14. SITE 616[1]

Shipboard Scientific Party[2]

HOLE 616

Date occupied: 11 October 1983, 0745 LCT

Date departed: 14 October 1983, 0930 LCT

Time on hole: 3 days, 2 hr.

Position: 26°48.67′N, 86°52.83′W

Water depth (sea level; corrected m, echo-sounding): 2983

Water depth (rig floor; corrected m, echo-sounding): 2993

Bottom felt (m, drill pipe): 2998.9

Penetration (m): 371

Number of cores: 34

Total length of cored section (m): 307.8

Total core recovered (m): 143.38

Core recovery (%): 47

Oldest sediment cored:
Depth sub-bottom (m): 371
Nature: Clay
Age: Pleistocene (Ericson Zone Y)
Measured velocity (km/s): 1.70

Basement: N/A

HOLE 616A

Date occupied: 14 October 1983, 1917 LCT

Date departed: 15 October 1983, 0726 LCT

Time on hole: 12 hr.

Position: 26°48.65′N, 86°52.86′W

Water depth (sea level; corrected m, echo-sounding): 2983

Water depth (rig floor; corrected m, echo-sounding): 2993

Bottom felt (m, drill pipe): 2998.9

Penetration (m): 132.4

Number of cores: 4

Total length of cored section (m): 38.4

Total core recovered (m): 24.21

Core recovery (%): 63

Oldest sediment cored:
Depth sub-bottom (m): 132.4
Nature: Clay
Age: Pleistocene (Ericson Zone Y)
Measured velocity (km/s): 1.78

Basement: N/A

HOLE 616B

Date occupied: 15 October 1983, 0825 LCT

Date departed: 16 October 1983, 1445 LCT

Time on hole: 1 day, 6 hr.

Position: 26°48.66′N, 86°52.85′W

Water depth (sea level; corrected m, echo-sounding): 2983

Water depth (rig floor; corrected m, echo-sounding): 2993

Bottom felt (m, drill pipe): 2998.8

Penetration (m): 204.3

Number of cores: 22

Total length of cored section (m): 143.2

Total core recovered (m): 113.74

Core recovery (%): 79

Oldest sediment cored:
Depth sub-bottom (m): 204.3
Nature: Clay
Age: Pleistocene (Ericson Zone Y)
Measured velocity (km/s): N/A

Basement: N/A

BACKGROUND AND OBJECTIVES

Site 616 is on the eastern margin of the modern Mississippi fan lobe in 2999 m of water. The site is approximately 195 km north of Site 615. Walker and Massingill (1970) mapped and described, from 3.5-kHz data, a large area of slump deposits; Site 616 is located within their slump mass.

The main central channel of the youngest fan lobe is located about 50 km south-southwest of the site. Based on seismic data, it was anticipated that sediments beneath the "slump deposits" would represent fine-grained

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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).

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overbank deposits or thin-bedded "interchannel" turbidites laid down on the margins of a fan lobe.

Only sparse high-resolution data are available in the vicinity of the drilling site. The sub-bottom 3.5-kHz profiler records show little or no penetration with the exception of a few isolated dipping reflectors. Deep-tow 4.5-kHz records acquired approximately 20 km west of the site (in the same "slump deposits") also illustrate dipping reflectors. However, they appear to be concentrated within certain sections, giving the appearance of multiple sequences of slide blocks. Single-channel airgun records illustrate a transparent zone, some 109 m thick, overlying high-amplitude discontinuous reflectors. Individual reflectors are extremely difficult to correlate and only sets or packages of reflectors could be traced within the area. The base of the modern fan lobe is 213 m below the seafloor, according to common depth point (CDP) data.

Site 616 was drilled to satisfy the following objectives:

1. To determine the nature and thickness of the upper seismically transparent unit ("slump deposit") and to assess the nature of the mechanism responsible for its emplacement,

2. To obtain sedimentological, paleontological, geochemical, and geotechnical properties of the sediments comprising the lateral margins of a fan lobe in the middle fan area, and

3. To determine the nature of the boundary between the modern fan lobe and the underlying lobe.

OPERATIONS

Hole 616

The drill site is located about 288 km southeast of the tip of the Mississippi River delta. The transit from Site 615 was made in 11¼ hr. and a beacon was released at 0745 hr., 11 October. After an additional 1½ hr. of profiling, the vessel returned to take station on the beacon, which was functioning perfectly.

Following the pipe trip, two unsuccessful attempts were made to capture the sediment/water interface with the advanced piston corer (APC). Both core barrels were recovered without core and with the breakaway piston head resting at the bottom of the liner. The first barrel stroked to 3000.5 m and had traces of sediment on the core catcher. The second extended to 2997.5 m and was recovered without a trace. For the third attempt, a fixed piston head was installed, and the bit was positioned at 2995.5 m. The 9.5-m corer recovered 6.1 m of core, and water depth was established at 2998.9 m (compared with 2983 m precision depth recorder depth) (Table 1).

Good results were obtained with the APC through clay and silt to about 75 m sub-bottom, where recovery dropped to about 50%. The APC was replaced by the extended core barrel (XCB) system at 104 m sub-bottom, but four consecutive cores produced a total recovery of only 1.36 m. Three APC cores then achieved about a half stroke before a withdrawal overpull of 95,000 lb. again prompted a switch to XCB coring. Two consecutive XCB cores yielded only 0.83 m of sediment. With

Table 1. Site 616 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 616							
1H	11	1705	2998.9-3005.0	0.0-6.1	6.1	6.10	100
2H	11	1831	3005.0-3014.5	6.1-15.6	9.5	8.91	94
3H	11	1925	3014.5-3024.0	15.6-25.1	9.5	9.41	99
4H	11	2018	3024.0-3033.5	25.1-34.6	9.5	9.52	100
5H	11	2145	3033.5-3043.1	34.6-44.2	9.6	9.20	96
6H	11	2220	3043.1-3052.7	44.2-53.8	9.6	8.53	89
7H	11	2330	3052.7-3062.3	53.8-63.4	9.6	8.98	94
8H	12	0040	3062.3-3071.9	63.4-73.0	9.6	4.01	42
9H	12	0123	3071.9-3081.5	73.0-82.6	9.6	5.32	55
10H	12	0229	3081.5-3091.1	82.6-92.2	9.6	4.68	49
11H	12	0450	3091.1-3100.7	92.2-101.8	9.6	4.77	50
Wash	12		3100.7-3102.9	101.8-104.0	—	—	—
12X	12	0625	3102.9-3112.5	104.0-113.6	9.6	0.00	0
13X	12	0803	3112.5-3122.1	113.6-123.2	9.6	1.33	14
14X	12	0905	3122.1-3131.7	123.2-132.8	9.6	0.01	tr
15X	12	1005	3131.7-3141.3	132.8-142.4	9.6	0.02	tr
16H	12	1102	3141.3-3147.9	142.4-149.0	6.6	6.58	99
Wash	12		3147.9-3150.9	149.0-152.0	—	—	—
17H	12	1215	3150.9-3156.2	152.0-157.3	5.3	5.05	95
Wash	12		3156.2-3160.5	157.3-161.6	—	—	—
18H	12	1320	3160.5-3164.4	161.6-165.5	3.9	3.85	99
Wash	12		3164.4-3170.1	165.5-171.2	—	—	—
19X	12	1438	3170.1-3179.6	171.2-180.7	9.5	tr	0
20X	12	1605	3179.6-3189.1	180.7-190.2	9.5	0.83	9
21W	12	1750	3189.1-3208.2	190.2-209.3	9.5	4.08	43
22W	12	1915	3208.2-3227.4	209.3-228.5	9.6	1.77	18
23W	12	2035	3227.4-3246.6	228.5-247.7	9.6	1.65	17
24W	12	2230	3246.6-3265.8	247.7-266.9	9.6	2.48	26
25W	13	0022	3265.8-3285.0	266.9-286.1	9.6	tr	0
26X	13	0200	3285.0-3294.6	286.1-295.7	9.6	1.27	13
27X	13	0332	3294.6-3304.2	295.7-305.3	9.6	tr	0
28X	13	0550	3304.2-3313.8	305.3-314.9	9.6	3.65	38
29X	13	0700	3313.8-3323.2	314.9-324.3	9.4	0.14	1
30X	13	0827	3323.2-3332.6	324.3-333.7	9.4	9.57	100
31X	13	0950	3332.6-3342.0	333.7-343.1	9.4	0.00	0
32X	13	1125	3342.0-3351.3	343.1-352.4	9.3	9.45	100
33X	13	1255	3351.3-3360.6	352.4-361.7	9.3	5.03	54
34X	13	1415	3360.6-3369.9	361.7-371.0	9.3	7.19	77
					307.8	143.38	47
Hole 616A							
Wash	14		2998.9-3033.5	0.0-34.6	—	—	—
1H	14	2145	3033.5-3043.1	34.6-44.2	9.6	0.38	4
Wash	14		3043.1-3102.5	44.2-103.6	—	—	—
2H	15	0033	3102.5-3112.1	103.6-113.2	9.6	7.83	82
3H	15	0135	3112.1-3121.7	113.2-122.8	9.6	8.57	89
4H	15	0530	3121.7-3131.3	122.8-132.4	9.6	7.43	77
					38.4	24.21	63
Hole 616B							
1H	15	0845	2998.8-3006.5	0.0-7.7	7.7	7.62	99
2H	15	0940	3006.5-3016.1	7.7-17.3	9.6	9.57	99
3H	15	1040	3016.1-3025.7	17.3-26.9	9.6	9.07	94
4H	15	1123	3025.7-3035.3	26.9-36.5	9.6	8.82	92
5H	15	1220	3035.3-3044.9	36.5-46.1	9.6	8.63	90
6H	15	1320	3044.9-3054.5	46.1-55.7	9.6	7.77	81
7H	15	1430	3054.5-3064.1	55.7-65.3	9.6	4.99	52
8H	15	1520	3064.1-3073.7	65.3-74.9	9.6	6.42	67
9H	15	1600	3073.7-3083.3	74.9-84.5	9.6	4.17	43
10H	15	1700	3083.3-3092.9	84.5-94.1	9.6	3.42	36
11H	15	1815	3092.9-3096.4	94.1-97.6	3.5	3.23	92
Wash	15		3096.4-3102.5	97.6-103.7	—	—	—
12H	15	1915	3102.5-3106.9	103.7-108.1	4.4	4.35	99
Wash	15		3106.9-3112.1	108.1-113.3	—	—	—
13H	15	2110	3112.1-3119.1	113.3-120.3	7.0	6.77	97
Wash	15		3119.1-3121.7	120.3-122.9	—	—	—
14H	15	2250	3121.7-3126.1	122.9-127.3	4.4	4.31	98
Wash	15		3126.1-3131.3	127.3-132.5	-.-	-.—	-
15H	16	0038	3131.3-3134.4	132.5-135.6	3.1	3.04	98
Wash	16		3134.4-3140.9	135.6-142.1	-.-	-.—	-
16H	16	0210	3140.9-3147.9	142.1-149.1	7.0	2.80	40
Wash	16		3147.9-3150.5	149.1-151.7	-.-	-.—	-
17H	16	0325	3150.5-3152.4	151.7-153.6	1.9	1.87	98
Wash	16		3152.4-3160.0	153.6-161.2	—	—	—
18H	16	0440	3160.0-3164.5	161.2-165.7	4.5	4.26	95
Wash	16		3164.5-3169.5	165.7-170.7	—	—	—
19H	16	0600	3169.5-3172.4	170.7-173.6	2.9	2.74	94
Wash	16		3172.4-3179.0	173.6-180.2	—	—	—
20H	16	0725	3179.0-3179.5	180.2-180.7	0.5	0.20	40
Wash	16		3179.5-3188.6	180.7-189.8	—	—	—
21H	16	0835	3188.6-3193.6	189.8-194.8	5.0	4.83	97
Wash	16		3193.6-3198.2	194.8-199.4	—	—	—
22H	16	0937	3198.2-3203.1	199.4-204.3	4.9	4.86	99
					143.2	113.74	79

[a] H following core number indicates hydraulic piston core, X indicates extended core barrel, W indicates wash core.

recovery low, the XCB was retrieved on each second pipe joint to 286 m sub-bottom. Continuous XCB cores then gave increasingly good recovery to 371 m in very stiff clay. The XCB was then dropped for the final planned core, and a 40-barrel mud flush was pumped into the pipe to condition the hole for logging.

As the connection was being made for the final core, the drill string abruptly became stuck. This was completely unexpected, as no hole problems had been encountered up to that time. Two hours of working the pipe failed to budge it, and it became evident that the bottom-hole assembly (BHA) was permanently emplaced. Lack of bumper sub action indicated that the stuck point was more than 50 m above the bit.

Because of low core recovery through the lower two-thirds of the section, well logs had again become increasingly important for the fulfillment of the site's scientific objectives. The stuck pipe now precluded open-hole logging, but a through-pipe gamma-ray log could still be run to delineate the sand/clay boundaries. The logging sheaves were rigged, and a formation density/compensated neutron/gamma ray (FDC/CNL/GR) log was recorded. Surprisingly there were only about 4 m of fill, and 9 m of open hole were logged below the bit. The natural gamma-ray curve was quite readable and was even more useful than had been anticipated.

The severing apparatus was then assembled and run down the pipe. The primacord charge successfully parted the string in the lowermost joint of 5½-in. drill pipe. When the logging cable was retrieved, it was found that the line had parted just above the cable head, resulting in the loss of the casing collar locator and the shooting sinker bar assembly.

The drill pipe was then recovered and the severed joint arrived on deck at 0930 hr., 14 October.

Hole 616A

The second borehole was added to the drilling program to obtain an oriented core in a shallow zone of steeply dipping beds and to recore the interval of low recovery from 114 to 142 m sub-bottom in Hole 616.

Assembling and spacing out the replacement BHA added about 4 hr. to the downtrip time, and Hole 616A was spudded at 1917 hr. The hole was drilled without coring to 34.6 m below seafloor (BSF), where the oriented core was desired (Table 1).

The special nonspiraling APC assembly and the prototype gyro orientation tool were then deployed. The coring assembly was retrieved after an apparently normal actuation. Disappointment prevailed when the core barrel was found to contain only 38 cm of sediment. The sticky clay had held the core catchers open, allowing the core to fall out during retrieval. The misadventure was compounded when it was found that no orientation data had been recorded. The wiring of the gyro tool had been damaged during final assembly. It was further discovered that a pressure case O-ring seal had failed. The pressure case had flooded and the gyro was damaged beyond repair.

The hole was then drilled to 94 m BSF, where the pipe began torquing. A bentonite mud flush freed the pipe after a delay of ½ hr. Continuous coring began at 103.6 m, but operations were again interrupted after two cores when the APC became stuck in the drill pipe as it was lowered for Core 616A-4. Two additional wireline trips were made in attempts to dislodge the corer, but each time the overshot pin sheared and no progress was made. The APC was finally knocked to the bottom by pumping a standard inner barrel down the pipe at high speed. Core 616A-4 was "shot" and retrieved routinely, and no evidence was found as to the cause of the sticking. The following core attempt produced an incomplete stroke indication and no core was recovered. As this was to be the final core of the hole, no further attempt was made and coring operations were terminated to maintain the operating schedule. The core bit was then pulled clear of the seafloor for respudding.

Hole 616B

The final hole at Site 616 was a planned 200-m penetration dedicated to geotechnical purposes. Continuous APC cores were taken to about 95 m sub-bottom, where complete stroke of the corer was no longer achieved (Table 1). Coring then continued in the APC mode, with uncored intervals drilled off to maintain the operating pace of one pipe connection per core. At 165 m sub-bottom the withdrawal overpull following Core 616B-18 reached 90,000 lb. Coring force was reduced somewhat for the remaining four cores by using 1½ shearpins instead of the maximum three. Overpull then remained within operating limits to the total depth of 204.3 m sub-bottom (3203.1 m pipe depth).

Excessive torque was required to rotate the drill string on three occasions during the coring of Hole 616B. In each case, operations were interrupted to flush the hole with bentonite mud and the hole trouble disappeared.

After a routine pipe trip, the vessel got under way at 1445 hr., October 16.

SEISMIC STRATIGRAPHY AND ACOUSTIC FACIES

Site 616 is located near the northeastern margin of the modern fan lobe, about 50 km from the main leveed channel. The base of the modern fan lobe, marked by seismic Horizon "20," (introductory chapter, this volume), is about 210 m thick at this site—only slightly thicker than on the lower fan. One of the main objectives for this site was to drill through the large submarine slump deposit defined by Walker and Massingill (1970).

Relatively little seismic-profiling data is available for defining drilling objectives because no detailed site survey was conducted. Final selection of this site was based on Line 22 of the 1981 U.S. Geological Survey Cruise G-81-7 (Figs. 1 and 2).

Seismic Stratigraphy

The seismic characteristics near Site 616 are shown in Figure 2. The air-gun seismic reflection profile reveals few distinct seismic facies. The most prominent is the relatively transparent zone in the upper part of the section (generally above 4.18 s). The section between the

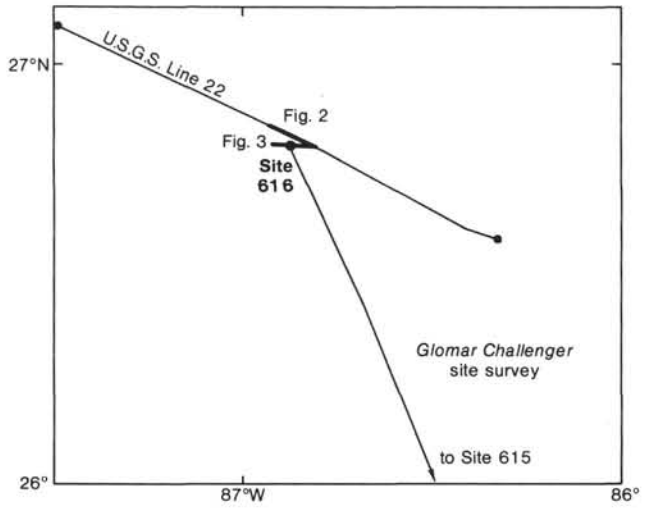

Figure 1. Map showing seismic survey tracklines near Site 616 and location of seismic profiles shown in Figures 2 and 3.

transparent zone and seismic Horizon "30" is generally devoid of any prominent reflector horizons. Rather, the section is typified by a chaotic mixture of continuous to discontinuous parallel reflectors and semitransparent zones with short parallel reflections.

The reflectors between the acoustically transparent zone and seismic Horizon "20" define a southeasterly thickening of this upper part of the section. This apparent change in thickness may result from differential compaction under the wedge of acoustically transparent material, which thins from 240 to 75 ms over a distance of 10 km. The area of this wedge-shaped unit is included within the slump terrain of Walker and Massingill (1970). How much (if any) of this wedge of acoustically transparent material is part of the proposed slump has been a widely debated issue.

Regional seismic lines crossing this portion of the fan suggest that the two youngest fan lobes were probably receiving sediment from at least two different sources in this region (Stelting et al., this volume). The chaotic nature of the seismic profile and the interfingering of minor seismic packages shown in Figure 2 support this concept.

Acoustic Facies

The 3.5-kHz reflection profile (Fig. 3) shows a prolonged or diffuse echo character with no mappable subbottom reflectors. This reflection character could result from either a slump/debris flow surface or from sandy sediment at the seafloor (Damuth, 1978; Normark et al., 1979). The seafloor itself shows local relief of a few meters in the vicinity of the drill site. About 1 km south of the drill site, at the abrupt break in slope, the shipboard 3.5-kHz profile (not shown) indicates that this reflection character likewise changes abruptly. To the south of the break in slope, the more gently sloping seafloor is underlain by several discontinuous subparallel reflectors in the upper 15 m (see fig. 6 in Walker and Massingill, 1970). Both the geometry and character of the reflector patterns are consistent with Site 616 being near the margin of a slump/debris flow.

One unusual feature of the profile in Figure 3 is that most of the hyperbolic ("side") echoes dip westward.

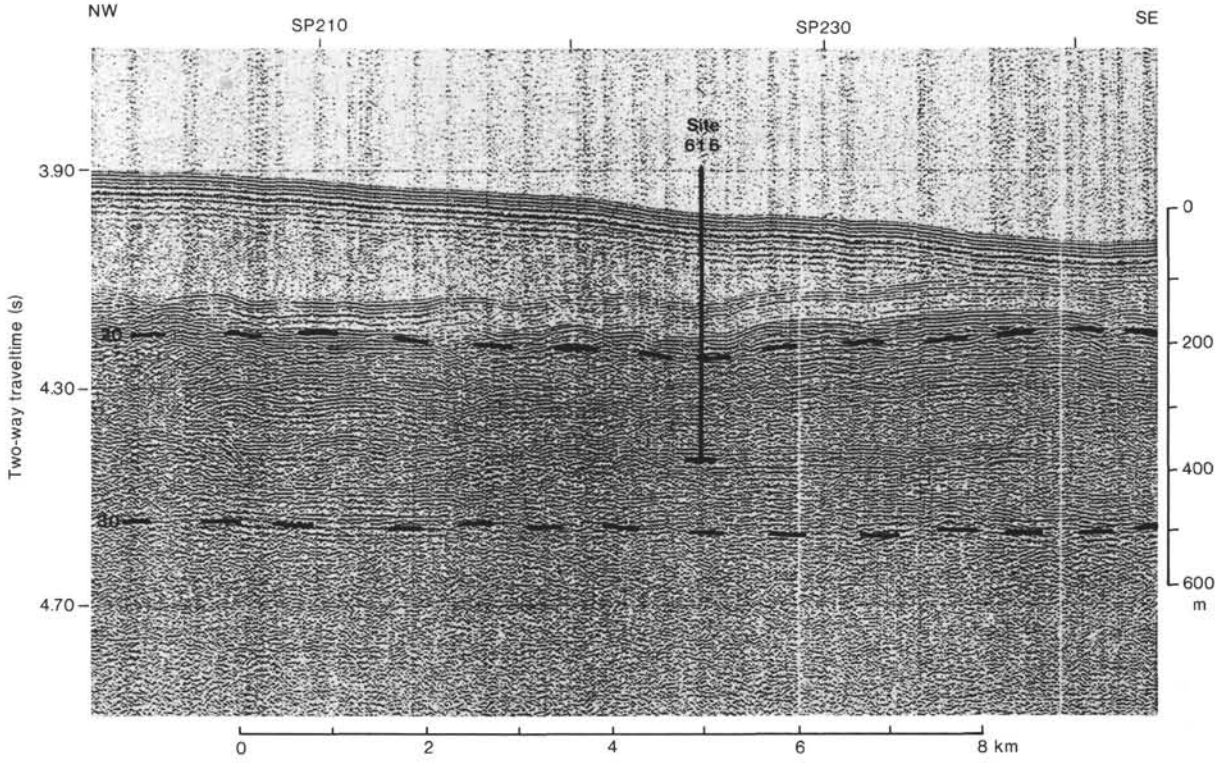

Figure 2. Single-channel air-gun seismic reflection profile (Line 22, 1981 U.S. Geological Survey *Gyre* Cruise G-81-7) which passes about 2 km northeast of Site 616. See Figure 1 for location.

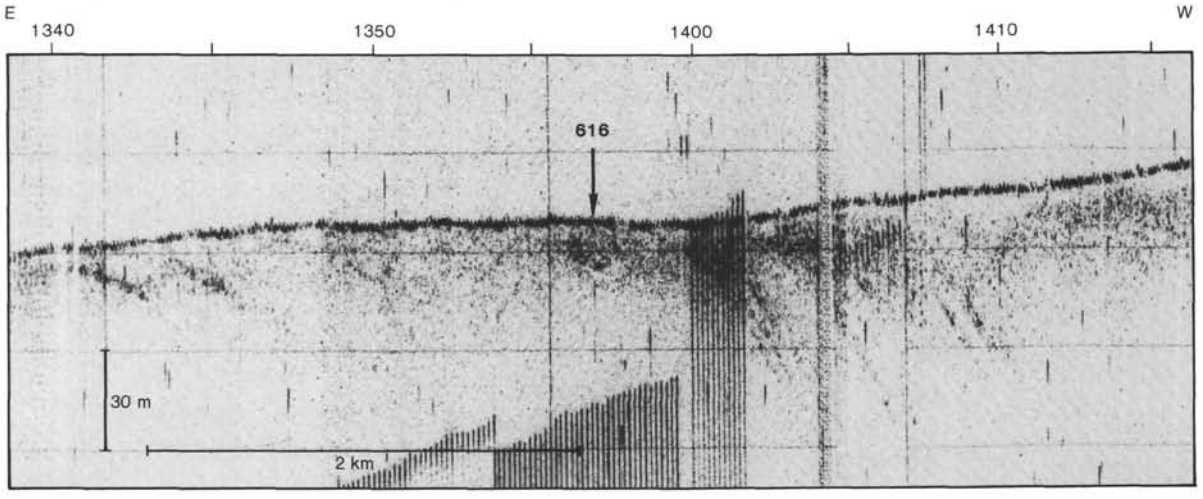

Figure 3. Shipboard 3.5-kHz high-resolution profile taken on board *Glomar Challenger*. See Figure 1 for location.

Several of the hyperbolic echoes appear to originate from surfaces just below the seafloor and are not obviously related to any seafloor topography. A deep-tow profile across the slump area about 90 km west-northwest of Site 616 indicates some of the same sub-bottom structures that might exist within the upper part of the section at Site 616. This profile shows a chaotic assemblage of sections that have varying degrees and directions of dip as well as apparently horizontal sections. The structure in this profile and at Site 616 is suggestive of areas underlain by a chaotic jumble of rotated slide blocks.

Seismic Stratigraphy Results

There is little correspondence between the indistinct reflection horizons and lithologic boundaries. The base of the transparent sequence at 130 to 133 m on the reflection profile has no apparent relationship to core lithologies or wireline logs. The continuous parallel reflectors at about 159 m sub-bottom may be the top of a major sandy sequence. The cores and the gamma log both show sand beds first occurring near 154-m depth in the hole. Horizon "20" occurs within an interval of limited but sandy core recovery and a sandy sequence is also indicated by downhole logging. Adjacent seismic sections show a channel system immediately below Horizon "20" (Stelting et al., this volume).

The reflectors below Horizon "20" all occur within mud or silty mud sequences with no indication of major lithologic breaks in the recovered cores.

Acoustic Facies Results

The lack of sub-bottom reflecting surfaces, together with the pattern of hyperbolic echoes on the shipboard 3.5-kHz profile, and the mix of sections with differing dips separated by areas with few or no sub-bottom reflectors seen on the deep-tow profile farther west are all consistent with the structure within the upper 95 m of the drill hole. The apparently abrupt and random changes in dip within the seismic section support the concept of numerous individual slide blocks within the acoustically transparent section.

Conclusions

The seismic stratigraphy at Site 616 is not easily correlatable with the core and downhole logging results. No major lithologic boundaries correspond to the area-wide reflectors. Only the shallow structure seen in a deep-tow reflection profile elsewhere over the slump area appears to correspond to the structures within the upper part of the drill hole. The base of the Walker and Massingill (1970) slump was not clearly defined by the seismic reflection or core data.

BIOSTRATIGRAPHY AND SEDIMENTATION RATES

Biostratigraphy

The section penetrated in Hole 616 is Quaternary, correlating with the planktonic foraminifer Zone N23 and the calcareous nannofossil Zone NN21. The interval includes the Holocene (Ericson Zone Z; Ericson and Wollin, 1968) and late Wisconsin glacial (Ericson Zone Y) (see Explanatory Notes, this volume). The warm interstadial of the Wisconsin (Zone X) was not encountered to a depth of 371 m (Fig. 4).

The Y Zone contains a poorly developed Pleistocene planktonic fauna in the sand and mud sequence with some reworked Cretaceous foraminifers and predominantly Cretaceous calcareous nannofossils.

Rare well-preserved Pleistocene radiolarians occur in Cores 616-1 through 616-9.

Foraminifers

Foraminifers from Hole 616 are Quaternary, Zone N23 (Blow, 1969). A warm-water, high-diversity planktonic ooze occurs in the upper portion of Section 616-1-1. This Holocene (Ericson Zone Z) fauna contains abundant *Globorotalia menardii* and *G. tumida*, along with associated bathyal foraminifers such as *Cibicides wuellerstorfi* and *Melonis pompilioides*.

The remainder of the hole is late Wisconsin glacial (Ericson Zone Y) and is composed of mud with some

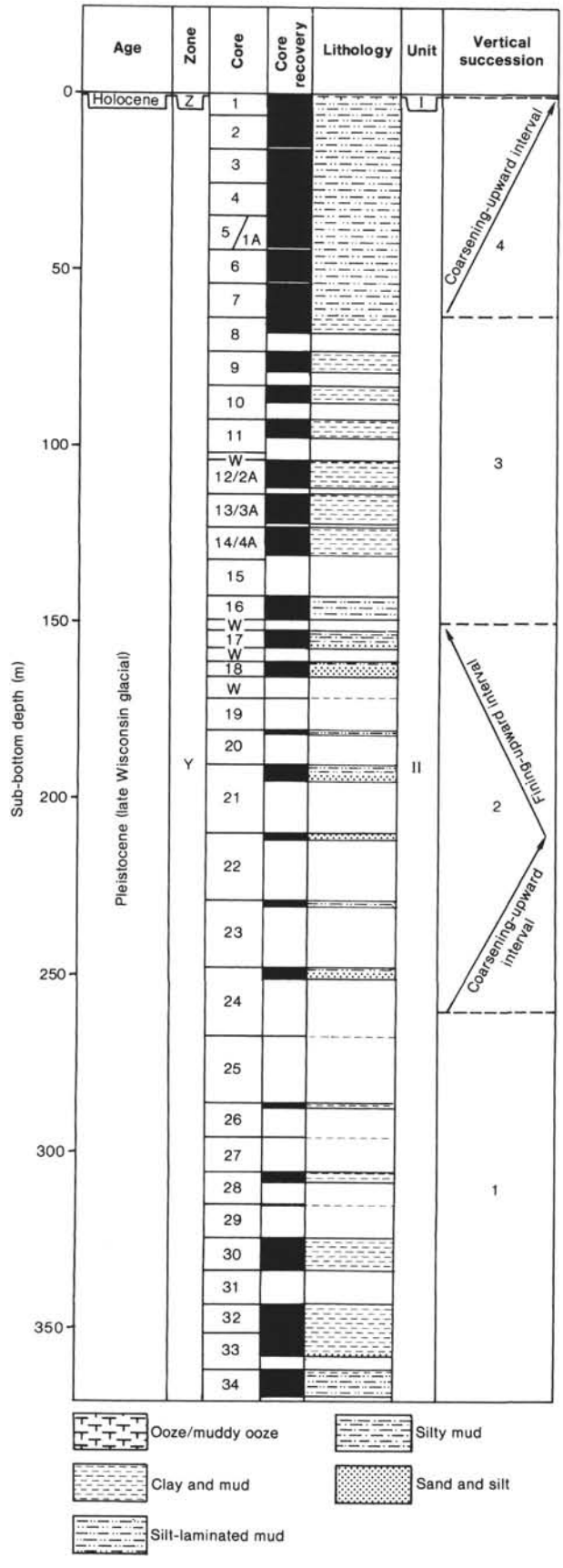

Figure 4. Lithostratigraphic summary for Site 616 showing age, core recovery (Holes 616 and 616A), graphic lithology, lithologic units and intervals. "W" in core column denotes "washed interval."

interbedded silt and sand. The foraminiferal fauna is generally poorly developed except for the interval from Cores 616-8 to 616-11, where there is an increase in planktonic and benthic foraminifers with *C. wuellerstorfi* occurring in Sample 616-9,CC. The cool-water planktonic foraminifer *G. inflata* disappears in Sample 616-7,CC, near the base of the slump deposit. Rapid deposition is evidenced by the general absence of bathyal benthic species and low frequencies of abundance of planktonic foraminifers. Reworked Cretaceous foraminifers occur below 30 m sub-bottom (Core 616-4) but are more common between Cores 616-17 through 616-22 (155–210 m sub-bottom).

Calcareous Nannofossils

All samples observed at Site 616 are interpreted to be in the *Emiliania huxleyi* Zone (NN21) of Martini (1971). A thin veneer of foraminifer ooze at the top of Section 616-1-1 contains common, well-preserved calcareous nannofossils. This veneer is not as thick or as well developed at this site as it was at Sites 614 and 615. These samples are dominated by very small coccoliths, which can only tentatively be identified as *E. huxleyi*. Few reworked Cretaceous nannofossils are contained in this ooze.

Reworked Cretaceous nannofossils are the major constituent of the rest of the sediments from Hole 616, indicating a terrigenous source of the sedimented material. Because of the rapid deposition rate of this interbedded sand–mud sequence, only trace to rare Pleistocene nannofossils are present in the samples examined. The determination of the presence of an *E. huxleyi/Gephyrocapsa* dominance reversal cannot readily be made because of the sparsity of indigenous Pleistocene forms, coupled with the dominance of reworked Late Cretaceous species. A slight increase in indigenous Pleistocene species is encountered in an interval consisting primarily of mud from Cores 616-8 through 616-10.

Sedimentation Rates

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

A sedimentation rate of 2.1 cm/1000 yr. is computed for the Holocene. This is a minimum rate assuming complete Holocene recovery (Fig. 5).

The slump feature (Cores 616-1 through 616-11) is excluded from the sedimentation rate of the Y Zone. The Y/X zonal boundary was not encountered. By using a seismic projection to the top of the X Zone (505 m), a projected minimum sedimentation rate of 555 cm/1000 yr. is computed for the Y Zone.

These calculations are based on nondecompacted sediment thicknesses.

LITHOSTRATIGRAPHY

At Site 616 we recognize two lithologic units in the 371 m of section drilled (Table 2 and Fig. 4). Including the three additional cores from Hole 616A, recovery was

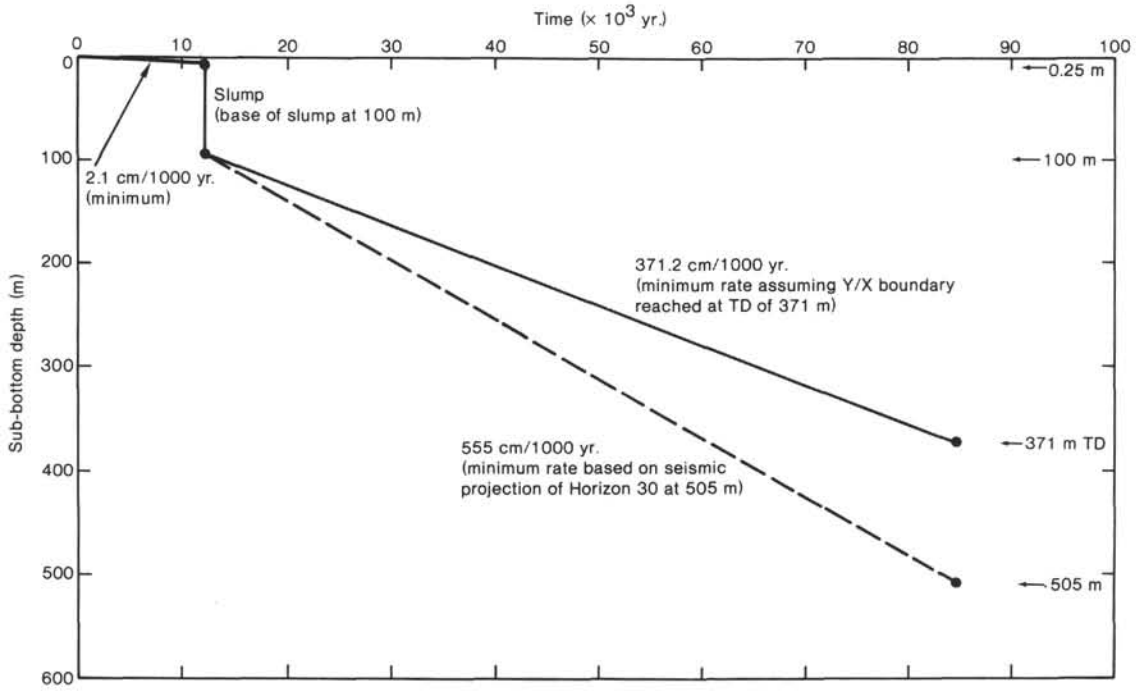

Figure 5. Site 616 sedimentation rates.

Table 2. Lithologic units of Site 616.

Lithologic unit	Sediment	Cored interval	Sub-bottom depth (m)
I	Ooze and muddy ooze	616-1-1, 0–20 cm	0–0.20
II	Muds, silts, and sands	616-1-1, 20 cm through 616-34,CC; 616A-1 through 616A-4; 616B-1 through 616B-22	0.20–371

just over 80% in the top 132 m of the section drilled (Cores 616-1 through 616-11 and 616A-2 through 616A-4), but only about 23% in the section drilled from 132 to 371 m sub-bottom (Cores 616-12 through 616-34).

Lithologic Unit I: Ooze and Muddy Ooze

This unit occurs as a thin layer about 20 cm thick at the very top of the section (Core 616-1). It is a yellow brown marly ooze. The upper 5 cm include abundant foraminifers and appear structureless and bioturbated; the lower 15 cm contain irregular silty laminations and foraminifers are less abundant. This unit passes down with a gradational contact into Unit II.

Lithologic Unit II: Mud, Silt, and Sand

In this unit, we can distinguish four different facies. In order of their relative proportion of the cores recovered, these are (1) silt-laminated muds (70%), (2) clays and muds (25%), (3) sands and silts (beds >10 cm thick) (3%), and (4) silty muds (2%) (Fig. 6). The gamma-ray log run through the drill pipe indicates up to 35% sand and silt in the section between 150 and 220 m sub-bottom, where core recovery was very low. In the top 80 to 90 m of Site 616, many of the laminae are steeply inclined (up to 60°) and sometimes show slide folding and microfaulting.

Silt-Laminated Mud Facies

This is the dominant sediment type at Site 616 and is especially common in the upper part of Unit II (e.g., 0–50 m sub-bottom). It varies from sections with about 10% very thin silt laminae to sections where up to 50% of the sediment is made up of thin to thick silt laminae. Between about 50 and 400 individual laminae can be counted visually per meter of section. These commonly occur in units ranging from 0.5 to 8 cm in thickness, with a single more distinct (thicker and coarser) silt lamina at the base overlain by several thinner indistinct laminae.

The basal silt laminae (1–5 mm thick) are often planar, or in some cases wavy, lenticular and discontinuous, and with low-amplitude microcross-lamination. There commonly appears to be a gradation through the overlying faint laminae into a thin layer of more homogeneous mud. This grading may be emphasized by color variation either from lighter to darker gray or from grayish to reddish. Rare red brown graded mud or clay beds without silt laminae are also present.

Thick silt laminae and thin beds (0.5–10 cm thick) occur irregularly throughout the section. They commonly have a sharp scoured base, and internal cross-lamination passing up into parallel lamination. These laminae are often accentuated by compositional variations from dark-colored lignite-rich to light-colored carbonate-rich layers. The silt beds commonly grade upward to silty mud, although the silt/mud contact is sometimes sharp.

The sediments are fine- and very-fine-grained silts, muds, and clays. They are dominantly terrigenous in composition, with only very rare foraminifers, nannofossils, and radiolarians. Lignite, wood fragments, spores, and pollen are ubiquitous and locally form up to 5% of the sediment. Quartz is the dominant silt-sized component.

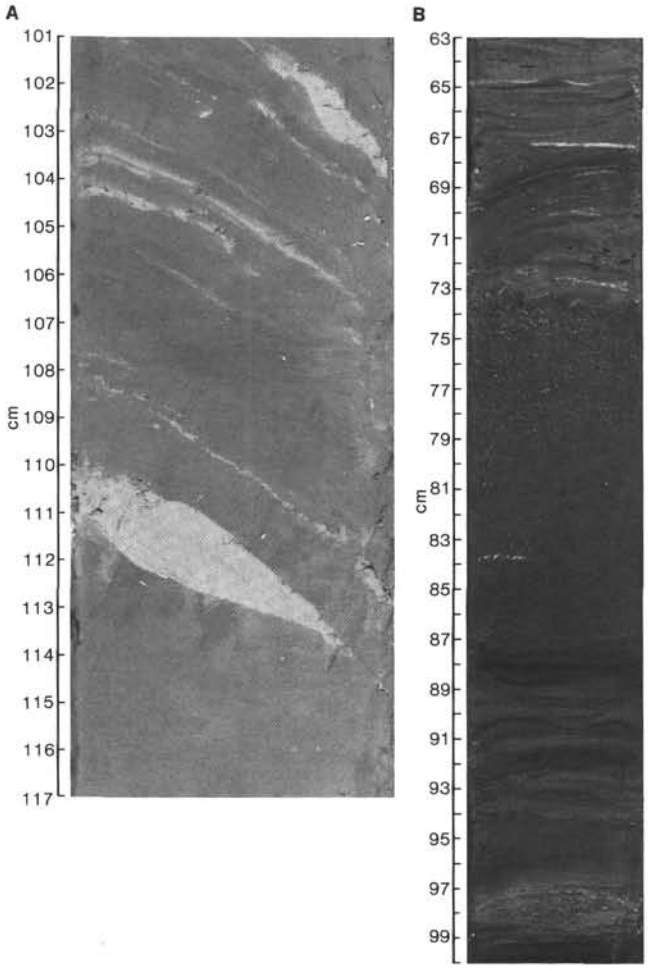

Figure 6. Photographs of typical lithofacies at Site 616. A. Muds with silt laminae and thin silt beds. In this example the layers are steeply dipping (Sample 616-6-2, 101–117 cm). B. Sands and silt beds (Sample 616-18-2, 63–100 cm).

Clay and Mud Facies

"Structureless" clays and muds are the second major facies recovered at Site 616, occurring particularly in the middle and lower parts of the section (e.g., 300–370 m sub-bottom). They commonly form essentially unbedded intervals up to several meters in thickness with irregular color variations or mottling and scattered silt pockets and lenses. The facies comprise clays, muds, and silty muds with between 40 and 90% clay fraction and almost no sand. The material is dominantly terrigenous with a trace of nannofossils and dispersed lignite. Quartz is the dominant, and carbonate a secondary, silt-sized component.

In a number of cores, the "structureless" muds can be seen to have numerous very indistinct laminae that are slightly darker and show subtle grain size and compositional differences from the adjacent layers. The laminae show some variation in frequency but are commonly about 2 cm apart. Possible interpretations for the regularly-spaced laminae include: (1) the laminae are entirely the result of coring disturbance, and (2) the layering reflects an original sedimentary lamination that has been subsequently disturbed by coring. There is evidence of disturbance at the core margins and of possible flowage and penetration of mud across the core width. Many of the laminae planes also show indications of shear, probably caused by rotation during drilling. However, the apparent compositional and textural variations, the wavy nature and irregular spacing of some laminae, and the streaking out of the laminae at the very edge of the core all suggest at least some primary sedimentary layering was present.

Sand and Silt Facies

Medium- to thick-bedded (more than 10 cm) sands and silts form only a small part of the recovered section (about 3%) (e.g., 190–220 m sub-bottom) although, as noted, core recovery was very low in the sandier intervals. The sands and silts are mostly structureless apart from a positive grading over a sharp, scoured base. They range from fine silty sand to medium-grained sand, with a maximum grain size of 15 mm (Core 616-22) and rare mud clasts. They are very poorly sorted with subangular to highly rounded grains and a dominantly terrigenous composition (quartz with minor carbonate, feldspar, micas, heavy minerals, and lignite). A few of the thinner graded beds (5–10 cm thick) in Core 616-21 are also poorly sorted medium-grained sands with some coarse sand grains.

Silty Mud Facies

Approximately 2% of the section is represented by the lignite-bearing, poorly sorted silty muds and muddy silts. They occur both in thin structureless layers, and in thicker (up to 50 cm) graded and sometimes poorly laminated beds that commonly overlie coarser silts and sands. Some of the thicker beds have isolated mud clasts and irregular concentrations of lignite and silt. They are confined to the middle, sandier part of the section that was drilled.

Vertical Succession

Good core recovery through the top 130 m of the section drilled at Site 616, together with a gamma-ray/bulk-density wireline log measured through the pipe to a depth of 250 m, allows us to distinguish four intervals within Unit II (Fig. 4). From bottom to top these are

1. Interval 1 comprises the lowermost 110 m of section from 370 to 260 m sub-bottom. It appears extremely uniform in the cores and on the gamma-ray log and consists mainly of structureless clays and muds.

2. Interval 2 is a 110-m-thick section of interbedded medium- to fine-grained sands, silty sands, lignite-bearing muds and fine-grained silt–mud turbidites from 260 to 150 m sub-bottom. There is an apparent coarsening upward from the base of the interval to about 210 m sub-bottom. The sand beds are as much as 2.5 m thick in this part of the interval. This is overlain by a fining-upward sequence.

3. Interval 3 comprises 85 m of silt muds from 150 to 63 m sub-bottom, laminated with some relatively structureless thin clay and mud units. The uppermost 35 m of this interval comprise inclined laminae, and associ-

ated soft-sediment deformation features continue to the base of Core 616-11.

4. Interval 4 comprises 63 m of silt-laminated muds and thin silt beds, from 63 to 0.2 m sub-bottom, interpreted as fine-grained turbidites (each from 0.5–4.0 cm thick). There are an average of 150 to 300 laminae per meter, with an increase in siltiness toward the top of the interval as shown by the decrease in API values on the gamma-ray log. Apart from the uppermost 9 m, most of the interval shows highly inclined laminae and other features indicative of mass movement. There is a possible repeat section near the base of Core 616-2 and top of Core 616-3. Locally in this interval, the laminae are near horizontal. There are about 10 changes of dip within the disturbed unit that are commonly marked by a thin (5–25 cm) highly contorted zone.

GEOCHEMISTRY

Organic Geochemistry

No significant gas, as evidenced by gas expansion cracks or pockets, was observed in the cored section at Site 616 for the same reasons outlined in the Site 621 chapter (this volume).

Inorganic Geochemistry

The observed results, which are described more extensively in Ishizuka, Kawahata, et al. (this volume), are summarized as follows:

1. pH values of interstitial water at Site 616 (pH 6.7–7.2) are slightly lower than those at Site 615 (pH 6.9–7.8).

2. Total alkalinity (maximum 13.2 mEq/L) of the interstitial water at Site 616 is generally the same as that at Site 615 (maximum 12.5 mEq/L).

3. As a whole, salinity tends to decrease slightly with depth. The salinity of Core 616-34 is 32.5‰ minimum. This value is similar to that below 353 m sub-bottom at Site 615.

PHYSICAL PROPERTIES

Wet-bulk density rapidly increases at an average rate of 0.008 g/cm^3 · m from a seafloor value of 1.45 g/cm^3 to about 1.70 g/cm^3 at a sub-bottom depth of 30 m (Fig. 7A). From 30 to 368 m sub-bottom, the wet-bulk density increases at an average rate of 0.001 g/cm^3 · m.

Wet (dry) water content rapidly decreases from a seafloor value of 51% (95%) to an average value of 33% (47%) at the 60-m level and 19.8% (24.4%) at a sub-bottom depth of 368 m (Fig. 7B, C). The average rates of decrease are 0.067% (1.117%)/m down to 60 m sub-bottom and 0.043% (0.073%)/m below the 60-m level.

Porosity values of 72.4% were measured at the seafloor. The porosity rapidly decreases in the upper 40 m to approximately 56% and reaches 40.4% at 368-m depth (Fig. 7D). Average rates of porosity decrease are calculated to be 0.41%/m down to 40 m and 0.048%/m below that depth.

Void ratio reflects the same trends as porosity and decreases at an average rate of 0.0024 per meter over the interval from 40 to 368 m. The average grain density of the sediment cores is 2.71 g/cm^3.

Undrained shear strength (C_u) increases in the upper 60 m of sediment at a rate of 1.07 kPa/m. From a depth of 60 to 368 m the rate of increase is similar; 1.1 kPa/m. Measured values of shear strength are plotted against depth in Figure 7E. A plot of undrained shear strength (C_u) versus overburden pressure (σ) is shown in Figure 8. The clays of Site 616 appear to be underconsolidated (for details see Bryant, Sweet, et al., this volume). This can be attributed to the high rates of deposition and the very-fine-grained nature of the clays which have a very low permeability.

The lowest sonic velocity recorded was 1.477 km/s. Velocities less than 1.500 km/s may result from inaccuracies in handling and measuring and therefore are not indicative of real velocities. The acoustic anisotropy is fairly large, with the velocities measured parallel to the bedding having in general the higher values. The rate of increase of velocity with depth averages about 0.761 m/s · m. This is an extremely crude estimate because of the large scatter of the velocity values (Fig. 7F).

SUMMARY AND CONCLUSIONS

Site 616 was cored to a total depth of 371.0 m below the mud line. The site is located on the eastern margin of the modern fan lobe in 2999 m of water.

The main scientific objectives at the site were (1) to assess the nature and thickness of the "slump deposits" of Walker and Massingill (1970) and (2) to determine the sedimentary and biostratigraphic characteristics of the margin of a fan lobe.

The sedimentary sequence was cored successively to a depth of 101.8 m with the APC, below which the XCB was used. APC core recovery was marginally successful, partially the result of a malfunctioning check valve in one of the core barrels. Good core recovery was again obtained with the XCB in the interval from 320 m to total depth at 371 m. The pipe became stuck at the bottom of the hole and required severing and loss of the BHA. A successful gamma-ray log was obtained through the drill string, providing data on the missing core sections. Hole 616A was offset slightly and a few cores were obtained of intervals poorly recovered in Hole 616. Hole 616B was drilled for geotechnical purposes and a series of cores were obtained to a depth of 204.3 m sub-bottom.

The major scientific conclusions are

1. The upper 100 m of the sedimentary sequence is a slightly coarsening-upward unit in which the maximum grain size is in the silt and fine-sand range. This "slump" section consists of several units, each displaying dipping laminae with dips as steep as 65° true. Variation in dip angle is common, however, within each unit the dip is constant. The units are separated either by normally laminated sediments or by disturbed and shear zones. The deposits obviously represent emplacement by mass-movement processes (slides), but the source of the sediment is unknown since the entire section is virtually devoid of fauna. It is possible that the failure is local, since sedimentary characteristics tend to indicate that the deposits

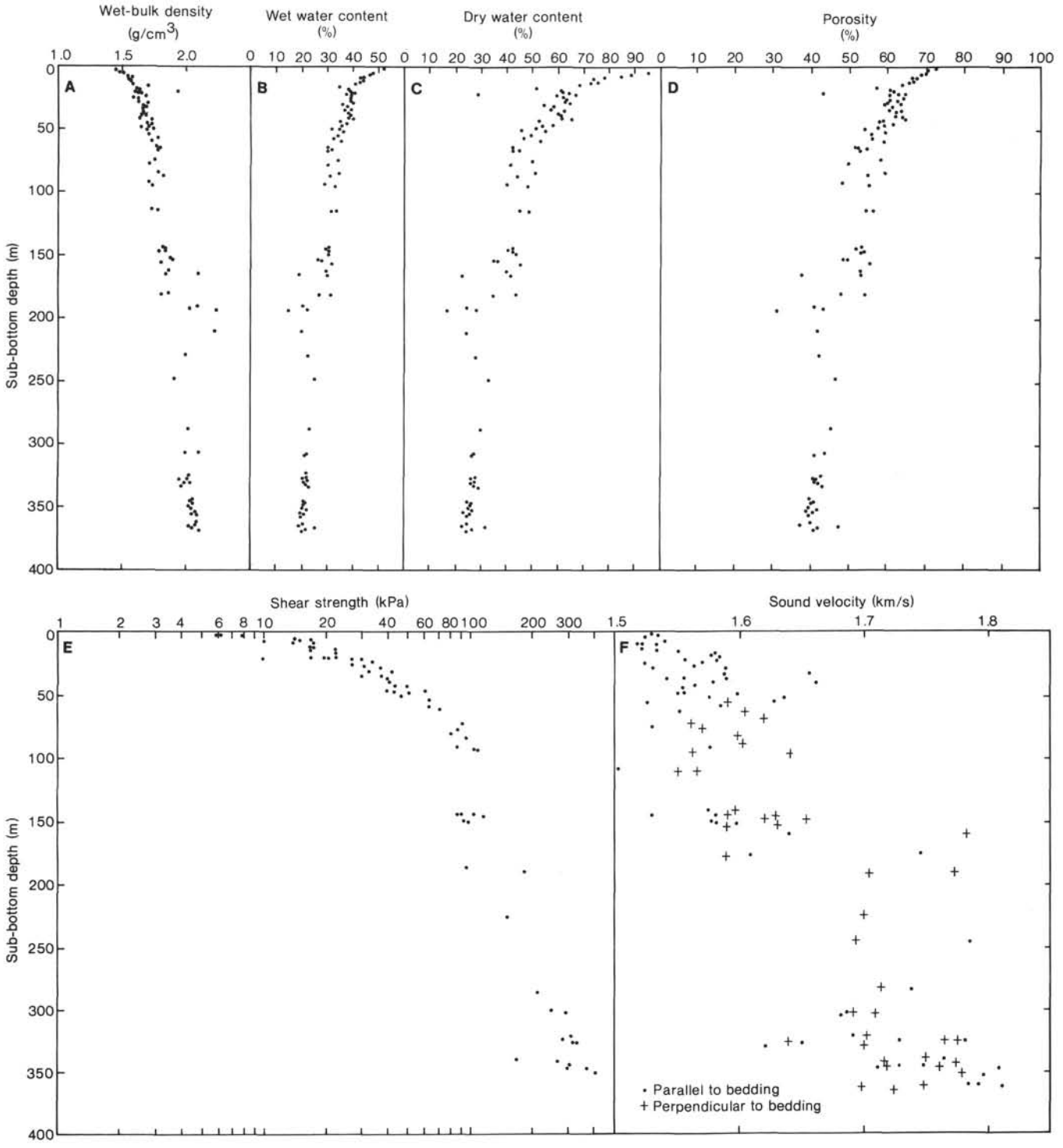

Figure 7. Mass physical properties of Site 616 sediments. A. Wet-bulk density. B. Water content related to weight of wet sediment. C. Water content related to weight of dry sediment. D. Porosity. E. Undrained shear strength. F. Sound velocity.

are fine-grained turbidites laid down as overbank sediments. However, it is also possible that this material moved as slides from the upper slope to the north. A high radiolarian content was present.

2. In addition to the mass-movement interval, two fan lobes were cored, the lower one being only partially cored. The lower fan lobe displays a coarsening-upward trend with a minimum of 7% net sand while the youngest fan lobe (88 m thick) has 33.8 m net sand or 38.5%. Later reexamination of seismic records indicates that the deposits cored from beneath the "slump" do not belong to the same fan lobe as the other sites, but to older ones.

3. Ericson's Zone Z (Holocene) is less than 1 m thick and the rest of the core is within Zone Y (late Wisconsin glacial). The entire section contains sparse planktonic foraminifers and no benthic fauna is found, suggesting

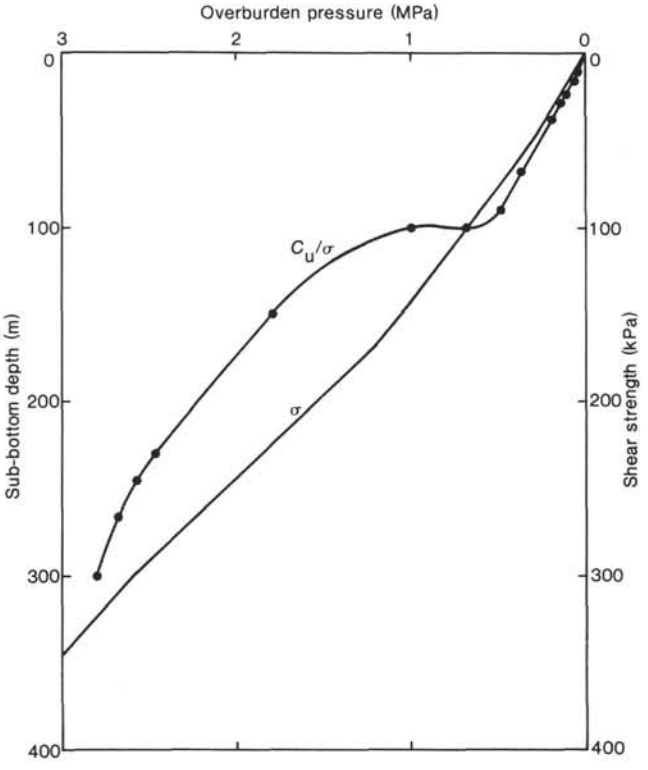

Figure 8. Undrained shear strength (C_u) versus overburden pressure (σ) and C_u/σ versus sub-bottom depth at Site 616.

extremely high depositional rates. One interval, from 65 to 150 m, contains a slightly higher faunal content, possibly representing slower accumulation rates. Seismic correlation of Zone X from Site 615 to Site 616 is relatively clear and an interpreted sedimentation rate of 555 cm/1000 yr. can be made for Zone Y. The high sedimentation rates and the virtual absence of planktonic and benthic fauna clearly demonstrate that thick sequences of fine-grained turbidites can be deposited in a short period of time in a deep-water setting and that low or non-depositional periods are too short for the accumulation of large quantities of planktonic organisms.

4. A successful gamma-log run was acquired through the drill string as a result of alternating high-gamma emitting clays and relatively clean sands. The log significantly aided in the interpretation of the missing cored sections.

5. No significant gas, as evidenced by gas-expansion cracks or pockets, is observed in the cored section. The difference between the Site 616 sediments (fine grained) and Site 615 sediments (coarser grained) suggests that coarser grain sizes are not a significant deterrent to gas accumulation and that other factors are responsible for the lack of gas. The absence or near absence of biogenic gases is probably a result of low microbial activity, low amount of organic matter, and rapid sedimentation rates.

6. The clays are highly underconsolidated and can be attributed to the high rates of sedimentation and the very fine-grained nature of the clays, which no doubt have a rather low permeability. Shear strengths increase at a rate of 1.07 kPa/m to 60 m and at a rate of 1.1 kPa/m to total depth.

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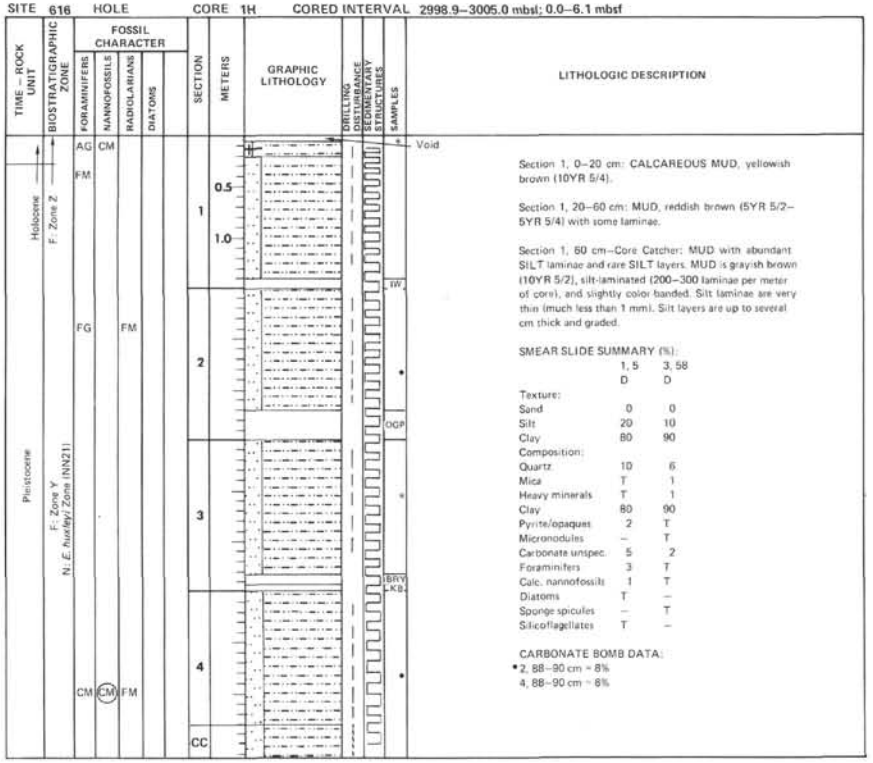
SITE 616 HOLE CORE 1H CORED INTERVAL 2998.9–3005.0 mbsl; 0.0–6.1 mbsf



LITHOLOGIC DESCRIPTION

Section 1, 0–20 cm: CALCAREOUS MUD, yellowish brown (10YR 5/4).

Section 1, 20–60 cm: MUD, reddish brown (5YR 5/2–5YR 5/4) with some laminae.

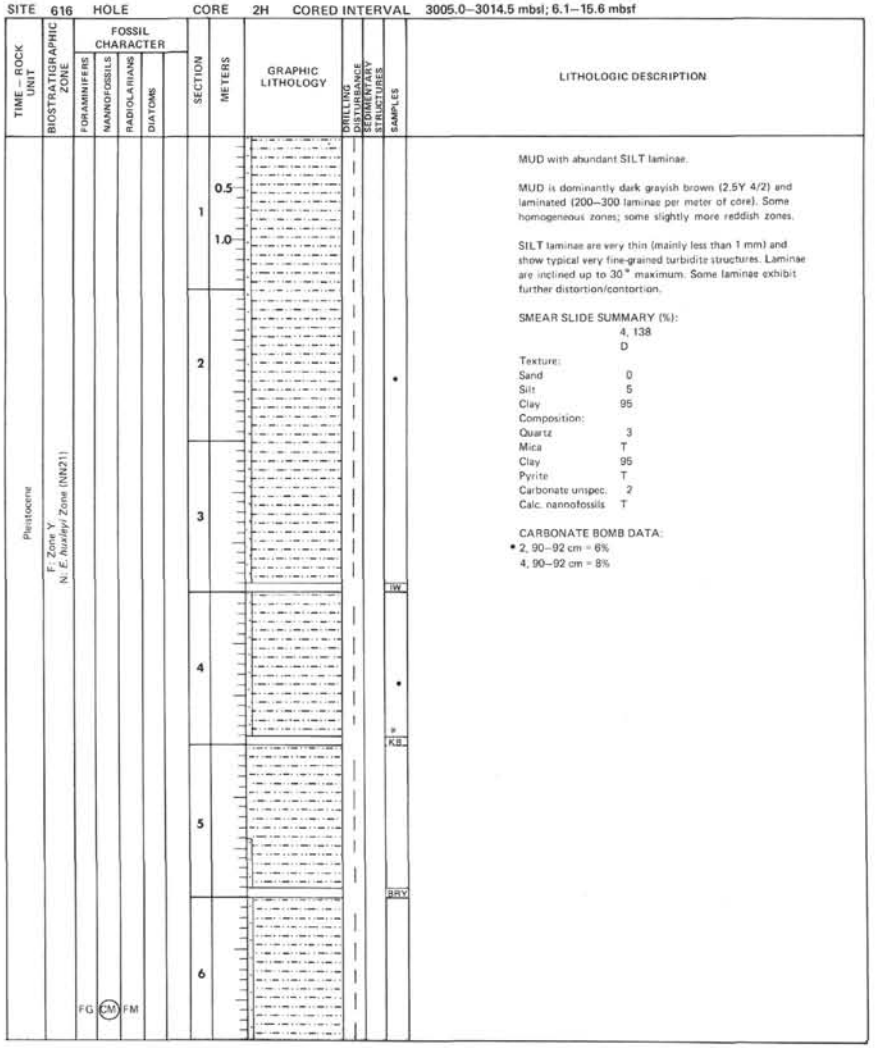
Section 1, 60 cm–Core Catcher: MUD with abundant SILT laminae and rare SILT layers. MUD is grayish brown (10YR 5/2), silt-laminated (200–300 laminae per meter of core), and slightly color banded. Silt laminae are very thin (much less than 1 mm). Silt layers are up to several cm thick and graded.

SMEAR SLIDE SUMMARY (%):

	1, 5 D	3, 58 D
Texture:		
Sand	0	0
Silt	20	10
Clay	80	90
Composition:		
Quartz	10	6
Mica	T	1
Heavy minerals	T	1
Clay	80	90
Pyrite/opaques	2	T
Micronodules	–	T
Carbonate unspec.	5	2
Foraminifers	3	T
Calc. nannofossils	1	T
Diatoms	T	–
Sponge spicules	–	T
Silicoflagellates	T	–

CARBONATE BOMB DATA:
• 2, 88–90 cm = 8%
4, 88–90 cm = 8%

SITE 616 HOLE CORE 2H CORED INTERVAL 3005.0–3014.5 mbsl; 6.1–15.6 mbsf



LITHOLOGIC DESCRIPTION

MUD with abundant SILT laminae.

MUD is dominantly dark grayish brown (2.5Y 4/2) and laminated (200–300 laminae per meter of core). Some homogeneous zones; some slightly more reddish zones.

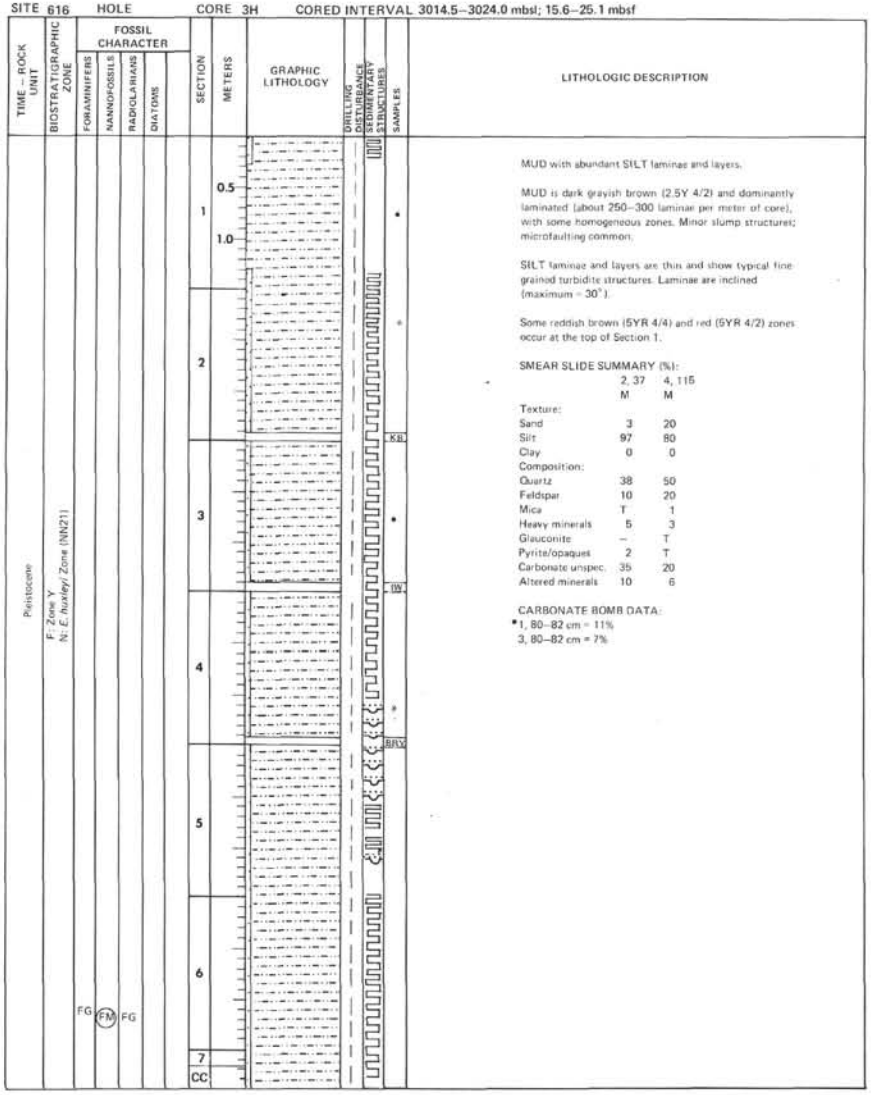
SILT laminae are very thin (mainly less than 1 mm) and show typical very fine-grained turbidite structures. Laminae are inclined up to 30° maximum. Some laminae exhibit further distortion/contortion.

SMEAR SLIDE SUMMARY (%):

	4, 138 D
Texture:	
Sand	0
Silt	5
Clay	95
Composition:	
Quartz	3
Mica	T
Clay	95
Pyrite	T
Carbonate unspec.	2
Calc. nannofossils	T

CARBONATE BOMB DATA:
• 2, 90–92 cm = 6%
4, 90–92 cm = 8%

SITE 616 HOLE CORE 3H CORED INTERVAL 3014.5–3024.0 mbsl; 15.6–25.1 mbsf



MUD with abundant SILT laminae and layers.

MUD is dark grayish brown (2.5Y 4/2) and dominantly laminated (about 250–300 laminae per meter of core), with some homogeneous zones. Minor slump structures; microfaulting common.

SILT laminae and layers are thin and show typical fine-grained turbidite structures. Laminae are inclined (maximum = 30°).

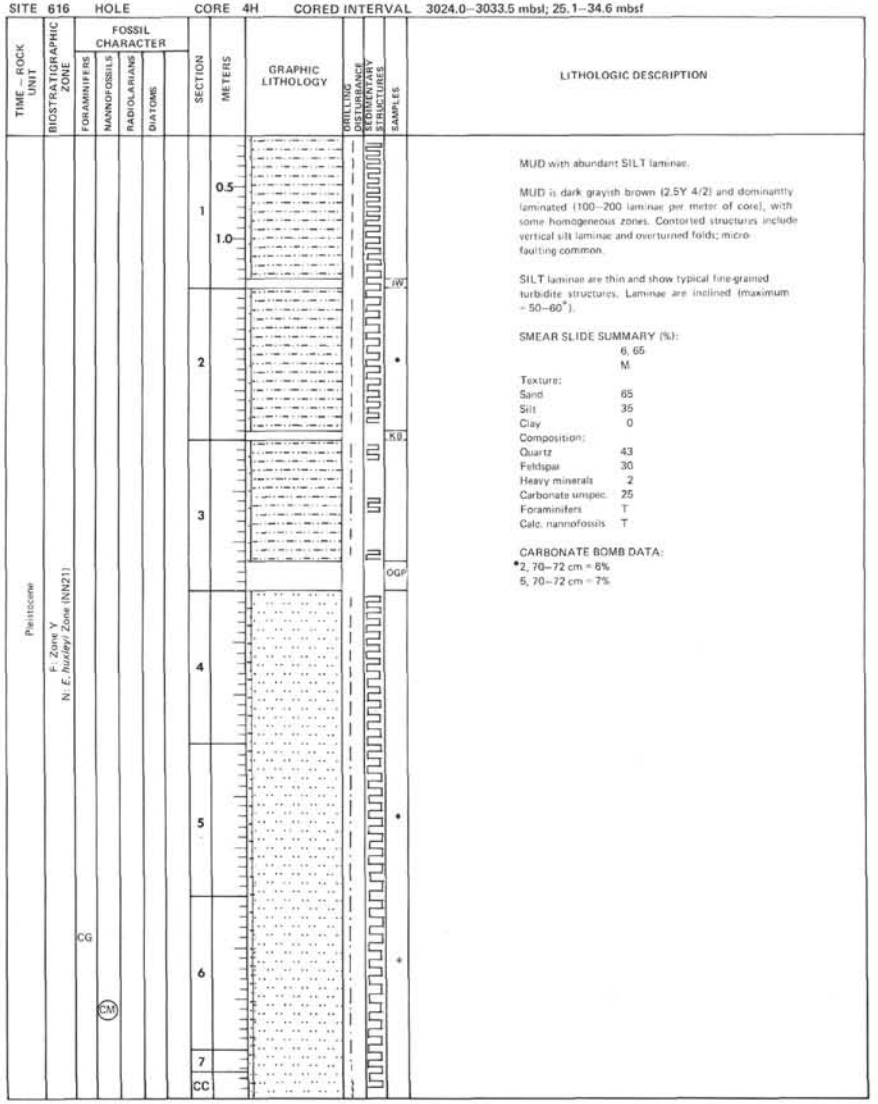
Some reddish brown (5YR 4/4) and red (5YR 4/2) zones occur at the top of Section 1.

SMEAR SLIDE SUMMARY (%):

	2, 37 M	4, 115 M
Texture:		
Sand	3	20
Silt	97	80
Clay	0	0
Composition:		
Quartz	38	50
Feldspar	10	20
Mica	T	1
Heavy minerals	5	3
Glauconite	–	T
Pyrite/opaques	2	T
Carbonate unspec.	35	20
Altered minerals	10	6

CARBONATE BOMB DATA:
*1, 80–82 cm = 11%
3, 80–82 cm = 7%

SITE 616 HOLE CORE 4H CORED INTERVAL 3024.0–3033.5 mbsl; 25.1–34.6 mbsf



MUD with abundant SILT laminae.

MUD is dark grayish brown (2.5Y 4/2) and dominantly laminated (100–200 laminae per meter of core), with some homogeneous zones. Contorted structures include vertical silt laminae and overturned folds; microfaulting common.

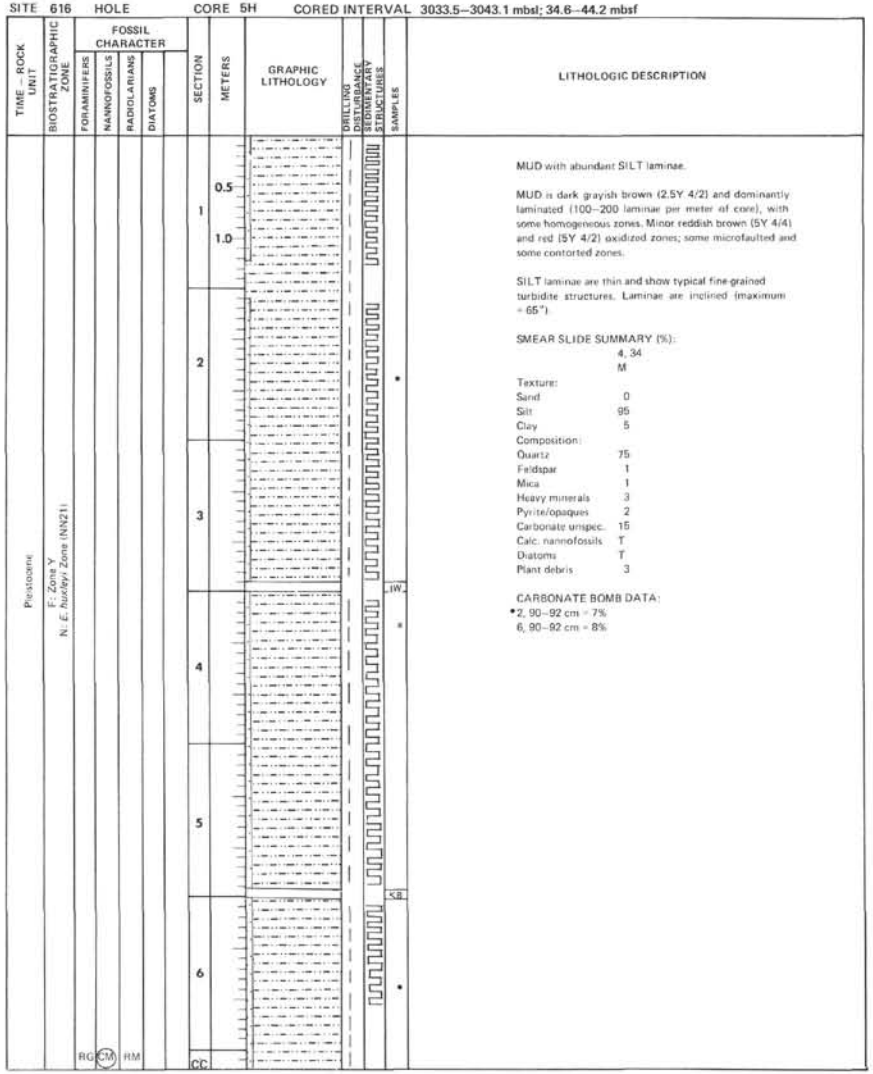
SILT laminae are thin and show typical fine-grained turbidite structures. Laminae are inclined (maximum = 50–60°).

SMEAR SLIDE SUMMARY (%):

	6, 65 M
Texture:	
Sand	65
Silt	35
Clay	0
Composition:	
Quartz	43
Feldspar	30
Heavy minerals	2
Carbonate unspec.	25
Foraminifers	T
Calc. nannofossils	T

CARBONATE BOMB DATA:
*2, 70–72 cm = 8%
5, 70–72 cm = 7%

SITE 616 HOLE CORE 5H CORED INTERVAL 3033.5–3043.1 mbsl; 34.6–44.2 mbsf



LITHOLOGIC DESCRIPTION

MUD with abundant SILT laminae.

MUD is dark grayish brown (2.5Y 4/2) and dominantly laminated (100–200 laminae per meter of core), with some homogeneous zones. Minor reddish brown (5Y 4/4) and red (5Y 4/2) oxidized zones; some microfaulted and some contorted zones.

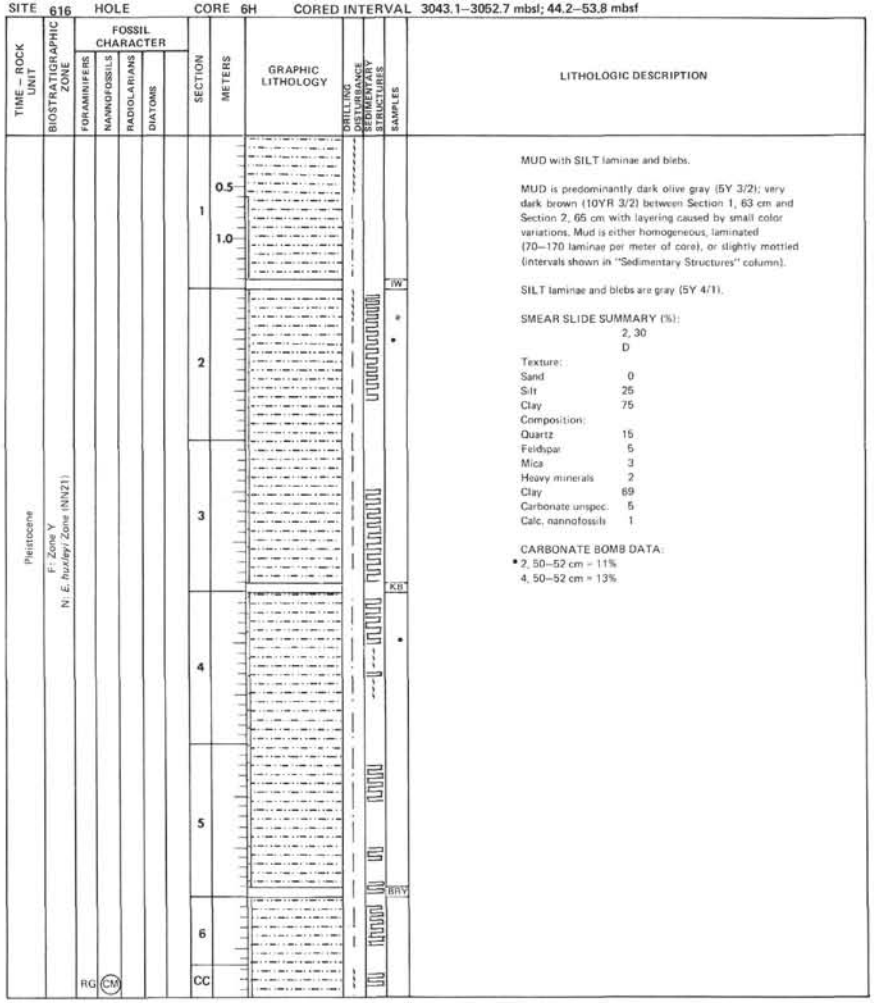
SILT laminae are thin and show typical fine-grained turbidite structures. Laminae are inclined (maximum = 65°).

SMEAR SLIDE SUMMARY (%):

	4, 34 M
Texture:	
Sand	0
Silt	95
Clay	5
Composition:	
Quartz	75
Feldspar	1
Mica	1
Heavy minerals	3
Pyrite/opaques	2
Carbonate unspec.	15
Calc. nannofossils	T
Diatoms	T
Plant debris	3

CARBONATE BOMB DATA:
*2, 90–92 cm = 7%
6, 90–92 cm = 8%

SITE 616 HOLE CORE 6H CORED INTERVAL 3043.1–3052.7 mbsl; 44.2–53.8 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT laminae and blebs.

MUD is predominantly dark olive gray (5Y 3/2); very dark brown (10YR 3/2) between Section 1, 63 cm and Section 2, 65 cm with layering caused by small color variations. Mud is either homogeneous, laminated (70–170 laminae per meter of core), or slightly mottled (intervals shown in "Sedimentary Structures" column).

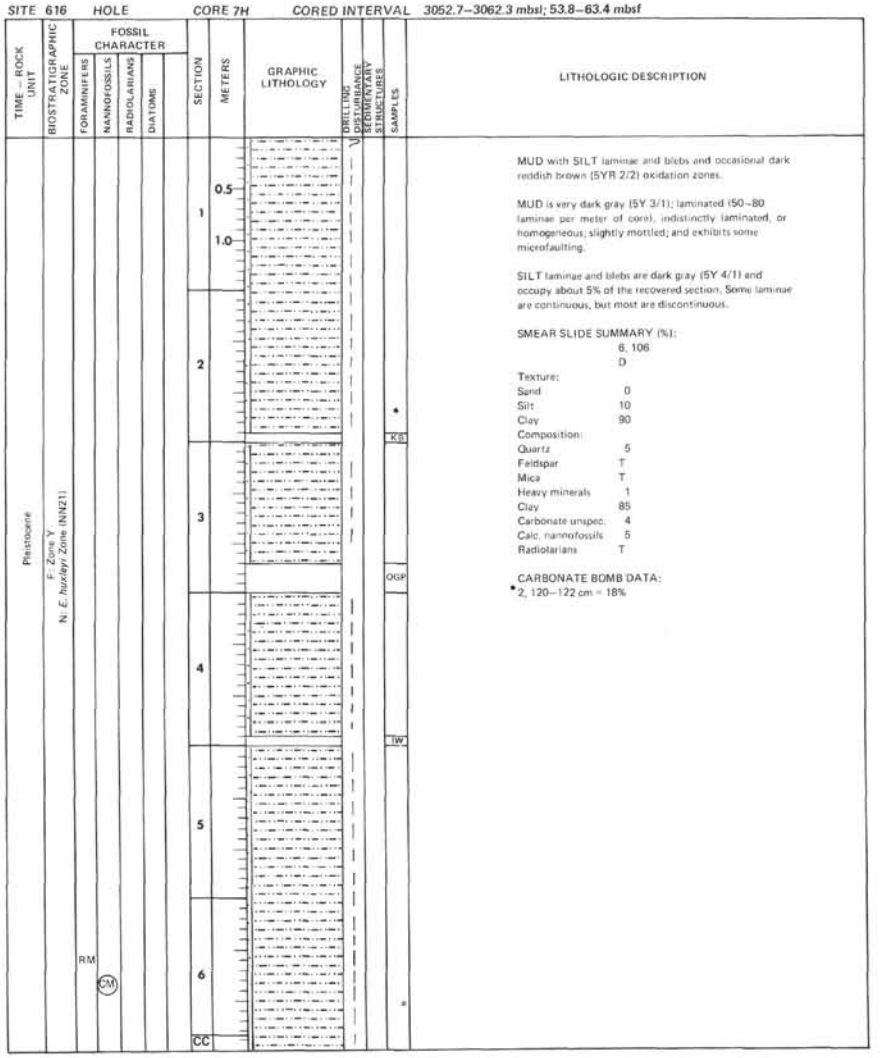
SILT laminae and blebs are gray (5Y 4/1).

SMEAR SLIDE SUMMARY (%):

	2, 30 D
Texture:	
Sand	0
Silt	25
Clay	75
Composition:	
Quartz	15
Feldspar	5
Mica	3
Heavy minerals	2
Clay	69
Carbonate unspec.	5
Calc. nannofossils	1

CARBONATE BOMB DATA:
*2, 50–52 cm = 11%
4, 50–52 cm = 13%

SITE 616 HOLE CORE 7H CORED INTERVAL 3052.7–3062.3 mbsl; 53.8–63.4 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT laminae and blebs and occasional dark reddish brown (5YR 2/2) oxidation zones.

MUD is very dark gray (5Y 3/1); laminated (50–80 laminae per meter of core), indistinctly laminated, or homogeneous; slightly mottled; and exhibits some microfaulting.

SILT laminae and blebs are dark gray (5Y 4/1) and occupy about 5% of the recovered section. Some laminae are continuous, but most are discontinuous.

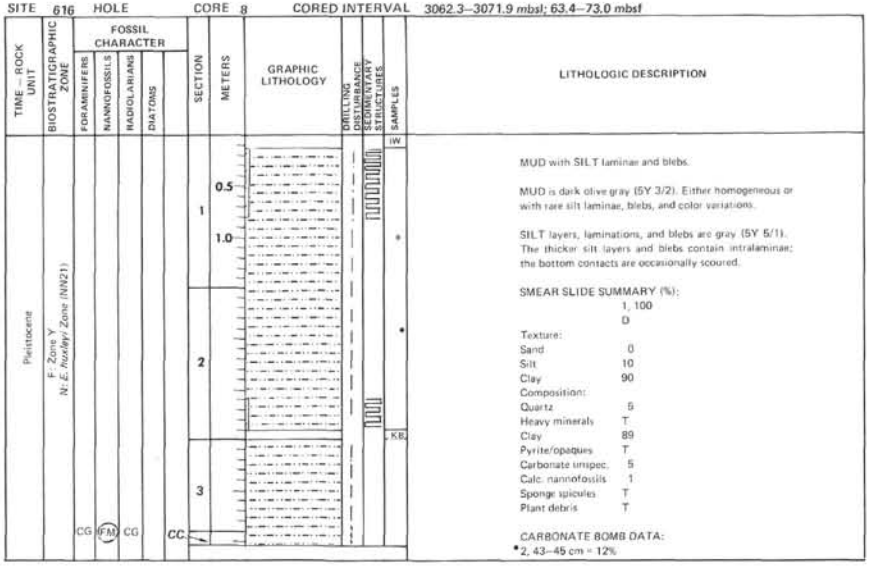
SMEAR SLIDE SUMMARY (%):

	6, 106 D
Texture:	
Sand	0
Silt	10
Clay	90
Composition:	
Quartz	5
Feldspar	T
Mica	T
Heavy minerals	1
Clay	85
Carbonate unspec.	4
Calc. nannofossils	5
Radiolarians	T

CARBONATE BOMB DATA:

•2, 120–122 cm = 18%

SITE 616 HOLE CORE 8 CORED INTERVAL 3062.3–3071.9 mbsl; 63.4–73.0 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT laminae and blebs.

MUD is dark olive gray (5Y 3/2). Either homogeneous or with rare silt laminae, blebs, and color variations.

SILT layers, laminations, and blebs are gray (5Y 5/1). The thicker silt layers and blebs contain intralaminae; the bottom contacts are occasionally scoured.

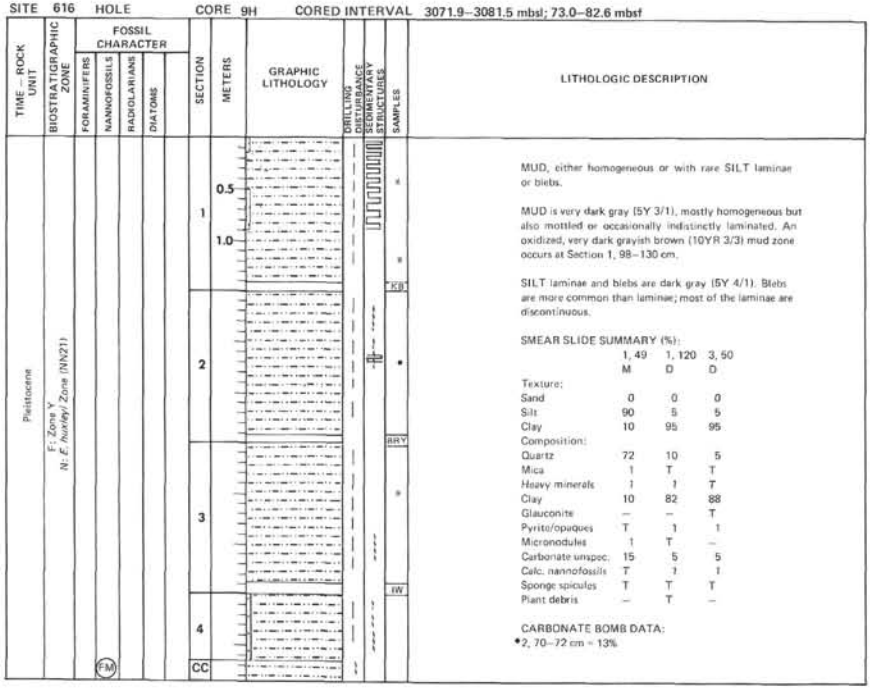
SMEAR SLIDE SUMMARY (%):

	1, 100 D
Texture:	
Sand	0
Silt	10
Clay	90
Composition:	
Quartz	5
Heavy minerals	T
Clay	89
Pyrite/opaques	T
Carbonate unspec.	5
Calc. nannofossils	1
Sponge spicules	T
Plant debris	T

CARBONATE BOMB DATA:

•2, 43–45 cm = 12%

SITE 616 HOLE CORE 9H CORED INTERVAL 3071.9–3081.5 mbsl; 73.0–82.6 mbsf



LITHOLOGIC DESCRIPTION

MUD, either homogeneous or with rare SILT laminae or blebs.

MUD is very dark gray (5Y 3/1), mostly homogeneous but also mottled or occasionally indistinctly laminated. An oxidized, very dark grayish brown (10YR 3/3) mud zone occurs at Section 1, 98–130 cm.

SILT laminae and blebs are dark gray (5Y 4/1). Blebs are more common than laminae; most of the laminae are discontinuous.

SMEAR SLIDE SUMMARY (%):

	1, 49 M	1, 120 D	3, 50 D
Texture:			
Sand	0	0	0
Silt	90	5	5
Clay	10	95	95
Composition:			
Quartz	72	10	5
Mica	1	T	T
Heavy minerals	1	1	T
Clay	10	82	88
Glauconite	—	—	T
Pyrite/opaques	T	1	1
Micronodules	1	T	—
Carbonate unspec.	15	5	5
Calc. nannofossils	T	1	1
Sponge spicules	T	T	T
Plant debris	—	T	—

CARBONATE BOMB DATA:

•2, 70–72 cm = 13%

SITE 616 HOLE CORE 10H CORED INTERVAL 3081.5–3091.1 mbsl; 82.6–92.2 mbsf

TIME – ROCK UNIT: Pleistocene
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone (NN21)
FOSSIL CHARACTER: FORAMINIFERS RG; NANNOFOSSILS CM; RADIOLARIANS; DIATOMS
SECTION: 1, 2, 3, CC
METERS: 0.5, 1.0
GRAPHIC LITHOLOGY
DRILLING DISTURBANCE
SEDIMENTARY STRUCTURES
SAMPLES: OGP, IW, KB

LITHOLOGIC DESCRIPTION

MUD, dark olive gray (5Y 3/2), and dominantly homogeneous with very rare silt blebs. Discrete coarse silt beds (2–3 cm thick and olive gray [5Y 3/2–5Y 4/2]) occur at Section 1, 75–78 cm; Section 3, 87–89 cm; and Section 3, 100–102 cm. The silt layer in Section 1 has a scoured base; silt layers in Section 3 are indistinctly normally graded.

SMEAR SLIDE SUMMARY (%):

	1, 76 M
Texture:	
Sand	10
Silt	80
Clay	10
Composition:	
Quartz	88
Feldspar	3
Mica	2
Heavy minerals	1
Carbonate unspec.	5
Calc. nannofossils	1
Other (spores)	T

CARBONATE BOMB DATA:
*1, 130–132 cm = 8%

SITE 616 HOLE CORE 11H CORED INTERVAL 3091.1–3100.7 mbsl; 92.2–101.8 mbsf

TIME – ROCK UNIT: Pleistocene
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone (NN21)
FOSSIL CHARACTER: FORAMINIFERS CG; NANNOFOSSILS CM; RADIOLARIANS; DIATOMS
SECTION: 1, 2, 3, CC
METERS: 0.5, 1.0
GRAPHIC LITHOLOGY
DRILLING DISTURBANCE
SEDIMENTARY STRUCTURES
SAMPLES: KB, IW, BRY

LITHOLOGIC DESCRIPTION

MUD, very dark gray (5Y 3/1); dominantly homogeneous with somewhat indistinct laminations in Section 2 mainly due to color variations (slight oxidation). MUD includes SILT/SILTY MUD beds and rare dark gray (5Y 4/1) SILT laminae and blebs. SILT/SILTY MUD beds are very dark gray (5Y 3/1).

SMEAR SLIDE SUMMARY (%):

	1, 75 M	2, 12 M
Texture:		
Sand	5	5
Silt	90	20
Clay	5	75
Composition:		
Quartz	77	20
Feldspar	7	2
Mica	4	1
Heavy minerals	2	1
Clay	–	70
Pyrite/opaques	–	T
Micronodules	–	1
Carbonate unspec.	10	5
Foraminifers	–	T
Calc. nannofossils	–	T
Sponge spicules	–	T

CARBONATE BOMB DATA:
1, 8–10 cm = 6%

Note: Core 12X, 3102.9–3112.5 mbsl;
*104.0–113.6 mbsf; no recovery.

SITE 616 HOLE CORE 13X CORED INTERVAL 3112.5–3122.1 mbsl; 113.6–123.2 mbsf

TIME – ROCK UNIT: Pleistocene
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone
FOSSIL CHARACTER: FORAMINIFERS RM; NANNOFOSSILS FM; RADIOLARIANS; DIATOMS
SECTION: 1, CC
METERS: 0.5
GRAPHIC LITHOLOGY
DRILLING DISTURBANCE
SEDIMENTARY STRUCTURES
SAMPLES

LITHOLOGIC DESCRIPTION

MUD, dark olive gray (5Y 3/2) and homogeneous with rare, thin, discontinuous silt laminae and blebs. Some of the silt blebs are olive gray (5Y 5/2).

SMEAR SLIDE SUMMARY (%):

	1, 28 D
Texture:	
Sand	0
Silt	15
Clay	85
Composition:	
Quartz	10
Mica	1
Heavy minerals	T
Clay	85
Glauconite	T
Pyrite/opaques	1
Micronodules	T
Carbonate unspec.	3
Calc. nannofossils	T

CARBONATE BOMB DATA:
*1, 57–59 cm = 7%

SITE 616 HOLE CORE 14X CORED INTERVAL 3122.1–3131.7 mbsl; 123.2–132.8 mbsf

TIME – ROCK UNIT: Pleistocene
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone (NN21)
FOSSIL CHARACTER: FORAMINIFERS FM; NANNOFOSSILS FM; RADIOLARIANS; DIATOMS
SECTION: CC
METERS
GRAPHIC LITHOLOGY
DRILLING DISTURBANCE
SEDIMENTARY STRUCTURES
SAMPLES

LITHOLOGIC DESCRIPTION

Core Catcher contained one small handful of homogeneous, dark olive gray (5Y 3/2) MUD. Rest of core was empty.

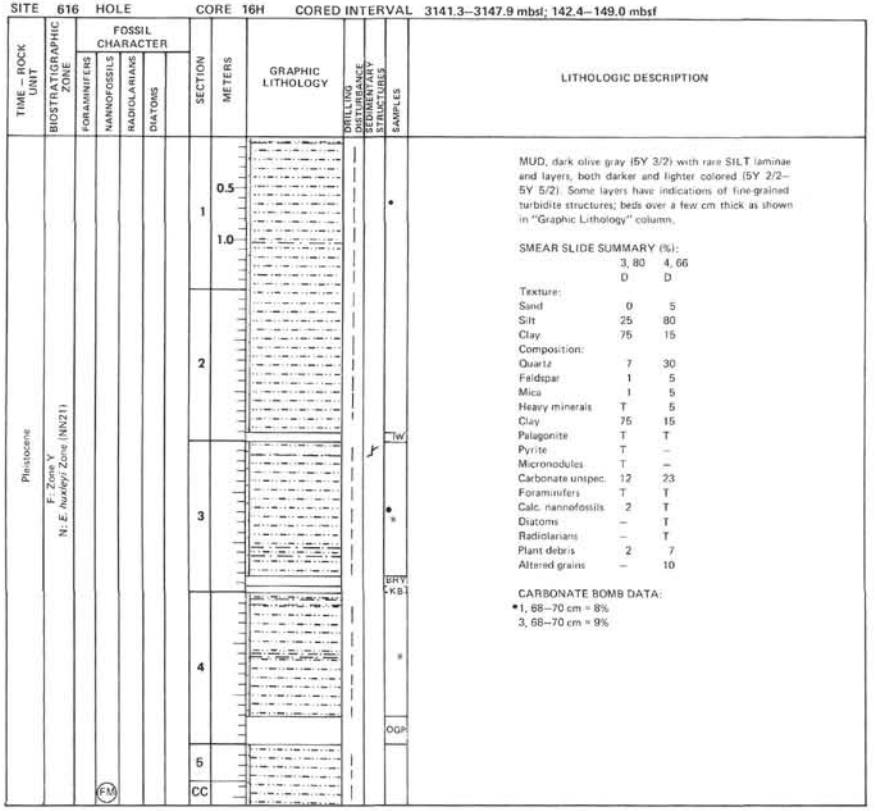
SITE 616 HOLE CORE 15X CORED INTERVAL 3131.7–3141.3 mbsl; 132.8–142.4 mbsf

TIME – ROCK UNIT: Pleistocene
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone (NN21)
FOSSIL CHARACTER: FORAMINIFERS RM; NANNOFOSSILS FM; RADIOLARIANS; DIATOMS
SECTION: CC
METERS
GRAPHIC LITHOLOGY
DRILLING DISTURBANCE
SEDIMENTARY STRUCTURES
SAMPLES

LITHOLOGIC DESCRIPTION

Core Catcher contained one small handful of homogeneous, dark olive gray (5Y 3/2) MUD. Rest of the core was empty.

SITE 616 HOLE CORE 16H CORED INTERVAL 3141.3–3147.9 mbsf; 142.4–149.0 mbsf



LITHOLOGIC DESCRIPTION

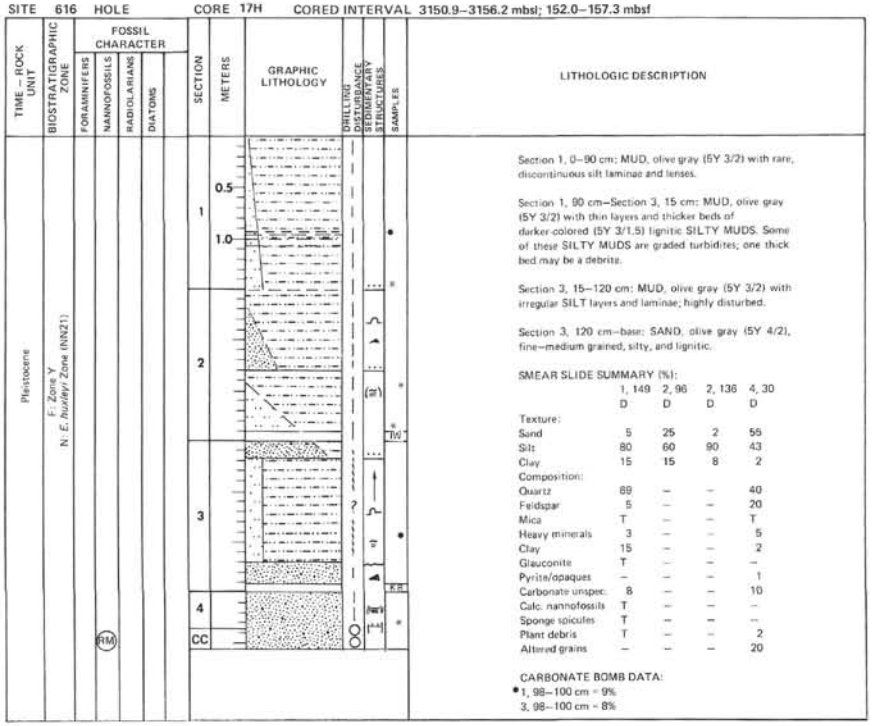
MUD, dark olive gray (5Y 3/2) with rare SILT laminae and layers, both darker and lighter colored (5Y 2/2–5Y 5/2). Some layers have indications of fine-grained turbidite structures; beds over a few cm thick as shown in "Graphic Lithology" column.

SMEAR SLIDE SUMMARY (%):

	3, 80 D	4, 66 D
Texture:		
Sand	0	5
Silt	25	80
Clay	75	15
Composition:		
Quartz	7	30
Feldspar	1	5
Mica	1	5
Heavy minerals	T	5
Clay	75	15
Palagonite	T	T
Pyrite	T	–
Micronodules	T	–
Carbonate unspec.	12	23
Foraminifers	T	T
Calc. nannofossils	2	T
Diatoms	–	T
Radiolarians	–	T
Plant debris	2	7
Altered grains	–	10

CARBONATE BOMB DATA:
•1, 68–70 cm = 8%
3, 68–70 cm = 9%

SITE 616 HOLE CORE 17H CORED INTERVAL 3150.9–3156.2 mbsf; 152.0–157.3 mbsf



LITHOLOGIC DESCRIPTION

Section 1, 0–90 cm: MUD, olive gray (5Y 3/2) with rare, discontinuous silt laminae and lenses.

Section 1, 90 cm–Section 3, 15 cm: MUD, olive gray (5Y 3/2) with thin layers and thicker beds of darker-colored (5Y 3/1.5) lignitic SILTY MUDS. Some of these SILTY MUDS are graded turbidites; one thick bed may be a debrite.

Section 3, 15–120 cm: MUD, olive gray (5Y 3/2) with irregular SILT layers and laminae; highly disturbed.

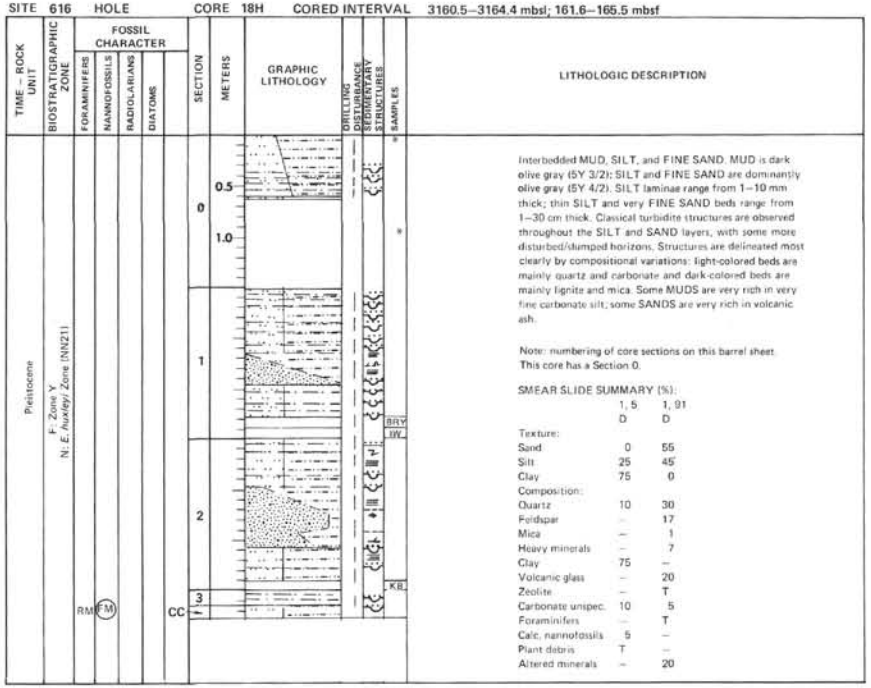
Section 3, 120 cm–base: SAND, olive gray (5Y 4/2), fine–medium grained, silty, and lignitic.

SMEAR SLIDE SUMMARY (%):

	1, 149 D	2, 96 D	2, 136 D	4, 30 D
Texture:				
Sand	5	25	2	55
Silt	80	60	90	43
Clay	15	15	8	2
Composition:				
Quartz	89	–	–	40
Feldspar	5	–	–	20
Mica	T	–	–	T
Heavy minerals	3	–	–	5
Clay	15	–	–	2
Glauconite	T	–	–	–
Pyrite/opaques	–	–	–	1
Carbonate unspec.	8	–	–	10
Calc. nannofossils	T	–	–	–
Sponge spicules	T	–	–	–
Plant debris	T	–	–	2
Altered grains	–	–	–	20

CARBONATE BOMB DATA:
•1, 98–100 cm = 9%
3, 98–100 cm = 8%

SITE 616 HOLE CORE 18H CORED INTERVAL 3160.5–3164.4 mbsl; 161.6–165.5 mbsf



LITHOLOGIC DESCRIPTION

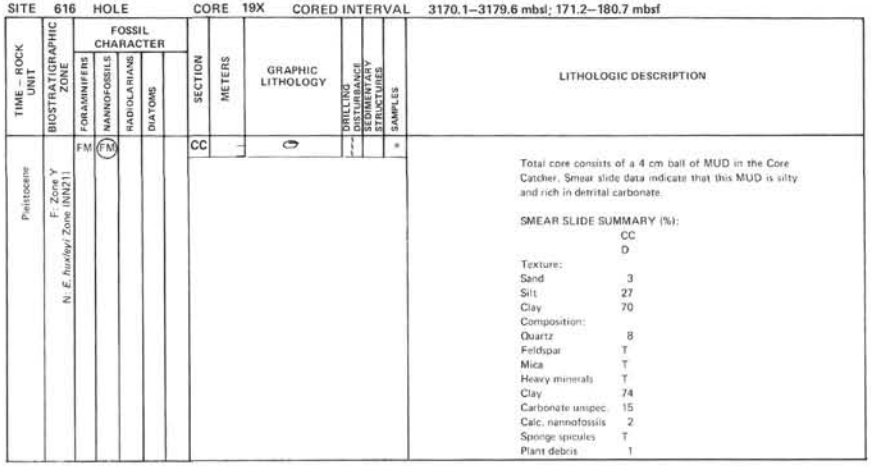
Interbedded MUD, SILT, and FINE SAND. MUD is dark olive gray (5Y 3/2); SILT and FINE SAND are dominantly olive gray (5Y 4/2). SILT laminae range from 1–10 mm thick; thin SILT and very FINE SAND beds range from 1–30 cm thick. Classical turbidite structures are observed throughout the SILT and SAND layers, with some more disturbed/slumped horizons. Structures are delineated most clearly by compositional variations: light-colored beds are mainly quartz and carbonate and dark-colored beds are mainly lignite and mica. Some MUDS are very rich in very fine carbonate silt; some SANDS are very rich in volcanic ash.

Note: numbering of core sections on this barrel sheet. This core has a Section 0.

SMEAR SLIDE SUMMARY (%):

	1, 5 D	1, 91 D
Texture:		
Sand	0	55
Silt	25	45
Clay	75	0
Composition:		
Quartz	10	30
Feldspar	–	17
Mica	–	1
Heavy minerals	–	7
Clay	75	–
Volcanic glass	–	20
Zeolite	–	T
Carbonate unspec.	10	5
Foraminifers	–	T
Calc. nannofossils	5	–
Plant debris	T	–
Altered minerals	–	20

SITE 616 HOLE CORE 19X CORED INTERVAL 3170.1–3179.6 mbsl; 171.2–180.7 mbsf



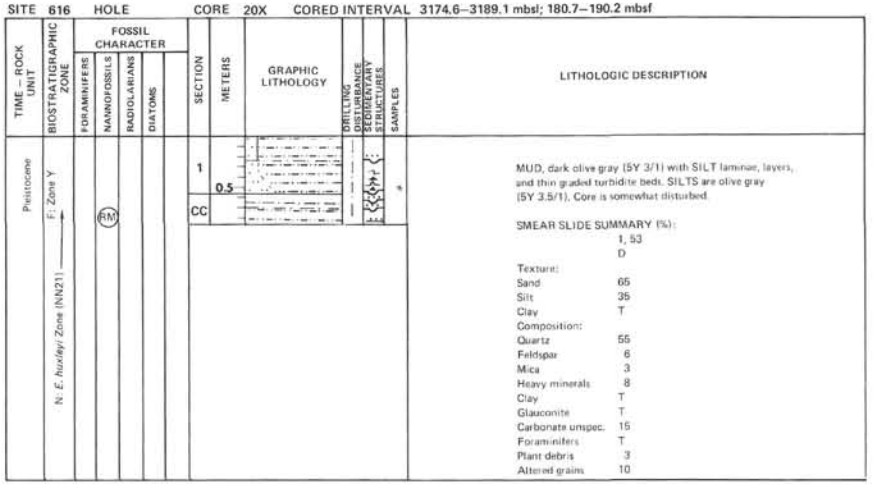
LITHOLOGIC DESCRIPTION

Total core consists of a 4 cm ball of MUD in the Core Catcher. Smear slide data indicate that this MUD is silty and rich in detrital carbonate.

SMEAR SLIDE SUMMARY (%):

	CC D
Texture:	
Sand	3
Silt	27
Clay	70
Composition:	
Quartz	8
Feldspar	T
Mica	T
Heavy minerals	T
Clay	74
Carbonate unspec.	15
Calc. nannofossils	2
Sponge spicules	T
Plant debris	1

SITE 616 HOLE CORE 20X CORED INTERVAL 3174.6–3189.1 mbsl; 180.7–190.2 mbsf



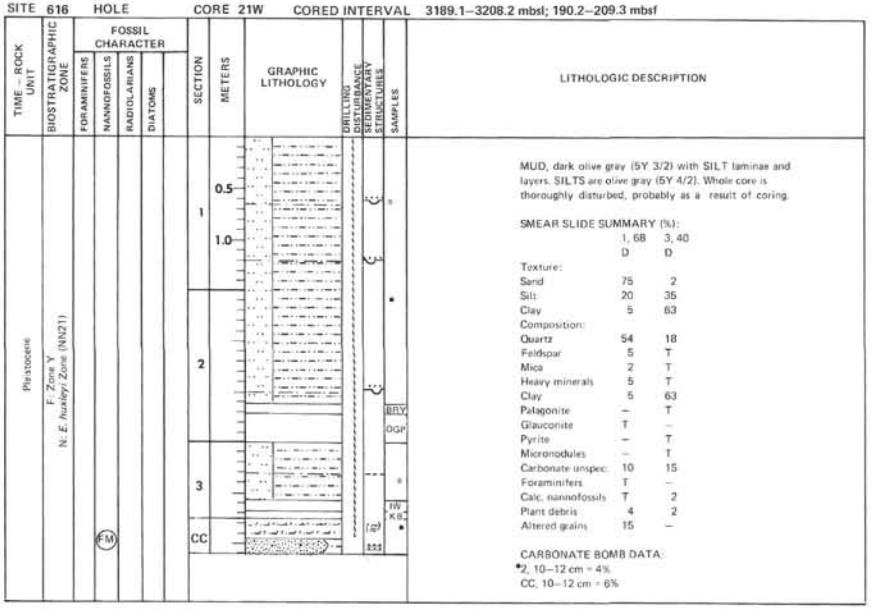
LITHOLOGIC DESCRIPTION

MUD, dark olive gray (5Y 3/1) with SILT laminae, layers, and thin graded turbidite beds. SILTS are olive gray (5Y 3.5/1). Core is somewhat disturbed.

SMEAR SLIDE SUMMARY (%):

	1, 53 D
Texture:	
Sand	65
Silt	35
Clay	T
Composition:	
Quartz	55
Feldspar	6
Mica	3
Heavy minerals	8
Clay	T
Glauconite	T
Carbonate unspec.	15
Foraminifers	T
Plant debris	3
Altered grains	10

SITE 616 HOLE CORE 21W CORED INTERVAL 3189.1–3208.2 mbsl; 190.2–209.3 mbsf



LITHOLOGIC DESCRIPTION

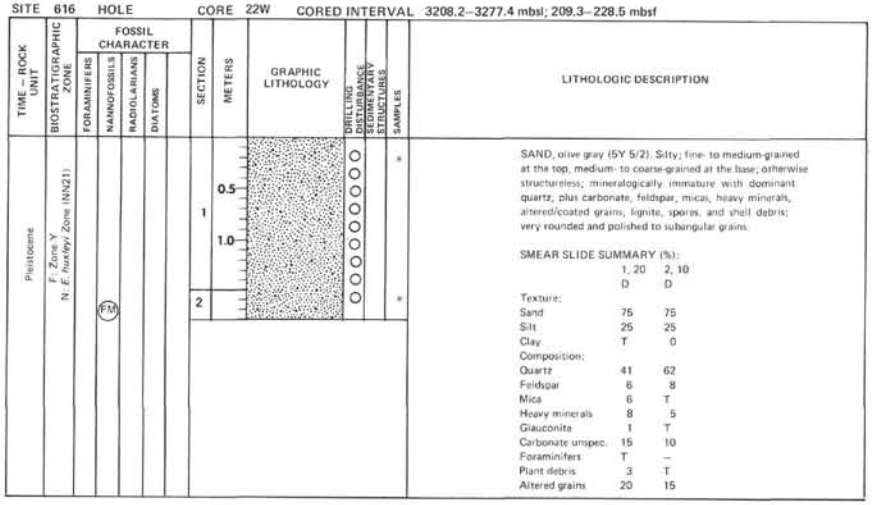
MUD, dark olive gray (5Y 3/2) with SILT laminae and layers. SILTS are olive gray (5Y 4/2). Whole core is thoroughly disturbed, probably as a result of coring.

SMEAR SLIDE SUMMARY (%):

	1, 68 D	3, 40 D
Texture:		
Sand	75	2
Silt	20	35
Clay	5	63
Composition:		
Quartz	54	18
Feldspar	5	T
Mica	2	T
Heavy minerals	5	T
Clay	5	63
Palagonite	–	T
Glauconite	T	–
Pyrite	–	T
Micronodules	–	T
Carbonate unspec.	10	15
Foraminifers	T	–
Calc. nannofossils	T	2
Plant debris	4	2
Altered grains	15	–

CARBONATE BOMB DATA:
*2, 10–12 cm = 4%
CC, 10–12 cm = 6%

SITE 616 HOLE CORE 22W CORED INTERVAL 3208.2–3277.4 mbsl; 209.3–228.5 mbsf

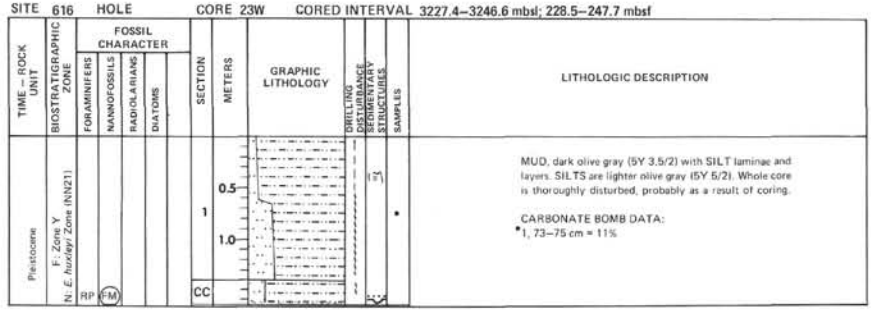


SAND, olive gray (5Y 5/2). Silty; fine- to medium-grained at the top, medium- to coarse-grained at the base; otherwise structureless; mineralogically immature with dominant quartz, plus carbonate, feldspar, micas, heavy minerals, altered/coated grains, lignite, spores, and shell debris; very rounded and polished to subangular grains.

SMEAR SLIDE SUMMARY (%):

	1, 20 D	2, 10 D
Texture:		
Sand	75	75
Silt	25	25
Clay	T	0
Composition:		
Quartz	41	62
Feldspar	6	8
Mica	6	T
Heavy minerals	8	5
Glauconite	1	T
Carbonate unspec.	15	10
Foraminifers	T	–
Plant debris	3	T
Altered grains	20	15

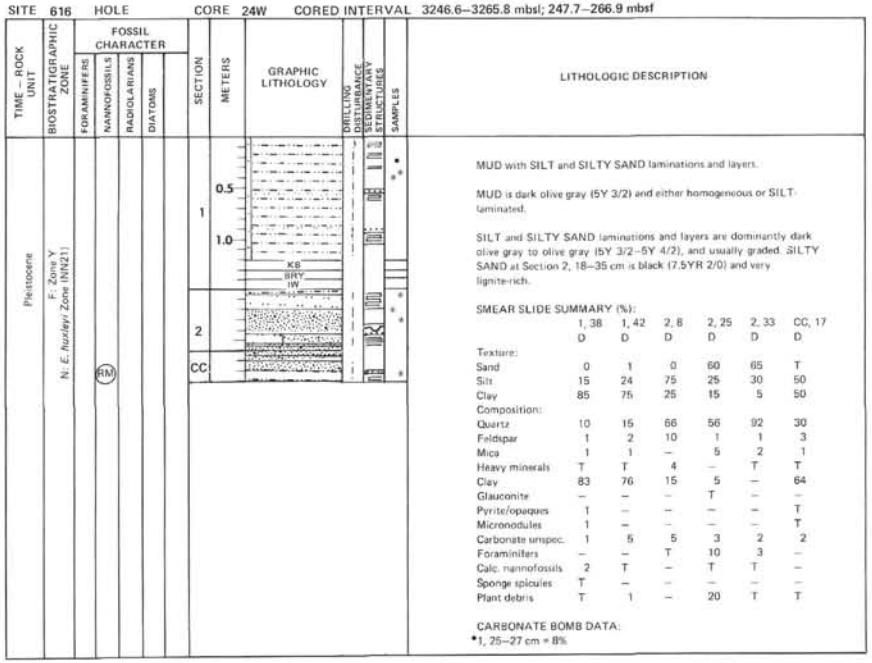
SITE 616 HOLE CORE 23W CORED INTERVAL 3227.4–3246.6 mbsl; 228.5–247.7 mbsf



MUD, dark olive gray (5Y 3.5/2) with SILT laminae and layers. SILTS are lighter olive gray (5Y 5/2). Whole core is thoroughly disturbed, probably as a result of coring.

CARBONATE BOMB DATA:
*1, 73–75 cm = 11%

SITE 616 HOLE CORE 24W CORED INTERVAL 3246.6–3265.8 mbsl; 247.7–266.9 mbsf



MUD with SILT and SILTY SAND laminations and layers.

MUD is dark olive gray (5Y 3/2) and either homogeneous or SILT-laminated.

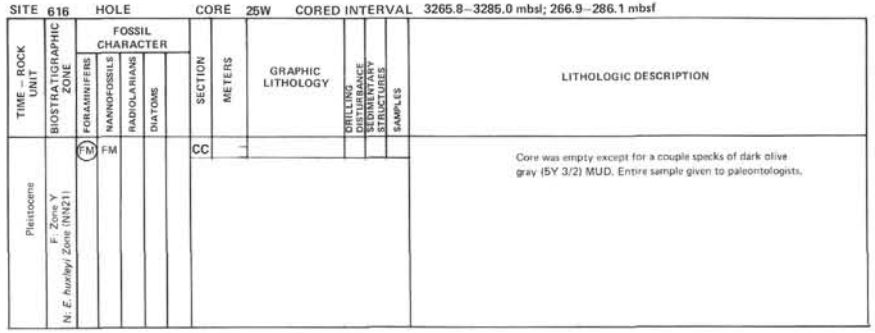
SILT and SILTY SAND laminations and layers are dominantly dark olive gray to olive gray (5Y 3/2–5Y 4/2), and usually graded. SILTY SAND at Section 2, 18–35 cm is black (7.5YR 2/0) and very lignite-rich.

SMEAR SLIDE SUMMARY (%):

	1, 38 D	1, 42 D	2, 8 D	2, 25 D	2, 33 D	CC, 17 D
Texture:						
Sand	0	1	0	60	65	T
Silt	15	24	75	25	30	50
Clay	85	75	25	15	5	50
Composition:						
Quartz	10	15	66	56	92	30
Feldspar	1	2	10	1	1	3
Mica	1	1	–	5	2	1
Heavy minerals	T	T	4	–	T	T
Clay	83	76	15	5	–	64
Glauconite	–	–	–	T	–	–
Pyrite/opaques	1	–	–	–	–	T
Micronodules	1	–	–	–	–	T
Carbonate unspec.	1	5	5	3	2	2
Foraminifers	–	–	T	10	3	–
Calc. nannofossils	2	T	–	T	T	–
Sponge spicules	T	–	–	–	–	–
Plant debris	T	1	–	20	T	T

CARBONATE BOMB DATA:
*1, 25–27 cm = 8%

SITE 616 HOLE CORE 25W CORED INTERVAL 3265.8–3285.0 mbsl; 266.9–286.1 mbsf



Core was empty except for a couple specks of dark olive gray (5Y 3/2) MUD. Entire sample given to paleontologists.

SITE 616 HOLE CORE 26X CORED INTERVAL 3285.0–3294.6 mbsl; 286.1–295.7 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone Y N: *E. huxleyi* Zone (NN21)		(FM)			1 CC	0.5 1.0				*

LITHOLOGIC DESCRIPTION

MUD, dark olive gray (5Y 3/2) and homogeneous with a few silt blebs and deformed fine–medium SILT/SAND layers. SILT and SAND blebs and layers are olive gray (5Y 5/2).

SMEAR SLIDE SUMMARY (%):

	1, 50 D
Texture:	
Sand	0
Silt	7
Clay	93
Composition:	
Quartz	5
Feldspar	T
Mica	2
Heavy minerals	T
Clay	91
Pyrite	T
Micronodules	T
Carbonate unspec.	1
Calc. nannofossils	1
Sponge spicules	T
Plant debris	T

CARBONATE BOMB DATA:
*1, 65–67 cm = 9%

SITE 616 HOLE CORE 27X CORED INTERVAL 3294.6–3304.2 mbsl; 295.7–305.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone Y N: *E. huxleyi* Zone (NN21)		(FM)			CC					*

LITHOLOGIC DESCRIPTION

Core was empty except for a small bell of dark olive gray (5Y 3/2) MUD. Entire sample was given to the shipboard paleontologists.

SMEAR SLIDE SUMMARY (%):

	CC D
Texture:	
Sand	0
Silt	7
Clay	93
Composition:	
Quartz	10
Mica	1
Heavy minerals	T
Clay	86
Pyrite	T
Carbonate unspec.	2
Calc. nannofossils	1
Sponge spicules	T
Plant debris	T

SITE 616 HOLE CORE 28X CORED INTERVAL 3304.2–3318.2 mbsl; 305.3–314.9 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone Y N: *E. huxleyi* Zone (NN21)	RM	(CM)			1 2 3 CC	0.5 1.0				* K-Ar IN * OGP BRLY

LITHOLOGIC DESCRIPTION

CLAY, dark olive gray (5Y 3/2) and homogeneous. Section 1, 5 cm contains a discontinuous SAND layer; Section 1, 25–27 cm contains an olive gray (5Y 5/2) SILT megableb. Most of the core contains faint, parallel "lineations" spaced 1–2 cm apart, which are probably shear planes induced by drilling (i. e. like drilling "biscuits").

SMEAR SLIDE SUMMARY (%):

	1, 90 D
Texture:	
Sand	0
Silt	5
Clay	95
Composition:	
Quartz	5
Mica	T
Heavy minerals	T
Clay	94
Pyrite/opaques	T
Carbonate unspec.	1
Calc. nannofossils	T
Sponge spicules	T
Plant debris	T

CARBONATE BOMB DATA:
*2, 7–9 cm = 11%

SITE 616 HOLE CORE 29H CORED INTERVAL 3313.8–3323.2 mbsl; 314.9–324.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone Y N: *E. huxleyi* Zone (NN21)	RM	(FM)			CC					*

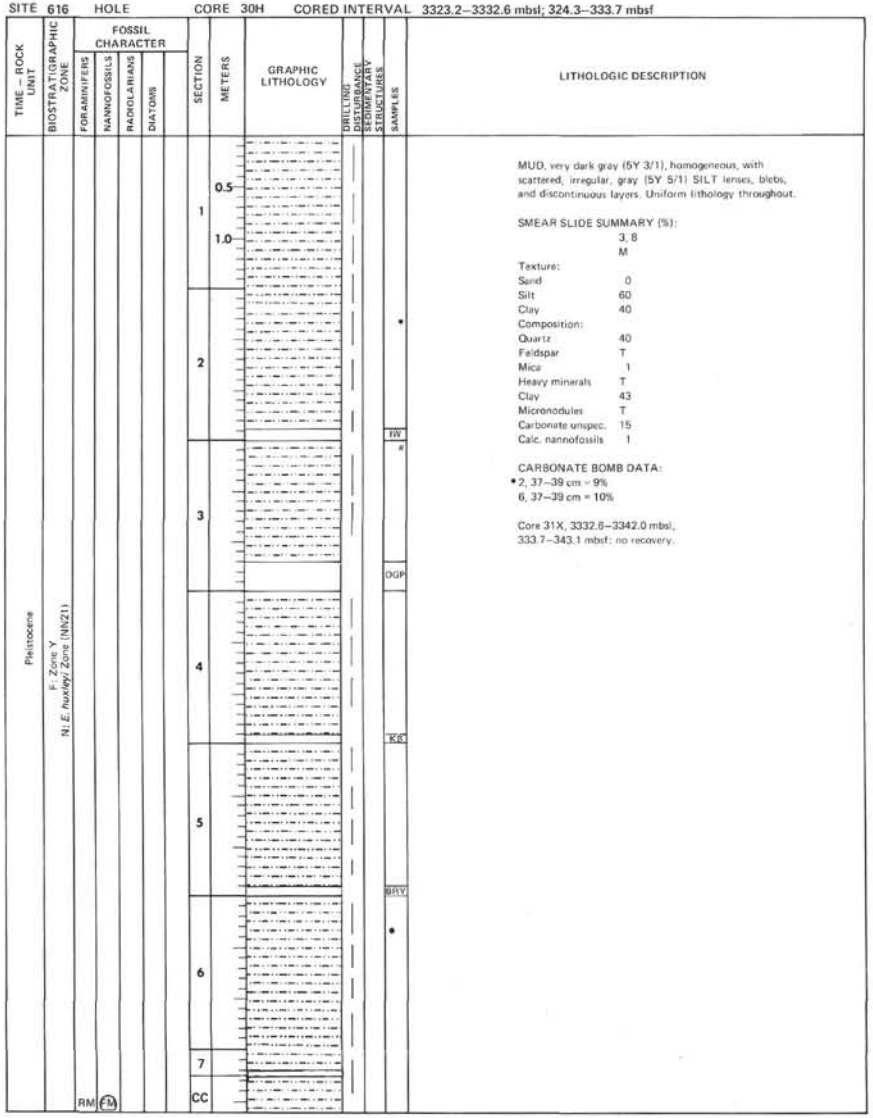
LITHOLOGIC DESCRIPTION

Core Catcher contained two small chunks of dark olive gray (5Y 3/2), homogeneous CLAY. Rest of the core was empty.

SMEAR SLIDE SUMMARY (%):

	CC D
Texture:	
Sand	0
Silt	3
Clay	97
Composition:	
Quartz	3
Mica	1
Heavy minerals	T
Clay	94
Pyrite	T
Micronodules	T
Carbonate unspec.	2
Calc. nannofossils	T
Sponge spicules	T

SITE 616 HOLE CORE 30H CORED INTERVAL 3323.2–3332.6 mbsl; 324.3–333.7 mbsf



MUD, very dark gray (5Y 3/1), homogeneous, with scattered, irregular, gray (5Y 5/1) SILT lenses, blebs, and discontinuous layers. Uniform lithology throughout.

SMEAR SLIDE SUMMARY (%):

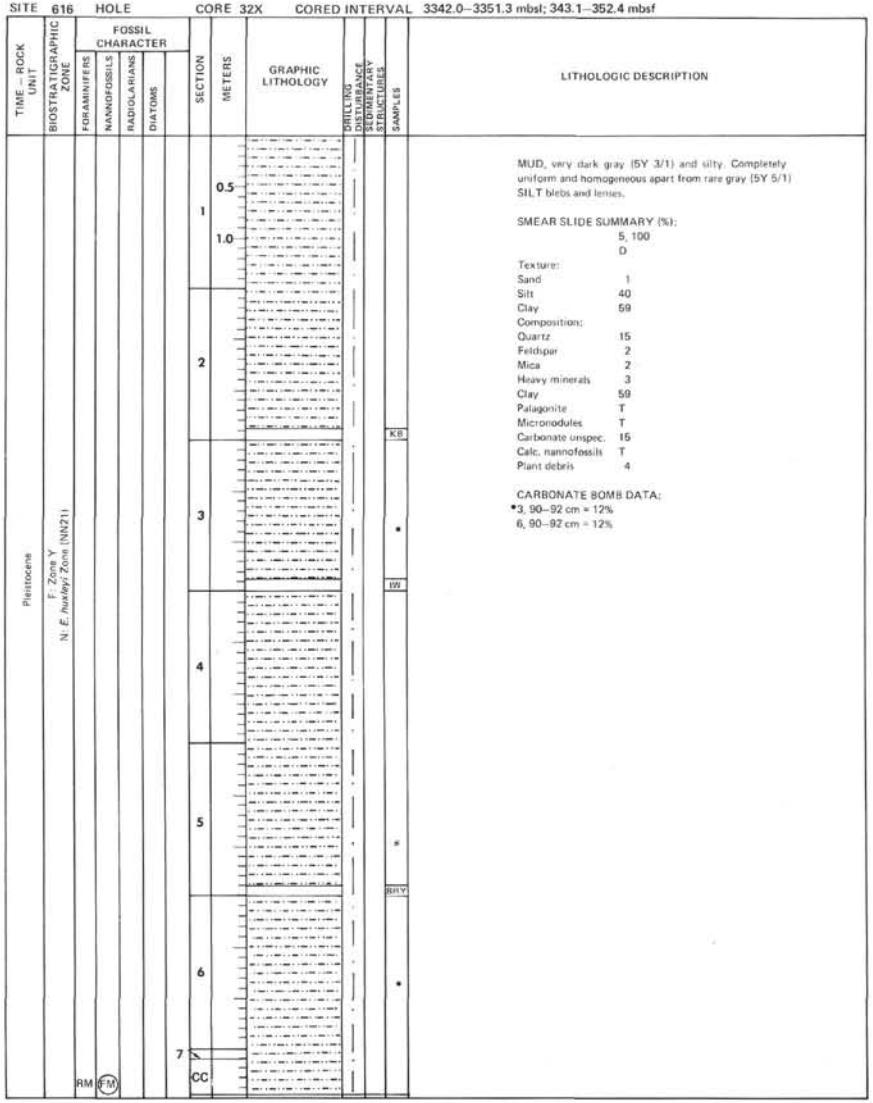
	3, 8 M
Texture:	
Sand	0
Silt	60
Clay	40
Composition:	
Quartz	40
Feldspar	T
Mica	1
Heavy minerals	T
Clay	43
Micronodules	T
Carbonate unspec.	15
Calc. nannofossils	1

CARBONATE BOMB DATA:

*2, 37–39 cm = 9%
6, 37–39 cm = 10%

Core 31X, 3332.6–3342.0 mbsl, 333.7–343.1 mbsf; no recovery.

SITE 616 HOLE CORE 32X CORED INTERVAL 3342.0–3351.3 mbsl; 343.1–352.4 mbsf



MUD, very dark gray (5Y 3/1) and silty. Completely uniform and homogeneous apart from rare gray (5Y 5/1) SILT blebs and lenses.

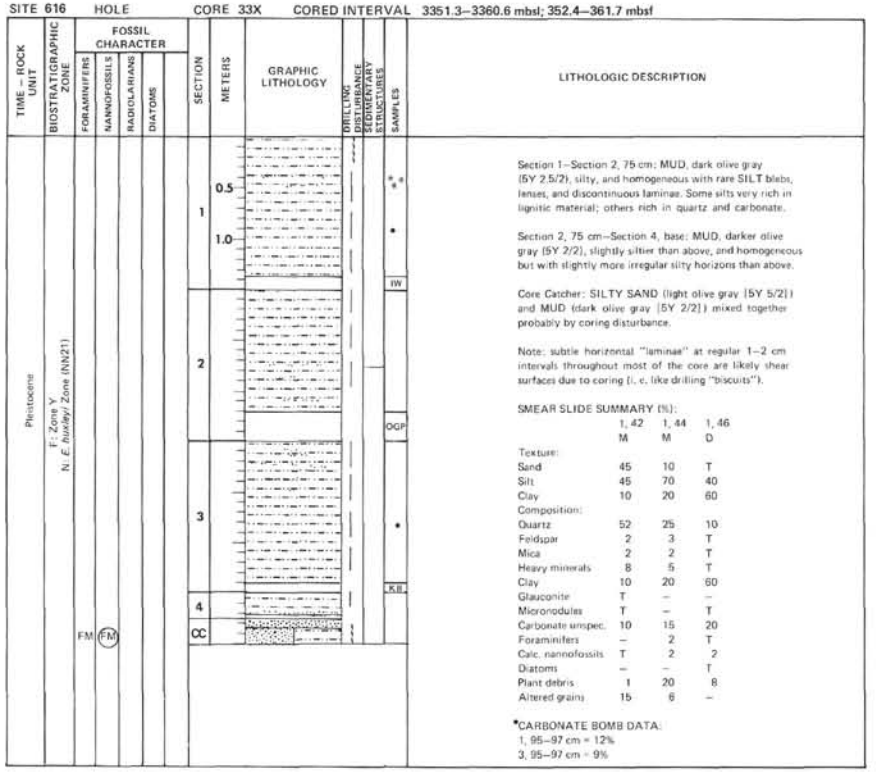
SMEAR SLIDE SUMMARY (%):

	5, 100 D
Texture:	
Sand	1
Silt	40
Clay	59
Composition:	
Quartz	15
Feldspar	2
Mica	2
Heavy minerals	3
Clay	59
Palagonite	T
Micronodules	T
Carbonate unspec.	15
Calc. nannofossils	T
Plant debris	4

CARBONATE BOMB DATA:

*3, 90–92 cm = 12%
6, 90–92 cm = 12%

SITE 616 HOLE CORE 33X CORED INTERVAL 3351.3–3360.6 mbsl; 352.4–361.7 mbsf



Section 1–Section 2, 75 cm: MUD, dark olive gray (5Y 2.5/2), silty, and homogeneous with rare SILT blebs, lenses, and discontinuous laminae. Some silts very rich in lignitic material; others rich in quartz and carbonate.

Section 2, 75 cm–Section 4, base: MUD, darker olive gray (5Y 2/2), slightly siltier than above, and homogeneous but with slightly more irregular silty horizons than above.

Core Catcher: SILTY SAND (light olive gray [5Y 5/2]) and MUD (dark olive gray [5Y 2/2]) mixed together probably by coring disturbance.

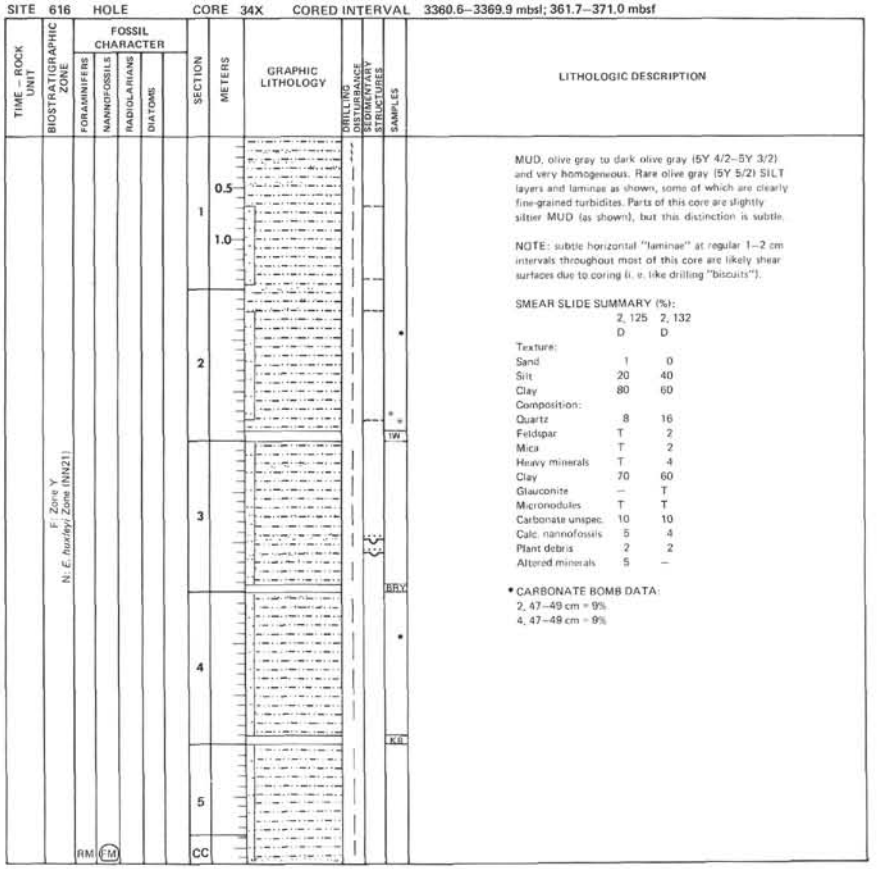
Note: subtle horizontal "laminae" at regular 1–2 cm intervals throughout most of the core are likely shear surfaces due to coring (i. e. like drilling "biscuits").

SMEAR SLIDE SUMMARY (%):

	1, 42 M	1, 44 M	1, 46 D
Texture:			
Sand	45	10	T
Silt	45	70	40
Clay	10	20	60
Composition:			
Quartz	52	25	10
Feldspar	2	3	T
Mica	2	2	T
Heavy minerals	8	5	T
Clay	10	20	60
Glauconite	T	–	–
Micronodules	T	–	T
Carbonate unspec.	10	15	20
Foraminifers	–	2	T
Calc. nannofossils	T	2	2
Diatoms	–	–	T
Plant debris	1	20	8
Altered grains	15	6	–

*CARBONATE BOMB DATA:
1, 95–97 cm = 12%
3, 95–97 cm = 9%

SITE 616 HOLE CORE 34X CORED INTERVAL 3360.6–3369.9 mbsl; 361.7–371.0 mbsf



MUD, olive gray to dark olive gray (5Y 4/2–5Y 3/2) and very homogeneous. Rare olive gray (5Y 5/2) SILT layers and laminae as shown, some of which are clearly fine-grained turbidites. Parts of this core are slightly siltier MUD (as shown), but this distinction is subtle.

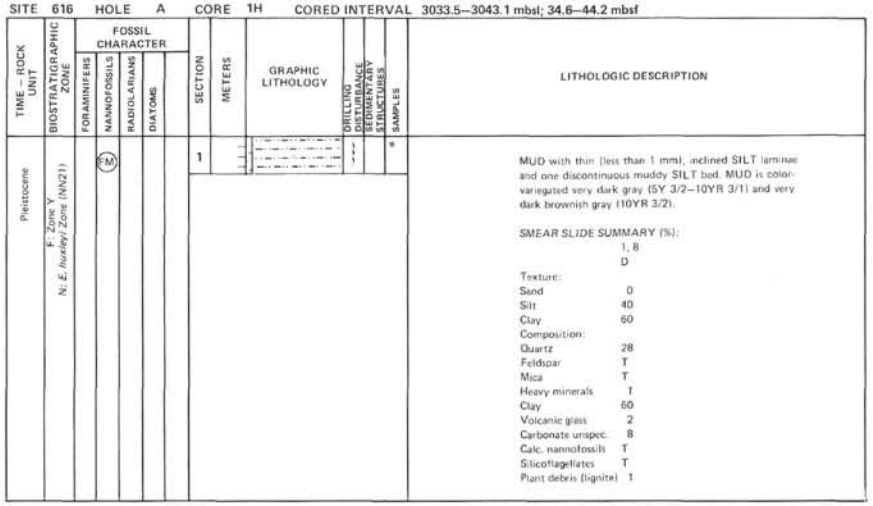
NOTE: subtle horizontal "laminae" at regular 1–2 cm intervals throughout most of this core are likely shear surfaces due to coring (i. e. like drilling "biscuits").

SMEAR SLIDE SUMMARY (%):

	2, 125 D	2, 132 D
Texture:		
Sand	1	0
Silt	20	40
Clay	80	60
Composition:		
Quartz	8	16
Feldspar	T	2
Mica	T	2
Heavy minerals	T	4
Clay	70	60
Glauconite	–	T
Micronodules	T	T
Carbonate unspec.	10	10
Calc. nannofossils	5	4
Plant debris	2	2
Altered minerals	5	–

*CARBONATE BOMB DATA:
2, 47–49 cm = 9%
4, 47–49 cm = 9%

SITE 616 HOLE A CORE 1H CORED INTERVAL 3033.5–3043.1 mbsl; 34.6–44.2 mbsf



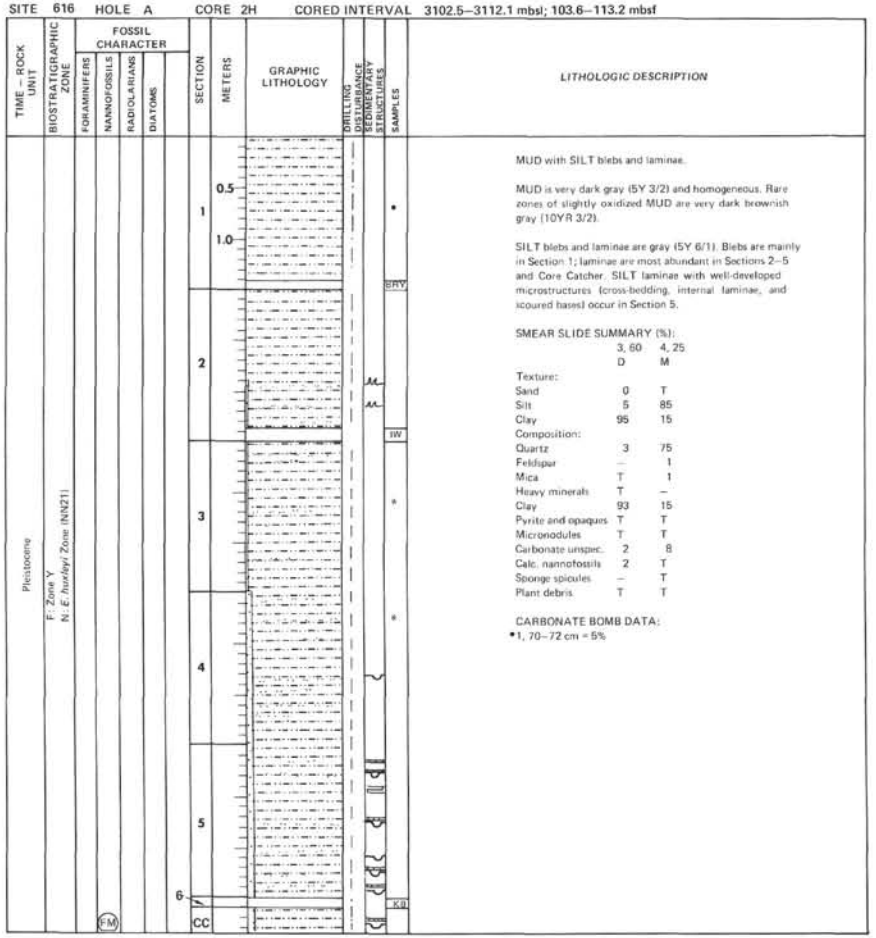
LITHOLOGIC DESCRIPTION

MUD with thin (less than 1 mm), inclined SILT laminae and one discontinuous muddy SILT bed. MUD is color-variegated very dark gray (5Y 3/2–10YR 3/1) and very dark brownish gray (10YR 3/2).

SMEAR SLIDE SUMMARY (%):

	1, 8 D
Texture:	
Sand	0
Silt	40
Clay	60
Composition:	
Quartz	28
Feldspar	T
Mica	T
Heavy minerals	T
Clay	60
Volcanic glass	2
Carbonate unspec.	8
Calc. nannofossils	T
Silicoflagellates	T
Plant debris (lignite)	1

SITE 616 HOLE A CORE 2H CORED INTERVAL 3102.5–3112.1 mbsl; 103.6–113.2 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT blebs and laminae.

MUD is very dark gray (5Y 3/2) and homogeneous. Rare zones of slightly oxidized MUD are very dark brownish gray (10YR 3/2).

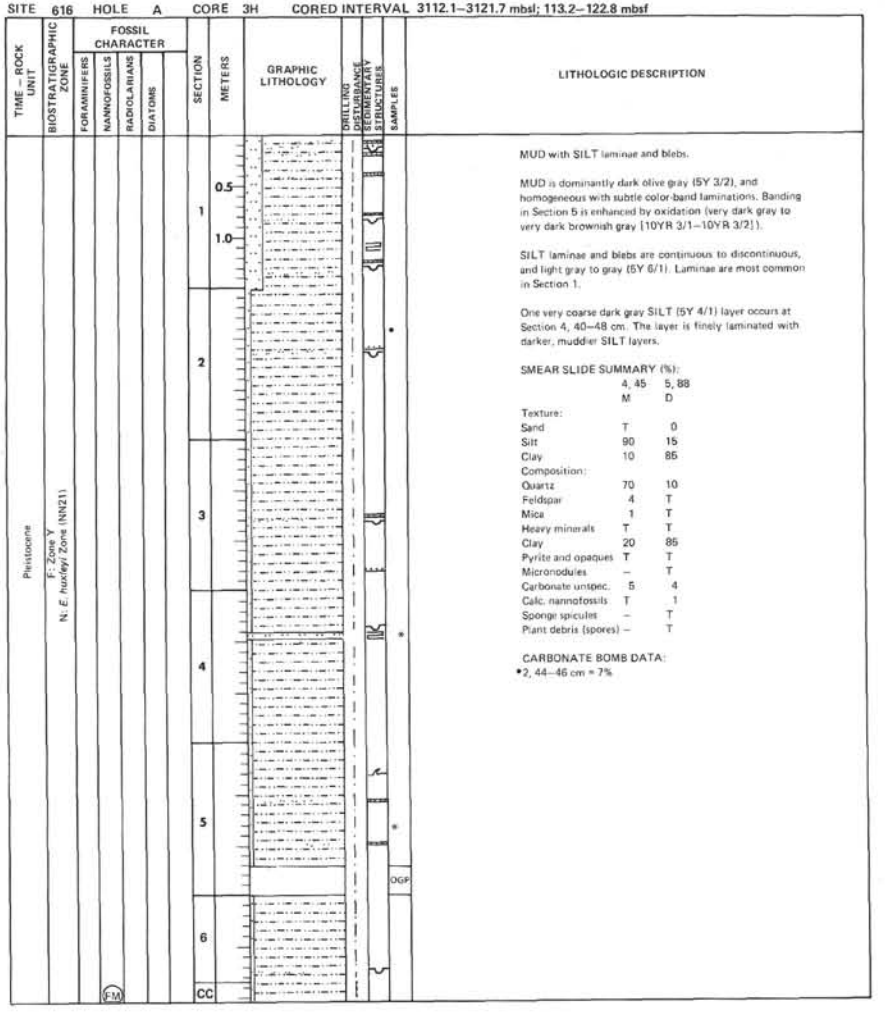
SILT blebs and laminae are gray (5Y 6/1). Blebs are mainly in Section 1; laminae are most abundant in Sections 2–5 and Core Catcher. SILT laminae with well-developed microstructures (cross-bedding, internal laminae, and scoured bases) occur in Section 5.

SMEAR SLIDE SUMMARY (%):

	3, 60 D	4, 25 M
Texture:		
Sand	0	T
Silt	5	85
Clay	95	15
Composition:		
Quartz	3	75
Feldspar	–	1
Mica	T	1
Heavy minerals	T	–
Clay	93	15
Pyrite and opaques	T	T
Micronodules	T	T
Carbonate unspec.	2	8
Calc. nannofossils	2	T
Sponge spicules	–	T
Plant debris	T	T

CARBONATE BOMB DATA:
•1, 70–72 cm = 5%

SITE 616 HOLE A CORE 3H CORED INTERVAL 3112.1–3121.7 mbsl; 113.2–122.8 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT laminae and blebs.

MUD is dominantly dark olive gray (5Y 3/2), and homogeneous with subtle color-band laminations. Banding in Section 5 is enhanced by oxidation (very dark gray to very dark brownish gray [10YR 3/1–10YR 3/2]).

SILT laminae and blebs are continuous to discontinuous, and light gray to gray (5Y 6/1). Laminae are most common in Section 1.

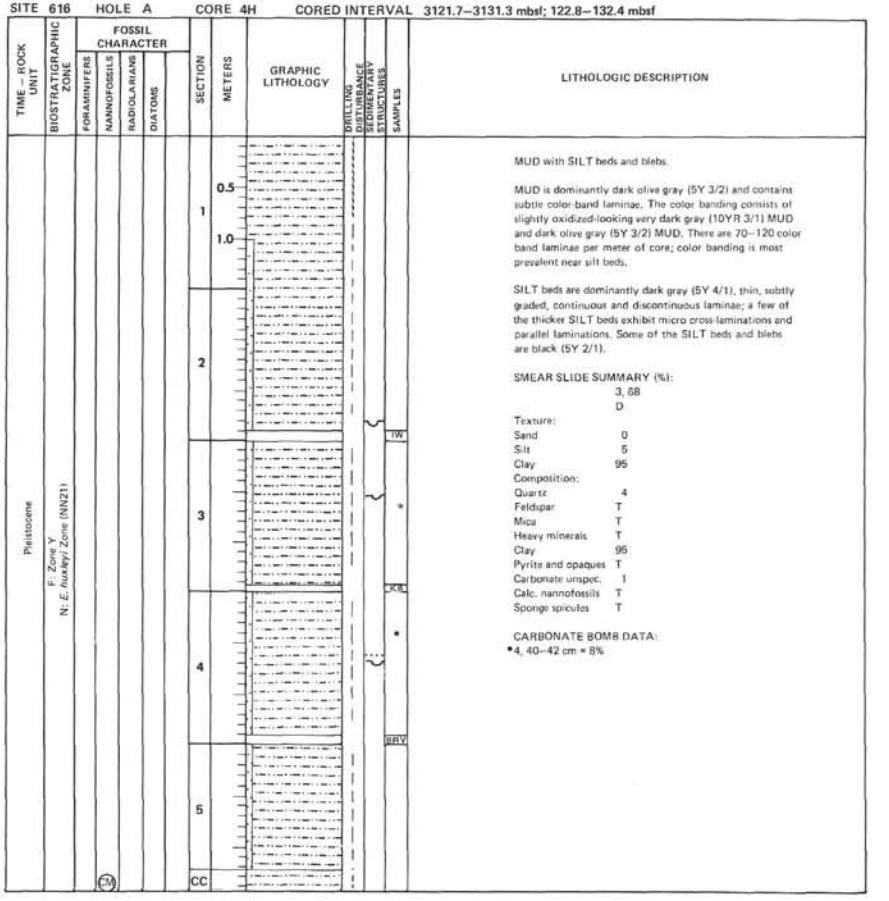
One very coarse dark gray SILT (5Y 4/1) layer occurs at Section 4, 40–48 cm. The layer is finely laminated with darker, muddier SILT layers.

SMEAR SLIDE SUMMARY (%):

	4, 45 M	5, 88 D
Texture:		
Sand	T	0
Silt	90	15
Clay	10	85
Composition:		
Quartz	70	10
Feldspar	4	T
Mica	1	T
Heavy minerals	T	T
Clay	20	85
Pyrite and opaques	T	T
Micronodules	–	T
Carbonate unspec.	5	4
Calc. nannofossils	T	1
Sponge spicules	–	T
Plant debris (spores)	–	T

CARBONATE BOMB DATA:
•2, 44–46 cm = 7%

SITE 616 HOLE A CORE 4H CORED INTERVAL 3121.7–3131.3 mbsl; 122.8–132.4 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT beds and blebs.

MUD is dominantly dark olive gray (5Y 3/2) and contains subtle color-band laminae. The color banding consists of slightly oxidized-looking very dark gray (10YR 3/1) MUD and dark olive gray (5Y 3/2) MUD. There are 70–120 color band laminae per meter of core; color banding is most prevalent near silt beds.

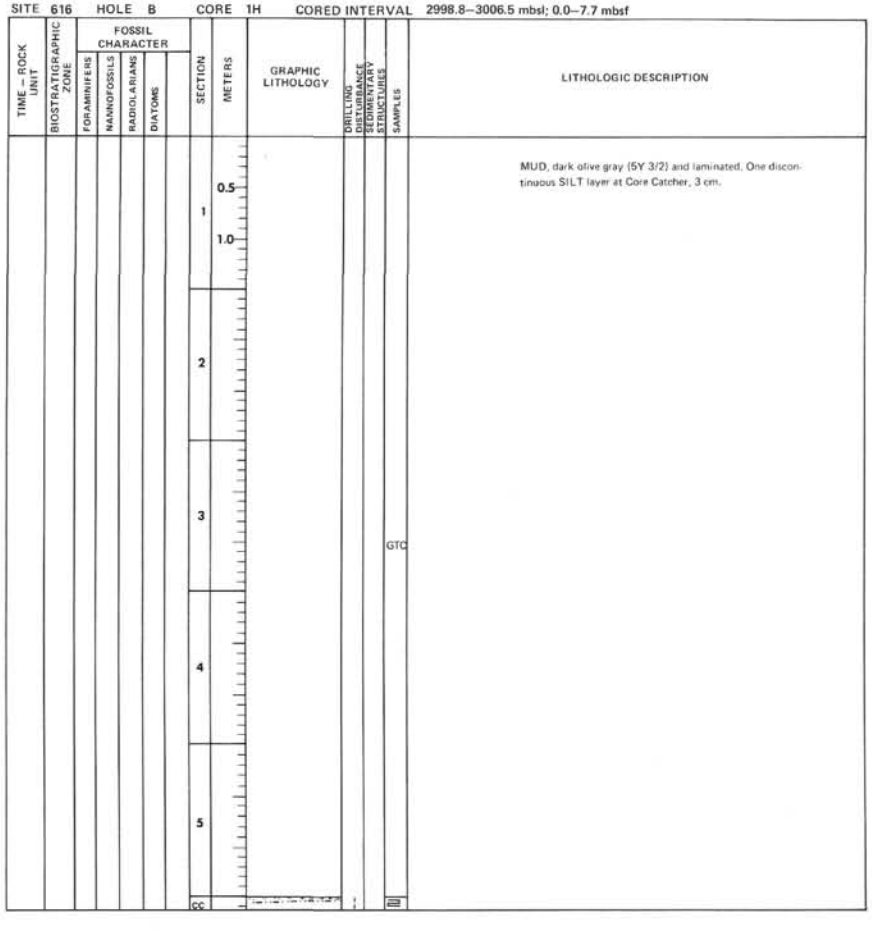
SILT beds are dominantly dark gray (5Y 4/1), thin, subtly graded, continuous and discontinuous laminae; a few of the thicker SILT beds exhibit micro cross-laminations and parallel laminations. Some of the SILT beds and blebs are black (5Y 2/1).

SMEAR SLIDE SUMMARY (%):

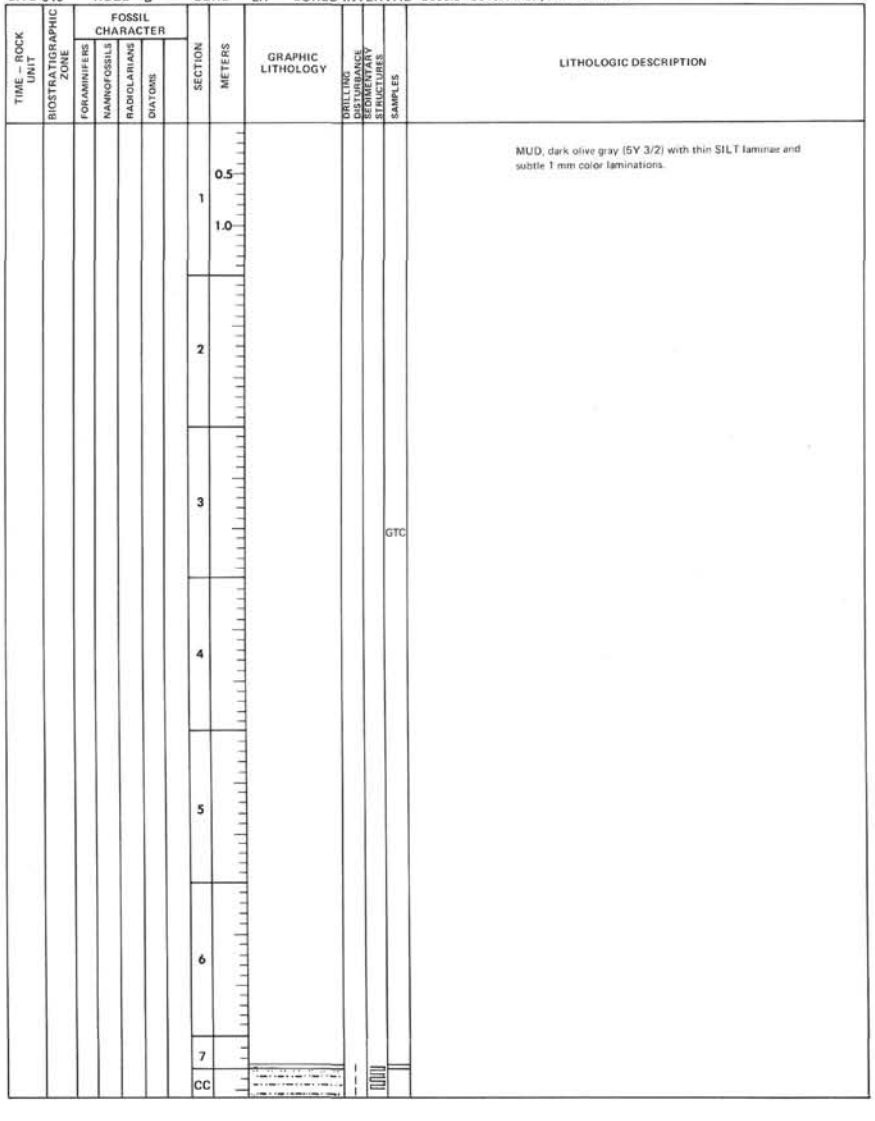
	3, 68 D
Texture:	
Sand	0
Silt	5
Clay	95
Composition:	
Quartz	4
Feldspar	T
Mica	T
Heavy minerals	T
Clay	95
Pyrite and opaques	T
Carbonate unspec.	1
Calc. nannofossils	T
Sponge spicules	T

CARBONATE BOMB DATA:
•4, 40–42 cm = 8%

SITE 616 HOLE B CORE 1H CORED INTERVAL 2998.8–3006.5 mbsl; 0.0–7.7 mbsf



SITE 616 HOLE B CORE 2H CORED INTERVAL 3006.5–3016.1 mbsl; 7.7–17.3 mbsf



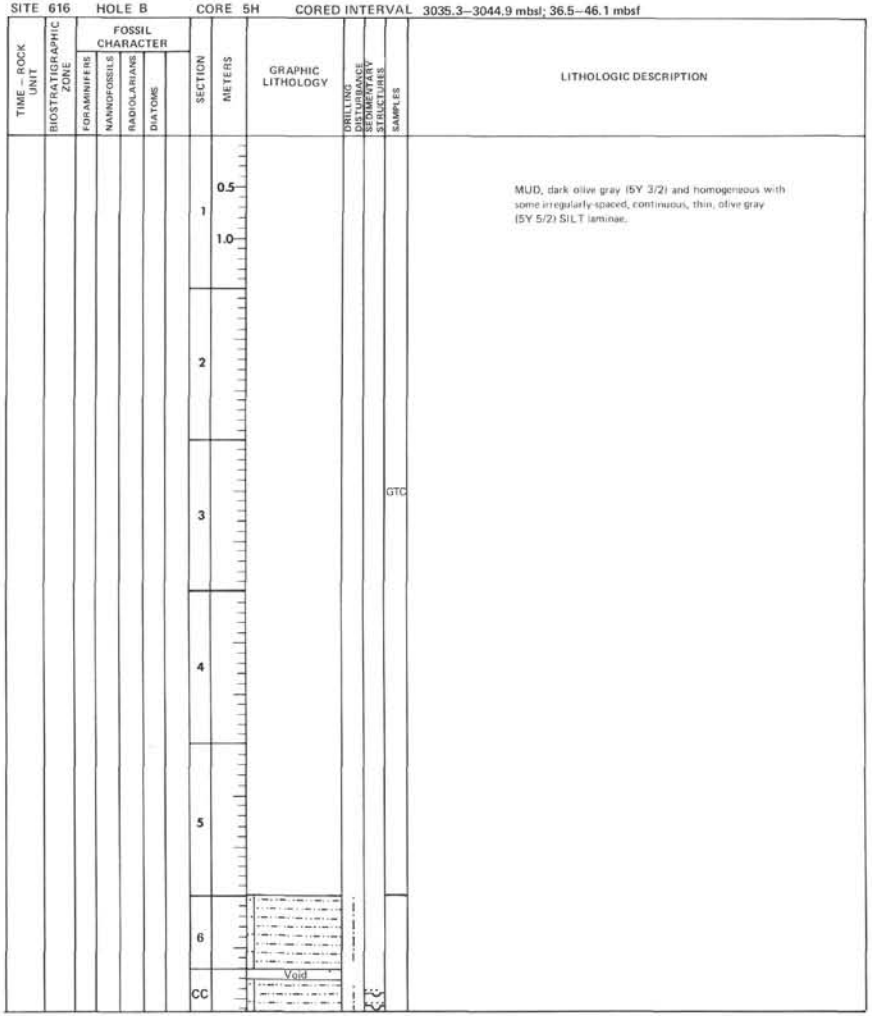
SITE 616 HOLE B CORE 3H CORED INTERVAL 3016.1–3025.7 mbsl; 17.3–26.9 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark brownish gray (10YR 3/2) with SILT laminae. Disrupted lighter olive gray (5Y 4/2–5Y 5/2) SILT beds and blebs at Core Catcher, 12–14 cm and 20–22 cm.
						1	1.0					
						2						
						3					GTC	
						4						
						5						
						6						
						CC						

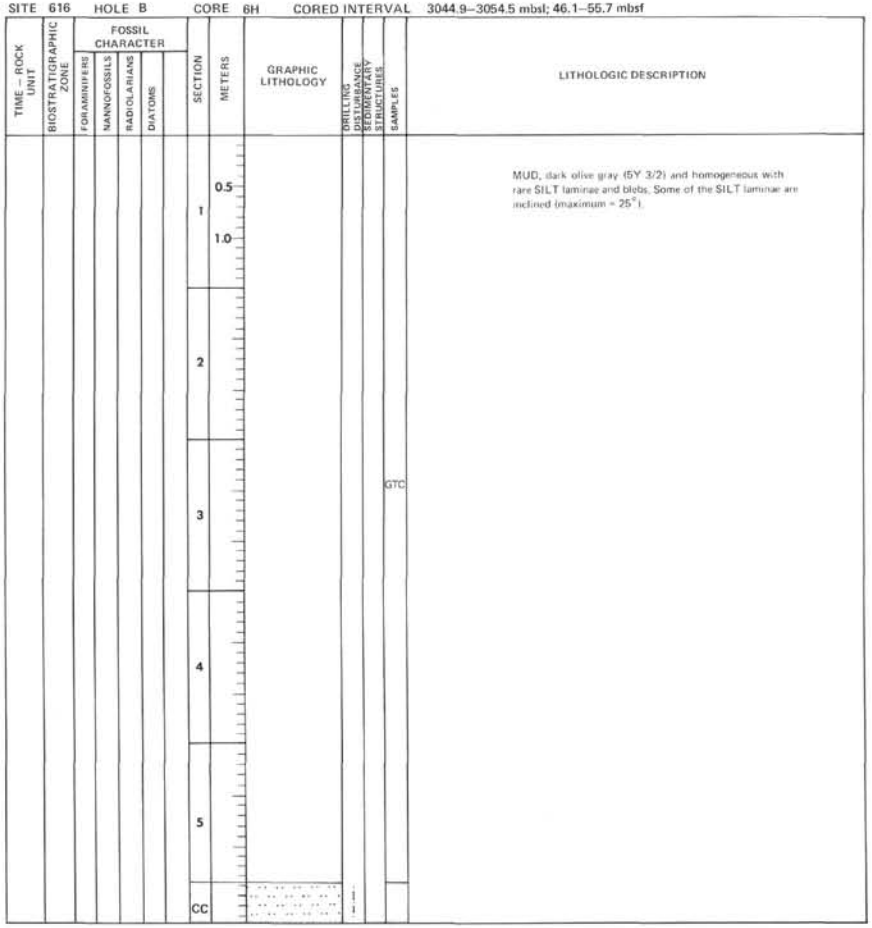
SITE 616 HOLE B CORE 4H CORED INTERVAL 3025.7–3035.3 mbsl; 26.9–36.5 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2) with disrupted SILT laminae. MUD is homogeneous without color-laminae.
						1	1.0					
						2						
						3					GTC	
						4						
						5						
						6						
						CC						

SITE 616 HOLE B CORE 5H CORED INTERVAL 3035.3–3044.9 mbsl; 36.5–46.1 mbsf



SITE 616 HOLE B CORE 6H CORED INTERVAL 3044.9–3054.5 mbsl; 46.1–55.7 mbsf



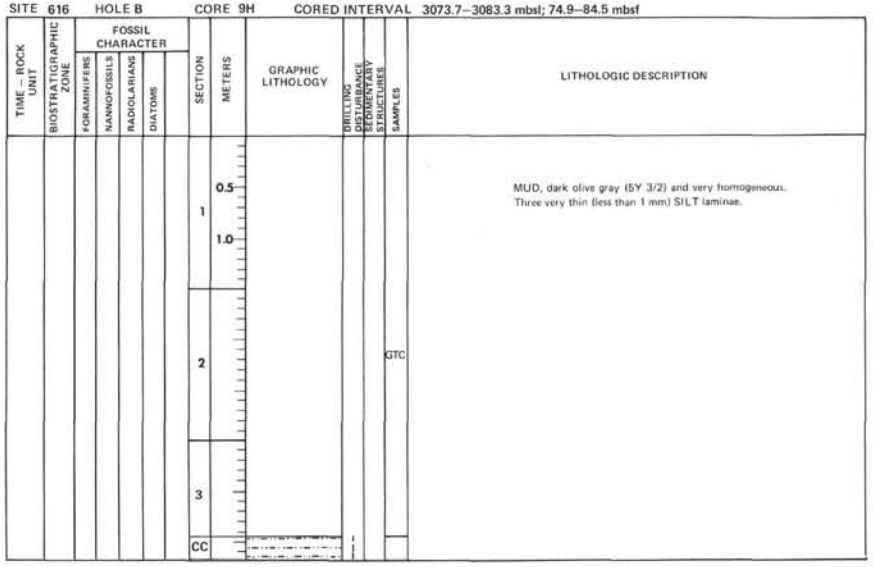
SITE 616 HOLE B CORE 7H CORED INTERVAL 3054.5–3064.1 mbsl; 55.7–65.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2) and homogeneous with rare, discontinuous SILT laminae and blebs.
						1	1.0					
						2					GTC	
						3						
						4						
						CC						

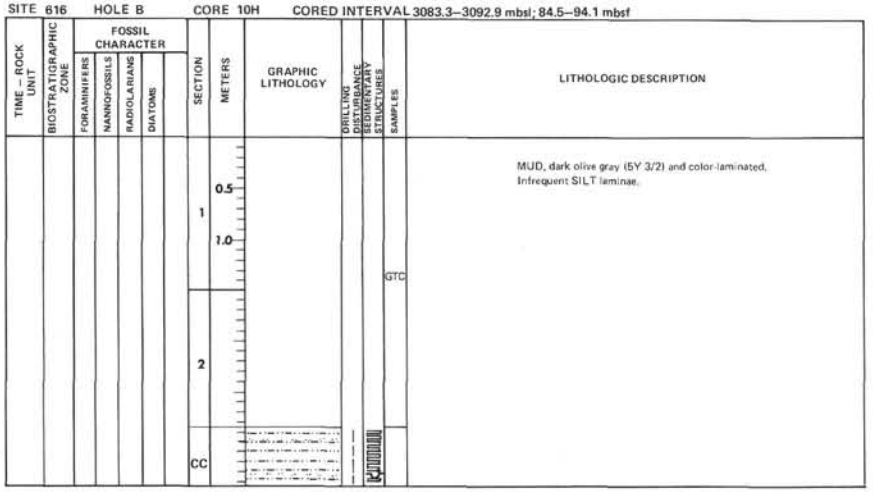
SITE 616 HOLE B CORE 8H CORED INTERVAL 3064.1–3073.7 mbsl; 65.3–74.9 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2) and homogeneous. Rare, very thin, discontinuous SILT laminae and blebs.
						1	1.0					
						2						
						3					GTC	
						4						
						5						
						CC						

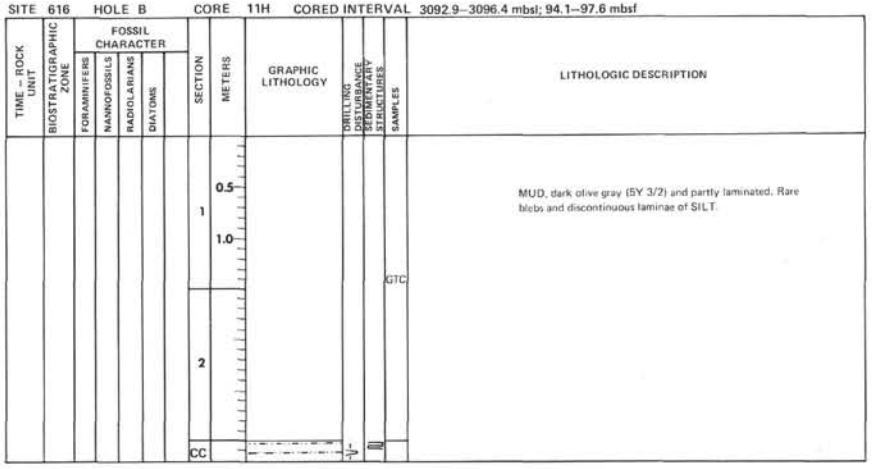
SITE 616 HOLE B CORE 9H CORED INTERVAL 3073.7–3083.3 mbsl; 74.9–84.5 mbsf



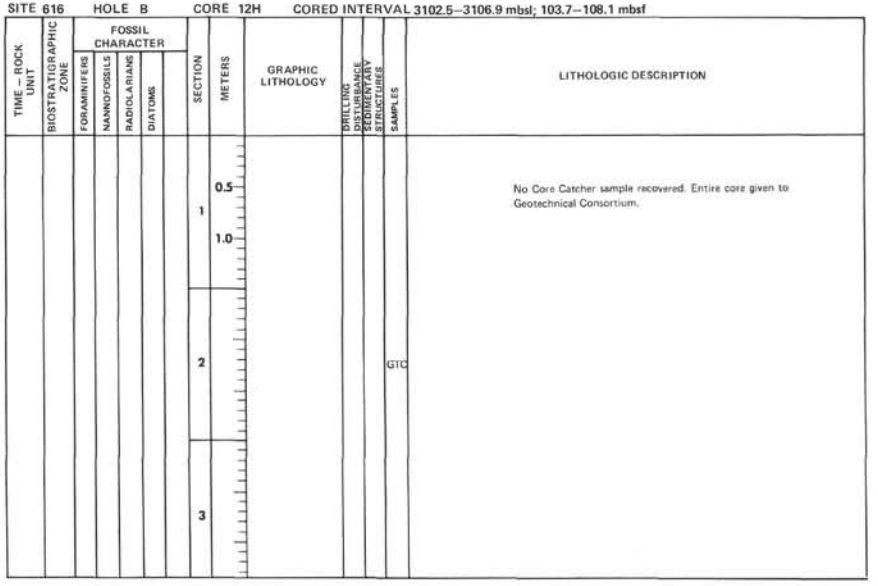
SITE 616 HOLE B CORE 10H CORED INTERVAL 3083.3–3092.9 mbsl; 84.5–94.1 mbsf



SITE 616 HOLE B CORE 11H CORED INTERVAL 3092.9–3096.4 mbsl; 94.1–97.6 mbsf



SITE 616 HOLE B CORE 12H CORED INTERVAL 3102.5–3106.9 mbsl; 103.7–108.1 mbsf



SITE 616 HOLE B CORE 13H CORED INTERVAL 3112.1–3119.1 mbsl; 113.3–120.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2). Dominantly homogeneous, with sets of very thin SILT laminations at Core Catcher, 12 and 18 cm. Silt laminae are dark olive gray to olive gray (5Y 3/2–5Y 4/2).
							1.0					
						2						
						3					GTC	
						4						
						5						
						CC						

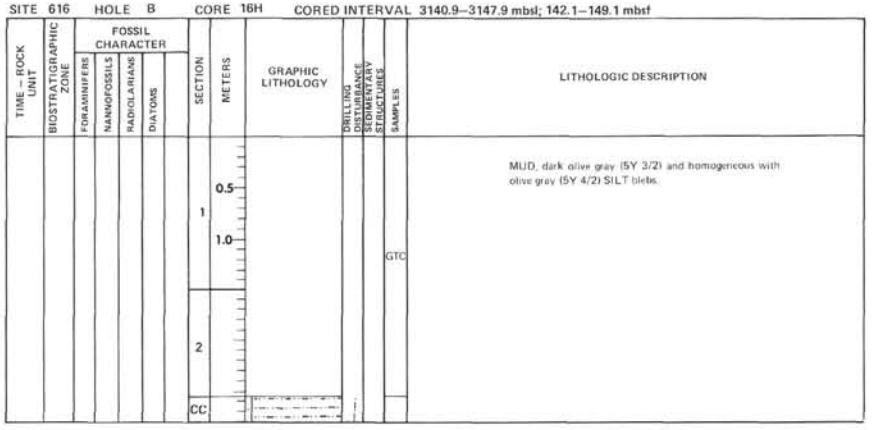
SITE 616 HOLE B CORE 14H CORED INTERVAL 3121.7–3126.1 mbsl; 122.9–127.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2) and finely (1–7 mm) laminated with numerous SILT blebs and several discontinuous SILT laminae. One 3 cm thick, continuous, dark olive gray (5Y 3/2), coarse SILT lamina occurs at the base of the Core Catcher. The rest of the silt laminae and blebs are olive gray (5Y 4/2).
							1.0					
						2					GTC	
						3						
						CC						

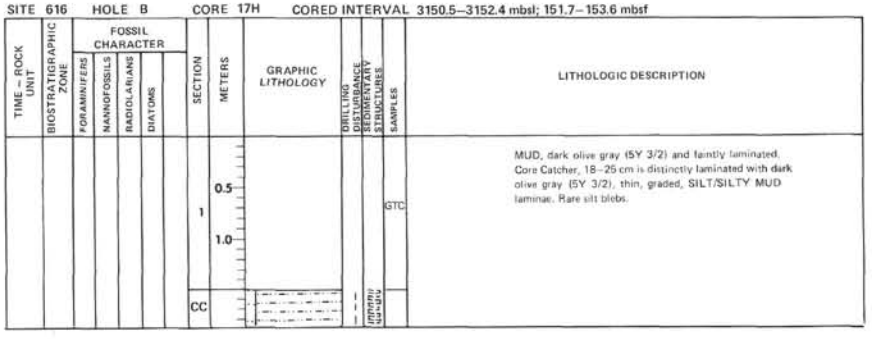
SITE 616 HOLE B CORE 15H CORED INTERVAL 3131.3–3134.4 mbsl; 132.5–135.6 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	FOSSIL CHARACTER: NANNOFOSSILS	FOSSIL CHARACTER: RADIOLARIANS	FOSSIL CHARACTER: DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5					MUD, dark olive gray (5Y 3/2) and finely laminated. Common, very thin, discontinuous SILT laminae and blebs.
							1.0					
						2					GTC	
						CC						

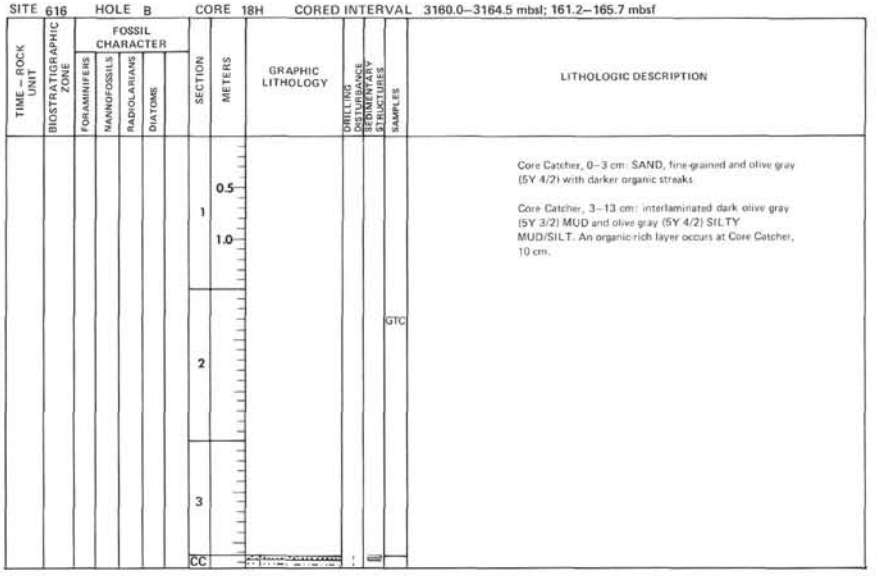
SITE 616 HOLE B CORE 16H CORED INTERVAL 3140.9–3147.9 mbsl; 142.1–149.1 mbsf



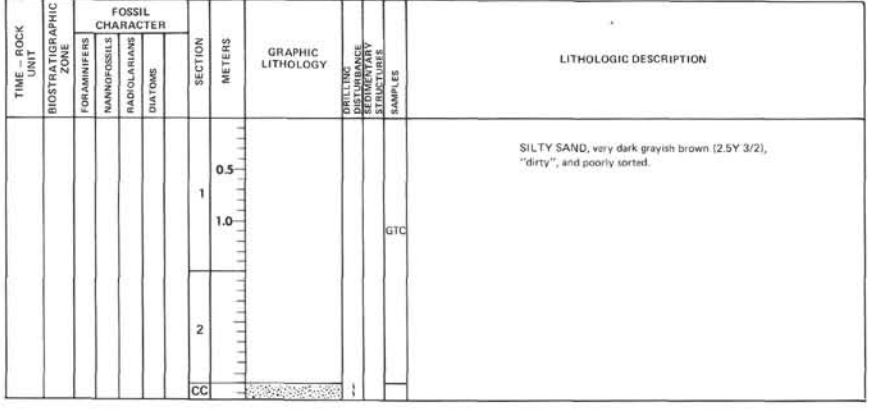
SITE 616 HOLE B CORE 17H CORED INTERVAL 3150.5–3152.4 mbsl; 151.7–153.6 mbsf



SITE 616 HOLE B CORE 18H CORED INTERVAL 3160.0–3164.5 mbsl; 161.2–165.7 mbsf



SITE 616 HOLE B CORE 19H CORED INTERVAL 3169.5–3172.4 mbsl; 170.7–173.6 mbsf



SITE 616 HOLE B CORE 20H CORED INTERVAL 3179.0–3179.5 mbsl; 180.2–180.7 mbsf

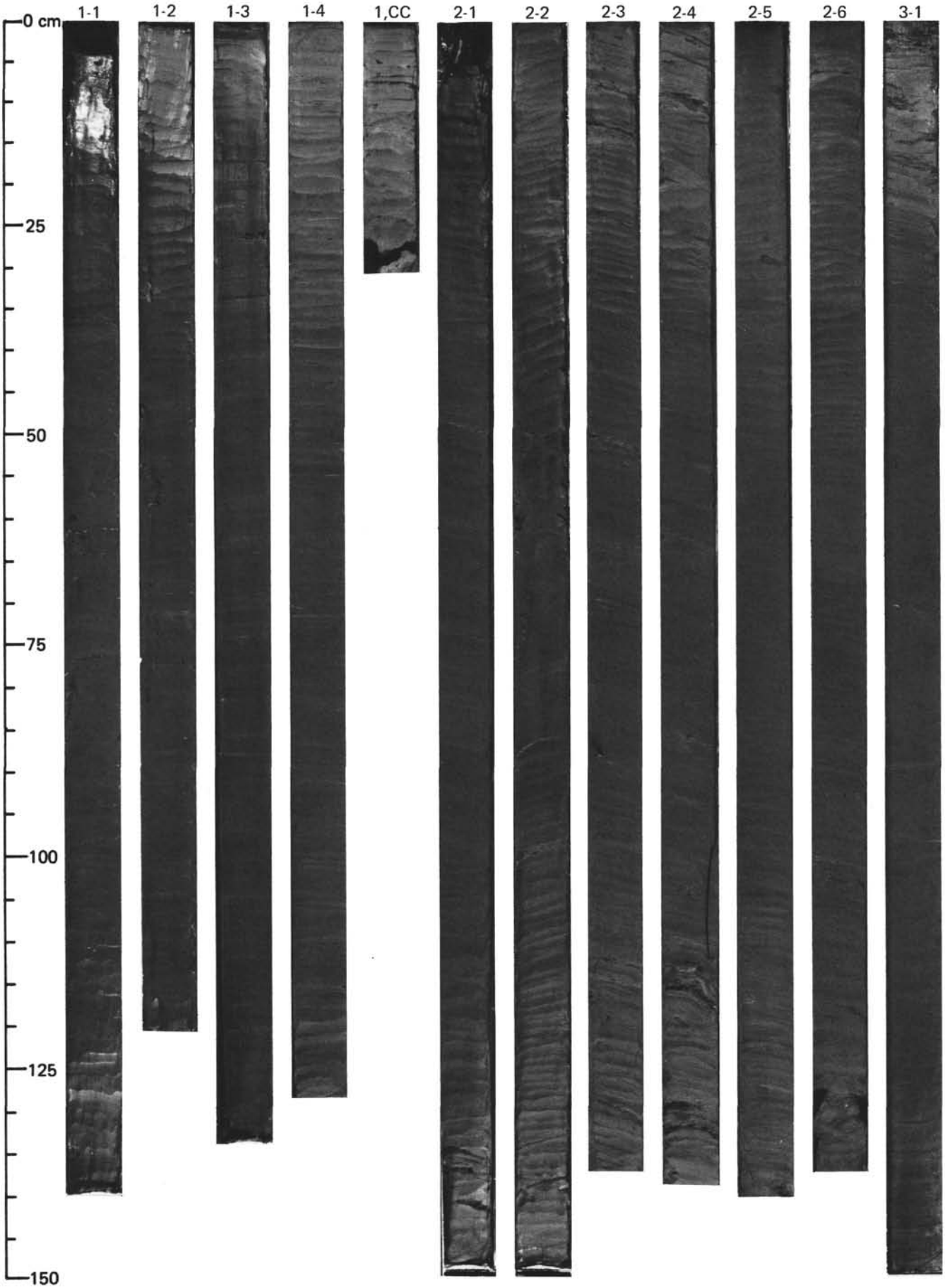
TIME—ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1					GTC	No Core Catcher. Entire core dedicated for shorebased Geotechnical Consortium studies.

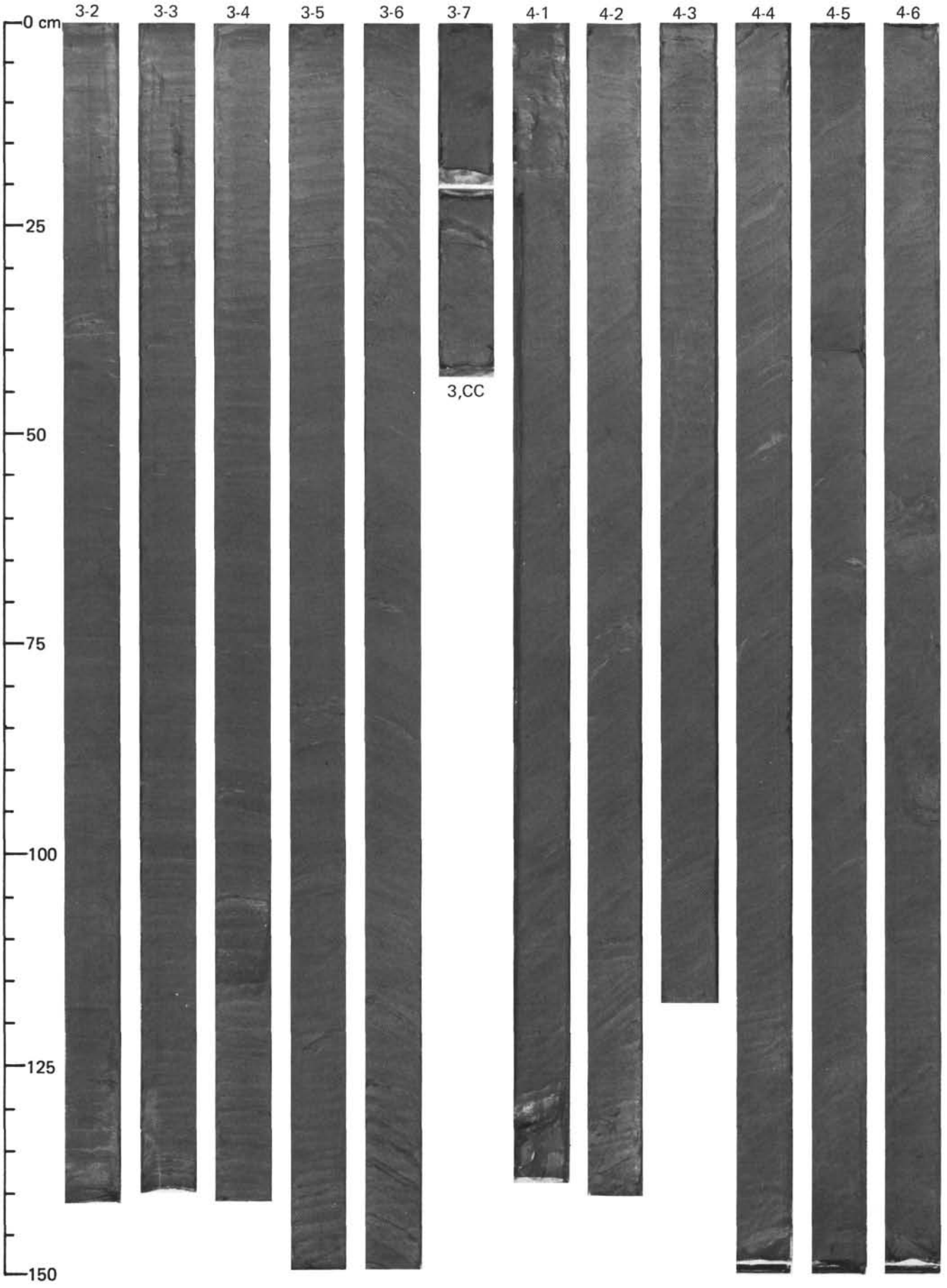
SITE 616 HOLE B CORE 21H CORED INTERVAL 3188.6–3193.6 mbsl; 189.8–194.8 mbsf

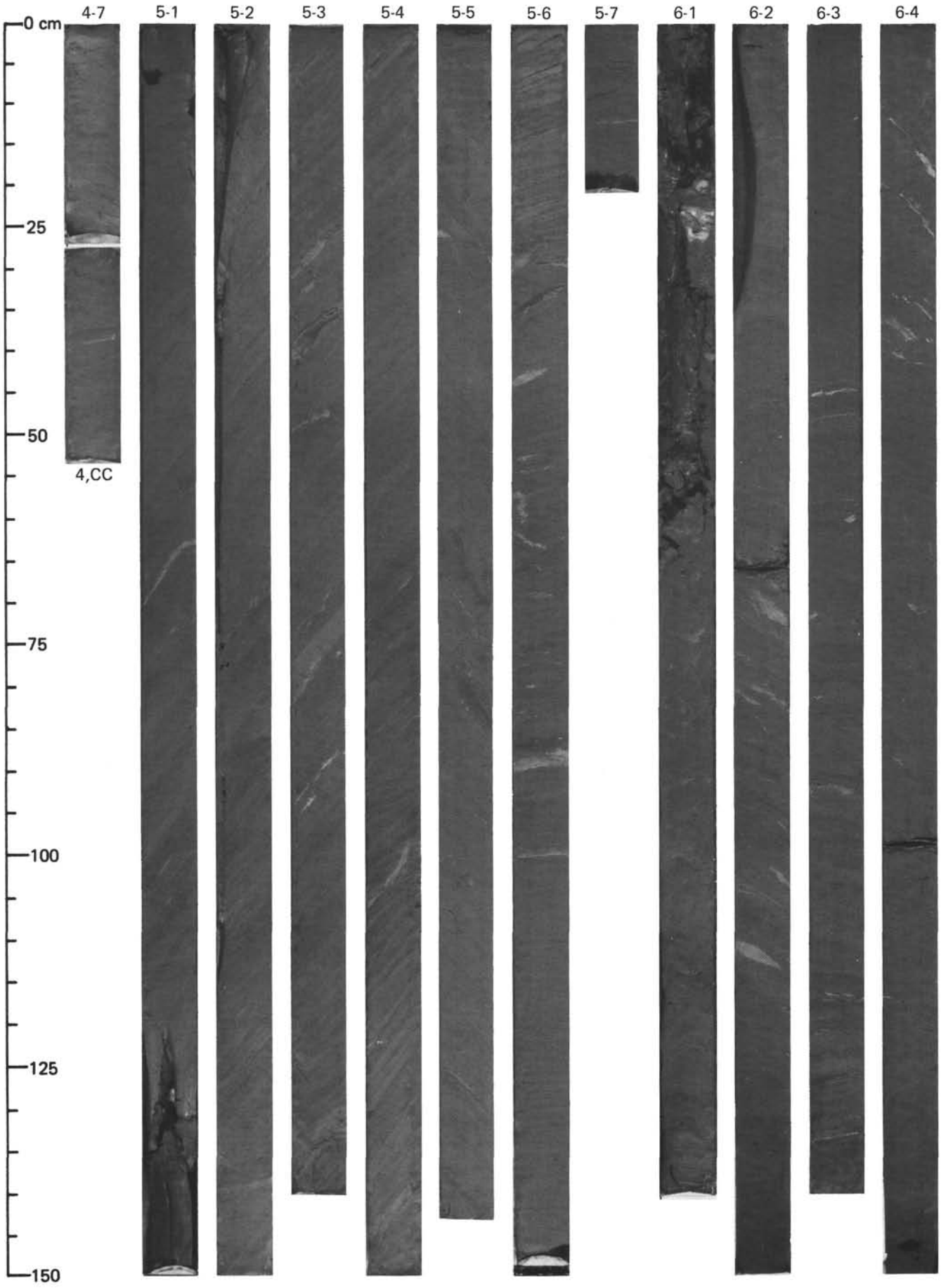
TIME—ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5 1.0					MUD, dark olive gray (5Y 3/2) and homogeneous. A thin, gray (5Y 5/1) lamina occurs at Core Catcher, 12 cm; several very thin SILT laminae occur at Core Catcher, 29–31 cm.
						2					GTC	
						3						
						CC			I T I			

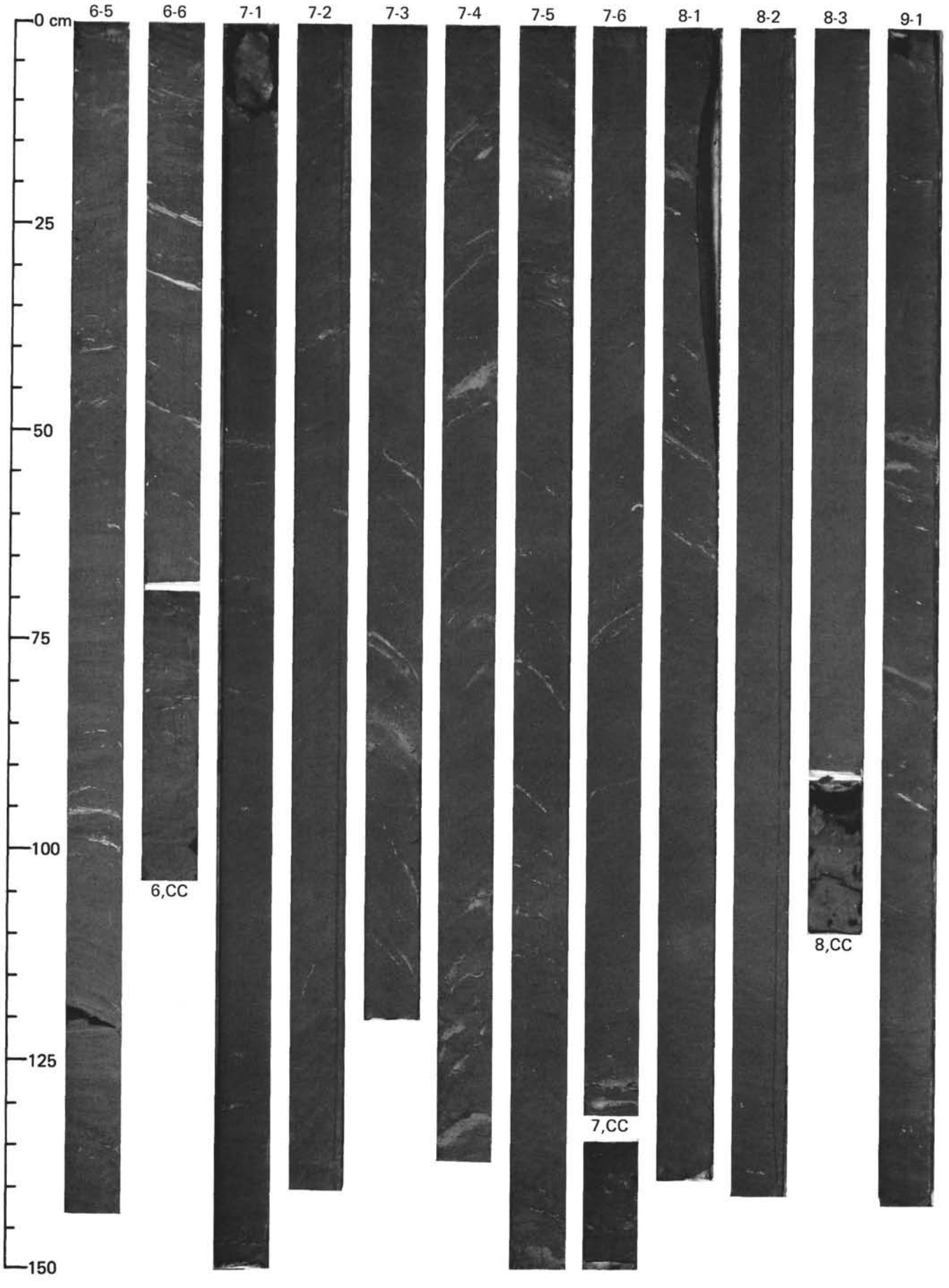
SITE 616 HOLE B CORE 22H CORED INTERVAL 3198.2–3203.1 mbsl; 199.4–204.3 mbsf

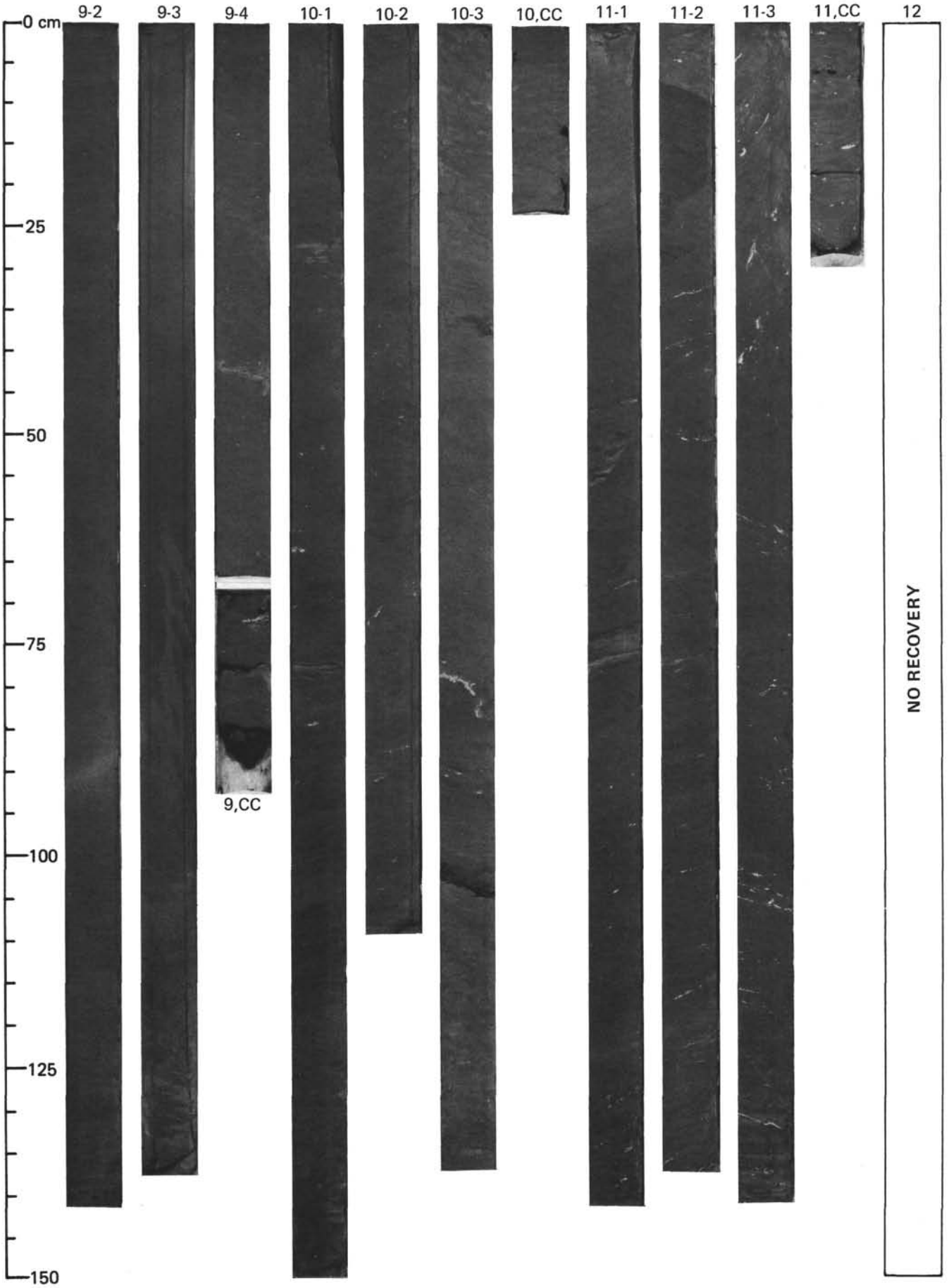
TIME—ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5 1.0					SILT, dark olive gray (5Y 3/2), coarse-grained, structureless, and disorganized with muddy matrix, clay chips, and lignite.
						2					GTC	
						3						
						CC						

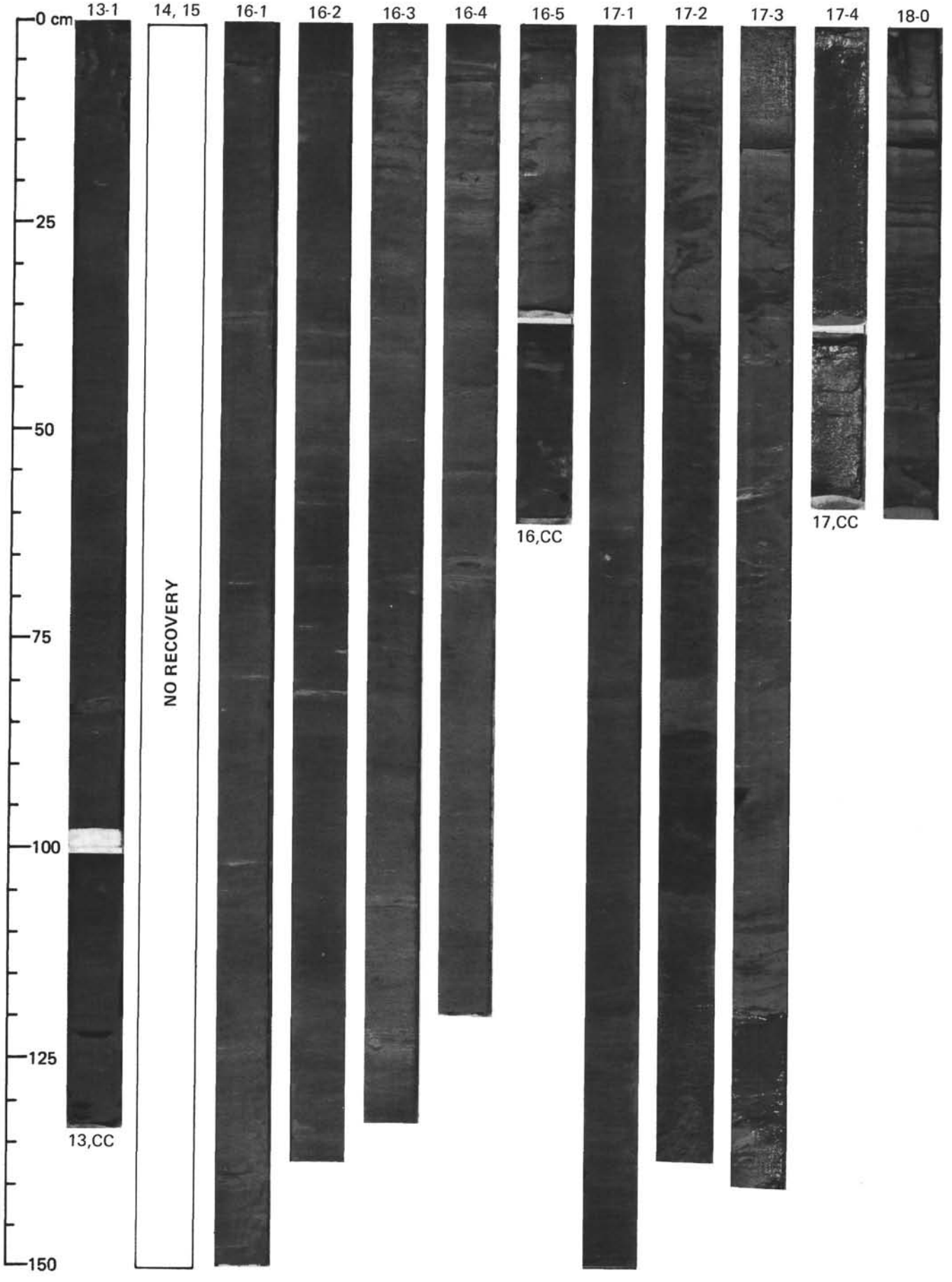

1-1
1-2
1-3
1-4
1,CC
2-1
2-2
2-3
2-4
2-5
2-6
3-1
0 cm
25
50
75
100
125
150

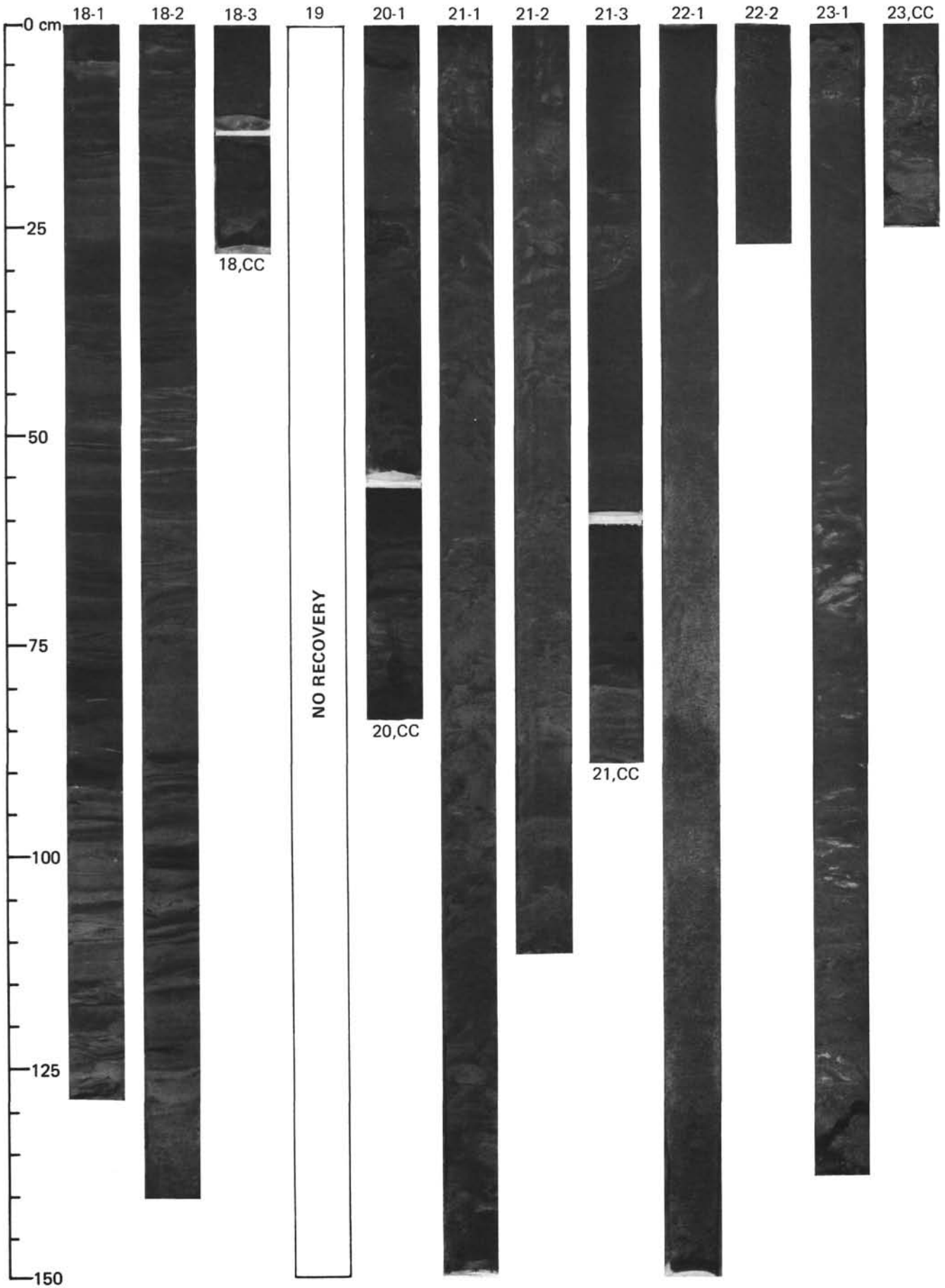

3-2
3-3
3-4
3-5
3-6
3-7
4-1
4-2
4-3
4-4
4-5
4-6
0 cm
25
50
75
100
125
150
3,CC

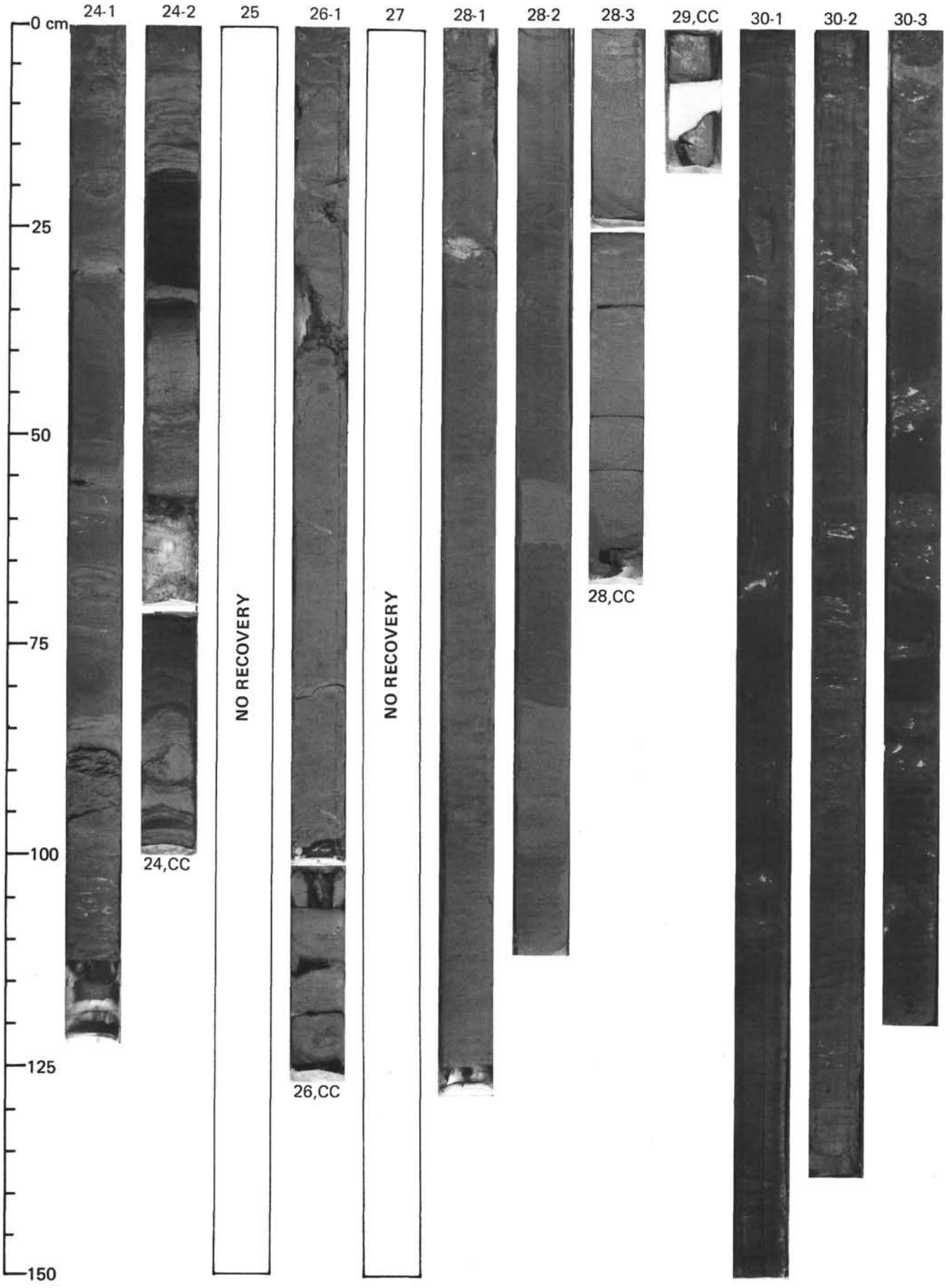

4-7
5-1
5-2
5-3
5-4
5-5
5-6
5-7
6-1
6-2
6-3
6-4
0 cm
25
50
4,CC
75
100
125
150

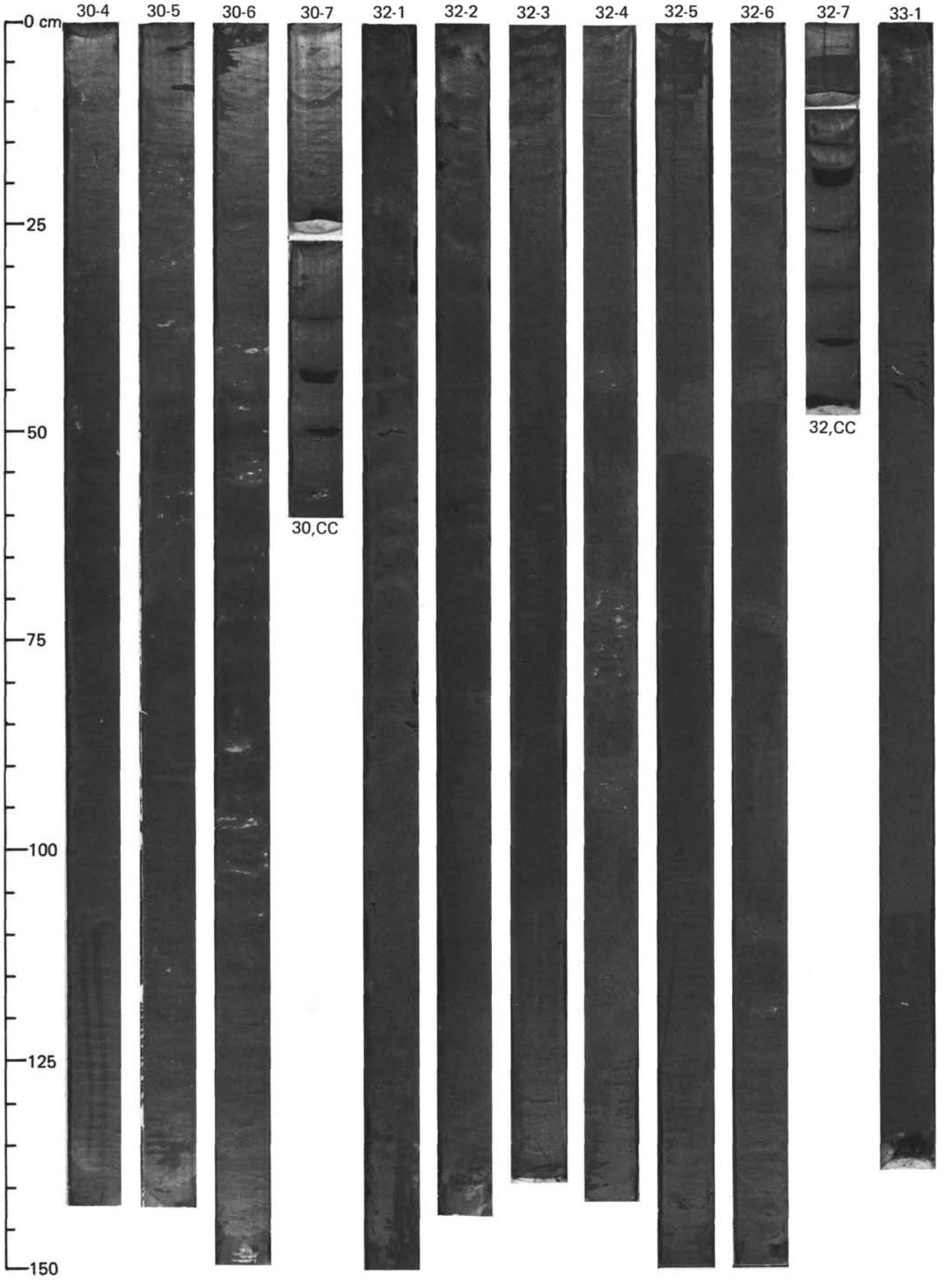

0 cm
25
50
75
100
125
150
6-5
6-6
6,CC
7-1
7-2
7-3
7-4
7-5
7-6
7,CC
8-1
8-2
8-3
8,CC
9-1

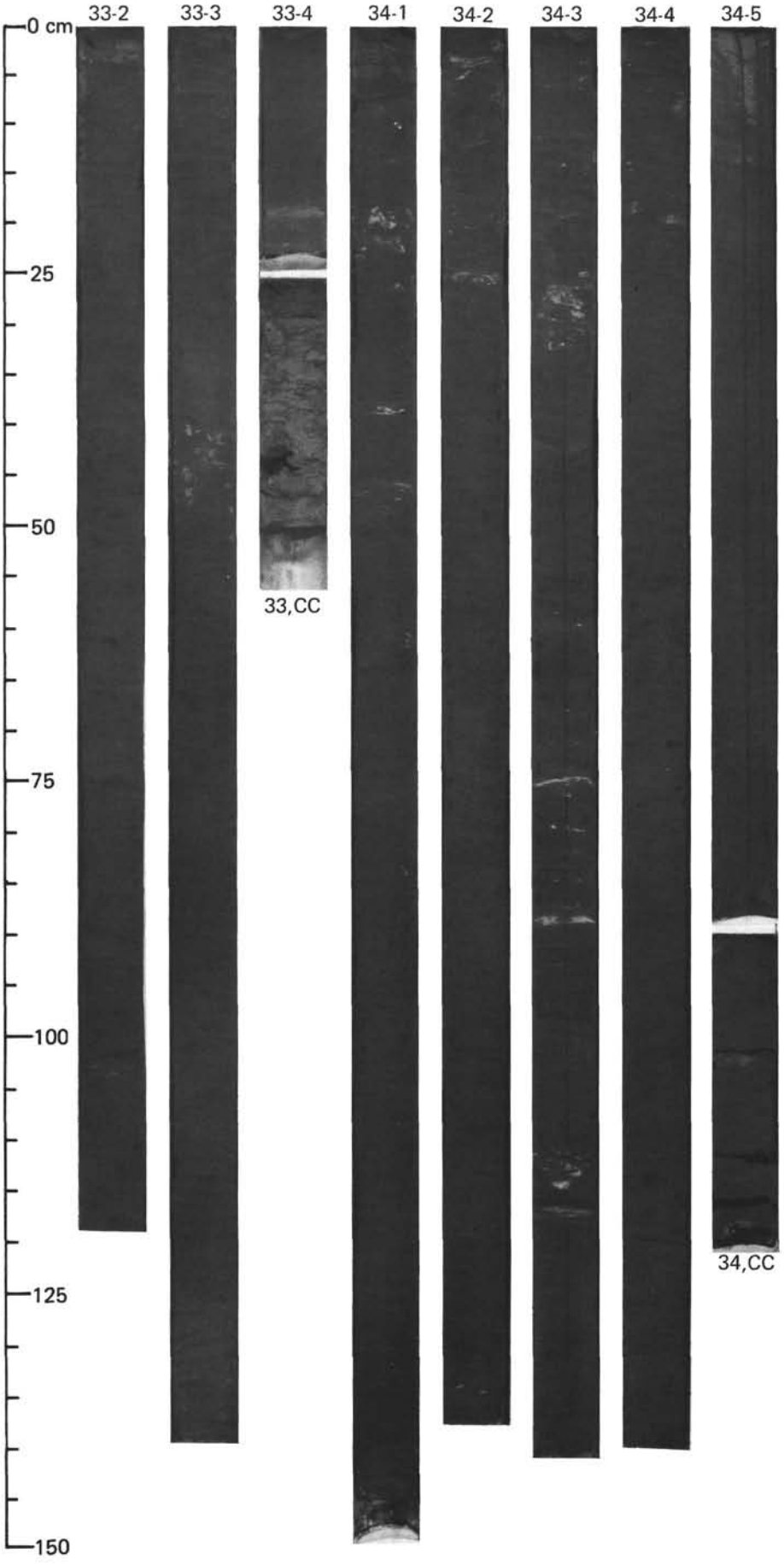

0 cm
25
50
75
100
125
150
9-2
9-3
9-4
9,CC
10-1
10-2
10-3
10,CC
11-1
11-2
11-3
11,CC
12
NO RECOVERY

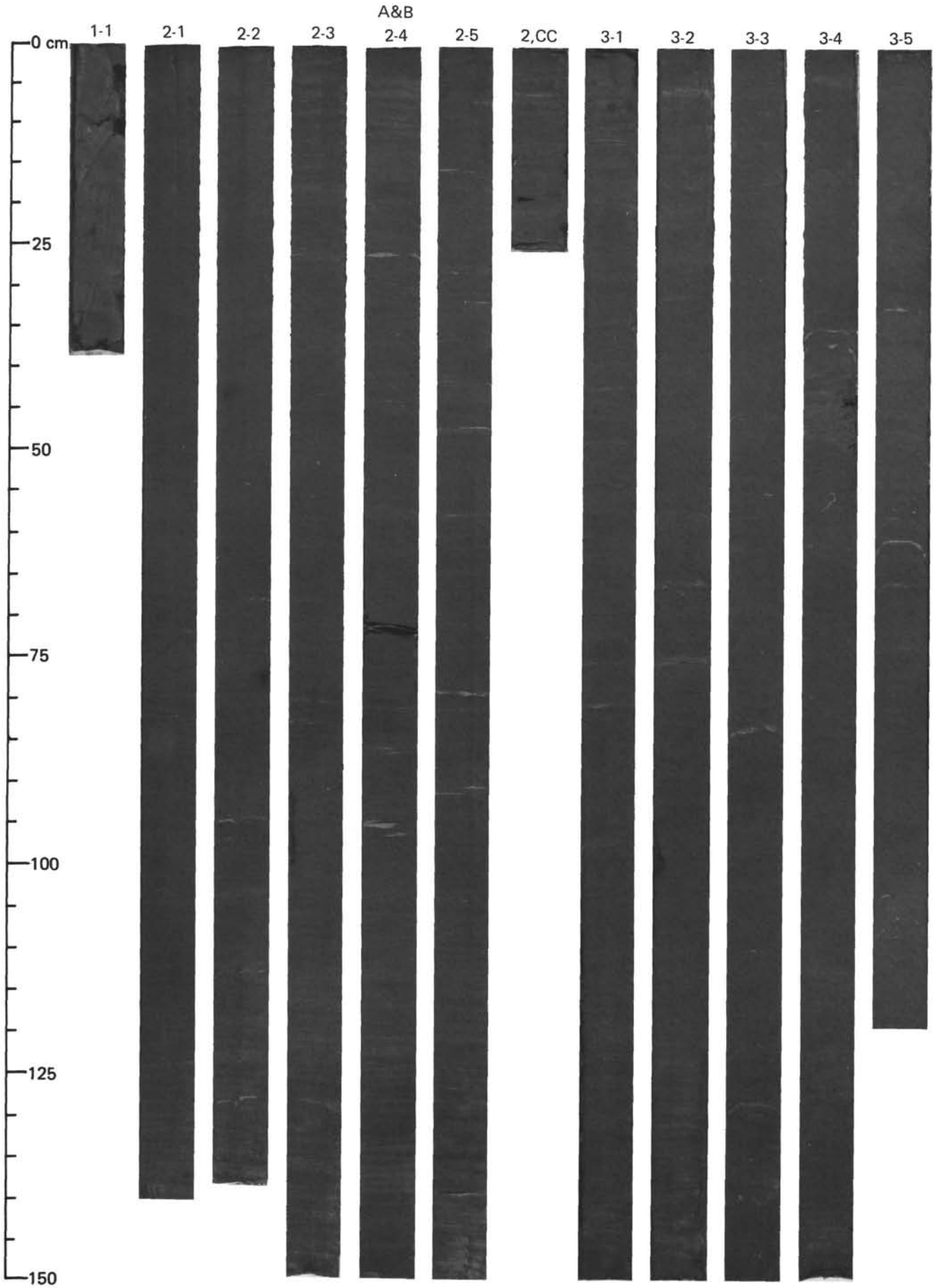

0 cm
25
50
75
100
125
150
13-1
14, 15
16-1
16-2
16-3
16-4
16-5
17-1
17-2
17-3
17-4
18-0
NO RECOVERY
13,CC
16,CC
17,CC

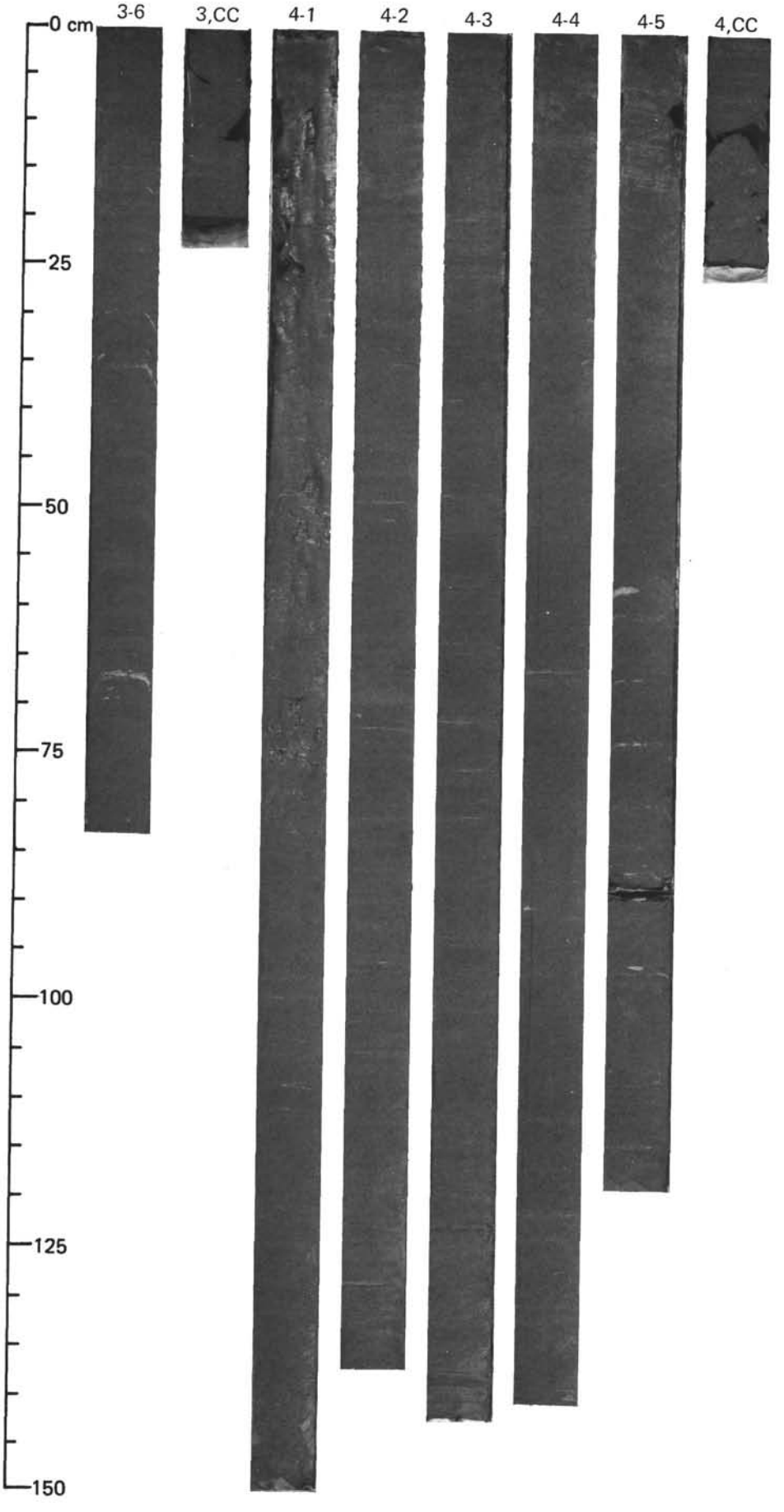

18-1
18-2
18-3
19
20-1
21-1
21-2
21-3
22-1
22-2
23-1
23,CC
0 cm
25
50
75
100
125
150
18,CC
NO RECOVERY
20,CC
21,CC

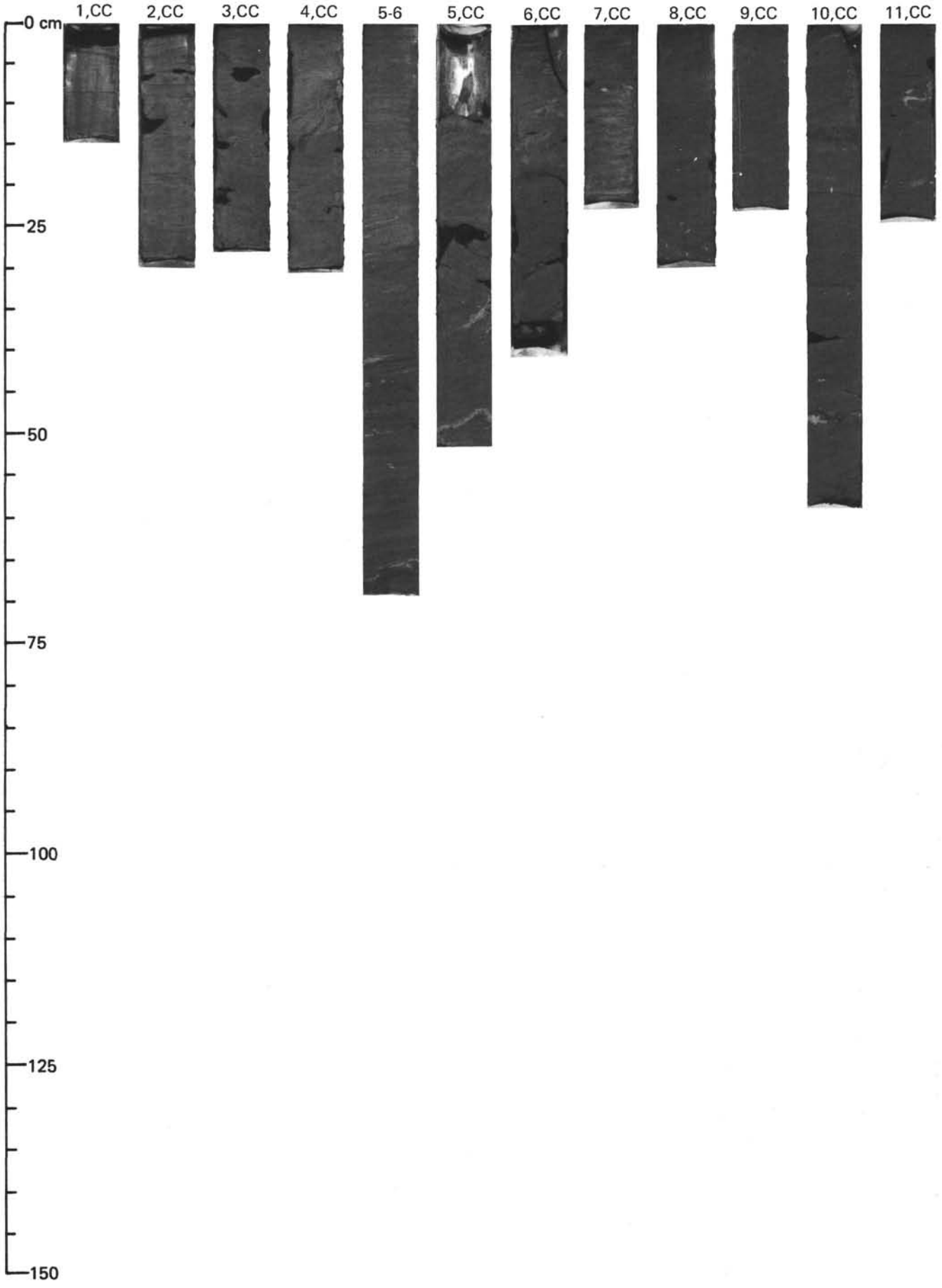

24-1
24-2
25
26-1
27
28-1
28-2
28-3
29,CC
30-1
30-2
30-3
0 cm
25
50
75
100
125
150
24,CC
NO RECOVERY
26,CC
NO RECOVERY
28,CC

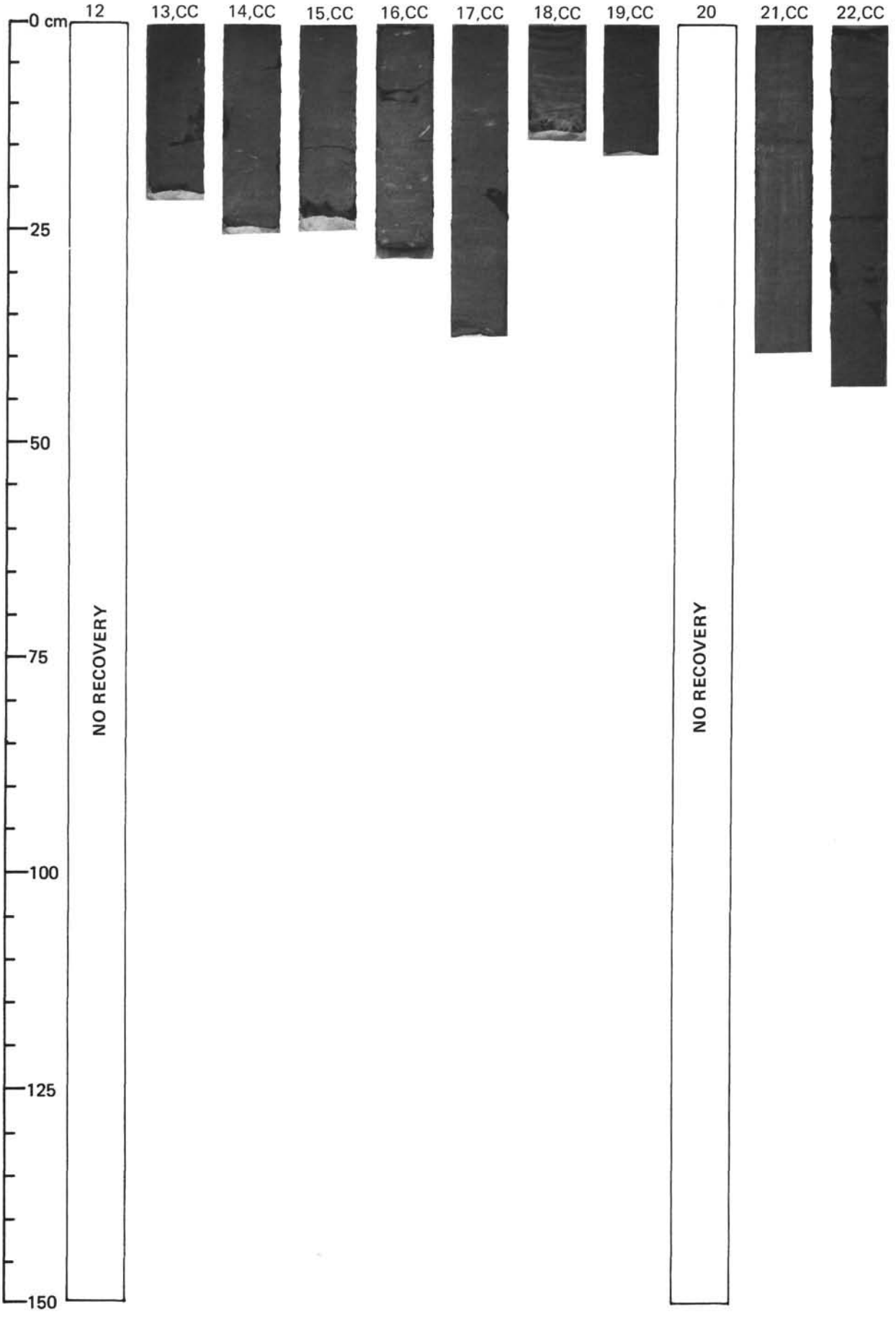

30-4
30-5
30-6
30-7
32-1
32-2
32-3
32-4
32-5
32-6
32-7
33-1
0 cm
25
50
75
100
125
150
30,CC
32,CC


33-2
33-3
33-4
34-1
34-2
34-3
34-4
34-5
0 cm
25
50
75
100
125
150
33,CC
34,CC


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


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


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


12
13,CC
14,CC
15,CC
16,CC
17,CC
18,CC
19,CC
20
21,CC
22,CC
0 cm
25
50
75
100
125
150
NO RECOVERY
NO RECOVERY