3. SITE 576[1]

Shipboard Scientific Party, with a contribution by Patricia Doyle[2]

HOLES 576, 576A, 576B

Date occupied: 16–18 May (576);
18–19 May (576A);
19–20 May (576B)

Date departed: 21 May 1982

Time on site: 4 days, 16 hr.

Position (latitude; longitude): 32°21.36′N; 164°16.54′E (576)
32°21.38′N; 164°16.52′E (576A)
32°21.37′N; 164°16.52′E (576B)

Water depth (sea level; corrected m, echo-sounding): 6217

Water depth (rig floor; corrected m, echo-sounding): 6227

Bottom felt (m, drill pipe): 6220.3 (576):
6218.0 (576A);
6219.3 (576B)

Penetration (m): 69.2 (576);
65.7 (576A);
74.8 (576B)

Number of cores: 8 (567);
7 (576A);
9 (576B)

Total length of cored section (m): Same as penetration (above)

Total core recovered (m): 68.52 (576);
66.20 (576A);
74.07 (576B)

Core recovery (%): 99 (576);
101 (576A);
99 (576B)

Oldest sediment cored:
Depth sub-bottom (m): 73
Nature: Nannofossil ooze–pelagic clay
Age: Campanian
Measured velocity (km/s): 1.43–1.50

Basement: Not reached

Principal results: Site 576 met all of its objectives. The surface ("transparent") acoustic layer was completely cored three times, with essentially full recovery. One complete section (Hole 576A) was stored vertically, unopened, for shore-based geotechnical studies.

The section cored consists of three lithologic units, with the top unit divisible into two subunits as follows:

Subunit IA (0 to 28 m, contact gradational over several meters) is a yellowish brown to brown pelagic clay of Pliocene and Quaternary age (based on paleomagnetics). Sedimentation rate decreases from 10 m/m.y. in the Brunhes Epoch to less than 3 m/m.y. at the base of the Matuyama Epoch. Based on earlier studies and the abundance of silt-sized quartz, we infer that this unit is largely of eolian origin.

Subunit IB (28 to 55 m) is a dark brown "slick" pelagic clay, zeolitic in part. This material is extremely homogeneous, very fine grained, and manganese rich. If deposition has been continuous, the average sedimentation rate decreased from about 1 m/m.y. during the late Neogene to about 0.35 m/m.y. at about 40 m.y. ago, before increasing to 0.6 m/m.y. (uncorrected for compaction) during the Late Cretaceous. Shore-based studies of ichthyoliths should further constrain these rates. By analogy with similar North and South Pacific pelagic clays, we infer that this subunit contains a large authigenic component.

Lithologic Unit II (55 to 76 m sub-bottom) is an interbedded dark brown pelagic clay similar to Subunit IB and pale brown nannofossil ooze of Campanian age. At the base of the unit, the clay layers also include pink bands and mottles. Several of the carbonate layers are graded and have sharp erosional basal contacts; these are turbidites. Other layers may be pelagic. The absence of microfossils younger than Campanian age and the results of earlier Deep Sea Drilling Project (DSDP) drilling in this region suggest that the components of the carbonate and clay layers are essentially contemporaneous. Whether the carbonate reflects enhanced biogenic deposition due to higher productivity (at the lower latitude of the site 70 m.y. ago) or to fluctuations in the carbonate compensation depth (CCD) is unclear.

Lithologic Unit III (76 m) consists of one small glassy chert chip and a few small fragments of off-white porcellanite. This unit forms the prominent reflector at the base of the "transparent" layer in the northwest Pacific.

Progressive consolidation of the pelagic clays of lithologic Units I and II yielded striking physical properties profiles. Both shear wave velocity and vane shear strength increased with depth (from 6 to 127 m/s and less than 20 to more than 1000 g/cm^2, respectively) without regard to the lithologic change from Subunit IA to IB. LL44-GPC3 at 30°N, 158°W showed similar trends.

The new Woods Hole Oceanographic Institution (WHOI) core-nose heat flow unit worked well on 7 of 11 deployments.

BACKGROUND AND OBJECTIVES

Site 576 (target Site NW-9) was proposed by the JOIDES Ocean Paleoenvironment, Sedimentary Petrology and Physical Properties, and Inorganic Geochemistry Panels as a "type" North Pacific red clay site. The general location was chosen to be far enough west to lie in an area of uniform pelagic sedimentation between Shatsky Rise and the Emperor Seamounts, but far enough east to minimize the fraction of the section occupied by ash layers. Our operational objectives were to recover a complete section above Cretaceous(?) chert by triple hydraulic piston coring (HPC), with the cores from one

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entire hole to be returned to shore unopened for detailed geotechnical studies.

Our specific scientific objectives were

1. To recover a very long-term record of North Pacific red clay sedimentation;
2. To assess the nature and history of authigenic sedimentation during the Late Cretaceous and Cenozoic;
3. To determine the Late Cretaceous and Cenozoic history of eolian sedimentation for comparison with the LL44-GPC3 record at 30°N, 158°W;
4. To collect an oriented undisturbed red clay section for paleomagnetic studies;
5. To determine the consolidation history of a "type" red clay section by detailed geotechnical studies;
6. To assess the nature of the red clay/chert boundary, and particularly to determine if the transition is marked by an increase in the content of opaline silica or enhanced diagenesis of the basal red clays.

Geologic and Topographic Setting

The regional seafloor morphology and echo character of the near-surface sediments of the northwest Pacific has been mapped by Damuth et al. (1983) using all available Lamont-Doherty, Scripps, and Hawaii Institute of Geophysics 3.5-kHz reflection records. Site 576 lies east of Shatsky Rise in an area of continuous, acoustically transparent sediment, 20 to 60 m thick, with a few continuous reflectors in the upper 15 m.

The area around Site 576 was surveyed in detail on R/V *Vema* Cruise 36-12. Based on bathymetric and isopach maps prepared from this survey, a drill site was selected at 32°20′N, 164°15′E. This area is characterized by gently rolling topography, with a northwesterly grain and local relief of less than 50 m over distances of tens of kilometers. There is a regional deepening of 100 m over 100 km from southwest to northeast across the site.

The site lies close to the magnetic bight, probably on Anomaly M13. Thus, the basement age is about 129 m.y.

The 3.5-kHz records show about 55 m of largely transparent sediment overlying a strongly reverberating reflector thought to be chert. The upper 20 m of section contain three strong and several weaker continuous reflectors. There is a weaker continuous reflector at 30 m and an intermittent weak reflector at about 50 m. On the basis of the *Vema*-36 piston cores, these reflectors were believed to be thin beds of volcanic ash. They allow precise correlations of piston and HPC cores.

The site selected for drilling is typical of the surrounding area for thousands of square kilometers.

OPERATIONS

We arrived at Site 576 after steaming for 10 days from Honolulu. This long transit provided an opportunity to check over the lab gear and process test "wash down" sections of core to iron out procedural questions in the lab. Air-gun and 3.5-kHz records collected en route to the site are of superior quality.

The D/V *Glomar Challenger* entered the E-2 survey area of R/V *Vema* Cruise 36-12 on 15 May 1982 (Z). Because of the detail of the *Vema* survey and uniformity of the surficial "transparent" layer, we pulled the air guns and magnetometer as we approached the site from the south and dropped the beacon at 2059Z on the basis of the 3.5-kHz profile.

Drill pipe run-in began at 2200Z on 15 May, with the first 9.5-m HPC core on deck at 1845Z on 16 May. The mud line at Hole 576 was established at 6220.3 m. Coring proceeded uneventfully for eight cores (Table 1), with significant time lost (7 hr.) only when the sand line parted during lowering of Core 7. The problem was attributed to "floating" of the core barrel because of the narrow clearance afforded by the undersize drift of the drill pipe and to omission of a swivel above the corer, again because of clearance problems. Fortunately the broken line caught in the first joint of pipe at the rig floor, thereby minimizing lost time. Because of this incident, however, the lowering speed was reduced for subsequent cores, thereby increasing on-site time.

Conventional heat flow/*in situ* pore water probe lowerings were made on three occasions in Hole 576. The heat flow system had equipment problems and did not generate usable data. The pore water appears to be seawater, probably because the sediment was not strong enough to support the bottom-hole assembly (BHA) and keep the probe in the sediment.

We had better luck with the new WHOI core nose temperature probe. Despite teething problems (the unit would not fit into its slot, even though the core nose sub had been at WHOI for some time, and the wires from the battery pack to the electronics unit break very easi-

Table 1. Site 576 coring summary (drilling depths).

Core	Date (May 1982)	Local time	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Percent recovered
Hole 576							
1	17	0545	6220.3–6223.0	0.0–2.7	2.7	2.71	100
2	17	0813	6223.0–6232.5	2.7–12.2	9.5	9.78	103
3	17	1031	6232.5–6242.0	12.2–21.7	9.5	6.64	70
4	17	1445	6242.0–6251.5	21.7–31.2	9.5	10.05	106
5	17	1655	6251.5–6261.0	31.2–40.7	9.5	9.81	103
6	17	2120	6261.0–6270.5	40.7–50.2	9.5	10.07	106
7	18	0805	6270.5–6280.0	50.2–59.7	9.5	9.78	103
8	18	1130	6280.0–6289.5	59.7–69.2	9.5	9.68	102
					69.2 (total)	68.52 (total)	99 (avg.)
Hole 567A							
1	18	1530	6218.0–6227.5	0.0–8.7	8.7	8.68	100
2	18	1802	6227.5–6237.0	8.7–18.2	9.5	9.28	98
3	18	2045	6237.0–6246.5	18.2–27.7	9.5	9.77	102
4	19	0000	6246.5–6256.0	27.7–37.2	9.5	9.11	96
5	19	0335	6256.0–6265.5	37.2–46.7	9.5	9.75	103
6	19	0540	6265.5–6275.0	46.7–56.2	9.5	9.75	103
7	19	0820	6275.0–6284.5	56.2–65.7	9.5	9.86	104
					65.7 (total)	66.20 (total)	101 (avg.)
Hole 576B							
1	19	1105	6219.3–6227.5	0.0–8.2	8.2	8.21	100
2	19	1400	6227.5–6237.0	8.2–17.7	9.5	9.59	101
3	19	1625	6237.0–6246.5	17.7–27.2	9.5	9.70	102
4	19	1845	6246.5–6256.0	27.2–36.7	9.5	9.73	102
5	19	2130	6256.0–6265.5	36.7–46.2	9.5	8.98	95
6	20	0000	6265.5–6275.0	46.2–55.7	9.5	9.27	98
7	20	0305	6275.0–6284.5	55.7–65.2	9.5	9.71	102
8	20	0600	6284.5–6294.0	65.2–74.7	9.5	8.87	93
9	20	0810	6294.0–6294.1	74.7–74.8	0.1	0.01	10
					74.8 (total)	74.07 (total)	99 (avg.)

ly), the unit worked on 7 of 11 attempts. Unfortunately, we could not "ground truth" the new instrument with the conventional probe at this location.

Holes 576A (seven cores which were all left upright and unopened for shore-based geotechnical studies) and 576B (nine cores before terminating in chert) proceeded smoothly, with the final core on deck at 2110Z on 19 May (Table 1).

Examination of the cores from Holes 576 and 576B revealed several points of concern:

1. "Flow-in" within cores. On several occasions, cores contained intervals of flow-in separated by intervals of normal looking sediment. The gross layering in the flow-in suggests that the HPC barrel was moving ahead as the piston was moving up (due to heave of the ship?). Thus, the sedimentary section is intermittently stretched, presumably with the loss of an equivalent amount of section from the bottom of the cored interval. This phenomenon introduces substantial uncertainties in the exact depths sampled

2. The interbedded clay–nannofossil ooze at the base of the section could be correlated in detail between the two holes. However, the sub-bottom depths were offset by 10 m, a displacement that is not evident in the 3.5-kHz records and that seems excessive given all the indications of laterally uniform post-chert deposition in the area. It is tempting to assume a one-stand (9.5-m) bookkeeping error during drilling of one of the holes, but we have no evidence of this. We hope that shore-based studies will allow the uniform dark brown clays that form the middle part of the cored section to be correlated in detail, thereby throwing additional light on this problem.

3. Shear strength profiles show a systematic decrease from the bottom of one core to the top of the next, even though all the sediments appear undisturbed. Whether this effect is due to progressive artificial consolidation, or to decreasing disturbance downcore is unclear. We favor the latter. It does indicate, however, that HPC samples must be used with caution for geotechnical studies.

Correlation of Holes 576 and 576B

The lithologic units recovered in Holes 576 and 576B are essentially identical (see Lithostratigraphy section that follows). However, the nominal sub-bottom depth (based on the drilling records) to the base of the clay unit (lithologic Unit I) is more than 10 m deeper in Hole 576 than in Hole 576B. In addition, the pattern of magnetic reversals in Cores 576-2 and -3 looks peculiar, and Hole 576B seems to be missing the Jaramillo Event. The remarkable depositional uniformity indicated by the *Vema*-36 piston cores and all the 3.5-kHz acoustic records near the site suggest that the differences in the nominal sub-bottom depths of lithologic boundaries in the two holes are spurious.

We have, therefore, attempted to adjust the core depths and location of "good" core (brecciated and flow-in material excluded) within cored intervals so as to minimize the differences between the two holes. The following "rules" and comments define what we did:

1. The top of Core 576-1 was placed at 4.5 m because of the short Brunhes record relative to Hole 576B and the presence of radiolarians older than 400,000 yr. in the uppermost sediments.

2. Based on the presence of the same volcanic ash bed and duplication of a portion of the magnetic record, we believe that Cores 576-2 and -3 sampled essentially the same early Matuyama section.

3. The absence of the Jaramillo Event in Hole 576B and the correlations of the Brunhes/Matuyama boundary and Olduvai Event between the two holes indicate that there is a gap of 3.4 m between Cores 576B-1 and -2.

4. Similarly, the correlations of the Olduvai Event and "friable"/"slick" boundary between the two holes indicates a gap of 2.4 m between Cores 576-2 and -4 (this interval corresponds to the incomplete recovery in Core 3).

5. To align the zeolitic interval of Subunit IB, and the Unit I/II boundary in the two holes, we have shortened Core 576-5 by 3 m. We hypothesize that the bumper subs may have closed at this point.

6. Intervals of no recovery, drilling brecciation, or flow-in are assigned to the bottoms of cores, unless a correlation is enhanced by attributing part of the defective interval to a core top or to its original position in the core (in the case of flow-in).

7. Except for the case described in (2) above, the adjustments do not lead to overlap of sections of "good" core within a hole.

8. Except for the case described in (5) above, the drillers' core lengths have been conserved. Only the sub-bottom depths have been adjusted.

For Hole 576B, the revisions are rather minor, but the interpretation of Hole 576 is significantly different. We have no simple explanation for the discrepancies, but feel that small topographic variations around the drill site, perhaps in combination with procedural adjustments accompanying the drilling of what was the first hole on Leg 86, may be responsible.

We believe that the section constructed from the adjusted core depths is a good first approximation to the *in situ* stratigraphy. Thus, although the acoustic profiler data were not used in the adjustments, the resultant depth of 55 m for the lithologic Unit I/II boundary is exactly as predicted from 3.5-kHz records. Small discrepancies undoubtedly remain. For example, we suspect that the ash at 12.5 m in Hole 576 lies in the gap between Cores 576B-1 and -2 (ash was found at the very top of Core 2), whereas the thicker ash at 16 m in Hole 576B should lie in the gap between Cores 576-2 and -4.

Table 2 allows depths in the core sections as labeled by DSDP to be converted to the new adjusted sub-bottom depth. Table 3 shows the depths drilled and "good" core recovered in Holes 576 and 576B in terms of the adjusted scale.

It is clear that the nominal 100% core recovery in each of the two continuously cored sections is somewhat misleading. In fact, the recovery of relatively undeformed core is closer to 80%. Fortunately, with the exception of about 2 m at an adjusted depth of 30 m, we managed to recover virtually the entire sediment section.

We departed the site at 1322Z on 20 May, steaming southeast and streaming the gear before profiling across the site en route to Site 577.

Table 2. Key to convert section depths in Holes 576 and 576B to sub-bottom depths in centimeters (see text for discussion).

Section	Depth (cm)	Adjusted sub-bottom depth (cm)	Comments
Hole 576			0–450 cm not recovered
1-1	0	450	Magnetics (B/M)
1-2	0	600	
1,CC	0	707	
2-1	0	720	Assumes no gap between Cores 1 and 2
2-2	0	870	
2-3	0	1020	
2-4	0	1170	
2-5	0	1320	
2-6	0	1470	
2-7	0	1620	
2,CC	0	1670	
3-1	0	960	Repeat of Core 2 ash and magnetics
3-2	0	1110	
3-3	0	1260	
3-4	0	1410	
3-5	0	1560	
3,CC	0	1592	
			1695–1980 cm not recovered
4-1	70	1980	Correlation of "rough-smooth" boundary
4-2	0	2060	
4-3	0	2210	
4-4	0	2360	
4-5	0	2510	
4-6	0	2660	
4-7	0	2810	
4,CC	0	2858	
5-1	40	2860	40 cm of cave-in debris
			2970–3158 cm not recovered
5-5	48	3158	Correlation of zeolitic clay
5-6	0	3260	
5-7	0	3410	
5,CC	0	3459	
			3459–3510 cm not recovered
6-3	70	3510	
6-4	0	3590	
6-5	0	3740	
6-6	0	3890	
6-7	0	4040	
6,CC	0	4085	
	40	4115	
			4125–4460 cm not recovered
7-1	0	4460	
7-2	50	4610	
7-3	0	4710	
7-4	0	4860	
7-5	0	5010	
7-6	0	5160	
7-7	0	5310	
7,CC	0	5360	
			5385–5425 cm not recovered
8-1	15	5425	
8-2	0	5560	
8-3	0	5710	
8-4	0	5860	
8-5	0	6010	
8-6	0	6160	
8-7	0	6310	
8,CC	0	6353	
	8	6358	
			Hole 576, 6379 cm total depth sampled
Hole 576B			
1-1	0	0	
1-2	0	150	
1-3	0	300	
1-4	0	450	
1-5	0	600	
1-6	0	750	

Table 2. (Continued).

Section	Depth (cm)	Adjusted sub-bottom depth (cm)	Comments
Hole 576B (Cont.)			
1,CC	0	807	
			820–1165 cm not recovered
2-1	5	1165	
2-2	0	1310	
2-3	0	1460	
			1560–1645 cm disturbed
2-4	35	1645	
2-5	0	1760	
2-6	0	1910	
2-7	0	2060	
2,CC	0	2098	
3-1	0	2110	
3-2	0	2260	
3-3	0	2410	
3-6	21	2470	
3-7	0	2599	
3,CC	0	2649	
			2671–3410 cm not recovered
4-3	100	3410	
4-4	0	3460	
4-5	0	3610	
4-6	0	3760	
4-7	0	3910	
4,CC	0	3962	
			3982–4010 cm not recovered
5-2	0	4010	
5-3	0	4160	
5-4	0	4310	
5-5	0	4460	
5-6	0	4610	
5,CC	2	4735	
			4755–5070 cm not recovered
6-1	110	5070	
6-2	0	5110	
6-3	0	5260	
6-4	0	5410	
6-5	0	5560	
6-6	0	5710	
6,CC	10	5852	
			5887–5913 cm not recovered
7-1	5	5913	
7-2	0	6058	
7-3	108	6208	
7-4	0	6250	
7-5	0	6400	
7-6	0	6550	
7-7	0	6700	
7,CC	0	6734	
			6771–6860 cm not recovered
8-1	115	6860	
8-2	0	6895	
8-3	0	7045	
8-4	0	7195	
8-5	0	7345	
8-6	0	7495	
			7500–7610 cm not recovered
9,CC	0	7610	Hole 576B, 7610 cm total depth sampled

LITHOSTRATIGRAPHY

The sediments recovered at Site 576 can be divided into three lithologic units based on macroscopic core descriptions, smear slide analyses, and carbonate content data. The lithostratigraphic succession observed in Holes 576 and 576B consists of a pelagic clay unit overlying an interbedded pelagic clay–nannofossil or nannofossil–foraminifer ooze unit which in turn overlies a chert unit (Fig. 1, Table 4).

Table 3. Adjusted sub-bottom depths (in meters, see text for discussion) of Site 576 cores and intervals of good quality core.

	Hole 576		Hole 576B	
Core	Length drilled (m)	Length recovered (m)	Length drilled (m)	Length recovered (m)
1	4.50–7.20	4.50–7.20	0.00–8.20	0.00–8.20
2	7.20–16.70	7.20–16.95	11.60–21.10	11.65–21.10
3	9.60–19.10	9.60–16.22	21.10–30.60	21.10–26.71
4	19.10–28.60	19.80–28.60	30.60–40.10	34.10–39.82
5	28.60–35.10[a]	28.60–29.70 31.58–34.97	40.10–49.60	40.10–47.55
6	35.10–44.60	35.10–41.25	49.60–59.10	50.70–58.87
7	44.60–54.10	44.60–53.85	59.10–68.60	59.15–67.71
8	54.10–63.60	54.25–63.77	68.60–76.10	68.60–75.00
9			76.10–76.20	76.10–76.11

[a] 3 m short—bumper subs closed?

Unit I: Pelagic Brown Clay

Lithologic Unit I is a pelagic brown clay recovered in both Holes 576 and 576B. It is divided into two subunits as follows.

Subunit IA

Subunit IA is a pelagic yellowish brown to brown, visibly burrowed clay found in Samples 576-1-1, 0 cm to 576-4-6, 53 cm and 576B-1-1, 0 cm to 576B-3-6, 150 cm. This subunit is composed of alternating yellowish brown and dark yellowish brown to brown highly mottled clay with burrows. The abundance of visible burrows decreases downhole. With the exception of Core 576-1, which is a silty clay containing 20–45% quartz, this subunit contains greater than 80% clay-size material and less than 15% visible quartz. Hole 576 contains two layers of volcanic ash in this subunit; each is 1 cm thick. Hole 576B contains three volcanic ash layers in this subunit; they range in thickness from 1 to 3 cm. This subunit contains no nannofossils or foraminifers and less than 10–12% siliceous microfossils (diatoms and radiolarians). Sponge spicules and silicoflagellates are present in only trace amounts. The abundance of siliceous organisms decreases with depth.

Subunit IB

Subunit IB is an unburrowed, homogeneous dark brown pelagic clay found in Samples 576-4-6, 53 cm to 576-8-2, 8 cm and 576B-3-6, 150 cm to 576B-6-4, 121 cm. Zeolites, principally phillipsite, are present in abundances of up to 10% in Sections 576-5-4 to 576-5-6 and 576B-4-1 to 576B-4-5. These two zeolite-rich zones appear to be stratigraphically correlative. Traces of fish debris are found throughout this subunit. The boundary between the two Subunits IA and IB is gradational over several meters.

Unit II: Interbedded Calcareous Ooze and Pelagic Brown Clay

Lithologic Unit II is composed of interbedded calcareous oozes and brown pelagic clays found in Samples 576-8-2, 8 cm to 576-8,CC and 576B-6-4, 121 cm to 576B-8,CC. The thickness of the calcareous ooze intervals ranges from 0.10 to 3.0 m; that of the clay intervals ranges from 0.10 to 1.10 m. The carbonate content in the oozes ranges from 80–98%. The calcareous oozes in these intervals are predominantly nannofossil oozes; foraminifers are present and increase in abundance downcore to 15% in Sample 576-8-6, 64–72 cm.

The interbedded calcareous oozes and pelagic clays in Hole 576 can be correlated layer-by-layer with those in Hole 576B (Fig. 2). Such a correlation indicates that the bottom of Hole 576 corresponds to Sample 576B-7-4, 110 cm. The thicknesses of the correlative layers are almost identical (Fig. 3) with the exceptions of the interval from Section 576-8-1 to the top of 576-8-2 and from Section 576B-6-4 to the top of 576B-6-5. In the latter hole the units are about 9% thicker (Fig. 4). In addition, the thickest calcareous ooze layer is 3.48 m thick in Hole 576, but 4.30 m thick in Hole 576B. This 0.82-m difference in layer thickness is likely due to "flow-in" in Hole 576B.

Contacts between the calcareous ooze and pelagic clay layers range from gradational to sharp. The base of each calcareous ooze layer is marked by a sharp contact, whereas the bases of the pelagic clay layers vary from very gradational to sharp.

Normal graded bedding is observed in the uppermost calcareous ooze layers in Samples 576-8-2, 8–21 and 34–66 cm and 576B-6-4, 121–132 and 150 cm to 576B-6-5, 40 and 60–80 cm. Normal graded bedding and small-scale crossbedding are also observed in the lower 20 cm of the thickest calcareous ooze layer in both holes (Samples 576-8-4, 25 cm to 576-8-6, 73 cm correlative to Samples 576B-7-1, 5 cm to 576B-7-3, 135 cm). These calcareous ooze layers all have sharp bottom contacts with the pelagic clay layers below. The graded bedding, small-scale cross bedding, and sharp basal contacts observed in these calcareous ooze layers suggest that they are turbidites. The other calcareous ooze layers lack these macroscopic features. It is uncertain, therefore, whether these deposits are also turbidites.

Unit III: Chert

Lithologic Unit III is a chert and/or silicified clay unit. It was not reached in Hole 576 and is only poorly recovered as small chips in Sample 576B-9,CC.

SEISMIC CORRELATIONS

High resolution seismic reflection profiles (3.5 and 12 kHz) and 100-Hz reflection profiles were recorded at Site 576. Both hull-mounted and near-bottom sound sources were utilized; the near-bottom transducer (3.5 and 5.25 kHz) was mounted on the drill string 99 m above the face of the drill bit. The quality of the 3.5-kHz echograms was substantially improved by repairing a factory-produced error in the booster for the hull-mounted transducer.

The 3.5-kHz echograms from the hull-mounted transducer revealed a three-part seismic section (Figs. 5 and 6, Table 5). The upper seismic section extends to 0.025 s below the seafloor (about 18 m, Reflector 2) and consists of several parallel sub-bottom reflectors. The middle seismic section has a base with variable sub-bottom

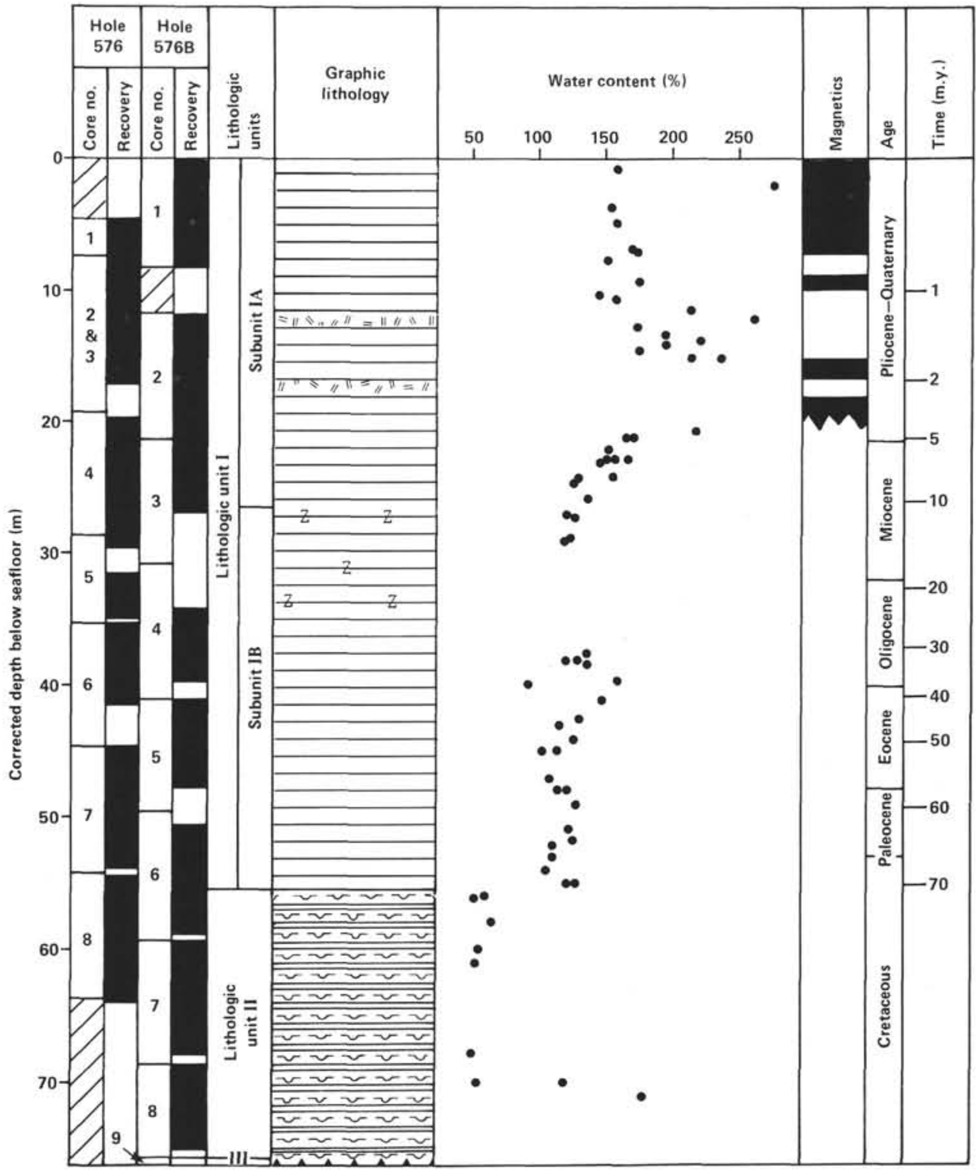

Figure 1. Site summary diagram showing Site 576 core numbers, core recovery, lithologic units, graphic lithology, water content (%), magnetostratigraphy, and age versus adjusted sub-bottom depths. Adjusted depths of cored and recovered intervals are given in Table 3. Symbols used in graphic lithology column are defined in Introduction and Explanatory Notes (this volume).

Table 4. Site 576 lithostratigraphic units.

		Core interval		Adjusted sub-bottom depth (m)	
	Lithologic units	Hole 576	Hole 576B	Hole 576	Hole 576B
I	Pelagic brown clay	1-1 to 8-2, 8 cm	1-1 to 6-4, 121 cm	4.5–55.7	0–55.3
	Subunit IA:				
	Pelagic yellowish brown to brown burrowed clay	1-1 to 4-6, 53 cm	1-1 to 3-6, 150 cm	4.5–27.1	0–26.2
	Subunit IB:				
	Unburrowed dark brown pelagic clay	4-6, 53 cm to 8-2, 8 cm	3-6, 150 cm to 6-4, 121 cm	27.1–55.7	26.2–55.3
II	Interbedded calcareous ooze and pelagic brown clay	8-2, 8 cm to end of hole	6-4, 121 cm to 8,CC	55.7–63.8	55.3–76.1
III	Chert	—	9	—	76.1

Note: — indicates no data.

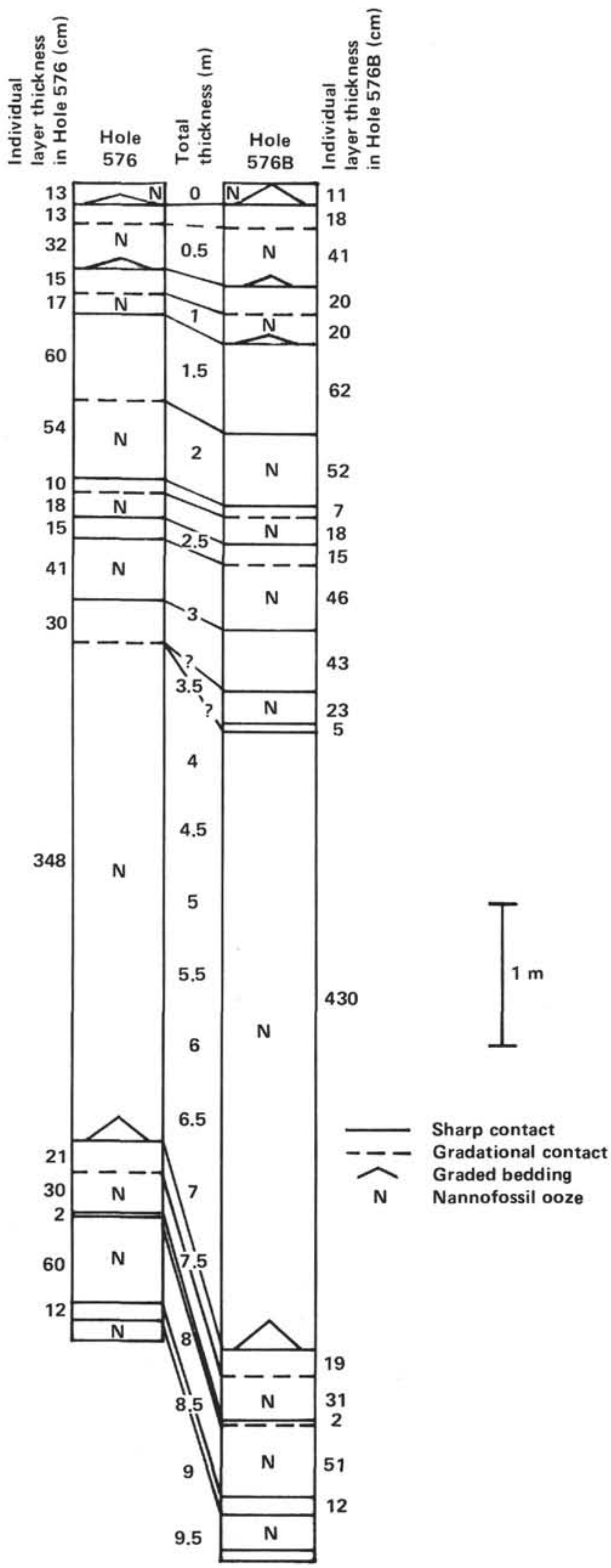

Figure 2. Correlation of interbedded calcareous ooze and pelagic clay layers in lithologic Unit II at Holes 576 and 576B.

depth (0.07–0.08 s, ~53–60 m) and consists of the essentially transparent section above Reflector 4. The lower seismic section consists of a strong, prolonged echo and a slightly deeper and weaker intermittent prolonged echo.

In the upper seismic section, strong echoes occur at 0.0053 s (~4 m), 0.016 s (~11.5 m, Reflection 1), and 0.025 s (~18 m, Reflector 2). Reflector 1 at about 11.5 m is probably the first ash layer (1.4 m.y. ago) encountered in Holes 576 and 576B. Reflector 2 at about 18 m probably represents the third ash layer recovered in Hole 576B. The interval thickness between Reflectors 1 and 2 (~6.5 m) is very similar to the observed thickness between the first and third cored ash layers in Samples 576B-2-1, 8 cm and 576B-2-5, 40 cm.

The middle transparent seismic section corresponds to the monotonous brown and reddish brown pelagic clay section cored between the ash layers and the interbedded pelagic clay and nannofossil ooze unit. Reflector 2a is closely associated with the transition between lithologic Subunits IA and IB (Fig. 6).

Reflector 3 (Figs. 5 and 6) is a strong, slightly prolonged echo that occurs 0.0695 s below the seafloor (~51.0 m). It is restricted to localized lows in Reflector 4 and has a ponded character. Although the ponded nature of Reflector 3 is consistent with the interpretation that it represents the calcareous turbidites of lithologic Unit II, the seismic interval thickness between the ash (Reflector 2) and Reflector 3 is about 33 m, whereas the interval thicknesses between the ash and the nannofossil oozes (turbidites) is 39 m.

Reflector 4 (Fig. 6, Table 5) defines the top surface of the lowest seismic section. The local relief on this surface suggests that Reflector 4 is not similar to the overlying ponded turbidites (Reflector 3). Reflector 4 may be a composite echo from turbidites in the local lows and chert on the local highs or it may represent single layers of relatively high density and viscosity. In either case, the thickness of the cored turbidite section (20.5 m) and the sub-bottom depth of the chert encountered at Site 576 (~76 m) do not permit positive correlation of the chert with the strong prolonged echo at Site 576. In order to correlate Reflector 4 with the cored chert, an improbable interval velocity of 2155 m/s would be necessary.

Reflectors 1 (ash), 2 (ash?), 4, and the intervening transparent layer can all be traced westward to the slopes of the Shatsky Rise and eastward for at least 400 km. Site 576 therefore provides control for not only regional lithologic but also time-stratigraphic correlations of Late Cretaceous and younger sediments.

The transducer mounted on the drill string returned weak seafloor echoes similar to those produced by the hull-mounted transducer, but Reflector 5 was more evident on the record of the drill string mounted pinger. The pinger-to-seafloor travel time showed that the Carter Correction Tables were 2 m too deep in this area (i.e., the seafloor depth is 6209, not 6211 m).

The 100-Hz records also reveal a three-part seismic section (Fig. 7): (1) weak, generally parallel reflections from 0 to about 0.05 s below seafloor, (2) strong, parallel echoes from 0.05 s to variable depths of 0.3 to 0.55 s

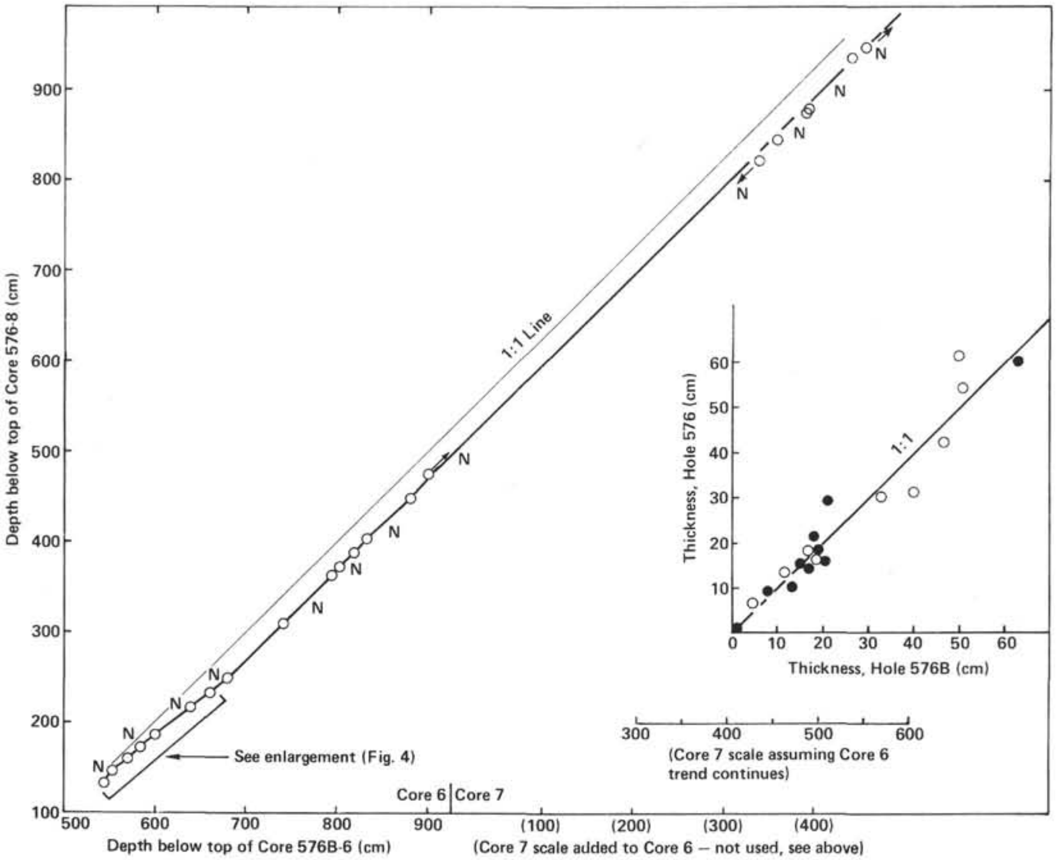

Figure 3. Graph comparing thickness of correlated calcareous ooze and pelagic clay layers at Holes 576 and 576B. N = nannofossil ooze layer. Inset: comparison of layer thicknesses, ● = red clay, ○ = nannofossil ooze.

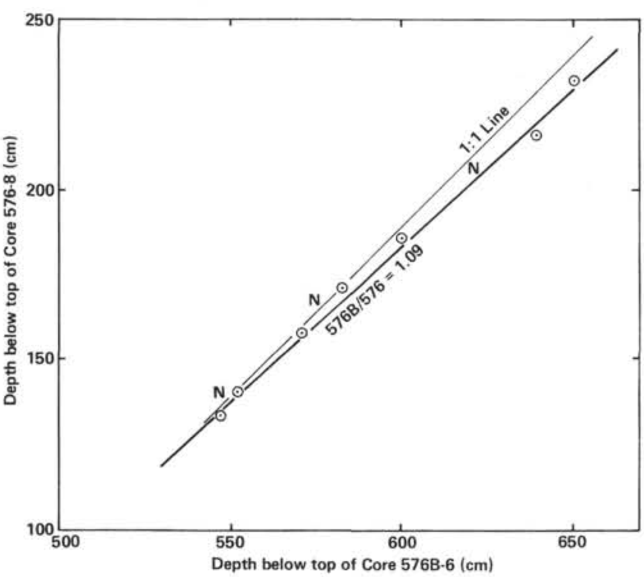

Figure 4. Graph comparing thickness of correlated calcareous ooze and pelagic clay layers in Holes 576 and 576B. (Expansion of lower part of graph shown in Figure 3.) N = nannofossil ooze layer.

below seafloor, and (3) very strong echoes that define a surface with very high relief. The upper section has a variable thickness of 0.05 to 0.07 s; the unit appears to "pond" in troughs of the underlying middle section. The upper section may represent sediments above the Cretaceous chert, since the seismic thickness is about 75 m at the site and the cored thickness to chert is 74 m at Hole 576B. The middle section with variable thickness of 0.23–0.5 s consists of an upper unit (2a) of parallel reflectors with variable thickness that overlie a lower semi-transparent unit (2b) of relatively constant thickness. Section 2 represents the Cretaceous nannofossil oozes and interbedded cherty sediments. The lowest section with very high relief is the echo off Cretaceous basement of M13 age (about 129 m.y.).

BIOSTRATIGRAPHY

Site 576 recovered 74 m of sediment ranging in age from late Quaternary through Late Cretaceous (Fig. 8). The sequence consists of 55 m of pelagic brown to yellowish brown clay overlying a unit composed of interbedded calcareous ooze and brown pelagic clays. A chert unit underlies this sequence.

Ichthyoliths, which were found throughout the clay interval, vary from rare to abundant in all samples. Nannofossils are restricted to the calcareous ooze layers where an abundant, moderately preserved Late Cretaceous assemblage is present. The brown clays are barren of foraminifers except for those few specimens that have been replaced by manganese oxide. The calcareous ooze layers contain abundant, well-preserved Upper Cretaceous

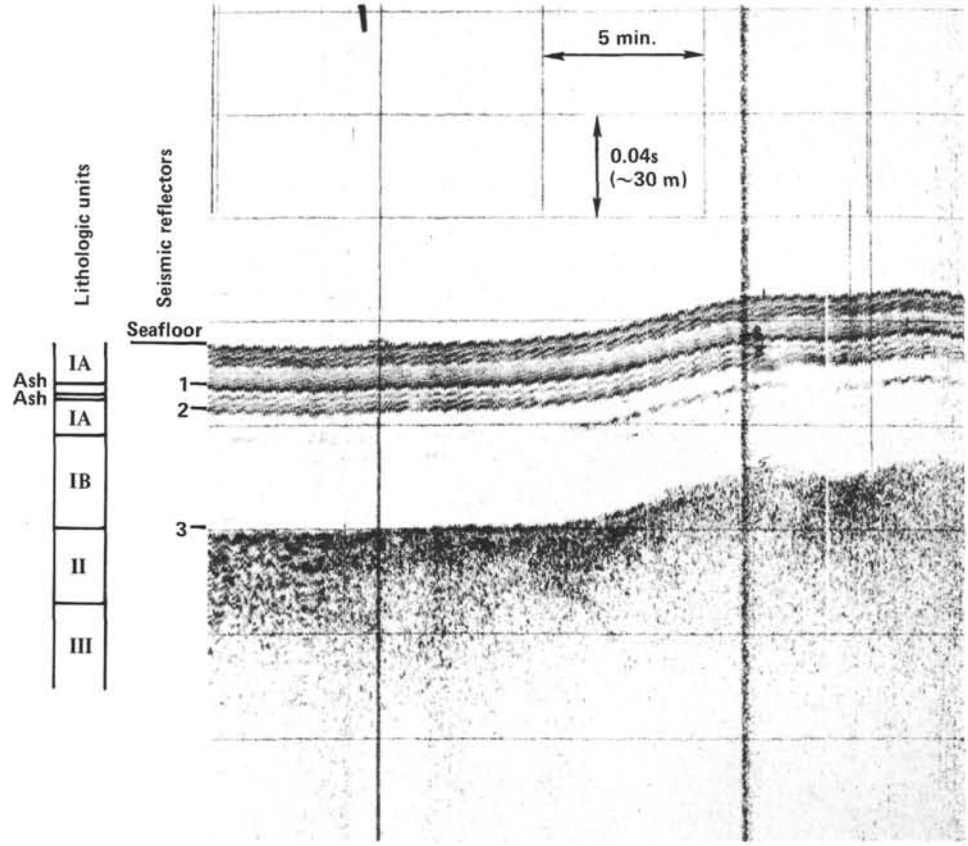

Figure 5. 3.5-kHz echogram from the hull-mounted transducer at Site 576 showing the three-part seismic section and reflectors described in the text. Sub-bottom depths to seismic reflectors are given in Table 5.

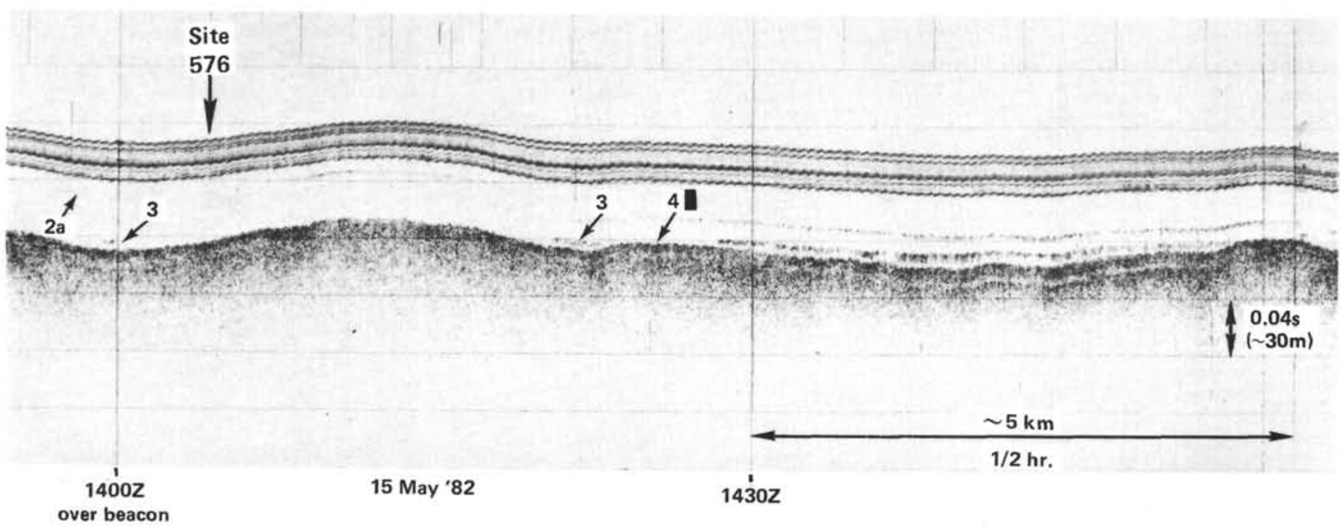

Figure 6. 3.5-kHz echogram from the hull-mounted transducer at Site 576 showing Reflectors 2a, 3, and 4 (Table 5) described in the text.

foraminifers. Although Quaternary–late Pliocene diatoms and radiolarians were found in the first several cores, they are abundant and well preserved only in the upper portion of Core 1 of each of the three holes.

The generally poor preservation and low abundance of each of the major microfossil groups precludes assignment of age boundaries to specific core sections at this site. Ichthyolith determinations indicate that the Oligocene/Miocene boundary lies between 32 and 35 m, the Eocene/Oligocene between 38.6 and 41.6 m, the Paleocene/Eocene between 44.6 and 51 m, and the Cretaceous/Tertiary boundary between 51 and 55 m.

Table 5. 3.5-kHz seismic correlations, Site 576.

Reflector	Relative strength[a]	Sub-bottom depth (s)	Depth (m) 1440 m/s	1500 m/s	1550 m/s	1574 m/s
	S	0.00526	3.8	3.9	4.08	4.1
1	S	0.0158	11.3	11.85	12.24	12.43
	W	0.0200	14.39	14.92	15.49	15.73
	W	0.0210	15.1	15.75	16.28	16.57
2	S	0.0247	17.78	18.50	19.10	19.47
2a	W	0.0358–0.0389	25.78–28.01	26.85–29.18	27.74–30.15	28.17–30.61
3	S	0.0695	50.04	52.12	53.86	54.70
4	S	0.0705–0.0800	50.77–57.53	52.80–59.90	54.60–57.90	55.49–62.90

[a] S = strong; W = weak.

Calcareous Nannofossils

The first seven cores recovered at Hole 576 were barren of calcareous nannofossils. Coccoliths are present only in samples from Core 8, where they occur in the calcareous ooze layers interbedded with pelagic brown clays. The common and moderately well preserved coccolith assemblages belong to the *Quadrum trifidum* Zone (upper Campanian).

The first five cores recovered at Hole 576B were barren of calcareous nannofossils. From Section 576B-6-4 to Sample 576B-9,CC, poorly to moderate preserved nannofossils of the Campanian *Q. trifidum, Ceratolithoides aculeus*, and *Broinsonia parca* Zones occur (Thierstein, 1976).

Foraminifers

Core-catcher samples were examined from all eight cores of Hole 576. Foraminifers were found in two Tertiary samples (576-3,CC and 576-4,CC). The individuals were completely replaced by manganese oxide and were difficult to distinguish from micronodules. This phenomenon was recorded by Thompson (1980) in the Japan Trench. The replaced foraminifers were abundant in Sample 576-3,CC, rare in Sample 576-4,CC and absent in Samples 576-1, -2, -5, -6, and -7,CC. Species included: *Globigerina dutertrei, G. linaperta, Pseudohastigerina wilcoxensis, Lagena* spp., and *Pullenia* spp. Rare specimens of the agglutinate form *Reophax difflugiformis* were found in Samples 576-1-1, 56–58 cm and 576-1,CC.

Abundant, moderately preserved foraminifers of Campanian age from the *Globotruncana fornicata–G. stuartiformis* Zone (Pessagno, 1967) were found in Sample 576-8,CC. Species include: *Globotruncana lapparenti, G. bulloides, G. angusticarinata, Globigerinelloides asperus, G. prairiehillensis, Hedbergella planispira, Hastigerina watersi, Heterohelix* spp., *Lagena* spp., and *Gyroidina* spp.

Samples from Hole 576A were not examined.

Samples 576B-1,CC to 576B-5,CC were barren of any foraminifers. Rare Mn-replaced specimens were found in Samples 576B-2-4, 130–132 cm; 576B-3-1, 92–94 cm; and 576B-3-4, 92–94 cm. Rare benthic foraminifers were found in Sample 576B-6,CC. These were: three specimens of *Anomalinoides pinguis* and two *Gavelinella* cf. *velascoensis*. Rare specimens from Sample 576B-7,CC were caught on the 149-μm sieve. Three agglutinate species were observed including: *Paratrochomminoides vitreus, Praecystammina globigerinaeformis*, and the torus-shaped solution remnants of a third species. Other species include: *Anomalinoides pinguis, Gavelinella* cf. *velascoensis*, and *Globigerina eugubina*.

Samples 576B-8,CC and 576B-9,CC were barren in the fraction larger than 149 μm. The 62.5- to 149-μm fraction of both samples contained an abundant, well-preserved Upper Cretaceous fauna (zone uncertain). Representative species include: *Globigerinelloides volutus, G. subcarinatus, G. multispinus, Heterohelix striata, H. navarroensis, H.* cf. *globocarinata*, and *Hastigerina* spp. Preliminary examination has revealed no specimens of *Globotruncana*. This genus is most important for the identification of Upper Cretaceous zones.

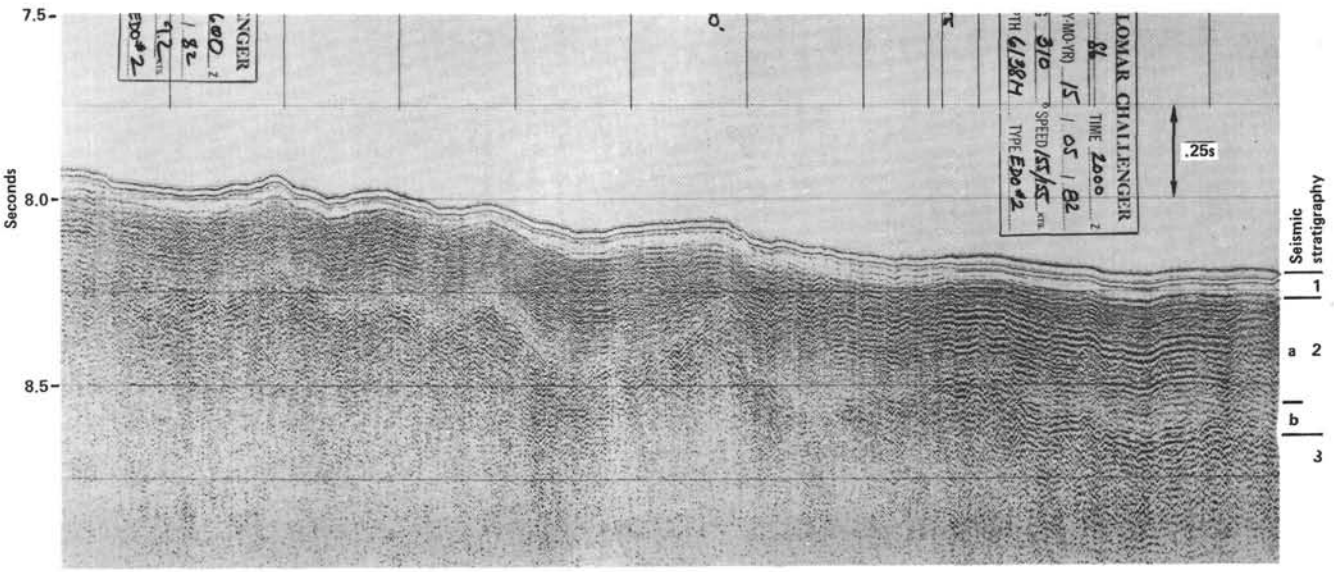

Figure 7. 100-Hz reflection profile taken on approach to Site 576 showing the three-part seismic section described in the text.

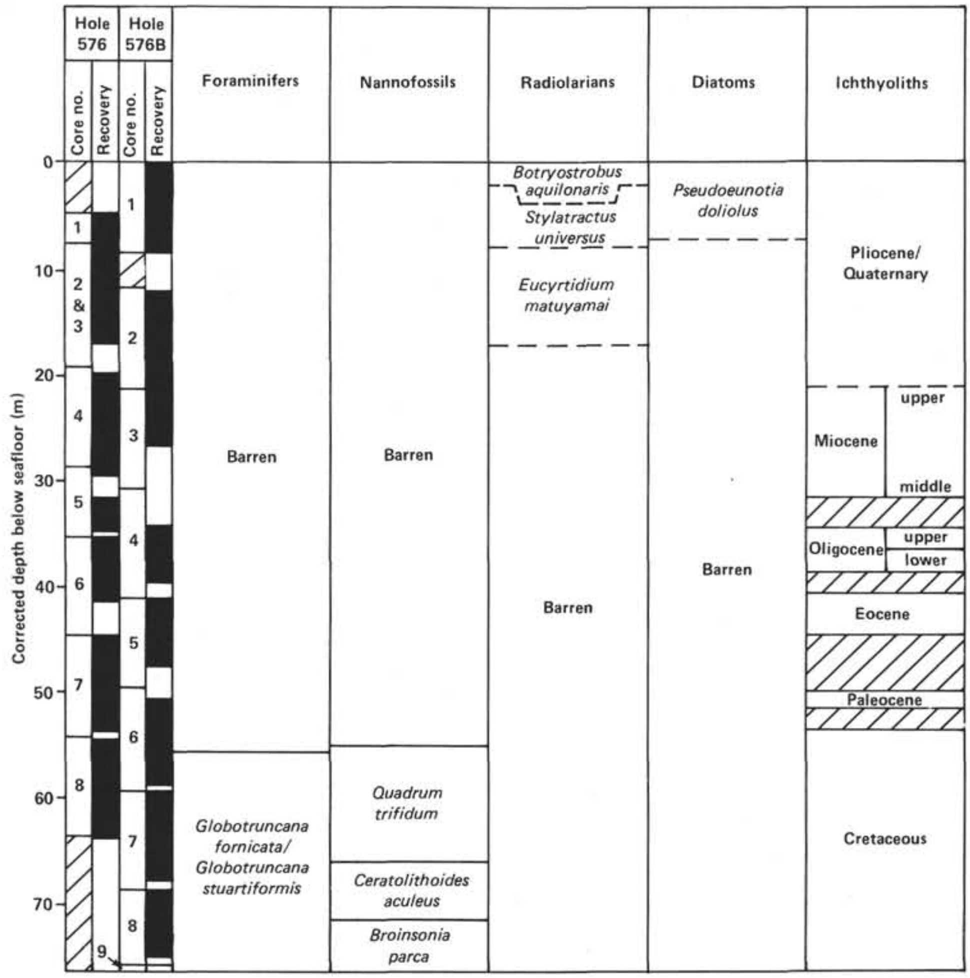

Figure 8. Site 576 biostratigraphic summary.

Radiolarians

Radiolarians are present in the first three cores at Site 576 (Section 576-1-1; Samples 576-1,CC; 576-2,CC; and 576-3,CC). The sediments in Core 576-1 are Pleistocene in age, with species characteristic of the *Botryostrobus aquilonaris* Zone (Hays, 1970) and the *Stylatractus universus* Zone (Hays, 1970) in sediments from the top and bottom of Core 576-1, respectively. Poorly preserved specimens are present in the core-catcher samples from Cores 576-2 and 576-3. Radiolarians are absent in core-catcher samples from Cores 576-4 through 8. A calcareous sequence in Core 576-8 from this hole contains poorly preserved Upper Cretaceous radiolarians.

Core 576A-1 contains common, moderately well-preserved radiolarians belonging to the *S. universus* Zone (Sample 576-1,CC) with only a few specimens present in Core 2 (Sample 576-2,CC). Core-catcher samples from subsequent cores are barren (Samples 576-3,CC through 576-7,CC).

The radiolarian fauna in Core 576B-1 (Section 576B-1-1; Sample 576B-1,CC) is Pleistocene in age with preservation decreasing rapidly from good at the core top to poor at the base. Core 576B-2 (Sample 576B-2,CC) from this hole contains only a few specimens and Core 576B-3 (Sample 576B-3,CC) is barren.

Diatoms

Diatoms become increasingly less abundant between Cores 576-1 and 3 and are absent from Cores 576-4 to 8. The presence of *Pseudoeunotia doliolus* and the absence of *Nitzschia reinholdii* and *N. fossilis* in Core 576-1 places the sample in the middle to late Quaternary *P. doliolus* Zone (Brunhes Normal Epoch, 0–0.73 m.y. ago; Burckle, 1977). Rare to few specimens and fragments of specimens of a moderately preserved Neogene species, *N. reinholdii, Nitzschia* spp., and *Coscinodiscus* spp., were recovered in Cores 576-2 and 3 from this hole. These assemblages consist of diatom taxa that are commonly found in warm water regions.

Only fragments of some Neogene species, *N. reinholdii, Thalassiosira lineata,* and *T. oestrupii,* were recovered in Cores 576A-1 through -3. In Core 576A-1, however, many fragments of moderately preserved *Ethmodiscus rex* were encountered. Diatoms were not found below Core 576A-4.

Core 576B-1 contains only a few fragments of some Neogene species, *Coscinodiscus* sp., *E. rex, T. lineata,* and *Thalassiothrix longissima*. Diatoms are absent from Cores 576B-2 to 9.

Ichthyoliths

Ichthyoliths are present throughout Hole 576A. Their abundance ranges from rare in the rapidly accumulating sediments in the top two cores to a peak abundance typically found near the Paleocene/Eocene boundary. Ichthyoliths in Cores 576A-1 and 2 are late Miocene or younger based on the coherent range of *Narrow triangle ragged base*. Core 576A-3 and Sections 576A-4-1 and -3 are Miocene with a rich and diverse assemblage of characteristic taxa. Representative subtypes are: *Two triangles, Triangle sinuous inline, Elliptical with line across*, and *Triangle irregular base*. Section 576A-3-3 contains an aberrant, very sparse assemblage of foraminifers, radiolarians, diatoms, and ichthyoliths. The ichthyoliths indicate only that the sample is Miocene.

The Oligocene/Miocene boundary falls between Sections 576A-4-3 and -4-5 based on the first occurrence of *Triangle with high inline apex* in Section 576A-4-5 and the first occurrence of *Small triangle long striations*, as well as the first occurrences of the discriminating Miocene taxa listed above, in Section 576A-4-3. The first appearance of *Rounded apex triangle* and *Flexed triangle shallow in base* in Section 576A-5-1 correlates with an early Oligocene age.

The Eocene/Oligocene boundary lies between Sections 576A-5-1 and -5-3. Sections 3 and 5 of that core are Eocene, most probably early and middle Eocene based on the absence of younger taxa and the presence of subtypes characteristically found in abundance in the Eocene: *Triangle with triangular projection, Triangle pointed margin ends*, and *Triangle medium wing*.

The Paleocene/Eocene boundary is between Sections 576A-6-1 and -6-3 and the Cretaceous/Tertiary boundary is between Sections 576A-6-3 and -6-5. The Cretaceous assemblages in Sections 576A-6-5 and -7 include subtypes *Striated blunt triangle, Triangle long inline, Triangle square inline*, and *Wide triangle projection*.

In Hole 576, the Cretaceous/Tertiary boundary is below Sample 576-8-1, 25 cm. In Hole 576B, the boundary is below Section 576B-6-3.

PALEOMAGNETICS

Detailed paleomagnetic studies of Site 576 samples are reported in a later chapter (see Heath, Rea, and Levi, this volume). Initial results indicate that the Brunhes/Matuyama boundary (0.73 m.y.) lies at 7.05 m sub-bottom and the Matuyama/Gauss boundary (2.47 m.y.) at 18.21 m sub-bottom. The Jaramillo boundaries (0.91 and 0.98 m.y.) were found at 8.95 and 9.85 m sub-bottom, and the Olduvai boundaries (1.66 and 1.68 m.y.) at 14.85 and 16.3 m sub-bottom, respectively. These levels correlate well with reversals recorded in *Vema*-36 cores collected near Site 576.

SEDIMENT ACCUMULATION RATES

An accurate shipboard determination of sedimentation rates at regular intervals throughout the sediment sequence recovered at Site 576 is difficult because calcareous and siliceous microfossils are not present in most of the cores. The age of the top of the hole is based on radiolarian stratigraphy with paleomagnetic data providing input for rates through the last 2.5 m.y. Ichthyolith stratigraphic ranges constrain ages in the least fossiliferous clays, but not very precisely (Fig. 9). Through the upper 18 m, the sedimentation rate decreased from 9.7 m/m.y during the Brunhes to about 2 m/m.y. at the base of the Matuyama (Fig. 10). A smooth sedimentation rate curve from 2.5 to 70 m.y. yields rates of about 1 m/m.y. at 5 m.y., decreasing to about 0.35 m/m.y. at about 40 m.y., and then increasing slightly to about 0.6 m/m.y. in the Late Cretaceous.

PHYSICAL PROPERTIES

Physical properties measurements at Site 576 were performed using mainly standard DSDP methods (Boyce, 1976a, b; Introduction and Explanatory Notes, this volume). Table 6 summarizes the properties that were measured at Holes 576 and 576B. Cores from Hole 576A were left unopened and used exclusively for detailed shore-based laboratory geotechnical tests (Marine Geotechnical Consortium, this volume). Figures 11, 12, and 13 show profiles of shear strength, compressional and shear wave velocity, and saturated bulk density and water content, respectively.

Measurements were taken at approximately 1.5-m intervals throughout the cores in Holes 576 and 576B. A full discussion of the physical properties of the recovered sediment, including tables of the data, is given by Schultheiss (this volume). However, some of the more interesting features of the data are highlighted here:

1. Shear strengths and shear wave velocities in the carbonate layers are generally much less than in the brown clay. This does not necessarily mean that the *in situ*

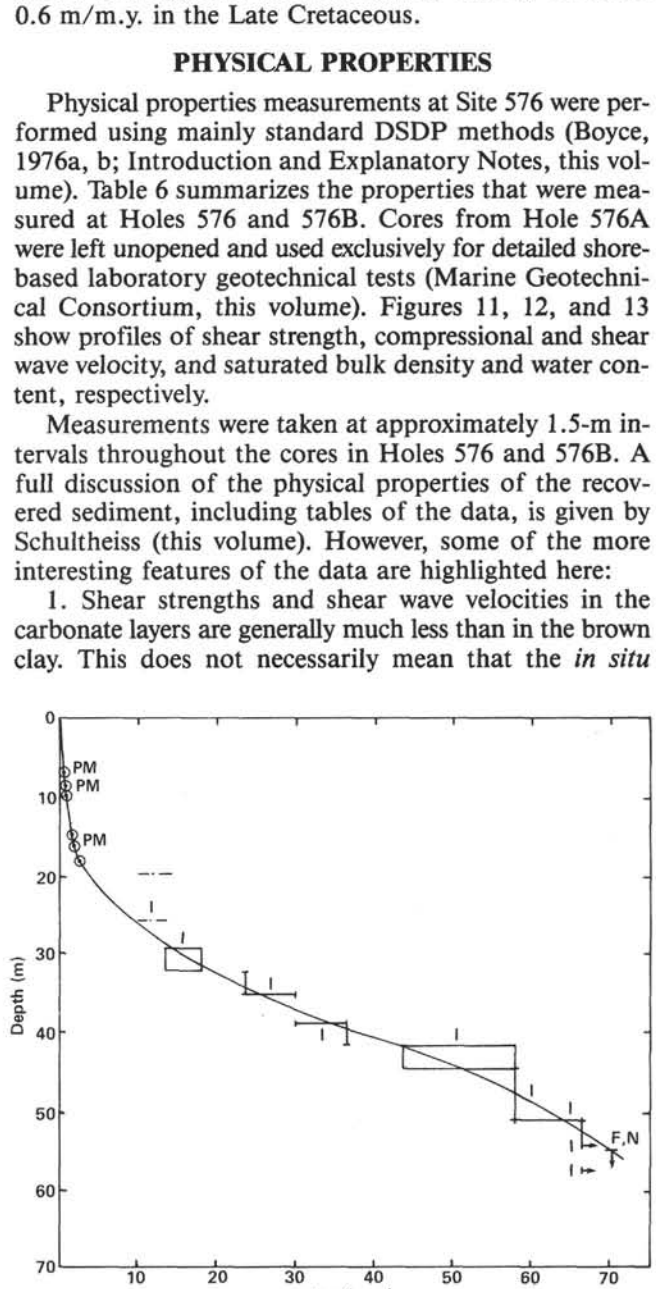

Figure 9. Age–depth curve for Site 576. PM = paleomagnetics, I = ichthyoliths, F = foraminifers, N = nannofossils.

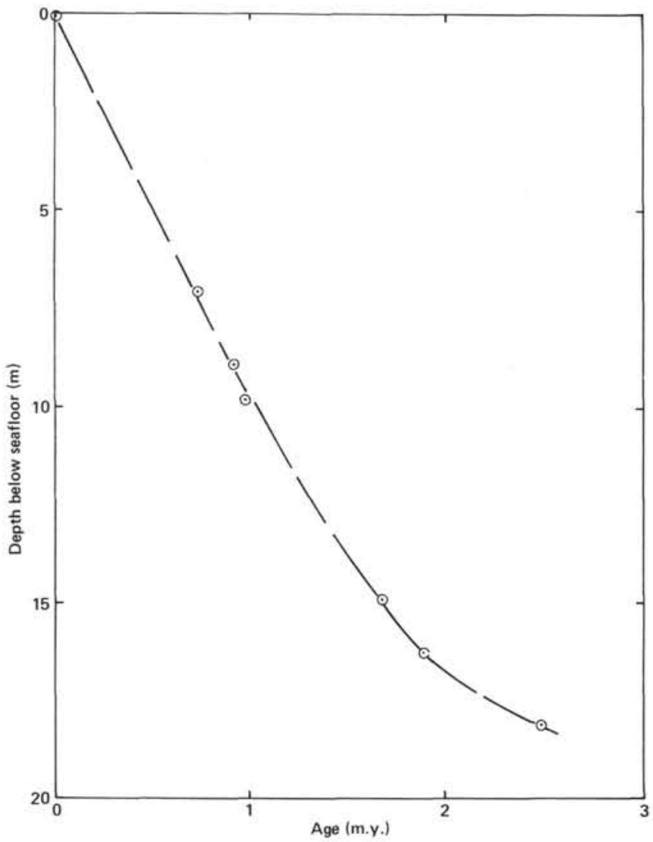

Figure 10. Age-depth curve for near-surface Site 576 sediments based on magnetic reversals.

Table 6. Physical properties measurements made at Site 576.

	Hole 576	Hole 576B
Shear strength		
Hand operated vane	x	x
Motorized vane	x	x
Wave velocity		
Shear wave	x	x
Compressional wave	x	x
Water content/bulk density		
Shipboard analysis	x	—
Shore-based analysis	x	x
Bulk density by 2 min. GRAPE	x	—

strengths vary by this amount; rather, it is probably caused by different forms of stress disturbance in the different lithologies.

2. Where there is a large amount of visual disturbance ("flow-in"), the shear strength in the brown clay is markedly reduced whereas the shear wave velocity is only slightly reduced.

3. The large increase in the shear strength and shear wave velocities in the brown clay below 65 m in Hole 576B may be indicative of the onset of diagenesis (Figs. 11 and 12).

4. The compressional wave velocity profile shows no obvious trend through the brown clay section and is always less than the water velocity. Peaks in the compressional wave velocity correspond to ash and carbonate layers (Fig. 12).

5. The uniformity of shear wave velocities measured parallel and perpendicular to the core axis indicates a total lack of anisotropy within any of the lithologies.

6. Water content increases markedly by up to 220% between 11 and 20 m in the brown clay unit before it gradually decreases to 110% at 50 m (Fig. 13). The cause of this is not known but a change in mineralogy, similar to that found in LL44-GPC3, is suspected. The increase in water content is consistent with a decrease in shear strength around 16 m as shown in Figure 11. Higher frequency fluctuations in water content (on a scale of approximately 0.5 m) occur in the brown clay and reflect subtle changes in lithology which are not yet understood.

INORGANIC GEOCHEMISTRY

Seven squeezed core samples from Hole 576A and three *in situ* pore water samples (PW-1, PW-2, and PW-3) from Hole 576 were analyzed for the standard suite of components: pH, alkalinity, salinity, calcium, magnesium, and chlorinity (Table 7). The squeezed samples show very little variability downcore, as would be expected from the very slow deposition rate of the pelagic clays which allows diffusional equilibration (Fig. 14).

The *in situ* samples look much like surface seawater, apparently somewhat diluted with distilled water (from the sampler) in the case of Sample PW-3. In all three cases, the Mg/salinity and chlorinity/salinity ratios are so close to surface seawater that contamination by drilling fluid is suspected. We assume that this was caused by the sediments being too weak to support the BHA, thereby allowing the heave of the ship to move the probe into and out of the sediment as it was drawing a sample. Mechanically, the operation of the probe with an HPC BHA did not cause any problems.

HEAT FLOW

A new heat flow instrument, developed by R. P. Von Herzen and others at WHOI, was used for the first time to record bottom hole temperatures. The instrument, specifically designed for use with the HPC, consists of a temperature sensor (thermistor), a recorder, and a battery pack that are inserted as a unit into a slot opened in the metal wall of the corer's shoe so that the temperature sensor is placed close to the shoe's tip. The recorder is a battery powered minicomputer that stores data of measured temperatures as a function of time at intervals specified by a program that is loaded into the computer prior to the operation. This instrument, which provides an efficient way of measuring undisturbed sediment temperature without interfering with the core-sampling process, was used throughout Leg 86.

Out of 11 test runs made at Site 576 (5 in Hole 576, 3 in Hole 576A, and 3 in Hole 576B), 7 (2 in Hole 576, 3 in Hole 576A, and 2 in Hole 576B) were successful. The reasons for the unsuccessful runs varied from case to case. However, either electrical disconnection between the recorder and the battery or problems with computer programming due to inexperienced operators (as the instrument is totally new) generally were responsible.

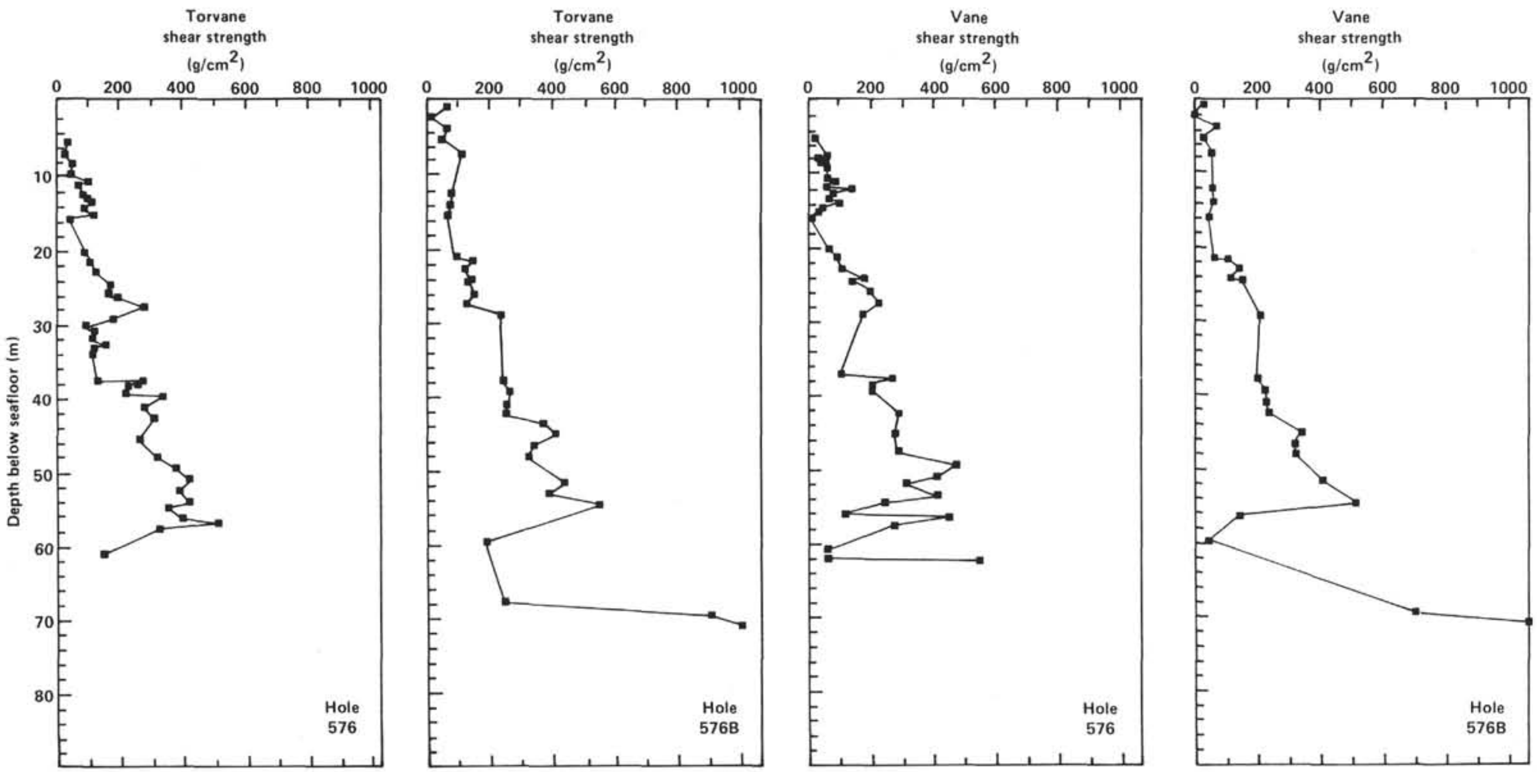

Figure 11. Plot of shear strength versus sub-bottom depth for Site 576.

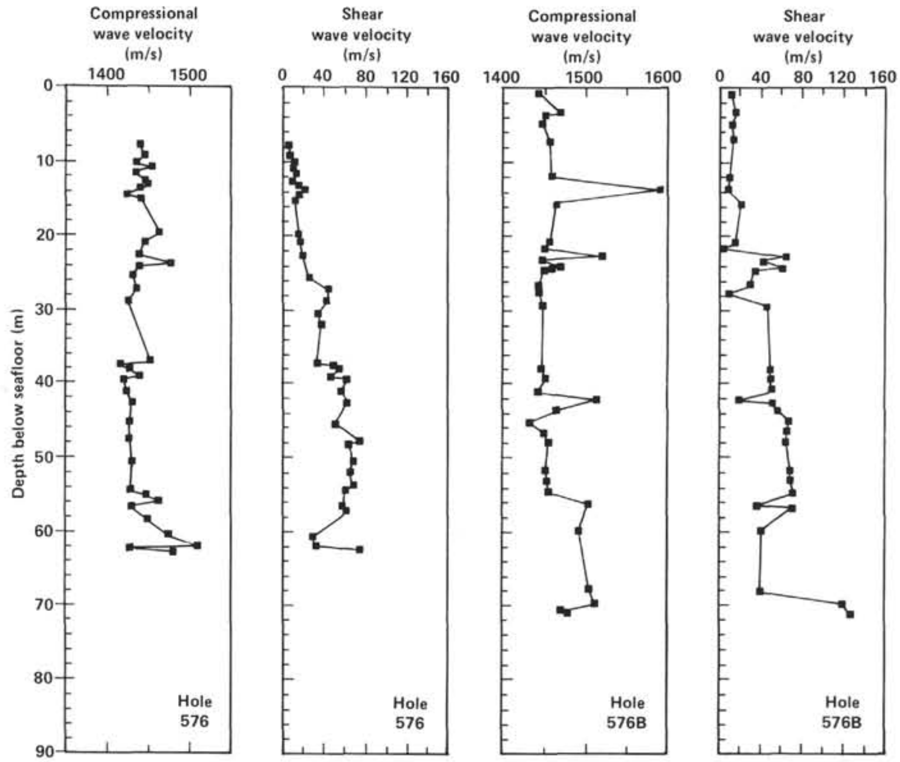

Figure 12. Plot of compressional and shear wave velocities versus sub-bottom depth for Site 576.

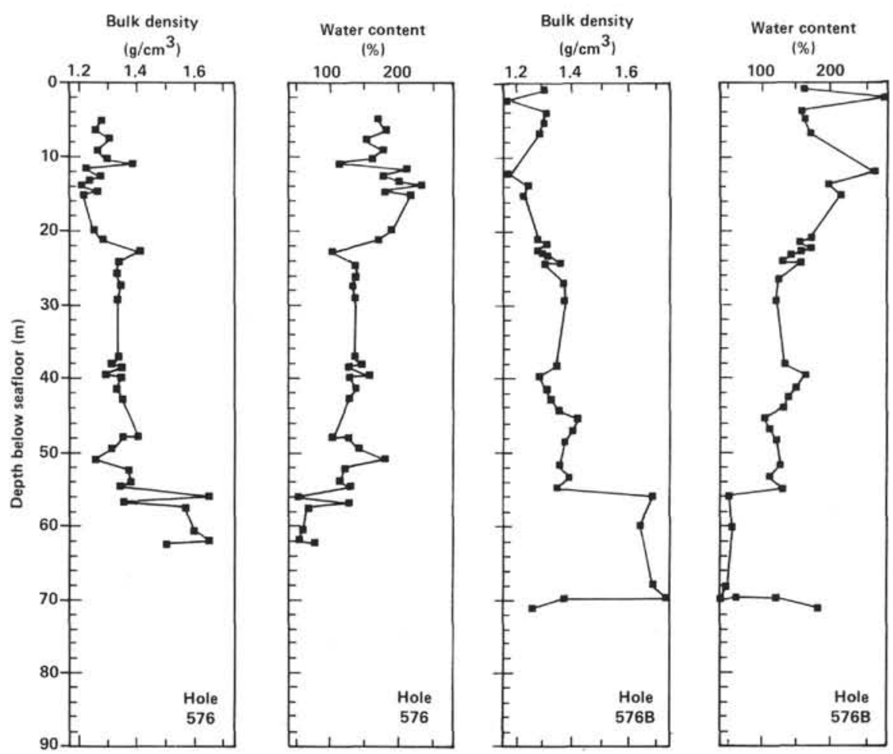

Figure 13. Profiles of saturated bulk density and water content versus sub-bottom depth for Site 576.

Table 7. Inorganic geochemistry measurements at Site 576.

Sample	pH	Alkalinity (mEq/l)	Salinity (‰)	Calcium m*M*	Magnesium m*M*	Chlorinity (‰)
IAPSO	7.74	2.59	35.2	10.55	53.99	19.376
SSW	8.22	2.46	35.2	10.15	53.79	19.174
PW-1	8.26	3.00	35.5	9.79	54.93	19.309
PW-2	8.30	2.53	35.2	9.96	53.31	19.073
PW-3	8.39	2.78	33.8	10.51	51.19	18.264
576A-1-4, 140–150 cm	7.11	2.63	35.2	10.37	53.62	18.871
576A-2-4, 140–150 cm	7.14	2.63	35.5	10.56	53.61	19.208
576A-3-5, 130–140 cm	7.19	2.84	35.5	10.65	51.29	19.174
576A-4-4, 140–150 cm	7.19	2.97	35.5	11.24	51.97	19.342
576A-5-4, 140–150 cm	7.34	3.14	35.5	10.96	53.03	19.376
576A-6-5, 130–140 cm	7.52	3.14	35.5	11.07	53.29	19.275
576A-6-5, 130–140 cm	7.29	2.71	35.8	10.06	53.45	19.275
576A-7-4, 130–140 cm	7.51	2.85	35.5	10.67	53.27	19.140

Temperature data for the successful runs, taken at 10-s intervals for a duration of more than 5 min., clearly show the changing thermal environment at the tip of the HPC. The portion of the cooling curve resulting from the dissipation of frictional heat generated by the HPC as it entered the sediment is most important for estimating the undisturbed sediment temperature. Analyses of the data from all successful runs yield a good estimate of the temperature profile in the unlithified sediments at Site 576 (see Horai and Von Herzen, this volume).

Thermal conductivity measurements on the recovered cores form an integral part of the heat flow study. Measurements were made on 211 samples selected from the cores of Holes 576, 576A, and 576B. These data are combined with the temperature measurements to compute the heat flow at Site 576 (see Horai and Von Herzen, this volume).

SUMMARY AND CONCLUSIONS

Site 576 sampled about 55 m of pelagic clay overlying 20 m of interbedded carbonate turbidites and pelagic clay, before terminating on chert at 76 m.

The upper 25–30 m of clay is yellowish brown, silty, and slightly biosiliceous. It yields a consistent natural remanent magnetization (NRM) record that fits the standard geomagnetic time scale. By analogy with other North Pacific clay sections, we infer that this section is dominated by eolian debris from Asia that increased from the late Miocene or early Pliocene to the late Pleistocene as the onset of northern hemisphere glaciation made large amounts of material available for wind transport. The rate of accumulation of the yellow brown clay has increased from about 2 m/m.y. in the Pliocene to almost 10 m/m.y. during the Brunhes.

The lower dark brown pelagic clays (about 28 to 55 m sub-bottom) are very homogeneous, "slick," and fine grained. Again, by analogy with other North Pacific sections, we infer that much of this material is authigenic. Preliminary ichthyolith dates suggest that the accumulation rate decreased from about 0.6 m/m.y. during the Late Cretaceous to 0.35 m/m.y. at 40 m.y. ago, then increased to about 1 m/m.y. at 2.5 m.y. ago.

Below 55 m, the pelagic clay is interbedded with nannofossil and foraminifer-nannofossil oozes, some, if not all, of which show the graded bedding characteristic of turbidites. The absence of fossils younger than Campanian in the ooze beds suggests that the clays are at least that old and may well be contemporaneous with the

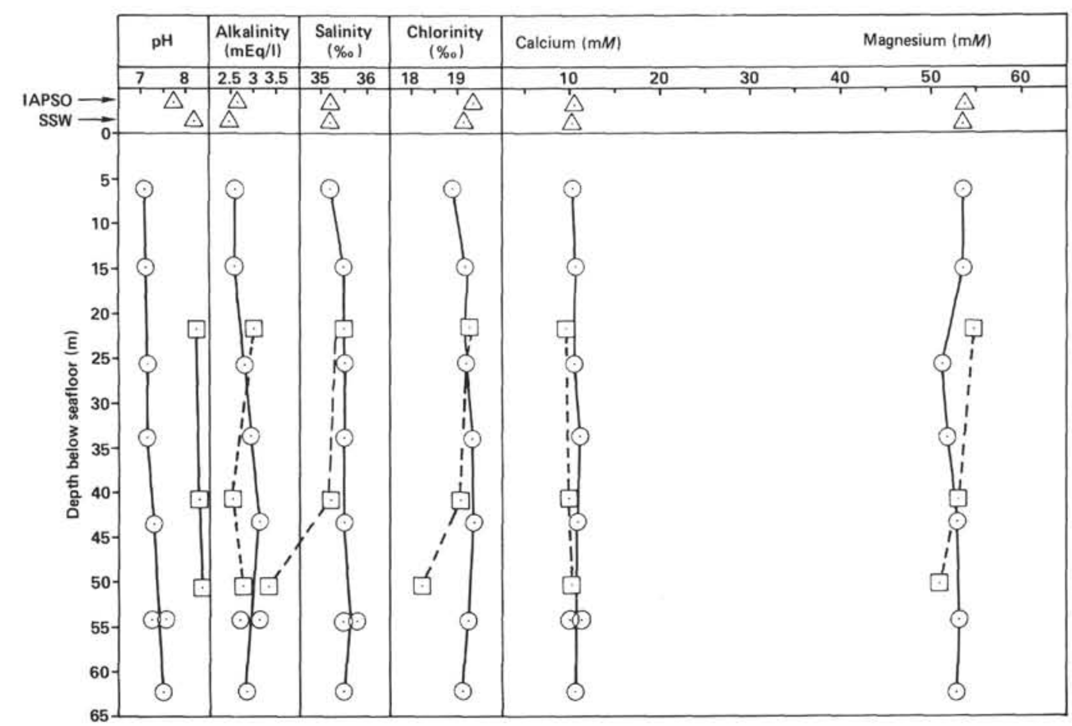

Figure 14. Profiles of pH, alkalinity (mEq/l), salinity (‰), chlorinity (‰), calcium (m*M*), and magnesium (m*M*) versus sub-bottom depth (m) from interstitial water samples analyzed at Site 576. Symbols are as follows: ⚠ = IAPSO and SSW standards; ⊙ = samples from Hole 576A; ⊡ = *in situ* pore water samples from Hole 576.

ooze. If so, the carbonate may be of local derivation, having slumped off nearby hills during a period of enhanced carbonate deposition due either to depression of the calcite compensation depth or increased carbonate productivity or both.

Drilling was terminated by a chert layer that stopped the HPC. The few chips recovered are "flinty" chert and light gray porcellanite typical of silicified pelagic carbonates.

Most of the physical properties of the pelagic clays change fairly monotonically downcore. Both the shear wave velocity and vane shear strength increase by more than an order of magnitude from the surface to 70 m. The deeper clays interbedded with the carbonates are significantly more indurated than the shallower beds. Whether this reflects enhanced diagenesis due to the enclosing carbonate or proximity to the chert remains to be determined. In contrast to the shear wave velocities, the compressional wave values in the clays hover in the vicinity of 1440 m/s. Carbonate values range up to 1510 m/s, explaining why the clay/ooze boundary is such a good acoustic reflector. The water content values peak at about 15–20 m sub-bottom. We attribute this to an increase in the abundance of smectite relative to illite at the base of the eolian-dominated section and continuing downcore. This hypothesis will be tested in shore-based studies.

Site 576 met its objective of recovering a "type" northwestern Pacific pelagic ("red") clay section. If, as suggested by the preliminary results, deposition has been continuous throughout the Cenozoic, this section will provide a record of eolian and authigenic deposition comparable to that in LL44-GPC3.

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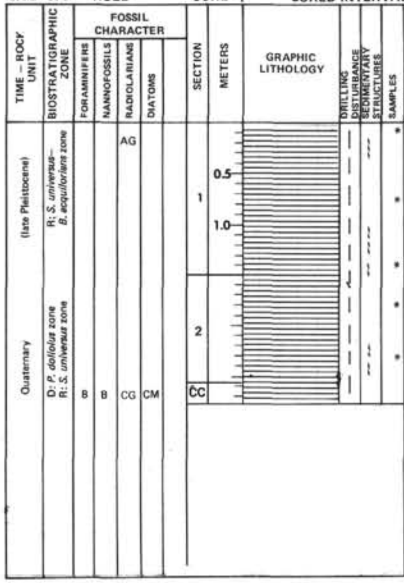
SITE 576 HOLE CORE 1 CORED INTERVAL 6220.3–6223.0 mbsl; 0.0–2.7 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

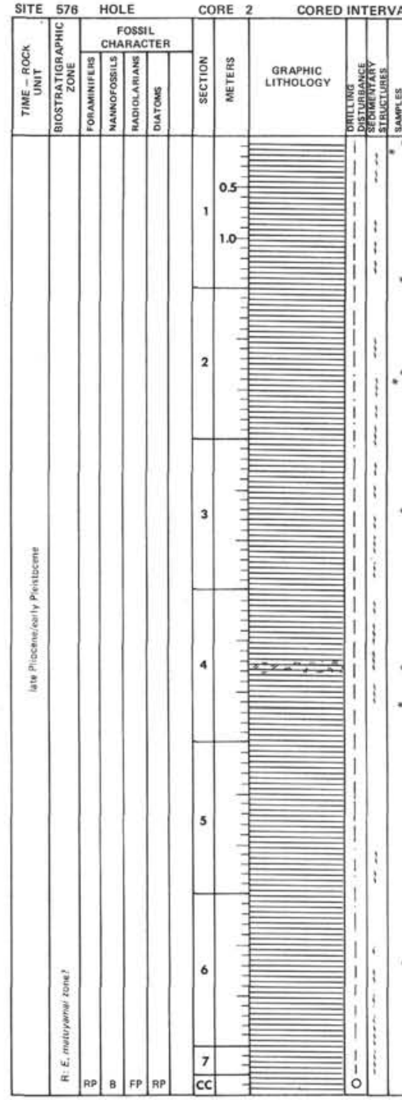
- Dominant colors: dark yellow brown (10YR 4/4), yellowish brown (10YR 5/4), light yellowish brown (10YR 6/4), yellowish brown (10YR 5/6), and brownish yellow (10YR 6/6).
- Core is slightly deformed throughout.
- Bioturbation evident, especially in lighter-colored intervals.

SMEAR SLIDE SUMMARY (%):

	1, 10	1, 80	1, 140	2, 30	2, 85
	D	D	D	D	D
Texture:					
Sand	0	3	0	0	0
Silt	25	40	10	10	10
Clay	75	57	90	90	90
Composition:					
Quartz	25	35	45	30	20
Feldspar	2	3	–	–	Tr
Mica	1	1	–	–	–
Heavy minerals	1	1	–	–	–
Clay	60	50	50	60	70
Volcanic glass	2	2	–	Tr	Tr
Micronodules	2	1	–	1	1
Foraminifers	1	2	–	–	–
Diatoms	–	–	1	2	3
Radiolarians	3	5	2	3	5
Sponge spicules	3	–	2	–	–
Silicoflagellates	–	–	–	1	–

Information on core description sheets, for ALL sites, represents field notes taken aboard ship under time pressure. Some of this information has been refined in accord with post-cruise findings, but production schedules prohibit definitive correlation of these sheets with subsequent findings. Thus the reader should be alerted to the occasional ambiguity or discrepancy.

SITE 576 HOLE CORE 2 CORED INTERVAL 6223.0–6232.5 mbsl; 2.7–12.2 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

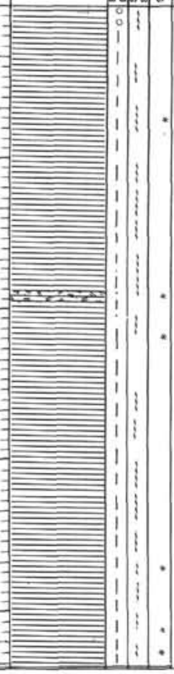
- Dominant colors: dark yellow brown (10YR 4/4) and yellowish brown (10YR 5/4) with dark brown (10YR 3/3), brown (7.5YR 5/4), brownish yellow (10YR 6/6, dark brown (10YR 4/3), and yellow brown (10YR 5/6) intervals. Minor colors: light gray (10YR 7/2) ash.
- Core is slightly deformed throughout.
- Much of this core has been extensively burrowed. Trace to minor amounts of volcanic ash are dispersed throughout the core, with one distinct ash layer in Section 4, 73–74 cm.

SMEAR SLIDE SUMMARY (%):

	1, 7	1, 15	1, 140	2, 86	2, 95	3, 70	4, 74	4, 116	6, 70
	D	D	D	D	D	D	M	D	D
Texture:									
Sand	0	1	1	1	1	Tr	30	1	Tr
Silt	5	10	7	7	10	5	68	1	6
Clay	95	89	92	92	89	95	2	98	94
Composition:									
Quartz	4	15	6	6	5	3	3	1	3
Feldspar	1	2	Tr	1	4	Tr	1	–	1
Mica	–	–	Tr	–	Tr	Tr	–	1	Tr
Heavy minerals	Tr	Tr	Tr	Tr	Tr	–	Tr	Tr	Tr
Clay	85	80	87	87	82	87	2	94	85
Volcanic glass	–	Tr	–	Tr	3	5	93	1	5
Palagonite	–	Tr	–	–	–	–	–	–	–
Micronodules	5	1	1	2	1	Tr	1	1	2
Diatoms	1	–	2	Tr	1	1	–	1	1
Radiolarians	3	2	3	3	3	3	–	2	3
Sponge spicules	1	–	Tr	Tr	Tr	Tr	–	Tr	Tr
Silicoflagellates	–	–	–	Tr	–	–	–	–	–

SITE 576 HOLE CORE 3 CORED INTERVAL 6232.5–6242.0 mbsl; 12.2–21.7 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	ICHTHYOLITHS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
late Pliocene/early Pleistocene		AP	B	RP	RP		1, 2, 3, 4, 5, CC	0.5, 1.0					



PELAGIC CLAY

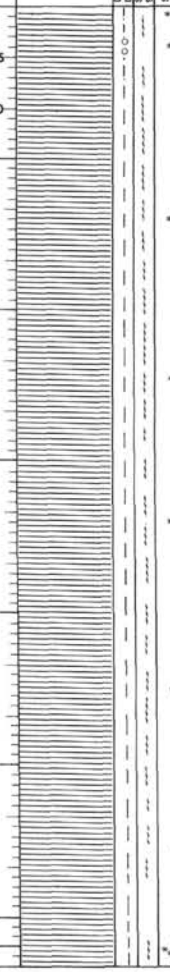
- Dominant colors: dark yellow brown (10YR 4/4), yellowish brown (10YR 5/4), and yellowish brown (10YR 5/6) with dark brown (10YR 3/3) and light yellowish brown (10YR 6/4) intervals. Minor colors: light gray (10YR 7/2) ash.
- Core is slightly deformed throughout.
- Much of this core has been extensively burrowed. There is one distinct, but discontinuous ash layer in Section 2, 137–139 cm.

SMEAR SLIDE SUMMARY (%):

	1, 110 D	2, 139 M	3, 30 D	4, 100 D	5, 20 D	CC D
Texture:						
Sand	1	60	1	5	2	0
Silt	7	40	6	15	14	20
Clay	92	0	93	80	84	80
Composition:						
Quartz	4	10	3	10	10	15
Feldspar	1	–	1	3	3	5
Mica	Tr	–	Tr	–	–	–
Heavy minerals	Tr	Tr	Tr	1	1	–
Clay	87	–	87	80	84	80
Volcanic glass	3	90	4	1	1	–
Micronodules	Tr	–	Tr	–	–	–
Diatoms	1	–	1	–	–	–
Radiolarians	4	–	4	5	1	–
Sponge spicules	Tr	–	Tr	–	–	–

SITE 576 HOLE CORE 4 CORED INTERVAL 6242.0–6251.5 mbsl; 21.7–31.2 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	ICHTHYOLITHS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
Pliocene?		B	B	B	B	RP	1, 2, 3, 4, 5, 6, 7, CC	0.5, 1.0					



PELAGIC CLAY

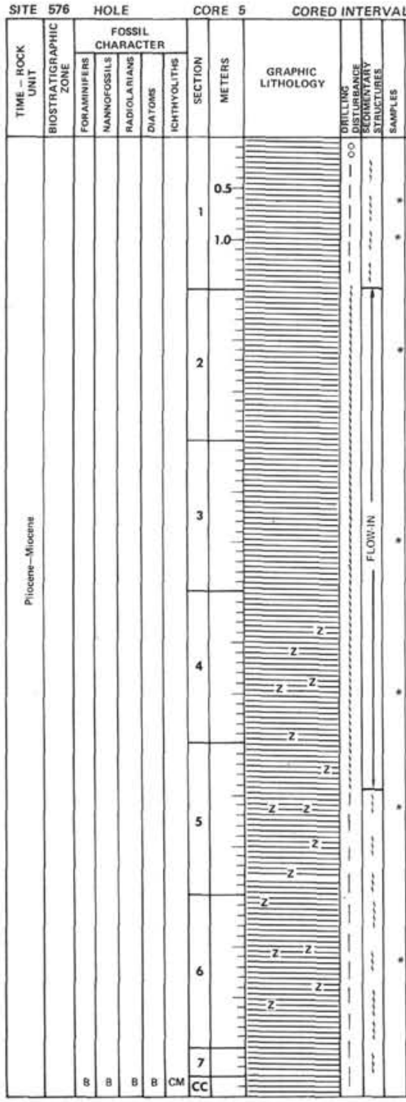
- Dominant colors: yellowish brown (10YR 5/4) and dark yellowish brown (10YR 4/4) with brown (7.5YR 5/6) burrows. Grades to brown (10YR 4/3) clay with yellowish brown (10YR 6/6) burrows at Section 2, 90–110 cm. Grades to dark brown (10YR 3/3) with yellowish (10YR 5/6) burrows below Section 6, 53 cm.
- Core is slightly deformed, with moderately deformed portions restricted to Section 1, 0–85 cm.
- This core has been extensively bioturbated, containing large burrows up to 3 cm in diameter. Sections 5, 6, and Core Catcher contain small nodules (less than 0.5 cm in diameter) and specks of MnO_2 that cover up to 3% of the core surface. Zeolites first appear in trace amounts in Section 3.

SMEAR SLIDE SUMMARY (%):

	1, 10 D	1, 40 D	2, 60 D	3, 70 D	4, 60 D	5, 75 D
Texture:						
Sand	1	1	2	0	0	3
Silt	15	11	9	7	18	12
Clay	84	88	89	93	82	85
Composition:						
Quartz	10	7	7	6	15	7
Feldspar	3	3	3	1	2	3
Heavy minerals	1	2	1	–	–	–
Clay	84	86	88	93	82	88
Volcanic glass	1	1	1	–	–	–
Pyrite	–	–	–	Tr	–	–
Zeolite	–	–	–	Tr	–	–
Carbonate unspec.	–	–	–	–	–	Tr
Radiolarians	1	1	–	–	–	–
Fish remains	–	–	–	Tr	1	1
Plant debris	–	–	–	–	–	1

	6, 80 D	7, 25 D	CC, 1 D	CC, 2 D	CC, 3 D
Texture:					
Sand	0	Tr	2	3	2
Silt	3	6	10	7	10
Clay	97	94	88	90	88
Composition:					
Quartz	Tr	4	8	7	7
Feldspar	Tr	2	2	2	5
Mica	1	Tr	–	–	–
Heavy minerals	–	Tr	–	1	–
Clay	95	92	90	90	88
Volcanic glass	–	Tr	–	–	–
Micronodules	Tr	2	–	–	–
Zeolite	4	–	–	–	–

SITE 576 HOLE CORE 5 CORED INTERVAL 6251.5–6261.0 mbsl; 31.2–40.7 mbsf



LITHOLOGIC DESCRIPTION

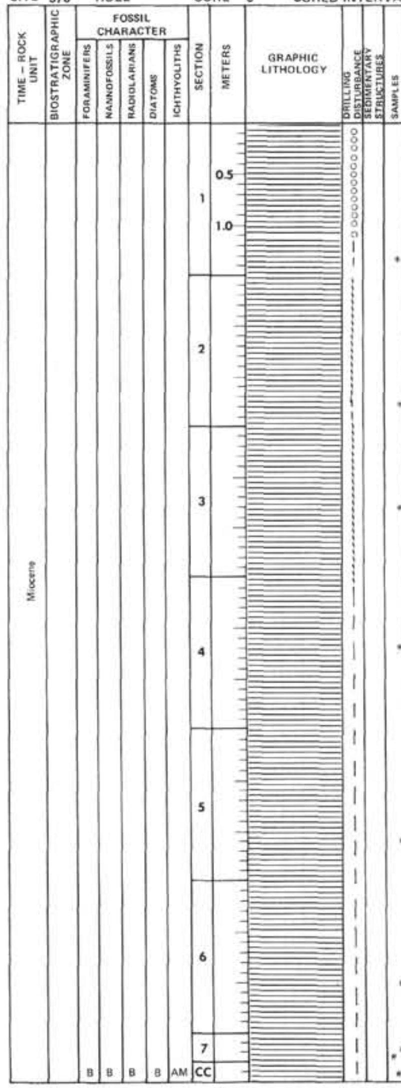
PELAGIC CLAY (Zeolitic clay in Sections 4 through 6.)

- Dominant colors: dark yellow brown (10YR 4/4) in Section 1; dark brown (10YR 3/3) in Sections 2 through 5, 49 cm, except for the lower portion of Section 3 which is dark yellowish brown (10YR 3/4). Below Section 5, 49 cm, the core is very dark grayish brown (10YR 3/2).
- Section 1 and core below Section 5, 49 cm is slightly deformed. The interval from Sections 2 to 5, 49 cm is very deformed, resulting from flow-in of drilled material.
- This core has been extensively bioturbated. Burrows in Sections 1 and 6 have "reaction rims" around them. The percentage of zeolites seen in smear slides increases downcore to approximately 10% in Section 4.

SMEAR SLIDE SUMMARY (%):

	1, 63	1, 100	2, 65	3, 100	4, 100	5, 65	6, 62
	D	D	D	D	D	D	D
Texture:							
Sand	0	1	0	0	0	0	0
Silt	4	6	5	4	11	7	10
Clay	96	93	95	96	89	93	90
Composition:							
Quartz	3	4	4	4	4	2	Tr
Feldspar	Tr	Tr	1	Tr	Tr	Tr	–
Mica	Tr	Tr	Tr	Tr	–	–	Tr
Clay	97	92	94	94	86	93	90
Volcanic glass	Tr	1	Tr	Tr	Tr	Tr	Tr
Pyrite	–	–	Tr	–	–	–	–
Micronodules	Tr	1	1	1	Tr	Tr	Tr
Zeolite	–	2	–	1	10	5	10

SITE 576 HOLE CORE 6 CORED INTERVAL 6261.0–6270.5 mbsl; 40.7–50.2 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Dominant colors: dark brown (7.5YR 3/2) throughout, except for dark reddish brown (5YR 3/2) interval in Section 3 and dark reddish brown (5YR 3/3) interval in Section 7 and Core Catcher.
- The top meter of Section 1 is soupy, and Sections 2 and 3 are very deformed. The rest of the core is slightly deformed.
- This core contains very homogeneous pelagic clay. There are 2 burrows in Section 4. Zeolites are found in trace amounts, but are much less abundant than in Core 4.

SMEAR SLIDE SUMMARY (%):

	1, 135	2, 130	3, 80	4, 70	5, 110	6, 100	7, 20	7, 30	CC
	D	D	D	D	D	D	D	D	D
Texture:									
Sand	Tr	1	1	1	Tr	Tr	1	2	0
Silt	3	4	2	3	2	2	7	15	7
Clay	97	95	97	96	98	98	92	83	93
Composition:									
Quartz	Tr	1	1	2	1	2	5	7	5
Feldspar	–	–	–	Tr	–	1	2	3	1
Mica	Tr	–	–	Tr	Tr	–	–	–	–
Clay	96	95	98	96	93	92	92	83	93
Volcanic glass	Tr	1	1	1	Tr	1	–	2	Tr
Palagonite	–	–	–	–	–	–	–	3	–
Micronodules	Tr	Tr	–	1	6	4	–	–	–
Zeolite	3	3	–	–	–	Tr	–	–	1
Opaques	–	–	–	–	–	–	1	2	–

SITE 576 HOLE CORE 7 CORED INTERVAL 6270.5–6280.0 mbsl; 50.2–59.7 mbsf

TIME-ROCK UNIT: lower to middle Miocene

FOSSIL CHARACTER: Foraminifers B; Nannofossils B; Radiolarians B; Diatoms B; Ichthyoliths FM

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

GRAPHIC LITHOLOGY

LITHOLOGIC DESCRIPTION

PELAGIC CLAY

*Dominant colors: dark reddish brown (5YR 3/3) and dark reddish brown (5YR 3/2). Minor colors: Sections 2 and 3 contain reddish brown (5YR 4/4) mottles. Section 3 contains a yellowish red (5YR 4/6) layer at 16–18 cm. Section 6 contains four continuous (at 60, 84, 103, and 111 cm) and two discontinuous (at 57.5 and 76 cm) thin dark reddish brown to reddish brown (5YR 3/4–5YR 4/3) layers. The Core Catcher has brown (7.5YR 5/6) strong vertical streaks.

*Core is slightly deformed throughout, except for one soupy section in the upper 50 cm of Section 2.

*This core contains homogeneous, undeformed clay with very restricted intervals of mottled clay. The distinct layers in Sections 3 and 6 are also clay.

SMEAR SLIDE SUMMARY (%):

	1, 30 D	2, 75 D	3, 10 D	3, 16 D	3, 24 D	4, 70 D	5, 70 D	6, 90 D	6, 111 D	CC D
Texture:										
Sand	2	0	0	3	1	1	1	2	1	1
Silt	10	10	4	7	7	7	10	3	4	2
Clay	88	90	96	90	92	92	89	95	95	97
Composition:										
Quartz	5	8	2	3	3	5	3	Tr	Tr	Tr
Feldspar	2	1	1	2	2	2	3	Tr	Tr	Tr
Mica	–	–	–	–	–	–	–	–	Tr	1
Heavy minerals	–	–	–	1	1	–	–	–	–	–
Clay	88	90	95	90	90	88	91	94	95	95
Volcanic glass	–	1	1	2	1	3	3	3	2	3
Pyrite	–	–	1	2	3	Tr	–	–	–	–
Micronodules	–	–	–	–	–	–	1	3	1	–
Zeolite	–	Tr	–	–	–	–	–	–	Tr	–
Carbonate unspec.	–	–	–	–	–	–	Tr	–	–	–
Calc. nannofossils	–	–	–	–	–	Tr	–	–	–	–
Opaques	5	Tr	Tr	Tr	Tr	Tr	–	2	–	Tr

SITE 576 HOLE CORE 8 CORED INTERVAL 6280.0–6289.5 mbsl; 59.7–69.2 mbsf

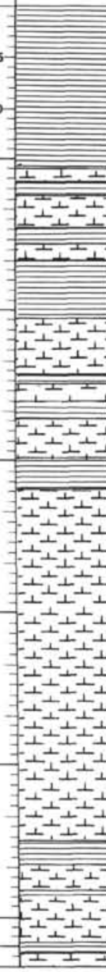
TIME-ROCK UNIT: upper Cretaceous (Campanian)

BIOSTRATIGRAPHIC ZONE: N: Q. trifidum zone; F: G. fornicata/G. stuartiformis zone

FOSSIL CHARACTER: Foraminifers AM; Nannofossils CP; Radiolarians B; Diatoms B; Ichthyoliths RM

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

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

INTERBEDDED PELAGIC CLAY AND NANNOFOSSIL OOZE, with proportion of nannofossil ooze increasing downcore.

*Dominant colors: clay intervals are dark brown (7.5YR 3/2), except for the clay in Section 1 which is dark reddish brown (5YR 3/2). The nannofossil ooze intervals are yellow (10YR 7/6), reddish yellow (7.5YR 6/8), light yellowish brown (10YR 6/4), and yellowish brown (10YR 5/6) in Sections 2 and 3; changing to very pale brown (10YR 7/4 and 10YR 8/4) in Sections 4, 5, and 6; changing to yellow (10YR 7/6) in the base of Section 6, Section 7, and the Core Catcher. Minor colors: white (10YR 8/2) and pink (7.5YR 8/4) nannofossil ooze layers approximately 1 cm thick in Section 6.

*This core is slightly deformed throughout.

*This core consists of interbedded dark brown pelagic clay with either gradational or sharp basal contacts and lighter-colored nannofossil ooze layers with sharp basal contacts. Much of the core is bioturbated. Several of the nannofossil ooze layers are normally graded. The base of the nannofossil ooze layer in Section 6 is crossbedded.

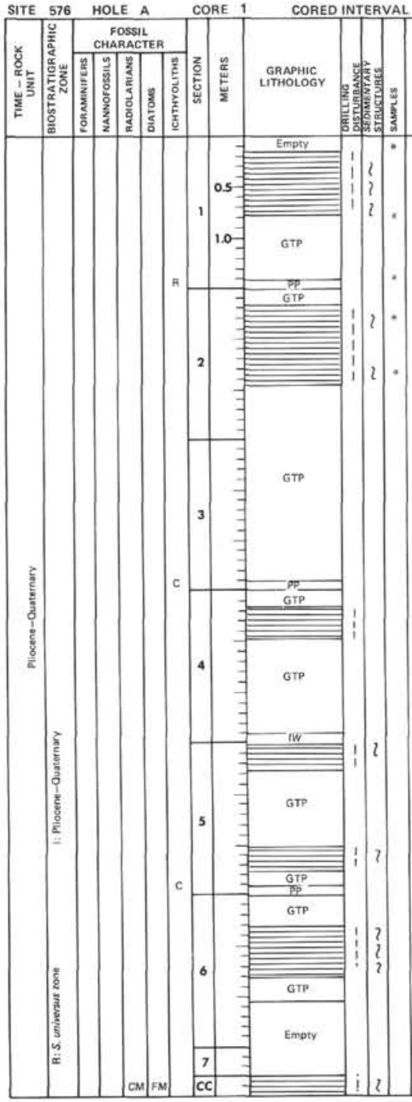
SMEAR SLIDE SUMMARY (%):

	1, 110 D	1, 138 D	2, 13 D	2, 30 D	2, 50 D	3, 40 D
Texture:						
Sand	0	0	Tr	Tr	0	Tr
Silt	3	2	2	5	1	2
Clay	97	98	98	95	99	98
Composition:						
Quartz	Tr	Tr	Tr	Tr	Tr	–
Feldspar	Tr	Tr	–	–	–	–
Mica	–	–	–	Tr	–	–
Clay	94	–	5	94	4	2
Volcanic glass	3	1	1	2	Tr	1
Micronodules	1	1	1	1	Tr	Tr
Foraminifers	–	–	Tr	–	Tr	Tr
Calc. nannofossils	–	97	92	–	95	96
Opaques	2	1	1	3	1	1

	4, 13 D	6, 40 D	6, 64 D	6, 73 D	6, 84 D
Texture:					
Sand	1	1	15	15	Tr
Silt	5	1	2	5	3
Clay	94	98	83	80	97
Composition:					
Quartz	Tr	–	–	–	Tr
Feldspar	Tr	–	–	–	–
Clay	1	1	–	2	95
Volcanic glass	3	1	2	5	2
Micronodules	Tr	Tr	Tr	–	Tr
Foraminifers	–	1	15	15	–
Calc. nannofossils	96	97	83	78	1
Fish remains	–	–	–	Tr	–
Opaques	–	–	Tr	–	2

$CaCO_3$ data:
1, 80 cm = 3%
2, 90 cm = 82%
3, 77 cm = 83%
4, 90 cm = 86%
5, 105 cm = 82%
6, 15 cm = 87%
6, 45 cm = 85%
6, 135 cm = 85%

SITE 576 HOLE A CORE 1 CORED INTERVAL 6218.0–6227.5 mbsl; 0.0–8.7 mbsf



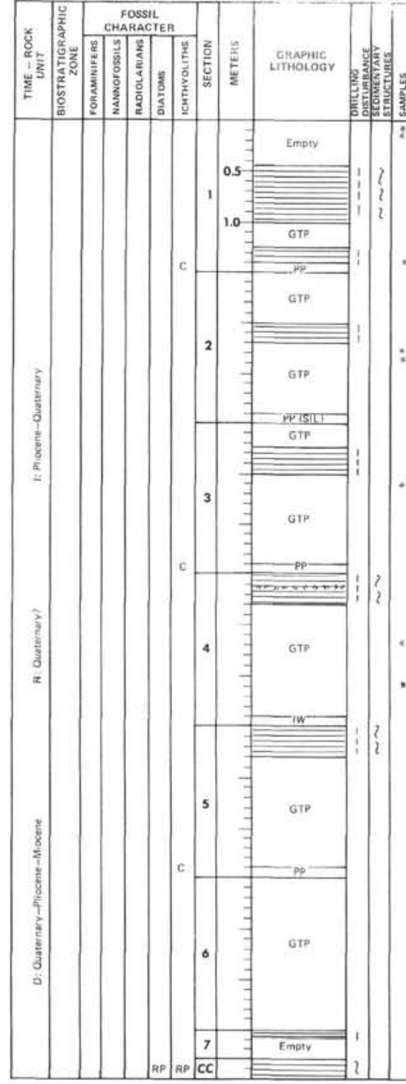
10YR 4/4 10YR 4/3 10YR 5/4 10YR 4/4	
10YR 5/4	
10YR 4/3	
10YR 4/3	
10YR 4/3	
10YR 5/4 10YR 4/3	
10YR 4/3	
10YR 5/3	

LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Dominant colors: brown (10YR 4/3) to dark brown, dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/4), and brown (10YR 5/3).
- This core consists of mottled pelagic clay. Drilling deformation is slight in all the split intervals.

SITE 576 HOLE A CORE 2 CORED INTERVAL 6227.5–6237.0 mbsl; 8.7–18.2 mbsf



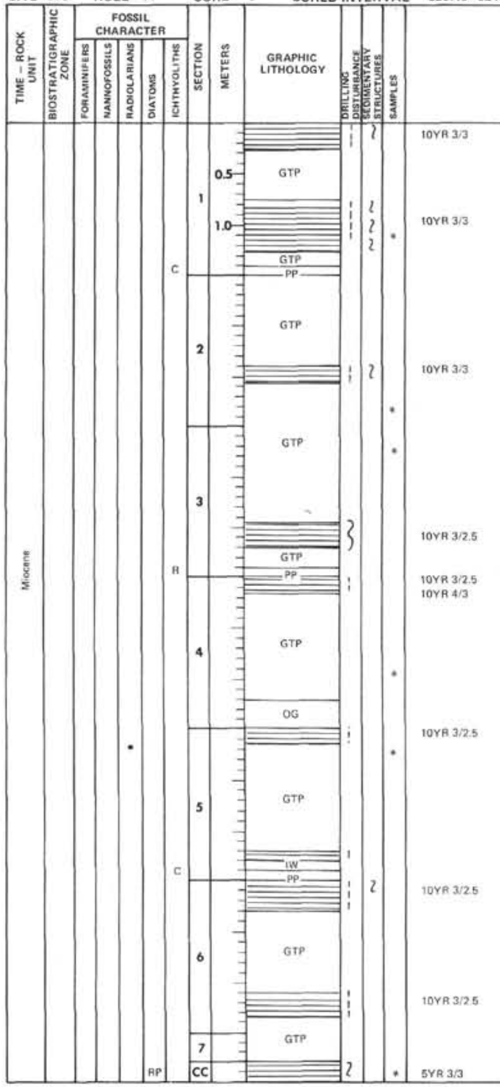
10YR 4/3	
10YR 4/3	
10YR 4/3	
10YR 4/3	
7.5YR 5/6 10YR 4/3	
10YR 4/3	
10YR 3/3	
10YR 4/3	

LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Dominant color: brown (10YR 4/3) to dark brown.
- Minor colors: ash layer and mottles in Section 4 are reddish yellow (7.5YR 5/6). Mottles in Sections 1 and 5 are yellowish brown (10YR 5/4–10YR 5/6).
- This core consists of homogeneous to mottled pelagic clay. The sections below Section 2 appear a bit "slicker" than the overlying sediment. Drilling deformation is slight in all the split intervals. An ash layer occurs in Section 4, 13–16 cm.

SITE 576 HOLE A CORE 3 CORED INTERVAL 6237.0–6246.5 mbsl; 18.2–27.7 mbsf

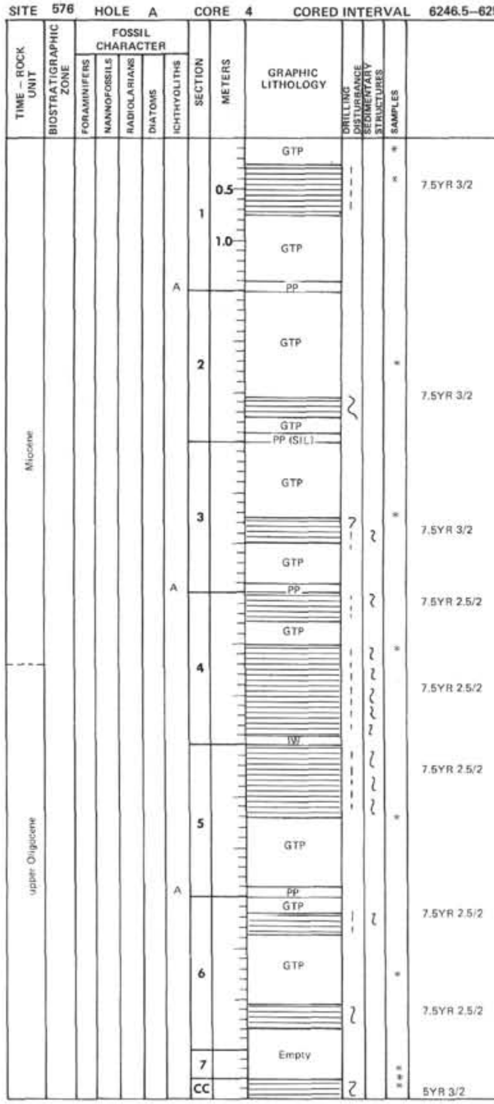


LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Dominant colors: dark yellowish brown (10YR 3/3) grading downcore to very dark grayish brown (10YR 3/2.5).
- This core consists of homogeneous to mottled "slick" pelagic clay. Clay in Sections 4 and 5 contains specks of MnO_2. Drilling deformation in the split intervals is slight, except for Section 3, 95–120 cm which contains flow-in.
- Minor colors: mottles in Sections 1 and 2 are reddish yellow (7.5YR 6/6). Thin zeolitic layer in Section 4, 9–9.5 cm is also reddish yellow (7.5YR 6/6).

SITE 576 HOLE A CORE 4 CORED INTERVAL 6246.5–6256.0 mbsl; 27.7–37.2 mbsf

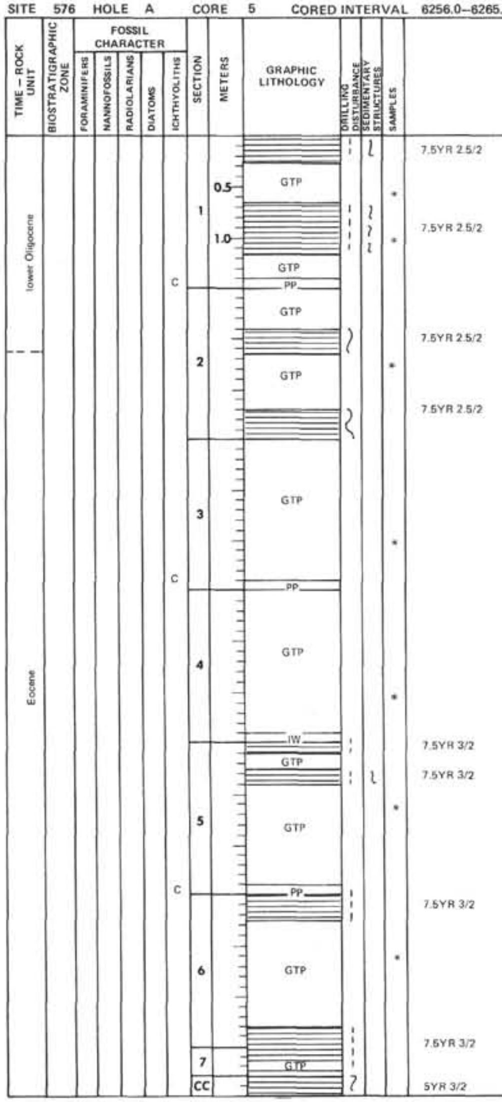


LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Domiant colors: dark brown (7.5YR 3/2) grading downcore to very dark brown (7.5YR 2.5/2).
- Minor colors: mottles are strong brown (7.5YR 5.5/6) to reddish yellow and very dark gray (10YR 3/1).
- This core consists of homogeneous to mottled "slick" pelagic clay. Flow-in occurs in split intervals of Section 2 (103–123 cm), Section 3 (73–84 cm), and Section 6 (107–127 cm). The rest of the split intervals are only slightly deformed by drilling.

SITE 576 HOLE A CORE 5 CORED INTERVAL 6256.0–6265.5 mbsl; 37.2–46.7 mbsf

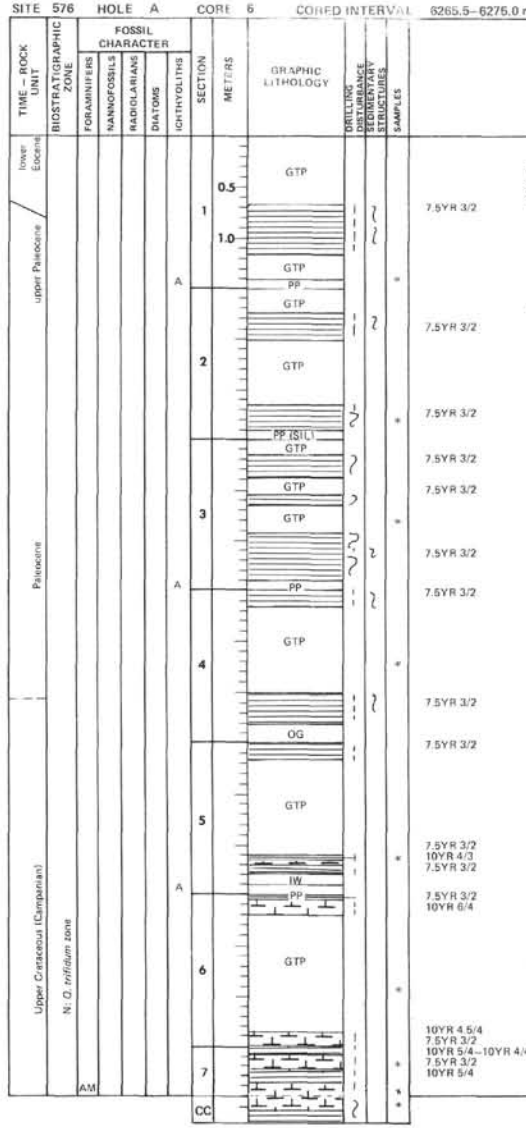


LITHOLOGIC DESCRIPTION

PELAGIC CLAY

- Dominant colors: very dark brown (7.5YR 2.5/2) grading downcore to dark brown (7.5YR 3/2).
- Minor colors: mottles are strong brown (7.5YR 5/6) and very dark gray (10YR 3/1) in Section 1, and reddish yellow (7.5YR 5.5/6) in Section 5.
- This core consists of "slick" pelagic clay, sparsely mottled only in Sections 1 and 5. Split intervals in Section 2 contain flow-in; the rest of the split intervals are only slightly deformed by drilling.

SITE 576 HOLE A CORE 6 CORED INTERVAL 6265.5–6275.0 mbsl; 46.7–56.2 mbsf

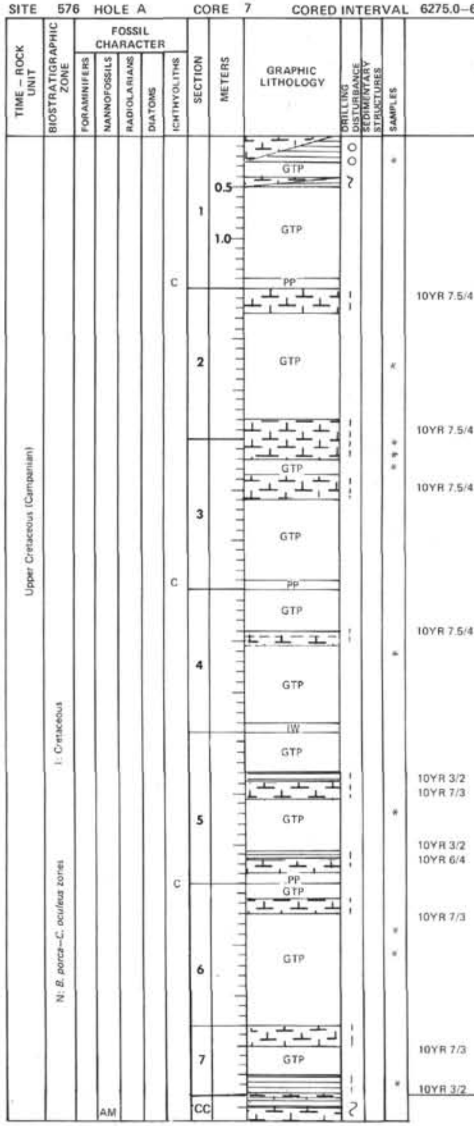


LITHOLOGIC DESCRIPTION

PELAGIC CLAY in Sections 1–4; INTERBEDDED PELAGIC CLAY and NANNOFOSSIL OOZE in Sections 5–7 and Core Catcher.

- Dominant colors: pelagic clay intervals are dark brown (7.5YR 3/2). Nannofossil ooze intervals are brown (10YR 4/3) to dark brown, light yellowish brown (10YR 6/4), yellowish brown (10YR 5/4), and dark yellowish brown (10YR 4/4).
- Sections 1–4 of this core contain homogeneous to slightly mottled "slick" pelagic clay. Sections 5–7 and the Core Catcher contain interbedded pelagic clay (similar to that in Sections 1–4) and nannofossil ooze. The split intervals in Section 2 (125–140 cm) and Section 3 (15–110 cm and 118–140 cm) contain flow-in; the rest of the split intervals are only slightly deformed by drilling.

SITE 576 HOLE A CORE 7 CORED INTERVAL 6275.0–6284.5 mbsl; 56.2–65.7 mbsf



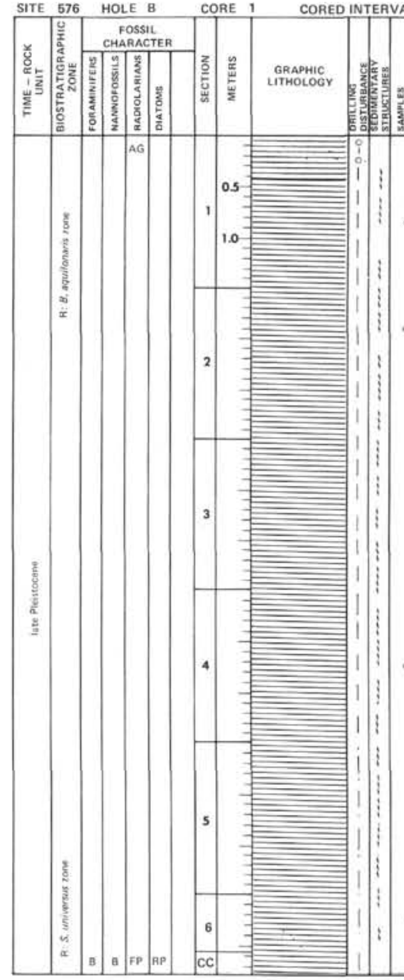
LITHOLOGIC DESCRIPTION

INTERBEDDED PELAGIC CLAY and NANNOFOSSIL OOZE

- Dominant colors: pelagic clay intervals are very dark grayish brown (10YR 3/2). Nannofossil ooze intervals are very pale brown (10YR 7.5/4), very pale brown (10YR 7/3–7/4), and light yellowish brown (10YR 6/4).
- This core consists of interbedded homogeneous pelagic clay and nannofossil ooze. Split intervals in Section 1 are very deformed by drilling; the rest of the split intervals are only slightly deformed.

NOTE that Sections 4 and 6 of this core were mistakenly cut to only 140 cm total length onboard ship. Core section dividers on this barrel sheet have been adjusted accordingly.

SITE 576 HOLE B CORE 1 CORED INTERVAL 6219.3–6227.5 mbsl; 0.0–8.2 mbsf



LITHOLOGIC DESCRIPTION

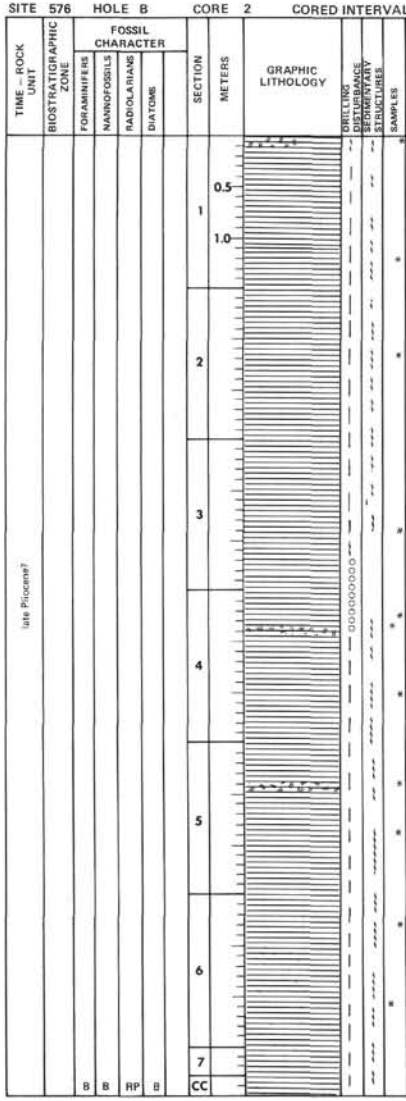
PELAGIC CLAY

- Dominant colors: yellowish brown (10YR 5/6), yellowish brown (10YR 5/4), and dark yellowish brown (10YR 4/4) with intervals of light yellowish brown (10YR 6/4) and dark brown (7.5YR 4/4).
- Sections 1 to 4 are slightly deformed; Sections 5 and 6 are moderately deformed.
- This core is composed of pelagic clay, both homogeneous and with varying amounts of mottles and burrows. MnO_2 streaks are present in some sections. Four pumice(?) pebbles were cored in Section 2, 117 cm.

SMEAR SLIDE SUMMARY (%):

	1, 90	2, 48	4, 75	6, 26
	D	D	D	D
Texture:				
Sand	5	5	3	1
Silt	15	20	12	10
Clay	80	75	85	89
Composition:				
Quartz	8	10	12	12
Feldspar	2	Tr	Tr	Tr
Clay	79	75	81	84
Volcanic glass	4	4	5	3
Micronodules	1	Tr	Tr	Tr
Diatoms	2	Tr	Tr	Tr
Radiolarians	5	5	2	1
Sponge spicules	Tr	Tr	Tr	Tr
Silicoflagellates	Tr	Tr	Tr	–
Opaques	–	1	–	–

SITE 576 HOLE B CORE 2 CORED INTERVAL 6227.5–6237.0 mbsl; 8.2–17.7 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

*Dominant colors: brown (10YR 5/3) and brown (7.5YR 5/4) in Sections 1 to 5, changing to brown (10YR 4/3) to dark brown at the base of Section 5. Reddish yellow (7.5YR 6/6) and brownish yellow (10YR 6/8) mottles. Minor colors: gray (10YR 6/1) ash in Section 5, 40 cm.

*This core is slightly deformed throughout, except for a soupy section in the base of Section 3 and top of Section 4.

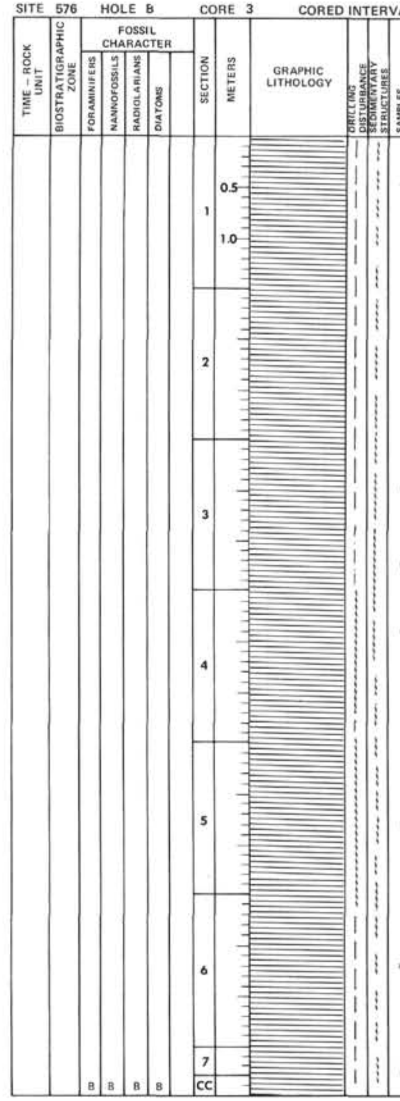
*This core is composed of pelagic clay darkening in color downcore with abundant mottles. Two ash layers were cored at Section 4, 40 cm and Section 5, 40 cm.

SMEAR SLIDE SUMMARY (%):

	1, 3	1, 120	2, 70	3, 96	4, 30	4, 40
	M	D	D	D	D	M
Texture:						
Sand	20	5	1	2	1	15
Silt	60	20	15	10	12	65
Clay	20	75	84	88	87	20
Composition:						
Quartz	7	10	15	10	10	5
Feldspar	3	1	5	2	Tr	2
Heavy minerals	2	–	Tr	Tr	–	–
Clay	–	75	75	88	87	2
Volcanic glass	88	1	Tr	Tr	3	90
Micronodules	–	–	–	–	Tr	–
Zeolite	–	–	Tr	Tr	–	1
Diatoms	–	1	Tr	–	–	–
Radiolarians	–	10	5	Tr	–	–
Sponge spicules	–	1	Tr	–	–	–
Opaques	–	1	–	–	–	Tr

	4, 100	5, 40	5, 90	6, 30	6, 110
	D	M	D	D	D
Texture:					
Sand	Tr	20	2	0	Tr
Silt	10	60	12	6	10
Clay	90	20	88	94	90
Composition:					
Quartz	7	3	10	4	7
Feldspar	1	1	1	Tr	Tr
Clay	90	5	85	95	90
Volcanic glass	2	90	3	1	3
Micronodules	Tr	–	Tr	Tr	Tr
Zeolites	–	1	–	–	–
Radiolarians	Tr	–	–	–	–
Opaques	–	–	1	Tr	–

SITE 576 HOLE B CORE 3 CORED INTERVAL 6237.0–6246.5 mbsl; 17.7–27.2 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

*Dominant colors: dark brown (10YR 4/3) and dark yellowish brown (10YR 3/4) clay grading to dark brown (7.5YR 3/2) clay below Section 6.

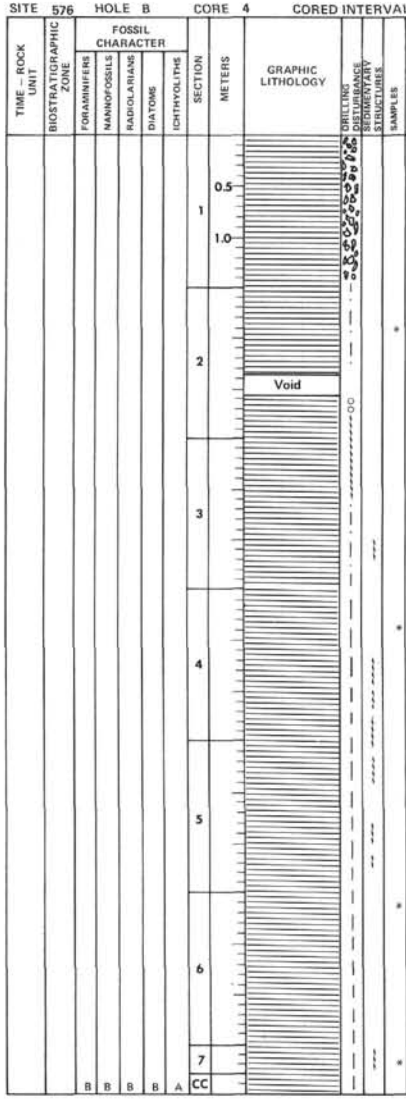
*This core has been slightly deformed, except for Sections 4 and 5 which were very deformed.

*This core has been bioturbated throughout, with abundant burrows and mottled zones. MnO_2 specks and streaks are common.

SMEAR SLIDE SUMMARY (%):

	1, 50	3, 50	3, 124	4, 40	5, 80	6, 70	7, 30
	D	D	D	D	D	D	D
Texture:							
Sand	1	2	1	Tr	Tr	Tr	0
Silt	9	15	7	10	8	7	12
Clay	90	83	92	90	92	93	88
Composition:							
Quartz	7	5	5	7	7	6	5
Feldspar	Tr	Tr	Tr	Tr	Tr	Tr	–
Mica	–	2	2	Tr	–	1	–
Clay	90	83	91	89	89	90	85
Volcanic glass	2	2	–	1	1	Tr	Tr
Micronodules	1	1	1	1	2	1	Tr
Zeolite	–	7	–	–	–	–	7
Fish remains	–	–	Tr	–	–	–	–
Opaques	Tr	Tr	1	2	1	2	3

SITE 576 HOLE B CORE 4 CORED INTERVAL 6246.5–6256.0 mbsl; 27.2–36.7 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

*Dominant colors: dark brown (7.5YR 3/2) and dark reddish brown (5YR 2/2). Burrows are dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6).

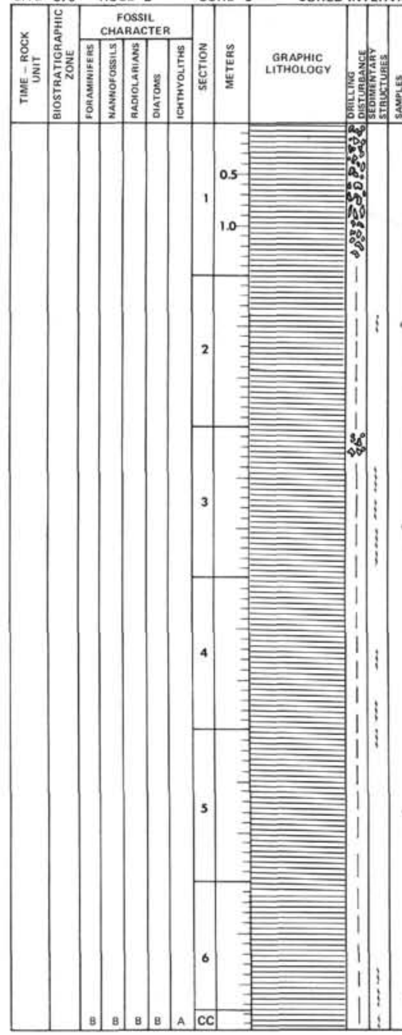
*Sections 4 to 7 of this core are slightly deformed. Section 1 is brecciated; Sections 2 and 3 are soupy and moderately to very deformed. Section 2 contains a void from 85–105 cm.

*This core consists of homogeneous brown pelagic clay with minor burrows and mottled zones.

SMEAR SLIDE SUMMARY (%):

	2, 40	4, 40	6, 15	7, 20
	D	D	D	D
Texture:				
Sand	Tr	0	1	0
Silt	10	8	2	4
Clay	90	92	97	96
Composition:				
Quartz	2	6	1	3
Feldspar	Tr	Tr	Tr	Tr
Mica	Tr	Tr	Tr	Tr
Clay	88	89	97	96
Volcanic glass	1	2	1	1
Micronodules	Tr	Tr	–	Tr
Zeolite	5	5	Tr	–
Hematite	4	3	1	–

SITE 576 HOLE B CORE 5 CORED INTERVAL 6256.0–6265.5 mbsl; 36.7–46.2 mbsf



LITHOLOGIC DESCRIPTION

PELAGIC CLAY

*Dominant colors: dark brown (7.5YR 3/2) and dark reddish brown (5YR 3/2). Burrows are dark reddish brown (5YR 3/4).

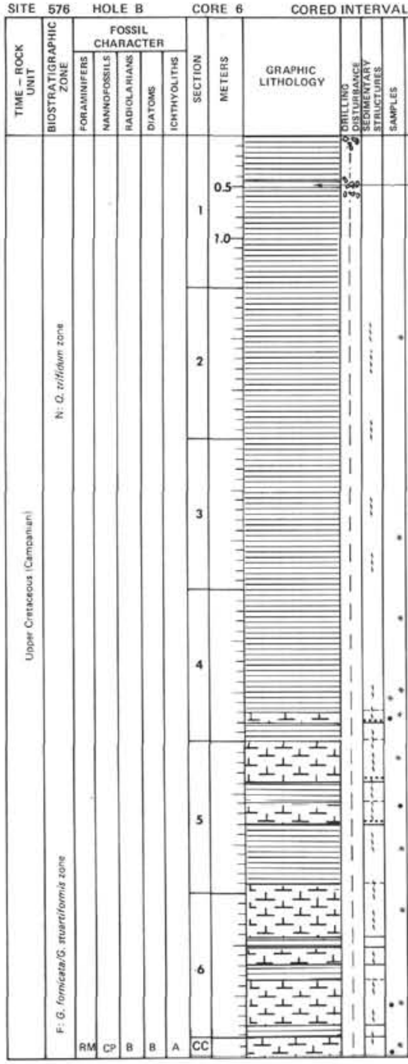
*Section 1 is brecciated and soupy. The rest of the core is slightly deformed.

*This core consists of homogeneous brown pelagic clay with only minor small burrows and mottled zones.

SMEAR SLIDE SUMMARY (%):

	2, 50	3, 100	5, 80	6, 116
	D	D	D	D
Texture:				
Sand	1	Tr	Tr	2
Silt	6	7	5	2
Clay	93	93	95	96
Composition:				
Quartz	2	Tr	Tr	1
Feldspar	Tr	Tr	Tr	Tr
Mica	Tr	Tr	Tr	–
Clay	92	96	95	96
Volcanic glass	1	1	1	2
Micronodules	1	1	1	1
Zeolite	–	Tr	Tr	–
Radiolarians	Tr	–	–	–
Opaques, Hematite	4	2	3	Tr

SITE 576 HOLE B CORE 6 CORED INTERVAL 6265.5–6275.0 mbsl; 46.2–55.7 mbsf



LITHOLOGIC DESCRIPTION

INTERBEDDED PELAGIC CLAY AND NANNOFOSSIL OOZE

* Dominant colors: clay intervals are dark brown (7.5YR 3/2) grading downcore into brown (7.5YR 4/4) in Section 4, and to dark yellowish brown (10YR 3/4) in Section 5. Nannofossil ooze intervals are light brownish yellow (10YR 6/4), yellowish brown (10YR 5/8, yellowish brown (10YR 5/6), and brownish yellow (10YR 6/8). Burrows are dark reddish brown (5YR 3/4) and dark brown (7.5YR 4/4).
* Except for the brecciated and soupy portions of Section 1, this core is slightly deformed throughout.
* This core contains interbedded homogeneous brown pelagic clay and brownish yellow mottled nannofossil ooze. Several of the ooze layers are normally graded, indicating deposition by turbidity currents.

Note: Core Catcher is 30 cm in length.

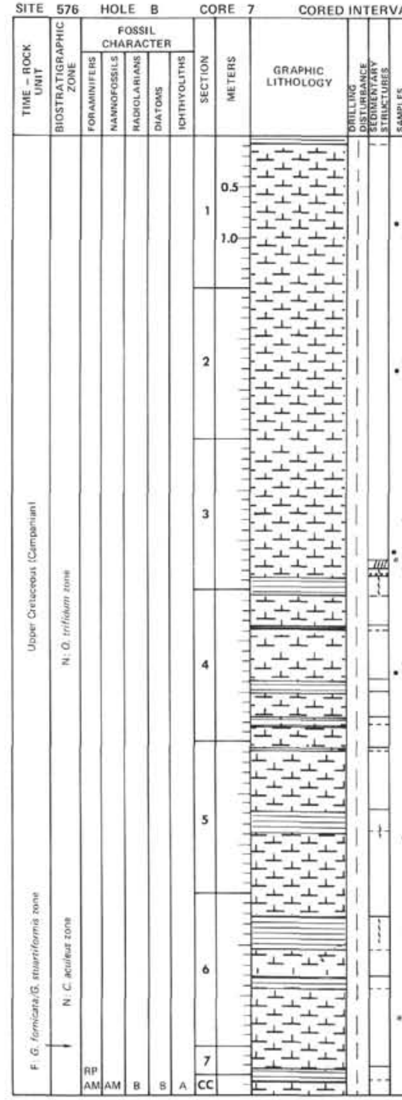
SMEAR SLIDE SUMMARY (%):

	2, 50	3, 100	4, 30	4, 100	4, 110	4, 125
	D	D	D	D	D	D
Texture:						
Sand	2	1	2	0	0	1
Silt	4	2	10	5	10	14
Clay	94	97	88	95	90	85
Composition:						
Quartz	1	1	5	5	2	5
Feldspar	–	–	3	3	2	2
Clay	94	97	78	85	89	10
Volcanic glass	2	2	4	2	2	Tr
Palagonite	–	Tr	–	–	–	–
Micronodules	2	Tr	–	–	–	–
Foraminifers	–	–	–	–	Tr	Tr
Calc. nannofossils	–	–	–	–	2	81
Radiolarians	–	–	–	–	Tr	–
Hematite	1	Tr	10	5	3	2

	5, 20	5, 105	6, 20	6, 110	CC
	D	D	D	D	D
Texture:					
Sand	0	0	0	1	1
Silt	50	10	40	9	19
Clay	50	90	60	90	80
Composition:					
Quartz	5	5	7	3	2
Feldspar	–	–	–	1	–
Heavy minerals	2	–	–	–	–
Clay	15	83	20	10	2
Volcanic glass	2	–	5	1	1
Glauconite	1	–	–	–	–
Zeolite	Tr	2	3	–	–
Carbonate unspec.	5	–	15	–	–
Foraminifers	70	–	–	Tr	–
Calc. nannofossils	–	5	50	85	95
Hematite	–	5	–	Tr	–

$CaCO_3$ data: 4, 129 cm = 83%; 5, 167 cm = 88%; 6, 110 cm = 84%; CC, 30 cm = 88%

SITE 576 HOLE B CORE 7 CORED INTERVAL 6275.0–6284.5 mbsl; 55.7–65.2 mbsf



LITHOLOGIC DESCRIPTION

INTERBEDDED PELAGIC CLAY AND NANNOFOSSIL OOZE

* Dominant colors: clay is dark brown (10YR 3/3) changing to dark yellowish brown (10YR 3/4) below Section 3. Nannofossil ooze is very pale brown (10YR 7/4). Minor colors: clay contains brown (7.5YR 5/4) and brown (10YR 5/3) mottles. Section 3 contains laminations of nannofossil ooze colored very pale brown (10YR 7/4), pink (7.5YR 8/4), light gray (10YR 7/2), white (10YR 8/2), and gray (10YR 5/1).
* Core is slightly deformed throughout.
* Thick nannofossil ooze layer in Sections 1 to 3 is normally graded and crossbedded at lower 20 cm with sharp bottom contact with underlying pelagic clay layer, thus appears to have been deposited by a turbidity current. Rest of ooze layers have sharp bottom contacts, but no obvious grading.

SMEAR SLIDE SUMMARY (%):

	1, 4	1, 100	2, 75	3, 50	3, 115
	D	D	D	D	D
Texture:					
Sand	3	0	1	0	5
Silt	12	10	19	40	15
Clay	85	90	80	60	80
Composition:					
Quartz	7	5	7	5	4
Feldspar	2	3	3	–	1
Clay	10	10	10	20	10
Volcanic glass	2	2	Tr	2	5
Pyrite	–	–	–	1	–
Micronodules	–	–	–	1	–
Carbonate unspec.	–	–	–	1	–
Foraminifers	3	–	–	–	5
Calc. nannofossils	73	80	80	70	75
Opaques – Hematite and Goethite	3	–	Tr	–	–

	3, 120	3, 130	4, 75	6, 35	6, 125
	D	D	D	D	D
Texture:					
Sand	6	3	0	0	0
Silt	20	17	50	15	60
Clay	74	80	50	85	40
Composition:					
Quartz	7	5	20	5	10
Feldspar	2	3	–	–	–
Clay	15	7	10	82	10
Volcanic glass	3	5	2	–	2
Pyrite	–	–	1	Tr	–
Micronodules	–	–	1	Tr	–
Zeolite	–	–	1	–	1
Foraminifers	5	–	Tr	–	2
Calc. nannofossils	67	80	65	3	75
Opaques – Hematite and Goethite	1	–	–	10	Tr

$CaCO_3$ data: 1, 86 cm = 91%; 2, 86 cm = 91%; 3, 86 cm = 92%; 3, 119 cm = 84%; 4, 80 cm = 89%; 5, 94 cm = 96%; 6, 100 cm = 98%

SITE 576 HOLE B CORE 8 CORED INTERVAL 6284.5–6294.0 mbsl; 65.2–74.7 mbsf

TIME – ROCK UNIT: Upper Cretaceous (Campanian)

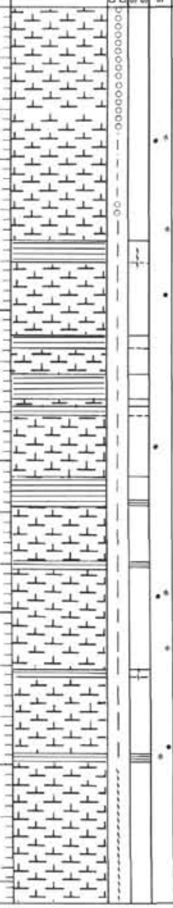
BIOSTRATIGRAPHIC ZONE: N: C. aculeus zone; F: G. fornicata/G. stuartiformis zone; N: B. parca

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

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

INTERBEDDED PELAGIC CLAY AND NANNOFOSSIL OOZE

- Dominant colors: clay is dark brown (10YR 3/3) grading to dark yellowish brown (10YR 3/4) in Section 3. Nannofossil ooze is light yellowish brown (10YR 6/4), very pale brown (10YR 7/4), brownish yellow (10YR 6/6), yellowish brown (10YR 5/6), and yellow (10YR 7/6). Minor colors: clay contains dark yellowish brown (10YR 4/4), strong brown (7.5YR 5/6), and black mottles and very dark brown to black and brown (10YR 5/3–10YR 3/3) laminations. Ooze in Section 2 contains white (10YR 8/2) zones.
- Section 1 is soupy. Section 6 is very deformed. The rest of the core is slightly deformed.
- The nannofossil ooze in this core is homogeneous, with no obvious grading or crossbedding. The clay ranges from homogeneous to mottled to laminated.

SMEAR SLIDE SUMMARY (%):

	1, 130	2, 70	4, 130	5, 35	5, 141
	D	D	D	D	D
Texture:					
Sand	7	4	0	5	0
Silt	23	15	60	25	25
Clay	70	81	40	70	75
Composition:					
Quartz	5	5	5	7	10
Feldspar	2	3	–	3	–
Clay	25	4	5	8	50
Volcanic glass	Tr	2	5	2	5
Palagonite	–	–	1	–	–
Glauconite	–	–	1	–	1
Micronodules	–	–	1	–	–
Zeolite	–	–	1	–	2
Carbonate unspec.	–	–	–	–	10
Foraminifers	7	3	1	3	1
Calc. nannofossils	61	80	80	77	20
Hematite and Goethite	Tr	3	–	–	–

$CaCO_3$ data: 1, 135 cm = 94%; 2, 135 cm = 90%; 3, 135 cm = 93%; 4, 135 cm = 91%; 5, 135 cm = 89%

SITE 576 HOLE B CORE 9 CORED INTERVAL 6294.0–6294.1 mbsl; 74.7–74.8 mbsf

TIME – ROCK UNIT: Upper Cretaceous

BIOSTRATIGRAPHIC ZONE: N: B. parca zone; F: G. fornicata/G. stuartiformis zone

FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS, ICHTHYOLITHS): AM CP B A

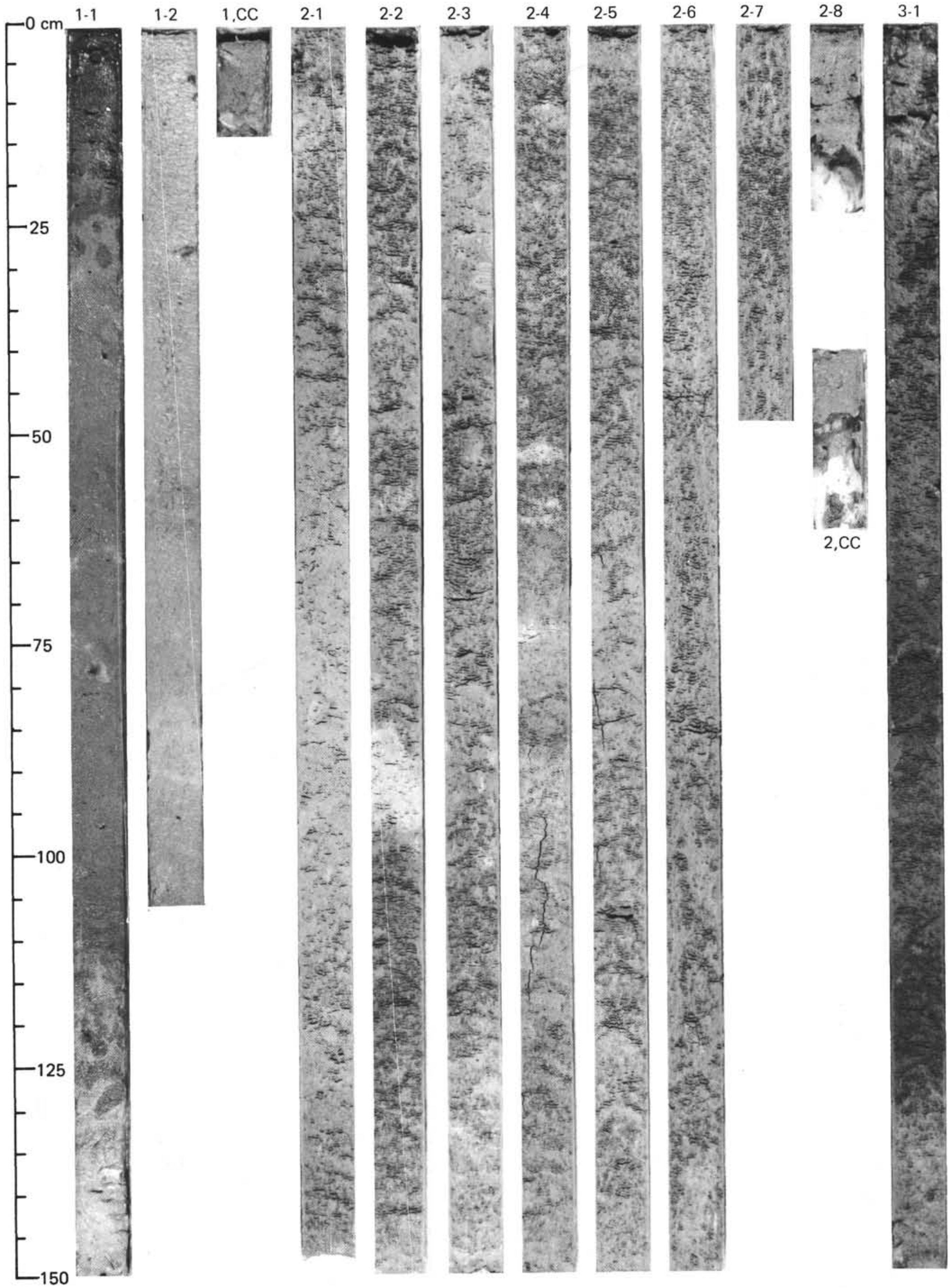
SECTION: CC, 1, 2, 3, 4, 5, 6, 7, CC

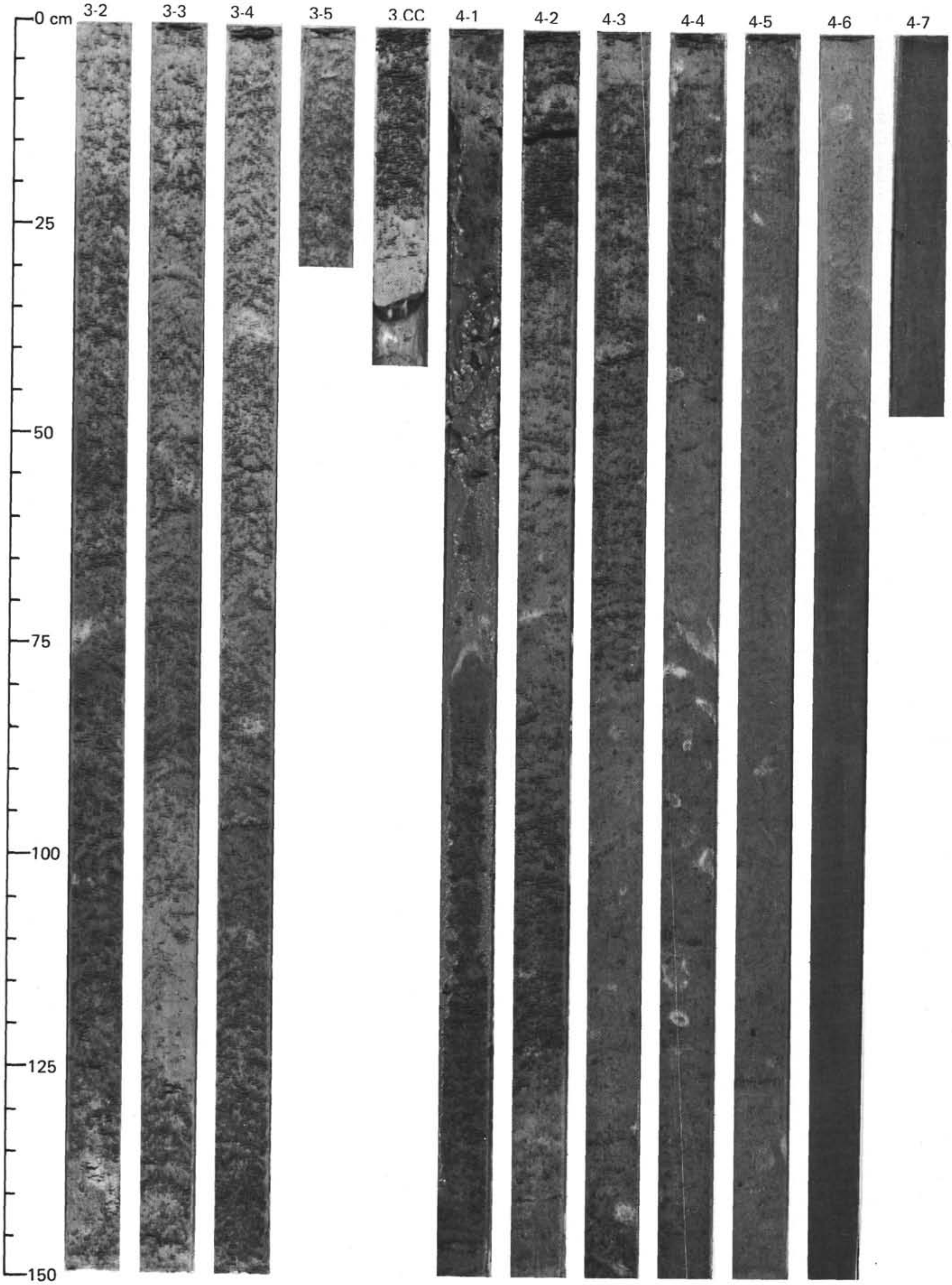
METERS: 0.5, 1.0

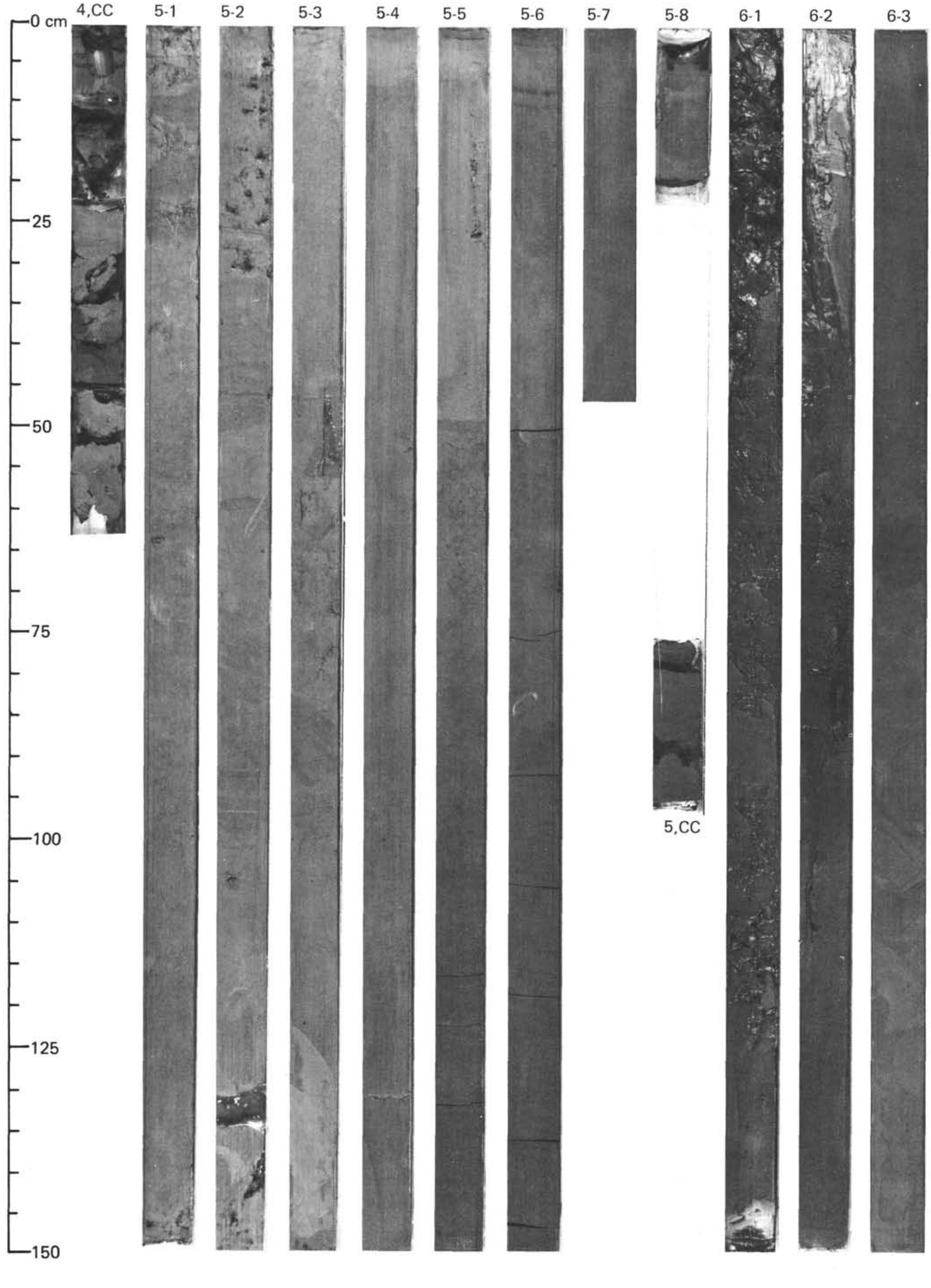
GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

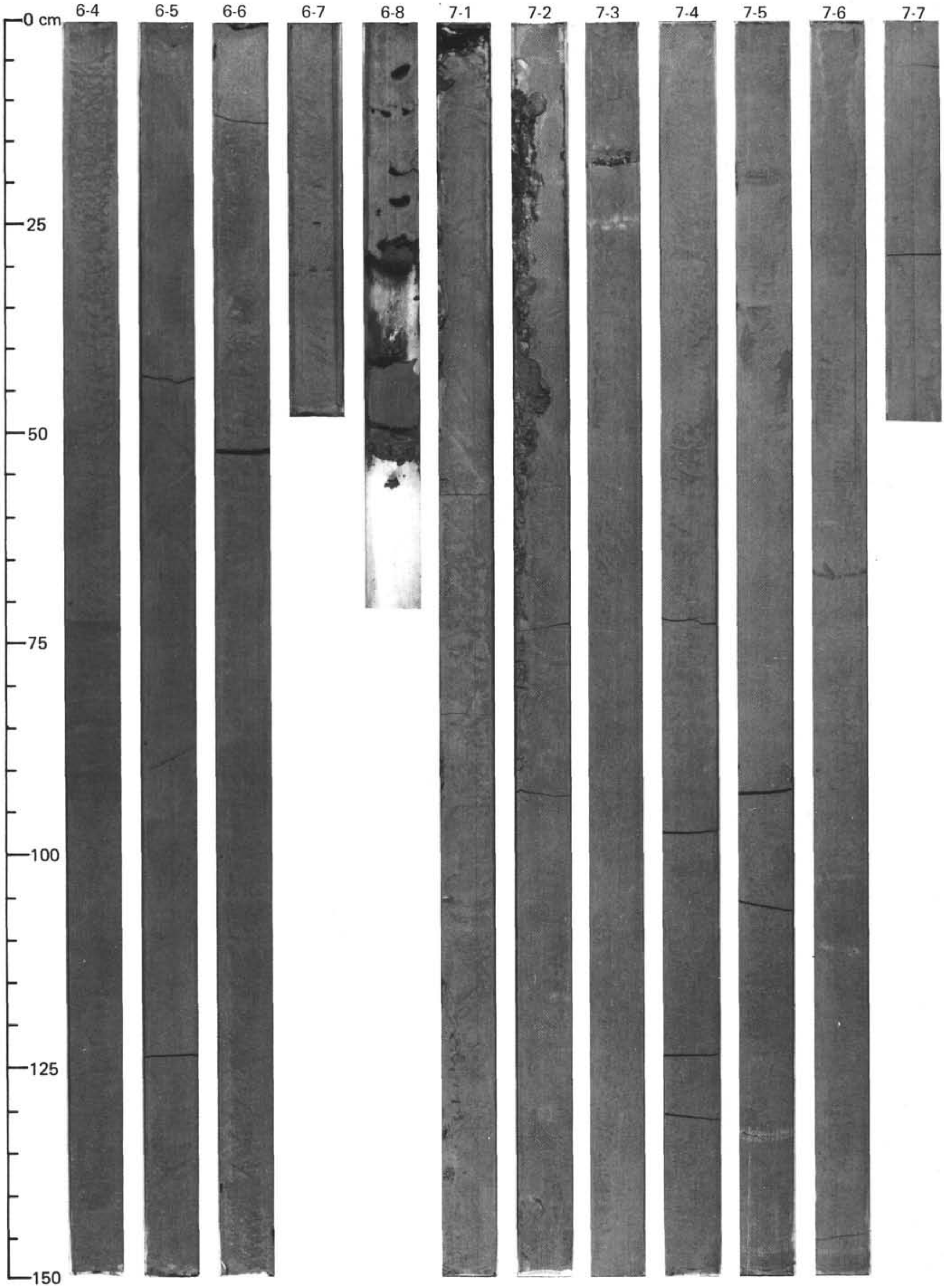
LITHOLOGIC DESCRIPTION

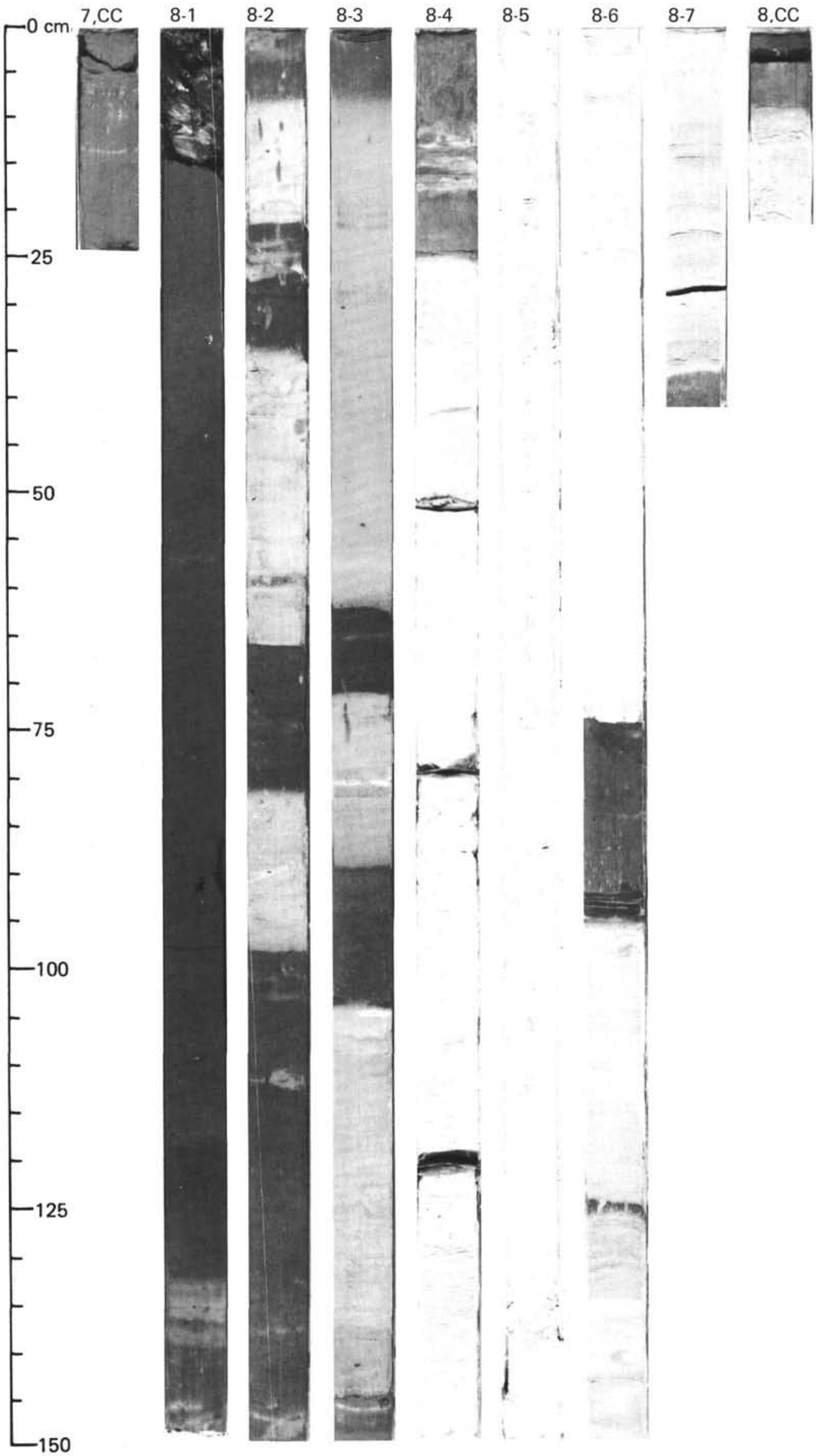
Core Catcher contained several small chert and silicified clay chips of a brownish yellow (10YR 6/6) color.

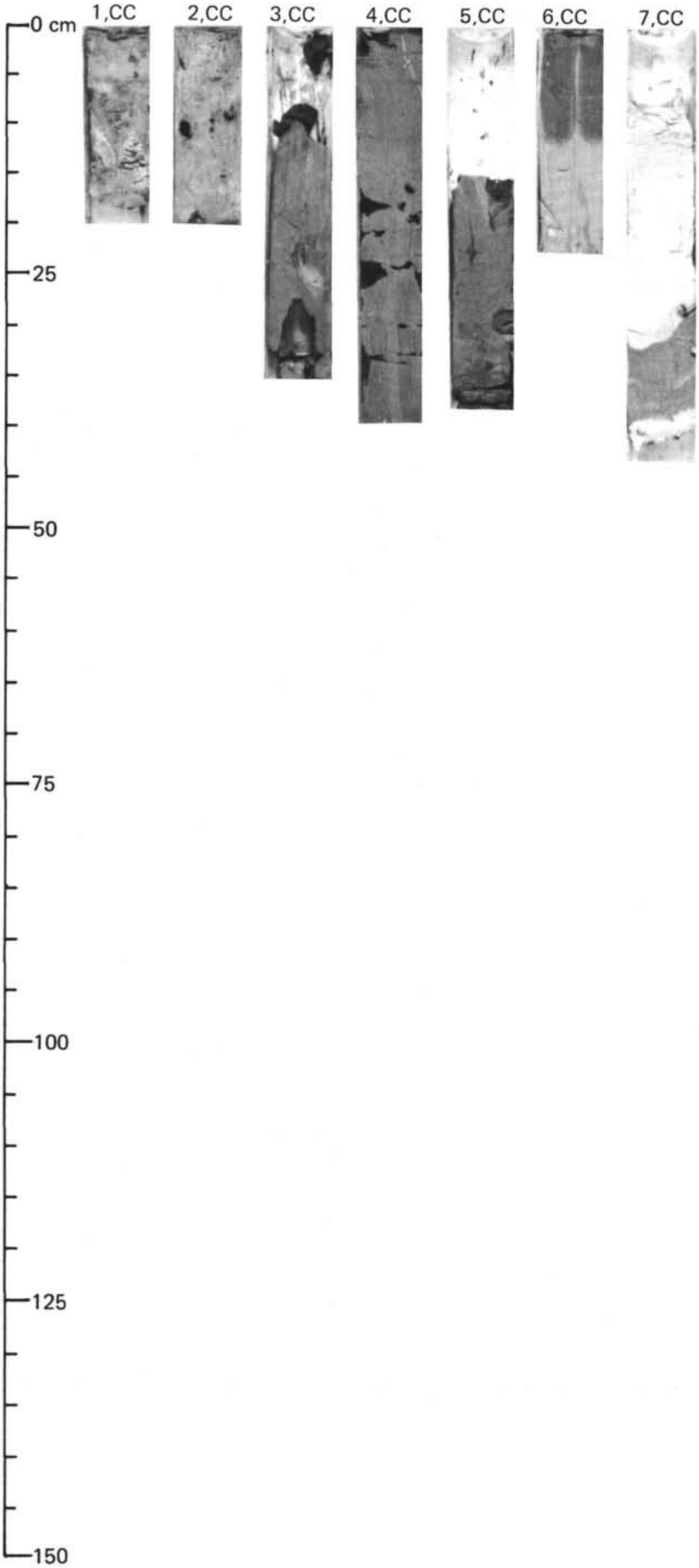

0 cm
25
50
75
100
125
150
1-1
1-2
1,CC
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2-8
2,CC
3-1

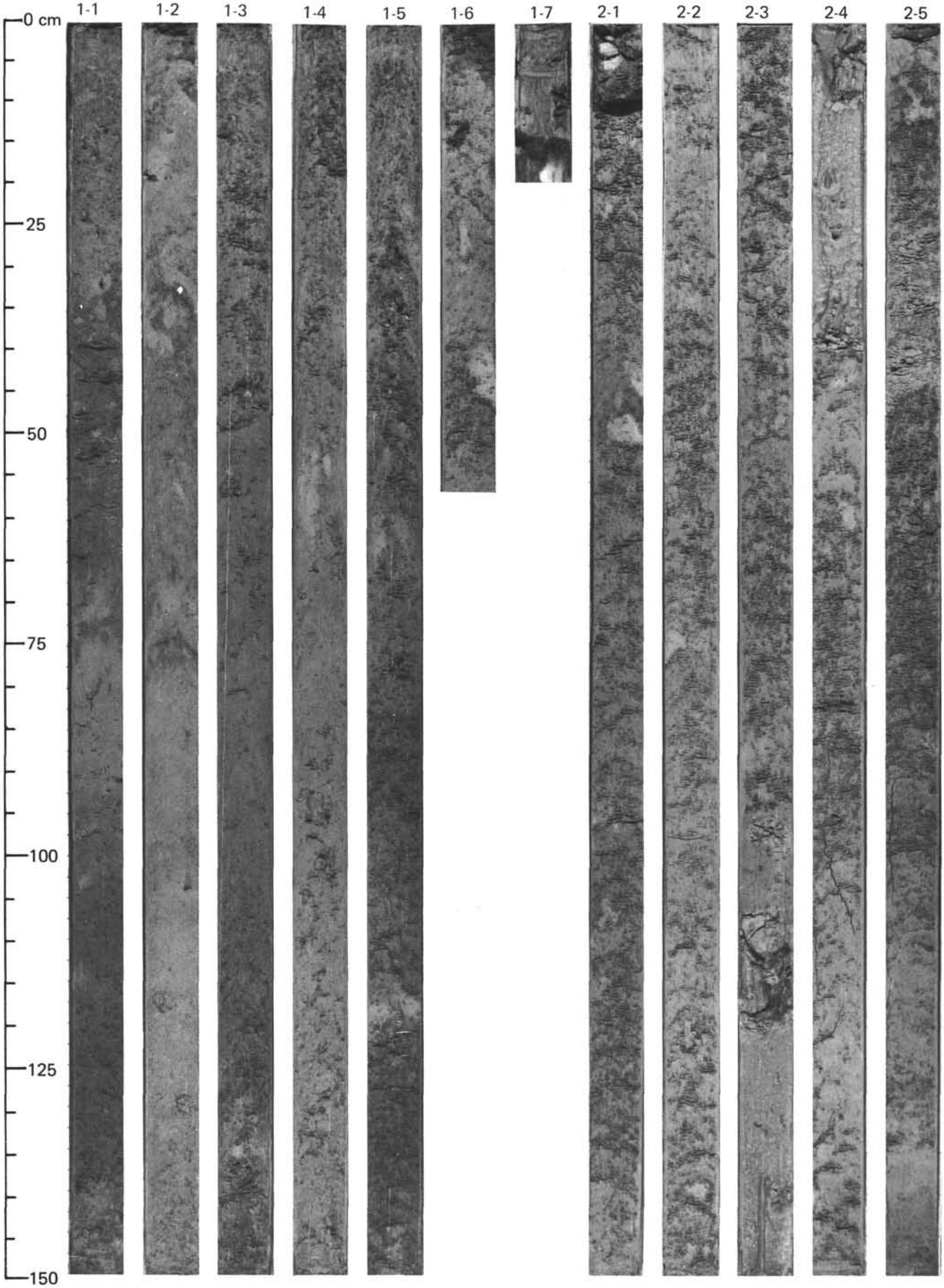

0 cm
25
50
75
100
125
150
3-2
3-3
3-4
3-5
3 CC
4-1
4-2
4-3
4-4
4-5
4-6
4-7

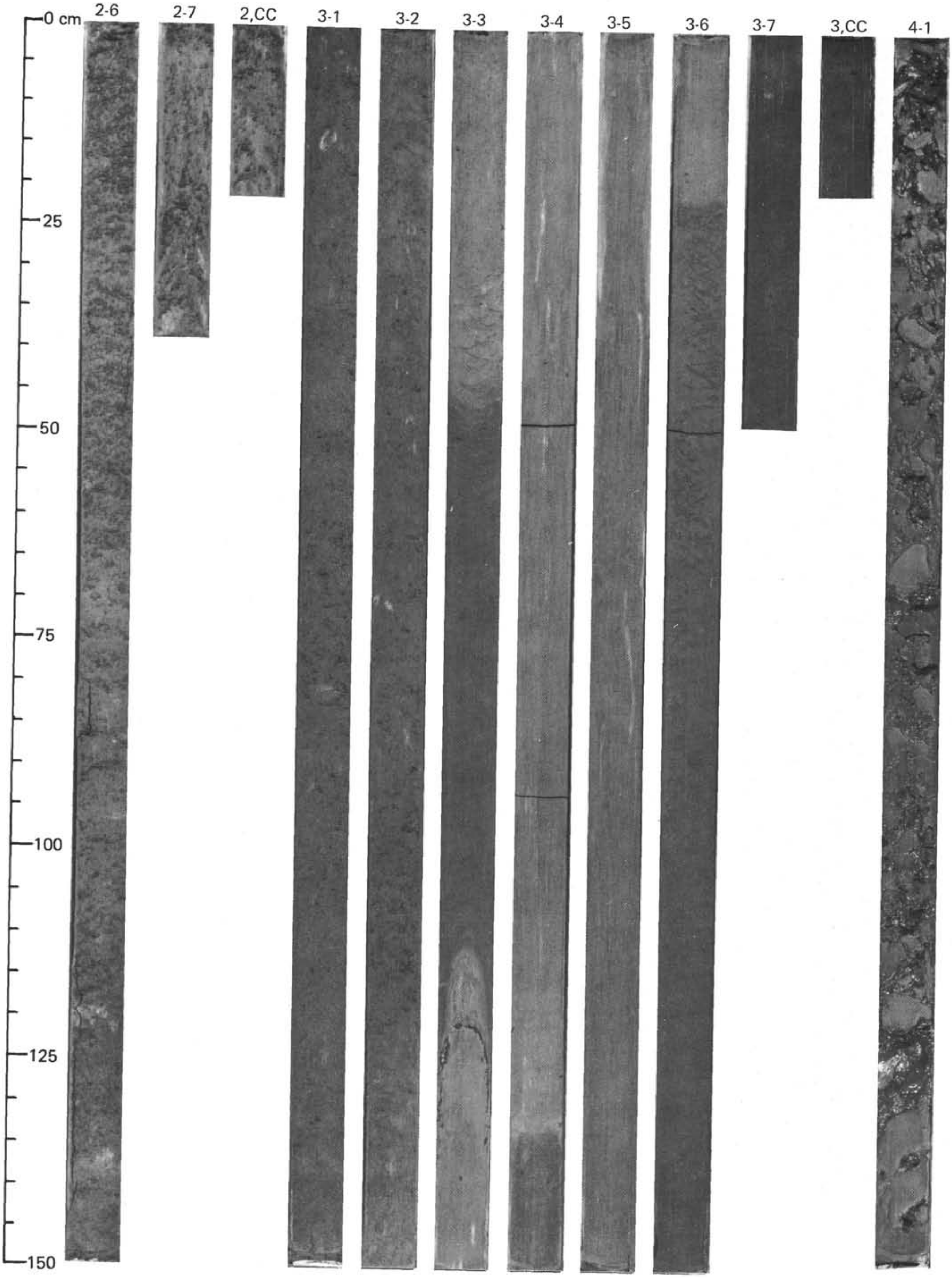

0 cm
25
50
75
100
125
150
4,CC
5-1
5-2
5-3
5-4
5-5
5-6
5-7
5-8
5,CC
6-1
6-2
6-3

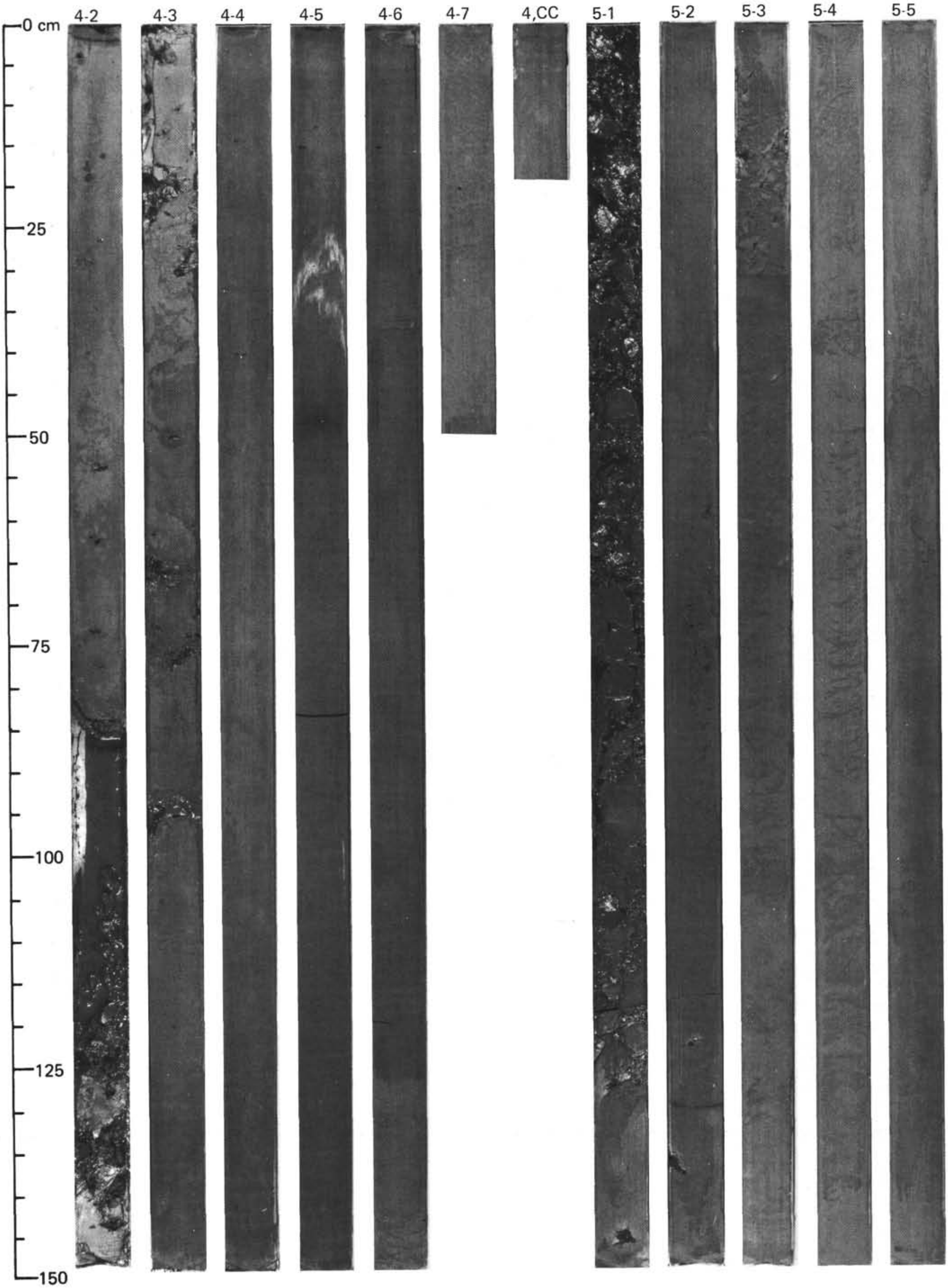

0 cm
25
50
75
100
125
150
6-4
6-5
6-6
6-7
6-8
7-1
7-2
7-3
7-4
7-5
7-6
7-7

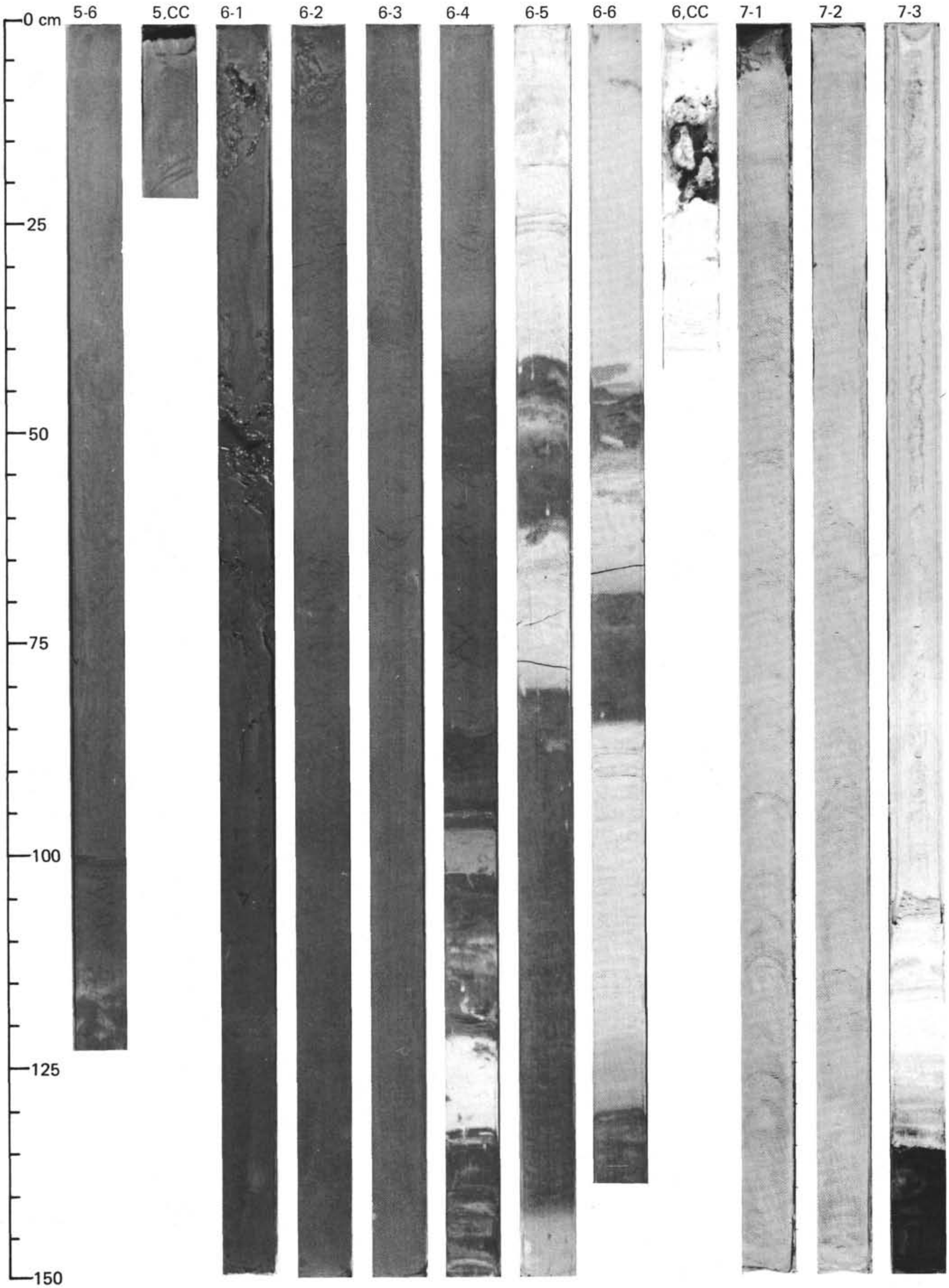

7,CC
8-1
8-2
8-3
8-4
8-5
8-6
8-7
8,CC
0 cm
25
50
75
100
125
150

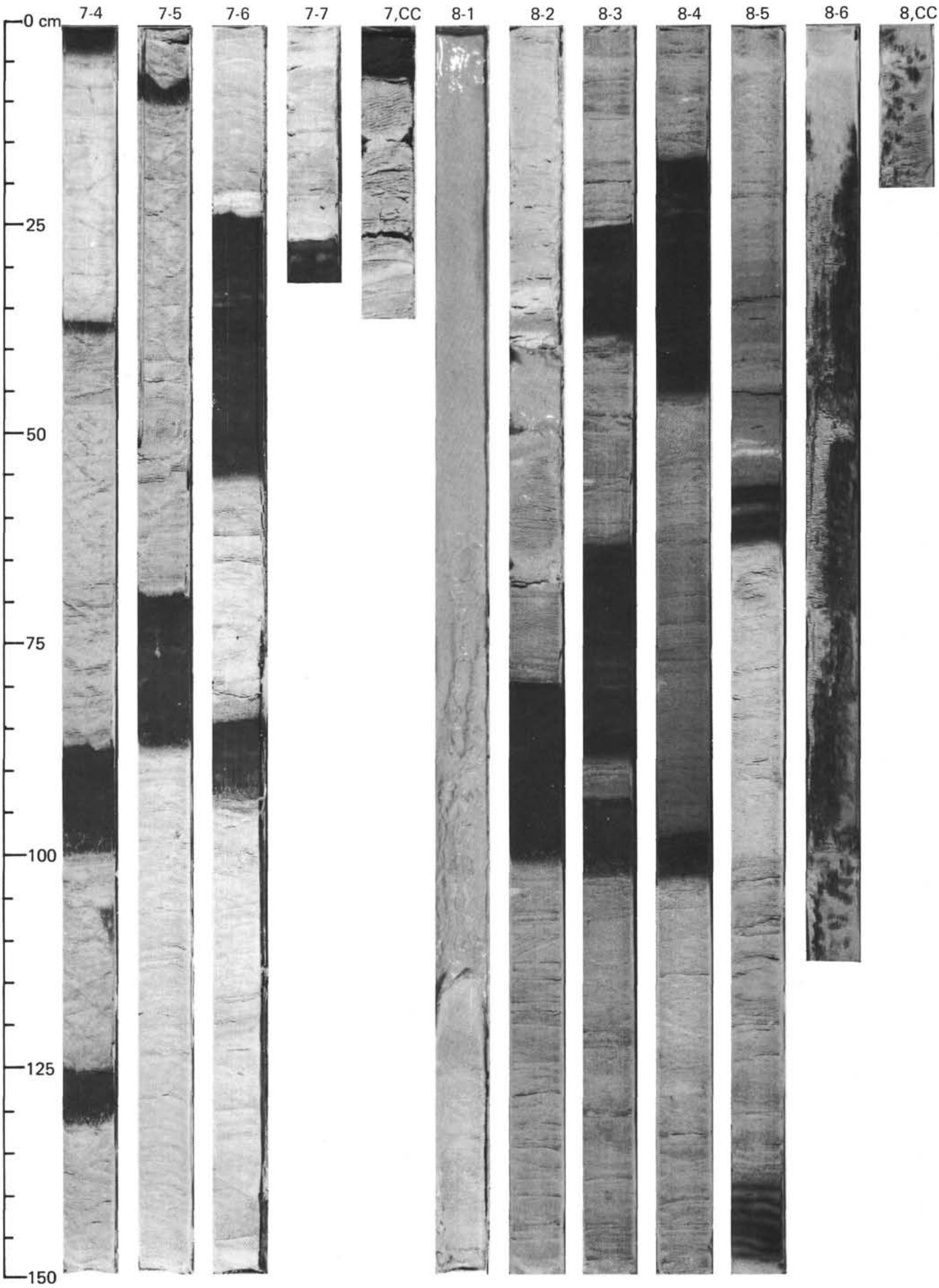

1,CC
2,CC
3,CC
4,CC
5,CC
6,CC
7,CC
0 cm
25
50
75
100
125
150


0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1-7
2-1
2-2
2-3
2-4
2-5


0 cm
25
50
75
100
125
150
2-6
2-7
2,CC
3-1
3-2
3-3
3-4
3-5
3-6
3-7
3,CC
4-1


4-2
4-3
4-4
4-5
4-6
4-7
4,CC
5-1
5-2
5-3
5-4
5-5
0 cm
25
50
75
100
125
150


0 cm
25
50
75
100
125
150
5-6
5,CC
6-1
6-2
6-3
6-4
6-5
6-6
6,CC
7-1
7-2
7-3



0 cm
25
50
75
100
125
150
7-4
7-5
7-6
7-7
7,CC
8-1
8-2
8-3
8-4
8-5
8-6
8,CC