5. SITE 466: SOUTHERN HESS RISE[1]

Shipboard Scientific Party[2]

HOLE 466

Date occupied: 28 August 1978

Date departed: 30 August 1978

Time on hole: 58.3 hours

Position (latitude; longitude): 34°11.46′N; 179°15.34′E

Water depth (corrected m, echo sounding): 2665

Bottom felt (m, drill pipe): 2672

Penetration (m): 312

Number of cores: 35

Total length of cored section (m): 312

Total core recovered (m): 105.4

Core recovery (%): 33.8

Oldest sediment cored:
Depth sub-bottom (m): 312
Nature: Limestone
Age: Late Albian

Igneous basement: Not penetrated

Principal results: A sediment sequence of 312 meters was continuously cored at Site 466 on southern Hess Rise (34°11.46′N, 179°15.34′E; 2665 m water depth), about 28 nautical miles northeast of Site 465 (Fig. 1). The upper Albian to Pleistocene sediment section has two major lithologic units, and at least three hiatuses (Fig. 2). Igneous basement was not reached. Oldest sediments (Unit II) are upper Albian olive-gray nannofossil chalk and limestone. This unit is correlative with the upper Albian limestone cored at Site 465, but is not as laminated and has a higher $CaCO_3$ content. The overlying sediments of Unit I are partly cherty nannofossil oozes of Turonian to Pleistocene age. The lower part of this unit, 158 meters thick and Turonian to early Maastrichtian in age, contains abundant chert, which is reflected by poor recovery from that interval. The upper part is 88 meters thick and ranges in age from middle Eocene to Pleistocene. The hiatuses are Cenomanian, late Santonian–early Campanian, early Maastrichtian–middle Eocene, and late Eocene–early Pliocene. Basalt pebbles in nannofossil ooze and chert indicate that some tectonic uplift and(or) volcanism occurred in the Late Cretaceous or early Tertiary.

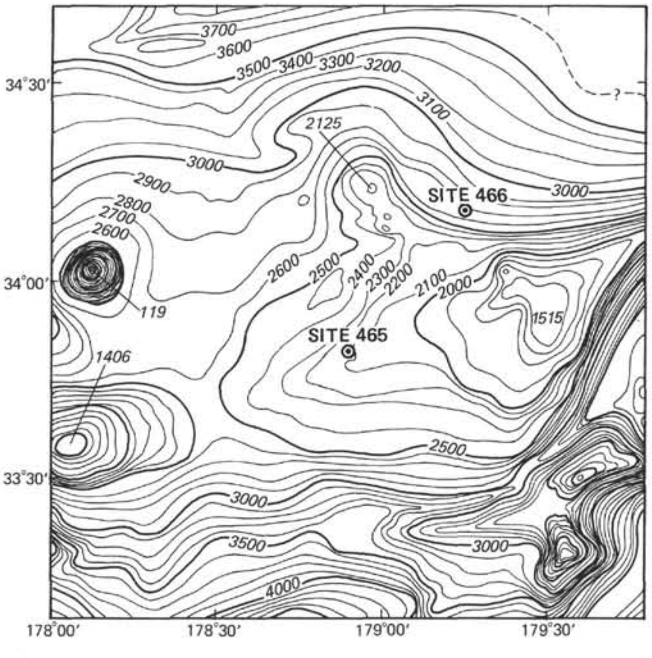

Figure 1. Location of DSDP Sites 465 and 466, southern Hess Rise. Bathymetry from Chase (this volume).

BACKGROUND AND OBJECTIVES

Hess Rise is an oceanic plateau that rises several kilometers above the surrounding deep-sea floor of the North Pacific; it is covered by a blanket of calcareous pelagic sediment that records the traverse of this segment of the Pacific Plate from equatorial regions during the middle Cretaceous to the north transitional latitudes. Because deep-sea drilling had failed to obtain long and well-preserved Neogene sediment sections from Hess Rise at Sites 310, 464, and 465, it is impossible to construct the Neogene paleoceanography and paleoenvironment of the central subtropical North Pacific water masses and of the North Pacific current bordering it to the north (Vincent, 1975).

Near the end of the Leg 62 cruise, after fulfilling our objectives at Site 465 on southern Hess Rise, we decided to use the approximately three days of remaining time to drill at Site 466 (Fig. 3). Major objectives were (1) to make another attempt to recover Neogene sediments, (2) to recover parts of the sedimentary column which had been eroded elsewhere on Hess Rise, (3) to recover the Cretaceous/Tertiary boundary in order to compare the sediments with those from Site 465, (4) to recover a more complete section of the basal Albian limestone,

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[1] *Initial Reports of the Deep Sea Drilling Project*, Volume 62.

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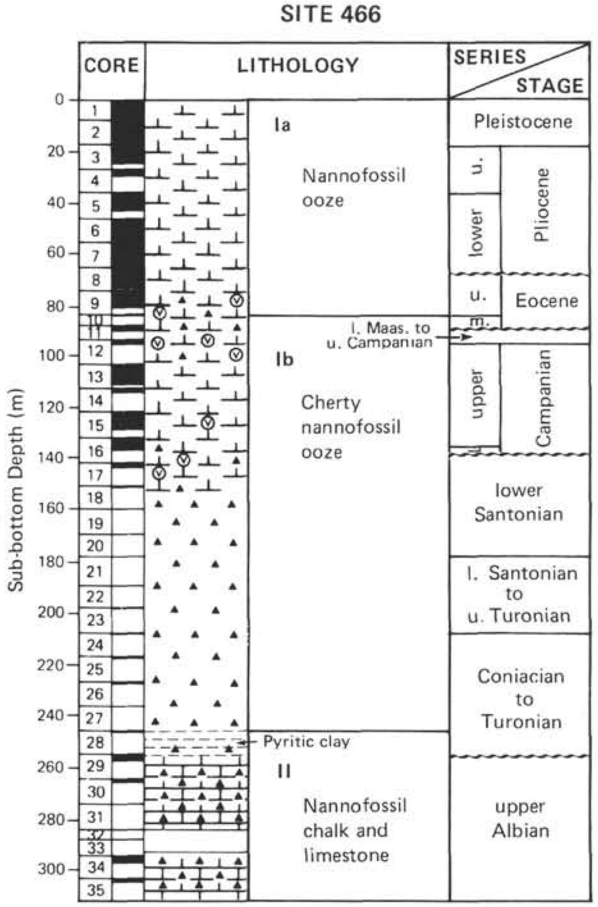

Figure 2. Stratigraphy of Site 466.

which should thereby provide additional data to interpret the depositional processes of the organic-carbon-rich sedimentation, and (5) to recover igneous basement in order to study the variability of basement rocks on southern Hess Rise.

A suitable drill site was located on the *Vema* V3212 trackline (close to 0000Z on July 27, 1975) about 50 km northeast of Site 465 (Fig. 4), where apparently young and almost acoustically transparent sediments overlie horizontally stratified sediments in a graben-like depression. The depression is in the middle of a structural high bounded on both sides by small, probably volcanic pinnacles. We hoped, therefore, that the depositional environment would be protected from the erosional current regime which had generated the hiatuses encountered at all previously drilled sites on Hess Rise.

OPERATIONS

Site 465 was abandoned at 0530Z on 28 August 1978, and the gear was streamed immediately. The ship steamed on a heading of 015° in order to intersect the *Vema* 3212 track line north of proposed Site 466, which lay along that track line at about 0000Z, 27 July 1975 (Fig. 4). We intersected the *Vema* 3212 track line at 0940Z and followed it in a southeast direction (125°) at about 9 knots, until 1045Z, when speed was reduced to 5 knots for the final approach. At 1112Z, the beacon was dropped (Fig. 5), gear was pulled in, and we attempted to return to the beacon. The beacon failed, and we searched for it until 1300Z, when we surveyed for another site for an additional 30 minutes, using the 3.5-kHz profiler. The second beacon was dropped approximately 1 km south-southwest of the first at 1332Z (Fig. 6). The ship came to an immediate stop and went into automatic control over the second beacon at 1427Z, August 28.

One hole was drilled at Site 466 in 2665 meters of water (corrected meters, echo sounding) and 35 cores were cut, to a sub-bottom depth of 312 meters (Table 1). Recovery was a low 33.8%; recovery was particularly low in the nannofossil ooze and chert sequence from 150 to 312 meters. The pressure core barrel was run from 84 to 88 meters and from 283.5 to 287.5 meters sub-bottom with no success, because of chert. Coring was relatively routine, except between Cores 25 and 26, when the bit became plugged and it was necessary to run a center bit.

The hole was terminated at 1130Z on August 30, after Core 35. The drill string was pulled until 1700Z, and the drill collars and the Bowen power sub were magnafluxed from 1700Z until 2300Z.

During magnafluxing, the ship drifted from the beacon about two miles (Fig. 6). At 2354Z, August 30, the site was abandoned and the ship got under way. The geophysical gear was streamed, and we took up a course to pass over the beacon. We missed the beacon and passed about 1 nautical mile east of the site at 0049Z, August 31, on a course of 180°. We continued on that course until 0157Z, when we turned to 120° for the transit to Honolulu.

LITHOLOGIC SUMMARY

Introduction

Two lithologic units were identified at Site 466, on the northeast part of Mellish Bank, southern Hess Rise (Table 2; Fig. 2). Unit I consists of 245.5 meters of nannofossil ooze which can be divided into two sub-units on the basis of the abundant chert below 84.0 meters. The lower sub-unit, IB, also contains pebbles of vesicular alkali basalt and hematite. Unit II consists of 66.5 meters of olive-gray nannofossil chalk and limestone. Pieces of chert are scattered through this unit, and only chert was recovered in Cores 18 through 27. A thin layer of black pyritic clay is at the top of Unit II in Core 28.

Sub-Unit IA, Nannofossil Ooze (0.0–84.0 m)

Sub-unit Ia is composed of 84.0 meters of nannofossil ooze that contains a few percent siliceous microfossils in the first four cores (Appendix A). Diatoms range up to 7% and average about 2% of the first four cores; radiolarians range up to 10% and average 3 to 4%. Sponge spicules and silicoflagellates occur in trace amounts. Foraminifers occur throughout Sub-unit IA. They compose 5 to 20% of Core 1 and average 3 to 5% of Cores 2 through 9.

The nannofossil ooze generally is very light gray to white, with a few darker-gray streaks caused by finely disseminated pyrite. Sediments in the entire unit are highly disturbed to soupy. In Cores 7 to 9, the light-gray

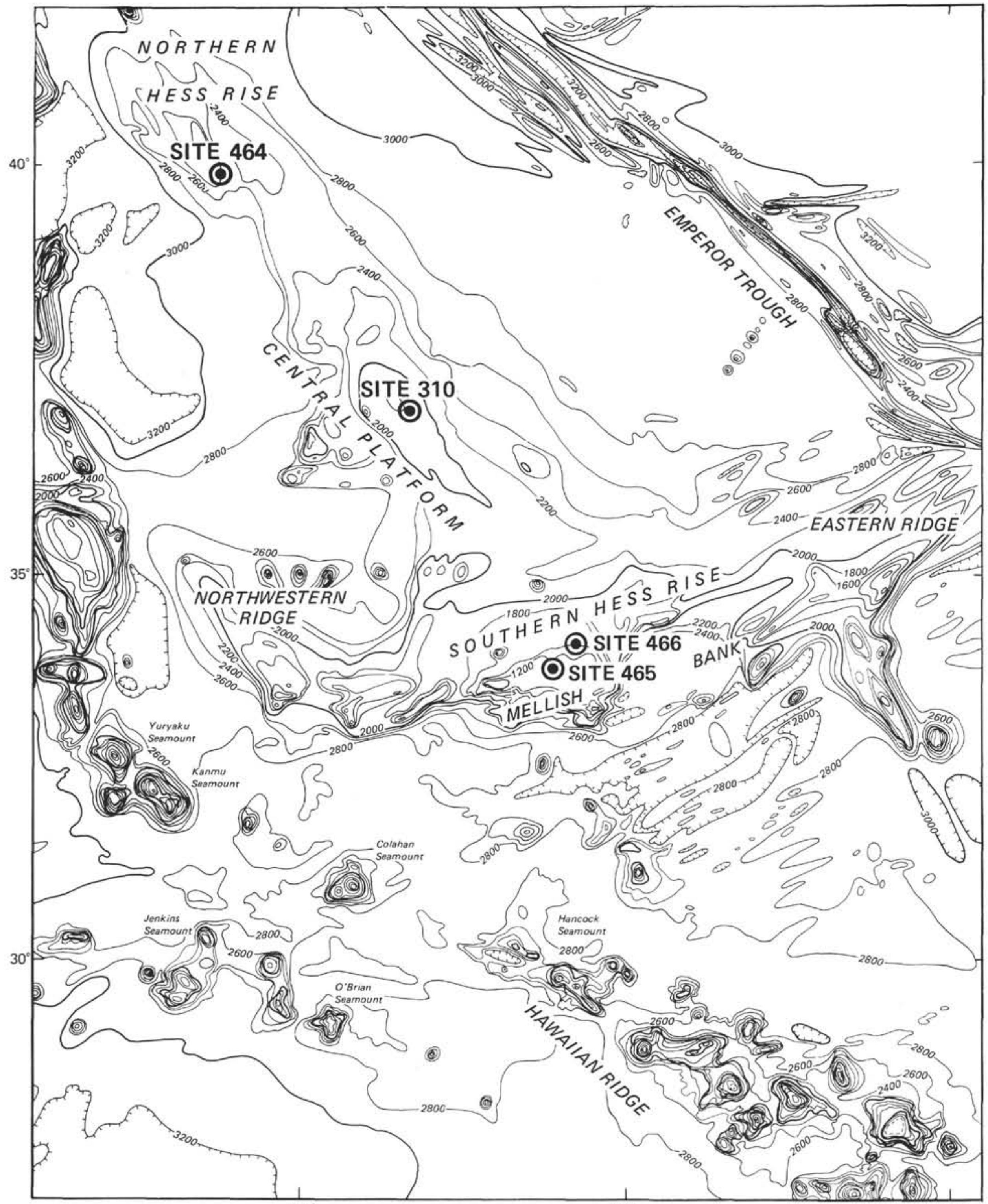

Figure 3. Location map showing sites drilled on Hess Rise. Bathymetry in fathoms (from Chase et al., 1971).

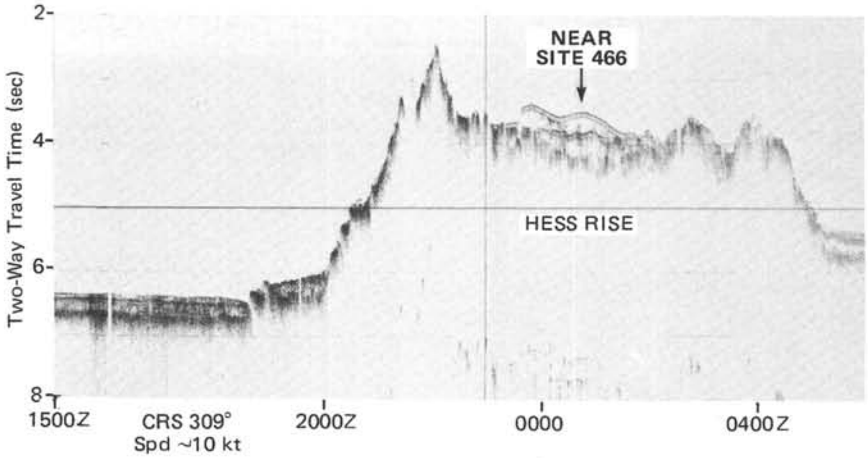

Figure 4. *Vema* 3212 10-second profile, showing approximate location of proposed Site 466.

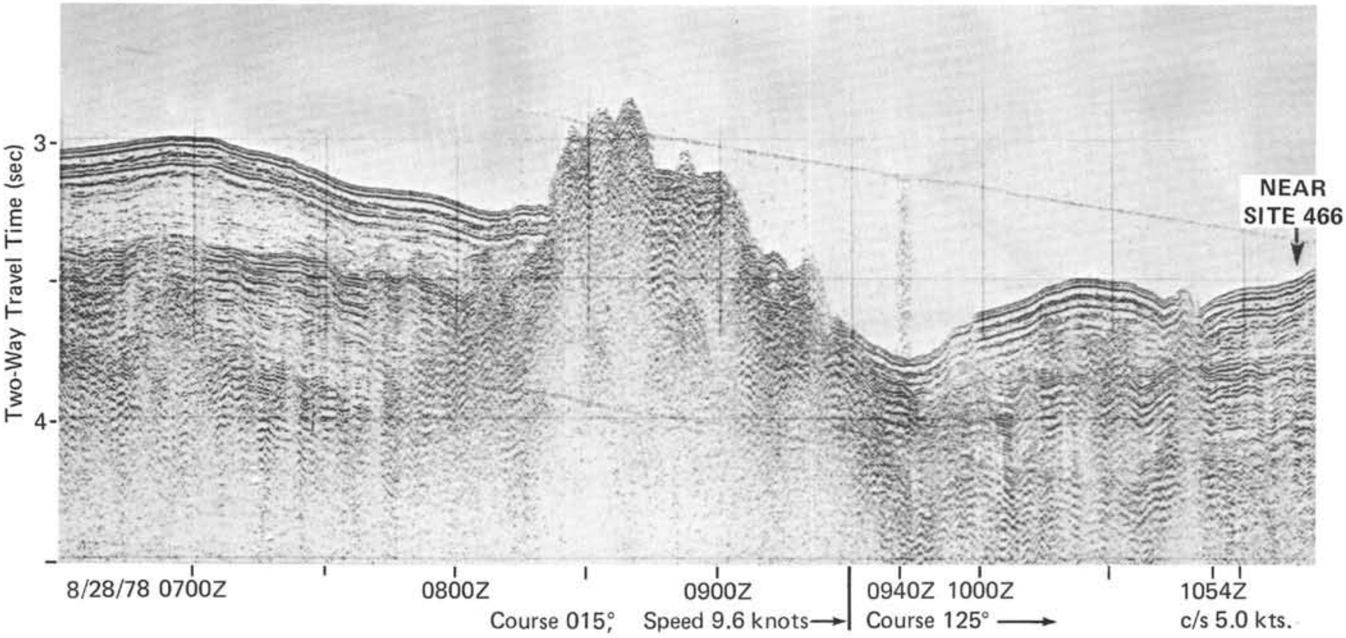

Figure 5. Air-gun seismic-reflection profile between Sites 465 and 466. Beacon drop is about 1 nautical mile northeast of Site 466. This beacon failed, and Site 466 was selected with the use of the 3.5-kHz profile.

to white color changes gradually down-core through pale brown to dark yellowish-brown; some mottling occurs in these lower three cores.

Quartz, feldspar, volcanic glass, clay, zeolites, hematite, and pyrite are present in trace amounts or a few percent in Sub-unit IA. Carbonate preservation is good near the top of the section; Core 1 contains both pteropods and complete coccospheres. The lower part of Sub-unit IA, Core 7 and below, has a significant proportion (30–40%, ranging up to 80%) of recrystallized calcite, both as microcrystalline ($< 1\ \mu m$) flakes and as larger (20–40 μm) crystals. A fragment of gray pumice was recovered between 715 and 718 cm in Core 1. Sub-unit IA ranges in age from Pleistocene to late Eocene. X-ray-mineralogy results are given in Appendix B (see Nagel and Schumann, this volume).

Unit IB, Cherty Nannofossil Ooze (84.0–245.5 m)

Chert, which is rare in the first nine cores recovered from Site 466, increases in abundance through the next 161.5 meters and is the dominant lithology recovered in 13 of the next 17 cores, the other 4 being nannofossil ooze. The abundant chert, presumably interbedded within the ooze, is the basis for the division of Unit I into two sub-units. High pump pressures necessary to keep the bit unplugged during coring of hard layers always washed out the softer sediments. The nannofossil ooze recovered in Sub-unit IB is white (both 10 YR 8/1 and N9) and contains 10 to 15% recrystallized calcite. Foraminifers, commonly as fragments, usually constitute 5 to 10%. Volcanic glass, Fe-Mn micronodules, zeolites, and pyrite all occur in trace amounts.

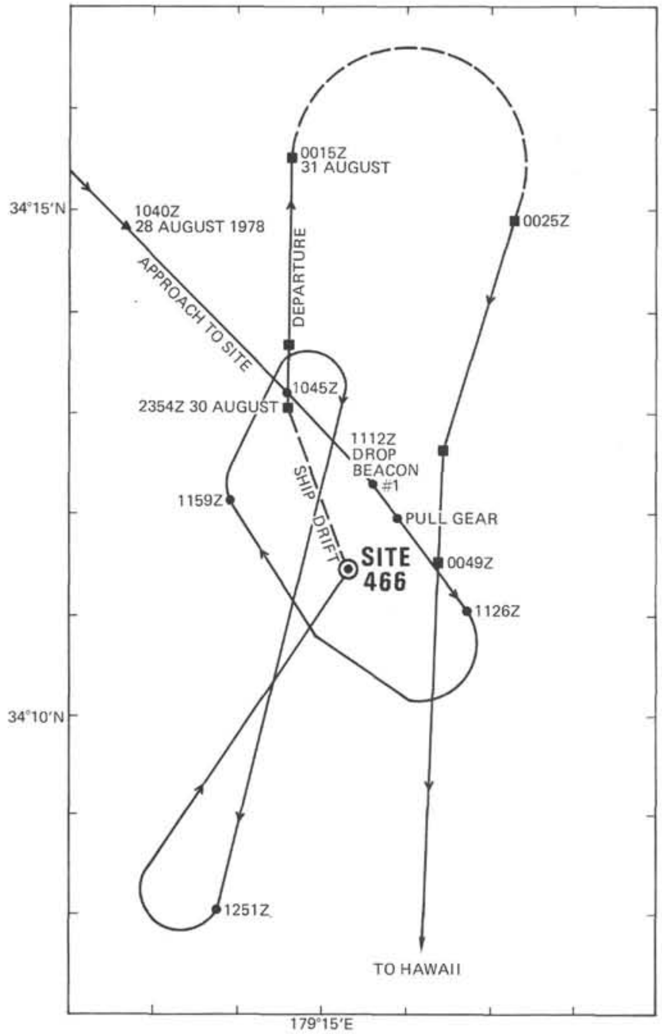

Figure 6. Track lines approaching and departing Site 466. Note the beacon drop (Fig. 5) at 1112Z and final site. Upon departure, the *Challenger* missed the beacon by more than 1 nautical mile during the attempt to pass over the beacon with the air-gun seismic gear streamed.

Table 1. Site 466 coring summary.

Core No.	Date (August 1978)	Time (L)	Depth From Drill Floor (m) Top Bottom	Depth Below Sea Floor (m) Top Bottom	Length Cored (m)	Length Recovered (m)	Percent Recovery
1	29	0917	2672.0-2680.0	0.0-8.0	9.5	8.2	100+
2	29	1011	2680.0-2689.5	8.0-17.5	9.5	9.45	99.5
3	29	1057	2689.5-2699.0	17.5-27.0	9.5	7.94	83.6
4	29	1150	2699.0-2708.5	27.0-36.5	9.5	3.33	35.1
5	29	1243	2708.5-2718.0	36.5-46.0	9.5	7.57	79.7
6	29	1329	2718.0-2727.5	46.0-55.5	9.5	9.43	99.3
7	29	1419	2727.5-2737.0	55.5-65.0	9.5	9.37	98.6
8	29	1511	2737.0-2746.5	65.0-74.5	9.5	8.88	93.6
9	29	1548	2746.5-2756.0	74.5-84.0	9.5	6.63	69.5
10	29	1648	2756.0-2760.0	84.0-88.0	4.0	0.20	5.0
11	29	1740	2760.0-2765.5	88.0-93.5	5.5	1.58	28.7
12	29	1826	2765.5-2775.0	93.5-103.0	9.5	1.07	11.3
13	29	1913	2775.0-2784.5	103.0-112.5	9.5	8.48	89.3
14	29	2005	2784.5-2794.0	112.5-122.0	9.5	0.99	10.4
15	29	2100	2794.0-2803.5	122.0-131.5	9.5	7.03	74.0
16	29	2146	2803.5-2813.0	131.5-141.0	9.5	4.47	47.1
17	29	2244	2813.0-2822.5	141.0-150.5	9.5	1.51	15.9
18	29	2339	2822.5-2832.0	150.5-160.0	9.5	0.31	3.3
19	30	0049	2832.0-2841.5	160.0-169.5	9.5	0.18	1.9
20	30	0147	2841.5-2851.0	169.5-179.0	9.5	0.14	1.5
21	30	0251	2851.0-2860.5	179.0-188.5	9.5	0.09	1.0
22	30	0353	2860.5-2870.0	188.5-198.0	9.5	0.05	0.5
23	30	0450	2870.0-2879.5	198.0-207.5	9.5	0.14	1.5
24	30	0550	2879.5-2889.0	207.5-217.0	9.5	0.15	1.6
25	30	0700	2889.0-2898.5	217.0-226.5	9.5	0.25	2.6
26	30	1121	2898.5-2908.0	226.5-236.0	9.5	0.46	4.8
27	30	1231	2908.0-2917.5	236.0-245.5	9.5	0.06	0.6
28	30	1407	2917.5-2927.0	245.5-255.0	9.5	0.26	2.7
29	30	1534	2927.0-2936.5	255.0-264.5	9.5	2.34	24.6
30	30	1647	2936.5-2946.0	264.5-274.0	9.5	1.10	11.6
31	30	1754	2946.0-2955.5	274.0-283.5	9.5	0.17	1.7
32	30	1851	2955.5-2959.5	283.5-287.5	4.0	0.0	0.0
33	30	2014	2959.5-2965.0	287.5-293.0	5.5	0.0	0.0
34	30	2128	2965.0-2974.5	293.0-302.5	9.5	2.61	27.5
35	30	2246	2974.5-2984.0	302.5-312.0	9.5	0.98	10.1
						105.4	33.78

Table 2. Lithologic units at Site 466.

Unit	Lithology	Cores	Sub-bottom Depth (m)	Thickness (m)	Age (m.y.)
IA	Nannofossil ooze	1-9	0-84.0	84.0	Pleistocene-late Eocene (0-39)
IB	Cherty nannofossil ooze	10-27	84.0-245.5	161.5	Late Eocene-Turonian (39-86)
II	Olive-gray nannofossil chalk and limestone	28-35	245.5-312.0	66.5	Late Albian (100-101)

The cherts (see Hein et al., this volume) present in Sub-unit IB occur in a wide range of colors, mainly shades of brown, grayish brown, and reddish brown. Toward the base of the unit, shades of gray and black become more common among the cherts.

Most sediment recovered in Sub-unit IB is informally termed drilling breccia; it is a composite of hard, usually small (2-30 mm) fragments of the indurated lithologies penetrated in the cored interval. Three sorts of materials observed in the drilling breccias in Sub-unit IB bear special mention. Cores 10 and 11 contained fragments of the large mollusk *Inoceramus*, which has been documented in many DSDP cores (Thiede and Dinkelman, 1977). A small piece of hematite, 2 to 3 cm in diameter was found in Core 10, and another in Core 19. A thin section of the hematite from Core 19 revealed quartz vein and vug fillings and a botryoidal form. Rounded alkali-basalt pebbles, ranging from fine-grained and homogeneous to coarsely vesicular, and from fresh to highly altered, were recovered in Cores 10, 11, 12, 14, 17, 20, 27, 28, and 29. A few small fragments of pumice also occur, usually 1 to 2 cm in diameter, but ranging up to 7 × 3.5 × 2 cm. Colors of the basalt fragments range from medium to dark gray (fresh) to pale yellow (glass groundmass completely altered to palagonite).

The stratigraphic position of these pebbles is very important, because they bear upon the nature and availability of an erodable and nearby source. Recovery of multiple basalt fragments in Cores 10, 11, 12, and 14 suggest that those pieces are near their correct stratigraphic position. Core 17 contained only two small fragments of basalt, and one piece of basalt occurred in each of Cores 20, 27, 28, and 29. The lower hematite fragment is in Core 19. These few pebbles may be downcore contamination. This kind of contamination is not recognizable in the chert fragments, because of the similarity and abundance of chert throughout the section. The basalt pebbles may have been deposited in the Upper Cretaceous nannofossil ooze, or they may have accumulated along the Maastrichtian/middle Eocene unconformity (see Vallier et al., this volume, for a complete discussion). Sub-unit IB ranges in age from late Eocene to Turonian.

Unit II, Olive-gray Nannofossil Chalk and Limestone (245.5–312.0 m)

The dominant lithology of Unit II is an olive-gray and dark-olive-gray nannofossil chalk and limestone more than 66.5 meters thick. Drilling terminated in this unit. Individual pieces of chalk or limestone either are massive or show very faint horizontal laminae. We did not recognize systematic changes in the degree of induration with depth, although the chalky pieces were in places broken up by drilling.

Many intervals of Unit II had an odor of H_2S upon opening the cores. Black chert occurs throughout Unit II, and some pieces have coatings of gray and olive-gray porcellanite. Single small basalt pebbles were found in Cores 28 and 29; presumably these are down-hole contamination from the stratigraphic levels of Cores 10 through 14.

Core 28, the uppermost core in Unit II, did not recover any of the olive-gray carbonate; rather, it contained an abbreviated section of gray chert overlying black pyritic clay. All of Unit II occurs within the same foraminifer zone in the late Albian; it is 100 to 101 m.y. old.

Discussion

The principal reason for moving to Site 466 was to core a thick series of Neogene sediments. This objective was partially fulfilled by the recovery of about 66.5 meters of Pleistocene and Pliocene nannofossil ooze, but the Miocene section was not present. This section appears to be complete through the lower Pliocene, and it shows excellent preservation of microfossils, as indicated by the coccospheres and pteropods. Sedimentation rates for this interval average 16.6 m/m.y. and are higher in the lower part.

The interval below the lower Pliocene in Core 7, Section 4, through Core 10 is a zone of dominantly middle to upper Eocene sediment that contains a significant amount of reworked material. Core 7 below Section 3 contains a mixture of Cretaceous, Eocene, Oligocene, and Miocene materials. Core 8 contains sediments of middle to late Eocene age, and reworked late Cretaceous material. Cores 9 and 10 contain middle to upper Eocene material, a trace of reworked Paleocene material, and reworked upper Cretaceous foraminifers. The entire Eocene section appears very condensed, having accumulated at about 2 m/m.y.; it is bounded by lacunas. Based on shipboard results, it is not possible to determine with confidence whether this Eocene and reworked zone is the result of two episodes of reworking—one in the late Eocene, involving Eocene, Paleocene, and Upper Cretaceous sediment, and another between the early Miocene and early Pliocene, involving sediments of all ages represented in Core 7—or the result of a single, more-extensive episode at this later time. There appears to have been significant reworking during the early Pliocene at Site 465 where the Eocene sediments are missing.

In all of the in-place and reworked sediments at Site 466 there is only a trace of the extensive Paleocene to upper Maastrichtian section recovered about 50 km to the southwest at Site 465. This nearly complete absence of the Cretaceous/Tertiary boundary section, even among the reworked material, is remarkable, because Site 466 appears to lie downslope from Site 465. We have no satisfactory explanation for the near absence of these sediments, but it must be the result of significant local variations in deposition, erosion, and redeposition of the pelagic materials.

A lacuna representing more than 20 m.y. occurs between the middle Eocene sediments of Core 10 and the lower Maastrichtian to upper Campanian sediments of Cores 11 through 15. The Upper Cretaceous (lower Maastrichtian–upper Campanian) sedimentation rate is approximately 40 m/m.y. Pebbles of alkali basalt occur in this interval. The existence of alkali basalt on southern Hess Rise provides some evidence of the type of volcanism that occurred. The large numbers (probably more than 50) of basalt pebbles, up to several centimeters in diameter, in a section of nannofossil ooze strongly implies that there is a nearby source directly upslope from Site 466. In addition, this source apparently was not present before late Campanian time, or similar basalt pebbles would be much more common lower in the section.

To explain the rather sudden appearance of basalt, presumably some 35 or 40 m.y. after the cessation of volcanism, the structural geology of Hess Rise has to be considered. Site 466 is about 5 km northwest of the southeast edge of a graben that crosses this part of Mellish Bank from southwest to northeast. The graben ranges from 12 to 16.5 km wide and 500 to 550 meters deep, and it is partly to completely filled with sediment (Fig. 7). Sediment cover on the uplifted southeastern margin of the graben is minimal or nil. This region is the most likely source for the abundant basalt pebbles in the Campanian to Maastrichtian oozes; the average slope between the source and site of deposition of the pebbles is more than 5°, steeper than most continental slopes.

We suggest, therefore, that the basalt became available for erosion sometime in the Campanian to Eocene interval, about 70 to 50 m.y. ago, most likely in the late Campanian, as a result of normal faulting that raised the basalt several hundreds of meters relative to the present Site 466. Any sediment covering the sea floor would have been raised along with the basement, and may have been winnowed down into the newly formed graben. Such an episode of normal faulting could explain both the influx of basalt pebbles and the higher-than-normal linear sedimentation rates of the upper Campanian to lower Maastrichtian ooze. The high sedimentation rates at this time at Site 465, 50 km to the southwest, may have had a similar cause: Site 465 is in a similar, although somewhat smaller, structural depression.

The basal sedimentary unit recovered at Site 466 is composed of olive-gray nannofossil limestone and chalk

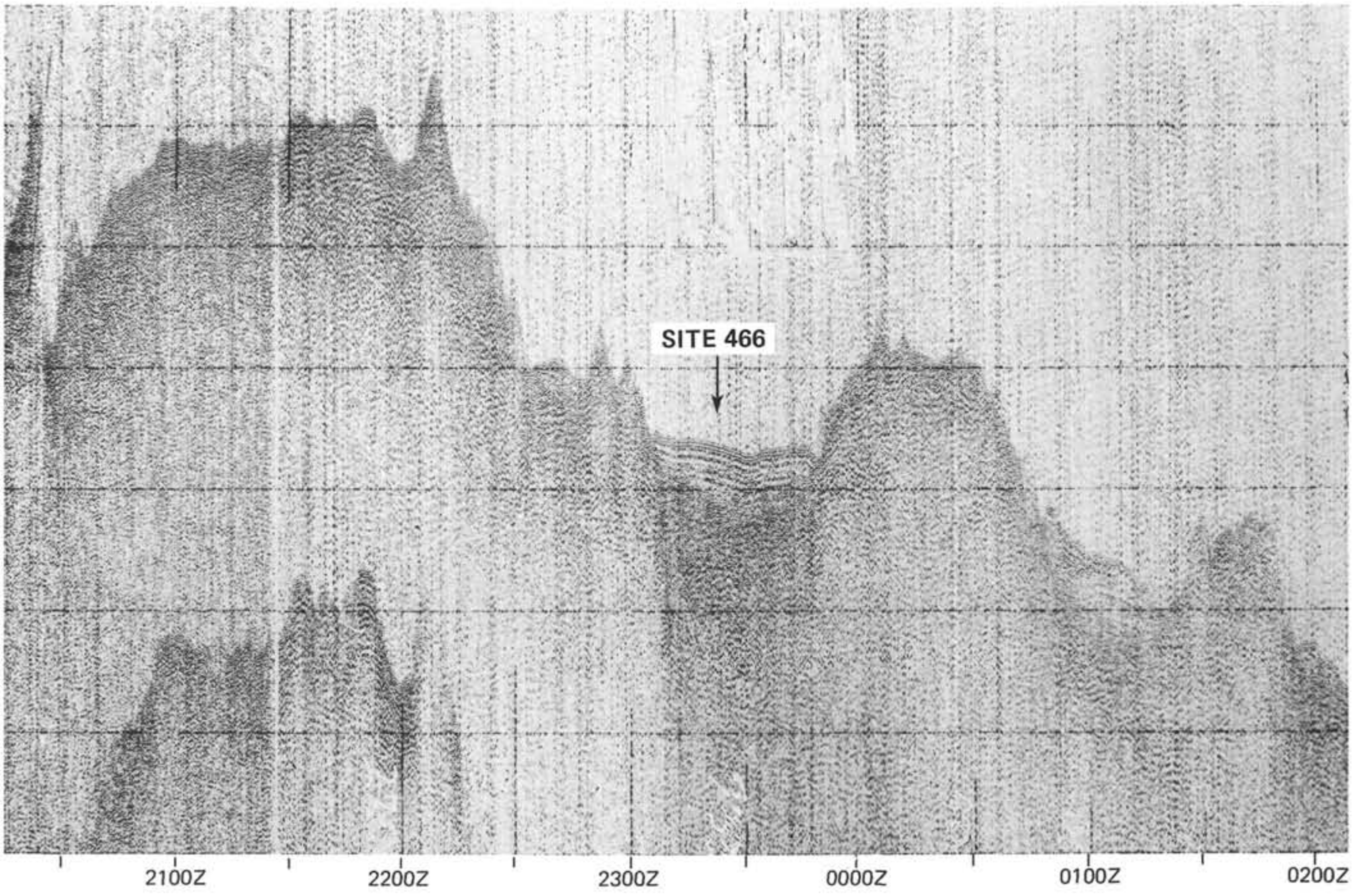

Figure 7. Air-gun seismic-reflection profile made by *Glomar Challenger* during Leg 55, passing within 10 km of Site 466. The small graben in which Site 466 was located is shown by the arrow. The broad area to the left (south) is the eastern end of Mellish Bank. Ship speed was about 8.0 knots.

of late Albian age. This unit displays faint horizontal laminations and is similar in lithology to the slightly lighter-colored basalt sedimentary unit of the same age at Site 465. This unit is the lateral equivalent of the upper Albian limestone at Site 465.

In gross aspect, the sediments at Site 466 are similar to those recovered at Site 465: nannofossil ooze overlying to olive-gray, laminated limestone. Higher sedimentation rates occurred at both sites during the same three intervals of the Late Cretaceous: late Albian, early Santonian, and late Campanian to early Maastrichtian. The most obvious difference between the two sites are that the Paleocene–Maastrichtian section, so well displayed at Site 465, is nearly absent at Site 466, only 50 km away, and that the Plio–Pleistocene section is much thicker at Site 466.

Sedimentation at Site 466 probably began in late Albian time, with the deposition of the olive-gray chalk and limestone, perhaps as turbidites originating from Mellish Bank. These turbidites probably overlie volcanic basement similar in age to that recovered at Site 465. Turbidite deposition ceased sometime during the late Albian, and siliceous and calcareous pelagic sedimentation began to dominate. This major change in the character of sedimentation, which occurred at about the same time at both Sites 465 and 466, may indicate the submergence of Mellish Bank below wave base.

Pelagic oozes continued to accumulate on the subsiding Hess Rise. Sediments deposited during the late Campanian contain evidence of an episode of faulting, resulting in formation of the graben. The northeasterly trend of the graben is parallel to the trend of some other major structural features of southern Hess Rise, implying that this Late Cretaceous faulting may have been very extensive. Therefore, the basalt pebbles in Upper Cretaceous oozes may date a major post-formation tectonic event of Hess Rise.

There is a lacuna between lower Maastrichtian and Eocene sediments, with little evidence of the thick section 50 km away at Site 465 containing the Cretaceous/Tertiary boundary. Much of the Tertiary is missing. At least one important time of reworking, as indicated by the mixed assemblage in Cores 7, 8, 9, and 10, occurred in the early Pliocene; reworking of similar age also occurred at Site 465. Sediments possibly were reworked also during the late Eocene. Normal to rapid pelagic sedimentation resumed in early Pliocene time and continues to the present, resulting in a thick, well-preserved section.

Igneous Rocks

Rounded pebbles of altered alkali basalt were studied in Cores 10, 11, 12, 14, 19, and 29. Most pebbles were concentrated in the core catchers along with chert fragments and pebbles (Vallier et al., this volume).

The basalt pebbles range from non-vesicular to highly vesicular and amygdaloidal. Vesicles are spherical and vary from 0.05 to 3.3 mm in diameter. Amygdules are filled with one or more of the minerals calcite, phillipsite, and smectite. Phenocrysts of plagioclase, olivine, clinopyroxene, and opaque minerals are set in glassy groundmasses with intersertal and pilotaxitic textures. Calcite, smectite, and iddingsite replace olivine, and clinopyroxene is commonly replaced by calcite or smectite. Smectite replaces glassy groundmasses.

Most basalt pebbles are alkalic, judging from their mineralogies and clinopyroxene chemistries. Alkali basalt is characteristic of late-stage edifice-building on oceanic islands and large seamounts. Our limited data suggest that Site 466 was near an oceanic island or islands which provided clasts to the site during the Late Cretaceous or early Tertiary.

INTERSTITIAL-WATER GEOCHEMISTRY

Results of shipboard measurements of *p*H, alkalinity, salinity, calcium, magnesium, and chlorinity in interstitial water from three whole-core sediment samples are presented in Figure 8. These three samples show no significant variation with depth through 110 meters of nannofossil ooze, and none of the six parameters differs significantly from concentrations in surface sea water.

PHYSICAL PROPERTIES

For the soft sediments of Cores 1 to 27 (nannofossil ooze), wet-bulk density and sound velocity were measured by the analog GRAPE technique and Hamilton frame velocimeter. Thermal conductivity was measured on each core by QTM. Only three mini-cores of limestone and chalk (below Core 29) were taken for measurements of velocity and wet-bulk densities by 2-minute GRAPE and gravimetric techniques. All the measured values of sound velocity, wet-bulk density, porosity, water content, and thermal conductivity at room temperature are shown in Figure 9 and listed in Appendix C.

Two acoustic units have been recognized; acoustic unit I can be divided into two sub-units on the basis of the increase of wet-bulk density below 60 meters. The boundary between Sub-units IA and IB does not strictly correspond to that between lithologic units, partly because of drilling effects and sampling. The mean values of wet-bulk density, interval velocity, thermal conductivity, and DT (double-way travel times) are listed in Table 3.

CORRELATION OF SEISMIC-REFLECTION PROFILES AND DRILLING RESULTS

Two major acoustic units, distinguished easily on the air-gun seismic-reflection profile, can be correlated with drilling results at Site 466 (Figs. 9 and 10). The first acoustic unit, 0.27 seconds DT (two-way time) thick, correlates with Lithologic Unit I, nannofossil ooze and chert. The calculated interval velocity, 1.85 km/s, does not correspond to the mean velocity calculated from sample measurements (1.52 km/s), probably because not enough velocities were determined on chert, which makes up a significant part of the unit.

The thickness of Lithologic Unit II is unknown, because the drill string penetrated only the upper 66 meters. A reflector at 0.52 seconds DT may correspond to igneous basement. If so, taking a measurement of 2.72 km/s as the average velocity for the unit (0.25 sec thick), the nannofossil chalk and limestone of Unit II may be as thick as 340 meters.

Drill time corresponds well with the change in lithologies between Units I and II. Drilling time increased at about 250 meters sub-bottom, where the nannofossil chalk and limestone of Unit II was penetrated.

BIOSTRATIGRAPHY

Biostratigraphic Summary

Continuous coring at Site 466 penetrated 312 meters of sediment, ranging in age from Pleistocene through

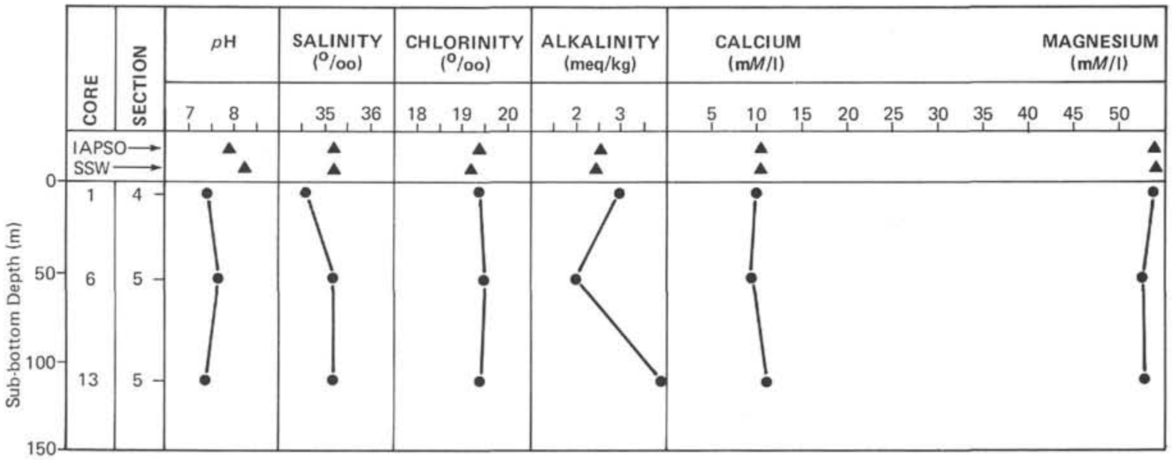

Figure 8. Interstitial-water geochemistry, Site 466.

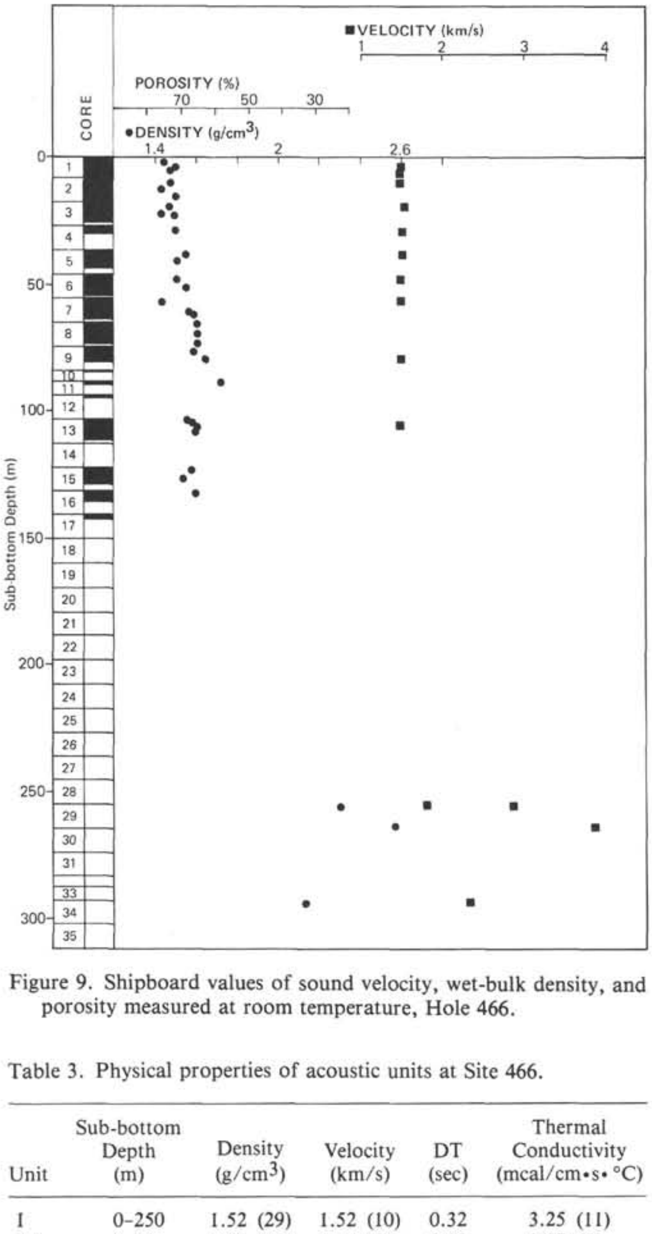

Figure 9. Shipboard values of sound velocity, wet-bulk density, and porosity measured at room temperature, Hole 466.

Table 3. Physical properties of acoustic units at Site 466.

Unit	Sub-bottom Depth (m)	Density (g/cm^3)	Velocity (km/s)	DT (sec)	Thermal Conductivity (mcal/cm•s•°C)
I	0–250	1.52 (29)	1.52 (10)	0.32	3.25 (11)
IA	0–60	1.48 (15)	1.51 (8)	0.08	3.07 (6)
IB	60–250	1.59 (14)	1.57 (2)	0.24	3.46 (5)
II	250–	2.30 (3)	2.72 (4)	0.25	4.93 (3)

Note: Number of samples is in parentheses.
[a] Estimated from seismic reflection (Fig. 5).

late Albian. Two major hiatuses occur in the Cenozoic, covering the late Miocene through the Oligocene (~35 m.y. duration) and most of the middle Eocene through the early Maastrichtian (~20 m.y. duration). The extent of hiatuses in the Cretaceous is difficult to assess, because of poor recovery. Most of the early Campanian and the late Santonian are missing (6 m.y.), as are the early Turonian and all of the Cenomanian (10 m.y.). Other sequences, such as the Coniacian and late Turonian, may be condensed.

Planktonic foraminifers and calcareous nannofossils are present through most of the section, although below the Campanian they usually are rare and poorly preserved. Radiolarians are common and well preserved in the Plio-Pleistocene, and moderately well preserved in the upper Albian. Diatoms are present only in the Plio-Pleistocene; they are moderately well preserved but rare.

From top to bottom, the section may be divided into five biostratigraphic units:

1) 66 meters of nannofossil ooze (Cores 1-7, Section 1 of Core 8), representing an apparently complete sequence from the upper Pleistocene to the lower Pliocene. Calcareous nannofossils are abundant and well preserved. Planktonic foraminifers are poorly preserved—surprisingly so, in view of the shallow depth at this site (2665 m). Radiolarians are common and well-preserved. Diatoms, present in Cores 1 to 5, are rare and moderately well preserved. The interval from Core 7, Section 4, to Core 8, Section 1, shows reworking of foraminifers and calcareous nannofossils, and includes representative species from the middle and late Miocene, late Oligocene, middle and late Eocene, and Late Cretaceous.

2) 22 meters of upper and middle Eocene nannofossil ooze (Cores 8-10). Calcareous nannofossils are abundant and well preserved, and indicate varying amounts of reworking. The planktonic foraminifers are also well preserved and show reworking of Eocene, Paleocene, and Cretaceous species. No siliceous fossils are present. Possibly the majority of fossils in this unit are redeposited from one or more sources elsewhere on the rise.

3) 47 meters of lower Maastrichtian to lower Campanian cherty nannofossil ooze (Core 11 to Core 16, Section 3). Calcareous nannofossils are abundant and moderately well preserved, whereas foraminifers are rather poorly preserved.

4) 120 meters of lower Santonian to upper Turonian cherty nannofossil ooze (Core 16,CC through Core 28; only chert was recovered throughout most of the interval). Because of the poor recovery in much of this interval (only cores 16 and 17 contain sediment, the remainder consisting of water cores and chert), biostratigraphic information is imprecise. Calcareous nannofossils are abundant in the upper part of the unit, and few to common in the lower part. They are poorly preserved throughout. Planktonic foraminifers are well preserved, although fragmented, in the upper part; only smaller ones are found in the water samples.

5) 57 meters of upper Albian nannofossil chalk and limestone (Cores 29-35). The calcareous nannofossils are rather poorly preserved, as are the planktonic foraminifers, which are partially recrystallized. The benthic foraminifers include both recrystallized and unaltered forms. Radiolarians reappear in this interval, and are well preserved, although of rather low diversity.

A summary of the various fossil zonations plotted against sub-bottom depth is presented in Figure 11.

Calcareous Nannofossils

Nannofossils are generally abundant in all soft sediments obtained from the thirty-five cores of Site 466. In the nannofossil oozes and cherty nannofossil oozes of Unit I, we recovered nannofossil assemblages of Plio-

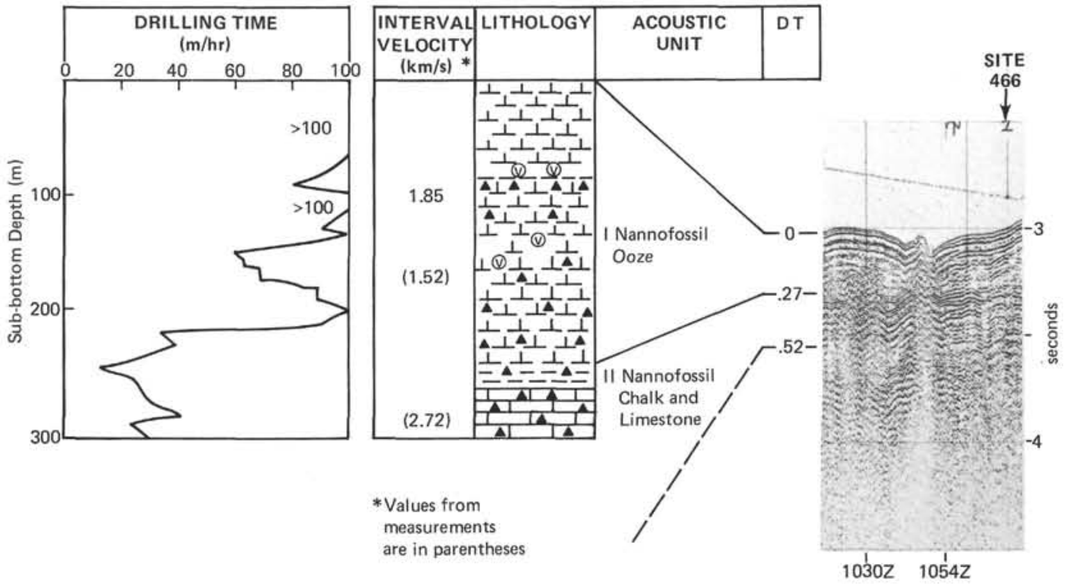

Figure 10. Correlation of seismic-reflection profile and drilling results, Site 466.

cene to Recent age, middle and late Eocene(?) age, Campanian and early Maastrichtian age, and late Turonian to early Santonian age. In the nannofossil chalks and limestones of Unit II to the bottom of the hole, the nannofossils belong to the *Eiffellithus turriseiffeli* Zone (100–104 m.y.), of late Albian age.

The nannofossil assemblages tentatively assigned to the middle and late Eocene may not be *in situ*, but may represent displacement of more or less homogeneous sediments, perhaps as slumps from nearby outcrops. In the mixed association of Cores 7 through 10, age was determined by the youngest nannofloral assemblage found. If these nannofloras were redeposited, the time at which redeposition occurred could be as recent as early Pliocene.

Cenozoic (Cores 1–10; 0–88 m)

In samples from the top of Core 1 (Sections 1 through 4, 17 cm), assemblages of abundant and well-preserved nannofossils are assigned to the *Gephyrocapsa oceanica* (NN20)/*Emiliania huxleyi* (NN21) zonal interval, of late Pleistocene to Recent age. Samples from the bottom of Core 1 and from Core 2 contain well-preserved assemblages of the *Pseudoemiliania lacunosa* (NN19) Zone, of early Pleistocene age. Very little reworking is noted in the Pleistocene.

In samples from the core catcher of Cores 3 and 4, assemblages of well-preserved nannofossils are assignable to the *Discoaster surculus* (NN16)/*Discoaster brouweri* NN18) zonal interval, of late Pliocene age.

Samples from the interval Core 5,CC to Core 8, Section 1, contain a species association characteristic of the *Discoaster asymmetricus* (NN14) Zone, of early Pliocene age. The nannofloras are well-preserved, but are slightly to moderately etched; they contain abundant discoasters and ceratoliths.

From Core 7, Section 4, 106 cm, to the top of Core 8, various reworked assemblages of moderate preservation are found intermixed with Pliocene (NN14) associations. The following age categories have been recognized (considering the most-diagnostic species and least number of zones needed to explain species presence): (1) middle and late Miocene (NN8–NN11), (2) late Oligocene (NP23–NP24), (3) late Eocene (NP17–NP19), (4) middle Eocene (NP14–NP15), (5) late Cretaceous (late Campanian).

These associations are present in various percentages in the studied samples and show varying preservation. Some of the nannofloras appear to be unmixed, or show only slight mixing of older components. A sample from the top of Core 8 is the lowest that can be determined to be of Pliocene age.

Samples from Core 8, Section 2, through Core 10, 66–88 cm, contain some mixing, but often are fairly homogeneous associations of middle and late Eocene age. Most samples from Core 8 show almost unmixed assemblages of species representing Zones NP17 to NP19; samples from Core 9 have mixed species from Zones NP19 to NP19, Zones NP14 to NP15, and Cretaceous species; and a sample from Core 10 contains an unmixed assemblage representing Zone NP14.

Mesozoic

Abundant and moderately well-preserved nannofossils are found throughout the lower Campanian to lower Maastrichtian section. Predominantly poorly preserved calcareous nannofossils were recovered from the upper Albian through lower Santonian section. In Core 21,CC some coccoliths are present in which the calcium carbonate is replaced by silica. A sequence of five nannofossil zones or zonal intervals has been recognized:

1) Upper Campanian to lower Maastrichtian (Core 11), *Tetralithus trifidus* Zone.

2) Upper Campanian (Core 12, Section 1, to Core 15,CC), *Tetralithus gothicus* Zone.

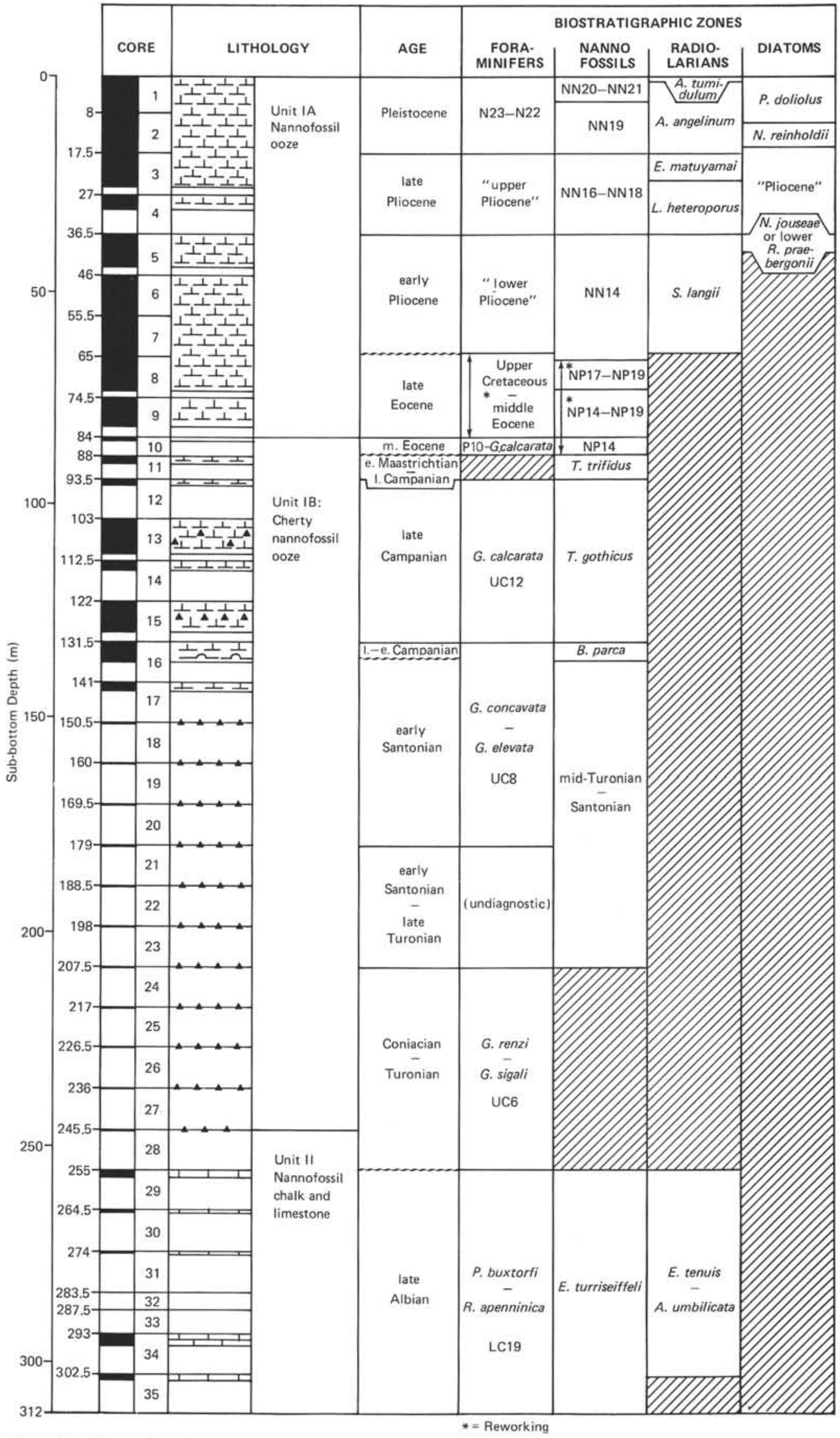

Figure 11. Biostratigraphy of Site 466.

3) Lower to Upper Campanian (Core 16, Section 1 to Section 3), *Broinsonia parca* Zone.

4) Middle Turonian to Santonian (Core 16,CC to Core 23,CC). This interval, with few to abundant coccoliths, is characterized by the lack of certain species important to the zonation. The upper limit of this zonal interval is determined by the first occurrence of *Broinsonia parca*, and the lower limit by the first occurrence of *Micula staurophora*.

5) Late Albian (Core 29, Section 1, through Core 35,CC), *Eiffellithus turriseiffeli* Zone.

Cores 24 through 28 are barren of coccoliths and consist of chert.

Foraminifers

Coarse Fraction (>63 μm) Components; Abundance and Preservation of Foraminifers

A visual estimate of the relative abundance of the main components of the sediment coarse fraction is presented in Appendix D. When no cores were recovered in the lower part of the section, the residue from water flowing out of the core liner was examined.

Planktonic foraminifers are the main components of the coarse fraction throughout the oozes of Lithologic Units IA and IB (Cores 1-27). They are poorly preserved in the Neogene (Core 1 through Core 7, Section 5). They are mostly well-preserved in the biostratigraphically mixed interval (Core 7, Section 7, through Core 10), except in a few horizons in which they are poorly preserved; benthic species dominate these assemblages, and fish remains especially abundant. Foraminifers are moderately well preserved in the Campanian to Santonian section (Cores 13-22), and mostly poorly preserved, because of recrystallization, in the Coniacian to Turonian sediments (Cores 24 and 25). Radiolarians are rare, but occur consistently throughout the Neogene (Core 1 through Core 7, Section 5); they are absent in the remainder of this sequence. Various rock fragments are common in the interval between Cores 10 and 16. Down to Core 16, there are rare occurrences of sponge spicules and echinoderm fragments. A large concentration of echinoderm spines (composed of dissolution-resistant calcite) is noticeable in the core catcher of Core 6. Fish remains are present throughout the mixed interval between Cores 7 and 10, and are especially abundant in the bottom of Core 9, in which the calcareous elements are mainly dissolved.

Of special interest are the large concentrations of phillipsite at the base of the Neogene section in Core 7, associated with reworked calcareous oozes of Oligocene, Eocene, Paleocene, and Cretaceous age. All transitions were observed between large (about 500 μm) twinned-crystal aggregates with excellent terminations and those which have been severely abraded. The delicate crystal terminations protruding from many of the crystal aggregates indicate that the phillipsite formed *in situ*, but the rounding of some aggregates also suggests some mechanical abrasion.

In the chalk and limestone of Lithologic Unit II (Cores 28-35), partly recrystallized foraminifers, radiolarians, limestone chips, and quartz grains are the main components of the coarse fraction.

Neogene

An apparently continuous Pleistocene through lowermost Pliocene sequence was recovered at Site 466. Throughout this section the foraminifer assemblages are poorly preserved, as shown by a large amount of fragmentation, concentration of resistant species, and a low planktonic/benthic ratio. Temperature-resistant species dominate the assemblages; variations in relative abundance reflect surface-temperature fluctuations.

Cores 1 and 2 are of Pleistocene (N23-N22) age, Cores 3 and 4 of late Pliocene age, and Core 5 through Core 7, Section 6, of early Pliocene age. A few reworked Upper Cretaceous and Eocene species were found in Core 7, Sections 4 through 6; Section 7 contains a mixed Oligocene, Eocene, and Cretaceous fauna.

Paleogene

Paleogene sediments were recovered from the mixed interval from Section 7-7 to Core 10. Each sample contains a different mixture of Eocene, Oligocene, Paleocene, and Cretaceous fossils; however, pure Oligocene faunas appeared only in Section 7-7, and Paleocene only in 10,CC. Representative fossils include: *Globoquadrina venezuelana* and *Turborotalia opima nana* (Oligocene); *Acarinina densa* and *Globigerinatella kugleri* (middle Eocene); *Morozovella aragonensis* and *M. quetra* (early Eocene); *M. velascoensis* and *M. occlusa* (Paleocene). The middle Eocene acarinids and globigerinathekids are recrystallized and darker than the lower Eocene-Paleocene forms.

The unmixed Cretaceous sediments are Maastrichtian to late Campanian in age. The presence of an excellently preserved specimen of *Globotruncana calcarata* (10,CC) is significant, as this fossil does not occur in sediments from the *G. calcarata* interval at this site.

Cretaceous

The Cretaceous section recovered at this site includes lower Maastrichtian-upper Campanian, lower Santonian, upper Turonian-lower Coniacian, and upper Albian faunas. Preservation in the Upper Cretaceous is only moderately good, while many fossils in the Albian section are poorly preserved. Most of the samples below the *Globotruncana tricarinata-G. calcarata* zonal interval are only core-water samples, so many if not all of the largest globotruncanids were not recovered, and it was difficult to assign zones to many of the samples. The following zonal assignments can be made:

Campanian. Only the *G. calcarata* Zone (12-15,CC) was recognized from core catchers at this site, although nannofossil data suggest that some older Campanian is present in Core 16. The index form *G. calcarata* was not found within this interval. Foraminifers are moderately dissolved, and the benthic forms are rare.

Santonian. Only the *G. concavata-G. elevata* Zone (16,CC-21,CC) was recognized, because *G. carinata* ranged throughout the samples. Most samples were water samples; the few core catchers (16,CC and 18,CC) contained some moderately well-preserved adult planktonic foraminifers. In water samples, only a few adult planktonic forms occurred in a predominantly chert and fine-fraction matrix. *Inoceramus* chunks were recognized in Cores 19 and 21.

Turonian-Coniacian. The *G. renzi-G. sigali* Zone (24–28,CC) was identified. Both zonal fossils were found, although the number of globotruncanids recovered was small. A larger orbitoidal foraminifer fragment (25,CC) suggests redeposition of shallow-water material.

Albian. The *R. apenninica-P. buxtorfi* Zone (21-1 to 33) was recognized, although *P. buxtorfi* was not found at this site. Faunas of hedbergellids, *R. apenninica*, and some *Ticinella* spp. were neither diverse nor particularly well preserved. Most planktonic foraminifers were partly recrystallized, and the benthic forms in 29,CC were silicified.

Radiolarians

At Site 466, two distinct radiolarian assemblages were recovered: (1) a Pliocene to Quaternary sequence in the upper 61 meters, and (2) a Cretaceous sequence in the lower 85 meters.

Pliocene to Quaternary Radiolarians

From the top of Core 1 through Sample 7-3, 120 cm, a continuous biostratigraphic series contains abundant to common, moderately well-preserved radiolarians. The darker uppermost 21 cm (Samples 1-1, 0 cm to 1-1, 20 cm) are upper Pleistocene (*Artostrobium tumidulum* Zone). Characteristic of this level are the relatively low number of species and the absence of many species known to occur in living subtropical plankton. From Sample 1-1, 20 cm to 7-3, 122 cm, all Pliocene and Quaternary zones are present. Variations in the relative abundance of water-mass indicator species reflect shifting of the various water masses in the central Pacific during the Pliocene and Quaternary. The relatively good preservation of the assemblage at this shallow-water site (2665 m) is noticeable. Radiolarians disappear with the first appearance of zeolites in Core 8.

Cretaceous Radiolarians

Cretaceous radiolarians are present in 28,CC. They are broken, and belong essentially to the Spongodiscidae. From Core 29 to 34, the fauna is datable and belongs to the *Eucyrtis tenuis* Zone to the *Acaeniolyte umbilicata* Zone. The best-preserved radiolarians were found in Cores 21 and 34. The characteristics of this assemblage are (1) the absence of members of Subfamily Saturnalinae (as at Site 465), (2) the distinct dominance of the Spongodiscidae, perhaps a characteristic of a shallow-water fauna, and (3) the lower diversity of the fauna compared to that at Site 463.

Diatoms

Diatoms are present in very low numbers at Site 466, and occur only in the upper five cores. Most of the individuals are representative of long-ranging species. Core 1 through Core 2, Section 1, belong to the *Pseudoeunotia doliolus* Zone of the late Pleistocene. Core 2, Sections 2 through 4, falls within the *N. reinholdii* Zone of the early Pleistocene. Cores 3 and 4 lack zonal markers, but the species associations indicate that these cores are Pliocene. Core 5, Sections 1 and 2, contains early Pliocene species of the *Nitzschia jouseae* Zone. Diatoms are absent below this level.

SEDIMENTATION RATES

Average sedimentation rates at Site 466 (Table 4) have been estimated using the time scales agreed upon for Leg 62 (see introduction to this volume). In Figure 12, the Cenozoic part of the accumulation curve was constructed mainly from nannoplankton data for the sake of clarity (although foraminifer and radiolarian data are in agreement with those of the nannoplankton), and from nannoplankton and foraminifer data for the Cretaceous.

The relatively high rate of sedimentation, 28 m/m.y., for the upper Albian (Cores 29–35) is a minimum rate. It was calculated using the age of the last occurrence of the nannofossil *E. turriseiffeli* in Core 29, and the age of the base of the *P. buxtorfi* foraminifer zone in Core 35. It is not known, however, if this zone extends below this level. It is probable that the upper Albian rate is higher, in view of the high value obtained in the upper Albian at nearby Site 465 (48 m/m.y.). The high sedimentation rate for upper Albian sediments possibly results from crossing the equatorial high-productivity zone, according to the model of Lancelot and Larson (1975), and from the occurrence of distal turbidites recognized in this interval.

A 12-m.y. hiatus spans the interval encompassing the Cenomanian through middle Turonian. A moderate sedimentation rate of about 12 m/m.y. occurred during the late Turonian through the Conacian. Sedimentation increased abruptly in the lower Santonian, reaching a value of 24 m/m.y.

There is a hiatus of 9 m.y. spanning the late Santonian and early Campanian. The same hiatus occurs at Site 465.

A relatively high sedimentation rate, 33 m/m.y., was calculated for upper Campanian and lower Maastrichtian sediments. This rate is similar to that of Site 465. Basalt pebbles in this interval at Site 466 show evidence of nearby uplift of basement.

A hiatus of 20 m.y. spans an interval from early Maastrichtian to middle Eocene. A similar hiatus was recognized at Site 463. Sedimentation during the middle and upper Eocene appears to have been very reduced, with a lower value of 2 m/m.y.

A major hiatus of 34 m.y. spans the Oligocene to earliest Pliocene. After this hiatus, moderate sedimentation occurred during the Pliocene. The sedimentation rate of 15 m/m.y. may be somewhat higher than normal as a result of the influx of displaced older sediments (Oligocene, Eocene, and Late Cretaceous) in this area. From the upper Pliocene to the Recent, a continuous undisturbed sequence accumulated at an average rate of 10 m/m.y.

Table 4. Thickness and sedimentation rates at Site 466.

Series or Stage	Sub-bottom Depth of Lower Boundary (m)	Thickness (m)	Duration of Interval (m.y.)	Average Sedimentation Rate (m/m.y.)
Pleistocene	17.5	17.5	1.8	10
Pliocene	66.5	49.0	3.2	15.3
Upper to middle Eocene	88	21.5	11	2
Lower Maastrichtian to upper Campanian	131.5	43.5	1.3	33
Lower Santonian	179.0	47.5	2	24
Coniacian to Turonian	255.0	76.0	6	12
Upper Albian	312	57	2	28

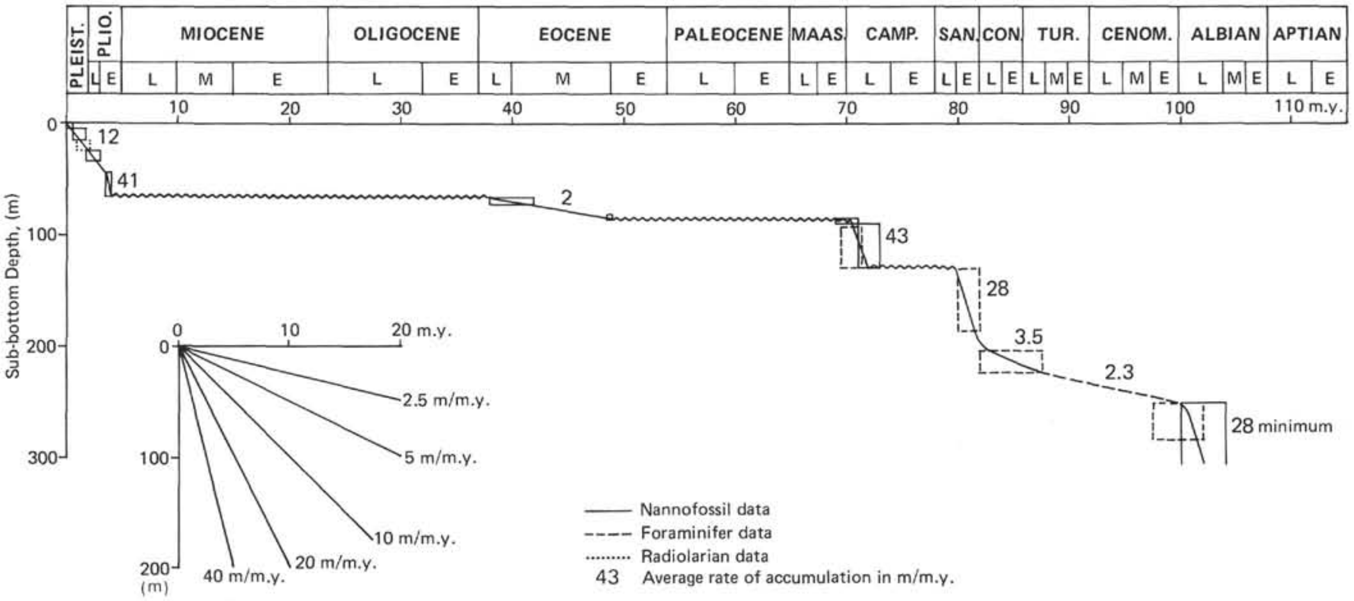

Figure 12. Sedimentation-rate curve for Site 466.

SUMMARY AND CONCLUSIONS

Regional Framework

Site 466 is situated in 2665 meters of water, approximately 50 km northeast of Site 465. Site 466 is in a 12- to 16-km-wide and 500- to 550-m-deep graben which was visible on the seismic-reflection profile (Fig. 5) obtained during the site approach (compare also Figs. 4 and 7). Because of time limitations, we were unable to reach basement, but common reworked and altered basalt pebbles allow us to describe some of the diversity of extrusives of the volcanic edifice under southern Hess Rise.

The 312-meter section of pelagic calcareous sediment at Site 466, only slightly more than 500 meters deeper than adjacent Site 465, is an excellent supplement to the deposits previously recovered from Hess Rise. The Site 466 sedimentary section reveals close similarities to that of Site 465, consisting dominantly of pelagic sediments deposited under the same surface-water currents. Therefore, both sites simultaneously recorded changes in North Pacific paleoceanography as southern Hess Rise moved from its Cretaceous equatorial position to its present location under the temperate surface water of the north-central North Pacific water mass. However, the sites are surprisingly different, probably because of differences of the local depositional settings. A site-summary chart (Fig. 13) shows the major data from sediment studies.

Biostratigraphic Framework of the Cored Section

The principal reason for moving to Site 466 was to core a thick section of Neogene deposits. This objective was partially fulfilled by the recovery of 66.5 meters of Pleistocene and Pliocene nannofossil ooze which contained representatives of all important planktonic-microfossil faunas (diatoms, radiolarians, silicoflagellates, nannofossils, and foraminifers). The lower Pliocene sediments are underlain by an interval characterized by intensive mixing, which in turn is underlain by Upper Cretaceous deposits (lower Maastrichtian and older) with radiolarians, calcareous nannofossils, and foraminifers. Major hiatuses were encountered between the late Santonian and late Campanian, and the late Maastrichtian and early Pliocene intervals. It is important to recognize that Holes 465 and 466 are strikingly dissimilar, especially in the distribution of hiatuses and preserved sediment sections (see introduction to this volume). These differences are particularly obvious in lowermost Tertiary and Upper Cretaceous parts of the sedimentary column; Hole 465A has an uninterrupted Cretaceous/Tertiary boundary sediment sequence. This

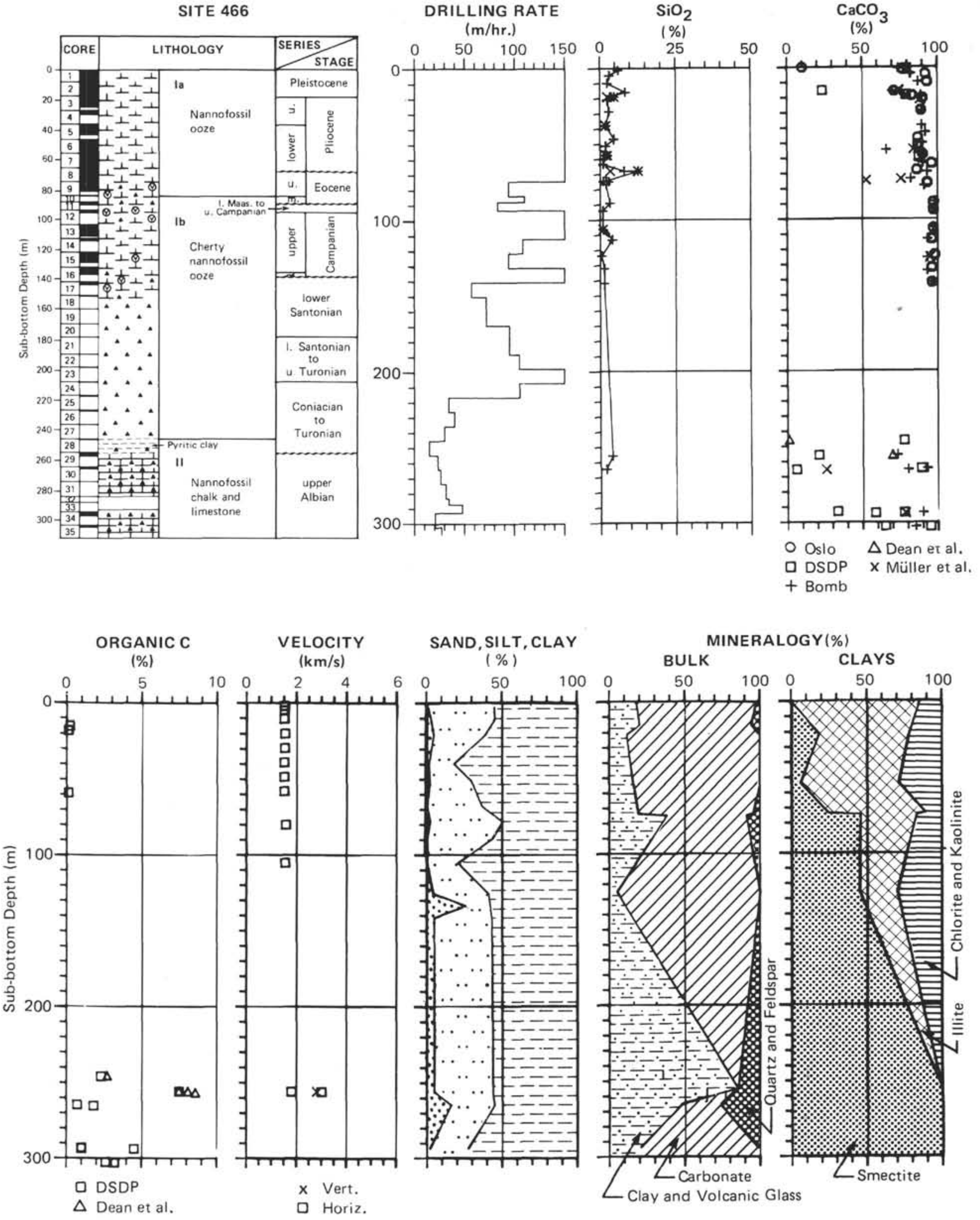

Figure 13. Site-summary chart, Site 466, southern Hess Rise. The data for the summary are compiled from the following sources: % $CaCO_3$ and % organic carbon from Dean (this volume); density, % porosity, water content (% water), and sound velocity from Appendix D (this chapter) and Fujii (this volume); % sand, silt, and clay from Appendix E (this chapter); and clay mineralogy from Appendix C (this chapter) and Nagel and Schumann (this volume).

dissimilarity is very perplexing, because Site 466 is situated down-slope from Site 465 on the same structural high.

Diatoms are present only in the Plio-Pleistocene part of the cored section, but radiolarians occur frequently and are well preserved in the Plio-Pleistocene section, whereas they are only moderately well preserved in the upper Albian section. The preservation of calcareous fossils throughout the section is difficult to understand. In the Plio-Pleistocene section, calcareous nannofossils are so well preserved that even coccospheres frequently occur in the sediment. However, planktonic foraminifers are poorly preserved and often fragmented despite the occurrence of pteropods and the shallow water depths at this site. Similar observations have been made at previous deep-sea driling sites in shallow water, but they cannot be explained satisfactorily at the present time. Both calcareous nannofossils and planktonic foraminifers are well preserved in the older Cenozoic sediments. In the Cretaceous part of the cored section, the preservation degenerates down-core until nannofossils and planktonic foraminifers are poorly preserved and recrystallized, whereas benthic foraminifers include both unaltered and recrystallized species.

The composition of the planktonic faunas and floras also reflects the horizontal plate movement under the equatorial region during the early Late Cretaceous, to the temperate or transitional location in the northern part of the central North Pacific gyre.

Lithostratigraphic Framework

The diversity of observed calcareous pelagic lithologies is small, and easily compared to the sedimentary column of Site 465. Unit I (0–245.5 m) is nannofossil ooze with much brownish to grayish-brown chert in the upper Turonian to lower Maastrichtian, but without chert in the upper Cenozoic. The nannofossil oozes are usually white, but they turn pale brown and yellowish-brown in Cores 7 and 9, just above the chert-rich interval. This interval is characterized by intensive mixing with fossil material from older stratigraphic intervals, and it possibly contains a short condensed Eocene section. Moreover, it is characterized by indications of slow sedimentation, including a particularly high concentration of fish debris at the base of Core 9, and a high proportion of large idiomorphic and abraded crystal aggregates of phillipsite at the base of the Neogene section in Core 7. It is tempting to make a lithofacies correlation to the lower Eocene to middle Miocene zeolitic pelagic clay and ooze section of Site 310, and to the brown-clay sequence at Site 464.

The 66.5 meters of olive-gray microfossil chalk and limestone of late Albian age is very similar to the corresponding lithofacies of Site 465. The rocks are rather homogeneous, probably somewhat less laminated than those of Site 465, smelled of H_2S when the cores were opened, and contain minor quantities of black chert.

The clay fraction (Appendix B) of these sediments shows high abundances of smectite; it probably was derived from deeply weathered volcanic rocks which were eroded during the late Albian. The major change of lithology between Units II and I during early Cenomanian–late Albian time might therefore mark the submergence of Mellish Bank, and consequently the cessation of clay flux to Sites 465 and 466.

Displaced Volcanic Pebbles

One of the most unexpected results at the site was the recovery of rounded pebbles of alkali basalt (Vallier et al., this volume), found in the interval between Cores 29 and 10, early Santonian to early Maastrichtian (pieces of Core 10 are within a paleontologically mixed zone; see discussion above). A few small fragments of pumice and two small pieces of hematite (in Cores 10 and 19) also were found. These volcanic rocks range from fine-grained and homogeneous to coarsely vesicular, and from relatively fresh to highly altered. Some have weathered, dark-gray to pale-yellow palagonite. It can be concluded therefore that this diverse rock assemblage represents a variety of source terranes, or a terrane with many rock types. These basalt pebbles may correspond to a late Campanian to early Tertiary faulting episode on the southern Hess Rise. This faulting episode might also explain the much higher-than-normal upper Campanian and lower Maastrichtian sedimentation rates (Fig. 12).

Igneous basement at this site may be as deep as 500 meters sub-bottom. The basement reflector is difficult to distinguish on the seismic-reflection profiles. However, the boundary between Units I and II is easily distinguished by a strong reflector at 0.27 seconds DT.

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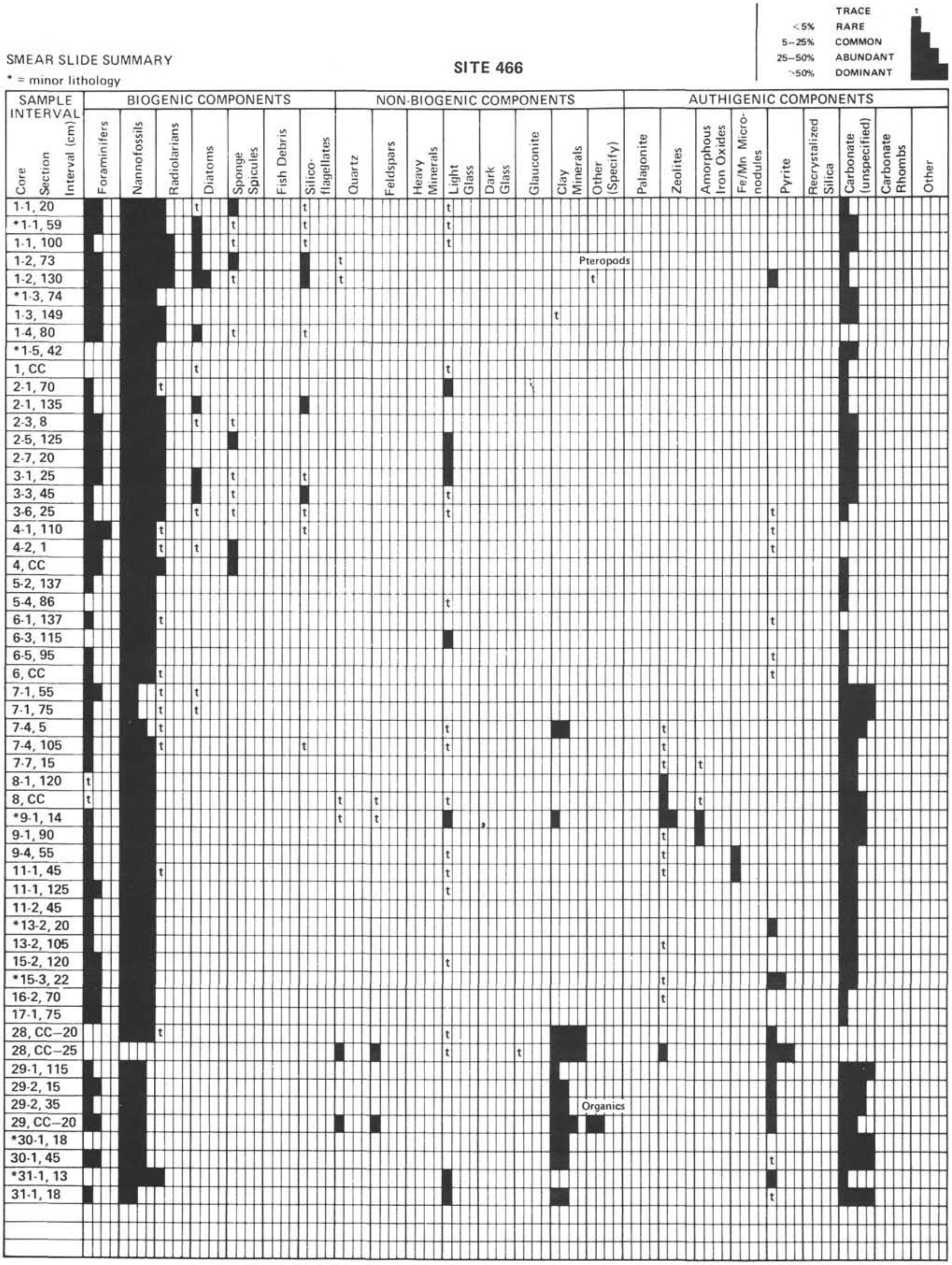
APPENDIX A

Smear-Slide Summary, Site 466



APPENDIX B
Bulk Mineralogy and Clay Mineralogy, Site 466 (from Nagel and Schumann, this volume)

Core	Section	Interval (cm)	Sample	Depth (m)	Clay Minerals + Volc. Glass	Quartz	Feldspar	Carbonates	Opal CT	Pyrite	Clinoptilolite	Phillipsite	Smectite	Illite	Chlorite	Kaolinite
1	1	57–59	1	0.58	17.9	2.6		79.5	—	—	—	—	—	85	10	5
2	5	120–122	2	15.21	20.1	4.6	1	74.3	—	—	—	—	—	—	—	—
3	3	106–108	3	21.57	11.5	1	—	88.5	—	—	—	—	18.5	59.3	13.1	9.1
6	6	55–57	4	54.06	16.0	3.3	—	84.0	—	—	—	—	6.0	65.0	16.0	13.0
8	6	110–112	5	73.61	19.4	—	—	75.6	—	—	—	5	24.5	64.5	7.0	4.0
9	1	13–17	6	74.66	38.4	—	—	52.6	—	—	—	7	46.0	37.0	7.0	10.0
15	3	20–22	7	125.21	5.2	—	—	94.8	—	—	—	—	45.0	25.0	30.0^{1}	
28	CC	20–21	8	255.00	85.4	2.6	—	—	12.0	—	—	—	100	—	—	—
30	1	80–81	9	265.30	47.9	13.0	—	25.6	13.5	—	—	—	—	—	—	—
34	1	86–87	10	292.86	20.8	—	—	78.2	1.0	—	—	—	—	—	—	—

1 = Not separated due to very small amounts.

APPENDIX C
Physical-Property Measurements, Site 466

			Hole	Velocity (km/sec)		GRAPE			Gravimetric						
Core No.	Sect. No.	Interval (cm)	Dep. (m)	Vert.	Horiz.	Den. g/cc	Poro. %	W.C. %	Poro. %	Den. g/cc	G.D. g/cc	Mean W.B. Den g/cc	Impedance 10^5 g/cc^2 sec	Heat. Cond.	Remarks
1	2	80–100	0.0–8.0			1.44	75.1								Nannofossil ooze
		59–61			1.52		75.11.44						2.19		Nannofossil ooze (siliceous)
		73				1.48	72.8							3.05	Nannofossil ooze (siliceous)
	3	60–90				1.47	73.2								Nannofossil ooze (light gray)
	4	40–60				1.44	75.1								Foraminifer–nannofossil ooze
		54–56			1.50	1.44	75.1						2.16		Foraminifer–nannofossil ooze
		144–150					42.9								
	5	60–90				1.45	74.4								Foraminifer–nannofossil ooze
2	2	60–90	8.0–17.5		1.50	1.46	73.8						2.19	2.81	Nannofossil ooze (light gray)
		63–65				1.47	73.2								Nannofossil ooze (light gray)
	4	60–90				1.43	76.0								Nannofossil ooze (light gray)
	6	70–100				1.49	72.5								Nannofossil ooze (light gray)
3	2	60–90	17.5–27.0			1.45	74.4								Nannofossil ooze (disturbed)
		80–82			1.54	1.45	74.4						2.23		Nannofossil ooze (disturbed)
	5	45				1.44	75.1							3.21	Nannofossil ooze (light gray)
		80–110				1.51	71.2								Nannofossil ooze (light gray)
4	1	95	27.0–36.5											2.97	Nannofossil ooze (light gray)
	2	70–100				1.50	71.9								Nannofossil ooze (light gray)
		85–87			1.53	1.50	71.9						2.30		Nannofossil ooze (light gray)
5	2	40–80	36.5–46.0			1.54	69.3								Nannofossil ooze (white)
		75–77			1.51	1.54	69.3						2.33		Nannofossil ooze (white)
		85				1.51	71.2							3.20	Nannofossil ooze (white)
	4	60–90				1.49	72.5								Nannofossil ooze (white)
6	2	60–90	46.0–55.5			1.51	70.9								Nannofossil ooze (N8–N7)
		74–76			1.51	1.51	70.9						2.28		Nannofossil ooze (white, light gray)
		109				1.50	71.6							3.17	Nannofossil ooze (white, light gray)
	4	60–90				1.56	68.1								Nannofossil ooze (white, light gray)
	5	144–150					41.3						2.16		Soupy to disturbed
7	2	60–90	55.5–65.0			1.44	75.4							3.45	Soupy to disturbed
		75–77			1.50	1.44	75.4								Soupy to disturbed
	3	86													Soupy to disturbed (gray BRN)
	5	60–90				1.57	67.7							3.70	Soupy to disturbed (gray BRN)
	6	60–90				1.59	66.5								Soupy to disturbed (gray BRN)
8	1	80	65.0–74.5			1.61	65.2								Soupy to disturbed (gray BRN)
	2	60–90				1.61	65.2								Soupy to disturbed (gray BRN)
	4	60–90				1.61	65.2							3.33	Soupy to disturbed (chert)
	6	60–90				1.61	64.9								Soupy to disturbed (chert)
9	1	85	74.5–84.0										2.64		
	2	60–90				1.60	65.8								
	4	60–90				1.65	63.0								Soupy to disturbed (with rock fragment)
		91–93			1.58	1.67	61.7								Soupy to disturbed (chert and basalt)
11	1	30–80	88.0–93.5			1.74	57.3								Soupy to disturbed (whole)
13	1	100–104	103.0–112.5			1.56	68.1								Soupy to disturbed (with chert)
	2	60–90				1.58	66.8								Soupy to disturbed (with chert)
		72–73			1.55	1.58	66.8						2.45		Soupy to disturbed (with chert)
	3	60–90				1.59	66.5								Soupy to disturbed (with chert)
	4	60–90	103.0–112.5			1.58	67.1								Nannofossil ooze (white)
		78				1.58	67.1							3.44	
	5	144–150						36.7							Nannofossil ooze (white)
15	2	15	122.0–131.5			1.58	66.8							3.36	Nannofossil ooze (white)
		40–70				1.57	67.7								Nannofossil ooze (white)
	4	60–90				1.54	69.3								Nannofossil ooze (white)
16	2	60–90	131.5–141.0.			1.60	65.8								Nannofossil ooze (white)
						(2-Minutes)									
29	1	95–97	255.0–264.5		1.81										Limestone (dark olive gray)
		107–109		2.82	3.01	2.29	24.8	11.8	25.8	2.23	2.65	2.26	6.37		Limestone (dark olive gray)
		115												4.76	Limestone (dark olive gray)
30	1	5–7	264.5–274.0	3.86	4.01	2.57	7.6	4.9	11.9	2.49	2.68	2.53	9.77		Nannofossil limestone (olive gray)
		8	274.0											5.93	Nannofossil limestone (olive gray)
34	2	46–48	293.0–302.5	2.37	2.61	2.13	34.2	14.3	29.2	2.09	2.53	2.11	5.00		Nannofossil chalk (dark gray)
		27												4.10	Nannofossil chalk (dark gray)

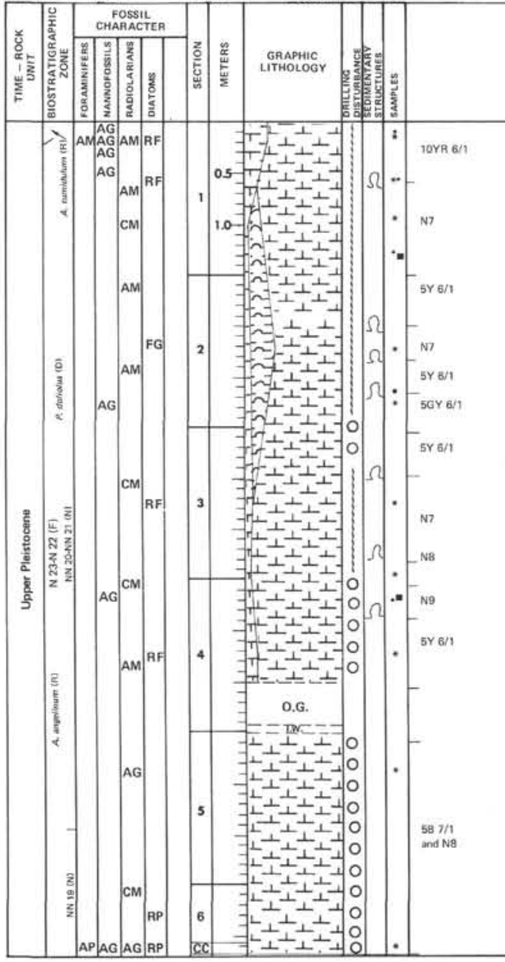
APPENDIX D
Coarse-Fraction Components, Site 466

Sample (interval in cm)	Foraminifer Preservation	Planktonic Foraminifers		Coarse-Fraction Components																			P: present R: rare <5% R-C: rare to common } 5-25% C: common C-A: common to abundant 25-50% A: abundant >50% VA: very abundant >90% P: poor M: moderate G: good
		Whole	Fragments	Benthic Foraminifers	Radiolarians	Sponge Spicules	Ostracodes	Mollusk Fragments	Echinoderm Fragments	Fish Fragments	Iron Oxide	Pumice	Volcanic Glass	Quartz Grains	Mica	Pyrite	Carbonate Rhombs	Phillipsite	Glauconite	Chalk Aggregates	Limestone Chips	Chert Fragments	Comments
466-1-1, top	P-M	A	C	C	R	R		P	P										P				
1,CC	P	C	A	C	R	R	P	P	P														
2,CC	P	C	A	C	R	R		P	P														
3,CC	P	C	A	C	R	R		P	P								P						
4,CC	P	C	A	C	R	R	P																
5,CC	P	C	A	C	R	R						P				R-C			R				
6,CC	P	C	A	C	R	R	P	C	C							P		R	P				
7-3	P	C	A	C	R	R	P	R	R									C					Phillipsite in
7-7	M	A	C	R		P		P	P	R								R					7-5 and 7-6
7,CC	G	A	R	R				P	P		P	R											
8,CC	G	A	R	R		P				P	P												Boersma's fiber
9 bottom	VP			C				R	R	C	C							R	R				Various rx
9,CC	G	A	R	R		P		P	P	P	R								R				fragments
10,CC	G	A	R	R		P				P	R									R	R	R-C	Various rx
13,CC	M	A	R	R				P	P		R								P			R	fragments and
14,CC	M	A	C	R							R								R	R	R	R	calcite crystals
15,CC	M	A	R	R		P		P	P		P												
16-1	M	A	R	R		P					P									R		C	Basalt fragments
18,CC	M	A	R	R	P																		
19 water	R-M	A	R																			C	Minute fauna
20 water	R-M	A	R																				
21 water	R-M	A	R																	P			
22 water	R-M	A	R																	R			
24 water	P	A	R																	R		C	
25 water	P	C	R																	C		C	Orbitoid fragment
28,CC	P	A		R	C														R		A		
29,CC	M	A	R	R	R	P			P		C*								P			R	*Specks on forams
31-1	P	A		R																	C		
32 water	P	R		R						P	C			A	R					C		R	
34,CC	P	C			C									C		R					C		
35,CC	P	C			C				P					C		R					C	R	

APPENDIX E
Grain-Size Analysis, Site 466

Hole	Core	Section	Interval (cm)	Sub-bottom Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
466	1	3	8.0	3.08	1.1	43.9	55.0	Silty clay
466	2	2	142.0	10.92	3.0	42.4	54.6	Silty clay
466	3	3	34.0	20.84	4.8	34.3	60.9	Silty clay
466	5	3	65.0	40.15	1.7	16.5	81.8	Clay
466	6	4	90.0	51.40	2.1	27.8	70.1	Silty clay
466	7	5	140.0	62.90	0.0	93.5	6.5	Silt
466	8	2	140.0	67.90	0.1	36.6	63.3	Silty clay
466	9	3	67.0	78.17	2.3	48.2	49.5	Silty clay
466	11	1	127.0	89.27	0.4	43.4	56.2	Silty clay
466	13	2	110.0	105.60	0.2	20.5	79.3	Clay
466	15	3	80.0	125.80	4.4	37.0	58.6	Silty clay
466	16	2	81.0	133.81	26.2	16.2	57.7	Sandy clay
466	17	1	74.0	141.74	5.0	38.5	56.5	Silty clay
466	29	1	89.0	255.89	4.9	39.3	55.9	Silty clay
466	30	1	58.0	265.08	16.1	28.9	55.0	Silty clay
466	34	1	72.0	293.72	1.9	25.5	72.6	Silty clay

SITE 466 HOLE CORE 1 CORED INTERVAL 0.0 to 8.0 m



LITHOLOGIC DESCRIPTION

FORAMINIFER NANNOFOSSIL OOZE–RADIOLARIAN NANNOFOSSIL OOZE

Light gray (N7, 10YR 6/1, 5Y 6/1, 5GY 6/1, and 5B 7/1) and white (N8 and N9) intensely disturbed to soupy ooze. Color changes are sublte with vertical streaking of the dominant colors common. A gray (N5) zone is at 58-60 cm and some gray (N6) spots are at 790 cm. A pumice pebble, gray (N5-N6), is at 715-718 cm. Well-preserved coccospheres are abundant in Section 2.

SMEAR SLIDE SUMMARY %

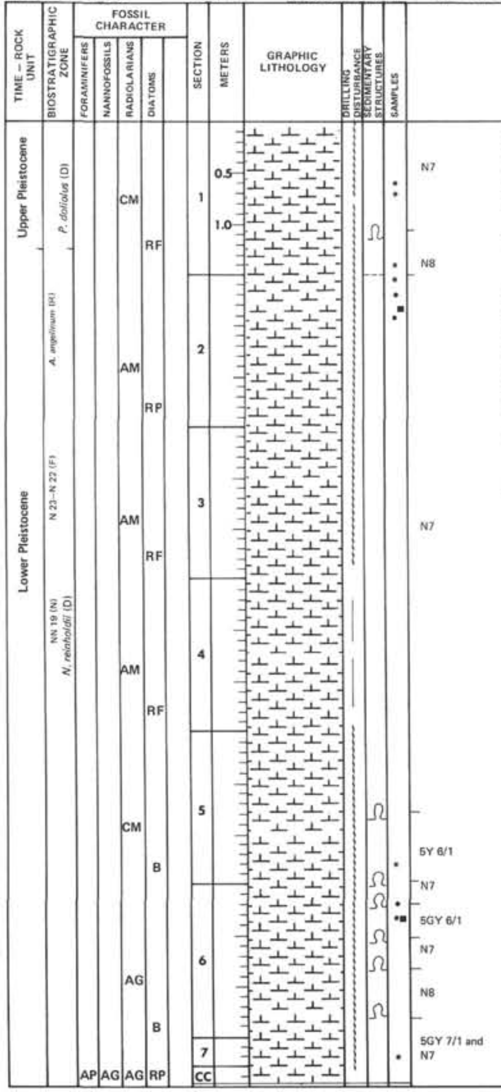
	1-20 (D)	1-59 (M)	1-100 (D)	2-73 (D)	2-130 (D)
Quartz	—	—	—	Tr	Tr
Volcanic glass	Tr	Tr	Tr	—	—
Clay	—	—	—	—	—
Pyrite	—	—	—	—	1
Carbonate unsp.	5	8	5	2	2
Foraminifera	20	5	5	10	12
Nannofossils	72	81	76	75	70
Pterop.	—	—	—	—	Tr
Diatoms	Tr	1	1	5	7
Radiolaria	2	5	10	6	7
Sponge spicules	1	Tr	Tr	1	Tr
Silicoflagellates	Tr	Tr	Tr	1	1

	3-74 (D)	3-149 (M)	4-80 (D)	CC (D)
Quartz	—	—	—	—
Volcanic glass	—	—	—	1
Clay	—	Tr	—	—
Pyrite	—	—	—	—
Carbonate unsp.	10	5	—	1
Foraminifera	10	7	15	—
Nannofossils	80	85	79	98
Pterop.	—	—	—	—
Diatoms	—	—	3	—
Radiolaria	—	3	3	—
Sponge spicules	—	—	—	—
Silicoflagellates	—	—	—	—

Silica and Iron Content:	1-130	4-20
SiO_2 =	13%	6.5%
Fe =	0.61%	0.26%

Carbonate Content:
1-20 = 79%
1-62 = 74%
*1-134 = 77%
2-120 = 82%
*4-23 = 92%

SITE 466 HOLE CORE 2 CORED INTERVAL 8.0 to 17.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Light gray (N7, 5Y 6/1, and 5GY 6/1) and white (N8), highly to moderately disturbed ooze. Vertical streaks of the major colors are common. Color change is often very subtle. Some darker streaks are enriched in pyrite: they are especially abundant from 45-75 cm.

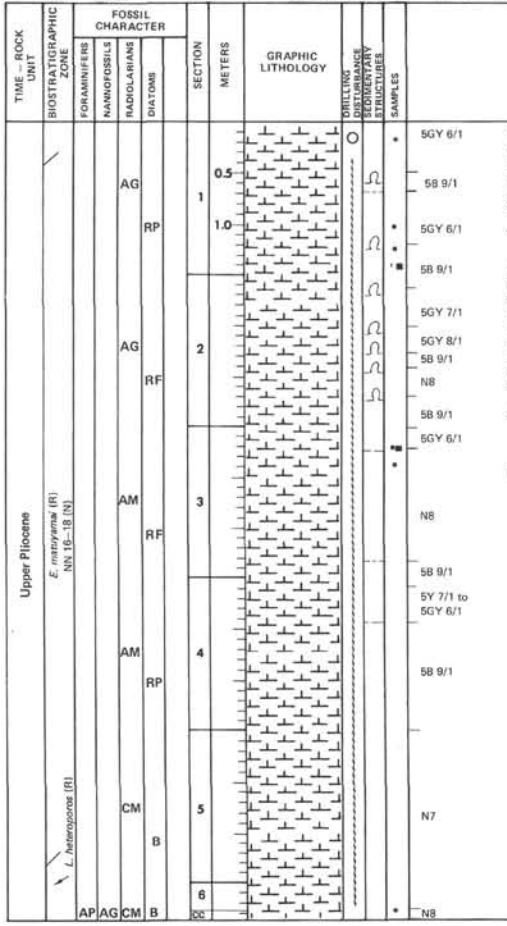
SMEAR SLIDE SUMMARY %

	1-57 (M)	1-70 (D)	1-135 (D)	3-8 (D)	5-125 (D)	7-20 (D)
Volcanic glass	—	5	—	—	3	3
Pyrite	20	—	—	—	—	—
Carbonate unsp.	—	5	5	10	10	7
Foraminifera	Tr	2	3	5	7	5
Nannofossils	80	88	82	82	78	82
Diatoms	—	—	2	Tr	—	—
Radiolaria	Tr	Tr	2	3	2	3
Sponge spicules	—	—	—	Tr	1	—
Silicoflagellates	—	—	1	—	—	—

Silica and Iron Content:	2-36	6-32
SiO_2 =	5.0%	18%
Fe =	0.26%	1.1%

Carbonate Content:
2-22 = 87%
*2-41 = 93%
6-22 = 70%
*6-37 = 71%

SITE 466 HOLE CORE 3 CORED INTERVAL 17.5 to 27.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely disturbed and marbled ooze. Color variations are shades of white (N8 and 5B 9/1) and grays (5GY 6/1, 5Y 7/1, 5Y 6/1, N5, and N6). Most color changes are gradational and subtle. Gray streaks (N4, N5, N3, 5GY 6/1 and 5Y 5/1) are probably enriched in pyrite. Streaks and mottles of the dominant colors are found throughout.

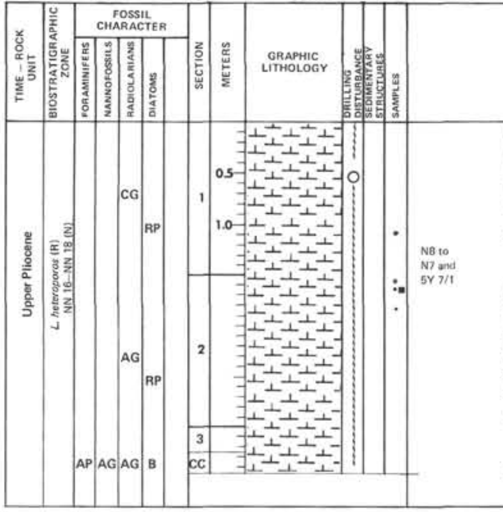
SMEAR SLIDE SUMMARY %

	1-25	3-45	6-25
Volcanic glass	2	Tr	Tr
Pyrite	—	—	Tr
Carbonate unsp.	5	5	4
Foraminifera	6	3	4
Nannofossils	83	89	91
Diatoms	1	1	Tr
Radiolaria	3	1	1
Sponge spicules	Tr	Tr	Tr
Silicoflagellates	Tr	1	Tr

Silica and Iron Content:	1-137	3-23
SiO_2 =	5.2%	5.0%
Fe =	0.69%	0.32%

Carbonate Content:
1-100 = 78%
1-120 = 89%
* 1-136 = 83%
* 3-20 = 90%

SITE 466 HOLE CORE 4 CORED INTERVAL 27.0 to 36.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely disturbed to soupy ooze, white (N8) to light gray (N7 and 5Y 7/1) in color. Colors are marbled by drilling disturbance and changes are subtle. A darker gray (N4) zone at 105 cm is enriched in foraminifera and pyrite. Dark gray (N5) streaks between 230-290 cm are enriched in pyrite.

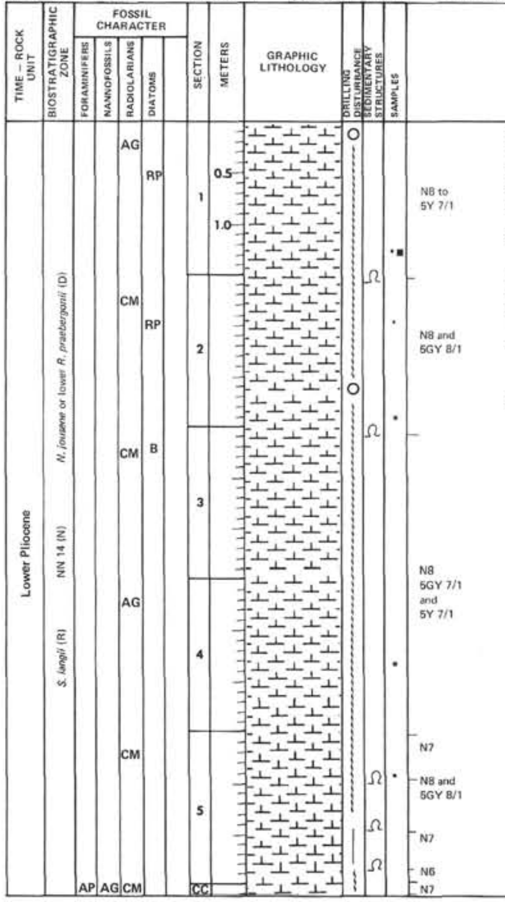
SMEAR SLIDE SUMMARY %

	1-110 (M)	2-1 (D)	CC (D)
Pyrite	Tr	—	—
Foraminifera	30	5	7
Calc. nannofossils	70	93	85
Carbonate unsp.	—	—	3
Diatoms	—	Tr	—
Radiolaria	Tr	Tr	3
Sponge spicules	—	2	2
Silicoflagellates	Tr	—	—

Silica and Iron Content:	2-8
SiO_2 =	6.4%
Fe =	0.40%

Carbonate Content:
* 2-14 = 89%
2-34 = 90%

SITE 466 HOLE CORE 5 CORED INTERVAL 36.5 to 46.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely disturbed to soupy, white (N8, 5GY 8/1) and light gray (5Y 7/1, 5GY 7/1, N7 and N6) ooze. The major colors are marbled by drilling disturbance, and gradations are subtle for the most part. Several black (N2) streaks are present in the core and are enriched in pyrite.

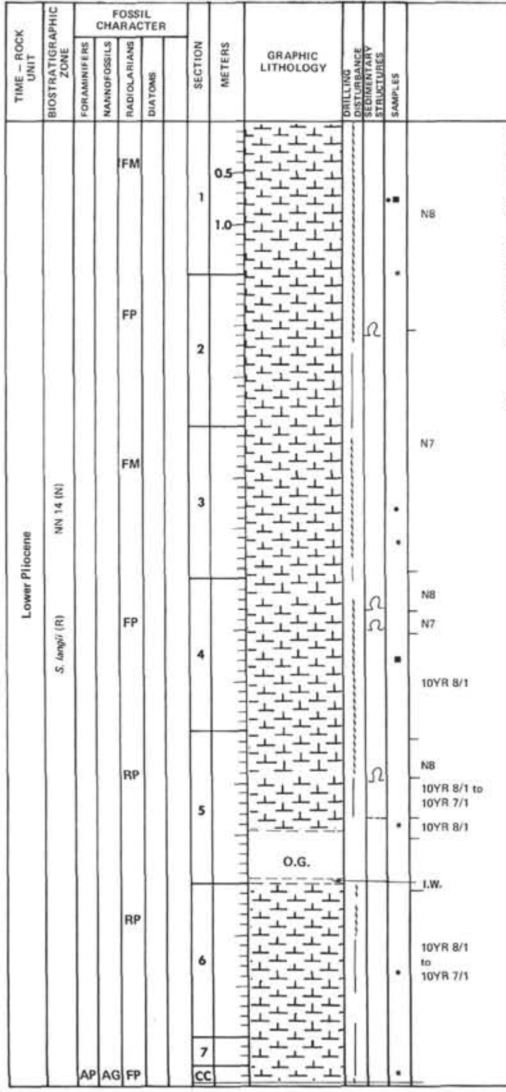
SMEAR SLIDE SUMMARY %

	2-137	4-86
Volcanic glass	—	Tr
Carbonate unsp.	3	3
Foraminifera	3	—
Nannofossils	94	97

Silica and Iron Content: 1-130
SiO_2 = 4.0%
Fe = 0.24%

Carbonate Content:
*1-127 = 91%
2-42 = 90%
5-42 = 92%

SITE 466 HOLE CORE 6 CORED INTERVAL 46.0 to 55.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely to moderately disturbed white (10YR 8/1, N8) and light gray (N7 and 10YR 7/1) ooze. Color changes are subtle and gradational. The lithology is fairly uniform.

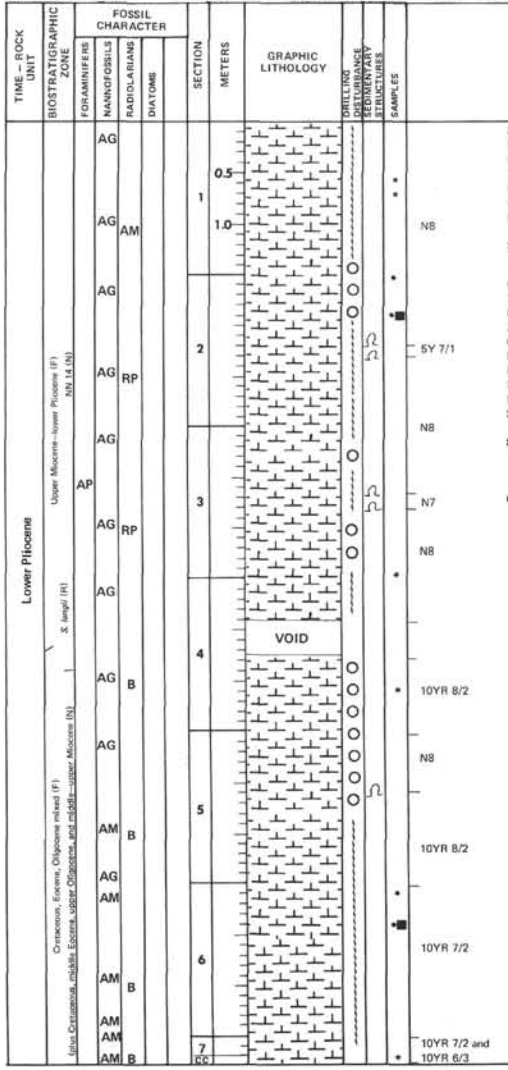
SMEAR SLIDE SUMMARY %

	1-137	3-115	5-95	CC
Volcanic glass	—	3	—	—
Pyrite	Tr	—	Tr	Tr
Carbonate unsp.	—	5	5	5
Foraminifera	3	—	5	5
Calc. nannofossils	97	92	90	90
Radiolaria	Tr	—	—	Tr

Silica and Iron Content: 1-73 4-73
SiO_2 = 10% 4.0%
Fe = 0.48% 0.27%

Carbonate Content:
*1-77 = 87%
3-85 = 90%
*4-77 = 87%
6-85 = 66%

SITE 466 HOLE CORE 7 CORED INTERVAL 55.5 to 65.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Soupy to intensely disturbed white (N8), gray (5Y 7/1), brownish white (10YR 8/2, 10YR 7/2) and pale brown (10YR 6/3) ooze. The amount of "brown" increases down core. Blebs of light gray (5Y 7/1) are at 49-56 cm, 82-88 cm, 130-135 cm, and light gray (N4) at 429-438 cm. A pale brown mottle (10YR 6/3) is at 654-673 cm.

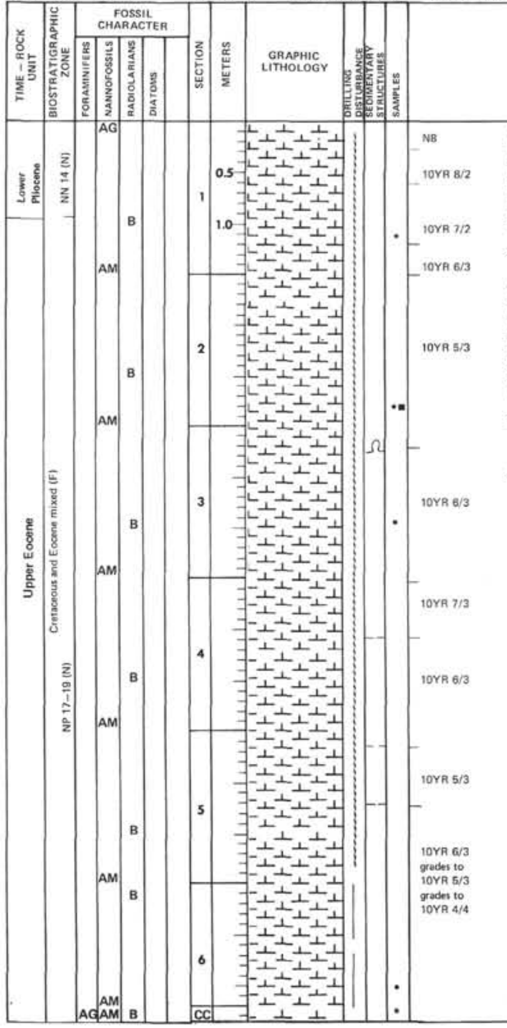
SMEAR SLIDE SUMMARY %

	1-55	1-75	4-5	4-105	7-15
Clay	—	—	10	—	—
Volcanic glass	—	—	Tr	Tr	—
Hematite	—	—	—	—	Tr
Zeolite	—	—	Tr	Tr	Tr
Carbonate unsp.	82	75	40	18	5
Foraminifera	8	3	2	2	3
Nannofossils	10	20	48	80	92
Radiolaria	Tr	Tr	Tr	Tr	—
Diatoms	Tr	Tr	—	—	—
Silicoflagellates	—	—	—	Tr	—

Silica and Iron Content:	2-40	6-40
SiO_2 =	4.0%	2.0%
Fe =	0.31%	0.14%

Carbonate Content:
2-10 = 90%
* 2-44 = 90%
6-10 = 90%
* 6-44 = 96%

SITE 466 HOLE CORE 8 CORED INTERVAL 65.0 to 74.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely to moderately disturbed brownish white (10YR 8/2), pale brown (10YR 7/2, 10YR 6/3) brown (10YR 5/3) and dark yellowish brown (10YR 4/4) ooze. The shades of the brown darken toward the base of the core. A mottle of gray (N7) is at 14-18 cm. Pale brown (10YR 8/4) mottles are at 227-234 cm, 514-523 cm, and 640-643 cm.

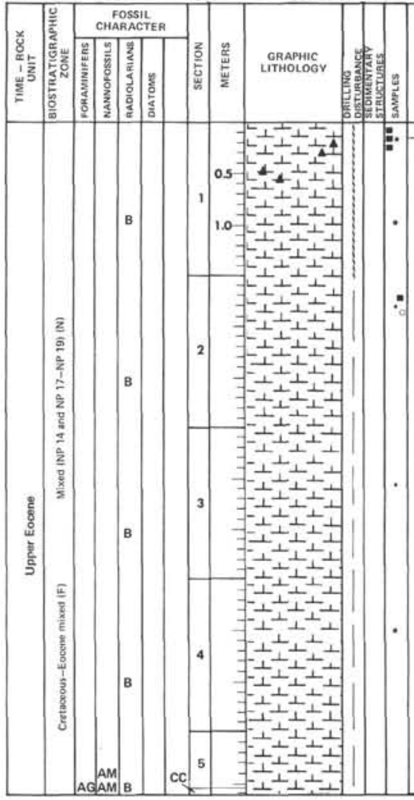
SMEAR SLIDE SUMMARY %

	1-120	CC
Quartz	—	Tr
Feldspar	—	Tr
Volcanic glass	—	Tr
Hematite	—	Tr
Zeolite	2	2
Carbonate unsp.	20	48
Foraminifera	Tr	Tr
Nannofossils	78	50

Silica and Iron Content:	2-130
SiO_2 =	7.2%
Fe =	0.62%

Carbonate Content:
*2-135 = 86%
3-90 = 93%
6-90 = 82%

SITE 466 HOLE CORE 9 CORED INTERVAL 74.5 to 84.0 m



LITHOLOGIC DESCRIPTION

10YR 8/2

10YR 7/3

NANNOFOSSIL OOZE
Intensely to moderately disturbed pale brownish white (10YR 8/2) and very pale brown (10YR 7/3) ooze. A very dark grayish brown (10YR 3/2) bleb of zeolitic nannofossil marlstone is at 12-16 cm. Fragments of grayish brown (10YR 5/2), dark reddish brown (5YR 2/2) and dark grayish brown (10YR 4/2) chert are in the interval from 18-60 cm.

SMEAR SLIDE SUMMARY %

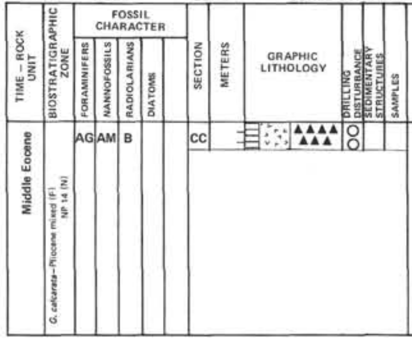
	1-14 (M)	1-90 (D)	4-55 (D)
Quartz	Tr	—	—
Feldspar	Tr	—	—
Clay	2	—	—
Volcanic glass	2	—	Tr
Hematite	2	3	—
Micronodules	—	—	2
Zeolite	7	Tr	Tr
Carbonate unsp.	30	30	20
Foraminifera	3	3	3
Calc. nannofossils	54	64	75

Silica and Iron Content:	1-08	1-14	1-24	2-22
SiO_2 =	4.0%	2.0%	6.2%	4.0%
Fe =	0.29%	2.5%	0.42%	0.38%

Carbonate Content: *2-30 = 93%
3-60 = 91%

Organic Carbon: 2-35 = 9.56%

SITE 466 HOLE CORE 10 CORED INTERVAL 84.0 to 88.0 m

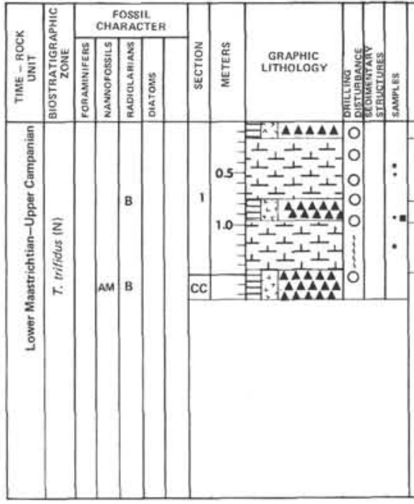


LITHOLOGIC DESCRIPTION

Drilling Breccia

CHERT FRAGMENTS: Very dark grayish brown (10YR 3/2) to almost clear (10YR 6/1).
BASALT: Unaltered very dark gray (5Y 3/1) vesicular pebbles up to 2 cm. Rounded with some glass-lined (?) vugs. Altered basalt, pale yellow (5Y 7/3) in color with glass-lined (?) vugs.
INOCERAMUS FRAGMENTS: 5 mm thick fragments up to 1.5 cm in diameter.
CRYSTALLINE CALCITE: Coatings on altered basalt.
HEMATITE: One 2 cm diameter pebble.

SITE 466 HOLE CORE 11 CORED INTERVAL 88.0 to 93.5 m



LITHOLOGIC DESCRIPTION

10YR 8/1

N9

NANNOFOSSIL OOZE
Soupy to intensely disturbed white (10YR 8/1, N9) ooze separated by zones of rock fragments. The rock fragments contain chert, very dark grayish brown (10YR 3/2) to translucent pale brownish gray (10YR 6/1); basalt, altered, which is pale yellow (5Y 7/3), and unaltered, which is very dark gray (5Y 3/1); and Inoceramus fragments. Chert pebbles below 140 cm are up to 5 cm in size.

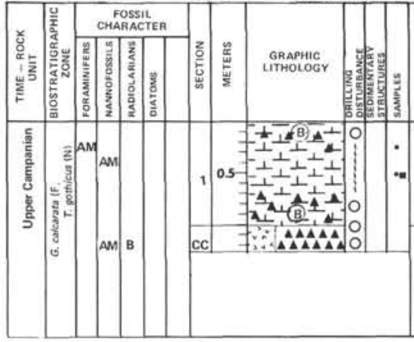
SMEAR SLIDE SUMMARY %

	1-45	1-125
Volcanic glass	Tr	Tr
Micronodules	Tr	—
Zeolite	Tr	—
Carbonate unsp.	15	10
Foraminifera	3	10
Nannofossils	82	80
Radiolaria	Tr	—

Silica and Iron Content:	1-94
SiO_2 =	7.1%
Fe =	0.06%

Carbonate Content: 1-52/54 = 98%
*1-97 = 97%

SITE 466 HOLE CORE 12 CORED INTERVAL 93.5 to 103.0 m



LITHOLOGIC DESCRIPTION

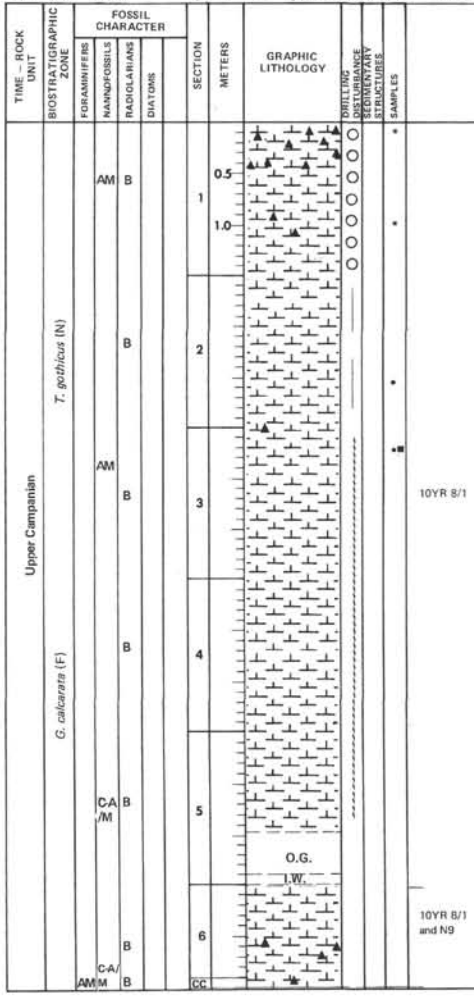
N8

NANNOFOSSIL OOZE
Soupy to intensely disturbed white (N8) ooze with basalt and chert fragments at the top and bottom of the core. The chert is light brownish gray (10YR 6/2), brown (10YR 4/3) and pale brown (10YR 6/3). Some with white (N8) porcellanite rims. The basalt is very dark gray (5Y 3/1) and pale yellow (5Y 7/3) vesicular, unaltered and altered.

Silica and Iron Content:	1-54
SiO_2 =	2.0%
Fe =	0.04%

Carbonate Content: 1-29 = 97%
*1-52 = 97%

SITE 466 HOLE CORE 13 CORED INTERVAL 103.0 to 112.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Soupy to moderately disturbed white (10YR 8/1 and N9) ooze: very uniform. Black (10YR 2.5/1) chert fragments are at 0-40 cm, 85 cm, 105 cm, and 295 cm. Chert fragments at 800 cm, 811 cm, 817 cm, and 895 cm are light gray (10YR 6/1), gray (10YR 4/1), and dark gray (10YR 3/1) with some mottling.

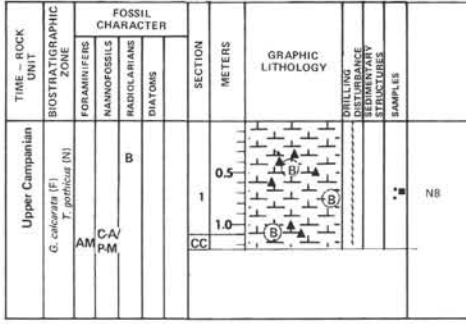
SMEAR SLIDE SUMMARY %

	2-20	2-105
Pyrite	3	—
Zeolite	—	Tr
Carbonate unsp.	15	20
Foraminifera	5	3
Nannofossils	77	77

Silica and Iron Content: 3-15
SiO_2 = 2.0%
Fe = 0.06%

Carbonate Content: 2-100 = 97%
*3-20 = 97%

SITE 466 HOLE CORE 14 CORED INTERVAL 112.5 to 122.0 m



LITHOLOGIC DESCRIPTION

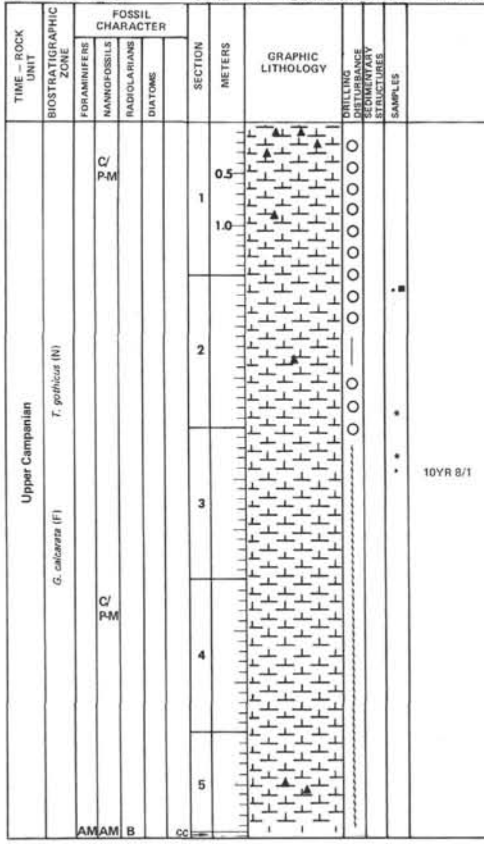
NANNOFOSSIL OOZE

Intensely disturbed white (N8) ooze with chert and basalt fragments. The chert is very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2) and white (N8). Basalt fragments are both altered, pale yellow (5Y 7/3) at 47 cm and 73-77 cm; and unaltered, black (N2) at 111 cm.

Silica and Iron Content: 1-62
SiO_2 = 8.7%
Fe = 0.08%

Carbonate Content: *1-69 = 96%
1-74 = 93%

SITE 466 HOLE CORE 15 CORED INTERVAL 122.0 to 131.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Soupy to intensely disturbed white (10YR 8/1) ooze. Chert, black (10YR 2/1), dark yellow brown (10YR 4/4), very dark gray (10YR 3/1), light brownish gray (10YR 6/2), and dark reddish brown (5YR 3/2), is found at 0-31 cm, 88 cm, 231 cm, and 644-656 cm. Gray (N6) mottles are at 320-326 cm, 360 cm, and 369-376 cm.

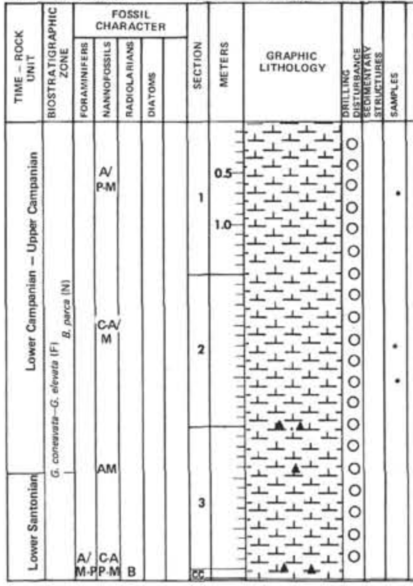
SMEAR SLIDE SUMMARY %

	2-130 (D)	3-22 (M)
Volcanic glass	Tr	—
Pyrite	—	15
Zeolite	—	Tr
Carbonate unsp.	10	10
Foraminifera	10	10
Calc. nannofossils	80	65

Silica and Iron Content: 2-15
SiO_2 = 1.0%
Fe = 0.02%

Carbonate Content: *2-20 = 98%
3-47 = 93%

SITE 466 HOLE CORE 16 CORED INTERVAL 131.5 to 141.0 m



LITHOLOGIC DESCRIPTION

10YR 8/1

NANNOFOSSIL OOZE

Uniform, soupy, white (10YR 8/1) ooze. Chert fragments are at 292-300 cm, 331 cm, and 440-445 cm; dark reddish gray (5YR 4/3) and reddish brown (5YR 4/3 and 5YR 4/4) in color.

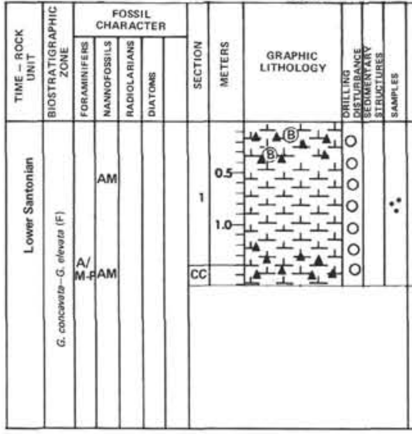
SMEAR SLIDE SUMMARY %

	2-70
Zeolite	Tr
Carbonate unsp.	4
Foraminifera	6
Nannofossils	90

Silica and Iron Content:		1-60
SiO_2	=	3.0%
Fe	=	0.12%

Carbonate Content: *1-67 = 96%
2-109 = 93%

SITE 466 HOLE CORE 17 CORED INTERVAL 141.0 to 150.5 m



LITHOLOGIC DESCRIPTION

10YR 8/1

NANNOFOSSIL OOZE, CHERT AND BASALT

Two zones of drilling breccia (0-40 cm and 120-211 cm) separated by soupy white (10YR 8/1) ooze. The breccia contains ooze, chert, and rounded basalt. The chert is brown (7.5YR 5/4), light brown (7.5YR 6/4) and rarely gray (10YR 5/2). Altered pale yellow (5Y 7/3) basalt is at 10 cm and 30 cm.

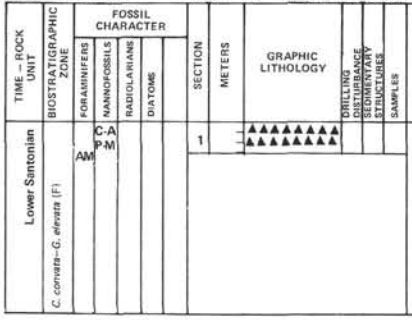
SMEAR SLIDE SUMMARY %

	1-75
Carbonate unsp.	5
Foraminifera	10
Nannofossils	85

Silica and Iron Content:		1-84
SiO_2	=	3.0%
Fe	=	0.14%

Carbonate Content: •1-89 = 96%
1-77 = 96%

SITE 466 HOLE CORE 18 CORED INTERVAL 150.5 to 160.0 m

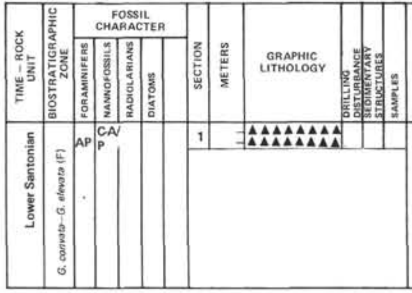


LITHOLOGIC DESCRIPTION

CHERT

Brown (7.5YR 5/4) and very dark grayish brown (10YR 3/2) chert fragments with some white (10YR 8/2) porcellanite.

SITE 466 HOLE CORE 19 CORED INTERVAL 160.0 to 169.5 m

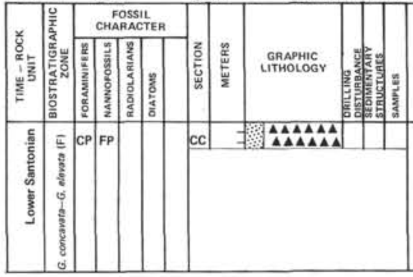


LITHOLOGIC DESCRIPTION

CHERT

Brown (7.5YR 5/4), reddish brown (5YR 4/3), and gray (5YR 5/1) chert with a very dense black (N2) rock (>3.0 g/cc) (hematite).

SITE 466 HOLE CORE 20 CORED INTERVAL 169.5 to 179.0 m



LITHOLOGIC DESCRIPTION

CHERT AND VOLCANIC SANDSTONE

Chert fragments are dark reddish brown (5YR 3/4) and some have white (10YR 8/2) porcellanite rims. One piece of volcanic sandstone with disseminated pyrite, well rounded in shape is found.

SITE 466 HOLE CORE 21 CORED INTERVAL 179.0 to 188.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Lower Santonian	*G. concavata–G. elevata* (F)	AM	FP			CC		▲▲▲▲▲▲▲▲				

CHERT
Three pieces of chert from 2-5 cm in size and many smaller fragments. The large pieces are light gray (N7) but the smaller ones show a complete color variation in the grays, and reddish browns.

SITE 466 HOLE CORE 22 CORED INTERVAL 188.5 to 198.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Upper Turomian – Lower Santonian	?	FP	FP			CC		▲▲▲▲▲▲▲▲				

CHERT
Three larger pieces of chert up to 3 cm in diameter: black (N2) with a white porcellanite rim, very dark grayish brown (10YR 3/2), and brown (7.5YR 5/4) with a pale brown (10YR 7/3) porcellanite rim. Smaller fragments in the core exhibit a range of colors in gray and reddish brown.

SITE 466 HOLE CORE 23 CORED INTERVAL 198.0 to 207.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Upper Turomian – Lower Santonian	?		FP			CC		▲▲▲▲▲▲▲▲				

CHERT
Nine fragments of chert: grays (N6, N5), black (N2), white (N9), brown (7.5YR 5/4) and grayish brown (10YR 5/2).

SITE 466 HOLE CORE 24 CORED INTERVAL 207.5 to 217.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Turonian – Coniacian	*G. renzi–G. sigali* (F)	CP				CC		▲▲▲▲▲▲▲▲				

CHERT
Six fragments of chert: grays (N7, N4), white (N8), black (N2), dark brown (7.5YR 4/2), and olive black (5Y 2/1).

SITE 466 HOLE CORE 25 CORED INTERVAL 217.0 to 226.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Turonian – Coniacian	*G. renzi–G. sigali* (F)	CP				CC		▲▲▲▲▲▲▲▲				

CHERT
Seventeen fragments of chert: mostly white to black shades (N1 to N8) with a couple of reddish brown pieces.

SITE 466 HOLE CORE 26 CORED INTERVAL 226.5 to 236.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
?			B			1		▲▲▲▲▲▲▲▲				

CHERT
Fragments of chert: dark yellowish brown (10YR 4/2), dark gray (7.5YR 3/1), dusky yellowish brown (10YR 2/2), and black (7.5YR 2/1). Some contain white (7.5YR 8/1) and gray (7.5YR 6/1) mottles.

SITE 466 HOLE CORE 27 CORED INTERVAL 236.0 to 245.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
?						CC		△▲▲▲▲▲▲▲				

CHERT
Black (N2), very dark gray (N3), medium gray (N5), and dark brown (10YR 3/3) chert. One piece of laminated gray ash and one piece of white (10YR 8/2) porcellanite.

SITE 466 HOLE CORE 28 CORED INTERVAL 245.5 to 255.0 m

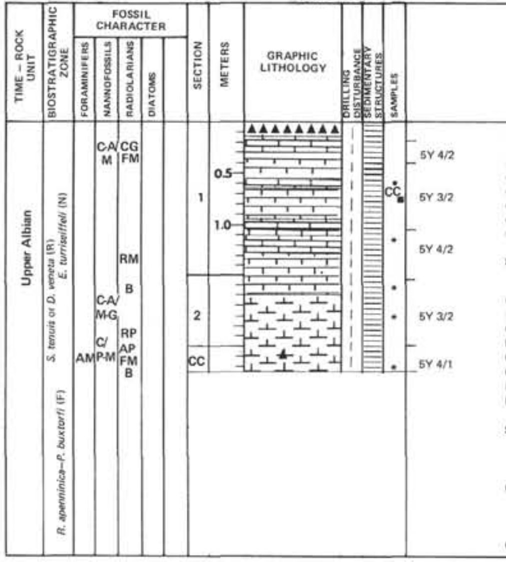
TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER				SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
		FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS							
Turonian – Coniacian	*G. renzi–G. sigali* (F)	RP	B	AM		CC		▲▲▲▲▲▲▲▲				5Y 2/1

CHERT AND PYRITIC CLAY
Chert fragments overlying black (5Y 2/1) pyritic clay. The chert is varying shades of gray (N7, N6, N5, N3), black (N2), and very dark brown (5Y 3/1). One fine frained dark gray (5Y 4/1) fragment may be basalt?

SMEAR SLIDE SUMMARY %

	CC-25
Quartz	
Feldspar	5
Clay	73
Glauconite	Tr
Pyrite	20
Zeolite	2
Calc. nannofossils	Tr
Volcanic glass	Tr

SITE 466 HOLE CORE 29 CORED INTERVAL 255.0 to 264.5 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL LIMESTONE AND CHALK

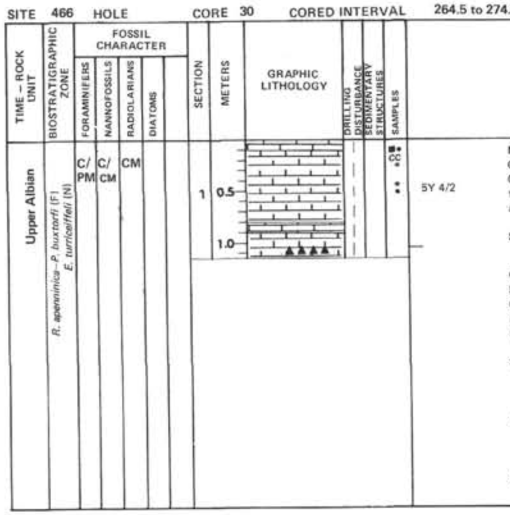
Limestone and chalk of varying degrees of induration. Some ooze is present. The sediment is finely laminated, and is olive gray (5Y 4/2, 4/1), and dark olive gray (5Y 3/2). A zone of breccia is at 0-17 cm containing black (N2) and gray (N1) chert; and a vesicular basalt, dark gray (5Y 3/1) with spots of brownish yellow (10YR 6/8). A black chert is at the bottom of the core at 217 cm. An olive black layer (5Y 2/1) of ooze is at 213-216 cm.

SMEAR SLIDE SUMMARY %

	1-115	2-15	2-35	CC-20
Quartz	—	—	—	} 2
Feldspar	—	—	—	
Clay	3	20	20	5
Pyrite	1	1	1	3
Organic carbon	—	—	—	10
Carbonate unsp.	88	19	34	24
Foraminifera	3	10	5	6
Nannofossils	5	50	40	30

Silica and Iron Content:	1-71
SiO_2 =	8.6%
Fe =	0.49%
Carbon-Carbonate:	1-72
% Carbonate	20.8
% Organic Carbon	7.5
Carbonate Content:	1-60 = 73%

SITE 466 HOLE CORE 30 CORED INTERVAL 264.5 to 274.0 m



LITHOLOGIC DESCRIPTION

NANNOFOSSIL LIMESTONE AND CHALK

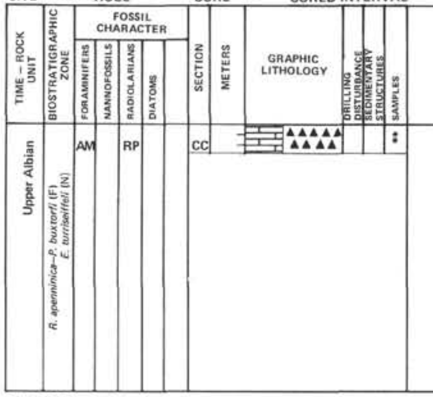
Olive gray (5Y 4/2) limestone and chalk with mottles of black (5Y 2/2). One piece of light gray (N7) limestone at 16-19 cm. At the bottom of the core are several black (N2) chert fragments up to 3 cm in diameter and one piece of the overlying limestone.

SMEAR SLIDE SUMMARY %

	1-18	1-45
Clay	Tr	10
Pyrite	—	Tr
Carbonate unsp.	80	55
Foraminifera	—	5
Nannofossils	15	30

Silica and Iron Content:	1-11
SiO_2 =	4.0%
Fe =	0.37%
Carbon-Carbonate:	1-12
% Carbonate	89.
% Organic Carbon	0.7
Carbonate Content:	1-10 = 93% 1-59 = 80%

SITE 466 HOLE CORE 31 CORED INTERVAL 274.0 to 283. 5 m



LITHOLOGIC DESCRIPTION

CHERT AND NANNOFOSSIL LIMESTONE

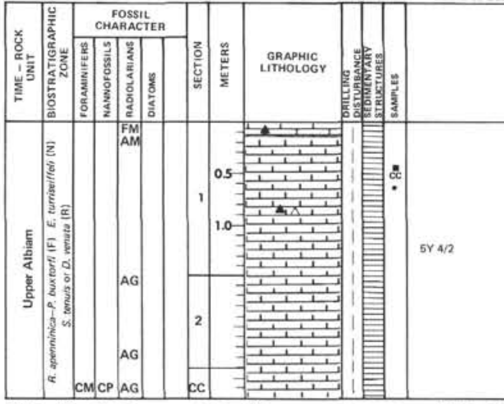
Drilling breccia of black (N2) chert up to 1 cm in size; and limestone, olive gray (5Y 4/2) in color, and up to 5 cm in diameter.

SMEAR SLIDE SUMMARY %

	1-13	1-18
Clay	—	12
Volcanic glass	2	1
Pyrite	1	Tr
Micronodules	8	—
Carbonate unsp.	2	65
Foraminifera	—	2
Nannofossils	86	20
Radiolaria	1	—

NOTE: Site 466, Core 32, 283.5–287.5 m: NO RECOVERY
Site 466, Core 33, 293.0–302.5 m: NO RECOVERY

SITE 466 HOLE CORE 34 CORED INTERVAL 293.0 to 302.5 m



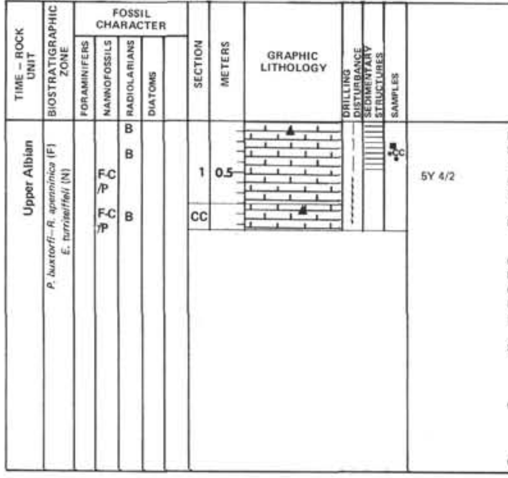
LITHOLOGIC DESCRIPTION

NANNOFOSSIL LIMESTONE AND CHALK

Olive gray (5Y 4/2) limestone overlying chalk of the same color. Both uniform in lithology with some faint laminations. Very dark gray (5Y 3/1) mottles are at 182-186 cm. Black (N2) chert is at 0-2 cm and 80-86 cm. The one at 80-86 cm has a large olive gray (5Y 4/2) porcellanite rim.

Silica and Iron Content:	1-49
SiO_2 =	—
Fe =	0.28%
Carbon-Carbonate:	1-48
% Carbonate	77.5%
% Organic Carbon	1.0%
Carbonate Content:	1-69 = 90%

SITE 466 HOLE CORE 35 CORED INTERVAL 302.5 to 312.0 m



LITHOLOGIC DESCRIPTION

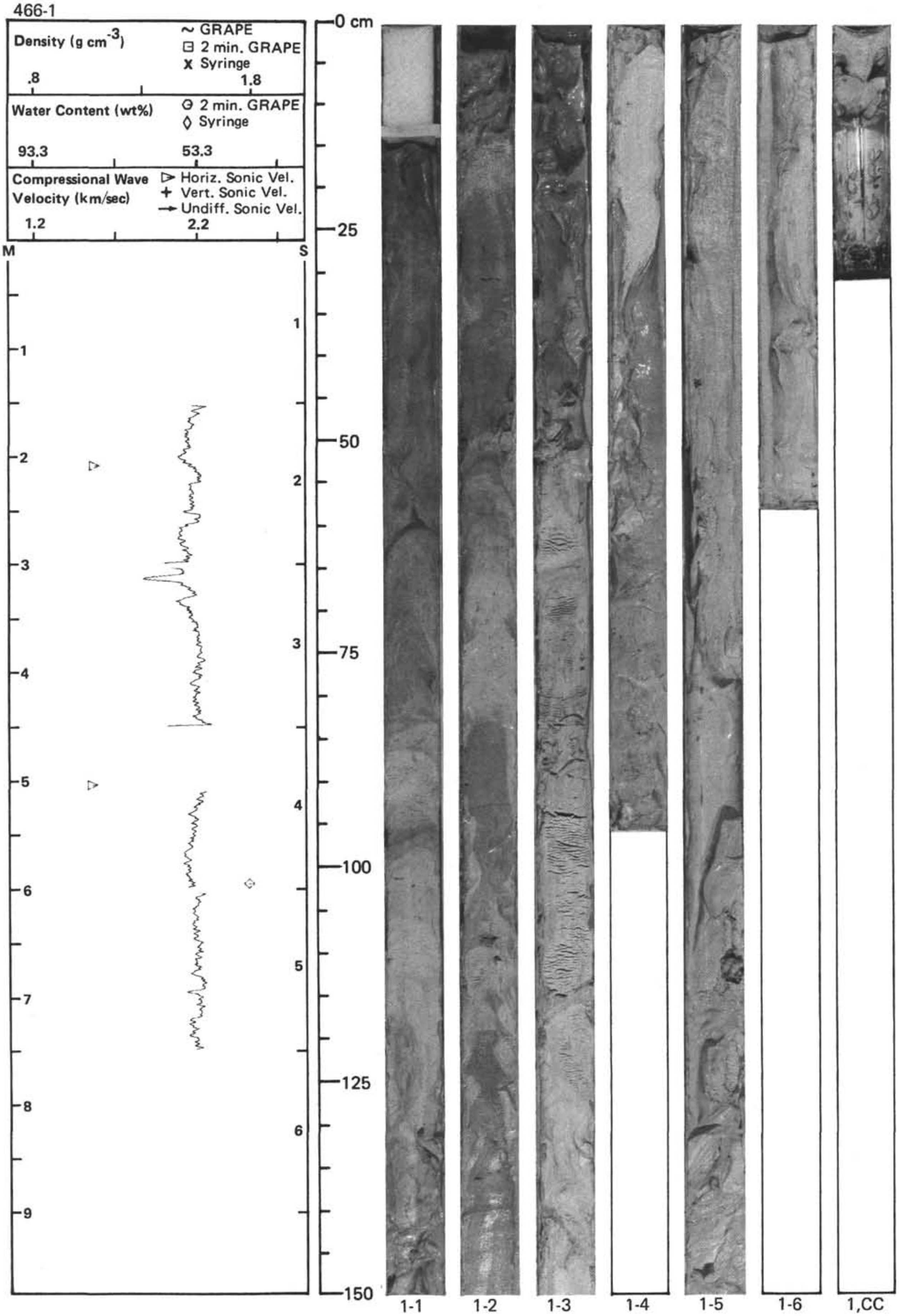
NANNOFOSSIL CHALK

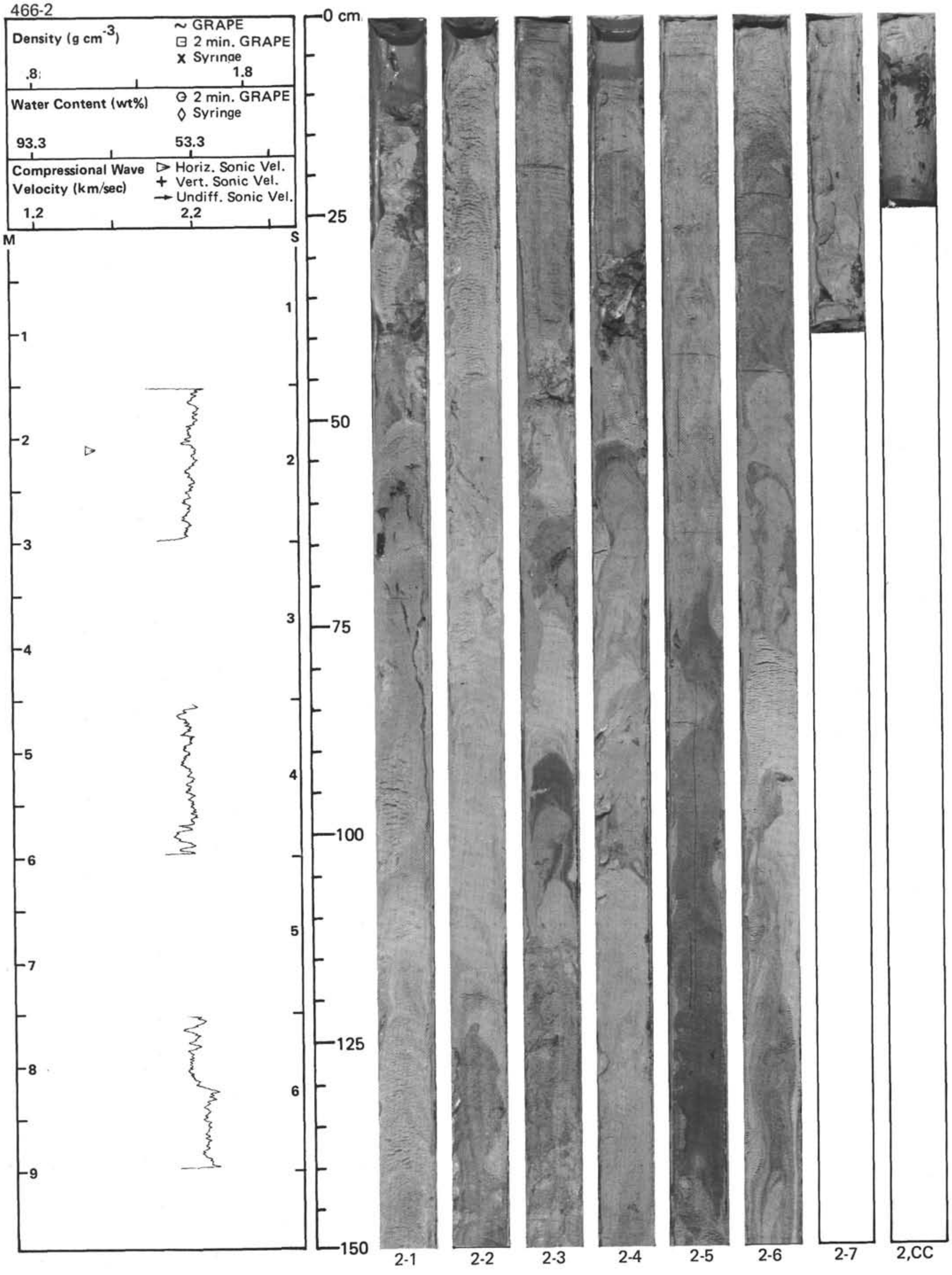
Slight and highly disturbed olive gray (5Y 4/2) chalk with the less disturbed sections showing faint laminations. Lithology is otherwise uniform. Black chert (5Y 2/1) is at 6-11 cm and 83-86 cm. Olive gray (5Y 4/2) porcellanite is also at 83-86 cm.

SMEAR SLIDE SUMMARY %

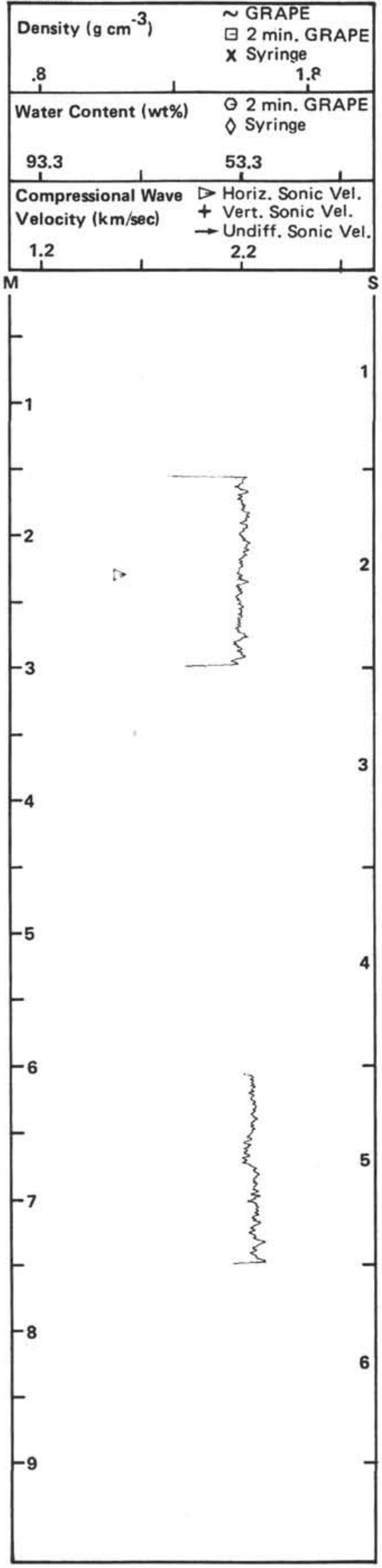
	1-30
Clay	7
Pyrite	1
Carbonate unsp.	50
Foraminifera	2
Nannofossils	40

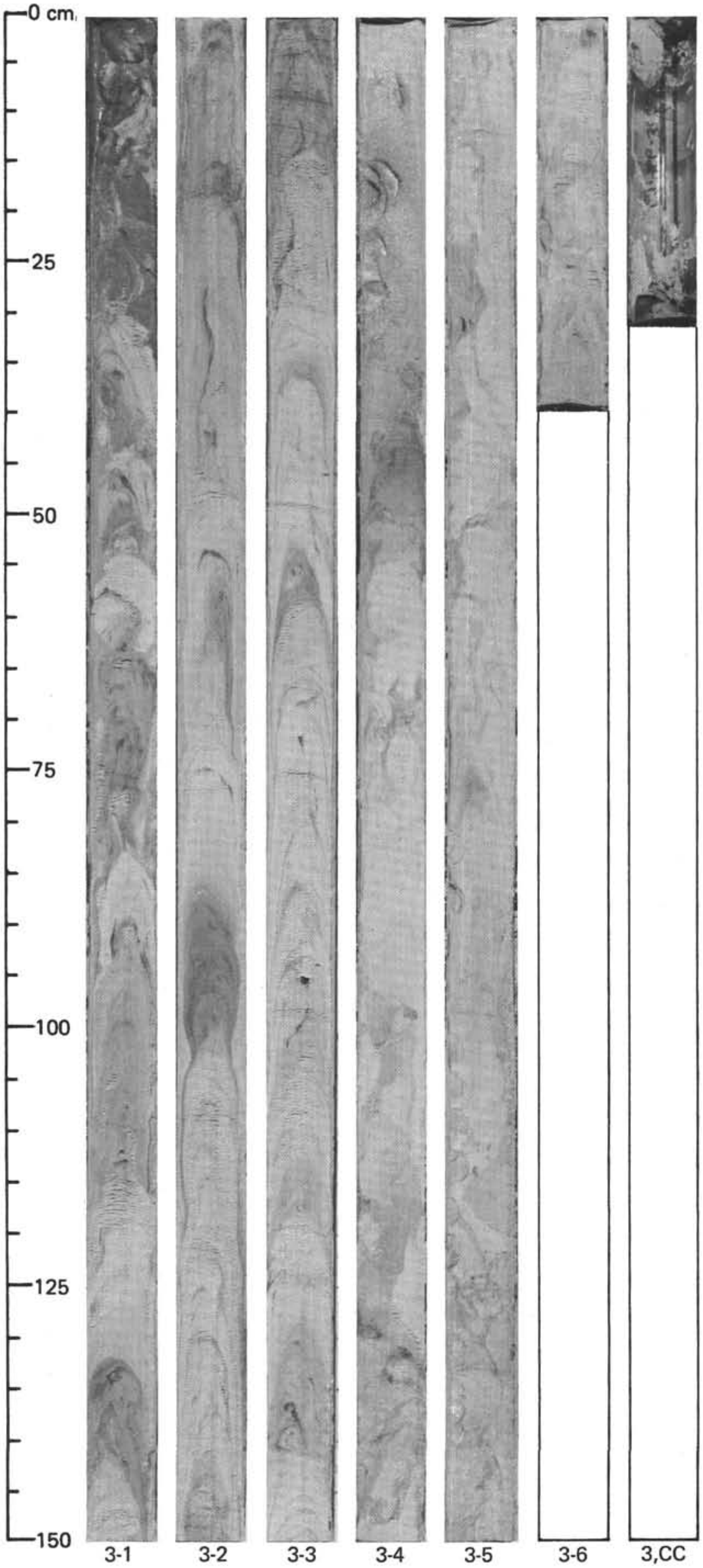
Silica and Iron Content:	1-26
SiO_2 =	6.4%
Fe =	0.43%
Carbon-Carbonate:	1-25
% Carbonate	65.0
% Organic Carbon	2.6
Carbonate Content:	1-42 = 85%

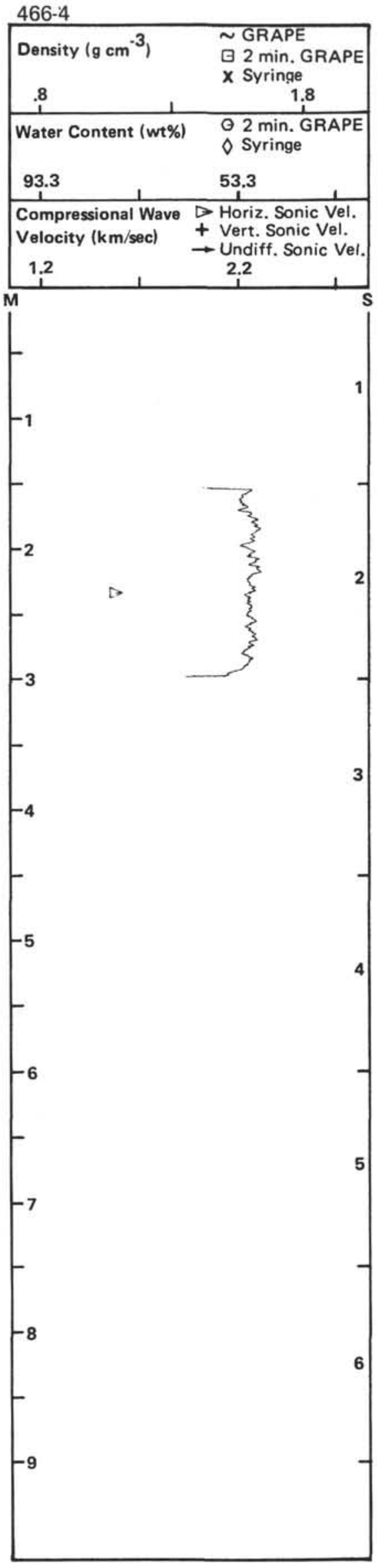

466-1
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
⊖ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1-6
1,CC

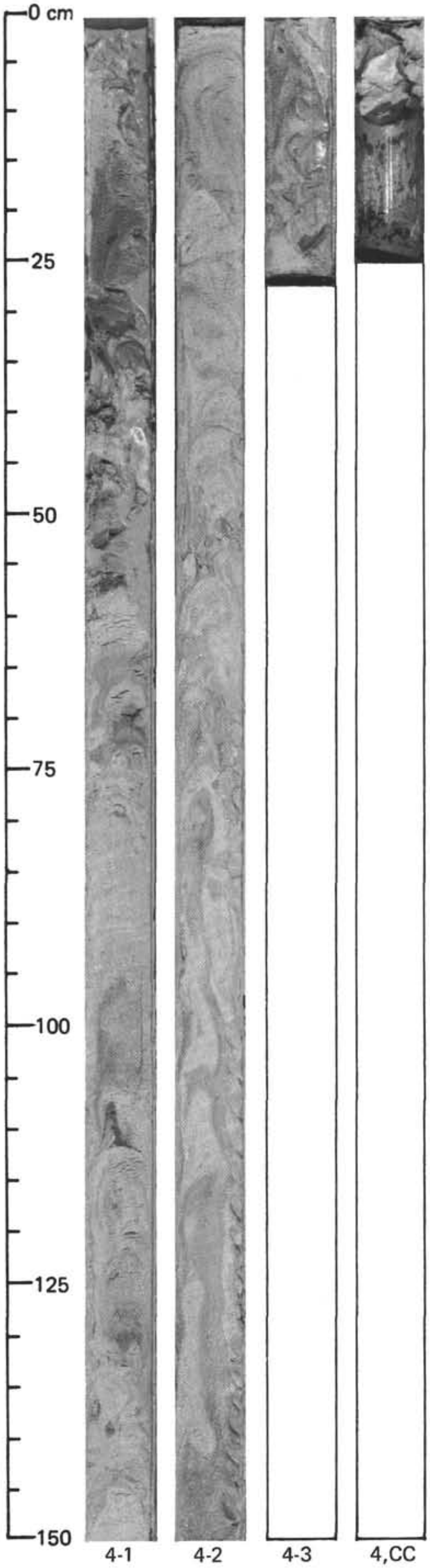

466-2
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
ϴ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9
0 cm
25
50
75
100
125
150
2-1
2-2
2-3
2-4
2-5
2-6
2-7
2,CC

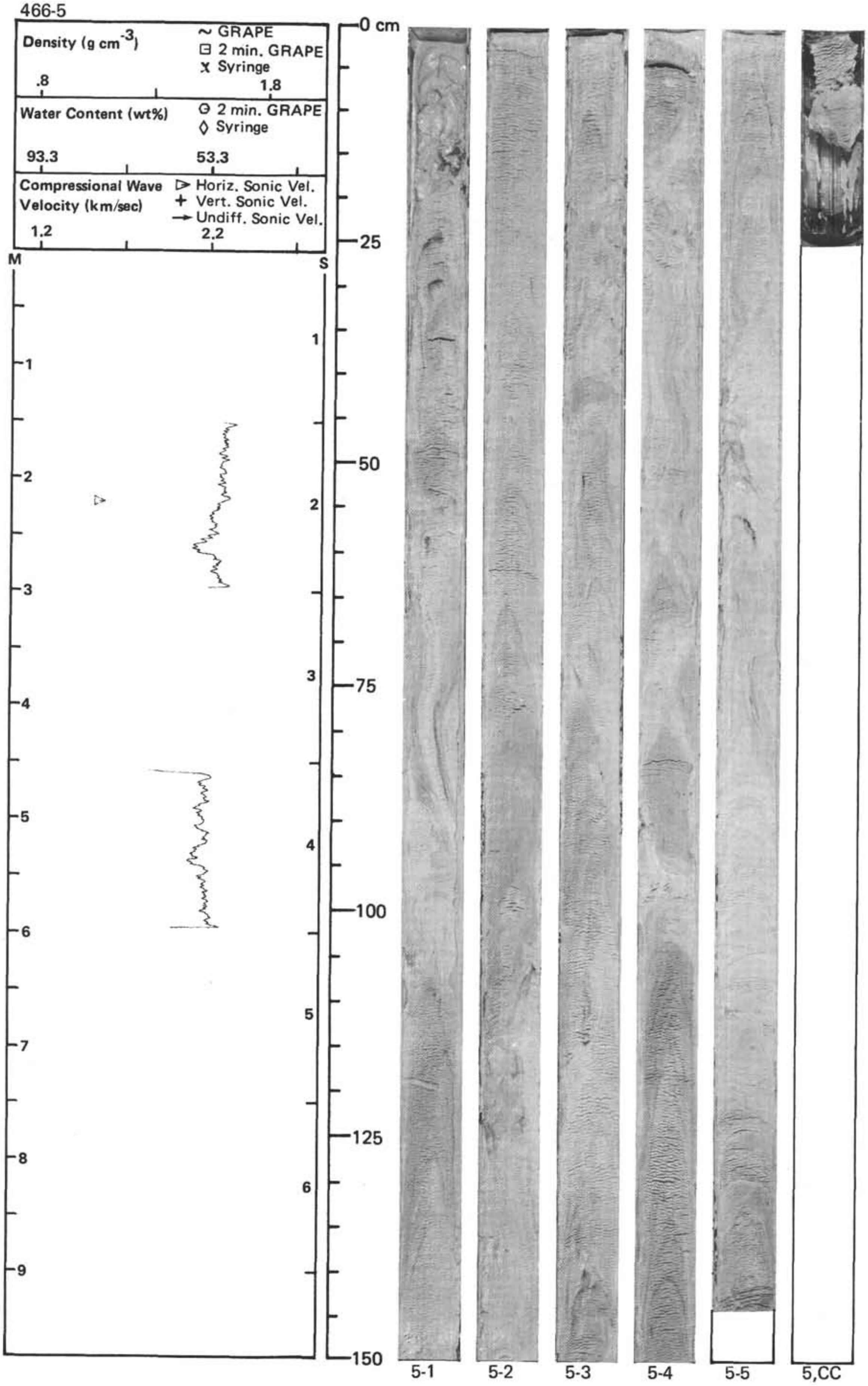
466-3

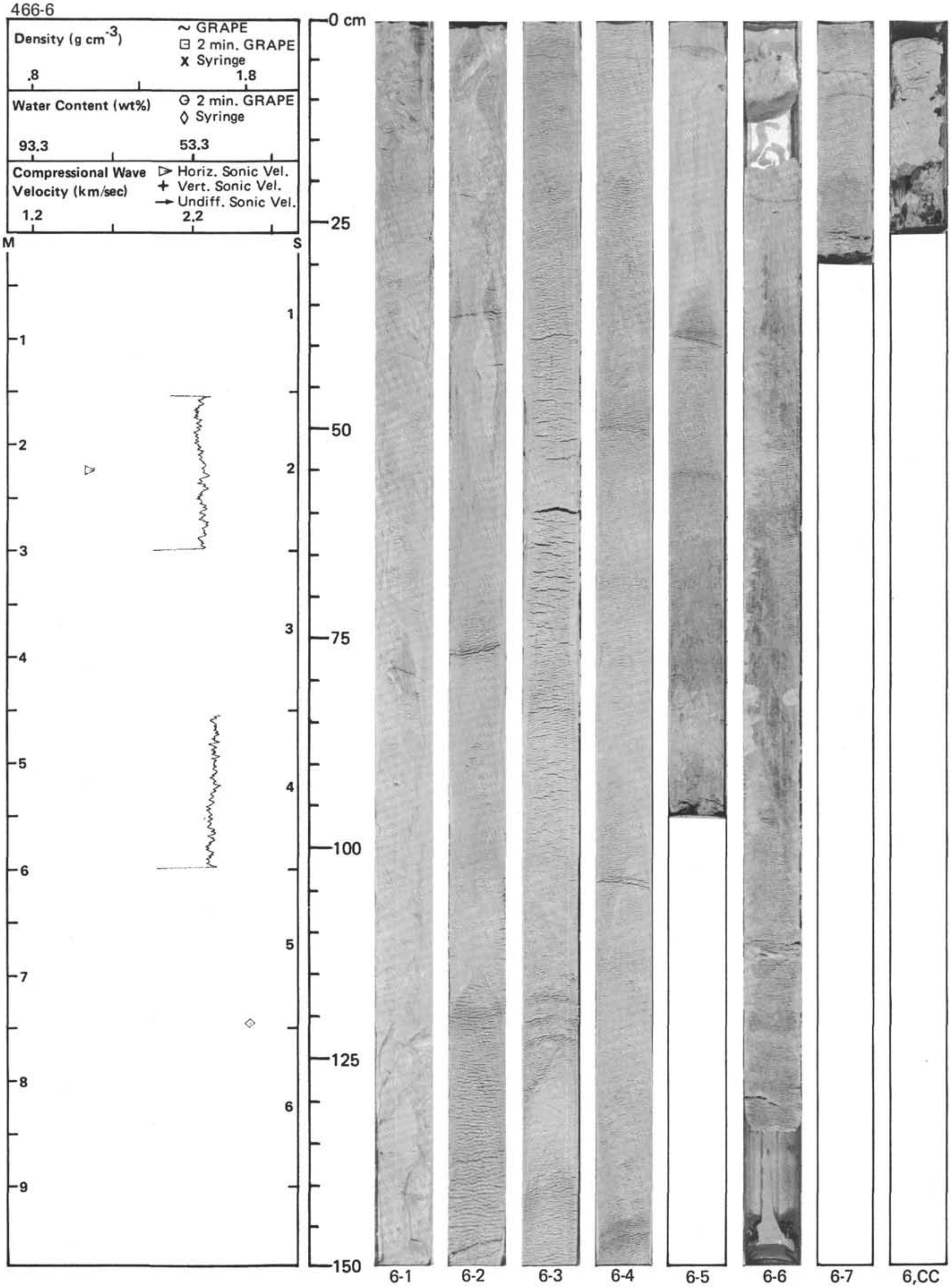

Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
Θ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9


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

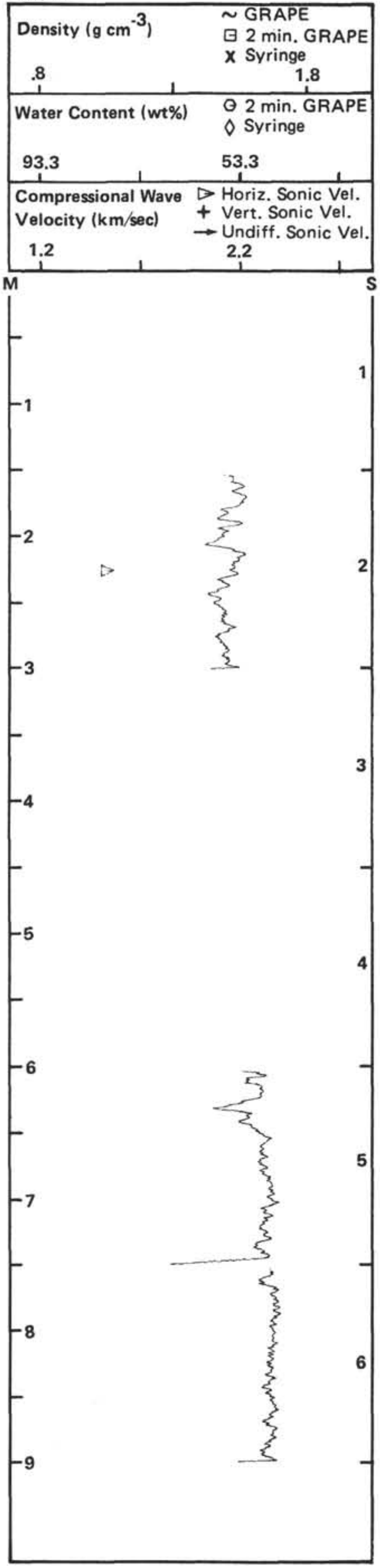

466-4
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
⊖ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9

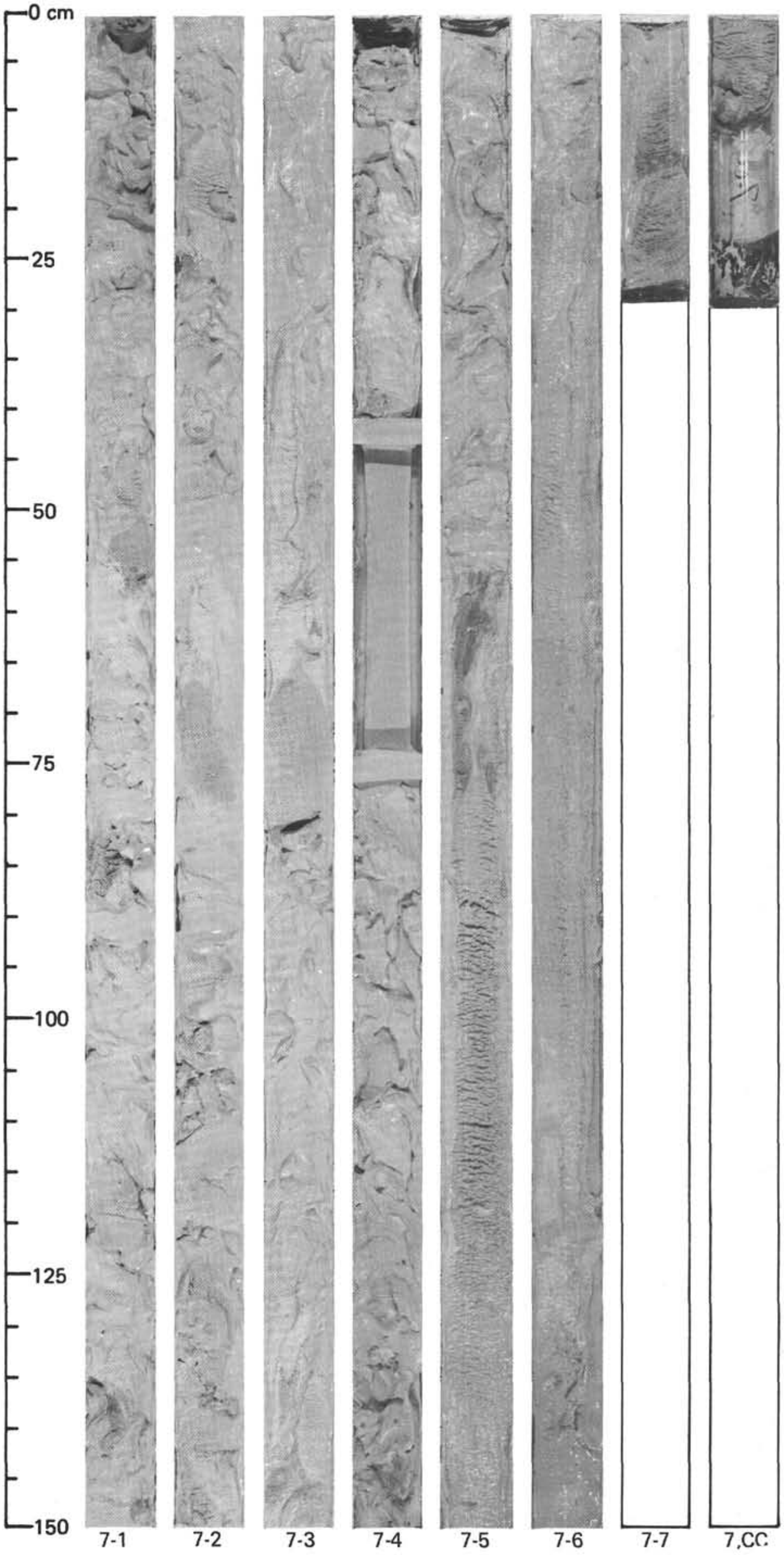

0 cm
25
50
75
100
125
150
4-1
4-2
4-3
4,CC


466-5
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
⊖ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6
0 cm
25
50
75
100
125
150
5-1
5-2
5-3
5-4
5-5
5,CC

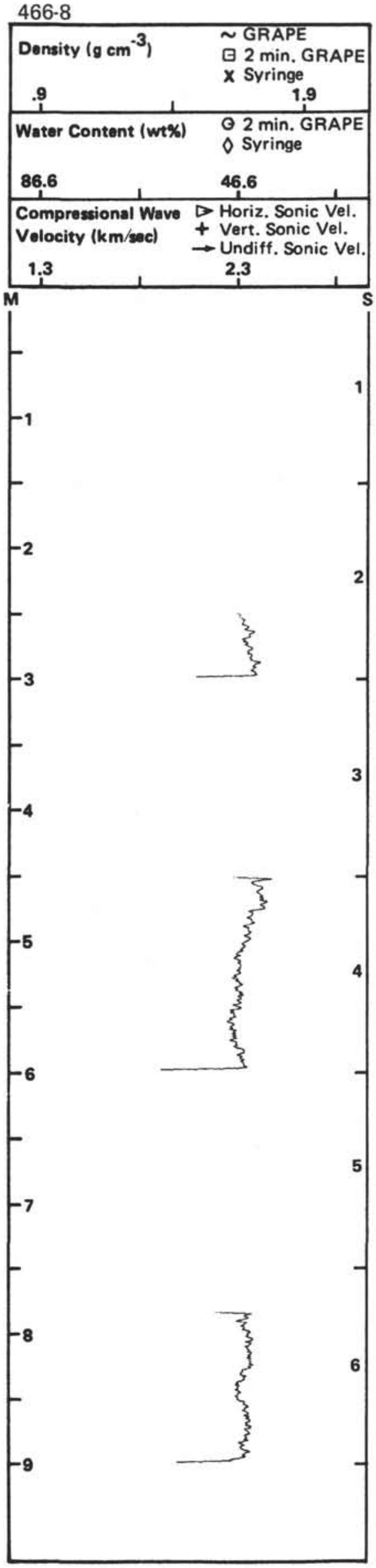

466-6
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
ʘ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9
0 cm
25
50
75
100
125
150
6-1
6-2
6-3
6-4
6-5
6-6
6-7
6,CC

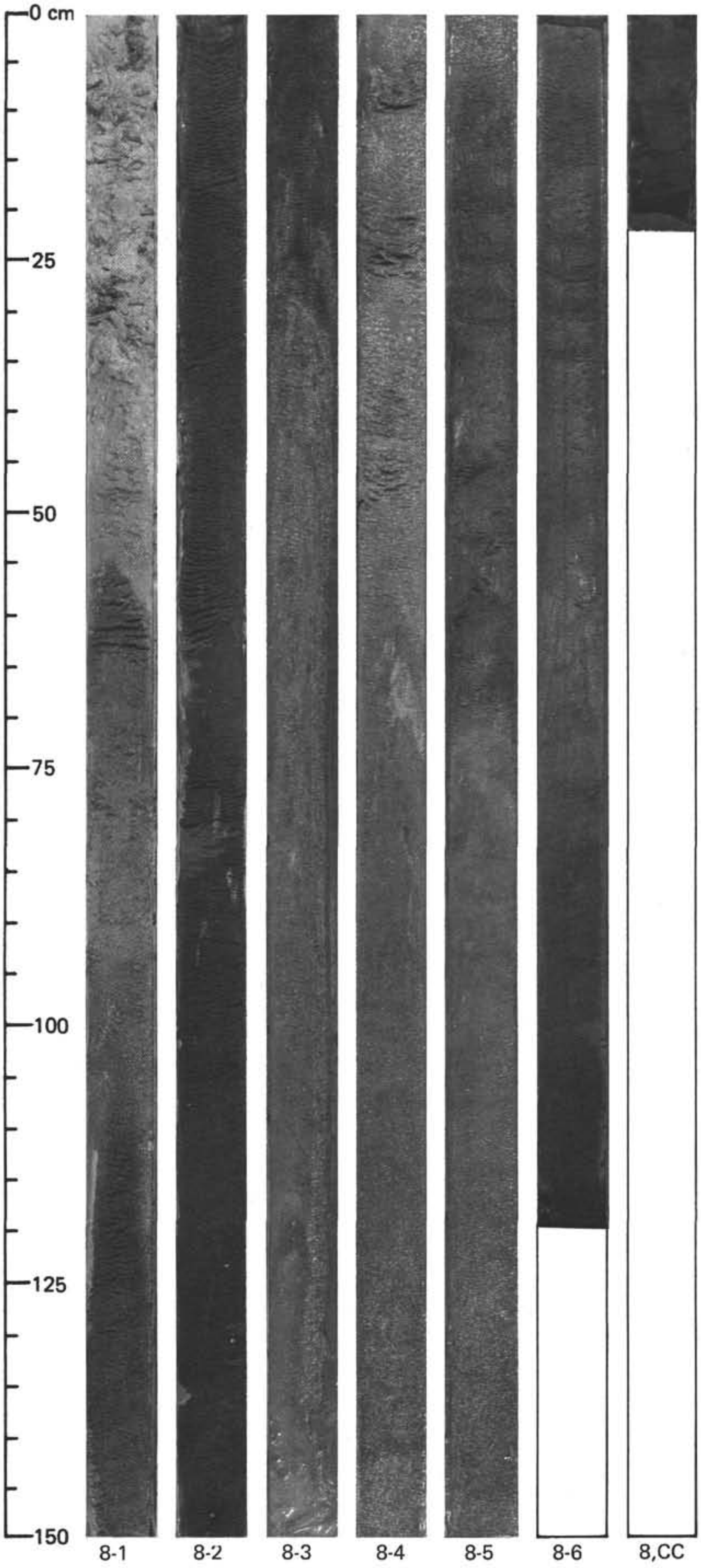
466-7

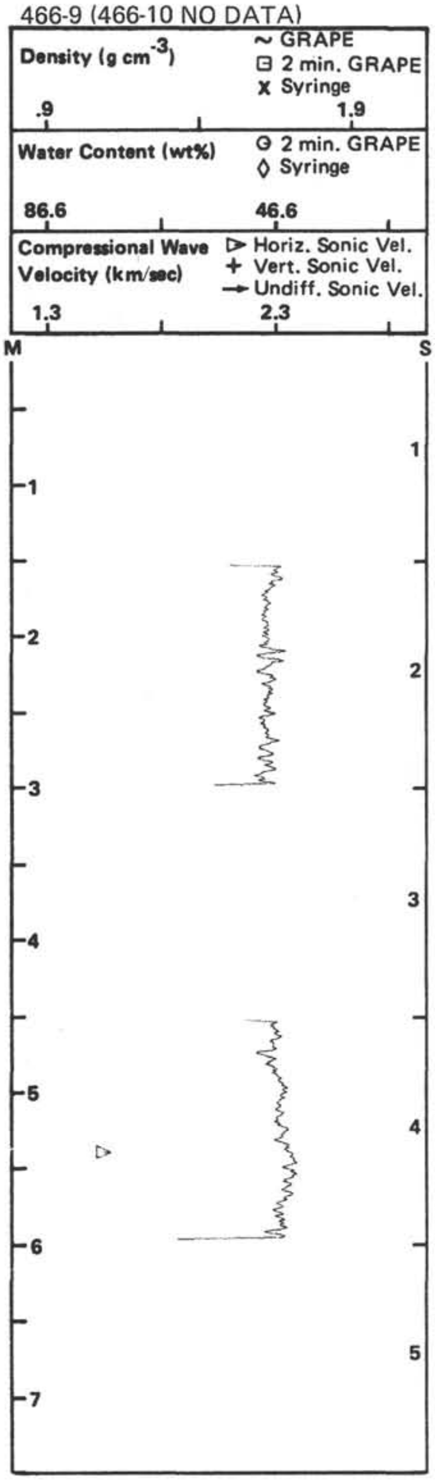

Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.8
1.8
Water Content (wt%)
⊖ 2 min. GRAPE
◊ Syringe
93.3
53.3
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.2
2.2
M
S
1
2
3
4
5
6
7
8
9

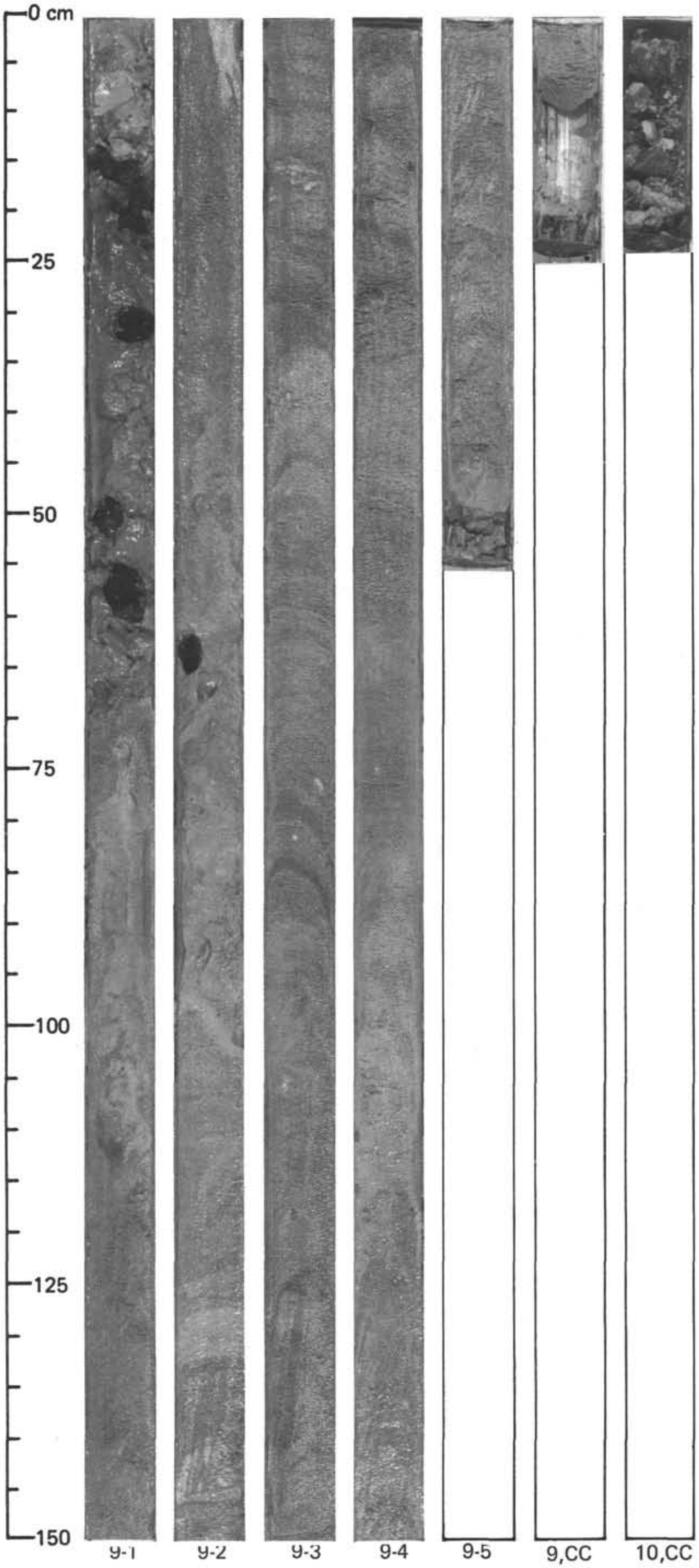

0 cm
25
50
75
100
125
150
7-1
7-2
7-3
7-4
7-5
7-6
7-7
7,CC

466-8

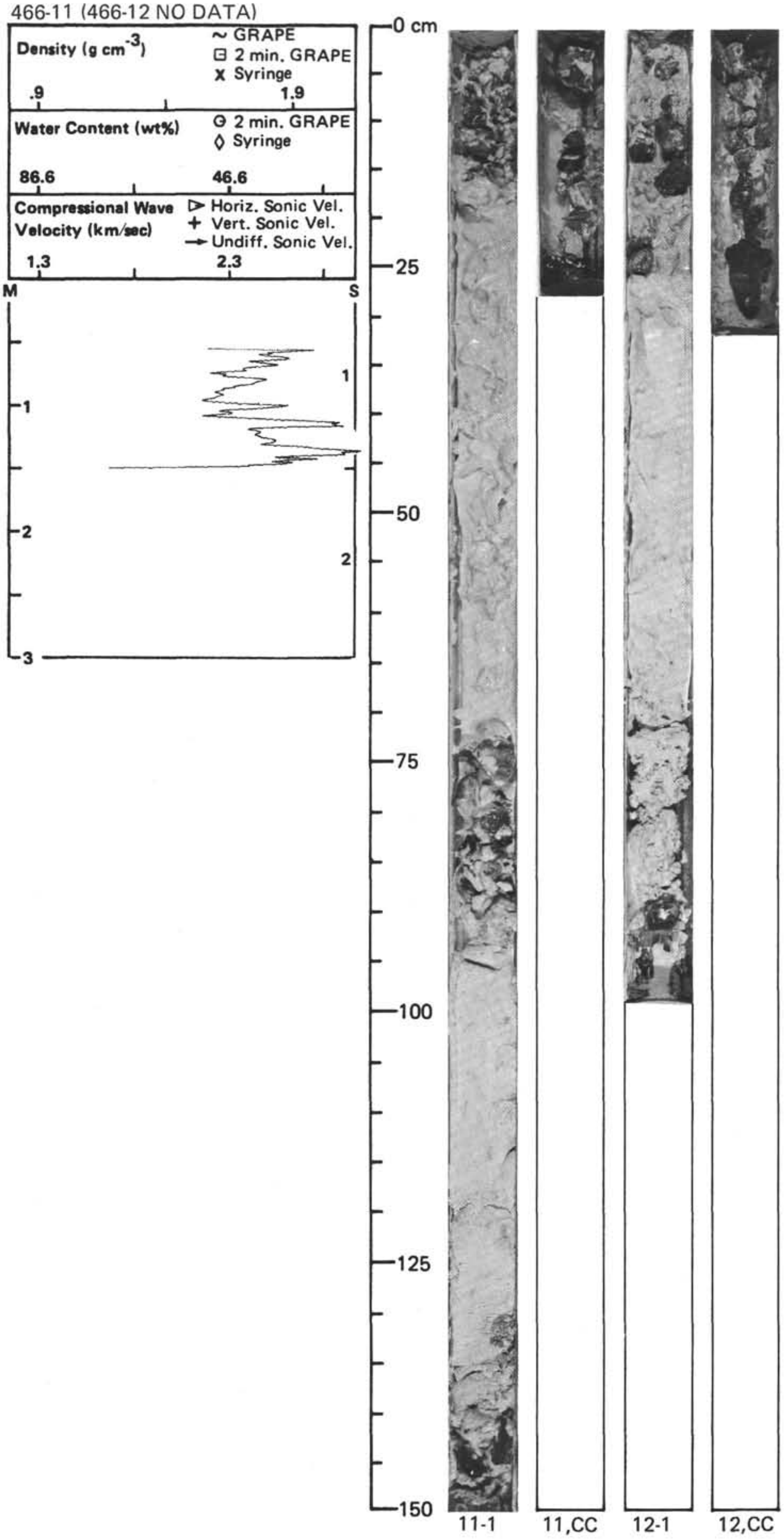

Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.9
1.9
Water Content (wt%)
⊖ 2 min. GRAPE
◊ Syringe
86.6
46.6
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.3
2.3
M
S
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6

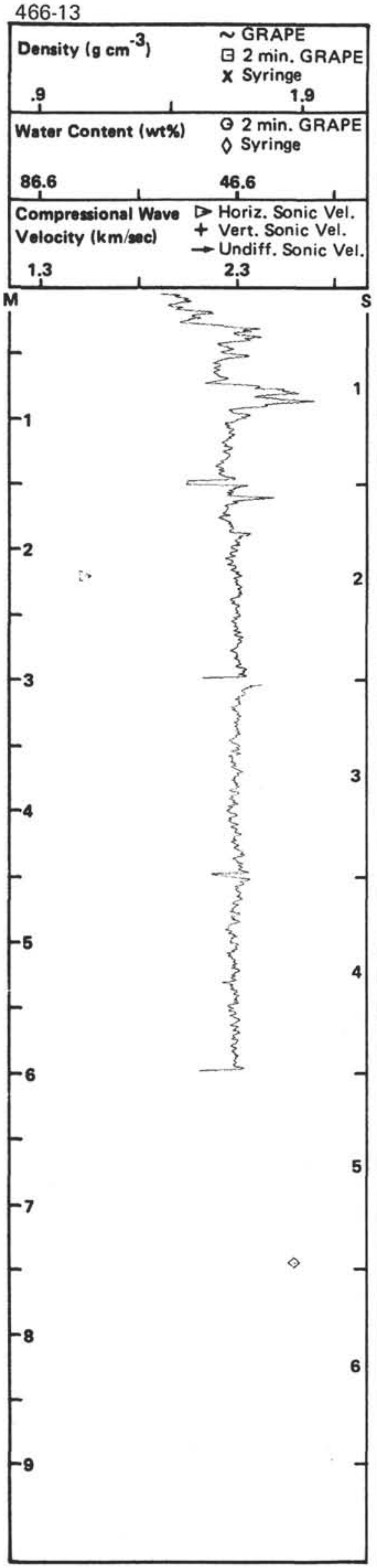

0 cm
25
50
75
100
125
150
8-1
8-2
8-3
8-4
8-5
8-6
8,CC

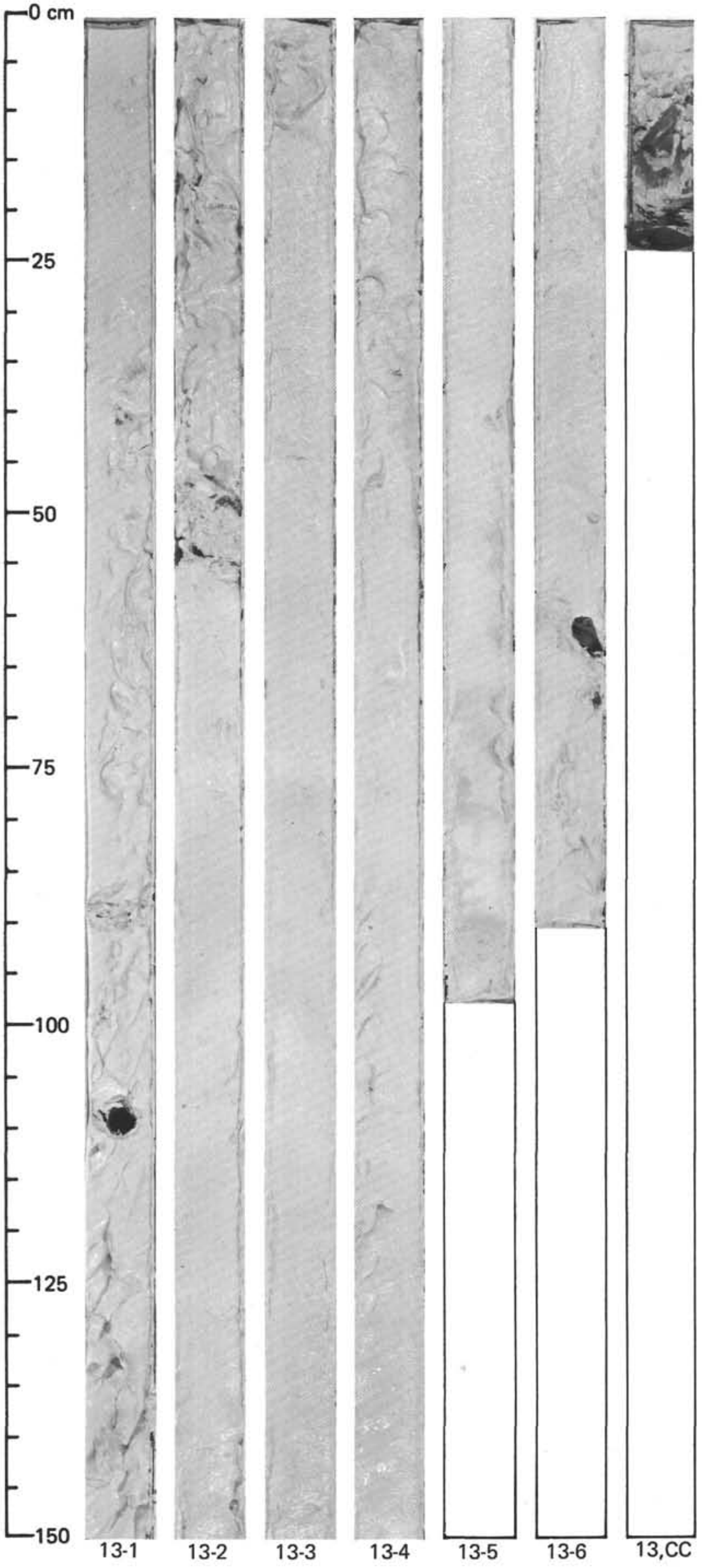

466-9 (466-10 NO DATA)
Density (g cm^{-3})
~ GRAPE
⊟ 2 min. GRAPE
X Syringe
.9
1.9
Water Content (wt%)
ʘ 2 min. GRAPE
◊ Syringe
86.6
46.6
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.3
2.3
M
S
1
2
3
4
5
6
7
1
2
3
4
5


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

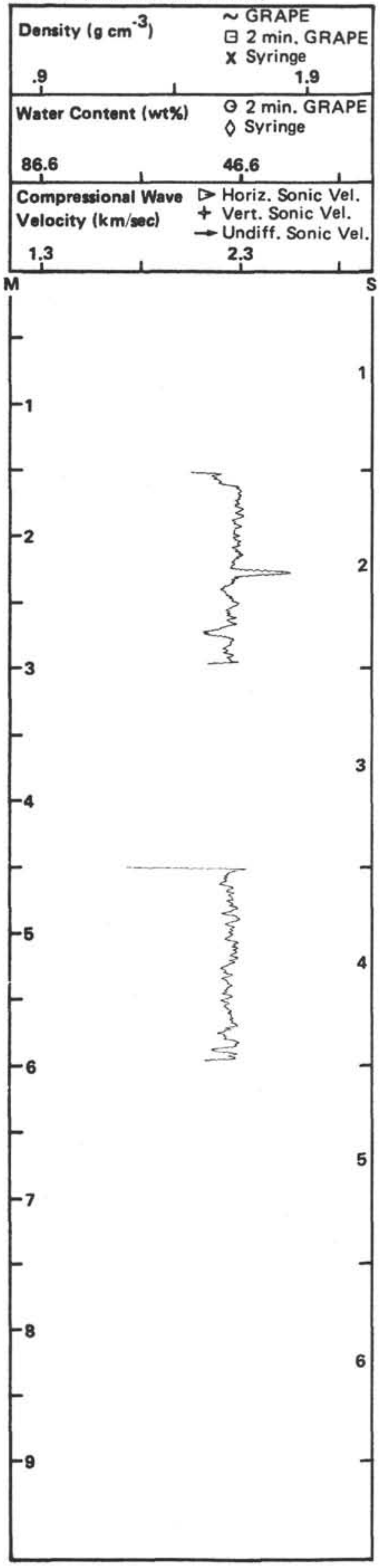
466-11 (466-12 NO DATA)

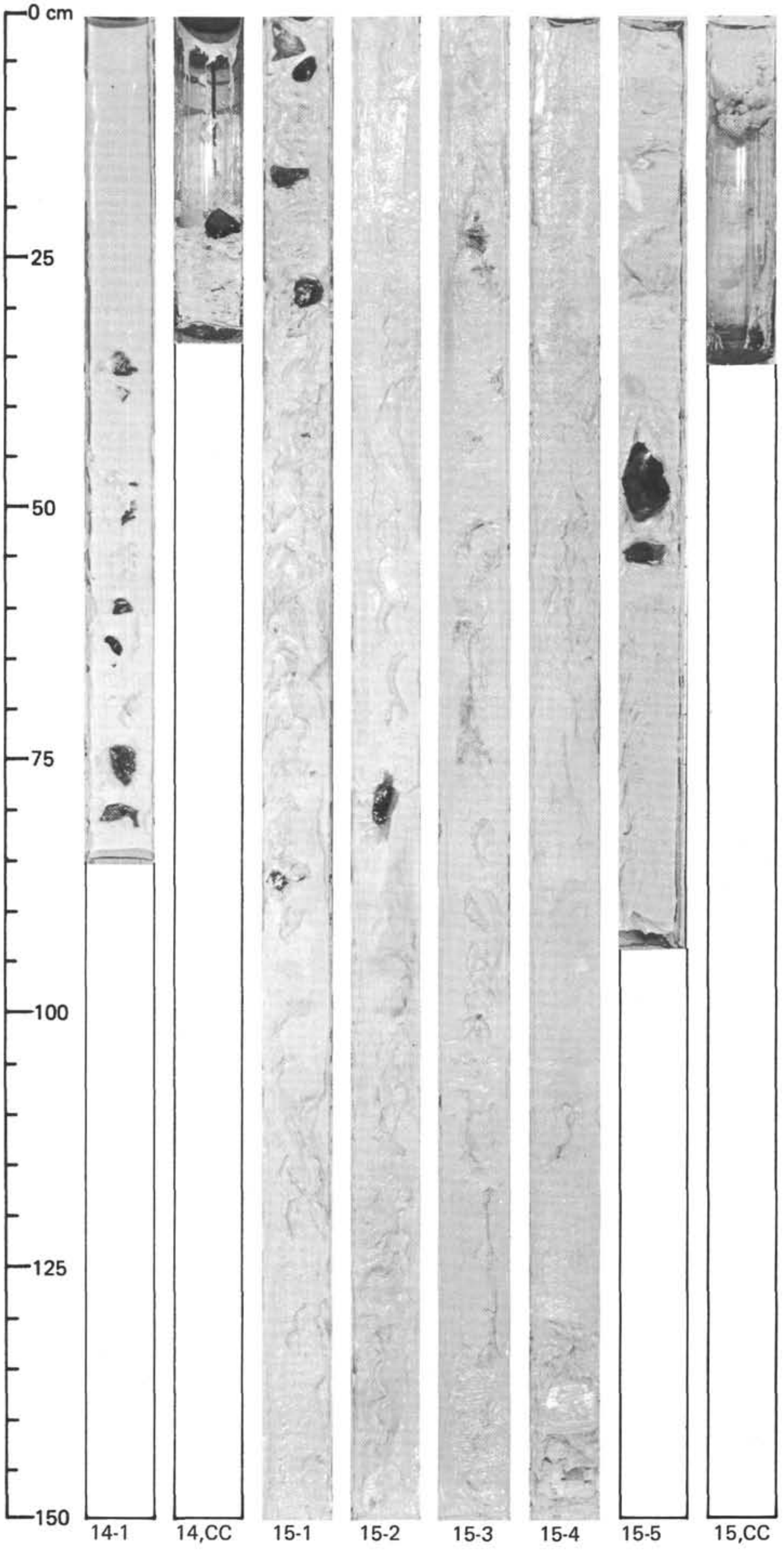



466-13
Density (g cm^{-3})
~ GRAPE
⊡ 2 min. GRAPE
X Syringe
.9
1.9
Water Content (wt%)
ʘ 2 min. GRAPE
◊ Syringe
86.6
46.6
Compressional Wave Velocity (km/sec)
▷ Horiz. Sonic Vel.
+ Vert. Sonic Vel.
→ Undiff. Sonic Vel.
1.3
2.3
M
S
1
2
3
4
5
6
7
8
9
1
2
3
4
5
6

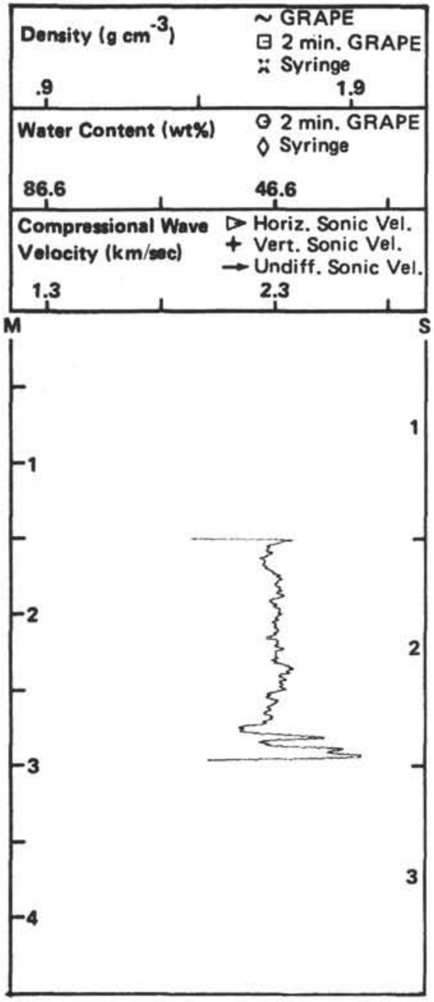

0 cm
25
50
75
100
125
150
13-1
13-2
13-3
13-4
13-5
13-6
13,CC

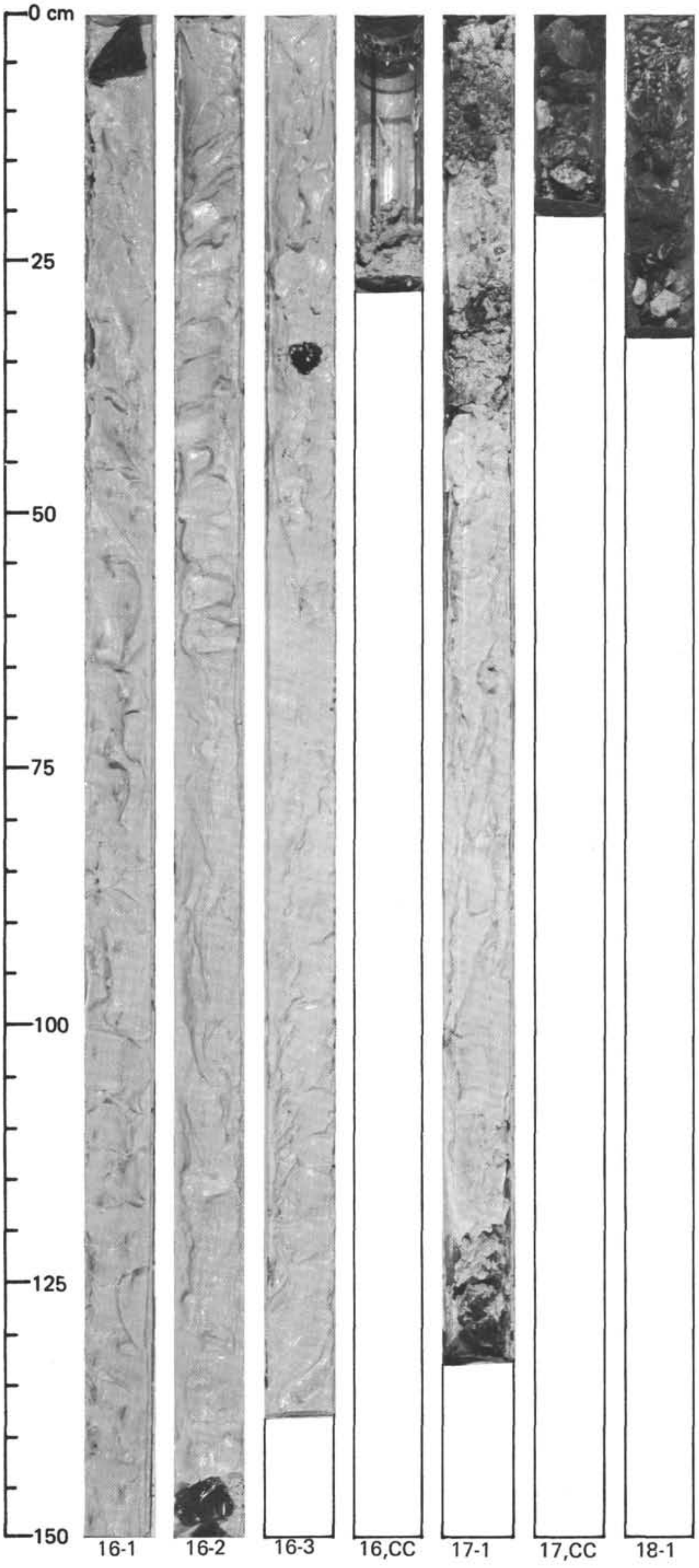
466-15 (466-14 NO DATA)



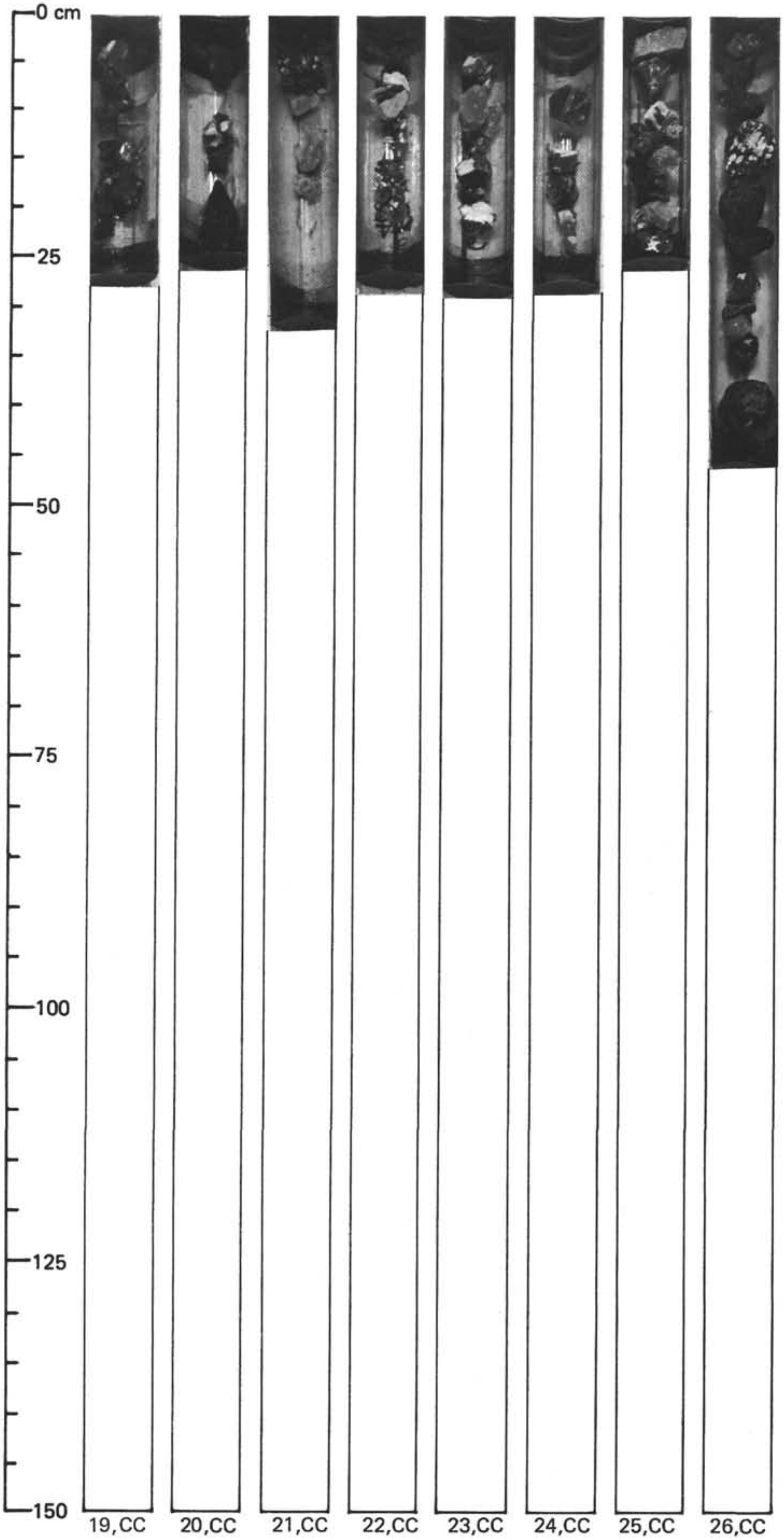


466-16 (466-17, 18 NO DATA)





466-19, 20, 21, 22, 23, 24, 25, 26
NO DATA



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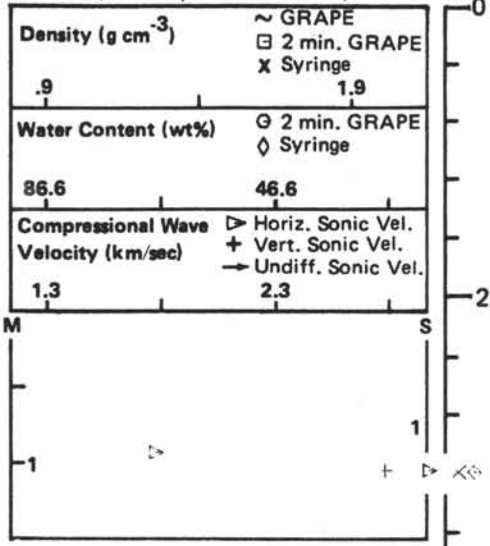
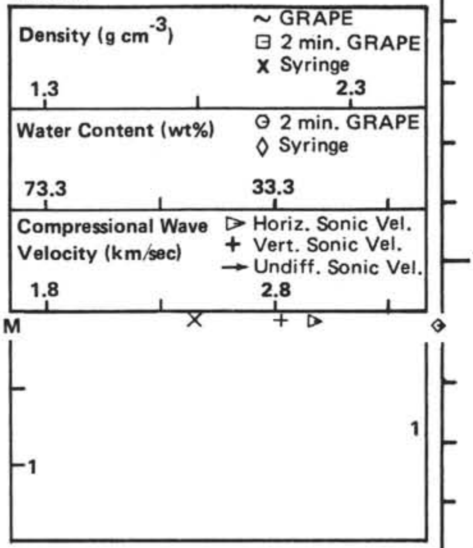
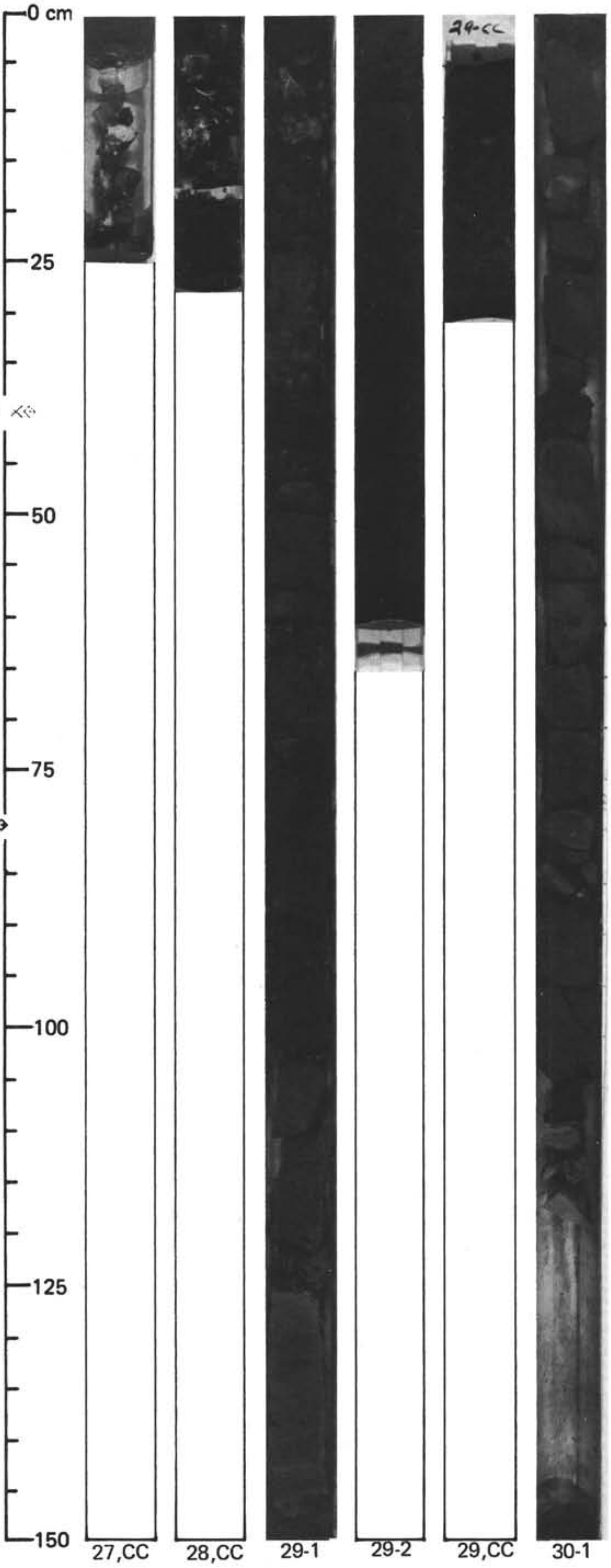


466-30





466-31, 32, 33, 34, 35 NO DATA