4. SITE 508[1]

Shipboard Scientific Party[2]

HOLES 508, 508A

Date occupied: November 24, 1979

Date departed: November 24, 1979

Time on hole: 8 hr., 42 min. (Hole 508); 15 hr., 18 min. (Hole 508A)

Position (latitude; longitude): 0°32′N; 86°06′W

Water depth (sea level; corrected m, echo-sounding): 2782.8

Water depth (rig floor; corrected m, echo-sounding): 2792.8

Bottom felt (m, drill pipe): 2794.4

Penetration (m): 35.3

Number of cores: 9

Total length of cored section (m): 35.3

Total core recovered (m): 35.03

Core recovery (%): 99

Oldest sediment cored:
Depth sub-bottom (m): 35.3
Nature: Siliceous foraminifer nannofossil ooze
Age: 270–440 × 10^3 y.
Measured seismic velocity (km/s): 1.52

Basement:
Depth sub-bottom (m): 35.3
Nature: Basalt
Seismic velocity range (km/s): 5.38

Principal results: Six holes were drilled at Site 508. In Hole 508 we cored 35 meters of siliceous foraminifer nannofossil ooze with 99% recovery using the hydraulic piston corer. Semilithified sediment was recovered immediately overlying the basement in Holes 508 and 508C. The sediments do not show a decrease in biogenic silica content with depth and microfossil preservation is better than at the mounds sites. The sediment's pore-water chemistry suggests that there is little input of formation waters in this area of presumed recharge. At Hole 508B, basement drilling penetrated 10 meters with 5.1% recovery before drilling was terminated. The basalts recovered are fine- to medium-grained aphyric to sparsely plagioclase phyric. Alteration rims are common and contain smectites, zeolites(?), and iron-oxyhydroxides. Some samples are slightly altered throughout, but no evidence was found of unequivocal hydrothermal alteration.

Heat-flow measurements and pore-water sampling were conducted at Hole 508A.

HOLE 508B

Date occupied: November 25, 1979

Date departed: November 26, 1979

Time on hole: 14 hr., 26 min.

Position (latitude; longitude): 0°32′N; 86°06′W

Water depth (sea level; corrected m, echo-sounding): 2777

Water depth (rig floor; corrected m, echo-sounding): 2787.0

Bottom felt (m, drill pipe): 2786

Penetration (m): 59.5

Number of cores: 4

Total length of cored section (m): 20.5

Total core recovered (m): 4.39

Core recovery (%): 21.4

Oldest sediment cored:
Depth sub-bottom (m): 4.0
Nature: Siliceous foraminifer nannofossil ooze
Age: 270–440 × 10^3 y.
Measured seismic velocity (km/s): 1.52

Basement:
Depth sub-bottom (m): 43–59.5
Nature: Basalt
Seismic velocity range (km/s): 5.38

Principal results: The major purpose was to drill into basement. Sediments were washed to basement, but unfortunately drilling was slow. We abandoned the hole after 10.1 meters of basalt had been drilled with a meager recovery of 5.1%. A mudline core was taken. Total recovery of sediment plus basalt was 21.4%.

HOLES 508C, 508D, 508E

Date occupied: November 26, 1979

Date departed: November 26, 1979

Time on hole: 4 hr., 46 min. (Hole 508C); 2 hr., 48 min. (Hole 508D); 8 hr., 10 min. (Hole 508E).

Position (latitude; longitude): 0°32′N; 86°06′W

Water depth (sea level; corrected m, echo-sounding): 2777

Water depth (rig floor; corrected m, echo-sounding): 2787.0

Bottom felt (m, drill pipe): 2787.0

Total length of cored section (m): 9.5

Total core recovered (m): 1.94

Core recovery (%): 20.4

Oldest sediment cored:
Depth sub-bottom (m): 51.5
Nature: Foraminifer nannofossil chalk

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[1] Honnorez, J., Von Herzen, R. P., et al., *Init. Repts. DSDP*, 70: Washington (U.S. Govt. Printing Office).

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Principal results: Ten meters of sediment were cored above the basement in Hole 508C. This interval was inadvertently washed during Hole 508B drilling. Heat-flow measurements and pore-water sampling were conducted at Holes 508D and 508E.

BACKGROUND AND OBJECTIVES

Site 508 (Fig. 1) is located at about 0°32′N latitude and 86°06′W longitude, approximately 28 km south of the Galapagos Spreading Center and 4 km south of Site 507.

This site, a relatively low heat-flow region without mounds, was chosen to provide a comparison to the high heat-flow areas with mounds that had previously been studied. The existence of low heat-flow values in this area had been determined from a detailed survey south of the spreading center by Green et al. (1981). In addition, deep-tow surveys (Klitgord and Mudie, 1974; Lonsdale, 1977) show the site to be free of any mounds, such as are found to the north. Morphologically, the site is near the middle of a gently northward tilted block several kilometers wide and extending in an east–west direction. The steeper slopes forming the north and south borders of the block are probably fault-controlled.

In addition to the usual measurements of various physical properties and the routine gathering of paleontological and lithological observations, the following specific questions were addressed at Site 508:

1) Is a layer of hydrothermal material present in the sediment column away from the mounds as Natland et al. (1979) have postulated?

2) How do the stratigraphy, lithology, and other sediment properties from a nonmound, relatively low heat-flow area compare with properties of a high heat-flow mounds area?

3) How do variations with depth of heat flow and pore-water chemistry compare with variations of these properties in the mounds area?

4) Are microfossils better preserved in the pelagic sediments of this area than in the pelagic sediments located in the mounds?

OPERATIONS

After successfully completing the scientific objectives at Site 507, the *Glomar Challenger* travelled 2.2 miles on a course of 210° true to Site 508, a nonmounds area of relatively low heat flow. A beacon was dropped at 0022 hr. local time (0522Z) on November 24, 1979 (Fig. 2). No detailed site survey was performed.

A total of six holes were drilled at Site 508 (Table 1). Their offset positions relative to the beacon and their spud-in times are as follows:

Hole	Offset Position (feet from beacon)	Spud-in Time
508	0 N, 0 E	0848 hr. (Nov. 24)
508A	0 N, 0 E	1918 hr. (Nov. 24)
508B	2720 S, 1270 W	1036 hr. (Nov. 25)
508C	2670 S, 1270 W	0214 hr. (Nov. 26)
508D	0 N, 0 E	1047 hr. (Nov. 26)
508E	0 N, 0 E	1335 hr. (Nov. 26)

Hole 508 was successfully cored to basement (35 m) with the hydraulic piston corer (HPC). The major pur-

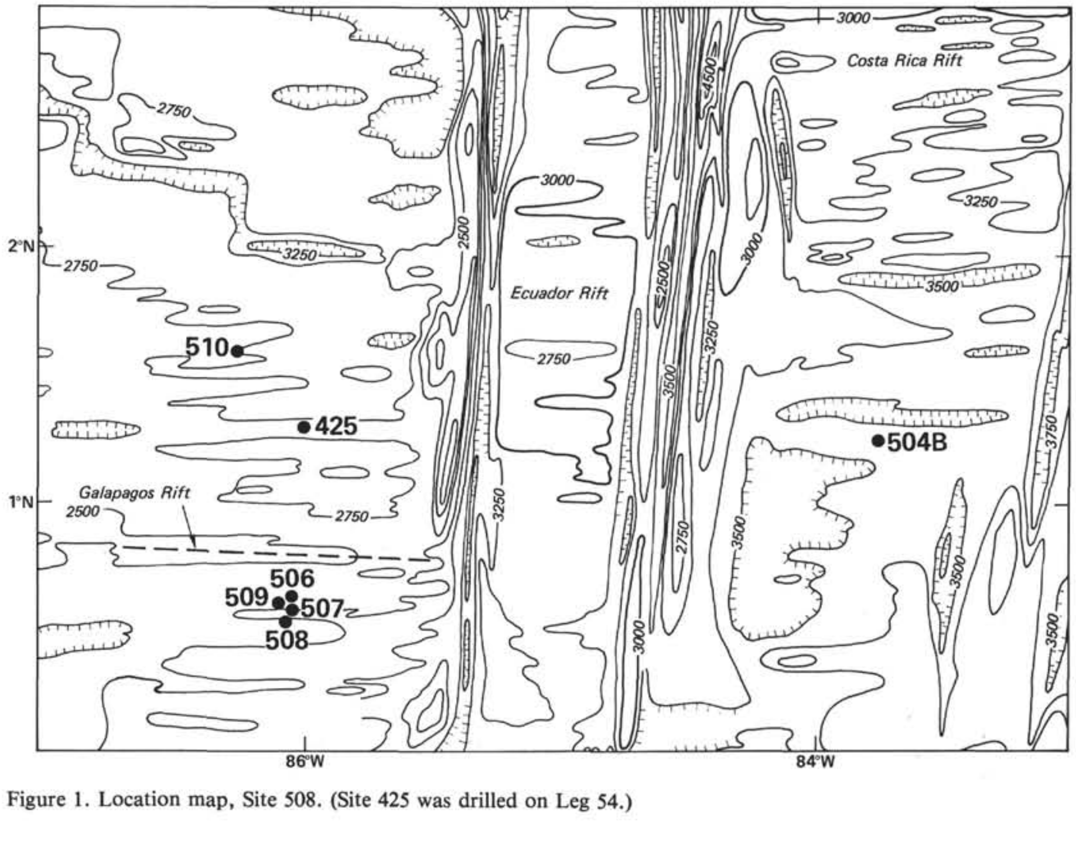

Figure 1. Location map, Site 508. (Site 425 was drilled on Leg 54.)

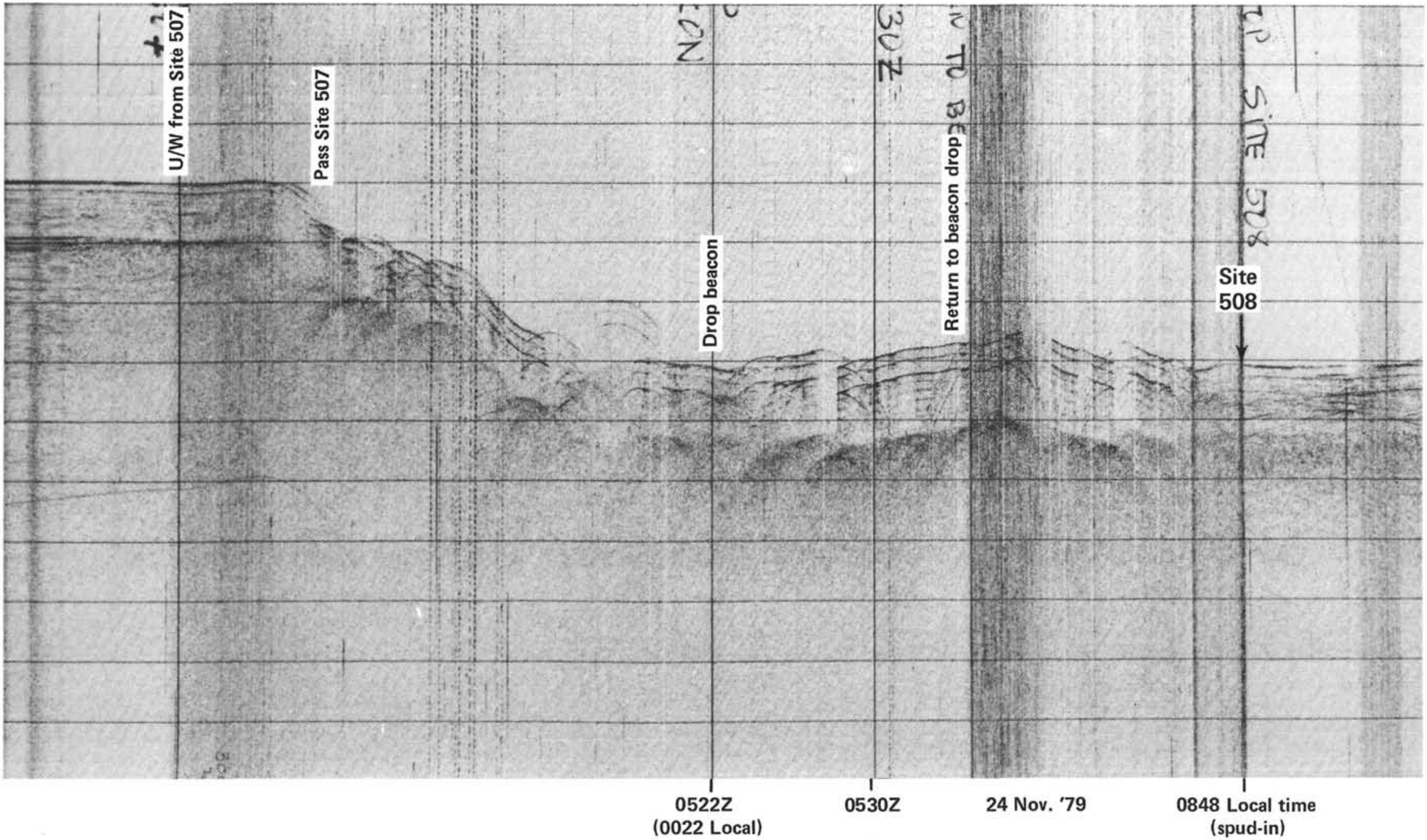

Figure 2. 3.5-kHz seismic record, Site 508.

Table 1. Coring summary, Site 508.

Core	Date	Time	Depth from Drill Floor (m) Top Bottom	Depth below Seafloor (m) Top Bottom	Length Cored (m)	Length Recovered (m)	Recovered (%)
Hole 508							
1	11/29/79	09.08	2794.4–2798.4	0.0–4.0	4.0	3.96	100
2	11/29/79	10.13	2798.4–2802.8	4.0–8.4	4.4	4.49	100
3	11/29/79	11.15	2802.8–2807.2	8.4–12.8	4.4	4.34	100
4	11/29/79	12.15	2807.2–2811.6	12.8–17.2	4.4	4.62	100
5	11/29/79	13.15	2811.6–2816.0	17.2–21.6	4.4	4.61	100
6	11/29/79	14.01	216.0–2820.3	21.6–26.0	4.4	4.58	100
7	11/29/79	14.53	2820.4–2824.8	26.00–30.4	4.4	4.8	100
8	11/29/79	15.52	2824.8–2829.2	30.4–34.0	4.4	3.98	90
9	11/29/79	17.50	2829.2–2829.7	34.8–35.3	0.5	0.05	10
Total					35.3	35.43	
Hole 508C							
1	11/26/79	0635	2829.0–2838.5	42.0–51.5	9.5	1.94	5

pose in drilling this hole was to sample and compare sediments, heat flow, and pore waters to the mounds sites.

Hole 508A was drilled for heat-flow and *in situ* pore-water studies. Temperature measurements were made at 12.6, 21.6, and 30.6 meters sub-bottom.

Hole 508B was drilled using the rotary drill bit. Since the major purpose was to sample basement basalts, sediments were washed to the basement, where we proceeded to drill. Unfortunately, drilling was slow (1.08 m/hr.) because the fractured nature of the rock caused torquing and jamming of the drill string. While we were abandoning the hole, the drill string became stuck for 10 minutes before it was freed.

In Hole 508C, 10 meters of sediment were cored above the basement contact using conventional drilling techniques. This interval was inadvertently washed during Hole 508B drilling, when increased resistance was thought to mean that the drill bit had made contact with basement. Pump pressure was increased and consequently only a water core was sampled.

Holes 508D and E were drilled for heat-flow and pore-water studies. The pore-water results for Hole 508D were unsatisfactory, and the experiments were run again in Hole 508E. In Hole 508E *in situ* temperature measurements were taken at 13.6, 23.6, and 27.6 meters, with pore waters sampled between 13.6 and 23.6 meters sub-bottom.

The *Glomar Challenger* was underway at 2145 hr. (local time), November 26, 1979, heading to Site 509.

SEDIMENT LITHOLOGY AND STRATIGRAPHY

Site 508 was located in a nonmounds area. Here we recovered only pelagic oozes in all three rotary core holes drilled (Fig. 3). The greatest recovery was from Hole 508, where 34.8 meters of sediment were penetrated before coring was terminated. In Hole 508B a few meters of surface sediment were recovered in a mudline core. The hole was washed down to a presumed basement at 43 meters depth. However, the next 8.5 meters of core contained a single chalky pebble, after which the drill bit encountered true basement. Hole 508C was washed down to near basement. Two meters of slightly indurated foraminifer nannofossil ooze were recovered.

The upper 33 meters of sediment at Hole 508 consist of dark and light greenish gray (5GY 4/1 to 5GY 8/1) and olive gray (5GY 5/2) siliceous nannofossil ooze. The main constituents, as estimated from smear slides are as follows: nannofossils 30–60%; diatoms 8–20%; radiolarians 3–15%; and foraminifers 1–10%. The total content of siliceous microfossils varies from 10 to 35%, usually averaging more than 20%. The foraminifer content in most cores is less than 5%. Trace amounts of pelagic brown clay are also present. The uppermost few centimeters of sediment in the hole is the brown pelagic ooze (5YR 4/1) observed in previous holes. Volcanic glass shards (brown or colorless) are present in trace amounts throughout the sedimentary section, but no single zone of volcanic glass enrichment was observed.

The oozes are commonly mottled as a result of bioturbation. Burrows, in particular Zoophycus, are present throughout all cores. In some cases, burrows contain blackish clumps of material (< 1 cm) which are enriched in very fine-grained opaque material of possible organic origin (e.g., Sample 508-2-2, 80–85 cm). Sediments in Cores 4 to 8 had a strong H_2S odor and contain trace amounts of microscopic opaque globules and cubes (less than 4–20 μm in size). The microglobules, which infill microfossils and are associated with burrows, have a yellowish metallic appearance in reflected light and are probably pyrite.

In one burrow where sulfide enrichment is observed (508-4-1, 89 cm) brownish green clay is also present. The clay particles are similar to the green hydrothermal clay.

The lowest 2 meters of the sedimentary section consist of grayish green (5GY 6/1) foraminifer nannofossil ooze. Relative to overlying sediments, they display an enrichment in foraminifers (20%) while siliceous microfossils are absent. Although the sediments are generally soupy as a result of drilling, a very firm but friable layer of recrystallized, finely granular carbonate chalk is present in Sample 508-8-3, 53–61 cm. This layer also contains minor amounts of foraminifers, nannofossils, volcanic glass, and sulfides. Between 61 and 64 cm, one fragment of well-lithified chalk is thinly coated with clinoptilolite crystals (see X-ray Diffraction Analysis, this chapter).

BIOSTRATIGRAPHY

Site 508 is located in a low heat-flow region. Forty-one meters of pelagic sediments were recovered at three holes (508, 508B, 508C), the deepest penetration of sediment being 34.9 meters at Hole 508. The relative abundance of calcareous nannofossils, foraminifers, diatoms, radiolarians, and silicoflagellates was determined by examining samples from 24 intervals (see core description). Only calcareous nannofossil and planktonic foraminifers were used for age determinations. Basal sediments are assigned to the *Gephyrocapsa oceanica* Zone (0.27 to 0.44 Ma). The presence of the planktonic foraminifer *Pulleniatina finalis* substantiates this late-Pleistocene age, although no zonal assignment was possible with this microfossil group.

Calcareous Nannofossils

The calcareous nannofossils are well preserved throughout the section (Table 2). In the basal sediments *Gephyrocapsa oceanica*, small *G.* spp., *Helicoponto-*

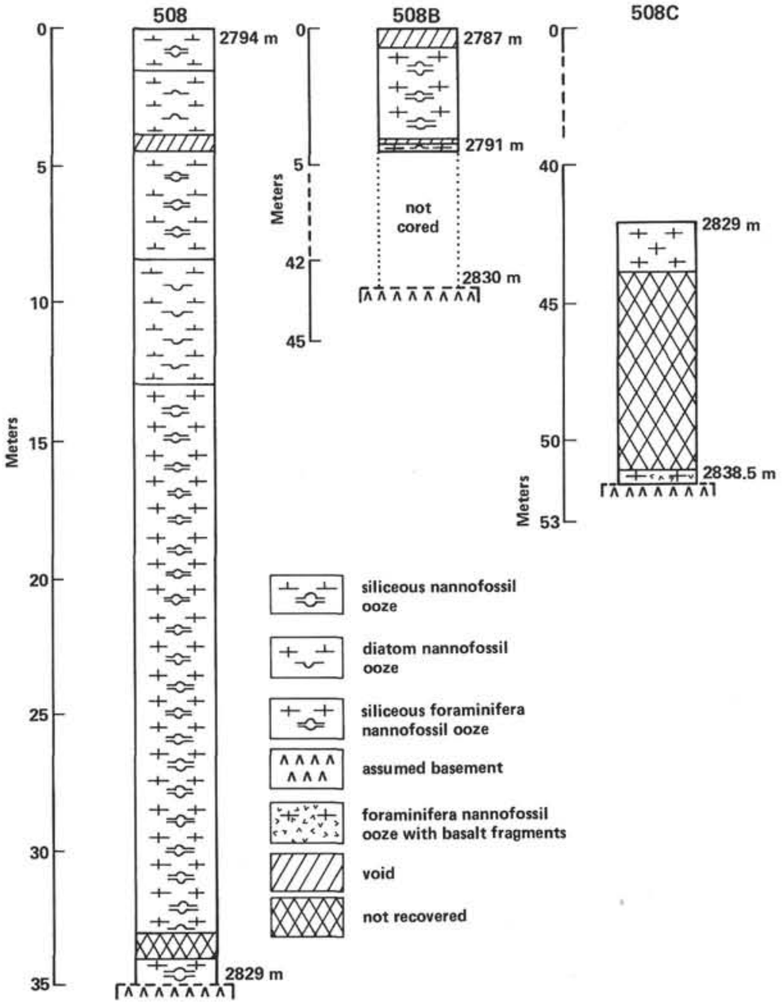

Figure 3. Lithostratigraphic summary, Site 508.

Table 2. Biostratigraphic sample locations, Site 508.

Sample (interval in cm)	Fossil Character Fora-minifers	Nanno-fossils	Radio-larians	Diatoms	Siliceous
Hole 508					
1-3, 66–68	CH	AG	CM	AM	RG
2-3, 106–108	CM	AM	FG	CM	RG
3-3, 103–105	CG	AG	FG	CP	B
4-3, 103–105	CG	AG	FG	CM	B
5-3, 103–105	CM	AM	CM	CM	B
6-3, 103–105	CM	AM	RM	FM	B
7-3, 98–100	CH	AG	CM	CM	B
8-3, 45–47	AG	AG	B	B	B

Note: Abundance: R = Rare, F = Few, C = Common, A = Abundant, B = Barren; Preservation: P = Poor, M = Moderate, G = Good.

Table 3. X-ray diffraction analysis, Site 508.

Sample (interval in cm)	Mineral	Major Peak (uncorr.) 2θ	d(Å)	Major Peak (corr.) 2θ	d(Å)
508-8-3, 60–61 (white crust or carbonate mudstone)	Calcite	39.2	2.30	39.4	2.29
	Calcite	35.7	2.51	35.9	2.50
		33.3	2.69	33.5	2.67
	Clinoptilolite	29.6	3.02	29.8	3.00
	Calcite	29.1	3.07	29.3	3.05
	Clinoptilolite	22.8	3.90	23.0	3.87
508B-1-3, 70 (MnO or consolidated nannofossil ooze?)	Calcite	29.1	3.07	29.3	3.05
	Sylvite	28.1	3.17	28.3	3.15
	(internal std.)	25.25	3.16	25.45	3.50

sphaera kamptneri, and *Cyclococcolithina leptopora* dominate the nannofossil assemblages. Rarely occurring are *Ceratolithus cristatus* and reworked discoasters.

Planktonic Foraminifers

The assemblages of planktonic foraminifers are about the same as those seen at all preceding sites, except for the rare occurrence of *Hastigerinella digitata* and an increase in the abundance of *Sphaeroidinella dehiscens.*

X-RAY DIFFRACTION ANALYSIS

The same sample preparation techniques were followed at Site 508 as had been used at Site 506. Results are summarized in Table 3.

Results

Calcite is the dominant mineral identified in all the pelagic ooze samples. The thin white crust coating a piece of carbonate mudstone from Section 508-8-3 contains calcite and clinoptilolite. This confirms the identification of clinoptilolite, which was made from a smear slide of the same material.

The sample of a Mn-oxide fragment from Sample 508-1-3, 70–71 cm showed only calcite peaks and appears to be consolidated ooze rather than a Mn-oxide concretion. However, it should be noted that Mn oxides are commonly amorphous and poorly crystallized and thus may not show any X-ray diffraction patterns.

SEDIMENTATION RATES

Table 4 summarizes estimates of sedimentation and accumulation rates for Site 508. Sedimentation and accumulation rates are similar to the off-mounds areas at Sites 506, 507, and 509. This supports the concept that a fairly uniform sedimentation pattern exists over the entire study area.

Table 4. Sedimentation rates, Site 508.

Hole	S^a	Sedimentation Rates (cm/10^3 y.)		P^b (%)	Sediment Accumulation Rate (cm/10^3 yrs.)		Average Grain Density (g/cm^3)	Accumulation Rate (g/cm^2/ 10^3 y.)	
		A	B		A	B		A	B
508	35.3	8.02	4.84	80.9	1.53	0.925	2.68	4.10	2.48
(off-mound)		13.07			2.49			6.67	
(high heat flow)									

Note: Sedimentation accumulation rate = $[(1 - P) \times \text{sediment thickness}/t]$, where t = time. Accumulation rate = sedimentation accumulation rates × average grain density. Columns lettered "A" show minimum and maximum values based on paleontological evidence. Paleontological evidence estimates the age at the bottom of each hole to be 270–440 × 10^3 y. Columns lettered "B" are values based on spreading rates taken from Klitgord and Mudie (1974). Spreading rate estimates assign an age of approximately 540 × 10^3 y. for the ocean crust in the area.

[a] S = Sediment thickness (recorded drilling thickness).

[b] P = Porosity (fractional void space) = (void space)/(total volume); values are averages taken from the Physical Properties section.

PORE-WATER GEOCHEMISTRY

Pore waters were sampled in three ways. Most samples were taken using the standard centrifugation technique described in the Site 506 summary. Six sediment sections were sampled both by centrifugation using 50 cm^3 tubes and spinning several days after collection and by squeezing in an N_2 glove bag (samples were squeezed primarily for He; Si was analyzed in excess water collected during the procedure). Results are summarized in Figure 4 and Tables 5, 6.

There are three results which come out of the calcium and magnesium data. First, the Ca and Mg concentrations of centrifuge samples down to 30 meters are close to bottom water values. This result was expected in this area of relatively low heat flow and presumed recharge. Second, the Ca concentrations of centrifuge samples rise below 32 meters. This may reflect diffusion of Ca out of basalt against downward advection and in a one dimensional model would imply a downward flow rate of about 0.5 cm/y.

Third, the *in situ* samples taken at this station are both enriched in Ca and depleted in Mg to an extent similar to that of mounds samples. This result is taken as indicating the presence of some formation water well up into the sediment section. The *in situ* results also cast some uncertainty on the validity of the Ca and Mg pore-water concentrations inferred from pore waters collected by centrifugation. This question will be discussed further in the Sites 506–509 summary (see Pore-Water Summary, Site 509).

In Hole 508, silica concentrations, about 600 μM/l, are typical for pelagic sediments of the region. Si decreases near the base of the sediments, perhaps reflecting the presence of Si-poor pore waters in the basement.

A slight sulfide odor was present in the cores. The NH_3 concentration reached nearly 60 μM/l, the highest value found in Site 506–509 samples. The decrease in NH_3 with depth may reflect transient state conditions

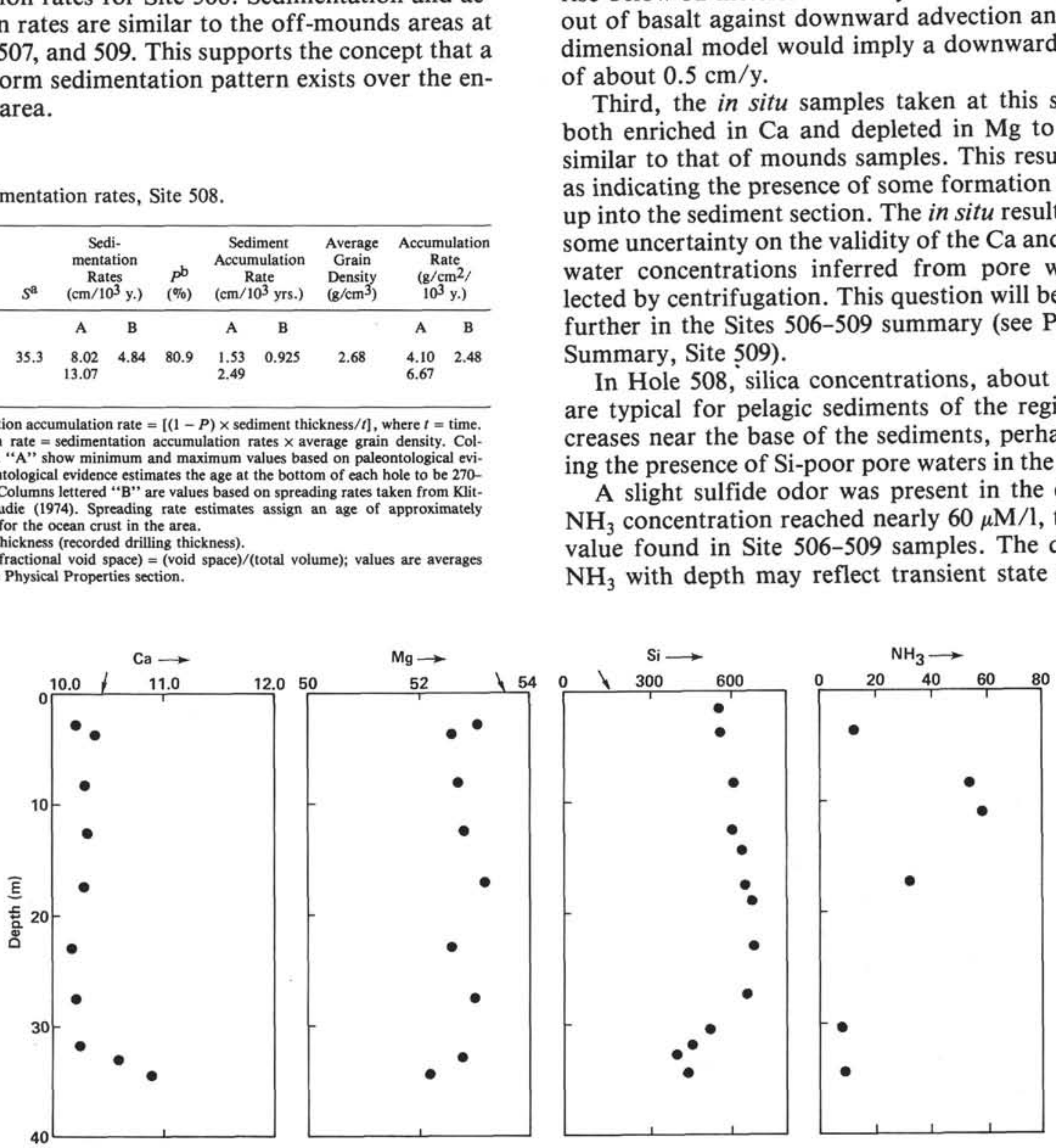

Figure 4. Pore-water chemistry of Hole 508 samples. (Ca and Mg in mM/l; Si and NH_3 in μM/l. Arrows indicate bottom water concentrations.)

Table 5. Shipboard pore-water data, Holes 508, 508C.

Core-Section	ISPW No.	Sub-bottom Depth (m)	SiO_2 (µM)	PO_4 (µM)	NH_3 (µM)	Ca^{2+} mM	Mg^{2+} mM	Cl (‰)	S (‰)
Hole 508									
1-1	90	1.39–1.50	550						
1-2	91	2.89–3.00				10.23	53.06	18.5	34.9
1-3	92	3.70–3.80	560		13	10.38	52.55	19.2	35.2
2-1	93	5.39–5.50							
2-2	94	6.89–7.00	570	804					
2-3	95	8.28–8.39	610		54	10.30	52.70	18.97	34.9
3-1	97	9.79–9.90							
3-2	98	11.29–11.40	610	860	58				
3-5	96	12.53–12.64	610			10.34	52.83	18.38	34.6
4-1	99	14.19–14.30	640						
4-2	100	15.69–15.80	560	920					
4-3	101	17.16–17.27	650		32	10.29	53.19	18.45	34.6
5-1	102	18.59–18.70	660						
5-2	103	19.79–19.90	550	910					
5-3	104	21.54–21.65							
6-1	105	22.95–23.06	660			10.17	52.52	18.35	34.4
6-2	107	24.49–24.60	610	840					
6-3	108	25.88–25.99							
7-1	109	27.39–27.50	650			10.24	52.96	18.80	34.9
7-2	110	28.89–29.00	510	830					
7-3	111	30.18–30.29	520		8				
8-1	112	31.79–31.90	460			10.25			
8-2	113	33.00–33.10	400			10.59	52.76	18.20	34.6
8-3	114	34.57–34.68	440		9	10.89	52.17	18.41	34.9
Hole 508C									
1-1	116		250			10.51			
1-2	117		190			10.01			

Table 6. Shipboard pore-water data for *in situ* samples, Site 508.

Sample	SiO_2 (µM)	Depth Sub-bottom	Ca^{2+} mM	Mg^{2+} mM	Cl (‰)	S
1W 106 ISPW #8	720	Site of 508 25 ± 2 m	10.98	51.64	18.83	34.9
1W 115 ISPW #10	660	Site of 508 16 ± 2 m	10.97	51.76	18.11	34.4

with respect to flow through the sediments or NH_3 incorporation into clay minerals.

PHYSICAL PROPERTIES

Sediments at Site 508 are only pelagic. Their wet-bulk density ranges from 1.27 to 1.46 g/cm³, porosity from 74.2 to 87.1%, sonic velocity from 1.50 to 1.55 km/s, and thermal conductivity from 0.85 to 1.00 W/m•K, respectively. Variations of these physical properties with respect to depth are similar to those of Site 507.

HEAT FLOW

Three lowerings of the downhole temperature instrument/pore-water sampler were made into undisturbed sediments near the location of Hole 508, owing to the failure of the pore-water sampler on the first two lowerings. Allowing for an imprecision of 0.05 to 0.1°/m, the gradients increase significantly with depth, characteristic of hydrothermal recharge through the sediments. As at Sites 506, 507, and 509, thermal conductivity measurements on Site 508 showed a significant increase of sediment conductivity with depth (Karato and Becker, this volume; Becker et al., this volume). Fits of temperature data to a steady-state pore-water migration equation, modified for the increase of conductivity with depth, yield surface heat flows and recharge rates of about 90 mWm^{-2} and 1×10^{-6} cm/s at Hole 508A, 230 mWm^{-2} and 0 cm/s at Hole 508D, and 76 mWm^{-2} and 1.7×10^{-6} cm/s at Hole 508E (Becker et al., this volume).

IGNEOUS PETROLOGY AND LITHOSTRATIGRAPHY

Basalt was recovered from two holes (508B and 508C) at Site 508 (Table 7). Three fragments of basalt were recovered in the core catcher of the hydraulic piston corer in the final core above basement at Hole 508C. Hard-rock drilling was attempted at Hole 508B. As a result of the same basement characteristics as at Sites 506 and 507, penetration (10.0 m) and recovery (5.1%) were poor.

The basalts recovered at Hole 508C are fine-grained moderately plagioclase phyric basalts. Pinpoint vesicles are scattered through the samples. Glassy rims occur in one sample on two sides and in a second sample on one side of the piece. Almost all these basalt samples have an alteration rim where vesicles are coated by a blue clay mineral. It is assumed that these samples represent pieces from the rubble layer overlying the basement as mentioned for Leg 54 and Site 506 basalts. Arguments for this assumption are (1) the almost complete alteration of the samples, suggesting a moderately to intense interaction between the basalts and seawater; (2) the occurrence of glassy rims at one or two sides of the samples, indicating a chilling of small units on the seafloor; and (3) the drilling characteristics of these units.

At Hole 508B, the basalts are fine- to medium-grained aphyric to moderately plagioclase phyric. Numerous pinpoint- to 1-mm diameter vesicles are scattered through all the samples. These vesicles are empty in the fresh basalt. Most of the samples are surrounded by an alteration rim. Secondary pyrite occurs as patches on the wall of a 6-mm diameter vug. Glassy rims occur on Piece 38 (on one side) and Piece 45 (on two sides).

Given the lack of oriented samples or significant differences in grain size or degree of vesiculation, no cooling units could be defined.

In thin section two textural types of basalt were observed: (1) glomerophyric, and (2) hyalopilitic. The former, Sample 508B-3-1 (Piece 39), is a moderately plagioclase clinopyroxene phyric basalt with 5% of often-zoned, lathy plagioclase and 3% of subhedral clinopyroxene which are intergrown, forming clusters. The groundmass consists of 45% plagioclase microlites, 32% anhedral clinopyroxenes or microlites, 8% opaques, and 4% glass.

The other thin section, Sample 508B-4-1 (Piece 44), has hyalopilitic texture with flow banding. The ground-

Table 7. Results of basalt coring activities, Site 508.

Hole	Sediment Thickness above Basalt (m)	Penetration into Basalt (m)	Recovery (%)
508B	51.5	10.1	5.1
508C	42.0	*	*

Note: * = fragments of basalt retrieved in core catcher of hydraulic piston corer.

mass of this fine-grained aphyric basalt consists of 42% plagioclase microlites, 35% anhedral lath plagioclase or microlites, 15% opaques, and 3% glass. Both thin sections show an alteration rind.

The grain size of opaque phases is proportional to the degree of undercooling as displayed by the morphology and texture of silicate minerals. Titanomagnetite, the dominant opaque mineral, ranges from a mean grain diameter of 20 μm in the medium-grained basalts to less than 5 μm in the glassy to variolitic samples. Secondary pyrite is commonly associated with green smectite in vesicle filling. Primary sulfide spherules are common (<5 to 10 μm) and consist of pyrrhotite. A few pyrrhotite spheres also have exsolved chalcopyrite.

Most of the samples are coated with a thin (<0.5 mm) blue, green, or brown material. One of them, Sample 508B-3-1 (Piece 40), shows a soft greenish gray, relatively thick (1 to 2 mm) coating.

On the sawn surfaces, it appears that all the samples have an altered rim, sometimes thick (maximum = 50 mm for a fragment retrieved in Sample 508C-1,CC). In these rims, vesicles are filled or coated by blue and/or green clay minerals. In the apparently fresh part of Sample 508B-3-1 (Piece 43) drusy zeolite(?) crystals occur in some vesicles; in the altered rim of the same sample, blue clay minerals appear to cap some other zeolite crystals.

Basement Alteration

Most samples are coated with a thin (<0.5 mm) blue, green, or brown material. Sample 508B-3-1 (Piece 40) shows a soft greenish gray, relatively thick (1–2 mm) coating.

On the sawn surfaces, it appears that all samples have an altered, sometimes thick rim (maximum = 50 mm for a fragment retrieved in 508C-1,CC), where vesicles are filled with or coated by blue or green clay minerals. In the apparently fresh part of Sample 508B-3-1 (Piece 43), drusy zeolite(?) crystals occur in some vesicles. In the altered rim of the same sample, blue clay minerals appear to cap some other zeolite crystals. Microscopic examination reveals that smectite fills all of the vesicles and miarolitic voids in the altered rim. As at Site 507, a zonation of the alteration was observed in Sample 508B-4-1 (Piece 44). The alteration here is, however, the following:

1) Fe-hydroxide + green smectite + brown smectite(?);
2) green smectite;
3) pale brown smectite;
4) void.

Such a zonation has already been mentioned in the Leg 69 (Hole 504B) site summaries, and has been explained by processes of nonoxidative and then oxidative low-temperature diagenesis.

Thus, alteration of basalts at Site 508 slightly differs from alteration of those at Sites 506 and 507 by the formation of zeolite(?) minerals in some vesicles, by the greater amount of smectite, and by the greater thickness of the altered rim. As at Sites 506 and 507, there is no sign of hydrothermal alteration.

Physical Properties (basement)

The wet-bulk density, porosity, and sonic velocity of basalt Sample 508B-4-1, 5–7 cm were measured. The wet-bulk density is 2.90 g/cm^3, porosity is 7.0%, and sonic velocity is 5.4 km/s.

BASEMENT PALEOMAGNETISM

Site 508 was drilled about 30 km south of the Galapagos Spreading Center, and its magnetic anomaly age is about 0.85×10^6 y. As a result of drilling difficulties similar to those experienced at Sites 506 and 507, only one oriented and one unoriented minicore were sampled for shipboard paleomagnetic investigations. The paleomagnetic measurements and the discussions associated with the results are essentially identical to those of Site 506. The uncertainties below, associated with mean values of the magnetic parameters, represent one standard deviation.

$\overline{J}_{NRM} = 13 \pm 1 \times 10^{-3}$ gauss (G)

$\overline{\chi} = 0.88 \pm 0.01 \times 10^{-3}$ G/Oe.

$\overline{Q} = 45 \pm 3$, illustrating that at Site 508, too, remanence is dominant over induced magnetism.

The NRM inclination of the oriented sample is $-4°$.

Though few, the magnetic results at Site 508 are consistent with the observed high-amplitude magnetic anomalies and the proximity of the site to the equator.

CONCLUSIONS

Site 508 is located at approximately 0°32′N latitude and 86°06′W longitude, about 28 km south of the Galapagos Spreading Center and 4 km south of Site 507.

Hole 508 was continuously cored through 34.8 meters of pelagic sediment. Average sediment recovery was 99%. In Hole 508B only a mudline core was recovered after which the bit was washed down to the basement. Basement drilling was attempted with only 10 meters penetration and 5.1% recovery. After slow penetration and torquing, the hole was abandoned after the drill bit had jammed. Hole 508C was drilled within 15 meters of Hole 508B with the purpose of recovering the sediments overlying the basement. Heat-flow measurements were carried out at Holes 508A, 508D, and 508E.

Hole 508 was cored 35 meters into the sediment cover, which is made up of siliceous foraminifer nannofossil ooze. It is not certain that the basement was reached. However, no basaltic fragment was found in the core catcher of the lowest core of this hole. Holes 508B and 508C were drilled through 51.5 meters of sediments similar to those of Hole 508. The recovery of a 10-cm thick interval of semilithified sediments about 0.5 meter above the bottom of Hole 508 plus the presence of an indurated chalk pebble in the last core above basement of Hole 508B and of partly indurated sediment in the only core of Hole 508C indicate that several meters of at least partly lithified sediments directly overlie the basement.

When compared to sediments from other sites of this leg, those at Site 508 show the following differences:

1) The presence of lithified or semilithified pelagic oozes in the lowermost portion of the sediment column.

Diagenesis related to compaction is an unlikely explanation for the formation of such rock.

2) The sediments do not show a decrease in the amount of siliceous organisms toward the bottom of the sedimentary column. Site 508 sediments display the best microfossil preservation of all sites.

3) The presence of H_2S and traces of pyrite indicate that reducing conditions are present throughout much of the sedimentary cover of Site 508.

The fossil assemblages were essentially identical to those of Holes 506 and 507. Similarly, all of the physical properties were approximately the same as those of the pelagic sediments of Hole 507, in spite of the large difference between the thermal regimes of the two sites.

Three heat-flow measurements yielded relatively low values ranging from 76 to 228 mWm^{-2}, in agreement with the previous short-probe measurements from research vessels. Two of these measurements show an increasing temperature gradient with depth, possibly as a result of hydrothermal recharge at rates on the order of 10^{-6} cm/s.

Pore-water magnesium and calcium concentrations are close to bottom water values, suggesting that there is little input of formation waters in this area of presumed recharge. The relatively high ammonia concentrations found at this site are compatible with such conclusions.

Basement drilling was attempted at one hole (508B), with relatively poor results. As a result of the same drilling characteristics as at the previous mounds sites, both penetration (10 m) and recovery (5.1%) were poor. The basalts are fine- to medium-grained aphyric to sparsely phyric plagioclase. They are often partly surrounded by a dark alteration rim and a few samples are slightly altered throughout. The alteration consists of the deposition of smectites, unidentified zeolites, and Fe-oxyhydroxides in vesicles and pore spaces. No sign of unequivocal hydrothermal alteration could be found.

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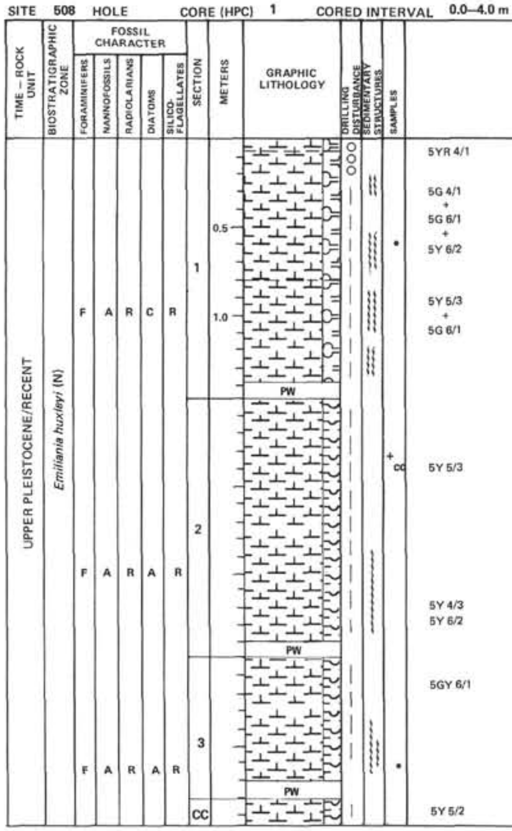
SITE 508 HOLE CORE (HPC) 1 CORED INTERVAL 0.0–4.0 m



LITHOLOGIC DESCRIPTION

FORAMINIFER SILICEOUS NANNOFOSSIL OOZE
Mottled, greenish gray, dark greenish gray to light olive gray siliceous nannofossil ooze. Large foraminifer are observed in the core. Mottling is due to bioturbation. The upper 5 cm is a brownish gray ooze. It is oxidized and marks the sediment water interface.

DIATOMACEOUS NANNOFOSSIL OOZE
In the lower sections diatoms are very abundant. All other characteristics of the sediment are the same.

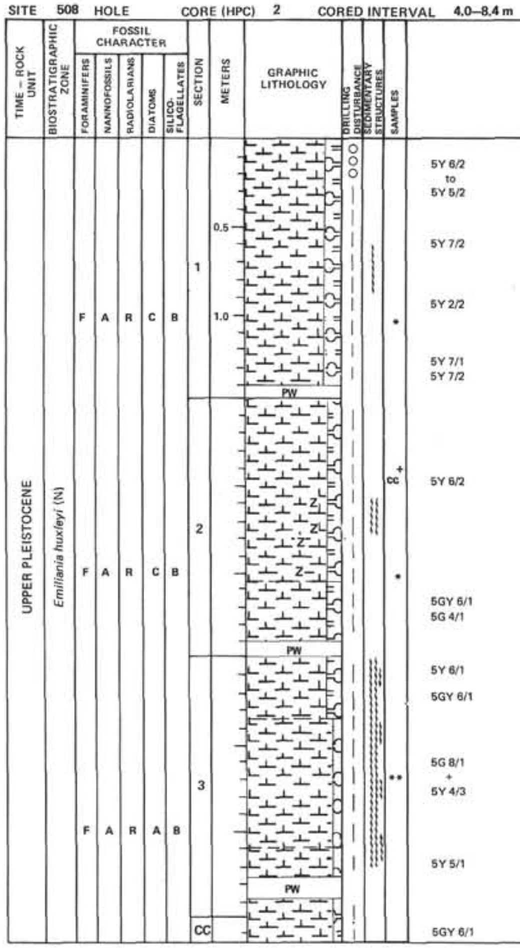
SMEAR SLIDE SUMMARY (%)

	1-60	3-60
COMPOSITION:		
Quartz	TR	–
Clay minerals	–	TR
Volcanic glass (light)	TR	–
Carbonate unspec.	8	2
Foraminifers	5	5
Calc. nannofossils	65	60
Diatoms	10	20
Radiolarians	10	8
Sponge spicules	2	5
Silicoflagellates	TR	TR

CARBON-CARBONATE (%)

	2, 32–34
Organic Carbon	3.69
Total Carbonate	62.0

SITE 508 HOLE CORE (HPC) 2 CORED INTERVAL 4.0–8.4 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE
Multicolor, light olive gray to olive gray siliceous nannofossil ooze. Bioturbation is well documented. Trace fossil include Zoophycus and a very large vertical burrow (0.1 cm wide by 80 cm long) which is cross cut by a zoophycus burrow (Section 3). Multicolored bands or thin beds of ooze are present in Section 2.

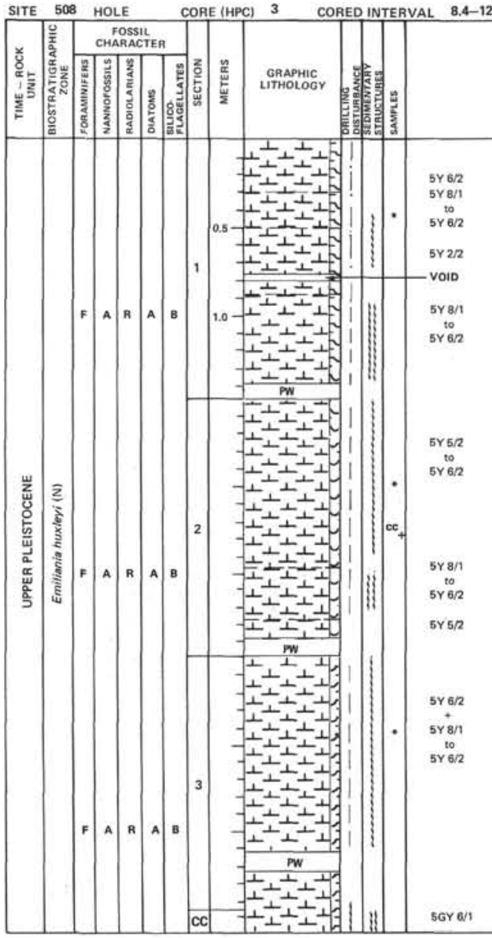
SMEAR SLIDE SUMMARY (%)

	1-101	2-101	3-68	3-68 (M)
COMPOSITION:				
Clay minerals	–	–	7	TR
Volcanic glass (light)	TR	TR	TR	TR
Zeolite	TR	–	TR	–
Carbonate unspec.	2	2	1	1
Foraminifers	3	5	3	5
Calc. nannofossils	75	75	75	75
Diatoms	13	10	10	13
Radiolarians	5	5	5	5
Sponge spicules	2	TR	2	–
Silicoflagellates	TR	TR	–	–
Opaques	–	TR	–	1

CARBON-CARBONATE (%)

	2, 40–42
Organic Carbon	1.49
Total Carbonate	52.0

SITE 508 HOLE CORE (HPC) 3 CORED INTERVAL 8.4–12.8 m



LITHOLOGIC DESCRIPTION

DIATOM NANNOFOSSIL OOZE

Light olive gray, olive gray to yellowish grey diatom nannofossil ooze. Many zoophycus burrows and mottles are present. Drilling disturbence is slight to moderate.

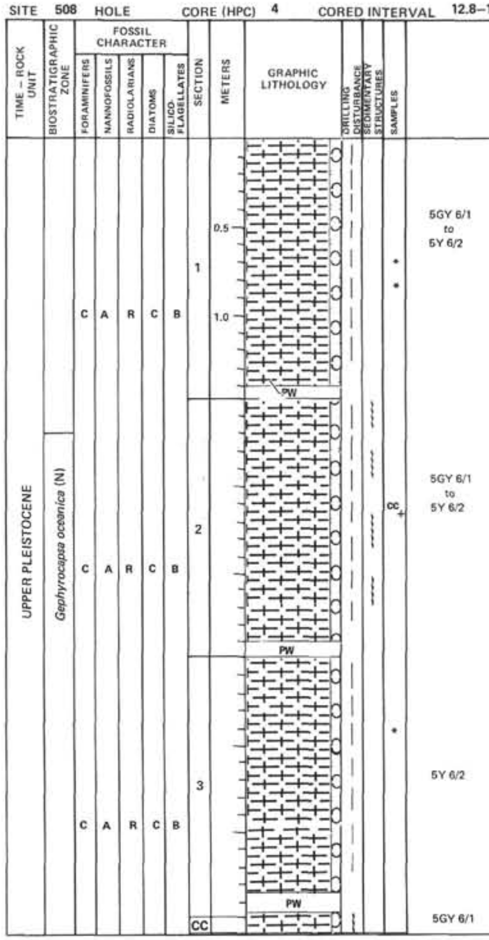
SMEAR SLIDE SUMMARY (%)

	1-44
COMPOSITION:	
Volcanic glass (light)	TR
Zeolite	TR
Carbonate unspec.	2
Foraminifers	1
Calc. nannofossils	80
Diatoms	15
Radiolarians	3
Sponge spicules	2
Silicoflagellates	TR

CARBON-CARBONATE (%)

	2, 78–80
Organic Carbon	1.29
Total Carbonate	44.0

SITE 508 HOLE CORE (HPC) 4 CORED INTERVAL 12.8–17.2 m



LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFER NANNOFOSSIL OOZE

Multicolored, variegated, greenish gray to light olive gray siliceous foraminifer nannofossil ooze. A small mottle of green clay (smectite?) was found in Section 1. The "rotten egg" odor indicative of reducing conditions was present. Iron sulfide (FeS_2) cubes are observed in smear slides.

SMEAR SLIDE SUMMARY (%)

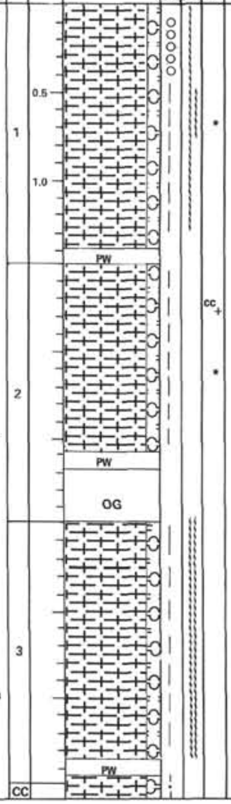
	1-74	1-89	3-75
COMPOSITION:			
Pyrite	–	1	–
Volcanic glass (light)	TR	TR	–
Zeolite	TR	–	–
Micronodules	TR	–	–
Carbonate unspec.	5	2	2
Foraminfiers	10	–	5
Calc. nannofossils	70	5	75
Diatoms	10	5	10
Radiolarians	5	5	5
Sponge spicules	TR	–	–
Silicoflagellates	TR	–	TR
Opaques	TR	–	–
Green clay	–	80	TR

CARBON-CARBONATE (%)

	2, 63–65
Organic Carbon	1.92
Total Carbonate	57.0

SITE 508 HOLE CORE (HPC) 5 CORED INTERVAL 17.2–21.6 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION
UPPER PLEISTOCENE	*Gephyrocapsa oceanica* (N)	C	A	R	C	B	1
		C	A	B	F	B	2
		C	A	R	C	B	3
							CC



5GY 6/1

5GY 6/1
+
5Y 6/2

5GY 6/1

5Y 6/2

5G 8/1

5G 8/1
+
5GY 6/1
+
5Y 6/1

5Y 6/2

LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFER NANNOFOSSIL OOZE
Greenish gray to light olive gray siliceous foraminifer nannofossil ooze. Biogenic mottling is found in Sections 1 and 3. The strong odor of H_2S suggest reducing conditions are present within the core.

SMEAR SLIDE SUMMARY (%)

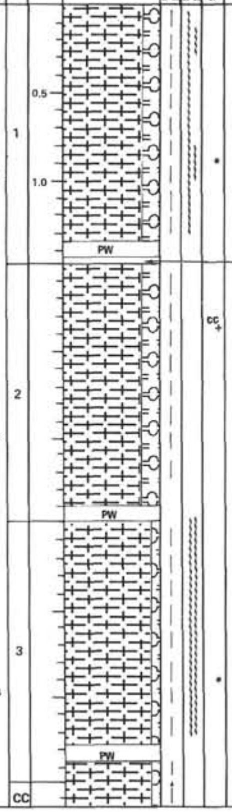
	1-67	2-62
COMPOSITION:		
Volcanic glass (light)	–	TR
Zeolite	TR	–
Micronodules	–	TR
Carbonate unspec.	5	5
Foraminifers	5	10
Calc. nannofossils	75	70
Diatoms	7	8
Radiolarians	5	5
Sponge spicules	3	2
Silicoflagellates	TR	TR

CARBON-CARBONATE (%)

	2, 20–22
Organic Carbon	2.88
Total Carbonate	70.0

SITE 508 HOLE CORE (HPC) 6 CORED INTERVAL 21.6–26.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SILICO-FLAGELLATES	SECTION
UPPER PLEISTOCENE	*Gephyrocapsa oceanica* (N)	F	A	B	F	B	1
		F	A	B	F	B	2
		F	A	B	F	B	3
							CC



5G 8/1
+
5Y 6/1
+
5YR 4/1

VOID

5Y 8/1
to
5GY 8/1

5GY 5/1
+
5GY 6/1

5Y 8/1
to
5GY 8/1

LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFER NANNOFOSSIL OOZE
Multicolored, mottled, light greenish gray, brownish gray to light olive gray siliceous foraminifer nannofossil ooze. Drilling disturbance is slight. Large foraminifer are visible in the cores. Layering exists in Section 1. This is due to color variations. Siliceous fossils appear more abundant than in the previous core.

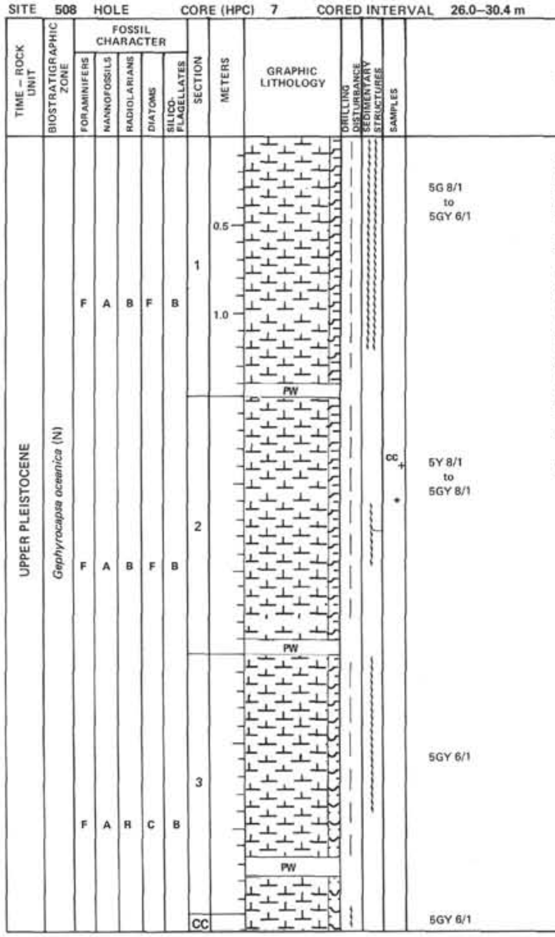
SMEAR SLIDE SUMMARY (%)

	1-70	3-70
COMPOSITION:		
Clay minerals	TR	TR
Volcanic glass (light)	TR	–
Zeolite	–	TR
Carbonate unspec.	3	2
Foraminifers	5	5
Calc. nannofossils	70	80
Diatoms	15	8
Radiolarians	5	2
Sponge spicules	TR	TR
Silicoflagellates	TR	–

CARBON-CARBONATE (%)

	2, 34–36
Organic Carbon	1.38
Total Carbonate	78.0

SITE 508 HOLE CORE (HPC) 7 CORED INTERVAL 26.0–30.4 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE

Mottled light greenish gray to yellowish gray siliceous nannofossil ooze. Diatoms are the most abundant siliceous constituent. Zoophycus and possible halo burrows are observed.

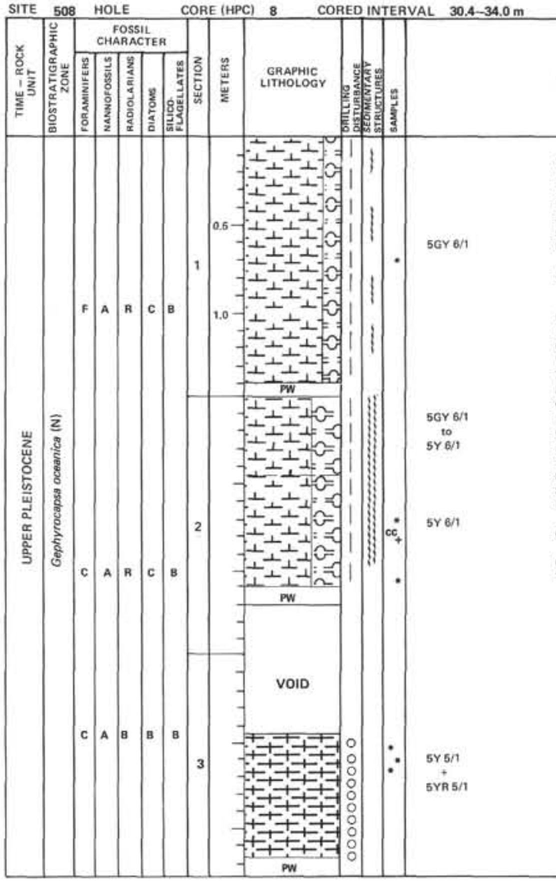
SMEAR SLIDE SUMMARY (%)

	2-61
COMPOSITION:	
Clay minerals	TR
Volcanic glass (light)	TR
Micronodules	TR
Carbonate unspec.	3
Foraminifers	2
Calc. nannofossils	75
Diatoms	15
Radiolarians	3
Sponge spicules	3

CARBON-CARBONATE (%)

	2, 34–36
Organic Carbon	0.87
Total Carbonate	63.0

SITE 508 HOLE CORE (HPC) 8 CORED INTERVAL 30.4–34.0 m



LITHOLOGIC DESCRIPTION

SILICEOUS NANNOFOSSIL OOZE TO SILICEOUS FORAMINIFER NANNOFOSSIL OOZE

Bioturbated, greenish gray to light olive gray nannofossil ooze. In the upper two sections siliceous microfossils are abundant. In the last section foraminifer replace siliceous diatoms and radiolaria. Horizonal to sub-horizontal burrows (zoophycus?) are present.

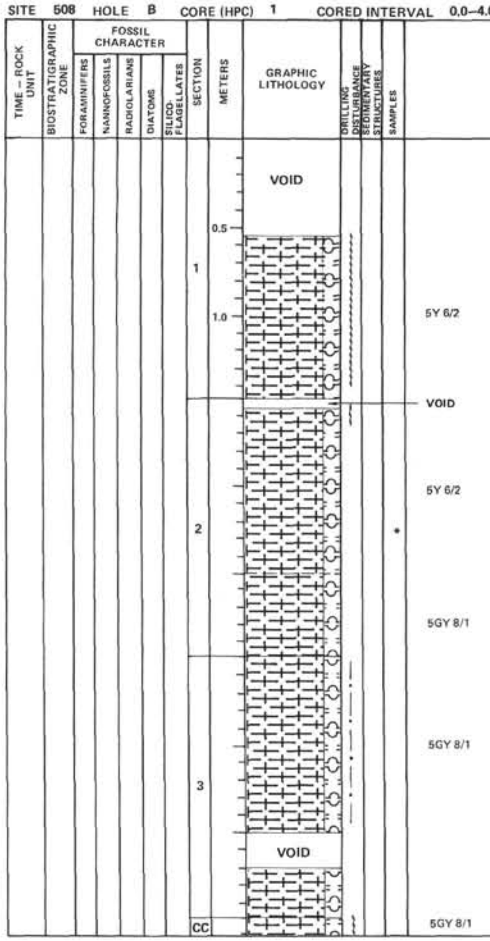
SMEAR SLIDE SUMMARY (%)

	1-70	2-70	2-110	3-57 (M)	3-61 (M)	3-70
COMPOSITION:						
Feldspar (plagioclase)	–	–	TR	–	–	TR
Clay minerals	–	TR	TR	–	–	3
Volcanic glass (light)	TR	TR	TR	TR	–	–
Zeolite	–	–	–	–	15	–
Micronodules	–	TR	–	–	–	–
Carbonate unspec.	5	2	5	99	–	–
Foraminifers	2	10	10	TR	40	25
Calc. nannofossils	75	60	50	TR	40	65
Diatoms	15	20	15	–	–	1
Radiolarians	3	10	15	–	–	1
Sponge spicules	TR	2	3	–	–	–
Silicoflagellates	TR	TR	2	–	–	–
Discoasters	TR	–	–	–	–	–

CARBON-CARBONATE (%)

	2, 79–81
Organic Carbon	1.41
Total Carbonate	63.0

SITE 508 HOLE B CORE (HPC) 1 CORED INTERVAL 0.0–4.0 m

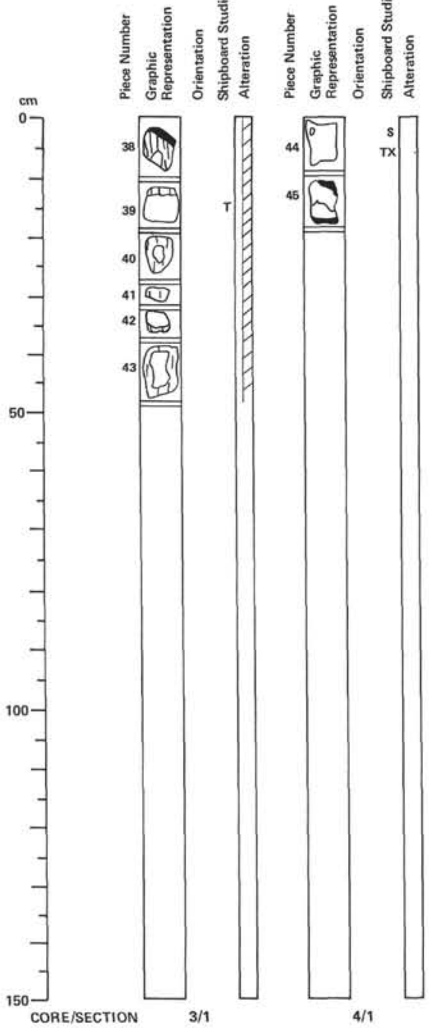


LITHOLOGIC DESCRIPTION

SILICEOUS FORAMINIFER NANNOFOSSIL OOZE
Light olive gray to light greenish gray siliceous foraminifer nannofossil ooze. The mottled fabric of the rock may be biogenic in origin but drilling disturbance is also observed.

SMEAR SLIDE SUMMARY (%)

	2-75
COMPOSITION:	
Volcanic glass (light)	TR
Micronodules	TR
Foraminifers	10
Calc. nannofossils	65
Diatoms	8
Radiolarians	10
Sponge spicules	1
Silicoflagellates	TR



70-508B-3 **Depth: 51.5–57.5 m**

3-1, Pieces 38–43

Dominant Lithology: Fine- to medium-grained aphyric to moderately plagioclase phyric basalt. Six non-orientable pieces of basalt. No cooling units defined. Vesicles are numerous, less than 1 mm in diameter, empty or partly filled by possible zeolite and blue and green clay mineral.

Thin Section Description

3-1, 10–15 cm (Piece 39):

Name: Medium-grained moderately plagioclase clinopyroxene phyric basalt with glomerophyric texture

Phenocrysts: 5% plagioclase (0.7x0.2 mm) often zoned laths, 3% clinopyroxene (0.5x0.2 mm) subhedral crystals

Groundmass: 45% plagioclase (0.5x0.01 mm and 0.08x0.16 mm) microlites, 32% clinopyroxene (0.008 to 0.16 mm) microlites and anhedral equant crystals, 7% (0.02 mm) skeletal titanomagnetite, 4% glass? Part of the groundmass is variolitic.

Vesicles: 2–3%, scattered, 0.025 in average diameter, some filled with smectite

Alteration: Brown, green colorless smectite and iron hydroxides filling vesicles and myarolitic voids in the alteration rim

70-508B-4 **Depth: 57.5–59.5 m**

4-1, Pieces 44–45

Dominant Lithology: Fine-grained aphyric basalt. One of the two pieces has glassy rims on two edges. Vesicles are numerous, less than 1 mm in diameter, mostly empty, sometimes coated with blue clay mineral or pyrite patches.

Thin Section Description

4-1, 0–8 cm (Piece 44):

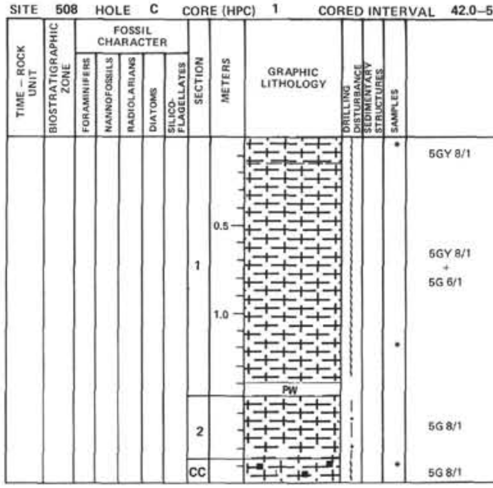
Name: Aphyric basalt, with a hyalopilitic texture, and flow bending

Groundmass: 42% plagioclase (0.1x0.01 mm) microlites, 35% clinopyroxene (0.08x0.02 mm) microlites or anhedral crysts, 15% skeletal titanomagnetite (0.02 mm), 3% glass(?).

Vesicles: 5%, scattered, 0.01–0.4 mm in diameter, filled with smectite. Several secondary pyrite crystals.

Alteration: Brown and green smectite, iron hydroxide filling the vesicles and myarolitic voids.

SITE 508 HOLE C CORE (HPC) 1 CORED INTERVAL 42.0–51.5 m



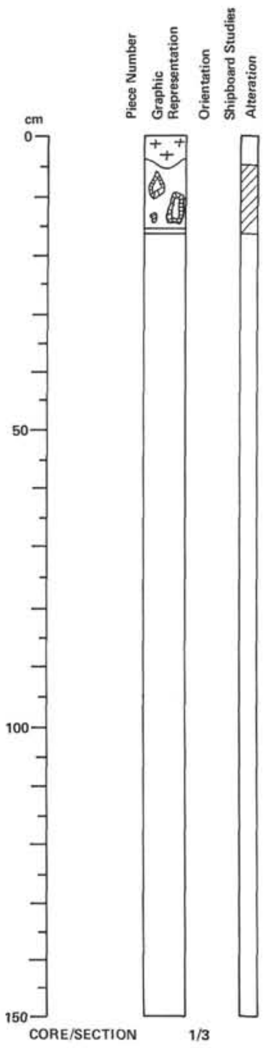
LITHOLOGIC DESCRIPTION

FORAMINIFER NANNOFOSSIL OOZE

Light greenish gray to light olive gray foraminifer nannofossil ooze. Some of the nannofossil ooze is indurated and is coated on one side by a thin layer of green clay. Gradational contacts are determined by color changes. Core-Catcher: in addition to the foraminifer nannofossil ooze, three pieces of basalt were recovered. They are described in the igneous rock barrel sheets.

SMEAR SLIDE SUMMARY (%)

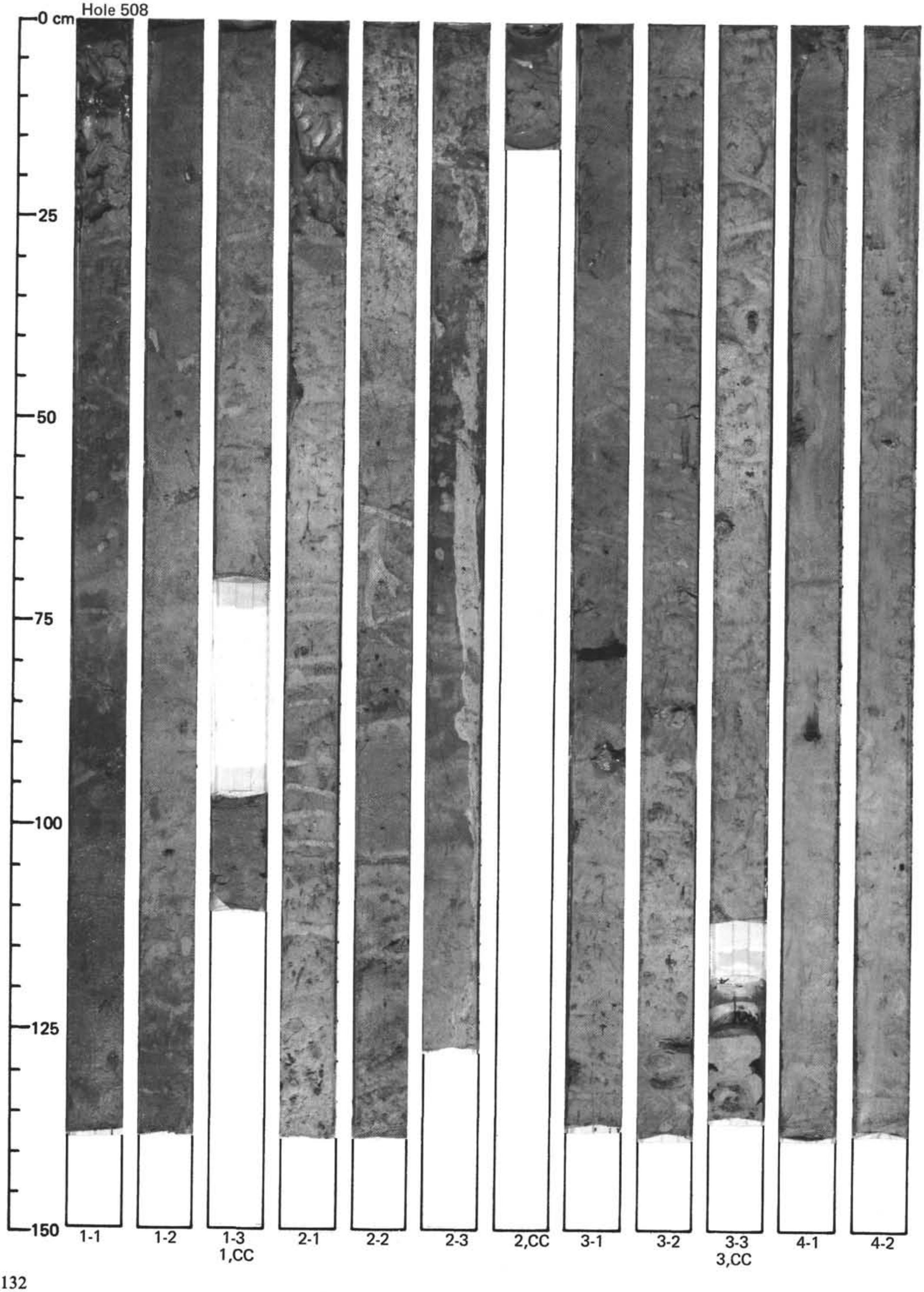
	1-9	1-120 (M)	CC-6
COMPOSITION:			
Clay minerals	–	40	TR
Volcanic glass (light)	TR	–	TR
Carbonate unspec.	–	–	5
Foraminifers	30	30	20
Calc. nannofossils	60	30	75
Diatoms	5	–	–
Radiolarians	5	–	–
Silicoflagellates	TR	–	–

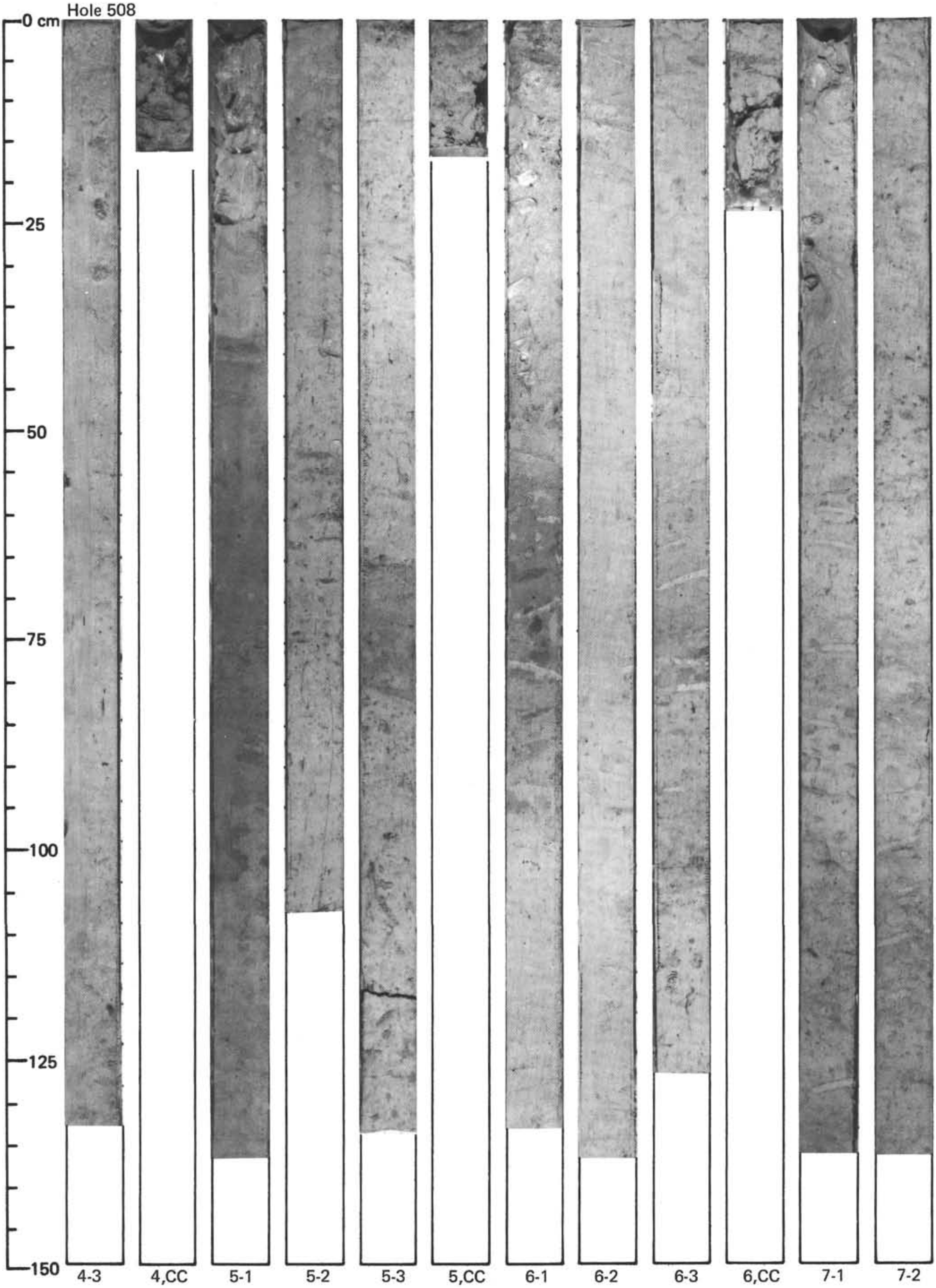


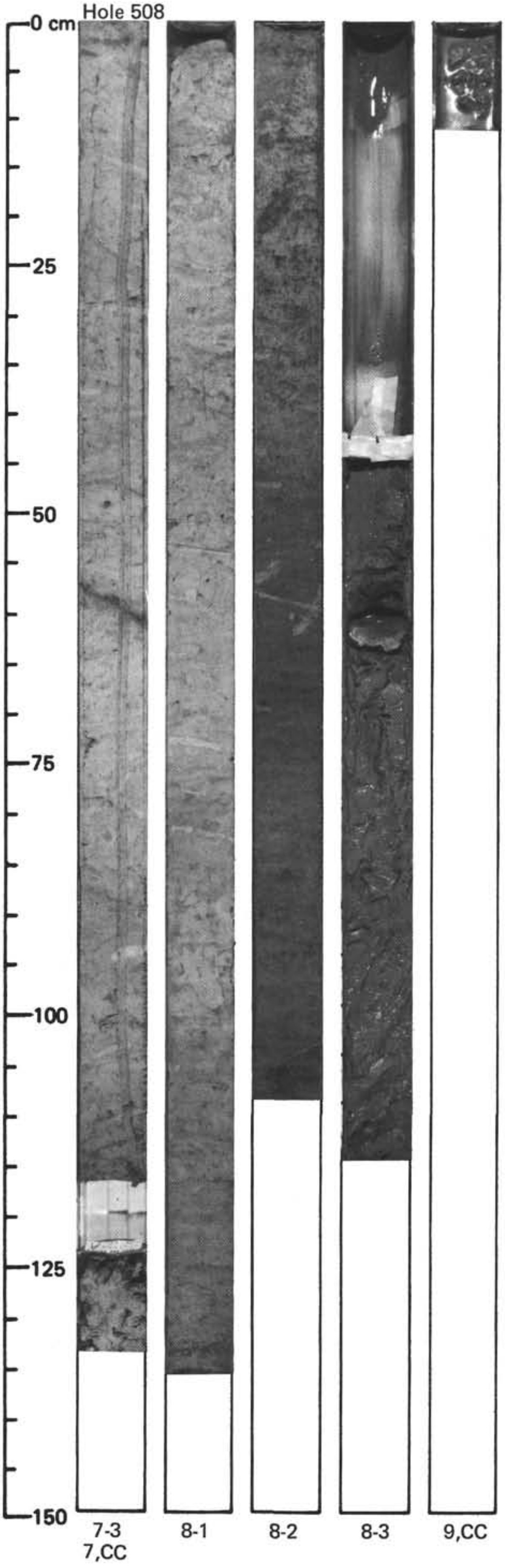
70-508C-1 *Depth: 42.0–51.5 m*

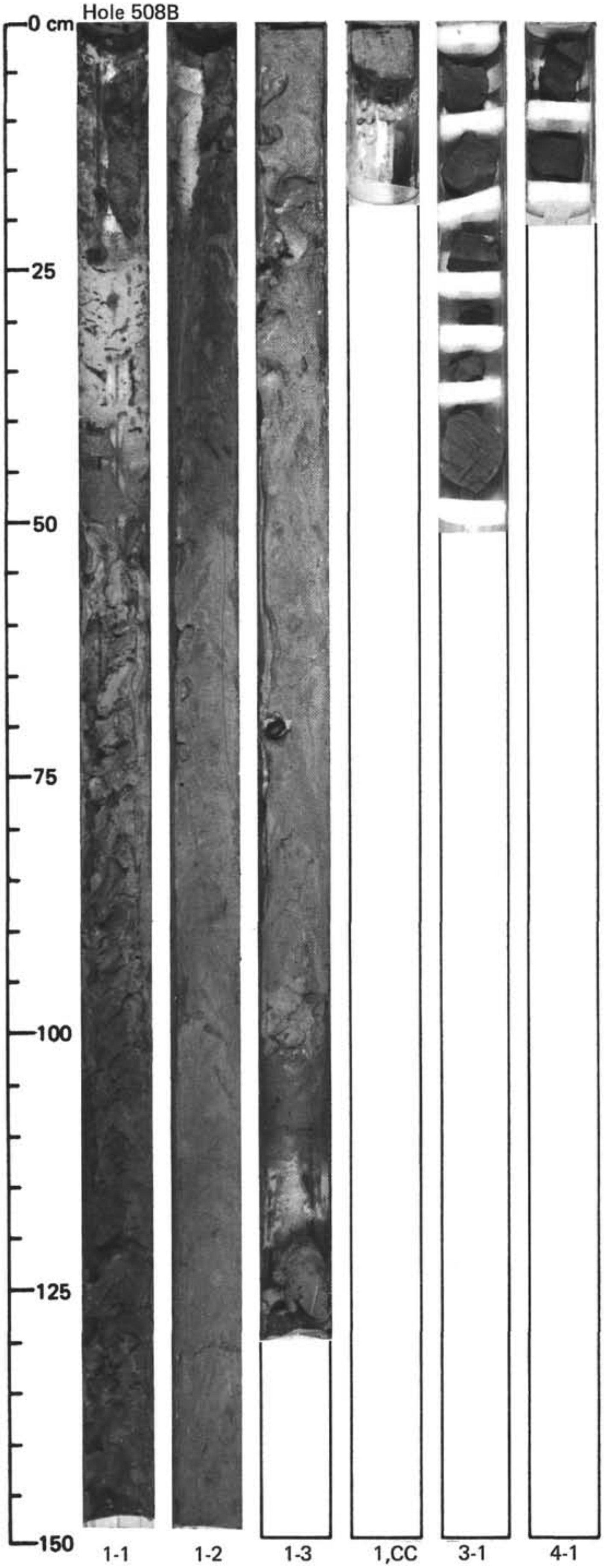
1-3

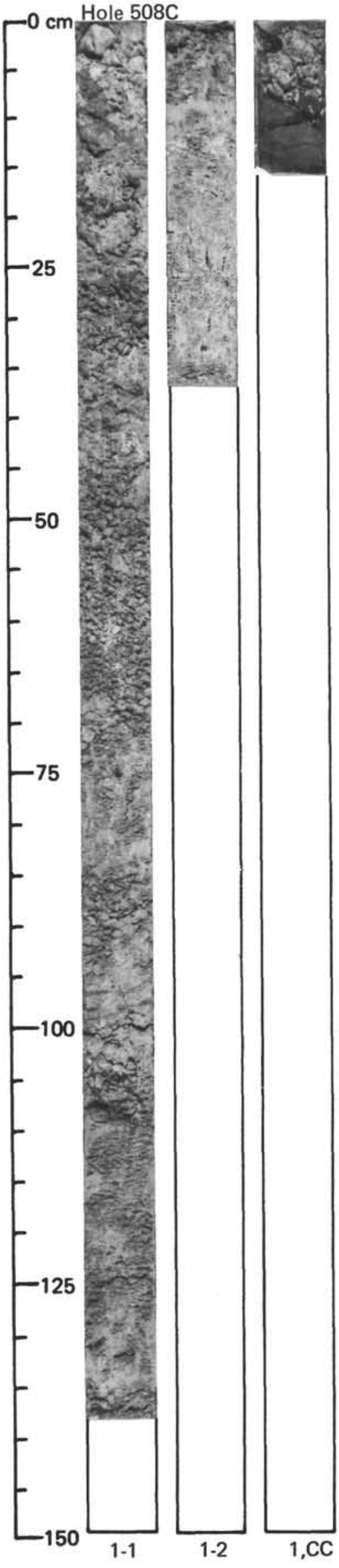
Dominant Lithology: Fine-grained moderately plagioclase phyric basalt. A glassy rim occurs on one of the three fragments. Alteration rims are on all the fragments.


Hole 508
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1,CC
2-1
2-2
2-3
2,CC
3-1
3-2
3-3
3,CC
4-1
4-2


Hole 508
0 cm
25
50
75
100
125
150
4-3
4,CC
5-1
5-2
5-3
5,CC
6-1
6-2
6-3
6,CC
7-1
7-2


Hole 508
0 cm
25
50
75
100
125
150
7-3
7,CC
8-1
8-2
8-3
9,CC


Hole 508B
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1,CC
3-1
4-1


0 cm
Hole 508C
25
50
75
100
125
150
1-1
1-2
1,CC