16. SITE 619[1]

Shipboard Scientific Party[2]

HOLE 619

Date occupied: 21 October 1983, 1359 LCT

Date departed: 22 October 1983, 2137 LCT

Time on hole: 1 day, 8 hr.

Position: 27°11.61′N, 91°24.54′W

Water depth (sea level; corrected m, echo-sounding): 2259

Water depth (rig floor; corrected m, echo sounding): 2269

Bottom felt (m, drill pipe): 2273.0

Penetration (m): 208.7

Number of cores: 25

Total length of cored section (m): 134.4

Total core recovered (m): 111.88

Core recovery (%): 83

Oldest sediment cored:
Depth sub-bottom (m): 208.7
Nature: Clay
Age: Pleistocene (Ericson Zone X?)
Measured velocity (km/s): N/A

Basement: N/A

HOLE 619A

Date occupied: 22 October 1983, 2137 LCT

Date departed: 23 October 1983, 0415 LCT

Time on hole: 7 hr.

Position: 27°11.61′N, 91°24.54′W

Water depth (sea level; corrected m, echo-sounding): 2259

Water depth (rig floor; corrected m, echo-sounding): 2269

Bottom felt (m, drill pipe): 2272.7

Penetration (m): 5.3

Number of cores: 1

Total length of cored section (m): 5.3

Total core recovered (m): 5.3

Core recovery (%): 100

Oldest sediment cored: N/A (mud line core only)

Basement: N/A

BACKGROUND AND OBJECTIVES

Site 619 is located near the axis of Pigmy Basin, a blocked-canyon intraslope basin on the middle continental slope off Louisiana. Pigmy Basin has a narrow, elongate shape trending about northeast–southwest. The bathymetry shows steep slopes with many bulges (slides scars?) along the diapir margin, and a rather flat bottom at a water depth of about 2260 m. A gradual shoaling was observed to the southwest; to the northeast, insufficient data are available to delineate the bottom configuration.

The main structural features are the ridges on both the northwest and southeast sides of the diapir having many high-angle normal faults. The top of the ridges are found in water depths of 1350 m (northwest side) and 1700 m (southeast side). The width of the short axis of the basin floor ranges from 3.8 to 7.5 km.

The fill of the basin proper shows onlapping of draping seismic reflectors onto the flanks on the northwest side of the basin and rather abrupt termination of reflectors against the flanks on the opposite side. This may either be a result of the orientation of the east–west profiles, or it demonstrates that the diapir on the northwest side has moved upward faster than the diapir on the other side. Thus the sedimentary sequence expands in a northwesterly direction.

Seismically, the sedimentary fill shows an acoustical sequence that starts with a transparent or semitransparent zone, overlain by a zone with discontinuous, more or less parallel reflectors, and topped by distinct, parallel continuous reflectors. This sequence is interpreted to represent, from bottom to top, sandy–silty deposits, silt-mud turbidites, and pelagic–hemipelagic sediments, respectively. It is postulated that the coarser deposits consist of turbidities and/or debris flows transported to the area at the end of a low sea-level stand or soon thereafter. During a continuing rise in sea level, large quantities

[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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of mud are delivered to the shelf edge, resulting in turbidity currents that follow the same path as the coarser-grained deposits. During high sea-level stands, sediment yield is reduced, and a hemipelagic deposition occurs together with a pelagic rain. These sequences are often interrupted by mass-movement deposits shed from the sides of the adjacent growing diapirs. Their presence is detected on seismic records by hyperbolics.

Our objectives at this site were

1. To determine the sedimentological, paleontological, geochemical, and geotechnical characteristics of the acoustical sequences,
2. To determine the rate of sedimentation of an acoustical sequence and its components,
3. To provide a near-complete biostratigraphic, geomagnetic, and oxygen-isotope stratigraphic section of the upper Pleistocene.

OPERATIONS

Hole 619

Current and wind conditions were found to be favorable for positioning (for the first time on the voyage) and the pipe trip was uneventful. Since precision depth recorder (PDR) depths had been consistently somewhat shallow on previous sites, the bit was lowered to the PDR depth of 2274 m for the first variable length hydraulic piston corer (VLHPC) core attempt. The core barrel was recovered nearly full, and there were indications that the sediment/water interface had not been recovered. One joint of pipe was set back and a second core was "shot" from 9.5 m higher. No core was recovered, but a water depth of 2273 m was estimated on the basis of traces of sediment in the lower meter of the plastic core liner.

Continuous piston cores were taken in gray mud to about 74 m below seafloor, below which complete 9.5-m stroke of the corer was no longer achieved (Table 1). Therefore, the uncored interval was drilled off to each following pipe connection. The installation of a shear-pin sub modified to take 3½ pins kept penetration/recovery at 4 to 5 m to about 155 m sub-bottom. At about 185 m, recovery and penetration dropped to very low levels. Coring operations were terminated at a drill pipe depth of 2481.7 m because of depth limitations and low core recovery.

Small amounts of methane gas were sampled from the cores below about 120 m sub-bottom, but no measurable increase in gas quantity or ethane content was noted.

Hole 619A

As considerable paleontological interest persisted in a "mud line" core, the pipe trip was halted just above the seafloor. The VLHPC was run to the bit and a core attempt was made from 2268.5 m. A good core containing the interface and 5.3 m of sediment was recovered (Table 1). The pipe trip then resumed and was completed at 0400 hr., 23 October. The vessel departed 15 min. later for a return to the middle fan operating area.

Table 1. Site 619 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 619							
1H	21	2052	2274.0–2283.5	1.0–10.5	9.5	9.12	96
2H	21	2158	2273.0–2274.0	0.0–1.0	1.0	0.01	1
3H	21	2306	2283.5–2293.2	10.5–20.2	9.7	8.83	91
4H	21	2359	2293.2–2302.9	20.2–29.9	9.7	8.10	84
5H	22	0047	2302.9–2312.6	29.9–39.6	9.7	6.83	70
6H	22	0135	2312.6–2322.3	39.6–49.3	9.7	8.22	85
7H	22	0225	2322.3–2332.0	49.3–59.0	9.7	7.77	80
8H	22	0317	2332.0–2341.7	59.0–68.7	9.7	6.34	65
9H	22	0410	2341.7–2346.2	68.7–73.2	4.5	4.43	98
Wash	22		2346.2–2351.4	73.2–78.4	—	—	—
10H	22	0500	2351.4–2357.5	78.4–84.5	6.1	6.10	100
Wash	22		2357.5–2361.0	84.5–88.0	—	—	—
11H	22	0555	2361.0–2366.1	88.0–93.1	5.1	5.04	99
Wash	22		2366.1–2370.1	93.1–97.6	—	—	—
12H	22	0645	2370.1–2375.1	97.6–102.1	4.5	4.50	100
Wash	22		2375.1–2380.2	102.1–107.2	—	—	—
13H	22	0732	2380.2–2386.8	107.2–113.8	6.6	6.40	97
Wash	22		2386.8–2389.8	113.8–116.8	—	—	—
14H	22	0911	2389.8–2392.2	116.8–119.2	2.4	2.37	99
Wash	22		2392.2–2399.4	119.2–126.4	—	—	—
15H	22	1002	2399.4–2403.5	126.4–130.5	4.1	4.06	99
Wash	22		2403.5–2409.0	130.5–136.0	—	—	—
16H	22	1045	2409.0–2414.8	136.0–141.8	5.8	5.74	99
Wash	22		2414.8–2418.7	141.8–145.7	—	—	—
17H	22	1135	2418.7–2423.8	145.7–150.8	5.1	5.01	98
Wash	22		2423.8–2428.4	150.8–155.4	—	—	—
18H	22	1230	2428.4–2431.4	155.4–158.4	3.0	2.72	91
Wash	22		2431.4–2438.1	158.4–165.1	—	—	—
19H	22	1335	2438.1–2442.1	165.1–169.1	4.0	3.70	93
Wash	22		2442.1–2447.7	169.1–174.7	—	—	—
20H	22	1445	2447.7–2451.2	174.7–178.2	3.5	3.32	95
Wash	22		2451.2–2457.3	178.2–184.3	—	—	—
21H	22	1525	2457.3–2460.3	184.3–187.3	3.0	0.00	0
22H	22	1615	2460.3–2463.3	187.3–190.3	3.0	2.45	82
Wash	22		2463.3–2476.7	190.3–203.7	—	—	—
23H	22	1825	2476.7–2479.7	203.7–206.7	3.0	0.02	1
24H	22	1925	2479.7–2480.7	206.7–207.7	1.0	0.02	2
25H	22	2030	2480.7–2481.7	207.7–208.7	1.0	0.78	78
					134.4	111.88	83
Hole 619A							
1H	22	2245	2272.7–2278.0	0.0–5.3	5.3	5.3	100

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

SEISMIC STRATIGRAPHY AND ACOUSTIC FACIES

Pigmy Basin is classified as a blocked-canyon intraslope basin (Bouma, 1981). It is located northwest of Orca Basin (Site 618), and displays a northeast to southwest orientation that is essentially parallel to Orca Basin.

A seismic survey grid was conducted across Pigmy Basin in 1980 by the U.S. Geological Survey (Fig. 1). Instrumentation included 5- and 40-in.^{3} air guns, a minisparker, and a 3.5-kHz sub-bottom profiler.

Seismic Stratigraphy

The seismic character at Site 619 is illustrated with a minisparker profiler, USGS Line 117 (Fig. 2). The main acoustic character of these typically hemipelagic sediments (see Lithostratigraphy section, this chapter) alternates between parallel and semitransparent seismic reflectors; the chaotic reflectors below 3.24 s (at the drill site) are the most notable exception.

On the basis of the relationships of the two main reflector characters, the section above 3.3 s is divided into six seismic units. Each of the units consists of parallel or subparallel reflectors overlying a zone of semitransparent or transparent reflectors, except for Unit 6, which

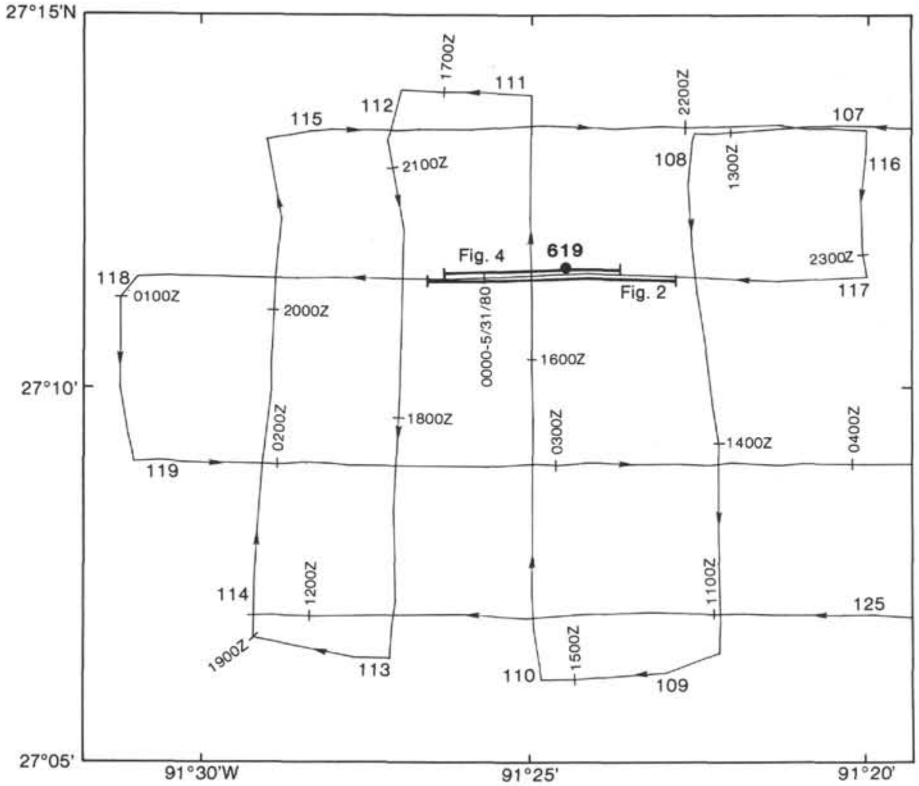

Figure 1. Pigmy Basin trackline map, U.S. Geological Survey Cruise G-80-4 (*Gyre*). Locations of Figures 2 and 4 indicated.

has a zone of chaotic reflectors separating the parallel and transparent reflection types.

In a recent paper, Bouma (1981) suggested this systematic alternation of seismic reflectors may be related to changes in sedimentation processes (e.g., type of sediment deposited) as effected by an external control (i.e., sea-level fluctuation or diapiric activity). Correlation of the seismic units with the core lithologies is compatible with this hypothesis (Fig. 3). The six lithologic units (see Lithostratigraphy section, this chapter) roughly correspond to the six seismic units, and each of the units tends to fine upward from mud or silt-laminated mud to clay (with rare silt laminae). The most coarse-grained deposits at Site 619 were found in Cores 619-19 to 619-22, which are within the zone of chaotic reflectors. The sediments in these cores are interbedded, structureless clays, silts, and sands, although the silt-laminated clays in Core 619-22 are contorted and inclined.

Acoustic Facies

The reflector patterns in the upper 70 m at Site 619 are shown in greater detail with a 3.5-kHz sub-bottom profiler record, USGS Line 117 (Fig. 4). All reflectors appear to be related to thin beds of silt or sand.

Conclusions

1. The cyclic repetition of the six seismic units may be a result of systematic changes in the type of sediment supplied to the basin.

2. Correlation of core lithologies and the seismic section suggests the reflection surfaces most commonly are silt or sand layers; they may also be related to changes in the carbonate content because of frequent changes in the abundance of fossils (see Biostratigraphy section, this chapter).

3. Each individual depositional event or close-spaced series of individual events (three or more) that interrupts the normal hemipelagic depositional system results in a large enough acoustical impedance to produce seismic reflectors.

BIOSTRATIGRAPHY AND SEDIMENTATION RATES

Biostratigraphy

The section penetrated in Holes 619 and 619A is Quaternary, correlating with the planktonic foraminifer Zone N23 and the calcareous nannofossil Zone NN21. This interval includes the Holocene (Zone Z), late Wisconsin glacial (Zone Y), Wisconsin interstadial (Zone X), and perhaps early Wisconsin glacial (Zone W) of Ericson and Wollin (1968) (see Explanatory Notes, this volume) (Fig. 3).

Zone Y is a sequence of bathyal muds with silt laminae containing cool-water planktonic foraminifers and reworked Cretaceous calcareous nannofossils.

Zone X (*Globorotalia flexuosa* Zone) is a warm-water foraminifer-rich gray mud with abundant calcareous nannofossils. The benthic foraminifers indicate a bathyal depositional environment for the sediments.

The X/W boundary may occur in Section 619-18-2 (Kohl, this volume). The W Zone (early Wisconsin gla-

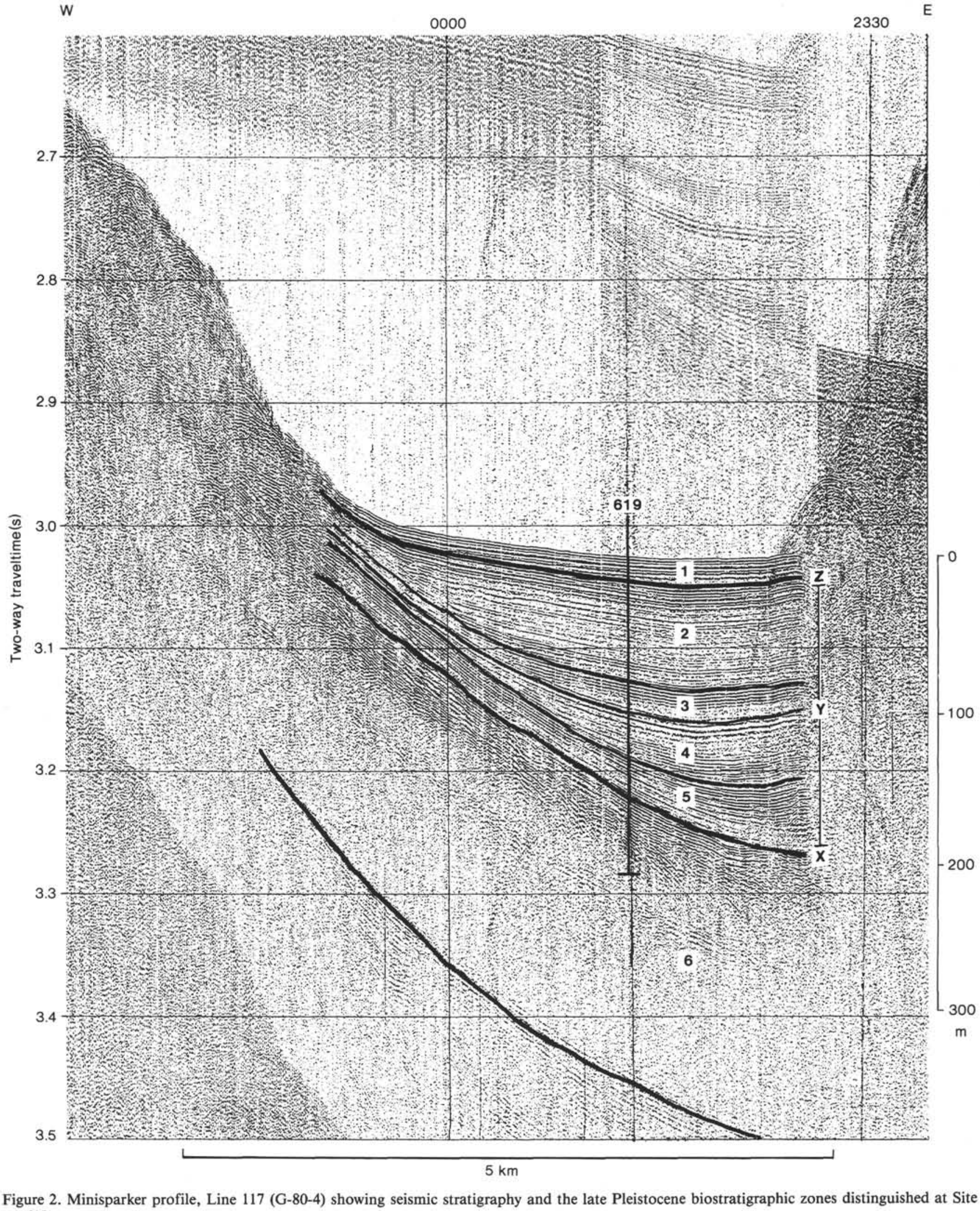

Figure 2. Minisparker profile, Line 117 (G-80-4) showing seismic stratigraphy and the late Pleistocene biostratigraphic zones distinguished at Site 619.

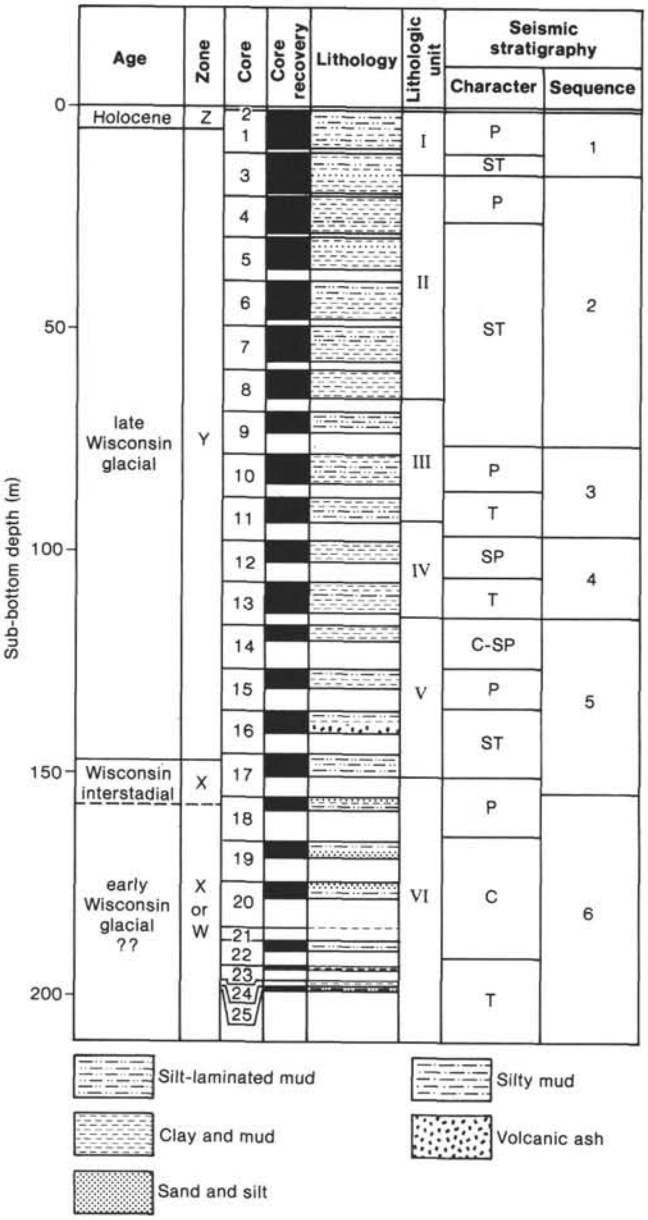

Figure 3. Lithostratigraphy of Site 619 showing age, lithology, core recovery, lithologic units, and comparison with seismic stratigraphy. Seismic character: C = chaotic; P = parallel; SP = subparallel; ST = semitransparent; T = transparent.

cial) is represented by a cool-water planktonic foraminifer assemblage and reworked Cretaceous calcareous nannofossils. The occurrence of shallow-water benthic foraminifers indicates that the sediments have been displaced from the neritic environment.

Foraminifers

Foraminifers from Holes 619 and 619A are Quaternary, Zone 23 (Blow, 1969). A warm-water, high-diversity Holocene (Zone Z) planktonic foraminifer fauna occurs in Core 619-1. This fauna contains abundant *G. menardii* and *G. tumida*, along with bathyal benthic foraminifers *Cibicides wuellerstorfi, Laticarinina pauperata*, and *Osangularia culter*.

Zone Y (late Wisconsin glacial) extends from Sections 619-2-1 through 619-17-1 and consists of mud with silt laminae. The cool-water planktonic foraminifer *G. inflata* is common throughout most of this interval. The occurrence of bathyal benthic foraminifers such as *C. wuellerstorfi, Gyroidina orbicularis*, and *Hoeglundina elegans* supports deep-water sedimentation for most of the Y Zone. The variation in abundance of benthic and planktonic species is probably related to variable sedimentation rates. A volcanic ash layer occurs in Sample 619-16,CC (2–6 cm) and is equivalent to the Y8 ash of Kennett and Huddlestun (1972) (see Ledbetter, this volume).

Zone X (warm Wisconsin interstadial) extends from Sections 619-17-2 through 619-18-1 and is a foraminifer-rich mud with abundant *G. menardii* and common *G. flexuosa. C. wuellerstorfi, O. culter*, and *H. elegans* are common bathyal benthic species.

Section 619-18-2 through Sample 619-25,CC (total depth of hole) may also belong to Ericson Zone X (Kohl, this volume); alternatively the interval may belong to Ericson Zone W. The intervals from Section 619-18-2 through Sample 619-20,CC and from Samples 619-23,CC through 619-25,CC are marked by a general decrease in foraminifer abundance with the cool-water planktonic foraminifer *G. inflata* being rare to common. The presence in these intervals of shallow-water benthic foraminifers such as *Ammonia beccarii, Hanzawaia concentrica, Florilus* spp., and *Elphidium* spp. indicates transport of the sediment from a neritic environment. In contrast, Samples 619-21,CC through 619-22,CC are dominated by warm-water planktonic foraminifers such as *G. menardii* and *G.* cf. *flexuosa*, along with occurrences of the bathyal benthic species *C. wuellerstorfi* and *L. pauperata*. Because of incomplete core recovery above and below this interval, the biostratigraphic position remains unclear (Kohl, this volume).

Calcareous Nannofossils

All cores recovered from this site are interpreted to be in the *Emiliania huxleyi* Zone (NN21) of Martini (1971). Abundant, well-preserved Quaternary calcareous nannofossils are found in the Holocene sediments and in the interval from approximately Cores 619-15 through 619-18; few reworked nannofossils are present. The remainder of the sediments recovered at this site contain few calcareous nannofossils and the assemblage is dominated by reworked Cretaceous species. The datum level represented by the reversal in dominance of *Gephyrocapsa caribbeanica* and *E. huxleyi* is encountered in Hole 619 at the base of Core 619-16. In tropical and subtropical waters this event is associated with oxygen-isotope Substages 5b–5a, approximately 0.085 Ma (Thierstein et al., 1977).

Sedimentation Rates

The sedimentation rates are calculated on the basis of four datums. An age of 0.012 Ma is used for the Holocene/Pleistocene boundary (Z/Y zonal boundary), 0.085 Ma for the Y/X zonal boundary, 0.127 Ma for the X/W

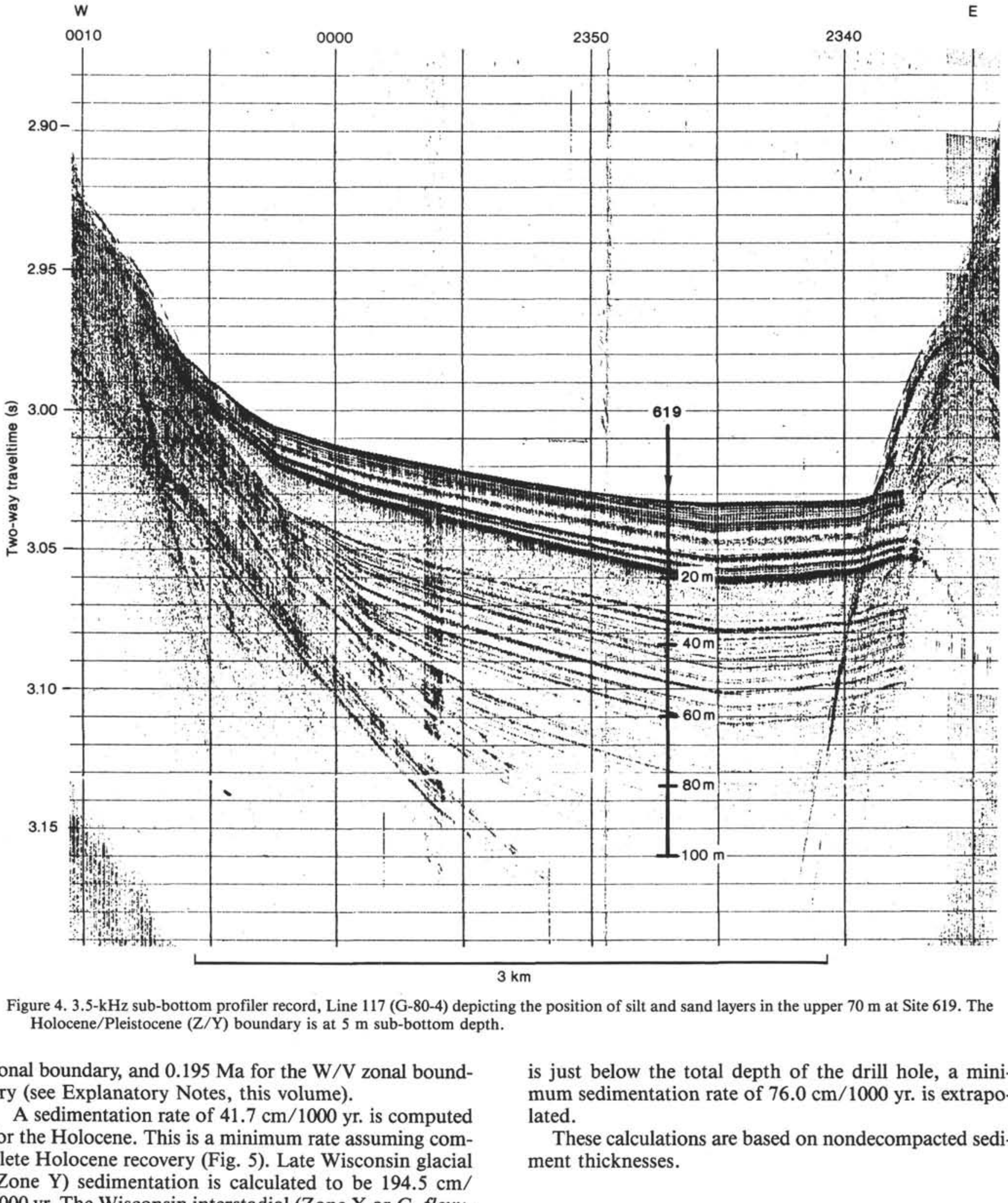

Figure 4. 3.5-kHz sub-bottom profiler record, Line 117 (G-80-4) depicting the position of silt and sand layers in the upper 70 m at Site 619. The Holocene/Pleistocene (Z/Y) boundary is at 5 m sub-bottom depth.

zonal boundary, and 0.195 Ma for the W/V zonal boundary (see Explanatory Notes, this volume).

A sedimentation rate of 41.7 cm/1000 yr. is computed for the Holocene. This is a minimum rate assuming complete Holocene recovery (Fig. 5). Late Wisconsin glacial (Zone Y) sedimentation is calculated to be 194.5 cm/1000 yr. The Wisconsin interstadial (Zone X or *G. flexuosa* Zone) is at least 10 m thick (Sections 619-17-2 through 619-18-1) and may extend to the base of the hole. Assuming the former scenario, a rate of 23.8 cm/1000 yr. is computed for this zone.

The interval below Section 619-18-1 may belong to Ericson Zone W. If so, the W/V zonal boundary was not encountered. However, assuming that the boundary is just below the total depth of the drill hole, a minimum sedimentation rate of 76.0 cm/1000 yr. is extrapolated.

These calculations are based on nondecompacted sediment thicknesses.

LITHOSTRATIGRAPHY

At Hole 619, a 208.7-m-thick series of dominantly hemipelagic sediments was cored using the hydraulic piston corer. In addition, a 5.3-m core was recovered at Hole 619A, using the variable length hydraulic piston corer to obtain better recovery at the water/mud interface.

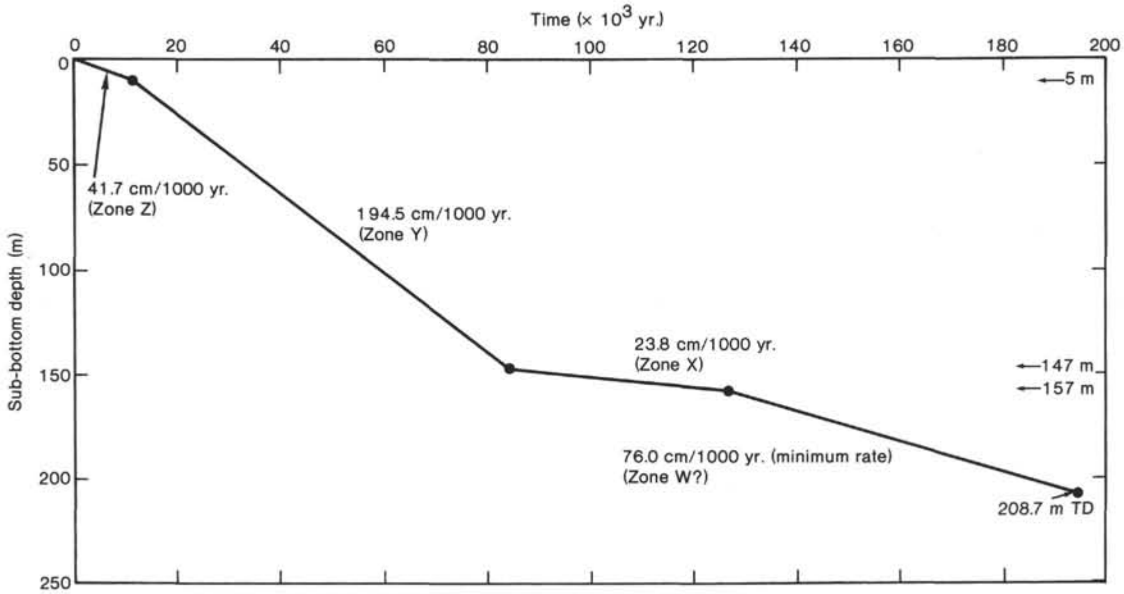

Figure 5. Site 619 sedimentation rates.

The sediments are relatively uniform throughout. However, on the basis of minor lithological changes together with seismic facies analysis, six lithological units can be identified (Table 2, Fig. 3). These units comprise six main facies: (1) calcareous, mainly structureless, clays and muds, (2) calcareous, color-banded clays and muds, (3) noncalcareous clays and muds, (4) silt-laminated muds, (5) sands and silts, and (6) pebbly muds (Fig. 6).

Core recovery down to 73.2 m sub-bottom was generally good (82%). Below that depth, incomplete sections were drilled, resulting in a less continuous sedimentary column available for sedimentologic description (i.e., 47% to 178.2 m sub-bottom and 11% from 178.2 to 208.7 m).

Lithologic Unit 1: Calcareous Clays and Muds

Unit 1 (0–14.83 m sub-bottom) consists predominantly of dark gray calcareous clay and mud, structureless or with color-banded intervals up to 0.8 m thick. The structureless facies comprises about 82% of this unit. The color-banded intervals are typified by thin laminated to thin bedded color bands alternating between dark gray, olive gray, and grayish browns.

The upper 5.5 m of the unit is moderately bioturbated and contains rare silt laminae. Each of these laminae has a sharp base and grades upward to clay. The unit generally coarsens from 7.5 m sub-bottom to the base and is moderately bioturbated below 10.5 m sub-bottom. Two thicker beds fine upward (i.e., graded bedding) from sand over 26- and 11-cm intervals at 7.70 and 12.55 m sub-bottom, respectively. A calcareous silty clay occurs at 10.5 to 12.4 m sub-bottom. The basal 0.22 m of Unit I consists of interlaminated sand and clay.

Table 2. Lithologic units of Site 619.

Lithologic unit	Sediment	Cored interval	Sub-bottom depth (m)
I	Calcareous clays and muds	619A-1; 619-1 through 619-3-3, 133 cm	0–14.83
II	Calcareous clays and muds	619-3-3, 133 cm through 619-8	14.83–65.34
III	Calcareous clays and muds	619-9 through 619-11	65.34–93.04
IV	Calcareous clays and muds	619-12 through 619-13	93.04–113.61
V	Calcareous and noncalcareous clays and muds	619-14 through 619-17	113.61–150.71
VI	Clays, muds, silts, and sands	619-18 through 619-25	150.71–280.71

The dominant lithology is composed primarily of clay-sized minerals with secondary quartz and nannofossils. Foraminifers and quartz are the major constituents of the silt and sand layers. The average calcium carbonate content is 12%.

Lithologic Unit II: Calcareous Clays and Muds

Unit II (14.83–65.34 m sub-bottom) consists of dark gray to dark olive gray calcareous clay down to 36.73 m sub-bottom (Sample 619-3-3, 133 cm through Core 619-5) and coarsens to dark gray calcareous mud from 39.6 m sub-bottom to the base of the unit (Cores 619-6 through 619-8). These muds are structureless (63% of the unit) with color-banded interbeds.

The clayey sediment in the upper half of Unit II can be subdivided based on the relationship of the structureless and color-banded facies. Alternating dark gray and dark olive gray color-banded clays occur from 14.83 to 18.00 m sub-bottom. These color bands are thick laminated to very thin bedded and tend to have sharp bottoms and tops. The clay is structureless down to 26.4 m sub-bottom where it grades to a structureless mud. Below the mud, from 26.75 to 36.73 m sub-bottom, the clay consists of interbedded structureless and color-banded intervals (ratio 55:45). Thicknesses of the alternating facies range from 0.1 to 1.4 m. The individual color bands are less than 1 cm thick (i.e., thin to thick laminated). Several zones of coarser-grained sediments occur within the interbedded interval: a mottled section with mud balls up to 2 cm in diameter from 26.75 to 27.2 m overlying a series of irregular to inclined, very thin silt laminae from 27.2 to 27.38 m; a 4-cm-thick sand at 31.15 m; and several silt laminae from 31.5 to 32.2 m.

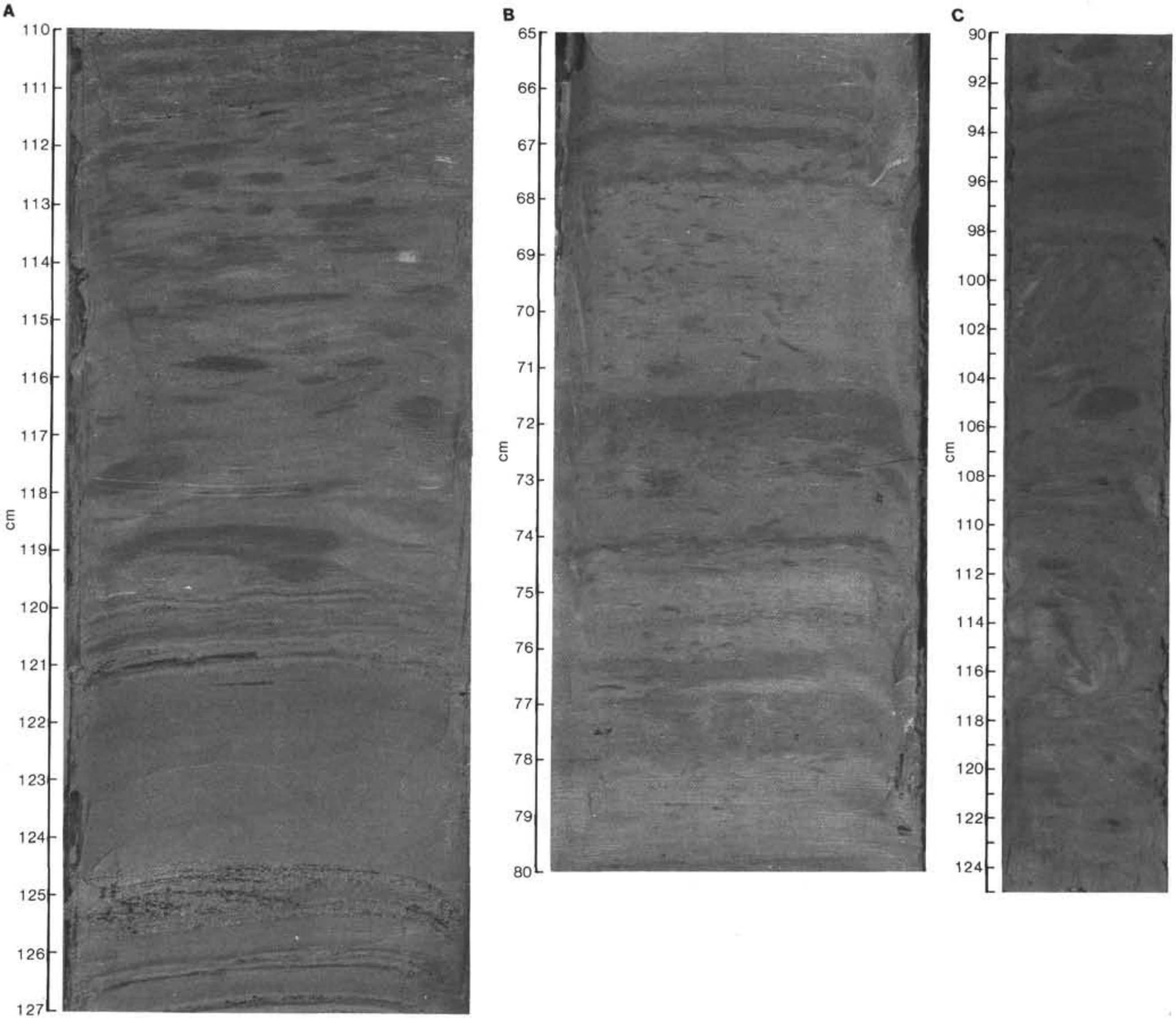

Figure 6. Photographs of sediments recovered at Site 619. A. Silt laminae and bioturbated band (Core 619-3-3, 110–127 cm). B. Color bands and bioturbation (Core 619-3-4, 65–80 cm). C. Pebbly mud (Core 619-17-3, 90–125 cm).

The mud in the bottom half of Unit II can also be subdivided by facies. The sediments are predominantly color banded from 39.6 to 43.35 m sub-bottom, and contain thin silt and sand laminae down to 40.9 m. The color bands are gray to dark gray down to 41.05 m and dark gray to very dark gray over the remainder of this interval. The dark gray mud is structureless with rare black coloration from 43.35 to 51.30 m sub-bottom. From 51.30 to 55.85 m sub-bottom, the sediment is characterized by interbedded structureless and color-banded silty clay (ratio 35:65). In this subunit, color banding down to 52.2 m is produced by thin–thick laminated, black organic-rich layers and thin silty sand laminae. The black layers are generally mottled (i.e., bioturbated). Color banding down to 55.05 m is produced by color hues lighter or darker than dark gray; the bands are thin laminated to very thin bedded. At the base of the subunit (55.05–55.85 m), very dark grayish brown-black layers (1 cm) produce the laminated appearance. The base of Unit II, from 59.0 to 65.34 m sub-bottom, is essentially a structureless mud although it displays subtle black layers at 60 m and more pronounced black layers (< 1 cm) from 64.4 to 64.8 m.

The muds in this unit are composed predominantly of clay-sized minerals (70%). Quartz and carbonates (mainly foraminifers and nannofossils) are the major secondary components. The average calcium carbonate content is 13%.

Lithologic Unit III: Calcareous Clays and Muds

Unit III (65.34–93.04 m sub-bottom) is composed of dark gray to dark olive gray calcareous clay and dark gray calcareous mud.

Core 619-9 (68.7–73.2 m sub-bottom) exhibits mottled, thin laminated to very thin bedded black, organic-rich layers in the dark gray mud down to 72.1 m. Below that depth, the mud is structureless with a contorted zone from 73.0 to 73.2 m.

Core 619-10 (78.4–84.5 m sub-bottom) is a predominantly dark gray to very dark gray mud. From 78.4 to 82.4 m, the mud is structureless with few thin black laminae and silt laminae. Abundant thin black laminae produce a laminated appearance from 82.4 to 84.5 m. Gas escape features are prevalent from 81.4 to 84.5 m sub-bottom.

Core 619-11 (88.0–93.04 m sub-bottom) consists of interbedded structureless and color-banded muds (ratio 50:50). The predominant color is dark gray, and the thin to thick laminated color bands are very dark gray, olive gray, and black. Thin silt laminae (and one sand lamina) occur from 89.9 to 91.4 m.

Clay-sized minerals are the major constituent of the muds in this unit; carbonate (unspecified) and quartz are the major secondary components. The average calcium carbonate content of 18% represents the highest concentration of carbonate at Site 619.

Lithologic Unit IV: Calcareous Clays and Muds

Unit IV (93.04–113.61 m sub-bottom) is a dark gray calcareous clay that becomes coarser downward to a predominantly dark gray calcareous mud. The clay is structureless and extends from the top of the unit to 108.15 m sub-bottom. Gas escape features are present at 101.0–101.5 m. A 1.05-m-thick calcareous sandy mud is present at 108.15–109.2 m sub-bottom. This structureless sandy mud contains dispersed foraminifers in its lower half. From 109.2 to 113.61 m sub-bottom, the unit consists of mottled, predominantly dark gray mud. The mottling is most extensive from 109.2 to 110.1 m and includes black, olive gray, and reddish hues as secondary colors. A chaotic mixture of sand and clayey sand at a depth of 112.5 m exhibits contorted bedding.

Foraminifers are dispersed throughout the mud and are the main component of the calcium carbonate (14%). Clay-sized minerals and quartz are the primary terrigenous components.

Lithologic Unit V: Calcareous and Noncalcareous Clays and Muds

Unit V (113.61–150.71 m sub-bottom) consists predominantly of clay. In general, it becomes coarser downward.

The sediment at the top of the unit (Core 619-14; 116.8–119.18 m sub-bottom) is a structureless dark gray calcareous clay (calcium carbonate content 18%). Indistinct thin laminae are present below 118.95 m.

From 126.4 to 128.9 m sub-bottom predominantly olive to dark olive gray calcareous clay (calcium carbonate content 11%) with thin silt laminae occurs. The silt laminae have disturbed bases and are normally graded in the interval from 126.8 to 127.75 m. This section is mottled, exhibits gas escape structures, and subtle coloration changes range from brown to dark green black. Below 128.9 m to a depth of 130.48 m, the sediment is a gaseous, dark gray, structureless calcareous clay.

From 136.0 to 139.2 m sub-bottom, a silt–sand laminated clay (calcium carbonate content 6%) is present. The clay is dark gray down to 136.4 m, and is predominantly greenish gray below that. The silt, sandy silt, and sand laminae are generally less than 1 cm thick. These laminae are dark greenish gray, have sharp bases and grade upward to clay over an interval of several centimeters. This laminated subunit is mottled (bioturbated?) and has dispersed foraminifers throughout. Several mud balls up to 2-cm diameter occur from 136.83 to 136.93 m. From 139.2 to 140.2 m sub-bottom, the sediment is a relatively structureless mud. The mud is greenish gray at the top and changes gradually to a dark greenish gray at the bottom. Discontinuous, broken silt laminae and dispersed foraminifers are common in this sequence. From 140.2 to 141.55 m sub-bottom, the sediment is a structureless, dark greenish gray clay. The clay has dispersed foraminifers and is mottled below 140.85 m. A medium-grained foraminifer sand which grades to clay over a 10-cm interval is present at 140.8 m. Two very thin beds of volcanic ash occur at 141.35–141.37 m and 141.38–141.41 m sub-bottom. The ash has been identified as the Y8 ash of Kennett and Huddlestun (1972) (Ledbetter, this volume).

From 145.7 to 147.4 m sub-bottom, a multicolored mottled clay occurs. The clay is black from 145.7 to 146.7 m, dark gray from 146.7 to 147.05 m, and dark greenish gray below the depth. The clay contains dispersed foraminifers and black, organic-rich mud balls around 146.50 m. From 147.4 to 148.45 m sub-bottom, the sediment is a dark greenish gray clayey sand. Based on the distribution of sand grains, the clayey sand appears to fine upward (i.e., normally graded) from 147.4 to 147.68 m and 147.68 to 148.45 m. Foraminifers and black mud balls (up to 7-cm diameter) are scattered throughout. Immediately below the clayey sand, from 148.45 to 150.71 m sub-bottom, occurs a 2.26-m-thick pebbly mud layer. This chaotic, mottled clayey deposit is predominantly dark greenish gray down to 150.0 m and greenish gray down to 150.71 m. Secondary colors include gray, dark gray, and reddish hues. The clasts are composed of clayey mud and silty mud, range in size from 1 to 5 cm, and increase in density downward. This chaotic subunit has dispersed foraminifers, and the degree of mottling decreases downward. Contorted structures are best preserved at 150.2 m.

Compositionally, the clays are composed of clay-sized minerals with secondary carbonate and quartz; nannofossils are most abundant in the calcareous section (above 130.48 m sub-bottom), and foraminifers are dominant in the lower half. The coarser-grained lithologies are composed primarily of quartz and the various carbonate components. The average calcium carbonate content in this unit is 12%.

Lithologic Unit VI: Clays, Muds, Silts, and Sands

Unit VI (150.71–280.71 m sub-bottom) contains a greater volume of coarse-grained detritus. The average composition of this unit is 21% sand, 41% silt, and 38% clay. By comparison, clay-sized detritus dominated the previous units with average values ranging from 70 to 82%. The lithologic relationships are highly variable being different in each core. Generally, the dominant lithology is a dark greenish gray, structureless clay with coarser-grained interbeds.

Core 18 (155.4–158.19 m sub-bottom) consists of very dark greenish gray mud that fines upward from a sand (same color). Below the sand (156.15 m), the remainder of the core is characterized by dark greenish gray, subtly mottled clay.

The interval from 165.1 to 168.77 m sub-bottom (Core 19) is a dark greenish gray, structureless clay with dark gray, structureless sand interbeds ranging from 6 to 24 cm thick.

In Core 20 (174.7–178.09 m sub-bottom), the sediments are dark greenish gray. From 174.7 m sub-bottom, the clay fines upward from silt (175.0–175.5 m) which is underlain by a mud that fines upward from a silty sand (175.5–175.8 m). Below the silty sand, the clay is structureless, fines upward from silt near the bottom of Core 20 through a clayey silt (177.76–178.09 m).

Recovery in Core 21 (184.3–187.3 m sub-bottom) consisted of only 2 cm of grayish calcareous clay. The section from 187.3 to 189.76 m (Core 22) contains inclined and contorted very thin to thin, silt-laminated dark greenish gray calcareous clay (187.3–188.6 m) overlying a very dark greenish gray, structureless calcareous clay. Core 25 (207.7–208.7 m sub-bottom) contains a very dark greenish gray to black, moderately bioturbated, structureless mud; gas escape structures are common.

The muds in this unit are composed of clay-sized minerals with secondary quartz. The silts and sands consist mainly of quartz: clay-sized minerals and carbonate components are the most abundant secondary minerals. The average calcium carbonate content is 6%.

GEOCHEMISTRY

Organic Geochemistry

In Pigmy Basin, no gas as evidenced by gas expansion cracks or pockets was observed in the cored sections between Cores 619-1 and 619-9 (0–73 m sub-bottom).

Small amounts of gas were obtained from Cores 619-10 and 619-12 (Table 3). These values were obtained from shipboard measurements. Amounts of methane are qualitative only, because the remaining gas collected is air that contaminates the sample during collection. If core methane pressure is high, this contamination becomes less severe. More precise shore-based measurements of gas ratios can be found in Pflaum et al., and Whelan and Tarafa (this volume).

Table 3. Carle gas shipboard data from Site 619, Leg 96.

Core-Section	Methane (%)	Ethane	C_1C_2[a]	CO_2 (ppm)
4-5	530 ppm	<0.02	nd	nd
5-4	844 ppm	<0.02	nd	513
6-5	0	<0.02	nd	522
7-5	0.014	<0.02	nd	463
8-4	0.04	<0.02	nd	294
9-3	0.7	<0.02	nd	328
10-2	1.2	<0.02	nd	307
12-3	48.7	<0.02	>2400	904
13-4	11.0	<0.02	nd	421
14-2	12.0	<0.02	nd	740
15-3	93.0	<0.02	>4650	766
16-3	84.0	<0.02	>4200	1304
17-3	18.3	<0.02	nd	694
18-1	89.0	<0.02	>4450	1725
19-2	92.0	<0.02	>4600	3071
20-2	93.3	<0.02	>4665	1892

[a] nd = not determined.

Large expansion voids were observed in Cores 619-15 through 619-20 (126–178 m sub-bottom) with the exception of Core 619-17. These voids seem to be most often associated with sandy layers within these sections. No gas was observed below Core 619-20, which could be because of the poor recoveries in these last cores. Analysis of these gases on the Carle Gas Chromatograph indicates that the gas is methane, with less than 0.02% ethane. Thus C_1/C_2 concentrations are >2000, indicating biogenic gas.

Dark black sediment layers were observed in Cores 619-17 and 619-18. These layers are similar to the layers observed in Orca Basin that were thought to be the result of iron sulfides deposited under anoxic conditions.

This site represents a continuously deposited organic-rich hemipelagic section where microbiological processes appear to significantly influence sediment organic matter, core gases, and interstitial water values. These processes are discussed in more detail in other parts of this volume as follows:

1. Viable anaerobic microorganisms to sub-bottom depths of at least 170 m (Whelan, Oremland, et al., this volume),
2. Isotopic and compositional studies of core gas (Pflaum et al., this volume),
3. Interstitial water alkalinity, acetate, and sulfate profiles (see Ishizuka, Kawahata, et al., Kennicutt et al., Whelan, Oremland, et al., this volume),
4. Studies of sediment organic matter (Kennicutt et al.; Whelan and Tarafa, this volume).

Inorganic Geochemistry

As a whole, the site does not show any drastic downhole changes in pH, total alkalinity, and salinity values. However, pH values change slightly with depth and salinity values decrease a little with depth. Results of shipboard data analyses are as follows:

1. All pH values are lower than those of surface seawater (pH 8.2). The pH of the interstitial water in Cores 619-1 and 619-2 is 7.0. Values increase gradually and slightly with depth below Core 619-3 (pH 6.8–7.8). Between Cores 619-17 and 619-18 is a small interruption in this increase (pH 7.8 and 7.5). Below Core 619-18, the pH of interstitial water increases again with depth (pH 7.5–7.9).
2. Total alkalinity values of interstitial water are between 3 and 8.5 mEq/L and average 6.2 mEq/L.
3. Salinity of interstitial water in Core 619-1 is 34.5‰ and decreases with depth until Core 619-8 (32.2‰), after which it is constant (about 32‰).

PHYSICAL PROPERTIES

Wet-bulk density increases from a low of 1.34 g/cm³ near the seafloor to a high of 1.99 g/cm³ at 175-m depth. The average rate of bulk density increase is 0.0092 g/

$cm^3 \cdot m$ in the upper 50 m and 0.0015 $g/cm^3 \cdot m$ below the 50-m level. At a depth of about 90 m bulk density decreases from the line of normal trend (Fig. 7A). This decrease in bulk density is attributed to the presence of free gas (methane) in the pore spaces.

Wet water content decreases from a seafloor value of 61.2% to a low value of 17.7% at 175-m depth (Fig. 7B). The line in Figure 7 shows the normal, gas-free, trend of wet water content plotted against depth. The points that deviate from the line are those measurements made on gassy sediments.

Dry water content shows similar trends since wet water content and deviations from the normal trend result from the presence of free gas within the sediment (Fig. 7C).

Porosity of the seafloor sediments is approximately 80%. The porosity decreases sharply to a value of 45% at 50-m depth (Fig. 7D). Below this depth the sediments display an average rate of porosity decrease of 0.084%/m to a value of 35% at 175-m depth as opposed to the average rate of porosity decrease of 0.704%/m for the upper section.

Undrained shear strength increases at an average rate of 0.615 kPa/m in the upper 50-m interval, from 3 kPa at the seafloor to a value to 33.5 kPa. The average rate of increase of shear strength between 50 and 175 m is 0.732 kPa/m. The ratio between undrained shear strength and overburden pressure shows that the sediments drilled at Site 619 are highly underconsolidated (for details see Bryant, Sweet, et al., this volume). The conditions of underconsolidation displayed by Site 619 sediments are attributed to high rates of sedimentation, low permeabilities, and the presence of gas in the pore spaces of the sediment. All measured values of undrained shear strength are plotted against depth in Figure 7E.

Figure 7F shows the results of sonic velocity measurements parallel and perpendicular to the bedding. The velocities display a very large variation with depth. The acoustic anisotropy is in some cases very large and conflicting. The large variation in velocities measured at similar depth can be attributed to the presence of gas in the pore spaces.

SUMMARY AND CONCLUSIONS

The site is located in Pigmy Basin, a northeast-southwest trending intraslope basin, in 2260 m water depth. The flat basin floor is bounded on the northeast and southwest by steep diapiric walls rising 700 m above the floor. The basin fill is seismically characterized by parallel, rather continuous reflectors alternating with transparent or semitransparent zones or discontinuous reflectors. Often, such a sequence is repeated multiple times. The drilled section penetrated 208.7 m of clays and muds containing an abundant benthic and planktonic fauna. The pelagic and hemipelagic muds contained only a minor amount of thin coarse-grained turbidites and was essentially free of mass-movement deposits shed off the adjacent diapiric walls. The absence of noticeable amounts of gas and the abundance of microfauna make this site especially suitable for late Pleistocene biostratigraphic, paleomagnetic, and oxygen-isotope studies.

The major conclusions are

1. The basin fill has been deposited primarily as pelagic and hemipelagic sedimentation, with only minor interruptions by localized mass movement and "coarse-grained" turbidite deposits.

2. A well-preserved and rather complete stratigraphic section of the Wisconsin was cored. Ericson's Zones Z, Y, and X (and W?) were penetrated. Computed accumulation rates were 41.7 cm/1000 yr. for the Holocene (Zone Z), 194.5 cm/1000 yr. for the late Wisconsin glacial (Zone Y, 142 m thick), and at least 23.8 cm/1000 yr. for the Wisconsin interstadial (Zone X, 10 m thick).

3. The predominantly clay section contains an abundance of bathyal benthic foraminifers except in the lower part of the section that may belong to Zone W (early Wisconsin glacial) which contains displaced shallow-water nearshore benthic fauna.

4. Diapiric movement, commonly responsible for shedding reworked sediments into the adjacent basin, must not have been extremely active during the late Pleistocene, as mass-movement deposits are minimal in the section penetrated.

5. A prominent ash layer was cored at a sub-bottom depth of 141.5 m, above the top of Ericson's Zone X. This ash is the Y8 ash of Kennett and Huddlestun (1972) that has been dated at 84,000 yr. before present (Ledbetter, this volume).

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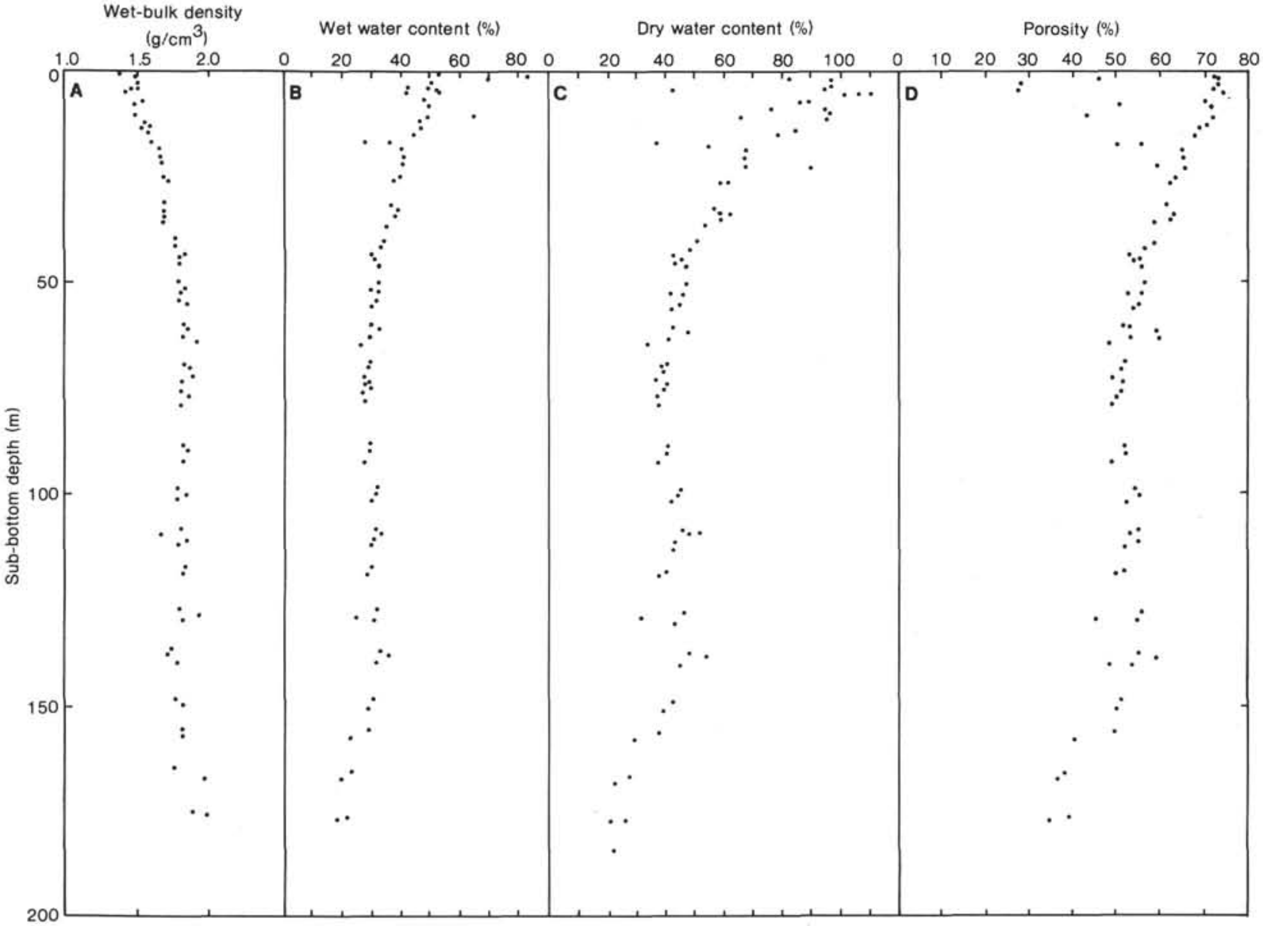


Figure 7. Mass physical properties of Site 619 sediments. A. Wet-bulk density. B. Water content related to weight of wet sediment. C. Water content related to weight of dry sediment. D. Porosity. E. Undrained shear strength. F. Sound velocity.

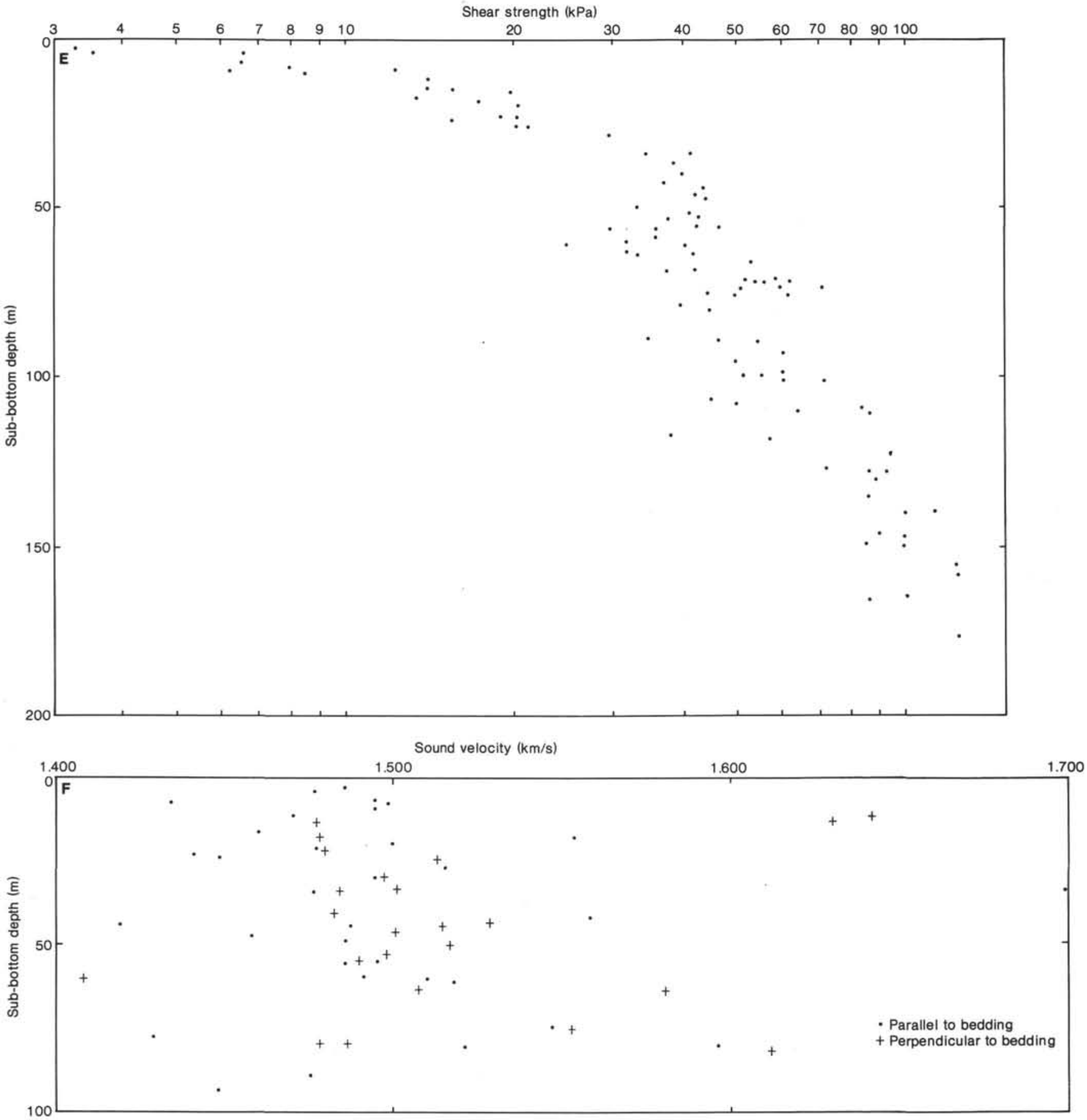
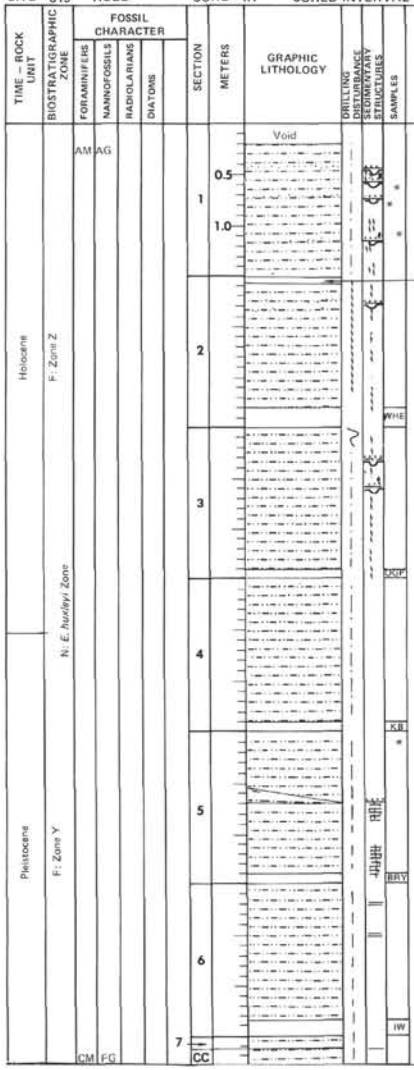


Figure 7 (continued).

SITE 619 HOLE CORE 1H CORED INTERVAL 2274.0–2283.5 mbsl; 1.0–10.5 mbsf



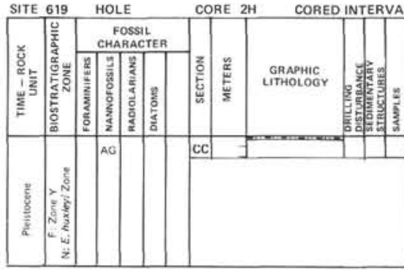
LITHOLOGIC DESCRIPTION

MUD, dark gray (5Y 4/1). Dominantly homogeneous with minor color bands of gray (10YR 4/1), grayish brown (10YR 3/2–10YR 4/2), and olive gray (5Y 4/2). Bioturbation common in Sections 1–3; less common below. Thin silts and fine sands occur in Sections 1, 2, and 3; some are graded and have scoured bases. Coarse, graded sandy mud occurs in Section 5.

SMEAR SLIDE SUMMARY (%):

	1, 68	1, 80	1, 112	5, 10
	M	D	D	D
Texture:				
Sand	25	2	0	0
Silt	40	13	15	10
Clay	35	85	85	90
Composition:				
Quartz	20	15	12	5
Feldspar	–	3	–	–
Mica	–	3	–	1
Heavy minerals	1	2	1	1
Clay	23	65	50	35
Volcanic glass	–	–	2	–
Carbonate unspec.	5	5	–	5
Foraminifers	40	–	T	10
Calc. nannofossils	10	5	35	40
Radiolarians	–	T	–	–
Sponge spicules	1	T	T	1
Plant debris (spores)	T	(T)	T	–
Opaques	–	2	–	2

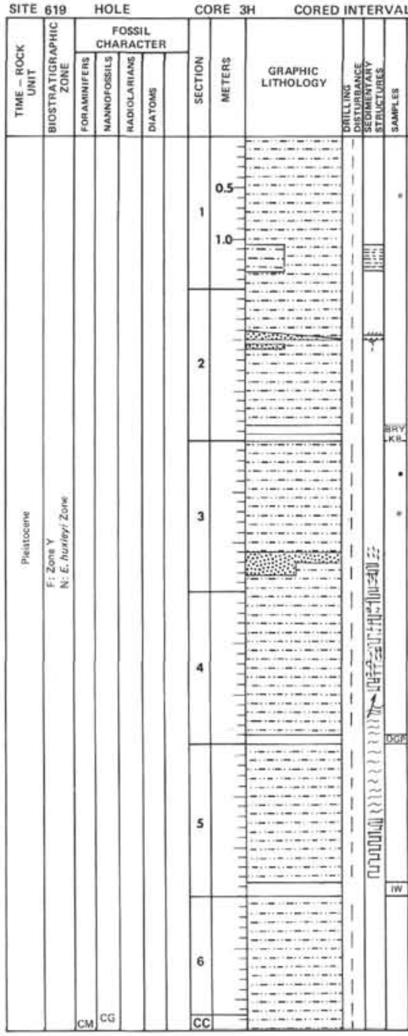
SITE 619 HOLE CORE 2H CORED INTERVAL 2273.0–2274.0 mbsl; 0.0–1.0 mbsf



LITHOLOGIC DESCRIPTION

Recovered 1 cm of MUD in the Core Catchery only; rest of core empty. Entire sample given to shipboard paleontologists.

SITE 619 HOLE CORE 3H CORED INTERVAL 2283.5–2293.2 mbsl; 10.5–20.2 mbsf



LITHOLOGIC DESCRIPTION

Section 1–Section 3, 132 cm: dark gray (5Y 4/1) homogeneous MUD. Interbedded with SILTY MUD and extensively bioturbated at Section 1, 105–133 cm. Interbedded with graded SANDS, one exhibiting a Bouma T_{a-e} sequence, at Section 2, 40–59 cm. Interbedded with SANDS and MUDS at Section 3, 110–132 cm.

Section 3, 132 cm–Section 5: dark olive gray (5Y 3/2) and dark gray (5Y 4/1) laminated MUD. Laminae enhanced by oxidation; mottling/bioturbation common.

Section 6 and Core Catcher: homogeneous, dark gray (5Y 4/1) MUD.

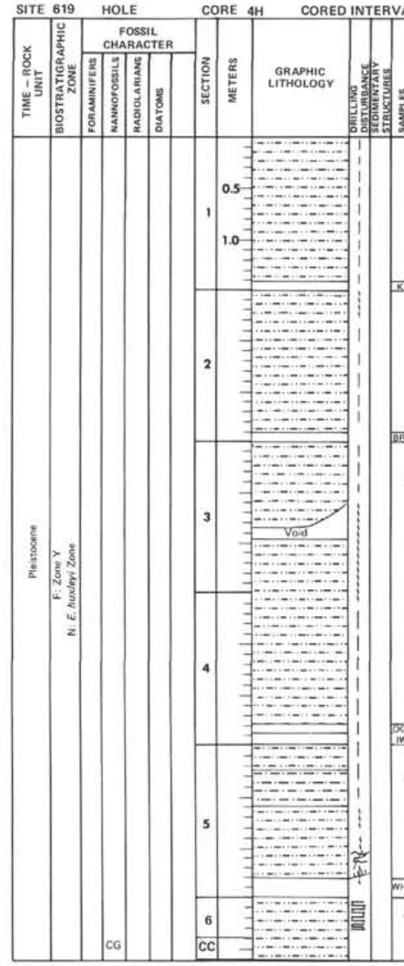
SMEAR SLIDE SUMMARY (%):

	1, 60	3, 75
	D	D
Texture:		
Sand	0	0
Silt	30	20
Clay	70	80
Composition:		
Quartz	15	8
Mica	3	T
Heavy minerals	2	1
Clay	62	73
Volcanic glass	–	T
Micronodules	5	–
Carbonate unspec.	10	1
Foraminifers	–	10
Calc. nannofossils	–	7
Sponge spicules	–	T
Plant debris (spores)	–	T
Opaques	3	–

CARBONATE BOMB DATA:

•3, 36 cm = 10%

SITE 619 HOLE CORE 4H CORED INTERVAL 2293.2–2302.9 mbsl; 20.2–29.9 mbsf



LITHOLOGIC DESCRIPTION

This core consists primarily of dark gray (5Y 4/1), homogeneous MUD, except as noted below.

Section 5, 21–55 cm consists of dark gray (5Y 4/1), structureless SANDY MUD.

Section 5, 55 cm–Section 6, 34 cm consists of mottled to laminated, dark gray (5Y 4/1) MUD with reddish and black streaks and layers and some gray mud balls. Laminations are regular, irregular, or inclined.

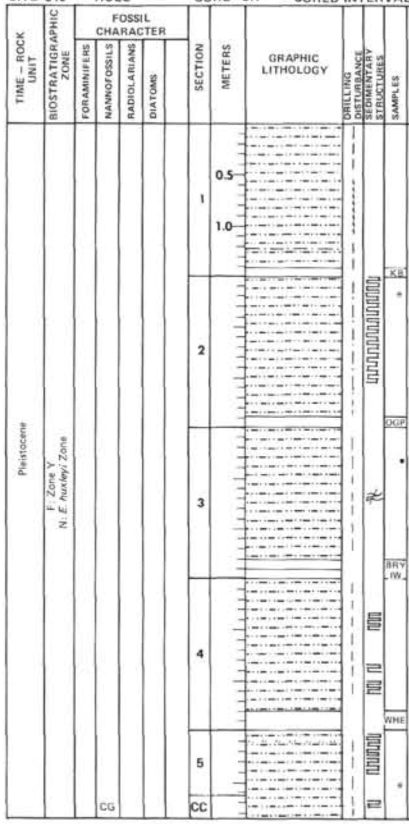
SMEAR SLIDE SUMMARY (%):

	5, 36	6, 20
	D	D
Texture:		
Sand	2	0
Silt	20	25
Clay	78	75
Composition:		
Quartz	10	15
Mica	T	–
Heavy minerals	–	1
Clay	67	72
Volcanic glass	T	–
Glauconite	T	–
Carbonate unspec.	5	2
Foraminifers	3	5
Calc. nannofossils	10	3
Plant debris (spores)	T	T
Opaques	5	–
Altered minerals	–	2

CARBONATE BOMB DATA:

•3, 36 cm = 11.0%

SITE 619 HOLE CORE 5H CORED INTERVAL 2302.9–2312.6 mbsl; 29.9–39.6 mbsf



LITHOLOGIC DESCRIPTION

Section 1–Section 2, 70 cm: dark gray (5Y 4/1), homogeneous MUD with color-band laminations in the lower 24 cm. Four cm-thick SAND layer occurs at Section 1, 121–125 cm. Laminations are black (2.5YR 2.5/0).

Section 2, 70 cm–Section 4, 130 cm: dark olive gray (5Y 3/2) MUD. Mainly homogeneous with occasional interbeds of dark gray (5Y 4/1) mud especially near the base.

Section 5 and Core Catcher: dark gray (5Y 4/1) MUD laminated with very dark gray (5Y 3/1) and very dark grayish brown (2.5Y 3/2) MUD.

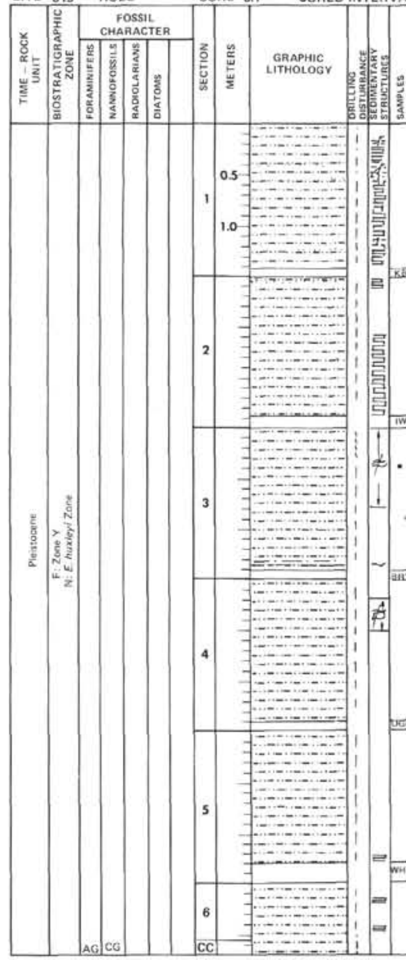
SMEAR SLIDE SUMMARY (%):

	2, 20	5, 55
	D	D
Texture:		
Sand	0	0
Silt	10	20
Clay	90	80
Composition:		
Quartz	4	14
Heavy minerals	T	T
Clay	87	75
Volcanic glass	—	T
Carbonate unspec.	1	2
Foraminifers	5	3
Calc. nannofossils	3	5
Plant debris (spores)	—	T
Altered minerals	T	1

CARBONATE BOMB DATA:

•3, 36 cm = 15%

SITE 619 HOLE CORE 6H CORED INTERVAL 2312.6–2322.3 mbsl; 39.6–49.3 mbsf



LITHOLOGIC DESCRIPTION

Dark gray (5Y 4/1) MUD. Laminated in upper part of core, and becoming more homogeneous downcore. Laminations are dominantly black MUD, and range from ~2 mm to 3 cm thick (average <1 cm). Core includes rare, very thin SILT and SAND laminae as indicated in "Graphic Lithology" column.

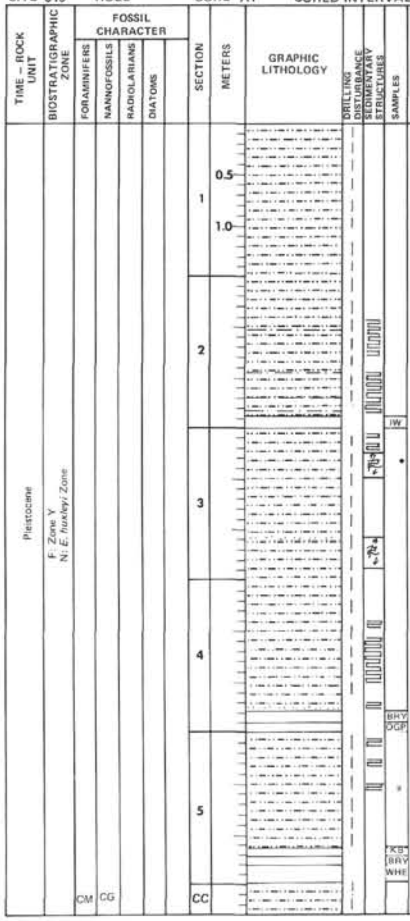
SMEAR SLIDE SUMMARY (%):

	3, 90
	D
Texture:	
Sand	0
Silt	40
Clay	60
Composition:	
Quartz	10
Feldspar	T
Clay	60
Carbonate unspec.	7
Calc. nannofossils	5
Altered minerals	10
Opaques	5

CARBONATE BOMB DATA:

•3, 36 cm = 11%

SITE 619 HOLE CORE 7H CORED INTERVAL 2322.3–2332.0 mbsl; 49.3–59.0 mbsf



LITHOLOGIC DESCRIPTION

Dark gray (5Y 4/1) MUD; homogeneous and laminated intervals as indicated in "Sedimentary Structures" column. Laminae are dominantly black (5Y 2.5/1) MUD, with minor very dark grayish brown (2.5Y 3/2) MUD beds in Section 5 and rare SILT and SAND laminae in Sections 2, 3, and 4.

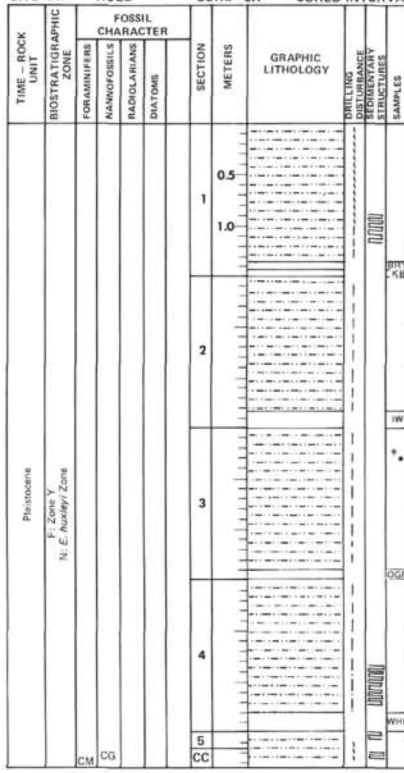
SMEAR SLIDE SUMMARY (%):

	5, 56
	D
Texture:	
Sand	0
Silt	40
Clay	60
Composition:	
Quartz	20
Feldspar	T
Clay	55
Micronodules	5
Carbonate unspec.	10
Calc. nannofossils	T
Altered minerals	5
Opaques	5

CARBONATE BOMB DATA:

•3, 36 cm = 13%

SITE 619 HOLE CORE 8H CORED INTERVAL 2332.0–2341.7 mbsl; 59.0–68.7 mbsf



LITHOLOGIC DESCRIPTION

MUD, dark gray (5Y 4/1) and homogeneous. Laminated with black (2.5Y 2.5/1) layers of MUD in Section 1 (90–120 cm), Section 4 (83–130 cm), Section 5, and the Core Catcher.

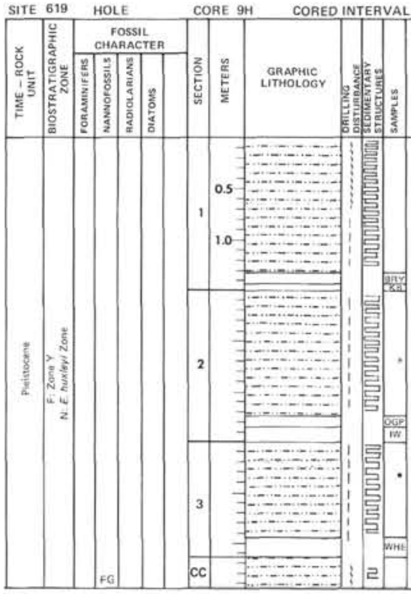
SMEAR SLIDE SUMMARY (%):

	3, 25
	D
Texture:	
Sand	0
Silt	30
Clay	70
Composition:	
Quartz	15
Feldspar	T
Clay	62
Micronodules	3
Carbonate unspec.	10
Calc. nannofossils	2
Plant debris (spores)	T
Altered minerals	3
Opaques	5

CARBONATE BOMB DATA:

•3, 38 cm = 15%

SITE 619 HOLE CORE 9H CORED INTERVAL 2341.7–2346.2 mbsl; 68.7–73.2 mbsf



LITHOLOGIC DESCRIPTION

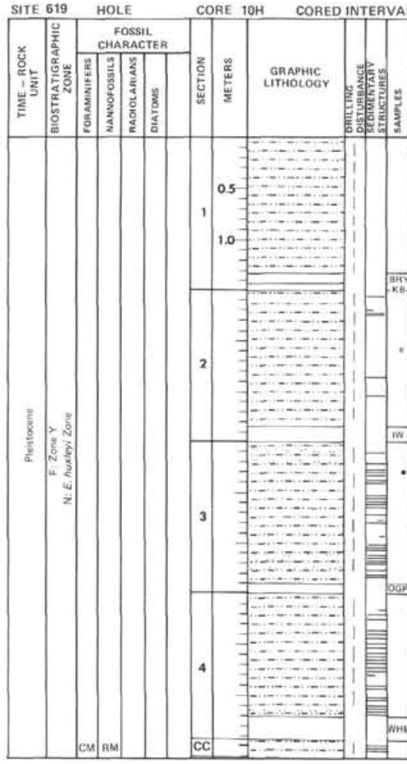
MUD, dark gray (5Y 4/1) and regularly laminated. Laminations are made mostly of very dark gray and BLACK (5Y 2/1 and 10YR 2.5/1) MUD with somewhat gradational tops and bases. Very thin SILT laminae occur at Section 1, 65 cm; Section 3, 20 cm; and Section 3, 24 cm.

SMEAR SLIDE SUMMARY (%):

	2, 70
	D
Texture:	
Sand	0
Silt	20
Clay	80
Composition:	
Quartz	12
Heavy minerals	2
Clay	80
Volcanic glass	T
Carbonate unspec.	1
Calc. nannofossils	2
Altered minerals	3

CARBONATE BOMB DATA:
•3, 36 cm = 18%

SITE 619 HOLE CORE 10H CORED INTERVAL 2351.4–2357.5 mbsl; 78.4–84.5 mbsf



LITHOLOGIC DESCRIPTION

Dark gray (10YR 4/1), homogeneous MUD becoming progressively more laminated downcore. Subtle color changes in MUD include very dark gray (10YR 3/1) and dark brown (7.5YR 3/2). Laminae are black (5Y 2.5/1), very dark grayish brown (10YR 3/2), and very dark gray (5Y 3/1); location of the MUD laminae are indicated in the "Sedimentary Structures" column. Section 2 and 3 include rare, very thin SILT laminae. Gas escape structures, concave bending of black laminae, and bulging end caps all indicate that this core contained some gas.

SMEAR SLIDE SUMMARY (%):

	2, 60
	D
Texture:	
Sand	0
Silt	40
Clay	60
Composition:	
Quartz	10
Feldspar	T
Mica	2
Heavy minerals	2
Clay	60
Micronodules	3
Carbonate unspec.	10
Calc. nannofossils	1
Altered minerals	12

CARBONATE BOMB DATA:
• 3, 36 cm = 18%

SITE 619 HOLE CORE 11H CORED INTERVAL 2361.0–2366.1 mbsl; 88.0–93.1 mbsf

TIME – ROCK UNIT: Pleistocene

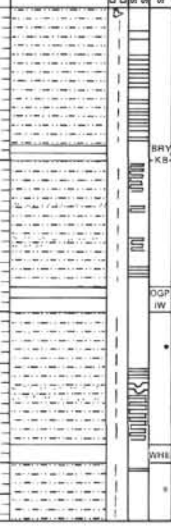
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone

FOSSIL CHARACTER: FORAMINIFERS: RM; NANNOFOSSILS: CG; RADIOLARIANS; DIATOMS

SECTION: 1, 2, 3, 4, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES: BRY, KB, OGP, IW, •, WHE, *



LITHOLOGIC DESCRIPTION

MUD, color-banded/laminated or homogeneous. Primarily dark gray (10YR 4/1) changing to primarily dark olive gray (5Y 3/2) in Section 4. Color bands and laminae are very dark gray (5Y 3/1) to black. Section 2 and 3 contain rare, very thin SILT laminae.

SMEAR SLIDE SUMMARY (%):

	4, 25
	D
Texture:	
Sand	0
Silt	15
Clay	85
Composition:	
Quartz	13
Heavy minerals	1
Clay	80
Carbonate unspec.	1
Foraminifers	T
Calc. nannofossils	2
Plant debris	T
Altered minerals	3

CARBONATE BOMB DATA:
•3, 36 cm = 22%

SITE 619 HOLE CORE 12H CORED INTERVAL 2370.1–2375.1 mbsl; 97.6–102.1 mbsf

TIME – ROCK UNIT: Pleistocene

BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone

FOSSIL CHARACTER: FORAMINIFERS: RM; NANNOFOSSILS: CG; RADIOLARIANS; DIATOMS

SECTION: 1, 2, 3, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES: BRY, KB, OGP, IW, •, WHE

LITHOLOGIC DESCRIPTION

Entire core consists of homogeneous, dark gray (10YR 4/1) MUD. Section 3, 40–90 cm contains some gas escape structures which make the core surface have a somewhat spongy texture.

CARBONATE BOMB DATA:
•3, 36 cm = 16%

SITE 619 HOLE CORE 13H CORED INTERVAL 2380.2–2386.8 mbsl; 107.2–113.8 mbsf

TIME – ROCK UNIT: Pleistocene

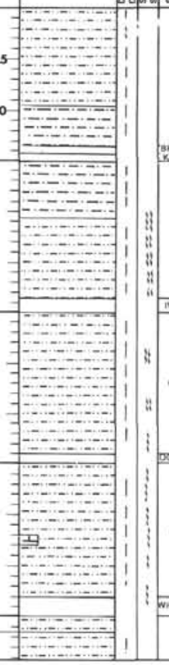
BIOSTRATIGRAPHIC ZONE: F: Zone Y; N: *E. huxleyi* Zone

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

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES: BRY, KB, IW, •, *, OGP, WHE



LITHOLOGIC DESCRIPTION

MUD with one interval of SANDY MUD.

MUD is dominantly dark gray (5Y 4/1) with mottles and color-bands of olive gray (5Y 4/2), very dark gray (5YR 3/1), dark grayish brown (10YR 3/2), and black (5Y 2/2; 5Y 2.5/1). MUD ranges from homogeneous to extensively burrowed and mottled. Bioturbation burrows typically 0.5–1.0 cm maximum dimension.

An interval of dark gray (5Y 4/1), massive SANDY MUD occurs at Section 1, 95 cm–Section 2, 55 cm.

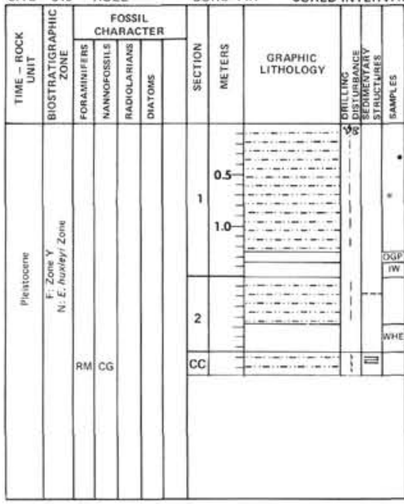
A few, folded thin laminae of FORAM SANDS occur at Section 4, 70–80 cm.

SMEAR SLIDE SUMMARY (%):

	3, 70	4, 70
	D	M
Texture:		
Sand	0	2
Silt	30	30
Clay	70	68
Composition:		
Quartz	21	20
Heavy minerals	T	1
Clay	63	61
Volcanic glass	5	–
Pyrite and opaques	–	1
Carbonate unspec.	1	10
Foraminifers	1	5
Calc. nannofossils	7	2
Sponge spicules	–	T
Plant debris (spores)	1	–
Altered minerals	1	–

CARBONATE BOMB DATA:
•3, 36 cm = 12.5%

SITE 619 HOLE CORE 14H CORED INTERVAL 2389.8–2392.2 mbsl; 116.8–119.2 mbsf



LITHOLOGIC DESCRIPTION

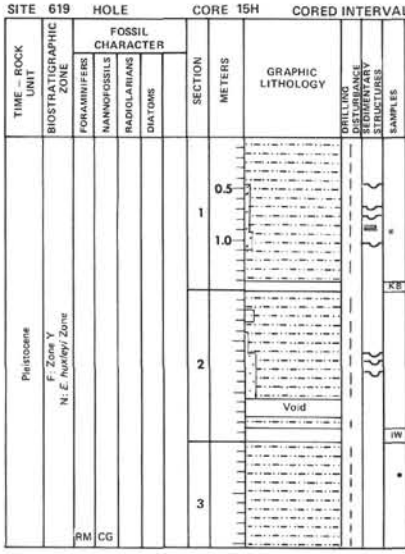
MUD, homogeneous, dark gray (10YR 4/1) changing to dark gray (5Y 4/1) at a gradational contact at Section 2, 11–15 cm. Core Catcher is poorly laminated with black layers.

SMEAR SLIDE SUMMARY (%):

	1, 75
	D
Texture:	
Sand	0
Silt	15
Clay	85
Composition:	
Quartz	9
Heavy minerals	T
Clay	60
Volcanic glass	T
Carbonate unspec.	5
Calc. nannofossils	25
Plant debris	T
Altered minerals	1

CARBONATE BOMB DATA:
•1, 36 cm = 18%

SITE 619 HOLE CORE 15H CORED INTERVAL 2399.4–2403.5 mbsl; 126.4–130.5 mbsf



LITHOLOGIC DESCRIPTION

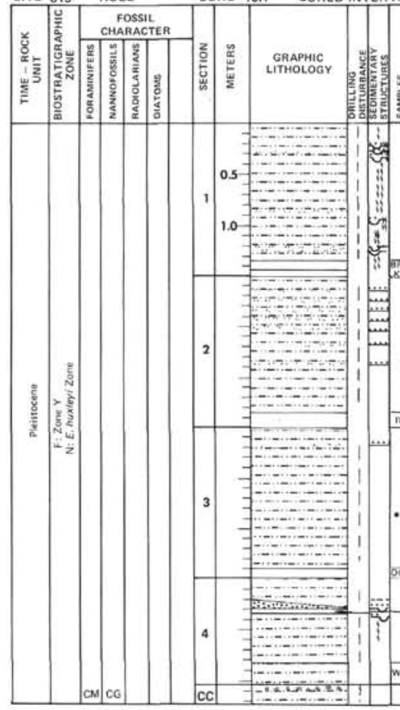
MUD, dominantly dark gray (5Y 4/1) with color-bands, mottles, and laminae of dark olive gray to olive gray (5Y 4/2–5Y 3/2), dark grayish brown (10YR 4/2), and black. Section 1 and 2 are bioturbated; Section 3 appears homogeneous. SILT laminae are common in Section 1 and 2, often with indistinct grading and scoured bases.

SMEAR SLIDE SUMMARY (%):

	1, 92
	M
Texture:	
Sand	0
Silt	50
Clay	50
Composition:	
Quartz	20
Heavy minerals	2
Clay	36
Volcanic glass	10
Pyrite and opaques	2
Carbonate unspec.	20
Calc. nannofossils	10

CARBONATE BOMB DATA:
•3, 36 cm = 11%

SITE 619 HOLE CORE 16H CORED INTERVAL 2409.0–2414.8 mbsl; 136.0–141.8 mbsf



LITHOLOGIC DESCRIPTION

MUD with SILT laminae and ASH layers.

MUD is dominantly dark greenish gray (5GY 4/1) and greenish gray (5GY 5/1). Bioturbation common, especially in Section 1.

The SILT laminae are especially common in Section 1 and 2. They are thin, have scoured bases, and appear to be normally-graded.

SAND bed occurs at Section 4, 20–30 cm. It is graded and has well-developed parallel-laminae.

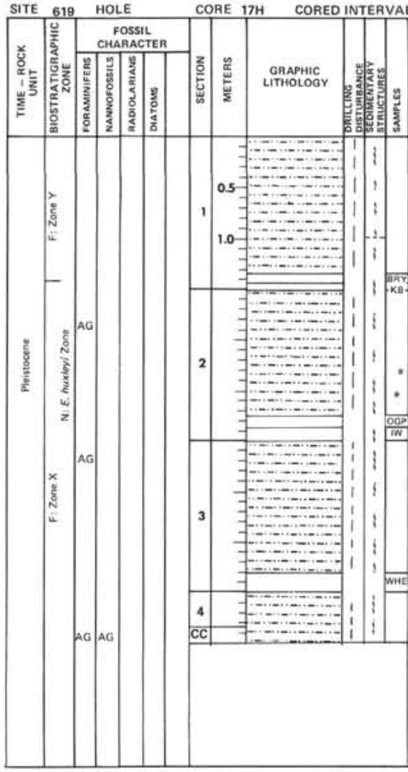
Two ASH layers occur in the Core Catcher.

SMEAR SLIDE SUMMARY (%):

	2, 87	3, 10	CC, 5
	M	D	M
Texture:			
Sand	50	0	20
Silt	40	25	80
Clay	10	75	0
Composition:			
Quartz	40	10	1
Feldspar	5	–	–
Mica	5	–	T
Heavy minerals	5	1	T
Clay	10	62	–
Volcanic glass	5	–	96
Micronodules	5	–	1
Carbonate unspec.	–	3	–
Foraminifers	5	7	2
Calc. nannofossils	–	13	–
Plant debris (spores)	–	T	–
Altered minerals	10	4	–
Opaques	10	–	–

CARBONATE BOMB DATA:
•3, 90 cm = 6%

SITE 619 HOLE CORE 17H CORED INTERVAL 2418.7–2423.8 mbsl; 145.7–150.8 mbsf



LITHOLOGIC DESCRIPTION

Section 1: MUD, black (7.5YR 2/0) grading to dark gray (5Y 4/1) at 100 cm. Intensely bioturbated, homogeneous with tiny blebs of foram sand and common dispersed forams.

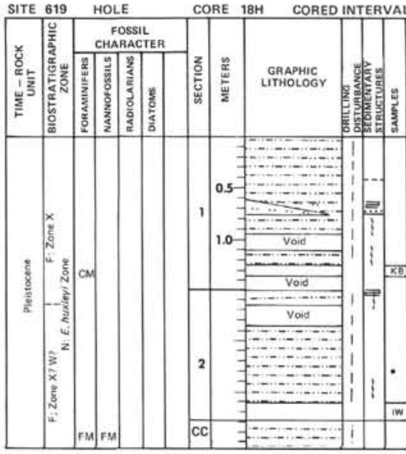
Section 2: MUD, dark greenish gray (5GY 4/1) with silty and sandy blebs and dispersed forams. The amount of coarse-grained blebs decreases upsection.

Section 3 and 4; MUD with reworked mud clasts. MUD is variegated in color, principally dark greenish gray (5GY 4/1) with minor greenish gray (5GY 5/1), dark gray (5Y 4/1), and gray (5Y 5/1). Bioturbated throughout; typical burrows are up to 2 cm in diameter. Section 3, 30 cm–Section 4, 35 cm contains reworked clay clasts and silt lenses. Whole sequence fines upward; maximum clast size at base is ~7 cm.

SMEAR SLIDE SUMMARY (%):

	2, 84	2, 105
	M	M
Texture:		
Sand	35	40
Silt	55	45
Clay	10	15
Composition:		
Quartz	21	25
Feldspar	2	2
Mica	–	T
Heavy minerals	6	–
Clay	10	15
Volcanic glass	–	T
Glauconite	–	T
Pyrite and opaques	4	–
Micronodules	2	–
Carbonate unspec.	30	15
Foraminifers	20	5
Calc. nannofossils	5	T
Plant debris	–	33
Altered minerals	–	5

SITE 619 HOLE CORE 18H CORED INTERVAL 2428.4–2431.4 mbsl; 155.4–158.4 mbsf



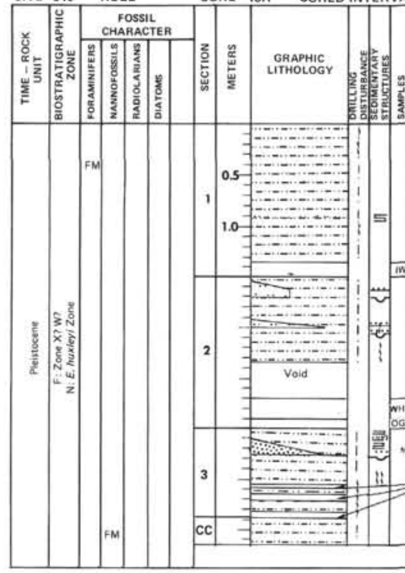
LITHOLOGIC DESCRIPTION

MUD with minor SILT layers.

MUD is very dark greenish gray (5GY 3/1) grading to dark greenish gray (5GY 4/1) at Section 1, 75 cm. Bioturbation and dispersed forams are rare. Section 1, 40–77 cm consists of a slightly siltier interval of MUD than the rest of the core; the grain size generally fines upward from Section 1, 77 cm. Several SILT layers occur at Section 1, 62–77 cm. They are graded and thin upward as a unit.

CARBONATE BOMB DATA:
*2, 83 cm = 3%

SITE 619 HOLE CORE 19H CORED INTERVAL 2438.1–2442.1 mbsl; 165.1–169.1 mbsf



LITHOLOGIC DESCRIPTION

MUD with several SILT and SAND laminae and layers.

MUD, very dark greenish gray (5GY 3/1) in Section 1 and 2 and the Core Catcher; Section 3, 0–52 cm is dark gray (5Y 4/1); Section 3, 52–80 cm is dark greenish gray (5GY 4/1). Bioturbation is rare. Section 1 contains 3 soupy or washed out zones at 0–5 cm, 18–30 cm, and 96–105 cm that may have been hydrates.

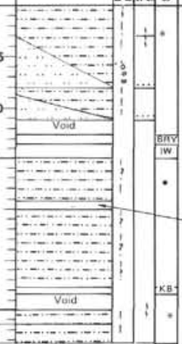
Section 1 contains several very thin SILT laminae at 87–90 cm. Section 2 and 3 contain several graded SILT or SAND with scoured bases. SAND layer in Section 3 exhibits Bouma T_{a-e} sequence.

SMEAR SLIDE SUMMARY (%):

	3, 24
	M
Texture:	
Sand	77
Silt	20
Clay	3
Composition:	
Quartz	24
Feldspar	3
Heavy minerals	3
Clay	20
Pyrite and opaques	3
Micronodules	2
Carbonate unspec.	45

SITE 619 HOLE CORE 20H CORED INTERVAL 2447.7–2451.2 mbsl; 174.7–178.2 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone		FM			1, 2, 3, CC	0.5, 1.0				BRY, IW, KB



LITHOLOGIC DESCRIPTION

Section 1: MUD and two graded SILT layers. MUD is very dark gray (N3) and homogeneous. SILT layers occur at Section 1, 30–80 cm and 80–112 cm. SILT layers are graded, have sharp bottom and top contacts, and are dark greenish gray (5GY 4/1) at the base grading to very dark gray (N3) at the top. Grading is distinct in lower SILT layer; upper SILT is too disturbed and soupy to see any structure really distinctly.

Section 2, 3, and Core Catcher: homogeneous, dark greenish gray (5GY 4/1) MUD with rare dispersed forams and silt blebs. Section 2 has very vague layering barely visible on a mm-scale.

SMEAR SLIDE SUMMARY (%):

	1, 30	3, 5
	D	D
Texture:		
Sand	5	7
Silt	75	63
Clay	20	30
Composition:		
Quartz	60	50
Feldspar	T	3
Mica	–	1
Heavy minerals	–	3
Clay	20	30
Carbonate unspec.	–	1
Foraminifers	–	2
Calc. nannofossils	T	T
Altered minerals	15	10
Opaques	5	–

CARBONATE BOMB DATA:
•2, 27 cm = 4%

SITE 619 HOLE CORE 21H CORED INTERVAL 2457.3–2460.3 mbsl; 184.3–187.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone		FG			CC					*

LITHOLOGIC DESCRIPTION

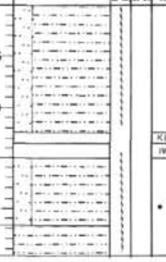
Only a handful of gray MUD was recovered in this core.

SMEAR SLIDE SUMMARY (%):

	CC
	D
Texture:	
Sand	T
Silt	15
Clay	85
Composition:	
Quartz	10
Mica	2
Heavy minerals	1
Clay	73
Pyrite and opaques	1
Carbonate unspec.	2
Foraminifers	1
Calc. nannofossils	10
Sponge spicules	T
Plant debris (spores)	T

SITE 619 HOLE CORE 22H CORED INTERVAL 2460.3–2463.3 mbsl; 187.3–190.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone	AG, CG	CG			1, 2, CC	0.5, 1.0				KB, IW, *



LITHOLOGIC DESCRIPTION

Highly-deformed MUD and SILT laminae.

Dark greenish gray (5GY 4/1) MUD with SILT laminae and dispersed forams. Abundance of SILT laminae decreases downcore. This core contains no preserved original sedimentary structures; material is all FLOW IN.

SMEAR SLIDE SUMMARY (%):

	2, 40
	D
Texture:	
Sand	0
Silt	20
Clay	80
Composition:	
Quartz	9
Heavy minerals	2
Clay	75
Volcanic glass	T
Foraminifers	3
Calc. nannofossils	2
Plant debris (spores)	1
Altered minerals	5

CARBONATE BOMB DATA:
•2, 50 cm = 11%

SITE 619 HOLE CORE 23H CORED INTERVAL 2476.7–2479.7 mbsl; 203.7–206.7 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone	CM	FG			CC					

LITHOLOGIC DESCRIPTION

Two cm of MUD recovered in Core Catcher; rest of core empty. Entire sample given to shipboard paleontologists.

SITE 619 HOLE CORE 24H CORED INTERVAL 2479.7–2480.7 mbsl; 206.7–207.7 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone	CG	FG			CC						Two cm of MUD recovered in Core Catcher; rest of core empty. Entire sample given to shipboard paleontologists.

SITE 619 HOLE CORE 25H CORED INTERVAL 2480.7–2481.7 mbsl; 207.7–208.7 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
Pleistocene	F: Zone X? W? N: *E. huxleyi* Zone	CM	FG			1	0.5	Void			*	
						CC						

LITHOLOGIC DESCRIPTION

MUD, very dark gray (N3) from Section 1, 0–15 cm and in the Core Catcher; very dark gray black (5Y 2.5/1) at Section 1, 15–52 cm. All color variations gradational. MUD is homogeneous, with 1 very thin discontinuous SILT laminae at Section 1, 25 cm and gas cavities at Section 1, 45–48 cm.

SMEAR SLIDE SUMMARY (%):

	1, 40
	D
Texture:	
Sand	2
Silt	35
Clay	63
Composition:	
Quartz	30
Clay	60
Foraminifers	T
Calc. nannofossils	3
Altered minerals	7

SITE 619 HOLE A CORE 1H CORED INTERVAL 2272.7–2278.0 mbsl; 0.0–5.3 mbsf

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
Holocene	F: Zone Z N: *E. huxleyi* Zone	AG	AG			1	0.5 1.0	Void				
						2						
						3					BRY IW	
Pleistocene	F: Zone Y					4						
		AG	AG			CC					•	

LITHOLOGIC DESCRIPTION

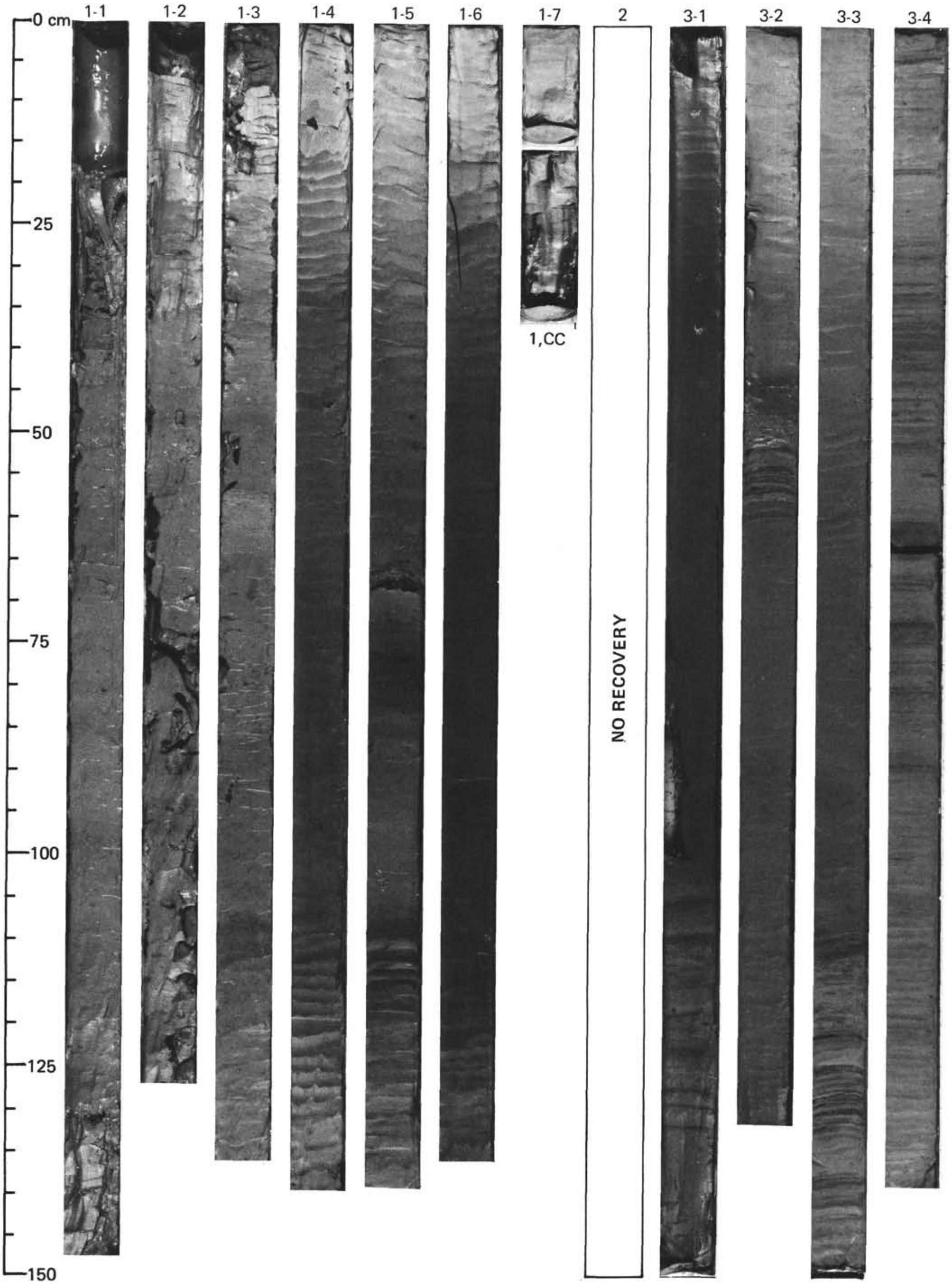
MUD with SILT laminae and rare FORAM SANDS.

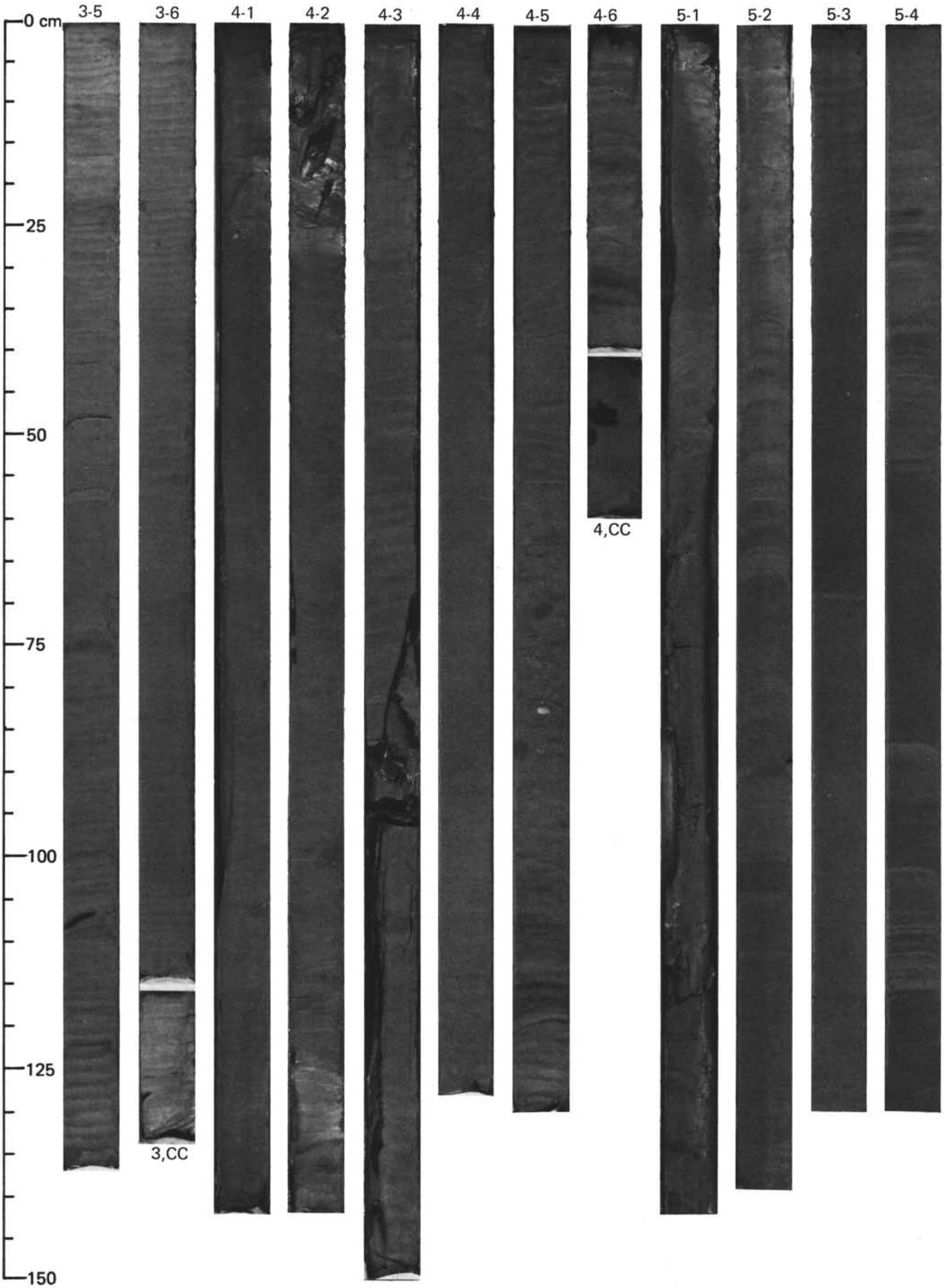
MUD is dominantly olive (5Y 4/3) with minor intervals of dark olive gray (5Y 3/2), very dark grayish brown (2.5Y 3/2), dark grayish brown (2.5Y 4/2), and grayish brown (2.5Y 5/2). Bioturbation is common.

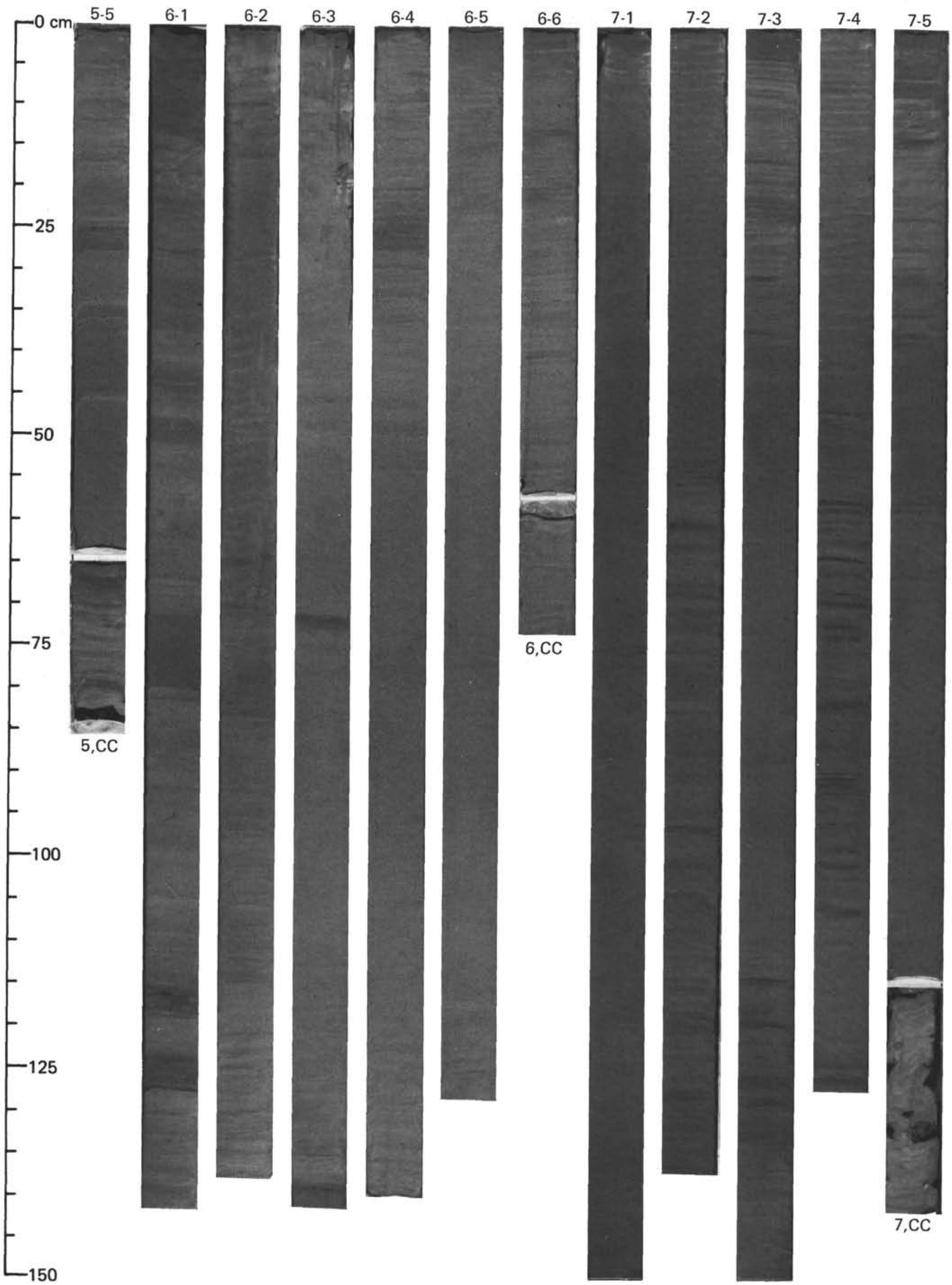
SILT laminae are thin (~0.5 cm thick on average), and rare except in Section 3. Laminae are poorly graded, and a few show scoured bases.

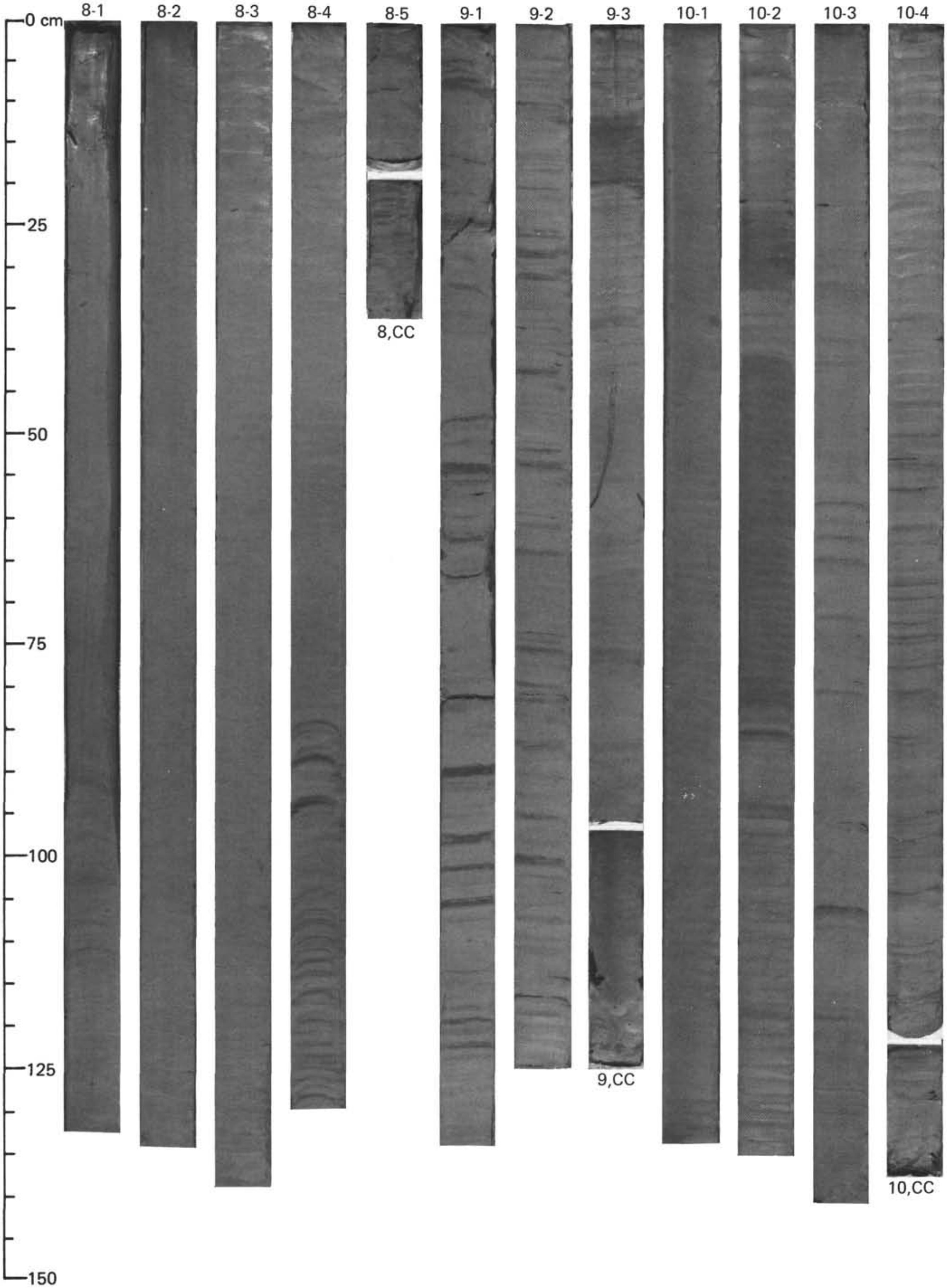
Distinct FORAM SANDS occur at Section 1, 105 cm; Section 3, 114–117 cm; and Section 4, 36–37 cm.

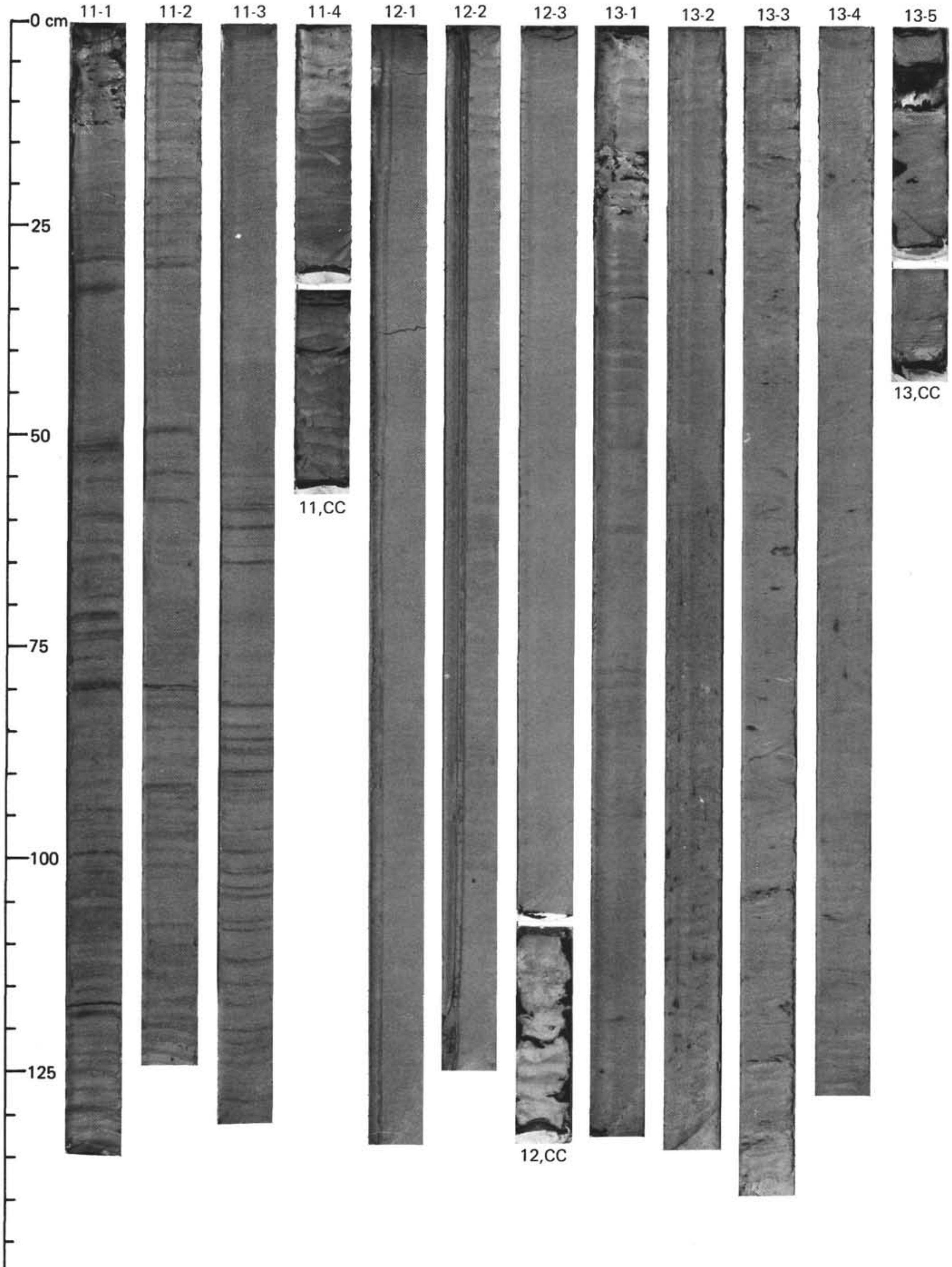
CARBONATE BOMB DATA:
•CC, 8 cm = 12.5%

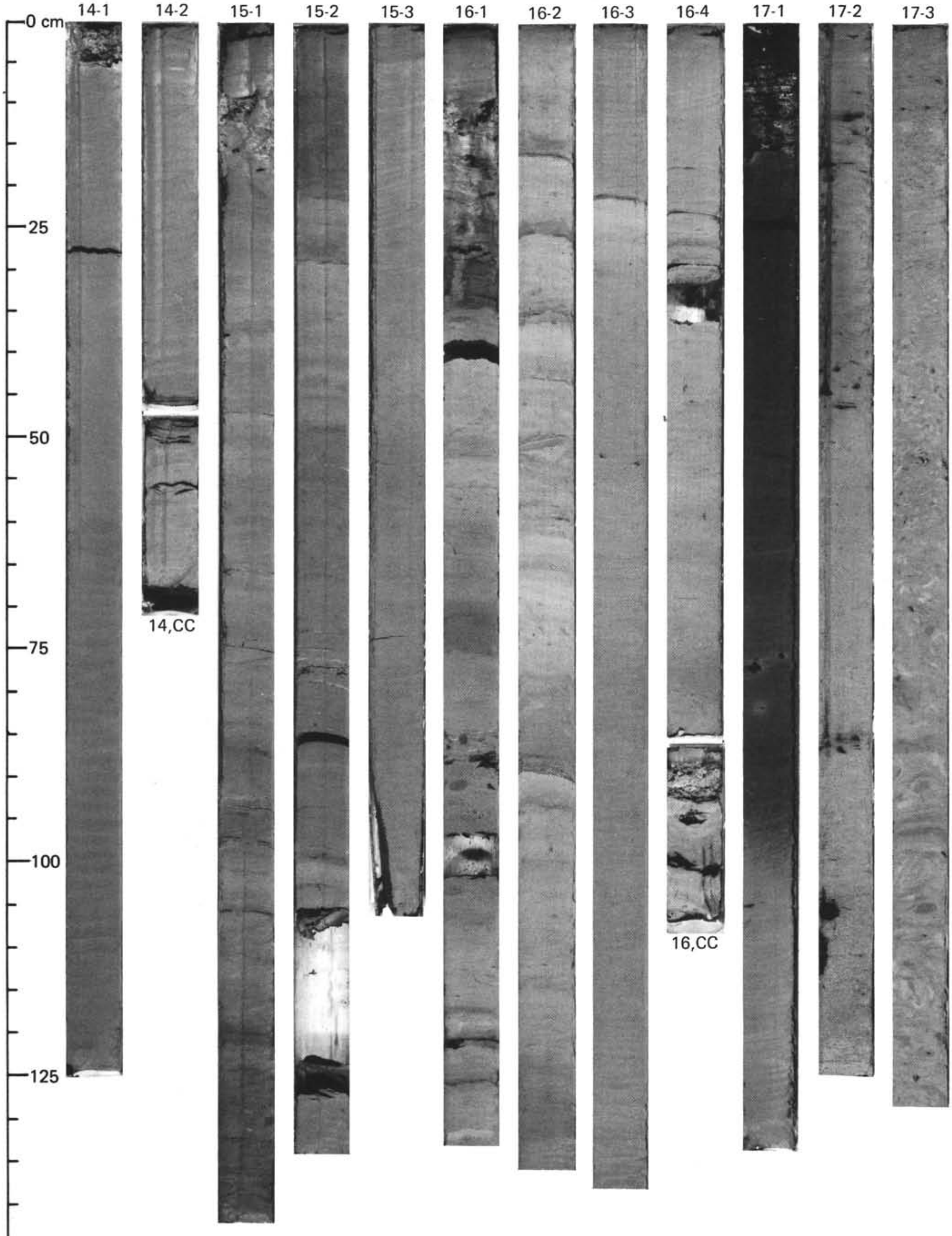

0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1,CC
2
NO RECOVERY
3-1
3-2
3-3
3-4

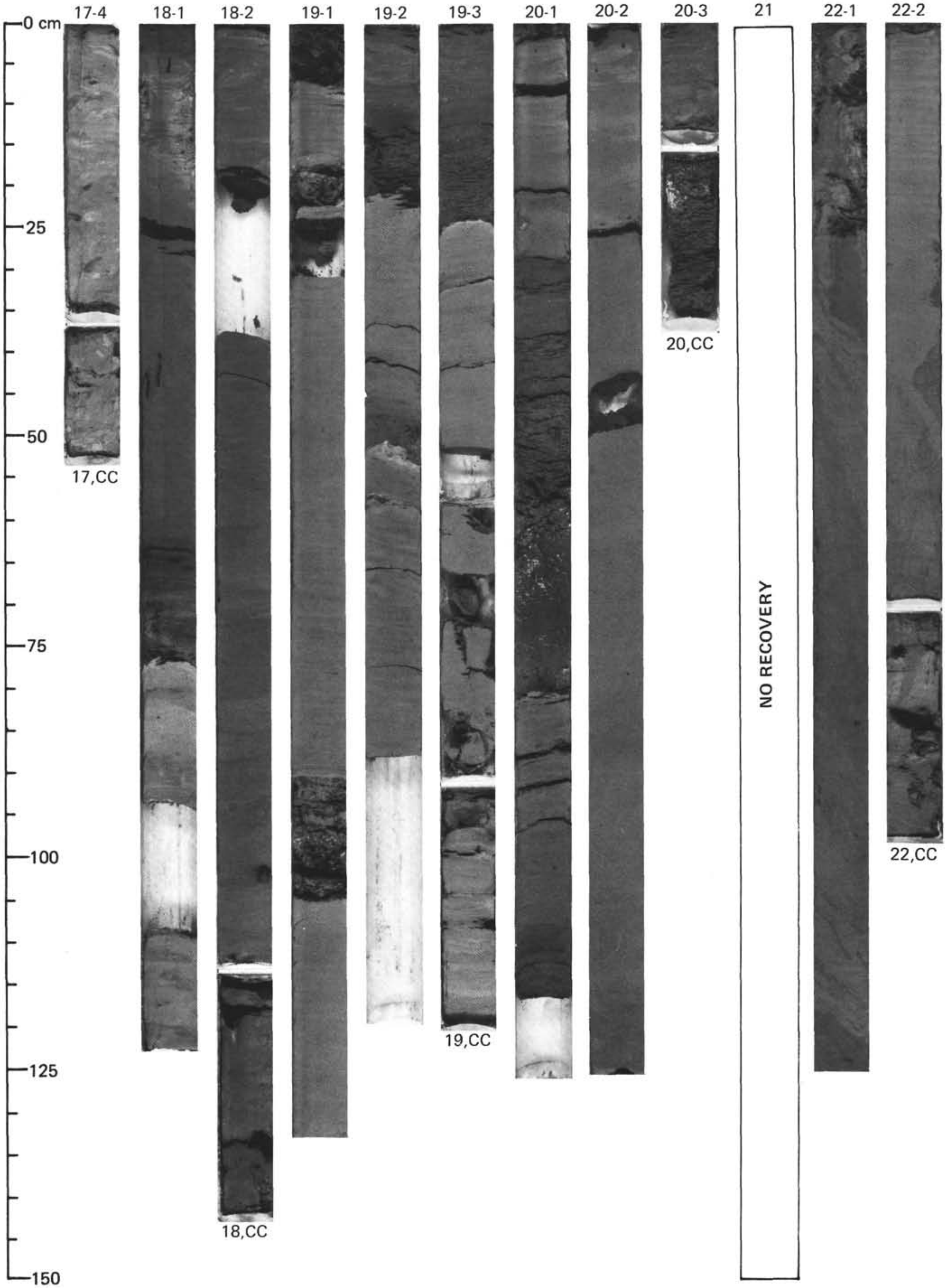

0 cm
25
50
75
100
125
150
3-5
3-6
4-1
4-2
4-3
4-4
4-5
4-6
5-1
5-2
5-3
5-4
3,CC
4,CC


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

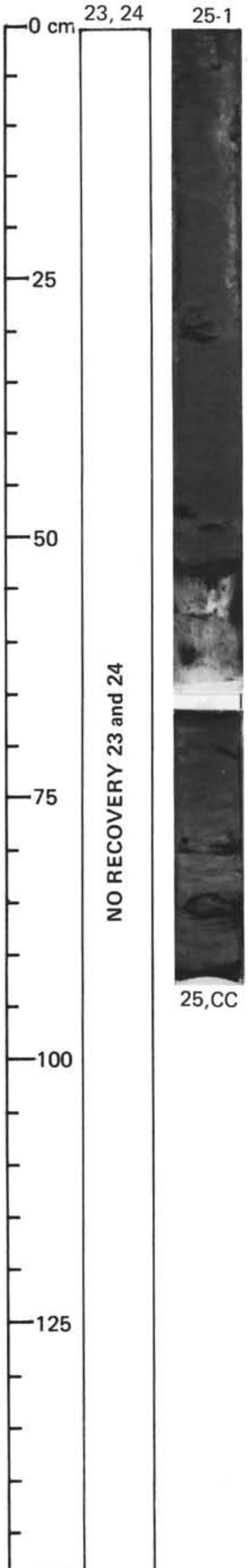

0 cm
25
50
75
100
125
150
8-1
8-2
8-3
8-4
8-5
8,CC
9-1
9-2
9-3
9,CC
10-1
10-2
10-3
10-4
10,CC

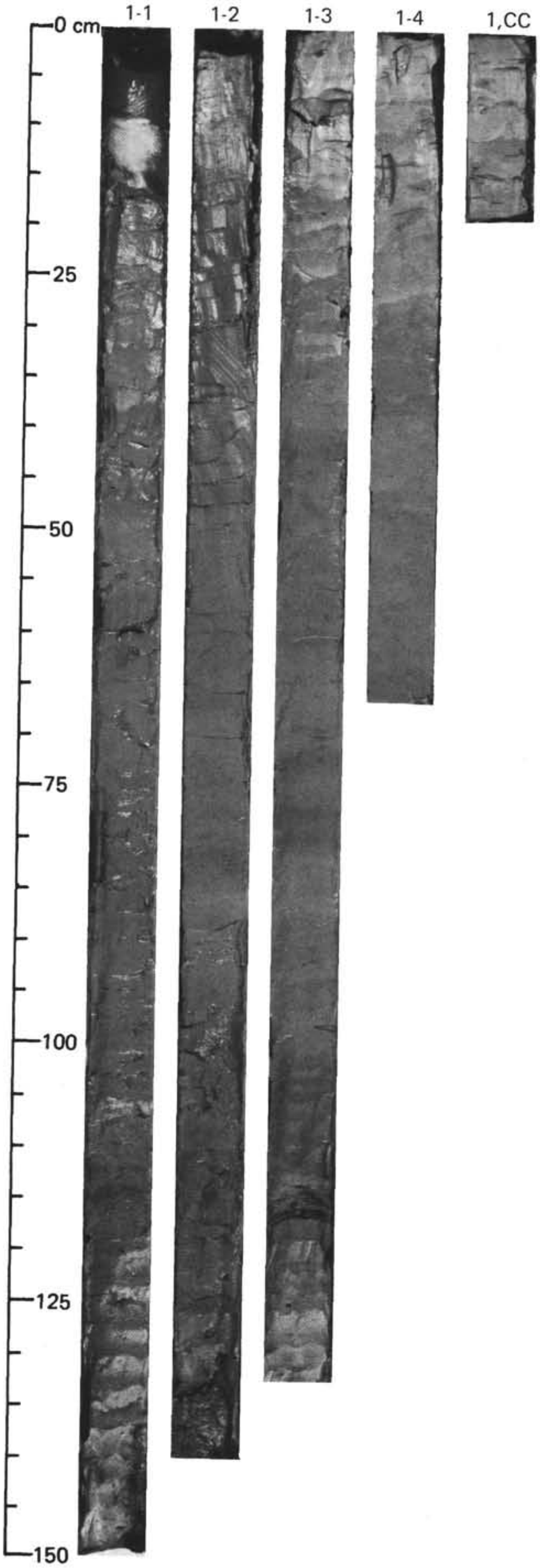

0 cm
25
50
75
100
125
150
11-1
11-2
11-3
11-4
11,CC
12-1
12-2
12-3
12,CC
13-1
13-2
13-3
13-4
13-5
13,CC


0 cm
25
50
75
100
125
150
14-1
14-2
14,CC
15-1
15-2
15-3
16-1
16-2
16-3
16-4
16,CC
17-1
17-2
17-3



17-4
18-1
18-2
19-1
19-2
19-3
20-1
20-2
20-3
21
22-1
22-2
0 cm
25
50
75
100
125
150
17,CC
18,CC
19,CC
20,CC
22,CC
NO RECOVERY


0 cm
25
50
75
100
125
150
23, 24
NO RECOVERY 23 and 24
25-1
25,CC


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