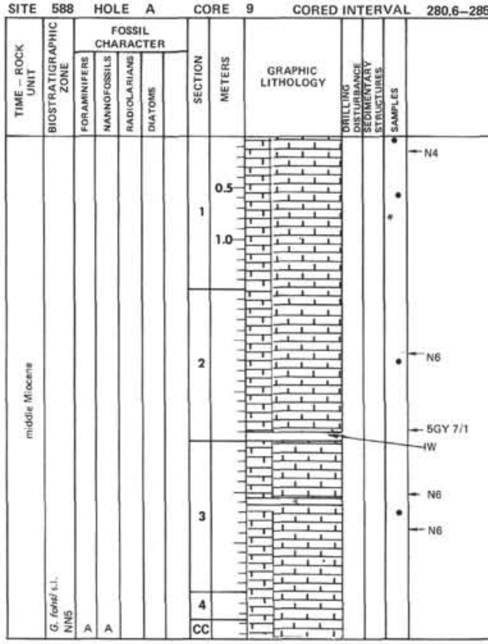
Light greenish gray (5GY 7/1) laminae.

Medium gray (N4–N6) laminae and nodules of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 17 D	2, 55 D	3, 98 D
Texture:			
Silt	C	C	C
Clay	D	D	D
Composition:			
Quartz	–	T	T
Heavy minerals	–	T	T
Foraminifers	C	C	R
Calc. nannofossils	D	D	D

SITE 588 HOLE A CORE 9 CORED INTERVAL 280.6–285.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

Light greenish gray (5GY 7/1) burrows.

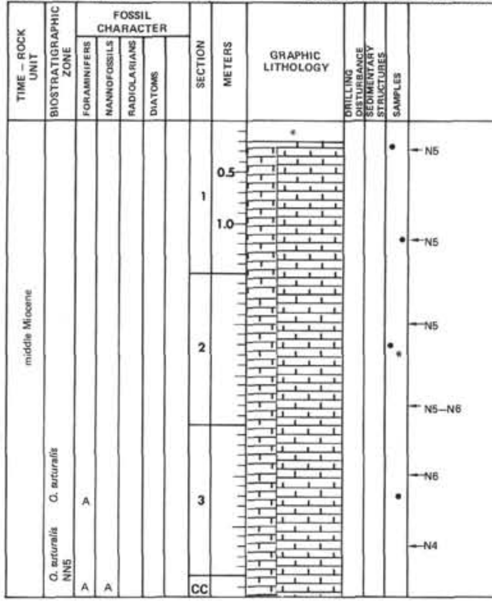
Medium gray (N4 to N6) laminae and nodules of iron sulfide.

* Artificial gap due to drilling.

SMEAR SLIDE SUMMARY:

	1, 80 D
Texture:	
Sand	R
Silt	C
Clay	D
Composition:	
Quartz	T
Heavy minerals	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 10 CORED INTERVAL 285.6–290.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

Very light gray (N8) to very light greenish gray (5GY 8/1).

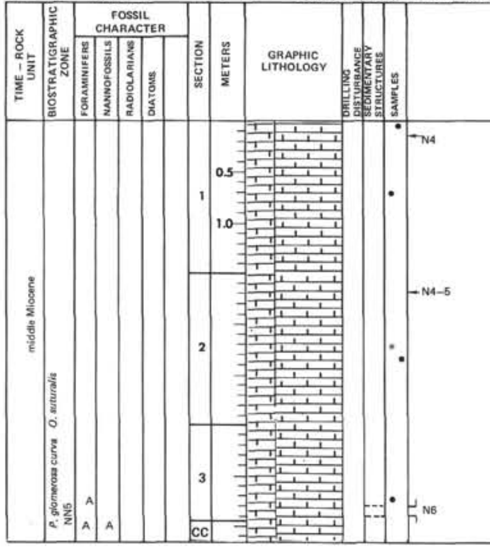
Medium gray (N4 to N6) laminae of iron sulfide.

*Artificial gap due to drilling.

SMEAR SLIDE SUMMARY:

	2, 80 D
Texture:	
Silt	C
Clay	D
Composition:	
Quartz	T
Heavy minerals	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 11 CORED INTERVAL 290.6–295.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous.

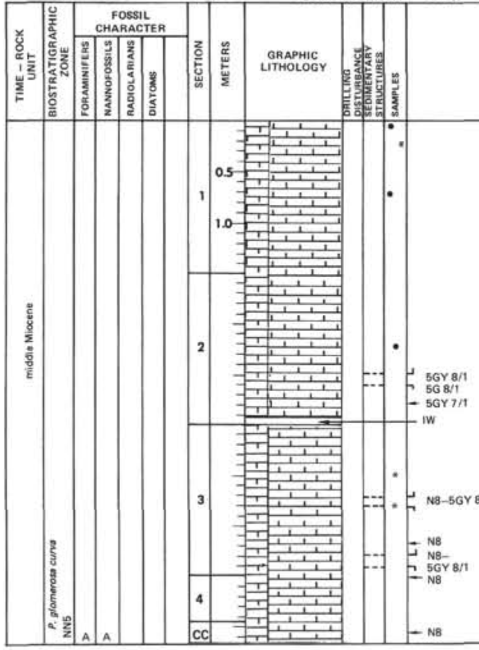
Very light gray (N8) to very light greenish gray (5GY 8/1).

Medium gray (N4 to N6) laminae and nodules of iron sulfide.

SMEAR SLIDE SUMMARY:

	2, 63 D
Texture:	
Silt	C
Clay	D
Composition:	
Quartz	T
Heavy minerals	R
Volcanic glass	T
Foraminifers	C
Calc. nannoosssils	D

SITE 588 HOLE A CORE 12 CORED INTERVAL 295.6–300.6 m



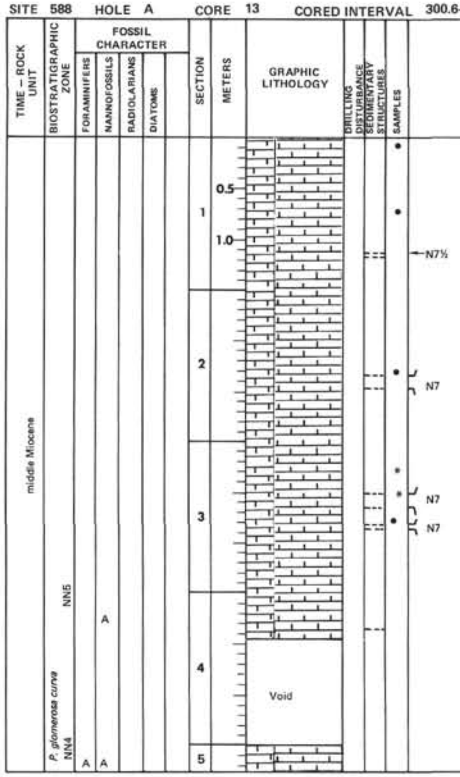
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, homogeneous. Very light gray (N8) to very light greenish gray (5GY 8/1), with light greenish gray (5GY 7/1) mottles and very light gray (N8) mottles.

SMEAR SLIDE SUMMARY:

	1, 31 D	3, 52 M	3, 84 D
Texture:			
Silt	C	–	–
Clay	D	–	–
Composition:			
Quartz	–	T	T
Heavy minerals	T	T	–
Pyrite	–	T	–
Foraminifers	C	R	C
Calc. nannofossils	D	D	D

SITE 588 HOLE A CORE 13 CORED INTERVAL 300.6–305.6 m



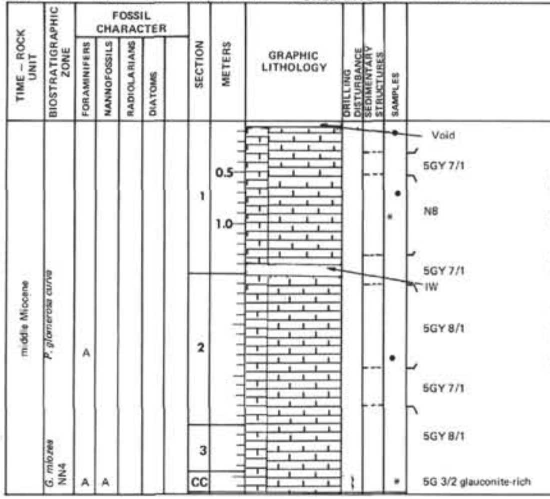
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, very light gray (N8) with a few, very subtle, darker bands; burrowing is moderate; overall very homogeneous.

SMEAR SLIDE SUMMARY:

	3, 56 M	3, 41 D
Composition:		
Quartz	T	T
Heavy minerals	T	–
Volcanic glass	T	–
Foraminifers	C	R
Calc. nannofossils	A	D

SITE 588 HOLE A CORE 14 CORED INTERVAL 305.6–310.6 m



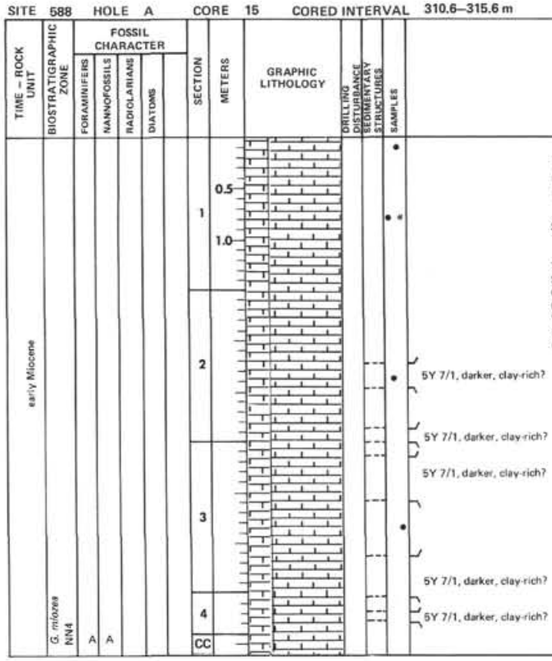
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, very light gray (N8), abundant burrows and iron sulfide, core becomes greener with increasing depth.

SMEAR SLIDE SUMMARY:

	1, 96 D	CC M
Composition:		
Quartz	T	T
Feldspar	–	T
Heavy minerals	T	–
Volcanic glass	–	T
Glauconite	–	A
Pyrite	T	–
Foraminifers	C	R
Calc. nannofossils	A	C

SITE 588 HOLE A CORE 15 CORED INTERVAL 310.6–315.6 m



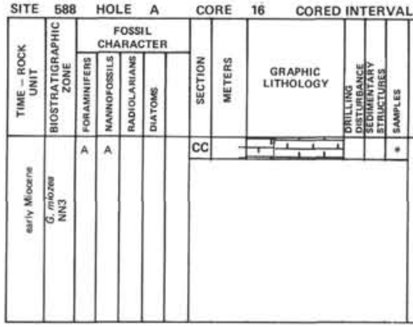
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, very light greenish gray (5GY 7/1), abundant burrowing activitiy, otherwise almost homogeneous.

SMEAR SLIDE SUMMARY:

	1, 74 D
Texture:	
Silt	C
Clay	D
Composition:	
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 16 CORED INTERVAL 315.6–325.2 m



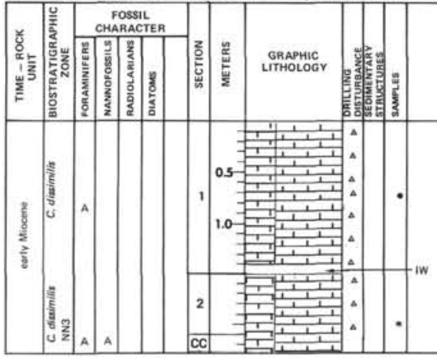
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, greenish gray (5GY 6/1), homogeneous.

SMEAR SLIDE SUMMARY:

	CC, 8 D
Composition:	
Quartz	T
Feldspar	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 17 CORED INTERVAL 325.2–334.8 m



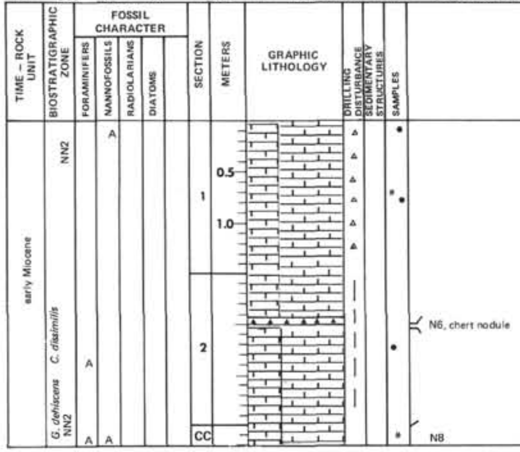
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, greenish gray (5GY 6/1), homogeneous, drilling disturbance has reduced interval to rubble.

SMEAR SLIDE SUMMARY:

	2, 45 D
Composition:	
Heavy minerals	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE A CORE 18 CORED INTERVAL 334.8–344.4 m



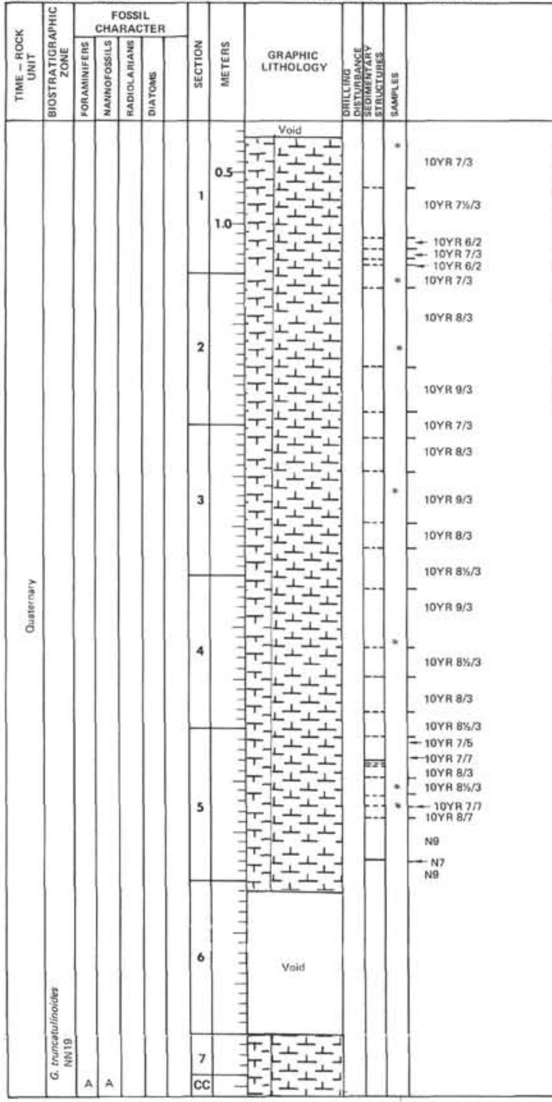
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, light greenish gray (5GY 7/1) to greenish gray (5GY 6/1); homogeneous throughout: moderately deformed.

SMEAR SLIDE SUMMARY:

	1, 70 D	CC D
Composition:		
Quartz	T	–
Heavy minerals	T	–
Glauconite	T	–
Foraminifers	C	C
Calc. nannofossils	A	D

SITE 588 HOLE B CORE 1 CORED INTERVAL 0.0–7.8 m



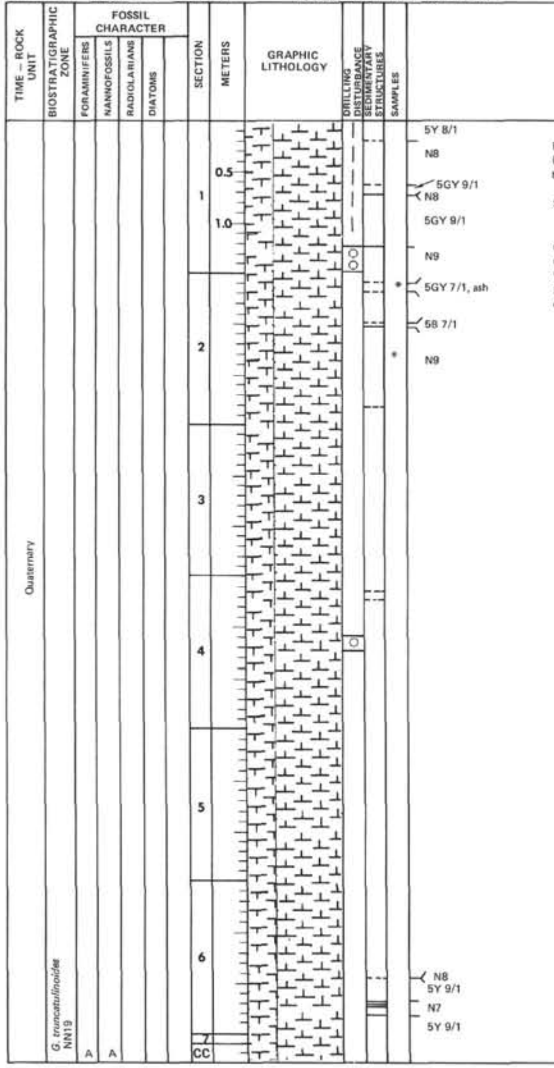
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING TO FORAMINIFER NANNOFOSSIL OOZE, very pale brown (10YR 7/3) and subtle variations of color gradations. Soft, with few bioturbation structures apparent. Core appears coarser in Section 1 than in Section 2. Zones of coarser material in Section 4, 115 to 150. Sharp color (redox) boundary at Section 5, 88 cm to a FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9) soft, with iron sulfide bands (< 2 mm thick), soft, homogeneous.

SMEAR SLIDE SUMMARY:

	1, 28	2, 10	2, 68	3, 68	4, 67
	D	D	D	D	
Composition:					
Quartz	–	T	T	T	T
Feldspar	–	–	T	–	–
Foraminifers	A	C	C	C	A
Calc. nannofossils	A	A	A	A	C
Sponge spicules	T	–	T	–	–

SITE 588 HOLE B CORE 2 CORED INTERVAL 7.8–17.4 m



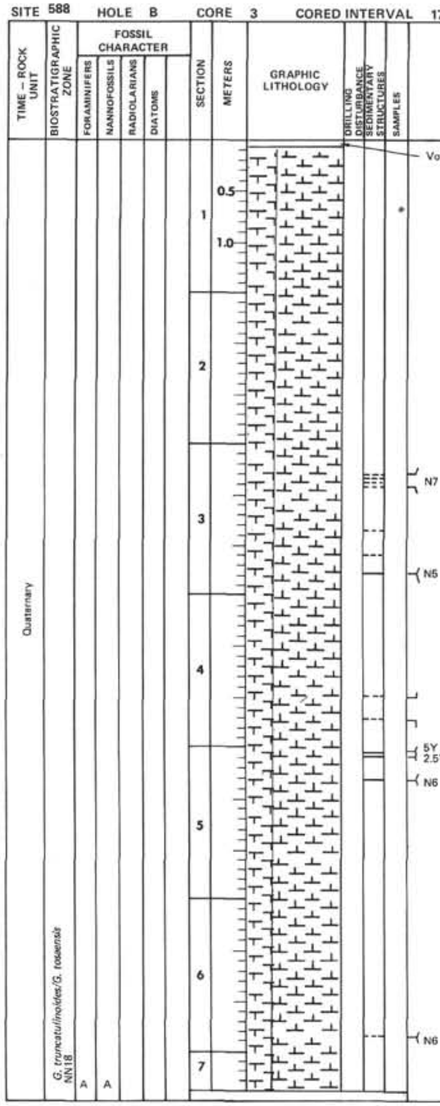
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), soft, homogeneous, traces of iron sulfide streaks, becoming abundant in Section 6.

SMEAR SLIDE SUMMARY:

	2, 15	2, 86
	M	D
Composition:		
Quartz	T	T
Volcanic glass	T	–
Foraminifers	C	R
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 3 CORED INTERVAL 17.4–27.0 m



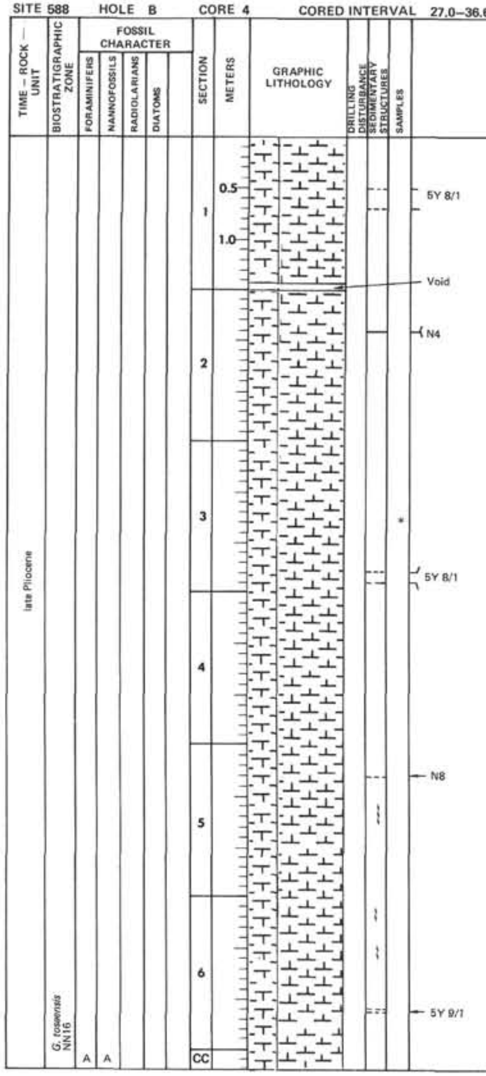
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), soft, with streaks and burrow molds of iron sulfide, homogeneous. Top of Section 5 has two faint oxidized iron bands, very pale yellow (2.5Y 9/4). Pockets of volcanic ash at Section 5, 75 cm and Section 6, 54 cm.

SMEAR SLIDE SUMMARY:

	1, 70
	D
Composition:	
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	A
Sponge spicules	T

SITE 588 HOLE B CORE 4 CORED INTERVAL 27.0–36.6 m



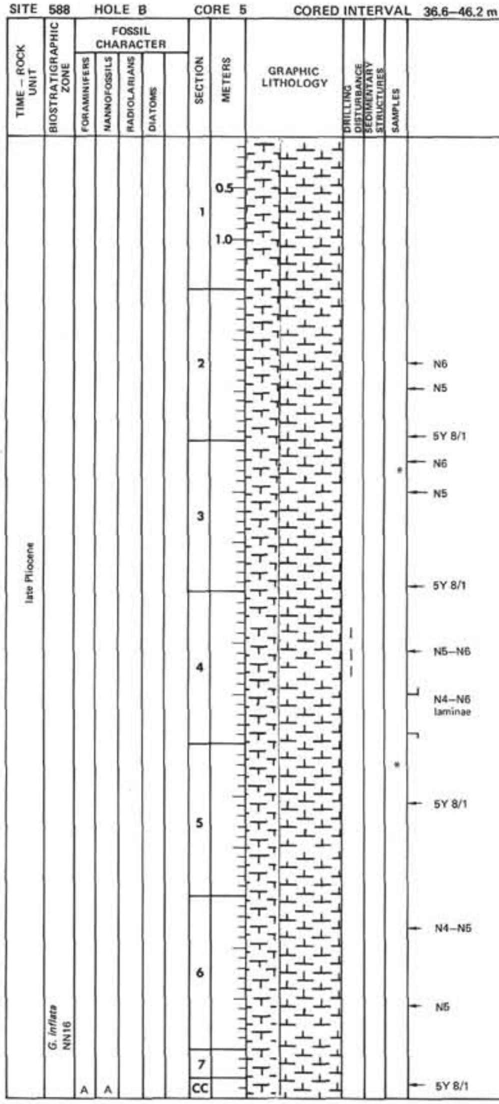
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), soft, iron sulfide laminae and burrow molds scattered throughout.

SMEAR SLIDE SUMMARY:

	3, 78
	D
Composition:	
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 5 CORED INTERVAL 36.6–46.2 m



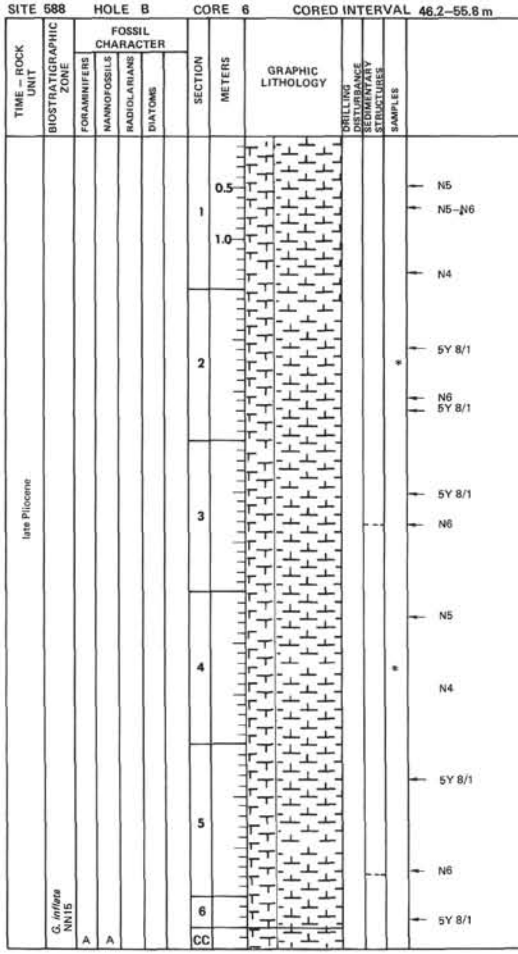
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	3, 20	5, 20
	D	D
Texture:		
Silt	C	–
Clay	D	–
Composition:		
Heavy minerals	–	T
Foraminifers	C	C
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 6 CORED INTERVAL 46.2–55.8 m



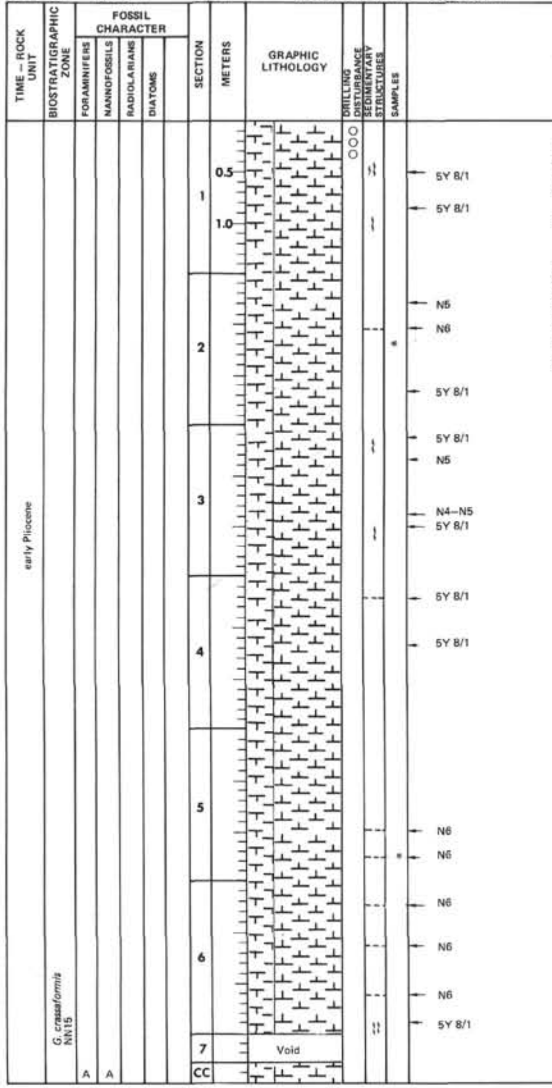
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	2, 63	4, 70
	D	D
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Heavy minerals	T	–
Foraminifers	C	C
Calc. nannofossils	D	D
Sponge spicules	–	T

SITE 588 HOLE B CORE 7 CORED INTERVAL 55.8–65.4 m



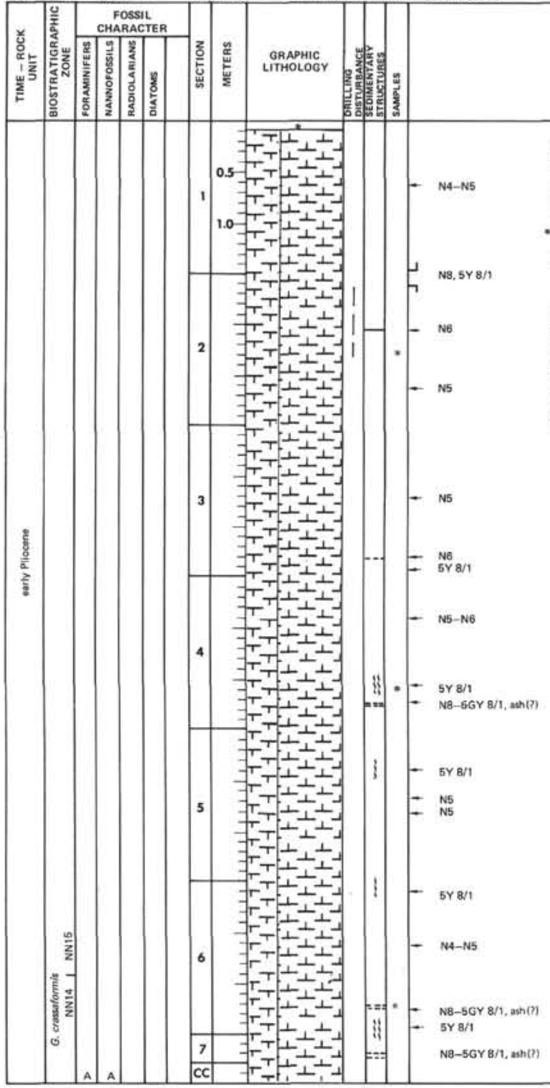
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core.

SMEAR SLIDE SUMMARY:

	2, 58	5, 125
	D	M
Texture:		
Sand	T	–
Silt	–	C
Clay	–	D
Composition:		
Heavy minerals	T	–
Foraminifers	C	R
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 8 CORED INTERVAL 65.4–76.0 m



LITHOLOGIC DESCRIPTION

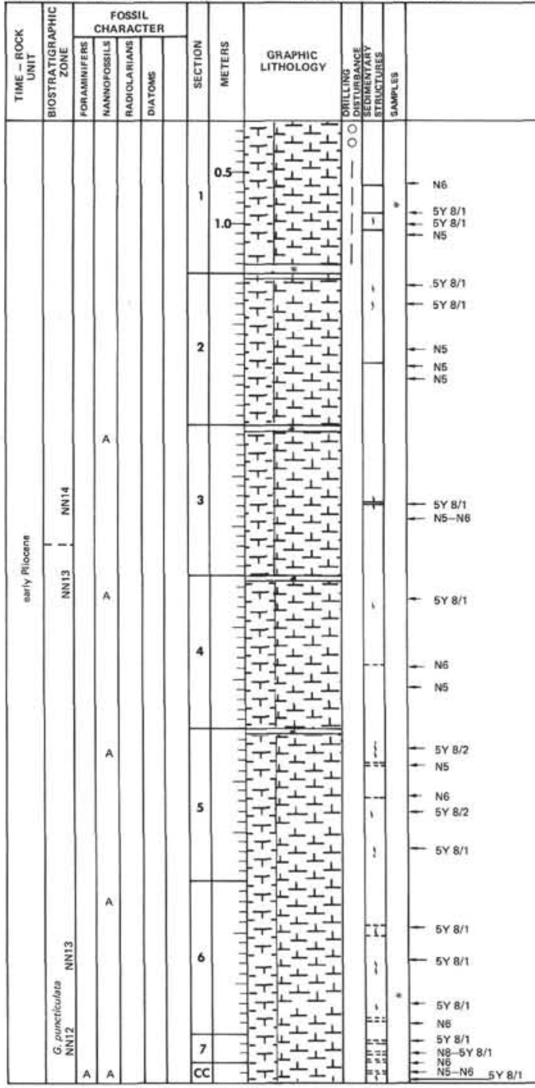
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Very light gray to very light greenish gray (N8 to 5GY 8/1) laminae.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 80	4, 108	6, 122
	D	M	M
Texture:			
Silt	C	C	C
Clay	D	D	D
Composition:			
Heavy minerals	T	T	T
Pyrite	–	–	T
Foraminifers	C	C	R
Calc. nannofossils	D	D	D
Sponge spicules	T	T	–

SITE 588 HOLE B CORE 9 CORED INTERVAL 76.0–85.6 m



LITHOLOGIC DESCRIPTION

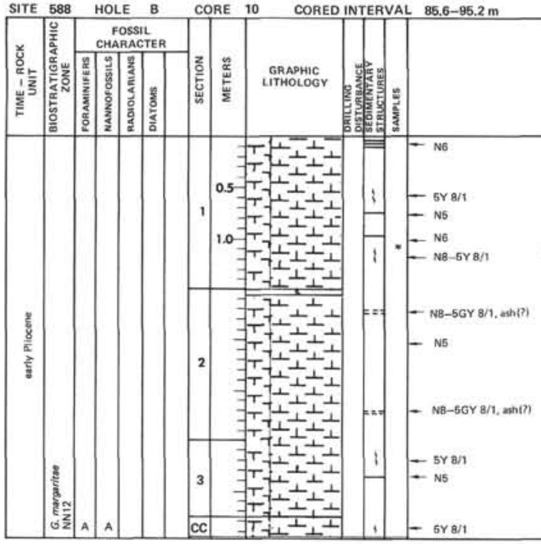
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	1, 80	6, 103
	D	M
Texture:		
Sand	–	T
Silt	C	C
Clay	D	D
Composition:		
Quartz	–	T
Heavy minerals	–	T
Pyrite	T	–
Foraminifers	C	C
Calc. nannofossils	D	D
Sponge spicules	T	–

SITE 588 HOLE B CORE 10 CORED INTERVAL 85.6–95.2 m



LITHOLOGIC DESCRIPTION

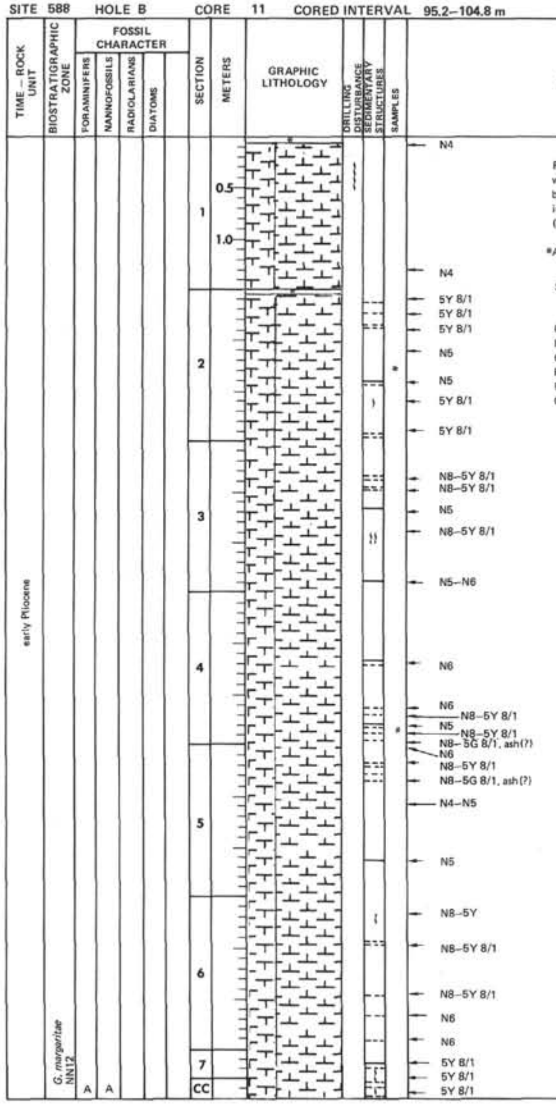
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Very light greenish gray (N8–5GY 8/1) laminae in Section 2.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	1, 116
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D
Sponge spicules	T

SITE 588 HOLE B CORE 11 CORED INTERVAL 95.2–104.8 m



LITHOLOGIC DESCRIPTION

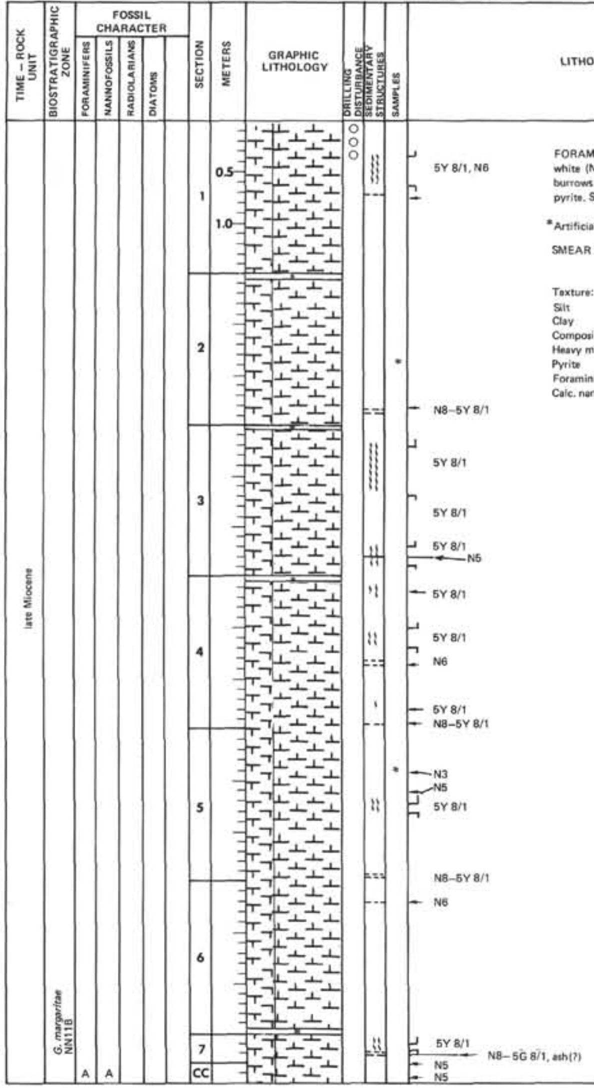
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Subtle very light greenish gray (N8–5GY 8/1) laminae.

*Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 79 D	4, 133 M
Composition:		
Heavy minerals	–	T
Glauconite	T	T
Pyrite	T	–
Foraminifers	R	C
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 12 CORED INTERVAL 104.8–114.4 m



LITHOLOGIC DESCRIPTION

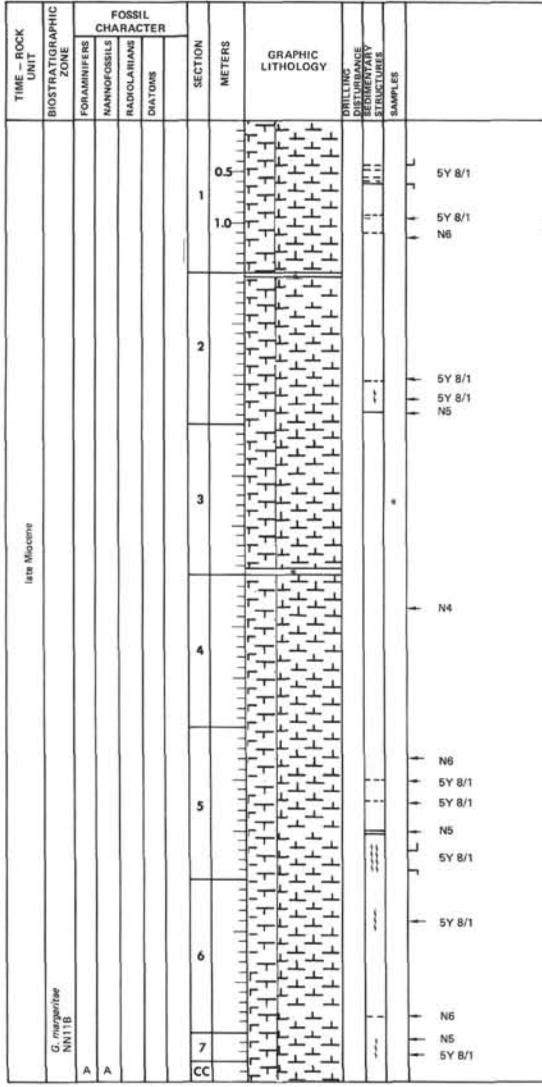
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of pyrite. Subtle very light greenish gray (N8–5GY 8/1) levels.

*Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 85 D	5, 35 M
Texture:		
Silt	C	R
Clay	D	D
Composition:		
Heavy minerals	–	T
Pyrite	–	A
Foraminifers	C	–
Calc. nannofossils	D	C

SITE 588 HOLE B CORE 13 CORED INTERVAL 114.4–124.0 m



LITHOLOGIC DESCRIPTION

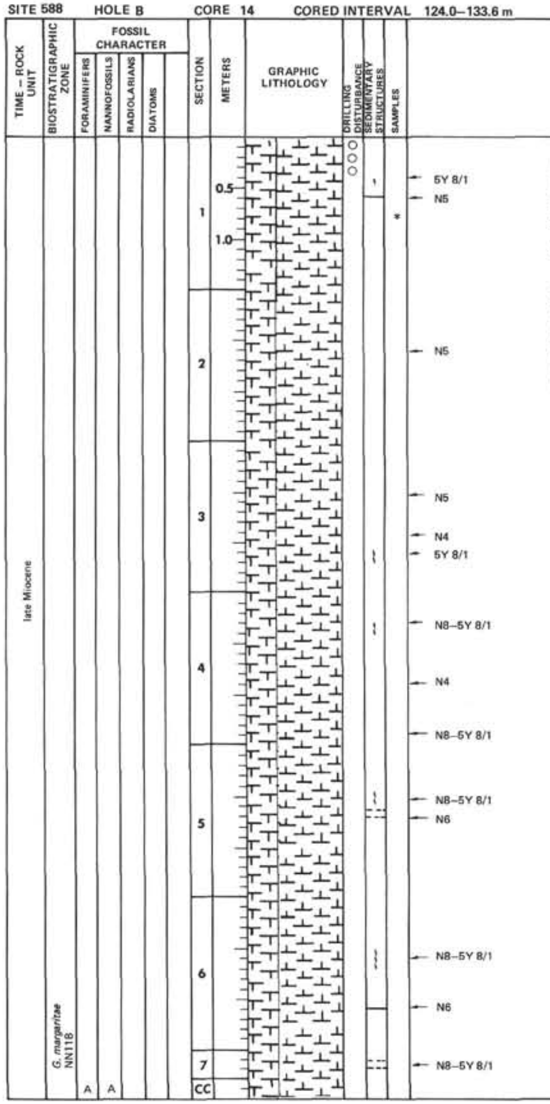
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	3, 84
	D
Texture:	
Silt	C
Clay	D
Composition:	
Heavy minerals	T
Foraminifers	R
Calc. nannofossils	D
Sponge spicules	T

SITE 588 HOLE B CORE 14 CORED INTERVAL 124.0–133.6 m



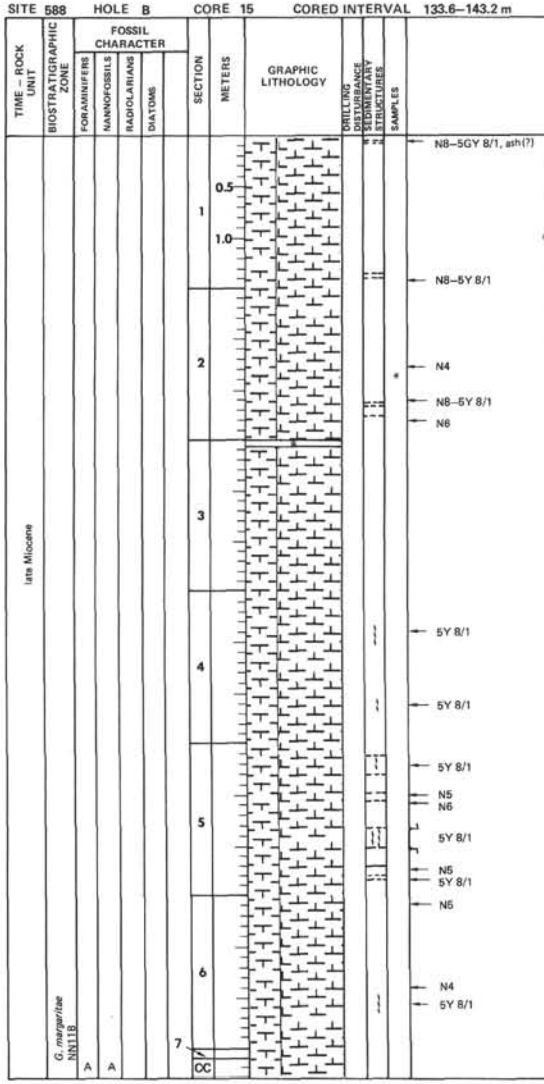
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Nodule of pyrite at 125 cm in Section 6.

SMEAR SLIDE SUMMARY:

	1, 80
	D
Texture:	
Silt	C
Clay	D
Composition:	
Heavy minerals	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 15 CORED INTERVAL 133.6–143.2 m



LITHOLOGIC DESCRIPTION

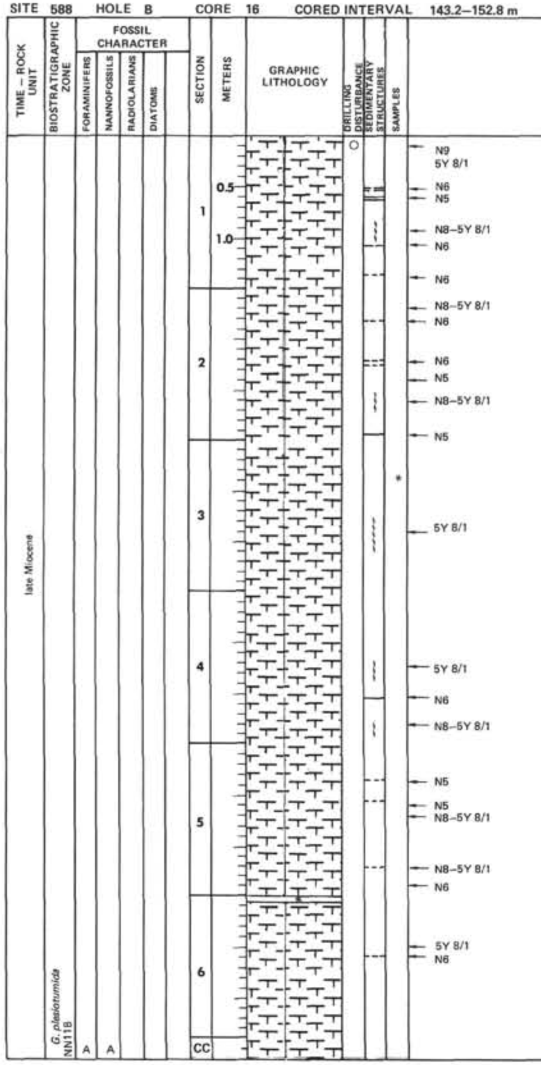
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray burrows and laminae (5Y 8/1). Medium gray (N4 to N6) laminae of iron sulfide along the core.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	2, 90
Texture:	
Silt	C
Clay	D
Composition:	
Heavy minerals	T
Foraminifers	C
Calc. nannofossils	D
Sponge spicules	T

SITE 588 HOLE B CORE 16 CORED INTERVAL 143.2–152.8 m



LITHOLOGIC DESCRIPTION

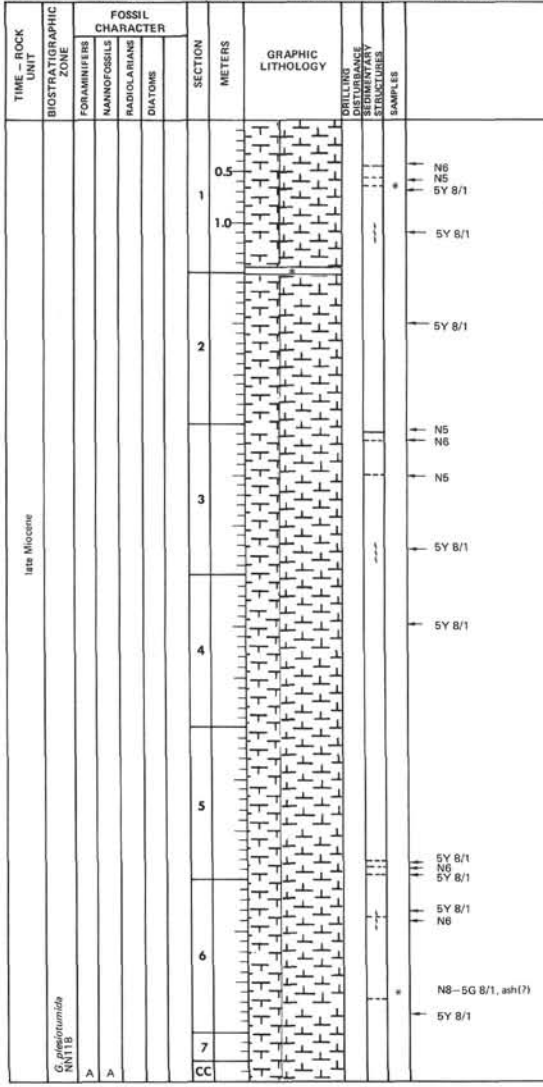
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8), with yellowish gray burrows and laminae (5Y 8/1). Medium gray (N4 to N6) laminae of iron sulfide along the core. Ring burrow at 130 cm in Section 5.

* Artificial gap: compaction.

SMEAR SLIDE SUMMARY:

	3, 40
	D
Texture:	
Silt	C
Clay	D
Composition:	
Heavy minerals	T
Pyrite	T
Foraminifers	C
Calc. nannofossils	D
Sponge spicules	T

SITE 588 HOLE B CORE 17 CORED INTERVAL 152.8–162.4 m



LITHOLOGIC DESCRIPTION

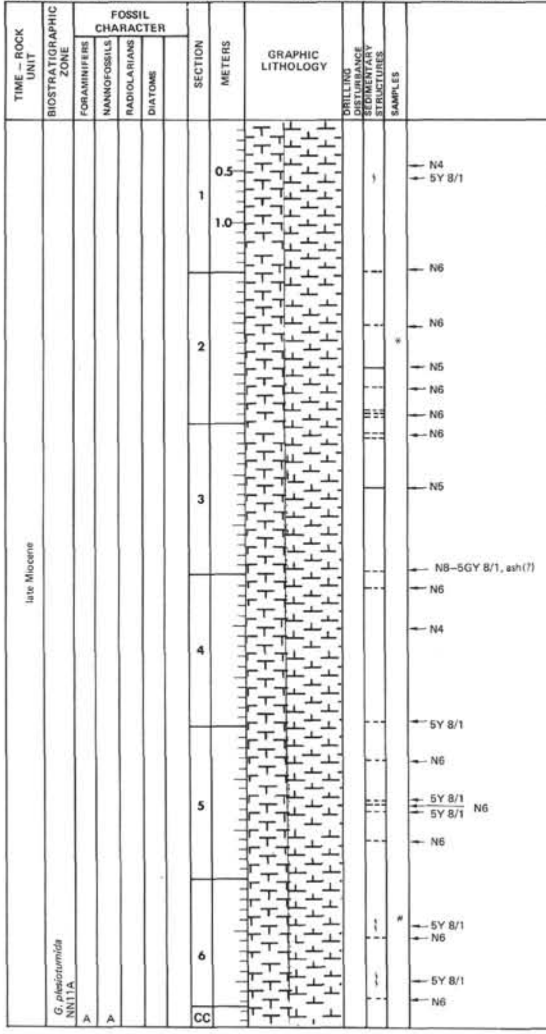
FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core.

* Artifical gap: compaction.

SMEAR SLIDE SUMMARY:

	1, 70 D	6, 118
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Heavy minerals	T	T
Volcanic glass	–	T
Pyrite	T	T
Foraminifers	C	C
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 18 CORED INTERVAL 162.4–172.0 m



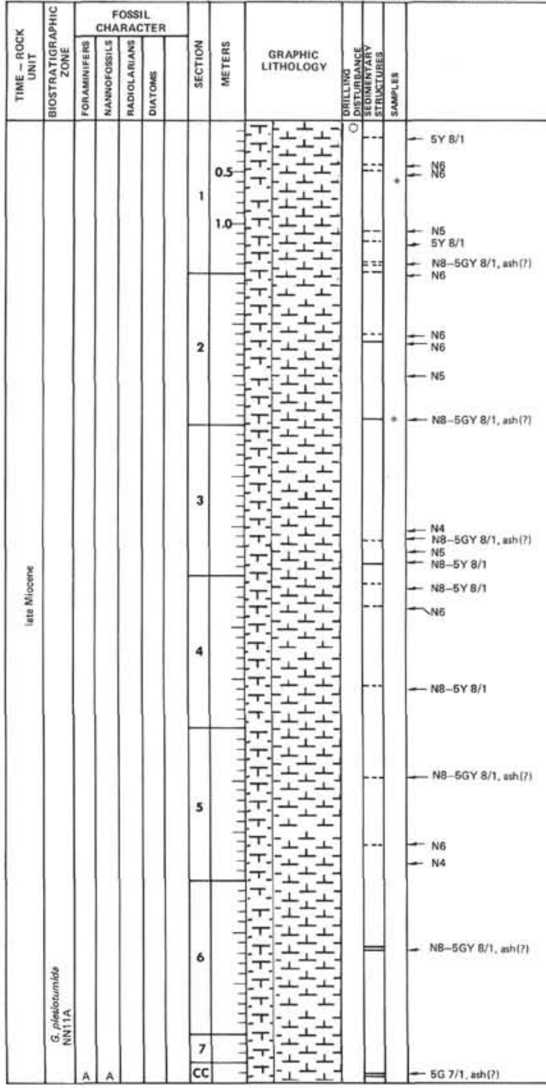
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Yellowish gray (5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Pyrite nodule at 55 cm in Section 4.

SMEAR SLIDE SUMMARY:

	2, 58 D	6, 50 M
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Heavy minerals	–	T
Volcanic glass	T	–
Pyrite	–	T
Foraminifers	C	C
Calc. nannofossils	D	D
Sponge spicules	–	T

SITE 588 HOLE B CORE 19 CORED INTERVAL 172.0–180.6 m



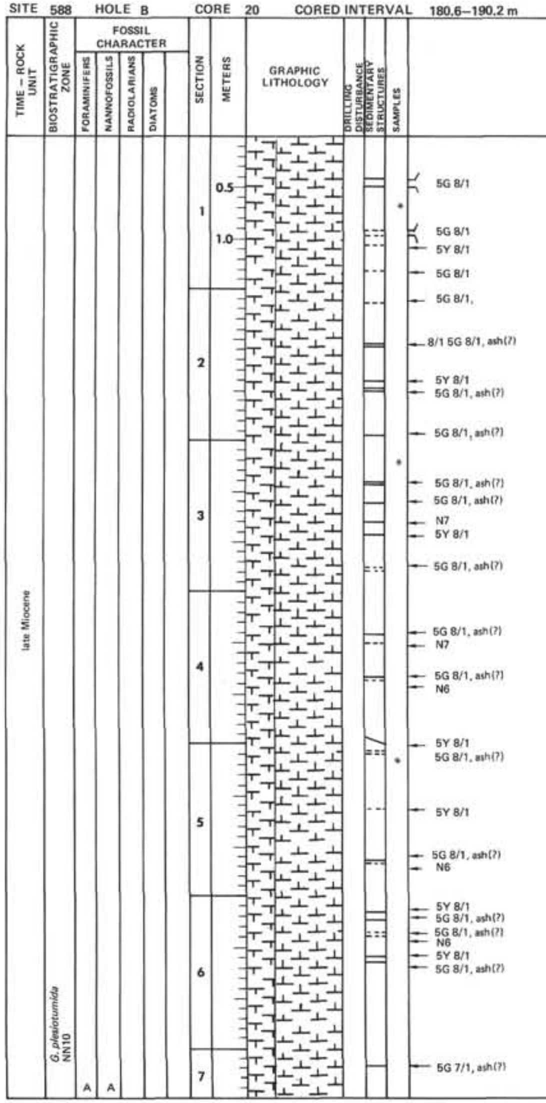
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft, white (N9) to very light gray (N8). Light yellowish gray (N8–5Y 8/1) burrows and laminae. Medium gray (N4 to N6) laminae of iron sulfide along the core. Light greenish gray (N8–5GY 8/1) laminae.

SMEAR SLIDE SUMMARY:

	1, 65	2, 140
	D	M
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Quartz	T	–
Heavy minerals	T	T
Pyrite	T	T
Foraminifers	R	C
Calc. nannofossils	D	D

SITE 588 HOLE B CORE 20 CORED INTERVAL 180.6–190.2 m



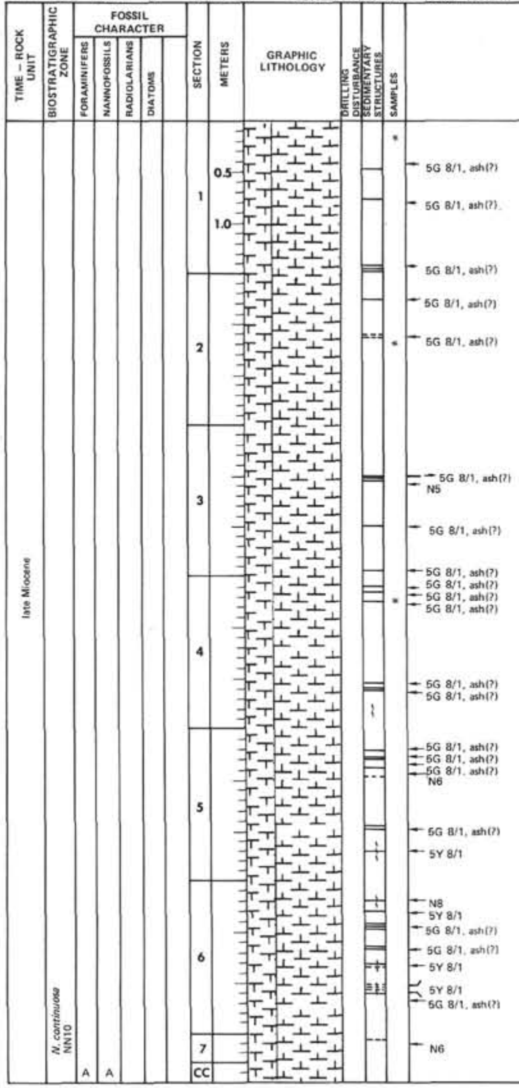
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8), firm, abundant burrows throughout, a series of green (5G 8/1) ash(?) laminae, occur, iron sulfide occurs as pockets, blebs, and as burrow linings.

SMEAR SLIDE SUMMARY:

	1, 71	3, 20	5, 20
	D	D	D
Composition:			
Heavy minerals	–	–	T
Foraminifers	C	C	C
Calc. nannofossils	A	D	D

SITE 588 HOLE B CORE 21 CORED INTERVAL 190.2–199.8 m



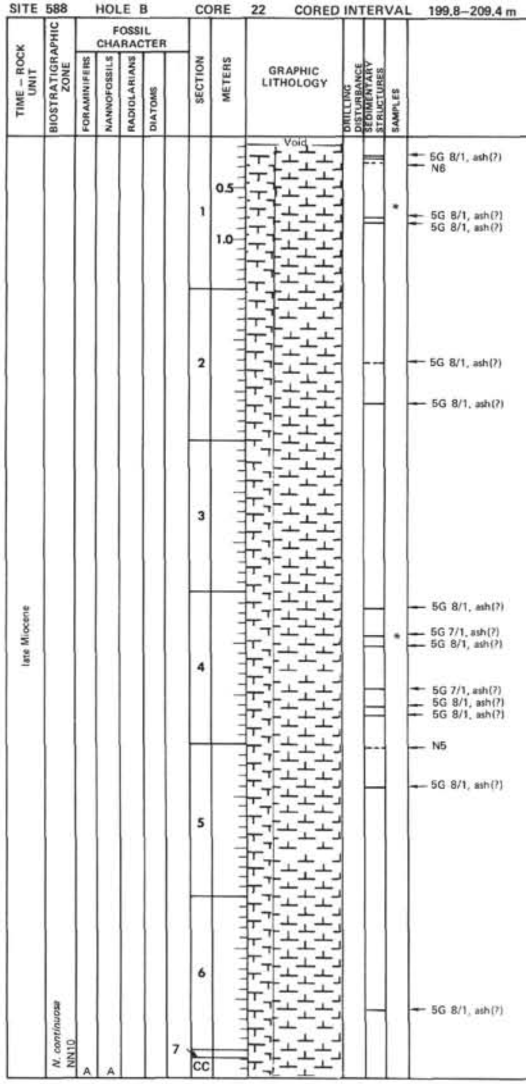
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8), firm, abundant pyrite and ash(?) laminations. Pyrite also occurs in streaks, blebs, and in burrows.

SMEAR SLIDE SUMMARY:

	1, 18 M	2, 64 D	4, 23 M
Composition:			
Quartz	–	–	T
Feldspar	–	–	T
Volcanic glass	–	–	R
Pyrite	A	–	–
Foraminifers	C	C	C
Calc. nannofossils	A	A	A

SITE 588 HOLE B CORE 22 CORED INTERVAL 199.8–209.4 m



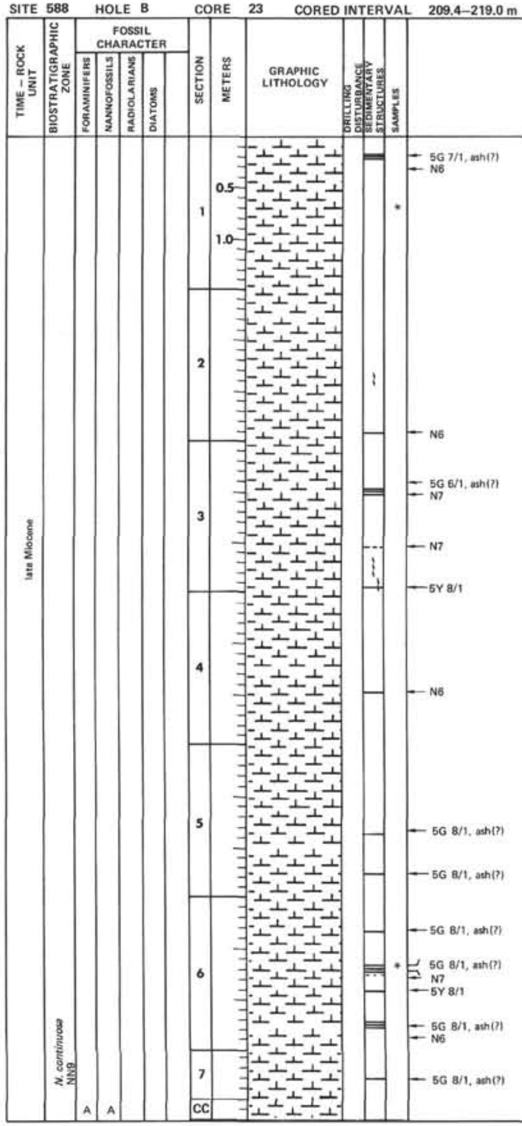
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8), firm, rare streaks, blebs, and burrow fillings of pyrite, common green (5G 8/1) ash(?) layers.

SMEAR SLIDE SUMMARY:

	1, 70 D	4, 47 M
Composition:		
Quartz	T	–
Feldspar	T	–
Volcanic glass	T	T
Pyrite	–	R
Foraminifers	C	C
Calc. nannofossils	A	A

SITE 588 HOLE B CORE 23 CORED INTERVAL 209.4–219.0 m



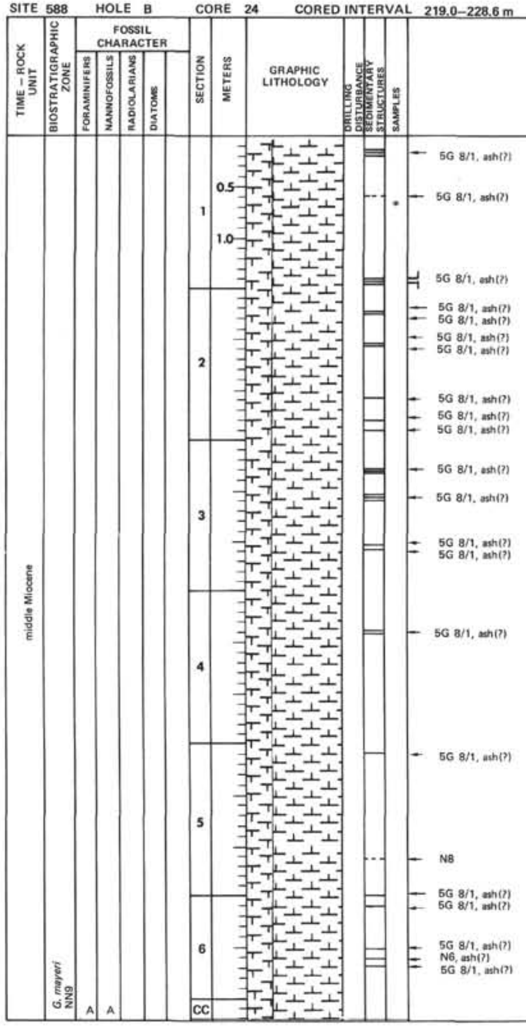
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light gray (N8), relatively soft, homogeneous, rare iron sulfide streaks, blebs, and laminae. Green (5G 7/1) volcanic ash(?) layers scattered throughout.

SMEAR SLIDE SUMMARY:

	1, 70	6, 70
	D	M
Composition:		
Feldspar	T	T
Volcanic glass	T	–
Pyrite	–	C
Foraminifers	R	C
Calc. nannofossils	D	A

SITE 588 HOLE B CORE 24 CORED INTERVAL 219.0–228.6 m



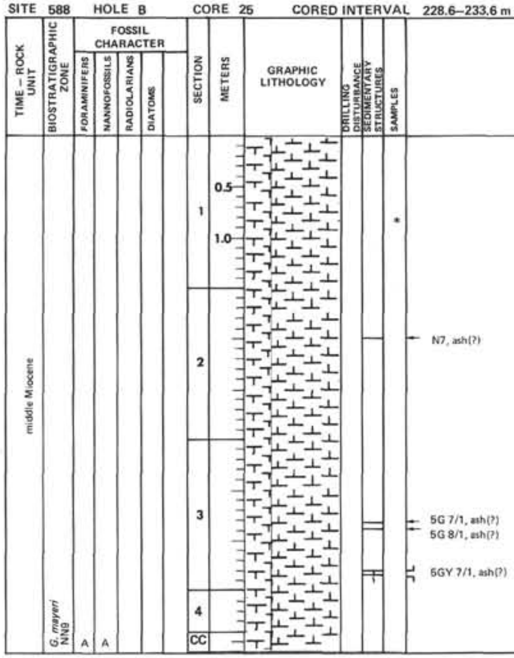
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, white (N9), firm, numerous interbedded ash(?) layers, some blebs and streaks of iron sulfide.

SMEAR SLIDE SUMMARY:

	1, 70
	D
Composition:	
Quartz	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 25 CORED INTERVAL 228.6–233.6 m



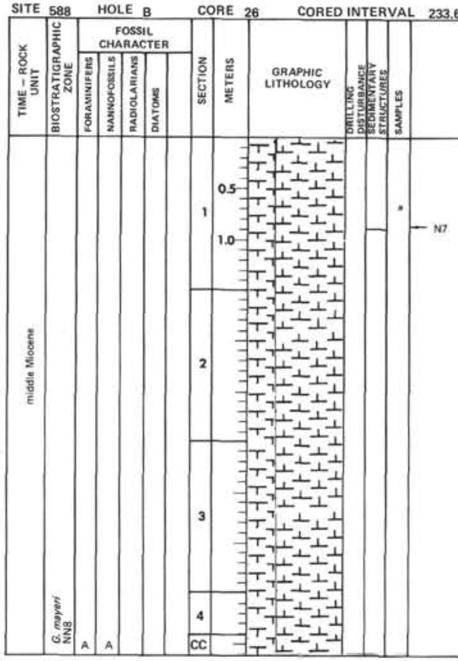
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8), very firm, homogeneous with rare green (5G 7/1) ash(?) laminae.

SMEAR SLIDE SUMMARY:

	1, 90
	D
Composition:	
Volcanic glass	T
Pyrite	T
Foraminifers	C
Calc. nannofossils	A

SITE 588 HOLE B CORE 26 CORED INTERVAL 233.6–238.6 m



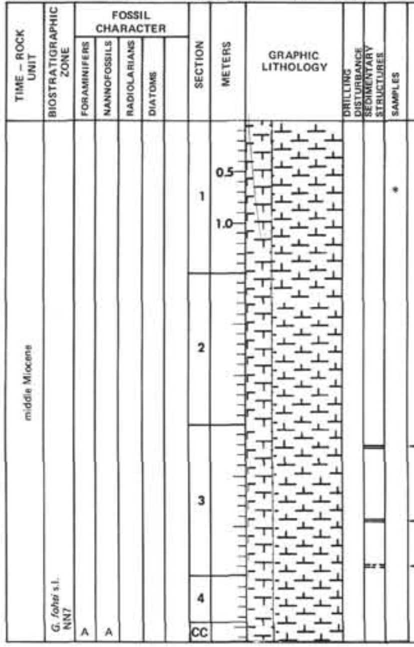
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8), very firm, extremely homogeneous.

SMEAR SLIDE SUMMARY:

	1, 70
	D
Composition:	
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D
Sponge spicules	T

SITE 588 HOLE B CORE 27 CORED INTERVAL 238.6–243.6 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very firm ooze, very light gray (N8), homogeneous throughout, a few iron sulfide blebs.

SMEAR SLIDE SUMMARY:

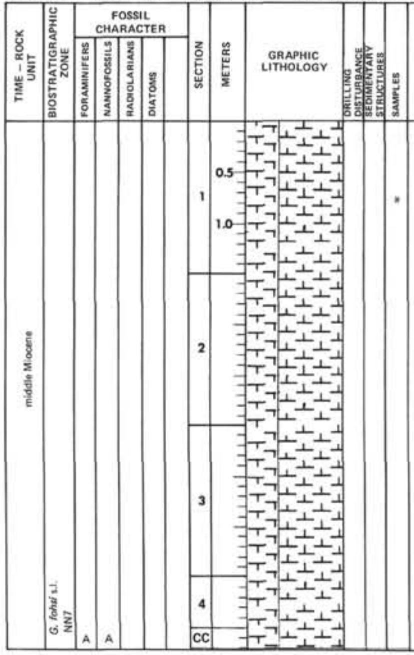
	1, 70
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

← 5G 7/1, ash(?)

← N6, ash(?) with iron sulfide

← N7, subtle

SITE 588 HOLE B CORE 28 CORED INTERVAL 243.6–248.6 m



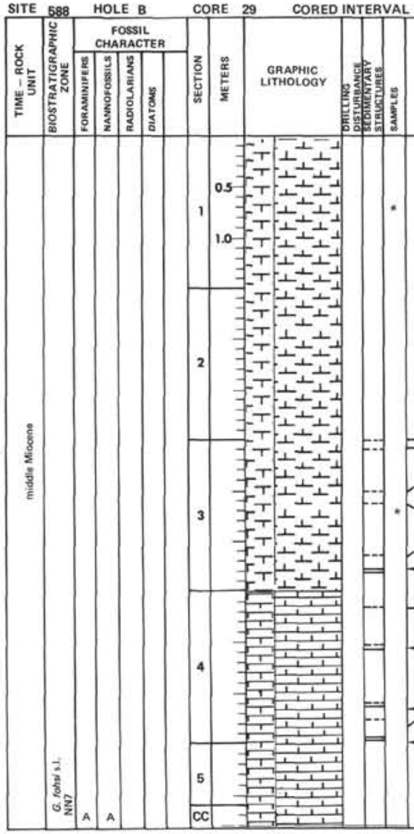
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, very light gray (N8); softer than overlying three or four cores; very homogeneous; minor pyrite.

SMEAR SLIDE SUMMARY:

	1, 80
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 29 CORED INTERVAL 248.6–258.2 m



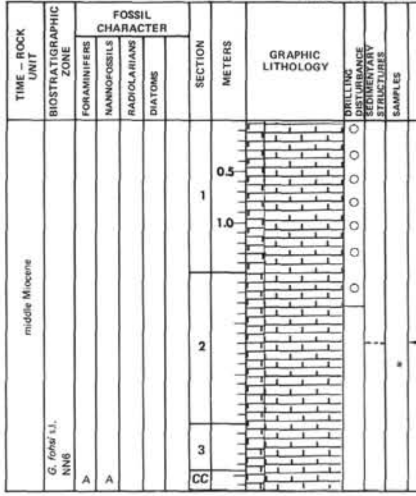
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL OOZE, soft ooze; very light gray (N8) becoming less pure carbonate and grayer color downhole; becoming much firmer in Section 3 and lower. FORAMINIFER-BEARING NANNOFOSSIL CHALK in Section 4 and lower.

SMEAR SLIDE SUMMARY:

	1, 71
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 30 CORED INTERVAL 258.2–267.8 m



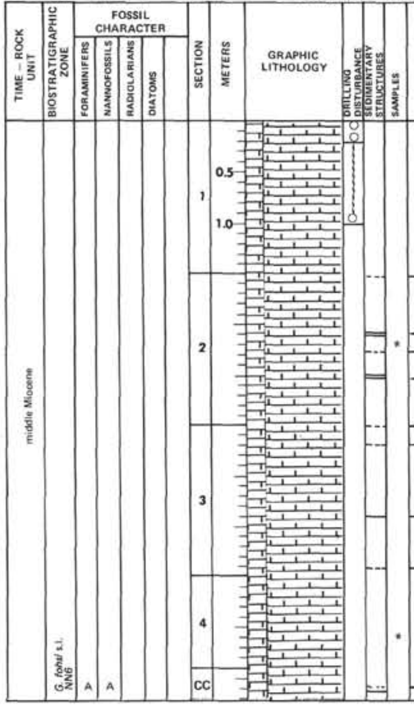
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, soft to very firm, very light gray (N8), homogeneous.

SMEAR SLIDE SUMMARY:

	2, 90
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE B CORE 31 CORED INTERVAL 267.8–277.4m



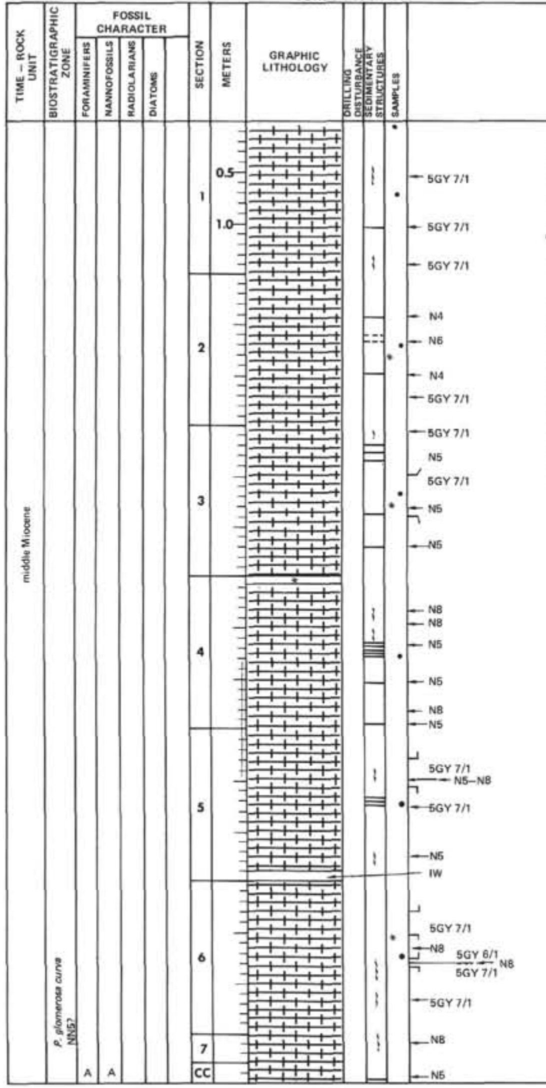
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very light gray (N8), almost homogeneous throughout.

SMEAR SLIDE SUMMARY:

	2, 60	4, 59
	M	D
Composition:		
Foraminifers	A	C
Calc. nannofossils	A	D

SITE 588 HOLE C CORE 1 CORED INTERVAL 305.7–315.3 m



LITHOLOGIC DESCRIPTION

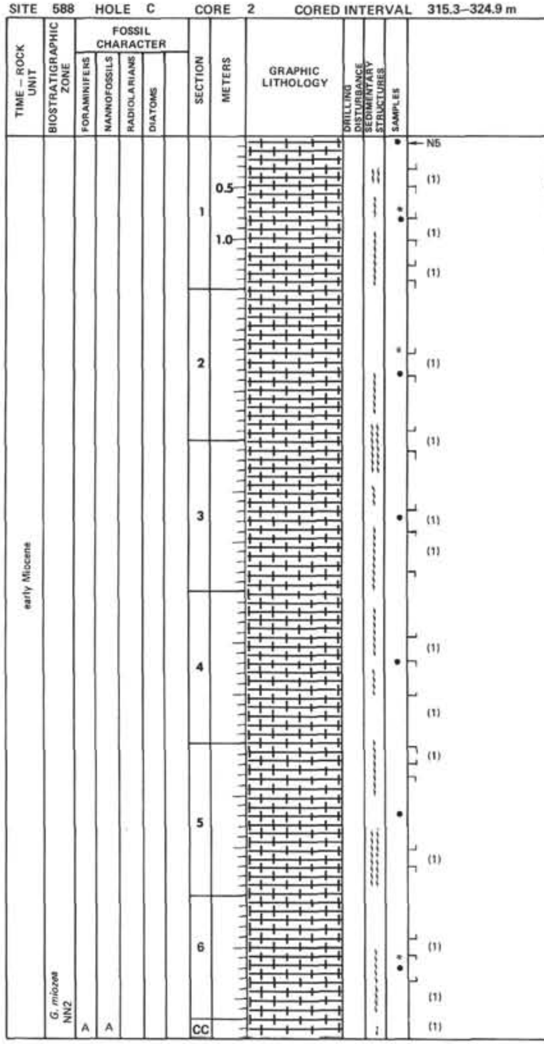
FORAMINIFER-NANNOFOSSIL CHALK, light greenish gray (5GY 8/1 to 5GY 7/1). Greenish gray (5GY 7/1) and light gray (N8) burrows and laminae. Medium gray (N4—N6) burrows and laminae. *Zoophycos*-like burrows (N4). Possible *Chondrites* along the core.

*Gap due to drilling.

SMEAR SLIDE SUMMARY:

	2, 80 D	3, 75	6, 68
Texture:			
Sand	T	T	T
Silt	C	C	A
Clay	D	D	A
Composition:			
Quartz	T	–	T
Feldspar	–	–	T
Mica	–	–	T
Heavy minerals	T	T	T
Volcanic glass	–	R	–
Pyrite	–	–	T
Foraminifers	A	A	A
Calc. nannofossils	A	A	A

SITE 588 HOLE C CORE 2 CORED INTERVAL 315.3–324.9 m



LITHOLOGIC DESCRIPTION

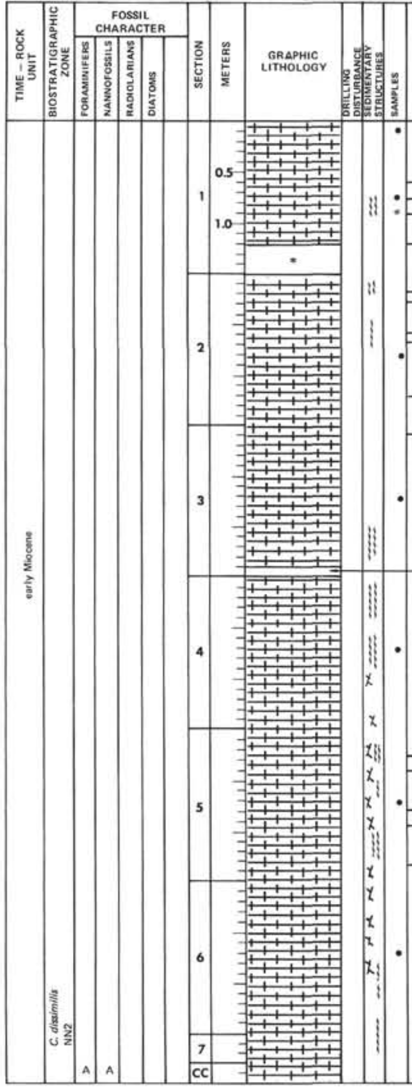
FORAMINIFER-NANNOFOSSIL CHALK, light greenish gray (5GY 8/1 to 5GY 7/1). Greenish gray (5GY 7/1, 5GY 6/1) and light greenish gray (5GY 8/1) burrows and laminae. Medium gray (N4–N6) laminae. *Zoophycos*-like and *Chondrites* burrows along the core.

(1) 5GY 7/1 levels.

SMEAR SLIDE SUMMARY:

	1, 74 D	2, 60 D	6, 53 D
Texture:			
Sand	–	R	–
Silt	A	A	–
Clay	A	A	–
Composition:			
Heavy minerals	T	T	T
Pyrite	T	T	T
Foraminifers	A	A	A
Calc. nannofossils	A	A	A

SITE 588 HOLE C CORE 3 CORED INTERVAL 324.9–334.5 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-NANNOFOSSIL CHALK, light greenish gray (5GY 8/1 to 5GY 7/1) becomes grayish yellow green (5GY 7/2) in Sections 3 and 4, then greenish gray (5GY 7/1 to 5GY 6/1) below. Light greenish gray (5GY 8/1) to greenish gray (5GY 6/1) burrows and laminae. Medium gray (N4 to N6) laminae. *Zoophycos*-like and *Chondrites* burrows along the core. Microfractures associated with N5 laminae are present in Sections 4, 5, and 6.

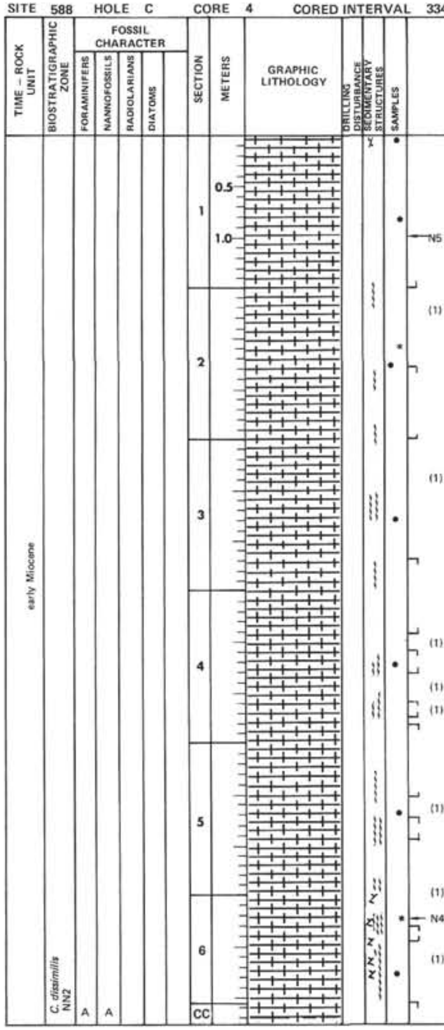
(1) 5GY 7/1)

* Gap due to drilling.

SMEAR SLIDE SUMMARY:

	1, 80 D
Texture:	
Sand	R
Silt	A
Clay	A
Composition:	
Quartz	T
Heavy minerals	T
Volcanic glass	T
Foraminifers	A
Calc. nannofossils	A

SITE 588 HOLE C CORE 4 CORED INTERVAL 334.5–344.1 m



LITHOLOGIC DESCRIPTION

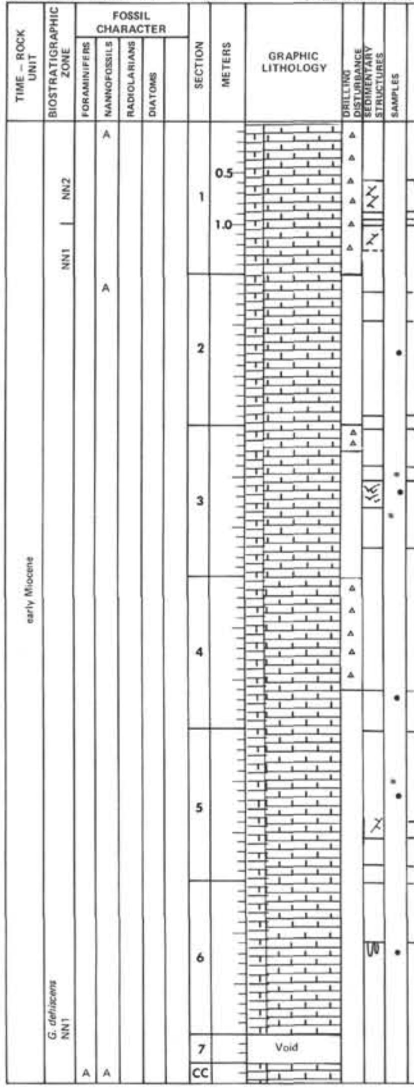
FORAMINIFER-NANNOFOSSIL CHALK, light greenish gray (5GY 7/1) to greenish gray (5GY 6/1). Greenish gray (5GY 6/1) and light greenish gray (5GY 7/1) burrows and laminae. *Zoophycos*-like and *Chondrites* burrows. Medium gray (N4–N6) laminae of iron sulfide. Microfractures in Section 6.

(1) 5GY 7/1

SMEAR SLIDE SUMMARY:

	2, 60 D	6, 30 M
Texture:		
Silt	–	A
Clay	–	A
Composition:		
Feldspar	T	–
Heavy minerals	T	T
Volcanic glass	–	T
Pyrite	R	R
Foraminifers	A	C
Calc. nannofossils	A	D

SITE 588 HOLE C CORE 5 CORED INTERVAL 344.1–353.7 m



LITHOLOGIC DESCRIPTION

N7½

Fracturing

N7

N8

Flaser N7½ bedding

N8

N7

N8

N7

5G 7/1

5G 5/1, volcanic sediment, lt. green clasts in darker matrix

Flaser beds and microfractures
N7

5GY 7/1

N8

5GY 5/1, burrow

5GY 7/1

5GY 6½/1

5GY 7/1

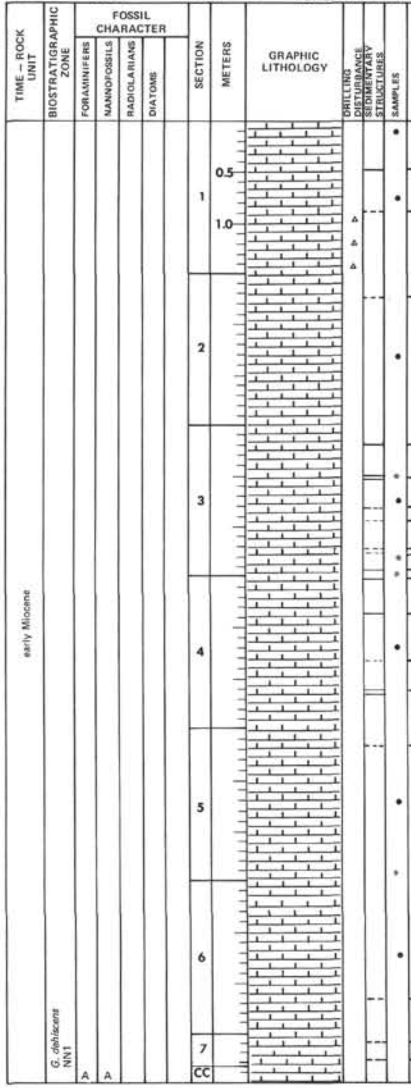
Burrowed surface

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, very light gray (N8); great deal of drilling disturbance. Brecciation and slickensides occur frequently. Mineralization by rhodochrosite(?) on slickenside surface at Section 1, 95 cm. *Chondrites* burrows.

SMEAR SLIDE SUMMARY:

	3, 96 D	5, 50 D	3, 52 M
Composition:			
Feldspar	–	T	T
Volcanic glass	–	–	T
Pyrite	T	–	T
Foraminifers	A	C	R
Calc. nannofossils	A	A	D
Biog. opal	–	–	R

SITE 588 HOLE C CORE 6 CORED INTERVAL 353.7–363.3 m



LITHOLOGIC DESCRIPTION

5GY 6/1

5GY 8/1

5GY 7/1

5GY 8/1

5G 6/2, very thin, distinct ash(?)

5BG 4/1, distinct, ash

5GY 6/1

5GY 6/1

5BG 4/1, distinct, ash, glass-rich

5G 6/1, glass-rich

5G 8/1

5GY 7/1

5BG 4/1, ash glass-rich

5GY 7/1

5GY 8/1

5GY 7½/1

5GY 7/1

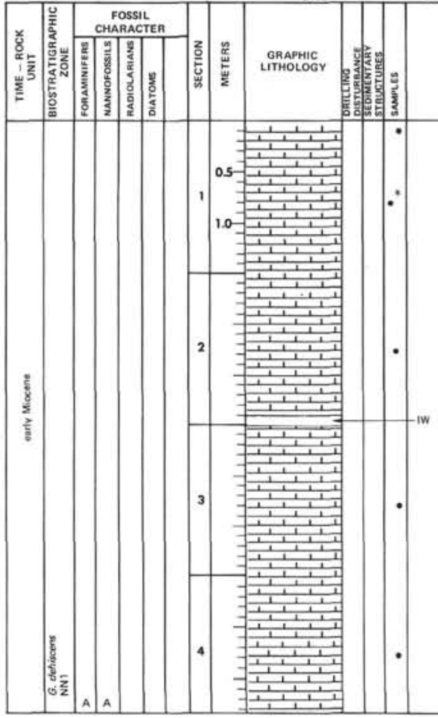
5GY 7½/1

NANNOFOSSIL CHALK, very firm, light greenish gray (5GY 8/1 or 5G 8/1), abundant burrowing; many fine flecks of iron sulfide throughout; numerous ash(?) layers beginning in Section 3.

SMEAR SLIDE SUMMARY:

	3, 131 D	6, 5 D	3, 51 M	3, 147 M
Texture:				
Silt	–	–	A	–
Clay	–	–	A	–
Composition:				
Quartz	T	–	C	T
Feldspar	–	T	C	T
Volcanic glass	–	T	A	C
Pyrite	–	–	C	A
Foraminifers	R	R	–	R
Calc. nannofossils	D	D	–	A

SITE 588 HOLE C CORE 7 CORED INTERVAL 363.3–372.9 m



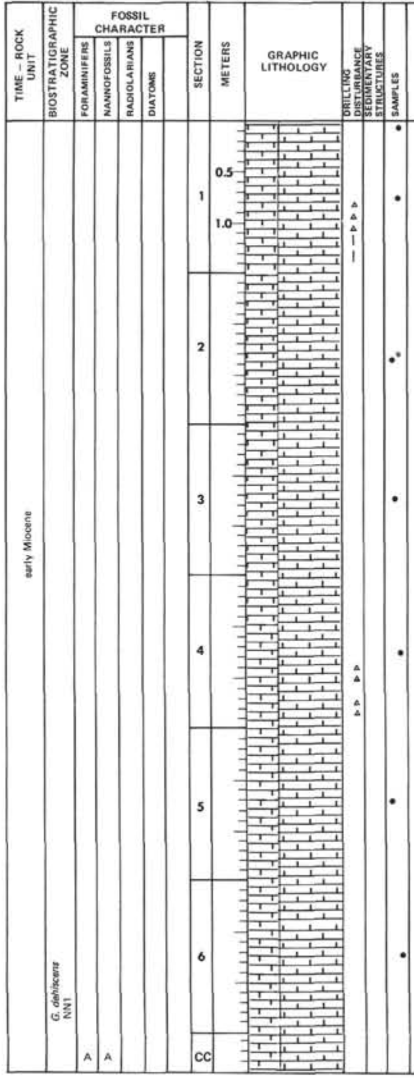
LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, very firm, light greenish gray (5GY 8/1); no more ash layers throughout entire core; extremely homogeneous throughout except for burrows.

SMEAR SLIDE SUMMARY:

	1, 70
	D
Composition:	
Feldspar	T
Foraminifers	R
Calc. nannofossils	D

SITE 588 HOLE C CORE 8 CORED INTERVAL 372.9–382.5 m



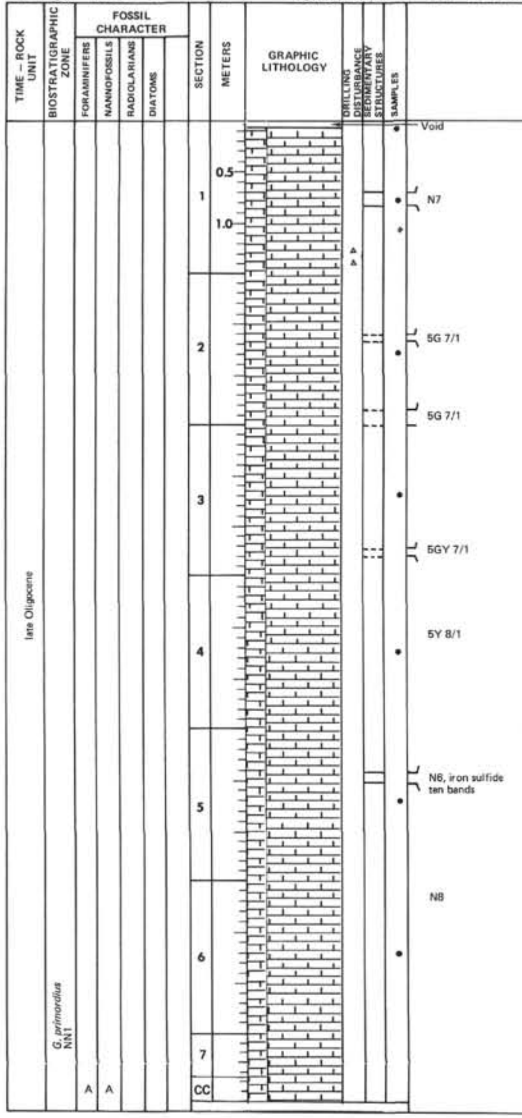
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, light gray (N7), moderate amount of burrowing, minor iron sulfide component, no obvious bedding.

SMEAR SLIDE SUMMARY:

	2, 70
	D
Composition:	
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE C CORE 9 CORED INTERVAL 382.5–392.1 m



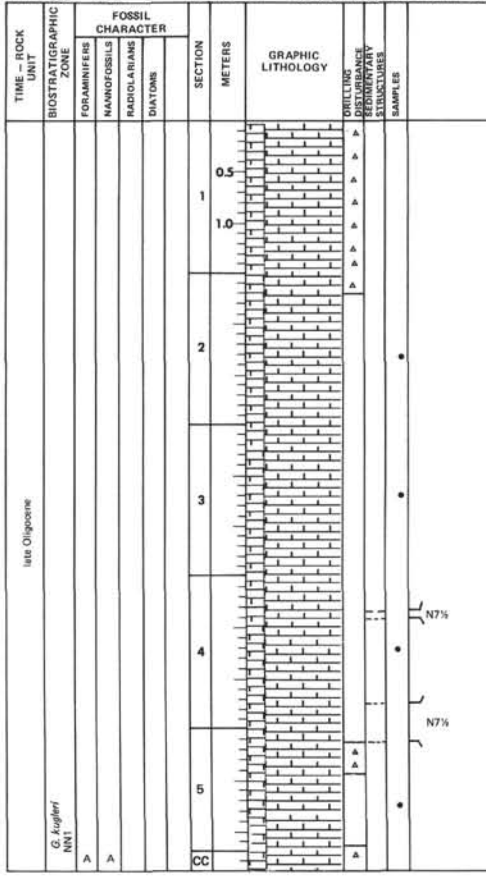
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, very light gray (N8), abundant burrows – many *Zoophycos*; very slight greenish hue throughout (glass?).

SMEAR SLIDE SUMMARY:

	1, 107 D
Composition:	
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

SITE 588 HOLE C CORE 10 CORED INTERVAL 392.1–401.7 m



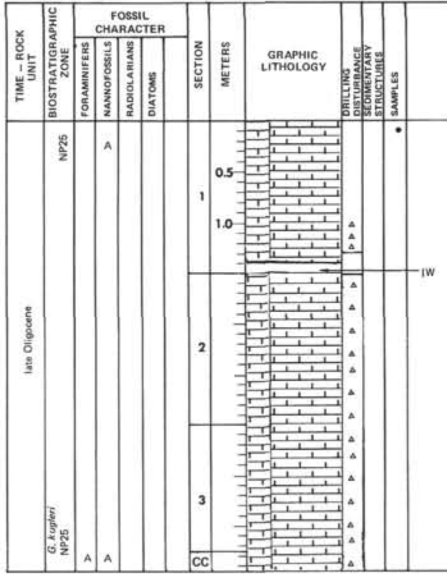
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, firm, very light gray (N8), moderate burrowing, otherwise homogeneous.

SMEAR SLIDE SUMMARY:

	2, 70 D
Composition:	
Feldspar	T
Volcanic glass	T
Foraminifers	C
Calc. nannofossils	D

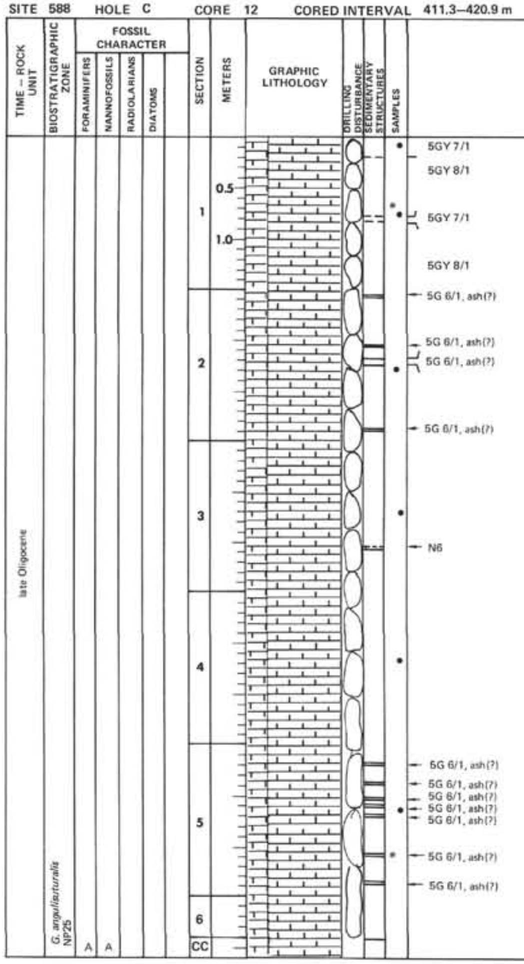
SITE 588 HOLE C CORE 11 CORED INTERVAL 401.7–411.3 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, light greenish gray (5GY 7/1), no bedding, moderate burrowing, some iron sulfide.

SITE 588 HOLE C CORE 12 CORED INTERVAL 411.3–420.9 m



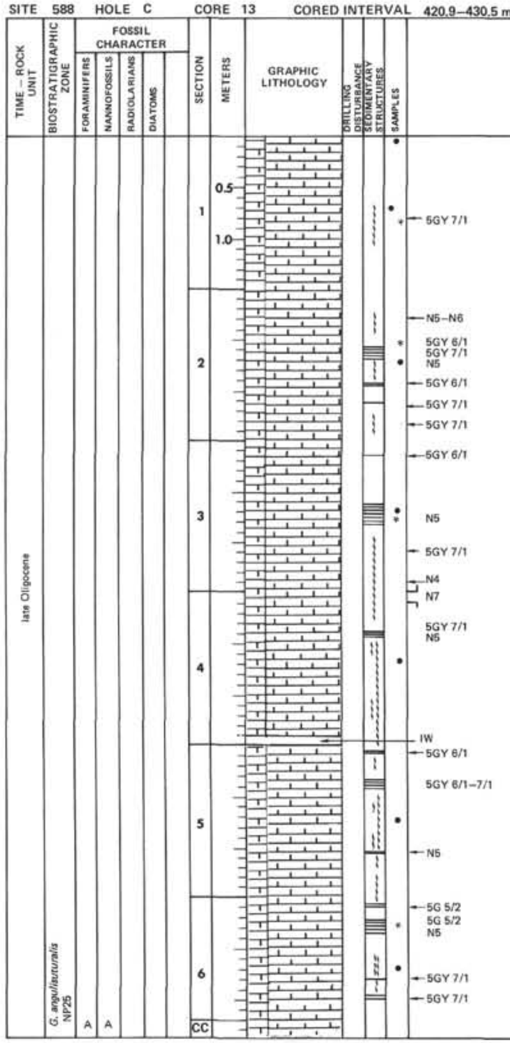
LITHOLOGIC DESCRIPTION

FORMINIFER-BEARING NANNOFOSSIL CHALK, firm, light greenish gray (5GY 8/1), homogeneous, burrows (*Zoophycos*), ash(?) layers are extremely compressed into mm thick bands.

SMEAR SLIDE SUMMARY:

	1, 70	5, 100
	D	M
Composition:		
Feldspar	–	R
Heavy minerals	–	T
Volcanic glass	T	C
Glauconite	–	T
Foraminifers	C	C
Calc. nannofossils	A	A
Sponge spicules	T	–

SITE 588 HOLE C CORE 13 CORED INTERVAL 420.9–430.5 m



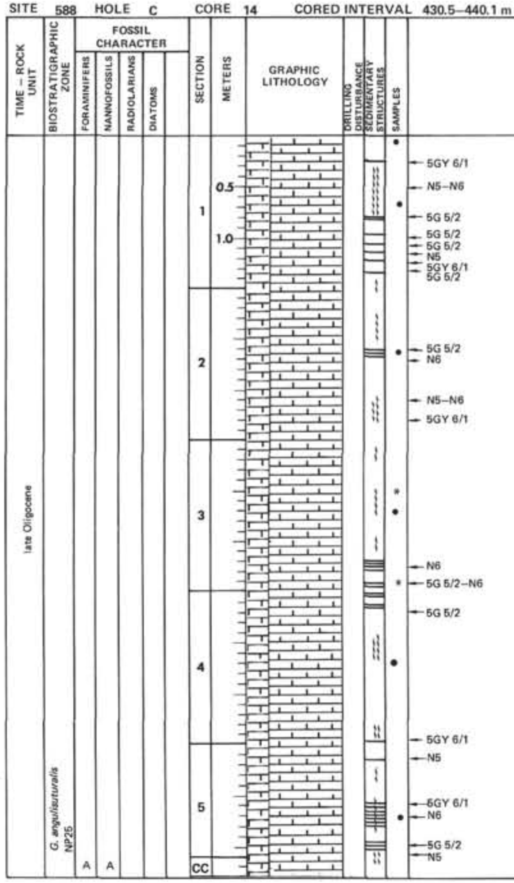
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, homogeneous, light greenish gray (5GY 8/1). Greenish gray (5GY 7/1, 5GY 6/1, 5G 5/2) burrows and laminae. *Zoophycos*-like burrows and *Chondrites* along the core. Medium gray (N4–N6) burrows and laminae.

SMEAR SLIDE SUMMARY:

	1, 80 D	2, 50 M	2, 61 M	3, 75 M	6, 29 M
Texture:					
Silt	–	–	–	A	C
Clay	–	–	–	A	D
Composition:					
Quartz	–	T	T	–	–
Feldspar	–	–	T	–	–
Heavy minerals	T	–	–	T	–
Volcanic glass	–	T	T	–	–
Pyrite	–	C	R	R	–
Foraminifers	C	A	C	C	C
Calc. nannofossils	A	A	D	D	D
Sponge spicules	–	–	R	–	–

SITE 588 HOLE C CORE 14 CORED INTERVAL 430.5–440.1 m



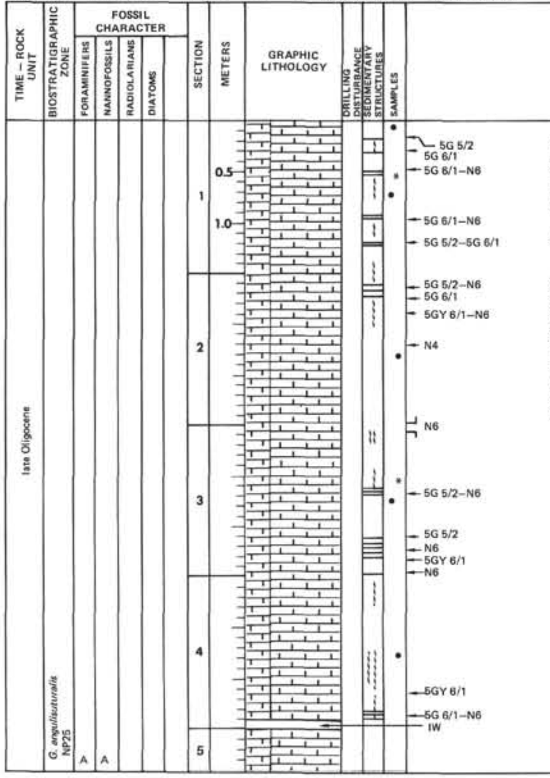
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, light greenish gray (5GY 7/1). Greenish gray (5GY 8/1, 5GY 6/1, 5G 5/2) burrows and laminae. Medium gray (N4–N6) burrows and laminae. *Zoophycos*-like burrows and *Chondrites* along the core.

SMEAR SLIDE SUMMARY:

	3, 60 D	3, 146 M
Texture:		
Silt	C	C
Clay	D	D
Composition:		
Quartz	–	T
Volcanic glass	T	R
Pyrite	–	R
Foraminifers	C	C
Calc. nannofossils	D	D
Sponge spicules	T	–

SITE 588 HOLE C CORE 15 CORED INTERVAL 440.1–449.7 m



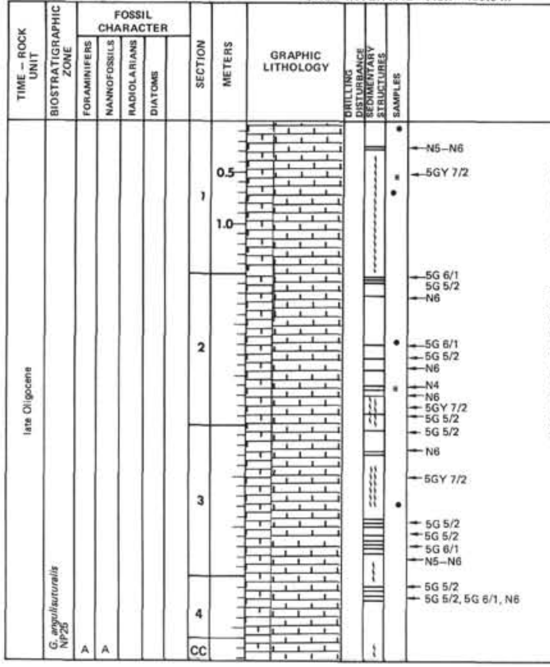
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, light greenish gray (5GY 7/1). Greenish gray (5GY 6/1, 5G 6/1, 5G 5/2) and medium gray (N4–N6) burrows and laminae. *Zoophycos*-like burrows and *Chondrites* along the core.

SMEAR SLIDE SUMMARY:

	1, 70	3, 65
	D	M
Texture:		
Silt	C	–
Clay	D	–
Composition:		
Quartz	–	T
Volcanic glass	R	–
Pyrite	R	R
Foraminifers	C	R
Calc. nannofossils	D	D
Sponge spicules	–	T

SITE 588 HOLE C CORE 16 CORED INTERVAL 449.7–459.3 m



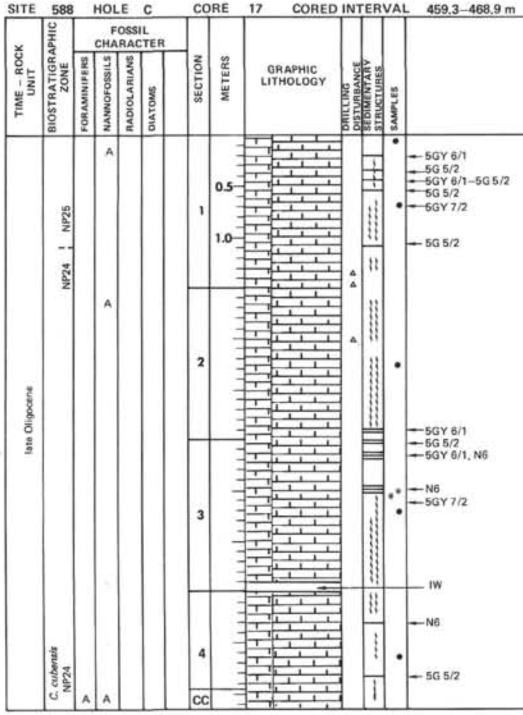
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, light greenish gray (5GY 7/1). Greenish gray (5GY 6/1, 5G 5/2), grayish yellow green (5GY 7/2) and medium gray (N4 to N6) burrows and laminae. *Zoophycos*-like burrows and *Chondrites* are present along the core.

SMEAR SLIDE SUMMARY:

	1, 57	2, 117
	D	M
Texture:		
Silt	C	–
Clay	D	–
Composition:		
Quartz	T	–
Feldspar	–	T
Volcanic glass	–	R
Pyrite	–	R
Foraminifers	C	C
Calc. nannofossils	D	D
Sponge spicules	T	–

SITE 588 HOLE C CORE 17 CORED INTERVAL 459.3–468.9 m



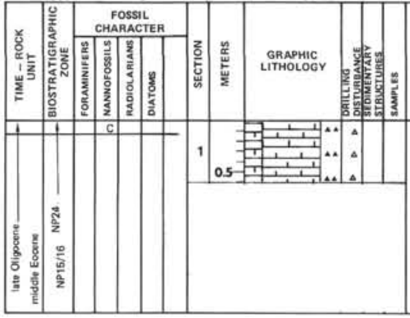
LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, light greenish gray (5GY 7/1). Greenish gray (5GY 6/1, 5G 5/2), grayish yellow green (5GY 7/2) and medium gray (N4 to N6) burrows and laminae. *Zoophycos*-like burrows and *Chondrites* are present along the core.

SMEAR SLIDE SUMMARY:

	3, 65 D	3, 47 M
Texture:		
Silt	A	C
Clay	A	D
Composition:		
Feldspar	–	T
Heavy minerals	T	–
Volcanic glass	T	T
Pyrite	–	T
Foraminifers	C	C
Calc. nannofossils	D	D
Silicoflagellates	T	–

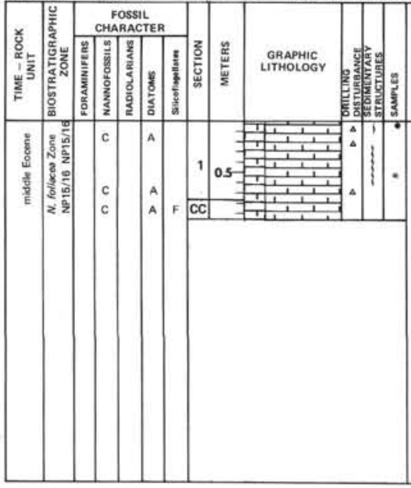
SITE 588 HOLE C CORE 18 CORED INTERVAL 468.9–478.5 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, very firm, compacted burrows, greenish-gray (5G 7/1), flaser-bedded in part and FORAMINIFER-BEARING CHERT, greenish gray (5G 7/1).

SITE 588 HOLE C CORE 19 CORED INTERVAL 478.5–488.1 m



LITHOLOGIC DESCRIPTION

FORAMINIFER-BEARING NANNOFOSSIL CHALK, grayish yellow green (5GY 7/2) from the top to 30 cm, then light greenish gray (5GY 7/1). Yellowish gray (5Y 6/2) and grayish yellow green (5GY 7/2) burrows.

SMEAR SLIDE SUMMARY:

	1, 54 D
Texture:	
Sand	R
Silt	C
Clay	D
Composition:	
Heavy minerals	T
Foraminifers	C
Calc. nannofossils	D
Diatoms	T
Sponge spicules	R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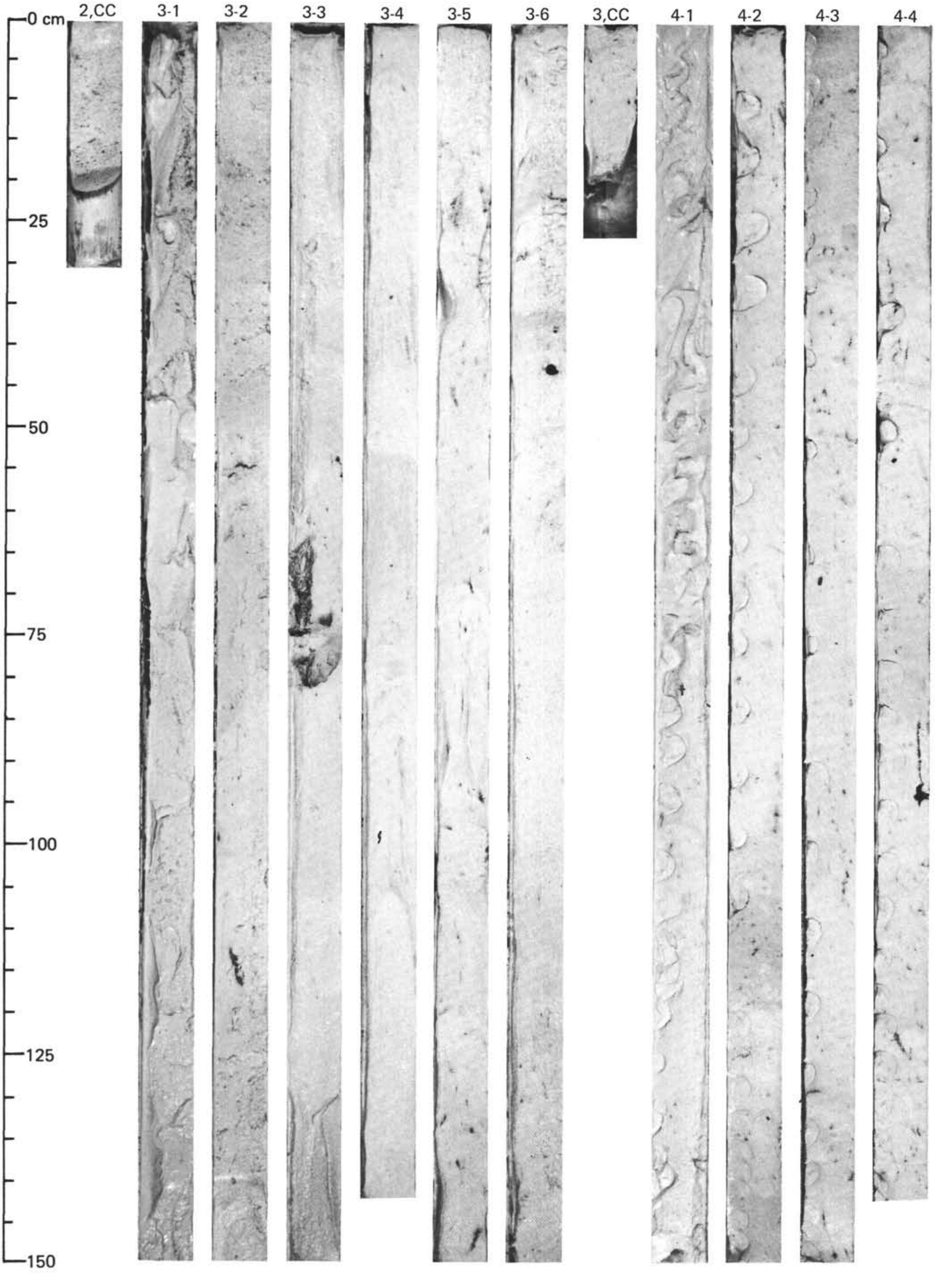
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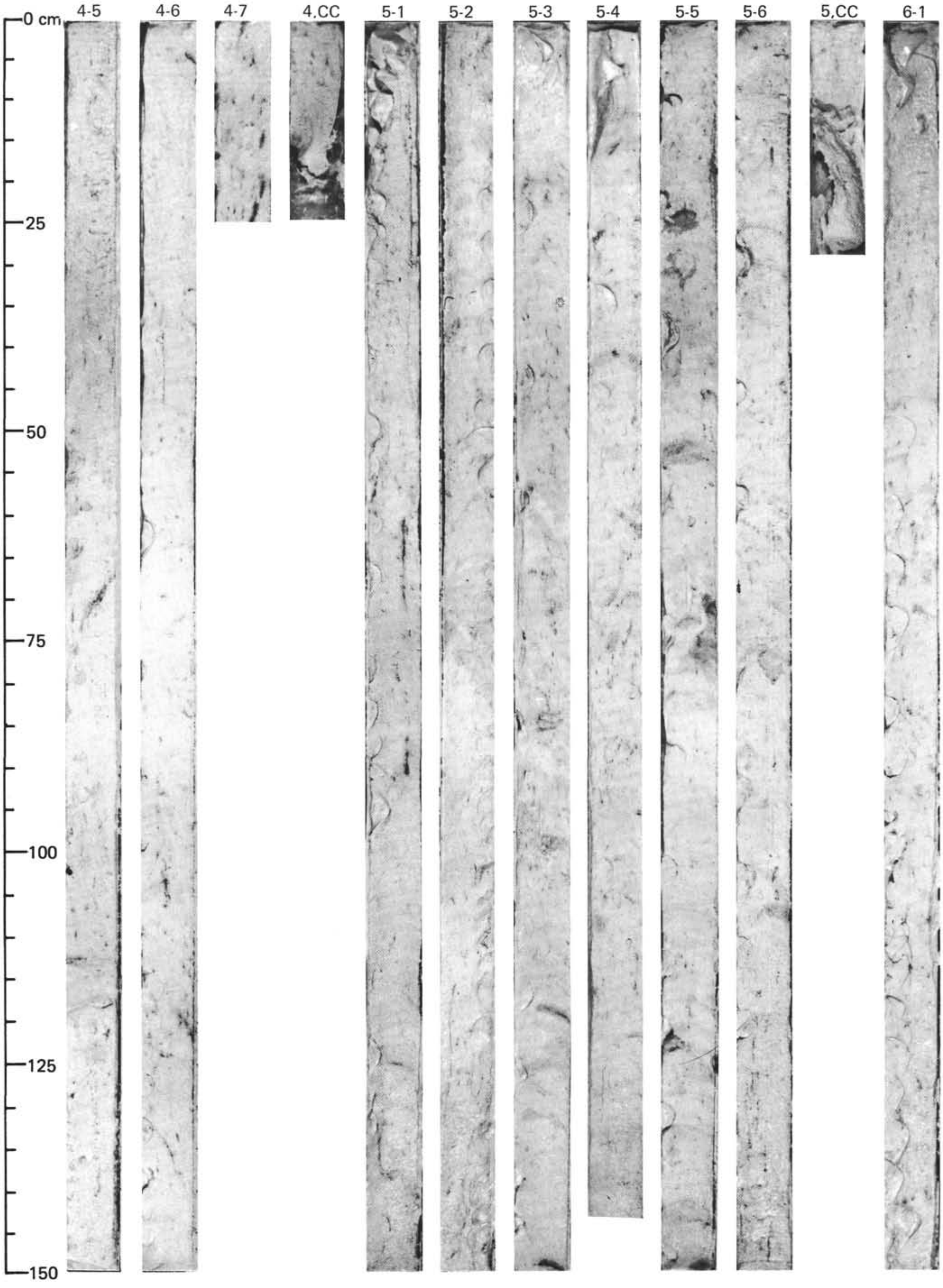
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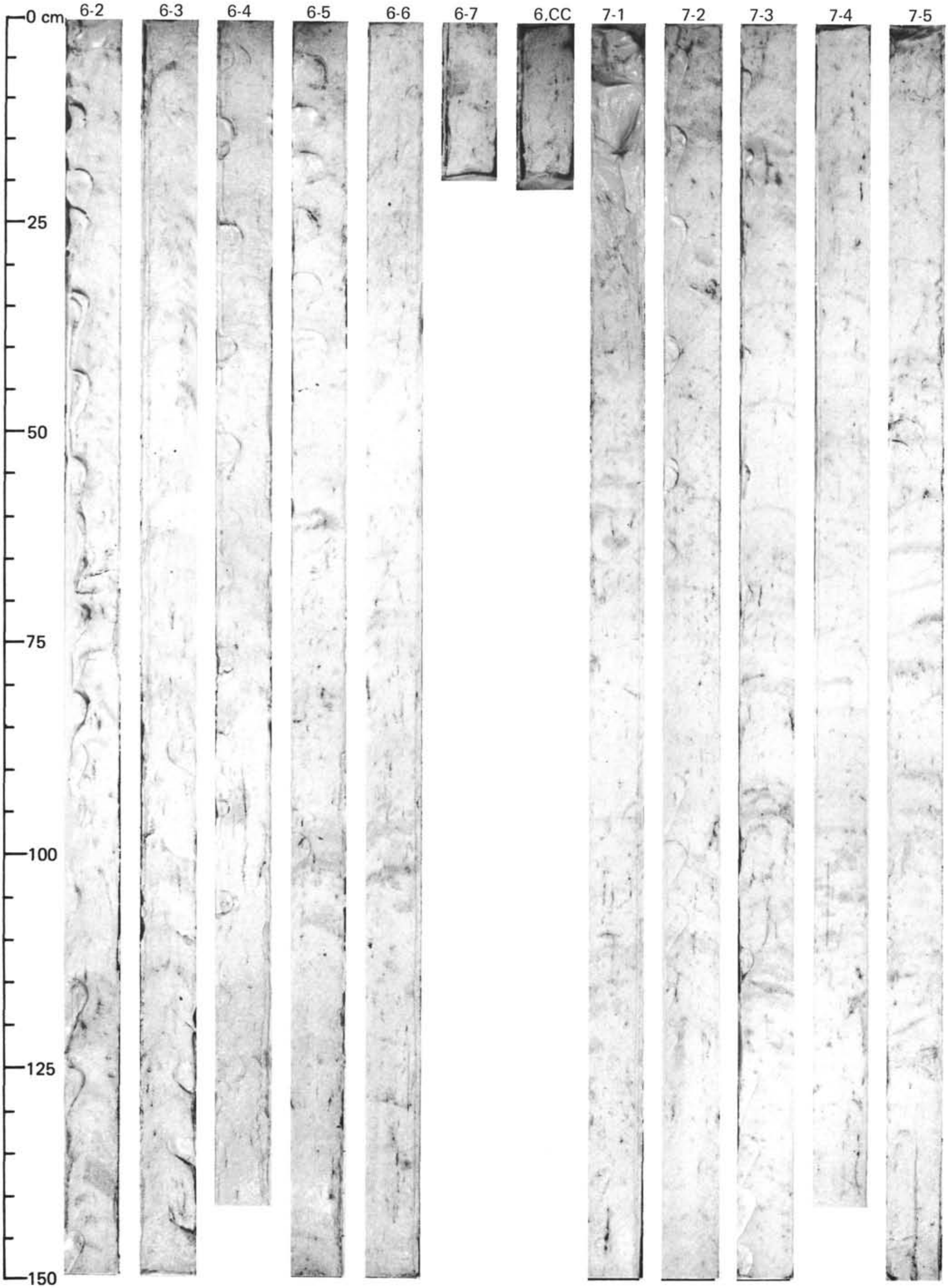
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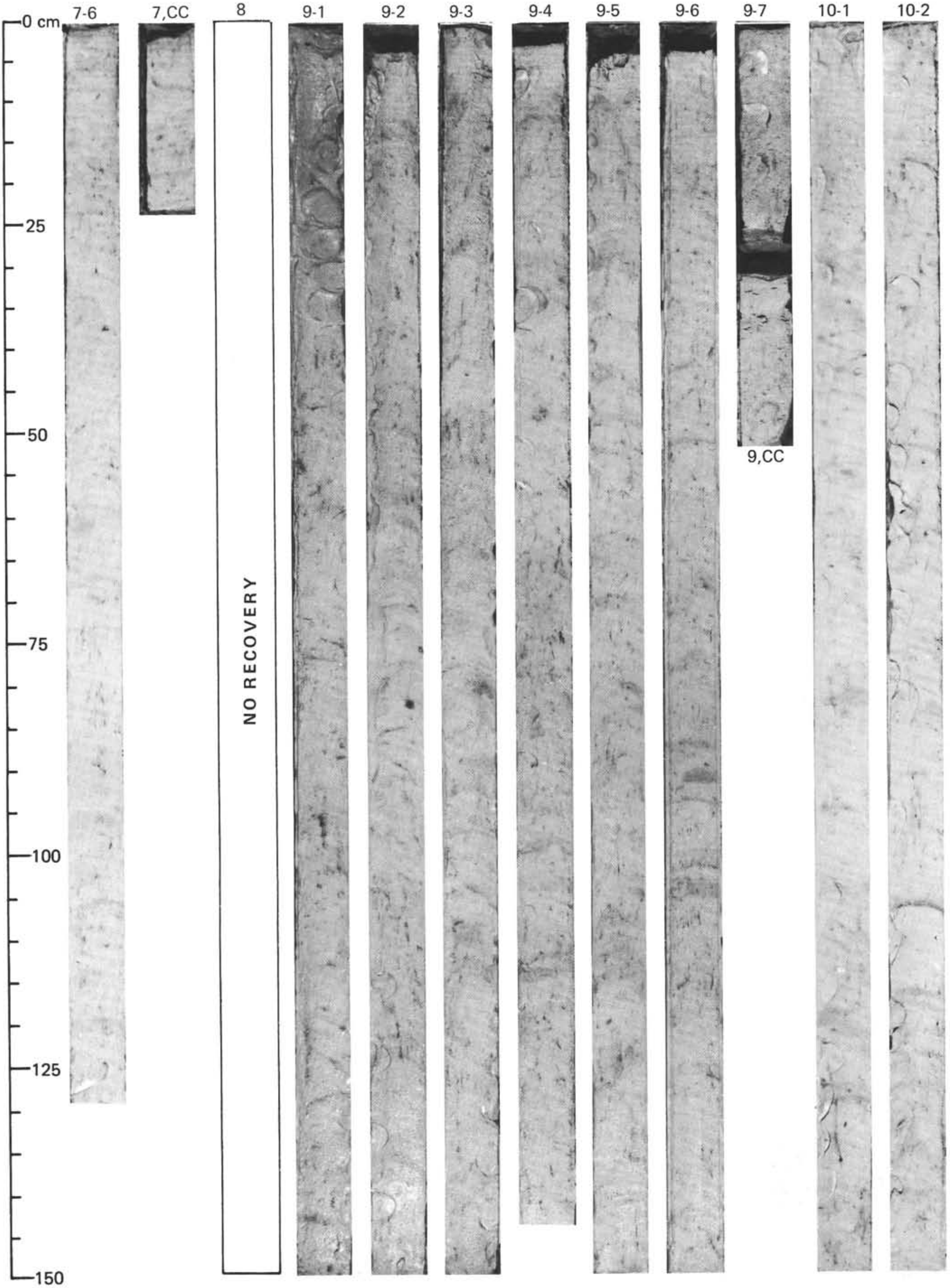
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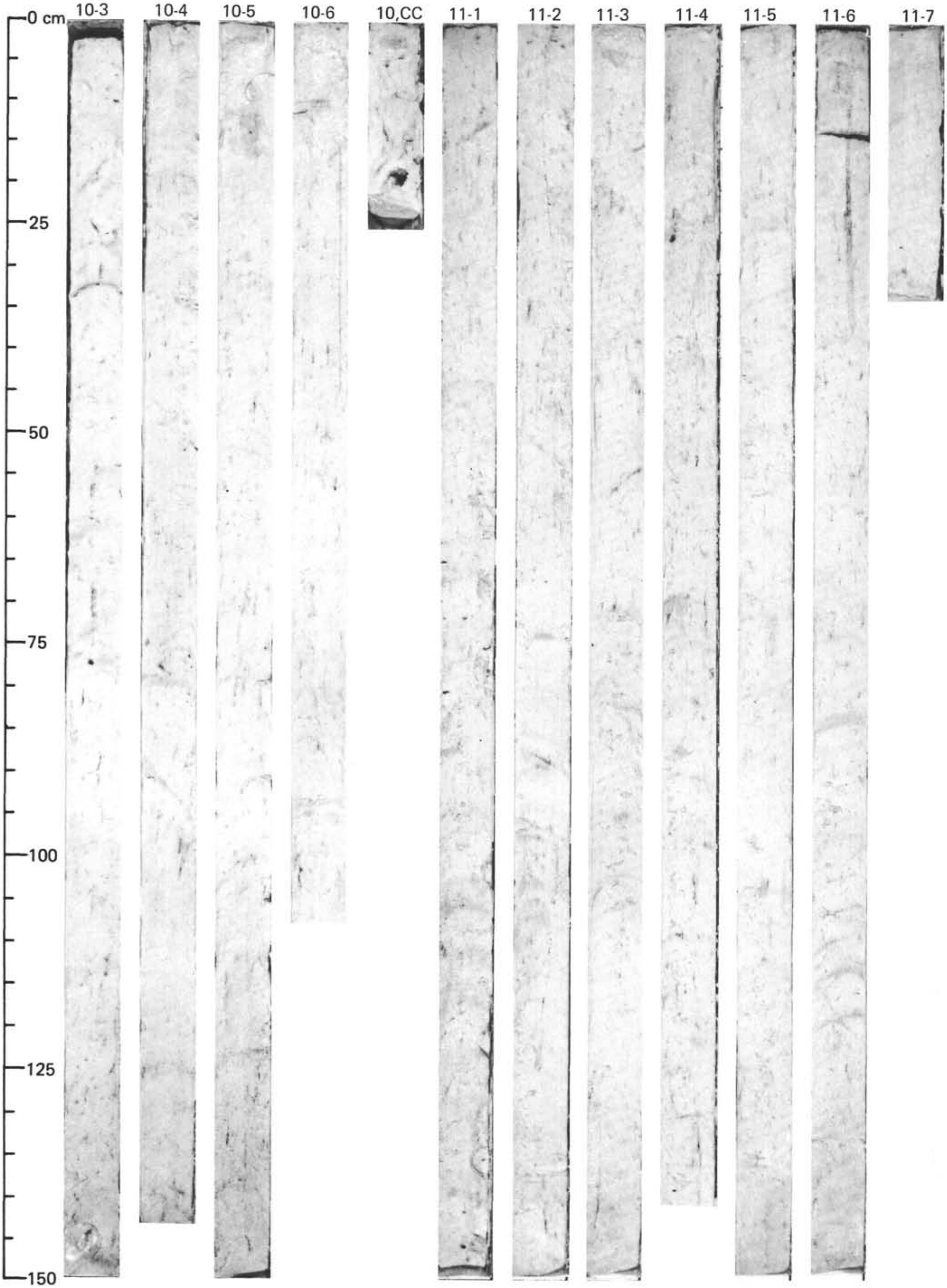
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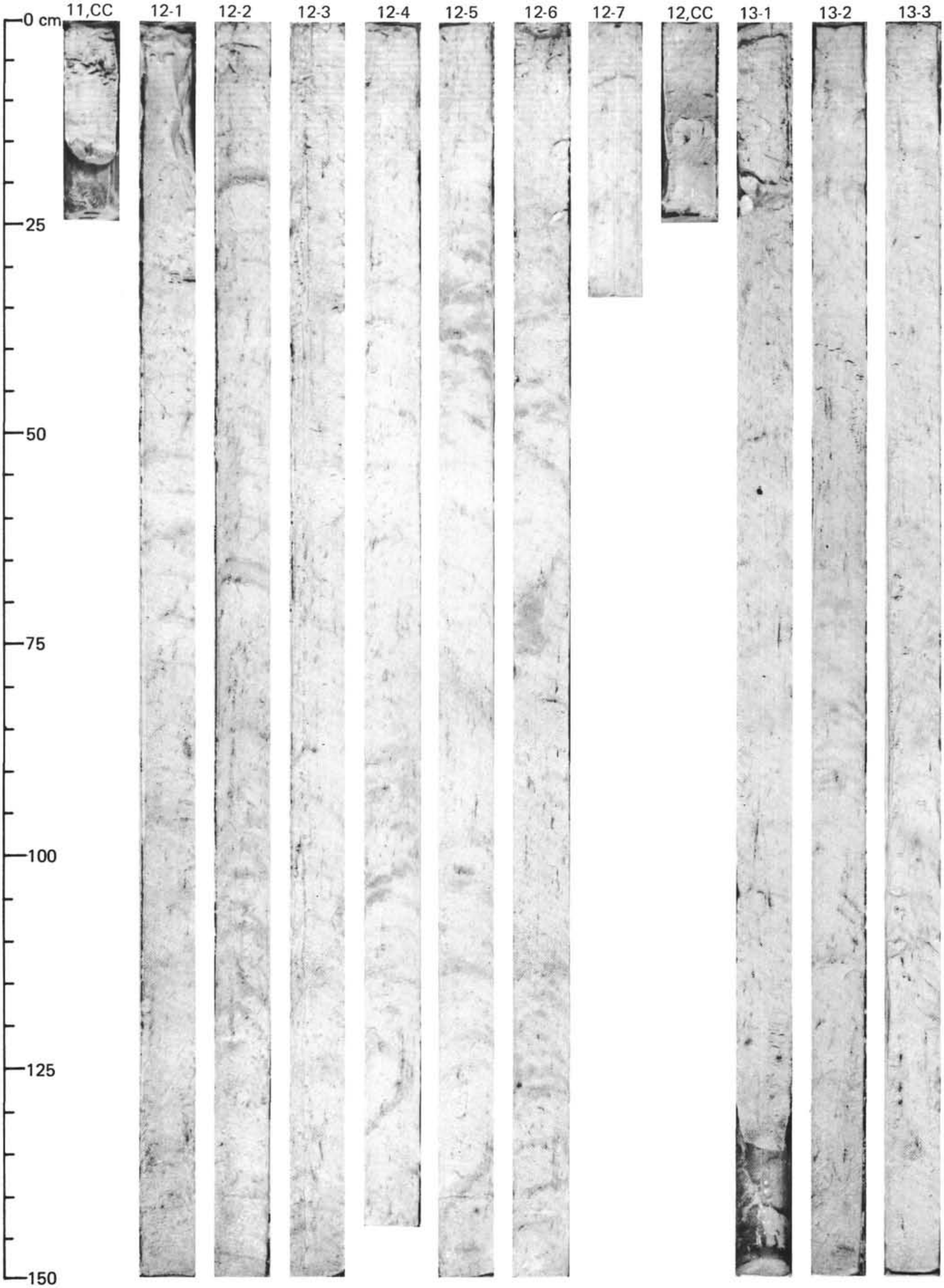
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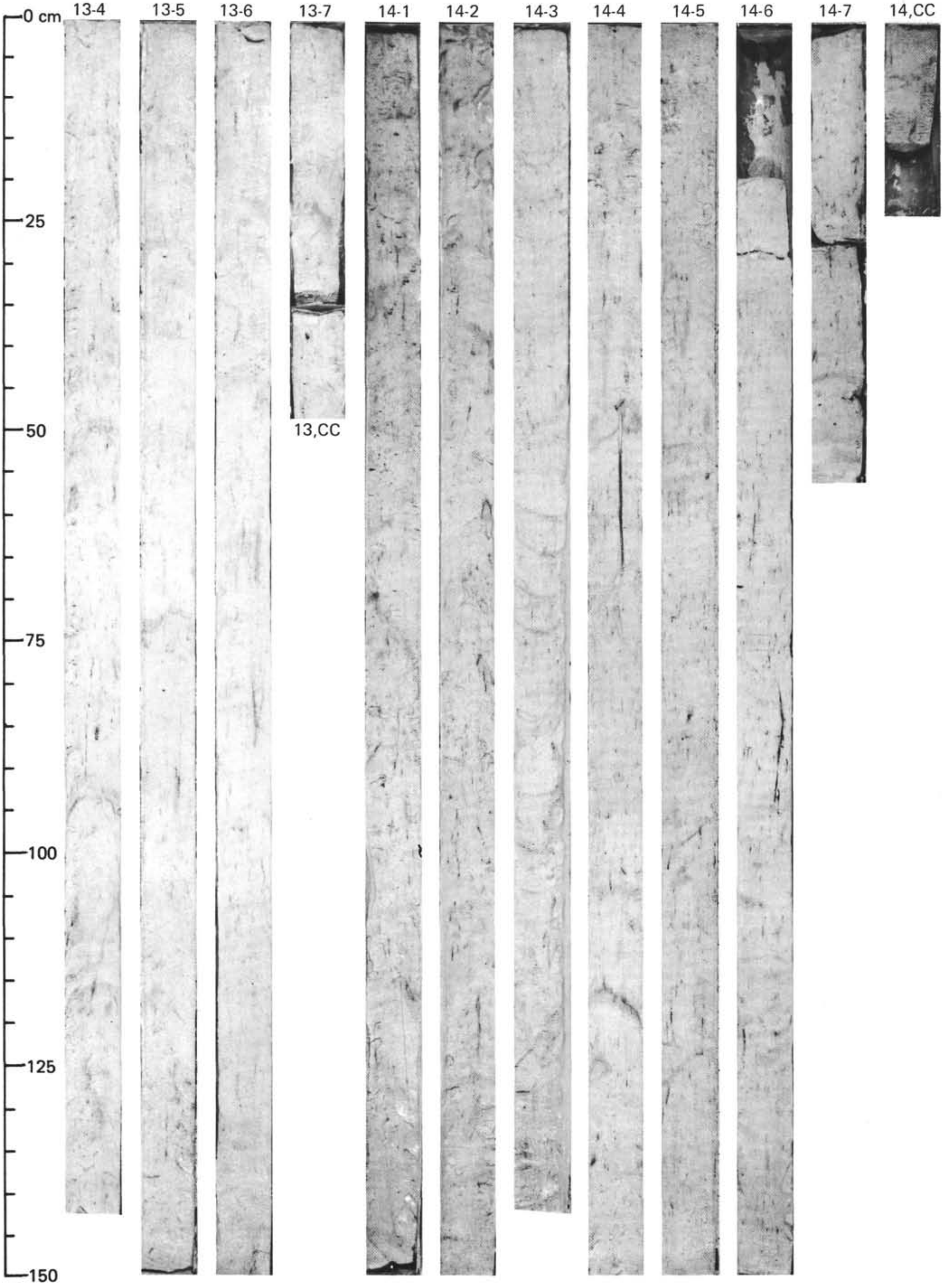
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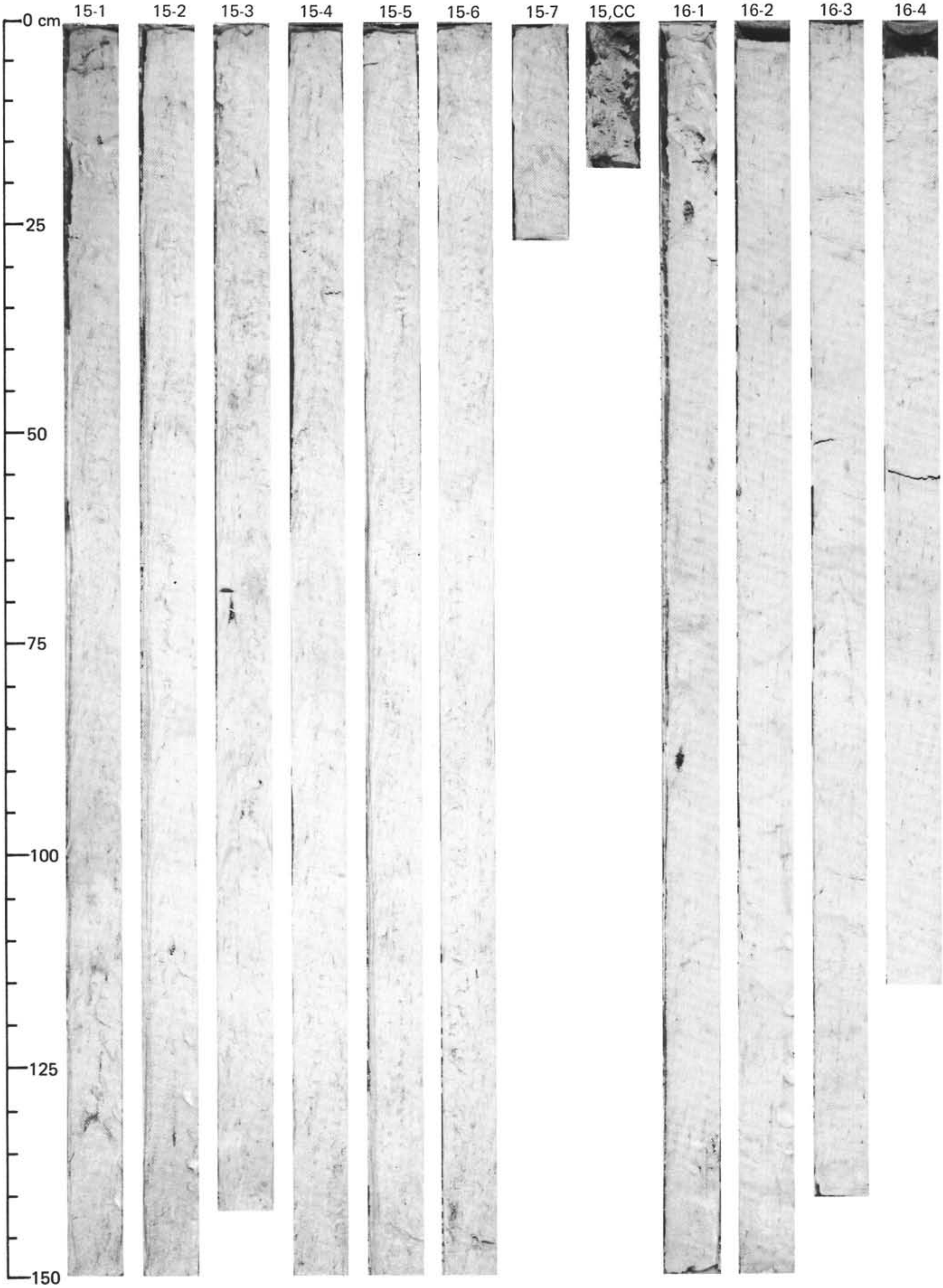
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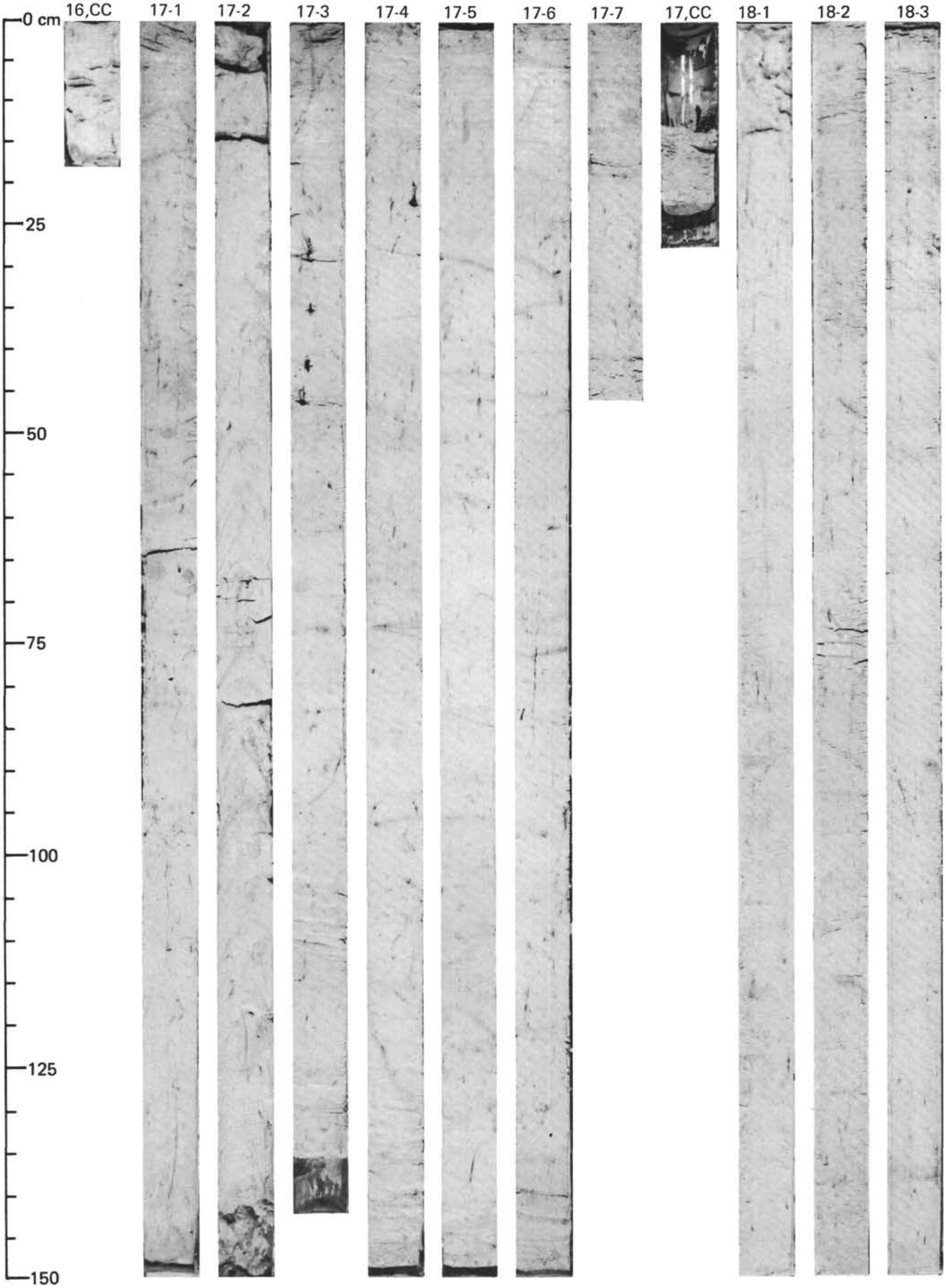
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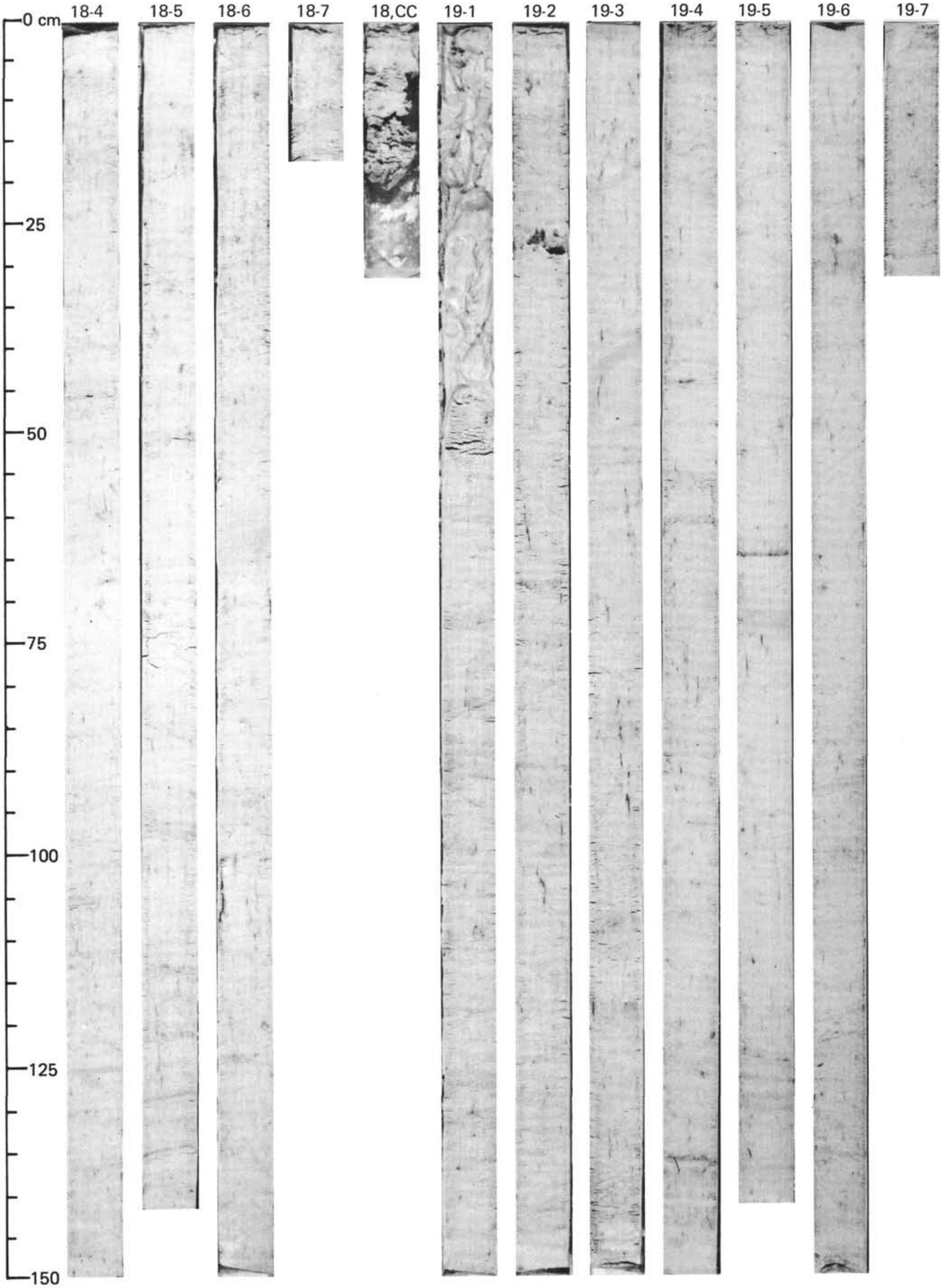
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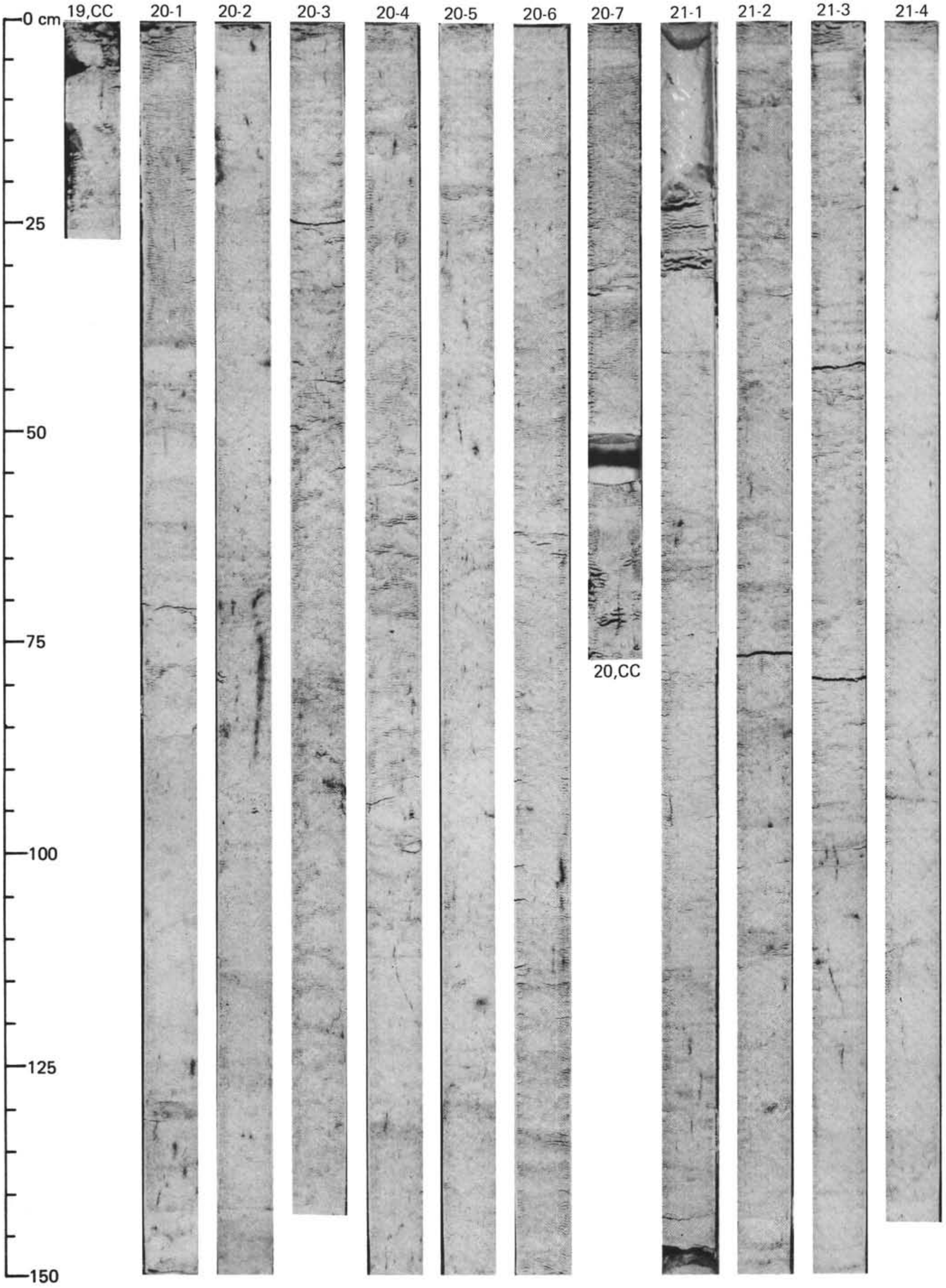
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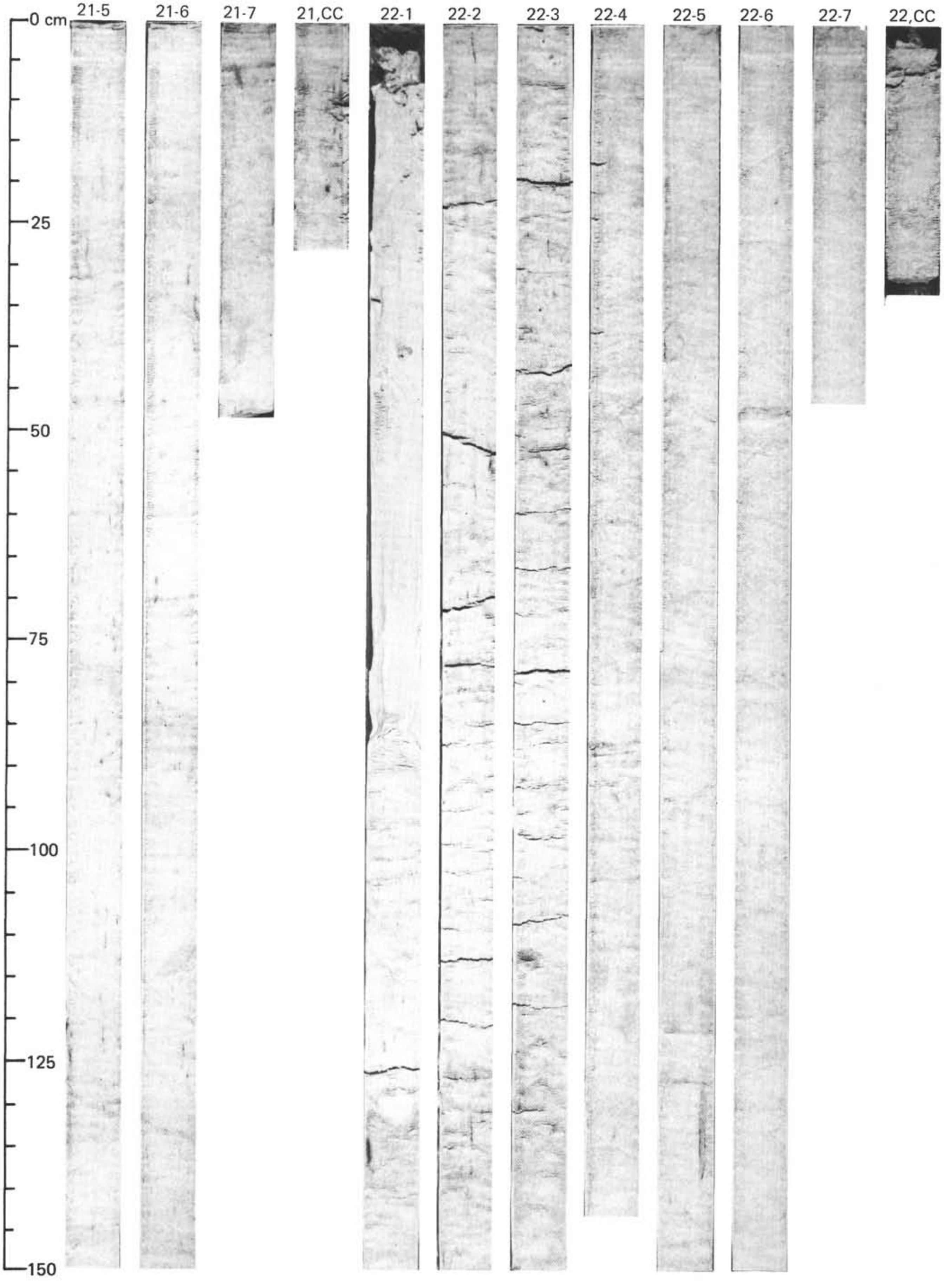
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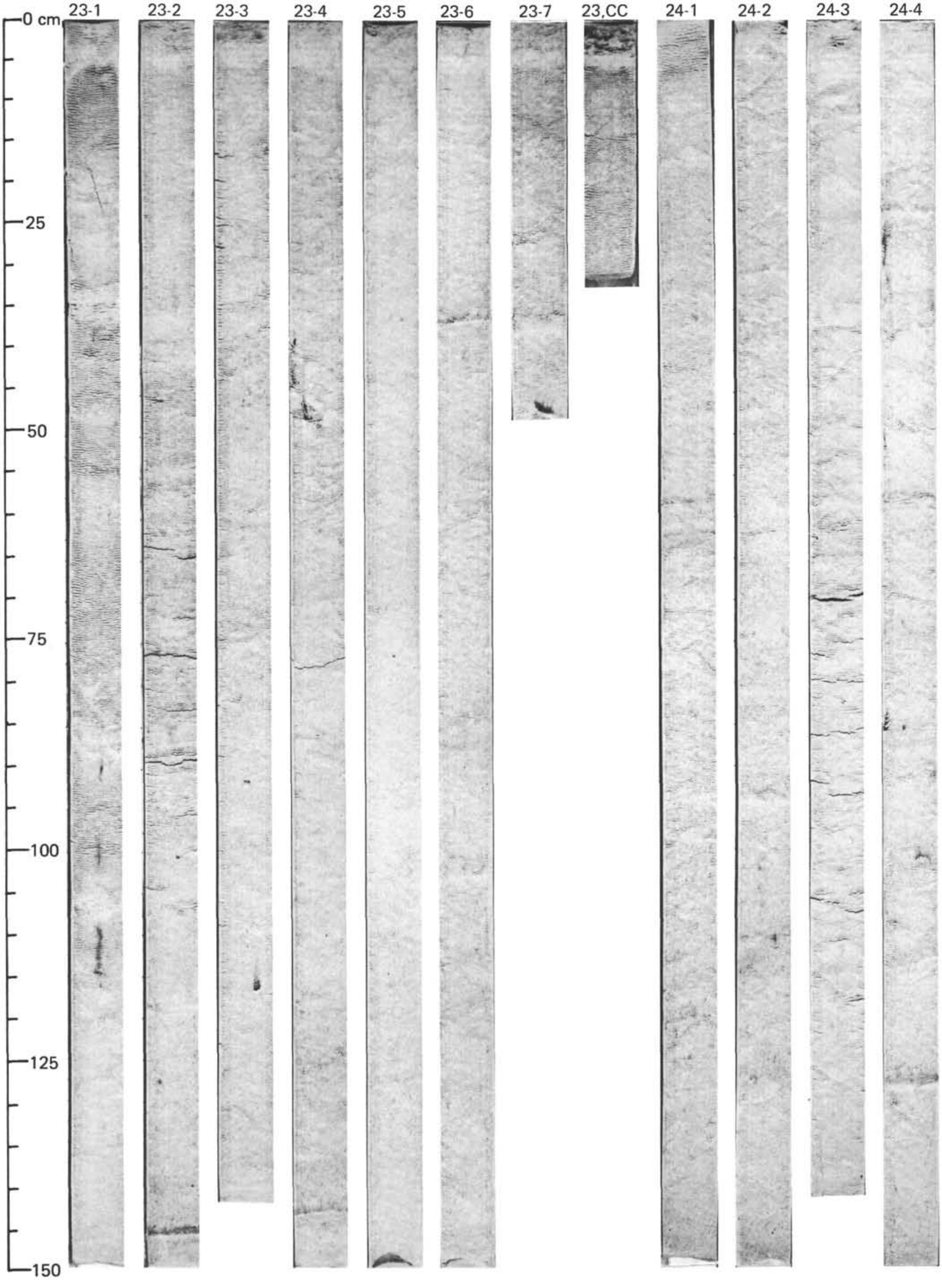
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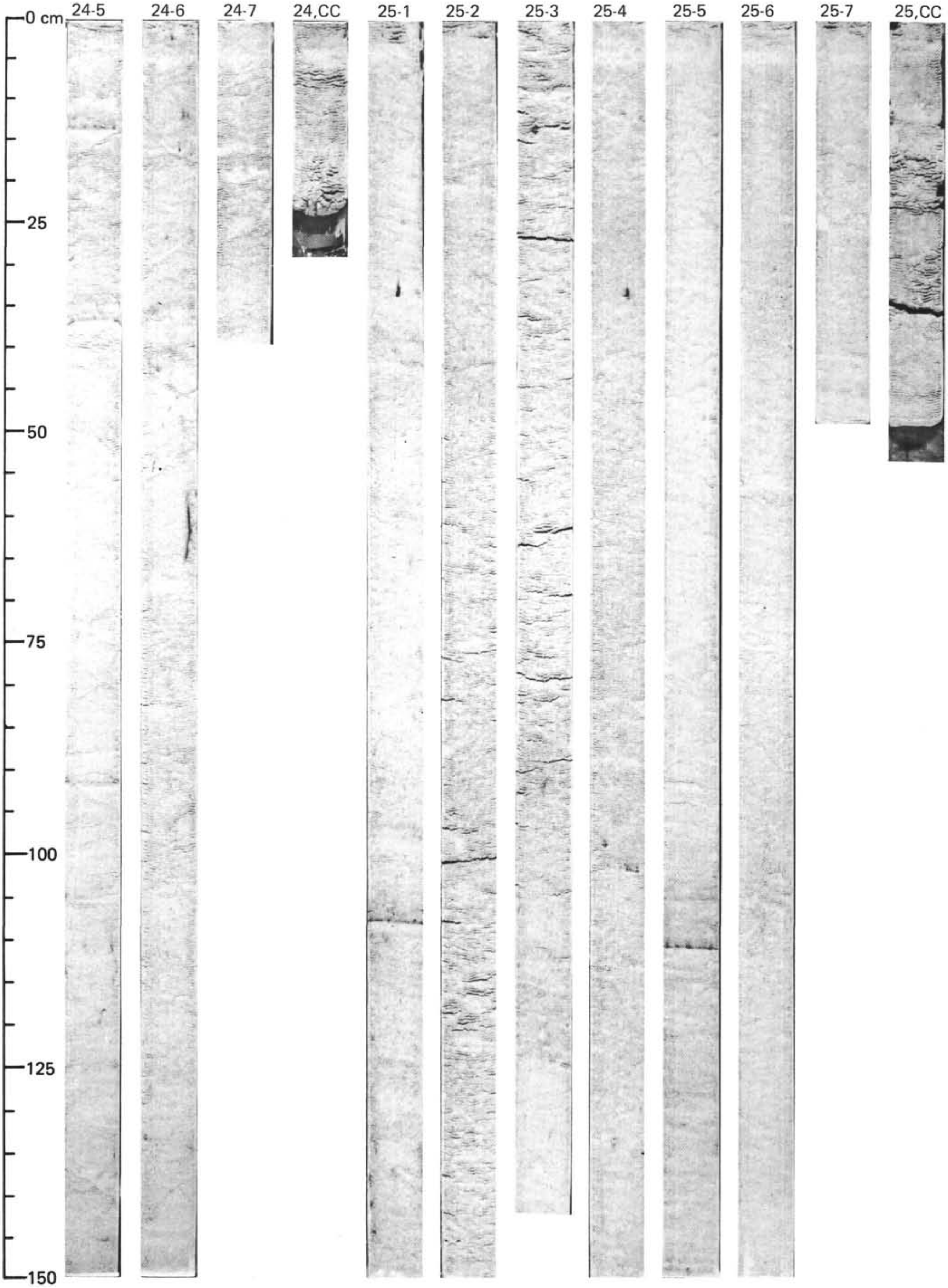
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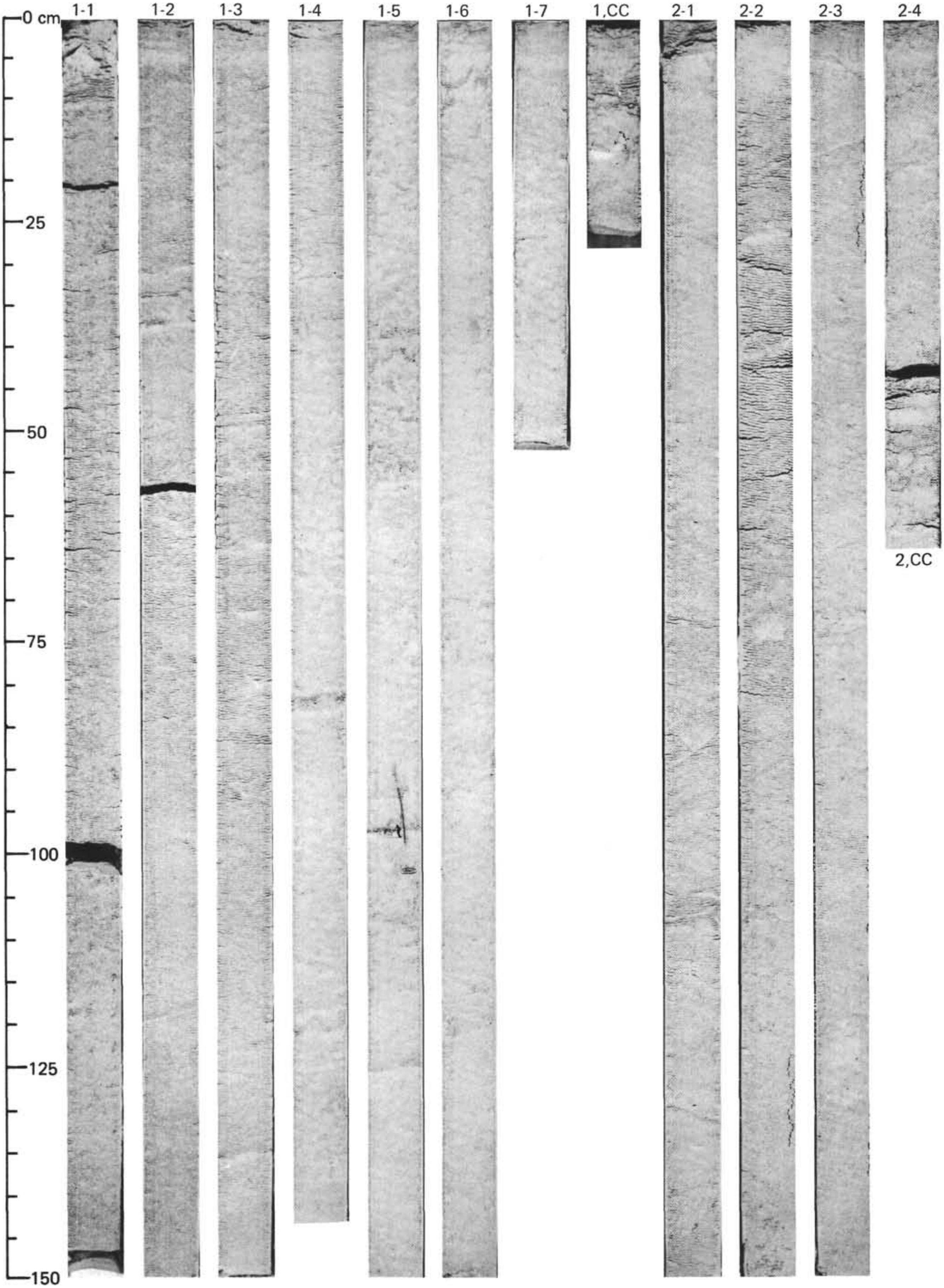
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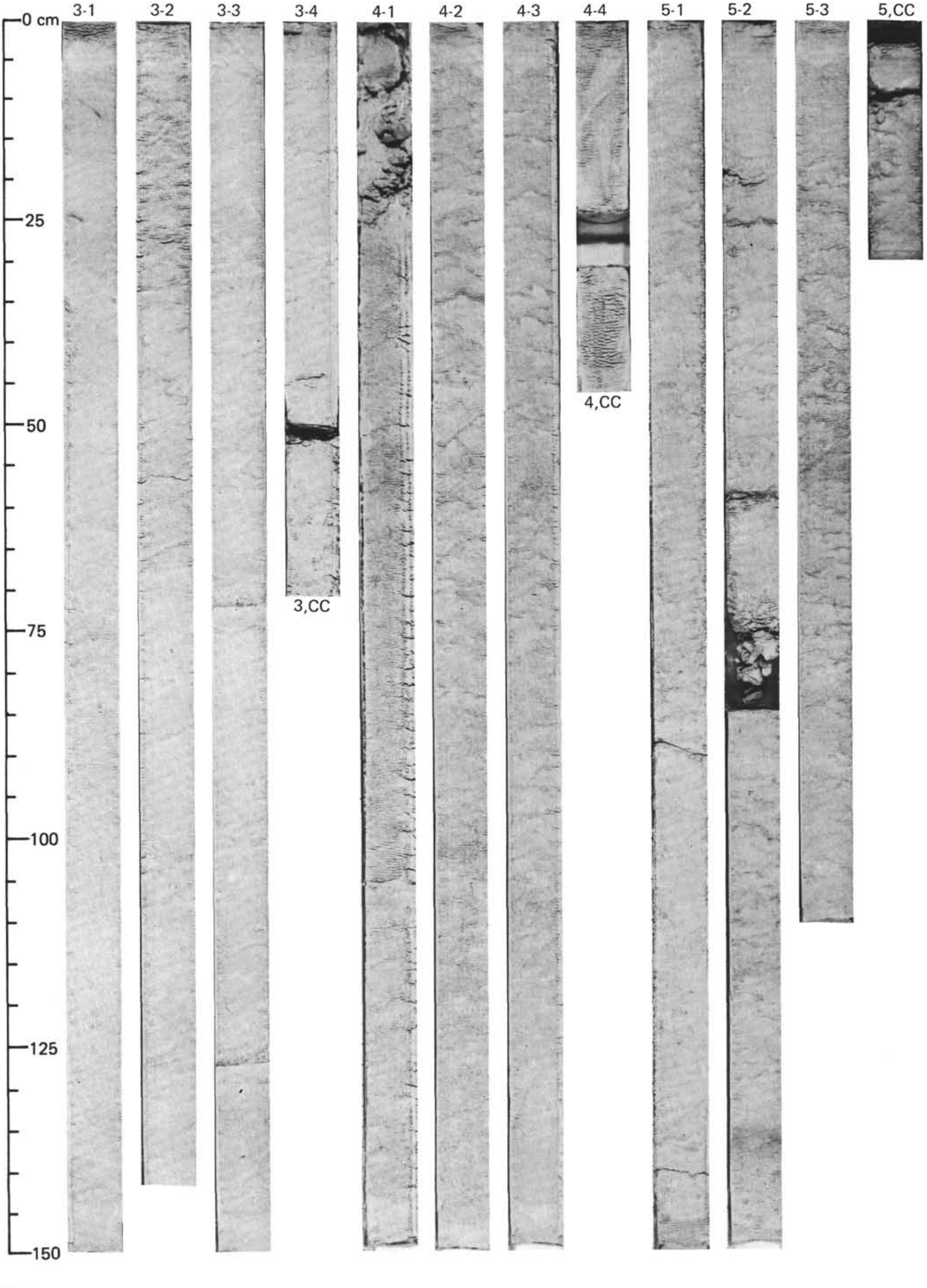
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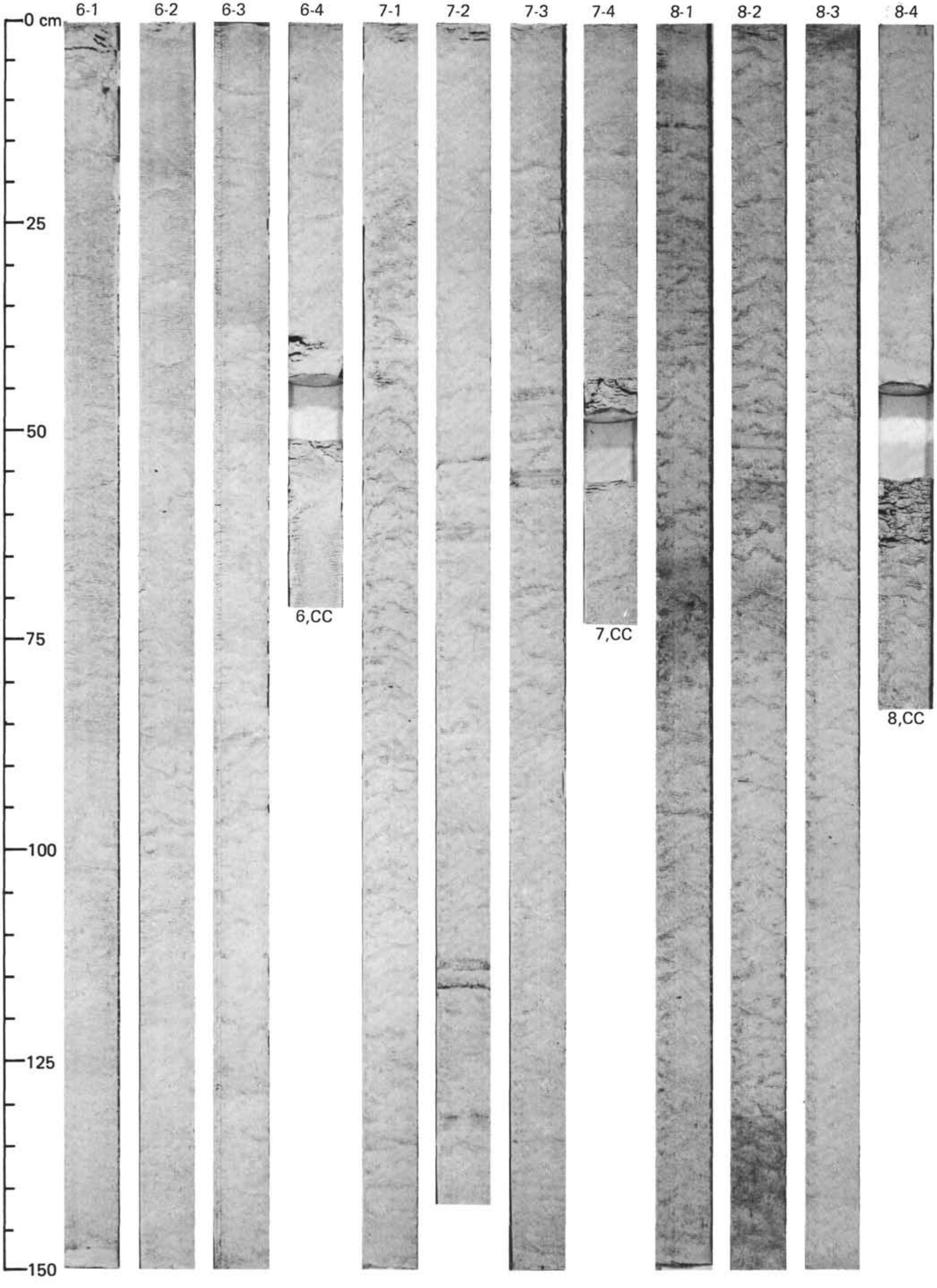
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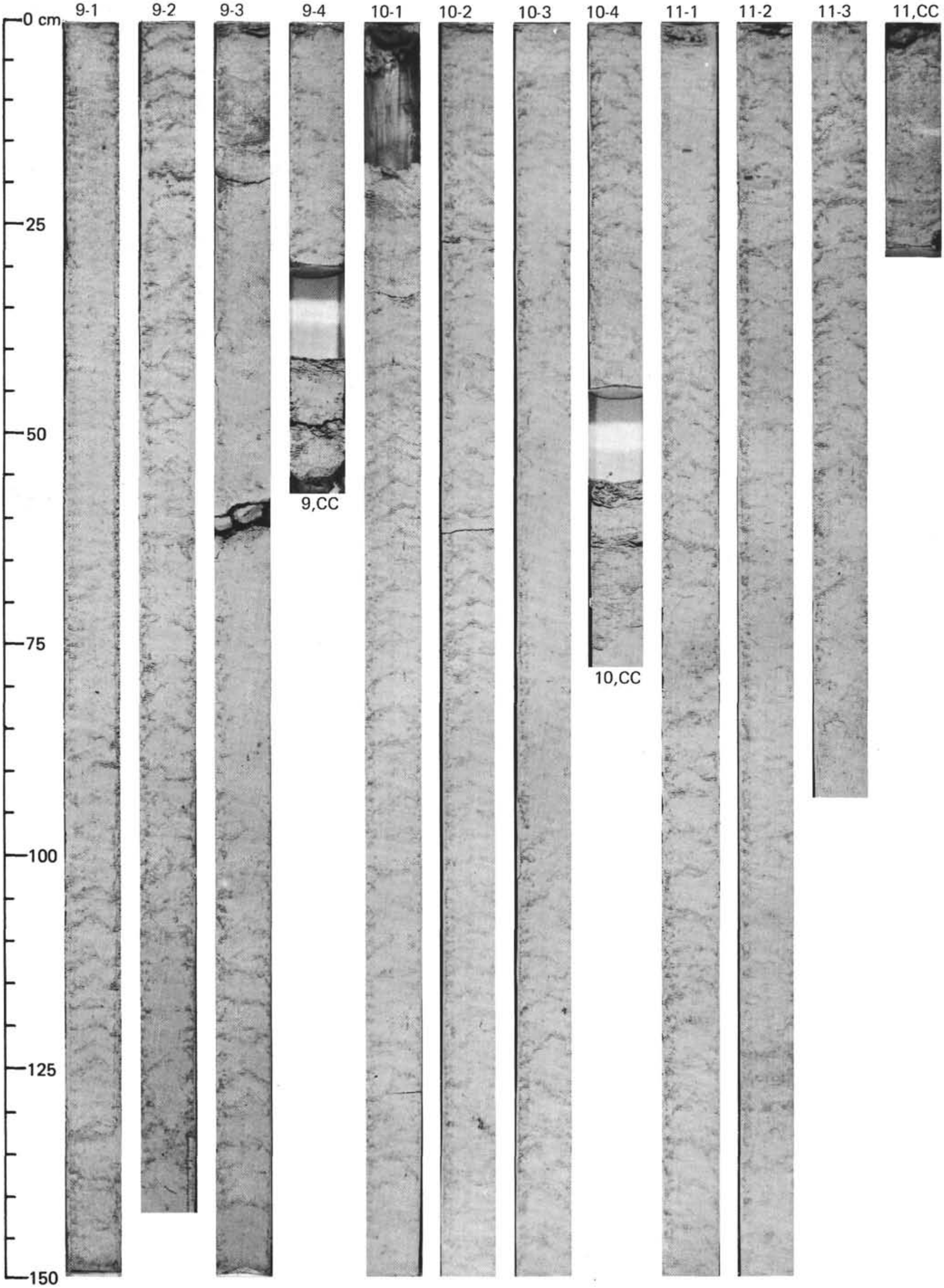
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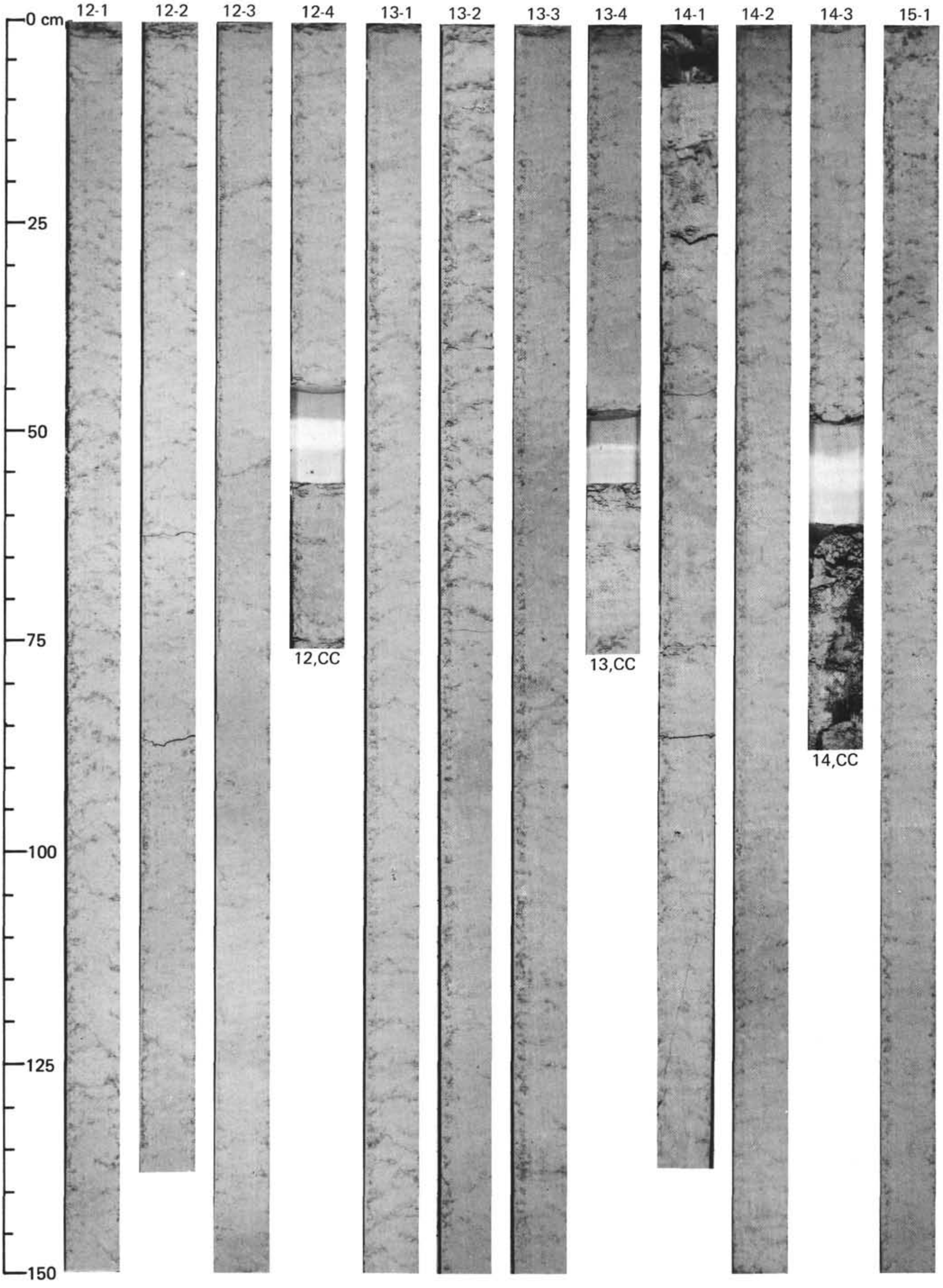
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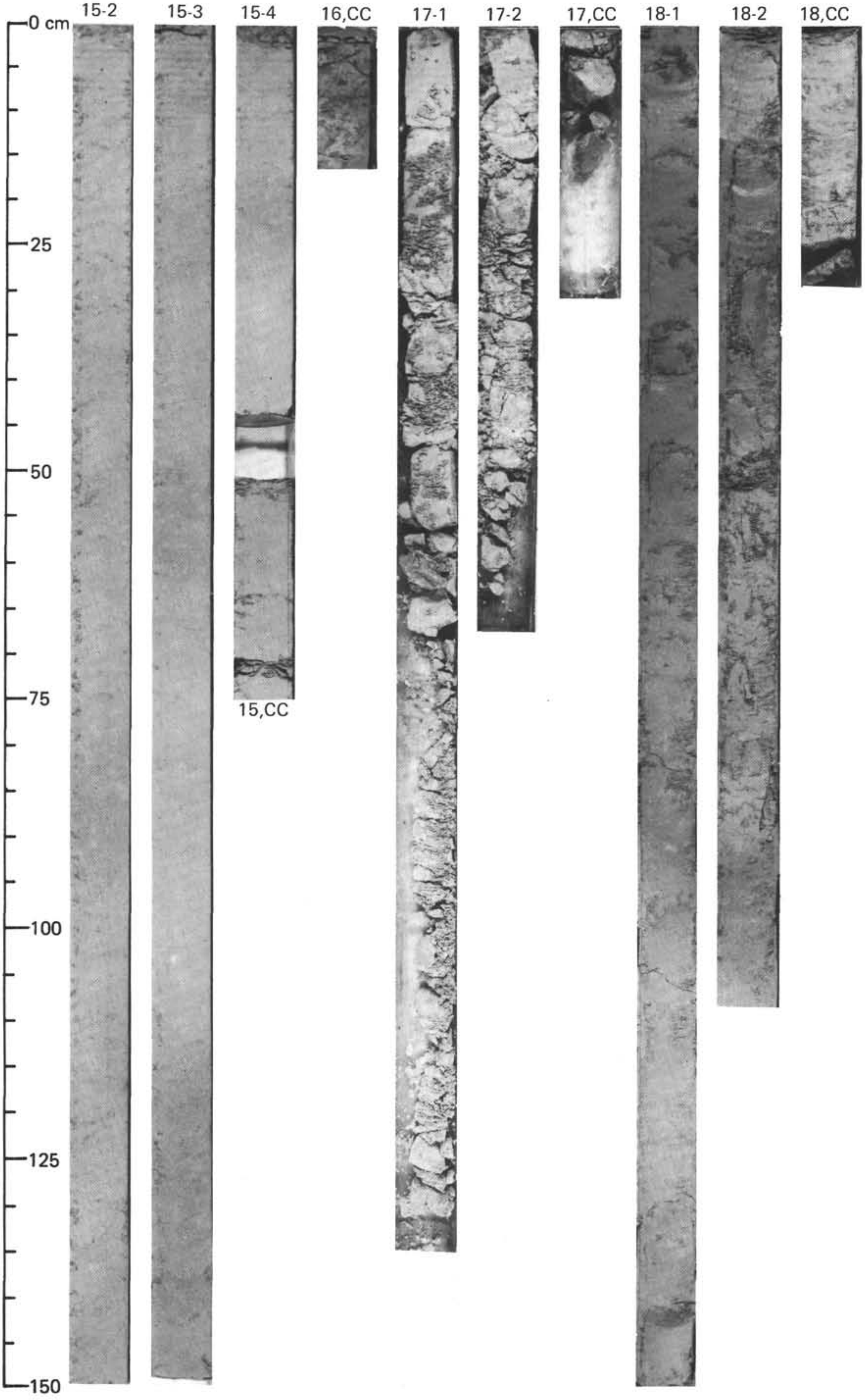
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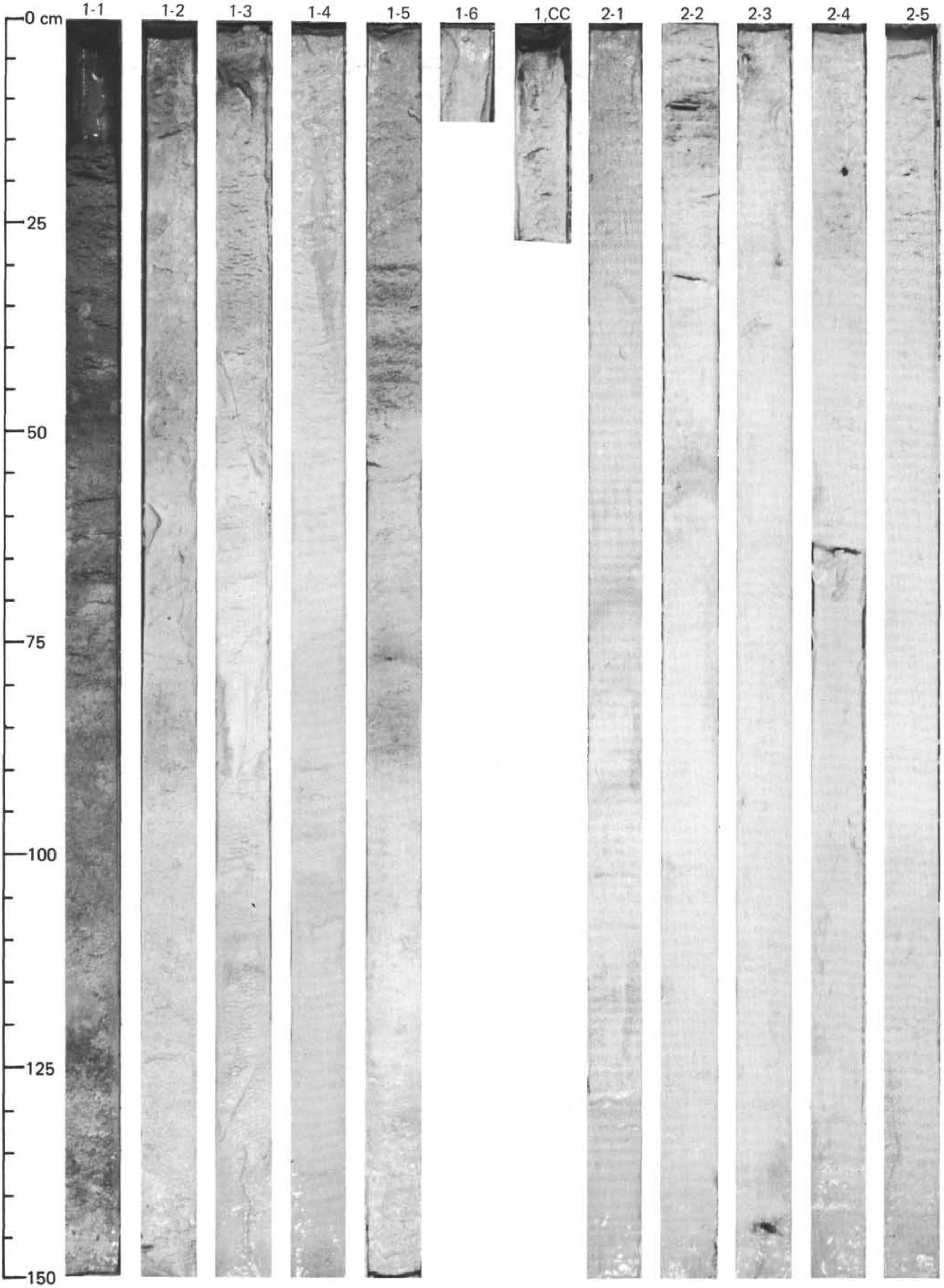
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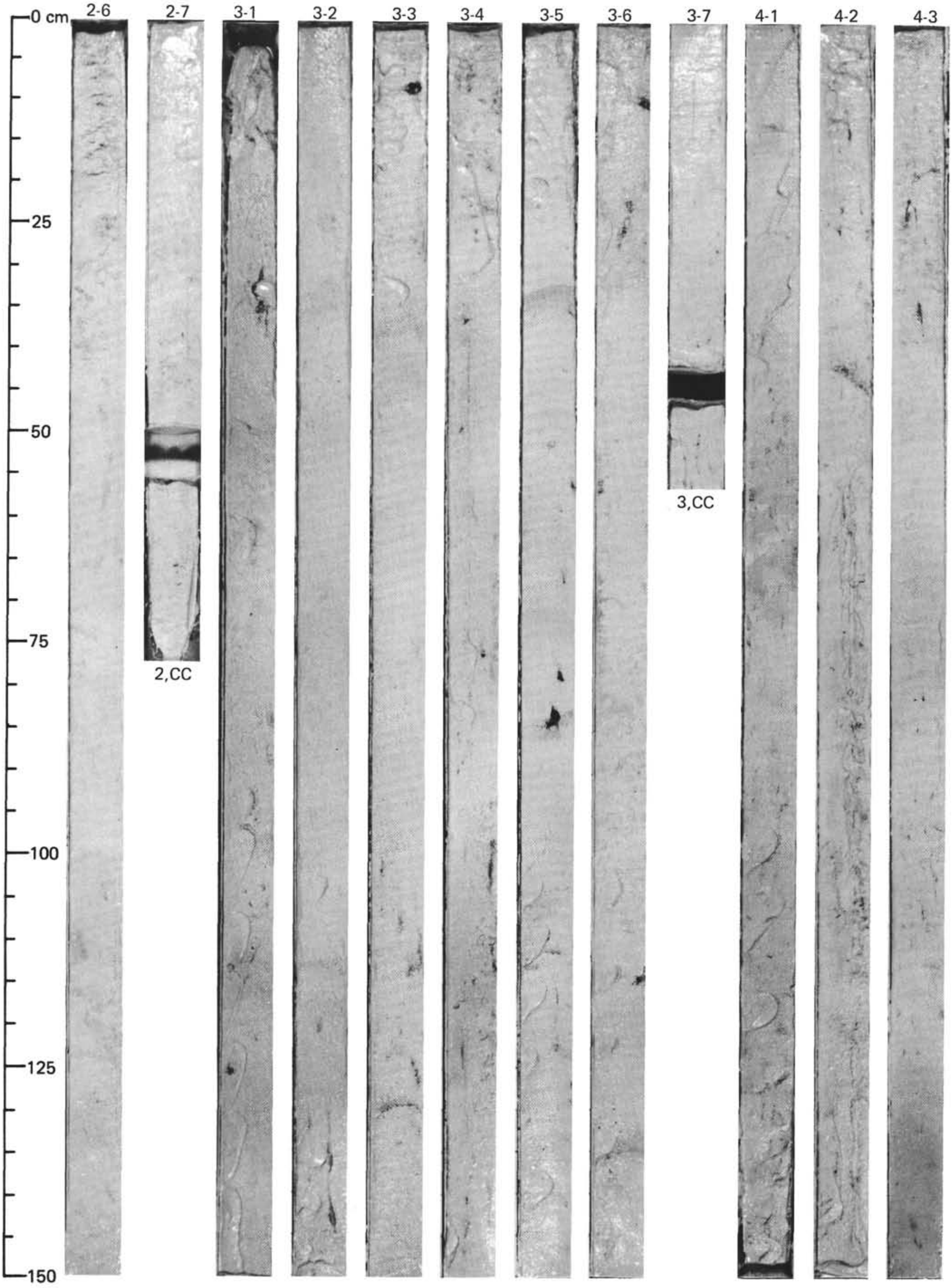
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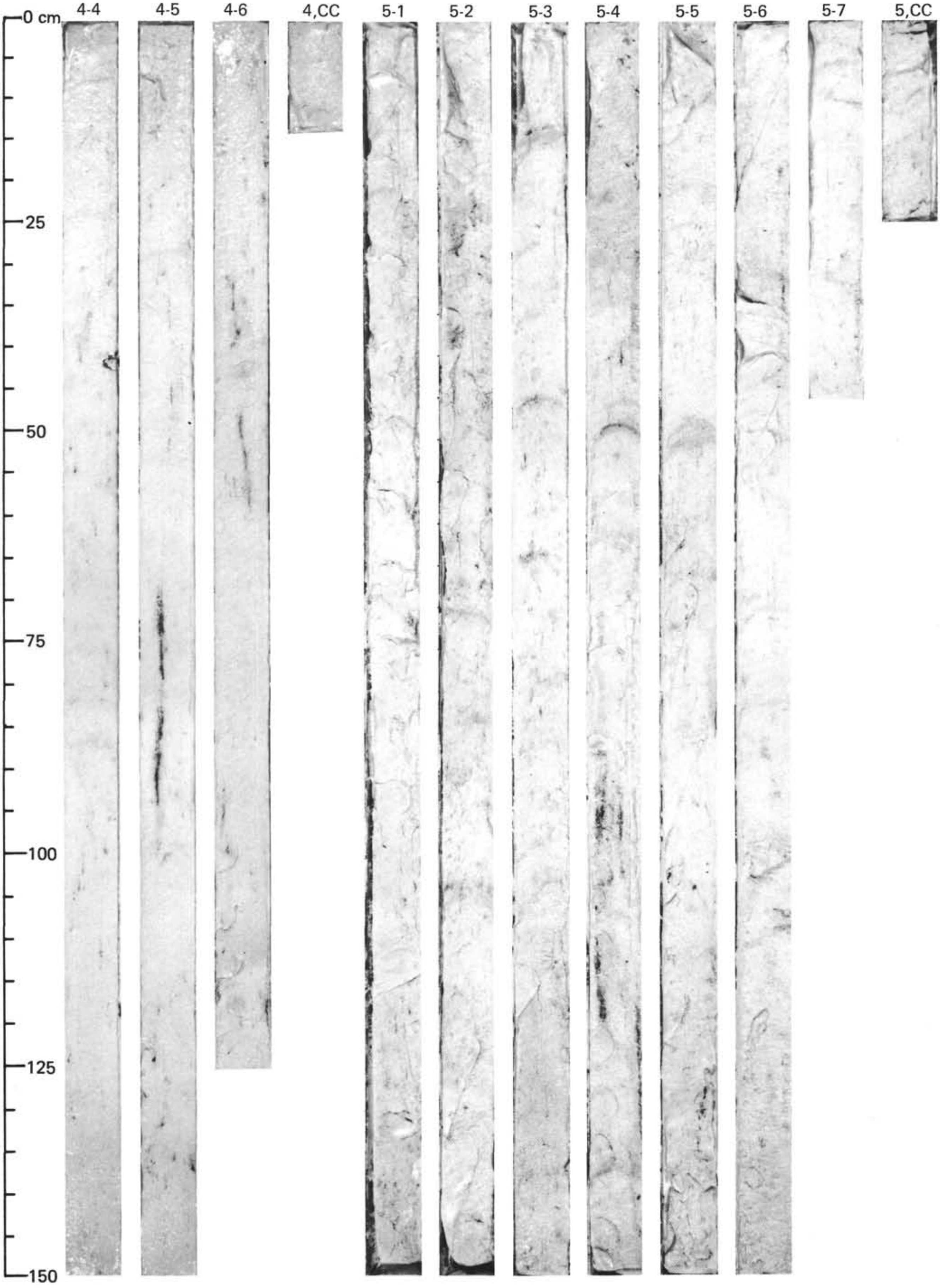
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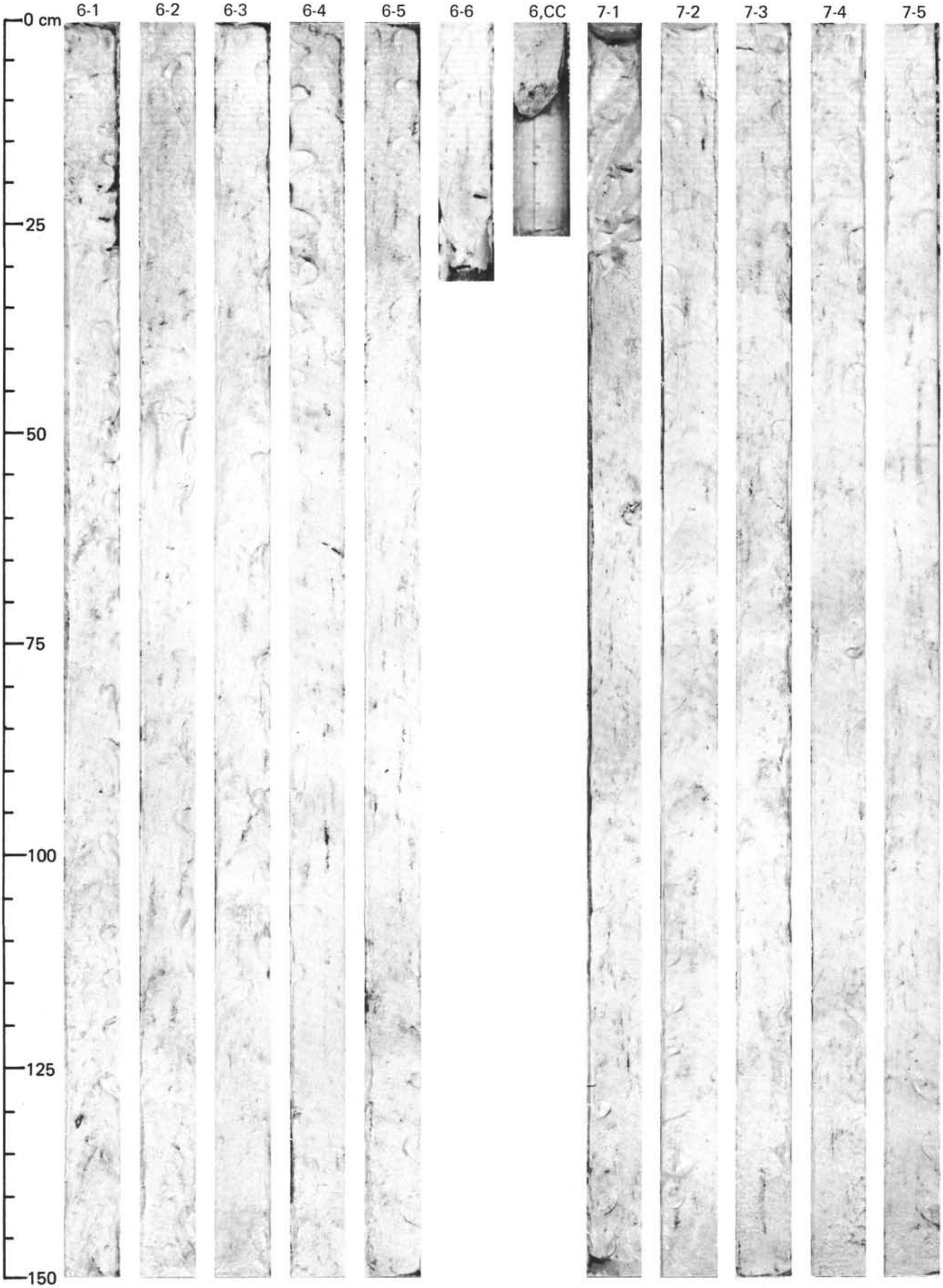
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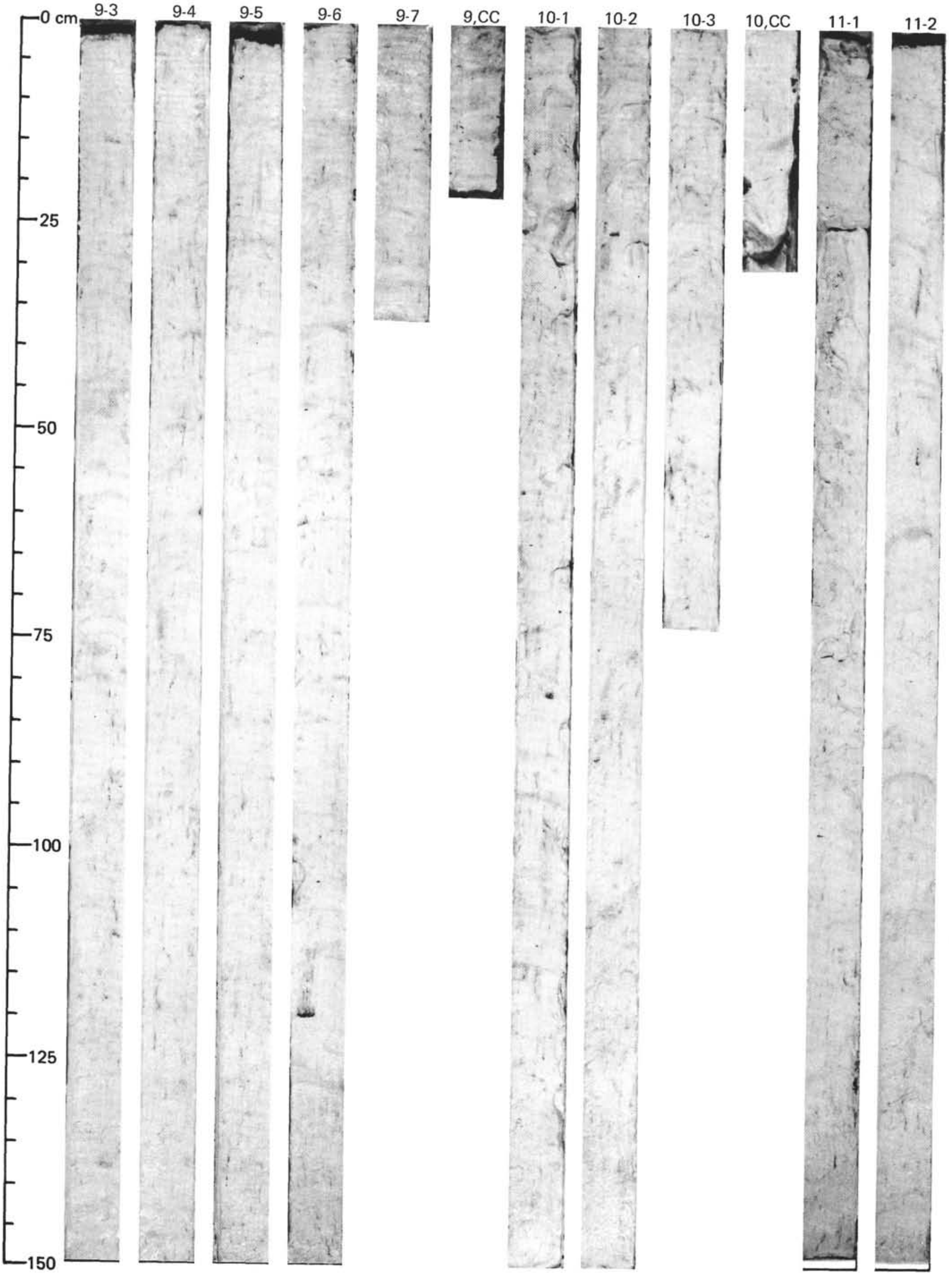
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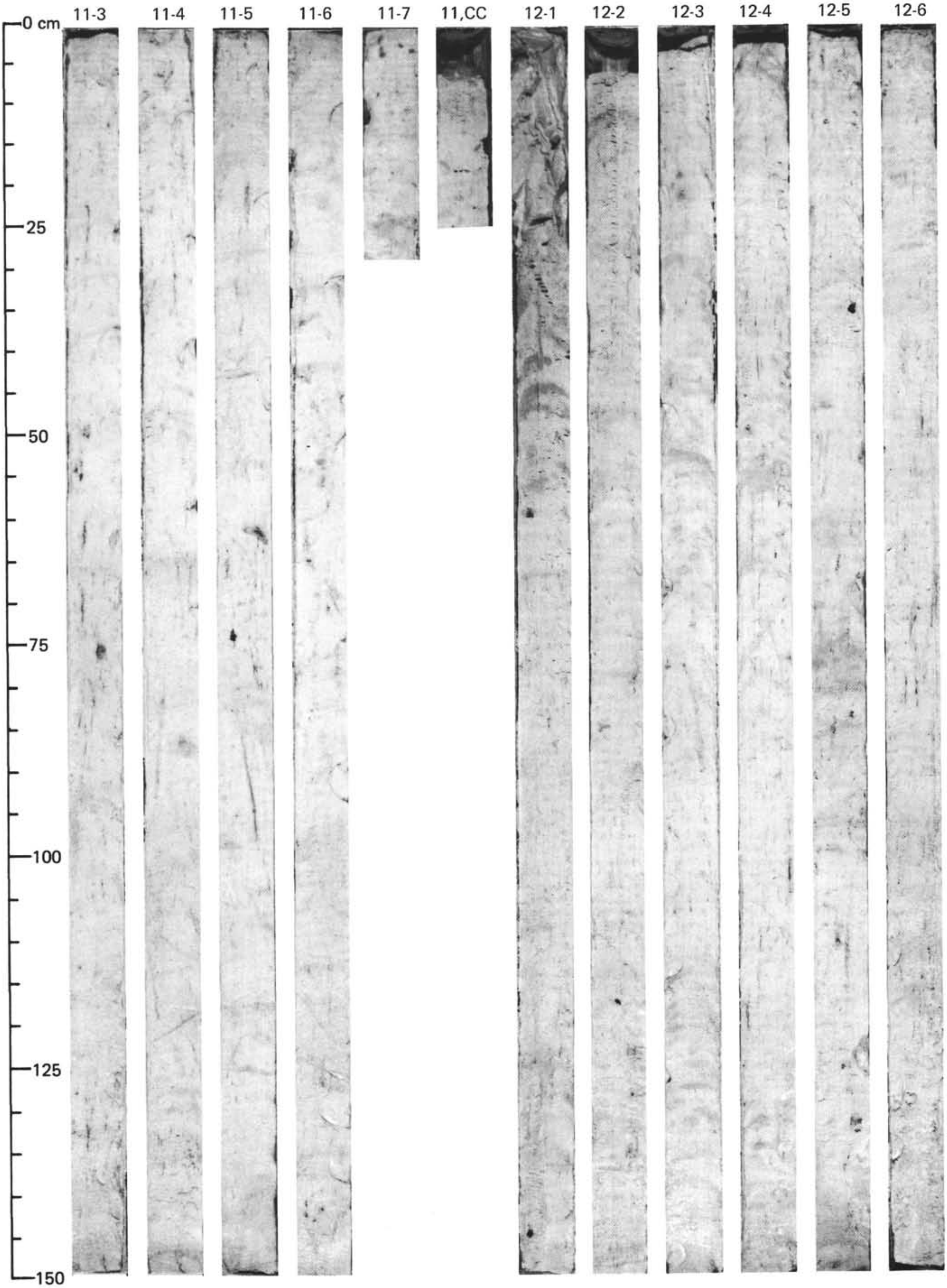
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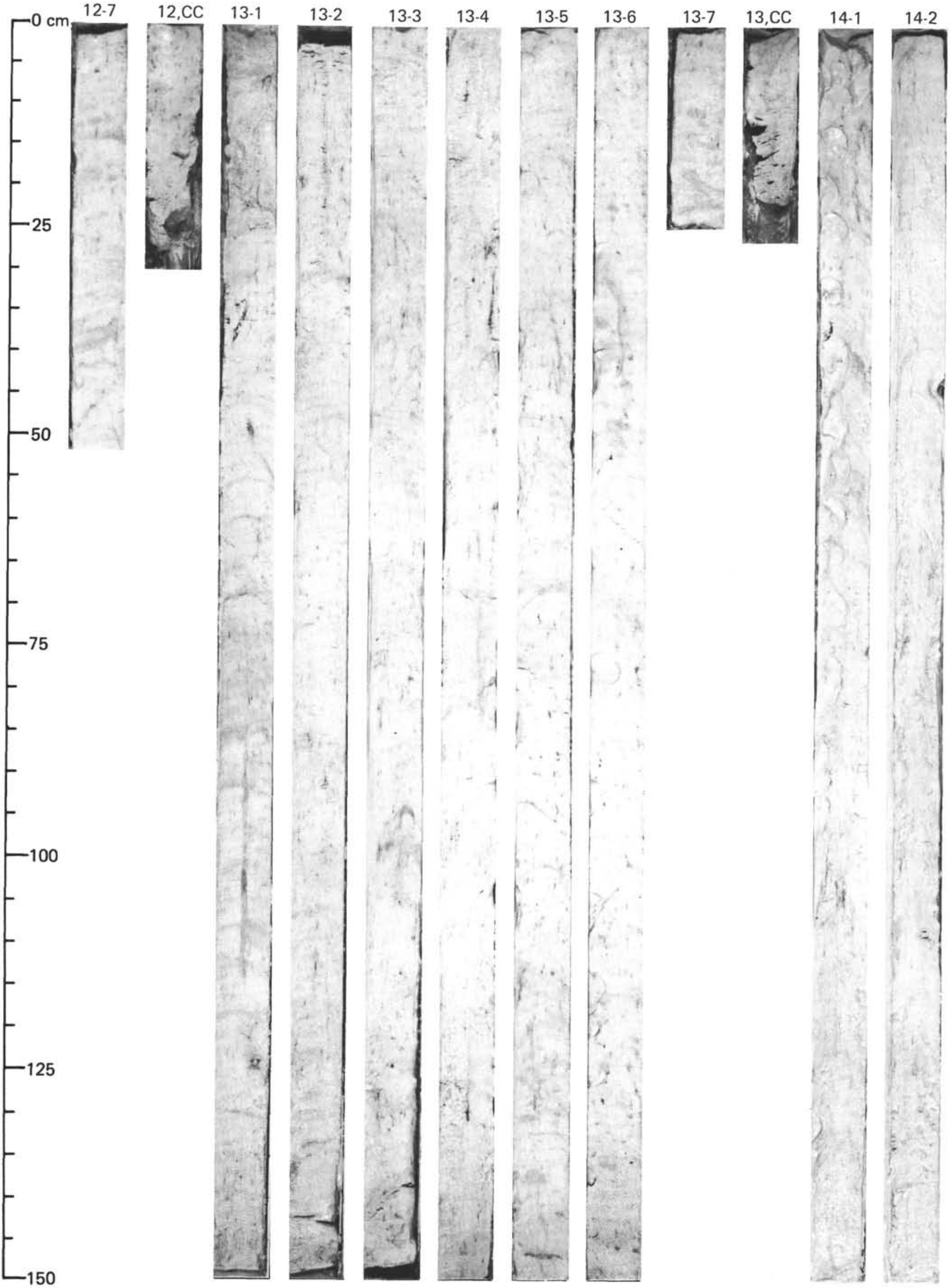
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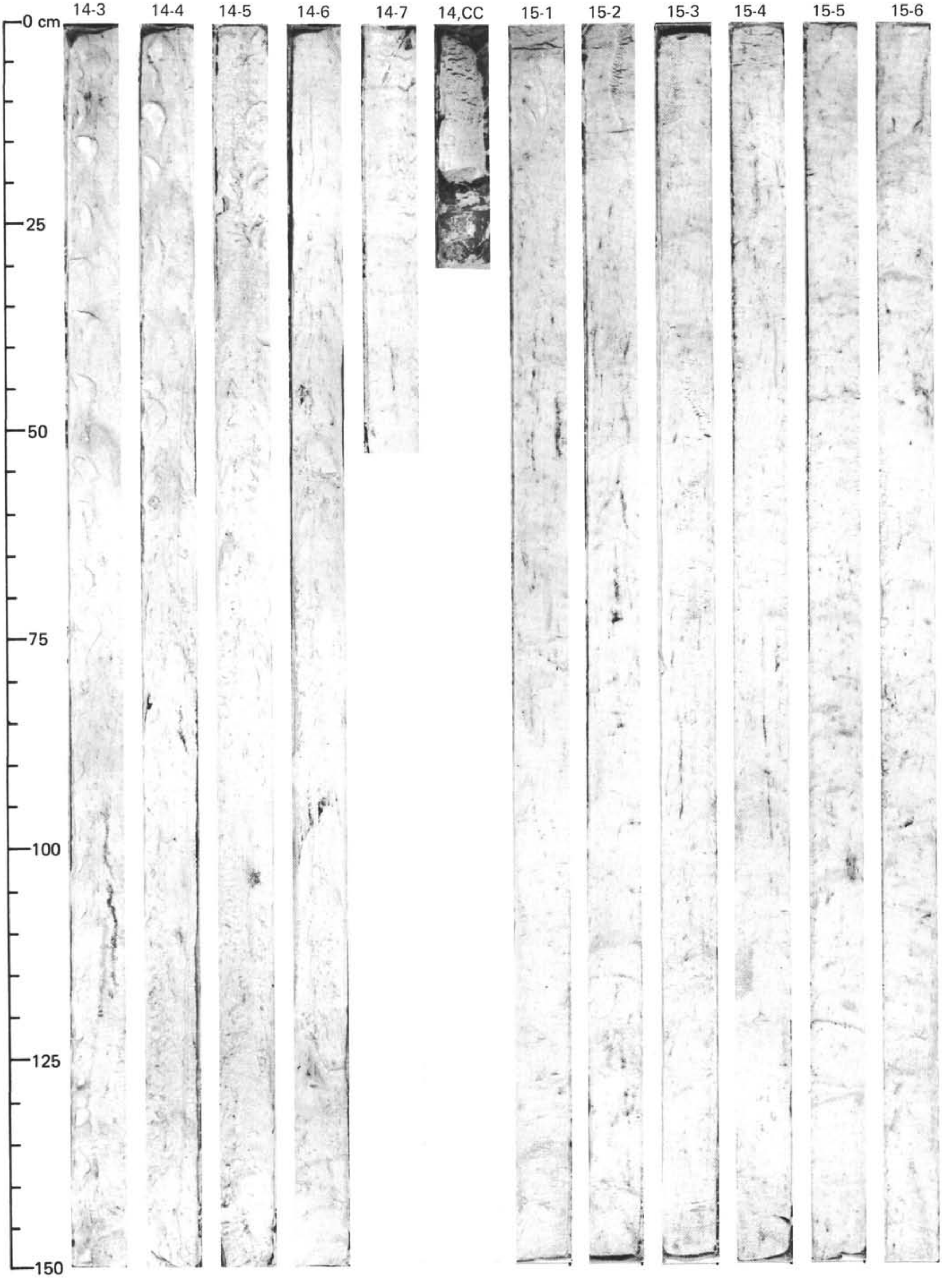
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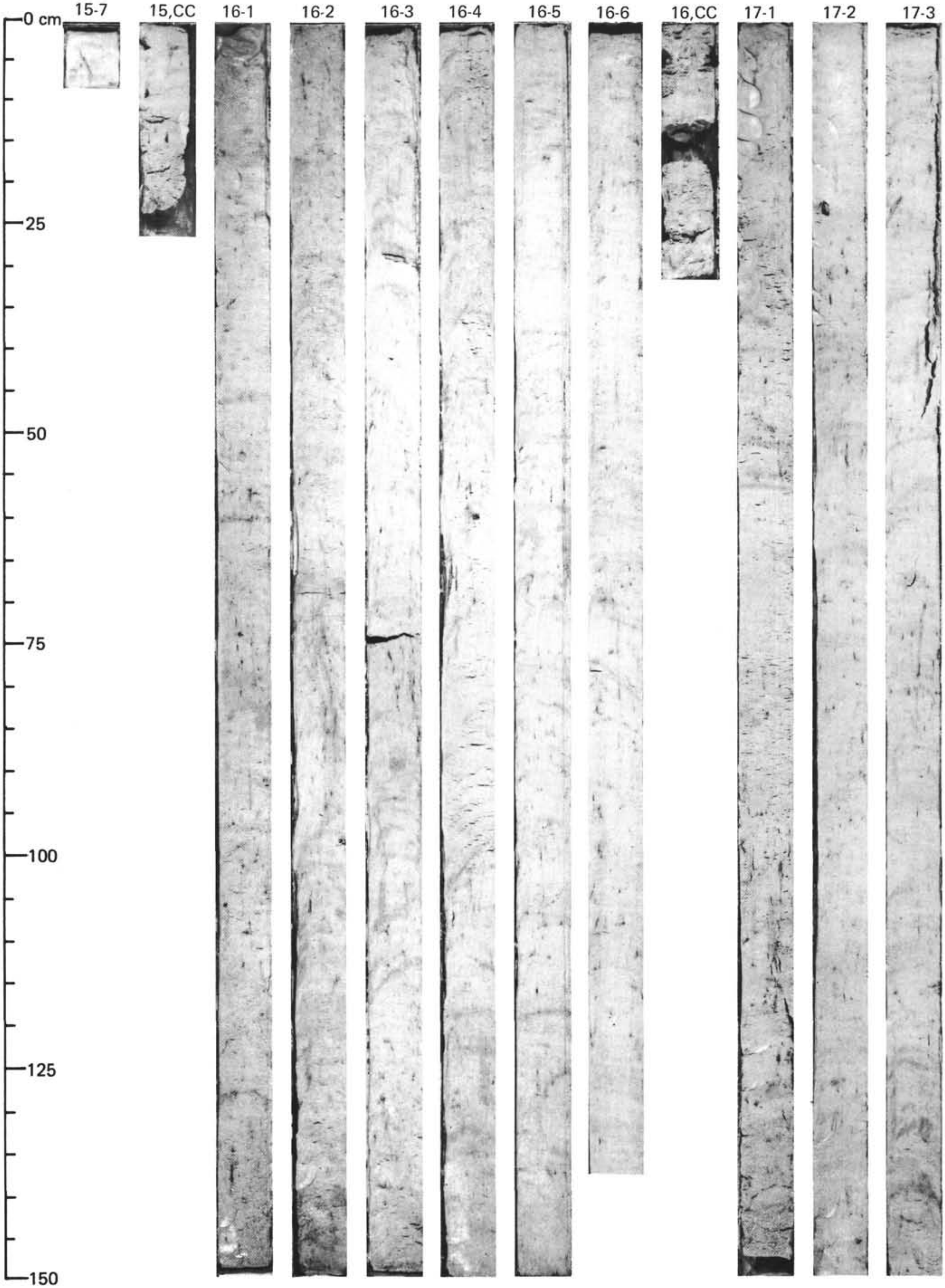
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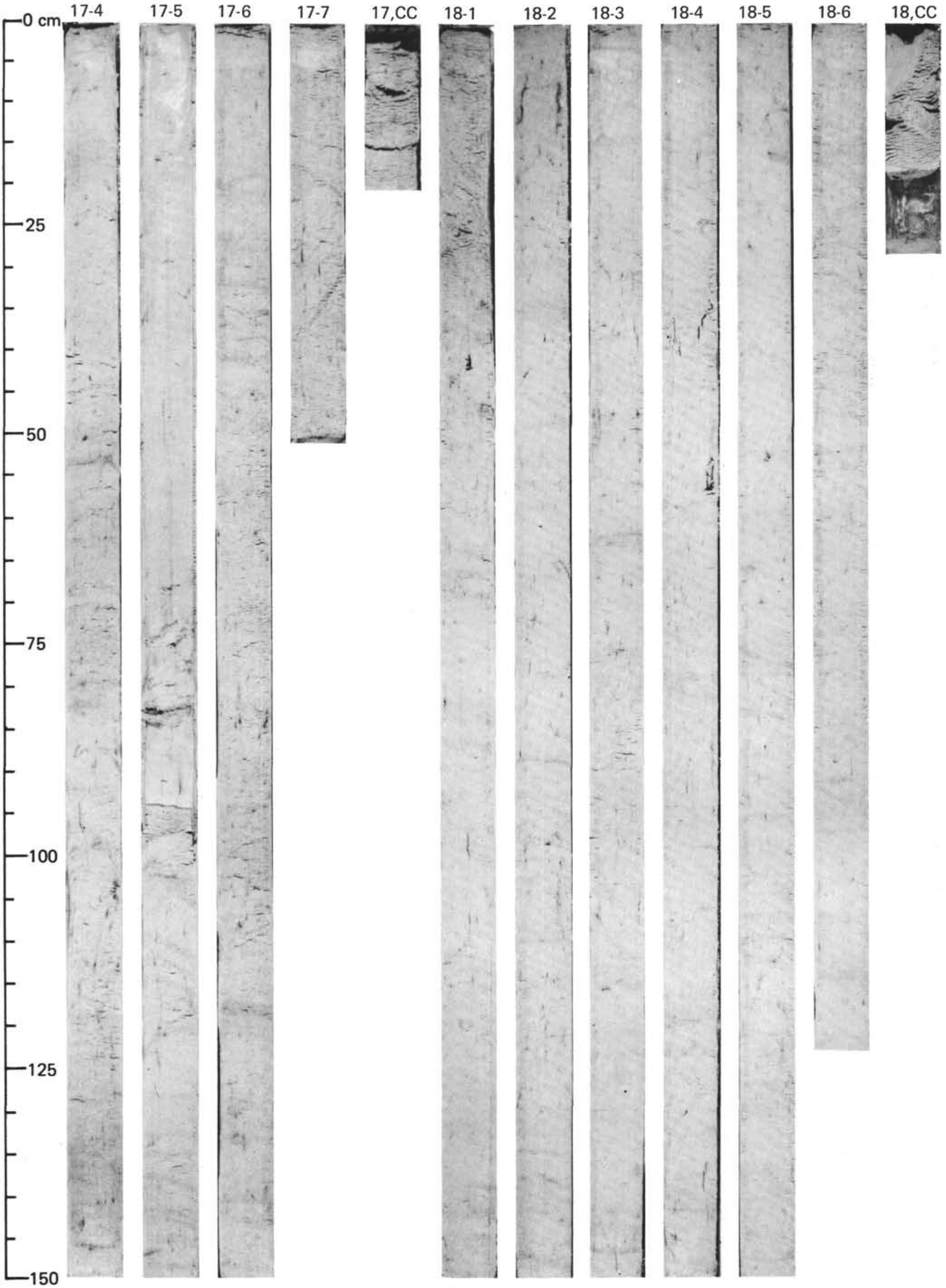
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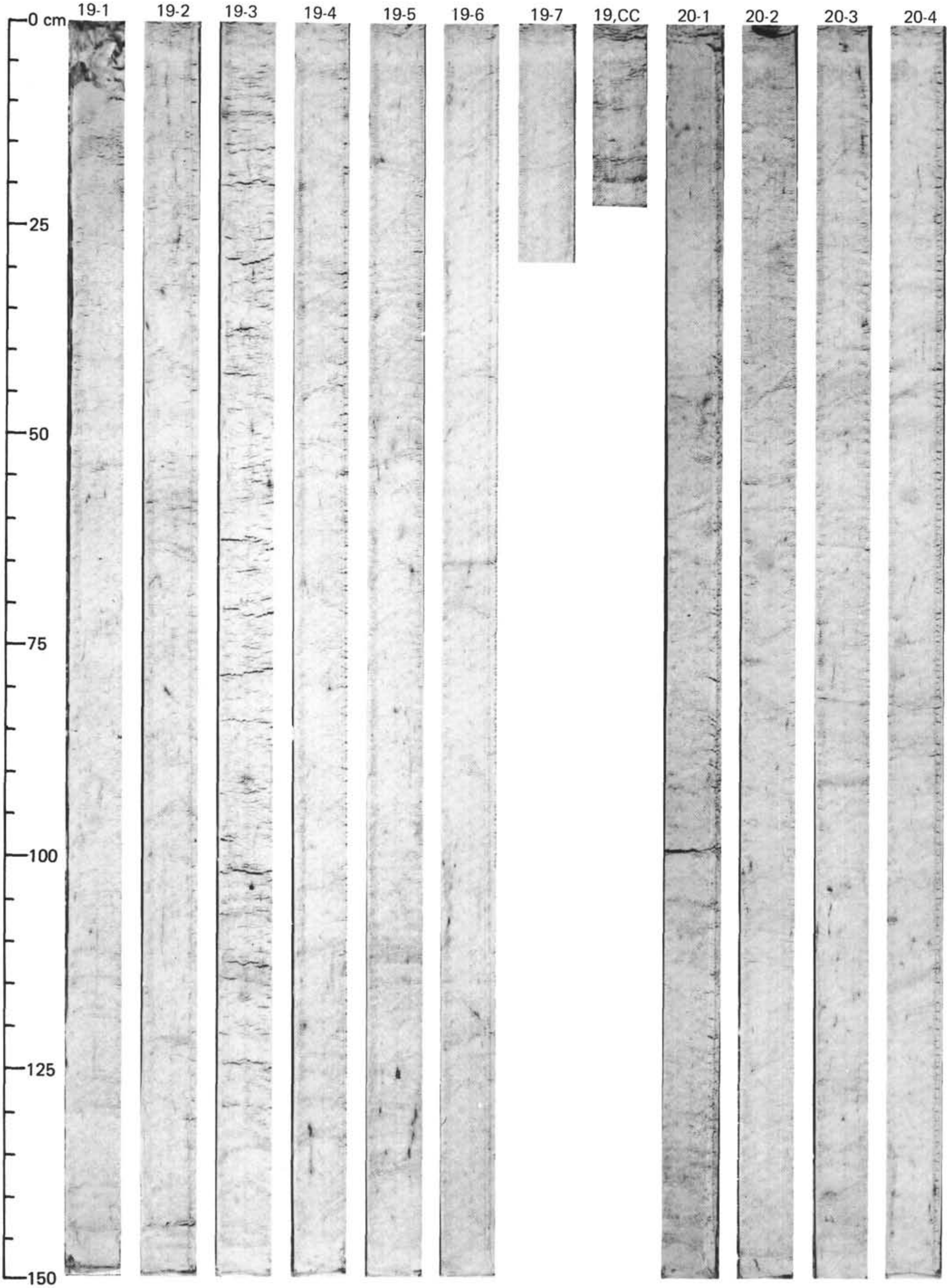
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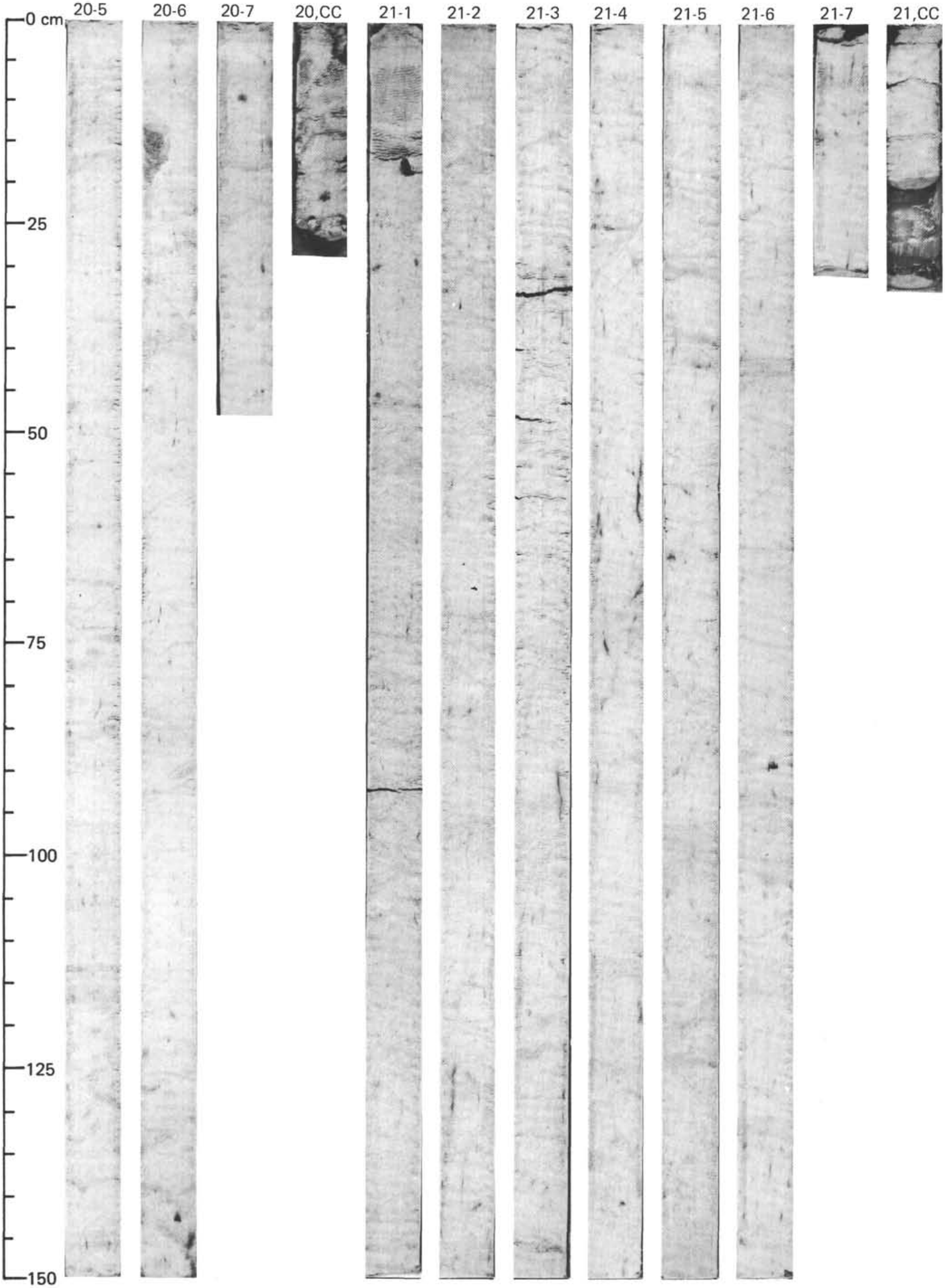
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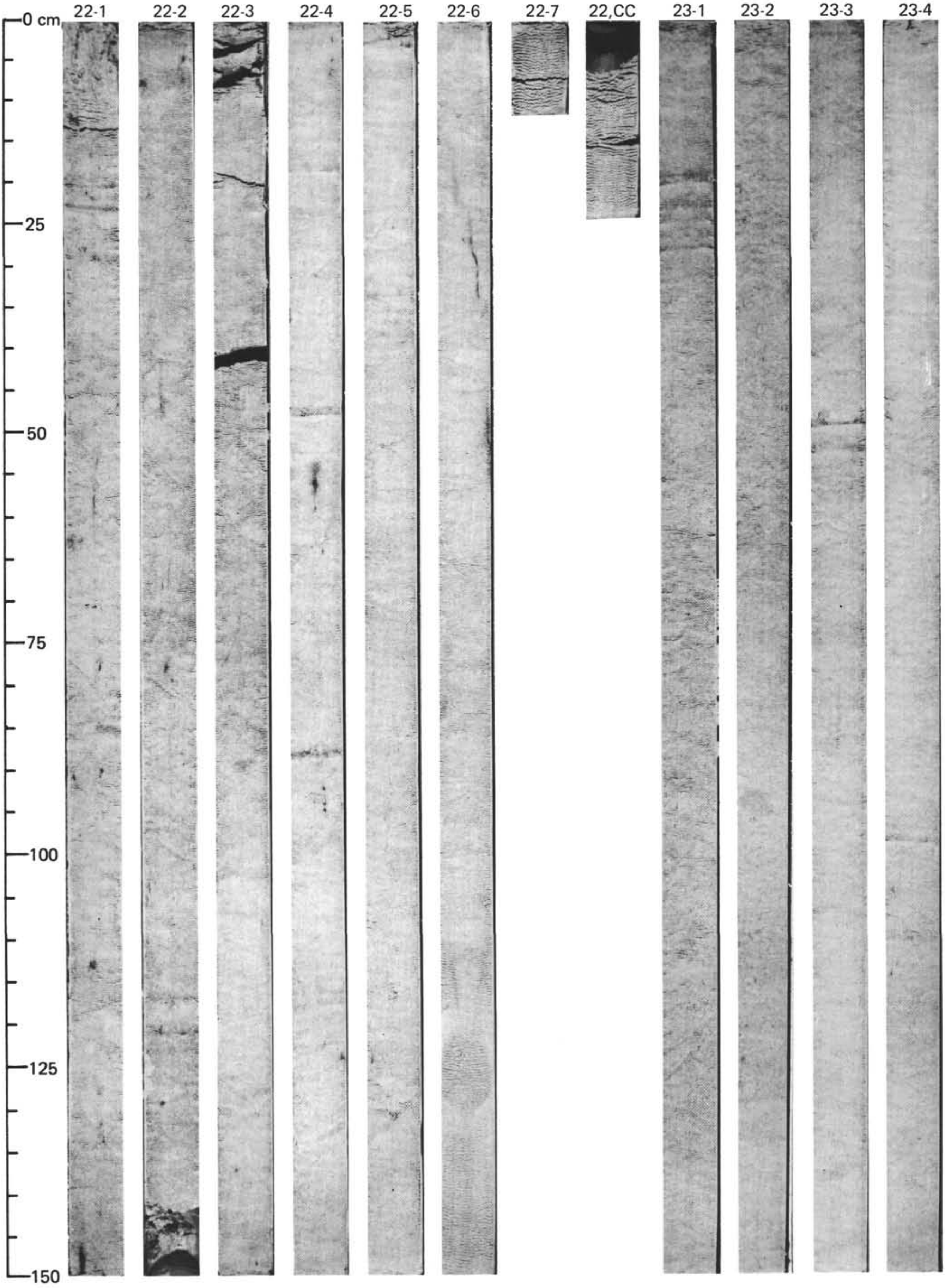
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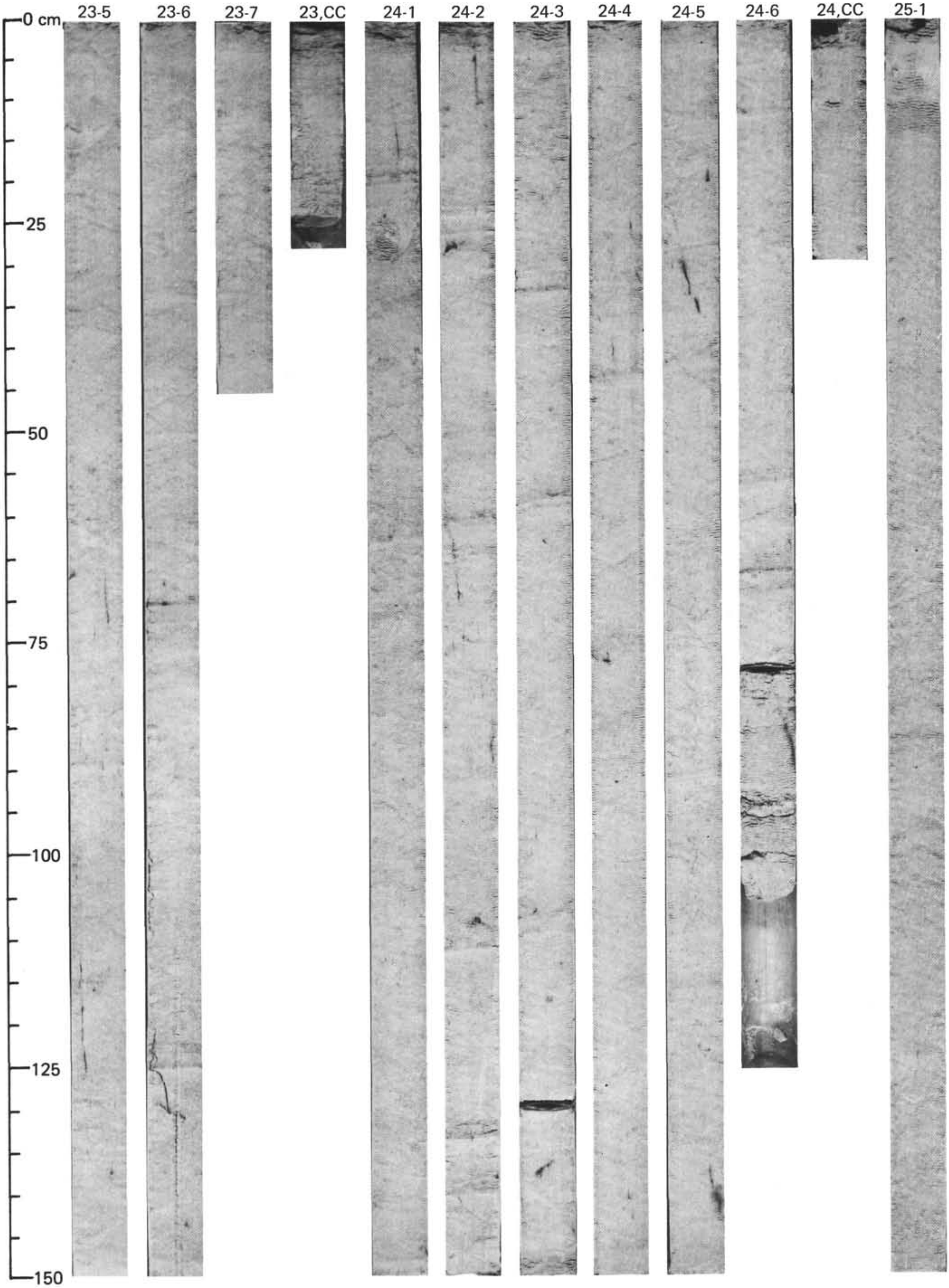
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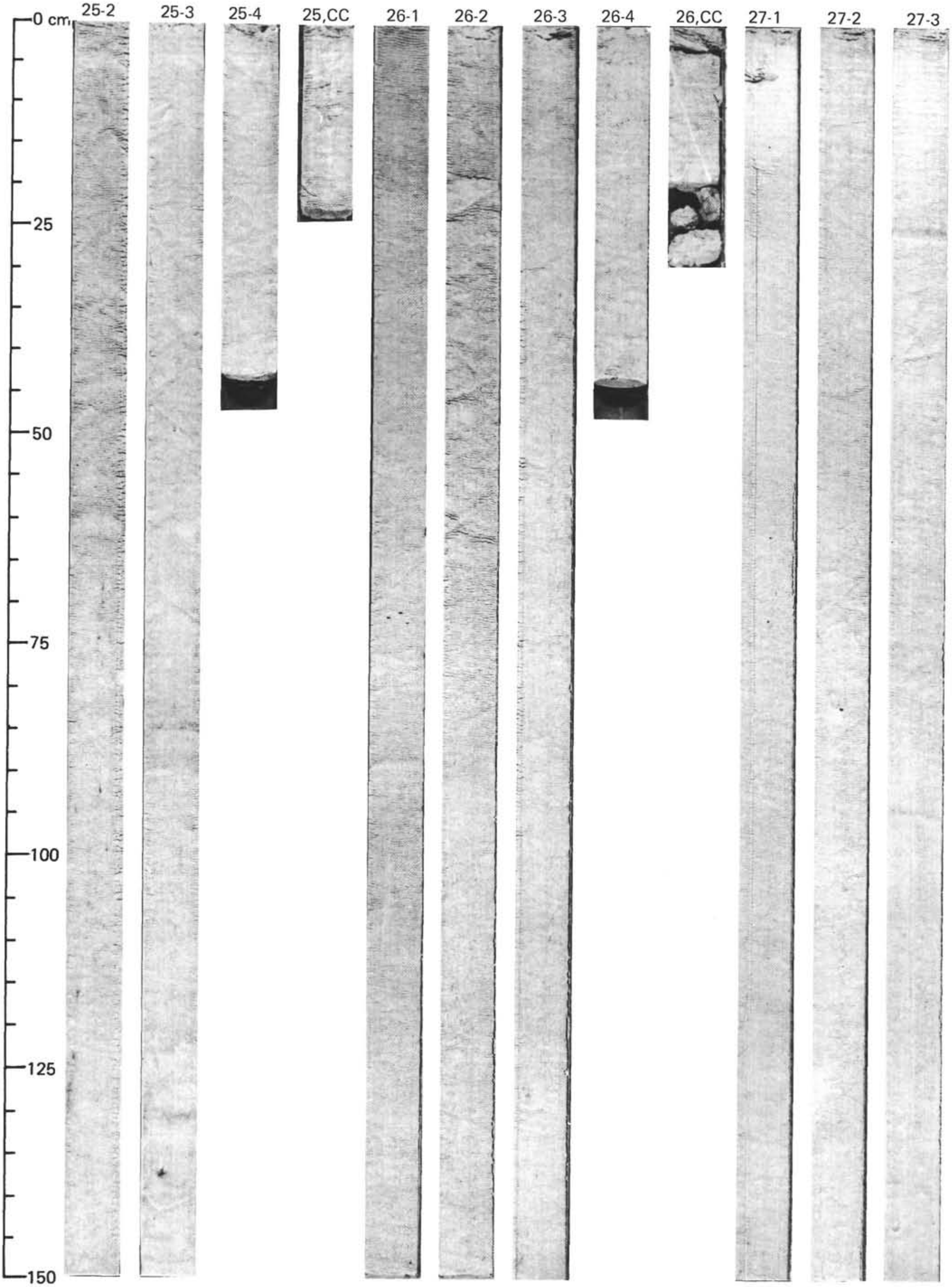
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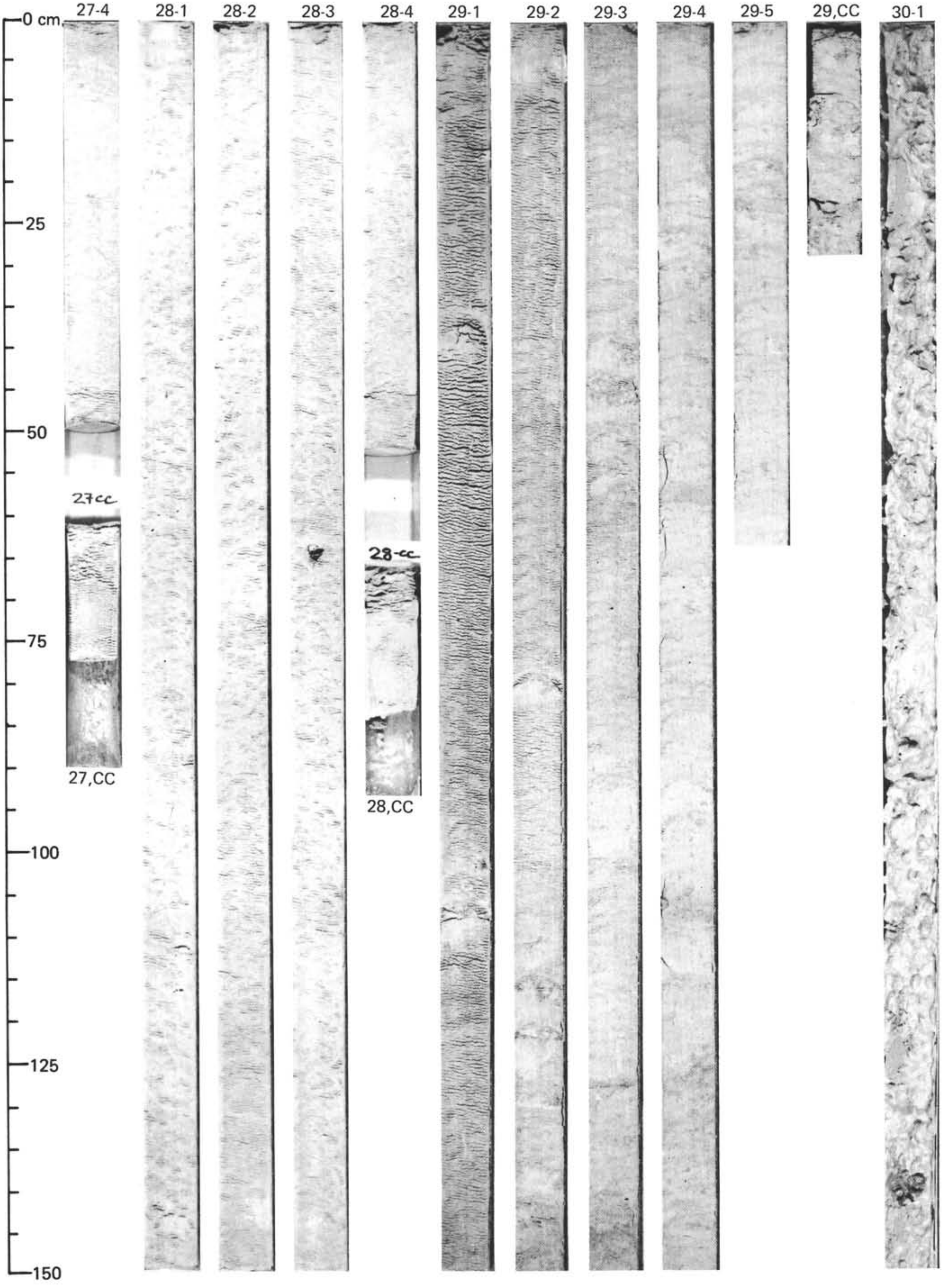
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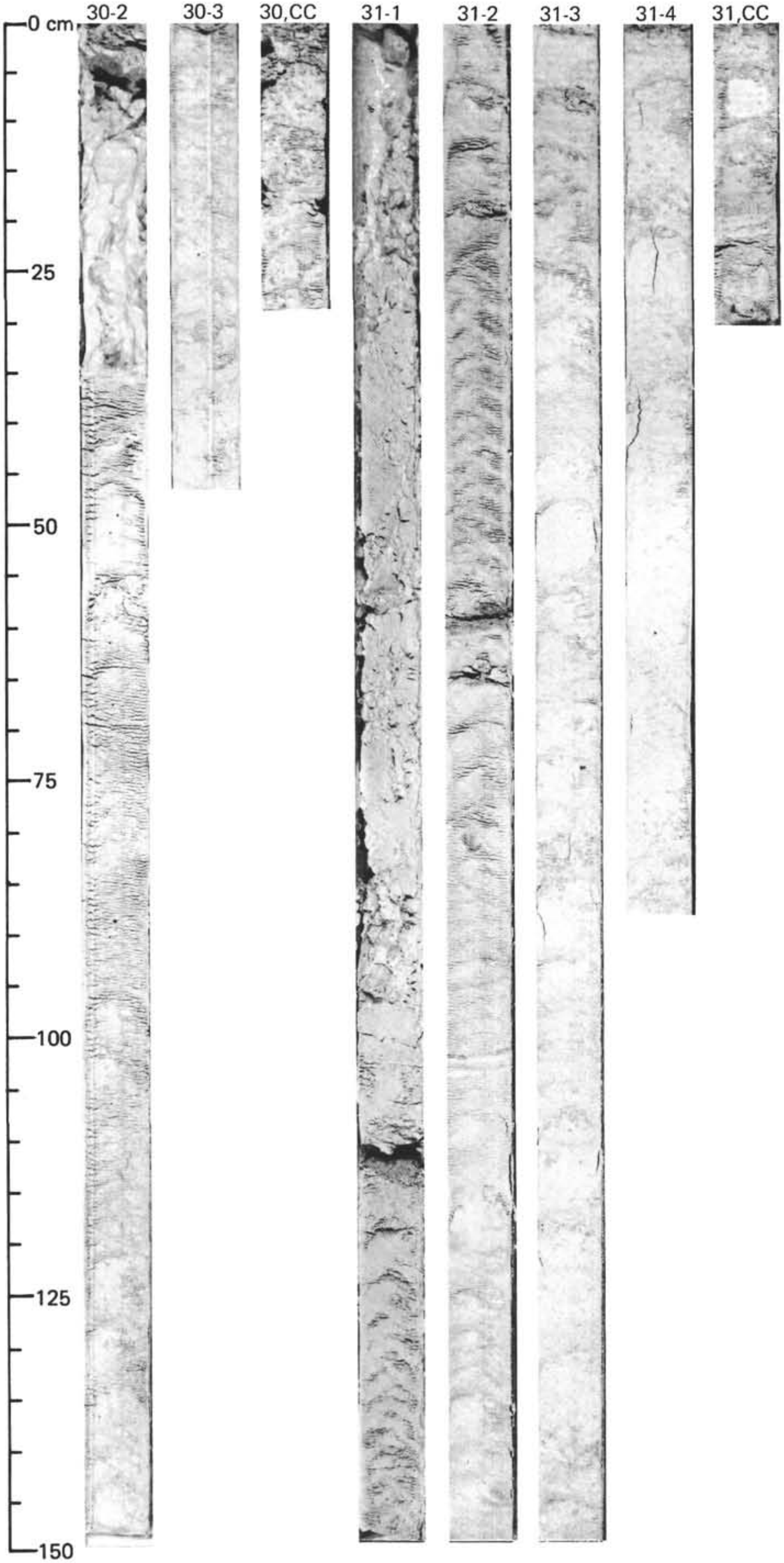
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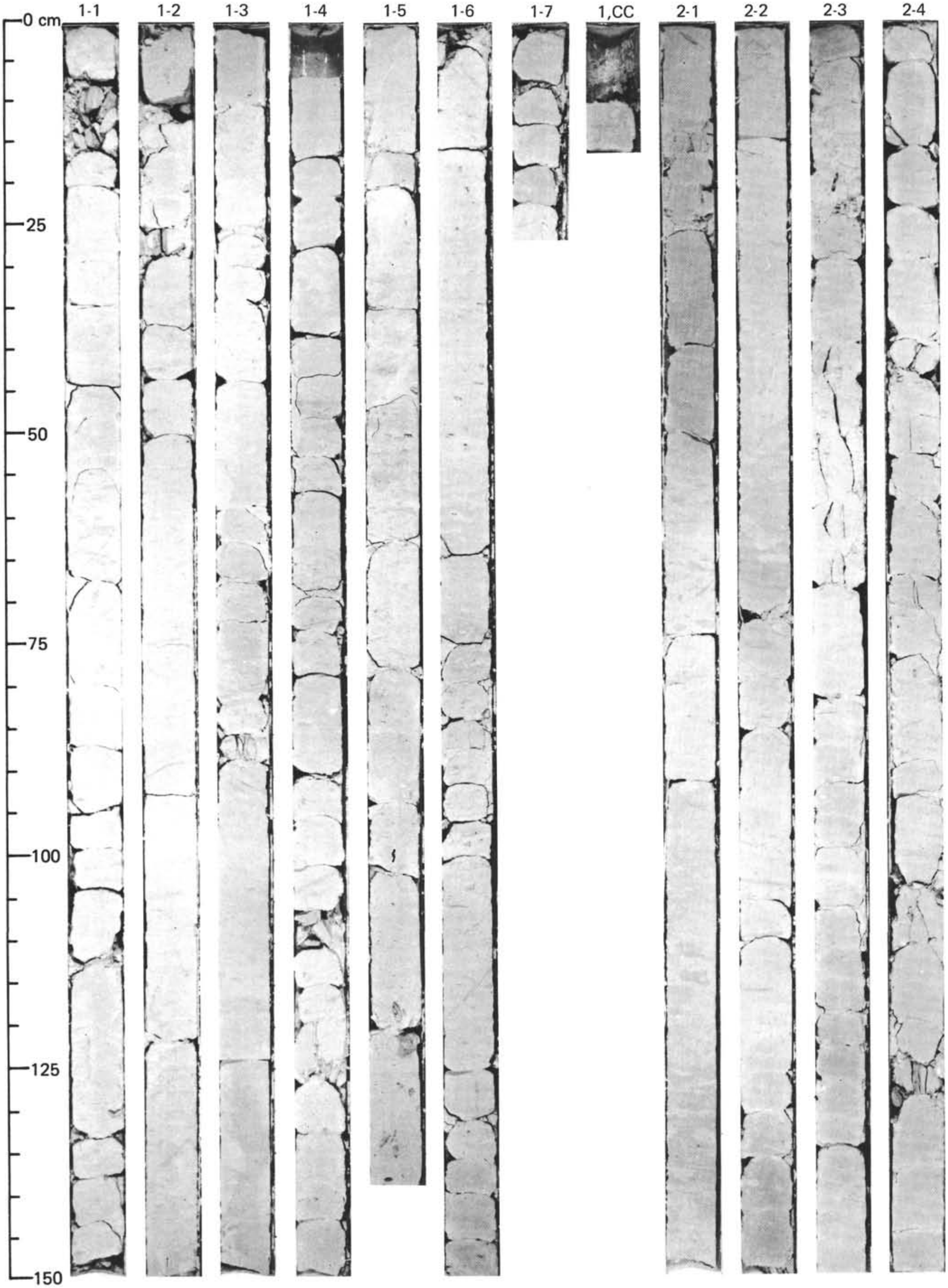
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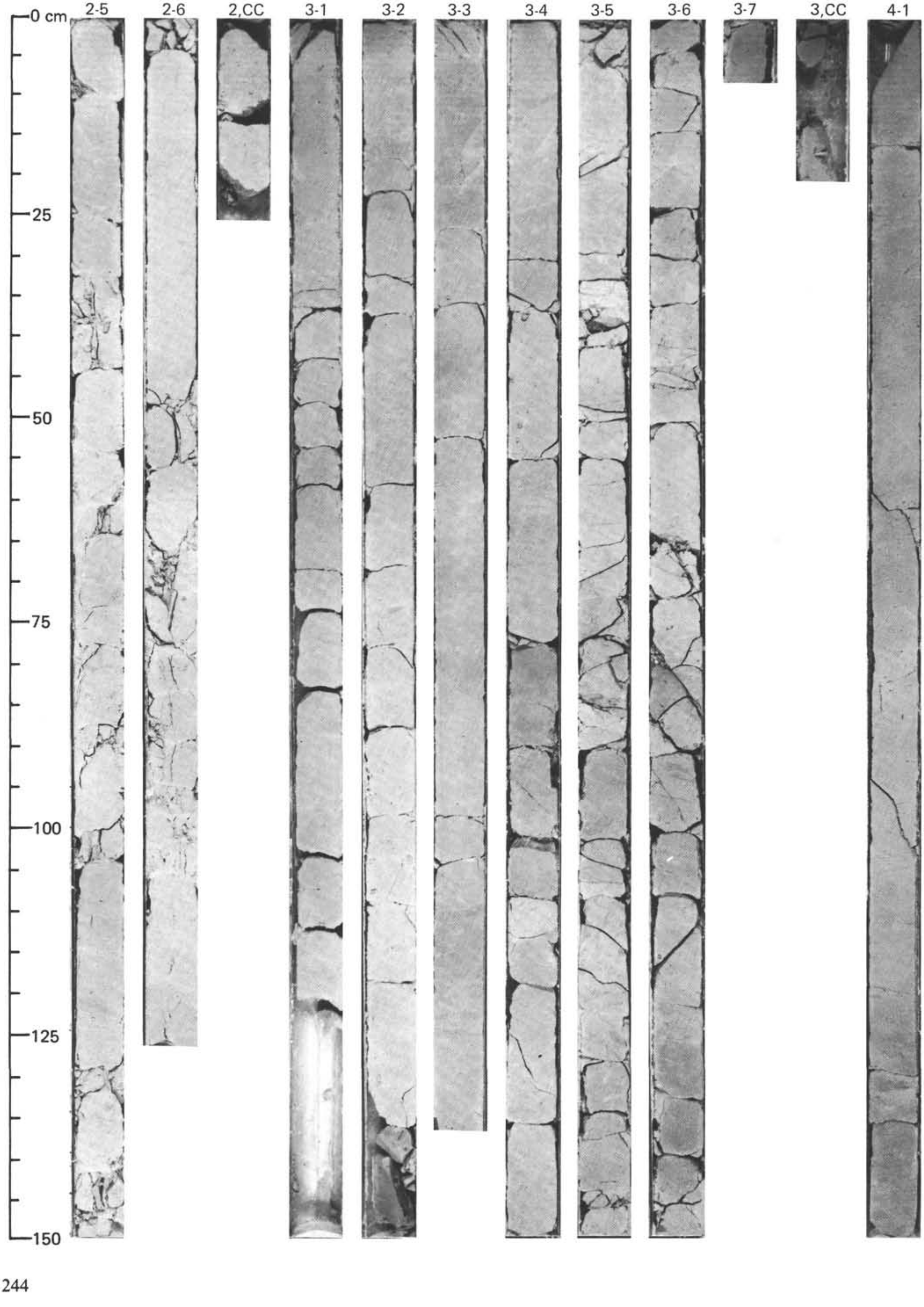
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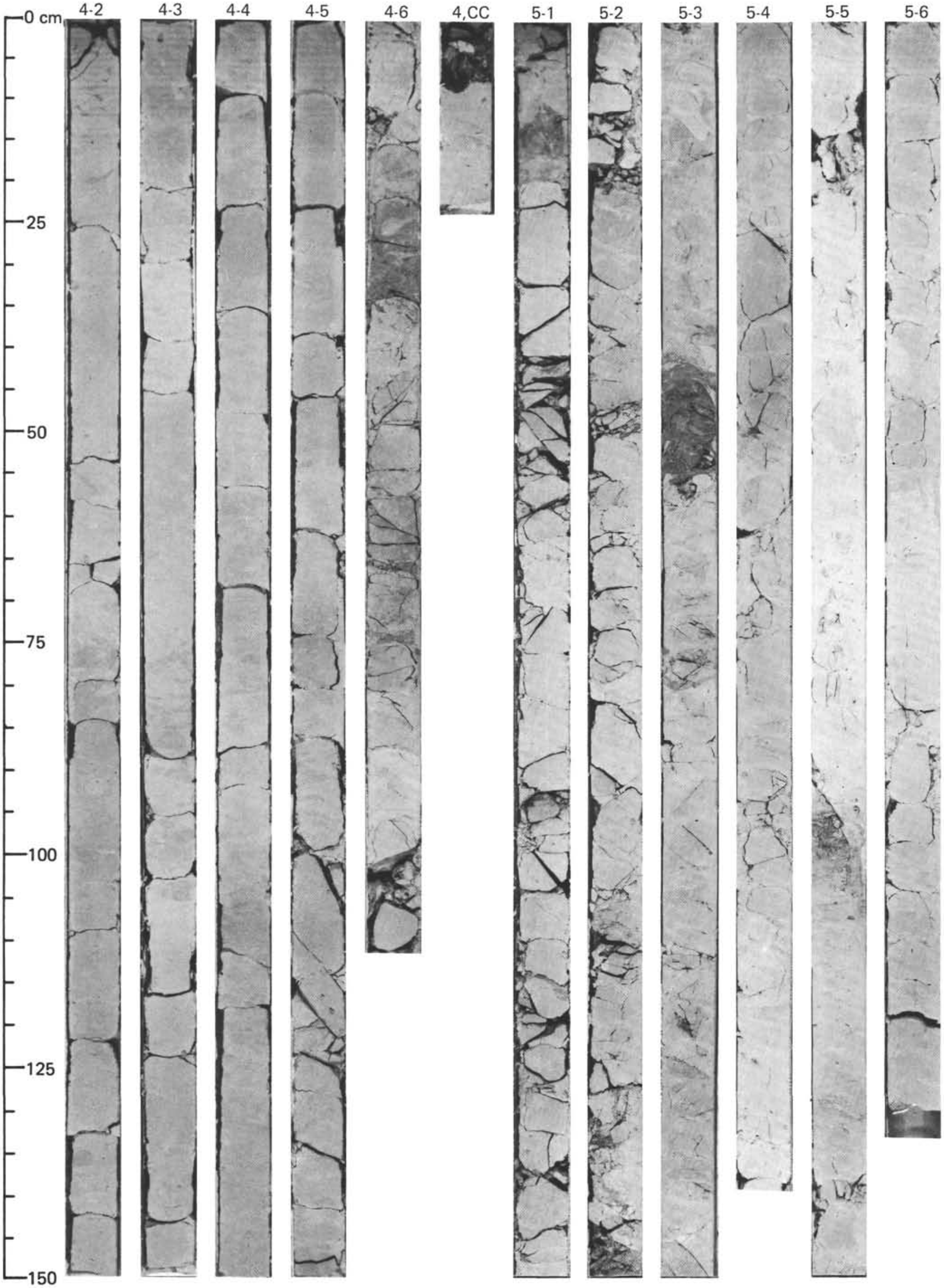
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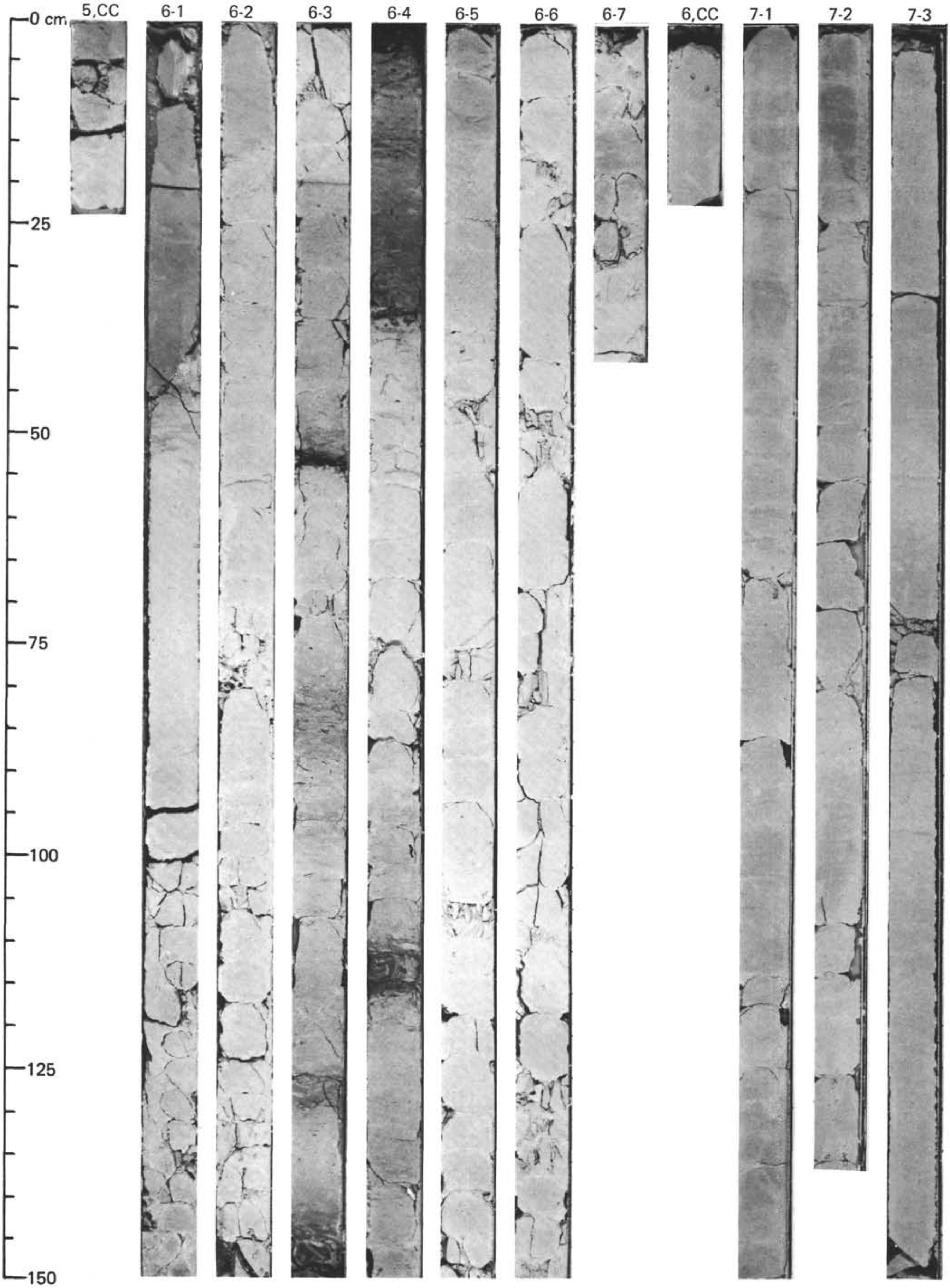
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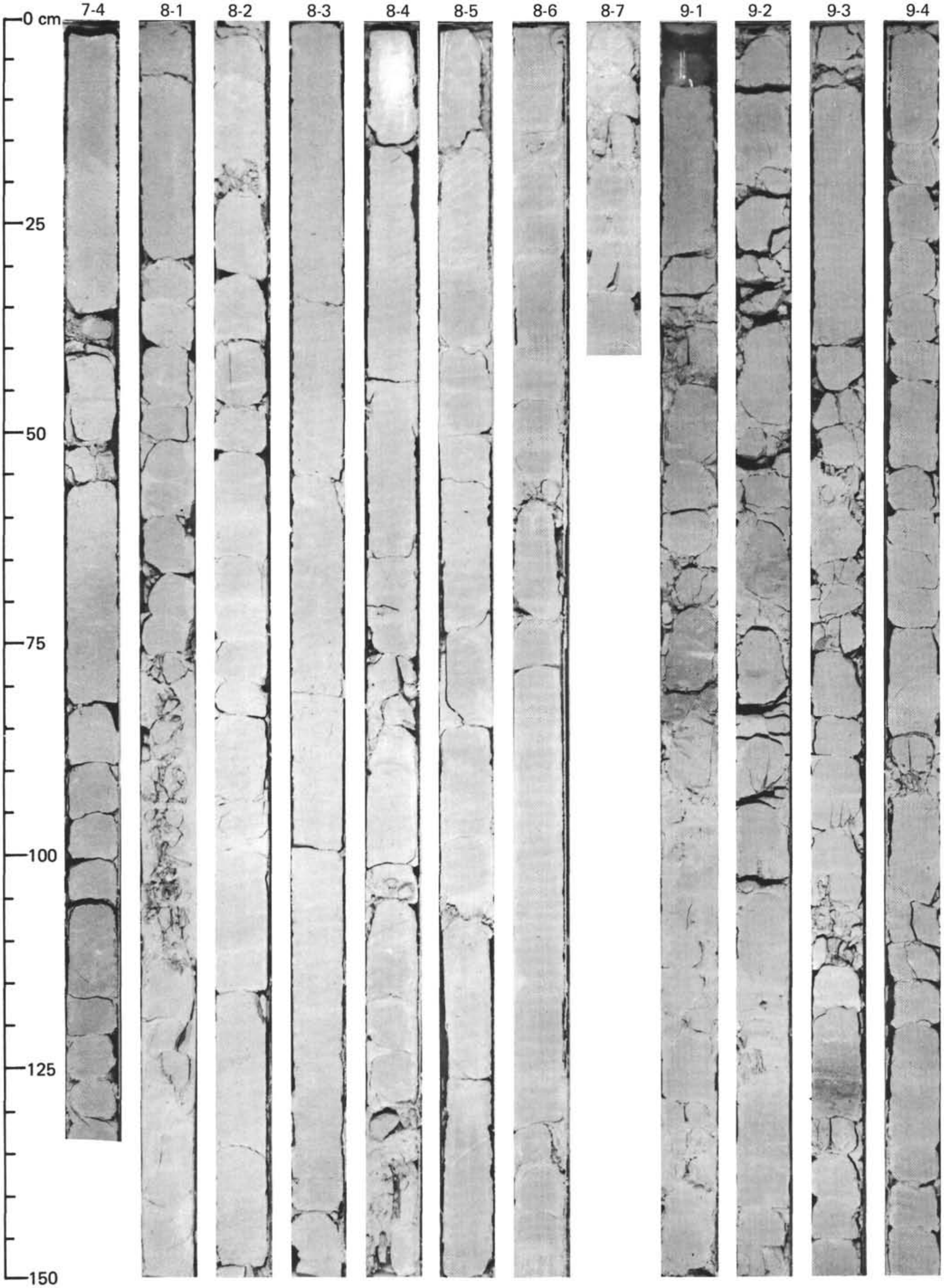
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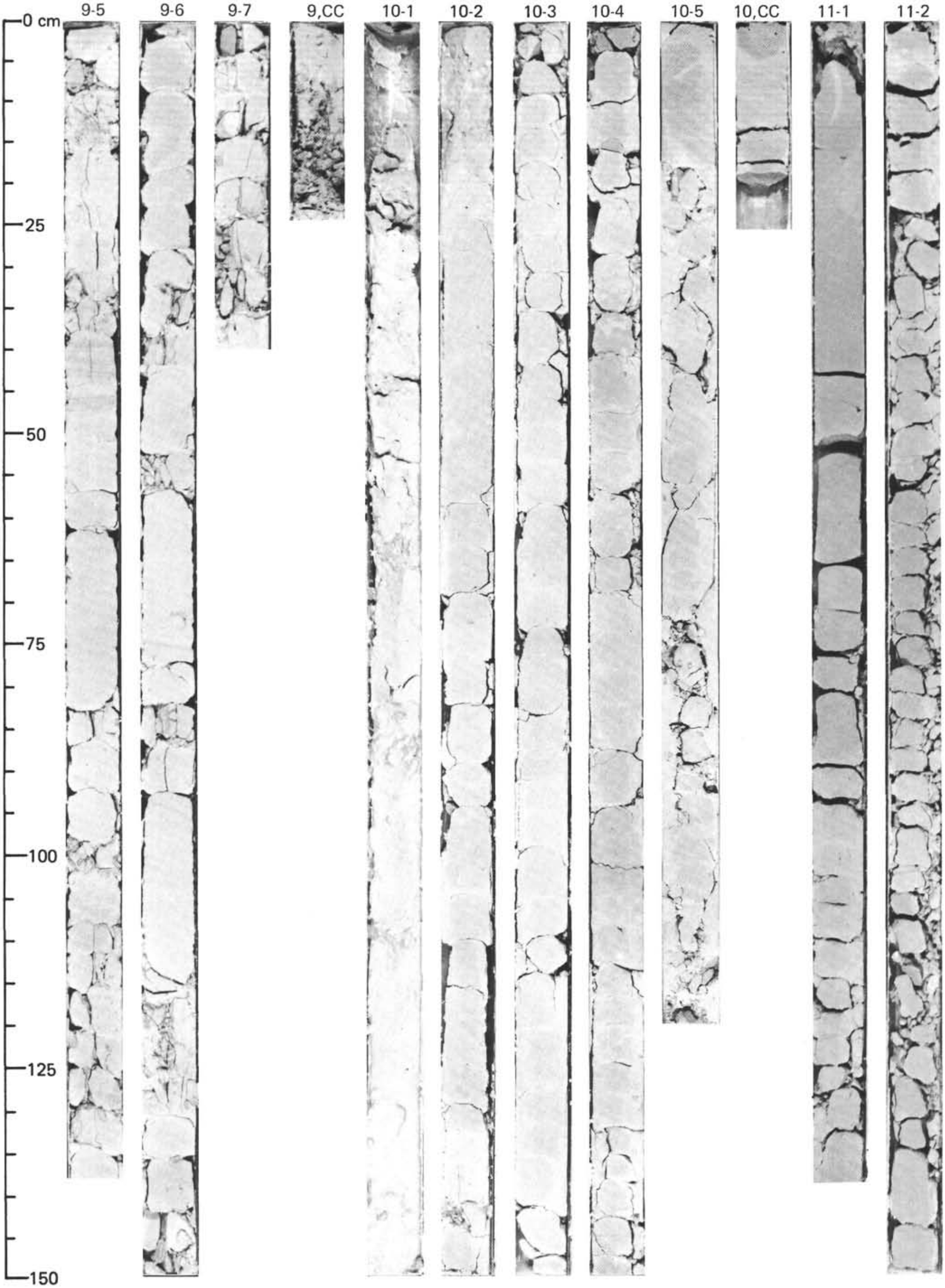
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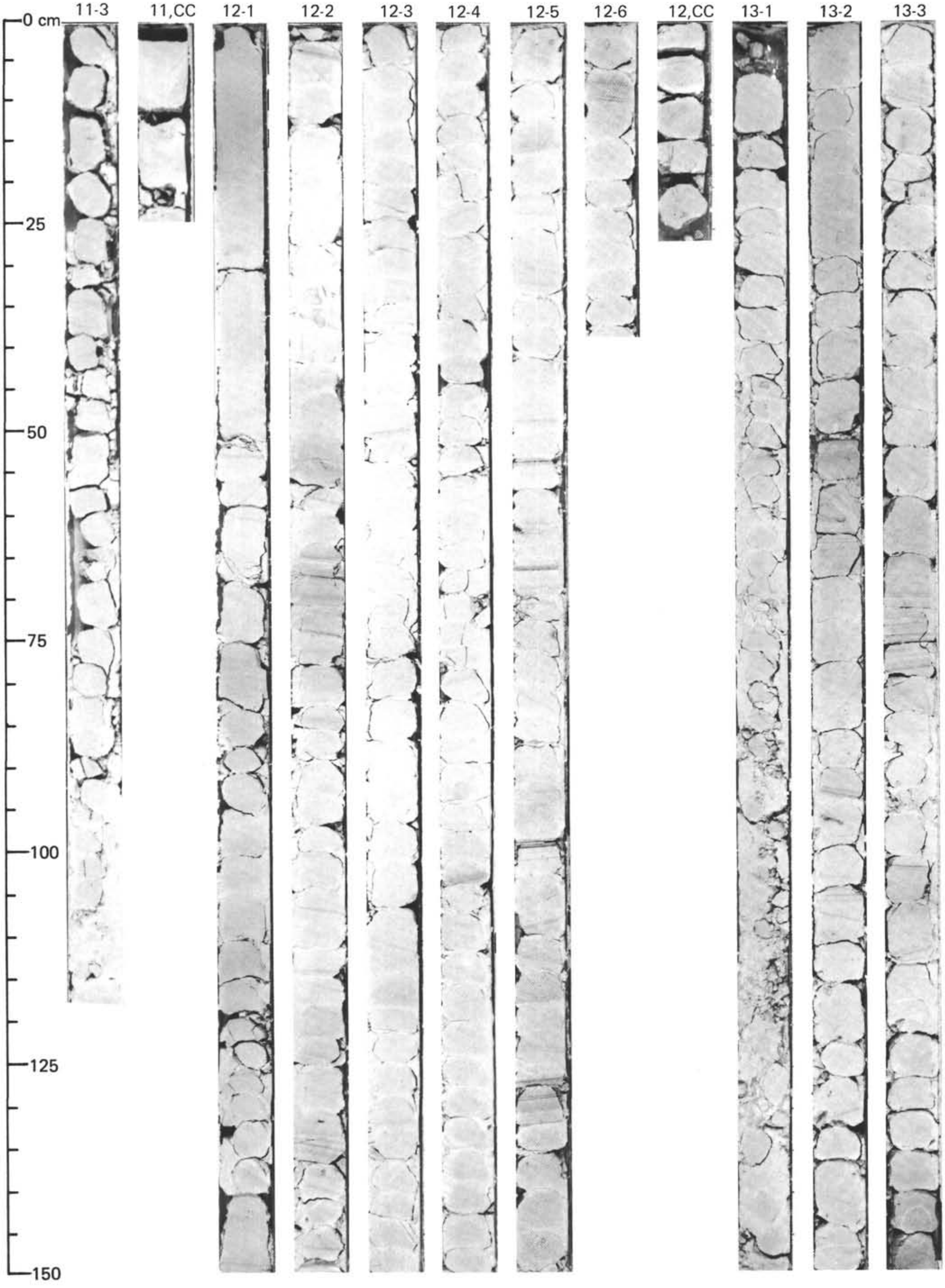
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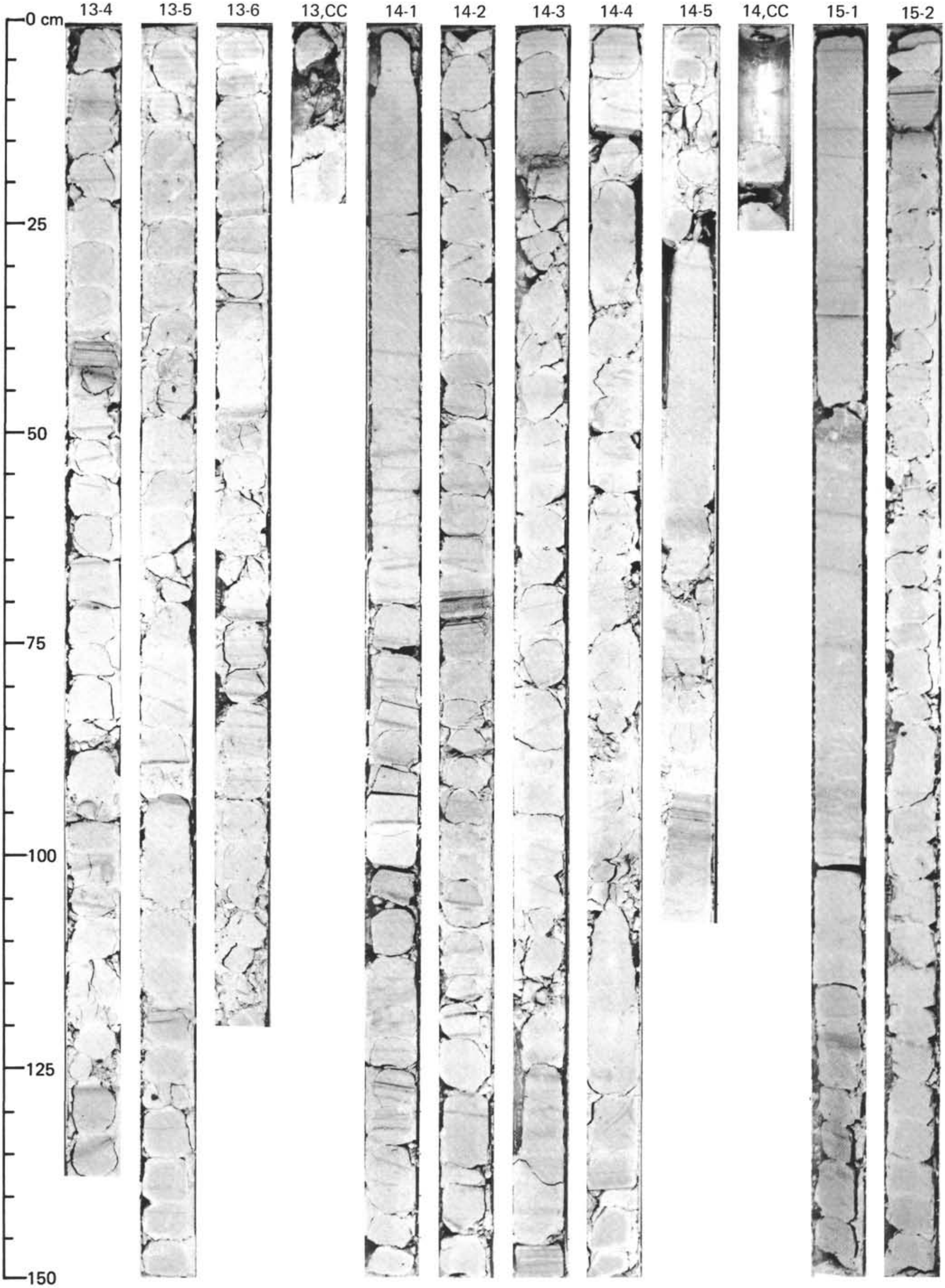
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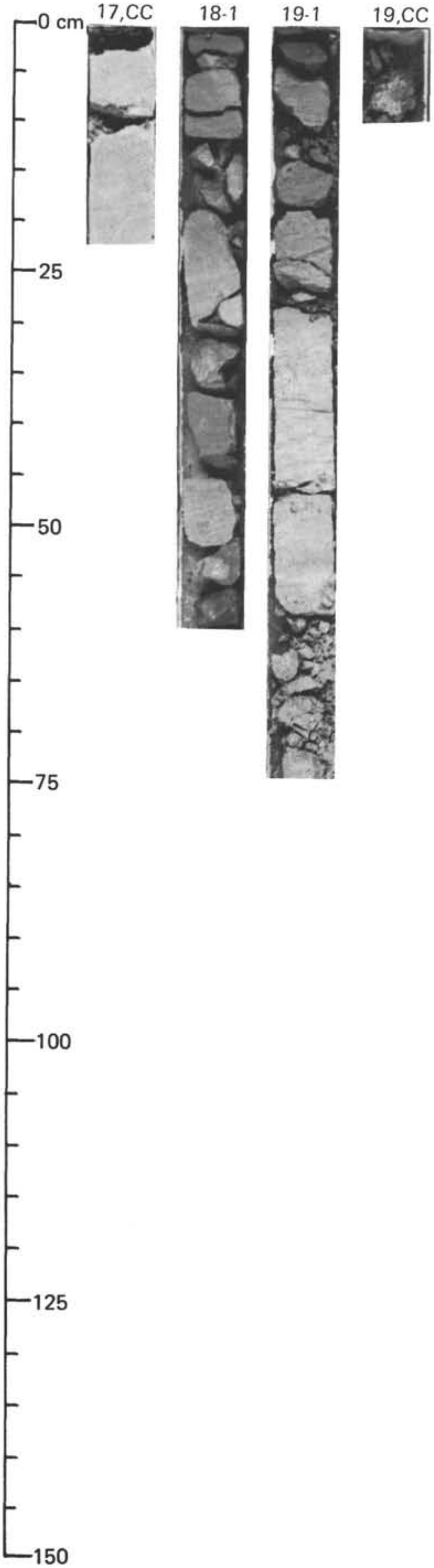
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