5. SITE 528[1]

Shipboard Scientific Party[2]

HOLE 528[3]

Date occupied: 4 July 1980

Date departed: 10 July 1980

Time on hole: 6 days, 2 hr.

Position: 28°31.49′S; 02°19.44′E

Water depth (sea level; corrected m, echo-sounding): 3800

Water depth (rig floor; corrected m, echo-sounding): 3810

Bottom felt (m, drill pipe): 3812

Penetration (m): 555.0

Number of cores: 47

Total length of cored section (m): 441.0

Total core recovered (m): 272.8

Core recovery (%): 62

Oldest sediment cored:
Depth sub-bottom (m): 545
Nature: Nannofossil chalk, claystone, siltstone
Age: Maestrichtian
Measured velocity (km/s): 2.0–2.7

Basement:
Depth sub-bottom (m): 555, top of basement complex 474.5 m
Nature: Basalt and interlayered sediment
Velocity range (km/s): 4.0–5.7

HOLE 528A

Date occupied: 10 July 1980

Date departed: 13 July 1980

Time on hole: 2 days, 23 hr., 6 min.

Position: 28°31.16′S; 02°18.97′E

Water depth (sea level; corrected m, echo-sounding): 3815

Water depth (rig floor; corrected m, echo-sounding): 3825

Bottom felt (m, drill pipe): 3825.5

Penetration (m): 130.5

Number of cores: 30

Total length of cored section (m): 130.5

Total core recovered (m): 116.5

Core recovery (%): 89

Oldest sediment cored:
Depth sub-bottom (m): 130.5
Nature: Nannofossil ooze
Age: late Oligocene
Measured velocity (km/s): 1.57

Principal results:

1. A complete sedimentary section from seafloor to 474 m sub-bottom was cored in two holes. The upper 130.5 m were cored by hydraulic piston corer. An additional 81 m of a basaltic basement complex were cored. Sediments were carbonate-rich oozes and chalks, with volcanic material common in the basal (Maestrichtian) unit.

2. Short hiatuses in the sedimentary section are found at the Miocene/Pliocene boundary and in the lower middle Miocene to lower Miocene (Hole 528A only). Other short breaks in the record may occur in the Oligocene and lower Paleocene. The mid-Miocene hiatus appears to be associated with a slump or erosional event.

3. The Oligocene section at Site 528 is more complete than at the adjacent deeper site (527), but most foraminifers are highly dissolved. Unlike many other Oligocene sections in the South Atlantic, Site 528 had no intervals containing common *Braarudosphaera*.

4. Sedimentation rates range up to slightly over 2 cm/10^3y. with maxima in the lower Pliocene–upper Miocene, the lower Eocene–upper Paleocene, and Maestrichtian.

5. The preservation of calcareous microfossils ranges from moderate to poor. Changes in the preservation of the calcareous microfossils tend to parallel the changes in accumulation rate, with the best preservation in the Pliocene and lower Eocene through Paleocene.

6. Sedimentation appears to be continuous across the Cretaceous/Tertiary boundary.

7. Incomplete paleomagnetic sequences are identified for the upper Oligocene, and a relatively complete lower Paleocene and Cretaceous record was obtained.

8. Lithologic, biostratigraphic, and paleomagnetic results indicate the presence of a slump or a brecciated zone in the lower Paleocene. Similar zones of disturbance may be present in this interval at other sites. This zone is observed in the velocity logging by a distinct velocity minima and is probably related to a continuous seismic reflector observed about 0.05–0.10 s of two-way travel time above the basement complex.

9. The recovered basement complex of 81 m has an age of middle Maestrichtian, slightly older than Site 527 and younger than Site 525. This is in agreement with seafloor magnetic anomalies and the interpretation of magnetic measurements made on the sediments.

10. As at other sites of the Walvis Ridge in which basement was cored, the basalts of the basement complex are intercalated with sediments. Eight different flow units are identified within this

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[1] Moore, T. C., Jr., Rabinowitz, P. D., et al., *Init. Repts. DSDP*, 74: Washington (U.S. Govt. Printing Office).

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[3] Principal results follow Hole 528A data.

complex; all but two are separated by sediments. The recovered units vary from phyric to aphyric with subophitic textures. All but two are rich in plagioclase phenocrysts.

11. Sediments near basement contain benthic microfossils that indicate slope depth (≤1500 m); this agrees with paleodepth estimates on the depth versus time backtracking technique.

BACKGROUND AND OBJECTIVES

Geologic and Oceanographic Setting

Site 528 (planned as SAII-3) lies at an intermediate depth between Sites 529 and 527 in a transect of sites extending down the western slope of a NNW-SSE-trending block in the Walvis Ridge (Fig. 1). Reflection records of the *Vema* and *Thomas B. Davie* (Fig. 1) show the presence of 0.48 s of sediments (approx. 480 m) conformably overlying a relatively flat acoustic basement. Studies of the crustal magnetic anomalies and the results of Sites 525 and 527 indicate that the basement age should be mid-Maestrichtian (68–70 Ma).

Although acoustic reflectors within the sediment column cannot be directly traced to Site 525, they can be traced to Site 527 and their general character compared to those at Site 525. These comparisons suggest that the lower Paleogene–Upper Cretaceous sections and basement complex at this site are similar to those at the other two sites of the transect. The mid-section reflector at Site 527 was correlated with an interval of carbonate-poor sediments and with breaks in accumulation that span much of the Miocene and part of the Oligocene. Traced upslope to Site 528, this rather strong reflector appears to split into two reflectors that are weaker than the single mid-section reflector at Site 527. It was anticipated that these reflectors represent smaller lithologic changes or shorter breaks in the stratigraphic record and that much of the mid-Tertiary section, which was missing at Site 527, would be recovered at Site 528. Results to date also indicate that the Walvis Ridge has followed a normal depth versus time cooling curve; therefore the depth at this site has probably increased from less than 1600 m at the time of crustal formation to approximately 3800 m (present depth).

The oceanographic setting of this site is identical to that of Site 525, 80 km to the SSE, and Site 527, 80 km to the NNW. Thus it is assumed that the pelagic rain of

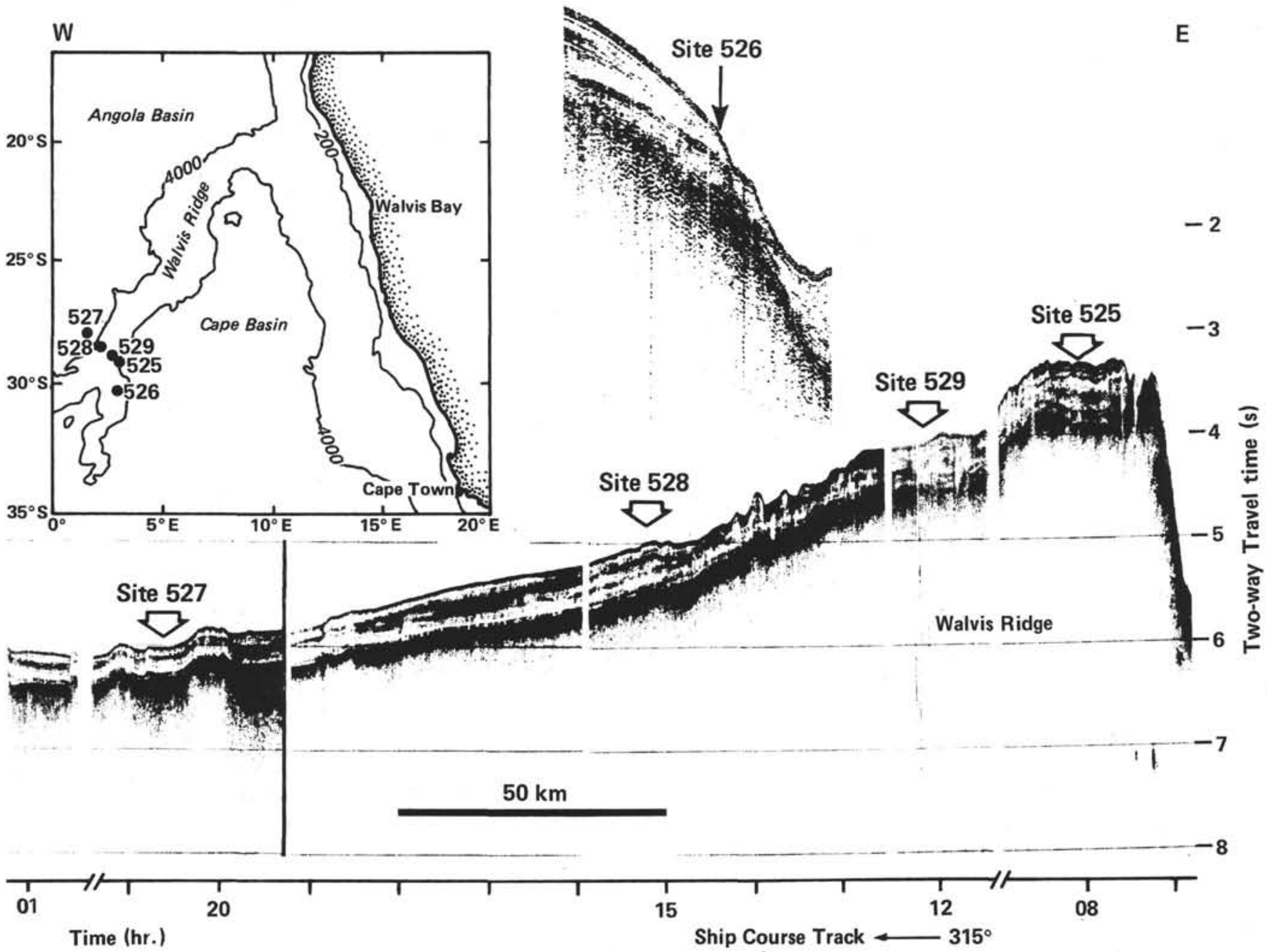

Figure 1. Index and location map and reflection profile record of *Vema* and *Thomas B. Davie*, Site 528.

biogenic and detrital material is the same at all sites of the transect. The major oceanographic difference in site locations lies in the water depth. At 3800 m, Site 528 is approximately 600 m shoaler than Site 527 and 800 m deeper than Site 529. All three sites presently lie within the depth interval covered by North Atlantic Deep Water. This water mass dominates the Angola Basin in modern times, and the relatively low dissolved CO_2 content (high alkalinity) of these waters assures good preservation of the recently deposited biogenic carbonates. Results of previous drilling on this and other legs of DSDP indicate, however, that both erosion and carbonate dissolution have strongly affected the mid-Tertiary sections recovered in this basin.

Scientific Objectives

The scientific objectives of this site, as part of the Walvis Ridge transect, focus on three main topics: (1) the history of bottom waters within the eastern South Atlantic; (2) the development of detailed biostratigraphies and paleomagnetic stratigraphies for this area; and (3) the tectonic evolution of the Walvis Ridge.

Site 528 is an intermediate-depth site on the Walvis Ridge depth transect and provides important additional control in our studies of the history of vertical gradients in this ocean basin. It is also the third site in this transect to be drilled to basement. Together, these three sites will be particularly important in establishing the early Tertiary–Late Cretaceous history of deep water masses and in detecting geochemical trends in the evolution of the crustal material which formed the Walvis Ridge.

OPERATIONS

Glomar Challenger departed Site 527 on 4 July 1980 at 0542 hr. Continuous seismic profiles, magnetics, and bathymetry were collected en route to Site 528. Two sonobuoys were attempted on the departure from Site 527. Both prematurely stopped transmitting.

A geophysical site survey was conducted prior to Leg 74 by *Thomas B. Davie* of the University of Cape Town on all of the Walvis Ridge sites to be drilled on this leg (Rabinowitz and Simpson, 1979). Other geological/geophysical ships' tracks in the vicinity which were of importance in the site selection included those of *Vema* (L-DGO) and *Atlantis II* (WHOI). A predrilling survey by *Challenger* in the site area was not necessary.

Glomar Challenger approached Site 528 from the northwest on a course of 135° and a speed of 7 kt. The beacon was dropped at 1130 hr., 4 July 1980, based on a PDR depth of 3739 m and a sediment thickness of 0.48 s (two-way reflection time) observed on seismic reflection profiles aboard *Challenger* and its correlation to the predrilling site survey. One of the air guns malfunctioned at about the time of the beacon drop. At 1138 hr. we reversed course to 315° to approach the site and commenced pulling in the towed geophysical gear. Figure 2 shows the ship's track for the approach on site.

On Site 528, we planned to rotary core from a sub-bottom depth where the sediments appeared stiff, through the sediment section into basement, and to log the hole. We then planned to hydraulic piston core the hole from the seafloor to the sub-bottom depth where rotary coring commenced.

Two holes were drilled (see Table 1).

Hole 528

We obtained 47 cores from this hole with a total penetration of 555.0 m below the seafloor. We obtained a mud line core and then washed down to 122.0 m sub-bottom before continuously coring to 555.0 m sub-bottom. A basement rock complex (basalt and sediment) was first encountered in Core 38 at 474.5 m. We thus cored 360.5 m of sediment (8.0 m at the mud line and 352.5 m continuously from Cores 2 to 39) and 80.5 m of the basement complex, with a combined recovery rate of 62%. The recovery rate of the sediments was 63%; the recovery rate of the basement complex was 56%.

After completion of the rotary drilling, we dropped the drill bit and logged the hole. In the first log, the density tool malfunctioned. We subsequently successfully logged sonic velocity (with passive gamma ray and caliper traces) before once again attempting the density log. During the second density run, the tool apparently got hung up in the bottom hole assembly, causing numerous "cattails" on the Schlumberger line and thus aborting the remainder of the logging program.

After logging, we attempted hydraulic piston coring. The piston corer collet did not appear to seat properly, and with worsening weather we were forced to lift the drill string. Upon recovery, the collet was found to be properly seated. We had to wait on weather for about 10 hr. before lowering the drill string again and resuming our drilling operation.

Hole 528A

We hydraulic piston cored 30 cores from the mud line to 130.5 m sub-bottom. The recovery rate was 89%. The piston coring penetration was planned to overlap the rotary drilling in order to have cored a complete sedimentary section.

After completion of Hole 528A, the drill string was retrieved and *Challenger* departed for Site SAII-7 (Site 526—see Operations for Site 527). A sonobuoy was deployed upon departing Site 528.

SEDIMENT LITHOLOGY

Sediments and Lithostratigraphy

At Site 528, two holes were drilled, 528 and 528A. At Hole 528, 555 m of sediment and basalt were penetrated by rotary drilling. Of this, 441 m of sediment were cored, which range in age from Pleistocene to middle Maestrichtian.

Hole 528A penetrated 130.5 m with the HPC. The sediments recovered range in age from Pleistocene to late Oligocene.

Three major lithologic sediment types are recognized: (1) nannofossil chalk and ooze, (2) foraminiferal nannofossil ooze and chalk, and (3) volcanogenic sandstones and claystones, interpreted as being turbidity current and/or slump deposits. These sediment types, together

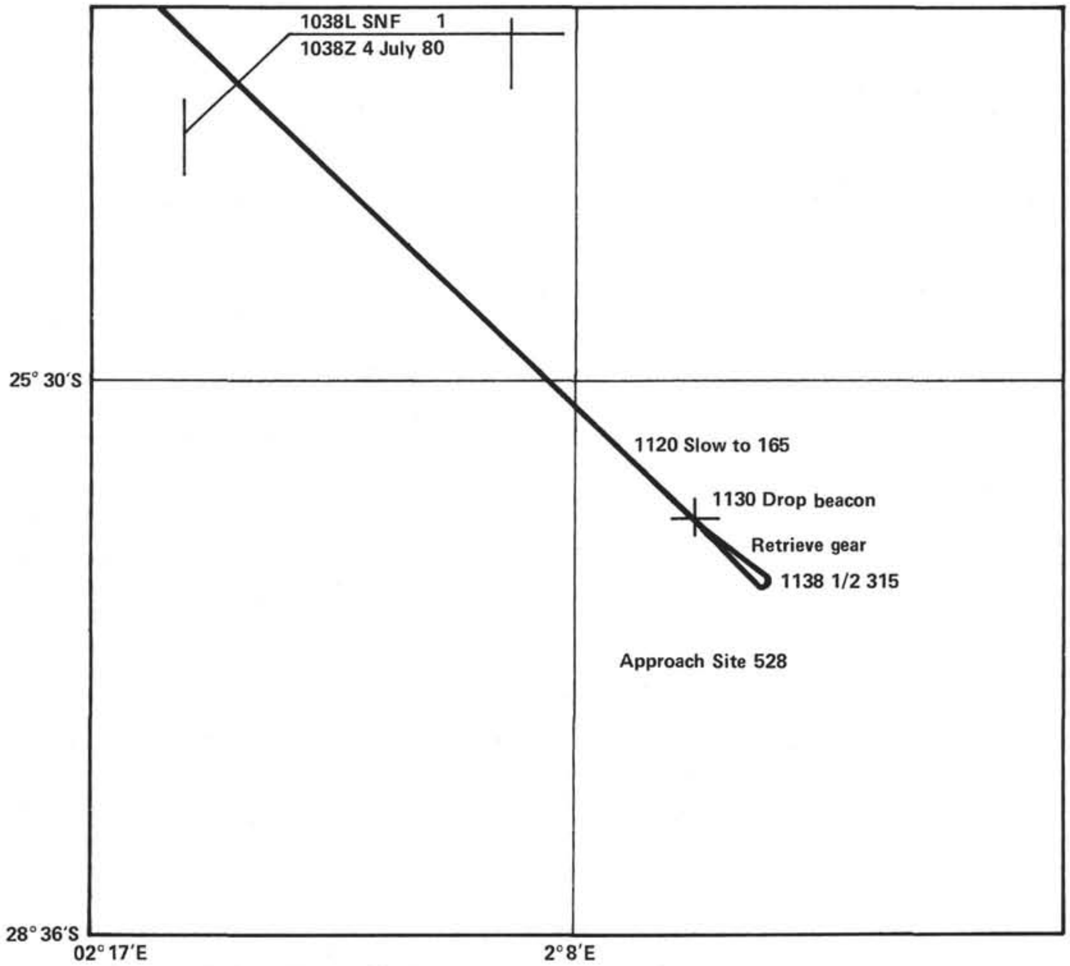

Figure 2. Ship's track for the approach to Site 528.

with $CaCO_3$ composition (%), color, and intensity of bioturbation define four lithologic units (Fig. 3).

Unit I: Foraminifer-Nannofossil Ooze/Chalk and Nannofossil Ooze and Chalk (Hole 528A, Cores 1-30; Hole 528, Core 1-5, 0-160 m sub-bottom)

This unit consists of a white (N9)—becoming pale yellowish brown (10YR 6/2) and very pale orange (10YR 8/2) downhole—foraminifer-nannofossil ooze and nannofossil ooze, with minor nannofossil chalk is the lowest section of Hole 528, where chalk to ooze sequences are recognizable (Core 5). The ooze/chalk ratio is about 1 in Cores 2 to 3 but tends to increase downhole. $CaCO_3$ content averages 85-90%.

In Core 2, Hole 528, the sediment recovered may be an anomalous layer, possibly because of large-scale mass movements such as slumping. The biostratigraphic ages determined for this core (Oligocene-Eocene) are older than the sediments immediately beneath. At about the same sub-bottom depth in Hole 528A, we bottomed in Oligocene age sediments which may be part of the same anomalous unit observed in Hole 528. Bioturbation is slight, and in general the darker brown layers show better preservation of these features. *Planolites*, halo burrows, *Chondrites*, and large vertical burrows are present in these layers.

Unit II: Nannofossil Chalk and Ooze(Hole 528, Core 6-middle Core 29, 160-382 m sub-bottom)

This unit consists of yellowish gray (5Y 8/1) white (N9) to pinkish gray (5YR8/1) nannofossil chalks and oozes. The amount of chalk increases downhole. $CaCO_3$ content averages about 90%. Colors are variable, and a noticeable change occurs at the base of Core 18: from generally yellowish gray (5Y 8/1) to white (N9) and pinkish gray (5YR 8/1).

Bioturbation is slight to moderate but increases downhole, where halo burrows, *Planolites*, and *Zoophycos* are recognizable.

Unit II is divided into two subunits.

Subunit IIa contains yellowish gray (5Y 8/1) to very pale orange (10YR 8/1) nannofossil chalk and ooze (Core 6 to 21), showing a high ooze/chalk ratio (80%/20%).

Subunit IIb contains white (N9) to pinkish gray (5YR 8/1) nannofossil ooze chalk (Core 22 to 29) showing moderately low to low ooze/chalk ratios in Cores 23, 24, and 25. Small-scale sedimentary structures (fine

Table 1. Coring summary, Site 528.

Core No.	Date (July 1980)	Time	Depth from Drill Floor (m) Top Bottom	Depth below Seafloor (m) Top Bottom	Length Cored (m)	Length Recovered (m)	Recovery (%)
Hole 528							
1	5	0235	3812.0-3820.0	0.0-8.0	8.0	6.7	84
Wash			3820.0-3934.0	8.0-122.0			
2	5	0737	3934.0-3943.5	122.0-131.5	9.5	0.8	8
3	5	0915	3943.5-3953.0	131.5-141.0	9.5	1.6	17
4	5	1037	3953.0-3962.5	141.0-150.5	9.5	9.5	100
5	5	1209	3962.5-3972.0	150.5-160.0	9.5	9.7	100+
6	5	1335	3972.0-3981.5	160.0-169.5	9.5	9.9	100+
7	5	1454	3981.5-3991.0	169.5-179.0	9.5	7.8	82
8	5	1617	3991.0-4000.5	179.0-188.5	9.5	7.1	75
9	5	1742	4000.5-4010.0	188.5-198.0	9.5	9.8	100+
10	5	1907	4010.0-4019.5	198.0-207.5	9.5	5.6	59
11	5	2030	4019.5-4029.0	207.5-217.0	9.5	3.2	34
12	5	2159	4029.0-4038.5	217.0-226.5	9.5	9.8	100+
13	5	2330	4038.5-4048.0	226.5-236.0	9.5	1.9	20
14	6	0100	4048.0-4057.5	236.0-245.5	9.5	2.4	25
15	6	0215	4057.5-4067.0	245.5-255.0	9.5	6.3	66
16	6	0336	4067.0-4076.5	255.0-264.5	9.5	8.2	86
17	6	0456	4076.5-4086.0	264.5-274.0	9.5	5.5	58
18	6	0620	4086.0-4095.5	274.0-283.5	9.5	5.4	57
19	6	0738	4095.5-4105.0	283.5-293.0	9.5	3.4	36
20	6	0852	4105.0-4114.5	293.0-302.5	9.5	6.8	72
21	6	1011	4114.5-4124.0	302.5-312.0	9.5	8.4	88
22	6	1136	4124.0-4133.5	312.0-321.5	9.5	4.8	51
23	6	1245	4133.5-4143.0	321.5-331.0	9.5	4.0	42
24	6	1415	4143.0-4152.5	331.0-340.5	9.5	5.3	56
25	6	1545	4152.5-4162.0	340.5-350.0	9.5	2.5	26
26	6	1737	4162.0-4171.5	350.0-359.5	9.5	2.3	24
27	6	1913	4171.5-4181.0	359.5-369.0	9.5	4.8	51
28	6	2054	4181.0-4190.5	369.0-378.5	9.5	2.5	26
29	6	2228	4190.5-4200.0	378.5-388.0	9.5	6.5	68
30	7	0009	4200.0-4209.5	388.0-397.5	9.5	5.4	57
31	7	0145	4209.5-4219.0	397.5-407.0	9.5	9.8	100+
32	7	0316	4219.0-4228.5	407.0-416.5	9.5	7.4	78
33	7	0452	4228.5-4238.0	416.5-426.0	9.5	8.9	94
34	7	0637	4238.0-4247.5	426.0-435.5	9.5	3.1	33
35	7	0837	4247.5-4257.0	435.5-445.0	9.5	3.5	37
36	7	1038	4257.0-4266.5	445.0-454.5	9.5	9.4	99
37	7	1228	4266.5-4276.0	454.5-464.0	9.5	9.7	100+
38	7	1428	4276.0-4285.5	464.0-473.5	9.5	6.6	69
39	7	1850	4285.5-4295.0	473.5-483.0	9.5	5.9	62
40	7	2315	4295.0-4304.0	483.0-492.0	9.0	8.8	98
41	8	0155	4304.0-4313.0	492.0-501.0	9.0	2.3	26
42	8	0455	4313.0-4322.0	501.0-510.0	9.0	5.9	66
43	8	0947	4322.0-4331.0	510.0-519.0	9.0	4.0	44
44	8	1155	4331.0-4340.0	519.0-528.0	9.0	4.3	48
45	8	1422	4340.0-4349.0	528.0-537.0	9.0	4.3	48
46	8	1607	4349.0-4358.0	537.0-546.0	9.0	7.4	82
47	8	1920	4358.0-4367.0	546.0-555.0	9.0	3.6	40
				Totals	441.0	272.8	62
Hole 528A							
1	11	0609	3825.5-3828.4	0.0-2.9	2.9	2.9	100
2	11	0723	3828.4-3832.8	2.9-7.3	4.4	5.1	100+
3	11	0828	3832.8-3837.2	7.3-11.7	4.4	5.2	100+
4	11	0940	3837.2-3841.6	11.7-16.1	4.4	4.6	100+
5	11	1040	3841.6-3846.0	16.1-20.5	4.4	5.2	100+
6	11	1150	3846.0-3850.4	20.5-24.9	4.4	5.2	100+
7	11	1303	3850.4-3854.8	24.9-29.3	4.4	4.6	100+
8	11	1417	3854.8-3859.2	29.3-33.7	4.4	4.9	100+
9	11	1530	3859.2-3863.6	33.7-38.1	4.4	4.8	100+
10	11	1627	3863.6-3868.0	38.1-42.5	4.4	4.9	100+
11	11	1740	3868.0-3872.4	42.5-46.9	4.4	4.9	100+
12	11	1854	3872.4-3876.8	46.9-51.3	4.4	4.8	100+
13	11	2021	3876.8-3881.2	51.3-55.7	4.4	4.9	100+
14	11	2140	3881.2-3885.6	55.7-60.1	4.4	3.2	73
15	11	2300	3885.6-3890.0	60.1-64.5	4.4	4.8	100+
16	12	0025	3890.0-3894.4	64.5-68.9	4.4	1.8	41
17	12	0141	3894.4-3898.8	68.9-73.3	4.4	2.0	45
18	12	0259	3898.8-3903.2	73.3-77.7	4.4	4.7	100+
19	12	0415	3903.2-3907.6	77.7-82.1	4.4	4.0	91
20	12	0535	3907.6-3912.0	82.1-86.5	4.4	1.2	27
21	12	1221	3912.0-3916.4	86.5-90.9	4.4	2.1	48
22	12	1350	3916.4-3920.8	90.9-95.3	4.4	4.5	100+
23	12	1515	3920.8-3925.2	95.3-99.7	4.4	4.5	100+
24	12	1934	3925.2-3929.6	99.7-104.1	4.4	1.2	27
25	12	2100	3929.6-3934.0	104.1-108.5	4.4	4.9	100+
26	13	0040	3934.0-3938.4	108.5-112.9	4.4	4.5	100+
27	13	0155	3938.4-3942.8	112.9-117.3	4.4	4.8	100+
28	13	0317	3942.8-3947.2	117.3-121.7	4.4	1.6	36
29	13	0455	3947.2-3951.6	121.7-126.1	4.4	1.7	39
30	13	0623	3951.6-3956.0	126.1-130.5	4.4	3.0	68
				Totals	130.5	116.5	89

parallel and cross lamination, flaser bedding, symmetrical and asymmetrical ripples) occur in Cores 28 and 29. They indicate a weak current activity, which coincides with a decrease of bioturbation.

Unit III: Foraminiferal Nannofossil Chalk Interbedded with Turbiditic Sequences (lower half of Cores 29–38; 382–474.5 m sub-bottom)

This unit consists of pale yellowish brown (10YR6/2) to reddish brown (10YR4/6) foraminiferal nannofossil chalk and light gray (N8) to greenish gray (5G6/1) volcanogenic turbidite sandstone and nannofossil chalk. The top of the unit is marked by a general color change and by a lithologic change from ooze/chalk to pure chalk with a simultaneous return of foraminifer.

Volcaniclastic material is present, either dispersed in chalk or concentrated in a cyclic sequence of greenish gray (5G 6/1) to greenish black (5G 2/1) layers, each showing graded bedding. This pattern is more common toward the base of the unit.

Bioturbation is strong throughout. As a result, the original color alternations are destroyed so that the unit appears intensively mottled. Bioturbation in the reddish layers consists of *Chondrites, Planolites, Zoophycos*, halo burrows, and vertical burrows. The mottles are generally white, so that bioturbation is as important in the whitish layers as in the reddish ones, although not as evident.

$CaCO_3$ content varies from 30 to 90%. This unit is divided into three subunits.

Subunit IIIa contains pale yellowish brown (10YR 6/2) to light gray (N8) foraminiferal nannofossil chalk (Cores 29 to 32). The chalk is less indurated than in Subunit IIIb. In Core 31, a sequence of broken and contorted chalky material is found in normally bedded sediments. This sequence, darker red in color, probably indicates some slumping activity in the depositional area. The pattern is not unique to this site only, but occurs also at Sites 525 (Hole 525A, Core 40) and 527 (Core 32). At all sites, the hypothesized slumping activity, variable in intensity, occurs just above the Cretaceous/Tertiary boundary.

Subunit IIIb contains light gray (N8) to moderate reddish brown (10R 4/6) foraminiferal nannofossil chalk (Cores 33–36). Some wispy beds of silty and volcanic material were recovered at the bottom of Core 36.

Subunit IIIc contains light gray (N8) to greenish gray (5G 6/1) volcanogenic turbidite sandstones and interbedded nannofossil chalk (Cores 37, 38). This subunit consists of an irregular alternation of fining-upward volcaniclastic sequences with varying clay content (smear slides estimates range from 10–78% clay) and nannofossil chalk. Parallel laminations, normal and reversed graded bedding, and flaser bedding are common in the volcaniclastic sandstone layers. Scours and scoured contacts with the chalky layers indicate turbidity currents which aperiodically transported and deposited volcanogenic in addition to pelagic sediments. Approximately 20 small-scale turbidite cycles are recorded in these two cores.

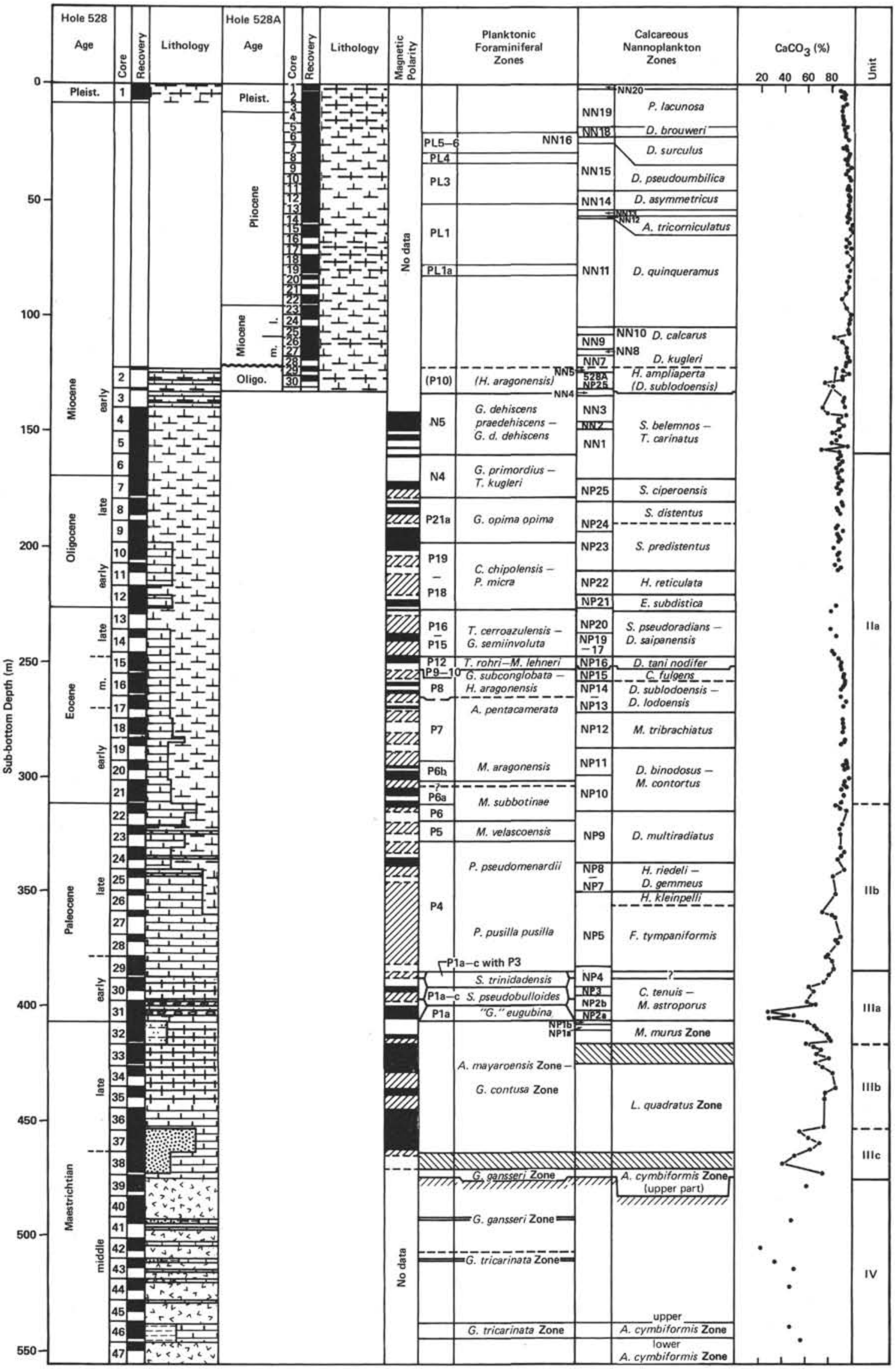

Figure 3. Lithostratigraphic, biostratigraphic, and paleomagnetic summary, Site 528. (See Introduction, this volume, for explanation of symbols used.)

Unit IV: Interbedded Sedimentary Rocks of the Basaltic Basement Complex (Cores 39–47; 474.5–555.0 m sub-bottom)

This unit consists of an alternation of basalt flows and intercalated sedimentary beds of variable thickness (50 cm–4 m). The latter are volcaniclastic turbidite sequences similar to those in Subunit IIIc and nannofossil limestones (very indurated chalks) to carbonate mudstones that contain sparse and poorly preserved foraminiferal tests. Some shell fragments (*Inoceramus*) occur in the limestones of Cores 44 and 45. The main color of the sediments is greenish gray (5G6/1), with $CaCO_3$ content varying from 20–60%.

INORGANIC GEOCHEMISTRY—INTERSTITIAL WATER STUDIES

The results of the interstitial water studies conducted at Site 528 (Holes 528, 528A) are summarized in Figure 4 and Table 2. All of the samples for the pore water analysis were taken from pelagic oozes, chalks, or limestones. None were taken from the turbidite layers. Thus the pore water analyses should reflect *in situ* conditions. The only correlation of pore water chemistry to lithostratigraphy occurs at the sediment/basement complex contact.

Trends in the chemical parameters are similar to those found in the previous Sites 525 and 527. pH, salinity, and chlorinity increase gradually with depth within the sediment column above basement, whereas alkalinity shows a gradual decrease. In the interlayered basalt-sediment sequence, the sediment pore water pH, salinity, and alkalinity gradients are more pronounced. This is probably the result of sediment-basalt interaction at elevated temperatures (see Inorganic Geochemistry section of Sites 525 and 527 chapters, this volume). The sediments appear altered and "baked" close to the basalt in some sections. Recrystallization of foraminifers also indicates a change in chemical environment within these interlayered sediments (see Biostratigraphic Summary, this chapter).

Calcium and magnesium also show the same trends as in the other sites, for reasons which have already been discussed (Sites 525 and 527 chapters, this volume). Interstitial waters from sediments within the basement complex show drastic changes in the concentration gradients of Ca and Mg. The interaction between sediments, pore waters, and basalt must have been, and perhaps still is, intense. This dramatic slope change is much greater than for normal sediment-seawater interaction. A final point of interest is the fact that magnesium concentration from Cores 43–46 (510–546 m sub-bottom in

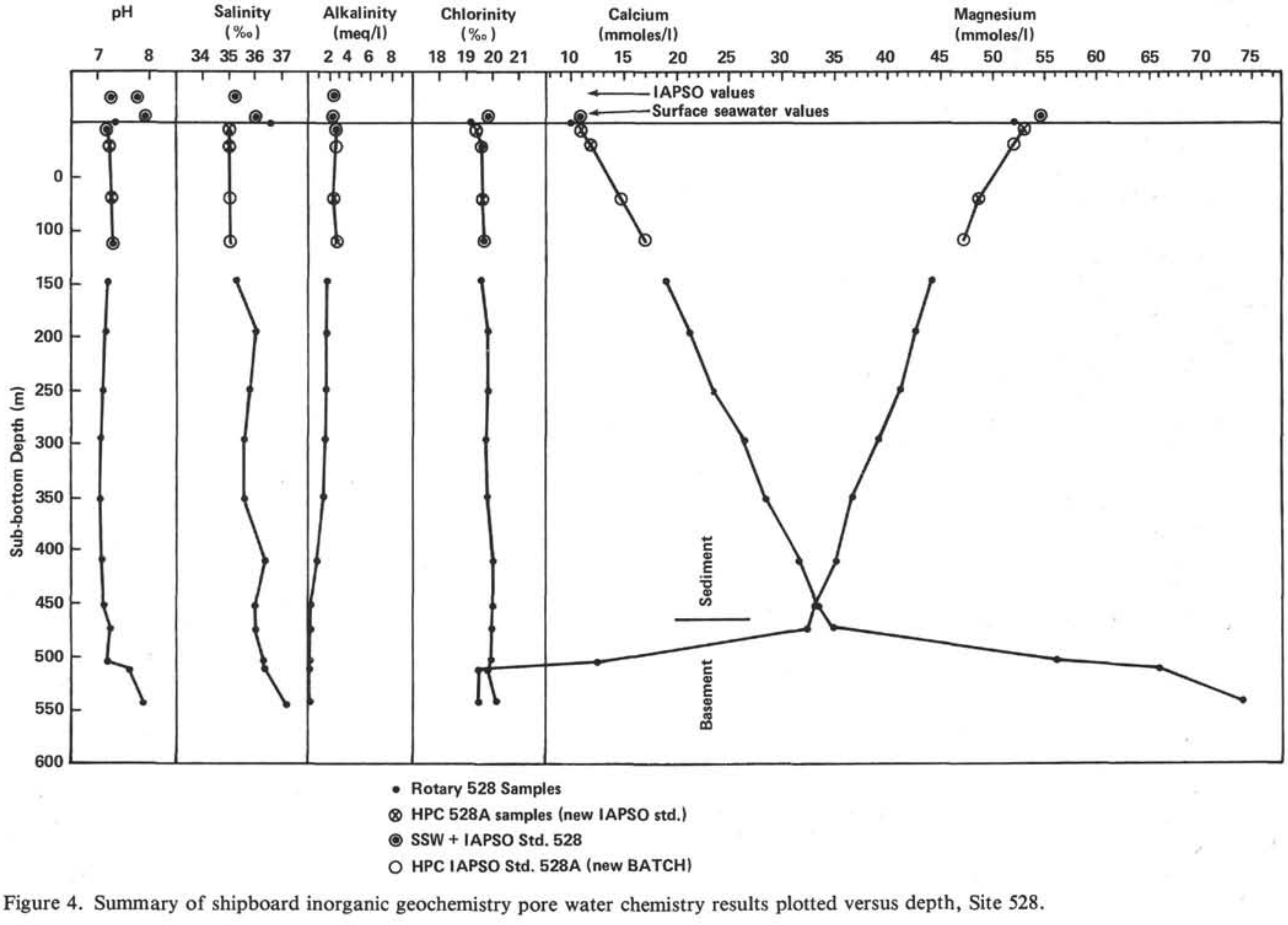

Figure 4. Summary of shipboard inorganic geochemistry pore water chemistry results plotted versus depth, Site 528.

Table 2. Summary of shipboard pore water study, Site 528.

Sample No.	DSDP Sample (interval in cm)	Sub-bottom Depth (m)	pH	Alkalinity (meq/l)	Salinity (‰)	Calcium (mmoles/l)	Magnesium (mmoles/l)	Chlorinity (‰)
	IAPSO		7.771	2.243	35.2	—	—	—
	SSW		7.904	2.242	36.0	10.67	54.67	19.80
Hole 528								
55	1-1, 144–150	1.44–1.50	7.278	2.341	36.6	10.22	52.07	19.23
56	4-4, 140–150	146.40–147.00	7.194	1.662	35.2	18.80	44.41	19.56
57	9-5, 140–150	195.40–196.00	7.158	1.588	36.0	21.28	42.70	19.83
58	15-4, 140–150	251.40–251.50	7.099	1.595	35.8	23.30	41.42	19.80
59	20-2, 140–150	295.90–296.00	7.050	1.556	35.5	26.30	39.33	19.77
60	26-1, 140–150	351.40–351.50	7.037	1.432	35.5	28.42	36.56	19.83
61	32-3, 140–150	411.40–411.50	7.063	0.880	36.3	31.76	35.14	20.00
62	36-2, 140–150	452.40–452.50	7.138	0.138	36.0	33.38	33.05	20.00
63	39-1, 0–10	473.50–473.60	7.227	—	36.0	34.80	32.58	19.94
64	42-2, 51–66	503.01–503.16	7.151	—	36.3	56.30	12.53	19.94
65	43-1, 48–58	510.48–510.58	7.535	0.130	36.3	65.56	1.14	19.80
66	46-4, 135–150	541.85–542.00	7.829	0	37.1	76.52	1.20	20.11
	IAPSO		7.291	2.308	35.2	—	—	—
Hole 528A								
67	2-1, 144–150	4.34–4.50	7.147	2.802	35.2	10.93	52.74	19.41
68	5-3, 144–150	20.54–20.60	7.220	2.529	35.2	12.02	52.07	19.61
69	17-1, 142–150	70.32–70.50	7.266	2.199	35.2	14.76	48.62	19.66
70	26-2, 143–150	111.43–111.50	7.277	2.645	35.2	16.95	47.14	19.66

Hole 528) is constant and almost negligible (1.14–1.20 mm/l). It appears that from this depth downward most of the magnesium has been taken out of the pore waters and has entered into a solid mineral phase. Calcium, on the other hand, continues to be dissolved.

X-RAY DIFFRACTION ANALYSIS

A total of 17 samples from Hole 528 and 1 from 528A were analyzed by X-ray diffraction. (For procedure, see Site 525 chapter.) In general, greater attention was paid to the minor lithologies than at Sites 525 and 527.

The results are shown in Table 3. Three samples of chert from Cores 23–25 were ground with a mortar and pestle and analyzed. The XRD traces from these samples show a predominance of quartz and opal-CT (disordered low cristobalite and tridymite) with calcite present as a minor component in Samples 528-23-2, 15 cm and 528-24-3, 51 cm and in greater quantity in 528-25-1, 87 cm. It is thought that these cherts are comparable to the "mature quartz cherts (type CII)" described by von Rad et al. (1978). Since clays and siliceous skeletal material are present in only very small amounts in the cores from Leg 74, it is suggested that devitrification of volcanic glass—a constant minor component at Site 528—may be the source of the silica. A suspected manganese nodule from Core 24 was also ground and analyzed, and the X-ray diffractogram showed that calcite and rhodochrosite were the only crystalline phases present. The presence of rhodochrosite as a precursor to manganese oxide formation has previously been described by Borella and Adelseck (1979). On acidification, a black amorphous material remained, which gave a blank XRD trace. Although neither manganese oxide nor hydroxides were positively identified, it seems probable that they are present as amorphous mineraloids.

Table 3. X-ray diffraction analysis, Site 528.

Sample (level, interval in cm)	Dominant/Minor Lithology	Minerals Identified
Hole 528		
23-2, 15	M (chert)	Quartz, opal-CT, calcite
24-3, 51	M (chert)	Quartz, opal-CT, calcite
24-4, 6	M (Mn-nodule)	Calcite, rhodocrosite?
	M (acid insoluble)	Amorphous
25-1, 87	M (chert)	Calcite, opal-CT, quartz
27-1, 110	D	Calcite, K-feldspar, quartz/illite
36-1, 114	M (turbidite)	Calcite, quartz, K-feldspar
36-3, 55	M (black patch)	Amorphous
36-5, 33	M (volcanic sand)	K-feldspars (orthoclase & sanidine), calcite
37-3, 107	D (chalk)	Calcite, smectite, quartz/illite, plagioclase, anorthoclase
38-1, 0–2	D (volcanic sand)	Calcite, quartz
38-3, 22	(volcanic sand)	K-feldspars (orthoclase/sanidine, anorthoclase), smectite
40-4, 85	M (vein in basalt)	Quartz, smectite
43-3, 100	D (acid insoluble)	Illite/quartz, feldspars
46-1, 115	M (brown chalk)	Calcite, quartz, feldspars, cristobalite, smectite
46-1, 123	M (clay)	Calcite, smectite, quartz, feldspars, cristobalite
46-1, 150	D (light green chalk)	Calcite, quartz, smectite
Hole 528A		
7-2, 80	D	Calcite, halite

The rest of the samples analyzed were from the turbidite-chalk sequences, both above and between the basalt flows (Units 3 and 4). Where the basalt directly overlies the chalk, the latter often shows a brown color that changes to greenish gray farther away from the contact. In Core 46, there was such a color change in the chalk with an interbedded dark green calcareous clay. One sample from each of the three layers was analyzed by XRD to determine the cause of the color change. The clay predictably showed the greatest amount of detrital material and smectite; quartz, feldspars, and cristobalite were also identified. The same minerals were found in the brown chalk but in lesser quantities, whereas the light greenish gray chalk contained only quartz and smectite. In Core 37, the chalk between turbidites is composed of calcite, smectite, quartz and/or illite, plagioclase, and anorthoclase. This shows the influence of volcanogenic minerals when compared with the chalk higher up the stratigraphic column, where illite/quartz and feldspars are the only acid-insoluble minerals (Hole 528, Core 27 and Hole 528A, Core 7).

The turbidites themselves generally consist of reworked calcite, quartz, and feldspars, with smectite in varying amounts. When the feldspars can be positively identified, they seem to be alkali feldspars and orthoclase; anorthoclase and sanidine are present in the sandstones from Cores 36 and 38. This seems highly unusual in an environment of basic volcanism.

Finally, some material from a mineralized vein in the basalt from Core 40 was analyzed and was shown to consist of quartz and smectite.

BIOSTRATIGRAPHIC SUMMARY

Site 528 is located at 28°31′S latitude and 02°19′E longitude on the western section of the Walvis Ridge, within the southern Atlantic subtropical gyre. Two holes, 528 (at 3791 m) and 528A (at 3801 m), were drilled; at Hole 528, we rotary-cored in the Pleistocene, washed down to 122 m, then continuously cored to basement in Core 39. Sediments were recovered from within the basalt from Cores 39 to 46. Hole 528A, using the HPC, continuously cored the section from the top down to 130 m and recovered sediments from Pleistocene to late Oligocene in age.

Nannofossils, planktonic foraminifers, benthic foraminifers, echinoids and ostracodes were recovered from most all samples. Results of study of all core catcher samples and more closely spaced samples across the Cretaceous/Tertiary boundary and in the basalt-enclosed sediment are shown in the biostratigraphic summary diagram (Fig. 3).

Calcareous Nannoplankton

Hole 528

Except for the first core, which sampled the topmost layer of sediments, continuous cores were taken from 122.0 m down to the basement at Hole 528. A continuous sequence ranging from lower Miocene to middle Maestrichtian was recognized in this interval. The Cretaceous/Tertiary boundary was recovered in Sample 528-31,CC and Section 1 of Core 32. Basalt was encountered in Section 1 of Core 39. The sediments immediately above the basalt belong to the upper part of the *Arkhangelskiella cymbiformis* Zone. The oldest sediments sandwiched in Core 46, however, are located within the lower part of the *A. cymbiformis* Zone, based on the presence of *Reinhardtites levis*.

Pleistocene (0–8 m)

Quaternary sediments, recovered in Core 1 core catcher, contain *Gephyrocapsa caribbeanica, G. oceanica*, and *Cyclococcolithus* cf. *macintyrei* but no typical *Helicosphaera sellii* or *Pseudoemiliana lacunosa*. The assemblage is Pleistocene in age.

Lower Miocene (122.0–169.8 m)

Core 2 top contains common *Discoaster exilis* and *Coccolithus floridanus*, with *Sphenolithus heteromorphus*, which indicates the NN4 to NN5 zonal interval. Because of environmental exclusion, *Helicosphaera ampliaperta* (index fossil for Zone NN4) was not found at this site. Tentatively, this sample is attributed to NN4 of the lower Miocene. Sample 528-2,CC contains material of middle Eocene age (Zone NP14) which is reworked. Recovery in Core 3 was poor; the lowermost sample (528-3-1, 117 cm) contains *S. heteromorphus*, without *S. belemnos*, and belongs to Zone NN4.

Sample 528-3,CC down to 528-4-3, 80–82 cm consistently contains *S. belemnos*, which limits this interval to Zone NN3. Sample 528-4,CC, neither *S. belemnos* nor *Triquetrorhabdulus carinatus* was found. It is probably within the NN3 to NN2 zonal interval. Typical *T. carinatus* was observed in Sample 528-5,CC, which indicates Zone NN2 of the lower Miocene. Sample 528-6,CC includes an assemblage of the Miocene–Oligocene transition, without *S. ciperoensis*, and is assigned to Zone NN1 of the lowermost Miocene.

Oligocene (169.8–226.7 m)

Sphenolithus ciperoensis was first encountered in Sample 528-7-1, 30–32 cm, which indicates NP25 of the upper Oligocene. Sample 528-7,CC still contains *S. ciperoensis*, without *S. distentus*, and remains in NP25 Zone. *Sphenolithus distentus* first appears in Sample 528-8-1, 45–47 cm, which places this sample in Zone NP24. Core 8 contains *S. distentus* with very rare *S. ciperoensis* and thus still belongs in Zone NP24. A smear slide prepared by the sedimentologists from Sample 528-9-1, 122 cm contains common isolated elements of *Braarudosphaera bigelowii*. This horizon might be correlated to one of the so-called "*Braarudosphaera* chalks" found in Oligocene intervals on Legs 3, 40, and 73. Samples 528-9,CC and 528-10,CC still belong in Zone NP23 because of the absence of *Reticulofenestra umbilica*.

Reticulofenestra umbilica was first encountered in Sample 528-11-2, 27–29 cm, which indicates this sample is located in Zone NP22 of the lower Oligocene. Zone NP22 continues to Sample 528-11,CC. The last appearance datum of *Cyclococcolithina formosa*, together with *Isthmolithus recurvus*, occurs in Sample 528-12-2, 116–118 cm, which locates this sample in Zone NP21 of the lowermost Oligocene. Sample 528-12,CC still belongs in Zone NP21 because of the absence of *Discoaster saipanensis* and *D. barbadiensis*.

Eocene (226.7–312.0 m)

Discoaster saipanensis and *D. barbadiensis* were traced upward in Sample 528-13-1, 17–19 cm, which belong to Zone NP20 of the uppermost Eocene. Both species in this sample are, however, very rare. In Sample 528-13,CC, *D. saipanensis* and *D. barbadiensis* become common. Also found in this sample are *Sphenolithus pseudoradians, Isthmolithus recurvus, Bramletteius ser-*

raculoides, D. tani, and *H. situliformis,* which constitute a typical assemblage of Zone NP20. *Isthmolithus recurvus* is reported to be a species typical of high latitudes (cool form?). Its common presence at this site may indicate cooling during late Eocene and early Oligocene time.

In Sample 528-14-2, 40–42 cm, the presence of *I. recurvus* and the absence of *S. pseudoradians* limit the sample to Zone NP19. *Chiasmolithus grandis* is first encountered in Sample 528-14-2, 85 cm, which indicates the NP17–NP18 zonal interval. The first appearance of *Reticulofenestra umbilica* occurs in Sample 528-15-2, 90–92 cm, in which *S. furcatolithoides* is also present. This sample is, therefore, attributed to Zone NP16 of the middle Eocene. In Sample 528-15,CC, the absence of *R. umbilica* and the presence of *Chipramalithus fulgens* and *Chiasmolithus gigas* then place the sample in Zone NP15.

The interval from Sample 528-16-2, 51–52 cm down to 528-17-4, 60–62 cm, including 528-16,CC, contains common *D. lodoensis, D. sublodoensis,* and *Triquetrorhabdulus inversus,* which are typical of Zone NP14. However, since *D. sublodoensis* extends down and overlaps with the range of *Marthasterites tribrachiatus* in Holes 525A and 527, the interval at this site could cover both Zones NP14 and NP13.

Marthasterites tribrachiatus, index fossil of Zone NP12 of the lower Eocene, was first encountered in Sample 528-17,CC. Zone NP12 continues down to Sample 528-19-2, 60–62 cm, where the first appearance of *D. lodoensis* occurs. Samples 528-19,CC through 528-20, CC belong to the NP11–NP10? zonal interval because of the absence of *D. lodoensis.* A sample taken from a layer of brownish clay in Sample 528-21-3, 106–107 cm contains a special assemblage which is characterized by moderately to well-preserved *M. tribrachiatus* (long-armed type), *M. contortus, D. multiradiatus, D. diastypus,* and *M. bramlettei*?. This assemblage obviously belongs to Zone NP10 of the basal Eocene. Sample 528-21,CC contains an assemblage of the Eocene–Paleocene transition with some *D.* cf. *diastypus.* Tentatively, the Paleocene/Eocene boundary is placed here.

Paleocene (312.0–407.0 m)

Samples 528-22,CC and 528-23,CC contain common *Discoaster multiradiatus* with abundant *Toweius* spp. and are typical of Zone NP9 of the upper Paleocene. In Samples 528-24,3 90–91 cm, 528-24,CC, and 528-25, CC, *D. multiradiatus* are absent. The presence of *D. mohleri* and some *Heliolithus* spp. then suggest the NP8–NP7 zonal interval. Sample 528-26,CC through 528-29-5, 15 cm, on the other hand, contain *Fasciculithus tympaniformis,* without *Heliolithus kleinpellii,* and are typical of Zone NP5. The thickness of Zone NP5 at this site is about 32 m, which is high compared with that of Holes 525A and 527.

Core 29 and Sample 528-30,CC are assigned to Zone NP2 of the lower Paleocene because of the presence of *Coccolithus tenuis* and *Biscutum* cf. *dimorphosum.* Sample 528-29,CC could be a transitional assemblage between Zones NP2 and NP3; however, no *Chiasmolithus danicus* was observed. In Sample 528-31,CC, the nannofossil assemblage is dominated by *Thoracosphaera* spp. and isolated elements of *Braarudosphaera bigelowii,* with some *Markalius astroporus* and *Zygodiscus sigmoides*; this is typical of Zone NP1 of the lowermost Tertiary.

Maestrichtian (407.0–basement)

Core 32, top, contains abundant Cretaceous forms, including *Micula murus,* and belongs to the *M. murus* Zone of the uppermost Maestrichtian. The Cretaceous/Tertiary boundary is right at the contact of Sample 528-31,CC and the top of Core 32, based on the calcareous nannofossil stratigraphy. The Cretaceous/Tertiary contact at this site is continuous, as it is at our other sites.

Sample 528-32,CC still contains *M. murus* and belongs in the *M. murus* Zone. Samples 528-33,CC through 528-37-6, 50–51 cm, on the other hand, are attributed to the *Lithraphidites quadratus* Zone, based on the absence of *M. murus* and the presence of *L. quadratus. Lucianorhabdus cayeuxii* was first encountered in Sample 528-36,CC; however, its occurrence is not consistent downward. Sample 528-37,CC is barren. Both 528-38,CC and 528-39-1, 90–93 cm (the oldest sediments right above basalt) are within the upper part of the *Arkhangelskiella cymbiformis* Zone, based on the absence of *L. quadratus, Broinsonia parca,* and *R. levis.* Several layers of sediment sandwiched within basalts were also investigated for their nannofossil contents. Among them, Samples 528-43,CC and 528-44-1, 111 cm, the top of Section 528-45-1, and Sample 528-46-1, 113–114 cm yield the same assemblage as above. Samples 528-46-4, 105 cm and 528-46,CC, however, contain *Reticulofenestra levis,* which suggests the lower part of the *A. cymbiformis* Zone. The last appearance datum of *B. parca* and *Quadrum trifidum* were not reached at Site 528.

Preservation

The preservation of calcareous nannoplankton recovered in this hole ranges from moderate to poor. Lower Miocene and upper Oligocene sediments in general yield moderately preserved nannofossils. The state of preservation of these minute fossils becomes poor from lower Oligocene to upper Paleocene. Dissolution, overgrowth, and fragmentation are so extensive that small species were totally eliminated, whereas large species, such as discoasters and *Chiasmolithus,* are strongly overgrown.

In the lower Paleocene interval, the preservation of nannofossils is improved and therefore classified as moderate. At the very base of the Tertiary, fragmentation is still severe; the common *Braarudosphaera bigelowii* found in Zone NP1 interval are all isolated elements.

Preservation of nannofossils in the uppermost Cretaceous is moderate but becomes moderate to poor downhole.

Hole 528A

Hole 528A was cored with the HPC continuously from the top of the section down to 130.5 m. Though the distance between Holes 528 and 528A is only about

0.5 mi., the successions of sediments in the interval of overlap of the two holes are slightly different. An apparent hiatus was observed between Sample 528A-28, CC and the top of Core 29, where Zone NN7 of the middle Miocene overlies Zone NP25 of the upper Oligocene. The entire lower Miocene, found at Hole 528, is missing at Hole 528A.

Pleistocene (0–16.1 m)

Core 1 through Sample 528A-4,CC contain *Gephyrocapsa caribbeanica, C.* cf. *doronicoides, Pseudoemiliana lacunosa, Emiliana* cf. *ovata*, and *Cyclococcolithus macintyrei*, which locates the assemblage in the lower part of Zone NN19. Sediments younger than 1.51 m.y. are either missing or very thin in this hole.

Pliocene–Upper Miocene (20.5–108.5 m)

Sample 528A-5,CC contain *Discoaster brouweri* and belongs to Zone NN18 of the upper Pliocene. Very rare *D. surculus* and *D. pentaradiatus*, in Sample 528A-4, CC, are tentatively interpreted as reworked forms. Sample 528A-6,CC contains common *D. brouweri*, with *D. pentaradiatus, D. surculus, D. asymmetricus*, and *D. tamalis*, which indicate Zone NN16.

Samples 528A-7,CC through 528A-10,CC contain abundant *Reticulofenestra pseudoumbilica*, with common Pliocene discoasters, and are attributed to Zone NN15 of the lower Pliocene. *Amaurolithus delicatus* was first encountered in Sample 528A-11,CC, which could be assigned to Zone NN14. Sample 528A-12,CC and Section 528A-13-3, on the other hand, contain *A. delicatus, Ceratolithus rugosus*, and *D. asymmetricus*, without *D. tamalis*, and are within the NN14–NN15 zonal interval.

Samples 528A-13,CC through 528A-23,CC contain an assemblage of the lower Pliocene to upper Miocene transition. *Amaurolithus* species are few to common in this interval. The first appearance datums of *C. acutus* and *C. armatus* are, however, difficult to recognize because of strong to moderate overgrowth which has altered the optical character of *Amaurolithus* species. Rare specimens of *A. tricorniculatus* were found in Sample 528A-18,CC and rare *A. bizzarus*, in Sample 528A-16,CC. *Amaurolithus amplificus* was found in Samples 528A-19,CC to 528A-21,CC. Because of the apparent absence of *D. quinqueramus*, the exact Miocene/Pliocene boundary at this site cannot be defined with calcareous nannofossils. The entire interval between Samples 528A-14,CC and 528A-23,CC, therefore, is assigned to Zone NN12 or to the upper part of Zone NN11.

A color change in the sediments between Sample 528A-23,CC and Section 528A-24-1 corresponds to a sharp floral change. Samples 528A-24-1, 70–72 cm, 528A-24,CC and 528A-25-3, 59–60 cm contain common *D. variabilis, D. neorecta, Minylitha convallis, Triquetrorhabdulus* cf. *rugosus*, and *D. neohamatus*, without *Amaurolithus* species. This assemblage represents Zone NN10—or at least is not younger than the lower part of the Zone NN11. The state of preservation of nannofossils also worsens significantly in Core 24. It is possible, therefore, that a short hiatus occurs between Sample 528A-23,CC and Core 24.

Middle Miocene (108.5–121.7 m)

Discoaster hamatus, index fossil for Zone NN9 of the middle Miocene, was first observed in Section 528A-26-1. *Catinaster coalitus* and *C. calyculus*, whose ranges are restricted to Zones NN8 and NN9, were found consistently from Sample 528A-27-1, 150 cm through 528A-27,CC. In Core 28, *C. coalitus* and *C. calyculus* are absent. The presence of *D.* cf. *kugleri* limits the entire Core 28 to Zone NN7 of the middle Miocene. It is worth mentioning that in the long core catcher of Core 28, the interval from the top down to 28 cm belongs to Zone NN7, and samples between 40 cm and the bottom contain middle Miocene assemblages mixed with upper Oligocene species.

Upper Oligocene (121.7–130.5 m)

The color of sediments changes significantly between Sample 528A-28,CC and Core 29. This corresponds to a sharp floral change. Cores 29 and 30 contain common *Coccolithus floridanus, Discoaster deflandrei, Sphenolithus moriformis, C. eopelagicus, D. bisectus*, and *Zygrhablithus bijugatus*, together with *S. ciperoensis*, the index fossil for Zone NP25 of the upper Oligocene. *Sphenolithus distentus* was observed only in Sample 528A-30,CC, which limits it to Zone NP24. Since the upper Oligocene zonal sequence is continuous and the nannofossil assemblages do not show apparent mixing, the entire upper Oligocene immediately below the middle Miocene could be in place. In this case, the entire lower Miocene section in Hole 528 is missing from Hole 528A.

Preservation

The preservation of calcareous nannofossils recovered in Hole 528A ranges from moderate to poor. The Pleistocene to upper Miocene (i.e., upper part of NN11) sediments in general yield moderately well preserved nannofossils. The nannofossils from the lower Pliocene to upper Miocene, however, show slight to moderate overgrowth.

Below Sample 528A-23,CC, where the color of sediments changes sharply, the state of preservation of nannofossils also worsens significantly. Most species are strongly etched or fragmented; by contrast the discoasters remain unaffected or show slight overgrowth. The situation improves in Core 28 (i.e., Zone NN7), where large coccoliths show moderate preservation.

The nannofossils from the upper Oligocene of this hole also show moderate preservation. The discoasters, however, show strong overgrowth.

Foraminifers

Foraminifers were recovered from all core catchers at both holes, although at some levels they were so dissolved that only one species remained. Preservation varied considerably through the section. In general, the Pliocene was moderately well preserved, the Miocene poorly preserved, the Oligocene very poorly to poorly preserved, the upper Eocene very poorly preserved, the middle Eocene moderately to poorly preserved, the lower Eocene and upper Paleocene moderately well preserved, the lower Paleocene moderately to well preserved, and the Cretaceous moderately to poorly preserved.

Benthic foraminifers were studied from all samples. Faunas indicated deposition at bathyal to slope depths throughout the sequence. The few benthic foraminifers thought to be in place in the sediments within the basalt sequence indicated deposition at slope depths.

Pleistocene–Pliocene (Core 528A-1–Sample 528A-20,CC)

Dissolution fragmentation is extreme from Sample 528A-23,CC down. Intermediate fragmentation, not so intense as to remove stratigraphically important species, is present in the top of the Miocene and in the lower part of the Pliocene. In the remainder of the Pliocene preservation is good, and in the Pleistocene, very good. The Pleistocene was identified in the first five cores. Pliocene Zones P15/6, P14, P13, P1/a, and P1/b were all discriminated. Typical faunas include *Globorotalia inflata* or *G. punticulata, Sphaeroidinellopsis seminulina, Globigerina nepenthes, Globorotalia miozea* and *Globigerina bulloides.*

Upper to Middle Miocene (Core 528A-21–Sample 528A-27,CC)

Cores 22 to 27 probably belong in the upper Miocene, although preservation is poor (extreme fragmentation by dissolution) and diagnostic species are absent. *Globigerina nepenthes* constitutes about 80% of most samples. The strongly contaminated faunas of Sample 528-28,CC contain a mixture of the middle Miocene *G. nepenthes* fauna, as well as lower Miocene and upper Oligocene species. It is not clear from the foraminifers if upper Miocene is contaminated into Oligocene, or Oligocene is reworked into middle Miocene sediments.

Lower Miocene (Samples 528-3,CC–528-6,CC)

Core catcher sediments are either strongly contaminated with younger materials or strongly dissolved. Cores 3 to 4 are as old as Zone N5 but may be as young as Zones N8–9. Zone N4 could be unequivocally recognized. Foraminifers are somewhat recrystallized. Benthic forms, which are relatively uncommon, include *Globocassidulina subglobosa, Stilostomella subspinosa, Vulvulina spinosa* (spinose variety); there are also frequent echinoid parts and fish teeth.

Paleogene

Sediment preservation ranges from very dissolved in the upper Oligocene to very well preserved in the basal Paleocene. In general, preservation is poorer in all faunas above the lower Eocene.

Upper Oligocene (Samples 528-7,CC–528-9,CC; Core 528A-29–Sample 528A-30,CC)

Sediments from 528A are moderately well preserved but are contaminated and difficult to assign to a zone. The presence of *Chiloguembelina cubensis* and *Turborotalia* cf. *opima* in Sample 528A-30,CC suggests Zone P21.

The very dissolved faunas of Hole 528 contain species typical of Zone P21a. Benthic foraminifers are rare, but echinoid fragments and fish teeth occur frequently. Benthic faunas through the Oligocene resemble those of the lower Miocene.

Lower Oligocene (Core 528-10–Sample 528-11,CC)

The presence of *Pseudohastigerina micra* and *P. barbadoensis*, but no typical upper Oligocene forms, places these samples in the lower Oligocene P18–19 zonal interval. Faunas are very dissolved and most foraminifers are recrystallizing.

Upper Eocene (Core 528-13–528-14,CC)

All foraminifers are dissolved except *Globigerinatheka index*. These unspecific faunas belong somewhere in the upper Eocene P15–16 zonal interval.

Middle Eocene (Core 528-15)

This interval contains generally poorly, but occasionally well, preserved material. The reduced faunas suggest that Sample 528-15-2, 60 cm probably belongs to Zone P12, based on the presence of *Morozovella aragonensis.* Accompanying forms are *Globigerapsis subconglobatus, Globigerina frontosa*, and *M. renzi*. Most globigerinids are bullate.

Sample 528-15,CC is assigned to the P9–P10 zonal interval on the basis of the presence of *Morozovella aragonensis, G. frontosa*, and *Acarinina densa*. This is the best middle Eocene fauna recovered from any of our sites.

Benthic faunas are different from those above: the predominant species *Aragonia aragoenesis, Nuttalides truempyi*, and *Anomalinoides* sp. are accompanied only by ostracodes.

Lower Eocene (Core 528-16–Sample 528-20,CC)

Zones P8, P7, and P6b are all represented; faunas, however, are recrystallized and dissolved, as at other sites. Faunas with abundant globigerinids and smooth-walled acarininids alternating with others rich in spinose acarininids and morozovellids will be useful for paleoceanographic work. Benthic faunas resemble those of the middle Eocene.

Lower Eocene–Upper Paleocene (Core 528-20–Sample 528-22,CC)

The Paleocene/Eocene boundary was recognized in Cores 20 to 22 by the extinction of the benthic foraminifer *Gavelinella beccariiformis*. No *Pseudohastigerina* spp. or *Morozovella edgari* were found. Faunas are moderately well preserved, although the "chalky" preservation characteristic of the chalk–ooze transition begins in Core 21. The rare benthic forms include pleurostomellids, nodosarids, *Nuttalides truempyi*, and echinoids. Fish teeth are also present.

Upper Paleocene (Core 528-22–Sample 528-29,CC)

Foraminifers are moderately well preserved despite the "chalkiness" which often obscures their ornamentation. In Zone P5 (Section 528-23-2–528-27-2) morozovellids are common.

By Zone P4 (Sections 528-23-2–528-28-2), faunas are dominated by globigerinids and small acarininids. Benthic foraminifers, slightly more common in these samples, resemble Eocene faunas.

Zone P3b (Section 528-28-2–Sample 528-29,CC) appears more complete here than at our previous sites; however, the preservation is somewhat worse than at Site 525 or 527. Zone P3a fossils, found mixed into Sample 528-29,CC below, indicate the presence of this zone in upper sections of Core 29. Benthic faunas of Zone P3 show greater affinities to those of the lower Paleocene and uppermost Cretaceous than to those of the upper Paleocene.

Lower Paleocene (Sample 528-29,CC–Section 528-31-7)

Zone P3a occurs in Sample 528-29,CC. Zone P1 is well represented at this site and preservation of its faunas generally good throughout, even in the hard, clay-rich layers above and within the "*Globigerina*" *eugubina* Zone. Planorotalids and subbotinids dominate the faunas. *Hedbergella monmouthensis* was located in Sample 528-30,CC but not in the "*G.*" *eugubina* faunas. The presence of large agglutinated benthic species and mollusk shells in Sample 528-29,CC suggests redeposition.

Faunas of the lower "*G.*" *eugubina* Zone (Section 528-31-7–top Core 528-32) are dominated by chiloguembelinids, and "*G.*" *eugubina* becomes more common and faunas more diverse in the upper "*G.*" *eugubina* Zone, Sample 528-31-7, 64 cm.

Volcanic minerals and glass occur through this zone, which is approximately 20 cm long at this site. *Nuttalides truempyi* is the most common benthic fauna.

Cretaceous

Maestrichtian faunas are diverse and better preserved than at Site 525 but not as well preserved as at Site 527. The uppermost Maestrichtian occurs, as at Site 527, in a bluish gray chalky layer, including some quartz and common pyrite. This horizon is better preserved here than at Site 527. The amount of volcanic material increases irregularly in lower samples, as does the quality of foraminiferal preservation. The most recrystallization occurs in sediment intercalated in the basalt from Cores 39 to 46 of Hole 528.

Maestrichtian

Two foraminiferal zones could be recognized at this site: the *Abathomphalus mayaroensis* (Section 528-32-1–Sample 528-42,CC) Zone and the *Globotruncana tricarinata* Zone (Core 528-43–Sample 528-54,CC). The uppermost gray blue layer is moderately well preserved and contains a unique fauna consisting of strongly ornamented *Pseudoguembelina excolata, Hedbergella monmouthensis, G. cretacea*, as well as most of the species present in lower levels. The ornament on *P. excolata* suggests warmer surface waters and the presence of *H. monmouthensis* heralds the boundary crisis, as it is one of the few forms which becomes abundant at mid-latitudes only below the boundary and crosses the boundary, then to appear relatively frequently in faunas of the basal "*Globigerina*" eugubina Zone.

As at other sites, the range of *A. mayaroensis, Globotruncana contusa*, and *Racemiguembelina fructicosa* is longer than predicted in standard zonations. Sediments intercalated in basalt vary from pure oozes to oozes with large quantities of mollusk debris. Benthic foraminifers occur much less frequently than at previous sites. In Core 39 of Hole 528, dark brown sediments (Sample 528-39-1, 99 cm) taken in contact with basalt contain pure oozes with very rare mollusk debris, normal bathyal slope benthic foraminiferal species including some large species of *Gyroidina*, and a few other benthic invertebrate remains. Higher, light brown samples (528-39-1, 79 cm and 528-39-1, 61 cm) contain vast amounts of *Inoceramus* crystals and other mollusk fragments, large echinoids and ostracodes, large slope benthic foraminifers, and some large agglutinants. The highest sample, 528-39-1, 26 cm, resembles Sample 528-39-1, 99 cm: a planktonic ooze containing rare, bathyal slope benthic forms and little other benthic invertebrate debris.

Sediments from Cores 42, 43, and 46 resemble the oozes without benthic faunas from Core 39. However, there is a significant amount of large, upper slope benthic foraminiferal faunas, including many gyroidinids and cibicidids.

SEDIMENT ACCUMULATION RATES

Figure 5 shows the age–depth plot for Site 528, based on data in Table 4. The time scale used is discussed in the Introduction (this volume). The late Miocene section from abouut 90 to 110 m is intensely dissolved, and it is not clear whether deposition was continuous but slow, or whether there is a hiatus present.

In Hole 528, redeposited Eocene material was found between 122 and 130 m, within early Miocene material. Below this, a continuous early Miocene through Oligocene sequence was cored. In 528A, at a similar depth, the early Miocene was not found; the middle Miocene passed directly into apparently in-place Oligocene sediment. Whatever the precise explanation for this difference between the two holes, it is clear that there was an erosional event in the later part of the early Miocene; we have not attempted to model accumulation across this event. There was also a hiatus in deposition at about the Eocene/Oligocene boundary.

In the early Paleocene, the age estimates constrain a rather unreasonably rapid accumulation rate; on the other hand, the paleomagnetic data imply a lower rate—about 0.8 cm/10^3 y. Even this seems high by comparison with other sites.

The data in Figure 5 can be modeled by a series of straight lines implying uniform sedimentation rates of 0.9 cm/10^3 y. from present to 3 Ma; 2.2 cm/10^3 y. from 3 to 6 Ma; 0.9 cm/10^3 y. from 9.5 to 11 Ma; 0.5 cm/10^3 y. from 19 to 39 Ma; 1.1 cm/10^3 y. from 51 to 60 Ma; 0.8 cm/10^3 y. from 60 to 65 Ma; and 2.5 cm/10^3 y. from 65 to 67.5 Ma.

Figure 6 shows these accumulation rates (lower part). Above, they have been converted to g/cm^2/10^3 y. of foraminifers, of total carbonate, and of total sediment

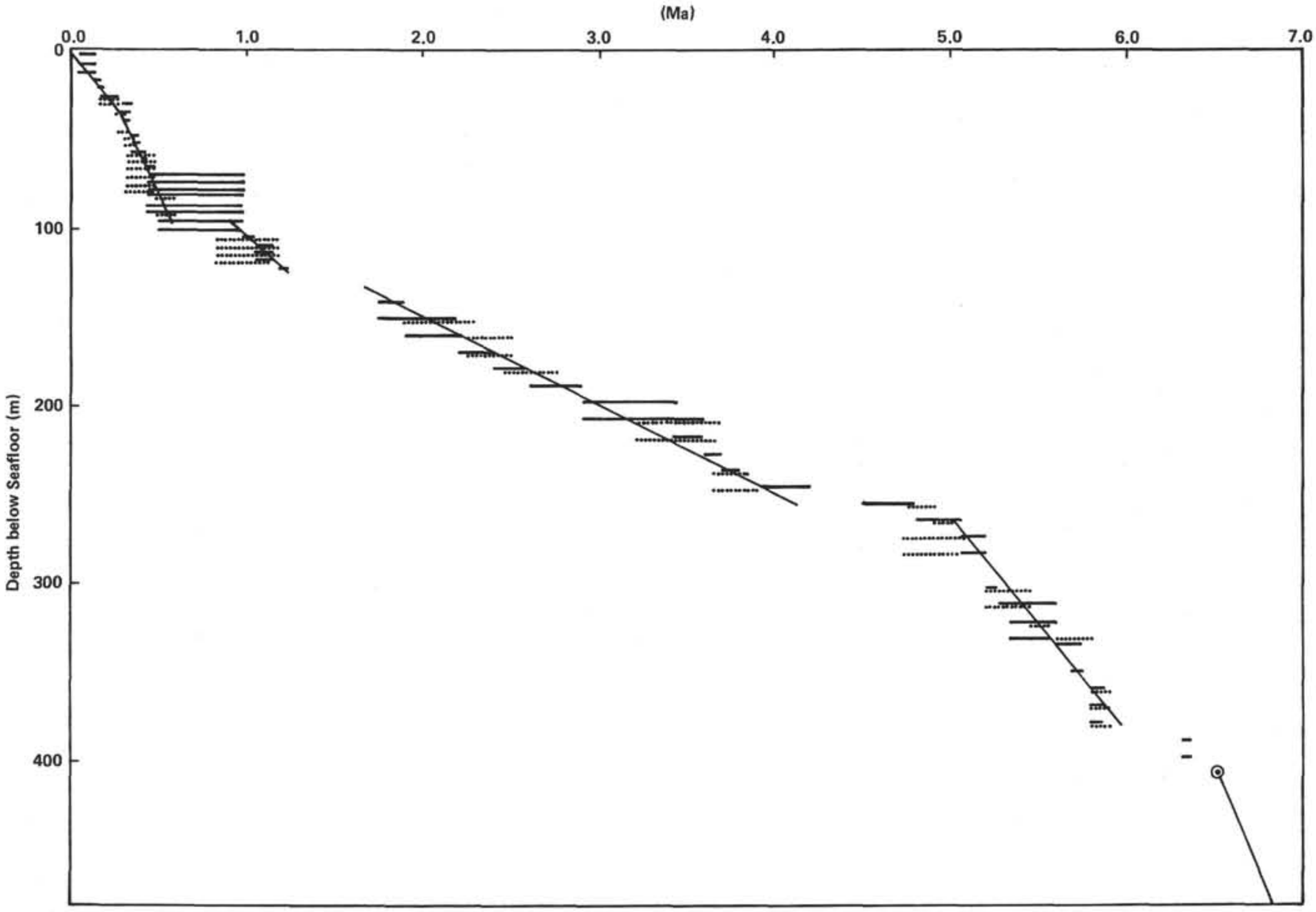

Figure 5. Age–depth plot, Site 528. Horizontal lines represent ranges in ages determined by nannofossils (solid line) and foraminifers (dashed line).

using the physical properties data and estimates of the weight percent foraminifer fraction (>63 μm) obtained from sieving samples for foraminiferal work.

The procedures used to construct Figure 6 are outlined in the Site 525 chapter; the data are in Table 5.

Some of the sediment in the Eocene and Paleocene may have been slumped into its present position, as indicated in the sedimentological and paleomagnetic reports. This probably explains the accumulation rates for the section from 60 to 65 Ma, which appear anomalously high for both carbonate and noncarbonate by comparison with Sites 525 and 527 (no foraminiferal accumulation data are available for this interval).

IGNEOUS PETROLOGY

Basaltic basement at Site 528 was reached at 474.5 meters sub-bottom. A total of 80 meters of basement was cored. It consisted of basalt flows and interlayered sediments. Recovery was 57%. Of the 45.6 meters recovered, 11.6 were sediments and 34.0 were basalt.

Site 528 lies between Anomalies 31 and 32, suggesting a basaltic crust formation age of approximately 68–70 Ma. This is in agreement with the age of the overlying sediment and the magnetic stratigraphy. Sediment accumulation between the basalt flow indicates episodic extrusion. The full extent of both the *Globotruncana gansseri* Zone and the upper part of the *Arkhangelskiella cymbiformis* Zone, spanning perhaps a million years, is contained in the intercalated and immediately overlying sediments (see biostratigraphy section), thus suggesting that emplacement of the cored basement may have taken place over a million-year time period.

Eight different basalt flow units are identified, with all but the last two being separated by sedimentary layers. A stratigraphic column indicating this subdivision is presented in Figure 7. Altered glassy margins are present at the tops of Units 1 to 5, and fine-grained basalt occurs at the tops of Units 6 to 8. The eight units may be grouped into two lithologic types, primarily on the basis of the presence or absence of phenocrysts.

Type 1 basalt is found in Units 1, 3, 4, 5, 6, and 8. It is a massive, gray, medium- to coarse-grained, sparsely to highly plagioclase phyric basalt. Plagioclase phenocrysts range up to 10 × 5 mm in size, are twinned, zoned, and comprise up to 25% of the rock. A few clinopyroxene and olivine phenocrysts are present but are very sparse. The olivine phenocrysts are completely altered to clay minerals. The concentration of phenocrysts within a unit is patchy and variable, suggesting local crystal-liquid sorting during emplacement.

Irregular spots of dark green clay are observed in these units. They are particularly prominent when concentrated in ±20 cm segments of core, as in parts of Units 1 and 6. These clay minerals may be the alteration

Table 4. Foraminifer and nannofossil data used to construct age-depth curve plot (Fig. 5), Holes 528, 528A.

Sample (level in cm)	Depth below Seafloor	Nannofossil Zone	Foraminifer Zone	Nannofossil Age (m.y.)	Foraminifer Age (m.y.)
Hole 528					
1,CC	8.0				
2,CC	131.5				
3,CC	141.0	NN3	N5 (mixed)	17.5–19	19–22.5
4,CC	150.5	NN3/2	N5	17.5–22	19–22.5
5,CC	160.0	NN2	N4	19–22	22.5–25
6,CC	169.5	NN1	N4	22–24	22.5–25
7,CC	179.0	NP25	P21G–22	24.0–26	25–28
8,CC	188.5	NP24		26–29	
9,CC	198.0	NP23	Olig.	29–34.5	
10,CC	207.5	NP23/22	P18–19	29–36	32–36.5
11,CC	217.0	NP22	P18–P19	34.3–36	32–36.5
12,CC	226.5	NP21		36–37	
13,CC	236.0	NP20	P15–16	37–38	36.5–38.5
14,CC	245.5	NP18/17	P15–16	39.2–42	36.5–38.5
15,CC	255.0	NP15	P10	45–48	47.3–49
16,CC	264.5	NP14/13	P9	48–50.5	49–50
17,CC	274.0	NP12	P8–P10	50.5–52	47.3–51
18,CC	283.5	NP12	P8–10	50.5–52	47.3–51
19,CC	293.0	NP11		52–52.6	
20,CC	302.5	NP11	P6	52–52.6	52–54.5
21,CC	313.0	NP10(?9)	P6	52.6–56	52–54.5
22,CC	321.5	NP9	P5	53.3–56	54.5–56
23,CC	331.0	NP9	P4	53.3–56	56–58
24-3, 91	324.91	NP8(?7)		56–57.4	
25,CC	350.0	NP7	P4	56.7–57.4	56–58
26,CC	359.0	NP5	P3G	57.8–58.6	58–59
27,CC	369.0	NP5	P3G	57.8–58.6	58–59
28,CC	378.5	NP5	P3G	57.8–58.6	58–59
29,CC	388.0	NP2	P1C/P3 (mixed)	63–63.5	63–63.4
30,CC	397.5	NP2	P1C	63–63.5	63–53.4
31,CC, top	407.0	NP1	*G. eugubina*	63.5–63.5	~65
32,CC	416.5	*M. murus*	*A. mayaroensis*		
33,CC	426.0	*L. quadratus*	*A. mayaroensis*		
34,CC	435.5	*L. quadratus*			
35,CC	445.0	*L. quadratus*			
36,CC	454.5	*L. quadratus*			
37,CC	464.0	barren	Barren		
38,CC	473.5	*A. cymbiformis*			
39	483.0				
29-1–29-2					
Hole 528A					
1,CC, 120	1.2	NN17		0.45–1.6	
2,CC	7.3	NN19		0.45–1.6	
3,CC	11.2	NN19		0.45–1.6	
4,CC	16.1	NN18(?17)	N22/23	1.6–2	
5	20.5	NN18	N22/23	1.6–2	
6,CC	24.9	NN16(?15)	PL5/6	2.3–3	1.3–2.8
7,CC	29.3	NN15	PL5/6	3.0–3.5	1.8–2.8
8,CC	33.7	NN15	PL4	3.0–3.5	2.8–3.0
9,CC	38.1	NN15	PL3	3.0–3.5	3.0–3.3
10,CC	42.5	NN15	PL3	3.0–3.5	3.0–3.3
11,CC	46.9	NN14	PL2	3.5–4	3.3–3.7
12,CC	51.3	NN14	PL2	3.5–4	3.3–3.7
13,CC	55.7	NN13/14	PL1	3.5–4.4	3.7–5
14	60.1	NN12	PL1	4.4–5	
15	64.5	NN12	PL1	4.4–5	
16,CC	68.9	NN12/11	PL1	4.4–9.9	
17,CC	73.3	NN12/11	PL1	4.4–9.9	
18-3, 130	77.0		PL1		3.7–5
18,CC	77.1	NN12/11			
19-2, 140	80.0		N17		5–5.7
19,CC	82.1	NN12/11			
20	86.5	NN12/11		4.4–9.9	
21,CC	90.9	NN11	N17		5–5.7
22	95.3	NN11(?12)	N17	5–7.9	5.7
23	99.7	NN11	N16	(5–9.9)	
24	104.1	NN10	N14/16	9.9–10.5	8.5–11.9
25	108.5	NN9	N16	10.5–11.6	8.5–10.4
26	112.9	NN9	N14/16	10.5–11.6	8.5–11.9
27	117.3	NN8/9	N14/16	10.5–11.9	8.5–11.9
28	121.7	NN7		11.9–12.4	
29	126.1	NP25		24.0–26.0	
30	130.5	NP24		26.0–29.0	

products of olivine and clinopyroxene, but the alteration is too advanced for positive identification.

Vesicles are sparse or absent except when concentrated in or near the tops of flow units. They are generally small (≤ 1 mm), rounded, and filled, predominantly with dark green clay minerals, although calcite and pyrite also occur.

Type 2 basalt is found in Units 2 and 7. It is a medium gray, fine- to medium-grained, aphyric basalt. Recovery of this basalt type, with small rubbly pieces forming a large percentage of the core, was much poorer than recovery of Type 1. The vesicles in the aphyric basalt vary in size from < 1 mm to approximately 1 cm in diameter and form 0 to 30% of the rock. The most dense concentrations occur within the upper 40 to 80 cm of the cooling units. These vesicles are predominantly open and rimmed with calcite, pyrite, and clay minerals.

The groundmass texture and mineralogy of the two basalt types is similar. Both have subophitic textures. The groundmass consists of euhedral plagioclase laths, subhedral to anhedral clinopyroxene grains, and irregular and skeletal magnetite grains. Plagioclase is slightly more abundant than clinopyroxene. Magnetite forms between 3 and 7% of the rock. In Type 1 basalt, phenocryst plagioclase is identified as labradorite and phenocryst clinopyroxene as augite. Both types show moderate alteration.

The variation between and within the two different basalt types may be a function of magma emplacement and cooling history. The size and abundance of phenocrysts are influenced by factors such as phase saturation, the presence of volatiles, degree of supercooling, fractional crystallization, and magma chamber residence time. The variation in groundmass grain size is a function of cooling rate, in turn dependent on flow thickness. In spite of textural variations, chemical differences may well be minor.

MAGNETICS

Paleomagnetic samples were obtained in the undisturbed sections of Cores 528-17 to 528-38 and measured aboard ship. Because of incomplete recovery, the record is sparse prior to the early Paleocene. The polarity interpretation is plotted with the hole summary diagram (Fig. 3), and details of the early Paleocene–Cretaceous are contained in the sedimentary paleomagnetism section (Chave, this volume). As at the other sites, the latter is consistent with the time scale of Ness et al. (1980) and suggest a basement age of Anomaly 31–32 time (~70 Ma). A long interval of low inclination in Cores 25–28 is suggestive of a large slump deposit. This is confirmed by both biostratigraphy and sedimentary structures.

As at the other sites, no useful information could be obtained from the hydraulic piston cores.

PHYSICAL PROPERTIES

The cylinder technique was used to obtain gravimetric data throughout Hole 528A and down to Core 24 of Hole 528. Below that, the bulk piece method was used. Vane shear strength measurements were made down to Core 24 of Hole 528. The data obtained are listed in Table 6. Figure 8 shows the diagram of physical properties versus depth. Lithologic Unit I, composed of carbonate ooze, was recovered in Hole 528A and in the upper five cores of Hole 528. This unit is rather uniform in its physical properties, except for the uppermost 50 m, which show a distinct increase of bulk density and a decrease of water content and porosity with depth. Below 50 m, these trends continue but are no longer as obvious as in the upper part. Bulk density increases slowly,

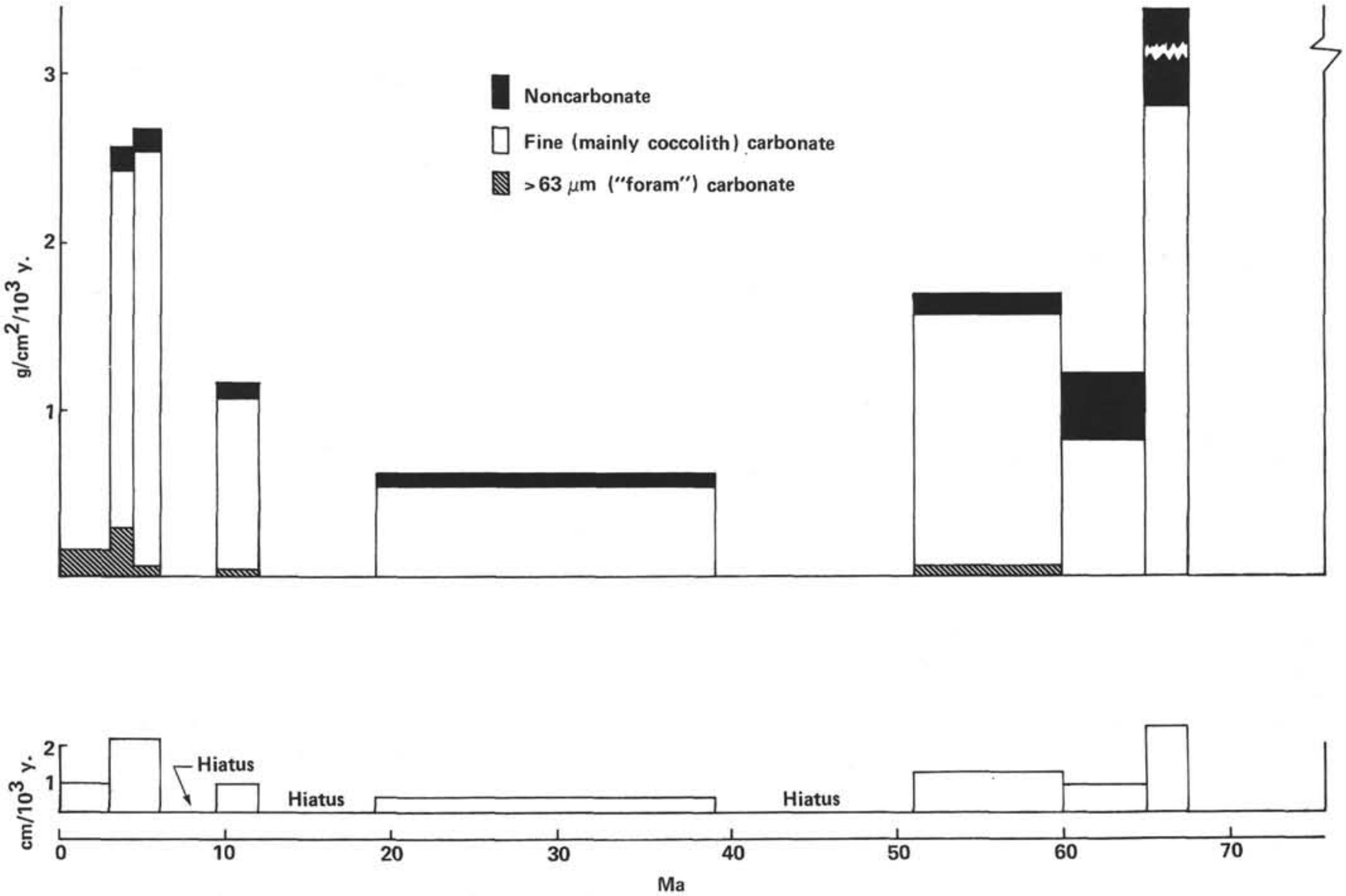

Figure 6. Accumulation rates, Site 528. Lower graph is total accumulation rates in $cm/10^3$ y. plotted against time. Upper graph shows accumulation rates for noncarbonate, coccoliths, and foraminifers. (All in $g/cm^2/10^3$ y.)

Table 5. Data used to generate accumulation rates, Site 528 (Fig. 6).

Time Interval (m.y.)	Core Interval	Accumulation ($cm/10^3$ y. av.)	Bulk Density (av.)	Grain Density (g/wet cm^3 av.)	Total Accumulation ($g/cm^2/10^3$ y.)	$CaCO_3$ (av.%)	Accumulation $CaCO_3$	Foram (av.%)	Accumulation ($g/cm^3/10^3$y.) Foram	Coccolith	Non-$CaCO_3$
Hole 528, 190–240 m											
19–39		0.5	1.80	1.25	0.625	87.5	0.547	0.78	0.007	0.54	0.078
51–60		1.22	1.89	1.39	1.70	92.1	1.57	2.78	0.064	1.50	0.13
60–65		0.8(?)	1.98	1.52	1.22	66.5	0.81	N.D.	N.D.	N.D.	0.41
65–67.5	32–37	2.5	2.02	1.58	3.8	73.9	2.81	N.D.	N.D.	N.D.	0.99
Hole 528A											
0.3	top–8	0.9	1.68	1.05	0.945	93.4	0.882	10.57	0.160	0.722	0.063
3–4.4	9–15	2.2	1.77	1.17	2.57	95.2	2.44	7.77	0.303	2.14	0.13
4.4–6	16–23	2.2	1.79	1.22	2.68	95.4	2.55	1.65	0.065	2.48	0.13
9.5–12	24–28	0.9	1.80	1.30	1.17	91.62	1.07	3.25	0.053	1.02	0.10

and water content and porosity decrease. In a depth between 115 and 135 m below the seafloor, both water content and porosity show distinctly lower values, and bulk density is somewhat higher than above and below, perhaps owing to a higher abundance of chalks in this section.

Grain density shows no trend in Unit I and averages 2.7 g/cm^3. Shrinkage reveals a slight decrease with increasing depth. Single higher values with more than 10% shrinkage in the lower parts of Unit I are probably due to layers with somewhat higher contents of clay.

Vane shear strength increases slowly with depth. Most values are less than 100 g/cm^2 (≈10 kPa). Below 115 m sub-bottom higher values, up to 1000 g/cm^2 (≈100 kPa), were obtained, correlating with the higher clay content in the lower part of Unit I and increasing cohesion of the sediments.

Sonic velocity is constant throughout Unit I, with values averaging 1.55 km/s. Unit II shows the effect of increasing diagenesis.

Water content decreases from about 32% at the top to about 23% at the bottom and porosity decreases from about 53 to 45%. Bulk density increases from about 1.80 to about 1.95 g/cm^3. Grain density shows only a slight change, increasing from 2.70 to 2.75 g/cm^3.

Table 6. Physical properties summary, Site 528.

Sample (interval in cm)	Sub-bottom Depth (m approx.)	2-Min. Count GRAPE Density (gm/cm³) ∥ To Bedding	2-Min. Count GRAPE Density (gm/cm³) ⊥ To Bedding	Gravimetric Data: Wet-Bulk Density (gm/cm³ approx.)	Gravimetric Data: Grain Density (gm/cm³ approx.)	Gravimetric Data, Salt-Corrected: Wet-Water Content (%)	Gravimetric Data, Salt-Corrected: Porosity (%)	Shrinkage (vol.%)	Vane Shear Strength ( ) = remolded (gm/cm³)	Penetrometer (mm) Fall Height 0 cm	Penetrometer (mm) Fall Height 1	Sonic Velocity ∥ To bedding (km/s)	Sonic Velocity ⊥ To bedding (km/s)	Acoustic Impedance ∥ To bedding (10^5 gm/cm² s)	Acoustic Impedance ⊥ To bedding (10^5 gm/cm² s)	Thermal Conductivity (W/m °C)
Hole 528																
2-1, 44–60	122.5			1.85	2.59	25.8	46.8									
3-1, 3–5	131.5			1.92	2.59	22.9	42.8	3.6	802	3.05	3.45	1.60		2.96		1.65
3-1, 42–64	132.0			1.89	2.68	25.9	47.7	0.6								
3-1, 72–74	132.2	1.92						10.6	964	1.05	2.45	1.61		3.05		1.40
3-1, 107–109	132.6			1.84	2.66	27.9	50.1									
4-1, 28–31	141.3			1.77	2.68	31.6	54.7	2.9								
4-2, 28–40	142.8					32.4										
4-2, 58	143.1							7.3	93	6	6.45	1.25				7.43
4-2, 117–120	143.7								215							
4-3, 28–31	144.3					31.2			47	6.45	7.2					
4-4, 48–76	146.1	1.43														
4-4, 115–118	146.7								70	5.1	6.5	1.56		2.23		1.40
4-5, 28–31	147.3					32.0			302	3.05	3.25					
4-6, 118–129	149.7					30.8										
5-2, 29–32	152.3					30.7			186	5.4	6.75	1.57				1.79
5-3, 6–30	153.7			1.82	2.73	29.9	53.2									
5-3, 79–81	154.3							6.8	482	2.95	4.3	1.57		2.86		1.39
5-5, 100–103	157.5					29.2			1075 (227)	4.5	1.85					
5-6, 23	158.2															
5-6, 60	158.6								854							
5-6, 122–130	159.3	1.88							227							
6-1, 135–148	161.4			1.81	2.70	30.2	53.2		70			1.52		2.86		1.42
6-3, 146–148	164.5					30.3		6.1	35	4.9	6.25	1.59		2.87		1.57
6-5, 107–110	167.1	1.80														
6-7, 44–47					33.3											
7-2, 120–130	172.3			1.81	2.70	30.1	53.1	6.5	35	6.05	5.45	1.60		2.89		1.44
7-3, 120–123	173.7					31.2										
7-6, 125–128	177.8					31.4										
8-1, 120–123	180.2					31.6										
8-3, 97–109	183.0	1.89							105	4.6	4.7	1.57		2.96		1.37
8-5, 91–94	185.9					31.4										
9-1, 134–137	189.9					31.1										
9-2, 4–15	190.1			1.81	2.72	30.2	53.4	5.6	35	4.7	5.2	1.57		2.84		1.56
9-3, 134–137	192.9					31.0										
9-5, 137–140	195.9					30.0										
9-7, 63–66	198.0					28.9										
10-1, 146–149	199.5					32.4										
10-2, 146–149	201.0					33.0										
10-3, 69–80	201.7	1.84							81	5.05	6.1	1.55		2.85		1.53
10-4, 103–106	203.5					29.6										
11-2, 0–3	209.0					34.1										
11-2, 88–90	209.9					33.2										
11-2, 98–113	210.0			1.79	2.69	30.8	53.9	6.4	41	8.1	6.9	1.55		2.77		1.26
11-2, 120–123	210.2			1.77	2.65	37.4	54.2	0.4								
12-3, 125–140	221.3	1.86							23	6.7	7.5	1.55		2.88		1.23
12-3, 147–149	221.4					30.8										
12-6, 147–149	226.0					30.2										
13-1, 124–125	227.7					29.9										
13-1, 131–139	227.9			1.87	2.66	26.1	47.8	4.2	529	1.45	3.3	1.61		3.00		1.76
14-2, 61–68	238.1					29.7			993	3.6	4.5					
14-2, 73–81	238.3			1.79	2.44	25.9	45.4	2.0				1.60		2.87		1.85
15-2, 5–13	247.7	1.90										1.58		3.01		1.64
15-2, 25–26	247.3					33.3										
15-6, 30–31	251.8					33.5										
16-3, 111–123	259.2			1.80	2.69	30.5	53.5	2.3	221	2.25	3.4	1.58		2.84		1.65
16-3, 144–146	259.5					30.3										
16-5, 90–92	261.9					27.8										
17-3, 2–14	267.6	1.93								3.3	4.2	1.61		3.11		1.60
17-4, 15–17	269.5					22.6			81							
18-3, 2–12	277.1			1.91	2.72	25.6	47.7	3.1	122	1.3	1.6	1.63		3.12		1.62
18-3, 15–17	277.2					24.9										
19-1, 94–97	284.5			1.83	2.61	27.5	49.1	0.5								
19-1, 110–124	284.7					24.4						1.73		3.16		2.01
19-3, 6–8	286.6					26.0										
20-1, 146–149	294.5					27.7										
20-2, 130–140	295.9			1.87	2.68	27.0	49.1	5.3	122	5.7	6.0	1.58		2.96		1.30
20-3, 116–119	297.2					25.9										
20-5, 42–45	299.4					24.7										
21-1, 147–150	304.0					28.0										
21-3, 126–137	306.8	1.92							320	2.2	5.3	1.60		3.06		1.41
21-5, 105–108	309.6					27.0										
22-1, 135–137	373.4					23.6										
22-2, 148–150	315.0					28.3										
22-3, 111–128	316.2			1.89	2.69	26.0	47.9	2.1	296	1.1	2.0	1.60		3.02		1.42
23-1, 109–112	322.6					26.6										
23-3, 79–85	325.3								343	2.6	3.45	1.62		3.18		1.88
23-3, 117–120	325.7	1.96														
23-4, 90–93	326.9					23.8										
24-1, 134–137	332.4					23.2										
24-2, 88–92	333.4					27.5										
24-3, 95–107	335.0			1.82	2.56	27.4	47.9		186	4.6	4.05	1.61		2.93		1.72
24-4, 61–64	336.1					26.1										
25-1, 28–30	340.8			1.92	2.75	25.4	47.2									
25-2, 57–66	342.6	1.98	2.00	1.95	2.73	24.9	45.4					1.79	1.78	3.49	3.48	1.52
26-1, 128–137	351.3	2.05	2.01	1.98	2.73	22.6	43.7					1.81	1.85	3.59	3.66	1.55
26,CC, 13–15	352.3			1.96	2.75	23.6	45.2									
27-1, 75–86	360.3	2.11	2.06	2.02	2.73	21.1	41.7		1.95	1.90	3.93	3.84	1.66			
27-2, 120–122	362.2			1.97	2.75	23.3	44.9									
27-3, 45–48	363.0			1.93	2.75	25.0	47.7									
28-2, 35–48	370.9	2.26	2.22	2.19	2.74	15.1	32.2		2.33	2.24	5.11	4.89	1.69			
29-3, 135–150	382.3	2.05	2.08	1.99	2.74	22.6	43.9		1.81	1.82	3.61	3.62	1.60			
30-3, 94–105	392.0	2.04	2.04	1.99	2.76	22.9	44.4		2.00	1.94	3.97	3.86	1.30			
31-2, 64–61	399.5	2.01	2.02	1.96	2.77	24.3	46.5		1.87	1.84	3.66	3.60	1.39			
32-1, 102–104	408.0			2.04	2.75	20.9	41.5									
32-1, 104–110	408.1	2.06	2.07	2.00	2.77	22.4	43.8		1.73	1.74	3.45	3.47	1.51			

Table 6. (Continued).

Sample (interval in cm)	Sub-bottom Depth (m approx.)	2-Min. Count GRAPE Density (gm/cm^3) ∥ xx	2-Min. Count GRAPE Density (gm/cm^3) ⊥ xx	Gravimetric Data: Wet-Bulk Density (gm/cm^3 approx.)	Gravimetric Data: Grain Density (gm/cm^3 approx.)	Gravimetric Data, Salt-Corrected: Wet-Water Content (%)	Gravimetric Data, Salt-Corrected: Porosity (%)	Shrinkage (vol.%)	Vane Shear Strength ( ) = remolded (gm/cm^3)	Penetrometer (mm) Fall Height 0 cm	Penetrometer (mm) Fall Height 1	Sonic Velocity ∥ To bedding (km/s)	Sonic Velocity ⊥ To bedding (km/s)	Acoustic Impedance ∥ To bedding (10^5 gm/cm^2 s)	Acoustic Impedance ⊥ To bedding (10^5 gm/cm^2 s)	Thermal Conductivity (W/m °C)
Hole 528 (Continued)																
33-2, 66–68	418.2			2.07	2.75	19.5	39.4									
33-2, 66–67	418.2	2.12	2.10	2.06	2.75	19.8	39.9					1.96	1.34	4.03	4.00	1.32
34-1, 20–31	426.2	2.13	2.10	2.03	2.75	20.9	41.5					1.95	1.88	3.95	3.82	1.60
35-1, 63–72	436.2	2.08	2.08	2.02	2.75	21.1	41.8					1.86	1.82	3.76	3.67	1.65
36-4, 116–127	450.7	2.07	2.12	2.05	2.79	21.1	42.2					1.91	1.87	3.91	3.83	1.48
37-2, 119–130	457.2	1.85	1.88	1.83	2.79	30.3	54.2					2.39	2.31	4.37	4.23	0.96
37-4, 132–142	460.4	2.11	2.11	2.06	2.76	19.9	40.2					2.07	1.98	4.26	4.07	1.47
37-6, 69–77	462.7	2.13	2.12	2.06	2.78	20.4	40.9					2.05	1.98	4.22	4.07	1.48
38-4, 93–103	471.0	2.12	2.11	2.05	2.77	20.4	41.0					2.01	1.97	4.11	4.05	1.40
39-1, 14–24	473.7	2.12	2.16	2.08	2.78	19.5	39.7					2.05	1.97	4.26	4.11	1.82
39-2, 6–15	475.1	2.76	2.76	2.79	2.93	2.7	7.3					5.25	5.18	14.63	14.54	1.06
39-4, 134–144	479.4	2.82	2.86	2.85	2.93	1.6	4.4					5.70	5.64	16.25	16.07	1.79
40-4, 16–26	487.7	2.82	2.81	2.86	2.94	1.5	4.1					5.51	5.68	15.74	16.24	1.68
42-1, 21–32	501.3	2.58	2.56	2.56	2.89	7.1	17.7					4.00	4.04	10.24	10.33	1.47
43-3, 1–10	513.1	2.80	2.78	2.81	2.92	2.1	5.7					5.30	5.50	14.90	15.46	1.73
43-3, 113–118	514.2	2.18	2.24	2.06	2.83	21.5	43.3					2.51	2.24	5.16	4.62	1.50
44-1, 72–81	513.8	2.44	2.30	2.26	2.78	13.4	23.7					2.73	2.39	6.16	5.40	1.93
44-3, 89–98	522.9	2.71	2.75	2.74	2.94	3.9	10.5					4.72	4.71	12.92	12.91	1.73
45-2, 76–85	530.3	2.73	2.76	2.73	2.95	4.3	11.5					4.75	4.60	12.98	12.56	1.76
46-1, 69–77	537.7	2.77	2.85	2.85	2.94	1.8	4.3					5.61	5.68	15.99	16.19	1.88
46-3, 98–107	541.0	1.85	1.87	1.82	2.79	30.8	54.7					2.06	1.99	3.75	3.63	1.19
47-7, 75–83	546.8	2.66	2.69	2.67	2.94	5.3	13.9					4.44	4.40	11.85	11.74	1.65
47-2, 140–150	543.0	2.51	2.51	2.59	2.95	7.4	18.7					3.87	3.93	10.02	10.18	1.70
Hole 528A																
1-1, 48–50	0.5					43.5										
1-2, 47–50	2.0			1.62	2.72	41.1	64.9	7.7								
1-2, 125–138	2.8								21	12.8	15.55	1.54		2.49		1.30
2-1, 118–138	4.2	1.71							43	10.8	14.95	1.56		2.66		1.11
2-2, 135–138	5.8					40.2										
2-3, 138–150	7.2			1.64	2.68	38.9	62.4	8.2	47	6.95	9.25	1.54		2.52		1.35
3-1, 143–146	8.7					38.2										
3-2, 130–142	10.1	1.73							47	9.5	11.4	1.52		2.63		1.38
3-3, 144–147	11.7			1.67	2.68	37.4	60.9	6.8								
4-1, 147–150	13.2					38.8										
4-2, 128–145	14.6			1.69	2.72	36.5	60.3	7.7	46	7.0	9.9	1.55		2.63		1.43
4-3, 135–138	16.1					35.9										
5-2, 117–120	18.8					36.6										
5-3, 121–134	20.4	1.82							46	9.4	10.9	1.16		2.12		1.47
5-4, 30–33	20.5					33.1										
6-1, 147–150	22.0					36.2										
6-2, 137–150	23.4			1.70	2.72	36.0	59.8	9.4	28	11.7	16.9	1.53		2.60		1.19
6-3, 147–150	24.9					37.1										
7-1, 147–150	26.4					38.5										
7-2, 128–143	27.8	1.77							49	8.8	13.65	1.54		2.73		1.25
7-3, 97–109	28.9			1.71	2.73	35.9	59.7	7.4	45	5.8	6.9	2.00		3.43		1.35
8-1, 141–143	30.7					35.4										
8-2, 132–143	32.1			1.73	2.68	33.7	57.0	7.4	33	15.8	10.7	1.56		2.69		1.44
8-3, 148–150	33.7					36.3										
9-1, 144–147	35.1					35.6										
9-2, 133–146	36.6	1.79							27	9.9	11.4	1.59		2.84		1.78
9-3, 137–140	38.1					34.9										
10-1, 147–150	39.6					33.6										
10-2, 132–144	41.0			1.73	2.70	34.1	57.6	7.6	27	9.7	12.25	1.57		2.71		1.45
10-3, 148–150	42.5					34.3										
11-1, 147–150	44.0					33.6										
11-2, 147–150	45.5					33.4										
11-3, 130–146	46.9	1.80							35	9.1	13.65	1.58		2.84		1.35
12-1, 147–150	48.4					33.7										
12-2, 129–150	49.8			1.73	2.71	34.5	58.1	8.6	36	6.85	7.5	1.58		2.73		1.20
12-3, 147–150	51.3					34.2										
13-1, 115–117	52.5					33.7										
13-2, 115–117	54.0					34.0										
13-3, 120–140	55.6	1.83							51	8.3	7.15	1.56		2.85		1.40
14-3, 11–18	58.8			1.79	2.73	31.3	54.8	6.7	25	10.95	9.8	1.56		2.79		1.47
15-2, 20–28	61.8	1.82							89	5.5	7.0	1.59		2.89		1.66
15-2, 109–112	62.7			1.81	2.72	30.5	53.7	4.5								
17-2, 4–6	68.9					33.1										
18-3, 124–136	77.6	1.82										1.54		2.80		
19-2, 59–61	79.8					32.2										
19-2, 119–131	80.4			1.80	2.74	31.1	54.7	4.2	25	9.4	10.2	1.52		2.74		1.41
21-2, 18–27	88.2			1.77	2.68	31.6	54.7	7.6	27	8.4	9.6	1.53		2.71		
22-1, 129–132	92.2					32.5										1.59
22-2, 128–142	93.7	1.88							73	5.65	5.7	1.55		2.91		1.41
22-3, 108–111	95.0					31.0										
23-1, 137–140	96.7					31.8										
23-2, 100–114	97.8			1.81	2.76	31.1	54.8	8.1	48	6.9	8.9	1.55		2.80		1.63
23-3, 111–114	99.4					30.6										
24-1, 80–82	100.5			1.80	2.62	29.1	51.2	8.5								
25-1, 125–128	105.3					29.2										
25-2, 114–128	106.8			1.79	2.68	30.9	53.8	8.2	25	9.9	9.5	1.58		2.82		1.53
25-3, 125–128	108.4	1.91														
26-1, 100–102	109.5					32.9										
26-2, 95–97	111.0					31.8										
26-3, 34–36	111.8					32.2										
27-1, 115–117	114.1					32.0										
27-2, 115–117	115.6					29.7										
27-3, 26–30	116.2			1.78	2.71	31.7	55.1	7.1								
27-3, 115–134	117.2					32.0			67	8.4	8.6	1.54		2.74		1.42
28,CC, 14–24	118.8			1.81	2.71	30.2	53.3	12.5	287	3.1	6.4	1.55		2.80		1.67
28,CC, 31–33	118.9					27.7										
30-1, 80–81	126.9			1.87	2.66	26.5	48.4	3.4								
30-1, 96–98	127.1					26.8										

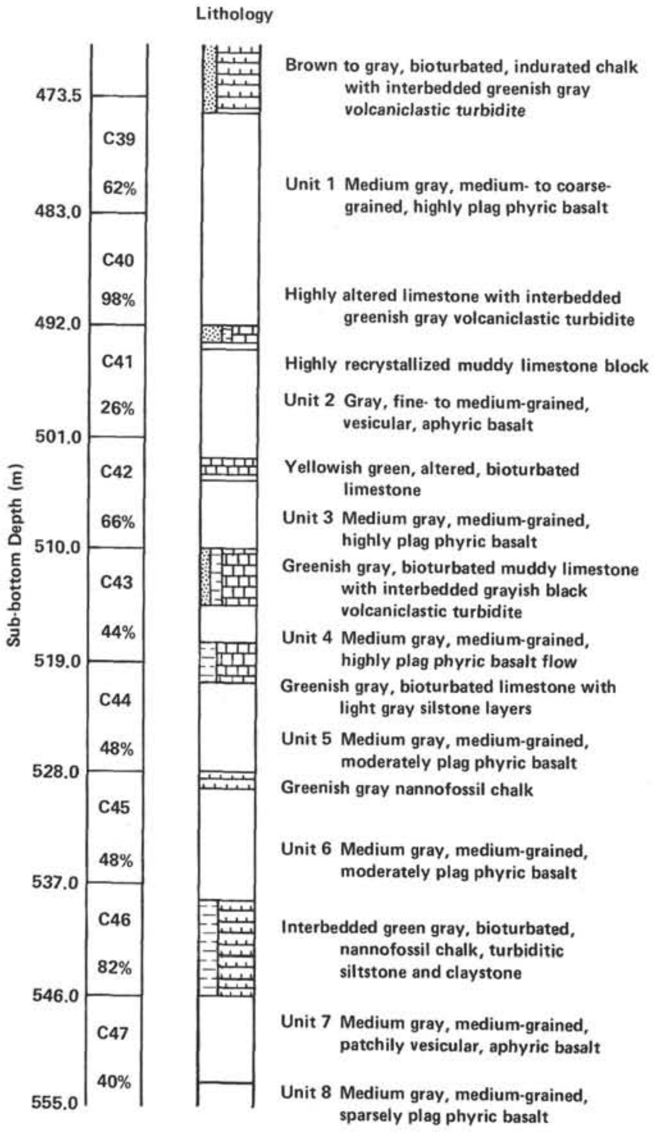

Figure 7. Hole 528 basalt lithology.

The same trends are seen in shear strength and shrinkage. Shear strength increases distinctly with depth. Below 300 m sub-bottom, it reaches values of 350 g/cm^2 (≙35 kPa). Single higher values (up to 1000 g/ cm^2) indicate higher cohesion layers of high clay content or increased lithification. In the same interval, shrinkage decreases from about 6% of volume to null. Below 340 m below seafloor, no further measurements of shear strength or shrinkage could be performed.

Sonic velocity is constant throughout the bulk sequence of Unit II, averaging 1.58 km/s, and increases abruptly only in the lowermost 40 m (360–380 m sub-bottom). This coincides with the increased abundance of chalks in the lower part of Unit II.

In Unit III, which is composed of chalks with increasing volcaniclastic content, the trend of Unit II continues more slowly. Bulk density increases to about 2.05 g/cm^3 at the bottom of the unit. The density data obtained from 2-min. GRAPE counts are generally somewhat higher than the gravimetric data. Water content and porosity decrease slightly to about 20% water content and 40% porosity. Grain density shows only a small increase in the lower part of Unit III, corresponding to the high abundance of volcanogenic material in this section. Because of the varying lithology of this unit, the sonic velocity data scatter more than in the upper parts and increase only slightly, from about 1.9 km/s at the top to about 2.05 km/s at the bottom of Unit III.

The basement complex of Unit IV consists of basalts with interbedded sediment layers. The physical properties of the basalt indicate lower alteration at this site than at the two previous sites, whereas the properties of the sediment are similar to that of Unit III, with a wider variation, and are about the same as at Site 527 (see Table 7).

Thermal conductivity shows a slight increase with depth. Most values in Unit I are less than 1.5 W/m °C (≙3.6 mcal/cm °C s), and below that unit an increase is observed. The data obtained in Unit IV (basement) are distinctly higher than those of the above.

DOWNHOLE LOGGING

We logged Hole 528 after completion of rotary drilling. Sonic logs (with corresponding gamma ray and caliper traces) were obtained. We desired to obtain density, resistivity, and final temperature logs. However, on our first density run we experienced equipment failure. On the second run, the Schlumberger line apparently hung up in the bottom hole assembly, which resulted in several "cattails" and hence aborted the remainder of the logs on this hole.

The sonic log (Fig. 9) agrees well with predictions and measurement from observed lithology. There is a general increase in velocity from about 290 m sub-bottom (Core 19) to about 380 m sub-bottom (Core 28), corresponding to a general increase in the ratio of nannofossil chalks to oozes. Above about 290 m sub-bottom (where the sediments are primarily oozes), the calipers show a much wider (or in part washed-out) hole. The measurements here, where "reliable," indicate nearly uniform velocity.

In the ~290–380 m sub-bottom interval, there is a small zone between 343 and 360 m in which an unresolved decrease in sonic velocity is observed. This decrease commences very close to the bottommost of a number of observed chert layers. There is no corresponding change in the gamma ray trace. Core recovery

Table 7. Physical properties summary for the basement complex, Site 528.

	Basalt (mean of 10 samples)	Sediment (mean of 3 samples)
Wet-bulk density (gravimetric)	2.85 g/cm^3	2.05 g/cm^3
Wet-water content	3.8%	21.9%
Porosity	9.8%	42.5%
Approximate grain density	2.93 g/cm^3	2.80 g/cm^3
Sonic velocity: horizontal	4.91 km/s	2.44 km/s
vertical	4.94 km/s	2.21 km/s
Thermal conductivity	1.66 W/m °C (=3.98 mcal/cm °C s)	1.54 W/m °C (=3.98 mcal/cm °C s)

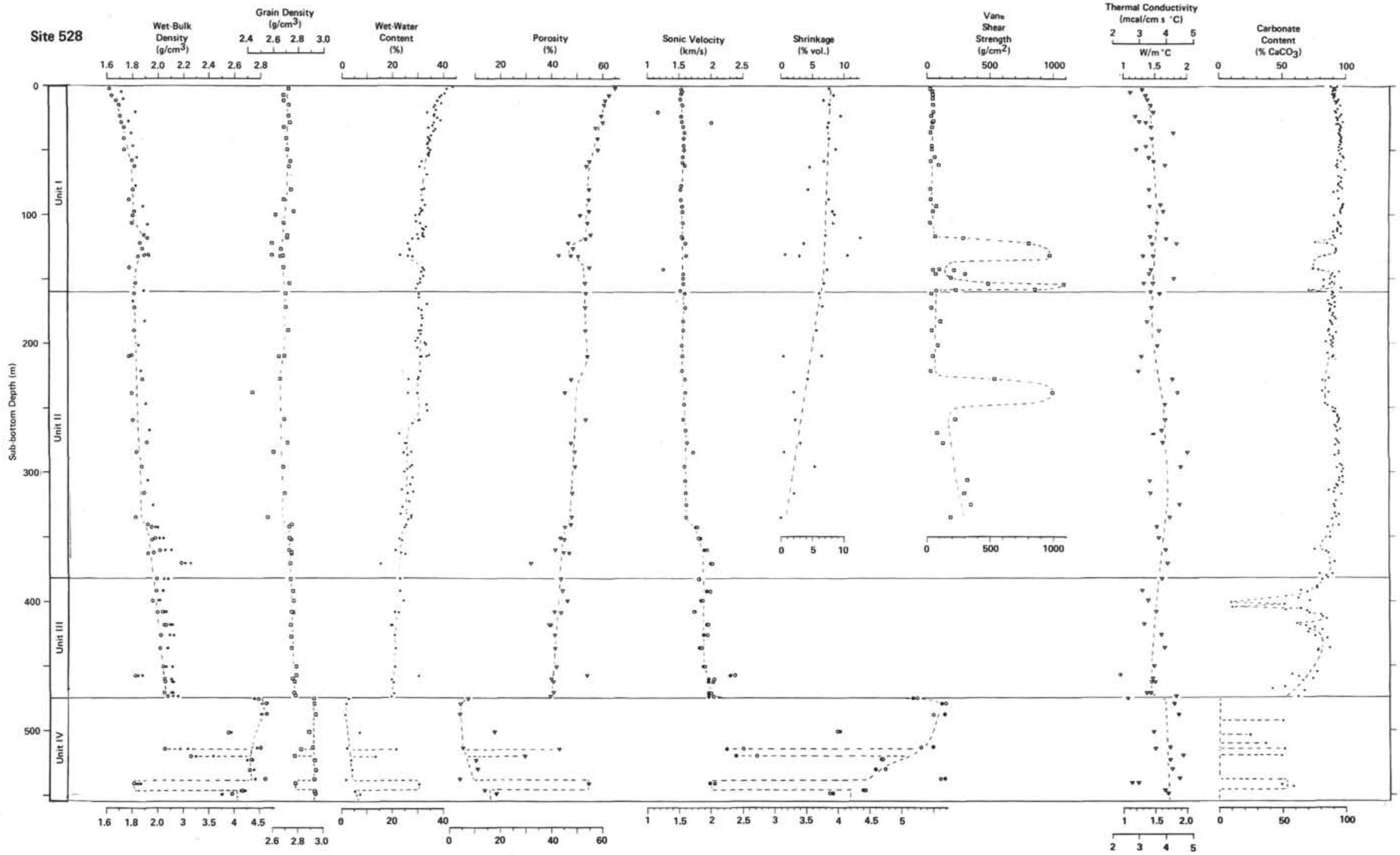

Figure 8. Plots of measured physical properties versus depth, Site 528.

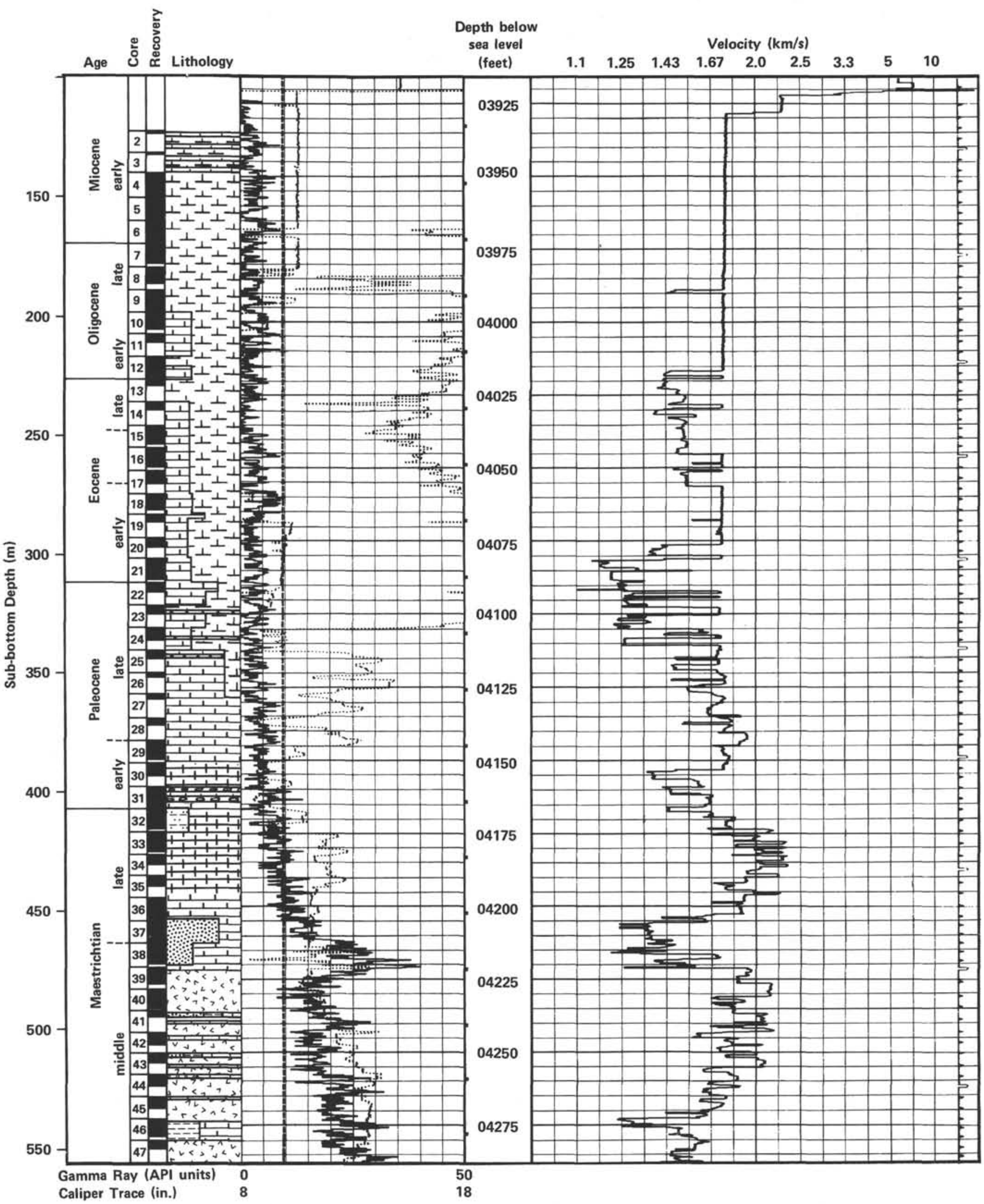

Figure 9. Correlation of sonic velocity, gamma ray (solid line), and caliper trace (dotted line) with lithostratigraphy.

was poor in this area; the caliper trace, however, shows the hole to be relatively undisturbed.

Between ~390 and 410 m sub-bottom (near the Cretaceous/Tertiary boundary), there is a pronounced decrease in the sonic velocity. There is also a pronounced increase in gamma ray intensity near this region, between 398 and 412 m sub-bottom. The lithology of this zone is marked by a change from foraminiferal nannofossil chalks above to an interval with brecciated muddy foraminiferal nannofossil chalk with pelagic foraminiferal nannofossil chalks interlayered within the breccia and below it. The sonic velocity low as well as the gamma ray high approximately coincides with the breccia and increased clay content in the bottommost part (~410–412 m). The increase in the gamma ray trace is consistent with the increased clay content between 400 and 420 m. However, the low in measured sound velocity extends above the zone of increased gamma ray activity and is probably related to the sediment in the interval of nonrecovery in Core 30.

There is a general decrease in sonic velocity from ~450 m sub-bottom to the basement complex at 474 m sub-bottom. This decrease in velocity corresponds to an increase in sand, silt, and clay content.

The basement complex is well defined by the sonic velocity and gamma ray logs. The intercalated sediments show predictable decreases in velocity; the basalts show a correlation between velocity highs and gamma ray lows. The details of the exact widths of sediment and basalt units can be resolved with the velocity and gamma ray logs.

SUMMARY AND CONCLUSIONS

Site 528 is on crust between Magnetic Anomalies 31 and 32 (middle Maestrichtian) in age and located on the western slope of a NNW–SSE-trending block of the Walvis Ridge. It is approximately midway up the slope on a transect across the Walvis Ridge into the Angola Basin. Two holes were drilled which give a complete section from the seafloor through the sedimentary layers (474.5 m sub-bottom) and 80.5 m into a basement complex consisting of basaltic rocks with intercalated sediments.

Hole 528. We obtained 47 rotary cores from this hole with a total penetration of 555.0 m below the seafloor and recovery of 62%. A basement rock complex was first encountered at 474.5 m sub-bottom and continuously cored for 80.5 m. In addition, a sonic velocity log (with gamma ray and caliper traces) was completed.

Hole 528A. We hydraulic-piston-cored 30 cores for a total length of 130.5 m and recovery rate of 89%. The principal geological and geophysical results are given in the following paragraphs.

Lithology: Sediments

Four major lithologic units are observed. One of these units is within the basement complex.

Unit I extends from the mud line to 160 m sub-bottom (early Miocene) and consists primarily of a homogeneous white to pale yellowish brown to very pale orange foraminifer–nannofossil ooze. Bioturbation is slight, with *Planolites*, halo burrows, and *Chondrites* present. An "anomalous" Oligocene–Eocene sequence is observed within Unit I which is probably reworked material. Calcium carbonate content in this unit is about 85 to 90%.

Unit II extends from 160 to 382 m sub-bottom (early Paleocene) and consists primarily of yellowish gray to white to pinkish gray nannofossil chalk and ooze with increasing ratio of chalk to ooze with depth. Calcium carbonate in this unit is about 90%. Bioturbation is slight to moderate, with *Planolites, Zoophycos*, and halo burrows present. Three small cherty layers are observed in Unit II.

Unit III extends from 382 m to the basement complex (mid-Maestrichtian) at 474.5 m sub-bottom and consists of alternating layers of pale yellowish to reddish brown foraminifer–nannofossil chalk and greenish gray volcanogenic turbidite sandstones and nannofossil chalks. Bioturbation is very high, with *Chondrites, Planolites, Zoophycos*, halo burrows, and vertical burrows present. Carbonate content varies from 30 to 90%. Just above the Cretaceous/Tertiary boundary in this unit, there is a brecciated sequence consisting of interbedded layers of slumped chalky material in pelagic sediments.

Unit IV consists of interlayered sedimentary rocks (volcanogenic turbidite sequences and indurated nannofossil chalks and limestones to carbonate mudstones) within the basaltic basement complex. Some shell fragments (*Inoceramus*) are observed within the limestones. Carbonate content varies between 20 and 60%.

Lithology: Basalt

We drilled 80.5 m in the basement complex with a recovery rate of 57%. Of the 45.6 m recovered, 11.6 are sediment and 34.0 are basalt.

Eight flow units are identified, all except the last two separated by sediments. Altered glassy margins are observed at the top of Units 1–5, and fine-grained basalt is observed at tops of Units 6–8. All of the units have a subophitic texture. The eight units may be grouped into two basic lithologic groups.

Units 1, 3, 4, 5, 6, 8: Massive gray, medium- to coarse-grained, sparsely to highly plagioclase phyric basalt. The few olivine phenocrysts are altered to clay minerals. Vesicles are sparse.

Units 2, 7: Medium gray, fine- to medium-grained aphyric basalt. Vesicles form 0 to 30% of rock.

Relationship of Lithology and Seismic Reflection Profile

The seismic stratigraphy is shown in Figure 10. The basal, very dark reflector is interpreted, as at Sites 525 and 527, to coincide with the top of the basaltic basement complex. The "smoothness" of the reflector is probably a manifestation of the basement complex consisting of basalt with intercalated sediments. The top of the prominent reflector about 0.06 s above basement is probably related to the top of Unit III (near the Cretaceous/Tertiary boundary) and to the change from nannofossil oozes and chalks to nannofossil chalks and volcanogenic mudstones and siltstones. This reflecting

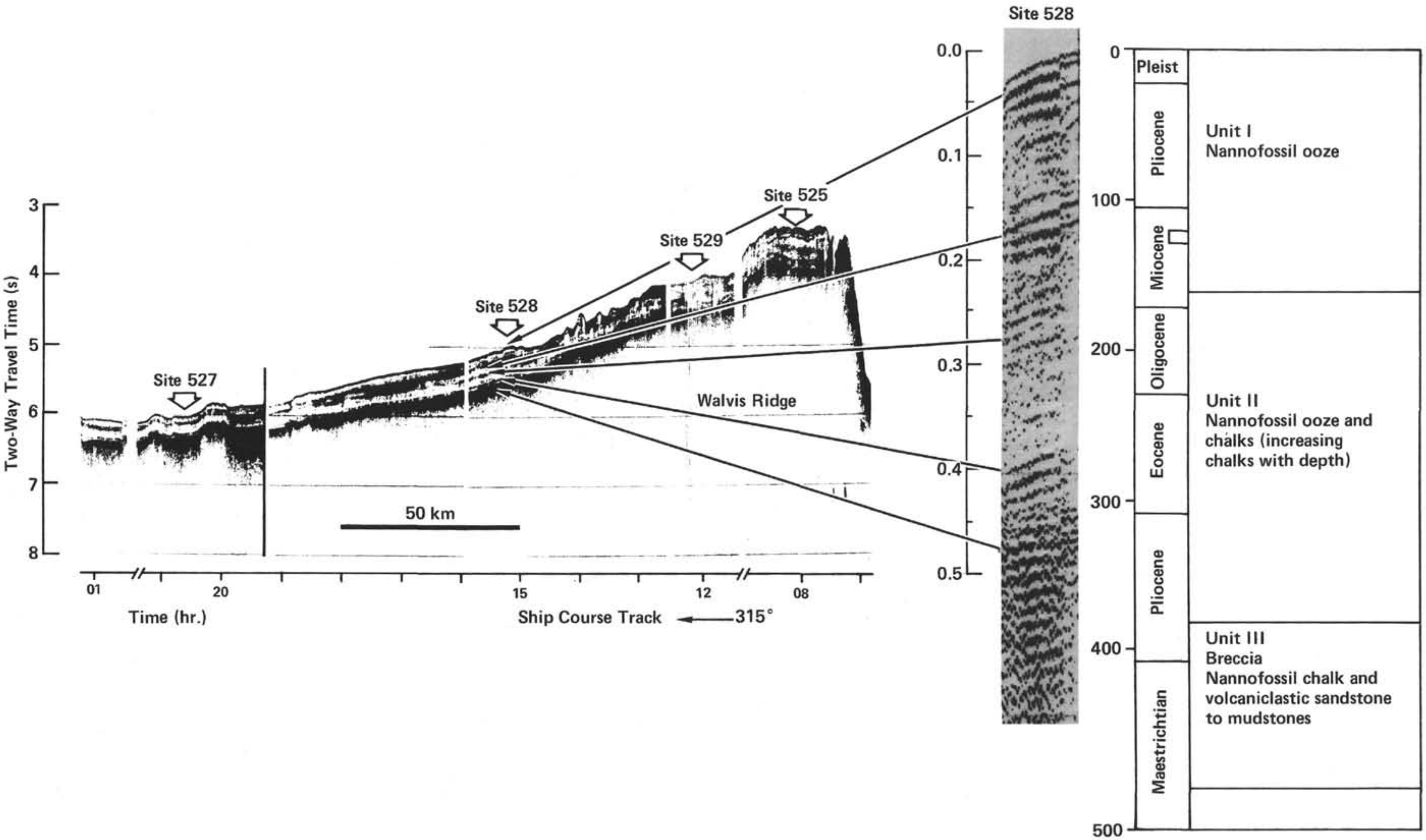

Figure 10. Correlation between seismic records and lithostratigraphy, Site 528.

horizon appears to continue from Site 525 at the top of the transect, downslope through Site 528 to the base of the transect at Site 527. Just above the Cretaceous/Tertiary boundary at the top of Unit III at this site, there is a brecciated zone which may be present at the other two sites and relate to this prominent reflecting horizon. At about 0.22 s above basement, a reflector is observed near the top of Unit II near the Eocene/Oligocene boundary and lithologic change from oozes to oozes and chalks. At about 0.33 s above basement, another prominent reflector is observed near the bottom of Unit I which may relate to the reworked material of Oligocene to Eocene age observed within the Miocene.

Physical Properties

The general trends in the physical properties are similar to those at Sites 525 and 527.

In Unit I (primarily nannofossil oozes), the physical properties are rather uniform except for the uppermost 50 m. Unit II, characterized by a transition from ooze to chalk, shows a distinct trend of increasing diagenesis with decreasing water content, porosity and shrinkage with depth, and increasing bulk density, grain density, shear strength, sonic velocity (in lowermost part) with depth. In Unit III, which consists mainly of alternating layers of nannofossil chalk and volcanogenic sediments, the Unit II trends continue, but increases are less rapid. Because of the varying lithology, the sonic velocity in this unit has a wider scatter than Unit II. The physical properties of the basement indicate that the recovered rocks are not as altered as at the two previous sites. The physical properties of the interbedded sediments are similar to those of the previous site (527).

Logging

Sonic velocity (with gamma ray and caliper traces) was logged at Site 528. In general, the sonic log agrees well with the measurement from the observed lithology. In particular, a velocity low and gamma ray high approximately coincide with the brecciated zone and increased clay content in the region just above the Cretaceous/Tertiary boundary. This is where we observe a very well defined seismic reflector about 0.06 s above basement. The logs in the basement complex were quite good. We expect to evaluate rather precisely the thicknesses of the sediments and basalts within basement.

Paleomagnetics

The hydraulic piston cores in Hole 528A yielded no usable paleomagnetic results, as at the other sites. Recovery from rotary cores in the Eocene and upper Paleocene was too spotty for reliable interpretation. Anomalies 7 to 10 in the Oligocene as well as the lower Paleocene and Cretaceous anomalies are more readily identifiable. The results are consistent with those of nearby Sites 525 and 527 and with the paleontological data.

Accumulation Rates

Except for the lower Miocene and Oligocene, sediment accumulation rates and changes in these rates at Site 528 are similar to those at the previous sites. There is a distinct maximum in the lower Pliocene, followed by very low rates through most of the upper Miocene. As at Site 527, there is a very short interval (10.5–12 Ma) when accumulation rates were again increased. The lower middle Miocene to upper lower Miocene interval is represented by redeposited Eocene and Oligocene material (Hole 528) and possibly a hiatus (Hole 528A) similar to that at Site 525. Below this, sediment accumulation through the lower Miocene (which is missing at 527) and the Oligocene (much of which is missing at both 525 and 527) is low but rather uniform at about 0.5 cm/10^3 y. Accumulation rates in the upper and middle Eocene are further reduced before rising again in the lower Eocene through Maestrichtian. Within the lower part of the section, slumps perturb the pattern of sedimentation rates, which is similar to that at Site 525 and averages about 1.2 cm/10^3 y.

Biostratigraphy and History of Walvis Ridge

A continuous section was drilled from the seafloor through the upper 80 m of basement midway up the western slope of a NNW–SSE-trending block of the Walvis Ridge. The morphology of this segment of the Walvis Ridge is parallel to the magnetic lineations and normal to the fracture zone trends (as at Sites 525 and 527).

The age of the crust (middle Maestrichtian), as determined from the identification of fossils within the sediment above basement and within the basement complex as well as from paleomagnetic measurements, is in agreement with the surface ship magnetic anomaly identification (between Anomalies 31 and 32) and thus further suggests that this part of the the Walvis Ridge was formed at a mid-ocean ridge spreading center.

The section recovered at Site 528 is nearly continuous; the only clear indications of large breaks in accumulation occur in the lower Miocene and across the Eocene–Oligocene boundary. Other smaller breaks in accumulation may occur at the top and base of the upper Miocene, within the upper Oligocene, within the upper Eocene, and at the top of the lower Paleocene. The interval spanning the lower Miocene was partially recovered in Hole 528 (Zones NN1–NN4); however, a substantial amount of reworked material, middle Eocene in age, was also contained in this interval (Hole 528, Core 2). In Hole 528A, this same sub-bottom depth interval contained middle Miocene overlying upper Oligocene. Hole 528A is offset approximately 0.5 mi. from Hole 528, and the difference in the two recovered sections may indicate local variations in deposition and erosion, possibly associated with slumping and/or small-scale faulting, occurring in the latest part of the early Miocene. In the transect of sites cored, the amount of lower Miocene recovered appears to be very closely associated with depth: at Site 525 only a very small portion of the uppermost lower Miocene appears to be missing, at Site 527 all of the lower Miocene is missing, and at this site only the lower part of this interval is recovered (in Hole 528 only). Unlike Sites 525 (located upslope) and 527 (located downslope), Site 528 recovered most of the Oligocene. Preservation was very poor in this interval.

Sedimentation rates are low (≤ 0.5 cm/10^3 y.); however, most of the Oligocene nannofossil zones were identified. The Oligocene *Braarudosphaera* chalk was not identified, but *Braarudosphaera* were common in one interval of Zone NP23. In the Oligocene, the foraminifers were too dissolved and fragmented to be stratigraphically useful.

In addition to the lower Miocene hiatus or slump, there are also indications of lateral transport of sediments in the lower Paleocene. Here, lithologic, biostratigraphic, and paleomagnetic results indicate an interval of slumped (but not reworked) material which greatly expands the thickness of nannofossil Zone NP5 over that found at other sites. This interval is also associated with the previously mentioned brecciated zone, located just above the Cretaceous/Tertiary boundary at this site.

Finally, turbidite sequences are found within and overlying the basement complex and indicate another interval of lateral transport of sediments at this site.

The calcareous microfossils at Site 528 are moderately to poorly preserved and show many of the broad patterns of dissolution and diagenetic alteration noted at the shallower and deeper sites. Maxima in accumulation rates are again found in the Maestrichtian at the base of the section (associated with turbidites and high volcanogenic input); in the lower Eocene–upper Paleocene (associated with relatively good carbonate preservation); for a very short interval in the upper middle Miocene (associated with increased carbonate preservation); and in the lower Pliocene–uppermost Miocene (again associated with increased carbonate preservation and perhaps increased carbonate supply). The accumulation rate in the Maestrichtian at Site 528 is close to that at the deeper site (527) and distinctly less than that at Site 525. For the lower Eocene–upper Paleocene, the accumulation rates are much closer to that at Site 525 (i.e., somewhat higher than at 527). In the uppermost middle Miocene, the accumulation rates at Site 528 lie between the relatively high rate at Site 525 (about 2 g/cm^2/10^3 y.) and the very low rate at Site 527. Finally, the lower Pliocene accumulation peak lies close to the value at the deeper site (527) and well above the surprisingly low rate at Site 525.

One of the most important differences between this site and its close neighbors in the depth transect is the presence of a nearly complete Oligocene section. At the shallower site (525) this interval appears to have been largely removed by erosion; at the deeper site (527), dissolution has removed all the Oligocene carbonate material. Site 529 does include a relatively complete Oligocene section. At Site 528, dissolution is strong in the Oligocene; however, paleomagnetic results are good in the upper Oligocene, and the nannofossil stratigraphy indicates that most of this part of the section is present.

It is clear from this transect of sites that the processes of carbonate dissolution, erosion by bottom currents, and the downslope transport of fine-grained, winnowed material have all played a role in the sedimentary history of the Walvis Ridge. Furthermore, the relative importance of these processes appears to have changed with time as well as with depth.

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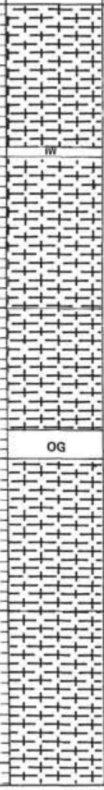
SITE 528 HOLE CORE 1 CORED INTERVAL 0.0–8.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Pleistocene	NN20 (N)					1	0.5, 1.0
early Pleistocene						2	
						3	
						4	
	N22/23 (F) NN19 (N)	AG	AM			5	
						CC	

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

10YR 8/3

10YR 8/3 with N9 patches

10YR 8/3

N9

10YR 8/3

FORAMINIFER NANNOFOSSIL OOZE

This core contains a soupy foraminifer nannofossil ooze.

The color is a very pale brown (10YR 8/3). Some white (N9) patches were present. They may have been layers prior to disturbance.

SMEAR SLIDE SUMMARY:

	1-70	2-130[a]
	D	D
Composition:		
Volcanic glass	1	–
Framinifers	10	98
Calcareous nannofossils	89	–
Urchin spines	–	TR

[a] Coarse fraction

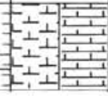
ORGANIC CARBON AND CARBONATE:

	1-11	2-11	3-11	4-11	5-11	CC-11
Organic carbon	–	–	–	–	–	–
Carbonate	88	91	92	89	91	91

SITE 528 HOLE CORE 2 CORED INTERVAL 122.0–131.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
middle Eocene	P10 (F) NP14/15 (N) (slumping)	AM	CP			1	0.5
						CC	

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

10YR 8/2

10YR 6/2
10R 8/2
10YR 8/2

NANNOFOSSIL OOZE AND CHALK

The core consists of a pale yellowish brown (10YR 6/2) to very pale orange (10YR 8/2) nannofossil ooze and chalk. A grayish orange pink (10R 8/2) lamination is present at 62 cm.

Calcareous discoasters are more abundant in the dominant lithology. The ooze and chalk appear to alternate but drilling has destroyed most layers. Fine laminations that alternate in colors may represent a cyclic sedimentation pattern or indicate current activity.

Note: The sediment recovered may be an anomalous layer possibly due to slumping. The biostratigraphic ages determined for this core are older than the underlying sediments immediately beneath.

SMEAR SLIDE SUMMARY:

	1-37	1-62
	D	M
Composition:		
Volcanic glass	1	1
Palagonite	1	–
Carbonate unspecified	TR	–
Foraminifers	5	1
Calcareous nannofossils	93	98
Discoasters (part of nannofossils)	30	–

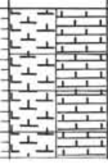
ORGANIC CARBON AND CARBONATE:

	1-24
Organic carbon	–
Carbonate	85

SITE 528 HOLE CORE 3 CORED INTERVAL 131.5–140.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
middle Miocene / early Miocene	NN5 (N) / NN4 (N) / N5 (F) NN3 (N)	CM	AM			1	0.5, 1.0
						CC	

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

10YR 6/2
10YR 4/2
10YR 6/2
10YR 4/2

10R 8/2 layer

10YR 6/2

10YR 6/2,
10YR 8/2

ALTERNATING LAYERS
NANNOFOSSIL OOZE AND CHALK

This core contains alternating layers of a pale yellowish brown (10YR 6/2) to dark yellowish brown (10YR 4/2) nannofossil ooze and chalk.

Within each unit the sediments appear to be laminated and may represent current or a cyclic sedimentation pattern. Most noticeable is a grayish orange pink (10R 8/2) layer in a dark chalk unit. The bioturbation is moderate so primary bedding is preserved.

SMEAR SLIDE SUMMARY:

	1-33	1-60	1-76
	D	D	M
Composition:			
Heavy minerals	TR	1	TR
Clay	–	TR	–
Volcanic glass	1	3	3
Palagonite	–	2	2
Foraminifers	5	5	5
Calcareous nannofossils	94	89	90

ORGANIC CARBON AND CARBONATE:

	1-10
Organic carbon	–
Carbonate	83

SITE 528 HOLE CORE 4 CORED INTERVAL 141.0–150.5 m

TIME-ROCK UNIT: early Miocene

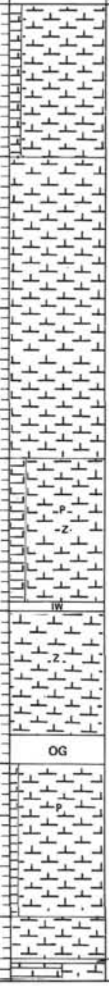
BIOSTRATIGRAPHIC ZONE: NN3 (N); NN2 (N); N5 (F) NN1 (N)

FOSSIL CHARACTER: FORAMINIFERS FP; NANNOFOSSILS AM

SECTIONS: 1, 2, 3, 4, 5, 6, 7, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:



Colors: 10YR 8/2 to 10YR 6/2; 10YR 5/4; 10YR 7/4; 10YR 8/2; 5Y 8/1; 5YR 8/1; 5Y 8/1; 10YR 4/2; 10YR 8/2; 10YR 4/2; 5YR 8/1; 10YR 8/2; 5Y 8/1; 5Y 8/1 + N7; N9; 5Y 8/1; 10YR 8/2; 5Y 8/1; 10YR 8/2; 5Y 7/1; N9; 5Y 7/1; 10YR 8/2; 5Y 8/1; VOID; 10YR 8/2; 10YR 7/4

LITHOLOGIC DESCRIPTION

NANNOFOSSI OOZE/CHALK

This core consists of a moderately bioturbated yellowish gray (5Y 8/1) to dark yellowish brown (10YR 4/2) and very pale orange (10YR 8/2) nannofossil ooze. Chalky beds are interspersed throughout. Colors are distinct and alternate. The darker brown layers show much better preservation of ichnofossil. They are firmer and with planolites, zoophycus, and large vertical burrows present.

SMEAR SLIDE SUMMARY:

	1-70	2-70	4-60	4-90
	D	D	D	D
Composition:				
Heavy minerals	TR	TR	1	–
Clay	–	–	3	–
Volcanic glass	1	1	5	1
Foraminifers	5	5	–	
Calcareous nannofossils	94	94	91	99

ORGANIC CARBON AND CARBONATE:

	1-4	2-4	3-4	4-4	5-4	6-4
Organic carbon	–	–	–	–	–	–
Carbonate	74	78	94	89	88	91

SITE 528 HOLE CORE 5 CORED INTERVAL 150.5–160.0 m

TIME-ROCK UNIT: early Miocene

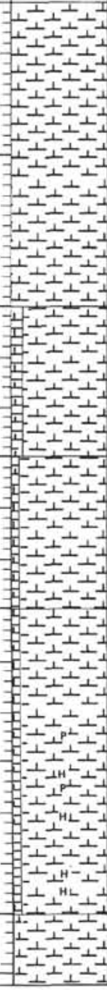
BIOSTRATIGRAPHIC ZONE: N4 (F) NN1 (N)

FOSSIL CHARACTER: FORAMINIFERS AM; NANNOFOSSILS AM

SECTIONS: 1, 2, 3, 4, 5, 6, 7, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY:



Colors: Pale yellow (5Y 8/3); Pale yellow (5Y 8/3); Pale yellow (5Y 7/4); 5Y 6/4; Pale yellow (5Y 7/4); 5Y 6/4; 5Y 6/6; 5Y 6/4; 5Y 6/3; 5Y 6/4; 5Y 8/3; 5Y 7/4; 10YR 6/2; 5Y 8/3; 10YR 8/2

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE/CHALK

The sediment recovered is slightly bioturbated alternating pale olive (5Y 6/4) and pale yellow sequence of ooze and chalk. A cyclic pattern is noticed. Cycles of chalk ooze layers are approximately 30–50 cm thick. Biogenic sedimentary structures are recognizable in the bottom most sections.

SMEAR SLIDE SUMMARY:

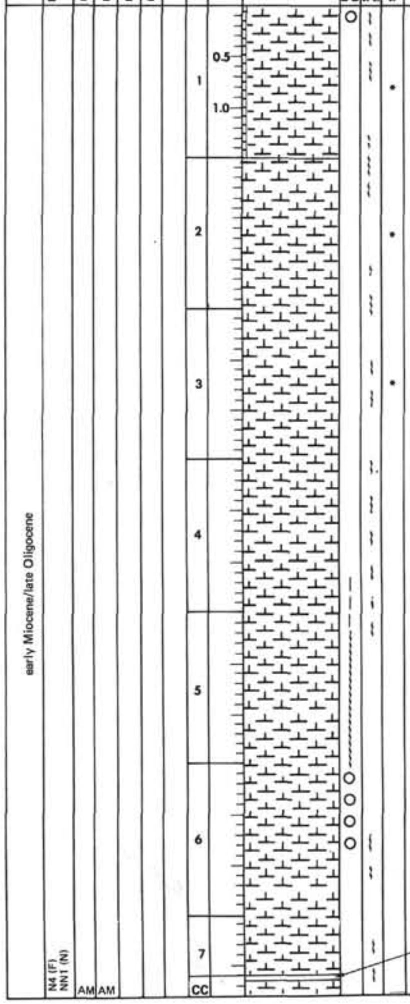
	1-80	3-80	4-80	6-80	7-28
	D	D	D	D	D
Composition:					
Quartz	–	TR	TR	TR	TR
Clay	–	TR	–	–	–
Volcanic glass	TR	2	TR	–	1
Palagonite	–	TR	TR	TR	TR
Pyrite	TR	1	TR	1	TR
Carbonate unspecified	TR	–	TR	–	1
Calcareous nannofossils	100	97	100	99	98

ORGANIC CARBON AND CARBONATE:

	1-14	2-14	3-14	4-14	5-14	6-14	7-14
Organic carbon	–	–	–	–	–	–	–
Carbonate	82	89	87	82	96	71	89

SITE 528 HOLE CORE 6 CORED INTERVAL 160.0–169.5 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION



5Y 8/1

5Y 8/1 to 10YR 8/2

5Y 8/1

NANNOFOSSIL OOZE

The core contains a homogeneous yellowish gray (5Y 8/1) slightly bioturbated nannofossil ooze. Occasional pinkish gray (5YR 8/1) mottles or patches are present. In the first section chalk beds are present at 92 and 100 cm.

SMEAR SLIDE SUMMARY:

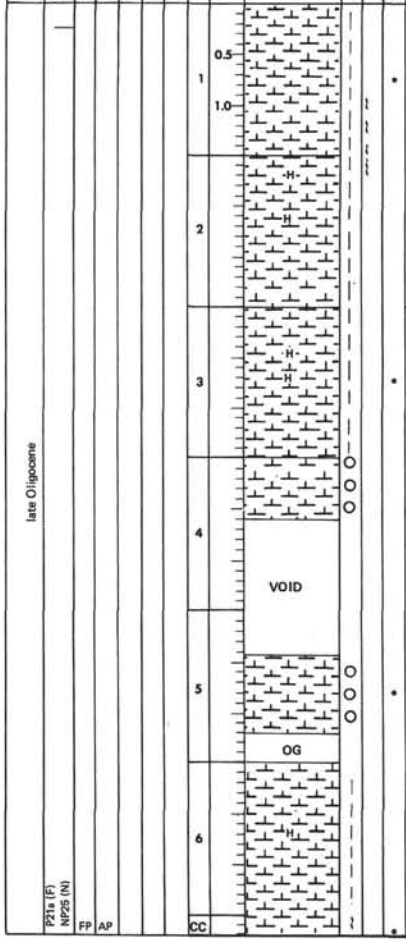
	1-80	2-80	3-80
	D	D	D
Composition:			
Heavy minerals	–	TR	–
Clay	–	–	TR
Volcanic glass	TR	TR	–
Palagonite	–	–	TR
Carbonate unspecified	TR	TR	–
Calcareous nannofossils (coccoliths)	95	97	93
Discoasters	5	3	7

ORGANIC CARBON AND CARBONATE:

	1-50	2-50	3-50	4-50	5-50	6-50	7-50
Organic carbon	–	–	–	–	–	–	–
Carbonate	90	89	91	89	86	91	87

SITE 528 HOLE CORE 7 CORED INTERVAL 169.5–179.0 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION



5YR 8/1*

10YR 7/4

10YR 8/2

10YR 7/4

NANNOFOSSIL OOZE

A pinkish gray (5YR 8/1) to very pale orange (10YR 8/2), moderately deformed to soupy nannofossil ooze was recovered. Preservation of trace fossils is minor with halo burrows being the only recognized schnogenera.

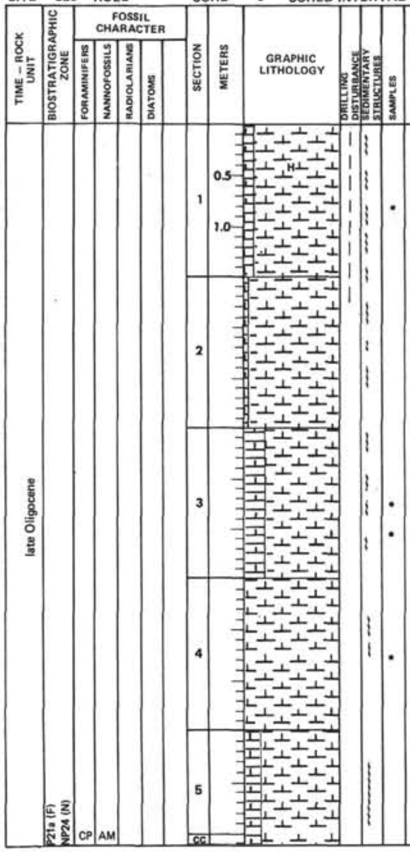
SMEAR SLIDE SUMMARY:

	1-80	3-80	5-80	CC
	D	D	D	D
Composition:				
Quartz	TR	–	TR	–
Heavy minerals	–	–	TR	–
Clay	1	–	–	–
Volcanic glass	–	1	–	–
Palagonite	TR	–	TR	TR
Pyrite	–	–	–	TR
Carbonate unspecified	1	1	1	1
Foraminifers	–	–	TR	TR
Calcareous nannofossils (coccoliths)	82	88	84	84
Discoasters	15	10	15	15
Dinoflagellates	1	–	–	–
Dolomites	TR	–	–	–

ORGANIC CARBON AND CARBONATE:

	1-60	2-60	3-60	4-60	5-60	6-60
Organic carbon	–	–	–	–	–	–
Carbonate	88	91	88	87	90	89

SITE 528 HOLE CORE 8 CORED INTERVAL 179.0–188.5 m



LITHOLOGIC DESCRIPTION

5Y 8/1

ALTERNATING LAYERS OF NANNOFOSSIL OOZE AND CHALK

A homogeneous yellowish gray (5Y 8/1) nannofossil ooze with minor chalk is present. Contacts between the chalk and ooze are sometimes sharp an other times gradational. *The thickness of chalk layers is from 5–10 cm. The* interval between chalk layers ranges from 15–50 cm.

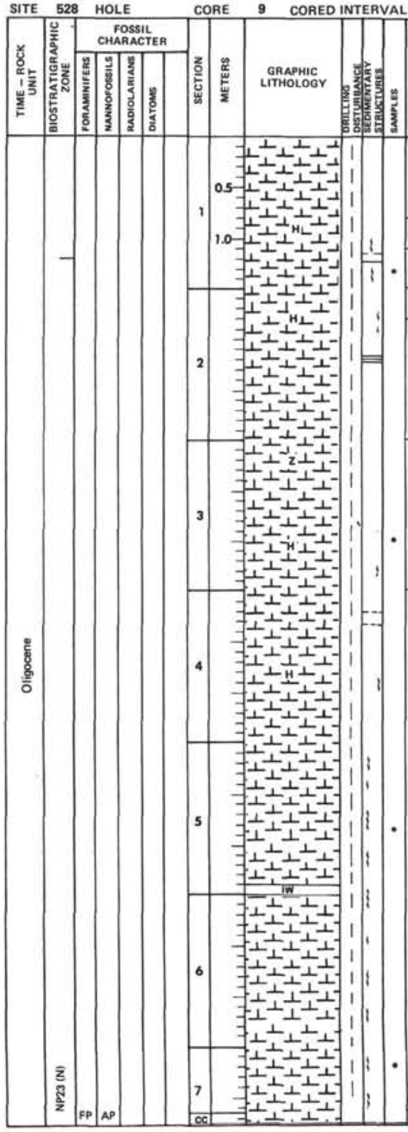
SMEAR SLIDE SUMMARY:

	1-80 D	3-80 D	3-110 D	4-80 D
Composition:				
Feldspar	–	TR	–	–
Heavy minerals	TR	TR	–	TR
Clay	–	5	10	3
Volcanic glass	–	TR	TR	TR
Palagonite	TR	–	3	–
Pyrite	TR	–	–	–
Foraminifers	TR	TR	–	–
Calcareous nannofossils	100	95	87	97
Dinoflagellates	–	TR	–	–

ORGANIC CARBON AND CARBONATE:

	1-36	2-36	3-36	4-36	5-36
Organic carbon	–	–	–	–	–
Carbonate	91	92	87	88	89

SITE 528 HOLE CORE 9 CORED INTERVAL 188.5–198.0 m



LITHOLOGIC DESCRIPTION

2.5YR 8/4 pale yellow

10YR 7/4

10YR 8/2

5Y 7/3

10YR 8/2

5Y 8/1

10YR 8/2

5Y 7/4

NANNOFOSSIL OOZE

This core contains a pale yellow (2.5YR 8/4) to very pale orange (10YR 8/2), slightly bioturbated nannofossil ooze. Minor amounts of parallel beds are observed.

Halo burrows are the dominant trace fossil identified.

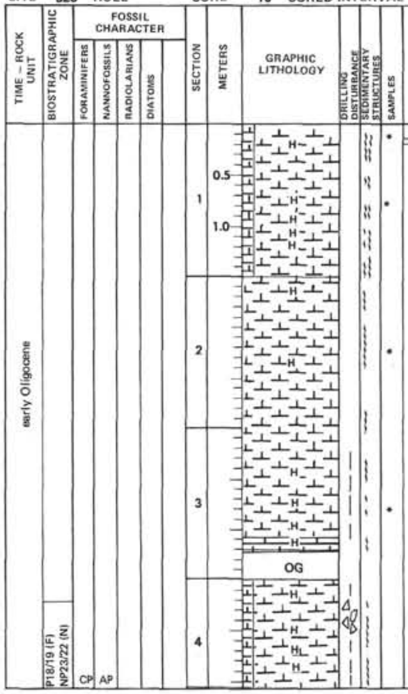
SMEAR SLIDE SUMMARY:

	1-122 D	3-95 D	5-80 D	7-20 D
Composition:				
Quartz	2	–	TR	–
Heavy minerals	–	TR	TR	–
Volcanic glass	TR	1	–	TR
Palagonite	TR	TR	TR	TR
Pyrite	TR	–	–	TR
Carbonate unspecified	1	TR	–	–
Foraminifers	–	TR	TR	TR
Calcareous nannofossils	92	96	95	99
Discoasters	5	3	5	1
Dolomites	TR	–	–	TR

ORGANIC CARBON AND CARBONATE:

	1-34	2-34	3-34	4-34	5-34	6-34	7-34
Organic carbon	–	–	–	–	–	–	–
Carbonate	87	86	92	87	89	90	88

SITE 528 HOLE CORE 10 CORED INTERVAL 198.0–207.5 m



LITHOLOGIC DESCRIPTION

5Y 8/1
5Y 7/2

5Y 8/1

NANNOFOSSIL OOZE AND CHALK

The core consists of a moderately to slightly bioturbated predominately yellowish gray (5Y 8/1) nannofossil ooze with minor chalks. Pinkish gray (5YR 8/1) halo burrows and mottles are present. In Section 4 the chalk and ooze alternate in intervals between 10 and 30 cm. Vertical burrows are also observed.

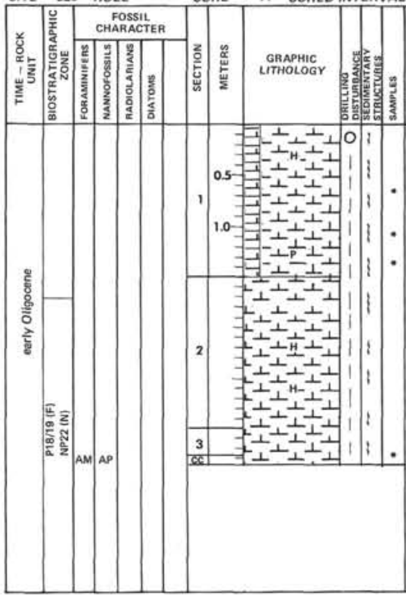
SMEAR SLIDE SUMMARY:

	1-17	1-80	2-80	3-86
	M	D	D	D
Composition:				
Feldspar	–	–	–	TR
Clay	–	3	10	10
Volcanic glass	TR	TR	TR	TR
Palagonite	TR	TR	TR	TR
Pyrite	TR	–	–	–
Carbonate unspecified	1	–	TR	–
Foraminifers	–	–	–	TR
Calcareous nannofossils	99	97	90	90
Dinoflagellates	–	TR	–	–
Dolomites	TR	–	–	–

ORGANIC CARBON AND CARBONATE:

	1-13	2-13	3-13	4-13
Organic carbon	–	–	–	–
Carbonate	84	89	88	89

SITE 528 HOLE CORE 11 CORED INTERVAL 207.5–217.0 m



LITHOLOGIC DESCRIPTION

10YR 8/2

ALTERNATING BEDS OF NANNOFOSSIL OOZE AND CHALK

The recovered sediments consists of a very pale orange (10YR 8/2) to yellowish gray (5Y 7/2) nannofossil oozes and chalks.

In Section 1 the beds alternate in cycles between 10–20 cm.

Biogenic mottling is moderate. Halo burrows are pinkish gray (5R 8/2).

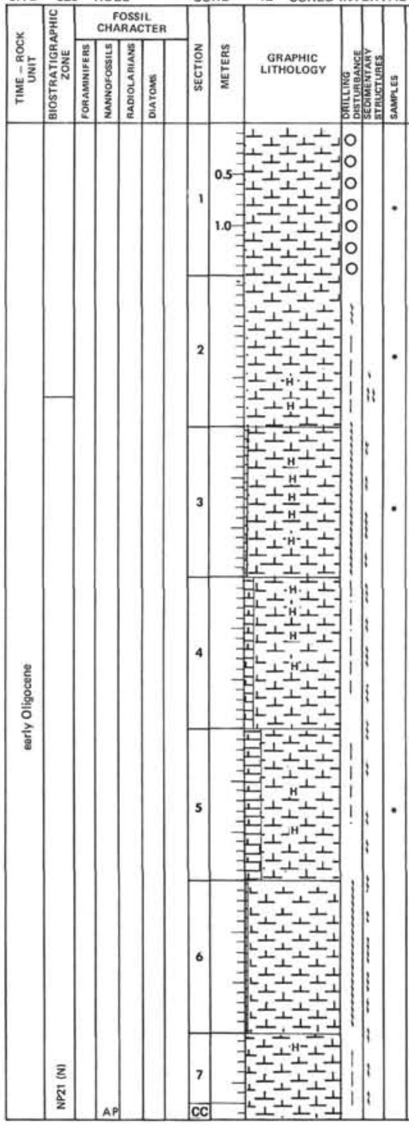
SMEAR SLIDE SUMMARY:

	1-73	1-105	1-132	CC
	D	D	D	D
Composition:				
Volcanic glass	TR	TR	TR	TR
Palagonite	–	TR	–	–
Pyrite	–	–	TR	–
Carbonate unspecified	2	1	1	TR
Foraminifers	2	2	2	2
Calcareous nannofossils (coccoliths)	93	97	96	97
Discoasters	3	TR	1	1

ORGANIC CARBON AND CARBONATE:

	1-15	2-15	3-15
Organic carbon	–	–	–
Carbonate	85	90	89

SITE 528 HOLE CORE 12 CORED INTERVAL 217.0–226.5 m



LITHOLOGIC DESCRIPTION

5Y 7/2

NANNOFOSSIL CHALK AND OOZE

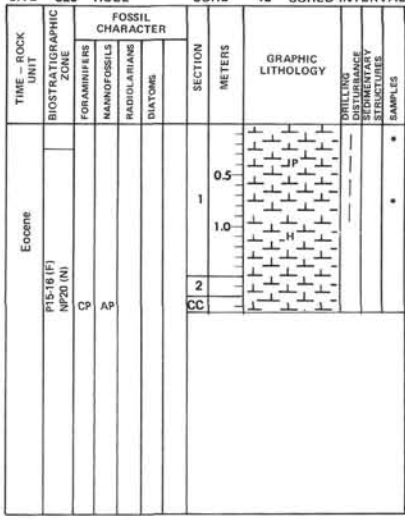
The cored interval contains a soupy to slightly disturbed homogeneous yellowish gray (5Y 8/1) alternating sequence of ooze and chalk. Halo burrows have pinkish gray (5YR 8/1) with medium gray outlines. Sections 4–6 show the chalk–ooze alternation of beds very well. The frequency of repeating beds is from 10–30 cm.

SMEAR SLIDE SUMMARY:

	1-80	2-80	3-80	5-80
	D	D	D	D
Composition:				
Quartz	–	–	1	–
Feldspar	–	–	TR	–
Heavy minerals	–	TR	–	–
Clay	10	5	2	10
Volcanic glass	TR	TR	TR	2
Palagonite	–	–	TR	–
Carbonate unspecified	–	TR	–	–
Foraminifers	TR	TR	–	–
Calcareous nannofossils	90	95	97	88
Dinoflagellates	–	TR	TR	TR

5Y 8/1

SITE 528 HOLE CORE 13 CORED INTERVAL 226.5–236.0 m



LITHOLOGIC DESCRIPTION

10YR 7/4

5YR 4/4

NANNOFOSSIL OOZE

This core contains a predominately grayish orange (10YR 7/4), slightly bioturbated nannofossil ooze. Located in Section 1 at 14–22 cm is a moderate brown (5YR 4/4) nannofossil ooze with high amounts of volcanic rock fragments (glass and palagonite) – e.g. marly nannofossil ooze.

Within this core is the Oligocene/Eocene boundary.

10YR 7/4

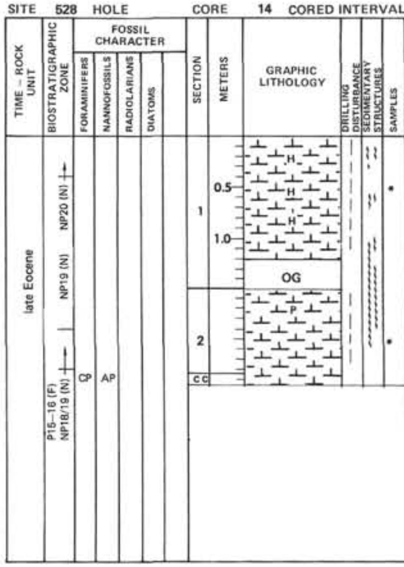
SMEAR SLIDE SUMMARY:

	1-18	1-80
	D	D
Composition:		
Quartz	TR	–
Clay	15	–
Volcanic glass	10	–
Palagonite	4	–
Foraminifers	–	1
Calcareous nannofossils	71	99

ORGANIC CARBON AND CARBONATE:

	1-11	2-15
Organic carbon	–	–
Carbonate	86	81

SITE 528 HOLE CORE 14 CORED INTERVAL 236.0–245.5 m



LITHOLOGIC DESCRIPTION

2.5Y 7/4

NANNOFOSSIL OOZE

The core consists of a pale yellow (2.5Y 7/4) moderately bioturbated nannofossil ooze. In both sections small layers of chalk are present. Planolites and halo burrows are trace fossils that are present.

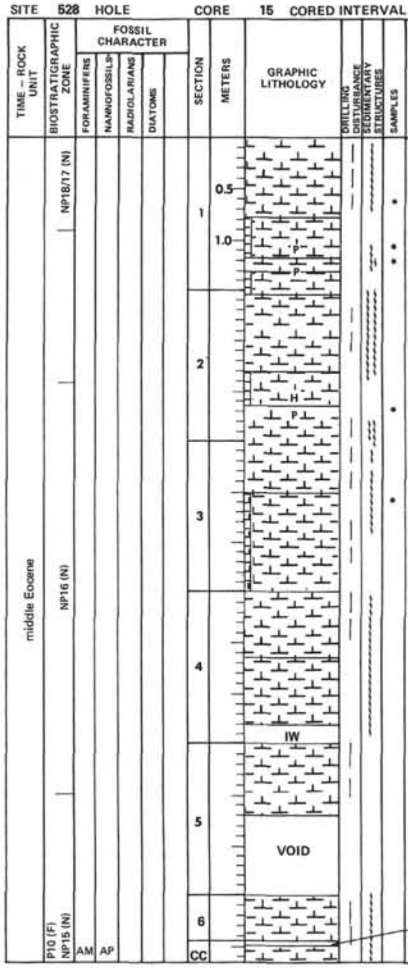
SMEAR SLIDE SUMMARY:

	1-50	2-50
	D	D
Composition:		
Heavy minerals	–	2
Clay	3	2
Volcanic glass	5	2
Palagonite	2	–
Carbonate unspecified	TR	TR
Foraminifers	TR	–
Calcareous nannofossils	85	91
Fish remains	TR	–
Calcareous dinoflagellates	5	3

ORGANIC CARBON AND CARBONATE:

	1-76	2-9
Organic carbon	–	–
Carbonate	81	86

SITE 528 HOLE CORE 15 CORED INTERVAL 245.5–255.0 m



LITHOLOGIC DESCRIPTION

10YR 7/3

10YR 6/4

2.5YR 7/4

2.5Y 7/2

VOID

NANNOFOSSIL OOZE AND
MINOR NANNOFOSSIL CHALK

A very pale brown (10YR 7/3) to light gray (2.5Y 7/2) nannofossil ooze was recovered. Mottling due to burrowing organisms is slight. Chalky layers are intercalated within the nannofossil chalk. The dark chalk layers contain higher amounts of volcanogenic rock fragments (approximately 10%). Grayish pink (5R 8/2) mottles are present and contain large sized nannofossils and large amounts of calcareous dinoflagellates.

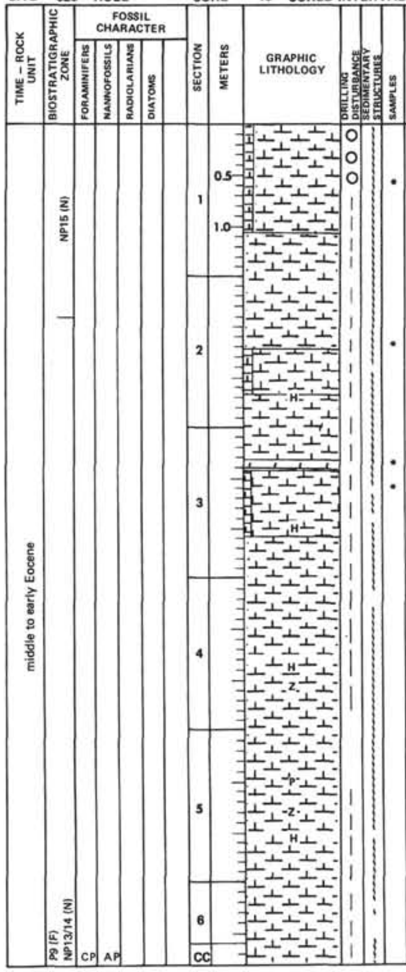
SMEAR SLIDE SUMMARY:

	1-65	1-115	1-125	2-120	3-70
	D	D	M	M	D
Composition:					
Quartz	–	–	3	–	–
Feldspar	–	–	5	–	–
Heavy minerals	–	–	2	–	TR
Clay	1	–	–	–	TR
Volcanic glass	3	1	10	–	2
Palagonite	6	2	30	–	3
Foraminifers	–	2	TR	–	3
Calcareous nannofossils	88	90	50	90	87
Calcareous dinoflagellates	2	5	–	10	5

ORGANIC CARBON AND CARBONATE:

	1-84	2-84	3-109	4-81	5-66	6-18
Organic carbon	–	–	–	–	–	–
Carbonate	83	85	89	91	90	91

SITE 528 HOLE CORE 16 CORED INTERVAL 255.0–264.5 m



LITHOLOGIC DESCRIPTION

5Y 8/1

5Y 6/1

5Y 8/1

5Y 6/1

N9

5Y 8/1

5Y 6/1

5Y 8/1

5Y 6/1

2.5Y 7/2

NANNOFOSSIL OOZE WITH MINOR AMOUNTS OF
NANNOFOSSIL CHALK

The core contains a slightly bioturbated yellowish gray (5Y 8/1) to light gray (2.5Y 7/2) nannofossil ooze with some nannofossil chalk. The chalks are interbedded with the ooze but no color patterns or cycles are evident. Darker layers found in the chalks and oozes have higher amounts of volcanogenic sediments.

One layer had a very high concentration of volcanic materials and may have been an ash(?). Other laminations may be the result of winnowing currents.

SMEAR SLIDE SUMMARY:

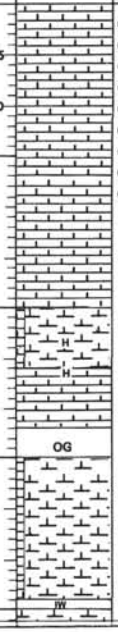
	1-70	2-70	3-36	3-70
	D	D	M	D
Composition:				
Quartz	–	–	5	–
Feldspar	–	–	5	–
Heavy minerals	–	1	5	–
Clay	–	1	–	–
Volcanic glass	1	TR	10	–
Palagonite	TR	–	10	–
Foraminifers	–	–	–	2
Calcareous nannofossils	99	98	65	97
Calcareous dinoflagellates	–	–	–	1

ORGANIC CARBON AND CARBONATE:

	1-32	2-11	3-11	4-25	5-22	6-61
Organic carbon	–	–	–	–	–	–
Carbonate	93	93	94	94	93	91

SITE 528 HOLE CORE 17 CORED INTERVAL 264.5–274.0 m

TIME – ROCK UNIT: early Eocene
BIOSTRATIGRAPHIC ZONE: NP14/13 (N); P8/10 (F), NP12 (N)
FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CP AP
SECTION: 1, 2, 3, 4, CC
METERS: 0.5, 1.0
GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 8/1

10YR 4/2 (CB5)

10YR 4/2

5Y 8/1

10YR 4/2

NANNOFOSSIL OOZE WITH MINOR NANNOFOSSIL CHALK

A faintly to horizontally laminated yellowish gray (5Y 8/1) nannofossil ooze was recovered. Dark yellowish brown to dusky yellowish brown layers or laminations occur. They contain high amounts of volcanogenic silt and sand-size fragments. Concentrations of infilled and recrystallized foraminifer are present in light gray areas – e.g. Section 3, 70–80 cm.

A few halo burrows are observed.

SMEAR SLIDE SUMMARY:

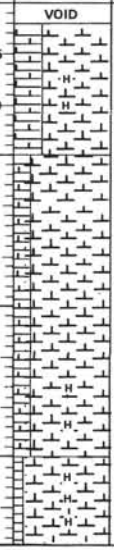
	2-70 D	3-73 M	3-75 M	3-78 M	4-70 D
Composition:					
Heavy minerals	–	10	–	–	–
Clay	–	–	–	–	TR
Volcanic glass	–	–	–	10	–
Palagonite	–	–	–	60	–
Foraminifers	–	40	3	–	TR
Calcareous nannofossils	100	50	97	30	100

ORGANIC CARBON AND CARBONATE:

	2-31	3-31	4-31
Organic carbon	–	–	–
Carbonate	92	95	93

SITE 528 HOLE CORE 18 CORED INTERVAL 274.0–283.5 m

TIME – ROCK UNIT: Eocene
BIOSTRATIGRAPHIC ZONE: P7 (F), NP12 (N)
FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): CP AP
SECTION: 1, 2, 3, 4
METERS: 0.5, 1.0
GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 8/1

10YR 7/4

5Y 8/1

10YR 4/2

NANNOFOSSIL OOZE AND CHALK

Alternating beds of nannofossil ooze and chalk were recovered. They are yellowish gray (5Y 8/1) to dark yellowish gray (10YR 4/2). Halo burrows are recongized. Minor black to brown laminations rich in volcanic sediments are present in Sections 1 and 2.

SMEAR SLIDE SUMMARY:

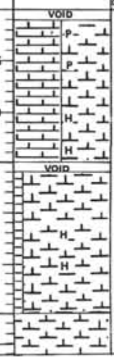
	1-60 D	2-75 M	4-60 D
Clay	–	10	–
Composition:			
Heavy minerals	TR	–	TR
Volcanic glass	–	TR	1
Palagonite	–	–	1
Foraminifers	5	2	5
Calcareous nannofossils	94	88	93
Calcareous dinoflagellates	1	–	–

ORGANIC CARBON AND CARBONATE:

	1-31	2-31	3-31	4-31
Organic carbon	–	–	–	–
Carbonate	92	93	94	91

SITE 528 HOLE CORE 19 CORED INTERVAL 283.5–293.0 m

TIME – ROCK UNIT: Eocene
BIOSTRATIGRAPHIC ZONE: NP12 (N); P7 (F), NP11 (N)
FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS): FP AP
SECTION: 1, 2, 3, CC
METERS: 0.5, 1.0
GRAPHIC LITHOLOGY



DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES

LITHOLOGIC DESCRIPTION

5Y 8/1

N9

10YR 4/2

N9

10YR 6/4

ALTERNATING LAYERS OF NANNOFOSSIL CHALK AND OOZE

This core contains a yellowish gray (5Y 8/1) nannofossil ooze. The ooze is interbedded between nannofossil chalk which is multicolored. Biogenic sedimentary structures in the chalk are well preserved. Planolites and large halo burrows which are white (N9) are well represented.

High amounts of calcareous dinoflagellates are observed in smear slides.

Some bedding contacts are sharp within chalk intervals.

SMEAR SLIDE SUMMARY:

	1-82 D	2-70 D
Composition:		
Quartz	TR	–
Volcanic glass	TR	TR
Palagonite	–	TR
Foraminifers	1	9
Calcareous nannofossils	89	86
Calcareous dinoflagellates	10	5

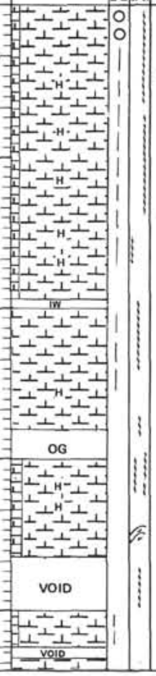
ORGANIC CARBON AND CARBONATE:

	1-15	2-15	3-15
Organic carbon	–	–	–
Carbonate	94	94	91

SITE 528 HOLE CORE 20 CORED INTERVAL 293.0–302.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
early Eocene						1	0.5, 1.0
						2	
						3	
						4	
	P5 (F) NP11 (N)	AM	AP			5	
						CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

10YR 8/2
10YR 5/4
5Y 8/2
2.5Y 6/6
5Y 8/2
10YR 8/2
5Y 8/2
10YR 8/2

NANNOFOSSIL OOZE WITH MINOR NANNOFOSSIL CHALK

The core contains a predominantly white (10YR 5/4) to very pale orange (10YR 8/2) nannofossil ooze. Some small chalk layers of moderate yellowish brown color are present.

Halo burrows and flazer bedding are present (Section 4).

SMEAR SLIDE SUMMARY:

	1-70	2-70
	D	D
Composition:		
Foraminifers	1	3
Calcareous nannofossils	98	98
Calcareous dinoflagellates	1	–

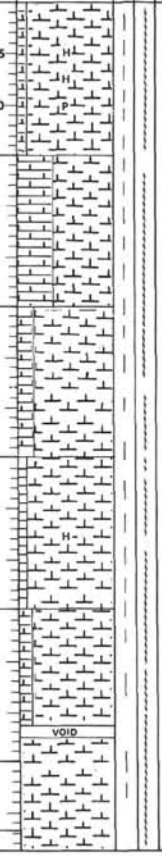
ORGANIC CARBON AND CARBONATE:

	1-34	2-34	3-34	4-34	5-34
Organic carbon	–	–	–	–	–
Carbonate	95	96	92	97	96

SITE 528 HOLE CORE 21 CORED INTERVAL 302.5–312.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
early Eocene	NP11 (N)					1	0.5, 1.0
						2	
						3	
late Paleocene	NP10 (N)					4	
						5	
	P6a (F) NP9/10 (N)					6	
		AM	AP			CC	

GRAPHIC LITHOLOGY / DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES



LITHOLOGIC DESCRIPTION

5Y 8/2
10YR 6/4
5Y 8/2
or
10YR 8/2
5Y 8/2
N9
2.5YR 6/6
5Y 8/2
or
10YR 8/2
5Y 8/2
10YR 8/2
5Y 8/2

NANNOFOSSIL OOZE WITH NANNOFOSSIL CHALKS

A white to very pale yellow nannofossil ooze is present. Nannofossil chalk is interbedded but decreases toward the bottom of the core. In Section 3 at approximately 105 cm a light red (2.5YR 6/6) volcanogenic-rich nannofossil chalk is present. Volcanic glass is the major non-calcareous constituent. Biogenic mottling is slight.

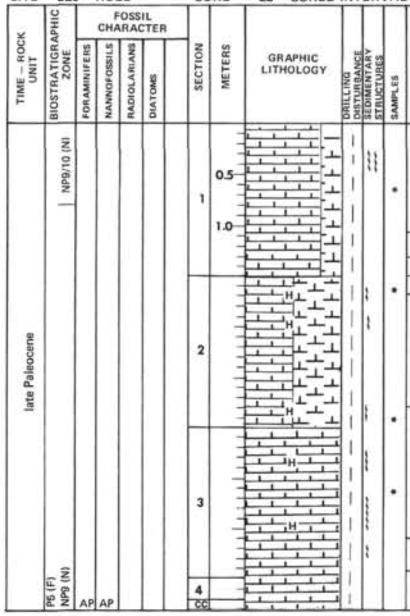
SMEAR SLIDE SUMMARY:

	1-80	2-106	3-50
	D	M	D
Composition:			
Volcanic glass	–	15	2
Palagonite	–	10	1
Foraminifers	5	–	1
Calcareous nannofossils	95	75	96

ORGANIC CARBON AND CARBONATE:

	1-64	2-64	3-64	4-64	5-64	6-64
Organic carbon	–	–	–	–	–	–
Carbonate	97	94	94	97	92	93

SITE 528 HOLE CORE 22 CORED INTERVAL 312.0–321.5 m



LITHOLOGIC DESCRIPTION

N9

5YR 8/1

N9

N8

N9 to 5YR 8/1

N8

N9

N8

NANNOFOSSIL CHALK AND OOZE

This core contains an alternating sequence of nannofossil chalks and ooze. The dominant colors are white (N9) to pinkish gray (5YR 8/1). The cycles vary from approximately 10–50 cm. Bioturbation is slight with halo burrows well preserved. Minor wavy bedding occurs in Section 1.

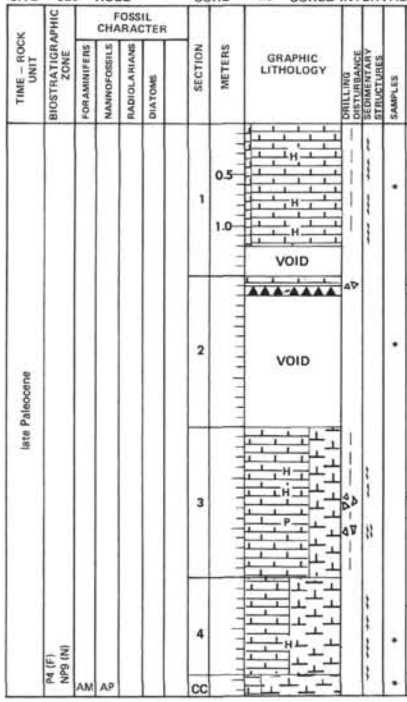
SMEAR SLIDE SUMMARY:

	1-70	2-22	2-140	3-70
	D	M	D	D
Composition:				
Quartz	–	–	TR	TR
Clay	–	85	1	–
Volcanic glass	–	TR	–	TR
Palagonite	TR	–	–	–
Carbonate unspecified	10	5	1	10
Foraminifers	TR	TR	1	1
Calcareous nannofossils	90	10	92	84
Discoasters	TR	TR	5	5
Dolomite	TR	–	–	–

ORGANIC CARBON AND CARBONATE:

	1-13	2-13	3-13	4-13
Organic carbon	–	–	–	–
Carbonate	91	86	90	96

SITE 528 HOLE CORE 23 CORED INTERVAL 321.5–331.0 m



LITHOLOGIC DESCRIPTION

5Y 8/1

5YR 7/2

5YR 8/1

5Y 8/1
5YR 8/1
5Y 8/1
5YR 8/1

5Y 8/1

N9

5Y 8/1

NANNOFOSSIL CHALK AND OOZE

An alternating sequence of pinkish gray (5YR 8/1) and yellowish gray (5Y 8/1) nannofossil chalk and ooze was recovered. In Section 3 where the ooze-chalk sequence is most intense the cycles repeat every 10 cm. A chert layer (fragments) was recovered in Section 2.

SMEAR SLIDE SUMMARY:

	1-70	2-70	4-70	CC
	D	D	D	D
Composition:				
Feldspar	–	TR	–	–
Mica	–	TR	–	–
Heavy minerals	–	TR	–	–
Clay	5	TR	20	20
Volcanic glass	–	–	TR	TR
Palagonite	3	2	1	TR
Pyrite	–	TR	–	–
Carbonate unspecified	1	–	TR	–
Foraminifers	TR	TR	–	–
Calcareous nannofossils	91	98	79	80

ORGANIC CARBON AND CARBONATE:

	1-24	3-24	4-24
Organic carbon	–	–	–
Carbonate	92	90	91

SITE 528 HOLE CORE 24 CORED INTERVAL 331.0–340.5 m

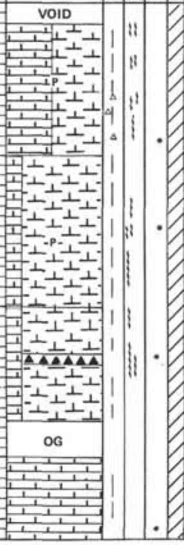
TIME – ROCK UNIT: late Paleocene

BIOSTRATIGRAPHIC ZONE: NP9 (N); P4 (F) NP 7/8 (N)

FOSSIL CHARACTER: FORAMINIFERS | NANNOFOSSILS: AM | RADIOLARIANS | DIATOMS

SECTION: 1, 2, 3, 4, CC

METERS: 0.5, 1.0



GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | POLARITY

LITHOLOGIC DESCRIPTION

N8

5YR 8/1

N9

5R 8/2

5YR 8/1

5YR 6/4

N9

10R 6/2

5YR 8/1

NANNOFOSSIL OOZE AND CHALK

The core contains alternating beds of nannofossil ooze and chalks. Bioturbation is intense in the chalk layers. A chert layer occurs between 50–55 cm in Section 3. Cycles repeat themselves on the order of 20–50 cm. The dominant color is pinkish gray (5YR 8/1).

SMEAR SLIDE SUMMARY:

	1-136	2-80	3-51	CC
	D	D	M	D
Composition:				
Quartz	1	–	50	–
Heavy minerals	–	TR	–	–
Volcanic glass	TR	–	–	–
Pyrite	–	–	–	TR
Carbonate unspecified	2	1	1	TR
Foraminifers	TR	1	–	1
Calcareous nannofossils	97	97	2	99
Dinoflagellates	–	1	–	–
Christobalite	–	–	47	–

ORGANIC CARBON AND CARBONATE:

	1-34	2-34	3-34	4-34
Organic carbon	–	–	–	–
Carbonate	91	94	92	89

SITE 528 HOLE CORE 25 CORED INTERVAL 340.5–350.0 m

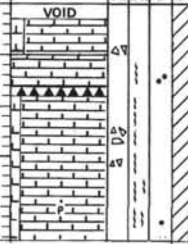
TIME – ROCK UNIT: late Paleocene

BIOSTRATIGRAPHIC ZONE: P4 (F) NP8/7 (N)

FOSSIL CHARACTER: FORAMINIFERS: CM | NANNOFOSSILS: AM | RADIOLARIANS | DIATOMS

SECTION: 1, 2

METERS: 0.5, 1.0



GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | POLARITY

LITHOLOGIC DESCRIPTION

5YR 8/1

5YR 7/2

5YR 8/1

NANNOFOSSIL CHALK AND OOZE

This core consists of alternating but somewhat indurated nannofossil chalk and ooze. The dominant color is pinkish gray (5YR 8/1).

Chert is present in Section 1 at 86–90 cm. Planolites is the only recognizable ichogenera.

SMEAR SLIDE SUMMARY:

	1-71	1-78	2-70
	D	M	D
Composition:			
Quartz	–	50	TR
Clay	15	–	15
Volcanic glass	TR	TR	3
Palagonite	–	TR	–
Carbonate unspecified	TR	2	–
Foraminifers	–	18	–
Calcareous nannofossils	85	–	82
Cristobalite	–	30	–

ORGANIC CARBON AND CARBONATE:

	1-27	2-27
Organic carbon	–	–
Carbonate	94	85

SITE 528 HOLE CORE 26 CORED INTERVAL 350.0–359.0 m

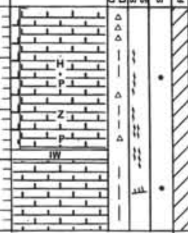
TIME – ROCK UNIT: Paleocene

BIOSTRATIGRAPHIC ZONE: P4 (F) NP5 (N)

FOSSIL CHARACTER: FORAMINIFERS: AM | NANNOFOSSILS: AM | RADIOLARIANS | DIATOMS

SECTION: 1, 2, CC

METERS: 0.5, 1.0



GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | POLARITY

LITHOLOGIC DESCRIPTION

5YR 7/2

5YR 8/1

5YR 7/2

5YR 8/1

5YR 7/2

5YR 8/1

NANNOFOSSIL CHALK

A moderately bioturbated alternating pinkish gray (5YR 8/1) to gray orange pink (5YR 7/2) indurated nannofossil chalk is present. Zoophycus planolites and halo burrows are present. Some fine-grained inclined lamination are present in Section 2.

Minor nannofossil ooze present in Section 1.

SMEAR SLIDE SUMMARY:

	1-70	2-30
	D	D
Composition:		
Heavy minerals	–	TR
Clay	–	5
Volcanic glass	–	TR
Palagonite	TR	TR
Carbonate unspecified	1	1
Calcareous nannofossils	98	93
Dinoflagellates	1	1
Dolomites	TR	TR

ORGANIC CARBON AND CARBONATE:

	1-119
Organic carbon	–
Carbonate	87

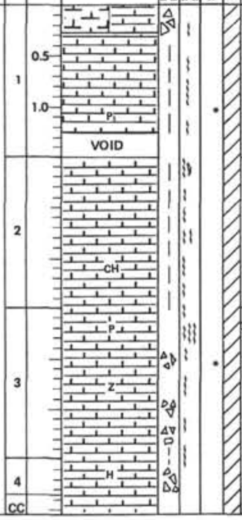
SITE 528 HOLE CORE 27 CORED INTERVAL 369.0–378.5 m

TIME – ROCK UNIT: Paleocene

BIOSTRATIGRAPHIC ZONE: P4 (F), NP5 (N)

FOSSIL CHARACTER: FORAMINIFERS AM, NANNOFOSSILS CP, RADIOLARIANS, DIATOMS

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



LITHOLOGIC DESCRIPTION

5YR 8/1
5YR 8/1 to N9
N8
5YR 7/2
N8

NANNOFOSSIL CHALK

A moderately bioturbated pale pinkish gray (5YR 8/1) to very light gray (N8) indurated chalk is observed. Composite, zoophycus and planolites burrows are present.

SMEAR SLIDE SUMMARY:

	1-110 D	3-60 D
Composition:		
Quartz	TR	TR
Heavy minerals	TR	–
Clay	15	25
Volcanic glass	TR	2
Pyrite	TR	–
Carbonate unspecified	1	–
Foraminifers	TR	–
Calcareous nannofossils	84	73
Dinoflagellates	TR	–

ORGANIC CARBON AND CARBONATE:

	1-8	2-8	3-8
Organic carbon	–	–	–
Carbonate	75	84	86

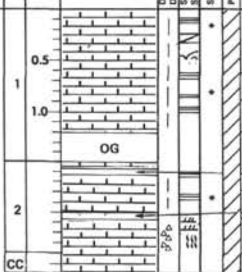
SITE 528 HOLE CORE 28 CORED INTERVAL 369.0–378.5 m

TIME – ROCK UNIT: Paleocene

BIOSTRATIGRAPHIC ZONE: P4 (F), NP5 (N)

FOSSIL CHARACTER: FORAMINIFERS AM, NANNOFOSSILS CP, RADIOLARIANS, DIATOMS

SECTION: 1, 2, CC — METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

N9
10YR 6/3
N9
N9 + 10YR 6/3
VOID
10YR 6/3
VOID
N9

NANNOFOSSIL CHALK

This core contains a finely laminated white (N9) to pale brown (10YR 6/3) nannofossil chalk. Microstructures are beautifully preserved. Lamination alternate in color giving a cyclic type sedimentation pattern. Flazer bedding, micro cross lamination and symmetrical and asymmetric (current) ripples also are observed. Microfaults also occur.

SMEAR SLIDE SUMMARY:

	1-22 D	1-80 D	2-40 D
Composition:			
Quartz	TR	TR	–
Feldspar	–	TR	–
Heavy minerals	–	–	TR
Volcanic glass	TR	–	TR
Palagonite	–	TR	–
Pyrite	–	–	TR
Carbonate unspecified	–	–	TR
Foraminifers	1	–	–
Calcareous nannofossils	98	100	100
Dinoflagellates	1	–	TR

ORGANIC CARBON AND CARBONATE:

	1-16	2-16	CC-16
Organic carbon	–	–	–
Carbonate	91	87	89

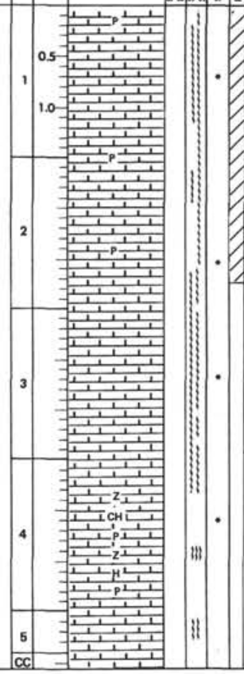
SITE 528 HOLE CORE 29 CORED INTERVAL 378.5–388.0 m

TIME – ROCK UNIT: early Paleocene

BIOSTRATIGRAPHIC ZONE: NP5 (N); P1c + mixed P3 (F), NP4 (N)*

FOSSIL CHARACTER: FORAMINIFERS AG, NANNOFOSSILS AM, RADIOLARIANS, DIATOMS

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



LITHOLOGIC DESCRIPTION

10YR 6/2
N9
5YR 8/1
N9
5YR 8/1
N9
10YR 7/2
5YR 8/1
10YR 7/3
5YR 8/1
N9
10YR 5/4
5YR 8/1
10YR 5/4
10YR 8/1

NANNOFOSSIL CHALK

A multicolored predominantly pale yellow brown (10YR 6/2) to white (N9) indurated chalk was recovered. Bioturbation is moderate with excellent preservation of ichnogenera.

The lower sections show a variety of alternating colors suggesting a cyclic pattern (geochemical?) superimposed on lithology.

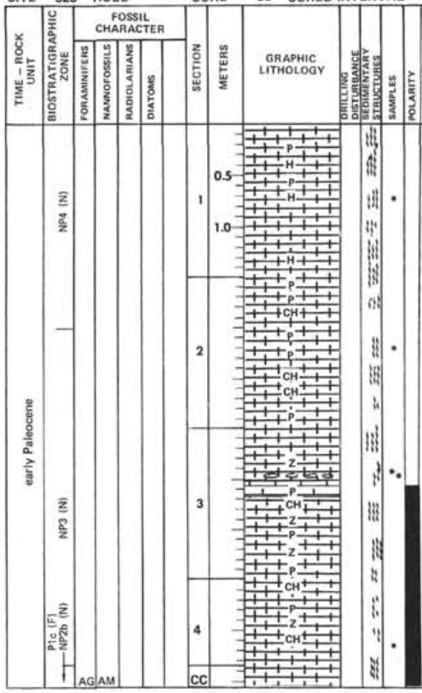
SMEAR SLIDE SUMMARY:

	1-70 D	2-103 D	3-70 D	4-70 D
Composition:				
Quartz	–	–	–	2
Feldspar	TR	TR	–	–
Mica	–	–	TR	–
Heavy minerals	–	TR	–	–
Volcanic glass	–	1	1	5
Palagonite	TR	TR	1	–
Pyrite	–	TR	–	TR
Foraminifers	TR	TR	1	TR
Calcareous nannofossils	100	99	97	93
Calcareous dinoflagellates	TR	–	–	–

ORGANIC CARBON AND CARBONATE:

	1-4	2-4	3-4	4-4
Organic carbon	–	–	–	–
Carbonate	79	84	85	81

SITE 528 HOLE CORE 30 CORED INTERVAL 388.0–397.5 m



LITHOLOGIC DESCRIPTION

10YR 7/4
7.5YR 6/4
10YR 7/4
7.5YR 6/4
10YR 7/4
7.5YR 6/4
7.5YR 7/2
N7
7.5YR 6/2
7.5 YR 7/2

FORAMINIFER NANNOFOSSIL CHALK

A very pale brown (10YR 7/4) to pinkish gray (7.5YR 7/2) highly bioturbated foraminifer nannofossil chalk was recovered. Ichnofossil preservation is excellent. No primary sedimentary structures are recognized.

In Section 3 a gray nannofossil chalk layer is present. Above this are greenish black intraclasts of entirely volcanogenic material. It apparently was a layer and may represent an ash layer.

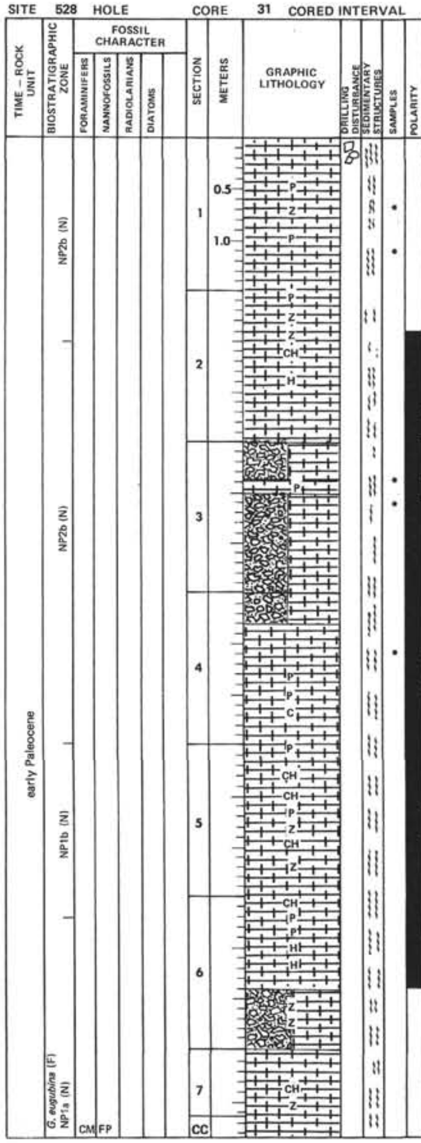
SMEAR SLIDE SUMMARY:

	1-75	2-80	3-51	3-56	4-70
	D	D	M	D	D
Composition:					
Quartz	–	TR	–	–	–
Heavy minerals	TR	–	–	–	–
Volcanic glass	TR	TR	50	2	2
Palagonite	–	–	50	1	3
Carbonate unspecified	–	1	–	–	–
Foraminifers	15	15	–	5	12
Calcareous nannofossils	82	83	TR	92	80
Calcareous dinoflagellates	3	1	–	–	3

ORGANIC CARBON AND CARBONATE:

	1-8	2-17	3-9	4-29
Organic carbon	–	–	–	–
Carbonate	77	77	64	69

SITE 528 HOLE CORE 31 CORED INTERVAL 397.5–407.0 m



LITHOLOGIC DESCRIPTION

7.5YR 7/2
7.5YR 6/4
5B 7/1
10YR 6/2
N8
N8
10R 4/2
5YR 6/4
10YR 4/2
N8
N9
N7
10R 4/2
2.5YR 4/4
7.5YR 6/4
2.5YR 4/4
N8
5YR 6/4
5YR 4/4
2.5YR 4/6

FORAMINIFER NANNOFOSSIL CHALK

This core consists of a light brown (7.5YR 6/4) grayish red (10R 4/2) and white foraminifer nannofossil chalk. The third through seventh sections contain an alternating sequence of slump material and pelagic sediments. The gray and whitesh intervals are pelagic and the brecciated and contorted layers are darker red to brown and contain more clay. Biogenic sedimentary structures are well preserved.

SMEAR SLIDE SUMMARY:

	1-70	1-115	3-45	3-70	4-70
	D	D	D	D	D
Composition:					
Heavy minerals	–	–	TR	TR	–
Clay	TR	–	10	20	–
Volcanic glass	TR	10	2	5	1
Palagonite	TR	5	2	10	–
Foraminifers	20	25	20	30	20
Calcareous nannofossils	80	60	65	34	79
Calcareous dinoflagellates	–	–	1	1	–

ORGANIC CARBON AND CARBONATE:

	1-23	2-33	3-14	4-22	5-57	6-23	7-51
Organic carbon	–	–	–	–	–	–	–
Carbonate	62	71	9	51	10	64	52

SITE 528 HOLE CORE 32 CORED INTERVAL 407.0–416.5 m

TIME-ROCK UNIT: late Cretaceous (Maastrichtian)

BIOSTRATIGRAPHIC ZONE: *A. mayaroensis* (F), *Micula Mura* (N)

FOSSIL CHARACTER: FORAMINIFERS AM; NANNOFOSSILS AM; RADIOLARIANS; DIATOMS

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

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY: CH, Z, P, H, VOID, IW, OG

DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES / POLARITY

LITHOLOGIC DESCRIPTION

5YR 7/2

N9

5YR 4/4

5YR 7/2

5YR 8/1

5YR 7/2

10YR 8/2

5YR 7/2

7.5YR 6/4

7.5YR 8/2

7.5YR 6/4

FORAMINIFER NANNOFOSSIL CHALK AND MUDDY FORAMINIFER NANNOFOSSIL CHALK

A highly bioturbated light gray to white (N8, N9) foraminifer nannofossil chalk alternating with a grayish orange (5YR 7/2) to light brown (7.5YR 6/4) muddy foraminifer nannofossil chalk was recovered.

Bedding contacts are gradational. The colors alternate and indicate a cyclic sedimentaiton pattern.

The Cretaceous–Tertiary boundary is located between the top of this core and the bottom of Core 31.

SMEAR SLIDE SUMMARY:

	1-70	2-50	3-70	4-70	5-70
	D	D	D	D	D
Composition:					
Heavy minerals	TR	1	1	–	1
Clay	10	15	20	10	10
Volcanic glass	1	2	2	5	5
Palagonite	1	2	5	2	2
Foraminifers	15	10	15	20	20
Calcareous nannofossils	73	70	57	73	62

ORGANIC CARBON AND CARBONATE:

	1-10	2-10	3-10	4-10	5-10
Organic carbon	–	–	–	–	–
Carbonate	69	71	80	81	84

SITE 528 HOLE CORE 33 CORED INTERVAL 416.5–426.0 m

BIOSTRATIGRAPHIC ZONE: *Micula mura* (n), *L. quadratus* (n)

FOSSIL CHARACTER: FORAMINIFERS AM; NANNOFOSSILS AP; RADIOLARIANS; DIATOMS

SECTION: 1, 2, 3, 4, 5, 6

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY: PL, CH, P, H, Z

DRILLING DISTURBANCE / SEDIMENTARY STRUCTURES / SAMPLES / POLARITY

LITHOLOGIC DESCRIPTION

7.5YR 7/4

5PB 3/2

10YR 8/1 white

5YR 6/4

7.5YR 6/4

N8

7.5YR 6/4

N8

5YR 6/4

N8

10R 4/2

N8

5YR 6/4

7.5YR 6/4

INDURATED NANNOFOSSIL CHALK

This core contains a highly indurated, multicolored, highly bioturbated nannofossil chalk. The dominant colors are a very light gray (N8) and light reddish brown (5YR 6/4).

The colors alternate with very vague and gradational contacts. The reddish areas contain many white to gray mottles suggesting that original bedding was a reddish color and subsequent mottling changed the color. Reddish mottles are not found in the grayish or whitish layers. The color patterns repeat every 10–50 cm.

A small turbidite with volcanic rock fragments and angular quartz sand occurs at the top of the core. The sands are graded. The bottom of the turbidite contains a black (N8) layer of glass and zeolites. This may be an ash that is associated with turbidite deposition.

SMEAR SLIDE SUMMARY:

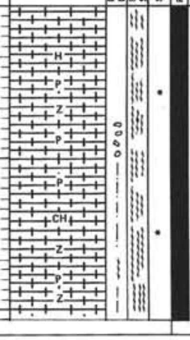
	1-31	1-37	1-40	2-70	4-30
	M	M	M	D	D
Texture:					
Sand	–	70	20	–	–
Silt	–	20	60	–	–
Clay	–	10	20	–	–
Composition:					
Quartz	–	30	–	–	–
Heavy minerals	–	10	–	–	–
Volcanic glass	40	25	40	TR	TR
Palagonite	50	35	35	TR	TR
Zeolites	–	–	25	–	–
Foraminifers	–	–	–	10	10
Calcareous nannofossils	10	–	–	90	90

ORGANIC CARBON AND CARBONATE:

	1-50	2-50	3-50	4-50	5-50	6-50
Organic carbon	–	–	–	–	–	–
Carbonate	61	63	75	71	81	70

SITE 528 HOLE CORE 34 CORED INTERVAL 426.0–435.5 m

TIME – ROCK UNIT: late Cretaceous (Maastrichtian)
BIOSTRATIGRAPHIC ZONE: *A. mayaroensis* (F), *L. quadratus* (N)
FOSSIL CHARACTER: FORAMINIFERS AP; NANNOFOSSILS AP
SECTION: 1, 2, CC
METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

5YR 5/6
N8
5YR 4/4
N8
5YR 4/4
5YR 6/4
N8
5YR 6/4
5Y 8/1
5YR 6/2

INDURATED FORAMINIFER NANNOFOSSIL CHALK

A severely bioturbated very light gray (N8) to light brown (5YR 6/4) indurated foraminifer nannofossil chalk. Colors alternate, but this may be due to biogenic activity. All types of ichnogenera are present.

SMEAR SLIDE SUMMARY:

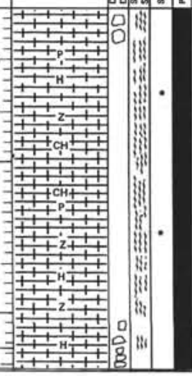
	1-80	2-80
	D	D
Composition:		
Heavy minerals	1	–
Volcanic glass	1	1
Palagonite	1	1
Foraminifers	20	20
Calcareous Nannofossils	77	78

ORGANIC CARBON AND CARBONATE:

	1-59	2-88
Organic carbon	–	–
Carbonate	76	85

SITE 528 HOLE CORE 35 CORED INTERVAL 435.5–445.0 m

TIME – ROCK UNIT: late Cretaceous (Maastrichtian)
BIOSTRATIGRAPHIC ZONE: *L. quadratus* (N)
FOSSIL CHARACTER: NANNOFOSSILS AP
SECTION: 1, 2, 3, CC
METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

N8
5YR 6/4
N8
5YR 6/4
N8
5YR 6/4

HIGHLY INDURATED FORAMINIFER NANNOFOSSIL CHALK

This core contains a highly mottled, very light gray (N8) and light brown (5YR 6/4) indurated foraminifer nannofossil chalk. The colors are intermixed with contacts vague and transitional, possibly indicating the alternation of colors is due to biologic activity.

SMEAR SLIDE SUMMARY:

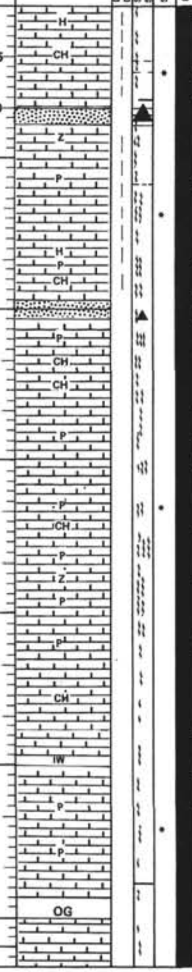
	1-80	2-80
	D	D
Composition:		
Heavy minerals	1	1
Clay	10	10
Volcanic glass	5	5
Palagonite	5	5
Foraminifers	15	10
Calcareous nannofossils	64	69

ORGANIC CARBON AND CARBONATE:

	1-51	2-51	3-2
Organic carbon	–	–	–
Carbonate	87	78	78

SITE 528 HOLE CORE 36 CORED INTERVAL 445.0–454.5 m

TIME – ROCK UNIT: late Cretaceous (Maastrichtian)
BIOSTRATIGRAPHIC ZONE: *A. mayaroensis* (F), *L. quadratus* (N)
FOSSIL CHARACTER: FORAMINIFERS AP; NANNOFOSSILS AP
SECTION: 1, 2, 3, 4, 5, 6, 7, CC
METERS: 0.5, 1.0



LITHOLOGIC DESCRIPTION

5YR 4/4 to N8
5YR 4/4
N8
5YR 4/4
5YR 5/6 to 5B 8/1
5B 9/1 to 5YR 4/6
5B 8/1
5YR 4/4
5B 7/1
5B 8/1 to 5YR 4/4
5YR 4/4
5B 8/1
N7
5YR 4/4 to 10YR 7/1
5YR 4/4
5B 9/1
5YR 4/4
N8
5YR 4/4
N8
10YR 7/1
5YR 4/4
5YR 4/4 to 10YR 7/1
5YR 4/4

INDURATED NANNOFOSSIL CHALK

A highly bioturbated moderate brown (5YR 4/4), white (N9), and very light gray (N8) indurated chalk was recovered. Colors alternate through the core with the brown beds being more distinct and the light beds being indistinct with color grading into each other.

Two small volcaniclastic turbidites are present within Sections 1–3. They are graded sands moving upward into silts and clays. Glass, palagonite, and quartz are the dominant volcanic constituents.

SMEAR SLIDE SUMMARY:

	1-70	2-67	4-50	6-70
	D	D	D	D
Composition:				
Quartz	–	TR	–	2
Feldspar	TR	–	–	TR
Heavy minerals	TR	–	–	–
Clay	–	5	–	–
Volcanic glass	2	5	3	1
Palagonite	2	1	10	–
Zeolites	–	–	5	–
Foraminifers	TR	TR	TR	TR
Calcareous nannofossils	96	89	82	97

SITE 528 HOLE CORE 37 CORED INTERVAL 454.5–464.0 m

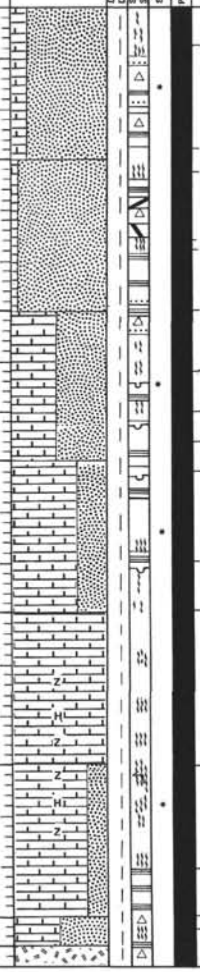
TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS) | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | POLARITY | LITHOLOGIC DESCRIPTION

late Cretaceous (Maastrichtian)

L. quadratus (N)

Sections: 1, 2, 3, 4, 5, 6, 7, CC

Meters: 0.5, 1.0



N8

5G 4/1

N8 to 5YR 6/4

5G 4/1

N8

5G 4/1

N8

5G 6/1

N8

5G 6/1

N8

5YR 6/4

N8 to 5YR 6/4

5YR 6/4

5G 4/1

N8

5G 4/1

VOLCANOGENIC TURBIDITE SANDS AND NANNOFOSSIL CHALK

The core consists of alternating beds of volcanically derived turbidite sands, silts, and clay which are a dark greenish gray (5G 4/1) and indurated nannofossil chalk (5YR 6/4). The turbidite sands are laminated and are graded. Some cross laminations and load casts are noted. Biogenic sedimentary structures are preserved in the chalks. Zoophycus and halo burrows are the most conspicuous. In total 13 small-scale turbidite cycles are recorded.

SMEAR SLIDE SUMMARY:

	1-80 D	3-80 D	4-74 D	6-43 D	
Texture:					
Sand	50	–	–	–	
Silt	10	–	–	–	
Clay	40	–	–	–	
Composition:					
Quartz	10	1	5	5	
Feldspar	–	–	5	–	
Heavy minerals	10	–	–	10	
Clay	49	5	88	10	
Volcanic glass	20	2	–	5	
Palagonite	–	–	–	10	
Carbonate unspecified	10	–	1	56	–
Calcareous nannofossils	1	92	1	4	–

ORGANIC CARBON AND CARBONATE:

	1-20	2-60	3-79	4-60	5-55
Organic carbon	–	–	–	–	–
Carbonate	77	57	63	74	66

SITE 528 HOLE CORE 38 CORED INTERVAL 464.0–473.5 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER (FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS) | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | POLARITY | LITHOLOGIC DESCRIPTION

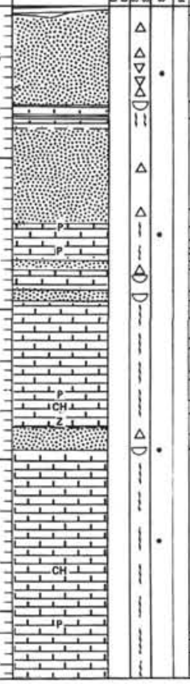
late Cretaceous (Maastrichtian)

G. gansseri (F)
A. cymbiformis (N)

AP AP

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

Meters: 0.5, 1.0



5YR 6/4 +
5B 9/1

5G 2/1

5G 6/1

5G 2/1

5GY 8/1

N8
5YR 4/4
N7
5B 7/1
5G 2/1
10YR 6/2
5G 2/1
5G 6/1
5Y 8/1 +
5G6/1
10YR 6/2
5Y 8/1
5G 6/1
10YR 6/2
5G 6/1
10YR 6/2

5G 6/1

5YR 4/4
N7

5YR 4/4

VOLCANOGENIC TURBIDITES AND INDURATED NANNOFOSSIL CHALKS

The core consists of a series of grading and inverse grading turbidite sands and silts alternating with indurated nannofossil chalks. The turbidites are generally greenish black (5G 2/1) with the chalks being a very light gray (N8) to moderate brown (5YR 4/4). Biogenic sedimentary structures are well preserved. Five distinct turbidite intervals are identified.

SMEAR SLIDE SUMMARY:

	1-70 D	2-80 D	3-145 D	4-80 D
Texture:				
Sand	60	–	20	–
Silt	10	–	20	–
Clay	30	–	60	–
Composition:				
Quartz	3	–	3	TR
Feldspar	TR	TR	–	TR
Mica	TR	–	–	–
Heavy minerals	1	–	10	–
Clay	41	–	77	–
Volcanic glass	40	1	–	–
Palagonite	15	1	5	5
Carbonate unspecified	–	1	–	1
Foraminifers	–	TR	–	TR
Calcareous nannofossils	TR	97	5	94

ORGANIC CARBON AND CARBONATE:

	2-70	3-70	4-91
Organic carbon	–	–	–
Carbonate	52	42	67

SITE 528 HOLE CORE 39 CORED INTERVAL 473.5–483.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Cretaceous (Maastrichtian)	*G. gansseri* (F) *A. cymbiformis* (N)	AP	CP			1, 2, 3	0.5, 1.0	IW, P, P, Z, H; BASALT			* *

10YR 6/2
5B 7/1
10YR 6/2
N7
10YR 6/2
5YR 5/2
N8
5YR 5/2

LITHOLOGIC DESCRIPTION

MUDDY NANNOFOSSIL CHALK

This core contains, very light gray (N8) and a pale yellowish brown (10YR 6/2) indurated muddy nannofossil chalk, that is in contact with basement (basalt). Biogenic mottling is present with halo and planolites trace fossils being conspicuous.

The non-carbonate components are volcanogenic rock fragments, palagonite, and clay minerals ranging from fine sand to silt in size.

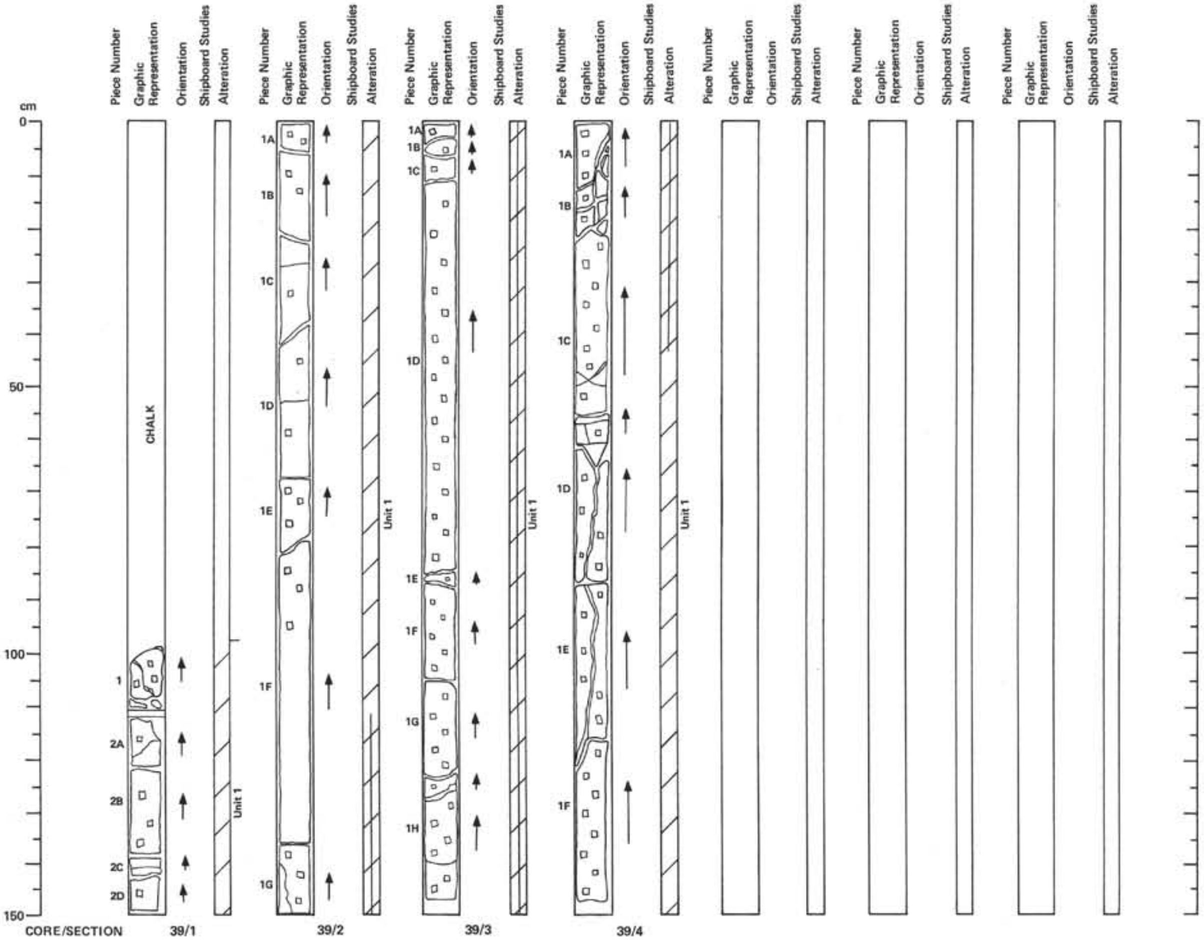
Large (up to 2 cm) mollusk shells are observed just about the sediment basalt interface.

SMEAR SLIDE SUMMARY:

	1-17	1-100
	D	D
Composition:		
Quartz	2	1
Clay	5	5
Volcanic glass	3	1
Palagonite	1	–
Pyrite	–	TR
Carbonate unspecified	10	5
Foraminifers	2	1
Calcareous nannofossils	77	86
Dinoflagellates	–	1

ORGANIC CARBON AND CARBONATE:

	1-34
Organic carbon	–
Carbonate	62



74-528-39 through 40 **Depth: 474.5–492.1 mbsf**

Core 39, Sections 1–4 and Core 40, Sections 1–6 (Unit 1)

Dominant Lithology: Highly plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium- to coarse-grained highly plagioclase phyric basalt. Plagioclase phenocryst abundance varies drastically in first few meters from 0% in places to 20–25%, characteristic of the remainder of the unit. Plagioclase phenocrysts are up to 15x8 mm in size and clearly twinned and zoned. A few patches of subhedral dark green clay spots (<2.0x1.0 mm) may represent concentrations of completely altered olivine and clinopyroxene phenocrysts which are otherwise very sparse. An altered glassy rind is present at top of unit. Majority of fractures between pieces have dark green smectite fillings and pyrite linings.

Thin Section Description:

40-3, 86–89 cm (Piece 1D):

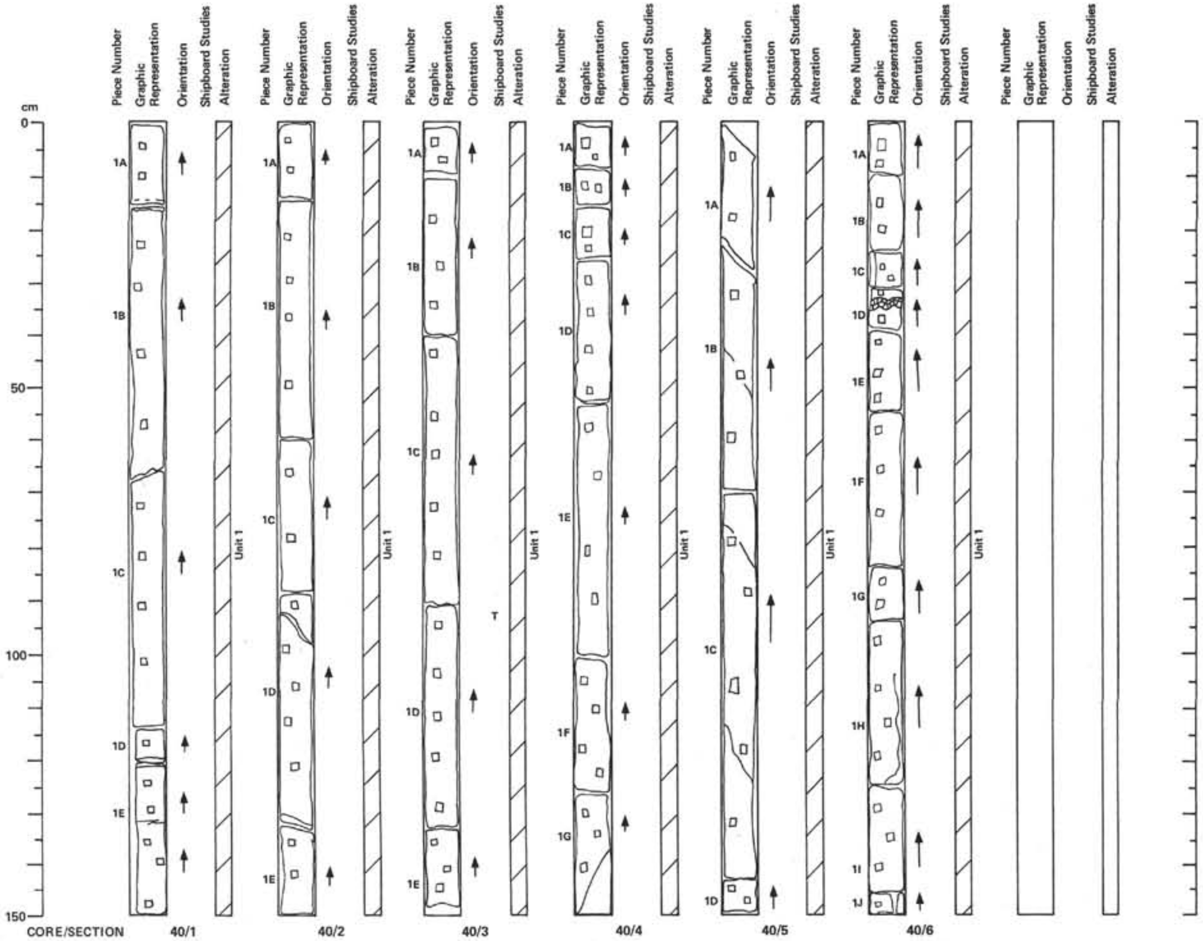
Name: Coarse-grained, highly plagioclase phyric basalt (flow interior).

Texture: Subophitic.

Phenocrysts: Plagioclase, 15%, 8.0x4.0 mm, euhedral stubby laths; clinopyroxene, <1%, 1.0x1.0 mm, subhedral.

Groundmass: Plagioclase, 42%, 0.6x0.2 mm, euhedral laths; clinopyroxene, 39%, 0.2x0.2 mm, subhedral; magnetite, 3%, 0.1x0.1 mm, skeletal.

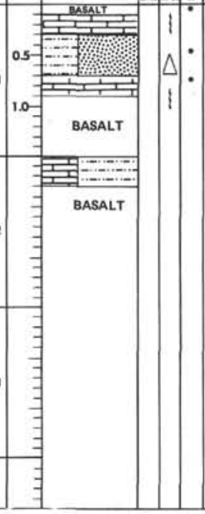
Alteration: Brown clays, 3%, replacing pyroxene in groundmass.



cm
0
50
100
150
Piece Number
Graphic Representation
Orientation
Shipboard Studies
Alteration
Unit 1
T
1A
1B
1C
1D
1E
1F
1G
1H
1I
1J
CORE/SECTION
40/1
40/2
40/3
40/4
40/5
40/6

SITE 528 HOLE CORE 41 CORED INTERVAL 492.0–501.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1, 2, 3	0.5, 1.0					



5YR 4/1
5Y 4/1
5G 6/1
5YR 4/1
5GY 3/2

INTERBEDDED MUDDY LIMESTONE AND VOLCANOCLASTIC TURBIDITE SEQUENCE BETWEEN BASALT UNITS

This core contains two sediment layers sandwiched between basalt.

The upper layer consists of two muddy limestones with a volcaniclastic turbidite sequence in between. The turbidite is sand to clay, fines upward and is horizontally bedded and laminated. The dominant color is a greenish gray. The limestones above and below are highly recrystallized and appear baked. They are brownish gray at the basalt contacts and grade to an olive gray (5Y 4/1) away from the basalt.

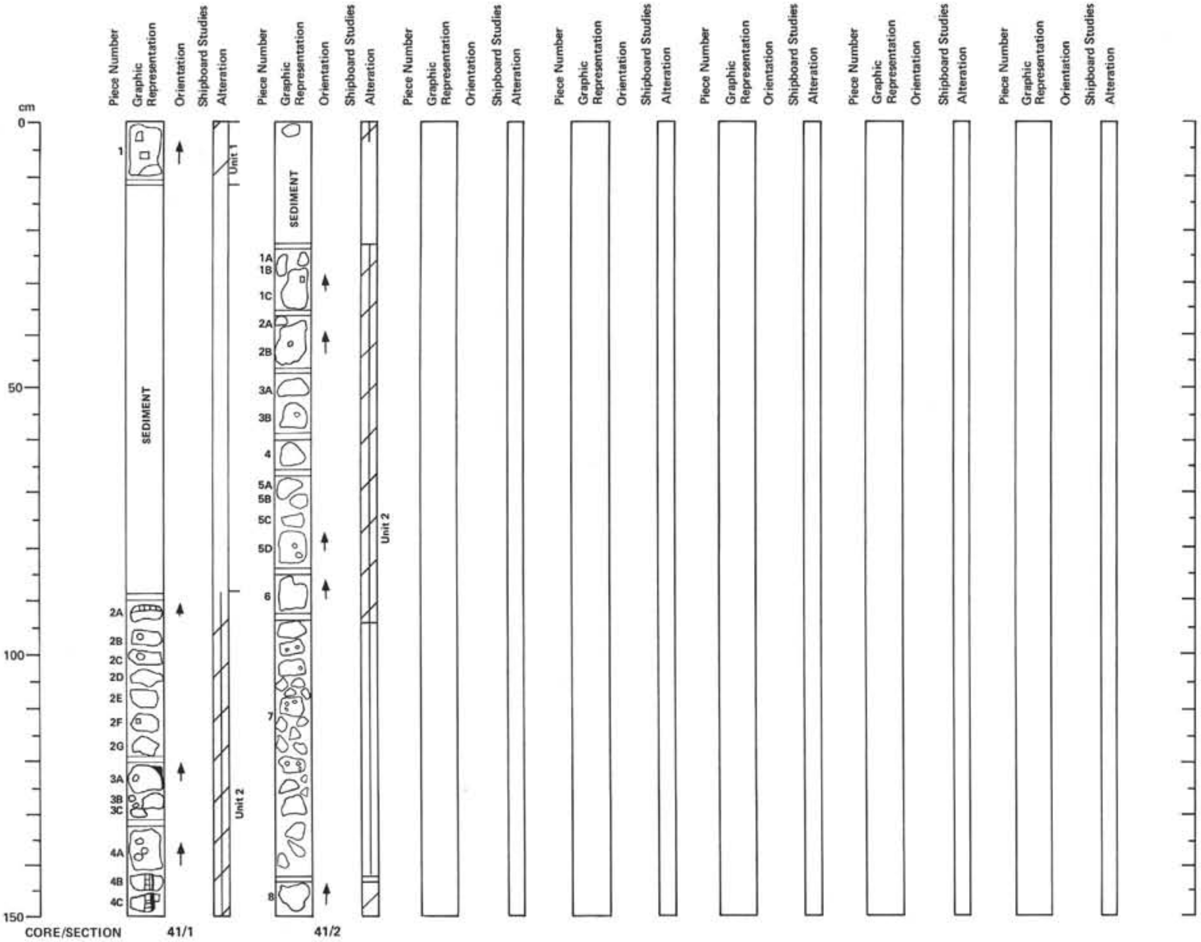
The calcareous mudstone in Section 2 is highly altered and appears green (5GY 3/2).

SMEAR SLIDE SUMMARY:

	1-15 D	1-50 D	1-80 D
Composition:			
Heavy minerals	–	2	–
Clay	–	10	–
Volcanic glass	20	10	20
Palagonite	55	18	40
Carbonate unspecified	10	25	30
Foraminifers	10	20	TR
Calcareous nannofossils	5	15	10

ORGANIC CARBON AND CARBONATE:

	1-25
Organic carbon	–
Carbonate	50



74-528-41 through 42 **Depth: 493.0–503.2 mbsf**

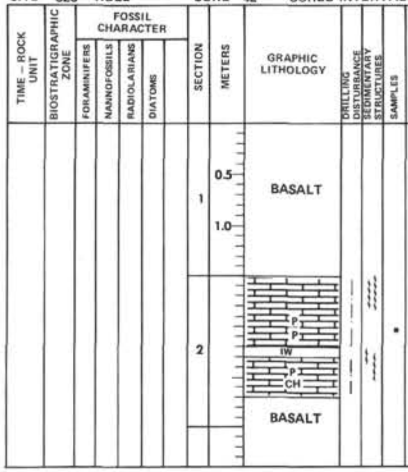
Core 41, Sections 1–2 and Core 42, Section 1 (Unit 2)

Dominant Lithology: Aphyric basalt.

Macroscopic Description: Gray, fine- to medium-grained, vesicular aphyric basalt. Recovery was poor, compared to that of phyric units, with rubbly fragments forming a large percentage of the core. Altered glassy rinds and vesicular patches occur in the top meter. A 25 cm-long piece of deformed, highly recrystallized, muddy limestone (top of Core 41, Section 2) is possibly a sediment block caught-up in the top of the flow. Vugs in upper half of unit are partially filled with calcite and pyrite crystals, vesicles in the lower half are completely filled with green smectite.

Thin Section Description:
42-1, 50–53 cm (Piece 1F):
Name: Medium-grained aphyric basalt (flow interior).
Texture: Subophitic.
Phenocrysts: None.
Groundmass: Plagioclase, 55%, 0.3x0.05 mm, laths; clinopyroxene, 50%, 0.1x0.1 mm, subhedral; magnetite, 5%, 0.05x0.03 mm, anhedral.
Vesicles: Voids, 1%, 1.0x1.0 mm, rounded and scattered.
Alteration: Brown clays, 15%, replacing groundmass, pyroxene, and plagioclase.

SITE 528 HOLE CORE 42 CORED INTERVAL 501.0–510.0 m



LITHOLOGIC DESCRIPTION

LIMESTONE

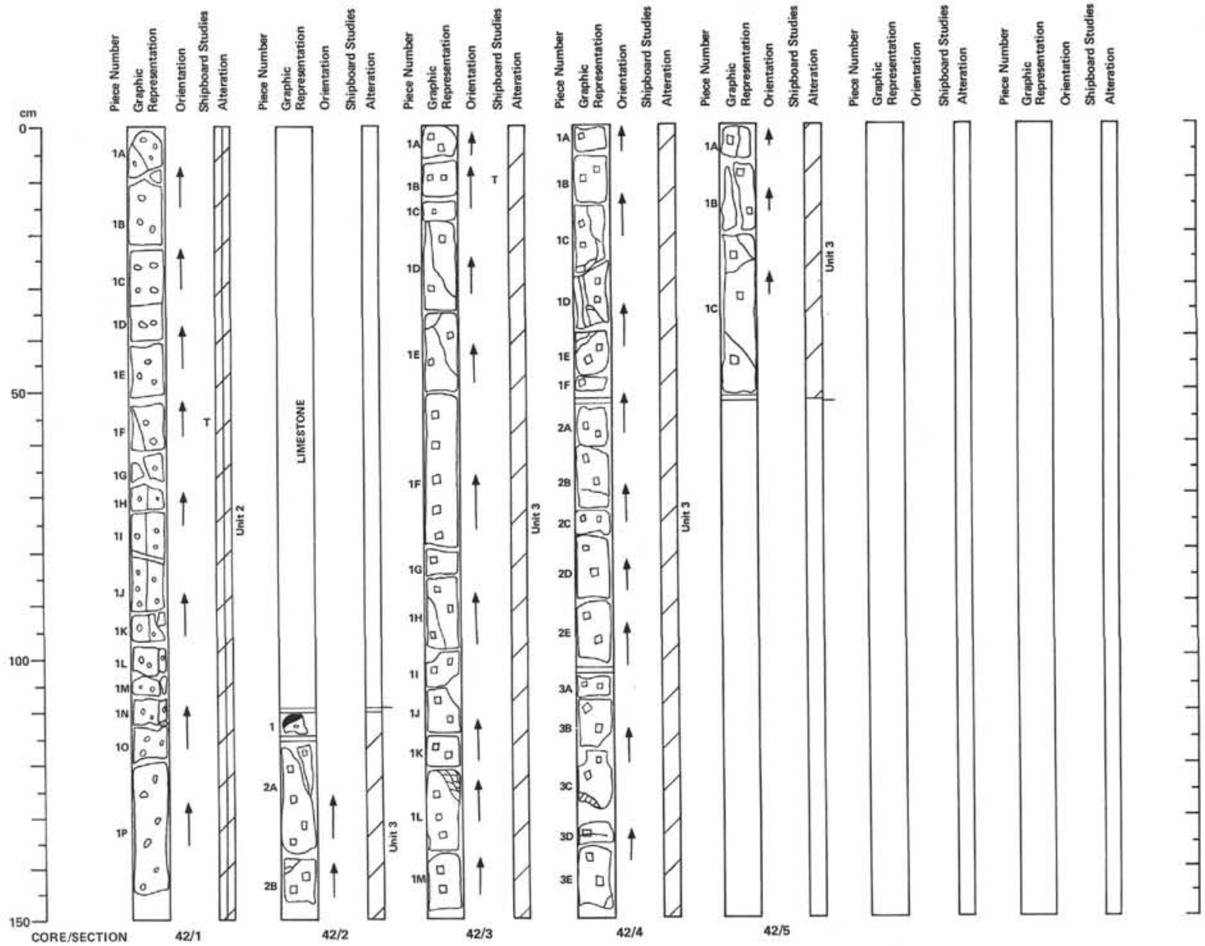
A dusky yellow green (5GY 5/2), highly altered (baked?) moderately bioturbated limestone was recovered. Foraminifers are the only identifiable fossils. Planolites sediment of which we recovered the bottom layers.

SMEAR SLIDE SUMMARY:

	2-50
	D
Composition:	
Heavy minerals	5
Clay	5
Volcanic glass	5
Palagonite	10
Carbonate unspecified	60
Foraminifers	15

ORGANIC CARBON AND CARBONATE:

	2-62
Organic carbon	–
Carbonate	24



74-528-42 **Depth: 504.9–510.0 mbsf**

Core 42, Sections 2–5 (Unit 3)

Dominant Lithology: Highly plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium-grained, highly plagioclase phyric basalt. Plagioclase phenocrysts are 20–25% in abundance, up to 10x5 mm in size, and clearly twinned and zoned. Smectite fills scattered vesicles and veins. Pyrite lines veins and appears scattered in groundmass. An altered glassy rind occurs at top of unit in Core 42, Section 2. Numerous subvertical fractures in bottom of unit (Core 42, Section 4).

Thin Section Description:

42-3, 8–11 cm (Piece 1B):

Name: Medium-grained highly plagioclase phyric basalt (flow interior).

Texture: Subophitic.

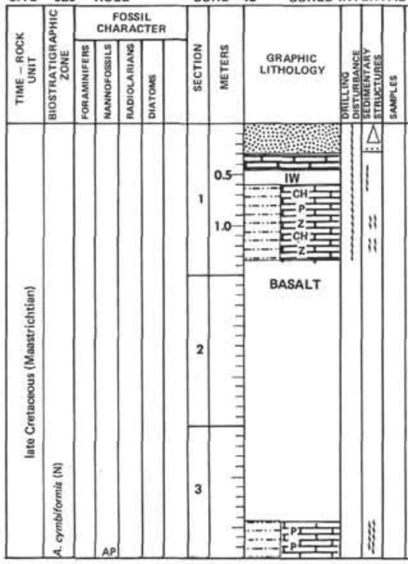
Phenocrysts: Plagioclase, 25%, 10x5 mm, euhedral stubby laths; olivine, <1%, 1.5x1.0 mm, euhedral (totally altered to clays); clinopyroxene, <1%, 2.0x2.0 mm, subhedral, intergrown with plagioclase.

Groundmass: Plagioclase, 36%, 0.3x0.05 mm, euhedral laths; clinopyroxene, 34%, 0.1x0.1 mm, subhedral; magnetite, 3%, 0.05x0.05 mm, anhedral.

Vesicles: None.

Alteration: Brown clays, 5%, replacing groundmass pyroxene.

SITE 528 HOLE CORE 43 CORED INTERVAL 510.0–519.0 m



5G 2/1

5G 6/1

5YR 3/4

LITHOLOGIC DESCRIPTION

MUDDY LIMESTONE WITH VOLCANOCLASTIC TURBIDITE SEQUENCE

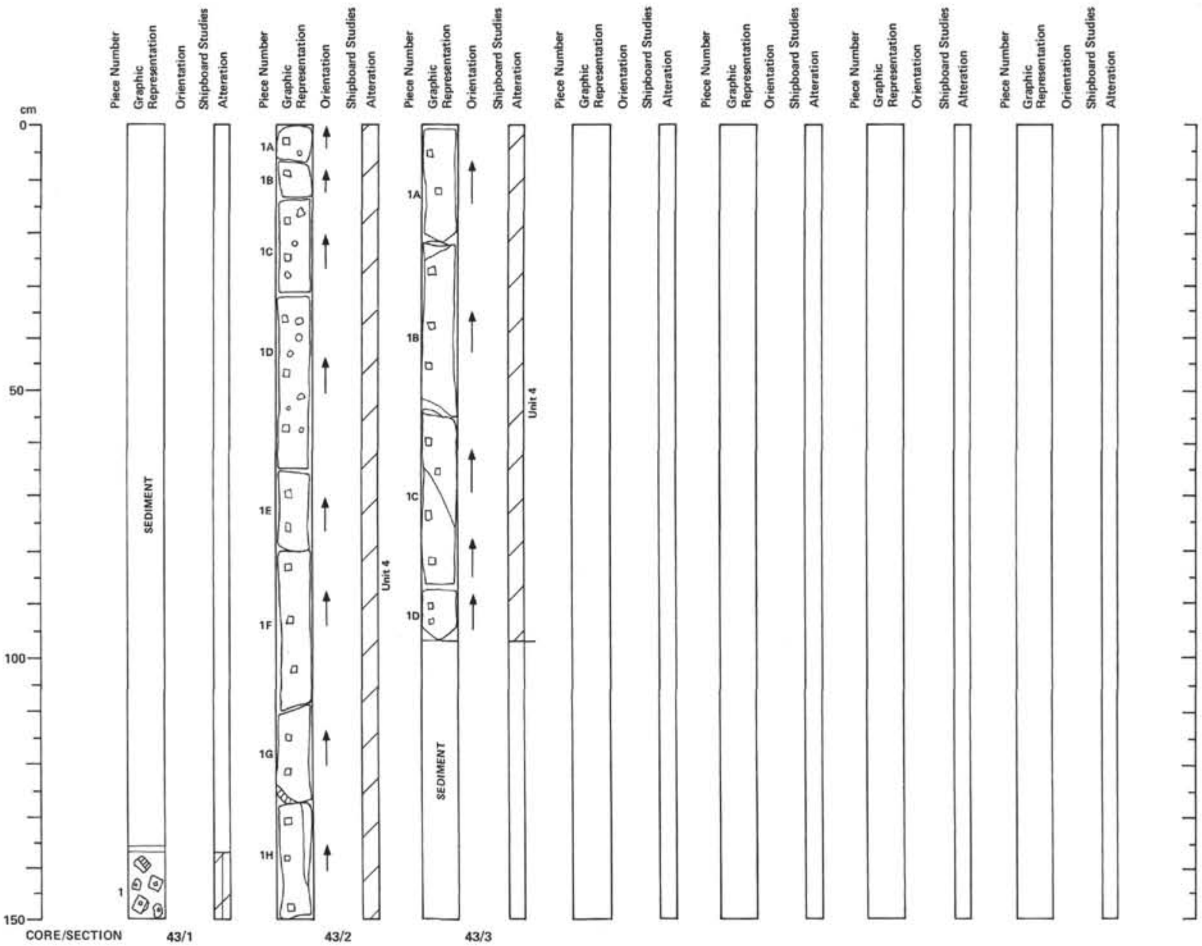
The top 5–6 m of the core were washed through before water pressure was reduced. This interval was probably sediment of which we recovered the bottom layers.

The sediment within basalt layers is found in two areas. The upper sequence is a grayish blue (5G 2/1) highly disturbed turbidite sequence. Below the turbidite, a greenish gray (5G 6/1) muddy limestone is present. It is moderately bioturbated and has high amounts of volcanogenic sediments.

The limestone below the basalt (Section 3) is a moderately bioturbated moderate brown (5YR 3/4) muddy limestone to calcareous mudstone.

ORGANIC CARBON AND CARBONATE:

	1-30	3-101
Organic carbon	—	—
Carbonate	36	51



74-528-43 **Depth: 515.0–518.0 mbsf**

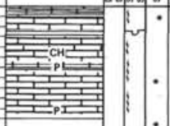
Core 43, Sections 1–3 (Unit 4)

Dominant Lithology: Highly plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium-grained, highly plagioclase phyric basalt. Plagioclase phenocrysts are up to 25% in abundance, up to 10x5 mm in size, and clearly twinned and zoned. Upper and lower chilled margins recovered, although upper glassy rind is altered. Upper 60 cm of unit carry vesicles filled with green smectite and minor pyrite. Possibly very sparse olivine/clinopyroxene phenocrysts altered to dark green clay. Basalt is slightly to moderately altered.

SITE 528 HOLE CORE 44 CORED INTERVAL 519.0–528.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
						1	0.5 1.0					
						2		BASALT				



5G 4/1

5G 6/1

LIMESTONE AND SILTSTONE LAYERS

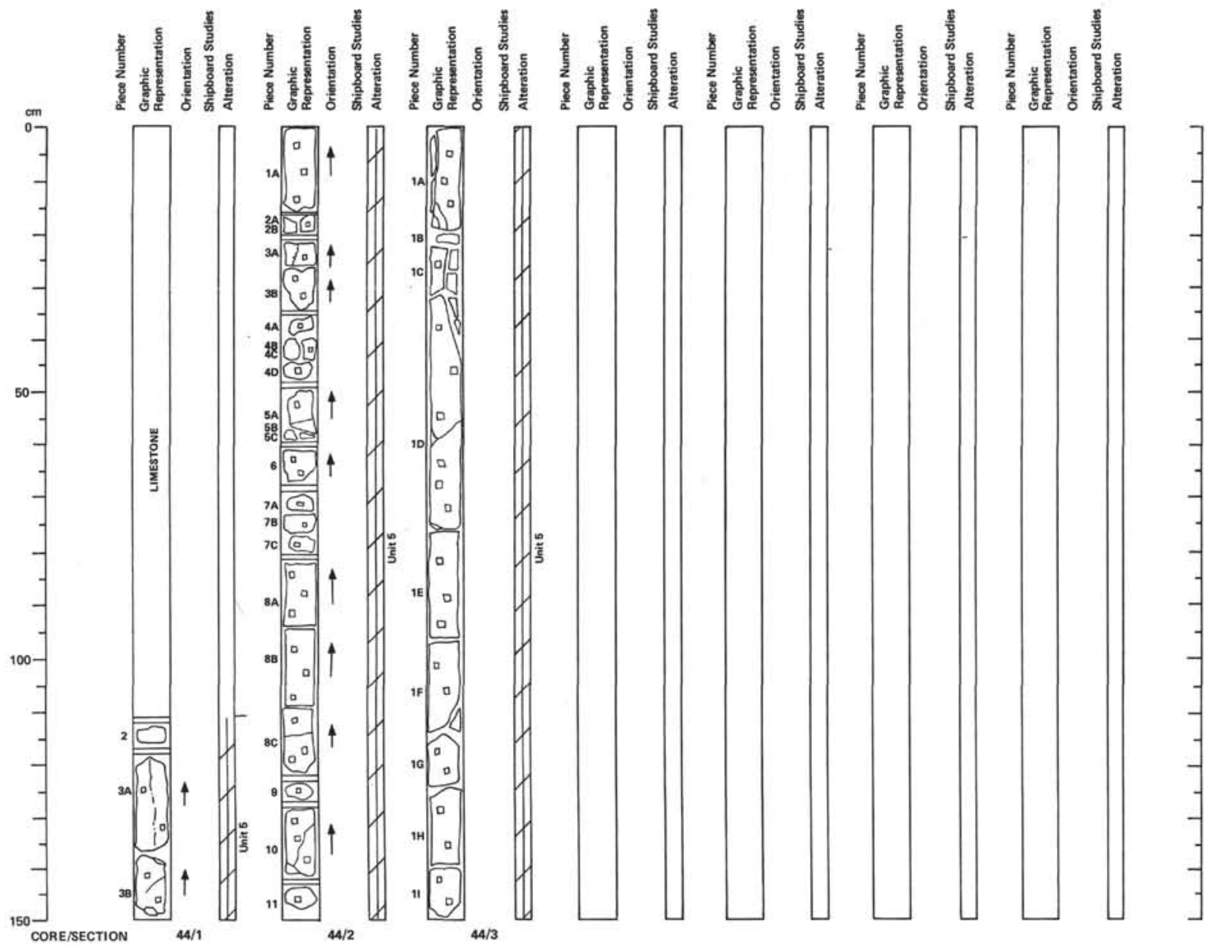
This core contains a greenish gray(5G 6/1) moderately bioturbated limestone with thin light gray (N7) siltstone layers. A large mollusk shell (*Inoceramus?*) is present at 93 cm. These sediments are located between basalt flows.

SMEAR SLIDE SUMMARY:

	1-5 M	1-70 D	1-110 D
Composition:			
Quartz	3	–	TR
Feldspar	TR	–	–
Clay	10	–	–
Volcanic glass	20	2	2
Palagonite	50	5	2
Calcareous nannofossils	17	93	96

ORGANIC CARBON AND CARBONATE:

	1-60
Organic carbon	–
Carbonate	49



74-528-44 **Depth: 521.0–528.0 mbsf**

Core 44, Sections 1–3 (Unit 5)

Dominant Lithology: Moderately plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium-grained, moderately plagioclase phyric basalt. Plagioclase phenocrysts are up to 10% in abundance, up to 5.0x2.0 mm in size. Altered glassy margin at top of unit recovered. Scattered vugs up to 8.0x4.0 mm lined or filled with carbonate and minor pyrite. Basalt is moderately altered.

SITE 528 HOLE CORE 45 CORED INTERVAL 528.0–537.0 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
						1	0.5 1.0	BASALT			**
						2					

LITHOLOGIC DESCRIPTION

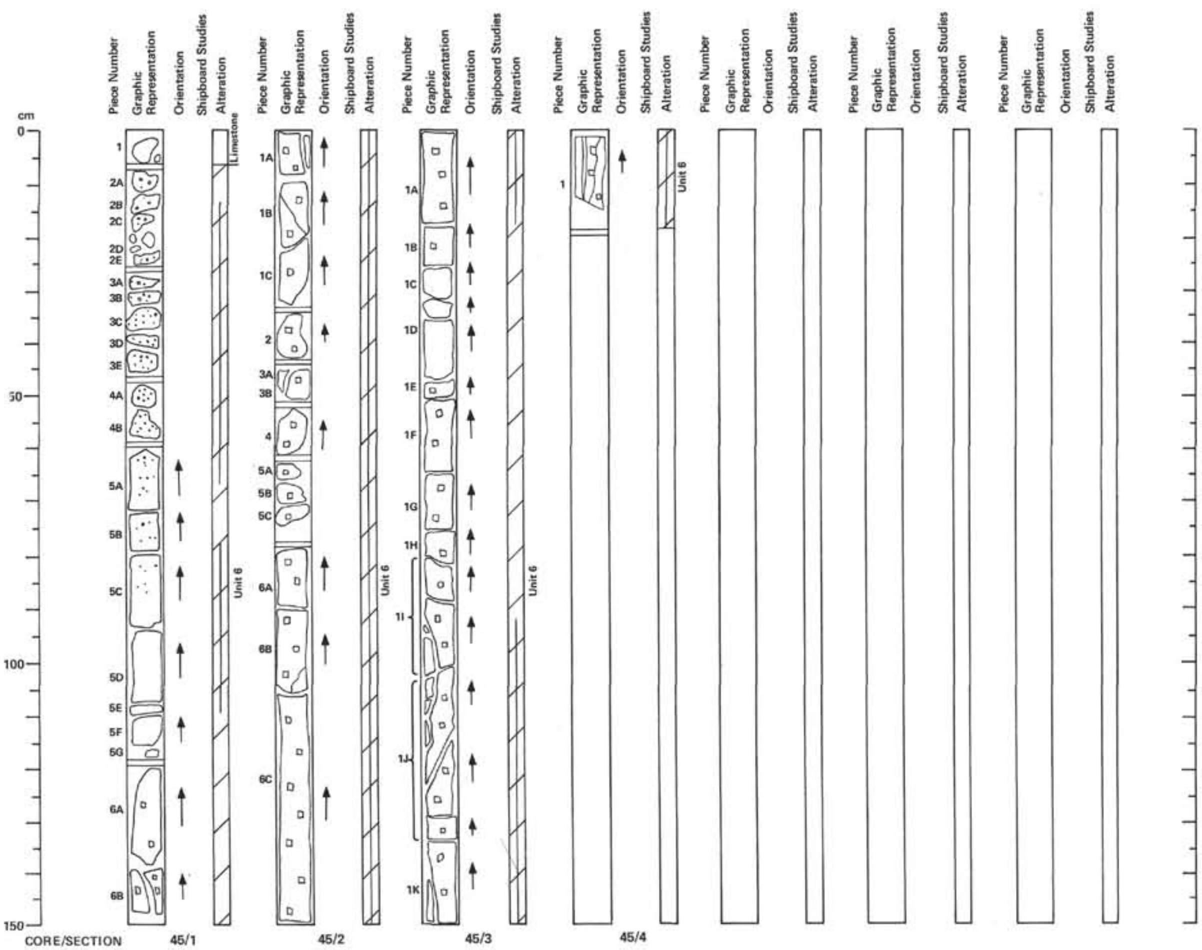
5G 6/1 greenish gray
5Y 6/1 light olive gray

NANNOFOSSIL CHALK

Two pieces of nannofossil chalk were recovered. They probably represent the remains of a washed out sedimemtary unit which existed between basalt flows. They are a greenish gray (5G 6/1) to light olive gray (5Y 6/1).

SMEAR SLIDE SUMMARY:

	1-3 D	1-3 D
Composition:		
Quartz	TR	TR
Feldspar	–	TR
Heavy minerals	TR	TR
Volcanic glass	2	3
Palagonite	5	5
Pyrite	TR	–
Calcareous nannofossils	93	92



74-528-45 through 46 **Depth: 528.1–538.2 mbsf**

Core 45, Sections 1–4 and Core 46, Section 1 (Unit 6)

Dominant Lithology: Moderately plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium-grained, moderately plagioclase phyric basalt. Basalt grades from highly vesicular and aphyric in the top 60 cm through to moderately phyric with no vesicles below the top 150 cm. Vesicles are empty at top, filled with carbonate below 50 cm. Plagioclase phenocrysts are up to 10% in abundance and 5.0x2.0 mm in size. Fine-grained lower and upper chilled margins halfway through the core mark division into two cooling units. Basalt is moderately altered.

Thin Section Description:

46-1, 38–41 cm (Piece 1E):

Name: Moderately plagioclase phyric basalt (flow interior).

Texture: Subophitic.

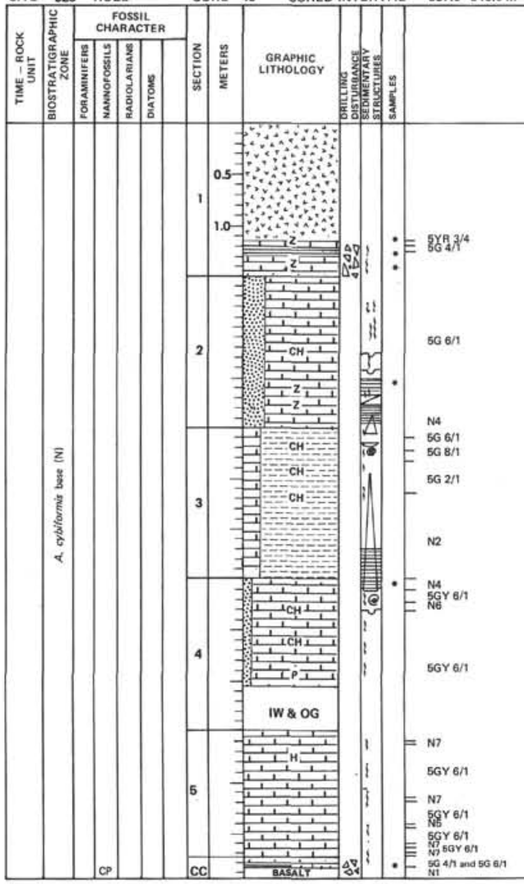
Phenocrysts: Plagioclase, 8%, 4.0x2.0 mm, zoned stubby laths (overgrowths produce irregular outlines); clinopyroxene, <1%, 1.0x0.3 mm, subhedral.

Groundmass: Plagioclase, 46%, 0.4x0.05 mm, euhedral laths; clinopyroxene, 42%, 0.1x0.1 mm, subhedral; magnetite, 3%, 0.05x0.03 mm, skeletal.

Vesicles: None.

Alteration: Brown clays, 4%, replacing groundmass pyroxene.

SITE 528 HOLE CORE 46 CORED INTERVAL 537.0–546.0 m



LITHOLOGIC DESCRIPTION

INDURATED NANNOFOSSIL CHALK AND VOLCANICLASTIC TURBIDITES

This core contains a greenish gray (5G 6/1) moderately mottled indurated nannofossil chalk, with interspersed greenish black (5G 2/1) siltstone beds.

Below this chalk a series of volcanoclastic turbidites or small-scale slump deposits are observed. The turbidites consist of a fine sand to silt, and show parallel and faint cross bedding. Grain size decreases upwards through each turbidite. Individual turbidites are separated by a pelagic interval (i.e. chalk).

Below the turbidites are found nannofossil chalks that are moderately bioturbated and contain large mollusk shells (*Inoceramus*).

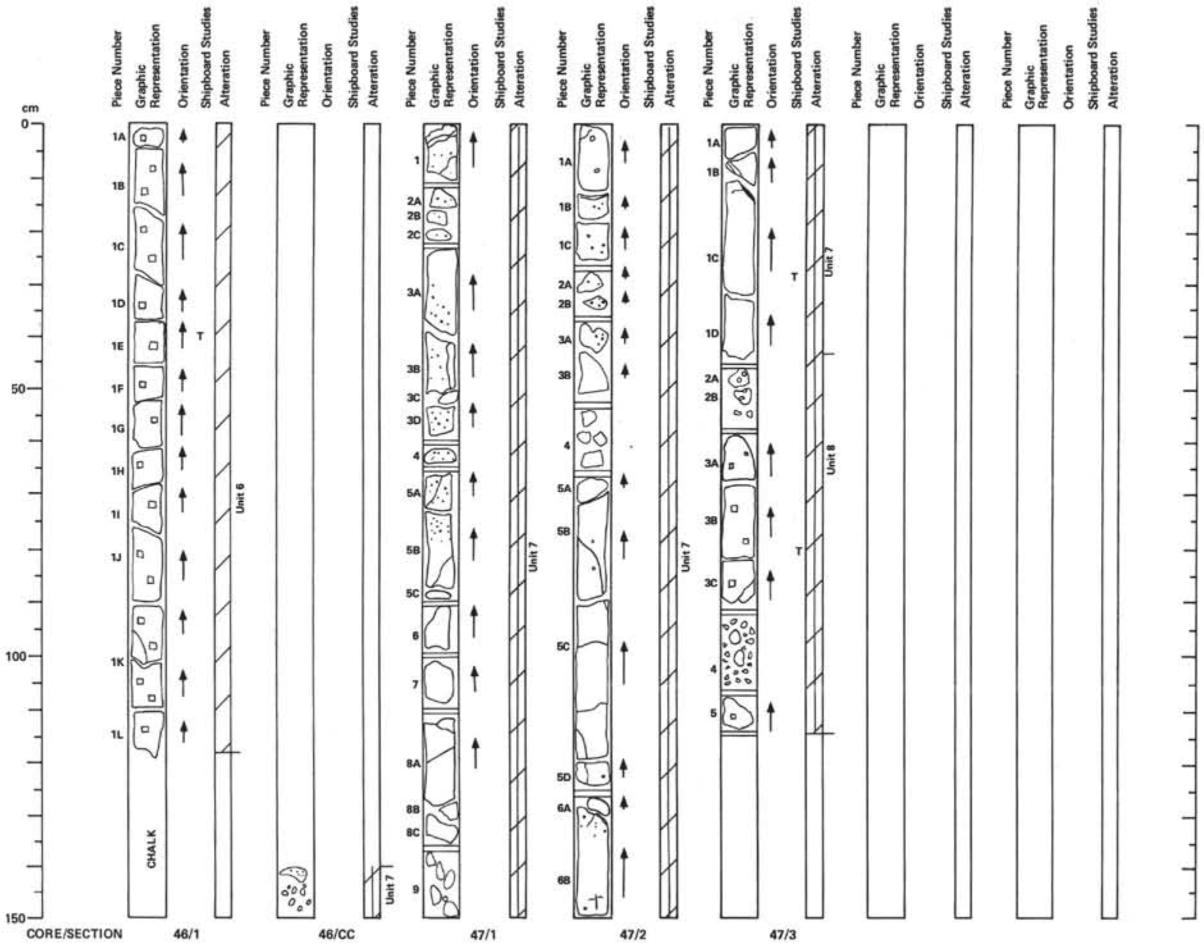
This entire sedimentary sequence is located between basalt flow.

SMEAR SLIDE SUMMARY:

	1-115	1-123	2-105	4-10	CC
	M	M	M	D	D
Texture:					
Sand	–	5	60	–	–
Silt	–	35	15	–	–
Clay	–	60	25	–	–
Composition:					
Quartz	2	10	–	TR	3
Feldspar	TR	–	15	–	TR
Heavy minerals	–	–	5	TR	TR
Clay	5	63	25	10	40
Volcanic glass	–	2	10	–	1
Palagonite	1	1	5	1	2
Pyrite	1	7	–	–	–
Carbonate unspecified	10	2	10	20	–
Foraminifers	1	–	–	TR	TR
Calcareous nannofossils	80	15	–	69	54
Other (too thick)	–	–	30	–	–

ORGANIC CARBON AND CARBONATE:

	4-47	5-60
Organic carbon	–	–
Carbonate	49	58



74-528-46 through 47 — **Depth: 545.9–554.0 mbsf**

Core 46, Section Core-Catcher and Core 47, Sections 1–3 (Unit 7)

Dominant Lithology: Aphyric basalt.

Macroscopic Description: Medium gray, medium-grained, patchy vesicular, aphyric basalt. Fine-grained upper chilled margin (Core 46, CC) was recovered. Basalt is moderately altered. Some vesicles empty, some filled with carbonate. Thin carbonate plus pyrite stringers scattered through the unit.

Thin Section Description:

47-3, 28–31 cm (Piece 1C):

- Name: Medium-grained aphyric basalt (flow interior).
- Texture: Subophitic.
- Phenocrysts: None.
- Groundmass: Plagioclase, 53%, 0.3x0.05 mm, euhedral laths; clinopyroxene, 40%, 0.1x0.06 mm, subhedral (altered); magnetite, 7%, 0.03x0.03 mm, anhedral.
- Vesicles: Voids, 1%, 1.0x1.0 mm, round and surrounded by fine-grained groundmass. Few vesicles filled with pyrite.
- Alteration: Brown clays, 20%, replacing groundmass pyroxene.

74-528-47 — **Depth: 554.0–555.0 mbsf**

Core 47, Section 3 (Unit 8)

Dominant Lithology: Sparsely plagioclase phyric basalt.

Macroscopic Description: Medium gray, medium-grained, sparsely, plagioclase phyric basalt. Top few cm are very fine-grained and have few large vesicles (8x4 mm). Plagioclase phenocrysts are approximately 1% in abundance and up to 4.0x2.0 mm in size. Hole 528 terminated 60 cm into this unit (Core 47, Section 3, 45–110 cm).

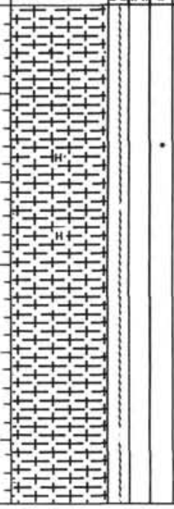
Thin Section Description:

47-3, 77–80 cm (Piece 3B):

- Name: Medium-grained, sparsely, plagioclase phyric basalt.
- Texture: Subophitic.
- Phenocrysts: Plagioclase, 1%, 4.0x2.0 mm, laths; clinopyroxene, <1%, 0.8x0.3 mm, subhedral.
- Groundmass: Plagioclase, 50%, 0.4x0.1 mm, euhedral laths; clinopyroxene, 42%, 0.2x0.1 mm, subhedral (altered); magnetite, 7%, 0.1x0.03, anhedral.
- Vesicles: None.
- Alteration: Brown clays, 20%, replacing groundmass pyroxene.

SITE 528 HOLE A CORE (HPC) 1 CORED INTERVAL 0.0–2.9 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
late Pleistocene	NN20 (N)					1	0.5, 1.0				*	5YR 8/1; N9
early Pleistocene	N22/23 (F) NN19 (N)	AG	AM			2						



FORAMINIFER NANNOFOSSIL OOZE

A highly disturbed foraminifer nannofossil ooze is present. The color is pinkish gray (5YR 8/1) with white (N9) scattered throughout. The mottles may have been due to bioturbation. Some resemble halo burrows. However the white areas may have been layers. Black wisps are noted throughout the cores. These wisps are drilling grease.

The core liner fractured and as a result any primary or secondary structures were destroyed or distorted beyond recognition.

SMEAR SLIDE SUMMARY:

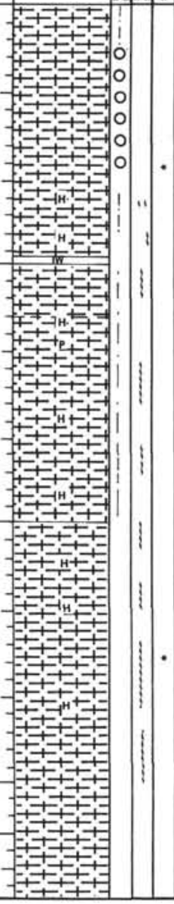
	1-80
	D
Compoisition:	
Volcanic glass	2
Foraminifers	20
Calcareous nannofossils	78

ORGANIC CARBON AND CARBONATE:

	1-34	2-34
Organic carbon	–	–
Carbonate	93	90

SITE 528 HOLE A CORE (HPC) 2 CORED INTERVAL 2.9–7.3 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early Pleistocene	N22 (F) NN19 (N)	AG	AM			1	0.5, 1.0				*	5YR 8/1 pinkish gray; N9
						2						5YR 8/1; 10YR 8/2 (white)
						3					*	5Y 8/1; N9
						4						5Y 8/1 to N9
						CC						



FORAMINIFER NANNOFOSSIL OOZE

A white (N9) pinkish gray (5YR 8/1) and yellowish gray (5Y 8/1) foraminifer nannofossil chalk is present. Bioturbation is slight with some halo burrows and planolites present.

SMEAR SLIDE SUMMARY:

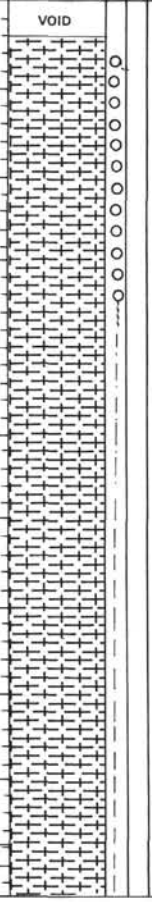
	1-90	3-80
	D	D
Composition:		
Quartz (chert)	1	–
Volcanic glass	3	5
Palagonite	1	–
Foraminifers	15	10
Calcareous nannofossils	80	85
Fish remains	–	TR
Calcareous dinoflagellates	TR	TR

ORGANIC CARBON AND CARBONATE:

	1-17	2-17	3-17	4-17
Organic carbon	–	–	–	–
Carbonate	90	89	89	90

SITE 528 HOLE A CORE (HPC) 3 CORED INTERVAL 7.3–11.7 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early Pleistocene	N22 (F) NN19 (N)	AG	AM			1, 2, 3, 4, CC	0.5, 1.0	VOID			• •	N9



FORAMINIFER-NANNOFOSSIL OOZE

A homogeneous white (N9) foraminifer nannofossil ooze was recovered. Black wisps are dispersed throughout the core. The black material appears to be opaque or organic infillings in foraminifers.

SMEAR SLIDE SUMMARY:

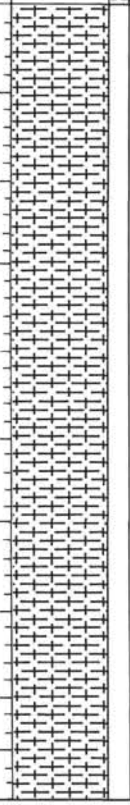
	2-80	4-20
	D	D
Composition:		
Volcanic glass	3	–
Foraminifers	20	30
Calcareous nannofossils	77	70
Fish remains	TR	–

ORGANIC CARBON AND CARBONATE:

	1-35	2-35	3-35	4-35
Organic carbon	–	–	–	–
Carbonate	91	90	94	91

SITE 528 HOLE A CORE (HPC) 4 CORED INTERVAL 11.7–16.1 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early Pleistocene	N22 (F) NN19 (N)	AG	AM			1, 2, 3, CC	0.5, 1.0				•	N9



FORAMINIFER NANNOFOSSIL OOZE

A white (N9) homogeneous foraminifer nannofossil ooze is present.

No sedimentary structures are observed.

SMEAR SLIDE SUMMARY:

	2-80
	D
Composition:	
Volcanic glass	TR
Foraminifers	20
Calcareous nannofossils	80

ORGANIC CARBON AND CARBONATE:

	1-34	2-34	3-34
Organic carbon	–	–	–
Carbonate	93	92	95

SITE 528 HOLE A CORE (HPC) 5 CORED INTERVAL 16.1–20.5 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	SECTION	METERS
early Pleistocene	NN19 (N) ?			1, 2, 3	0.5, 1.0
late Pliocene	N22 (F) NN18 (N)	AG	AM	4, CC	

FORAMINIFER-NANNOFOSSIL OOZE

A homogeneous white (N9) to titanium white foraminifer nannofossil ooze is present. The abundance of foraminifers is evident by the gritty feel of the sediment and observation without the aid of a microscope.

SMEAR SLIDE SUMMARY:

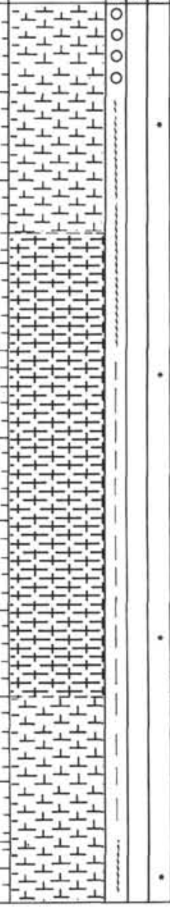
	3-80 D
Composition:	
Volcanic glass	3
Foraminifers	30
Calcareous nannofossils	67

ORGANIC CARBON AND CARBONATE:

	2-15	3-15	4-15
Organic carbon	–	–	–
Carbonate	93	91	92

SITE 528 HOLE A CORE (HPC) 6 CORED INTERVAL 20.5–24.9 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	SECTION	METERS
late Pliocene	NN18 (N)			1, 2, 3	0.5, 1.0
	?				
	PL5–6 (F) NN18 (N)	AG	AM	4, CC	



N9

5YR 8/1

N9

5YR 8/1

NANNOFOSSIL OOZE AND FORAMINIFER NANNOFOSSIL OOZE

A homogeneous white (N9) to pinkish gray (5YR 8/1) nannofossil and foraminifer nannofossil ooze is present. No sedimentary structures are recognized. Some faint patches are present but cannot be identified as trace fossils.

SMEAR SLIDE SUMMARY:

	1-70 D	2-70 D	3-70 D	CC-20 D
Composition:				
Volcanic glass	TR	1	TR	TR
Palagonite	TR	TR	–	TR
Carbonate unspecified	–	TR	TR	TR
Foraminifers	5	25	15	10
Calcareous nannofossils	95	74	85	90

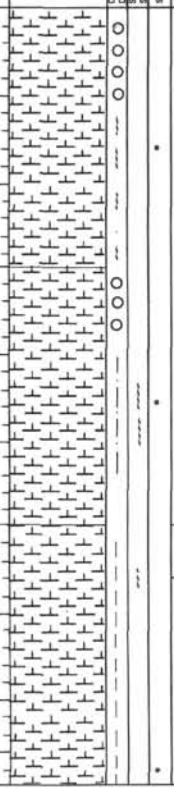
ORGANIC CARBON AND CARBONATE:

	1-149	2-149	3-149	4-34
Organic carbon	–	–	–	–
Carbonate	96	95	92	93

SITE 528 HOLE A CORE (HPC) 7 CORED INTERVAL 24.9–29.3 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Pliocene	NN16 (N)					1	0.5, 1.0
						2	
early Pliocene	PL 5–6 (F) NN15 (N)					3	
		AG	AM			CC	

GRAPHIC LITHOLOGY



N9

5Y 8/1

N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

A homogeneous white (N9) nannofossil ooze was recovered. Faint mottles which may be biogenic sedimentary structures are present in Sections 2 and 3. Discoasters are abundant and comprise up to 15% of nannofossil population.

SMEAR SLIDE SUMMARY:

	1-80 D	2-80 D	CC D
Composition:			
Quartz	TR	TR	1
Heavy minerals	–	–	TR
Volcanic glass	1	1	TR
Palagonite	–	TR	–
Carbonate unspecified	2	1	3
Foraminifers	5	3	3
Calcareous nannofossils	91	85	78
Dinoflagellates	1	TR	TR
Discasters	–	10	15

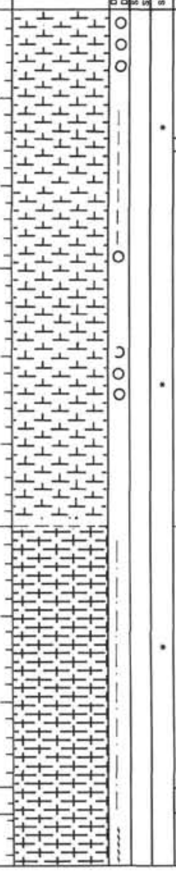
ORGANIC CARBON AND CARBONATE:

	1-148	2-146	3-115
Organic carbon	–	–	–
Carbonate	93	97	94

SITE 528 HOLE A CORE (HPC) 8 CORED INTERVAL 29.3–33.7 m

TIME-ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
early Pliocene	PL4 (F) NN15 (N)					1	0.5, 1.0
						2	
						3	
						4	
		AG	AM			CC	

GRAPHIC LITHOLOGY



N9

N8

N9

N9 to 5Y 8/1

N9

N9 to 5Y 8/1

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE TO FORAMINIFER NANNOFOSSIL OOZE

The core contains a homogeneous white (N9) nannofossil to foraminifer nannofossil ooze. No sedimentary structures.

SMEAR SLIDE SUMMARY:

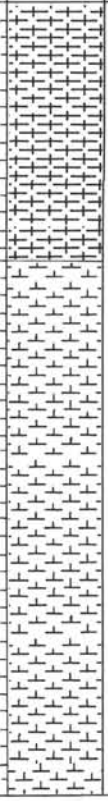
	1-70 D	2-70 D	3-70 D
Composition:			
Quartz	–	–	TR
Heavy minerals	TR	–	–
Palagonite	3	2	–
Carbonate unspecified	1	1	1
Foraminifers	3	5	15
Calcareous nannofossils	93	92	84
Dinoflagellates	–	TR	–

ORGANIC CARBON AND CARBONATE:

	1-2	2-2	3-2	4-2
Organic carbon	–	–	–	–
Carbonate	92	95	96	95

SITE 528 HOLE A CORE (HPC) 9 CORED INTERVAL 33.7–38.1 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early Pliocene	PL3 (F) NN15 (N)	AG	AM			1, 2, 3, CC	0.5, 1.0					N9; N9 to 5YR 8/1; N9



NANNOFOSSIL OOZE TO FORAMINIFER NANNOFOSSIL OOZE

This core contains a white (N9) moderately disturbed nannofossil to foraminifer nannofossil ooze. Some areas (e.g. 100–110 cm, Section 1) are a little firmer.

SMEAR SLIDE SUMMARY:

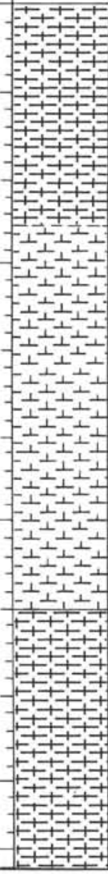
	1-100	2-100	3-100
	D	D	D
Composition:			
Quartz	TR	–	–
Heavy minerals	TR	TR	–
Volcanic glass	TR	1	TR
Carbonate unspecified	1	3	2
Foraminifers	15	5	3
Calcareous nannofossils	84	91	95
Dinoflagellates	TR	TR	TR

ORGANIC CARBON AND CARBONATE:

	2-3	3-3	CC
Organic carbon	–	–	–
Carbonate	95	94	95

SITE 528 HOLE A CORE (HPC) 10 CORED INTERVAL 38.1–42.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
early Pliocene	PL3 (F) NN15 (N)	AG	AM			1, 2, 3, 4, CC	0.5, 1.0					N9; N9 and 5GY 8/1; N9



NANNOFOSSIL OOZE TO FORAMINIFER NANNOFOSSIL OOZE

A very deformed, homogeneous white (N9) nannofossil to foraminifer nannofossil ooze. Some pinkish gray (5YR 8/1) patches and streaks are present.

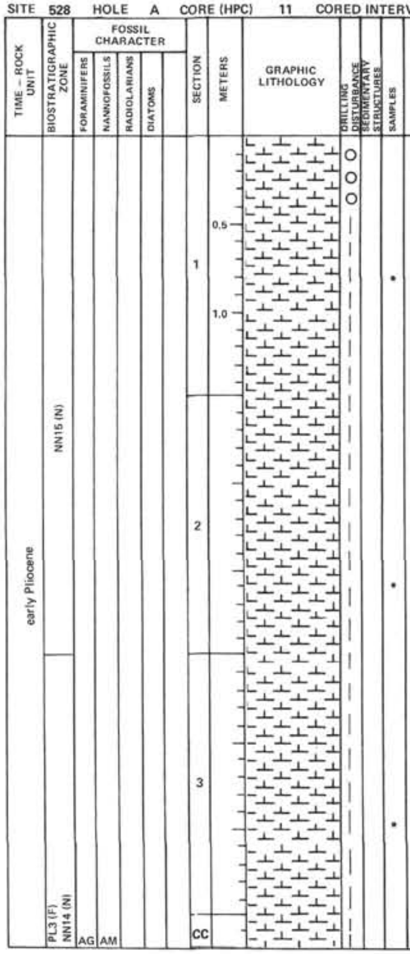
SMEAR SLIDE SUMMARY:

	1-100	2-100	3-70
	D	D	D
Composition:			
Heavy minerals	TR	–	–
Volcanic glass	TR	TR	–
Palagonite	2	TR	1
Carbonate unspecified	–	TR	–
Foraminifers	20	5	15
Calcareous nannofossils	78	95	84

ORGANIC CARBON AND CARBONATE:

	1-12	2-12	3-12
Organic carbon	–	–	–
Carbonate	93	96	96

SITE 528 HOLE A CORE (HPC) 11 CORED INTERVAL 42.5–46.7 m



N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

This core contains a homogeneous white (N9) nannofossil ooze. In Section 2 from 115–120 and 143–145 cm the ooze is slightly firmer. No sedimentary structures are present.

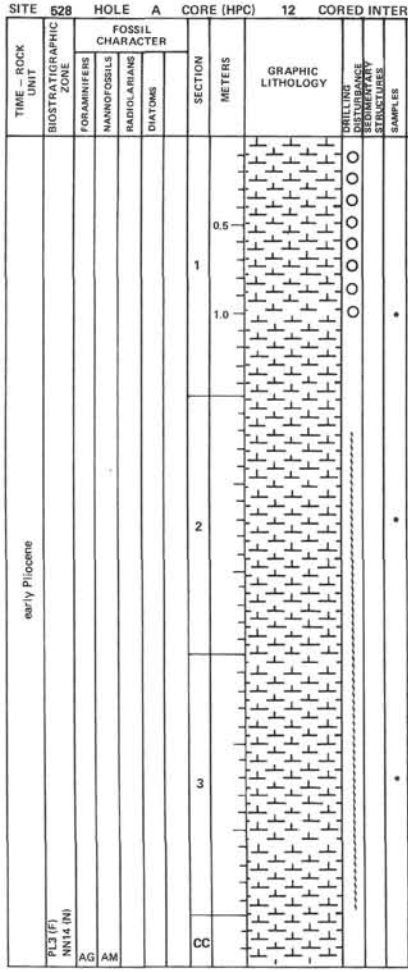
SMEAR SLIDE SUMMARY:

	1-80	2-117	3-100
	D	D	D
Composition:			
Quartz	TR	–	TR
Volcanic glass	1	TR	1
Palagonite	–	–	1
Carbonate unspecified	TR	TR	1
Foraminifers	1	5	2
Calcareous nannofossils	98	95	95
Dinoflagellates	TR	–	TR

ORGANIC CARBON AND CARBONATE:

	1-10	2-10	3-10
Organic carbon	–	–	–
Carbonate	95	96	95

SITE 528 HOLE A CORE (HPC) 12 CORED INTERVAL 46.9–51.3 m



N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

A homogeneous white (N9), soupy to highly deformed nannofossil ooze was recovered. No sedimentary structures are present.

SMEAR SLIDE SUMMARY:

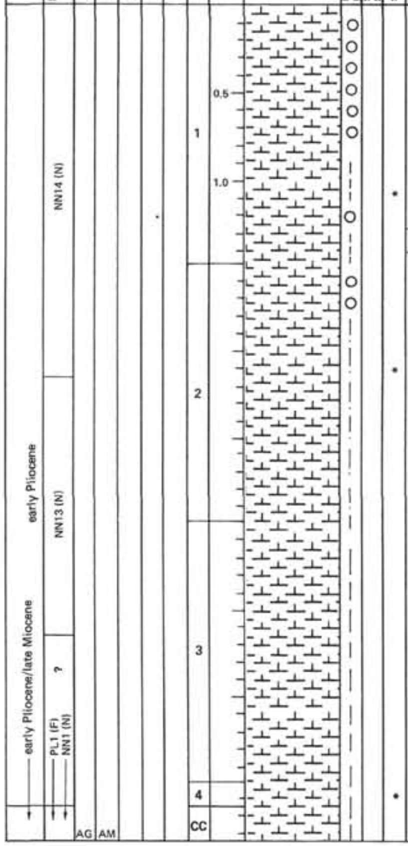
	1-100	2-70	3-70
	D	D	D
Composition:			
Quartz	TR	TR	3
Volcanic glass	2	TR	5
Palagonite	1	–	–
Carbonate unspecified	–	–	TR
Foraminifers	10	TR	5
Calcareous nannofossils	87	100	87

ORGANIC CARBON AND CARBONATE:

	1-10	2-10	3-10
Organic carbon	–	–	–
Carbonate	94	96	94

SITE 528 HOLE A CORE (HPC) 13 CORED INTERVAL 51.3–55.7 m

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



NANNOFOSSIL OOZE

This core contains a white (N9) to bluish white (5B 9/1) nannofossil ooze. The ooze is homogeneous throughout with no noticeable sedimentary structures. Some slightly firmer zones are present in Sections 2 and 3.

SMEAR SLIDE SUMMARY:

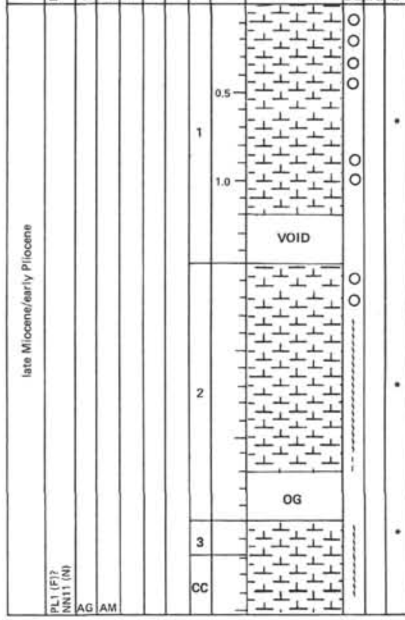
	1-110	2-70	4-10
	D	D	D
Composition:			
Quartz	TR	–	–
Volcanic glass	–	1	TR
Carbonate unspecified	–	1	TR
Foraminifers	3	5	1
Calcareous nannofossils	97	92	98
Dinoflagellates	TR	1	1

ORGANIC CARBON AND CARBONATE:

	1-147	2-147	3-147
Organic carbon	–	–	–
Carbonate	98	97	98

SITE 528 HOLE A CORE (HPC) 14 CORED INTERVAL 55.7–60.1 m

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



NANNOFOSSIL OOZE

A homogeneous titanium white nannofossil ooze is present. The core is soupy to highly deformed. No sedimentary structures are present.

SMEAR SLIDE SUMMARY:

	1-70	2-70	3-10
	D	D	D
Composition:			
Volcanic glass	1	2	TR
Palagonite	–	–	TR
Foraminifers	10	TR	–
Calcareous nannofossils	89	98	100
Dinoflagellates	Tr	–	–

ORGANIC CARBON AND CARBONATE:

	2-25	3-3
Organic carbon	–	–
Carbonate	93	96

SITE 528 HOLE A CORE (HPC) 15 CORED INTERVAL 60.1–64.5 m

TIME – ROCK UNIT: late Miocene/early Pliocene

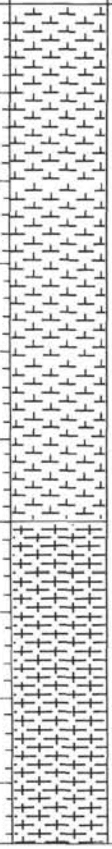
BIOSTRATIGRAPHIC ZONE: PL1 (F)? NN11 (N)

FOSSIL CHARACTER: FORAMINIFERS AM; NANNOFOSSILS AM; RADIOLARIANS; DIATOMS

SECTION: 1, 2, 3, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL TO FORAMINIFER NANNOFOSSIL OOZE

The core contains a white (N9) to brilliant white nannofossil to foraminifer nannofossil ooze. No sedimentary structures can bo positively identified.

Some slightly firmer areas are present throughout the cores.

SMEAR SLIDE SUMMARY:

	1-80	3-80	
	D	D	
Composition:			
Volcanic glass	–	TR	
Foraminifers	TR	20	
Calcareous nannofossils	100	80	
Calcareous dinoflagellates	–	TR	–

ORGANIC CARBON AND CARBONATE:

	1-6	2-6	3-6
Organic carbon	–	–	–
Carbonate	93	97	93

SITE 528 HOLE A CORE (HPC) 16 CORED INTERVAL 64.5–68.9 m

TIME – ROCK UNIT: late Miocene/early Pliocene

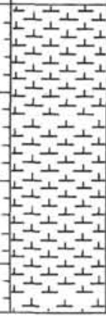
BIOSTRATIGRAPHIC ZONE: PL1 (F)? NN11 (N)

FOSSIL CHARACTER: FORAMINIFERS AM; NANNOFOSSILS AM; RADIOLARIANS; DIATOMS

SECTION: 1, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

A white (N9), homogeneous nannofossil ooze was recovered. No sedimentary structures were preserved.

SMEAR SLIDE SUMMARY:

	1-80
	D
Composition:	
Volcanic glass	TR
Carbonate unspecified	TR
Foraminifers	5
Calcareous nannofossils	95
Calcareous dinoflagellates	TR

ORGANIC CARBON AND CARBONATE:

	1-40
Organic carbon	–
Carbonate	99

SITE 528 HOLE A CORE (HPC) 17 CORED INTERVAL 68.9–73.3 m

TIME – ROCK UNIT: late Miocene/early Pliocene

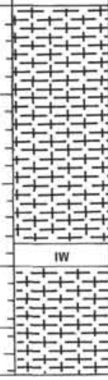
BIOSTRATIGRAPHIC ZONE: PL1 (F)? NN11 (N)

FOSSIL CHARACTER: FORAMINIFERS AP; NANNOFOSSILS AM; RADIOLARIANS; DIATOMS

SECTION: 1, 2, CC

METERS: 0.5, 1.0

GRAPHIC LITHOLOGY



DRILLING DISTURBANCE; SEDIMENTARY STRUCTURES; SAMPLES

N9

LITHOLOGIC DESCRIPTION

FORAMINIFER NANNOFOSSIL OOZE

A white (N9) foraminifer nannofossil ooze was recovered. It is highly disturbed by drilling and is homogeneous throughout. No sedimentary structures are preserved.

SMEAR SLIDE SUMMARY:

	2-15
	D
Composition:	
Volcanic glass	TR
Foraminifers	15
Calcareous nannofossils	85
Calcareous dinoflagellates	TR

ORGANIC CARBON AND CARBONATE:

	1-105	2-29
Organic carbon	–	–
Carbonate	94	96

SITE 528 HOLE A CORE (HPC) 18 CORED INTERVAL 73.3–77.7 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

late Miocene/early Pliocene

PL1 (F)? NN11 (N)

AP AM

Sections: 1, 2, 3, CC

Meters: 0.5, 1.0

N9

FORAMINIFER NANNOFOSSIL OOZE

A highly disturbed, homogeneous white (N9) foraminifer nannofossil ooze was recovered.

While coring Core 18, a hard layer was encountered. A similar layer was encountered at Hole 528 at 64–73 m.

Due to weather conditions and increased pressure to penetrate this interval almost the entire core was liquified.

SMEAR SLIDE SUMMARY:

	1-85
	D
Composition:	
Foraminifers	10
Calcareous nannofossils	90
Calcareous dinoflagellates	TR

ORGANIC CARBON AND CARBONATE:

	1-52	2-52	3-52
Organic carbon	—	—	—
Carbonate	96	94	94

SITE 528 HOLE A CORE (HPC) 19 CORED INTERVAL 77.7–82.1 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

late Miocene

N17 (F) NN11 (N)

AP AM

Sections: 1, 2, 3, CC

Meters: 0.5, 1.0

N9

NANNOFOSSIL OOZE

A white (N9) homogeneous moderately disturbed to soupy nannofossil ooze was recovered. No sedimentary structures are observed.

SMEAR SLIDE SUMMARY:

	1-110
	D
Composition:	
Foraminifers	5
Calcareous nannofossils	95

ORGANIC CARBON AND CARBONATE:

	1-39	2-39	3-39
Organic carbon	—	—	—
Carbonate	95	97	93

SITE 528 HOLE A CORE (HPC) 20 CORED INTERVAL 82.1–86.5 m

TIME – ROCK UNIT | BIOSTRATIGRAPHIC ZONE | FOSSIL CHARACTER: FORAMINIFERS, NANNOFOSSILS, RADIOLARIANS, DIATOMS | SECTION | METERS | GRAPHIC LITHOLOGY | DRILLING DISTURBANCE | SEDIMENTARY STRUCTURES | SAMPLES | LITHOLOGIC DESCRIPTION

late Miocene

N7 (F)? NN11 (N)

AP AM

Sections: 1, CC

Meters: 0.5, 1.0

N9

NANNOFOSSIL OOZE

This core contains a homogeneous white (N9) nannofossil ooze. It is structureless, odorless, and tasteless.

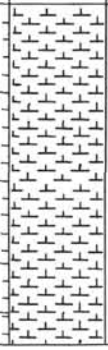
ORGANIC CARBON AND CARBONATE:

	1-20
Organic carbon	—
Carbonate	90

SITE 528 HOLE A CORE (HPC) 21 CORED INTERVAL 86.5–90.9 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Miocene	N16–17 (F) NN11 (N)	AP	AM			1, 2, CC	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

N9

NANNOFOSSIL OOZE

A white (N9) homoeneous nannofossil ooze is present. No sedimentary structures are observed.

SMEAR SLIDE SUMMARY:

	1-80 D	2-20 D	CC D
Composition:			
Heavy minerals	TR	TR	TR
Volcanic glass	TR	TR	TR
Palagonite	TR	TR	–
Carbonate unspecified	TR	–	–
Foraminifers	7	–	–
Calcareous nannofossils	93	100	100
Dinoflagellates	TR	–	–

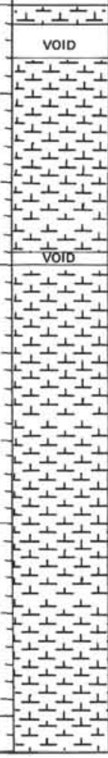
ORGANIC CARBON AND CARBONATE:

	1-140
Organic carbon	–
Carbonate	94

SITE 528 HOLE A CORE (HPC) 22 CORED INTERVAL 90.9–95.3 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS
late Miocene	NN11 (N)	AP	AM			1, 2, 3, CC	0.5, 1.0

GRAPHIC LITHOLOGY



LITHOLOGIC DESCRIPTION

N9

NANNOFOSSIL OOZE

A white (N9) homogeneous nannofossil ooze was recovered. Drilling disturbance was slight. No sedimentary structures were preserved.

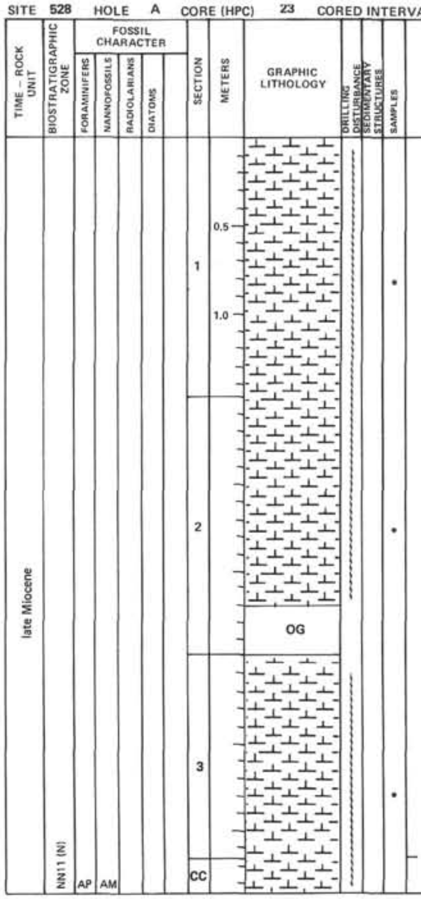
SMEAR SLIDE SUMMARY:

	1-80 D	3-60 D
Composition:		
Palagonite	TR	–
Carbonate unspecified	TR	–
Forminifers	100	100
Dinoflagellates	–	TR

ORGANIC CARBON AND CARBONATE:

	1-28	2-28	3-28
Organic carbon	–	–	–
Carbonate	98	97	97

SITE 528 HOLE A CORE (HPC) 23 CORED INTERVAL 95.3–99.7 m



N9

N9 to 10YR 8/2

N9

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

This core contains a white (N9) homogeneous nannofossil ooze. Drilling disturbance has destroyed any sedimentary structures which may have existed.

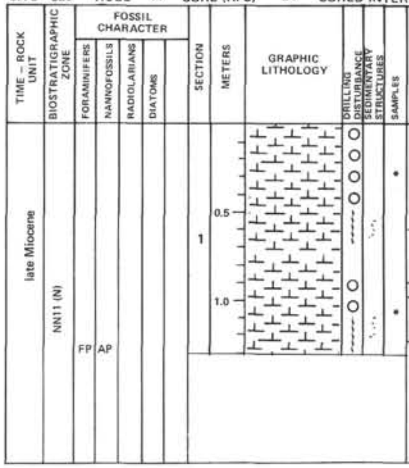
SMEAR SLIDE SUMMARY:

	1-80	2-80	3-80
	D	D	D
Composition:			
Quartz	TR	–	TR
Volcanic glass	TR	TR	TR
Palagonite	TR	–	TR
Foraminifers	TR	–	–
Calcareous nannofossils	100	100	100
Dinfolagellates	TR	TR	–

ORGANIC CARBON AND CARBONATE:

	1-19	2-19	3-19
Organic carbon	–	–	–
Carbonate	96	95	96

SITE 528 HOLE A CORE (HPC) 24 CORED INTERVAL 99.7–104.1 m



5YR 8/1

10YR 8/2

5YR 8/1

10YR 8/2

LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

A soupy to very deformed pinkish gray (5YR 8/1) to very pale orange (10YR 8/2) nannofossil ooze was recovered.

Faint traces or mottles may represent biogenic activity. This is uncertain due to the drilling disturbance.

SMEAR SLIDE SUMMARY:

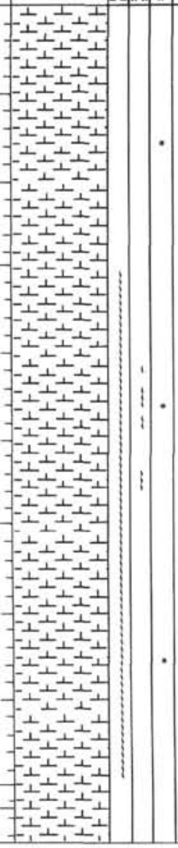
	1-30	1-110
	D	D
Composition:		
Heavy minerals	TR	TR
Volcanic glass	TR	TR
Palagonite	TR	TR
Foraminifers	–	TR
Calcareous nannofossils	100	100

ORGANIC CARBON AND CARBONATE:

	1-119
Organic carbon	–
Carbonate	90

SITE 528 HOLE A CORE (HPC) 25 CORED INTERVAL 104.1–108.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
late Miocene	NN10 (N)	AP	AP			1, 2, 3, 4, CC	0.5, 1.0					



10YR 8/2

NANNOFOSSIL OOZE

A very pale orange (10YR 8/2) homogeneous nannofossil ooze was recovered. Darker patches of medium light gray (N6) and pinkish gray (5Y 8/1) are observed. These are probably burrows which have been elongated and distorted due to drilling.

SMEAR SLIDE SUMMARY:

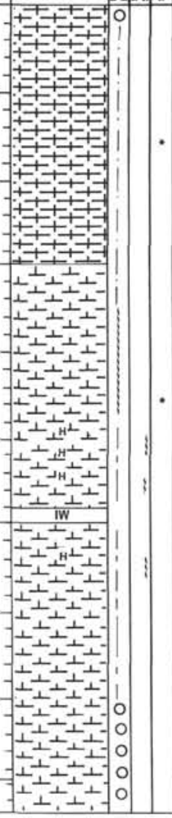
	1-80	2-80	3-80
	D	D	D
Composition:			
Heavy minerals	–	TR	–
Volcanic glass	–	TR	TR
Palagonite	TR	–	–
Carbonate unspecified	TR	–	TR
Foraminfiers	–	TR	TR
Calcareous nannofossils	100	100	100
Dinoflagellates	TR	TR	–

ORGANIC CARBON AND CARBONATE:

	1-149	2-149	3-149
Organic carbon	–	–	–
Carbonate	94	94	95

SITE 528 HOLE A CORE (HPC) 26 CORED INTERVAL 108.5–112.9 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS	SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES	LITHOLOGIC DESCRIPTION
middle Miocene	NN9 (N)	AP	AP			1, 2, 3, CC	0.5, 1.0					



2.5Y 8/2 to 5Y 8/1

FORAMINIFER NANNOFOSSIL OOZE TO NANNOFOSSIL OOZE

This core contains a white (2.5Y 8/2) (actually off white) homogeneous moderately disturbed nannofossil ooze. Foraminifer content averages from 8–15%. Several halo burrows are observed at the bottom of Section 2 and top of Section 3.

SMEAR SLIDE SUMMARY:

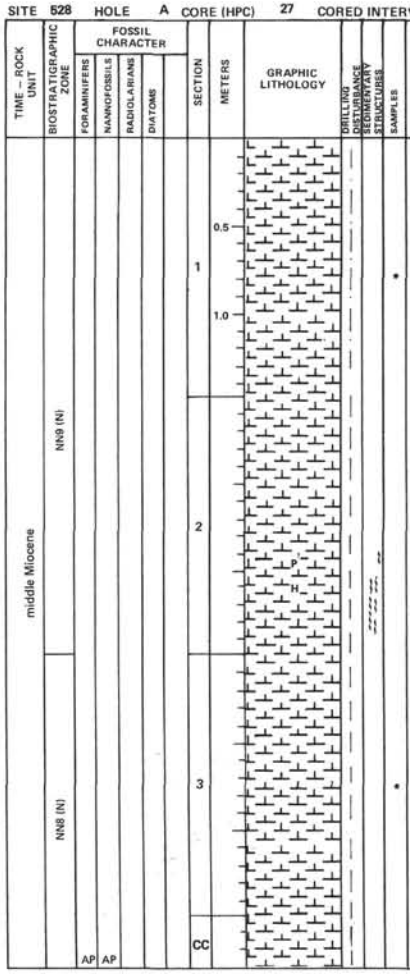
	1-80	2-80
	D	D
Composition:		
Foraminfiers	15	8
Calcareous nannofossils	85	92
Calcareous dinoflagellites	TR	TR

ORGANIC CARBON AND CARBONATE:

	1-45	2-45	3-45	3-130
Organic carbon	–	–	–	–
Carbonate	96	93	93	93

2.5Y 8/2

SITE 528 HOLE A CORE (HPC) 27 CORED INTERVAL 112.9–117.3 m



LITHOLOGIC DESCRIPTION

2.5Y 8/2
white

2.5Y 8/2
to 2.5Y 7/2
light gray

2.5Y 6/4

2.5Y 7/2

NANNOFOSSIL OOZE

This core contains a white (N9) to light gray (2.5Y 7/2) nannofossil ooze. The ooze is predominantly homogeneous but at the bottom of Section 2 a moderately bioturbated zone is found. Planolites and halo burrows are recognized. This zone is a light yellowish brown (2.5Y 6/4).

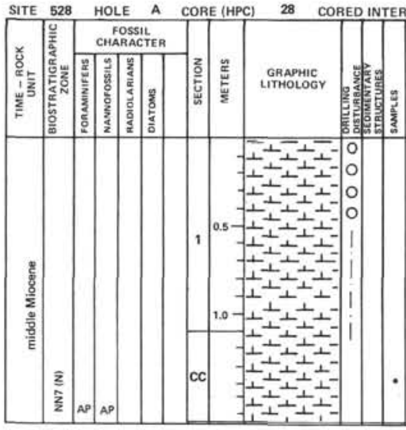
SMEAR SLIDE SUMMARY:

	1-80	3-80
	D	D
Composition:		
Volcanic glass	TR	TR
Foraminifers	5	2
Calcareous nannofossils	95	98

ORGANIC CARBON AND CARBONATE:

	1-10	2-10	3-10
Organic carbon	–	–	–
Carbonate	90	96	90

SITE 528 HOLE A CORE (HPC) 28 CORED INTERVAL 117.3–121.7 m



LITHOLOGIC DESCRIPTION

5Y 8/1
yellowish gray

5Y 8/2

2.5Y 6/4

2.5Y 5/4

NANNOFOSSIL OOZE

This core contains a yellowish gray (5Y 8/1) grading to a light olive brown (2.5Y 5/4) nannofossil ooze. A definite color change is noted in the Core-Catcher.

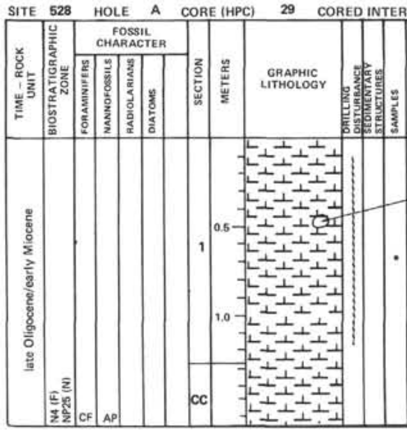
SMEAR SLIDE SUMMARY:

	CC
	D
Composition:	
Clay	TR
Volcanic glass	TR
Foraminifers	2
Calcareous nannofossils	98

ORGANIC CARBON AND CARBONATE:

	1-47	CC-28
Organic carbon	–	–
Carbonate	91	76

SITE 528 HOLE A CORE (HPC) 29 CORED INTERVAL 126.1–130.5 m



LITHOLOGIC DESCRIPTION

5YR 8/1

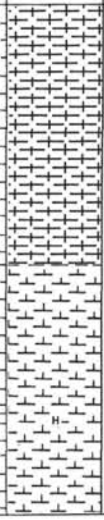
NANNOFOSSIL OOZE

This core contains a highly disturbed pinkish gray (5YR 8/1) nannofossil ooze. Black patches are found the most noticeable at 48 cm. They are MnO concretions, mixed with $CaCO_3$.

SMEAR SLIDE SUMMARY:

	1-70
	D
Composition:	
Volcanic glass	TR
Carbonate unspecified	TR
Foraminifers	1
Calcareous nannofossils	99

SITE 528 HOLE A CORE (HPC) 30 CORED INTERVAL 126.6–130.5 m

TIME – ROCK UNIT	BIOSTRATIGRAPHIC ZONE	FOSSIL CHARACTER: FORAMINIFERS	NANNOFOSSILS	RADIOLARIANS	DIATOMS		SECTION	METERS	GRAPHIC LITHOLOGY	DRILLING DISTURBANCE	SEDIMENTARY STRUCTURES	SAMPLES
late Oligocene	P21–22 (F) NP24 (N)	CF	AP				1 2 CC	0.5 1.0				• •

LITHOLOGIC DESCRIPTION

5YR 8/1

5YR 8/2

FORAMINIFER NANNOFOSSIL AND NANNOFOSSIL OOZE

This core contains a homogeneous pinkish white (5YR 8/2) and pinkish gray (5YR 8/1) foraminifer nannofossil and nannofossil ooze.

Section 2 contains some diffuse black blebs which are interpreted to be *MnO* concretions. They are poorly consolidated.

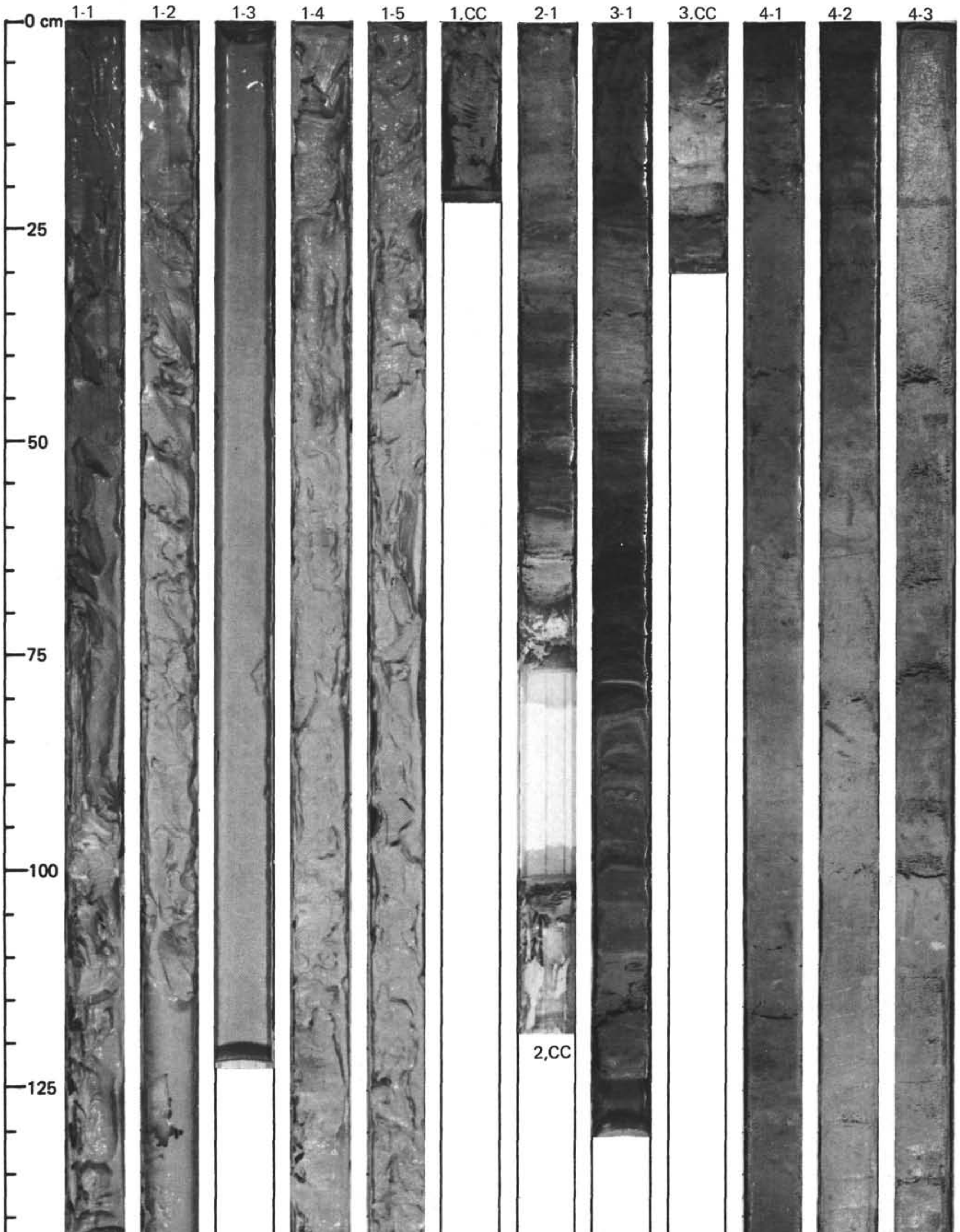
One halo burrow is recognized in the Core-Catcher.

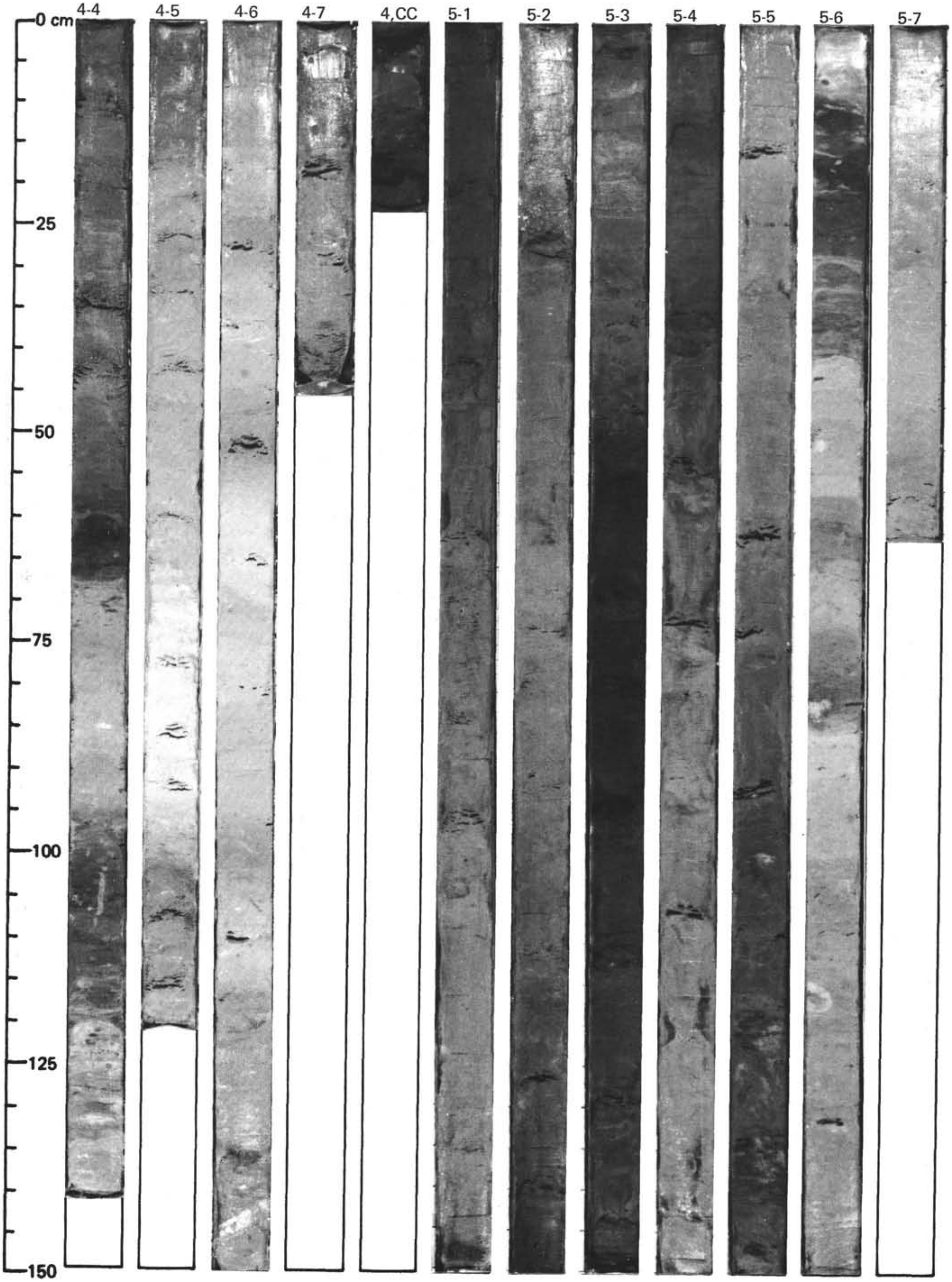
SMEAR SLIDE SUMMARY:

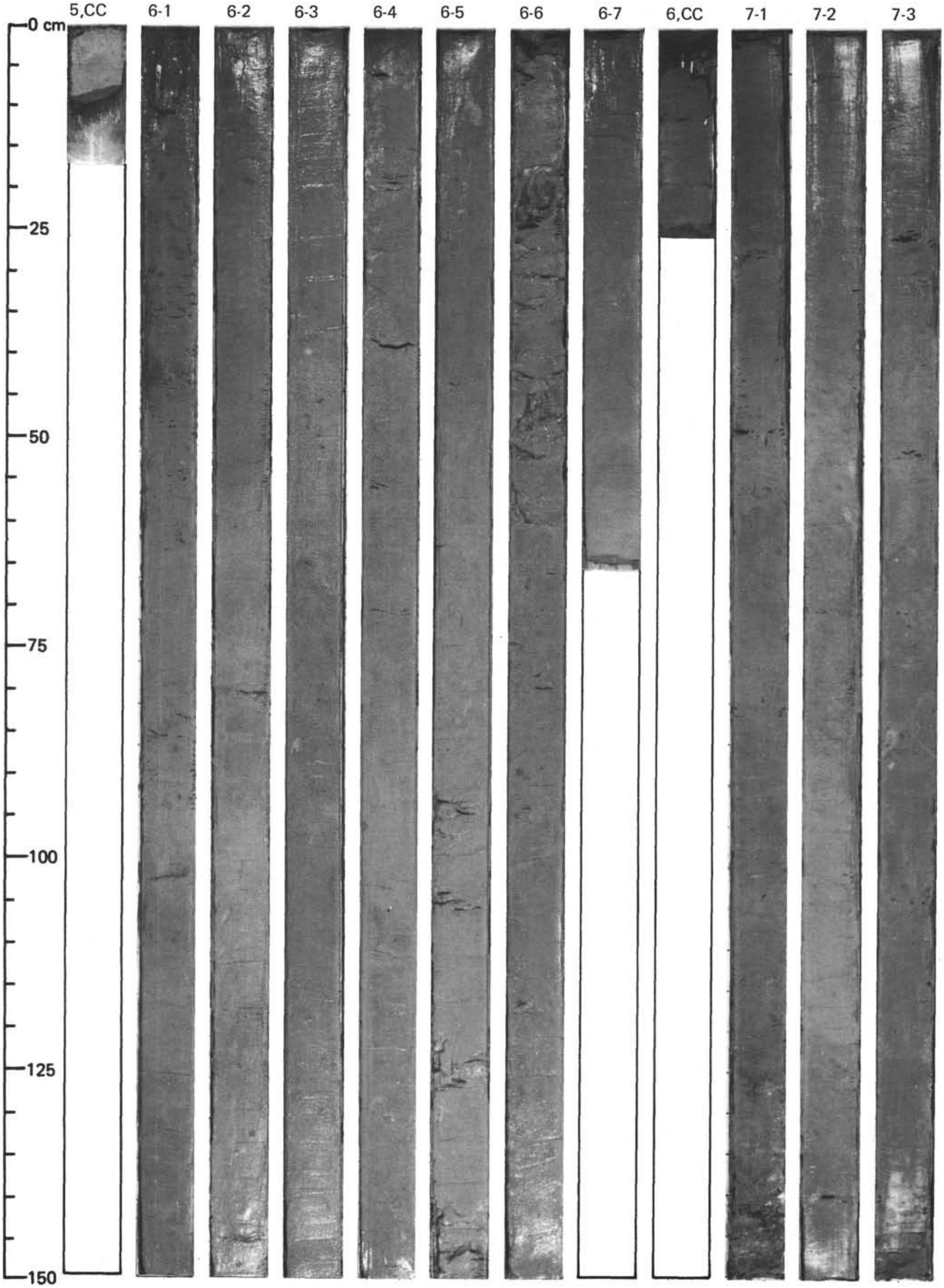
	1-80	2-40
	D	D
Composition:		
Clay	TR	–
Volcanic glass	–	TR
Foraminifers	10	5
Calcareous nannofossils	90	95

ORGANIC CARBON AND CARBONATE:

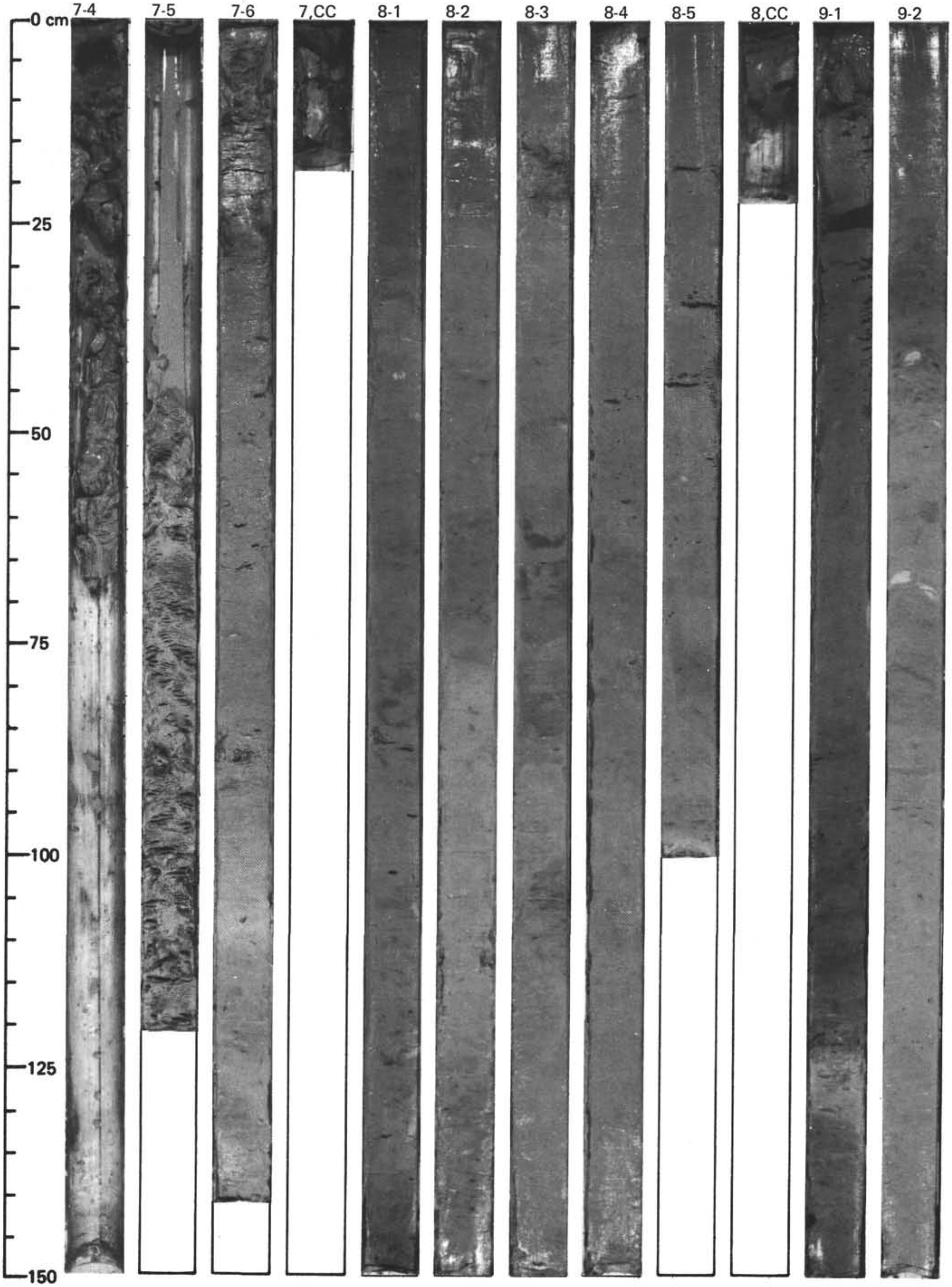
	1-10	2-10
Organic carbon	–	–
Carbonate	92	92

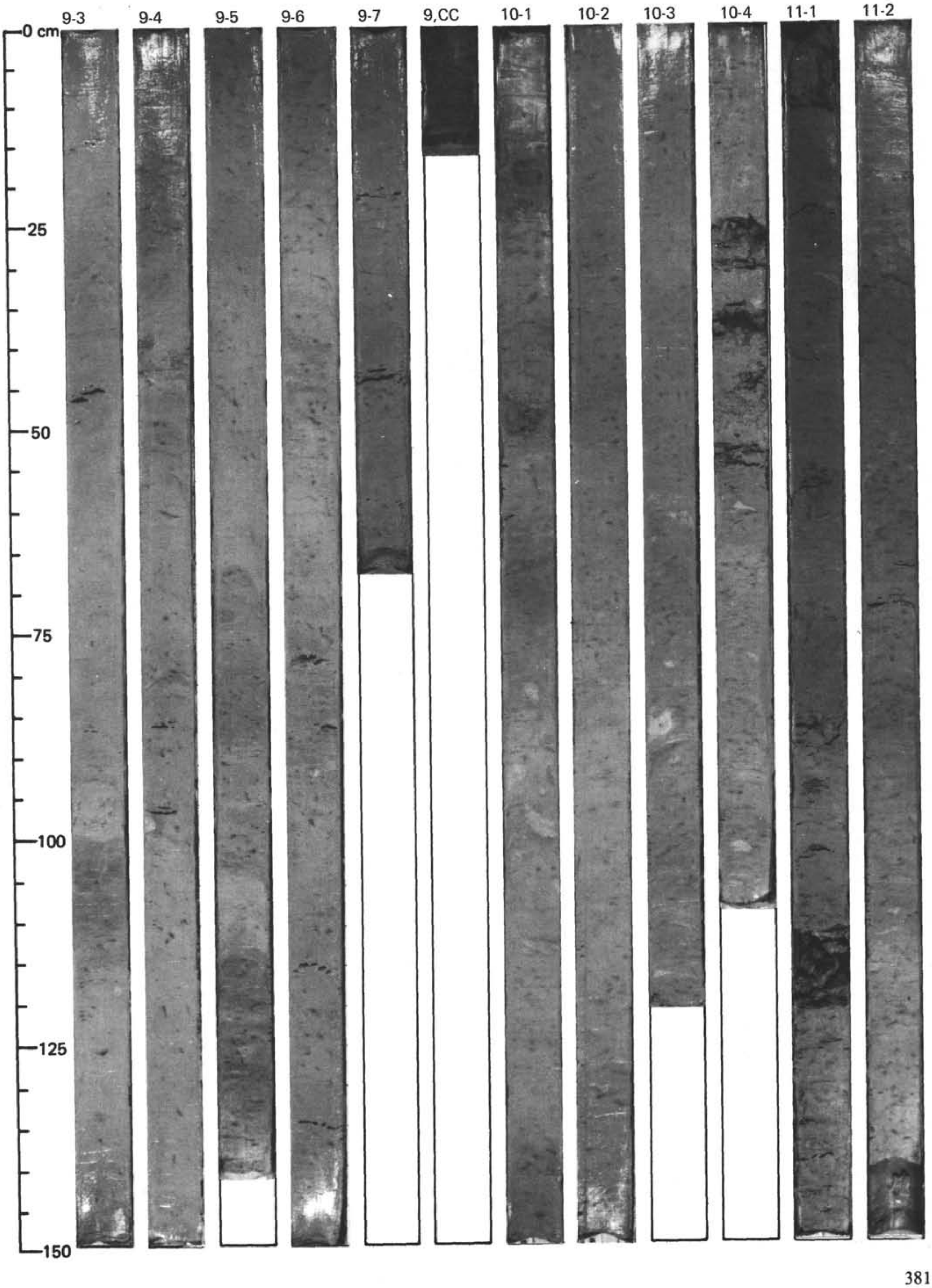

0 cm
25
50
75
100
125
150
1-1
1-2
1-3
1-4
1-5
1,CC
2-1
3-1
3,CC
4-1
4-2
4-3
2,CC

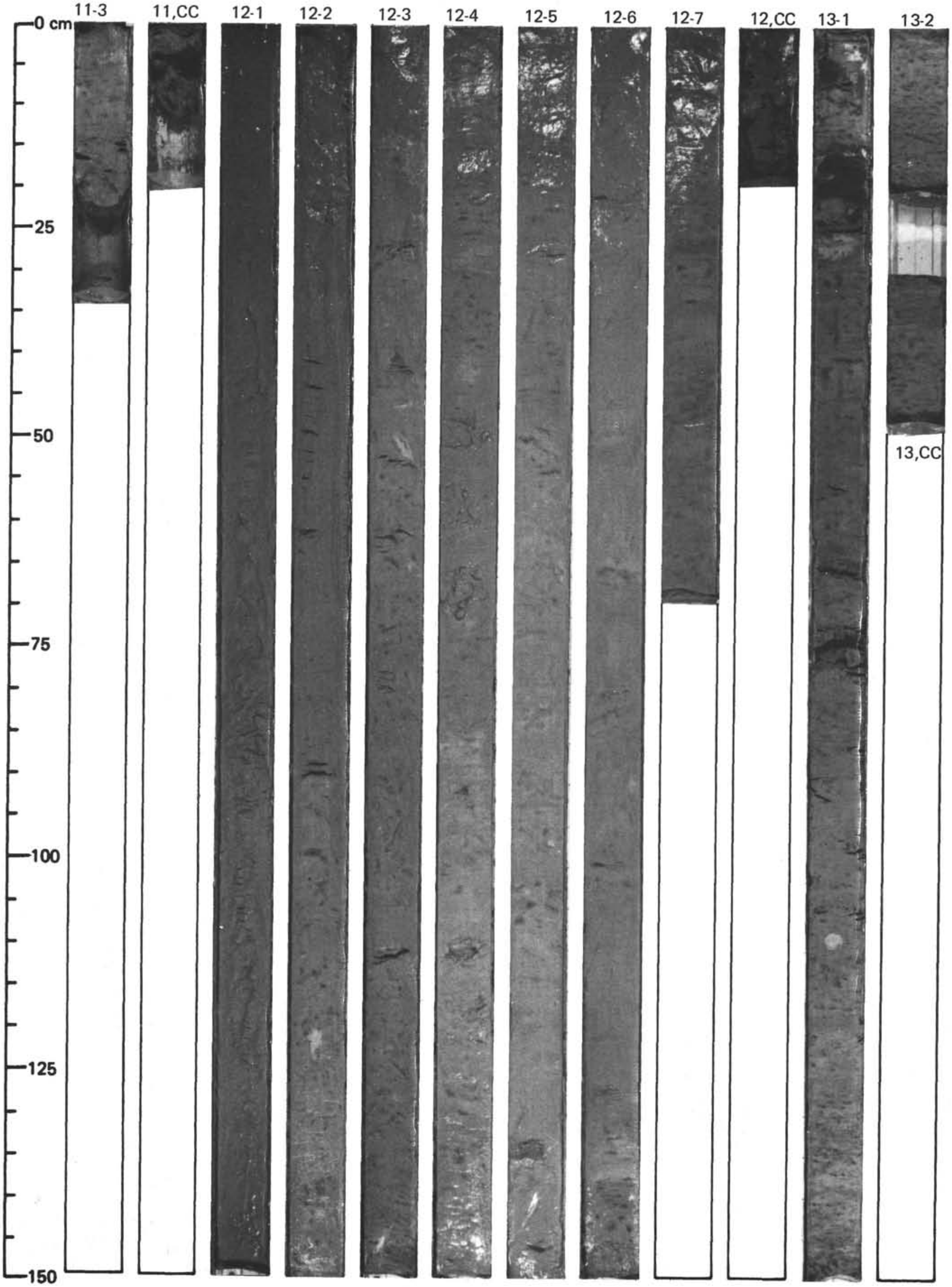

4-4
4-5
4-6
4-7
4,CC
5-1
5-2
5-3
5-4
5-5
5-6
5-7
0 cm
25
50
75
100
125
150

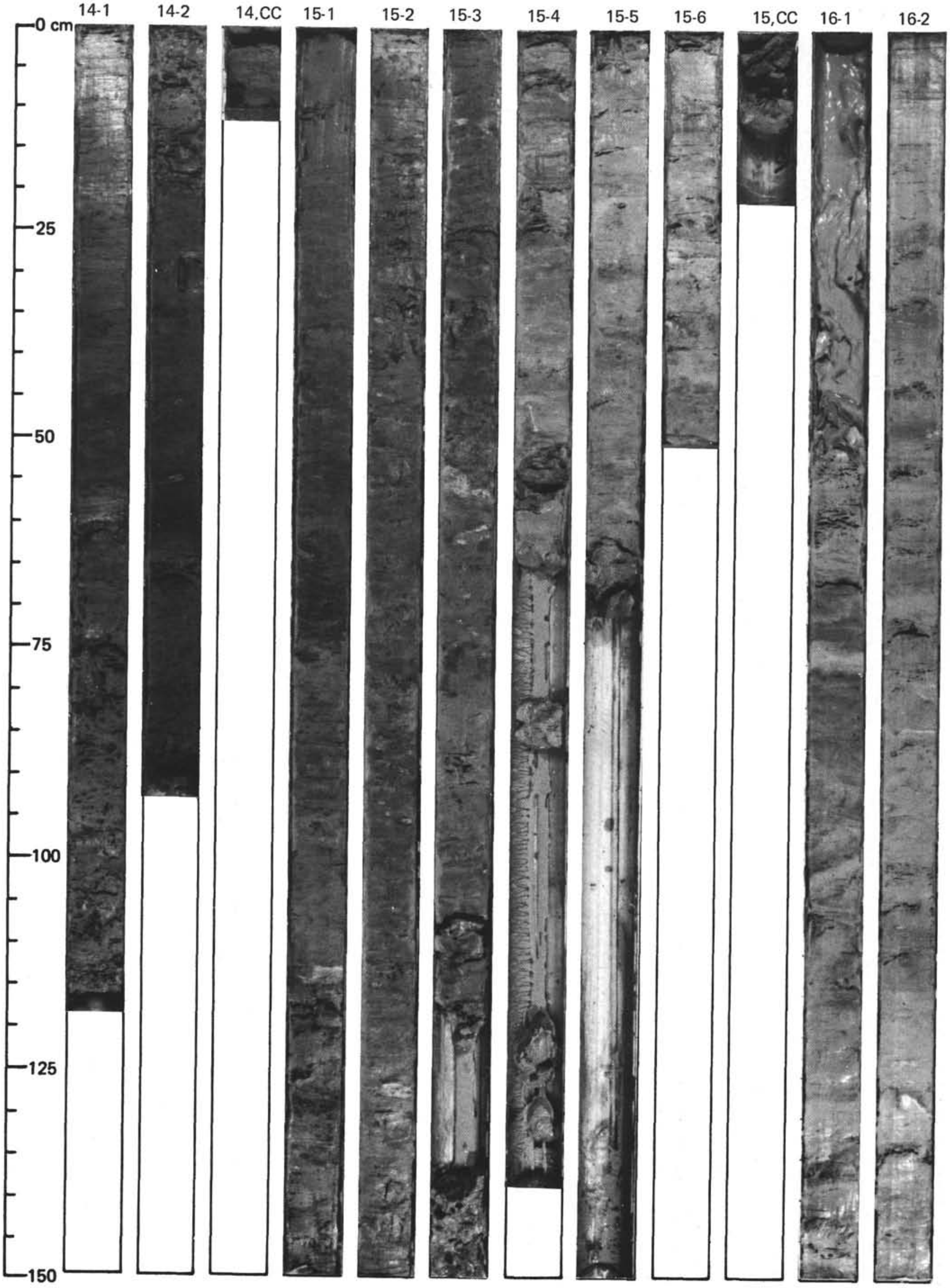


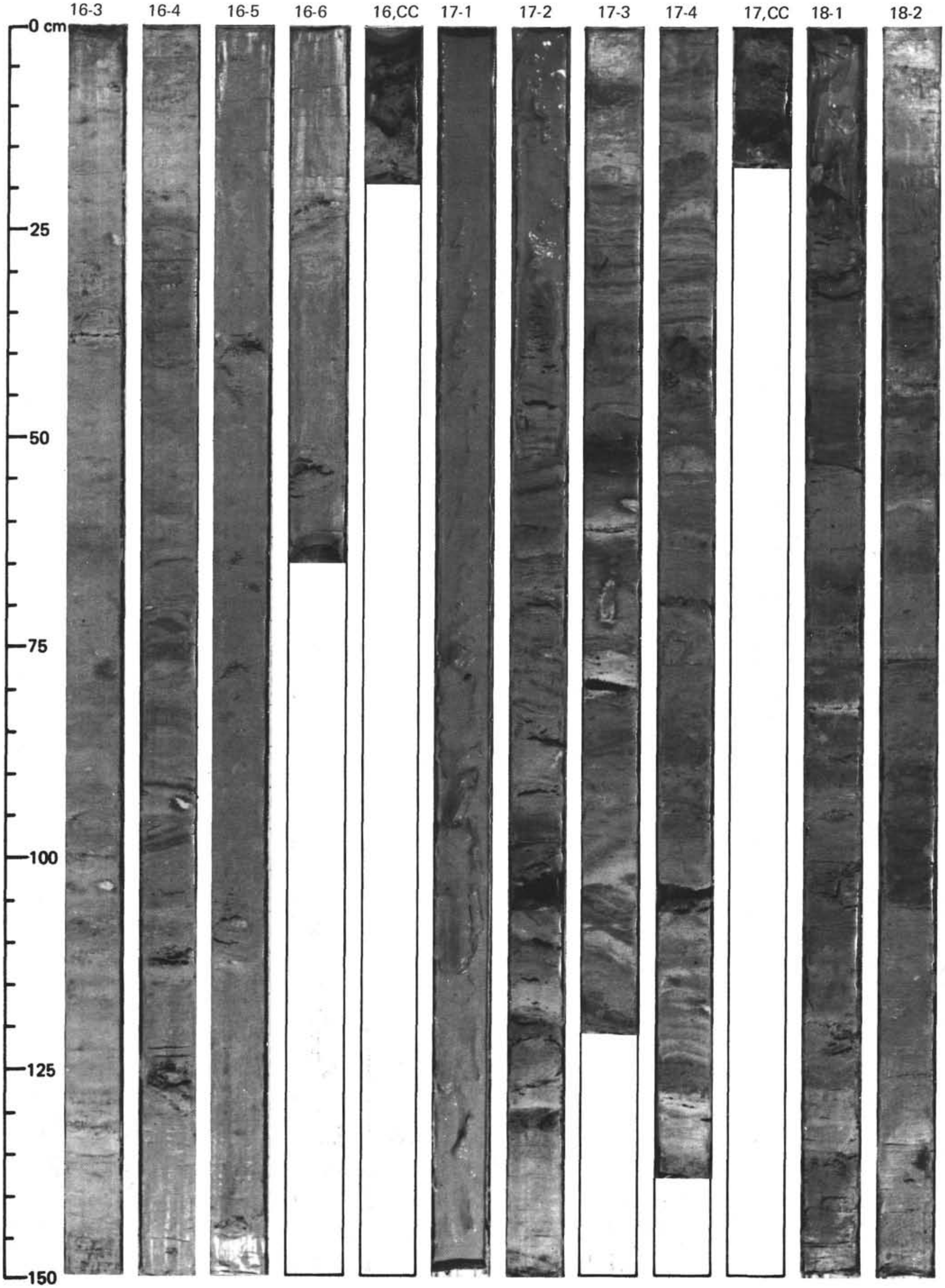
0 cm
25
50
75
100
125
150
5,CC
6-1
6-2
6-3
6-4
6-5
6-6
6-7
6,CC
7-1
7-2
7-3

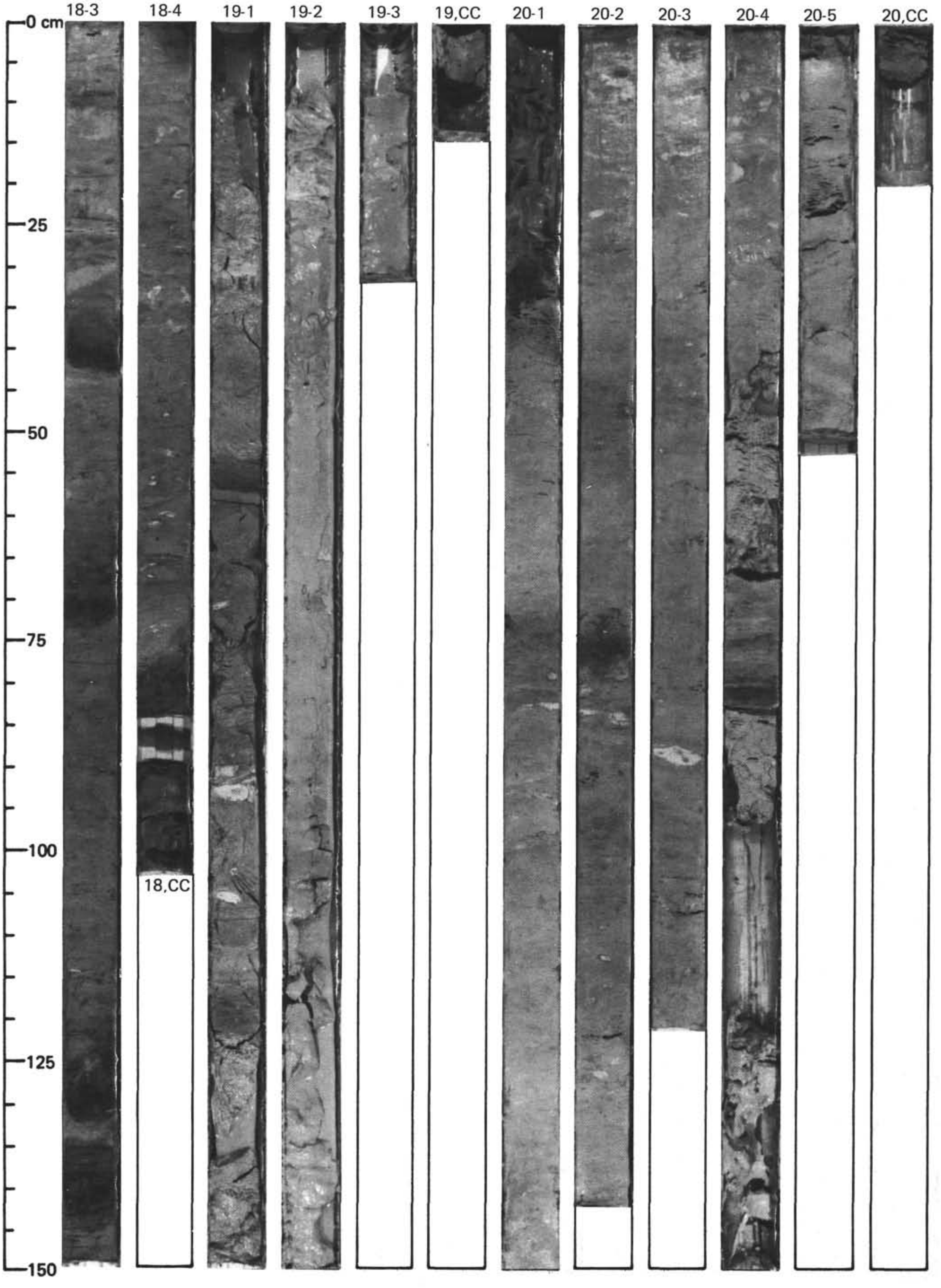

0 cm
25
50
75
100
125
150
7-4
7-5
7-6
7,CC
8-1
8-2
8-3
8-4
8-5
8,CC
9-1
9-2

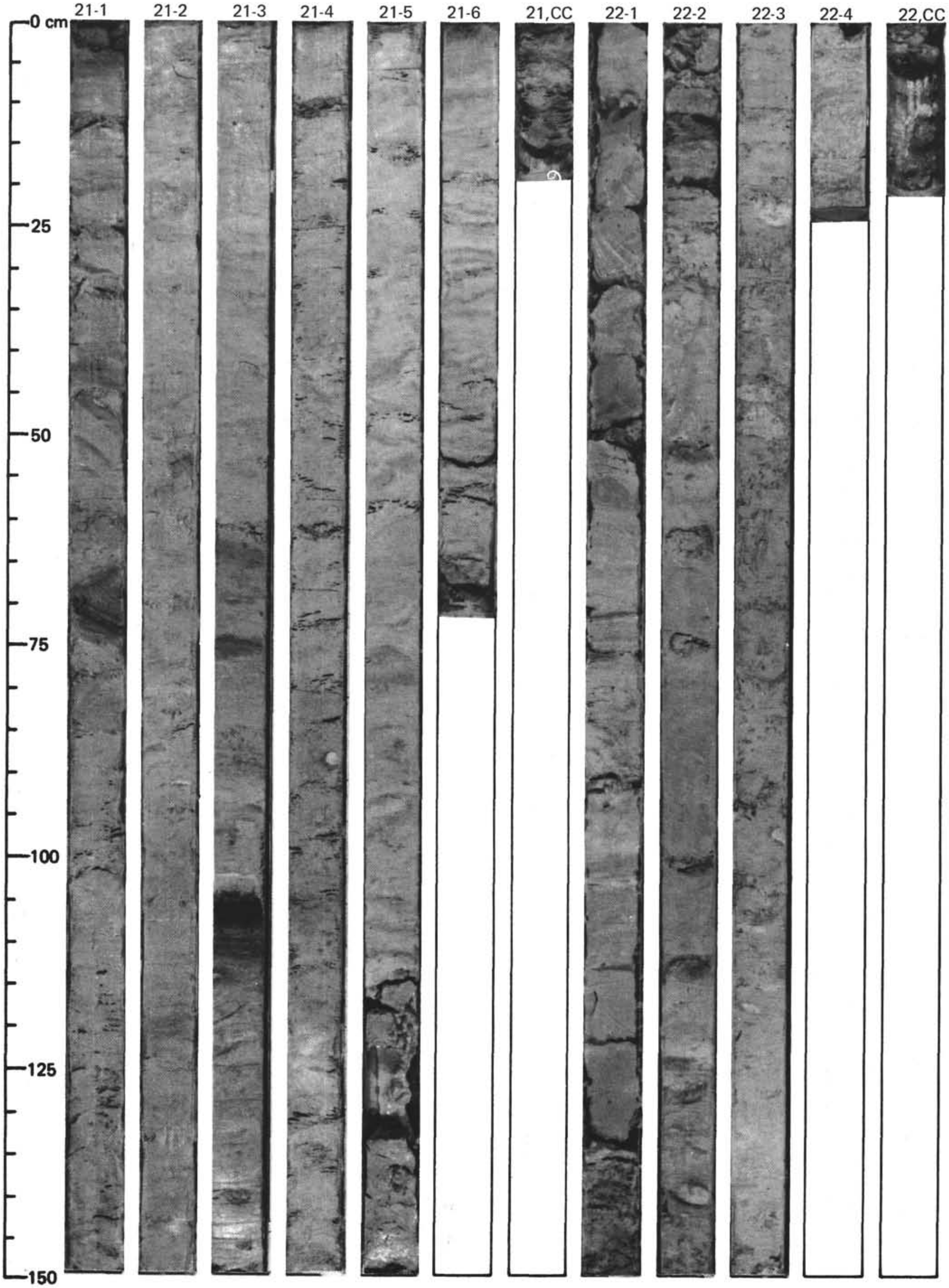

9-3
9-4
9-5
9-6
9-7
9,CC
10-1
10-2
10-3
10-4
11-1
11-2
0 cm
25
50
75
100
125
150


11-3
11,CC
12-1
12-2
12-3
12-4
12-5
12-6
12-7
12,CC
13-1
13-2
13,CC
0 cm
25
50
75
100
125
150

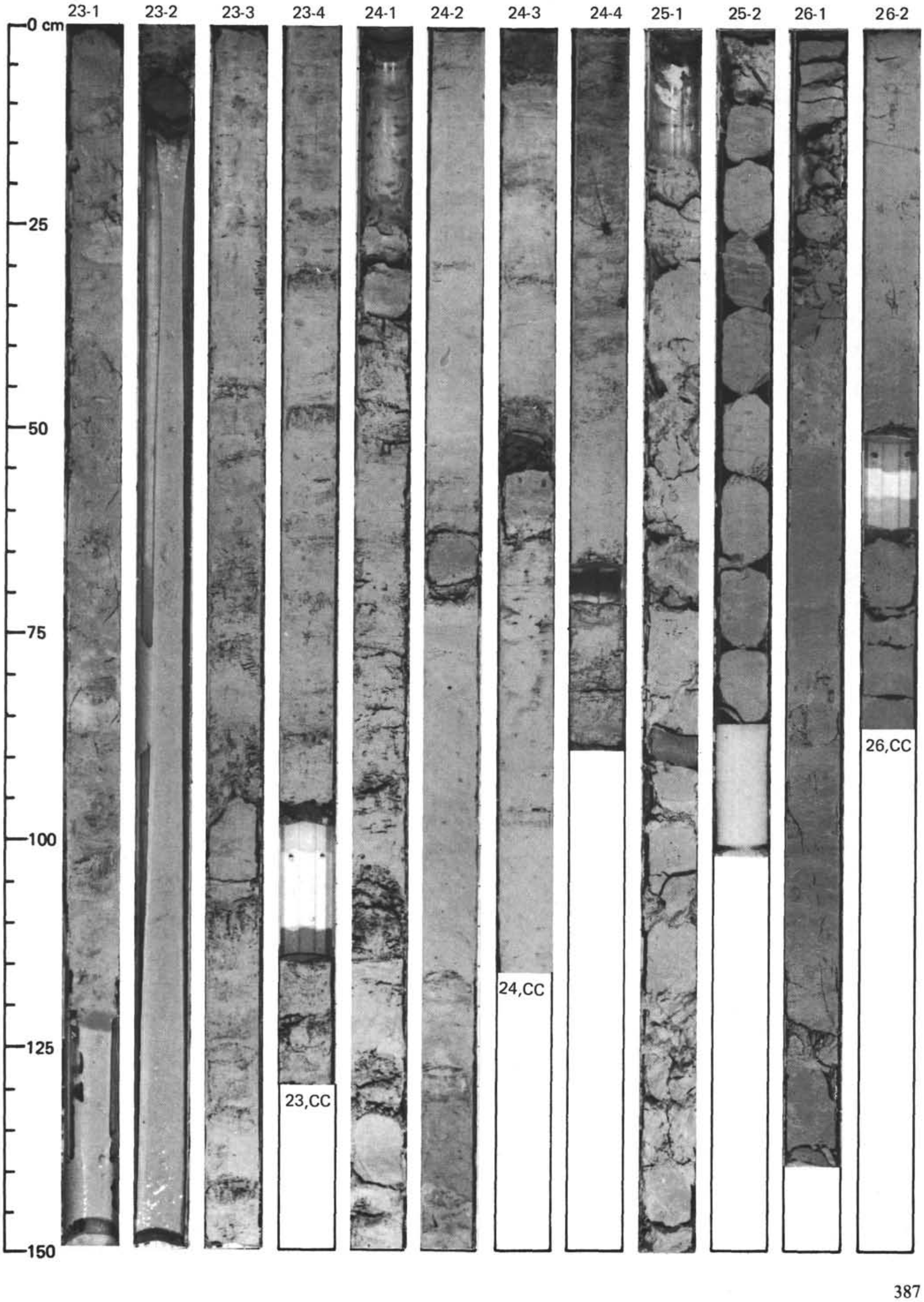

14-1
14-2
14,CC
15-1
15-2
15-3
15-4
15-5
15-6
15,CC
16-1
16-2
0 cm
25
50
75
100
125
150

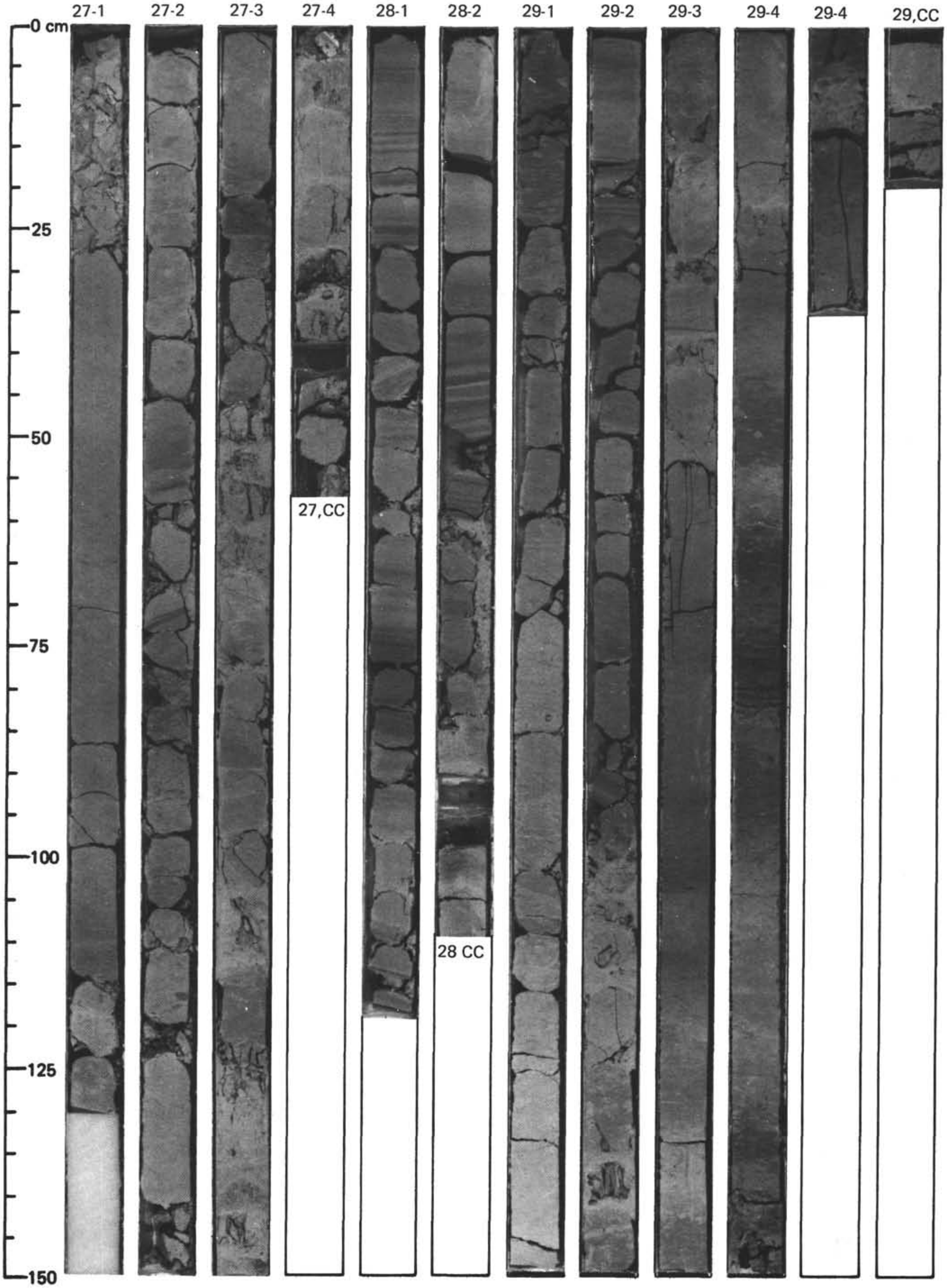

16-3
16-4
16-5
16-6
16,CC
17-1
17-2
17-3
17-4
17,CC
18-1
18-2
0 cm
25
50
75
100
125
150

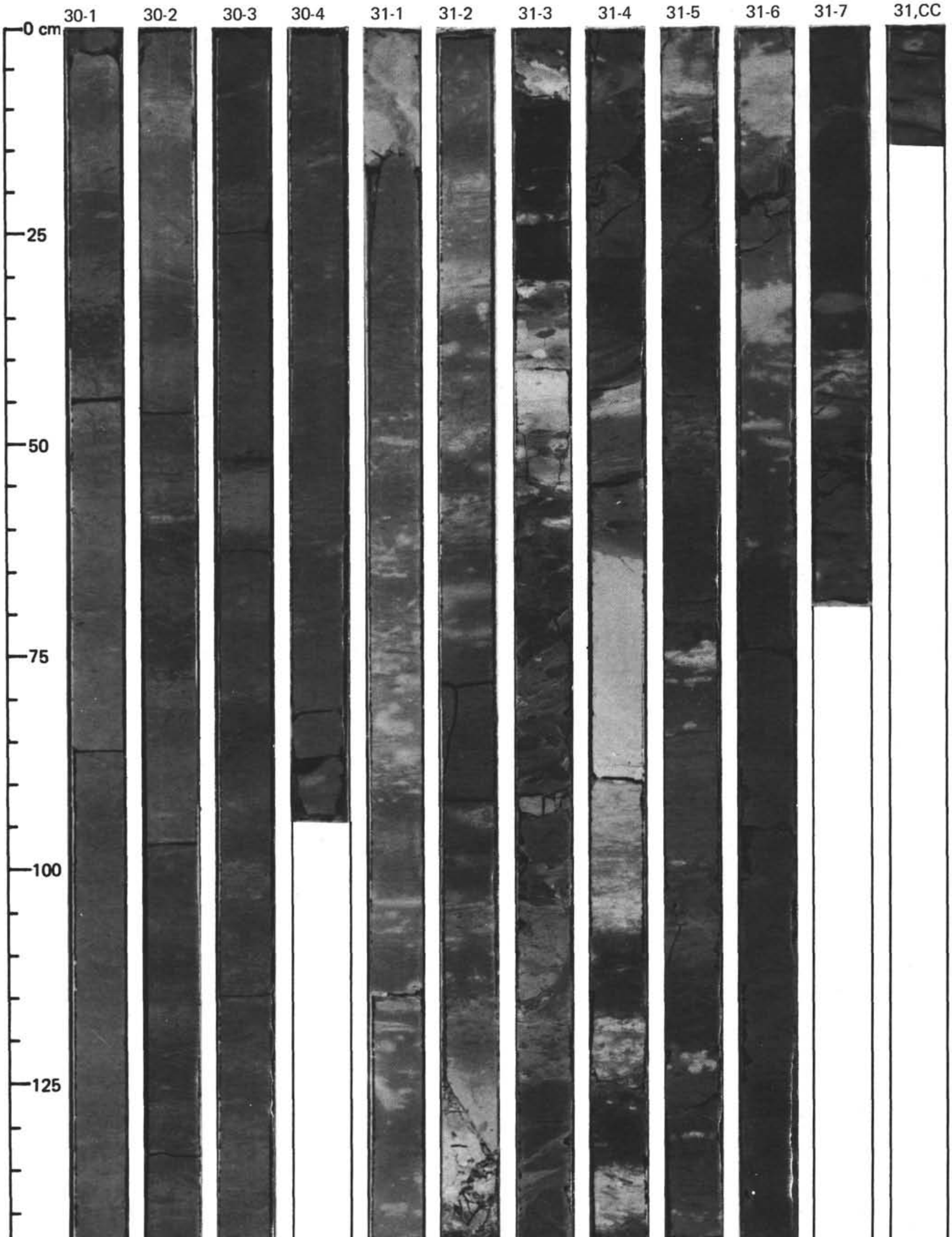

18-3
18-4
19-1
19-2
19-3
19,CC
20-1
20-2
20-3
20-4
20-5
20,CC
0 cm
25
50
75
100
125
150
18,CC

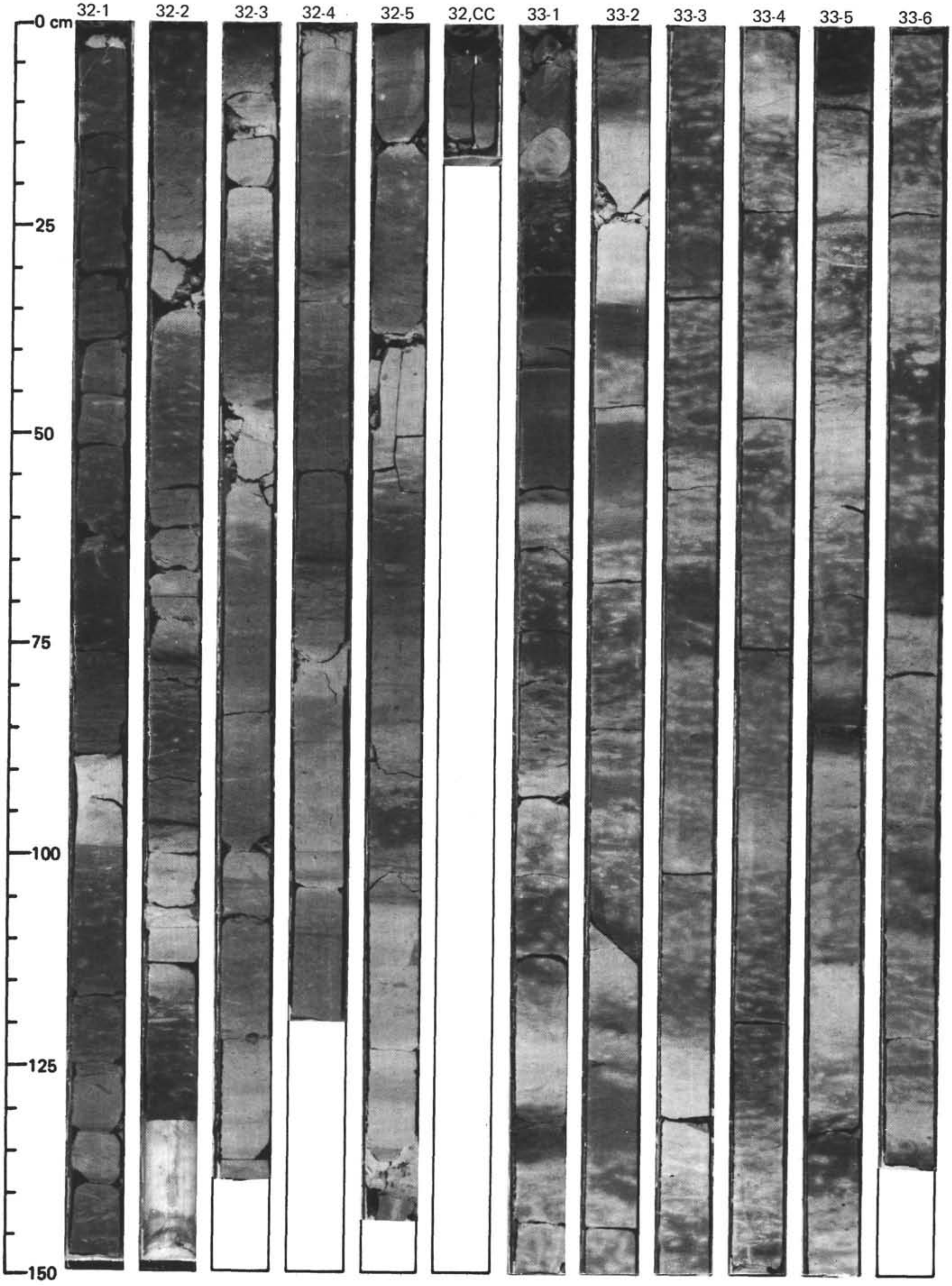


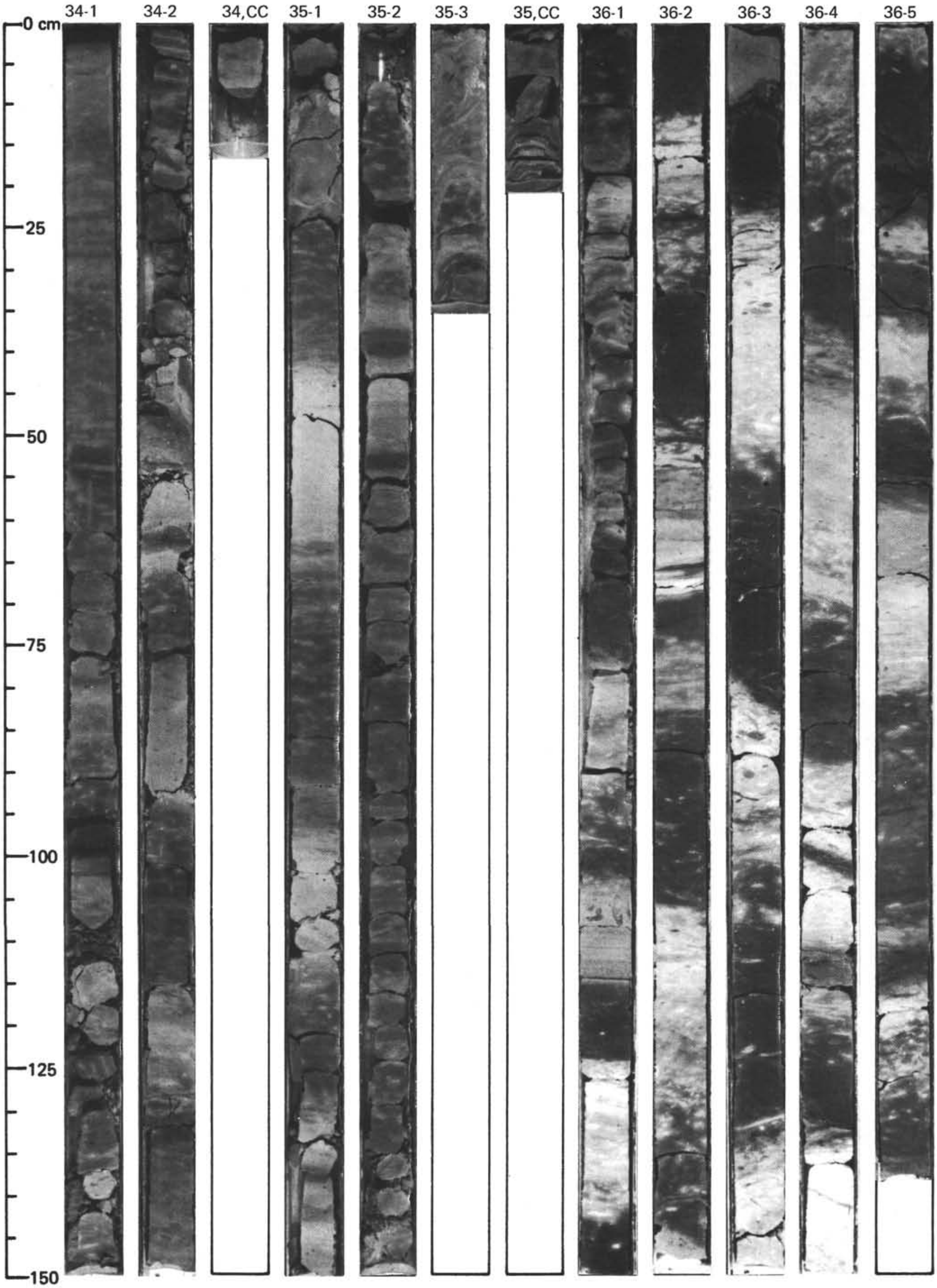
21-1
21-2
21-3
21-4
21-5
21-6
21,CC
22-1
22-2
22-3
22-4
22,CC
0 cm
25
50
75
100
125
150

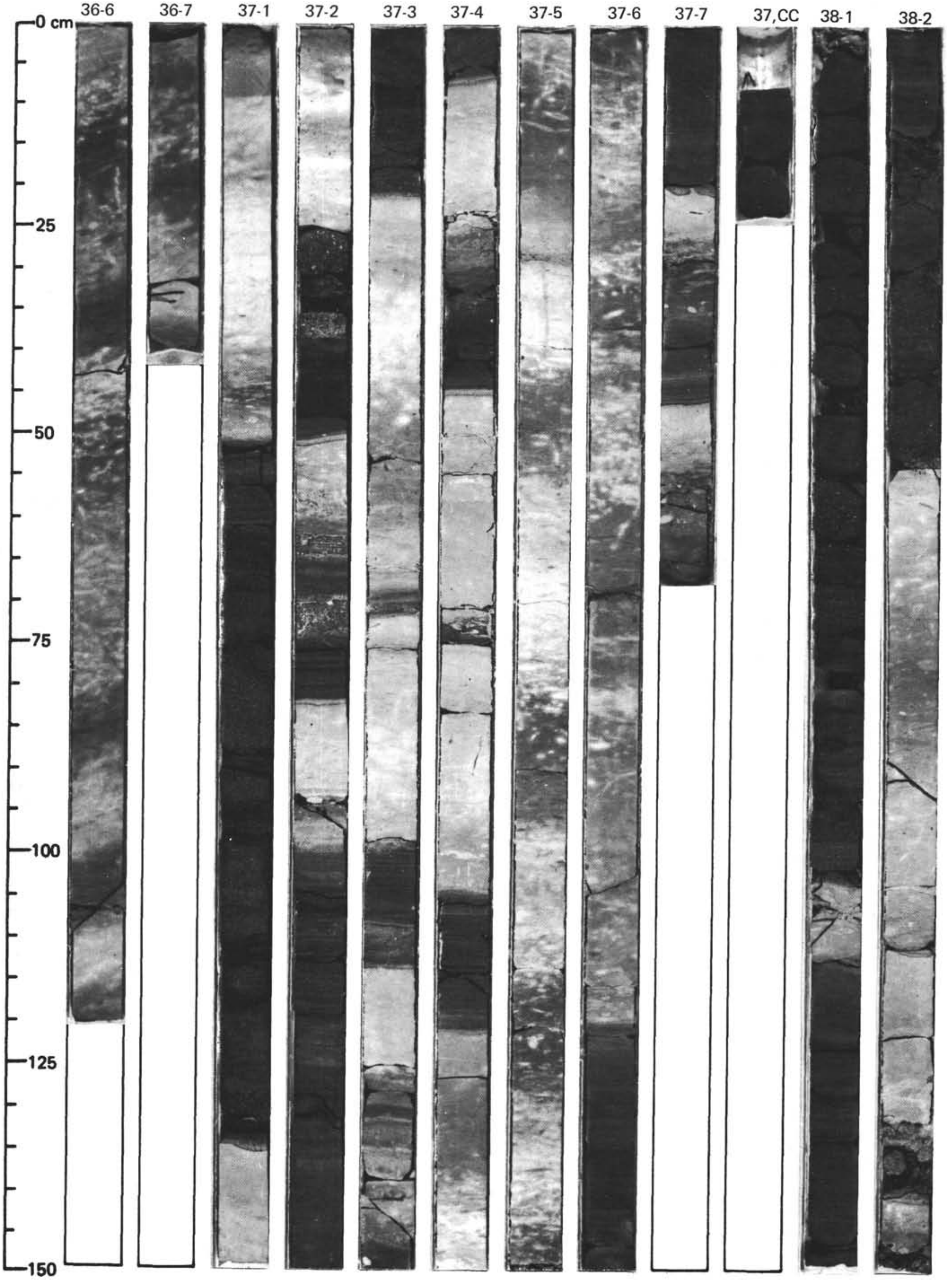

23-1
23-2
23-3
23-4
24-1
24-2
24-3
24-4
25-1
25-2
26-1
26-2
0 cm
25
50
75
100
125
150
23,CC
24,CC
26,CC

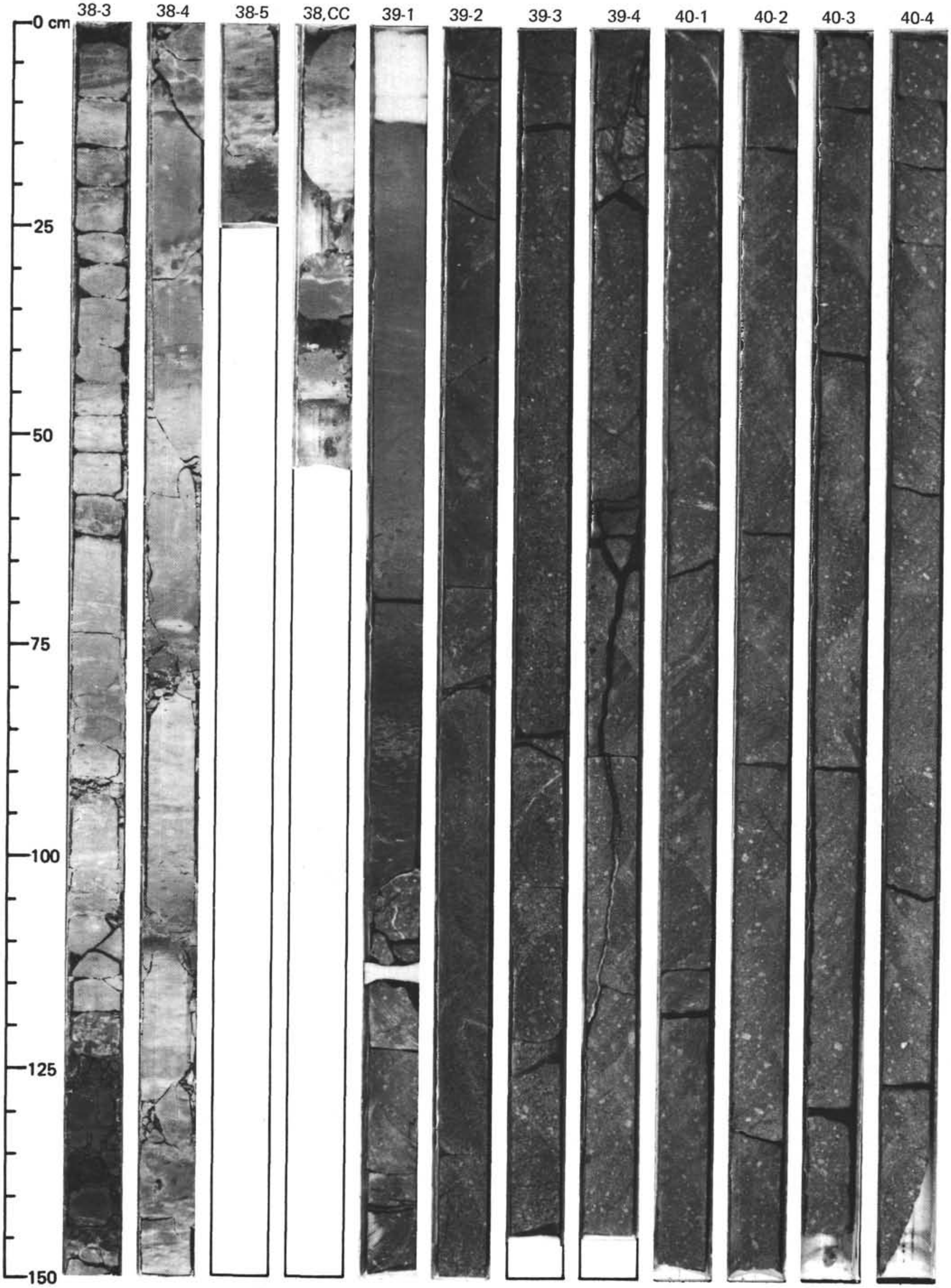

27-1
27-2
27-3
27-4
28-1
28-2
29-1
29-2
29-3
29-4
29-4
29,CC
0 cm
25
50
75
100
125
150
27,CC
28 CC

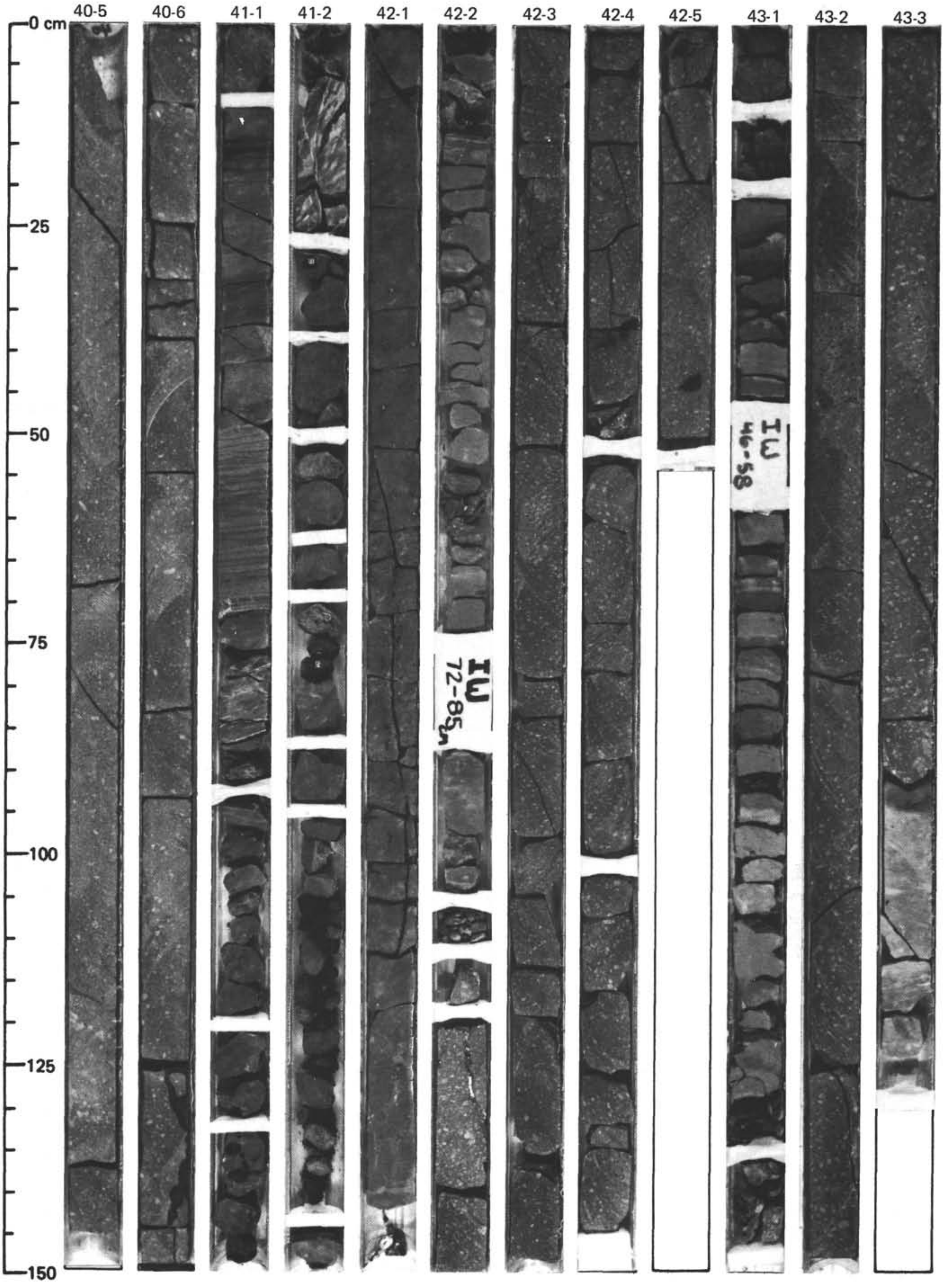

30-1
30-2
30-3
30-4
31-1
31-2
31-3
31-4
31-5
31-6
31-7
31,CC
0 cm
25
50
75
100
125
150

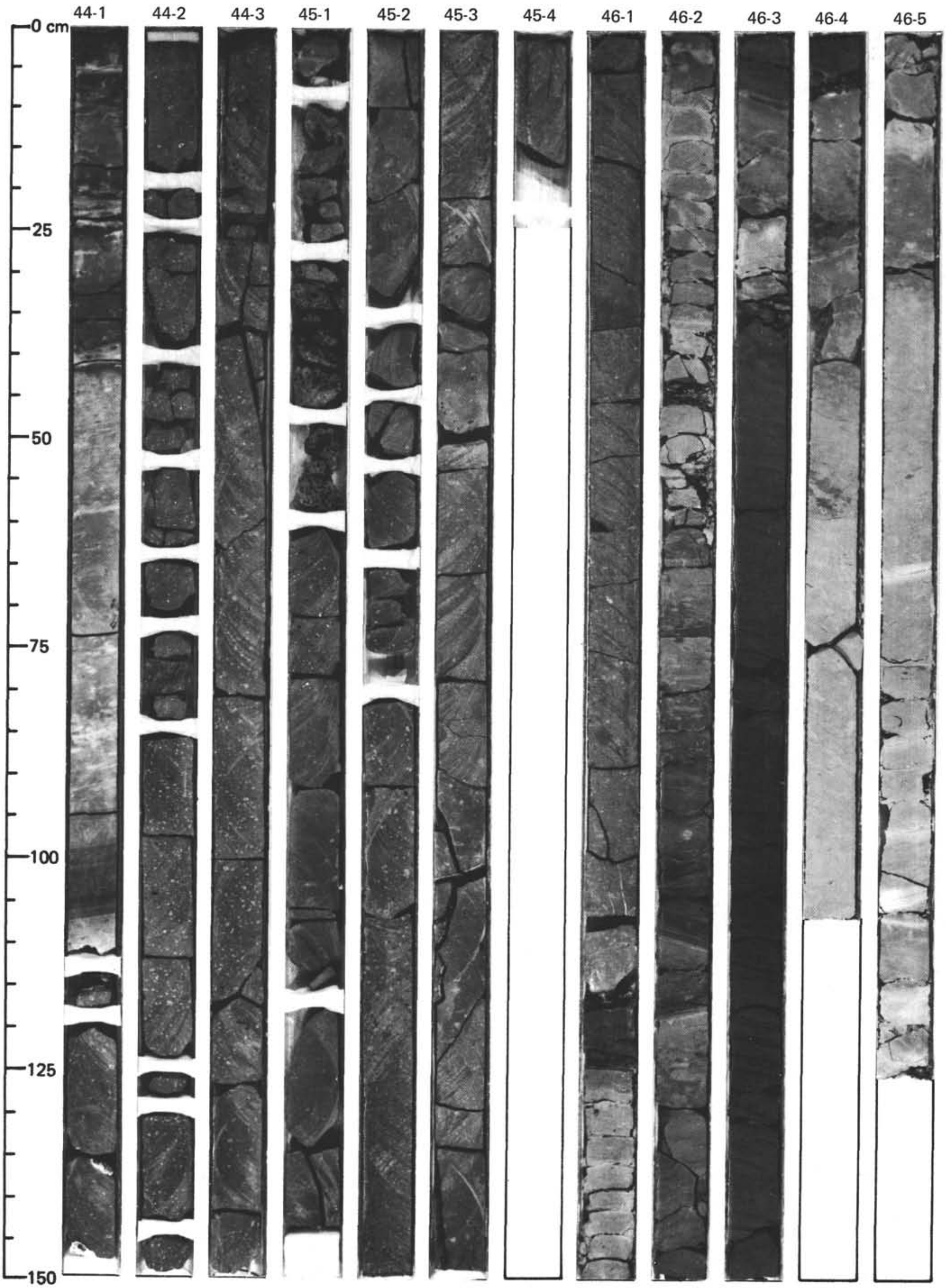

32-1
32-2
32-3
32-4
32-5
32,CC
33-1
33-2
33-3
33-4
33-5
33-6
0 cm
25
50
75
100
125
150

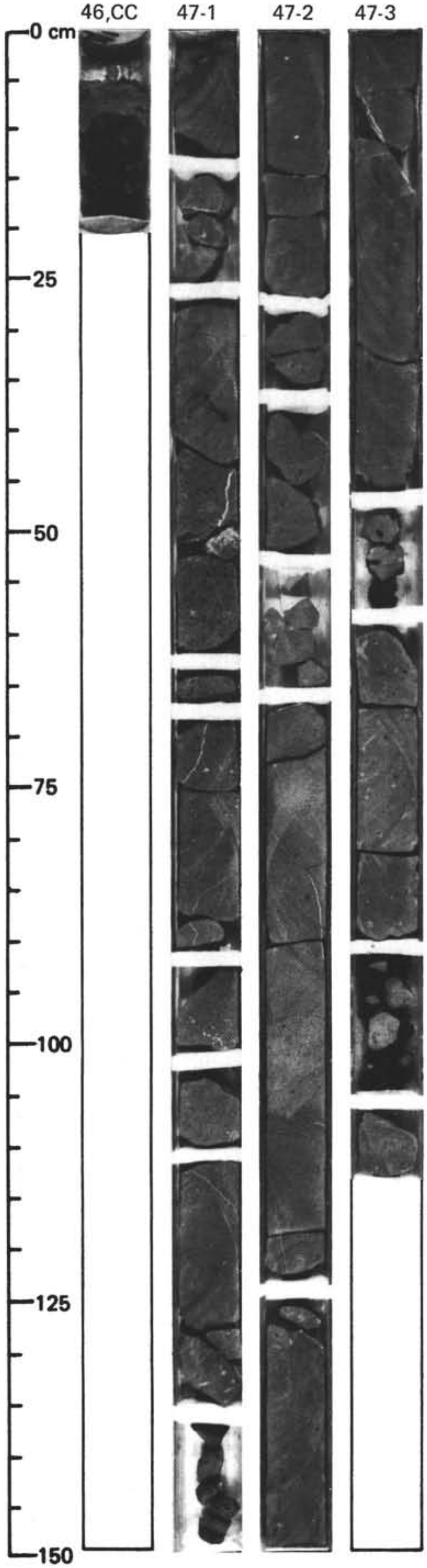

34-1
34-2
34,CC
35-1
35-2
35-3
35,CC
36-1
36-2
36-3
36-4
36-5
0 cm
25
50
75
100
125
150

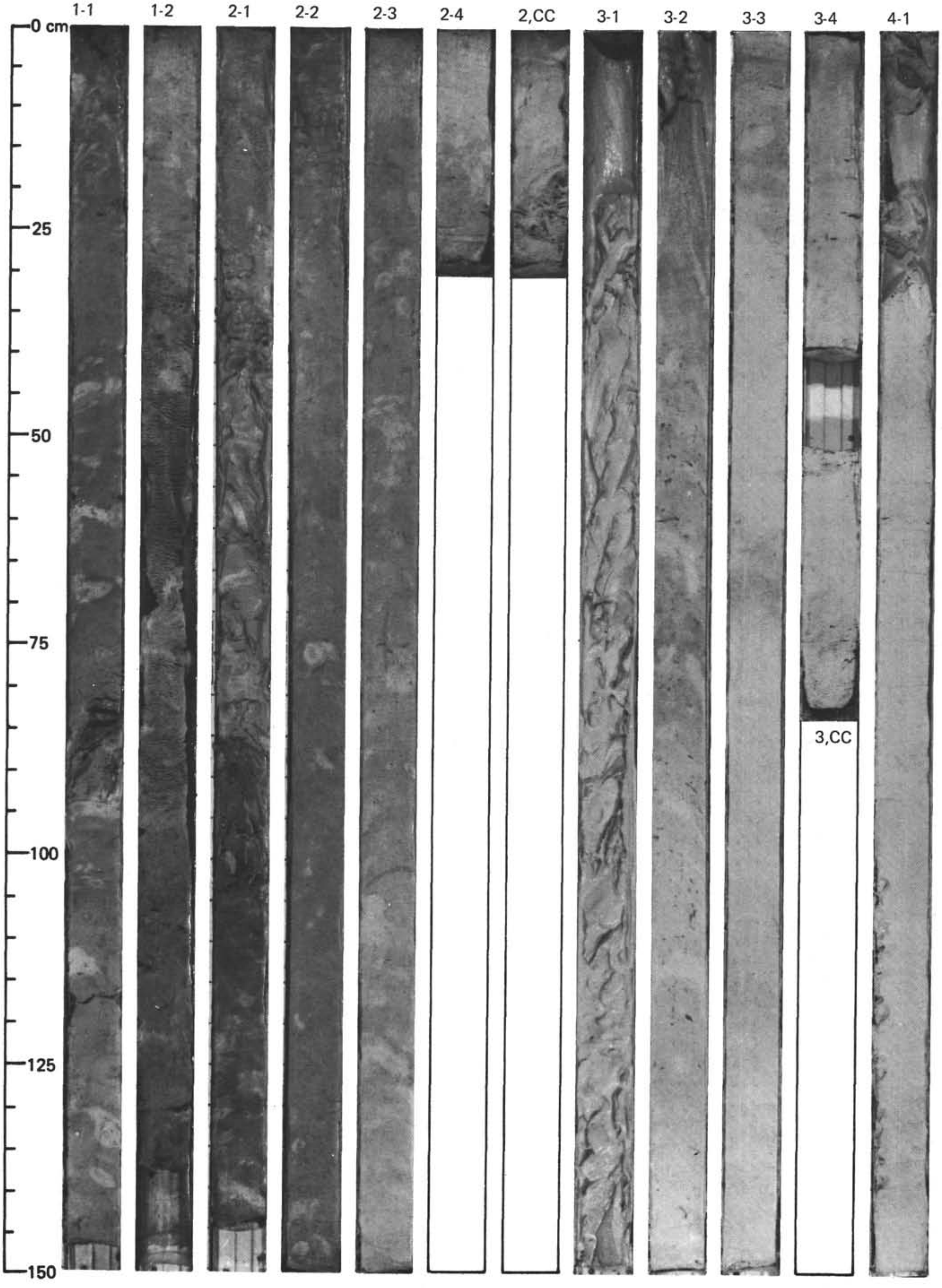

36-6
36-7
37-1
37-2
37-3
37-4
37-5
37-6
37-7
37,CC
38-1
38-2
0 cm
25
50
75
100
125
150

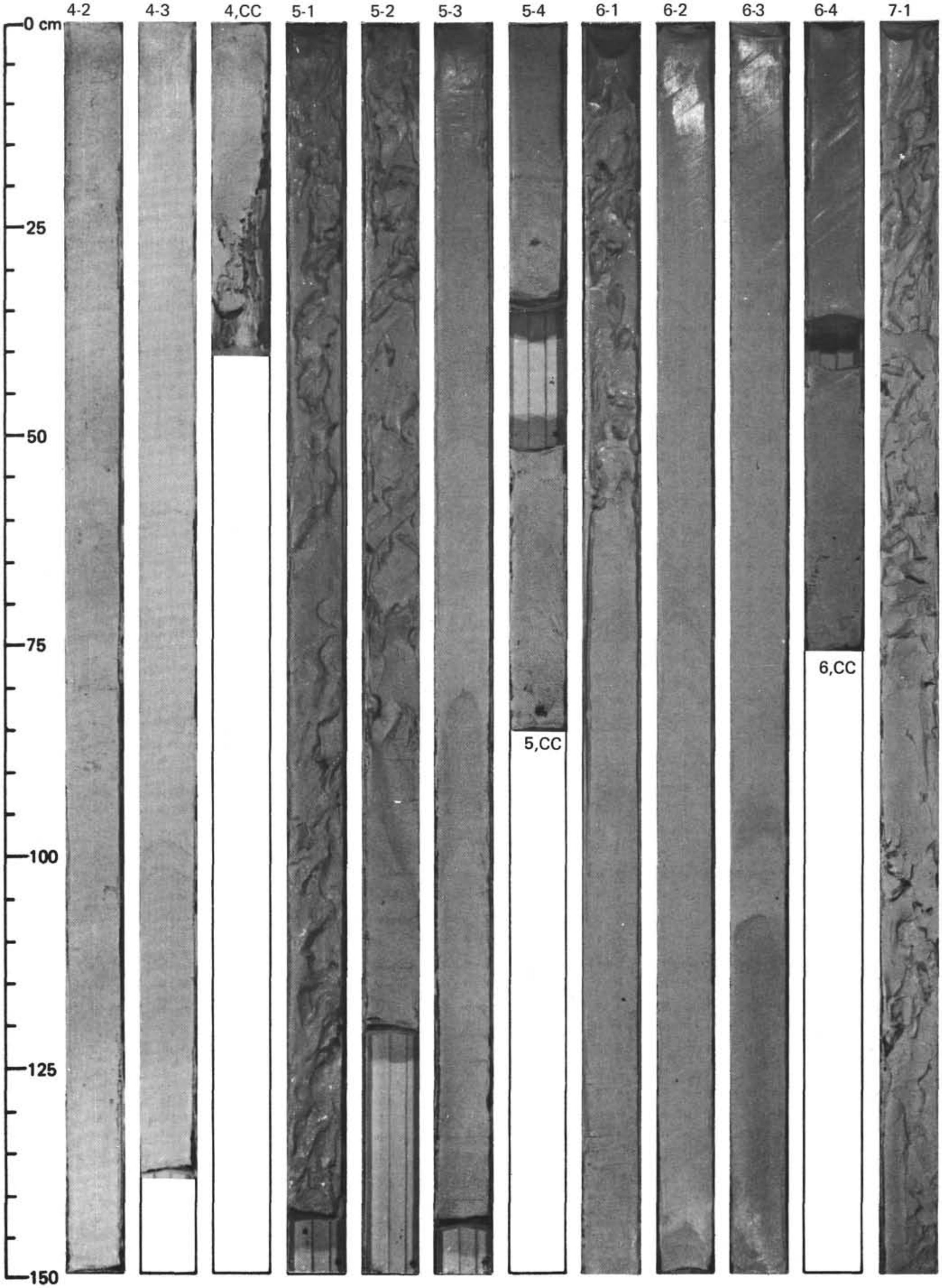

38-3
38-4
38-5
38,CC
39-1
39-2
39-3
39-4
40-1
40-2
40-3
40-4
0 cm
25
50
75
100
125
150

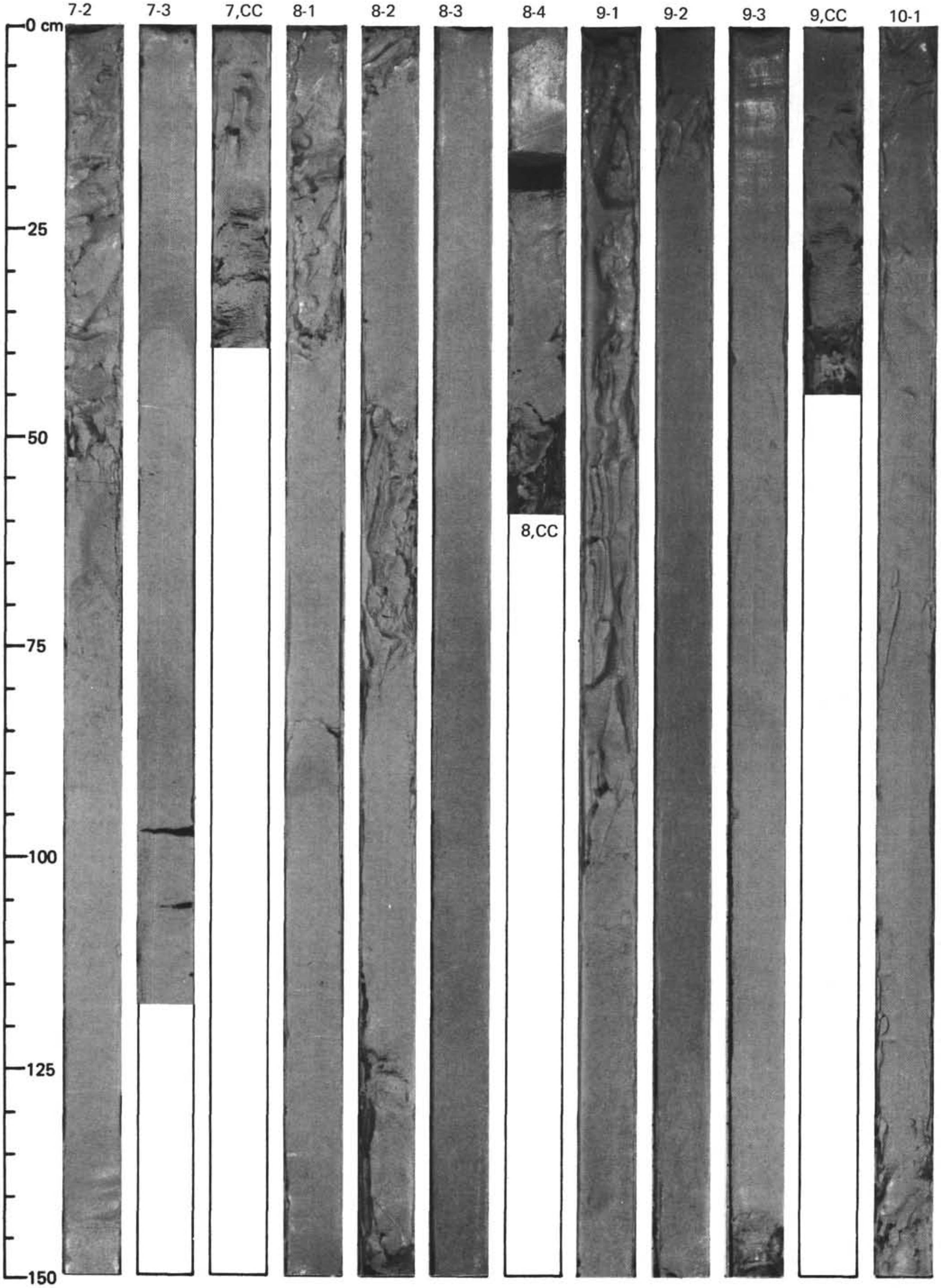

40-5
40-6
41-1
41-2
42-1
42-2
42-3
42-4
42-5
43-1
43-2
43-3
0 cm
25
50
75
100
125
150
IW 72-85
IW 46-58

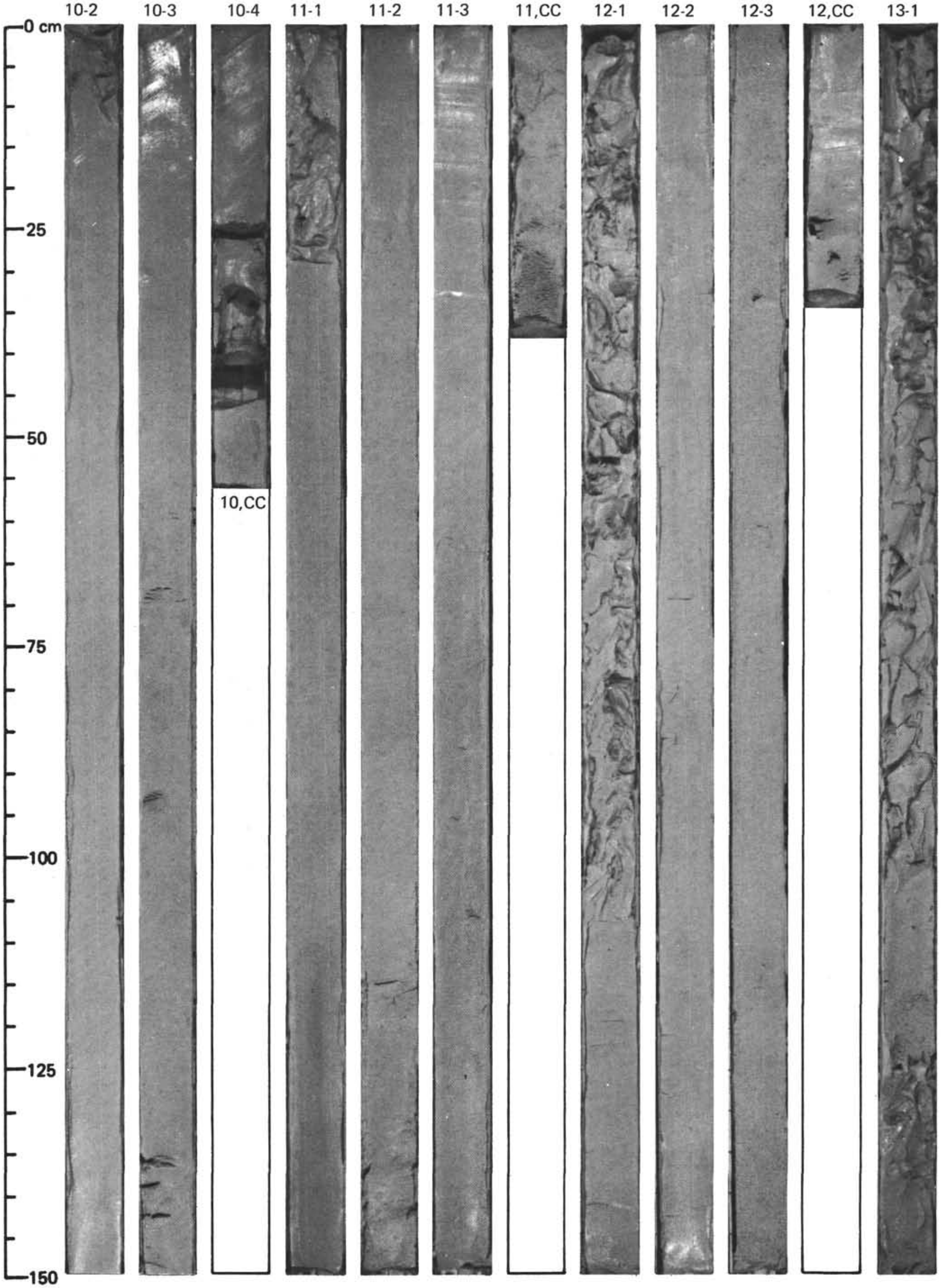

44-1
44-2
44-3
45-1
45-2
45-3
45-4
46-1
46-2
46-3
46-4
46-5
0 cm
25
50
75
100
125
150

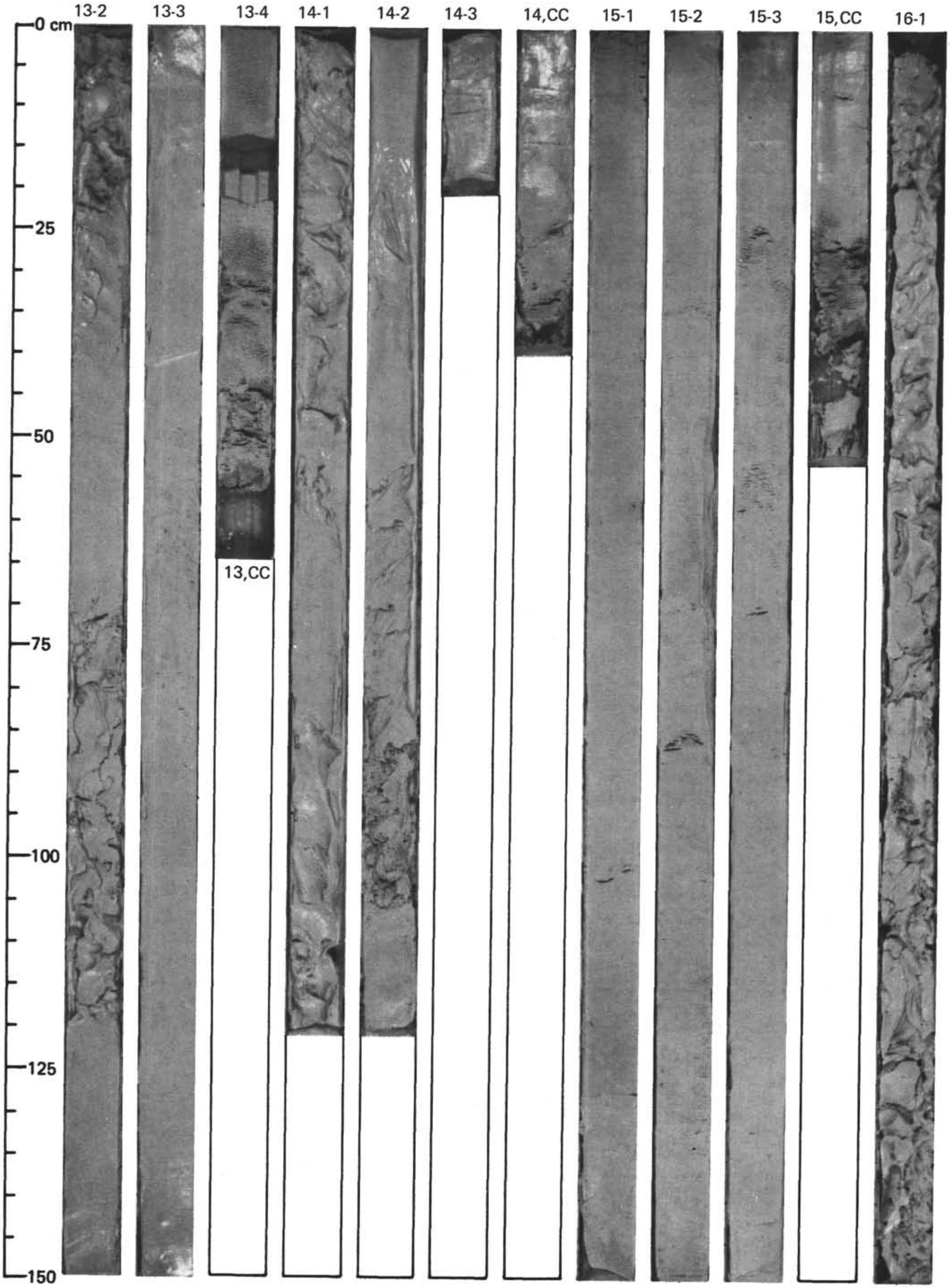

46,CC
47-1
47-2
47-3
0 cm
25
50
75
100
125
150

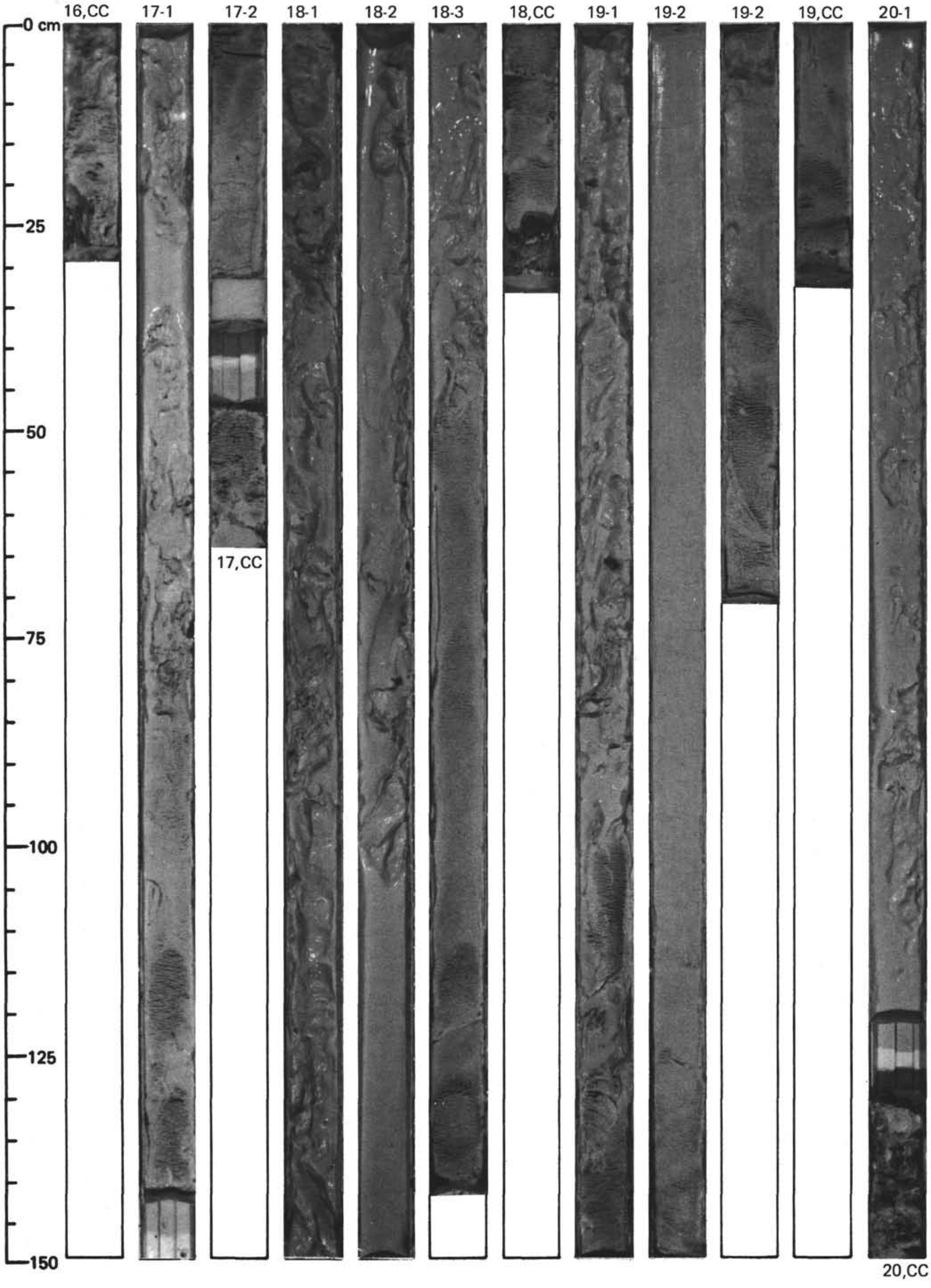

1-1
1-2
2-1
2-2
2-3
2-4
2,CC
3-1
3-2
3-3
3-4
4-1
0 cm
25
50
75
100
125
150
3,CC

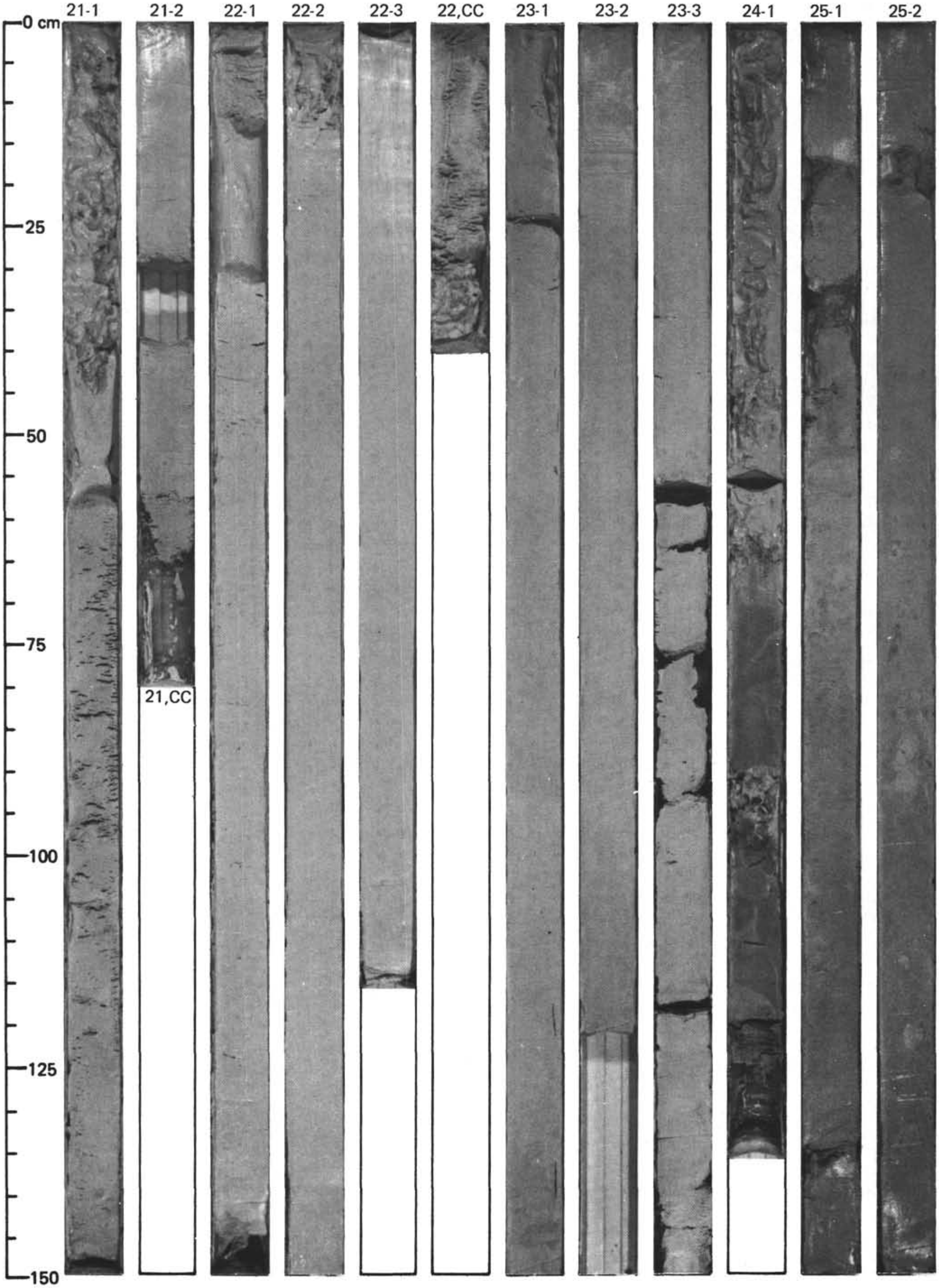

4-2
4-3
4,CC
5-1
5-2
5-3
5-4
6-1
6-2
6-3
6-4
7-1
0 cm
25
50
75
100
125
150
5,CC
6,CC

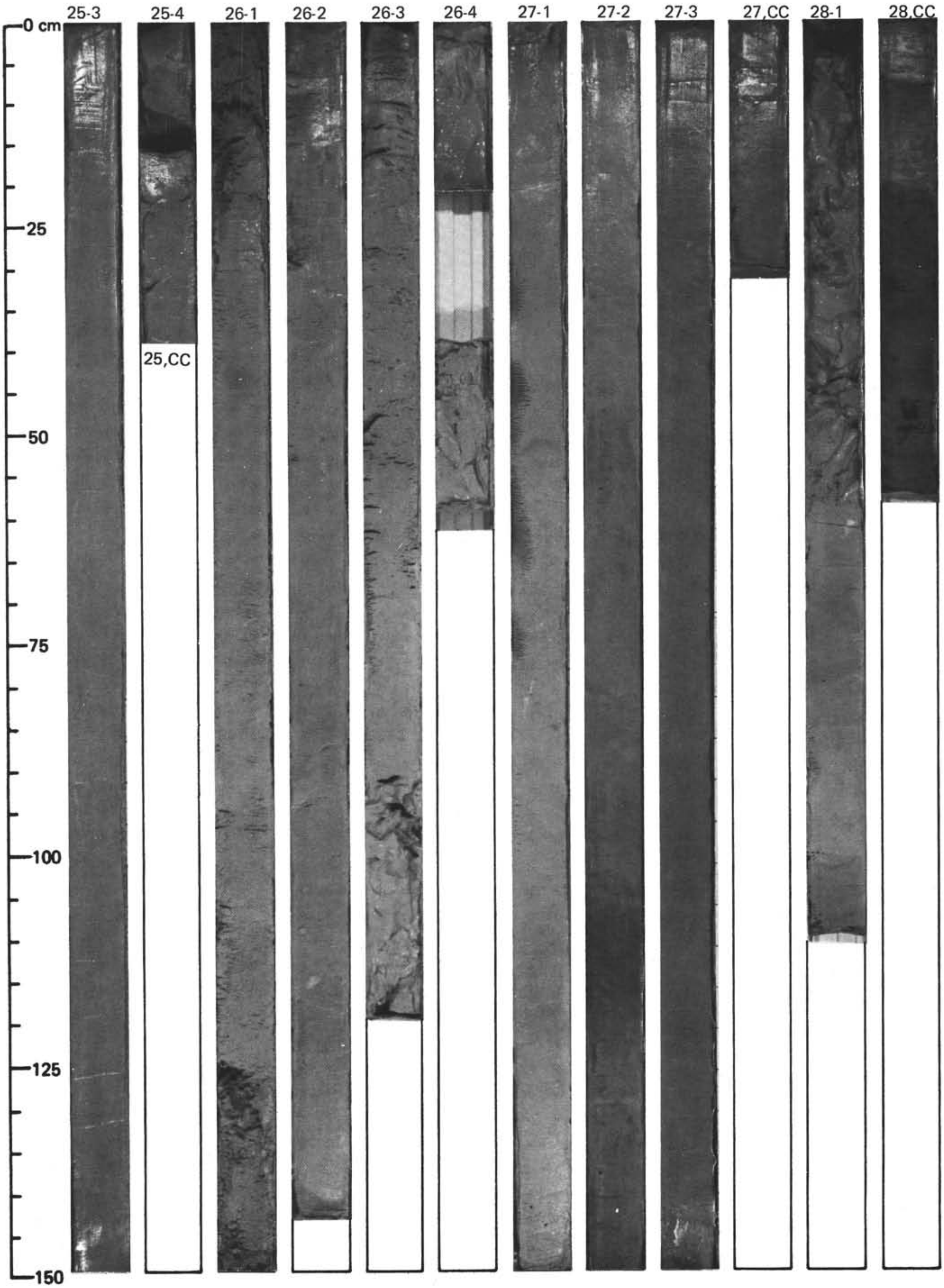

7-2
7-3
7,CC
8-1
8-2
8-3
8-4
9-1
9-2
9-3
9,CC
10-1
8,CC
0 cm
25
50
75
100
125
150

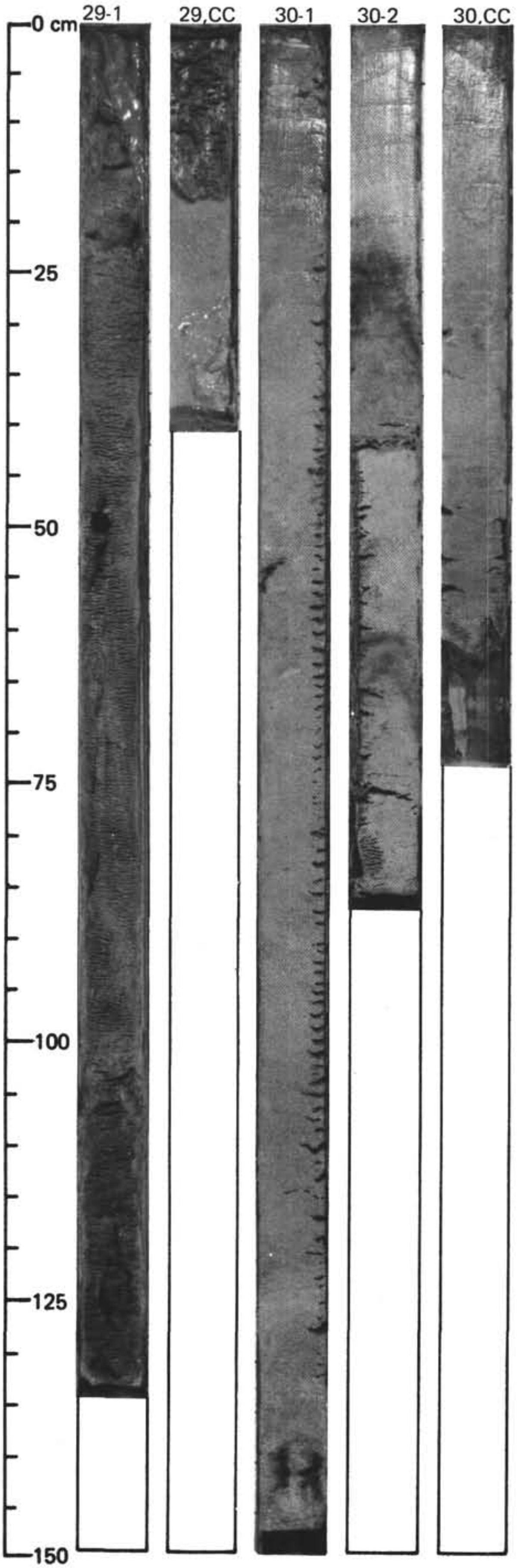

10-2
10-3
10-4
11-1
11-2
11-3
11,CC
12-1
12-2
12-3
12,CC
13-1
0 cm
25
50
75
100
125
150
10,CC


13-2
13-3
13-4
14-1
14-2
14-3
14,CC
15-1
15-2
15-3
15,CC
16-1
13,CC
0 cm
25
50
75
100
125
150


16,CC
17-1
17-2
18-1
18-2
18-3
18,CC
19-1
19-2
19-2
19,CC
20-1
0 cm
25
50
75
100
125
150
17,CC
20,CC


21-1
21-2
22-1
22-2
22-3
22,CC
23-1
23-2
23-3
24-1
25-1
25-2
0 cm
25
50
75
100
125
150
21,CC


25-3
25-4
26-1
26-2
26-3
26-4
27-1
27-2
27-3
27,CC
28-1
28,CC
25,CC
0 cm
25
50
75
100
125
150


0 cm
25
50
75
100
125
150
29-1
29,CC
30-1
30-2
30,CC