7. SITE 580[1]

Shipboard Scientific Party[2]

HOLE 580

Date occupied: 6 June 1982

Date departed: 8 June 1982

Time on hole: 2 days, 3 hr.

Position (latitude; longitude): 41°37.47′N; 153°58.58′E

Water depth (sea level; corrected m, echo-sounding): 5375

Water depth (rig floor; corrected m, echo-sounding): 5385

Bottom felt (m, drill pipe): 5386.7

Penetration (m): 155.3

Number of cores: 17

Total length of cored section (m): 155.3

Total core recovered (m): 140.74

Core recovery (%): 91

Oldest sediment cored:
Depth sub-bottom (m): 155.3
Nature: siliceous clay
Age: late Pliocene
Measured velocity (km/s): 1.5

Basement: Not reached

Principal results: A thick sequence of Pleistocene and late Pliocene sediments was recovered at Site 580. Siliceous microfossils (diatoms and radiolarians) are generally abundant and moderately to well preserved. An excellent magnetic reversal record can be identified back to the middle of the Gauss Normal Epoch.

One hundred and fifty-five meters of sediment were penetrated. Except for the numerous ash layers and indurated darkish green layers, these sediments are a remarkably uniform gray, olive gray, and dark gray color. Based on these data, the entire sedimentary sequence recovered at Site 580 is placed in one lithologic unit. However, based on changes in biosiliceous components and clay-sized carbonate, five subunits are recognized.

The upper subunit (Subunit IA) extends from 0 to 60.3 m sub-bottom and is predominantly a siliceous clay. Underlying this (Subunit IB) and extending from 60.3 to 79.3 m sub-bottom is a calcareous siliceous clay, characterized by up to 25% clay-sized carbonate material. Subunit IC (79.3–117.3 m sub-bottom) is similar lithologically to Subunit IA. Subunit ID (117.3–136.3 m sub-bottom) is a clayey diatom ooze, characterized by up to 60% diatoms. The lowest subunit (Subunit IE), extending from 136.3 to 155.3 m sub-bottom, is similar to Subunit IA.

Sedimentation rates are unusually high for the Pleistocene and late Pliocene, averaging 50 m/m.y. No unconformities or abrupt changes in sedimentation rate were encountered.

The heat-flow program operated normally. The temperature data clearly show a linear increase with depth. No temperature reversals were recorded.

BACKGROUND AND OBJECTIVES

Site 580 (target Site NW-5A) lies near the present-day subarctic front (42°N) and the northern margin of the transition zone between the subarctic and subtropical gyres. The transition zone defines the convergence of the Kuroshio and Oyashio currents and is marked by high biological productivity. Because of its location, this site will be the reference point for the modern subarctic/subtropical gyre boundary. This site is thought to be the northernmost limit of the subarctic front during the late Neogene and Quaternary.

Our specific scientific objectives were

1. To obtain a detailed paleoceanographic record in the subtropical/subarctic gyre transition zone for the late Miocene to Recent and, in particular, to document the north–south migration of the frontal zone with time.
2. To determine a midlatitude stratigraphy using paleomagnetics, tephrachronology, and biostratigraphy (chiefly siliceous).
3. To determine the time of onset of significant biosiliceous accumulation for comparison with the more southerly Sites 578 and 579.
4. To determine the timing and nature of the onset of the mid-Pliocene and Pleistocene climatic deterioration.
5. To assess the role of orbital forcing in determining pre-Pleistocene paleoclimatic oscillations.
6. To assess the nature and history of authigenic sedimentation in pre-biosiliceous (older than mid-Miocene) sediments.
7. To determine the Cenozoic history of eolian sedimentation for comparison with sites to the south and east.

OPERATIONS

From Site 579, we steamed northward for approximately 1 day, toward Site 580 (target Site NW-5A). Good quality 3.5- and 12-kHz records were collected while underway. The vessel entered the region of NW-5A at approximately 1400 hr. local time (0300Z). Because of the hummocky nature of the bottom topography and because of uncertainties concerning the nature of the to-

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[1] Heath, G. R., Burckle, L. H., et al., *Init. Repts. DSDP*, 86: Washington (U.S. Govt. Printing Office).

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pography at the target site, the core site was selected some 6 miles short of our target where our air-gun records indicated a reasonably smooth bottom. The beacon was dropped at 1436 local time (0336Z) and gear was retrieved as the vessel passed over the site. At 1630 hr. (0530Z) drill pipe run-in began but was halted at 2130 hr. (1030Z) when the drawworks shorted out. Troubleshooting indicated a problem with a faulty brush holder, which was replaced by 2400 hr. (1300Z). Running in hole continued until 1104 hr. (0004Z), when the corer reached bottom and spudding was attempted. This proved unsuccessful, as the first core recovered only water, and a second attempt was made. This was successful and the first core was recovered shortly thereafter. Following these initial mishaps, the station was occupied without any further problems. Unusually calm seas insured almost complete recovery and relatively little sediment disturbance. The heat-flow shoe was run seven times, all successful. Unfortunately, a combination heat-flow shoe–heat-flow probe–pore water–pressure measurement test failed when a tubing connector on line to the lower pressure port leaked while running in hole. The system was flooded.

A total depth of 155.3 m was reached in one hole at this site. Seventeen cores were recovered, most with full, or close to full, penetration (Table 1).

We departed the site at 0700Z, 7 May, steaming north toward Site 581 (target Site MSS-82C).

LITHOSTRATIGRAPHY

The lithostratigraphy of sediments recovered at Site 580 is based on macroscopic descriptions of the cores and on smear slide analyses with a petrographic microscope. The sediments cored at Site 580 are similar to those cored at Site 579.

The sediments recovered at Site 580 are relatively uniform in color, ranging from gray (5Y 5/1) and dark gray (5Y 4/1) to olive gray (5Y 4/2–5Y 5/2). Smear slide analyses indicate that downhole abundances of siliceous microfossils range from 10 to 70%, averaging about 30%. Quartz abundances average 5%, but range up to 15%. A large number of thin, stiff to indurated, dark greenish gray (5GY 4/1 or 5G 4/1) layers are observed throughout the hole. Smear slide analyses of these layers indicates that they are composed of the same material as the adjacent sediment. Dark gray to black (5Y 3/1, 5Y 3/2, and 5Y 2/1) layers of clay are commonly found immediately below the indurated greenish-gray layers. Volcanic ash layers are common throughout the hole. A total of 89 volcanic ash layers, ranging in thickness from 0.5 to 18.5 cm, were identified (Fig. 1).

Table 1. Site 580 coring summary.

Core	Date (June 1982)	Local time	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Percent recovered
1	6	1428	5386.7–5390.0	0.0–3.3	3.3	3.32	101
2	6	1639	5390.0–5399.5	3.3–12.8	9.5	8.39	88
3	6	1855	5399.5–5409.0	12.8–22.3	9.5	8.62	91
4	6	2105	5409.0–5418.5	22.3–31.8	9.5	8.88	93
5	6	2334	5418.5–5428.0	31.8–41.3	9.5	9.14	96
6	7	0204	5428.0–5437.5	41.3–50.8	9.5	8.80	93
7	7	0440	5437.5–5447.0	50.8–60.3	9.5	7.74	81
8	7	0720	5447.0–5456.5	60.3–69.8	9.5	9.27	98
9	7	0945	5456.5–5466.0	69.8–79.3	9.5	7.51	79
10	7	1200	5466.0–5475.5	79.3–88.8	9.5	8.65	91
11	7	1425	5475.5–5485.0	88.8–98.3	9.5	7.30	77
12	7	1640	5485.0–5494.5	98.3–107.8	9.5	9.29	98
13	7	1850	5494.5–5504.0	107.8–117.3	9.5	9.08	96
14	7	2117	5504.0–5513.5	117.3–126.8	9.5	9.14	96
15	8	0330	5513.5–5523.0	126.8–136.3	9.5	8.45	89
16	8	0620	5523.0–5532.5	136.3–145.8	9.5	8.97	94
17	8	0902	5532.5–5542.0	145.8–155.3	9.5	7.72	81
					155.3 (total)	140.74 (total)	91 (avg.)

Unit I: Siliceous Clay

On the basis of these data, the sedimentary section recovered at Site 580 is classified as a single siliceous clay unit (lithologic Unit I). However, this siliceous clay unit can be subdivided into five subunits (Fig. 1, Table 2).

Subunit IA

This subunit occurs in Cores 1 through 7 and is a siliceous clay containing 2–25% diatoms, 0–15% radiolarians, and 3–15% quartz, with an average composition of approximately 20% diatoms, 10% radiolarians, and 7% quartz. Feldspar and heavy minerals are present in abundances of less than 2%. Volcanic glass contents outside of recognizable ash layers range from 2 to 10%, but are generally greater than 5%. The remainder of the sediment, averaging approximately 56%, is clay material. This subunit contains 43 identifiable ash layers.

Subunit IB

This subunit occurs in Cores 8 and 9, and is a calcareous siliceous clay characterized by 3–25% unspecified clay-sized carbonate material, 10–25% diatoms, 5–7% radiolarians, and 5–10% quartz. Average composition is approximately 10–15% carbonate, 17% diatoms, 6% radiolarians, and 7% quartz. Feldspar abundances are less than 2%, and dispersed ash contents range from 3 to 7%. The remainder of the sediment, averaging approximately 55%, is clay. This subunit contains seven identifiable ash layers.

Subunit IC

This subunit occurs in Cores 10 through 13, and is a siliceous clay similar to Subunit IA. Maximum diatom abundance in Subunit IC is 35%, slightly greater than in Subunit IA, but the approximate average composition of Subunit IC (20% diatoms, 7% radiolarians, 6% quartz) is very similar to that of Subunit IA. Eighteen recognizable ash layers occur in this subunit.

Subunit ID

This subunit occurs in Cores 14 and 15 and is a clayey diatom ooze containing 50–60% diatoms, 2–10% radiolarians, and 5–10% quartz. Average composition of this interval is approximately 52% diatoms, 6% radiolarians, and 7% quartz. Feldspar abundances are a constant 2% throughout this subunit, and dispersed volcanic ash abundances range from 5 to 10%. The remainder of the sediment, averaging approximately 27%, is clay. This subunit contains seven ash layers.

Subunit IE

This subunit occurs in Cores 16 and 17 and is another siliceous clay subunit. It is slightly enriched in siliceous microfossils relative to Subunits IA and IC, with an av-

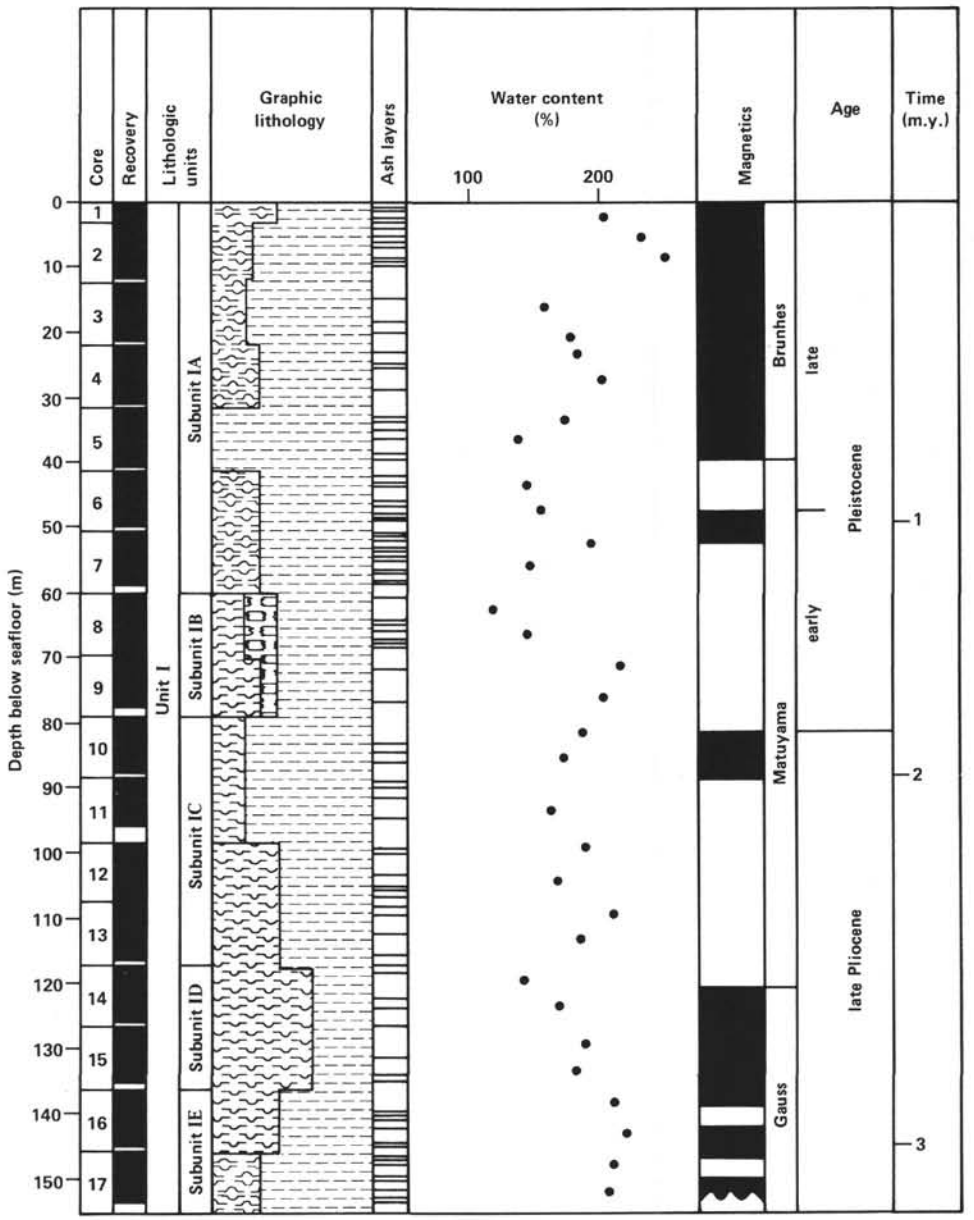

Figure 1. Site summary diagram showing Site 580 core numbers, core recovery, lithologic units, graphic lithology, ash layer locations, water content (%), magnetostratigraphy, and age. Symbols used in graphic lithology column are defined in Introduction and Explanatory Notes (this volume).

Table 2. Site 580 lithostratigraphic units.

Lithologic unit	Cored interval	Sub-bottom depth (m)
I: Siliceous clay		
Subunit IA: siliceous clay	1-1, 0 cm to 7,CC	0.0-60.3
Subunit IB: calcareous siliceous clay	8-1, 0 cm to 9,CC	60.3-79.3
Subunit IC: siliceous clay	10-1, 0 cm to 13,CC	79.3-117.3
Subunit ID: clayey diatom ooze	14-1, 0 cm to 15,CC	117.3-136.3
Subunit IE: siliceous clay	16-1, 0 cm to 17,CC	136.3-155.3

erage composition of approximately 27% diatoms and 8% radiolarians. Feldspar is rare to absent, quartz averages 7%, and dispersed volcanic glass abundances range from 2 to 10%, averaging approximately 5%. The remainder of the sediment, averaging approximately 53%, is clay. This subunit contains 14 recognizable ash layers.

SEISMIC CORRELATION

High-resolution seismic reflection profiles (3.5 and 12 kHz) and 100-Hz reflection profiles were recorded at Site 580. Only a hull-mounted 3.5-kHz sound source was utilized. The 3.5-kHz echograms over Site 580 reveal a fairly uniform seismic section of parallel sub-bottom reflectors (Fig. 2). This seismic section can be divided into a four-part sequence based on gaps in the reflector sequence and relative strength of the return signals (Table 3).

The uppermost seismic unit consists of three strong reflectors and extends to 0.0166 s below the seafloor

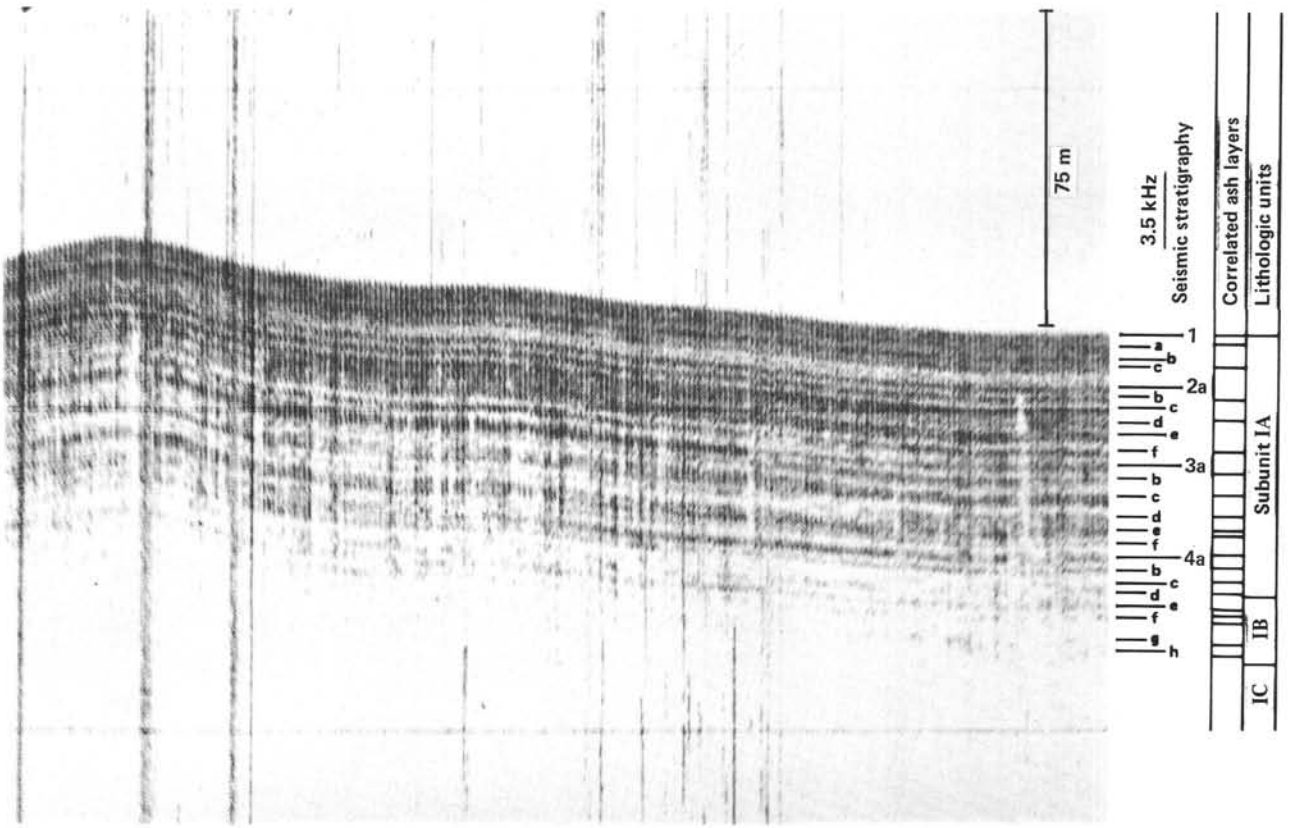

Figure 2. 3.5-kHz echogram near Site 580 showing the four-part seismic sequence described in the text. Sub-bottom depths and sources of seismic reflectors are given in Table 3.

Table 3. 3.5-kHz seismic correlations, Site 580.

Reflector	Relative strength[a]	Sub-bottom depth (s)	Sub-bottom depth (m) 1440 m/s	1480 m/s	1504 m/s	Source Depth (m)	Lithology	Thickness (cm)
1a	S	0.00269	1.94	1.99	2.02	2.25	Ash 2	10.5
b	S	0.00662	4.76	4.90	4.98			
c	S	0.0108	7.78	7.96	8.12	7.7	Ash 8	15
2a	S	0.0166	11.95	12.24	12.48		No core	
b	S	0.0200	14.4	14.77	15.04	15.34	Ash 11,12	6,6
c	S	0.0228	16.42	16.836	17.15			
d	S	0.0269	19.39	19.90	20.23	19.8	Ash 16	2
e	S	0.0310	22.32	22.96	23.3	24.6	Ash 18?	6
f	S	0.0362	26.06	26.78	27.22	27.8	Ash 19?	6
3a	I	0.0413	29.74	30.53	31.06			
b	I	0.0447	32.18	33.06	33.61	32.8	Ash 20	8
c	I	0.0506	36.43	37.42	38.05			
d	IT-I	0.0568	40.90	42.01	42.71	42.75	Ash 27	14
						42.8	Ash 28	9
e	W-I	0.0612	44.06	45.30	46.02	45.45	Ash 32?	5
						46.4	Ash 33?	16
f	W	0.0642	46.22	47.52	48.28	47.25	Ash 35	5
4a	W-I	0.0685	49.32	50.66	51.51	51.6	Ash 37	11
b	IT-I	0.0724–0.0732	52.13–52.70	53.57–54.18	54.44–55.05	54.3	Ash 42	13
c	IT	0.0765	55.08	56.63	57.53	57.7	Ash 46	3
d	IT-W	0.0796–0.0807	57.31–58.10	58.92–59.69	59.86–60.69	60.4	Ash 49	6
e	IT-W	0.0839–0.0848	60.41–61.06	62.06–62.75	63.09–63.77	64.0	Ash 50	6
f	IT-W	0.0888	63.94	65.66	66.78	65.6	Ash 52	13
						67.5	Ash 53?	5
g	IT	0.0954	68.69	70.63	71.74	72.2	Ash 56	11
h	IT	0.0998	71.86	73.88	75.05	75.8	Ash 57	9

[a] S = strong; I = Intermediate; IT = intermittent, but weak; W = weak, but generally continuous.

(12.5 m at 1504 m/s). A thin transparent layer below the deepest reflector in seismic Unit 1 separates that unit from the top of seismic Unit 2. Seismic Unit 2 consists of six strong reflectors and extends to 0.413 s below the seafloor (31.1 m at 1504 m/s). A very thin transparent layer at the base of seismic Unit 2 separates that unit from the top of seismic Unit 3. Seismic Unit 3 consists of six reflectors of variable strengths and extends to 0.0685 s below the seafloor (51.5 m at 1504 m/s). Seismic Unit 4 consists of generally weak and discontinuous reflectors; only the top reflector is of intermediate strength. Unit 4 extends to 0.0998 s below the seafloor (75.0 m at 1504 m/s).

The source of these reflectors was difficult to determine primarily because of the large number of close equally spaced ash layers and indurated clay layers. In general, the reflectors correlate with ash layers, especially below about 45 m sub-bottom depth (Fig. 2, Table 3). However, several strong reflectors in the upper 45 m correlate with sections of core that do not contain ash layers. These strong reflectors could result from interference effects due to the ubiquitous thin, indurated pyritic clay layers. Alternatively, ash layers displaced in the core by unrecognized zones of "flow-in" or ash layers assigned incorrect depths because of inaccurate depth to the top of the core could account for the reflectors. The top of lithostratigraphic Subunit IB (60.3 m sub-bottom) is near Reflector 4d (~59.8–60.7 m, Table 3).

The 100-Hz seismic reflection profiles reveal a four-part seismic section at Site 580 (Fig. 3). The uppermost seismic unit (Unit 1) extends to 0.295 s below the seafloor (221 m at 1500 m/s) and consists of four subunits. The uppermost seismic subunit (1a) is composed of strong, parallel, and continuous reflectors. Subunit 1a extends to 0.01 s below the seafloor (75 m at 1500 m/s), corresponds with the entire 3.5-kHz seismic section (Fig. 2, seismic Units 1, 2, 3, and 4), and correlates with lithostratigraphic Units IA, IB, and perhaps the very top of IC. Seismic Subunit 1b occurs between 0.01 and 0.195 s (146.2 m at 1500 m/s) and is a zone of weak, discontinuous reflectors that wedge out away from the site. It correlates with lithostratigraphic Units IC and ID. Seismic Subunit 1c extends to 0.22 s below the seafloor (165 m at 1500 m/s) and consists of strong, continuous, and parallel reflectors. It may correlate with lithostratigraphic Subunit IE. Seismic Subunit 1d extends to 0.295 s below the seafloor (221.2 m at 1500 m/s) and is a transparent layer.

Seismic Unit 2 is divided into two subunits. Seismic Subunit 2a consists of strong, continuous, parallel reflectors extending to about 0.36 s below the seafloor (270 m at 1500 m/s). Seismic Subunit 2b is a transparent zone extending to 0.50 s below the seafloor (375 m at 1500 m/s).

Seismic Unit 3 consists of strong, slightly incoherent echoes that extend to 0.57 s below the seafloor. Seismic

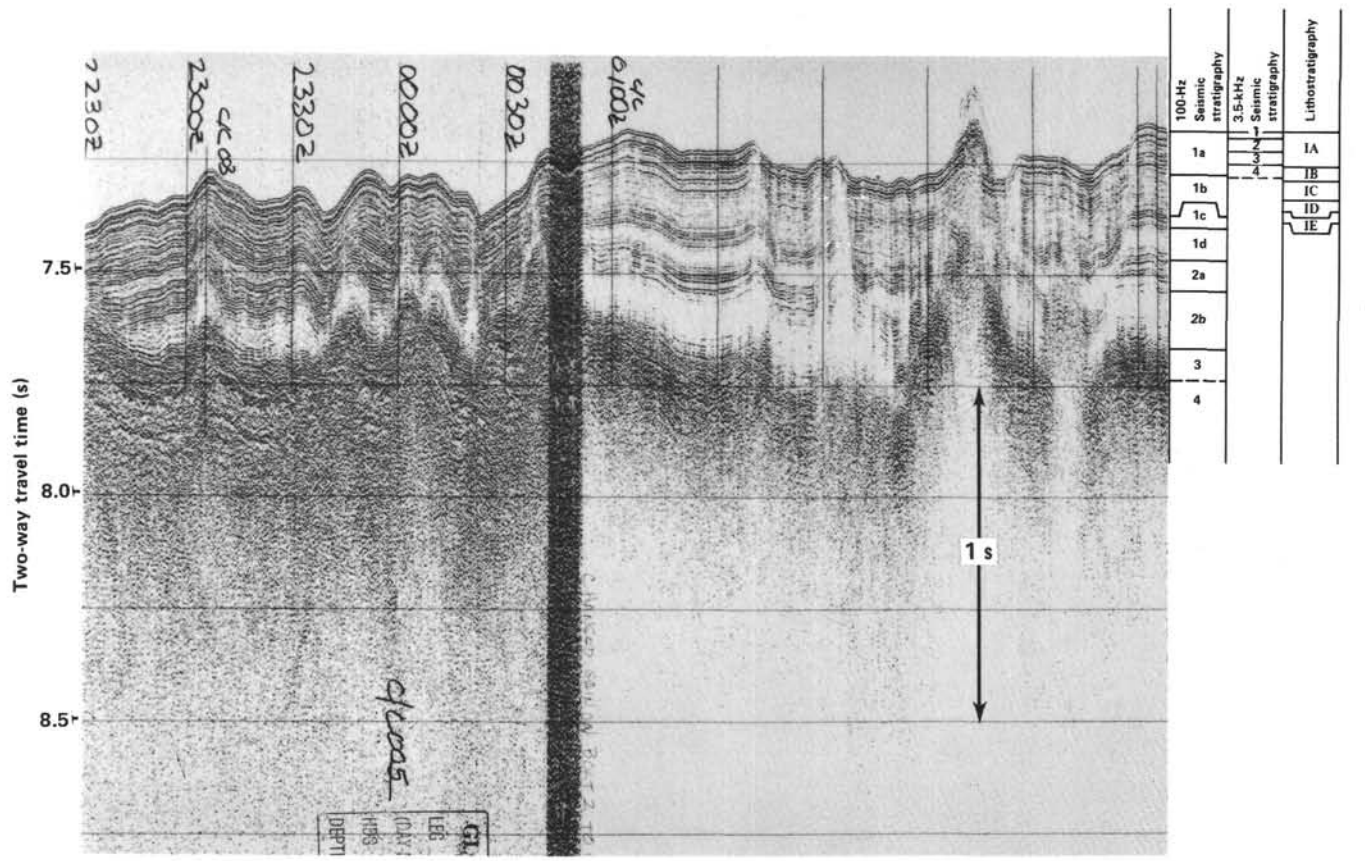

Figure 3. 100-Hz reflection profile over Site 580 showing the four-part seismic sequence described in the text and correlative 3.5-kHz seismic stratigraphic units and lithostratigraphic units.

Unit 3 is conformable with seismic Unit 4 underlying it, but unconformable with the overlying seismic units; both seismic Units 1 and 2 downlap Unit 3 over bathymetric highs. The source of seismic Units 2b and 3 is equivocal but based on the unconformity, the echo character, and the sub-bottom depth, it is probable that seismic Unit 2b is pelagic clay and seismic Unit 3 is Cretaceous chert and associated sedimentary rocks.

Seismic Unit 4 consists of a strong, slightly prolonged reflector and probably is basaltic "basement."

BIOSTRATIGRAPHY

About 155 m of Quaternary and late Pliocene sediments were recovered at Site 580. Abundant, well-preserved diatoms were found in all samples examined. Radiolarians were also common to abundant and well preserved in most sections. Rare to common silicoflagellates were noted in all core-catcher samples. In four core-catcher samples, poorly to moderately preserved foraminifers were recovered. Common, poorly preserved calcareous nannofossils were found in one core-catcher sample (580-13,CC).

The biostratigraphic summary based on three groups of microfossils is shown in Figure 4. The boundary between early and late Pleistocene occurs near the base of Core 6, and the Plio–Pleistocene boundary falls near the top of Core 11 based on the radiolarian and diatom biostratigraphic data.

Calcareous Nannofossils

Only one sample (580-13,CC) contained calcareous nannofossils. The poorly preserved assemblage includes *Crenalithus doronicoides, Coccolithus pelagicus, Calcidiscus macintyrei, Cyclococcolithus leptoporus, Emiliania ovata, Ceratolithus rugosus, Discoaster brouweri*, and *Reticulofenestra* sp. This assemblage indicates a probable Pliocene age.

Foraminifers

Core-catcher samples from all 17 cores recovered at Hole 580 were examined. Four core-catcher samples contained foraminifers (580-1,CC; 580-2,CC; 580-5,CC; 580-13,CC). Samples 580-1,CC, 580-2,CC, and 580-5,CC contained a Pleistocene assemblage typical of the *Glo-*

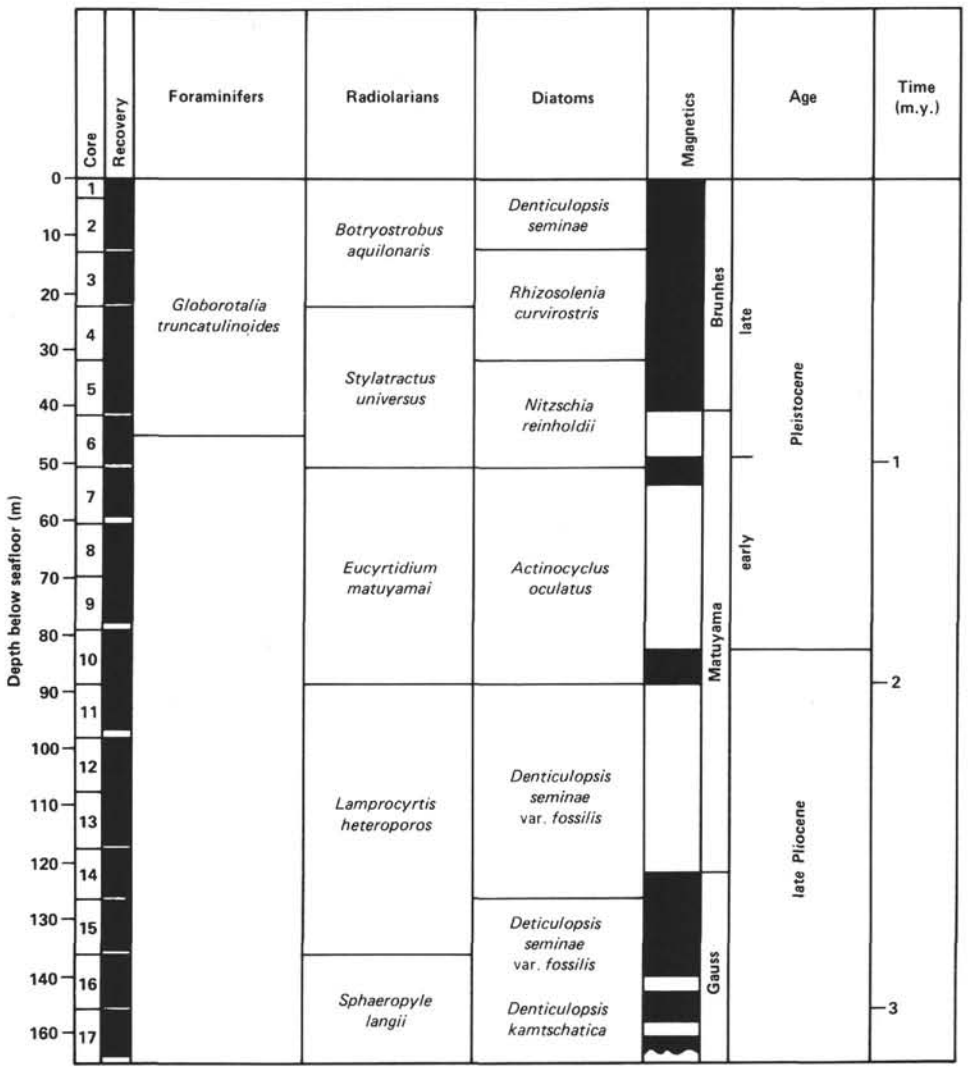

Figure 4. Site 580 biostratigraphic and magnetostratigraphic summary.

borotalia truncatulinoides Zone (Stainforth et al., 1975) or Zone N22 (Blow, 1969). The fauna included *G. truncatulinoides* (580-1,CC only), *G. humerosa, G. acostaensis, G. continuosa, G. obesa, G. inflata*, and *Neogloboquadrina pachyderma* (sinistral). Samples 580-1,CC and 580-2,CC contain rare benthic species such as *Pullenia quinqueloba, Cibicides pseudoungerianus, Melonis affinis, M. pompilioides, Gyroidina neosoldanii*, and *Parafissurina* spp. Shore-based studies have shown that this Pleistocene planktonic fauna can be found as deep as 44.9 m (Sample 580-6-3, 60 cm). Sample 580-13,CC contained an upper Pliocene fauna indicative of the upper part of the *Pulleniatina obliquiloculata* Zone equivalent to N21. The fauna consists of *Globorotalia humerosa, G. acostaensis, G. obesa, G. venezuelana, G. crassaformis*, and *Pulleniatina primalis.*

Preservation of all the specimens was poor to moderate. All show heavy but uniform dissolution effects. The tests are fragile and appear chalky. Features such as pores and apertures are commonly enlarged. Where present, the abundance of foraminifers in Hole 580 was low with only about 30–50 specimens per 10–15 cm^3 sample.

Radiolarians

Sediment samples from Hole 580 contain late Quaternary through late Pliocene radiolarians. Figure 4 shows the shipboard radiolarian biostratigraphy for this site.

All core-catcher samples from Hole 580 contain radiolarians. Common, well-preserved radiolarians characteristic of the late Pleistocene *Botryostrobus aquilonaris* Zone (Hays, 1970) are found in Samples 580-1,CC through 580-3,CC. Samples 580-4,CC through 580-6,CC contain generally well-preserved common to abundant radiolarians. The presence of *Stylatractus universus* and the absence of *Eucyrtidium matuyamai* in these cores (Cores 4 through 6) indicate that this sediment sequence belongs to the *S. universus* Zone (Hays, 1970). The *E. matuyamai* Zone (Hays, 1970; Foreman, 1973) is represented in sediment from this hole in Samples 580-7,CC through 580-10,CC based on the presence of the radiolarian species *E. matuyamai.* The sediment sequence in Samples 580-11,CC through 580-15,CC is assigned to the *Lamprocyrtis heteroporos* Zone (Hays, 1970; Foreman, 1975) based on the absence of *E. matuyamai* and *Stichocorys peregrina.* The radiolarians found in Samples 580-16,CC and 580-17,CC are late Pliocene in age, based on the presence of *S. peregrina.* The faunal assemblage in these cores (Cores 16 and 17) is characteristic of the mid to upper portion of the *Sphaeropyle langii* Zone (Foreman, 1975) since *Lamprocyrtis heteroporos* in addition to *Stichocorys peregrina* is present in these sediment samples.

Diatoms

A thick Quaternary and late Pliocene diatom biostratigraphic section was recovered at Site 580 and is suitable, in conjunction with Site 579, for a study of north–south migrations of the cold-water Oyashio Current and the warm-water Kuroshio Current from late Pliocene to Recent time. As cold-water species are dominant, the diatom zonation of Koizumi (1973) is applied to this section. Diatoms are abundant and well preserved.

Cores 1 and 2 belong to the latest Quaternary *Denticulopsis seminae* Zone, and Cores 3 and 4 to the late Pleistocene *Rhizosolenia curvirostris* Zone. Cores 5 and 6 are assigned to the middle Pleistocene *Nitzschia reinholdii* Zone. The last occurrence of the silicoflagellate *Mesocena quadrangula*, which is around the Jaramillo Event of the geomagnetic Matuyama Epoch, occurs in Core 6. The early Pleistocene *Actinocyclus oculatus* Zone occurs in samples from Cores 7 to 10. The Pliocene/Pleistocene boundary is placed between *Coscinodiscus pustulatus* and *Thalassiosira zabelina* in Core 11. Cores 11 through 14 are assigned to the late Pliocene *D. seminae* var. *fossilis* Zone by the presence of *D. seminae* var. *fossilis* and the absence of *D. kamtschatica.* Core 13 is placed in the lower Matuyama Epoch between the Olduvai Event and the top of the Gauss Epoch by the presence of *Thalassiosira convexa* and the absence of *D. kamtschatica.* Diatom assemblages in Cores 15 through 17 are placed in the *D. seminae* var. *fossilis–D. kamtschatica* Zone. Core 17 is estimated to be more than 2.7 m.y. old because of the presence of *N. jouseae.*

PALEOMAGNETICS

Paleomagnetic analyses using stepwise alternating field (AF) demagnetization techniques were made on 358 samples from the 155.3 m of sediments penetrated at Site 580.

In the upper part of the hole, the intensities of the natural remanent magnetization (NRM) show a systematic overall decrease from about 6×10^{-5} Gauss near the top of the hole to about 6×10^{-7} Gauss at about 120 m sub-bottom. Below this level, to the base of the hole, NRM intensities were somewhat higher again. Within virtually all the cores, NRM values vary by at least one order of magnitude. In contrast, the magnetic stability remains remarkably constant throughout. Median destructive field (MDF) measurements typically fall within the range of 300 ± 50 Oe. The directional changes between NRM and stable directions upon AF demagnetization are generally small.

The polarity pattern derived from the downhole variation of the stable magnetization directions is shown in Figure 4. The Brunhes/Matuyama boundary was identified at 40.00 m sub-bottom (Sample 580-5-6, 70 cm), and the Matuyama/Gauss boundary at 121.44 m sub-bottom (Sample 580-14-3, 114 cm). The Jaramillo and Olduvai events in the reversed Matuyama Epoch as well as the Kaena and Mammoth events in the normal Gauss Epoch are clearly recognizable in the record. In addition, one of the short events of the Reunion series and a yet unnamed event between the Jaramillo and Olduvai were found. The base of the hole, at 155.30 m sub-bottom, did not reach the Gauss/Gilbert boundary. Using the most recent polarity time scale of Berggren et al. (in press), the extrapolated absolute age at the base of the hole is about 3.30 m.y. The sediment column at this site accumulated at a remarkably constant average rate of about 46.5 m/m.y.

Above a sub-bottom depth of about 120 m (corresponding roughly to the Matuyama/Gauss boundary at 2.47 m.y.), the stable inclinations measured scatter around the axial dipole value for the present latitude of the site (60.6°). Only below this depth does the stable inclination record gradually become shallower, reflecting the northward component of the Pacific Plate motion.

The general variation in the inclination data throughout the hole apparently results from a normal range of secular paleofield variation. In contrast, the stable declination pattern is much more complex as it frequently includes variable amounts of disturbances introduced by the coring process.

SEDIMENT ACCUMULATION RATES

Nine radiolarian and diatom biostratigraphic zonal boundaries identified in the cores of Site 580 (Fig. 4), in addition to the paleomagnetic stratigraphy, were used to estimate the sediment accumulation rates at this site. The resulting curve (Fig. 5) shows a remarkably constant rate of deposition of almost 50 m/m.y. for the Quaternary through late Pliocene.

PHYSICAL PROPERTIES

Physical properties measurements at Site 580 were performed using mainly standard Deep Sea Drilling Project (DSDP) methods (Boyce, 1976a,b; see Introduction and Explanatory Notes, this volume). Table 4 summarizes the properties that were measured in Hole 580. These measurements were generally taken at 4.5-m intervals throughout the core. Detailed compressional wave velocity profiles were made on selected ash layers to determine the fine-scale velocity structure. Figures 6, 7, and 8 show profiles of compressional wave velocity, saturated bulk density and water content, and shear strength, respectively.

A full discussion of the physical properties of the recovered sediment, including tables of the data, is given by Schultheiss (this volume). Some of the more interesting features of the data are highlighted here:

1. As at Sites 578 and 579, the velocity profile for Site 580 (Fig. 6) is dominated by high velocity pyrite-indurated clay and ash beds. Velocities in the siliceous clays and oozes rise gradually downhole from about 1470 m/s

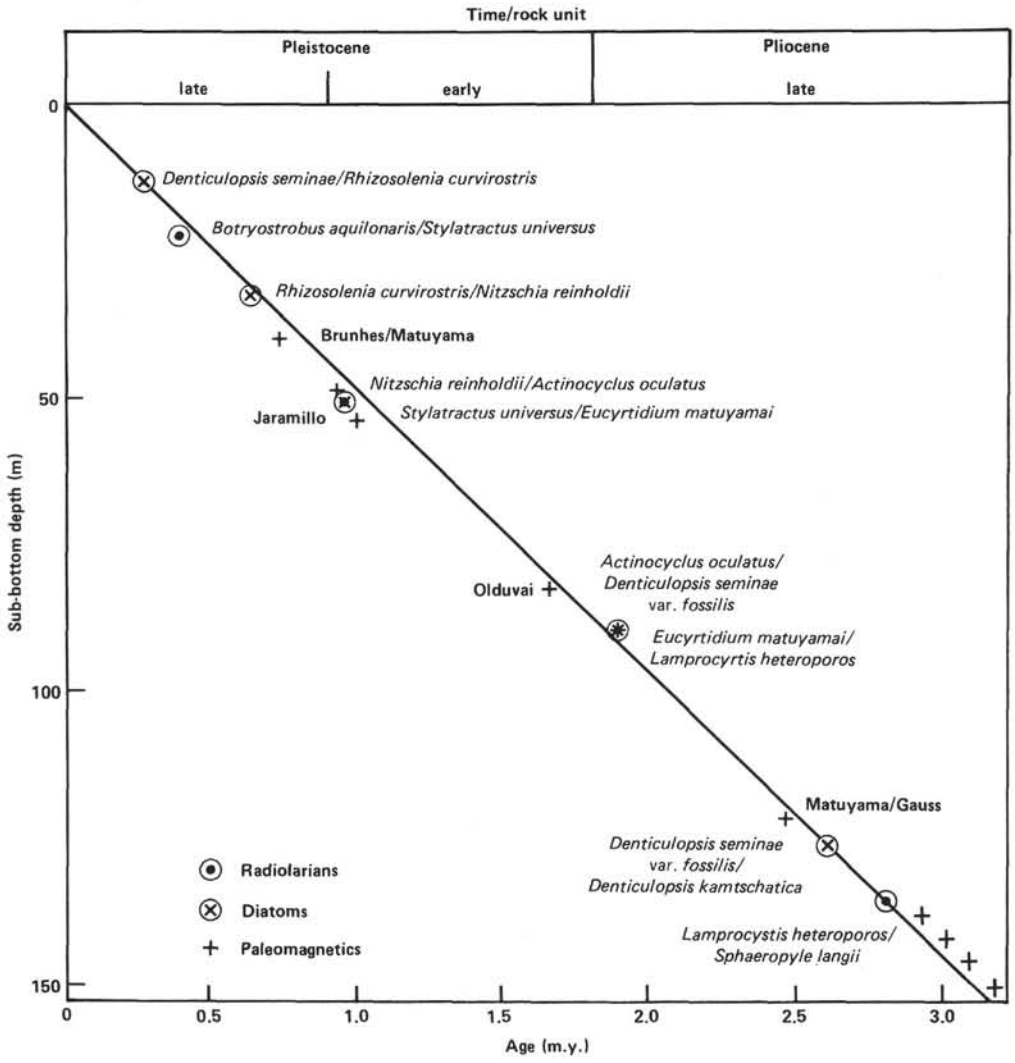

Figure 5. Site 580 sediment accumulation rates.

Table 4. Physical properties measurements made at Site 580.

	Hole 580
Shear strength	
Hand-operated vane	x
Motorized vane	x
Compressional wave velocity	x
Water content/bulk density	
Shipboard analysis	x
Shore-based analysis	x
Bulk density by 2-min. GRAPE	x

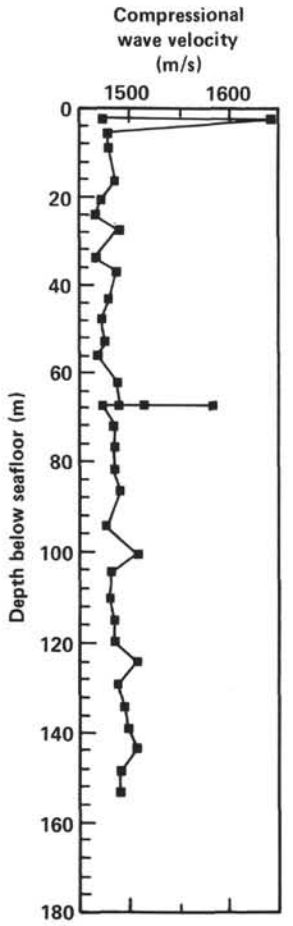

Figure 6. Plot of compressional wave velocity versus sub-bottom depth at Site 580.

in Core 1 to 1490 m/s in Core 17 at a sub-bottom depth of 150 m.

2. A detailed velocity structure was obtained from five ash layers by taking measurements at 1 or 2 cm intervals through the beds. Some of these examples clearly showed that the sharp basal contact produced a maximum velocity near or at the bottom of the ash layer. The velocities tend to decrease more slowly up through the layers.

3. The velocity structure in these ash beds is primarily governed by their bulk density structure. A comparison of the GRAPE record with the measured velocity profile for Section 580-2-2 illustrated the close relationship between the two profiles. This type of detailed profile may prove useful for modeling acoustic reflectors for correlation with seismic sections.

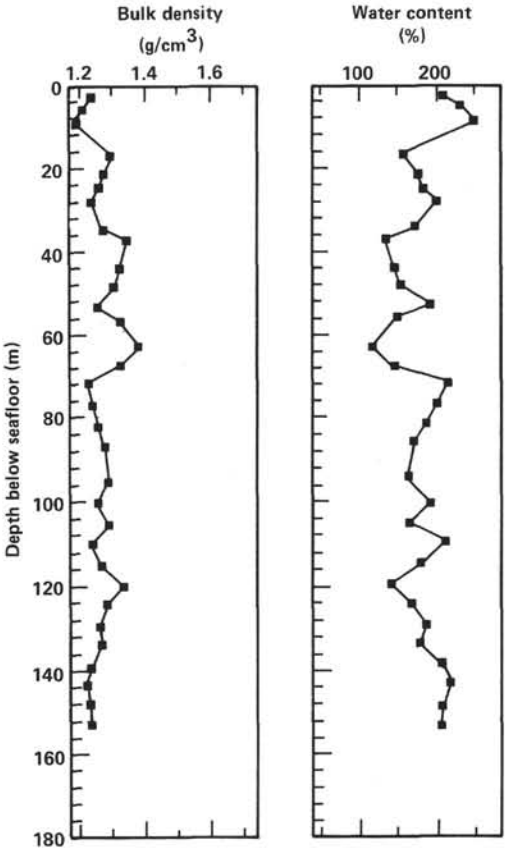

Figure 7. Plot of saturated bulk density and water content versus sub-bottom depth at Site 580.

4. The water-content profile (Fig. 7) shows an erratic decrease from around 230% at the seafloor to 120% at 63 m sub-bottom. This roughly corresponds to lithologic Subunit IA (siliceous clay). An increase of up to 212% in water content occurs in Subunit IB (calcareous siliceous clay, 60.3–79.3 m). In Subunit IC (79.3–117.3 m), which is lithologically similar to Subunit IA, the water content is essentially constant at about 180%. Lithologic Subunit ID (diatom ooze) initially exhibits a decrease in water content to 140% but then increases slowly through Subunit ID before decreasing again in Subunit IE (which is lithologically similar to IA and IC).

5. The shear strength measurements (Fig. 8) show a nearly linear increase with depth up to 800 g/cm^2 at 150 m sub-bottom.

INORGANIC GEOCHEMISTRY

Six squeezed core samples from Hole 580 were analyzed for the standard suite of components: pH, alkalinity, salinity, chlorinity, calcium, and magnesium (Table 5). No *in situ* samples were taken.

As at the two prior sites, calcium increases linearly with depth (Fig. 9), suggesting diffusion from a carbonate source beneath the drilled section to the seafloor. Magnesium decreases nonlinearly with depth, probably

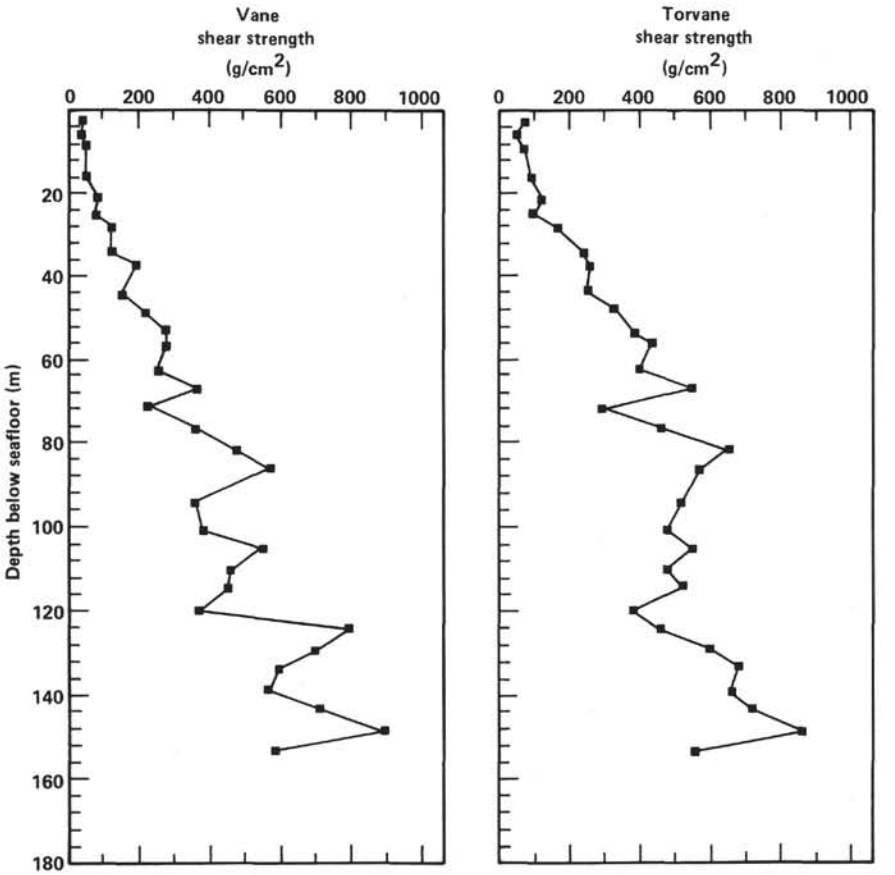

Figure 8. Plot of shear strength versus sub-bottom depth at Site 580.

Table 5. Inorganic geochemistry measurements made at Site 580.

Sample	pH	Alkalinity (mEq/l)	Salinity (‰)	Calcium (mM)	Magnesium (mM)	Chlorinity (‰)
IAPSO	7.81	2.45	35.2	10.55	53.99	19.376
SSW	7.96	2.33	34.1	10.15	51.62	18.58
580-2-5, 140–150 cm	7.61	5.85	35.2	10.61	51.22	19.36
580-5-5, 140–150 cm	7.59	7.87	35.2	11.22	49.12	19.16
580-8-5, 140–150 cm	7.49	8.44	35.2	11.41	47.45	19.39
580-11-4, 140–150 cm	7.55	8.64	34.9	11.79	46.42	19.46
580-14-5, 140–150 cm	7.57	8.59	34.9	12.16	46.04	19.36
580-17-5, 140–150 cm	7.64	8.43	34.9	12.29	45.68	19.36

due to uptake by the abundant altering ash in the drilled section. Alkalinity increases with depth to about 60 m, presumably due to oxidation of organic matter by sulfate-reducing bacteria, which must outweigh the effects of the alteration of volcanic ash.

HEAT FLOW

Measurements of sediment temperature using the new Woods Hole Oceanographic Institution (WHOI) heat-flow instrument were made at 11 locations in Hole 580. All runs were successful. Recorder WHOI-4A, connected either to battery pack NTLT-2 or NTLT-3, was used at every other core starting with Core 3 throughout the hole. At the sub-bottom depth interval of 60 to 100 m, where temperature distributions were most complex at the two previous sites, auxiliary measurements were made by recorder WHOI-01 connected to battery pack TILT-3. A comparison run with the conventional ERI-type heat flow instrument was made using the same recorder–battery unit. The comparison was unsuccessful owing to a failure on the part of the ERI-type instrument. The data from the new WHOI instrument were, however, useful and are valuable in providing a detailed temperature profile in a relatively shallow sediment section. The temperature data, combined with a detailed thermal conductivity profile constructed from 250 measurements on cores recovered from Hole 580, provided an estimate of heat flow at this site (see Horai and Von Herzen, this volume).

Past DSDP heat-flow studies have measured downhole temperatures at typical intervals of 100 m in deep holes. Oceanic heat-flow studies from ordinary research vessels have measured near-surface temperature to a depth of 10 to 15 m at intervals of 1 to 2 m. The field tests made on this leg demonstrated that the new WHOI hydraulic piston core (HPC) core-nose heat-flow instrument can be deployed successively to yield detailed temperature profiles in soft oceanic sediments.

SUMMARY AND CONCLUSIONS

At Site 580, we recovered a thick sequence of Quaternary and late Pliocene sediments. Siliceous microfossils (diatoms and radiolarians) are generally abundant and moderately to well preserved. An excellent magnetic reversal record can be identified back to the middle of the Gauss Normal Epoch.

One hundred and fifty-five meters of sediment were penetrated. Except for the numerous ash layers, these

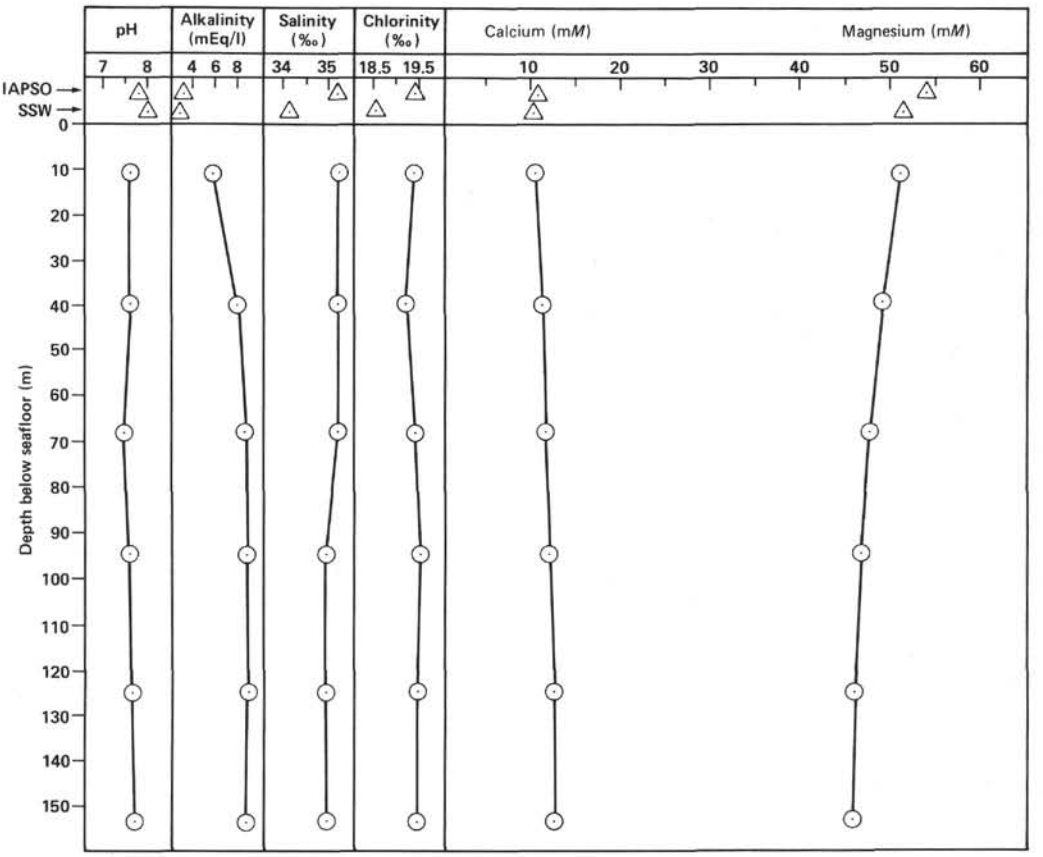

Figure 9. Profiles of pH, alkalinity, salinity (‰), chlorinity (‰), calcium (m*M*), and magnesium (m*M*) versus sub-bottom depth for interstitial water samples analyzed at Site 580. Symbols are as follows: △ = IAPSO and SSW standards; ⊙ = samples from Hole 580.

sediments are relatively uniform in color and texture. As at Site 579, we encountered numerous thin, well indurated, dark grayish green layers that were lithologically dissimilar from the adjacent, soft biosiliceous clay. Unlike Site 579, thin, dark gray to black layers of clay are commonly found immediately below the indurated layers.

The sediments from this site are placed into one lithologic unit, which is characterized as a siliceous clay, gray to dark gray to olive gray in color, with variable abundances of biogenic silica ranging from 10 to 70%. Based on these discrete changes in lithology and on the unexpected occurrence of clay-sized carbonate in one section of the hole, we can subdivide lithologic Unit I as follows:

Subunit IA (0–60.3 m) is a siliceous clay that is gray, olive gray, to dark gray in color. It contains 2–25% diatoms, 0–15% radiolarians, and 3–15% quartz. Feldspar and heavy minerals are present in abundances of less than 2%, while disseminated ash ranges from 2 to 10% in abundance. The remainder of the sediment (56%) is clay. The subunit contains 43 ash layers.

Subunit IB (60.3–79.3 m) is a calcareous biosiliceous clay. The distinguishing characteristic is the presence of 3 to 25% unspecified clay-sized carbonate. Additionally, the subunit contains 10–25% diatoms, 5–7% radiolarians, and 5–10% quartz. Quartz abundance ranges up to 10%, while feldspar is usually less than 2% and disseminated ash ranges from 3 to 7%. The remainder of the sediment (55%) is composed of clay. The subunit contains seven recognizable ash layers.

Subunit IC (73.9–117.3 m) is a siliceous clay with average composition similar to that of Subunit IA. Eighteen recognizable ash layers occur in this unit.

Subunit ID (117.3–136.3 m) is a clayey diatom ooze containing 50–60% diatoms, 2–10% radiolarians, and 5–10% quartz. Feldspar abundances are a constant 2% throughout this layer and disseminated ash ranges from 5 to 10%. The remainder of the sediment (~27%) is clay. This subunit contains seven ash layers.

Subunit IE (136.3–155.3 m) is another siliceous clay similar in composition to Subunits IA and IC except that it is slightly more enriched in diatoms. The bulk of the sediment (~53%) is clay. This subunit contains 14 ash layers.

Although the stiff greenish gray layers were present throughout all seventeen cores recovered, their locations were not recorded in the same detail as the ash layers.

Figure 4 summarizes the paleomagnetics and biostratigraphy for this site. Because of good weather, excellent recovery was achieved with minimum flow-in or coring disturbance. Thus, an excellent paleomagnetic reversal record was obtained at this site. Additionally, there was unusually fine preservation of the siliceous microfossils, making it possible to verify the magnetic reversal record via biostratigraphy. Both of the major siliceous microfossil groups (radiolarians and diatoms) were used to

verify that the hole bottomed in the middle part of the Gauss. This excellent stratigraphic control permitted us to determine, in detail, sedimentation rates during the interval of time covered by this hole. Figure 5 is an age–depth curve for the interval sampled. Sedimentation rates are high (on the order of 50 m/m.y.) in the Pleistocene and late Pliocene.

Figure 10 shows the numbers of ash layers accumulated per million year interval. There is a high of 48 ash layers during the late Pleistocene and only 18 during the early Pleistocene and latest Pliocene. This does not conform with the pattern that we saw at Sites 578 and 579 or with what Furuta and Arai (1980) observed at Site 436. Since this site has been well within the range of ash falls during the entire depositional history of this hole, changes in the number of ash layers accumulated per unit time may well represent evidence for episodicity.

Because of the large number of ash layers at this site it was difficult to determine the sources of the seismic reflections. In general, the reflectors correlated with the ash layers below 45 m sub-bottom depth. However, there were several strong reflectors in the upper 45 m that definitely did not correlate with ash layers. It is entirely possible that these strong reflectors may result from the ubiquitous, indurated to semi-indurated gray–green layers. The 100-Hz seismic reflection profiles indicate a four-part seismic section at this site. The uppermost seismic unit (0–221 m at a velocity of 1.5 km/s) includes the interval cored at this site and is subdivided into four subunits. Subunits 1a and 1c contain distinct, continuous reflectors while Subunit 1b contains indistinct, discontinuous reflectors. It is interesting that the number of ash layers/m.y. roughly correlates with these subunits (see Fig. 10).

As we found at Sites 578 and 579, the compressional wave velocity profile for Site 580 is dominated by high velocity, semi-indurated greenish clay and ash layers. Velocities rise gradually downhole from 1.47 to 1.49 km/s in the siliceous clays and oozes. Detailed velocity profiles obtained on five ash layers clearly show that, for some layers, the maximum velocity occurs at or near the sharp, basal contact.

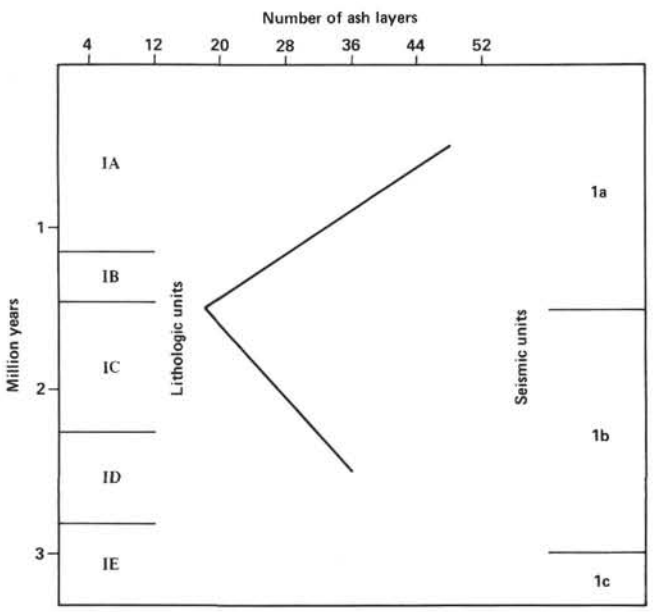

Figure 10. Plot of number of ash layers accumulated per million years at Site 580.

A total of eleven heat flow measurements were taken at Site 580. Measurements began at 22.3 m sub-bottom depth and continued to a sub-bottom depth of 155.3 m. Except for one anomalous point at 70 m, the data show a fairly linear increase in temperature with depth.

The objectives for this site—to obtain a detailed paleoceanographic record in the subtropical–subarctic gyre transition zone for the late Cenozoic; to refine the mid-latitude stratigraphy using paleomagnetics, tephrachronology, and biostratigraphy; to determine the time of onset of significant biosiliceous accumulation; to determine the timing and nature of the onset of the mid-Pliocene and Pleistocene climatic deterioration; to assess the nature and history of authigenic sedimentation in pre-biosiliceous sediments; and to determine the Cenozoic history of eolian sedimentation for comparison with sites to the south and north—was only partly achieved. Because of time limitations, we were unable to core as deep as our objectives required.

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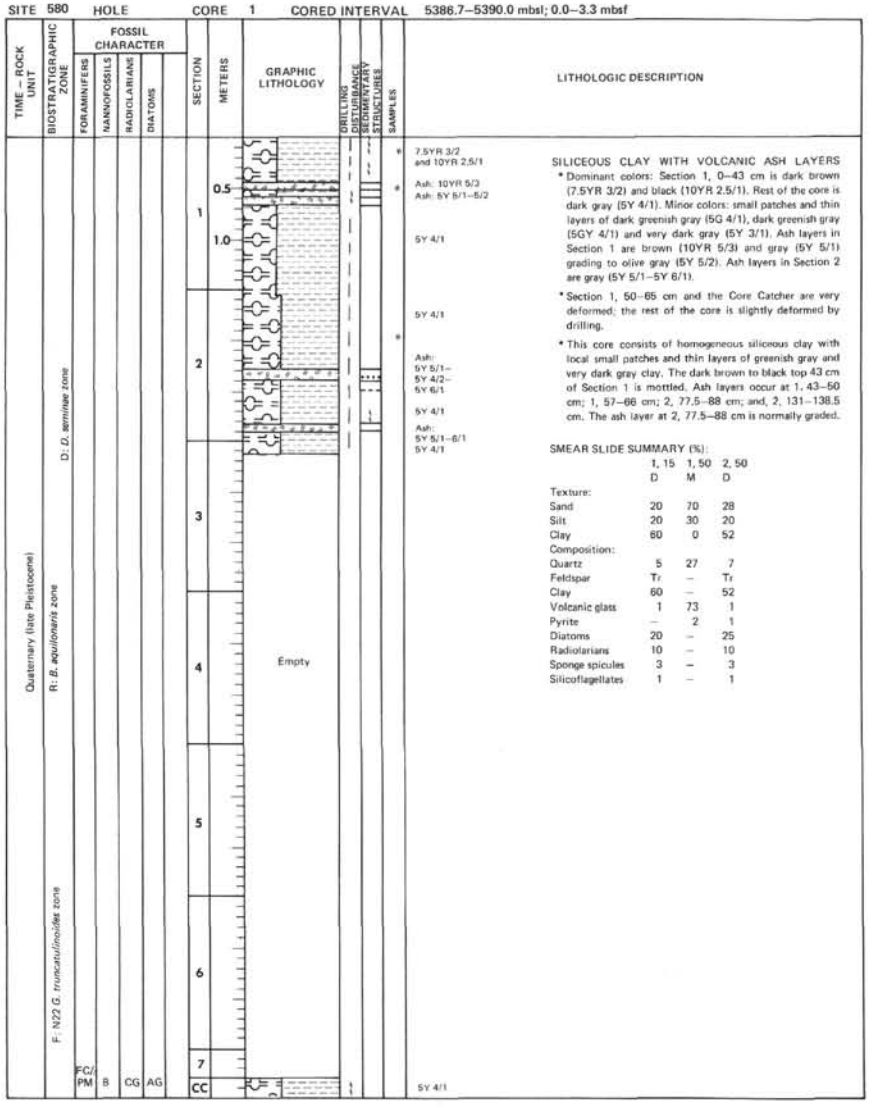
SITE 580 HOLE CORE 1 CORED INTERVAL 5386.7–5390.0 mbsl; 0.0–3.3 mbsf



LITHOLOGIC DESCRIPTION

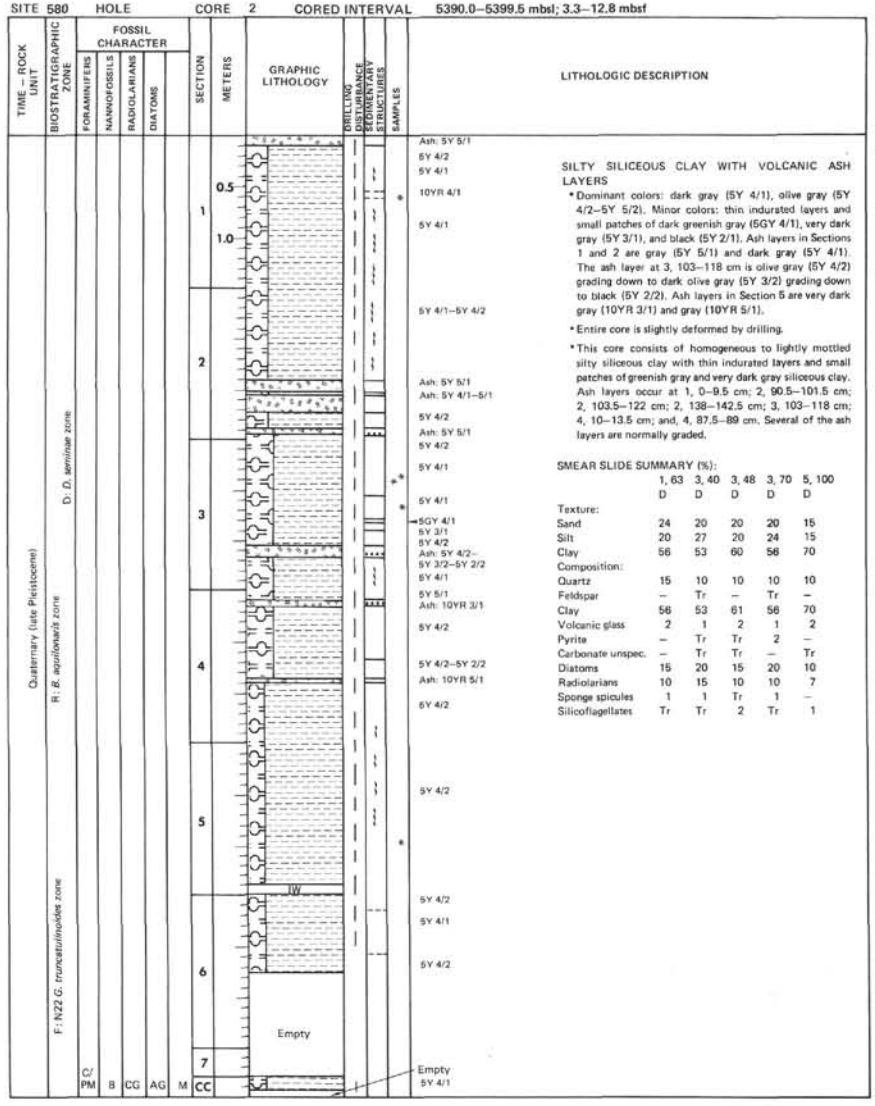
SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

* Dominant colors: Section 1, 0–43 cm is dark brown (7.5YR 3/2) and black (10YR 2.5/1). Rest of the core is dark gray (5Y 4/1). Minor colors: small patches and thin layers of dark greenish gray (5G 4/1), dark greenish gray (5GY 4/1) and very dark gray (5Y 3/1). Ash layers in Section 1 are brown (10YR 5/3) and gray (5Y 5/1) grading to olive gray (5Y 5/2). Ash layers in Section 2 are gray (5Y 5/1–5Y 6/1).
* Section 1, 50–65 cm and the Core Catcher are very deformed; the rest of the core is slightly deformed by drilling.
* This core consists of homogeneous siliceous clay with local small patches and thin layers of greenish gray and very dark gray clay. The dark brown to black top 43 cm of Section 1 is mottled. Ash layers occur at 1, 43–50 cm; 1, 57–66 cm; 2, 77.5–88 cm; and, 2, 131–138.5 cm. The ash layer at 2, 77.5–88 cm is normally graded.

SMEAR SLIDE SUMMARY (%):

	1, 15 D	1, 50 M	2, 50 D
Texture:			
Sand	20	70	28
Silt	20	30	20
Clay	60	0	52
Composition:			
Quartz	5	27	7
Feldspar	Tr	–	Tr
Clay	60	–	52
Volcanic glass	1	73	1
Pyrite	–	2	1
Diatoms	20	–	25
Radiolarians	10	–	10
Sponge spicules	3	–	3
Silicoflagellates	1	–	1

SITE 580 HOLE CORE 2 CORED INTERVAL 5390.0–5399.5 mbsl; 3.3–12.8 mbsf



SILTY SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

* Dominant colors: dark gray (5Y 4/1), olive gray (5Y 4/2–5Y 5/2). Minor colors: thin indurated layers and small patches of dark greenish gray (5GY 4/1), very dark gray (5Y 3/1), and black (5Y 2/1). Ash layers in Sections 1 and 2 are gray (5Y 5/1) and dark gray (5Y 4/1). The ash layer at 3, 103–118 cm is olive gray (5Y 4/2) grading down to dark olive gray (5Y 3/2) grading down to black (5Y 2/2). Ash layers in Section 5 are very dark gray (10YR 3/1) and gray (10YR 5/1).
* Entire core is slightly deformed by drilling.
* This core consists of homogeneous to lightly mottled silty siliceous clay with thin indurated layers and small patches of greenish gray and very dark gray siliceous clay. Ash layers occur at 1, 0–9.5 cm; 2, 90.5–101.5 cm; 2, 103.5–122 cm; 2, 138–142.5 cm; 3, 103–118 cm; 4, 10–13.5 cm; and, 4, 87.5–89 cm. Several of the ash layers are normally graded.

SMEAR SLIDE SUMMARY (%):

	1, 63 D	3, 40 D	3, 48 D	3, 70 D	5, 100 D
Texture:					
Sand	24	20	20	20	15
Silt	20	27	20	24	15
Clay	56	53	60	56	70
Composition:					
Quartz	15	10	10	10	10
Feldspar	–	Tr	–	Tr	–
Clay	56	53	61	56	70
Volcanic glass	2	1	2	1	2
Pyrite	–	Tr	Tr	2	–
Carbonate unspec.	–	Tr	Tr	–	Tr
Diatoms	15	20	15	20	10
Radiolarians	10	15	10	10	7
Sponge spicules	1	1	Tr	1	–
Silicoflagellates	Tr	Tr	2	Tr	1

SITE 580 HOLE CORE 3 CORED INTERVAL 5399.5–5409.0 mbsf; 12.8–22.3 mbsf

TIME–ROCK UNIT: Quaternary (late Pleistocene)

BIOSTRATIGRAPHIC ZONE: S: *D. octangulatus* zone (age between 310,000 and 425,000 yrs. BP); R: *B. aquilonaris* zone; D: *R. curvirostris* zone (0.27–0.68 mybp)

FOSSIL CHARACTER: FORAMINIFERS B; NANNOFOSSILS B; RADIOLARIANS AG; DIATOMS AG

SECTION 1–7, CC; METERS 0.5, 1.0

GRAPHIC LITHOLOGY: OG; Empty

DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

5Y 4/1; 5Y 5/1; 5Y 2/1; 5Y 4/1; 5GY 5/1; 5Y 4/2; 5Y 4/2; 5Y 4/1; 5Y 2/1; 5Y 4/1; 5Y 5/1; Ash: 5Y 4/2–5Y 6/1; 5Y 4/1; 5Y 5/1 and 5Y 4/1; 5Y 4/2; 5Y 4/1; 5Y 4/2; 5Y 5/1; 5Y 3/1; 5Y 4/1; Ash: 5Y 4/1–5Y 2/2; 5Y 4/2–5/1; 5Y 4/2; 5Y 5/1; 5Y 4/1; 5Y 5/1; 5Y 5/1–5GY 5/1; Ash: 5Y 4/1; 5Y 4/2; 5Y 4/1

LITHOLOGIC DESCRIPTION

SILTY SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

*Dominant colors: dark gray (5Y 4/1) gray (5Y 5/1), olive gray (5Y 4/2), and greenish gray (5GY 5/1) with layers of very dark gray (5Y 3/1) and black (5Y 2/1). Minor colors: thin indurated layers and small patches of dark greenish gray (5GY 4/1) and dark greenish gray (5G 4/1). Ash layer in Section 2 is olive gray (5Y 4/2) grading to gray (5Y 6/1). Ash layer in Section 4 is dark gray (5Y 4/1) grading to black (5Y 2/2). Ash layer in Section 5 is dark gray (5Y 4/1).

*Top of Section 1 is soupy; rest of the core is slightly deformed by drilling.

*This core consists of homogeneous to lightly mottled silty siliceous clay with thin (0.2–3.0 cm) indurated layers and small patches of greenish gray siliceous clay. Ash layers occur at 2, 114–120 cm; 4, 87–90 cm; and, 5, 95–97 cm.

SMEAR SLIDE SUMMARY (%):

	2, 100 D	4, 80 D	6, 100 D
Texture:			
Sand	20	20	20
Silt	29	27	25
Clay	51	53	55
Composition:			
Quartz	10	10	5
Feldspar	Tr	Tr	Tr
Clay	51	53	55
Volcanic glass	1	5	3
Pyrite	Tr	2	2
Carbonate unspec.	Tr	Tr	–
Diatoms	20	15	25
Radiolarians	15	15	10
Sponge spicules	2	Tr	–
Silicoflagellates	1	Tr	Tr

SITE 580 HOLE CORE 4 CORED INTERVAL 5409.0–5418.5 mbsf; 22.3–31.8 mbsf

TIME–ROCK UNIT: Quaternary (late Pleistocene)

BIOSTRATIGRAPHIC ZONE: S: *D. octangulatus* zone; R: *S. universus* zone; D: *R. curvirostris* zone

FOSSIL CHARACTER: FORAMINIFERS B; NANNOFOSSILS B; RADIOLARIANS CG; DIATOMS AG

SECTION 1–7, CC; METERS 0.5, 1.0

GRAPHIC LITHOLOGY: Empty

DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

5Y 5/1; 5Y 3/1–5Y 4/1; 5Y 4/2; Ash: 5Y 7/1; 5Y 4/1; Ash: 5Y 6/1; 5Y 4/2; 5Y 4/1; 5Y 5/1; 5Y 4/1; 5Y 4/2; Ash: 5Y 4/2–5G 4/1; 5Y 4/2; 5Y 4/1; 5Y 2/1; 5Y 4/2; 5GY 5/1; 5Y 4/2; 5Y 4/1; 5Y 5/1; 5Y 4/2; 5Y 4/2

LITHOLOGIC DESCRIPTION

SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

*Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2), and greenish gray (5GY 5/1). Minor colors: thin, indurated layers and small patches of dark greenish gray (5G 4/1) and very dark gray (5Y 3/1). Ash layers are very light gray (5Y 7/1) (2, 4–6 cm), gray (5Y 6/1) (2, 78–84 cm), and olive gray (5Y 4/2) grading to dark greenish gray (5G 4/1) (4, 124–130 cm). The ash pocket in Section 1 is very dark gray (5Y 3/1).

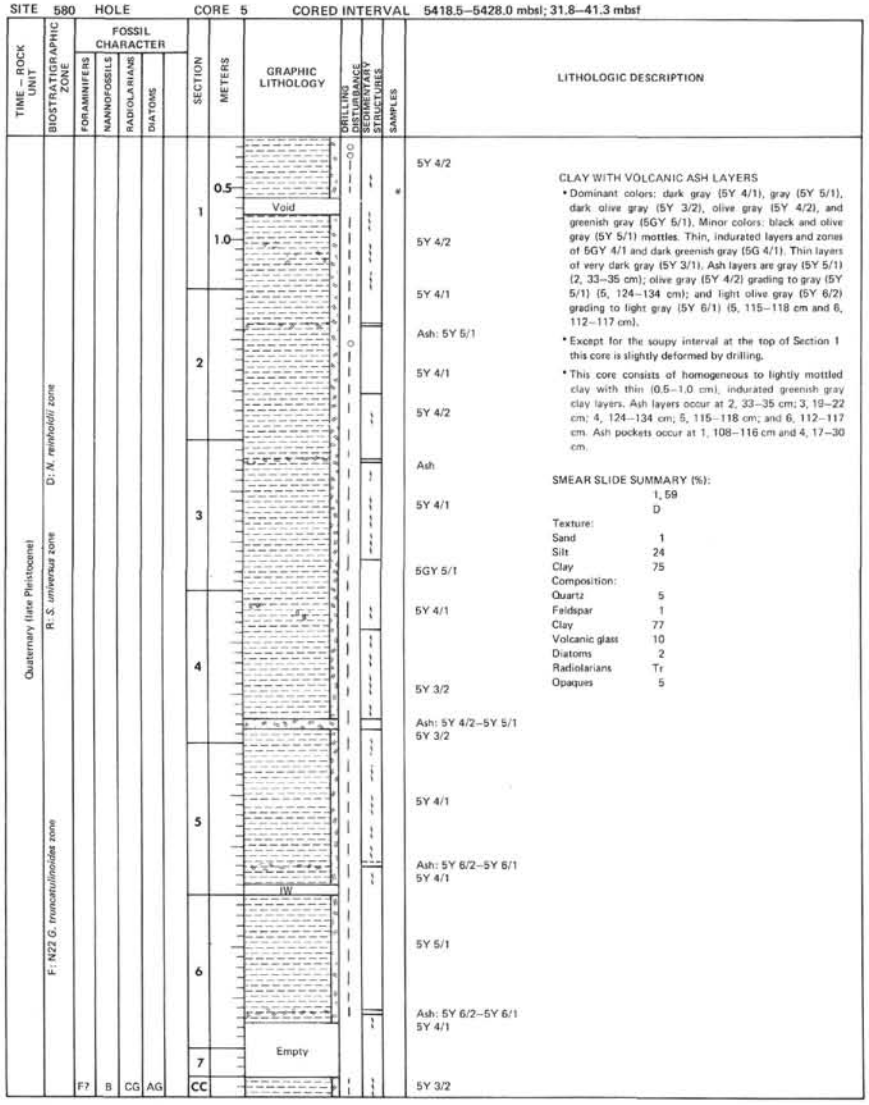
*Entire core is slightly deformed by drilling.

*This core consists of lightly mottled siliceous clay with thin (0.5–1.0 cm), indurated greenish gray siliceous clay layers. Ash layers occur at 2, 4–6 cm; 2, 78–84 cm; and, 4, 124–130 cm. Section 1, 11–14 cm contains a small ash pocket.

SMEAR SLIDE SUMMARY (%):

	1, 92 D	2, 120 D	2, 145 D	6, 40 D
Texture:				
Sand	5	5	7	10
Silt	40	45	43	35
Clay	55	50	50	55
Composition:				
Quartz	7	7	8	5
Feldspar	1	1	1	1
Heavy minerals	1	1	1	–
Clay	59	47	48	57
Volcanic glass	2	3	10	3
Foraminifers	Tr	Tr	–	–
Diatoms	20	25	20	25
Radiolarians	10	15	10	7
Silicoflagellates	–	1	2	2

SITE 580 HOLE CORE 5 CORED INTERVAL 5418.5–5428.0 mbsl; 31.8–41.3 mbsf



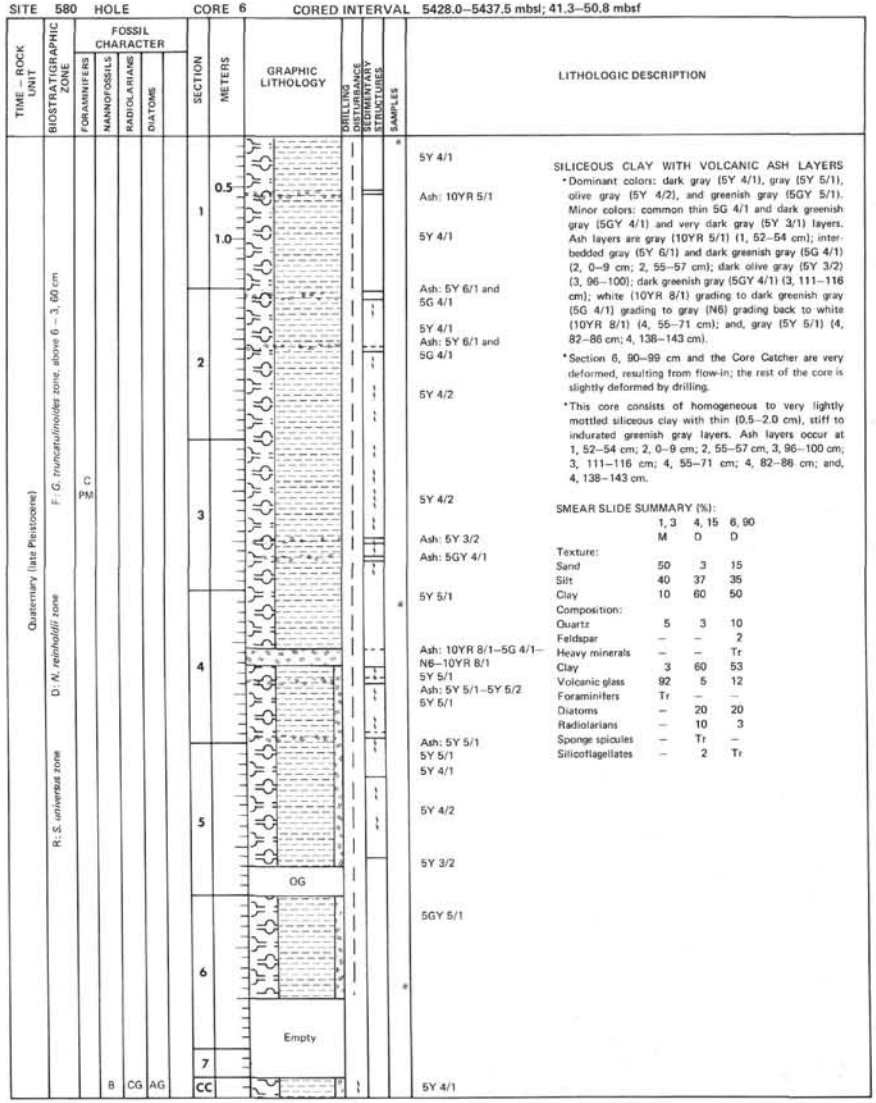
CLAY WITH VOLCANIC ASH LAYERS

- Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), dark olive gray (5Y 3/2), olive gray (5Y 4/2), and greenish gray (5GY 5/1). Minor colors: black and olive gray (5Y 5/1) mottles. Thin, indurated layers and zones of 5GY 4/1 and dark greenish gray (5G 4/1). Thin layers of very dark gray (5Y 3/1). Ash layers are gray (5Y 5/1) (2, 33–35 cm); olive gray (5Y 4/2) grading to gray (5Y 5/1) (5, 124–134 cm); and light olive gray (5Y 6/2) grading to light gray (5Y 6/1) (5, 115–118 cm and 6, 112–117 cm).
- Except for the soupy interval at the top of Section 1 this core is slightly deformed by drilling.
- This core consists of homogeneous to lightly mottled clay with thin (0.5–1.0 cm), indurated greenish gray clay layers. Ash layers occur at 2, 33–35 cm; 3, 19–22 cm; 4, 124–134 cm; 5, 115–118 cm; and 6, 112–117 cm. Ash pockets occur at 1, 108–116 cm and 4, 17–30 cm.

SMEAR SLIDE SUMMARY (%):

	1, 59 D
Texture:	
Sand	1
Silt	24
Clay	75
Composition:	
Quartz	5
Feldspar	1
Clay	77
Volcanic glass	10
Diatoms	2
Radiolarians	Tr
Opaques	5

SITE 580 HOLE CORE 6 CORED INTERVAL 5428.0–5437.5 mbsl; 41.3–50.8 mbsf



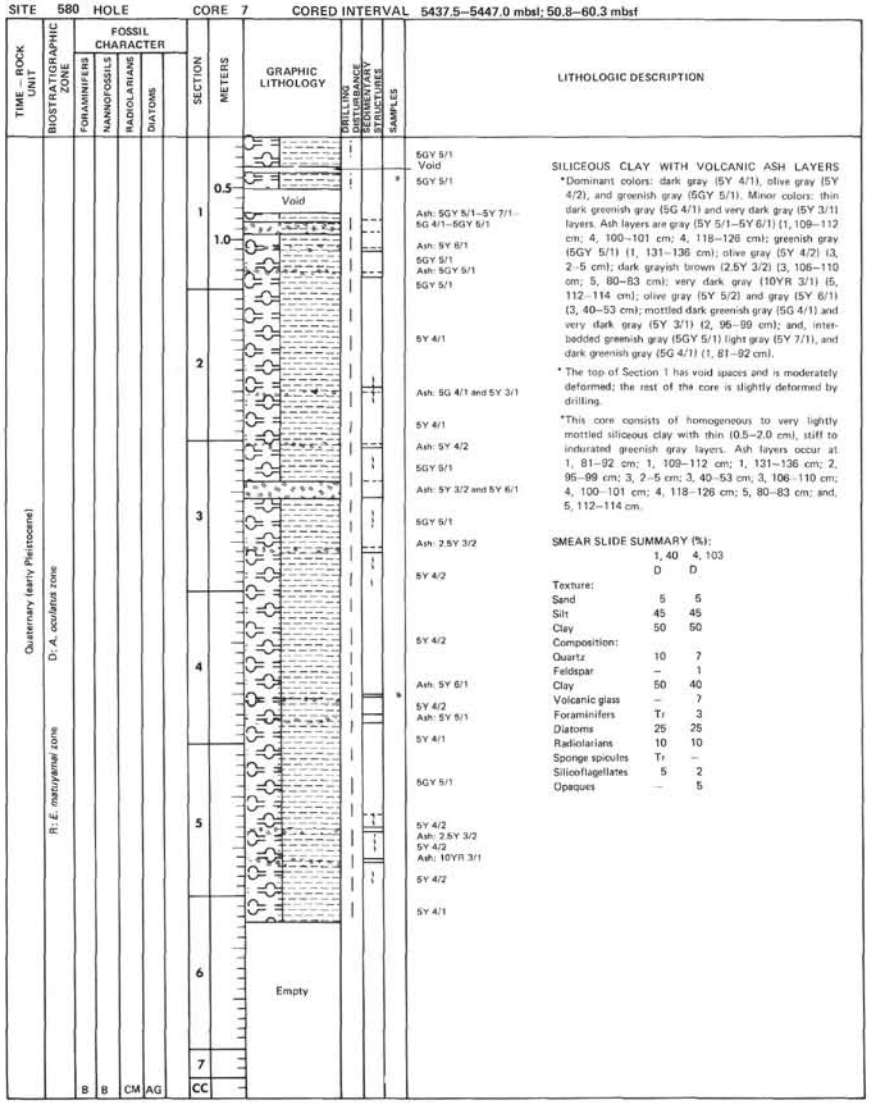
SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

- Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2), and greenish gray (5GY 5/1). Minor colors: common thin 5G 4/1 and dark greenish gray (5GY 4/1) and very dark gray (5Y 3/1) layers. Ash layers are gray (10YR 5/1) (1, 52–54 cm); interbedded gray (5Y 6/1) and dark greenish gray (5G 4/1) (2, 0–9 cm; 2, 55–57 cm); dark olive gray (5Y 3/2) (3, 96–100); dark greenish gray (5GY 4/1) (3, 111–116 cm); white (10YR 8/1) grading to dark greenish gray (5G 4/1) grading to gray (N6) grading back to white (10YR 8/1) (4, 55–71 cm); and, gray (5Y 5/1) (4, 82–86 cm; 4, 138–143 cm).
- Section 6, 90–99 cm and the Core Catcher are very deformed, resulting from flow-in; the rest of the core is slightly deformed by drilling.
- This core consists of homogeneous to very lightly mottled siliceous clay with thin (0.5–2.0 cm), stiff to indurated greenish gray layers. Ash layers occur at 1, 52–54 cm; 2, 0–9 cm; 2, 55–57 cm, 3, 96–100 cm; 3, 111–116 cm; 4, 55–71 cm; 4, 82–86 cm; and, 4, 138–143 cm.

SMEAR SLIDE SUMMARY (%):

	1, 3 M	4, 15 D	6, 90 D
Texture:			
Sand	50	3	15
Silt	40	37	35
Clay	10	60	50
Composition:			
Quartz	5	3	10
Feldspar	–	–	2
Heavy minerals	–	–	Tr
Clay	3	60	53
Volcanic glass	92	5	12
Foraminifers	Tr	–	–
Diatoms	–	20	20
Radiolarians	–	10	3
Sponge spicules	–	Tr	–
Silicoflagellates	–	2	Tr

SITE 580 HOLE CORE 7 CORED INTERVAL 5437.5–5447.0 mbsl; 50.8–60.3 mbsf



LITHOLOGIC DESCRIPTION

SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

*Dominant colors: dark gray (5Y 4/1), olive gray (5Y 4/2), and greenish gray (5GY 5/1). Minor colors: thin dark greenish gray (5G 4/1) and very dark gray (5Y 3/1) layers. Ash layers are gray (5Y 5/1–5Y 6/1) (1, 109–112 cm; 4, 100–101 cm; 4, 118–126 cm); greenish gray (5GY 5/1) (1, 131–136 cm); olive gray (5Y 4/2) (3, 2–5 cm); dark grayish brown (2.5Y 3/2) (3, 106–110 cm; 5, 80–83 cm); very dark gray (10YR 3/1) (5, 112–114 cm); olive gray (5Y 5/2) and gray (5Y 6/1) (3, 40–53 cm); mottled dark greenish gray (5G 4/1) and very dark gray (5Y 3/1) (2, 95–99 cm); and, interbedded greenish gray (5GY 5/1) light gray (5Y 7/1), and dark greenish gray (5G 4/1) (1, 81–92 cm).

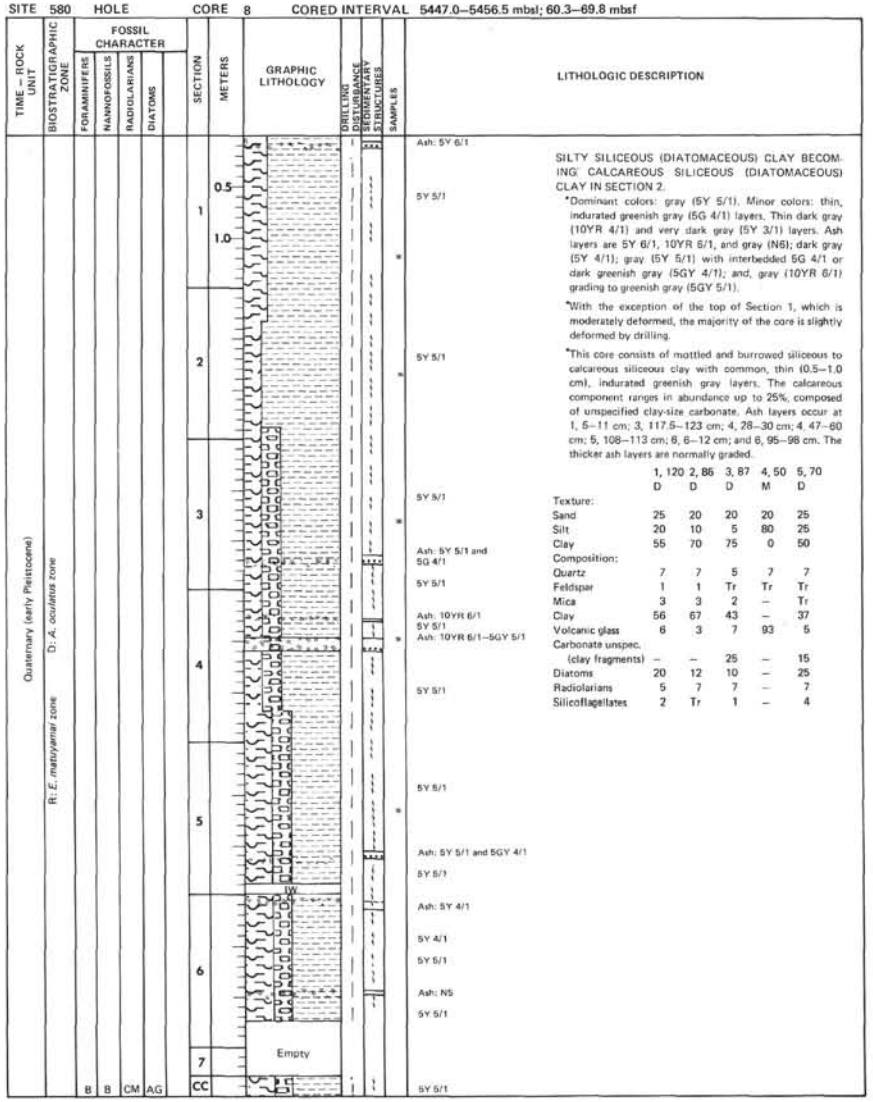
* The top of Section 1 has void spaces and is moderately deformed; the rest of the core is slightly deformed by drilling.

*This core consists of homogeneous to very lightly mottled siliceous clay with thin (0.5–2.0 cm), stiff to indurated greenish gray layers. Ash layers occur at 1, 81–92 cm; 1, 109–112 cm; 1, 131–136 cm; 2, 95–99 cm; 3, 2–5 cm; 3, 40–53 cm; 3, 106–110 cm; 4, 100–101 cm; 4, 118–126 cm; 5, 80–83 cm; and, 5, 112–114 cm.

SMEAR SLIDE SUMMARY (%):

	1, 40 D	4, 103 D
Texture:		
Sand	5	5
Silt	45	45
Clay	50	50
Composition:		
Quartz	10	7
Feldspar	–	1
Clay	50	40
Volcanic glass	–	7
Foraminifers	Tr	3
Diatoms	25	25
Radiolarians	10	10
Sponge spicules	Tr	–
Silicoflagellates	5	2
Opaques	–	5

SITE 580 HOLE CORE 8 CORED INTERVAL 5447.0–5456.5 mbsl; 60.3–69.8 mbsf



LITHOLOGIC DESCRIPTION

SILTY SILICEOUS (DIATOMACEOUS) CLAY BECOMING CALCAREOUS SILICEOUS (DIATOMACEOUS) CLAY IN SECTION 2.

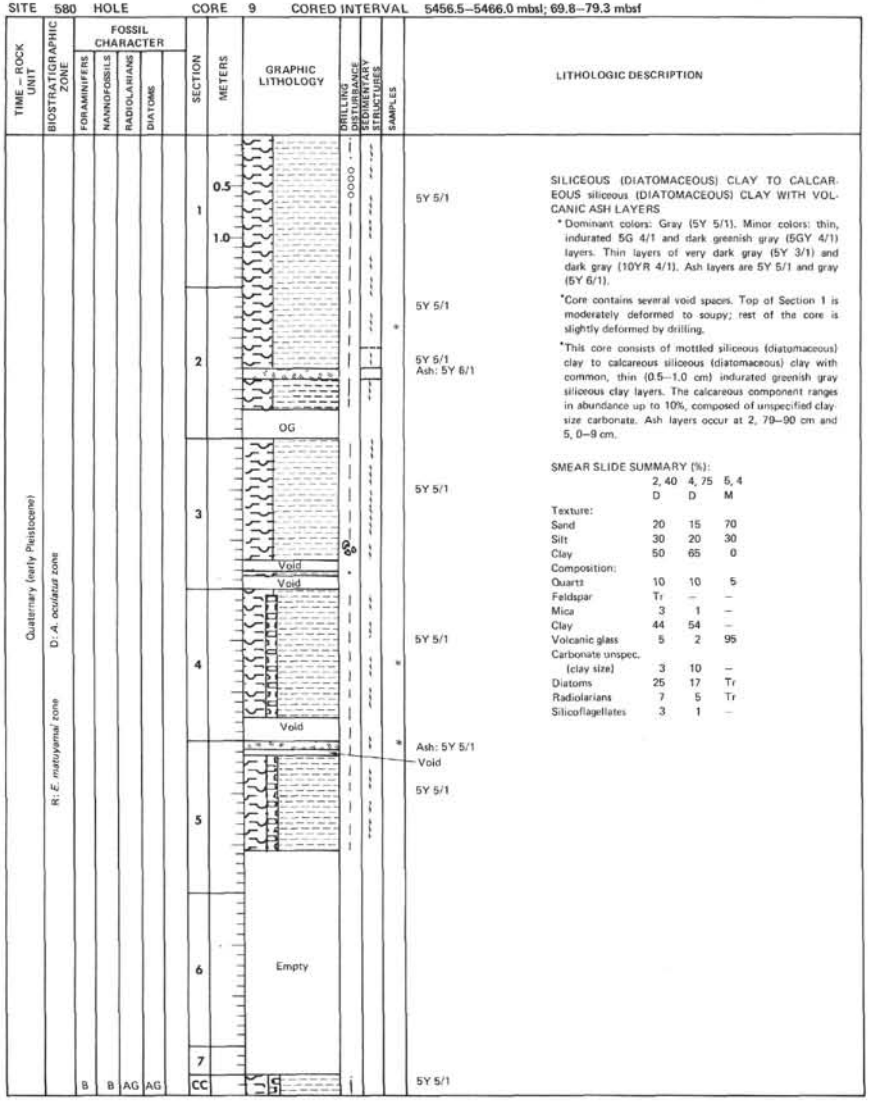
*Dominant colors: gray (5Y 5/1). Minor colors: thin, indurated greenish gray (5G 4/1) layers. Thin dark gray (10YR 4/1) and very dark gray (5Y 3/1) layers. Ash layers are 5Y 6/1, 10YR 6/1, and gray (N6); dark gray (5Y 4/1); gray (5Y 5/1) with interbedded 5G 4/1 or dark greenish gray (5GY 4/1); and, gray (10YR 6/1) grading to greenish gray (5GY 5/1).

*With the exception of the top of Section 1, which is moderately deformed, the majority of the core is slightly deformed by drilling.

*This core consists of mottled and burrowed siliceous to calcareous siliceous clay with common, thin (0.5–1.0 cm), indurated greenish gray layers. The calcareous component ranges in abundance up to 25%, composed of unspecified clay-size carbonate. Ash layers occur at 1, 5–11 cm; 3, 117.5–123 cm; 4, 28–30 cm; 4, 47–60 cm; 5, 108–113 cm; 6, 6–12 cm; and 6, 95–98 cm. The thicker ash layers are normally graded.

	1, 120 D	2, 86 D	3, 87 D	4, 50 M	5, 70 D
Texture:					
Sand	25	20	20	20	25
Silt	20	10	5	80	25
Clay	55	70	75	0	50
Composition:					
Quartz	7	7	5	7	7
Feldspar	1	1	Tr	Tr	Tr
Mica	3	3	2	–	Tr
Clay	56	67	43	–	37
Volcanic glass	6	3	7	93	5
Carbonate unspec. (clay fragments)	–	–	25	–	15
Diatoms	20	12	10	–	25
Radiolarians	5	7	7	–	7
Silicoflagellates	2	Tr	1	–	4

SITE 580 HOLE CORE 9 CORED INTERVAL 5456.5–5466.0 mbsl; 69.8–79.3 mbsf



SILICEOUS (DIATOMACEOUS) CLAY TO CALCAREOUS siliceous (DIATOMACEOUS) CLAY WITH VOLCANIC ASH LAYERS

* Dominant colors: Gray (5Y 5/1). Minor colors: thin, indurated 5G 4/1 and dark greenish gray (5GY 4/1) layers. Thin layers of very dark gray (5Y 3/1) and dark gray (10YR 4/1). Ash layers are 5Y 5/1 and gray (5Y 6/1).

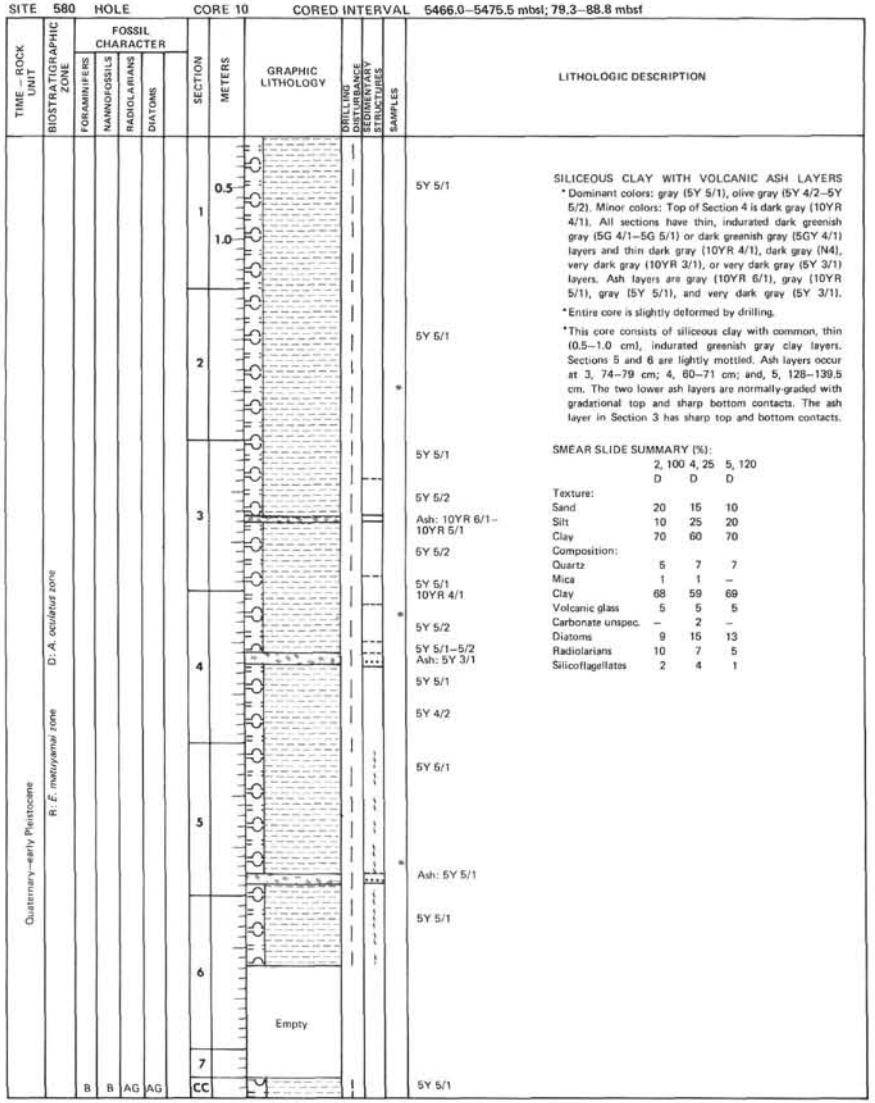
*Core contains several void spaces. Top of Section 1 is moderately deformed to soupy; rest of the core is slightly deformed by drilling.

*This core consists of mottled siliceous (diatomaceous) clay to calcareous siliceous (diatomaceous) clay with common, thin (0.5–1.0 cm) indurated greenish gray siliceous clay layers. The calcareous component ranges in abundance up to 10%, composed of unspecified clay-size carbonate. Ash layers occur at 2, 79–90 cm and 5, 0–9 cm.

SMEAR SLIDE SUMMARY (%):

	2, 40 D	4, 75 D	5, 4 M
Texture:			
Sand	20	15	70
Silt	30	20	30
Clay	50	65	0
Composition:			
Quartz	10	10	5
Feldspar	Tr	–	–
Mica	3	1	–
Clay	44	54	–
Volcanic glass	5	2	95
Carbonate unspec. [clay size]	3	10	–
Diatoms	25	17	Tr
Radiolarians	7	5	Tr
Silicoflagellates	3	1	–

SITE 580 HOLE CORE 10 CORED INTERVAL 5466.0–5475.5 mbsl; 79.3–88.8 mbsf



SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

* Dominant colors: gray (5Y 5/1), olive gray (5Y 4/2–5Y 5/2). Minor colors: Top of Section 4 is dark gray (10YR 4/1). All sections have thin, indurated dark greenish gray (5G 4/1–5G 5/1) or dark greenish gray (5GY 4/1) layers and thin dark gray (10YR 4/1), dark gray (N4), very dark gray (10YR 3/1), or very dark gray (5Y 3/1) layers. Ash layers are gray (10YR 6/1), gray (10YR 5/1), gray (5Y 5/1), and very dark gray (5Y 3/1).

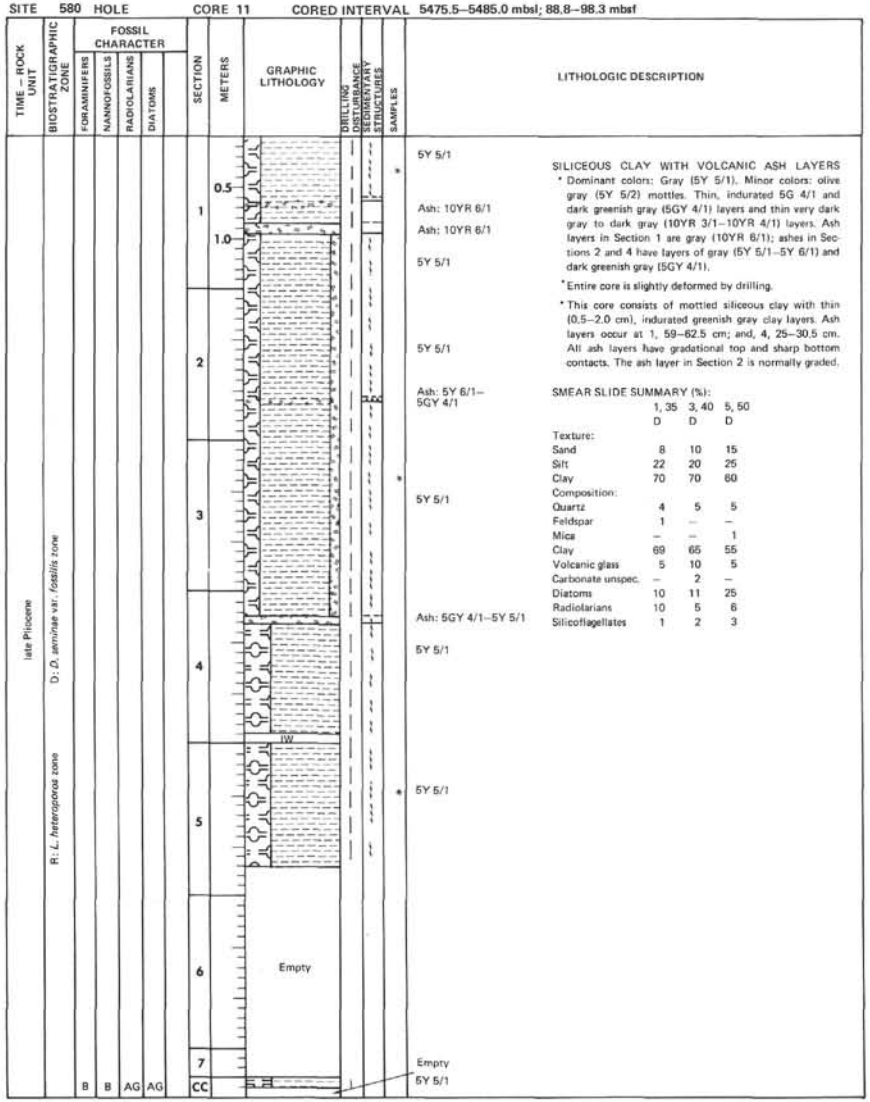
*Entire core is slightly deformed by drilling.

*This core consists of siliceous clay with common, thin (0.5–1.0 cm), indurated greenish gray clay layers. Sections 5 and 6 are lightly mottled. Ash layers occur at 3, 74–79 cm; 4, 60–71 cm; and, 5, 128–139.5 cm. The two lower ash layers are normally-graded with gradational top and sharp bottom contacts. The ash layer in Section 3 has sharp top and bottom contacts.

SMEAR SLIDE SUMMARY (%):

	2, 100 D	4, 25 D	5, 120 D
Texture:			
Sand	20	15	10
Silt	10	25	20
Clay	70	60	70
Composition:			
Quartz	5	7	7
Mica	1	1	–
Clay	68	59	69
Volcanic glass	5	5	5
Carbonate unspec.	–	2	–
Diatoms	9	15	13
Radiolarians	10	7	5
Silicoflagellates	2	4	1

SITE 580 HOLE CORE 11 CORED INTERVAL 5475.5–5485.0 mbsl; 88.8–98.3 mbsf



LITHOLOGIC DESCRIPTION

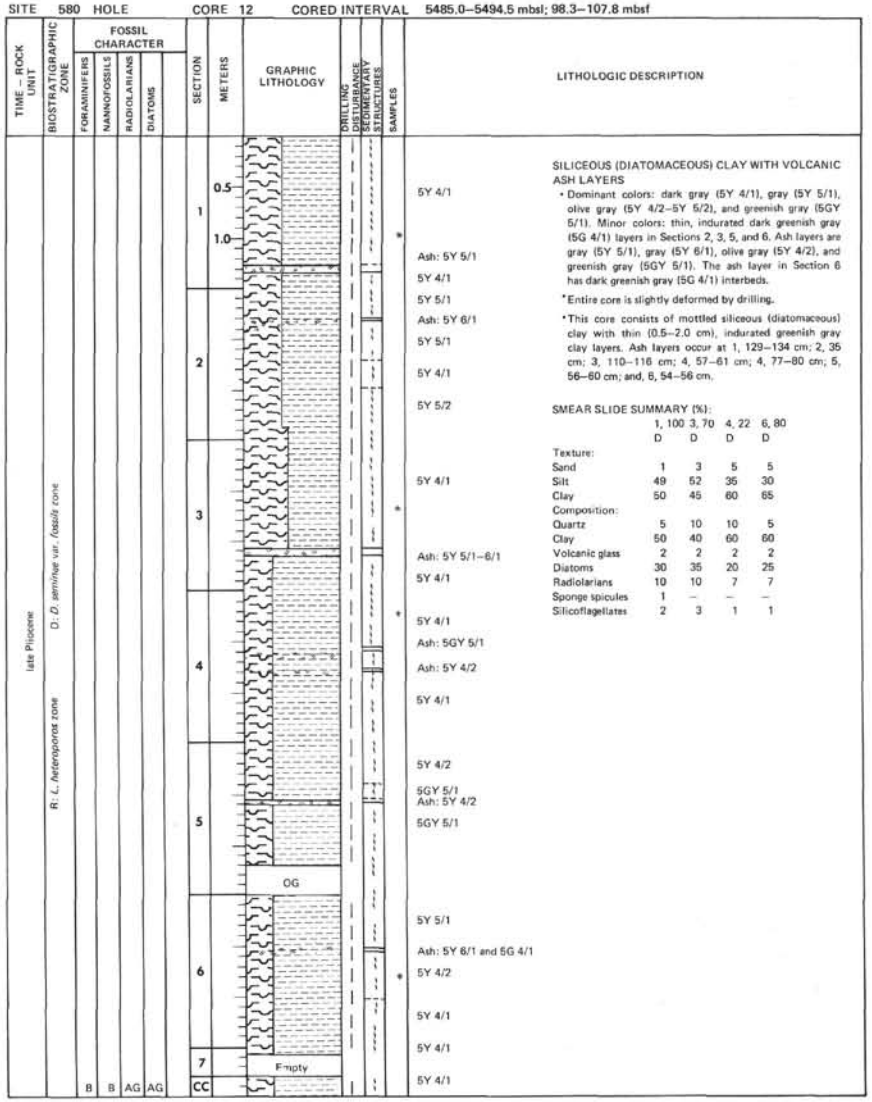
SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

- Dominant colors: Gray (5Y 5/1). Minor colors: olive gray (5Y 5/2) mottles. Thin, indurated 5G 4/1 and dark greenish gray (5GY 4/1) layers and thin very dark gray to dark gray (10YR 3/1–10YR 4/1) layers. Ash layers in Section 1 are gray (10YR 6/1); ashes in Sections 2 and 4 have layers of gray (5Y 5/1–5Y 6/1) and dark greenish gray (5GY 4/1).
- *Entire core is slightly deformed by drilling.
- *This core consists of mottled siliceous clay with thin (0.5–2.0 cm), indurated greenish gray clay layers. Ash layers occur at 1, 59–62.5 cm; and, 4, 25–30.5 cm. All ash layers have gradational top and sharp bottom contacts. The ash layer in Section 2 is normally graded.

SMEAR SLIDE SUMMARY (%):

	1, 35 D	3, 40 D	5, 50 D
Texture:			
Sand	8	10	15
Silt	22	20	25
Clay	70	70	60
Composition:			
Quartz	4	5	5
Feldspar	1	–	–
Mica	–	–	1
Clay	69	65	55
Volcanic glass	5	10	5
Carbonate unspec.	–	2	–
Diatoms	10	11	25
Radiolarians	10	5	6
Silicoflagellates	1	2	3

SITE 580 HOLE CORE 12 CORED INTERVAL 5485.0–5494.5 mbsl; 98.3–107.8 mbsf



LITHOLOGIC DESCRIPTION

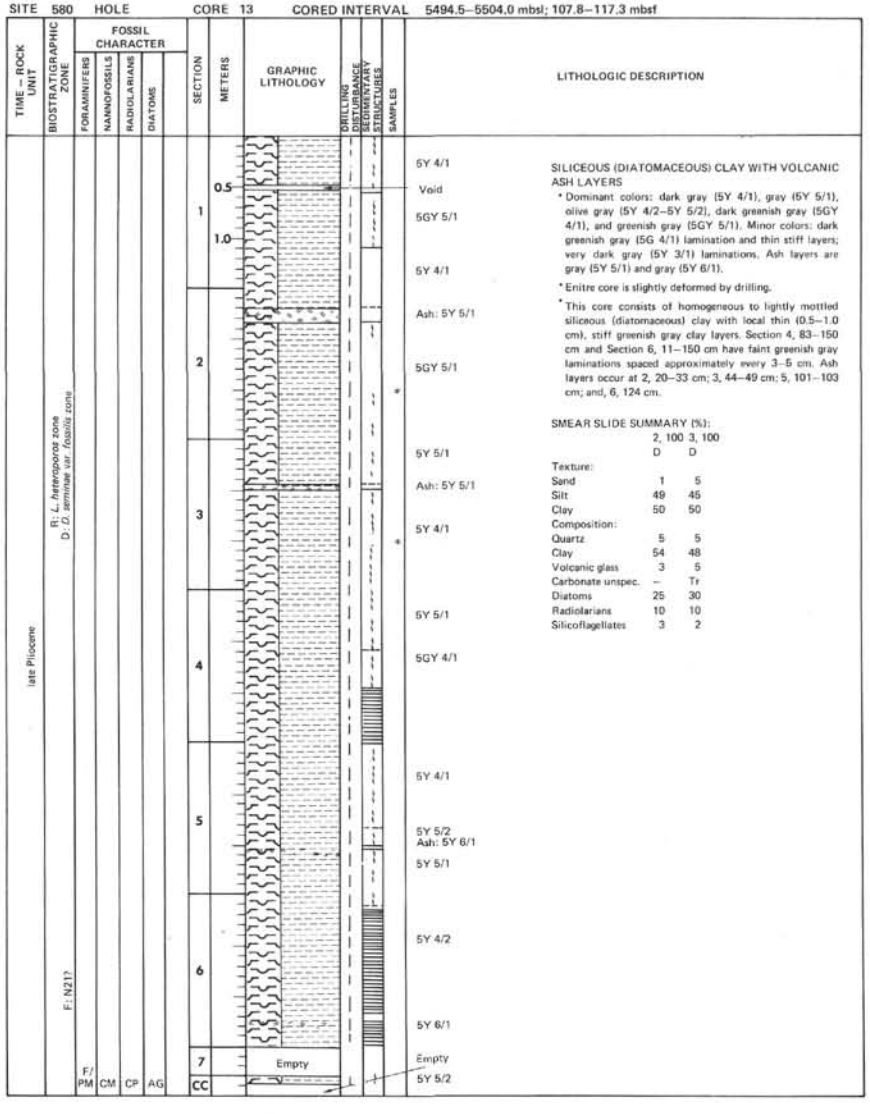
SILICEOUS (DIATOMACEOUS) CLAY WITH VOLCANIC ASH LAYERS

- Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2–5Y 5/2), and greenish gray (5GY 5/1). Minor colors: thin, indurated dark greenish gray (5G 4/1) layers in Sections 2, 3, 5, and 6. Ash layers are gray (5Y 5/1), gray (5Y 6/1), olive gray (5Y 4/2), and greenish gray (5GY 5/1). The ash layer in Section 6 has dark greenish gray (5G 4/1) interbeds.
- *Entire core is slightly deformed by drilling.
- *This core consists of mottled siliceous (diatomaceous) clay with thin (0.5–2.0 cm), indurated greenish gray clay layers. Ash layers occur at 1, 129–134 cm; 2, 35 cm; 3, 110–116 cm; 4, 57–61 cm; 4, 77–80 cm; 5, 56–60 cm; and, 6, 54–56 cm.

SMEAR SLIDE SUMMARY (%):

	1, 100 D	3, 70 D	4, 22 D	6, 80 D
Texture:				
Sand	1	3	5	5
Silt	49	52	35	30
Clay	50	45	60	65
Composition:				
Quartz	5	10	10	5
Clay	50	40	60	60
Volcanic glass	2	2	2	2
Diatoms	30	35	20	25
Radiolarians	10	10	7	7
Sponge spicules	1	–	–	–
Silicoflagellates	2	3	1	1

SITE 580 HOLE CORE 13 CORED INTERVAL 5494.5–5504.0 mbsl; 107.8–117.3 mbsf



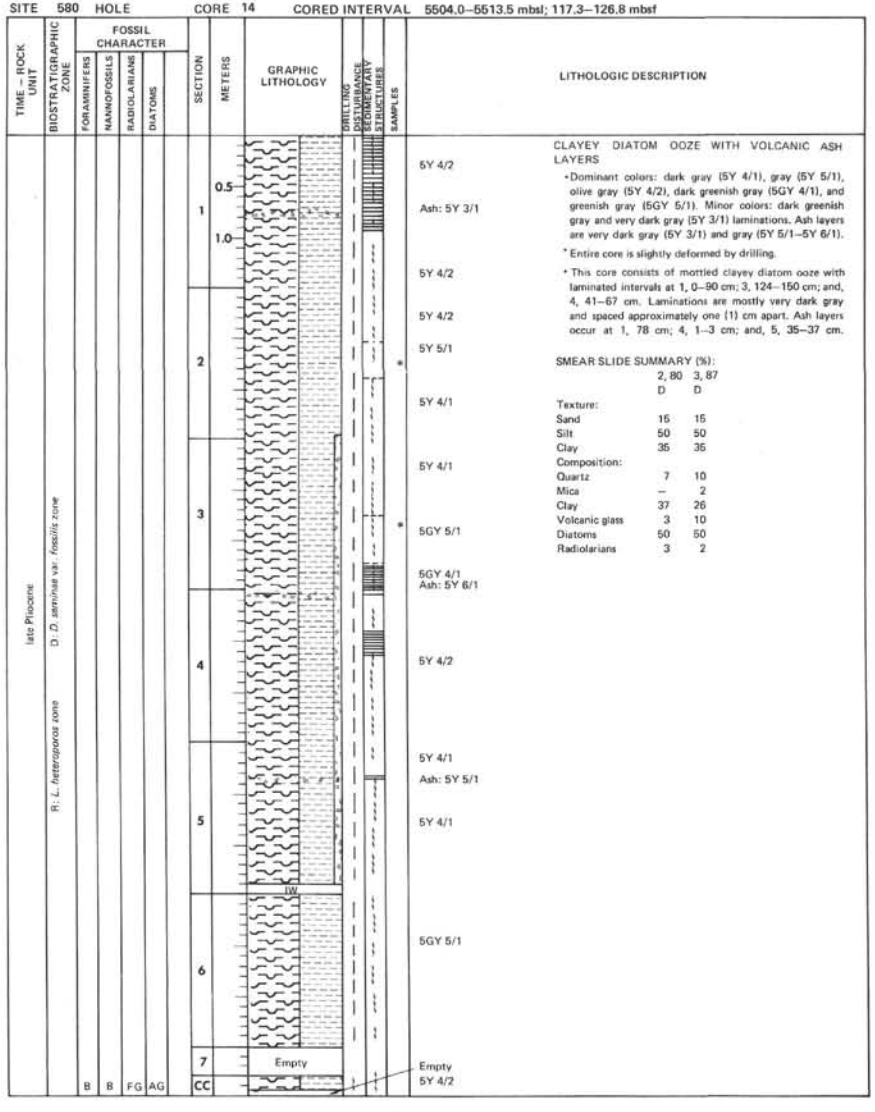
SILICEOUS (DIATOMACEOUS) CLAY WITH VOLCANIC ASH LAYERS

- Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2–5Y 5/2), dark greenish gray (5GY 4/1), and greenish gray (5GY 5/1). Minor colors: dark greenish gray (5G 4/1) lamination and thin stiff layers; very dark gray (5Y 3/1) laminations. Ash layers are gray (5Y 5/1) and gray (5Y 6/1).
- * Enitre core is slightly deformed by drilling.
- * This core consists of homogeneous to lightly mottled siliceous (diatomaceous) clay with local thin (0.5–1.0 cm), stiff greenish gray clay layers. Section 4, 83–150 cm and Section 6, 11–150 cm have faint greenish gray laminations spaced approximately every 3–5 cm. Ash layers occur at 2, 20–33 cm; 3, 44–49 cm; 5, 101–103 cm; and, 6, 124 cm.

SMEAR SLIDE SUMMARY (%):

	2, 100 D	3, 100 D
Texture:		
Sand	1	5
Silt	49	45
Clay	50	50
Composition:		
Quartz	5	5
Clay	54	48
Volcanic glass	3	5
Carbonate unspec.	–	Tr
Diatoms	25	30
Radiolarians	10	10
Silicoflagellates	3	2

SITE 580 HOLE CORE 14 CORED INTERVAL 5504.0–5513.5 mbsl; 117.3–126.8 mbsf



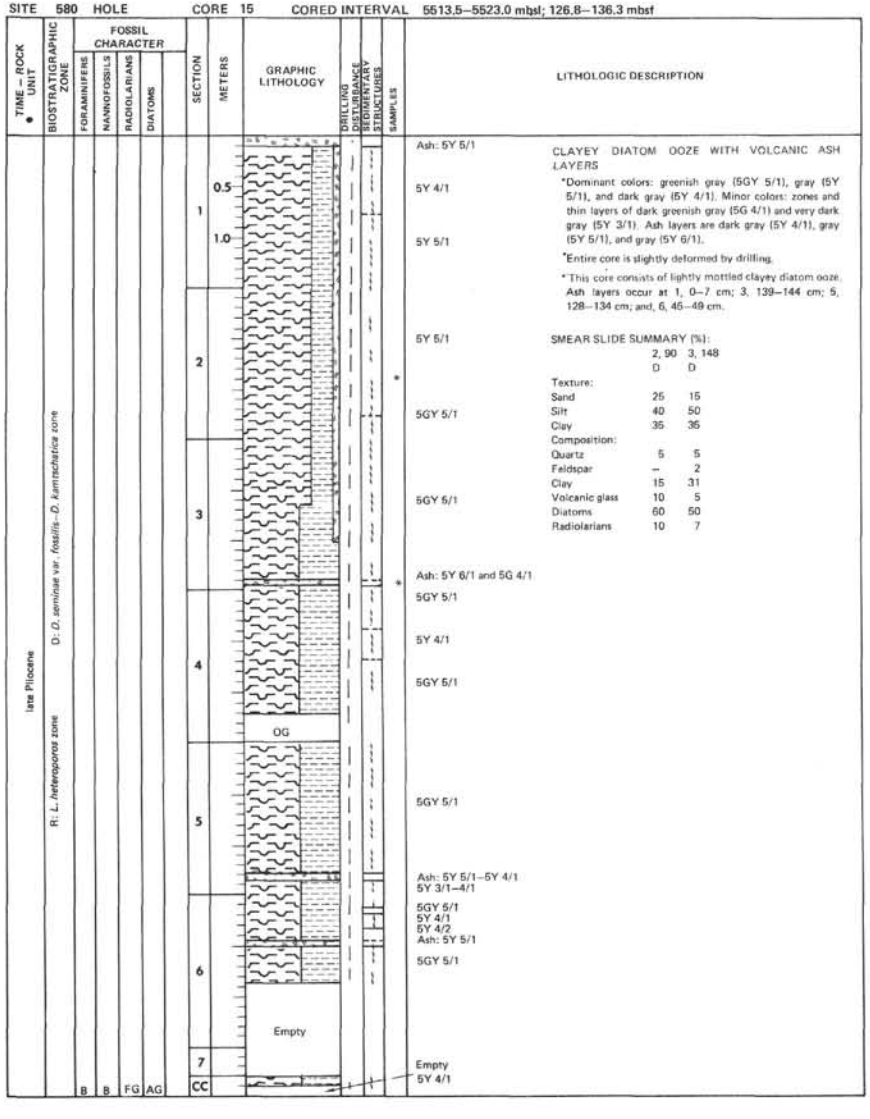
CLAYEY DIATOM OOZE WITH VOLCANIC ASH LAYERS

- Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2), dark greenish gray (5GY 4/1), and greenish gray (5GY 5/1). Minor colors: dark greenish gray and very dark gray (5Y 3/1) laminations. Ash layers are very dark gray (5Y 3/1) and gray (5Y 5/1–5Y 6/1).
- * Entire core is slightly deformed by drilling.
- * This core consists of mottled clayey diatom ooze with laminated intervals at 1, 0–90 cm; 3, 124–150 cm; and, 4, 41–67 cm. Laminations are mostly very dark gray and spaced approximately one (1) cm apart. Ash layers occur at 1, 78 cm; 4, 1–3 cm; and, 5, 35–37 cm.

SMEAR SLIDE SUMMARY (%):

	2, 80 D	3, 87 D
Texture:		
Sand	15	15
Silt	50	50
Clay	35	35
Composition:		
Quartz	7	10
Mica	–	2
Clay	37	26
Volcanic glass	3	10
Diatoms	50	50
Radiolarians	3	2

SITE 580 HOLE CORE 15 CORED INTERVAL 5513.5–5523.0 mbsl; 126.8–136.3 mbsf



CLAYEY DIATOM OOZE WITH VOLCANIC ASH LAYERS

*Dominant colors: greenish gray (5GY 5/1), gray (5Y 5/1), and dark gray (5Y 4/1). Minor colors: zones and thin layers of dark greenish gray (5G 4/1) and very dark gray (5Y 3/1). Ash layers are dark gray (5Y 4/1), gray (5Y 5/1), and gray (5Y 6/1).

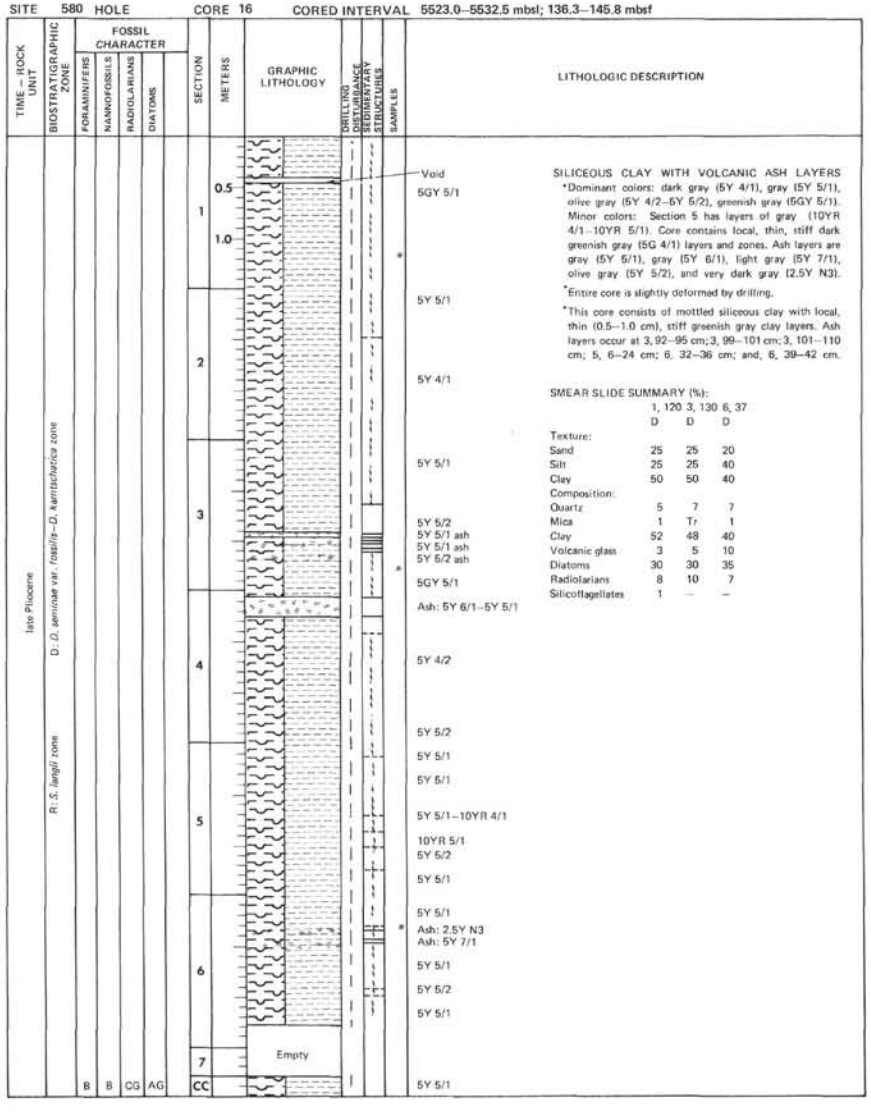
*Entire core is slightly deformed by drilling.

*This core consists of lightly mottled clayey diatom ooze. Ash layers occur at 1, 0–7 cm; 3, 139–144 cm; 5, 128–134 cm; and, 6, 45–49 cm.

SMEAR SLIDE SUMMARY (%):

	2, 90 D	3, 148 D
Texture:		
Sand	25	15
Silt	40	50
Clay	35	35
Composition:		
Quartz	5	5
Feldspar	–	2
Clay	15	31
Volcanic glass	10	5
Diatoms	60	50
Radiolarians	10	7

SITE 580 HOLE CORE 16 CORED INTERVAL 5523.0–5532.5 mbsl; 136.3–145.8 mbsf



SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

*Dominant colors: dark gray (5Y 4/1), gray (5Y 5/1), olive gray (5Y 4/2–5Y 5/2), greenish gray (5GY 5/1). Minor colors: Section 5 has layers of gray (10YR 4/1–10YR 5/1). Core contains local, thin, stiff dark greenish gray (5G 4/1) layers and zones. Ash layers are gray (5Y 5/1), gray (5Y 6/1), light gray (5Y 7/1), olive gray (5Y 5/2), and very dark gray (2.5Y N3).

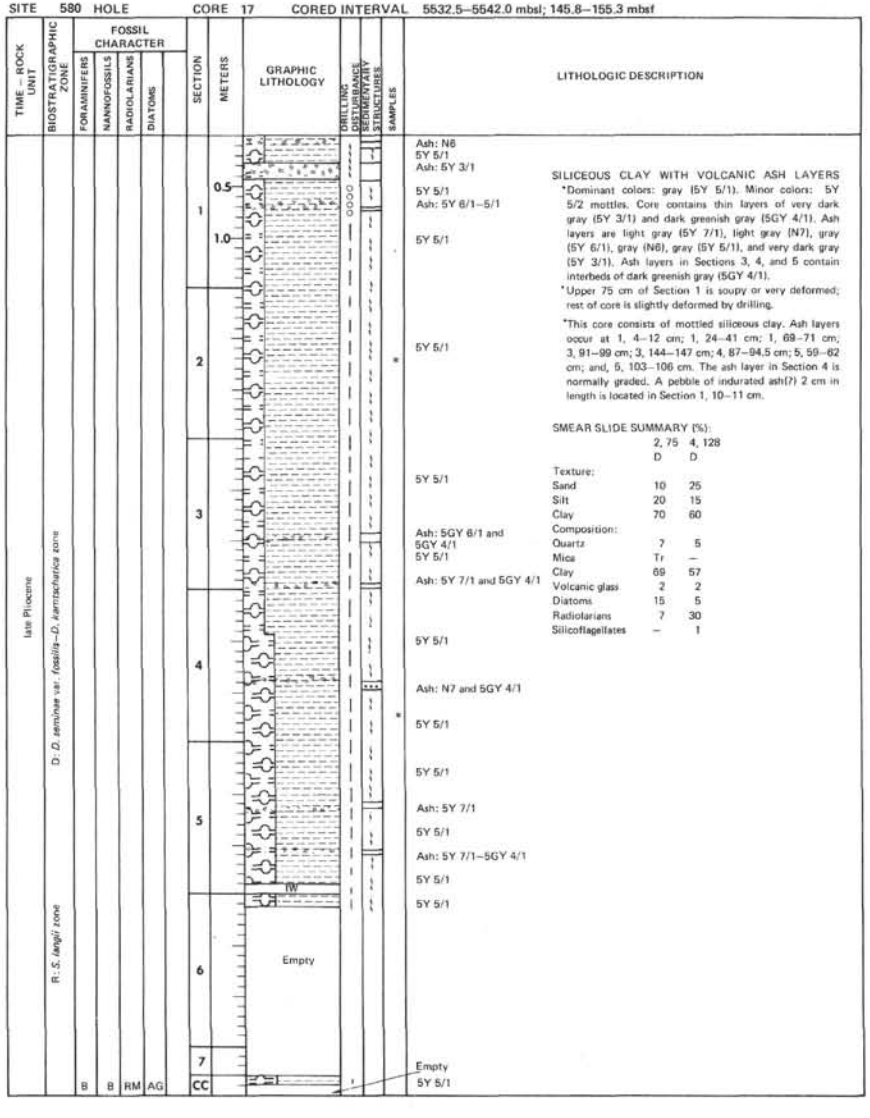
*Entire core is slightly deformed by drilling.

*This core consists of mottled siliceous clay with local, thin (0.5–1.0 cm), stiff greenish gray clay layers. Ash layers occur at 3, 92–95 cm; 3, 99–101 cm; 3, 101–110 cm; 5, 6–24 cm; 6, 32–36 cm; and, 6, 39–42 cm.

SMEAR SLIDE SUMMARY (%):

	1, 120 D	3, 130 D	6, 37 D
Texture:			
Sand	25	25	20
Silt	25	25	40
Clay	50	50	40
Composition:			
Quartz	5	7	7
Mica	1	Tr	1
Clay	52	48	40
Volcanic glass	3	5	10
Diatoms	30	30	35
Radiolarians	8	10	7
Silicoflagellates	1	–	–

SITE 580 HOLE CORE 17 CORED INTERVAL 5532.5–5542.0 mbsl; 145.8–155.3 mbsf



SILICEOUS CLAY WITH VOLCANIC ASH LAYERS

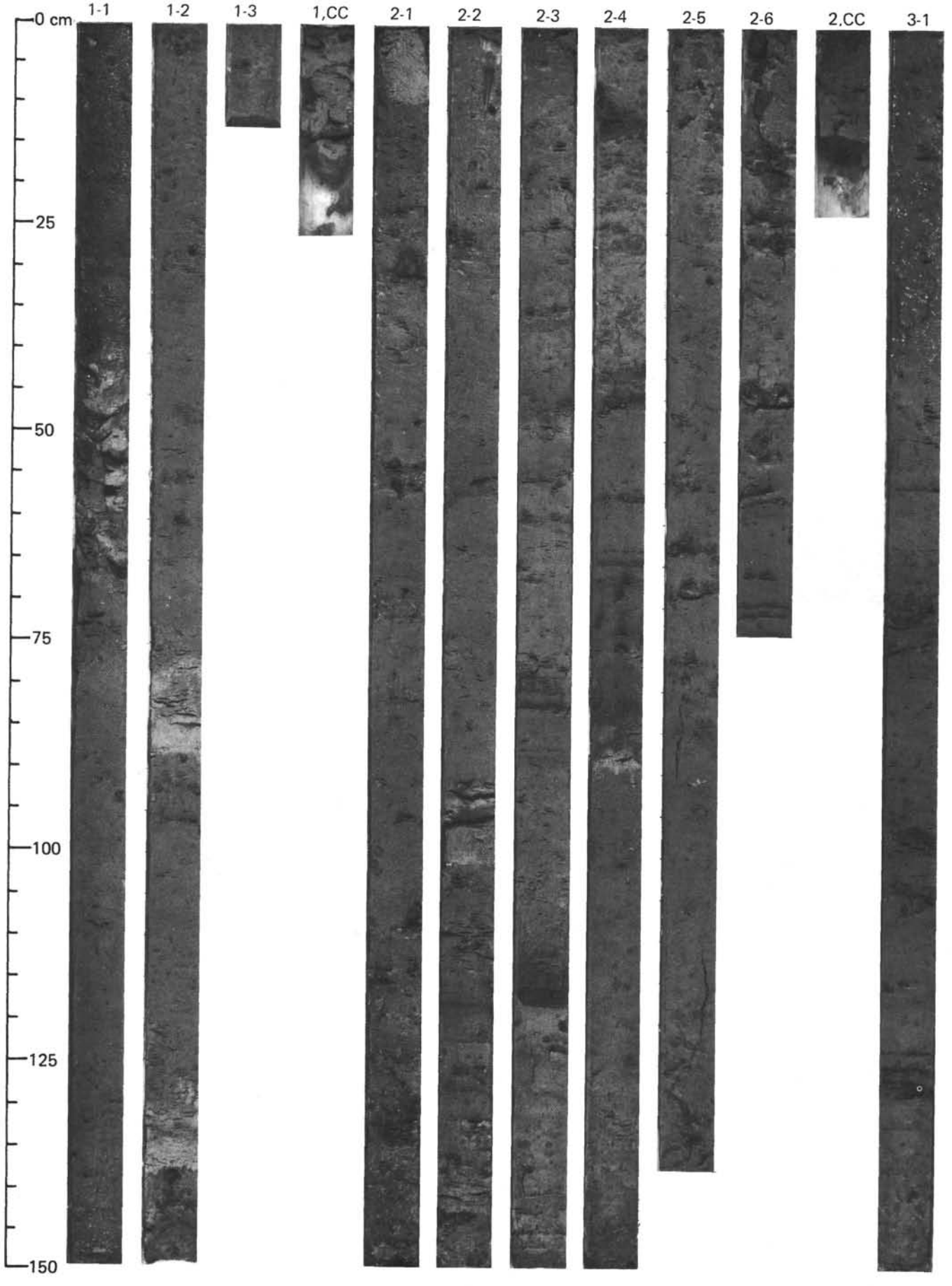
*Dominant colors: gray (5Y 5/1). Minor colors: 5Y 5/2 mottles. Core contains thin layers of very dark gray (5Y 3/1) and dark greenish gray (5GY 4/1). Ash layers are light gray (5Y 7/1), light gray (N7), gray (5Y 6/1), gray (N6), gray (5Y 5/1), and very dark gray (5Y 3/1). Ash layers in Sections 3, 4, and 5 contain interbeds of dark greenish gray (5GY 4/1).

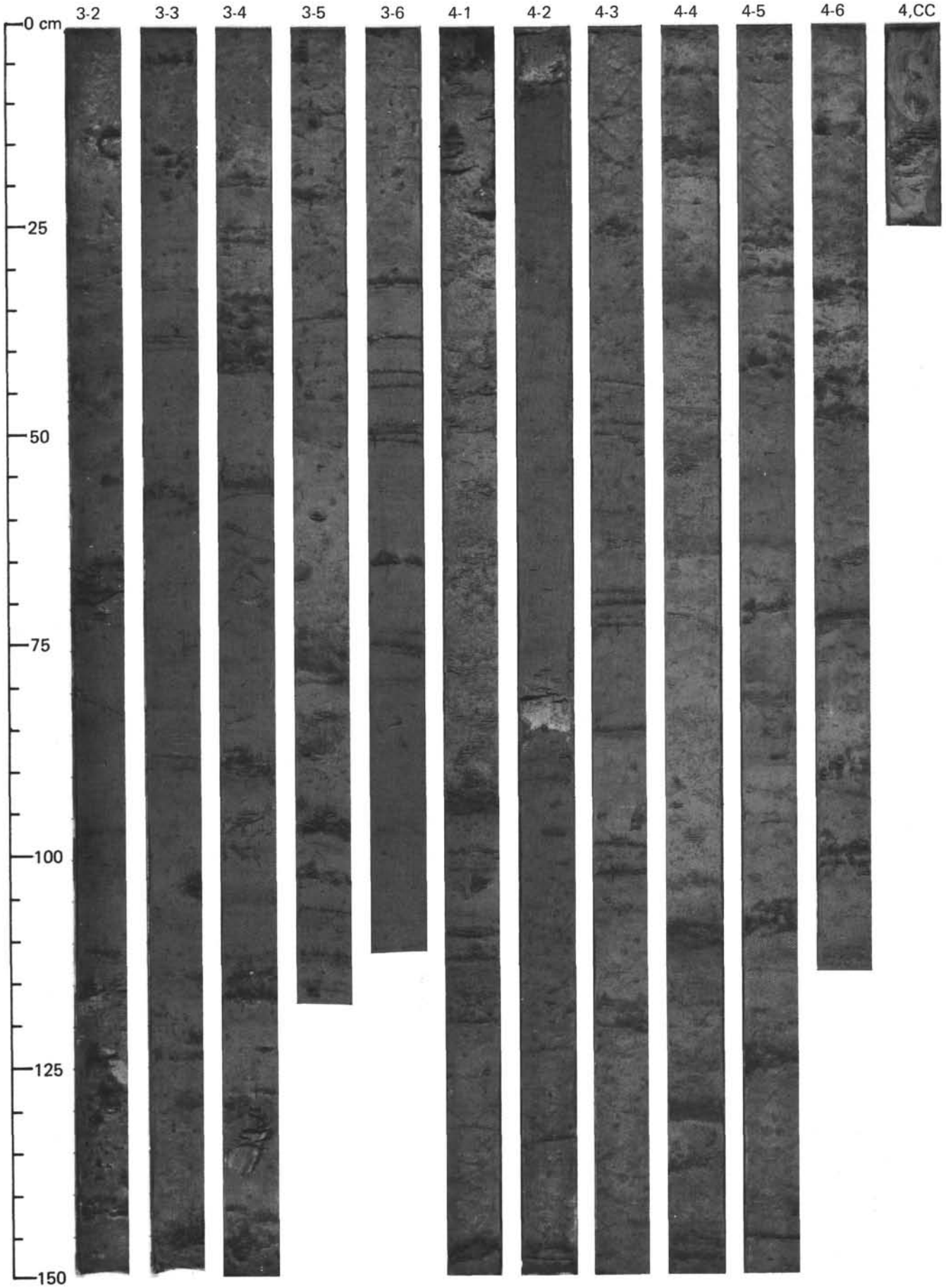
*Upper 75 cm of Section 1 is soupy or very deformed; rest of core is slightly deformed by drilling.

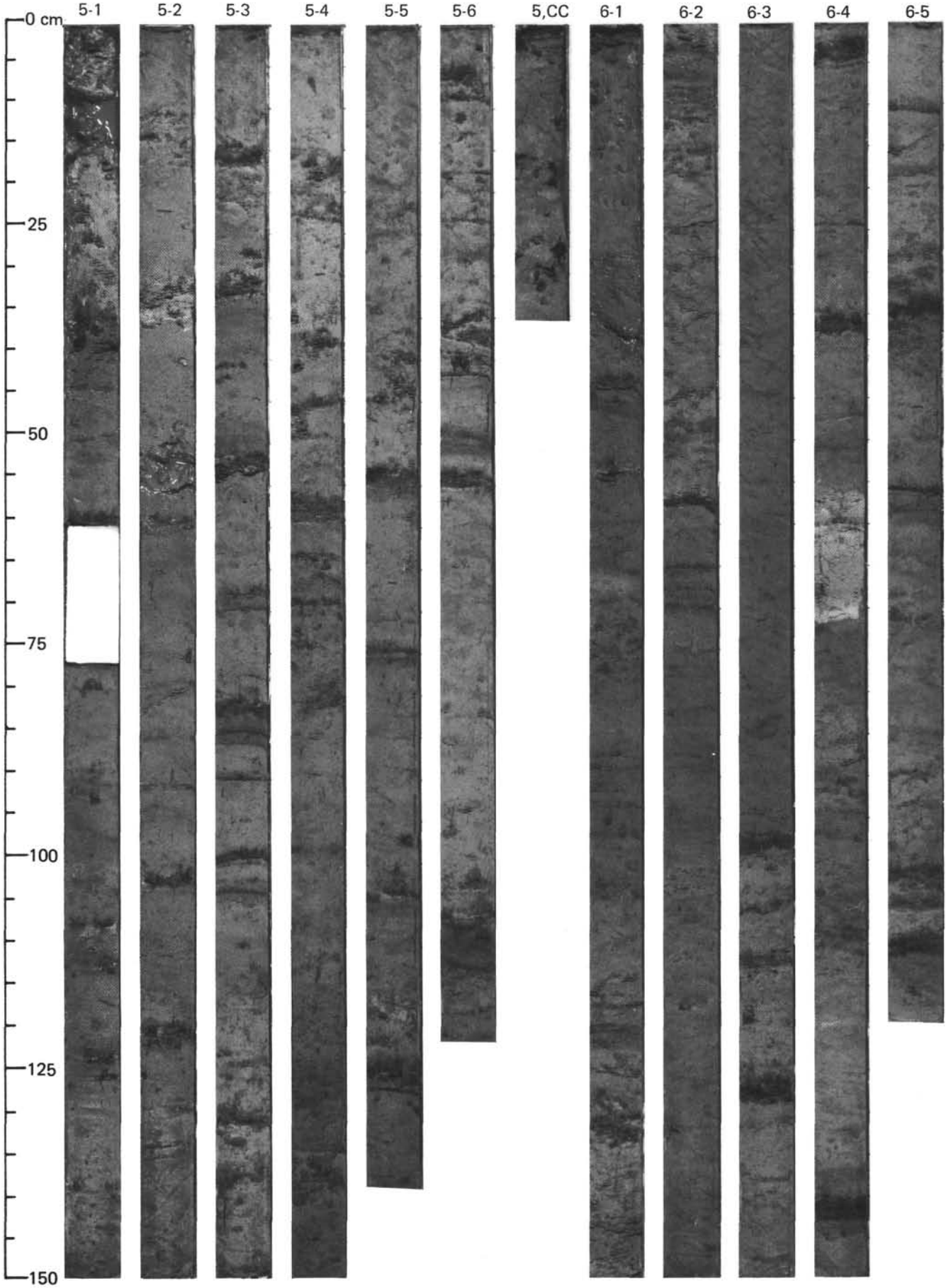
*This core consists of mottled siliceous clay. Ash layers occur at 1, 4–12 cm; 1, 24–41 cm; 1, 69–71 cm; 3, 91–99 cm; 3, 144–147 cm; 4, 87–94.5 cm; 5, 59–62 cm; and, 5, 103–106 cm. The ash layer in Section 4 is normally graded. A pebble of indurated ash(?) 2 cm in length is located in Section 1, 10–11 cm.

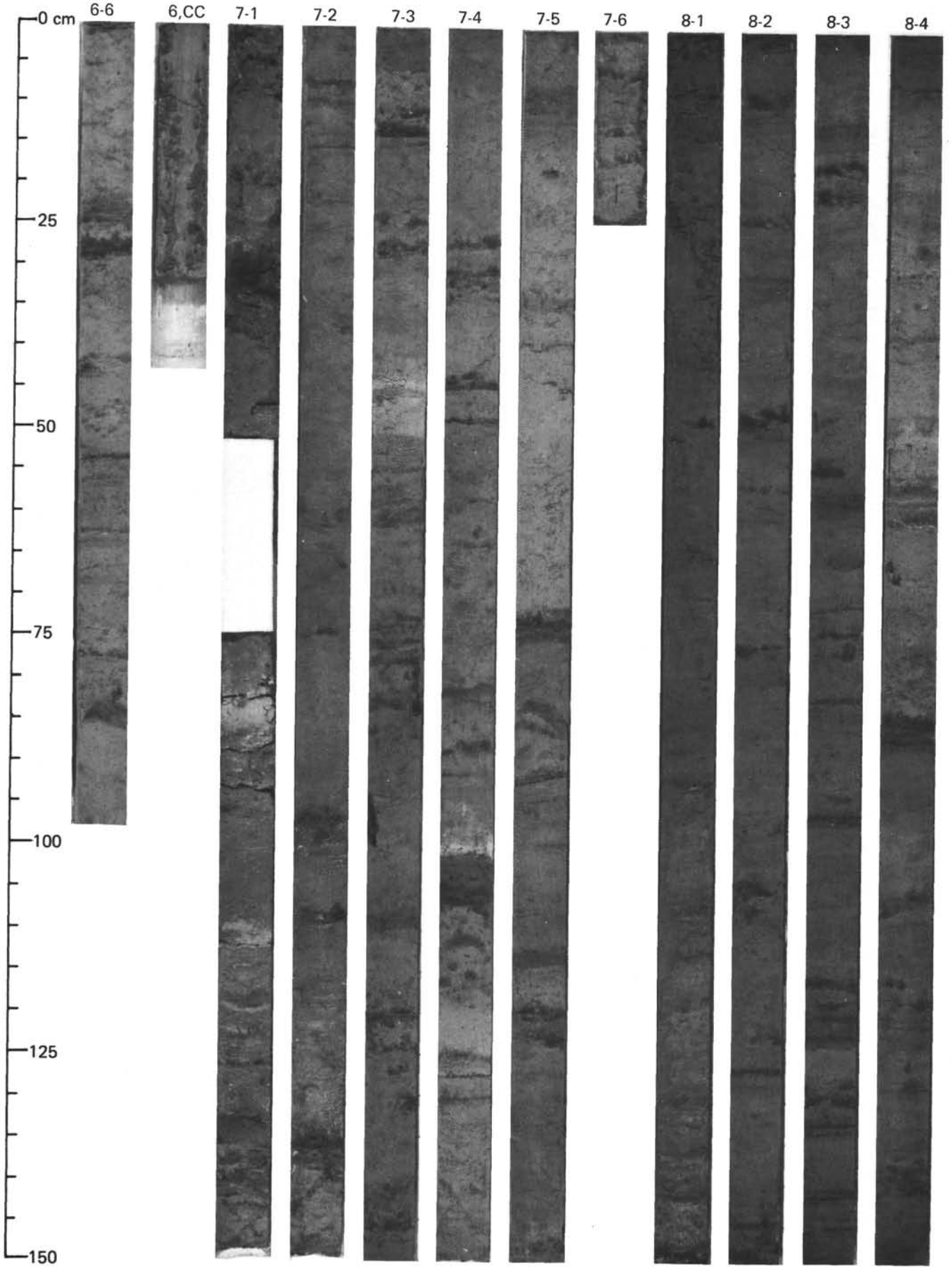
SMEAR SLIDE SUMMARY (%):

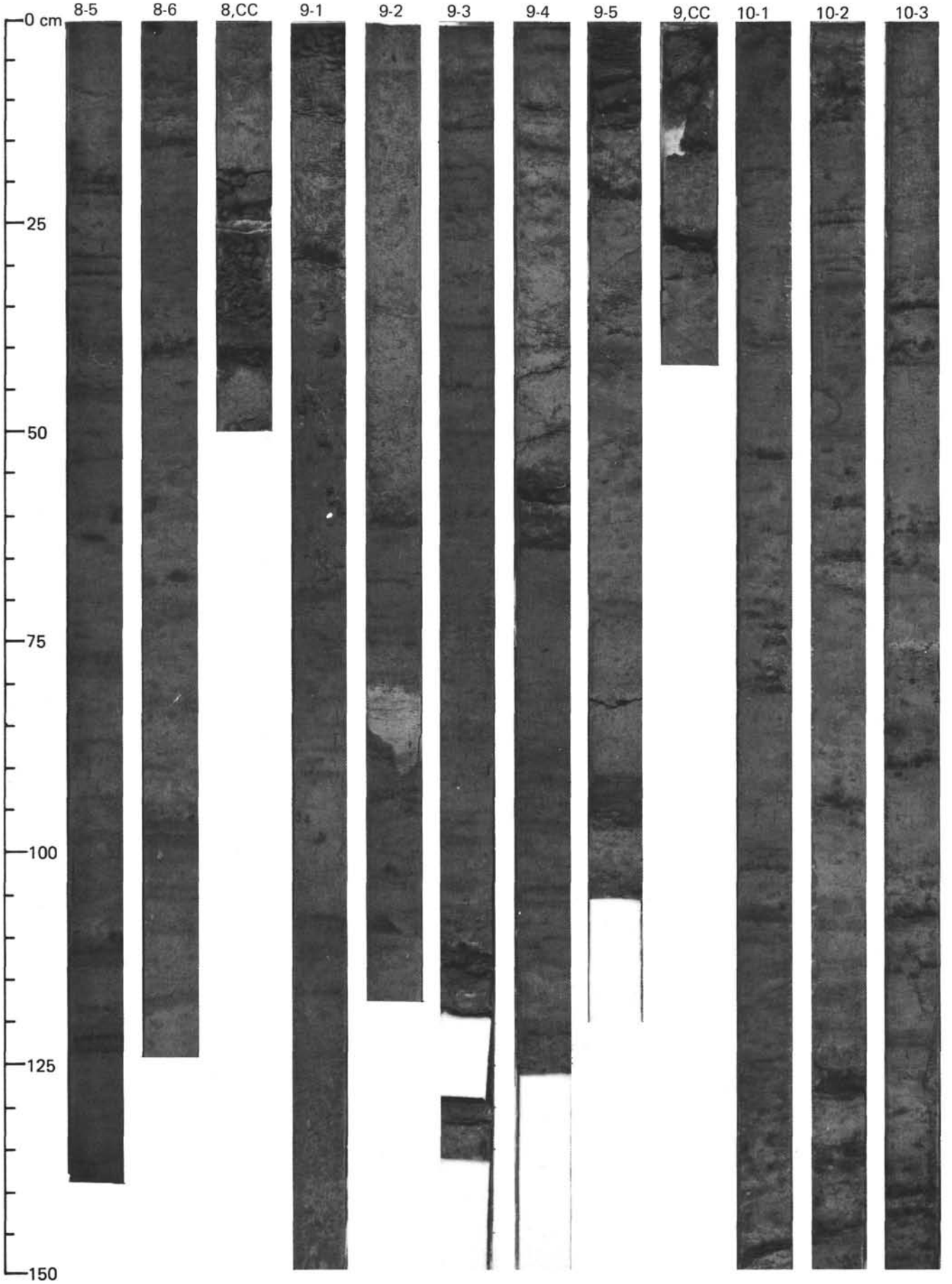
	2, 75 D	4, 128 D
Texture:		
Sand	10	25
Silt	20	15
Clay	70	60
Composition:		
Quartz	7	5
Mica	Tr	–
Clay	69	57
Volcanic glass	2	2
Diatoms	15	5
Radiolarians	7	30
Silicoflagellates	–	1

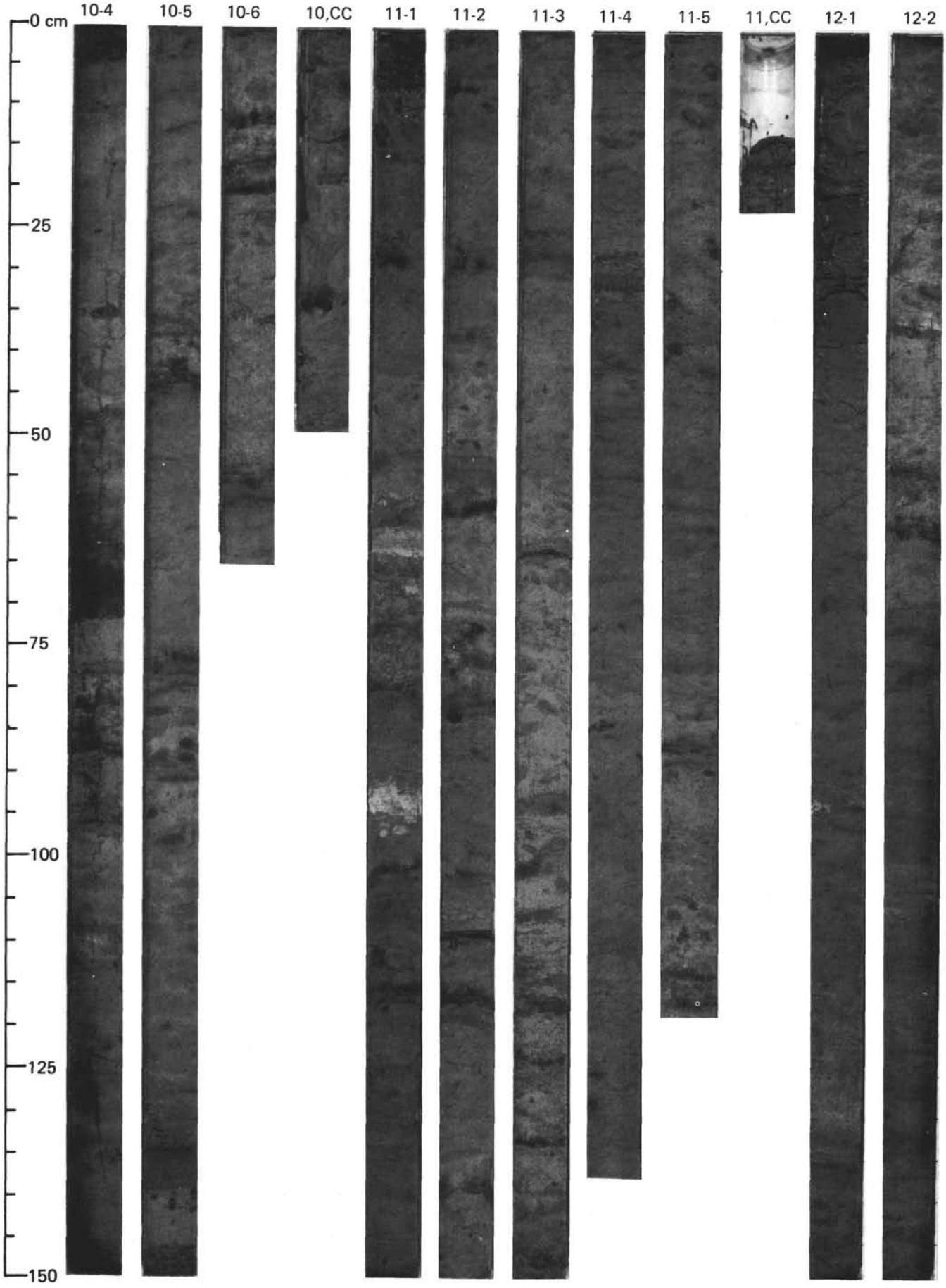

0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1,CC
2-1
2-2
2-3
2-4
2-5
2-6
2,CC
3-1

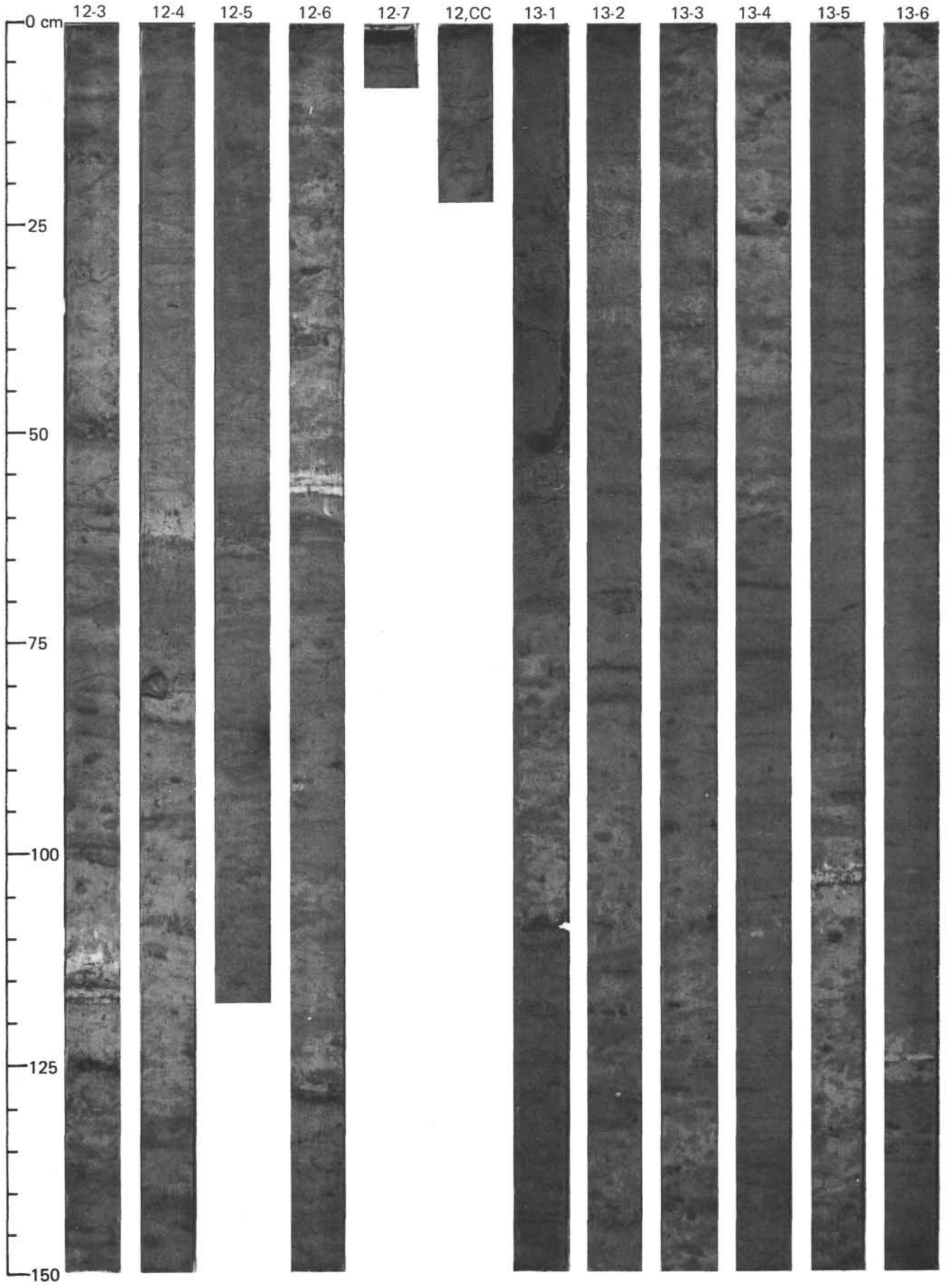

0 cm
25
50
75
100
125
150
3-2
3-3
3-4
3-5
3-6
4-1
4-2
4-3
4-4
4-5
4-6
4,CC

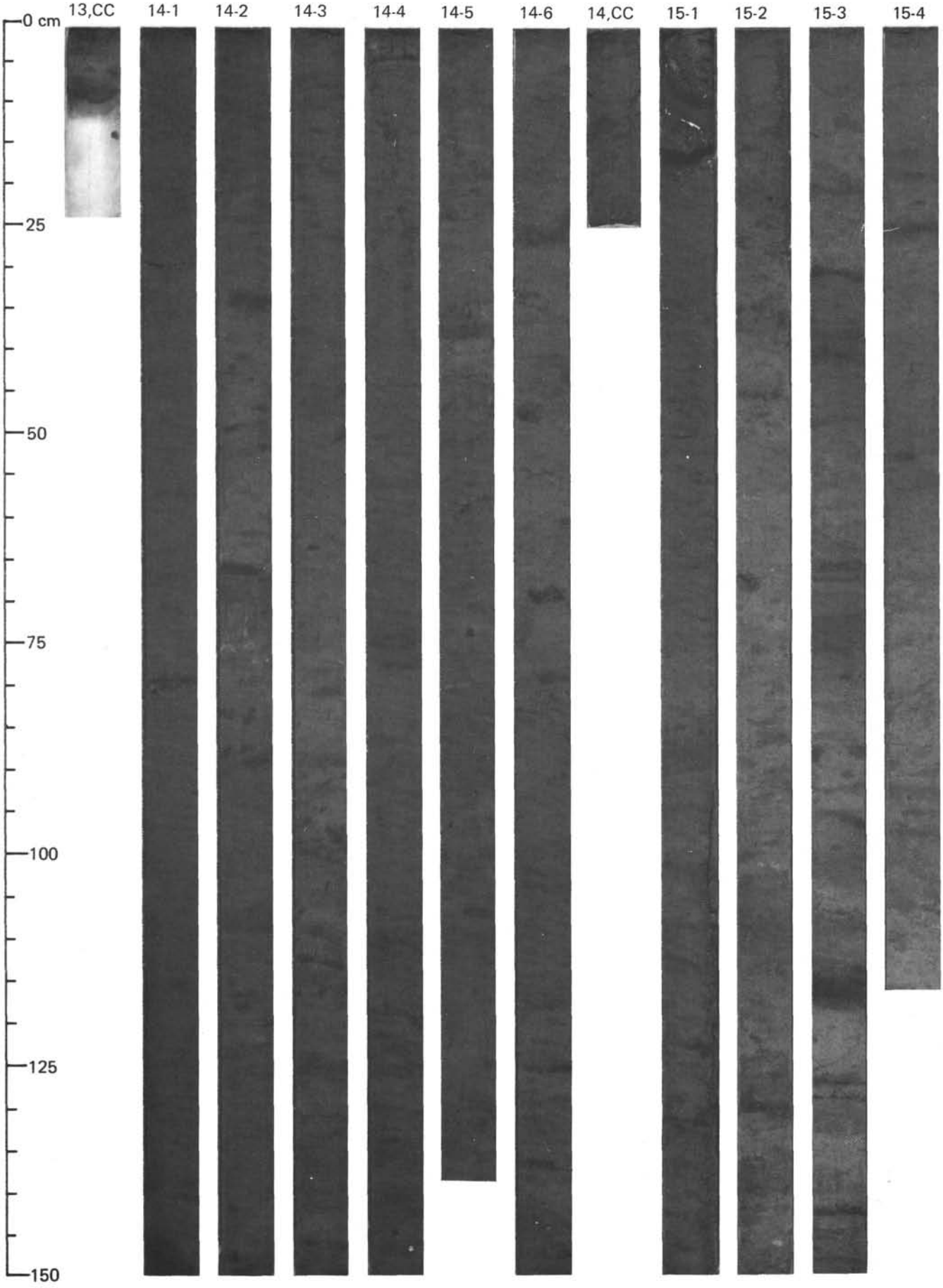

5-1
5-2
5-3
5-4
5-5
5-6
5,CC
6-1
6-2
6-3
6-4
6-5
0 cm
25
50
75
100
125
150

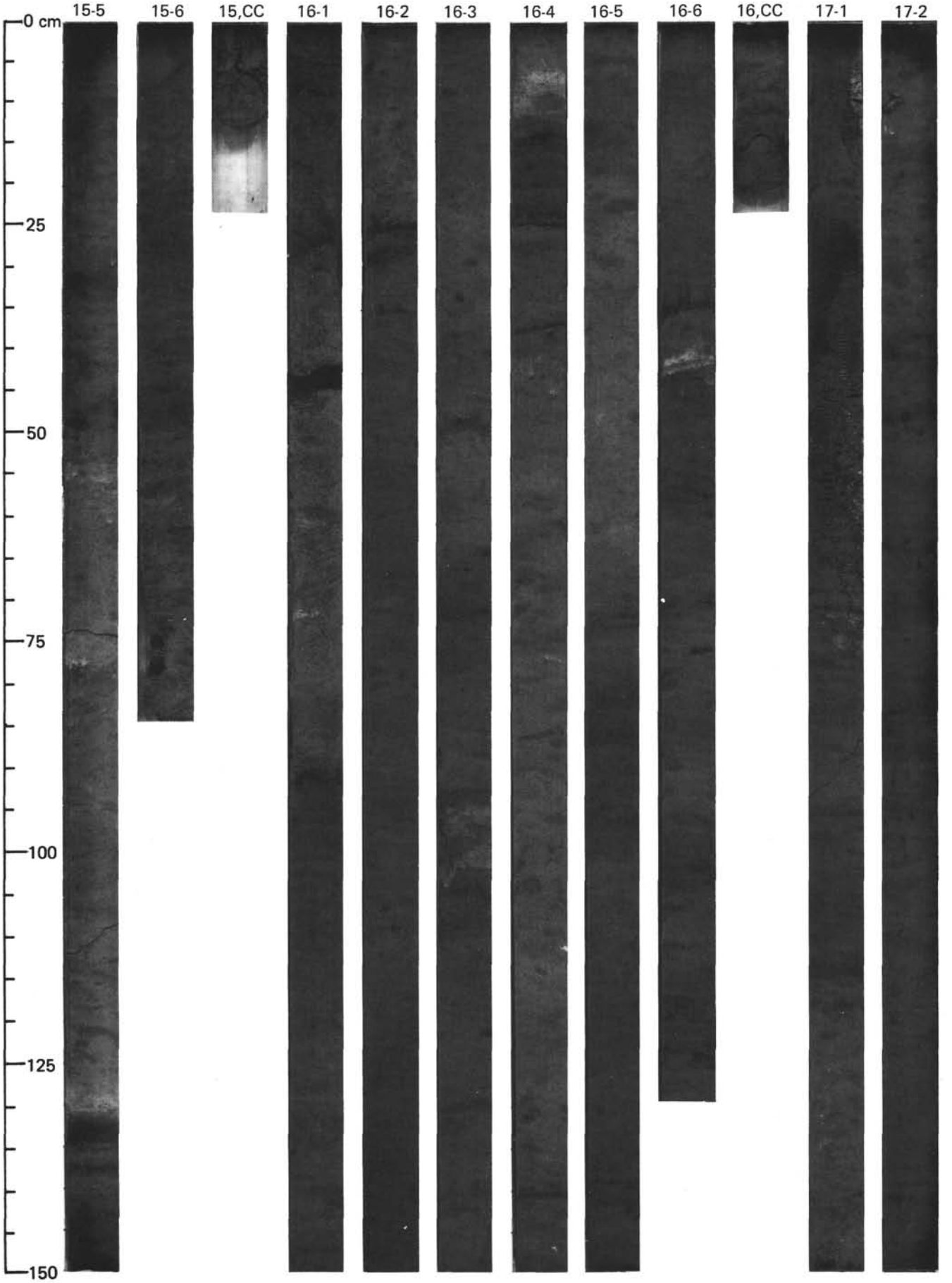

0 cm
6-6
6,CC
7-1
7-2
7-3
7-4
7-5
7-6
8-1
8-2
8-3
8-4
25
50
75
100
125
150

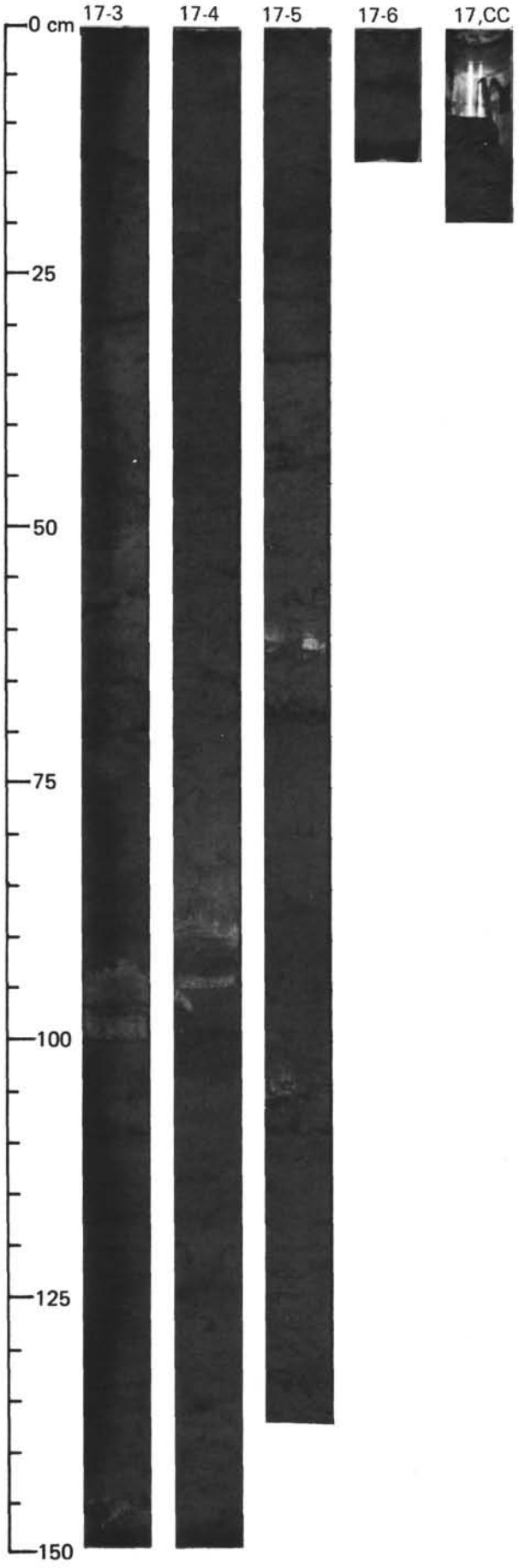

8-5
8-6
8,CC
9-1
9-2
9-3
9-4
9-5
9,CC
10-1
10-2
10-3
0 cm
25
50
75
100
125
150


0 cm
25
50
75
100
125
150
10-4
10-5
10-6
10,CC
11-1
11-2
11-3
11-4
11-5
11,CC
12-1
12-2


12-3
12-4
12-5
12-6
12-7
12,CC
13-1
13-2
13-3
13-4
13-5
13-6
0 cm
25
50
75
100
125
150


13,CC
14-1
14-2
14-3
14-4
14-5
14-6
14,CC
15-1
15-2
15-3
15-4
0 cm
25
50
75
100
125
150


15-5
15-6
15,CC
16-1
16-2
16-3
16-4
16-5
16-6
16,CC
17-1
17-2
0 cm
25
50
75
100
125
150


17-3
17-4
17-5
17-6
17,CC
0 cm
25
50
75
100
125
150