# 3. SITE 435: JAPAN TRENCH UPPER SLOPE, LEG 56

Shipboard Scientific Party[1]

## HOLES 435 AND 435A

**Date Occupied:** 18 September 1977 (1700)

**Date Departed:** 22 September 1977 (1130)

**Time on Hole:** 3 days, 18.5 hours

**Position:** 39°44.09′N, 143°47.53′E (Hole 435)
39°44.10′N, 143°47.59′E (Hole 435A)

**Water Depth (sea level):** 3401 corrected meters, echo sounding

**Water Depth (rig floor):** 3411 corrected meters, echo sounding

**Bottom Felt (meters, drill pipe):** 3413 (Hole 435), 3414 (Hole 435A)

**Penetration:** 244.5 meters

**Number of Cores:** 27

**Total Length of Cored Section:** 252.5 meters

**Total Core Recovery:** 123.63 meters

**Oldest Sediment Cored:** Early Pliocene

**Principal results:**

Holes 435 and 435A were drilled in 3400 meters of water and continuously cored to a sub-bottom depth of 244.5 meters. The drilled section provided a complete sequence from the late Pleistocene to the early Pliocene. Climatic cooling trends are identified by the planktonic foraminifer assemblages. Benthonic foraminifer assemblages indicate a gradual uplift of the sea floor of about 500 meters during the late Neogene. The presence of shallower benthonic taxa, diatoms, radiolarians, and foraminifers are evidence of occasional downslope transport of sediments. Datum levels are in good agreement and indicate a fairly uniform sedimentary accumulation rate of 40 m/m.y. (Figure 1).

Lithologically, the section is an extremely uniform hemipelagic diatomaceous silty clay and muddy diatomaceous ooze. The sediments are similar to those drilled at other transect sites and to those on the lower slope. The main differences between Sites 435 and 434 are that 435 has a somewhat higher biogenic silica content in the Pliocene section and more abundant lithic components in sandy ash layers and lacks extensive fracturing and diagenetic carbonate components. Erratic pebbles, representing a wide variety of rock types, occur. At a depth of 220 meters sub-bottom, noticeable lithification and induration of the sediments begin. The lowest part of the section is a muddy diatomite and shows faceting of the sediments, caused perhaps by drilling disturbance.

Physical properties measurements on the cores show an abrupt and significant decrease in bulk density and thermal conductivity at about 70 meters sub-bottom. There is no similar change in seismic velocity. The velocity values in the interval from 70 to 170 meters are extremely uniform. At greater depth, the velocity increases gradually toward the bottom of the hole, corresponding to the increasing induration of the sediments with depth.

Geochemically, these sediments closely resemble those found at Site 434 — they are anoxic. However, no $H_2S$ odor was associated with the Site 435 sediments, possibly because the interstitial water alkalinities were higher here. We also observed biogenic methane.

The recovery of a complete, undisturbed section of hemipelagic sediments at this site was somewhat of a surprise, considering the disturbed nature of the acoustical stratigraphy in the seismic section (see Background).

## BACKGROUND

Site 435 is located on the upper portion of the landward trench slope above the midslope terrace in a water depth of 3400 meters. According to the seismic reflection profile across the site (Figure 2), this site is not on the active Neogene accretionary wedge, but lies near the edge of the more stable continental block. A reflector identified as a Cretaceous erosional surface (see site chapter for Sites 438 and 439) can be traced below this site with moderate confidence. The acoustical stratigraphy, however, is disrupted, as evidenced by the discontinuous nature of reflectors in the Neogene sediments. These same reflectors can be easily traced farther west. This suggests that the whole section near this site has undergone small downslope displacements along closely spaced, steeply dipping, fault planes. Bedding plane reflectors below this site show a slight landward dip and some appear to outcrop on the seafloor. The upper half kilometer of this part of the slope may be part of a large slump block. A vague, arcuate line, con-

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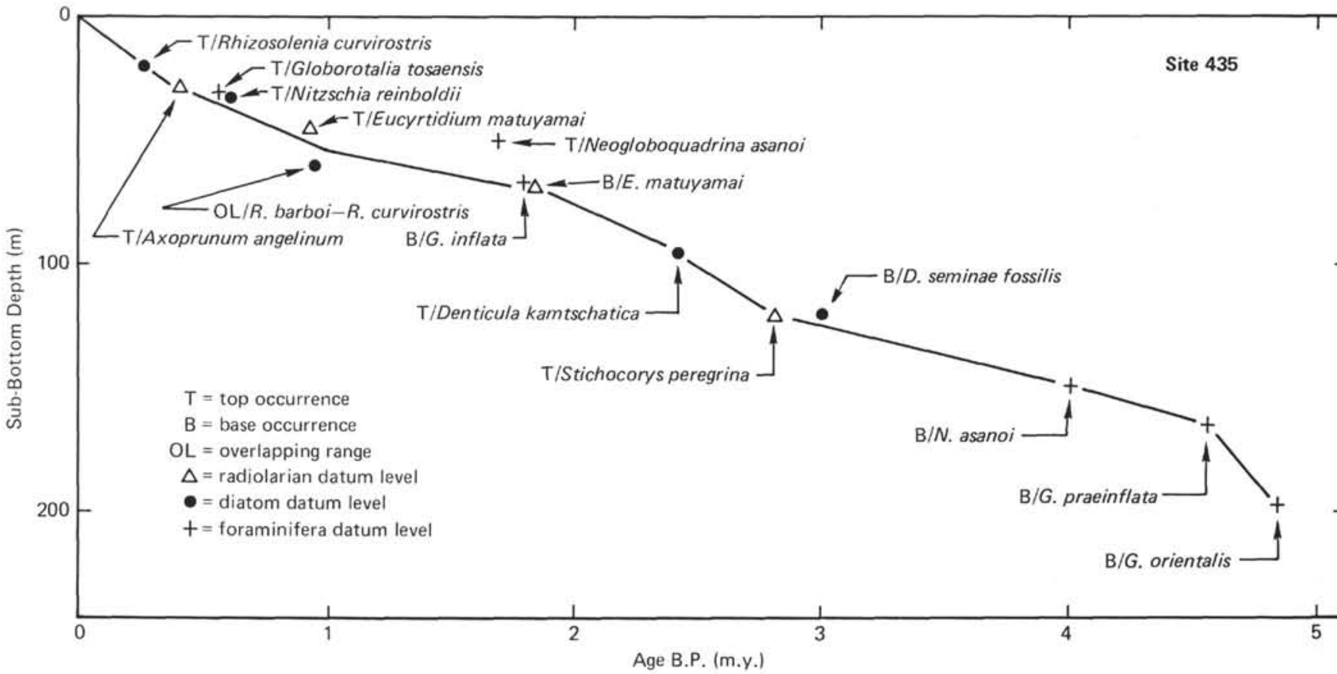


Figure 1. *Sediment age versus depth curve for Site 435.*

cave upward, can be traced on the seismic profiles (Figure 2) and may represent a plane of slippage. The small counterclockwise rotation viewed on the profile associated with this slumping may be the cause of the landward dip of the acoustical stratigraphy. With the apparent outcropping of layers suggested in the seismic profile, we expected that more recent sedimentary units might be missing at this site.

## OBJECTIVES

It was planned to drill 500 meters into the section in hopes of sampling both Neogene and Paleogene sequences. The main objective at this site was to drill the Paleogene and reveal any stratigraphic gaps, particularly at the end of the early Miocene. Such gaps are clearly visible in land sections on the Japanese Islands and are associated with the green tuff "orogeny" chiefly on the Sea of Japan side of Honshu, in the Fossa Magna area, and, in the western and northeastern parts of Hokkaido, the Takachiho orogeny in Kyushu (Shuto, 1963) and the Hidaka orogeny in Hokkaido (Hunahashi, 1957; Minato et al., 1965).

On the other hand, it was hoped that the section obtained at Site 435 would fill gaps in the biostratigraphy, particularly for foraminifers and calcareous nannofossils. If the site were above the calcite compensation depth (CCD), calcareous fossils should be found in abundance.

## OPERATIONS

Tropical storm Emma had forced us temporarily to abandon drilling efforts at Site 434. The storm's progress northward slowed and her future movements were unpredictable. In view of this uncertainty it seemed advisable to drill instead at a shallower site, since we could retrieve drill string quicker if the storm threatened again. Therefore we chose one of the preselected sites on the upper slope with a water depth of about 3400 meters. We dropped the beacon on the first pass over the site and Hole 435 was spud-in at 0400 hours, 19 September, with 3414 meters of drill pipe out. We drilled and cored continuously to 150.5 meters sub-bottom. Sixteen cores were obtained.

When Emma began to move our direction again, sea conditions forced us to abandon further drilling and to pull the pipe above the mudline. The *Glomar* weathered the storm with the pipe suspended below the ship. By noon on the 20th we were able to lower to the sea floor again to begin Hole 435A. This hole was spudded at 0450 hours, 21 September. After taking a mudline core we drilled with the center bit inserted to 149.5 meters and resumed continuous coring at that depth. The *Glomar Challenger* drilled and cored to 244.5 meters, obtaining 11 cores. At this point an unpredicted cold front passed through the area, bringing winds of 50 mph, and we were forced once more to foresake the drilling and retrieve the pipe. This concluded operations at Site 435.

## LITHOSTRATIGRAPHY

At Site 435 we distinguish only one lithologic unit, consisting of unconsolidated diatomaceous silty clay and muddy diatomaceous ooze with an extremely uniform grayish-olive to olive-gray color (Figure 3). Only the two lowermost cores are indurated (muddy diatomite). Volcanic ash layers and fragments of pumice occur throughout the section.

On the basis of a distinct change in the ratio of biogenic, terrigenous, and volcanic constituents we differentiated two sub-units: Sub-unit 1A, diatomaceous

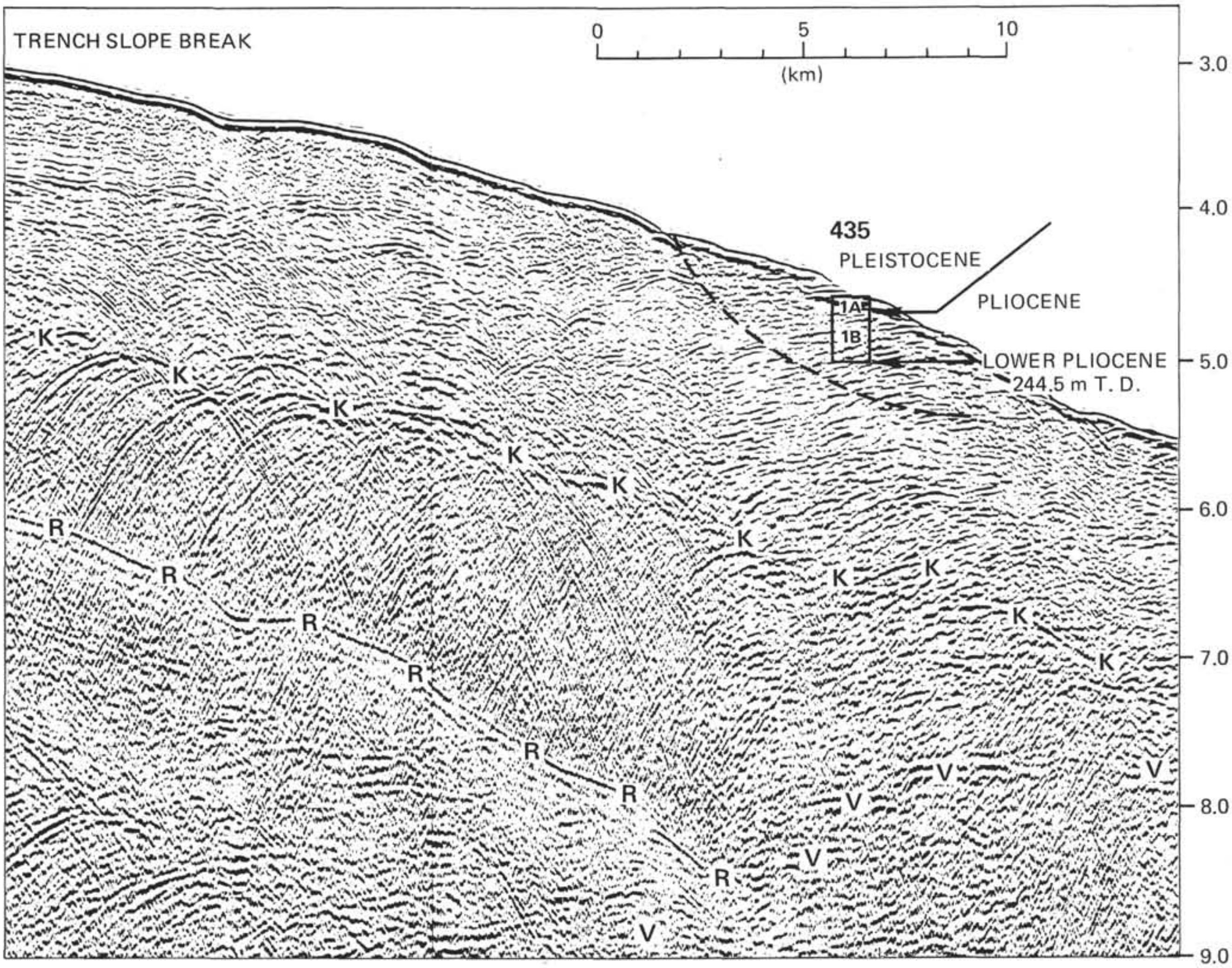


Figure 2. *Multichannel seismic profile across Site 435, provided by the courtesy of JNOC, with the lithologic section superimposed. "K" marks prominent reflector believed to be an erosional surface, "V" marks an undefined deeper reflector, and "R" marks the multiple of the bottom reflector.*

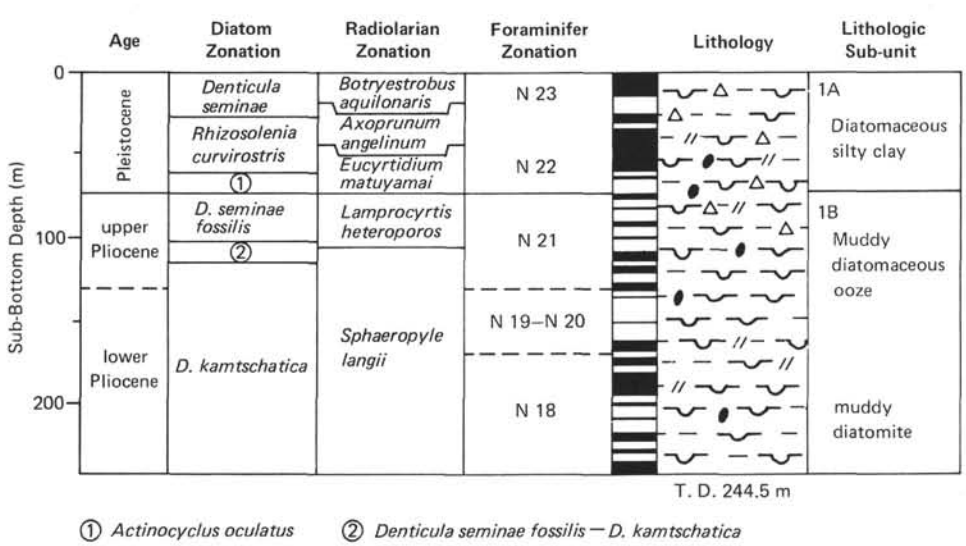


Figure 3. *Lithologic and biostratigraphic zonation of the sedimentary section at Site 435.*

silty clay, and Sub-unit 1B, muddy diatomaceous ooze and muddy diatomite.

*Unit 1, Sub-unit 1A (Cores 435-1-435-8, 0–74.5 m sub-bottom, Pleistocene)*

This sub-unit consists of very soft grayish-olive diatomaceous silty clay and diatomaceous clayey silt with intercalated ash layers and occasional pebble-sized pumice fragments. Clay and silt concentrations occur in about the same proportions; an additional sand content is less than 2 per cent.

Terrigenous and volcanic constituents make up about 75 to 85 per cent of the sub-unit and consist of clay minerals (45–55%), quartz (10–20%), feldspars (8–15%), and volcanic glass (5–15%). Heavy minerals, mainly pyroxene and hornblende, are relatively abundant (up to 5%). Biogenic constituents (15–25%) are predominantly diatoms; sponge spicules and radiolarians occur only in minor quantities. The abundance of carbonate sediments is very low or absent.

Ash layers (ash sands rich in plagioclase and pyroxene or vitric ash) occur mainly in the lower part of Sub-unit A (Cores 5–8); the thickest ash sand encountered in Core 8 measures 1.50 meters. We detected no sedimentary structures, probably as a result of drilling deformation.

*Unit 1, Sub-unit 1B (Cores 435-9 to 435A-11, 74.5–244.5 sub-bottom, Pleistocene–Pliocene.*

The sub-unit consists of very uniform unconsolidated grayish-olive to olive gray muddy diatomaceous ooze which in its lowermost part grades into slightly indurated muddy diatomite. Thin ash layers and pumice fragments occur throughout the sub-unit but are less abundant than in Sub-unit A.

The same constituents compose Sub-unit B as do Sub-unit A; however, biogenic constituents have increased considerably (30–50%) at the expense of terrigenous and volcanic materials (70–30%). Concentrations of clay minerals, quartz, feldspars, volcanic glass, and heavy minerals are thus considerably lower, but the ratios between these constituents remain about the same. Texturally the sediments from Cores 435-9 to 435A-6 are mainly clayey silts; below this they are silty clays. Sedimentary structures (mottling, burrows) were preserved only in the slightly indurated sediments of the two lowermost cores.

**Petrology of Erratic Pebbles**

Pebbles collected from 435 cores consist of dacite, andesite, metabasalt, tuff breccia, pumice, vitric tuff, granodiorite, metaquartzite, mudstone, wacke, and marlstone. Brief descriptions are given here on pebbles of igneous and metamorphic rocks.

Dacite pebbles are divided into two groups: augite-hypersthene dacite and an intensely silicified dacite. In the former, plagioclase phenocrysts (1–1.5 mm) are mostly altered or kaolinite and calcite. Phenocrystal augite (0.6–1 mm) is replaced either by calcite (Sample 435-5-3, 11–12 cm) or by epidote (Sample 435-7-1, 19–20 cm), and hypersthene is altered to chlorite. The groundmass composed of oligoclase laths (<0.06 mm) shows fluidal hyalopilitic texture.

Intensely silicified dacite is represented by Samples 435-8-2, 111–113 cm, and 435A-9-1, 19–20 cm. Phenocrystal plagioclase is completely replaced by sericite, hornblende by magnetite and chlorite, and pyroxene by chlorite. The groundmass is intensely silicified.

Of the andesite pebbles, Sample 435-7-1, 43–44 cm, is hypersthene andesite (Figure 4). Phenocrystal plagioclase (0.6–2.4 mm long) is euhedral and An 63 to 65 per cent in composition, occupying nearly 40 per cent of the rock. Some plagioclase phenocrysts show zonal structure. Hypersthene phenocrysts (about 0.3 mm) are scarce and are mostly altered to chlorite. The groundmass showing hyalopilitic texture is composed of plagioclase laths of less than 0.2 mm, slightly silicified glass and magnetite.

Sample 435A-8-1, 15–17 cm, is altered, quartz-bearing, hornblende–pyroxene andesite. Plagioclase phenocrysts (1–1.5 mm) are completely altered to sericite. Mafic minerals are partly altered to chlorite and partly to iron ores. Fresh apatite is well preserved. Euhedral magnetite cubes (about 0.15 mm) are scattered throughout. The groundmass composed of plagioclase laths, pyroxene, and magnetite is intensely silicified.

Metabasalt (Sample 435-7-1, 106–107 cm) is on the whole much altered and marked by many quartz veins. Phenocrysts (0.3 mm) composed of euhedral augite and plagioclase are rather scarce. The groundmass is composed of plagioclase, augite, and chlorite, showing hyalopilitic to intergranular texture. Anhedral secondary quartz is observed in the groundmass.

Granodiorite (Sample 435-14-1, 12–15 cm, Figure 5) shows granular texture consisting of plagioclase, biotite, hornblende, and quartz in that order of abundance. Plagioclase (about 1 mm long) is euhedral and An 43 per cent in composition. Hornblende and biotite are subhedral to anhedral.

Pumpellyite metaquartzite (Sample 435-14-1, 4–7 cm) consists of pumpellyite and quartz in almost equal amounts. The former occurs as patches and fillings

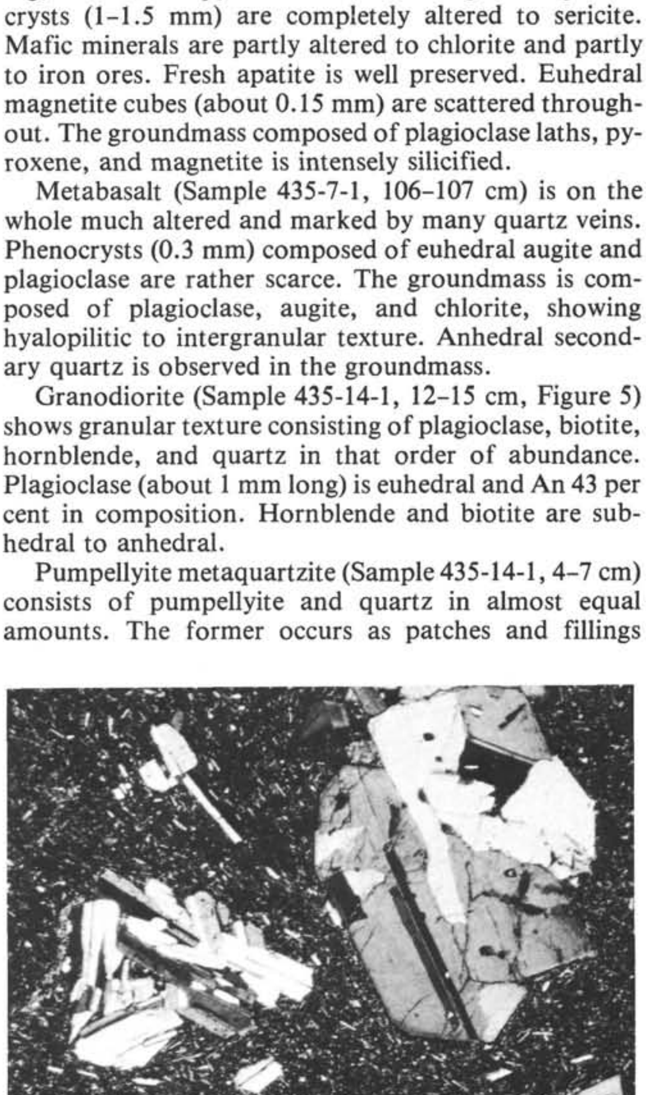

Figure 4. *Photomicrograph of hypersthene-andesite pebbles (Sample 435-7-1, 43–44 cm). Bar scale equals 0.1 mm.*

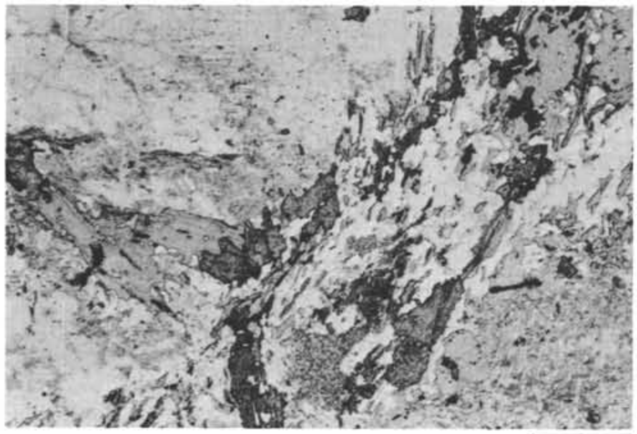

Figure 5. *Photomicrograph of granodiorite pebble (Sample 435-14-1, 12–15 cm). Bar scale equals 0.1 mm.*

along sutures of mylonitized quartz crystals. Optically it is yellow in color without distinct pleochroism and shows anomalous interference colors of bluish-gray to yellowish-gray. Quartz is made up of elongated polycrystalline showing intense undulatory extinction.

A pebble of tuff breccia (Sample 435-7-4, 9–10 cm) shows that andesite fragments (2 mm), euhedral quartz (about 0.5 mm), plagioclase (0.5–2 mm) phenocrysts, and pumice fragments (1 mm) are set in the vitric matrix. In andesite fragments plagioclase phenocrysts show zonal structure and are floated in the groundmass of hyalopilitic texture in which plagioclase laths are less than 0.1 mm. Quartz is embedded as corroded phenocrysts, though some are broken. Plagioclase phenocrysts show simple forms of twinning, some of which have zonal structure. The composition of plagioclase falls in An 50 per cent.

The last rock type of pebbles is tuffs, which include plagioclase-bearing vitric tuff (Samples 435-5-4, 40–42 cm, and 435A-2-1, 1–3 cm), hornblende-biotite-plagioclase vitric tuff (Sample 435-6-6, 31–33 cm), and biotite-plagioclase vitric tuff (Sample 435-6-1, 12-15).

## BIOSTRATIGRAPHY

### Introduction

Hole 435 produced a complete late Neogene sequence from early Pliocene to latest Pleistocene. Microfossil evidence identified the Pliocene/Pleistocene boundary as occurring between the Core 8 core catcher and Core 9, Section 3. Hole 435A mudline Core 1 was late Pleistocene, and Core 2 began in early Pliocene sediments with a biostratigraphic overlap with Core 16 of Hole 435. Core 435A-11,CC bottomed in early Pliocene sediments close to the Miocene/Pliocene boundary. It is noteworthy that all three microfossil groups (diatoms, radiolarians and foraminifers) showed consistent agreement in zonation, which suggests that the sediments were not greatly reworked or disturbed following deposition.

The mudstones produced excellent diatom floras and radiolarian faunas but only fair foraminiferal faunas, probably because of the proximity of the site to the CCD (3500 m). Microfossil evidence for slumping is weak, although the composition of the benthonic foraminiferal assemblages is more typical of middle bathyal biofacies in depths shallower than this site.

Because this site lies near the boundary of the warm, northward-flowing Kuroshio Current and the cold, southward-flowing Oyashio Current, microfossil assemblages recovered from it show a history of climatic deterioration throughout the late Pliocene and Quaternary.

### Diatoms

Abundant and well-preserved diatoms are present in all samples examined from Holes 435 and 435A. A composite section of the two holes displays a complete zonal sequence from late Pleistocene to early Pliocene (Figure 3). The Pliocene/Pleistocene boundary occurs within Core 9 of Hole 435, based on the correlation of the overlapping ranges of *Rhizosolenia curvirostris* and *R. barboi* to a level just above the Olduvai paleomagnetic event. The top of the *Denticula seminae fossilis–D. kamtschatica* Zone, located in Cores 11 and 12, is correlated to the Matuyama/Gauss Paleomagnetic Epoch boundary at 2.4 m.y.B.P., and the top of the *D. kamtschatica* Zone is in Core 14. The bottom of Hole 435 is within the *D. kamtschatica* Zone and is early Pliocene. Core 1 of Hole 435A, the mudline core, is within the Pleistocene *D. seminae* Zone, and Cores 2 through 11 are within the *D. kamtschatica* Zone of the early Pliocene.

### Radiolaria

Sediments containing few to common well-preserved radiolarians were recovered from Site 435. Cores 1 and 2 yielded *Botryostrobus aquilonaris* and *Lamprocyrtis haysi* but lack *Stylacontarium acquilonium* and *Axoprunum angelinum*; these cores belong to the *B. aquilonaris* Zone. In Cores 4 and 5, *A. angelinum* occurs, and *Eucyrtidium matuyamai* is found in Cores 6 to 8; these intervals are assigned to the *A. angelinum* Zone and *E. matuyamai* Zone, respectively. All cores below Core 9 produced *Sphaeropyle langii*, and the uppermost occurrence of *Stichocorys peregrina* in Core 12 permitted assignment of Cores 9 to 11 to the *Lamprocyrtis heteroporos* Zone and Cores 12 to 16 to the *S. langii* Zone. The uppermost core of 435A belongs to the *B. aquilonaris* Zone. Cores 2 through 11 were assigned to the *Sphaeropyle langii* Zone, based on occurrences of *S. peregrina* and *L. heteroporos.*

### Foraminifera

Although foraminifers occur continuously throughout Holes 435 and 435A, planktonic species useful for age assignment are only sporadically present. The approximate position of the Brunhes/Matuyama Paleomagnetic Epoch boundary is indicated by the top of the range of *Globorotalia tosaensis* in Core 4-2. The Pliocene/Pleistocene boundary is placed between Cores 8,CC and 9 on the basis of the first occurrences of *G. truncatulinoides* and *G. inflata* in Core 8 and the last occurrences of *Neogloboquadrina asanoi* and *G. orientalis* in Core 9. Most planktonic foraminifers in Hole

435A are poorly preserved, and only Core 6 yielded enough individuals to identify the middle to early Pliocene, including *Globoquadrina altispira*, very rare *Sphaeroidinellopsis*, and the first *Globorotalia orientalis*.

Coiling directions of *Neogloboquadrina pachyderma* show a progressive climatic cooling since the Pliocene/Pleistocene boundary. Very large percentages of sinistrally coiled *N. pachyderma* in Cores 4 and 5 suggest a more southerly confluence of the Kuroshio and Oyashio Currents than at present, followed by a gradual but slight warming to modern conditions in Cores 1 and 2.

The benthonic foraminiferal succession at Hole 435A indicates lower bathyal or abyssal depths at the bottom of this hole and a shallowing to middle bathyal depths by Core 7 in Hole 435, a rise of about 300 to 600 meters during the late Tertiary. The top of the continuous range of the agglutinated species *Martinottiella* occurs in Core 13 of Hole 435 near the early/late Pliocene boundary, although several individuals occur near the Pliocene/Pleistocene boundary.

## PHYSICAL PROPERTIES

At Site 435 we determined compressional sound velocity, wet bulk density, water content, porosity, undrained shear strength, and thermal conductivity. A summary of the shipboard techniques for determining these parameters is included in the Introduction to this volume, and a more detailed discussion (with the exception of thermal conductivity) is presented by Boyce (1976). Physical properties values for Holes 435 and 435A are considered together.

The condition of the cores allowed frequent determination of velocity and of wet bulk density with the GRAPE; gravimetric techniques gave good determinations of density, porosity, and water content between 0 and 65 meters sub-bottom (Cores 1-7, Hole 435, and Core 1, Hole 435A), where the sediment was soft and the syringe technique worked well, and below about 150 meters (Core 2, Hole 435A), where the sediment was lithified enough to allow good sampling by extracting a chunk of the core material. Determinations in the interval between 65 and 150 meters were affected by the fractured and broken nature of the sediment, which resulted in questionable volumes in syringe samples and were too soft for use of the chunk methods.

Data for physical properties are presented in the Appendix to this volume and are plotted on the Site 435 Site Summary Chart (back pocket, this volume). Table 1 shows the averages of the measured values of velocity, density, and porosity for each lithologic unit.

TABLE 1
Correlation of Physical Property Data with Lithology at Site 435

| Lithologic Sub-unit | Depth Interval (m) | Interval Velocity (km/s) | Density ($Mg/m^3$) | Porosity (%) | Cumulative Two-Way Travel Time (s) |
|---|---|---|---|---|---|
| 1A | 0–74.5 | 1.55 ± 0.02 | 1.45 ± 0.26 | 66 ± 5 | 0.096 |
| 1B | 74.5–244.5 | 1.60 ± 0.07 | 1.38 ± 0.13 | 67 ± 7 | 0.309 |

Note: Values for velocity, density and porosity are averages of measured values over each lithologic unit. The two-way travel time is calculated from the interval velocity and indicates the seismic reflection time to the base of the lithologic unit.

### Velocity

Between 0 and 200 meters sub-bottom depth, velocity averages 1.55 cm/s, with two zones of slightly higher velocity at 80 to 95 meters (1.60 km/s) and 153 to 190 meters (about 1.62 km/s). Below 200 meters, velocity increases to a maximum of about 1.65 km/s. There is a slight but noticeable cyclic variation of velocities between 44 and 66 meters—for example, between 44 and 48.5 meters, 50 and 59.5 meters, and 61.5 and 66 meters. Although changes in velocity are close to the resolving power of the velocity measurements, these cycles cross core boundaries and may indicate slight changes in compaction, lithification, or lithology. The presence of these cycles is supported by density and water content data. The high-velocity zone between 80 and 95 meters corresponds to the ash-rich and sandy lower portion of Sub-unit 1A and also correlates with the first appearance of gas pressure and methane in the cores. The higher velocities of about 1.65 km/s between 200 and 240 meters probably indicate increased consolidation of the sediments. In general, the relatively uniform velocity increase with depth suggests a normal consolidation process within the cored sediments.

### Wet Bulk Density

Continuous GRAPE wet bulk density data agree moderately well with values determined on samples taken by syringe and chunk method. Two-minute GRAPE data generally indicate a greater density. Although the scatter is rather large, several trends are clear. Between 0 and 75 meters (Sub-unit 1A) average wet bulk density ranges between about 1.3 to 1.6 $Mg/m^3$, averaging 1.45 $Mg/m^3$. Below 75 meters the measured value of density is anomalously low compared to the upper part of the hole, averaging about 1.38 $Mg/m^3$, except between 180 and 200 meters, where the density is similar to that observed in the top 75 meters (about 1.46 $Mg/m^3$). The upper boundary of this low density zone generally corresponds to the zone with greatest gas pressure. Most of the cores are crumbly and cracked, probably partly because of degassing, expansion, and splitting during core retrieval. This condition could lead to determinations that are low compared to *in situ* conditions for the syringe data because of the inaccuracy of volume measurement in the continuous GRAPE data due to voids within the sediment.

### Porosity and Water Content

In general, the cored sediment has from 60 per cent to 75 per cent porosity, averaging about 66 per cent throughout the hole. Deviations from this average are observed between 50 and 100 meters, where porosity and water content are slightly lower than the average, and between 100 and 160 meters, where measured values are somewhat greater. The somewhat higher density between 180 and 200 meters corresponds with decreases in both porosity and water content, suggesting somewhat greater compaction effects within this zone. In general, porosity and water content changes correspond to changes in the density and are consistent with relatively unconsolidated marine sediments.

### Shear Strength

Shear strength determinations were all made with the CL-600 Torvane apparatus. In general, the shear strength increases from about 9 kPa at the surface to 60 kPa at a sub-bottom depth of about 65 meters, which is compatible with increased compaction due to burial. Below this depth the sediment is crumbly and cracked and the shear strength decreases. Vane shear tests were terminated below 173 meters when insertion or rotation caused fracturing of the material. A plot of the shear strength values is included in the chapter by Carson and Bruns (this volume).

### Thermal Conductivity

Conductivity measurements were made with the Showa Denko QTM instrument and the needle probe instrument on each core section when the condition of the sample allowed a valid observation. The results are plotted versus depth in Figure 6.

The QTM results show considerable scatter in values within a single core (a standard deviation of 7-10% is typical). Below 70 meters, most of the individual QTM values are higher than the needle probe results in the same core. In the harder materials deep in the hole, some of the very low conductivity values revealed by the needle probe may have been caused by fractured material.

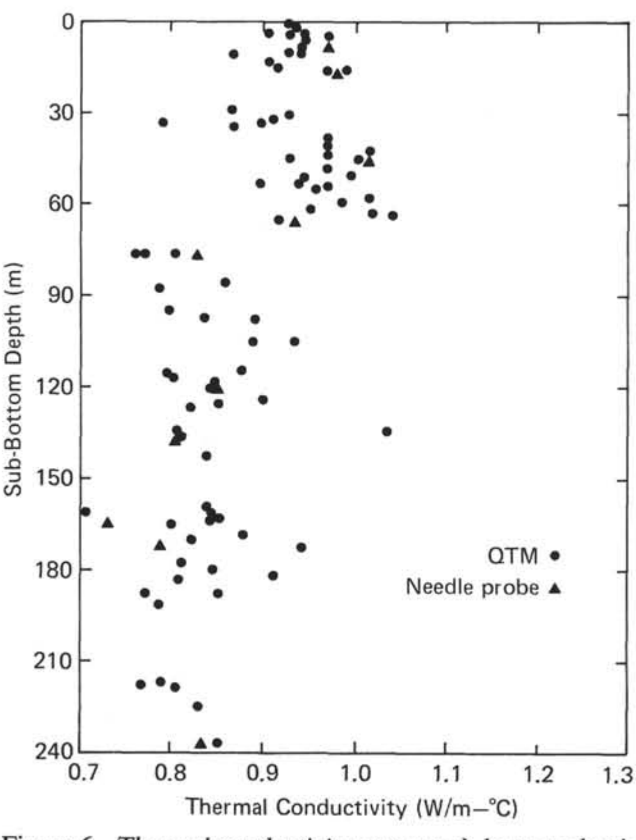


Figure 6. *Thermal conductivity versus sub-bottom depth, Site 435.*

Taken at face value, the data show conductivity to be relatively high, about 0.94 in the upper 70 meters; at greater depth conductivity decreases abruptly to about 0.82. Because the composition of sediment in these holes is so uniform, this change in conductivity is not easily understandable. The values in the lower part of the section are more typical of diatomaceous oozes and muds, whereas those in the upper part of the section are more typical of coarser-grained sediments such as terrigenous deposits (Langseth and von Herzen, 1971).

### Discussion

Because of the generally good recovery, it was possible to make frequent determinations of the physical properties at Site 435. Variations in velocity, density, and water content in the upper 70 meters suggest some cyclic lithologic variations. Minor changes in velocity and density also occur in the ash-rich and sandy lower portion of Sub-unit 1A.

Figure 7 shows plots testing the correlation of thermal conductivity with water content, wet bulk density, and acoustic velocity. The range of values is very small and the scatter of measurements too large for very valid tests. With the exception of a few values, there is a direct correlation of conductivity with bulk density and an inverse correlation with water content. This dependence of conductivity on water content and bulk density is usual in marine sediments and indicates internal consistency in the data set. In fact, values that lie well off the main trends are suspect.

Earlier in this section it was pointed out that bulk densities and water content may have been influenced by gas-induced dilatation of the sediments after they were retrieved. This dilatation would probably decrease the thermal conductivity as well. If this is the case, the decrease in conductivity with depth may be an artifact and not occur *in situ*. Such gas-induced changes in physical properties can produce serious errors if these properties are then used to infer heat flow values, subsurface temperatures, and compaction effects. The inverse correlation of conductivity with seismic velocity vaguely suggested by the results is probably produced by the same dilatation effect.

Table 1 presents the lithologic units and average velocity values used to calculate two-way reflection times to lithologic boundaries.

## INORGANIC GEOCHEMISTRY

Levels of sediment calcium carbonate; organic carbon and interstitial water salinity; chlorinity; calcium and magnesium content; and alkalinity are shown in Figure 8. It can be seen that the shallowest interstitial water sample, 435-1-2, 140-150 cm, has levels of all species which are approximately those of surface sea water. At 50 meters, the alkalinity increases to about 14 times its sea water value and then levels off to 20 meq/1

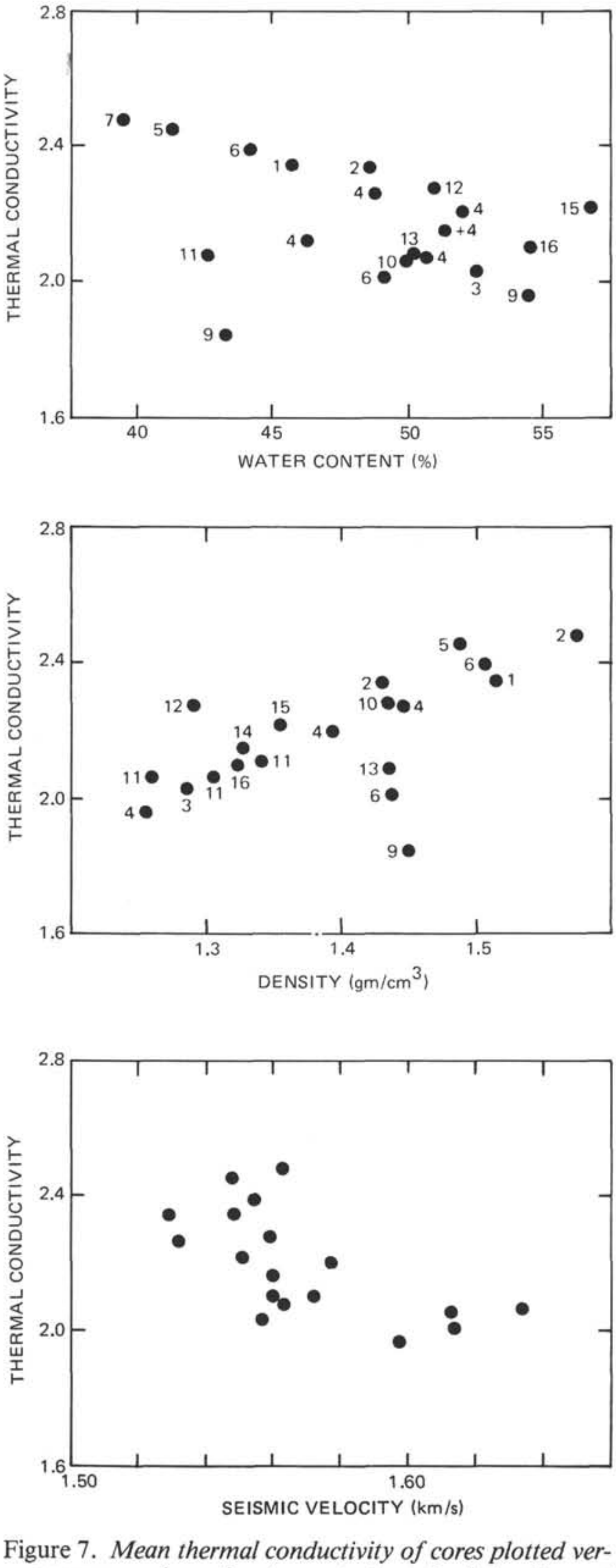


Figure 7. *Mean thermal conductivity of cores plotted versus mean values of water content, wet bulk density, and seismic velocity. In the upper two plots the numbers of the cores are plotted next to the data points. Thermal conductivity figures = millicalories/cm-s-°C.*

(about 9 times the surface sea water value) throughout the rest of the hole. Concurrently, calcium and magnesium both decrease at 50 meters (by 70 mmoles/l and 14 mmoles/l, respectively, from the surface sea water value) and then remain approximately constant to hole bottom. Chlorinity and salinity both show a small but real decrease with depth. These changes indicate dilution by fresh water with depth from some unknown source. Similar decreases (typically 5-10%) have been noted previously, particularly in rapidly deposited organic-rich sediments typical of continental margin areas and rapidly filling ocean trenches (Sayles and Manheim, 1975). Sources of fresh water suggested by Sayles and Manheim (1975) for other DSDP sites include (1) organic matter oxidation (generally quantitatively insufficient to account for the observed changes); (2) fresh water flowing in the subsurface from land; and (3) expulsion of water from clays — particularly montmorillonite — on burial. Clay alteration is a possible source at this site since, although freshening is not observed at 50 meters, it is evident at 100 meters (Figure 8).

These sediments generally resemble those from Holes 434 and 434B, with some interesting exceptions. Below the surface, interstitial water alkalinities are a little higher than those in Holes 434 and 434B. In addition, no $H_2S$ odor was detected in any of the cores, although evidence of black iron sulfide minerals was seen throughout Hole 435. The absence of $H_2S$ cannot be due to a higher concentration of iron at this site, because mineral iron concentrations were about the same in holes at Sites 435 and 434 (see Kurnosov et al. and Murdmaa et al., both in this volume). The higher alkalinity in Hole 435 may account for the difference.

Methane was found throughout the hole. It is assumed to be biogenic because of low $C_1/C_2$ ratios, $C_{13}$ values of -77.9 to -83.75, and high interstitial water alkalinities known to accompany activities of sulfate-reducing and methane-producing bacteria. For further discussion see the Geochemistry section for Site 434 and Whelan and Sato, both in this volume. Organic carbon levels were 0.44 to 1.2 per cent — adequate to support microbial groups.

Low shipboard pyrolysis-fluorescence values from this material (see Figure 9 and Appendix I) indicated that this material showed little potential for petroleum generation. (For a discussion of pyrolysis-fluorescence technique, see Site 434 site chapter.) The low values obtained are high enough to suggest this carbon is not reworked and might be adequate as microbial food.

Other geochemical measurements carried out on these sediments include determination of lead, tin, copper, nickel, zinc, silver, boron, iron, manganese, titanium, and both amorphous and clay $SiO_2$ (see Kurnosov et al. and Murdmaa et al., both in this volume).

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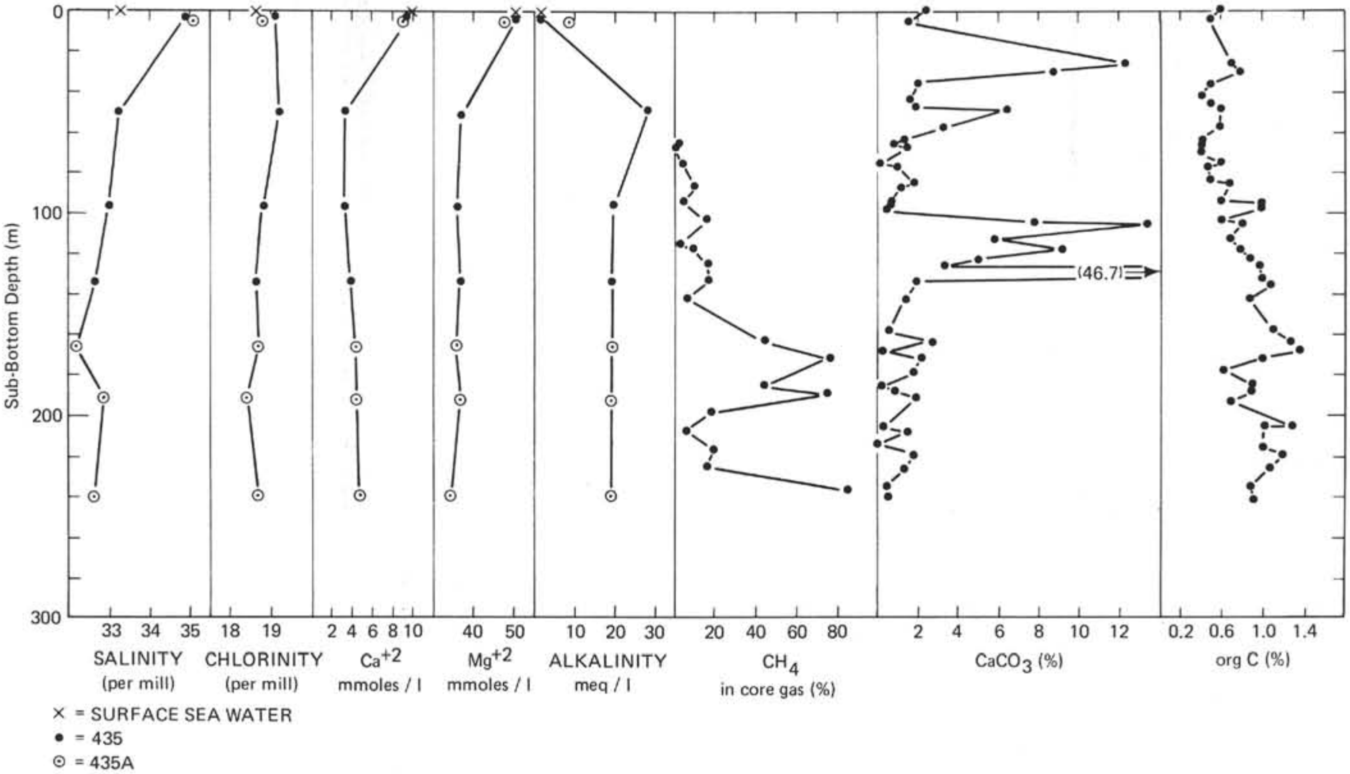



Figure 8. *Holes 435 and 435A: interstitial water analysis (salinity, chlorinity, alkalinity, and calcium and magnesium). Percentage of $CH_4$ in core gas and percentages of calcium carbonate and organic carbon in sediments.*

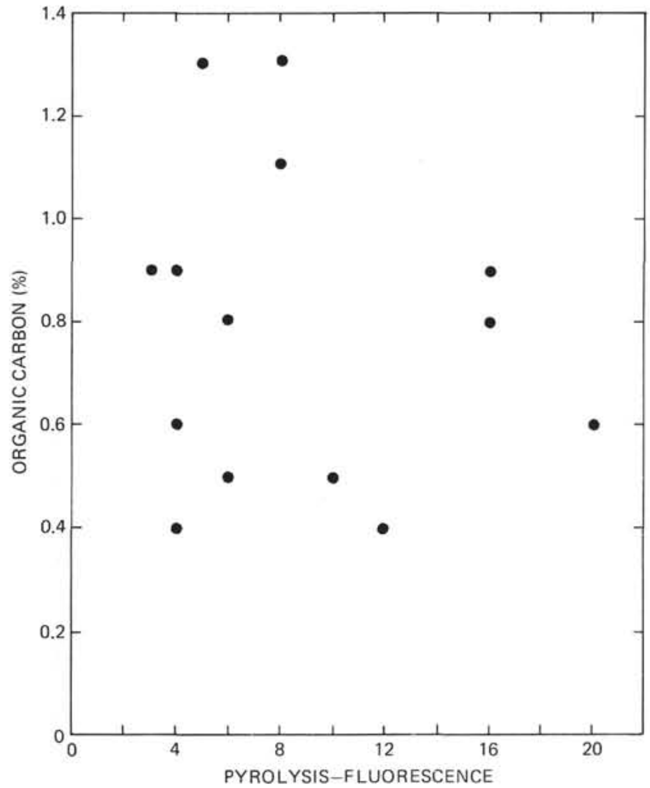
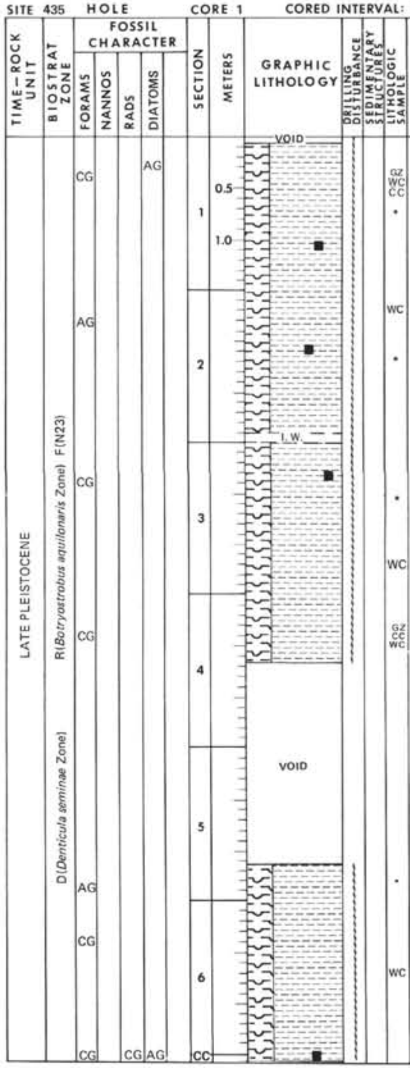



Figure 9. *Organic carbon pyrolysis-fluorescence versus organic carbon content for Holes 435 and 435A.*

SITE 435 HOLE CORE 1 CORED INTERVAL: 0.0-8.0 m




## LITHOLOGIC DESCRIPTION

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), very deformed with scattered light green pumice fragments (■) and occasional dark olive green irregular zones rich in vitric ash. Some dusky blue green mottled areas are slightly richer in sand than the major lithology.

**CARBON-CARBONATE (%)**

| | 1-40 | 4-40 |
|---|---|---|
| Carbonate: | 2.0 | 1.0 |
| Organic carbon: | 0.6 | 0.5 |

**CARBONATE BOMB:** 2%, 1-119

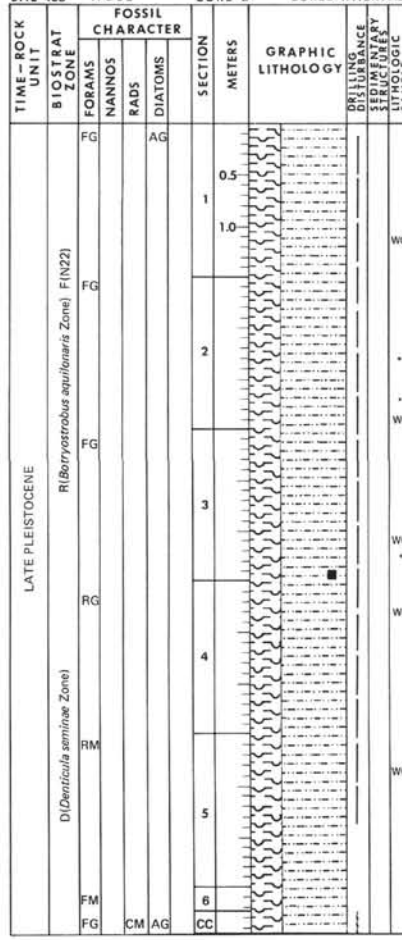
**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-27 | 16 | 54 | 30 |
| 4-27 | 8 | 54 | 38 |

**SMEAR SLIDES (%)**

| | 1-75<br>2-75<br>3-60<br>5-130 |
|---|---|
| Quartz | 5 |
| Feldspar | 10 |
| Mica | TR |
| Heavy mins. | TR |
| Clay | 50 |
| Volcanic glass | 5 |
| Pyrite | TR |
| Foraminifera | TR |
| Diatoms | 25 |
| Radiolarians | TR |
| Sponge spicules | 5 |

SITE 435 HOLE CORE 2 CORED INTERVAL: 8.0-17.5 m




## LITHOLOGIC DESCRIPTION

10Y 4/2

**MUDDY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), moderately deformed with occasional light green pumice fragments (pebble size ■) and deformed silty-sandy horizons (for example, Section 3, 125-130 cm) that are dark olive green.

**CARBONATE BOMB:** 0%, CC-9

**SMEAR SLIDES (%)**

| | 2-85 | 2-122 | 3-129 |
|---|---|---|---|
| Quartz | 4 | 3 | TR |
| Feldspar | 11 | 7 | 25 |
| Mica | 2 | 2 | — |
| Heavy mins. | 3 | 1 | 8 |
| Clay | 46 | 53 | 15 |
| Volcanic glass | 3 | 3 | 20 |
| Rock frags. | — | — | 22 |
| Pyrite | 1 | 1 | TR |
| Carb. unspec. | TR | — | 3 |
| Foraminifera | — | — | TR |
| Diatoms | 25 | 30 | 10 |
| Radiolarians | 2 | TR | TR |
| Sponge spicules | 3 | 2 | 2 |
| Silicoflagellates | TR | TR | — |

Site 435, Core 3, Cored Interval: 17.5-27.0 m, **NO RECOVERY**

## SITE 435 HOLE CORE 4 CORED INTERVAL: 27.0-36.5 m

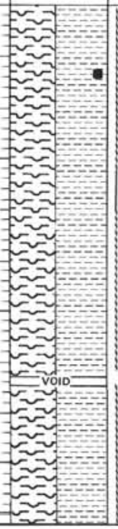
TIME-ROCK UNIT: LATE PLEISTOCENE

BIOSTRAT ZONE: F(N22); D(*Rhizosolenia curvirostris* Zone) R(*Axoprunum angelinum* Zone)

FOSSIL CHARACTER (FORAMS / NANNOS / RADS / DIATOMS): AG; AG; AG; FG; FG CG AG

SECTION: 1, 2, 3, 4, CC — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:




LITHOLOGIC SAMPLE: GZ CC WC; •; •WC; •; WC GZ CC

### LITHOLOGIC DESCRIPTION

mottled 10Y 4/2 and 10Y 5/2; 10Y 4/2; mottled 10Y 4/2 and 10Y 5/2; 10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** mottled greyish olive (10Y 4/2) to light greyish olive (10Y 5/2), very deformed with occasional pebble-size light green pumice fragments (■) and darker olive sandy patches (for example, Section 2, 118-123 cm).

A nannofossil-rich zone is near Section 2, 25 cm, but calcareous nannos are uncommon for the remainder of the core.

**CARBON-CARBONATE (%)**

| | 1-52 | 3-52 |
|---|---|---|
| Carbonate: | 12.0 | 9.0 |
| Organic carbon: | 0.7 | 0.8 |

**CARBONATE BOMB:** 12%, 2-25; 3%, CC-9

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-50 | 7 | 50 | 43 |
| 3-50 | 7 | 52 | 41 |

**SMEAR SLIDES (%)**

| | 2-54 | 2-25 | 2-121 |
|---|---|---|---|
| Quartz | 2 | 2 | — |
| Feldspar | 10 | 5 | 20 |
| Mica | 1 | TR | TR |
| Heavy mins. | TR | TR | 3 |
| Clay | 40 | 27 | 23 |
| Rock frags. | — | — | 20 |
| Volcanic glass | TR | 5 | 5 |
| Glauconite | — | — | 2 |
| Carb. unspec. | 2 | 5 | — |
| Foraminifera | TR | — | — |
| Calc. nannos. | — | 20 | TR |
| Diatoms | 30 | 20 | 10 |
| Radiolarians | 2 | 2 | TR |
| Sponge spicules | 5 | 3 | 2 |
| Silicoflagellates | TR | — | — |
| Mafics | — | — | 15 |

## SITE 435 HOLE CORE 5 CORED INTERVAL: 36.5-46.0 m

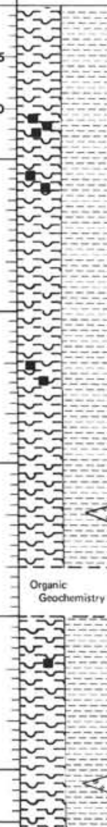
TIME-ROCK UNIT: PLEISTOCENE

BIOSTRAT ZONE: F(N22); D(*Rhizosolenia curvirostris* Zone) R(*Axoprunum angelinum* Zone)

FOSSIL CHARACTER (FORAMS / NANNOS / RADS / DIATOMS): RM; FG; CG; CG; RM; FG; RG CM AG

SECTION: 1, 2, 3, 4, 5, 6, CC — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:




LITHOLOGIC SAMPLE: CC GZ; WC; •; WC •; WC •; GZ •; CC; WC; • WC

### LITHOLOGIC DESCRIPTION

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), very deformed with pale green ash-rich zones (for example Section 4, 45-60 cm and Section 6, 10-20 cm), sandy zones (for example Section 1, 110-111 cm) and scattered pumice and dacite fragments.

**CARBON-CARBONATE (%)**

| | 1-20 | 5-20 |
|---|---|---|
| Carbonate: | 2.0 | 2.0 |
| Organic carbon: | 0.5 | 0.4 |

**CARBONATE BOMB:** 2%, CC-15

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-30 | 9 | 46 | 45 |
| 4-30 | 14 | 45 | 41 |

**SMEAR SLIDES (%)**

| | 2-80 4-22 | 4-58† 6-15† | 1-110† |
|---|---|---|---|
| Quartz | 2 | — | 1 |
| Feldspar | 5 | 15 | 15 |
| Mica | TR | TR | TR |
| Heavy mins. | TR | 10 | 6 |
| Clay | 55 | 15 | 28 |
| Volcanic glass | 2 | 60 | 5 |
| Glauconite | — | — | 2 |
| Pyrite | 1 | 5 | — |
| Foraminifera | — | — | — |
| Carb. unspec. | TR | — | — |
| Calc. nannos. | TR | — | TR |
| Diatoms | 30 | 5 | 25 |
| Radiolarians | 2 | TR | 1 |
| Sponge spicules | 5 | TR | 2 |
| Silicoflagellates | 1 | — | TR |
| Lithic fragments | — | — | 15 |

SITE 435 HOLE CORE 6 CORED INTERVAL: 46.0-55.5 m

TIME-ROCK UNIT | BIOSTRAT ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE

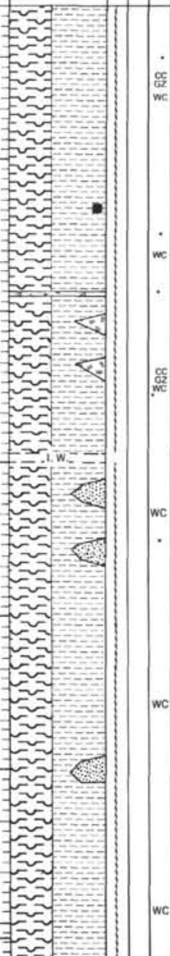
PLEISTOCENE

F(N22)

D(*Rhizosolenia curvirostris* Zone) R(*Eucyrtidium matuyamai* Zone)

FM
RM
RM
FM
RP
FG
RG
RM CM CG

1 0.5 1.0
2
3
4
5
6
7
CC




10Y 4/2

## LITHOLOGIC DESCRIPTION

**CLAYEY VITRIC DIATOMACEOUS OOZE:** greyish olive (10Y 4/2) to light olive grey (5Y 3/2), very deformed with scattered pale green ash rich zones, darker green sandy areas and occasional pumice fragments (■). Ash content appears slightly greater than previous cores. Heavy minerals are significant in sandy zones.

**CARBON-CARBONATE (%)**

| | 1-70 | 3-70 |
|---|---|---|
| Carbonate: | 2.0 | 6.0 |
| Organic carbon: | 0.5 | 0.6 |

**CARBONATE BOMB:** 0%, CC-25

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-71 | 9 | 44 | 47 |
| 3-71 | 10 | 38 | 52 |

**SMEAR SLIDES (%)**

| | 1-60 2-80 | 2-133† 2-72† | 4-81† |
|---|---|---|---|
| Quartz | 2 | — | 2 |
| Feldspar | 10 | 5-20 | 15 |
| Mica | TR | — | — |
| Heavy mins. | TR | 2 | 60 |
| Clay | 40 | TR | — |
| Volcanic glass | 10 | 65-95 | 15 |
| Pyrite | 2 | 0-10 | TR |
| Carb. unspec. | TR | — | — |
| Diatoms | 30 | — | 5 |
| Radiolarians | 2 | — | TR |
| Sponge spicules | 5 | — | 2 |
| Silicoflagellates | TR | — | — |
| Lithic fragments | — | 0- 5 | — |

SITE 435 HOLE CORE 7 CORED INTERVAL: 55.5-65.0 m

TIME-ROCK UNIT | BIOSTRAT ZONE | FOSSIL CHARACTER: FORAMS, NANNOS, RADS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE

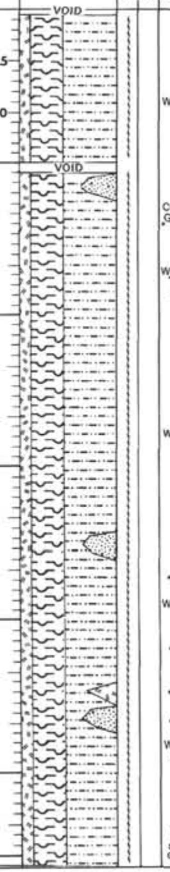
PLEISTOCENE

F(N22)

D(*Rhizosplenia curvirostris* Zone) R(*Eucyrtidium matuyamai* Zone)

RM
RM
RP
RM
RM
RM
RM FM AG

1 0.5 1.0
2
3
4
5
6
CC




10Y 4/2

5Y 3/2

10Y 4/2

## LITHOLOGIC DESCRIPTION

**VITRIC DIATOMACEOUS SILTY CLAY:** greyish olive (10Y 4/2) to olive grey, very deformed with patches of dark olive silty sand and light bluish green muddy ash. Significant pyrite in sandy patches. (Patchy zones are probably horizons disturbed by drilling.)

**CARBON-CARBONATE (%)**

| | 2-48 | 6-70 |
|---|---|---|
| Carbonate: | 3.0 | 1.0 |
| Organic carbon: | 0.6 | 0.4 |

**CARBONATE BOMB:** 1%, CC-20

**GRAIN SIZE (%)**

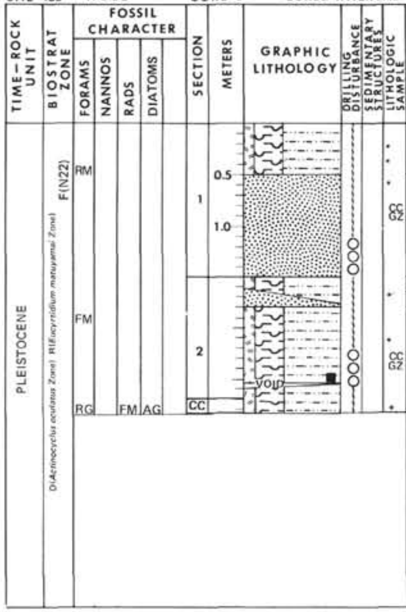
| | Sand | Silt | Clay |
|---|---|---|---|
| 2-50 | 9 | 42 | 49 |
| 6-68 | 12 | 38 | 50 |

**SMEAR SLIDES (%)**

| | 2-60 4-110 5-28 5-100 6-50 CC-5 | 5-70† | 2-118† 5-137† |
|---|---|---|---|
| Quartz | 2 | 2 | — |
| Feldspar | 15 | 15 | 35 |
| Mica | TR | — | — |
| Clay | 45 | — | — |
| Volcanic glass | 15 | 70 | — |
| Glauconite | TR | — | — |
| Pyrite | 1 | 1 | 5 |
| Carb. unspec. | TR | — | — |
| Foraminifera | — | — | — |
| Calc. nannos | — | — | — |
| Diatoms | 20 | — | TR |
| Radiolarians | 1 | — | — |
| Sponge spicules | 5 | — | — |
| Silicoflagellates | — | — | — |
| Heavy mins. | — | — | 45 |

(Note: abun. pyrite in 5-137 is not noted above.)

SITE 435 HOLE CORE 8 CORED INTERVAL: 65.0-74.5 m




## LITHOLOGIC DESCRIPTION

5GY 3/2

**VITRIC DIATOMACEOUS SILTY CLAY:** 0-52 cm, 150-170 cm, 180-290 cm. Greyish olive green (5GY 3/2), very deformed, contact with underlying sand appears gradational perhaps due to drilling.. No distinct ash zones.

5GY 4/1

**PYROXENE-PLAGIOCLASE SAND:** 52-150 cm, 162-180 cm. Dark greenish grey (5GY 4/1), very deformed with no internal structure. Hornblende also occurs as detrital grains.

5GY 3/2

5GY 4/1

5GY 3/2

**CARBON-CARBONATE (%)**

| | 1-82 | 2-79 |
|---|---|---|
| Carbonate: | 1.0 | 2.0 |
| Organic carbon: | 0.4 | 0.4 |

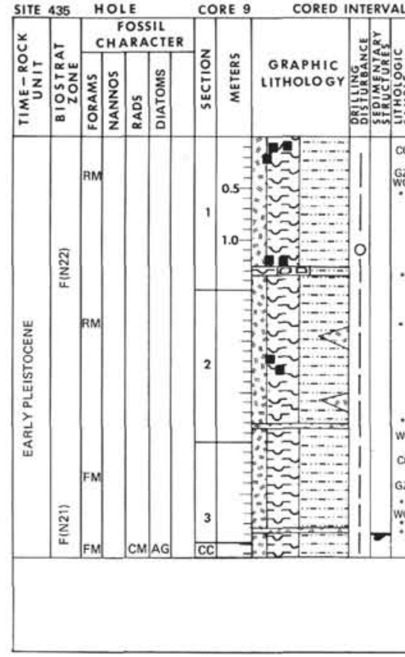
**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 2-80 | 23 | 43 | 34 |

**SMEAR SLIDES (%)**

| | 1-22<br>1-36<br>2-60<br>CC-6 | 1-60 |
|---|---|---|
| Quartz | 2 | — |
| Feldspar | 20 | 45-50 |
| Mica | — | — |
| Heavy mins. | — | 15-20 |
| Clay | 50 | TR |
| Volcanic glass | 5-10 | 10 |
| Glauconite | TR | — |
| Pyrite | 2 | TR |
| Diatoms | 10-15 | 3 |
| Radiolarians | 1 | 1 |
| Sponge spicules | 5 | 1 |
| Silicoflagellates | — | — |
| Rock fragments | — | 15-20 |

SITE 435 HOLE CORE 9 CORED INTERVAL: 74.5-84.0 m




## LITHOLOGIC DESCRIPTION

5GY 3/2

**VITRIC SPICULAR DIATOMACEOUS SILTY CLAY:** 0-128 cm and 136-414 cm. Greyish olive green (5G 3/2) to dusky yellow green (5GY 5/2) with irregular patches of very light grey (N8) and light grey (N7) ash, greyish black to greenish black (N2 to 5GY 2/1) diatom mud and scattered pumice and lithic fragments.

A relatively undisturbed diatomaceous calcareous clay, dusky yellow green (5GY 5/2) is at 128 to 136 cm. Vitric ash, greenish grey (5GY 5/1), is at 282 to 284 cm and 387 to 390 cm and shows only slight deformation. The latter ash bed shows apparent load structures and a lower pyrite-rich zone.

**CARBON-CARBONATE (%)**

| | 1-17 | 3-17 |
|---|---|---|
| Carbonate: | 0.0. | 1.0 |
| Organic carbon: | 0.6 | 0.5 |

5GY 5/2

**CARBONATE BOMB:** 0%, CC-2

**GRAIN SIZE (%)**

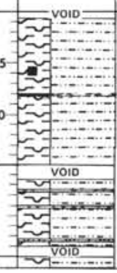
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-41 | 27 | 42 | 31 |
| 3-41 | 6 | 40 | 54 |

**SMEAR SLIDES (%)**

| | 3-60<br>2-35<br>1-51 | 2-118†<br>3-87†<br>3-90† | 1-30 |
|---|---|---|---|
| Quartz | 2 | — | 2 |
| Feldspar | 15 | 30 | 3 |
| Heavy mins. | — | 5 | — |
| Clay | 45 | 5 | 40 |
| Volcanic glass | 10 | 30-80 | — |
| Pyrite | 1 | 3-20 | TR |
| Carb. unspec. | — | — | 30 |
| Diatoms | 15 | 0- 5 | 10 |
| Radiolarians | TR | TR | — |
| Sponge spicules | 12 | TR | 5 |
| Rock fragments | — | 0-10 | — |

SITE 435 HOLE CORE 10 CORED INTERVAL: 84.0-93.5 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS |
|---|---|---|---|---|---|---|---|
| LATE PLIOCENE | F(N21) D(Denticula seminae fossilis Zone) R(Lamprocyrtis heteroporos Zone) | FM | | | | 1 | 0.5, 1.0 |
| | | FG | | | | 2 | |
| | | FM | | CG | AG | CC | |




GZ • CC — 10Y 4/2; • — 5Y 5/2; WC • — 5GY 3/2; • GZ CC WC • • — 5GY 5/2; • — 10Y 4/2

## LITHOLOGIC DESCRIPTION

**DIATOMACEOUS SILTY CLAY:** variable color; ranges from greyish olive (10Y 4/2) to dusky yellow green (5GY 5/2), only slightly deformed with several light or greyish olive green((5GY 3/2) ash layers, some greyish black (N2) sand (for example, at 221-223 cm) and a few scattered pumice fragments.

**CARBON-CARBONATE (%)**

| | 1-48 | 2-48 |
|---|---|---|
| Carbonate: | 2.0 | 1.0 |
| Organic carbon: | 0.5 | 0.7 |

**CARBONATE BOMB:** 0%, CC-7

**GRAIN SIZE (%)**

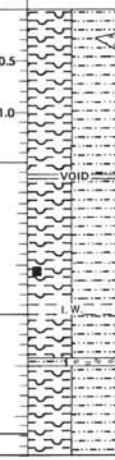
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-45 | 7 | 49 | 44 |
| 2-45 | 1 | 46 | 53 |

**SMEAR SLIDES (%)**

| | 1-45 1-93 1-126 2-67 2-79 CC-13 | 2-30† | 2-79† |
|---|---|---|---|
| Quartz | 2 | — | — |
| Feldspar | 15 | 10 | 20 |
| Heavy mins. | — | TR | 5 |
| Clay | 55 | — | 15 |
| Volcanic glass | 5 | 90 | 10 |
| Glauconite | TR | — | — |
| Pyrite | 1 | TR | 5 |
| Diatoms | 15 | — | 20 |
| Radiolarians | 1 | — | TR |
| Sponge spicules | 10-15 | — | 5 |
| Silicoflagellates | TR | — | — |
| Rock fragments | — | — | 20 |

SITE 435 HOLE CORE 11 CORED INTERVAL: 93.5-103.0 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS |
|---|---|---|---|---|---|---|---|
| LATE PLIOCENE | F(N21) D(Denticula seminae fossilis Zone) R(Lamprocyrtis heteroporos Zone) | | | RM | | 1 | 0.5, 1.0 |
| | | | | RM | | 2 | |
| | | | | RM | | 3 | |
| | | | FM | | | CC | |




• CC GZ; WC; • CC — 10Y 4/2; WC; •; CC GZ WC; • — 5GY 3/2

## LITHOLOGIC DESCRIPTION

**MUDDY SPICULAR DIATOMACEOUS OOZE:** greyish olive (10Y 4/2) to greyish, moderately deformed with several light grey (N7) ash layers and patches and occasional pumice fragments.

**CARBON-CARBONATE (%)**

| | 1-81 | 2-81 | 3-81 |
|---|---|---|---|
| Carbonate: | 1.0 | 1.0 | 0.0 |
| Organic carbon: | 0.6 | 1.0 | 1.0 |

**CARBONATE BOMB:** *0%, CC-20*

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-87 | 5 | 57 | 38 |
| 3-87 | 6 | 51 | 43 |

**SMEAR SLIDES (%)**

| | 1-70 2-80 CC-11 | 3-50† |
|---|---|---|
| Quartz | 2 | TR |
| Feldspar | 10-15 | 10 |
| Mica | TR | TR |
| Heavy mins. | TR | TR |
| Clay | 50 | 25 |
| Volcanic glass | 5 | 60 |
| Glauconite | TR | — |
| Pyrite | 2 | TR |
| Carb. unspec. | TR | — |
| Foraminifera | TR | — |
| Diatoms | 20 | 5 |
| Radiolarians | 2 | TR |
| Sponge spicules | 15 | TR |
| Silicoflagellates | TR | TR |

**SITE 435 HOLE CORE 12 CORED INTERVAL: 103.0-112.5 m**

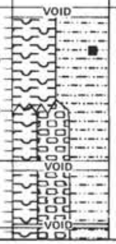
TIME-ROCK UNIT: LATE PLIOCENE

BIOSTRAT ZONE: F(N21) R(*Lamprocyrtis heteroporos* Zone) D(*Denticula seminae fossilis* Zone)

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, DIATOMS): CG, FG, CG

SECTION: 1, 2, CC — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY




LITHOLOGIC SAMPLE: GZ CC, WC, WC

10Y 4/2 to 5GY 3/2; 5GY 5/2; 5Y 5/6; 5Y 4/4

## LITHOLOGIC DESCRIPTION

**MUDDY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2) to greyish olive green (5GY 3/2), moderately deformed with occasional lithic clasts that are very well rounded. Ooze is slightly silty and locally ash rich. 0-100 cm.

**MUDDY CALCAREOUS DIATOMACEOUS OOZE:** Dusky yellow green (5GY 5/2) to light olive brown (5Y 5/6), moderately deformed. (Contact of this unit with diatomaceous ooze above is gradational and indistinct.) Also contains fair amount of sponge spicules. 100-225 cm.

**CARBON-CARBONATE (%)**

| | 1-69 | 2-38 |
|---|---|---|
| Carbonate: | 8.0 | 13.0 |
| Organic carbon: | 0.6 | 0.8 |

**CARBONATE BOMB:** 6%, CC-7

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-62 | 4 | 59 | 37 |
| 2-28 | 2 | 41 | 57 |

**SMEAR SLIDES (%)**

| | 1-27 1-34 1-81 | 1-101† 2-41† CC-5† |
|---|---|---|
| Quartz | 2 | TR |
| Feldspar | 15 | 10 |
| Mica | — | TR |
| Heavy mins. | TR | TR |
| Clay | 25 | 25 |
| Volcanic glass | 5 | 3 |
| Lithic fragments | 5 | — |
| Glauconite | TR | — |
| Pyrite | 1 | 1 |
| Carb. unspec. | — | 25 |
| Foraminifera | — | TR |
| Calc. nannos. | — | 10 |
| Diatoms | 25 | 20 |
| Radiolarians | 3 | 5 |
| Sponge spicules | 20 | 10 |

**SITE 435 HOLE CORE 13 CORED INTERVAL: 112.5-122.0 m**

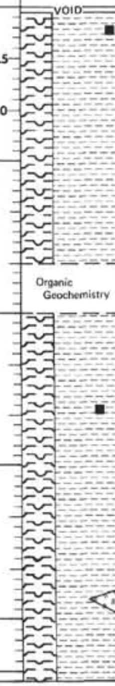
TIME-ROCK UNIT: MIDDLE PLIOCENE

BIOSTRAT ZONE: F(N21) D(*D. seminae fossilis*-*D. kamtschatica* Zone) R(*Sphaeropyle langii* Zone)

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, DIATOMS): FM, FM, FM, FM, FM, FG, CG, AG

SECTION: 1, 2, 3, 4, 5, CC — METERS: 0.5, 1.0

GRAPHIC LITHOLOGY




LITHOLOGIC SAMPLE: GZ CC, WC, WC, WC, WC, WC, GZ CC

10Y 4/2

## LITHOLOGIC DESCRIPTION

**DIATOMACEOUS CLAY:** greyish olive, moderately deformed with small (2 mm diameter) sponges/sponge spicule concentrations scattered throughout, occasional lithic fragments and light grey ash zones.

**CARBON-CARBONATE (%)**

| | 1-45 | 5-45 |
|---|---|---|
| Carbonate: | 6.0 | 9.0 |
| Organic carbon: | 0.7 | 0.7 |

**CARBONATE BOMB:** 5%, CC-7

**GRAIN SIZE (%)**

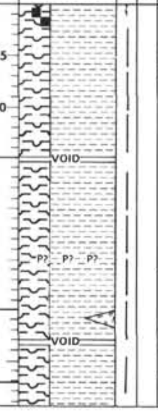
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-43 | 4 | 51 | 45 |
| 5-43 | 2 | 49 | 49 |

**SMEAR SLIDES (%)**

| | 1-109 2-45 | 4-130† |
|---|---|---|
| Quartz | 1 | — |
| Feldspar | 5 | 2 |
| Mica | TR | — |
| Heavy mins. | TR | TR |
| Clay | 50 | — |
| Volcanic glass | 8 | 98 |
| Glauconite | TR | — |
| Pyrite | 2 | — |
| Carb. unspec. | TR | — |
| Diatoms | 20 | TR |
| Radiolarians | TR | — |
| Sponge spicules | 8 | — |
| Silicoflagellates | — | TR |

SITE 435 HOLE CORE 14 CORED INTERVAL: 122.0-131.5 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS |
|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N21) R(*Sphaeropyle langii* Zone) D(*Denticula kamtschatica* Zone) | CM | | | | 1 | 0.5, 1.0 |
| | | FM | | | | 2 | |
| | | FM | | | | 3 | |
| | | RM | | CG | AG | CC | |




Lithologic samples: GZ, CC (Section 1); GZ, CC (Section 3)

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), moderately deformed with scattered sponge spicule concentrations, light grey in color (N8). Occasional rounded pebbles of metaquartzite, lithic wacke, and granodiorite; ash rich zones; and pyritized (P?) areas are found.

**CARBON-CARBONATE (%)**

| | 1-67 | 3-67 |
|---|---|---|
| Carbonate: | 5.0 | 3.0 |
| Organic carbon: | 0.9 | 1.0 |

**CARBONATE BOMB:** 3%, CC-1

**GRAIN SIZE (%)**

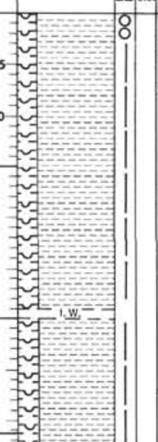
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-46 | 1 | 46 | 53 |
| 3-46 | 1 | 52 | 47 |

**SMEAR SLIDES (%)**

| | 1-50 2-102 | 3-16† |
|---|---|---|
| Quartz | TR | — |
| Feldspar | 5 | 3 |
| Mica | TR | TR |
| Heavy mins. | TR | 1 |
| Clay | 50 | — |
| Volcanic glass | 1 | 95 |
| Glauconite | TR | TR |
| Carb. unspec. | 5 | TR |
| Foraminifera | TR | — |
| Diatoms | 20 | TR |
| Radiolarians | TR | — |
| Sponge spicules | 10 | — |

SITE 435 HOLE CORE 15 CORED INTERVAL: 131.5-141.0 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS |
|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N19) R(*Sphaeropyle langii* Zone) D(*Denticula kamtschatica* Zone) | FM | | | | 1 | 0.5, 1.0 |
| | | FM | | | | 2 | |
| | | RM | | | | 3 | |
| | | RM | | CG | AG | CC | |




Lithologic samples: CC, GZ (Section 1); CC, GZ (Section 2)

10Y 4/2

**DIATOMACEOUS CLAY:** greyish olive (10Y 4/2), moderately deformed with occasional small (2 mm) "sponges" scattered throughout, (either sponges or disintegrated pieces of larger sponges) and some pyritized areas.

**CARBON-CARBONATE (%)**

| | 1-29 | 3-29 |
|---|---|---|
| Carbonate: | 47.0 | 2.0 |
| Organic carbon: | 1.0 | 1.1 |

**CARBONATE BOMB:** 2%, CC-15

**GRAIN SIZE (%)**

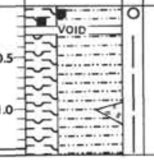
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-40 | 4 | 54 | 42 |
| 3-40 | 5 | 49 | 46 |

**SMEAR SLIDES (%)**

| | 1-75 2-75 3-75 |
|---|---|
| Quartz | TR |
| Feldspar | 2 |
| Mica | TR |
| Heavy mins. | TR |
| Clay | 45 |
| Volcanic glass | 1 |
| Glauconite | TR |
| Carb. unspec. | 2- 4 |
| Foraminifera | TR |
| Diatoms | 12-16 |
| Sponge spicules | 10 |

SITE 435 HOLE CORE 16 CORED INTERVAL: 141.0-150.5 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS |
|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N19) R(*Sphaeropyle langii* Zone) D(*Denticula kamtschatica* Zone) | RM | | | | 1 | 0.5, 1.0 |
| | | RM | | CG | AG | CC | |




Lithologic samples: CC, GZ (Section 1)

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), moderately deformed with sponge spicule concentrations (sponges?) scattered throughout; some light grey ash blebs and some rounded pebbles of dacite tuff at the top (downhole contamination?) are also present.

**CARBON-CARBONATE (%)**

| | 1-100 |
|---|---|
| Carbonate: | 1.0 |
| Organic carbon: | 0.9 |

**CARBONATE BOMB:** 3%, CC-1

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-110 | 2 | 48 | 50 |

**SMEAR SLIDES (%)**

| | 1-75 | 1-106† |
|---|---|---|
| Quartz | TR | — |
| Feldspar | 5 | 2 |
| Mica | TR | — |
| Heavy mins. | TR | TR |
| Clay | 50 | — |
| Volcanic glass | 2 | >95 |
| Glauconite | TR | — |
| Carb. unspec. | 2 | — |
| Foraminifera | TR | — |
| Diatoms | 20 | TR |
| Radiolarians | TR | — |
| Sponge spicules | 10 | — |

## SITE 435 HOLE A CORE 1 CORED INTERVAL: 0.0-7.0 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LATE PLEISTOCENE | F(N23); R(*Botryostrobus aquilonaris* Zone); D(*Denticula seminae* Zone) | FM | | | | 1 | 0.5, 1.0 | | | | • |
| | | CG | | | | 2 | | VOID | | | WC |
| | | FG | | | | 3 | | | | | • |
| | | FM | | | | 4 | | I. W. | | | |
| | | CG | | | | 5 | | | | | WC |
| | | FM | | CG | AG | CC | | | | | |

### LITHOLOGIC DESCRIPTION

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), very deformed, with patches of darker sandy silt and scattered pumice and lithic fragments ( ■ ).

10Y 4/2

**SMEAR SLIDES (%)**

| | 1-40 | 3-70 |
|---|---|---|
| Quartz | 2-4 | 1 |
| Feldspar | 5 | 30 |
| Mica | TR | TR |
| Heavy mins. | 1 | 1 |
| Clay | 40 | 40 |
| Volcanic glass | 5 | 10 |
| Glauconite | TR | — |
| Pyrite | TR | TR |
| Carb. unspec. | — | 2 |
| Diatoms | 35 | 15 |
| Radiolarians | 5 | TR |
| Sponge spicules | 10 | 5 |
| Silicoflagellates | TR | — |
| Fe-oxide | TR | — |

## SITE 435 HOLE A CORE 2 CORED INTERVAL: 149.5-159.0 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N19); D(*Denticula kamtschatica* Zone); R(*Sphaeropyle langii* Zone) | RM | | | | 1 | 0.5, 1.0 | VOID | | | WC • |
| | | RM | | CG | AG | CC | | | | | |

### LITHOLOGIC DESCRIPTION

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), very disturbed with scattered sponge spicule concentrations (small sponges?) and a pebble of vitric tuff (downhole contamination?).

**CARBONATE BOMB:** 0%, CC-1

**SMEAR SLIDE (%)**

| | 1-70 |
|---|---|
| Quartz | <2 |
| Feldspar | 5 |
| Mica | TR |
| Heavy mins. | — |
| Clay | 40 |
| Volcanic glass | 1 |
| Pyrite | 1 |
| Foraminifera | 1 |
| Diatoms | 35 |
| Radiolarians | 2 |
| Sponge spicules | 15 |
| Silicoflagellates | TR |

## SITE 435 HOLE A CORE 3 CORED INTERVAL: 159.0-168.5 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N19); D(*Denticula kamtschatica* Zone); R(*Sphaeropyle langii* Zone) | RM | | | | 1 | 0.5, 1.0 | VOID | | | GZ CC, WC |
| | | FM | | | | 2 | | | | | WC, • |
| | | RM | | | | 3 | | I. W. | | | •, WC |
| | | FM | | | | 4 | | | | | •, •, GZ CC WC |
| | | | | | | 5 | | VOID | | | |
| | | RM | | CG | AG | CC | | | | | |

### LITHOLOGIC DESCRIPTION

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), only slightly deformed with several ash layers. Ash is either light grey (N7) or olive grey (5Y 3/2) due to abundant pyrite. Ash bed at 487-489 cm has a light grey top and a pyrite-rich lower part. Light sponge spicule concentrations (small sponges?) occur scattered throughout. Though ash beds indicate only slight deformation, no obvious laminations or structures are noted in the bulk of the core.

**CARBON-CARBONATE (%)**

| | 1-74 | 4-74 |
|---|---|---|
| Carbonate: | 1.0 | 3.0 |
| Organic carbon: | 1.1 | 1.3 |

**CARBONATE BOMB:** 0%, CC-1

**GRAIN SIZE (%)**

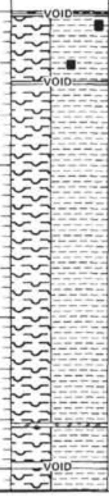
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-70 | 3 | 59 | 38 |
| 4-70 | 1 | 47 | 52 |

**SMEAR SLIDES (%)**

| | 3-28 | 2-135† 4-37† | 4-39 |
|---|---|---|---|
| Quartz | <1 | — | — |
| Feldspar | 5 | 2- 5 | 5 |
| Mica | TR | 1 | TR |
| Heavy mins. | — | TR | — |
| Clay | 25-30 | 5 | 80 |
| Volcanic glass | | 85-90 | — |
| Glauconite | — | — | — |
| Pyrite | 2 | 2 | 15 |
| Carb. unspec. | — | — | — |
| Foraminifera | — | — | — |
| Diatoms | 45 | TR | — |
| Radiolarians | 2 | — | — |
| Sponge spicules | 10 | TR | — |
| Silicoflagellates | — | — | — |

SITE 435 HOLE A CORE 4 CORED INTERVAL: 168.5-178.0 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N18) R(Sphaeropyle langii Zone) | RM, RM, RM, RM | | CG | | 1, 2, 3, CC | 0.5, 1.0 | VOID, VOID, VOID | | | CC GZ, WC, WC, CC GZ, WC | 10Y 4/2 |



## LITHOLOGIC DESCRIPTION

**CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), only slightly deformed with scattered sponge spicule concentrations, occasional pebbles (downhole contamination?) and a single olive grey (5Y 3/2) ash horizon.

**CARBON-CARBONATE (%)**

| | 1-59 | 3-59 |
|---|---|---|
| Carbonate: | 0.0 | 2.0 |
| Organic carbon: | 1.4 | 1.0 |

**CARBONATE BOMB:** 0%, CC-1

**GRAIN SIZE (%)**

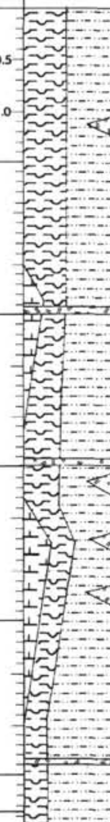
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-60 | 1 | 50 | 49 |
| 3-60 | 1 | 47 | 52 |

**SMEAR SLIDE (%)**

| | 1-70 |
|---|---|
| Quartz | <1 |
| Feldspar | 3 |
| Mica | TR |
| Heavy mins. | TR |
| Clay | 45 |
| Volcanic glass | 2 |
| Diatoms | 45 |
| Radiolarians | <2 |
| Sponge spicules | 5 |
| Silicoflagellates | <1 |

SITE 435 HOLE A CORE 5 CORED INTERVAL: 178.0-187.5 m

| TIME-ROCK UNIT | BIOSTRAT ZONE | FORAMS | NANNOS | RADS | DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | LITHOLOGIC SAMPLE | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| EARLY PLIOCENE | F(N18) D(Denticula kamtschatica Zone) R(Sphaeropyle langii Zone) | RP, RP, RM, RM, RM, FP | | CG | AG | 1, 2, 3, 4, 5, 6, CC | 0.5, 1.0 | | | | GZ CC, WC, WC, WC, WC, GZ CC, WC | 10Y 4/2, mottled 10Y 4/2-5Y 4/4, 5Y 4/4, 10Y 4/2, 5Y 5/6, 10Y 4/2, 5Y 5/6 |



## LITHOLOGIC DESCRIPTION

***MUDDY DIATOMACEOUS OOZE–DIATOMACEOUS SILTY CLAY:***
**DIATOMACEOUS SILTY CLAY–DIATOMACEOUS SILTY CLAY:**
Greyish olive (10Y 4/2) to light olive brown (5Y 5/6), relatively undeformed with occasional ash and sandy ash blebs and layers. Nanno content is variable, enriched in certain parts of the core. Mottled areas are possibly burrowed.

**CARBON-CARBONATE (%)**

| | 1-85 | 5-85 |
|---|---|---|
| Carbonate: | 2.0 | 0.0 |
| Organic carbon: | 0.6 | 0.9 |

**CARBONATE BOMB:** 0%, CC-1

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-80 | 5 | 58 | 37 |
| 5-80 | 10 | 45 | 45 |

**SMEAR SLIDES (%)**

| | 1-70 | 2-136 3-75 4-70 | 5-60 6-10 CC-10 | 2-144† 3-137† |
|---|---|---|---|---|
| Quartz | 2 | 2 | 2 | — |
| Feldspar | 12 | 15 | 25 | 20-30 |
| Mica | — | TR | TR | — |
| Heavy mins. | — | — | TR | 0- 3 |
| Clay | 40 | 10-40 | 25-45 | — |
| Lithic fragments | — | — | — | 0-15 |
| Volcanic glass | 8 | 8 | 5-15 | 40-80 |
| Pyrite | 1 | 1 | TR | 0- 5 |
| Carb. unspec. | — | 2-15 | 2 | TR |
| Foraminifera | — | TR | — | — |
| Calc. nannos. | — | 5-25 | TR | TR |
| Diatoms | 30 | 10-15 | 5-15 | 2 |
| Radiolarians | TR | TR | 2 | TR |
| Sponge spicules | 8 | 10-15 | 5-15 | TR |
| Silicoflagellates | — | — | — | — |
| Glauconite | — | — | TR | 2 |

## SITE 435 HOLE A CORE 6 CORED INTERVAL: 187.5-197.0 m

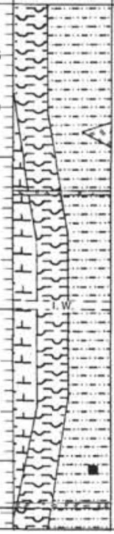
TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); D(*Denticula kamtschatica* Zone) R(*Sphaeropyle langii* Zone)

FOSSIL CHARACTER: FORAMS: FG, FM, FM, FM; NANNOS; RADS: FG; DIATOMS: AG

SECTION: 1, 2, 3, 4, CC

METERS: 0.5, 1.0



LITHOLOGIC SAMPLE: CC, GZ, WC, W.C, WC, GZ, CC

10Y 4/2

5Y 4/4

### LITHOLOGIC DESCRIPTION

**DIATOMACEOUS CLAY–DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), slightly deformed with occasional silty ash layers, one pumice ( ■) fragment and scattered sponge spicule concentrations (small sponges?). Coccoliths and a few discoasters become more abundant below 180 cm. Several color-mottled patches (for example at 1-70 cm) could be caused by burrowing–although very indistinct.

**CARBON-CARBONATE (%)**

| | 1-38 | 4-36 |
|---|---|---|
| Carbonate: | 1.0 | 2.0 |
| Organic carbon: | 0.9 | 0.7 |

**CARBONATE BOMB:** 0%, CC

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-74 | 12 | 50 | 38 |
| 4-21 | 1 | 48 | 51 |

**SMEAR SLIDES (%)**

| | 1-20<br>1-89 | 1-69<br>2-82<br>2-130<br>3-70<br>4-17<br>CC-15 | 1-133†<br>2-37†<br>4-40† |
|---|---|---|---|
| Quartz | 1 | 2 | 0-3 |
| Feldspar | 12 | 15 | 10-15 |
| Mica | — | — | TR |
| Heavy mins. | — | — | TR |
| Clay | 50 | 30-40 | 0-10 |
| Volcanic glass | 10-15 | 5-10 | 70-90 |
| Lithic frags. | — | — | — |
| Palagonite | TR | — | — |
| Glauconite | TR | 0- 5 | — |
| Pyrite | — | 1 | 1 |
| Carb. unspec. | — | 5-15 | — |
| Foraminifera | — | — | — |
| Calc. nannos. | — | 2-20 | — |
| Diatoms | 20 | 15-25 | 2 |
| Radiolarians | — | 1 | TR |
| Sponge spicules | 10 | 10-15 | TR |
| Silicoflagellates | — | — | — |

## SITE 435 HOLE A CORE 7 CORED INTERVAL: 197.0-206.5 m

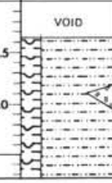
TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); D(*Denticula kamtschatica* Zone) R(*Sphaeropyle langii* Zone)

FOSSIL CHARACTER: FORAMS: RP; RADS: FG; DIATOMS: AG

SECTION: 1, CC

METERS: 0.5, 1.0



LITHOLOGIC SAMPLE: W.C, CC, GZ, CC, WC

10Y 4/2

5Y 4/4

### LITHOLOGIC DESCRIPTION

**DIATOMACEOUS CLAY:** greyish olive (10Y 4/2) to moderate olive brown (5Y 4/4), very deformed with one ash horizon. No obvious structures.

**CARBON-CARBONATE (%)**

| | CC |
|---|---|
| Carbonate: | 0.0 |
| Organic carbon | 1.3 |

**CARBONATE BOMB:** 0%, CC-25

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-96 | 1 | 43 | 56 |

**SMEAR SLIDES (%)**

| | 1-80<br>CC-8 | 1-90† |
|---|---|---|
| Quartz | 2 | — |
| Feldspar | 10 | 10 |
| Mica | — | TR |
| Heavy mins. | — | TR |
| Clay | 55 | 5 |
| Volcanic glass | 10 | 80 |
| Lithic frags. | — | 4 |
| Glauconite | — | — |
| Pyrite | 1 | TR |
| Carb. unspec. | 0- 5 | TR |
| Foraminifera | — | — |
| Calc. nannos. | — | — |
| Diatoms | 15 | 1 |
| Radiolarians | TR | TR |
| Sponge spicules | 10 | TR |
| Silicoflagellates | — | — |

## SITE 435 HOLE A CORE 8 CORED INTERVAL: 206.0-216.5 m

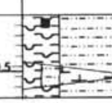
TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); D(*Denticula kamtschatica* Zone) R(*Sphaeropyle langii* Zone)

FOSSIL CHARACTER: FORAMS: B; RADS: FG; DIATOMS: AG

SECTION: 1, CC

METERS: 0.5



LITHOLOGIC SAMPLE: GZ, CC, WC

10Y 4/2

5Y 3/2

10Y 4/2

### LITHOLOGIC DESCRIPTION

**MUDDY DIATOMACEOUS OOZE:** 0-47 cm, 70-80 cm. Greyish olive (10Y 4/2), very deformed with one 6 cm silicified dacite cobble ( ■). Grades downward and upward into diatomaceous nannofossil marl (47-70 cm).

**CARBON-CARBONATE (%)**

| | 1-47 |
|---|---|
| Carbonate: | 1.0 |
| Organic carbon: | 1.0 |

**CARBONATE BOMB:** 0%, CC-7

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-40 | 3 | 43 | 54 |

**SMEAR SLIDES (%)**

| | 1-25<br>CC-25 | 1-47†<br>1-55† |
|---|---|---|
| Quartz | 2 | <2 |
| Feldspar | 10 | 8 |
| Mica | — | — |
| Heavy mins. | — | — |
| Clay | 45-55 | 10-40 |
| Volcanic glass | 3- 5 | 6 |
| Glauconite | TR | TR |
| Pyrite | — | 1 |
| Carb. unspec. | 1 | 0-10 |
| Foraminifera | — | — |
| Calc. nannos. | 1 | 7-60 |
| Diatoms | 20-25 | 5-20 |
| Radiolarians | 2 | — |
| Sponge spicules | 10 | 5-10 |
| Silicoflagellates | — | — |

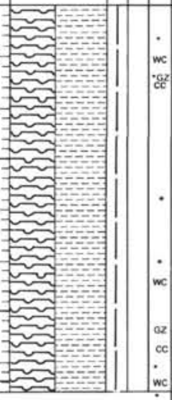
**SITE 435 HOLE A CORE 9 CORED INTERVAL: 216.0-225.5 m**

TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); R(*Sphaeropyle langii* Zone); D(*Denticula kamtschatica* Zone)

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, DIATOMS): RM; RM FG AG

SECTION: 1, 2, 3, CC — METERS: 0.5, 1.0



## LITHOLOGIC DESCRIPTION

10Y 4/2

**CLAYEY DIATOMITE – CLAYEY DIATOMACEOUS OOZE:** greyish olive (10Y 4/2), moderate deformation - mostly brecciation from drilling. Alternation of indurated "diatomite" and soft ooze appears random and difficult to depict graphically because of brecciation. Occasional sponge spicule concentrations are scattered randomly throughout the core.

**CARBON-CARBONATE (%)**

| | 1-72 | 3-36 |
|---|---|---|
| Carbonate: | 0.0 | 2.0 |
| Organic carbon: | 1.0 | 1.2 |

**CARBONATE BOMB:** 0%, 2-144

**GRAIN SIZE (%)**

| | Sand | Silt | Clay |
|---|---|---|---|
| 1-70 | 1 | 45 | 54 |
| 3-14 | 1 | 46 | 53 |

**SMEAR SLIDES (%)**

| | 1-30 through CC-5 |
|---|---|
| Quartz | <1 |
| Feldspar | 1 |
| Mica | TR |
| Heavy mins. | TR |
| Clay | 40-50 |
| Volcanic glass | 2- 3 |
| Glauconite | — |
| Pyrite | 1 |
| Carb. unspec. | 1 |
| Foraminifera | 1 |
| Calc. nannos. | 1 |
| Diatoms | 30-40 |
| Radiolarians | 1 |
| Sponge spicules | 5-10 |
| Silicoflagellates | 1 |

**SITE 435 HOLE A CORE 10 CORED INTERVAL: 225.5-235.0 m**

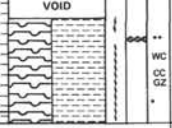
TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); R(*Sphaeropyle langii* Zone); D(*Denticula kamtschatica* Zone)

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, DIATOMS): B FG AG

SECTION: 1, CC — METERS: 0.5, 1.0

VOID



## LITHOLOGIC DESCRIPTION

mottled 10Y 4/2 to 5Y 5/2

**CLAYEY DIATOMITE:** mottled greyish olive (10Y 4/2) to lighter olive grey (5Y 5/3), badly brecciated from drilling. Coccoliths appear to be concentrated in the lighter parts of the core. The core, from 35-50 cm, also appears extensively burrowed.

**CARBON-CARBONATE (%)**

| | 1-66 |
|---|---|
| Carbonate: | 1.0 |
| Organic carbon: | 1.1 |

**CARBONATE BOMB:** 0%, 1-107

**SMEAR SLIDES (%)**

| | 1-47 1-95 | 1-45† |
|---|---|---|
| Quartz | — | — |
| Feldspar | TR | TR |
| Mica | — | — |
| Heavy mins. | — | — |
| Clay | 30-45 | 20 |
| Volcanic glass | TR | TR |
| Glauconite | TR | — |
| Pyrite | 1 | 1 |
| Carb. unspec. | 1 | 1 |
| Foraminifera | 1 | 1 |
| Calc. nannos. | 2 | 35 |
| Diatoms | 40-50 | 40 |
| Radiolarians | 2 | TR |
| Sponge spicules | 4 | 1 |
| Silicoflagellates | 1 | TR |

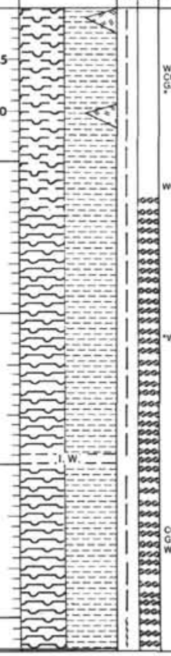
**SITE 435 HOLE A CORE 11 CORED INTERVAL: 235.0-244.5 m**

TIME-ROCK UNIT: EARLY PLIOCENE

BIOSTRAT ZONE: F(N18); R(*Sphaeropyle langii* Zone); D(*Denticula kamtschatica* Zone)

FOSSIL CHARACTER (FORAMS, NANNOS, RADS, DIATOMS): RM; RM; RG; RM; RM FG CM

SECTION: 1, 2, 3, 4, CC — METERS: 0.5, 1.0



## LITHOLOGIC DESCRIPTION

10Y 4/2

**CLAYEY DIATOMACEOUS OOZE – CLAYEY DIATOMITE:** greyish olive (10Y 4/2) to mottled greyish olive (10Y 4/2), dusky yellow (5Y 6/4) and olive grey (5Y 3/2). Slightly deformed and brecciated in spots from drilling. The core is more indurated from 190-600 cm. Mottled areas are clearly burrowed with lighter olive areas richer in nannos. Occasional sponge spicule concentrations scattered throughout. Several ash rich zones near the top of the core.

**CARBON-CARBONATE (%)**

| | 1-69 | 4-69 |
|---|---|---|
| Carbonate: | 0.0 | 0.0 |
| Organic carbon: | 0.9 | 0.9 |

**CARBONATE BOMB:** 3%, 2-96
0%, CC-26

mottled 10Y 4/2, 5Y 3/2, 5Y 6/4

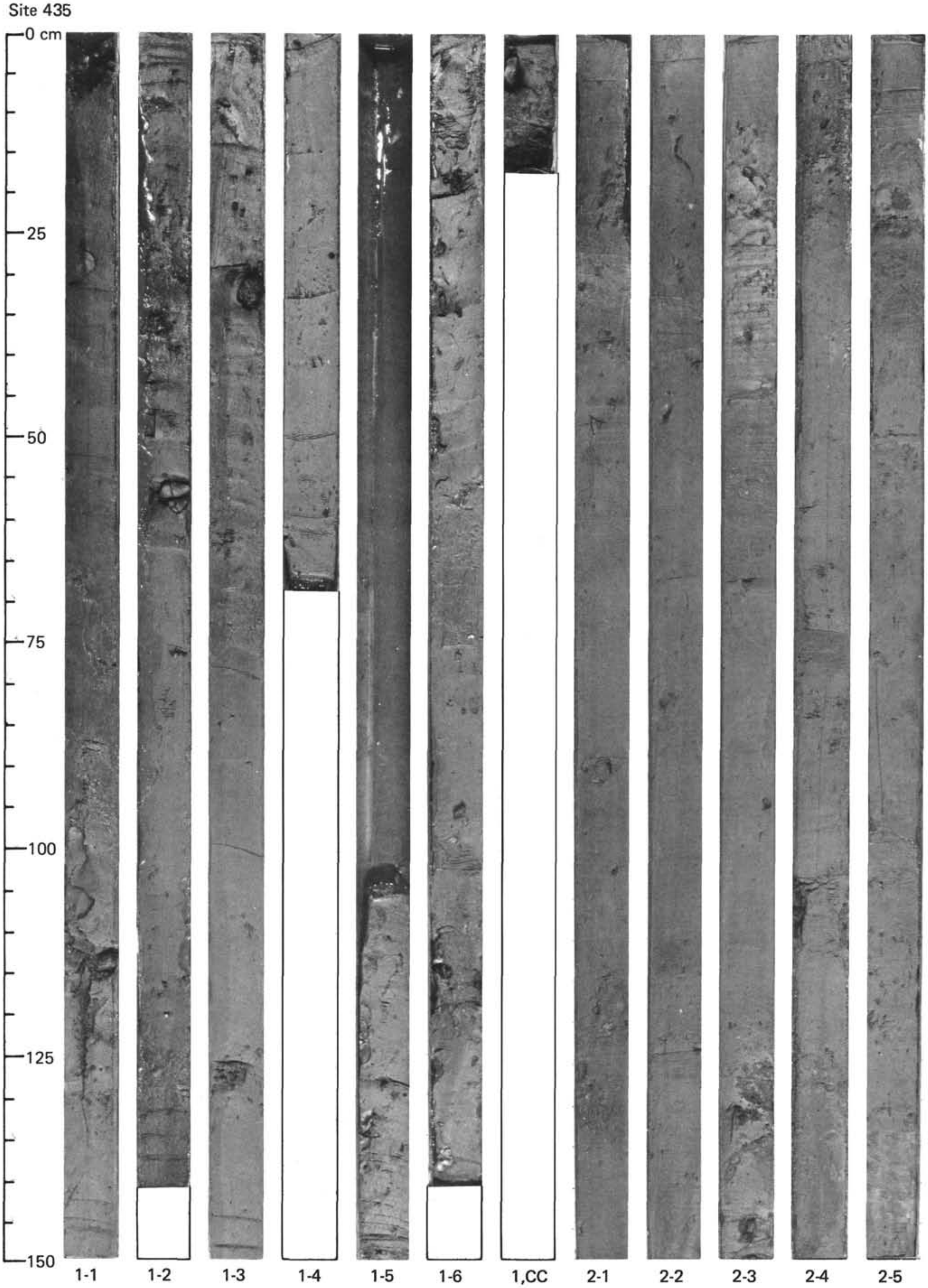
**GRAIN SIZE (%)**

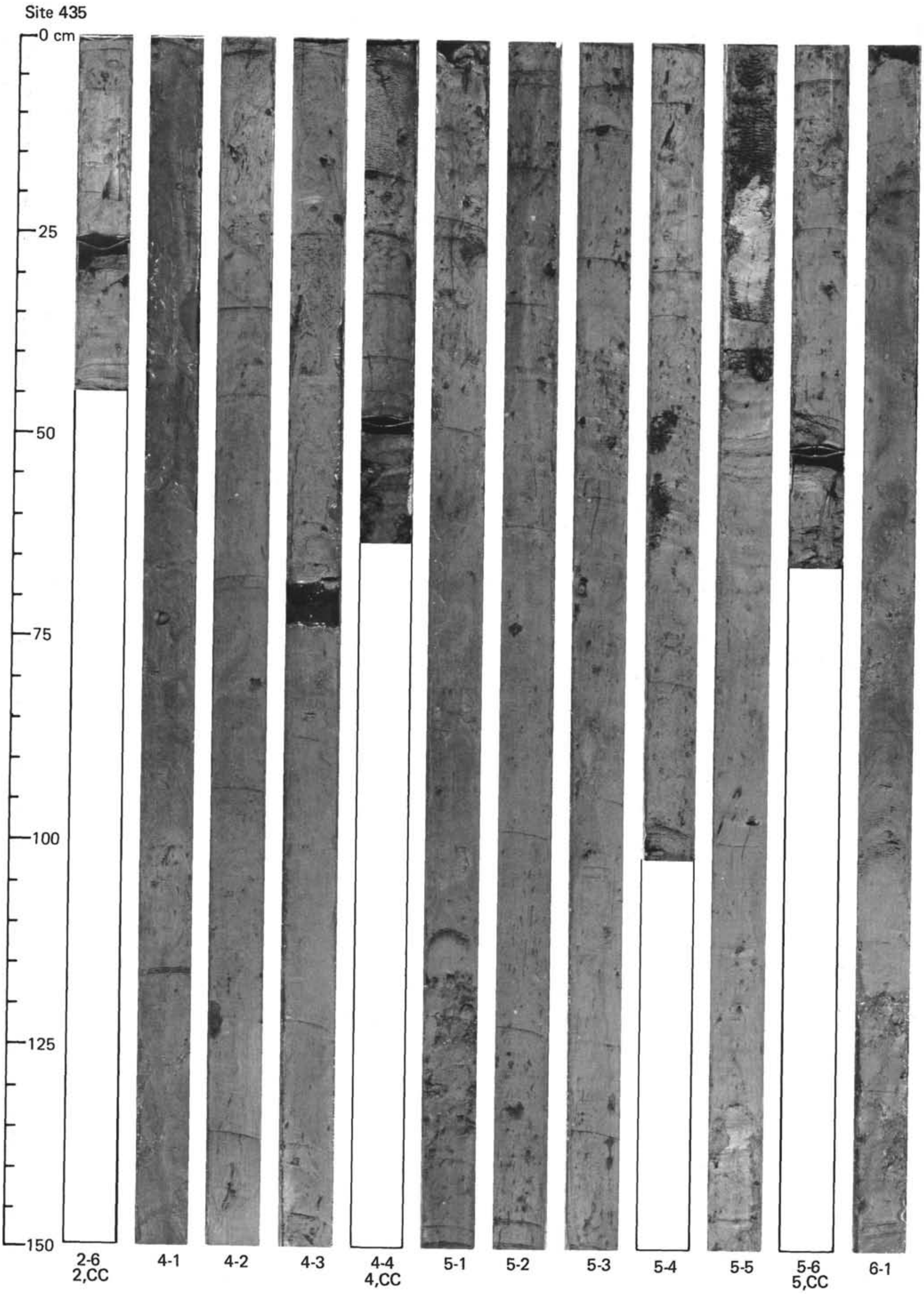
| | Sand | Silt | Clay |
|---|---|---|---|
| 1-70 | 1 | 47 | 52 |
| 4-70 | 1 | 36 | 63 |

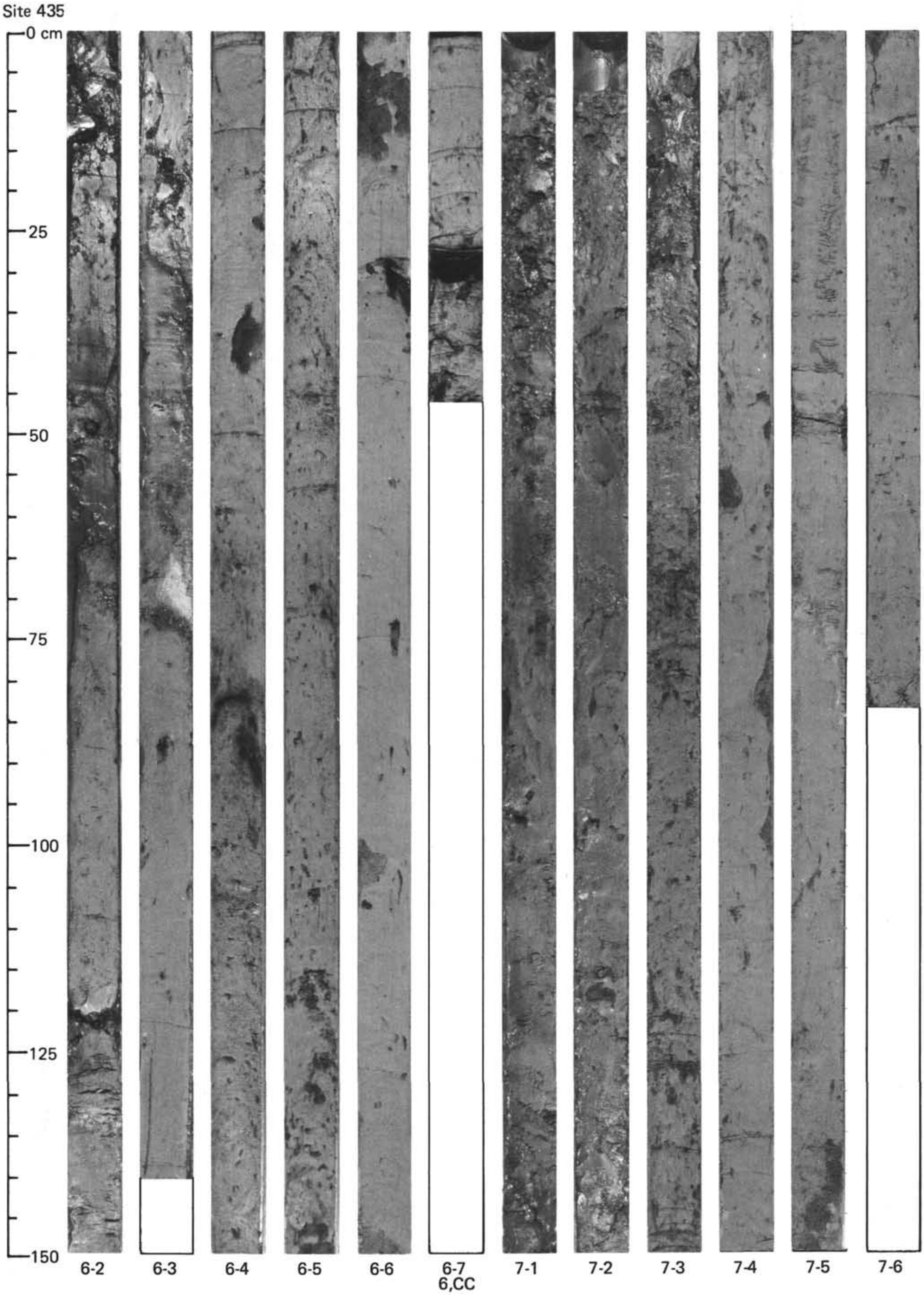
**SMEAR SLIDES (%)**

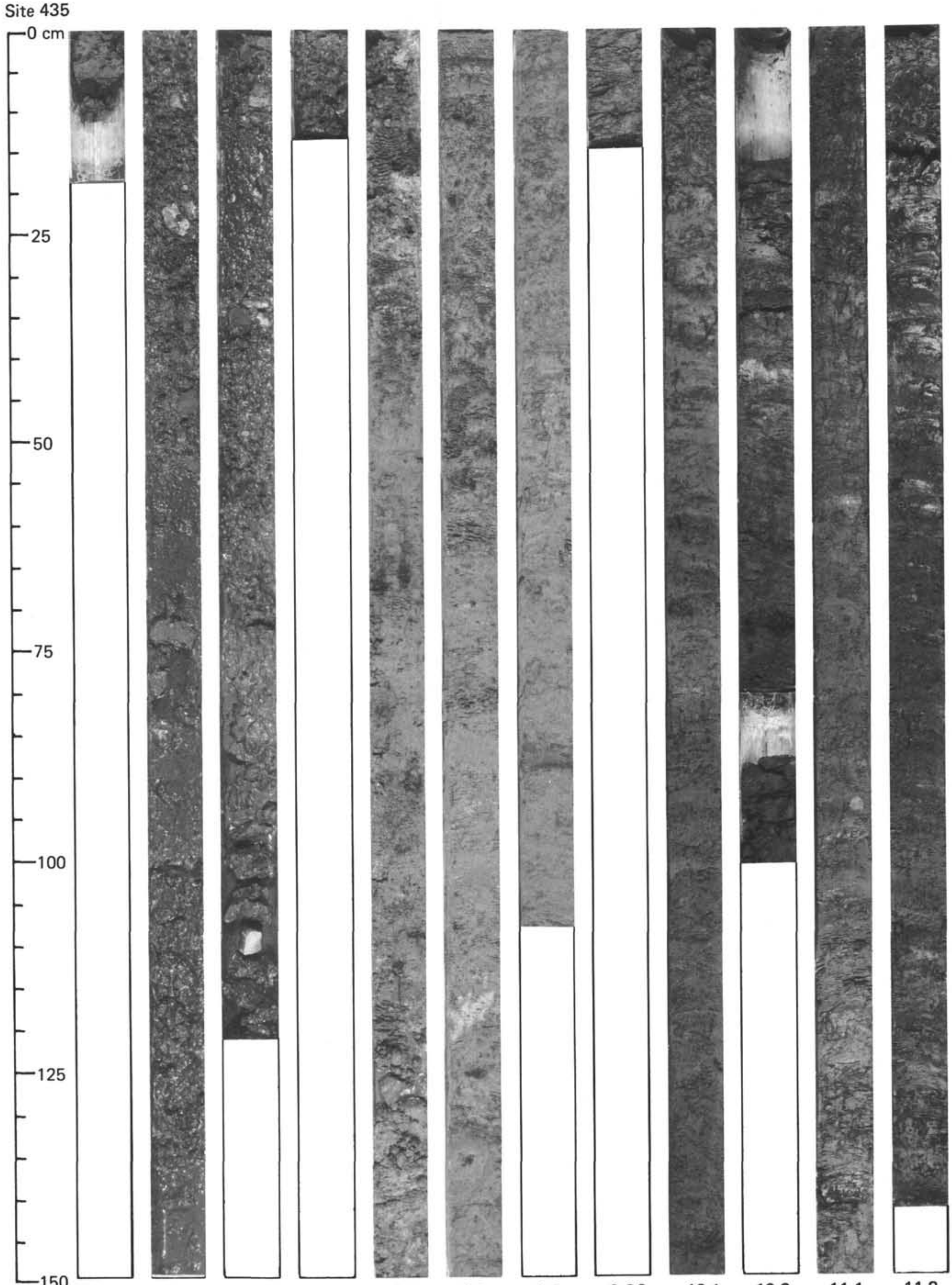
| | 1-75 3-20 | 1-7† |
|---|---|---|
| Quartz | 1 | 2 |
| Feldspar | 1 | 7-10 |
| Mica | TR | 2 |
| Heavy mins. | — | TR |
| Clay | 40-55 | 5 |
| Volcanic glass | TR | 50 |
| Glauconite | — | 3 |
| Pyrite | 1 | 1 |
| Carb. unspec. | 0- 2 | — |
| Foraminifera | — | TR |
| Calc. nannos. | 0- 2 | — |
| Diatoms | 35-50 | 20 |
| Radiolarians | 2 | 2 |
| Sponge spicules | 5 | 10 |
| Silicoflagellates | TR | — |

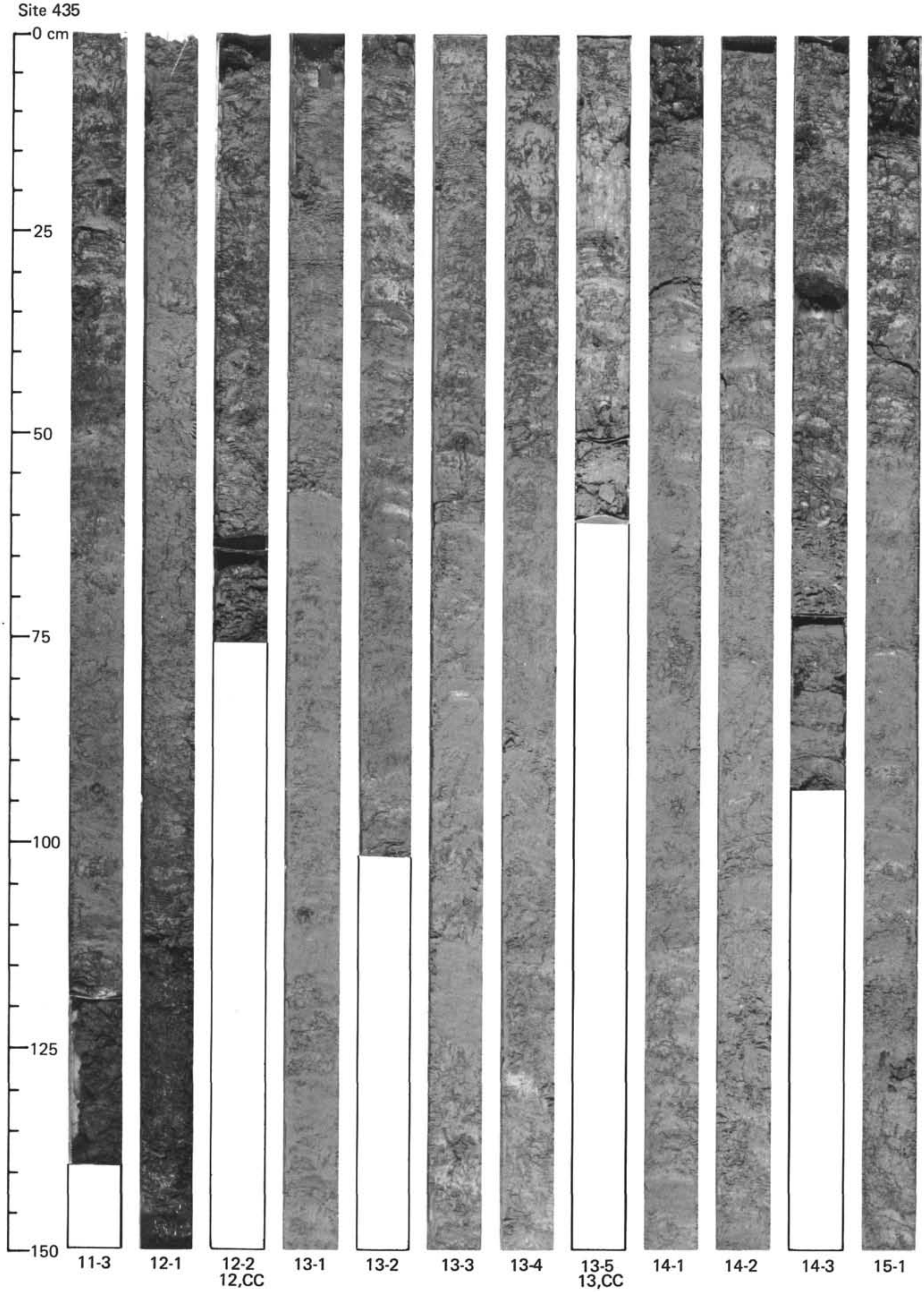
10Y 4/2


Site 435
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1,CC
2-1
2-2
2-3
2-4
2-5

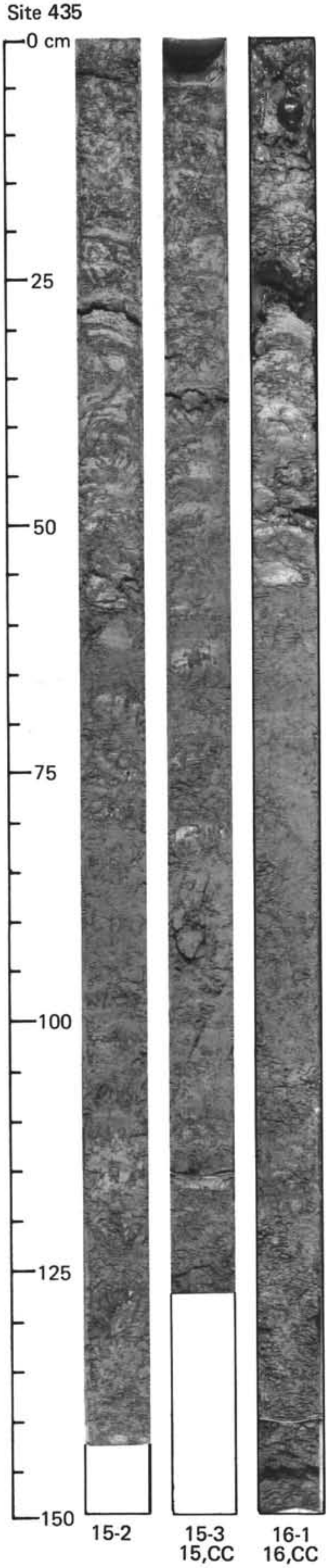

Site 435
0 cm
25
50
75
100
125
150
2-6
2,CC
4-1
4-2
4-3
4-4
4,CC
5-1
5-2
5-3
5-4
5-5
5-6
5,CC
6-1

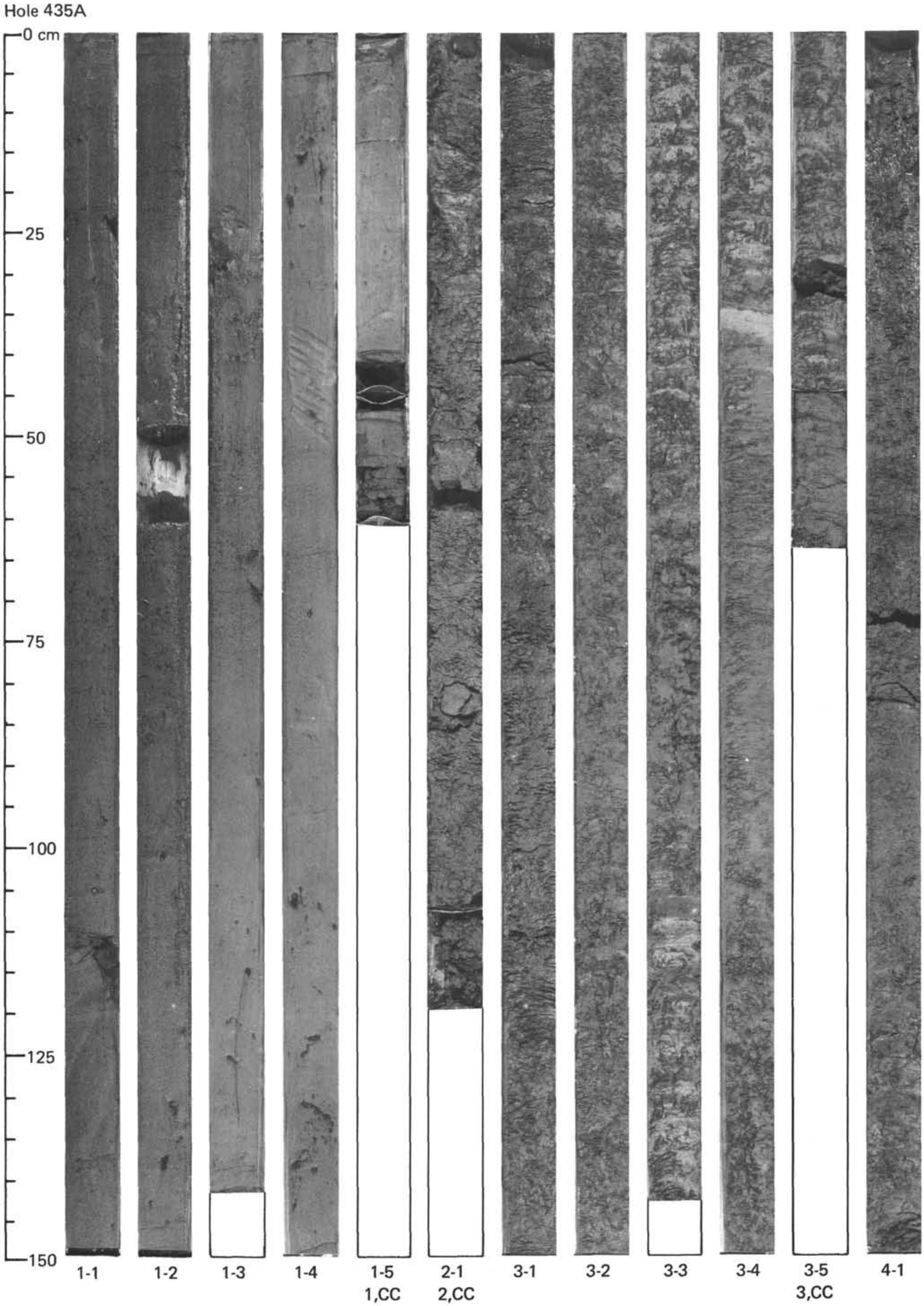

Site 435
0 cm
25
50
75
100
125
150
6-2
6-3
6-4
6-5
6-6
6-7
6,CC
7-1
7-2
7-3
7-4
7-5
7-6

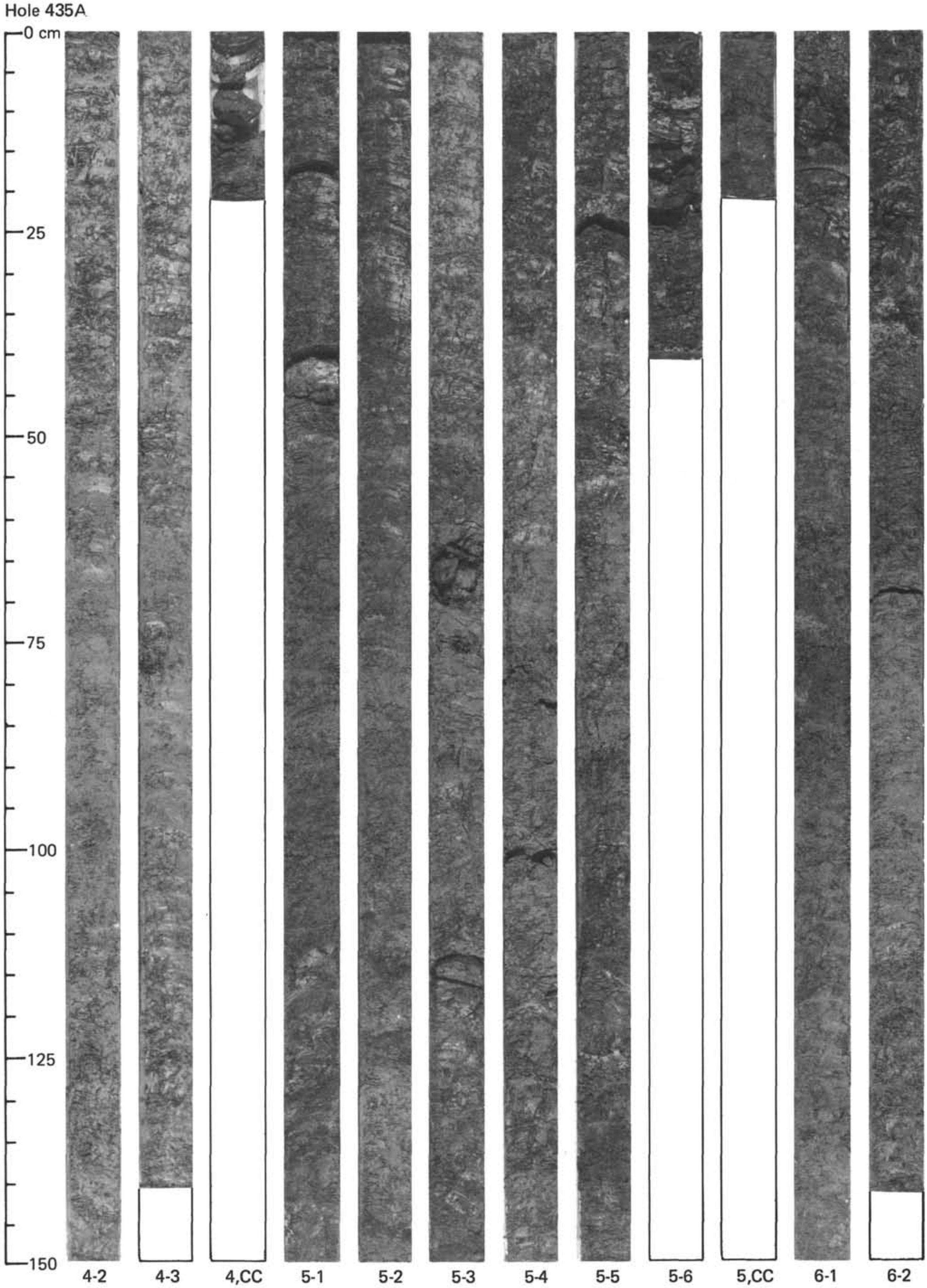

Site 435
0 cm
25
50
75
100
125
150
7,CC
8-1
8-2
8,CC
9-1
9-2
9-3
9,CC
10-1
10-2
11-1
11-2



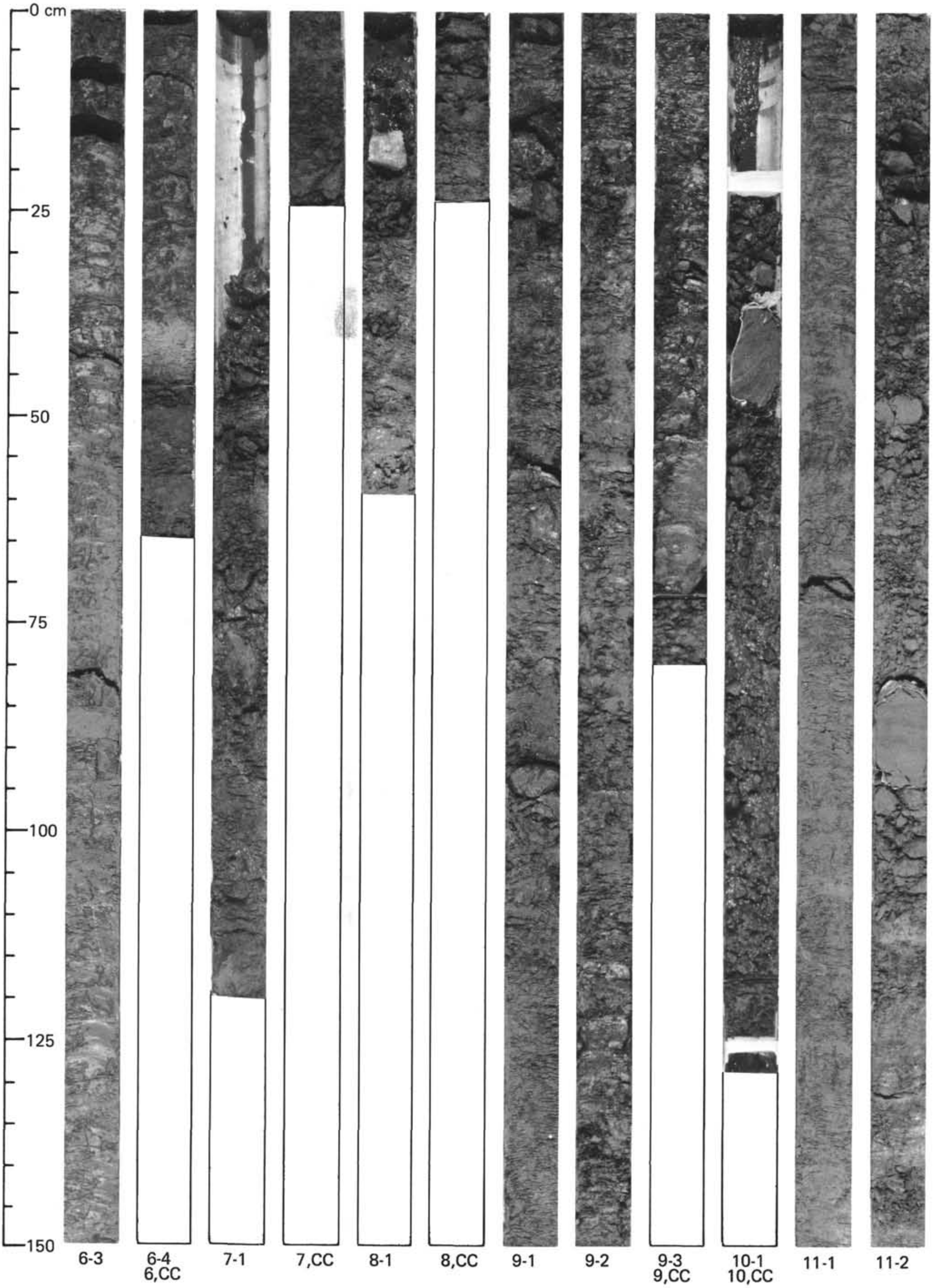
Site 435
0 cm
25
50
75
100
125
150
11-3
12-1
12-2
12,CC
13-1
13-2
13-3
13-4
13-5
13,CC
14-1
14-2
14-3
15-1

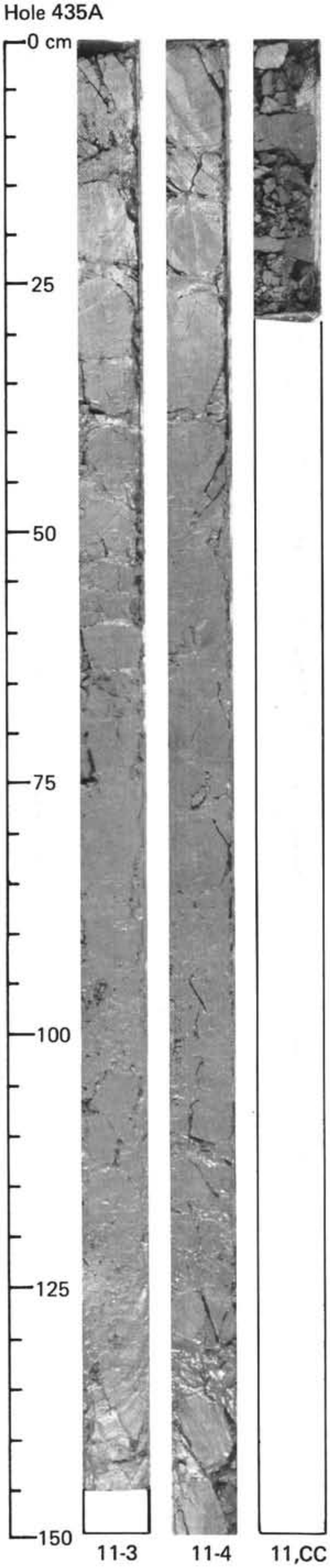

Site 435
0 cm
25
50
75
100
125
150
15-2
15-3
15,CC
16-1
16,CC


Hole 435A
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1,CC
2-1
2,CC
3-1
3-2
3-3
3-4
3-5
3,CC
4-1


Hole 435A
0 cm
25
50
75
100
125
150
4-2
4-3
4,CC
5-1
5-2
5-3
5-4
5-5
5-6
5,CC
6-1
6-2

Hole 435A


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


Hole 435A
0 cm
25
50
75
100
125
150
11-3
11-4
11,CC