4. SITE 549[1]

Shipboard Scientific Party[2]

HOLE 549

Position: 49°05.28′N; 13°05.88′W

Water depth (sea level; corrected m, echo-sounding): 2515

Water depth (rig floor; corrected m, echo-sounding): 2525

Bottom felt (m, drill pipe): 2533

Penetration (m): 1001.5

Number of cores: 99

Total length of cored section (m): 812.5

Total core recovered (m): 369.7

Core recovery (%): 45.5

Oldest sediment cored:
Depth sub-bottom (m): 964.5
Nature: Micaceous foliated sandstone
Age: Paleozoic (middle to late Devonian)
Measured velocity (km/s): 3.672–4.256

Basement:
Depth sub-bottom (m): 964.5
Nature: Micaceous foliated sandstone
Velocity range (km/s): 3.672–4.256

Principal results: See discussion following site data for Hole 549A.

HOLE 549A

Position: 49°05.29′N; 13°05.89′W

Water depth (sea level; corrected m, echo-sounding): 2513

Water depth (rig floor; corrected m, echo-sounding): 2523

Bottom felt (m, drill pipe): 2535.5

Penetration (m): 198.5

Number of cores: 42

Total length of cored section (m): 196

Total core recovered (m): 144.4

Core recovery (%): 73.7

Oldest sediment cored:
Depth sub-bottom (m): 198.5
Nature: Bluish white nannofossil chalk
Age: middle Eocene
Measured velocity (km/s): 1.647

Basement: Not reached

Principal results: Two holes (549 and 549A) were drilled at Site 549 near the seaward edge of a tilted block of Hercynian basement that underlies the Pendragon Escarpment (Fig. 1). This is the second shallowest site on the Goban Spur transect.

Using the variable length hydraulic piston corer (VLHPC), we recovered an abbreviated 144.4 m sequence (196 m penetration) of Holocene through middle Eocene nannofossil and marly nannofossil ooze and chalk in Hole 549A (Tables 1–3). Rotary coring in Hole 549 recovered 369.7 m (812.5 m penetration) of upper middle Eocene through lower Barremian chalks, mudstones, sandstones, and limestones, which overlie foliated, micaceous middle to upper Devonian sandstone (37 m penetration; total depth 1001.5 m) (Tables 1–3).

One downhole log run was successful, and heat flow measurements documented a geothermal gradient of 24.46°C/km.

The most significant achievements at Site 549 were as follows:

1. Recovery of a thick Barremian synrift sequence that directly overlies Hercynian basement of middle to late Devonian age. The sediments and fossils reveal the gradual invasion of marine waters, beginning with a littoral sequence and culminating in open marine, middle to outer sublittoral paleoenvironments. The presence of ferruginous quartzose clays and abundant plant debris suggests the proximity of subaerial blocks of Hercynian basement.
2. Identification of the oldest postrift sediments as early Albian in age.
3. Recovery of 0.5 m of black shale (late Cenomanian) that contains marine organic carbon and is embedded within a 100 m sequence of white Upper Cretaceous chalk.
4. Recovery of a nearly complete sequence of upper Paleocene to upper Oligocene pelagic sediments that contain rich assemblages of mostly well preserved calcareous micro- and nannofossils. This sequence may be the best biostratigraphic reference section for this interval in the eastern North Atlantic.

Eleven lithologic units were identified (Table 3):

Unit 1: 0–27 m below seafloor (BSF), alternating zones of light reddish brown calcareous muds and light gray marly foraminifer-

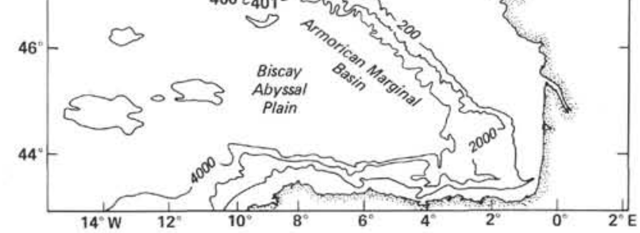

Figure 1. Location map for Leg 80 drill sites (548–551). Three Leg 48 drill sites (400–402) are also shown.

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[1] Graciansky, P. C. de, Poag, C. W., et al., *Init. Repts. DSDP*, 80: Washington (U.S. Govt. Printing Office).

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Table 1. Coring summary, Leg 80.

Hole	Latitude	Longitude	Water depth (m)	Number of cores	Cores with recovery	Percent of cores with recovery[a]	Meters cored	Meters recovered	Percent recovered[b]	Meters drilled	Total penetration (m)	Average penetration rate (m/hr.)[c]	Time on hole or site (hr.)
548	48°54.95′N	12°09.84′W	1256	35	35	100.0	211.0	210.9	99.9	0	211.0		45.2
548A	48°54.93′N	12°09.87′W	1256	38	38	100.0	346.0	246.5	71.2	205.5	551.5	42.4	82.9
		Total for site		73	73	100.0	557.0	457.4	82.1	205.5	762.5		128.1
549	49°05.28′N	13°05.88′W	2533	99	93	93.9	812.5	369.7	45.5	189.0	1001.5	7.9	301.2
549A	49°05.29′N	13°05.89′W	2535.5	42	41	77.6	196.0	144.4	73.7	0	198.5		54.2
		Total for site		141	134	95.0	1008.5	514.1	51.0	189.0	1200.0		355.4
550	48°30.91′N	13°26.37′W	4432	48	46	95.8	442.5	262.6	59.3	94.0	536.5	36.4	115.3
550A	48°30.91′N	13°26.39′W	4432	0	0	0	0	0	0	95.0	95.0	170.6	19.2
550B	48°30.96′N	13°26.32′W	4432	30	30	100.0	264.5	177.9	67.3	456.0	720.5	14.2	150.3
		Total for site		78	76	97.4	707.0	440.5	62.3	645.0	1352.0	34.0[d]	284.8
551	48°54.64′N	13°30.09′W	3909	14	13	92.9	125.0	81.0	64.8	76.0	201.0	9.1	75.2
		Total for leg		306	296	96.7	2397.5	1493.0	62.2	1115.5	3515.5		843.5

Note: Blanks signify that quantities are unknown.

[a] Total for site is calculated from total number of cores and total cores with recovery.

[b] Total for site is calculated from total meters cored and total meters recovered.

[c] Rotary coring only.

[d] Total meters penetrated divided by number of rotating hours.

nannofossil ooze. Sediment is Holocene-Pleistocene in age and lower bathyal in nature. As at Site 548, the alternation of glacial and interglacial deposits yielded a clear record of Quaternary paleoclimates. There is a hiatus of 3 m.y. at the base (the Pliocene and lowest Pleistocene are missing).

Unit 2: 27–276.5 m BSF, light greenish gray to bluish white nannofossil chalk. Sediment is late Miocene to middle Eocene in age and bathyal in nature. The Miocene section is abbreviated; the Oligocene and Eocene sections are thick and nearly complete, containing well preserved micro- and nannofossils.

Unit 3: 276.5–382 m BSF, brownish to grayish marly nannofossil chalk and greenish gray nannofossil chalk. Sediment is middle Eocene to late Paleocene in age and bathyal in nature. The section appears to be complete, although there is a 0.5 m.y. hiatus at the base (the lower Thanetian is missing).

Unit 4: 382–426.6 m BSF, light brown, green, and white nannofossil chalk. Sediment is Danian to early Turonian in age and bathyal in nature. There is a major hiatus near the top (about 3 m.y.; the lower Danian is missing).

Unit 5: 426.6–479 m BSF, clayey nannofossil chalk. Sediment is early Turonian to early middle Cenomanian in age and bathyal in nature. There is a 4 m.y. hiatus at the base (the upper Albian is missing).

Unit 6: 479–664.2 m BSF, dark calcareous siltstones. Sediment is middle to early Albian in age and outer sublittoral in nature; it represents the oldest(?) postrift unit. There is a hiatus at the base (the earliest(?) Albian and latest(?) Aptian are missing).

Unit 7: 664.2–673.9 m BSF, red sandy dolomite. Sediment is of unknown age. The unit may represent the top of the synrift sequence. There is an 8 m.y. hiatus at the base (most or all of the Aptian is missing).

Unit 8: 673.9–755 m BSF, reddish to gray calcareous and sandy calcareous mudstones. Sediment is early late Barremian to late early Barremian in age and middle to outer sublittoral in nature.

Unit 9: 755–801.5 m BSF, calcareous grainstones (poor recovery). Sediment is early Barremian in age and middle sublittoral in nature.

Unit 10: 801.5–964.5 m BSF, interbedded calcareous and noncalcareous sandy mudstones and mudstones. Sediment is early Barremian to Hauterivian(?) in age and littoral to inner sublittoral in nature.

Unit 11: 964.5–1001.5 m BSF, foliated micaceous sandstone. Sandstones are Paleozoic in age and form the Hercynian basement.

Site chapter results are based chiefly on shipboard analysis and interpretation. The specialty chapters reflect postcruise revisions and additional data. Where discrepancies arise, the specialty chapters should be considered correct.

SITE APPROACH AND OPERATIONS

Glomar Challenger departed Site 548 at 2220 hr. (local time) on 14 June, heading northwest to the location proposed for Site 549, which was 37.6 naut. mi. (69 km) distant (Fig. 1). The approach strategy was to join control seismic line IOS (Institute of Oceanographic Sciences) CM 10 at shot point 2700, which was 25 km northeast of the proposed site, and to proceed southwest along the seismic line to the site (Fig. 2A).

However, lack of a pit (pitot) log to measure ship's speed, inability to use ship's LORAN navigation system in the northern Biscay region, long time intervals between satellite fixes, and prevailing northwest wind (average 15 knots) combined to place us on a course parallel to, but 1 naut. mi. (1.8 km) north of, line CM 10. *Glomar Challenger*'s precision depth recorder (PDR) and the air gun seismic record were compared with line CM 10 in an attempt to recognize similar bottom topography and shallow structure. After the ship made the southwest turn the first satellite fix arrived (at 0316 hr. on 15 June), but it was no good. The first good fix arrived 1 hr. 45 min. later (at 0500 hr.), as we approached a point that appeared to be on structural strike with the proposed site. Therefore, at 0513 hr. a beacon was dropped there (Fig. 2B).

As we continued away from the beacon, parallel to line CM 10, it became obvious that the beacon was too far down the escarpment to match the proposed location. Because of the poor prospect for accurate satellite navigation, we decided to use the emplaced beacon to maneuver to the proper location. We passed over the proposed location twice, but we found no clear bathymetric or structural correspondence to line CM 10, so we decided to move updip (upslope) from the beacon to the water depth equivalent to the proposed site and to drop the target beacon there. This we did at 0823 hr., establishing Site 549 1.2 naut. mi. (2.2 km) northwest of, and approximately along strike from, the originally pro-

Table 2. Coring summary, Site 549.

Core	Date (June 1981)	Time (hr.)	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Recovery (%)
Hole 549A							
1	28	0950	2535.0-2543.5	0.0-8.0	8.0	7.70	96
2	28	1040	2543.5-2553.0	8.0-17.5	9.5	9.08	96
3	28	1137	2553.0-2562.5	17.5-27.0	9.5	8.65	91
4	28	1235	2562.5-2572.0	27.0-36.5	9.5	9.21	97
5	28	1320	2572.0-2581.5	36.5-46.0	9.5	9.00	95
6	28	1408	2581.5-2591.0	46.0-55.5	9.5	8.91	94
7	28	1502	2591.0-2600.5	55.5-65.0	9.5	9.20	97
8	28	1600	2600.5-2610.0	65.0-74.5	9.5	8.44	89
9	28	1636	2610.0-2619.5	74.5-84.0	9.5	8.54	90
10	28	1730	2619.5-2629.0	84.0-93.5	9.5	9.31	98
11	28	1850	2629.0-2638.5	93.5-103.0	9.5	9.42	99
12	28	1947	2638.5-2641.5	103.0-106.0	3.0	2.46	82
13	28	2051	2641.5-2646.5	106.0-111.0	5.0	5.01	100
14	28	2150	2646.5-2651.5	111.0-116.0	5.0	2.25	45
15	28	2250	2651.5-2655.0	116.0-119.5	3.5	3.34	95
16	28	2345	2655.0-2658.0	119.5-122.5	3.0	1.96	65
17	29	0043	2658.0-2661.0	122.5-125.5	3.0	2.16	72
18	29	0137	2661.0-2662.5	125.5-127.0	1.5	1.38	92
19	29	0230	2662.5-2663.5	127.0-128.0	1.0	0.65	65
20	29	0311	2663.5-2664.5	128.0-129.0	1.0	0.70	70
21	29	0440	2664.5-2660.0	129.0-130.5	1.5	1.25	83
22	29	0530	2666.0-2666.5	130.5-131.0	0.5	0.53	100
23	29	0620	2666.5-2667.5	131.0-132.0	1.0	tr	0
24	29	0620	2667.5-2670.5	132.0-135.0	3.0	3.07	100
25	29	0715	2670.5-2673.0	135.0-137.5	2.5	2.14	0[a]
26	29	0810	2673.0-2674.0	137.5-138.5	1.0	1.17	100
27	29	0915	2674.0-2675.5	138.5-140.0	1.5	1.50	100
28	29	1010	2675.5-2678.5	140.0-143.0	3.0	2.63	88
29	29	1102	2678.5-2679.0	143.0-143.5	0.5	tr	0
30	29	1140	2679.0-2681.0	143.5-145.5	2.0	0	0
31	29	1220	2681.0-2683.0	145.5-147.5	2.0	0.02	10
32	29	1305	2683.0-2686.0	147.5-150.5	3.0	2.69	90
33	29	1415	2686.0-2691.0	150.5-155.5	5.0	3.64	73
34	29	1444	2691.0-2696.0	155.5-160.5	5.0	1.75	35
35	29	1535	2696.0-2701.0	160.5-165.5	5.0	0.75	15
36	29	1625	2701.0-2706.0	165.5-170.5	5.0	0.46	9
37	29	1730	2706.0-2711.0	170.5-175.5	5.0	0.48	10
38	29	1812	2711.0-2716.0	175.5-180.5	5.0	0.66	13
39	29	1900	2716.0-2721.0	180.5-185.5	5.0	2.19	44
40	29	1948	2721.0-2726.0	185.5-190.5	5.0	1.31	26
41	29	2015	2726.0-2731.0	190.5-195.5	5.0	0.44	9
42	29	2125	2731.0-2731.5	195.5-196.0	0.5	0.31	6
Hole 549							
1	15	1730	2533.0-2542.5	0-9.5	9.5	9.42	99
H1	15		2542.5-2627.0	9.5-94.0	84.5	0	0
H2	15		2627.0-2684.0	94.0-151.0	57.0	0	0
H3	16		2684.0-2731.5	151.0-198.5	47.5	0	0
2	16	0538	2731.5-2741.0	198.5-208.0	9.5	7.50	79
3	16	0705	2741.0-2750.5	208.0-217.5	9.5	1.61	17
4	16	0819	2750.5-2760.0	217.5-227.0	9.5	9.53	100
5	16	0928	2760.0-2769.5	227.0-236.5	9.5	9.52	100
6	16	1230	2769.5-2779.0	236.5-246.0	9.5	7.45	78
7	16	1348	2779.0-2788.5	246.0-255.5	9.5	7.63	80
8	16	1515	2788.5-2798.0	255.5-265.0	9.5	6.76	71
9	16	1700	2798.0-2807.5	265.0-274.5	9.5	5.08	53
10	17	0207	2807.5-2817.0	274.5-284.0	9.5	9.63	100
11	17	0340	2817.0-2826.5	284.0-293.5	9.5	9.35	98
12	17	0504	2826.5-2836.0	293.5-303.0	9.5	5.94	63
13	17	0700	2836.0-2845.5	303.0-312.5	9.5	9.69	100
14	17	0820	2845.5-2855.0	312.5-322.0	9.5	9.77	100
15	17	0950	2855.0-2864.5	322.0-331.5	9.5	9.59	100
16	17	1145	2864.5-2874.0	331.5-341.0	9.5	9.54	100
17	17	1205	2874.0-2883.5	341.0-350.5	9.5	9.53	100
18	17	1440	2883.5-2893.0	350.5-360.0	9.5	5.63	100
19	17	1556	2893.0-2902.5	360.0-369.5	9.5	6.57	69
20	17	1811	2902.5-2912.0	269.5-379.0	9.5	9.16	96
21	17	1925	2912.0-2921.5	379.0-388.5	9.5	4.86	51
22	17	2035	2921.5-2931.0	388.5-398.0	9.5	7.30	77
23	17	2135	2931.0-2940.5	398.0-407.5	9.5	7.68	81
24	17	2235	2940.5-2950.0	407.5-417.0	9.5	4.16	44
25	18	0145	2950.0-2959.5	417.0-426.5	9.5	2.81	30
26	18	0311	2959.5-2969.0	426.5-436.0	9.5	0.80	8
27	18	0428	2969.0-2978.5	436.0-445.5	9.5	0.55	6
28	18	0550	2978.5-2988.0	445.5-455.0	9.5	3.56	37
29	18	0645	2988.0-2997.5	455.0-464.5	9.5	0.51	5
30	18	0844	2997.5-3007.0	464.5-474.0	9.5	tr	0
31	18	1046	3007.0-3016.5	474.0-483.5	9.5	0	0
32	18	1316	3016.5-3026.0	483.5-493.0	9.5	0.71	7
33	18	1500	3026.0-3035.5	493.0-502.5	9.5	0.15	2
34	18	1614	3035.5-3045.0	502.5-512.0	9.5	1.39	15
35	18	1743	3045.0-3054.5	512.0-521.5	9.5	1.74	18
36	18	1915	3054.5-3055.5	521.5-522.5	1.0	0.52	52
37	18	2150	3055.5-3064.0	522.5-531.0	8.5	2.38	28
38	18	2330	3064.0-3073.5	531.0-540.5	9.5	0.33	3
39	19	0202	3073.5-3083.0	540.5-550.0	9.5	0.28	3
40	19	0432	3083.0-3092.5	550.0-559.5	9.5	0.42	4
41	19	0636	3092.5-3102.5	559.5-568.0	9.5	0	0
Hole 549A (Cont.)							
42	19	0925	3102.0-3111.5	569.0-578.5	9.5	4.06	43
43	19	1215	3111.5-3121.0	578.5-588.0	9.5	5.43	57
44	19	1520	3121.0-3130.5	588.0-597.5	9.5	6.80	72
45	19	1734	3130.5-3140.0	597.5-607.0	9.5	7.83	82
46	19	1930	3140.0-3149.5	607.0-616.5	9.5	5.60	59
47	19	2140	3149.5-3159.0	616.5-626.0	9.5	6.90	73
48	20	0037	3159.0-3168.5	626.0-635.5	9.5	0.36	4
49	20	0250	3168.5-3178.0	635.5-645.0	9.5	0.07	1
50	20	0420	3178.0-3187.5	645.0-654.5	9.5	tr	0
51	20	0615	3187.5-3197.0	654.5-664.0	9.5	0	0
52	20	0854	3197.0-3206.6	664.0-673.5	9.5	1.31	14
53	20	1354	3206.5-3216.0	673.5-683.0	9.5	3.26	34
54	20	1822	3216.0-3225.0	683.0-692.0	9.0	4.99	55
55	20	2355	3225.0-3234.0	692.0-701.0	9.0	7.24	80
56	21	0437	3234.0-3243.0	701.0-710.0	9.0	6.34	70
57	21	0920	3243.0-3252.0	710.0-719.0	9.0	7.05	78
58	21	1511	3252.0-3261.0	719.0-728.0	9.0	9.55	100
59	21	1935	3261.0-3270.0	728.0-737.0	9.0	4.35	48
60	21	2258	3270.0-3279.0	737.0-746.0	9.0	8.71	97
61	22	0123	3279.0-3288.0	746.0-755.0	9.0	4.90	54
62	22	0254	3288.0-3297.0	755.0-764.0	9.0	0.06	1
63	22	0418	3297.0-3301.5	764.0-768.5	4.5	0	0
64	22	0600	3301.5-3306.0	768.5-773.0	4.5	0	0
65	22	0811	3306.0-3311.0	773.0-778.0	5.0	0	0
66	22	0950	3311.0-3320.5	778.0-787.5	9.5	tr	0
67	22	1118	3320.5-3325.5	787.5-792.5	5.0	0.60	12
68	22	1228	3325.5-3326.5	792.5-793.5	1.0	tr	0
69	22	1408	3326.5-3327.5	793.5-794.5	1.0	0.10	10
70	22	1535	3327.5-3330.0	794.5-797.0	2.5	0.78	31
71	22	1645	3330.0-3334.5	797.0-801.5	4.5	0.22	5
72	22	1917	3345.5-3339.5	801.5-806.5	5.0	2.52	50
73	22	2102	3339.5-3344.0	806.5-811.0	4.5	3.29	73
74	23	0130	3344.0-3349.0	811.0-816.0	5.0	4.46	89
75	23	0530	3349.0-3358.0	816.0-825.0	9.0	4.41	49
76	23	0818	3358.0-3367.0	825.0-834.0	9.0	3.58	40
77	23	1000	3367.0-3376.0	834.0-843.0	9.0	0.21	2
78	23	1250	3376.0-3385.0	843.0-852.0	9.0	1.92	21
79	23	1550	3385.0-3394.0	852.0-861.0	9.0	1.28	14
80	23	1835	3394.0-3403.0	861.0-870.0	9.0	2.89	32
81	23	2015	3403.0-3407.5	870.0-874.5	4.5	2.19	49
82	23	2330	3407.5-3412.0	874.5-379.0	4.5	2.37	53
83	24	0325	3412.0-3417.0	879.0-884.0	5.0	3.16	63
84	24	0559	3417.0-3421.0	884.0-888.0	4.0	2.84	71
85	24	0918	3421.0-3430.0	880.0-897.0	9.0	3.62	40
86	24	1430	3430.0-3439.0	897.0-906.0	9.0	4.31	48
87	24	2000	3439.0-3443.5	906.0-910.5	4.5	4.19	93
88	25	0114	3443.5-3452.5	910.5-919.5	9.0	5.13	57
89	25	0612	3452.5-3461.5	919.5-928.5	9.0	3.17	35
90	25	1009	3461.5-3470.5	928.5-937.5	9.0	3.81	42
91	25	1331	3470.5-3479.5	937.5-946.5	9.0	2.59	29
92	25	1521	3479.5-3488.5	946.5-955.5	9.0	1.30	14
93	25	1739	3488.5-3497.5	955.5-964.5	9.0	1.75	19
94	25	2024	3497.5-3506.5	964.5-973.5	9.0	1.74	19
95	25	2222	3506.5-3511.0	973.5-978.0	4.5	2.34	52
96	26	0030	3511.0-3515.0	978.0-982.5	4.5	1.10	24
97	26	0425	3515.0-3524.5	982.5-991.5	9.0	1.50	17
98	26	1010	3524.5-3529.5	991.5-996.5	5.0	2.04	41
99	26	1211	3529.5-3534.5	996.5-1001.5	5.0	0.45	9

Table 2. (Continued).

[a] Shattered liner.

posed location. We launched a second a beacon for Site 549 almost immediately thereafter (at 0826 hr.) about 1.25 naut. mi. north-northwest of the originally proposed location.

Pipe operations commenced at 0915 hr. The PDR water depth at Site 549 was 2525 m, and a mudline punch core was taken to determine true depth. On the first attempt the bit was lowered to 2533 m and the inner barrel was retrieved with no trace of sediment. One joint of pipe was added and a second attempt, to 2542.5 m, was made. A nearly full (9.4 m) core was recovered, and water depth was established at 2533 m.

Subsequent hydraulic piston coring was planned, so we drilled the soft calcareous ooze to 198.5 m BSF without coring. Three combination temperature probe–*in situ* water sampler runs were made in this interval. Because of various equipment problems, the only success was one

Table 3. Lithologic units, Site 549.

Unit	Hole-Core-Section (level in cm)	Depth (m BSF)	Main lithologies	Age
1	549A-1 to 549A-3	0-27	Marly calcareous nannofossil and foraminiferal-nannofossil oozes	Quaternary
2	549A-4 to 549A-42 and 549-2 to 549-10-3 (65)	27-276.5	Bluish white to light greenish gray	late Miocene to middle Eocene
3	549-10-3 (65) to 549-21-3 (15)	276.5-382	Brown, yellow, and gray marly nannofossil and nannofossil chalk	early Eocene to late Paleocene
4	549-21-3 (15) to 549-26-1 (10)	382-426.6	Light-colored nannofossil chalks	early Paleocene to early Turonian
5	549-26-1 (10) to 549-31	426.6-479	Greenish gray nannofossil chalk	early Turonian to early Cenomanian(?)
6	549-32 to 549-52-1 (15)	479-664.2	Gray calcareous siltstone	middle to early(?) Albian
7	549-52-1 (15) to 549-53-1 (30)	664.2-673.9	Sandy dolosparite	Uncertain—possibly Aptian
8	549-53-1 (30) to 549-61	673.9-755	Reddish, yellowish, and gray calcareous and sandy calcareous sandstones	early late Barremian to early Barremian
9	549-62 to 549-71	755-801.5	Grainstones	early Barremian
10	549-72 to 549-93	801.5-964.5	Interbedded calcareous and noncalcareous sandy mudstones and mudstones	early Barremian
11	549-94 to 549-99	964.5-1001.5	Foliated calcareous sandstone	middle to late Devonian

Notes: Cross rule denotes change in lithology; wavy line denotes unconformity. Bold wavy line denotes major unconformity.

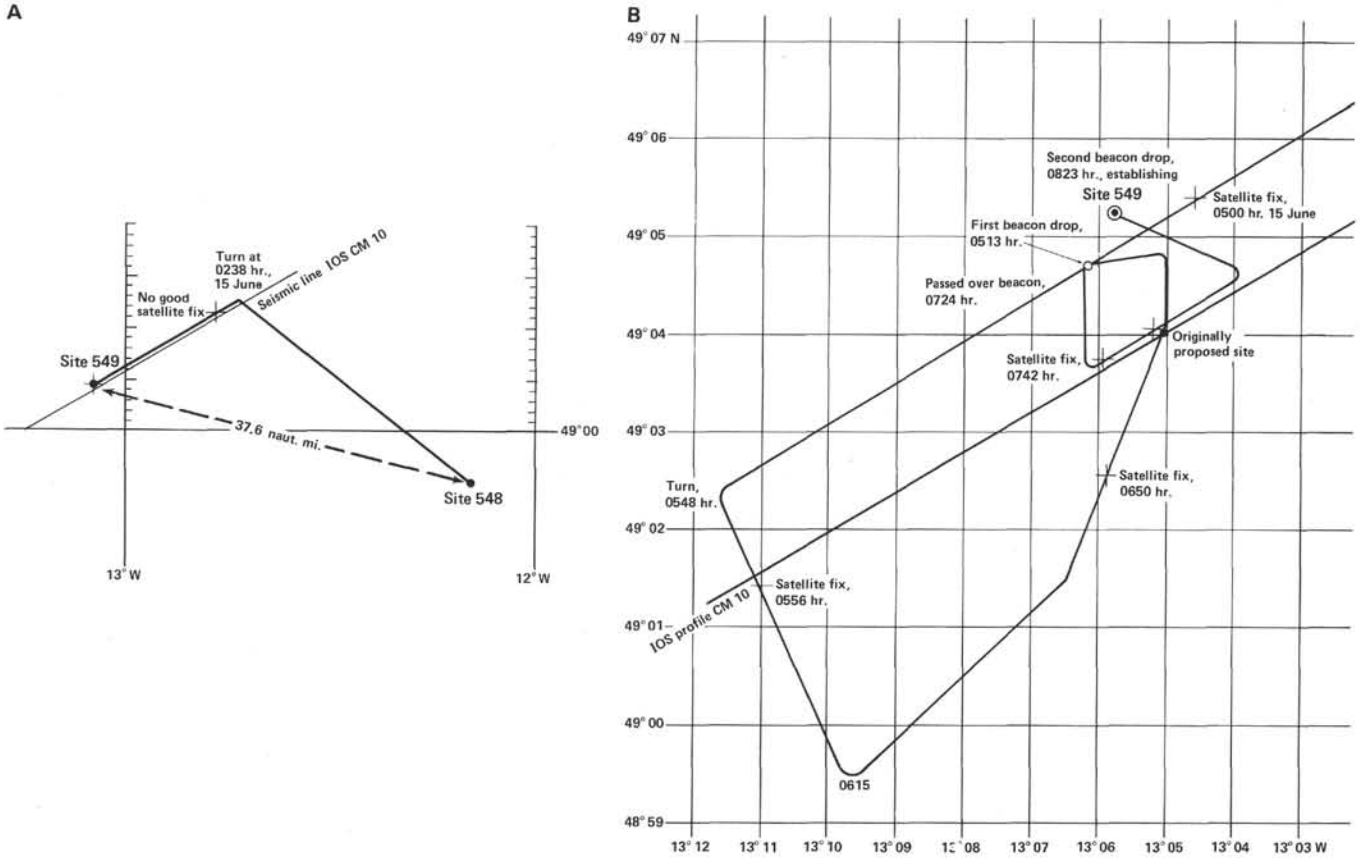

Figure 2. A. Ship's track from Site 548. B. Approach to Site 549. Position of this map with respect to (A) is revealed by latitude, longitude.

good water sample. Continuous coring began at 198.5 m BSF and continued to total depth. Temperature was measured successfully at 236.5 m BSF. Two subsequent attempts to measure temperature failed, apparently because the sediment was too firm for the probe to penetrate. An interval of anomalously soft chalky ooze provided a final opportunity to measure temperature and thus to determine the geothermal gradient of the area, and this attempt, which was made at 417 m, was successful.

Coring proceeded through varying chalk, mudstone, and limestone lithologies. Core recovery was disappointingly low in units of sandy chalk, bioclastic limestone, and silty mudstone. The recovery of the first two lithologies is often poor because of their friable nature. The mudstone, however, seemed well indurated and cohesive, and we do not know why it was not recovered. The sediments became more marly and richer in clay as depth increased, and it became apparent that the cutting structure of the bit, which had been selected for a limestone–coarse clastic sequence, was far from optimum for these sediments. The short-toothed bit made painfully slow progress through a long sequence of silty mudstones and clays. After about 65 rotating hours and 800 m of penetration, core diameter decreased and drilling torque became irregular, indicating that at least one of the bit's four bearings had begun to fail. These conditions remained virtually unchanged for nearly 200 m and 50 additional rotating hours. Then core diameter and recovery began to decrease further, indicating progressive failure, although penetration rate increased because the lithology became more sandy. After 37 m of basement (hard Devonian sandstone) had been cored, penetration rate slowed drastically, and total failure appeared imminent. Coring was terminated after 126.3 rotating hours and a total penetration of 1001.5 m. The final core arrived on deck at 1215 hr. on 26 June.

After some difficulty the bit was released, and the hole was filled with fresh water-bentonite mud in preparation for logging. The drill string was pulled, without incident, nearly to the intended logging position, when the pipe suddenly became stuck—apparently when the larger-diameter bottom hole assembly (BHA) was pulled into a keyseat—at about 175 m BSF. A circulating head was attached, and fluid circulation was found to be unimpaired. Nevertheless, freeing the pipe required working it 1.25 hr. with overpulls up to 200,000 lb. With the BHA free in the hole and the end of the pipe at 137 m BSF, the logging sheaves were rigged and logging operations began.

As at Site 548, the first logging sonde used was the long-spaced sonic–dual induction–gamma ray–caliper tool. The heavy 22 m logging tool was deployed on the pitching vessel with considerable difficulty, and there was concern that the flexible sonic module had been damaged by bending. In-pipe checks soon showed all functions to be normal, however, and the sonde was run down the drill pipe. The open hole was in good condition except in three places where the tool stopped on bridges or ledges. In each case, the weight of the tool helped it to break through the obstruction, and the sonde eventually reached a depth only 2.5 m short of the total drill depth. Excellent dual induction and gamma ray logs were recorded. The sonic velocity curve was extremely noisy, and only the upper third of the log was usable. As the logging tool was being removed from the pipe, it became fouled in the circulating head, and the cable pulled tight. The cable's weakest point (the cable head) failed, and the entire logging tool fell back down the pipe.

A fishing tool that incorporated a special slip-type core catcher on an inner core barrel was assembled and lowered on the sandline. The barrel was set down and picked up several times without any indication of becoming engaged, when a sudden loss of weight indicated that the overshot pin had sheared and that the inner core barrel assembly had also been lost in the hole.

A shorter fishing tool using an identical core catcher was then run on the sandline, but no contact was made. Three joints of pipe were added, and the string was lowered, with slow rotation and circulation, to within 17 m of total depth. After three or four vigorous stabs, the fish was caught. It had been pulled only a few meters up the pipe, however, when it became jammed and could be moved neither up nor down. When attempts to free the fish failed, the overshot was worked vigorously to shear the pin and (it was hoped) leave the fish in the pipe for recovery with the drill string. With the sandline back on deck, the pump was engaged at low volume, and the pressure confirmed that the pipe remained obstructed. Because of the obstruction in the pipe and because no hydrocarbons had been detected in the cores, the intended plugging operation was foregone. The drill string was then recovered, and the complete logging sonde was found wedged in the BHA. The lowermost section had been crushed and buckled to such an extent that it would not pass through the bit release top connector, and only about 30 cm of logging tool protruded from the pipe.

The BHA was partly disassembled to remove the fish and then reassembled in the hydraulic piston coring configuration. At 0115 hr. on 28 June, the pipe trip for Hole 549A began.

During the first pipe trip for Hole 549A, the ship was offset 30 m north to position the new hole outside the area disturbed by Hole 549. A PDR reading at the offset position indicated a water depth of 2523 m. To allow for the 8 m depth discrepancy noted at Hole 549, the special piston coring bit was positioned at 2524.5 m to attempt to recover seafloor sediment and to determine water depth precisely. The 9.5 m stroke to 2534 m produced only water, and the procedure was repeated after one joint of pipe was added. The second attempt, which was made at 0930 hr. on 28 June, recovered an 8 m core and established the water depth as 2535.5 m. The discrepancy between the PDR and drill pipe depths is attributed to the sloping, irregular bathymetry of the area.

Weather and sea conditions were favorable, and piston cores of high quality were recovered to a depth of 103 m BSF. Core 12, punched from this depth, failed to achieve full stroke, and only 3 m were recovered. The 9.5 m corer was then replaced by the 5 m unit. Only one full core was obtained with this unit before the firm chalky ooze became too stiff for a full stroke of the corer. The remaining 85 m gap in the Site 549 sections was cored with incomplete recovery that usually ranged from 0.5 to 3.0 m per core. Total depth was 196 m BSF, approximately the depth of the top of the section cored in Hole 549. The drill string was then recovered, and the bit arrived on deck at 0315 hr. on 30 June.

SEDIMENT LITHOLOGY

At Site 549, 1001.5 m of sediments and sedimentary rocks were continuously cored (Table 3). The upper 196 m were cored using the hydraulic piston corer, the remainder by conventional (rotary) drilling. The post-Hercynian sedimentary sequence at Site 549 is divided into ten lithologic units ranging in age from Quaternary to Early Cretaceous. The sediments overlie Devonian basement composed of quartzites. The Holocene to lower Albian postrift sequence consists primarily of nannofossil chalks, marly nannofossil chalks, and calcareous siltstones, all deposited in open sea environments. This sequence is interrupted by major unconformities between the Pleistocene and the upper Miocene and between the upper Paleocene and the Maestrichtian. The Miocene record is condensed and contains two minor unconformities.

A major unconformity representing the Aptian separates the Holocene to Albian sequence from the underlying Barremian synrift deposits, which are 291 m thick and consist of limestones, calcareous mudstones, mudstones, sandy mudstones, and sandstones. The Barremian sequence records an upward evolution from estuarine or restricted marine through epireefal to sublittoral paleoenvironments.

The Devonian basement consists of weakly deformed crossbedded micaceous quartzite.

Unit 1

Unit 1 consists of interbedded dark-colored marly calcareous oozes and lighter-colored nannofossil oozes. It occurs in Hole 549A from 0 to 27 m BSF[3] (Cores 1 to 3) and is Holocene–Pleistocene in age.

Unit 1 consists of olive gray (5Y 4/2–5/2), light gray (5Y 7/1), pale green gray (5GY 8/1), and reddish gray (2–5Y 5/2) soft marly calcareous oozes, nannofossil oozes, foraminifer–nannofossil oozes, calcareous muds, and muds interbedded on a scale of 10 to 150 cm. The uppermost 35 cm (549A-1-1, 0–35 cm) consists of pale yellow marly foraminifer–nannofossil ooze of Holocene age.

In general, the lighter gray layers are more calcareous (up to 70% $CaCO_3$, according to carbonate bomb analysis) than the darker layers (as little as 5% $CaCO_3$). Smear slide analysis shows that the carbonate fraction is composed of calcareous nannofossils (5–70%), unspecified carbonate (possibly shell fragments) (5–40%), and foraminifers (up to 30%). The detrital fraction is comprised of clay minerals (up to 40%), quartz (up to 40%), and mica (up to 10%). The clay minerals are illite, smectite, chlorite, and kaolinite (in decreasing order of importance) (Chennaux et al., this volume). Ice-rafted pebbles occur at 549A-1-2, 75 cm and 549A-2-2, 149 cm. Bioturbation and disseminated pyrite occur throughout.

Color changes (Fig. 3) are believed to be related to paleoclimatic variation, the darker, more terrigenous horizons having been deposited during glacial periods, the lighter, more calcareous layers during interglacial periods. This interpretation is supported by paleontological evidence (see Biostratigraphy [Nannoplankton], below). Most of the contacts between the darker and lighter layers are gradational. However, sharp erosional contacts occur at the base of some of the darker, more marly horizons (e.g., Sections 549A-1-3, 549A-2-1, 549A-3-3, and 549A-3-4). These beds are often graded (e.g., Sections 549A-1-3, and 549A-3-4) and may be turbidites.

Biostratigraphic evidence indicates an unconformity between the Pleistocene sediments of Unit 1 and the Miocene sediments of Unit 2; the unconformity occurs at 549A-4-1, 25 cm.

Unit 2

Unit 2 consists of light-colored nannofossil chalks. It occurs in Hole 549A from 27 to 196 m BSF (Cores 4 to 42) and in Hole 549 from 198.5 to 276.5 m BSF (Core 2 to 549-10-3, 65 cm), and it is late Miocene to middle Eocene in age (Snyder and Waters; and Müller, both this volume).

Unit 2 consists of bluish white (5B 9/1), light greenish gray (5G 8/1, 5GY 7/1, 5GY 7/2), and greenish gray (5G 6/1) firm, homogeneous, nannofossil and (more rarely) foraminifer–nannofossil chalk. Color changes are usually gradational; exceptions occur in Sections 549A-6-3, 549-2-2, and 549-2-3, where the contacts between white and green sediments are sharp. Core 549-2 also contains resedimented chalk clasts (Section 3, 50–60 cm) and distorted bedding (Section 2, 37–105 cm; and Section 3, 29–92 cm and 135–150 cm [Fig. 4]). Microfaulting appears in Section 549-4-1 from 117 to 120 cm and in Section 549-7-5 from 20 to 40 cm. Occasional detritusrich lenses and layers of gray (5GY 7/1–7/2) chalk occur toward the base of Unit 2 in Hole 549 (Sections 549-6-4 and 549-6-5, Core 7, and Section 549-8-3). Bioturbation occurs throughout Unit 2, but it is often difficult to detect owing to the extreme homogeneity of the sediments.

The major component of the Unit 2 sediments is calcareous nannofossils (35–90%). The subsidiary biogenic components include foraminifers (0–20%), sponge spicules (0–20%), carbonate particles (probably shell fragments, 0–20%), and very rare radiolarians and diatoms. Fossil preservation is good to excellent. Total carbonate content varies from 62 to 97% (according to carbonate bomb analysis) but is usually 75 to 90%. Siderite occurs in trace quantities in Cores 5, 9, 13 to 15, and 20. Terrigenous sediment is always a minor part of the sediments, except near the base (Core 549-6 downward), where it may reach 25%; it consists primarily of clay minerals (smectite, illite, and mixed-layer clays, Chennaux et al., this volume), with minor amounts of quartz. Volcanic

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[3] All depths below seafloor are drill string depths, which may or may not correspond exactly to depths obtained by well-logging techniques.

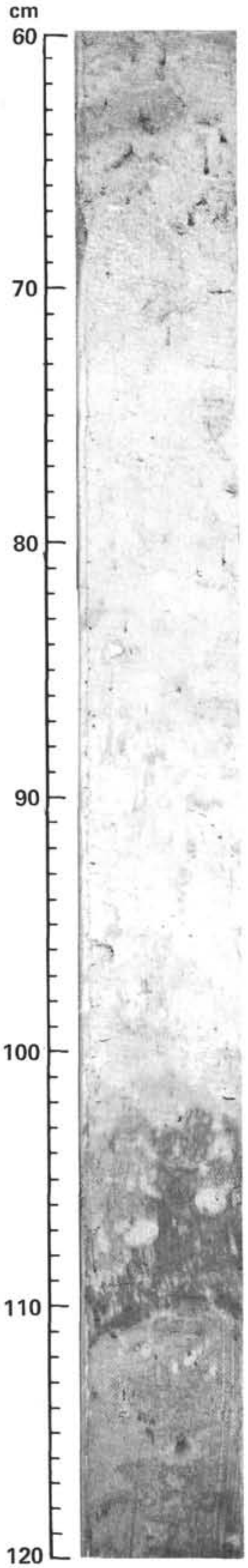


Figure 3. Example of climate-controlled lithologic variation in the Pleistocene section. Section 549A-2-5.

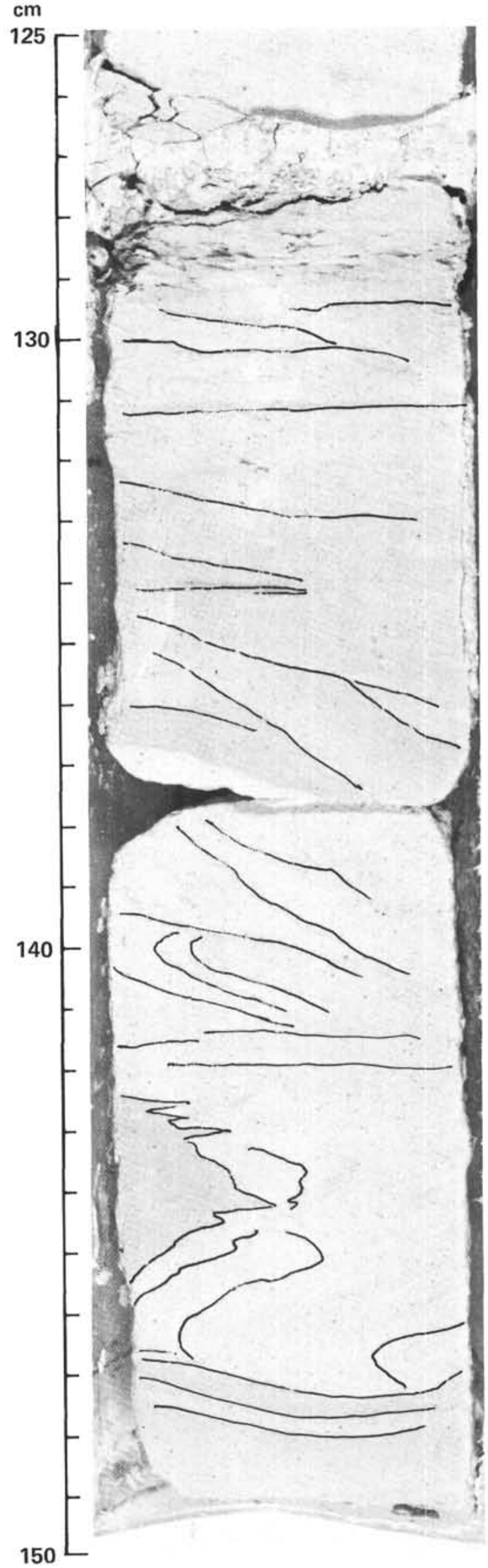


Figure 4. Slump structures within the Eocene section. Section 549-2-3.

glass was detected in Section 549-2-3 from 135 to 150 cm and in Section 549-9-1 at 10 cm. The glass is also probably distributed sporadically throughout the Eocene part of this unit, where silty stringers occur (Knox, this volume).

A number of minor color changes occur within Unit 2. In Core 6 of Hole 549A, there is a slight change of color in Section 1 at 60 cm that corresponds to an increase of sediment hardness and marks an unconformity between the upper and middle Miocene; in Section 549A-6-3 at 80 cm there is a downward color change from greenish gray to bluish white that corresponds to a lower Miocene to Oligocene unconformity. Otherwise, little lithologic change is observed across either of these boundaries. Overall, the Miocene succession (which is only 24 m thick) is highly condensed.

Unit 3

Unit 3 consists of brown and gray nannofossil chalks. It occurs in Hole 549 from 276.5 to 382 m BSF (549-10-3, 65 cm to 549-21-3, 15 cm) and is early Eocene to late Paleocene in age.

Unit 3 conformably underlies Unit 2, and it comprises dark brown to light gray marly nannofossil chalks. Unit 3 is differentiated from Unit 2 by its higher content of terrigenous sediment, which is reflected in a slight increase in the values of the gamma ray measurements (see Downhole Logging, below). Unit 3 is divided into four subunits on the basis of color variation and differences in composition.

Subunit 3a

Subunit 3a consists of brown marly nannofossil chalks. It occurs from 276.5 to 322 m BSF (549-10-3, 65 cm to Core 14) and is early Eocene in age.

Subunit 3a is composed of yellowish brown (2.5Y 6/4, 10YR 5/4–6/4), olive brown (2.5Y 5/4–4/5), and light brownish gray (2.5Y 5/2–6/2) marly nannofossil chalks containing light greenish gray veins and burrow mottling. The boundaries between the various colors are gradational or sharp. Contorted bedding occurs in Section 549-10-3 from 60 to 110 cm (Fig. 5). Smear slide analysis indicates that Subunit 3a is composed of calcareous nannofossils (40–70%), sponge spicules (0–20%), unspecified carbonate (5–20%), foraminifers (up to 10%), quartz (5–15%), and clay minerals (5–30%). Smectite is the dominant clay mineral, but subsidiary illite and mixed-layer clays also occur throughout (Chennaux et al., this volume). Carbonate bomb analyses yield $CaCO_3$ values ranging from 15 to 70%; most values fall in the range from 35 to 65%. Bioturbation is intensive throughout Subunit 3a, and glauconite is frequently concentrated within burrows. Finely dispersed volcanic ash occurs throughout the subunit (Knox, this volume).

Subunit 3b

Subunit 3b consists of green gray nannofossil chalks. It occurs from 322 to 335 m BSF (Core 549-15 to 549-16-3, 50 cm) and is early Eocene in age.

Subunit 3b is distinguished from Subunit 3a on the basis of its color and a downward increase in natural

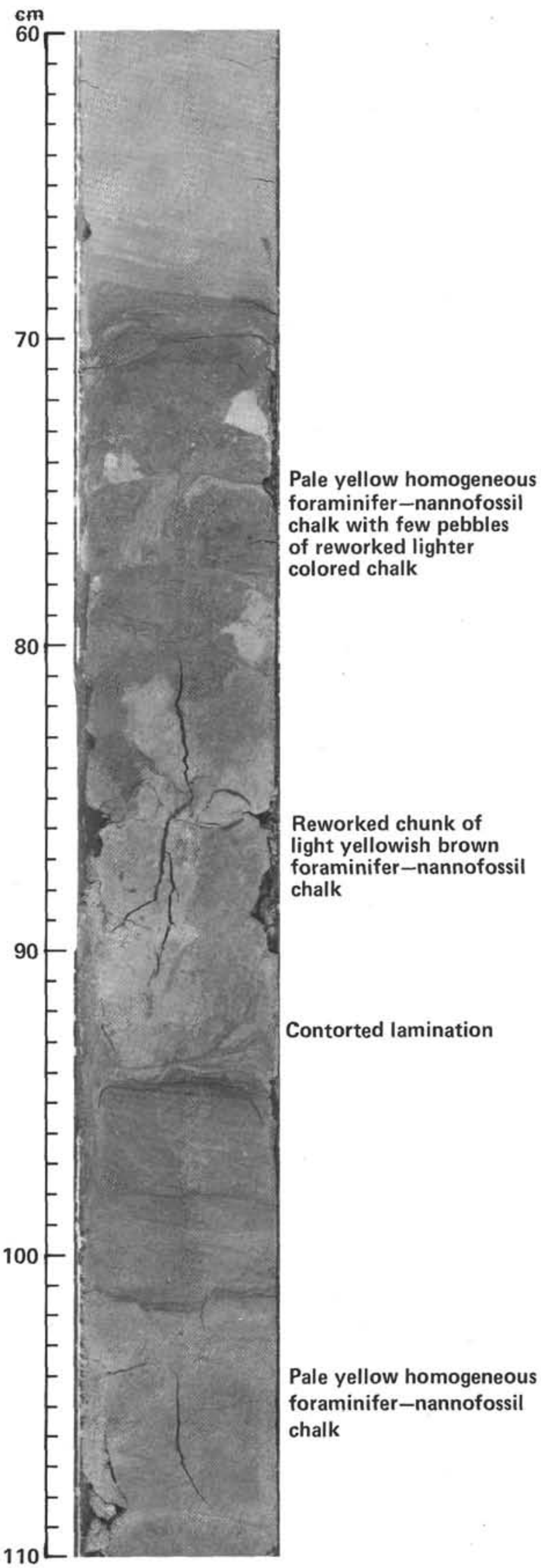


Figure 5. Contorted bedding within Subunit 3a. Section 549-10-3.

gamma ray intensity. Color ranges from light greenish gray (5GY 7/1) through greenish gray (5GY 5/1–6/1) to olive (5Y 5/3), in contrast to the brown and yellow chalks found above. In all other characteristics Subunit 3b falls within the ranges previously described for Subunit 3a.

Subunit 3c

Subunit 3c consists of brown, siliceous, marly nannofossil chalks. It occurs from 335 to 350.5 m BSF (549-16-3, 50 cm to Section 549-17-6) and is late Paleocene in age.

Subunit 3c is composed of marly nannofossil chalk and is distinguished from Subunit 3b above on the basis of color and differences in composition; most notably, the content of quartz and number of sponge spicules decrease, and mixed-layer clays are completely absent. The major colors are shades of brown (2.5Y 6/2–6/4, 7/5YR 5/3, 7.5YR 4/4), but minor veins and burrow mottling in shades of gray also occur. Core 17 includes several bands of fine greenish laminae and one band, nearly 70 cm thick, of homogeneous brown clay. The major components fall within the range described for Subunits 3a and 3b. Gamma ray intensity decreases gradually downward in this subunit.

Subunit 3d

Subunit 3d consists of gray siliceous nannofossil chalks. It occurs from 350.5 to 382 m BSF (Section 549-17,CC to 549-21-3, 15 cm) and is late Paleocene in age.

Subunit 3d is distinguished from overlying Subunit 3c by color, siliceous microfossil content, and chert content. The predominant colors are shades of gray (2.5Y 7/2, 5Y 7/1–7/2, 10YR 7/2), with veins and mottled bands in shades of light brown (10YR 6/2–6/3, 10YR 7/4). The sediments of Subunit 3d consist of calcareous nannofossils (30–90%), sponge spicules (0–10%), diatoms and radiolarians (0–25%), and terrigenous detritus (10–40%, mainly quartz and smectite). Volcanic glass is found throughout the subunit, both dispersed and in discrete ash layers (e.g., that at 549-18-2, 66 cm, which contains 60% volcanic glass). Chert bands occur in Section 549-18-1 from 0 to 90 cm. There are concentrations of siliceous microfossils in light brown to tan intervals that are up to 2 m thick, and make up the entire core catcher section of Core 17 and much of Cores 18 and 19. Core 20 lacks any significant siliceous component, although it contains a few radiolarians. Distorted bedding and resedimented chalk clasts are visible in Section 549-18-1. Subunit 3d is characterized by low sonic velocity (high porosity and low density).

The sediments contain numerous laminated and fine cross-stratified beds (Section 549-18-1) and erosional boundaries with clay clasts (Section 549-19-4). Mottling in this subunit is variable but is particularly well developed below an erosional contact in Section 549-20-5, where burrowing is highlighted by a greenish mineral, possibly glauconite. Dark mottling is also visible at the base of Core 19.

A thin section cut from Section 549-18-1 (25–26 cm) is identified as an indurated radiolarian-, diatom-, and nannofossil-bearing chert. The chert is laminated and contains scattered radiolarians that are infilled by opal and occur in a matrix of fragmented nannofossils, diatoms, and diffuse opal. Occasional sponge spicules and radiolarian spines are also present.

Unit 4

Unit 4 consists of light-colored nannofossil chalks. (Graciansky and Bourbon, this volume). It occurs in Hole 549 from 382 to 426.6 m BSF (549-21-3, 15 cm to 549-26-1, 10 cm) and is early Paleocene to early Turonian in age.

Unit 4 consists of gray (5GY 7/2, 5Y 8/1), white (2.5Y 8/0, 5B 5/1), pinkish white (7.5YR 8/2), and pale brown (10YR 7/1–7/3, 10YR 8/3) nannofossil (or, rarely, foraminifer–nannofossil) chalks. The contacts between beds of different colors are usually gradational. The contact between Units 3 and 4 is a minor unconformity between lower and upper Paleocene sediments (see Biostratigraphy, below). Smear slide analysis indicates that the major components are calcareous nannofossils (60–90%), foraminifers (0–20%), and unspecified carbonate (10–30%). Terrigenous detritus occurs in the form of clay minerals in only minor amounts (up to 10%). Carbonate bomb analyses confirm the high $CaCO_3$ content (84–95%). Natural gamma ray intensity is extremely low throughout Unit 4.

Unit 4 is extensively bioturbated and contains large burrows that are frequently outlined by fine rims of grayish or reddish sediment (e.g., Sections 549-21-2 and 549-21-3). The nannofossil chalks show little sedimentary structure except for fine laminations from Sections 549-22-2 to 549-22-4 and in Sections 549-25-2 and 549-25-3 (Fig. 6). In Core 23, Sections 1 to 5 contain pink (7.5YR 8/4) chalk clasts embedded in a gray (5Y 7/2) chalk matrix; distorted laminated beds occur in Core 23 in Sections 1 and 3 to 5 (Fig. 7). Syndepositional microfaulting is visible in Section 549-22-3 at 20 cm.

Reddish brown (5YR 4/4) flint nodules (mainly composed of opal-CT) occur near the base of Unit 4 (549-24-2, 55–65 cm; 549-24-3, 0–10 cm; 549-25-2, 50–55 cm; 549-25-3, 0–10 cm; and 549-26-1, 0–10 cm). Large fragments of *Inoceramus* shells occur in Section 549-25-2 from 15 to 20 cm.

Unit 5

Unit 5 consists of gray and greenish gray nannofossil chalks. It occurs from 426.6 to 479 m BSF (549-26-1, 10 cm to Core 31) and is early Turonian to early Cenomanian(?) in age.

Drilling in Unit 5 was characterized by very poor recovery (4.4 m of core were recovered from 57 m drilled). Unit 5 is differentiated from Unit 4 on the basis of color, terrigenous sediment content (higher), and variations in downhole logging characteristics. Despite zero recovery in Cores 30 and 31, the base of Unit 5 is clearly visible in the well logs at 479 m BSF, where gamma ray intensity increases sharply (see Downhole Logging, below).

Unit 5 consists of a sequence of gray (5Y 7/1), olive (5Y 6/2–6/3), and greenish gray (5GY 6/1–7/1, 5G 5/2–5/3) marly nannofossil chalks, with occasional layers rich

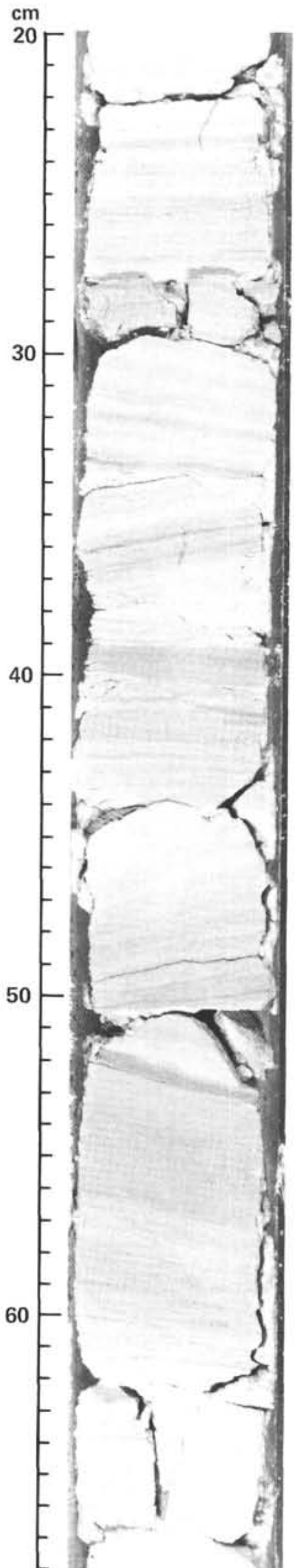


Figure 6. Thin laminations in early Maestrichtian chalk (Unit 4). Section 549-22-4.

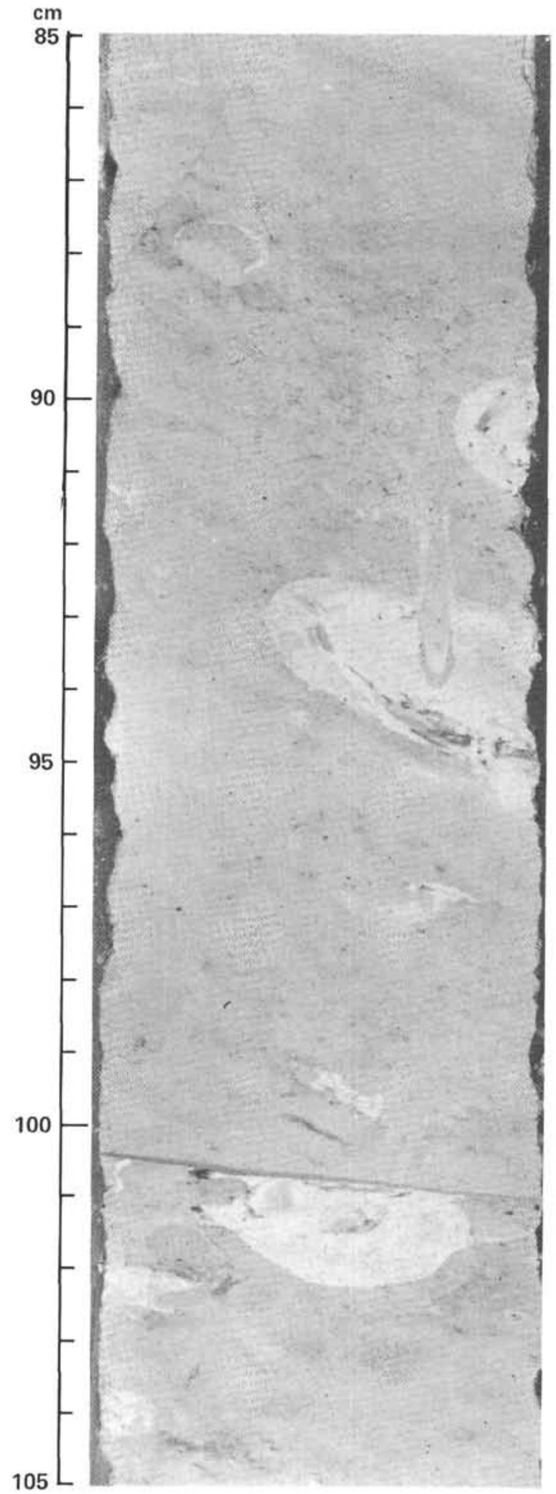


Figure 7. Contorted bedding in Unit 4 (late Campanian or early Maestrichtian). Section 549-23-1. Note the burrow that intersects the light-colored chalk at 91 to 94 cm and the oblique compactional fractures between 85 and 93 cm.

in carbon, volcanic ash, and pyrite. The major lithic components are calcareous nannofossils (30-80%), unspecified biogenic carbonate (5-60%), and highly variable amounts of detritus (0-50%, mostly clay minerals and quartz). Black carbonaceous shales containing up to 3.5% organic carbon (mainly of marine origin) occur in Section 549-27-1 from 20 to 41 cm and 49 to 53 cm. These intervals are enriched in pyrite (according to smear slide analysis) and biogenic opal-CT (according to X-ray diffraction). In Section 549-27-1 from 47 to 49 cm, a thin band of altered, grayish green (5GY 6/1) volcanic ash occurs (Fig. 8); X-ray diffraction detected quartz, smectite, and zeolites within this interval.

Unit 6

Unit 6 consists of gray calcareous siltstones. It occurs from 479 to 664.15 m BSF (Hole 549, Core 32 to 549-52-1, 15 cm) and is middle to early(?) Albian in age.

Recovery in Unit 6 was poor throughout, especially in the upper part (Cores 32–41), where recovery averaged less than 10% (in Cores 42–51, recovery averaged 35%). Although the lithologic boundary between Units 5 and 6 was not retrieved, downhole logging suggests that the boundary is at 479 m BSF (see Unit 5). Unit 6 is characterized by higher gamma ray intensities and lower average velocity values than Unit 5 or 7.

Unit 6 is a relatively homogeneous series of hard, laminated, gray (N4–N8), greenish gray (5GY 4/1), and olive gray (5Y 3/2) calcareous mudstones. There is single layer of nannofossil chalk in Section 549-38-1 from 0 to 40 cm. Burrow mottling and disseminated pyrite occur throughout. Plant fragments are seen occasionally in Cores 35 to 47.

In general, Unit 6 consists of calcareous mudstones. The relative proportions of terrigenous and calcareous sediment are highly variable, and the variations are rhythmic. The origin of such cyclic deposits may be related to variations in the orbital characteristics of the Earth (Graciansky and Gillot, this volume). The variations appear as color banding on a scale of 2 to 50 cm in Figure 9. The lighter gray layers are richer in carbonate (up to 83% $CaCO_3$), and the darker gray layers are relatively poor in carbonate (as little as 15% $CaCO_3$). The TOC contents more or less follow the variation in color.

Terrigenous detritus consists of quartz (0–25%) and clay minerals (15–35%); zeolites occur in trace quantities (less than 5%). The biogenic fraction consists of nannofossils, foraminifers, radiolarians, sponge spicules, and, more rarely, echinoderm and unspecified shell debris. A thin section from 549-42-2, 3 cm shows that the fine laminae are due to variations in clay content on a scale of 1 to 2 mm. The percentage of clay minerals in this thin section approaches 50%; the rest is largely unspecified carbonate and quartz. Occasional foraminifers, radiolarians, sponge spicules, fish fragments, and clay clasts are apparent.

It should be noted that although these dark gray shales are contemporaneous with the black shales of Albian age found previously in the Bay of Biscay (DSDP Leg 48; Montadert, Roberts, et al., 1979), they are not particularly rich in organic matter (total organic carbon [TOC] = 0.17–0.72%); as at the Leg 48 sites, the organic matter is of terrigenous origin.

Unit 7

Unit 7 consists of red sandy dolosparite (Borkowski and Mazzullo, this volume). It occurs from 664.15 to 673.85 m BSF (549-52-1, 15 cm to 549-53-1, 30 cm) and is of uncertain (possibly Aptian) age.

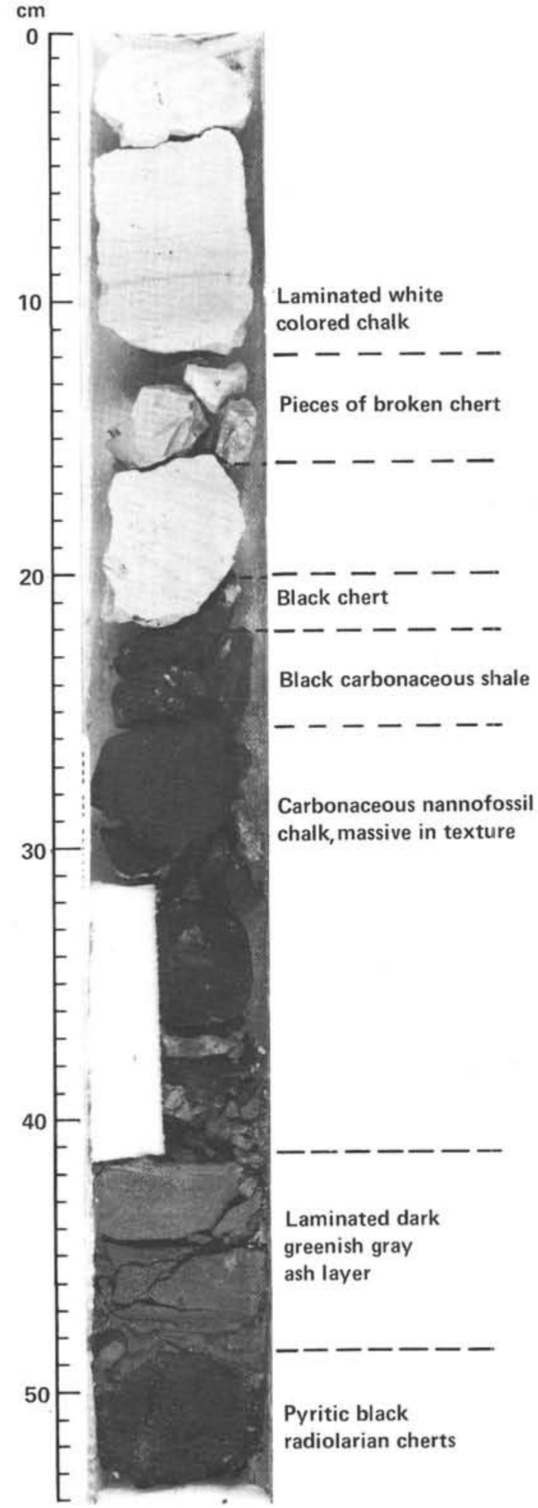


Figure 8. Laminated dark greenish gray ash layer within Unit 5. Section 549-27-1.

Unit 7 is a red (10YR 5/6) sandstone cemented by calcite, dolomite, and quartz. It contains few fossils and thus cannot be accurately dated paleontologically. However, its age is limited by the early Albian sediments in

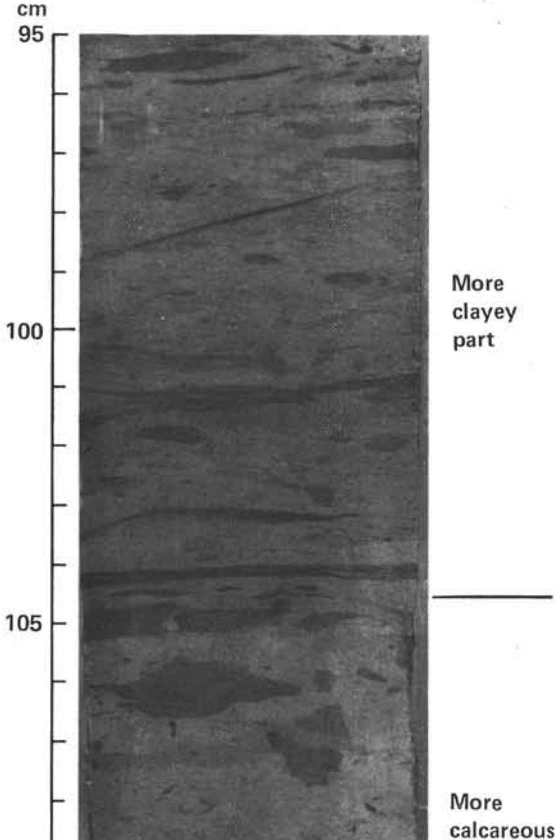


Figure 9. Color banding within Unit 6 (Albian). Section 549-45-3. Note that sediment is pervasively burrowed.

Unit 6 and the early late Barremian sediments in Unit 8. Poor recovery within Unit 7 prevents an accurate direct estimate of its thickness, but the unit is marked by a distinct drop in gamma ray intensity and by a large increase in formation resistivity. Downhole measurements suggest that Unit 7 is 7 m thick (rather than the 9.7 m suggested by drilling).

The detrital fraction of this sediment is largely quartz, with minor amounts of feldspar, chert, clay (smectite and mixed-layer clays), and igneous and metamorphic rock fragments. In terms of texture, the sandstone is moderately well sorted, and the detrital grain outlines appear well rounded when viewed with a luminoscope (Borkowski and Mazzullo, this volume). Occasional ghosts of benthic foraminifers are visible in the thin sections, suggesting a marine origin for the sediments. Red iron oxide staining occurs throughout Unit 7.

The quartz grains do not float freely in the carbonate cement; rather they are cemented together by secondary silica to form an interlocking network of grains.

The carbonate cement fills in most of the remaining primary pores and partially replaces the detrital and authigenic quartz. Thus, carbonate cementation was a secondary diagenetic event (it followed silica cementation). Numerous dolomitization phases occurred after this, as evidenced by the zoned dolomites observed with the luminoscope.

Unit 8

Unit 8 consists of gray, red, and yellow calcareous mudstones (Rat et al., this volume). It occurs from 673.85 to 755 m BSF (549-53-1, 30 cm to Core 61) and is early Barremian in age.

Unit 8 consists of calcareous mudstones and sandy mudstones that coarsen toward the base of the unit. The contact with the overlying dolomitic Unit 7 was not recovered (see above).

In Core 53, 2.7 m of calcareous mudstone in various shades of red, yellow, and brown were recovered. The upper 70 cm consists of red (10R 5/6) homogeneous calcareous mudstone. The remainder is made up of laminated, red (10R 3/4, 10R 4/2), yellow (7.5YR 7/8, 10YR 4/6, 2.5Y 6/6), and brownish (7.5YR 5/2, 5YR 6/3, 10YR 4/2) calcareous mudstones. $CaCO_3$ makes up 40 to 60% of the sediment; the remainder is quartz (10–30%), clay minerals (20–25%), and chlorite-mica (5–10%). Quartz grains and planktonic foraminifers are frequently stained red (the stain is most likely derived from the overlying red dolomitic unit).

The rest of Unit 8 consists of a series of dark gray (10YR 4/1–5/1) to gray (5Y 5/1), massive to weakly laminated calcareous mudstones and sandy calcareous mudstones (Fig. 10), which gradually coarsen with increasing depth; smear slide analysis indicates that the sand fraction gradually increases from 10% (in Core 54) to 30% (in Core 60). Dark gray, detritusrich horizons and lighter gray carbonate-rich layers are interbedded on a scale of 10 to 100 cm; carbonate becomes more important toward the base of the subunit. The $CaCO_3$ content varies widely (15–80%, according to carbonate bomb analysis), reflecting the carbonate-poor and carbonate-rich lithologies. Both lithologies are highly bioturbated. Smear slides and thin sections show that most of the carbonate is in the form of fragments of brachiopods, echinoderms, benthic foraminifers, and gastropods, with less common algae and planktonic foraminifers. At the

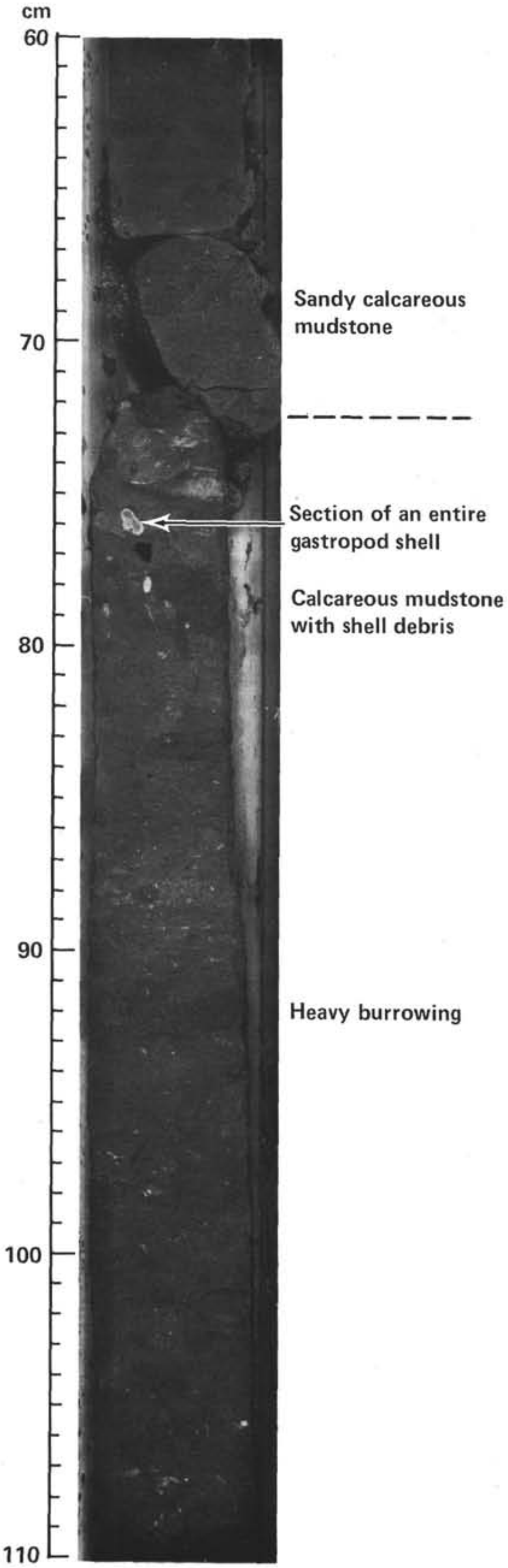


Figure 10. Calcareous sediments within Unit 8 (early Barremian). Section 549-60-4.

base of the unit (Core 61), worm tubes, bryozoans, and coral fragments become more abundant. Sponge spicules are dispersed throughout in small quantities. Terrigenous sediment is mostly quartz (5–55%) and clay minerals (0–10%), with rare feldspar, mica, and heavy minerals. The clay mineral suite contains abundant illite and mixed-layer clays throughout; chlorite is restricted to Cores 53 and 54; smectite occurs in variable quantities only below Core 55; kaolinite appears only in small amounts in discrete horizons in Cores 57 and 58. Disseminated pyrite and glauconite occur throughout, with the latter increasing in abundance toward the base of the unit. Scattered plant fragments are common, particularly in the carbonate-poor facies. Belemnite fragments occur in Sections 549-55-2 and 549-59-1.

The Unit 8 sediments have relatively high natural remanent magnetization, possibly reflecting the abundance of terrigenous sediment or the presence of heavy minerals. High gamma ray intensities also reflect the presence of terrigenous sediment.

Unit 9

Unit 9 consists of calcareous grainstones. It occurs from 755 to 801.5 m BSF (Hole 549, Cores 62 to 71) and is early Barremian in age.

Unit 9 consists primarily of hard, brittle, carbonate grainstones, with lesser amounts of micrites and algal encrustation (Fig. 11). Recovery was very poor within Unit 9, averaging only 5%. The grainstones that dominate this unit are light gray (5Y 7/1), gray (7.5YR 6/0), yellowish gray (2.5Y 8/2), or dark gray (5Y 4/1).

Core 62 is represented by only one small piece of rock, which was found in the core catcher (Fig. 11). Thin section examination shows that it consists of layers of milleporid encrustation and a small section of limestone consisting of sand-sized fragments of brachiopod, mollusc, and gastropod shells in a highly recrystallized sparite cement. Nothing was recovered from Cores 63 to 66. The remainder of Unit 9 consists primarily of grainstones rich in fragments of brachiopods, corals, bryozoans, sponges, echinoderms, and gastropods; some altered glauconite and micritic intraclasts (e.g., Section 549-70-1) and pellets are also present. Algal mudstones are only a minor component of this part of the unit. Core 70 contains a thin (8 cm) bed of bryozoanrich sediment and a thicker (37 cm) quartzrich, carbonate-poor claystone, in which there are several shell-covered erosion surfaces. In general, the grainstone particles are on the order of several millimeters in size, and they are oriented in random directions. The presence of noncalcareous quartzose claystone in Core 70, which is correlated with a noticeable peak in gamma ray intensity, indicates that terrigenous influence was periodically important within the carbonate facies represented by Unit 9.

Downhole logging helps to fill the lithologic gaps in Unit 9 that result from poor recovery. Both the gamma ray intensity and resistivity records show that the lithology of the unit varies. An interval of relatively low gamma ray intensity and average to higher resistivity occurs in Cores 64 and 65 (768.5–778 m). This may represent a facies not recovered. Overall, the grainstones appear to

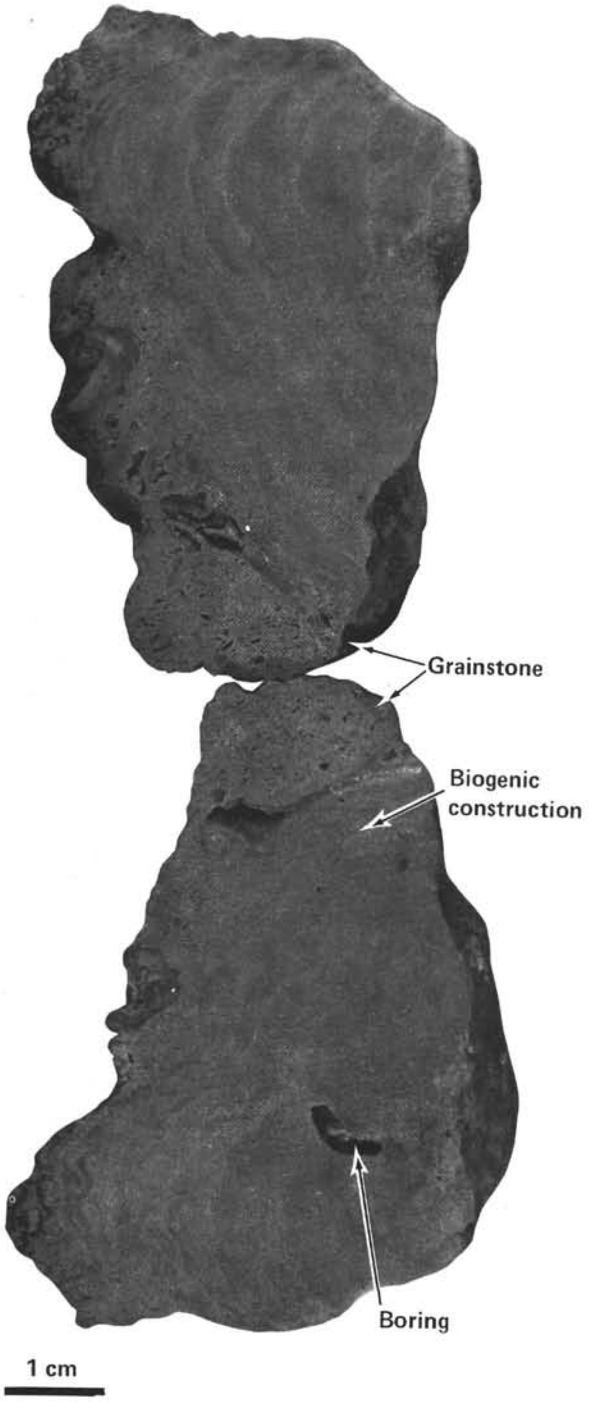


Figure 11. Bored biogenic construction associated with vuggy carbonate grainstone, Unit 9 (early Barremian). Section 549-62,CC.

be marked by low gamma ray intensity and relatively low resistivity. Unit 9 has high sonic velocities throughout (3.4–3.5 km/s).

Unit 10

Unit 10 consists of gray calcareous mudstones and sandstones that grade downward to mudstones and sandstones. It occurs from 801.5 to 964.5 m BSF (Hole 549, Cores 72 to 93) and is early Barremian in age.

Unit 10 consists of interbedded shelly, sandy calcareous mudstone that occasionally grades to wackestone and is interbedded with mudstone, sandy mudstone, and sandstone. There is evidence of an increased influx of terrigenous sediment in the lower part of the unit.

Because of variations in the relative proportions of carbonate and terrigenous sediment, as well as variations in the color of these sediments, this unit has been divided into four subunits. The lithologies of Subunits 10a to 10d can be summarized as follows:

Subunit 10a consists of gray, shelly, sandy mudstones and wackestones that are rich in brachiopods, bivalves, and corals and are interbedded with gray carbonate-poor mudstones and sandy mudstones. Carbonate-rich and carbonate-poor lithologies each make up about 50% of this subunit.

In Subunit 10b there is only one thin shellrich sediment layer. The remainder of the subunit consists of gray, calcareous sandstones, mudstones, and sandy mudstones.

Subunit 10c consists largely of calcareous sediments that are somewhat finer grained than those of Subunit 10b (which consists of mudstones and sandy mudstones only); it is distinguished by its highly variegated color (greens, reds, browns, and pinks), which indicates deposition under variable oxidizing conditions.

Subunit 10d consists largely of brown or gray carbonate-deficient claystones, siltstones, mudstones, sandy mudstones, and sandstones. Downhole logging records a downward increase in gamma ray intensity close to the boundary between Units 9 and 10 (at 803 m); sonic velocity also decreases, from around 3.5 to 3.06 km/s. There are strong small-scale fluctuations in gamma ray intensity, sonic velocity, and resistivity within Unit 10 that reflect the complex interbedding of different lithologies.

Subunit 10a

Subunit 10a consists of interbedded sandy, shelly mudstones and carbonate-poor sandy mudstones. It occurs from 801.5 to 843 m BSF (Cores 72 to 77) and is early Barremian in age.

Subunit 10a consists of gray (5Y 5/1), bluish gray (5B 5/1), and dark gray (5Y 4/1), shelly, sandy mudstones and wackestones that are interbedded with gray and dark gray, carbonate-poor mudstones and sandy mudstones (Fig. 12). In general, the carbonate-rich rock is lighter in color and harder (more cemented) than the carbonate-poor rock. Each lithology makes up about 50% of the subunit.

Sediments rich in shell fragments make up most of Core 72 and are interbedded with terrigenous sediment in Cores 74 to 77; terrigenous sediment dominates Core 73. The carbonate-rich lithology consists of whole shells; sand-sized fragments of brachiopods, gastropods, bivalves, bryozoans, echinoderms, algae, and corals; and a mud fraction composed of calcite, quartz, and nannofossils, with subsidiary dolomite and opaque minerals. The $CaCO_3$ values for this lithology range up to 34% (according to carbonate bomb analysis), but total carbonate content may be higher owing to the occurrence of dolomite. Section 549-75-3 contains a wackestone rich in ooids. Traces of hematite, pyrite, gypsum, and glauconite are found throughout the limestones. Tro-

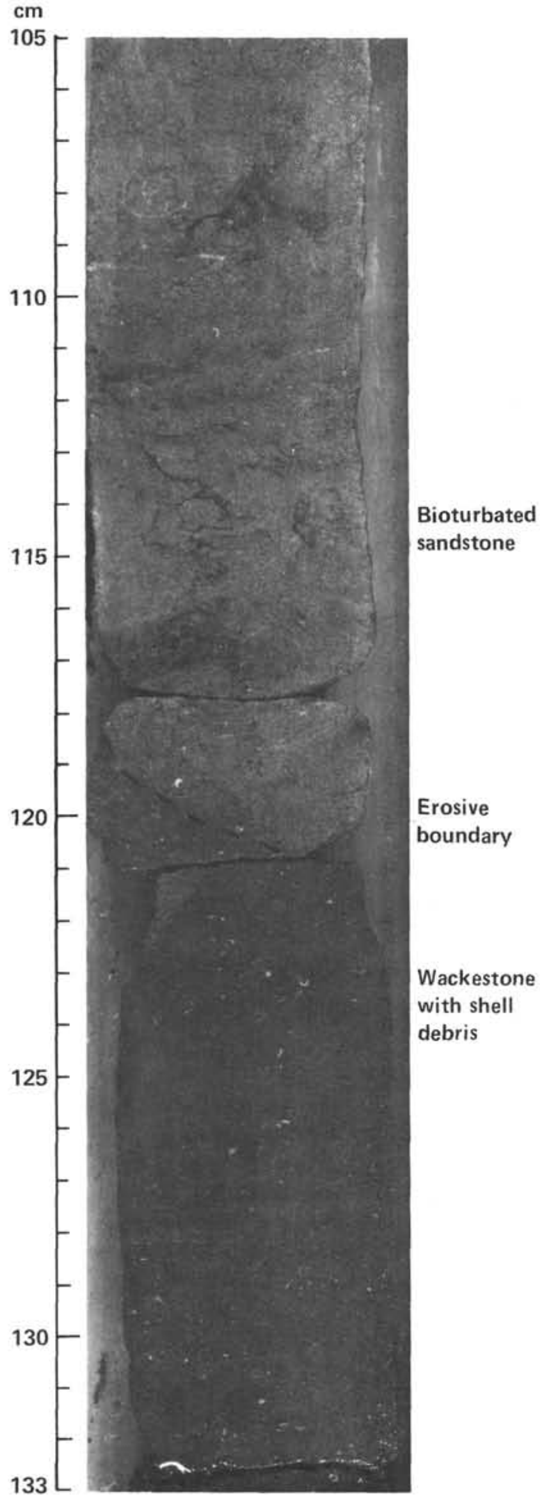


Figure 12. Sandstone and shelly wackestone of Subunit 10a (early Barremian). Section 549-75-2.

choline foraminifers occur in Cores 72 to 75 but are absent below.

The carbonate-poor lithology consists of mudstones, sandy mudstones, and sandstones, with $CaCO_3$ values as low as 4% (according to carbonate bomb analysis). The sand-sized fraction consists primarily of quartz, the mud fraction of quartz, feldspar, and clay minerals. Plant fragments and pyrite are scattered throughout.

The clay mineral suite within Cores 72 to 74 consists largely of illite, smectite, and mixed-layer clays. Kaolinite and chlorite appear in Core 75 and below, where a corresponding loss of smectite and mixed-layer clays takes place (Rat et al., this volume).

Thin sections of the hard limestone (Sections 549-73-3 [71–73 cm] and 549-76-2 [124–126 cm]) contain corals, trocholine foraminifers, echinoderms, gastropods, bryozoans, glauconite, ooliths, and fragments of terebratulids in a recrystallized sparry calcite cement.

The lower boundary of Subunit 10a is visible in the cores at 843 m BSF; on the gamma ray log, however, a marked decrease in intensity that probably corresponds to this boundary occurs at 847 m BSF (see Downhole Logging, below).

Subunit 10b

Subunit 10b consists of interbedded calcareous and noncalcareous sandstones, sandy mudstones, and mudstones. It occurs from 843 to 870 m BSF (Cores 78 to 80) and is early Barremian in age.

Subunit 10b consists of interbedded gray (5Y 4/2) and dark gray (5Y 3/2), massive calcareous sandstones, mudstones, and sandy mudstones; there is only one thin bed of limestone within this interval.

The calcareous sandstones are color banded. The darker gray layers contain more terrigenous detritus, and the lighter gray layers are richer in carbonate. These sandstones are composed predominantly of quartz, with lesser amounts of feldspar, mica, clay, chlorite, heavy minerals, carbonate cement, and shell fragments (echinoderms).

The sandy mudstones and mudstones consist of quartz and clay minerals, with lesser amounts of feldspar, heavy minerals, and dolomite. They also contain rare shell fragments, coaly wood fragments, and pyrite, which may be concentrated in thin beds. The clay minerals consist of kaolinite, illite, chlorite, and mixed-layer clays.

Burrows are not very obvious in this subunit. There is one erosion surface, overlain by mud-supported shell debris, in Section 549-79-1 at 40 cm. A single thin (less than 20 cm), gray olive (5Y 5/2), pelloidal grainstone, which grades upwards into a wackestone, is present in Section 549-79-1 from 90 to 107 cm. In Core 80, parts of Sections 1 and 2 contain contorted bedding (Fig. 13).

Subunit 10c

Subunit 10c consists of color-banded calcareous and noncalcareous mudstones. It occurs from 870 to 884 m BSF (Cores 81 to 83) and is early Barremian in age.

Subunit 10c consists of highly variegated, interbedded, calcareous mudstones and sandy mudstones and one bed (less than 40 cm) of sandy limestone. The mudstones are thinly laminated and often burrow-mottled; some contorted beds were observed (Section 549-82-2, Fig. 14). Colors range from green (5G 6/1) to dark gray (7.5YR 5/0), reddish brown (7YR 6/6), blue gray (5B 7/1), brown gray (5YR 4/1), orange pink (10R 7/4), yellow brown (10YR 5/4), gray red (10R 4/2), and olive gray.

Figure 13. Contorted bedding within Subunit 10b (early Barremian). Section 549-80-1.

The major component of the terrigenous sediment is quartz, which is often iron stained, and clay; only minor amounts of dolomite, calcite, and pyrite occur. Wood fragments are abundant in Core 82. The clay mineral suite is similar to that in Subunit 10b. Only the sandy mudstone (Section 549-81-2) contains shell fragments. The thin sandy limestone at the top of Core 82 is gray (5Y 4/1) and fines upward.

Subunit 10d

Subunit 10d consists of interbedded mudstones, sandy mudstones, and sandstones. It occurs from 884 to 964.5 m BSF (Cores 84 to 93) and is early Barremian(?) in age.

Subunit 10d consists of thin, interbedded, terrigenous claystones, siltstones, mudstones, sandy mudstones, sandstones, and occasional thin layers of shelly limestone.

The terrigenous units are usually dark brown (10YR 3/3), olive brown (2.5Y 4/4), dark gray brown (2.5Y 3/2), dark gray (2.5Y 5/1), olive (2.5Y 4/3), olive gray (5Y 5/2), greenish gray (5G 6/1), gray (10YR 5/1), or olive (2.5Y 4/3). They are deficient in fine-grained calcareous material and contain only occasional large shell fragments, which are sometimes concentrated in layers. In general, they are rich in quartz, with secondary amounts of feldspar, mica, heavy minerals, clay minerals, and pyrite; carbonized wood fragments are dispersed throughout (Fig. 15). The clay minerals consist of illite, kaolinite, chlorite, and mixed-layer clays. Siderite concretions were detected in Cores 90 and 91.

The terrigenous sediments are laminated and only occasionally burrowed and mottled. In Section 549-84-1 there is a displaced block that consists of a bed of shell- and pebble-bearing sandy mud and a bed of organic-carbon-rich mudstone (Fig. 16). The block has apparently been rotated nearly 90° from the horizontal. There are large sediment clasts in a layer below this block, as well as in Section 549-93-1. Upward-fining sequences (sandy mudstones grading to mudstones or claystones) occur in Sections 549-86-1, 549-88-2, 549-88-3, 549-90-1, and 549-90-2. Upward-coarsening sequences occur in Sections 549-89-2, and 549-92-1. Most other contacts between terrigenous sediments of different textures are abrupt. In Core 86, there is an erosional contact overlain by mud clasts. Irregular contacts are also present in Sections 549-88-2 and 549-90-1.

The shelly lithology, which constitutes only a small part of this unit, is usually dark gray (5Y 5/1), dark olive gray (5Y 3/2), or olive gray (5Y 5/2). It is hard, massive, bioturbated, and rich in large fragments of echinoderms, algae, worm tubes, and bryozoans.

In Core 92 a band of hard sideritic(?) rock (Fig. 17) was found along with the sediment types discussed above. In Section 549-93-1, hard limestone intraclasts contain echinoderm and bryozoan fragments.

Unit 11

Unit 11 consists of Hercynian basement. It occurs from 964.5 to 1001.5 m BSF (total depth of hole) (Cores 94 to 99) and is middle to late Devonian in age.

Unit 11 is composed of fine to medium-grained, micaceous, laminated and cross-laminated quartzite. The bedding is tilted at a high angle (greater than 45°) to the

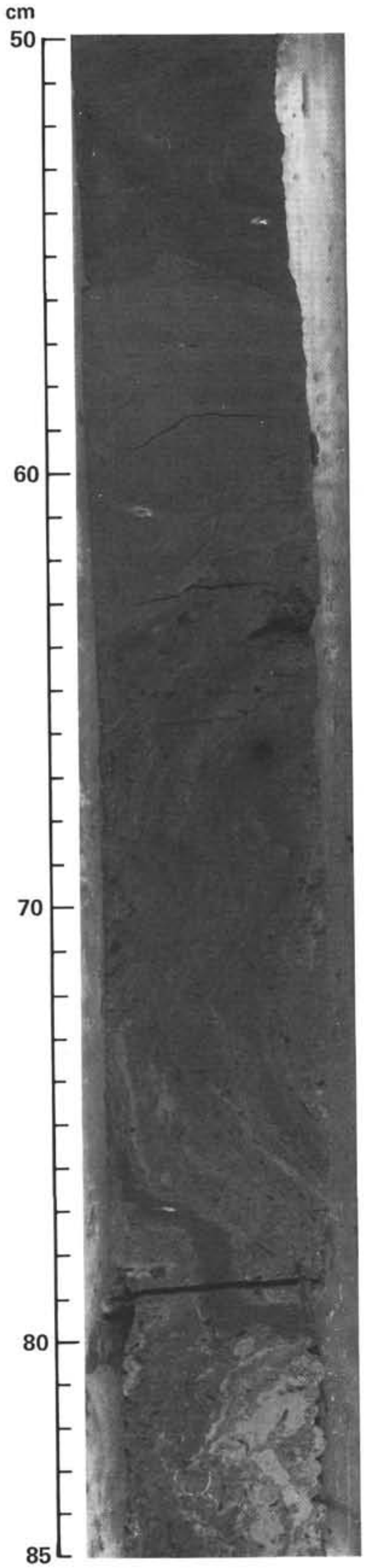


Figure 14. Contorted bedding within Subunit 10c (early Barremian). Section 549-82-2. Slump structure probable.

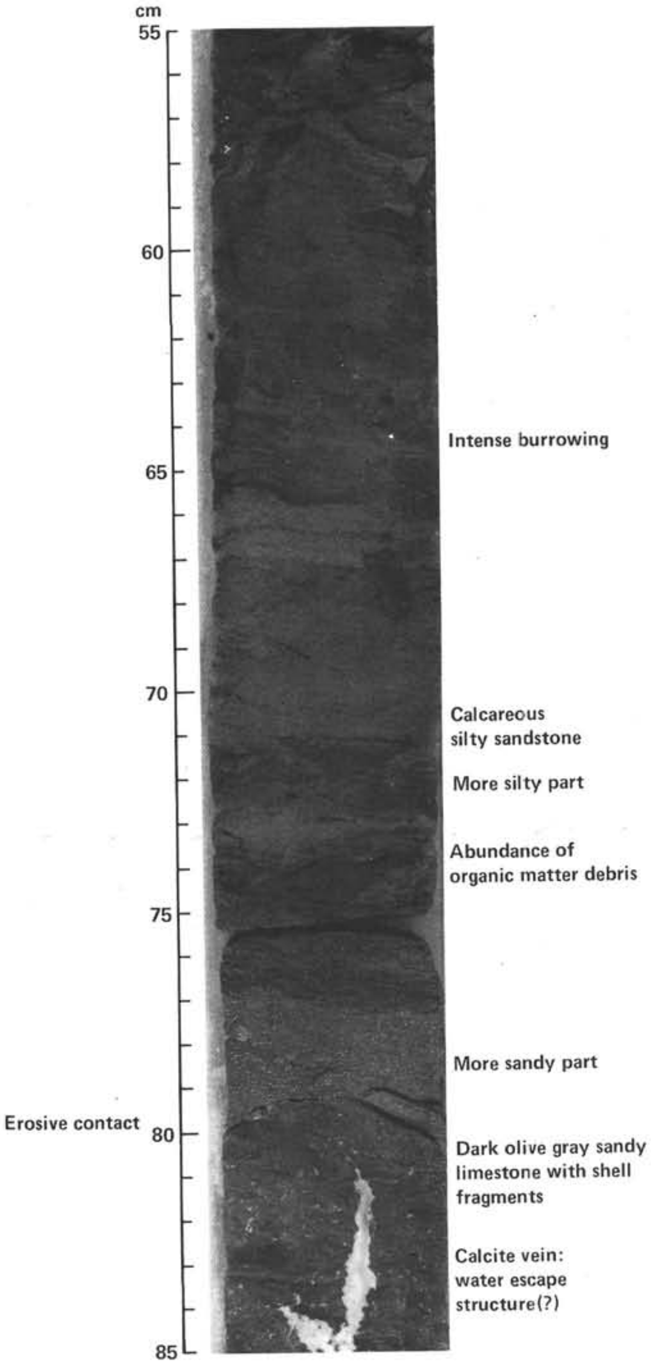


Figure 15. Terrigenous sediments of Subunit 10d (early Barremian). Section 549-90-1.

horizontal. It is light olive brown (2.5Y 5/4), dark yellowish brown (10YR 4/4), or dark gray (2.5Y 4/0).

The contact between the Hercynian basement and the overlying sediments was not recovered. However, it is believed to occur where measurements of formation resistivity increase markedly (at 967 m BSF). The contact represents a period of erosion or nondeposition that may have lasted some 250 m.y.

This rock consists of sutured quartz (greater than 90%) and sericite(?). The latter fills fractures and pores

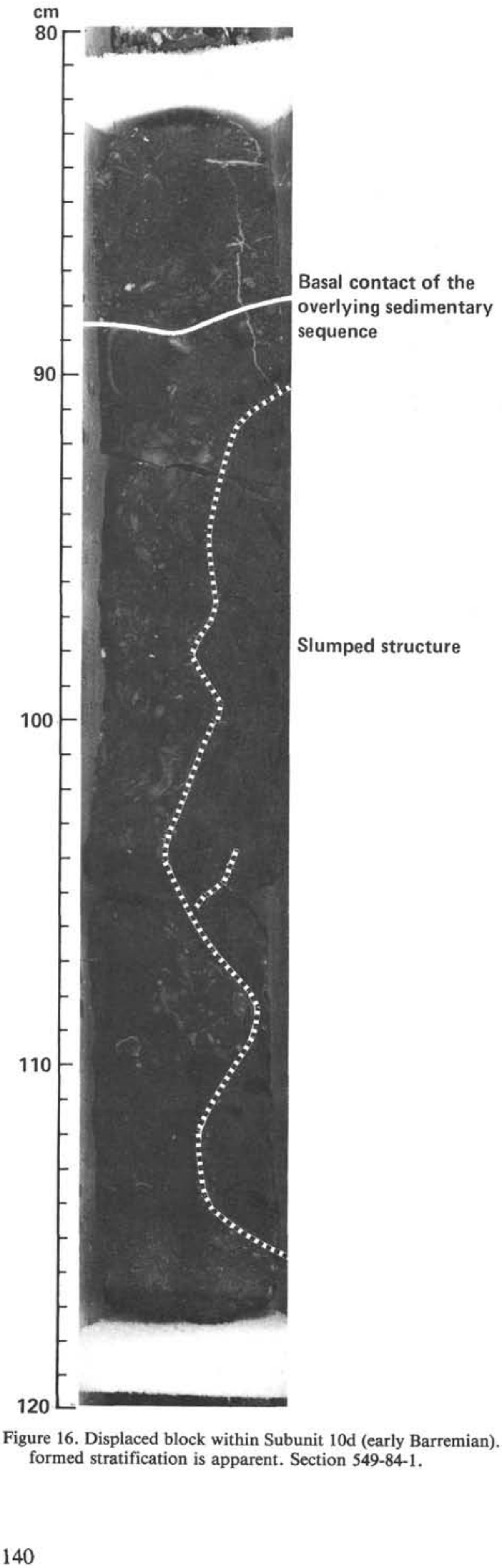


Figure 16. Displaced block within Subunit 10d (early Barremian). Deformed stratification is apparent. Section 549-84-1.

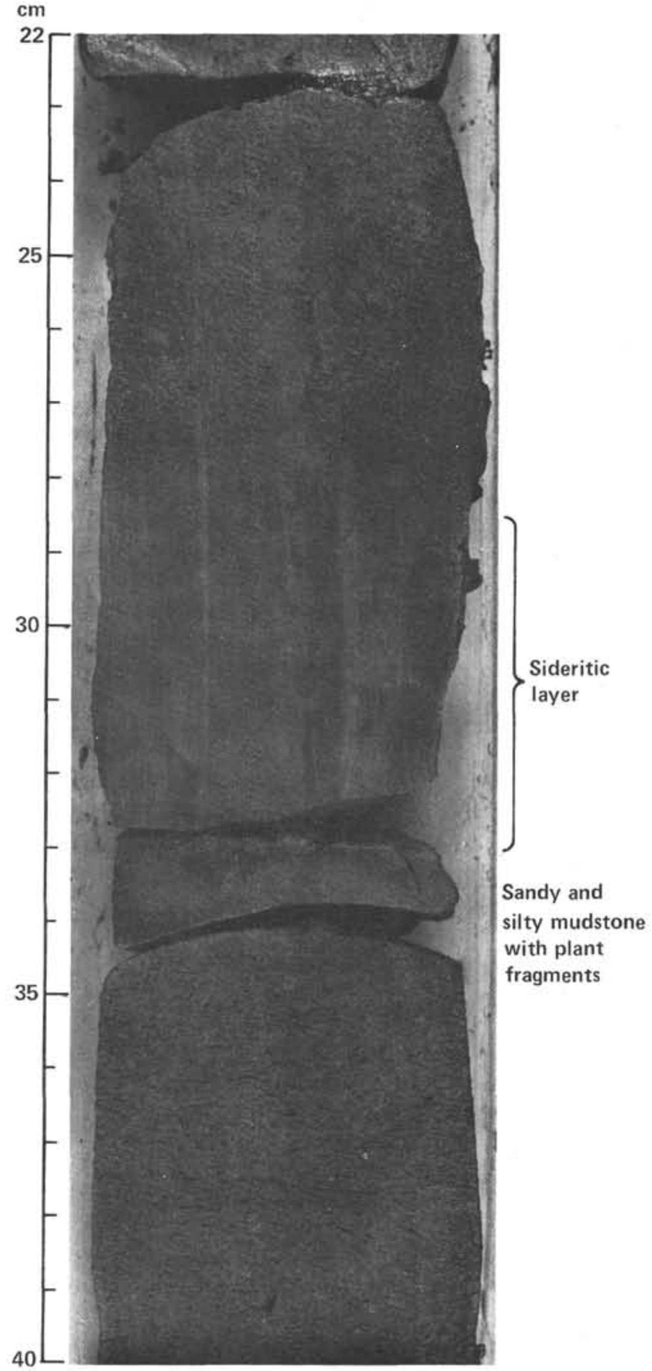


Figure 17. Sideritic(?) bed within Subunit 10d (early Barremian). Section 549-92-1.

in the quartzite and, in Core 99, is concentrated in a very thin (less than 2 cm) layer. The quartzite is usually well laminated as a result of changes in grain size; the coarse-grained beds are sometimes stained dark brown with iron. In addition, small trough cross-beds and tangential planar cross-beds were observed.

The sandstones have fracture planes that are oriented parallel to the coring direction. Some of these are striated and are lined with micaceous or talclike mineral deposits (Fig. 18).

Figure 18. Striated fractures lined with micaceous or talclike minerals; Unit 11 (?Devonian). Section 549-94-1.

BIOSTRATIGRAPHY

Summary

The upper part of the section at Site 549 (Hole 549A; 0–196.5 m BSF) was cored with the variable length hydraulic piston corer. The Quaternary to uppermost middle Eocene section is incomplete (Fig. 19). The thin Quaternary section (27 m) is underlain by upper to lower Miocene nannofossil chalk. This sequence, which is only about 24 m thick, is interrupted by an unconformable surface that represents most of the middle Miocene. Another unconformity that represents the lowermost Miocene marks the contact of the lower Miocene with the upper Oligocene.

In contrast, the thick (145 m) upper Oligocene to uppermost middle Eocene section seems to be nearly complete. The sediments are rich in micro- and nannofossils of good to moderate preservation, presenting an unusually good opportunity for detailed studies of the Oligocene/Eocene boundary and for the fine resolution of biozone boundaries (Snyder et al; Loubere; and Miller et al., all this volume). Rotary coring (Hole 549) penetrated a sequence of middle Eocene to lower Paleocene biozones (198.5–383 m BSF). The sediments are generally rich in foraminifers and nannoplankton, and siliceous microfossils (which occur in relation to several interbedded ash layers; see Knox, this volume) are also present within the middle Eocene and within a short interval of the upper Paleocene (Zone NP9).

Diagenetic processes have altered the micro- and nannofossils in the middle Eocene, but preservation is better within the more clayey sediments of the lower Eocene and Paleocene. The middle/lower Eocene boundary coincides with a lithologic change (Units 2, 3a); the lower Eocene section is marked by an influx of terrigenous detritus. The foraminiferal and nannoplankton assemblages are diverse throughout the Tertiary, and their compositions are indicative of bathyal environments. An unconformity representing a gap of about 2 m.y. (lower Paleocene) separates Tertiary from Cretaceous sediments. A relatively thin Upper Cretaceous section (95 m), which contains several small stratigraphic gaps, was deposited in bathyal environments. Between unconformities there are several relatively long intervals of continuous sediment accumulation. The uppermost is largely Maestrichtian, and there is a thin layer of Campanian sediments at the base. (The middle part of the Maestrichtian may be missing; see Müller, this volume.) The next interval extends from the Coniacian/Santonian to the basal Turonian or uppermost Cenomanian. The lowest involves lower through middle Cenomanian sediments. The Upper Cretaceous units are underlain by a thick section (190 m) of middle to lower Albian calcareous mudstone that was probably deposited in sublittoral environments and corresponds to the earliest postrift deposits at this site. This Albian sequence is marked by the alternation of soft mudstones and indurated calcareous mudstones, cyclic sedimentation that might reflect fluctuations in climate. The sediment accumulation rate is unusually high (67.5 m/m.y.).

The Albian sequence is underlain by a red sandy dolomite of uncertain age. The dolomite is underlain by a thick Barremian section (about 285 m). The lower part of the upper Barremian and the lower Barremian have been identified. The precise age of the lowermost part of the sequence has been difficult to determine, but it is considered to be Barremian, since biostratigraphic evidence indicates the absence of the Hauterivian. The gradual development from shallow subtidal or even tidal (estuary or tidal flat?) environments to sublittoral–upper bathyal environments and more open marine conditions can be followed remarkably well upward through the Barremian sequence (Magniez and Sigal; and Rat et al., both this volume).

The Barremian sequence lies unconformably above a yellowish brown foliated sandstone that is related to the Devonian from lithologic comparisons with Old Red Sandstone outcroppings in the British Isles (Lefort et al., this volume). The sandstone lies at a depth of 964.5 m BSP and represents Hercynian basement.

The boundaries specified in the following discussion were identified on board ship. They are superseded by the boundaries shown in the Site 549 Superlog (back pocket), which represent the results of subsequent shore-based work. For more detail, see Caralp et al. and Snyder and Waters (both this volume).

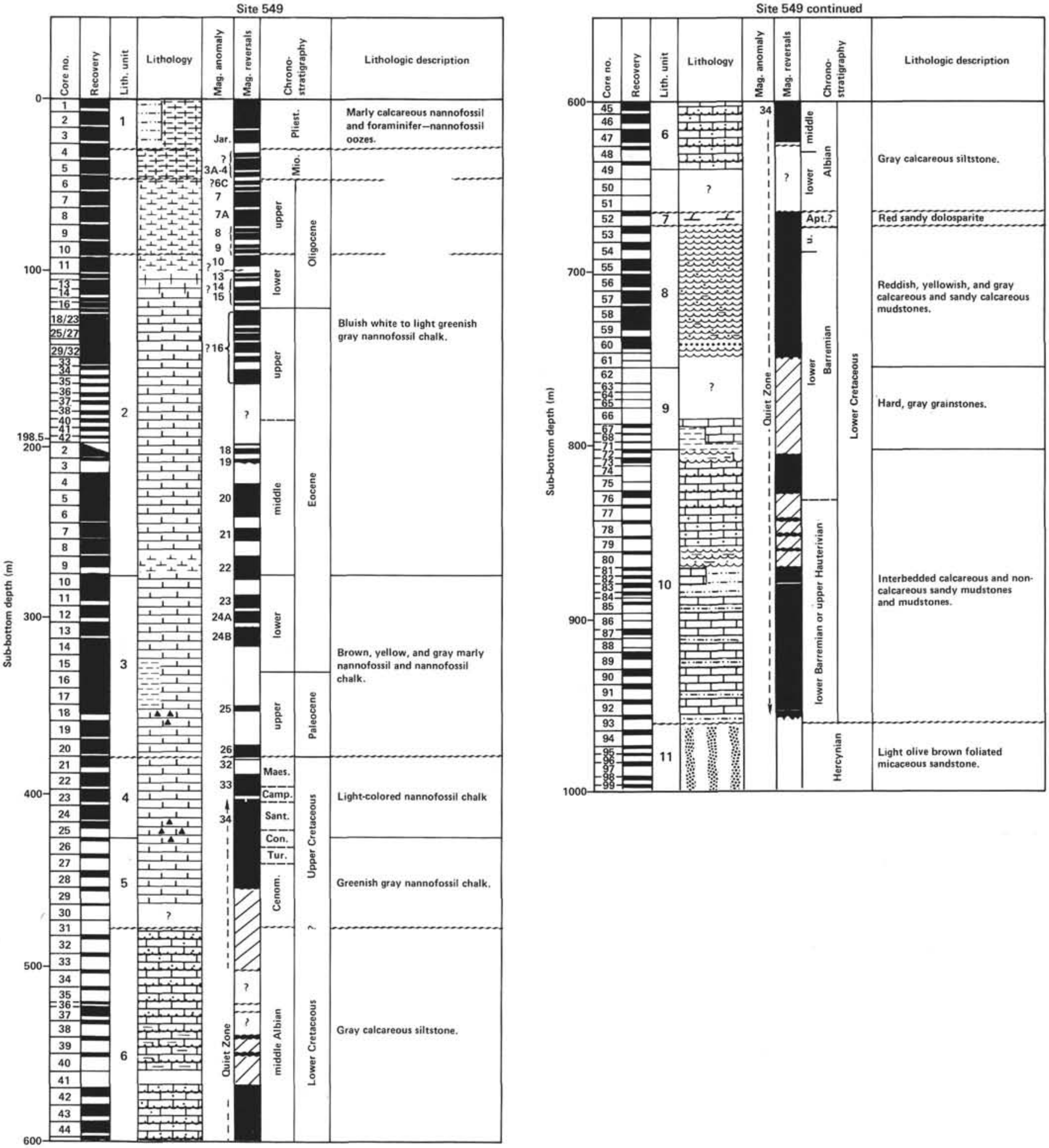


Figure 19. Stratigraphic section at Site 549. Lithology as defined in Explanatory Notes.

Foraminifers

Cenozoic

A surficial veneer of Holocene sediments in Hole 549A is underlain by approximately 27 m of Pleistocene sediments (Samples 549A-1-2, 8–11 cm through 549A-4-1, 60–63 cm; Fig. 19). The assemblages from this abbreviated section, which includes portions of Zones N22 and N21, are typical of neither glacial nor interglacial assemblages. Numerical dominance is shared almost equally among *Globigerina bulloides, Globorotalia inflata, Neogloboquadrina pachyderma*, and *N. "du/*

pac". The excellent preservation and general lack of detrital quartz in these samples suggest that the section bears a closer resemblance to the interglacial than the glacial intervals recognized at Site 548. The Pleistocene section at Site 549 may represent a transition between glacial and interglacial conditions. In the lower part of the section the apparent FAD of *Globorotalia truncatulinoides* occurs, and below it there is an interval in which this species occurs with *G. tosaensis*. However, for the reasons outlined in the discussion of Site 548, this datum is not interpreted as the base of the Pleistocene. Because *Neogloboquadrina atlantica* does not appear in sediments above the underlying unconformity, no Pliocene sediments have been recognized. For more detail, see Caralp et al. (this volume).

Immediately below the lower Pleistocene sediments of Sample 549A-4-1, 60–63 cm there is an unconformity that represents the entire Pliocene. The planktonic foraminiferal fauna of Sample 549A-4-2, 60–63 cm has been assigned to the upper Miocene (Zone N17) on the basis of the presence of such species as *Sphaeroidinellopsis subdehiscens, S. seminulina, Globorotalia cibaoensis, Globigerina woodi*, and *G. decoraperta*. This sample also contains numerous specimens of *Bolboforma* (see Müller et al., this volume).

The N17/N16 zonal boundary, according to the LAD of *Globorotalia lenguaensis*, lies between Samples 549A-4-5, 60–63 cm and 549-5-1, 30–33 cm. Thus, Zone N17 is unusually thin, suggesting that a portion of it is missing. The stratigraphic ranges of some species present in the uppermost sample of this Miocene section reinforce this interpretation. For example, *Sphaeroidinellopsis seminulina*, which ranges only into mid-N17, is present in Sample 549A-4-2, 60–63 cm. The entire upper Miocene section, which extends downward through Sample 549-6-1, 30–33 cm, is approximately 19 m thick.

Below the sediments of Zone N16 there is another unconformity, this one representing nearly the entire middle Miocene (Zones N9–N15; Fig. 19). Samples 549A-6-2, 30–33 cm through 549A-6-4, 30–33 cm contain planktonic assemblages that are indicative of the Zone N8–N7 interval. Diagnostic species include *Praeorbulina glomerosa, Globigerinatella insueta, Globigerinoides sicanus*, and *Globorotalia fohsi peripheroronda*. Sample 549A-6-2, 30–33 cm also contains rare specimens of *Bolboforma*. The Zone N8–N7 interval, which is underlain by yet another unconformity, is only about 5 m thick.

The unconformity between Samples 549-6-4, 30–33 cm and 549A-6-5, 30–33 cm represents most of the lower Miocene (Zones N6, N5, and a portion of N4; Fig. 19). Sediments of Zone N4 (upper Oligocene) are distinguished from the overlying Miocene sediments by the last common occurrence of *Catapsydrax unicavus* and *C. dissimilis* and by the LAD of *Globigerina angulisuturalis* and *G. tripartita*. The N4/P22 zonal boundary lies immediately above Sample 549A-7-5, 30–33 cm. Its position is based on the LAD of *Globigerina officinalis* and the last common occurrence of *Globorotalia opima nana*. The boundary between Zones P22 and P21, according to the LAD of *G. opima opima* and *G. postcretacea*, lies just above Sample 549A-8-3, 50–53 cm. The P21/P20 zonal boundary lies between Samples 549A-10-2, 40–43 cm and 549A-10-3, 40–43 cm. Its position is based on the first common occurrence of *G. opima opima*, the LAD of *G. increbescens*, and the stratigraphic proximity of the FAD for *Globigerina angulisuturalis*. The boundary between Zone P20 and the underlying Zone P19–P18 interval, which lies between Samples 549A-11-5, 30–33 cm and 549A-11-6, 30–33 cm, is based on the LAD of *Pseudohastigerina micra* and *Globigerina eocaena*. Foraminiferal evidence discussed in more detail below was used to place the Oligocene/Eocene boundary between Samples 549A-17-1, 30–33 cm and 549A-17-2, 30–33 cm. If this interpretation of the boundary is correct, the entire Oligocene section is approximately 72 m thick.

The placement of the Oligocene/Eocene boundary (which is discussed by Snyder et al.; Miller et al.; and Loubere, all this volume) is based partly on the LAD of the genus *Hantkenina. H. alabamensis* occurs in Sample 549A-17-2, 30–33 cm, and *H. longispina* is present in the sample immediately below (Fig. 19). Although specimens of *Hantkenina* are consistently present in Cores 549A-17 to 549A-29, they are also rare. The fragility of the species in this genus makes it unlikely that these specimens have been reworked. Specimens of subspecies of *Globorotalia cerroazulensis*, although extremely rare, also persist through Sample 549A-17-2, 30–33 cm. The last common specimens of *G. cerroazulensis cerroazulensis* and *G. cerroazulensis cocoaensis* occur in Sample 549A-21-1, 30–33 cm. *G. cerroazulensis cunialensis*, which in terms of evolution is the most advanced member of this lineage, is rare in Sample 549A-18-1, 30–33 cm. Its presence is indicative of late Eocene deposition. The immediately overlying Oligocene section is complete, indicating continuous deposition across the epoch boundary.

The upper Eocene section extends downward through Sample 549A-38-1, 41–43 cm; as a result, the total thickness of this interval is approximately 67 m (Fig. 19). Zone P17 extends downward through Sample 549A-27-1, 40–43 cm. Its lower boundary is marked by the FAD of *Globigerina ampliapertura* and *Globorotalia cerroazulensis cocoaensis*. Primarily because of the FAD of *G. postcretacea* and the LAD of *Globigerinatheka barri*, the P16/P15 boundary has been placed between Sample 549A-34-1, 49–52 cm and Section 549A-35,CC. The upper/middle Eocene (P15/P14) boundary was recognized by the LAD of *Truncorotaloides collactea* and *T. rohri* and the approximate FAD of *Globigerina angiporoides*. Long-ranging but numerically important species of the upper Eocene include *Glogerinatheka index, Chiloguembelina cubensis, Catapsydrax unicavus, C. dissimilis*, and *Globigerina eocaena*.

The middle Eocene extends from Sample 549A-39-1, 70–73 cm downward through Sample 549-9-4, 18–21 cm, a thickness of about 79 m (Fig. 19). The position of the P14/P13 zonal boundary is based primarily on the LAD of *Acarinina bullbrooki* and the FAD of *Chiloguembelina cubensis*. The position of the boundary between Zones P13 and P12 is based primarily on the

LAD of *Acarinina pentacamerata*. The FAD of *Catapsydrax dissimilis* and *C. unicavus* occurs 2 or 3 m below this boundary. The LAD of *Acarinina broedermanni* and the simultaneous FAD of *Globigerinatheka index* and *G. barri* mark the boundary between P12 and the underlying P11–P10 interval. The latter two zones cannot be readily differentiated from the planktonic foraminifers. The base of Zone P10 (the middle/lower Eocene boundary) is marked by the FAD of *Acarinina bullbrooki* and the LAD of *A. soldadoensis soldadoensis* and *A. soldadoensis angulosa*.

The lower Eocene section extends downward from Sample 549-10-1, 67–69 cm through Sample 549-16-3, 52–56 cm, a total thickness of approximately 65 m (Fig. 19). The P9/P8 zonal boundary is based on the FAD of *Globigerina frontosa* and *Morozovella causasica* and the LAD of *Morozovella subbotinae* and *Acarinina pseudotopilensis*. The LAD of *Morozovella formosa gracilis* and *M. lensiformis* serves as the primary evidence of the P8/P7 zonal boundary. The LAD of *M. marginodentata*, a species that is common in the remainder of the lower Eocene, occurs just below the P8/P7 boundary. The differentiation of Zones P7 and P6 is based primarily on the LAD of *Planorotalites chapmani*. The base of Zone P6 is marked by the simultaneous FAD of *Morozovella wilcoxensis, M. subbotinae*, and *M. marginodentata*. Long-ranging but numerically important species of the middle and lower Eocene include *Globigerina eocaena, G. linaperta, Pseudohastigerina wilcoxensis*, and *Acarinina primitiva*.

The sediments from Sample 549-16-4, 57–60 cm downward through Sample 549-21-3, 12–15 cm have been identified as upper Paleocene (Fig. 19). It is difficult to subdivide this interval on the basis of planktonic foraminiferal evidence, however. The uppermost Paleocene section contains a mixture of forms from Zones P5 and P4. The P4 forms may be reworked and mixed with a more typical P5 fauna. Further complicating the interpretation is a barren interval within the upper Paleocene (Sample 549-16-6, 12–15 cm and Samples 549-17-4, 63–66 cm through 549-19-1, 10–13 cm). The samples below the barren zone contain a typical zone P4 assemblage that includes *Planorotalites pseudomenardii, Subbotina triloculinoides, Morozovella pusilla*, and *M. conicotruncata*. The interval is approximately 40 m thick and includes Zone P4 and at least part of Zone P5. The underlying zone (P3) is differentiated by the FAD of *Planorotalites pseudomenardii* and *Morozovella aequa*. The thickness of Zone P3 is approximately 5 m. Below it there is a thin (less than 2 m thick layer of sediment) that has been assigned to Zone P2 because of the concurrent presence of *Morozovella uncinata, Planorotalites compressa, Subbotina triloculinoides, S. inconstans*, and *S. pseudobulloides*. The Zone P2 sediments unconformably overlie Cretaceous strata.

Maestrichtian to Cenomanian

Late Cretaceous sediments form a relatively thin series, but all stages may be present (Fig. 19). These strata accumulated in outer sublittoral to upper bathyal environments. Small stratigraphic gaps may occur repeatedly throughout the section (as between the Danian and Maestrichtian), but this cannot firmly be established at the present stage of examination.

Section 549-21,CC belongs to the upper Maestrichtian (MC11 or late MC10 Zone), as indicated by the presence of *Racemiguembelina fructicosa* in a very rich and characteristic planktonic assemblage.

The core catchers of Cores 22 and 23 (Hole 549) yielded encrusted and badly preserved foraminifers that indicate an early Maestrichtian or late Campanian age (e.g., *Globotruncana arca, Schackoina multispinata, Buliminella carseyae, Bolivinoides* cf. *decorata*).

Section 549-24,CC belongs to the Santonian; it contains a very rich planktonic assemblage that includes such diagnostic species as *Globotruncata lapparenti, G. coronata, G. sinuosa*, and *G. concavata carinata*.

Section 549-25,CC yielded a Santonian or Coniacian assemblage.

In Section 549-26,CC a poor and badly preserved assemblage of small planktonic forms, including large specimens of *Hedbergella* and probably *Globotruncana praehelvetica*, suggests a Turonian age.

Core 549-27, which is characterized by a black shaly facies, contains no diagnostic species. Sample 549-27-1, 5–8 cm may belong to the upper Cenomanian or to the basal Turonian stage.

Core 549-28 definitely belongs to the Cenomanian (probably middle Cenomanian); it contains *Rotalipora reicheli* and the *R. cushmani* group.

Cores 549-28 and 549-30,CC yielded early Cenomanian assemblages, including *R. appenninica, R. balernaensis, R.* cf. *globotruncanoides, R.* cf. *brotzeni*, and the *Globotruncana delrioensis* group.

Albian

A sudden lithologic change separates Cores 549-30 and 549-32 (Fig. 19). According to the downhole logging records, it occurs within the unrecovered part of Core 549-31. Benthic foraminifers are present and have relatively long ranges throughout the Albian. Planktonic foraminifers predominate; they form an assemblage that has been observed frequently in lower Albian sediments from other North Atlantic sites. This assemblage is present below the more specialized forms (such as *Ticinella*), which appear in the middle Albian and characterize the rest of the stage. Accordingly, an early Albian to early middle Albian age (late MCi-23 and/or MCi-24 Zones) is likely (and agrees with the age indicated by the calcareous nannofossils). The diagnostic planktonic species include *Hedbergella infracretacea, H.* cf. *gorbachikae, H. globigerinelloides, H. planispira, H. trochoidea, H.* cf. *rischi*, and numerous other small globigerinids. Among the benthic species appear *Spiroplectammina baudouiniana, Gaudryina dividens, Gubkinella graysonensis, Neobulimina minima, Praebulimina nannina, Pleurostomella subnodosa* group, *P. subbotinae, Gavelinella intermedia, Gyroidinoides infracretacea, Valvulineria parva, Conorotalites rumanus, Eponides chalilovi*, and *E. moremani*. These assemblages originated in open marine, upper bathyal, or possibly outer sublittoral environments. The ostracod fauna is very poor, and identification is a problem, inasmuch as all specimens are poorly preserved and very small.

No important changes seem to occur from Cores 549-32 to 549-49; the presence or absence of given species in the washed residue probably results from the small amount of available material. The absence of benthic species is especially unlikely to be significant, since these species are usually rare. Cores 549-50 and 549-51 were not recovered.

Barremian (Foraminifers and Ostracods)

The thick series of sediments from Cores 549-53 to 549-91 is assigned to the Barremian because of the foraminifers and calcareous nannofossils present (Fig. 19). Although their microfossil content is not indicative, a Barremian age can be confidently applied to Cores 549-52 and 549-93 because of the characteristic microfacies, which has been investigated in thin section (Magniez and Sigal, this volume).

Three succeeding assemblages of facies-linked foraminifers can be distinguished (1, 2, and 3 from base to top; see below). They suggest three very different environments. The upper assemblage contains some benthic forms that usually have biostratigraphic value. They suggest that Cores 549-59 to 549-60 approximately correspond to the interval between the lower and upper Barremian (MCi-13/-14 boundary). Younger Barremian diagnostic species (MCi-15) have not been observed in the overlying cores. In the underlying cores, the species encountered are not diagnostic of an early Barremian age. Accordingly, the lower part of the series may belong to the Hauterivian stage. However, according to the general foraminiferal assemblage and the calcareous nannofossils, this seems unlikely.

With a few exceptions (Cores 549-55, 549-61, and 549-76 to 549-85), the assemblages of ostracods are poor and of low diversity, and they include ornamented species that probably indicate some environmental restriction. All the species found indicate nearly normal salinities in a shallow-water paleoenvironment. Many of the species recorded here are known from Barremian and Aptian deposits and therefore are not useful for finer stratigraphic subdivision.

Assemblage 3 (Upper)

From Core 549-53 to Section 549-61,CC, nearly all the samples examined yielded foraminifers. This assemblage contains many more species than the underlying two assemblages, but the diagnostic species are very few. The most important benthic species is *Conorotalites bartensteini*, with its two subspecies *bartensteini* and *intercedens*. The subspecies *intercedens* evolved from *bartensteini* in Core 549-59 or 549-60, a fact that could indicate the MCi-13 Zone (late early Barremian). It is noteworthy that the subspecies *aptiensis*, which evolved from *intercedens*, was not observed; this suggests that these sediments do not reach the MCi-15 Zone (late late Barremian). A second important form is the planktonic genus *Hedbergella*, which develops many small species (*H. hauterivica, H. kugleri, H. tuschepsensis, H. infracretacea, H. sigali*, and *Clavihedbergella eocretacea*). These species are not diagnostic of Barremian age, but their abundance indicates an open marine environment.

The remaining forms in Assemblage 3 are benthic and form a typical assemblage of numerous lagenids (*Lenticula, Astacolus, Tristix, Lingulina*), gavelinellids (*G. barremiana*, the first occurrence of which could denote the early/late Barremian or Mci-13/-14 boundary), various trocholinids (*T. infragranulata, T.* cf. *acuta, T. paucigranulata*), which are distinctly smaller than the species that characterize the underlying assemblage, marssonellids (*M. subtrochus*), and uvigerinamminids (*U. hannoverana, U. tealbyensis*, and new species). The whole fauna supports the assignment of a Barremian age to these sediments. This assemblage accumulated in middle to outer sublittoral environments.

Assemblage 2 (Middle)

From Section 549-70,CC to Core 549-79, foraminifers are present in all the samples examined, but they form a very different assemblage. Prolific and large trocholinids dominate (*T. aptiensis* with varieties, *T.* cf. *burlini*, and other new forms). The *Choffatella decipiens* group is observed in most washed residues and thin sections. Thin sections also show the presence of agglutinating lituolids with calcareous tests, miliolids and other porcelaneous species, encrusting arenaceous (*Acruliammina, Coscinophragma*) or porcelaneous (*Nubecularia*) forms, and fragmented sections of *Orbitolina*. Other benthic species are relatively few and sporadic (lagenids, *Epistomina* cf. *colomi, Patellovalvulina patruliusi*). A few specimens of *Trocholina* and *Choffatella* were also observed in Assemblage 3 within Core 549-61 (washed samples and thin sections from Sections 3 and 4). These specimens are believed to be allochthonous, as is also suggested by the petrographic observations. Planktonic species are absent from Assemblage 2.

These microfossils, as well as other fragments of large fossils, suggest that deposition took place in a shallow or infralittoral carbonate environment, perhaps in the vicinity of reefs. The downhole geophysical logs indicate that this paleoenvironment probably also prevailed during the deposition of unrecovered Cores 549-62 to 549-66 and 549-68, although the missing sediments may be richer in carbonate. The sediments and fossils encountered in this section (from 549-76-2, 65–70 cm to 549-79-1, 37–38 cm) can be considered transitional, because *Choffatella* and *Trocholina* are also present, although they appear in a sandy facies inherited from the underlying series.

Assemblage 1 (Lower)

From Core 80 to Sample 549-91-1, 146–150 cm, the *Choffatella decipiens* group and various species of *Haplophragmoides* dominate. Subordinate benthic forms include *Glomospira, Ammobaculites, Trochammina*, miliolids, encrusting species as in Assemblage 2, lenticulinids, and a few large trocholinids. A single sample (from 549-85,CC) yielded a quite different assemblage that included more lagenids and more numerous epistominids (*Epistomina ornata, E.* cf. *hechti*).

Microfossils as well as other organic remains and abundant plant debris point to a littoral or shallow sublittoral environment with variable salinity and a massive influx of continental material.

The lowermost layers (Cores 92 and 93) are almost barren. Only scattered encrusting forms (*Acruliammina, Coscinophragma*) have been observed in the thin sections.

Nannoplankton

Hole 549A

Quaternary

The Pleistocene is encountered from the top of Core 1 to Sample 549A-4-1, 4–5 cm (Fig. 19). The *Emiliania huxleyi* Zone (NN21) is present from Samples 549A-1-1, 8–11 cm to 549A-2-2, 10–13 cm. The *Gephyrocapsa oceanica* Zone (NN20) is present from Samples 549A-2-2, 95–96 cm to 549A-3-2, 51–54 cm, although *G. oceanica* itself is rare in the sediments because the site is so far north and the climate is so cool. The *Pseudoemiliania lacunosa* Zone (NN19) is present from Samples 549A-3-2, 115–118 cm to 549A-4-1, 4–5 cm. The lowermost part of Zone NN19 is missing.

The Pleistocene sequence is characterized, as at Site 548, by the alternation of layers rich in autochthonous, low-diversity nannoplankton assemblages (*Coccolithus pelagicus, Gephyrocapsa ericsonii*) and layers with abundant reworked (Cretaceous–Tertiary) nannoplankton and detrital material. The alternation is due to fluctuations between glacial and interglacial climates (Caralp et al., this volume).

The alternation of assemblages is less pronounced within the lower Pleistocene (NN19), indicating that climate was more stable during this time. However, variations in the abundance of *Coccolithus pelagicus* within this zone indicate that paleoceanographic conditions fluctuated. The Pleistocene is unconformably underlain by the upper Miocene (hiatus of 3.5 m.y.).

Tertiary

The *Discoaster quinqueramus* Zone (NN11) is present from Sample 549A-4-1, 50–51 cm to 549A-6-1, 61 cm (Fig. 19). The sediments are rich in moderately to well preserved nannoplankton. The coccoliths in some layers are slightly fragmented. The abundance of the discoasters fluctuates, recording variations in environmental (climatic?) conditions. The discoasters that are more typical of cooler water masses (*D. variabilis, D. calcaris*, and *D. surculus*) are frequent, but *D. quinqueramus* is generally rare or absent.

The lower part of the middle Miocene *D. exilis* Zone (NN6) was identified from 549A-6-1, 69 cm to Sample 549A-6-1, 71–72 cm on the basis of *D. exilis* and *Cyclicargolithus abisectus*. The unconformity between the late and middle Miocene represents a hiatus of approximately 6 m.y.

The *D. exilis* Zone is underlain by the *Sphenolithus heteromorphus* Zone (NN5) which occurs from 549A-6-1, 75 cm to 549A-6-2, 138 cm; the *Helicosphaera ampliaperta* Zone (NN4), which occurs at 549A-6-3, 52 cm; and the *Sphenolithus belemnos* Zone (NN3), which occurs from 549A-6-3, 59 cm to 549A-6-3, 78 cm. The condensed lower Miocene section is comparable to that at Site 548.

The upper part of the lower Miocene (NN3 and 4 Zones) is separated from the underlying upper Oligocene by an unconformity that represents a hiatus of at least 5 m.y. (Fig. 19).

Sphenolithus ciperoensis, which is an indicator of the upper Oligocene (NP25 Zone), occurs from 549A-6-3, 95 cm to Sample 549A-7-6, 70–72 cm. The sediments in which it is found are rich in large nannoplankton that are both slightly overgrown by calcite and slightly broken. The most common species are *Cyclicargolithus abisectus, Dictyococcites dictyodus, Zygrhablithus bijugatus, Reticulofenestra lockeri*, and *Coccolithus pelagicus*. *Sphenolithus ciperoensis* is present in all samples.

The *Sphenolithus distentus* (NP24) Zone was encountered from Section 549A-7,CC to Sample 549A-10-5, 100–103 cm. The zone determination is based on the presence of *S. ciperoensis, S. distentus, Cyclicargolithus abisectus*, and *Helicopontosphaera recta*. Water mass fluctuations within this zone are indicated by the presence or absence of *Chiasmolithus altus*. The middle Oligocene *Sphenolithus predistentus* Zone (NP23) was identified from Samples 549A-10-6, 100–103 cm to 549A-11-2, 10–13 cm. The abundant nannofossils are partially broken. The thinness of Zone NP23 suggests that part of this zone is missing.

Lower Oligocene sediments were encountered from Sample 549A-11-3, 10–13 cm to Section 549A-23,CC (Fig. 19). Zone NP22 (the *Helicosphaera reticulata* Zone) is present from Samples 549A-11-3, 10–13 to 549A-12,CC, as indicated by the presence of *Reticulofenestra umbilica* and the absence of *Cyclococcolithus formosus*. The sediments are rich in nannoplankton that have slight calcite overgrowths and are broken. Sponge spicules and fragments of radiolarians and diatoms are frequent. The interval from Sample 549A-13-1, 10–13 cm to Section 549A-23,CC belongs to the *Ericsonia subdisticha* Zone (NP21). Large specimens of *Braarudosphaera bigelowi* were observed in Sample 549A-15-1, 10–13 cm.

The determination of the Eocene/Oligocene boundary is based on the last occurrences of *Discoaster saipanensis* and *D. barbadiensis* in Section 549A-24-1 (see Snyder et al., this volume). Nannoplankton belonging to Zones NP19 and NP20 were encountered from Sample 549A-24-1, 10–13 cm to Section 549A-37,CC (Fig. 19). The subdivision of these two zones is difficult because *Sphenolithus pseudoradians* is missing. If the boundary is determined by using the first occurrence of *Helicosphaera reticulata*, it lies between Samples 549A-32-1, 30–32 cm and 549A-32-1, 100–103 cm. The last occurrence of *Cribrocentrum reticulatum* is within Zone NP20. The *Chiasmolithus oamaruensis* Zone (NP18) is present from Sample 549A-38-1, 27–29 cm to Section 549A-42,CC. The upper Eocene is a continuous section of sediments that are rich in moderately to well preserved nannoplankton and fragments of siliceous microfossils.

Hole 549

Tertiary

Hole 549 was washed down to 198.5 m BSF (Fig. 19). The mudline core is Pleistocene in age (NN21). In Core 2 (198.5–208.0 m BSF), the upper Eocene *Chiasmolithus oamaruensis* Zone (NP18) is present in Sections 1 to 4, as indicated by the presence of *C. oamaruensis* and the absence of *Isthmolithus recurvus*. The sediments are rich in well preserved to slightly broken nannoplankton and contain fragments of siliceous microfossils.

A complete middle Eocene section 66 m thick was encountered from Samples 549-2-5, 23–24 cm to 549-10-3, 10–11 cm (Fig. 19). The *Discoaster saipanensis* Zone (NP17) is present from Sample 549-2-5, 23–24 cm to Section 549-2,CC; the *D. tani nodifer* Zone (NP16) occurs from Samples 549-3-1, 120–121 cm to 549-6-3, 62–63 cm (first *D. tani nodifer*); the *Chiphragmalithus alatus* Zone (NP15) occurs from Samples 549-6-4, 62–63 cm to 549-9-3, 16–17 cm; and the *Discoaster sublodoensis* Zone (NP14) occurs from Section 549-9,CC to Sample 549-10-3, 10–11 cm. The sediments are rich in fragmented nannoplankton, radiolarians, and diatoms. A biogenic change (disappearance of siliceous microfossils) takes place within the lowermost part of Zone NP14.

The middle Eocene is underlain by a continuous lower Eocene section about 50 m thick. It occurs from Samples 549-10-3, 102–103 cm to 549-16-3, 50–51 cm (Fig. 19). Nannoplankton are abundant, but in Zone NP13 they are badly preserved as a result of diagenesis. Preservation is good in Zones NP12 to NP10, probably as a result of the higher amount of terrigenous detritus and clay minerals. Siliceous microfossils are missing.

The *Discoaster lodoensis* Zone (NP13) is present from Sample 549-10-3, 102–103 cm to Section 549-10,CC; the *Marthasterites tribrachiatus* Zone (NP12) is present from Sample 549-11-1, 99–100 cm to Section 549-12,CC; the *Discoaster binodosus* Zone (NP11) occurs from Samples 549-13-1, 49–50 cm to 549-15-6, 139–140 cm; and the *Marthasterites contortus* Zone (NP10) occurs from Section 549-15,CC to Sample 549-16-3, 50–51 cm.

The Eocene/Paleocene boundary lies in Section 549-16-3 between 50–51 cm and 105–106 cm (Fig. 19), as indicated by the extinction of *Fasciculithus tympaniformis* and the first occurrence of *Marthasterites contortus*.

The *Discoaster multiradiatus* Zone (NP9) was identified from Samples 549-16-3, 105–106 cm to 549-18-2, 30–31 cm. The nannoplankton are abundant and well preserved. A stratigraphically significant change occurs within this zone between Sections 1 and 2 of Core 17, as indicated by the large numbers of siliceous microfossils (radiolarians, few diatoms) within the deeper part. At the top of Zone NP9 (Samples 549-16-3, 105–106 cm and 549-16-4, 55–56 cm) there is a layer enriched in large specimens of *Braarudosphaera bigelowi*.

The *Heliolithus riedeli* Zone (NP8) was encountered from Samples 549-18-3, 38–39 cm to 549-19-2, 36–37 cm. Nannofossils and siliceous microfossils are common. Samples 549-19-3, 15–17 cm to 549-20-1, 64–65 cm belong to the *Discoaster mohleri* Zone (NP7). The NP7 Zone determination is based on the presence of *D. mohleri* and the absence of *H. riedeli*. Nannoplankton are abundant and well preserved; siliceous microfossils are missing. The *Heliolithus kleinpellii* Zone (NP6) is present from Sample 549-20-2, 6–7 cm to Section 549-20,CC, and the *Fasciculithus tympaniformis* Zone (NP5) is present in Sample 549-21-3, 10–11 cm.

An unconformity representing a hiatus of at least 1 m.y. lies between Zones NP5 and NP3 (Fig. 19). Zone NP3 is present at 549-21-4, 7 cm and 19–20 cm, where *Braarudosphaera bigelowi* is common. At 549-21-4, 19 cm, a few Cretaceous specimens are present. The nannoplankton are badly preserved as a result of heavy calcite overgrowth. The lowermost part of the Danian is missing because of an unconformity representing a hiatus of about 4 m.y.

Cretaceous

Maestrichtian assemblages are present from 549-21-4, 25 cm to Sample 549-23-3, 28–29 cm, along with some reworked Campanian specimens (which occur at 549-22-2, 50 cm and in Sample 549-22-3, 80–81 cm) (Fig. 19).

The late Maestrichtian *Micula mura* Zone is present from 549-21-4, 25 cm to Sample 549-22-1, 41–42 cm. It is underlain by the *Tetralithus trifidus* Zone of the early Maestrichtian, which runs from Samples 549-22-2, 50–51 cm to 549-23-3, 28–29 cm. The middle part of the Maestrichtian seems to be missing. The nannoplankton are abundant, but they are overgrown and fragmented by diagenesis. *Lucianorhabdus cayeuxii* is common, indicating that Site 549 was located at this time in an outer sublittoral to upper bathyal environment.

Floras of Campanian age (as indicated by the presence of *Broinsonia parca* and *Eiffelithus eximius*) were encountered in Core 23.

Cores 24 and 25 contain undifferentiated Santonian-Coniacian assemblages (Fig. 19). *Marthasterites furcatus* and *Lithastrinus grillii* are rare. The nannoplankton are common, but they are generally broken as a result of diagenesis. The Santonian-Coniacian sequence is underlain by a very condensed section of early Turonian age that occurs in Core 26 and probably in Core 27.

The *Eiffellithus turriseiffeli* Zone, which is characterized by *E. turriseiffeli* and *Podorhabdus albianus* and is of Cenomanian–late Albian age, is present at least from the top of Core 549-28 to Section 549-30,CC. Nannoplankton are rare within the lower part of Core 28 and in Cores 29 and 30 as a result of severe fragmentation that is related to diagenesis.

The middle Albian *Prediscosphaera cretacea* Zone is relatively thick (180.5 m, Cores 31–50; Fig. 19). The calcareous mudstones in this interval are poor in nannoplankton, probably because of recrystallization; calcite (sparite) and sponge spicules are common. In contrast, nannoplankton are frequent in the darker silty mudstones. Fragile species are generally broken, whereas dissolution-resistant species are well preserved and more abundant. Pyrite and terrigenous detritus are frequent. The uppermost part of the *Parhabdolithus angustus* Zone (lower Albian) is probably present in Core 52. In Core 53 there is an important unconformity that represents a hiatus of about 10 m.y. between the lower Albian and middle Barremian.

The middle-lower Barremian (*Lithraphidites bollii* Zone) has a thickness of 291.0 m (Fig. 19). The zone determination is based on the presence of *Nannoconus colomi, Calcicalathina oblongata*, and *Hayesites radiatus.*

The sediments in Section 549-53-1 are rich in hematite, and the number of nannofossils is reduced by dissolution and fragmentation, probably as a result of diagenetic processes.

Nannoconids are rare in Cores 53 and 54, but they are common in most of the samples from Cores 55 to 60. The abundance of nannoplankton and the diversity of the assemblages indicate that the sediments of the upper part of the Barremian sequence were deposited in an outer sublittoral environment. However, slight paleoenvironmental fluctuations are indicated by layers in which nannoplankton are rare and of subnormal size. The most common species are *Nannoconus colomi, Parhabdolithus speculum, P. asper, Cretarhabdus angustiforatus, Watznaueria barnesae, W. communis, Conusphaera mexicana*, and *Manivitella pemmatoidea.*

Nannoplankton are rare or missing from Cores 70 to 82. In general the specimens are small in size and the diversity of the assemblages is low. Pyrite, organic matter (plant fragments), and terrigenous detritus are common. Nannoconids are absent or occur only sporadically. These characteristics stem from the very shallow-water, near-shore environments in which the lower Barremian sediments (Cores 70–88) were deposited (see Rat et al., this volume). Nannoplankton are absent from Cores 83 to 88.

SEDIMENT ACCUMULATION RATES

The sediment accumulation rates for Site 549 (Holes 549 and 549A) are plotted in Figure 20. Accumulation was rapid during early Barremian synrift deposition (97.3 m/m.y.). After an important (erosional?) hiatus (12 m.y.), middle Albian strata accumulated at a similar high rate (93 m/m.y.). During the Upper Cretaceous, the site rapidly subsided to bathyal depths, deposition was interrupted several times, and the rate of accumulation decreased drastically (to 3.5–5 m/m.y.).

There was a threefold increase in accumulation rate (11.0 m/m.y.) during the early Tertiary (Paleocene to middle Eocene). Late Eocene accumulation rates increased even more, to 17.2 m/m.y. The subsequent early Oligocene rates decreased fourfold, to 4.9 m/m.y. This low rate contrasts with a late Oligocene rate of about 7.6 m/m.y., and the difference suggests that part of the early Oligocene sediment column is missing.

The Neogene and Quaternary sections are thin and contain so many stratigraphic gaps that no attempt was made to calculate individual accumulation rates. However, the rate for the entire Neogene–Quaternary interval is 2.1 m/m.y., the lowest rate calculated for this site.

ORGANIC GEOCHEMISTRY

Total organic carbon (TOC), carbonate, and total nitrogen contents were measured on 154 samples from Holes 549 and 549A by standard shipboard procedures (Waples and Cunningham, this volume). Rock-Eval pyrolysis was carried out on 67 of these samples; the results of that analysis are tabulated elsewhere (Waples and Cunningham, this volume). Additional work has been completed on shore by Hartung et al. (this volume).

Total Organic Carbon, Carbonate, and Nitrogen

Plots of TOC versus burial depth at Site 549 (Fig. 21 and Superlog) do not decrease monotonically with burial depth, as they did at Site 548. One important difference between Sites 548 and 549 is that the more clastic-rock-rich Pliocene–Pleistocene section (lithologic Unit 1) at Site 549 is much thinner than at Site 548. Highly calcareous sediments with very low TOC values (lower Turonian–upper Miocene, Units 2–4) therefore appear at shallow depths at Site 549, eliminating any decrease that might have been due to organic diagenesis.

Organic carbon enrichment occurs within two intervals at Site 549. Samples high in TOC (average 3.4%) were recovered from Section 549-27-1 (upper Cenomanian, Unit 5), in two beds of black sediment separated by a thin organic-carbon-lean ash bed. Black, organic-carbon-rich sediments of similar age are well known in the North Atlantic and are usually referred to as black shales. Although this terminology is not always precisely correct, we shall adopt this usage in our report.

An unconformity separates the black shales from underlying Albian to Barremian sediments (Units 6–10). These Lower Cretaceous sediments are also enriched in organic carbon (Table 4 and Superlog). Several samples with very high TOC values (3–6%) contain large plant fragments (Batten et al., this volume). Highest TOC values and greatest enrichment in macroscopic plant fragments occur in the oldest sediments (bottom half of Unit 10; Rat et al., this volume). Background enrichment is rather modest, however; the rock matrix, excluding macroscopic plant fragments, contains less than 1% TOC.

Carbonate contents vary from 5 to 97% in the Tertiary and Quaternary section (Units 1–3). Sediments with low carbonate contents are much rarer than at Site 548; most of the post-Mesozoic section comprises nannofossil oozes.

Carbonate contents are low in the black shales of Unit 5, and average (with much fluctuation) about 50% in the Albian and upper Barremian sediments (Unit 6). The lower Barremian sediments (Units 8–10) are mostly carbonate free, although calcareous layers are present intermittently (see Superlog).

Because clayrich sediments recovered on Leg 80 contain both organic and inorganic nitrogen (Waples, "Nitrogen", this volume), atomic C/N ratios must be used with caution as indicators of organic matter type and diagenesis. If organic nitrogen is considered alone, it can be seen that the upper Cenomanian black sediments of Unit 5 differ substantially from the Albian–Barremian sediments of Units 6–10 (Table 4). Atomic C/N_{org} ratios have values of nearly 80 for the Albian–Barremian sediments but of less than 20 for the upper Cenomanian samples. These differences are related to the types of organic matter that contribute to each group of samples: the upper Cenomanian samples contain organic matter from both marine and terrestrial sources, whereas the Albian–Barremian cores are dominated by woody and coaly terrestrial organic matter (Cunningham and Gilbert; Waples, "Nitrogen"; and Waples and Cunningham, all this volume).

Rock-Eval Pyrolysis

The hydrogen indices of samples from all lithologic units at Site 549 are well within the Type III range on the Van Krevelen diagram (Fig. 22), with the exception of the black shales from Unit 5 (discussed below). Hydrogen indices range from 0 to 150 mg HC/g TOC, suggesting that the sedimentary organic matter is terrestrially derived. The highest hydrogen indices among samples containing Type III organic matter occur in sediments at the bottom of Unit 10 (Table 4). The T_{max} values (average 418°C) and moderate oxygen indices (average 150 mg CO_2/g TOC) indicate an immature state of thermal maturity for the organic matter in these sediments.

The black shale interval in Section 549-27-1 (Unit 5) has much higher hydrogen indices than the rest of the section at Site 549 (Table 4). The hydrogen indices (average 317 mg HC/g TOC) are in the Type II–III range on the Van Krevelen diagram, indicating an approximately equal mixture of marine and terrestrial organic matter. The low T_{max} values (average 423°C) suggest that these samples are also thermally immature.

Organic Facies

Two distinct organic facies are present at Site 549: terrestrially dominated and mixed terrestrial–marine. A background of terrigenous organic matter dominates all sediments recovered at this site. The accumulation of terrigenous organic carbon was maximum in the early Barremian, probably as a result of high sediment accumulation rates in the synrift sediments in combination with proximity to land. These sediments, which were deposited in a well oxygenated environment, are extensively bioturbated. The presence of local concentrations of pyrite of both micro- and macroscopic size indicates that reducing microenvironments existed within the sediments, particularly in the vicinity of large organic particles, but does not require the presence of an anoxic water column above the sediments. The organic richness of some samples (up to 5.8% TOC) is due solely to the coarse size and poor biodegradability of the woody fragments.

The Unit 1 to 4 sediments, in contrast, were apparently laid down in a well oxygenated pelagic setting. They contain less organic material for that reason and because land sources were much more distant.

Mixed marine and terrestrial organic matter occurs only in the black shale interval of late Cenomanian age (Unit 5). Fine laminations, organic carbon enrichment, and preservation of marine organic matter suggest that the black shale was deposited during a brief period of bottom water anoxia. The mechanism by which the black shale formed was exceptional in the sedimentary history at Site 549. Whether the brief anoxic episode was caused by a general oceanic anoxic event or by local events is discussed elsewhere (Cunningham and Gilbert; Graciansky and Gillot; Waples and Cunningham; and Waples, "Anoxia", all this volume).

PALEOMAGNETISM

In the Miocene and Oligocene the frequency of the geomagnetic field reversals is relatively high. Therefore, since the Miocene section is very condensed (Fig. 19), it has been impossible to define a magnetostratigraphy. The Oligocene to upper Eocene section is more complete, and an attempt has been made to identify specific magnetic anomalies within the section.

The results from the upper part of Hole 549 (down to the unconformity between the upper Paleocene and Upper Cretaceous sediments) enabled a polarity stratigraphy to be constructed for the middle Eocene to upper Paleocene section. This continuous stratigraphic sequence should enable a detailed correlation between the magnetostratigraphic and biostratigraphic studies to be made.

The section of Mesozoic sediments below the Paleocene/Maestrichtian unconformity is less complete than the overlying Paleogene sequence (Fig. 19). Two short normal polarity intervals in the Maestrichtian and Campanian are tentatively correlated with Anomalies 32 and 33. These are preceded by a long normal polarity interval (Cores 24–93) that is thought to represent the Cretaceous magnetic quiet zone (Townsend; and Hailwood and Folami, both this volume).

PHYSICAL PROPERTIES

The physical properties of the Site 549 section are discussed in Appendix I.

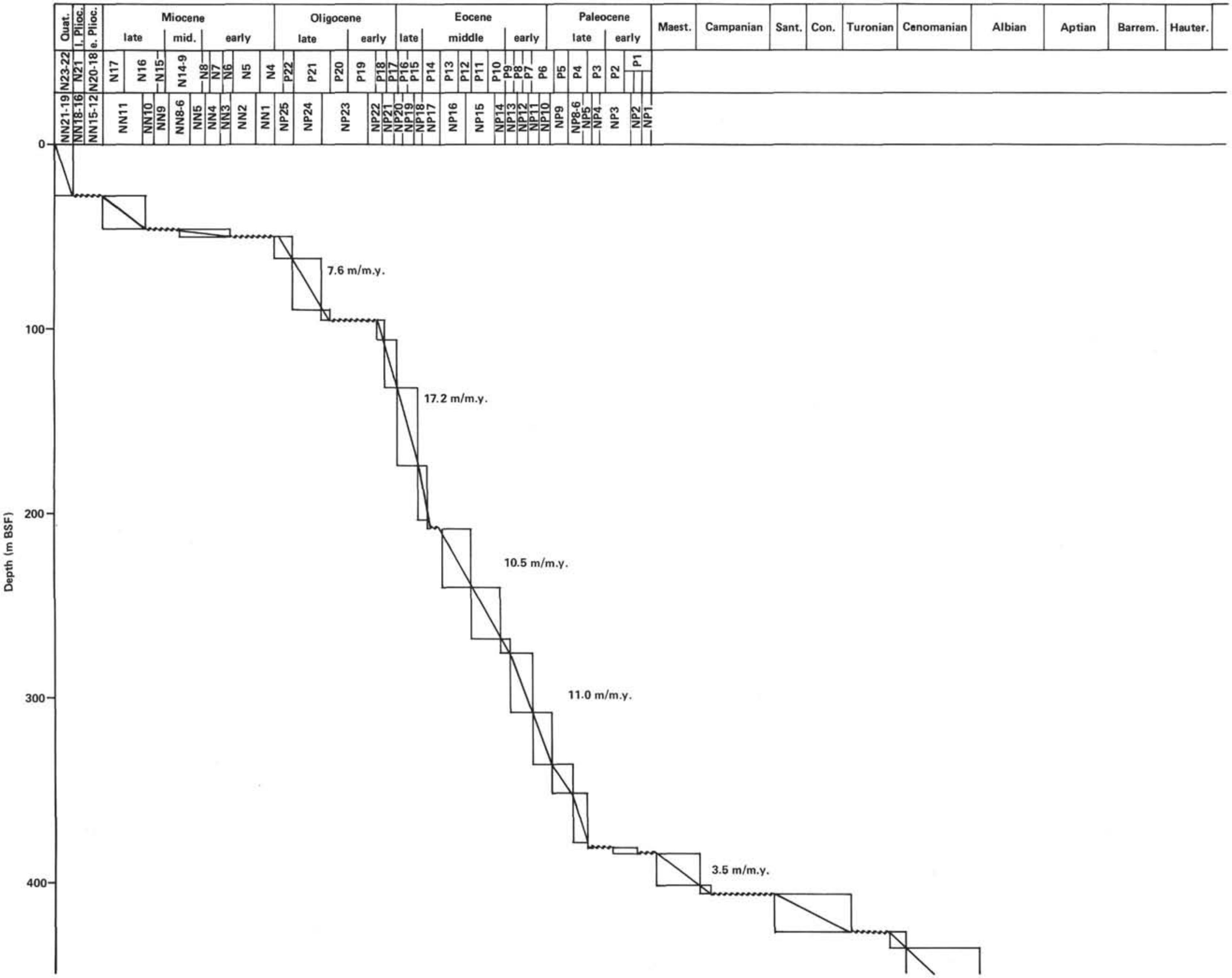
DOWNHOLE LOGGING

The dual induction, gamma ray, and caliper logs run at this site gave good results, but the sonic velocity log was erratic. A second logging run was made with porosity tools intended to provide density, neutron porosity, and natural gamma ray information, but no results were obtained because the tool was lost in the hole (see Site Approach and Operations).

Interpretation

Unit 1 (0–27 m BSF)

The gamma ray log recorded through the drill pipe was the only log recorded over this interval (Fig. 23). The alternation of marly calcareous (5–25% $CaCO_3$) nannofossil ooze and foraminifer-nannofossil ooze (70% $CaCO_3$) is precisely recorded on the log (see Superlog). Three main peaks of maximum clay content occur at 7 m, 13 m, and between 19 and 26 m. The shapes of the


Quat.
l. Plioc.
e. Plioc.
Miocene
late
mid.
early
Oligocene
late
early
Eocene
late
middle
early
Paleocene
late
early
Maest.
Campanian
Sant.
Con.
Turonian
Cenomanian
Albian
Aptian
Barrem.
Hauter.
N23-22
N21
N20-18
N17
N16
N15
N14-9
N8
N7
N6
N5
N4
P22
P21
P20
P19
P18
P17
P16
P15
P14
P13
P12
P11
P10
P9
P8
P7
P6
P5
P4
P3
P2
P1
NN21-19
NN18-16
NN15-12
NN11
NN10
NN9
NN8-6
NN5
NN4
NN3
NN2
NN1
NP25
NP24
NP23
NP22
NP21
NP20
NP19
NP18
NP17
NP16
NP15
NP14
NP13
NP12
NP11
NP10
NP9
NP8-6
NP5
NP4
NP3
NP2
NP1
0
100
200
300
400
Depth (m BSF)
7.6 m/m.y.
17.2 m/m.y.
10.5 m/m.y.
11.0 m/m.y.
3.5 m/m.y.

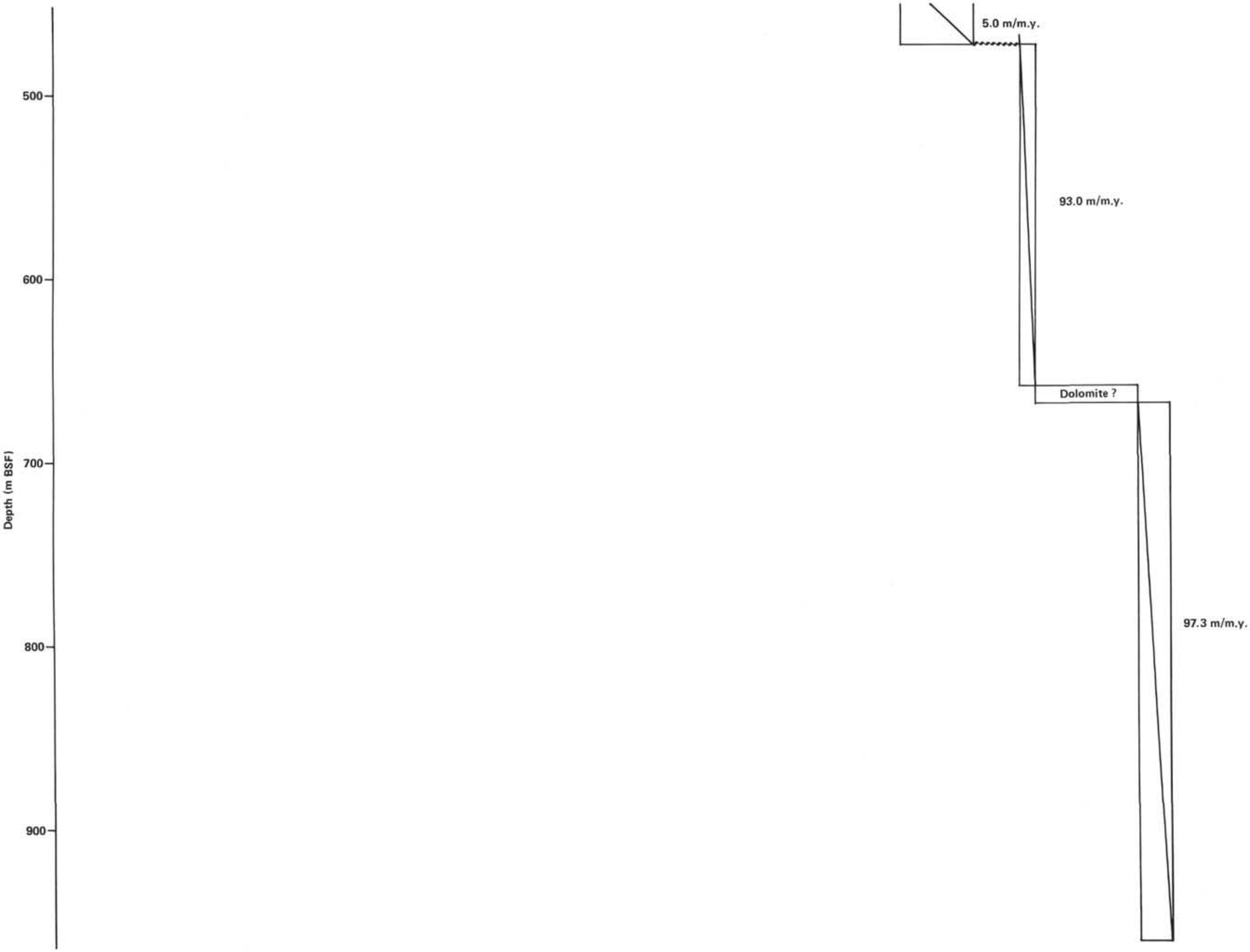


Figure 20. Sediment accumulation rate curve for Site 549.

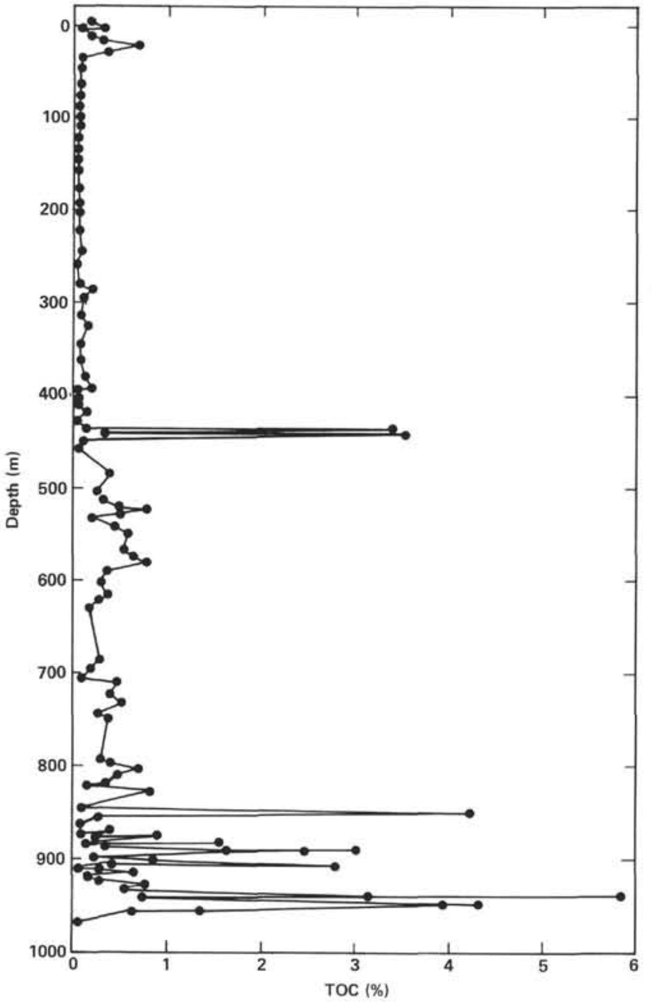


Figure 21. Plot of TOC versus burial depth at Site 549

curves suggest a symmetric (i.e., cyclic) alternation of clayey and calcareous units, an inference that agrees with the climatic cyclicity suggested by other evidence.

Unit 2 (27–276.5 m BSF)

The gamma ray log recorded through the drill pipe was the only log recorded in the upper part of this interval (down to 110 m BSF; Fig. 23). Entry from the drill stem into the open hole is recorded by a marked deflection of the gamma ray curve at 110 m. Unit 2 may be subdivided as follows:

27–40 m: Cyclic alternation of clayey and calcareous lithologies, with maximum gamma ray intensity (i.e., maximum clay) at 30 m.

40–195 m: The gamma ray curve is remarkably regular, with low values corresponding to very homogeneous, highly calcareous sediment (85–90% average). Resistivity is somewhat more variable.

195–276.5 m: Caliper, gamma ray, and resistivity curves are slightly more undulating, corresponding to lithologies that are more variable than those above. Gamma ray average values increase from top to bottom as calcium carbonate content decreases from 85% at the top (Cores 40–41) to 60 to 70% at the bottom (Cores 8–9).

Table 4. Organic geochemical data for Site 549.

Core-Section (interval in cm)	$CaCO_3$ (%)	TOC (%)	N (%)	C/N	Rock-Eval			
					T_{max}	H-index	O-index	$S_1/(S_1 + S_2)$
Hole 549A								
1-1, 11–12	65	0.17	0.036	6.2	367	29	1265	0.62
1-2, 30–31	26	0.26	0.048	7.1	400	19	189	0.58
1-4, 35–36	70	0.11	0.024	6.0	375	27	2582	0.57
2-2, 15–16	66	0.13	0.026	6.7	371	23	1951	0.57
2-4, 15–16	16	0.30	0.045	8.9	420	27	737	0.33
3-2, 43–44	5	0.66	0.066	13.4	428	36	217	0.27
4-1, 15–16	47	0.33	0.048	9.0	383	70	673	0.18
4-5, 15–16	86	0.07	0.014	7.2				
5-2, 15–16	86	0.06	0.012	6.8				
5-4, 15–16	85	0.07	0.014	6.7				
6-1, 125–126	93	0.05	0.006	10.2				
7-4, 9–10	91							
8-2, 21–22	93	0.04	0.006	9.3				
8-6, 10–11	90	0.04	0.007	8.2				
9-2, 10–11	93	0.04	0.006	9.2				
9-4, 10–11	93	0.03	0.006	7.5	—	67	5067	0.33
11-2, 16–17	88	0.04	0.007	7.5				
11-4, 16–17	87	0.04	0.007	7.1				
12-2, 55–56	93	0.03	0.005	8.1				
13-2, 5–6	88	0.06	0.009	9.5				
14-2, 25–26	89	0.08	0.010	10.2	368	25	1988	0.50
15-2, 5–6	95							
16-2, 5–6	88	0.04	0.007	7.2				
17-2, 5–6	97							
18-1, 5–6	90	0.05	0.007	8.7				
22,CC 27–28	93	0.02	0.005	6.4				
24-2, 5–6	95	0.01	0.003	5.3				
25-2, 5–6	86							
26-1, 37–38	89	0.02	0.005	5.4				
27-1, 37–38	89							
28-1, 56–57	90	0.03	0.007	6.5				
33-1, 29–30	84	0.04	0.008	6.0				
34-1, 30–31	89							
35-1, 30–31	86							
36-1, 10–11	95							
37-1, 10–11	89							
38-1, 11–12	84							
39-1, 11–12	86	0.05	0.010	6.9				
41-1, 7–8	85	0.05	0.010	6.7				
42-1, 3–4	75	0.05	0.015	4.8				
Hole 549								
2-2, 44–46	82	0.04	0.009	5.2	—	0	0	—
4-2, 58–59	83	0.05	0.010	6.1				
5-2, 57–58	75							
6-5, 63–64	70				—	0	0	—
7-2, 29–30	62	0.08	0.020	4.9				
8-2, 72–73	69	0.05	0.016	4.1				
9-2, 56–57	74							
10-2, 45–46	76							
10-5, 51–52	72	0.06	0.013	6.1	—	0	0	—
11-2, 59–60	15	0.15	0.026	7.5	—	0	0	—
11-5, 109–110	33	0.10	0.032	4.2				
12-1, 48–49	46							
13-2, 43–44	62							
14-2, 55–56	63	0.07	0.016	5.8				
14-4, 16–17	68							
15-2, 56–57	39	0.10	0.030	4.1				
16-2, 56–57	41				—	0	0	—
17-2, 79–80	53	0.05	0.025	2.4				
18-2, 35–36	43							
19-2, 41–42	63	0.05	0.009	6.3				
20-5, 9–10	57	0.10	0.021	6.3				
21-2, 19–20	73	0.09	0.015	7.9	415	202	500	0.83
22-1, 43–44	94	0.16	0.017	13.0				
22-2, 105–106	95	0.04	0.004	12.6				
23-2, 54–55	94	0.03	0.002	17.4				
24-2, 18–19	92	0.04	0.005	11.6				
25-1, 37–38	90	0.10	0.011	13.1	—	0	0	—
25-2, 24–25	86	0.07	0.006	15.3				
26-1, 24–25	84	0.05	0.007	9.5	—	0	0	—
27-1, 10–11	67	0.06	0.012	74	—	0	0	—
27-1, 29–30	31	3.37	0.166	25.3	428	316	46	0.01
27-1, 42–43	3	0.28	0.021	17.3	415	54	100	0.17
27-1, 50–51	9	3.51	0.162	27.1	418	318	29	0.04
28-1, 73–74	69	0.08	0.010	10.4	—	0	0	—
28-2, 25–26	75	0.07	0.008	12.0				
29-1, 19–20	67	0.05	0.006	11.2				
32-1, 17–18	22	0.36	0.027	16.2	420	31	136	0.15
33,CC	17				427			0.80
34-1, 52–53	51	0.25	0.017	19.1	412	16	144	0.20
35-1, 7–8	15	0.29	0.013	29.3	425	38	138	0.15
36-1, 20–21	49	0.46	0.023	24.9	421	39	78	0.06
37-1, 31–32	23	0.72	0.042	22.0	417	13	61	0.10
37-2, 32–33	23	0.49	0.033	18.5				
38-1, 34–35	83	0.18	0.010	21.4				
39-1, 6–7	32	0.43	0.032	17.5				
40-1, 7–8	33	0.54	0.032	21.3	417	15	78	0.27
42-1, 38–39	72	0.52	0.016	40.4	426	7	50	0.25
42-2, 36–37	41	0.57	0.027	26.1				
43-2, 88–89	28	0.72	0.029	31.3	421	7	63	0.17
44-2, 110–111	58	0.34	0.024	17.9				
45-3, 40–41	40	0.28	0.018	18.9				
46-4, 91–92	32	0.33	0.023	19.1	421	3	115	0.67
47-1, 46–47	32	0.33	0.027	16.6				
47-4, 72–33	40	0.26	0.018	19.3				
48-1, 33–34	49	0.17	0.014	16.9				

Table 4. (Continued).

Core-Section (interval in cm)	$CaCO_3$ (%)	TOC (%)	N (%)	C/N	Rock-Eval			
					T_{max}	H-index	O-index	$S_1/(S_1 + S_2)$
Hole 549A (Cont.)								
54-2, 91-92	31	0.26	0.030	11.9	417	12	103	0.25
55-2, 114-115	52	0.21	0.022	12.7				
56-1, 44-45	80	0.09	0.010	13.1	417	11	289	0.50
57-2, 53-55	16	0.42	0.036	14.3	422	17	83	0.13
58-2, 38-39	24	0.40	0.030	17.8	425	20	88	0.20
59-3, 52-53	21	0.47	0.036	17.6				
60-5, 127-128	52	0.27	0.015	24.0	418	15	107	0.20
61-2, 107-108	24	0.36	0.025	19.2	412	29	108	0.08
70-1, 30-31	1	0.30	0.038	10.4	427	13	80	0.33
70-1, 75-76	1	0.37	0.036	13.3	418	27	57	0.09
72-1, 94-95	16	0.67	0,043	20.6	414	58	55	0.05
73-1, 51-52	25	0.47	0.028	22.1	409	0	70	—
74-2, 24-25	8	0.47	0.029	21.4				
75-2, 81-82	33	0.35	0.025	18.1	412	23	206	0.11
75-4, 14-15	4	0.16	0.028	7.6				
76-2, 51-52	9	0.80	0.034	30.6				
78-1, 30-31	34	0.07	0.025	3.6	415	14	571	0.29
79-1, 7-8	0	4.20	0.101	54.6	415	15	40	0.05
79-1, 79-80	4	0.27	0.024	15.0	412	15	167	0.20
80-1, 80-81	6				421			0.02
80-2, 26-27	31	0.11	0.012	6.9	426	18	546	0.33
81-1, 56-57	0	0.10	0.034	4.1				
81-2, 47-48	0	0.36	0.036	13.5	431	25	119	0.18
82-1, 28-29	19	0.26	0.020	16.7	414	27	309	0.13
82-1, 126-127	2	0.08	0.033	3.2	414	25	400	0.60
82-2, 11-12	0	0.19	0.041	6.2				
82-2, 71-72	1	0.91	0.043	28.3	415	40	122	0.16
83-2, 57-58	0	0.13	0.026	6.6				
83-2, 73-74	0	0.10	0.016	8.5	420	54	100	0.30
84-1, 3-4	0	0.19	0.024	10.3				
84-1, 130-131	2	1.52	0.040	50.2	425	49	74	0.03
84-2, 29-30	0	0.31	0.032	12.8	423	84	68	0.07
84-2, 97-98	0	0.12	0.023	6.9				
85-1, 69-70	26	0.38	0.032	15.7				
85-1, 100-101	1	1.62	0.045	48.1	422	134	50	0.01
85-2, 38-39	4	3.01	0.065	60.5	418	95	64	0.01
85-2, 40-42	14	2.43	0.057	55.8	412	102	53	0.04
86-1, 120-121	0	0.22	0.042	7.0				
86-2, 118-119	4	0.81	0.040	26.9	416	40	90	0.06
87-1, 137-138	2	2.75	0.059	60.6				
87-2, 82-83	43	0.41	0.027	20.5	421	34	127	0.16
87-3, 19-20	35	0.41	0.031	17.4				
88-1, 44-45	62	0.26	0.020	17.0	414	42	242	0.08
88-2, 63-64	2	0.07	0.030	3.0				
88-3, 28-29	0	0.15	0.044	4.6	417	7	73	0.50
88-3, 121-122	0	0.60	0.051	15.6				
89-1, 95-96	63							
89-2, 38-39	62	0.25	0.020	14.6				
89,CC	29	0.13	0.024	6.9				
90-1, 113-114	0	0.75	0.030	32.7				
90-3, 19-20	1	0.57	0.038	19.5				
91-1, 6-7	1	3.13	0.066	63.0	416	134	225	0.02
91-2, 20	0	5.82	0.086	89.3	415	91	88	0.03
91-2, 70	1	0.72	0.023	40.7				
92-1, 85	0	4.28	0.092	61.1	416	152	129	0.04
92-1, 104-105	0	3.93	0.069	74.9	407	137	65	0.07
93-1, 83-84	2	1.33	0.049	35.7	415	19	41	0.04
93-2, 16-17	1	0.63	0.023	36.2	408	35	44	0.04
94-1, 141	4	0.05	0.017	3.6				

Note: Blanks denote that Rock-Eval pyrolysis was not done; dashes denote that no value was determined during pyrolysis; zero denotes that that value was yielded by pyrolysis.

Unit 3 (276.5–382 m BSF [cores]; 276.5–383 m BSF [logging])

There is no sharp logging discontinuity at the boundary between Units 2 and 3, even though lithology changes across the boundary (Fig. 23). Differences between Units 2 and 3 may be indicated in the gamma ray record by more variable lithologies in Unit 3, i.e., alternations of more clayey and more calcareous beds, with progressive changes from one facies to the other. The boundaries between our subdivisions of Unit 3 (3a to 3d) are not obvious from the logs. However, there are large-scale undulations in the gamma ray curve that correspond to variations in $CaCO_3$ and clay contents; these are accompanied by smaller alternations and may be described as follows:

276.5–290 m: Relatively low gamma ray values accompany calcareous beds (about 75% $CaCO_3$ in Cores 10 and 11).

290–297 m: Higher gamma ray and resistivity values correlate with more marly sediments (average 40% $CaCO_3$). Caliper log also suggests a greater degree of caving within this interval.

297–320 m: A generally lower gamma ray value accompanies sediments with higher $CaCO_3$ content (60–65%). Sharp peaks of higher intensity indicate clayey intercalations.

320–345 m: Higher gamma ray values accompany a more marly interval (60–65% $CaCO_3$).

345–368 m: Lower gamma ray values accompany more calcareous sediments (less than 60% $CaCO_3$).

368–379 m: Lower resistivity and higher gamma ray values than below and above accompany a more clayey unit. A marked intensity peak at 377 m indicates the accumulation of radioactive material. This peak has no counterparts on other logging curves; it is probably related to the unconformity observed between lower Paleocene white chalks (Unit 3) and upper Paleocene brownish marls (Unit 4).

The shape of the gamma ray curve at the boundary between the Upper Cretaceous white chalks and brownish upper Paleocene–Eocene marls is remarkably similar to the shape of the curve at the same point at Site 548.

Unit 4 (382–426.6 m BSF [cores]; 383–429 m BSF [logging])

Below the intra-Paleocene unconformity, white nannofossil chalks are characterized by a uniform lithology that is rich in calcium carbonate (90–95%). This sediment produces a smooth gamma ray curve, although the resistivity curve is irregular (Fig. 23). The slumped beds of Core 23 (around 400 m BSF) are not apparent from the log.

Unit 5 (426.6–479 m BSF [cores]; 429–479 m BSF [logging])

The color contrast between Maestrichtian–Turonian white chalks and Turonian to Cenomanian greenish gray chalks, which also corresponds to a difference in $CaCO_3$ content (from 90–95% in the former to 65–90% in the latter), correlates well with a sharp change in the gamma ray and resistivity curves (Fig. 23).

The black shale layer of latest Cenomanian age (Core 27), which has widespread counterparts in the Cretaceous sediments of northwestern Europe, is recorded as a distinct double peak in the gamma ray curve and a low resistivity value. Only 33 cm were recovered in the incomplete core, and the convention used for core recording fixed the depth of the shale at 436.20 m. The logging record, however, shows that the shale spans the interval from 439 to 440 m BSF.

Unit 6 (479–664.15 m BSF [cores]; 479–660 m BSF [logging])

The boundaries of Unit 6 are defined by marked deflections in the gamma ray and resistivity curves (Fig. 23). Within Unit 6, layers with relatively low gamma ray and high resistivity values regularly alternate with layers showing higher natural radioactivity and lower resistivi-

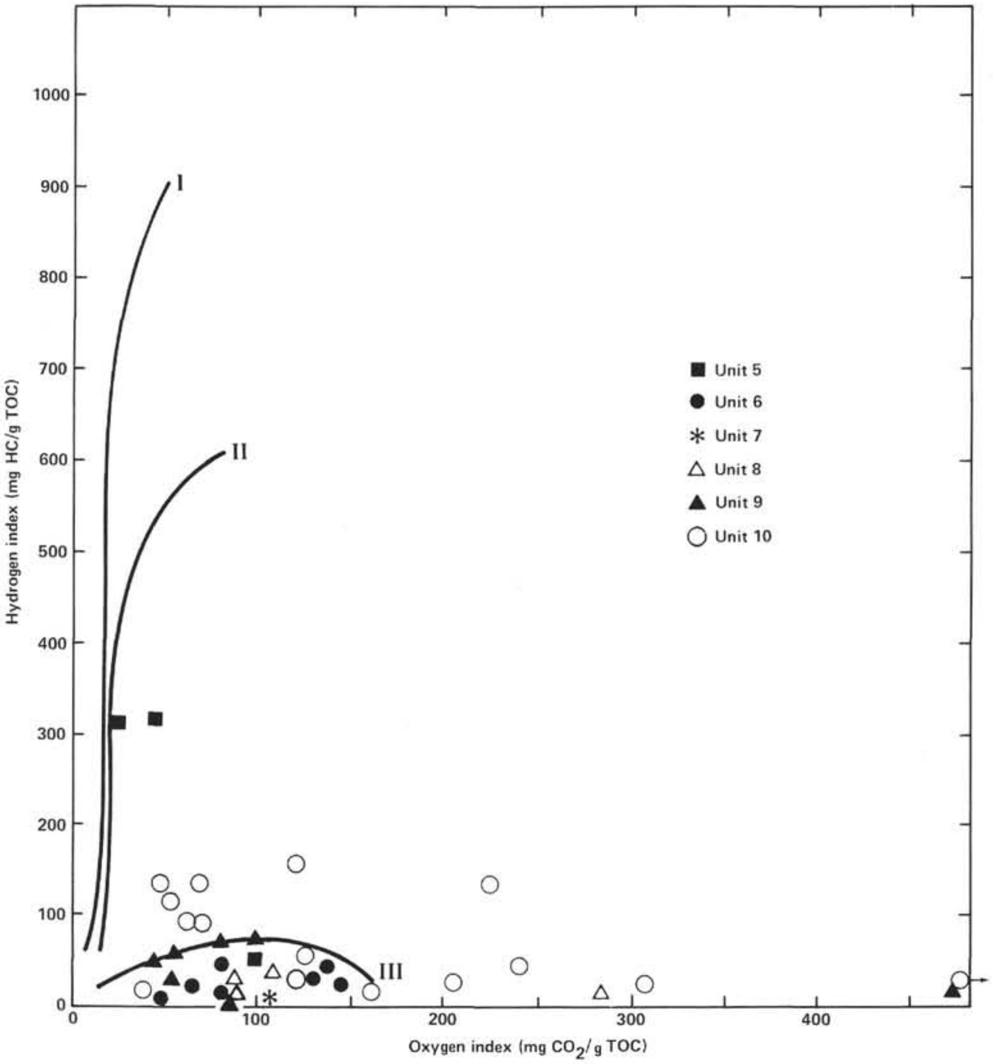


Figure 22. Van Krevelen diagram for Site 549.

ty. These fluctuations correspond to alternations between lithologies having more carbonate (50-80% $CaCO_3$) and less carbonate (15-20% $CaCO_3$), respectively.

479-520 m: Average gamma ray values are relatively low, corresponding to the presence of calcareous beds within this interval.

520-590 m: Average gamma ray values are relatively high, and the resistivity curve is smooth. These characteristics suggest a lithology that is relatively homogeneous and rich in clay. There is an exception in Cores 38 and 39 (530-550 m), where fluctuations in gamma ray intensities indicate the alternation of calcareous and marly horizons.

590-660 m: Fluctuations in gamma ray intensity are most pronounced in this interval, indicating great variation in $CaCO_3$ and clay contents. Between 615 and 645 m there are high gamma ray values that probably arise from relatively soft marly beds, beds that might also account for the poor recovery in Cores 47 to 50.

Some of the fluctuations in the gamma ray curve in Unit 6 are asymmetrical; gradual increases in intensity uphole are followed by sharp decreases (Fig. 23). This asymmetry suggests a gradual transition from calcareous to marly beds followed by a relatively abrupt return to more calcareous sedimentation. At least five such sequences between 5 and 10 m thick are apparent (Fig. 23).

Near the boundary between Units 6 and 7 (664 m), there is a strong peak in the gamma ray curve that may represent the unconformity responsible for the absence of most or all of the Aptian section.

Unit 7 (664.15-673.85 m BSF [cores]; 660-669 m BSF [logging])

The calcareous and dolomitic sandstone of Unit 7 is characterized by low gamma ray intensity and high resistivity in the logging curves (Fig. 23). A peak of gamma ray intensity and a corresponding low resistivity around 667 m may represent unsampled argillaceous horizon. The hardness of Unit 7 caused very slow drilling, which required the use of mud pumps. The increased hole size immediately above Unit 7 was probably caused by pump pressure.

Unit 8 (673.85–755 m BSF [cores]; 669–752 m BSF [logging])

Smooth logging curves suggest that the sediments in Unit 8 are homogeneous except near the base (Core 60, 744–748 m), where a decrease in gamma ray and resistivity values corresponds to a coarser detrital facies (Fig. 23).

Unit 9 (755–801.5 m BSF [cores]; 752–805 m BSF [logging])

Low gamma ray intensity and resistivity in the upper part of Unit 9 characterize the poorly recovered grainstone sequence (Fig. 23). Near the base, there is an increase in both parameters that documents the occurrence of finer grained packstones and wackestones (800–805 m).

The resistivity gradient suggests that porosity decreases from the top to the bottom of Unit 9. The self potential curve shows that the interstitial water between 750 and 800 m was more saline than the fresh water of the drilling fluid.

Unit 10

Subunit 10a (801.5–843 m BSF [cores]; 805–846.5 m BSF [logging])

This subunit has generally high gamma ray and resistivity values, although small-scale variations of considerable magnitude occur throughout (Fig. 23). These variations correlate with the alternation of calcareous and argillaceous beds. The logs suggest an upward increase in the number of calcareous beds, although preliminary examination of the cores indicates approximately equal distribution of calcareous and argillaceous lithologies. An interval of low natural radioactivity and low resistivity in Sections 549-75-2 and 549-75-3 can be correlated with a 2.3 m oolitic grainstone.

Subunits 10b to 10d (843–964.5 m BSF [cores]; 846.5–965 m BSF [logging])

Wide fluctuations in the gamma ray and resistivity curves occur throughout Subunits 10b to 10d, as would be expected from the wide variety of lithologies in the cores (Fig. 23). No precise interpretation of the logs is possible because of the limited number of parameters recorded. However, in general, relatively pure sandstones can be correlated with intervals of low natural radioactivity and low resistivity. Claystones have high radioactivity and medium to high resistivity, and limestones have low radioactivity.

Unit 11 (964.5–1001.5 m BSF [cores]; 965–?[4] [logging])

The basement rocks (with the exception of the upper 2 m) are highly resistive and moderately radioactive (Fig. 23). The lower resistivity observed in the upper 2 m may indicate the weathering of the Hercynian basement to that depth.

CORRELATION OF SEISMIC PROFILES WITH DRILLING RESULTS

The correlation of the Site 549 seismic profiles with the drilling results is discussed in Appendix I.

SUMMARY AND CONCLUSIONS

Site 549 (2535.5 m water depth) is located above the seaward tip of a tilted basement high, near the upper edge of the Pendragon Escarpment, which truncates the seaward slope of the Goban Spur (Fig. 24). After having thoroughly cored thick postrift sediments at Site 548, we drilled Site 549 to penetrate the synrift sediments. The most desirable location for synrift coring would have been updip in the middle of the associated half-graben, where the synrift sediments are considerably thicker (about 1200 m) and are more completely represented. Site 549 is a compromise location that provided basement, synrift, and postrift strata in a single, nonreentry hole.

The chief objectives at Site 549 were to determine the age, nature, and subsidence history of the basement; the age, nature, and paleoenvironmental setting of the synrift and postrift rocks; and the age and nature of the principal reflectors and seismic unconformities displayed on our control seismic line IOS CM 10.

These objectives were achieved, albeit with some difficulty. Core recovery was approximately 50% of that attempted (511.8 of 1001.5 m), and, unfortunately, it was poor in some critical intervals, such as the synrift/postrift contact. Completion of only one downhole logging run and the poor sonic record from that run hampered correlations somewhat, but the resistivity and gamma ray records allowed adequate lithologic interpretation of most of the poorly recovered sections.

The most important achievements were the documentation of nearly 300 m of Barremian synrift strata overlying Hercynian basement; the dating of the postrift unconformity as late Barremian–early Albian; the recovery of an almost uninterrupted, richly fossiliferous, upper Paleocene to upper Oligocene sequence; and the correlation of six major seismic reflectors with stratigraphic gaps in the cores.

Hercynian Basement

Basement was penetrated for 37 m, and 9.5 m of foliated micaceous sandstone were recovered. Nearly vertical bedding, slight metamorphic cleavage, subhorizontal micaceous lineations, and sericite oriented parallel to the foliation are clear indications that the sandstone participated in the Hercynian tectonism of the Paleozoic basement. No fossils were recovered from these strata. The radiometric dating of micas yielded a Cambrian age, but the lithology of both onshore sections and the basement at Site 548 led us to believe that they were deposited during the Devonian (Lefort et al., this volume).

Barremian Synrift Deposits

Beneath Site 549 the Barremian sequence appears as a thick lens of distinctive, high-amplitude, discontinu-

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[4] Logging tools could not reach the bottom of the hole because of rock fallen from above; therefore, the logging curves do not indicate the actual terminal depth of the hole.

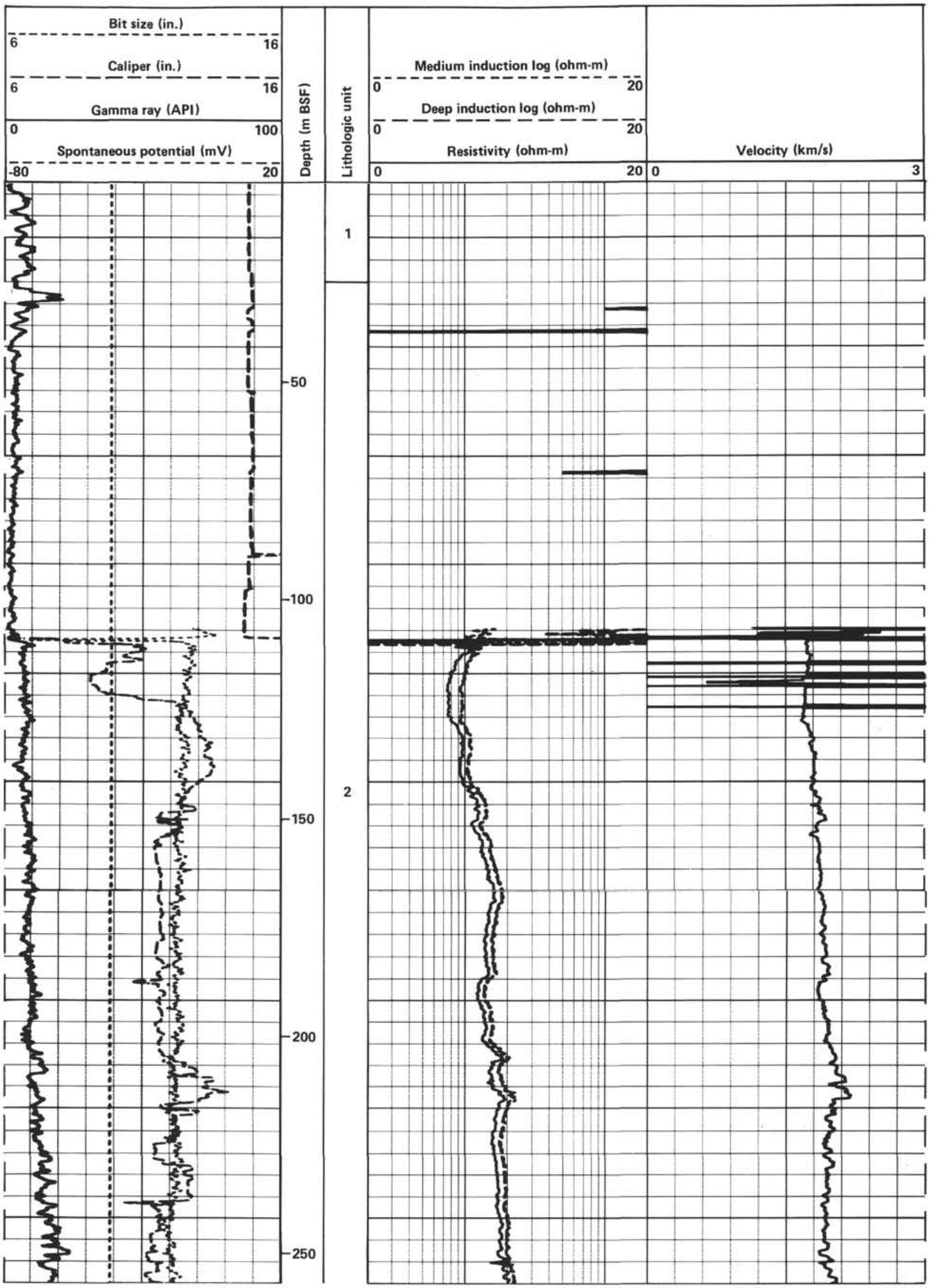

Figure 23. Downhole geophysical log for Site 549.

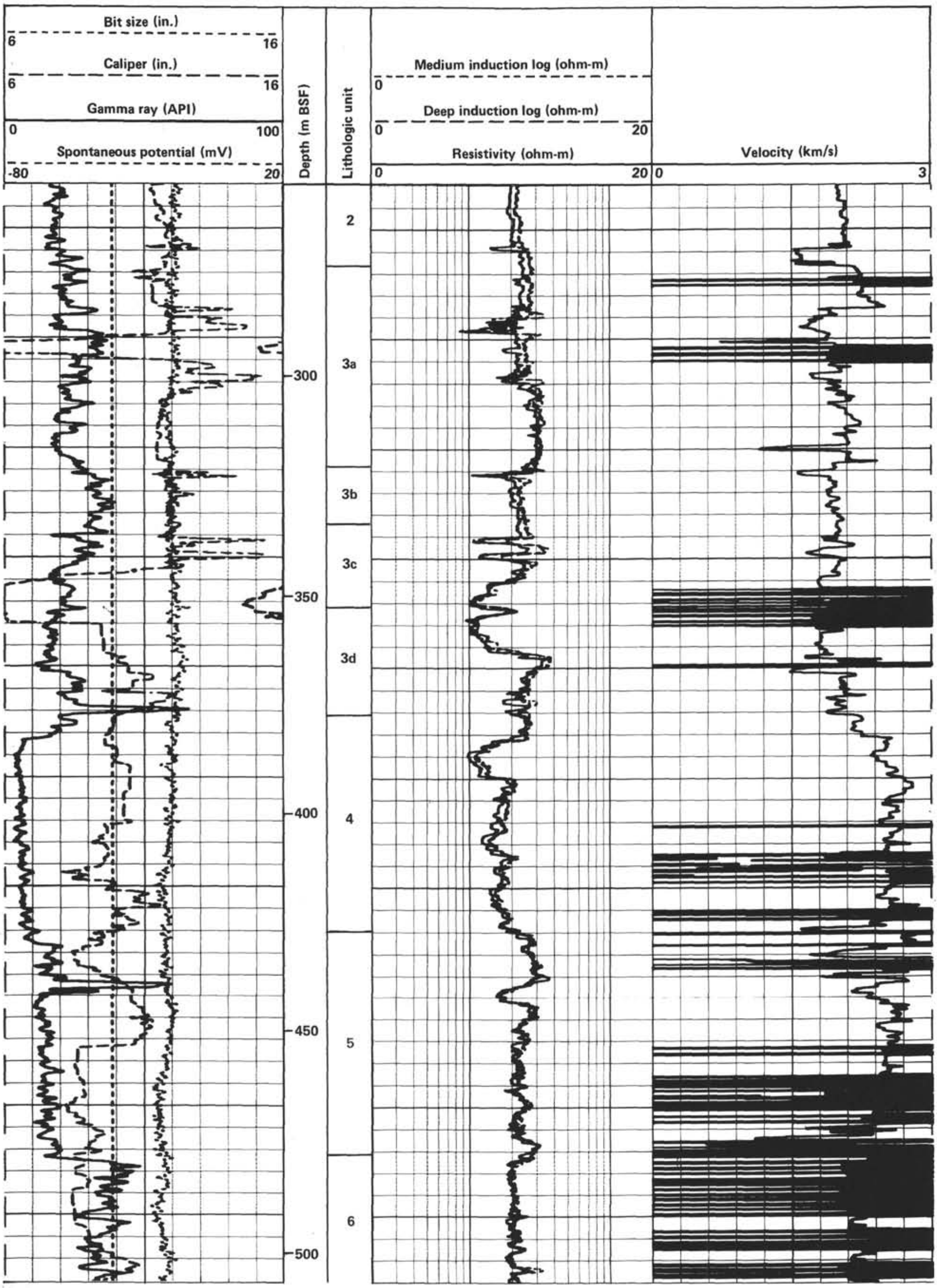

Figure 23. (Continued).

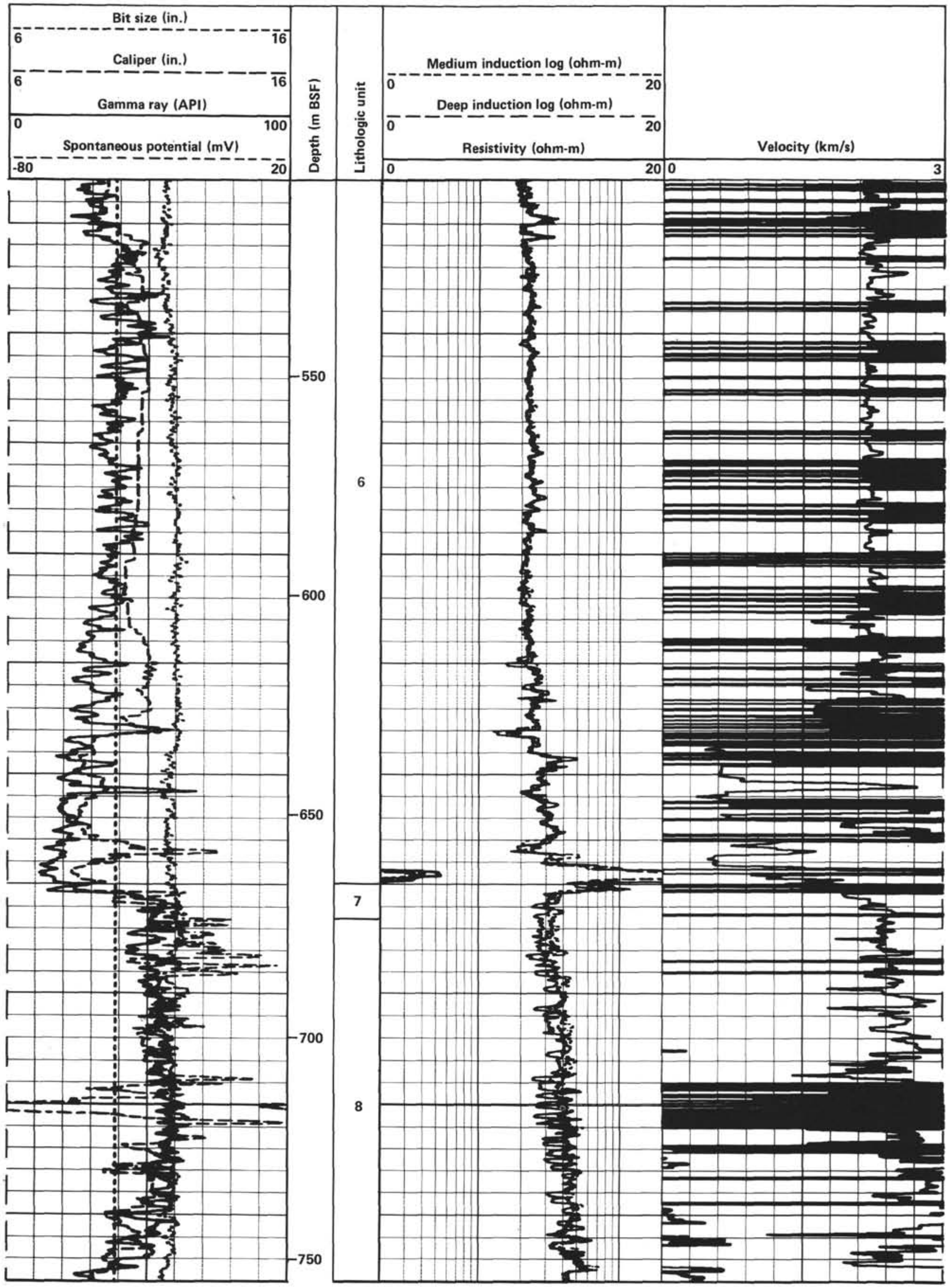

Figure 23. (Continued).

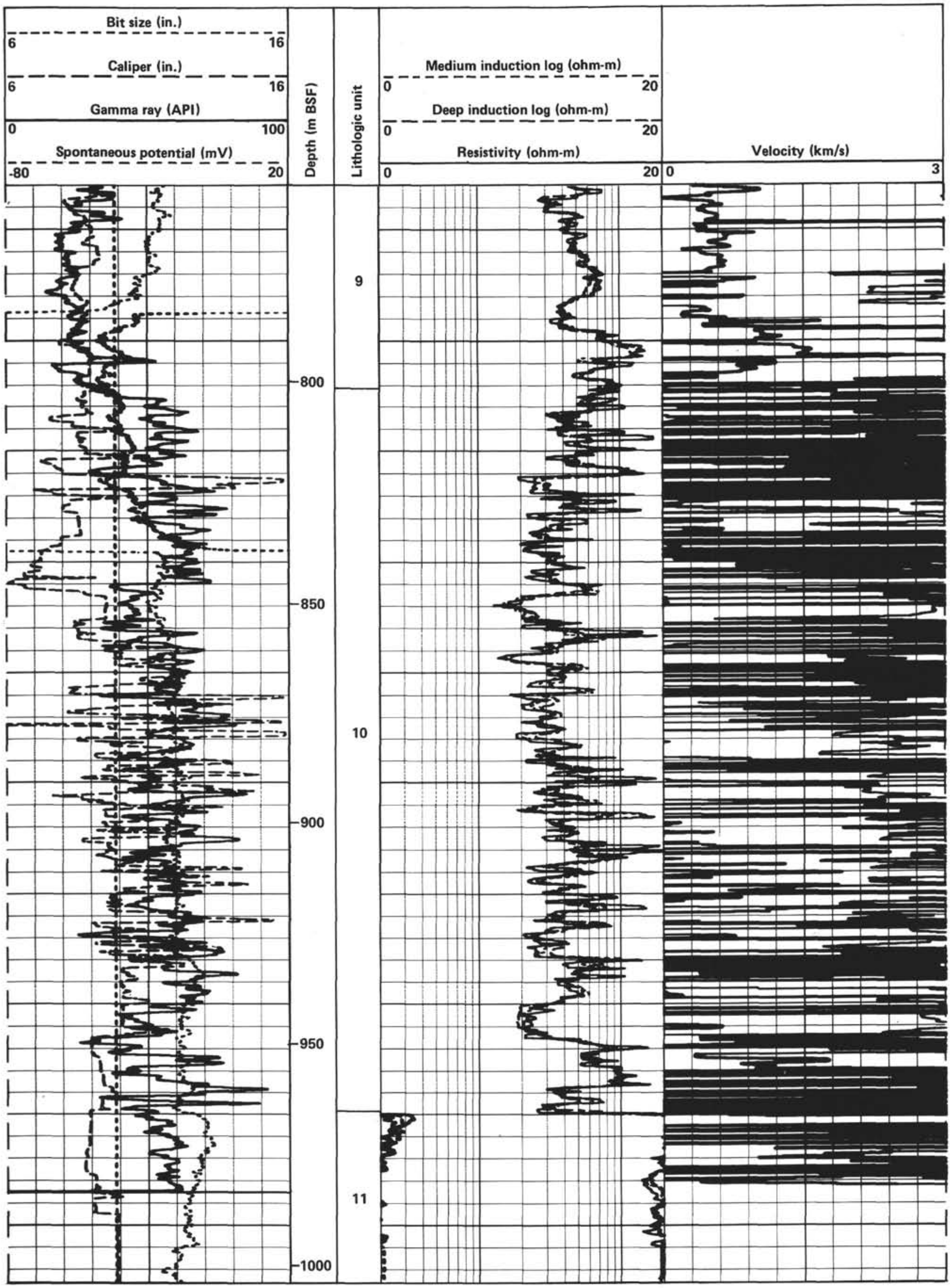

Figure 23. (Continued).

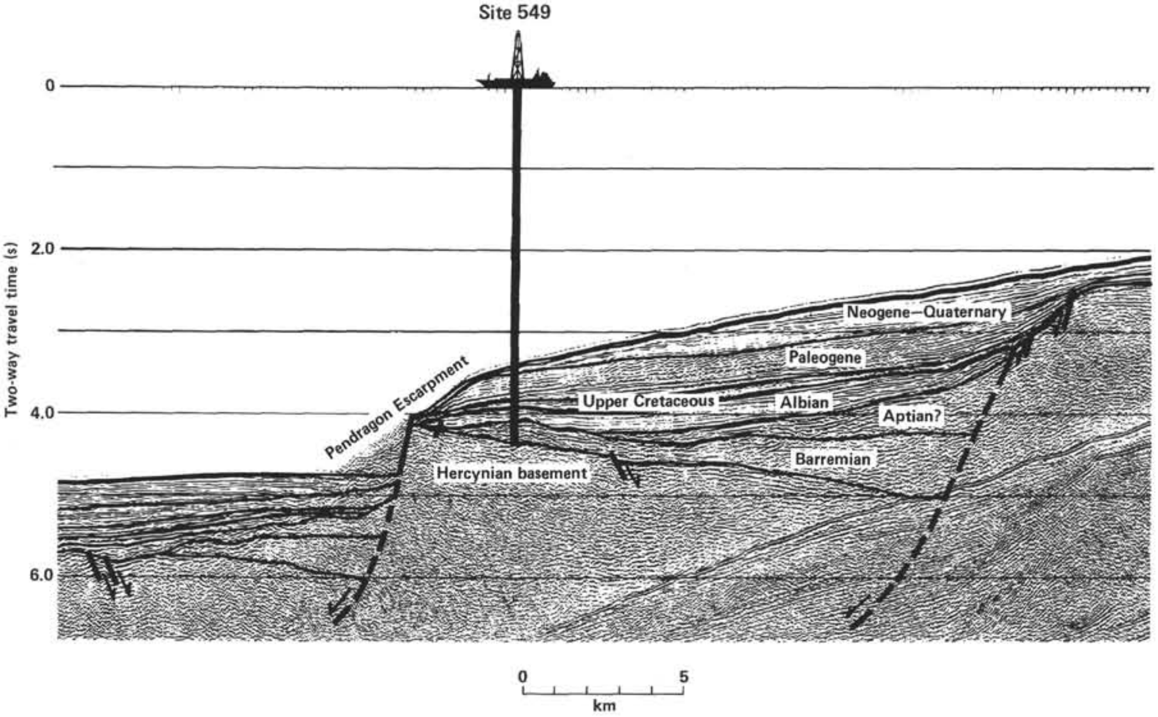

Figure 24. Segment of multichannel seismic profile CM 10 across Site 549 (see Fig. 2A).

ous seismic reflectors that form a depositional high beneath the site (Fig. 24). The seismic characteristics change rapidly both updip and downdip from the site. On the downdip side, some reflectors near the base and at the top of the lens have the arched geometry that is often characteristic of carbonate buildups.

Our cores reveal a 290 m sequence of Barremian sedimentary rocks that accumulated rapidly (97.3 m/m.y.) during a transgression of marine waters over the upraised basement block. This transgression is in evidence as a series of four lithologic subunits (Subunits 10d to 10a). The basal part of the transgressive sequence (Subunit 10d) comprises 150 m of noncalcareous terrigenous mudstones and interbedded calcareous mudstones that contain several assemblages of hyposaline microfossils and abundant terrestrial plant debris. Thus, the early Barremian deposition took place in coastal environments in which hyposaline conditions frequently alternated with shallow marine ones (Rat et al.; Magniez and Sigal; Batten et al.; and Mazzullo et al., all this volume).

The second, compositionally more complex part of the transgressive sequence is represented by 40 m of vuggy skeletal packstones and wackestones that have been cemented as grainstones by several phases of diagenetic recrystallization (Subunit 10c). The diverse micro- and macrofauna (e.g., bryozoans, crinoids, solitary corals, milleporids, trocholine foraminifers) in conjunction with scattered oncolites and ooliths appear to be the products of the mixing of several different carbonate facies. A complicated cyclical alternation of the carbonates and silty clays is hinted at in one core, but poor recovery in this interval limits the precision of this interpretation.

The third and last part of the Barremian transgression deposited 120 m of calcareous sandy mudstones that contain planktonic foraminifers and calcareous nannoplankton typical of open marine, outer sublittoral paleoenvironments (Subunits 10a, b).

Similar three-part transgressive cycles are characteristic of many Lower Cretaceous formations in western Europe. In the Cantabrian Mountains of northern Spain and in the western Pyrenees, which were much closer to the Goban Spur during the Barremian than at present, the carbonate sequences equivalent to our Subunit 10c built broad platforms (Urgonian facies) during several cycles of progradation and regression that lasted from the Barremian to the late Aptian (Rat et al., this volume). In some places (such as the western Pyrenees), the cycles persisted even into the Albian. In most of these places the growth of the carbonate platforms matched the rise in sea level (or the subsidence rates) and persisted for long periods of time. At Site 549, the 40 m Barremian carbonate section represents only approximately 0.6 m.y. of accumulation, but a few hundred meters northeastward, the presence of arching reflectors suggests that small carbonate buildups may have persisted there throughout most of the Barremian (about 5 m.y.).

Postrift Unconformity

The postrift unconformity at Site 549 separates upper Barremian from lower Albian rocks. The uppermost part of the Barremian stage, most or all of the Aptian stage, and a part of the Albian stage are missing at an 8 m.y. hiatus. This hiatus corresponds closely to the major middle Aptian sea level drop and accompanying global unconformity (112 m.y.) indicated by Vail et al. (1977). A high-amplitude reflector marks the unconformity on seismic profile CM 10 and can be traced from its apparent outcrop on the Pendragon Escarpment (Masson et al., this volume). Only the upper two-thirds of the Albian sequence is present beneath Site 549.

The basal unit tentatively assigned to the Albian section is a 6 to 7 m layer of hard (acoustic velocity 5000 m/s), sandy dolosparite of uncertain age and origin. We have tentatively assigned it to the Albian, but it may belong to the upper Barremian or Aptian.

Above the dolosparite there are 185 m of gray calcareous siltstones that contain middle or outer sublittoral micro- and nannofossils and scattered belemnite remains. This part of the Albian sequence can be divided into two subunits on the basis of downhole logging and the shipboard measurement of physical properties, although none of the lower, higher velocity subunit (velocity 2500 m/s) was recovered. The recovered upper subunit displays an irregular alternation of calcareous beds (as much as 83% carbonate) and clayey beds (as little as 5% carbonate). Such alternations are characteristic of Lower Cretaceous beds in Tethyan and other eastern Atlantic areas (Graciansky and Gillot, this volume). Alternating sequences are also present in coeval beds at Site 402, but there they incorporate turbidite beds and ammonite-bearing layers (Montadert, Roberts, et al., 1979).

The dark Albian strata are similar to the black shales of the mid-Cretaceous anoxic event discussed in recent literature (e.g., Schlanger and Jenkins, 1976). However, at Site 549 the total organic carbon rarely exceeds 0.5% (maximum 0.72% in a single sample). The organic matter is wholly of terrestrial origin and is visually evident in the form of patchily abundant woody debris. Lack of marine organic carbon and ubiquity of bioturbation indicate well oxygenated bottom waters. The prevailing dark color seems to be, at least in part, the result of micropyrite disseminated throughout the Albian beds (Waples and Cunningham; Cunningham and Gilbert; Waples, "Reappraisal;" Batten et al.; and Fauconnier, all this volume). Other mid-Cretaceous dark-colored shales deposited under oxidizing conditions have been recovered at Sites 400 and 402 in the Meriadzek area (Tissot et al., 1980), Site 398 on Vigo Seamount off Portugal (Deroo et al., 1979), and at several sites in the North American Basin (Tissot et al., 1980).

Albian rates of sediment accumulation were almost as high (93 m/m.y.) as those of the Barremian (97.5 m/m.y.). High rates of deposition and increasing amounts of terrigenous components also characterize Albian strata throughout most of the North Atlantic (in shelf as well as oceanic basins). This is demonstrated vividly along the U.S. Atlantic margin, where Aptian–Albian siliciclastics buried shelf-edge reefal banks and supplied large quantities of terrigenous debris that were incorporated in the Hatteras Formation of the North American Basin (Poag, 1980, 1982a, b, in press).

Middle Albian–Cenomanian Unconformity

A 19 m coring gap that separates middle Albian from Cenomanian strata also encompasses a probable 14 m.y. hiatus in which the upper Albian and lower Cenomanian are missing, as indicated by extrapolated sediment accumulation rates, downhole log analysis, and the interpretation of the seismic sequences. A late Albian–Cenomanian gap is known at other widely scattered sites (including shelf, slope, and rise locations) around the North Atlantic. These unconformities may be associated with the major early Cenomanian (97 m.y.) sea level drop and unconformity indicated by Vail et al. (1977) and/or other paleoceanographic changes possibly caused by the initial interconnection of the South Atlantic and North Atlantic waters.

Upper Cretaceous Deposits

As rapid subsidence and rising sea level submerged the Goban Spur during the late Cenomanian–Maestrichtian, 100 m of varicolored pelagic chalk downlapped the underlying Albian high at Site 549, accumulating at a severely reduced rate compared to that of the Albian (drop from 93 to 3.5 m/m.y.). It is clear that the lower part of the Cenomanian sequence is missing beneath Site 549 (Magniez and Sigal; and Müller, this volume), but it is better represented, if not complete, northeastward in the half-graben (Fig. 24 and Masson et al., this volume). Sedimentary thinning across the Albian depositional high (beneath Site 549) and proximity to the Pendragon Escarpment may have produced additional small stratigraphic gaps, although at least a part of each standard Upper Cretaceous stage is represented by diagnostic biota.

An especially notable aspect of the upper Cenomanian chalk sequence is the presence of a 1.4 m interval of radiolarian cherts and volcanic ash. The sequence is interbedded with a laminated black shale that contains organic carbon (TOC 3.5%) of at least partly marine origin. This deposit may have resulted from local upwelling that produced anoxic bottom waters for a short period at Site 549. Black shales of Cenomanian–Turonian age are common in the North Atlantic, and they also have been thoroughly documented in northwest Europe and in Cretaceous sediments from the western part of the U.S.A. (Graciansky et al., 1984).

Lower Paleocene Gap

The Cretaceous–Tertiary contact at Site 549 is an unconformity (approximately 5 m.y. hiatus) between the upper Maestrichtian and the upper Danian. The contact appears as a continuous high-amplitude reflector on line CM 10 that truncates the Upper Cretaceous reflectors beneath the site. A more complete Paleocene section is present in the half-graben updip.

The contact is also marked by an upward decrease in carbonate (75–95% vs. 45–65%), a change in acoustic impedance, and an increase upward in remanent magnetization (Townsend, this volume). A nearly coeval hiatus has been documented also at nearby Sites 400, 401, and 548. A major sea level drop and unconformity (60 m.y.) indicated by Vail et al. (1977) coincide approximately with this hiatus.

Upper Paleocene to Upper Oligocene

The sedimentary mound beneath Site 549 was still high enough to cause thinning over its crest during the early part of the late Paleocene, but during the latest Paleocene the submarine topography was finally smoothed by filling of the half-graben depression and burial of the mound (Fig. 24). Burial of the mound seems to have contributed to the subsequent accumulation of a thick (180.5 m), nearly continuous sequence of bathyal Paleogene deposits. This exceptionally complete, richly fossiliferous sequence provides an unparalleled stratigraphic reference section for the upper Paleocene to upper Oligocene interval. Its suitability for fine resolution of stratigraphic sequences is further enhanced by the recognition of a sequence of magnetic polarity reversals within this interval.

The upper Paleocene and lower Eocene strata were rapidly deposited (28.5 m/m.y.), are typically brownish, gray, or gray green, and are characteristically enriched in terrigenous clays probably derived from the European landmass, which was widely emergent during this time (Graciansky and Poag, this volume). Volcanic episodes in the Rockall Bank region may have contributed to the significant number of volcanic ash layers. The lower to middle Eocene contact, which was unconformable at Site 548, is conformable here and is marked only by a progressive but rapid color and lithologic change: the clays and ash beds disappear upward and the brown colors change to light greenish grays. The remanent magnetization, acoustic velocity, gamma ray intensity, and sediment accumulation rate all decrease upward across the boundary.

Light greenish gray, bathyal nannofossil chalks persisted from the middle Eocene to the late Oligocene. The only significant measured changes are an upward decrease in acoustic velocity across the Eocene/Oligocene boundary and a deflection in the sediment accumulation curve that suggests a small hiatus in the late Oligocene. A coeval late Oligocene unconformity was noted at Site 548, and both may be related to the major late Oligocene drop in sea level postulated by Vail et al. (1977).

Miocene

Only subtle color variations separate the upper Oligocene chalks from those of the Miocene, although the contact is unconformable, according to nannofossil biochronology (a hiatus of about 5 m.y.). This constant lithology and color also mask at least one additional 5 m.y. biostratigraphic gap within the middle to upper Miocene beds. All together, only 20 m of chalk represent the Miocene (approximate average accumulation rate of only 2.0 m/m.y.). The seismic profile (Fig. 24) shows that Site 549 is located at the downdip feather edge of a lens of Neogene sediments.

Pliocene–Pleistocene

A strongly truncated series of seismic reflectors (Fig. 24) updip from Site 549 appears to represent the eroded edge of a relatively thick Pliocene–Pleistocene wedge. However, at Site 549 all the Pliocene section has been removed, and lower Pleistocene sediments rest on the upper Miocene surface (5 m.y. hiatus). The thin veneer (27 m) of Pleistocene sediment contains all the standard foraminiferal and nannofossil biozones, but the thinness of the unit suggests that parts of the Pleistocene sequence may be missing. As at Site 548, alternating marly and less marly beds reflect changing Pleistocene paleoclimates and the attendant variability in terrigenous detrital influx (Snyder et al.; Müller; Pujol et al.; Caralp; Pujos; and Labracherie, all this volume).

Conclusion

Through a combination of continuous coring and downhole logging, we documented the stratigraphic record at Site 549 and reconstructed the depositional and subsidence history of a typical part of the Goban Spur continental margin.

The acoustic basement is part of a tilted continental fault block composed in part of slightly metamorphosed Paleozoic sandstone, the subvertical foliation of which reflects its participation in Hercynian folding.

Perhaps of most importance is the vivid sedimentological and paleontological record of synrift submergence that took place during the Barremian. High sediment accumulation rates and near sea level paleoenvironments suggest that rapid tilting of the fault block was matched by almost equally rapid deposition until middle Barremian time, when deeper marine (outer sublittoral) conditions finally prevailed. Prerift deposition was terminated at Site 549 by truncation of the Barremian synrift deposits some time between the late Barremian and early Albian.

Postrift deposition began with dark, sublittoral, calcareous Albian sandstones, and after a mid-Cretaceous hiatus it continued as a thin series of bathyal Upper Cretaceous chalks that appears to have been interrupted by several minor hiatuses. Initial postrift subsidence of the basement beneath Site 549 was rapid, as evidenced by the submergence of the depositional surface from near sea level (deposition and alteration of the basal Albian(?) dolosparite) to about 1000 to 2000 m below sea level (Cenomanian chalks) in the span of about 12 m.y. (net subsidence rate of about 83 to 166 m/m.y.). A subsequent deceleration of subsidence is verified by the maintenance of bathyal depths (2000–3000 m) at the site from the Cenomanian to the present (about 95 m.y.).

The Cretaceous–Tertiary transition is marked by another major period of erosion and nondeposition, but it is followed by remarkably quiescent Paleogene deposition that preserved an undisturbed series of bathyal nannofossil chalks that span the late Paleocene to late Oligocene interval. This depositional continuum was punctuated by only one possible minor hiatus in the late Oligocene.

The Neogene and Quaternary record is spotty. A thin sequence of Miocene strata is interrupted by several unconformities, and it is separated from the Pleistocene by a major gap that includes the entire Pliocene.

Six significant unconformities were dated and correlated with shipboard geophysical measurements and our control seismic reflection profiles in order to extrapolate the core hole data across the entire fault block. Four of these unconformities occupy stratigraphic positions that are clearly coincident with global unconformities that Vail et al. (1977) believe were caused by eustatic lowerings of sea level.

Site 549 will no doubt long remain an essential guidepost to the complex interplay of faulting, subsidence, variable sediment sources, sea level fluctuations, and paleoclimatic cycles that have controlled the synrift and postrift development of the Goban Spur and the northern Biscay continental margin (Masson et al.; Graciansky and Poag; and Sibuet et al., all this volume). The extrapolation of these data, and the processes they imply, will accelerate our understanding of the construction of other passive continental margins.

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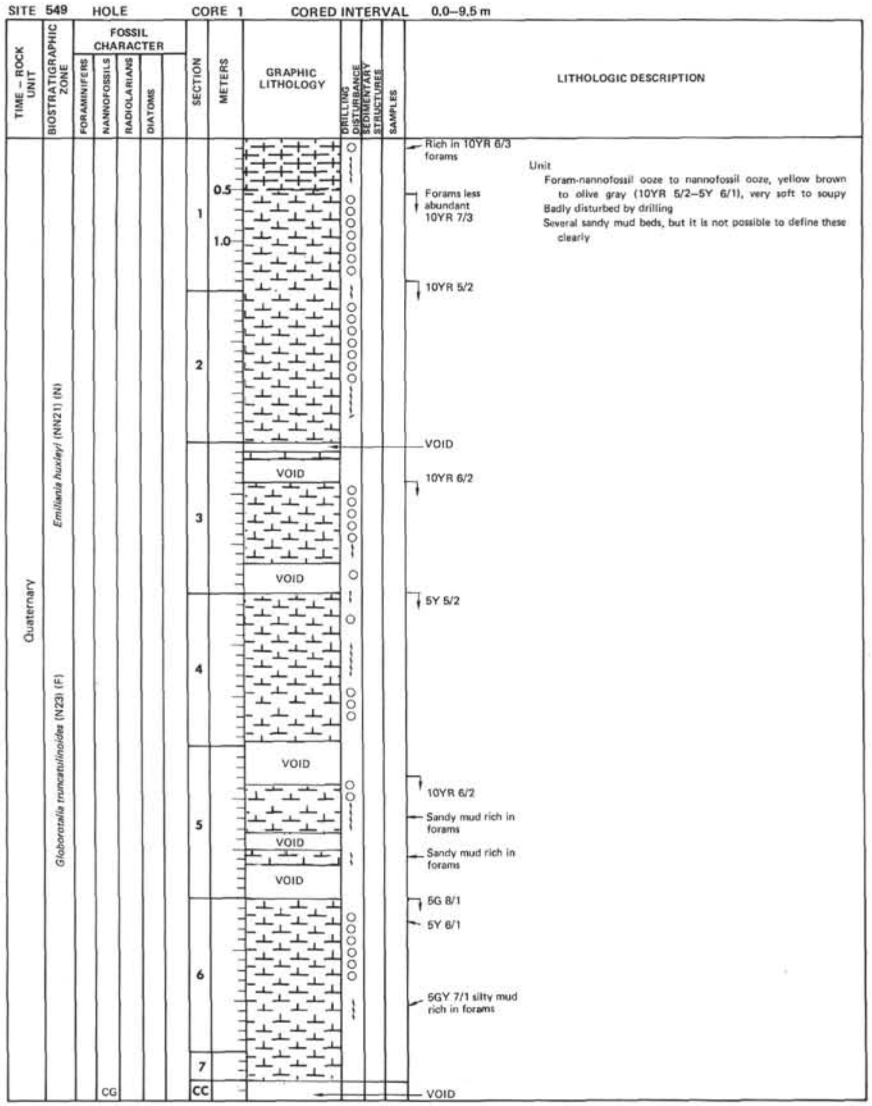
Date of Initial Receipt: September 6, 1983
Date of Acceptance: November 9, 1983

SITE 549 HOLE CORE 1 CORED INTERVAL 0.0–9.5 m



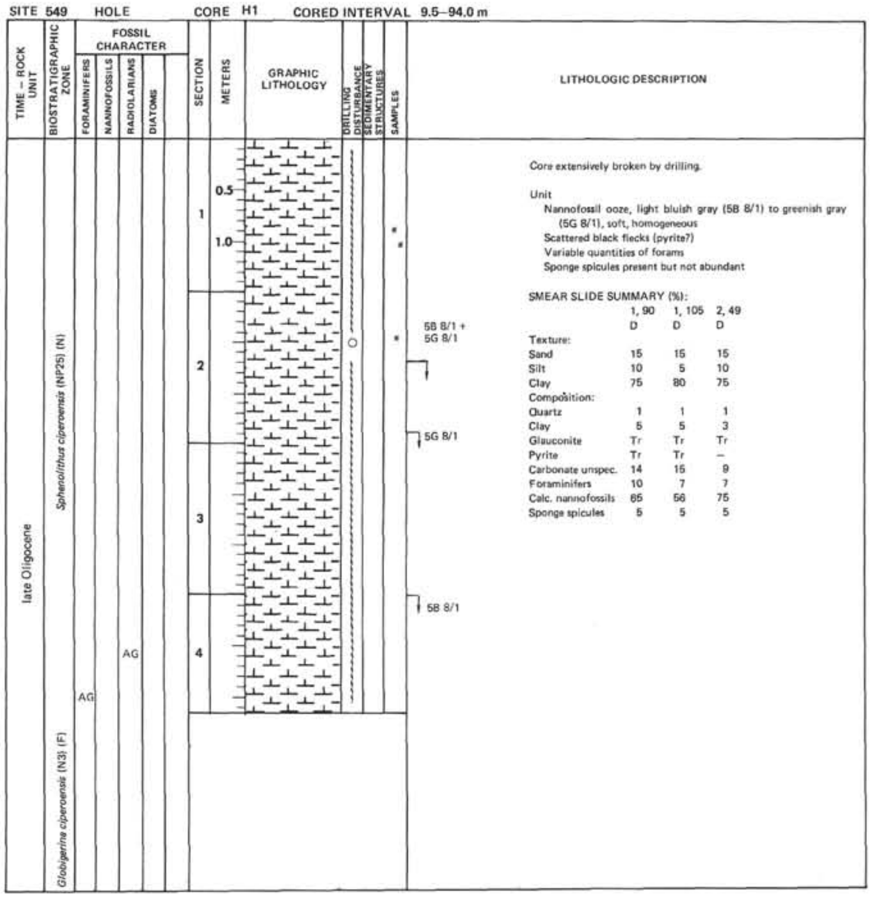
Unit

Foram-nannofossil ooze to nannofossil ooze, yellow brown to olive gray (10YR 5/2–5Y 6/1), very soft to soupy

Badly disturbed by drilling

Several sandy mud beds, but it is not possible to define these clearly

SITE 549 HOLE CORE H1 CORED INTERVAL 9.5–94.0 m



Core extensively broken by drilling.

Unit

Nannofossil ooze, light bluish gray (5B 8/1) to greenish gray (5G 8/1), soft, homogeneous

Scattered black flecks (pyrite?)

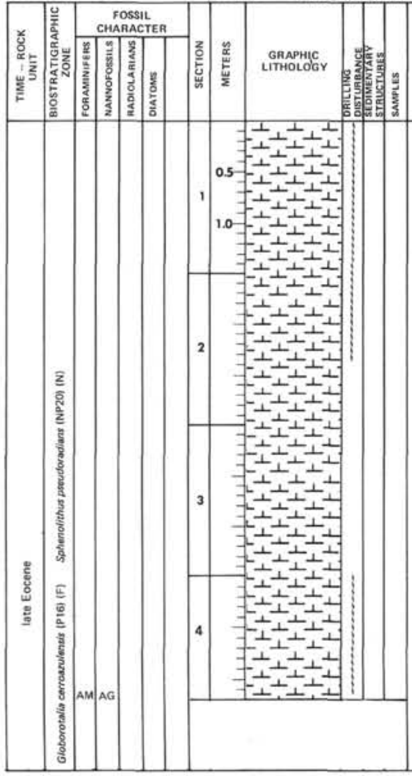
Variable quantities of forams

Sponge spicules present but not abundant

SMEAR SLIDE SUMMARY (%):

	1, 90	1, 105	2, 49
	D	D	D
Texture:			
Sand	15	15	15
Silt	10	5	10
Clay	75	80	75
Composition:			
Quartz	1	1	1
Clay	5	5	3
Glauconite	Tr	Tr	Tr
Pyrite	Tr	Tr	–
Carbonate unspec.	14	15	9
Foraminifers	10	7	7
Calc. nannofossils	65	56	75
Sponge spicules	5	5	5

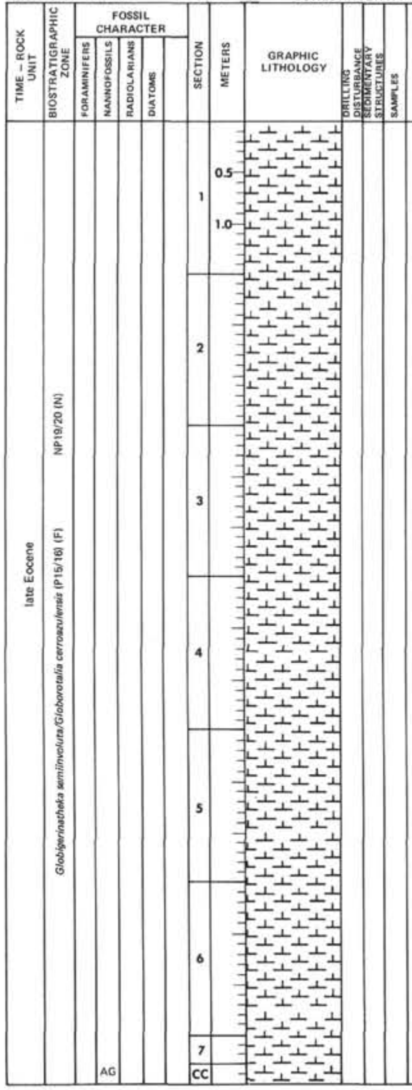
SITE 549 HOLE CORE H2 CORED INTERVAL 94.0–151.0 m



LITHOLOGIC DESCRIPTION

Unit
Nannofossil ooze, light greenish gray (5G 8/1), homogeneous, moderately to extensively deformed and broken by drilling

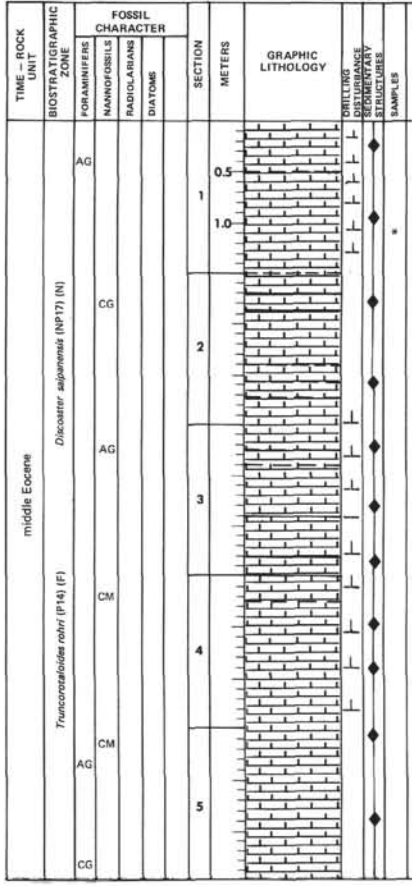
SITE 549 HOLE CORE H3 CORED INTERVAL 151.0–200.0 m



LITHOLOGIC DESCRIPTION

NANNO OOZE
Light greenish gray (5G 8/1)
Massive and homogeneous
Wash core

SITE 549 HOLE CORE 2 CORED INTERVAL 198.5–208.0 m



LITHOLOGIC DESCRIPTION

Section 1: light greenish gray (5G 8/1 and 5GY 8/1) chalk, minor bioturbation, with streaks of pyrite throughout, lower section rich in sponge spicules.
Section 2: NANNO CHALK, alternating between light greenish gray, greenish gray, and bluish white (5G 8/1, 5G 6/1, and 5B 9/1) chalk; minor and moderate bioturbation; section between 37 and 106 cm has inclined bedding.
Section 3: NANNO CHALK, alternating between 5G 8/1, 5GY 8/1, and 5B 9/1 chalk; burrow mottled; bedded between 29 and 92 cm and 135–150 cm; large clasts in mud matrix between 50 and 60 cm; last 15 cm rich in volcanic glass.
Section 4: NANNO CHALK, burrowed moderately; 5G 8/1, 5B 9/1 in 0–7 cm; 5G 6/1 and 5B 9/1 in 7–16 cm and remainder 5G 8/1 chalk.

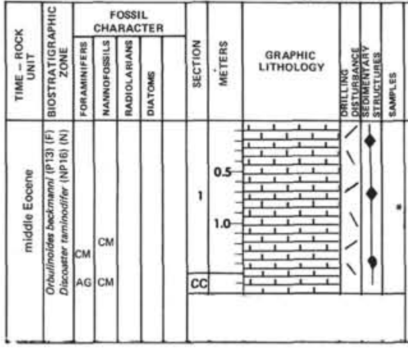
SMEAR SLIDE SUMMARY (%):

	1, 110
	D
Texture:	
Sand	<10
Mud	90
Composition:	
Volcanic glass	Tr
Carbonate unspec.	5
Foraminifers	5
Calc. nannofossils	70
Sponge spicules	20

ORGANIC CARBON AND CARBONATE (%):

	2, 44
Organic carbon	0.04
Carbonate	82

SITE 549 HOLE CORE 3 CORED INTERVAL 208.0–217.5 m



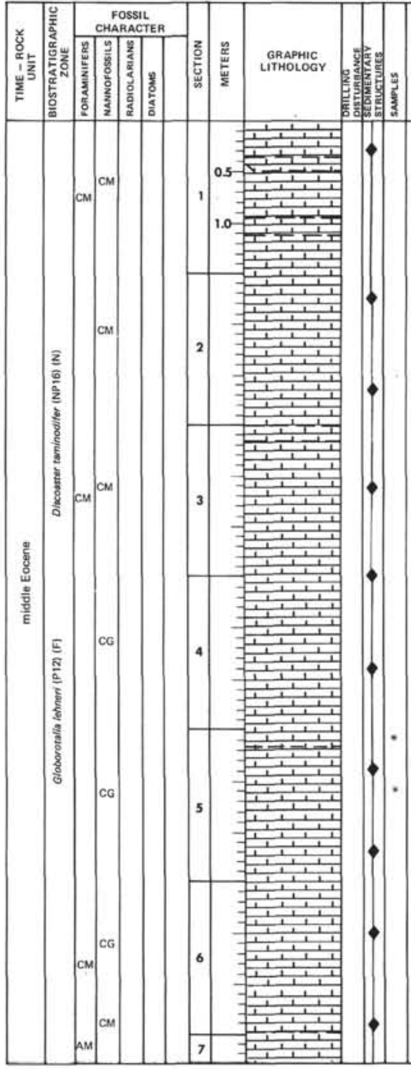
LITHOLOGIC DESCRIPTION

Light greenish gray NANNO CHALK, minor bioturbation
Pyritic bed at 89–91 cm

SMEAR SLIDE SUMMARY (%):

	1, 89
	D
Texture:	
Sand	< 10
Mud	90
Composition:	
Carbonate unspec.	< 10
Foraminifers	< 10
Calc. nannofossils	> 70

SITE 549 HOLE CORE 4 CORED INTERVAL 217.5–227.0 m



LITHOLOGIC DESCRIPTION

NANNO CHALK
Alternating in color between light greenish gray (5G 8/1) and greenish gray (5G 6/1)
Moderately and occasionally intensely bioturbated
Fault in Section 1, 117–120 cm
Pyrite bleb at Section 2, 108 cm; Section 3, 9 cm; and Section 4, 6 cm.

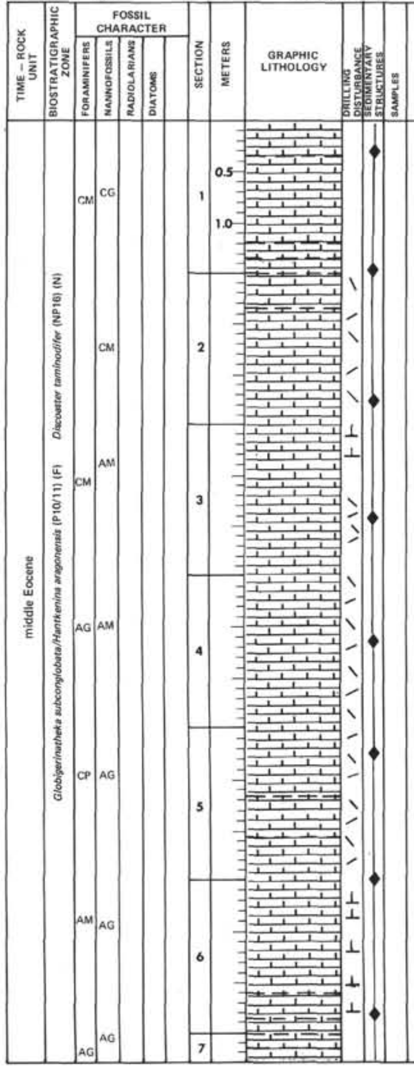
SMEAR SLIDE SUMMARY (%):

	5, 10	5, 60
	D	D
Texture:		
Sand	<10	<10
Mud	90	90
Composition:		
Carbonate unspec.	–	5
Foraminifers	< 5	< 5
Calc. nannofossils	>70	>70
Diatoms	Tr	–
Radiolarians	Tr	Tr
Sponge spicules	>5	<10

ORGANIC CARBON AND CARBONATE (%):

	2, 58
Organic carbon	0.05
Carbonate	83

SITE 549 HOLE CORE 5 CORED INTERVAL 227.0–236.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL CHALK

Alternating greenish gray and light greenish gray (5G 6/1 and 5G 8/1) chalk

All moderately bioturbated

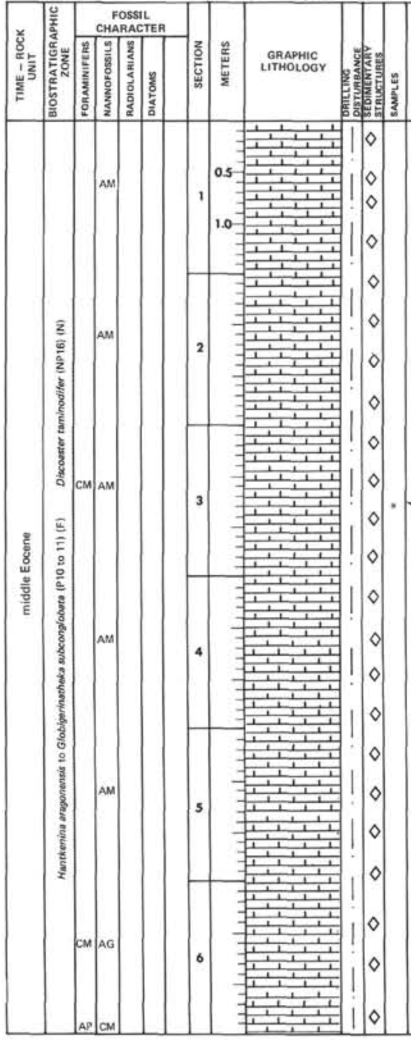
All hard

Pyritic blebs and streaks at Section 1, 13 cm; Section 3, 109–110 cm; and Section 4, 32–34 cm

ORGANIC CARBON AND CARBONATE (%):

	2, 57
Carbonate	75

SITE 549 HOLE CORE 6 CORED INTERVAL 236.5–246.0 m



Bioturbated silty chalk grains in gray and black (sponge spicules + quartz + forams)

LITHOLOGIC DESCRIPTION

UNIT

Nannofossil chalk, light greenish gray (5GY 7/1), firm to very firm, moderately to intensely mottled

Sections 4 and 5 contain lenses of gray silty chalk (mm scale) and some burrows lined at the bottom with gray silty chalk.

All contacts are extensively mottled

Common sponge spicules

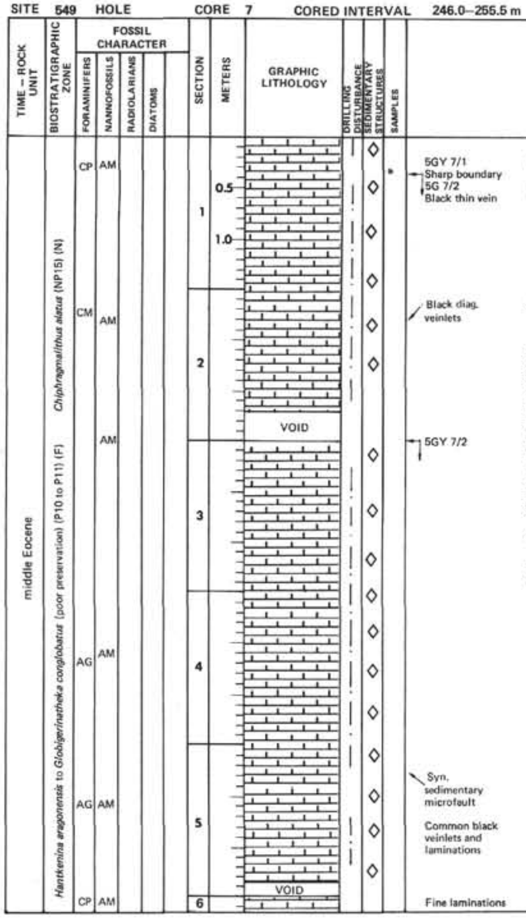
SMEAR SLIDE SUMMARY (%):

	3, 78
	D
Texture:	
Sand	15
Silt	25
Clay	60
Composition:	
Quartz Feldspar Mica Heavy minerals	10
Clay	15
Glauconite	Tr
Carbonate unspec.	20
Foraminifers	10
Calc. nannofossils	35
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	5, 63
Carbonate	70

SITE 549 HOLE CORE 7 CORED INTERVAL 246.0–255.5 m



LITHOLOGIC DESCRIPTION

Most of section broken by drilling

Unit

Nannofossil chalk, light greenish to greenish gray (5GY 7/1 to 5G 7/2), firm to very firm, moderately to extensively mottled in shades of green,

Burrows on scale of mm

Laminations and small pods of grayer, siltier chalk become more common towards the bottom of the core

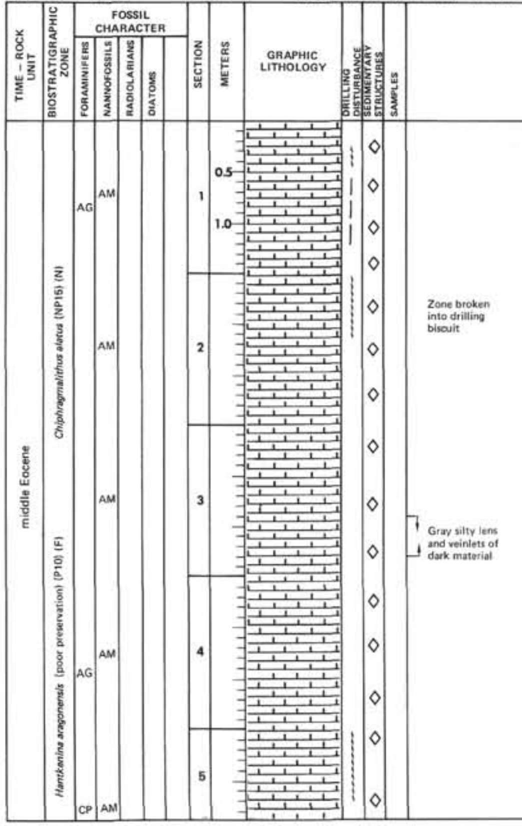
SMEAR SLIDE SUMMARY (%):

	1, 16 D	1, 36 D	5, 53 D
Texture:			
Sand	2	10	5
Silt	3	15	10
Clay	95	75	85
Composition:			
Heavy minerals	–	2	–
Clay	15	20	20
Carbonate unspec.	–	5	3
Foraminifers	1	3	2
Calc. nannofossils	80	60	65
Radiolarians	2	5	3
Sponge spicules	2	5	7

ORGANIC CARBON AND CARBONATE (%):

	2, 29
Organic carbon	0.08
Carbonate	62

SITE 549 HOLE CORE 8 CORED INTERVAL 255.5–265.0 m



LITHOLOGIC DESCRIPTION

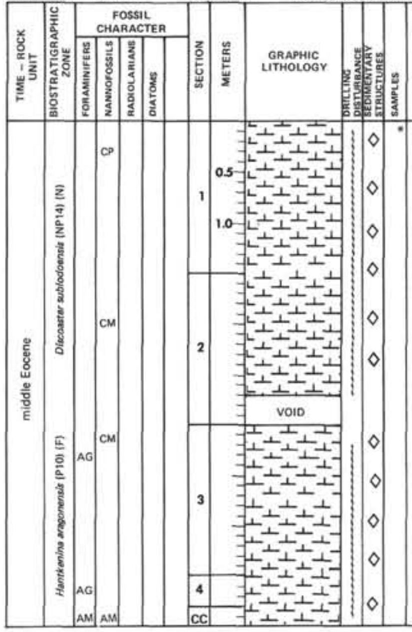
Unit

Nannofossil chalk, light greenish gray (5GY 7/1–7/2), firm to very firm, burrowed moderately, scattered laminae and small lens of siltier gray chalk, burrows are of mm size

ORGANIC CARBON AND CARBONATE (%):

	2, 72
Organic carbon	0.05
Carbonate	69

SITE 549 HOLE CORE 9 CORED INTERVAL 265.0–274.5 m



LITHOLOGIC DESCRIPTION

Unit

Nannofossil chalk, greenish gray (5GY 7/1), firm to very firm, mottled in shades of green, burrows on a scale of mm, structure is obscured by the drilling but the smear slide shows a significant terrigenous component, especially in the silt and mud size fraction

Volcanic glass may be present

Sponge spicules are present but not abundant

Most of this core was broken into 2–6 cm thick drilling biscuits.

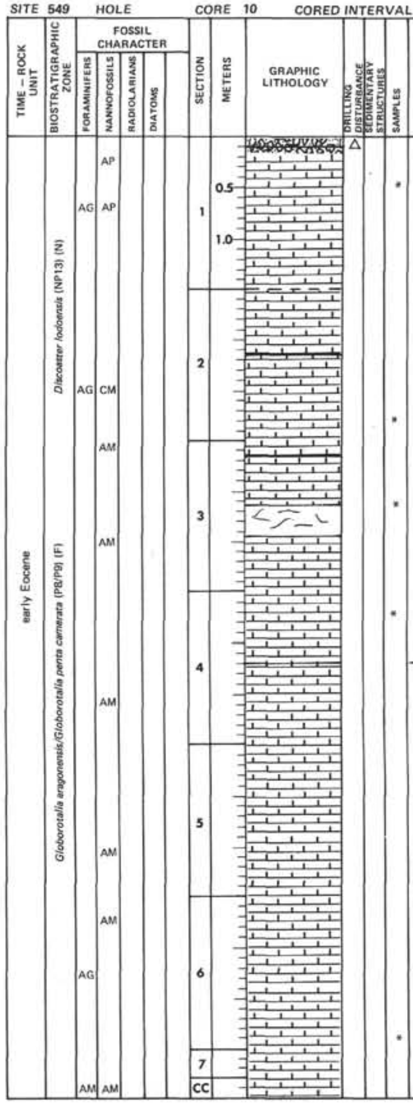
SMEAR SLIDE SUMMARY (%):

	1, 10 D
Texture:	
Sand	10
Silt	20
Clay	70
Composition:	
Quartz	5–10
Clay	15
Volcanic glass	Tr
Carbonate unspec.	20
Calc. nannofossils	50
Sponge spicules	5

ORGANIC CARBON AND CARBONATE (%):

	2, 56
Carbonate	74

SITE 549 HOLE CORE 10 CORED INTERVAL 274.5–284.0 m



← Abrupt color change

LITHOLOGIC DESCRIPTION

Section 1, 0–10 cm: drilling breccia.

Section 1, 10–150 cm: pale olive (5Y 6/3), homogeneous foram nannofossil chalk mottled with burrow filled with gray (5G 7/1) nanno chalk.

Section 2, 0–65 cm: light gray (2.5Y 7/2), homogeneous foram-nanno chalk burrow mottled with very pale blue (5B 8/2) nanno-chalk.

Section 2, 65 cm–Section 3, 15 cm: pale yellow (5Y 5/3) to light yellowish brown (2.5Y 6/4) burrow mottled foram nanno-chalk.

Section 3, 15–60 cm: pale yellow homogeneous foram-nanno chalk.

Section 3, 60–95 cm: light yellowish brown foram-nanno chalk with contorted bedding, slump(?).

Section 3, 95 cm–Section 4, 70 cm: pale yellow (2.5Y 7/4) homogeneous foram-nanno chalk, extensively bioturbated. Color grades to light yellowish brown (2.5Y 6/4) at base.

Section 4, 70 cm through Core-Catcher: pale yellow (2.5Y 7/4) nanno or foram-nanno chalk, extensively bioturbated.

Large burrow in Section 6, 38–45, 63, and 85 cm.

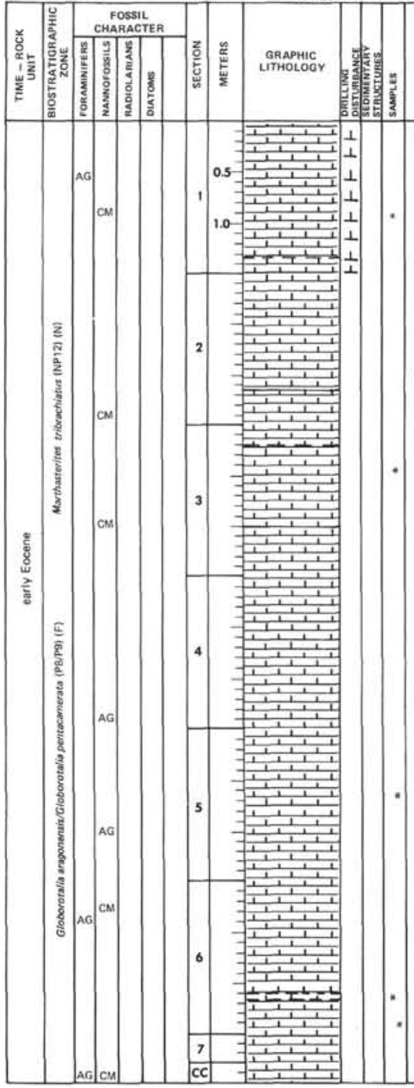
SMEAR SLIDE SUMMARY (%):

	1, 45 D	2, 90 D	3, 60 D	4, 50 D	6, 98 D
Texture:					
Sand	10	–	5	5	–
Clay	90	100	95	95	100
Composition:					
Quartz	5	5	5	5	5
Feldspar	–	–	–	Tr	5
Mica	Tr	–	–	–	–
Clay	10	20	10	10	20
Pyrite	Tr	–	–	–	–
Carbonate unspec.	20	10	20	10	20
Foraminifers	10	–	5	5	–
Calc. nannofossils	40	60	55	60	50
Radiolarians	Tr	–	–	–	–
Sponge spicules	–	–	–	10	–

ORGANIC CARBON AND CARBONATE (%):

	2, 45	5, 51
Carbonate	76	72

SITE 549 HOLE CORE 11 CORED INTERVAL 284.0–293.5 m



LITHOLOGIC DESCRIPTION

2.5Y 5/4
gradation
2.5Y 4/4

2.5Y 5/4

2.5Y 5/8
grades
2.5Y 4/4

5GY 7/1 vein of nanno chalk

10YR 4/4 nanno chalk

Section 1, 0–130 cm: light yellowish brown (2.5Y 6/4) nannofossil chalk mottled with light greenish gray (5BG 7/1) veins. Abundant (<0.5 mm) white spots, forams(?).

Section 1, 130 cm–Section 2, 115 cm: whole unit mottled with light greenish gray (5BG 7/1) spots and veins. Abundant small (0.5 mm) white spots.

Section 2, 115 cm–Section 3, 20 cm: nannofossil chalk.

Section 3, 20 cm–100 cm: nanno chalk mottled with gray veins or spots.

Section 3, 100 cm through Core-Catcher: grayish brown to light olive brown (2.5Y 5/2–2.5Y 5/4) nannofossil chalk mottled with light greenish gray (5GY 7/1) veins and spots. Large gray veins (1 cm) at 39–41 and (120–121 cm in Section 5. Abundant white spots (0.5 mm), forams(?).

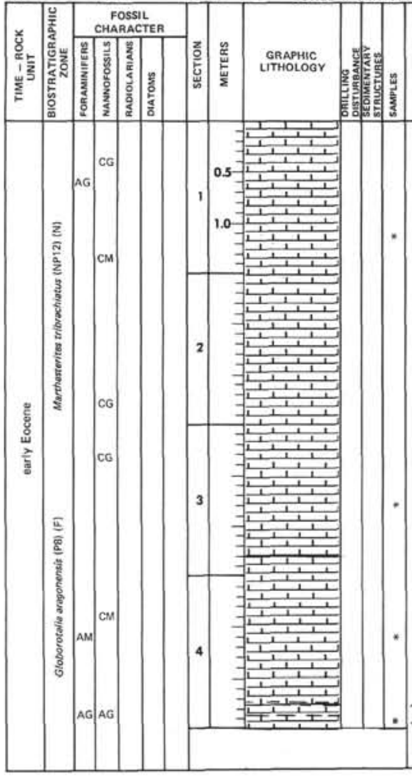
SMEAR SLIDE SUMMARY (%):

	1, 93	3, 44	5, 69	6, 112	6, 140
	D	D	D	D	D
Texture:					
Clay	100	100	100	–	–
Composition:					
Quartz	5	10	5	10	5
Feldspar	–	5	–	–	–
Clay	10	10	10	5	10
Volcanic glass	–	Tr	–	–	–
Pyrite	–	–	5	–	–
Carbonate unspec.	25	10	10	10	20
Foraminifers	–	5	–	10	–
Calc. nannofossils	15	50	50	15	40
Radiolarians	–	Tr	–	10	–
Sponge spicules	15	10	5	10	20

ORGANIC CARBON AND CARBONATE (%):

	2, 59	5, 109
Organic carbon	0.15	–
Carbonate	15	33

SITE 549 HOLE CORE 12 CORED INTERVAL 293.5–303.0 m



LITHOLOGIC DESCRIPTION

2.5Y 5/4
grades
2.5Y 6/4

2.5Y 6/4

Gradational contact intensely bioturbated

5GY 7/1–5GY 6/1 bioturbated nannofossil chalks

Section 1, 0 cm–Section 3, 130 cm: nannofossil chalk mottled with light greenish gray (5BG 7/1) spots, veins, and burrows.

Section 3, 130 cm–Section 4, 125 cm: yellowish brown to dark yellowish brown (10YR 5/4–4/4) nannofossil chalk mottled with light greenish gray spots, veins, and burrows. Large burrows at 16 and 49 cm.

Section 4, 120–130 cm: gradational contact, intensely burrowed.

Section 4, 130–150 cm: light greenish gray to greenish gray (5GY 7/1–5GY 6/1), bioturbated nannofossil chalk.

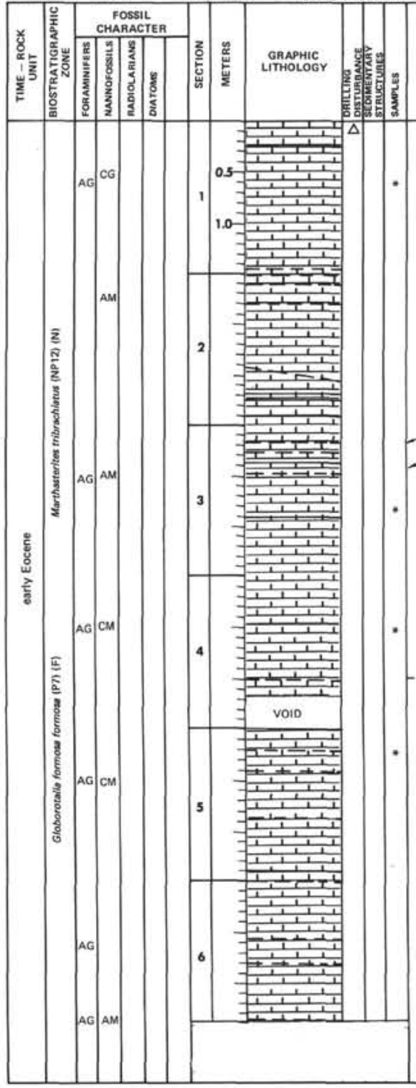
SMEAR SLIDE SUMMARY (%):

	1, 106	3, 77	4, 68	4, 144
	D	D	D	D
Texture:				
Clay	100	100	100	–
Composition:				
Quartz	5	5	10	5
Feldspar	5	–	–	–
Clay	10	10	10	5
Pyrite	5	–	–	–
Carbonate unspec.	15	10	10	10
Calc. nannofossils	40	60	70	60
Radiolarians	Tr	–	–	Tr
Sponge spicules	15	15	–	15

ORGANIC CARBON AND CARBONATE (%):

	1, 48
Carbonate	46

SITE 549 HOLE CORE 13 CORED INTERVAL 303.0–312.5 m



10YR 5/4

color grades

10YR 6/4

2.5YR 7/4
2.5Y 7/2
5GY 7/1
2.5Y 7/2

10YR 6/4

10YR 5/4

2.5Y 6/4
Gradual boundary

10YR 4/3

10YR 5/4 mottled with 10YR 4/3 and 5G 7/1

10YR 6/4
Color grade
10YR 5/4

2.5Y 7/2

2.5Y 6/4

5GY 7/1

10YR 6/4

5GY 7/1

10YR 6/3

10YR 6/3

2.5Y 7/2

5GY 7/1

2.5Y 6/2–7/2

10YR 5/4

5GY 7/1

10YR 6/3–5/4

LITHOLOGIC DESCRIPTION

Section 1, 0–20 cm: drilling breccia.

Section 1, 20 cm–Section 6, 140 cm: nannofossil chalk, burrow mottled with light greenish gray (5G 7/1).

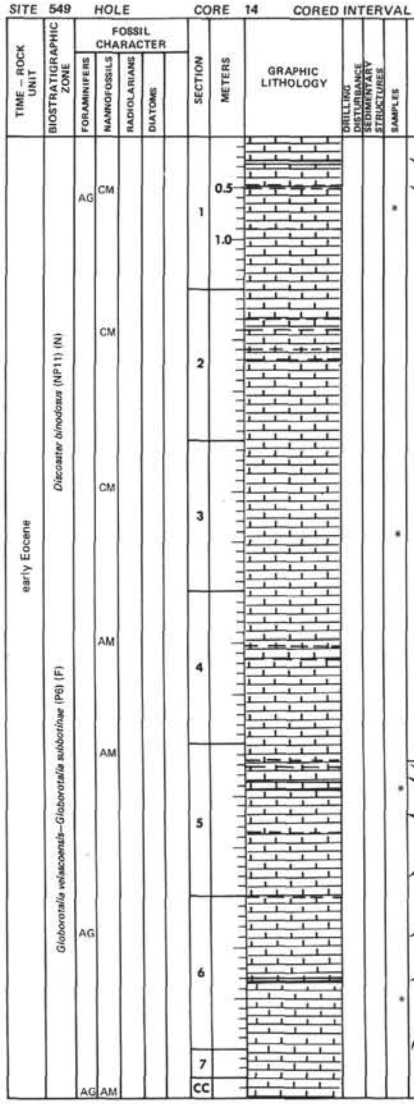
SMEAR SLIDE SUMMARY (%):

	1, 66	3, 85	4, 58	5, 22
	D	D	D	D
Texture:				
Clay	100	100	100	–
Composition:				
Quartz	5	5	10	5
Feldspar	Tr	–	–	–
Clay	20	10	20	15
Carbonate unspec.	20	10	10	10
Foraminifers	–	Tr	–	Tr
Calc. nannofossils	40	60	45	60
Sponge spicules	20	10	15	10

ORGANIC CARBON AND CARBONATE (%):

	2, 43
Carbonate	62

SITE 549 HOLE CORE 14 CORED INTERVAL 312.5–322.0 m



10YR 4/4
0.5 cm 5Y 7/1
10YR 4/4
Gradation boundary

Highly variable sequence 10YR 4/4–5Y 7/1

2.5Y 6/2

5GY 7/1
2.5Y 6/2
5GY 7/1 layered

5GY 7/1 streaked with dark gray

2.5Y 7/2–5/2

10YR 5/3–5/4

5GY 7/1 band

10YR 5/3–5/4

LITHOLOGIC DESCRIPTION

All core marly nannofossil chalk.

Zones marked 'A' have greenish gray mottling reaching approximately 50%.

Section 1, 50–90 cm: highly variable sequence dark brown to light gray (10YR 4/4–5Y 7/1).

Section 1, 90 cm–Section 5, 15 cm: light brownish gray (2.5Y 6/2) mottled with light greenish gray (5G 7/1).

Section 2, 137.5 cm and Section 4, 10.5 cm has 0.5 cm band of light greenish gray (5GY 7/1).

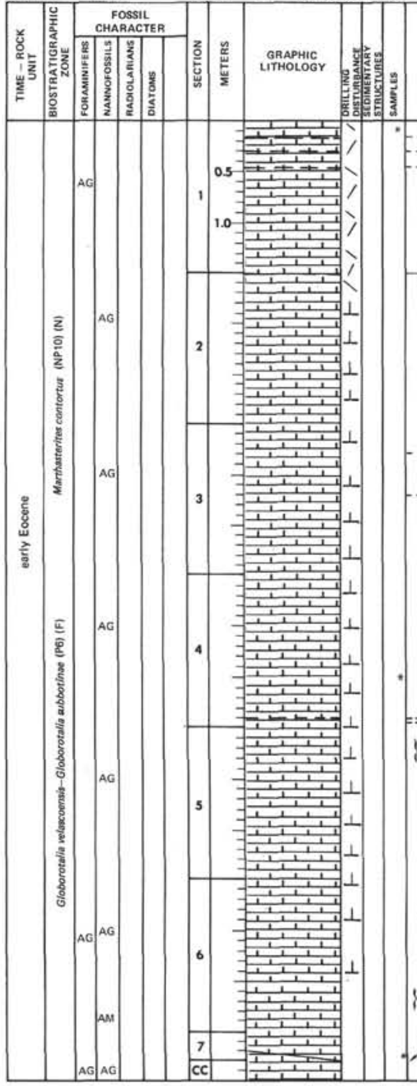
SMEAR SLIDE SUMMARY (%):

	1, 70	3, 94	5, 41	5, 48	6, 101
	D	D	D	D	D
Composition:					
Quartz	15	15	10	10	5
Feldspar	5	Tr	–	Tr	–
Clay	15	15	25	30	25
Pyrite	–	–	–	–	<5
Carbonate unspec.	5	10	10	5	10
Foraminifers	Tr	–	–	–	5
Calc. nannofossils	50	50	40	40	50
Radiolarians	–	–	–	–	Tr
Sponge spicules	5	10	10	10	–

ORGANIC CARBON AND CARBONATE (%):

	2, 55	4, 16
Carbonate	63	68

SITE 549 HOLE CORE 15 CORED INTERVAL 322.0–331.5 m



LITHOLOGIC DESCRIPTION

Section 1, 10–54 cm: very fine, hard homogeneous, mottled with dark greenish gray (5GY 4/1).

Section 1, 54–150 cm: mottled throughout with greenish gray (5G 6/1), reduction spot-mottling(?), pyrite within mottles.

Section 2, 0 cm–Section 3, 30 cm: olive (5Y 5/3) with large areas of light greenish gray (5G 7/1). Heavily mottled at 7–81 cm, Section 2. Mottled areas (89–91 cm, Section 2) contain 5GY 5/1.

Section 3, 70 cm: little mottling below, color changes slightly.

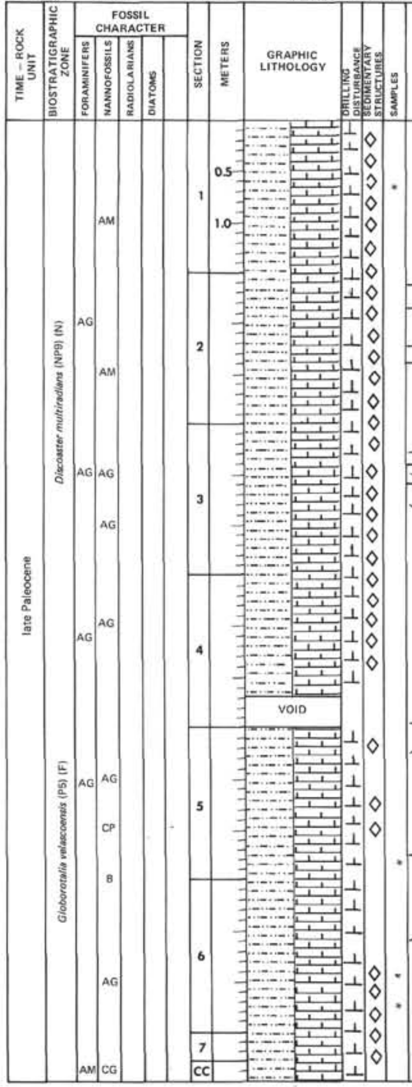
SMEAR SLIDE SUMMARY (%):

	1, 6	4, 100	7, 33
	D	D	M
Composition:			
Quartz	–	5	15
Mica	–	10	10
Pyrite	90	–	–
Carbonate unspec.	–	20	20
Foraminifers	–	<5	<5
Calc. nannofossils	10	60	50
Sponge spicules	–	–	Tr

ORGANIC CARBON AND CARBONATE (%):

	2, 56
Organic carbon	0.10
Carbonate	39

SITE 549 HOLE CORE 16 CORED INTERVAL 331.5–341.0 m



LITHOLOGIC DESCRIPTION

Unit

Marly nannofossil chalk, light brown (2.5Y 6/2) to brown (7.5YR 5/3), firm to very firm, intensely to moderately burrowed, mottles occasionaly greenish gray, mm size

Below Section 4 mm sized lens and bands of darker clayey material are found

Variable quantities of forams give a white speckled appearance

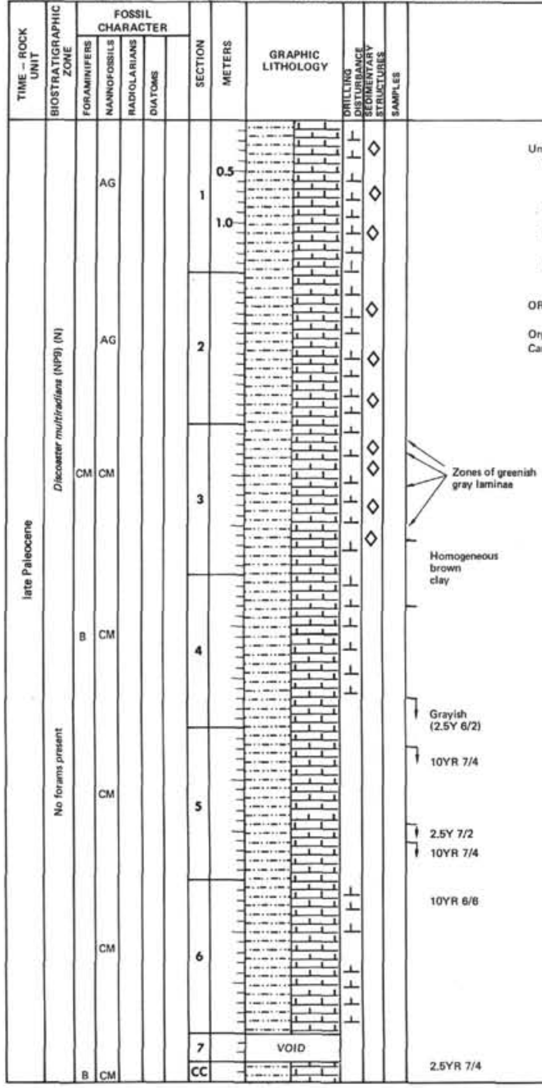
SMEAR SLIDE SUMMARY (%):

	1, 64	5, 137	6, 92	6, 127
	D	D	D	D
Texture:				
Sand	10	5	10	10
Silt	20	15	30	20
Clay	70	80	60	70
Composition:				
Quartz	10	5–10	10	
Feldspar	–	5	–	10
Mica	–		–	
Heavy minerals	–		–	
Clay	30	40	20	20
Volcanic glass	–	Tr	5	–
Glauconite	–	–	–	Tr
Carbonate unspec.	10	15	20	20
Foraminifers	1–5	Tr	5	10
Calc. nannofossils	40	30	30	40
Diatoms	–	–	Tr	–
Sponge spicules	–	–	Tr	Tr
Chlorite	5–10	5–10	5–10	<5

ORGANIC CARBON AND CARBONATE (%):

	2, 56
Carbonate	41

SITE 549 HOLE CORE 17 CORED INTERVAL 341.0–350.5 m



LITHOLOGIC DESCRIPTION

Unit

Marly nannofossil chalk, light yellow brown (2.5Y 6/4) to dark reddish brown (7.5YR 4/4), the darker color is confined to more clayey beds, firm to very firm

Little to moderate burrowing, some burrows filled with greenish sediment

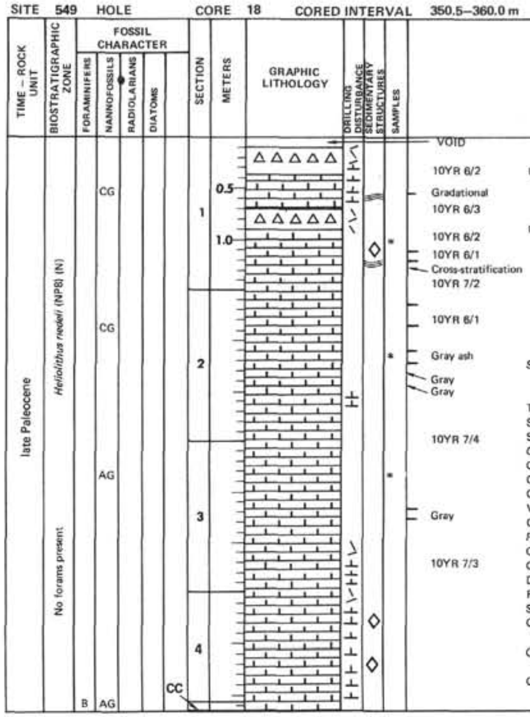
Entire core contains faint banding by color units, lighter horizons are more silty and may contain faint laminations

Lighter units contain variable quantities of forams appearing as scattered white speckles

ORGANIC CARBON AND CARBONATE (%):

	2, 79
Organic carbon	0.05
Carbonate	53

SITE 549 HOLE CORE 18 CORED INTERVAL 350.5–360.0 m



LITHOLOGIC DESCRIPTION

Unit 1

Chert bands, pale yellow to light olive brown (2.5Y 7/4–2.5Y 5/4), hard, amorphous, brecciated by drilling

Unit 2

Siliceous nannofossil chalk, light brownish gray (10YR 6/2–6/1) to tan (10YR 7/3), very firm

Little mottling, gray units contain fine laminations in places and at least one fish layer

Colors are banded, contact gradational

Variable concentrations of siliceous matter, diatoms, and radiolarians appear richer in tan sediments

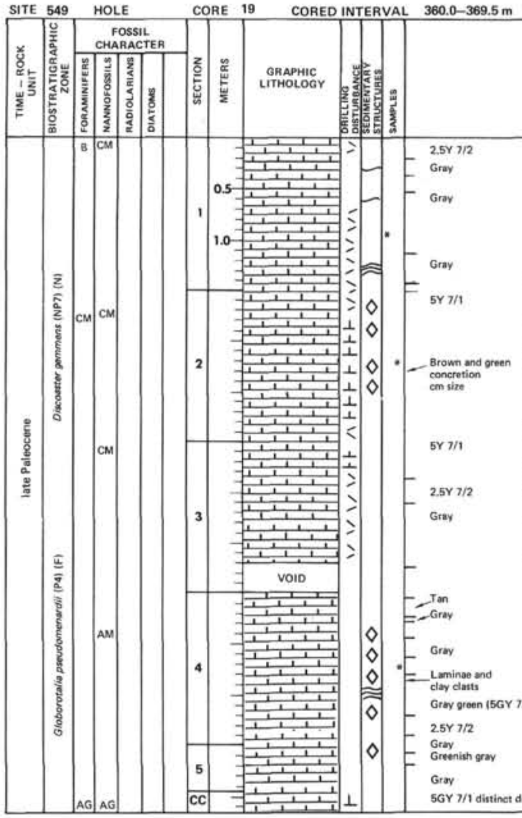
SMEAR SLIDE SUMMARY (%):

	1, 101	2, 66	3, 34
	D	D	D
Texture:			
Sand	5	50	10
Silt	15	40	30
Clay	80	10	60
Composition:			
Quartz	Tr	25	Tr
Clay	20	–	20
Volcanic glass	–	60	–
Glauconite	Tr	–	Tr
Pyrite	–	Tr	–
Carbonate unspec.	10	Tr	10
Calc. nannofossils	60	5	30
Diatoms	–	–	20
Radiolarians	Tr	Tr	5
Sponge spicules	5–10		5–10
Chlorite	1–5	5–10	Tr

ORGANIC CARBON AND CARBONATE (%):

	2, 35
Carbonate	43

SITE 549 HOLE CORE 19 CORED INTERVAL 360.0–369.5 m



LITHOLOGIC DESCRIPTION

Unit

Nannofossil chalk, tan (2.5Y 7/2) to gray (5Y 7/1) and greenish gray (5GY 7/1), very firm

Colors as shown, tan units not labelled, contacts gradational

Moderate to little mottling

Gray beds occasionally contain fine laminations

Siliceous material abundance variable

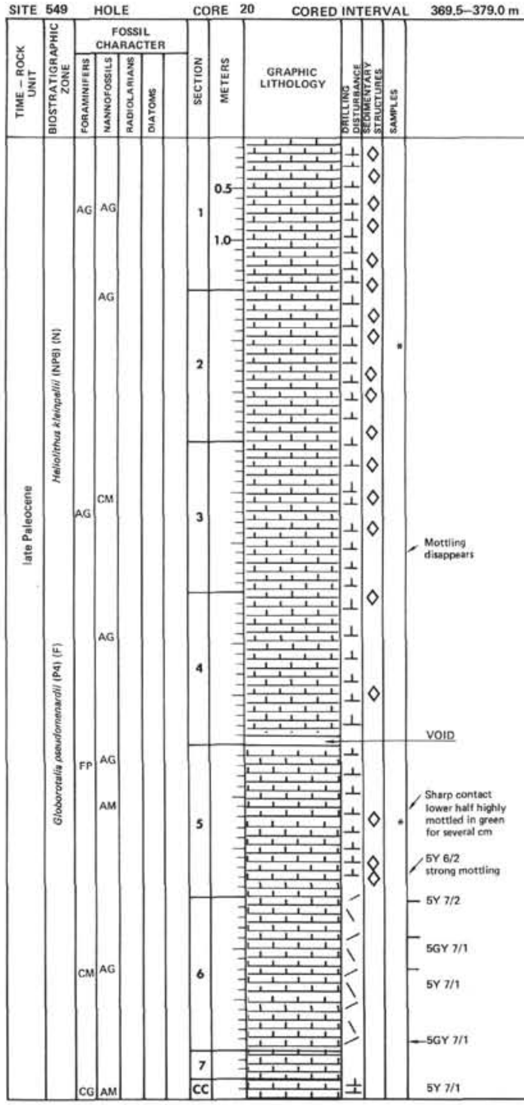
SMEAR SLIDE SUMMARY (%):

	1, 47 D	2, 75 D	4, 72 D
Texture:			
Sand	5	5	3
Silt	30	5	10
Clay	65	90	87
Composition:			
Clay	20	10	< 5
Volcanic glass	5	–	–
Carbonate unspec.	–	10	5
Calc. nannofossils	55	77	90
Diatoms	5	–	–
Radiolarians	5	3	Tr
Sponge spicules	5–10	–	–
Chlorite	Tr	–	–

ORGANIC CARBON AND CARBONATE (%):

	2, 41
Organic carbon	0.05
Carbonate	63

SITE 549 HOLE CORE 20 CORED INTERVAL 369.5–379.0 m



LITHOLOGIC DESCRIPTION

Unit 1

Nannofossil chalk, greenish gray (5GY 7/1) to gray (5Y 7/1) in Section 6, firm to very firm

Moderately to little mottled in shades of gray

Sharp erosional contact in Section 5, lower part of which is highly mottled in green (probably glauconite)

Color contacts are gradational

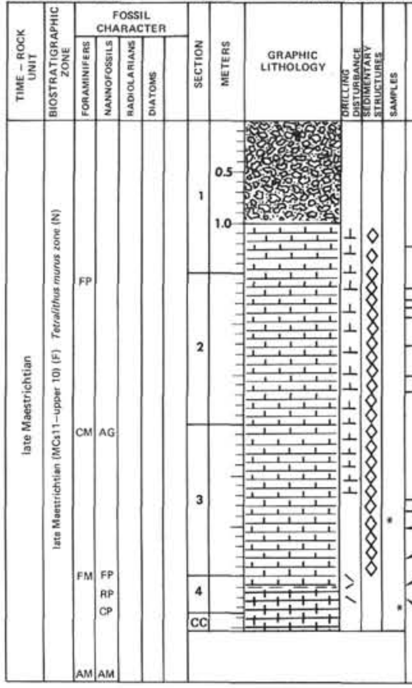
SMEAR SLIDE SUMMARY (%):

	2, 56 D	5, 73 D
Texture:		
Sand	5	5
Silt	25	25
Clay	70	70
Composition:		
Quartz	–	} 25
Feldspar	–	
Clay	20	15
Volcanic glass	Tr	Tr
Carbonate unspec.	10	20
Foraminifers	Tr	Tr
Calc. nannofossils	60	40
Radiolarians	Tr	1
Chlorite	5	Tr

ORGANIC CARBON AND CARBONATE (%):

	5, 10
Carbonate	57

SITE 549 HOLE CORE 21 CORED INTERVAL 379.0–388.5 m



LITHOLOGIC DESCRIPTION

5GY 7/2 up to 5% chlorite

5GY 8/1 large cm size burrows

Gray

Gray

Gray

Very mottled

Gray, very mottled in dark gray

Very mottled

Very mottled 2.5Y 7/2

Sharp erosional contact – below is white (5B 9/1)

Thin chunk of gray chalk with lenses of glauconite white (5B 9/1)

White chalk

Unit 1

Nannofossil chalk, greenish gray (5GY 7/2), firm to very firm, extensively mottled in shades of gray, color bands of gray (5Y 8/1) present, color contacts gradational

Gray layer mottling often vivid due to occurrence of darker gray burrow linings

The lining contains micrograins of opaque reddish, diamond shaped mineral

Unit 2

Foram-nannofossil chalk, white (5B 9/1), very firm, gritty (forams) homogeneous

Quartz grains show pressure extinction, metamorphic source

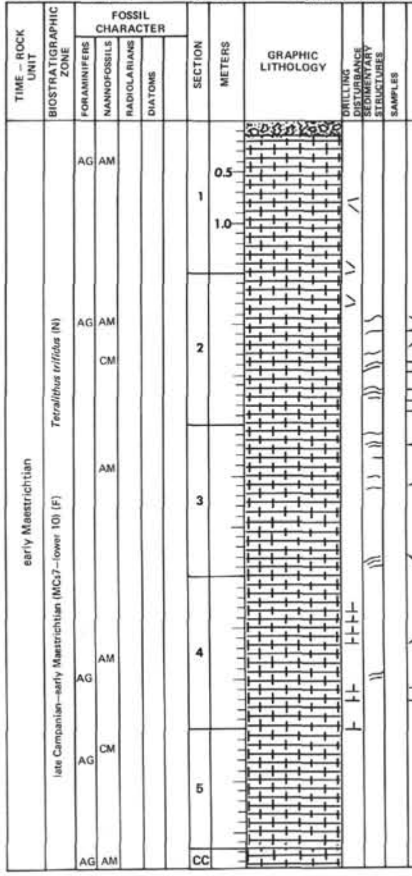
SMEAR SLIDE SUMMARY (%):

	3, 98	4, 33
	D	D
Texture:		
Sand	5	20
Silt	15	20
Clay	80	60
Composition:		
Quartz	5	Tr
Clay	10	–
Volcanic glass	Tr	–
Glauconite	Tr	–
Carbonate unspec.	10	20
Foraminifers	–	20
Calc. nannofossils	70	60
Chlorite	Tr	–

ORGANIC CARBON AND CARBONATE (%):

	2, 19
Carbonate	73

SITE 549 HOLE CORE 22 CORED INTERVAL 388.5–398.0 m



LITHOLOGIC DESCRIPTION

Laminations

Laminated

Laminated
Paler
Darker

Microfaults

Flaser lamination

White homogeneous

Loaded bed deformed laminae and micro-ripples

White band

Flaser lamination

White, homogeneous

Pale brown, nearly homogeneous

White, homogeneous

Brecciated pink and gray

Unit

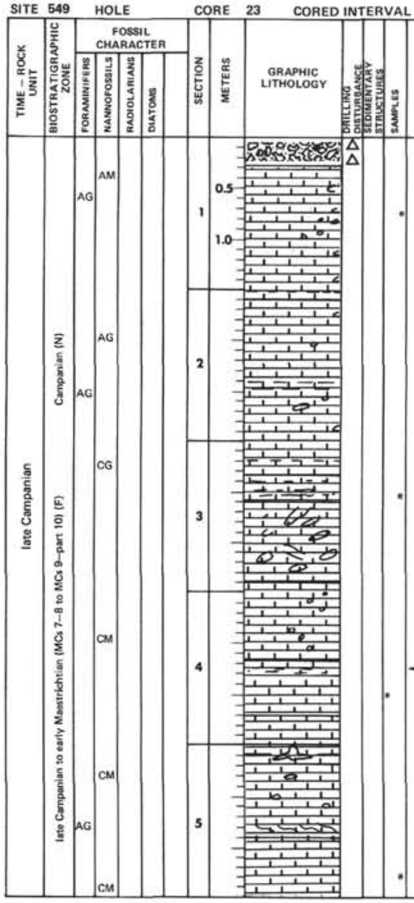
Foram-nannofossil chalk, white (2.5Y 8/0), homogeneous to pale brown (10YR 7/3) and laminated occasional micro-ripples, contacts of homogeneous and laminated units are sharp, mottling is minor

5–10% sand fraction is forams plus some chlorite clay may make up to 20% of chalk

ORGANIC CARBON AND CARBONATE (%):

	1, 43	2, 105
Organic carbon	–	0.04
Carbonate	94	95

SITE 549 HOLE CORE 23 CORED INTERVAL 398.0–407.5 m



LITHOLOGIC DESCRIPTION

Section 1, 0–25 cm: drilling breccia.

Section 1, 25 cm–Section 3, 20 cm: light gray (5Y 7/2) nannofossil chalk with clasts of pink (7.5YR 8/4) nannofossil chalk (also veins).

Section 3, 20–35 cm: slightly distorted laminated beds.

Section 3, 35–60 cm: 10YR 7/2 laminated nannofossil chalk. Laminations become more prominent towards base.

Section 3, 60–140 cm: severely distorted nannofossil chalk white to light gray (10YR 8/2–7/1).

At 140 cm of Section 3 stylolite or fracture with black non-organic staining.

Section 3, 140 cm–Section 4, 70 cm: light gray (10YR 7/1) nannofossil chalk with pink (7.5YR 8/4) nannofossil chalk clasts.

SMEAR SLIDE SUMMARY (%):

	1, 73 D	1, 79 D	3, 59 D	4, 103 D	5, 130 D
Texture:					
Sand	–	5	–	–	–
Clay	100	95	100	90	–
Composition:					
Carbonate unspec.	30	20	30	10	20
Foraminifers	–	5	–	–	–
Calc. nannofossils	70	75	70	90	80

ORGANIC CARBON AND CARBONATE (%):

	2, 54
Organic carbon	0.03
Carbonate	94

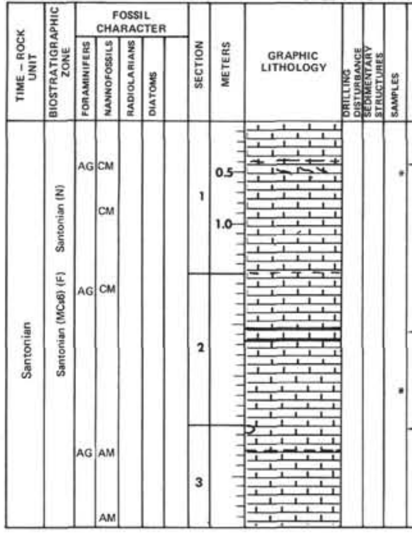
← Distorted layer

10YR 7/1 nanno chalk with pink veins and clasts

Slight distortion

Pinkish white (7.5YR 8/2) nannofossil chalk

SITE 549 HOLE CORE 24 CORED INTERVAL 407.5–417.0 m



LITHOLOGIC DESCRIPTION

10YR 8/3

← Slight distortion

7.5YR 8/2

10YR 8/3

← 5YR 4/4 flint

10YR 8/3

← Flint nodule

7.5YR 8/2

Whole core, nanno chalk, homogeneous, little sediment structure.

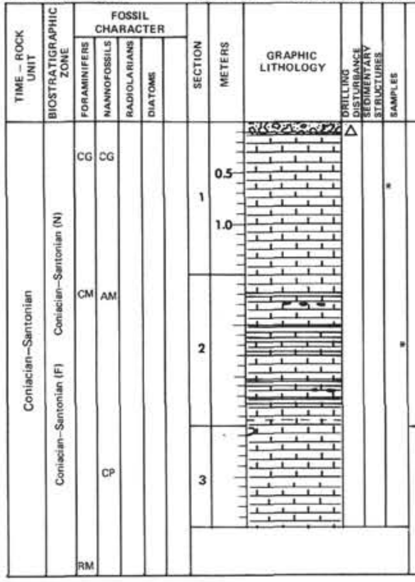
SMEAR SLIDE SUMMARY (%):

	1, 52 D	2, 115 D
Texture:		
Clay	100	100
Composition:		
Carbonate unspec.	20	30
Calc. nannofossils	80	70

ORGANIC CARBON AND CARBONATE (%):

	2, 18
Organic carbon	0.04
Carbonate	92

SITE 549 HOLE CORE 25 CORED INTERVAL 417.0–426.5 m



LITHOLOGIC DESCRIPTION

← Flint nodule

Section 1, 0–10 cm: drilling breccia.

Section 1, 10 cm–Section 1, 20 cm: white nannofossil chalk, homogeneous, 10YR 8/2.

Section 2, 20–60 cm: all of this in matrix of white (10YR 8/2) nannofossil chalk.

Section 2, 20–30 cm: inoceramus shells.

Section 2, 55 cm: flint layer.

Section 2, 60 cm: inoceramus shell.

Section 2, 65–70, 105–110, and 120–125 cm: laminated layers.

Brown (10YR 6/3) clasts at Section 2, 115 cm.

Section 3: pinkish white (7.5YR 8/2) nannofossil chalk. Burrow mottled and homogeneous.

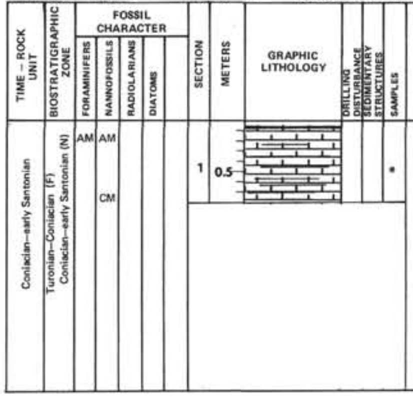
SMEAR SLIDE SUMMARY (%):

	1, 67 D	2, 70 D
Texture:		
Clay	100	100
Composition:		
Carbonate unspec.	20	20
Foraminifers	Tr	–
Calc. nannofossils	80	80

ORGANIC CARBON AND CARBONATE (%):

	1, 37	2, 24
Carbonate	90	86

SITE 549 HOLE CORE 26 CORED INTERVAL 426.5–436.0 m



LITHOLOGIC DESCRIPTION

Light greenish gray (5GY 7/1) laminated nannofossil chalk with darker greenish gray (5GY 6/1) laminae. Section 1, 5–10 cm: flint layer.

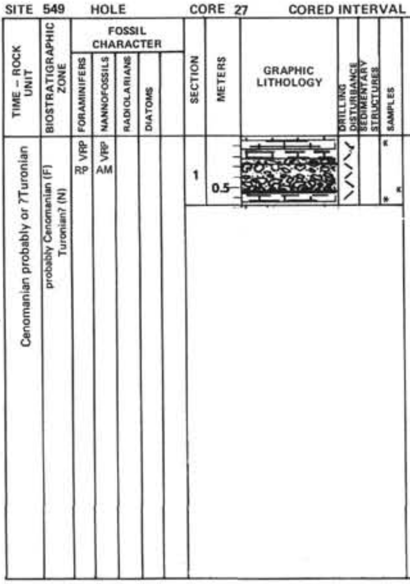
SMEAR SLIDE SUMMARY (%):

	1, 50
	D
Texture:	
Clay	100
Composition:	
Carbonate unspec.	20
Calc. nannofossils	80

ORGANIC CARBON AND CARBONATE (%):

	1, 24
Carbonate	84

SITE 549 HOLE CORE 27 CORED INTERVAL 436.0–445.5 m



LITHOLOGIC DESCRIPTION

Section 1, 10–25 cm: laminated nannofossil chalk, with darker greenish gray (5GY 6/1) laminae light greenish gray (5GY 7/1).

Section 1, 25–50 cm: drilling breccia.

Section 1, 50–67 cm: sequence of greenish gray (5GY 6/1) at top, dark greenish gray in middle to black at bottom pyritic recrystalized nannofossil(?) oozes.

Section 1, 56 cm: altered volcanic ash.

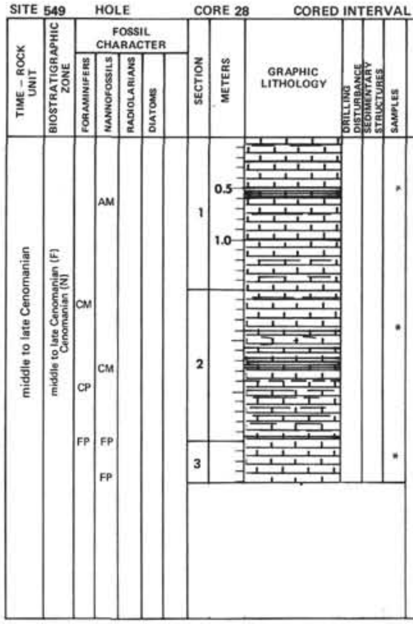
SMEAR SLIDE SUMMARY (%):

	1, 11	1, 56	1, 64
	D	D	D
Texture:			
Clay	100	–	100
Composition:			
Quartz	5	–	–
Feldspar	Tr	–	–
Clay	20	–	–
Volcanic ash	–	80	–
Pyrite	Tr	–	10
Carbonate unspec.	10	–	30
Calc. nannofossils	50	20	70
Sponge spicules	<5	–	–

ORGANIC CARBON AND CARBONATE (%):

	1, 10	1, 29	1, 42	1, 50
Organic carbon	–	3.37	0.28	3.51
Carbonate	67	31	3	9

SITE 549 HOLE CORE 28 CORED INTERVAL 445.5–455.0 m



LITHOLOGIC DESCRIPTION

All core is nannofossil chalk.

Section 1, 0–25 cm: 2.5Y 6/2, faintly laminated.

Section 1, 50–60 cm: 2.5Y 6/2 with 5G 5/2 laminae.

Section 1, 60 cm–Section 2, 50 cm: weakly laminated, 5Y 6/2.

Section 2, 50–65 cm: slightly distorted layer.

Section 1, 75–85 cm: strongly laminated 5G 7/2 in 5Y 7/3.

Section 2, 85 cm–145 cm: 2.5Y 6/2 faintly laminated.

Section 2, 145 cm through Section 3: homogeneous, 5Y 6/3.

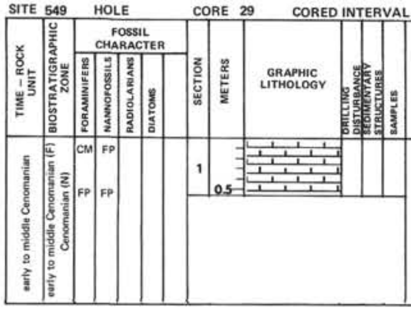
SMEAR SLIDE SUMMARY (%):

	1, 10	1, 53	2, 40
	D	D	D
Texture:			
Sand	10	} 10	–
Silt	10		–
Clay	80	90	–
Composition:			
Quartz	20	10	5
Feldspar	<5	5	–
Clay	30	20	5
Pyrite	10	–	–
Carbonate unspec.	5	10	60
Foraminifers	–	–	5
Calc. nannofossils	30	50	20

ORGANIC CARBON AND CARBONATE (%):

	1, 73	2, 25
Organic carbon	–	0.07
Carbonate	69	75

SITE 549 HOLE CORE 29 CORED INTERVAL 455.5–464.5 m



LITHOLOGIC DESCRIPTION

Homogeneous pale olive (5Y 6/3) nannofossil chalk. Belemnite at 44 cm, Section 1.

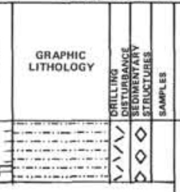
ORGANIC CARBON AND CARBONATE (%)

	1, 19
Carbonate	67

NOTE: Core 30 and 31: no recovery.

SITE 549 HOLE CORE 32 CORED INTERVAL 483.5–493.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER					SECTION	METERS
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS			
middle Albian	early to middle Albian (late MCi 24 to MCi 25) (F) *Prediscosphaera cretacea* (N)						1	
							CC	0.5
		FP						



LITHOLOGIC DESCRIPTION

Unit

Calcareous silty mudstone, very dark gray (5Y 3/1), very firm, has mild reaction to HCL

Banded in shades of gray on a scale of cm

Contacts sharp and well burrowed

Burrows on scale of mm, some are cm size

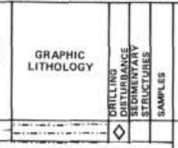
Sand and silt size grains are: quartz, feldspar and scattered black flecks, foraminifers

ORGANIC CARBON AND CARBONATE (%):

	1, 17
Organic carbon	0.36
Carbonate	22

SITE 549 HOLE CORE 33 CORED INTERVAL 493.0–502.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER					SECTION	METERS
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS		
middle Albian	early to middle Albian (late MCi 24 to MCi 25) (F) *Prediscosphaera cretacea* (N)	CP	CM	B		B	1	



LITHOLOGIC DESCRIPTION

Unit

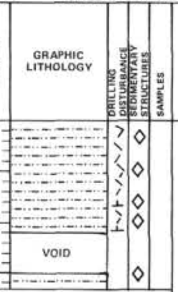
Calcareous mudstone, greenish gray (5GY 4/1), very firm to hard, well mottled on a scale of mm, scattered small lenses (mm long) of dark green (5G 4/2) material

ORGANIC CARBON AND CARBONATE (%):

	CC
Carbonate	17

SITE 549 HOLE CORE 34 CORED INTERVAL 502.5–512.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER					SECTION	METERS
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS		
middle Albian	early to middle Albian (late MCi 24 to MCi 25) (F) *Prediscosphaera cretacea* (N)	FM		C		RP		
			FP				1	0.5
								1.0
			FP				2	



LITHOLOGIC DESCRIPTION

Unit

Very calcareous mudstone, dusky green (5G 4/1), very firm to hard, thinly laminated in shades of darker green, laminae disrupted by moderate to abundant burrows

Dark green mineral present in fine lenses scattered infrequently in the section

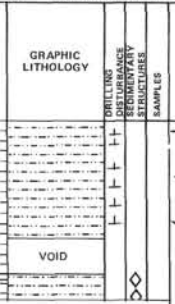
Section 2 contains laminae of gray (5Y 5/1), material appears more calcareous

ORGANIC CARBON AND CARBONATE (%):

	1, 52
Organic carbon	0.25
Carbonate	51

SITE 549 HOLE CORE 35 CORED INTERVAL 512.0–521.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER					SECTION	METERS
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS		
middle Albian	early to middle Albian (late MCi 24 to MCi 25) (F) *Prediscosphaera cretacea* (N)	AM		F		RP		
			AM					
							1	0.5
								1.0
		AG		F		RP		
							2	
		CM	AM			RP		
							CC	



LITHOLOGIC DESCRIPTION

5Y 3/2
5GY 4/1
gradational contact
Darker, very mottled
Sharp contact
Lighter
0.5 cm wide dark gray bands
5GY 4/1
5GY 4/1

Unit

Calcareous silty mudstone, olive gray (5Y 3/2) in the upper 10 cm and greenish gray (5GY 4/1) in the rest of the core, very firm to hard

Moderately mottled, mottles are mostly horizontal, mm wide and up to cm long

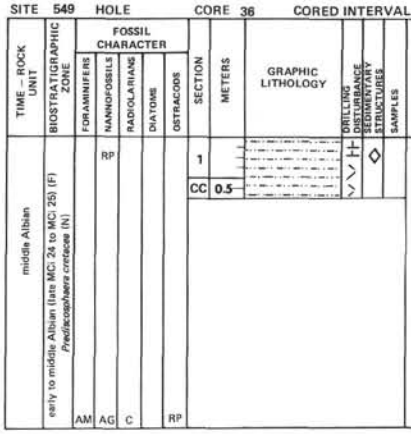
Fine sand and silt sized grains: quartz, feldspar, and scattered black flecks and lenses (up to several mm long), foraminifers, minor amount of glauconite

Mineral fabric seems horizontal

ORGANIC CARBON AND CARBONATE (%):

	1, 7
Organic carbon	0.29
Carbonate	15

SITE 549 HOLE CORE 36 CORED INTERVAL 521.5–522.5 m



LITHOLOGIC DESCRIPTION

Light gray coarser zone more calcareous

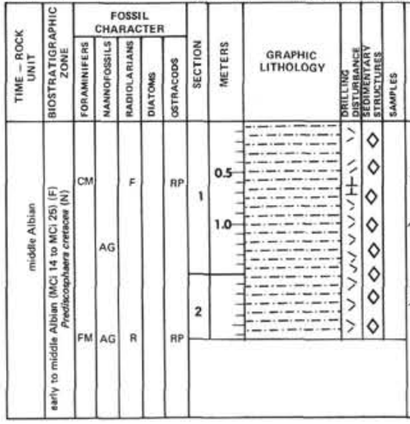
Unit

Very calcareous silty mudstone, light gray (N7) in upper 10 cm section and olive gray (5Y 4/1) below, very firm to hard, darker sediment are well mottled in shades of green (5GY 4/1), mottles are fine laminations and burrows, most of which are horizontal

ORGANIC CARBON AND CARBONATE (%):

	1, 20
Organic carbon	0.46
Carbonate	49

SITE 549 HOLE CORE 37 CORED INTERVAL 522.5–531.0 m



LITHOLOGIC DESCRIPTION

Darker band very mottled

Darker band very mottled

Micro-faults

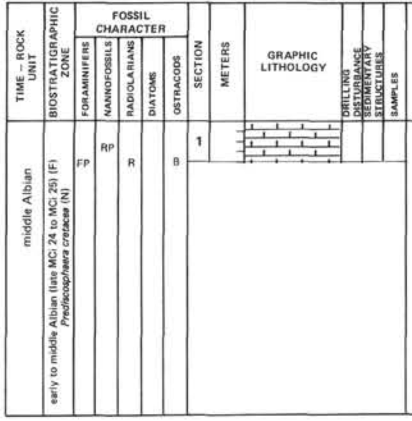
Unit

Calcareous mudstone, dark olive gray (5Y 4/1) to dark greenish gray (5GY 4/1), firm to hard, has a silty feel, moderately to extensively mottled in shades of dark gray, mottles are mm wide and up to cm long, almost all are horizontal

ORGANIC CARBON AND CARBONATE (%):

	1, 31	2, 32
Organic carbon	0.72	0.49
Carbonate	23	23

SITE 549 HOLE CORE 38 CORED INTERVAL 531.0–540.5 m



LITHOLOGIC DESCRIPTION

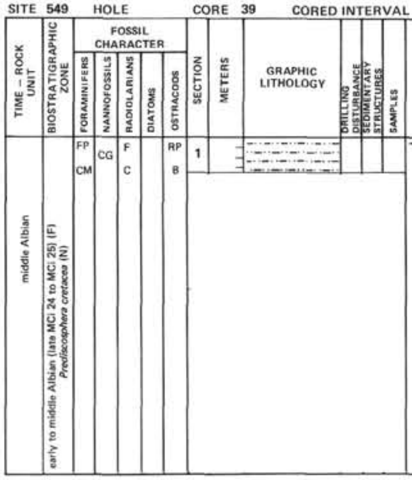
Unit

Nannofossil chalk, medium dark gray to very light gray (N4–N8), very firm to hard, nearly homogeneous, no distinct structures

ORGANIC CARBON AND CARBONATE (%):

	1, 34
Organic carbon	0.18
Carbonate	83

SITE 549 HOLE CORE 39 CORED INTERVAL 540.5–550.0 m



LITHOLOGIC DESCRIPTION

← Concentration of darker material

Unit

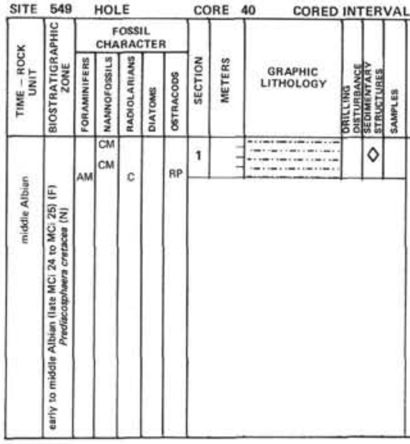
Calcareous mudstone, dark gray to medium light gray (N3–N6) in slightly mottled laminae, no significant structures

Main components: nannofossils, quartz, unspecified carbonate and opaque dark material

ORGANIC CARBON AND CARBONATE (%):

	1, 6
Carbonate	32

SITE 549 HOLE CORE 40 CORED INTERVAL 550.0–559.5 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous mudstone, medium dark gray (N4) with mottled laminae of gray (N6), firm to hard

Dusky yellow green streaks at 14, 24, 32, and 35 cm

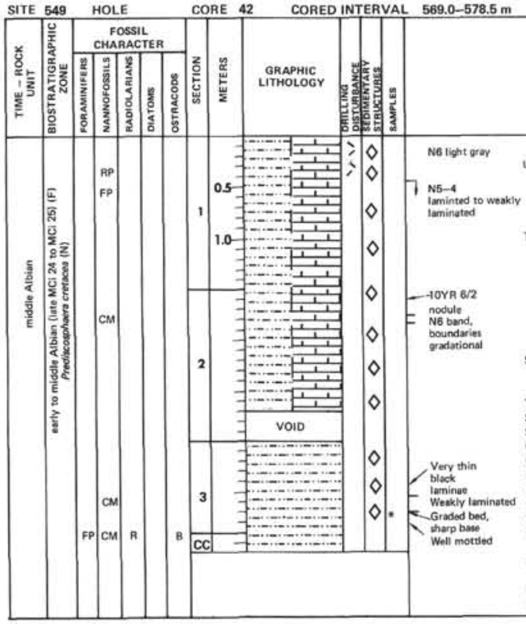
Components are: unspecified carbonate, nannofossils, quartz, and opaque black material

ORGANIC CARBON AND CARBONATE (%):

	1, 7
Organic carbon	0,54
Carbonate	33

Note: Core 41: no recovery.

SITE 549 HOLE CORE 42 CORED INTERVAL 569.0–578.5 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous mudstone, dark gray (N5–4) to light gray (N6), very firm to hard laminated to weakly laminated in shades of darker gray

Thin section in Section 2 shows:

Laminations due to clay content on a scale of 1–2 mm

Sand-silt size particles: quartz, opaque spindle shaped particles, forams, unspecified carbonate, chlorite-mica, clay clasts

Mineral clay content approaching 50%

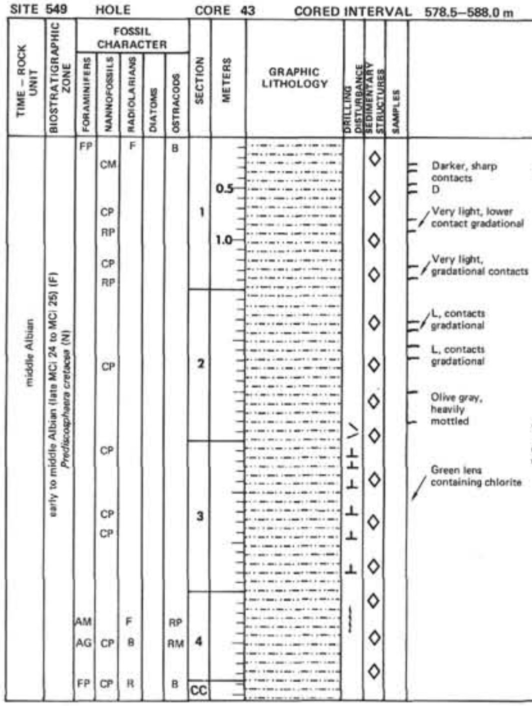
SMEAR SLIDE SUMMARY (%):

	3, 71 D
Texture:	
Sand	10
Silt	30
Clay	60
Composition:	
Quartz	40
Feldspar	5
Clay	10
Carbonate unspec.	20
Calc. nannofossils	25

ORGANIC CARBON AND CARBONATE (%):

	1, 38	2, 36
Organic carbon	0.52	0.57
Carbonate	72	41

SITE 549 HOLE CORE 43 CORED INTERVAL 578.5–588.0 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous mudstone, light to dark gray (7.5YR 5/0–4/0), very firm to hard

Well mottled with mottling most concentrated in darker layers, darker layers usually have sharp boundaries

Lighter layers have less structure and gradational boundaries

Mottling is mostly horizontal, mm wide and up to cm long forming dark gray distorted laminae

Sand sized minerals: quartz, calcite, feldspar, and black opaque

Light layers richer in calcite

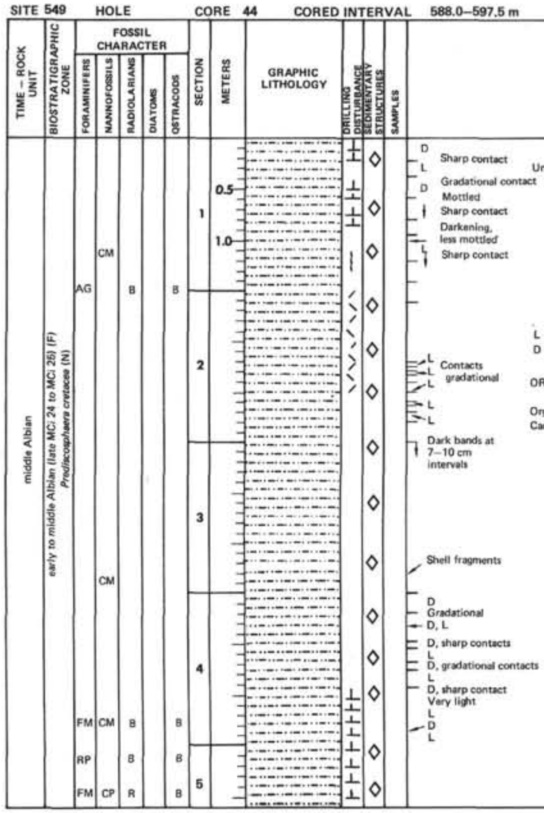
Occasional thin lens of chloritic material

L = light color and D = dark color – banding throughout

ORGANIC CARBON AND CARBONATE (%):

	2, 88
Organic carbon	0.72
Carbonate	28

SITE 549 HOLE CORE 44 CORED INTERVAL 588.0–597.5 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous silty mudstone, dark gray (7.5YR 4/0) and olive gray (5Y 5/1) to lighter gray (2.5Y 5/0), very firm to hard, moderately to well mottled in shades of gray, mottles mm wide, up to cm long and almost all aligned horizontally forming disrupted laminae

Unit is banded on scale of tens of centimeters, darker bands more homogeneous

Lighter bands more calcareous

Contacts variable, dark beds often have sharp boundaries

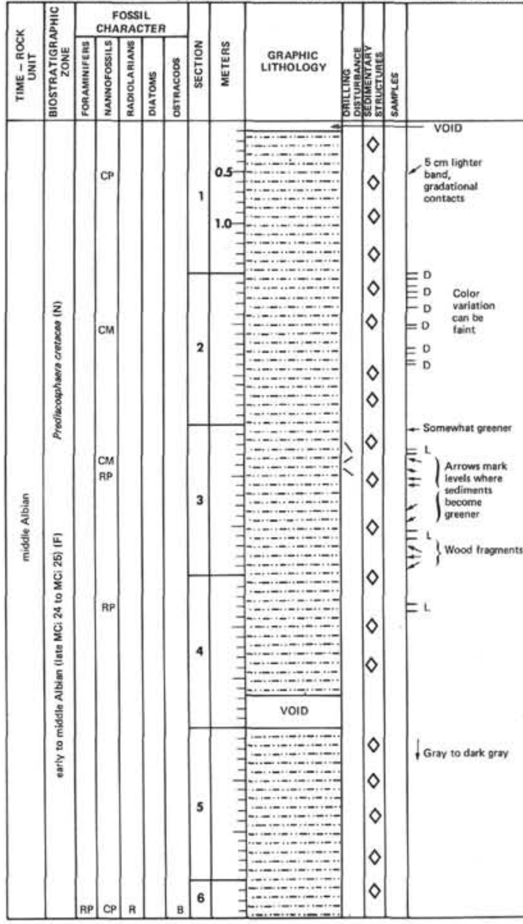
Occasional fine lens of dark green chloritic material

L = light color
D = darker color

ORGANIC CARBON AND CARBONATE (%):

	2, 110
Organic carbon	0.34
Carbonate	58

SITE 549 HOLE CORE 45 CORED INTERVAL 597.5–607.0 m



LITHOLOGIC DESCRIPTION °

Unit

Calcareous silty mudstone, gray (N5) to dark gray (2.5Y 5/0), very firm to hard

Moderately to extensively mottled and banded in shades of gray

Mottling is mostly horizontal, mm wide and up to cm long

Banding density is variable and darker bands appear less mottled than main rock

Lighter bands appear more calcareous

Darker bands usually have sharp contacts

Occasional fossil wood fragment

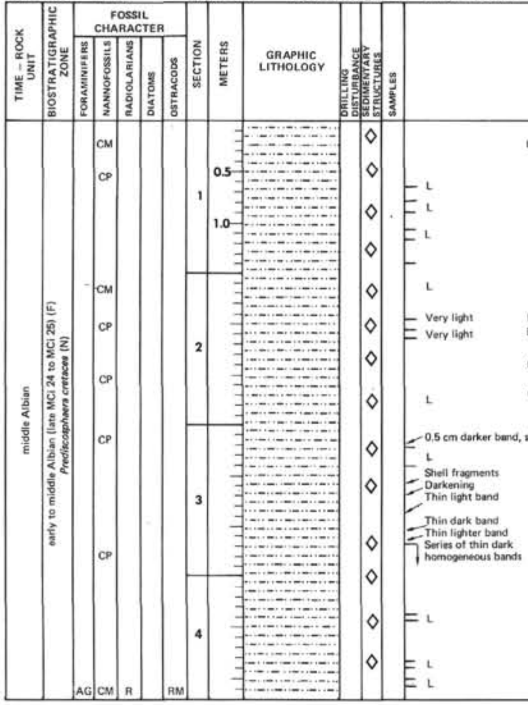
Sand sized particles include: quartz, forams, opaque dark spindle shaped particles, calcareous particles

ORGANIC CARBON AND CARBONATE (%):

	3, 40
Organic carbon	0.28
Carbonate	40

L = light color and D = dark color

SITE 549 HOLE CORE 46 CORED INTERVAL 607.0–616.5 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous silty mudstone, dark gray (2.5YR 4/0) to light gray (7.5YR 7/0), very firm to hard, moderately to well mottled and variably color banded in shades of gray

Mottles are mostly horizontal, mm wide and cm long

Color bands:

Darker tend to have sharp contacts, light are gradational

Light bands show less structure and are more calcareous

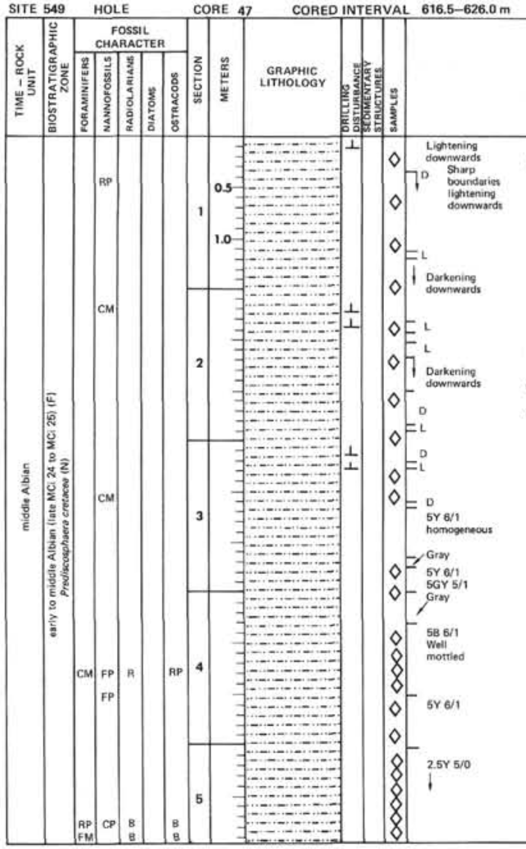
Fine green lenses and fleck soccasionally seen appear to be mostly chlorite-like material

L = lighter color
D = darker color

ORGANIC CARBON AND CARBONATE (%):

	4, 91
Carbonate	32

SITE 549 HOLE CORE 47 CORED INTERVAL 616.5–626.0 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous silty mudstone, dark gray (2.5YR 4/0) to lighter gray (2.5YR 5/0, 5Y 7/1), very firm to hard

Moderately to well mottled, most mottles horizontal, mm wide and up to cm long

Color banded in shades of gray, paler and darker bands less mottles than rest of core

Very top of core is light colored chalk

Scattered small nacrous shell fragments and fossil wood chips in core

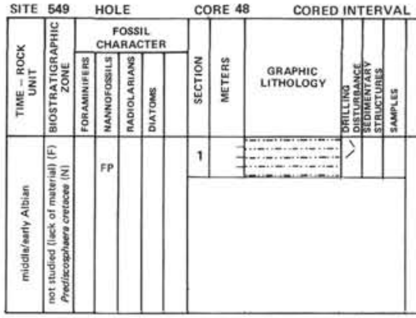
Scattered dark green fine lenses and flecks

L = lighter color
D = darker color

ORGANIC CARBON AND CARBONATE (%):

	1, 46	4, 72
Carbonate	32	40

SITE 549 HOLE CORE 48 CORED INTERVAL 626.0–635.5 m



LITHOLOGIC DESCRIPTION

Unit

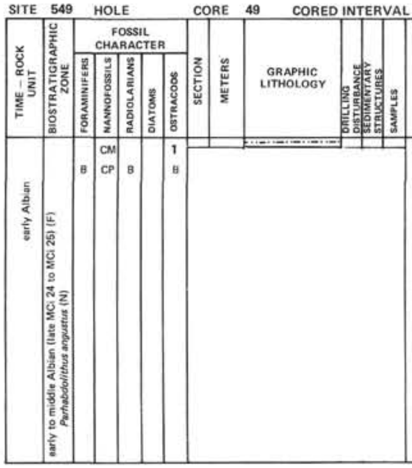
Calcareous silty mudstone, medium light gray (N5) to light gray (N6), very firm to hard, extensively mottled in darker grays

Slightly darker band from 23–25 cm

ORGANIC CARBON AND CARBONATE (%):

	1, 33
Carbonate	49

SITE 549 HOLE CORE 49 CORED INTERVAL 635.5–645.0 m



LITHOLOGIC DESCRIPTION

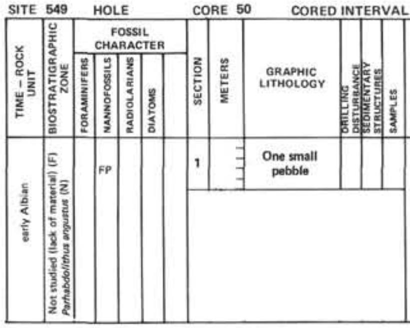
Unit

Calcareous mudstone, gray (N5–N6) laminated with laminae disturbed by burrowing, 7 cm core

ORGANIC CARBON AND CARBONATE (%):

	1, 33
Organic carbon	0.17
Carbonate	49

SITE 549 HOLE CORE 50 CORED INTERVAL 645.0–654.5 m



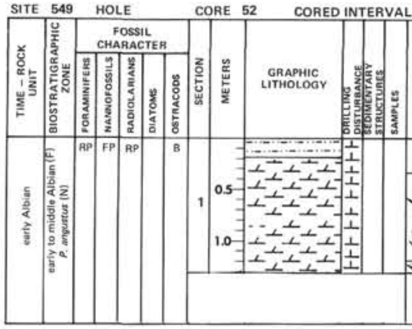
LITHOLOGIC DESCRIPTION

Unit

One small pebble of greenish gray (5GY 6/1) calcareous silty mudstone, contains one burrow filled with darker material

NOTE: Core 51: no recovery.

SITE 549 HOLE CORE 52 CORED INTERVAL 664.0–673.5 m



LITHOLOGIC DESCRIPTION

Coarser more orange

Dark streaks tabular mineral + quartz = 10% rock

More red

Dark lenses, quartz + dark mineral

Many sand sized dark minerals, much altered

Unit 1

Calcareous mudstone, gray (10YR 6/1), very firm, one large lens of darker material

Unit 2:

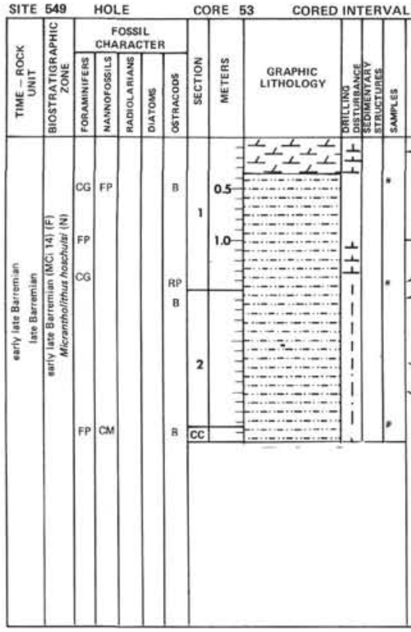
Coarse grained dolomitic siltstone, red (10YR 5/6), hard, scattered dark mineral and occasional dark cm size lens or streak

Quartz and calcite also present

Quartz filled voids occur infrequently

Several voids stained sulphur yellow

SITE 549 HOLE CORE 53 CORED INTERVAL 673.5–683.0 m



LITHOLOGIC DESCRIPTION

Geoids with quartz crystals

Increasing concentration of 7.5YR 7/8 mudstone

Sharp contact 10YR 6/2

5YR 6/3, sharp contact

7.5YR 5/2

Sharp contact 10YR 4/2

10YR 5/1, banded

Unit 1:

Coarse grained dolomitic siltstone, red (10YR 7/6), hard, scattered black flecks, dark mineral

Unit 2:

Calcareous mudstone, red (10R 5/6), soft to firm, homogeneous

Common quartz, coated by red material

Mixed downward with a yellow (10Y 6/2) calcareous mudstone

Unit 3:

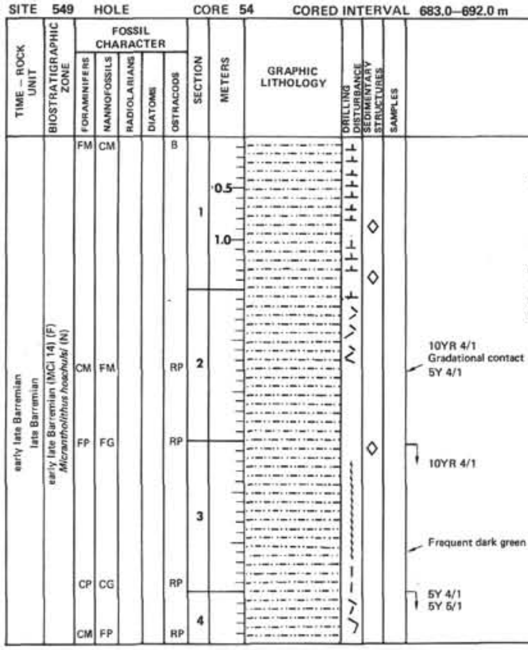
Calcareous mudstone, olive gray (10Y 6/2) to brown (7.5YR 5/2), soft to firm, homogeneous, abundant quartz and calcite or dolomite rhombs

Contains flecks of fossil wood

SMEAR SLIDE SUMMARY (%):

	1, 42	1, 142	2, 138
	D	D	D
Texture:			
Sand	5–10	10	15
Silt	40	40	35
Clay	50	50	50
Composition:			
Quartz	25–30	10	20
Clay	25	20	20
Glauconite	–	Tr	–
Carbonate unspec.	30	50	35
Calc. nannofossils	10	10	20
Fish remains	–	Tr	–
Chlorite	5–10	5	5

SITE 549 HOLE CORE 54 CORED INTERVAL 683.0–692.0 m



LITHOLOGIC DESCRIPTION

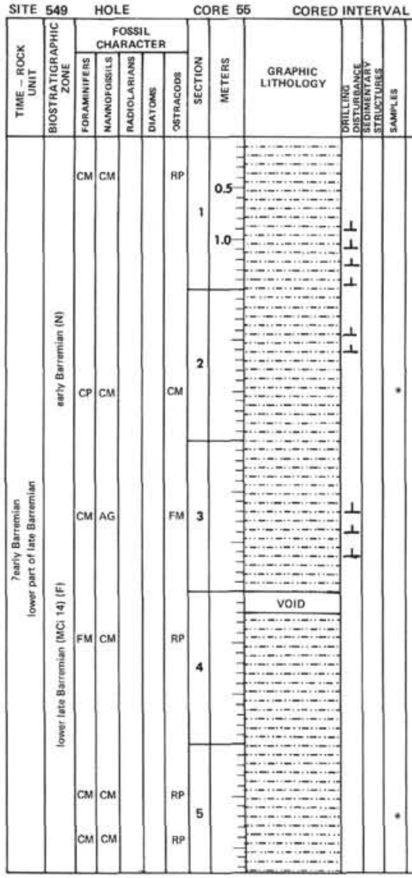
Unit

Calcareous mudstone, dark gray (10YR 4/1) to gray (5Y 5/1), firm to very firm, somewhat silty texture, homogeneous to very faintly mottled, scattered black flecks and some pieces of black fossil wood (<cm size)

ORGANIC CARBON AND CARBONATE (%):

	2, 91
Organic carbon	0.26
Carbonate	31

SITE 549 HOLE CORE 55 CORED INTERVAL 692.0–701.0 m



LITHOLOGIC DESCRIPTION

Weakly laminated, 5Y 5/1, bioturbated calcareous mudstone. Occasional plant debris, shell fragments (brachiopods and rare belemonites) throughout. Patches and spots rich in green colored mineral ('chlorite'?).

Bioturbation very intense at Section 4, 107–150 cm.

Strongly laminated band at Section 5, 88–100 cm.

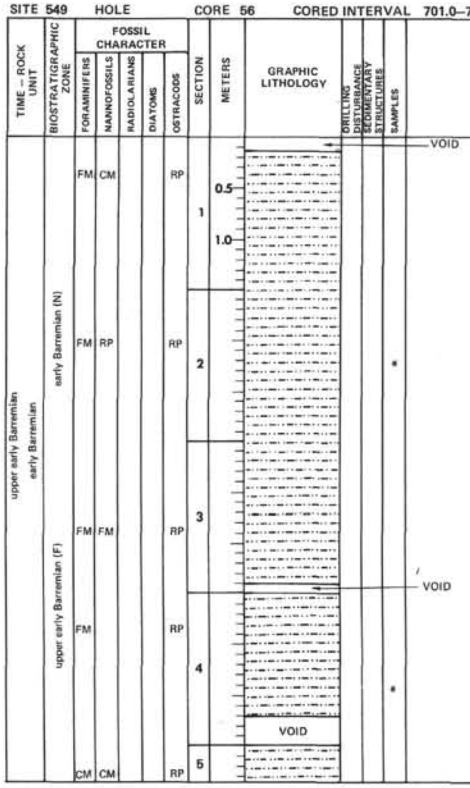
SMEAR SLIDE SUMMARY (%):

	2, 97 D	5, 70 D
Texture:		
Sand	10	10
Silt	40	40
Clay	50	50
Composition:		
Quartz	5	10
Feldspar	5	10
Clay	10	10
Carbonate unspec.	40	40
Calc. nannofossils	30	20

ORGANIC CARBON AND CARBONATE (%):

	2, 114
Organic carbon	0,21
Carbonate	52

SITE 549 HOLE CORE 56 CORED INTERVAL 701.0–710.0 m



LITHOLOGIC DESCRIPTION

Gray (5Y 5/1) weakly laminated, bioturbated, from calcareous mudstones.

Scattered organic (plant?) fragments throughout.

Occasional spots of a green (?diagenetic) mineral.

Section 1 has a noticably hard band of ?limestone greenish gray (5GY 7/1) at 104–105 cm.

Section 4 has a more strongly laminated band between 40–45 cm.

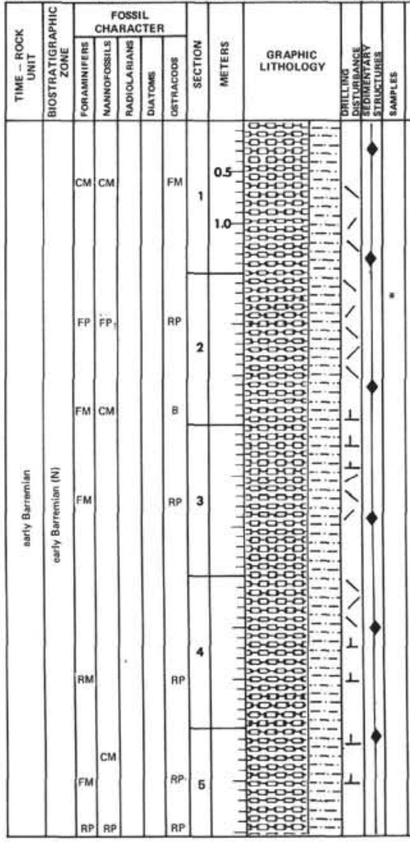
SMEAR SLIDE SUMMARY (%):

	2, 70	4, 96
	D	D
Composition:		
Quartz	15	35
Feldspar	5	Tr
Pyrite	25	20
Carbonate unspec.	50	30
Calc. nannofossils	–	5

ORGANIC CARBON AND CARBONATE (%):

	1, 44
Organic carbon	0.09
Carbonate	80

SITE 549 HOLE CORE 57 CORED INTERVAL 710.0–719.0 m



LITHOLOGIC DESCRIPTION

CALCAREOUS MUDSTONE, MARLY

Usually 5Y 5/1 in color; Section 2, 99–120 cm 5Y 6/1

Burrowed moderately to intensely

Many burrows lined with greenish gray sediment

Plant fragments: Section 1, 37 and 110–111 cm, and disseminated through Sections 1, 3, 4, and 5; Section 3, 90–150 cm; and Section 5, 69–74 cm

Shell fragments: Section 1, 104, 110, 138, and 144 cm (brachiopod); Section 2, 68 cm and Section 4, throughout

Core streaked with greenish gray chlorite, rich beds in Section 2, 76–77 cm; Section 3, 57 and 69–70 cm; and Section 4, 113 cm (in burrow)

Section 4, 129–150 cm and Section 5 laminated, occasionally disturbed by burrowing

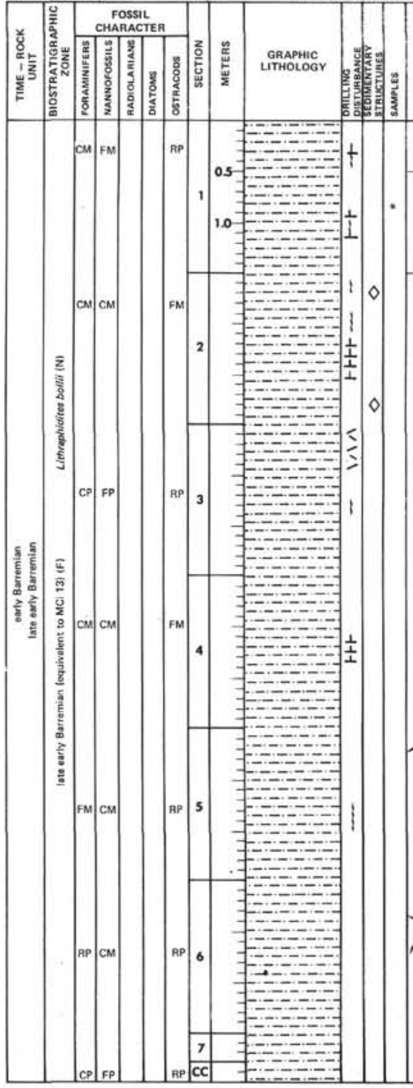
SMEAR SLIDE SUMMARY (%):

	2, 20
	D
Texture:	
Sand	20
Mud	80
Composition:	
Quartz	15
Mica	10
Clay	10
Pyrite	5
Carbonate unspec.	30
Calc. nannofossils	30
Plant debris	Tr
Dolomite	Tr

ORGANIC CARBON AND CARBONATE (%):

	2, 53
Organic carbon	0.42
Carbonate	16

SITE 549 HOLE CORE 58 CORED INTERVAL 719.0–728.0 m



LITHOLOGIC DESCRIPTION

Thin laminae scattered throughout Could be drilling disturbance

Brachiopod fragment

Dark green lens

Unit

Calcareous sandy mudstone, dark gray (5Y 4/1), soft to firm, homogeneous with occasional faint mottling

Scattered black flecks and fragments (<cm) of fossil wood

Occasional lighter (< cm) bands and lenses of dark green material

Rare shell fragments

Sediment has abundant quartz and noticable content of opaque and colored heavy minerals

Frequent well formed calcite or dolomite rhombs

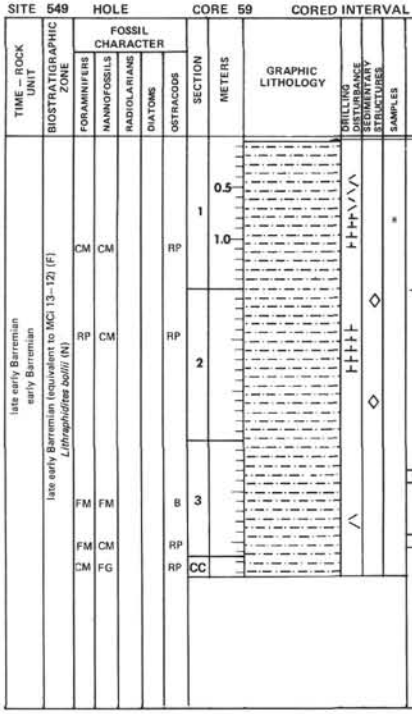
SMEAR SLIDE SUMMARY (%):

	1, 83
	D
Texture:	
Sand	25
Silt	35
Clay	40
Composition:	
Quartz	55
Feldspar	5
Heavy minerals	3
Clay	10
Carbonate unspec.	30
Calc. nannofossils	Tr
Chlorite	5

ORGANIC CARBON AND CARBONATE (%):

	2, 38
Organic carbon	0.40
Carbonate	24

SITE 549 HOLE CORE 59 CORED INTERVAL 728.0–737.0 m



LITHOLOGIC DESCRIPTION

VOID

Small shell

Faint laminae

Concentration of small fossil wood fragments

Unit

Calcareous sandy mudstone, dark gray (5Y 4/1), firm to very firm, homogeneous to faintly bioturbated

Scattered black flecks and small pieces of fossil wood

Occasional small shell

One belemnite

Rare small dark green streaks and lenses

Sediment contains abundant quartz and rhombs of calcite or dolomite

Noticable quantity of opaque and colored heavy minerals

Microcline present

Common fish vertebra

Scattered foraminifers

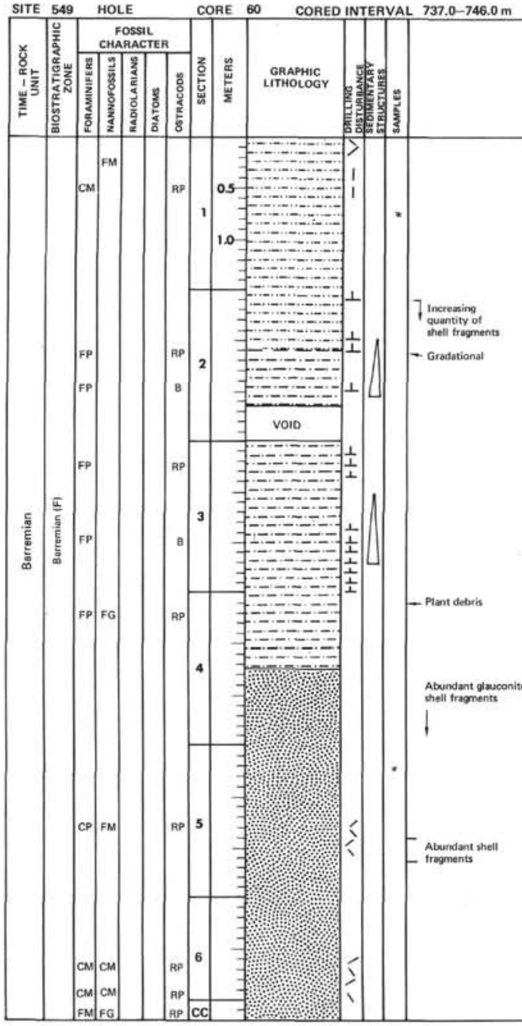
SMEAR SLIDE SUMMARY (%):

	1, 85
	D
Texture:	
Sand	30
Silt	30
Clay	40
Composition:	
Quartz	50
Feldspar	3
Clay	10
Glauconite	Tr
Carbonate unspec.	30
Foraminifers	Tr
Calc. nannofossils	Tr
Fish remains	Tr
Plant debris	Tr
Chlorite	5

ORGANIC CARBON AND CARBONATE (%):

	3, 52
Organic carbon	0.47
Carbonate	21

SITE 549 HOLE CORE 60 CORED INTERVAL 737.0–746.0 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous siltstone, gray (5Y 4/1), very firm, grading downward to a gray (5Y 5/1) fine to medium sandstone, very firm

Both sediment types have minor bioturbation but lack any real sedimentary structures

Both contain shell and fossil wood fragments

The sandstone is rich in glauconite

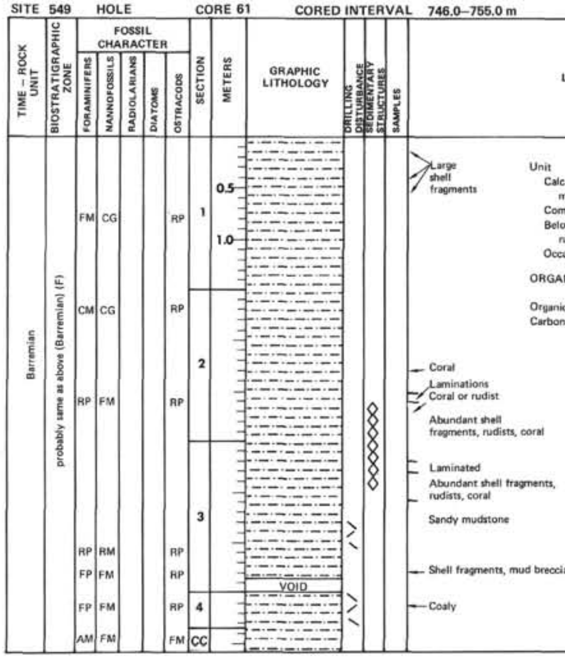
SMEAR SLIDE SUMMARY (%):

	1, 77	5, 28
	D	D
Texture:		
Sand	–	30
Silt	–	} 70
Clay	–	
Composition:		
Quartz	15	10
Heavy minerals	–	<5
Clay	–	10
Glauconite	10	10
Pyrite	Tr	<5
Carbonate unspec.	40	50
Calc. nannofossils	25	10

ORGANIC CARBON AND CARBONATE (%):

	5, 127
Organic carbon	0,27
Carbonate	52

SITE 549 HOLE CORE 61 CORED INTERVAL 746.0–755.0 m



LITHOLOGIC DESCRIPTION

Unit

Calcareous sandy mudstone, gray (5Y 5/1), firm to very firm, minor to extensive mottling in shades of gray

Common scattered shell debris and fossil wood

Below Section 2, 85 cm abundant large shell debris, corals, rudists, brachiopods and others

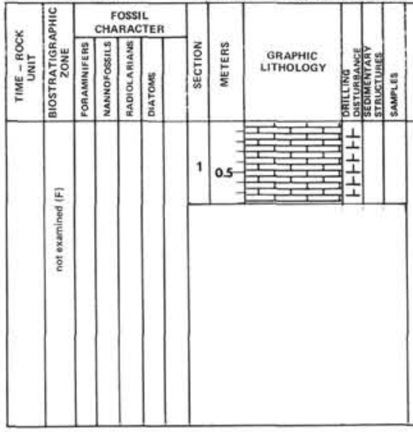
Occasional lamination as marked

ORGANIC CARBON AND CARBONATE (%):

	2, 107
Organic carbon	0.36
Carbonate	24

NOTE: Core 62-66: no recovery.

SITE 549 HOLE CORE 67 CORED INTERVAL 787.5–792.5 m



LITHOLOGIC DESCRIPTION

Unit

Grainstone, gray (7.5YR 6/0) hard, porous (up to several mm spaces), matrix of shell fragments, shells, subangular micritic particles and pelloids

Shell fragments of brachiopods, corals, rudists, sponges, echinoderms, gastropods

Grain size is generally several mm

Random orientation

At 14 and 76 cm pieces of limestone are composed of a finely laminated gray brown mudstone (algal?) truncated by grainstone

In several places colonial corals are growing on grainstone surfaces

Common trocholina forams

NOTE: Core 68: no recovery.

SITE 549 HOLE CORE 69 CORED INTERVAL 793.5–794.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION
	not examined (F)					1

LITHOLOGIC DESCRIPTION

Unit

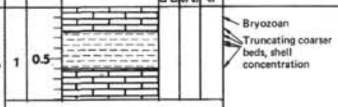
Three fragments, grainstone, gray (2.5Y 6/2), hard, in contact with a grayish brown (2.5Y 5/2) mudstone (algal?)

Grainstone is porous, shell supported matrix

Mudstone is homogeneous

SITE 549 HOLE CORE 70 CORED INTERVAL 794.5–797.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS	SECTION
middle Barremian	middle Barremian (F)	RP	RG			B	1
		RP	B			B	
		FP	RG			RP	



LITHOLOGIC DESCRIPTION

Unit

0–10 cm: intraclastic rudstone, dark gray (5Y 4/1–3/1), hard. Abundant micritic clasts, some coated by one or two layers of fine calcite. Some clasts are empty and filled by crystalline calcite or dolomite(?). Clasts are darker colored. Rock matrix is shell fragmental.

15–23 cm: bryozoan limestone, pale gray, hard, on one piece the surface is truncated by a grainstone.

23–60 cm: claystone, dark reddish brown (2.5YR 3/4), hard, laminated, and microfaulted, several erosion surfaces (lamina truncated) where coarser shell debris is found. Rich in quartz and contains little calcite.

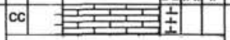
60–90 cm: grainstone, rudstone, light gray (5Y 7/1), hard, porous with matrix of shell fragments, common pelloids. One piece has a laminated pale brown gray mudstone (algal?) with grainstone above and below, one contact conformable and the other is erosive.

ORGANIC CARBON AND CARBONATE (%):

	1, 30	1, 75
Organic carbon	0.30	0.37

SITE 549 HOLE CORE 71 CORED INTERVAL 797.0–801.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION
	not examined (F)					CC



LITHOLOGIC DESCRIPTION

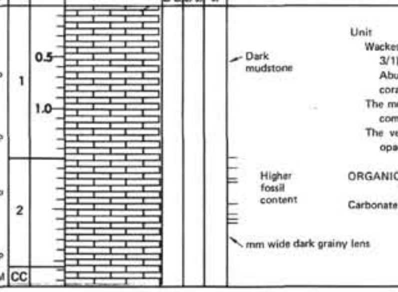
Unit

Grainstone and massive limestone fragments, yellowish gray (2.5Y 8/2), hard

Grainstone is composed of shell-fragment matrix, very porous, some voids have well formed crystals of dolomite/calcite in them

SITE 549 HOLE CORE 72 CORED INTERVAL 801.5–806.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS	SECTION
	early Barremian or earlier (F)	CG				RP	1
		FP				RP	
		AM				RP	2
		AM	RG			RP	
		AG	RG			RM	CC



LITHOLOGIC DESCRIPTION

Unit

Wackestone with some sections of packstone, dark gray (5Y 3/1), firm to hard, grains are macro- and microfossils. Abundant shell fragments along with entire fossils – corals, brachiopods, gastropods, and others.

The mud fraction is composed of abundant calcite fragments, common quartz, black opaque particles, and chlorite.

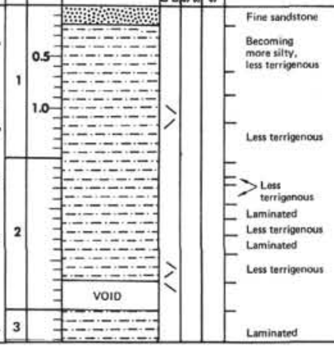
The very fine fraction contains calcite grains, quartz, black opaque grains, and an occasional nannofossil.

ORGANIC CARBON AND CARBONATE (%):

	1, 94
Carbonate	16

SITE 549 HOLE CORE 73 CORED INTERVAL 806.5–811.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	OSTRACODS	SECTION
	early Barremian or earlier (F)	AG	RG			RP	1
		AM	RG			B	
		RP	RG			RP	
		FP				RP	2
		RP				RP	
		RP	B			RP	3



LITHOLOGIC DESCRIPTION

Unit

Calcareous sandy mudstone, gray to olive gray (5Y 5/1–4/1), very firm to hard

Most of the sand sized material is shell fragments

Some faint burrows

As marked, the unit alternates between darker firm bands and lighter, more calcareous, hard bands

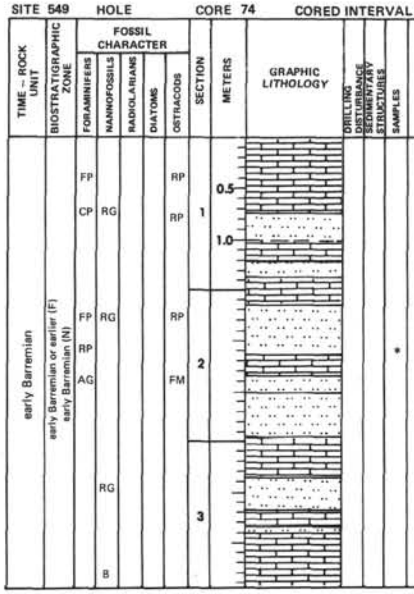
The lighter bands contain abundant fine to very fine (algal?) carbonate.

Darker bands appear more terrigenous and can be finely laminated

ORGANIC CARBON AND CARBONATE (%):

	1, 51
Organic carbon	0.47
Carbonate	25

SITE 549 HOLE CORE 74 CORED INTERVAL 811.0–816.0 m



LITHOLOGIC DESCRIPTION

Alternating hard, bluish gray (5B 5/1) marly limestone and dark gray (5Y 4/1) slightly calcareous siltstone.

Section 2, 86–101 cm has extensive recrystalized calcite veining.

Shell fragments abundant throughout, but more so in hard limestones.

Occasional wood fragments throughout.

Hard layers probably equally calcite cement. Soft layers largely uncemented.

SMEAR SLIDE SUMMARY (%):

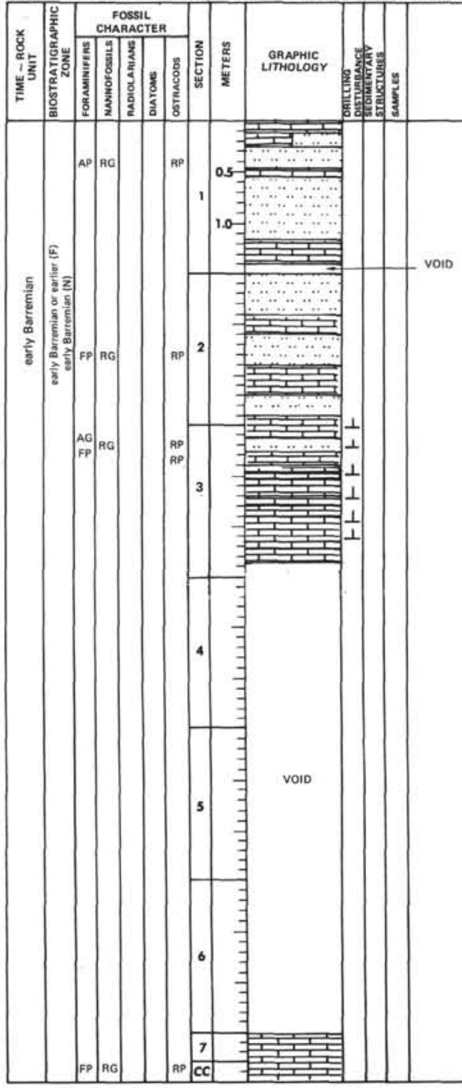
	2, 62 D
Texture:	
Sand	20
Silt	50
Clay	30
Composition:	
Quartz	80
Clay	Tr
Pyrite	Tr
Carbonate unspec.	10
Calc. nannofossils	Tr

Note: smear slide from softer layer.

ORGANIC CARBON AND CARBONATE (%):

	2, 24
Organic carbon	0.47
Carbonate	8

SITE 549 HOLE CORE 75 CORED INTERVAL 816.0–825.0 m



LITHOLOGIC DESCRIPTION

Alternation of hard gray (5Y 5/1) marly bioclastic limestone to dark gray (5Y 4/1) calcareous siltstone, which contains abundant small bioclastic fragments.

Hardness probably reflects degree of carbonate cementation.

Section 3, 25–97 cm: interbedded oolitic bioclastic limestones and calcite siltstones containing limited amounts of bioclasts.

Section 3, 97 cm–Section 7, 25 cm: coarse grained bioclastic limestone.

Section 7, 25 cm through Core-Catcher: dark brown (7.5YR 4/4–3/2) laminated silty mudstone.

SMEAR SLIDE SUMMARY (%):

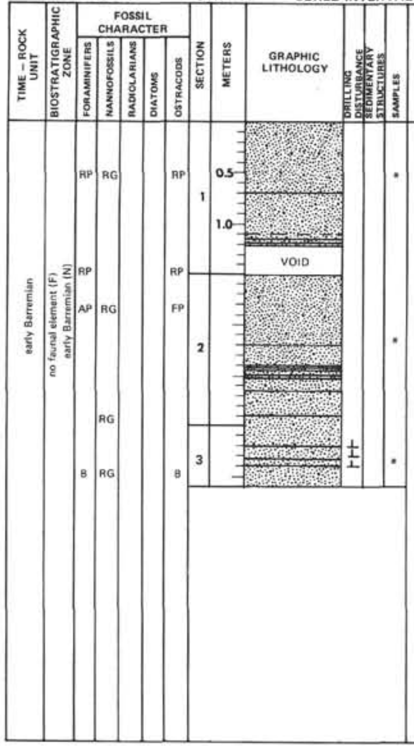
	1, 90 D	3, 63 D	CC D
Texture:			
Sand	10	10	–
Silt	70	40	40
Clay	20	50	60
Composition:			
Quartz	65	50	65
Clay	Tr	Tr	25
Pyrite	–	Tr	–
Carbonate unspec.	30	40	Tr
Calc. nannofossils	–	Tr	–

Note: smear slides sampled from siltstones only, limestones too hard.

ORGANIC CARBON AND CARBONATE (%):

	2, 81	3, 15
Organic carbon	0.35	0.16
Carbonate	33	4

SITE 549 HOLE CORE 76 CORED INTERVAL 825.0–834.0 m



LITHOLOGIC DESCRIPTION

Section 1, 0–70 cm: dark gray (5Y 4/2), firm, calcareous siltstone.

Section 1, 70–120 cm: dark gray to gray (5Y 4/1–5/1), calcareous siltstone grading downward to bioclastic limestone. Some with laminations at base of unit.

Section 2, 0–70 cm: gray (5Y 4/1) calcareous siltstone.

Section 2, 70–90 cm: silty bioclastic limestone, 5Y 5/1; laminated at base.

Calcite vein at Section 2, 98–99 cm.

Section 2, 100–112 cm: 5Y 4/1 calcareous siltstone.

At Section 2, 112–137 cm: 5Y 5/1 very coarse bioclastic limestone.

Section 2, 137 cm–Section 3, 20 cm: 5Y 4/1 calcareous siltstone.

Section 3, 20–30 cm: sandy siltstone.

Section 3, 30–40 cm: silty bioclastic limestone, wackestone.

Section 3, 40–60 cm: olive gray (5Y 5/2), silty calcareous sandstone, hard.

Thin section in Section 3: mollusc shells micritized, some forams, 10% quartz, 40% unspecified carbonate, 5% hematite, 40% dolomite cement, traces of gypsum and glauconite.

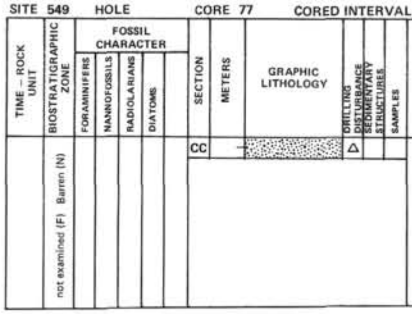
SMEAR SLIDE SUMMARY (%):

	1, 52	2, 65	3, 36
	D	D	D
Composition:			
Quartz	60	50	30
Feldspar	–	–	Tr
Heavy minerals	Tr	–	–
Clay	–	–	10
Carbonate unspec.	30	45	50
Calc. nannofossils	Tr	Tr	–

ORGANIC CARBON AND CARBONATE (%):

	2, 51
Organic carbon	0.80
Carbonate	9

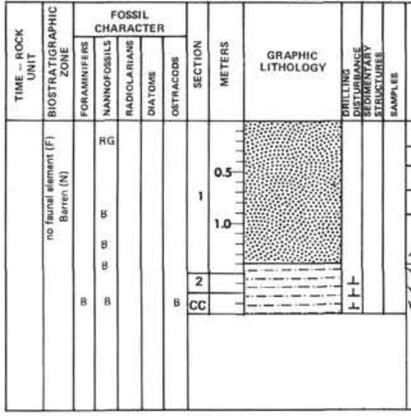
SITE 549 HOLE CORE 77 CORED INTERVAL 834.0–843.0 m



LITHOLOGIC DESCRIPTION

Core-Catcher only: highly fragmented by drilling, largest fragment ~5 cm diameter, 5Y 4/1 sandy, shelly, calcareous siltstone.

SITE 549 HOLE CORE 78 CORED INTERVAL 843.0–852.0 m



Darker

Lighter

Darker

Lighter

5Y 4/2

Large shell fragments, gastropods, worm tubes

Contact sharp

5Y 3/2

Faint lamination, color grading to 10YR 4/2

Belemnites?

LITHOLOGIC DESCRIPTION

Unit 1

Fine calcareous sandstone, gray (5Y 4/2), hard, banded in shades of gray. Darker are somewhat coarser and more terrigenous, lighter are more calcareous. Color contacts are rapidly gradational, lighter bands very occasionally mottled. Scattered concentrations of shell fragments. Composed dominantly of calcite/dolomite and quartz grains, common feldspars and chlorite, and noticeable quantity of heavy minerals.

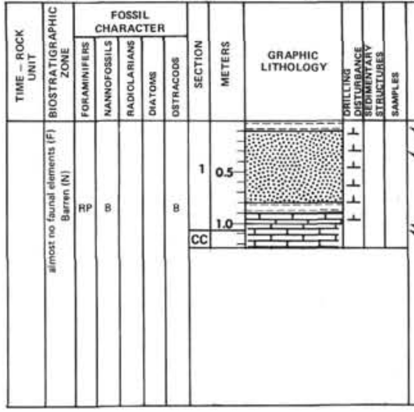
Unit 2

Homogeneous silty mudstone, dark gray (5Y 3/2), soft, scattered black flecks, and moderately calcareous.

ORGANIC CARBON AND CARBONATE (%):

	1, 30
Organic carbon	0.07
Carbonate	34

SITE 549 HOLE CORE 79 CORED INTERVAL 852.0–861.0 m



Black, non-calcareous

Erosive contact shell concentration

Slightly calcaerous contacts lost by drilling

Pelloidal floatstone

Pelloidal grainstone

Hard, rich in shell fragments

LITHOLOGIC DESCRIPTION

Unit

Medium sandstone, light gray (5Y 6/1), hard, calcareous, rich in <2 mm size shell fragments. Shell oreintation is subhorizontal. Abundant colored minerals.

Above and below the sandstone are gray to black mudstones poor in calcite

At the base of the core a fractured pelloidal floatstone (particles 1–2 mm size) with matrix of fine sandstone as described above

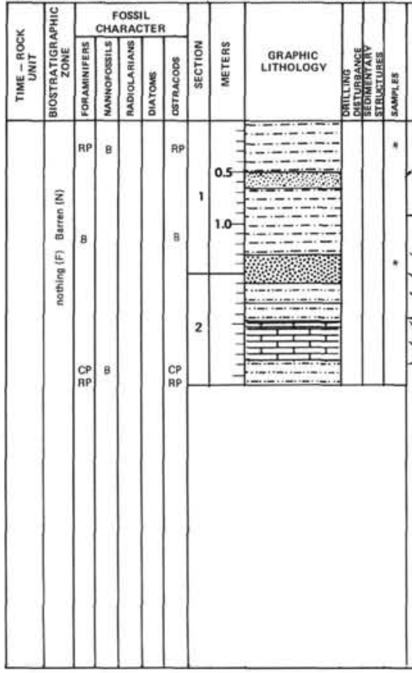
Below the floatstone is a pelloidal grainstone, massive, well sorted with abundant shell fragments, very gray olive (5Y 5/2)

Most contacts are obscured by drilling

ORGANIC CARBON AND CARBONATE (%):

	1, 7	1, 79
Carbonate	0	4

SITE 549 HOLE CORE 80 CORED INTERVAL 861.0–870.0 m



LITHOLOGIC DESCRIPTION

Rich in randomly orientated shell fragments
Contorted bedding, abundant wood fragments
Contact sharp, coarse grained above
Light and dark green dolomitic
Pyrite crystals
Abundant shell fragments
Fine grained
More terrigenous, contorted bedding
Scattered shell fragments

Unit

Alternation of:

1 – homogeneous sandy mudstone, dark olive gray (5Y 3/1), firm; with

2 – dark gray (5Y 4/1) clayey mudstone, soft to firm (with little calcite and moderate to very abundant fossil carbonaceous wood) and with

3 – fine grained, ?terrigenous limestone, hard, grayish brown (2.5Y 5/2) to greenish gray (5GY 5/1).

Contorted bedding observed as marked – slumping?

Bedding marked by color of units above and below deformation

Sandy fractions contain heavy minerals

Scattered black flecks in sandy mudstones

Sandstone at base of section contains common grains of dolomite

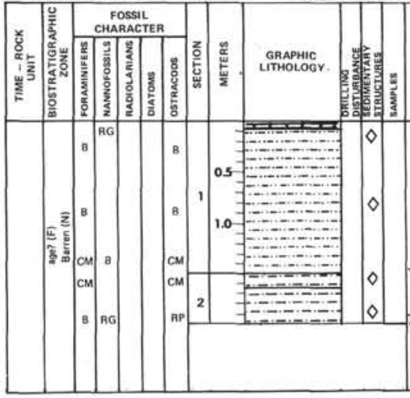
SMEAR SLIDE SUMMARY (%):

	1, 27	1, 140
	D	D
Texture:		
Sand	50	50
Silt	30	30
Clay	20	20
Composition:		
Quartz	50	40
Feldspar	Tr	1–5
Heavy minerals	Tr–5	1–5
Clay	20	10
Dolomite	–	20
Carbonate unspec.	20	1–10
Chlorite	1–5	10–15

ORGANIC CARBON AND CARBONATE (%):

	1, 80	2, 26
Carbonate	6	31

SITE 549 HOLE CORE 81 CORED INTERVAL 870.0–874.5 m



LITHOLOGIC DESCRIPTION

7.5YR 4/0 gradational to mm calcareous downwards 5YR 3/4
Calcareous shell fragments
Rich in shell fragments, calcite cement
Non-calcareous mudstone mixed with bed above

Unit 1

Silty mudstone, dark gray (7.5YR 4/0), very firm, calcareous near top only, mottled in places, color grading downward to dark reddish brown (5YR 3/4) in noncalcareous section

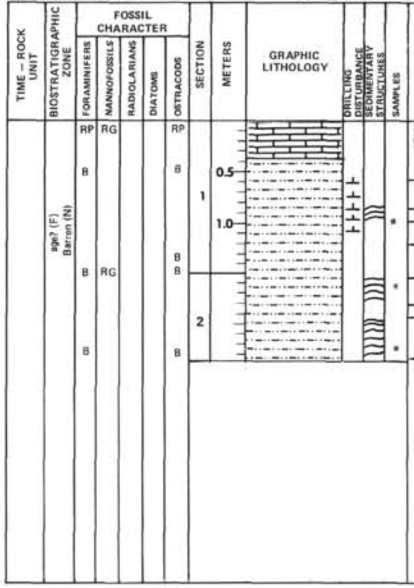
Unit 2

Calcareous sandy siltstone, olive (5Y 4/3), firm to hard, abundant to common shell fragments, parts are more grayish and harder containing more fine calcareous material

ORGANIC CARBON AND CARBONATE (%):

	1, 56	2, 47
Organic carbon	–	0.36
Carbonate	0	0

SITE 549 HOLE CORE 82 CORED INTERVAL 874.5–879.0 m



LITHOLOGIC DESCRIPTION

Sandier
Green
Alternations of red and green
Laminated
Bioturbation
Laminated ↓Gray
Homogeneous
Laminated abundant wood
Large pyrite crystal

Unit 1

Homogeneous sandy limestone, gray (5Y 4/1) becomes sandier towards base

Unit 2

Mudstone to claystone, green (5G 6/1) to reddish brown (7YR 6/6–6/1) to gray (5Y 5/2–5/1 and 10YR 3/1), often finely laminated and with abundant wood fragments (carbonized) in the lower part of the core. Dominant constituents are quartz and clay minerals.

Many of the quartz grain are iron stained

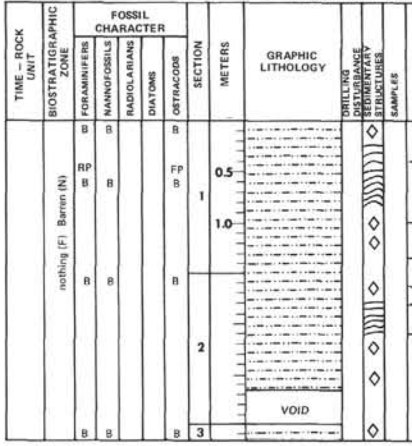
SMEAR SLIDE SUMMARY (%):

	1, 105	2, 16	2, 80
	D	D	D
Texture:			
Sand	10	10	20
Silt	40	10	30
Clay	50	80	50
Composition:			
Quartz	70	20	60
Feldspar	–	–	Tr
Heavy minerals	–	–	Tr
Clay	30	75	35

ORGANIC CARBON AND CARBONATE (%):

	1, 28	1, 126	2, 11	2, 71
Organic carbon	0.26	0.08	–	0.91
Carbonate	19	2	0	1

SITE 549 HOLE CORE 83 CORED INTERVAL 879.0–884.0 m



LITHOLOGIC DESCRIPTION

Blue gray mottled with brown gray
Lamina pink and brown
Laminae of red, brown, blue, and gray
Blue gray, mottled
Yellow gray
Yellow gray mottles
Red brown mottles
Brown and gray lamina
Olive brown mottling

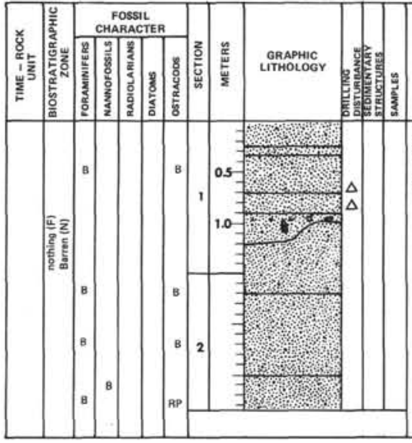
Unit

Mudstone, blue gray (5B 7/1), firm, laminated or mottled with mudstones of various colors: brown gray (5YR 4/1), orange pink (10R 7/4), yellow brown (10YR 5/4), gray-red (10R 4/2), and olive gray (5Y 4/1).

ORGANIC CARBON AND CARBONATE (%):

	2, 73
Carbonate	0

SITE 549 HOLE CORE 84 CORED INTERVAL 884.0–888.0 m



LITHOLOGIC DESCRIPTION

10YR 3/3 homogeneous

2.5Y 4/4

2.5 4/3 and 5G 5/1 mottled together

Section 1 0–70 cm: siltstone.

Section 1, 70–120 cm: large slump block, sediment is graded from coarse at right of core to fine at left; contains large gastropod layer along length of core. Large fragments up to 1 cm in diameter.

Section 1, 100 cm: large organic fragment at left of core.

Section 1, 120–Section 2, 20 cm: very dark gray (2.5Y N3), weakly laminated sandy siltstone, with large black sediment clasts near base (Section 2, 10–20 cm).

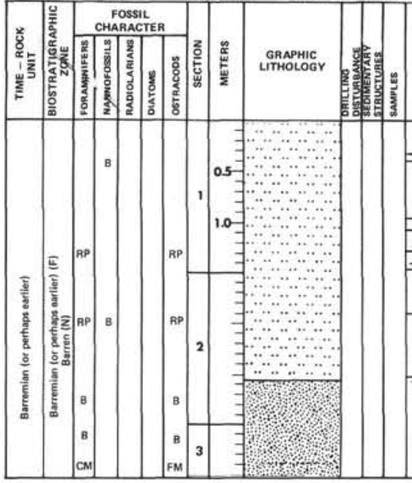
Section 2, 70–100 cm: olive (10Y 4/3) to greenish gray (5GY 5/1) mottled sandy siltstone.

Section 2, 100–130 cm: olive (5Y 4/2) from homogeneous sandy siltstone.

ORGANIC CARBON AND CARBONATE (%):

	1, 3	1, 130	2, 29	2, 97
Organic carbon	0.19	1.52	0.31	–
Carbonate	0	2	0	0

SITE 549 HOLE CORE 85 CORED INTERVAL 888.0–897.0 m



LITHOLOGIC DESCRIPTION

Coral, large shell fragment

Color darkening

Dark with black mottles

Pyrite and wood fragments

Large shell fragments

5Y 2/1
Black abundant shell fragment + wood

Large pyrite
5Y 3/1
Abundant small black crystals

Hard, shelly

Large wood and shell fragments

Unit 1

Calcareous siltstone, olive gray (5Y 5/2–3/2), firm, moderate to abundant larger shell fragments and carbonized wood fragments.

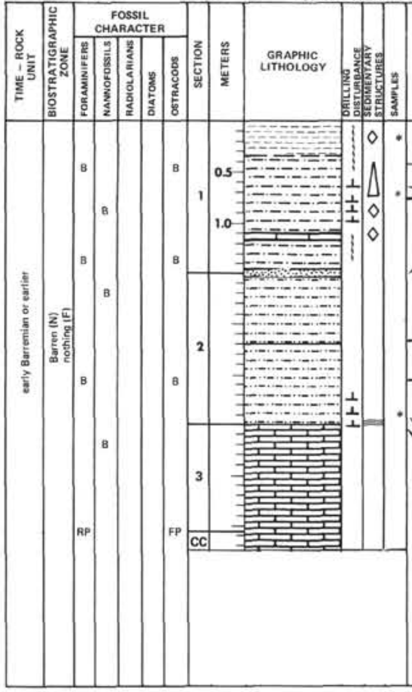
Unit 2:

Sandy siltstone, dark gray (5Y 4/1–3/1), firm, in places abundant small (0.2 mm) black crystals and shell and wood fragments.

ORGANIC CARBON AND CARBONATE (%):

	1, 69	1, 100	2, 38	2, 40
Organic carbon	0.38	1.62	3.01	–
Carbonate	26	1	4	14

SITE 549 HOLE CORE 86 CORED INTERVAL 897.0–906.0 m



LITHOLOGIC DESCRIPTION

Mottles olive gray and green gray

Becomes more calcareous

Quartz grains have Fe-oxide coat

Hard, calcareous olive mottling

Erosive contact, mud clasts

Non-calcareous

Calcareous, large shell fragments

Non-calcareous

Non-calcareous matrix, large shell fragments and fossil wood

Black laminae

Large wood fragments + pyrite

Unit 1

Claystone, greenish gray (5GY 6/1), firm to plastic, noncalcareous, some fine laminations

Mineralogy dominated by quartz

Unit 2

Sandy to silty mudstone, gray (5Y 4/0–5/1–3/1), firm to hard, calcareous in hard sections, matrix non-calcareous in silter sections, abundant to moderate quantities of shell fragments and carbonized wood fragments

Most contacts are lost due to drilling, occasional burrowing

Mineralogy dominated by quartz

Becomes limestone at Section 3, massive and very shelly

Heavy minerals of various sorts are present in all sections; dolomite is present as sand; chlorites are present and well formed

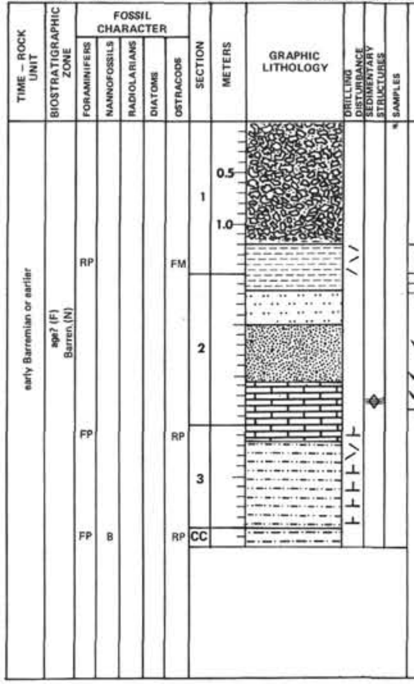
SMEAR SLIDE SUMMARY (%):

	1, 12	1, 75	2, 144
	D	D	D
Texture:			
Sand	10	40	70
Silt	40	30	20
Clay	50	30	10
Composition:			
Quartz	70	60	60
Feldspar	5	5	1–5
Mica	Tr	Tr	Tr
Heavy minerals	Tr	Tr	Tr
Clay	0–15	20	10
Carbonate unspec.	–	5	1–5
Chlorite	5–10	10	10

ORGANIC CARBON AND CARBONATE (%):

	1, 120	2, 118
Organic carbon	0.22	0.81
Carbonate	0	4

SITE 549 HOLE CORE 87 CORED INTERVAL 906.0–910.5 m



LITHOLOGIC DESCRIPTION

Sandier
Non-calcareous
Abundant shell fragments
Shell fragments not abundant but is calcareous
Shell fragments, pelloids
Boundary very irregular
Deformed lenses + stringers of sand
Less silty

Unit 1:

Claystone to mudstone and siltstone, dark olive gray to gray (5Y 3/2–5/1 and 2.5YR 4/0), firm, variable carbonate content, most horizons contain shell fragments and small black flecks of organic matter

All unit is rich in terrigenous *material*, quartz is dominant, heavy minerals are common, these include opaques and possibly pyroxene and tourmaline

Sediments generally show little coherent structure, nearly all boundaries are sharp, but a number are artificial due to drilling

Unit 2

Shelly limestone, dark gray (5Y 5/1) hard, variable amounts of sand and silt, shells as fragments

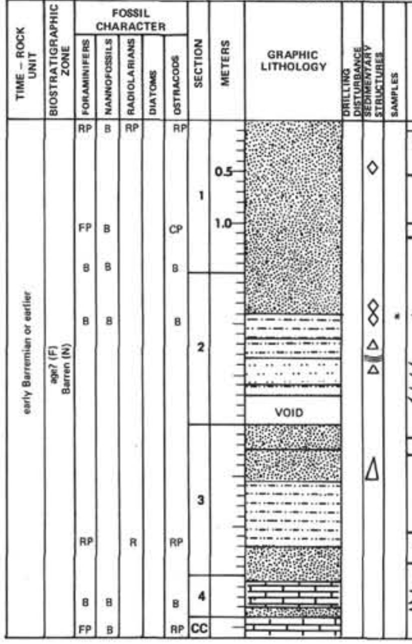
SMEAR SLIDE SUMMARY (%):

	1, 3
	D
Texture:	
Sand	20
Silt	50
Clay	30
Composition:	
Quartz	60
Feldspar	Tr
Mica	Tr
Heavy minerals	10
Clay	10
unspec.	10–20

ORGANIC CARBON AND CARBONATE (%):

	1, 137	2, 82	3, 19
Organic carbon	2.75	0.41	0.41
Carbonate	2	43	35

SITE 549 HOLE CORE 88 CORED INTERVAL 910.5–919.5 m



LITHOLOGIC DESCRIPTION

Shell fragments increasing
2.5Y 3/2
5Y 4/1 abundant shell fragments
Abundant clay clasts
5G 6/1 homogeneous non-calcareous
Contact sharp irregular non-calcareous
10YR 4/2 laminated base
Dark gray mudstone
Greenish siltstone
Calcareous clay clasts
Dark gray Calcareous
Non-calcareous, brown
5G 6/2 slightly calcareous
Olive brown stain, plant material
Dark gray, homogeneous
Non-calcareous
Bioclastic silty mudstone, calcareous
Black pyritic non-calcareous

Unit 1:

Sandy siltstone, siltstone or mudstone, dark grayish brown (2.5Y 3/2) to gray (5Y 4/1) to greenish gray (5G 6/1), firm, slightly to moderately calcareous, several horizons of abundant shell fragments, occasional burrow mottling, boundaries sharp

Quartz is the dominant mineral, often iron stained

Glauconite is present

Unit 2:

Calcareous siltstones or bioclastic limestones, dark gray (2.5Y 5/1), hard, moderate to abundant calcite in matrix, large shell fragments

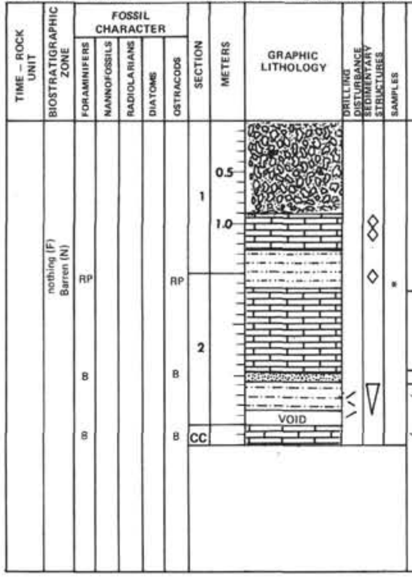
SMEAR SLIDE SUMMARY (%):

	2, 45
	D
Texture:	
Sand	20
Silt	60
Clay	20
Composition:	
Quartz	85
Clay	5
Glauconite	5

ORGANIC CARBON AND CARBONATE (%):

	1, 44	2, 63	3, 28	3, 121
Organic carbon	0.26	–	–	–
Carbonate	62	2	0	0

SITE 549 HOLE CORE 89 CORED INTERVAL 919.5–928.5 m



LITHOLOGIC DESCRIPTION

Non-calcareous
Weakly laminated abundant small shell fragments, calcite veining
Black, clay clasts
Non-calcareous 5GY 5/1, 10YR 3/3 at base
Intensely mix of olive and gray

Unit 1:

Silty and sandy bioclastic limestone, dark gray to very dark gray (5Y 4/1–3/1), hard, abundant small shell fragments bioturbated or faintly laminated occasional gastropod shell

Unit 2:

Sandy silt and mudstone, olive (5Y 4/3) to greenish gray (5GY 6/1–5/1), firm, little carbonate, occasionally mottled, quartz is the dominant component, wood fragments present

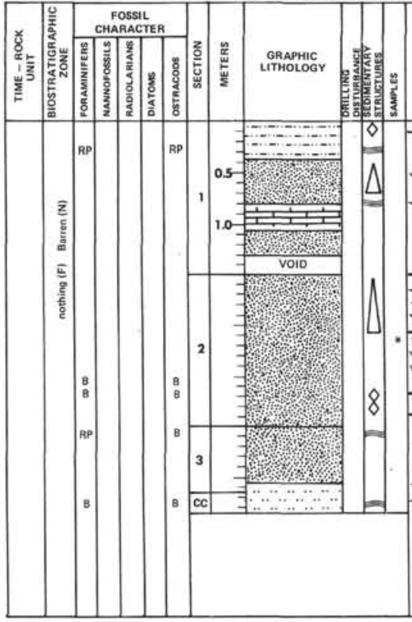
SMEAR SLIDE SUMMARY (%):

	2, 10
	D
Texture:	
Sand	20
Silt	60
Clay	20
Composition:	
Quartz	70
Clay	20
Pyrite	Tr
Carbonate unspec.	Tr
Plant debris	Tr

ORGANIC CARBON AND CARBONATE (%):

	1, 95	2, 38	CC
Carbonate	63	62	29

SITE 549 HOLE CORE 90 CORED INTERVAL 928.5–937.5 m



LITHOLOGIC DESCRIPTION

2.5Y 6/2 calcareous
2.5Y 4/2 little calcareous
Many dark gray burrows
Erosive contact 5Y 3/2
Non-calcareous abundant plant fragments
5GY 5/1
Calcareous
Abundant shell fragments
Bioturbated
5Y 4/1
Slightly calcareous
Non-calcareous concretions
Banded in shades of gray, plant fragments
Greenish gray
Dark gray, non-calcareous
Abundant shell fragments
Calcareous
Organic rich layer

Unit 1:

Mudstone to sandy siltstone, light brown gray (2.5Y 6/2) to olive gray (5Y 5/2) or greenish gray, firm

Variable, but generally low carbonate content

Variable quantity of shell fragments, most of these present in the upper part of Section 2

Wood fragments common to abundant

Bioturbation present in variable degrees, some lamination occurs as marked

Tops of sandy siltstones are graded

Unit 2:

Sandy or silty shelly limestone, dark olive gray (5Y 3/2), hard, may be weakly laminated, contains plant fragments

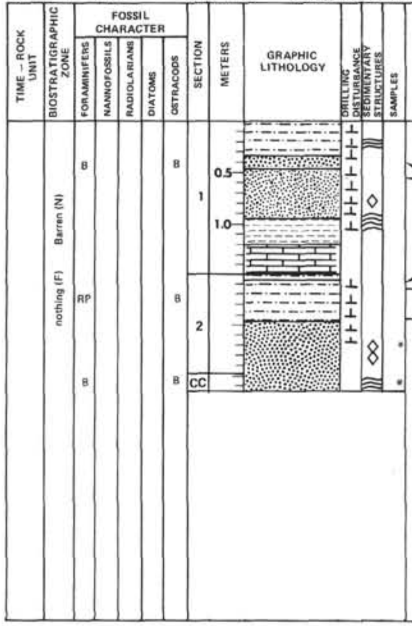
SMEAR SLIDE SUMMARY (%):

	2, 65
	D
Sand	15
Silt	45
Clay	40
Composition:	
Quartz	35
Heavy minerals	15
Clay	30
Carbonate unspec.	5
Coalified wood	15

ORGANIC CARBON AND CARBONATE (%):

	1, 113	3, 19
Carbonate	0	1

SITE 549 HOLE CORE 91 CORED INTERVAL 937.5–946.5 m



LITHOLOGIC DESCRIPTION

Abundant wood fragments, dark gray, non-calcareous

Non-calcareous

Plant fragments slightly calcareous

Dark brown, calcareous, hard 5Y 4/1 shelly

Calcareous

Non-calcareous, coarse sand, poorly sorted, wood fragments

Sharp contact

5G 6/1

Abundant plant material as olive brown stain, non-calcareous

Dark gray, concretions, fossil wood

Unit 1:

Claystone to sandstone, dark gray (10YR 4/1) to greenish gray (5G 6/1), firm, variable but generally low carbonate content, often

Abundant carbonized wood fragments

Top of Section 2 contains a poorly sorted mudstone with coarse quartz and rock fragments

May be mottled and often shows some lamination

Contacts generally sharp but many are formed by drilling

Quartz is dominant mineral and heavy minerals are present, possibly including tourmaline and staurolite

Unit 2:

Shelly limestone, dark gray (5Y 4/1), hard with abundant shell fragments, contact to terrigenous sediments is obscured by drilling

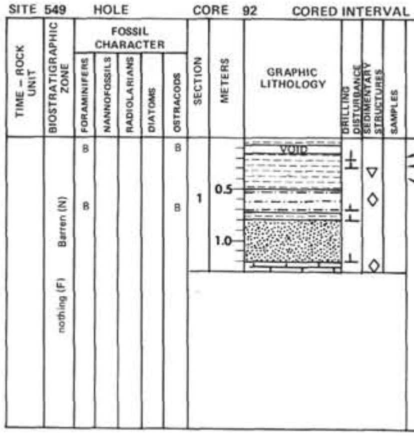
SMEAR SLIDE SUMMARY (%):

	2, 70	CC
	D	D
Texture:		
Sand	85	20
Silt	10	40
Clay	5	40
Composition:		
Quartz	85	60
Feldspar	5–10	–
Heavy minerals	Tr	5
Clay	5	30

ORGANIC CARBON AND CARBONATE (%):

	1, 6	2, 70
Carbonate	1	1

SITE 549 HOLE CORE 92 CORED INTERVAL 946.5–955.5 m



LITHOLOGIC DESCRIPTION

Gritty mm size clay clasts

Reddish fine claystone

Sharp grain size contact, mottled

2.5YR 2/0 carbonaceous wood fragments of all sizes, mud clasts (pyritized)

Unit 1:

Claystone to sandy siltstone, gray (10YR 5/1) to dark gray (2.5YR 2/0), firm, non-calcareous, variable but generally abundant wood fragments (carbonized)

Contacts are generally sharp and particle alignment subhorizontal to horizontal

Sandy siltstone around 100 cm contains non-calcareous nodules

Unit 2:

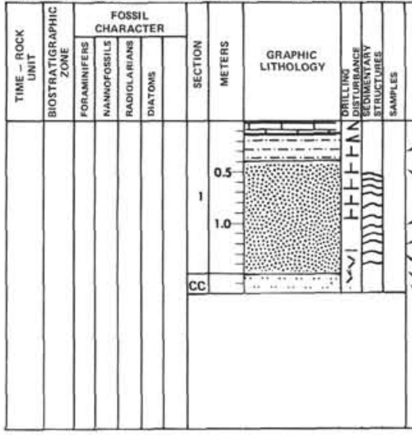
Shelly limestone, olive gray (5Y 5/2), hard, shell fragments are small (mm)

Mottles outlined in fine dark lines

ORGANIC CARBON AND CARBONATE (%):

	1, 85	1, 104
Carbonate	0	0

SITE 549 HOLE CORE 93 CORED INTERVAL 955.5–964.5 m



LITHOLOGIC DESCRIPTION

10YR 7/2

Jumble of pale limestone & dark carbonaceous rock

Abundant shell fragments including echinoderm

cm size pale clay clast

Shell concretion, rock is porous, shell dissolution

Non-calcareous nodule

Shell concretion, rock porous

Gray, hard, plant debris

Unit 1:

Massive limestone, pale brownish gray (10YR 7/2), fine grained, well sorted, very hard, signs of faint lamina and very small burrows

Unit 2:

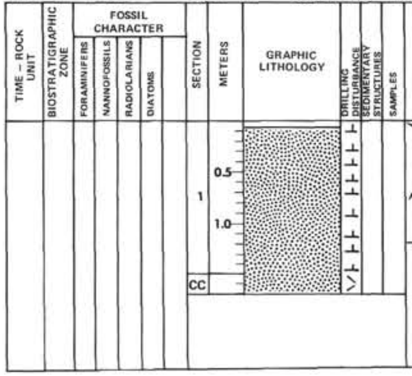
Sandy mudstone to sandstone, dark gray (5Y 5/1), firm, top of unit, near 40 cm, is lighter color and somewhat calcareous, rest is noncalcareous

Contains scattered fossil wood debris outlining fine distorted laminae, a few clay clasts and large burrows, several sections where shells are concentrated and seem dissolved out of rock

ORGANIC CARBON AND CARBONATE (%):

	1, 83	CC, 16
Carbonate	2	1

SITE 549 HOLE CORE 94 CORED INTERVAL 9645.–973.5 m



LITHOLOGIC DESCRIPTION

Pale gray to dark gray quartzite

cm size claystone clast

Rubble, 1 piece slickensided

Unit 1:

Top of Section 1, quartzite, pale gray to dark gray (2.5Y 6/2, 4/0), fine grained, hard, contact to Unit 2 is absent

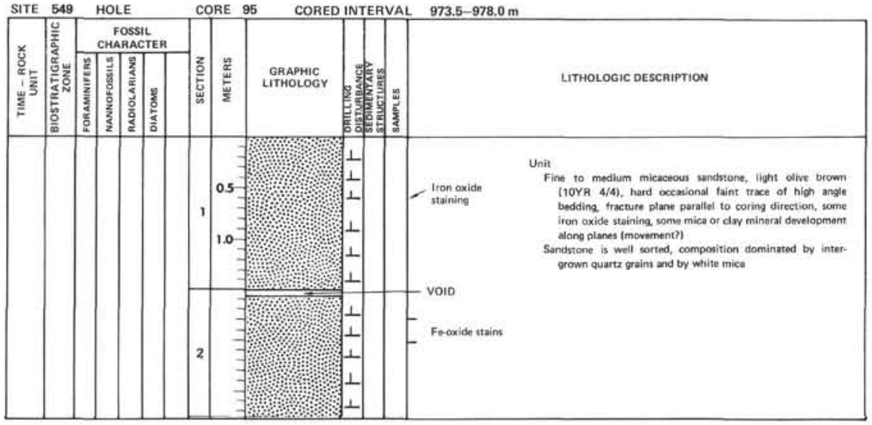
Unit 2:

Micaceous fine to medium sandstone, light olive brown (2.5Y 5/4), hard, shows some high angle bedding and a fracture surface running parallel to coring direction, generally homogeneous, quartz and mica are dominant components, mica is somewhat altered, sericitized, quartz crystals intergrown some

ORGANIC CARBON AND CARBONATE (%):

	1, 141
Carbonate	4

SITE 549 HOLE CORE 95 CORED INTERVAL 973.5–978.0 m



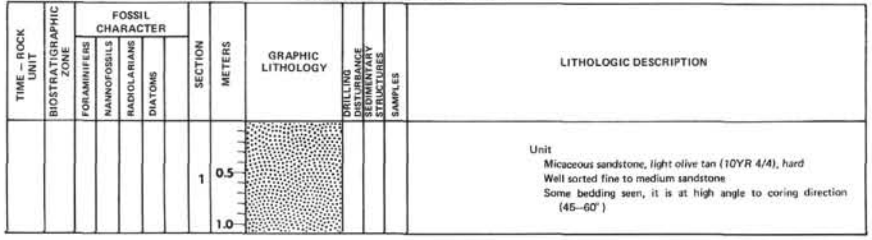
LITHOLOGIC DESCRIPTION

Unit

Fine to medium micaceous sandstone, light olive brown (10YR 4/4), hard occasional faint trace of high angle bedding, fracture plane parallel to coring direction, some iron oxide staining, some mica or clay mineral development along planes (movement?)

Sandstone is well sorted, composition dominated by intergrown quartz grains and by white mica

SITE 549 HOLE CORE 96 CORED INTERVAL 978.0–982.5 m



LITHOLOGIC DESCRIPTION

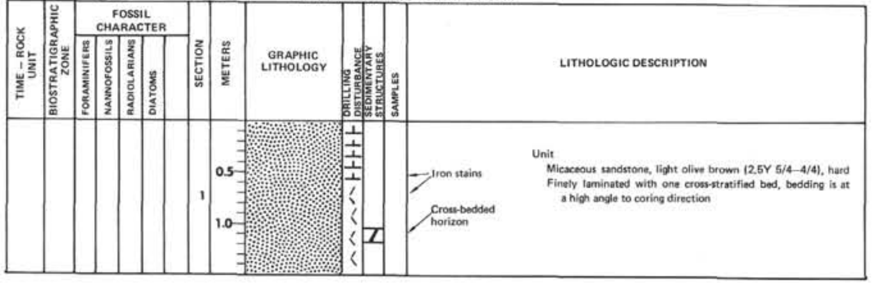
Unit

Micaceous sandstone, *light olive tan (10YR 4/4), hard*

Well sorted fine to medium sandstone

Some bedding seen, it is at high angle to coring direction (45–60°)

SITE 549 HOLE CORE 97 CORED INTERVAL 982.5–991.5 m



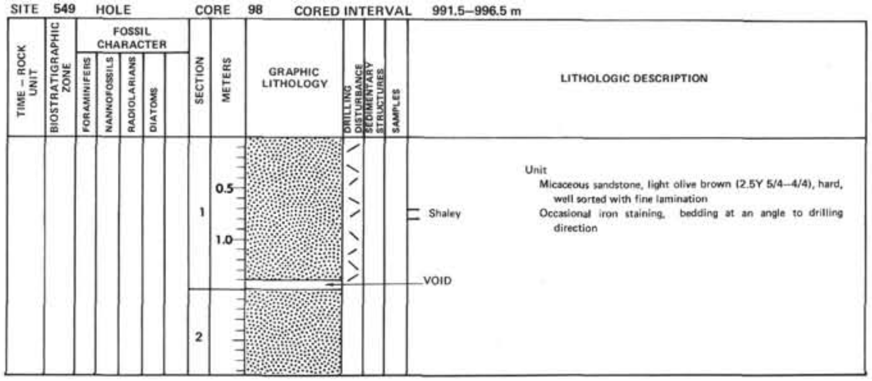
LITHOLOGIC DESCRIPTION

Unit

Micaceous sandstone, light olive brown (2.5Y 5/4–4/4), hard

Finely laminated with one cross-stratified bed, bedding is at a high angle to coring direction

SITE 549 HOLE CORE 98 CORED INTERVAL 991.5–996.5 m



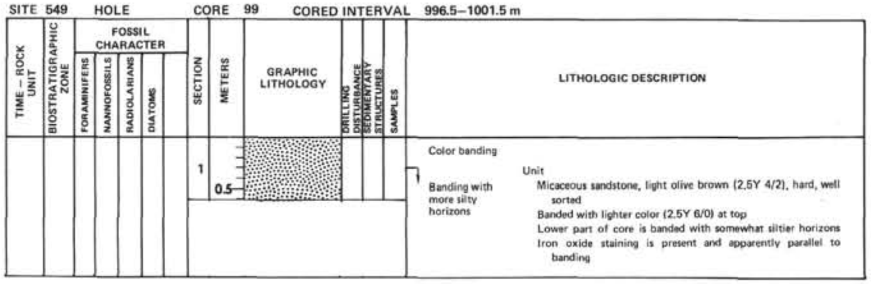
LITHOLOGIC DESCRIPTION

Unit

Micaceous sandstone, light olive brown (2.5Y 5/4–4/4), hard, well sorted with fine lamination

Occasional iron staining, bedding at an angle to drilling direction

SITE 549 HOLE CORE 99 CORED INTERVAL 996.5–1001.5 m



LITHOLOGIC DESCRIPTION

Unit

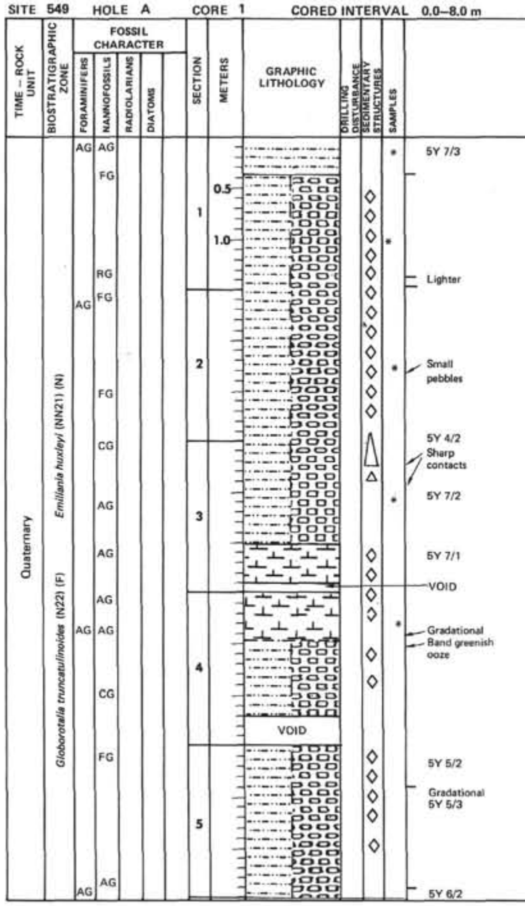
Micaceous sandstone, light olive brown (2.5Y 4/2), hard, well sorted

Banded with lighter color (2.5Y 6/0) at top

Lower part of core is banded with somewhat siltier horizons

Iron oxide staining is present and apparently parallel to banding

SITE 549 HOLE A CORE 1 CORED INTERVAL 0.0–8.0 m



LITHOLOGIC DESCRIPTION

Unit

Marly calcareous ooze to nannofossil ooze, pale yellow (5Y 7/3) at top, olive gray (5Y 5/2) to light gray (5Y 7/1), soft

Generally homogneous with scattered diffuse thin blackish bands and occasional small pebble

Two graded units with erosive bottom contacts, ooze becomes sandier (biogenic particles) at base of each unit

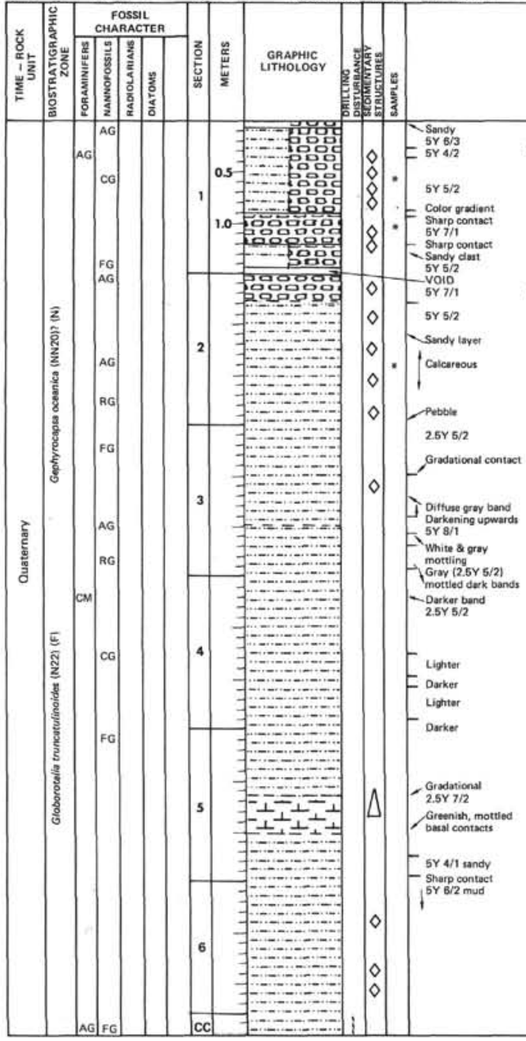
SMEAR SLIDE SUMMARY (%):

	1, 14	1, 106	2, 80	3, 58	4, 32
	D	D	D	D	D
Texture:					
Sand	–	–	–	–	15
Silt	–	–	–	–	85
Clay	–	–	–	–	
Composition:					
Quartz	–	5	25	20	5
Mica	5	–	–	–	5
Clay	40	40	20	20	–
Carbonate unspec.	15	30	30	25	–
Foraminifers	10	–	–	–	5
Calc. nannofossils	30	20	10	20	>70
Diatoms	–	–	–	–	Tr
Radiolarians	Tr	–	–	5	–
Sponge spicules	Tr	–	–	–	–

ORGANIC CARBON AND CARBONATE (%):

	1, 11	2, 30	4, 35
Organic carbon	0.17	0.26	0.11
Carbonate	65	26	70

SITE 549 HOLE A CORE 2 CORED INTERVAL 8.0–17.5 m



LITHOLOGIC DESCRIPTION

Unit 1

Marly calcareous ooze to calcareous mud, olive gray (5Y 5/2 to reddish gray (2.5Y 5/2), soft

Homogeneous to somewhat bioturbated, contacts mottled to sharp

Occasional small pebbles

Scattered small black flecks

Occasional larger (1–2 mm) size shell fragments (pteropods, forams)

Unit 2

Calcareous ooze to nannofossil ooze, light gray (5Y 7/1), soft, generally richer in nannofossils then Unit 1, homogeneous less quartz than Unit 1, somewhat less clay

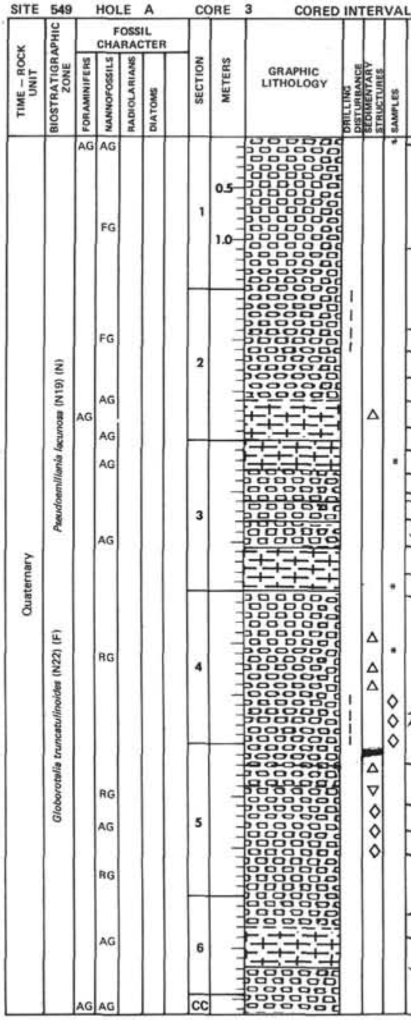
SMEAR SLIDE SUMMARY (%):

	1, 55	1, 101	2, 92
	D	D	D
Texture:			
Sand	10	10	10
Silt	40	30	40
Clay	50	60	50
Composition:			
Quartz	25	–	40
Feldspar	Tr	5	Tr
Mica and chlorite	1–5	–	10
Clay	40	35	30
Carbonate unspec.	5–10	25	20
Foraminifers	Tr	10	1–5
Calc. nannofossils	20	25	1–5
Opaques	1–5	–	–

ORGANIC CARBON AND CARBONATE (%):

	2, 15	4, 15
Organic carbon	0.13	0.30
Carbonate	66	16

SITE 549 HOLE A CORE 3 CORED INTERVAL 17.5–27.0 m



5Y 6/1
5Y 4/2
Gradational contact
2.5Y 5/2
N3 mottles
2.5Y 6/2
Alternation light gray and brown gray
5Y 8/1
N8
5GY 8/1 sandy
Gradational contact
Sandy
Gradational contact
Mixed olive & green gray
Sharp
Diffuse, sandier green and gray
Sharp base, brown and green
Gray and green mottles
Pale green gray
Sandy
5Y 6/1
Silty
5Y 3/1
2.5Y 7/0 band
2.5Y 6/2
2.5Y 5/2
2.5Y 6/1
5Y 5/2
Sharp
5Y 7/1
Sharp
10YR 8/1
Sharp
10YR 6/1
2.5Y 5/2
Grittier
Sandy
Gradational contact
2.5Y 8/0
Sandy
Clay, olive gray
Gritty
5GY 6/1 clay

LITHOLOGIC DESCRIPTION

Unit

Marly calcareous ooze with some horizons of nannofossil ooze or foram-nannofossil ooze, olive gray (5Y 4/2) to whitish gray (N3) or pale green gray (5GY 8/1), soft

Considerable variation in sand and terrigenous component amount

Sand may be either as quartz or as foraminifera

Contacts between coarser and finer beds may be either sharp or gradational

Mottling is present but not dominant

Occasional scattered flecks of black material-pyrite?

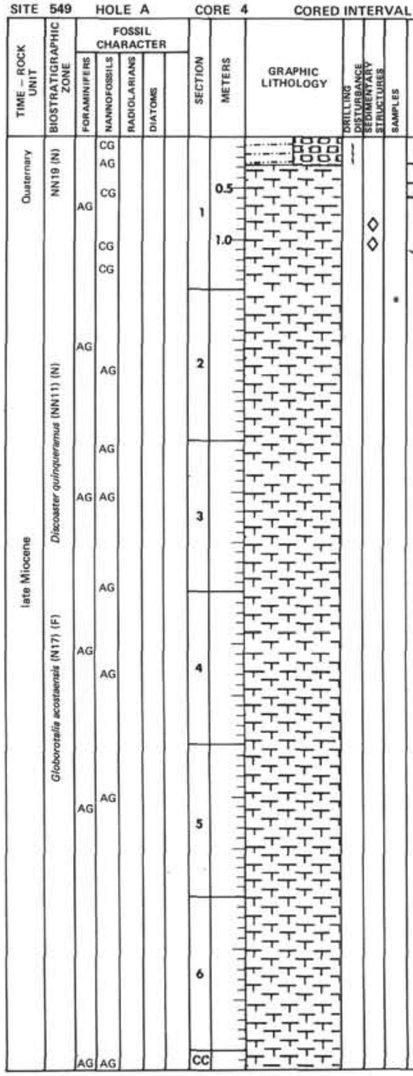
SMEAR SLIDE SUMMARY (%):

	1, 8	3, 25	3, 148	4, 54
	D	D	D	D
Texture:				
Sand	15	10	40	10
Silt	30	20	20	15
Clay	55	70	40	75
Composition:				
Quartz	25	3	20	5
Mica	Tr	–	–	Tr
Heavy minerals	3	–	–	Tr
Clay	25	20	10	< 5
Carbonate unspec.	17	23	10	40
Foraminifers	–	5	30	15
Calc. nannofossils	30	50	30	35

ORGANIC CARBON AND CARBONATE (%):

	2, 43
Carbonate	5

SITE 549 HOLE A CORE 4 CORED INTERVAL 27.0–36.5 m



5Y 5/1
5GY 8/1
Diffuse contact
5GY 7/1
Sharp contact
5GY 8/1
Somewhat darker band
5B 9/1

LITHOLOGIC DESCRIPTION

Unit 1

Marly olive gray nannofossil ooze, probably material fallen into the hole from above

Unit 2

Foraminiferal-nannofossil ooze, light greenish gray (5GY 8/1), reaching light bluish gray (5B 9/1) in the Core-Catcher

Soft, nearly homogeneous except for diffuse horizontal to sub-horizontal purplish thin laminae that cross the core occasionally (6 to 20 cm intervals roughly), also occasional burrows filled by grittier material (burrows mm in size)

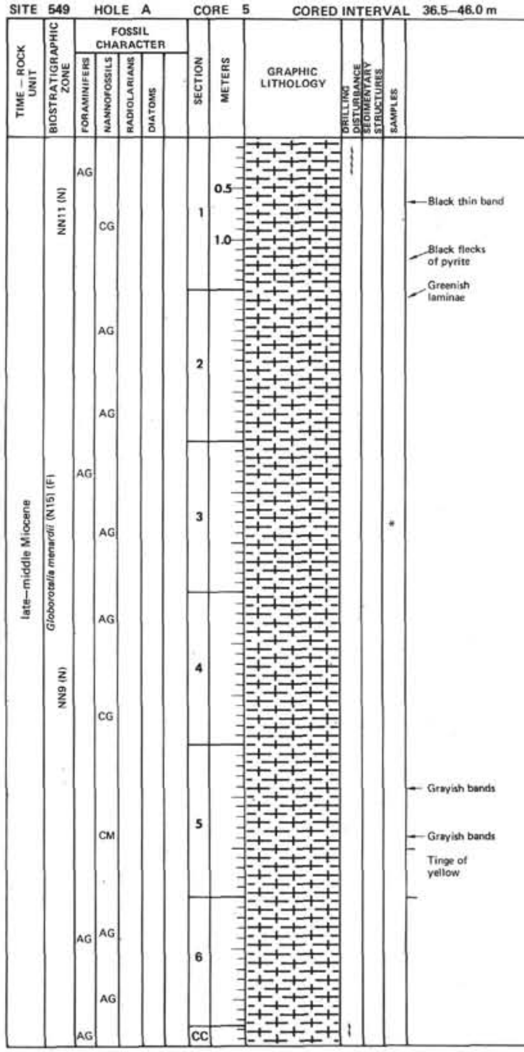
SMEAR SLIDE SUMMARY (%):

	2, 10
	D
Texture:	
Sand	20
Silt	10
Clay	70
Composition:	
Quartz	5
Feldspar	Tr–5
Clay	10
Foraminifers	20
Calc. nannofossils	65
Sponge spicules	Tr

ORGANIC CARBON AND CARBONATE (%):

	1, 15	5, 15
Organic carbon	0.33	0.07
Carbonate	47	86

SITE 549 HOLE A CORE 5 CORED INTERVAL 36.5–46.0 m



LITHOLOGIC DESCRIPTION

Unit

Foraminiferal-nannofossil ooze, light green (5G 7/1)

Firm

Homogeneous except for irregular purplish laminae (2–4 mm wide) with diffuse boundaries, that occur 5 to 20 cm apart in the core

Occasional black flecks of pyrite

Section 2 has a long crack running down the center and parallel to the core

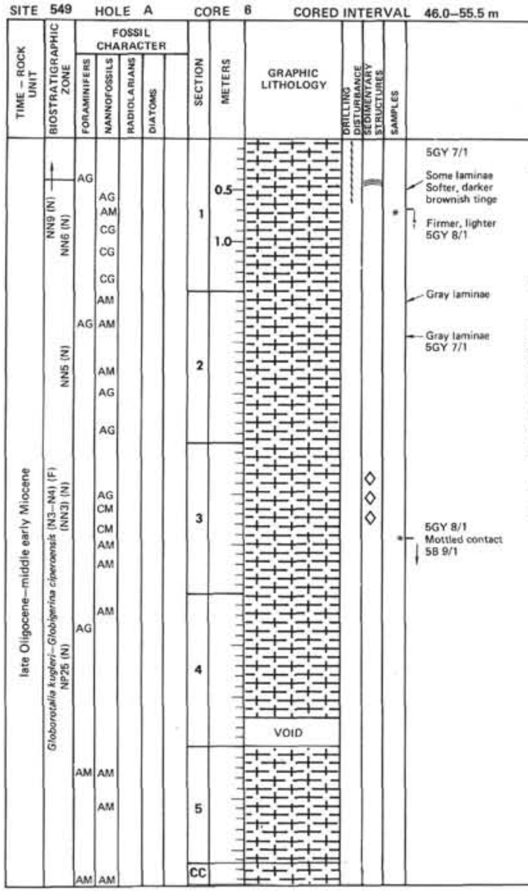
SMEAR SLIDE SUMMARY (%):

	3, 81
	D
Texture:	
Sand	15
Silt	25
Clay	60
Composition:	
Feldspar	2
Clay	15
Carbonate unspec.	18
Foraminifers	15
Calc. nannofossils	45
Sponge spicules	5

ORGANIC CARBON AND CARBONATE (%):

	2, 15	4, 15
Organic carbon	0.06	0.07
Carbonate	86	85

SITE 549 HOLE A CORE 6 CORED INTERVAL 46.0–55.5 m



LITHOLOGIC DESCRIPTION

Unit

Nannofossil ooze, light greenish gray (5GY 8/1) above Section 3 and bluish white (5B 9/1) below

Firm and nearly homogeneous

Color contacts are sharp

Terrigenous component of these sediments is small

Foraminiferal content variable

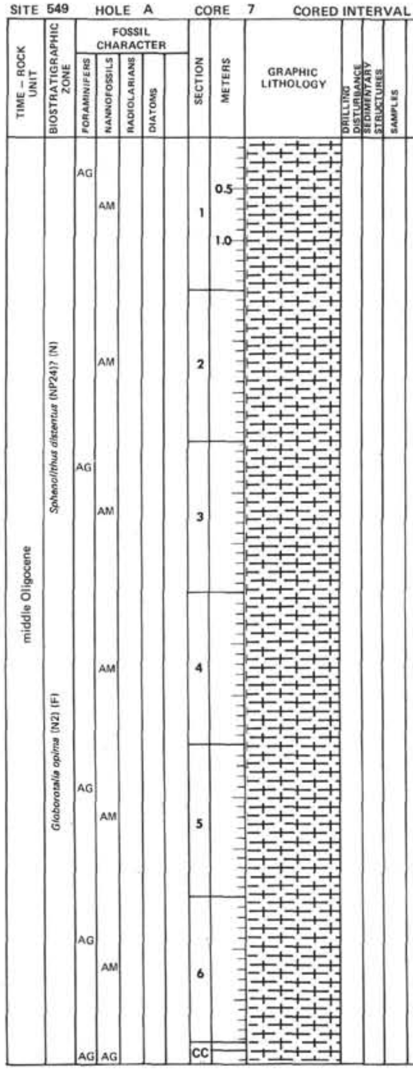
SMEAR SLIDE SUMMARY (%):

	1, 67	3, 94
	D	D
Texture:		
Sand	1	1–5
Silt	3	–
Clay	96	–
Composition:		
Mica + chlorite	Tr	Tr
Clay	1–5	10
Carbonate unspec.	5	10
Foraminifers	1–5	Tr
Calc. nannofossils	87	70

ORGANIC CARBON AND CARBONATE (%):

	1, 125
Carbonate	93

SITE 549 HOLE A CORE 7 CORED INTERVAL 55.5–65.0 m



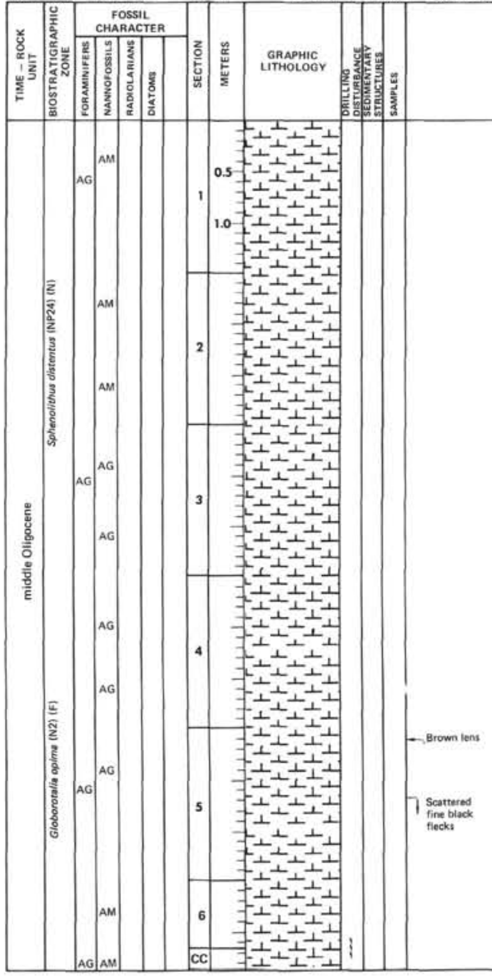
LITHOLOGIC DESCRIPTION

Unit
Foraminiferal-nannofossil chalk, bluish white (5B 9/1), firm, homogeneous

ORGANIC CARBON AND CARBONATE (%):

	4, 9
Carbonate	91

SITE 549 HOLE A CORE 8 CORED INTERVAL 65.0–74.5 m



LITHOLOGIC DESCRIPTION

Unit
Nannofossil ooze, light greenish gray (5G 8/1), soft to firm
Foraminiferal content variable
Homogeneous except towards base of core where fine black flecks (pyrite?) begin to appear

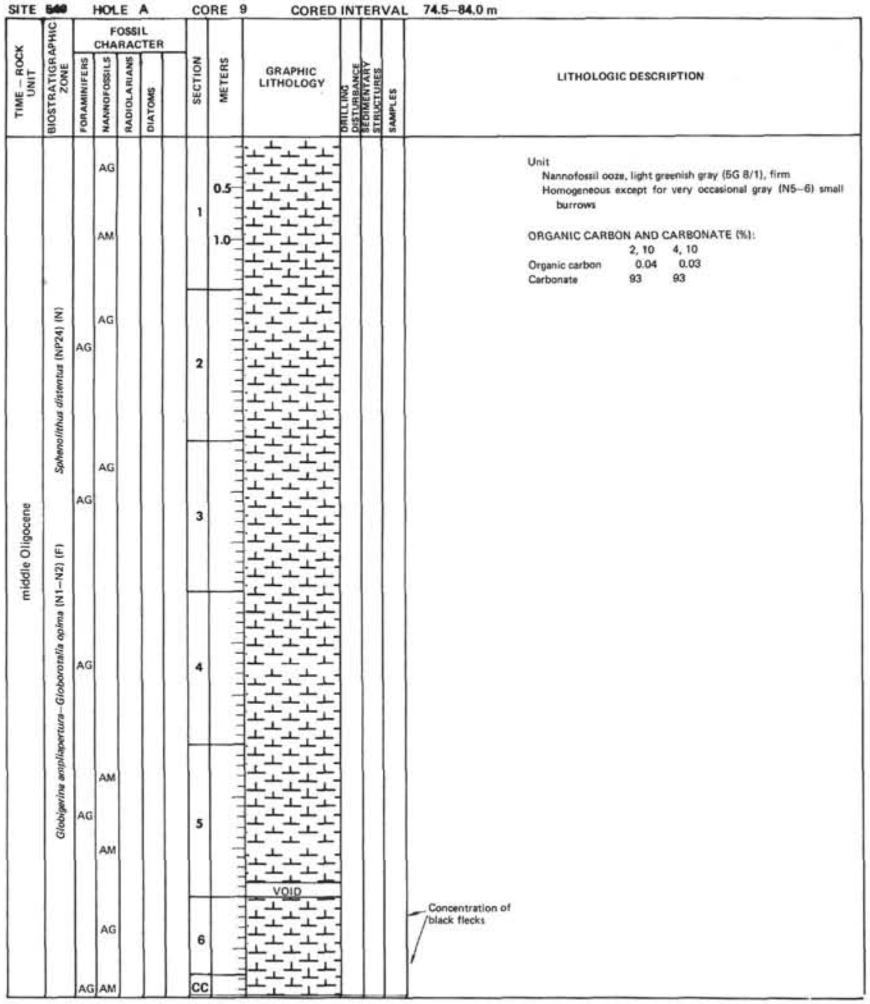
SMEAR SLIDE SUMMARY (%):

	1, 80
	D
Texture:	
Sand	2
Silt	18
Clay	80
Composition:	
Clay	5
Carbonate unspec.	3
Foraminifers	2
Calc. nannofossils	90

ORGANIC CARBON AND CARBONATE (%):

	2, 21	6, 10
Organic carbon	0.04	0.04
Carbonate	93	90

SITE 549 HOLE A CORE 9 CORED INTERVAL 74.5–84.0 m

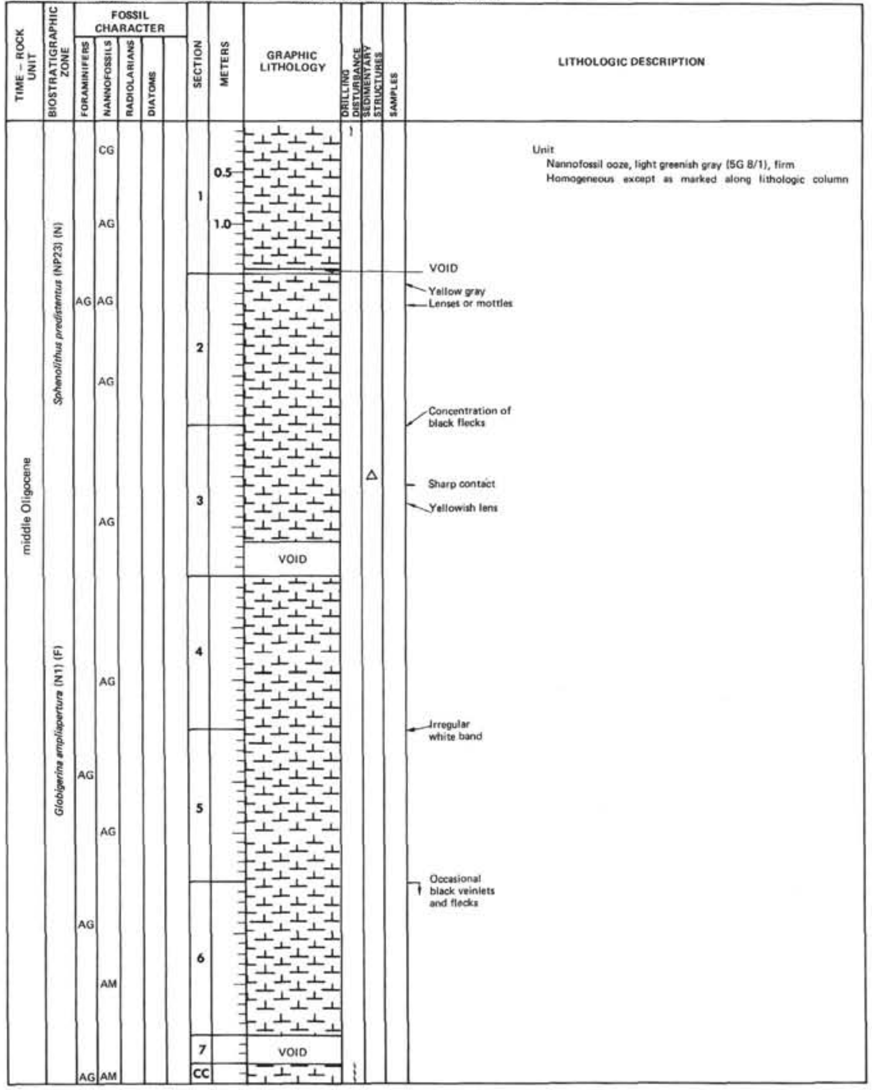


Unit
Nannofossil ooze, light greenish gray (5G 8/1), firm
Homogeneous except for very occasional gray (N5–6) small burrows

ORGANIC CARBON AND CARBONATE (%):

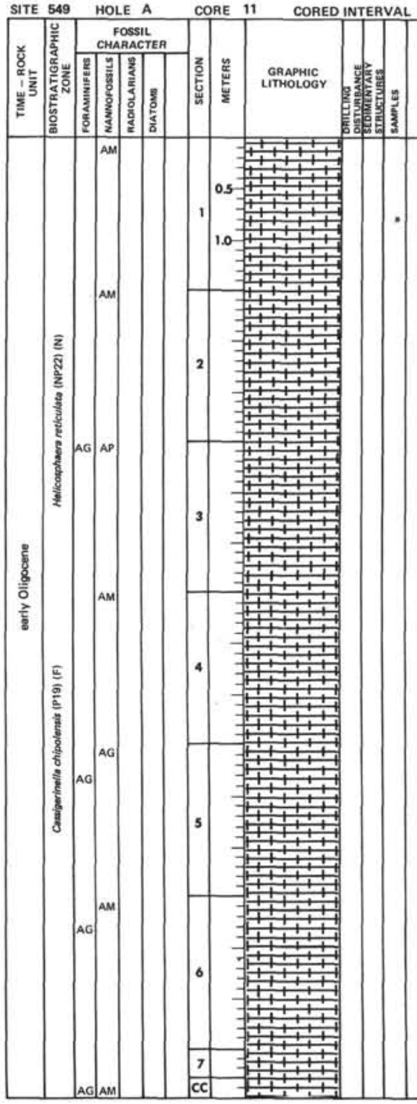
	2, 10	4, 10
Organic carbon	0.04	0.03
Carbonate	93	93

SITE 549 HOLE A CORE 10 CORED INTERVAL 84.0–93.5 m



Unit
Nannofossil ooze, light greenish gray (5G 8/1), firm
Homogeneous except as marked along lithologic column

SITE 549 HOLE A CORE 11 CORED INTERVAL 93.5–103.0 m



LITHOLOGIC DESCRIPTION

Homogeneous, 5B 9/1, firm, nannofossil chalk/foram nanno chalk
Variable foram %

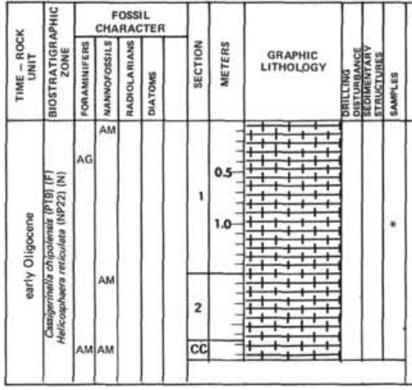
SMEAR SLIDE SUMMARY (%):

	1, 80 D
Composition:	
Clay	Tr
Foraminifers	20
Calc. nannofossils	65
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	2, 16	4, 16
Organic carbon	0.04	0.04
Carbonate	88	87

SITE 549 HOLE A CORE 12 CORED INTERVAL 103.0–106.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, foram-nannofossil chalk
Variable foram and siliceous content

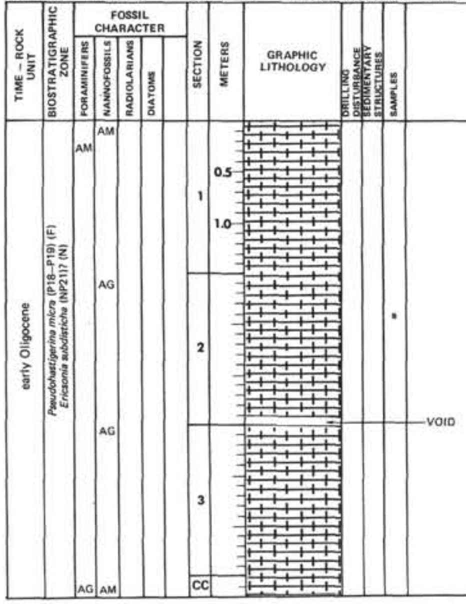
SMEAR SLIDE SUMMARY (%):

	1, 100 D
Composition:	
Foraminifers	10
Calc. nannofossils	70
Sponge spicules	15

ORGANIC CARBON AND CARBONATE (%):

	2, 55
Organic carbon	0.03
Carbonate	93

SITE 549 HOLE A CORE 13 CORED INTERVAL 106.0–111.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, foram-nannofossil ooze
Variable foram and siliceous content
Faint greenish horizons Section 2, 50–90 cm

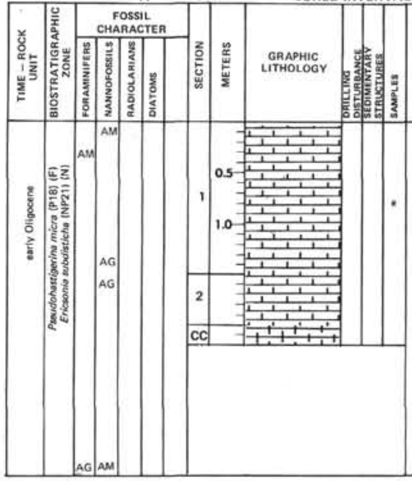
SMEAR SLIDE SUMMARY (%):

	2, 50 D
Composition:	
Clay	Tr
Foraminifers	20
Calc. nannofossils	50
Radiolarians	Tr
Sponge spicules	20

ORGANIC CARBON AND CARBONATE (%):

	2, 5
Organic carbon	0.06
Carbonate	88

SITE 549 HOLE A CORE 14 CORED INTERVAL 111.0–116.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous foram-nannofossil chalk
Variable foram-siliceous content

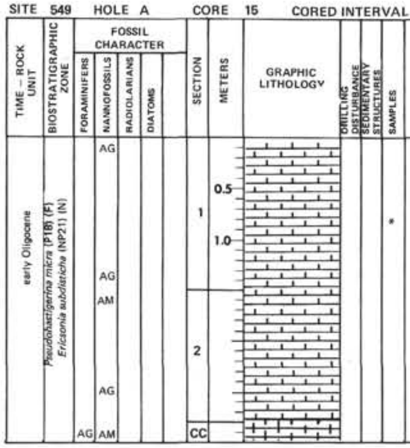
SMEAR SLIDE SUMMARY (%):

	1, 76
	D
Texture:	
Sand	10
Silt	10
Clay	80
Composition:	
Clay	Tr
Foraminifers	10
Calc. nannofossils	70
Diatoms	Tr
Radiolarians	5
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	2, 25
Organic carbon	0.08
Carbonate	89

SITE 549 HOLE A CORE 15 CORED INTERVAL 116.0–119.5 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous nannofossil chalk

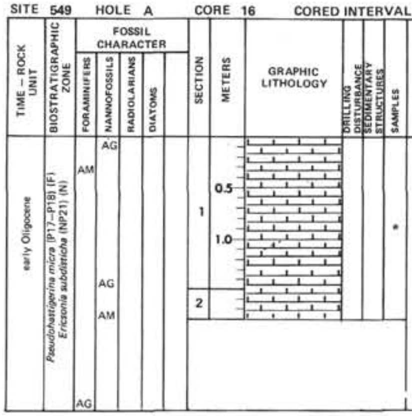
SMEAR SLIDE SUMMARY (%):

	1, 80
	D
Texture:	
Sand	5
Silt	10
Clay	85
Composition:	
Foraminifers	5
Calc. nannofossils	75
Radiolarians	5
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	2, 5
Carbonate	85

SITE 549 HOLE A CORE 16 CORED INTERVAL 119.5–122.5 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

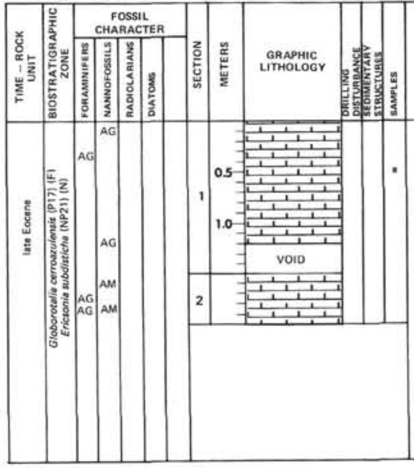
SMEAR SLIDE SUMMARY (%):

	1, 84
	D
Composition:	
Clay	Tr
Foraminifers	10
Calc. nannofossils	65
Diatoms	Tr
Radiolarians	5
Sponge spicules	15

ORGANIC CARBON AND CARBONATE (%):

	2, 5
Organic carbon	0.04
Carbonate	88

SITE 549 HOLE A CORE 17 CORED INTERVAL 122.5–125.5 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

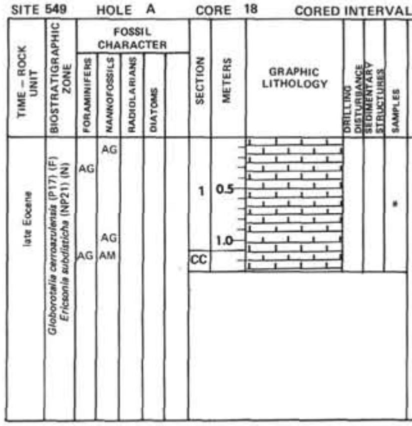
SMEAR SLIDE SUMMARY (%):

	1, 50
	D
Texture:	
Sand	10
Silt	10
Clay	80
Composition:	
Clay	Tr
Carbonate unspec.	10
Foraminifers	10
Calc. nannofossils	60
Radiolarians	5
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	2, 5
Carbonate	97

SITE 549 HOLE A CORE 18 CORED INTERVAL 125.5–127.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous nannofossil chalk

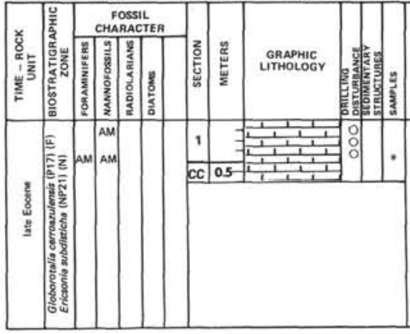
SMEAR SLIDE SUMMARY (%):

	1, 70
	D
Composition:	
Quartz	Tr
Clay	Tr
Carbonate unspec.	20
Foraminifers	5
Calc. nannofossils	60
Radiolarians	Tr
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	1, 5
Carbonate	90

SITE 549 HOLE A CORE 19 CORED INTERVAL 127.0–128.0 m



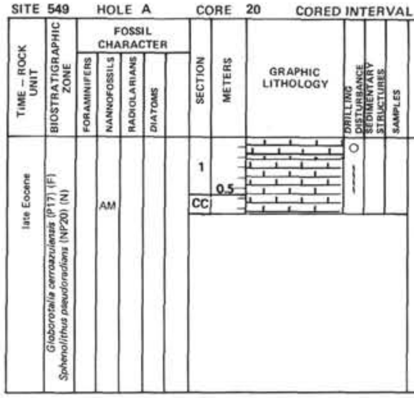
LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

SMEAR SLIDE SUMMARY (%):

	1, 35
	D
Composition:	
Carbonate unspec.	20
Foraminifers	Tr
Calc. nannofossils	60
Radiolarians	5
Sponge spicules	10

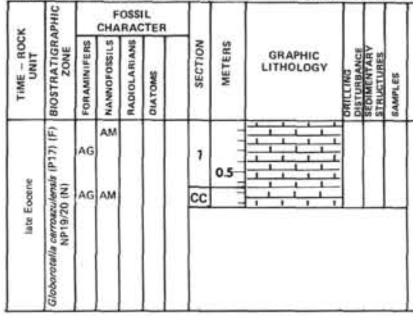
SITE 549 HOLE A CORE 20 CORED INTERVAL 128.0–129.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous nannofossil ooze
Mud disturbed by drilling

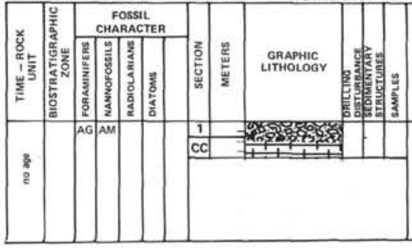
SITE 549 HOLE A CORE 21 CORED INTERVAL 129.0–130.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

SITE 549 HOLE A CORE 22 CORED INTERVAL 130.5–131.0 m



LITHOLOGIC DESCRIPTION

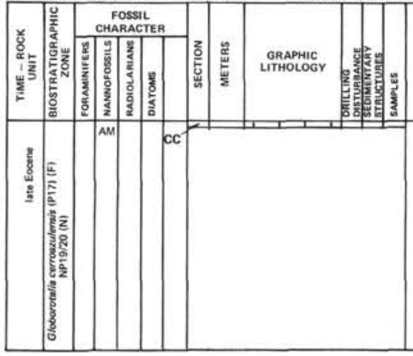
Drilling breccia

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

ORGANIC CARBON AND CARBONATE (%):

	CC, 27
Carbonate	93

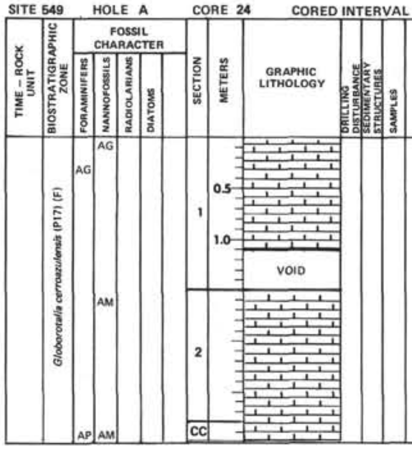
SITE 549 HOLE A CORE 23 CORED INTERVAL 130.5–131.0 m



LITHOLOGIC DESCRIPTION

Trace only, bluish white (5B 9/1), homogeneous, firm, nannofossil chalk

SITE 549 HOLE A CORE 24 CORED INTERVAL 132.0–135.0 m



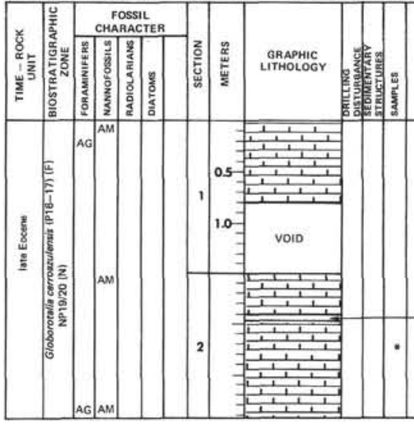
LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), firm, homogeneous, nannofossil chalk

ORGANIC CARBONAND CARBONATE (%):

	2, 5
Carbonate	95

SITE 549 HOLE A CORE 25 CORED INTERVAL 135.0–137.5 m



VOID

LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), homogeneous, firm, nannofossil chalk

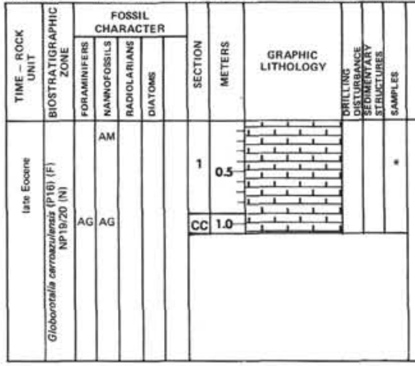
SMEAR SLIDE SUMMARY (%):

	2, 76
	D
Texture:	
Sand	5
Silt	10
Clay	85
Composition:	
Foraminifers	5
Calc. nannofossils	80
Radiolarians	Tr
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	2, 5
Carbonate	86

SITE 549 HOLE A CORE 26 CORED INTERVAL 137.5–138.5 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), homogeneous, nannofossil chalk, firm

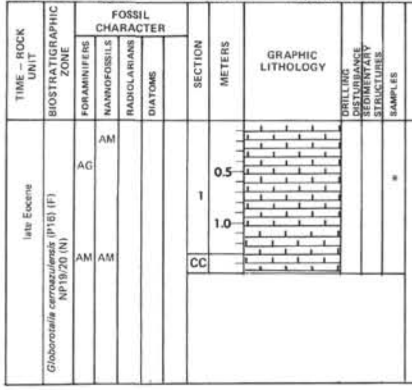
SMEAR SLIDE SUMMARY (%):

	1, 32
	D
Composition:	
Foraminifers	Tr
Calc. nannofossils	85
Radiolarians	Tr
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	1, 37
Carbonate	89

SITE 549 HOLE A CORE 27 CORED INTERVAL 138.5–140.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), homogeneous, firm, nannofossil chalk

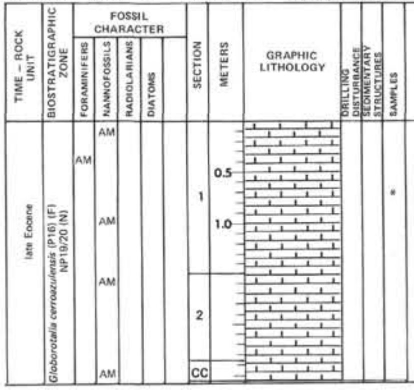
SMEAR SLIDE SUMMARY (%):

	1, 60
	D
Composition:	
Foraminifers	Tr
Calc. nannofossils	85
Radiolarians	Tr
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	1, 37
Carbonate	89

SITE 549 HOLE A CORE 28 CORED INTERVAL 140.0–143.0 m



LITHOLOGIC DESCRIPTION

Bluish white (5B 9/1), homogeneous, firm, nannofossil chalk

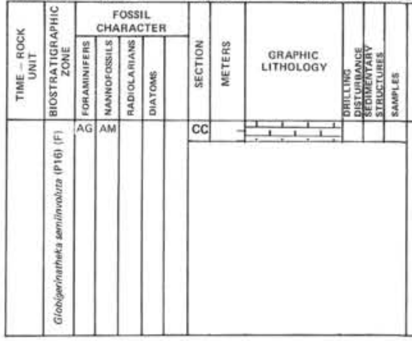
SMEAR SLIDE SUMMARY (%):

	1, 70
	D
Composition:	
Foraminifers	Tr
Calc. nannofossils	80
Radiolarians	Tr
Sponge spicules	15

ORGANIC CARBON AND CARBONATE (%)

	1, 56
Carbonate	90

SITE 549 HOLE A CORE 29 CORED INTERVAL 143.0–143.5 m

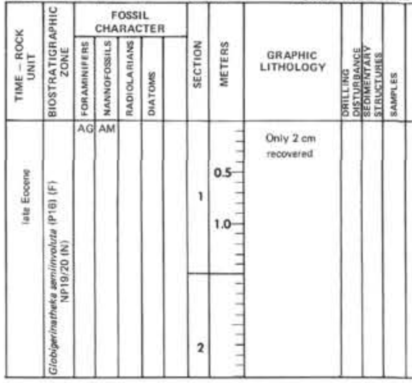


LITHOLOGIC DESCRIPTION

Trace only, bluish white (5B 9/1), firm, nannofossil chalk, homogeneous

NOTE: 549A, Core 30, 143.5–145.5 m: no recovery.

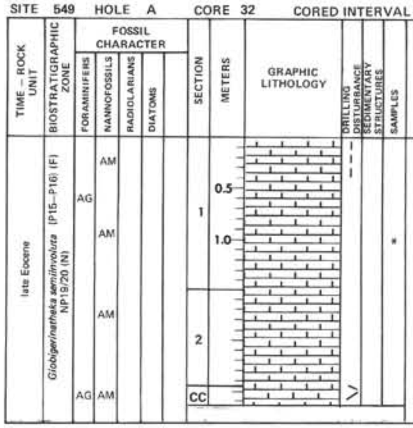
SITE 549 HOLE A CORE 31 CORED INTERVAL 145.5–147.5 m



LITHOLOGIC DESCRIPTION

Two cm of light greenish gray chalk

SITE 549 HOLE A CORE 32 CORED INTERVAL 147.5–150.5 m



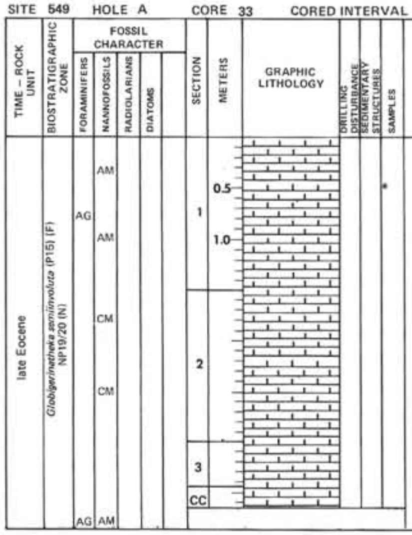
LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 8/1), firm
Homogeneous, sponge spicules are common

SMEAR SLIDE SUMMARY (%):

	1, 100
	D
Texture:	
Sand	Tr
Silt	10
Clay	90
Composition:	
Clay	<5
Glauconite	Tr
Foraminifers	<3
Calc. nannofossils	83
Radiolarians	1
Sponge spicules	10

SITE 549 HOLE A CORE 33 CORED INTERVAL 150.5–155.5 m



LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 8/1), firm
Homogeneous
Sponge spicules present

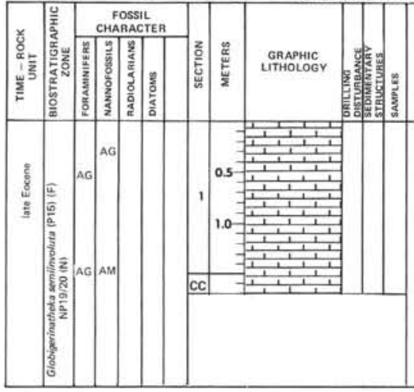
SMEAR SLIDE SUMMARY (%):

	1, 50
	D
Texture:	
Sand	15
Silt	25
Clay	60
Composition:	
Quartz	Tr–5
Clay	Tr–10
Carbonate unspec.	10
Foraminifers	5–10
Calc. nannofossils	60–70
Radiolarians	Tr
Sponge spicules	5

ORGANIC CARBON AND CARBONATE (%):

	1, 29
Carbonate	84

SITE 549 HOLE A CORE 34 CORED INTERVAL 155.5–160.5 m



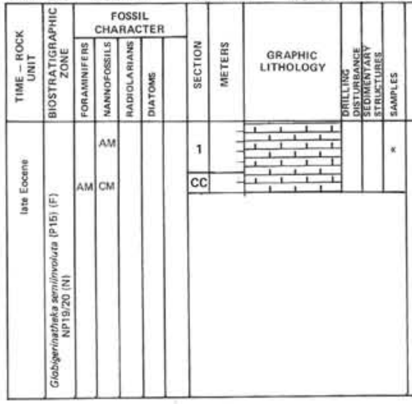
LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 8/1), firm, homogeneous

ORGANIC CARBON AND CARBONATE (%):

	1, 30
Carbonate	89

SITE 549 HOLE A CORE 35 CORED INTERVAL 160.5–165.5 m



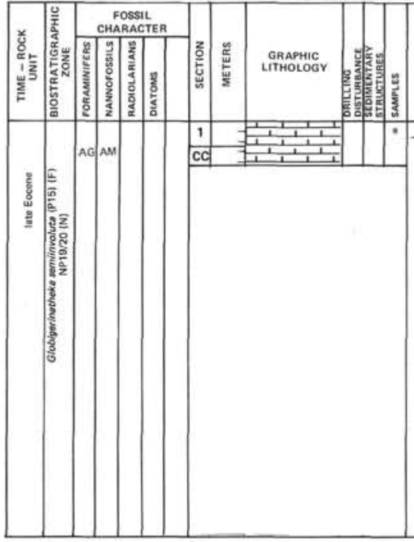
LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 8/1), firm, homogeneous

ORGANIC CARBON AND CARBONATE (%):

	1, 30
Carbonate	86

SITE 549 HOLE A CORE 36 CORED INTERVAL 165.5–170.5 m



LITHOLOGIC DESCRIPTION

← Hard zone Hard

Unit

Nannofossil chalk, light greenish gray (5GY 8/1), firm to hard

Homogeneous in color, seem to be zones where chalk becomes quite hard

Sponge spicules present in moderate amounts

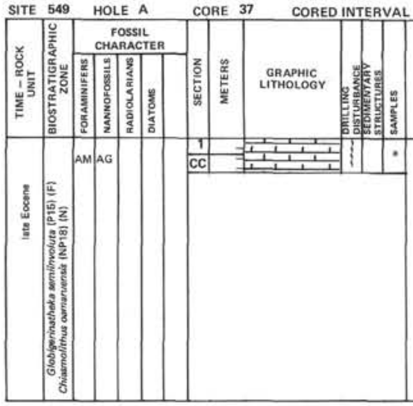
SMEAR SLIDE SUMMARY (%):

	1, 10
	D
Texture:	
Sand	10
Silt	20
Clay	70
Composition:	
Quartz	} 5
Feldspar	
Clay	10
Carbonate unspec.	10
Foraminifers	5–10
Calc. nannofossils	55–65
Radiolarians	Tr
Sponge spicules	5–10

ORGANIC CARBON AND CARBONATE (%):

	1, 10
Carbonate	95

SITE 549 HOLE A CORE 37 CORED INTERVAL 170.5–175.5 m



LITHOLOGIC DESCRIPTION

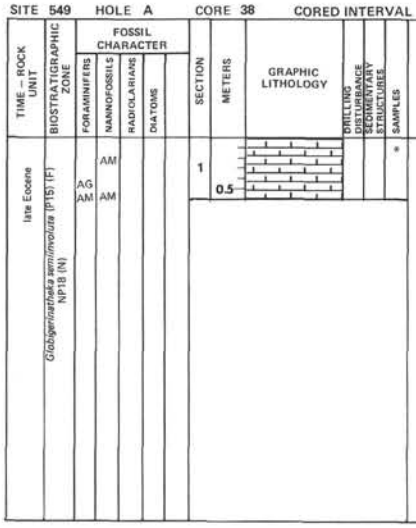
Unit

Nannofossil chalk, light greenish gray (5GY 8/1), firm to soft, homogeneous

ORGANIC CARBON AND CARBONATE (%):

	1, 10
Carbonate	89

SITE 549 HOLE A CORE 38 CORED INTERVAL 175.5–180.5 m



LITHOLOGIC DESCRIPTION

Unit

Nannofossil chalk, light greenish gray (5GY 8/1), hard to very firm

Homogeneous

Sponge spicules common

Between 30 and 60 cm there are 3 or 4 fine purplish lines that run sub-horizontally to vertically down the core

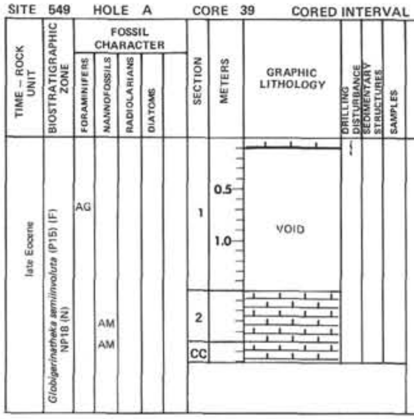
SMEAR SLIDE SUMMARY (%):

	1, 10
	D
Texture:	
Sand	20
Silt	10
Clay	70
Composition:	
Clay	5
Foraminifers	20
Calc. nannofossils	65
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	1, 11
Carbonate	84

SITE 549 HOLE A CORE 39 CORED INTERVAL 180.5–185.5 m



LITHOLOGIC DESCRIPTION

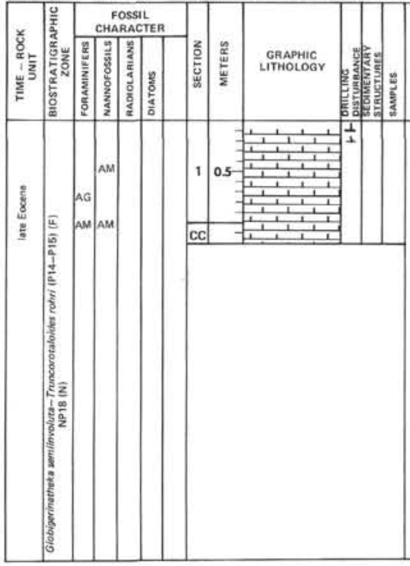
Unit

Nannofossil chalk, light greenish gray (5GY 7/1), firm, homogeneous

ORGANIC CARBON AND CARBONATE (%):

	1, 11
Carbonate	86

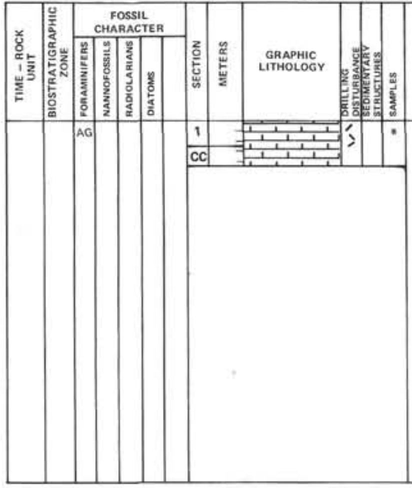
SITE 549 HOLE A CORE 40 CORED INTERVAL 185.5–190.5 m



LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 7/1), firm, homogeneous

SITE 549 HOLE A CORE 41 CORED INTERVAL 190.5–195.5 m



LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 7/1), very firm
Homogeneous
Common sponge spicules

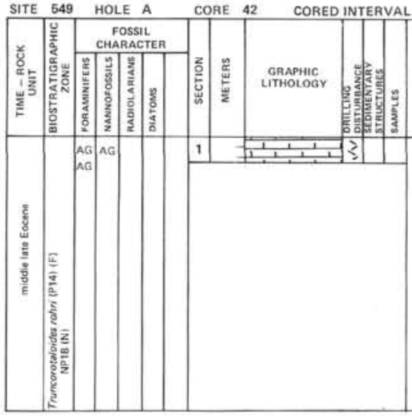
SMEAR SLIDE SUMMARY (%):

	1, 10
	D
Texture:	
Sand	2
Silt	5
Clay	93
Composition:	
Clay	5
Carbonate unspec.	10
Foraminifers	1
Calc. nannofossils	75
Radiolarians	3
Sponge spicules	10

ORGANIC CARBON AND CARBONATE (%):

	1, 7
Carbonate	85

SITE 549 HOLE A CORE 42 CORED INTERVAL 195.5–200.5 m

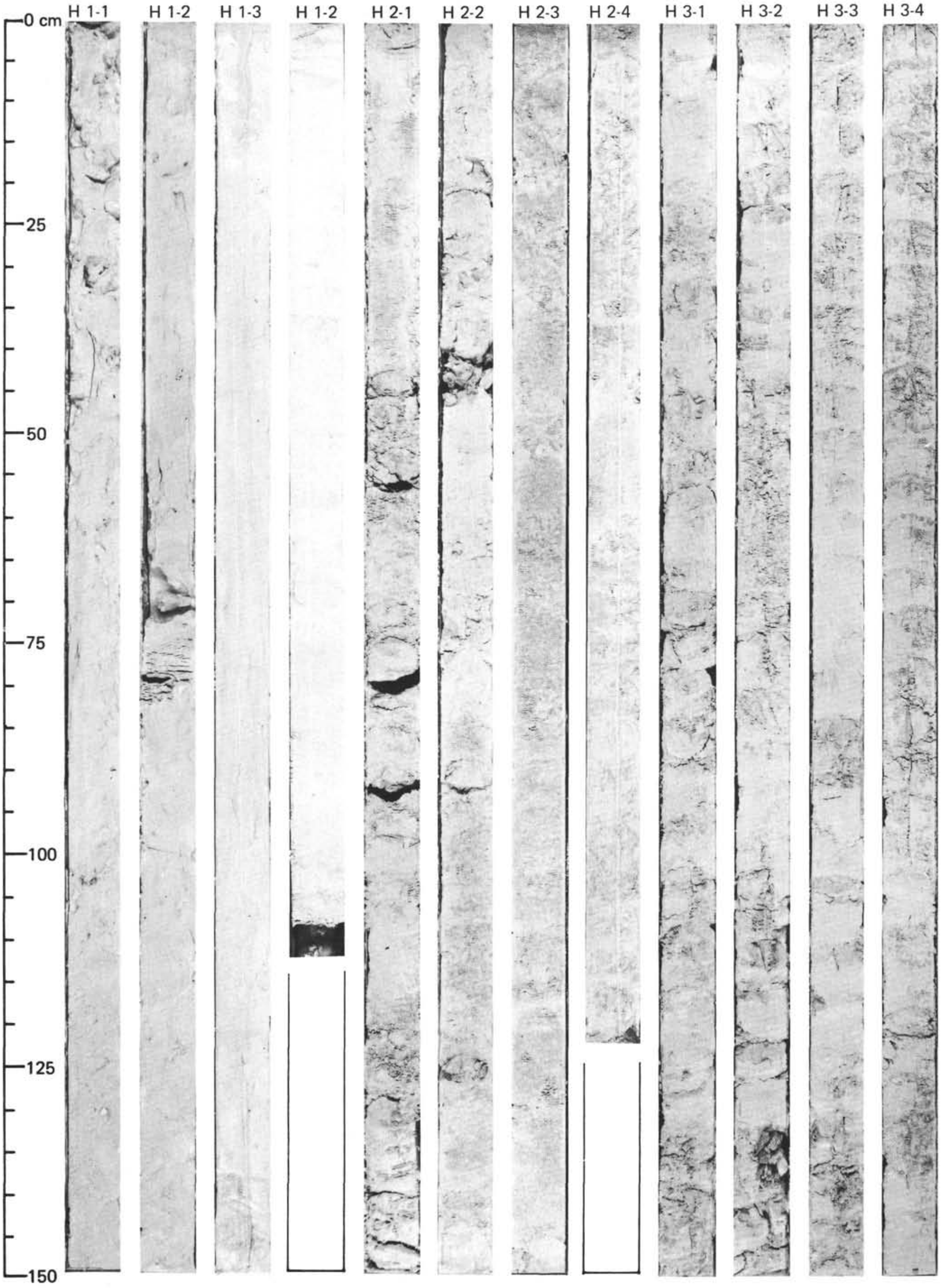


LITHOLOGIC DESCRIPTION

Unit
Nannofossil chalk, light greenish gray (5GY 7/1), very firm to hard
Homogeneous

ORGANIC CARBON AND CARBONATE (%):

	1, 3
Carbonate	75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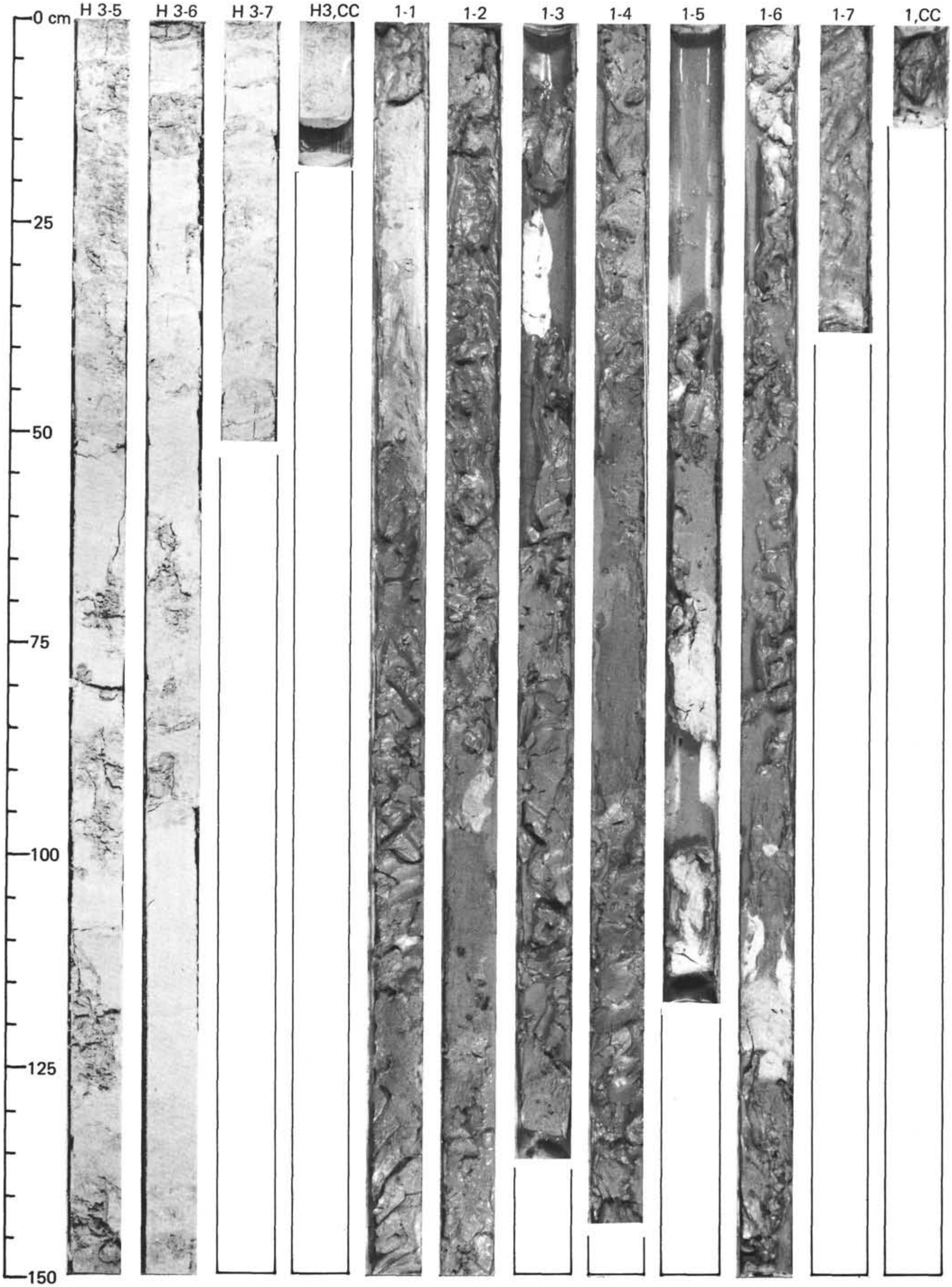
H 3-3
H 3-4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H 3-6
H 3-7
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1-6
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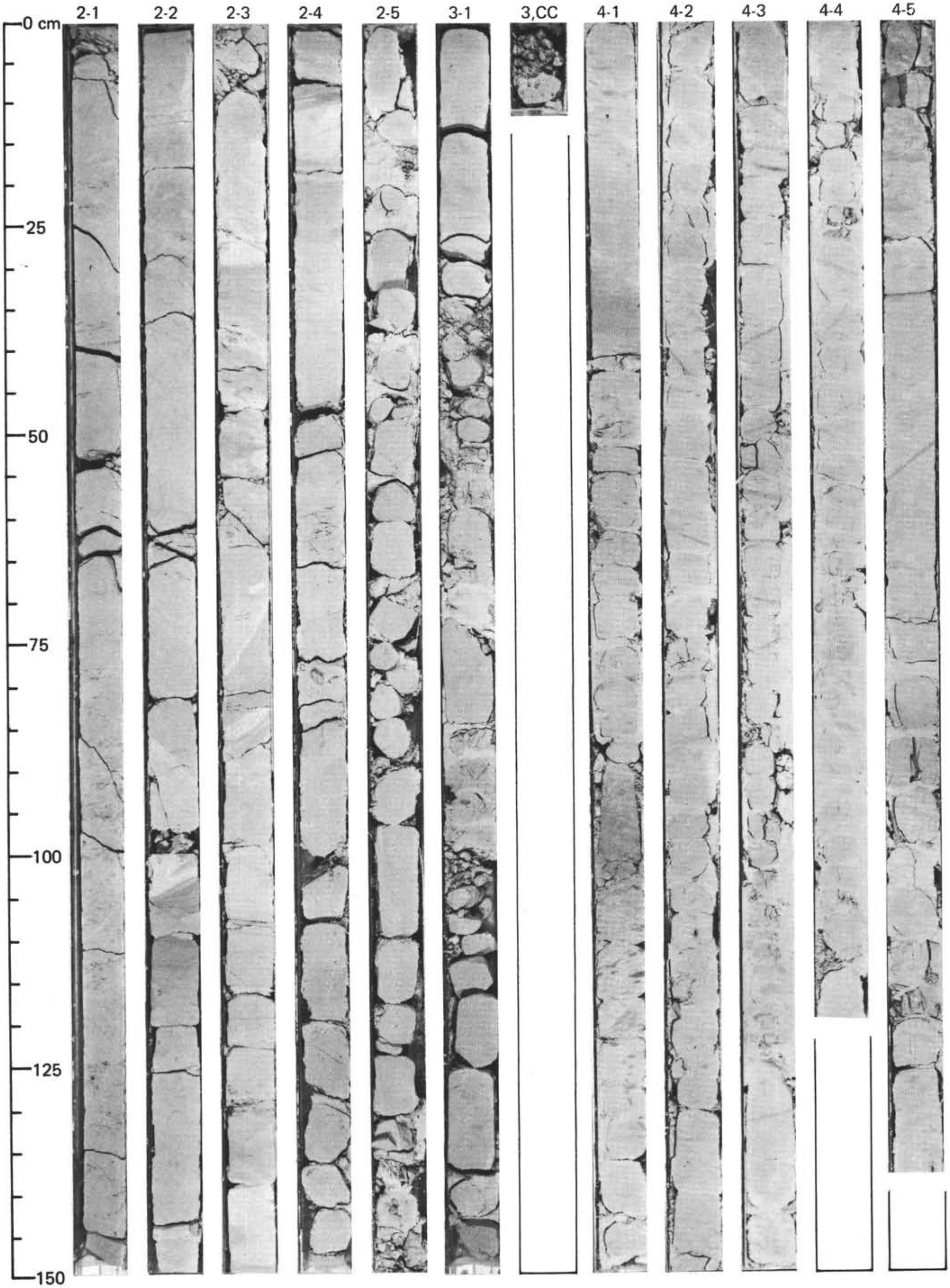
1,CC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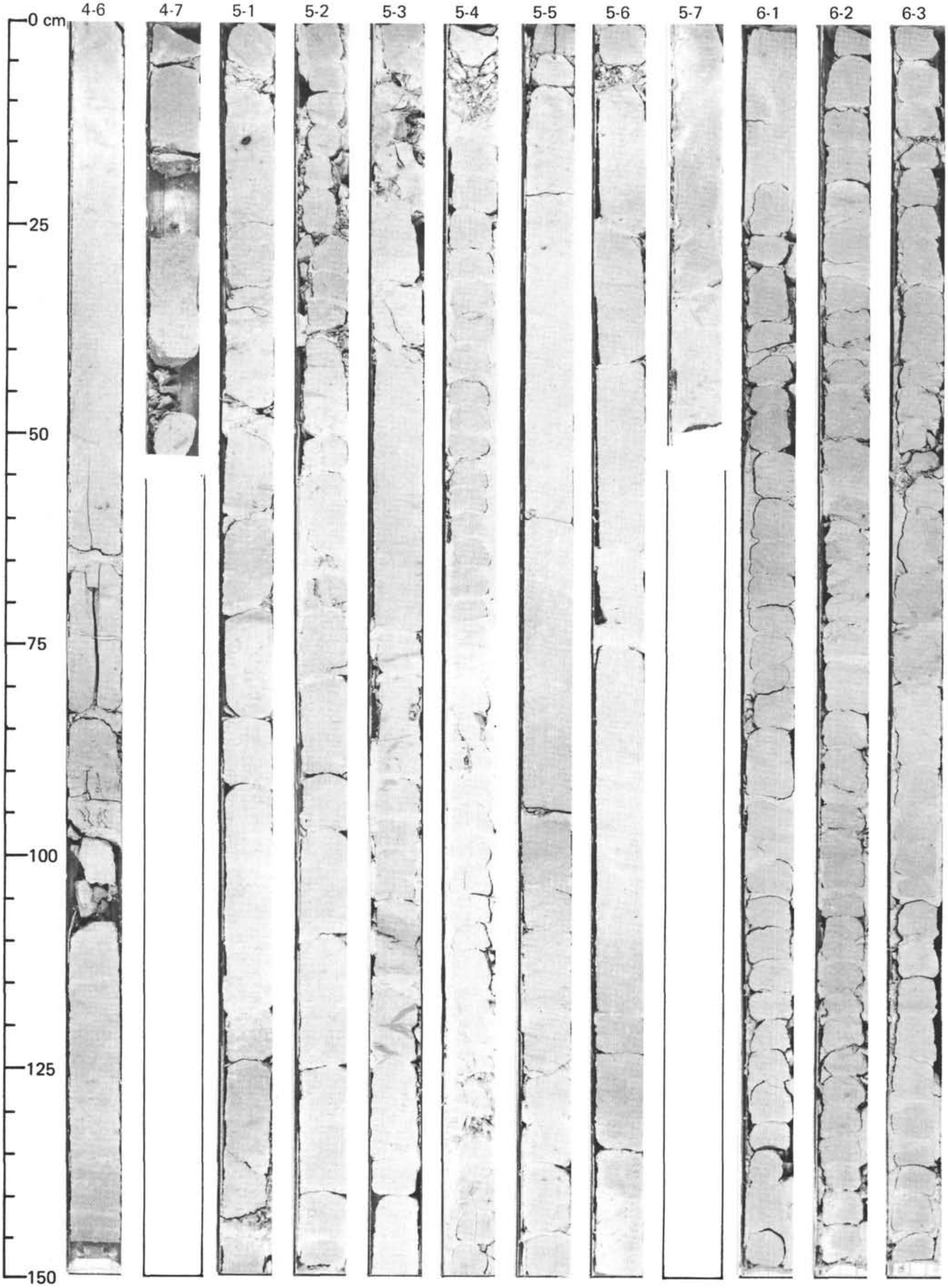
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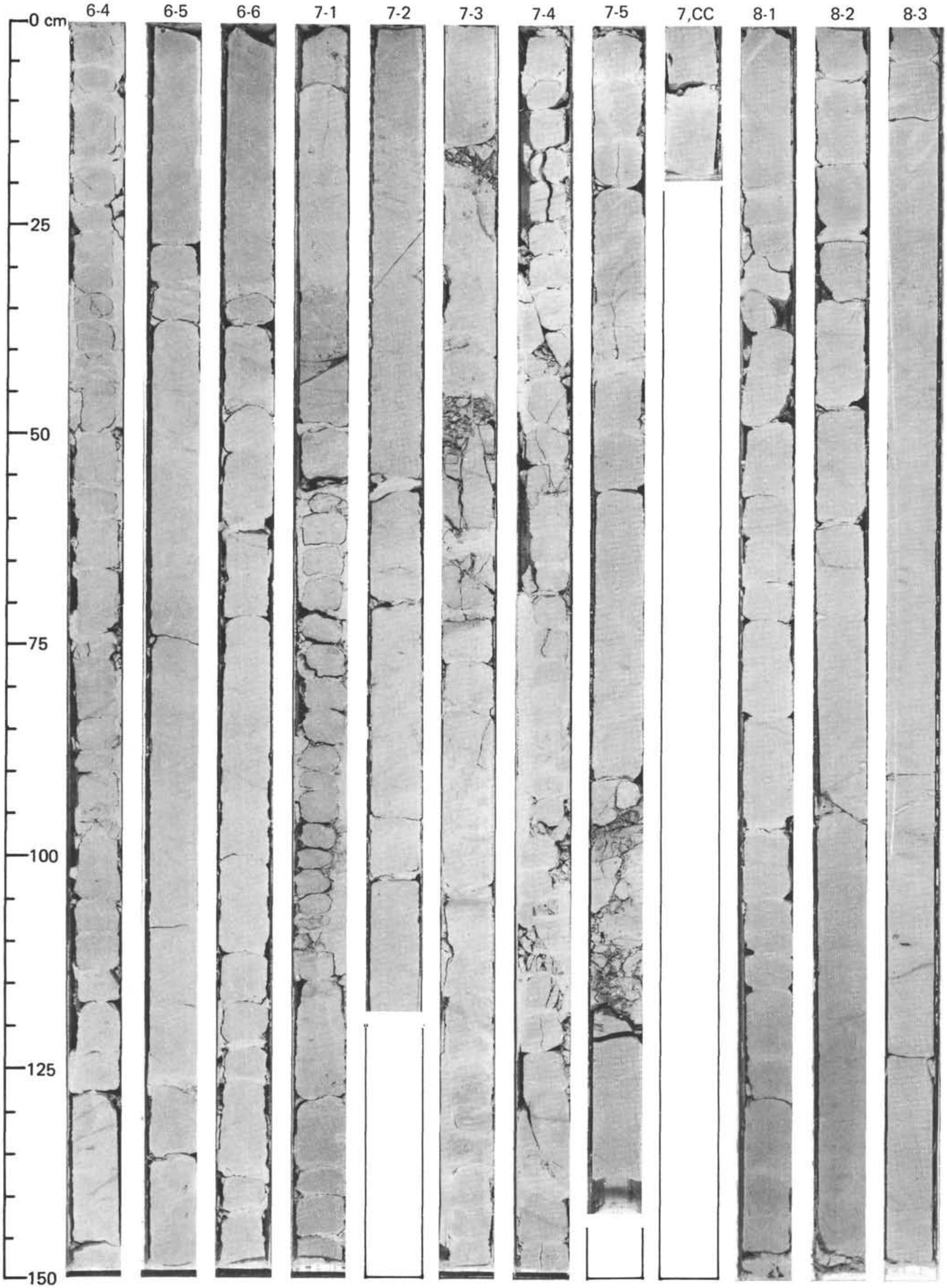
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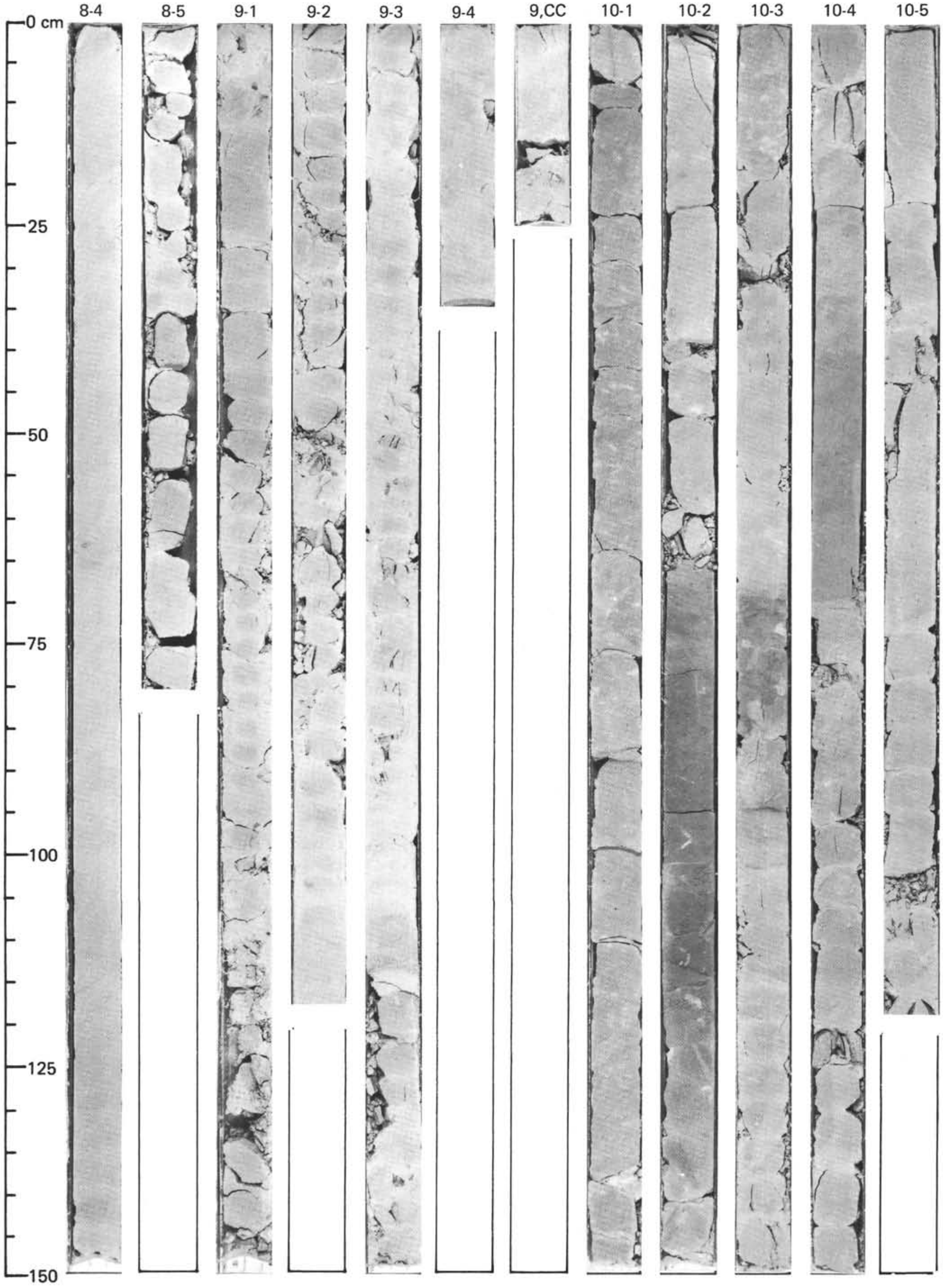
8-3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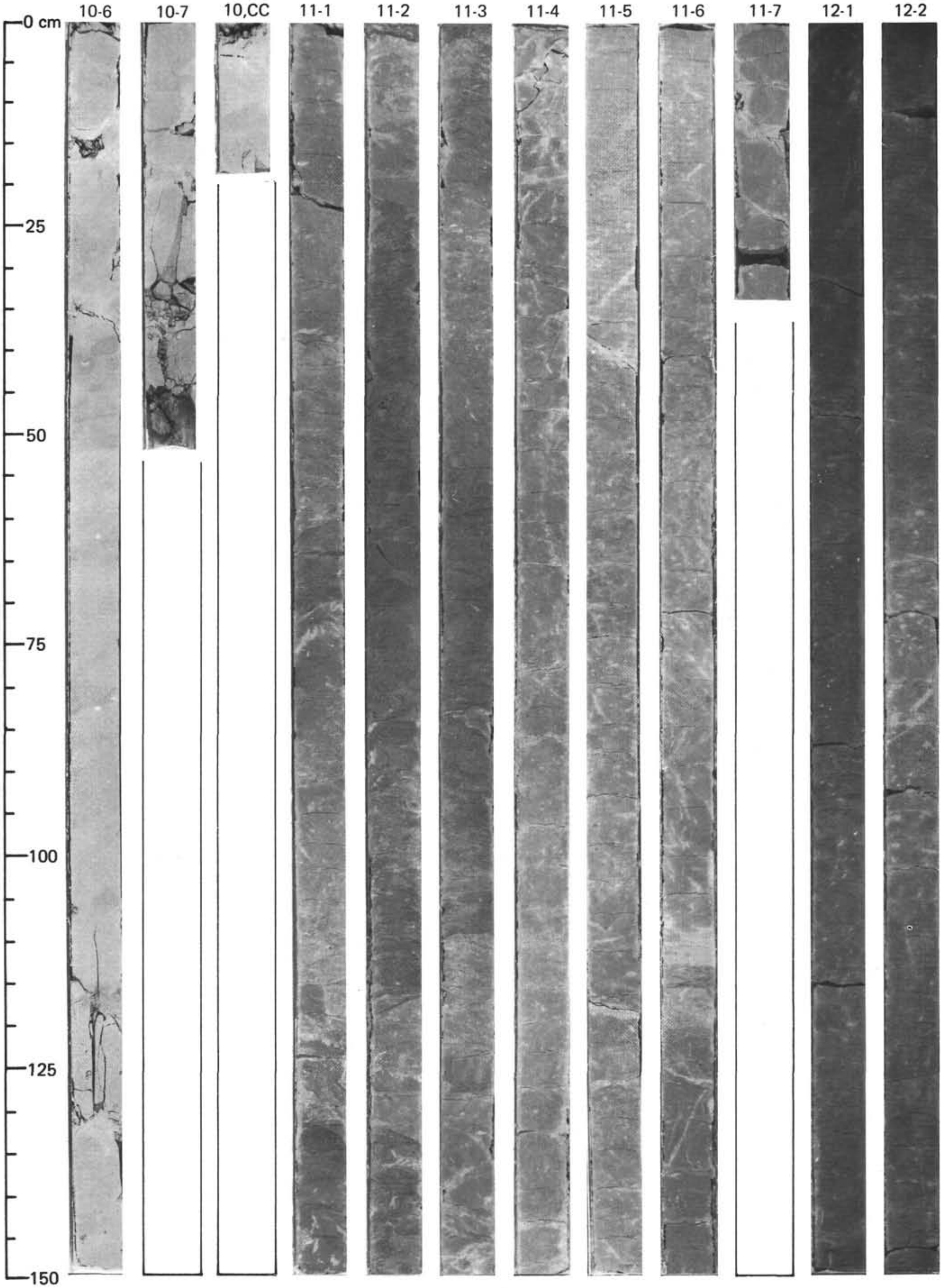
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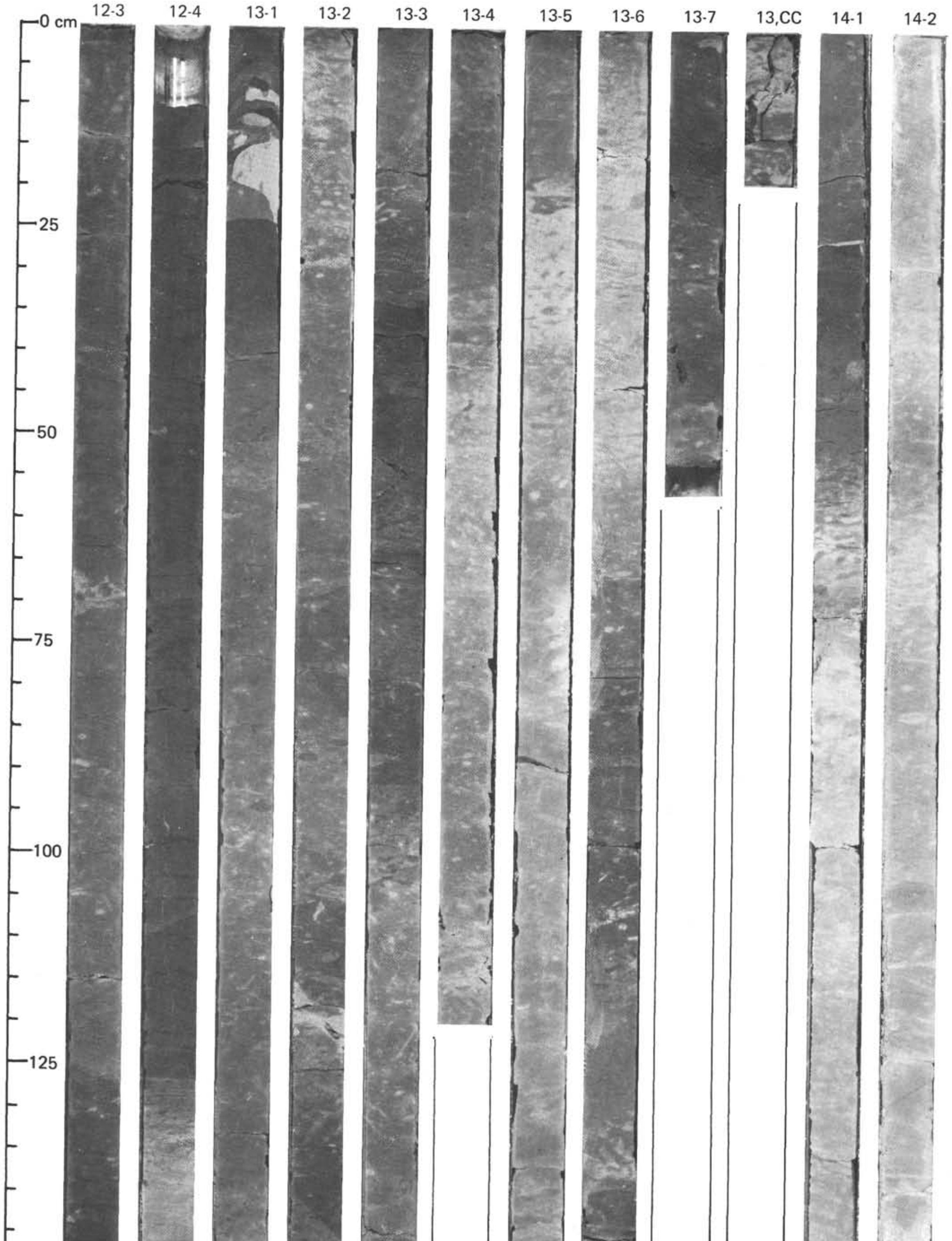
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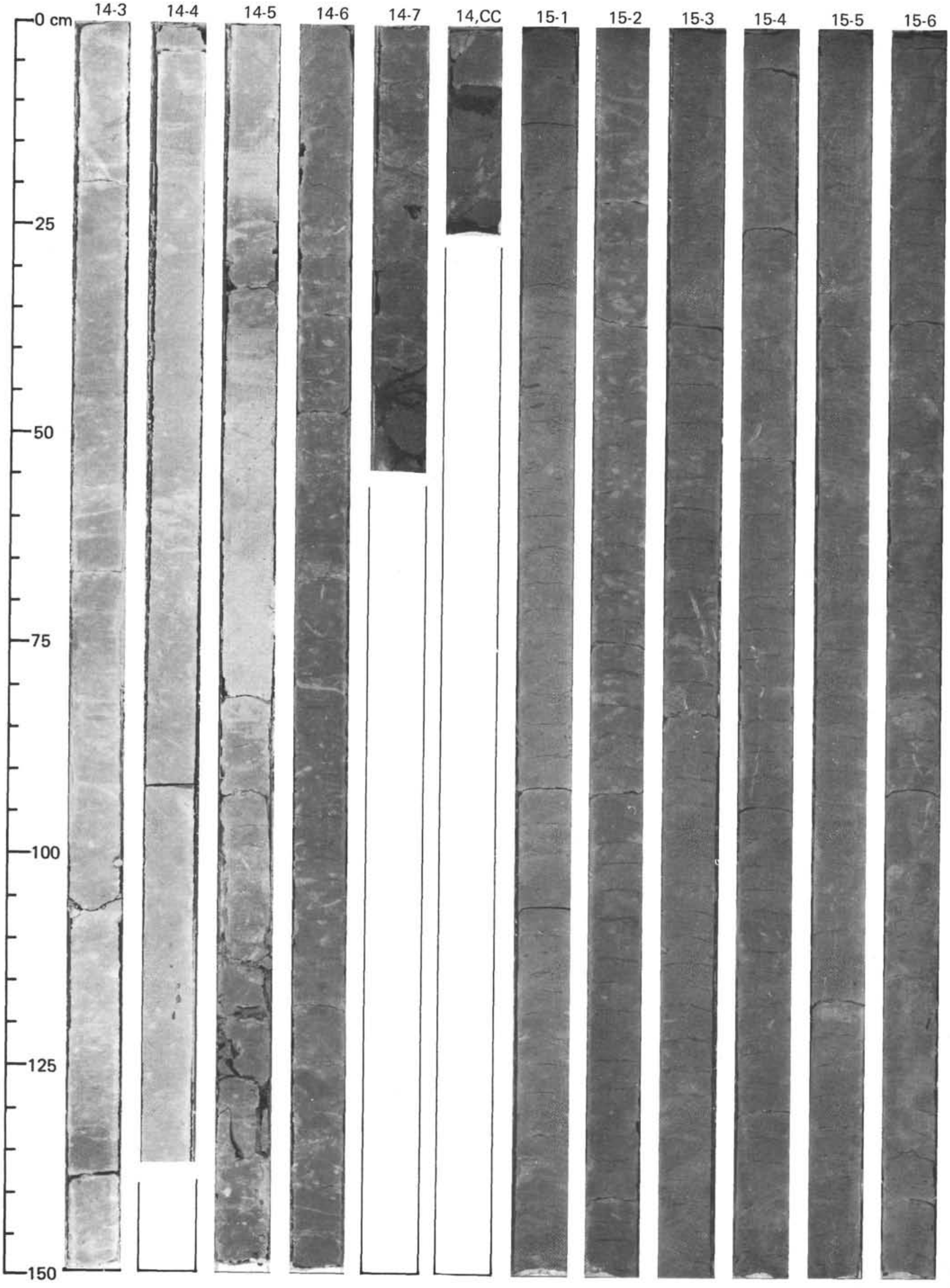
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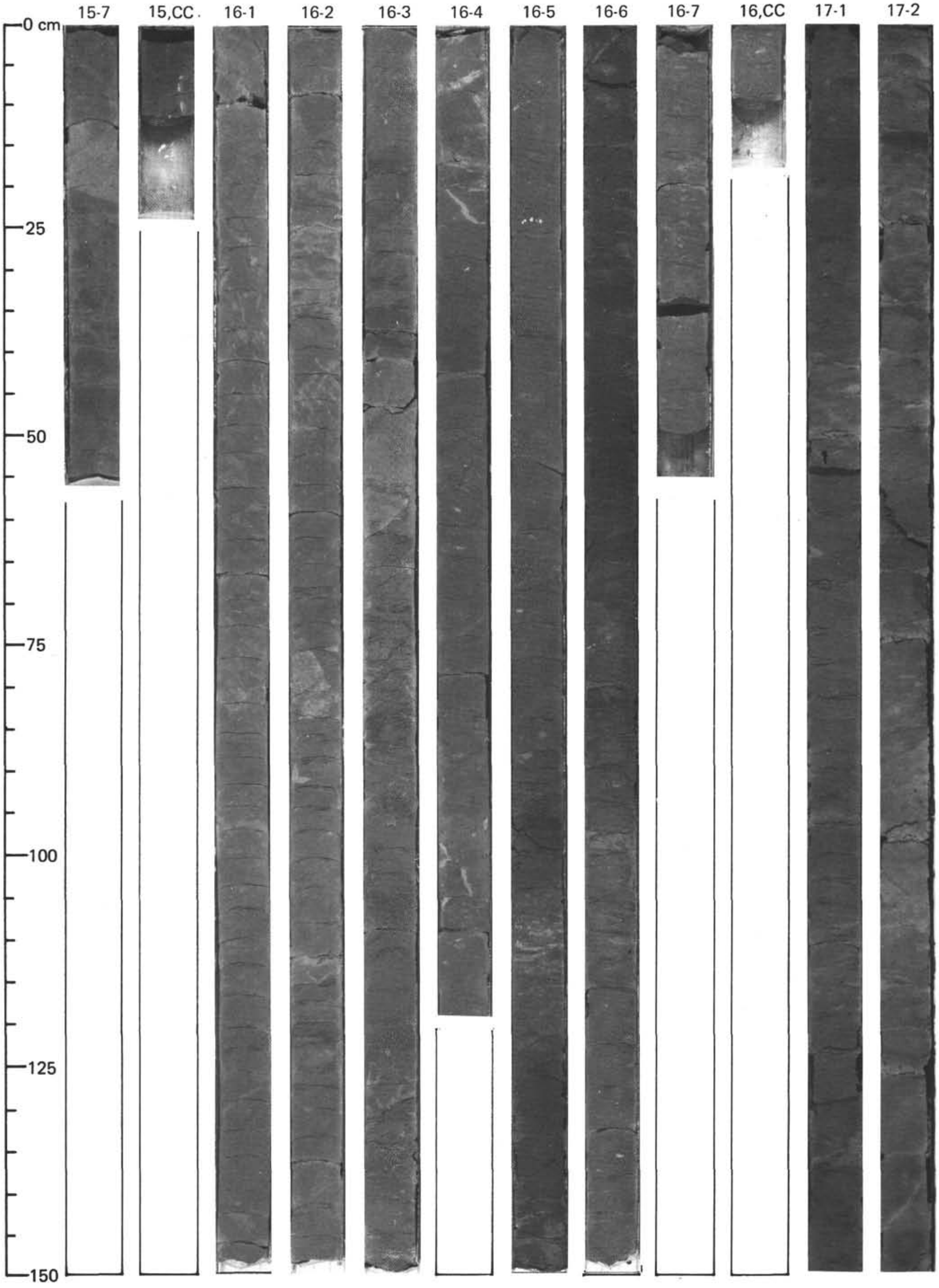
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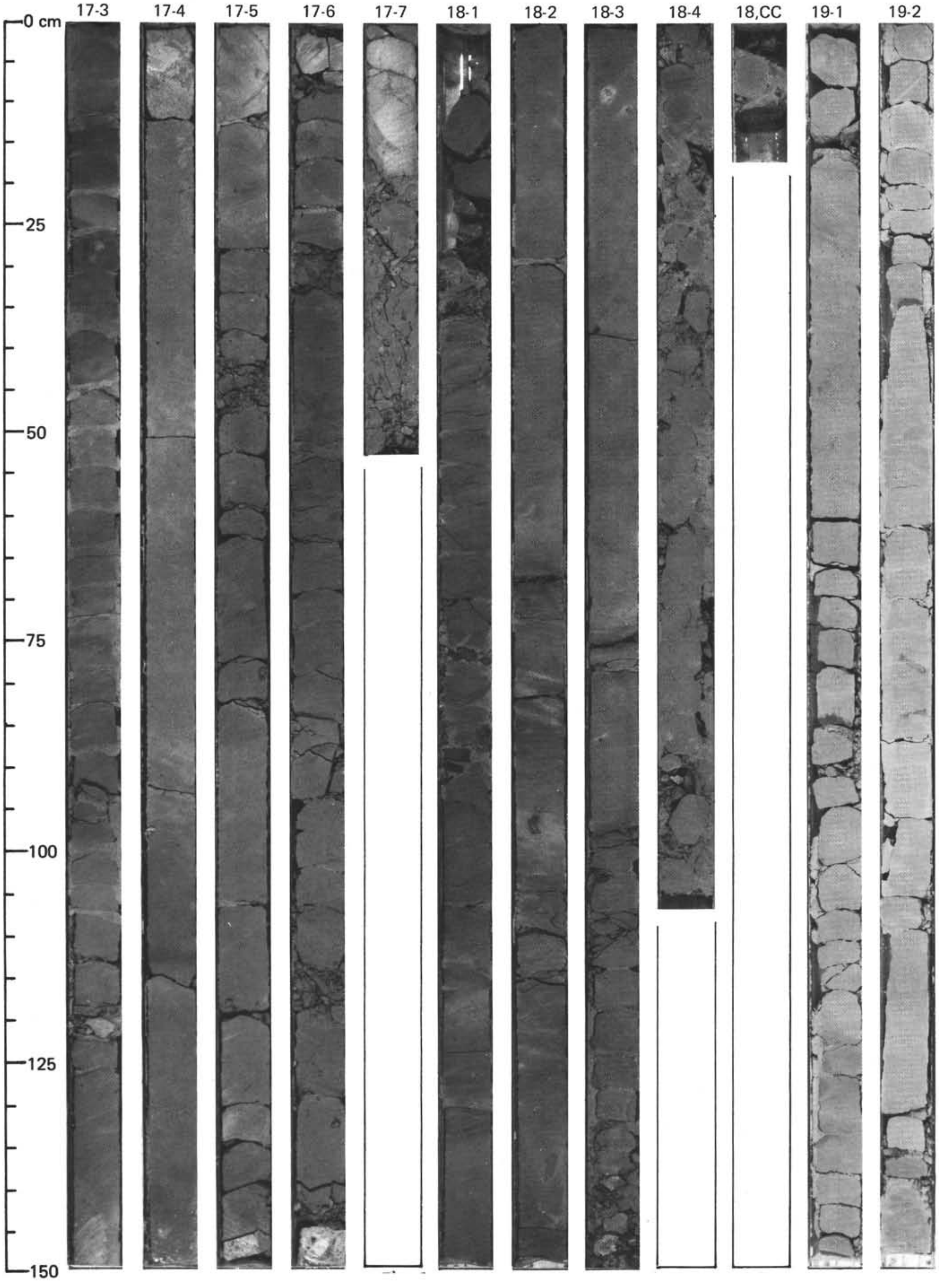
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18-1
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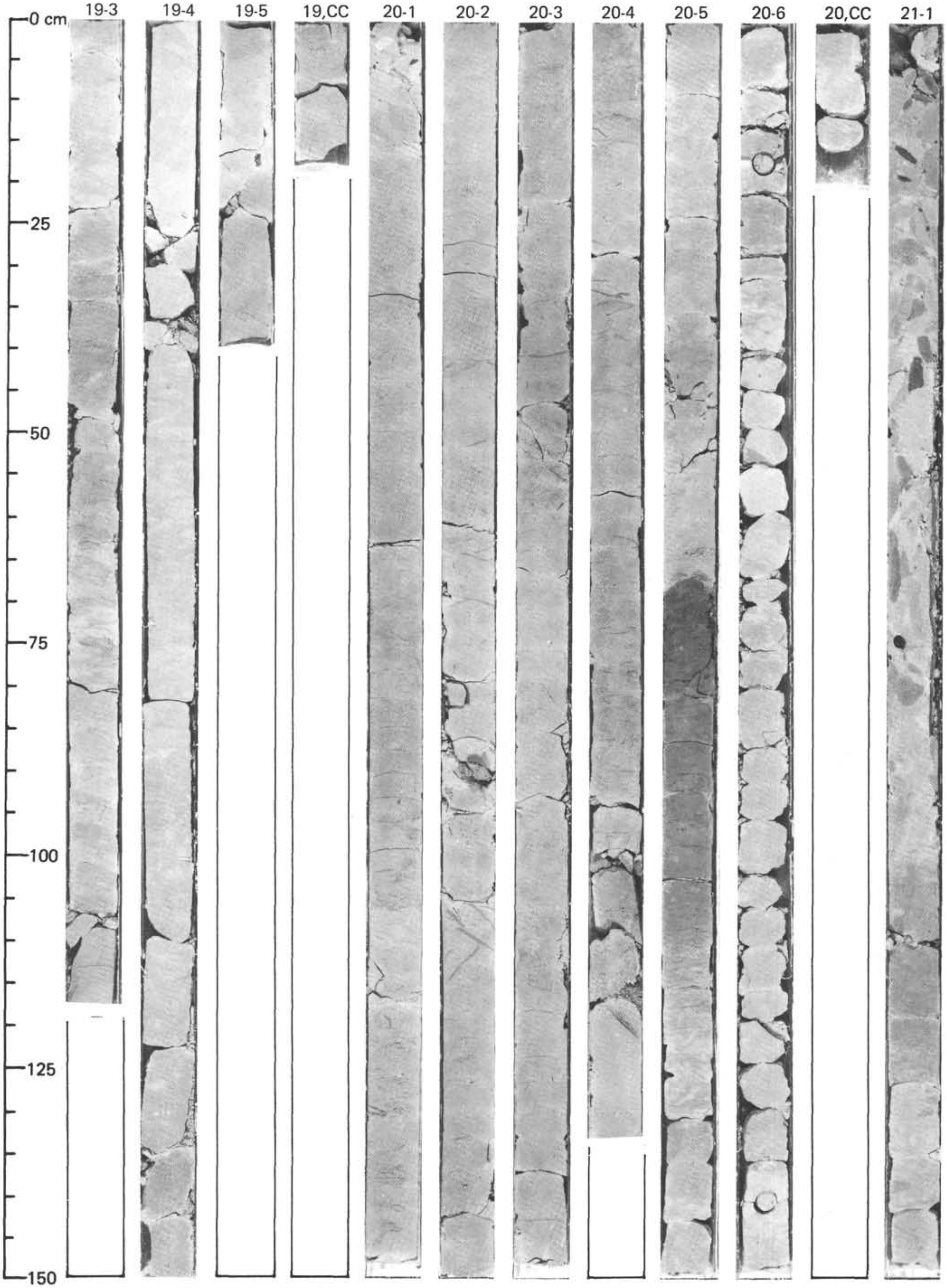
19-1
19-2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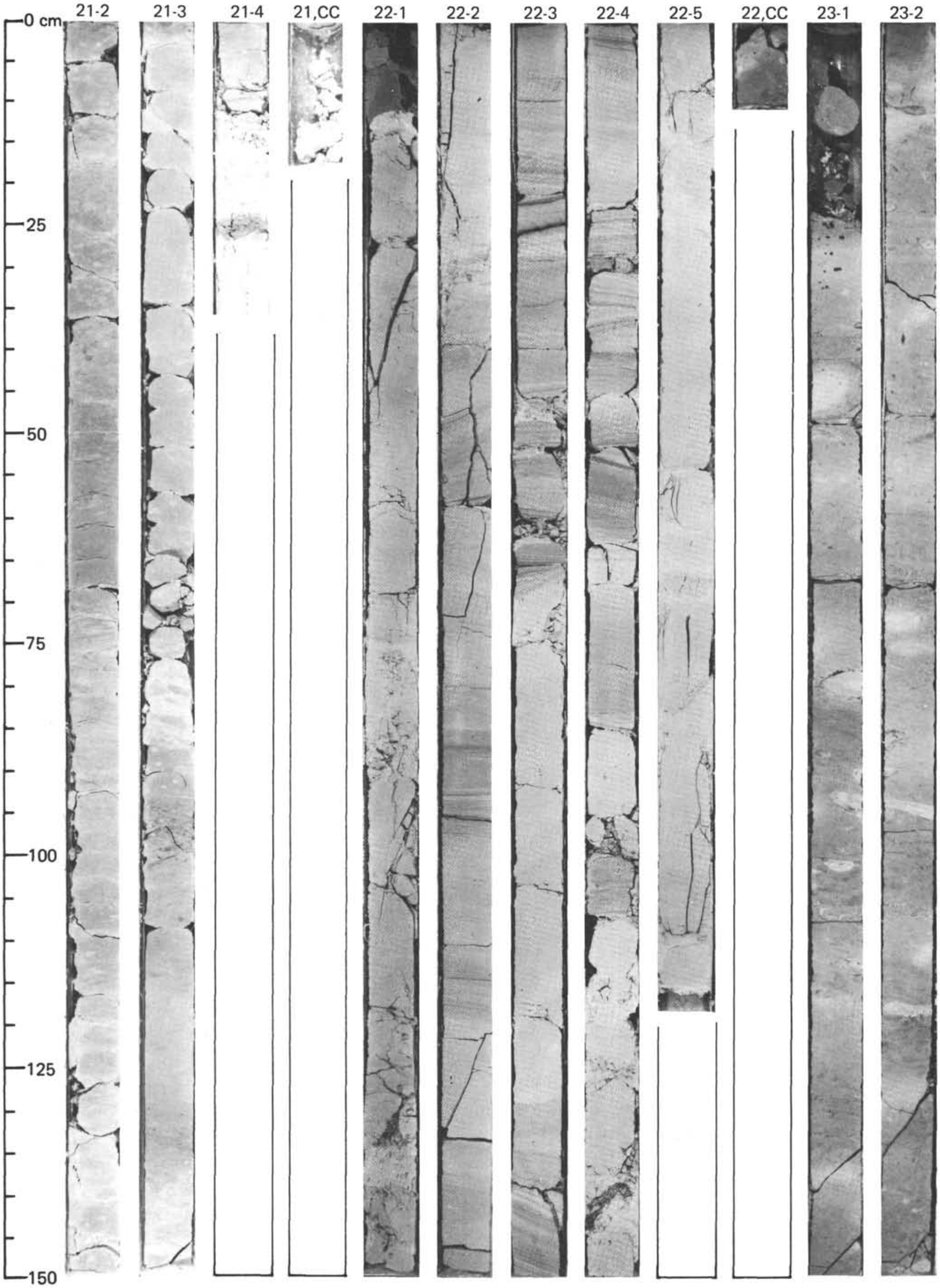
21-1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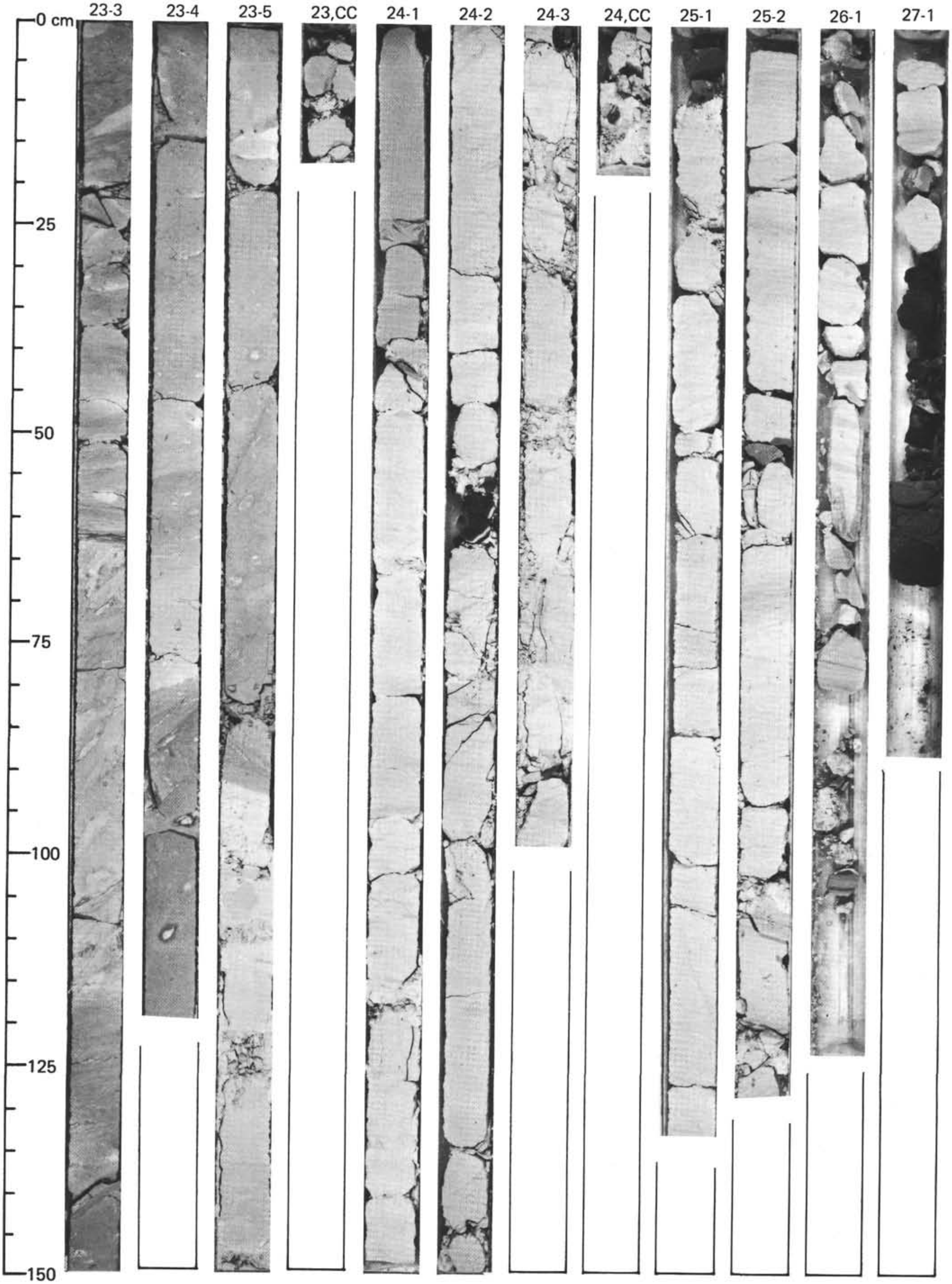
23-1
23-2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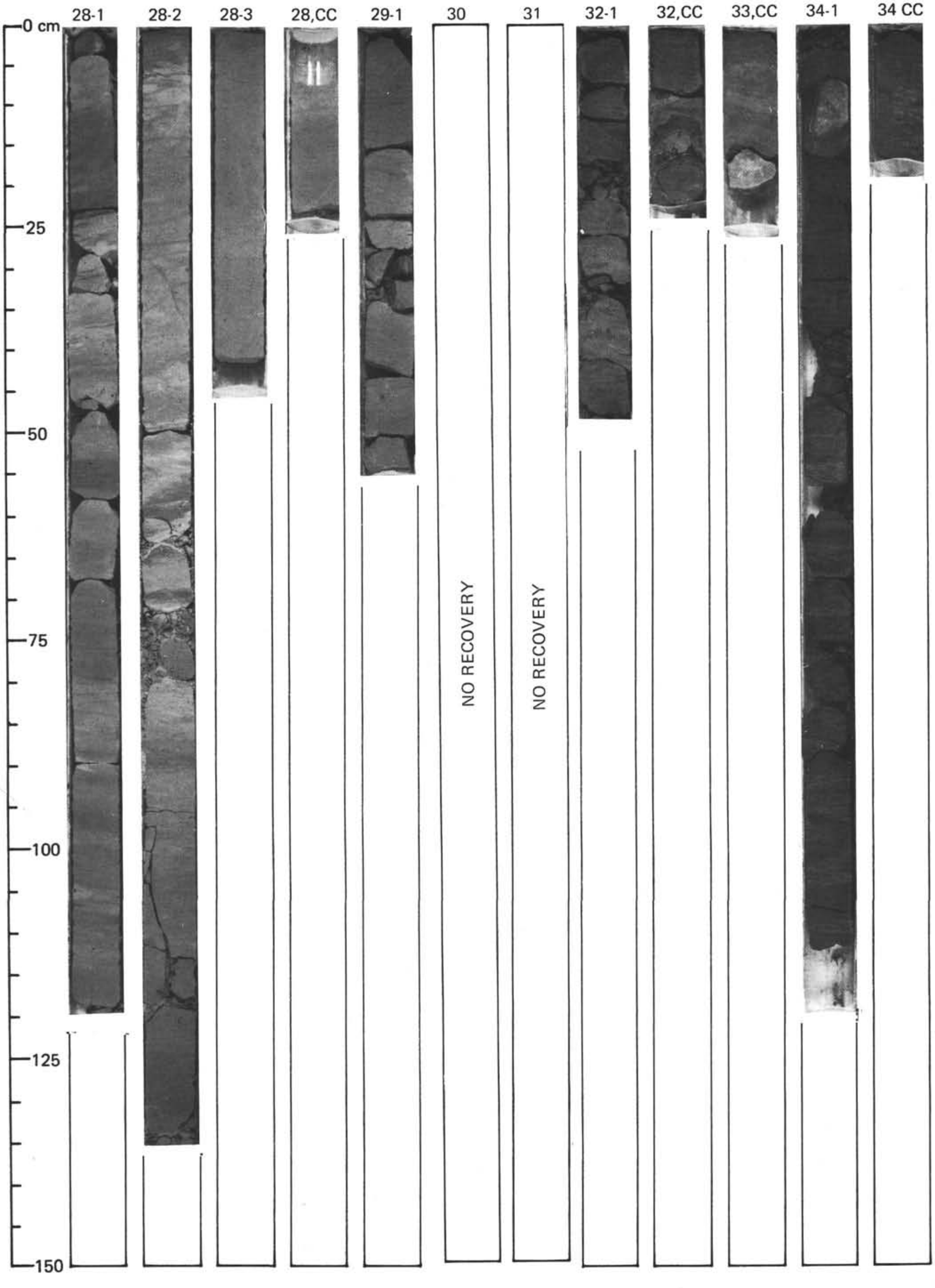
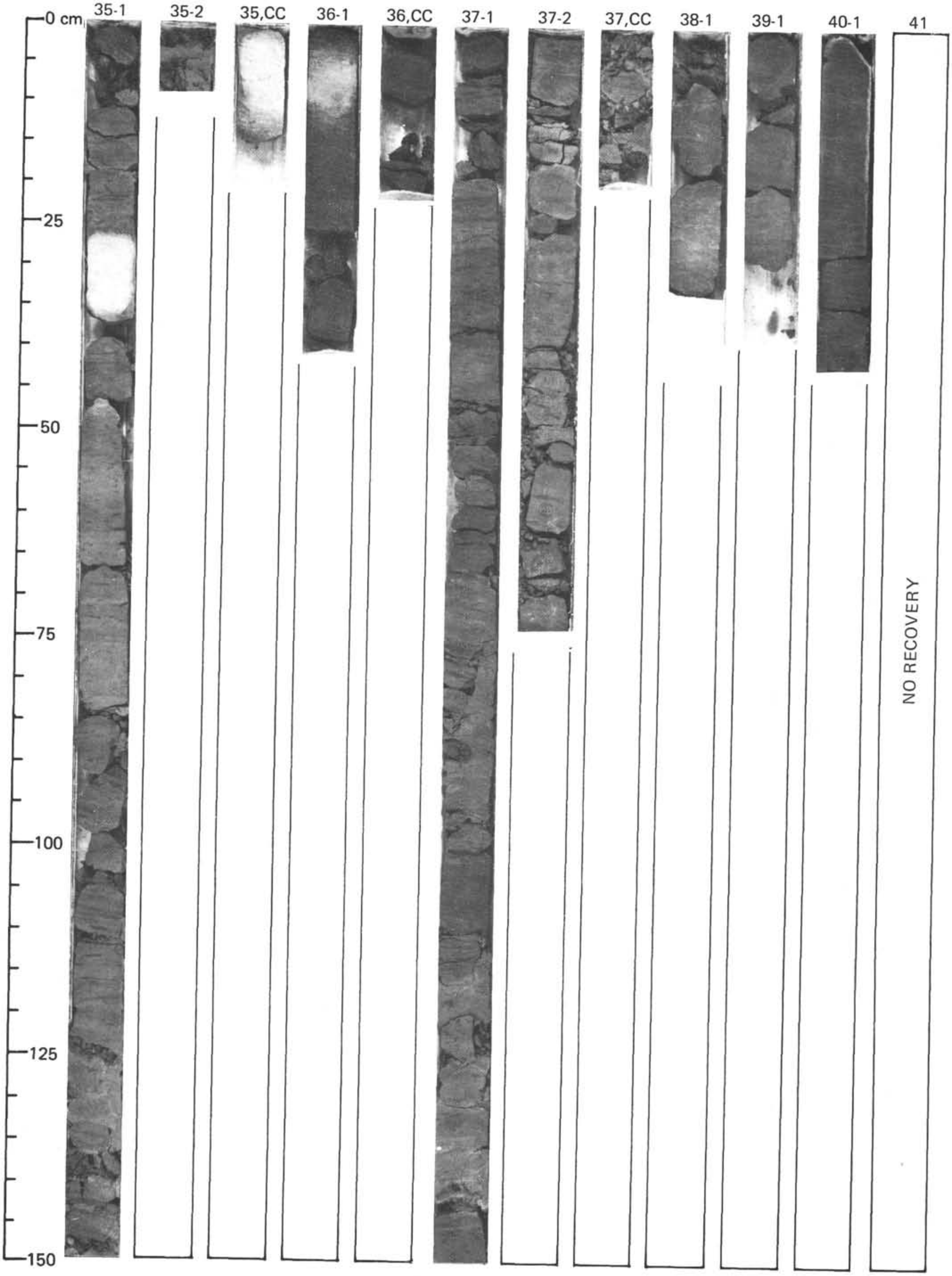
27-1


28-1
28-2
28-3
28,CC
29-1
30
31
32-1
32,CC
33,CC
34-1
34 CC
0 cm
25
50
75
100
125
150
NO RECOVERY
NO RECOVERY


0 cm
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35-1
35-2
35,CC
36-1
36,CC
37-1
37-2
37,CC
38-1
39-1
40-1
41
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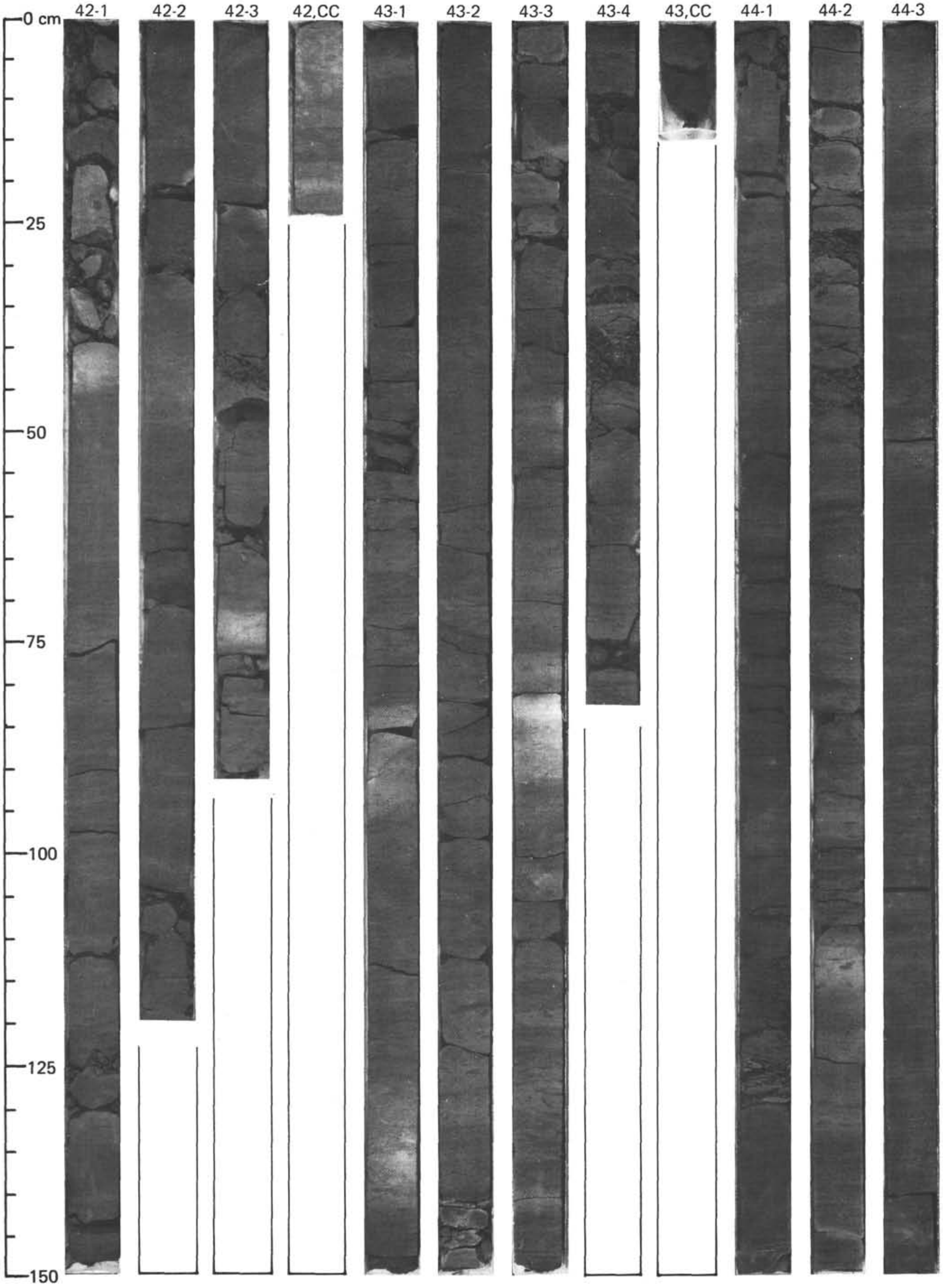
0 cm
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42-1
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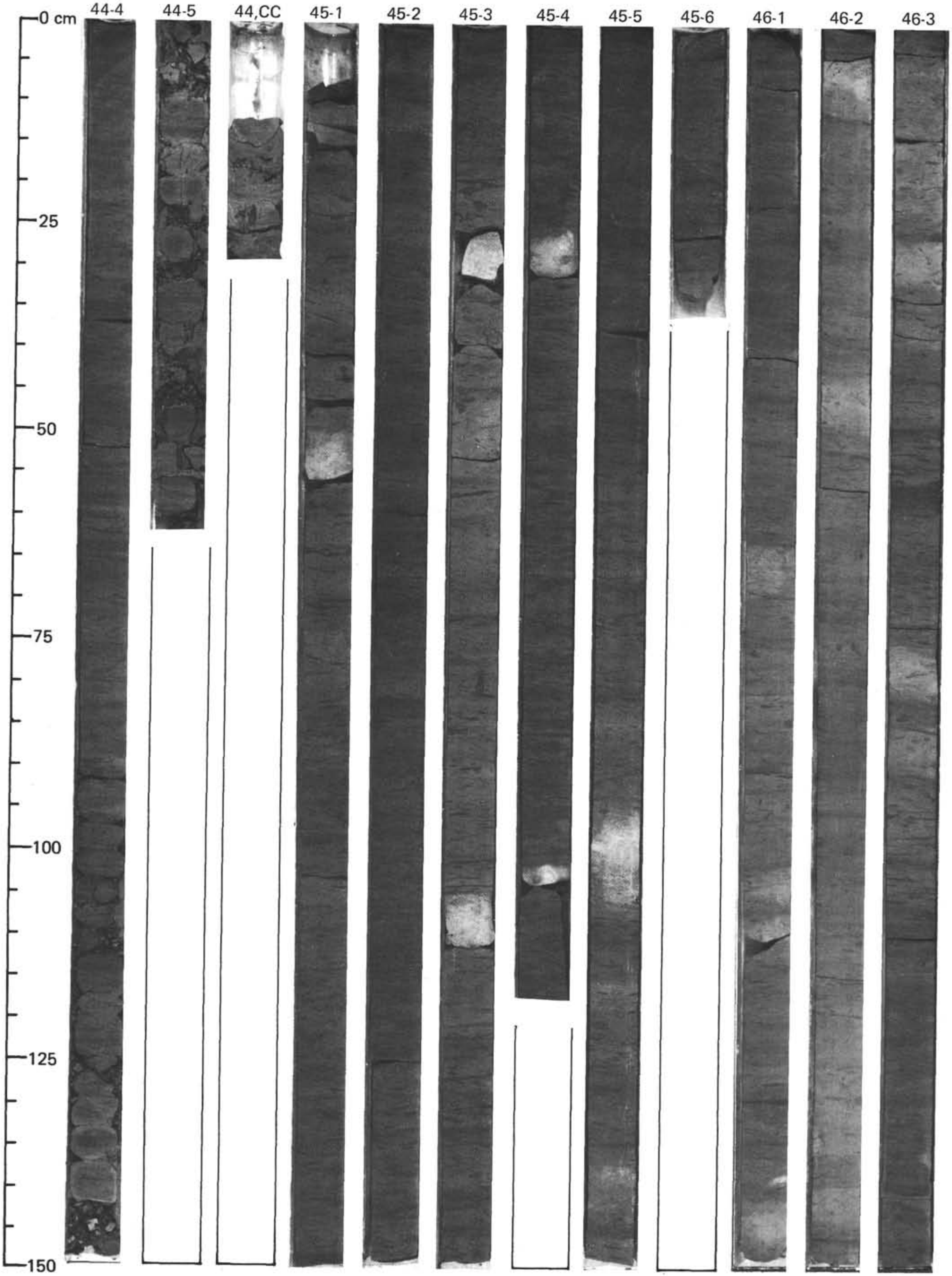
42-3
42,CC
43-1
43-2
43-3
43-4
43,CC
44-1
44-2
44-3


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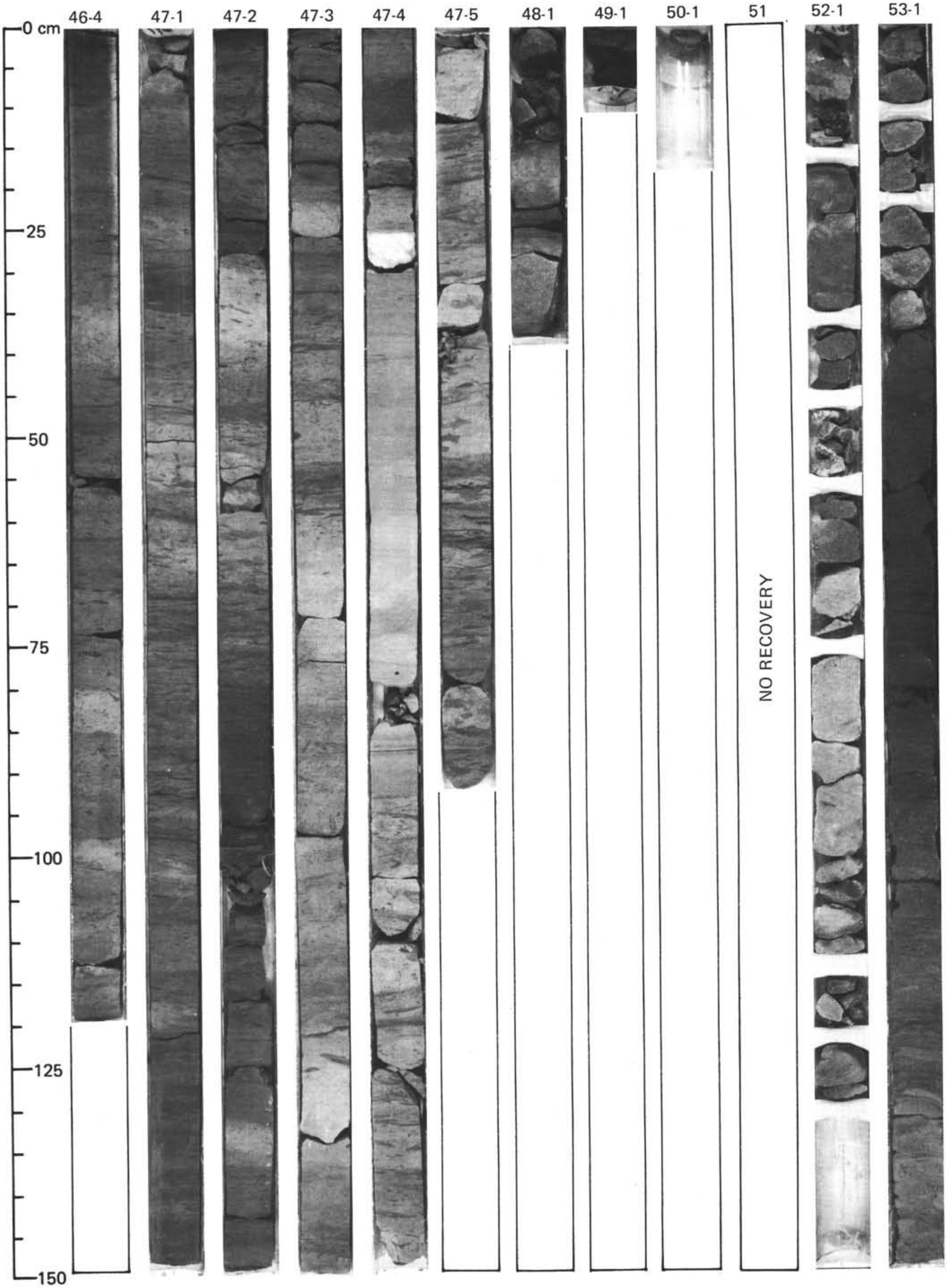
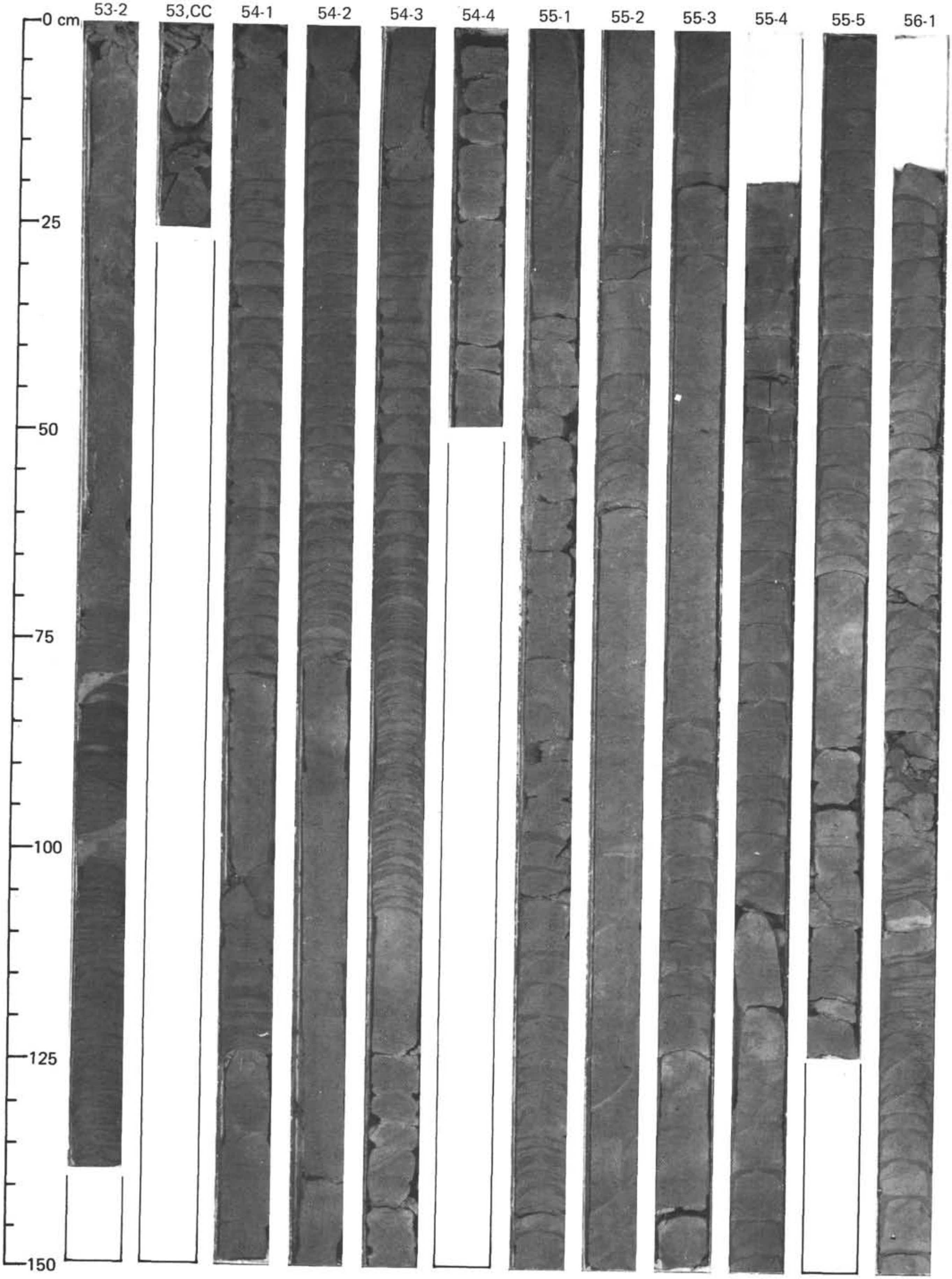
50
75
100
125
150
44-4
44-5
44,CC
45-1
45-2
45-3
45-4
45-5
45-6
46-1
46-2
46-3


46-4
47-1
47-2
47-3
47-4
47-5
48-1
49-1
50-1
51
52-1
53-1
0 cm
25
50
75
100
125
150
NO RECOVERY


53-2
53,CC
54-1
54-2
54-3
54-4
55-1
55-2
55-3
55-4
55-5
56-1
0 cm
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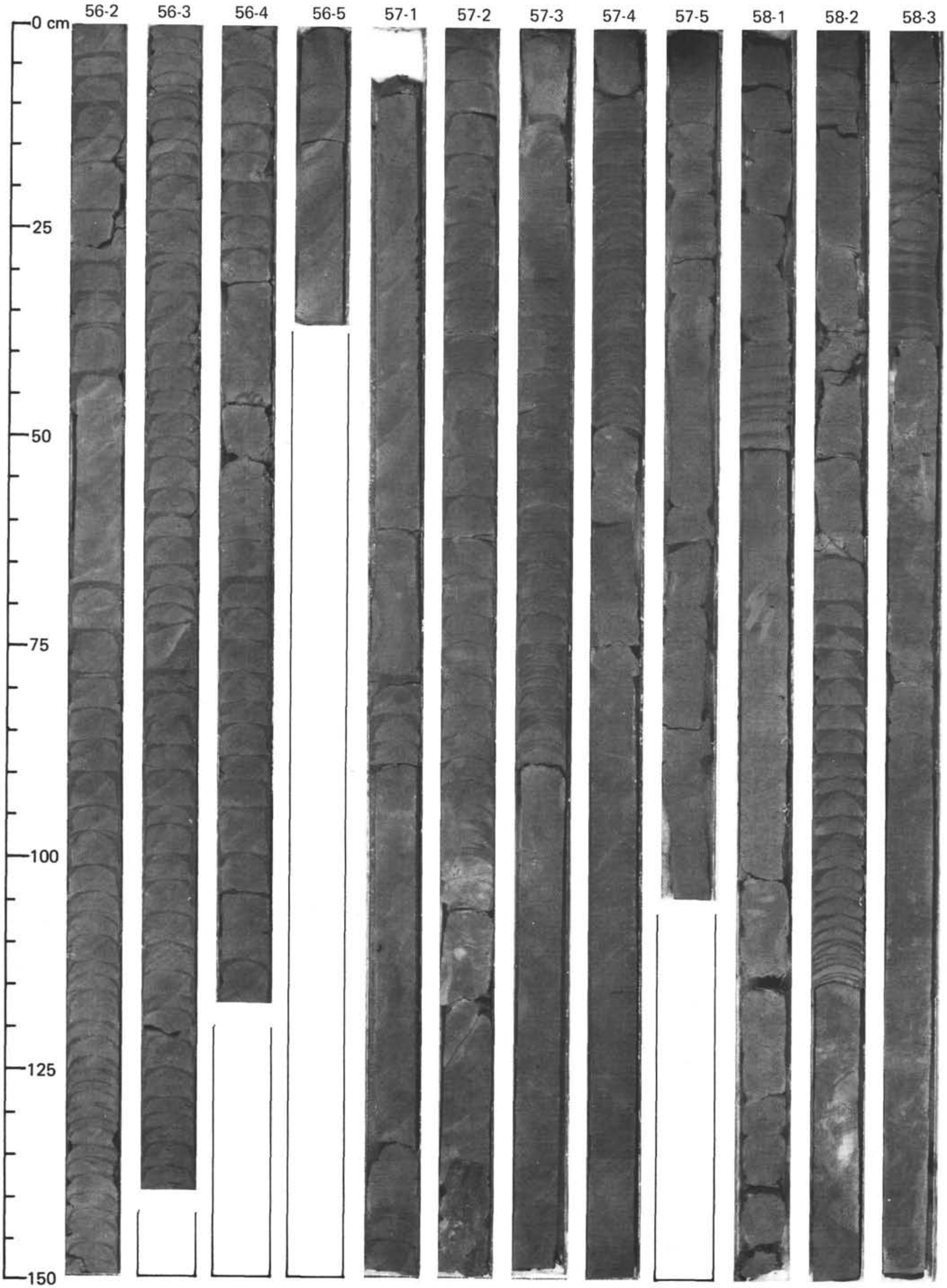
75
100
125
150


0 cm
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150
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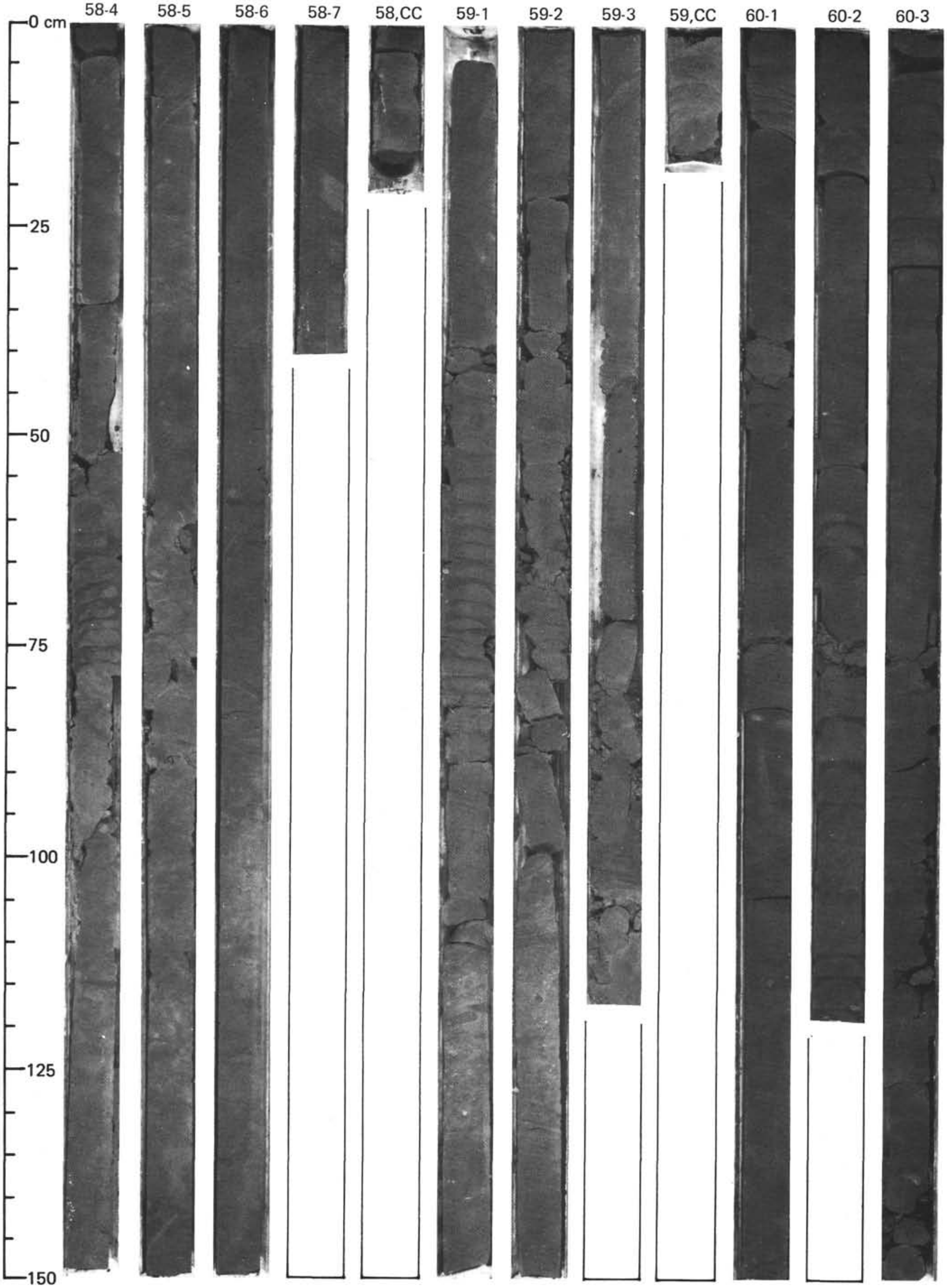
56-3
56-4
56-5
57-1
57-2
57-3
57-4
57-5
58-1
58-2
58-3


58-4
58-5
58-6
58-7
58,CC
59-1
59-2
59-3
59,CC
60-1
60-2
60-3
0 cm
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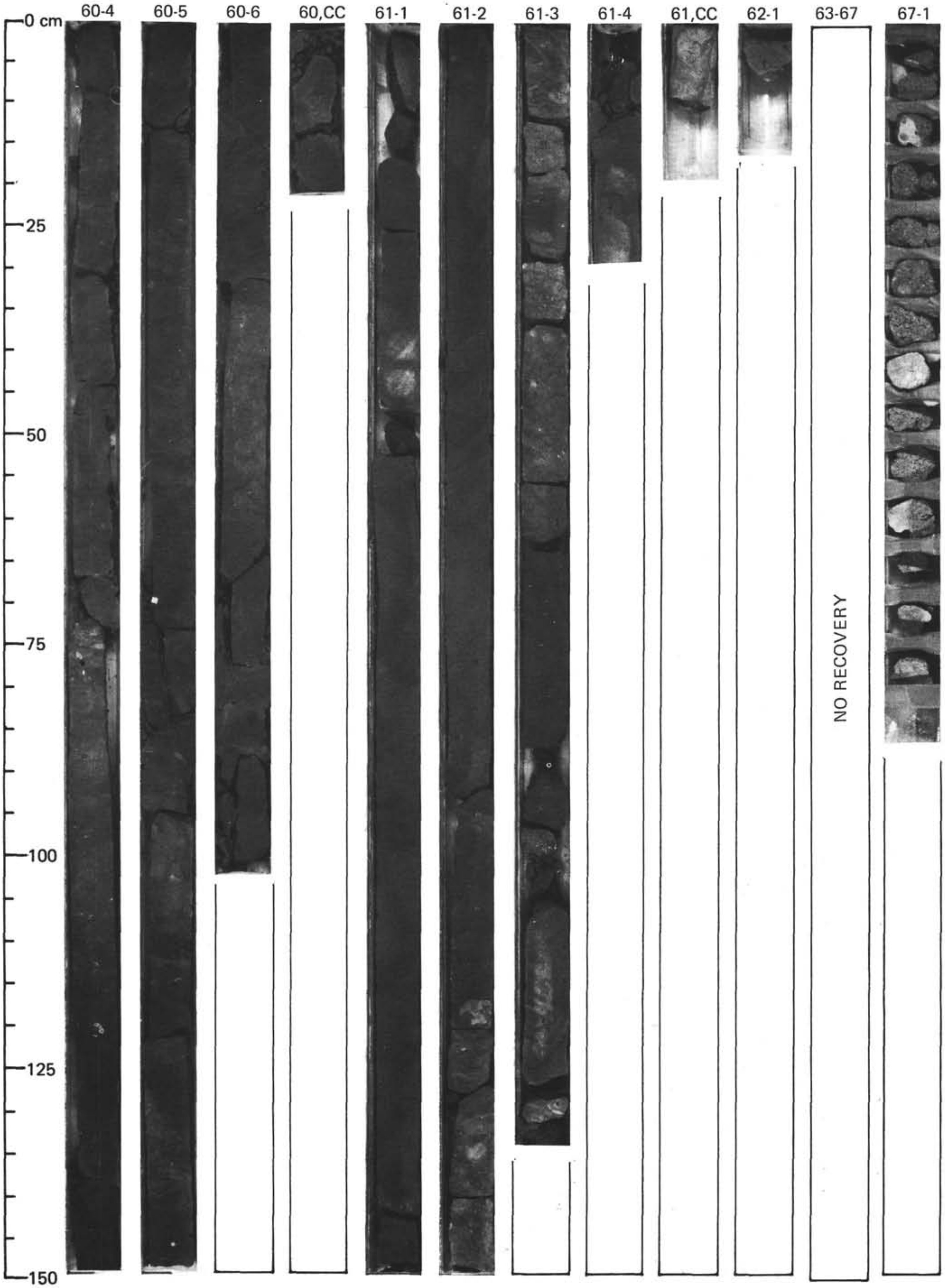
75
100
125
150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60-5
60-6
60,CC
61-1
61-2
61-3
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61,CC
62-1
63-67
67-1
0 cm
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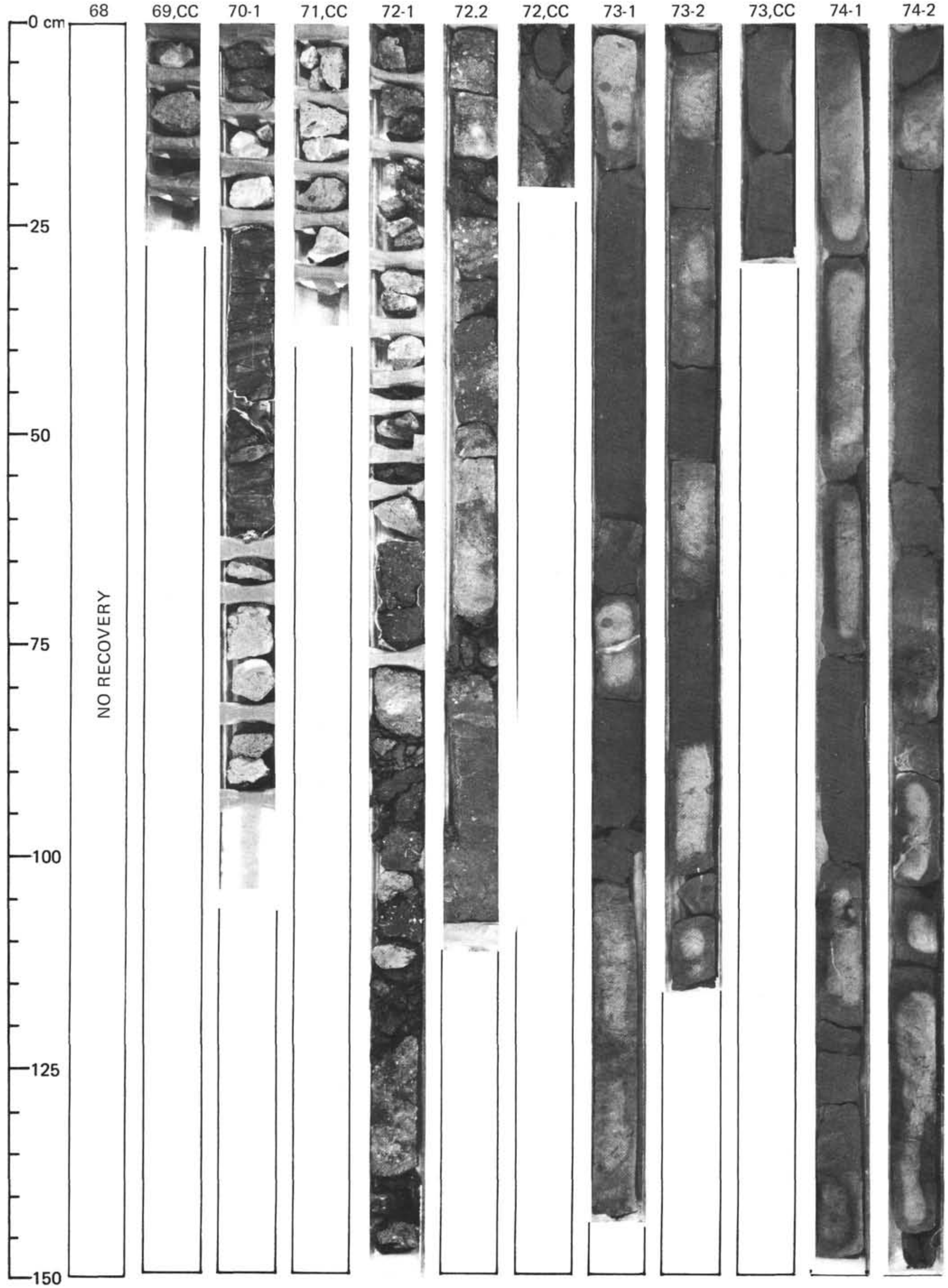
NO RECOVERY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75
100
125
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68
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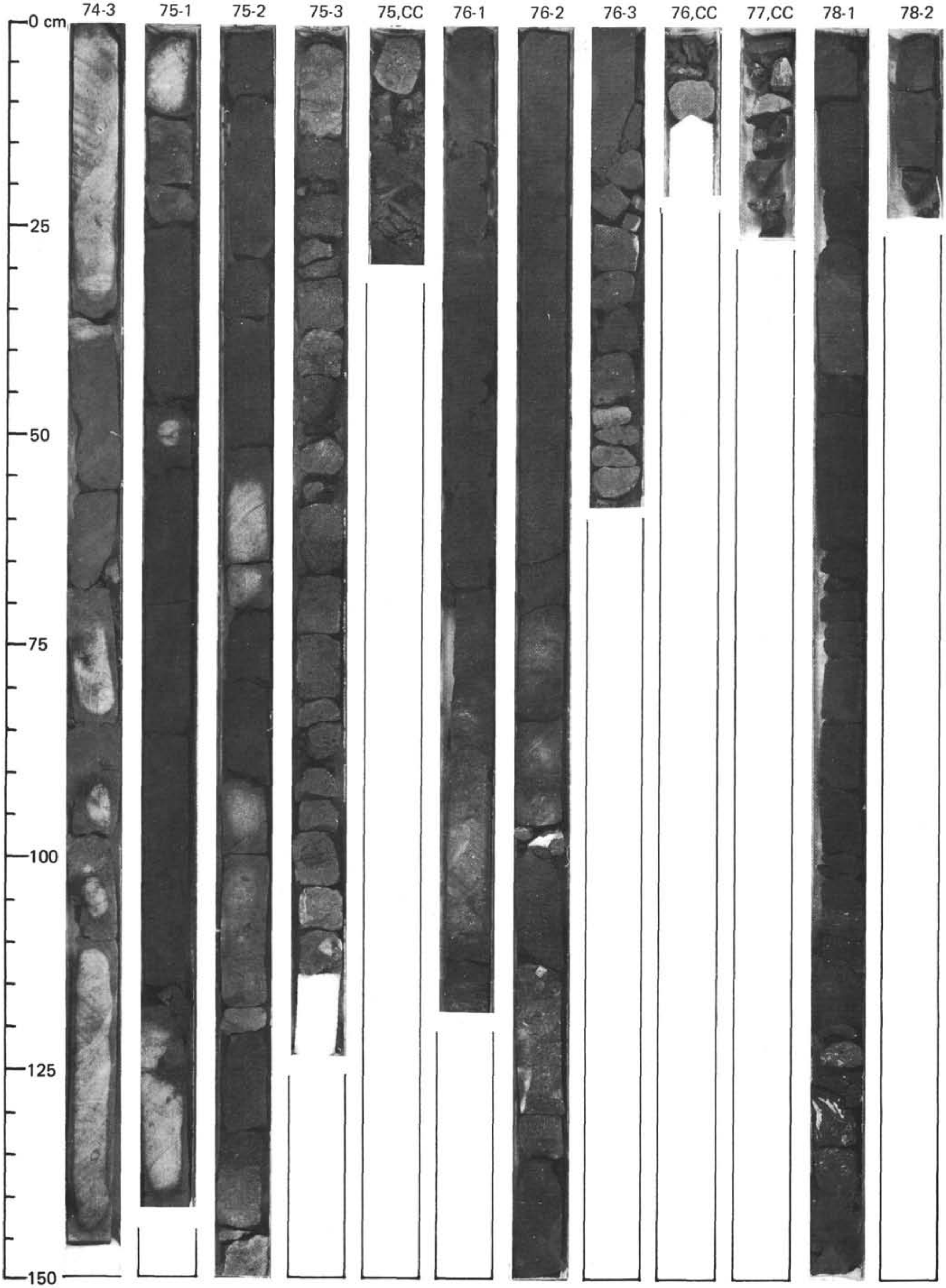
71,CC
72-1
72.2
72,CC
73-1
73-2
73,CC
74-1
74-2
NO RECOVERY


74-3
75-1
75-2
75-3
75,CC
76-1
76-2
76-3
76,CC
77,CC
78-1
78-2
0 cm
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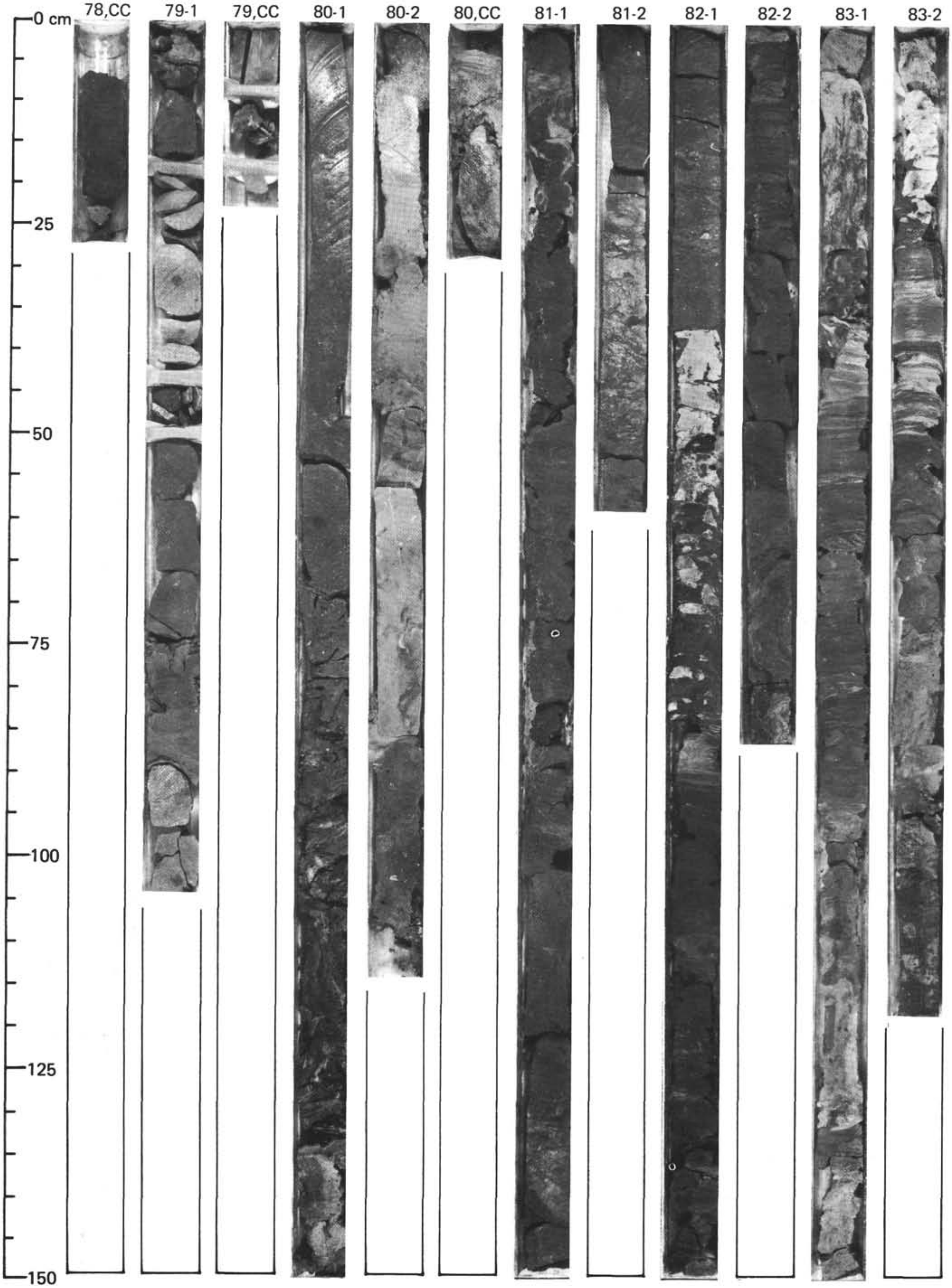
150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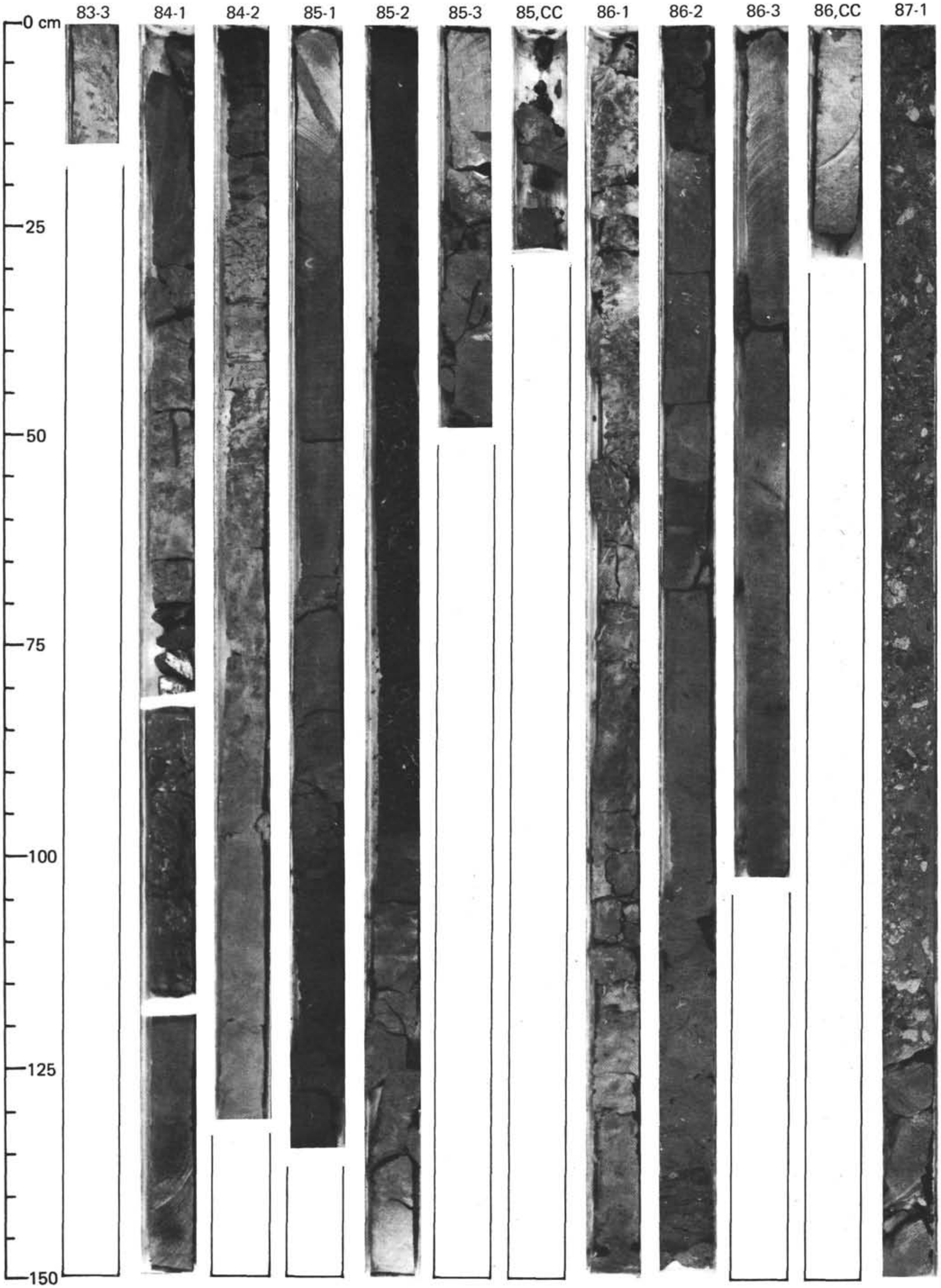
79,CC
80-1
80-2
80,CC
81-1
81-2
82-1
82-2
83-1
83-2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84-2
85-1
85-2
85-3
85,CC
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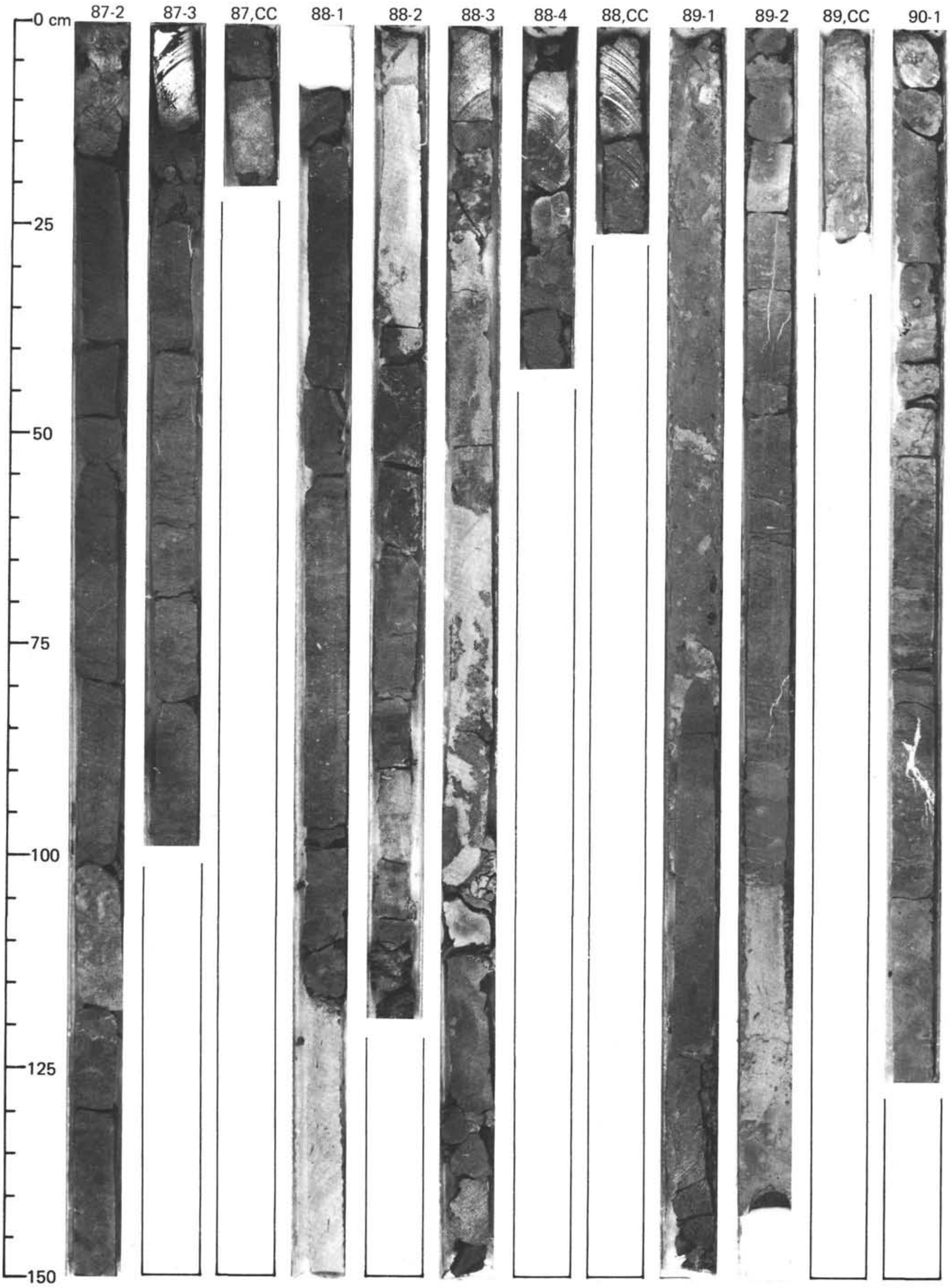
86-3
86,CC
87-1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75
100
125
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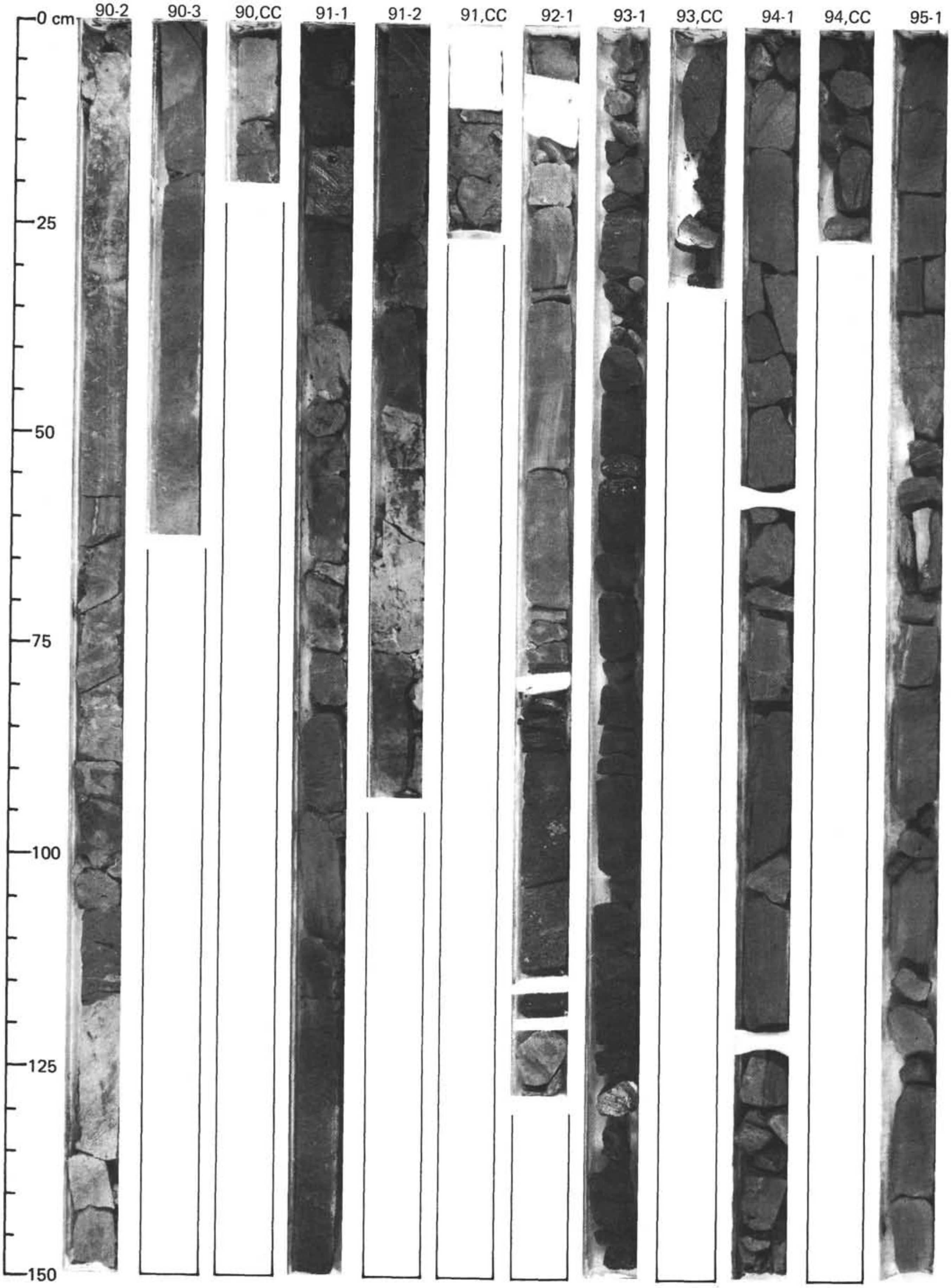
87-3
87,CC
88-1
88-2
88-3
88-4
88,CC
89-1
89-2
89,CC
90-1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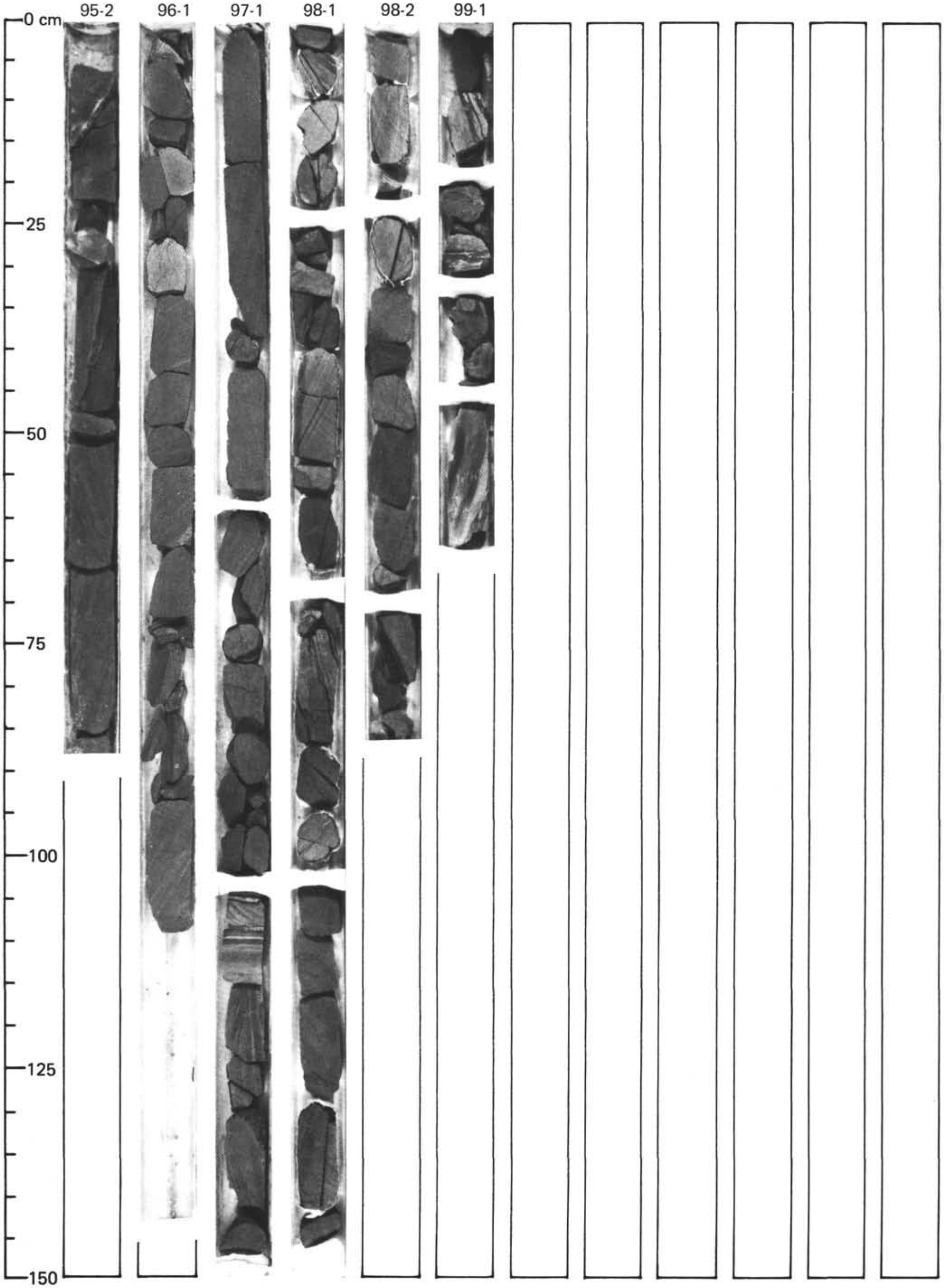
90-3
90,CC
91-1
91-2
91,CC
92-1
93-1
93,CC
94-1
94,CC
95-1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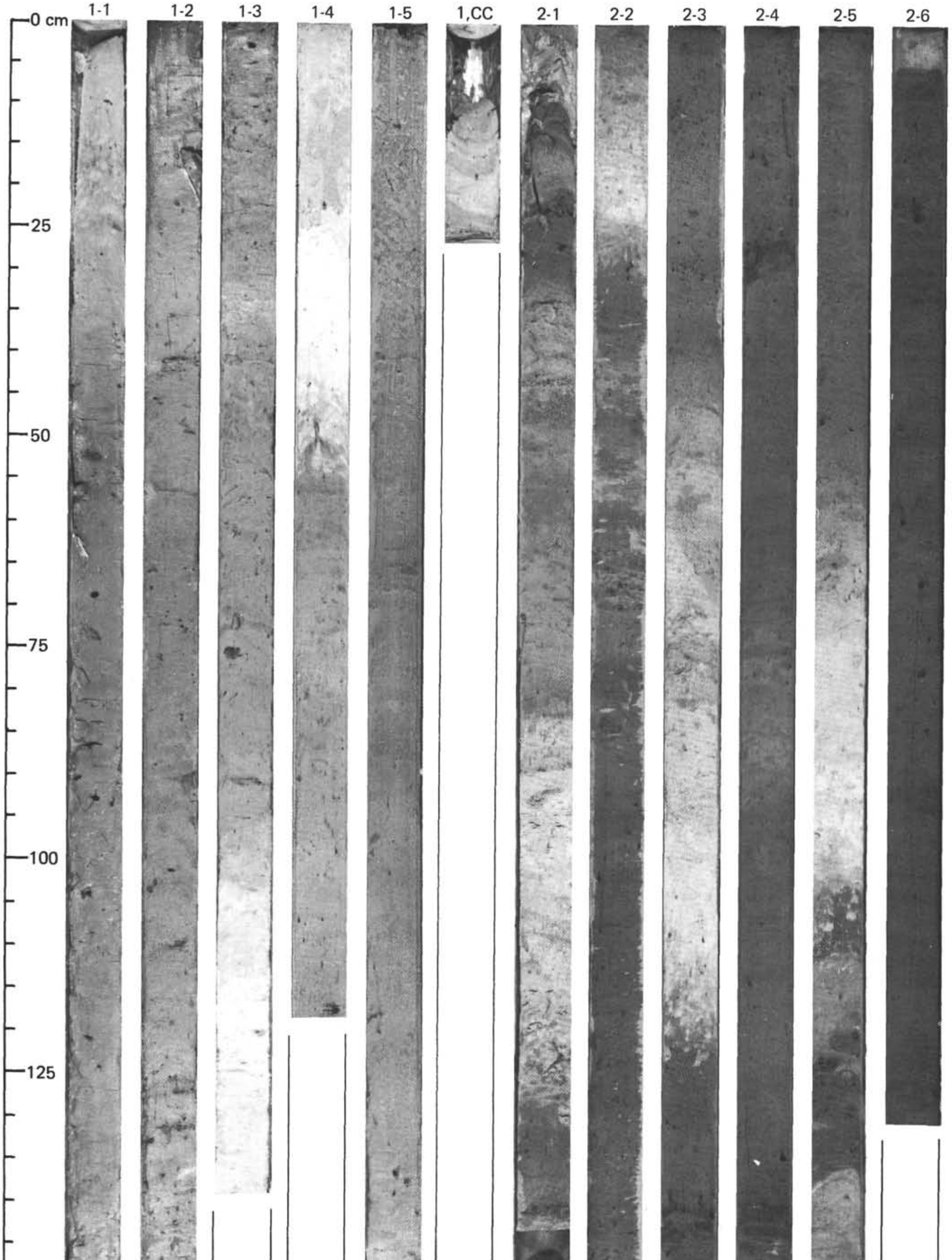
96-1
97-1
98-1
98-2
99-1


0 cm
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1-2
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1-4
1-5
1,CC
2-1
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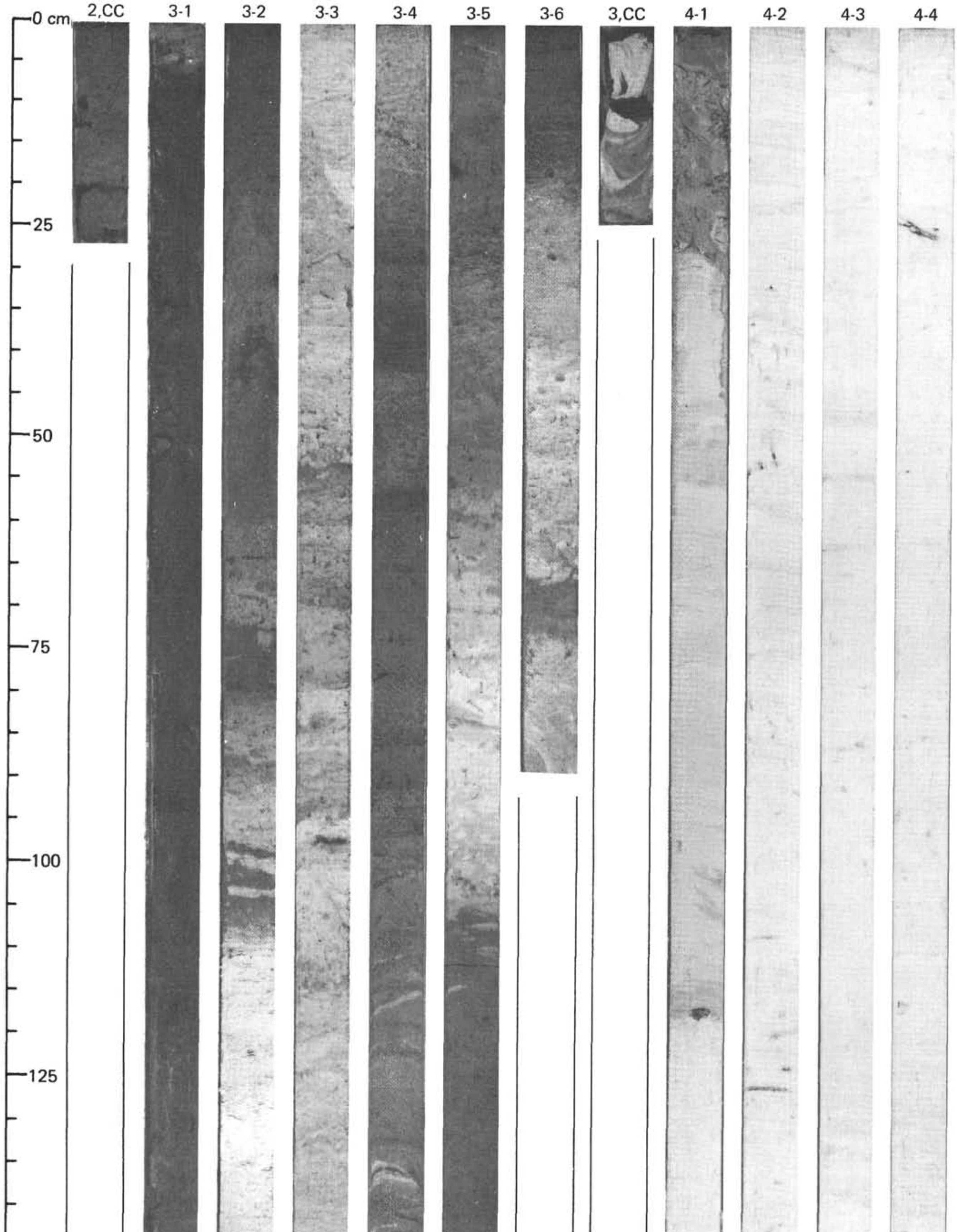
2-3
2-4
2-5
2-6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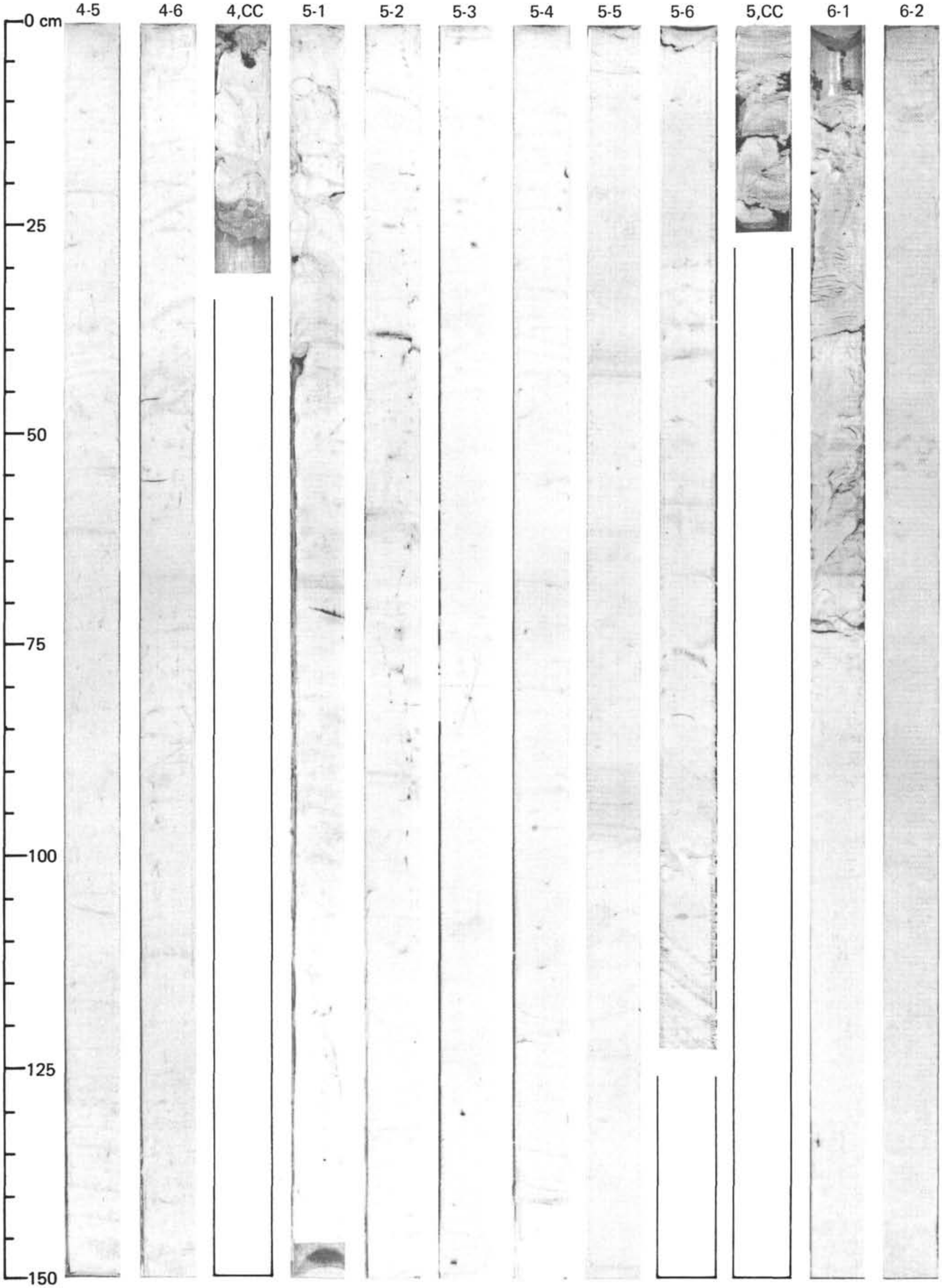
3-2
3-3
3-4
3-5
3-6
3,CC
4-1
4-2
4-3
4-4


0 cm
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4-5
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4,CC
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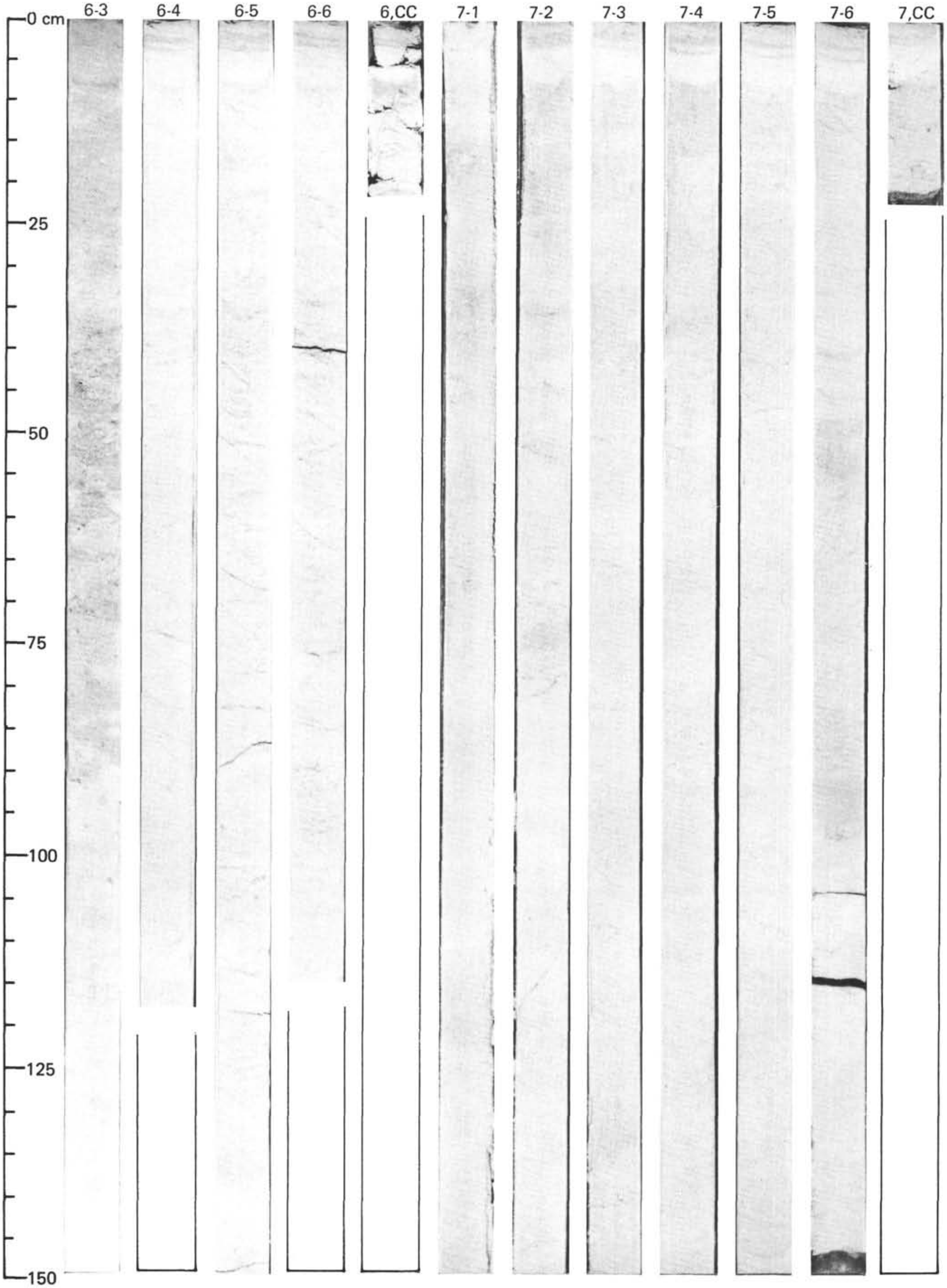
5-6
5,CC
6-1
6-2


6-3
6-4
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6,CC
7-1
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7-3
7-4
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7,CC
0 cm
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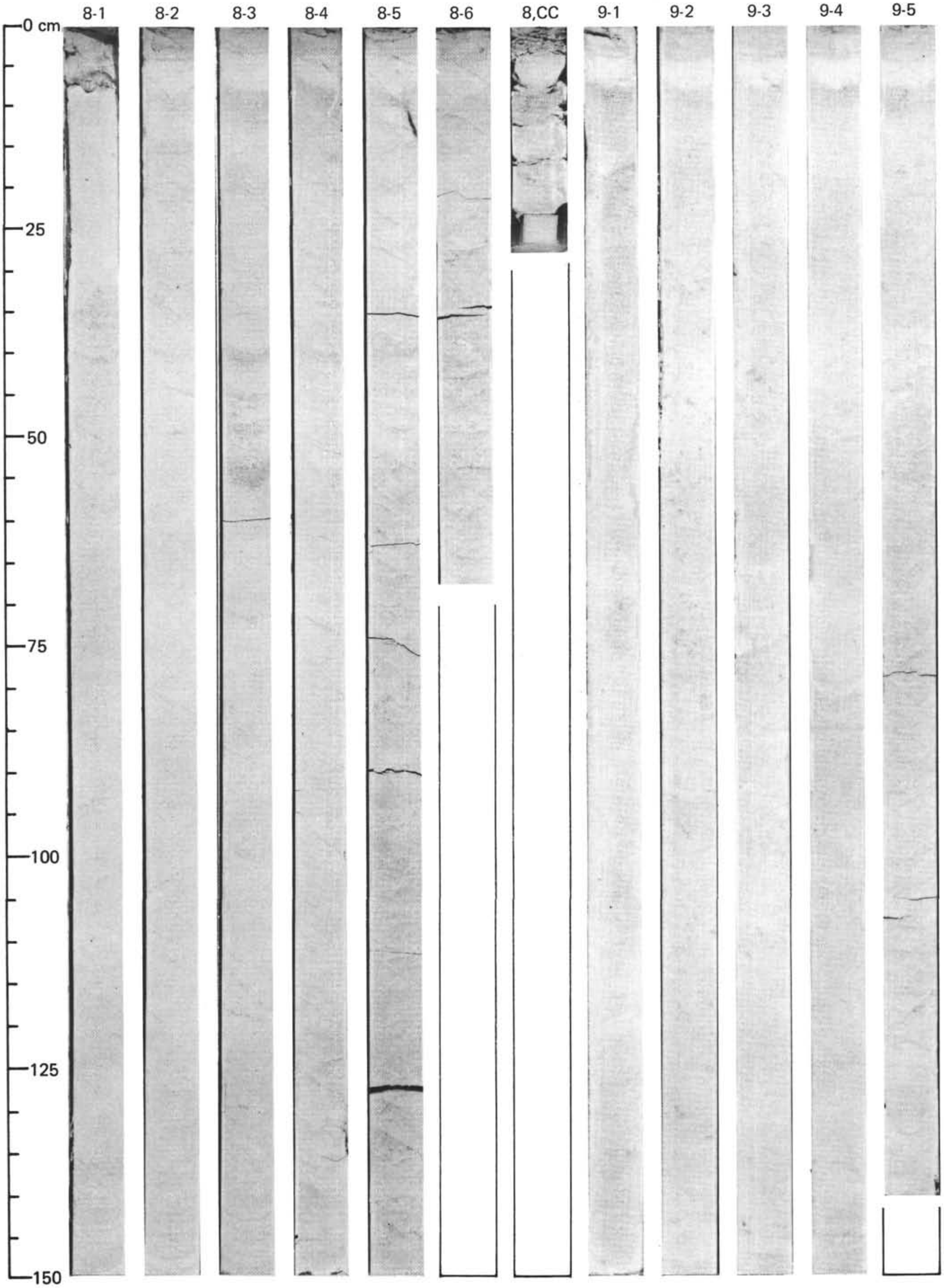
8-1
8-2
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8-6
8,CC
9-1
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9-4
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0 cm
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9-6
9,CC
10-1
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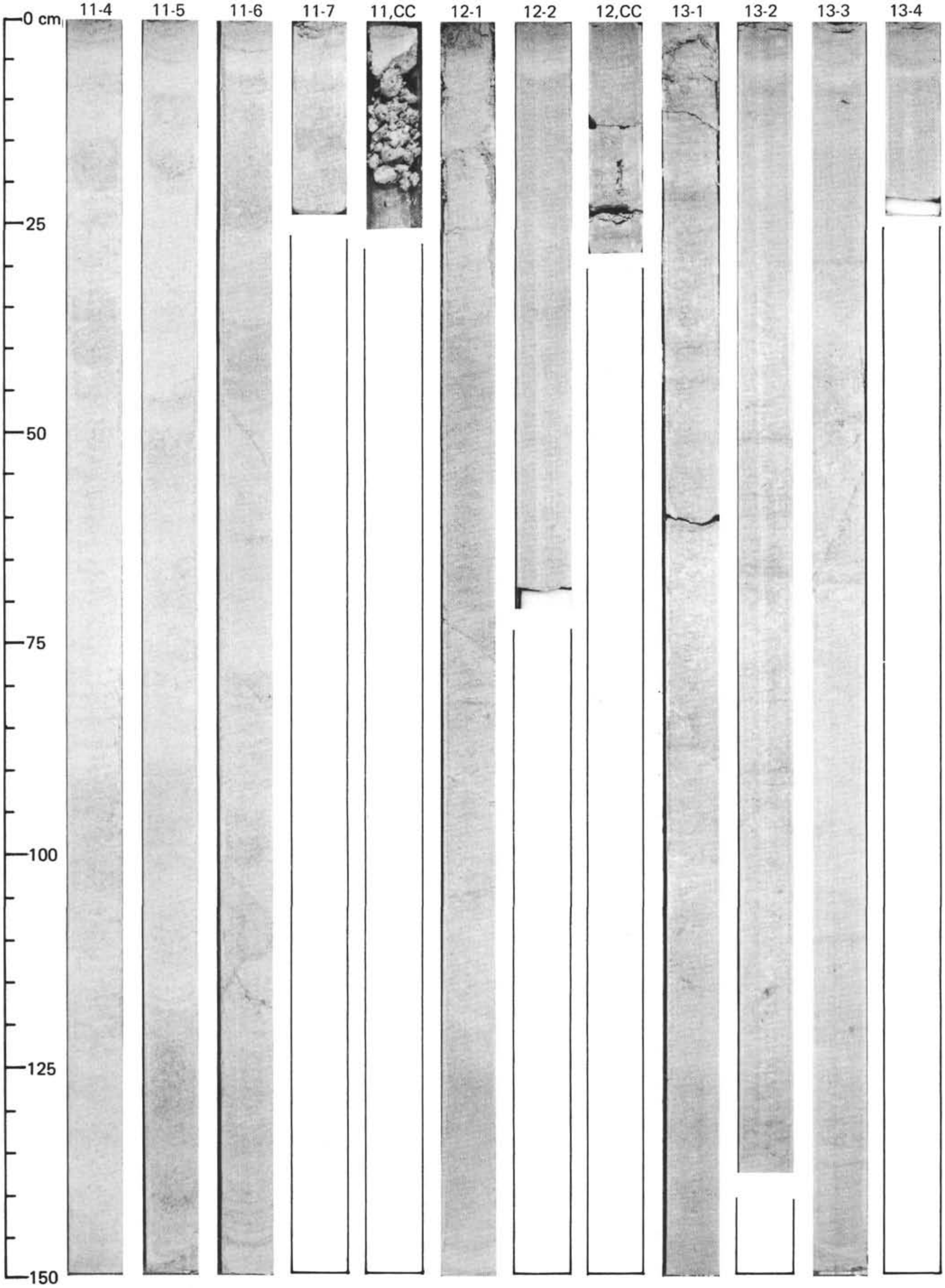
10-3
10-4
10-5
10-6
10,CC
11-1
11-2
11-3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11,CC
12-1
12-2
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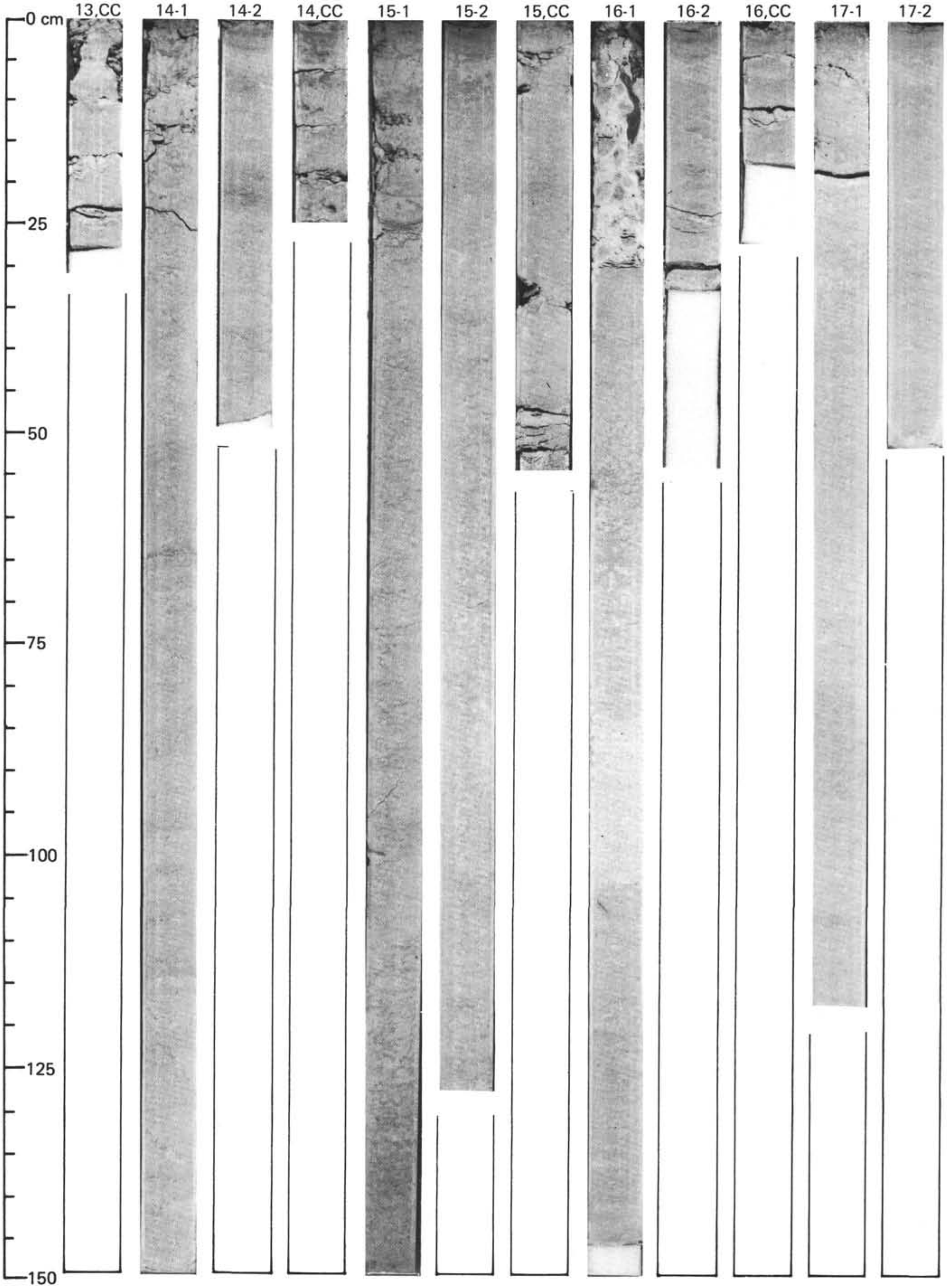
13-2
13-3
13-4


0 cm
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14,CC
15-1
15-2
15,CC
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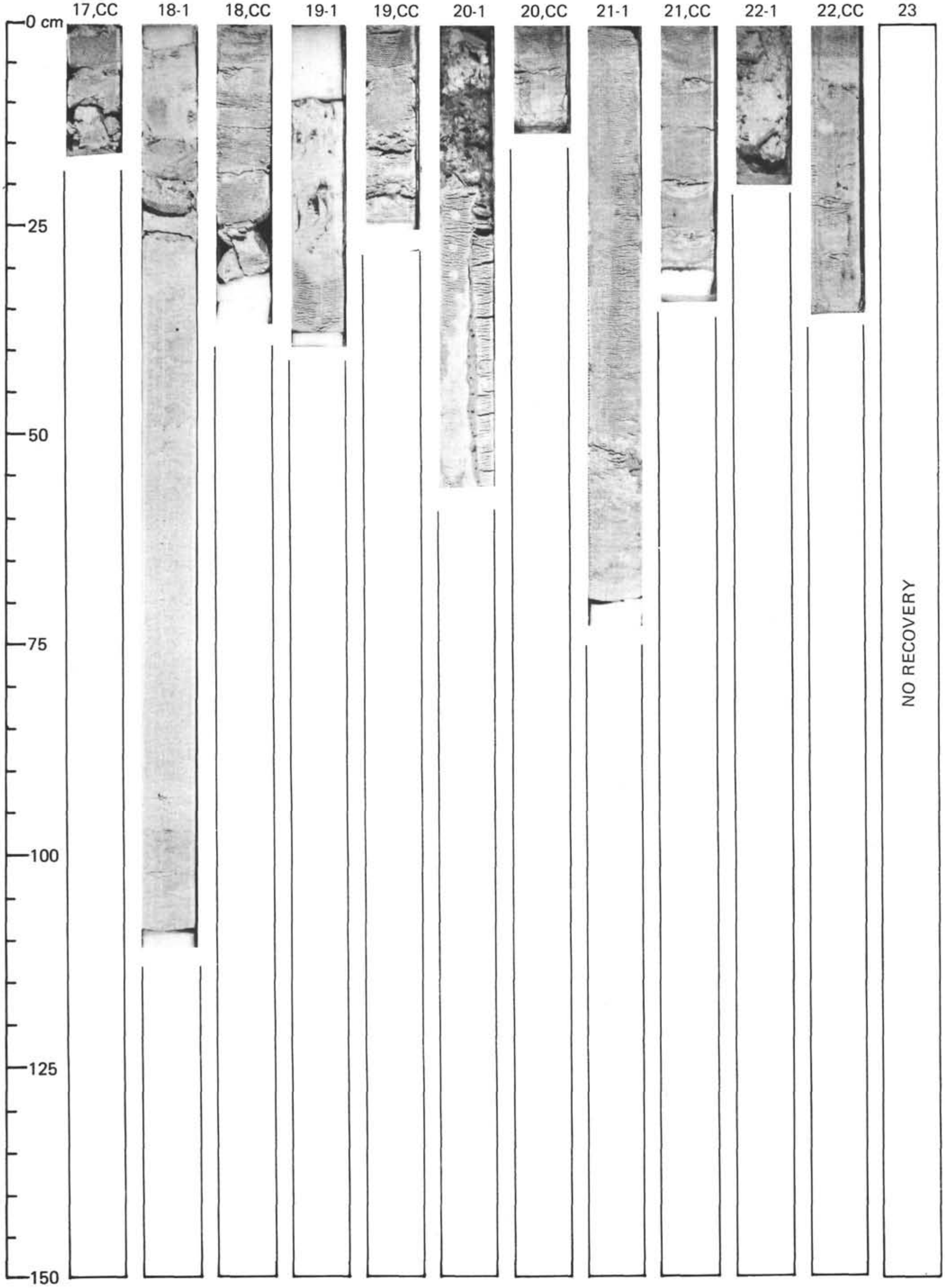
16,CC
17-1
17-2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17,CC
18-1
18,CC
19-1
19,CC
20-1
20,CC
21-1
21,CC
22-1
22,CC
23
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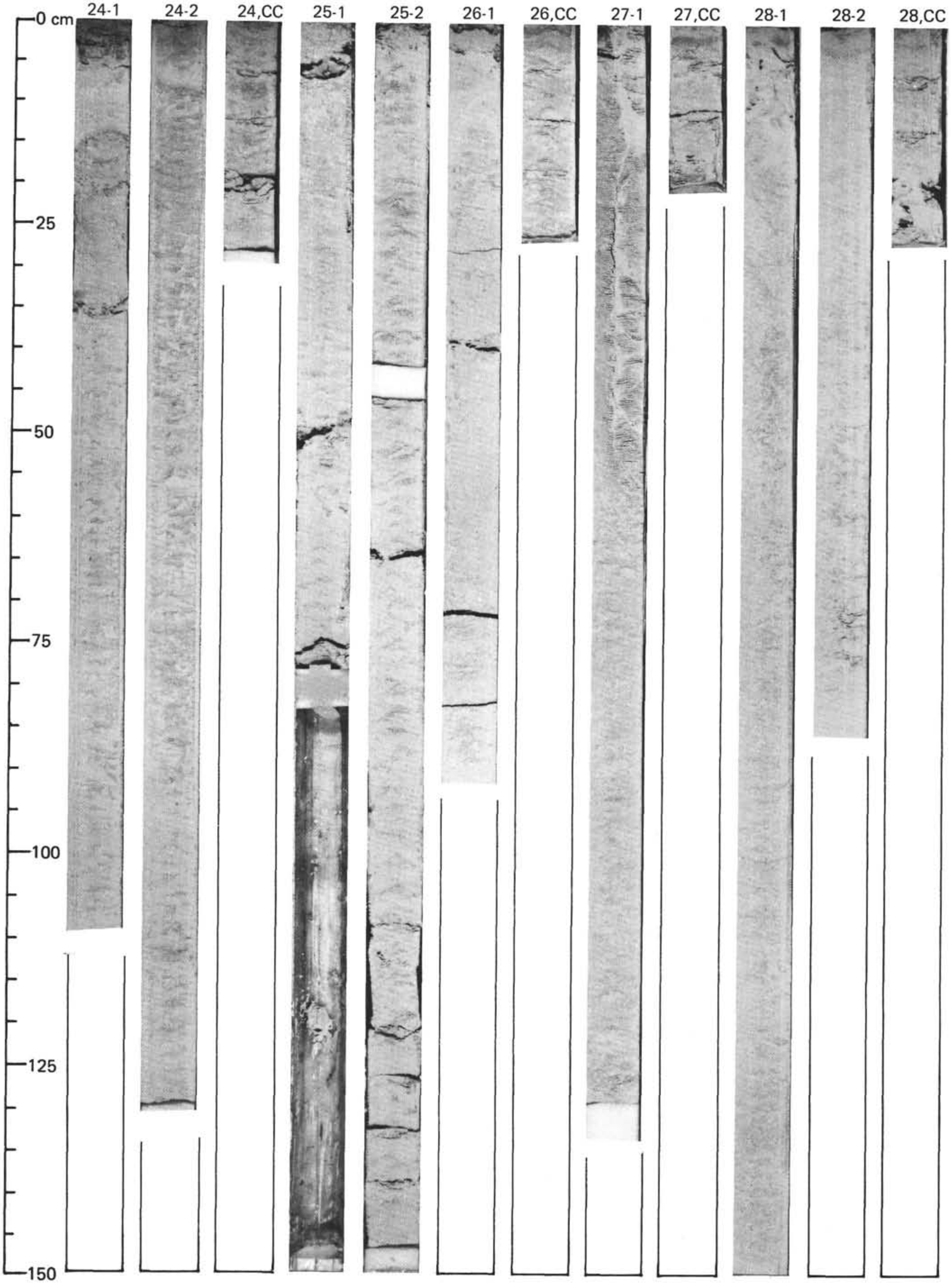
0 cm
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24-2
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25-1
25-2
26-1
26,CC
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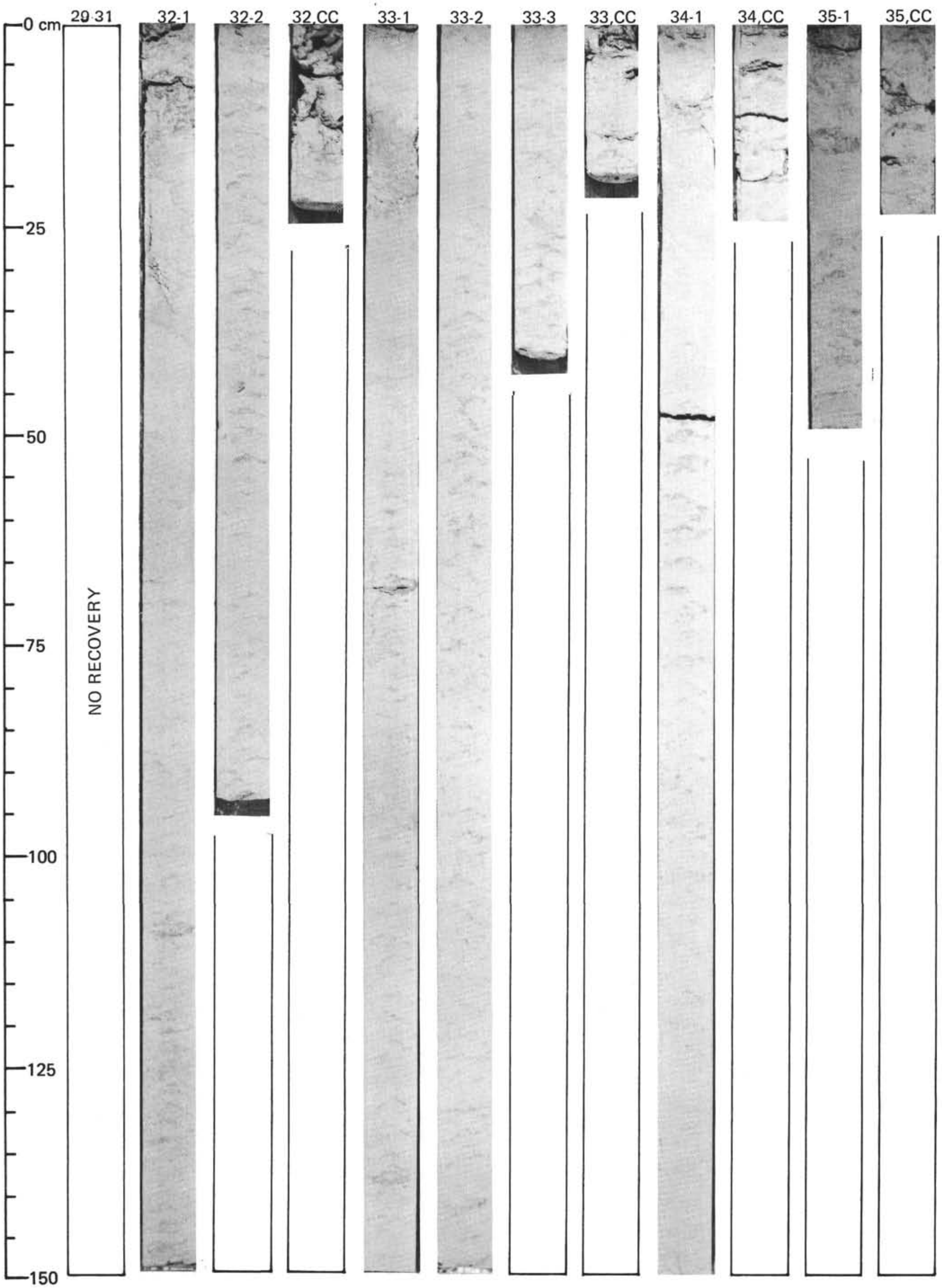
28-1
28-2
28,CC


0 cm
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32-2
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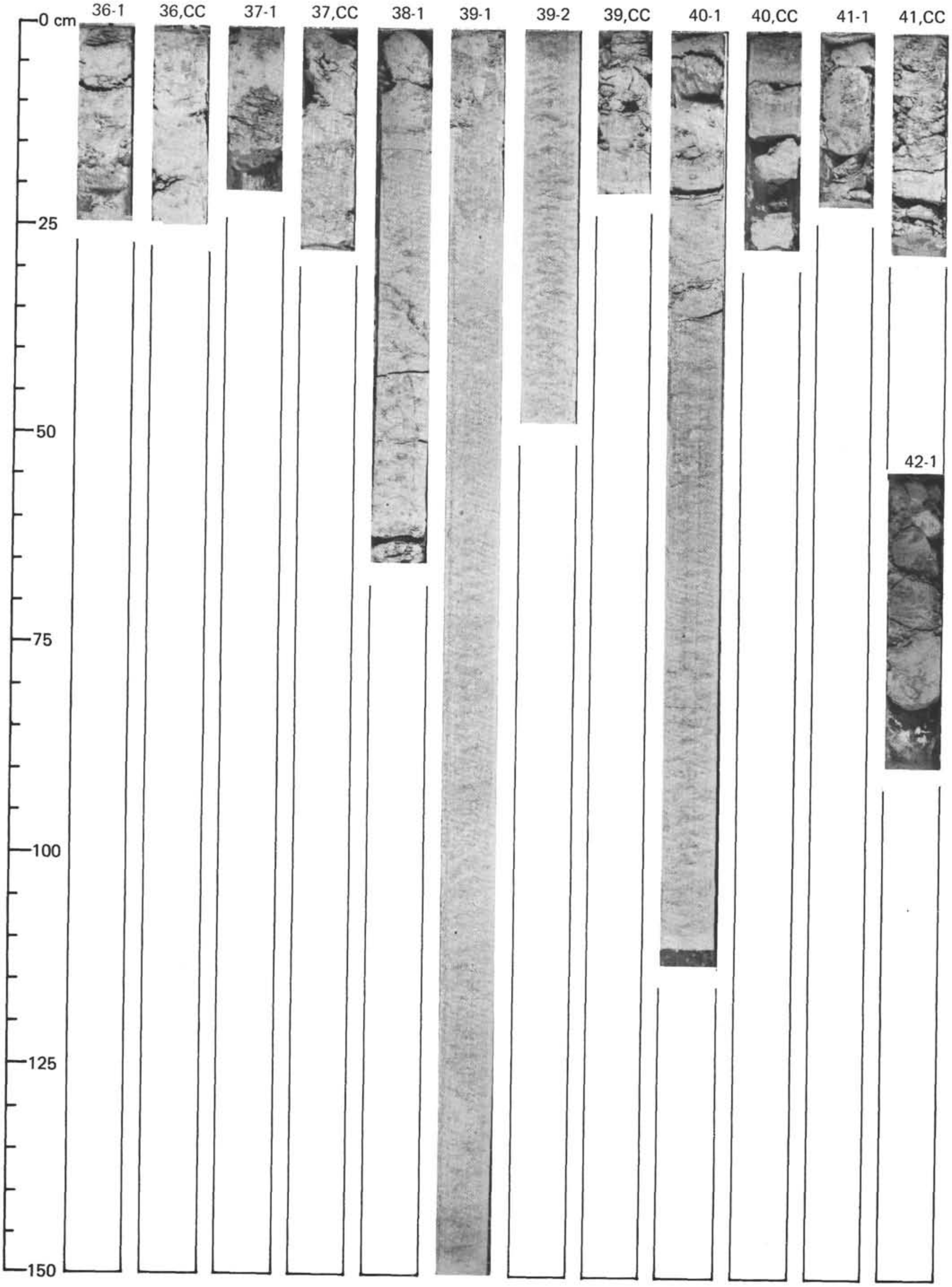
33-1
33-2
33-3
33,CC
34-1
34,CC
35-1
35,CC
NO RECOVERY


0 cm
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125
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36-1
36,CC
37-1
37,CC
38-1
39-1
39-2
39,CC
40-1
40,CC
41-1
41,CC
42-1