8. SITE 396: 23°N, MID-ATLANTIC RIDGE

Shipboard Scientific Party[1]

SITE DATA

Date Occupied: 11 January 1976 (0200)

Date Departed: 14 January 1976 (2230)

Time on Hole: 3 days, 20 hours, 30 min

Position: 22°58.88'N, 43°30.95'W

Water Depth (sea level): 4450 corrected meters, echo sounding

Water Depth (rig floor): 4460 corrected meters, echo sounding

Bottom Felt at: 4460 meters, drill pipe

Penetration: 221.49 meters

Number of Holes: 1

Number of Cores: 25

Total Length of Cored Section: 221.49 meters

Total Core Recovered: 133.28 meters

Percentage Core Recovery: 60 per cent

Oldest Sediment Cored:
Depth sub-bottom: 125 meters
Nature: Foraminifer-nannofossil ooze
Chronostratigraphic unit: middle Miocene
Measured velocity: 1.5-1.8 km/sec

Basement
Depth sub-bottom: 96 meters sub-basement
Nature: Basalt

Principal Results: Site 396 was drilled at latitude 22°58.88'N, longitude 40°30.95'W, in a water depth of 4450 meters. The site is about 1.4 km from the western edge of a sediment pond, Atlantic survey Site AT-6, within normal-polarity magnetic anomaly 5 (8.7 to 10 m.y.). It is at the approximate conjugate position, on the opposite side of the ridge axis, to Site 395. The regional bathymetry and the magnetic anomalies are well lineated, and no evidence of fracture zones is apparent in the vicinity of the sediment pond. One hundred twenty-five meters of sediment were continuously cored; the basalt/sediment contact was recovered in undisturbed form. The sediments above the basalt contact are tentatively assigned to the *Discoaster exilis* Zone (middle Miocene; ~14 m.y.). The sediments can be divided into two units. The first, from 0 to 117 meters sub-bottom, is a nannofossil ooze interbedded with lesser foraminifer-nannofossil ooze and foraminiferal sands. The second, from 117 to 125 meters, is brown calcareous basal clay interbedded with marly nannofossil ooze. Recovery in the sediments was 80.7 per cent.

We drilled 96 meters beneath the sediments, at which depth the bit became worn. Basement recovery was 33 per cent. The cored rocks consist lithologically of fairly uniform phyric basalt pillows with a multitude of glass zones, lithified sediment veins, and contact zones. The lava is plagioclase (5 to 15%) and olivine (1 to 3%) phyric. Clinopyroxene is not a phenocryst phase. The groundmass of all the rocks is fine grained, often spherulitic, with feldspar laths around 0.1 mm long. There is no basis for discrimination of lithologic units from hand-specimen petrology. Two varieties of carbonate veins cross many of the samples. The first is a lithified (baked?) sedimetary carbonate, observed only in the upper three cores; the second is a recrystallized white vein carbonate. The presence of the sedimentary carbonate in the basalts suggests that the upper part of the sequence was intruded into or extruded onto carbonate ooze.

Despite the hand-specimen and petrographic uniformity of the basalts, compositional variation is significant, particularly in Mg/(Mg + Fe) values (0.58 to 0.66), Ni concentrations (111 to 189 ppm), and in Sr values. These variations do not simply reflect varying proportions of modal phenocryst content, since Al_2O_3 and CaO concentrations are approximately constant (16.7% and 12.0%, respectively). Most of this variation can be attributed to fractional crystallization involving olivine and subordinate plagioclase. Three comagmatic sequences are observed, differentiated primarily by abundance of Sr. One is the topmost basement core. The second is from the base of this unit (127 m sub-bottom) to 191 meters, and contains Sr in concentrations of 154 ppm (average). Variations in TiO_2, Ni, and Zr within this inverval suggest a single comagmatic sequence involving olivine control. The third sequence is from 201 meters to the bottom of the hole (221 m), and contains Sr in concentrations of 131 ppm (average).

The magnetic inclinations fall into three separate groups. The upper group, identified by only two samples, from near the top of basement, is reversed at a shallow angle of −20°. The middle group, which extends to about 70 meters sub-basement, is scattered around an average inclination of +35°. The lower magnetic group has average inclinations of −5°, and coincides with the lower geochemical unit. The average intensity of the entire 96 meters of sub-basement is $1.53 \pm 0.15 \times 10^3$ emu/cm^3. This value is less than half that obtained at Hole 395A, and suggests either that the basaltic pillows of Site 396 are more extensively oxidized than the units of Hole 395A, or perhaps that this section was extruded during a magnetic transition.

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In summary, three geochemical units and three magnetic units occur in Hole 396. The geochemical breaks coincide with the magnetic breaks.

OPERATIONS

Atlantic survey area AT-6 was surveyed by R/V *Atlantis* II (WHOI—M. Purdy, Chief Scientist) and R/V *Akademik Kurchatov* (USSR). The results of these excellent site surveys (Purdy et al., this volume) enabled us to locate the optimum drilling location in minimum time, aboard *Glomar Challenger.* The reasons for selecting the particular sediment pond we drilled are given in Chapter 16, this volume. The sediment pond is situated near the center of the well-developed magnetic anomaly 5 (10 m.y.) east of the Mid-Atlantic Ridge axis. Both the regional topography and the magnetic anomalies are characterized by long linear troughs and highs. There is no evidence for fracture zones either in the magnetics or the topography. Seismic refraction (sonobuoy) results over the sediment show seismic structure representative of "normal" ocean crust of this age (~400 m of crust with Layer 2A velocities, ~1.5 km of crust with Layer 2B velocities) although the results are not ideal (Purdy, this volume). The topography, together with the location of the sediment pond and extent of crustal blocks causing the magnetic anomalies, is given in Figure 1. Super-imposed is the track made by *Glomar Challenger* in approaching the site and dropping the beacon.

The site was selected as a prime location for deep crustal drilling. On Leg 45, sufficient time was not available to begin drilling a deep hole. Our primary purposes for going to survey area AT-6 were to drill a pilot hole that would provide Leg 46 scientists with additional information regarding the feasibility of deep drilling, and to compare results here with our results on Site 395 drilling. Since the ultimate aim at this site was to study the ocean crust beneath the sediments, we tried to select the site in a region of minimum sediment thickness. As at Site 395, the eventual plan was (if the pilot hole were successful) to set a re-entry cone and case to basement. Minimum sediment thickness was therefore highly desirable. It was an operational necessity, however, to have about 100 meters of sediment for spudding in and supporting the bottom-hole assembly. Since magnetic anomaly 5 encompasses the entire sediment pond, we were not confined in our drilling to any particular location within the pond, as we were at Site 395. Seismic reflection profiles (Figure 2) show a two-way reflection time of 0.3 sec near the center of the pond. We chose the western edge of the pond, where a small step in basement or basement high minimized the sediment overburden. We dropped the beacon on the first pass over the western edge of the sediment pond (previously collected site survey data enabled us to do this), where sediment thickness corresponds to 0.15 sec two-way travel time (135 m if we assume $\overline{v}$ = 180 km/sec). We then steamed across the sediment pond, reversed course to obtain reflection records while the beacon was on the sea floor, and retrieved geophysical gear; we did this to confirm sediment thickness.

We encountered no major operational difficulties during drilling. We cored continuously until the bit became completely worn; this occurred at 221 meters beneath the sea floor. Basement was encountered at 125 meters beneath sea floor, in close agreement with the estimate from seismic data. We cored 96 meters of basement, and recovered 32 meters (33%). The coring intervals are given in Table 1.

SEDIMENTS

Lithologic Description

We cored sediments continuously from 4450.00 meters below sea level to 4575.24 meters at Site 396, and recovered 101.19 meters (80.7%) in 14 cores. Core 4 had no recovery, because the plastic sack in the core catcher broke and the sediments washed out as the core barrel was pulled to the ship. Excluding Core 4, recovery was 87.4 per cent. The sediments range from Pleistocene to middle Miocene above basalt. Sediments in the core catcher of Core 21 within the basalt are upper Miocene, and apparently fell down the hole.

Hole 396 is on the western edge of a small northerly trending sediment pond about 3 × 10 km in dimensions and 300 meters deep in its deepest part (Purdy, et al., this volume). The pond is somewhat larger than that cored at Site 395, and lies between two prominent north-trending ridges in a region of generally north-lineated topography. The bounding ridges rise to about 1000 meters above the sediment pond, but relief is generally lower and not as steep as at Site 395. The ridges, nevertheless, are in many places free of sediment. The sediments at Site 396 have therefore largely slumped or been swept into the pond from the adjacent ridges.

The sediments can be divided into two units, as follows.

UNIT I (Cores 1 through 13, Section 6, 145 cm, 0 to 1117.15 m sub-bottom, 4450.00 to 4567.15 m below sea level) is nannofossil ooze interbedded with lesser

TABLE 1
Coring Summary, Site 396

Core	Date (January 1976)	Time	Depth From Drill Floor (m)	Depth Below Sea Floor (m)	Length Cored (m)	Length Recovered (m)	Recovery (%)
1	11	1525	4460.00-4465.00	0.00-5.00	5.00	5.00	100
2	11	1712	4465.00-4474.28	5.00-14.28	9.28	7.30	79
3	11	1830	4474.28-4483.84	14.28-23.84	9.56	5.54	58
4	11	1950	4483.84-4493.10	23.84-33.10	9.26	0.00	0
5	11	2110	4493.10-4502.37	33.10-42.37	9.27	9.00	97
6	11	2210	4502.37-4511.92	42.37-51.92	9.55	8.00	84
7	11	2320	4511.92-4521.47	51.92-61.16	9.24	9.15	99
8	12	0102	4521.47-4530.72	61.16-70.41	9.25	8.10	88
9	12	0200	4530.72-4539.95	70.41-79.64	9.23	6.65	72
10	12	0310	4539.95-4549.18	79.64-89.18	9.54	8.27	87
11	12	0412	4549.18-4558.41	89.18-98.41	9.23	8.60	93
12	12	0525	4558.41-4567.96	98.41-107.96	9.55	8.20	86
13	12	0640	4567.96-4577.20	107.96-117.20	9.24	9.24	100
14	12	0825	4577.20-4586.74	117.20-126.74	9.54	9.54	100
15	12	1315	4586.74-4596.05	126.74-136.05	9.31	4.95	53
16	12	1800	4596.05-4605.30	136.05-145.30	9.25	5.83	63
17	12	2240	4605.30-4614.55	145.30-154.55	9.25	0.00	0
18	13	0530	4614.55-4623.56	154.55-163.56	9.01	4.78	53
19	13	1005	4623.56-4632.82	163.56-172.80	9.26	3.00	32
20	13	1215	4632.82-4642.06	172.80-182.06	9.24	0.00	0
21	13	1340	4642.06-4651.33	182.06-191.33	9.27	1.03	11
22	13	1730	4651.33-4660.59	191.33-200.59	9.26	5.70	62
23	13	2030	4660.59-4670.24	200.59-210.24	9.65	0.70	7
24	13	2310	4670.24-4679.49	210.24-219.49	9.25	3.60	39
25	14	0310	4679.49-4681.49	219.49-221.49	2.00	1.10	55
Total					221.49	133.28	60

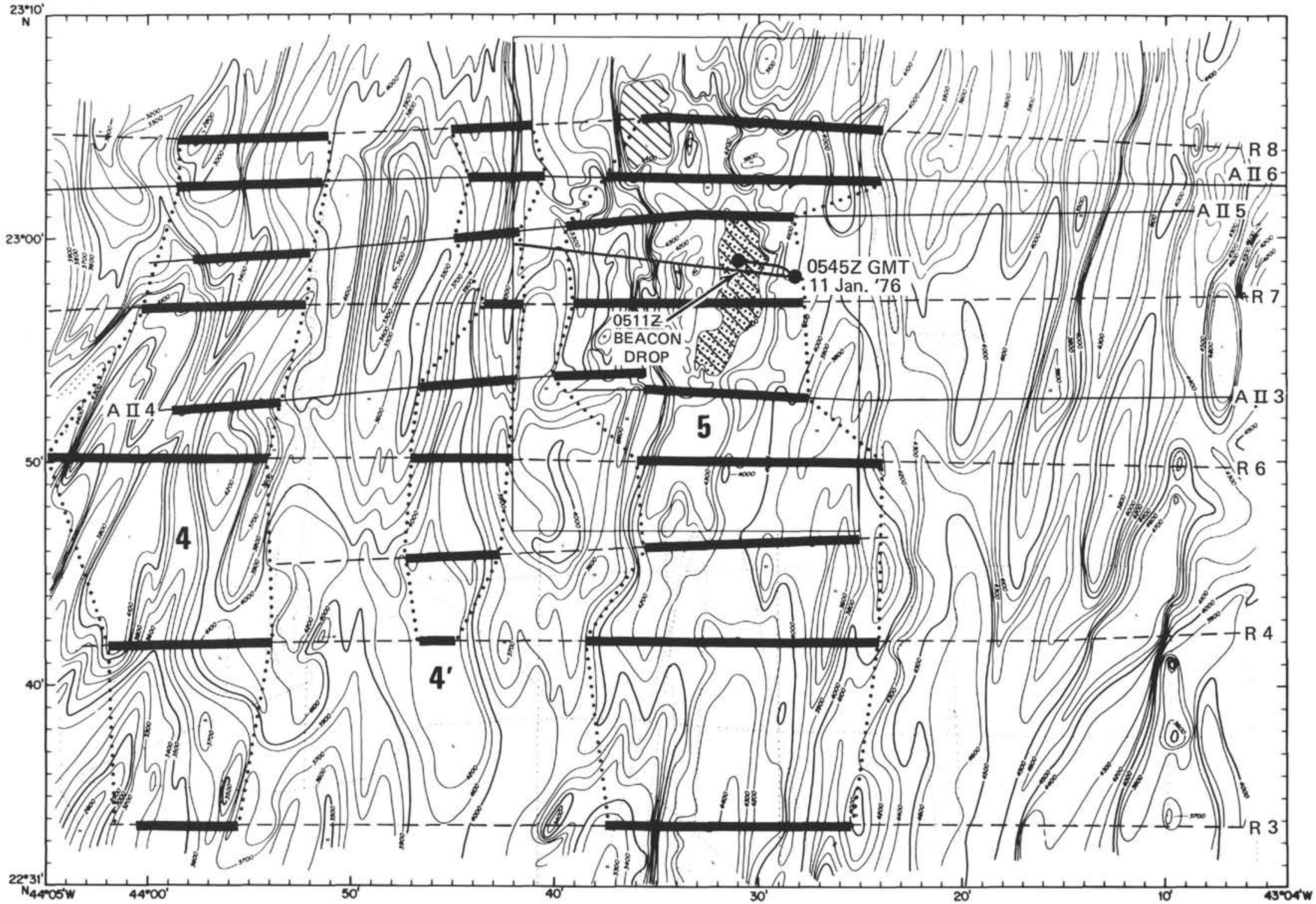


Figure 1. *Bathymetry and magnetics of survey area AT-6, with* Glomar Challenger *approach track superimposed. Sediment pond is shaded.*

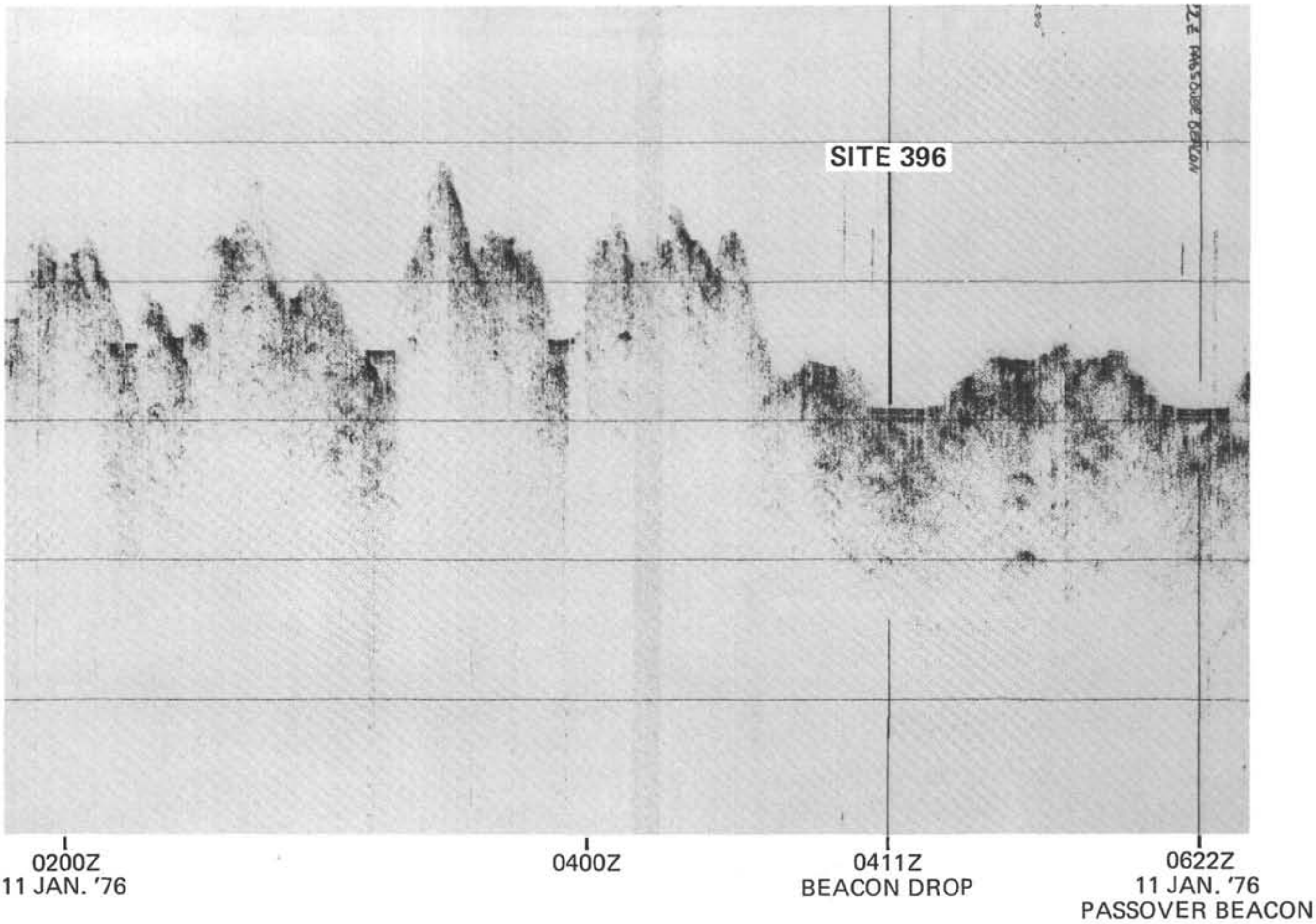


Figure 2. *Approach profile of* Glomar Challenger *to Site 396.*

foraminifer-nannofossil ooze and rare foraminiferal sands. Colors range from pale brown to pale yellowish brown, and are slightly darker in Cores 1 through 4 than in 5 through 13. The lower part of Core 13 darkens to yellow-brown toward the top of Unit II. The darker colors result from a larger proportion of brown clays and associated reddish hydrous iron oxides. A small deformed patch of brown clay occurs in Core 5, Section 3.

Deformation caused by drilling is intense throughout Unit I. In general, sedimentary structures are preserved only in the lowest sections of each core. Beds and traces of beds are evident in Cores 6, 7, and 10, but are not very prominent. Core 11, Section 4, and Core 13, Sections 5 and 6, have beds every 10 to 50 cm, characterized by faint color and slight variations in "grittiness" (proportion of foraminifers to nannofossils). Each bed is very sharply defined. Bioturbation apparently did not occur. Throughout Unit I, both foraminifers and nannofossils occur. Traces of hydrous, amorphous-looking iron oxides, sponge spicules, and fish debris are present in most smear slides, but heavy minerals and volcanic glass are notably absent. The only significant variation among the components of the sediments occurs in local foraminiferal sands, and in a noticeable general increase in the proportion of foraminifers in Cores 7 and 8; this proportion drops sporadically from there through Core 14.

The general characteristic of Unit I is its uniformity. Partly, this is because structures have been obliterated by drilling deformation. But mostly, the proportion of foraminifers to nannofossils varies little in the less deformed sections. The contrast to Site 395 is marked in this respect. The sequence at Site 395 grades downward from foraminifer-nannofossil ooze (5 to 20% foraminifers), with interbedded foraminiferal sands, to nannofossil oozes. In Hole 396, this sequence is reversed: nannofossil oozes with less than 1 per cent foraminifers abruptly grade into foraminifer-nannofossil ooze with 5 to 20 per cent foraminifers in Core 7.

At this time, we can only speculate about the reasons for these differences. Perhaps different histories of subsidence, relative to the foraminiferal lysocline at Sites 395 and 396, were involved. The average distance of sediment transport from adjacent ridges was also probably different at the two sites. This, coupled with differences in slopes of the ridges, would cause foraminifers and nannofossils in sediments slumped from the ridges or carried from them in turbidity currents to sort differently. The lack of well-preserved obvious graded beds in both the Site 395 and the Site 396 cores, however, makes this interpretation difficult to assess without detailed grain-size analysis. But the average finer grain size of Site 396 sediments, together with the lack of volcanic glass, heavy minerals, and basaltic sand grains (all present at Site 395), suggests that Site 396 is farther from any possible turbidite sources than Site 395. Site 396 is about 1.4 km from the closest edge of the sediment pond, compared with about 0.3 km at Site 395.

UNIT II (Core 13, Section 6, 145 cm to Core 14, Section 6, 10 cm: 117.15 to 125.34 m sub-bottom, 4567.15 to 4575.34 m below sea level) is dark yellowish brown to dark brown calcareous basal clay interbedded with pale yellowish brown marly nannofossil ooze. Foraminifers are scarce in the oozes and virtually absent in the clays. Staining of coccoliths with amorphous hydrous iron oxides is intense even in the layers less rich in clay. Bioturbation is not evident. The clays contain as little as 15 per cent $CaCO_3$ (carbonate bomb analysis), and are quite stiff. They are generally fragmented and brecciated by drilling. The marly nannofossil oozes are relatively soft and pliant. Traces of manganese oxide micronodules are present. A well-preserved fish tooth about 5 mm long was found in brown clay in Core 14, Section 1.

The clays are most prevalent in Core 14, Sections 1 through 3, where they have been drastically mixed with marly nannofossil ooze. Coherent clay pieces up to 10 cm long occur in this mix. Sections 4 and 5 are homogeneous marly nannofossil oozes. The sediment/basalt contact at the top of Section 6 is in this ooze. Sediments were pressed about 50 cm farther into Section 6 during drilling, however; rounded to angular basalt pieces are embedded in deformed ooze to that point.

The clays in Cores 13 and 14 are typical in appearance of basal Fe-Mn-rich clays at many DSDP sites, and are very similar to basal clays at Site 395. These clays are considered to be precipitates from hydrothermal metal-rich solutions emanating from the basement rocks (Timofeev et al., this volume), though they have rarely been described in the context of the Mid-Atlantic Ridge.

Sediments in Basalt

The topmost basalts drilled at Site 396 are in intimate contact with recrystallized calcareous sediments in cracks and with largely palagonitized glass breccias spalled from pillows. The limestones are very pale yellow to very pale brown and occur in 0.2- to 5-cm cracks and cavities. Recrystallization is essentially complete, but ghosts of foraminifer tests are visible in some thin sections. There is no trace of nannofossils.

Basalt pillows apparently intruded the sediments while the sediments were extremely fluid; they were probably no more than a few meters thick at the time. Contraction cracks in the basalt apparently sucked up sediment as they formed. Delicate flow patterns in these cracks are preserved in the lithified sediments. The sediments do not appear to have contained large percentages of Fe and Mn at the time of basalt intrusion.

Core 21 penetrated a small pocket of sediments. Only a small amount of this material was recovered. It is a pale yellow brown foraminifer-nannofossil ooze, and contains upper Miocene microfossils that apparently fell down the hole.

Biostratigraphy (by Ansis Kaneps, DSDP)

The physiographic setting of Site 396 is analogous to that of Site 395, but the site is situated on the opposite (east) side of the Mid-Atlantic Ridge crest. The section penetrated also consists of foraminifer-nannofossil oozes, but unexpectedly the oldest sediments cored are middle Miocene (13.6 ±1.6 m.y.) rather than upper Miocene, as was predicted by sea-floor spreading anomaly ages. There is no explanation for this discrepancy at this time. As at Site 395, reworking and drilling disturbance complicate the biostratigraphic sequence.

The oldest sediments cored (Core 14) belong to the *Discoaster exilis* Zone and the *Globorotalia fohsi fohsi* Zone. Overlying these sediments (with probable disconformity) is lower Pliocene (Cores 12 and 13), for which assignment to the *Ceratolithus rugosus* Zone is suggested (~4 to 4.4 m.y.). This is in turn disconformably overlain by upper Pliocene sediments (Cores 8 through 11), characterized by the foraminifer species *Globorotalia miocenica*, along with other upper Pliocene markers, such as *G. tosaensis, G. patenis, G. exilis,* and *Globigerinoides fistulosus.* The remainder of the section is lower Pleistocene, except for a thin upper Pleistocene and/or Recent sequence in Core 1. Reworked Pliocene species *(Globoquadrina altispira, Globorotalia multicamerata, Sphaeroidinellopsis* spp.) occur as high as Core 5 (some 25 m above the Pliocene/Pleistocene contact). The bulk of the section at Site 396 appears to have been deposited during late Pliocene through early Pleistocene time (between about 2.7 and 1.0 m.y.); the remainder of middle Miocene through Recent time is poorly represented. This abnormal thickening of the upper Pliocene and lower Pleistocene, together with the evidence for extensive reworking, strongly suggests concentration of sediments, by redeposition from surrounding hills, in the basin in which Site 396 is situated.

Magnetics

No sediments at Site 396 were sufficiently undisturbed to bother taking magnetic measurements.

Physical Properties and Chemistry

On Figure 3 are plotted variation with depth of porosity, grain density, water content, and $CaCO_3$ content (as determined using the carbonate bomb). GRAPE density and porosity were determined only on relatively undisturbed cores (from Core 5), but are not plotted here. In general, as at Site 395, GRAPE density increases and porosity decreases with sediment compaction. As at Site 395, separate cube porosity measurements were made on least-disturbed samples, which should more accurately reflect *in situ* conditions. As at Site 395, porosity and water content are fairly con-

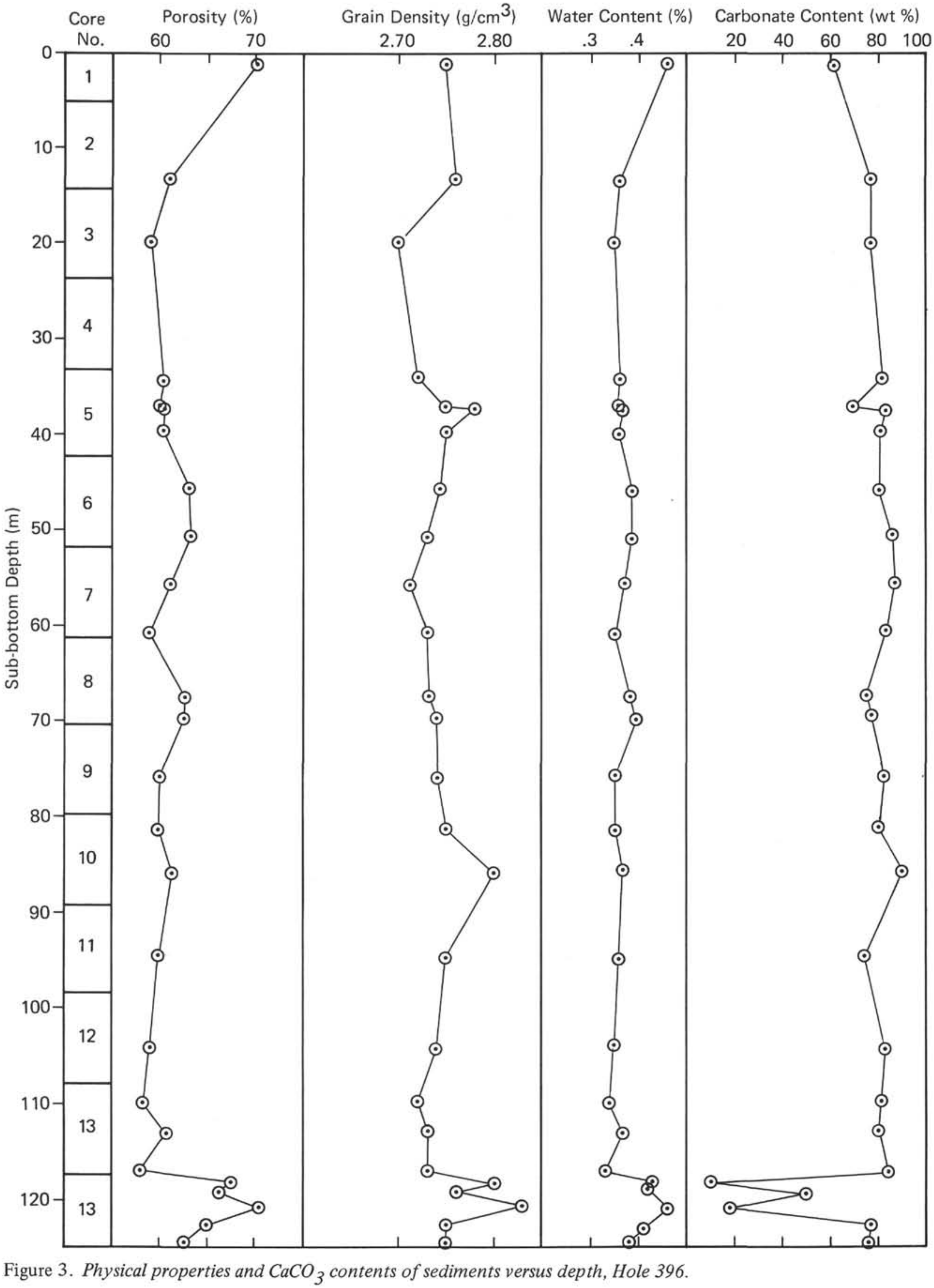


Figure 3. *Physical properties and $CaCO_3$ contents of sediments versus depth, Hole 396.*

stant with depth after the initial decrease, and only increase in the basal clays of Core 14.

Grain densities given are densities of the sediments determined dry, so that most of the effects of drilling disturbance and addition of water have been eliminated. The small "spike" in the plots of grain density and carbonate content (Core 5) correspond to the small patch of calcareous red clay described earlier.

The percentage of $CaCO_3$ is somewhat low in Core 1, increases to between 80 and 90 per cent from Core 5 through Core 13, and drops sharply in the basal clays. These clays are much lower in $CaCO_3$ than those of Site 395, but recovery at Site 396 was more complete. We attribute the low $CaCO_3$ in Core 1 to a decline in the rate of carbonate sedimentation, resulting from subsidence of the sea floor closer to the lysocline. The content of pelagic clays is higher as a result.

The water contents, porosities, and saturated bulk densities of the sediments from Hole 396 (27 samples) are given in Table 2.

IGNEOUS ROCKS

Lithologic Summary

Hole 396 was drilled for 96 meters sub-basement. The cored rocks consist of a fairly uniform sequence of phyric basalt pillows, with a multitude of glass zones and lithified sediment veins and contact zones. The lava is plagioclase and olivine phyric; clinopyroxene is not a phenocryst phase, and is generally spherulitic to skeletal, even in the groundmass. The proportion of phenocrysts varies from about 7 to about 15 per cent; of this only about 1 to 3 per cent is olivine, and the rest is plagioclase. The feldspar phenocrysts vary from 0.5 to 3 mm in length, and are often zoned, but the core composition is about An_{76}. They are generally euhedral; coexisting with them are a few very rounded plagioclases, quite possibly xenocrysts, a very small proportion of which contain brown-red spinel. The same is true of the olivines: some rounded crystals include spinel, but generally the olivines are altered in large degree to a brown iddingsitic material. Both the rounded and subrounded olivines have a $2V \sim 90°$ ($\sim Fo_{88}$), and are around 1 to 2 mm in diameter. The spinels present are usually included in feldspar phenocrysts, but do occur rarely in the groundmass. They are deep red-brown in the upper part of the core, but toward the bottom they become browner and lose the ruby-red tinge shown by the spinels in the upper cores. The groundmass of all these rocks is fine grained, often spherulitic—with feldspar laths around 0.1 mm long—and dendritic or spherulitic clinopyroxene. None of the basalts have ophitic texture. The clear, very pale brown glass zones contain phenocrysts of olivine and plagioclase.

TABLE 2
Physical Properties of Sediments, Site 396

Sample (Interval in cm)	% Water Content (E/A)	Porosity (E/D)	Wet-Bulk Density (g/cm^3) (A/D)
1-2, 19-21	0.461	0.701	1.52
2-6, 65-67	0.362	0.610	1.69
3-4, 98-100	0.346	0.589	1.70
5-1, 104-106	0.358	0.603	1.69
5-3, 105-107	0.351	0.598	1.70
5-3, 125-127	3.55	0.604	1.70
5-5, 60-62	0.358	0.605	1.69
6-3, 24-26	0.386	0.632	1.64
6-6, 96-98	0.386	0.632	1.64
7-3, 69-71	0.368	0.611	1.66
7-6, 142-144	0.343	0.588	1.71
8-5, 46-48	0.380	0.626	1.65
8-6, 92-94	0.395	0.654	1.65
9-4, 90-92	3.52	0.599	1.70
10-2, 26-28	0.350	0.596	1.71
10-5, 23-25	0.361	0.613	1.70
11-4, 92-94	0.352	0.599	1.70
12-2, 40-42	0.348	0.592	1.70
12-4, 126-127	0.345	0.590	1.71
13-2, 47-49	0.338	0.581	1.72
13-4, 52-54	0.362	0.607	1.68
13-6, 121-123	0.338	0.582	1.72
14-1, 119-121	0.426	0.675	1.58
14-2, 47-49	0.416	0.662	1.59
14-3, 75-77	0.455	0.703	1.55
14-4, 98-100	0.402	0.649	1.61
14-5, 136-138	0.378	0.625	1.66

Two varieties of carbonate veins cross many of the samples. The first is lithified (baked?) sedimentary carbonate. Veins of this material are pale brown, in parts are relatively uncrystallized, and may contain rare patches of virtually unaltered foraminifer-nannofossil ooze. This carbonate type occurs as a coating on glassy surfaces, as veins 0.2 to 1.0 cm wide, and as "blebs" in some of the basalt samples. It is restricted to the upper cores, 14, 15, 16. The second type is a characteristic recrystallized white vein carbonate. It occurs generally in much thinner veins, about 1 mm wide or less. The presence of included sedimentary carbonate in these basalts suggests that the upper part of the sequence was intruded into a carbonate ooze.

Although there are three chemical units, coinciding with three magnetic units, the lithology—to the extent examined on shipboard—is uniform and not divisible into more than one unit.

Geochemistry

Basalts were recovered to a total sub-basement depth of 96 meters. All are extrusive, petrographically uniform, plagioclase-olivine phyric basalts. Total phenocryst abundance varies along the core from 5 to 15 per cent; plagioclase and olivine phenocryst contents average about 10 and 2 per cent, respectively. All the samples are altered, and show yellow-brown discoloration developing from cracks. Many of these cracks contain carbonate. Samples selected for chemical analysis (Appendix I, this volume; Bougault et al., this volume) were chosen to avoid veins and yellowish brown alteration zones. Even so, almost all are moderately altered, and undergo relatively high loss on ignition, yielding values from -2.0 to 3.1. These values are similar to the most altered samples analyzed from Hole 395A.

Despite the petrographic uniformity of these basalts, three different units have been defined: P_a, P_b, and P_c.

The subscripts a, b, and c (rather than 1, 2, and 3, conventional for Site 395) were chosen because the causes of geochemical variations in Hole 396 are less certain than at Site 395; there is more overlap, and combinations of partial melting, fractionation, and mixing could explain them. The groups are more distinct magnetically than geochemically (see Paleomagnetism, this chapter). The averages of the analyses of these units and their standard deviation (σ) values are reported in Table 3. The boundary between P_a and P_b is situated between Samples 14-6, 97-99 cm and 14, CC, 17-19 cm, and the boundary between P_b and P_c is between Samples 22-3, 108-110 cm and 22-4, 135-137 cm.

Composition varies significantly among these basalts, particularly in Mg/(Mg + Fe) values (0.58 to 0.66) and Ni concentrations (111 to 189 ppm). These variations do not simply reflect varying proportions of modal phenocryst content, since Al_2O_3 and CaO concentrations are approximately constant (e.g., 16.7% and 12.0%, respectively). Most of the variation can be attributed to fractional crystallization involving olivine and subordinate plagioclase. Thus, the sequence of increasing TiO_2 and Zr with decreasing MgO, Mg/(Mg + Fe), and Ni concentrations, in samples from Core 21 through Core 15 to Cores 16, 18, and 19 (Bougault et al., this volume), suggests a single comagmatic sequence involving olivine control. The sample from Section 14-6 is probably a more evolved member of this sequence (Mg/[Mg + Fe] = 0.58), derived by plagioclase and olivine (and pyroxene?) fractionation, with plagioclase the dominant phase (e.g., plagioclase:olivine = 80:20).

TABLE 3
Averages of Chemical Analyses (%) of the Three Basaltic Units Defined for Site 396

	P_a	P_b	P_c
Unit	1	4	4
SiO_2	49.3	49.68	49.45
		0.13	0.35
Al_2O_3	16.25	16.78	16.73
		0.10	0.15
Fe_2O_3 (t)	9.96	9.33	9.48
		0.24	0.16
FeO	5.36		
MnO	0.16	0.16	0.16
MgO	7.0	8.17	7.55
		0.31	0.26
CaO	11.57	11.98	12.03
		0.09	0.07
Na_2O	2.40	2.41	2.46
		0.07	0.03
K_2O	0.31	0.24	0.21
		0.04	0.05
TiO_2	1.50	1.27	1.29
		0.02	
P_2O_5	0.15	0.12	0.11
		0.01	0.01
Total	98.60	100.14	99.47
LoI	-2.0	-2.8	2.25
		0.3	0.21

As already mentioned for Site 395 (Chapter 7, this volume), a more complex process (or processes) is required to explain Sr behavior (average of 131 ppm in Unit P_c and 156 ppm in Unit P_b). This process could be alteration or mobilization of Sr, non-equilibrium of Sr between liquids and fractionating plagioclases, etc. On the other hand, the constancy of Zr/Ti implies a homogeneous source with respect to these two elements.

Paleomagnetism in Basalts, Hole 396

The sampling and measurement techniques for paleomagnetism at this hole were identical to those described for Hole 395A. All samples appeared to be plagioclase phyric pillow basalts, with no obvious grouping into individual units by lithology. The relatively low values of intensity and the high median destructive field shown in Table 4 are consistent with this observation. The integrated average magnetization intensity of the entire 100 meters of sub-basement basalt is $1.53 \pm 0.15 \times 10^{-3}$ emu/cm^3. This value is less than half the value of 3.78×10^{-3} emu/cm^3 obtained for Hole 395A. This may be because the basaltic pillows of Hole 396 were more extensively oxidized than the units of Hole 395A, or, perhaps because this section of igneous crust was extruded during a magnetic transition. There is no obvious trend in intensity with depth. Sample 396-18-1, 109-111 cm (Table 4) was specifically sampled in an oxidized and veined zone. Clearly, the effect of alteration (presumably low-temperature oxidation) is to reduce the intensity of magnetization. This result is consistent with previous studies of low-temperature alteration of submarine basalts.

The stable magnetic inclinations occur in three separate groups defined by depth. The upper group, consisting of two samples from Core 14, Section 6, are reversed at a shallow angle of $-20°$. The middle group, which consists of most of the samples in the hole, is scattered around an average inclination of $+35°$, and corresponds to chemical unit P_b. The lower magnetic unit, with inclinations close to $-5°$, coincides with the bottom geochemical unit in this hole.

The causes of the low inclinations may be (1) secular variation of the earth's magnetic field, with three separate eruptive events; (2) fault-block rotation; or (3) combinations of the above (Johnson, Chapter 14, this volume). The low intensities of magnetization, compared with Site 395, appear to reflect (1) increased oxidation of the magnetic minerals in the older Site 396 basalts, and (2) reduced availability of the magnetic mineral (Johnson, Chapter 15, this volume).

Physical Properties of Basement Rocks

The saturated bulk densities of 28 basalt samples from Site 396 are given in Table 5. In general, the densities are uniform and comparable to those of the aphyric basalt units of Site 395.

TABLE 4
Paleomagnetism Data, Site 396

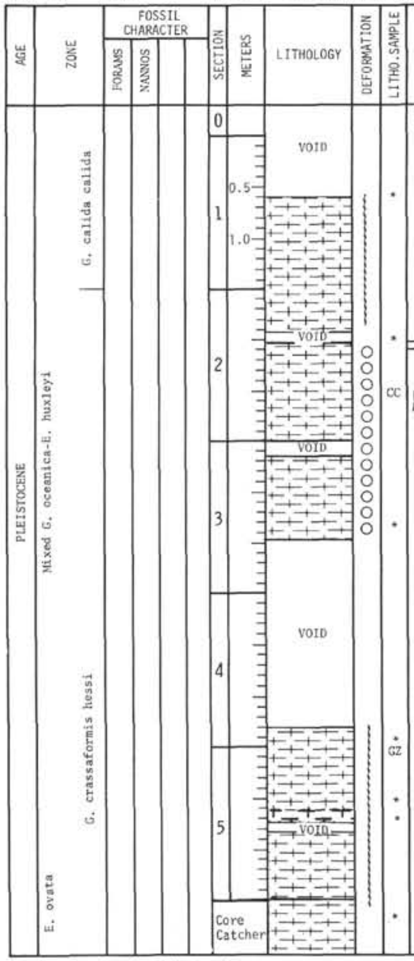
Sample (Interval in cm)	Stable Inclination (°)	Intensity of Remanence (× 10^{-3} emu/cm^3)	Median Demagnetizing Field (Oe)	Quality of Orientation[a]	Comments
14-6, 14-16	−21.8	1.52	700	M	Phyric pillow
14-6, 97-99	−19.8	1.21	550	M	Phyric pillow
14, CC, 17-19	+41.5	1.55	490	MG	Phyric pillow
15-2, 91-93	+38.2	1.64	700	M	Phyric pillow
15-3, 138-140	+36.1	1.51	425	G	Phyric pillow
15-4, 50-52	+37.0	.788	550	M	Phyric pillow
16-1, 90-92	+35.0	1.51	350	MG	Phyric pillow
16-2, 57-59	+36.4	1.43	500	MG	Phyric pillow
16-3, 68-70	+33.1	.926	550	M	Phyric pillow
16-4, 91-93	+35.2	1.27	300	MG	Phyric pillow
18-1, 68-70	+33.8	.944	550	M	Phyric pillow
18-1, 109-111	+37.7	.251	450	MG	Oxidized phyric pillow
18-2, 42-44	+32.8	1.26	350	M	Phyric pillow
18-3, 124-126	+27.9	1.53	225	G	Phyric pillow
18, CC, 10-12	+29.4	1.16	450	M	Phyric pillow
19-1, 22-24	+29.4	1.55	250	G	Phyric pillow
19-2, 48-50	+32.0	1.64	510	M	Phyric pillow
21-1, 70-72	+34.3	.911	550	G	Phyric pillow
22-1, 139-141	+33.3	.811	700	MG	Phyric pillow
22-2, 131-133	+34.5	1.42	550	MG	Phyric pillow
22-3, 108-110	+36.6	.750	700	MG	Phyric pillow
22-4, 135-137	−4.8	4.53	450	G	Phyric pillow
22, CC, 138-140	−2.5	1.61	450	M	Phyric pillow
23-1, 67-69	−4.2	2.05	450	M	Phyric pillow
23-1, 102-104	−4.4	2.16	450	M	Phyric pillow
24-1, 107-109	−8.3	1.11	900	MG	Phyric pillow
24-2, 80-82	−6.0	1.88	450	G	Phyric pillow
24-3, 138-140	−6.9	2.83	450	G	Phyric pillow
25-1, 111-113	−4.2	2.39	450	G	Phyric pillow

[a] M = moderate, MG = moderately good, G = good.

TABLE 5
Bulk Densities of Basalt, Site 396

Core	Section	Interval (cm)	Wet-Bulk Density g/cm^3 (A/D)
14	6	14-16	2.77
14	6	97-99	2.82
14	CC	17-19	2.81
15	2	91-93	2.82
15	3	138-140	2.86
15	4	50-52	2.84
16	1	90-92	2.84
16	2	57-59	2.84
16	3	68-70	2.82
16	4	91-93	2.84
18	1	68-70	2.78
18	1	109-111	2.71
18	2	42-44	2.79
18	3	124-126	2.86
18	CC	10-12	2.82
19	1	22-24	2.80
19	2	48-50	2.85
21	1	70-72	2.77
22	1	139-141	2.81
22	2	131-133	2.82
22	3	108-110	2.81
22	4	135-137	2.86
22	CC	138-140	2.82
23	1	102-104	2.77
24	1	107-109	2.76
24	2	80-82	2.85
24	3	138-140	2.85
25	1	111-113	2.85

Site 396 Hole Core 1 Cored Interval: 4460-4465 m (0-5 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 6/4

10YR 5/4

10YR 6/4

10YR 5/4

10YR 7/4

10YR 7/4

FORAMINIFER-NANNOFOSSIL OOZE

Light yellowish brown (10YR 6/4) to very pale brown (10YR 7/4) foraminifer-nannofossil ooze, highly disturbed, or soupy. Small bed of foram sand in Section 5.

Smear Slides: 1-63, 2-46, 3-75, 4-140, 5-50, 5-77, CC

Forams	4-40%	Fe-Ox	Tr
Nannos	55-80%	Clay	5-10%
Diatoms	Tr	Sponge Spic.	Tr

Smear Slides: (all but 5-77)

(all but 5-77)		5-77	
Sand	0%	Sand	20%
Silt	0- 7%	Silt	10%
Clay	93-100%	Clay	70%

Carbon Carbonate

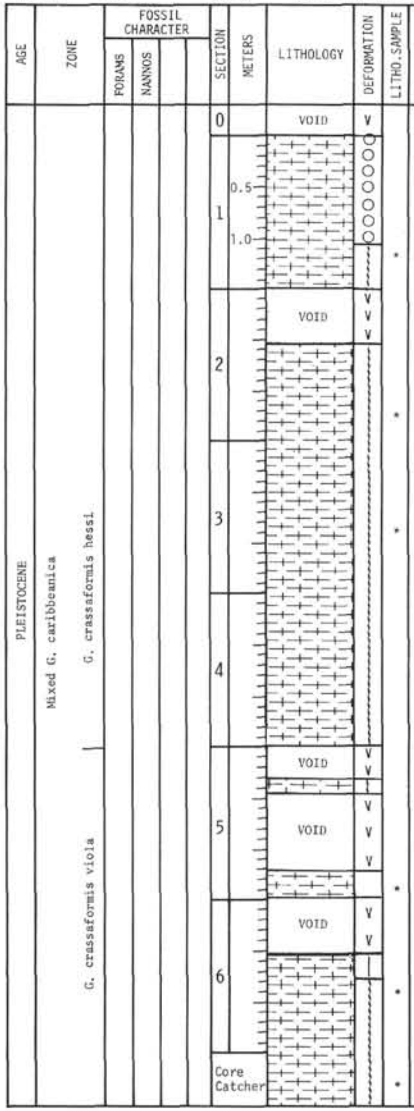
2-100	9.7	0.1	80

Grain Size

4-144	0.8	12.4	86.8

Explanatory notes in Chapter 1

Site 396 Hole Core 2 Cored Interval: 4465-4475.28 m (5.00-14.28 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 6/4

10YR 7/6

10YR 6/4

10YR 6/4

10YR 6/4

10YR 6/4

FORAMINIFER-NANNOFOSSIL OOZE

Soupy to highly deformed light yellowish brown (10YR 6/4) to brown (10YR 7/6) foraminifer-nannofossil ooze.

Smear Slides: 1-120, 2-119, 3-85, 4-75, 5-140, 6-89, CC

Forams	2- 3%
Nannos	97-98%
Fe-Ox	Tr
Sponge Spic.	Tr

Sand	0%
Silt	1- 2%
Clay	98-100%

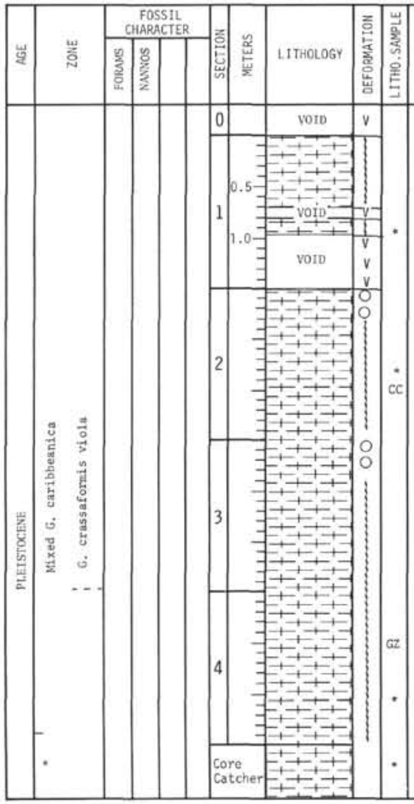
Carbon Carbonate

2-100	8.7	0.0	72

Grain Size

4-50	25.6	16.8	57.7

Site 396 Hole Core 3 Cored Interval: 4474-.28-4483.84 m (14.28-23.84 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 6/4

10YR 6/4

10YR 6/4

10YR 6/4

10YR 7/4

FORAMINIFER-NANNOFOSSIL OOZE

Soupy to highly deformed light yellowish brown (10YR 6/4) or very pale brown foraminifer-nannofossil ooze.

Smear Slides: 1-90, 2-80, 4-100, CC

Forams	Tr- 1%
Nannos	99%
Fe-Ox	Tr
Sponge Spic.	Tr
Fish Debris	Tr

Sand	0%
Silt	Tr- 1%
Clay	99-100%

<u>Carbon Carbonate</u>

2-100	10.3	0.0	86

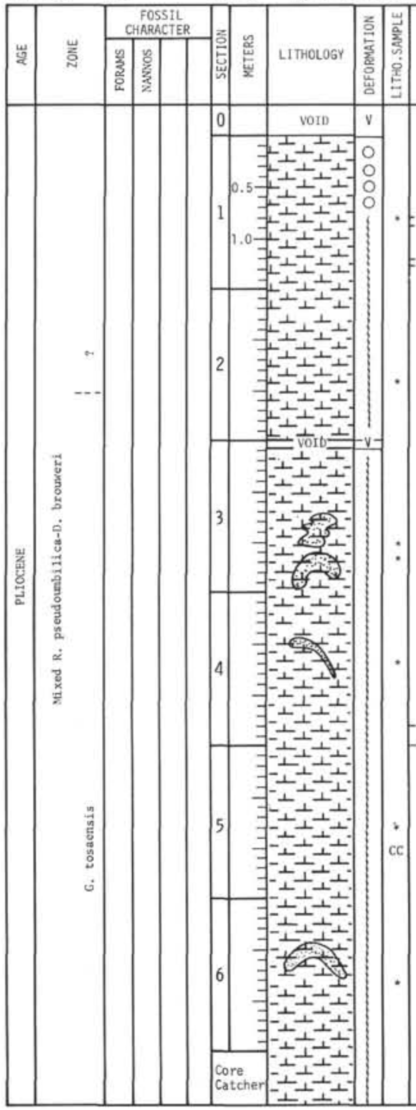
<u>Grain Size</u>

4-50	0.1	15.7	84.2

Site 396, Core 4, 4483.84-4493.10 m (23.85-33.10 m subbottom): NO RECOVERY

Explanatory notes in Chapter 1

Site 396 Hole Core 5 Cored Interval: 4493.10-4502.37 m (33.10-42.37 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 7/3

10YR 8/4

10YR 7/4

10YR 8/4

10YR 7/4

10YR 7/4

10YR 6/4

10YR 7/4

10YR 4/4

10YR 8/3

10YR 6/4

CHEM. SAMPLE

10YR 6/4

NANNOFOSSIL OOZE

Light yellowish brown (10YR 6/4) to very pale brown (10YR 7/3 or 10YR 7/4), soupy to highly deformed nannofossil ooze. Darker patches approach marly oozes (pelagic clay plus ooze).

Smear Slides: 1-81, 2-90, 3-117, 4-67, 5-75, 6-75

Forams	Tr- 7%	Sand	0%
Nannos	93-100%	Silt	1- 5%
Fe-Ox	Tr	Clay	95-99%

3-108

Forams	Tr	Sand	0%
Nannos	45%	Silt	Tr
Carb. Unspec.	1%	Clay	99%
Fish Remains	1%		
Clay	50%		
Fe-Ox	2- 3%		

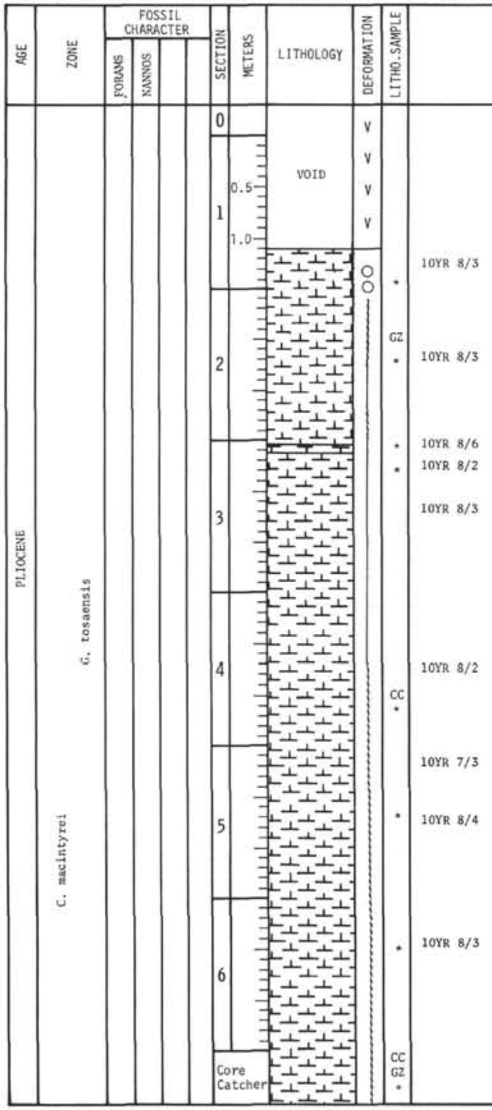
<u>Carbon Carbonate</u>

2-100	10.6	0.0	88

<u>Grain Size</u>

4-50	0.8	16.7	82.5

Site 396 Hole Core 6 Cored Interval: 4502.37-4511.92 m (42.37-51.92 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Soupy to intensely deformed, pale yellow brown (10YR 8/3) nannofossil ooze with almost white (10YR 8/6) foraminifer layers, the largest in Section 3.

Smear Slides: 1-140, 2-70, 3-30, 5-66, 6-50, CC

Forams	0- 2%	Sand	-%
Nannos	98-100%	Silt	1- 2%
Fe-Ox	Tr	Clay	98-100%

3-3

Forams	50%	Sand	3%
Nannos	49%	Silt	50%
Fe-Ox	1%	Clay	47%

Carbon Carbonate

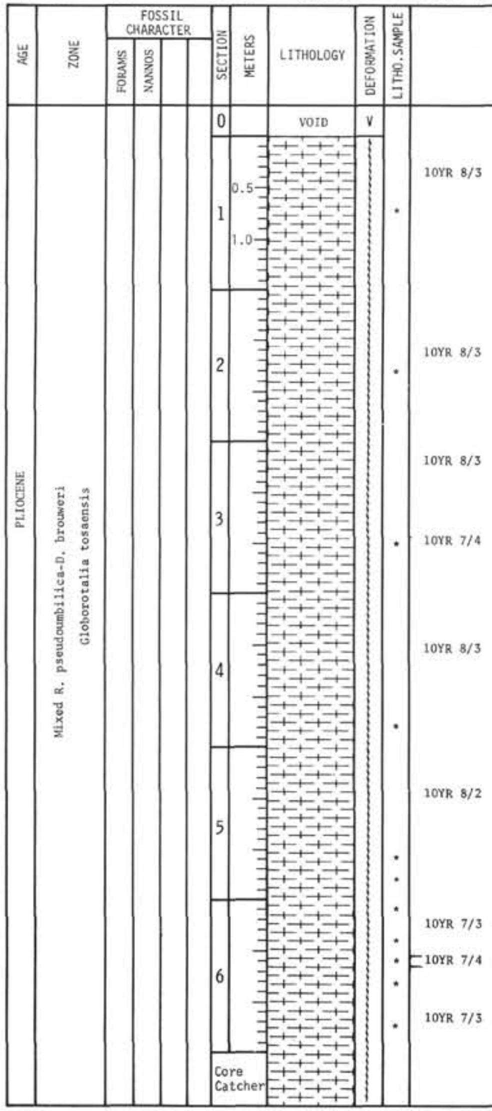
4-100	10.9	0.0	90
CC	10.7	0.7	83

Grain Size

2-50	14.8	34.0	51.2
CC	2.2	22.2	73.7

Explanatory notes in Chapter 1

Site 396 Hole Core 7 Cored Interval: 4511.92-4521.47 m (51.92-61.16 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Intensely deformed pale yellowish brown (10YR 7/4 and 10YR 8/3) nannofossil ooze.

Smear Slides: 1-80, 2-80, 3-115, 4-80, 5-110, 5-130, 6-8, 6-40, 6-53, 6-80, 6-122, CC

Forams	0- 3%	Sand	0%
Nannos	99-100%	Silt	0- 2%
Fe-Ox	Tr	Clay	98-100%

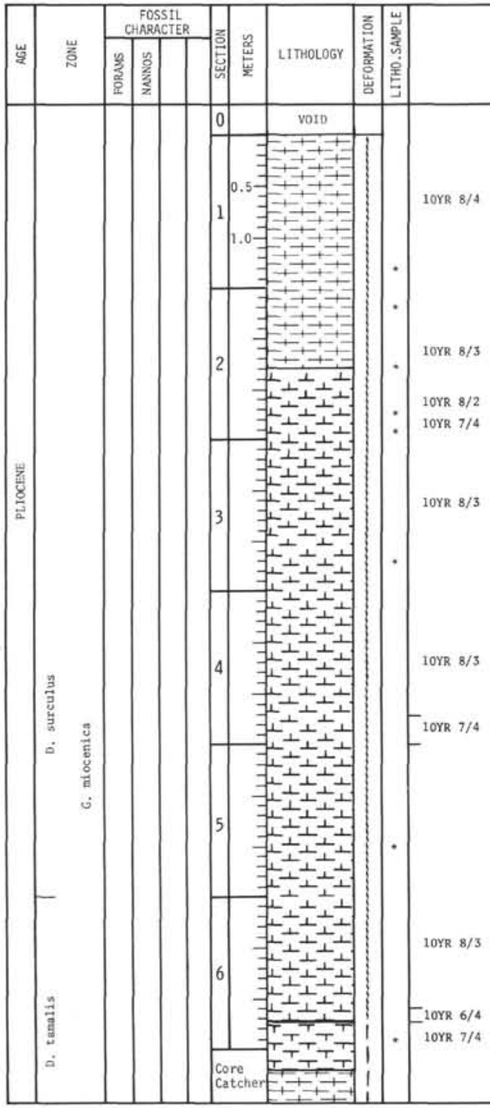
Carbon Carbonate

2-100	10.6	0.2	86

Grain Size

4-50	0.1	26.3	73.7

Site 396 Hole Core 8 Cored Interval: 4521,-47-4530.72 m (61.16-70.41 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE AND FORAMINIFER-NANNOFOSSIL OOZE

Highly deformed toward top, less so toward bottom, pale yellowish brown (10YR 8/3) to very pale brown (10YR 7/3 or 10YR 7/4) or yellow (10YR 8/2) ooze. May once have been well bedded, alternating foram sand and nanno ooze, now well mixed.

Smear Slides: 1-130, 2-20, 2-80

Forams	10-25%	Sand	0- 3%
Nannos	75-90%	Silt	10-20%
Fe-Ox	Tr	Clay	77-90%
Sponge Spic.	Tr		

2-125, 2-147, 3-40, 4-70, 5-110

Forams	0- 5%	Sand	0-Tr
Nannos	95-100%	Silt	0- 4%
Fe-Ox	Tr	Clay	96-100%

6-141

Forams	55%	Sand	3%
Nannos	44%	Silt	50%
Fe-Ox	Tr	Clay	47%

Carbon Carbonate

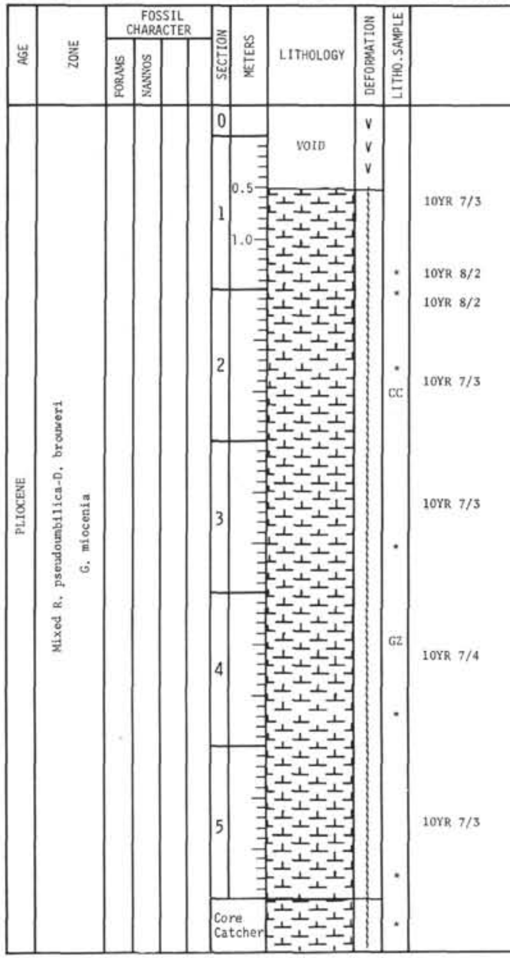
2-100	10.8	0.8	83

Grain Size

4-50	8.4	24.8	66.8

Explanatory notes in Chapter 1

Site 396 Hole Core 9 Cored Interval: 4530.72-4539.95 m (70.41-79.64 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Highly deformed yellow (10YR 8/2) or pale yellow brown (10YR 7/3) nannofossil ooze. Only slight color variations indicate some form of bedding. Otherwise, very uniform.

Smear Slides: 1-130, 1-150, 2-80, 3-100, 4-100, 5-110, CC

Forams	0- 2%	Sand	0%
Nannos	98-100%	Silt	Tr
Fe-Ox	Tr	Clay	99%

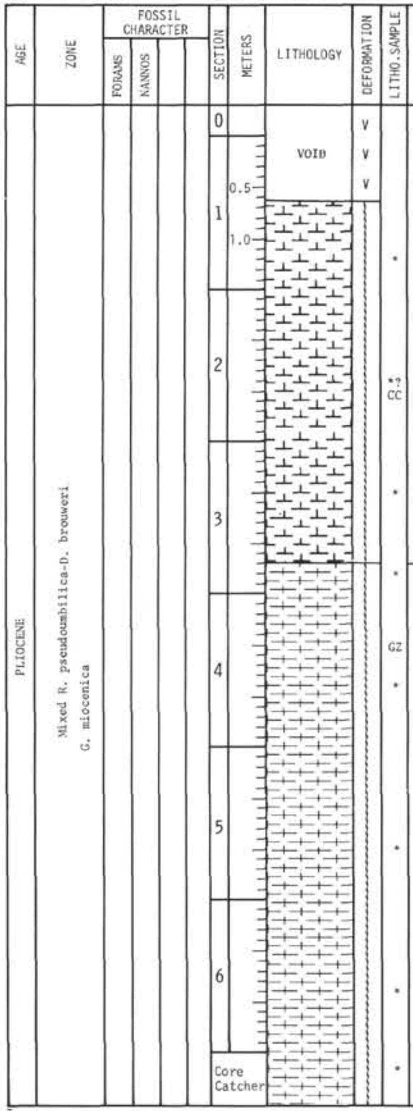
Carbon Carbonate

2-100	10.8	0.8	83

Grain Size

4-50	0.0	35.8	64.1

Site 396 Hole Core 10 Cored Interval: 4539.95-4549.18 m (79.64-89.18 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 7/4
10YR 7/4
10YR 7/4
10YR 8/3
10YR 8/3
10YR 8/3
10YR 8/3

NANNOFOSSIL OOZE

Moderately to intensely deformed pale yellow brown (10YR 7/3) to very pale brown (10YR 7/4) nannofossil ooze. No structures. Very homogeneous. Shades of color differences only.

Smear Slides: 1-120, 2-100?, 3-51

Forams	Tr	Sand	0%
Nannos	99%	Silt	Tr
Fe-Ox	Tr	Clay	99-100%

FORAMINIFER-NANNOFOSSIL OOZE

Moderately deformed pale yellow brown (10YR 8/3) foraminifer-nannofossil ooze. Very homogeneous.

Smear Slides: 3-130, 4-90, 5-93, 6-81, CC

Forams	5-60%	Sand	0- 2%
Nannos	40-95%	Silt	5-60%
Fe-Ox	Tr	Clay	40-95%

Carbon Carbonate

2-100	10.7	0.9	82

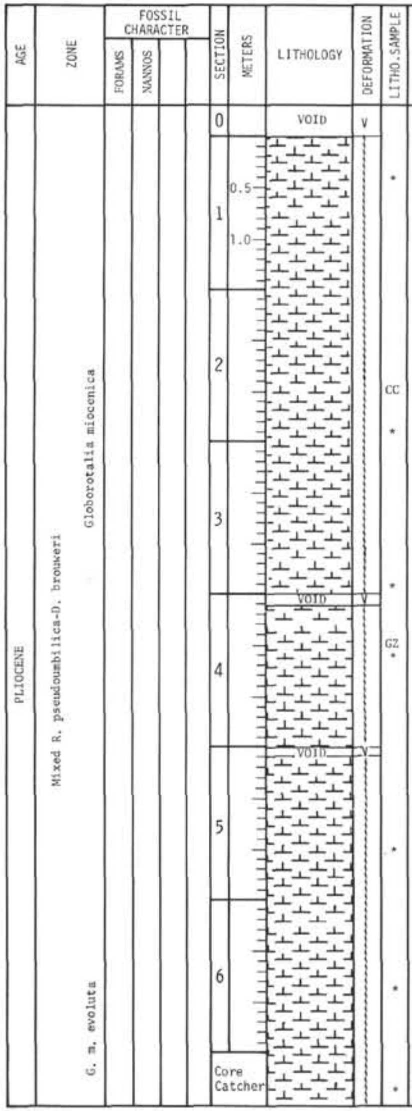
Grain Size

4-50	30.3	44.1	25.6

Note: Sand, silt fraction of smear slides is likely to be underestimated because coarse materials tend to be scraped off during smear slide preparation.

Explanatory notes in Chapter 1

Site 396 Hole Core 11 Cored Interval: 4549.18-4558.41 m (89.18-98.41 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 8/3
10YR 7/3
spots of 10YR 8/3
10YR 7/3
10YR 8/3
10YR 7/3
10YR 8/3
10YR 7/3
10YR 8/3
10YR 7/3
10YR 6/4
10YR 7/3
10YR 8/3
10YR 7/3
10YR 7/3

NANNOFOSSIL OOZE

Intensely to moderately deformed pale yellow brown 10YR 8/3 or very pale brown 10YR 7/3 to 10YR 7/4 nannofossil ooze. No sedimentary structures except abrupt minor changes of color at bedding surfaces. Minor browner 10YR 6/4 marly layers.

Smear slides: 1-40 2-140 3-140 4-60 5-98
6-80 and cc

Forams	0-2%	Sand	0%
Nannos	98-100%	Silt	Tr-2%
Fe-Ox	Tr	Clay	98-100%

4-121

Forams	7%	Sand	0%
Nannos	93%	Silt	5%
Fe-Ox	Tr	Clay	95%

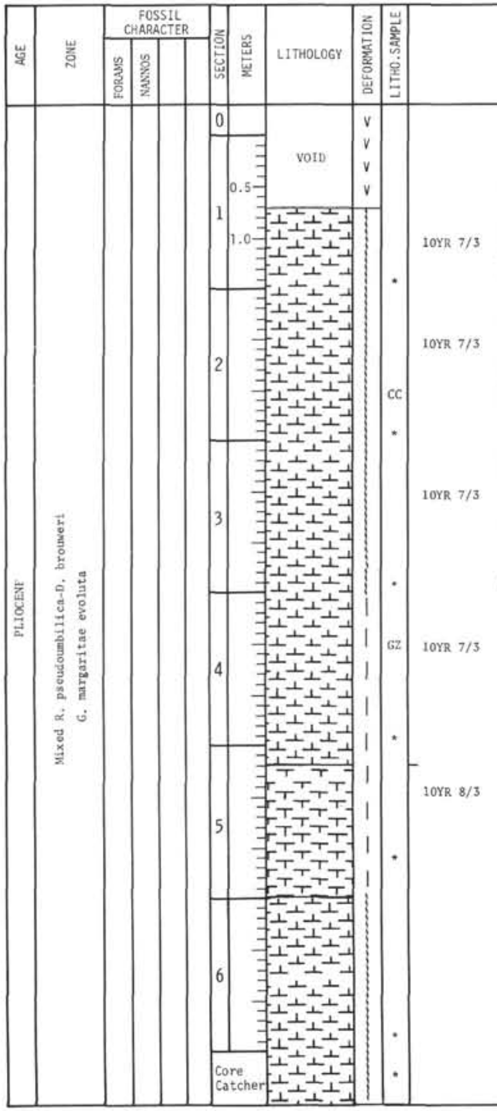
Carbon Carbonate

2-100	10.9	0.5	87

Grain Size

4-52	0.1	25.9	74

Site 396 Hole Core 12 Cored Interval: 4558.41-4567.96 m (98.41-107.96 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE AND FORAMINIFER-NANNOFOSSIL OOZE

Very pale brown (10YR 7/3 or 10YR 7/4) nannofossil ooze, moderately to intensely deformed, plus one layer in Section 5 of gritty foraminifer-nannofossil ooze, pale yellow brown (10YR 8/3). Nannofossil ooze is homogeneous. No obvious bedding planes except the foram-rich layer in Section 5.

Smear Slides: 1-140 2-140 3-140 4-140 6-130
and cc

Forams	Tr-3%	Sand	0%
Nannos	97-100%	Silt	Tr-2%
Fe-Ox	Tr	Clay	98-100%

5-110

Forams 30	30%	Sand	5%
Nannos	70%	Silt	25%
Fe-Ox	--	Clay	70%

Carbon Carbonate

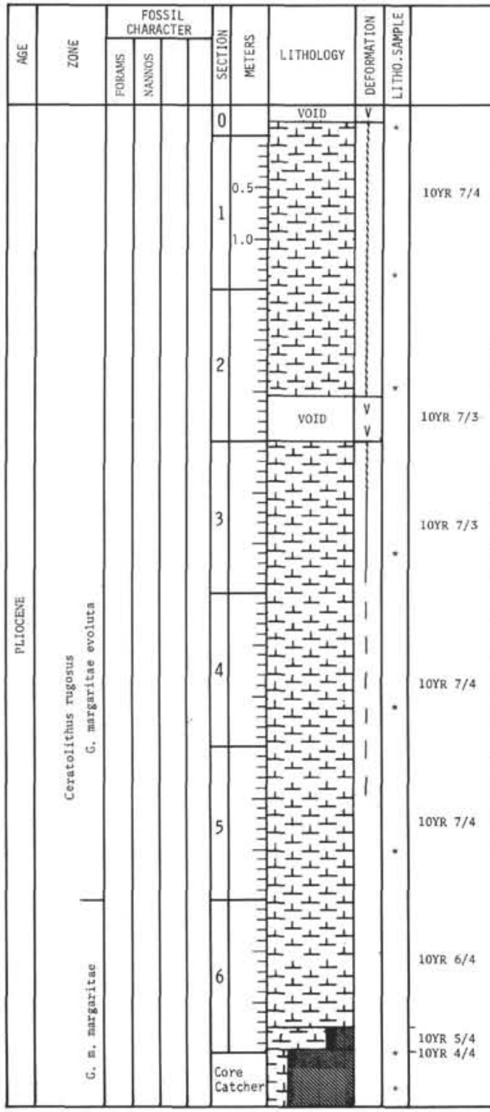
2-101	10.8	0.0	89%

Grain Size

4-50	0.0	32.9	67.4%

Explanatory notes in Chapter 1

Site 396 Hole Core 13 Cored Interval: 4567.96-4577.20 m (107.96-117.20 m subbottom)



LITHOLOGIC DESCRIPTION

NANNOFOSSIL OOZE

Note: upon retrieving this core, the liner was damaged at the bottom of what is here shown as section 2. It was not possible to determine how much sediment was lost or what the precise interval of the sediments above the damaged zone should be. This was because the damaged liner was both broken and compressed (twisted). It was necessary to have a shortened Section 2 and a lengthened Section 0 because of the damaged interval.

The sediment is moderately to intensely deformed very pale brown (10YR 7/4 or 10YR 7/3) nannofossil ooze. There are no sedimentary structures and the sediment is homogeneous except for subtle color changes.

METALIFERROUS BROWN CLAY AND MARLY NANNOFOSSIL OOZE

The base of the core contains brown (10YR 5/4 or 10YR 4/4) clays and marly clays. Smear slides contain more hydrous (?) iron and manganese (?) oxides than the nannofossil oozes. This and their proximity to basement suggests that the clays are metaliferrous, similar to clays found above basalt at many places in the world oceans.

Smear Slides: 0-125 1-130 2-90 3-100 4-100
5-100 6-147 cc

Forams	Tr-6%	Sand	0-Tr
Nannos	94-99%	Silt	0-5%
Fe-Ox	Tr-1%*	Clay	95-100%

* except 6-147 and cc in which everything is coated sith Fe-oxides and brown clays.

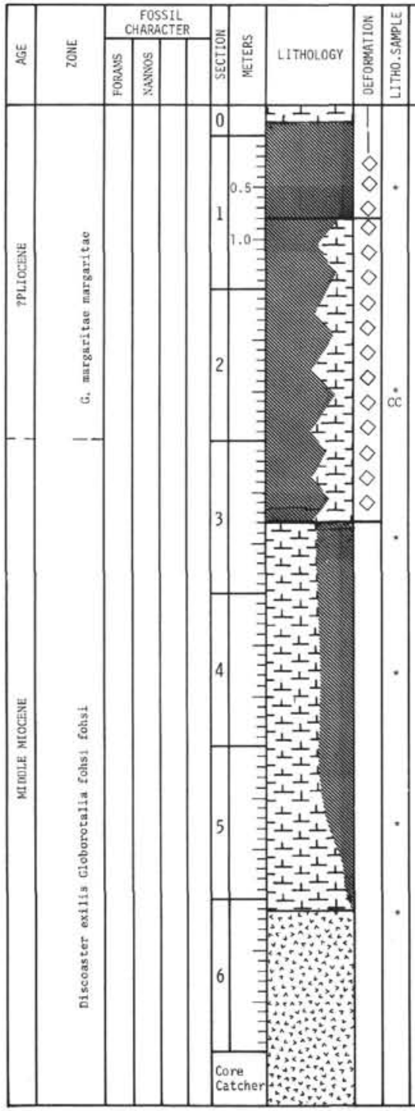
Carbon Carbonate

2-100	10.0	0.0	83%

Grain Size

4-52	0.6	32.9	66.6%

Site 396 Hole Core 14 Cored Interval: 4577.20-4586.74 m (117.20-126.74 m subbottom)



LITHOLOGIC DESCRIPTION

10YR 7/4

BROWN CLAYS, MARLY NANNOFOSSIL OOZE, NANNOFOSSIL OOZE AND BASALT

The top of the core contains mainly brown clays. These are fairiy firm, but fractured by drilling and mixed with soupy brown nanoofossil ooze. This is indicated by a broken line in the interval from 1-80 to 3-80 in the lithology column. The clays are generally brown (10YR5/4 or 10YR 4/4) but they are smeared with lighter-colored soupy nannofossil ooze. Little deformed marly nannofossil ooze (10YR 5/6) overlies basalt. The four topmost pieces of basalt were completely encased in this material, a result of compression of the ooze into the core as the basalt was drilled. The basalt of Section 14-6 is described in more detail on the first of the following basalt description forms.

10YR 3/3

10YR 5/6

Remark:

The brown clays are similar to basal metaliferrous clays common above basalt in the world oceans. It is important to note, however, that the most clay-rich layers in this core did not immediately overlie basalt.

10YR 5/6

Smear Slides: 1-40 2-100 3-100 4-75*

Forams	Tr-1%	Sand	0%
Nannos	97-99%	Silt	1%
Fe-Ox	1-3%	Clay	99%

10YR 5/6

*Note: the percentage of clays was difficult to estimate in these smear slides. The %$CaCO_3$ given below indicates 57% clay and iron-manganese oxides occurs in sediment similar to that represented by these smear slides.

Smear Slides: 5-75 6-10

Forams	Tr-3%	Sand	0%
Nannos	97-100%	Silt	Tr-3%
Fe-Ox q	Tr	Clay	97-100%

10YR 5/6

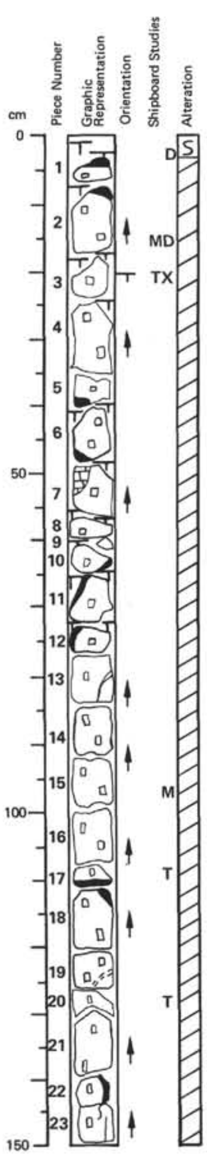
Carbon Carbonate

2-100 5.2 0.1 43%

Grain Size

4-50 1.7 49.4 48.8%

Explanatory notes in Chapter 1



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		14	6

MAJOR ROCK TYPE – SPARSELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Fine-grained, very fine-grained, and glassy sparsely plagioclase and olivine phyric basalt. The basalt is moderately altered, and has glassy zones in Pieces 1, 2, 5, 10, 11, 12, 17, 18 and 22. Small variolites occur adjacent to the glassy zones. Plagioclase phenocrysts from about 10% of the rocks, and are up to 7 mm across. Olivine is rare and no more than about 2 mm across (euhedral ol. noted in Piece 15). In Piece 7, lithified foram-nanno ooze occurs adhering to the basalt. Similar sediments fill a 3 mm crack in Piece 19. Most pieces are moderately altered and have alteration "rinds". The freshest pieces are 1-6, but the most intense alteration occurs next to the lithified sediments in Piece 7 (altered to a dark ochre brown color).

Pieces 1-13, embedded in sediments are marked by interval only on the sawed surface. Pieces 14-23 are labeled on the bottom sides.

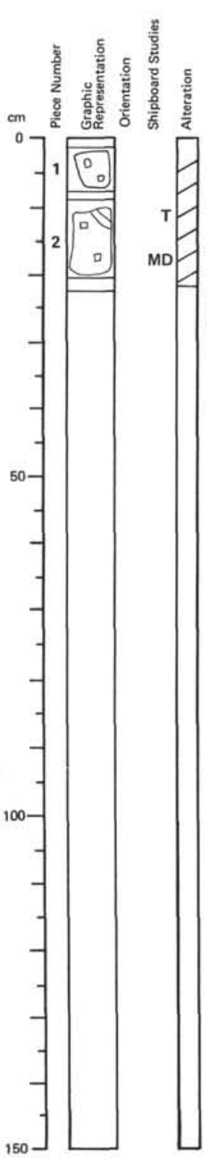
Thin Section Description

20-25 cm (Piece 3), 108-110 cm (Piece 17), 125-128 cm (Piece 20): Sparsely phyric basalts with vitrophyric to intersertal textures. Phenocrysts: plagioclase 7-10% (.2 x 1 mm to 2 x 7 mm); olivine Tr-1% (.1 to .6 mm); clinopyroxene nil. Groundmass: plagioclase 20-50% (.1 x .4 mm); clinopyroxene trace; olivine 3-5% (.02-.1 mm). Plagioclase phenocrysts contain glass blebs. Groundmass plagioclase is skeletal. Piece 17 is least crystallized, contains 15% fresh glass, 55% microcrystalline mesostasis. Pieces 3 and 20 have 40% mesostasis, mostly microcrystalline to subvariolitic, but partially intersertal in places. Mesostasis in all has microcrystalline titanomagnetite, cpx., and acicular plagioclase intergrowths, with some clays. Vesicles (1-2%) are filled partly by microcrystalline "devitrified" glass, and clay minerals. Palagonite (tr) present in Piece 17 along with minor zeolites. Phenocrysts partially rounded.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
20-25 cm:												
49.3	16.25	9.96	7.0	11.57	0.31	1.50	-2.0	0.58	287	111	148	109

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
14-16 cm:	-21.8°	1.52	700	—	—	2.77	–
97-99 cm:	-19.8°	1.21	550	—	—	—	–

Note: Yellowish brown (10YR 5/6) foram-nanno ooze occurs at the very top of this section. The top 13 pieces of basalt are embedded in it (it was apparently squeezed around the basalt during drilling). Effectively 100% recovery occurred in this section. Although the sediments are disturbed, the basalt-sediment contact was recovered. The basalts appear to represent a pillow-lava sequence.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		14	CC

MAJOR ROCK TYPE – SPARSELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

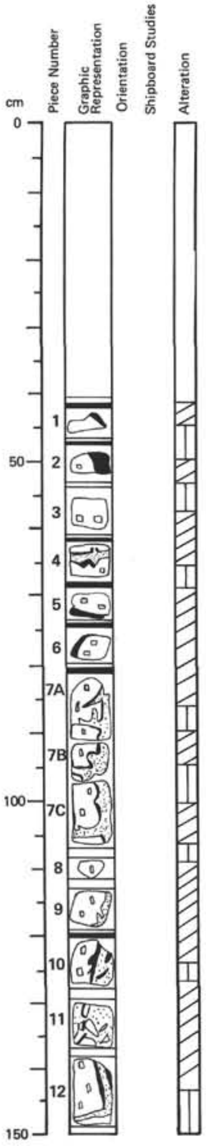
Macroscopic Description

Given in Section 6. Both Pieces 1 and 2 contain lithified sediments. Piece 1 is altered to a light brown color.

Thin Section Description

Core-catcher 10-12 cm (Piece 2): Sparsely plagioclase-olivine phyric basalt with foraminifera-bearing crack filling. Phenocrysts: plagioclase 5% (4 mm); olivine 1% (2.5 mm); cpx. nil. Groundmass: plagioclase 30% elongate, skeletal; olivine 3%; cpx. 1%; mesostasis 40% microcrystalline; crack filling 20% with outlines of foraminifera tests. Trace of palagonite in glass.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
17-19 cm:	+41.5°	1.55	490	—	—	2.81	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

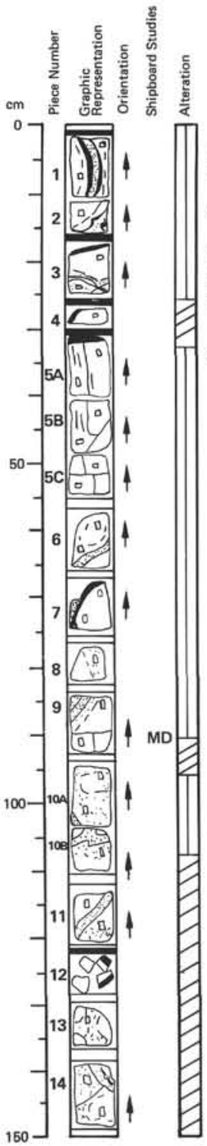
LEG	SITE	HOLE	CORE	SECT.
45	396		15	1

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

Fine-grained, very fine-grained and glassy plagioclase-olivine phyric basalt. Plagioclase 7-10% (1-7 mm); olivine Tr-2% (1-2 mm). Glass present in many pieces as shown. Glass locally partially palagonitized. Abundant baked and lithified sediments adhering to basalt pieces and in cracks, sometimes with glass on either side of cracks. Smear slides show mainly recrystallized limestone, but relict foraminifers appear in thin sections. Sediments in Pieces 10 and 11 have inclusions of palagonitized glass. Piece 11 is essentially hyaloclastite.

This sequence, like basalts in Core 14, extruded into ooze.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

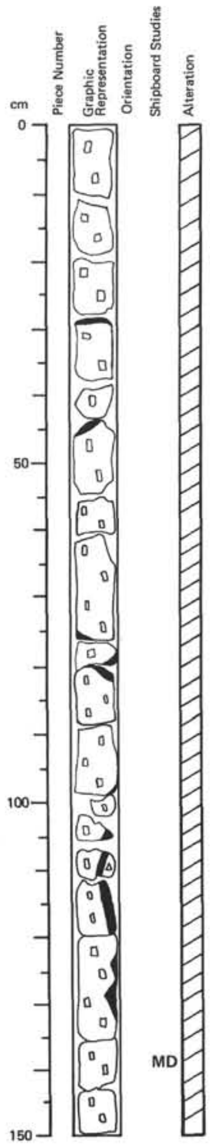
LEG	SITE	HOLE	CORE	SECT.
45	396		15	2

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

A continuation of fine-grained to glassy sparsely phyric pillow basalts with abundant lithified sediments in cracks and attached to basalt, described in Section 1. Glass present as indicated on many pieces, and on both sides of cracks containing lithified sediments. Zones of rather great alteration next to such cracks. No particular variation in proportions of phenocrysts, which are similar in size and abundance to those of Section 1. Pervasively moderately to intensely altered.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
91-93 cm:	+38.2°	1.64	700	—	—	2.82	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

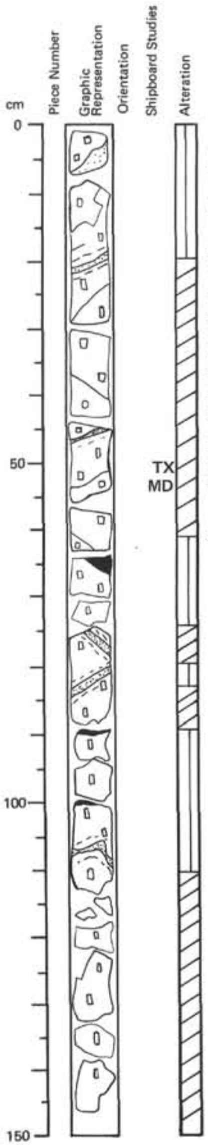
LEG	SITE	HOLE	CORE	SECT.
45	396		15	3

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

A continuation of basalts described in Sections 1 and 2. Glass zones common, as marked, often associated with lithified sediment pockets, as at 107 cm, 124-115 cm. Glass sediment breccia at 110 cm.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
138-140 cm:	+36.1°	1.51	425	—	—	2.86	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		15	4

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

A continuation of basalts described in Sections 1 through 3. Marked by interval only. Glass not as abundant as in previous sections (near 65 cm, 90 cm and 99 cm only). Alteration more intense adjacent to cracks containing lithified foram-nanno ooze.

Thin Section Description

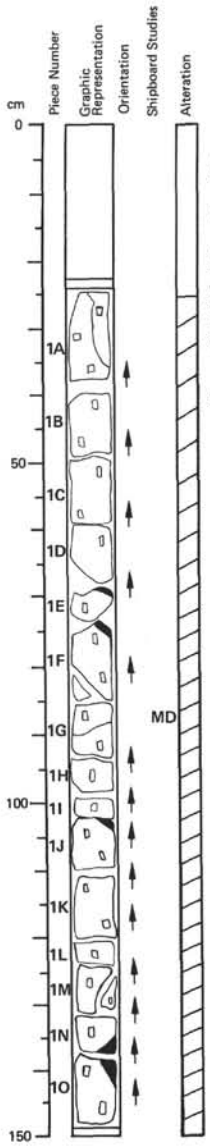
48-53 cm: Sparsely phyric olivine-plagioclase basalt, intersertal texture. Phenocrysts: plagioclase 10% (.2-7 mm) eu-subhedral; olivine 1% (.2-2 mm) eu-subhedral; cpx. nil. Groundmass: plagioclase 40%, olivine 5%, matrix 40% (5% dusty titanomagnetite, microcrystalline plagioclase 5%, cpx. 90%). Plagioclase in groundmass is represented both by laths and by microcrystalline skeletal crystals intergrown with cpx. Trace spinel also noted. Plagioclase phenocrysts locally contain glass blebs. Some olivine phenocrysts are rounded. No information on alteration.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
48-53 cm:												
49.5	16.75	9.17	8.5	11.88	0.21	1.24	-3.1	0.65	399	171	155	86

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
50-52 cm:	+37.0°	.788	550	—	—	2.84	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		16	1



MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

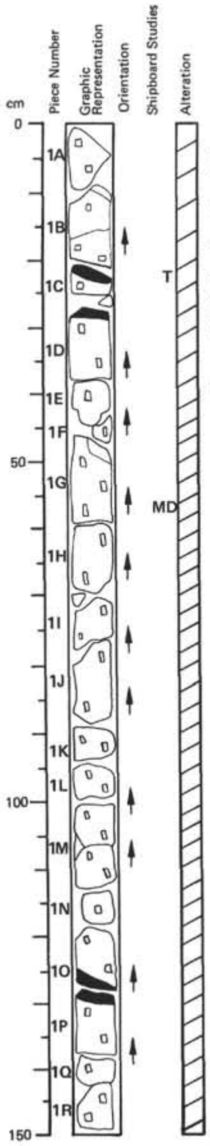
Macroscopic Description Core 16 Section 1 through core-catcher

Fine-grained, very fine-grained and glassy plagioclase-olivine phyric basalt. Plagioclase 3-5% (1-7 mm), olivine Tr-2%. Glass present in many pieces as shown, generally slightly palagonitized. Cracks and veins of recrystallized limestone, formerly foram-nanno ooze, into which the basalts were extruded. Alteration moderate to intense throughout, but glass can be fresh. Glass locally occurs adjacent to sediment-filled cracks. Vesicles are Tr-2%, less than 1 mm diameter, and partially filled with brown and/or gray-brown secondary clays. Alteration is more intense adjacent to glass and to lithified sediments in cracks.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
90-92 cm:	+35.0°	1.51	350	—	—	2.84	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		16	2



MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

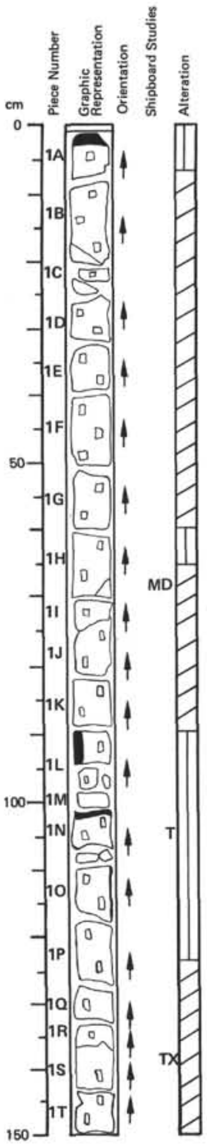
Macroscopic Description

Given in Section 1. Glass on Pieces 1C, 1D, 1I, 1O, and 1P. Carbonate veins cut 1D (not lithified sediments). Lithified sediments fill cracks in 1B, and 1R.

Thin Section Description

21-22 cm (Piece 1B): Carbonate crack filling: contains two types of carbonate (calcite): 1) fine-grained; 2) coarse-grained, both recrystallized. Trace of dark glass and plagioclase fragments. No fossils preserved. Filling is at bottom of piece.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
57-59 cm:	+36.4°	1.43	500	—	—	2.84	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		16	3

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

Given in Section 1. Glass present in 1A, 1L, and 1N. Carbonate veins (not lithified sediments) present in some pieces. Lithified sediments not noted in this seciton.

Thin Section Description

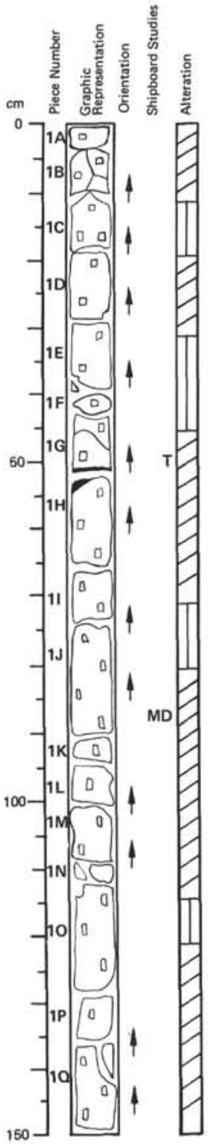
101-103 cm: Sparsely phyric olivine-plagioclase basalt, variolitic to subvariolitic groundmass. Phenocrysts: plagioclase 5% (.2 x 1 mm up to 4 x 9 mm) eu-subhedral; olivine trace (.2-1 mm). Groundmass: plagioclase 1% skeletal, elongate, the rest microcrystalline and variolitic. Plagioclase phenocrysts contain some glass blebs. Some as well are rounded. Carbonate in cracks and around the edges of some plagioclase crystals.

137-142 cm (Piece 1R): Sparsely phyric olivine-plagioclase basalt, intersertal groundmass. Phenocrysts: plagioclase 5% (.2-3 mm) eu-subhedral, with relict blebs of basaltic glass, some rounded; olivine: 1% (.1-1.5 mm) eu-subhedral, partly altered to clays. Groundmass: plagioclase 50%; clinopyroxene 40%; olivine 5%; titanomagnetite 1%; picotite trace. Groundmass partly altered to clays. Vesicles (1-2%) filled with yellow-gray and yellow-brown clays. Spinels may contain rounded inclusions of microcrystalline "devitrified" glass(?).

The above two thin sections probably represent an edge and the interior of a single cooling unit.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
137-142 cm:												
49.8	16.73	9.24	8.1	11.95	0.24	1.27	-2.4	0.63	390	143	155	90

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
68-70 cm:	+33.1°	.926	550	—	—	2.82	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		16	4

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

Given in Section 1. Glass in Pieces 1E, 1G, and 1H. Cracks more abundant than in higher sections, generally filled with carbonate. Lithified sediments not noted in this section. Plagioclase slightly higher than usual, 7-10%. Alteration more intense along cracks and veins.

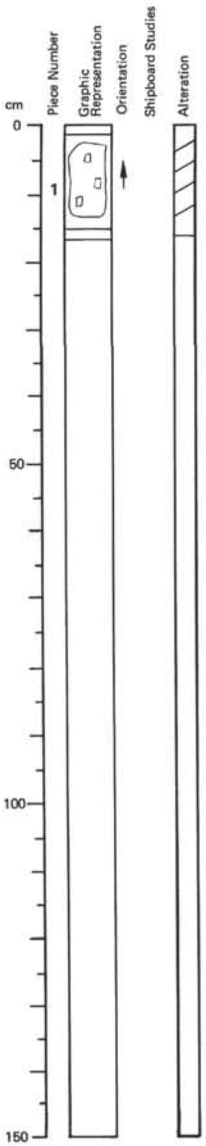
Thin Section Description

53-54 cm (Piece 1G): Sparsely phyric plagioclase-olivine basalt with variolitic groundmass. Phenocrysts: plagioclase 3-5% (.2-2.5 mm) subhedral, An_{70}; olivine 1% (.2-1.5 mm) subhedral, some rounded. Mesostasis 90%, partly microcrystalline, partly black, comprised of intersecting spherulites of indeterminant mineralogy. Plagioclase phenocrysts contain either inclusions of picotite, or of volcanic glass. Matrix is partly altered to clay minerals, and contains skeletal elongate acicular plagioclase in small amounts.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
91-93 cm:	+35.2°	1.27	300	—	—	2.84	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
4 5	3 9 6		1 6	CC



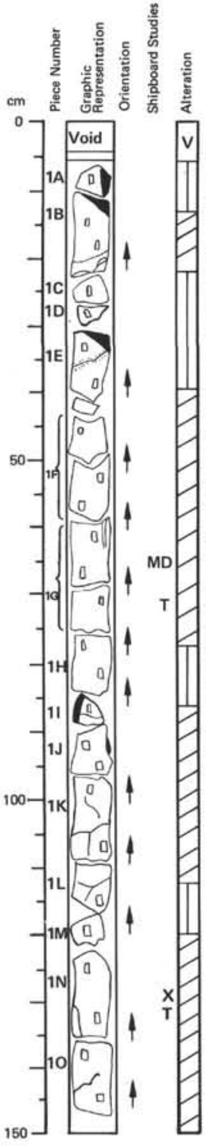
MAJOR ROCK TYPE – SPARSELY TO MODERATELY PHYRIC PLAGIOCLASE-OLIVINE PHYRIC FINE-GRAINED BASALT

Macroscopic Description

Given in Section 1.

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
4 5	3 9 6		1 8	1



MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLVINE PHYRIC BASALT

Macroscopic Description Sections 1 through core-catcher

Fine-grained, very fine-grained, and glassy plagioclase-olivine phyric basalt. Plagioclase 2-7% (1-5 mm), olivine Tr-2% (1-3 mm). Glass present in many places as shown. Has cracks lined with carbonate, but no recrystallized foram-nanno ooze is present. Alteration is moderate to intense throughout, especially adjacent to cracks and glass. Vesicles are Tr-3%, less than 1 mm, and partially filled with secondary clays. Glass is partially palagonitized. There are minor fluctuations in the abundance of plagioclase phenocrysts; some pieces are virtually aphyric, many have no more than 3% plagioclase phenocrysts, others contain as much as 5-7%. Olivine is more constant 1-2%, but is generally partially altered to reddish secondary minerals. Grain size ranges from glassy, through subvariolitic zones of incipient crystallization, to fine-grained but essentially holocrystalline rocks, representing the transition from pillow selvage to pillow interior. It is doubtful whether a single pillow thicker than about 1 meter was cored in this interval.

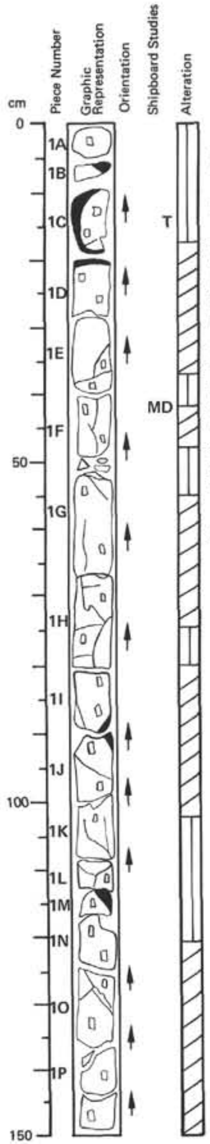
Thin Section Description

70-78 cm (Piece 1G): Sparsely phyric plagioclase-olivine basalt, subvariolitic to subophitic groundmass. Phenocrysts: plagioclase 5-7% (.2-4 mm) eu-subhedral; olivine 1% (.2-1.5 mm) eu-subhedral. Both olivine and plagioclase phenocrysts contain rounded inclusions of glass. Picotite is rare. Matrix (90%) contains skeletal olivine (1%), skeletal plagioclase (45%), titanomagnetite (1-3%, dust sized), and clinopyroxene (50%). It is partly altered to clay minerals, and is partly subvariolitic "sworls", and partly interlocking crystal laths.

130-136 cm (Piece 1N): Sparsely phyric plagioclase-olivine basalt, subvariolitic groundmass. Phenocrysts: plagioclase 10% (.2-3 mm) eu-subhedral; olivine 1% (.2-.8 mm) eu-subhedral. The groundmass is largely dark, microcrystalline subvariolitic "sworls" with about 5% tiny skeletal olivine crystals. Needle-like plagioclase and clinopyroxene in about equal proportions make up the sworls, which are dusted with fine opaques. Chrome spinel is accessory. The matrix is partly altered to clays, and has minor secondary calcite. Plagioclase phenocrysts are rounded, and contain blebs of glass.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
130-136 cm:	49.7	16.93	9.68	7.9	12.09	0.29	1.27	−2.6	0.62	383	142	146	87

	Inc.	NRM	MDF	Vρ (‖)	Vρ (⊥)	D	P
68-70 cm:	+33.8°	.944	440	—	—	2.78	–
109-111 cm:	+37.7°	.251	450	—	—	2.71	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		18	2

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

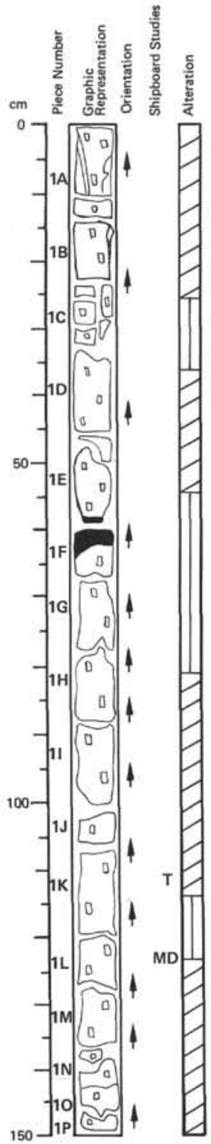
Macroscopic Description

Basic description given in Section 1. In this section, glass is present in Pieces 1B, 1C, 1D, 1I, 1J, and 1M. Plagioclase is more abundant than usual in the glassy zones of Pieces 1B and 1C. Plag. phenocrysts decrease in abundance from 7% to 3% from Pieces 1D to 1H, whereas olivine increases from less than 1% to 2-3%. In 1H, plagioclase increases abruptly back to 7% and olivine again decreases. Plagioclase is also concentrated in the glassy part of Pieces 1J, is low in 1K, but increases back to about 7% at the bottom of the section.

Thin Section Description

10-19 cm (Piece 1C): Sparsely phyric plagioclase-olivine basalt with glassy-variolitic groundmass. Phenocrysts: plagioclase 4% (.2-5 mm); olivine trace, skeletal. Matrix is microcrystalline, variolitic, or glassy. Glass pale brown, variolites dark brown to black; microcrystalline portions very dark but with fine, acicular plagioclase needles forming in sworls. Glass contains some palagonite. Phenocrysts are partly rounded; olivine phenocrysts partly altered to clays, and surrounded by plagioclase phenocrysts in some cases. Carbonate (5%) crystallized in tiny cracks and in portions of olivine crystals altered to clays.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
42-44 cm:	+32.8°	1.26	350	—	—	2.79	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		18	3

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

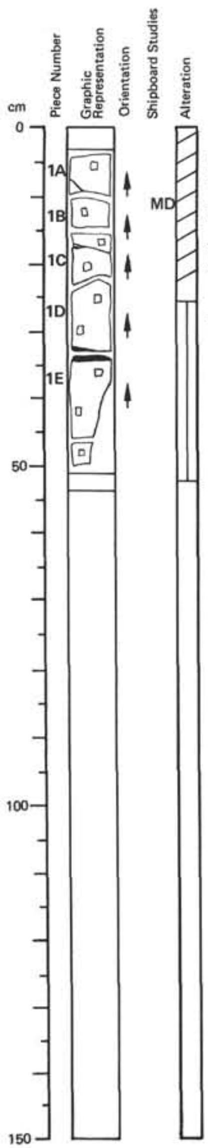
Macroscopic Description

Basic description given in Section 1. Glass present in Pieces 1E and 1F. Basalt is more altered along zones of glass. Glass is partly altered to palagonite and clay minerals(?). Carbonate veins are present in Pieces 1A, 1B, and 1K, and to a lesser extent in other pieces. No lithified sediments are present.

Thin Section Description

118-120 cm (Piece 1L): Sparsely phyric plagioclase-olivine basalt, with microcrystalline groundmass. Phenocrysts: plagioclase 7%, eu-subhedral, up to 5 mm; olivine - trace, up to 3 mm; titanomagnetite 3% (up to .1 mm). Matrix 90%, acicular skeletal crystals of plagioclase, cpx., and euhedral olivine in proportions 12:7:1. Trace of clay minerals. Olivine altered to "iddingsite" and clear clays.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
124-126 cm:	+27.9°	1.53	225	—	—	2.86	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

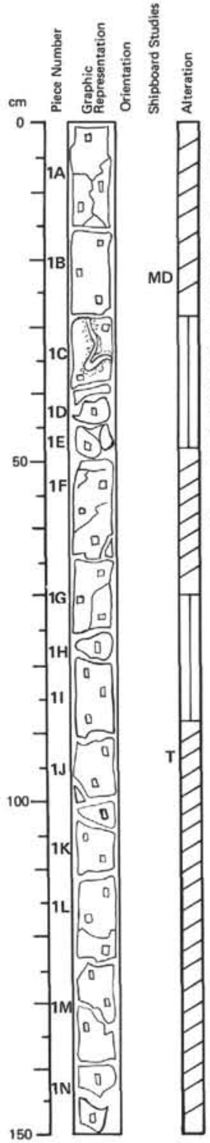
LEG		SITE			HOLE	CORE		SECT.
4	5	3	9	6		1	8	CC

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Basic description given in Section 1. Glass present in Pieces 1D and 1E. Plagioclase most abundant (5-7%) in Pieces 1A and 1B, but as low as 3% in other pieces. Carbonate veinlets in all pieces.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
10-12 cm:	+29.4°	1.16	450	—	—	2.82	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG		SITE			HOLE	CORE		SECT.
4	5	3	9	6		1	9	1

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

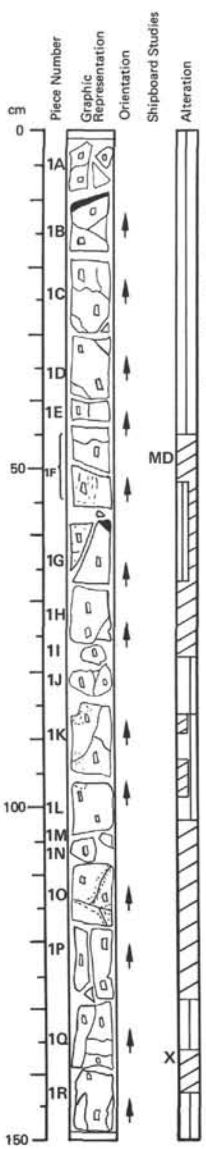
Macroscopic Description Sections 1 and 2

Fine-grained, very fine-grained, and glassy plagioclase-olivine phyric basalt. Plagioclase 3-7% (1-5 mm), olivine Tr-2% (1-3 mm). Glass present only in Section 2. Olivine is generally partially altered to reddish secondary minerals. Moderately to intensely altered throughout, especially adjacent to carbonate veins which are locally abundant. In Section 1, carbonate veins are most abundant in Pieces 1C-F. There is a large carbonate vein in Piece 1C.

Thin Section Description

93-95 cm (Piece 1J): Sparsely phyric plagioclase-olivine basalt, with subvariolitic to intersertal groundmass. Phenocrysts: plagioclase 5-7% (.2-4 mm) subhedral; olivine less than 1% (.2-.8 mm) subhedral; spinel (chromian) Tr. Groundmass: plagioclase 40%, euhedral laths and acicular needles; olivine 2-3%, euhedral; intersertal matrix of titanomagnetite dust (10% of matrix), plagioclase (20% of matrix) and clinopyroxene (70% of matrix),all microcrystalline. Some olivine phenocrysts are altered to clays. Some plagioclase phenocrysts contain blebs of microcrystalline "devitrified" glass.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
22-24 cm:	+29.4	1.55	250	—	—	2.80	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		19	2

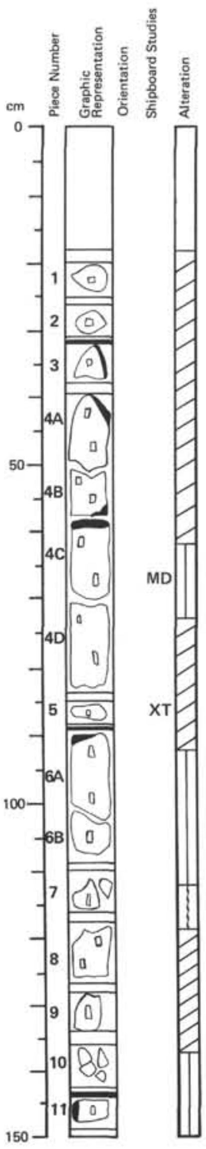
MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Basic description given in Section 1. Glass present in Pieces 1B and 1G. Plagioclase phenocrysts generally 5-7% except in Piece 1J -1% , and 1K - 2%. Glass partly altered to palagonite.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
138-141 cm:	49.7	16.70	9.23	7.7	11.98	0.21	1.29	-3.0	0.62	385	142	168	86

	Inc.	NRM	MDF	Vρ (‖)	Vρ (⊥)	D	P
48-50 cm:	+32.0°	1.64	510	—	—	2.85	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		21	1

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Fine-grained, very fine-grained and glassy plagioclase-olivine sparsely phyric basalt. Plagioclase 10-15% (1-4 mm). Olivine 2-3%, some altered, some fresh (1-2 mm). Phenocrysts contain blebs of glass. Vesicles filled with secondary clays (1-3%, less than 1 mm diam.). Phenocrysts somewhat scarce in Pieces 6A, 6B (7% total). This basalt is more phyric than previous cores.

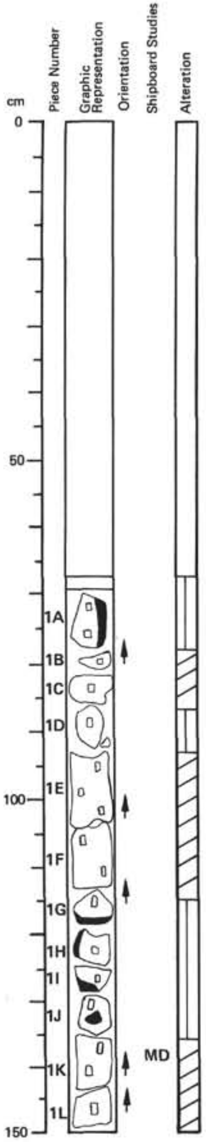
Thin Section Description

89-90 cm (Piece 5): Sparsely phyric plagioclase olivine basalt, intersertal groundmass. Phenocrysts: plagioclase 5%, eu-subhedral; olivine 2%, eu-subhedral. Groundmass: plagioclase 50%, clinopyroxene 25%, olivine 10%, all with skeletal habit. Titanomagnetite "dust" 2%; vesicles 3%; clays-trace; calcite 1-2%. Glomerocrysts of intergrown plagioclase and olivine phenocrysts present. Phenocrysts rounded; plagioclase phenocrysts contain glass blebs.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
87-89 cm:	48.9	17.08	8.95	8.7	12.24	0.25	1.19	-2.4	0.66	407	189	150	85

	Inc.	NRM	MDF	Vρ (‖)	Vρ (⊥)	D	P
70-72 cm:	+34.3°	.911	550	—	—	2.77	–

Cooling unit boundaries on Pieces 3, 4A, 4C, 6A, and 11.



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		22	1

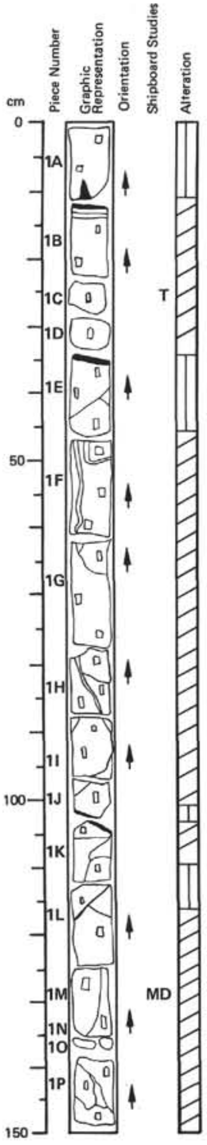
MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description Sections 1 through core-catcher

Fine-grained, very fine-grained, and glassy plagioclase-olivine sparsely to moderately phyric basalt. Plagioclase 3-10% (1-5 mm) olivine 1-3% (2-4 mm), vesicles 1-2% (less than 1 mm). Alteration moderate to intense. Olivine partly altered to reddish secondary minerals. Carbonate veins locally abundant. Glass partially palagonitized, associated with some zeolites.

In Section 1, an exceptionally large (1 cm) plagioclase phenocryst occurs in Piece 1A. From Pieces 1B to 1F, plag. increases from 3-7% and olivine from 1-5%.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
139-141 cm:	+33.3°	.811	700	—	—	2.81	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		22	2

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

General description given in Section 1. Glass present in Pieces 1A, 1B, 1E, 1J, and 1K. Pieces 1E-1J probably represent a single pillow in which olivine increases from about 3% near the top to 7% near the bottom. A plagioclase crystal in Piece 1F is 1.5 cm across. One in Piece 1G is 1 cm across. Carbonate veinlets are present in all specimens.

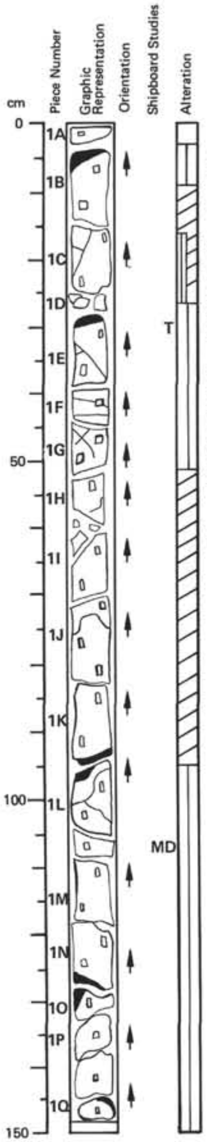
Thin Section Description

25-27 cm (Piece 1C): Moderately phyric plagioclase-olivine basalt, subvariolitic groundmass. Phenocrysts: plagioclase 20% (.2-.5 mm) eu-subhedral; olivine 5% (.1-2 mm); spinel - trace. Mesostasis 70% ismicrocrystalline, cpx.:plag.:titanomagnetite = 10:7:1. Partly altered to clay minerals. Vesicles 1-2% partly filled by carbonates and clays. Plagioclase phenocrysts locally contain blebs of glass, and some are zoned. Olivine contains blebs of microcrystalline glass and chrome spinel.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
131-133 cm:	+34.5°	1.42	550	—	—	2.82	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		22	3



MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

General description given in Section 1. Glass present in Sections 1B, 1E, 1K, 1L, 1N, 1O, and 1Q. Pieces 1E-1K are probably a section through a pillow. Plagioclase and olivine phenocrysts increase in abundance and grian size from Pieces 1E (plag. about 3%, ol. less than 1%) to 1H and 1I (plag. 7%, ol. 3%, partly fresh) and then decrease again to Piece 1K. A similar sequence probably representing a pillow was recognized between Pieces 1L and 1Q. At glassy zones, reddish brown alteration (palagonite?) is present. Olivine most altered in intensely altered pieces; partly fresh in moderately altered pieces.

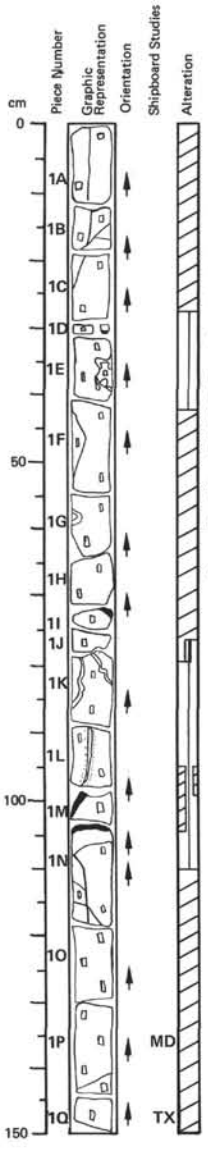
Thin Section Description

29-31 cm (Piece 1E): Moderately phyric plagioclase-olivine basalt, vitrophyric groundmass. Phenocrysts: plagioclase 13% up to 7 mm; olivine 2%, up to 2 mm; both subrounded, skeletal. Matrix ranges from glassy (pale brown) to dark brown and black, where spherulites coalesce. Within this dark matrix, tiny needles of plagioclase and crystals of olivine can be seen here and there. Portions of the glass are altered to palagonite. Plag. is An_{70}. Olivine phenocrysts contain blebs of clear glass.

	Inc.	NRM	MDF	V_ρ (∥)	V_ρ (⊥)	D	P
108-110 cm:	+36.6°	.750	700	—	—	2.81	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		22	4



MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

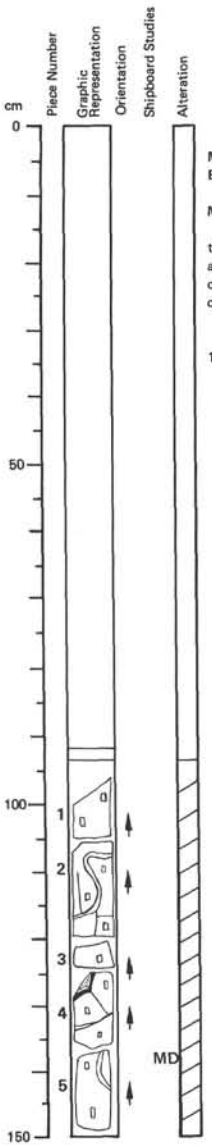
General description given in Section 1. Glass present in Pieces 1I, 1M, and 1N. Plagioclase abundance slightly lower from Pieces 1A to 1H (5-7%) than from Pieces 1I to 1Q (7-10%). Carbonate veinlets in most pieces, prominent in Pieces 1E, 1F, 1G, 1K, and 1L. Pieces 1D, 1E, and the top of Piece 1F are more vesicular (2%, less than 1 mm, empty) than other pieces in the section. Some reddish secondary minerals are in the carbonate vein in Piece 1E.

Thin Section Description

144-150 cm (Piece 1Q): Sparsely phyric plagioclase-olivine basalt, holocrystalline basaltic groundmass. Phenocrysts: plagioclase 10% (up to 5 mm) eu-subhedral, skeletal, contain glass inclusions; olivine 2% (2.5 mm) eu-subhedral, mostly altered to clays and Fe-hydroxides ("iddingsite"). Groundmass: plagioclase 40%; clinopyroxene 35%; olivine 3%; titanomagnetite 3%. Clay minerals, Fe-hydroxides, and vesicles present in trace quantities. Plag. and olivine phenocrysts can form glomerophyric aggregates. Both are typically rounded.

	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
144-150 cm:	49.8	16.93	9.47	7.6	12.11	0.25	1.29	-2.3	0.61	309	123	135	86

	Inc.	NRM	MDF	V_ρ (∥)	V_ρ (⊥)	D	P
135-137 cm:	-4.8°	4.53	450	—	—	2.86	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

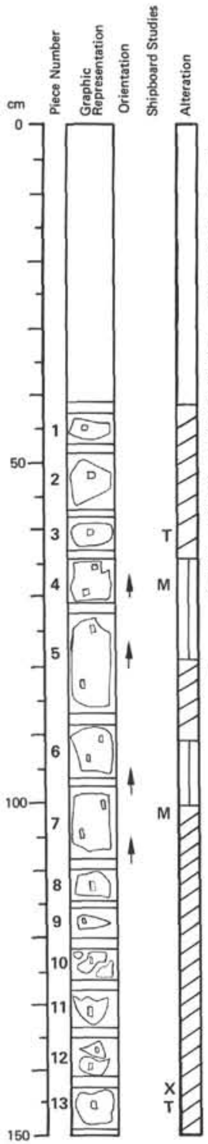
LEG	SITE	HOLE	CORE	SECT.
45	396		22	CC

MAJOR ROCK TYPE – SPARSELY TO MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

General description given in Section 1. Pieces should have been placed at the top of the section; they were recovered contiguous to the bottom of Section 4. Glass present inPiece 4, as well as a small bit of "baked" sediments (foram-nanno ooze). A broken surface of Piece 1 is coated with carbonate with black spots (Mn?). Another surface of Piece 1 is coated with carbonate and further coated with a dark greenish-brown secondary mineral.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
138-140 cm:	–2.5°	1.61	450	—	—	2.82	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		23	1

MAJOR ROCK TYPE – PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Fine-grained plagioclase-olivine phyric basalt. Plagioclase more abundant than in previous cores (about 20%); size 1-4 mm, usually 3 mm, rare up to 12 mm (in Piece 6). Some phenocrysts contain small dark glass inclusions. Olivine is 1-3%, from 1-3 mm, usually 2 mm, partly altered to reddish secondary minerals. Vesicles are 1-2% and 0.5 to 1.0 mm, partly filled by greenish-gray or brown clays. Pieces are moderately to intensely altered. Carbonate veinlets are present especially in Pieces 4-7. No glass is present, and variations in groundmass grian size were not noted.

Thin Section Description

59-61 cm (Piece 3): Moderately phyric plagioclase-olivine basalt, subvariolitic gorundmass. Phenocrysts 15% (.2-5 mm) eu-subhedral, An_{70}; olivine less than 1% subhedral. Mesostasis contains tiny skeletal acicular plagioclase needles 35%; clinopyroxene 45%; titanomagnetite "dust" 5%. Matrix is partially altered to clays, and has a trace of calcite in cracks and vesicles. Vesicles also contain clays. Plagioclase phenocrysts contain inclusions of microcrystalline "devitrified" basalt glass.

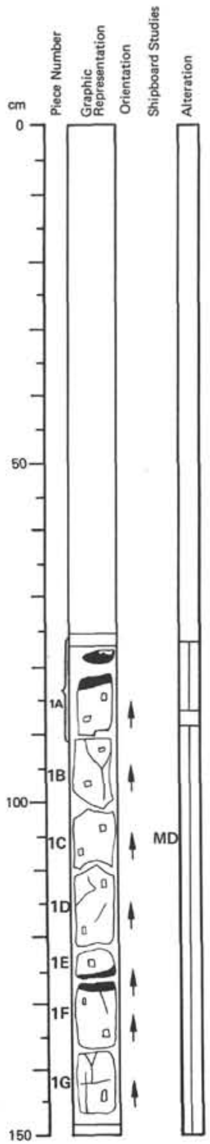
143-147 cm (Piece 13): Virtually identical to Piece 3, with 10% plagioclase phenocrysts, and about 1% olivine phenocrysts. Matrix characteristics very similar. Some vesicles are partly filled by partly crystallized basaltic glass.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
143-147 cm:												
49.2	16.68	9.29	7.3	11.96	0.21	1.29	95.9	0.61	316	128	133	93

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
67-69 cm:	–4.2°	2.05	450	—	—	–	–
102-104 cm:	–4.4°	2.16	450	—	—	2.77	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
4 5	3 9 6		2 4	1



MAJOR ROCK TYPE – PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description Sections 1 through 3

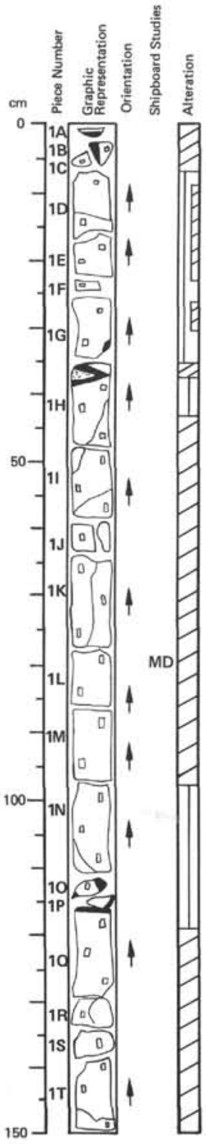
Fine-grained, very fine-grained, and glassy plagioclase-olivine phyric basalt. Plagioclase 5-20%, more abundant in Section 1 than in Sections 2 or 3, and usually 1-3 mm across, rarely 5 to 10 mm across. Olivine Tr-3% and 1-3 mm, usually partially altered to reddish secondary minerals. Alteration moderate to intense throughout. Carbonate veinlets present in most pieces, sometimes associated with manganese spots (especially visible on fracture surfaces coated with carbonate).

In Section 1, glass present on Pieces 1A, 1E, and 1F. Proportion of plagioclase phenocrysts in Piece 1E is low (5%) increasing to the top of the cooling unit (20% in Piece 1A).

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
107-109 cm:	-8.3°	1.11	900	—	—	2.76	–

VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
4 5	3 9 6		2 4	2

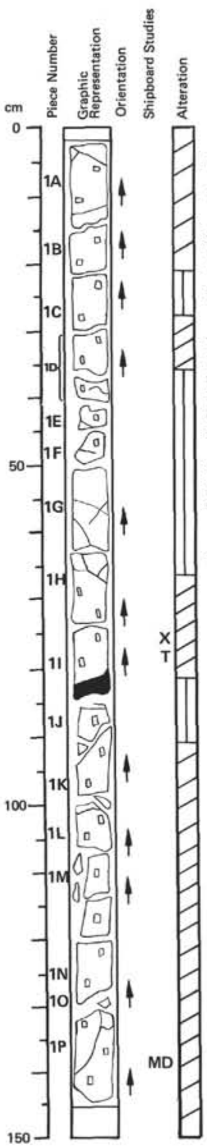


MAJOR ROCK TYPE – MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

General description given in Section 1. In this section, plag. is lower in abundance than in Section 1 (7-10% this section) with no marked gradients in proportion. Glass is present in Pieces 1A, 1B, 1G, 1H, 1O, 1P, and 1Q. Carbonate veinlets are present in many pieces, baked sediments only in Piece 1H. In Piece 1H, the size of plagioclase phenocrysts increases downward.

	Inc.	NRM	MDF	Vρ (∥)	Vρ (⊥)	D	P
80-82 cm:	-6.0°	1.88	450	—	—	2.85	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		24	3

MAJOR ROCK TYPE – MODERATELY PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

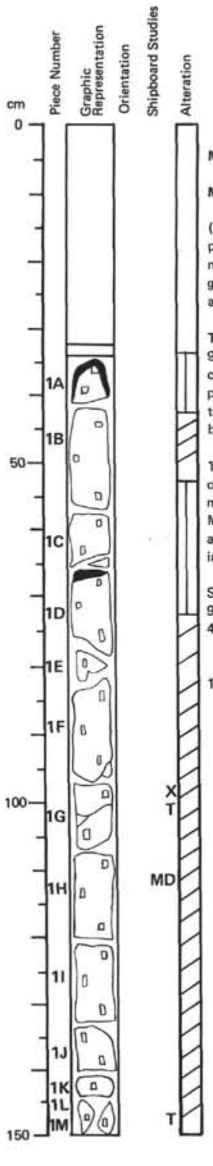
General description given in Section 1. From Section 2, Pieces 1P to Section 3, Piece 1I is an apparent cooling unit. No significant variation of plagioclase phenocrysts is observed in this cooling unit. Olivine is only about 1% in the glass of Piece 1I, however, and 3% in the cooling unit interior. From Pieces 1J to 1P, plagioclase phenocrysts increase from 5% to 10%, and olivine phenocrysts from less than 1% to about 3%. Black spots of Mn are seen on carbonates of Pieces 1D, 1J, and 1M.

Thin Section Description

73-78 cm (Piece 1I): Moderately phyric plagioclase olivine basalt, subvariolitic to intersertal groundmass. Phenocrysts: plagioclase 20% (.2-4 mm) subeuhedral; olivine 1% (.1-.4 mm) eu-subhedral. Plag. is An_{70-75}. Groundmass: plagioclase 10% acicular, skeletal; olivine 1% skeletal. Matrix mostly finely crystalline cpx.:plag. = 2:1, with a fine dust of titanomagnetite. Some phenocrysts of plagioclase and olivine are rounded. Some vesicles (1-2%) contain microcrystalline volcanic glass, partly altered.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
73-78 cm:												
49.1	16.58	9.68	7.9	12.07	0.23	1.29	-2.0	0.62	226	124	128	86

	Inc.	NRM	MDF	Vρ (‖)	Vρ (⊥)	D	P
138-140 cm:	-6.9°	2.83	450	—	—	2.85	–



VISUAL CORE DESCRIPTION FOR IGNEOUS ROCKS

LEG	SITE	HOLE	CORE	SECT.
45	396		25	1

MAJOR ROCK TYPE – PLAGIOCLASE-OLIVINE PHYRIC BASALT

Macroscopic Description

Fine-grained, very fine-grained and glassy plagioclase-olivine phyric basalt. Plagioclase 15-20% (1-3 mm, usually 2 mm). Olivine 1-3% (1-2 mm). Some large plagioclase megacrysts (1 cm) present, but rare). Glass present in Pieces 1A and 1D, partially altered to palagonite. Alteration is moderate to intense, especially in fine-grained to glassy pieces. Variolites are present next to the glassy zones. Small veinlets of carbonate are present in the glassy pieces. A few small vesicles are also present close to the glass. Olivine is partially altered to reddish secondary minerals.

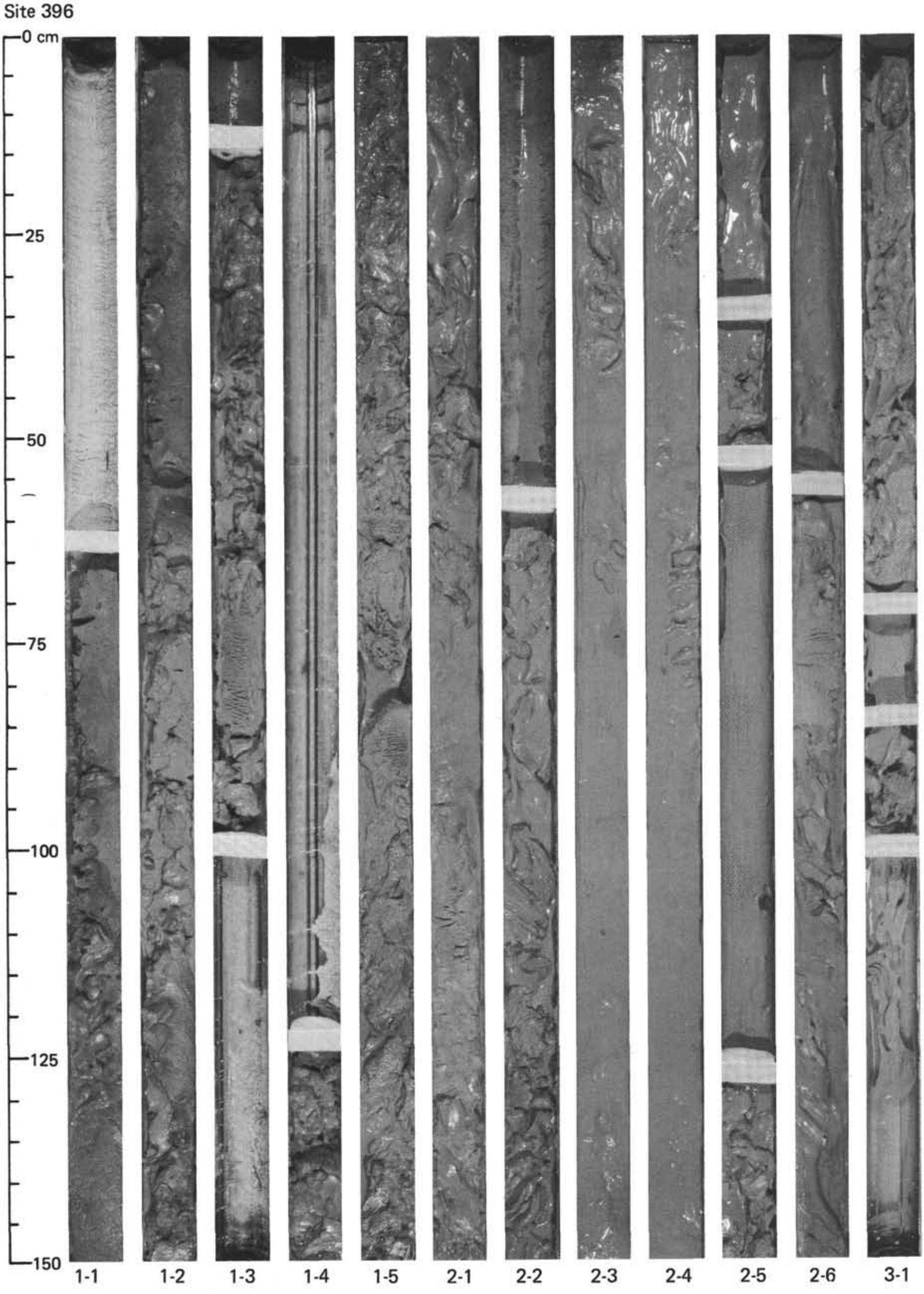
Thin Section Description

96-100 cm (Piece 1G): Moderately phyric plagioclase-olivine basalt, intersertal groundmass. Phenocrysts: plagioclase 15% (.8-3 mm) subhedral; olivine 1% (.5-1 mm) sub-euhedral. Groundmass: plagioclase 25%; cpx. - trace; olivine - trace; microcrystalline mesostasis 60% with cpx.:plag.: titanomagnetite = 5:4:1. Vesicles (1-2%) filled with clays. Some plagioclase phenocrysts contain blebs of altered volcanic glass. Olivine partly altered to clays. Plagioclase phenocrysts are skeletal.

141-143 cm (Piece 1L): Sparsely phyric plagioclase-olivine basalt, subvariolitic groundmass. Phenocrysts: plagioclase 7% (1-2 mm) sub-euhedral; olivine 3% (.3-1 mm) skeletal, sub-euhedral. Groundmass: plagioclase 10% (.01-.4 mm) skeletal, acicular; olivine 1% (.1-.2 mm) skeletal, not elongate. Microcrystalline mesostasis composed of titanomagnetite "dust", and highly skeletal clinopyroxene and plagioclase. Largely replaced by clay minerals. Form of mesostasis is subvariolitic "sworls". Note: interval on thin section should be 144-149 cm.

SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	TiO_2	IL	Mg/(Mg+Fe)	Cr	Ni	Sr	Zr
96-100 cm:												
49.7	16.71	9.49	7.4	11.99	0.13	1.29	-2.2	0.61	310	109	130	81

	Inc.	NRM	MDF	Vρ (‖)	Vρ (⊥)	D	P
111-113 cm:	-4.2°	2.39	450	—	—	2.85	–


Site 396
0 cm
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50
75
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125
150
1-1
1-2
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1-5
2-1
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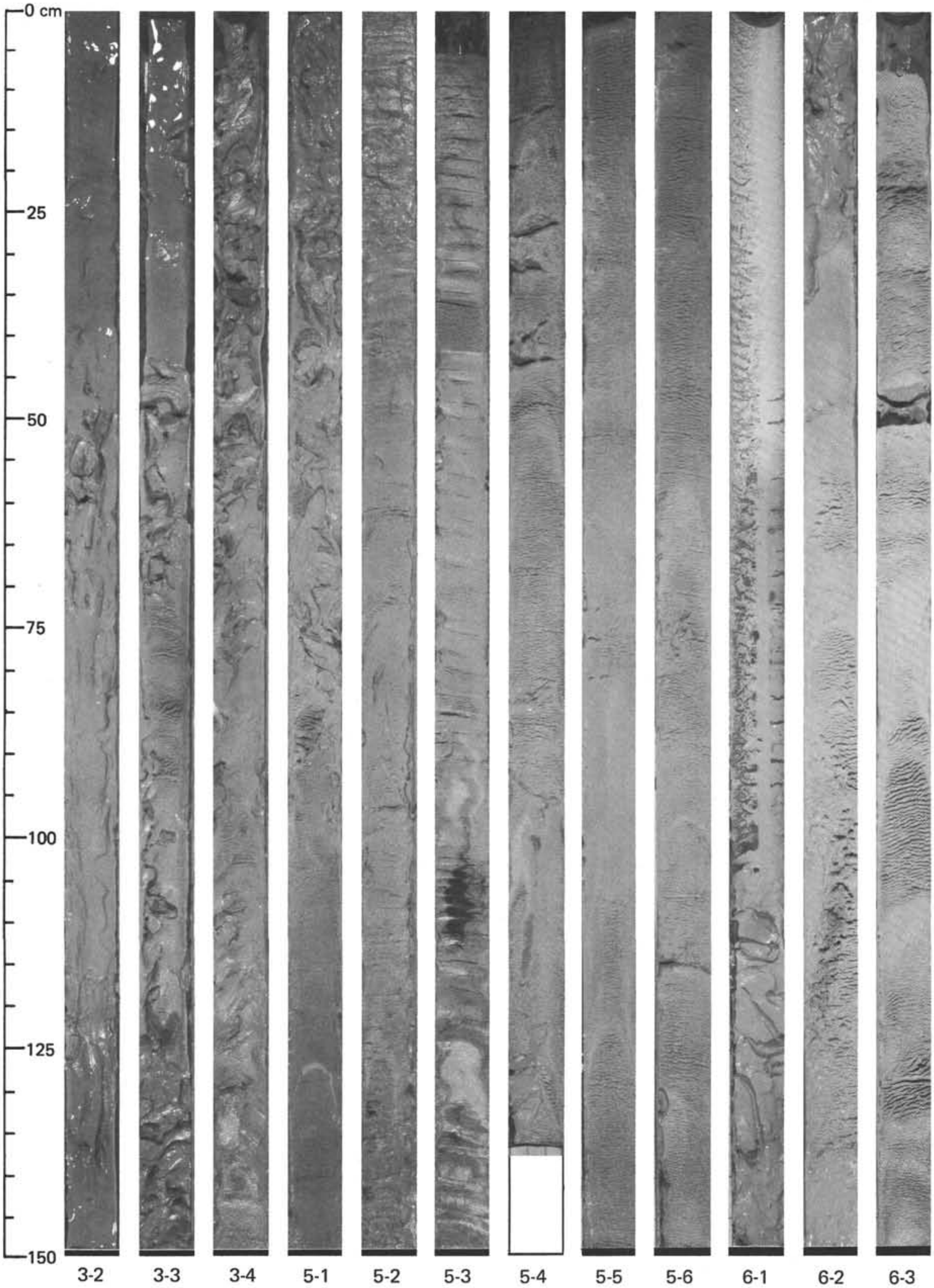
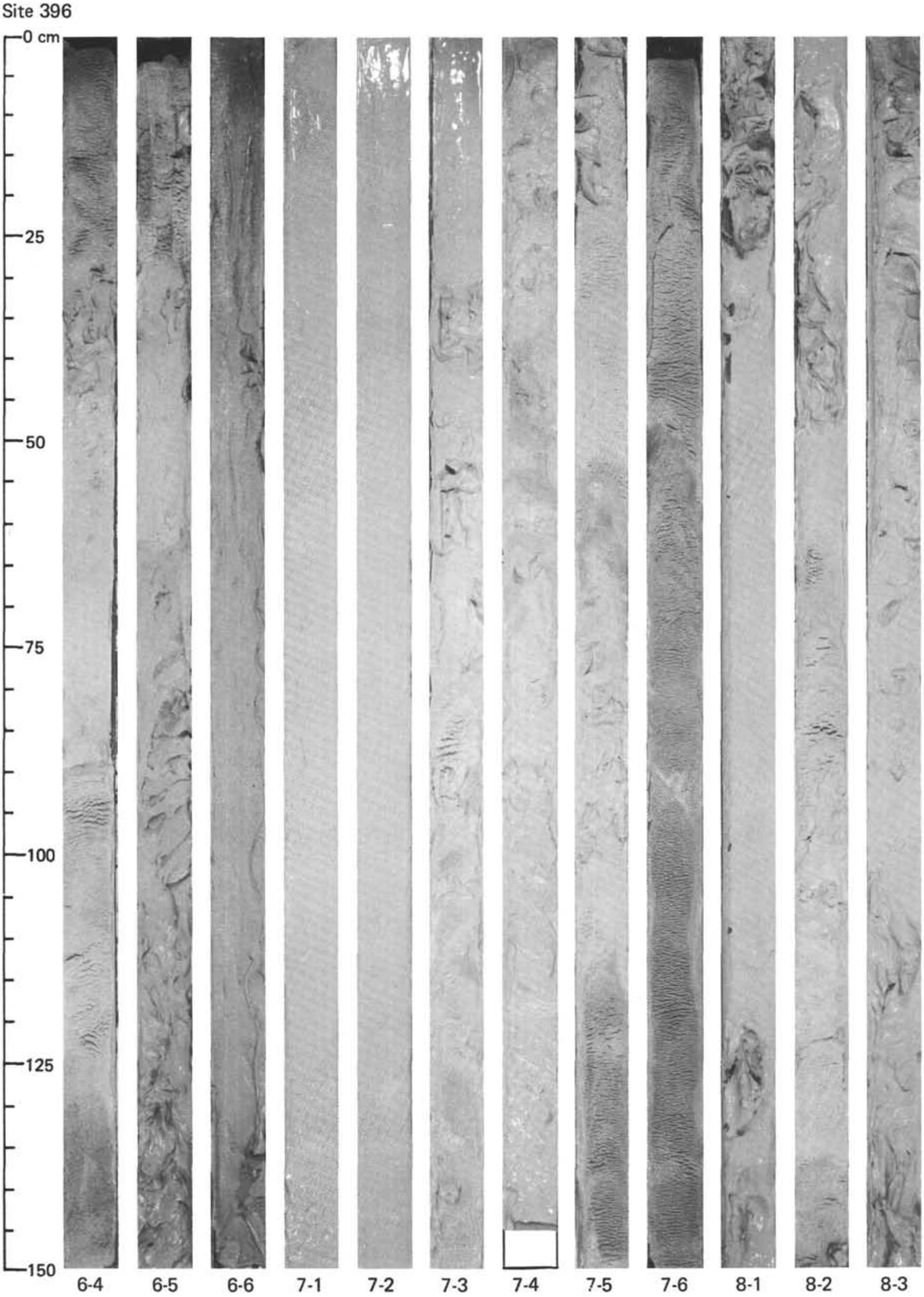
2-3
2-4
2-5
2-6
3-1

Site 396




Site 396
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125
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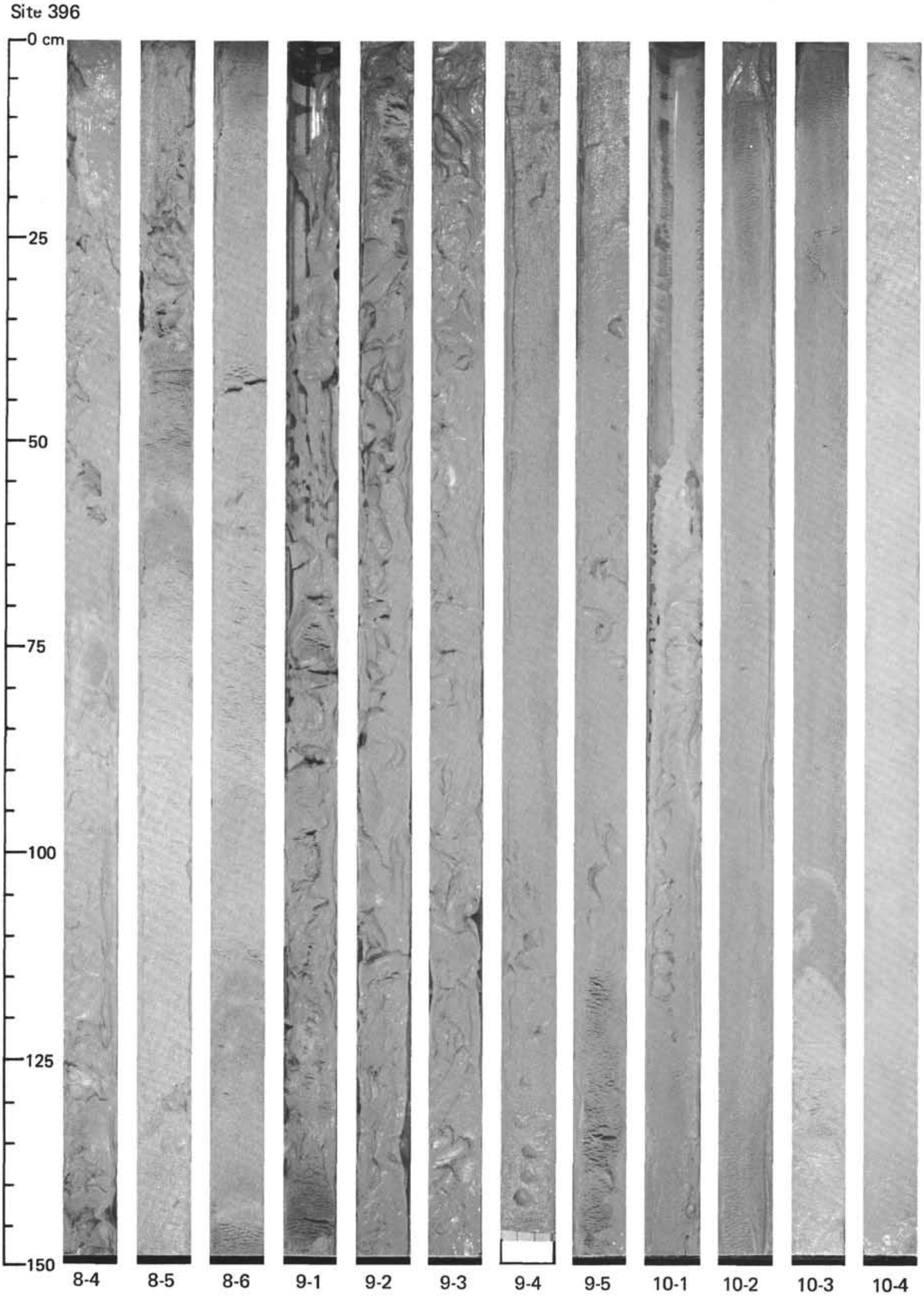
7-6
8-1
8-2
8-3


Site 396
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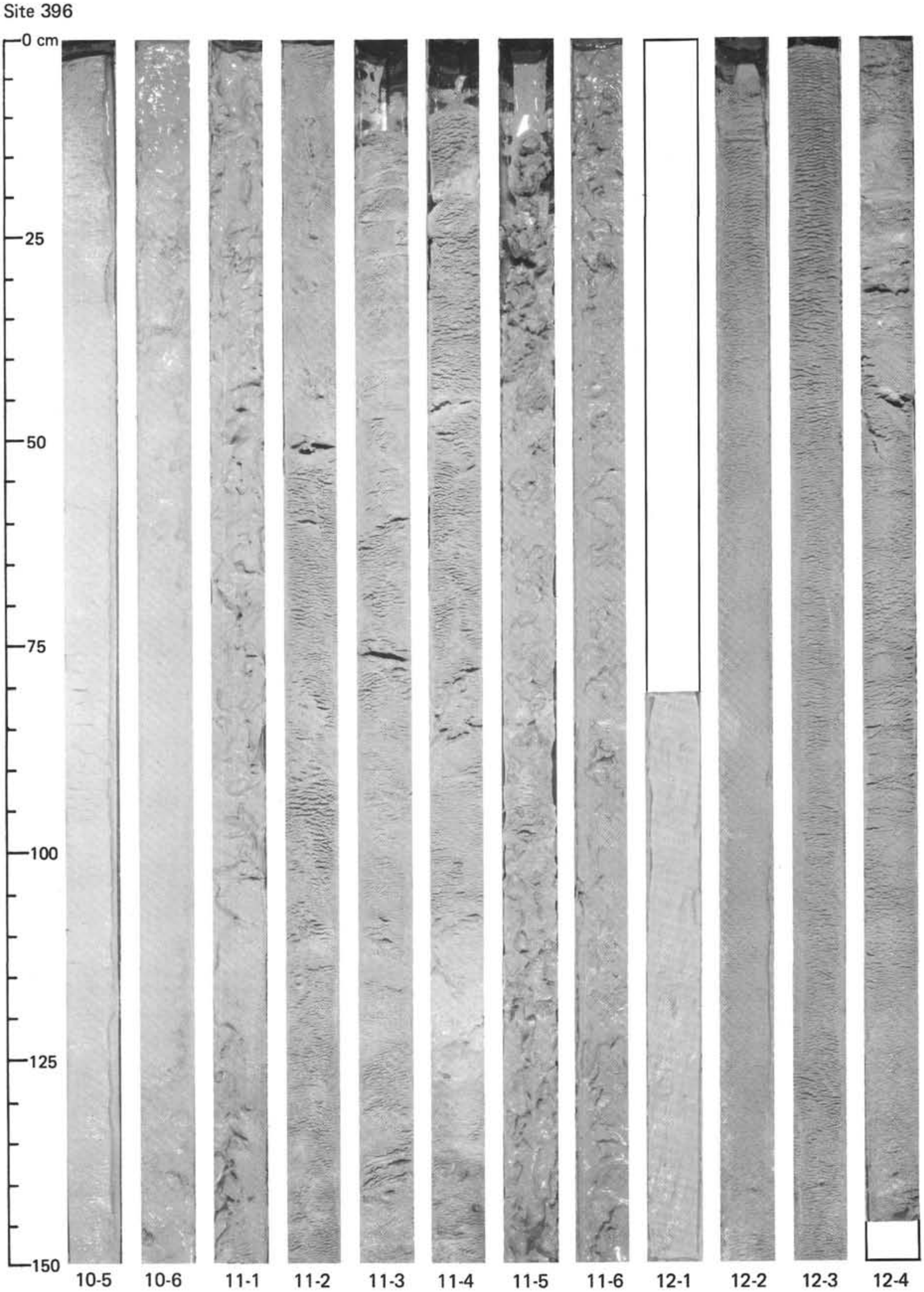
10-4


Site 396
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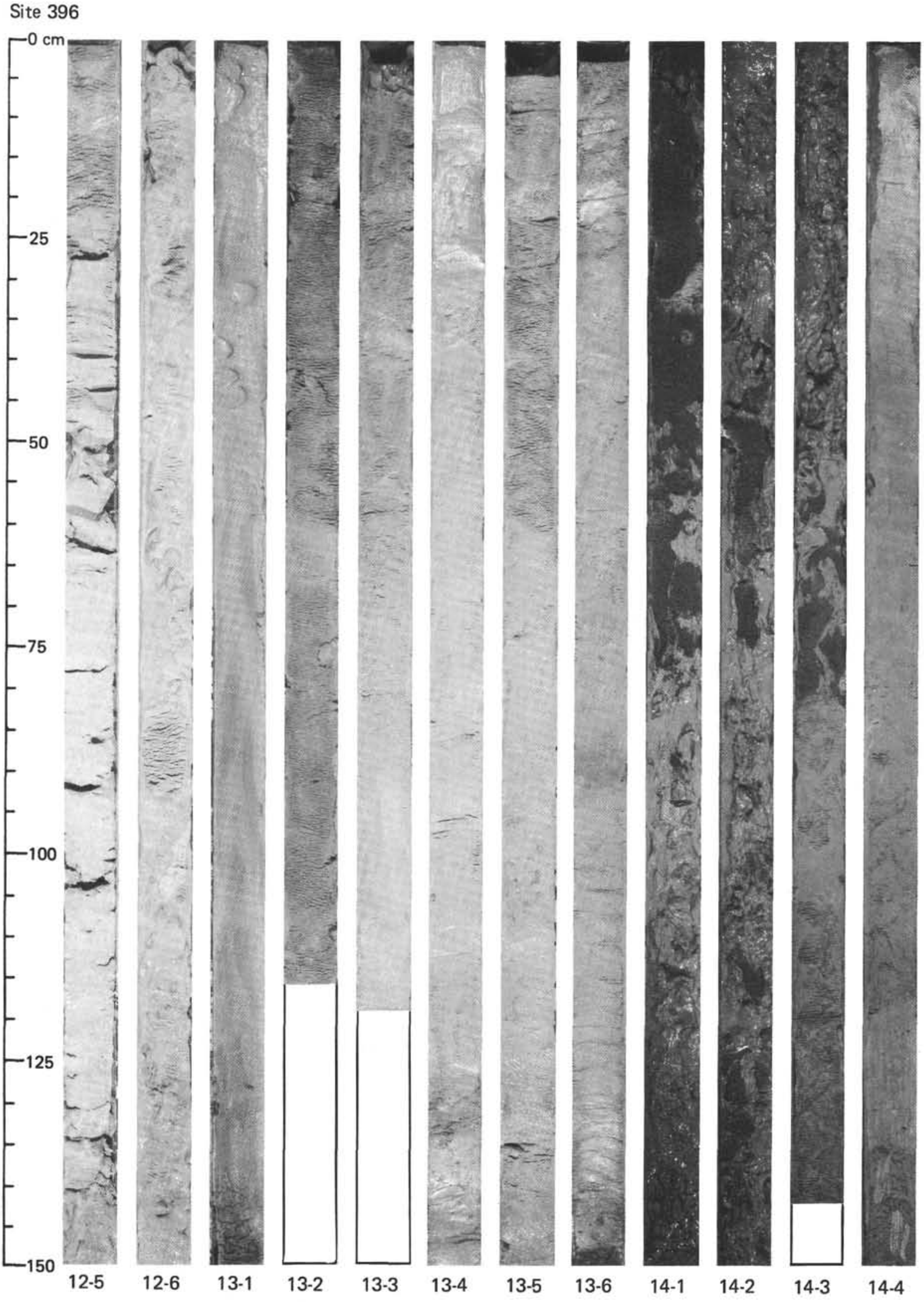
12-4


Site 396
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12-5
12-6
13-1
13-2
13-3
13-4
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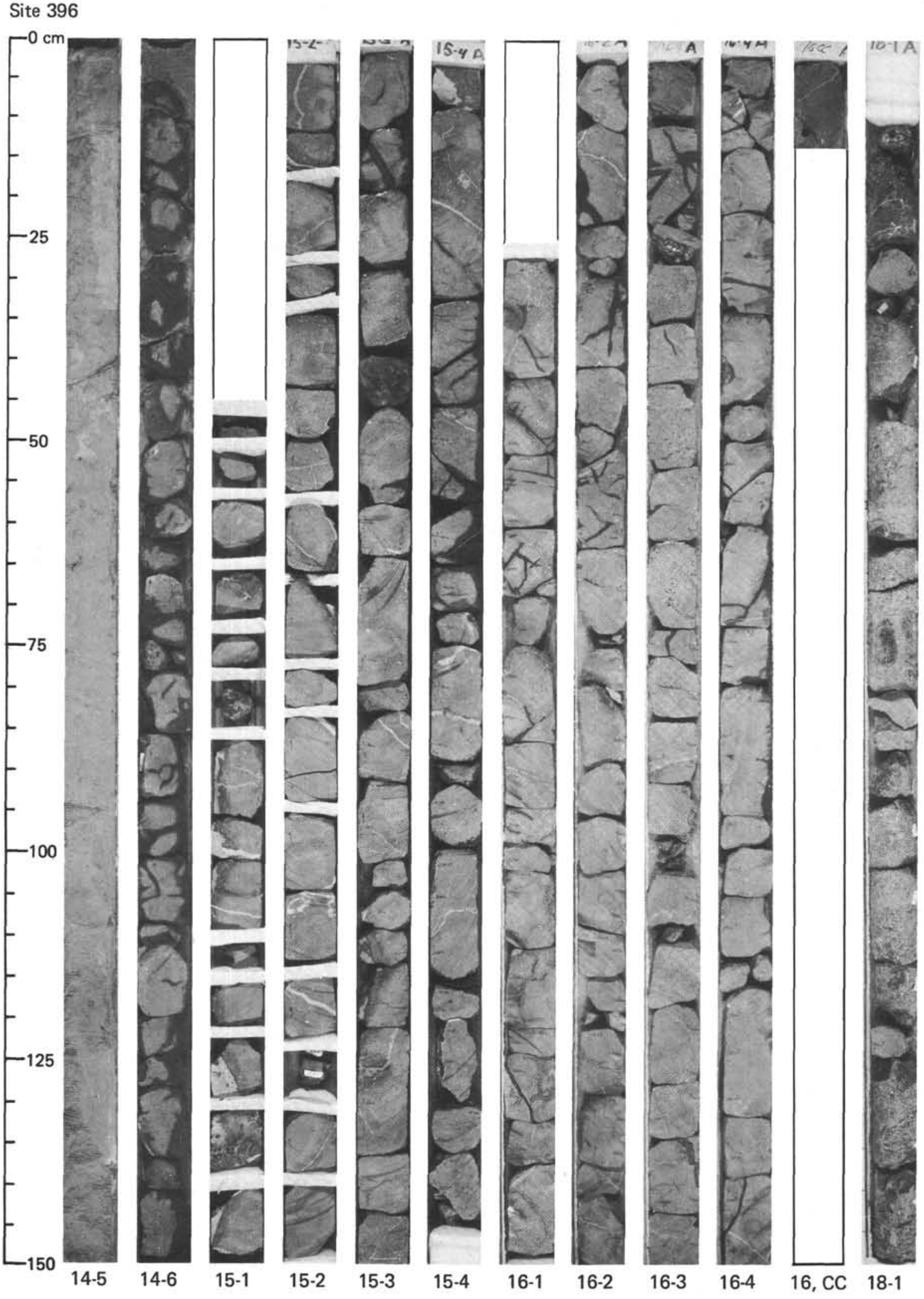
14-2
14-3
14-4


Site 396
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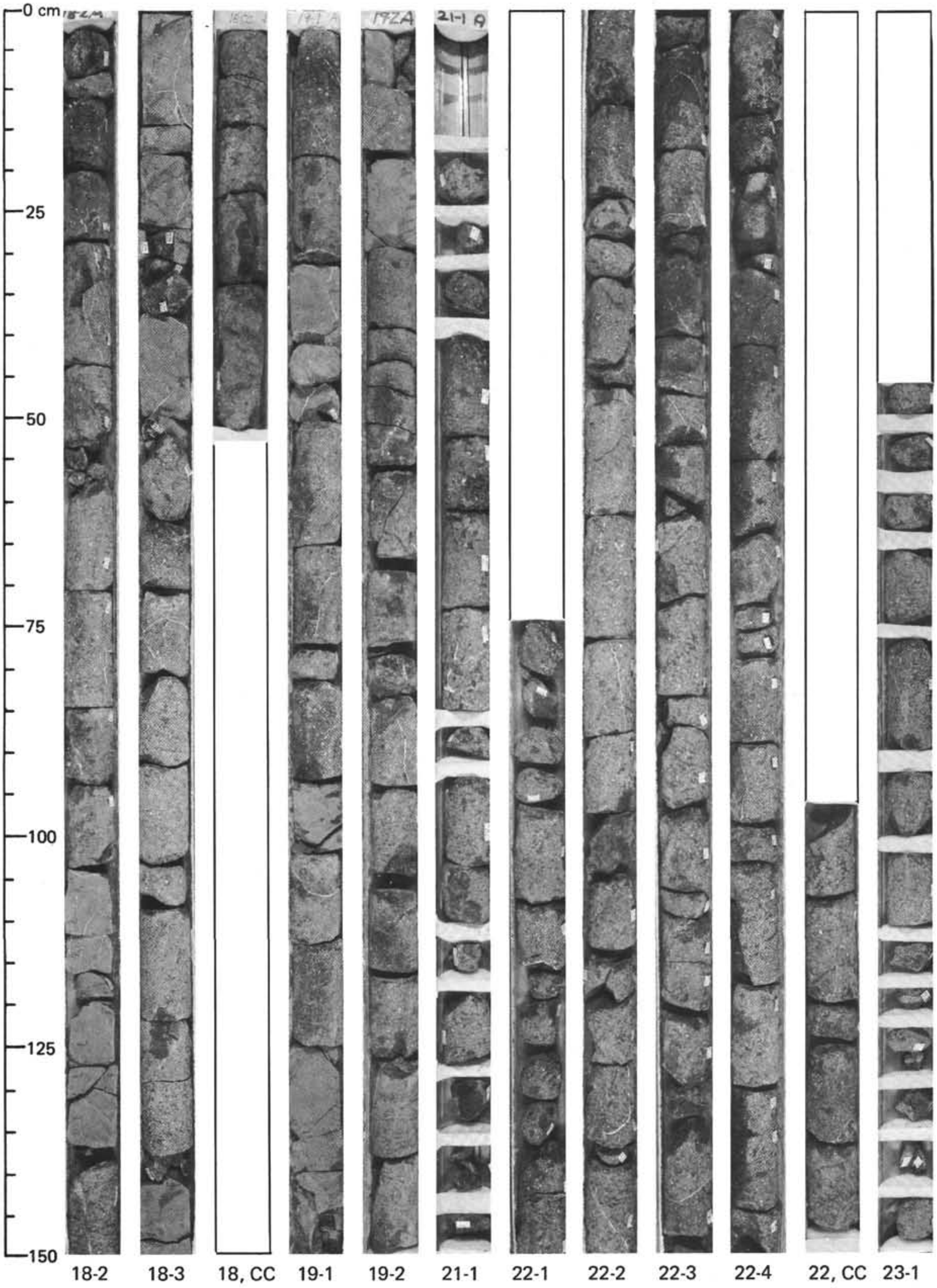
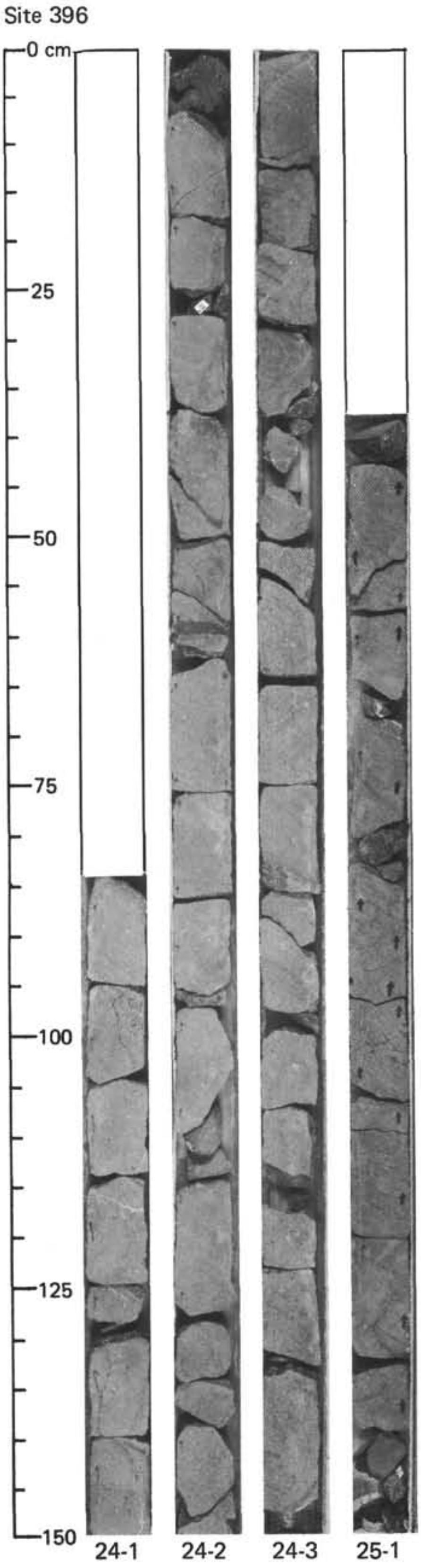
14-5
14-6
15-1
15-2
15-3
15-4
16-1
16-2
16-3
16-4
16, CC
18-1

Site 396


0 cm
25
50
75
100
125
150
18-2
18-3
18, CC
19-1
19-2
21-1
22-1
22-2
22-3
22-4
22, CC
23-1


Site 396
0 cm
25
50
75
100
125
150
24-1
24-2
24-3
25-1