7. SITE 611[1]

Shipboard Scientific Party[2]

HOLE 611

Date occupied: 6 August 1983

Date departed: 7 August 1983

Time on hole: 23.6 hr.

Position: 52°50.47′N; 30°18.58′W

Water depth (sea level; corrected m, echo-sounding): 3203

Water depth (rig floor; corrected m, echo-sounding): 3212.8

Bottom felt (m, drill pipe): 3203.6

Penetration (m): 125.8

Number of cores: 14

Total length of cored section (m): 125.8

Total core recovered (m): 112.21

Core recovery (%): 89.2

Oldest sediment cored:
Sub-bottom depth (m): 125.8
Nature: calcareous mud
Age: late Pliocene (NN16)
Measured velocity (km/s): 1.517

Basement: not reached

HOLE 611A

Date occupied: 7 August 1983

Date departed: 8 August 1983

Time on hole: 17.6 hr.

Position: 52°50.47′N; 30°18.58′W

Water depth (sea level; corrected m, echo-sounding): 3203

Water depth (rig floor; corrected m, echo-sounding): 3212.8

Bottom felt (m, drill pipe): 3203.6

Penetration (m): 132

Number of cores: 14

Total length of cored section (m): 132

Total core recovered (m): 99.4

Core recovery (%): 75.5

Oldest sediment cored:
Sub-bottom depth (m): 122.4
Nature: calcareous mud
Age: late Pliocene (NN16)

Basement: not reached

HOLE 611B

Date occupied: 8 August 1983

Date departed: 8 August 1983

Time on hole: 2.5 hr.

Position: 52°50.15′N; 30°19.10′W

Water depth (sea level; corrected m, echo-sounding): 3228

Water depth (rig floor; corrected m, echo-sounding): 3245.8

Bottom felt (m, drill pipe): 3227.6

Penetration (m): 8.9

Number of cores: 1

Total length of cored section (m): 8.9

Total core recovered (m): 8.9

Core recovery (%): 100

Oldest sediment cored:
Sub-bottom depth (m): 8.9
Nature: calcareous mud and foraminifer–nannofossil ooze
Age: Quaternary (NN21)
Measured velocity (km/s): 1.501

Basement: not reached

HOLE 611C

Date occupied: 8 August 1983

Date departed: 11 August 1983

Time on hole: 66.25 hr. (2.75 days)

Position: 52°50.15′N; 30°19.10′W

Water depth (sea level; corrected m, echo-sounding): 3230

Water depth (rig floor; corrected m, echo-sounding): 3245.8

Bottom felt (m, drill pipe): 3227.6

Penetration (m): 511.6

Number of cores: 47

Total length of cored section (m): 434.8

Total core recovered (m): 344.05

Core recovery (%): 79.1

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

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Oldest sediment cored:
Sub-bottom depth (m): 511.6
Nature: marly nannofossil chalk
Age: late Miocene (NN9)
Measured velocity (km/s): 1.970

Basement: not reached

HOLE 611D

Date occupied: 11 August 1983

Date departed: 12 August 1983

Time on hole: 19.5 hr.

Position: 52°50.47′N; 30°18.58′W

Water depth (sea level; corrected m, echo-sounding): 3195

Water depth (rig floor; corrected m, echo-sounding): 3212.8

Bottom felt (m, drill pipe): 3199.5

Penetration (m): 244.1

Number of cores: 14

Total length of cored section (m): 124.8

Total core recovered (m): 122.3

Core recovery (%): 97.9

Oldest sediment cored:
Sub-bottom depth (m): 244.1
Nature: nannofossil chalk
Age: early Pliocene (NN15)

Basement: not reached

HOLE 611E

Date occupied: 12 August 1983

Date departed: 12 August 1983

Time on hole: 6.75 hr.

Position: 52°50.47′N; 30°18.58′W

Water depth (sea level; corrected m, echo-sounding): 3195

Water depth (rig floor; corrected m, echo-sounding): 3212.8

Bottom felt (m, drill pipe): 3199.5

Penetration (m): 25.7

Number of cores: 2

Total length of cored section (m): 19.2

Total core recovered (m): 19.2

Core recovery (%): 100

Oldest sediment cored:
Sub-bottom depth (m): 25.7
Nature: calcareous mud and foraminifer-nannofossil ooze
Age: Quaternary (NN19)

Basement: not reached

Principal results: Six holes were drilled on the lower southeastern flank of Gardar Ridge. Four holes were drilled on the broad crest of a sediment wave at 3203 m water depth (corrected). Two holes were located in an adjacent trough half a nautical mile to the southeast and in water 29 m deeper. No clear sediment wave migration was visible on crossing 3.5-kHz profiles, and most waves in the vicinity appear symmetrical. Air-gun records show faint indications of inclined reflectors below 0.2 s (two-way traveltime).

A continuous Quaternary through Miocene section was recovered with the variable length hydraulic piston corer (VLHPC) and the extended core barrel (XCB) in the trough—Hole 611C—and a complementary Quaternary through Pliocene, continuous VLHPC and XCB section was recovered on the wave crest in the combined Holes 611A and 611D.

Coring in the overlapping crest Holes 611 and 611A provided an almost complete section for paleoclimatic studies spanning the last 2.47 Ma (to the Gauss). Three spot cores were taken at Holes 611D and 611E in attempts to fill perceived gaps in this record. Still the sequence appears to have one to, at most, three interruptions (Ruddiman et al., this volume).

Glacial–interglacial mud to ooze cycles extend to 91 m sub-bottom in the wave crest sequence and to 114 m in the trough. Below these levels, the sequence is made up of nannofossil oozes and chalks, which in the Pliocene become siliceous and/or marly.

No primary sedimentary structures that might be attributed to current sedimentation were observed. Some wave crest-to-trough differences in bed thickness were found. No hiatuses were detected, and sedimentation rates are high (around 58 m/m.y.) and generally linear. Some indications are present in the accumulation rate curves for the Pliocene and Quaternary of wave crest-to-trough differences that are best explained by large-scale wave migration in the Pliocene.

Good correlations of seismic reflectors with mid-drift lithologic changes can be made, but low penetration rates in Miocene sediments meant that the base of the drift at 1.0 s sub-bottom (two-way traveltime) was beyond the reach of the drilling in the time available at this site.

BACKGROUND AND OBJECTIVES

Site 611 is located on the southeastern edge of Gardar Ridge (Fig. 1), which is a thick sediment pile or drift that has accumulated along the eastern flank of the Reykjanes Ridge under the influence of deep overflow water from the Norwegian Sea (Johnson et al., 1971). McCave et al. (1980) considered that the axis of the major southwesterly Iceland-Scotland Overflow Water current lies between the steep northwest slope of Gardar Ridge and the crest of the Reykjanes Ridge. Spillover is thought to occur down the long, gentle slope of the Gardar Ridge. Site 611 lies in an area where the southernmost bottom water flow in the Iceland Basin is thought to pass westward into the Charlie Gibbs Fracture Zone, through which it reaches the western basin (Worthington and Volkmann, 1965; Garner, 1972).

Gardar Drift extends from the Icelandic margin to the Charlie Gibbs Fracture Zone, a distance of almost 1300 km. At its northern end its continuity is not obvious on published bathymetric maps (Fig. 1; Laughton and Monahan, 1978). It is mapped on seismic reflection profiles, however, as a continuous thick sediment pile, established on the lower eastern flanks of the Reykjanes Ridge (Johnson et al., 1971; Ruddiman, 1972). In the vicinity of Site 611, the water depth is around 3200 m, and the total thickness of sediment visible on seismic records (Fig. 2) is 1300 m (1.3 s). With a basement age of 35.5 Ma based on magnetic isochrons, the projected mean sedimentation rate for this sediment drift is about 37 m/m.y. However, hiatuses are thought likely in the Oligocene and lower to middle Miocene based upon previous deep-sea drilling in the northern North Atlantic (Shor and Poore, 1979); thus the mean late Neogene deposition rate could be considerably higher. The upper Quaternary core (V27-116) taken at the location of Site 611 consisted of calcareous oozes and interbedded glacial marine muds with a mean rate of deposition of 40 m/m.y.

The surface of Gardar Ridge in this area is ornamented with a field of longitudinal sediment waves. To the south of Site 611 long-range sidescan sonar (GLORIA)

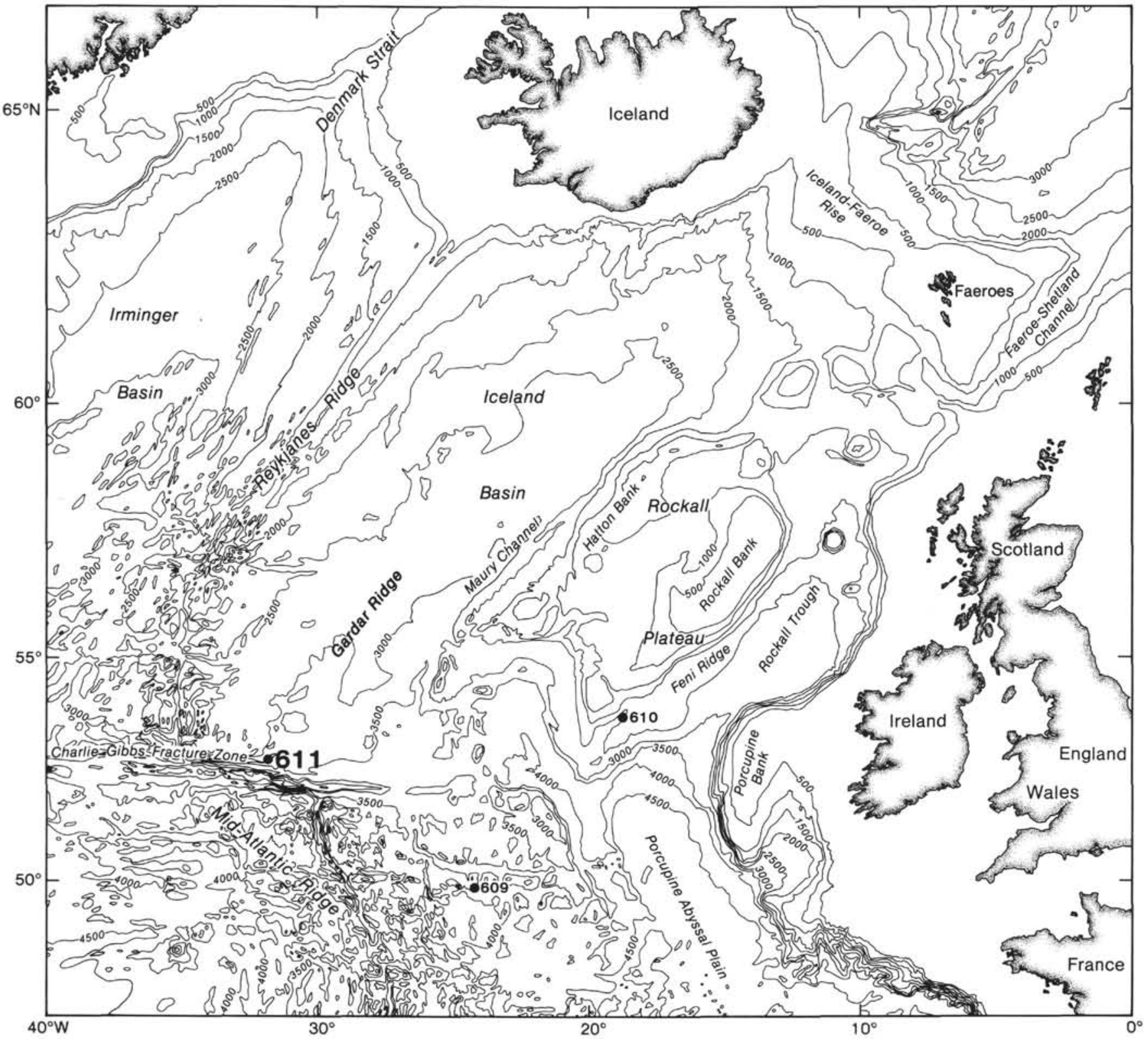

Figure 1. Location of Site 611; bathymetry given in meters (after Laughton and Monahan, 1978).

coverage allows the crests of these waves to be traced over 6 km (Fig. 3). At the site, individual waves appear traceable over a similar distance between the 3.5-kHz seismic survey tracks. The GLORIA and profiling records indicated that wave trends change in this area from WSW-ENE immediately east of Site 611, to NW-SE north of the Charlie Gibbs Fracture Zone. The 3.5-kHz profiles show that the waves have amplitudes of around 10 m and wave lengths of around 1.5 km. Most waves appear symmetrical, and evidence of migration is scant.

The principal objectives at Site 611 were paleoclimatic. Site 611 lies within the present circulation of the subpolar gyre. Upper Quaternary lithologies vary between moderately calcareous interglacial oozes and muddy glacial marine deposits. Sea-surface temperature (SST) variations in the late Quaternary were of high amplitude, but not so high as in cores just to the south, largely because these waters chilled to the freezing point during glacials and could cool no more. The rhythm of Quaternary SST change in this area is dominantly at the 100,000- and 41,000-yr. cycles, but a small 23,000-yr. rhythm persists (Ruddiman and McIntyre, 1984). The primary objective at Site 611 was to trace these rhythmic changes back into the Neogene, in particular to see what changes occurred before the onset of large-scale Northern Hemisphere glaciation. Ancillary paleoclimatic objectives included the attempt to delineate the history of ice rafting, the history of carbonate dissolution, and the definition of long stable-isotopic sequences.

Sedimentological objectives at Site 611 were aimed at complementing the sequence of bottom current deposits documented from the crest of Feni Ridge and looking for vertical and lateral sediment facies variation in another drift sequence. Again, we hoped to date mid-sedi-

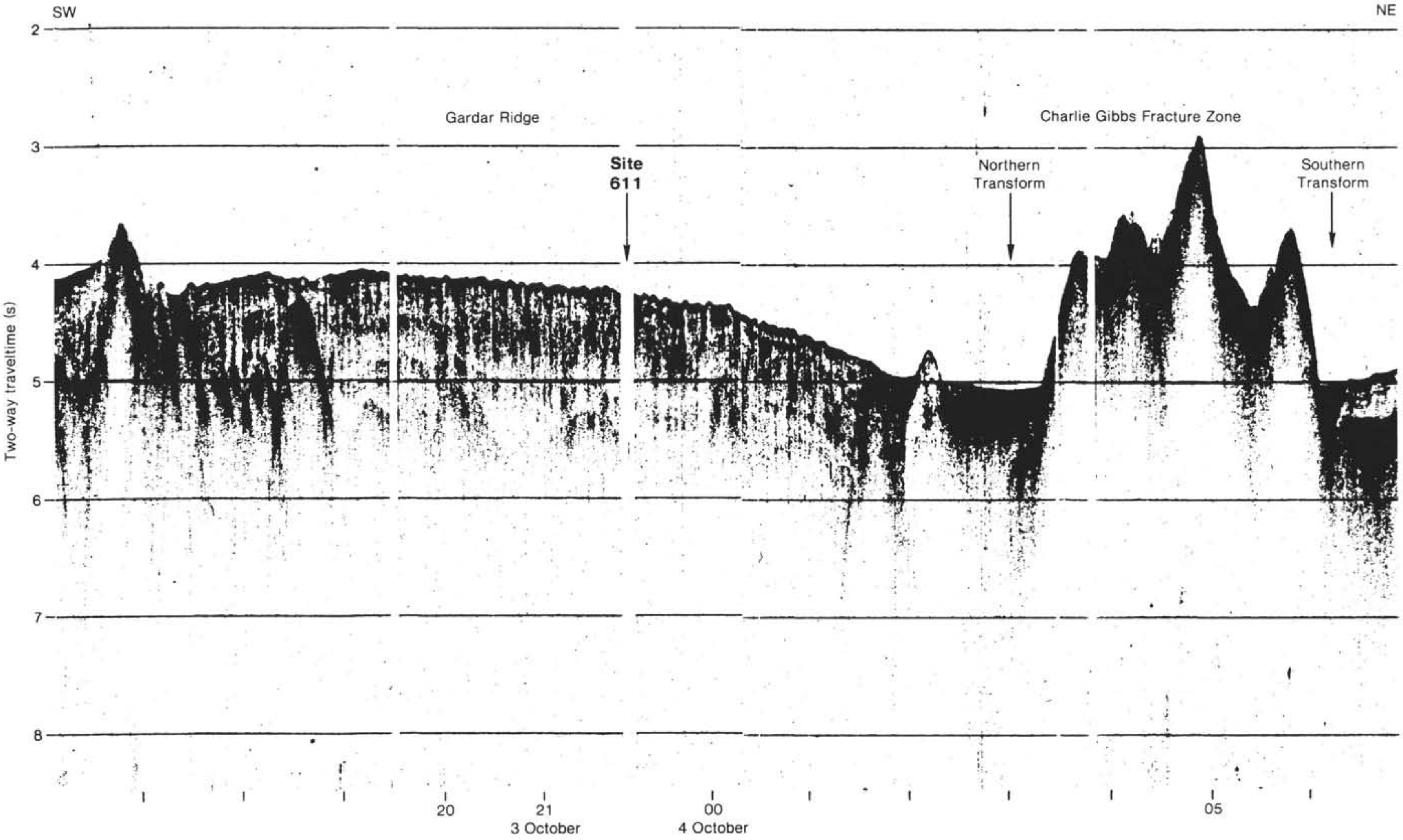

Figure 2. Single-channel air-gun profile across Gardar Ridge. The location of Site 611 is indicated.

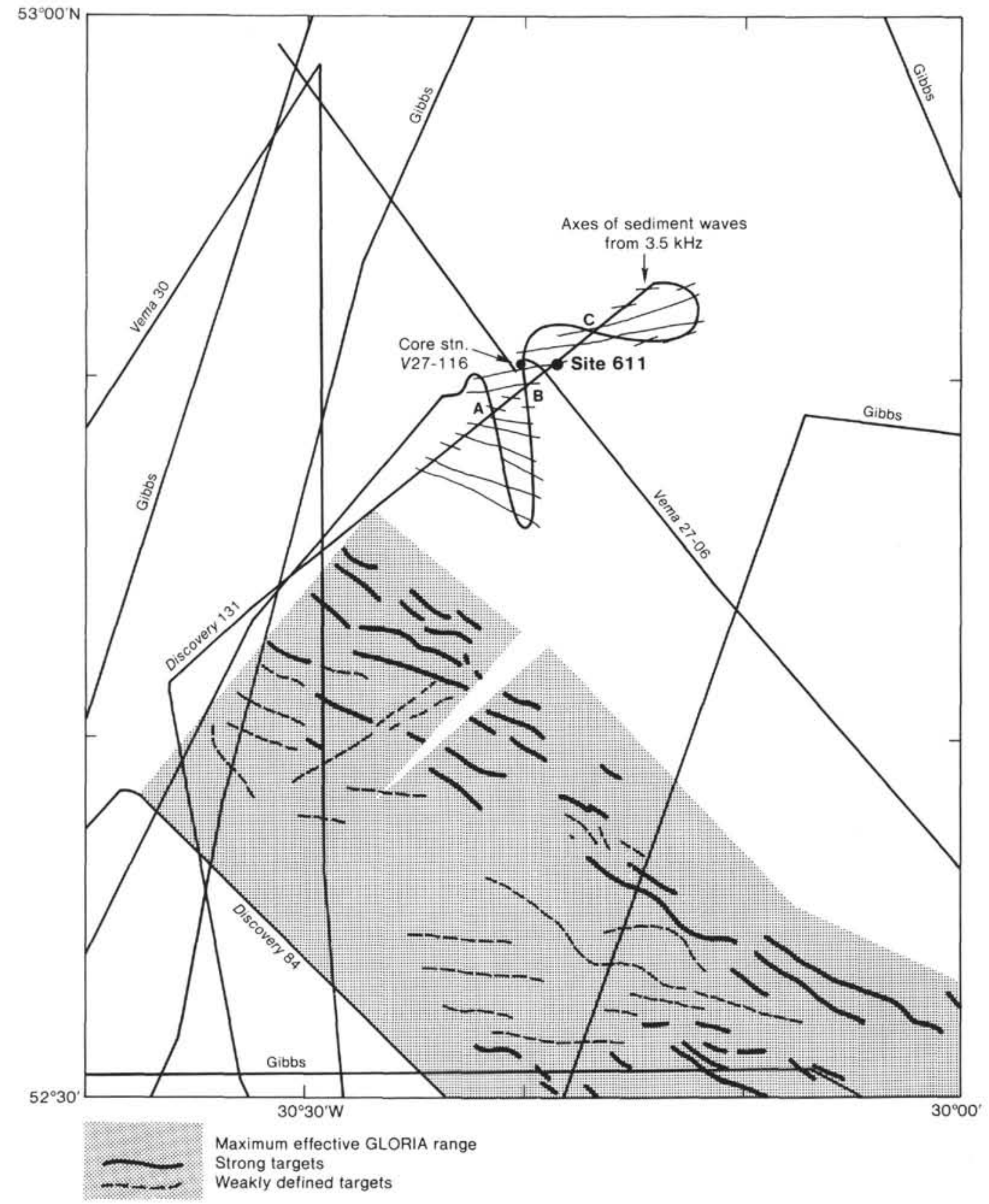

Figure 3. Site survey data and GLORIA coverage around Site 611. A, B, and C are positions of crossover points in the survey; wave axes are indicated (see also Figs. 17 and 18).

ment seismic reflectors and, through our high-resolution stratigraphy, to detect local as well as regional hiatuses that might be related to periods of accelerated bottom water flow.

OPERATIONS

Glomar Challenger approached Site 611 from the east on 6 August 1983 and took a southwesterly heading (230°) after a course change at 1115 hr.[3]. A further course adjustment at 1140 hr. to 238° brought the vessel on a track paralleling the *Discovery* 131 site survey line (Fig. 4).

Sediment wave crests were detected at 0.5 to 1.0 km spacings as on the IOS (Institute of Oceanographic Sciences, Wormley, U.K.) and LDGO (Lamont-Doherty Geological Observatory) 3.5-kHz profiles; thus we were confident that we could identify a suitable wave-crest location close to the *Vema* 27-116 core site on which to drop the beacon. From the *Discovery* 131 profile, we selected a large sediment wave that we expected to cross north and east of the site location listed in the prospectus. A 16-kHz beacon was dropped over the feature at 1204 hr. in 3197 m of water (uncorrected depth). A satellite fix was obtained at 1211 hr., and we made a starboard turn at 1220 hr. to retrace our profile back over the beacon. Individual sediment wave crests were recog-

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

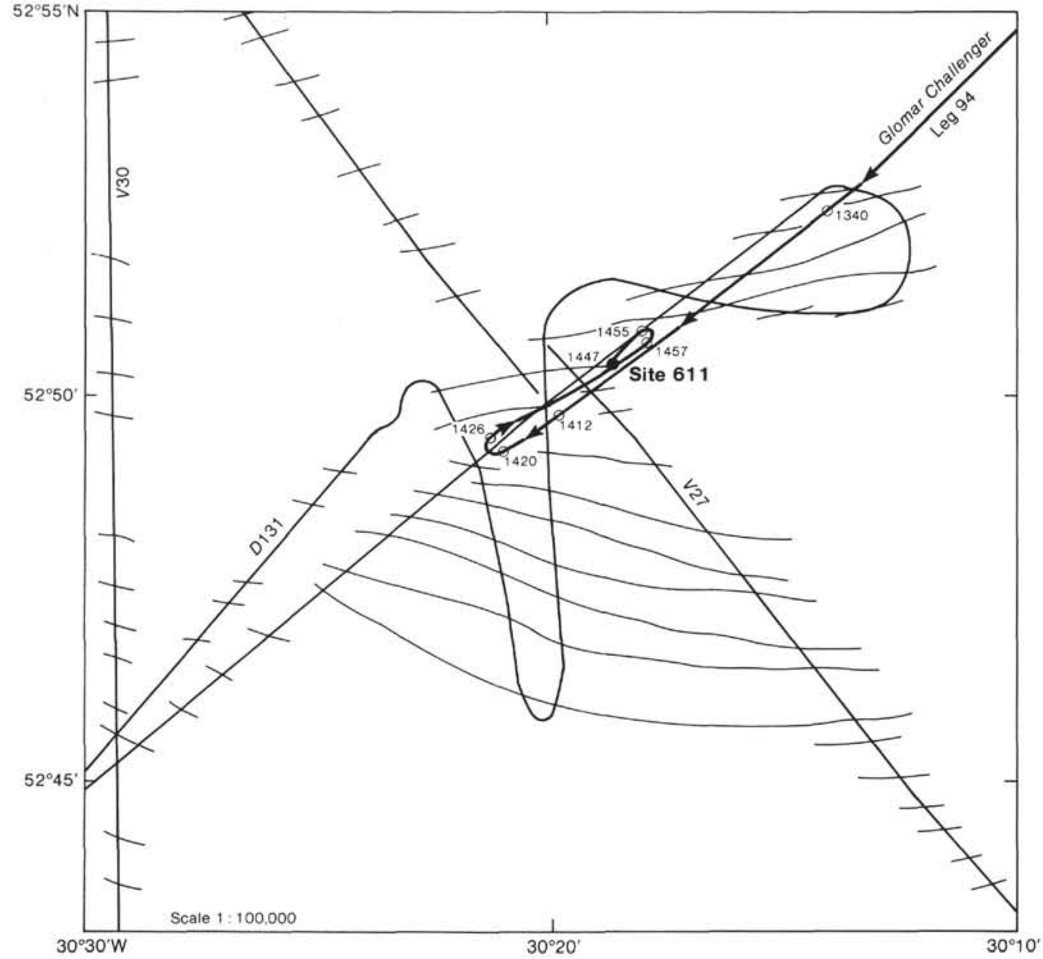


Figure 4. *Glomar Challenger* approach to Site 611 on Gardar Ridge. Axes of sediment waves drawn from presite survey lines of *Discovery* 131 and *Vema* 27 and 30. Times on the *Glomar Challenger* track are in Greenwich Mean Time (Zulu).

nized on the return track, and we passed over the beacon at 1247 hr. We then slowed to retrieve the seismic gear and after a port turn at 1251 hr., returned to the beacon.

We arrived at the beacon at 1345 hr. Troubleshooting the positioning system incurred a 25-min. delay. Averaging of satellite fixes later showed the location of this site to be 52°50.47′N; 30°18.58′W.

We began running in Hole 611 at 1430 hr. on 6 August. Spud-in was at 2115 hr., and the first VLHPC core came on deck at 2146 hr. (Table 1). We then cored continuously to 125.8 m, finishing with Core 611-14, which had to be washed over and came on board at 1330 hr., 7 August. Although many liners were fractured, core quality was generally good.

We pulled out of the hole at 1330 hr. and cleared the mudline at 1410 hr. We then decided to take advantage of calm seas and spudded in to Hole 611A (with no offset) at 1458 hr. in order to core the same Pliocene-Pleistocene sequence and obtain overlap through the section. Core 611A-1 came on deck at 1530 hr., and we finished the hole with Core 14 at 0701 hr. on 8 August, reaching a total depth of 132.0 m. Again, many liners fractured, and Core 14 recovered only a glacial erratic rock. We pulled out of the hole at 0700 hr. and cleared the mudline by 0730 hr.

At this point we planned an offset into the adjacent wave trough for Hole 611B and, assuming the wave crests to be trending roughly east-northeast/west-southwest (Figs. 4, 5), we opted for a move northward (bearing 350°; 2000 ft. probable offset from the beacon). The expected 30- to 40-m increase in depth did not occur. Water depths detected by the echo sounder increased by only 8 m, even though the vessel slowly offset to the limits of positioning control on the beacon (3000 ft. or 0.5 n.mi.). Thinking that we had possibly obtained a wrong trend direction for the sediment wave axes, we began to offset southeastward (Fig. 5) and again found little change in water depth; the water became shallower by 4 m. We then decided to return to the beacon, expecting to parallel our initial profile into the beacon drop. Still no significant change in relief was observed (another 4-m shallowing). Our next move was to continue to offset along the direction of our initial profile, and on this southwesterly course we eventually began to find increased water depths. Still, only a 25-m increase was observed at

Table 1. Coring summary, Site 611.

Core no.	Date (August, 1983)	Time (hr.)	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Recovery (%)
			Top Bottom	Top Bottom			
Hole 611							
1	6	2146	3202.6–3203.6	0.0–1.0	1.0	0.82	82.0
2	6	2305	3203.6–3213.2	1.0–10.6	9.6	9.52	99.1
3	7	0010	3213.2–3222.8	10.6–20.2	9.6	8.87	92.4
4	7	0130	3222.8–3232.4	20.2–29.8	9.6	9.14	95.2
5	7	0233	3232.4–3242.0	29.8–39.4	9.6	9.21	95.9
6	7	0345	3242.0–3251.6	39.4–49.0	9.6	8.44	87.9
7	7	0455	3251.6–3261.2	49.0–58.6	9.6	9.42	98.1
8	7	0600	3261.2–3270.8	58.6–68.2	9.6	8.55	89.1
9	7	0710	3270.8–3280.4	68.2–77.8	9.6	9.08	94.6
10	7	0825	3280.4–3290.0	77.8–87.4	9.6	9.11	94.9
11	7	0937	3290.0–3299.6	87.4–97.0	9.6	6.80	70.8
12	7	1059	3299.6–3309.2	97.0–106.6	9.6	7.99	83.2
13	7	1216	3309.2–3318.8	106.6–116.2	9.6	6.52	67.9
14	7	1330	3318.8–3328.4	116.2–125.8	9.6	8.74	91.1
					125.8	112.21	89.2
Hole 611A							
1	7	1530	3200.9–3208.1	0.0–7.2	7.2	7.19	99.9
2	7	1640	3208.1–3217.7	7.2–16.8	9.6	8.14	84.8
3	7	1742	3217.7–3227.3	16.8–26.4	9.6	9.31	97.0
4	7	1847	3227.3–3236.9	26.4–36.0	9.6	8.85	92.2
5	7	1950	3236.9–3246.5	36.0–45.6	9.6	9.05	94.3
6	7	2100	3246.5–3256.1	45.6–55.2	9.6	8.55	89.0
7	7	2200	3256.1–3265.7	55.2–64.8	9.6	6.90	71.9
8	7	2310	3265.7–3275.3	64.8–74.4	9.6	8.10	85.0
9	8	0030	3275.3–3284.9	74.4–84.0	9.6	1.07	11.1
10	8	0147	3284.9–3294.5	84.0–93.6	9.6	8.01	83.4
11	8	0257	3294.5–3304.1	93.6–103.2	9.6	7.72	80.4
12	8	0437	3304.1–3313.7	103.2–112.8	9.6	7.99	83.2
13	8	0547	3313.7–3323.3	112.8–122.4	9.6	8.53	88.9
14	8	0701	3323.3–3332.9	122.4–132.0	9.6	0.00	0.0
					132.0	99.4	75.3
Hole 611B							
1	8	1445	3227.7–3236.6	0.0–8.9	8.9	8.9	100.00
Hole 611C							
1	8	1722	3227.6–3230.0	0.0–2.4	2.4	2.4	100.0
2	8	1837	3230.0–3235.0	2.4–7.4	5.0	4.91	98.2
3	8	1948	3235.0–3240.0	7.4–12.4	5.0	5.07	101.4
4	8	2111	3240.0–3249.6	12.4–22.0	9.6	9.11	94.9
5	8	2219	3249.6–3259.2	22.0–31.6	9.6	9.38	97.7
6	8	2324	3259.2–3268.8	31.6–41.2	9.6	8.86	92.3
7	9	0039	3268.8–3278.4	41.2–50.8	9.6	0.00	0.0
8	9	0147	3278.4–3288.0	50.8–60.4	9.6	8.93	93.0
9	9	0304	3288.0–3297.6	60.4–70.0	9.6	9.59	99.9
10	9	0415	3297.6–3307.2	70.0–79.6	9.6	8.20	85.4
11	9	0525	3307.2–3316.8	79.6–89.2	9.6	9.51	99.1
12	9	0650	3316.8–3326.4	89.2–98.8	9.6	9.66	100.6
13	9	0752	3326.4–3336.0	98.8–108.4	9.6	8.91	92.8
14	9	0903	3336.0–3345.6	108.4–118.0	9.6	9.49	98.9
15	9	1026	3345.6–3355.2	118.0–127.6	9.6	9.71	101.1
16	9	1128	3355.2–3364.8	127.6–137.2	9.6	9.81	102.2
17	9	1248	3364.8–3374.4	137.2–146.8	9.6	2.32	24.2
18	9	1356	3374.4–3384.0	146.8–156.4	9.6	9.72	101.2
19	9	1510	3384.0–3393.6	156.4–166.0	9.6	4.83	50.3
20	9	1651	3393.6–3404.2	166.0–175.6	9.6	2.91	30.3
21	9	1825	3404.2–3412.8	175.6–185.2	9.6	1.39	14.5
22	9	1930	3412.8–3422.4	185.2–194.8	9.6	9.79	101.9
23	9	2048	3432.0–3422.4	194.8–204.4	9.6	2.70	28.1
24	9	2205	3432.0–3441.6	204.4–214.0	9.6	8.26	86.04
25	9	2307	3441.6–3451.2	214.0–223.6	9.6	0.00	0.0
26	10	0028	3451.2–3460.8	223.6–233.2	9.6	5.33	55.5
27	10	0152	3460.8–3470.4	233.2–242.8	9.6	9.80	102.1
28	10	0310	3470.4–3480.0	242.8–252.4	9.6	9.68	100.8
29	10	0415	3480.0–3489.6	252.4–262.0	9.6	9.90	103.1
30	10	0515	3489.6–3499.2	262.0–271.6	9.6	9.55	99.5
31	10	0625	3499.2–3508.8	271.6–281.2	9.6	9.81	102.2
32	10	0740	3508.8–3518.4	281.2–290.8	9.6	9.65	100.5

Table 1 (continued).

Core no.	Date (August, 1983)	Time (hr.)	Depth from drill floor (m) Top Bottom	Depth below seafloor (m) Top Bottom	Length cored (m)	Length recovered (m)	Recovery (%)
Hole 611C (Cont.)							
33	10	0851	3518.4-3528.0	290.8-300.4	9.6	9.71	101.1
34	10	1001	3528.0-3537.6	300.4-310.0	9.6	0.00	0.0
35	10	1118	3537.6-3547.2	310.0-319.6	9.6	3.92	40.8
36	10	1248	3547.2-3556.8	319.6-329.2	9.6	9.54	99.4
37	10	1357	3556.8-3566.4	329.2-338.8	9.6	5.72	59.6
38	10	1510	3566.4-3576.0	338.8-348.4	9.6	9.60	100.0
39	10	1631	3576.0-3585.6	348.4-358.0	9.6	9.95	103.7
40	10	1751	3585.6-3595.2	358.0-367.6	9.6	2.61	27.2
41	10	1905	3595.2-3604.8	367.6-377.2	9.6	9.91	103.2
42	10	2027	3604.8-3614.4	377.2-386.8	9.6	9.65	100.5
43	10	2150	3614.4-3624.0	386.8-396.4	9.6	8.83	92.0
Wash	10		3624.0-3662.4	396.4-434.8			
44	11	0120	3662.4-3672.0	434.8-444.4	9.6	9.47	98.6
45	11	0255	3672.0-3681.6	444.4-454.0	9.6	8.56	89.2
Wash	11		3681.6-3720.0	454.0-492.4			
46	11	0711	3720.0-3729.6	492.4-502.2	9.6	9.31	97.0
47	11	0902	3729.6-3739.2	502.2-511.6	9.6	8.09	84.3
					434.8	344.05	79.1[a]
Hole 611D							
Wash	11		3199.5-3205.0	0.0-5.5			
1	11	1357	3205.0-3214.6	5.5-15.1	9.6	9.24	96.3
Wash	11		3214.6-3328.4	15.1-128.9			
2	11	1635	3328.4-3338.0	128.9-138.5	9.6	9.82	102.3
3	11	1740	3338.0-3347.6	138.5-148.1	9.6	9.61	100.1
4	11	1855	3347.6-3357.2	148.1-157.7	9.6	9.89	103.0
5	11	2005	3357.2-3366.8	157.7-167.3	9.6	9.59	99.9
6	11	2116	3366.8-3371.8	167.3-172.3	5.0	5.19	103.8
7	11	2218	3371.8-3376.4	172.3-176.9	4.6	7.19	163.7
8	11	2329	3376.4-3386.0	176.9-186.5	9.6	9.82	102.3
9	12	0052	3386.0-3395.6	186.5-196.1	9.6	9.64	100.4
10	12	0200	3395.6-3405.2	196.1-205.7	9.6	9.81	102.2
11	12	0307	3405.2-3414.8	205.7-215.3	9.6	9.58	99.8
12	12	0414	3414.8-3424.4	215.3-224.9	9.6	8.23	85.7
13	12	0522	3424.4-3434.0	224.9-234.5	9.6	9.56	99.6
14	12	0636	3434.0-3443.6	234.5-244.1	9.6	5.12	53.3
					124.8	122.3	97.9[a]
Hole 611E							
Wash	12		3199.5-3206.0	0.0-6.5			
1	12	906	3206.0-3215.6	6.5-16.1	9.6	9.56	99.6
2	12	1006	3215.6-3225.2	16.1-25.7	9.6	9.65	100.5
					19.2	19.21	100[a]

[a] Excluding washed intervals.

the maximum range of the positioning system. Our only recourse was a move directly southward, and this proved to be successful (a further 8-m depth increase). Hole 611B was eventually occupied near the southwestern limit of our permissible offset range at 3227 m water depth (uncorrected). This is 33 m deeper than the wave-crest Holes 610 and 610A. In all, six hours were devoted to this offset (Fig. 5). Averaging of satellite fixes later showed the location of this offset hole to be 52°50.15′N; 30°19.10′W.

We spudded into Hole 611B in the sediment wave trough at 1345 hr. on 8 August. One 8.9-m VLHPC core was retrieved at 1445 hr., but on the attempt for a second core, the barrel broke off at a pin at the top sub and was lost. Rather than use up time fishing for the broken piece, we ended Hole 611B by pulling out at 1550 hr. on 8 August.

We then spudded in at Hole 611C (no offset) at 1615 hr. on 8 August and retrieved a first core at 1722 hr. The first three cores were taken with a 5-m barrel while a second VLHPC barrel was being rigged. We cored continuously with the VLHPC through Core 611C-14 taken at 0903 hr, on 9 August at a sub-bottom depth of 118.0 m, and then cored continuously with the XCB through Core 611C-43 to a depth of 396.4 m, reached at 2150 hr. on 10 August. We then washed down 38.4 m, took Cores 44 and 45 at 434.8-454.0 m sub-bottom, washed down another 38.4 m, and finished Hole 611C with Cores 46 and 47 at 492.4-511.6 m. Recovery was erratic, with numerous short cores, some caused by glacial debris drop-

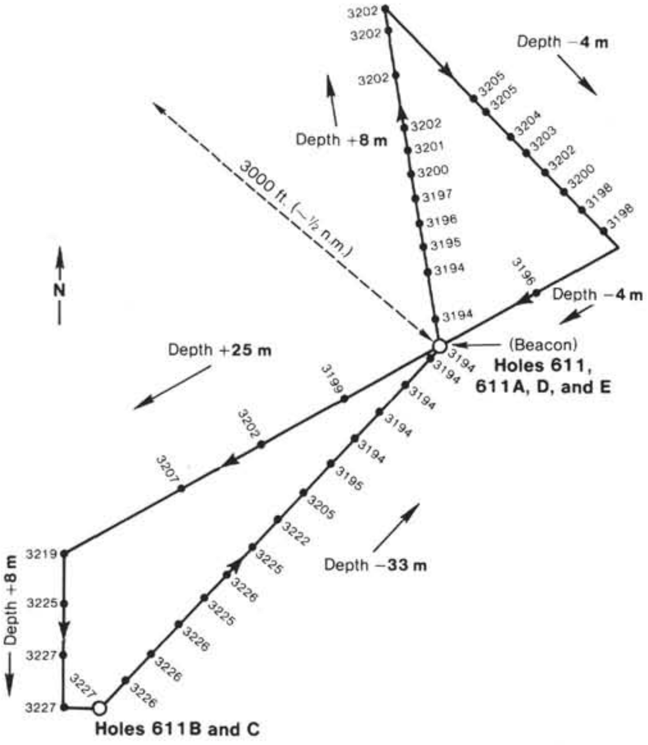


Figure 5. *Glomar Challenger* track between crest and trough holes at Site 611 (8 August, 1983, 11 August, 1983). Numbers are water depths in meters. Numbers adjacent to arrows indicate water-depth differences along tracks.

ping down the hole. Core 611C-47 came on deck at 0902 hr. on 11 August, and we began to pull out of the hole, clearing the mudline at 1030 hr.

We then decided that our best use of the remaining day or less of on-site time would be to return to the beacon and extend downward the upper section cored in Holes 611 and 611A.

During our return move to the beacon (Figs. 5, 6), it became clear that a southward initial offset crest-to-trough would have saved us considerable time: only 1.5 hr. were necessary for this move back to the beacon.

We spudded into Hole 611D at 1200 hr. on 11 August, washed down to 5.5 m, and took one VLHPC core to fill in a gap detected by analysis of core photographs from Holes 611 and 611A. This core came on board at 1357 hr. We then washed down to 128.9 m and began continuous XCB coring with Core 611D-2, retrieved at 1635 hr. on 11 August. We cored continuously until bringing Core 611D-14 on board at 0636 hr. on 12 August, having reached a depth of 244.1 m sub-bottom.

We began pulling out of the hole at 0636 hr. and cleared the mudline at 0730 hr. We spudded into Hole 611E at 0745 hr. to take two last VLHPC cores in the uppermost sediments that had been disturbed on previous attempts. We began pulling out of the hole after Core 611E-2 arrived on deck at 1006 hr. We finished pulling pipe at 2115 hr., spending extra time in order to Magnaflux the drill collar joints of the bottom-hole assembly and to check the power sub for cracks.

A postsite survey was planned before leaving Site 611. The vessel was underway by 2146 hr. on a course of 190°, and a track was run on this heading while streaming the seismic gear (Fig. 6). A port turn was made at 2205 hr; a satellite fix was received at 2206 hr. We passed over the beacon on a 350° course at 2232 hr. in an attempt to learn more of the shape of the drill site sediment wave for comparison with our offset maneuvers after Hole 611B (Fig. 5). It became clear that the wave is a broad double-crested feature that extends over 0.5 n.mi. in a south-to-north direction, and that our initial assumptions of its axis trend were generally correct. It would have been impossible to offset far enough northward while maintaining the beacon signal, and still reach the trough in that direction. Our offset maneuvers to the north and northwest had all been around this broad sediment wave crest.

At 2246 hr. we made a starboard turn and ran a southeasterly course, turning again at 2302 hr. to 229° to parallel our first track into the beacon. A course adjustment was made at 2315 hr. to pass over the beacon again (at 2318 hr.) so that we could then try to take a suitable course change to pass over Hole 611C. In fact, we eventually passed abeam of Hole 611C at 2323 hr. and continued our survey away from Site 611 on a heading of 218°. The survey was completed at 2330 hr., and we departed for St. John's, Newfoundland.

We then ordered up the first full gale of the cruise, but took care to select following winds so that it could blow us into port a day early.

SEDIMENT LITHOLOGY

At Site 611, sediments vary from pure terrigenous muds to nearly pure pelagic oozes and chalks. Two lithologic units were recognized (Figs. 7, 8).

Unit I comprises 0 to 138.5 m in the sediment wave crest hole (611D), and 0.0 to 149 m in the trough hole (611C). All sediments recovered from Holes 611A, 611B, and 611E on the crest belong to Unit I.

Unit I consists of slightly marly nannofossil oozes, foraminiferal-nannofossil oozes (10–30% detrital material) or marly oozes (30–70% detrital material), alternating with calcareous muds or muds containing 70 to 100% detrital material. These terrigenous muds are relatively thicker and more common in the trough hole (611C). Smear-slide composition indicates calcareous and siliceous organisms, clay, volcanic glass, feldspar, quartz and heavy minerals, rare mica, and often a relatively important component of clay-sized terrigenous particles.

Except for some shades of brown in the upper few meters of Unit I, colors range from very light gray or greenish gray to dark gray or greenish gray, and generally vary according to the amount of terrigenous material. Some of the darker calcareous mud intervals appear to be somewhat silty. Changes in color and in lithology are gradational, sometimes showing transitions over 0.5 to 1.0 m. No sharp contacts were observed. Green and rare gray laminations are present throughout Unit I. Their thickness varies from 1 mm to 1 cm, and they are generally diffuse. Pyritic mottles are very rare. Several dark

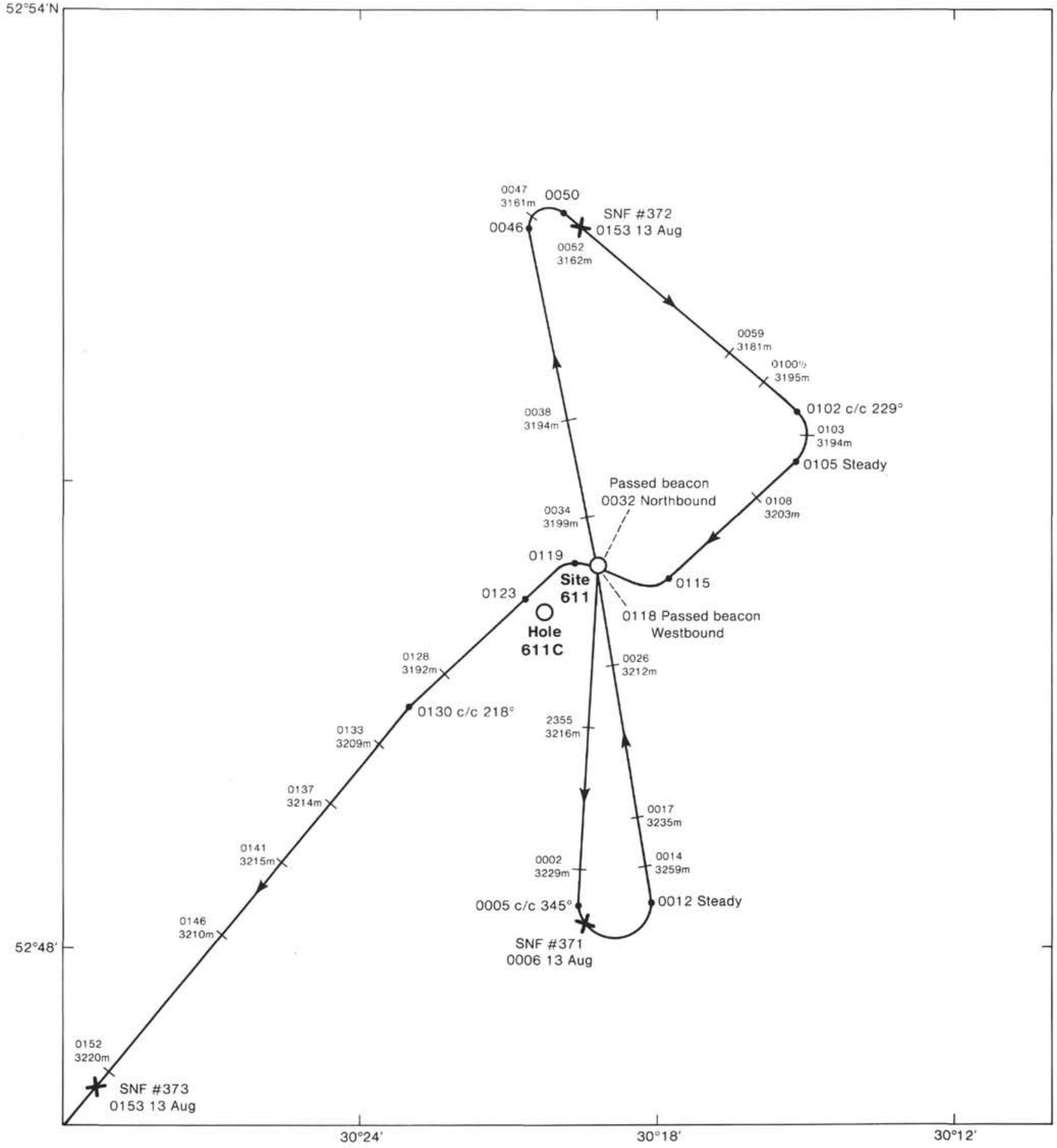


Figure 6. *Glomar Challenger* track on leaving Site 611 (postsite survey). Indicated are depths in meters and Greenwich Mean Time (Zulu), 12 and 13 August 1983. Arrows indicate direction of ship. SNF = Satellite Navigation Fix.

gray intervals rich in volcanic glass (5–15%) and/or tuff fragments occur in Unit I. In Hole 611, around 81.75 m, there is a thin (3 cm), sandy (50% sand-sized grains) ash layer containing 50% volcanic glass. No clear correlations between ash layers in different holes could be made. Scattered ash is very rare.

Siliceous organisms, mostly diatoms and sponge spicules, are present in varying amounts throughout Unit I. Siliceous foraminiferal nannofossil oozes (10–20% silica) were recognized at 0 to 15 m, 28.0 to 59.5 m, and 91 to 178 m in the crest holes, and between 114 and 167 m in the trough hole, with a maximum (20%) between 118 and 140 m. Siliceous organisms were not observed in the calcareous muds. Based on the siliceous content, Unit I can be divided into two subunits: Subunit IA, which contains calcareous terrigenous sediments (0–91 m in the

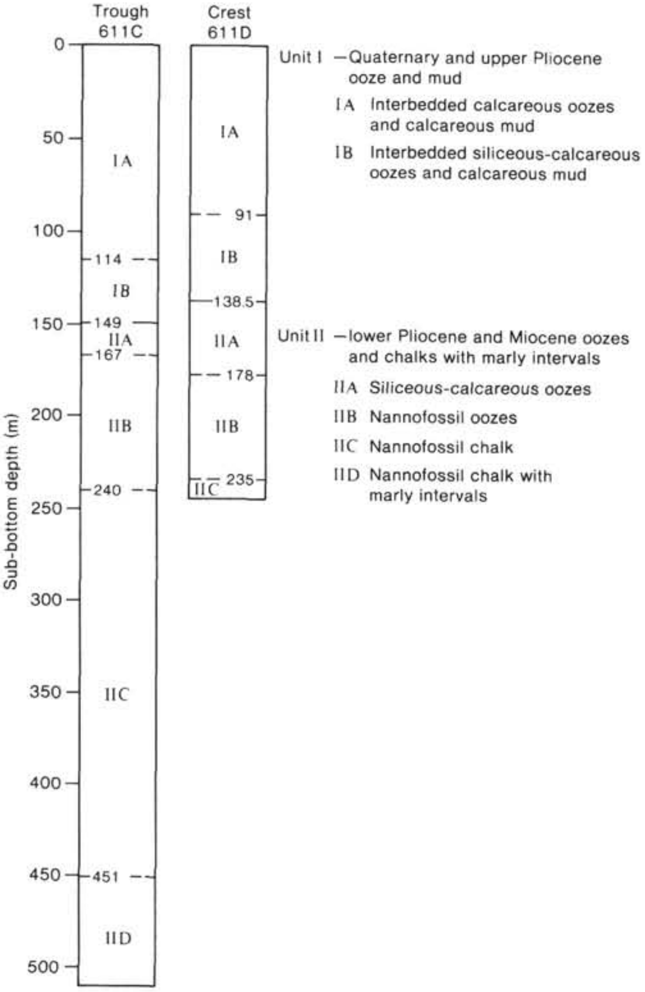


Figure 7. Summary of the lithologic units at Site 611, in crest and trough holes.

crest holes, 0–114 m on the trough hole); and Subunit IB, composed of siliceous-calcareous terrigenous sediments (91.0–138.5 m in the crest holes; 114–149 m in the trough hole).

Bioturbation is generally common in Unit I. Rare but distinctive Zoophycos burrows are present below 90 to 100 m in the crest holes and beginning at 72 m in the trough hole.

Dropstones are common, especially between 10 and 100 m. In over 450 m of sediment recovered within this depth interval, 89 dropstones larger than 1 cm were found. The composition of the dropstones is shown in Figure 9.

Unit I sediments are not altogether typical of deep-water pelagic deposits. They were deposited at high sedimentation rates (see Sedimentation Rate section) and contain reworked Cretaceous nannofossils. However, no sediment structures indicative of strong bottom-current transport and deposition were observed, nor were turbidite features found.

Unit II (149–511 m in the trough hole, Hole 611C; 138.5 m to bottom in the crest hole, Hole 611D) consists of sediments of early Pliocene and Miocene age, dominantly almost pure pelagic oozes and chalks that alternate with thinner marly intervals. The frequency of color changes is reduced relative to Unit I; colors range from light (greenish) gray to (greenish) gray.

Four sub-units can be distinguished: Subunit IIA, siliceous nannofossil oozes, containing about 10% silica (149–167 m in the trough holes; 138.5–178 m in the crest hole); Subunit IIB, nannofossil oozes (167–240 m in the trough hole; 178–235 m in the crest hole); Subunit IIC, calcareous chalk (240–451 m in the trough hole; 235 m to bottom—244 m—in the crest hole); and Subunit IID (below 451 m), nannofossil chalk with marly intervals.

Throughout Subunits IIA and B, bioturbation is generally common, as indicated by gray and olive gray mottles. Diffuse green layers are common and vary from very thin laminae (< 1 mm) to thin beds (2–3 cm). Pyritic mottling is occasionally present. The first chalky intervals appear around 233 m; below this level, the number of hard intervals increases progressively. Subunit IIC displays very common gray and light brown burrow mottling. Diffuse green patches occur frequently, tending to elongate into a form of lamination, but distinct laminations are very rare. Some green, wispy laminations have been observed, mostly in the marly intervals. Between 323.3 and 324.2 m, most mottles appear flattened and tilted (15°); at 323.7 m, a fragment of the core has been broken by a microfault with slickensides. Below 325.6 m, the general bedding inclination increases to 35 to 45°. Green laminations are often crosscut by very thin, dark microfissures. Between 331 and 334 m, laminations and mottles are rare, but are tilted at 80°. A fault with slickensides is present; the sediment colors are slightly different on either side, but have similar bedding inclination. Below 334 m, the general bedding appears horizontal again; some faults with slickensides are present at 390 to 395 m and between 494 and 500 m.

PHYSICAL PROPERTIES

The physical properties measured on samples from Holes 611 and 611C are shown in Figures 10 and 11, respectively. Gravimetric tests were done on sediments from the entire length of Hole 611, 0 to 125 m sub-bottom depth, and the middle part of Hole 611C, 120 to 250 m sub-bottom.

The values of dry water content are scattered between 70 and 140% in the first 100 m (Hole 611, Fig. 10A). The dry water content starts to decrease roughly linearly from 135% at 120 m to 55% at 240 m sub-bottom (Hole 611C, Fig. 11A). Wet water content values are less scattered than dry values. Wet water contents vary between 40 and 60% over the upper 100 m (Fig. 10B). They then decrease linearly from 55% at 120 m to 35% at 250 m sub-bottom (Fig. 11B).

Values of porosity stay around 75% for the upper 120 m (Fig. 10C), then decrease from 75% at 120 m to 60% at approximately 250 m sub-bottom depth (Fig. 11C).

Void ratio values are scattered in the first 130 m (Fig. 10D), varying between 1.5 to 4.5. Void ratio decreases from 3.5 at 120 m to 1.5 at 250 m sub-bottom depth at a roughly linear rate (Fig. 11D).

Grain density varies between 2.5 and 3.0 g/cm^3. This variation is more than at the other sites and could be

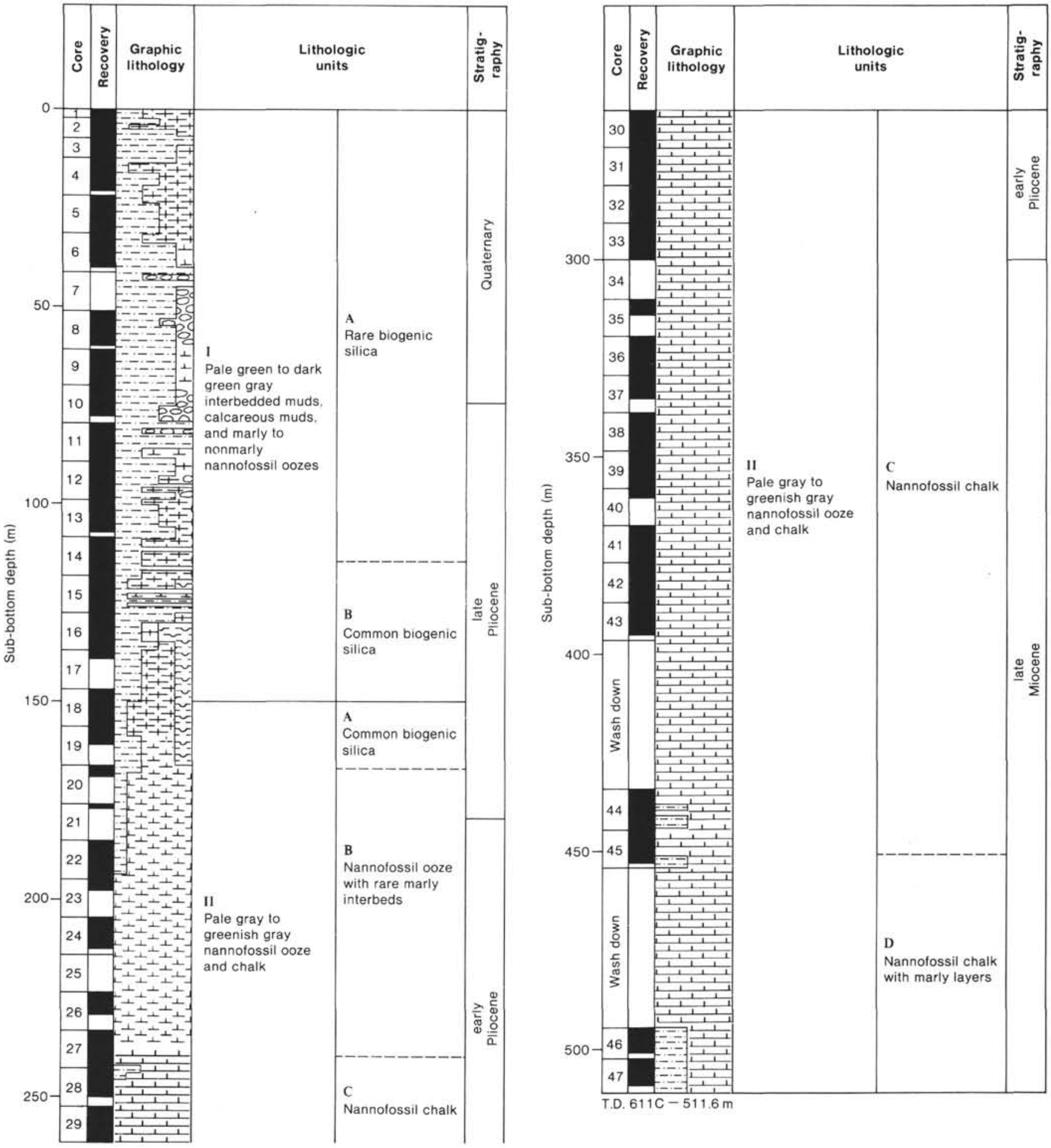


Figure 8. Recovery and lithologic units at Site 611 (Hole 611C).

caused by somewhat greater lithologic variation (Figs. 10E and 11E).

Most values of wet-bulk density fall between 1.4 and 1.5 g/cm^3 over the upper 120 m (Fig. 10F). Wet-bulk density increases from about 1.4 g/cm^3 at 120 m to approximately 1.7 g/cm^3 at 250 m sub-bottom (Fig. 11F). Values for bulk density derived from continuous GRAPE and 2-minute GRAPE measurements confirm this gravimetric data (Fig. 11G).

Sonic velocity measurements at this site show values of 1.53 km/s over the upper 280 m (Figs. 10G and 11H). Sonic velocity increases linearly with depth from 1.54 km/s at 280 m to 2 km/s at 500 m sub-bottom depth (Fig. 11H).

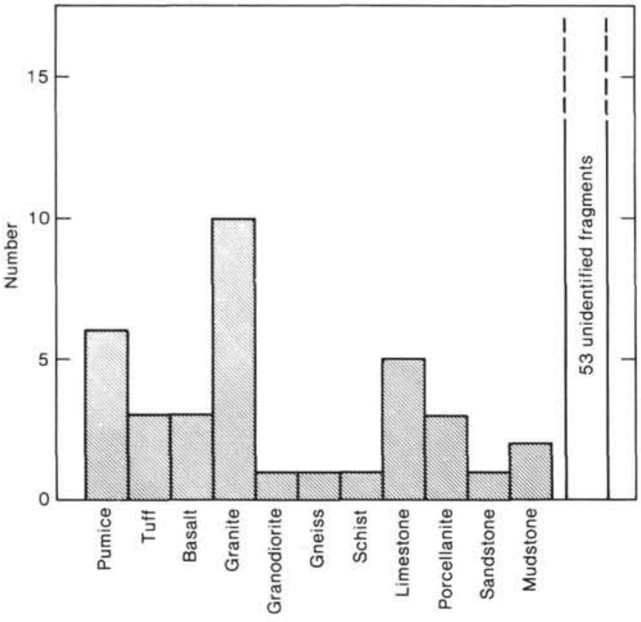


Figure 9. Composition of glacial erratics (dropstones) at Site 611. (Number = 36.)

Shear strength increases with depth from values around 75 g/cm^2 at the surface to about 600 g/cm^2 at 120 m sub-bottom (Fig. 10H).

SEISMIC STRATIGRAPHY

The *Glomar Challenger* air-gun records obtained on our run in to Site 611 could be matched quite well with those recorded by *Discovery* during the site survey (see also Jacobs, this volume). Because the reflectors are much more clearly defined on the latter records (Fig. 12A), we will use them to discuss the acoustic units at this site. Selected acoustic units are outlined alongside the Leg 94 profile in Figure 12B.

Acoustic basement is defined by an irregular, probably faulted reflector that varies between 1.2 and 2.0 s sub-bottom (two-way traveltime) in the vicinity of the site (acoustic Unit F). At Site 611, it is relatively shallow: 1.3 s. A deep flat-lying reflector occurs at around 1.0 s sub-bottom and defines the top of a sequence that apparently fills the basement relief. Around Site 611 this sequence, acoustic Unit E, is in places almost 0.4 s thick.

Above the 1.0-s regional reflector is the Gardar sediment drift section. Between 0.5 and 1.0 s sub-bottom the *Discovery* profiles (Fig. 12A) show an interval of reverberant returns in which there is some suggestion of inclined reflectors (acoustic Unit D). The *Challenger* profile over this interval (Fig. 12B) is generally transparent in the lower part, passing upward into a more reflective zone above 0.7 s. Between 0.5 and 0.2 s on the *Discovery* profile, a zone of strong reflectivity occurs that is matched on the *Challenger* record by an interval between 0.4 and 0.5 s that is only generally reflective but passes into a stronger reflectivity interval between 0.4 and 0.2 s. We have split the 0.2- to 0.5-s interval at 0.4 s on Figure 12B into two acoustic units (B and C) based upon this difference in the profiles, because a relationship is evident with the lithologies drilled at Site 610. Acoustic Unit B on the *Challenger* profile shows faint returns that may again represent inclined reflectors.

Both sets of records show a marked change at 0.2 s sub-bottom below a wavey stratified upper sequence, the surface relief of which is the sediment-wave ornamentation of the drift.

Correlations with the lithologies drilled are defined in Figure 12B. Calculated two-way traveltimes for specific cored intervals are shown in Table 2, derived from seismic velocities measured on the recovered sediments.

Lithologic Unit I, which extends to 149 m sub-bottom in Hole 611C, represents about 0.2 s of two-way traveltime (Table 2) and contains the glacial-interglacial carbonate cycles. As at other Leg 94 sites, this correlates with the uppermost acoustic Unit A.

Acoustic Units B and C are represented by lithologic Subunits IIA and IIB, and IIC, respectively. The reflectivity change defining the base of acoustic Unit C corresponds in Hole 611C to a change (calculated at 0.5 s sub-bottom in Table 2) to more marly nannofossil chalks at 451 m sub-bottom within lithologic Subunit IID. Calculations show that the reflectivity increase in the *Challenger* records passing upward through 0.4 s sub-bottom probably represents the boundary between lithologic Subunits IIB and IIC at 240 m in Hole 611C.

We have little information below 0.5 s (451 m) sub-bottom. Cores 611C-46 and -47, which extend to 511.6 m total depth, show that the thick acoustic Unit D is, at least in its upper parts, made up of nannofossil chalks with marly intervals (lithologic Subunit IID).

BIOSTRATIGRAPHY

Six holes were drilled on the southeastern flank of the Gardar Ridge, resulting in the recovery of a continuous upper Miocene through Quaternary sedimentary sequence. Although the preservation and abundance of microfossils vary among samples, nannofossils are generally moderately to well preserved with moderate to high diversity. Similarly, foraminifers are generally abundant and well preserved, with the exception of some upper Miocene samples in which planktonic foraminifers are rare or flattened. In addition, samples generally contain few to common moderately preserved diatoms.

Holes 611, 611A, 611D, and 611E were drilled on the crest of a sediment wave, whereas Holes 611B and 611C were drilled in the trough. Holes 611 and 611A recovered 125.8 and 132.0 m, respectively, of upper Pliocene through Quaternary sediments. The Pliocene/Pleistocene boundary is placed within Core 8 of Holes 611 and 611A, Core 10 of Hole 611C based on paleomagnetic and paleontological datums (see Fig. 13 and sedimentation rate curves, Figs. 14A and 14B) (for an updated version, see Baldauf et al., this volume).

Fourteen cores were recovered from Hole 611D. Except for a VLHPC core taken from 5.5 to 15.1 m (Core 611D-1), the upper 128.9 m of sediments were washed. Coring continued to a sub-bottom depth of 244.1 m. With the exception of Core 611D-1, which is Quaternary in age, all sediments recovered are Pliocene in age (2.6–3.9 Ma). The Gilbert/Gauss boundary, which cor-

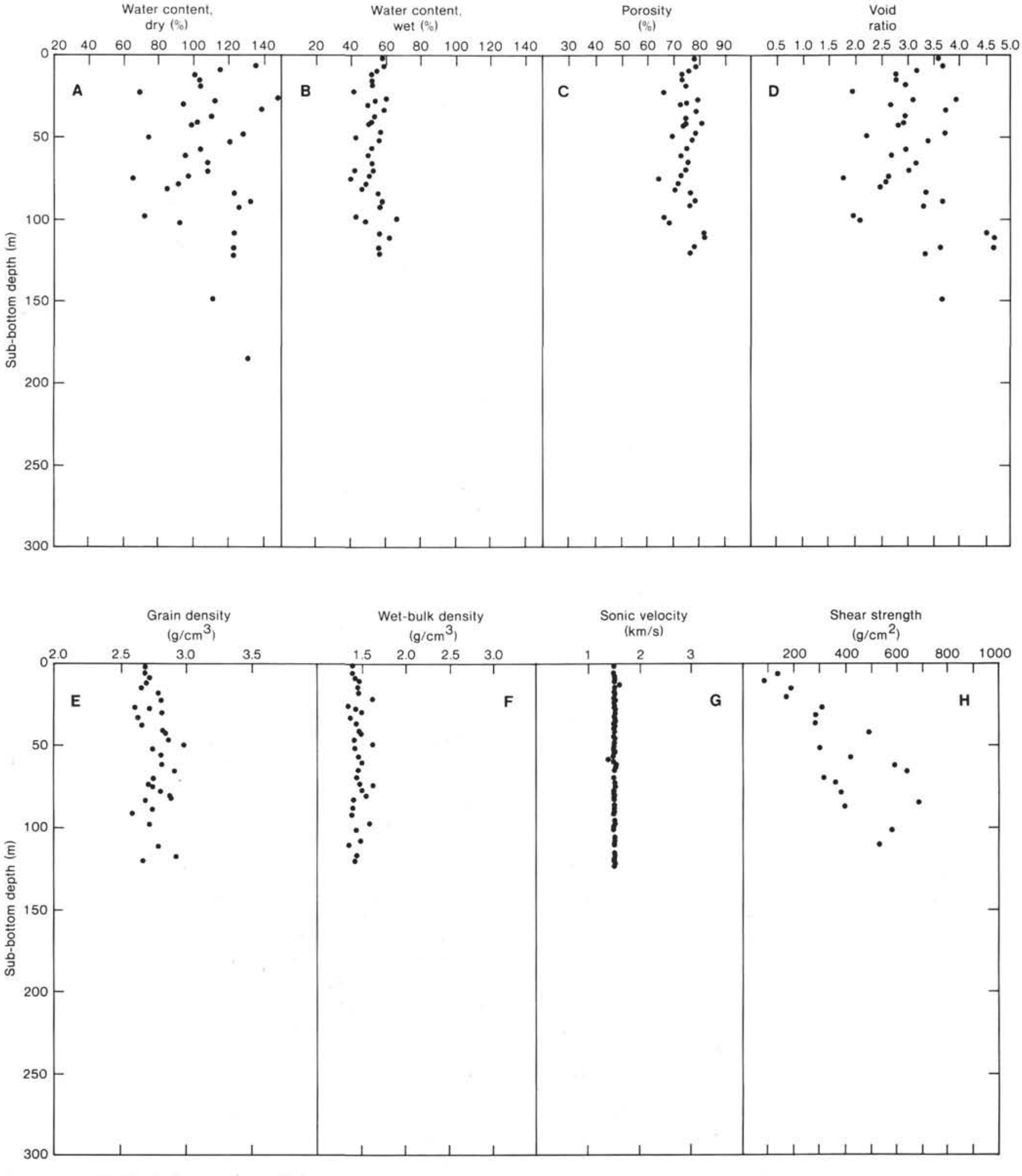


Figure 10. A–H. Physical properties at Hole 611.

responds to the early Pliocene/late Pliocene boundary (3.40 Ma), is placed in Core 611D-10 at a depth of 200 m.

The two cores recovered from Hole 611E are middle to late Quaternary in age, based on paleomagnetic and paleontological datums.

Hole 611C, drilled within the trough, was continuously cored to a depth of 396.4 m. Below this depth, 50 m of sediments were washed. This was followed by 19.2 m (two cores) of coring. This washdown and coring sequence was repeated a second time resulting in a total depth of 511.6 m. Age control is based on 33 datums in-

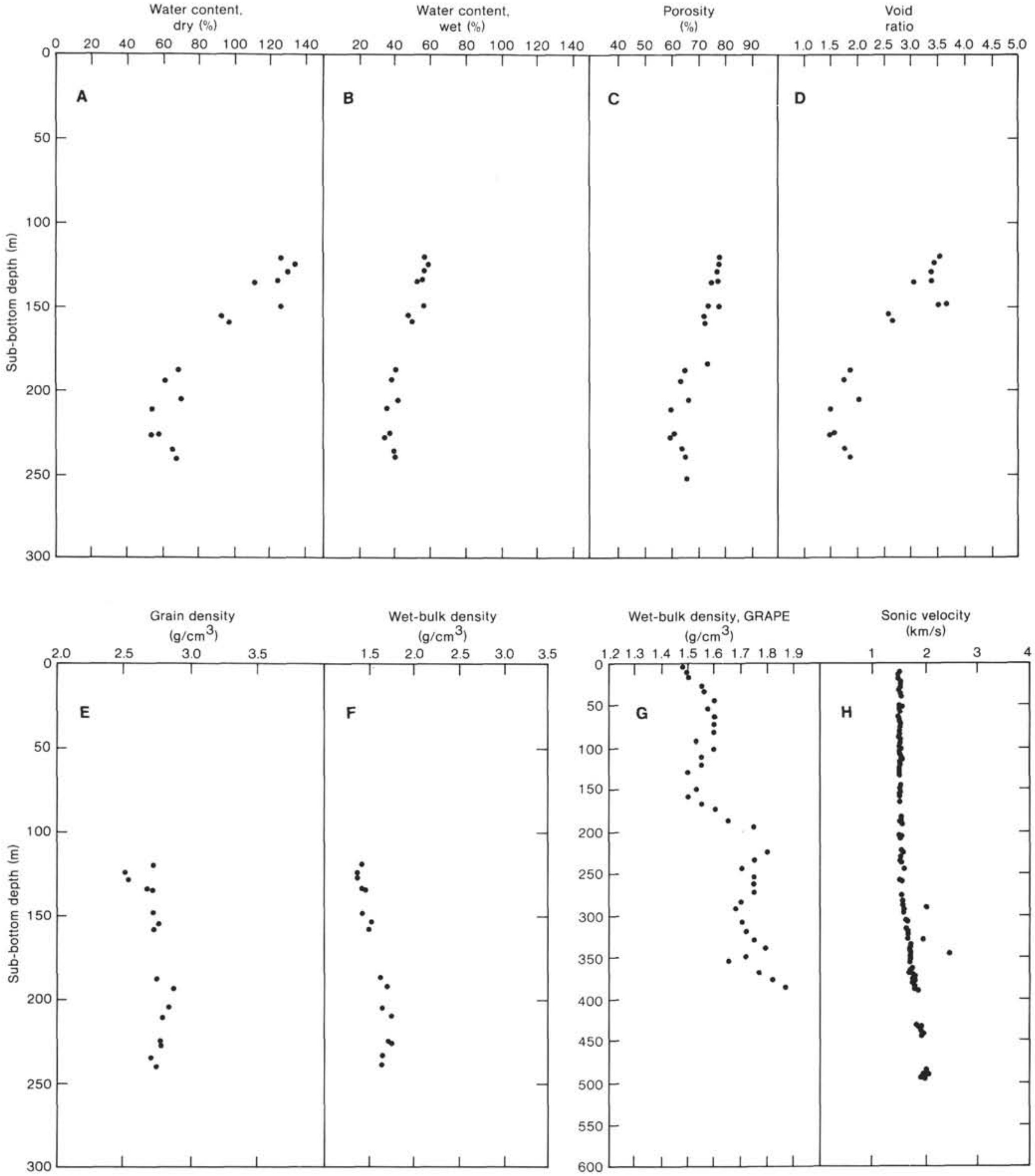
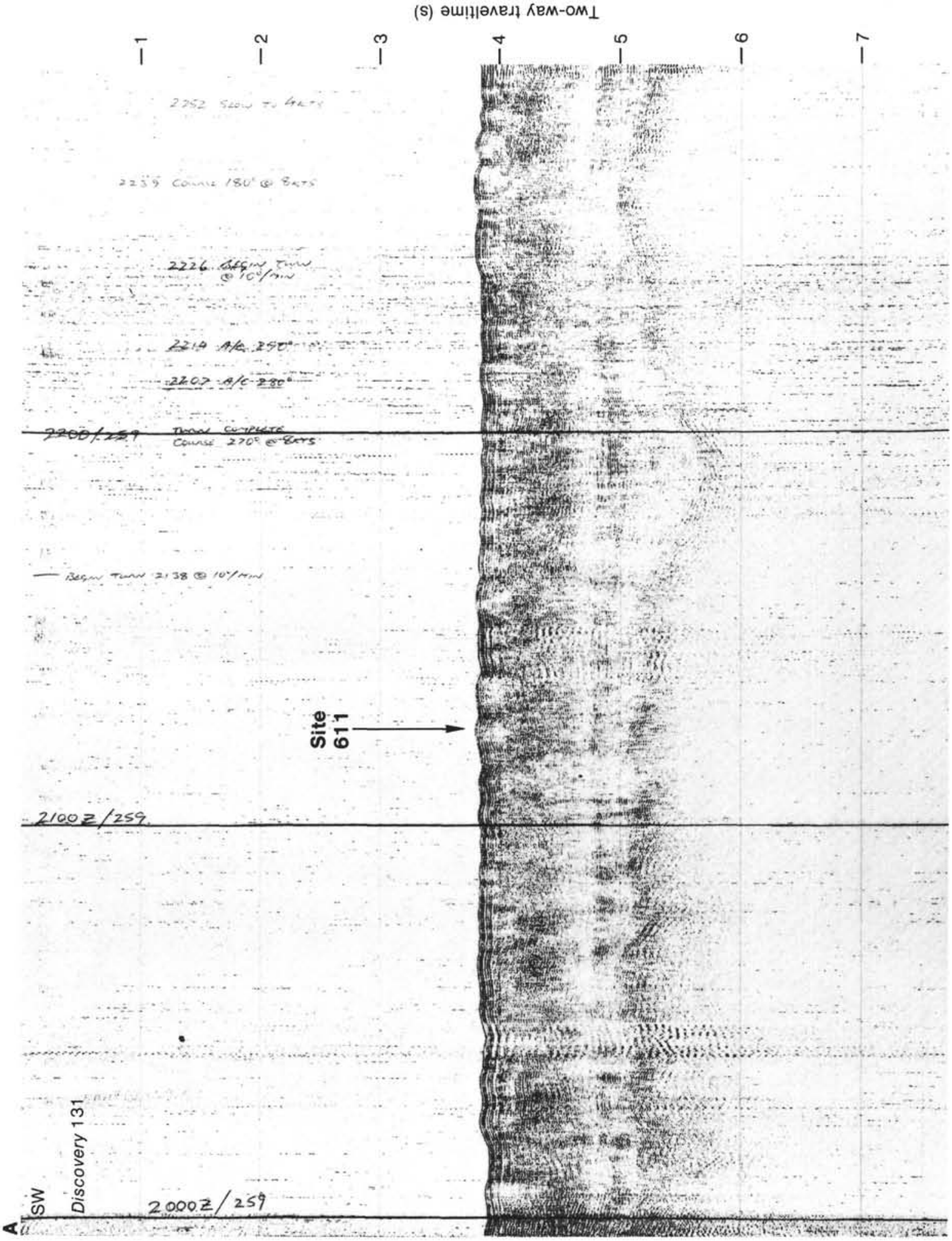


Figure 11. Physical properties, Hole 611C. A–F. 0–300 m sub-bottom. G, H. Wet-bulk density (derived from GRAPE) and sonic velocity—0–600 m sub-bottom.

dicating a late middle Miocene to Quaternary age for sediments recovered from Hole 611C. The Miocene/Pliocene boundary (5.3 Ma) is placed below Core 611C-33 at an approximate depth of 300 m. The Pliocene/Quaternary boundary is placed in the lower portion of Core 611C-10 (77 m). The lower/upper Pliocene boundary occurs in Core 611C-21 at 180 m. The one core recovered from Hole 611B, which was begun in the trough and quickly abandoned, is of Quaternary age.

Calcareous Nannofossils

Core-catcher material examined contains middle Miocene to Holocene calcareous nannofossils. The state of


Two-way traveltime (s)
1
2
3
4
5
6
7
A
SW
Discovery 131
Site 611
2000Z/259
2100Z/259
2200/259
Turn complete Course 270° @ 8kts
Begin turn 2138 @ 10°/min
2207 A/C 280°
2214 A/C 290°
2226 Begin turn @ 10°/min
2239 Course 180° @ 8kts
2252 Slow to 6kts

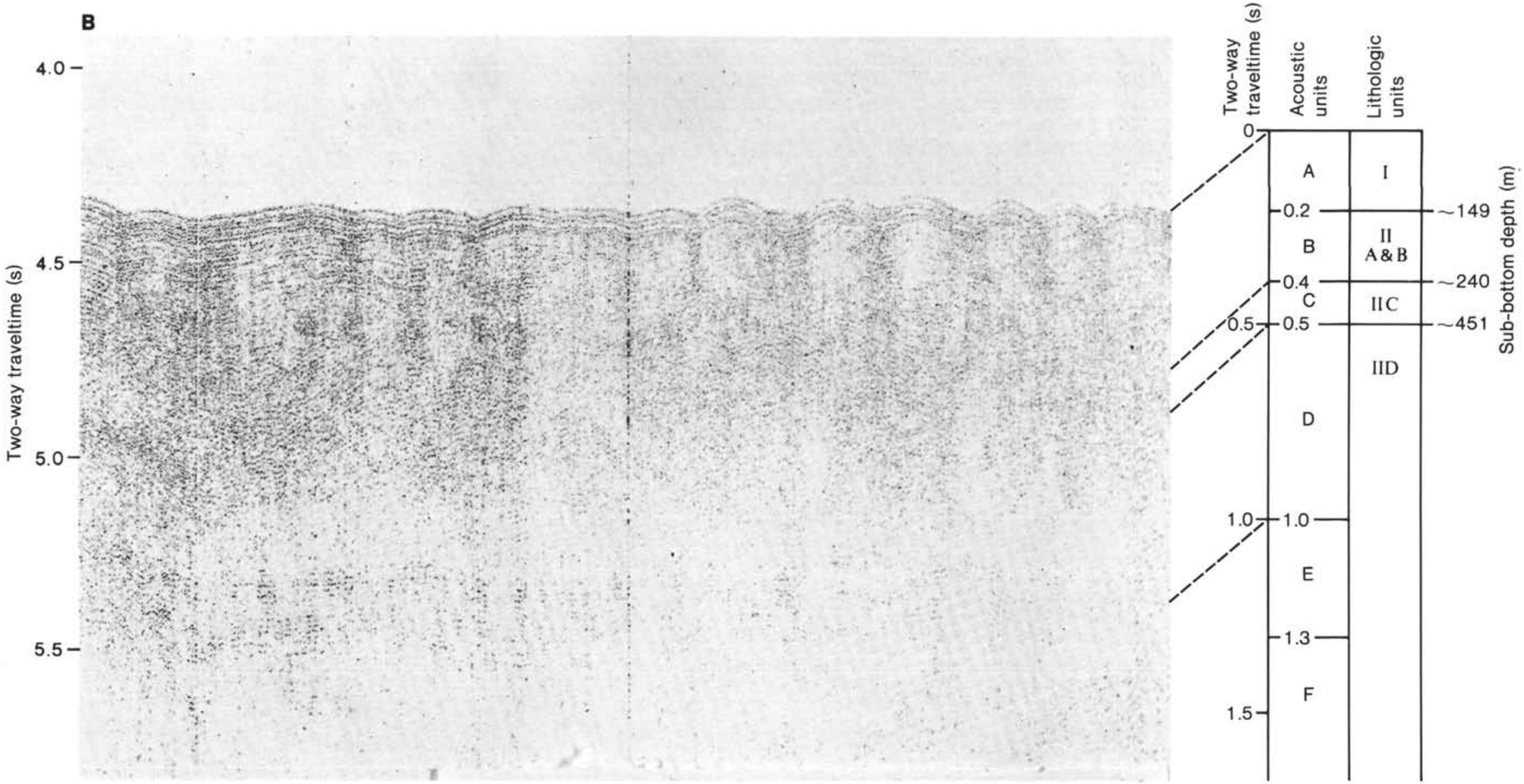


Figure 12. A. Single-channel air-gun record from *Discovery* site survey; the position of Site 611 is indicated. B. Air-gun record from the *Glomar Challenger*, showing the same area as is depicted in Figure 12A, and correlation of acoustic units with lithologic units at Site 611.

Table 2. Hole 611C: seismic velocity calculations.

Cored interval (m)	Mean seismic velocity (m/s)	Equivalent seconds (two-way traveltime)	Cumulative seconds (two-way traveltime)
0-166	760	0.218	0.0-0.218
166-282	775	0.150	0.218-0.368
282-321	800	0.050	0.368-0.418
321-338	825	0.021	0.418-0.439
338-396	882	0.023	0.439-0.462
396-454	968	0.060	0.499-0.522

preservation is moderate to poor and the species diversity is low to moderate.

Holes 611 and 611A

Samples 611-1,CC contains abundant coccoliths. *Emiliania huxleyi*, gephyrocapsids, *Calcidiscus leptoporus*, and *Helicosphaera carteri* are dominant, and a few species, such as *Discolithina multipora, Ceratolithus cristatus, Gephyrocapsa aperta* and *Discolithina japonica*, occur rarely. This sample may thus represent the late Pleistocene to Holocene *Emiliania huxleyi* Zone (NN21). Samples 611-2,CC 611A-1,CC and 611A-2,CC contain Cretaceous reworked specimens such as *Watznaueria barnesae, Arkhangelskiella cymbiformis*, and *Eiffellithus turriseiffeli*. The occurrence of *Pseudoemiliania lacunosa* and the absence of discoasters suggest that Samples 611-2,CC through 611-8,CC and 611A-1,CC through 611A-10,CC can be correlated with early Pleistocene *Pseudoemiliania lacunosa* Zone (NN19). Discoasters are extremely rare, and therefore it is hard to detect the last appearance datum (LAD) of *Discoaster brouweri*. The Pliocene/Pleistocene boundary may be placed between Samples 611-8,CC and 611-9,CC and 611A-10,CC and 611A-11,CC. Samples 611-9,CC through 611-12,CC and 611A-11,CC are characterized by the occurrence of *Discoaster brouweri* and belong to the uppermost Pliocene *Discoaster brouweri* Zone (NN18). Among these samples, 611-10,CC contains a few *Gephyrocapsa oceanica* and *G. caribbeanica*. They probably represent downhole contamination, but occurrences of these species in upper Pliocene formations have been reported by several investigators (for example Takayama, 1977). Sample 611A-12,CC contains *Discoaster pentaradiatus* together with *D. brouweri* and is placed in the *Discoaster pentaradiatus* Zone (NN17). The remaining samples of these holes are considered to belong to the *Discoaster surculus* Zone (NN16), based on the occurrence of *Discoaster surculus*.

Hole 611C

Abundant occurrences of *Emiliania huxleyi* suggest that Samples 611C-1,CC and 611-2,CC can be correlated with the late Pleistocene to Holocene *Emiliania huxleyi* Zone (NN21). A few specimens of *Eiffellithus turriseiffeli* and *Watznaueria barnesae* in Sample 611C-2,CC are considered to be reworked from Cretaceous outcrops. Sample 611C-3,CC belongs to the *Gephyrocapsa oceanica* Zone (NN20), according to the absence of *Emiliania huxleyi* and *Pseudoemiliania lacunosa*. The seven samples below this (Samples 611C-4,CC through 611-9,CC) contain abundant *Pseudoemiliania lacunosa*, and all are placed in the lower Pleistocene *Pseudoemiliania lacunosa* Zone (NN19). Several reworked Cretaceous specimens are found in this zone (in Sample 611C-5,CC). Calcareous nannofossils are almost absent in Sample 611C-10,CC. As in previous holes, discoasters are missing or extremely rare in the upper Pliocene sediments. As a result, the Pliocene/Pleistocene boundary is not precisely detected. However, Sample 611C-11,CC does contain *Discoaster brouweri* and *D. triradiatus* and the Pliocene/Pleistocene boundary is placed between Samples 611C-9,CC and 611C-11,CC (see Takayama and Sato, this volume).

Samples 611C-11,CC through 611C-13,CC are assigned to the *Discoaster brouweri* Zone (NN18). Judging by the coexistence of *Discoaster pentaradiatus* and *D. surculus*, Sample 611C-14,CC is placed in the NN16 *Discoaster surculus* Zone. Below this, discoasterid assemblages gradually change with an increase in the number of species and the number of specimens. *Reticulofenestra pseudoumbilica* is comparatively dominant. The abundance of *Reticulofenestra pseudoumbilica*, however, increases in Sample 611C-22,CC; this species may thus become extinct in Core 22, with occurrences above this sample representing reworking. Consequently, the boundary between the *Discoaster surculus* Zone (NN16) and *Reticulofenestra pseudoumbilica* Zone (NN15) is placed between Samples 611C-21,CC and 611C-22,CC.

Because amauroliths occur in Samples 611C-27,CC through 611-29,CC, the *Reticulofenestra pseudoumbilica* Zone (NN15)/*Discoaster asymmetricus* Zone (NN14) boundary is placed in Core 27. Below this boundary, *Discoaster asymmetricus* and ceratoliths are missing or extremely rare. Thus the distinction between the *Discoaster asymmetricus* Zone (NN14), the *Ceratolithus rugosus* Zone (NN13), and the *Amaurolithus tricorniculatus* Zone (NN12) is uncertain. Below the NN15/NN14 boundary, rare to common *Discoaster quinqueramus* are found; however the abundant occurrence of this species is first recognized in Sample 611-31,CC. Thus the *Amaurolithus tricorniculatus* Zone (NN12)/*Discoaster quinqueramus* Zone (NN11) boundary is placed in Core 611C-31. Occurrences of *Discoaster quinqueramus* above this boundary are attributed to reworking.

Samples 611C-44,CC and -45,CC contain no *Discoaster quinqueramus* specimens and may belong to the NN10 *Discoaster calcaris* Zone. In Sample 611C-46,CC, obtained from the bottom of this hole, a few specimens of *Discoaster hamatus* are found. If these are not reworked specimens, this sample can be assigned to the middle to upper Miocene *Discoaster hamatus* Zone (NN9), and the absolute age of the bottom sediments of Hole 611C is slightly older than 11 Ma. In the lower half of this hole, comparatively abundant Oligocene–Eocene reworked specimens are recognized.

Hole 611D

Sample 611D-1,CC, which was obtained after washing down to 5.5 m sub-bottom, contains abundant *Gephyrocapsa caribbeanica, Helicosphaera carteri, Calcidiscus leptoporus* together with *Gephyrocapsa oceanica*

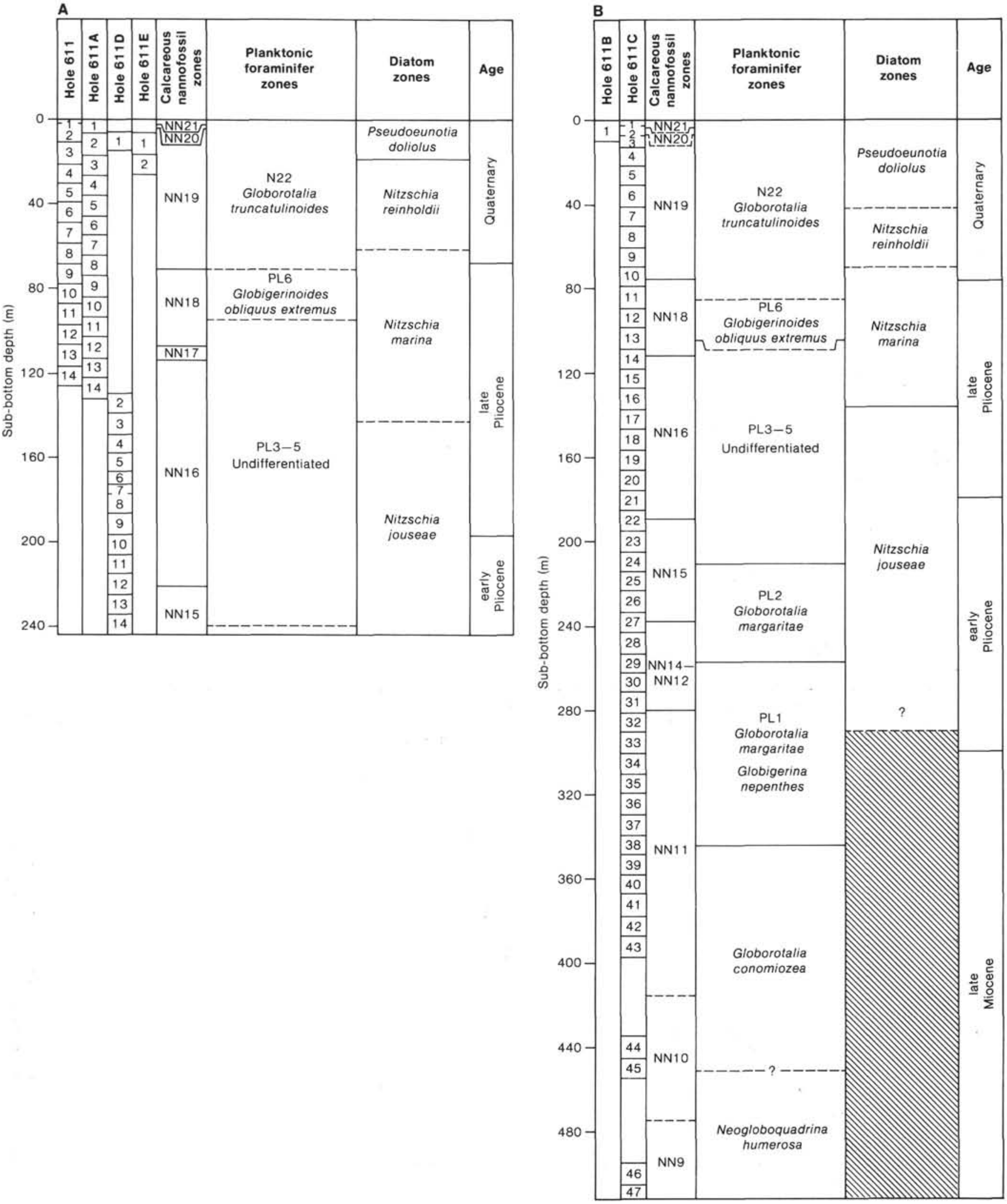


Figure 13. Biostratigraphic summary, Site 611. A. Crest holes—611, 611A, 611D, 611E. B. Trough holes—611B, 611C. Hachured area in the Diatom column indicates that samples are barren or contain rare non-age-diagnostic fragments. For an updated version, see Baldauf et al., this volume.

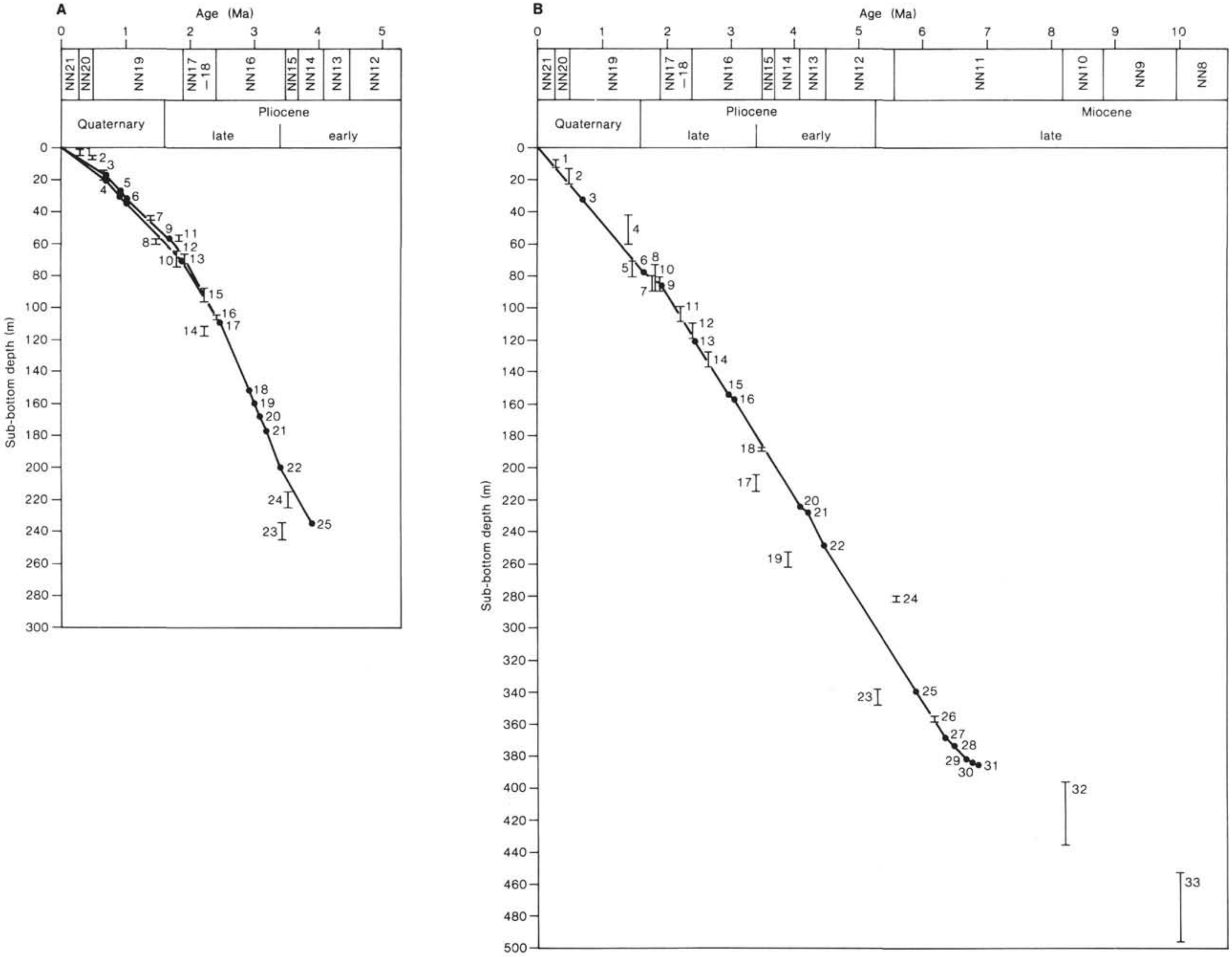


Figure 14. Time versus depth plots for the cores taken at Site 611, with nannofossil zonation shown at the top. The datum levels used to construct the curves are listed in Table 6. A. Crest holes—611, 611A, 611D. B. Trough holes—611B, 611C.

and *Pseudoemiliania lacunosa*. This sample is referred to the lower Pleistocene *Pseudoemiliania lacunosa* Zone (NN19). Samples 611D-2,CC through -11,CC, which were continuously cored after washing down to 128.9 m sub-bottom, contain *Pseudoemiliania lacunosa, Helicosphaera sellii*, and *Calcidiscus macintyrei* together with *Discoaster brouweri, D. pentaradiatus, D. surculus*, and *D. asymmetricus* and *D. tamalis*. These samples belong to the upper Pliocene *Discoaster surculus* Zone (NN16). Throughout this zone, specimens of *Reticulofenestra pseudoumbilica* are found, but the number of specimens is not as abundant as in Hole 611C. Therefore the NN16/NN15 boundary is comparatively clearly marked in Core 611D-12. Samples 611D-12,CC on down to the bottom of the hole are assigned to the *Reticulofenestra pseudoumbilica* Zone (NN15), based on the abundant occurrence of *Reticulofenestra pseudoumbilica*.

Hole 611E

Hole 611E, the last hole drilled during Leg 94, was washed down to 6.5 m sub-bottom, and two cores were obtained. These cores contain abundant gephyrocapsids and *Pseudoemiliania lacunosa* together with *Helicosphaera carteri, Calcidiscus leptoporus, Syracosphaera* sp., and *Discolithina multipora*, and are placed in the lower Pleistocene *Pseudoemiliania lacunosa* Zone (NN19).

Planktonic Foraminifers

The fauna of Site 611 is generally abundant and well preserved, although a few samples from the upper Miocene show reduced numbers and in some cases only moderate preservation. At the base of Hole 611C (near the middle/upper Miocene boundary), there are numerous flattened specimens; broken specimens also occur at some levels, particularly in the midpart of the Pliocene. Faunas are generally of cool-temperate type, similar to those at Site 610, with neogloboquadrinids dominating most samples. Some warmer influences can be seen in the lower part of the upper Miocene.

Holes 611, 611A, 611D, 611E

These holes were all drilled on the crest of a mudwave and represent a continuous sequence to 244 m. As at previous sites, it has been much easier to apply a simplified version of Berggren's (1977) subtropical temperate zonation than Poore and Berggren's (1975) temperate zonation (see also Weaver; and Weaver and Clement, this volume). *Globorotalia truncatulinoides* is very rare at this site and occurs in the warmer-water samples only. Its usefulness as a stratigraphic marker is therefore limited and, as at Site 610, the first occurrence of *Neogloboquadrina pachyderma* (sinistral, s, encrusted form) has been found to provide a better marker for the base of the *G. truncatulinoides* Zone. *N. pachyderma* (s) first appears in Cores 611-9, 611A-8, and in the washed interval between Cores 611D-1 and 611D-2. The fauna of this zone contains abundant *Globigerina bulloides, G. quinqueloba, N. pachyderma* (dextral, d), *Globorotalia scitula*, and *G. inflata* during warm intervals, and is dominated by *N. pachyderma* (s) during cold intervals.

As at previous sites, the absence of *Globorotalia miocenica* prevents an easy definition Zone PL6. At Site 607, the base of this zone was close to the transition from *Globorotalia puncticulata* to *G. inflata*, and this is used here to approximate the base of Zone PL6. The transition occurs in Core 611-11; between 611A-9,CC and 611A-11,CC (because no specimens of either species occur in 611A-10,CC); and in the washed interval of Hole 611D. The fauna of this zone is similar to that of the Quaternary but without *N. pachyderma* (s).

Distinction cannot be made between Zones PL3–5, and they are treated as one interval. The base of this interval is marked by the disappearance of *G. margaritae*, which occurs in Core 611D-14. The fauna of this interval contains abundant *Neogloboquadrina atlantica, N. pachyderma, Globigerina bulloides*, and *Globorotalia puncticulata. N. atlantica* (d) disappears near the top of this zone, and specimens of *Globorotalia* of *G. pliozea* can be found near the base. Zone PL2 contains a similar fauna with the addition of *Globorotalia margaritae*.

Hole 611C

This hole was drilled in the trough of mudwave. It provides an almost complete section to 512 m (upper Miocene), with two short washed intervals in the upper Miocene. Faunas from the upper part of the hole are comparable to the other holes at this site, with the boundaries of the zones occurring at the following levels: the base of the *Globorotalia truncatulinoides* Zone lies in Core 611C-11, based on the first occurrence of *Neogloboquadrina pachyderma* (s). Zone PL6 begins in Core 611C-13 based on the transition from *Globorotalia puncticulata* to *G. inflata*. Zones PL3–5 begin in Core 611C-24 at the last appearance of *Globorotalia margaritae*. Close agreement is found in the ages of these datums between the crest and trough holes when they are calculated from the sedimentation rate curves.

Zone PL2 extends to Core 611C-29, with the base being taken at the extinction of *Globigerina nepenthes*. The fauna of this zone is slightly more diverse than the zones above, with rare occurrences of warmer-water species such as *Globigerinoides obliquus* and *G. trilobus*. The fauna is nevertheless still dominated by neogloboquadrinids. The first occurrence of *Globorotalia puncticulata* lies close to the top of this zone.

Zone PL1 extends from the first occurrence of *Globorotalia margaritae* in Core 611C-38 to the extinction of *Globigerina nepenthes* in Core 611C-29. The fauna of this interval is similar to Zone PL2, with *G. nepenthes* being very rare, and lower occurrences of *G. margaritae* being atypical forms. The base of this zone is in any case taken to be at the base of the range of *G. margaritae* and not at the last occurrence of *Globoquadrina dehiscens*, as defined by Berggren (1977). This zone therefore crosses the Miocene/Pliocene boundary.

Globorotalia conomiozea occurs in Cores 611C-38 and -39, and forms attributable to this species occur down to Core 611C-45. The position of the base of the *G. conomiozea* Zone is therefore not certain, but it may lie in Core 611C-45. Below this, specimens of neogloboquadrinids occur to the base of the section, suggesting that these cores belong in the *N. humerosa* Zone. A few specimens of *G.* cf. *miozea* have, however, been found that might indicate a middle Miocene age for Core 611C-47, which is not in agreement with a nannofossil age of NN9 (late Miocene).

Benthic Foraminifers

Benthic foraminifers constitute less than 1% of the total foraminiferal fauna in the 63-μm fraction in almost all samples studied (list of samples given in Table 3). Only in Sample 611-14,CC is the planktonic–benthic ratio unusually low (P/B = 0.18). This number is valid only if whole specimens of planktonic foraminifers are counted; many unrecognizable fragments are present in this sample. Almost all samples studied contained sufficient specimens for counts of 200 individuals. Sample 611A-3,CC contained only 20 specimens, and data from this sample are not included in the discussion.

Samples below 611C-35,CC were dried at about 110°C for at least one hour, then soaked in kerosene. Subsequently the kerosene was poured off, water was added, and the samples were heated for at least 30 min. This treatment cleaned the fauna well in all samples.

Preservation is excellent to good above 300 m. The aragonitic species *Hoeglundina elegans* is preserved in Samples 611-1-1, 0-2 cm, -7,CC, -11,CC, and -13,CC. Below 300 m the preservation varies from good to moderate. In Samples 611C-45,CC and -47,CC, some specimens are crushed and/or recrystallized.

The diversity is generally moderate (30–40 species) to high (40–50 species), but low in Sample 611-14,CC (21 species). In most samples above 611-17,CC the diversity is moderate, and in most samples below that level the diversity is high. The lowest diversity was found in very dark gray sediments, but there is no obvious correlation with lithology, because other dark gray sediments contain a high-diversity fauna. The low-diversity fauna in Sample 611-14,CC contains abundant *Epistominella exigua;* a similar fauna was observed in a sample at Site 609 in a very dark layer just below the contact with white ooze. Because plankton is rare in Sample 611-14,CC, this sample might represent a meltwater-spike.

At Site 611, the relative abundances show strong fluctuation. The mudline sample contain an *E. exigua* fauna, as expected at this depth and latitude for a recent fauna (Streeter, 1973). The most obvious important changes in the benthic fauna occur between Samples 611C-17,CC and -21,CC, that is, between about 2.8 and 3.5 Ma. Above this interval, *Cassidulina crassa* and, in some samples, *Cassidulina teretis* are common, as are *Eponides pusillus* and *Astrononion pusillum*. The "biserial group" (*Bolivina* spp., *Stainforthia complanata, Francesita advena, Fursenkoina* spp.) shows larger fluctuations and is somewhat more common above this same level, whereas *Globocassidulina subglobosa* is more common lower in the section. *Nuttallides umbonifera*, which at other sites was more common before the onset of glaciation, has a spotty occurrence at Site 611. *Uvigerina* spp. shows several peaks in abundance in the upper 40 m, but is consistently present from Sample 611C-17,CC down. This pattern of changes in the benthic fauna suggests that bottom waters in the early Pliocene at this location were less oxygenated than today, and that a change in bottom-water circulation occurred during the late Pliocene, between about 3.5 and 2.8 Ma.

Uvigerina spp. shows a large peak in relative abundance (28.5%) in Sample 611C-39,CC. Its abundance is much lower is some samples from Cores 611C-38 and -39 that were not counted, but just inspected. This peak probably can be correlated with the peak in *Uvigerina* abundance that has been observed just above the widespread shift in ^{13}C at 6.2 Ma (e.g., Vincent et al., 1980).

Table 3. Samples used in the study of benthic foraminifers.

Hole-core-section, interval in cm			
611-1-1, 0-2	611-14,CC	611C-21,CC	611C-37,CC
611-1,CC	611A-3,CC	611C-23,CC	611C-39,CC
611-5,CC	611A-4,CC	611C-27,CC	611C-41,CC
611-7,CC	611C-4,CC	611C-31,CC	611C-43,CC
611-9,CC	611C-5,CC	611C-33,CC	611C-45,CC
611-11,CC	611C-17,CC	611C-35,CC	611C-47,CC
611-13,CC	611C-19,CC		

Diatoms

Diatoms are generally present within the six holes drilled at Site 611. Although the diatom flora present is dominated by the cosmopolitan species *Coscinodiscus marginatus, Thalassiothrix longissima, Thalassionema nitzschioides, Thalassiosira leptopus, Thalassiosira eccentrica, Nitzschia reinholdii*, and *Actinocyclus divisus*, the warm-temperate species *Pseudoeunotia doliolus, Nitzschia jouseae*, and *Thalassiosira convexa* are also observed. In addition, an influx of the cold-temperate species *Denticulopsis seminae, D. seminae* var. *fossilis, Rhizosolenia barboi, R. curvirostris*, and *Thalassiosira nidulus* approximates the Jaramillo Subchron. Samples 611-1,CC through 611-3-3, 25–30 cm, and 611A-1,CC are placed into the *Pseudoeunotia doliolus* Zone of Burckle (1977).

The first occurrence of *P. doliolus* in Samples 611-7-5, 43–45 cm and 611A-8,CC allows placement of Samples 611-7-5, 43–45 cm through 611-3-3, 45–50 cm and 611A-8,CC through 611A-4,CC in the *Nitzschia reinholdii* Zone of Burckle (1977). Within this interval, the influx of the cold temperate species occurs in Samples 611-5-6, 43–45 cm to 611-3,CC. The remaining portion of Holes 611 and 611A is placed into the *Nitzschia marina* Zone of Baldauf (1985).

A continuous upper Miocene through Quaternary sequence was recovered from Hole 611C. Diatoms are generally present within the upper 40 cores recovered. Below this interval, samples examined are barren or contain rare diatoms fragments.

Sample 611C-1,CC through 611C-4,CC are assigned to the *P. doliolus* Zone of Burckle (1977), based on the presence of *P. doliolus* stratigraphically above the last occurrence of *N. reinholdii*.

The first occurrence of *Pseudoeunotia doliolus* occurs in Sample 611C-9,CC. Therefore Cores 611C-6 through -9 are placed in the *Pseudoeunotia doliolus* Zone of Burckle (1977). The last occurrence of *Nitzschia jouseae*, which defines the boundary between the *N. jouseae* Zone and the *N. marina* Zone, occurs in Sample 611C-16,CC. Therefore, Cores 611C-9 through -15 are assigned to the *Nitzschia marina* Zone of Baldauf (1985). Sample 611C-16,CC is assigned to the *Nitzschia jouseae* Zone of Baldauf (1985). Owing to poor preservation and lack of age-diagnostic forms, the base of the *N. jouseae* Zone was not observed.

With the exception of Samples 611D-1,CC -5,CC, and 611E-1,CC, no age-diagnostic specimens were observed in samples examined from Holes 611D and 611E. Samples 611D-1,CC and 611E-1,CC are both assigned to the Quaternary *P. doliolus* Zone of Burckle (1977), based on the occurrence of *P. doliolus*. Samples 611D-3,CC through 611D-14,CC are placed in the *N. jouseae* Zone of Baldauf (1985), based on the presence of *N. jouseae*.

Radiolarians

Radiolarians are well preserved, but generally not very abundant in some of the samples examined from Site 611 (Table 4). To date, only core catchers from Holes 611 and 611C have been examined. In Hole 611, core catchers of Cores 611-2, -5, -6, and -7 are barren or contain only occasional specimens. Very sparse assemblages were found in Cores 611-8, -12, and -14; Cores 611-1, -3, -4, -11, and -13 have assemblages made up of species that are long ranged, and most of which are believed to live deep in the water column.

In Pliocene to upper Miocene sediments below Core 611C-15, radiolarians are very rare or absent, with the exception of Cores 611C-18, -20, and -27, which contain assemblages similar to the ones described above.

Table 4. Preservation and abundance of radiolarians in Holes 611 and 611C.

Hole 611			Hole 611C		
Sample	Abundance	Preservation	Sample	Abundance	Preservation
1,CC	R	G	15,CC	VR	M
2,CC	VR	P	16,CC	R	M
3,CC	F	G	17,CC	VR	M
4,CC	F	G	18,CC	F	M
5,CC	B		19,CC	VR	M
6,CC	VR	M	20,CC	F	M
7,CC	B		21,CC	VR	M
8,CC	VR	M	22,CC	VR	M
9,CC	B		23,CC	VR	M
10,CC	B		24,CC	VR	M
11,CC	F	P	25,CC	VR	M
12,CC	VR	M	27,CC	F	G
13,CC	F	G	28,CC	R	G
14,CC	R	G	29,CC	B	
			30,CC	VR	P
			31,CC	B	
			32,CC	VR	P
			33,CC	B	
			36,CC	VR	M
			37,CC	B	
			38,CC	B	
			40,CC	VR	M
			41,CC	VR	P
			42,CC	B	
			43,CC	B	
			44,CC	B	
			45,CC	B	
			46,CC	B	
			47,CC	B	

Note: C = 5000–10,000 specimen/slide; F = 1000–5000; R = <1000; VR = <200. B = barren. G = good; M = moderate; P = poor.

PALEOMAGNETICS

Paleomagnetic samples were taken at an interval of one per section (every 1.5 m) from the sediment obtained from the six holes cored at Site 611. The same procedures used at the five previous sites on Leg 94 were employed at this site. Pilot samples selected throughout the intervals studied were subjected to progressive alternating field (AF) demagnetization studies. In this case, a normal overprint is apparent and is readily removed by treatment at a peak field of 10 mT. A stable, single-component magnetization is indicated by the trajectory, which decays linearly toward the origin. Based on these results, the remaining samples were partially demagnetized using a peak alternating field of 10 mT.

The resulting inclination records obtained after AF treatment at 10 mT are discussed in detail by Clement and Robinson (this volume) for each of the holes cored at this site, with the exception of Hole 611B. Only one core was taken from Hole 611B, and the samples measured from that core were all of normal polarity. This, and the biostratigraphy, suggests that this core falls completely within the Brunhes Chronozone. The depths of the polarity boundaries are given in Table 5.

The high remanent magnetization intensities (up to 1.5×10^{-4} emu/cm^3) of the samples measured at these holes, combined with the high sedimentation rates (up to 80 m/m.y.), allowed high-resolution records of the polarity sequences to be obtained. In Holes 611 and 611A, detailed polarity records for the last 2.5 m.y. were obtained. The correlation of the observed chronozones to the magnetic polarity time scale (MPTS) was straightforward. In both of these holes, a notable change in the sedimentation rate occurs below the Brunhes Chronozone. This change in sedimentation rate was only observed in the holes cored on the crest of the sediment wave.

At Hole 611C, a nearly complete record of the polarity reversal sequence for the last 7 m.y. was obtained. Problems with core recovery and drilling disturbance, however, resulted in a number of gaps in the data. Although a number of subchronozones were not observed because of these gaps (e.g., the Jaramillo Subchronozone), the major chronozones were readily identifiable (Table 5). From a depth of 240 to 340 m, severe drilling disturbance resulted in very poor coverage. The high sedimentation rates allowed identification of the subchronozones, but the depths of the majority of the polarity reversals could not be determined because of the recovery problems. From a sub-bottom depth of 340 to 398 m, the sediment was consolidated enough to allow recovery of less deformed cores. The results obtained from this interval made it possible to identify chronozones that correlate to Chrons 6 and 7.

Samples were also taken from the two cores obtained after washing down to 434 m. Although the intensities were notably lower in this interval (0.2×10^{-6} emu/cm^3), the magnetizations were normal in polarity throughout this interval. These two cores fall within NN10, which

Table 5. Depths of reversal boundaries, Site 611.

Reversal		Age (Ma)	Sample (core-section, cm level)	Sub-bottom depth[a] (m)
Hole 611				
Brunhes		0.73	3-6, 97/4-1, 97	19.08/21.18
Jaramillo	(top)	0.91	4-6, 97/5-1, 97	28.68/30.78
	(bottom)	0.98	5-3, 97/5-4, 97	33.78/35.28
Cobb Mtn.	(top)	1.1	5-6, 97/6-1, 105	38.28/40.46
	(bottom)		6-1, 105/6-2, 97	40.46/41.88
Olduvai	(top)	1.66	7-6, 97/8-1, 97	57.48/59.58
	(bottom)	1.88	8-6, 80/9-1, 97	66.91/69.18
Reunion	(top)		9-2, 97/9-3, 97	70.68/72.18
	(bottom)		9-3, 97/9-4, 97	72.18/73.68
Matuyama/Gauss		2.47	13-3, 97/13-4, 97	110.58/112.08
Hole 611A				
Brunhes		0.73	3-3, 97/3-4, 97	20.78/22.28
Jaramillo	(top)	0.91	4-3, 98/4-4, 98	30.39/31.89
	(bottom)	0.98	4-6, 98/5-1, 120	34.89/37.21
Olduvai	(bottom)	1.88	8-4, 98/8-5, 110	70.29/71.91
Matuyama/Gauss		2.47	12-5, 127/13-1, 100	110.48/113.81
Hole 611D				
Kaena	(top)	2.92	4-4, 97/4-5, 97	153.58/155.08
	(bottom)	2.99	5-2, 97/5-3, 97	160.18/161.68
Mammoth	(top)	3.08	6-1, 97/6-2, 97	168.28/169.78
	(bottom)	3.18	8-1, 104/8-2, 97	177.95/179.38
Gauss/Gilbert		3.40	10-3, 100/10-4, 100	200.11/201.61
Cochiti	(top)	3.88	14-1, 140/14-2, 97	235.91/236.98
Hole 611E				
Brunhes		0.73	2-5, 97/2-6, 97	23.08/24.58
Jaramillo	(top)	0.91	2-6, 97/2-7, 10	24.58/25.21
Hole 611C				
Brunhes		0.73	6-1, 100/6-2, 98	32.61/34.09
Olduvai	(top)	1.66	10-6, 50/11-1, 98	78.01/80.59
	(bottom)	1.88	11-5, 98/11-6, 98	86.59/88.09
Reunion	(top)		12-5, 80/12-6, 97	96.01/97.68
	(bottom)		12-6, 97/13-1, 97	97.68/99.78
Matuyama/Gauss		2.47	15-2, 103/15-3, 97	120.54/121.98
Kaena	(bottom)	2.99	18-4, 97/18-5, 97	152.28/153.78
Mammoth	(top)	3.08	18-6, 97/19-1, 100	155.28/157.41
Nunivak	(top)	4.10	26-1, 95/26-2, 65	224.56/225.76
	(bottom)	4.24	26-3, 95/27-1, 97	227.56/234.18
C1	(bottom)	4.47	28-2, 15/28-5, 135	244.46/250.16
Chron 5	(bottom)	5.89	38-1, 63/38-2, 22	339.44/340.53
Chron 6	(top)	6.37	41-1, 140/41-3, 59	369.01/371.20
	(bottom)	6.50	41-5, 51/41-6, 54	374.12/375.65
Chron 7	(top)	6.70	42-3, 120/42-4, 122	381.41/382.93
	(bottom)	6.78	42-4, 122/42-5, 114	382.93/384.35
	(top)	6.85	42-5, 114/42-6, 71	384.35/385.42

[a] Midpoint depths of samples in third column.

argues for a correlation of this normal Chronozone to Chron 9. Unless there was a dramatic change in sedimentation rate, it is difficult to correlate a normal chronozone this long to any other normal chron in the allowable biostratigraphic range.

Results were obtained from two cores taken after a subsequent washdown to 493 m; the polarity sequence in this interval consists of a short reversed zone bounded above and below by normal polarity zones. Biostratigraphic data suggest that Core 46 is in NN10 and that Core 47 is possibly in NN9, although the presence of reworked specimens makes this assignment difficult. The preferred correlation to the magnetic polarity time scale is that the reversed zone is the first reversed interval below Chron 9.

Hole 611D was an extension of the crest holes. Again, a high-resolution polarity record was obtained starting at 132 m. The correlation of the observed chronozones to the magnetic polarity time scale is straightforward (Table 5). The record obtained at this hole extends from near the top of the Gauss to the top of the Cochiti Subchronozone.

The results from Hole 611E are shown plotted in Table 5. One reversed polarity sample was measured in Section 611E-2-6, suggesting that the base of the Brunhes had been detected. A normal polarity sample from Section 611E-2-7, however, complicated this interpretation. This second normal polarity sample may be the top of the Jaramillo, but such a correlation would imply dramatic sedimentation rate changes between this hole and Holes 611 and 611A. Unfortunately, a longer sequence is needed to clarify this correlation.

SEDIMENTATION RATES

Sedimentation rates at Site 610 were generally linear and no major hiatuses were identified. In the first deep hole drilled at the trough location, 611C, the age-depth relationship is well-controlled by biostratigraphic and paleomagnetic datums and extends to the late Miocene (almost 7 Ma) as a straight line (Fig. 14B, Table 6). The mean sedimentation rate is 58 m/m.y. A rate of 45 m/m.y. is calculated for the interval 0 to 85 m sub-bottom. Below about 385 m sub-bottom, no curve has been drawn because of uncertainties as to the placing of paleomagnetic boundaries combined with a suspicion of unreliable biostratigraphic datums caused by reworking (see also Baldauf et al., this volume).

Figure 14A shows the curve of the sedimentation rate constructed from the datums obtained from Holes 611, 611A, and 611D drilled on the sediment wave crest (Table 6). The curve begins with low glacial-interglacial rates around 29 m/m.y. in the latest Quaternary (Brunhes) and 36.5 m/m.y. in the early Quaternary (to the top of the Olduvai). It then steepens markedly with very high rates of around 80 m/m.y. in the more siliceous sediments of the Pliocene (to the top of the Cochiti Subchron).

It became clear during the drilling at Hole 611D that the above variations in Pliocene-Quaternary sedimentation rates might hold a record of large-scale sediment wave migration at the site. Because of this, the sequence drilled in Holes 611 and 611A to only about 130 m was extended by a return to the wave crest for Hole 611D and the completion of the curve shown in Figure 14A to 244.1 m sub-bottom. Despite the uncertainties noted at the base of this hole, we are able to show that overall sediment wave migration is likely; by noting differences in the Pliocene-Quaternary accumulation rate curves, we hypothesize that migration occurred mainly in the Pliocene (see Summary and Conclusions section; see also Kidd and Hill, this volume).

GEOCHEMISTRY

Carbonate Bomb

Results of the carbonate bomb analyses carried out at Site 611 should be viewed with caution, because sam-

Table 6. Datum levels used to construct Figure 14.

Number	Datum level	Age (Ma)
Hole 611C (trough hole)		
1	Top *Emiliana huxleyi*	0.28
2	Top of *Pseudoemiliania lacunosa*	0.47
3	Matuyama/Brunhes	0.73
4	Top of *Helicosphaera sellii*	1.37
5	Top of *Calcidiscus macintyrei*	1.45
6	Top of Olduvai	1.66
7	Top of *Neogloboquadrina pachyderma* (s) (see text)	1.78
8	Bottom of *Pseudoeunotia doliolus*	1.80
9	Bottom of Olduvai	1.88
10	Top of discoasters	1.90
11	Bottom of *Globorotalia inflata* (PL6)	2.20
12	Top of *Discoaster pentaradiatus*	2.40
13	Top of Gauss	2.47
14	Top of *Nitzschia jouseae*	2.65
15	Bottom of Kaena	2.99
16	Top of Mammoth	3.08
17	Top of *Globorotalia margaritae*	3.40
18	Top of *Reticulofenestra umbilica*	3.50
19	Top of *Globigerina nepenthes*	3.90
20	Top of Nunivak	4.10
21	Bottom of Nunivak	4.24
22	Bottom of C1	4.47
23	Bottom of *Globorotalia margaritae*	5.30
24	Top of *Discoaster quinqueramus*	5.60
25	Bottom of Chron 5,N2	5.89
26	Acme of *Uvigerina* spp.	6.20
27	Top of Chron 6,N1	6.37
28	Bottom of Chron 6,N1	6.50
29	Top of Chron 7,N1	6.70
30	Bottom of Chron 7,N1	6.78
31	Top of Chron 7,N2	6.85
32	Top of *Discoaster quinqueramus*	8.20
33	Top of *Discoaster hamatus*	10.00
Hole 611 (crest hole)		
1	Top of *Emiliania huxleyi*	0.28
2	Top of *Pseudoemiliania lacunosa*	0.47
3	Top of *Nitzschia reinholdii*	0.65
4	Matuyama/Brunhes	0.65
5	Top of Jaramillo	0.91
6	Bottom of Jaramillo	0.98
7	Top of *Helicosphaera sellii*	1.37
8	Top of *Calcidiscus macintyrei*	1.45
9	Top of Olduvai	1.66
10	Top of *Neogloboquadrina pachyderma* (s) (see text)	1.78
11	Bottom of *Pseudoeunotia doliolus*	1.80
12	Bottom of Olduvai	1.88
13	Top of discoasters	1.90
14	Top of *Thalassiosira convexa*	2.20
15	Bottom of *Globorotalia inflata* (PL6)	2.20
16	Top of *Discoaster pentaradiatus*	2.40
Hole 611D (crest of hole)		
17	Top of Gauss	2.47
18	Top of Kaena	2.92
19	Bottom of Kaena	2.99
20	Top of Mammoth	3.08
21	Bottom of Mammoth	3.18
22	Gilbert/Gauss	3.40
23	Top of *Globorotalia margaritae*	3.40
24	Top of *Reticulofenestra pseudoumbilica*	3.50
25	Top of Cochiti	3.88

ple weighing was carried out in heavy weather during the run in to St. John's. In addition, the plot shown in Figure 15 includes data from both crest (611) and trough (611C) holes. The $CaCO_3$ curve shows greater than usual variability particularly in the lower part of the hole (Fig. 15). Within the glacial cycles of the top 150 m, carbonate values range from 2 to 67%. Below this depth, the variability decreases but ranges from 53 to 84% with a single anomalously low value of 32% at 350.31 m. The low value is explained by the sample having come from a large pyritized burrow. Below 350 m, the carbonate curve shows a gradual decrease from 70 to 60%. Despite the questionable quality of the data, the variability shown between 150 and 350 m is thought to be genuine. This is supported by smear-slide data (see section on Lithostratigraphy).

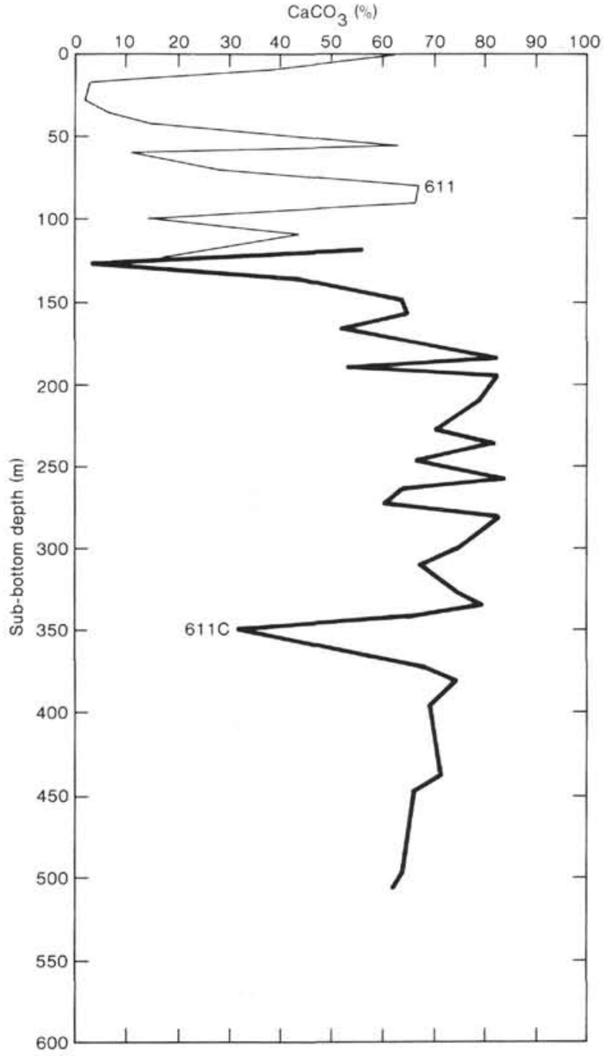


Figure 15. Carbonate bomb analyses, Site 611.

Interstitial Water

Samples for interstitial water analysis were taken from the top 90 m of crest Hole 611 and from below 150 m in trough Hole 611C (Fig. 16). Samples at 154 and 509 m from Hole 611C were not taken immediately upon recovery, but were removed from the working half several hours later.

The pH and alkalinity plots show slight variability in samples from the shallow Hole 611A (Fig. 16), whereas salinity gradually decreases from 34 to 32‰. In Hole 611C, the pH increases significantly below 350 m, whereas the alkalinity shows a corresponding decrease to values

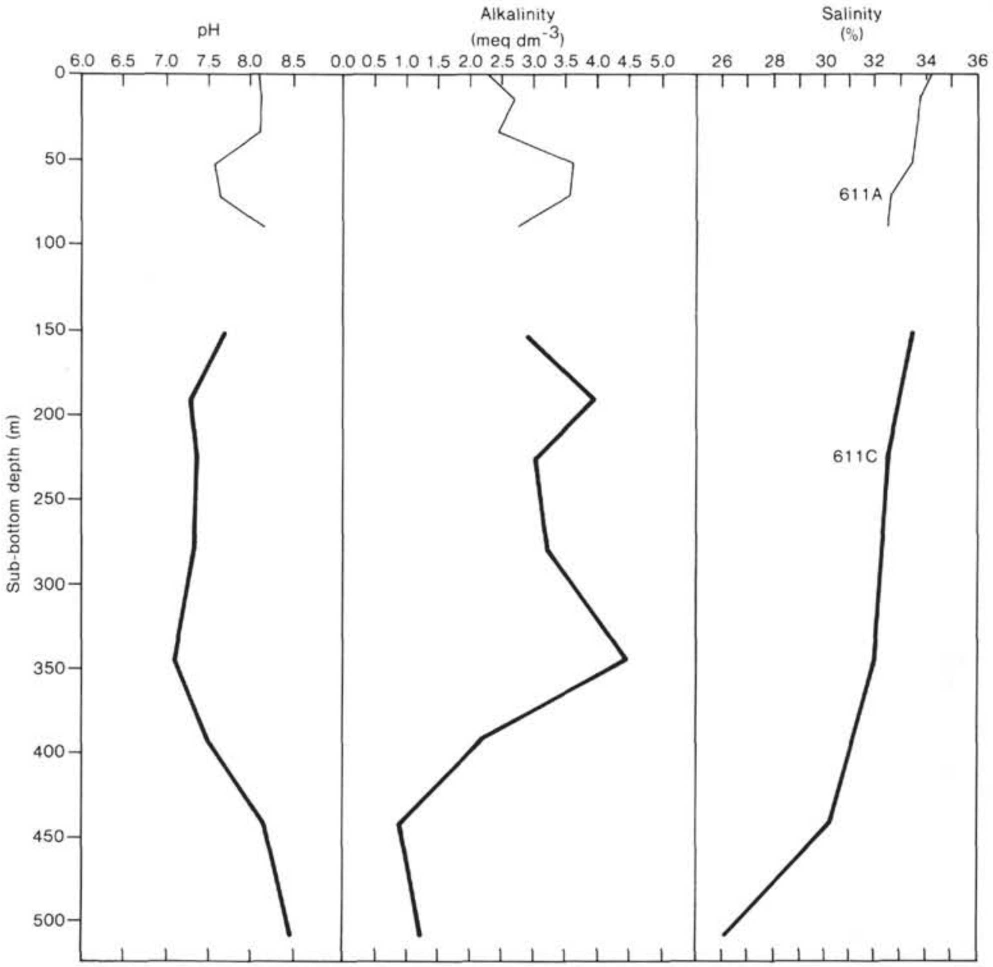


Figure 16. Interstitial water analyses, Site 611.

close to 1.0 meq dm^{-3}. Salinity in Hole 611C decreases gradually from 33.5‰ at 150 m sub-bottom to 30.2‰ at 440 m. The rather low salinity of 26.2‰ at 509 m is suspect and may be caused by contamination between the time of recovery and sampling.

SUMMARY AND CONCLUSIONS

At Site 611 on the southern flank of Gardar Ridge we drilled six holes. Four holes (611, 611A, 611D, and 611E) were cored on the crest of a sediment wave, and two (611B and 611C) were in an adjacent trough about 0.5 n.mi to the southeast and in water 33 m (uncorrected) deeper than the crest. Holes 611 and 611A were overlapping VLHPC holes drilled to 125.8 and 132 m sub-bottom, respectively. Primarily these were chosen to investigate the Pliocene–Quaternary paleoclimatic record. Holes 611C and 611B were offset holes drilled in the trough to look for wave crest-to-trough sediment faces and accumulation rate variation. In Hole 611B, a VLHPC core barrel was lost when only one core had been taken, but in Hole 611C a section was recovered with continuous VLHPC and XCB coring to 396.4 m sub-bottom and then extended to 511.6 m with washed intervals at 396.4 to 434.8 m and 454.0 to 492.4 m sub-bottom. The continuous VLHPC recovery was taken for comparison with Holes 611 and 611A, whereas the deeper drilling was an attempt to identify seismic reflectors within the sequence and establish the overall history of drift sedimentation. Low penetration rates in 611C eventually led us to abandon our deep reflector objectives, and we moved back to the wave crest to investigate an intriguing possibility that wave migration might be recognized if we examined the sedimentation rate curve to depths below those cored at Holes 611 and 611A. Hole 611D was washed to 5.5 m sub-bottom, and a VLHPC core was taken to fill a gap in the recovery from previous crest holes. Then a further major wash down was made to 128.9 m, from which level we continuously XCB cored Hole 611D to 244.1 m sub-bottom. Hole 611E was a brief attempt to fill other core recovery gaps in the VLHPC section on the crest with two cores in the interval from 6.5 to 25.7 m sub-bottom.

Glacial–Interglacial Climate Cycles

Our principal objective at Site 611 was paleoclimatic: an investigation of late Neogene and Quaternary sea surface temperature (SST) change at the northern end of the Leg 94 transect. The glacial–interglacial carbonate cycles make up lithologic Unit I, which extends to 138.5 m sub-bottom in the wave crest hole and to 149 m in the trough (Fig. 8).

Continuity of the upper Pliocene and Pleistocene sequences at Site 611 was harder to test than at the previous four sites because of incomplete recovery, disturbance of the recovered sediment, and the relatively muted color and textural contrasts in the glacial carbonate cycles. Given the uncertainty imposed by these factors, the sequence appears to have one, to at most three, interruptions in continuity during the last 2.4 Ma (Ruddiman et al., this volume). The most likely gap occurs at 5 to 8 m sub-bottom, beginning about 250,000 years ago, and extends for an unknown span of time back into the Brunhes (roughly 10,000–100,000 yr.). Other possible short gaps (10,000 yr.) occur at roughly 1.6 and 2.0 Ma. Another problem with correlations at this site is the anomalous addition of sediment units in one core (or, alternatively, losses in another). This suggests a somewhat more episodically disturbed sedimentation regime than we have detected at the other sites of Leg 94 by simple visual lithologic correlations (see Ruddiman et al., this volume).

Drift Sedimentation

As at Feni Ridge, our sedimentological objectives on this flank of Gardar Ridge, at about 3200 m water depth, were to characterize the deposits accumulating on major sediment drifts. But here we were in a lower flank setting, as opposed to the near ridge crest location of Site 610. Again the lithologies are pelagic in type, although they are generally more terrigenous than on Feni Ridge. In the upper part of the Gardar Ridge sequence, the coarser terrigenous component is largely due to the ice-rafted sediment input.

Within lithologic Unit I, detrital mud intervals occur that generally are thicker and more frequent in the wave trough than at the sediment-wave crest. Dark gray layers rich in volcanic ash are present in lithologic Unit I as at the Feni Ridge, but no hole-to-hole correlation is apparent at this site.

Below the glacial-interglacial cycles of Unit I, the sequence is made up entirely of oozes and chalks. These vary only when their content of biogenic silica increases, as in lithologic Subunit IIA, or where they contain marly intervals. The latter are probably indicative of intermittent detrital input.

Although there is no dramatic evidence of a sudden increase in detrital muds from Icelandic sources at 3.4 to 3.1 Ma, as hypothesized after drilling at Site 609, there is a progressive tendency toward lower $CaCO_3$ values above the last high $CaCO_3$ value at 170 m (3.5 Ma). The higher detrital content throughout Site 611 may have partly masked the increase that was obvious at Site 609. Mean sedimentation rates are high, 58 cm/m.y., but as with Feni Ridge, they are exceeded by rates in the "pelagic" Site 609. A systematic fluctuation in the Pliocene-Quaternary accumulation rate curves is discussed later. No hiatuses were observed despite high-resolution biostratigraphic and paleomagnetic control.

No primary structures that might relate to bottom-current sedimentation were identified, neither were any sharp bedding contacts observed. We awaited X-radiography of the cores to confirm this lack of current structures (see Hill, this volume). Some thickening and thinning of the carbonate cycles between crest and trough was observed as noted earlier, but it is not clear at present whether this is related to core disturbance or due to local slumping or other crest-to-trough sediment redistribution.

No obvious grain-size differences were detected between the crest and trough holes, but again shore-based analyses are required to confirm our preliminary impressions (see Kidd and Hill, this volume). Reworking of fine nannofossil material was recognized throughout the section drilled. In the upper section, most reworked specimens are Cretaceous in age, whereas in the lower part, Eocene to Oligocene specimens are most common. Soft-sediment deformation features were noted from 323.3 to 324.2 m in Hole 611C, with flattening of burrow mottles and tilting of laminae. Isolated microfaults occur, and inclined bedding at 35° to 45° (apparent dips) is found below 325.6 m sub-bottom, in some cases crosscut by Zoophycos burrows. Cross-bedding apparently becomes horizontal again below 334 m, but isolated microfaults still occur. An explanation of this combination of features might be that localized slumping and sliding of sediment has occurred.

Sediment Wave Morphology and Stratigraphy

High-resolution 3.5-kHz seismic profiles around Site 611 show the morphology and acoustic sub-bottom characteristics of the sediment waves. Figures 17 and 18 show selected profiles of the waves in the vicinity of the drill site from the *Discovery*-131 site survey. The waves in this area are characteristically irregular in shape and amplitude, varying from 10 to 40 m in height. Some have broad summits, as evidenced by our on-site maneuvering over the one that we drilled (Figs. 5, 6). On the other hand, it appears from track-to-track correlation that wave crests are spaced fairly regularly at 1- to 2-km intervals and are subparallel to the regional bathymetric contours (Fig. 5). No clear wave migration is evident from the 3.5-kHz profiles, although thickening and thinning of sub-bottom returns does occur. The air-gun records (Fig. 12B) provide some suggestion of inclined bedding, such as within acoustic Unit B (see previous section). In a few cases, the returns below sediment waves might be interpreted as migrating. The overall impression, however, is one of drape; some large waves at the surface are clearly located over high points in the basement relief.

Pliocene–Quaternary Sedimentation Rates and Possible Large-Scale Sediment-Wave Migration

Although there is little evidence in seismic profiles to indicate sediment-wave migration, it is still necessary to account for the regular trends and spacing in the sediment-wave field. Initial comparisons of the sedimentation-rate curves at Holes 611 and 611C (crest and trough, respectively) suggested that there were significant differ-

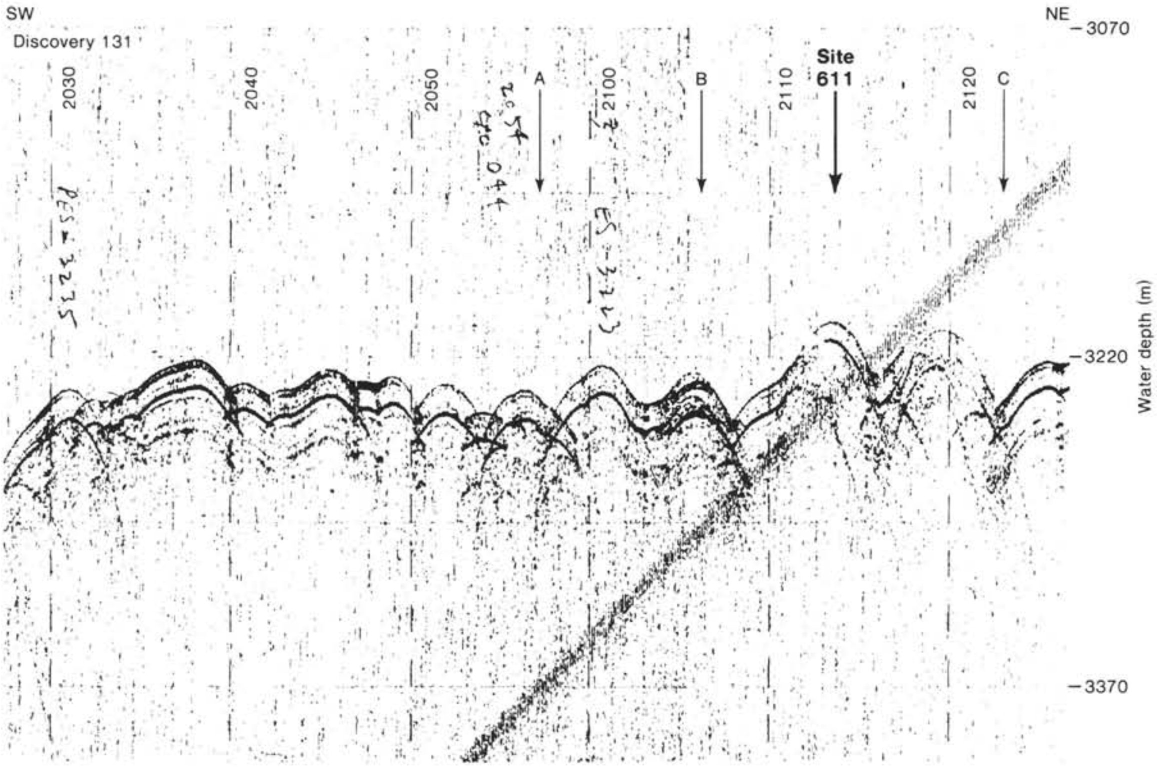


Figure 17. Southwest–northeast part of the *Discovery*-131 presite 3.5-kHz profile. Hour time marks (Greenwich Mean Time) are noted along the track. A, B, and C are positions of crossover points in the survey; see Figure 3 for location of tracks.

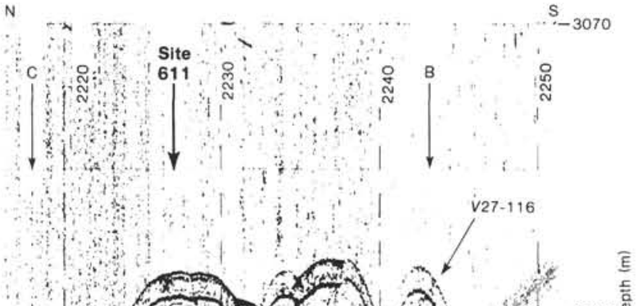


Figure 18. North–south part of the *Discovery*-131 presite 3.5-kHz profiling cruise. (Notations as in Fig. 17. Note position of Lamont-Doherty Geological Observatory sediment core *V*27-116. See Fig. 3 for location of tracks.)

ences between the sites during the Quaternary and that, by drilling deeper at the crest site, it might be possible to account for the sediment-wave topography. Sediment-wave migration should be characterized by differences in sedimentation rate between the crest and the trough. Thus the offset back to the beacon from Hole 611C was made, and Hole 611D was drilled below 110 m sub-bottom in the sediment-wave crest.

The sedimentation rates in the top 240 m of the crest and trough holes are compared in Figure 19, using a reference datum of 3200 m below sea level. The two locations presently differ in elevation by about 30 m, but temporal changes in the relative elevation are shown by the convergence and crossover of the two sedimentation-rate curves. Prior to 3.8 Ma, the position of crest and trough appears to have been reversed, and the present-day crest (Hole 611C) has been constructed since that time. Interval sedimentation rates (Fig. 20) reached as high as 98 m/m.y. in Hole 611D (crest site) and 75 m./m.y. in Hole 611C (trough site) during the late Pliocene, then decreased at both sites during the Quaternary.

These data are compatible with Pliocene sediment-wave migration. Figure 21 was constructed by plotting sub-bottom elevations for 0.5-m.y. time intervals and attempting to fit a sediment-wave profile of proportions similar to present-day waves at the site. The profiles serve an illustrative purpose only, but they demonstrate how Pliocene sediment-wave migration could account for the sedimentation-rate curves at Site 611. Figure 21 further suggests that high sedimentation rates during the Pliocene were accompanied by lateral migration of the sediment waves; this migration either slowed during the Quaternary or was replaced by processes that resulted in pelagic drape (see Kidd and Hill, this volume).

It is possible that, in looking for wave migration in the 3.5-kHz profiles with a penetration of only 30 to

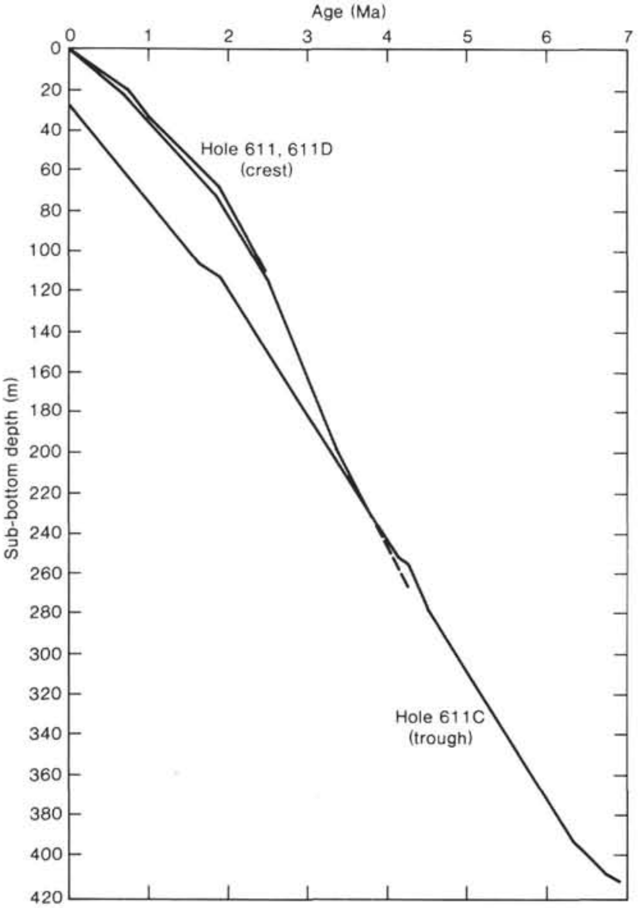


Figure 19. Time versus depth plot for crest and trough holes combined, with adjustment for difference in water depth. The curves are the same ones as plotted in Figure 14A and B.

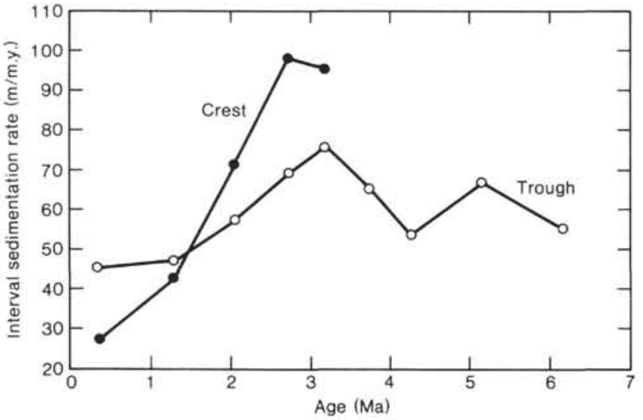


Figure 20. Interval sedimentation rates for crest and trough holes at Site 611.

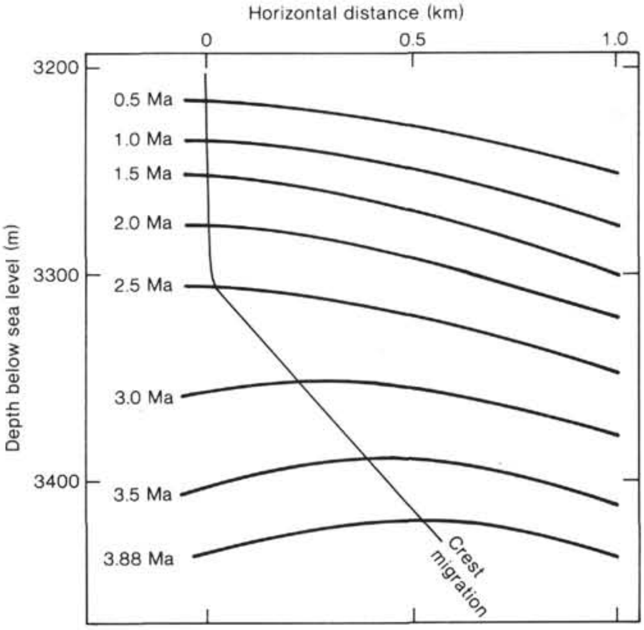


Figure 21. Profiles of the sediment wave drilled at Site 611 at time intervals of 0.5 m.y. The shape of the wave is kept constant.

40 m, we were missing a larger-scale migration within the drift sequence. The paucity of identifiable reflector migration on the air-gun profiles might result from a general lack of lithologic change in the preglacial sediments.

At this time, the preceding explanations of large-scale sedimentation-rate changes in terms of sediment-wave migration should be regarded as a working hypothesis that has been tested once and seen to be compatible with the available stratigraphic data. More detailed work is required to establish that the changes in sedimentation between crest and trough are the result of autochthonous sedimentary processes rather than the influx (or removal) of allochthonous sediment.

REFERENCES

Baldauf, J. G., 1985. Cenozoic diatom biostratigraphy and paleoceanography of the Rockall Plateau Region, North Atlantic, DSDP Leg 81. *In* Roberts, D. G., Schnitker, D., et al., *Init. Repts. DSDP*, 81: Washington (U.S. Govt. Printing Office), 439–477.

Berggren, W. A., 1977. Late Neogene planktonic foraminiferal biostratigraphy of the Rio Grande Rise (South Atlantic). *Mar. Micropaleontol.*, 2:251–265.

Berggren, W. A., Kent, D. V., and Van Couvering, J. A., in press. Neogene geochronology and chronobiostratigraphy. *In* Snelling, N. J. (Ed.), *Geochronology and the Geological Record*. J. Geol. Soc. London Mem.

Burckle, L. H., 1977. Pliocene and Pleistocene diatom datum levels from the equatorial Pacific. *Quat. Geol.*, 7:330–340.

Garner, D. M., 1972. Flow through the Charlie Gibbs Fracture Zone, Mid-Atlantic Ridge. *Can. J. Earth. Sci.* 9:116–121.

Johnson, G. L., Vogt, P. R., and Schneider, E. D., 1971. Morphology of the Northeastern Atlantic and Labrador Sea. *Deutsche Hydrographische Zeitschrift*, 24:49–73.

Laughton, A. S., and Monahan, D., 1978. General bathymetric chart of the oceans (GEBCO), sheet 5.04. Canadian Hydrographic Service, Ottawa.

McCave, I. N., Lonsdale, P. F., Hollister, C. D., and Garner, W. D., 1980. Sediment transport over the Hatton and Gardar contourite drifts. *J. Sed. Petrol.*, 50:1049–1062.

Poore, R. Z., and Berggren, W. A., 1975. Late Cenozoic planktonic foraminiferal biostratigraphy and paleoclimatology of the Hatton-Rockall Basin. *J. Foraminif. Res.*, 5:270–293.

Ruddiman, W. F., 1972. Sediment redistribution on the Reykjanes Ridge: seismic evidence *Bull. Geol. Soc. Am.*, 93:1039–2062.

Ruddiman, W. F., and McIntyre, A., 1984. Ice-age thermal response and climatic role of the surface Atlantic Ocean, 40°N–55°N, *Bull. Geol. Soc. Am.*, 83:2039–2062.

Shor, A. N., and Poore, R. Z., 1979. Bottom currents and ice rafting in the North Atlantic: interpretation of Neogene depositional environments of Leg 49 cores. *In* Luyendyk, B. P., Cann, J. R., et al., *Init. Repts. DSDP*, 49: Washington (U.S. Govt. Printing Office), 859-872.

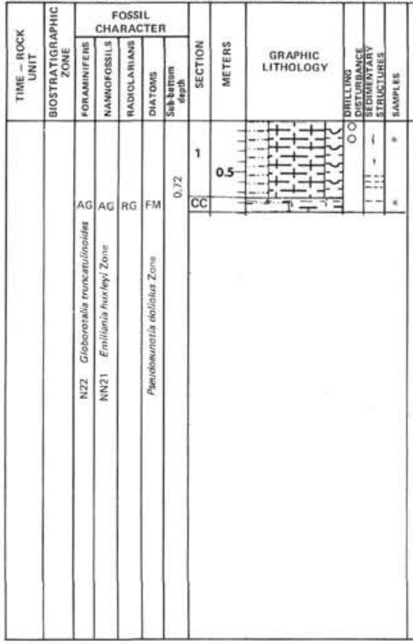
Streeter, S. S., 1973. Bottom water and benthonic foraminifera in the North Atlantic. Glacial-interglacial contrasts. *Quat. Res.*, 3:131-141.

Takayama, T., 1977. Some remarks on Pliocene-Pleistocene calcareous nannofossils from le Castella and Santa Maria di Cantazaro, southern Italy. *Giornale di Geologia*, 41:115-122.

Vincent, E., Killingley, J. S., and Berger, W. H., 1980. The magnetic Epoch-6 carbon shift: a change in the ocean's 13C/12C ratio 6.2 million years ago. *Mar. Micropaleontol.*, 5:185-203.

Worthington, L. V., and Volkmann, G. H., 1965. The volume of transport of Norwegian Sea overflow water in the North Atlantic. *Deep-Sea Res.*, 12:667-676.

SITE 611 HOLE CORE 1 CORED INTERVAL 0.0–1.0 m



LITHOLOGIC DESCRIPTION

10YR 5/3
10YR 4/2
10YR 5/2
2.5Y 5/2
5Y 4/2

SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, brown to dark grayish brown (10YR 5/3 to 10YR 4/2).

Lower part of Core Catcher: MARLY FORAMINIFERAL NANNOFOSSIL OOZE, olive gray (5Y 4/2), containing volcanic glass in coarse fraction.

0.53 to 0.60 m: dark grayish brown (10YR 4/2) layer, very bioturbated by frequent small *chondrite*-type burrows, and one *zoophycos* at 0.60 m.

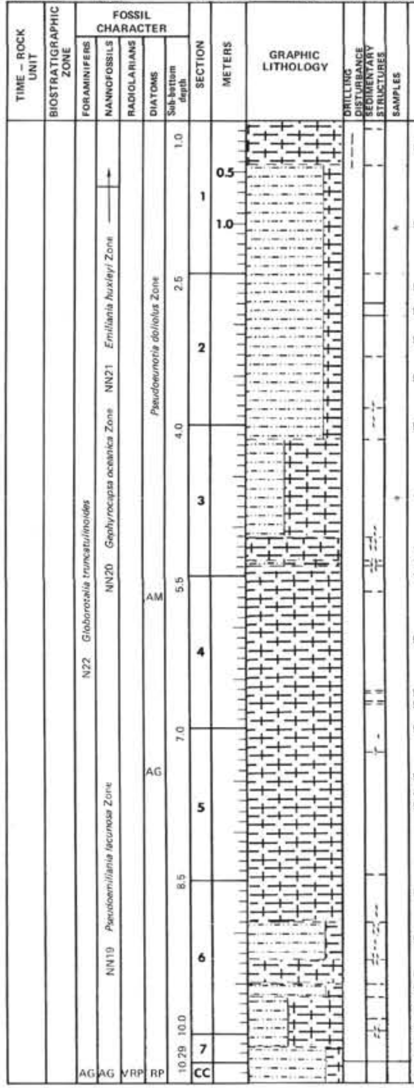
SMEAR SLIDE SUMMARY (%)

	1, 20 D	CC, 10 M
Composition:		
Quartz	10	26
Feldspar	–	2
Mica	1	2
Heavy minerals	4	5
Clay	5	10
Volcanic glass	TR	–
Foraminifers	15	15
Calc. nannofossils	51	30
Diatoms	2	2
Radiolarians	1	TR
Sponge spicules	10	8
Silicoflagellates	1	TR

ORGANIC CARBON AND CARBONATE (%)

	1, 20–21
Organic carbon	–
Carbonate	65

SITE 611 HOLE CORE 2 CORED INTERVAL 1.0–10.6 m



LITHOLOGIC DESCRIPTION

10YR 5/3
N7
5Y 5/2
5Y 6/1
5Y 5/1
5Y 6/1
5Y 5/3
5Y 6/1
10YR 6/4
10YR 8/2
10YR 6/4
10YR 8/1
5GY 6/1
5G 5/1
5G 5/1
5GY 6/1
5GY 6/1
and
5GY 7/1
N7
5Y 4/1
N7
5Y 4/1
N6
5Y 6/1
5Y 7/1
5Y 5/2
N6

Alternating:
FORAMINIFERAL NANNOFOSSIL OOZE, light gray (N7), very light gray (10YR 8/1 or 8/2) or greenish gray (5GY 7/1 or 6/1);
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (N6), light yellowish brown (10YR 6/4) or light gray to olive gray (5Y 7/1 to 5/2); and
CALCAREOUS MUD, gray to olive gray (5Y 6/1 to 5/2) or dark gray (5Y 4/1).

Three DROPSTONES: 2 pumices and 1 tuff.

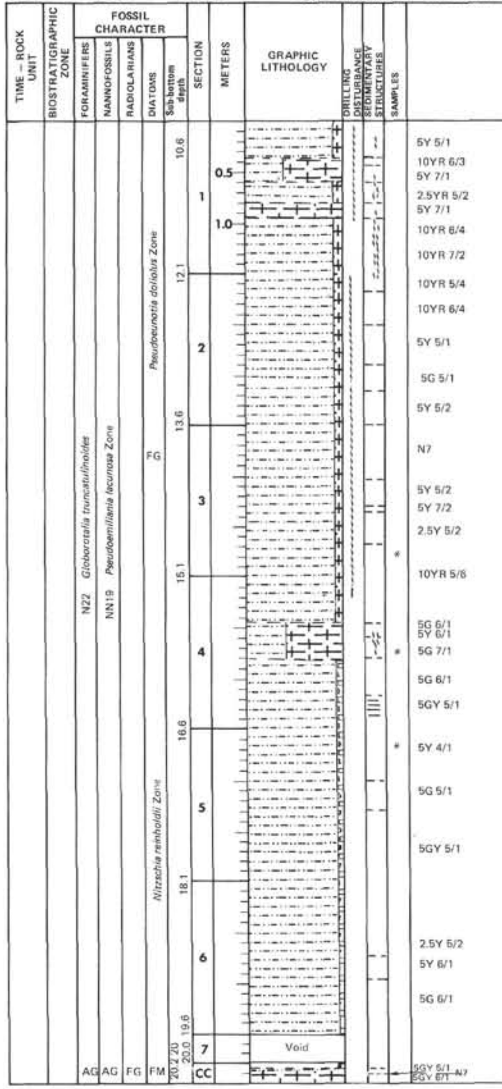
SMEAR SLIDE SUMMARY (%)

	1, 106 D	3, 82	4, 115
Compositon:			
Quartz	52	5	–
Feldspar	1	1	–
Heavy minerals	3	2	1
Clay	20	35	8
Volcanic glass	4	1	–
Carbonate unspec.	15	2	1
Foraminifers	3	16	10
Calc. nannofossils	2	38	78
Diatoms	TR	–	2
Sponge spicules	TR	–	TR

ORGANIC CARBON AND CARBONATE (%)

	6, 39–40
Organic carbon	–
Carbonate	41

SITE 611 HOLE CORE 3 CORED INTERVAL 10.6–20.2 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD to MUD, light to dark gray (5Y 7/2 to 4/1) or pale brown to yellowish brown (10YR 6/3 to 5/6) or greenish gray (5GY 5/1 to 5G 6/1), with silty laminations between 16.25 to 16.50 m.

MARLY FORAMINIFERAL NANNOFOSSIL OOZE intervals:
10.95 to 11.20 m: pale brown (10YR 6/3) and light gray (5Y 7/1); and
15.55 to 15.90 m: light gray to gray (5G 7/1 to 6/1).

FORAMINIFERAL NANNOFOSSIL OOZE intervals:
11.3 to 11.45 m: light gray (5Y 7/1); and
20.0 to 20.2 m (CC): light gray (N7) to greenish gray (5GY 6/1).

Greenish LAMINATIONS between 16.3 to 16.5 m.

Dropstones.

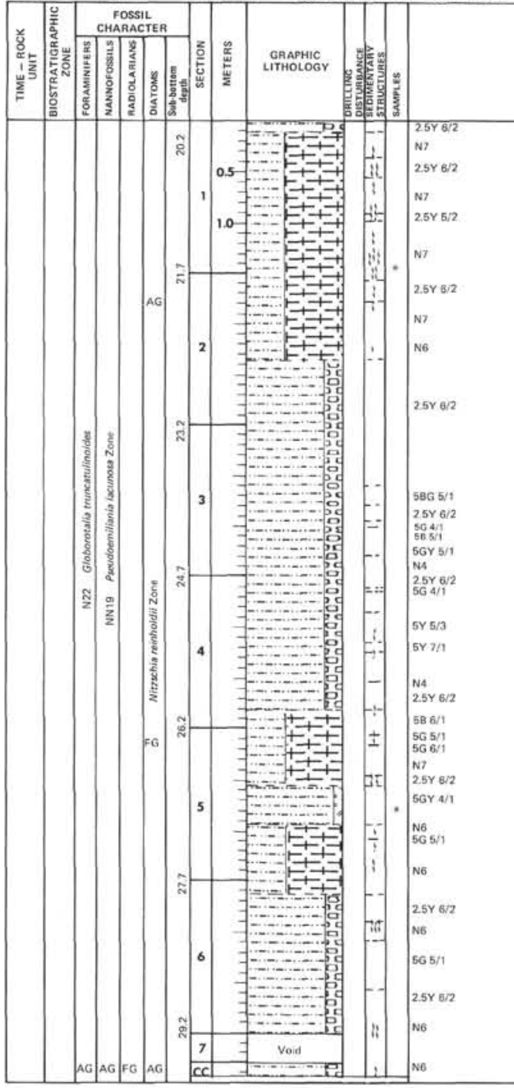
SMEAR SLIDE SUMMARY (%)

	3, 133	4, 75	5, 19
	D	M	D
Texture:			
Sand	10	–	12
Silt	35	–	38
Clay	55	–	50
Composition:			
Quartz	57	10	47
Feldspar	TR	TR	1
Heavy minerals	1	TR	2
Clay	25	25	35
Volcanic glass	3	–	5
Carbonate unspec.	8	–	9
Foraminifers	4	10	–
Calc. nannofossils	2	54	1
Diatoms	–	1	–
Sponge spicules	–	TR	–

ORGANIC CARBON AND CARBONATE (%)

	5, 19–20
Organic carbon	–
Carbonate	3

SITE 611 HOLE CORE 4 CORED INTERVAL 20.2–29.8 m



LITHOLOGIC DESCRIPTION

Alternating:
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (N7 to N6), grayish brown (2.5Y 5/2) or bluish gray (5B 6/1); and
CALCAREOUS MUD, greenish gray (5G 5/1 or 5BG 5/1), or light brownish gray (2.5Y 6/2), this last color appears to be more silty.

26.75 to 27.2 m: layer of dark greenish gray (5GY 4/1) ASH-BEARING MUD (10% volcanic glass).

Rare greenish gray (5G 5/1 or 6/1) or gray (N4) LAMINATIONS.

Rare PYRITIC HALOS.

Dropstones.

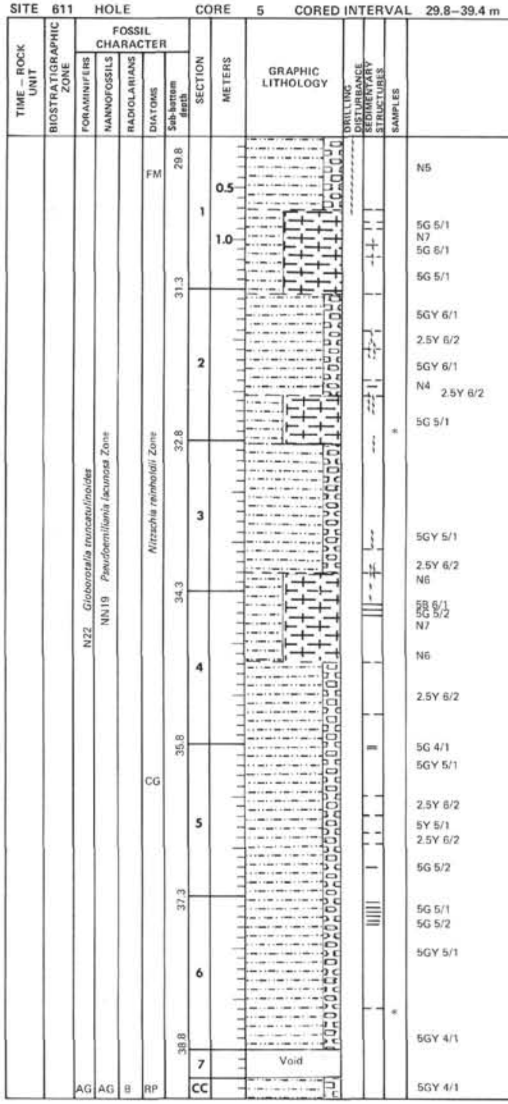
SMEAR SLIDE SUMMARY (%)

	1, 145	5, 76
	D	M
Texture:		
Sand	–	15
Silt	–	40
Clay	–	45
Composition:		
Quartz	–	55
Feldspar	1	–
Heavy minerals	TR	2
Clay	35	30
Volcanic glass	1	10
Micronodules	–	TR
Carbonate unspec.	1	3
Foraminifers	10	–
Calc. nannofossils	50	TR
Diatoms	2	–
Radiolarians	TR	–
Sponge spicules	TR	–

ORGANIC CARBON AND CARBONATE (%)

	5, 76–77
Organic carbon	–
Carbonate	2

SITE 611 HOLE CORE 5 CORED INTERVAL 29.8–39.4 m



LITHOLOGIC DESCRIPTION

Alternating:
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (N7 or N6) or greenish gray (5G 5/1);~ 40% detrital; and
CALCAREOUS MUD, gray (N5), greenish gray (5GY 6/1 or 5/1), or light brownish gray (2.5Y 6/2); this last color appears to be more silty;~ 80% detrital.

Some greenish gray (5G 5/1 or 5/2) LAMINATIONS, especially between 34.40 to 34.60 m and 37.35 to 37.55 m.

FORAMINIFERAL SAND patch at 31.50 m.

Common DROPSTONES.

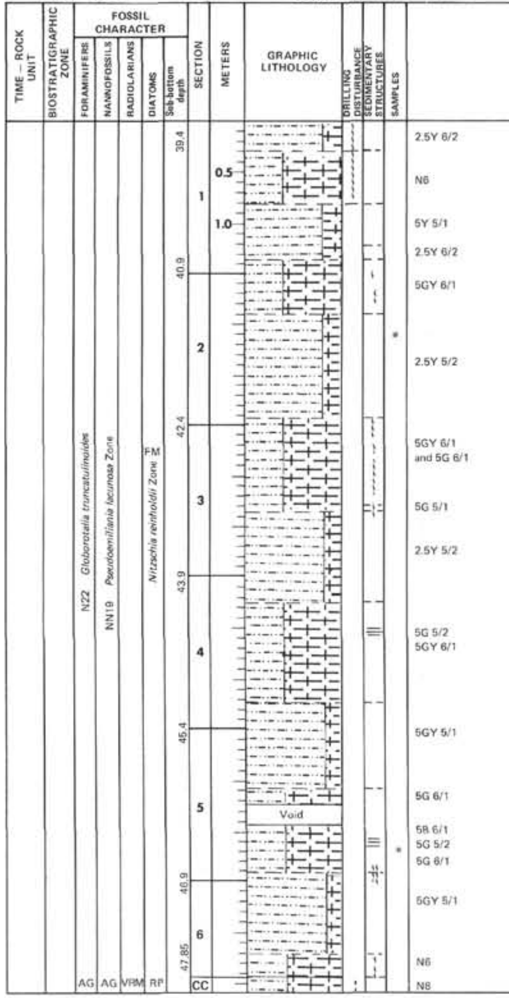
SMEAR SLIDE SUMMARY (%):

	2, 145	6, 120
Texture:		
Sand	–	15
Silt	–	35
Clay	–	50
Composition:		
Quartz	15	62
Feldspar	1	1
Heavy minerals	3	–
Clay	20	20
Volcanic glass	–	3
Carbonate unspec.	1	3
Foraminifers	14	7
Calc. nannofossils	40	4
Diatoms	5	–
Radiolarians	TR	–
Sponge spicules	1	TR
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	3, 104–105
Organic carbon	–
Carbonate	6

SITE 611 HOLE CORE 6 CORED INTERVAL 39.4–49.0 m



LITHOLOGIC DESCRIPTION

39.4 to 39.7 m: downhole contamination (pebbles).

Alternating:
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (N6) or greenish gray (5G 6/1 or 5GY 6/1); and
CALCAREOUS MUD (80% detrital), gray (5Y 5/1) to greenish gray (5GY 5/1), or light brownish gray to grayish brown (2.5Y 6/2 to 5/2); these two colors appearing more silty.

Rare greenish (5G 5/2) or bluish (5B 6/1) LAMINATIONS between 43.4 to 43.5 m and 46.5 to 46.6 m.

One DROPSTONE: ash and pyrite clast at 41.15 m.

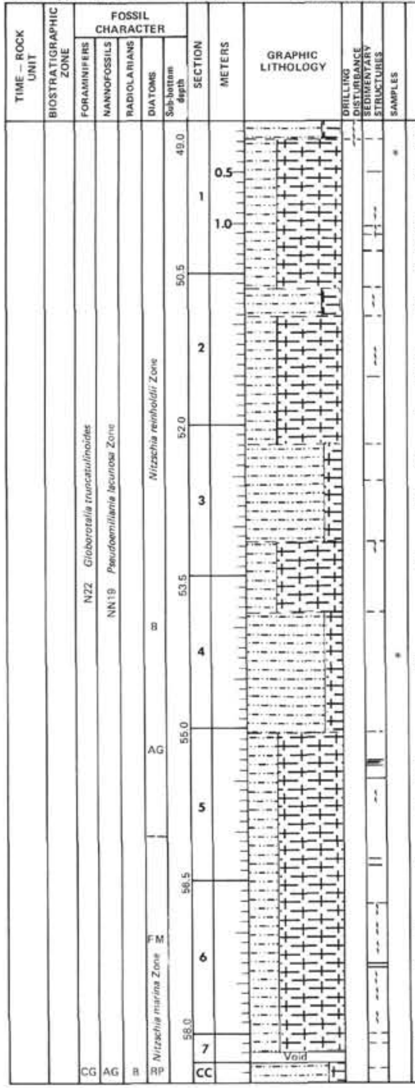
SMEAR SLIDE SUMMARY (%)

	2, 67 D	5, 120 D
Texture:		
Sand	15	–
Silt	25	–
Clay	60	–
Composition:		
Quartz	50	–
Feldspar	1	–
Heavy minerals	3	–
Clay	30	40
Volcanic glass	2	1
Carbonate unspec.	3	–
Foraminifers	5	25
Calc. nannofossils	6	31
Diatoms	–	2
Sponge spicules	–	1
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 65–66
Organic carbon	–
Carbonate	15

SITE 611 HOLE CORE 7 CORED INTERVAL 49.0–58.6 m



LITHOLOGIC DESCRIPTION

5Y 6/1
N7
5B 6/1
5GY 6/1
5GY 5/1
5Y 5/1
5GY 5/1
5Y 6/1
5G 6/1
5G 5/2
5G 6/1
5GY 4/1
5Y 4/1
5GY 6/1
5Y 5/1
5G 6/2
5B 5/1
5GY 6/1
5G 6/2
5GY 6/1
5G 4/2
5GY 5/1
5GY 6/1
5GY 4/1
5GY 5/1

Alternating:
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, greenish gray (5GY 5/1 or 6/1); and
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1), or dark greenish gray (5GY 4/1); some intervals seem to be more silty: 51.10 to 51.30 m and 53.88 to 54.40 m. Marly foraminiferal nannofossil ooze intervals are thicker than calcareous mud intervals.

Rare greenish (5G 6/2 to 4/2) or bluish (5B 5/1 or 6/1) gray LAMINATIONS.

DROPSTONES.

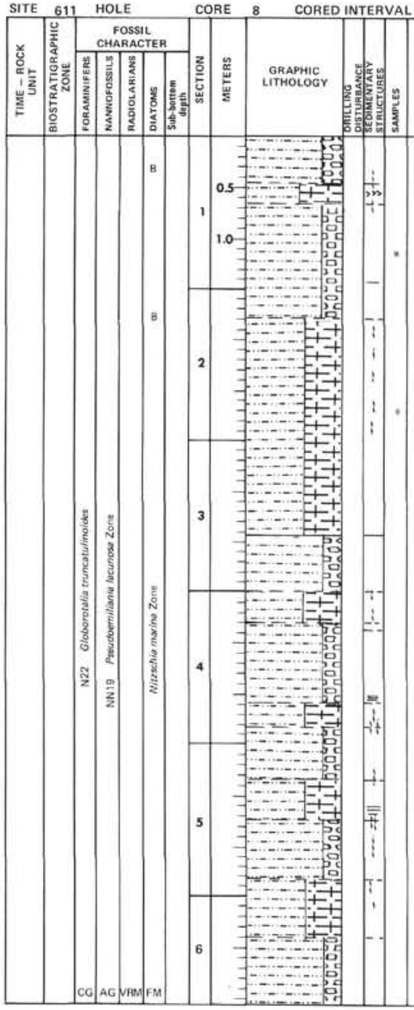
SMEAR SLIDE SUMMARY (%)

	1, 30	4, 75
	D	D
Texture:		
Sand	–	5
Silt	–	30
Clay	–	65
Composition:		
Quartz	–	53
Feldspar	–	TR
Heavy minerals	TR	1
Clay	30	30
Volcanic glass	–	3
Carbonate unspec.	–	1
Foraminifers	12	4
Calc. nannofossils	53	8
Diatoms	4	–
Radiolarians	TR	–
Sponge spicules	1	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	5, 40–41
Organic carbon	–
Carbonate	63

SITE 611 HOLE CORE 8 CORED INTERVAL 58.6–68.2 m



LITHOLOGIC DESCRIPTION

5GY 5/1
5GY 6/1
5GY 5/1
5G 5/2
5GY 6/1
5GY 5/1
5GY 6/1
5Y 5/2
5GY 5/1
5G 4/2
N4
5GY 6/1
5GY 5/1
5GY 6/1
5G 5/2
5GY 5/1
5GY 6/1
5GY 5/1

CALCAREOUS MUD
Alternating layers of:
Very fine grained mud (75% clay); ~40% $CaCO_3$ (foraminifers and nannofossils); light greenish gray (5GY 6/1); and relatively coarse grained mud (40% silt, 45% clay); poorer in $CaCO_3$ (20%); greenish gray (5GY 5/1). Some intervals seem "rougher" (more silty): 59.9 to 60.35 m; 62.05 to 62.50 m; and 65.6 to 65.9 m.

Rare greenish (5G 5/2 to 4/2) LAMINATIONS.

Small patches of FORAMINIFERAL SAND between 62.76 and 62.82 m.

DROPSTONES.

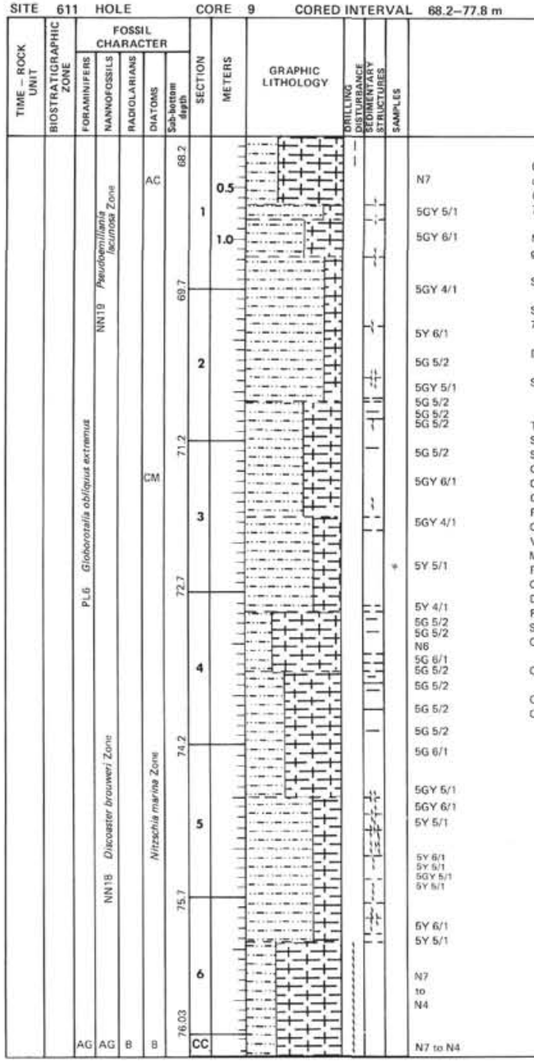
SMEAR SLIDE SUMMARY (%)

	1, 120	2, 120
Texture:		
Sand	15	5
Silt	40	20
Clay	45	75
Composition:		
Quartz	52	29
Feldspar	1	–
Heavy minerals	3	2
Clay	20	30
Volcanic glass	2	–
Micronodules	–	TR
Carbonate unspec.	8	–
Foraminifers	12	14
Calc. nannofossils	2	25

ORGANIC CARBON AND CARBONATE (%)

	1, 117–118
Organic carbon	–
Carbonate	11

SITE 611 HOLE CORE 9 CORED INTERVAL 68.2–77.8 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD, greenish gray (5GY 6/1 to 4/1), or gray to dark gray (5Y 6/1 to 4/1); some "rougher" (more silty) intervals: 69.4 to 69.7 m; 69.86 to 69.91 m; 70.28 to 70.58 m; 71.8 to 72.08 m; and 72.70 to 73.0 m.

MARLY FORAMINIFERAL NANNOFOSSIL OOZE, light gray to dark gray (N7 to N4) or greenish gray (5G 6/1).

Some grayish green (5G 5/2) LAMINATIONS.

Small FORAMINIFERAL SAND patches between 73.88 to 74.10 m.

DROPSTONES.

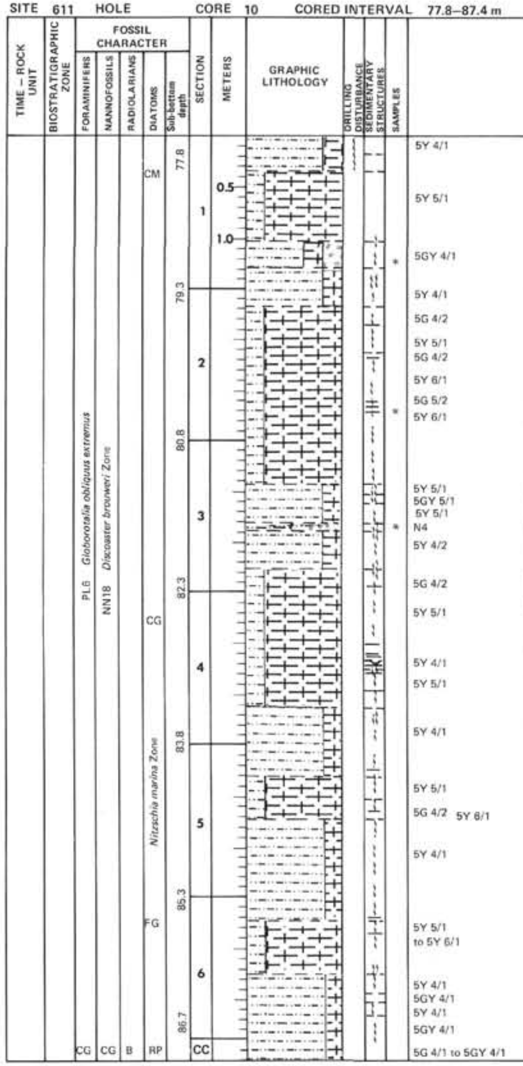
SMEAR SLIDE SUMMARY (%)

	3, 130 D
Texture	
Sand	5
Silt	15
Clay	80
Composition:	
Quartz	32
Feldspar	TR
Clay	35
Volcanic glass	1
Micronodules	4
Foraminifiers	5
Calc. nannofossils	20
Diatoms	1
Radiolarians	TR
Sponge spicules	TR
Opaque oxides	2

ORGANIC CARBON AND CARBONATE (%)

	2, 80–82
Organic carbon	–
Carbonate	28

SITE 611 HOLE CORE 10 CORED INTERVAL 77.8–87.4 m



LITHOLOGIC DESCRIPTION

0–19 cm: washed-down gravel.

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1);
and
FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (5Y 6/1 to 5/1). Both generally slightly mottled.

78.85 to 79.10 m: layer of ASH-BEARING MUD; dark gray (5GY 4/1).

81.75 to 81.78 m: layer of VOLCANIC SANDY MUD (50% volcanic glass; grain size: 50% sand, 35% silt).

Grayish green (5G 5/2 to 4/2) LAMINATIONS, sometimes slightly indurated.

79.1 to 79.3 m: *CHONDRITE* TYPE BURROWS.

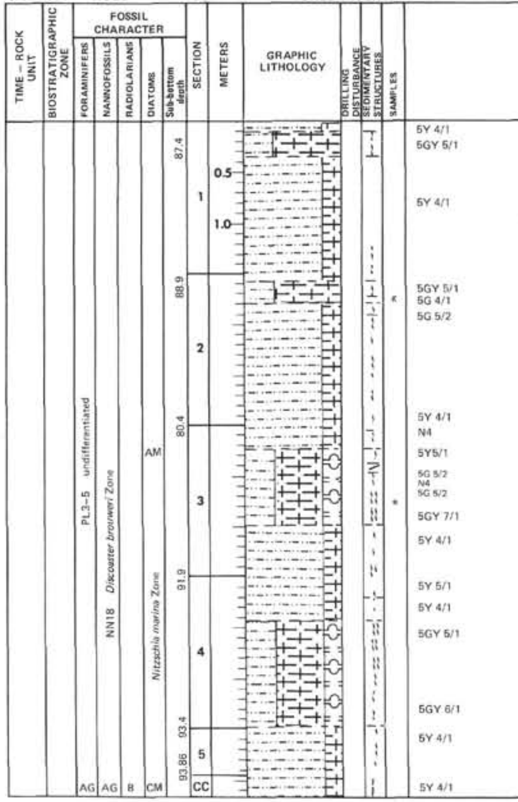
SMEAR SLIDE SUMMARY (%)

	1, 120 M	2, 128 D	3, 87 M
Texture:			
Sand	20	–	50
Silt	50	–	35
Clay	30	–	15
Composition:			
Quartz	45	15	35
Feldspar	7	–	8
Mica	TR	5	2
Heavy minerals	TR	–	–
Clay	15	5	–
Volcanic glass	15	–	50
Glauconite	–	–	1
Carbonate unspec.	10	5	3
Foraminifiers	–	10	–
Calc. nannofossils	8	49	1
Diatoms	–	4	–
Radiolarians	–	2	–
Sponge spicules	–	5	–

ORGANIC CARBON AND CARBONATE (%)

	2, 128–129
Organic carbon	–
Carbonate	67

SITE 611 HOLE CORE 11 CORED INTERVAL 87.4–97.0 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1); and
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, greenish gray (5GY 5/1), becoming MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE at 90.6 m; light greenish gray to greenish gray (5GY 7/1 to 5/1).

Rare gray (N4) or green (5G 5/2) LAMINATIONS in CALCAREOUS MUD.

Common green (5G 5/2) diffuse LAMINATIONS in siliceous ooze.

Common MOTTLING between 89.2 m and the base; gray or olive.

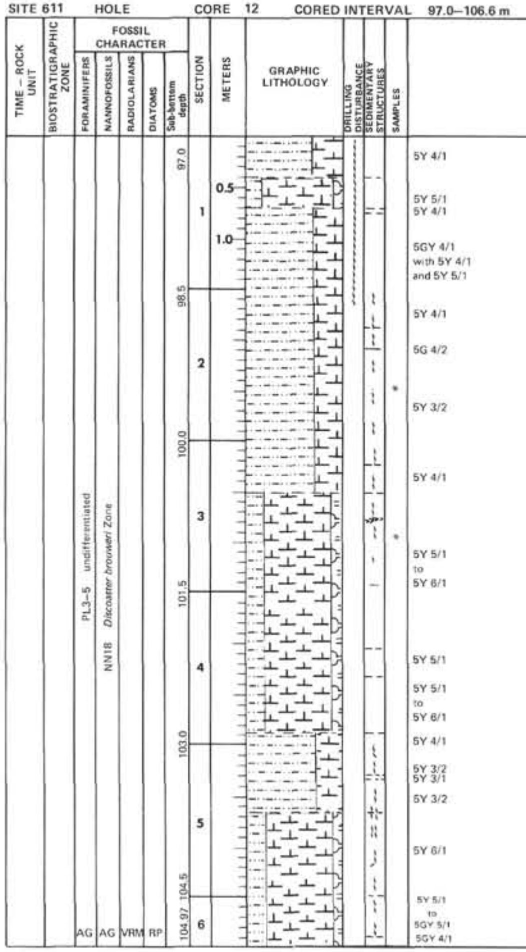
SMEAR SLIDE SUMMARY (%)

	2, 25	3, 80	4, 130
	M	D	D
Composition:			
Quartz	5	15	15
Feldspar	–	–	2
Mica	TR	–	5
Heavy minerals	–	5	3
Clay	20	5	2
Volcanic glass	–	–	TR
Foraminifers	15	10	10
Calc. nannofossils	55	42	40
Diatoms	2	4	3
Radiolarians	–	2	2
Sponge spicules	3	15	15
Silicoflagellates	–	2	TR

ORGANIC CARBON AND CARBONATE (%)

	3, 80–81
Organic carbon	–
Carbonate	66

SITE 611 HOLE CORE 12 CORED INTERVAL 97.0–106.6 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, dark gray (5Y 4/1) to dark olive gray (5Y 3/2); and
SILICEOUS NANNOFOSSIL OOZE, gray (5Y 5/1 or 6/1).

Generally common MOTTLING.

Rare green LAMINATIONS.

ZOOPHYCOS burrow at 100.8 m.

104.91 to 104.97 m: indurated green interval.

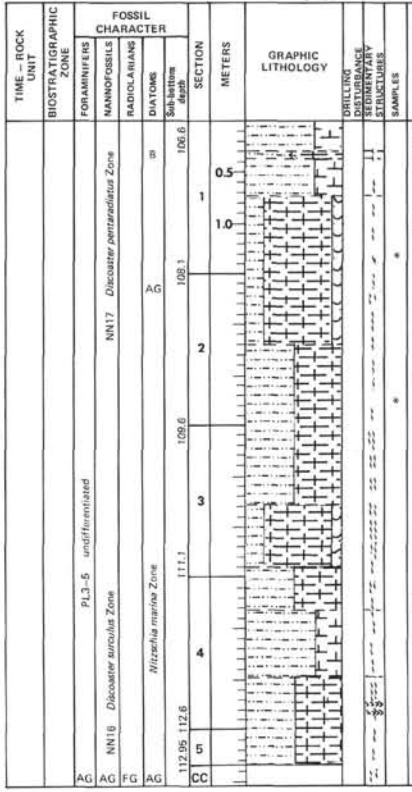
SMEAR SLIDE SUMMARY (%)

	2, 91	3, 98
	D	D
Texture:		
Sand	20	–
Silt	50	–
Clay	30	–
Composition:		
Quartz	30	18
Mica	5	2
Heavy minerals	1	–
Clay	34	–
Carbonate unspec.	–	5
Foraminifers	3	TR
Calc. nannofossils	22	58
Diatoms	2	2
Radiolarians	2	3
Sponge spicules	1	7

ORGANIC CARBON AND CARBONATE (%)

	2, 93–94
Organic carbon	–
Carbonate	14

SITE 611 HOLE CORE 13 CORED INTERVAL 106.6–116.2 m



LITHOLOGIC DESCRIPTION

5Y 4/1
5GY 5/1
5Y 4/1
5GY 6/1
5GY 5/1
5GY 5/1
5GY 6/1
5GY 5/1
5Y 4/1
5GY 5/1
5GY 5/1

MARLY FORAMINIFERAL NANNOFOSSIL OOZE (greenish gray 5GY 5/1) and SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE (light greenish gray 5GY 6/1). Very gradational contacts between one sediment type and the other.

Common dark green (5G 4/2) and olive gray (5Y 6/1) *laminations or mottling.*

CALCAREOUS MUD intervals: 106.6 to 107.35 m and 111.4 to 112.2 m, with greenish gray (5GY 3/1 and 5Y 5/1) diffuse layers.

ZOOPHYCOS BURROWS at 112.4 and 112.42 m.

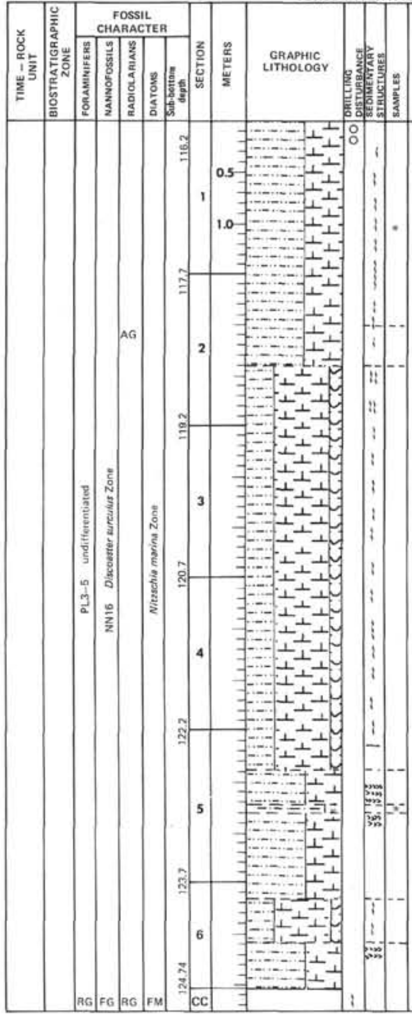
SMEAR SLIDE SUMMARY (%)

	1, 130	2, 130
	D	D
Composition:		
Quartz	10	20
Mica	5	TR
Heavy minerals	2	5
Clay	3	25
Foraminifers	10	10
Calc. nannofossils	57	33
Diatoms	3	2
Radiolarians	1	TR
Sponge spicules	10	5
Silicoflagellates	TR	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 130–131
Organic carbon	–
Carbonate	44

SITE 611 HOLE CORE 14 CORED INTERVAL 116.2–125.8 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD (dark gray 5Y 4/1 to 3/1) and *MARLY SILICEOUS NANNOFOSSIL OOZE* (gray 5Y 5/1 to 6/1) with very gradational contacts between one type and the other.

5Y 4/1

122.9 to 123 m: SANDY VOLCANIC LAYER, rich in tuff fragments.

Green (5G 4/2) and brown MOTTLING.

ZOOPHYCOS BURROWS: 122.7 to 123.1 m and 124.3 to 124.4 m.

5Y 5/1

PLANOLITES (?) BURROWS: 124.03 to 124.10 m.

SMEAR SLIDE SUMMARY (%)

	1, 110	5, 80
	D	M
Texture:		
Sand	2	40
Silt	68	35
Clay	30	25
Composition:		
Quartz	52	45
Feldspar	–	15
Mica	3	5
Clay (Tuff fragments)	–	20
Volcanic glass	–	15
Glauconite	TR	–
Pyrite	TR	–
Carbonate detrital	5	–
Foraminifers	2	–
Calc. nannofossils	30	–
Diatoms	2	–
Radiolarians	2	TR
Sponge spicules	4	–
Plant debris (pollen)	–	TR

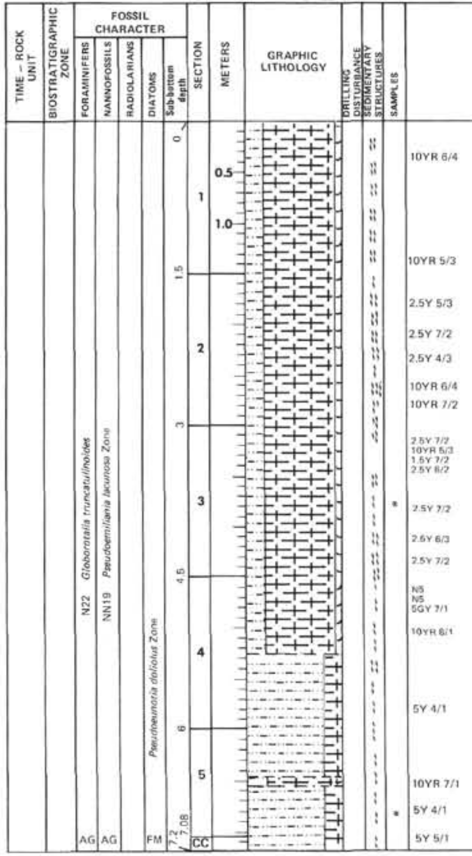
5Y 5/1
to
5Y 6/1

ORGANIC CARBON AND CARBONATE (%)

	5, 128–130
Organic carbon	–
Carbonate	17

5Y 4/1 to 5Y 3/1
5Y 3/1
5Y 4/1
5Y 5/1
5Y 4/1
5Y 4/1

SITE 611 HOLE A CORE 1 CORED INTERVAL 0.0–7.2 m



LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE (0.00 to 5.30 m), light gray to gray (10YR 7/1 to 6/1) or grayish brown (2.5Y 7/2 to 4/3).

CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1).

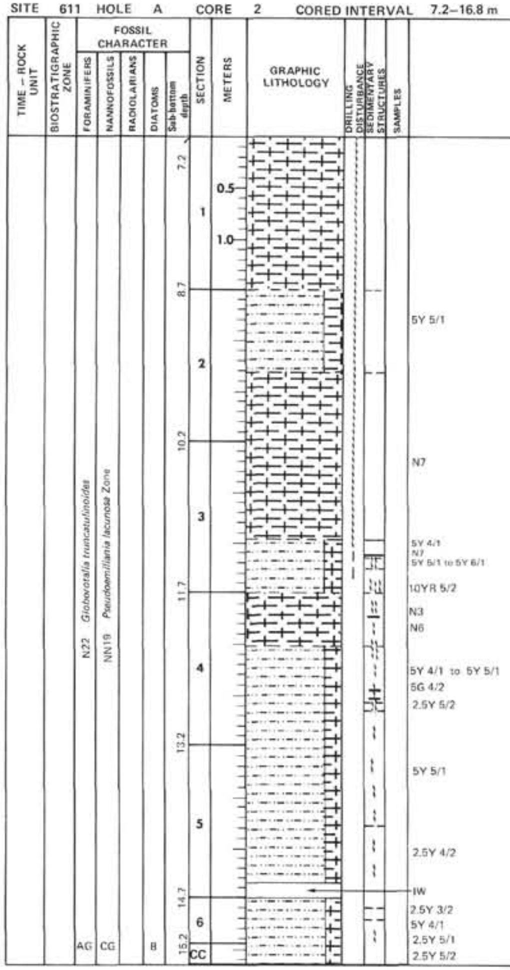
Common MOTTLING.

Rare gray (N5) and greenish gray (5GY 7/1) LAMINATIONS.

SMEAR SLIDE SUMMARY (%)

	3, 80 D	5, 78 D
Composition:		
Quartz	18	42
Feldspar	–	5
Heavy minerals	2	5
Clay	–	30
Volcanic glass	–	3
Foraminifers	10	10
Calc. nannofossils	60	5
Diatoms	2	–
Sponge spicules	8	–

SITE 611 HOLE A CORE 2 CORED INTERVAL 7.2–16.8 m



LITHOLOGIC DESCRIPTION

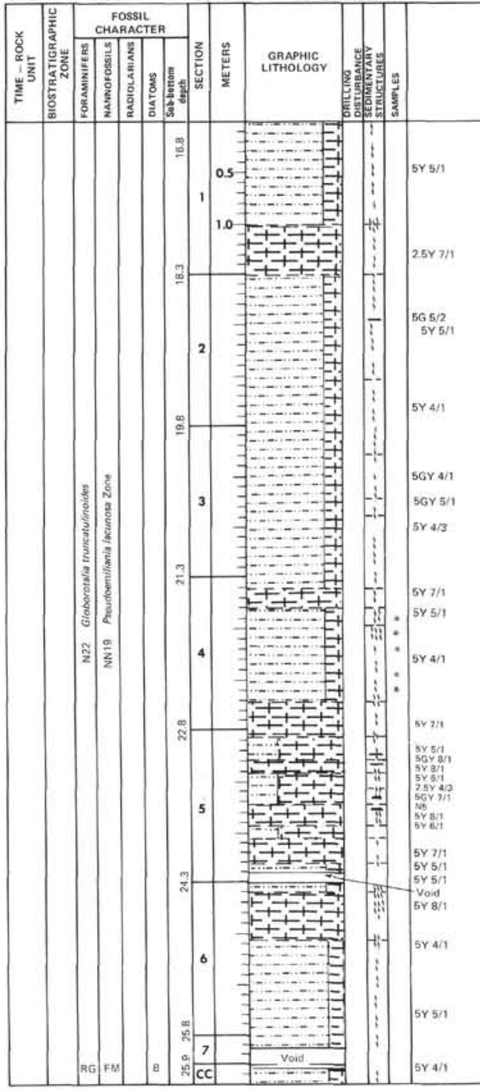
First section very disturbed; mixed calcareous mud and foraminiferal nannofossil ooze.

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1), grayish brown (10YR 5/2) to dark grayish brown (2.5Y 3/2); and
FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (N7 or N6).

Slight MOTTLING. Rare green (5G 4/2) PATCHES and green (5G 4/2) LAMINATIONS. Rare PYRITIC (N3) LAMINATIONS.

PLANOLITES BURROWS between 11.91 and 11.94 m.

SITE 611 HOLE A CORE 3 CORED INTERVAL 16.8–26.4 m



LITHOLOGIC DESCRIPTION

16.8 to 22.5 m: alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1); and
thiner layers of FORAMINIFERAL NANNOFOSSIL OOZE, light gray (5Y 8/1 to 7/1 or 2.5Y 7/1).
22.5 to 24.1 m: alternating thin layers of:
FORAMINIFERAL NANNOFOSSIL OOZE; and
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 6/1).

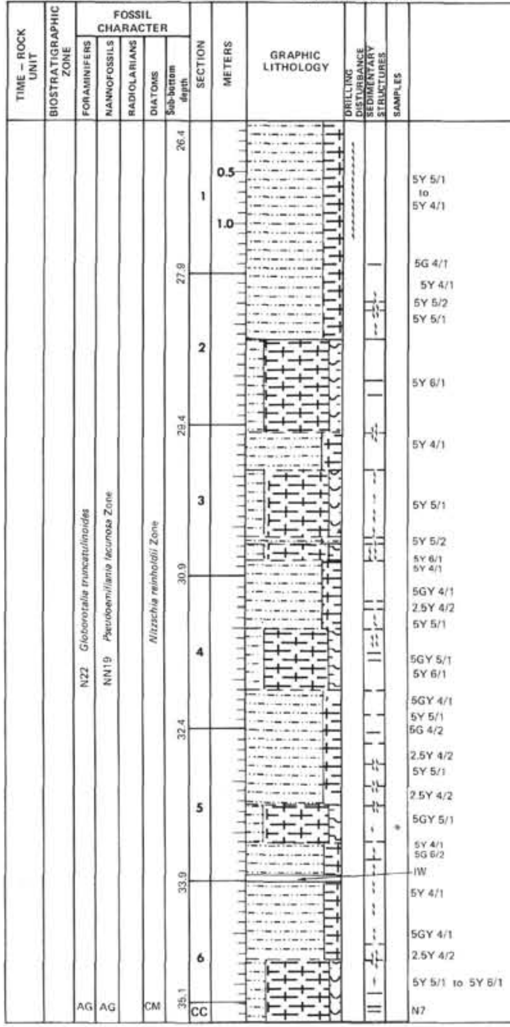
Slight to common MOTTLING.

Common small *CHONDRITE*-TYPE BURROWS between 21.74 and 22.51 m.

SMEAR SLIDE SUMMARY (%)

	4, 39 to 111 D	
Composition:		
Quartz	40	30
Feldspar	10	20
Mica	5	10
Heavy minerals	5	10
Clay	30	40
Foraminifers	10	20
Calc. nannofossils	5	30

SITE 611 HOLE A CORE 4 CORED INTERVAL 26.4–36.0 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1) or dark grayish brown (2.5Y 4/2); often silty, mainly homogeneous; bases of layers often mottled; and
MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 6/1) or greenish gray (5GY 5/1); probably marly foraminiferal nannofossil ooze in the upper part of the core, gradually becoming siliceous; mottled.

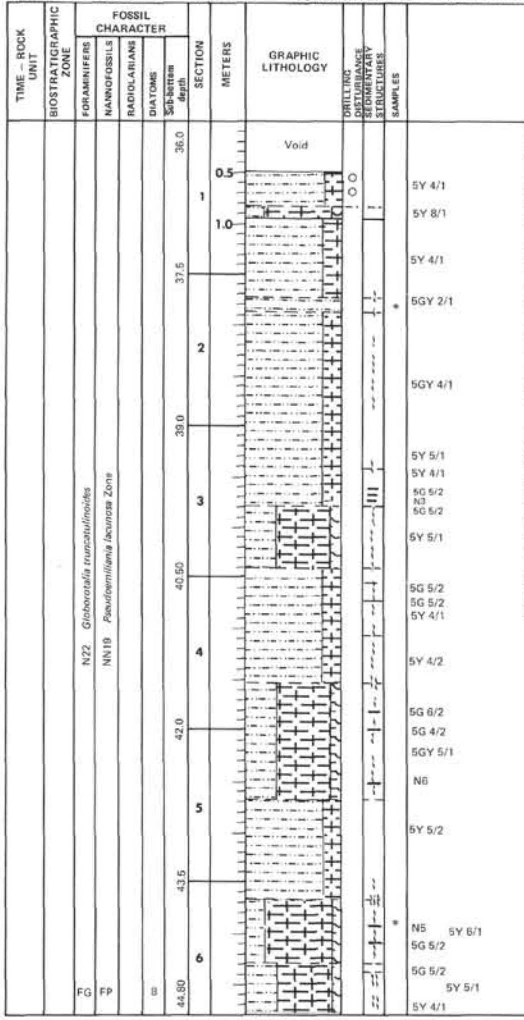
Rare green or gray LAMINATIONS.

Gray (N7) PYRITIC HALO at 33.30 m.

SMEAR SLIDE SUMMARY (%)

	5, 100 D
Composition:	
Quartz	25
Mica	TR
Heavy minerals	TR
Foraminifers	7
Calc. nannofossils	58
Diatoms	1
Radiolarians	2
Sponge spicules	7

SITE 611 HOLE A CORE 5 CORED INTERVAL 36.0–45.6 m



LITHOLOGIC DESCRIPTION

Alternating layers of:
CALCAREOUS MUD, olive gray to dark gray (5Y 5/2 to 4/1) or dark greenish gray (5GY 4/1); and
MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE to SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, very light gray to gray (5Y 8/1 to 5/1) or greenish gray (5GY 5/1).

Faint MOTTLING, especially on foraminiferal nannofossil ooze.

Greenish (5G 6/2 to 4/2) or gray (N3 to N5) LAMINATIONS.

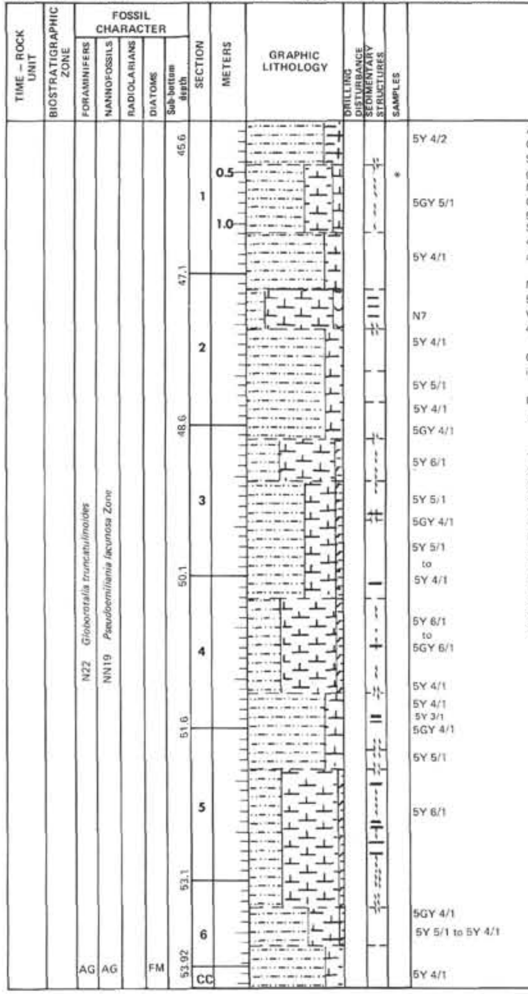
40.50 to 41.54 m: common mottling and diffuse laminations.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	2, 38 M	6, 42 D
Texture:		
Sand	15	–
Silt	60	–
Clay	25	–
Composition:		
Quartz	40	15
Feldspar	10	2
Mica	–	2
Heavy minerals	10	2
Clay	20	–
Foraminifers	–	10
Calc. nannofossils	–	59
Diatoms	–	2
Sponge spicules	–	8
Tuff clasts	20	–

SITE 611 HOLE A CORE 6 CORED INTERVAL 45.6–55.2 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, dark gray (5Y 4/1 to 4/2) or SILICEOUS CALCAREOUS MUD, gray (5Y 5/1 to 4/1) or greenish gray (5GY 4/1); and
MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, gray (N7) or light greenish gray (5Y 6/1 to 5GY 6/1).
Some calcareous mud intervals seem more silty:
45.6 to 46.05 m; 46.46 to 47.2 m; 47.65 to 48.75 m; and 53.35 to 53.92 m.

MOTTLING: 45.6 to 47.1 m; 48.75 to 50.10 m; and 52.0 to 53.35 m.
VOLCANIC ASH-RICH(?) LAYERS, dark, at 48.57 to 49.60 m and 51.49 to 51.50 m.

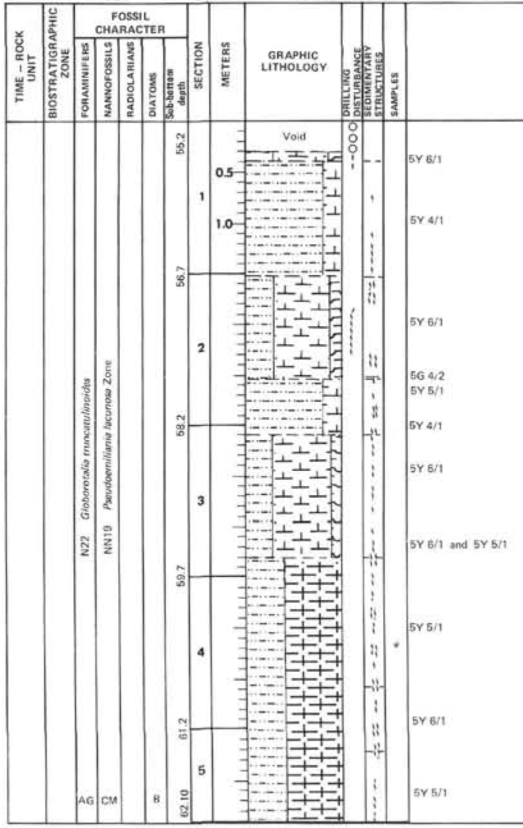
Greenish or gray LAMINATIONS, particularly indurated 52.5 to 52.8 m.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	60 D
Texture:	
Sand	5
Silt	45
Clay	50
Composition:	
Quartz	58
Mica	1
Heavy minerals	1
Foraminifers	2
Calc. nannofossils	28
Diatoms	1
Radiolarians	3
Sponge spicules	8
Silicoflagellates	TR

SITE 611 HOLE A CORE 7 CORED INTERVAL 55.2–64.8 m



LITHOLOGIC DESCRIPTION

MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE (gray 5Y 6/1) to MARLY FORAMINIFERAL NANNOFOSSIL OOZE (gray 5Y 5/1 to 6/1); amount of siliceous organisms decreasing probably progressively, becoming <10% around 59.6 m.

Interval between 58.34 to 59.56 is varicolored, predominantly gray (5Y 5/1 or 6/1), with common green, olive, and gray LAMINATIONS, and common MOTTLING; 59.01 to 59.07 m: common *CHONDRITE*-TYPE BURROWS.

Two layers of CALCAREOUS MUD; dark gray (5Y 4/1): 55.6 to 56.72 m and 57.75 to 58.24 m.

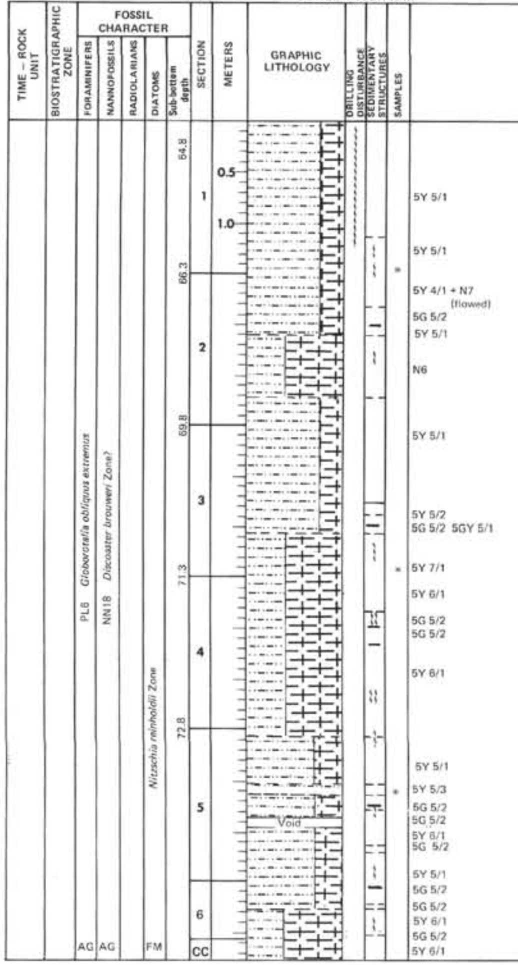
Generally common mottling.

61.73 to 61.90 m: common sandsize grained clasts with sharp contacts, grayish green (5G 4/2).

SMEAR SLIDE SUMMARY (%)

	4, 70
Composition:	
Quartz	25
Feldspar	5
Mica	TR
Heavy minerals	5
Clay	5
Foraminifers	10
Calc. nannofossils	43
Diatoms	2
Radiolarians	TR
Sponge spicul	5
Silicoflagellat	TR

SITE 611 HOLE A CORE 8 CORED INTERVAL 64.8–74.4 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1);
and
MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray (N6 or 5Y 6/1).

73.3 to 73.45 m: layer of olive (5Y 5/3) MUD.

Green (5G 5/2) LAMINATIONS, sometimes relatively thick (2 to 5 cm).

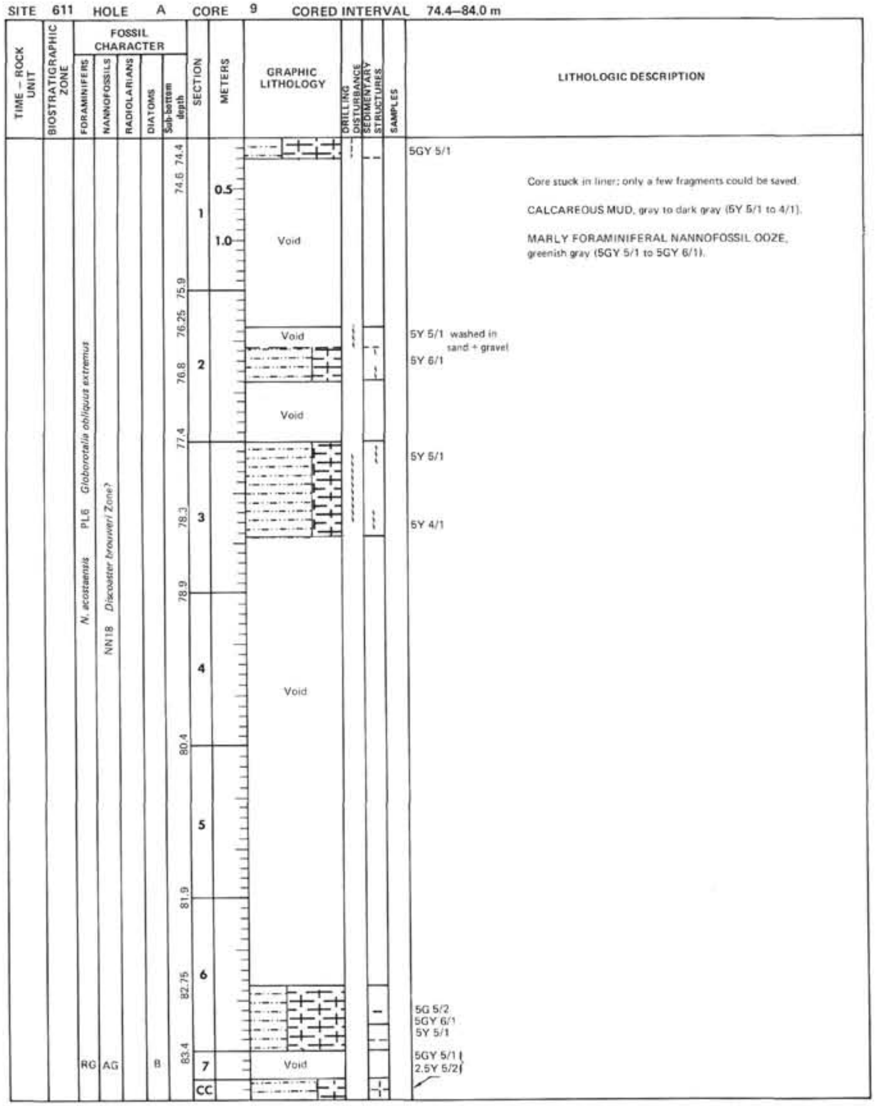
Green (5G 5/2) PATCHES between 72.31 and 72.46 m.

DROPSTONES.

SMEAR SLIDE SUMMARY (%)

	1, 140 D	3, 144
Texture:		
Sand	15	–
Silt	25	–
Clay	60	–
Composition:		
Quartz	41	30
Heavy minerals	4	TR
Clay	20	5
Volcanic glass	6	–
Micronodules	TR	–
Carbonate unspec.	1	TR
Foraminifers	8	6
Calc. nannofossils	20	57
Sponge spicules	TR	TR

SITE 611 HOLE A CORE 9 CORED INTERVAL 74.4–84.0 m



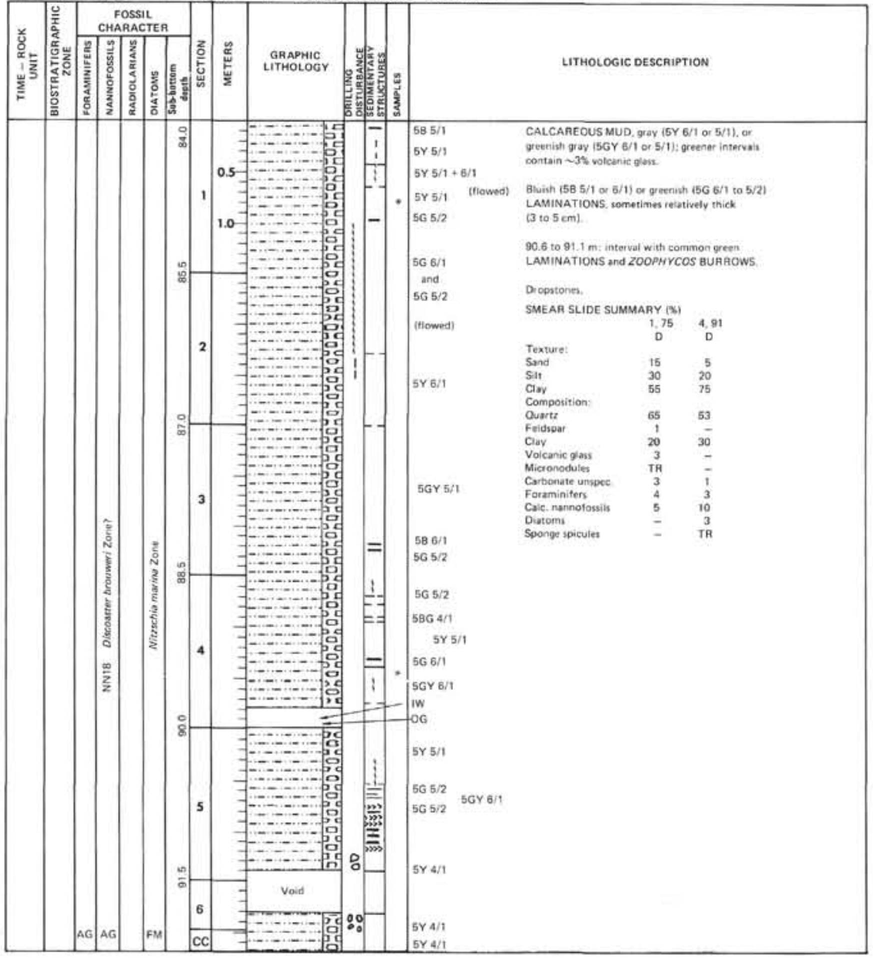
LITHOLOGIC DESCRIPTION

Core stuck in liner; only a few fragments could be saved.

CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1).

MARLY FORAMINIFERAL NANNOFOSSIL OOZE, greenish gray (5GY 5/1 to 5GY 6/1).

SITE 611 HOLE A CORE 10 CORED INTERVAL 84.0–93.6 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD, gray (5Y 6/1 or 5/1), or greenish gray (5GY 6/1 or 5/1); greener intervals contain ~3% volcanic glass.

Bluish (5B 5/1 or 6/1) or greenish (5G 6/1 to 5/2) LAMINATIONS, sometimes relatively thick (3 to 5 cm).

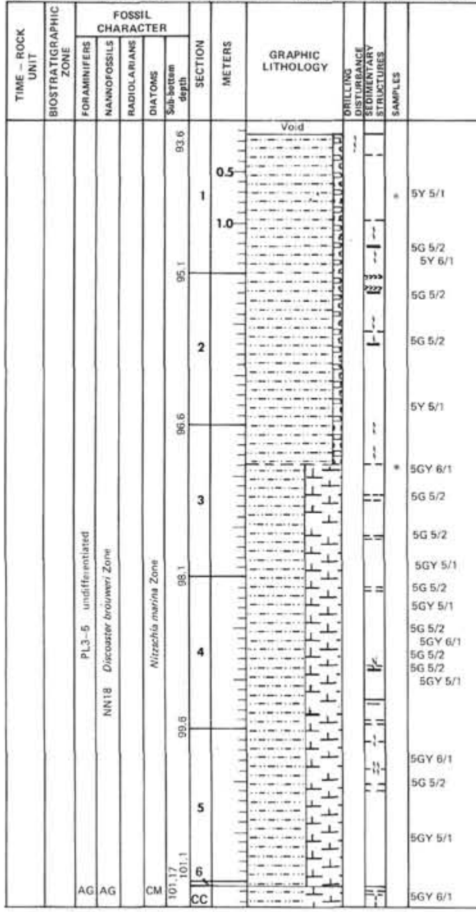
90.6 to 91.1 m: interval with common green LAMINATIONS and *ZOOPHYCOS* BURROWS.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	1, 75 D	4, 91 D
Texture:		
Sand	15	5
Silt	30	20
Clay	55	75
Composition:		
Quartz	65	53
Feldspar	1	–
Clay	20	30
Volcanic glass	3	–
Micronodules	TR	–
Carbonate unspec.	3	1
Foraminifers	4	3
Calc. nannofossils	5	10
Diatoms	–	3
Sponge spicules	–	TR

SITE 611 HOLE A CORE 11 CORED INTERVAL 93.6–103.2 m



LITHOLOGIC DESCRIPTION

93.7 to 97.0 m: CALCAREOUS MUD, gray (5Y 6/1 to 5/1), containing ~10% $CaCO_3$ (smear slide estimation).

97.0 to 101.2 m: CALCAREOUS MUD to MARLY NANNOFOSSIL OOZE, greenish gray (5GY 6/1 to 5/1), containing more than 30% $CaCO_3$ and ~8% siliceous organisms/smear slide estimation).

Green LAMINATIONS (5G 5/2), sometimes relatively thick (3.4 cm).

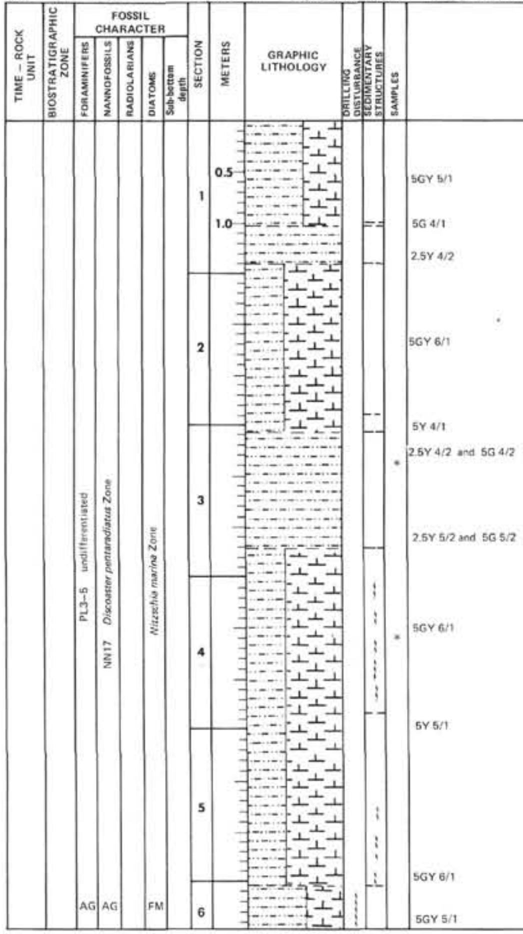
Rare *ZOOPHYCOS* BURROWS.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	1, 75	3, 47
	D	D
Texture:		
Sand	10	10
Silt	25	20
Clay	65	70
Composition:		
Quartz	65	37
Feldspar	1	3
Heavy minerrals	3	–
Clay	20	30
Carbonate unspec.	3	1
Foraminifers	3	8
Calc. nannofossils	6	20
Diatoms	TR	8
Radiolarians	—	TR
Sponge spicules	TR	TR
Silicoflagellates	—	TR

SITE 611 HOLE A CORE 12 CORED INTERVAL 103.2–112.8 m



LITHOLOGIC DESCRIPTION

Mostly MARLY NANNOFOSSIL OOZE, gray to greenish gray (5Y 5/1 to 5GY 6/1).

Top and bottom of core: CALCAREOUS MUD, greenish gray (5GY 5/1).

Two layers of MUD, dark grayish brown (2.5Y 4/2) to grayish green (5G 4/2), containing ~7% volcanic glass: 104.25 to 104.62 m and 106.30 to 107.4 m.

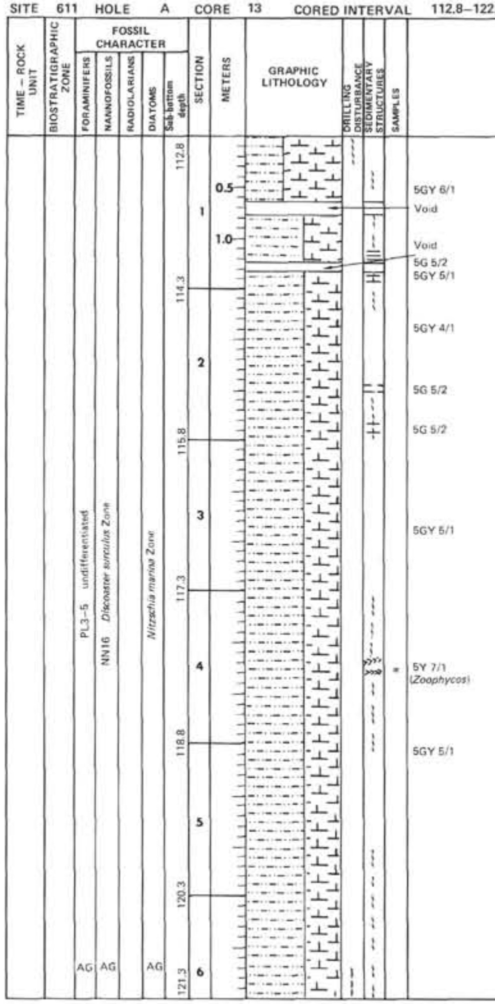
Distorted green (5G 5/2) or gray (5Y 5/1) LAMINATIONS common between 104.7 and 104.84 m.

Common green (5G 5/2) LAMINATIONS and PATCHES on marly nannofossil ooze intervals.

SMEAR SLIDE SUMMARY (%)

	3, 40	4, 60
	D	D
Texture:		
Sand	20	–
Silt	35	–
Clay	45	–
Composition:		
Quartz	65	25
Feldspar	1	TR
Heavy minerals	4	3
Clay	25	15
Volcanic glass	7	–
Micronodules	TR	–
Carbonate unspec.	1	TR
Foraminifers	–	4
Calc. nannofossils	TR	45
Diatoms	–	7
Radiolarians	–	TR
Sponge spicules	–	1
Silicoflagellates	–	TR

SITE 611 HOLE A CORE 13 CORED INTERVAL 112.8–122.4 m



LITHOLOGIC DESCRIPTION

Layer of MARLY NANNOFOSSIL OOZE, greenish gray (5GY 6/1), but mostly CALCAREOUS MUD, greenish gray to dark greenish gray (5GY 5/1 to 4/1).

Green (5G 5/2) faint irregular PATCHES and LAMINATIONS.

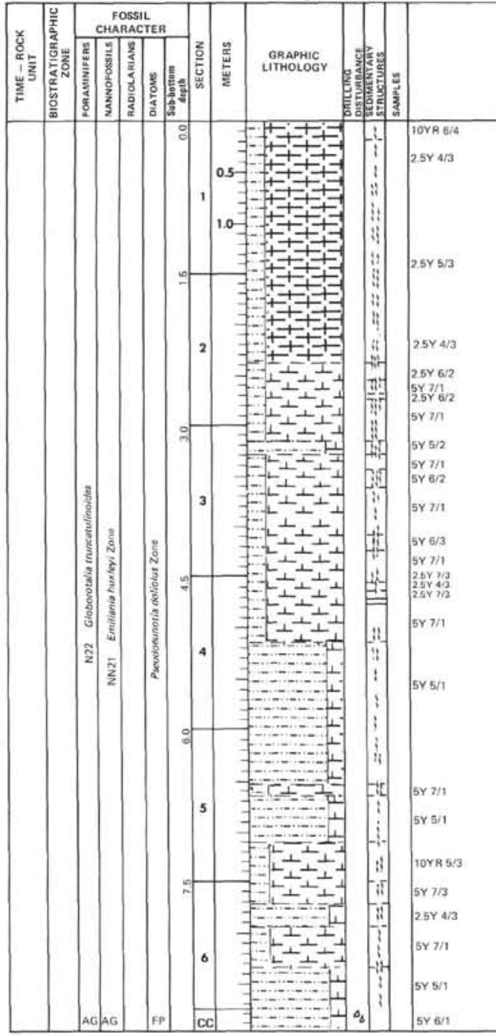
ZOOPHYCOS BURROWS between 118.20 and 118.30 m.

Dropstone.

SMEAR SLIDE SUMMARY (%)

	4, 77
Texture:	
Sand	5
Silt	15
Clay	80
Composition:	
Quartz	38
Heavy minerals	1
Clay	30
Pyrite	3
Micronodules	TR
Carbonate unspec.	1
Foraminifers	2
Calc. nannofossils	19
Diatoms	5
Radiolarians	TR
Sponge spicules	1
Silicoflagellates	TR

SITE 611 HOLE B CORE 1 CORED INTERVAL 0.0–8.9 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1);
and
FORAMINIFERAL NANNOFOSSIL OOZE, light yellowish brown (10YR 6/4) or grayish brown (2.5Y 5/3 to 4/3), becoming NANNOFOSSIL OOZE, yellow (2.5Y 7/3) to brownish gray (2.5Y 6/2), or gray (5Y 7/1 to 6/3).

Generally common MOTTLING.

0.16 to 0.84 m; 5.17 to 6.30 m; and 6.62 to 7.10 m: common coarse sandsized SANDSTONE and MUDSTONE CLASTS.

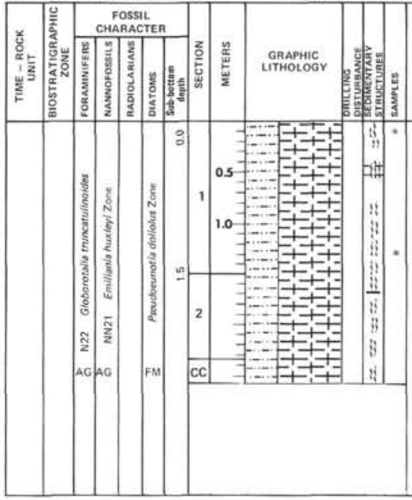
3.35 to 3.37 m: SAND-FILLED BURROWS.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	2, 144
	D
Composition:	
Quartz	15
Heavy minerals	TR
Carbonate unspec.	5
Foraminifers	7
Calc. nannofossils	87
Diatoms	1
Radiolarians	1
Sponge spicules	4

SITE 611 HOLE C CORE 1 CORED INTERVAL 0.0–2.4 m



LITHOLOGIC DESCRIPTION

10YR 5/4 to 10YR 6/4
10YR 4/4
10YR 5/4 to 10YR 6/4
10YR 5/4
N8
10YR 5/4

MARLY FORAMINIFERAL NANNOFOSSIL OOZE, light to dark yellowish brown (10YR 6/4 to 4/4).

Numerous SANDY CLASTS.

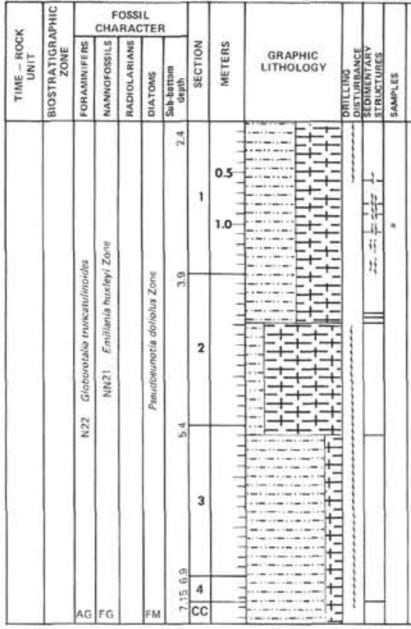
Highly MOTTLED *CHONDRITES* BURROWS.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	1, 10 D	1, 80 D
Composition:		
Quartz	26	21
Feldspar	2	2
Mica	TR	TR
Heavy minerals	2	2
Clay	20	5
Foraminifers	10	10
Calc. nannofossils	46	50
Diatoms	2	5
Radiolarians	TR	TR
Sponge spicules	2	5
Silicoflagellates	TR	TR

SITE 611 HOLE C CORE 2 CORED INTERVAL 2.4–7.4 m



LITHOLOGIC DESCRIPTION

5Y 7/1
10YR 6/2
2.5Y 5/2
5Y 7/1
2.5Y 6/2
2.5Y 7/1
2.5Y 4/2
2.5Y 8/3
5Y 7/1
5Y 5/1
5Y 5/1

Whole core appears to have extensive flowage.

MARLY FORAMINIFERAL NANNOFOSSIL OOZE, light gray (2.5Y 7/1) to grayish brown (2.5Y 5/2); and FORAMINIFERAL NANNOFOSSIL OOZE, light gray (5Y 7/1).

Very sharp laminations: dark grayish brown (2.5Y 4/2) and pale yellow (2.5Y 8/3), both 0.5 to 1 cm thick.

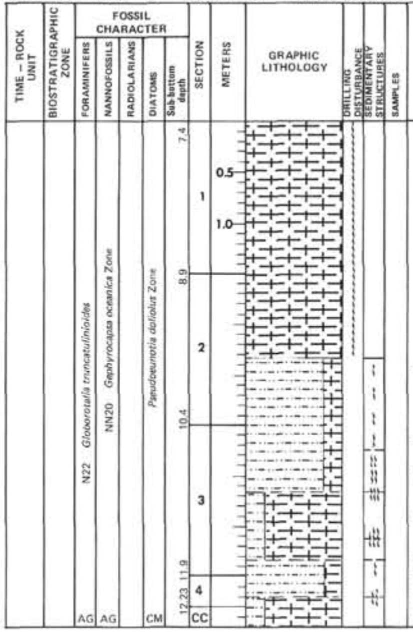
CALCAREOUS MUD, gray (5Y 5/1).

5.73 to 5.89 m and 6.26 to 6.87 m: common coarse sand-sized MUDSTONE(?) clasts.

SMEAR SLIDE SUMMARY (%)

	1, 100 D
Composition:	
Quartz	30
Feldspar	2
Mica	TR
Heavy minerals	2
Clay	20
Foraminifers	10
Calc. nannofossils	30
Diatoms	3
Radiolarians	TR
Sponge spicules	3
Silicoflagellates	TR

SITE 611 HOLE C CORE 3 CORED INTERVAL 7.4–12.4 m



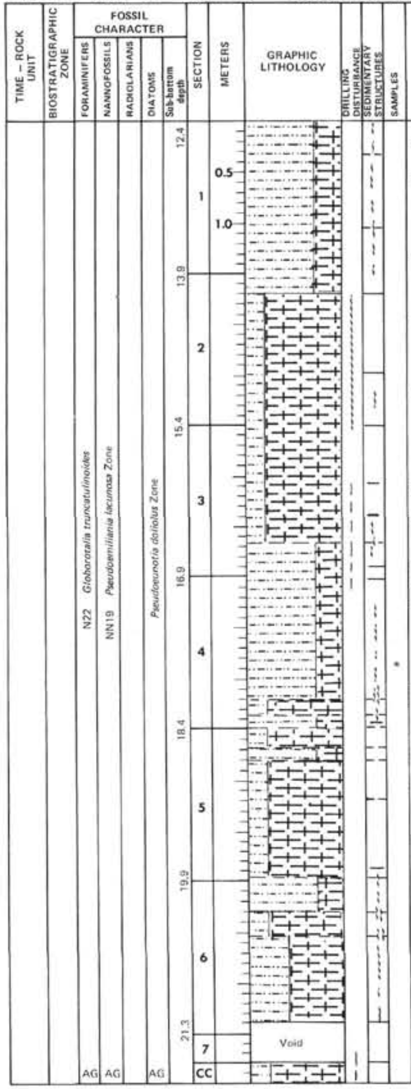
LITHOLOGIC DESCRIPTION

7.40 to 9.75 m: very deformed by coring; mixing of gray silty mud and brown or light gray ooze.

Alternating:
CALCAREOUS MUD, dark olive gray (5Y 4/1 to 4/2) or dark grayish brown (2.5Y 4/2), appearing silty; mottled; brown patches between 9.75 and 10.40 m; and FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (5Y 7/1 to 6/1) mottled; some pyritic patches and streaks.

5Y 4/1
5BG 4/1
2.5Y 4/2
5Y 7/1
5Y 6/1
5Y 4/2
5Y 4/1
5Y 6/1
5Y 6/1

SITE 611 HOLE C CORE 4 CORED INTERVAL 12.4–22.0 m



LITHOLOGIC DESCRIPTION

5Y 5/1
5Y 4/1
5Y 5/1
5Y 7/1
5Y 7/1 and 5Y 5/2
N5
5Y 7/1
5G 6/2
5Y 7/1
5Y 7/1
5Y 5/1
5Y 6/1
5Y 7/1
5Y 7/1 5Y 5/1
5Y 8/1
5Y 5/2
5Y 6/1
5Y 7/1
5G 5/2
5Y 5/1
5Y 6/1
5Y 5/1
5Y 6/1
5GY 7/1
(laminated)
5Y 6/1

Flowage from 14.15 to 15.4 m.

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1); and FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (5Y 7/1 to 6/1).

Common sand-sized clasts: 13.0 to 14.1 m and 17.40 to 17.46 m (mudstone).

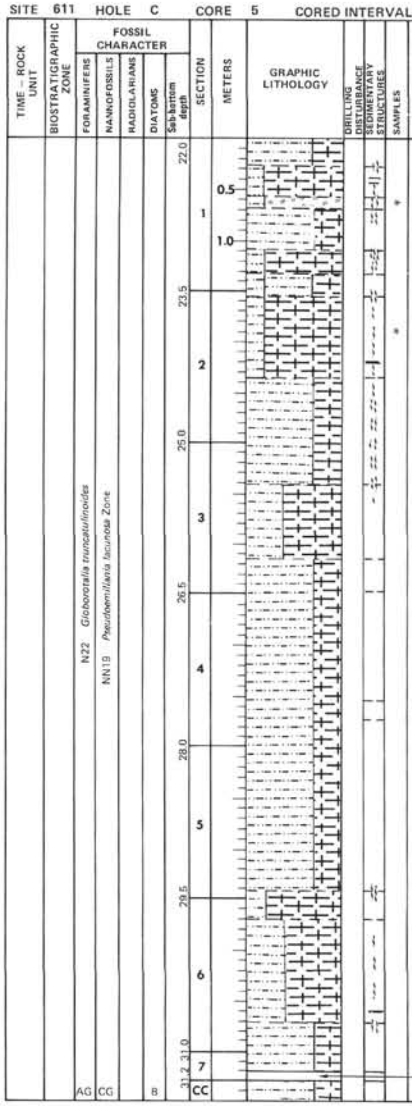
General mottling, more common on ooze.

Common diffuse green (5G 5/2) gray (5Y 6/1) and olive laminations between 19.10 to 20.2 m.

SMEAR SLIDE SUMMARY (%)

	4, 90
	D
Texture:	
Sand	15
Silt	45
Clay	40
Composition:	
Quartz	35
Feldspar	5
Heavy minerals	TR
Clay	30
Foraminifers	15
Calc. nannofossils	15

SITE 611 HOLE C CORE 5 CORED INTERVAL 22.0–31.6 m



LITHOLOGIC DESCRIPTION

5Y 4/1
5Y 7/1
5G 5/2
5GY 4/1
5Y 5/1
5Y 7/1
5Y 5/1
5Y 4/2
5Y 7/1
N3
5Y 4/2
5Y 5/1
2.5Y 5/2
5Y 6/2
5Y 5/1
2.5Y 3/2
5GY 4/1
5Y 4/1
5Y 7/1
5Y 6/1
5Y 5/1
5G 5/2
5Y 4/1
Void
5Y 4/1

Alternating:
CALCAREOUS MUD, gray to olive gray (5Y 5/1 to 4/2), or grayish brown to very dark grayish brown (2.5Y 5/2 to 3/2); some intervals appear more silty: 31.6 to 31.9 m, 36.2 to 37.2 m, and 37.8 to 39.2 m; and FORAMINIFERAL NANNOFOSSIL OOZE, light gray (5Y 7/1) to MARLY FORAMINIFERAL NANNOFOSSIL OOZE, gray to olive gray (5Y 6/1 to 6/2).

32.2 to 32.31 m: layer of VOLCANIC MUD (rich in TUFF); underlaying mud seems ash-rich.

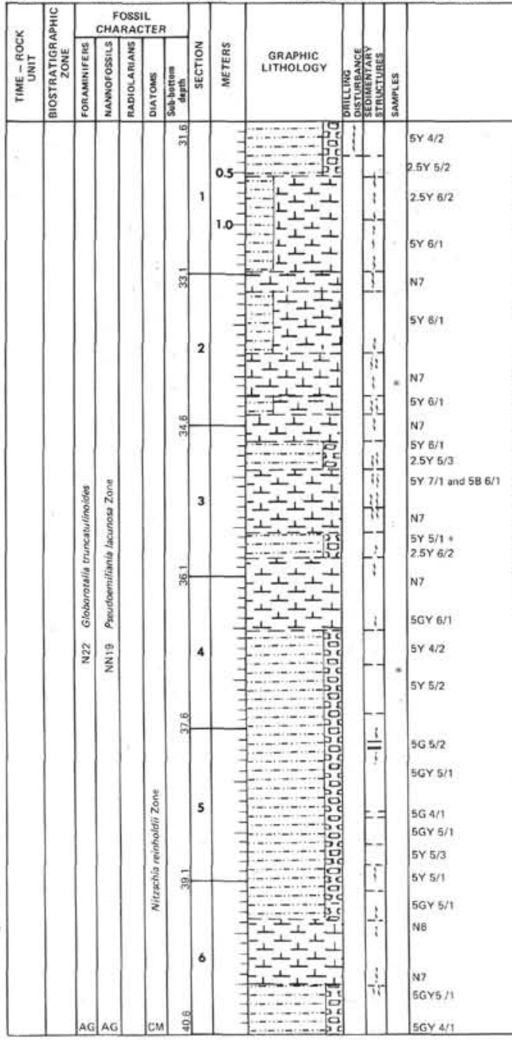
Rare green or gray LAMINATIONS 37.36 to 37.60 m: yellowish brown (10YR 5/4) patch.

MOTTLED INTERVALS: 31.6 to 32.2 m, 32.7 to 32.95 m, and 34.6 to 35.05 m.

SMEAR SLIDE SUMMARY (%)

	1, 60	2, 42
	M	D
Texture:		
Sand	30	–
Silt	60	–
Clay	10	–
Composition:		
Quartz	19	15
Mica	TR	–
Volcanic glass	65	–
Glauconite	1	–
Carbonate unspec.	–	3
Foraminifers	TR	10
Calc. nannofossils	15	68
Diatoms	–	TR
Radiolarians	–	TR
Sponge spicules	–	4

SITE 611 HOLE C CORE 6 CORED INTERVAL 31.6–41.2 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to olive gray (5Y 5/1 to 4/2) or dark grayish brown (2.5Y 5/2 to 5/3); and NANNOFOSSIL OOZE, light gray (N7 to N6) to MARLY NANNOFOSSIL OOZE, gray to brownish gray (5Y 6/1, 2.5Y 6/1 to 6/2).

Rare green (5G 5/2) laminations.

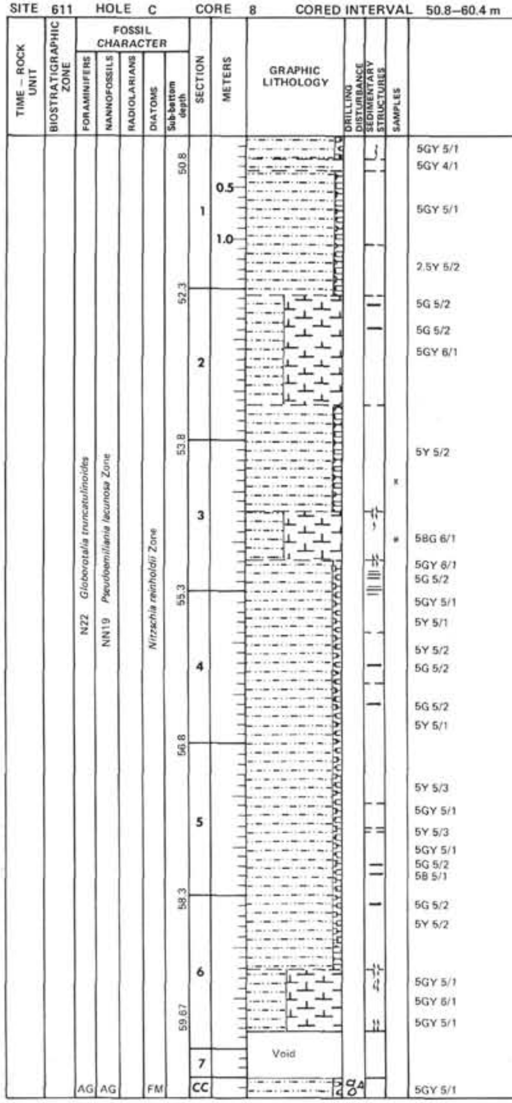
38.56 to 38.63 m: scattered ash.

SMEAR SLIDE SUMMARY (%)

	2, 102 D	4, 94 D
Texture:		
Sand	–	15
Silt	–	25
Clay	–	60
Composition:		
Quartz	–	60
Feldspar	TR	–
Heavy minerals	–	3
Clay	5	20
Volcanic glass	–	3
Carbonate unspec.	1	8
Foraminifers	9	4
Calc. nannofossils	84	2
Diatoms	1	–
Radiolarians	TR	–
Sponge spicules	TR	TR
Silicoflagellates	TR	–

Note: Core 7, 41.2–50.8 m: no recovery.

SITE 611 HOLE C CORE 8 CORED INTERVAL 50.8–60.4 m



LITHOLOGIC DESCRIPTION

Mostly CALCAREOUS MUD (slightly >10% carbonate), gray (5Y 5/1 to 5/3), greenish gray (5GY 5/1) or grayish brown (2.5Y 5/2). Some intervals seem more silty: 51.06 to 51.30 m, 51.8 to 52.35 m, 53.45 to 54.5 m, 55.86 to 56.0 m, 58.4 to 58.54 m, and 58.85 to 59.10 m.

Rare intervals of MARLY NANNOFOSSIL OOZE, greenish or bluish gray (5GY 6/1 or 5BG 6/1).

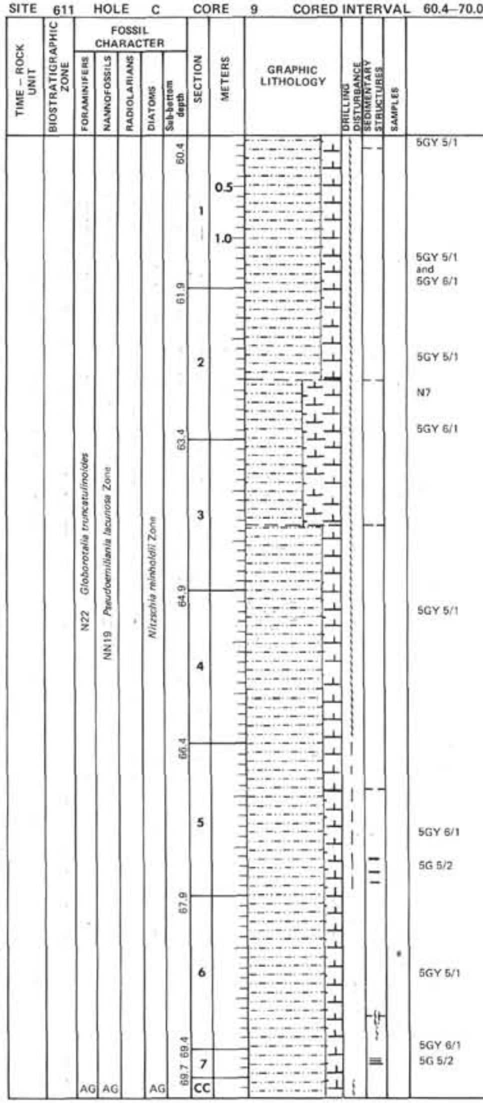
MUD LAYER, probably volcanic, dark greenish gray (5GY 4/1) between 51.06 to 51.15 m.

57.25 to 57.30 m: igneous dropstone and clasts of quartz, ash and tuff.

SMEAR SLIDE SUMMARY (%)

	3, 40 D	3, 95 M
Texture:		
Sand	20	–
Silt	40	–
Clay	40	–
Composition:		
Quartz	54	–
Feldspar	1	1
Heavy minerals	6	TR
Clay	20	35
Volcanic glass	7	–
Carbonate unspec.	8	1
Foraminifers	2	10
Calc. nannofossils	2	53
Diatoms	TR	–
Sponge spicules	TR	–

SITE 611 HOLE C CORE 9 CORED INTERVAL 60.4–70.0 m



LITHOLOGIC DESCRIPTION

Most part of the core flowed.

CALCAREOUS MUD, greenish gray (5GY 6/1 or 5/1).

Lighter interval from 62.8 to 64.20 m probably more calcareous: MARLY NANNOFOSSIL OOZE, light gray (N7) to greenish gray (5GY 6/1).

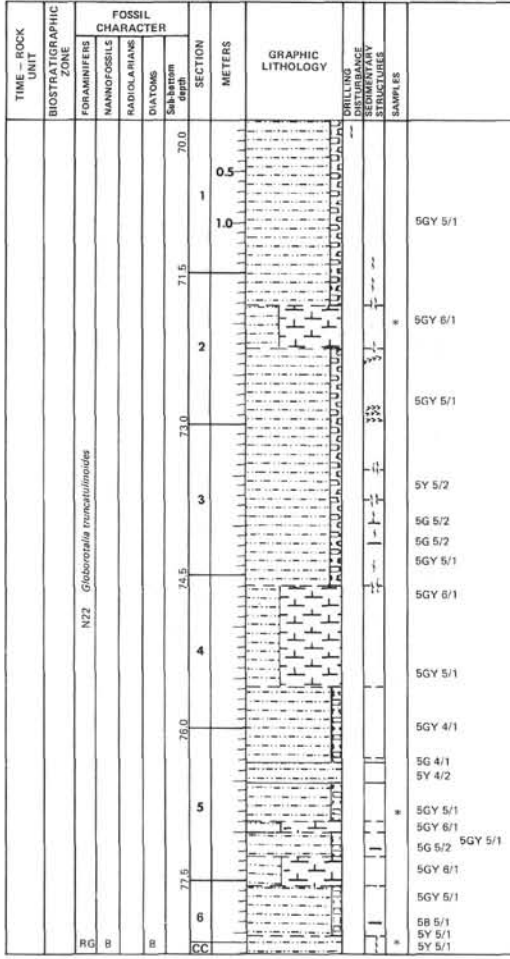
Some green (5G 5/2) LAMINATIONS in undisturbed part of the core.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	6, 60
	D
Texture:	
Sand	5
Silt	20
Clay	75
Composition:	
Quartz	47
Feldspar	TR
Heavy minerals	1
Clay	30
Volcanic glass	3
Carbonate unspec.	1
Calc. nannofossils	18

SITE 611 HOLE C CORE 10 CORED INTERVAL 70.0–79.6 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, olive gray (5Y 5/2) or dark greenish gray (5GY 5/1 to 4/1); and
MARLY NANNOFOSSIL OOZE, greenish gray (5GY 6/1). Layers become more and more thin towards core base.

Two layers of MUD (ash-bearing): 76.3 to 76.5 m: olive gray (5Y 4/2) with sharp contacts; and 78.10 to base: gray (5Y 5/1).

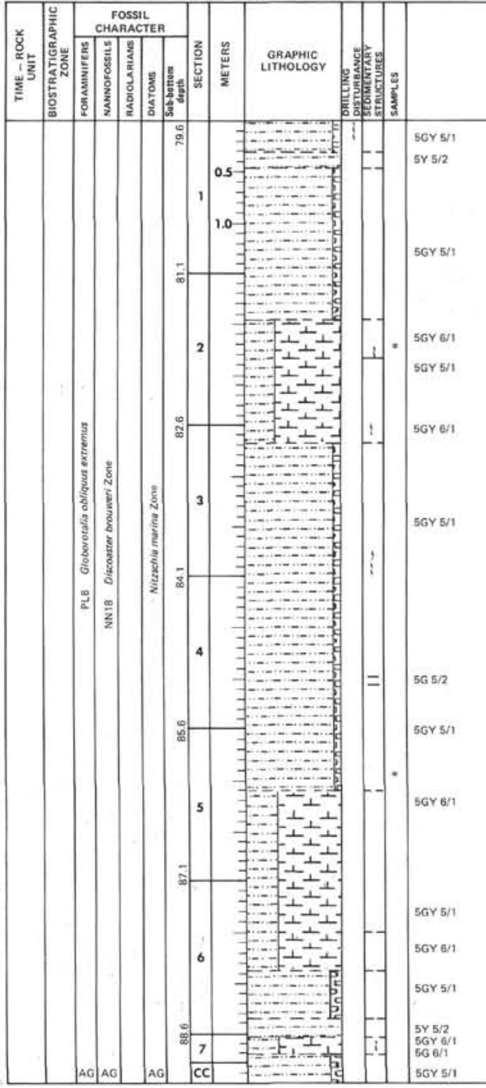
Rare green (5G 5/2) LAMINATIONS in calcareous mud.

Common *zoophycos* between 72.3 and 73.0 m.

SMEAR SLIDE SUMMARY (%)

	2, 49	5, 88	6, 62
	D	D	M
Texture:			
Sand	–	15	–
Silt	–	30	–
Clay	–	55	–
Composition:			
Quartz	–	57	68
Feldspar	TR	TR	2
Heavy minerals	–	4	3
Clay	30	25	20
Volcanic glass	–	3	5
Carbonate unspec.	TR	8	1
Foraminifers	7	1	1
Calc. nannofossils	57	2	
Diatoms	6	–	–
Radiolarians	TR	–	–
Sponge spicules	TR	–	–
Silicoflagellates	TR	–	–

SITE 611 HOLE C CORE 11 CORED INTERVAL 79.6–89.2 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, greenish gray (5GY 5/1 to 5/2); and MARLY NANNOFOSSIL OOZE, light greenish gray (5GY 6/1) with very gradational contacts between one type and the other, especially around 82.3 and 87.1 m.

Some silty intervals in calcareous mud: 81.33 to 81.57 m, 82.88 to 83.6 m, and 84.1 to 85.95 m.

MUD layers, olive gray (5Y 5/2) at 79.8 to 79.95 m and 88.45 to 88.6 m.

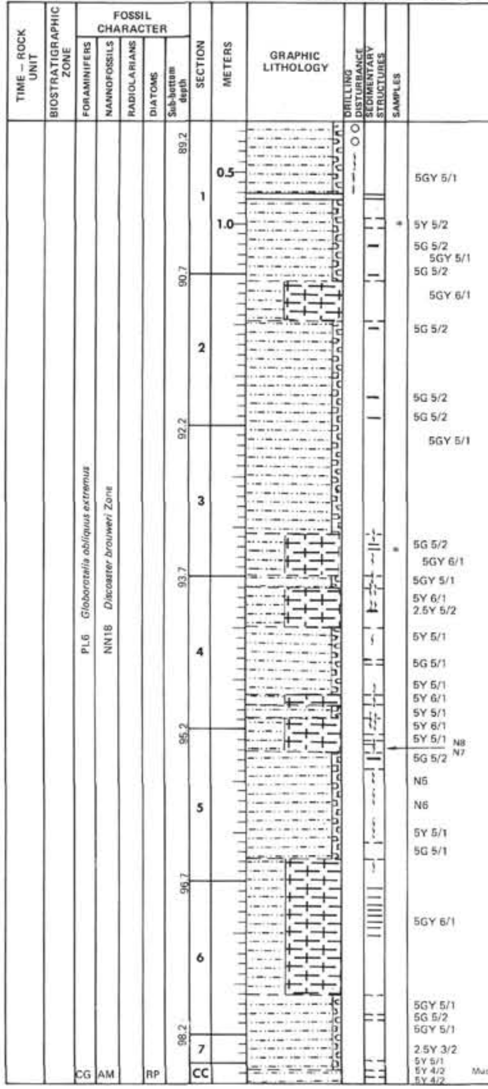
Very rare green (5G 5/2) LAMINATIONS.

88.02 m: SANDY ASH clast.

SMEAR SLIDE SUMMARY (%):

	2, 73	5, 44
	D	D
Texture:		
Sand	–	10
Silt	–	25
Clay	–	65
Composition:		
Quartz	–	64
Feldspar	TR	–
Heavy minerals	1	1
Clay	25	20
Volcanic glass	–	5
Carbonate unspec.	TR	7
Foraminifers	8	TR
Calc. nannofossils	66	3
Diatoms	TR	–
Sponge spicules	TR	TR

SITE 611 HOLE C CORE 12 CORED INTERVAL 89.2–98.8 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUD, greenish gray (5GY 5/1), gray to olive gray (5Y 5/1 to 5/2), grayish brown (2.5Y 5/2) or gray (N6 to N5) alternating with thinner intervals of MARLY FORAMINIFERAL NANNOFOSSIL OOZE, light gray (N8 to N7), or light greenish gray (5GY 6/1) with very gradational contacts between both types.

Rare green (5G 5/2) or grayish brown (2.5Y 5/2) LAMINATIONS; common between 96.8 and 97.3 m (with light brownish gray [10YR 6/2] traces of burrows].

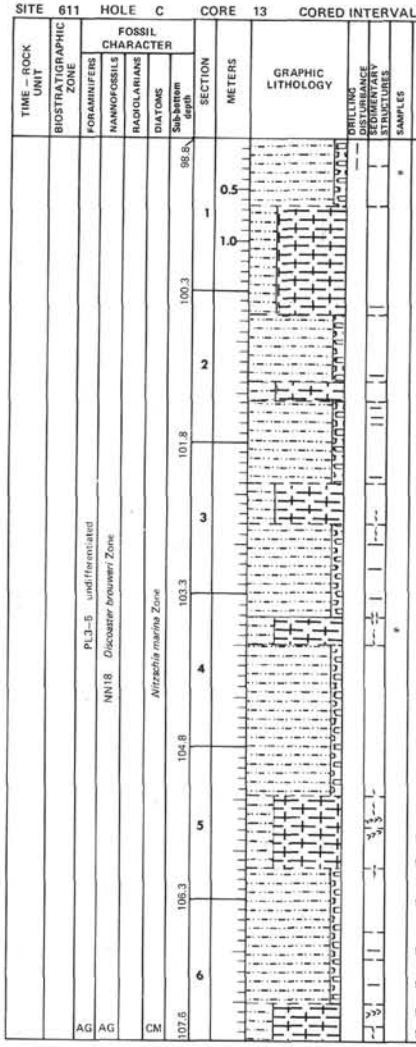
Small SANDY PATCHES: 94.98 to 95.1 m.

In Core Catcher: dark green (5G 4/1) layer (3 cm) of ASH-BEARING MUD.

SMEAR SLIDE SUMMARY (%)

	1, 101	3, 133
	D	D
Texture:		
Sand	15	–
Silt	30	–
Clay	55	–
Composition:		
Quartz	60	–
Feldspar	TR	TR
Heavy minerals	3	TR
Clay	20	35
Volcanic glass	5	–
Carbonate unspec.	7	TR
Foraminifers	1	13
Calc. nannofossils	4	52
Diatoms	–	TR

SITE 611 HOLE C CORE 13 CORED INTERVAL 98.8–108.4 m



LITHOLOGIC DESCRIPTION

5Y 5/1 + 5G 4/1 (mixed)
5Y 4/2
5GY 6/1
5G 5/2
5GY 5/1
5G 5/2
5GY 6/1
5B 6/1
5B 6/1
5GY 5/1
5G 4/1
5GY 6/1
5G 5/2
5GY 4/1
5G 4/1
5G 4/1
5GY 6/1
5GY 5/1
5Y 4/1
5Y 6/1
5GY 6/1
5GY 5/1
5GY 4/1
5G 5/2 5GY 5/1
5GY 6/1 5GY 4/1
5GY 6/1
5GY 7/1

CALCAREOUS MUD, dark gray or greenish gray (5Y 4/1 or 5GY 5/1 to 4/1) alternating with thinner intervals of FORAMINIFERAL NANNOFOSSIL OOZE to MARLY FORAMINIFERAL NANNOFOSSIL OOZE, light greenish gray to greenish gray (5GY 7/1 to 6/1).

107.25 m: thin (1 cm) layer of marly foraminiferal nannofossil ooze in calcareous mud interval.

Green (5G 5/2) and bluish gray (5B 6/1) LAMINATIONS. Bluish ones may be halos around burrows.

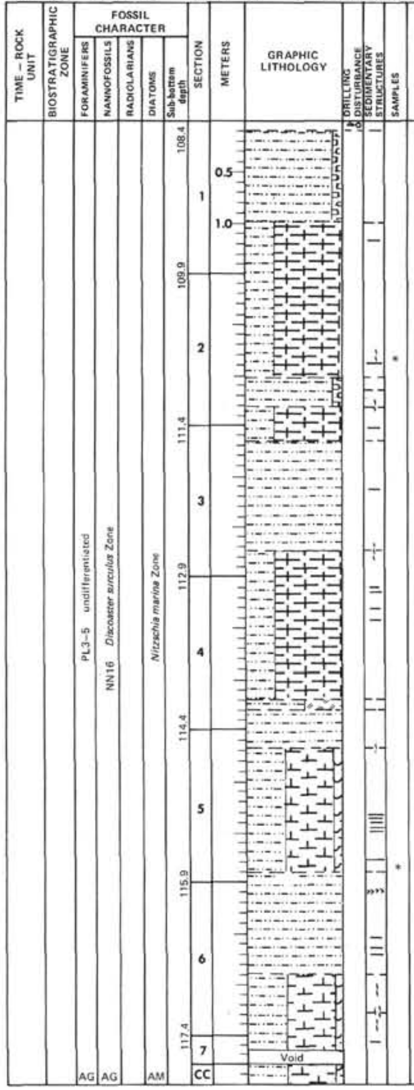
Rare *ZOOPHYCOS* BURROWS.

Dropstone.

SMEAR SLIDE SUMMARY (%)

	1, 32 D	4, 35 D
Texture:		
Sand	20	–
Silt	30	–
Clay	50	–
Composition:		
Quartz	62	–
Feldspar	TR	–
Heavy minerals	4	TR
Clay	15	20
Volcanic glass	6	–
Carbonate unspec.	7	–
Foraminifers	2	11
Calc. nannofossils	4	63
Diatoms	–	6
Sponge spicules	TR	TR

SITE 611 HOLE C CORE 14 CORED INTERVAL 108.4–118.0 m



LITHOLOGIC DESCRIPTION

Downhole contamination
5Y 5/1
5G 4/2
5GY 5/1
5B 5/1
5G 5/1
5Y 4/1
5GY 5/1
5G 5/2
5GY 5/1
5GY 4/1
5B 3/1
5GY 4/1
5G 5/2
5GY 5/1
5G 4/1
5Y 4/1
5GY 6/1
5G 5/2
5GY 4/1 + 5Y 4/1
5G 4/2
5BG 4/1
5Y 5/1 + 5GY 6/1 mixed
5GY 6/1
5B 5/1
5GY 6/1

Alternating:
CALCAREOUS MUD, gray to dark gray (5Y 5/1 to 4/1), becoming (around 111.55 m): MUD, dark gray to greenish gray (5Y 4/1 to 5GY 4/1); and MARLY FORAMINIFERAL NANNOFOSSIL OOZE, greenish gray (5GY 5/1), becoming (around 114.60 m): MARLY DIATOMACEOUS NANNOFOSSIL OOZE, lighter greenish gray (5GY 6/1).

ASH-BEARING MUD layer between 114.14 and 114.18 m.

Green (5G 5/2) or bluish (5B 5/1 or 3/1) LAMINATIONS.

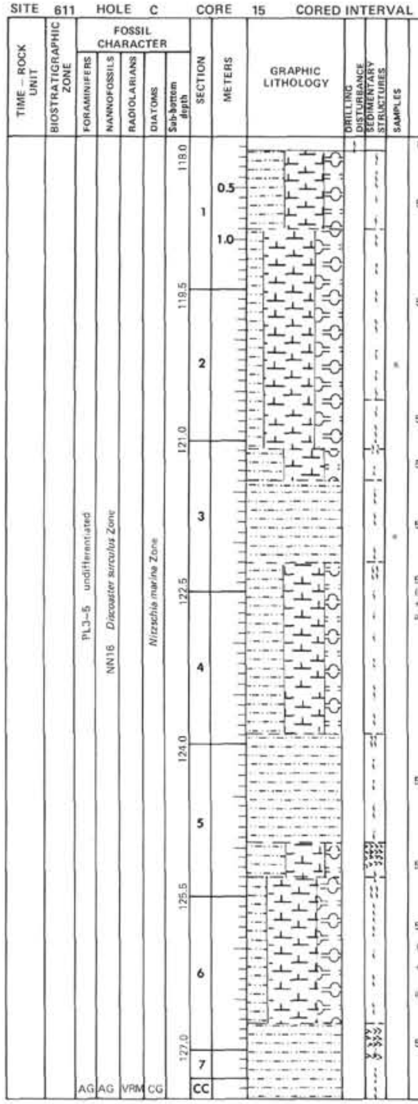
Green mud patches: 112.31 m, 112.47 to 112.49 m, and 112.95 m.

Foraminifer-rich interval: 113.55 to 113.65 m.

SMEAR SLIDE SUMMARY (%)

	2, 85 D	5, 138 D
Composition:		
Quartz	1	–
Feldspar	TR	–
Heavy minerals	TR	1
Clay	30	35
Volcanic glass	TR	–
Carbonate unspec.	TR	–
Foraminifers	12	6
Calc. nannofossils	57	47
Diatoms	7	10
Radiolarians	TR	TR
Sponge spicules	TR	1
Silicoflagellates	–	TR

SITE 611 HOLE C CORE 15 CORED INTERVAL 118.0–127.6 m



LITHOLOGIC DESCRIPTION

Pebbly wash-down

5Y 5/1

5Y 6/1

5GY 7/1

5Y 5/1

5Y 4/1

5Y 5/1 (dominant) + 5G 5/2 and 5Y 6/1

5Y 4/1

5Y 5/1

5GY 6/1 (dominant) + 5G 5/2 and 5Y 6/1

5Y 4/1

SILICEOUS NANNOFOSSIL OOZE, light gray or greenish gray (5Y 6/1 or 5GY 7/1), to **MARLY SILICEOUS NANNOFOSSIL OOZE**, gray (5Y 5/1), alternating with thinner layers of **MUD**, dark gray (5Y 4/1).

Green (5G 5/2) or gray (5Y 6/1) **LAMINATIONS** in whole core, especially common in siliceous nannofossil ooze.

General **MOTTLING**.

Common *ZOOPHYCOS* **BURROWS** between: 124.95 and 125.20 m; 125.8 and 127.10 m.

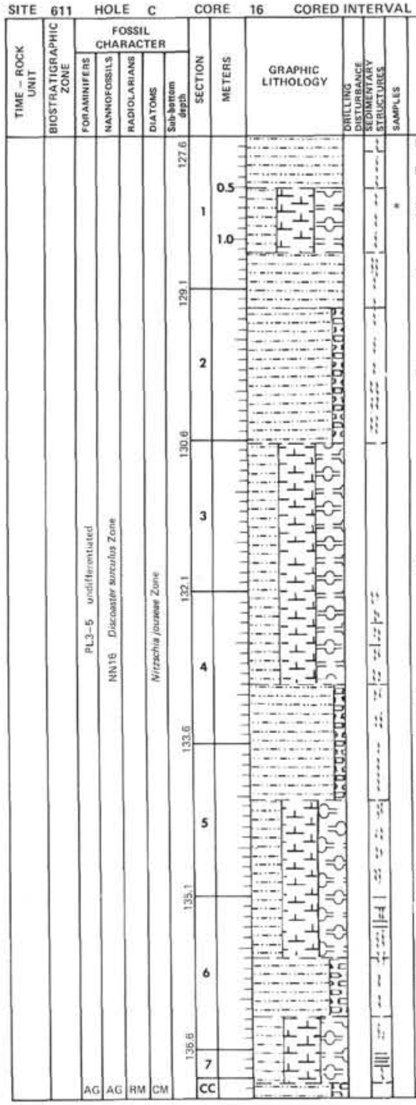
SMEAR SLIDE SUMMARY (%)

	2, 71 D	3, 90 D
Texture:		
Sand	–	5
Silt	–	40
Clay	–	55
Composition:		
Quartz	20	98
Feldspar	–	
Mica	TR	
Heavy minerals	5	
Clay	–	
Carbonate unspec.	–	2
Foraminifers	5	–
Calc. nannofossils	40	–
Diatoms	12	–
Radiolarians	TR	–
Sponge spicules	18	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	2, 71–72
Organic carbon	–
Carbonate	56

SITE 611 HOLE C CORE 16 CORED INTERVAL 127.6–137.2 m



LITHOLOGIC DESCRIPTION

5Y 2/2

5Y 4/1

5Y 5/1 to 6/1

5Y 3/2

5Y 4/1

5Y 6/1

5Y 5/1

5Y 4/1

5Y 4/1

5Y 6/1

5G 5/2

5Y 4/1

5Y 6/1

5G 5/2

10Y 4/2

5G 4/2

5Y 4/1

Alternating:
MUD, dark olive gray (5Y 3/2) to **CALCAREOUS MUD**, dark gray (5Y 4/1). Amount of carbonate probably increasing towards core base; and **MARLY SILICEOUS NANNOFOSSIL OOZE**, gray (5Y 4/1 to 5/1), to **SILICEOUS NANNOFOSSIL OOZE**, light gray (5Y 5/1 to 6/1).

General **MOTTLING**; especially on siliceous nannofossil ooze: green (5G 5/2) mottles and laminations.

Two brown (10Y 4/2) laminations at 136.75 and 136.76 m.

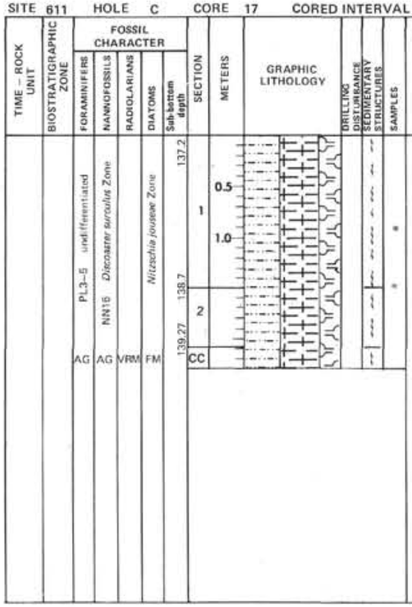
SMEAR SLIDE SUMMARY (%)

	1, 70 D
Composition:	
Quartz	30
Carbonate unspec.	3
Foraminifers	4
Calc. nannofossils	33
Diatoms	3
Radiolarians	2
Sponge spicules	20

ORGANIC CARBON AND CARBONATE (%)

	1, 7–8
Organic carbon	–
Carbonate	3

SITE 611 HOLE C CORE 17 CORED INTERVAL 137.2–146.8 m



LITHOLOGIC DESCRIPTION

5GY 5/1

5G 3/2

5Y 5/1

5Y 5/1

MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 5/1) to greenish gray (5GY 5/1).

Common greenish gray (5GY 6/1) and olive MOTTLES and diffuse horizontal LAMINATIONS.

138.69 to 138.70 m: dark grayish green (5G 3/2) thin layer of GLAUCONITE.

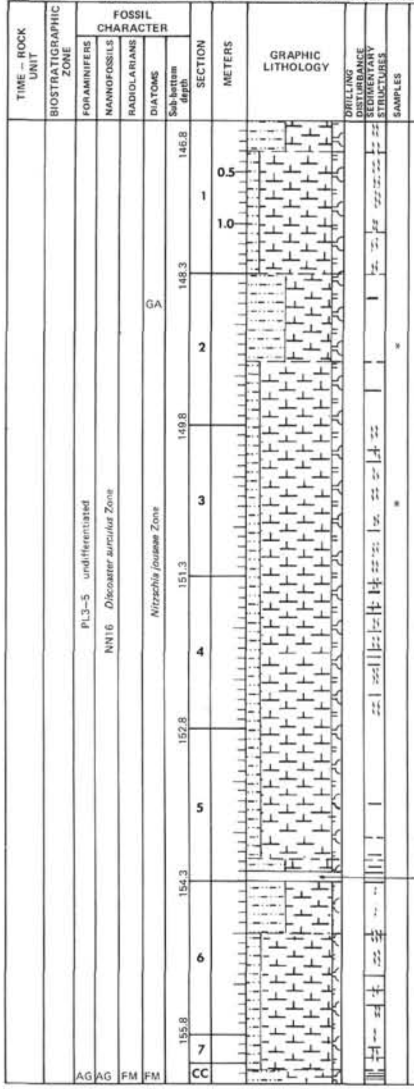
SMEAR SLIDE SUMMARY (%)

	1, 90 D	1, 149 M
Composition:		
Quartz	38	–
Mica	–	1
Heavy minerals	–	TR
Glauconite	–	94
Pyrite	–	1
Carbonate unspec.	2	–
Foraminifers	12	–
Calc. nannofossils	31	4
Diatoms	3	–
Radiolarians	2	–
Sponge spicules	10	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	1, 93–94
Organic carbon	–
Carbonate	43

SITE 611 HOLE C CORE 18 CORED INTERVAL 146.8–156.4 m



LITHOLOGIC DESCRIPTION

5Y 5/1

5Y 6/1

5Y 7/1

5Y 6/1

5Y 7/1

5G 5/2

5Y 5/1

5G 5/2

5Y 6/1
to
5Y 7/1

5Y 6/1
to
5Y 7/1

5Y 6/1

5Y 7/1

5Y 4/1

IW

5Y 5/1

5Y 7/1

5Y 6/1

5Y 5/1

SILICEOUS NANNOFOSSIL OOZE, light gray (5Y 7/1 to 6/1), with some MARLY intervals, gray (5Y 5/1 to 4/1).

General MOTTLING, green or brown, occasionally pyritic.

Common green (5G 5/2) LAMINATIONS.

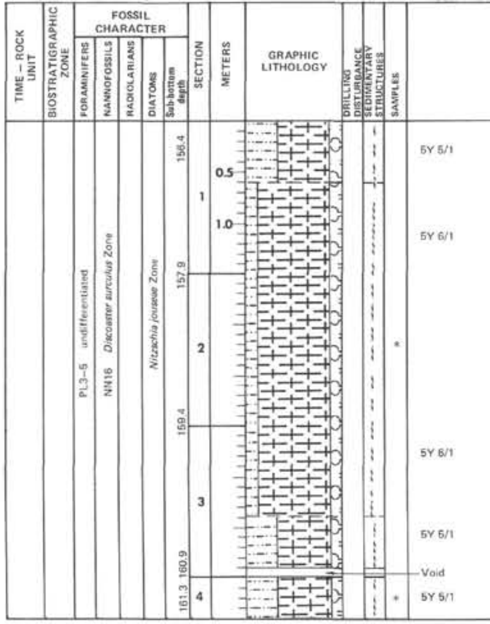
SMEAR SLIDE SUMMARY (%)

	2, 70 D	3, 80 D
Composition:		
Quartz	20	10
Heavy minerals	5	2
Clay	20	3
Foraminifers	5	5
Calc. nannofossils	40	70
Diatoms	2	2
Sponge spicules	8	8

ORGANIC CARBON AND CARBONATE (%)

	3, 81–82
Organic carbon	–
Carbonate	64

SITE 611 HOLE C CORE 19 CORED INTERVAL 156.4–166.0 m



LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, greenish gray (5Y 6/1) to MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, darker greenish gray (5Y 5/1).

Common green (5G 5/2) and light gray (5Y 7/1) LAMINATIONS AND MOTTLES.

Dark green (5G 3/2) *GLAUCONITE PATCHES* at: 159.15 m, 160.32 m, and 161.14 m (burrow fills).

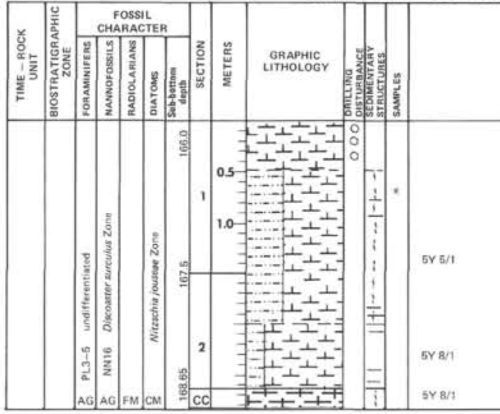
SMEAR SLIDE SUMMARY (%)

	2, 70	4, 24
	D	M
Composition:		
Quartz	15	10
Heavy minerals	2	–
Clay	3	–
Volcanic glass	TR	–
Glauconite	–	83
Carbonate unspec.	–	2
Foraminifers	15	–
Calc. nannofossils	55	5
Diatoms	5	–
Radiolarians	TR	–
Sponge spicules	5	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	2, 79–80
Organic carbon	–
Carbonate	65

SITE 611 HOLE C CORE 20 CORED INTERVAL 166.0–175.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE to MARLY NANNOFOSSIL OOZE, very light gray (5Y 8/1) or gray (5Y 5/1), mottling, green laminations.

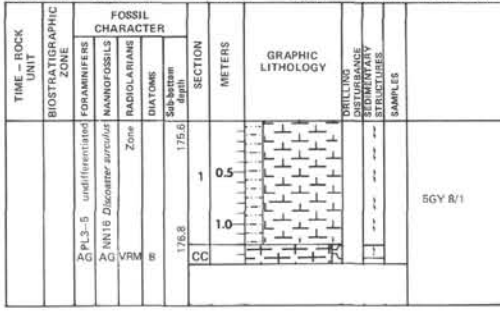
SMEAR SLIDE SUMMARY (%)

	1, 70
	D
Composition:	
Quartz	45
Foraminifers	8
Calc. nannofossils	40
Diatoms	1
Sponge spicules	6

ORGANIC CARBON AND CARBONATE (%)

	1, 70–71
Organic carbon	–
Carbonate	52

SITE 611 HOLE C CORE 21 CORED INTERVAL 175.6–185.2 m



LITHOLOGIC DESCRIPTION

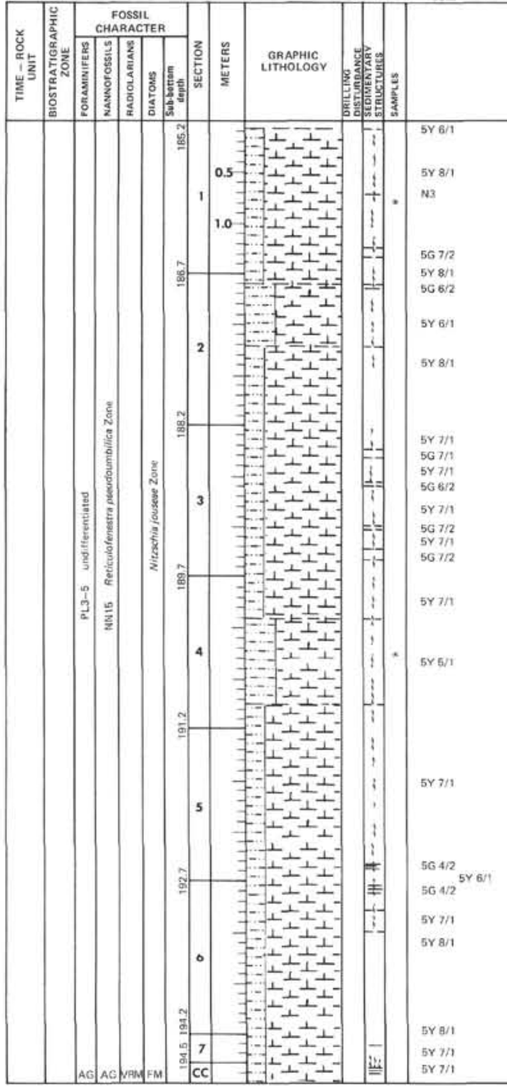
NANNOFOSSIL OOZE, light greenish gray (5GY 8/1 to 7/1).

Common green (5G 5/2 to 5GY 8/1) gray (5Y 8/1 or N3 to N5) MOTTLES.

Common diffuse green LAMINATIONS.

Dark green (5G 4/2) BURROW FILLS of glauconite, at 176.05 m and in Core Catcher.

SITE 611 HOLE C CORE 22 CORED INTERVAL 185.2–194.8 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light to light gray (5Y 8/1 to 7/1). Some MARLY intervals, gray (5Y 6/1 to 5/1).

Common green mottling, occasionally pyritic.

Very common green (5G 4/2) laminations, or thin layers (5G 7/1 to 5G 6/2).

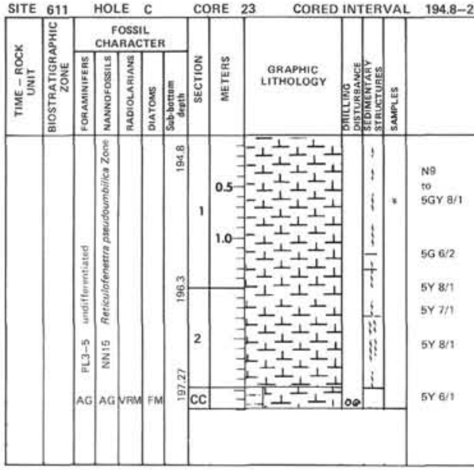
SMEAR SLIDE SUMMARY (%)

	1, 80	4, 80
	D	D
Composition:		
Quartz	20	30
Mica	–	2
Carbonate unspec.	–	3
Foraminifers	4	6
Calc. nannofossils	76	52
Radiolarians	–	2
Sponge spicules	–	3

ORGANIC CARBON AND CARBONATE (%)

	1, 80–81	4, 80–81
Organic carbon	–	–
Carbonate	83	53

SITE 611 HOLE C CORE 23 CORED INTERVAL 194.8–204.4 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, white with local pale greenish (N9 to 5GY 8/1) cast, or very light gray (5Y 8/1 to 5Y 7/1).

Green and gray MOTTLING.

Rare green (5G 6/2) LAMINATIONS.

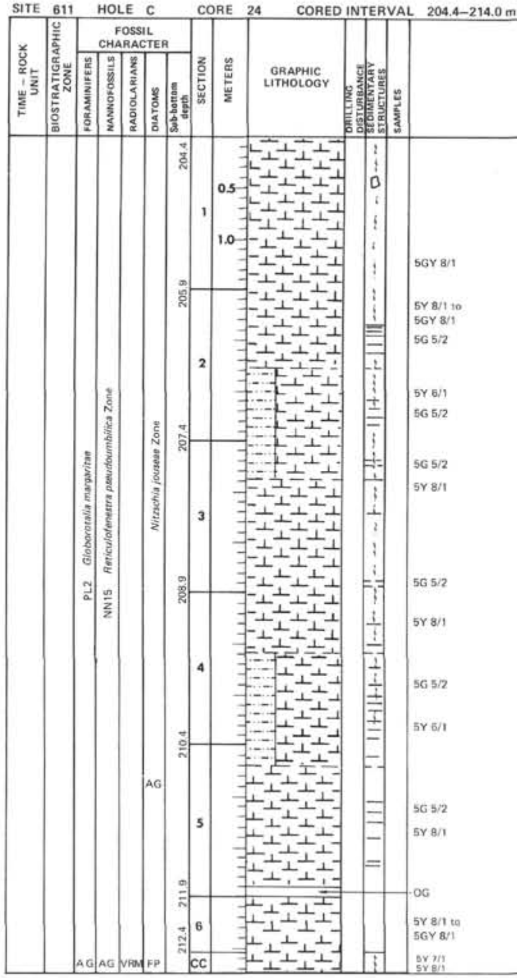
SMEAR SLIDE SUMMARY (%)

	1, 70
	D
Composition:	
Quartz	10
Carbonate unspec.	2
Foraminifers	4
Calc. nannofossils	84

ORGANIC CARBON AND CARBONATE (%)

	1, 70–71
Organic carbon	–
Carbonate	83

SITE 611 HOLE C CORE 24 CORED INTERVAL 204.4–214.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light gray to very light greenish gray (5Y 8/1 to 5GY 8/1), and MARLY intervals, gray (5Y 6/1).

PYRITIC MOTTLING.

Common green LAMINATIONS or thin intervals (2–4 cm); rare gray or brown laminations.

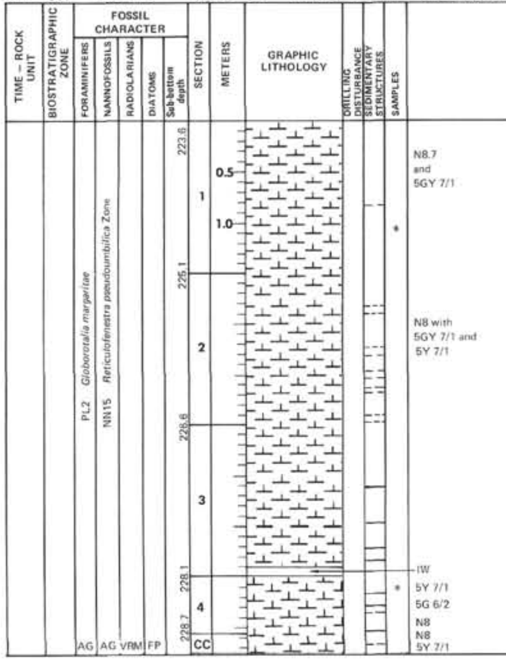
204.80 m: large (4.5 cm) pebble.

ORGANIC CARBON AND CARBONATE (%)

	5, 70–71
Organic carbon	–
Carbonate	79

Note: Core 25, 214.0–223.6 m: no recovery.

SITE 611 HOLE C CORE 26 CORED INTERVAL 223.6–233.2 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light gray (N8), with gray (5Y 7/1 and 5GY 7/1) patches.

Common green (5G 6/2) patches, becoming laminations around 226.5 m.

Pyritic mottling and patches.

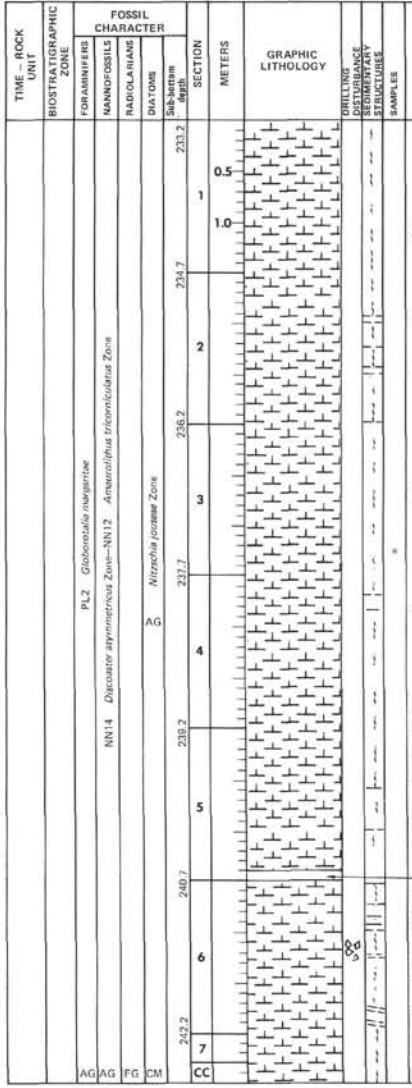
SMEAR SLIDE SUMMARY (%)

	1, 111 D	
Composition:		
Heavy minerals	TR	1
Clay	5	25
Carbonate unspec.	–	TR
Foraminifers	5	6
Calc. nannofossils	90	64
Diatoms	TR	3
Sponge spicules	TR	1

ORGANIC CARBON AND CARBONATE (%)

	4, 13–14
Organic carbon	–
Carbonate	70

SITE 611 HOLE C CORE 27 CORED INTERVAL 233.2–242.8 m



N8 dominant

5Y 7/1

N5

5Y 7/1 dominant

5G 7/2

N8 dominant

5G 5/2

5Y 7/1

OG

5Y 6/1

5Y 7/1

5G 7/2

5Y 7/1

N8

5G 7/2

5G 7/1

N8

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, becoming more and more chalky light gray (N8 or 5Y 7/1), with common gray and greenish (5Y 7/1; 5G 7/2 to 6/2) patches.

From 240.7 m down: NANNOFOSSIL CHALK (cut by saw), light gray (N8 or 5Y 7/1) with evident burrowing (gray 5Y 7/1).

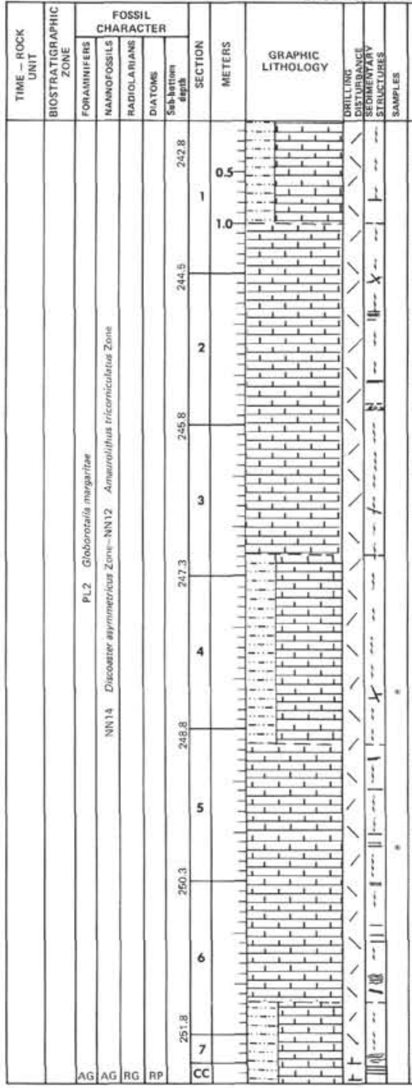
SMEAR SLIDE SUMMARY (%)

	3, 133
	D
Composition:	
Quartz	TR
Heavy minerals	TR
Clay	8
Carbonate unspec.	1
Foraminifers	4
Calc. nannofossils	85
Diatoms	2
Radiolarians	TR
Sponge spicules	TR
Silicoflagellates	TR

ORGANIC CARBON AND CARBONATE (%)

	3, 31–32
Organic carbon	–
Carbonate	82

SITE 611 HOLE C CORE 28 CORED INTERVAL 242.8–252.4 m



5Y 6/1

5Y77/1

5G 6/2

5G 7/2

5GY 7/1

2.5Y 6/2

2.5Y 6/2

5GY 7/1 to
5Y 7/1

2.5Y 7/2

5Y 6/1

5G 6/2

5G 6/2

5G 6/2

5Y 7/1

5G 7/2

2.5Y 7/2

5G 7/2

5Y 8/1

2.5Y 7/2

5G 6/2

2.5Y 7/2

5Y 6/1

2.5Y 6/2

LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in (soft ooze) between hard chalk blocks.

NANNOFOSSIL CHALK, light gray to light greenish gray (5Y 7/1 to 5GY 7/1); darker (5Y 6/1) MARLY intervals.

Frequent green (5G 6/2 or 5/2) or light brownish gray (2.5Y 7/2 to 6/2) patches.

Rare laminations in almost all of the core, but frequent (and wispy) below 252.0 m (in Core Catcher).

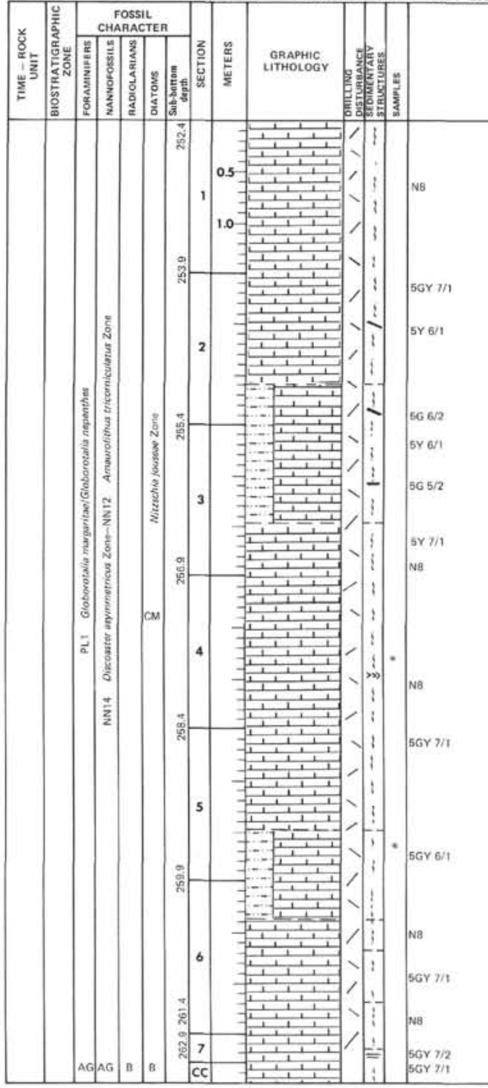
SMEAR SLIDE SUMMARY (%)

	4, 115	5, 115
	D	D
Composition:		
Heavy minerals	TR	–
Clay	35	8
Micronodules	–	TR
Carbonate unspec.	TR	–
Foraminifers	3	4
Calc. nannofossils	60	86
Diatoms	2	2
Sponge spicules	TR	TR
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	4, 30–31
Organic carbon	–
Carbonate	66

SITE 611 HOLE C CORE 29 CORED INTERVAL 252.4–262.0 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in between blocks.

NANNOFOSSIL CHALK, very light gray or greenish gray (N8 to 5Y 7/1 to 5GY 7/1); darker MARLY intervals (5Y 6/1 or 5GY 6/1); transitions between both types very gradational.

Frequent gray (5Y 7/1) or green (5G 7/2 to 5G 5/2) patches.

Rare green (5G 6/1 to 5/2) laminations.

Deformed *Zoophycos* burrow at 257.85 m.

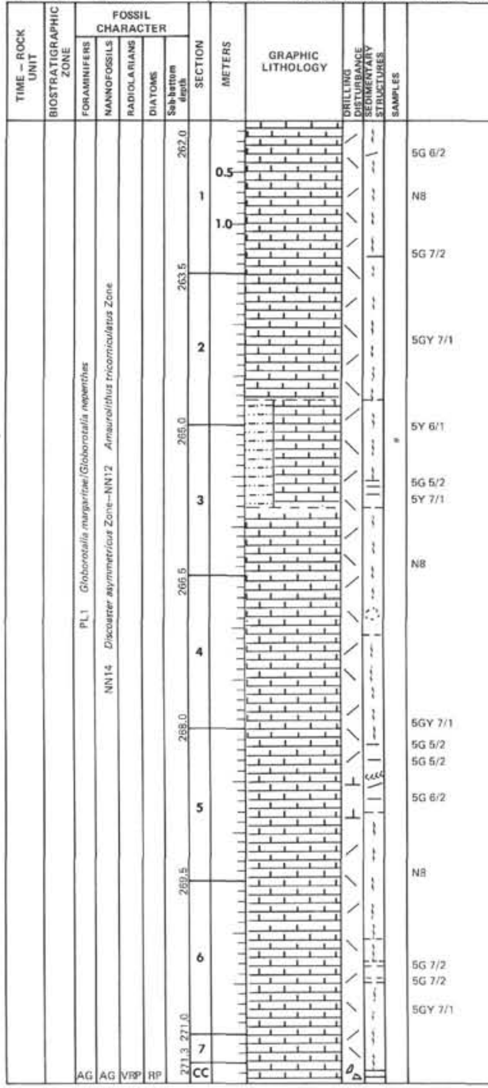
SMEAR SLIDE SUMMARY (%)

	4, 83	5, 119
	D	M
Composition:		
Heavy minerals	–	TR
Clay	6	25
Micronodules	TR	–
Carbonate unspec.	TR	1
Foraminifers	3	7
Calc. nannofossils	91	61
Diatoms	TR	–
Sponge spicules	TR	TR
Silicoflagellates	–	TR

ORGANIC CARBON AND CARBONATE (%)

	4, 85–86
Organic carbon	–
Carbonate	84

SITE 611 HOLE C CORE 30 CORED INTERVAL 262.0–271.6 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in between blocks. Hard blocks get larger towards base.

NANNOFOSSIL CHALK, very light gray (N8) to greenish gray (5GY 7/1); darker (5Y 6/1) MARLY intervals.

Frequent light brownish gray (2.5Y 7/2 to 6/2) burrow patches, and green (5G 7/2 to 6/2) disrupted laminations.

Rare green (5G 7/2 to 5/2) laminations.

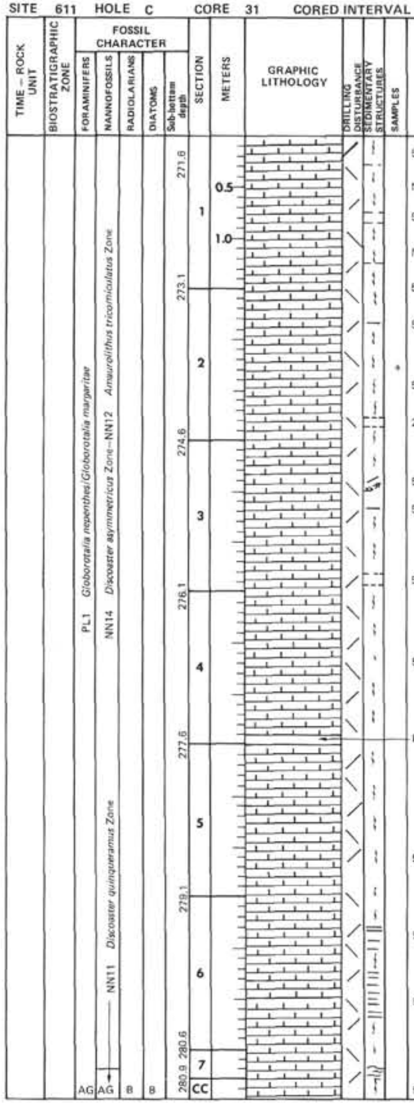
SMEAR SLIDE SUMMARY (%)

	3, 18	4, 12
	D	D
Composition:		
Feldspar	TR	–
Heavy minerals	–	TR
Clay	20	5
Micronodules	TR	–
Carbonate unspec.	1	TR
Foraminifers	3	4
Calc. nannofossils	73	91
Diatoms	3	–
Radiolarians	TR	–
Sponge spicules	TR	–
Silicoflagellates	TR	–

ORGANIC CARBON AND CARBONATE (%)

	3, 17–18
Organic carbon	–
Carbonate	64

SITE 611 HOLE C CORE 31 CORED INTERVAL 271.6–281.2 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in between blocks.

NANNOFOSSIL CHALK, very light gray to greenish gray (N8 to 5GY 7/1).

Common light brownish gray (2.5Y 7/2) burrow mottling.

279.3 to 280.3 m: common green (5G 6/2) diffuse or broken-up laminations.

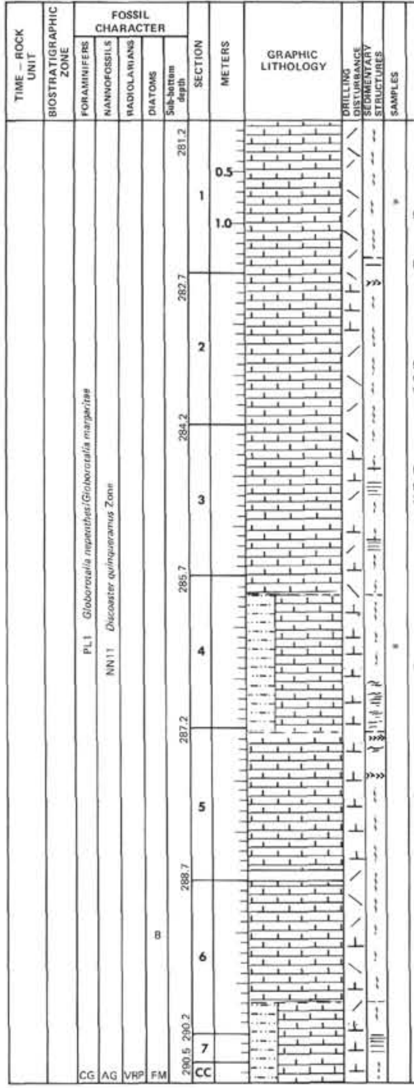
SMEAR SLIDE SUMMARY (%)

	2, 80
	D
Composition:	
Quartz	TR
Heavy minerals	TR
Clay	25
Carbonate unspec.	TR
Foraminifers	2
Calc. nannofossils	70
Diatoms	3
Radiolarians	TR
Sponge spicules	TR
Silicoflagellates	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 80–81
Organic carbon	–
Carbonate	60

SITE 611 HOLE C CORE 32 CORED INTERVAL 281.2–290.8 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; hard blocks become larger under 284.0 m; flow-in between blocks.

NANNOFOSSIL CHALK, very light gray to greenish gray (N8 or 5GY 7/1), or SLIGHTLY MARLY and darker (5Y 5/1), mottled by frequent brownish gray (2.5Y 7/2) patches and more or less disrupted greenish (5GY 7/2) laminations.

On marly intervals: green (5G 5/2 to 4/2) wispy laminations.

Zoophycos burrows.

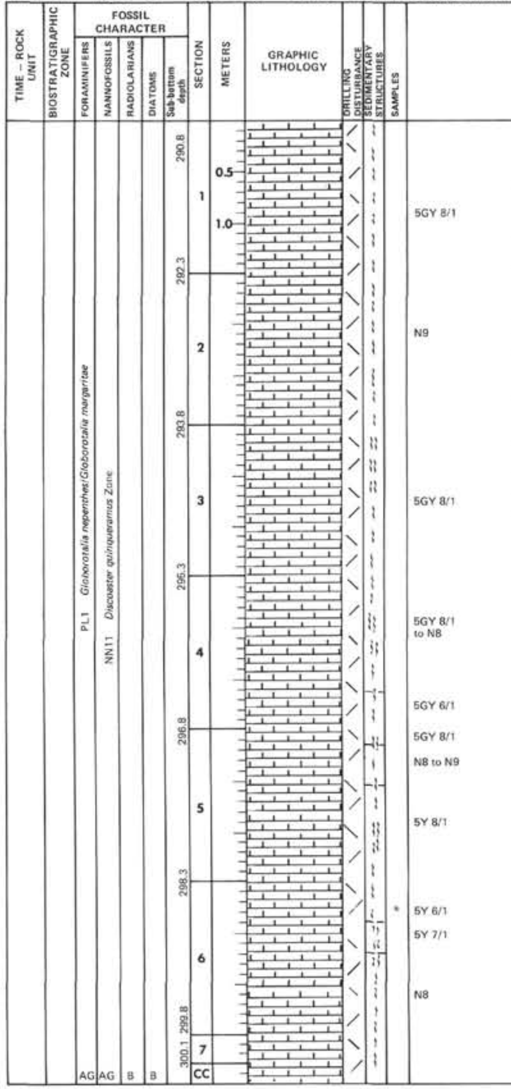
SMEAR SLIDE SUMMARY (%)

	1, 72	4, 70
	D	D
Composition:		
Feldspar	–	TR
Heavy minerals	–	TR
Clay	8	25
Micronodules	–	TR
Carbonate unspec.	TR	–
Foraminifers	5	2
Calc. nannofossils	87	72
Diatoms	TR	1
Sponge spicules	TR	TR

ORGANIC CARBON AND CARBONATE (%)

	1, 70–71
Organic carbon	–
Carbonate	83

SITE 611 HOLE C CORE 33 CORED INTERVAL 290.8–300.4 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in between blocks.

NANNOFOSSIL CHALK, very light gray to gray (N8 or 5Y 8/1 to 6/1), or greenish gray (5GY 8/1).

Frequent gray (5Y 7/1) burrow mottles and green (5G 5/2) wispy laminations.

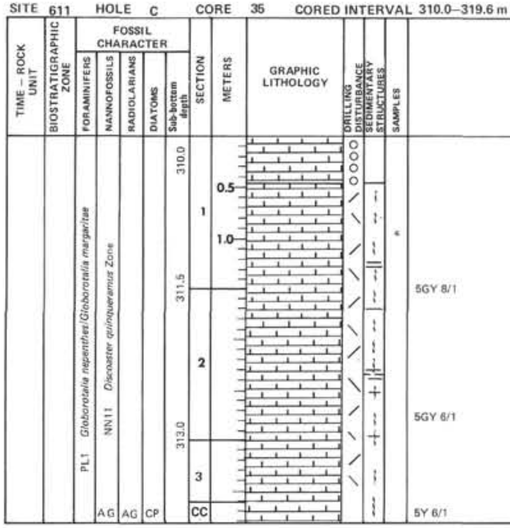
SMEAR SLIDE SUMMARY (%)

	6, 35
	M
Composition:	
Quartz	1
Mica	TR
Heavy minerals	4
Foraminifers	5
Calc. nannofossils	85
Diatoms	1
Radiolarians	TR
Sponge spicules	2
Silicoflagellates	2

ORGANIC CARBON AND CARBONATE (%)

	6, 35–36
Organic carbon	–
Carbonate	75

SITE 611 HOLE C CORE 35 CORED INTERVAL 310.0–319.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, very light greenish gray to greenish gray (5GY 8/1 to 6/1). Very fragmented by drilling; flow-in. Green and brown patches and mottles throughout. Green laminations.

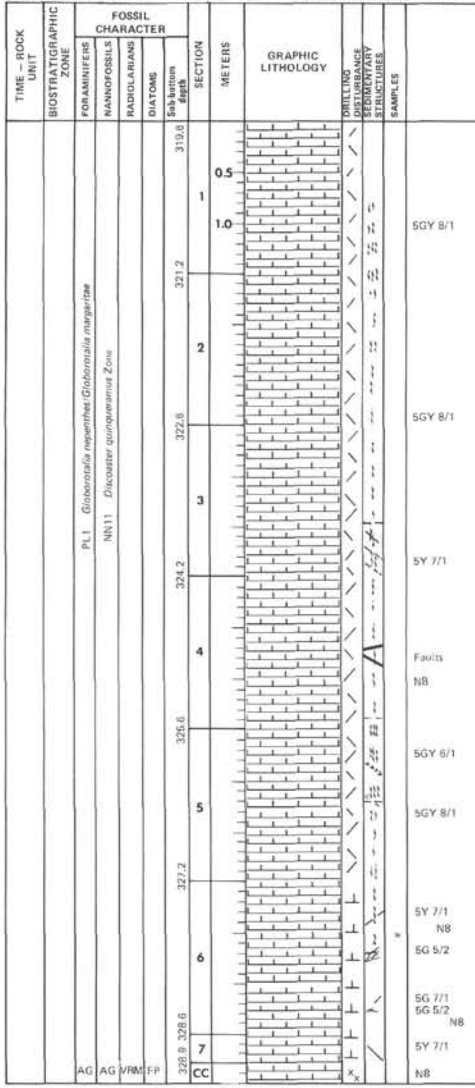
SMEAR SLIDE SUMMARY (%)

	1, 90
	D
Composition:	
Quartz	10
Carbonate unspec.	4
Foraminifers	1
Calc. nannofossils	85
Sponge spicules	TR

ORGANIC CARBON AND CARBONATE (%)

	1, 90–91
Organic carbon	–
Carbonate	67

SITE 611 HOLE C CORE 36 CORED INTERVAL 319.6–329.2 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling, with flow-in between blocks.

NANNOFOSSIL CHALK, light gray (N8 to 5Y 7/1), or light greenish gray (5GY 8/1 to 6/1) with frequent gray (5Y 7/1) burrow mottles and green (5G 5/2) irregular wispy laminations.

323.5 to 324.2 m: most mottles appear flattened and tilted (~15°).

323.7 m: first fault with SLICKENSIDES.

From 325.6 m: mottles and green laminations are tilted (45–55°) and cross-cut by *zoophycos* burrows. Green laminae frequent 326.7 to 327.2 m (with thin dark microfinures), rare under 327.2 m.

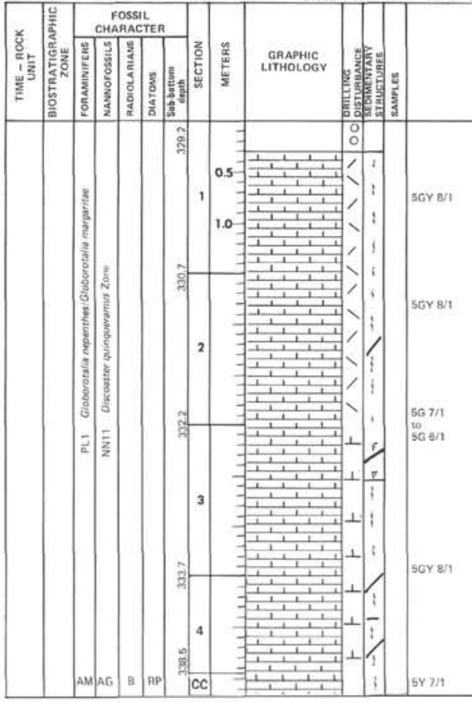
SMEAR SLIDE SUMMARY (%)

	6, 47
Composition:	
Quartz	12
Heavy minerals	3
Foraminifers	5
Calc. nannofossils	80

ORGANIC CARBON AND CARBONATE (%)

	6, 46–47
Organic carbon	–
Carbonate	75

SITE 611 HOLE C CORE 37 CORED INTERVAL 329.2–338.8 m



LITHOLOGIC DESCRIPTION

Fragmented by drilling; flow-in between blocks.

NANNOFOSSIL CHALK, very light greenish gray (5G 7/1 or 5GY 8/1).

Common green and brown mottles and irregularly-shaped burrows.

Rare inclined (70 to 80°) laminations.

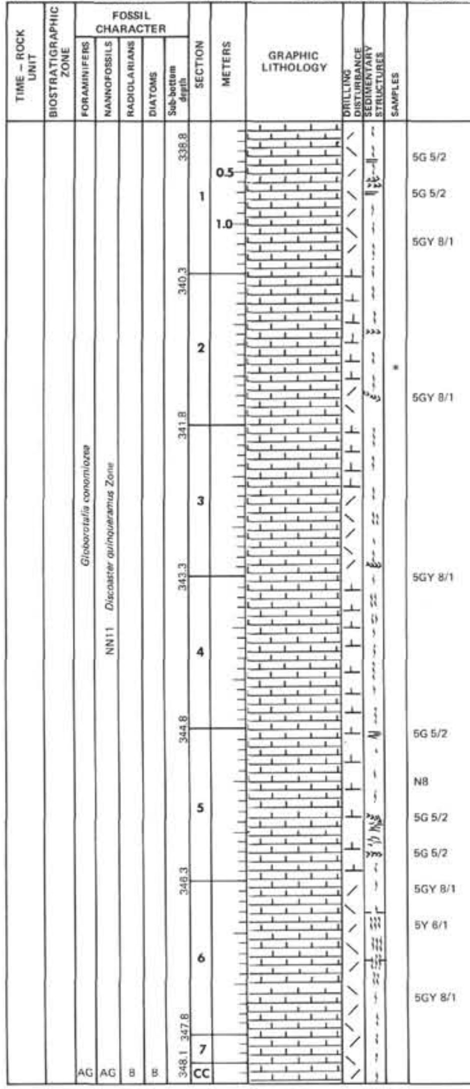
332.71 m: fault with slickensides; different sediment colors either side; general bedding inclined (~80°) either side.

334.12 m: horizontal lamination.

ORGANIC CARBON AND CARBONATE (%)

	4, 26–27
Organic carbon	–
Carbonate	80

SITE 611 HOLE C CORE 38 CORED INTERVAL 338.8–348.4 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flow-in between blocks.

NANNOFOSSIL CHALK, very light greenish gray to greenish gray (5GY 8/1 to 6/1).

Gray (5Y 7/1) burrow mottles; common between 346.7 and 347.4 m.

Green (5G 5/2) wispy laminations; common between 346.4 and 346.9 m. 347.8 to 348.1 m: common diffuse green (5G 5/2 or 5GY 7/2) broke-up laminations.

Zoophycos burrows.

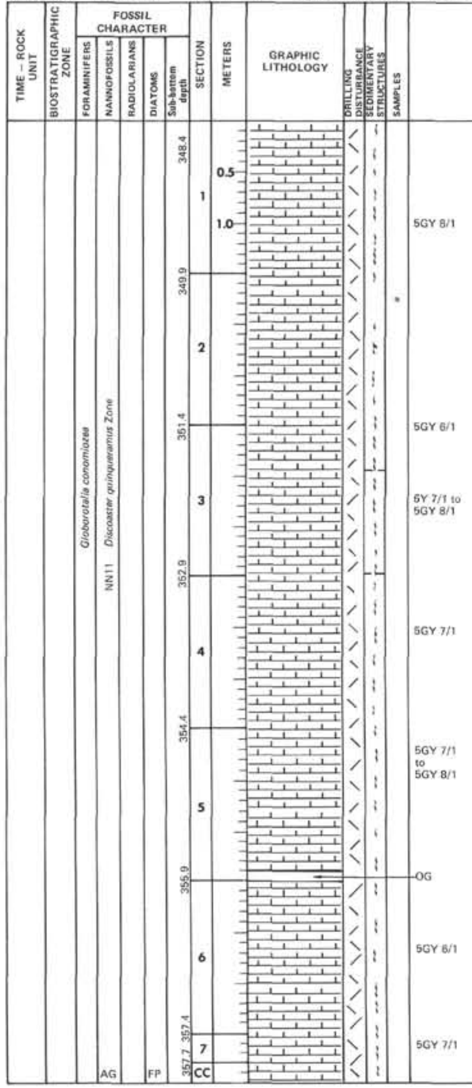
SMEAR SLIDE SUMMARY (%)

	2, 97
	D
Composition:	
Quartz	5
Foraminifers	5
Calc. nannofossils	90
Sponge spicules	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 97–98
Organic carbon	–
Carbonate	67

SITE 611 HOLE C CORE 39 CORED INTERVAL 348.4–358.0 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; only ~ 40% recovery from 348.4 to 349.72 m; flowage.

NANNOFOSSIL CHALK, very light greenish gray to greenish gray (5GY 8/1 to 6/1).

Common gray (5Y 7/1) and green (5G 5/2) mottles.

350.10 to 350.20 m: dark green (5G 4/2) halos to light green burrows.

Zoophycos.

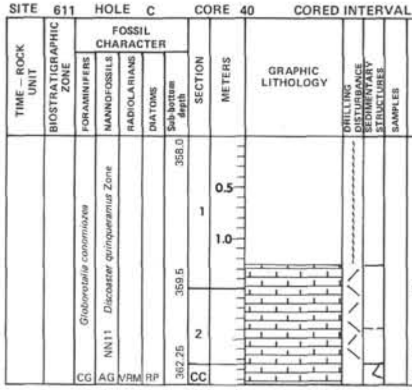
SMEAR SLIDE SUMMARY (%)

	2, 40
	D
Composition:	
Quartz	10
Mica	TR
Heavy minerals	5
Foraminifers	5
Calc. nannofossils	80
Diatoms	TR
Radiolarians	TR

ORGANIC CARBON AND CARBONATE (%)

	2, 40–41
Organic carbon	–
Carbonate	32

SITE 611 HOLE C CORE 40 CORED INTERVAL 358.0–367.6 m



LITHOLOGIC DESCRIPTION

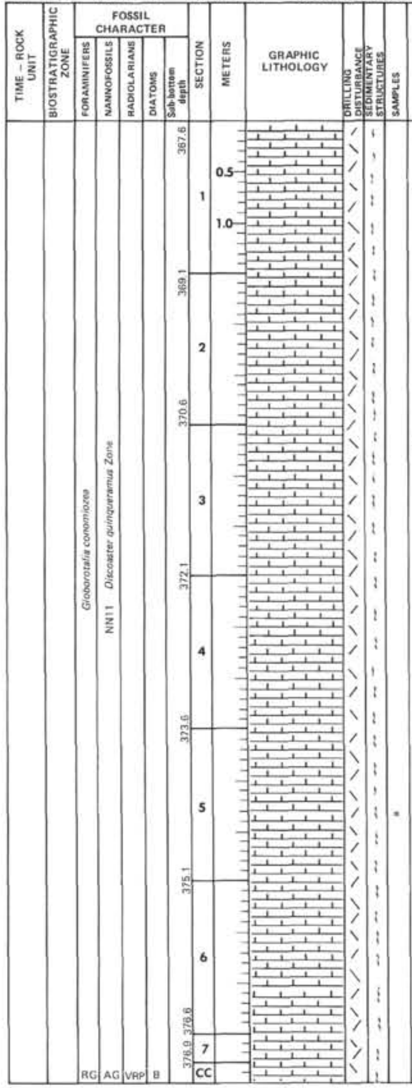
358.0 to 359.25 m: wash-down; including a 7 cm gneiss fragment.

359.25 to base: very fragmented, and extensive flowage.

NANNOFOSSIL CHALK, very light greenish gray to greenish gray (5GY 8/1 to 6/1).

Minor gray (5Y 7/1) mottling.

SITE 611 HOLE C CORE 41 CORED INTERVAL 367.6–377.2 m



LITHOLOGIC DESCRIPTION

Very fragmented, with important flowage between blocks; ~40% recovery.

NANNOFOSSIL CHALK, very light greenish gray (5GY 8/1 to 7/1).

Common green (5G 7/2), light brownish gray (10YR 7/1) or light gray (N7 – pyritic), mottling.

Rare vague horizontal green diffuse laminations.

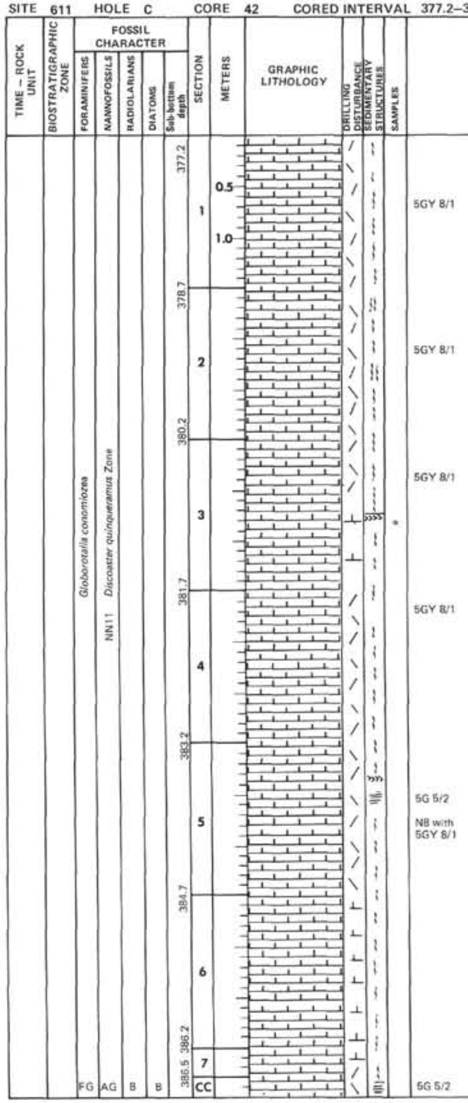
SMEAR SLIDE SUMMARY (%)

	5, 77
	D
Composition:	
Quartz	5
Clay	5
Volcanic glass	TR
Carbonate unspec.	TR
Foraminifers	2
Calc. nannofossils	88
Diatoms Radiolarians Sponge spicules Silicoflagellates	1

ORGANIC CARBON AND CARBONATE (%)

	5, 76–77
Organic carbon	–
Carbonate	69

SITE 611 HOLE C CORE 42 CORED INTERVAL 377.2–386.18 m



LITHOLOGIC DESCRIPTION

Very fragmented by drilling; flowage between blocks.

NANNOFOSSIL CHALK, very light gray (*N8*) or very light greenish gray (5GY 8/1).

Common subhorizontal light brownish gray (10YR 7/1) burrow mottles; some *zoophycos*.

Rare wispy green (5G 5/2) laminations.

390.50 m: fault with slickensides; upper sediment lightly darker than lower sediment.

395.91 m: horizontal burrow crosscutting vertical burrow.

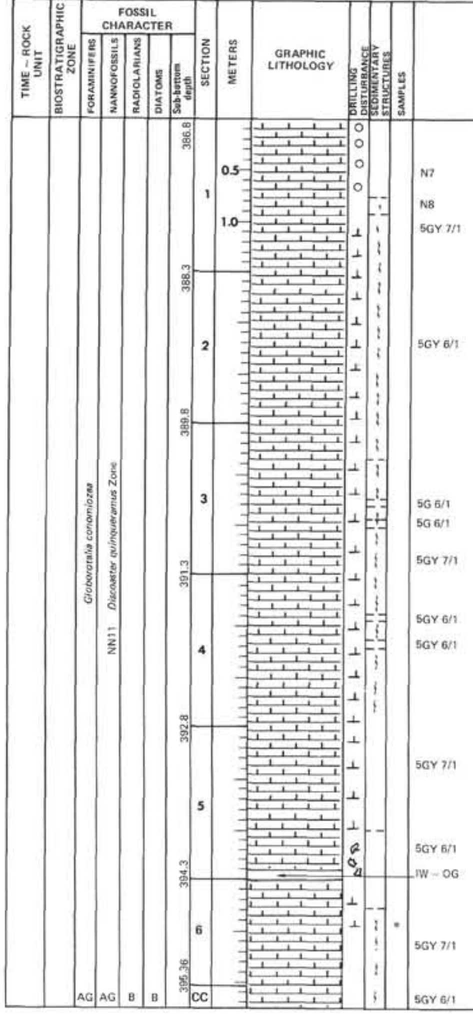
SMEAR SLIDE SUMMARY (%)

	3, 80
	D
Composition:	
Quartz	5
Mica	TR
Heavy minerals	5
Foraminifers	5
Calc. nannofossils	85
Diatoms	TR
Sponge spicules	TR

ORGANIC CARBON AND CARBONATE (%)

	3, 80–81
Organic carbon	–
Carbonate	74

SITE 611 HOLE C CORE 43 CORED INTERVAL 386.8–396.4 m



LITHOLOGIC DESCRIPTION

Fragmented by drilling; flowage between hard fragments.

NANNOFOSSIL CHALK, very light gray or greenish gray (N8 to N7; 5GY 7/1 to 6/1).

Common gray (10YR 7/1) burrow mottles and green (5G 7/2) mottles.

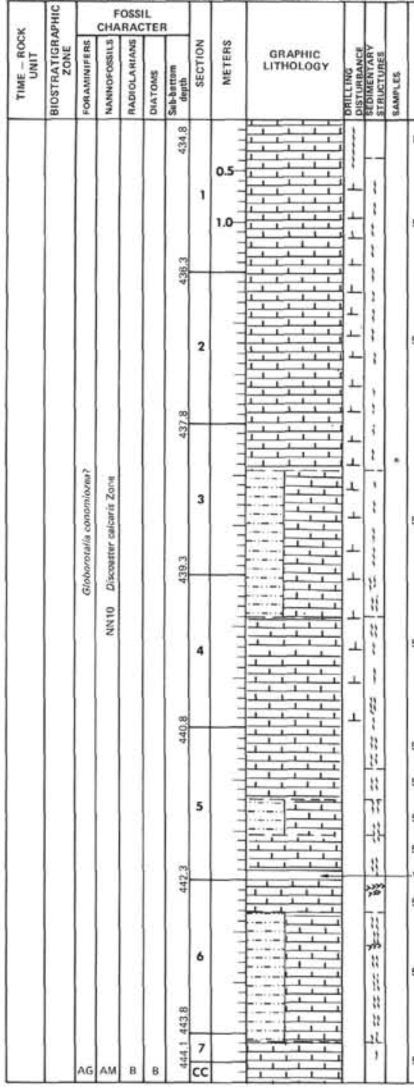
SMEAR SLIDE SUMMARY (%)

	6, 47
	D
Composition:	
Heavy minerals	TR
Clay	6
Carbonate unspec.	1
Calc. nannofossils	93

ORGANIC CARBON AND CARBONATE (%)

	6, 46–47
Organic carbon	–
Carbonate	69

SITE 611 HOLE C CORE 44 CORED INTERVAL 434.8–444.4 m



LITHOLOGIC DESCRIPTION

N6
5GY 7/1
5GY 7/1
5GY 6/1
5GY 7/1
5GY 6/1
5GY 7/1
5GY 6/1
5GY 7/1
Void
5GY 7/1
5GY 6/1
5GY 7/1

Fragmented, but hard fragments length increases towards base, and flowage decreases.

NANNOFOSSIL CHALK, light greenish gray (5GY 7/1) (5GY 6/1).

Common light brownish gray (2.5Y 6/2) burrows and mottles.

Below 439.3 m: increasing burrowing; gray (5Y 6/1) and green (5G 7/2) mottles.

Zoophycos.

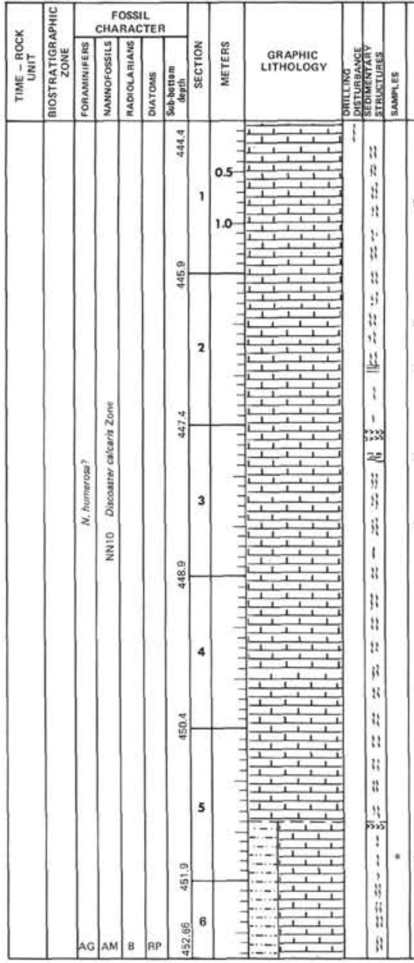
SMEAR SLIDE SUMMARY (%)

	3, 45
	D
Composition:	
Heavy minerals	TR
Clay	10
Carbonate unspec.	1
Foraminifers	2
Calc. nannofossils	87

ORGANIC CARBON AND CARBONATE (%)

	3, 41–42
Organic carbon	—
Carbonate	71

SITE 611 HOLE C CORE 45 CORED INTERVAL 444.4–454.0 m



LITHOLOGIC DESCRIPTION

5GY 6/1
5GY 6/1
2.5Y 6/2
2.5Y 6/2
5GY 6/1
5GY 6/1
5GY 5/1

NANNOFOSSIL CHALK, light greenish gray (5GY 6/1) becoming very gradually darker (greenish gray 5GY 5/1) and MARLY towards base.

Some slightly darker intervals in the upper part of core are also probably marly, but changes are too gradual to be noted.

Abundant burrowing: green (5G 6/2), light brownish gray (2.5Y 7/2 to 6/2) and gray (N5–N6) mottles.

Zoophycos.

~446.8 m: thin brownish (2.5Y 6/2) laminations.

~447.7 m: brownish (2.5Y 6/2) wavy bedding.

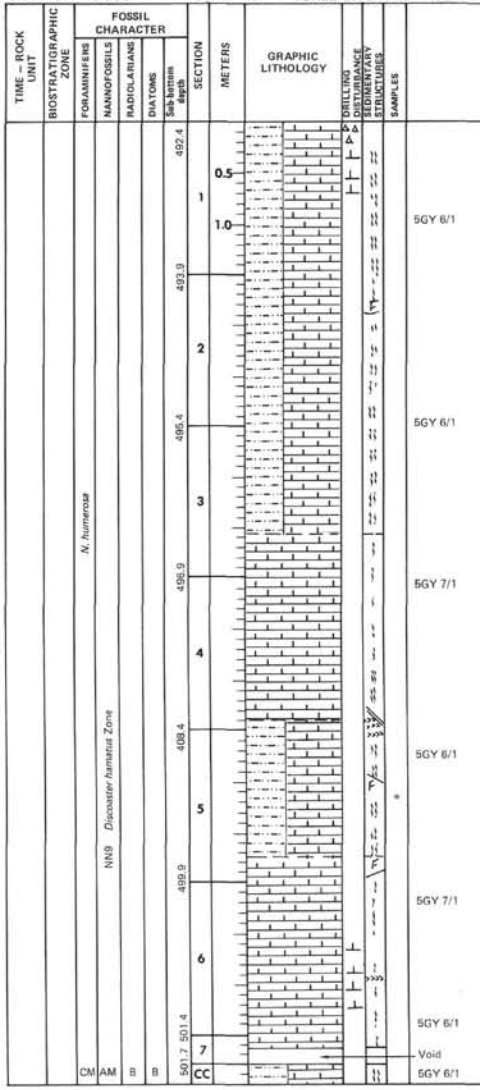
SMEAR SLIDE SUMMARY (%)

	5, 135
	D
Composition:	
Clay	35
Carbonate unspec.	1
Foraminifers	4
Calc. nannofossils	60

ORGANIC CARBON AND CARBONATE (%)

	3, 35–36
Organic carbon	—
Carbonate	66

SITE 611 HOLE C CORE 46 CORED INTERVAL 492.4–502.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK to MARLY NANNOFOSSIL CHALK, light greenish gray (5GY 7/1) to greenish gray (5GY 6/1).

Abundant burrowing: green (5G 6/2), light brownish gray (2.5Y 7/2 to 6/2) and gray (N6) mottles.

Zoophycos.

Some faults with slickensides.

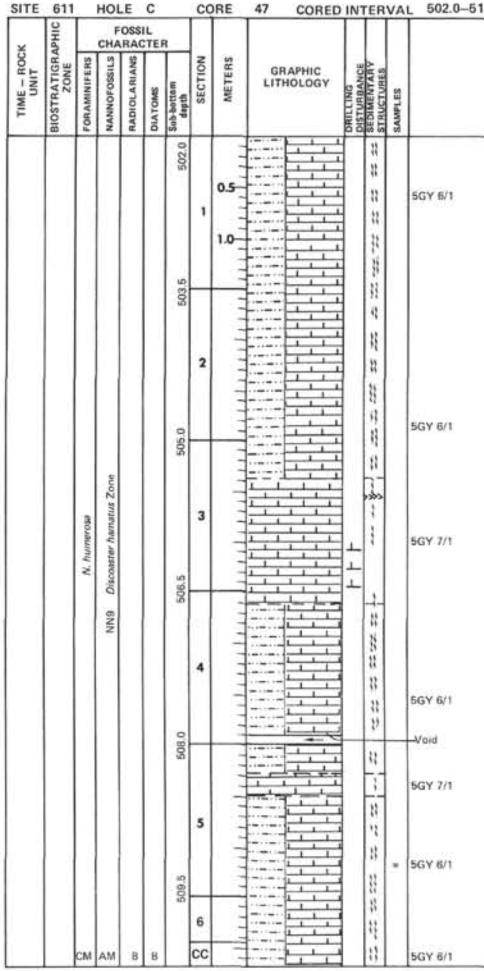
SMEAR SLIDE SUMMARY (%)

	5, 70
Composition:	
Quartz	TR
Feldspar	TR
Heavy minerals	1
Clay	45
Carbonate unspec.	1
Calc. nannofossils	53

ORGANIC CARBON AND CARBONATE (%)

	5, 70–71
Organic carbon	–
Carbonate	63

SITE 611 HOLE C CORE 47 CORED INTERVAL 502.0–511.6 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK to MARLY NANNOFOSSIL CHALK, light greenish gray (5GY 7/1) to greenish gray (5GY 6/1).

Abundant burrowing: gray (N5) and mostly light brownish gray (10YR 6/2) mottles.

Rare *zoophycos.*

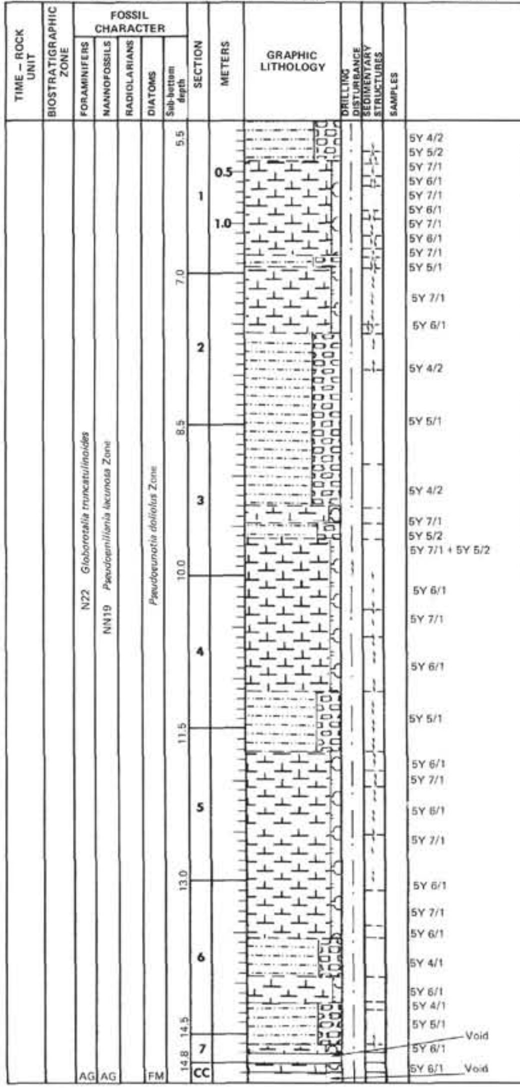
SMEAR SLIDE SUMMARY (%)

	5, 130
Composition:	
Heavy minerals	TR
Clay	45
Micronodules	TR
Carbonate unspec.	TR
Calc. nannofossils	55

ORGANIC CARBON AND CARBONATE (%)

	3, 80–81
Organic carbon	–
Carbonate	62

SITE 611 HOLE D CORE 1 CORED INTERVAL 5.5–15.1 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, olive gray (5Y 5/2 to 4/2); and SILICEOUS NANNOFOSSIL OOZE, light gray (5Y 7/1), darker gray (5Y 6/1), probably marly intervals.

Abundant granule-sized dropstones in calcareous mud intervals. 14.20 to 14.28 m: tuff clasts.

Siliceous nannofossil ooze generally mottled.

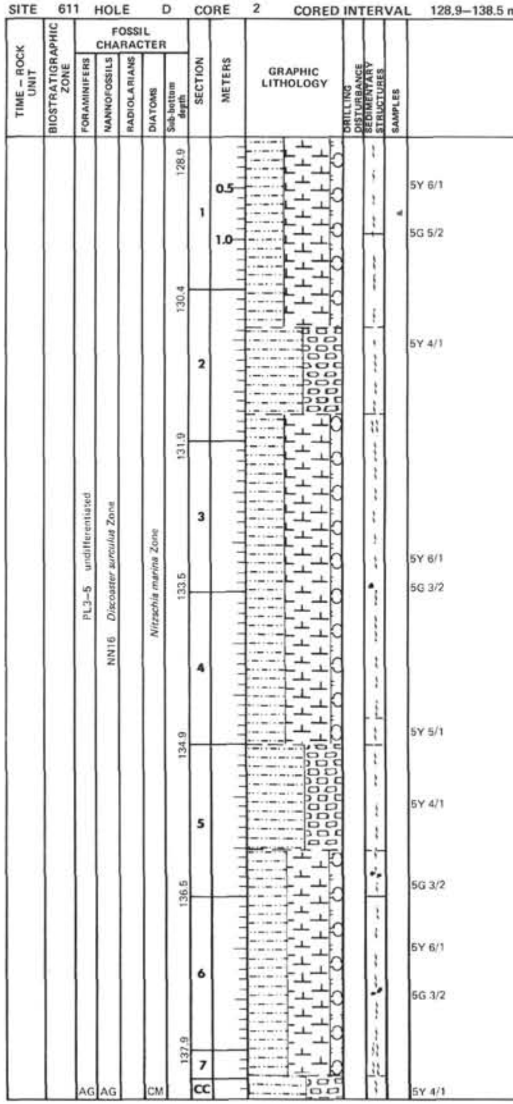
Pyritized burrow: 12.62 to 12.64 m.

7.55 m: limestone dropstone.

SMEAR SLIDE SUMMARY (%)

	2, 18 D	3, 18 D
Composition:		
Quartz	5	30
Heavy minerals	–	5
Clay	–	30
Volcanic glass	–	5
Carbonate unspec.	10	20
Foraminifers	2	TR
Calc. nannofossils	83	10
Diatoms	2	–
Sponge spicules	8	–

SITE 611 HOLE D CORE 2 CORED INTERVAL 128.9–138.5 m



LITHOLOGIC DESCRIPTION

MARLY SILICEOUS NANNOFOSSIL OOZE, light gray to gray (5Y 6/1 to 5Y 5/1), alternating with thinner intervals of CALCAREOUS MUD, dark gray (5Y 4/1).

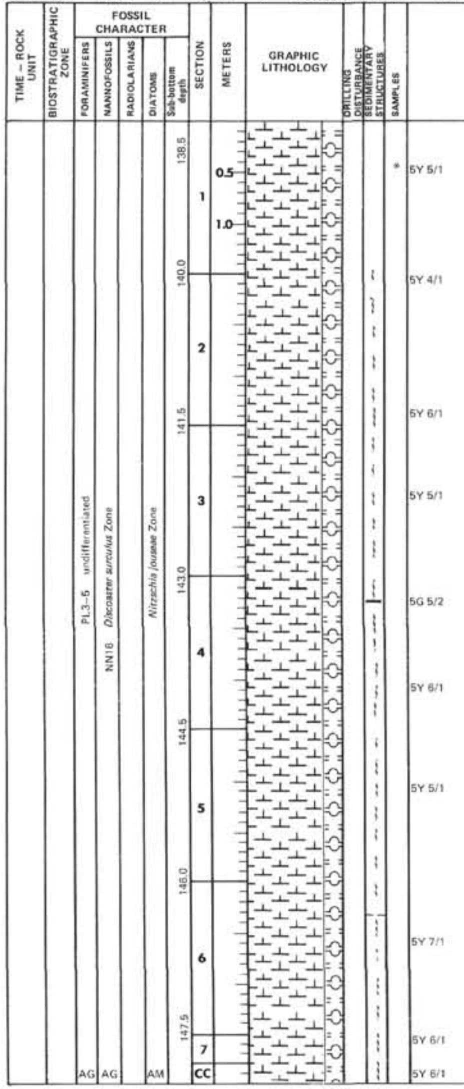
Common green (5G 5/2) and olive gray (5Y 6/2) mottles and laminations; less common on calcareous mud.

Rare green (5G 3/2) small patches of glauconite.

SMEAR SLIDE SUMMARY (%)

	1, 75 D
Composition:	
Quartz	30
Feldspar	5
Mica	TR
Heavy minerals	5
Foraminifers	5
Calc. nannofossils	42
Diatoms	5
Radiolarians	TR
Sponge spicules	8
Silicoflagellates	TR

SITE 611 HOLE D CORE 3 CORED INTERVAL 138.5–148.1 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE, light gray to gray (5Y 7/1 to 5/1). Darker (5Y 4/1) interval probably marly, but changes of color very gradational.

Common green mottling.

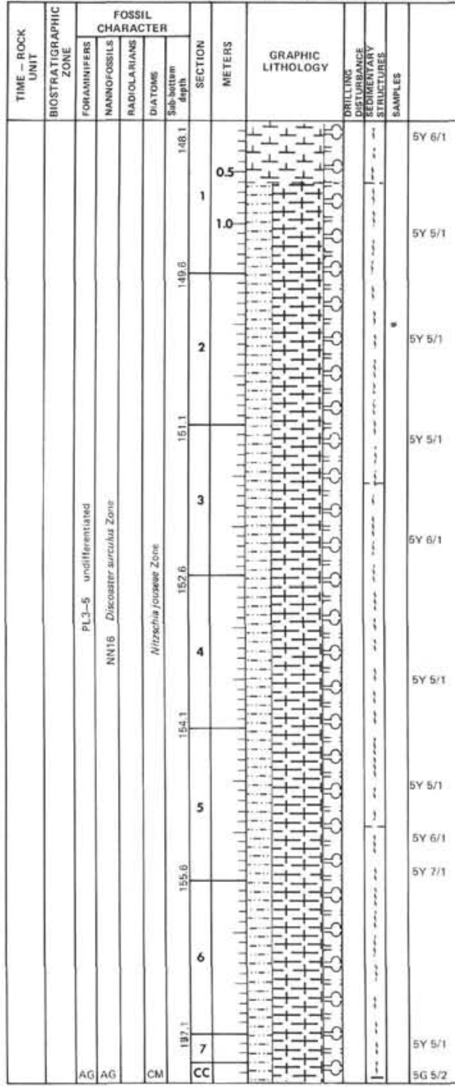
146.56 m: very dark green haloed burrow.

147.77 m: small (0.5 cm) pyritic patch.

SMEAR SLIDE SUMMARY (%)

	1, 50 D
Composition:	
Clay	5
Carbonate unspec.	2
Foraminifers	3
Calc. nannofossils	68
Diatoms	10
Radiolarians	2
Sponge spicules	10

SITE 611 HOLE D CORE 4 CORED INTERVAL 148.1–157.7 m



LITHOLOGIC DESCRIPTION

MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, light gray to gray (5Y 7/1 to 5/1).

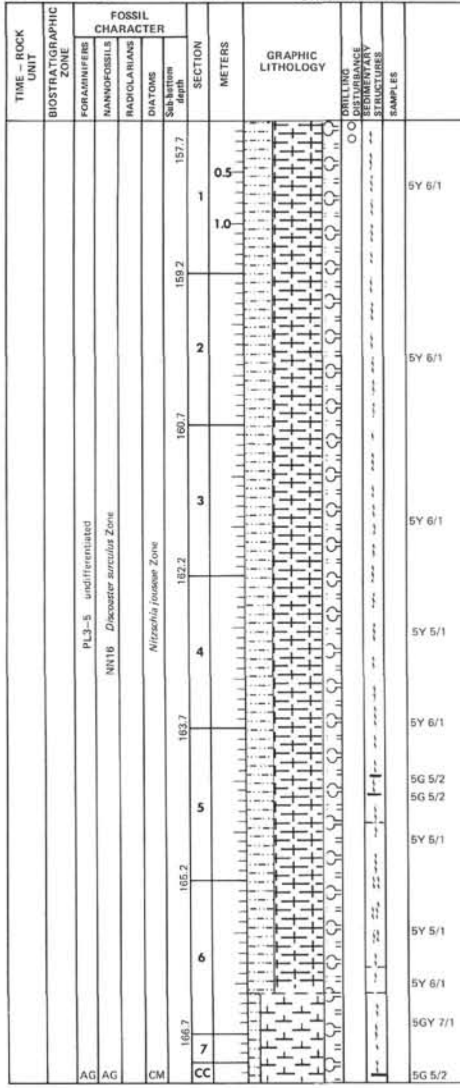
Very gradational changes of color, probably in relation with slight variations of detrital amount.

General green mottling and diffuse green patches, but no real laminations.

SMEAR SLIDE SUMMARY (%)

	2, 50 D
Composition:	
Quartz	20
Mica	TR
Heavy minerals	10
Clay	5
Foraminifers	15
Calc. nannofossils	35
Diatoms	8
Sponge spicules	7

SITE 611 HOLE D CORE 5 CORED INTERVAL 157.7–167.3 m



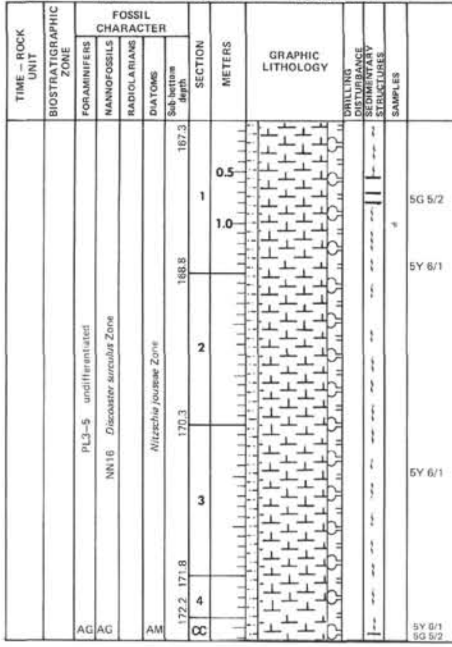
LITHOLOGIC DESCRIPTION

MARLY SILICEOUS FORAMINIFERAL NANNOFOSSIL OOZE, gray (5Y 5/1 to 6/1).

Below 166.3 m: SILICEOUS NANNOFOSSIL OOZE, light greenish gray (5GY 7/1).

Common olive gray (5Y 6/2) and green (5G 5/2) mottling. Rare diffuse green (5G 5/2) laminations. Rare small green (5G 3/2) patches of glauconite.

SITE 611 HOLE D CORE 6 CORED INTERVAL 167.3–172.3 m



LITHOLOGIC DESCRIPTION

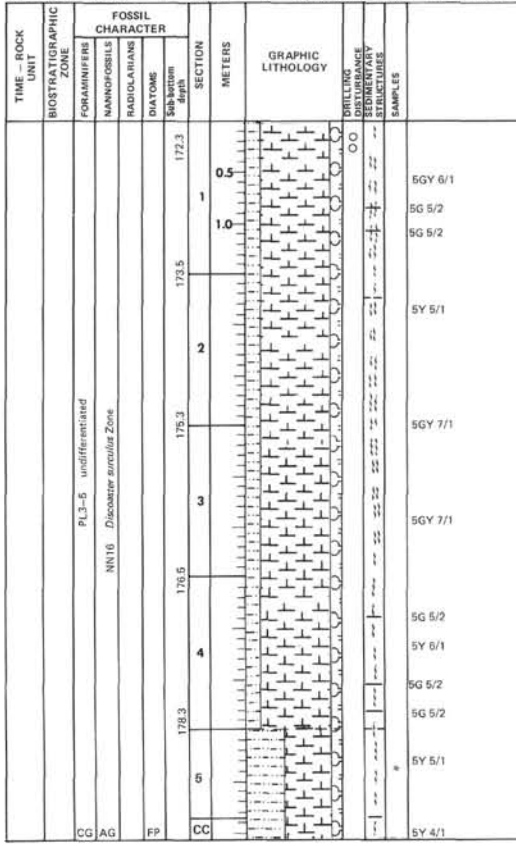
SILICEOUS NANNOFOSSIL OOZE, gray (5Y 6/1).

Mottling: frequent diffuse green patches, tending towards laminae. Rare laminations, green (5G 5/2).

SMEAR SLIDE SUMMARY (%)

	1, 100 D
Composition:	
Quartz	10
Clay	5
Volcanic glass (brown)	TR
Carbonate unspec.	5
Foraminifers	1
Calc. nannofossils	61
Diatoms	5
Radiolarians	TR
Sponge spicules	8

SITE 611 HOLE D CORE 7 CORED INTERVAL 172.3–176.9 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE, light greenish gray to gray (5GY 7/1 to 5Y 6/1).

Below 178.3 m: MARLY SILICEOUS NANNOFOSSIL OOZE, gray to dark gray (5Y 5/1 to 4/1).

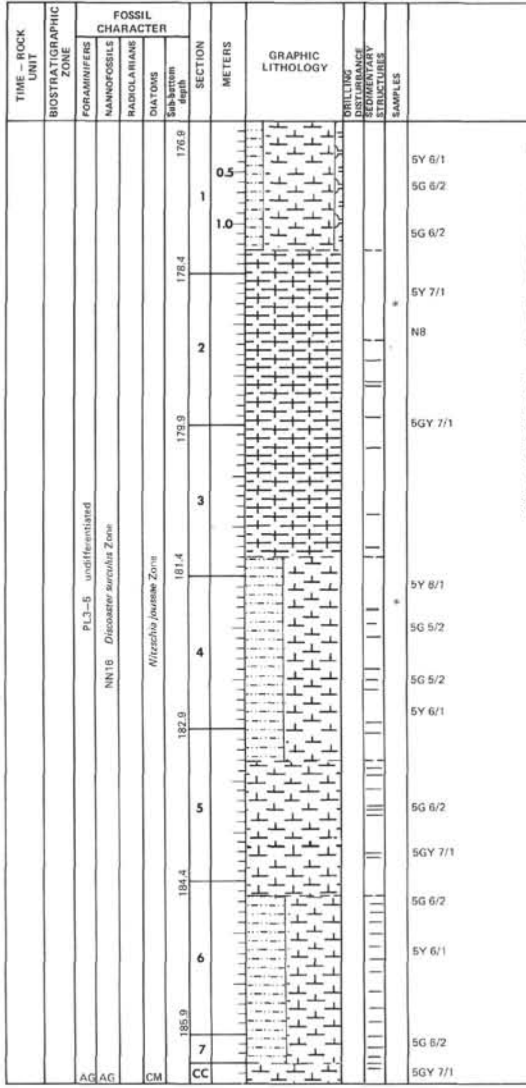
Frequent diffuse green patches (almost laminations). Rare real green (5G 5/2) laminations.

Common olive gray mottles.

SMEAR SLIDE SUMMARY (%)

	5, 37 D
Texture:	
Sand	–
Silt	15
Clay	85
Composition:	
Quartz	40
Mica	1
Foraminifers	TR
Calc. nannofossils	46
Diatoms	4
Radiolarians	2
Sponge spicules	7

SITE 611 HOLE D CORE 8 CORED INTERVAL 176.9–186.5 m



LITHOLOGIC DESCRIPTION

176.9 to 178.15 m: SILICEOUS NANNOFOSSIL OOZE, gray (5Y 6/1).

178.15 to 181.2 m: FORAMINIFERAL NANNOFOSSIL OOZE, light gray to light greenish gray (5Y 7/1 to 5GY 7/1).

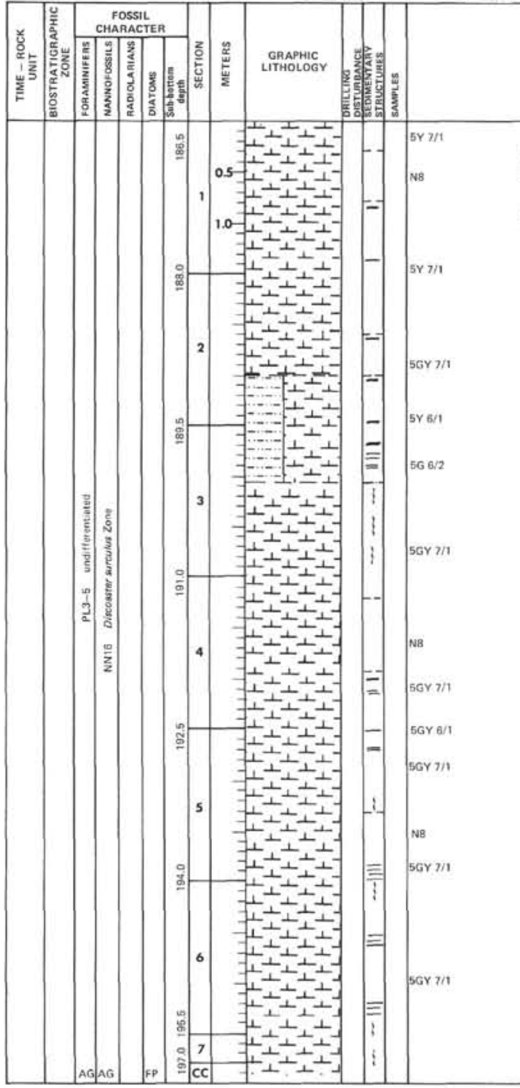
Below 181.2 m: alternating:
MARLY NANNOFOSSIL OOZE, gray (5Y 6/1); and NANNOFOSSIL OOZE, light greenish gray (5GY 7/1), mottled with faint burrows, light olive gray (2.5Y 7/2).

On the whole core: frequent green (5G 5/2 or 6/2) laminations or patches.

SMEAR SLIDE SUMMARY (%)

	2, 30 D	4, 30 D
Composition:		
Quartz	TR	–
Heavy minerals	TR	1
Clay	5	35
Micronodules	–	TR
Foraminifers	13	4
Calc. nannofossils	75	66
Diatoms	2	4
Radiolarians	TR	–
Sponge spicules	TR	–
Silicoflagellates	TR	TR

SITE 611 HOLE D CORE 9 CORED INTERVAL 186.5–196.1 m

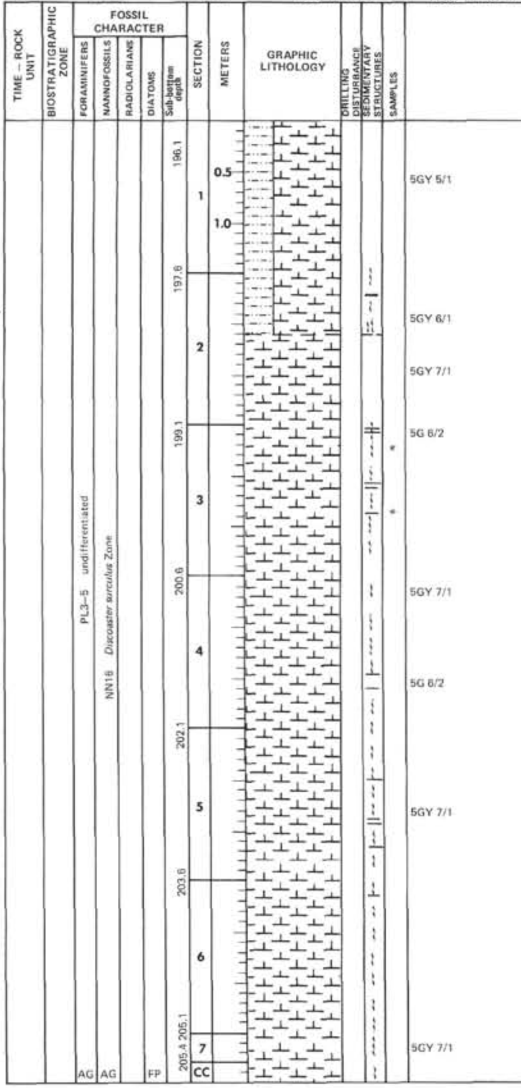


LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light gray to light greenish gray (N8 or 5Y 7/1 to 5GY 7/1); rare darker gray (5Y 6/1 or 5GY 6/1) MARLY intervals.

Common green (5G 6/2) LAMINATIONS or patches; rare olive gray (2.5Y 7/2) burrow mottles.

SITE 611 HOLE D CORE 10 CORED INTERVAL 196.1–205.7 m



LITHOLOGIC DESCRIPTION

196.1 to 198.2 m: MARLY NANNOFOSSIL OOZE, greenish gray (5GY 5/1 to 6/1).

Below 198.2 m: NANNOFOSSIL OOZE, very light greenish gray (5GY 7/1).

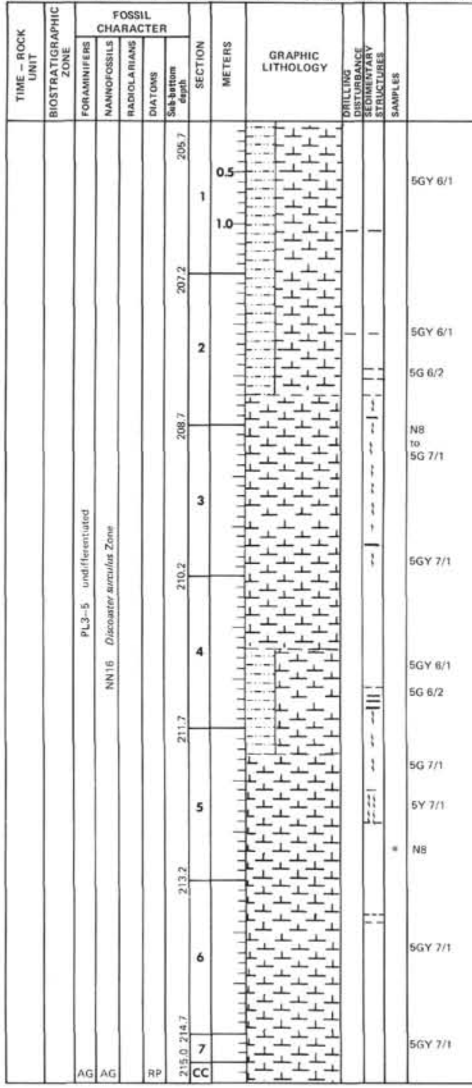
Rare distinct green (5G 6/2) laminations; but frequent green (5G 6/2) patches and common olive gray (2.5Y 7/2) burrow mottles.

Rare chalky intervals.

SMEAR SLIDE SUMMARY (%)

	3, 22 D	3, 80 D
Composition:		
Quartz	TR	–
Clay	4	10
Micronodules	TR	TR
Carbonate unspec.	TR	–
Foraminifers	6	6
Calc. nannofossils	87	84
Diatoms	3	TR
Sponge spicules	TR	TR
Silicoflagellates	TR	–

SITE 611 HOLE D CORE 11 CORED INTERVAL 205.7–215.3 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, very light gray or greenish gray (N8 or 5G 7/1 to 5GY 7/1) to MARLY NANNOFOSSIL OOZE, greenish gray (5GY 6/1).

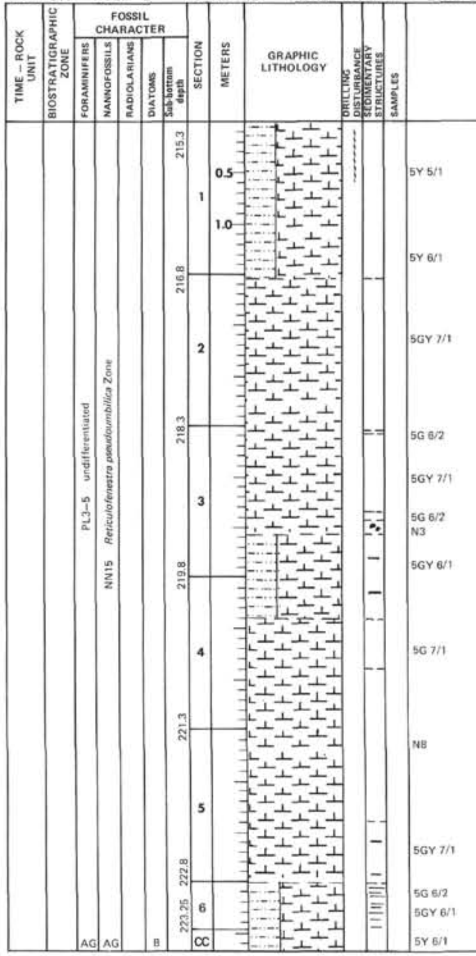
Green (5G 6/2) laminations and patches.

Chalky intervals getting more common.

SMEAR SLIDE SUMMARY (%)

	5, 130 D
Composition:	
Quartz	TR
Feldspar	TR
Clay	4
Carbonate unspec.	TR
Foraminifers	7
Calc. nannofossils	89
Diatoms	TR

SITE 611 HOLE D CORE 12 CORED INTERVAL 215.3–224.9 m



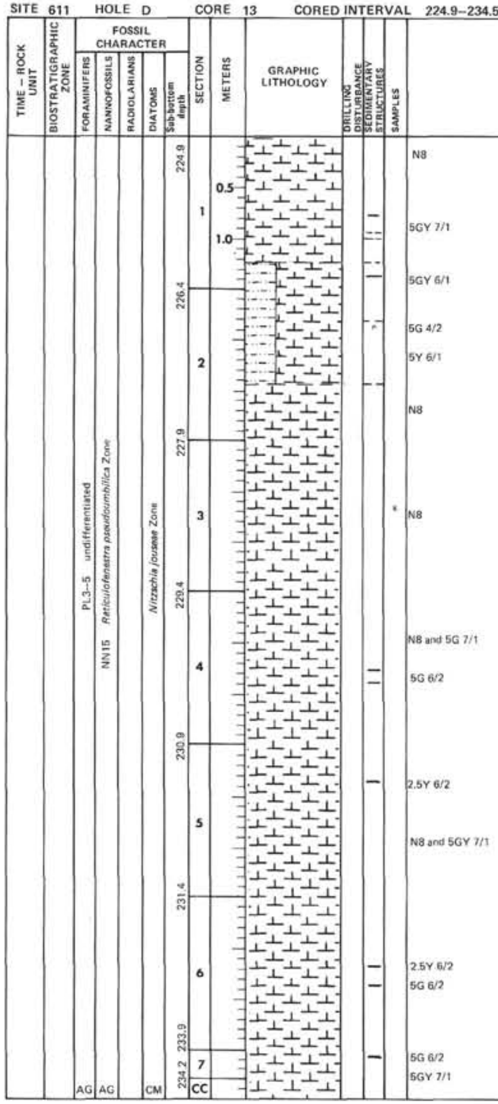
LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, light gray to greenish gray (N8 or 5GY 7/1) to MARLY NANNOFOSSIL OOZE, gray to greenish gray (5Y 6/1 to 5/1; 5GY 6/1).

Rare green (5G 6/2) laminations, frequent between 222.8 and 223.25 m. Diffuse green (5G 6/2) patches. Rare pyritic (N3) patches.

Scattered chalky intervals.

SITE 611 HOLE D CORE 13 CORED INTERVAL 224.9–234.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE, almost CHALK under 231.5 m, very light gray or greenish gray.

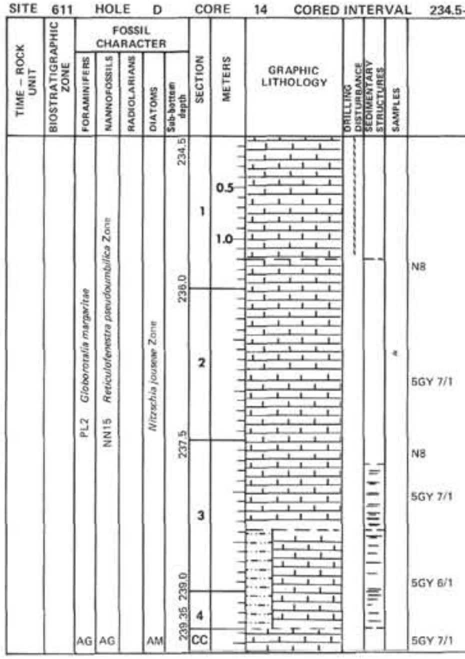
One dark (5Y 6/1 to 5GY 6/1) MARLY interval.

Rare green (5G 6/2) or olive gray (2.5Y 6/2) laminations.

SMEAR SLIDE SUMMARY (%)

	3, 70
	D
Composition:	
Clay	5
Carbonate unspec.	TR
Foraminifers	3
Calc. nannofossils	92
Diatoms	TR
Sponge spicules	TR

SITE 611 HOLE D CORE 14 CORED INTERVAL 234.5–244.1 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK, very light gray or greenish gray (N8 or 5GY 7/1) to MARLY NANNOFOSSIL CHALK, greenish gray (5GY 6/1).

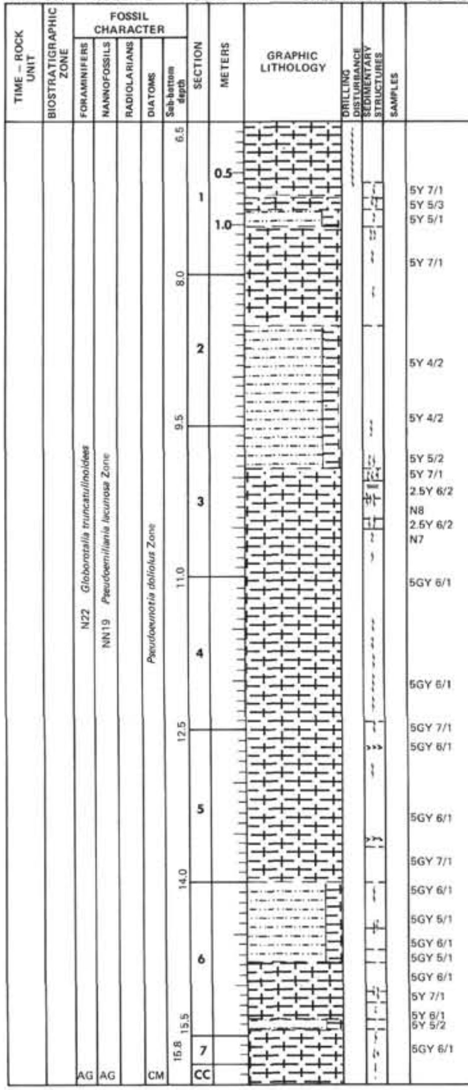
234.5 to 235.7 m: soupy ooze, breccia and downhole gravel.

Frequent green (5G 6/2) laminations under 237.8 m.

SMEAR SLIDE SUMMARY (%)

	2, 65
	D
Composition:	
Clay	7
Foraminifers	4
Calc. nannofossils	89
Diatoms	TR
Sponge spicules	TR

SITE 611 HOLE E CORE 1 CORED INTERVAL 6.5–16.1 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray to olive gray (5Y 5/1 to 4/2) or greenish gray (5GY 5/1); and FORAMINIFERAL NANNOFOSSIL OOZE, light gray (N7 or 5Y 7/1) or light greenish gray (5GY 7/1). Darker (5Y 6/1 or 5GY 6/1) intervals are probably MARLY.

Rare green (5G 6/2) or gray (N8 or N7), bluish (5B 5/1) laminations.

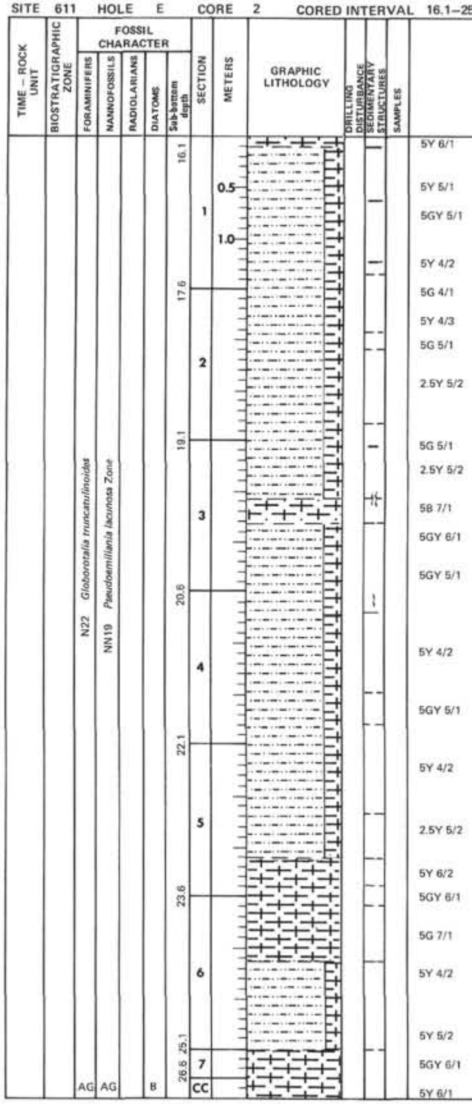
Open burrows; *Zoophycos*.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	3, 85	6, 30
	M	D
Texture:		
Sand	–	10
Silt	–	20
Clay	–	70
Composition:		
Quartz	–	38
Heavy minerals	–	2
Clay	TR	30
Volcanic glass	–	3
Carbonate unspec.	–	3
Foraminifers	12	6
Calc. nannofossils	85	18
Diatoms	3	–
Sponge spicules	TR	–

SITE 611 HOLE E CORE 2 CORED INTERVAL 16.1–25.7 m



LITHOLOGIC DESCRIPTION

Alternating:
CALCAREOUS MUD, gray, olive gray to dark olive gray (5Y 5/1 to 5Y 4/3) or greenish gray (5GY 5/1); and FORAMINIFERAL NANNOFOSSIL OOZE, light gray or greenish gray (5B 7/1, 5G 7/1); darker intervals (5Y 6/1 or 5GY 6/1) probably MARLY.

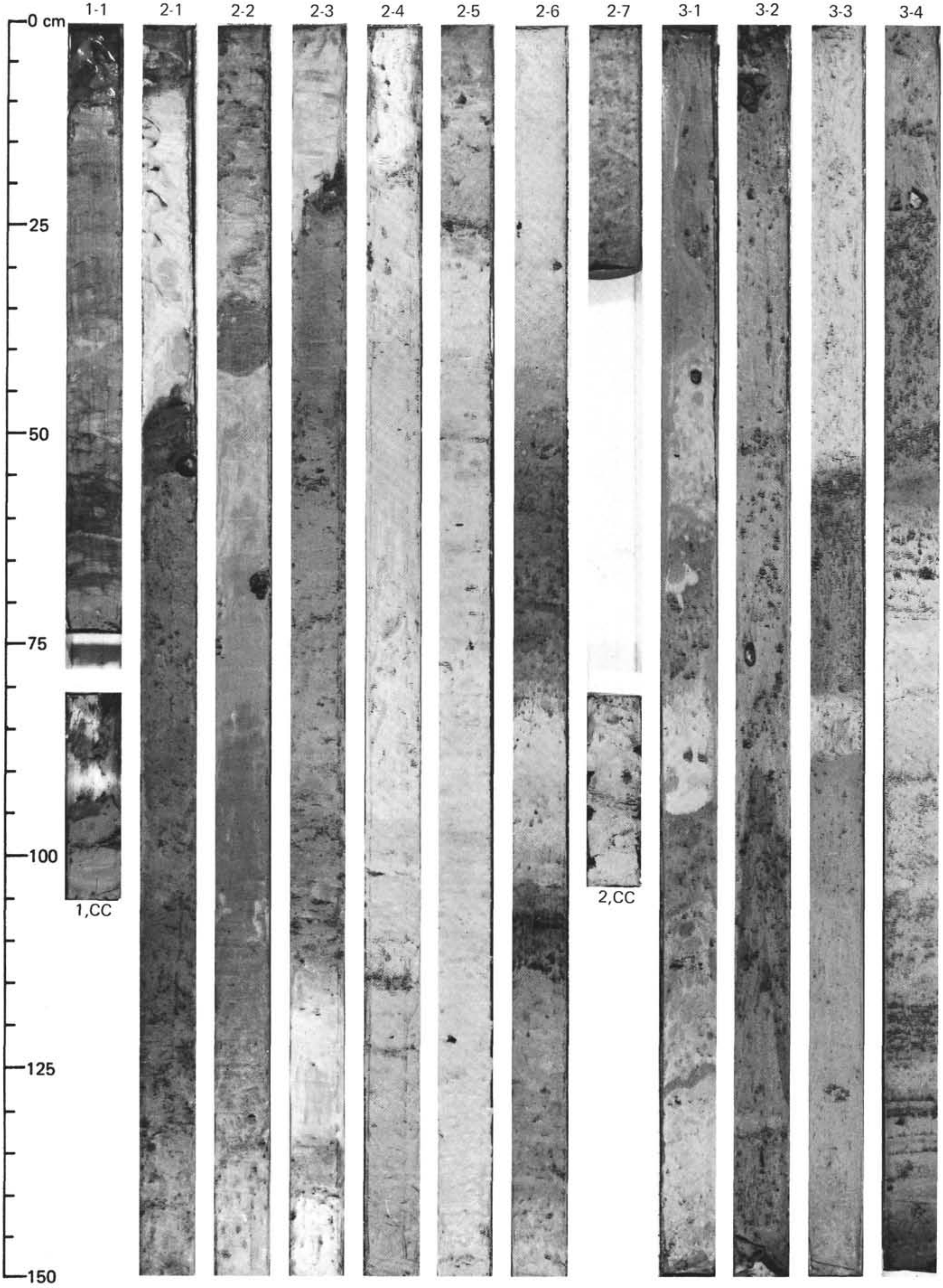
Very rare (5G 5/1 or 4/1) laminations.

Rare open burrows.

Dropstones.

SMEAR SLIDE SUMMARY (%)

	2, 55	3, 80
	D	M
Texture:		
Sand	15	–
Silt	30	–
Clay	55	–
Composition:		
Quartz	36	–
Feldspar	1	–
Heavy minerals	4	1
Clay	30	5
Volcanic glass	3	–
Carbonate unspec.	8	2
Foraminifers	5	10
Calc. nannofossils	3	80
Diatoms	–	2
Radiolarians	–	TR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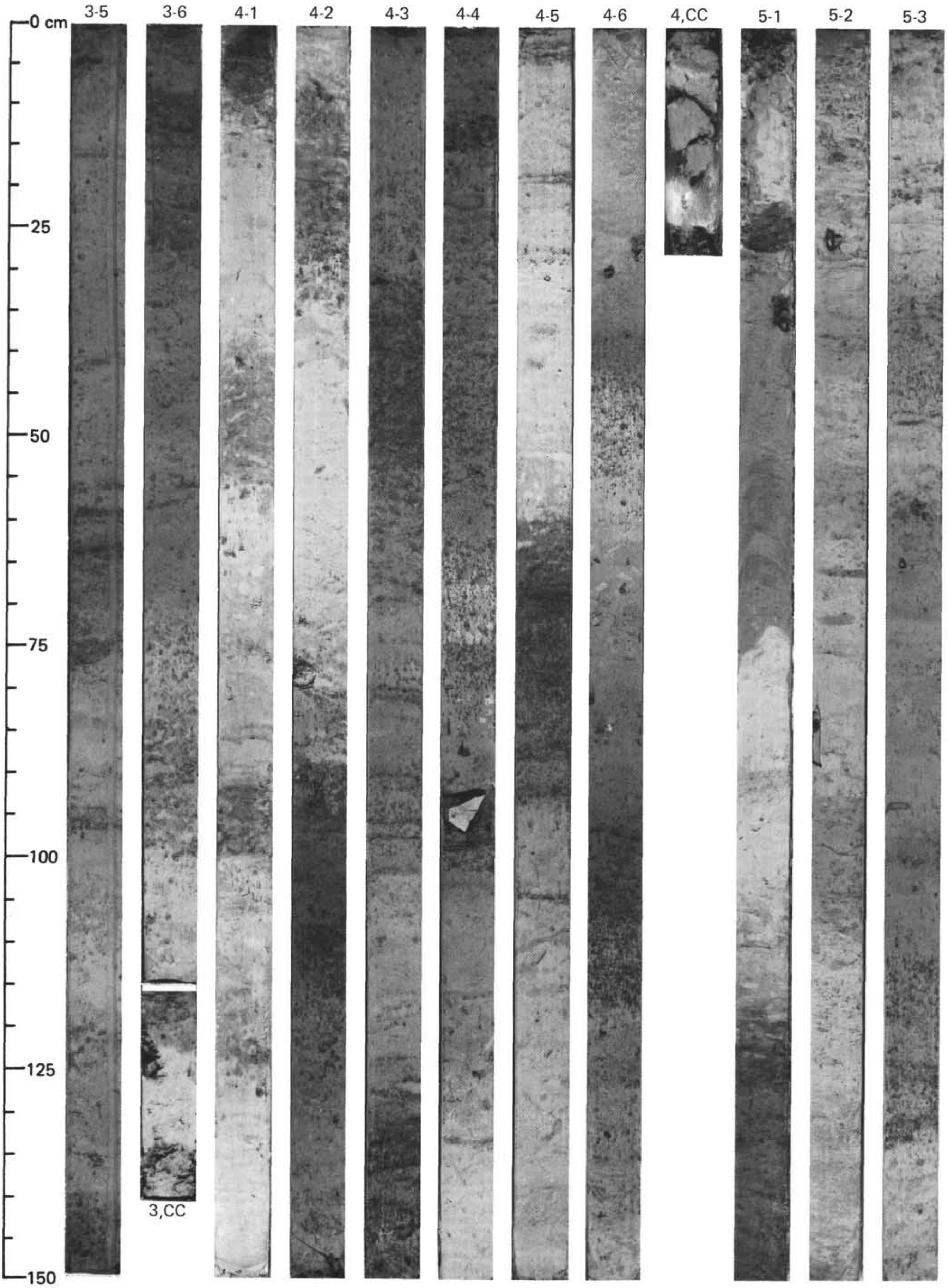
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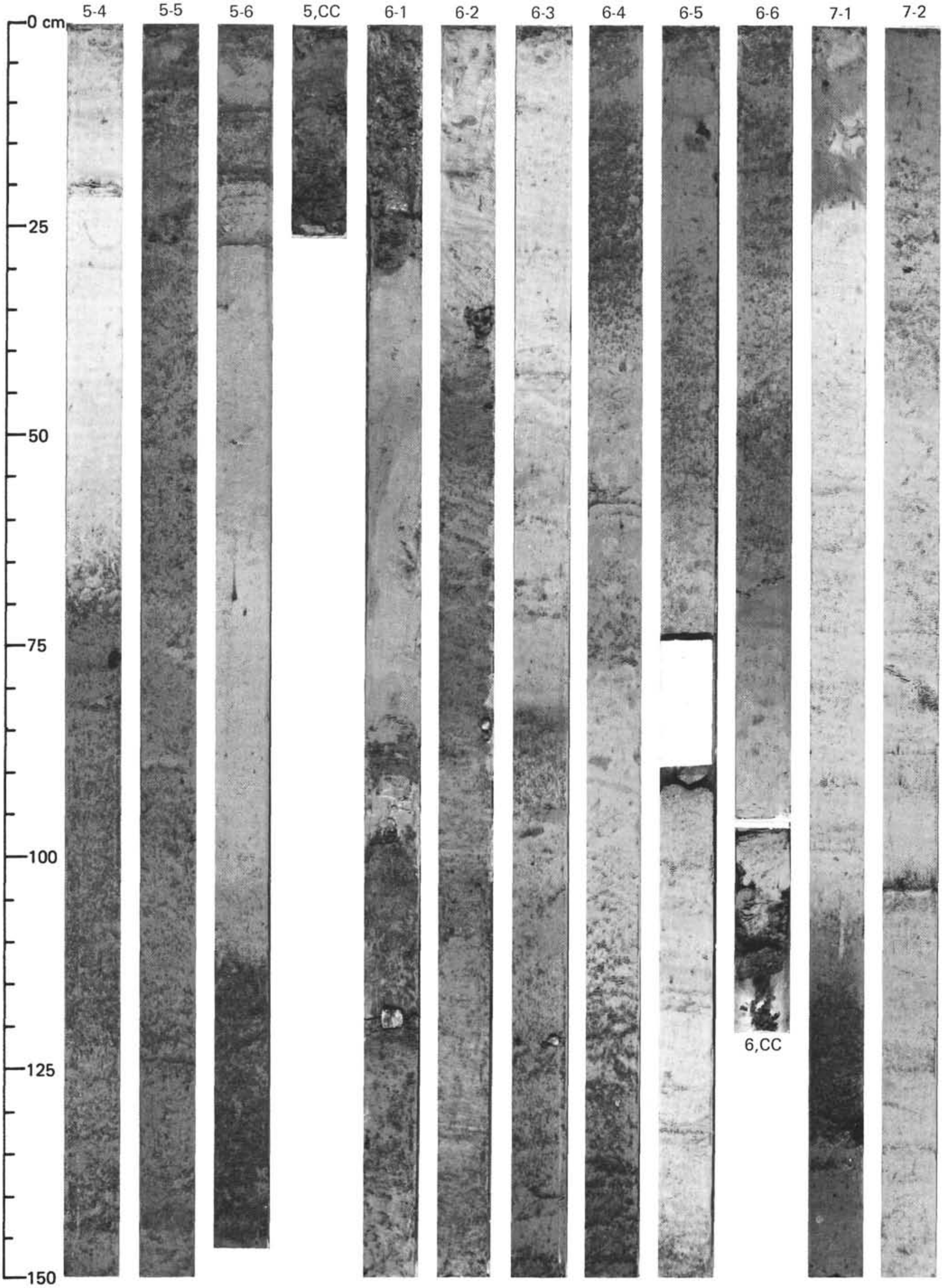
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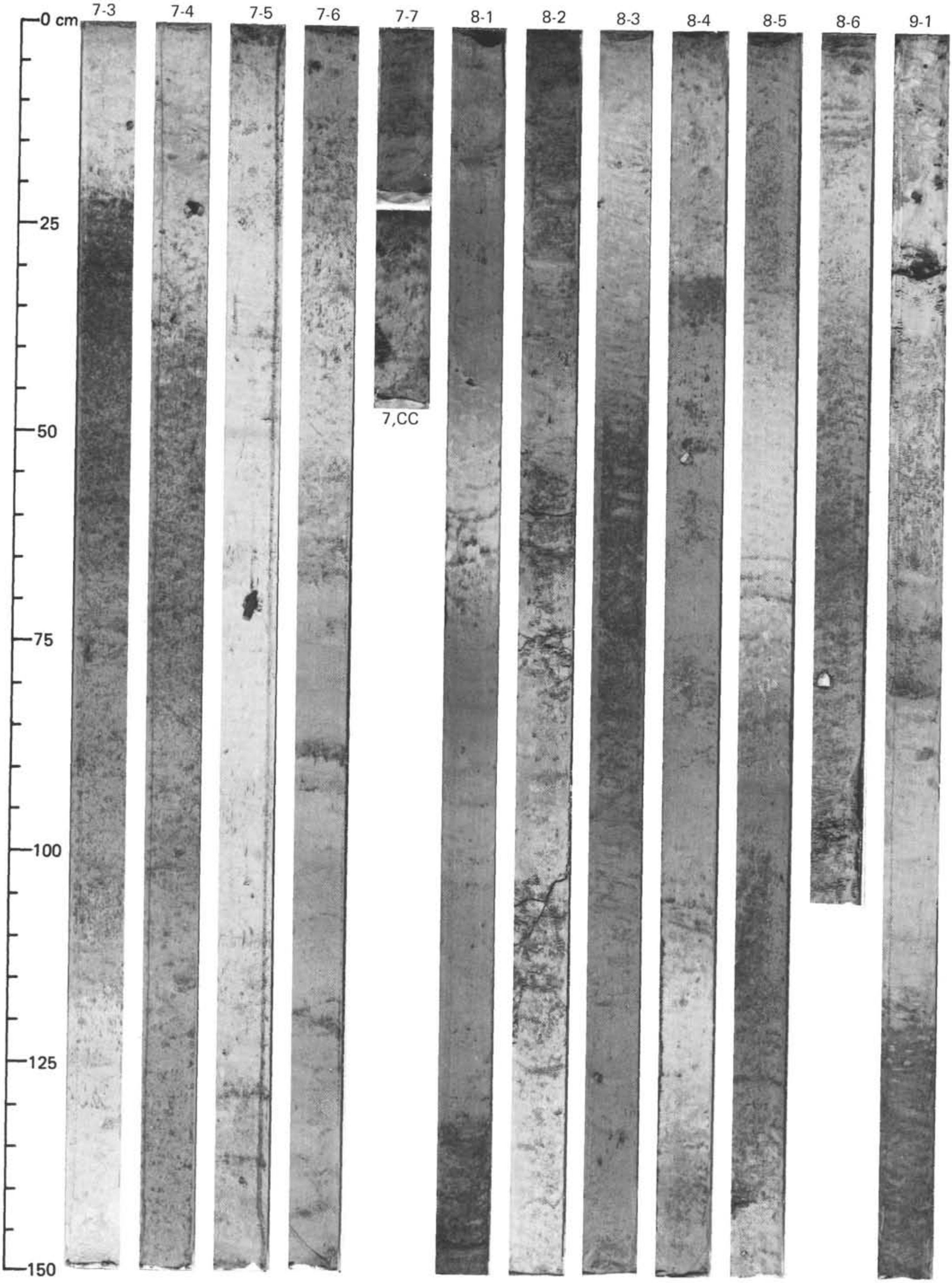
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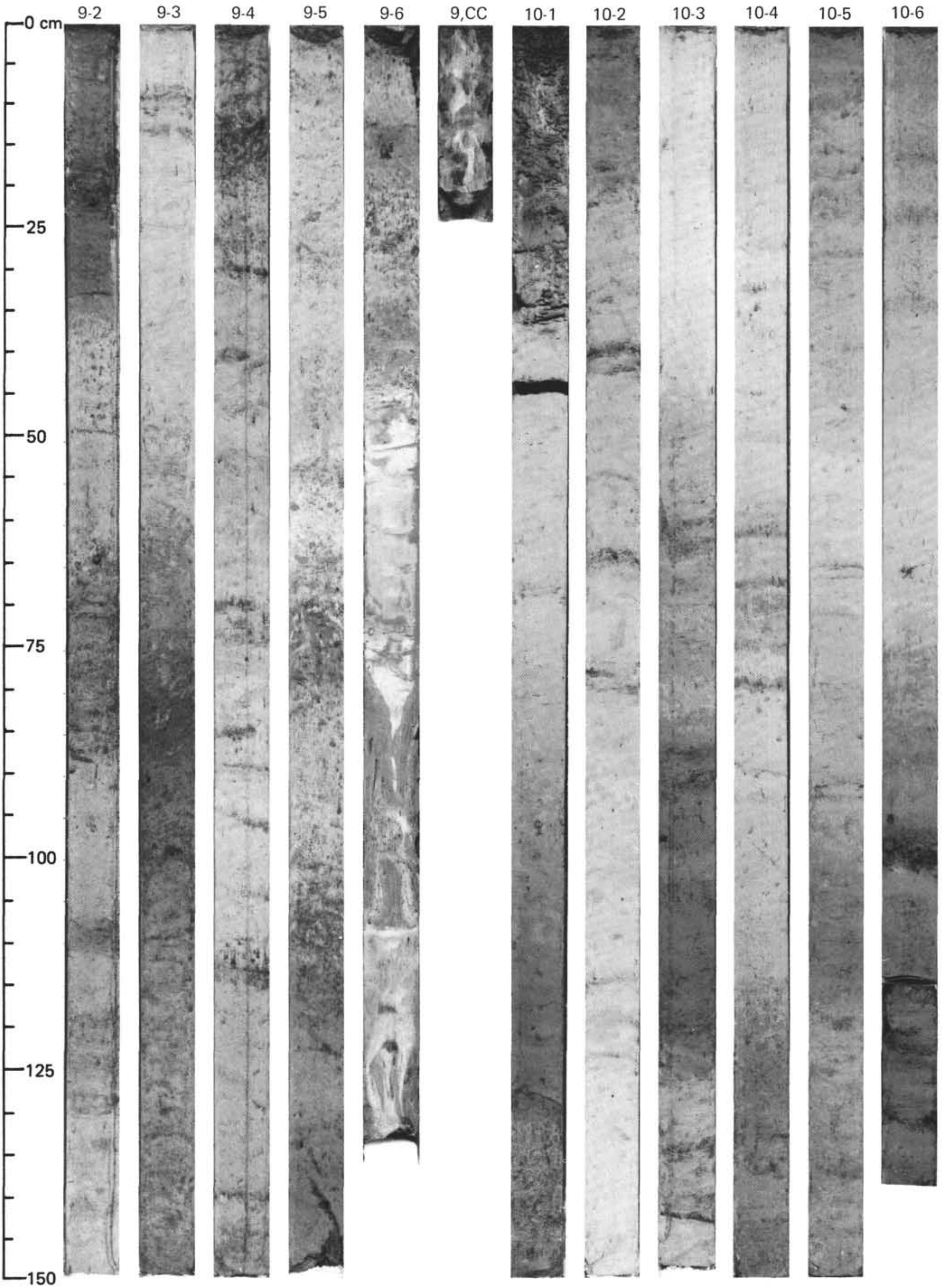
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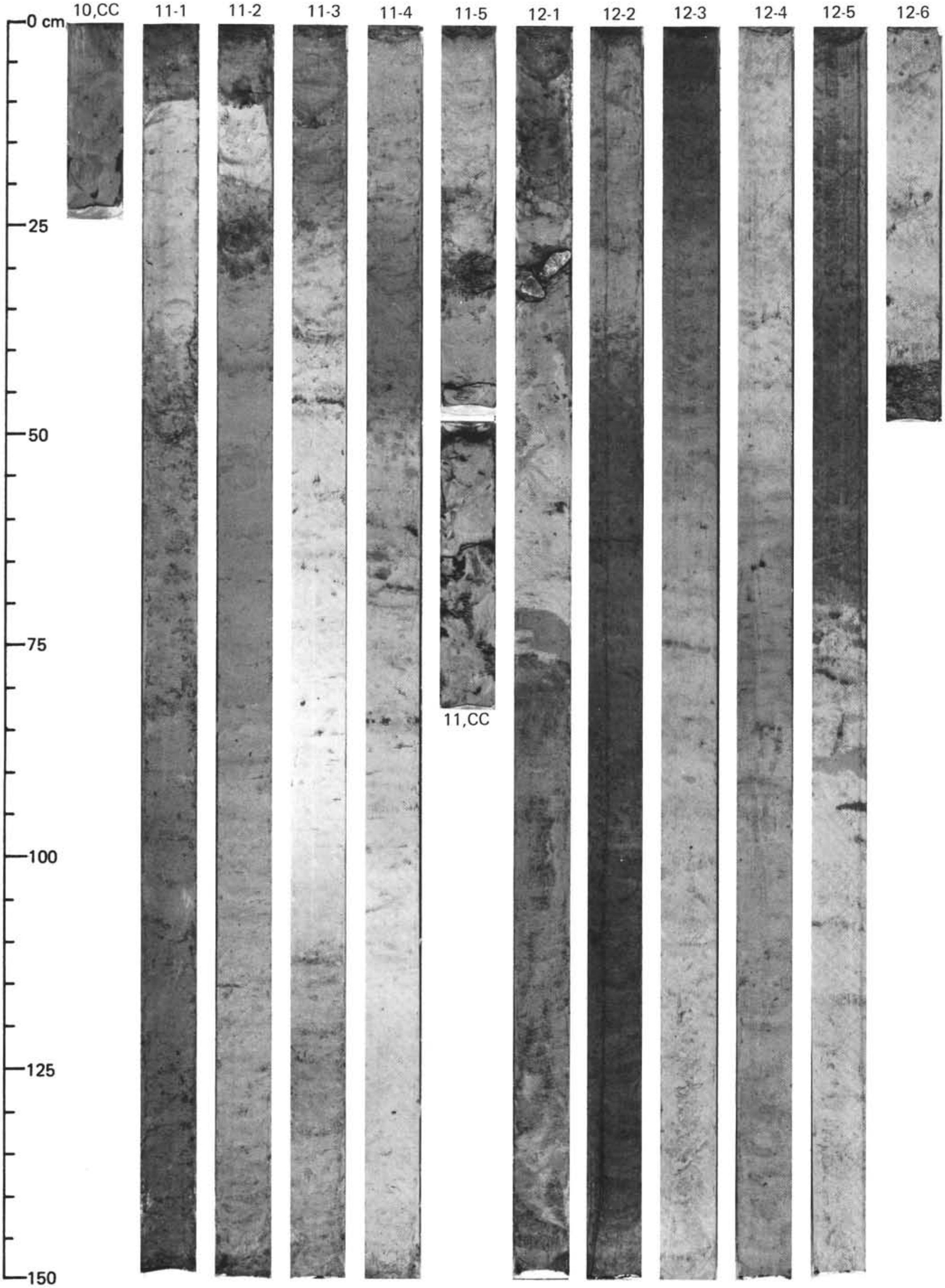
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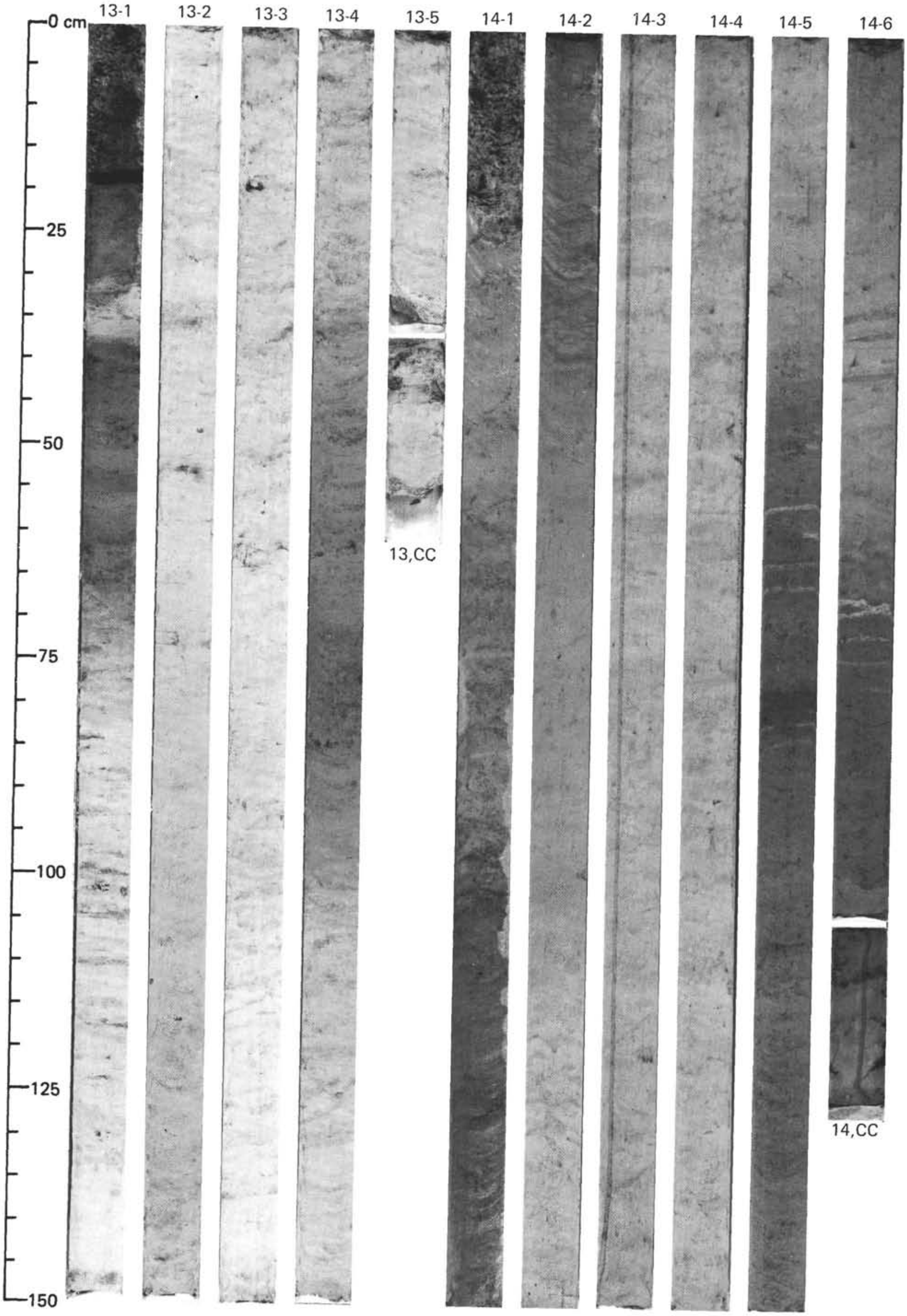
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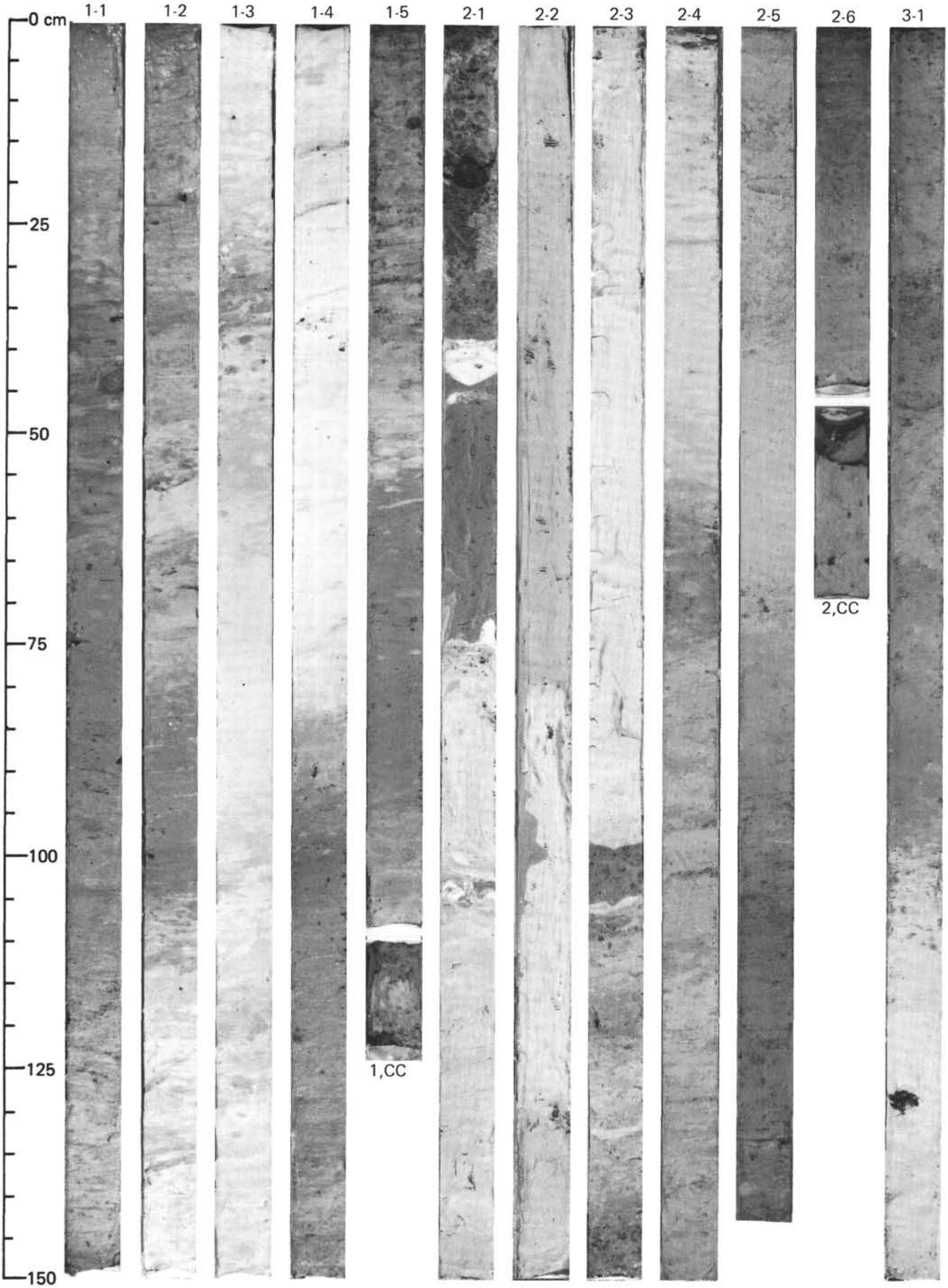
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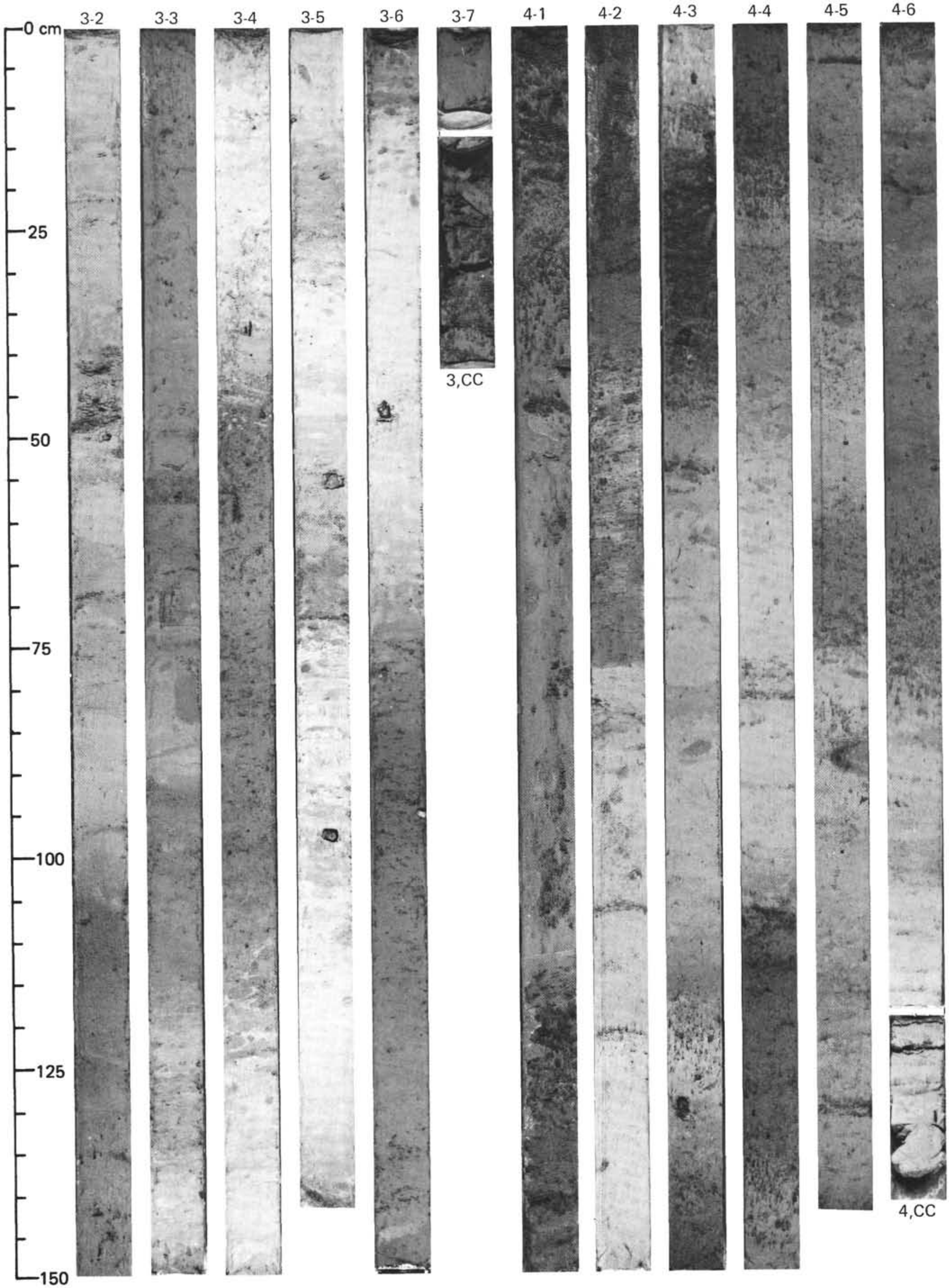
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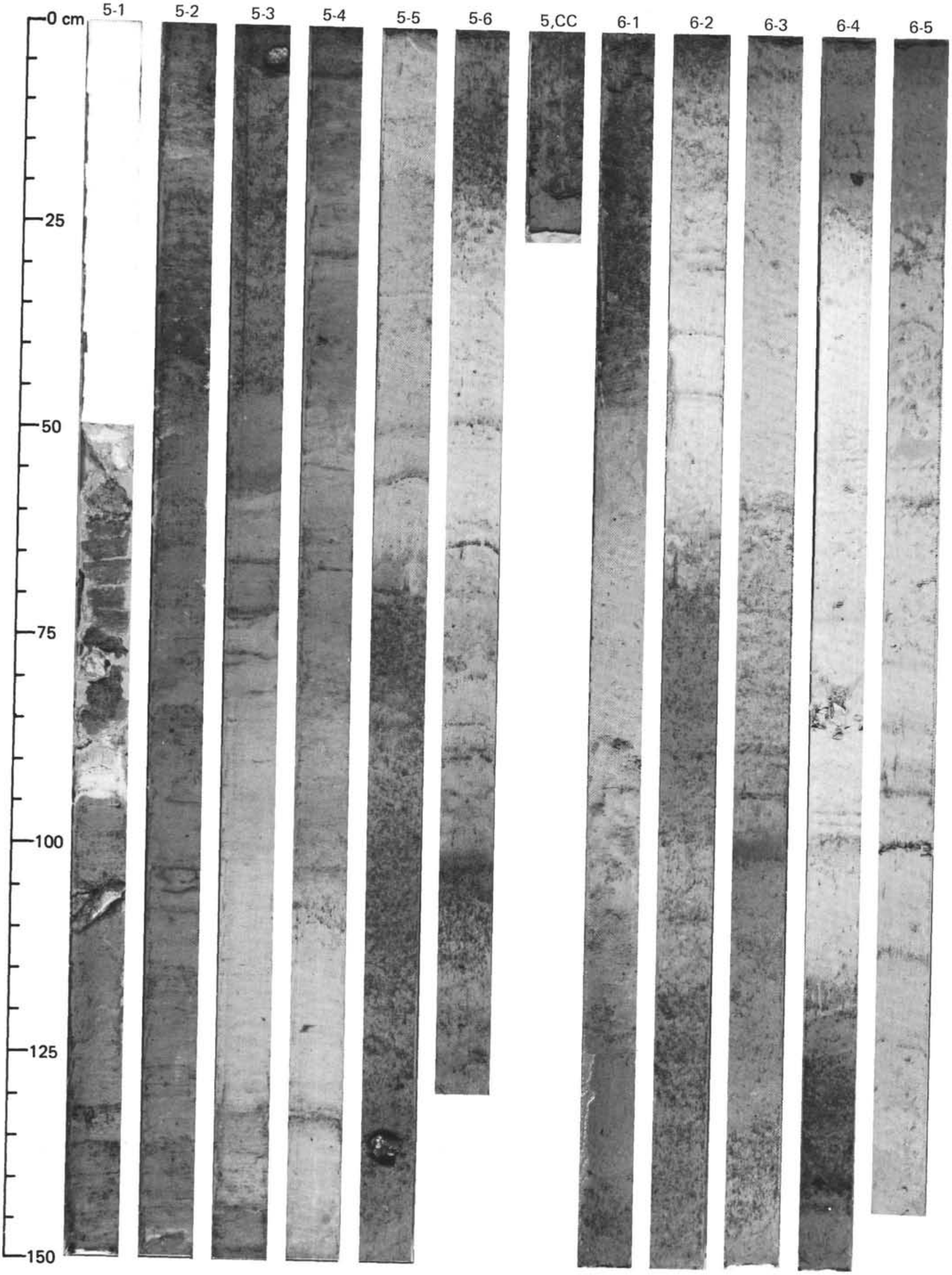
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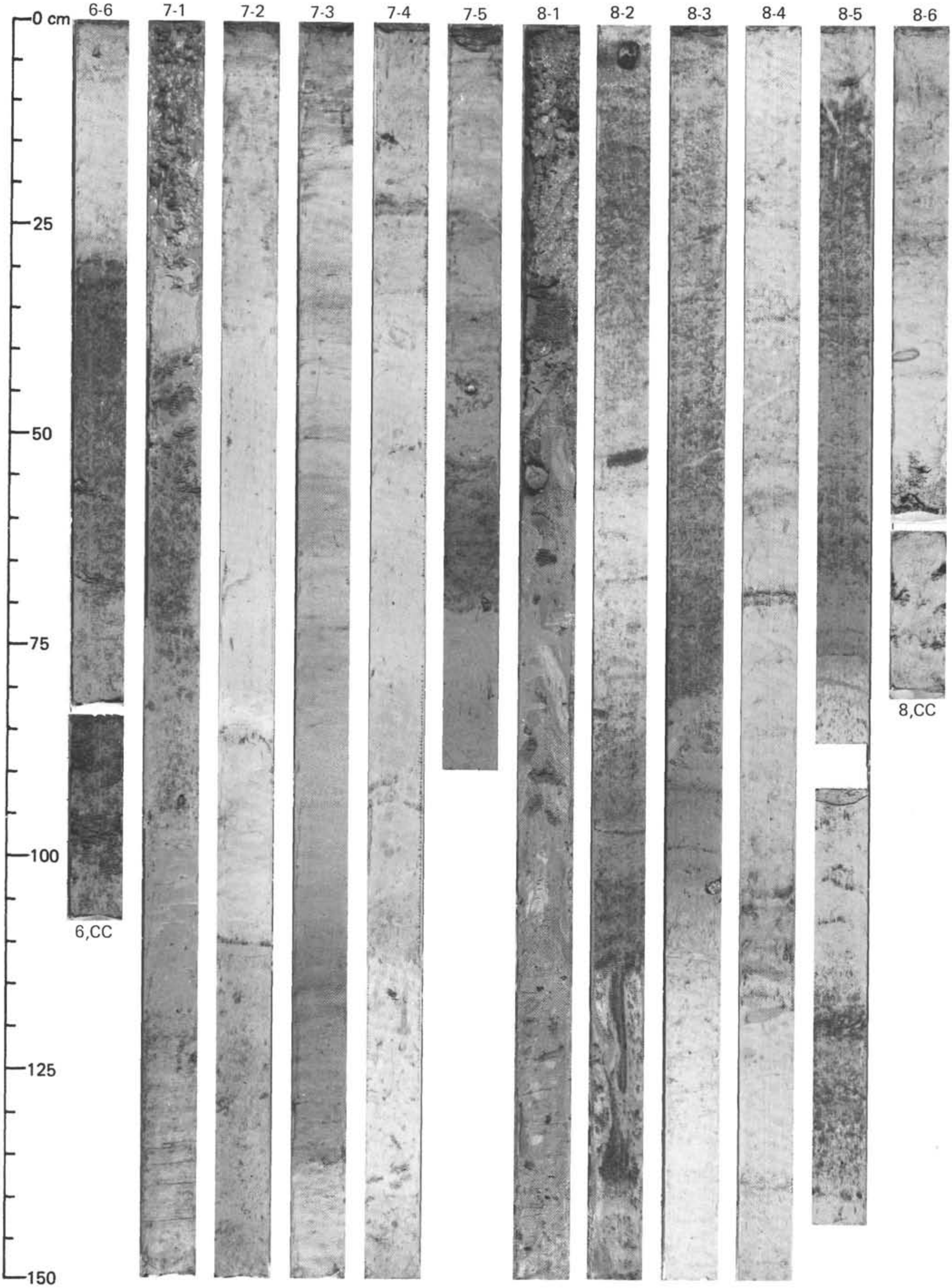
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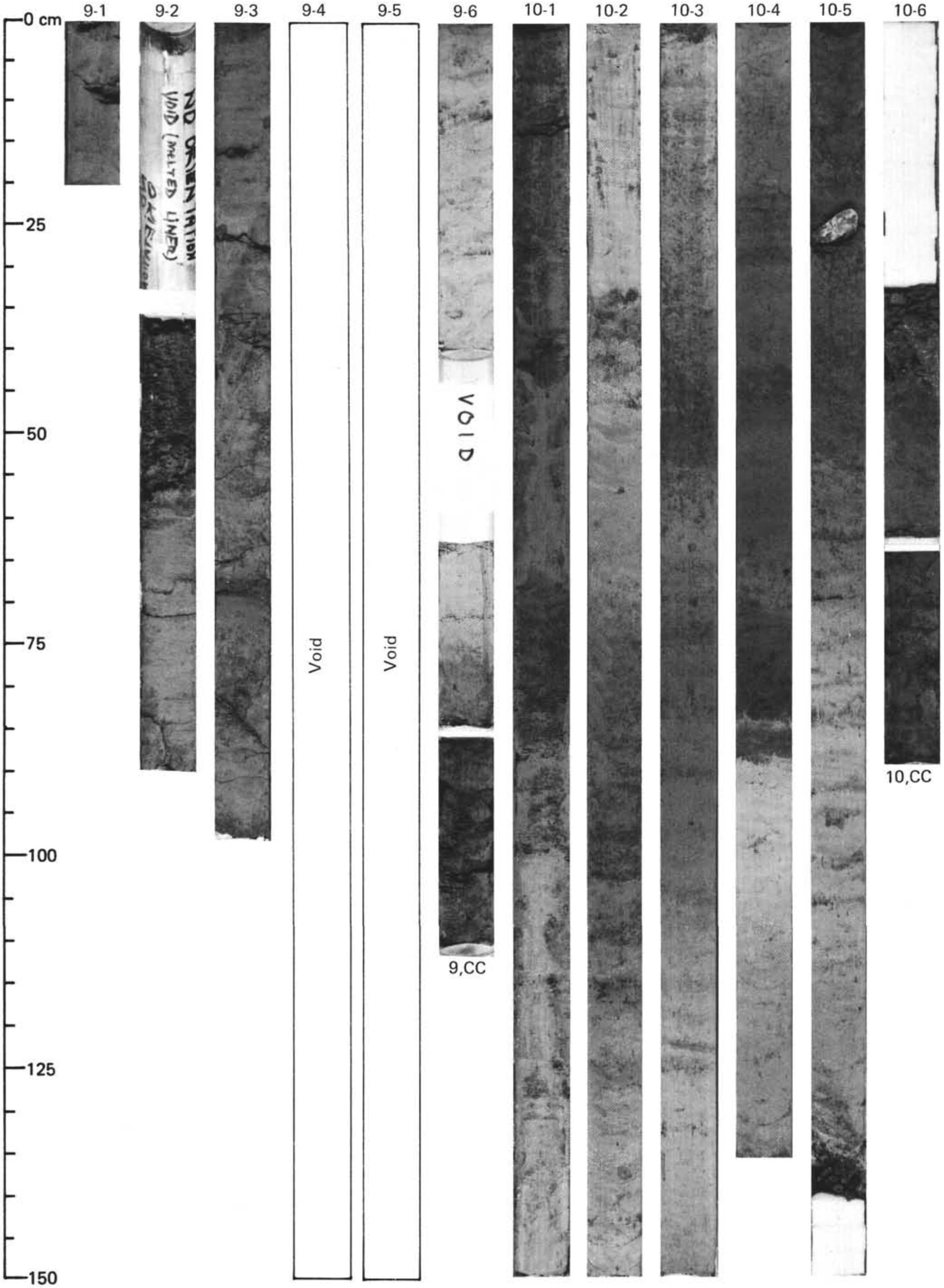
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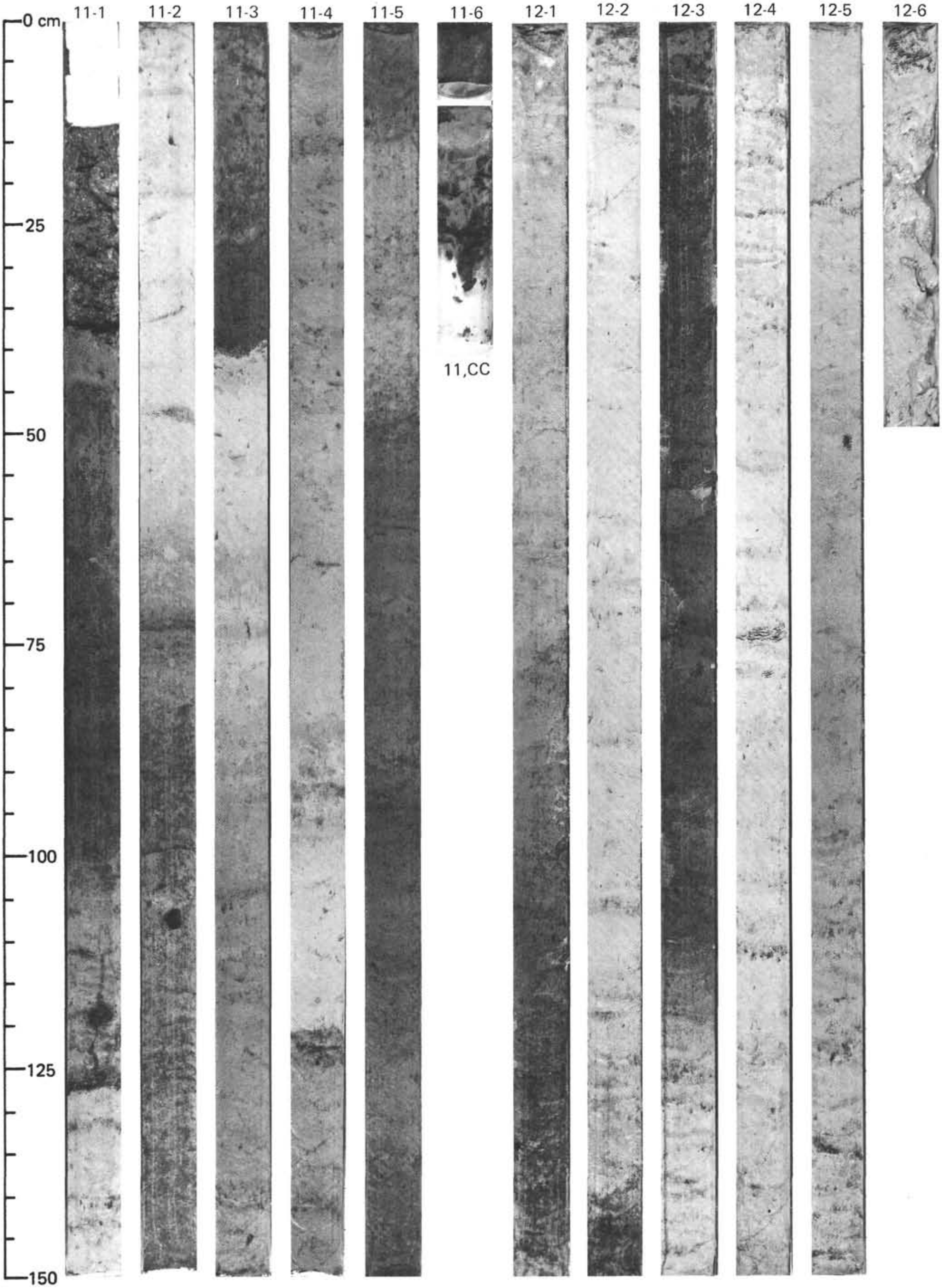
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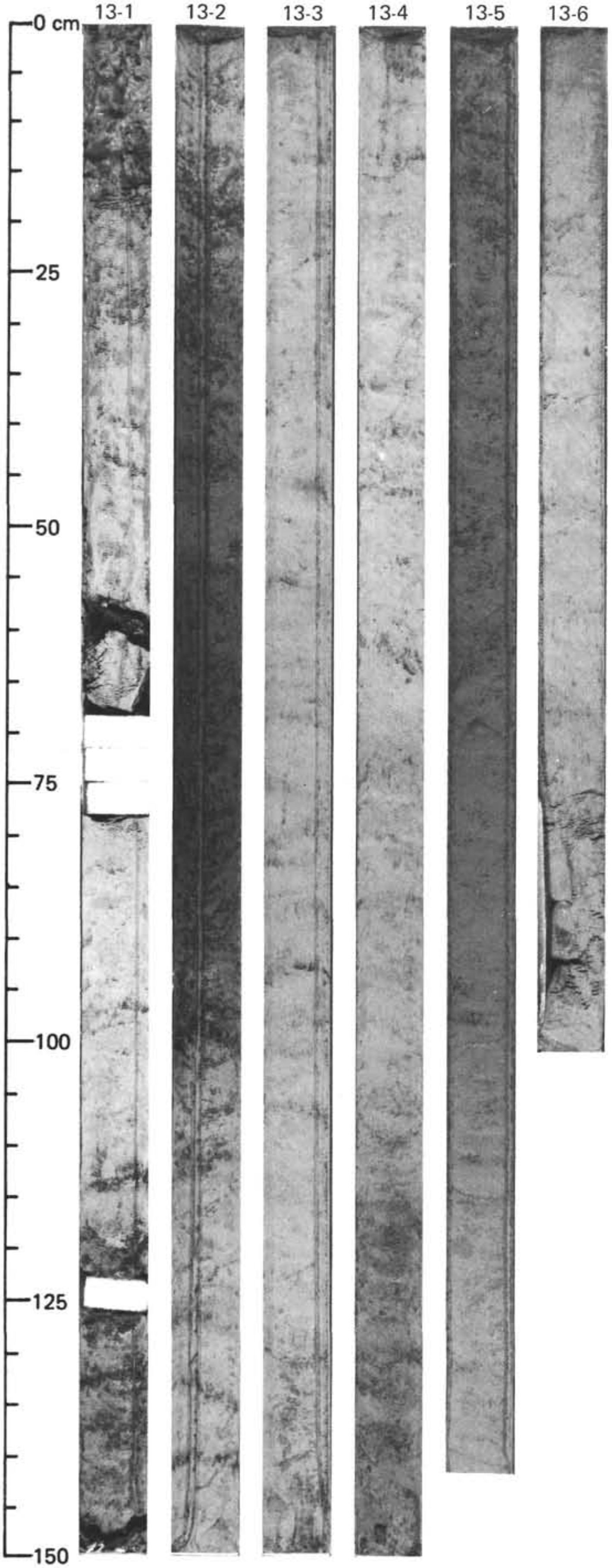
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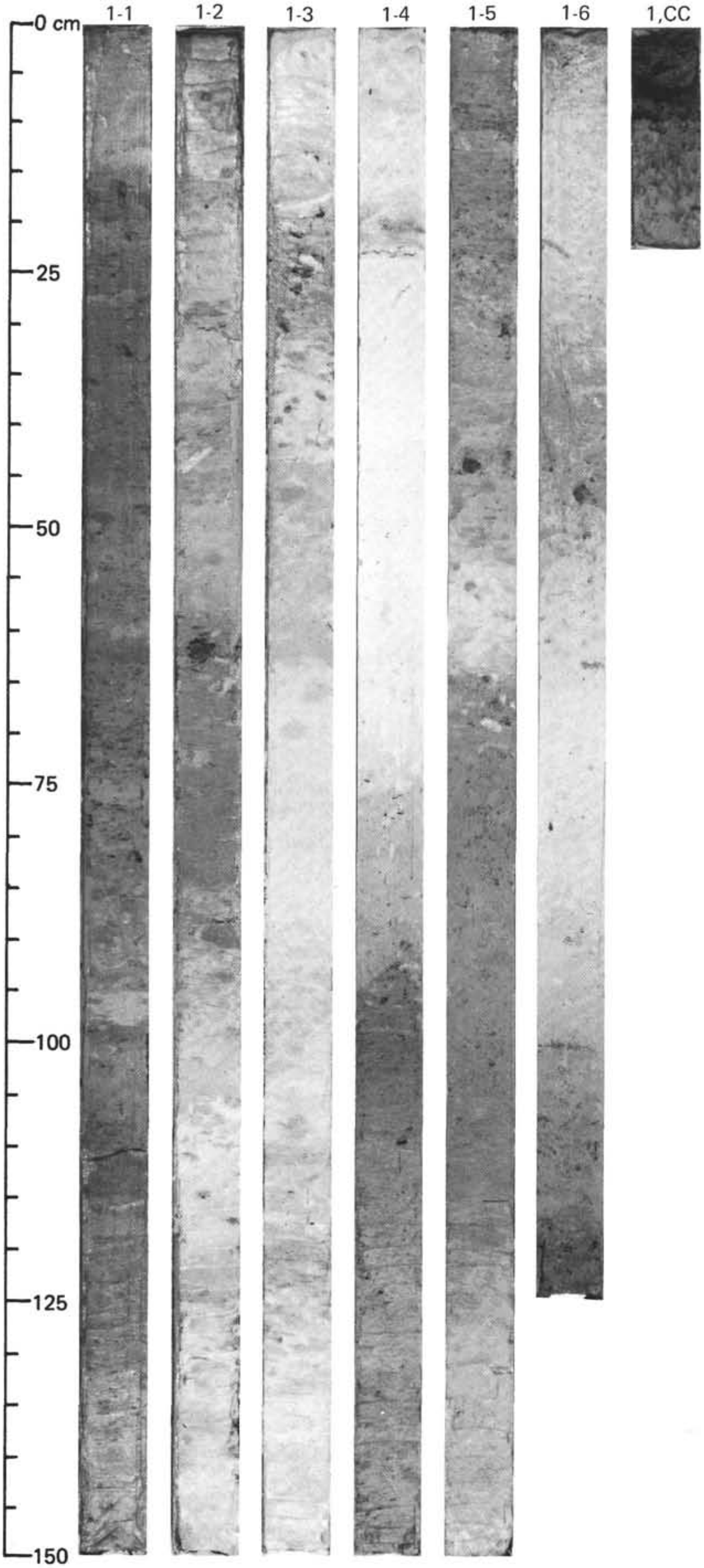
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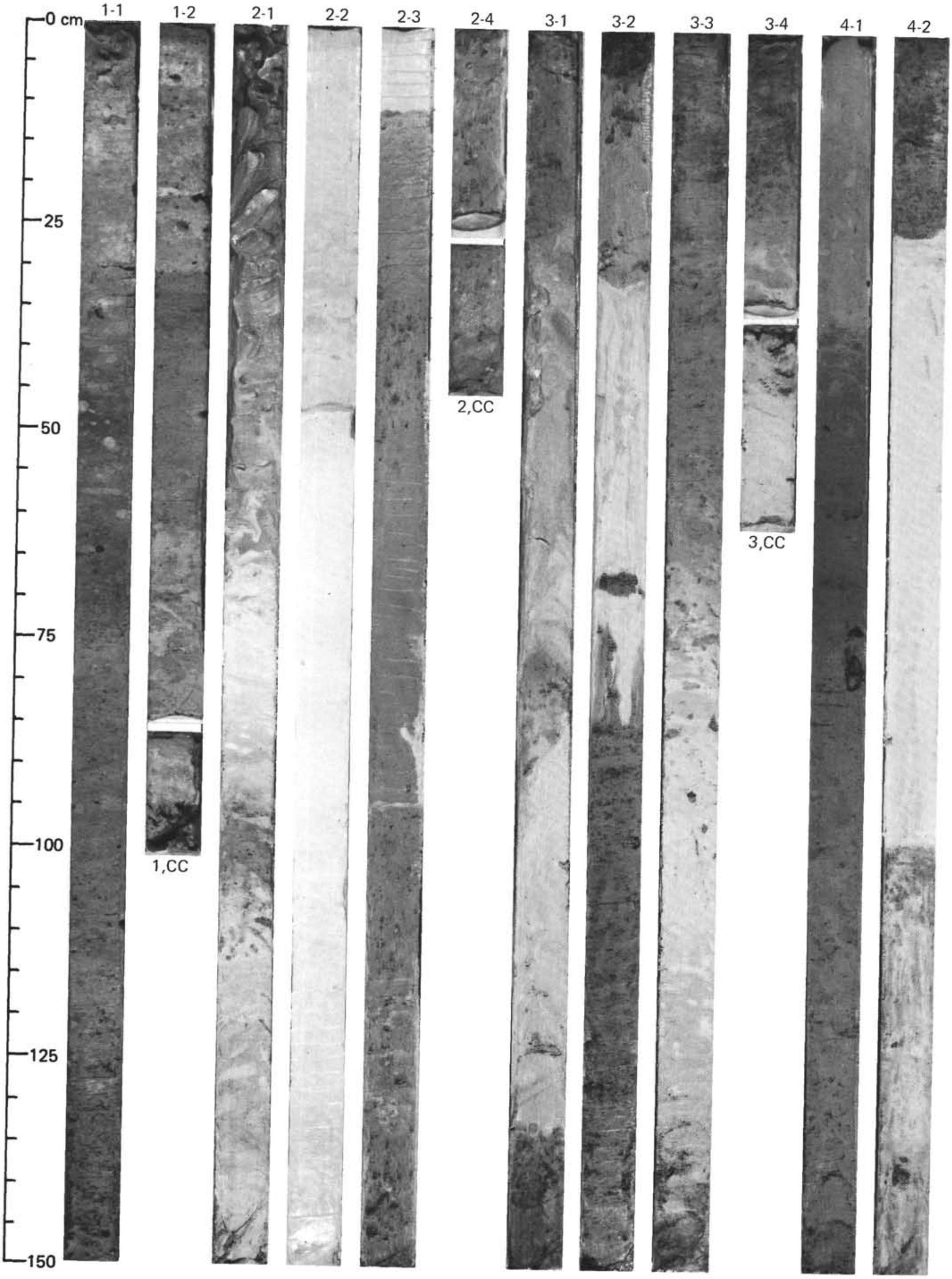
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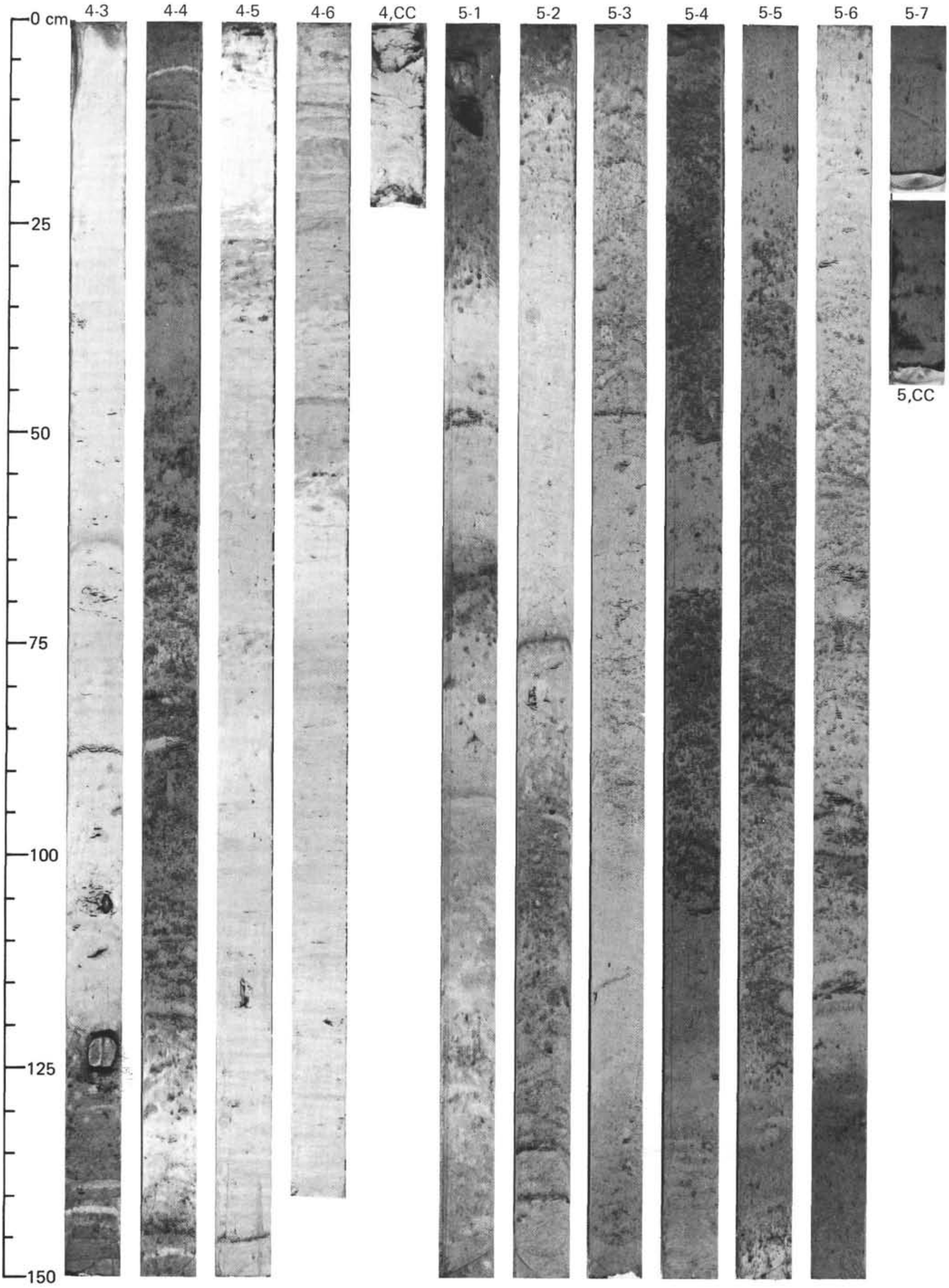
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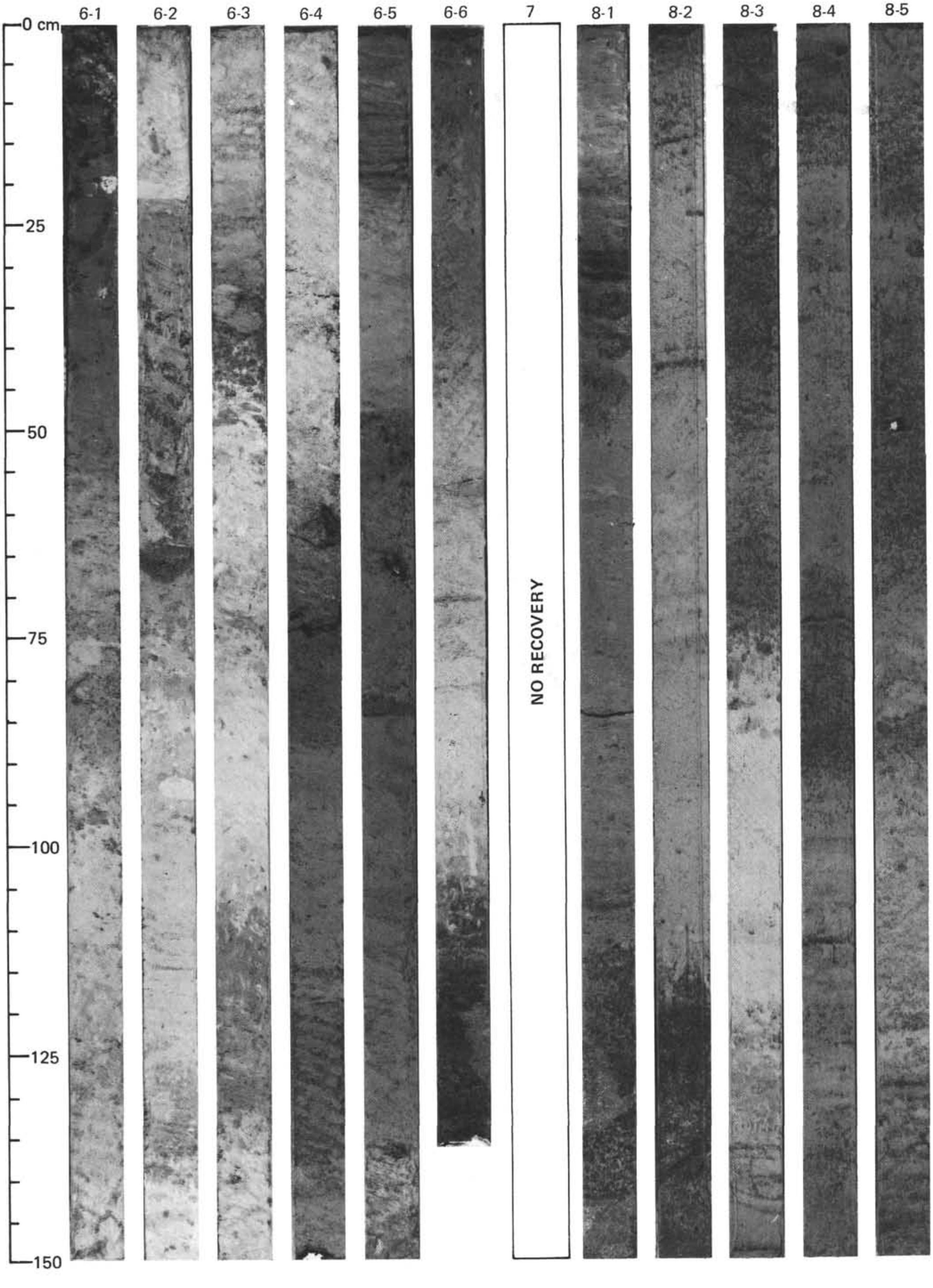
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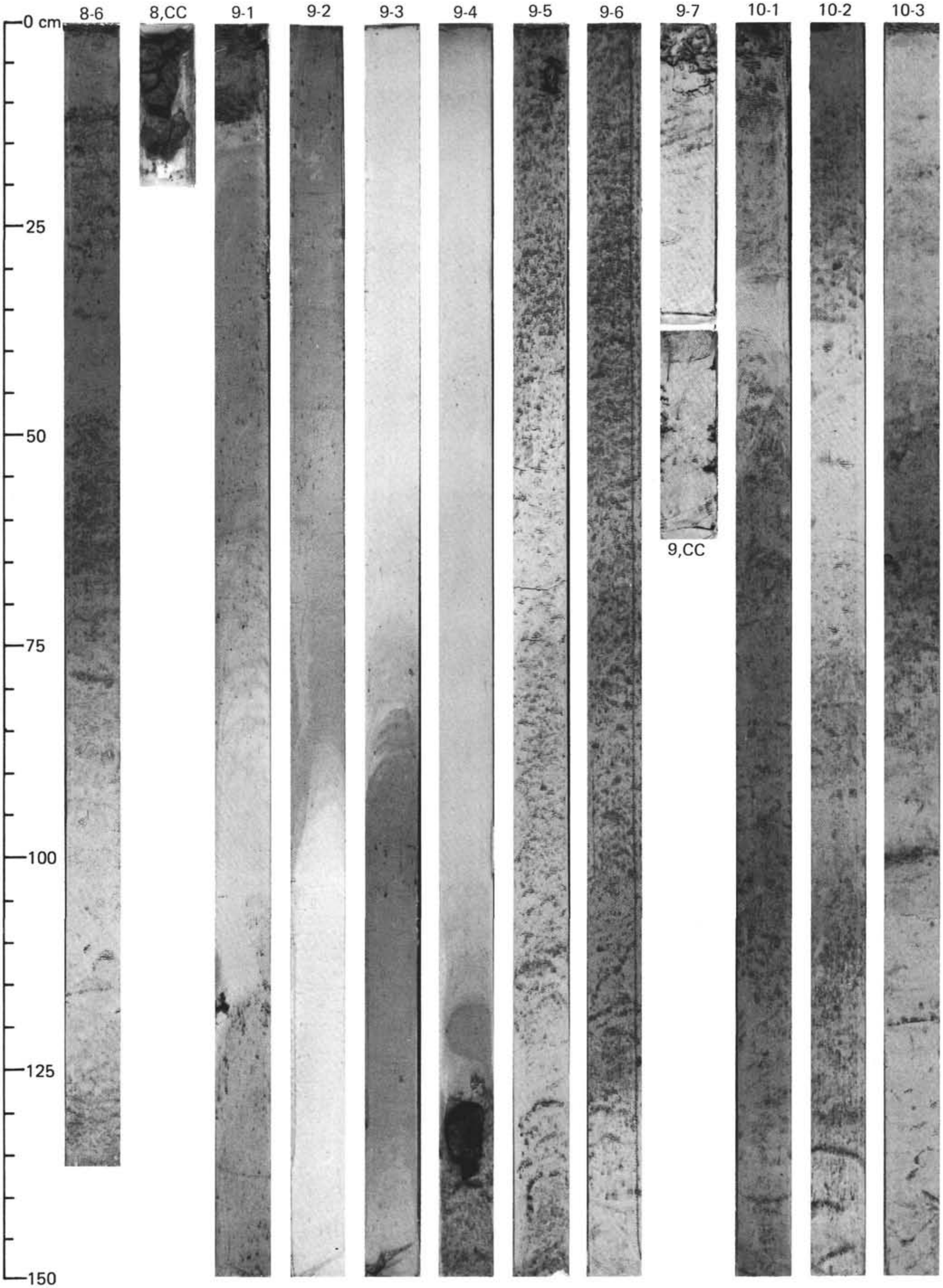
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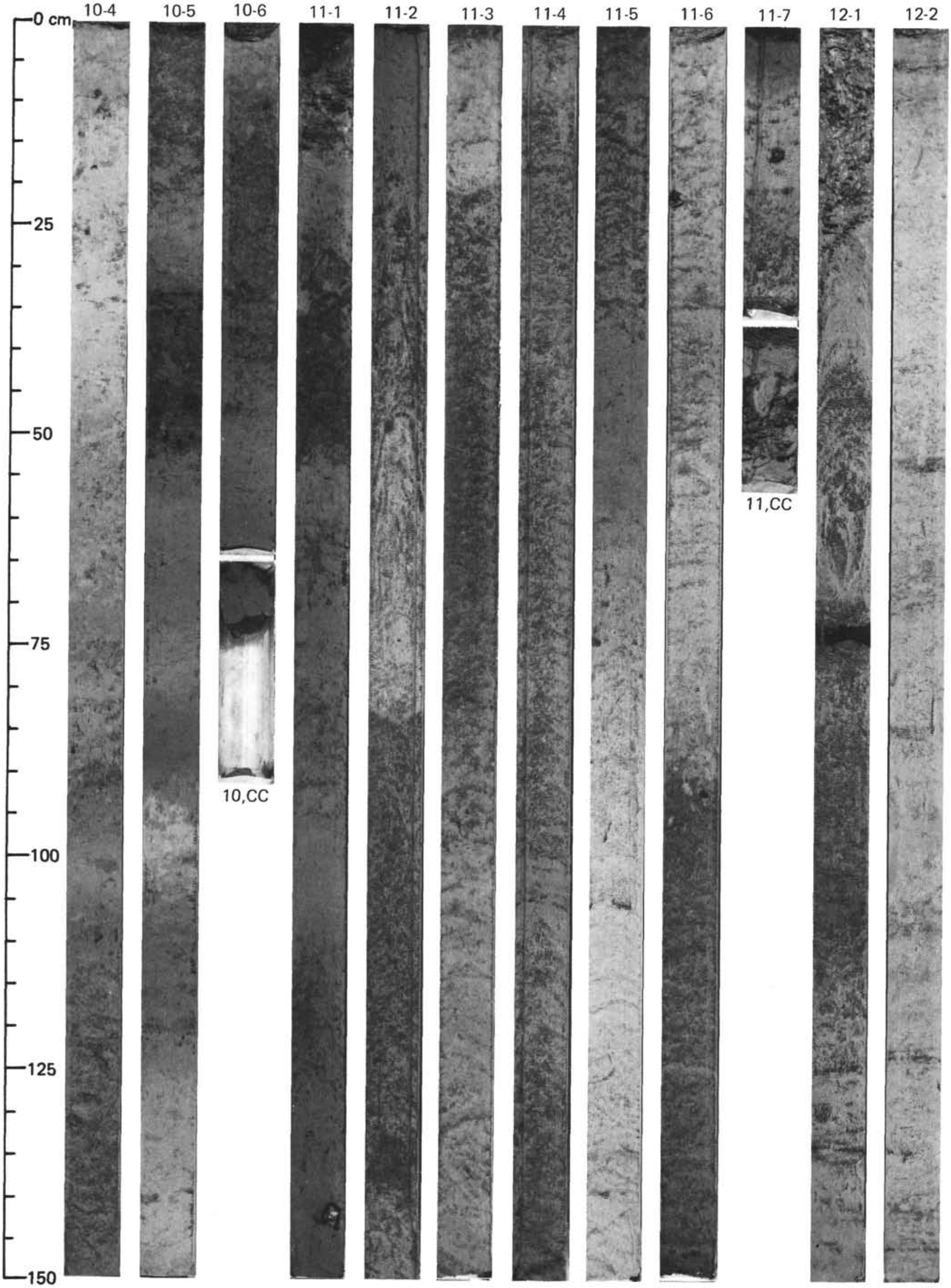
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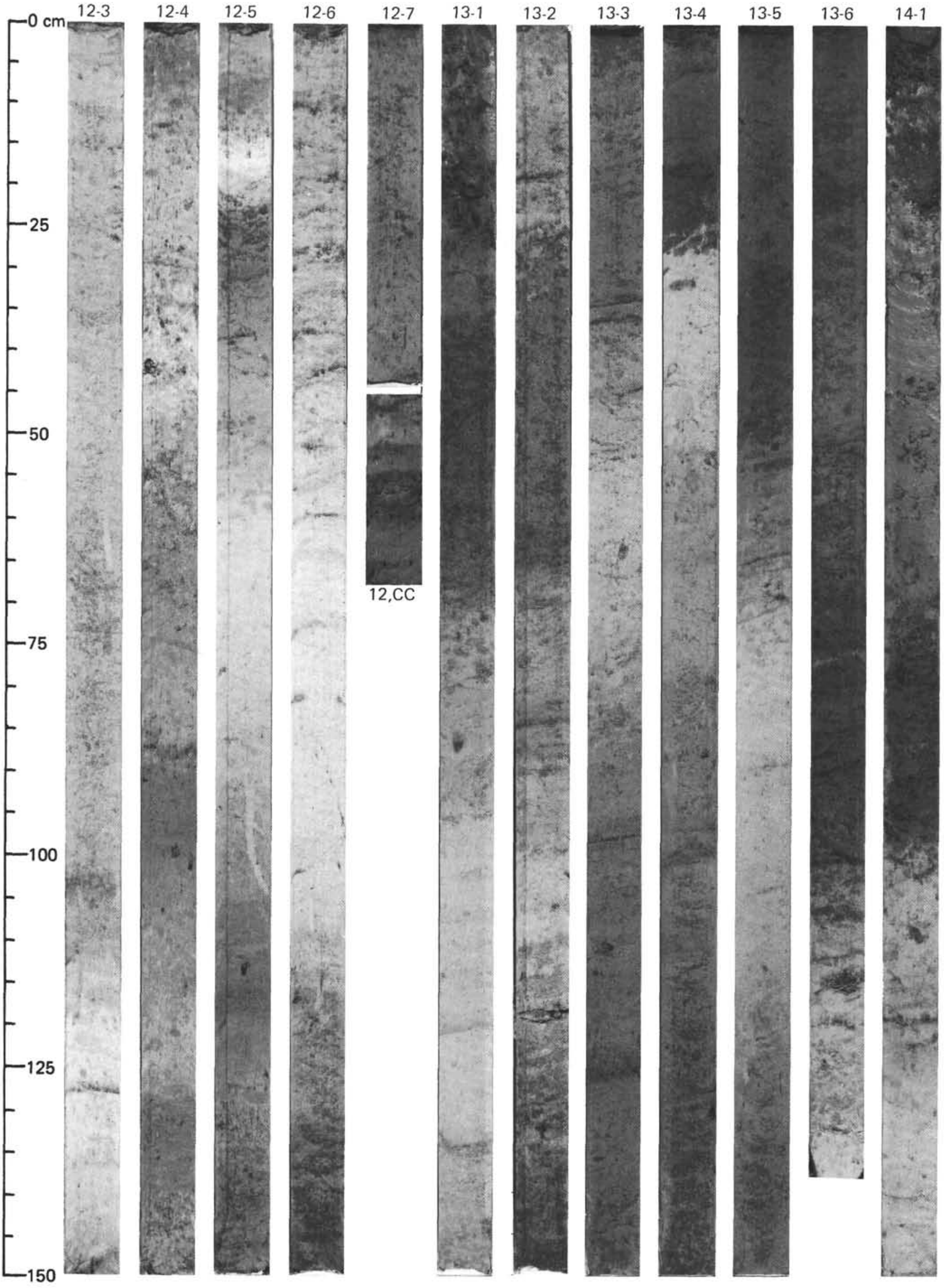
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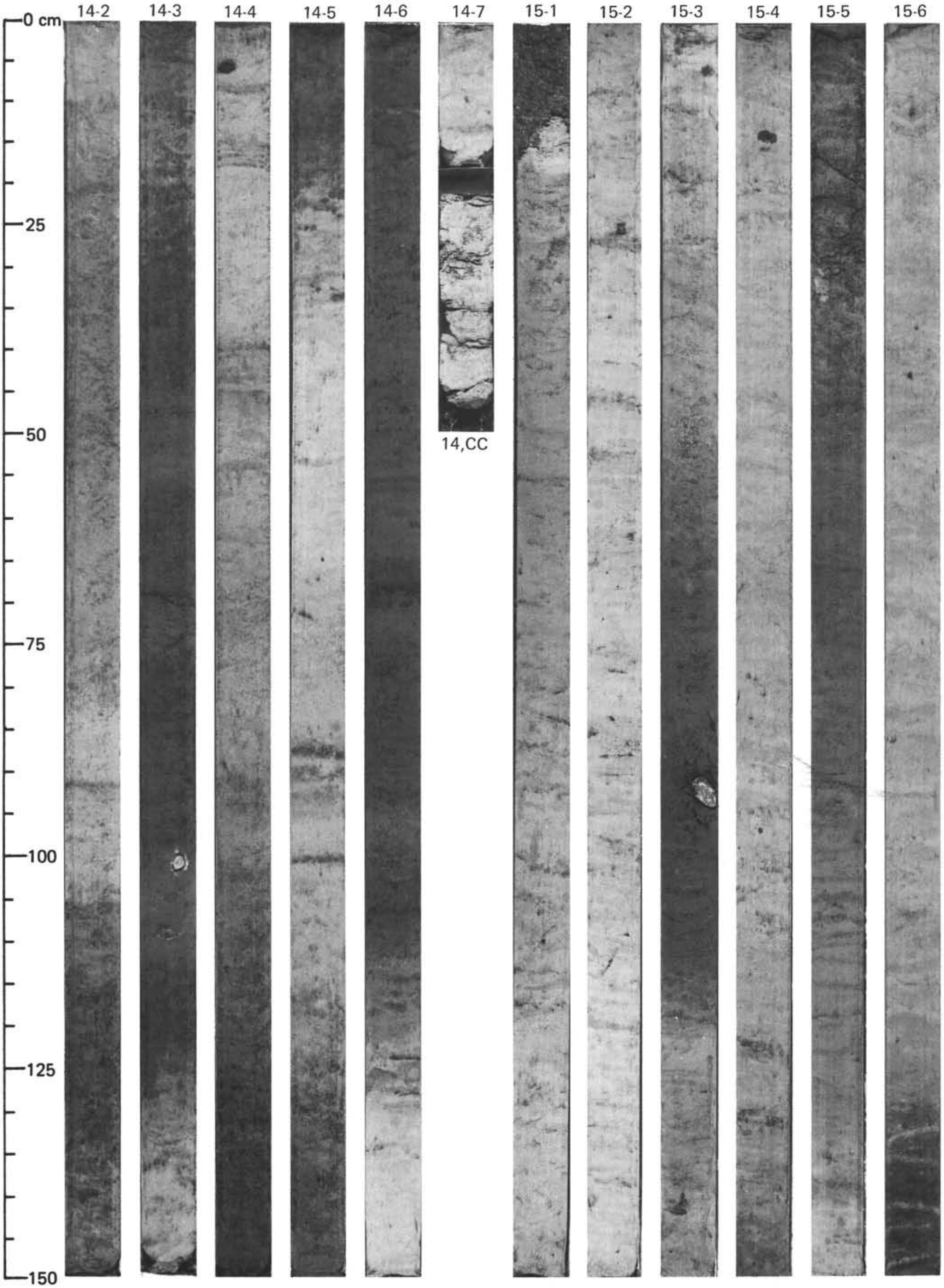
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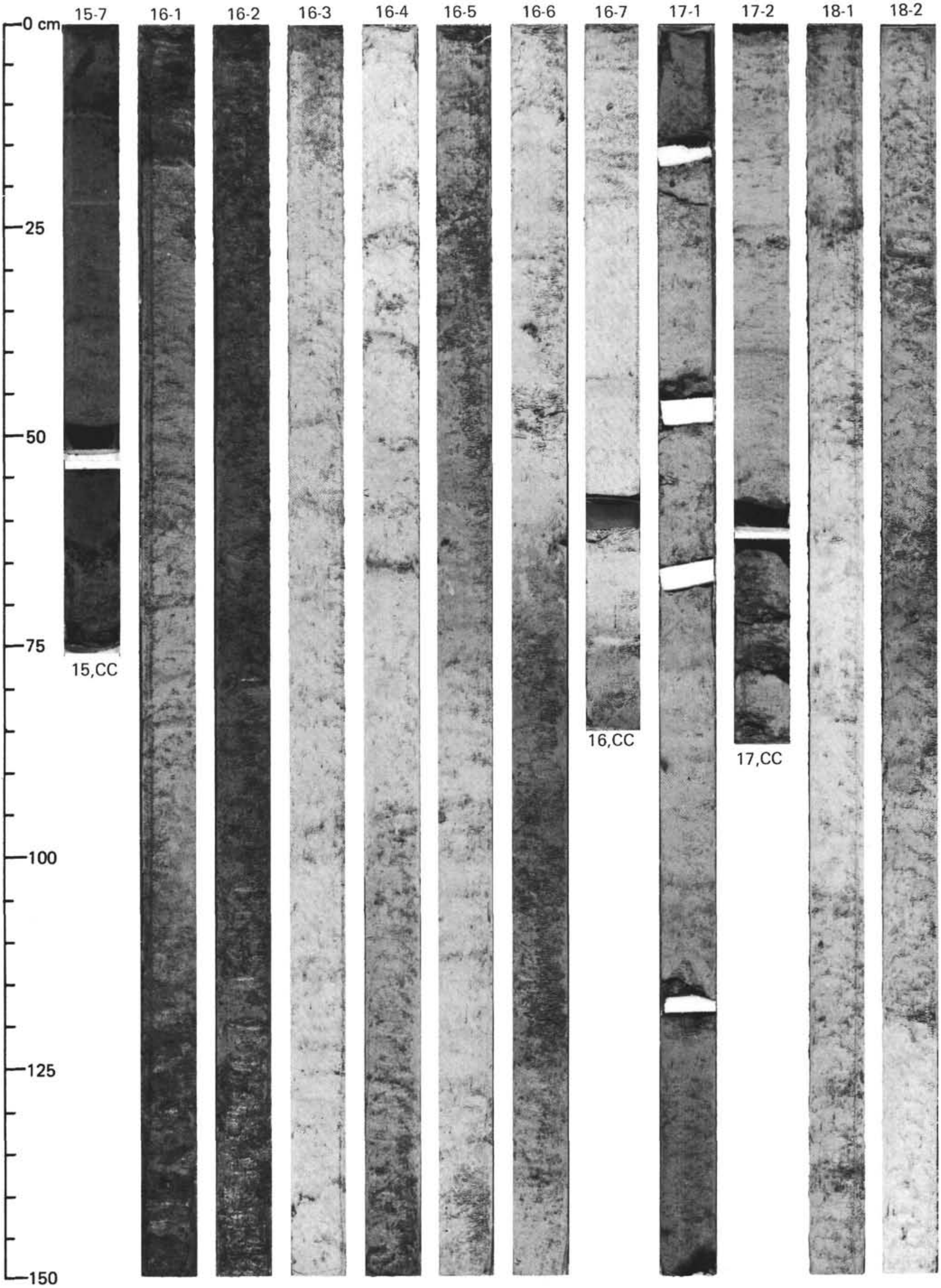
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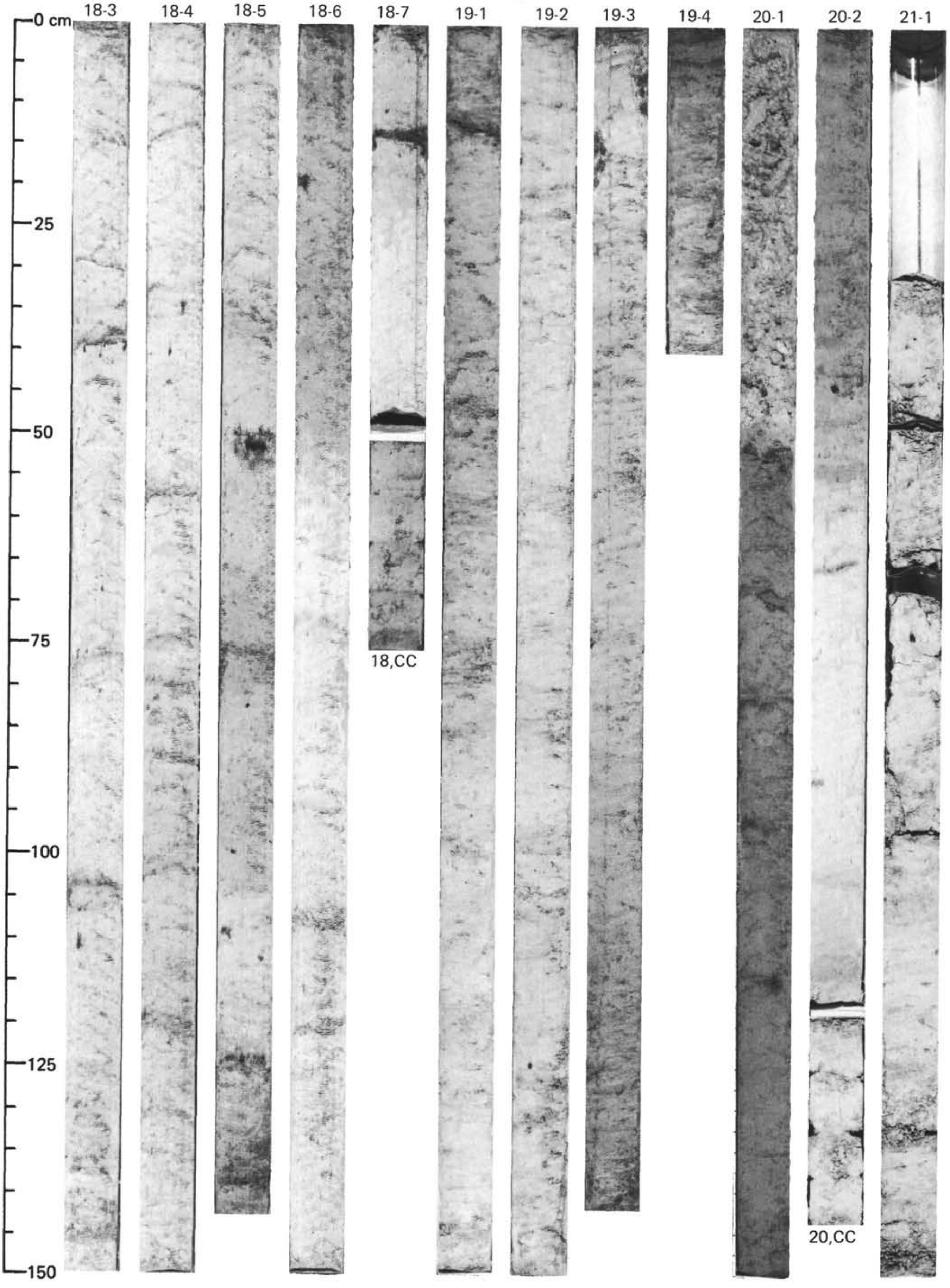
16,CC
17,CC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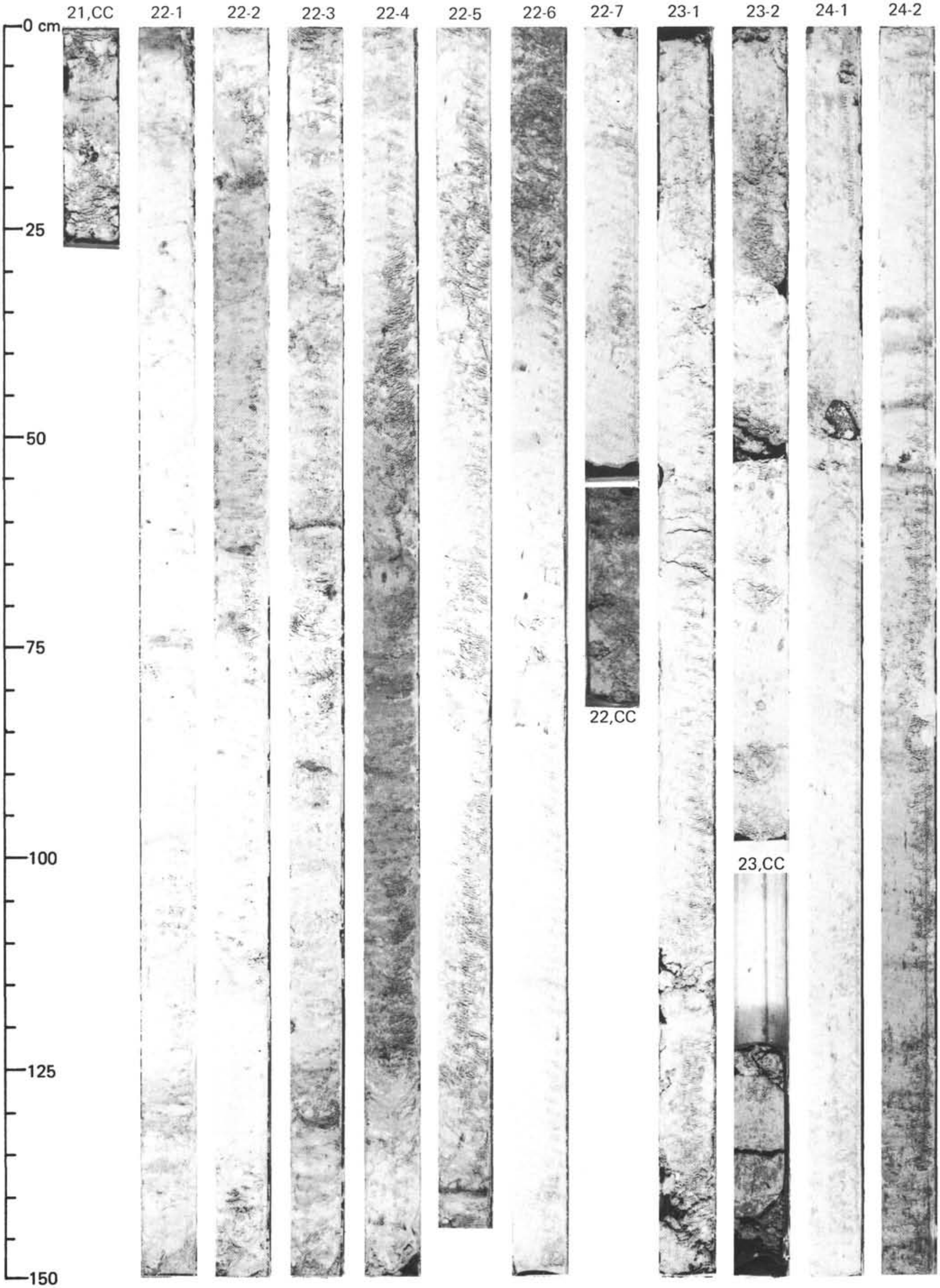
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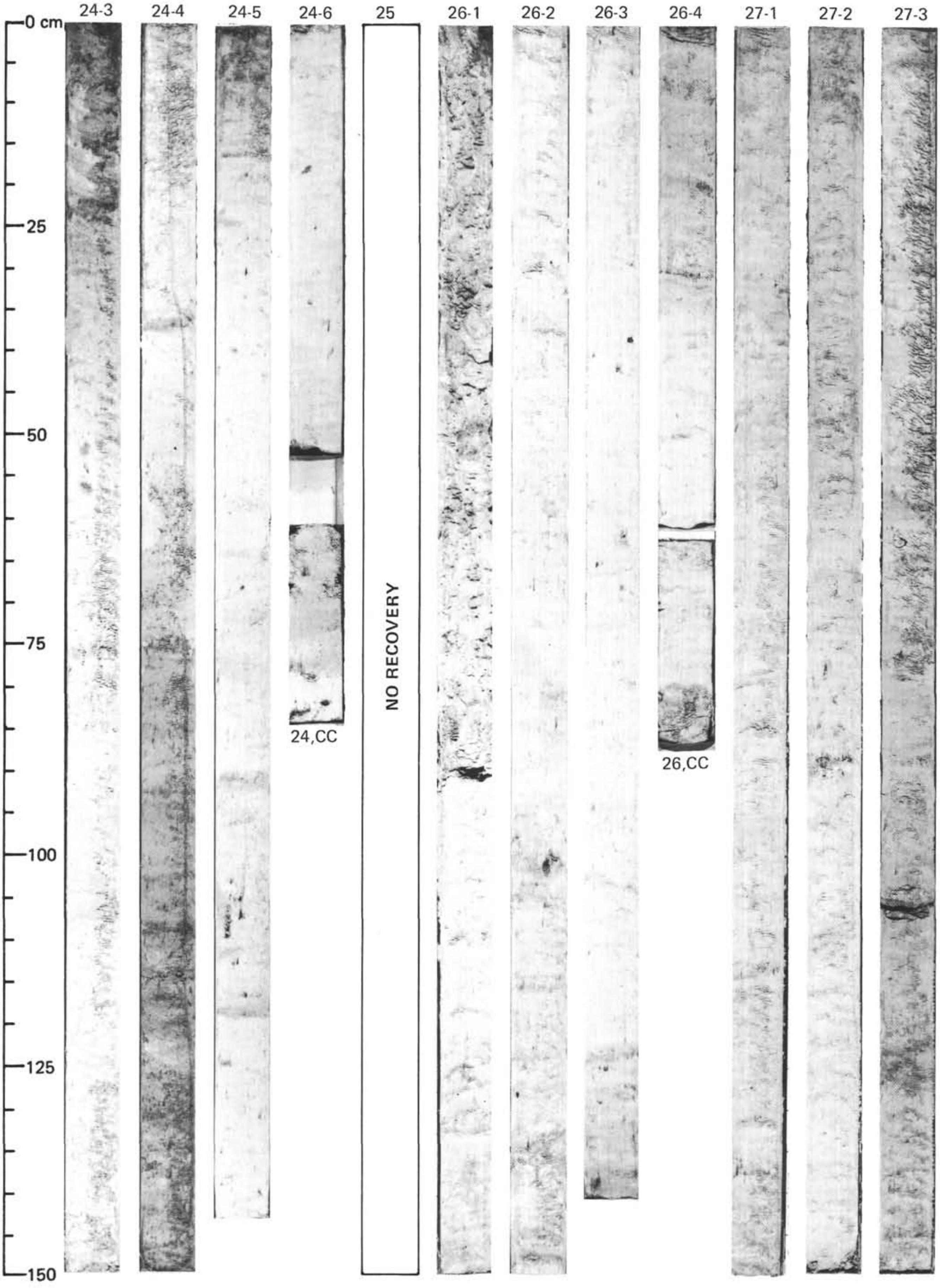
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NO RECOVERY
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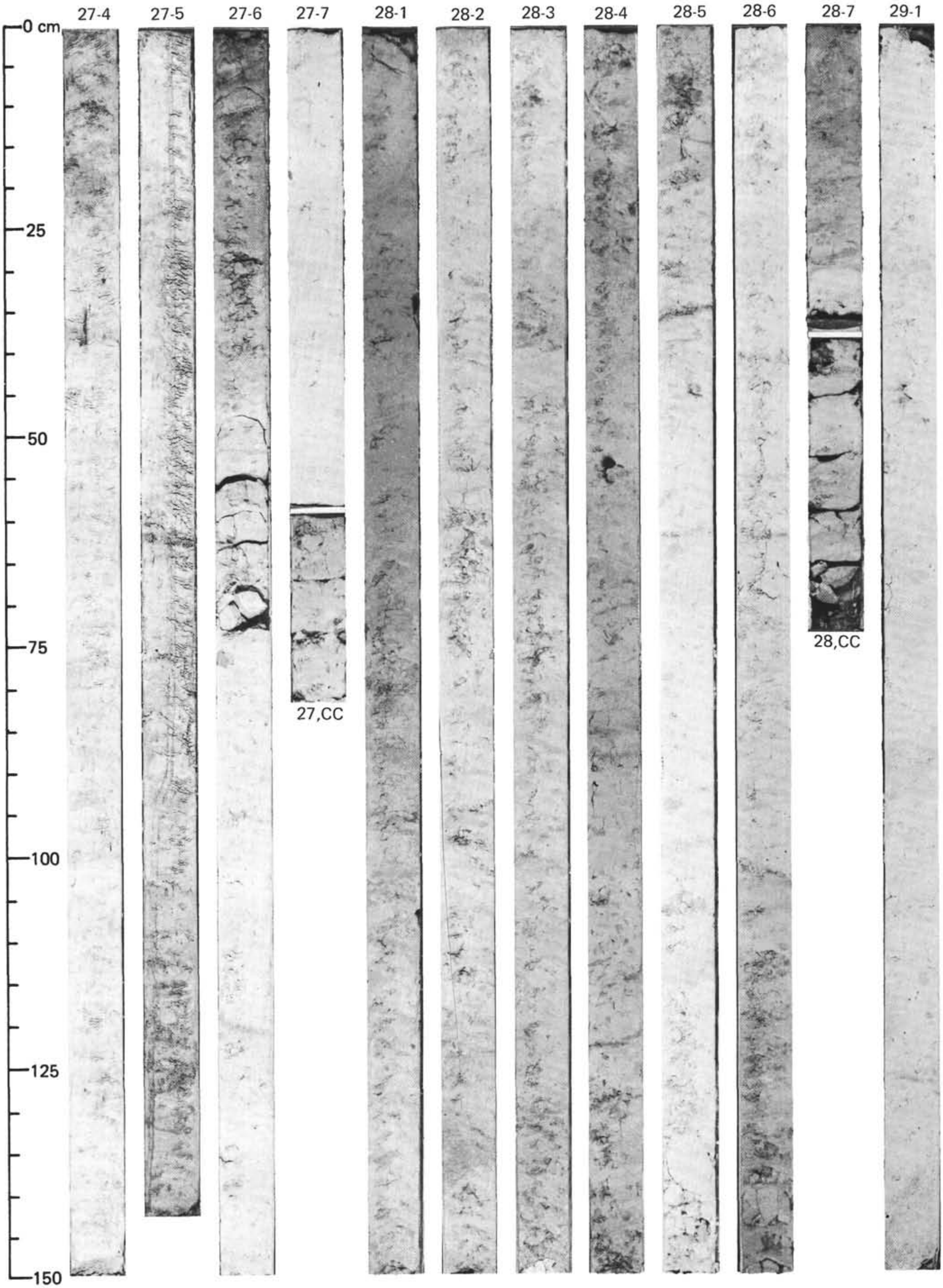
27-3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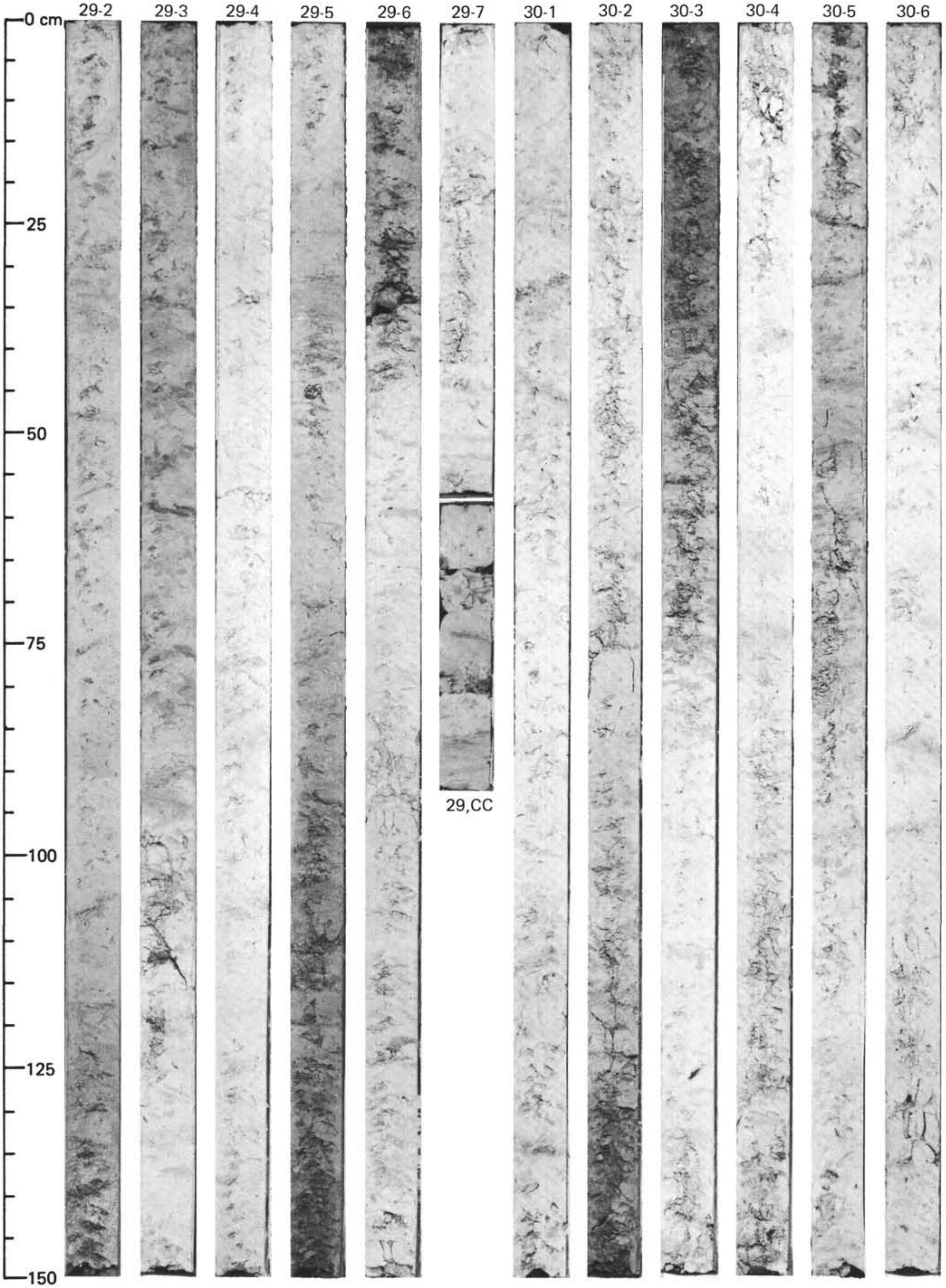
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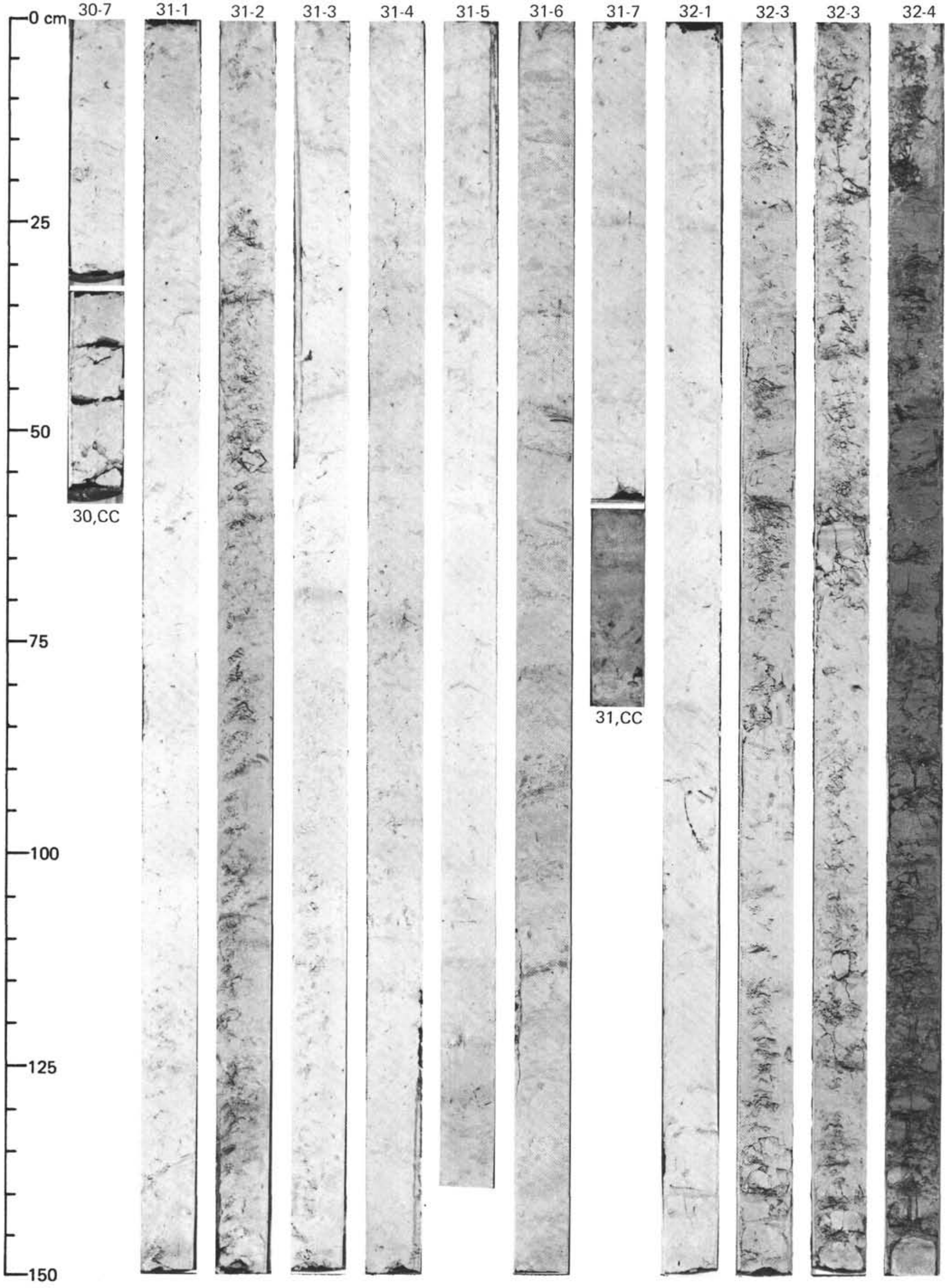
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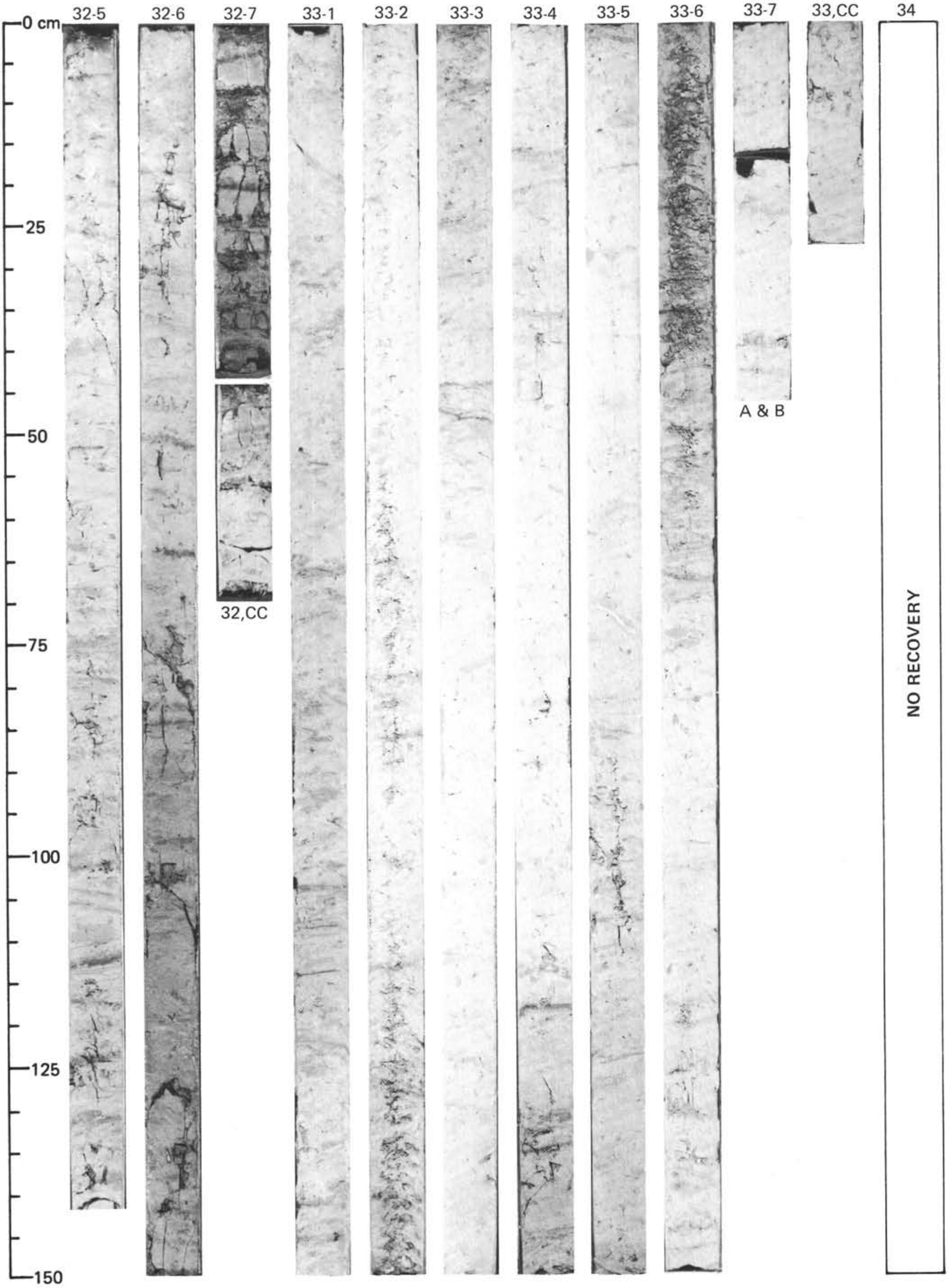
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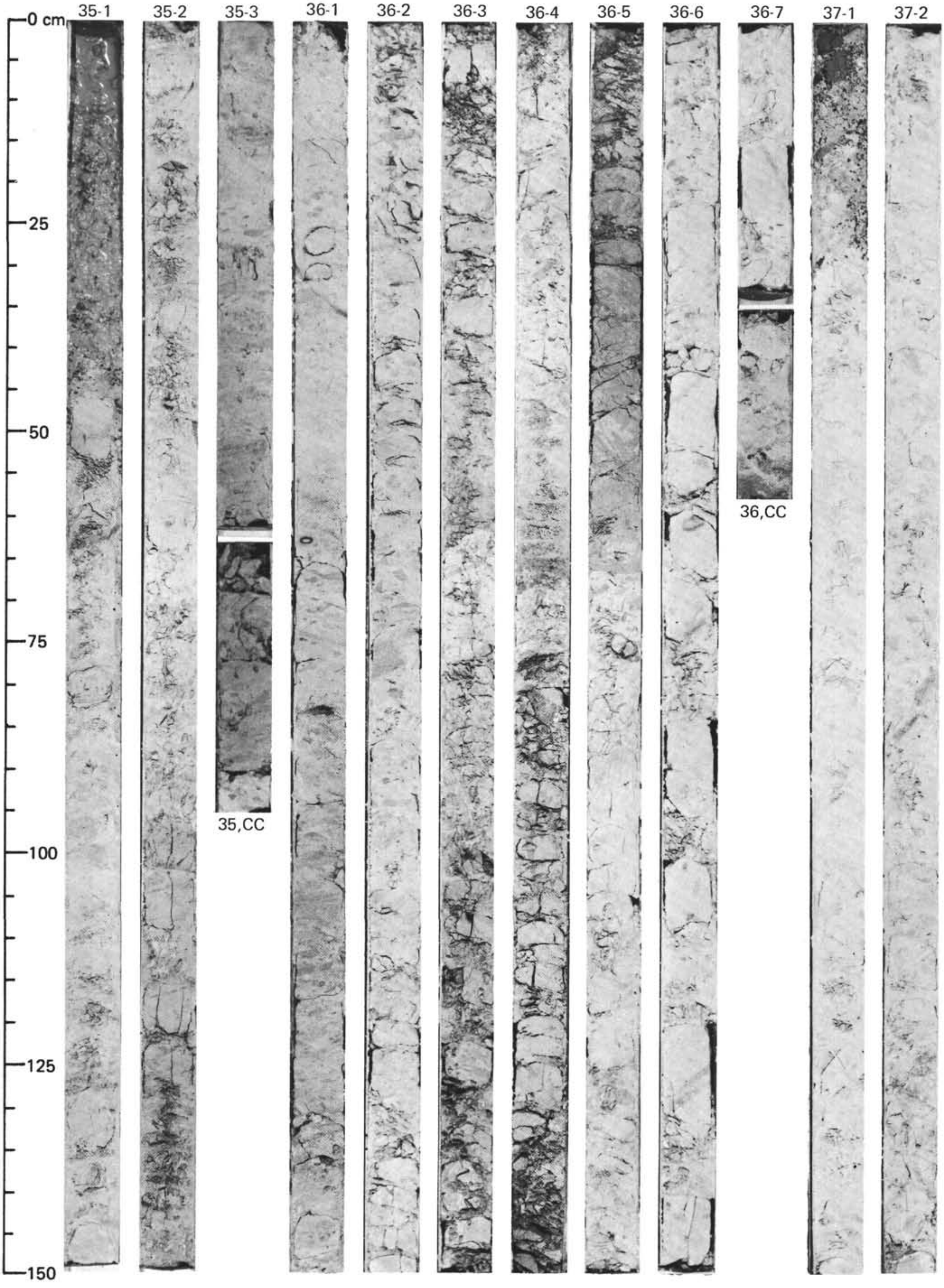
33,CC
34
NO RECOVERY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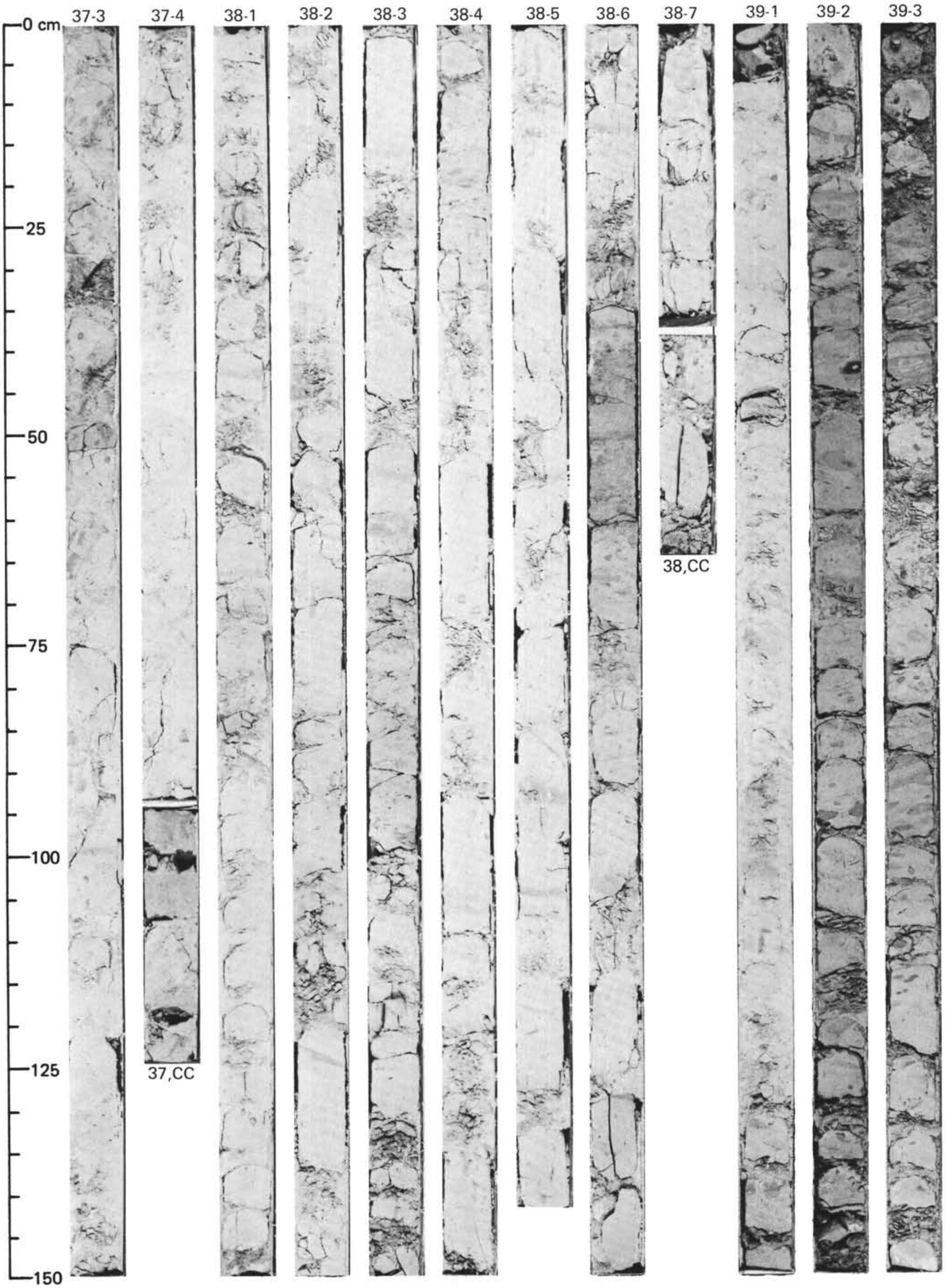
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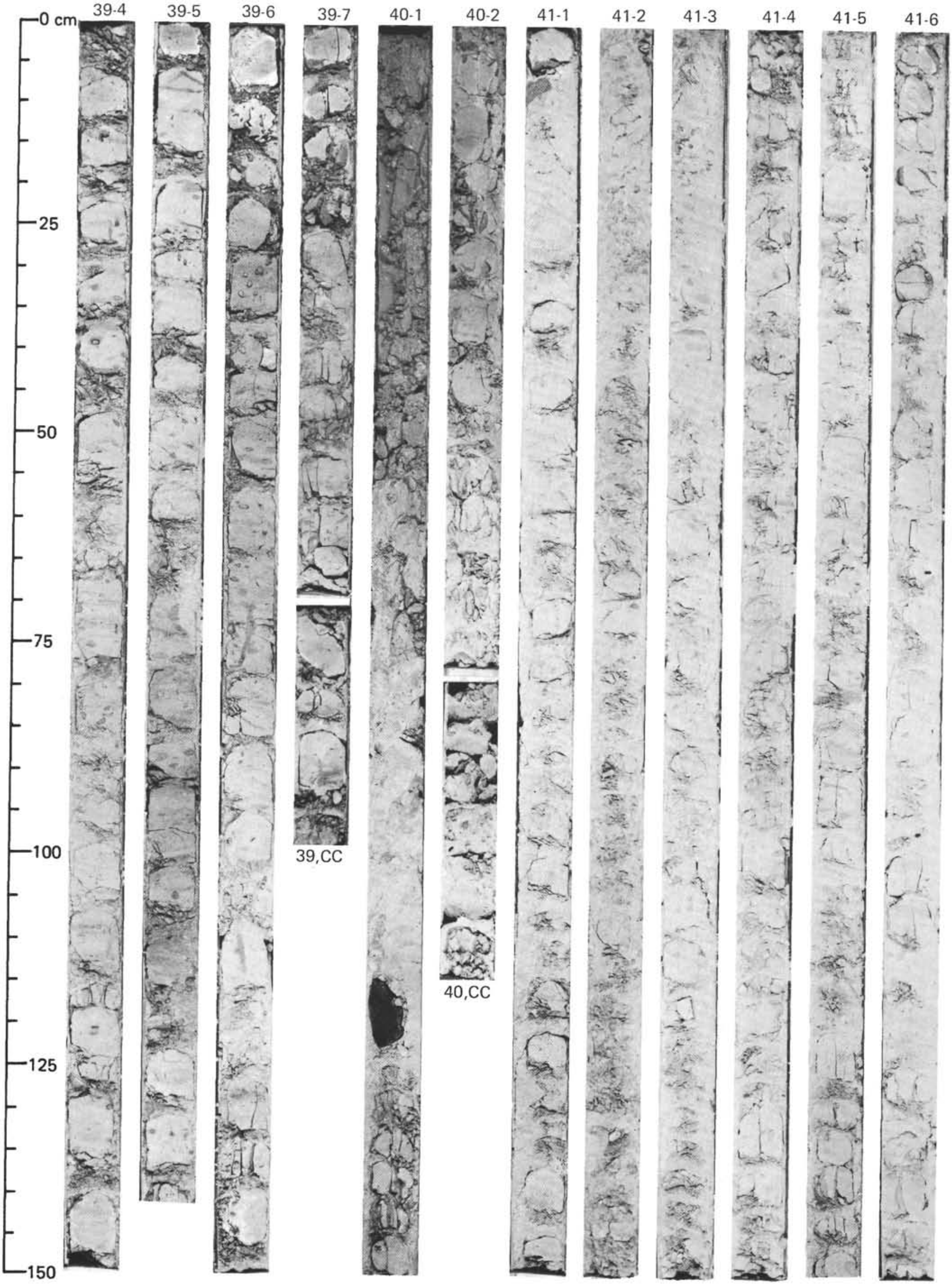
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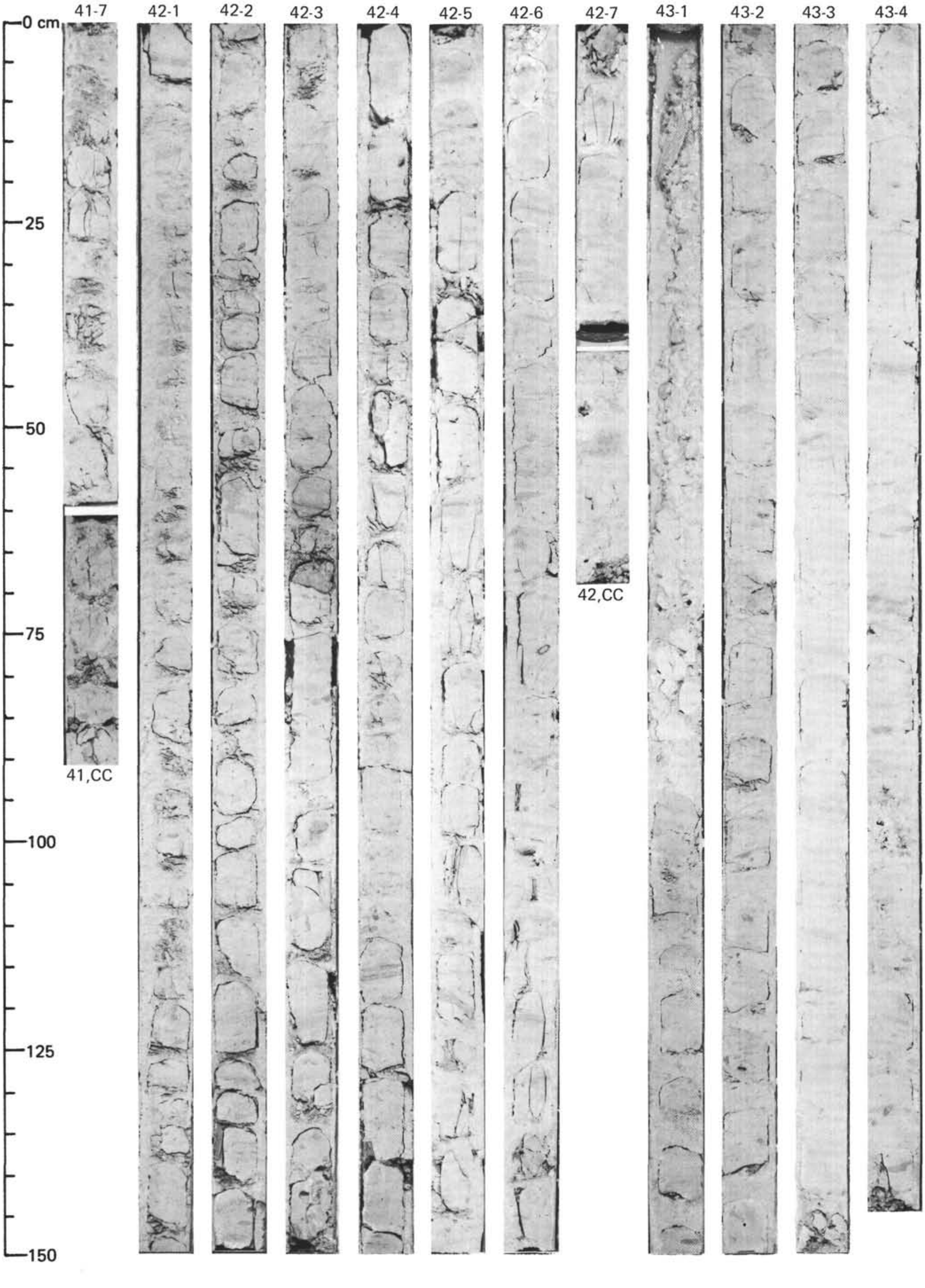
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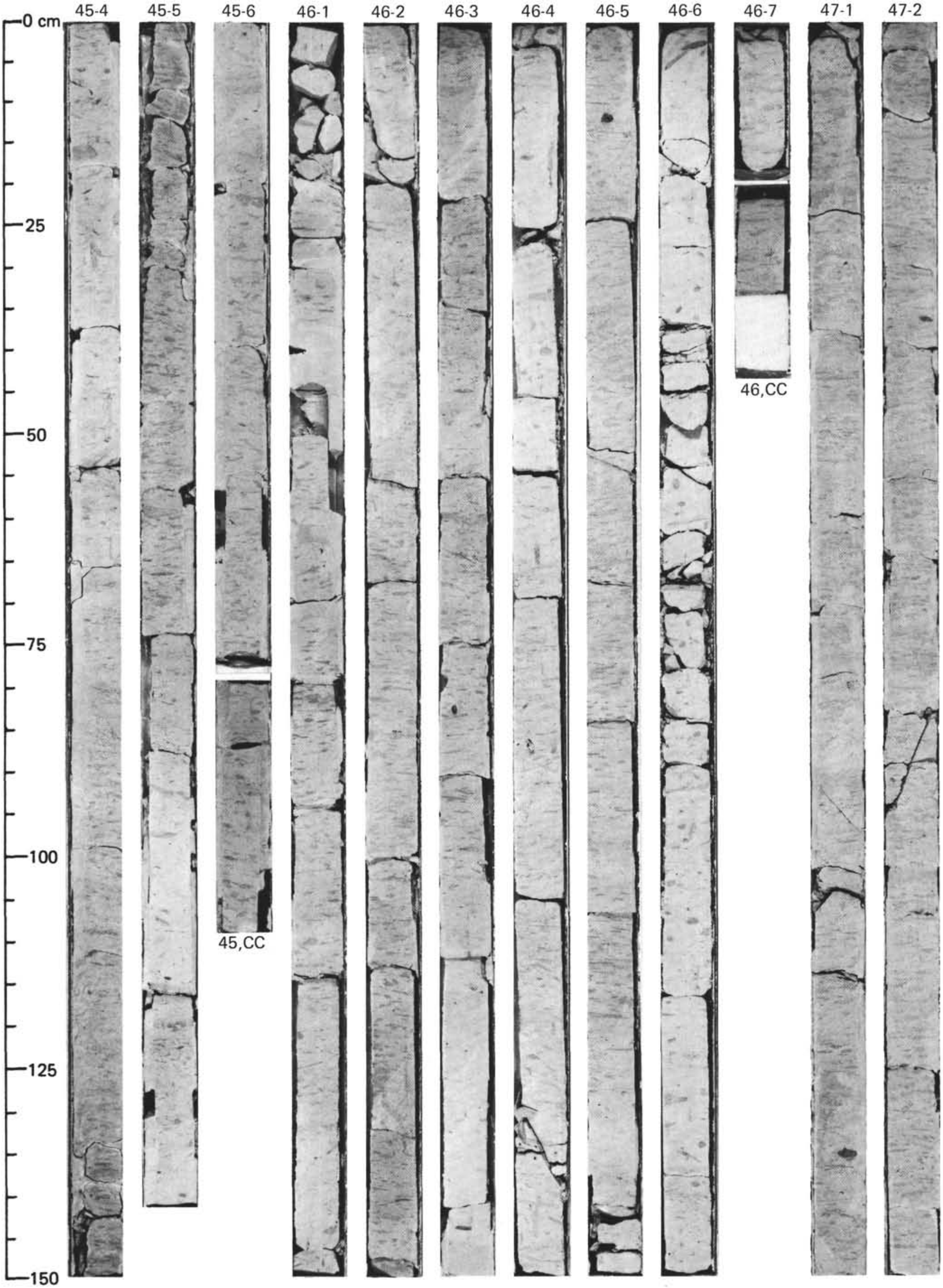
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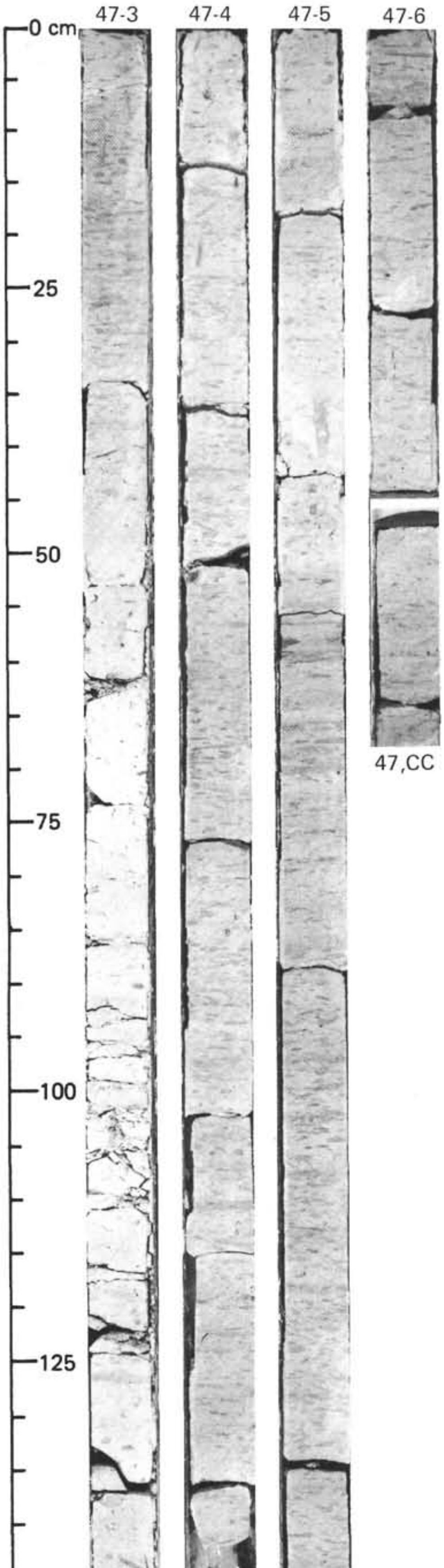
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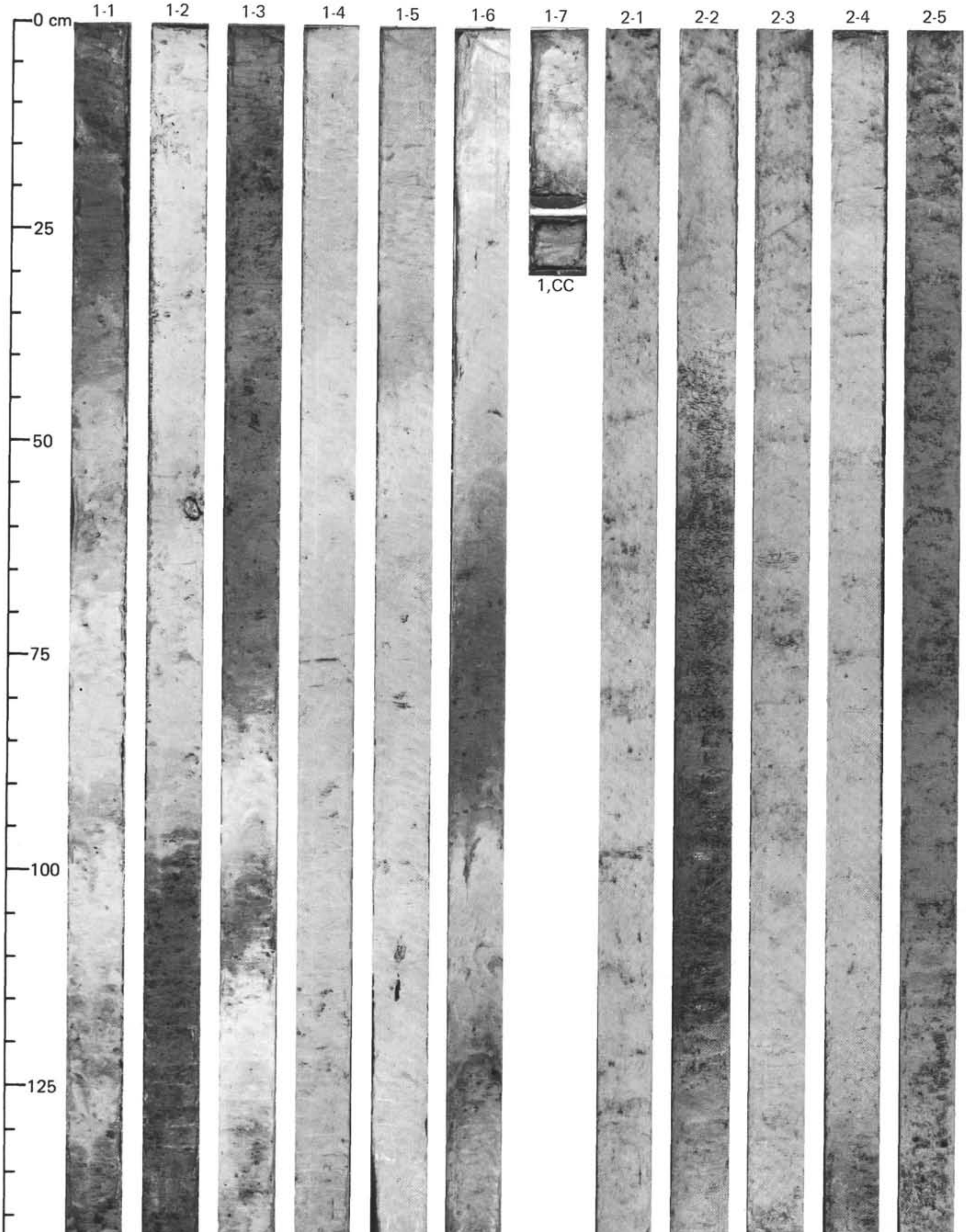
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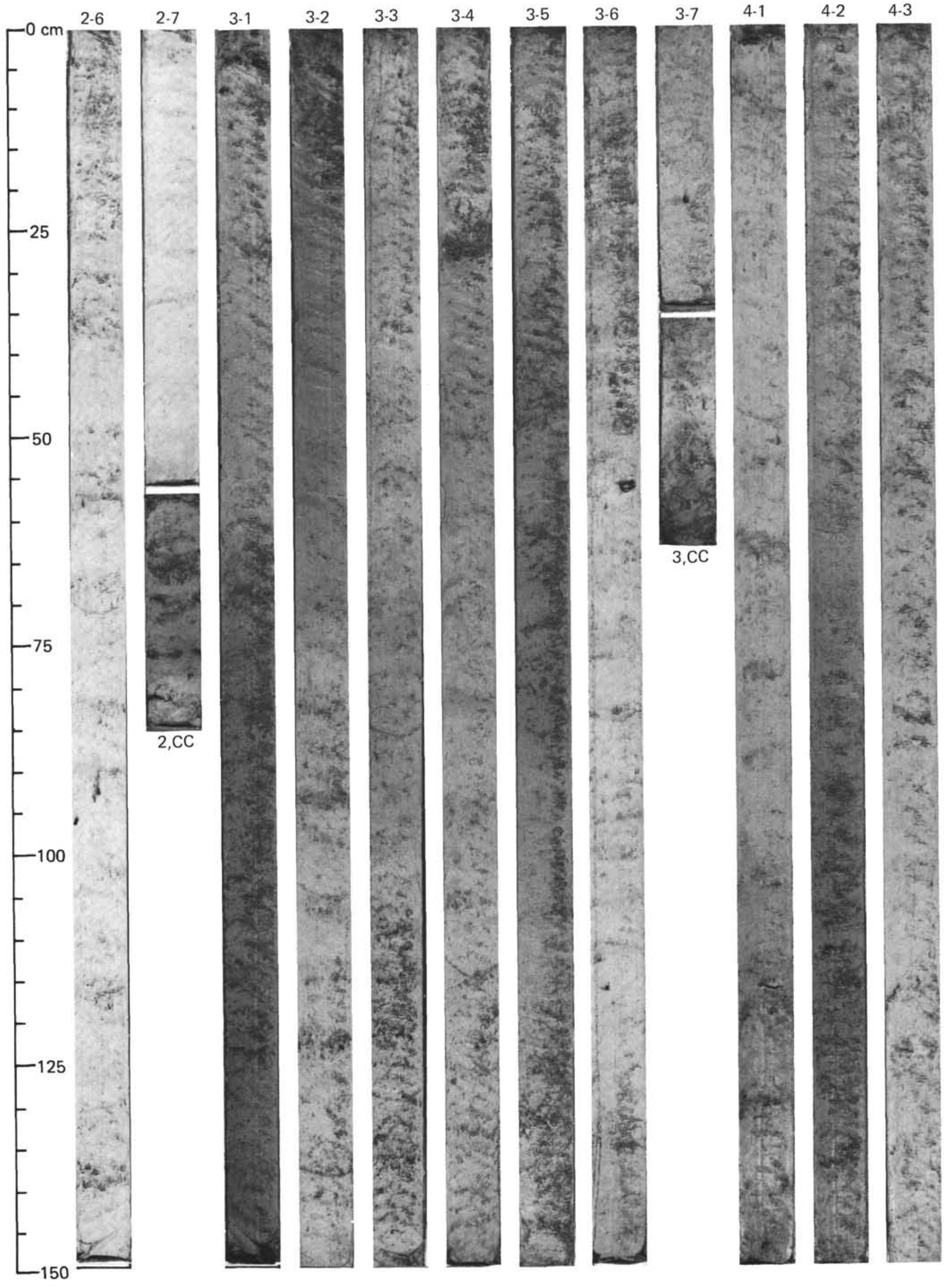
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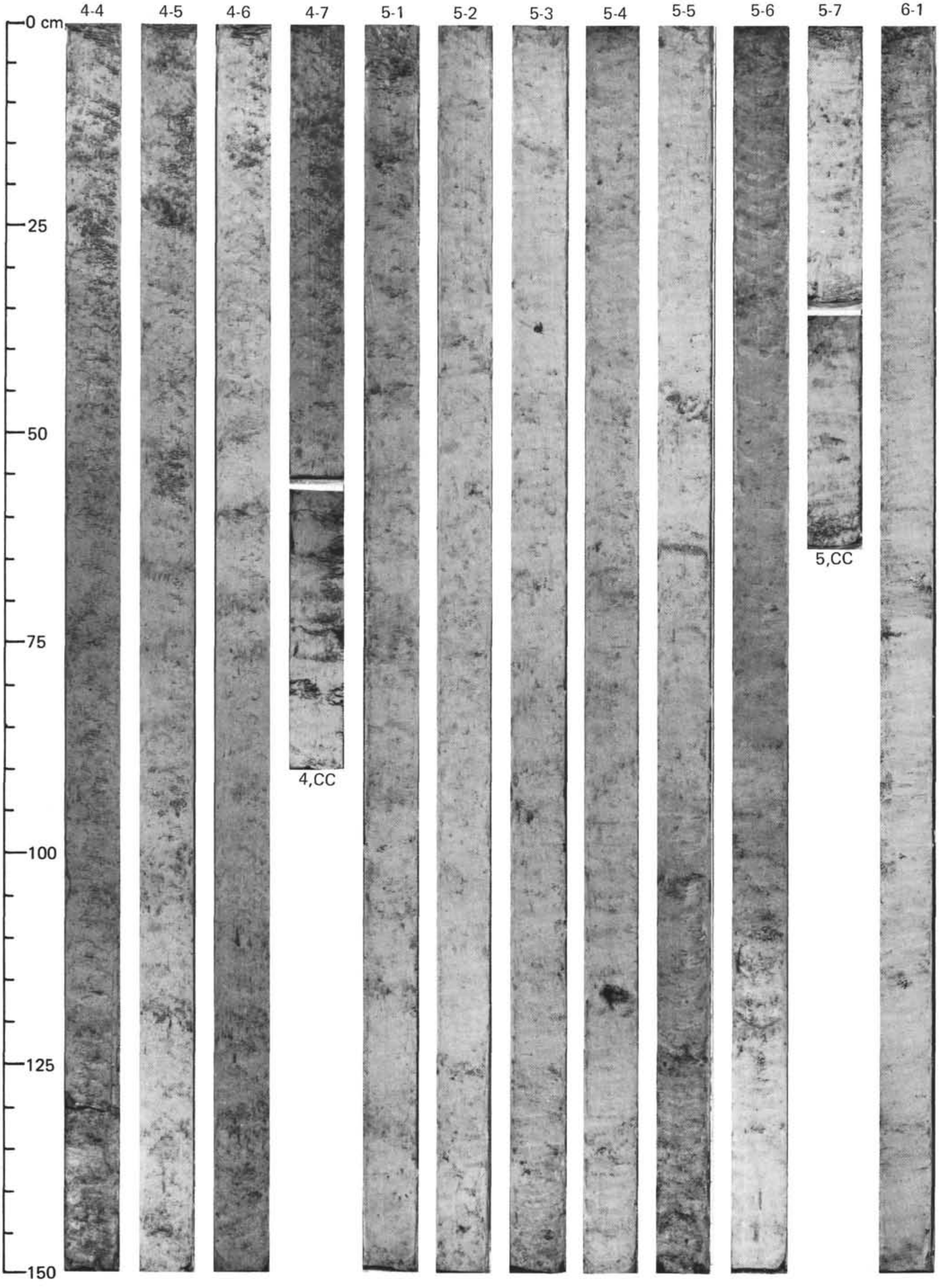
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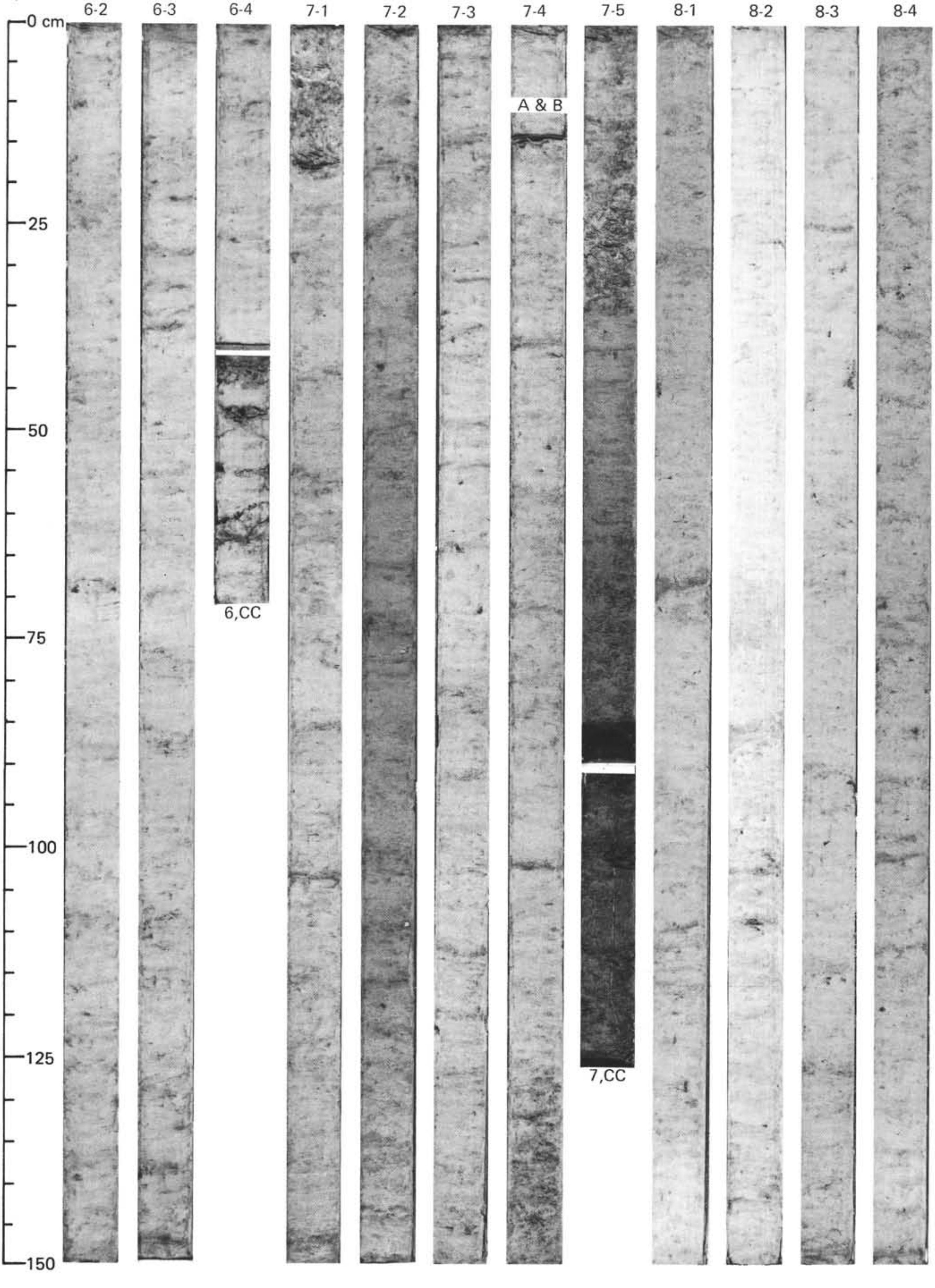
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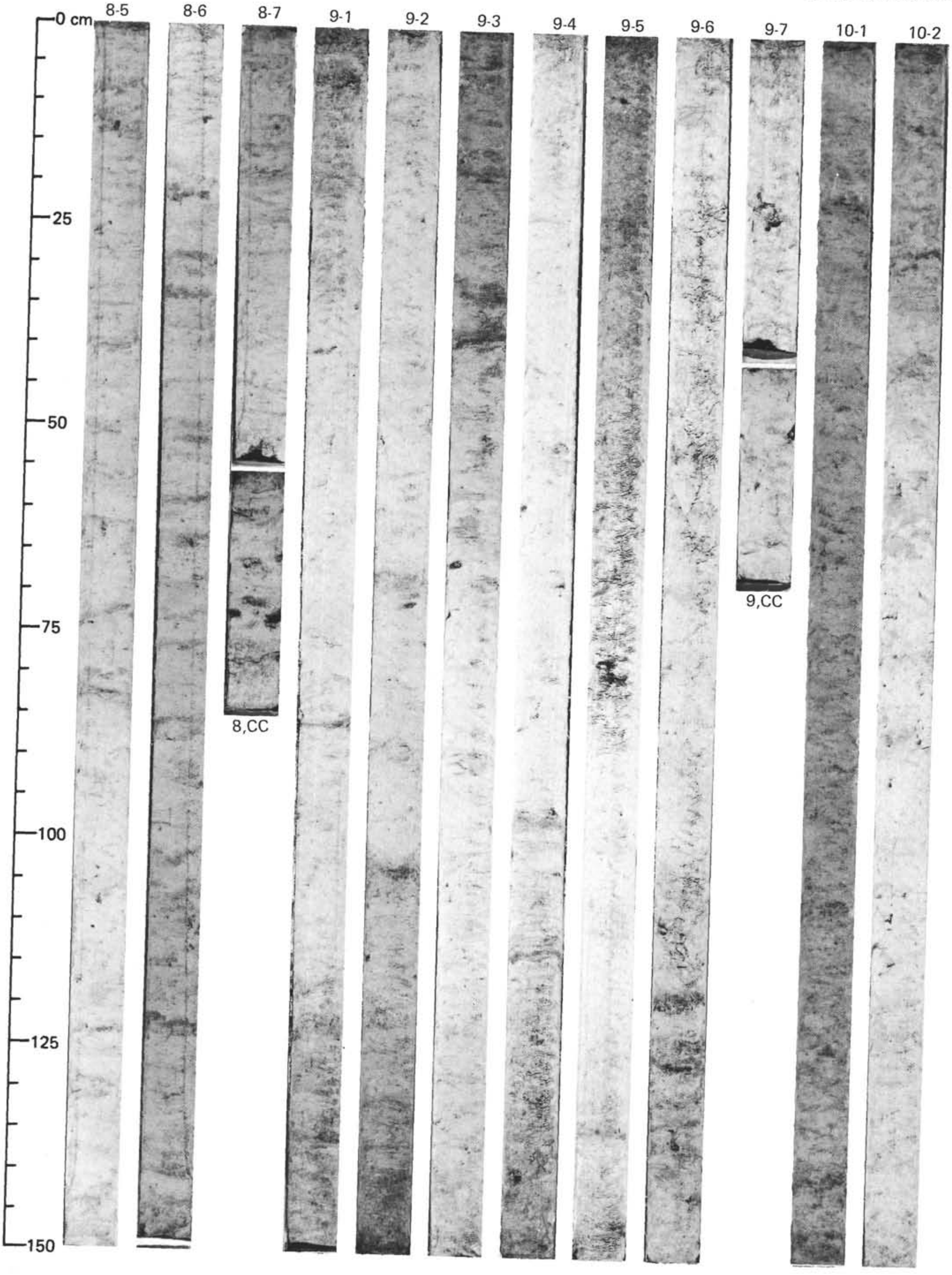
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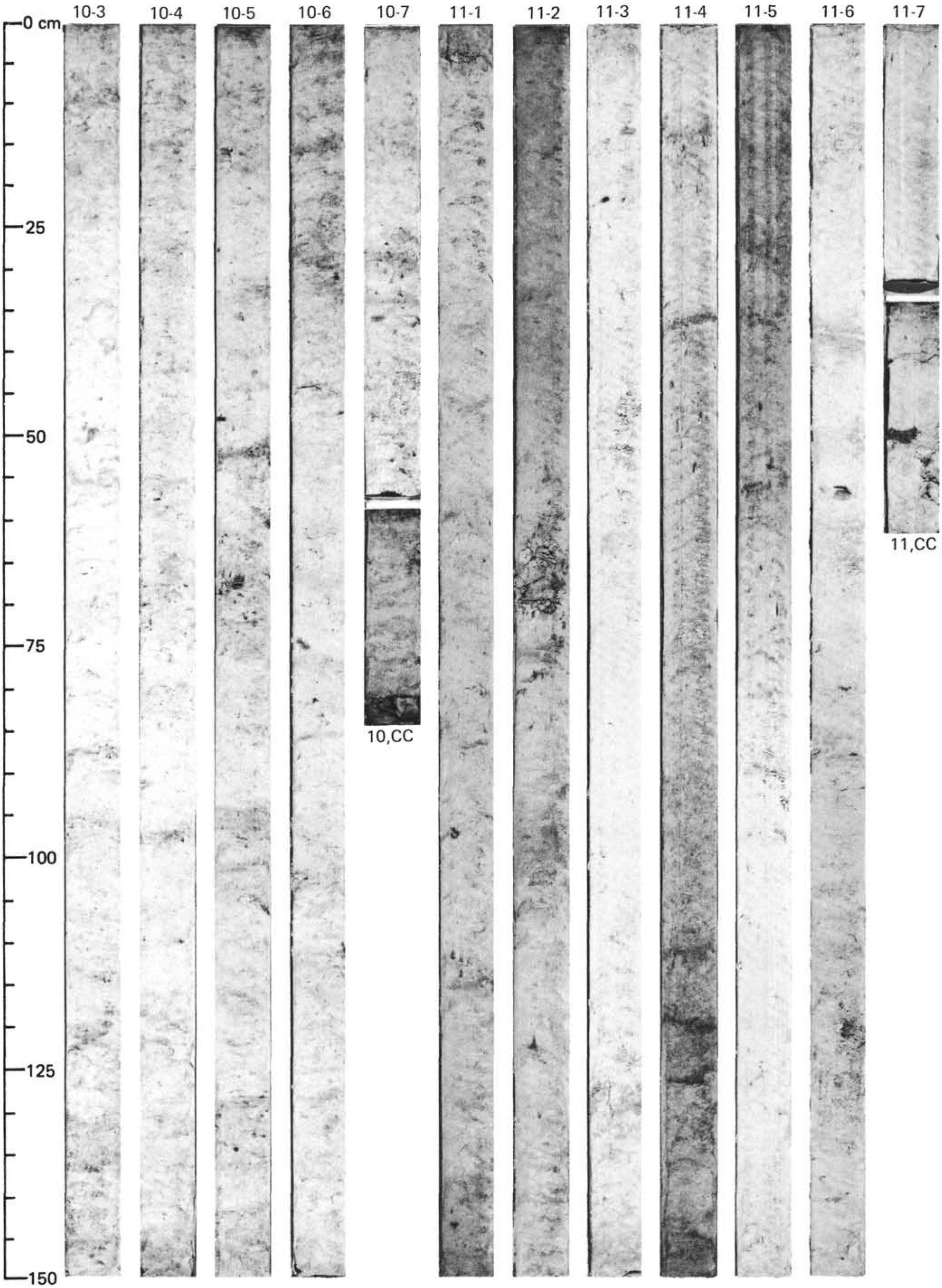
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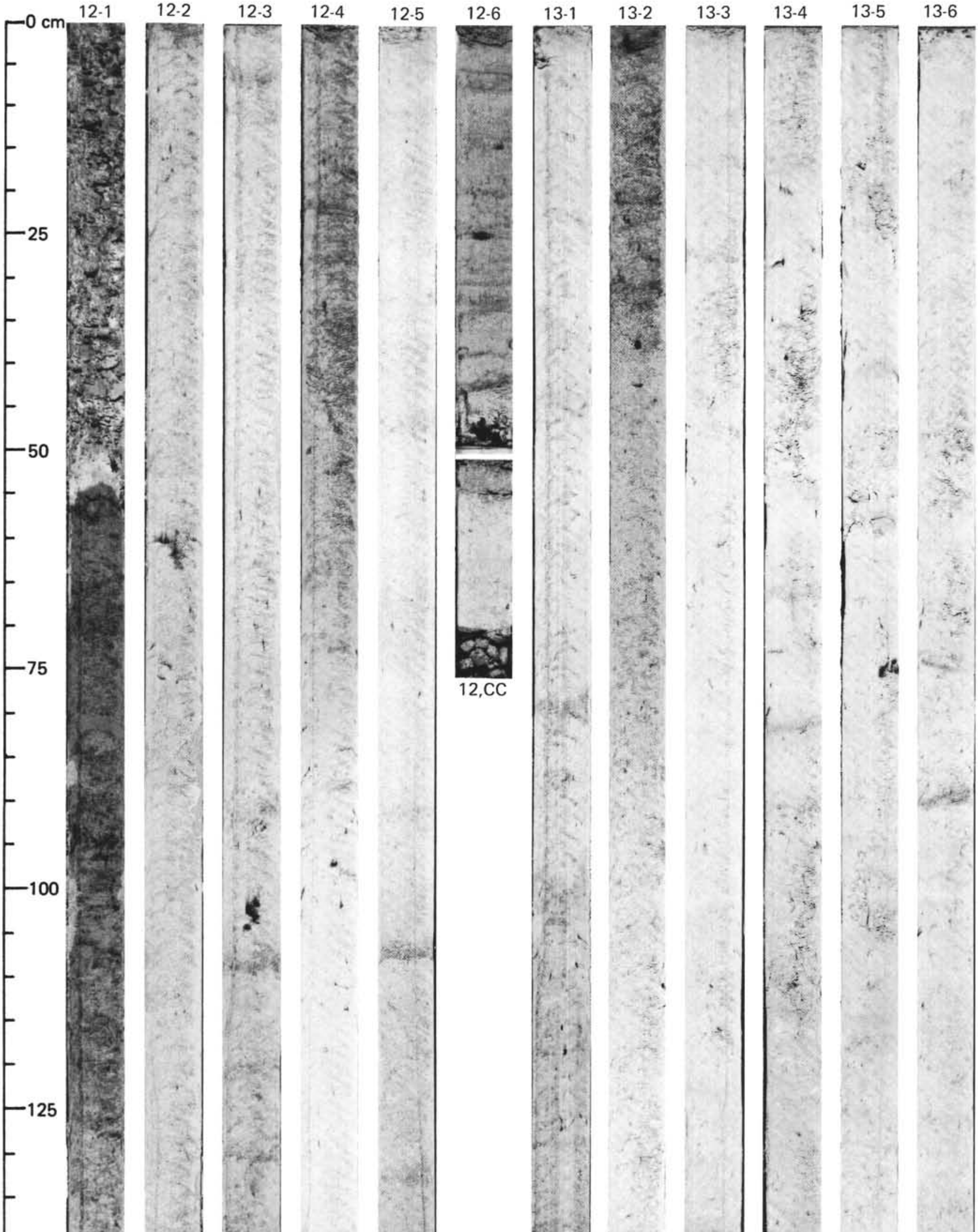
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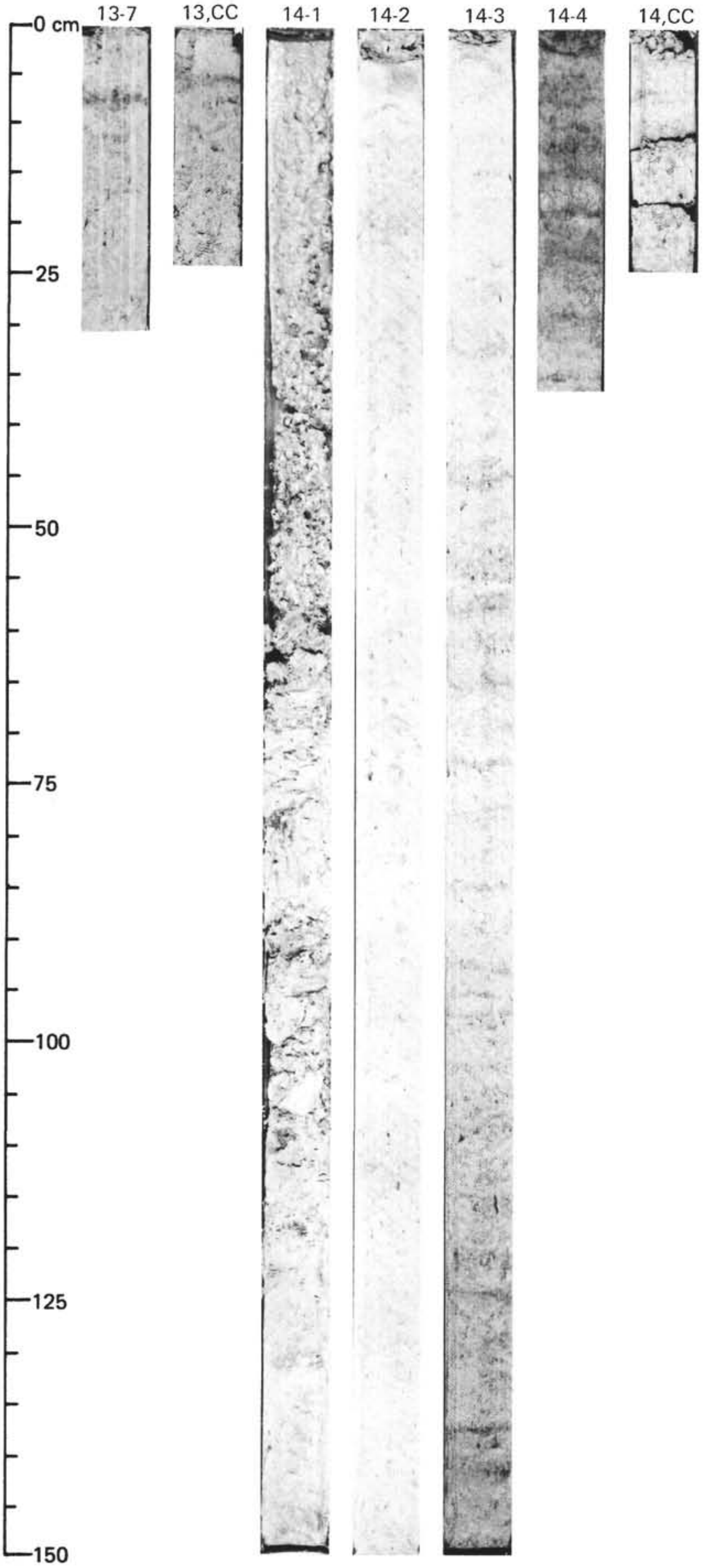
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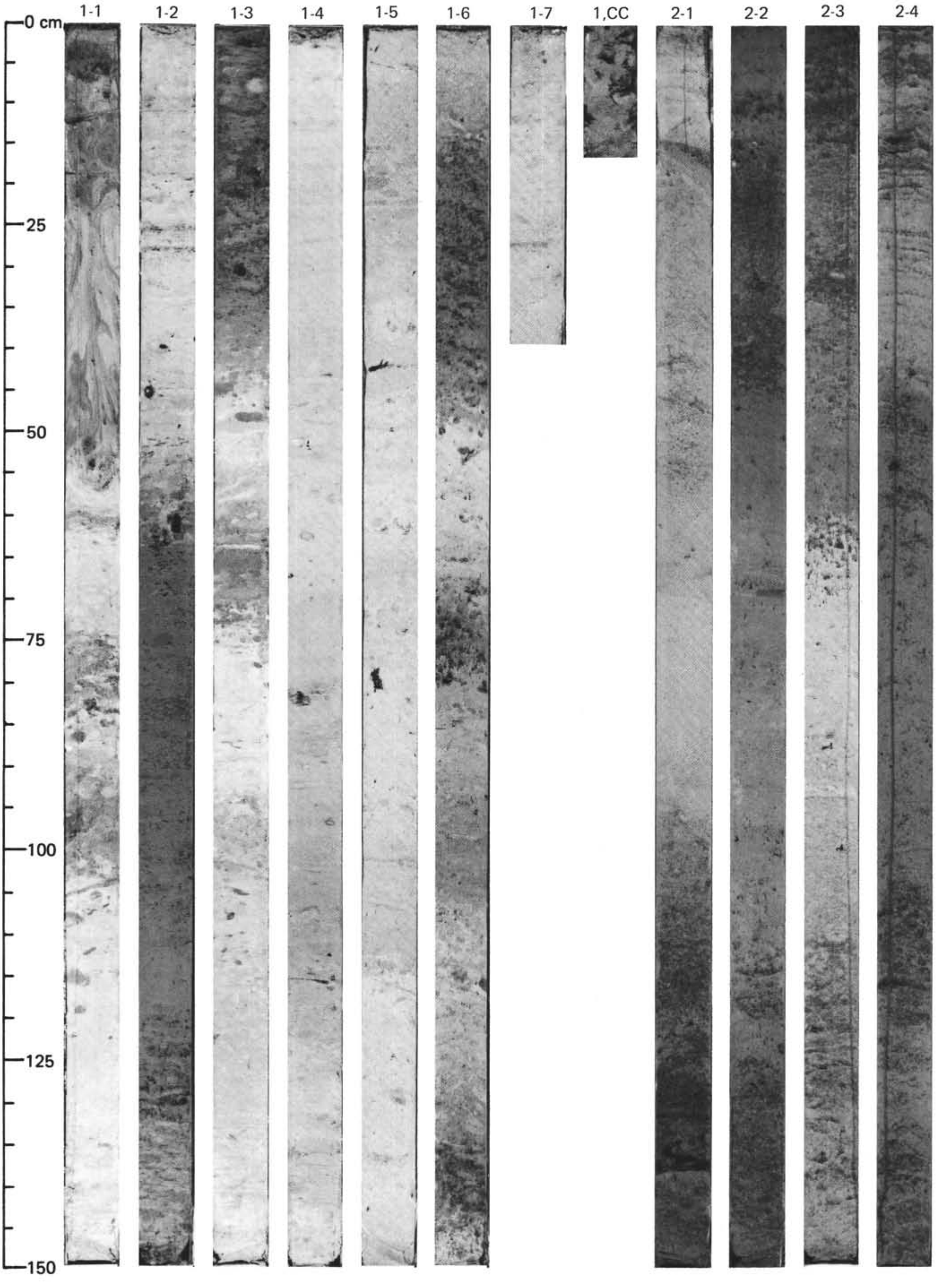
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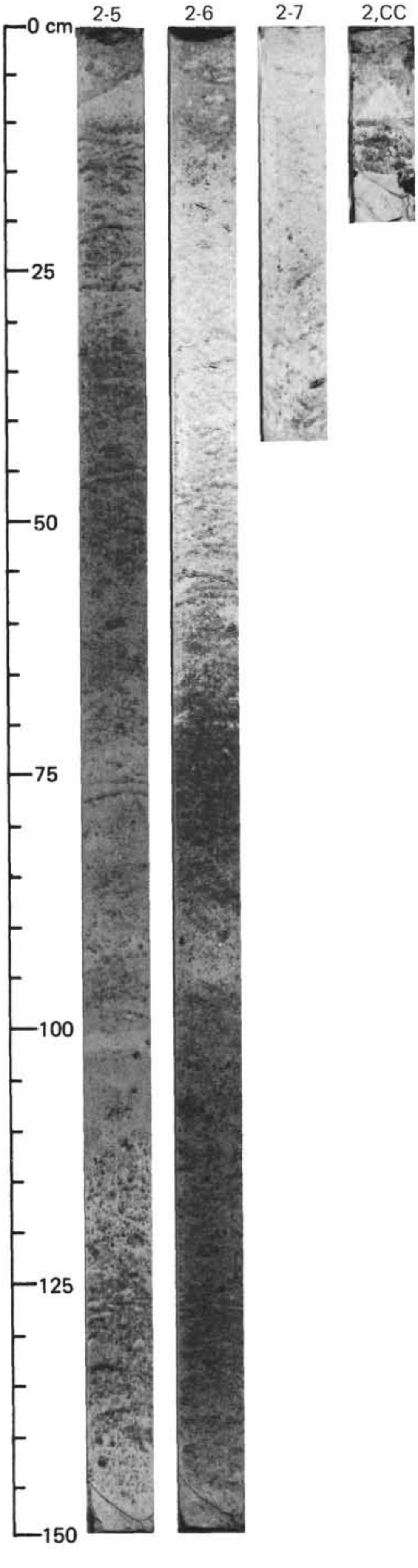
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