17. SITE 618[1]

Shipboard Scientific Party[2]

HOLE 618

Date occupied: 19 October 1983, 2153 LCT

Date departed: 21 October 1983, 0135 LCT

Time on hole: 1 day, 3 hr.

Position: 27°00.68′N, 91°15.73′W

Water depth (sea level; corrected m, echo-sounding): 2412.4

Water depth (rig floor; corrected m, echo-sounding): 2422.4

Bottom felt (m, drill pipe): 2422.4

Penetration (m): 92.5

Number of cores: 11

Total length of cored section (m): 78

Total core recovered (m): 67.47

Core recovery (%): 87

Oldest sediment cored:
Depth sub-bottom (m): 92.5
Nature: Gassy clay
Age: Pleistocene (Ericson Zone Y)
Measured velocity (km/s): N/A

Basement: N/A

HOLE 618A

Date occupied: 21 October 1983, 0135 LCT

Date departed: 21 October 1983, 1211 LCT

Time on hole: 10 hr., 36 min.

Position: 27°00.68′N, 91°15.73′W

Water depth (sea level; corrected m, echo-sounding): 2412.4

Water depth (rig floor; corrected m, echo-sounding): 2422.4

Bottom felt (m, drill pipe): 2422.4

Penetration (m): 47.6

Number of cores: 3

Total length of cored section (m): 28.7

Total core recovered (m): 18.52

Core recovery (%): 65

Oldest sediment cored:
Depth sub-bottom (m): 47.6
Nature: Gassy clay
Age: Pleistocene (Ericson Zone Y)
Measured velocity (km/s): N/A

Basement: N/A

BACKGROUND AND OBJECTIVES

Holes 618 and 618A

Site 618 is located in Orca Basin near the center of the northern sub-basin at a water depth of about 2400 m. Orca Basin is an interdomal basin on the continental slope off Louisiana. It has a slight arcuate shape, is about 25 km long in a north-northeast/south-southwest direction and has a width that ranges from 6 to 9 km. The surrounding diapiric highs rise to depths of 1700 to 1900 m below sea level, while the bottom of both sub-basins lies at a depth of about 2400 m.

A 200-m-thick hypersaline, anoxic brine resides on the bottom of Orca Basin. The bottom sediments, as revealed in piston cores, are black, varved, anoxic clays that may not exceed a thickness of 13 to 20 m. These clays are underlain by sediments that may have been deposited in a more oxic environment.

Seismically, sub-bottom records are of poor quality and therefore neither the thickness of the anoxic sediments nor of the underlying deposits can be established via acoustical methods. The steep walls of this narrow basin show a multitude of hummocks interpreted as slumps. Specifically, high-resolution records reveal an abundance of steep faults on the diapiric tops and slumps on their flanks. Most of the bottom fill may well have resulted from slumping rather than from continuous pelagic and hemipelagic deposition.

Holes 618 and 618A were drilled to satisfy the following objectives:

1. To establish a good stratigraphic record—biostratigraphic, paleomagnetic, and oxygen isotope—of the upper Pleistocene,

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[1] Bouma, A. H., Coleman, J. M., Meyer, A. W., et al., *Init. Repts. DSDP*, 96: Washington (U.S. Govt. Printing Office).

[2] Addresses: Arnold H. Bouma (Co-Chief Scientist), Gulf Research and Development Company, P.O. Box 37048, Houston, TX 77236, (present address: Chevron Oil Field Research Company, P.O. Box 36506, Houston, TX 77236); James M. Coleman (Co-Chief Scientist), Coastal Studies Institute, Louisiana State University, Baton Rouge, LA 70803; Audrey W. Meyer (Shipboard Science Representative), Deep Sea Drilling Project, Scripps Institution of Oceanography, La Jolla, CA 92093, (present address: Ocean Drilling Program, 500 University Drive West, Texas A&M University, College Station, TX 77843); James Brooks, Department of Oceanography, Texas A&M University, College Station, TX 77843; William R. Bryant, Department of Oceanography, Texas A&M University, College Station, TX 77843; Richard Constans, Paleontology Section, Chevron U.S.A. Inc., 935 Gravier Street, New Orleans, LA 70112; Michel Cremer, Département de Géologie et Océanographie, Université de Bordeaux I, Avenue des Facultés, 33405 Talence Cedex, France; Laurence I. Droz, Laboratoire de Géodynamique Sous-Marine, 06230 Villefranche-sur-Mer, France; Toshio Ishizuka, Ocean Research Institute, University of Tokyo, Tokyo 164, Japan; Mahlon C. Kennicutt II, Department of Oceanography, Texas A&M University, College Station, TX 77843; Barry Kohl, Chevron U.S.A. Inc., 935 Gravier Street, New Orleans, LA 70112; William R. Normark, Pacific Branch of Marine Geology, U.S. Geological Survey (MS-999), 345 Middlefield Road, Menlo Park, CA 94025; Suzanne O'Connell, Lamont-Doherty Geological Observatory of Columbia University, Palisades, NY 10964, (present address: Ocean Drilling Program, 500 University Drive West, Texas A&M University, College Station, TX 77843); Mary Parker, Department of Geology, Florida State University, Tallahassee, FL 32306, (present address: AMOCO Production Company, P.O. Box 50879, New Orleans, LA 70150); Kevin T. Pickering, Department of Earth Sciences, University of London, Goldsmith's College, London SE 14 6NW, United Kingdom; (present address: Department of Geology, University of Leicester, Leicester LE1 7RH, United Kingdom); Claudia Schroeder, Department of Geology, Dalhousie University, Halifax, Nova Scotia B3H 3J5, Canada; Charles E. Stelting, Gulf Research and Development Company, P.O. Box 37048, Houston, TX 77236, (present address: Chevron Oil Field Research Company, P.O. Box 36506, Houston, TX 77236); Dorrik A. V. Stow, University of Edinburgh, Edinburgh EH9 3JW, Scotland, United Kingdom, (present address: Geology Department, University of Nottingham, Nottingham NG7 2RD, United Kingdom); William E. Sweet, Mineral Management Service, P.O. Box 7944, Metairie, LA 77010; Andreas Wetzel, Geologisches Palaeontologisches Institut der Universität, Sigwartstrasse 10, D7400 Tübingen, Federal Republic of Germany; and Jean K. Whelan, Chemistry Department, Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

2. To determine the geochemical parameters of the sediments and their vertical trends,
3. To determine if the brine originated from "exposed" salt near the top part of one of the surrounding diapirs or if saline fluid migrated upward from deeper-seated salt,
4. To establish the age and formation of this interdomal basin,
5. To determine the geotechnical characteristics of sediments deposited in anoxic and oxic environments,
6. To determine the sedimentological properties of the sediments, and
7. To relate the anoxic deposits to other black shales.

OPERATIONS

Hole 618

Hole 618 is about 208 km south-southwest of the Louisiana coast in a totally enclosed basin on the Texas–Louisiana slope. The basin was known to contain 200 m of highly saline water, which made the precision depth recorder (PDR) depth of 2391 m somewhat suspect.

The wind and current conditions were far from ideal at the new site, but the current was generally less than at Site 617 (see Site 617 chapter, this volume). Satisfactory positioning was achieved after 2½ hr. of effort, and the pipe trip began. Since the special outer core barrel drill collars required for the advanced piston corer (APC) had been lost, a different bottom-hole assembly (BHA) configuration was made up for the variable length hydraulic piston corer (VLHPC). In addition, the connections of the upper BHA were inspected for damage from bending stress.

The estimated depth correction for the velocity of brine filling the basin proved to be too conservative, and two "water cores" were taken before the VLHPC found the seafloor. Unfortunately, on this run, the two shear pins that hold the VLHPC together failed because of pipe surge resulting from vessel motion. The inner barrel was thus stroked to full length and was stabbed into the seafloor while the attempt was made to pressure up and actuate the corer. The corer was retrieved as soon as pressure failed to build normally, but drill string motion had already broken off the inner core barrel just below its point of emergence from the core bit. The VLHPC was then redressed with the alternate inner barrel and the maximum three shear pins. After a half-hour delay to stabilize marginal positioning following a wind shift, the VLHPC actuated normally to spud Hole 618 at 1331 hr., 20 October. The recovered core was measured to determine water depth at 2422.4 m (Table 1).

Continuous cores were taken to 63 m below seafloor with incomplete stroke beginning at 50 m sub-bottom. Below 63 m, each remaining uncored interval was drilled off to the next pipe connection. The material cored was gray and black sandy mud which had been slump deposited under anoxic conditions. The malodorous sediment contained considerable methane gas, which decreased in quantity with depth, and some gas hydrate. After 11 cores (92.5 m), the scientific objectives were declared complete.

Table 1. Site 618 coring summary.

Core[a]	Date (Oct. 1983)	Time	Depth from drill floor (m)	Depth below seafloor (m)	Length cored (m)	Length recovered (m)	Amount recovered (%)
Hole 618							
1H	20	1352	2422.4–2428.9	0.0–6.5	6.5	6.54	100
2H	20	1458	2428.9–2438.5	6.5–16.1	9.6	7.07	74
3H	20	1608	2438.5–2448.1	16.1–25.7	9.6	9.01	94
4H	20	1700	2448.1–2457.7	25.7–35.3	9.6	8.93	93
5H	20	1802	2457.7–2467.3	35.3–44.9	9.6	7.60	79
6H	20	1902	2467.3–2473.3	44.9–50.9	6.0	5.28	88
7H	20	2010	2473.3–2479.3	50.9–56.9	6.0	5.21	87
8H	20	2120	2479.3–2485.9	56.9–63.5	6.6	5.21	79
Wash	20		2485.9–2492.3	63.5–69.9	—	—	—
9H	20	2227	2492.3–2496.8	69.9–74.4	4.5	3.52	78
Wash	20		2496.8–2501.9	74.4–79.5	—	—	—
10H	20	2344	2501.9–2508.5	79.5–86.1	6.6	6.61	100
Wash	20		2508.5–2511.5	86.1–89.1	—	—	—
11H	21	0045	2511.5–2514.9	89.1–92.5	3.4	2.49	73
					78.0	67.47	87
Hole 618A							
Wash	21		2422.4–2431.6	0.0–9.2	—	—	—
1H	21	0538	2431.6–2441.1	9.2–18.8	9.5	7.82	82
Wash	21		2441.1–2450.7	18.8–28.4	—	—	—
2H	21	0646	2450.7–2460.3	28.4–38.0	9.6	6.31	66
3H	21	0740	2460.3–2469.9	38.0–47.6	9.6	4.39	46
					28.7	18.52	65

[a] H following core number indicates hydraulic piston coring.

Hole 618A

As additional samples of the upper sediments were desired, a second shallow hole was planned at the same location. The "mud line" core again proved difficult; the shear pins again failed on the initial descent and the soft sediment washed out of the core barrel on the second attempt. Three cores were eventually recovered between the seafloor and 47.6 m sub-bottom (Table 1). Gas hydrate samples were collected.

The drill string was then pulled and *Glomar Challenger* departed for Site 619 at 1212 hr., 21 October.

SEISMIC STRATIGRAPHY AND ACOUSTIC FACIES

Orca Basin is a small (25 by 8 km) interdomal basin with a 200-m-thick anoxic brine layer (salinity of 251‰ and density 1.31 g/cm^3) overlying the basin floor. Site 618 is in the northeastern corner of the basin (see Introduction to Intraslope Basins, this volume) between a small (10 m) topographic high and the basin wall.

The first survey of the basin was conducted by Texas A&M University using an 800-J minisparker system (Trabant and Presley, 1978). An additional survey was made by the U.S. Geological Survey in 1980 using 40- and 5-in^3 air guns, a minisparker, and a hull-mounted 3.5-kHz system. Figure 1 shows the survey grid from the U.S.G.S. survey, the location of Site 618, and the *Glomar Challenger* ship track near that site.

Seismic Stratigraphy

Figure 2 shows a minisparker profile (U.S.G.S. Line 69) over Site 618. Several high-amplitude reflectors are observed in the seismic section, but the occurrence of hyperbolic refractions at the drill site does not allow correlation of the seismic data with the gassy sediments recovered at this site. Generally, the chaotic jumble of re-

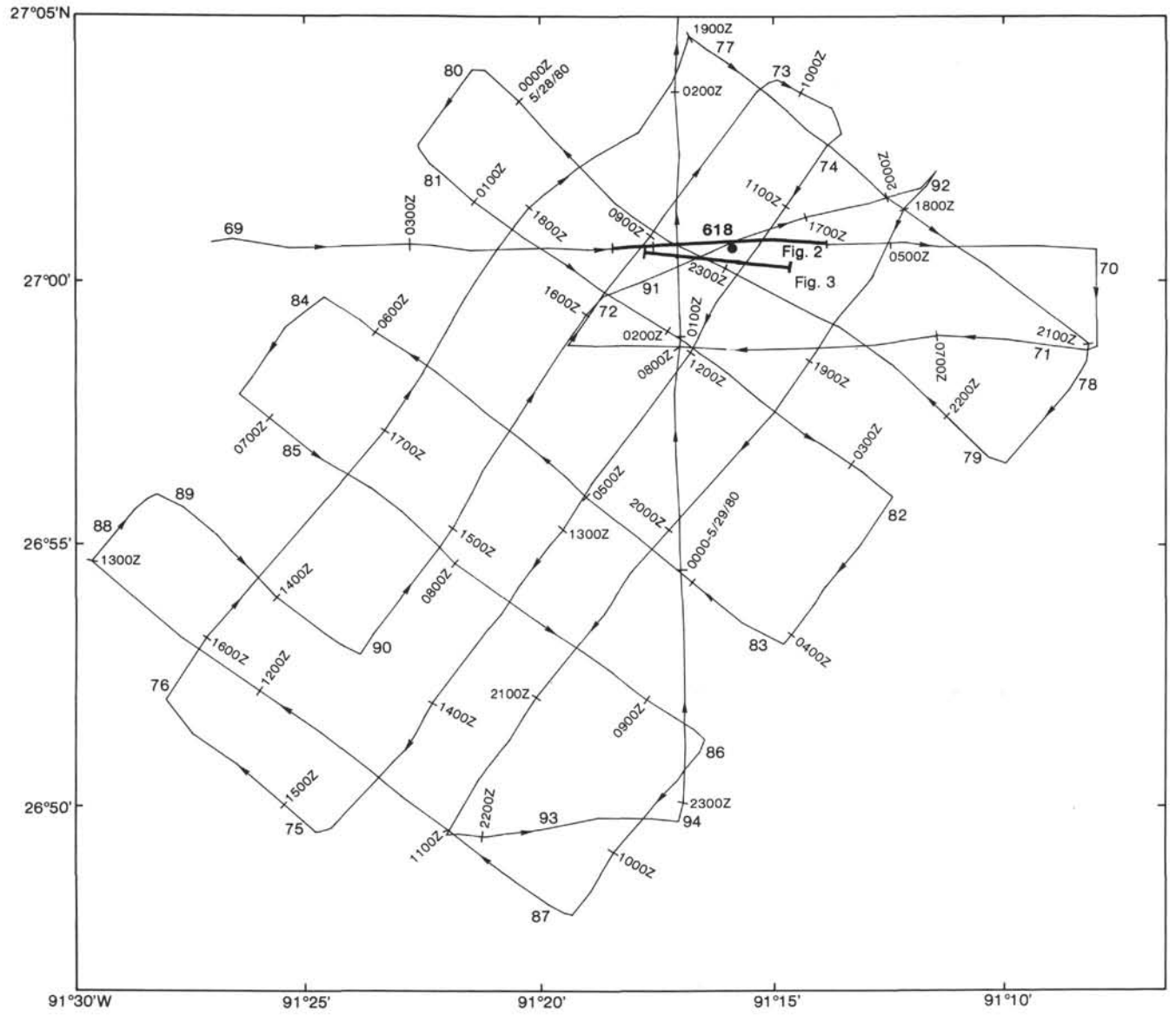

Figure 1. Seismic coverage (U.S.G.S. Cruise 80-G-4) over Orca Basin. Locations of seismic reflection profiles from Figures 2 and 3 are shown with heavy lines.

flectors is consistent with the extensive slope failure inferred from the cores. The quality of the seismic data does not lend itself to separating out individual failure events, however.

Acoustic Facies

The 3.5-kHz *Glomar Challenger* shipboard profile for Site 618 is shown in Figure 3. The steep western wall has rounded and hyperbolic acoustic returns that could indicate either side-lobe reflections or possibly downslope sediment movement. Shallow (2–8 m) concave-upward sub-bottom reflectors in the local saddle strongly suggest that some of the material moved downslope and across the saddle as intact lenses or slides (Fig. 3A). The area immediately underlying Site 618 has no acoustic penetration. The lack of penetration, its topographic position, and the incorporated gas suggest that the shallow sediments may not have any internal sedimentary structure. The upper 16.1 m of Site 618 are structureless, gassy mud.

Results

1. No basinwide reflectors are present.
2. The reflector inclination, acoustic character, and surface topography seen on the 3.5-kHz profile and other seismic reflector profiles suggest sediment sliding and deformed material are present at Site 618.

BIOSTRATIGRAPHY AND SEDIMENTATION RATES

Biostratigraphy

The section penetrated in Holes 618 and 618A is Quaternary, correlating with the planktonic foraminifer Zone

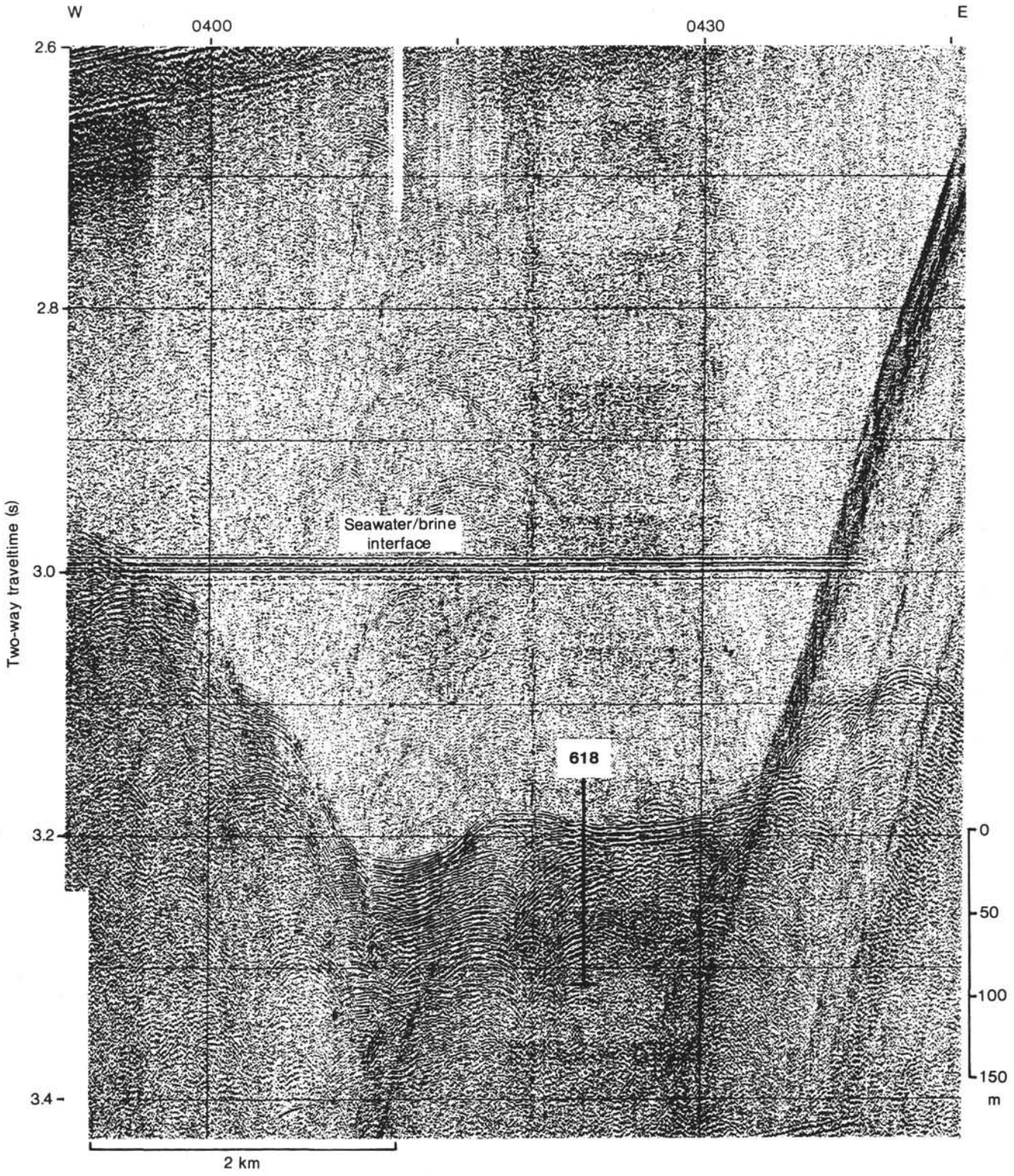

Figure 2. Minisparker profile (U.S.G.S. Line 69) showing deeper reflectors at Site 618. Location of line shown in Figure 1.

N23 and the calcareous nannofossil Zone NN21. This interval includes a displaced sediment section (0–11 m sub-bottom), Holocene (Ericson Zone Z; Ericson and Wollin, 1968), and the late Wisconsin glacial (Ericson Zone Y) (Fig. 4). The warm interstadial of the Wisconsin (Ericson Zone X or *Globorotalia flexuosa* Zone) was not encountered at the total depth of 92.5 m (see Explanatory Notes, this volume).

Ericson Zone Y contains a well-preserved Pleistocene planktonic and benthic foraminifer fauna with Pleistocene and reworked Cretaceous calcareous nannofossils occurring in generally equal abundances.

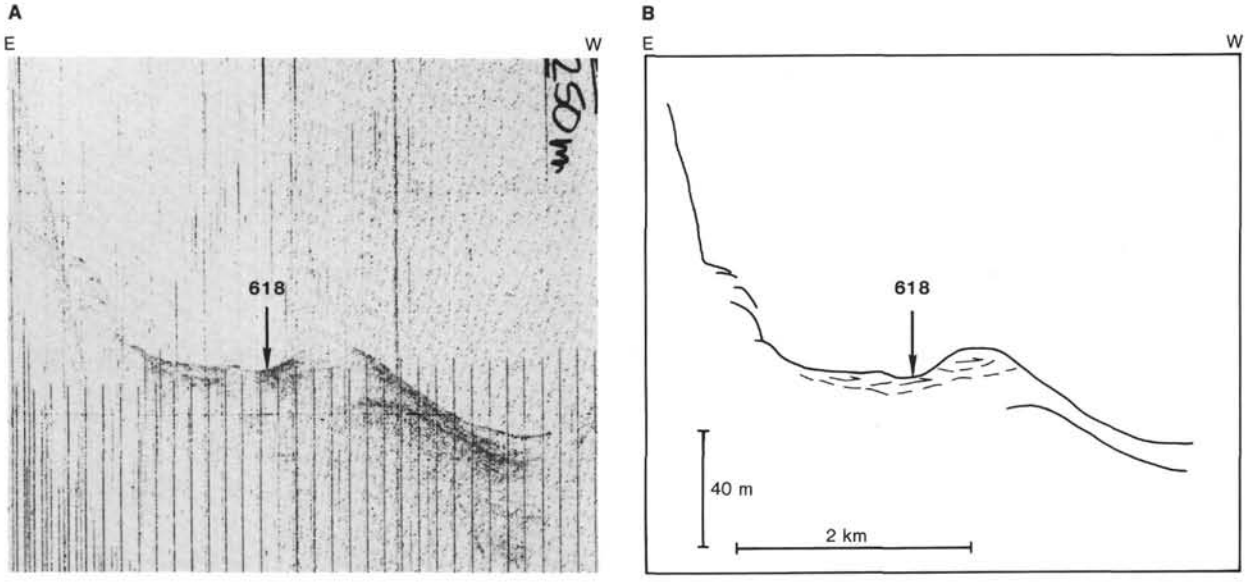

Figure 3. A. 3.5-kHz profile at Site 618, *Glomar Challenger.* B. Interpretive sketch based on 3.5-kHz profile. Location of profile shown in Figure 1.

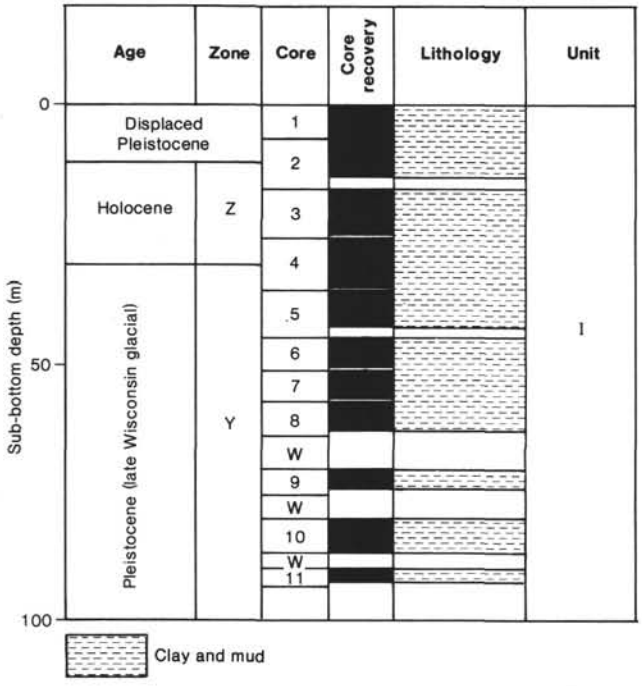

Figure 4. Lithostratigraphy of Hole 618, showing age and lithology of the one lithologic unit. The silt-laminated mud intervals are too thin to be indicated. W = washed interval (see Table 1).

Rare, reworked Pliocene planktonic foraminifers and calcareous nannofossils occur throughout Hole 618. The foraminifers represent Zone N19-21 (Blow, 1969).

There are scattered occurrences of well-preserved Pleistocene radiolarians.

Foraminifers

Foraminifers from Holes 618 and 618A are Quaternary, Zone N23 (Blow, 1969). A displaced foraminifer fauna containing common cool-water *G. inflata* and rare reworked Pliocene foraminifers (*G. miocenica, Globoquadrina altispira,* and *Globigerina nepenthes*) occurs in the interval of Core 618-1 through Section 618-2-3. The fauna represents a mixture of dominantly Wisconsin glacial sediments with some Pliocene and Holocene sediments probably displaced from the basin margin during the late Holocene.

A warm-water Holocene section (Ericson Zone Z) is present from Sample 618-2-5,CC through Section 618-4-3. *Globorotalia menardii* and *G. tumida* are common to abundant, along with occurrences of rare benthic foraminifers.

Zone Y (late Wisconsin glacial) extends from Sample 618-4-6,CC through Section 618-11 and consists of gray mud with fine to very fine sand in the washed residue. The fauna is composed of dominantly cool *G. inflata* with some warm-water planktonic foraminifers and common bathyal benthic foraminifers such as *Cibicides wuellerstorfi.* A few samples contain rare reworked Pliocene planktonic foraminifers ranging in age from N19 to N21 (early to late Pliocene).

Calcareous Nannofossils

All cores recovered from this site are interpreted to be in the *Emiliania huxleyi* Zone (NN21) of Martini (1971). Calcareous nannofossils are few to common in all samples, with Quaternary and reworked Cretaceous nannofossils occurring in generally equal abundances. Rare occurrences of reworked Pliocene nannofossils are noted in most samples, with *Discoaster pentaradiatus, D. brouweri,* and *Sphenolithus abies* occurring most commonly as the reworked constituent. Miocene and Eocene species show very rare, sporadic occurrences and include *D. quinqueramus, D. bollii,* and *D. barbadiensis.*

Carbonate clasts averaging 0.5 mm in size are found in washed foraminifer Samples 618-4-4, 120–126 cm; 618-

7,CC; and 618A-3,CC. These clasts contain common to abundant, moderately preserved nannofossils of early Pliocene age. The fairly diverse nannofossil flora includes *D. pentaradiatus, D. brouweri, S. abies, Reticulofenestra pseudoumbilica*, and *D. tamalis* and is assignable to Okada and Bukry's (1980) *R. pseudoumbilica* Zone (CN11), equivalent to NN15 of Martini (1971). The common co-occurrence of *Pseudoemiliania lacunosa, Gephyrocapsa oceanica*, and other gephyrocapsids in these clasts suggests that they may be early Pleistocene in age, with a common reworked Pliocene constituent.

Sedimentation Rates

The sedimentation rates are based on two datums. An age of 0.012 Ma is used for the Holocene/Pleistocene boundary (Z/Y zonal boundary) and 0.085 Ma for the Y/X zonal boundary (see Explanatory Notes, this volume).

A displaced sediment interval, 0–11 m (Core 618-1 through Section 618-2-3) is excluded from the sedimentation rate of the Z Zone. A sedimentation rate of 166.7 cm/1000 yr. is computed for the Holocene. This is a minimum rate with the exclusion of the displaced sediment thickness (Fig. 5).

The Y/X zonal boundary was not encountered. However, assuming that the boundary is just below the total depth of the hole (92.5 m) since it cannot be determined seismically, a minimum sedimentation rate of 84.3 cm/1000 yr. is extrapolated.

These calculations are based on nondecompacted sediment thicknesses.

LITHOSTRATIGRAPHY

At Site 618 we recognize a single lithologic unit in the 92.5 m of section drilled (Fig. 4): a gas-disrupted, reworked, and predominantly structureless gray silty mud and clay. This unit consists of two facies: (1) clays and muds and (2) silt-laminated muds.

Lithologic Unit I: Muds and Silts

Clay and Mud Facies

This is the dominant facies type and consists of structureless gray clays and muds. Micropaleontological data suggest that the uppermost parts of the unit, Section 618-1-1 through Section 618-2-3, are displaced and that much of the section beneath Section 618-5-1 contains mixed faunas indicative of reworking (see Biostratigraphy section, this chapter). Dispersed clasts of relatively cohesive dark clay and mud (as much as 0.5 cm, but more typically 1–2 mm in diameter) locally comprise about 10% of this unit. The gray muds include carbonate concretions, 2 to 3 mm in diameter, formed around foraminifers and other biogenic nuclei. Pyrite commonly forms a rind around these concretions.

Silt-Laminated Mud Facies

Silt-laminated muds occur at two intervals: (1) Sections 618-3-1 through 618-5-1 contain color-banded silty-sandy muds and clays and biogenic-rich sandy and silty muds and (2) Sections 618-10-2 through 618-10-4 contain laminated and graded sandy-silty muds.

The color-banded silty-sandy muds and clays in Sections 618-3-1 through 618-5-1 form layers ranging from a few millimeters to a few centimeters thick that alternate between light gray and dark gray black in coloration. In some cases (e.g., Section 618-3-3), the gray and black layers become thinner and more closely spaced upward over distances on the order of tens of centimeters. The contacts between colors vary from abrupt to gradational without displaying any consistent trends from one color to another. The interbedded dark biogenic-rich sandy and silty mud layers range from 0.5 to 1 cm thick, have either abrupt or gradational contacts, and are dominantly of fine-to-very-fine sand size. These layers are rich in foraminifers, pteropod fragments, and other organic material.

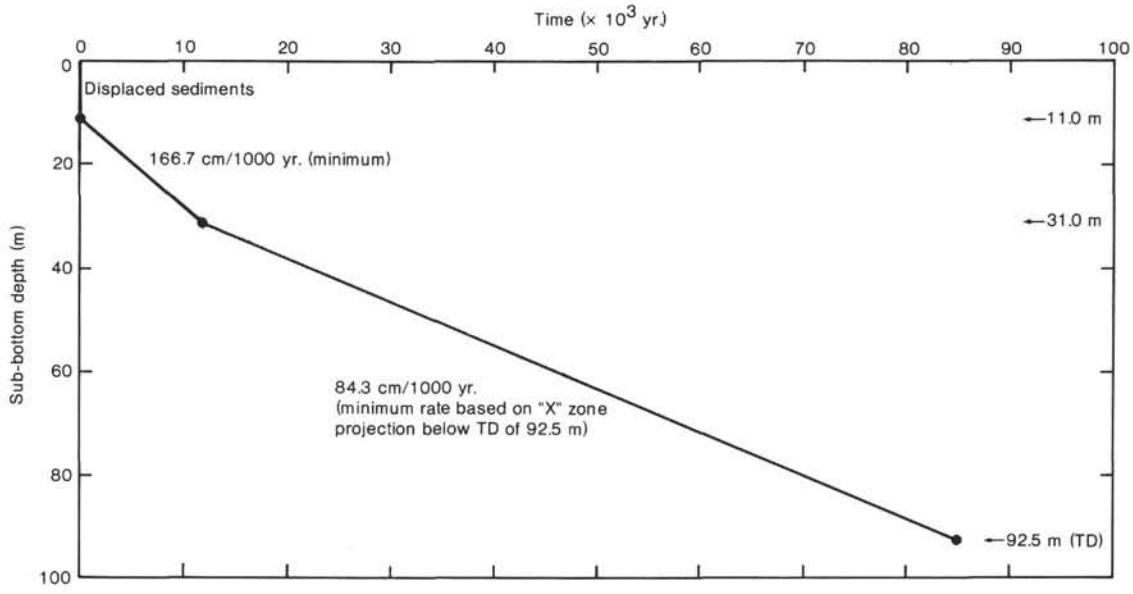

Figure 5. Site 618 sedimentation rates.

The laminated and graded sandy and silty muds in Sections 618-10-2 through 618-10-4 form layers ranging from 5 to 15 cm thick with normal grading and sharp planar, sometimes microscoured, bases. The grading usually is from fine-grained sand to mud. A poorly defined parallel to subparallel microlamination is observed in most beds, especially in their upper parts. These sandy and silty muds contain abundant quartz, common biogenic material, and rare micas, feldspars, opaque minerals, and carbonate grains.

GEOCHEMISTRY

Organic Geochemistry

Gas pockets were detected in all cores starting at the sediment/water interface and continuing to the bottom of the hole at 92.5 m below seafloor. Gas expansion cracks severely disrupted the core. The amount of gas in the cores appeared to be greatest in Cores 618-1 through 618-6, then decreased down to Core 618-10, and again increased in Core 618-11. The percentage of methane in the gas increased from 17% at the surface to 96% in Core 618-11 (Table 2). The low methane values at the surface were attributed to atmospheric contamination because of incomplete core recoveries and cracked liner. No ethane was detectable using the Carle Gas Chromatograph with a thermal conductivity detector. The detection limit of the instrument was 0.01% ethane, which indicates that the C1/C2 ratio was greater than 3500 throughout the hole. These values are typical of methane produced by methanogenic bacteria.

Sediments collected from within the top 30 m and from Core 618-10 were tested for microbiological activity by spiking subcores with ^{14}C-labeled substrates under anaerobic conditions (Whelan et al., this volume). There were indications of activity in Cores 618-1 and 618-2 as salinity decreased from the very high values near the sediment/water interface (see Inorganic Geochemistry section, this chapter). Very high levels of interstitial water acetate (Whelan et al., this volume) may also be related to these microbiological processes.

Table 2. Carle gas data from Site 618.

Core-Section	Methane (%)	Ethane (%)	C1/C2	CO_2[a] (ppm)
1-2	17.0	<0.02		nd
1-3	28.4	<0.02		nd
2-2	7.0	<0.02		103
2-2	8.1	<0.02		nd
2-3	0.25	<0.02		nd
3-5	92.0	<0.02		102+
3-5	98.4	<0.02	>5000	nd
3-5	97.5	<0.02	>5000	nd
4-2	96	<0.02	>3400	1177
5-4	83.9	<0.02	>3400	601
6-3	92.1	<0.02	>3400	420
7-3	86.2	<0.02	>3400	353
8-5	70.7	<0.02	>3400	1186
9-2	68.0	<0.02	>3400	1691
10-5	68.9	<0.02	>3400	1459
11-2	96.0	<0.02	>3400	2735

[a] nd = not determined.

Gas hydrates were detected in a number of cores from Holes 618 and 618A. The first evidence of gas hydrate was observed in the top section of Core 618-4 at 26 m sub-bottom. This hydrate was observed in gray mud and consisted of a few white crystals of a few millimeters in diameter. Upon splitting Core 618-4, a hydrated area was observed in Sample 618-4-2, 11–18 cm in a sandy section. This area was bubbling slightly and was more fluid than the surrounding areas because of hydrate decomposition. At Hole 618A, gas hydrates were observed in both Cores 618A-2 and 618A-3 in the 19 to 37 m sub-bottom depth interval. The hydrates in Core 618A-2 may have been restricted to the bottom portion of the core, but appeared to be distributed throughout Core 618A-3. These hydrates appeared to range in size from a few millimeters to possibly a centimeter in diameter and were white. Samples were frozen in liquid nitrogen for shore-based analysis (Pflaum et al., this volume). It is possible, because of the gassy nature of the entire core at Holes 618 and 618A, that gas hydrates could have been scattered throughout the cores. However, the hydrates were dispersed in the core in small crystals. The origin of the hydrate gas is biogenic.

Gravity and piston cores taken from the center of Orca Basin generally show a black layer (9–13 m thick) underlain by gray sediments. Interstitial water salinity levels in the center of the Orca Basin have been reported to be high enough to prohibit growth of methanogenic bacteria. Hole 618 is peculiar in showing predominantly gray mud with only occasional black layers. The black layers, which are thought to be produced by iron sulfides deposited during periods of overlying anoxic seawater, were scattered throughout the upper five cores in layers from a few centimeters to tens of centimeters thick. Black layers were absent from Cores 618-6 through 618-9, then reappeared in Core 618-10 in two sections, and were absent from Core 618-11. The distribution of black layers in the upper portion of this site is consistent with the placement of the site on a rise in the bottom of the basin which was 12 to 18 m high. This rise appears to be a slump feature underlain by black mud more characteristic of the basin surficial mud (see Lithostratigraphy section, this chapter).

Inorganic Geochemistry

This site is unique with regard to the decrease in salinity with depth. This unusual vertical profile, as shown in Figure 6, is a result of dissolution of nearby salt which also causes the water overlying the basin floor to be hypersaline. The inorganic geochemistry results are summarized as follows:

1. The pH values are limited to a range between 7.4 and 7.8 except for those values at depths of 2.5 and 90 m (pH 6.5 and 8.2, respectively).

2. Total alkalinity in one section (Core 618-3) is the highest value found at this site. The values are 3.9 mEq/L in Core 618-1 and a sudden increase to 21.5 mEq/L in Core 618-3. Below Core 618-3, the values decrease generally to 6.5 mEq/L.

3. Acetate levels were among the highest ever detected in marine or marsh sediments. At the sediment/wa-

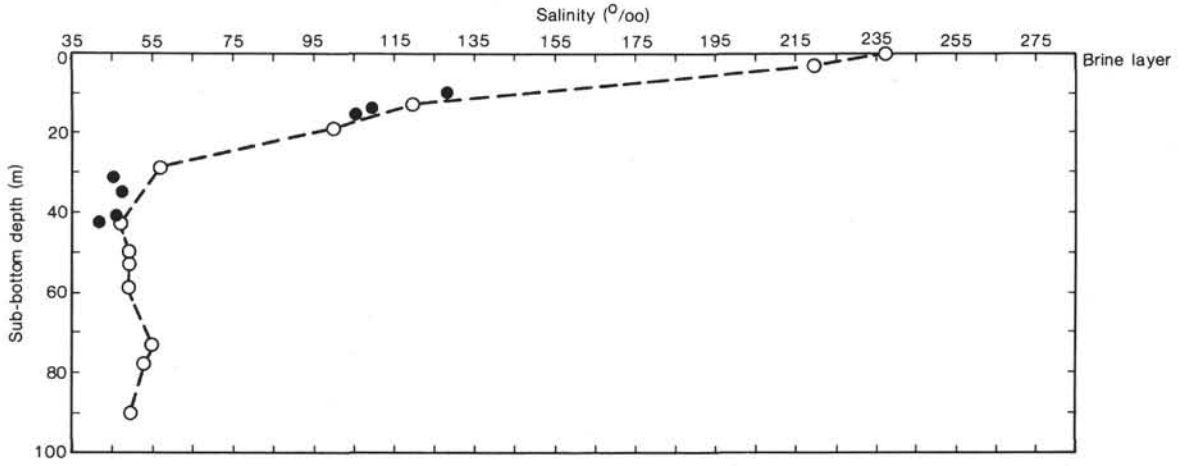

Figure 6. Plot of salinity (‰) versus sub-bottom depth (m) at Site 618. Open circles, Hole 618; filled circles, Hole 618A.

ter interface, acetate was >1000 μm and remained at relatively high levels (~100 μm) in Cores 618-2 and 618-10 (Whelan et al., this volume).

4. Salinity values at the sediment/water interface are nearly as high as those in the Red Sea (salinity 240–260‰). Salinity in surface sediment at Site 618 (0–2 cm sub-bottom) is 237‰. This value decreases rapidly with depth to about 30 m and then becomes constant (48 to 56‰) to total depth (Core 618-11). However, it is still considerably above seawater values of about 36‰. Salinity values of interstitial water are lower for Hole 618A than for Hole 618 at the same depths.

The break in the interstitial water salinity curve at 30 m corresponds to a sediment age of about 12,000 yr. This is also the age of sediment, as determined by ^{14}C, where the basin organic matter source changed from terrestrial (in deeper sediments) to marine (in shallower Holocene sediments) as determined by $\delta^{13}C$ of sediment organic matter (Behrens, 1980). An explanation consistent with these data is that the Orca Basin remained open until 12,000 yr. ago so that somewhat elevated interstitial water salinities represent a "steady state" dissolution of the surrounding salt diapirs. The basin was then closed so that gradual dissolution of salt diapirs caused an increase and buildup of bottom water salinity over the next 12,000 yr. Alternatively, the salinity gradient between 0 and 30 m may have been caused by diffusion of bottom-water brine downward into the sediments. The inorganic geochemistry data are discussed more extensively in Ishizuka, Kawahata, et al. (this volume).

PHYSICAL PROPERTIES

The sediments of Site 618 contained large amounts of methane gas which formed bubbles upon depressuring and destroyed the *in situ* sediment fabric. For that reason, no physical property measurements were made on the sediments from Site 618.

SUMMARY AND CONCLUSIONS

At Site 618, we cored to a depth of 92.5 m using the advanced piston corer. Recovery was excellent to a depth of 62.5 m, below which the core recovery became less than 50%. The main objectives at this site were to obtain material to provide a complete stratigraphic sequence of the upper Pleistocene and to obtain chemical characteristics and trends with depth concerning the influence and origin of the anoxic brine overlying these deposits.

Site 618 is located in Orca Basin near the center of the northern sub-basin, where it was assumed to contain black anoxic muds underlain by oxic or less anoxic gray muds. Good biostratigraphy data, combined with paleomagnetic and oxygen-isotope data, would be useful in obtaining a more precise understanding of the development of the basin and would provide an excellent opportunity to establish a biostratigraphic chronology for the late Pleistocene. Geochemical analyses would help to establish the source and the characteristics of the brine and its relationship to formation of the basin.

The results of the coring indicate an extremely high rate of sedimentation and the entire sequence is characterized by an abundance of reworked sediments. The near-surface sediments consist of approximately 16 m of gray muds having a high gas content and an abundance of reworked Pliocene fauna. This sequence has been interpreted as a Holocene emplaced mass-movement deposit. Beneath this unit, a 1.5-m zone of black anoxic sediments occurs. Gray clays, interbedded with thin dark black clays, continue to a depth of approximately 41 m; the remainder of the cored sequence consists predominantly of gray clays.

Sampling for paleomagnetic studies could not be accomplished because of gas expansion cracks throughout the core. The sediments contain a poor fauna, and displaced fauna seem to dominate the sequence. Interstitial water analyses show a rapid decrease in salinity from about 230‰ at the surface to 45‰ at a depth of 30 m. Below this depth, the change is minimal.

The scientific objectives, as outlined above, were not achieved. The presence of gas caused extensive disturbance of the cores and sedimentary structures were normally impossible to determine except in a few zones. All indications tend to confirm the faunal analyses, the en-

tire section consists of a high percentage of displaced material, likely being shed from the adjacent growing diapirs.

In conclusion, the following findings can be provided:

1. The sedimentary column consists of grayish clays with intercalations of black anoxic muds.

2. Gas expansion cracks were found throughout the cores and only biogenic methane was encountered.

3. The salinity of the interstitial water decreases downward, an indication that the saline pore fluids did not migrate upward from the underlying salt.

4. Very small white, crystalline gas hydrates were found in the upper cores.

5. The stratigraphic sequence is highly disturbed as a result of localized mass-movement processes and the presence of gas.

6. The Holocene sediment accumulation rate is computed to be 166.7 cm/1000 yr. and a minimum accumulation rate of Ericson's Zone Y is 84.3 cm/1000 yr. The base of Zone Y was not reached by the drill string and cannot be determined seismically.

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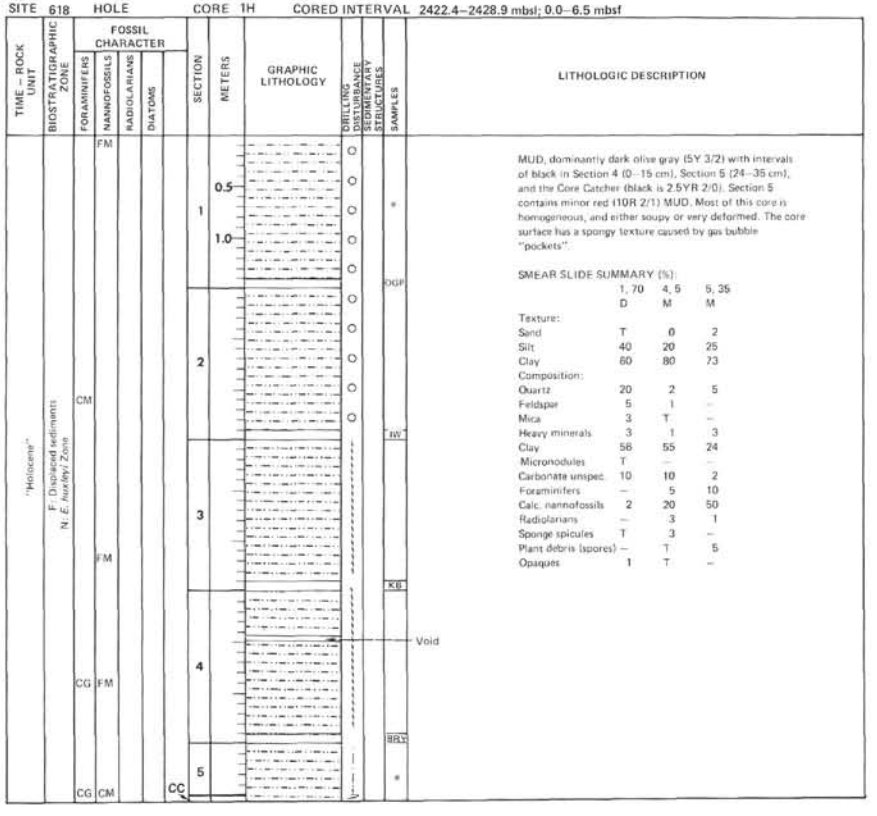
SITE 618 HOLE CORE 1H CORED INTERVAL 2422.4–2428.9 mbsl; 0.0–6.5 mbsf

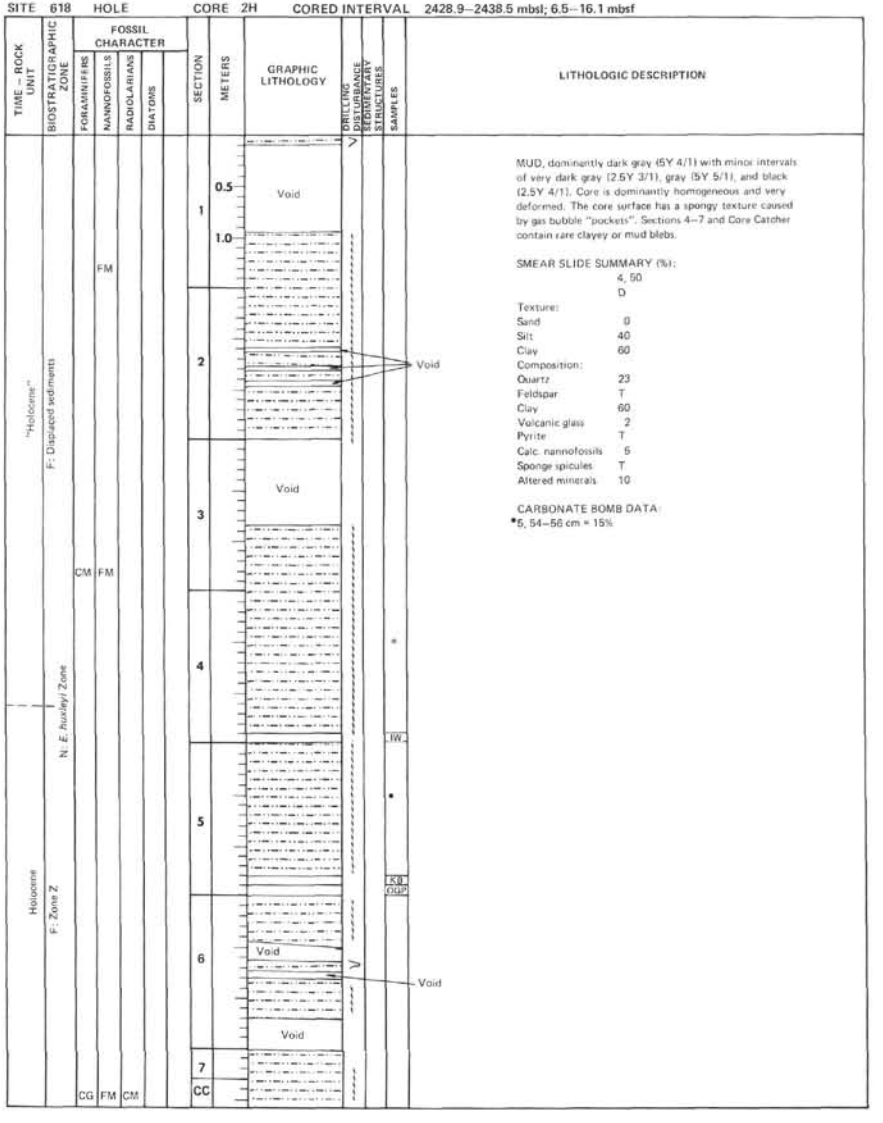


MUD, dominantly dark olive gray (5Y 3/2) with intervals of black in Section 4 (0–15 cm), Section 5 (24–35 cm), and the Core Catcher (black is 2.5YR 2/0). Section 5 contains minor red (10R 2/1) MUD. Most of this core is homogeneous, and either soupy or very deformed. The core surface has a spongy texture caused by gas bubble "pockets".

SMEAR SLIDE SUMMARY (%):

	1, 70 D	4, 5 M	5, 35 M
Texture:			
Sand	T	0	2
Silt	40	20	25
Clay	60	80	73
Composition:			
Quartz	20	2	5
Feldspar	5	1	–
Mica	3	T	–
Heavy minerals	3	1	3
Clay	56	55	24
Micronodules	T	–	–
Carbonate unspec.	10	10	2
Foraminifers	–	5	10
Calc. nannofossils	2	20	50
Radiolarians	–	3	1
Sponge spicules	T	3	–
Plant debris (spores)	–	T	5
Opaques	1	T	–

SITE 618 HOLE CORE 2H CORED INTERVAL 2428.9–2438.5 mbsl; 6.5–16.1 mbsf



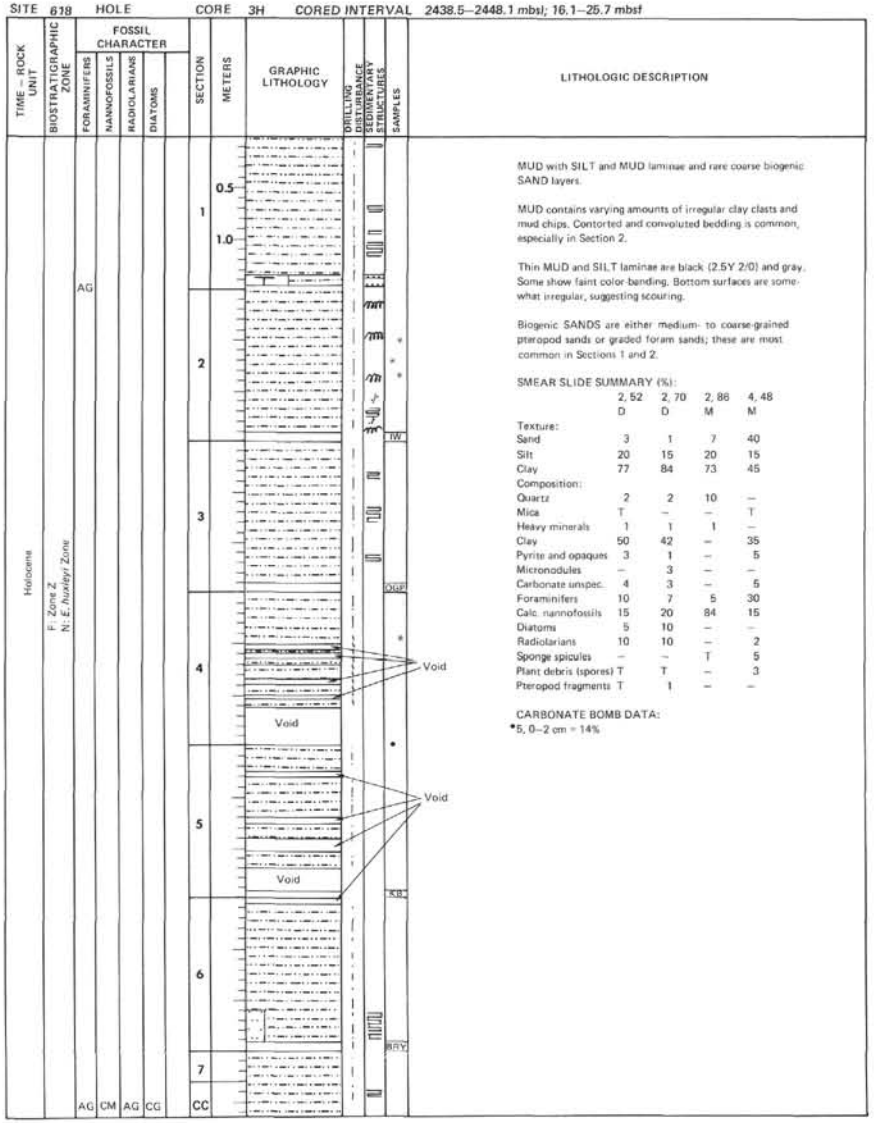
MUD, dominantly dark gray (5Y 4/1) with minor intervals of very dark gray (2.5Y 3/1), gray (5Y 5/1), and black (2.5Y 4/1). Core is dominantly homogeneous and very deformed. The core surface has a spongy texture caused by gas bubble "pockets". Sections 4–7 and Core Catcher contain rare clayey or mud blebs.

SMEAR SLIDE SUMMARY (%):

	4, 50 D
Texture:	
Sand	0
Silt	40
Clay	60
Composition:	
Quartz	23
Feldspar	T
Clay	60
Volcanic glass	2
Pyrite	T
Calc. nannofossils	5
Sponge spicules	T
Altered minerals	10

CARBONATE BOMB DATA:
*5, 54–56 cm = 15%

SITE 618 HOLE CORE 3H CORED INTERVAL 2438.5–2448.1 mbsl; 16.1–25.7 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT and MUD laminae and rare coarse biogenic SAND layers.

MUD contains varying amounts of irregular clay clasts and mud chips. Contorted and convoluted bedding is common, especially in Section 2.

Thin MUD and SILT laminae are black (2.5Y 2/0) and gray. Some show faint color-banding. Bottom surfaces are somewhat irregular, suggesting scouring.

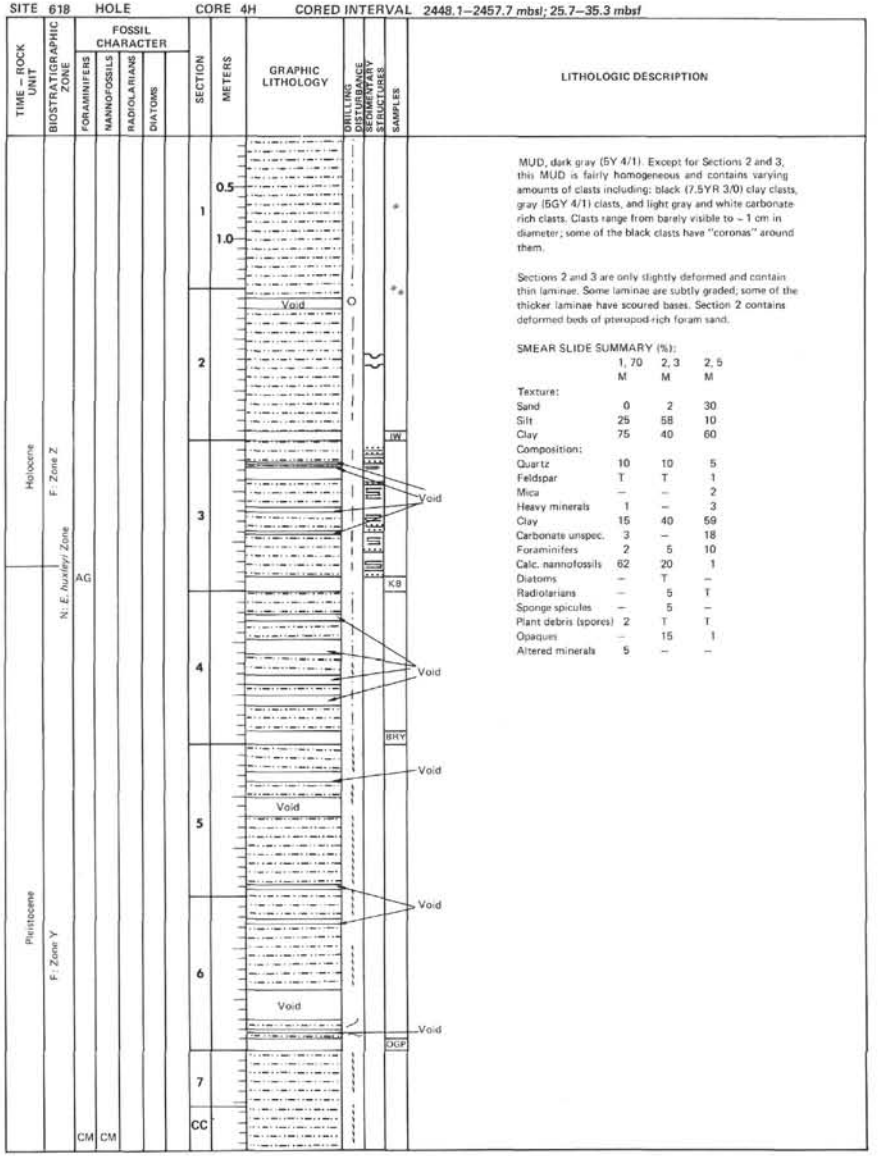
Biogenic SANDS are either medium- to coarse-grained pteropod sands or graded foram sands; these are most common in Sections 1 and 2.

SMEAR SLIDE SUMMARY (%):

	2, 52 D	2, 70 D	2, 86 M	4, 48 M
Texture:				
Sand	3	1	7	40
Silt	20	15	20	15
Clay	77	84	73	45
Composition:				
Quartz	2	2	10	—
Mica	T	—	—	T
Heavy minerals	1	1	1	—
Clay	50	42	—	35
Pyrite and opaques	3	1	—	5
Micronodules	—	3	—	—
Carbonate unspec.	4	3	—	5
Foraminifers	10	7	5	30
Calc. nannofossils	15	20	84	15
Diatoms	5	10	—	—
Radiolarians	10	10	—	2
Sponge spicules	—	—	T	5
Plant debris (spores)	T	T	—	3
Pteropod fragments	T	1	—	—

CARBONATE BOMB DATA:
*5, 0–2 cm = 14%

SITE 618 HOLE CORE 4H CORED INTERVAL 2448.1–2457.7 mbsl; 25.7–35.3 mbsf



LITHOLOGIC DESCRIPTION

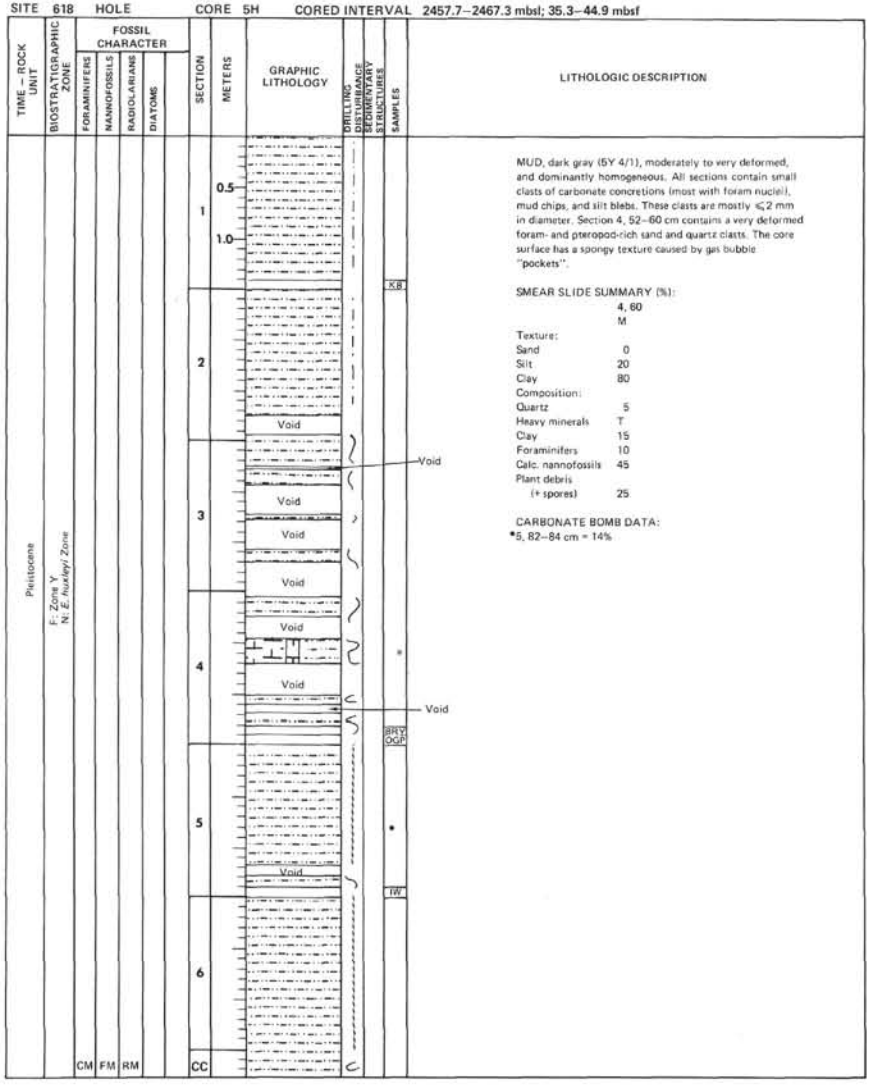
MUD, dark gray (5Y 4/1). Except for Sections 2 and 3, this MUD is fairly homogeneous and contains varying amounts of clasts including: black (7.5YR 3/0) clay clasts, gray (5GY 4/1) clasts, and light gray and white carbonate-rich clasts. Clasts range from barely visible to ~ 1 cm in diameter; some of the black clasts have "coronas" around them.

Sections 2 and 3 are only slightly deformed and contain thin laminae. Some laminae are subtly graded; some of the thicker laminae have scoured bases. Section 2 contains deformed beds of pteropod-rich foram sand.

SMEAR SLIDE SUMMARY (%):

	1, 70 M	2, 3 M	2, 5 M
Texture:			
Sand	0	2	30
Silt	25	58	10
Clay	75	40	60
Composition:			
Quartz	10	10	5
Feldspar	T	T	1
Mica	—	—	2
Heavy minerals	1	—	3
Clay	15	40	59
Carbonate unspec.	3	—	18
Foraminifers	2	5	10
Calc. nannofossils	62	20	1
Diatoms	—	T	—
Radiolarians	—	5	T
Sponge spicules	—	5	—
Plant debris (spores)	2	T	T
Opaques	—	15	1
Altered minerals	5	—	—

SITE 618 HOLE CORE 5H CORED INTERVAL 2457.7–2467.3 mbsf; 35.3–44.9 mbsf



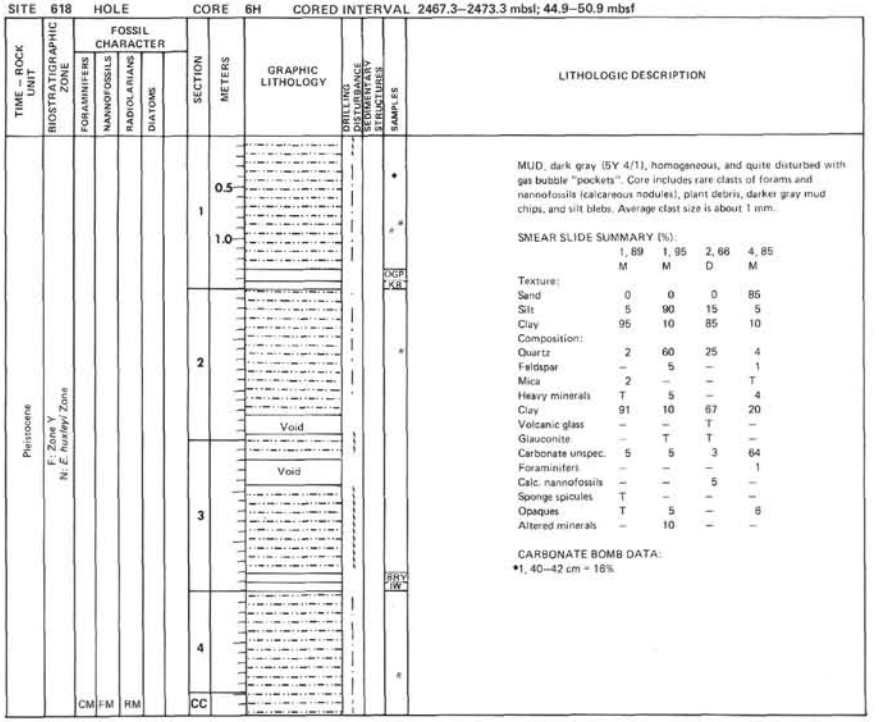
MUD, dark gray (5Y 4/1), moderately to very deformed, and dominantly homogeneous. All sections contain small clasts of carbonate concretions (most with foram nuclei), mud chips, and silt blebs. These clasts are mostly ≤2 mm in diameter. Section 4, 52–60 cm contains a very deformed foram- and pteropod-rich sand and quartz clasts. The core surface has a spongy texture caused by gas bubble "pockets".

SMEAR SLIDE SUMMARY (%):

	4, 60 M
Texture:	
Sand	0
Silt	20
Clay	80
Composition:	
Quartz	5
Heavy minerals	T
Clay	15
Foraminifers	10
Calc. nannofossils	45
Plant debris (+ spores)	25

CARBONATE BOMB DATA:
*5, 82–84 cm = 14%

SITE 618 HOLE CORE 6H CORED INTERVAL 2467.3–2473.3 mbsf; 44.9–50.9 mbsf



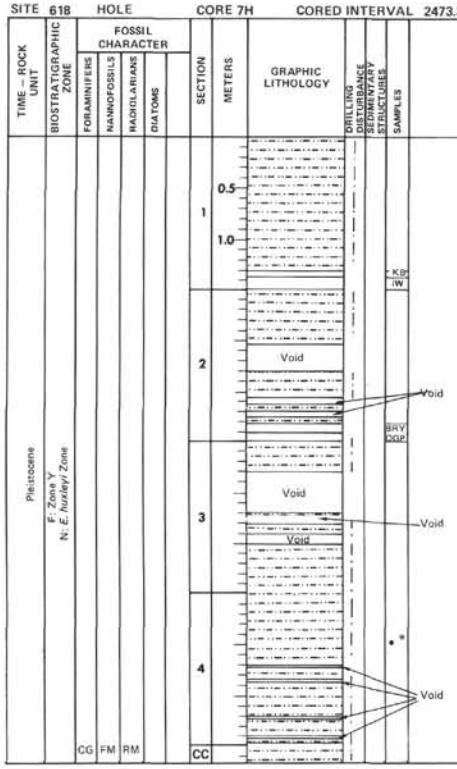
MUD, dark gray (5Y 4/1), homogeneous, and quite disturbed with gas bubble "pockets". Core includes rare clasts of forams and nannofossils (calcareous nodules), plant debris, darker gray mud chips, and silt blebs. Average clast size is about 1 mm.

SMEAR SLIDE SUMMARY (%):

	1, 89 M	1, 95 M	2, 66 D	4, 85 M
Texture:				
Sand	0	0	0	85
Silt	5	90	15	5
Clay	95	10	85	10
Composition:				
Quartz	2	60	25	4
Feldspar	–	5	–	1
Mica	2	–	–	T
Heavy minerals	T	5	–	4
Clay	91	10	67	20
Volcanic glass	–	–	T	–
Glauconite	–	T	T	–
Carbonate unspec.	5	5	3	64
Foraminifers	–	–	–	1
Calc. nannofossils	–	–	5	–
Sponge spicules	T	–	–	–
Opaques	T	5	–	6
Altered minerals	–	10	–	–

CARBONATE BOMB DATA:
*1, 40–42 cm = 16%

SITE 618 HOLE CORE 7H CORED INTERVAL 2473.3–2479.3 mbsl; 50.9–56.9 mbsf



LITHOLOGIC DESCRIPTION

MUD, dark gray (5Y 4/1), homogeneous, and quite disturbed with gas bubble "pockets". Core includes rare clasts of foraminifera with nannofossil cement, quartz-rich SILT, red and black clay chips, shell fragments, carbonate concretions with pyrite coating. Average clast size is about 1 mm.

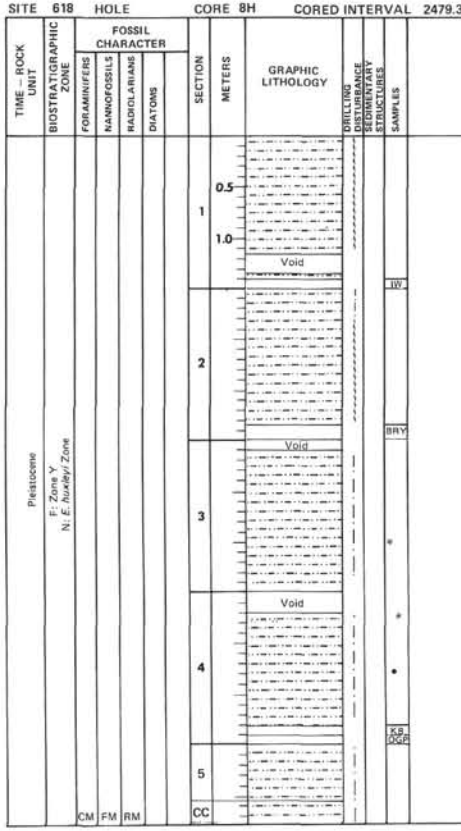
SMEAR SLIDE SUMMARY (%):

	4, 43 M
Texture:	
Sand	0
Silt	2
Clay	98
Composition:	
Quartz	1
Clay	2
Carbonate unspec.	2
Sponge spicules	T
Opaques	95

CARBONATE BOMB DATA:

*4, 50–52 cm = 16%

SITE 618 HOLE CORE 8H CORED INTERVAL 2479.3–2485.9 mbsf



LITHOLOGIC DESCRIPTION

MUD, dark gray (5Y 4/1), homogeneous, and quite disturbed with gas bubble "pockets". Section 1 and 2 contain extensive soupy areas. Core includes clasts similar to those described in Core 7H.

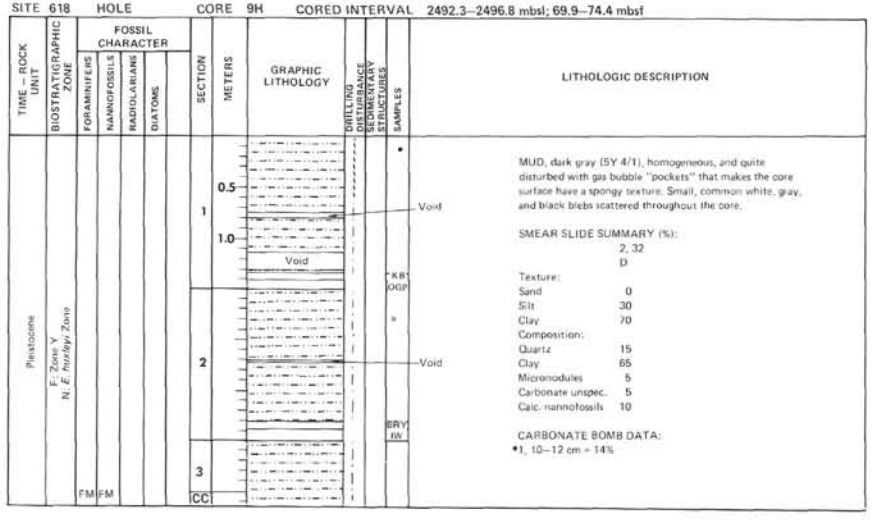
SMEAR SLIDE SUMMARY (%):

	3, 100 M	4, 28 M
Texture:		
Sand	20	25
Silt	65	65
Clay	15	10
Composition:		
Quartz	55	49
Feldspar	–	1
Mica	T	5
Heavy minerals	5	10
Clay	15	10
Volcanic glass	T	–
Carbonate unspec.	5	10
Calc. nannofossils	10	–
Sponge spicules	T	–
Altered minerals	10	15

CARBONATE BOMB DATA:

*4, 80–82 cm = 14%

SITE 618 HOLE CORE 9H CORED INTERVAL 2492.3–2496.8 mbsl; 69.9–74.4 mbsf



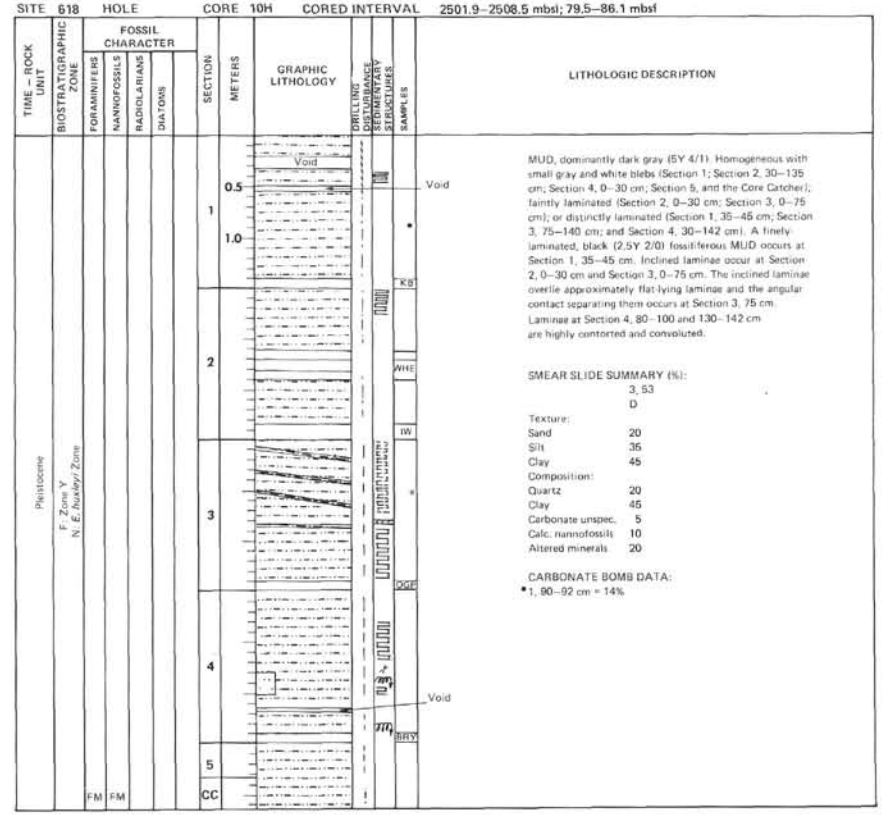
MUD, dark gray (5Y 4/1), homogeneous, and quite disturbed with gas bubble "pockets" that makes the core surface have a spongy texture. Small, common white, gray, and black blebs scattered throughout the core.

SMEAR SLIDE SUMMARY (%):

	2, 32 D
Texture:	
Sand	0
Silt	30
Clay	70
Composition:	
Quartz	15
Clay	65
Micronodules	5
Carbonate unspec.	5
Calc. nannofossils	10

CARBONATE BOMB DATA:
*1, 10–12 cm = 14%

SITE 618 HOLE CORE 10H CORED INTERVAL 2501.9–2508.5 mbsl; 79.5–86.1 mbsf



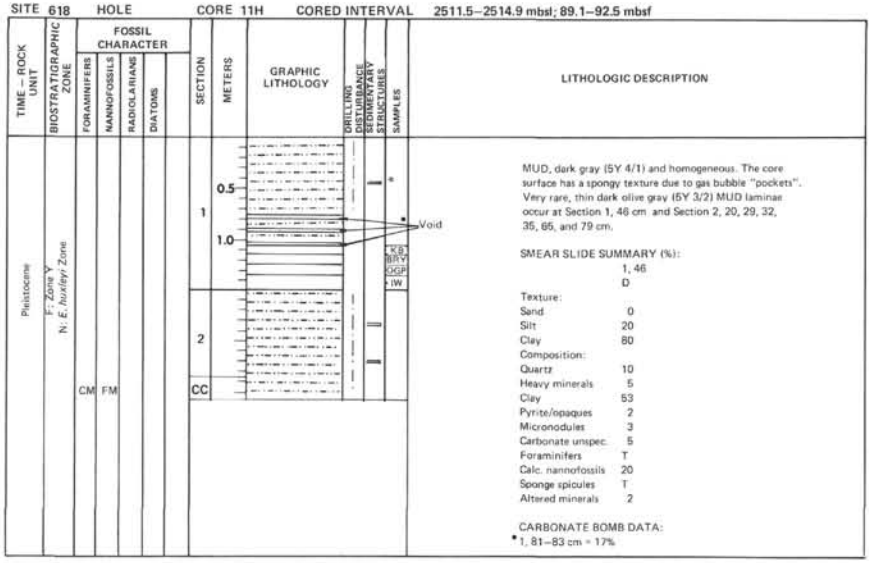
MUD, dominantly dark gray (5Y 4/1). Homogeneous with small gray and white blebs (Section 1; Section 2, 30–135 cm; Section 4, 0–30 cm; Section 5, and the Core Catcher); faintly laminated (Section 2, 0–30 cm; Section 3, 0–75 cm); or distinctly laminated (Section 1, 35–45 cm; Section 3, 75–140 cm; and Section 4, 30–142 cm). A finely laminated, black (2.5Y 2/0) fossiliferous MUD occurs at Section 1, 35–45 cm. Inclined laminae occur at Section 2, 0–30 cm and Section 3, 0–75 cm. The inclined laminae overlie approximately flat-lying laminae and the angular contact separating them occurs at Section 3, 75 cm. Laminae at Section 4, 80–100 and 130–142 cm are highly contorted and convoluted.

SMEAR SLIDE SUMMARY (%):

	3, 53 D
Texture:	
Sand	20
Silt	35
Clay	45
Composition:	
Quartz	20
Clay	45
Carbonate unspec.	5
Calc. nannofossils	10
Altered minerals	20

CARBONATE BOMB DATA:
*1, 90–92 cm = 14%

SITE 618 HOLE CORE 11H CORED INTERVAL 2511.5–2514.9 mbsl; 89.1–92.5 mbsf



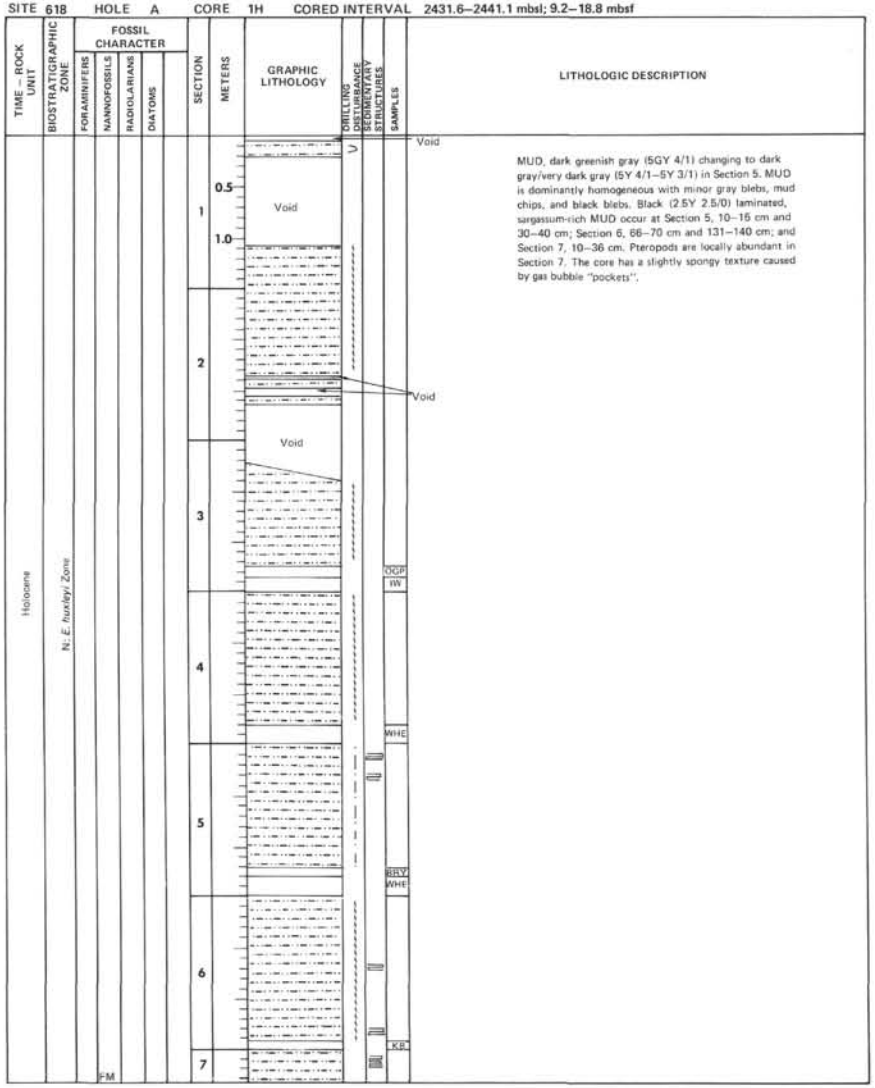
MUD, dark gray (5Y 4/1) and homogeneous. The core surface has a spongy texture due to gas bubble "pockets". Very rare, thin dark olive gray (5Y 3/2) MUD laminae occur at Section 1, 46 cm and Section 2, 20, 29, 32, 35, 65, and 79 cm.

SMEAR SLIDE SUMMARY (%):

	1, 46 D
Texture:	
Sand	0
Silt	20
Clay	80
Composition:	
Quartz	10
Heavy minerals	5
Clay	53
Pyrite/opaques	2
Micronodules	3
Carbonate unspec.	5
Foraminifers	T
Calc. nannofossils	20
Sponge spicules	T
Altered minerals	2

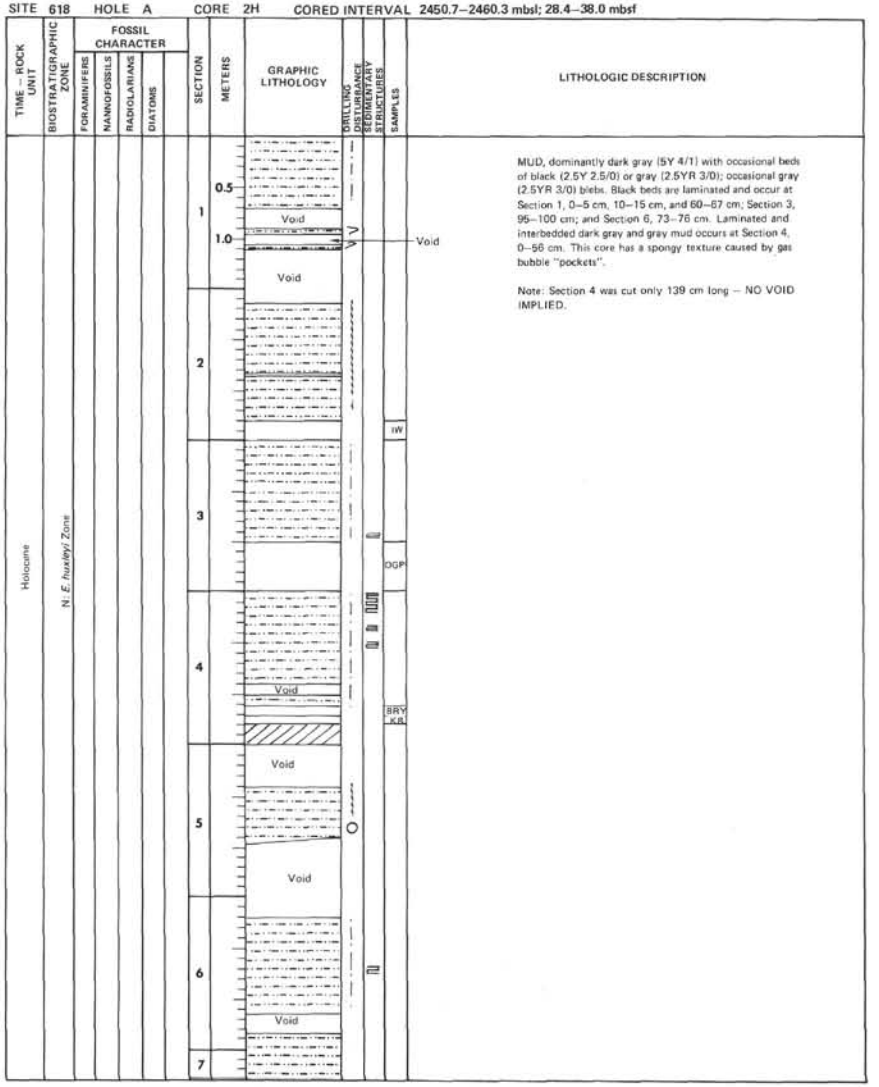
CARBONATE BOMB DATA:
*1, 81–83 cm = 17%

SITE 618 HOLE A CORE 1H CORED INTERVAL 2431.6–2441.1 mbsl; 9.2–18.8 mbsf



MUD, dark greenish gray (5GY 4/1) changing to dark gray/very dark gray (5Y 4/1–5Y 3/1) in Section 5. MUD is dominantly homogeneous with minor gray blebs, mud chips, and black blebs. Black (2.5Y 2.5/0) laminated, sargassum-rich MUD occur at Section 5, 10–16 cm and 30–40 cm; Section 6, 66–70 cm and 131–140 cm; and Section 7, 10–36 cm. Pteropods are locally abundant in Section 7. The core has a slightly spongy texture caused by gas bubble "pockets".

SITE 618 HOLE A CORE 2H CORED INTERVAL 2450.7–2460.3 mbsl; 28.4–38.0 mbsf



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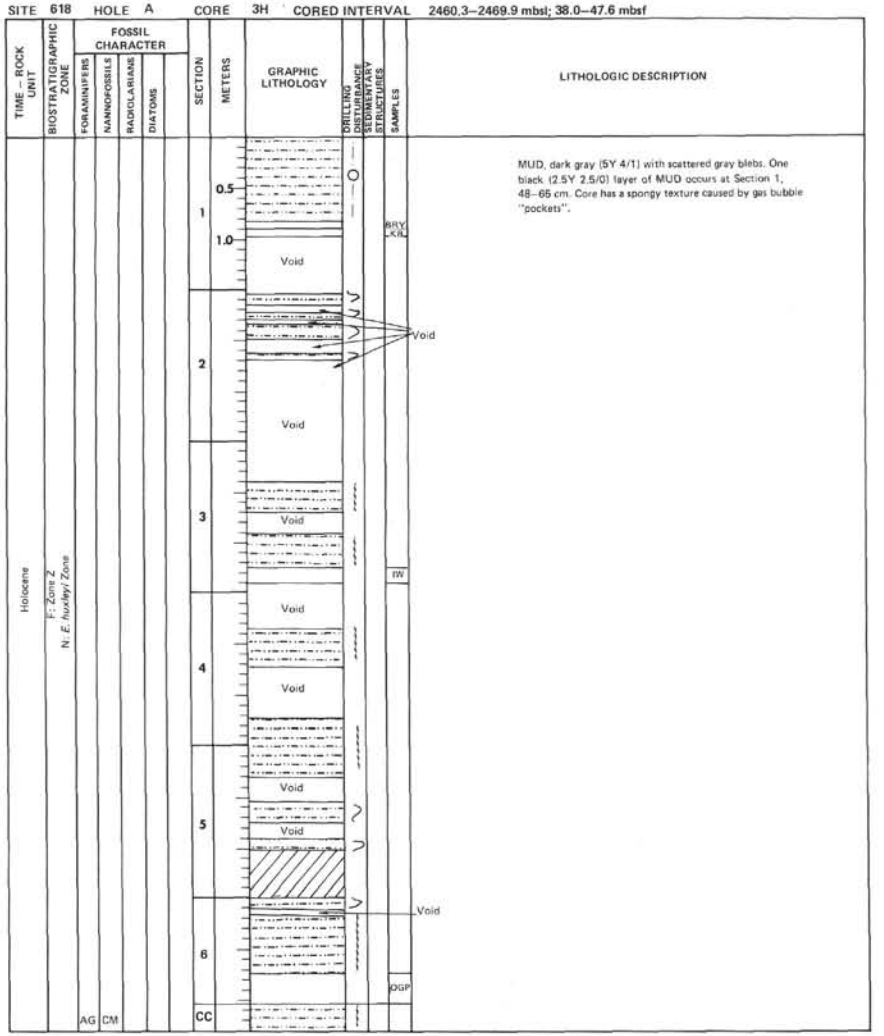

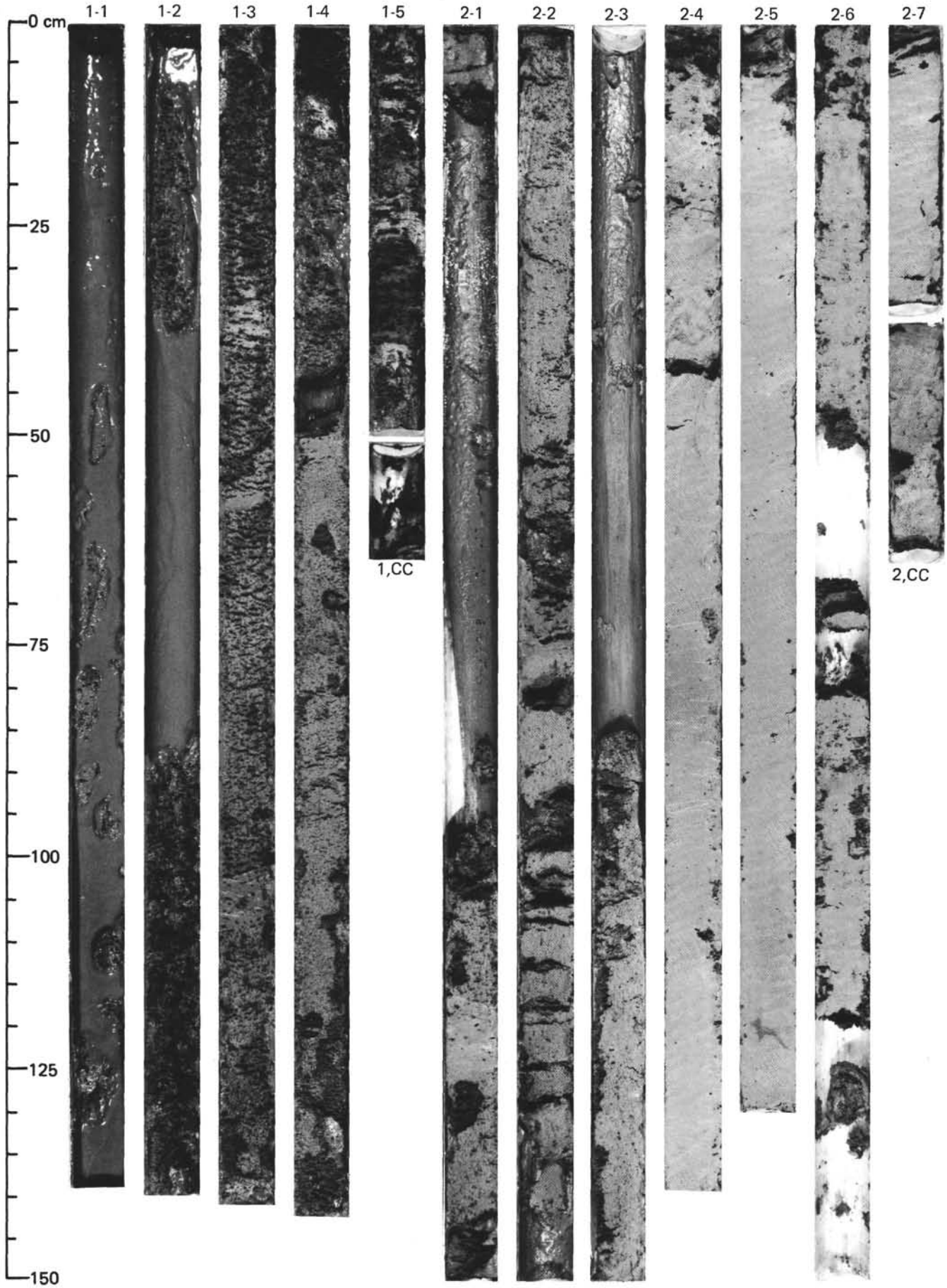
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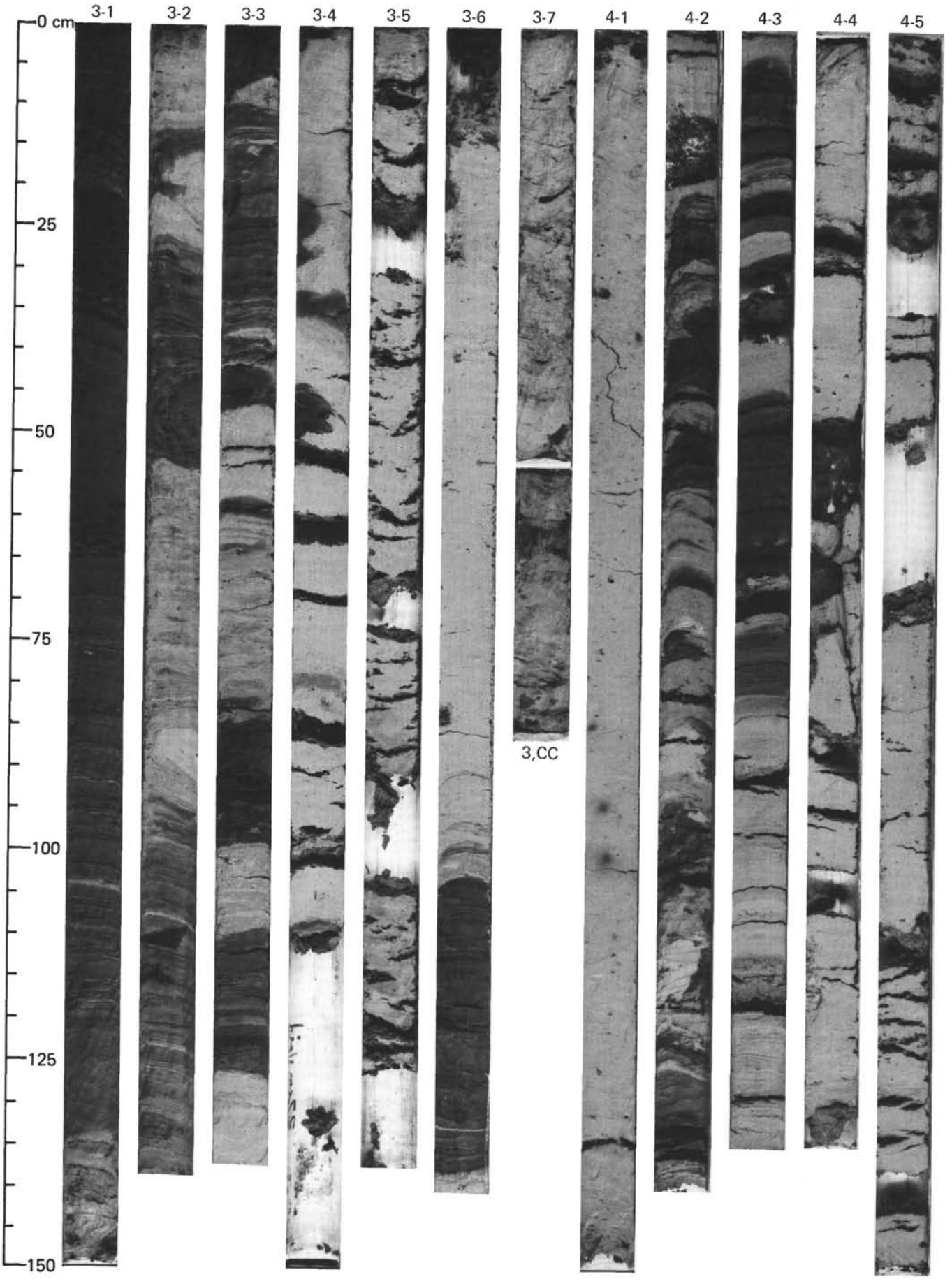
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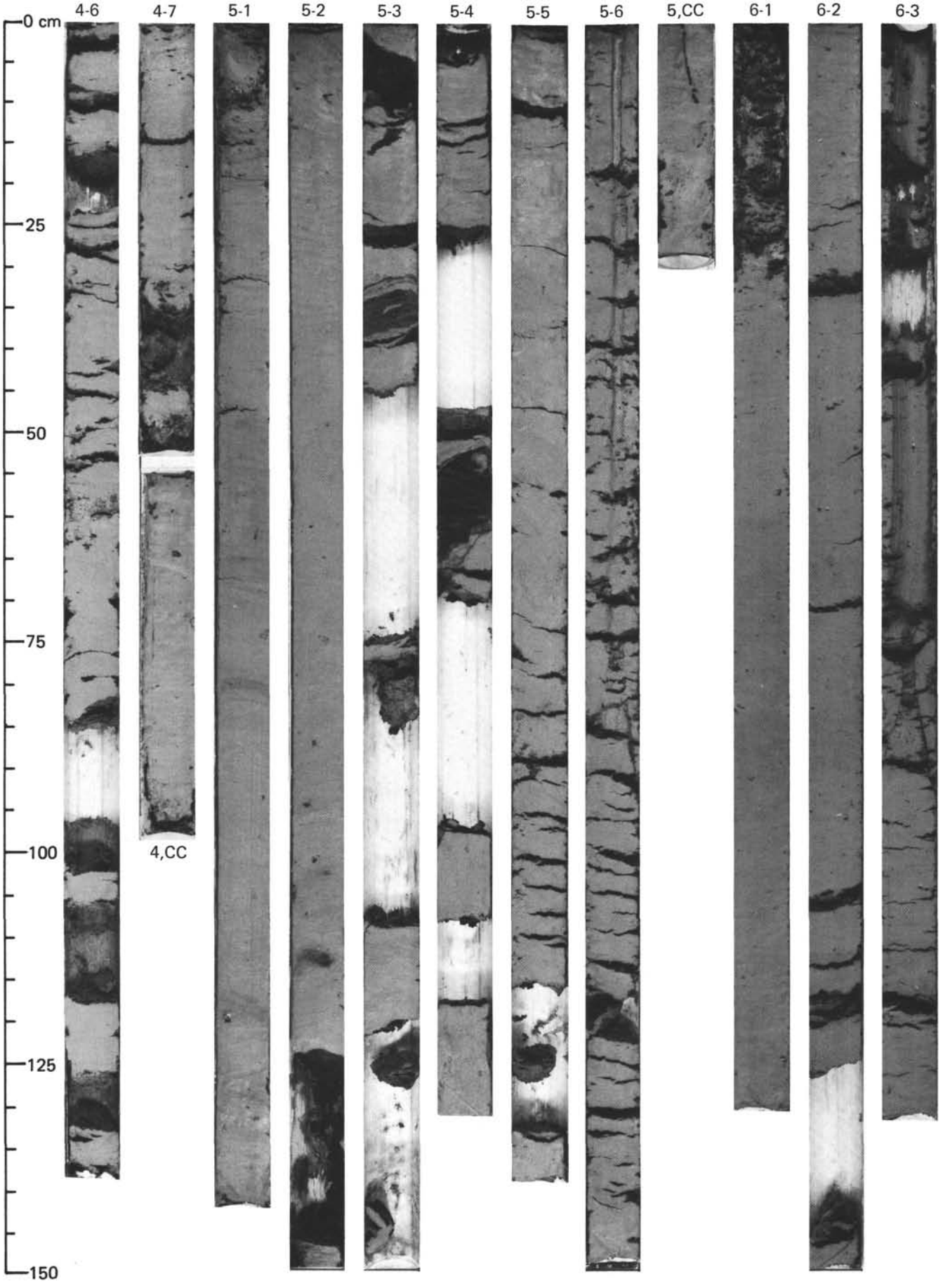
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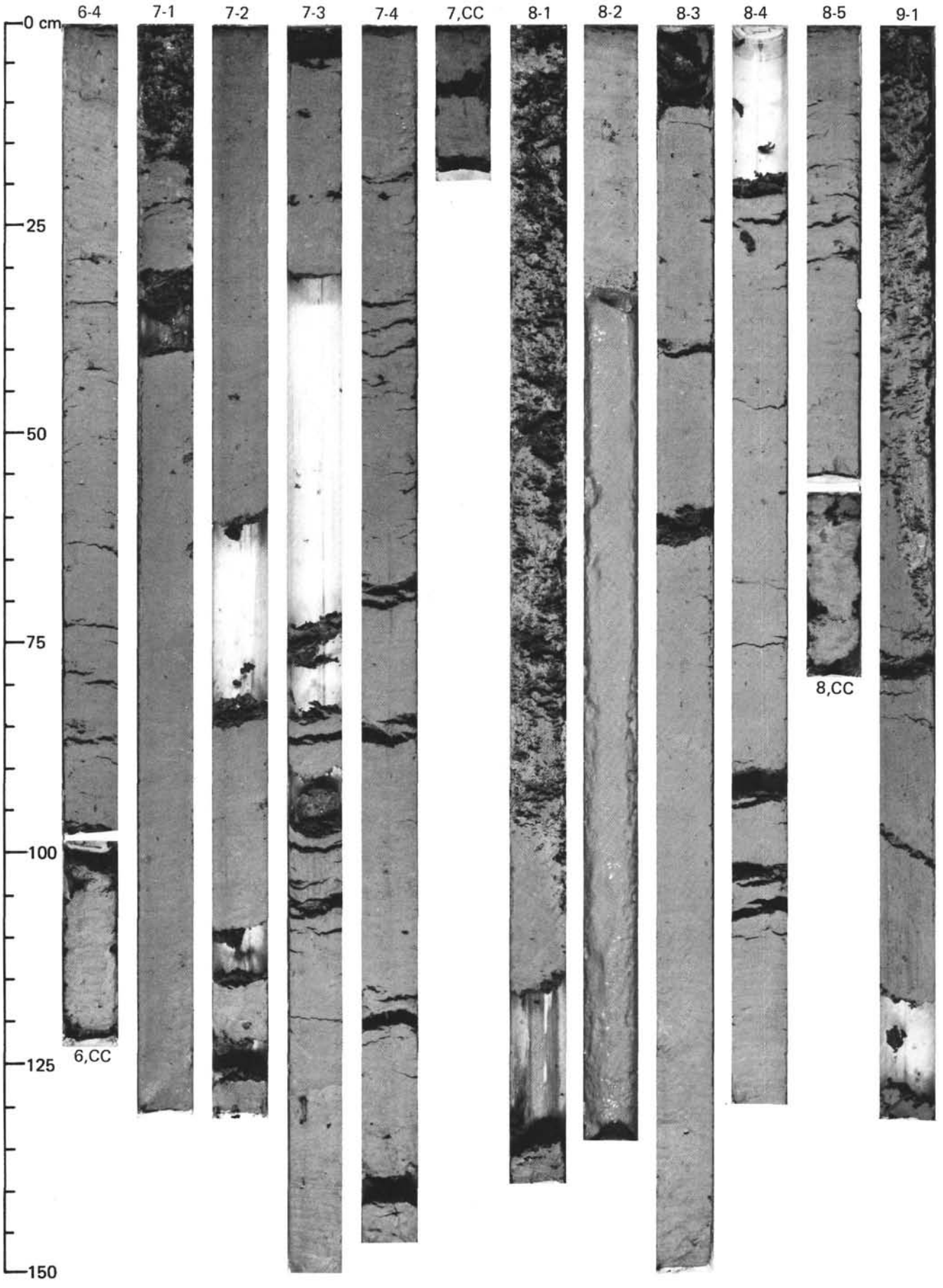
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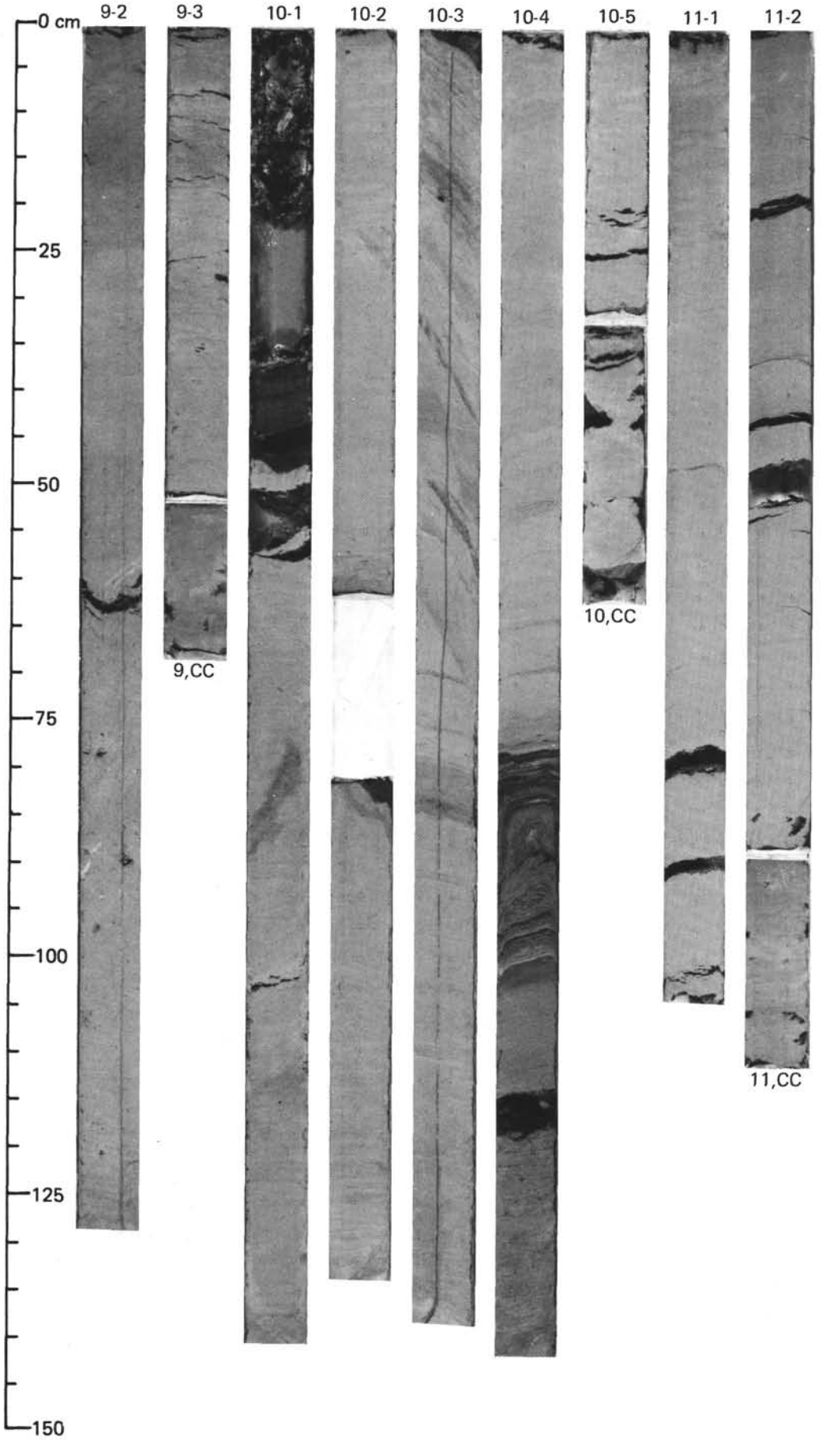
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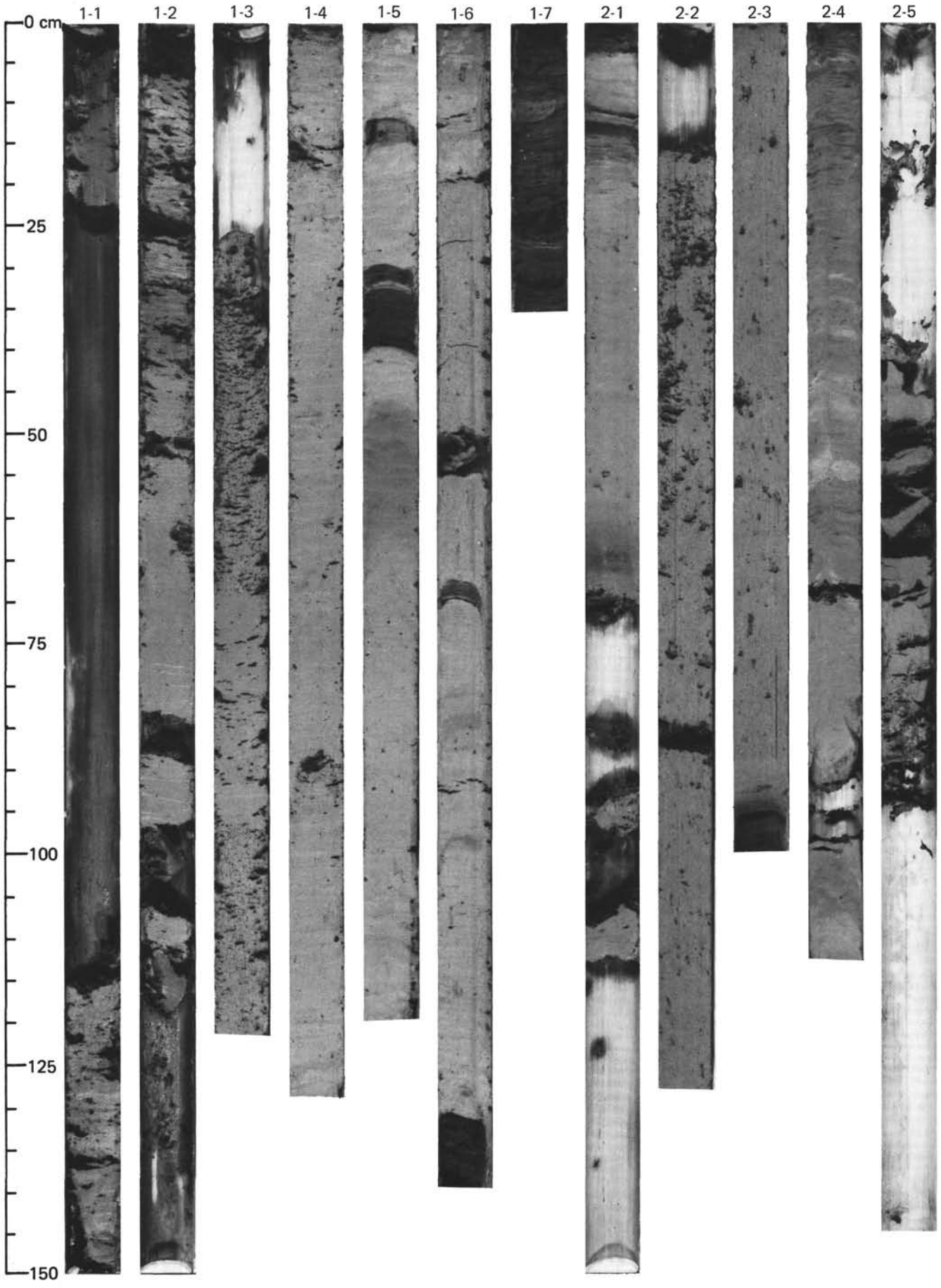
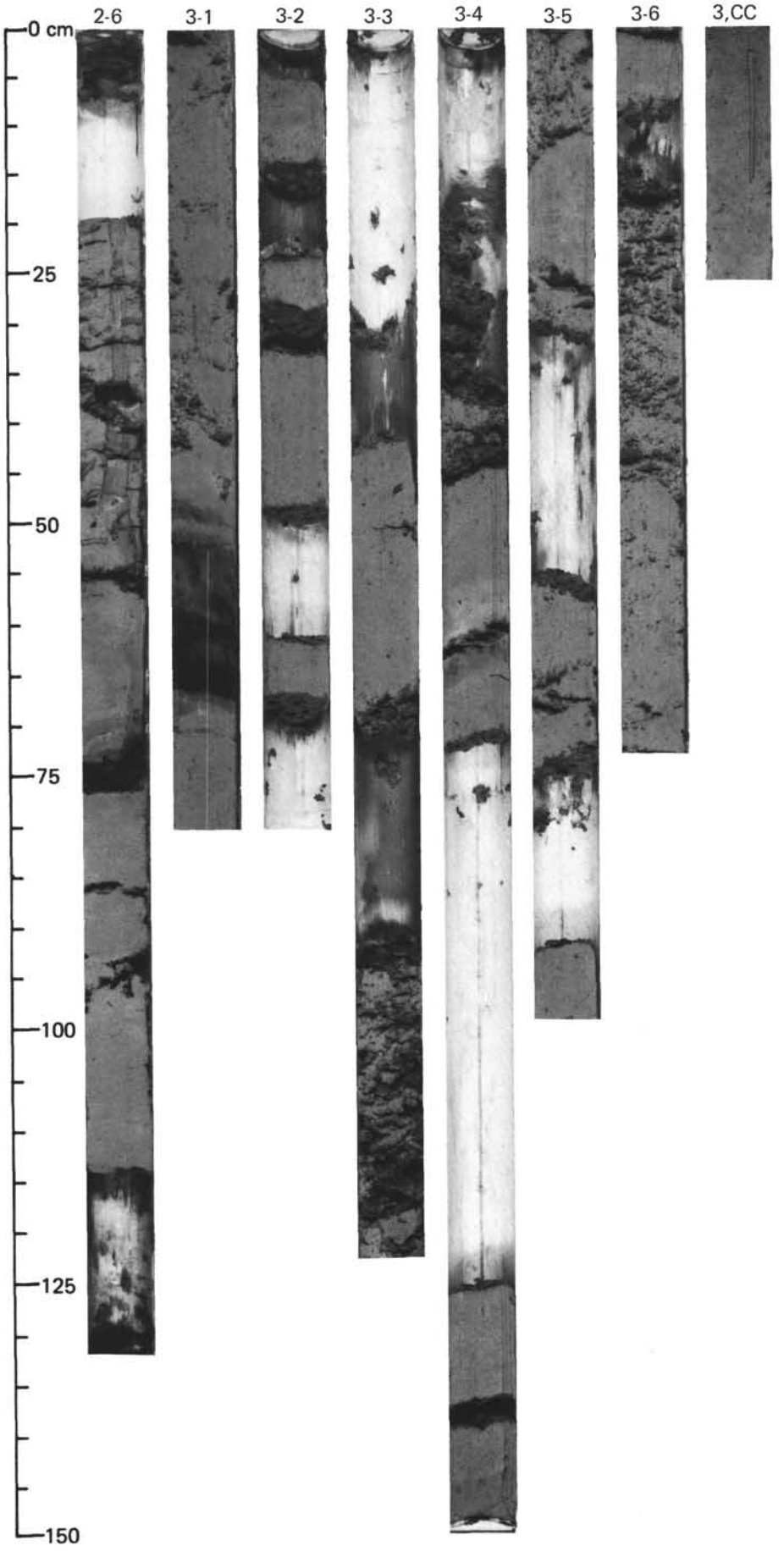
75
100
125
150
9-2
9-3
10-1
10-2
10-3
10-4
10-5
11-1
11-2
9,CC
10,CC
11,CC


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


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